بسم الله الرحمن الرحيم

Ministry of Environment and Energy
މިނިސްޓްރީ އޮފް އެންވަޔަރަންމަންޓް އެންޑް އެނަރޖީ

Environmental Protection Agency
އެންވަޔަރަންމަންޓަލް ޕްރޮޓެކްޝަން އޭޖެންސީ

[illegible]

އާންމު މަޢުލޫމާތު

ޕްރޮޖެކްޓުގެ ނަން: Environmental Impact Assessment for proposed development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at Thunburi, Laamu Atoll

ޕްރޮޖެކްޓް ތައްޔާރުކުރި ކޮންސަލްޓެންޓުންގެ ނަން: Mahfooz Abdul Wahhab — މޯބައިލް ނަންބަރު: 9994467

ކޮންސަލްޓެންޓުން ރަޖިސްޓްރޭޝަން ނަންބަރު: EIA P22/2016 — ހުއްދަ ހަމަވާ ތާރީޚް: 27/12/2026

އިދާރާ: The Hawks Pvt Ltd — މޯބައިލް ނަންބަރު: 918 7000

މުރާޖަޢާކުރަން ބޭނުންވާ އެއް ދަރަޖަ: ދަރަޖަ 1 (5000ރ) ☑ ދަރަޖަ 2 (10000ރ) ☐ ދަރަޖަ 3 (20000ރ) ☐

ރިޕޯޓުގައި ހިމެނޭ މަޢުލޫމާތު

		ކޮންސަލްޓެންޓް ފުރިހަމަ ކުރުމަށް	އިދާރީ ބޭނުމަށް
1	ހުށަހަޅާ ކޮޕީތަކުގެ އަދަދު	1	☐
2	އިލެކްޓްރޯނިކް ކޮޕީގެ ފޯމެޓް	PDF	☐
3	ޓަރމްސް އޮފް ރިފަރެންސް މަންޒޫރު ކުރި ތާރީޚް	10/23	☐
4	ސާރާ ޚުލާޞާ ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	xxiii	☐
5	ޓަރމްސް އޮފް ރިފަރެންސް ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	339	☐
6	އިދާރާތަކުން ގެ ބައްދަލުވު ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	33	☐
7	މަޝްވަރާގެ ބައްދަލުވު ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	113	☐
8	ތަން އަންގާ ކަރުދާސް ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	341	☐
9	ތަނުގެ ކަރުދާސް (އިންފްރާސްޓްރަކްޗަރ)ގެ ސަފުހާ ނަންބަރު	341	☐
10	ޑްރެޖިން އަރި އިންސްޕެކްޝަން ހިމެނިފައިވާ ސަފުހާ ނަންބަރު:	116	☐
11	ރިޕޯޓުގައި ބޭނުންކުރި މަސްދަރުތަކުގެ ސަފުހާ ނަންބަރު	35	☐
12	ރިޕޯޓުގައި ކަމާބެހޭ ފަރާތްތަކާއި ކުރި މަޝްވަރާ ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	247	☐
13	ތިމާވެށްޓަށް އަސަރު ފޯރާނެ މިންވަރު ބަޔާންކޮށްފައިވާ ސަފުހާ ނަންބަރު	258	☐
14	ބަދަލުގައި ކުރެވިދާނެ ކަންތައްތައް އެކަށައަޅާ ބަލާފައިވާ ބައި ހިމެނިފައިވާ ސަފުހާ ނަންބަރު:	288	☐
15	ތިމާވެށްޓަށް ލިބޭ ގެއްލުމުގެ އަސަރުތައް ކުޑަކުރުމަށް އަޅާނެ ފިޔަވަޅުތައް ބަޔާންކޮށްފައިވާ ސަފުހާ ނަންބަރު:	301	☐
16	ތިމާވެށި މޮނިޓަރކުރުމާއި ބެހޭ ބައި ހިމެނިފައިވާ ސަފުހާ ނަންބަރު:	321	☐
17	މި ރިޕޯޓު ތައްޔާރުކުރި ކޮންސަލްޓެންޓުންގެ އިތުރުން ރިޕޯޓު ހެދުމުގައި ބައިވެރިވި މީހުންގެ ވަކިވަކި ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	-	☐
18	އަމަލު ކުރާނެ ރިޕޯޓު ހުށަހަޅާ ކަމުގެ ލިޔު ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	349	☐
19	އިދާރާގެ ކޮމިޓްމަންޓް ސީޓު ހިމެނިފައިވާ ސަފުހާ ނަންބަރު:	xxii	☐
20	ކޮންސަލްޓެންޓް ޑިކްލަރޭޝަނުގައި ސޮއި ކޮށްފައިވާ ސަފުހާ ނަންބަރު:	xxi	☐
21	އިދާރާގެ ޑިކްލަރޭޝަނުގައި ސޮއި ކޮށްފައިވާ ސަފުހާ ނަންބަރު:	xxii	☐
22	މަޝްވަރާގެ ބައިވެރިންގެ ލިސްޓް ހިމެނިފައިވާ ސަފުހާ ނަންބަރު	340	☐

މި ފޯމުގައި ދީފައިވާ އީ.އައި.އޭ ރިޕޯޓު އެޕްރޫވަލްއަށް ހުށަހަޅަމެވެ.

އިދާރާގެ ނަން: The Hawks Pvt Ltd — ތާރީޚް: 28th May 2023 — ސޮއި:

The Hawks Private Limited
Republic of Maldives
C-109/2007

އިދާރީ ބޭނުމަށް

ރިޕޯޓު ރިސީވްކުރި ނަންބަރު .... ތާރީޚް ....

ރިޕޯޓު ފުރިހަމަ ކަމަށް ކޮށްފައިވޭ ☐

ނަން .... ސޮއި ....

ރިޕޯޓު ފުރިހަމަ ކަމަށް ... ☐

ނަން .... ސޮއި ....

ހެއްދަވައިދިނީ / ފާސްކުރި

ނަން .... ސޮއި ....

June 2023

ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED DEVELOPMENT OF HARBOR, ACCESS CHANNEL, POWERHOUSE, WASTE MANAGEMENT CENTER, WATER AND SEWER FACILITIES AT THUNBURI, LAAMU ATOLL

ECO-TECH CONSULTANCY

Proponent;

The Hawk's Pvt Ltd

Consultants;

Mahfooz Abdul Wahhab

Ibrahim Rashihu Adam

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III. LIST OF FIGURES

IV. CONSULTANTS DECLARATION

We hereby declare that the statements made in this EIA report are true, complete and correct to the best of our knowledge and available information at the time of writing the report.

Name: Mahfooz Abdul Wahhab (Lead Consultant)

Date: 26th May 2023

Sign:

Name: Ibrahim Rashihu Adam (Co-Consultant)

Date: 26th May 2023

Sign:

V. LETTER OF COMMITMENT AND DECLARATION OF PROPONENT

بسم الله الرحمن الرحيم

THE HAWKS PRIVATE LIMITED
REG: (C-109/2007)
H. Zoneyria, 7th Floor, Boduthakurufaanu Magu,
Male', Republic of Maldives, 20057

The Hawks Pvt Ltd
Think smart - Supply fast

Reference no: TH-GM001-2023

Mr. Ibrahim Naeem
Director General
Environment Protection Agency
Male'
Maldives

28 May 2023

Dear Mr. Naeem,

Re: Environmental Impact Assessment for proposed development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at Thunburi, Laamu Atoll

As per the requirements of the EIA regulation, we hereby confirm our commitment to implement the mitigation and monitoring measures according to what is proposed in the EIA report attached herewith.

Your sincerely

Hassan Rifau
Chief Executive Officer

C-109/2007

بسم الله الرحمن الرحيم

THE HAWKS PRIVATE LIMITED
REG: (C-109/2007)
H. Zoneyria, 7th Floor, Boduthakurufaanu Magu,
Male', Republic of Maldives, 20057

Think smart - Supply fast

28 May 2023

Declaration of the proponent

As the representative of the proponent of the proposed development I guarantee that I have read the report thoroughly and that to the best of my knowledge all information provided here is accurate and complete. In addition, I confirm our commitment to making sure that the contractor implements all mitigation measures proposed in the present report and adhere to the monitoring schedule given.

The Hawks Private Limited
C-109/2007

Signature:
Name: Hassan Rifau
Designation: Chief Executive Officer

VI. ސާދާ ހުލާސާ

މި ރިޕޯޓަކީ ލ.ތުނބުރި އެގްރިކަލްޗަރަލް ރަށެއްގެ ގޮތުގައި ތަރައްޤީކުރުމަށް ބޭނުންވާ ވަސީލަތްތައް ކަމުގައިވާ، އިންޖީނުގެއާއި، ފެން އުފައްދާ އަދި ސަޕްލައިކުރާ ނިޒާމާއި، ނަރުދަމާ ނިޒާމާއި، ނަޖިހާއި ނަޖިސްފެން ސާފުކުރާ ނިޒާމާއި، ކުނި މެނޭޖުކުރާ ނިޒާމު ގާއިމުކޮށް ހިންގުމުން ވެއްޓަށް ކުރާނެ ނޭދެވޭ އަސަރު ދެނެގަނެ، އެ އަސަރުތައް ކުޑަކުރާނެ ގޮތްތައް ދެނެގަތުމާއި އަދި އެ ރަށުގައި ބަނދަރު ތަރައްޤީކުރުމުން ވެއްޓަށް ކުރާނެ ނޭދެވޭ އަސަރު ދެނެގަނެ، އެ އަސަރުތައް ކުޑަކުރާނެ ގޮތްތައް ދެނެގަތުމަށްޓަކައި އެކުލަވާލެވިފައިވާ ރިޕޯޓެކެވެ. މި ރިޕޯޓުގެ މައިގަނޑު ބައިތަކުގެ ތެރޭގައި ހިމެނިފައިވަނީ ރިޕޯޓުގެ ތައާރަފު، މަޝްރޫޢާ ގުޅުންހުރި ސިޔާސަތުތަކާއި، ގާނޫނު، ގަވާއިދު އަދި އުސޫލުތައް، މަޝްރޫޢުގައި ހިމެނިފައިވާ ބައިތަކާއި މަޝްރޫޢު ކުރިއަށް ގެންދާނެ ގޮތުގެ ތަފްސީލު، މަޝްރޫޢު ކުރިއަށް ގެންދާ ސަރަހައްދުގެ ތިމާވެށީގެ ހާލަތު ދެނެގަތުމަށް ބޭނުންކޮށްފައިވާ މެތެޑޮލޮޖީތައް އަދި އެ ސަރަހައްދުގެ ތިމާވެށީގެ ހާލަތު، މަޝްރޫޢާ ގުޅުންހުރި އެންމެހާ ފަރާތްތަކުން މަޝްވަރާކުރުމުން ދެކޭގޮތް ތަފްސީލު، މަޝްރޫޢުގެ ބައިތަކަށް ގެނެވިދާނެ ބަދަލުތަކާއި، މަޝްރޫޢުގެ ސަބަބުން ވެއްޓަށް ކުރާނެ ނޭދެވޭ އަސަރުތަކާއި، މި އަސަރުތަކަށް ކުޑަކުރުމަށް އަޅަންވާނެ ފިޔަވަޅުތަކާއި، މަޝްރޫޢު ކުރިއަށް ގެންދާއިރު ވެއްޓަށް އަންނަމުންދާ ބަދަލުތައް ދެނެގަންނާނެ ގޮތުގެ ޕްލޭން އަދި ނިންމުމެވެ.

ލ.ތުނބުރިއަކީ އެގްރިކަލްޗަރުގެ މަސައްކަތްތަކަށް ކުއްޔަށް ދޫކޮށްފައިވާ ރަށެކެވެ. އަދި އެރަށުގައި، އެދެވޭ ފެންވަރެއްގައި މި މަސައްކަތްތަކަށް ފުޅާކުރުމަށްޓަކައި އަސާސީ ޚިދުމަތްތައް ގާއިމުކުރަން ބޭނުންވެއެވެ. މިގޮތުން، ފަސޭހައިން ރަށުން އަރައި ފޭބުމަށްޓަކައި ބަނދަރު ގާއިމުކުރުމާއި، އަސާސީ ޚިދުމަތްތައް ކަރަންޓު، ފެނާއި ނަރުދަމާ އަދި ކުނި މެނޭޖުކުރުމަށް އިންތިޒާމު ހަމަޖެއްސުމަށް އެކަށީގެންވާ ވަސީލަތްތައް ގާއިމުކުރަން ބޭނުންވެއެވެ.

މަޝްރޫޢު ކުރިއަށްގެންދާ ސަރަހައްދު ތިމާވެށި ދެނެގަތުމުގެ ގޮތުން ވަނީ އެސަރަހައްދުގެ ބޭސްލައިން، ދިރުންތަކާއި، ވައިގެ ކޮލިޓީ، އަޑު، އިޖުތިމާއީ އަދި އިގްތިސާދީ ހާލަތު، ފެންފަށުގެ ހާލަތު އަދި ހާދިސާ ނުވަތަ ކާރިސާ ތަކަށް ރައްކާތެރިވެފައިވާ މިންވަރު ބަލާބެލުމެވެ. މަޝްރޫޢުގެ ސަބަބުން ވެއްޓަށް ކުރާނެ މައިގަނޑު އަސަރުތަކަކީ ކަމަށް ފާހަގަކުރެވިފައިވަނީ،

ކަނޑުގެ ދިރުންތަކަށް ކޮންމެވެސް ނޫނީ އަސަރެއް، އަޑުގަދަވުމާއި ވައި ނުސާފުވުމާއި، ނުރައްކާތެރި ހާދިސާތައް ހިންގުމުގެ ސަރަހައްދަށް ބޮޑު އަދި ކުރު މުއްދަތުގެ ސަރަހައްދުން ދިމާވާން ނޫނީ އަސަރު ކުރެއެވެ.

މި އަސަރުތަކަށް ކުޑަކުރުމަށް އަޅާނެ މައިގަނޑު ފިޔަވަޅުތަކަކީ، ކޮންޑުގެ ސަރަހައްދުން އަޑާ ހިފެހެއްޓޭ ކޮންސްޓްރަކްޝަން ކުރުމުގެ ފިޔަވަޅުތައް އަޅުއްވާ، ވެހިކަލްތައް ރަނގަޅަށް މެއިންޓެއިން ކުރުމާއި، ބޭނުންކުރެވޭގައި ބަދު ވެހިކަލްތައް ބޭނުންނުކުރުމާއި، ހިރަފުސް އުދުން މަދުވާން ގޮތްތަކަށް މަސައްކަތްކުރުމަށް ދުވާލު ގަޑިތަކަށް ހާއްސަކުރުމާއި، ބޮޑު އަދި ކުޑަ ރަށެއް އަޑު ބޭނުންކުރުމުގައި ހުނަރު އުސޫލުތަކަށް ސަމާލުކަން ދިނުމާއި، ހާދިސާއާއި ހިނގައިދާނަމަ އެކަން ހައްލުކުރުމަށް ޖީފްއާ ތައްޔާރު ބޭއްލުމާއި، މަސައްކަތުކުރުމަށް ބޭނުންކުރާ ވަސީލަތްތައް ބޭނުންކުރުމާއި، މަސައްކަތު ހިންގާ ސަރަހައްދުގެ ތަކެތި ފަހަރުގާ ބެލެހެއްޓުން ދޭހަވާން ގޮތަށް ކުރުމާއި، ސަލާމަތުގެ ބާރު ހިފައި ދުނިޔޭގެ އެއްވެސް ހިސާބަކުން އަންގައިދޭ ފިޔަވަޅުތައް ނެގުމުން ތަޢާރަފްކުރެވޭނެ.

މަސައްކަތު ގެންދިޔުން ބެލެހެއްޓުމުގެ ގޮތުގައި ބަލަހައްޓާފައިވާ ކުންފުނި ބަލަހައްޓާގައި ބޭނުމެއްވާ ދެމެދު ގުޅުމާއި ބެލެހެއްޓުންތެރިކަން، ރިޕޯޓްސް މިނިސްޓްރީއަށް ހުށަހަޅައިގެން ބޭނުންވާ ފީގެ ބާރަށް ބޭރުކުރާ މަޢުލޫމާތުގައި، ބެލެހެއްޓުމުގެ ޕްރިންސިޕަލް ބަލަހައްޓާ ކުރުމާއި، ސަރަހައްދު ސަރަހައްދުގެ ބެހެއްޓުމާއި، ސަރަހައްދު ހިމާޔަތް ކުރުމާއި ބެހެއްޓުމުގެ ނިސްބަތުން މަސައްކަތްތަކުގެ ހިންގާގޮތް ހޯދާނެ. އަދި މި ޕްރޮޖެކްޓްގެ ދައުރުން މަސައްކަތުގެ މަސައްކަތްތަކުގެ ކުރިއަށްދާ ވަރު ބަލާއިރު ހިތި ވެއްޓެން އަނގަތުމުގެ ބެލެހެއްޓުން ދުނިޔެއިގެ ބަދަލުތަކުގެ އަސަރުތަކަށް ޕްރޮޖެކްޓްގައި ކޮންސަ ސަރަހައްދުގެ މާލީ ކުރިއެރުވާ މިންވަރު ބެހެއްޓުމާއި، ފެންތަރައް ޓަންކީގެ ކުރުމާއި، ކަނި އެއްބާ މިންވަރު ދުނިޔޭގެ ބާއްވައި ޓެސްޓް އަދި އެއަށް ޓެކްނިކަލް ބެލުމާއި ހާރިސާތަކަށް ހިމާޔާ މިންވަރު ބެލެހެއްޓުން ހިފާނެއެވެ.

މި ޕްރޮޖެކްޓުގައި ބައްޓަންކޮށްފައިވާ ގޮތުން ކުޑަކުރުމަށް އަޅަންޖެހޭ ފިޔަވަޅުތަކާއި އެއްގޮތަށް މަސައްކަތް މަސައްކަތުގެ ކުރިއަށް ގެންގޮސްދިނަމަ، މަސައްކަތުގެ ސަރަހައްދުން ލިބޭނެ ގެއްލުމަކީ ވަރަށް ކުޑަ ގެއްލުމެއް ކަމަށް ފެނިގެންދާ، މަސައްކަތުގެ މަސައްކަތް ކުރިއަށް ގެންދިއުން އެކަށީގެން ކުރިއަށްގެންދަނިވެ.

VII. EXECUTIVE SUMMARY

The purpose of this EIA is to critically analyze and assess the potential environmental impacts associated with the proposed project to establish utility service (power, water, Sewerage, waste management) with island accessibility (harbor and access channel) at L. Thunbir and propose the solutions and preferred alternatives as well as mitigation measures to minimize any negative impacts whilst trying to derive the maximum positive impacts from the project.

The proposed agriculture development project is located in the island of Thun'buri in Hadhunmathi atoll (Laamu) at 2°04'28.47" N and 73°32'24.41" E. The nearest airport is L. Kahdhoo Airport approximately 22 km south of Thunburi. The closest islands to the project location are; inhabited island of L. Dhanbidhoo approximately 697 m north of Thun'buri. Next, Isdhoo and Kalhaidhoo which is approximately 3.34 km north of L. Thun'buri. The closest uninhabited islands to the project location are Hulhiyandhoo which is approximately 14 m north of L. Thun'buri and Dhonberahaa which is approximately 343 m southwest of L. Thun'buri. Holhurahaa which is approximately 300 m south of L. Thun'buri. There are no environmentally protection or sensitive areas within 5km of the project island.

The Government of Maldives has initiated many policies, programmes and projects to ensure the food security of the country. This includes establishment of Agro-National Corporation (AgroNat) which develops the capacity of the local farmers by ensuring their produce will have a reliable market demand. The proposed agriculture development project in L.Thunburri is expected to contribute to the policies of food security by the Government of Maldives. This project is phase 1 of the project which aims to achieve the establishment of the accessibility and the utility services required for the operations of the project.

Interconnection between islands within the atoll and other atolls are mainly dependent on sea transportation. The jetty/harbor component is vital while developing an island for any purpose and this proposal focuses on the development of Thunburi island for agriculture. During the development and operational stages, the harbor will act as the pivoting point of all the operations carried out on the island.

The 150 TPD RO plant will be used to produce sufficient water to meet the peak demand when any other water source is not available. As the water requirement of the farm will be met with combination of desalinized water and harvested rainwater, no ground water will be pumped.

7 generators in the powerhouse would provide the energy necessary to function without causing any setbacks. The development of the RO plant and powerhouse would provide the island the necessary means to implement the rest of the project swiftly and effectively during phase 2. Furthermore, with the solar panels being installed along with the powerhouse would provide the island with clean energy reducing the load on the diesel generators and release of GHGs with air pollutants.

The major regulatory requirements for the project involve obtaining the EIA decision statement to go ahead with the project as per the EIA regulation, following with the legislations pertaining to electricity provision, waste management, water and sewerage services and dredging.

In order to assess the existing environment of the project site, various aspects were studied under the EIA. Some of them are structural environment, terrestrial megafauna, air quality, noise, socioeconomic environment, water quality and hazard vulnerability.

The major impacts highlighted for the construction phase of the project is the impact on marine environment, damages to the benthos, sedimentation, impacts due to noise, impacts on soil /ground and risk of accidents on workers. The major impacts during operational phase are on air quality, marine environment, hydrodynamics, and the beneficial socioeconomic impacts

Major mitigation measures proposed in the construction phase is to ensure the sedimentation impacts are mitigated appropriately. Further mitigation measures include that the vehicles are maintained properly, avoiding unnecessary use of vehicles, taking dust suppression actions such as spraying water on ground, restriction of work hours to during day time, following oil and chemical handing procedures and having emergency spill clean-up crew at site. And during operational phase it is proposed to ensure that the generators at the powerhouse are well maintained, ensure optimal operations at the waste management center at all times, raising chimney above the canopy of the island, ensure leak detection systems are working and ensure leak repairs are done timely to avoid further incidents, ensure timely outfall inspections and attend to repairs timely if need be and monitoring the water quality of the supplied water to ensure safety of the supplied water.

Main alternatives that were studied were the no-project option, alternative to jetty design, alternative intake method for the desalination plan, alternative material for storage tanks, alternative sewer treatment technology and alternative location for outfalls. The environmental monitoring formulated in the EIA includes to monitor marine environment, groundwater, turbidity, waste generation, incident occurrence and noise generation during construction phase and air quality, groundwater, waste, shoreline, marine environment, supply water quality and incident occurrence during operational phase of the project.

The socioeconomic benefits during the operations outweigh the negative impacts of the construction phase of the proposed project. Hence, with the mitigation measures (and preferred alternatives) outlined in the report, it is recommended to proceed with the project as planned.

1. INTRODUCTION

1.1 Structure of the EIA

This Environmental Impact Assessment (EIA) addresses the potential impacts of the proposed development on the physical, biological, environmental and socio-economic aspects of the development area in addition to providing safeguards to reduce any environmental effects.

In addition to forming a basis for the assessment and approval of the proposed project, this EIA provides the community and government authorities with information on all aspects of the proposal. The EIA has been divided into following sections;

- **Section I - III**: CONTENTS- Provides hyperlinks to various sections, figures and tables of the EIA report.
- **Section IV - V**: DECLARATIONS- Provides the Proponent and Consultant's declaration for the EIA report.
- **Section VI - VII**: EXECUTIVE SUMMARY- Provide a brief non-technical summary of key finding of the EIA report.
- **Section 1**: INTRODUCTION- Provides an outline of the structure and purpose of the EIA as well as objectives of the proposed development.
- **Section 2**: METHODOLOGY- Describes the detailed methods used for data collection on the existing environment and baseline conditions.
- **Section 3**: STATUTORY REQUIREMENTS- Outlines the relevant legislative requirements pertaining to the proposed project.
- **Section 4**: PROJECT DESCRIPTION- Describes the proposed development in detail.
- **Section 5**: EXISITING ENVIRONMENT- Describes the present conditions of the physical components of the study area and sets baseline conditions.
- **Section 6**: STAKEHOLDER CONSULTATION- Provides details on the consultation process and parties consulted for this study.

- **Section 7**: POTENTIAL IMPACT ANALYSIS- Describes the prevailing environmental characteristics and constraints of the site and locality being investigated and an assessment of the potential environmental impacts associated with the proposed development.
- **Section 8:** OPTIONS ASSESSMENT- Discusses all the available alternatives for the project and justifies the preferred option.
- **Section 9:** MITIGATION MEASURES- Outlines the mitigation measures that would be implemented to reduce any potentially adverse impacts.
- **Section 10**: ENVIRONMENTAL MONITORING- Outlines the environmental management monitoring parameters that would be used to monitor the changes.
- **Section 11**: JUSTIFICATION AND CONCLUSION- The conclusions drawn from the proposed project and impact analysis with the justification of the preferred options.
- **Section 12**: ACKNOWLEDGEMENTS- Highlights the parties which had contributed to the preparation of this EIA report.
- **Section 13**: APPENDICES- Supporting documents and information are provided as appendices to this EIA.

1.2 Project Objectives

The primary objective of the proposed project is to establish utility service (power, water, Sewerage, waste management) with island accessibility (harbor and access channel) at L.Thunburi.

1.3 Need for the Project

Agriculture is one of the most important sectors of the Maldivian economy. However, the agriculture sector requires significant development in the Maldives. The contributions of the agriculture sector and fishery sector to GDP have been declining (agriculture 1.3% and fishery 4.2% of GDP as of 2018). Due to this decline in agriculture, large quantities of fruits and vegetables are imported to the country. These include stable crops, vegetables and fruits which can be grown in the Maldives. Furthermore, significant quantities of poultry products are imported to the country.

The COVID19 pandemic has exposed the vulnerability of the country in terms of food security. The Government of Maldives has initiated many policies, programmes and projects to ensure the food security of the country. This includes establishment of Agro-National Corporation (AgroNat) which develops the capacity of the local farmers by ensuring their produce will have a reliable market demand. The proposed agriculture development project in L. Thun’buri is expected to contribute to the policies of food security by the Government of Maldives. This project is phase 1 of the project which aims to achieve the establishment of the jetty, RO plant and powerhouse.

Interconnection between islands within the atoll and other atolls are mainly dependent on sea transportation. The jetty/habour component is vital while developing an island for any purpose and this proposal focuses on the development of Thun'buri island for agriculture. During the development and operational stages, the jetty will act as the pivoting point of all the operations carried out on the island.

The 150 TPD RO plant will be used to produce sufficient water to meet the peak demand when any other water source is not available (rainwater harvested, treated wastewater). As the water requirement of the farm will be met with combination of desalinized water, harvested rainwater, no ground water will be pumped.

7 generators in the powerhouse would provide the energy necessary to function without causing any setbacks. The development of the RO plant and powerhouse would provide the island the necessary means to implement the rest of the project swiftly and effectively during phase 2. Furthermore, with the solar panels being installed along with the powerhouse would provide the island with clean energy reducing the load on the diesel generators and release of GHGs with air pollutants.

1.4 Summary of Impact Assessment Methodology

The scoping meeting for the proposed project was held at the EPA on 02nd March 2023. The project proponents, EIA consultants and all other relevant stakeholders attended this meeting. The scope of the meeting as discussed at the meeting were approved and the ToR issued on the 17th April 2023 (the approved ToR is attached in appendix section Appendix C).

Based on the approved ToR the proponent and the consultants have conducted a risk-based environmental review as part of the planning process. Data has been drawn from a wide range of sources, including existing similar project EIA reports, baseline data, consultations with stakeholders, existing legislations, professional judgement and expertise of the consultants. Impacts were identified based on the locations of the project components as well as type of service to be provided. The detailed impact assessment methodology is described under chapter 7.

1.5 List of similar project EIAs reviewed

As part of relevant literature review for impact prediction as mentioned in the above section the following project EIAs were reviewed;

- Environmental Impact Assessment for the proposed 300 TPD R0 Plant installation and Borehole construction at Lh. Kanuhura
- EIA for the upgrading of RO plant at Asseyri Prison, K. Himmafushi
- EIA for the Establishment of Water and Sewer system at A.Dh Dhigurah
- EIA for the Proposed shore protection, shoreline restoration, channel dredging and development of floating pontoon platform cages in the lagoon at N. Karinmaa Vattaru, Maldives
- EIA for Powerhouse relocation at Ha. Dhihdhoo
- EIA for the Establishment of Sewer system at ADh Dhangethi
- EIA for the proposed Quay Wall and Jetty at Ukulhas, Alif Alif Atoll
- EIA for Sheet Piling in Hawks Land, Thilafushi, Male’ Atoll
- EIA for Poultry Farm Development in M. Gaakureli
- Environmental Impact Assessment for the operation of standby generations in STELCO Hulhumale' old powerhouse facility and their grid connection
- Environmental Impact Assessment for the construction of a Waste Management Facility in K. Maafushi

1.6 Purpose of this EIA

The purpose of this EIA is to critically analyze the environmental and socio-economic impacts which may arise due to the construction and operation of the proposed project. After analyzing the impacts, it would be then possible to suggest proper mitigation measures to prevent/reduce any negative impacts and to enhance any positive impacts. The study involves evaluation of baseline conditions, prediction of the likely impacts, stakeholder consultation and design mitigation measures.

1.7 The EIA Process

The EIA process in the Maldives is coordinated by the Environmental Protection Agency (EPA) of the Maldives in order to ensure that environmental considerations are included in decisions regarding projects which may have an adverse impact on the environment.

The first step in the process involves screening (for the projects that may have significant impacts on the environment which are listed as projects requiring an EIA under appendix D of the EIA regulation 2012, an EIA application shall be provided to EPA and upon review EPA will call for the scoping meeting) of the project to determine whether a particular project warrants preparation of an EIA. Based on this decision, the EPA then decides the scope of the EIA which is conferred to the project proponents, the consultants as well as any relevant stakeholders to the project at a scoping meeting. A document ideally encompassing the issues and impacts that have been identified during the scoping meeting will then be issued known as the Terms of Reference (ToR). The consultant then prepares the EIA in accordance with the ToR and/or the range of issues identified during the scoping process. Once the findings of the EIA has been reported to the EPA, it gets reviewed following which an EIA Decision Statement (DS) is issued to the proponent who is responsible for implementing the project according to the DS and undertake appropriate environmental monitoring if required and report to the EPA.

Note; due to the covid19 situation scoping meeting are held online.

1.8 The Consultant

The EIA was prepared by Eco-Tech Consultancy, which is an environmental and information technology consultancy firm registered in the Maldives on 2021. The company specializes in providing environmental solutions to clients. However, the company's services are not just limited to Environmental Impact Assessment, Environmental Monitoring Reports and Environment Management Systems, with their partners they provide land surveying and IT solutions as well. Within the short period Eco-Tech Consultancy has completed a total of 30 assignments that includes Environmental Impact Assessment reports, Environmental Monitoring Reports and RO Plant registrations.

The following registered EIA Consultants of Eco-Tech Consultancy were involved in the preparation of this EIA report;

- Mahfooz Abdul Wahhab, Consultant registration no: P22/2016 (Lead Consultant)
- Ibrahim Rashihu Adam, Consultant registration no: P06/2017

1.9 The Proponent

The proponent of this project is The Hawks Pvt. Ltd. The Hawks Pvt Ltd is one of the leading companies for the import & distribution of high-quality fuel across the Maldives. With more than 10 years' experience in the area of fuel supply, and an exceptional attention to the needs of their clients, the Maldivian company has developed an extensive product portfolio ranging from diesel and petrol supply and related services to sea transportation and hotel operations. The Hawks Pvt Ltd, founded by chairman Mr. Ahmed Rasheed Hassan in 2007. The company values highest quality of all their products, delivery on time, and an exceptional customer service. The Hawks Pvt Ltd has a strategic vision to diversify their business portfolio and this project is undertaken under the said vision.

1.9.1 Contact details of Focal Point of the Proponent

Name:	Abdul Aleem Abdul Gafoor
Mobile No:	918 7000

E-mail: aleem@thehawks.biz

Website: https://thehawks.biz/

2. METHODOLOGY

This chapter describes the EIA report formulation method and the methods used to collect and analyze site-specific baseline data along with the potential limitations and uncertainty in data collection methods.

2.1 EIA report formulation

The three main guiding principles that was utilized in the formulation of this EIA report was the Environment Impact Assessment Regulation 2012, the approved Terms of Reference, and the EIA writing guideline 2012. Supporting principles were adopted from the UNEP EIA Training Resource Manual 2002 and AS/NZS ISO 3100:2009 Risk management principles and guidelines. Lastly project information was used in determining the locations for baseline studies.

The contents in the chapters of this EIA report were as per the appendix E of the EIA regulations 2012 and the approved ToR. The EIA layout and structure is as per the EIA writing guideline. The baseline data which was collected in accordance with the ToR and EPA data collection guidelines as much as possible. The detailed methodology employed for baseline data collection is described in the following section 2.2.

All the legislation pertaining to the proposed development was studied through the published legislations under the Maldivian governments gazette and relevant government bodies websites.

Stakeholder consultation were done via public hearing for the EIAs that require public consultations and through face-to-face meeting or online meetings or via email communications.

The potential impacts were identified and analysed as per the method described in chapter 7.

Alternative were analysed based on its technical viability, economic feasibility, legal compliance, environmental practicability and social acceptability.

Preferred mitigation measures were determined based on the most significant impacts, where the mitigation measures would mitigate the adverse impacts or amplify the positive impacts further.

Similarly monitoring parameters were also determined based on the most significant impacts that could have adverse impacts to the environment.

Conclusion was justified by comparing the project need and the envisaged environmental impacts associated with the project.

2.2 Site-specific baseline data collection methods

All site-specific data were collected on 26th, 27th and 28th April 2023. The climatic conditions at the sampling times were calm to light winds from North and SW at speeds between 0 to 6 Knots.

2.2.1 Water quality

2 Groundwater samples were taken. 1 groundwater sample was collected from an existing well while the other was attained from a dug well on the island during the survey. 5 marine water samples were collected (Refer to Table 3 and Figure 2 for sampling locations and respective GPS coordinates). Samples were collected in 500 mL Plastic bottles by first rinsing the bottle with the sampling water three times. Marine water samples were collected just below the surface. Samples for microbial testing was collected in two 100 mL sterilized Theobags. Before collecting the micobiral sample, each time alcohol was applied to the sampler's hand to minimize cross contamination. Marine water samples were collected on 28th April 2023 between 09:00 to 10:30 hours, and ground water sample collected on 28th April 2023 between 10:40 to 11:15 hours.

Samples were then sent to Maldives Water and Sewerage Company's (MWSC) water quality assurance laboratory in a chilled ice box for testing.

2.2.2 Noise

Noise level was measured using a sound meter. Sound was measured for 1 minute at the desired location and the maximum and minimum was recorded (Refer to Table 3 and Figure 2 for sampling locations and respective GPS coordinates).

2.2.3 Structural Environment

The structural environment of the proposed project site was visually inspected and qualitative notes were taken on the type, number and quality of existing infrastructure.

2.2.4 Air Quality

Air quality was measured using a hand-held temperature / humidity / PM2.5 / PM10 / HCHO / TVOC / CO / CO_2 / AQI Air Detector. To avoid any bias from the surveyor the meter was left at each site for at least one minute to acclimatise before taking the reading. Readings were recorded on 27th April 2023 between 09:00 to 10:30 (Refer to Table 3 and Figure 2 for sampling locations and respective GPS coordinates).

2.2.5 Socioeconomic Environment

The most recent socio-economic data was obtained from Maldives Population and Housing Census 2022 and 2014, which was used to describe the demography, main economic activities, amenities, community needs and historical sites.

2.2.6 Bathymetry

“For Bathymetric survey, a fiber glass boat with an out-board engine was used. the survey boat was hired by considering its shallow drought and the agility to access through difficult turns. Bathymetric system was setup on right side of the boat. 0.75m pole was attached to the hull of survey vessel where 0.3m was submerged with sounding transducer attached to the tip of submerged pole. On top of the pole GR5 GPS receiver was attached. Field controller connecting to GNSS receiver and eco sounder data streaming from both instruments at the same time.

The survey area requested was loaded to field controller. Where possible the survey path followed a grid of pre-determined transects set perpendicular to the general seabed contours with few adjacent lines in order to delineate the gradient changes. This method provided overlaps in data for validations. On completion of the transects, the data was checked on board to identify areas of low or missing coverage. These areas were resurveyed until coverage was complete. While maintaining a constant suitable speed all the measurements were logged to field controller continuously throughout the survey

Points were exported from the controller and loaded to AutoCAD Civil 3D software for data processing and drafting. As it is to be expected with sounding instruments anomalies in the data did occur during the survey becoming more numerous at turning point at the end of transects. These anomalies were easily identified when TIN surface was created on CIVIL 3D. Once the data has been cleaned and confirmed TIN surface was labelled and represented with color bands." (MapScape, 2023)

2.2.7 Shoreline

The detailed methodology used for the shoreline is not presented in the IEE for agricultural project in L. Thun'buri by Up Close Solutions Pvt Ltd. As the shoreline were done by a third party, we do not know the detailed method used and the IEE for agricultural project in L. Thun'buri by Up Close Solutions Pvt Ltd does not provide the detailed method. The given method in the report is quote, "The reef line, shoreline and vegetation line and existing infrastructure were mapped. Mapping was undertaken using standard DGPS and mapped on AutoCAD and ArcGIS." (UpCloseSolutions, n.d)

2.2.8 Terrestrial Megafauna

Any terrestrial species encountered during the survey was recorded to give an indication of the terrestrial fauna on the island. For birds even if the species was not visually found, hearing of calls were noted as the species being present.

2.2.9 Terrestrial Vegetation

A 30 m long transect was laid at the desired location and the trees touching or crossing the transect line above (higher branches) were counted. In order to give an indication of the maturity of the trees the estimated height of the trees was given in 4 storeys (ground, 0-2m, 2-4m, and >4m). The locations of vegetation transect are given in Figure 2 and respective GPS coordinates on Table 3.

2.2.10 Current measurement

A drogue constructed from plastic plates joined together by bolts to make four fins (Figure 1) to catch the currents, were used to measure currents. The drogue was deployed for a few minutes, the start and end location of the drogue was geo-referenced using a GPS. The distance travelled was later calculated and the speed of currents determined. Drogue runs were done at 4 different locations (the locations of current measurement are shown on Figure 2 and respective GPS coordinates on Table 3).

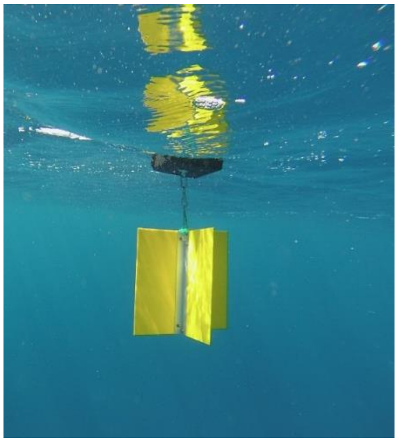


Figure 1: Drogue deployed at sea for current measurement (left)

2.2.11 Benthic Substrate Analysis

CPCe software was used to assess the benthic substrate, which is one of the most widely used tools for marine assessments (Kohler & Gill, 2006). 15 pictures were taken at each respective site from which 10 photos are chosen for analysis (Refer to Table 3 and Figure 2 for sampling locations and respective GPS coordinates). CPCe used 25 points on each photograph to point out the substrate found at each point. The software calculates the percentage of each substrate for the 10 photographs. The method is repeated to take 4 transects at different locations.

Percentage live coral cover was used as an indicator to categorize the condition of the reef (Table 1). The categories were used from (Rizmaadi, et al., 2018), with an additional category of very poor.

Table 1: Reef condition categories based on % live coral cover.

Category	% Live coral cover
Very poor	0%-10.9%
Poor	11%-24.9%
Moderate	25%-49.9%
Good	50%-74.9%
Exceptional	75%-100%

2.2.12 Fish Census

The number of fish encountered while swimming for 5 minutes in a straight line on the reef were all counted to get the total abundance. Fish census were carried out at the 4 locations where benthic substrate analysis were undertaken (Refer to Table 3 and Figure 2 for sampling locations and respective GPS coordinates). The fishes were identified using the (Fishes of the Maldives, 2003), (FishBase, 2023), (Kuiter, 2014), and (Coleman, Godfrey, Bridge, & Moritz, 2019). After identification of the fishes, the abundance of each species for all sites was calculated along with the relative abundance for each family.

2.2.13 Hazard Vulnerability

The vulnerability of the proposed project site to storms, cyclonic winds, storm surge, seismic activity and tsunami were determined based on the disaster risk profile for Maldives 2006 and multi-hazard risk atlas of Maldives 2020. Risk of flooding was determined by analysing available rainfall data from the nearest meteorological station.

2.3 Limitations in data collection methods

There are several sources of uncertainty and limitations in any data collection method, some of which we aren't even aware of it. Nonetheless, the possible sources of uncertainty and limitations for the methods used to collect data for this EIA is described below.

Firstly, the water quality tests were not done on-site, therefore the results may not reflect the actual physical parameters of water for example temperature.

Air quality and noise measurements were taken only at one time. While these parameters may change depending on the time and the season. Furthermore, the air quality reference ranges to which the collected data are compared to are for averages or exceedance for a set time (1 hour or 8 hour) but the readings that we have taken is a one time reading.

Noise measurements were taken for a short period of time and during daytime only. The noise levels may be very different at night time.

Vegetation clearance was estimated by counting the trees on an overlaid georeferenced model of the Island. As such the undergrowth will not be accounted for and hence the vegetation clearance will be in under estimate.

The terrestrial fauna surveys were only focused on mega fauna and hence did not include groups like insects.

Data for income situation and distribution on an atoll level was not up-to-date, hence information for previous years was used to estimate the income status of the region. Therefore, the obtained representation of income situation and distribution for the region might not reflect the actual situation.

Current measurements were taken only at one time. While currents may change depending on the time and the season.

During benthic substrate analysis, the category of the substrate is very subjective and hence different analyzers may perceive a substrate category differently. To avoid this human bias, one analyzer has analyzed all the transects for this EIA.

Fish census were taken only at one time, while the abundance of fish may differ with tide, day, night and with season. Furthermore, since the fish census was done via snorkeling only the fish mostly living at 0-5m depth would be recorded. Finally, the abundance of fish was calculated based on the numbers only without factoring in the size or mass of the fish which could lead to misinterpretation of the total biomass of the different groups of fishes.

2.4 Data gaps

The most contrasting data gap is the lack of long-term site-specific data and the data that was taken under this EIA was also a snapshot of the full environmental setting as can be seen evidently from the above section. Namely, these data gaps include; lack of site-specific hazard risk analysis, climatic conditions, currents in both seasons, seasonal erosion patterns, fish census data for different tides and seasons.

2.5 Uncertainty in data

The first and foremost uncertainty in any data arises from the data collection method as it is impossible to devise a sampling method that is devoid of error. Hence any physical, chemical or biological parameter that is measured will have an error or uncertainty from the data collection method itself as no method by nature is 100% accurate. Additional uncertainties to the sampling method arises from the instrument used, these include the instruments resolution, accuracy and precision errors. Thirdly the human error that will be imposed when a person measures a parameter using a specific sampling method by using a particular instrument. Other factors include the time and environment.

Some of the results presented in this report are given with a confidence interval. The confidence interval is calculated at 95%, which means that we are 95% confident that the true value lies within the range given. Uncertainty could be calculated like this for certain parameters as some of the results provided are from third party data which does not have information of accuracy and precision. And in other cases it is not possible to calculate as the measurements are only discreet data describing a varying parameter. In these types of cases the initial value obtained is given. Caution must be taken when using this type of data, as it is this type of data that usually warrants long-term studies.

2.6 Management of Uncertainties and Data Gaps

Due to the abovementioned limitations, data gaps and uncertainties, the following assumptions were made;

Table 2: uncertainties and data gaps in collected data and how it was managed

Data	Sources of Uncertainty	Data Gap	Assumption (how it was managed)
Hazard risk	Modelling errors due to imperfect understanding of	No site-specific data	The available broadscale hazard risk analysis of the Maldives was

	the natural setting and lack of long-term data		used to determine the site-specific hazard risk at the proposed project site.
Temperature, rainfall, wind	Equipment precision errors Human error	No site-specific data	Regional climatic conditions from the meteorological centre for wind, rain, temperature was assumed true for the proposed project location.
Water quality parameters	Off-site testing Equipment precision errors Human error	Data lacking for both seasons	The tested water quality parameters (except for temperature) in the laboratory was assumed to be the onsite conditions.

2.7 Geographic Coordinates for all sampling locations

All the sampling locations were geo-referenced. The coordinates for all sampling locations are shown in Table 3 and Figure 2 below.

Table 3: Geographic coordinates for all sampling location at Island name

Code	Type	Location	GPS Coordinates	
			Easting	Northing
D1	Refers to location D1 of water sample, drogue run, fish census and benthic transect	(Project Construction site) Harbor	336931.00	229587.00
D2	Refers to location D2 of water sample, drogue run, fish census and benthic transect	(Project Construction site) Access Channel	336391.00	229523.00
D3	Refers to location D3 of water sample, visual inspection	(Project Construction site) Coastal embayment	337516.00	229369.00
D4	Refers to location D4 of water sample, drogue run, fish census and benthic transect	(Project Construction site) Outfall location	338041.00	229238.00
D5	Refers to location D5 of water sample	RO Plant	337934.08	229290.13

		Intake location		
C	Refers to location C of water sample, drogue run, fish census and benthic transect	(Control site) South of the proposed harbor	336907.00	229263.00
GC	Ground water sample at location GC	Existing well Near temporary site	337592.00	229502.00
G1	Ground water sample at location G1	RO plant & powerhouse location	337771.00	229408.00
VT1	Refers to location VT1 of vegetation transect and identification terrestrial animals	Near jetty location	337471.00	229609.00
VT2	Refers to location VT2 of vegetation transect and identification terrestrial animals	Near Outfall location	337874.00	229311.00
VT3	Refers to location VT3 of vegetation transect and identification terrestrial animals	Coastal embayment	337561.00	229317.00
VC	Refers to location VT3 of vegetation transect and identification terrestrial animals	Northern side of the island	337739.00	229651.00
N1& N2	Refers to location N1 & N2 of Noise measurement	Near powerhouse & RO Plant	337874.00	229311.00
N3	Refers to location N3 of Noise measurement	Near jetty area.	337471.00	229609.00
N4	Refers to location N4 of Noise measurement	Coastal embayment (Control)	337561.00	229317.00
AQ1 & AQ2	Refers to location AQ1 & AQ2 of Air quality measurement	Near powerhouse & RO Plant	337874.00	229311.00
AQ3	Refers to location AQ3 of Air quality measurement	Near jetty area.	337471.00	229609.00
AQ4	Refers to location AQ4 of Air quality measurement	Coastal embayment (Control)	337561.00	229317.00

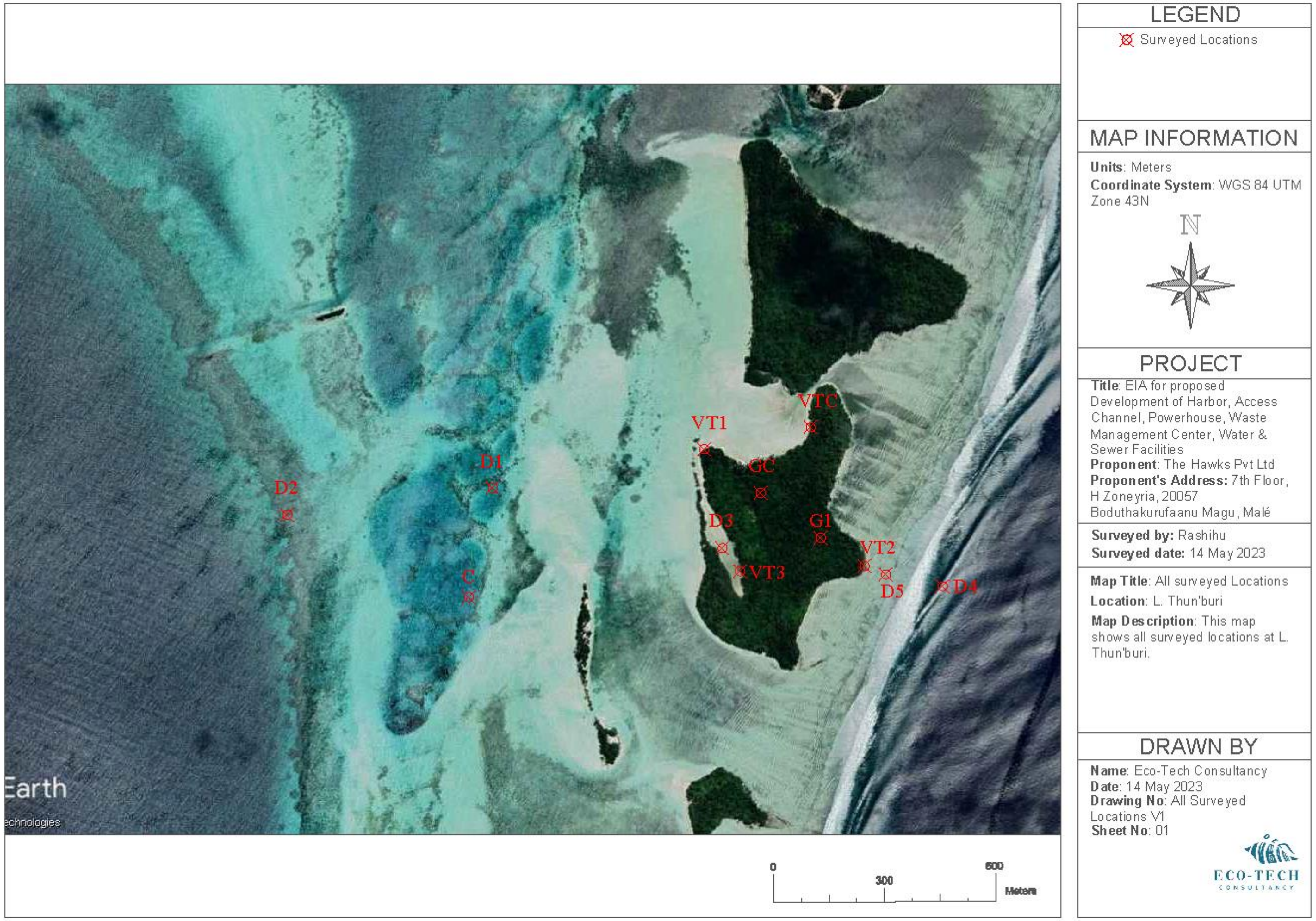


Figure 2: sampling locations at L. Thun'buri

3. STATUTORY REQUIREMENTS

This section describes the statutory requirements relevant to the proposed proposal. Section 3.1 describes all the relevant laws, policies and strategic action plans that must be complied to for this proposal. Section 3.2 describes all the pertinent regulations, section 3.3 all the guidelines and section 3.4 describe all the international conventions that the Maldives are a party to.

3.1 Laws, Policies and Strategic Action Plans

This section describes the applicable laws, policies and strategic action plans pertaining to the proposed development.

3.1.1 Environmental Protection and Preservation Act (4/93)

The Environmental protection and Preservation Act of the Maldives was enacted to protect the environment and its resources for the current and future generations. Relevant articles under this law pertaining to the proposed project are:-

- Article 2 states that the instructions for environmental protection will be given from the competent authority and everyone must respectfully follow these instructions;
  - Article 3 states that all matters relating to environmental protection and preservation must be handled by the Ministry of Planning, Human Resource and Environment (MPHRE);
  - Article 4 states that MPHRE must declare protected sites and species and formulate the regulations to manage them. If any other party wants to declare a protected site or species they must be registered in the MPHRE and managed according to regulations made by the Ministry;
  - Article 5 states that any projects which pose significant impacts to the environment, an EIA report has to be made and submitted to the MPHRE. The projects which require an EIA and the regulation must be made by MPHRE;

- Article 6 states that if any project is found to cause significant adverse impacts, MPHRE have the right to stop the project;
- Article 7 states that any waste, oil or hazardous gas must not be dumped into any part of the Maldives, however, if strictly needs to be disposed it should be disposed of in an area designated by the Government. If such hazardous gas, waste or oil is to be disposed by combustion, it should be done in a way it does not impact human health and environment;
- Article 8 states that any hazardous waste must not be disposed into any part of the Maldives. Before trans-boundary transfer of such waste, approval must be taken from the Ministry of Transport and Communication by writing to the Ministry at least 3 months beforehand.
- Article 9 states that any party who violates this law or any regulation under this law is punishable to no more than MVR 100 million according to the offence. The fine will be applied by the MPHRE.
- Article 10 states that any offence to this law or any regulation under this law or any action resulting in environment damage, the compensation for such damages can be taken through judicial processes.

3.1.1.1 1st addendum to Environmental Protection and Preservation Act (4/93) law no 12/2014

Article 3 and 11 of the Environmental Protection and Preservation Act (4/93) of Maldives is amended as follows:-

Under article 3, all matters relating to environmental protection and preservation must be handled by the Ministry charged with implementation of environmental policy.

3.1.2 Law on General Public Services (4/96)

Under this law, the general public services are electricity, telephone, water and sewerage services. Relevant articles under this law pertaining to the proposed project are:-

- Article 3 states that any party can provide general public services only after getting registered in the competent authority and according to its regulations;
- Article 4 states that any public service must be provided after a contract agreement has been made between the service provider and the customer. The agreement must be made according to the regulations put forward by the competent authority;
- Article 5 states that a transfer of service between customers must be made only after a contract has been made between the customers according to the service providers regulations. If the customer fails to comply with the agreement, the service provider can discontinue service only after approval from competent authority;
- Article 7 states that the service provider can permanently discontinue its services according to regulation mentioned in article 3 of this law. However temporary discontinuation can be made after giving prior notification to the customers and according to the agreement made between the service provider and the customer;
- Article 8 states that the tariffs for the services must be approved from the competent authority prior to implementation. Further, any amendments to tariff structure also must be approved from the competent authority before implementation; and
- Article 9 states that any damage made to service provider's facilities by anyone, he can be charged with 10-year prison penalty or banishment. Further, any action against this law (excluding what is mentioned in article 9 (a) of this law) can be charged between MVR 100 to MVR 5000 by the competent authority.

3.1.3 Waste management policy

With the implementation of waste management policy 2015, the 2011 and 2007 policy is void. The waste management policy which came into effect on 2015 is to ensure that the

Maldivians are well aware of the waste management techniques and maintains cleanliness as well as the natural aesthetics and clean air quality of the country is well maintained. Under this policy, all the inhabited islands need to implement a waste management plan and manage all the wastes generated from that island in accordance with that policy.

3.1.4 Waste management act (24/2022)

The waste management act came into force in 18th December 2022 with the main objectives of implementing sustainable waste management, establish waste management standards, minimize negative impacts from waste to the environment and human health. The act outlines the principles for waste management, roles and responsibilities of the relevant institutions.

3.1.5 Maldives Energy Act (18/2021)

The Maldives Energy Act was published on 11th October 2021 with the aims to regulating power production, power usage, electricity services, protecting the rights of customers, detailing the rights and responsibilities of service providers, upkeeping the quality of services, regulating power tariff rates, promoting renewable energy, facilitate sustainable development of the energy industry in a manner that is environmentally friendly, resilient to the impacts of climate change, facilitate reduction in GHG emissions, economically feasibility. Relevant notable articles under this law pertaining to the proposed project are:-

- Chapter 1 – Introduction. the following are some aspects highlighted under the chapter.
  - Energy sector policy:
    - Shall be formulated and gazetted.
    - All involved in electricity service provision shall adhere to it.
    - Policy shall be reviewed and revised in every 5 years.
  - Energy sector plan:
    - 10-year plan on the energy sector development shall be formulated.

    - All licensees for electricity service provision shall provide a plan on service provision to the Ministry.
- Chapter 2 relates to the Roles and Responsibilities of the institutions, under which the following are highlighted:
  - Responsibility of the Ministry:
    - Facilitation of electricity services at an affordable rate in all inhibited islands, facilitating the investments for the sector,
    - Provision of technical assistance to island councils,
    - Implementing the international commitments relative to the sector,
    - Formulation of regulations and ensuring sustainable levels of electricity services are received to all inhibited islands.
  - The Authority and Responsibility of the Regulator:
    - Enforcement of regulations,
    - Licensing,
    - Tarrif setting,
    - Monitoring and revision,
    - Regulating of service providers,
    - Formulating of standards relevant to the sector etc.
  - Roles and responsibilities of island councils.
  - Responsibility of other entities to provided assistance for the enforcement of the act.
- Chapter 3 is regarding the renewable energy. The following are discussed in the chapter
  - Ownership
  - Development
  - Target setting
  - utilising the space required for renewable energy
  - providing preference to renewable energy.
- Chapter 4 deals with petroleum and petroleum products. It details the following aspects regarding petroleum and petroleum products

  - Licensing and its relevant details
  - Quality Assurance
  - Stock Management
  - Environmental protection and general public health safety
  - Regulatory aspects for vessels carrying petroleum and petroleum product
- Chapter 5 deals with production of power and provision of its services, the following are some aspects highlighted under the chapter
  - Service provider and customer rights
  - Provision of services
  - Licensing
  - Responsibilities of service providers
  - Provision of services for personals with financial vulnerabilities
  - Monitoring
  - Inspections
  - Tariff settings
  - Application of services
  - Quality assurance
  - Termination of services
  - Emergency power cut
  - Vandalism and disruption of services
  - Ownership
- Chapter 6 deals with economising electricity and its efficient use, the following are some aspects highlighted under the chapter
  - Energy saving and its efficiency
  - Information collection
  - Formulation of regulation and guidelines
  - Energy efficiency certifications
  - Energy auditing
  - Annual energy report

  - Ill practices in electricity usage
- Chapter 7 highlights regarding the transition from previous legal framework of the energy sector.

3.1.6 Maldives Energy Policy and Strategy 2016

Maldives Energy Policy and Strategy 2016 consists of revised policies derived from Maldives Energy Policy and Strategy 2010. The 9 policies are reduced to 5 key policy statements.

- Strengthen the institutional and regulatory framework of the energy sector
- Promote energy conservation and efficiency
- Developing and enforcing standards for exhaust emissions for power plants, vehicles and vessels that use fossil fuel in order to improve air quality
- Increase the share of renewable energy in the national energy mix
- Improve the reliability and sustainability of electrical services and maintain universal access to electricity
- Devising means to reliably meet energy demands in a consistent manner assuring security and reliability of supply
- Improve the operational performance of service providers to manage the electrical power infrastructure
- Increase efficiency of the energy systems and quality of energy services provided
- Review and regularly implement electricity tariff adjustments
- Develop and update an integrated system management and expansion plan for utilities
- Increase national energy security
- Ensure environmentally safe and adequate storage, supply and distribution of fuel to meet the demand.

3.1.7 Water and sewerage Act (8/2020)

The water and sewerage Act was published on 05th August 2020 with the aims to provide safe water and sanitation services to the general public by implementing guidelines for providing water and sanitation service, operation and maintenance of water and sewer facilities, and other related guidelines. Relevant articles under this law pertaining to the proposed project are:-

- Article 5 states that, to provide the water and sanitation services entitled for every citizen of Maldives, it is the duty of the government to implement the following;
  - establishing facilities required to provide water and sanitation services sustainably
  - ensuring that safe water and adequate sanitation services are provided
  - overcoming any hindrance to provide water and sanitation service
  - establishing standards for water and sanitation service
  - ensuring that the water and sanitation service providers follow the set standards
  - researching and developing the water and sanitation sector
- Article 6 states that the water and sanitation policies shall be declared by the Minister as advised by the President. These policies shall be made available to the general public. All parties involved in the water and sanitation sector must fully comply with these policies.
- Article 7 states that Utility Regulatory Authority shall be responsible to implement this law.
- Article 8 states the duties of the Ministry in detail. These include drafting the polices, laws and regulations required to implement this law, establishing water and sanitation facilities in all inhabited Islands of the Maldives within 05 years of implementation of this law, ensuring that proper sewerage facilities are established on tourist and other industrial islands, and all the works to develop the water and sanitation sector.
- Article 9 states that the Council has the authority to declare the fees that could be taken from the water and sanitation service in accordance with the Utility Regulatory

Authority and Governments policies and regulations. Additional responsibilities of the Council include; monitoring the third party water and sanitation service provider, monitoring environmental impacts due to water and sewer systems, providing information about water and sanitation service on the Island to the Competent Authorities, ensuring that enough water is available to the living population of the Island, and providing water and sanitation service via a licensed third party.

- Article 10 states the points that must be included in the third party agreement mentioned in article 9.
- Article 11 states the duties of Utility Regulatory Authority, which is to give licenses to all water and sewerage facilities in the Maldives and monitoring them.
- Article 15 states that the licensed all water and sanitation service providers must submit a plan to provider water and sanitation service annually with an implementation report which specifies; (1) water quality, (2) lost water, (3) service interruption, (4) costs, (5) revenue generated, and (6) CSR activities.
- Article 18 states that the groundwater presents in Tourism, Industrial and Reclaimed Islands are protected.
- Article 19 states that the groundwater presents in Tourism, Industrial and Reclaimed Islands cannot be used for commercial purposes. For existing agricultural Island a period of 2 years must be given for them to install RO plants and for inhabited islands, RO plants must be installed for agricultural field larger than 10,000 m^2.
- Article 20 states that any activity that contaminates the ground water is prohibited. Exclusive of this clause is using fertilizer for agricultural purpose and installing septic tanks in households. The article further states that fuel and other chemicals must be handled properly such that spills do not occur and if a spill occurs, the proponent must be responsible for clean-up. Finally, it is prohibited to dispose water which contains fuel and chemicals from Engine maintenance to the sea.
- Article 21 states that dewatering must be done in accordance with the regulations made under this law.

- Article 22 states that it is prohibited to dispose brine into ground or wetlands. Further, mixing of permeate water and rain water must be done according to set guidelines of the Utility Regulatory Authority.
- Article 24 states that there must be 05 days of water stored in case of emergency by all the service providers. Emergency water storage must be allocated in reference to the living population on the island, available water, and land availability for water storage.
- Article 25 states that operating license for water and sanitation service must be issued after the EIA process.
- Article 27 states that power required for the operation of RO plants must be from renewable energy sources. However, a period of 05 years shall be given to existing RO plants for transition. Nonetheless during an emergency situation due to a disaster on in case of renewable energy system failure, power from Diesel generators could be used.
- Article 28 states that rain water must be included as much as possible in the provision of Desalinated water.
- Article 29 states that it is the duty of the water and sanitation service provider to do all works required to provide the service in the assigned region for them. Additional responsibilities include; providing reports to Utility Regulatory Authority, upgrading water and sewerage facilities according to new technology, providing the first house connection free of charge, and water testing to ensure quality of water.
- Article 30 states that the water and sanitation service provider reserved the right to prohibit certain substances being disposed into the sewer system, installing meters, and entering households and commercial places.
- Article 31 states that the water facilities on inhabited islands of the Maldives must be established in accordance with MFDA's regulations. Additional points under this article include; the established water systems must have the capacity to test for water quality and disinfect, and it is the responsibility of the building's owner to establish measure to manage pressure in tall buildings, if a license for providing water has already been issued to an inhabited Island a second RO plant by another party could be installed with the approval of the Utility Regulatory Authority.

- Article 32 states that the Ministry shall declare publicly the Islands which require an STP and duration for establishing STP's on these Islands. On the islands where the Ministry has declared that an STP is required, on these islands sewerage services must only be provided with an STP. However, during an emergency situation due to flooding, disposal of this storm water is allowed without the involvement of an STP. Additional points include; Disposing of water from dewatering to the sewerage network is prohibited and technical specification for sewerage facilities must be made by the Utility Regulatory Authority.
- Article 34 states that an agreement must be made prior to giving approval to any water and sanitation service provider and this agreement must be registered in the Utility Regulatory Authority.
- Article 35 states that all water and sewer systems in the Maldives must be operated after registering in the Utility Regulatory Authority.
- Article 36 states that water and sewer services in inhabited Islands of the Maldives must be given after taking the operating license from the Utility Regulatory Authority.
- Article 37 states that an exclusive operating license could only be given after getting the written approval from the president as advised by the Parliament if it is needed for the betterment of the country.
- Article 38 states the requirements of the operating license, these include; operation and maintenance of water and sewer systems in accordance with the regulations set by the Utility Regulatory Authority, implementing the business plan mentioned in article 41(a-2), reporting, and fulfilling other requirements set by the Utility Regulatory Authority.
- Article 41 states that the procedures for obtaining the operating license must be publicly made available. The article further details the information the service provider must submit while applying for the operating license.
- Article 42 states that the fees for water and sewer for inhabited Islands will be declared by the Utility Regulatory Authority.
- Article 43 states that the service provider must submit a performance report to the Utility Regulatory Authority, Council, and Ministry annually

- Article 44 states that customers have the right to report any complaints regarding the service provider to the Utility Regulatory Authority.
- Article 45 states that the Utility Regulatory Authority has the right to investigate the service provider of any misconduct or even if the Utility Regulatory Authority deems necessary.
- Article 60 states that if there are any overlaps with other laws regarding water and sanitation, this law shall take precedence.
- Article 61 states that with the implementation of this law, the articles pertaining to water and sanitation services under the law on general public services (4/96) is void.

3.1.8 Utility Regulatory Authority Law (26/2020)

This Utility Regulatory Authority Law was drafted to establish an Authority that will oversee the general public services given in the Maldives. The specific objectives of this law include;

- Ensure that the general public services given in the Maldives are provided sustainably
- Ensure that general public services are given efficiently and with minimal damage to the environment
- Ensure that general public services are given at adequate standards
- Create a competitive environment to develop general public services in the Maldives
- Draft and implement regulations on general public services
- Regulate the general public service providers
- Create awareness on the rights of the customers and the service providers

This law has 16 chapters. Chapter 1 states the objectives of the law, Chapter 2 states the responsibilities of the Utility Regulatory Authority, Chapter 3 states how the board of directors are to be established and their responsibilities, Chapter 4 states the organizational structure of the Utility Regulatory Authority, Chapter 5 states the responsibilities of the Minister, Chapter 6 states details about operating licenses, Chapter 7 states how tariffs are to be implemented, chapter 8, 9 and 12, 13, 14 sates the rights of the Utility Regulatory Authority in relation to monitoring service providers, Chapter 10 states the discipline that the Utility Regulatory Authority must have, Chapter 11 states guides on conflict resolution, Chapter 15 states the budget and reporting by the Utility Regulatory Authority, Chapter 16 states the changes in existing institutional framework such as the transfer of Maldives Energy Authority and EPA Water, Sanitation and Waste section to the Utility Regulatory Authority. Relevant articles under this law pertaining to the proposed project are:-

- Article 4 states all the responsibilities of the Utility Regulatory Authority. The most important responsibilities include; giving operating license to service providers, implementing all laws and regulations pertaining to general public services and ensuring that the service providers abide by them, implementing tariff, drafting and implementing regulation and guidelines for providing general public services.
- Article 23 states that a license must be obtained in order to provide any general public service in the Maldives.
- Article 24 states that the license for general public services will be given by the Utility Regulatory Authority.
- Article 25 states that an exclusive operating license will only be given after getting the written approval from the president as advised by the Parliament if it is needed for the betterment of the country.
- Article 29 states that the fees taken for general public services must be as per the approved tariffs from the Utility Regulatory Authority.
- The Service providers must strictly follow the directions of the Utility Regulatory Authority as mentioned in chapters 8, 9, 12, 13, and 14.

3.1.9 The National Water and Sewerage Strategic Plan (The NWSSP 2020-2025)

The NWSSP 2020-2025 is an action plan made under the article 14(a) of Water and Sewerage Act (8/2020). The strategies and targets included in the action plan is derived from the National Strategic Action Plan 2019-2023 endorsed by the Government in 2019. The vision of this action plan is to ensure equitable access to safe water and improved sewerage serviced for all. The mission is to provide efficient, effective and reliable water supply and sewerage services, promote conservation and management of the water resources, and to develop sector capacity for sustainable management of resources and services. The action plan has 6 policy goals with its associated target in order to reach the vision. These are;

- Policy 1: Ensure access to safe water supply and adequate sewerage services
  - Target 1.1: By 2020, Water and Sewerage Act is ratified
  - Target 1.2: By 2020, Utility Regulatoryy Authority (URA) for integrated utility services is functional
  - Target 1.3: By 2021, Water and Sanitation coordination committee is functional
  - Target 1.4: By 2023, all water and sewerage utility providers have an operating license
- Policy 2: Adopt cost-effective and environment-friendly water and sewerage infrastructure
  - Target 2.1: By 2020, a standard mechanism to foster private sector investment in the water and sanitation sector will be in effect
  - Target 2.2: By 2023, all inhabited islands, will have access to safe water supply and sewerage facilities
  - Target 2.3: By 2023, 30% of energy consumption for water and sewerage facilities across the Maldives will be met with renewable energy
- Policy 3: Build sector capacity in water resources, water supply and sewerage services
  - Target 3.1: By 2023, at least 60% of technical staff in utility service providers are licensed (/ By 2023, all technical staff operating and maintaining the water and

sewerage facilities will have at least certificate level 3 qualification and will be licensed)

- Target 3.2: By 2023, at least 40 engineers will be trained in water and sanitation related field
- Target 3.3: By 2023, at least 30% of all employees working in water and sewerage facilities in each island shall be women
- Target 3.4: By 2022, collaborative partnership arrangements will be made with at least 3 local/international educational institutes for capacity building of water and sewerage sector programmes and services
- Target 3.5: By 2024, two (2) staff at each island or city council will be trained for overall utility operational services, governance and best practices

- Policy 4: Strengthen advocacy and awareness programs on water resources, water supply and sewerage
  - Target 4.1: By 2022, public perceptions on safe water and sanitation practices improved by 33% compared to 2018 levels
  - Target 4.2: By 2023, at least 40% of households phased out single-use bottled water use
  - Target 4.3: By 2023, WASH awareness programs targeting to island functionaries, front line workers, CBOs and NGOs that are active in all island communities are carried out
- Policy 5: Protect and conserve natural water resources
  - Target 5.1: By 2023, water resource conservation and management plans are implemented in all inhabited islands.
- Policy 6: Build flood resilient island communities
  - Target 6.1: By 2021, identify and map flood prone islands
  - Target 6.2: By 2022, develop and enforce design criteria's and guidelines for flood mitigation

3.1.10 Decentralization Act (7/2010)

This act was drafted in accordance to the article 8 of the Constitution of Maldives in order to declare the Institutions required to decentralize the governing of Maldives. The Institutions that would be established under this Act are; Local Councils, Atoll Councils, and City Councils. The Act specifies the jurisdiction of all of these Institutions. Relevant articles under this law pertaining to the proposed project are:-

- Article 8(b) states that it is the duty of the Atoll Council to inform the project proponents, of the general public’s suggestions and concerns for any developmental projects within its jurisdiction.
- Article 8(g) states that it is the duty of the Atoll Council to allocate land for investments that promote social and economic growth within its jurisdiction in accordance with the built environment and any other relevant regulations.
- Article 23(c) states that it is the duty of the Local Council to implement developmental projects that the government assigns to the Council.
- Article 23(d) states that is the duty of the Local Council to properly monitor and report on developmental projects that are being carried out on the Island to the respective Ministry.
- Article 23(i) states that is it the duty of the Local Council to allocate land for developmental projects as advised by the Atoll Council in accordance with the LUP and Built Environmental Regulations.
- Article 68 states that the Local Councils must be involved in the planning stage of any developmental projects.
- Article 69 states that, if an EIA is required for any developmental project, an EIA must be done for the project and the report must be shared with the Atoll Council. Further, the project proponent must share with the Atoll Council the potential environmental impacts mentioned in the report along with the proposed mitigation measures.

3.1.10.1 8th amendment to Decentralization Act

With the 8th amendment to the Decentralization Act, Local Councils were given additional authority. Relevant articles under this amendment pertaining to the proposed project are:-

- Article 68 was amended as follows; Local Councils must be involved in the planning stage of any developmental projects. Further, if an EIA is required for any developmental project, an EIA must be done for the project and the report must be shared with the Local Council. Further, the project proponent must share with the Local Council the potential environmental impacts mentioned in the report along with the proposed mitigation measures.
- Article 69 was amended as follows; for PSIP projects, if the total value of the project is less than 5 million rufiyaa, then those projects must be implemented through the Local Council. For Projects higher than 5 million rufiyaa, the government agency could still implement the project via the Local Council under certain set guideline by the government agency.
- An additional section was also added to Article 69 which states that;
    - 69-1(a) the Councils must provide the following general public services; (1) electricity, (2) water, and (3) Sanitation.
    - 69-1(b) the general public services must be given in accordance with the competent authority's guidelines and regulations.
    - 69-2(a) if the general public services are to be provided via a third party, an agreement must be made between the Council and the third party service provider.
    - 69-3 (a)electricity, water and sewerage facilities must be established in accordance with the LUP.

3.1.11 National Strategic Action Plan

The Strategic Action Plan (SAP) of the Government of Maldives is a central policy framework and planning document that guides the overall development direction of the Maldives for the next five years. The SAP consolidates the current Government's manifesto pledges with existing sectoral priorities. The SAP serves as the main implementation and monitoring tool to track the progress of the delivery of the Government's policies and development priorities. The SAP is formally rolled out into the line ministries' day to day operations from 1 October 2019. The SAP consists of 5 Sectors and 33 subsectors.

3.1.12 Public Health Protection Act (7/2012)

The purpose of this act is to establish policies for protection of public health, identify persons responsible for protection of public health, define how public health protection policies will be implemented and establish policies to limit basic rights ensured under the Maldives Constitution to Maldivians and people living in Maldives to necessary extents to protect public health. Chapter 5 of the act outlines health hazards, eliminating risk, reporting health hazards, and order of things that can be done and not done in relation to a building. Chapter 6 of the act outlines the procedures for declaring state of emergency.

3.1.13 Immigration Act (1/2007)

This act lays down the rules for the departure and entry of Maldivian Nationals and foreign Nationals. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 3; all persons shall enter the Maldives from an authorised port, unless a person is compelled to do otherwise, due to sudden natural causes, or an emergency which is beyond the control of the person. Persons departing from the Maldives shall also depart from an authorised port unless in cases of emergency as stated above.

- Article 7; (a) A foreign national may enter the Maldives if he/she can produce a valid passport and a valid permit of entry. (b) A foreign national may leave the Maldives provided that he/she has a valid passport. (c) Pursuant to subsection (a), a foreign national may enter the Maldives, unless as stated otherwise in the Regulations made under this Act, by filling a disembarkation form as specified in the Regulations and by submitting it with the passport to an immigration officer, and upon the leave to grant a permit of entry for the Maldives. (d) A foreign national may depart from the Maldives, unless as stated otherwise in the Regulations made under this Act, by filling an embarkation form as specified in the Regulations, and submitting it with the passport to an immigration officer and upon the leave to grant departure.
- Article 8; (a) For the purposes of this Act, permits to remain in the Maldives shall be divided into the following eight types;

  (1) Tourist Visa
  (2) Diplomatic Visa
  (3) Student Visa
  (4) Business Visa
  (5) Dependant Visa
  (6) Work Visa
  (7) Resident Visa
  (8) Special Visa

  (b) The permits specified in subsection (a) are subject to the Regulations made under this Act.

3.1.14 Anti-Human Trafficking Act (12/2013)

This act was enacted to combat human trafficking in the Maldives in order to protect human rights and human dignity. As per international best practices this act includes three main components of criminalization, prevention and rehabilitation of victims, making human trafficking a criminal offense in the Maldives. The law also strictly prohibits forced labor and fraudulent recruitment. The main objective of this act include;

- Preventing human trafficking in the Maldives
- Establish crimes of human trafficking and prescribe the punishments
- Provide for prosecution of perpetrators under this act
- Providing protection and assistance to victims of human trafficking
- Promote and protect the human rights of trafficked victims
- Engage in cooperation with local and international NGOs working against human trafficking to combat human trafficking

3.1.15 National Biodiversity Strategy and Action Plan

The National Biodiversity Strategy and Action Plan 2016-2025 (NBSAP 2016-2025) seeks to ensure that threats to biodiversity are addressed, biodiversity is conserved, sustainably used and benefits arising from them are shared equitably. It also encompasses ways of addressing gaps, challenges and constraints highlighted in earlier sections. It is a living document that will have the capacity to adapt to changes in national conditions, capacities and to the changes in the intrinational arena.

3.1.16 Climate Emergency Act (9/2021)

Climate Emergency Act was enacted in the Maldives in order to tackle the dangers that Maldives and its citizens face due to climate change. This act aims to bring forth regulations and mitigation measures to face the impacts of climate change, and to make Maldives a leading nation in advocating for action on climate change. It also aims to make the country carbon neutral while reaching its sustainable development goals.

- Article 2 states that Maldives should be a carbon neutral country by the year 2030, offsetting the same amount of carbon as those emitted. Any changes to the regulations can only be brought in consideration of new scientific findings and changes in international climate mitigation policies.
- Article 5 states that an action plan must be created to analyse the current situation and strategies to reach the climate goas in the country. The action plan must include regulations to make the country carbon neutral and resilient to climate change, adaptation and mitigation measures to respond to climate impacts, implementation of climate adaptation and mitigation in developmental plans, methods of monitoring of greenhouse gas emissions, development and implementation of renewable energy and its storage, and the roles of the government and other related bodies in strategizing and reaching climate mitigation goals.
- Article 7 states that any emissions from flights and ships travelling through Maldives under circumstances not stated in the law will not be considered when calculating total national emissions.

3.1.17 Heritage Act (12/2019)

This law aims at safeguarding the perpetuation of items and sites of historical significance to future generations and ensures the documentation, preservation, and protection of cultural heritage.

- Article 2 states that portable heritage items, historic constructions or buildings, historic sites, and any cultural skills or talent all fall under heritage to be protected under this law. It also defines each category and states that they will be valued by the importance of their inheritance to future generations.

Article 3 states that all policies regarding heritage protection will be made under the guidance of the president. Under this law, ‘Department of Heritage’ was renamed ‘National Center for Cultural Heritage’.

- Article 5 states that a catalogue of all heritage artefacts and sites must be published and reviewed to update once every 2 years.
- Article 6 states that a written permit must be obtained from the NCCH if any artefacts are to be moved from its place of origin. If any artefacts are found being moved without necessary permits, they must be detained immediately, and NCCH must be informed. It also states that any historical buildings or heritage sites must have a boundary marked and disclosed at protected. If any work needs to be carried out that encroaches this boundary, a permit must be acquired from the NCCH
- Article 6 also states that NCCH will determine the ownership of heritage artefacts and sites and their guardians.
- Article 7 states that the following heritage items and sites legally belong to the government:
    - All artefacts and sites under the legal custody of the government at the time of passing of this legislature;
    - All artefacts and sites legally renounced by their owners which meets the requirements outlined in this legislature;
    - Any artefacts or sites historically important which have not yet been found within the maritime boundary of Maldives, be it in water or on land.
- Article 7 also states that in order to claim ownership of an artefact or site, one must inform the local council. If any items or sites are not claimed, they will be considered government property until someone claims ownership. If a historical item is found on a land leased by the government, all works must be halted on site until the items are assessed by NCCH.
- Article 8 states that all names historically given to islands, lagoons, reefs, and other places must be documented by NCCH without any changes. Paperwork for developmental plans carried out in such places must include these names.

- Article 10 states that any damages caused to heritage artefacts or sites can be fined, depending on its value, an amount between MVR10,000 and MVR1,000,000.

3.2 Regulations

This section describes the applicable regulations pertaining to the proposed development.

3.2.1 Environmental Impact Assessment Regulation 2012 (2012/R-27)

The EIA Regulation, which came into force in 2007, has been revised and this revised EIA Regulation is currently in force since May 2012. The Regulation sets out the criteria to determine whether a development proposal is likely to significantly affect the environment and is therefore subject to an EIA. Schedule D of the EIA Regulation defines the type of projects that would be subject to EIA. The main purpose of this Regulation is to provide step-by-step guidance for proponents, consultants, government agencies and general public on how to obtain approval in the form of an Environmental DS. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 6 states that when government agencies propose a project, while finalizing the location for the project, they should reflect on the criteria's mentioned in Schedule B of this regulation. Furthermore, they should reflect on all the laws and regulations pertaining to environmental protection in the Maldives as well as international conventions, plans and programs to which Maldives is a party to.
- Article 7 states that the proponent must apply for an Environmental DS prior to commencement of any developmental project in accordance with article 8 of this regulation.
- Article 8 states that the proponent must apply for a screening if the developmental project is not listed in the inclusive list for EIAs (Schedule D of this regulation). If the proposed developmental project is listed under Schedule D of this regulation, then the proponent must submit an EIA application form.

- Article 11 states that a scoping meeting must be conducted and a ToR must be agreed upon by the proponent and the competent authority.
- Article 12 states that the EIA report must be written as per the approved ToR and the report must be a technical report with scientifically proven alternatives, impacts, and mitigations.
- Article 13 states that the competent authority must assign two independent reviewers to review the submitted EIA report and within 28 working days the competent authority must issue an Environmental DS or for additional information.
- Article 14 states that the Environmental DS must be; (1) Approval with the condition that the proponent follows the proposed mitigation measures (2) EIA report rejection due to poor quality of the report (3) Rejection of the proposal by the competent authority due to potential irreversible negative impacts. The approval has a validity of 1 year. If the proponent could not start the works within one year of the approval due to force major, then the competent authority could give an extension.
- Article 15 states that if the proponent is not contented with the DS, then the proponent may apply to review the DS.

Since the enactment of the EIA regulation in 2012 there have been five amendments to the regulation. These five amendments are discussed below;

3.2.1.1 1st amendment to the Environmental Impact Assessment Regulation 2012 (2013/R-18)

The first amendment to the EIA regulation 2012 involved the establishment of a guideline for fining environmental offences under article 20. According to the guideline fines are as follows; (1) MVR 20,000 for first offence (2) MVR 60,000 for second offence (3) MVR 120,000 for 3rd offence (4) MVR 200,000 for repeated offences after the 3rd time.

3.2.1.2 2nd amendment to the Environmental Impact Assessment Regulation 2012 (2015/R-174)

With the 2nd amendment to the environmental impact assessment regulation 2012, there were some procedural changes made to the EIA process. The most important was the shifting of tourism related development projects EIAs to the Ministry of Tourism (article 4). The detailed amendments made to the relevant articles are discussed below;

- Article 7 was amended to have three categories of review period as follows; (1) MVR 5000 for a 15 day review period, (2) MVR 5000 for a 10 day review period, (3) MVR 5000 for a 05 day review period
- Article 8 was amended to have 5 categories of Environmental DS for screening as follows; (1) Environment Management Plan, (2) Initial Environmental Examination, (3) Environmental Impact Assessment, (4) Approval to go forth with the screened project, and (5) Approval to go forth with the project according to the mitigation measures proposed by EPA.
- Article 9 was amended to have 3 categories of Environmental DS for an IEE as follows; (1) Environmental Impact Assessment report if the project is anticipated to have major environmental impacts, (2) Environment Management Plan, (3) Approval to go forth with the project if the project is not anticipated to have major environmental impacts.
- Article 14 was amended to have a guideline for extending the Environmental DS as follows; (1) Extension for Environmental DS must be applied by the proponent with the justification for the delay, (2) If extension was applied before the deadline for Environmental DS, an extension shall be granted without a fine, (3) If extension was applied within one month of the deadline for Environmental DS, a fine of MVR 5000 will be charged, (4) If extension was applied within 2 month of the deadline for Environmental DS, a fine of MVR 10,000 will be charged, (5) an extension shall not be granted if applied after 2 months of the deadline for Environmental DS, (6) extension for environmental DS shall be granted for a maximum of 1 year and only once. Further points were added to article 14 to set out the guideline for applying, review and issuing

Environment DS for addendums. In this regard a proponent can apply for an addendum for an approved EIA report if; (1) it has not been 5 years since the Environmental DS was issued, (2) scope change, (3) works within 500 m of the proposed project.

- Schedule D of the regulation was amended to exclude all tourism related projects and some further changes to the list of project were also made.
- Schedule U was added to the regulation. For the projects under this schedule, approval to go ahead with the project will be granted once the proponent submits a commitment to implement the mitigation measures prescribed by EPA. There project are; (1) maintenance dredging without any changes to the initial footprint, (2) removing vegetation by local plot owners, (3) clearing roads for new housing plots after getting approval from island Council, (4) drilling borehole on land for extracting water.

3.2.1.3 3rd amendment to the Environmental Impact Regulation 2012 (2016/R-66)

One of the major amendments to the EIA regulation with this amendment is that the EIA consultants are classified into 2 categories (article 16). To be eligible for a category A consultant, the applicant should hold a minimum of level 7 qualification in an environment related field recognized by the Maldives National Qualification Framework. Likewise, to be eligible for a category B consultant, the applicant should hold a minimum of level 7 qualification in specific fields relevant for the nature of the project recognized by the Maldives National Qualification Framework. Additional detailed amendments made to the relevant articles are discussed below;

- Article 5 was amended to mention the implementing agency to be EPA on behalf of the Ministry.
- Article 6 was amended such that except for EMP and Environmental monitoring reports, all other reports under this regulation shall be made by a registered EIA Consultant. Further points were added to the article which mentions to submit data which could be used for environmental monitoring and the proponent must inform the Ministry in

writing prior to commencement of the project once the approval has been granted for a project.

- Article 11 was amended such that while applying for EIA, the ToR must be submitted in an editable format along with the application form and project brief. Furthermore, it is now mentioned that that the ToR must be agreed upon during the scoping meeting and that only another registered EIA Consultant could replace the projects EIA Consultant if he cannot attend the scoping meeting, and the proponent could apply for an extension on the validity of the ToR during a 1-year period from the scoping meeting date.
- Article 13 was amended to include more guidelines on how to manage the EIA review process. An additional point was also added which gives the authority to EPA to conduct a review meeting with the Consultant and Proponent if they deem necessary.
- Article 14 was amended to include 2 more points which states that the Environmental DS must have the parameters for the environmental monitoring report and the schedule. The Ministry could ask the proponent to submit environmental monitoring reports up to 5 years or more if the Ministry deems necessary. Additionally, the proponent must share the Environmental DS with the Contractor ad a copy of this Environmental DS and a copy of the approved EIA report must be made available at the project site.
- Article 20 was amended to include the guideline on how to penalize offences under this regulation.

3.2.1.4 4th amendment to the Environmental Impact Regulation 2012 (2017/R-7)

Under this amendment the Schedule U which was added under the 2nd amendment to the EIA regulation (2015/R-174) was amended to include two more type of projects; (5) all projects except for the projects mentioned in point N of this schedule for newly reclaimed areas on natural islands until three years from the reclaimed date, (6) all projects except for the projects mentioned in point N of this schedule for newly reclaimed islands until three years from the reclamation date.

The projects mentioned in point N of this schedule are any project that involves dangerous chemicals, oil storage, incinerators, release of toxic chemicals to atmosphere, and fiber works. However, if the reclaimed lands were to be populated then any major developmental project shall be subjected to EIA.

3.2.1.5 5th amendment to the Environmental Impact Regulation 2012 (2018/R-131)

With this 5th amendment, Tourism related developments are again included under this regulation. Additionally, the Schedule D was amended to include tourist resort development and tourist hotel developments in the inclusive list for EIAs.

3.2.2 Waste Management Regulation (2013/R-58)

The waste management regulation dictates the principles needed to follow when handling waste. The aim is to minimize adverse impacts to the environment and human health from waste. Under this regulation, island councils are required to make a waste management plan and submit it to the competent authority. This plan must be reviewed at least every five years. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 8 states that hazardous waste are specified in Schedule J and under no circumstance should it be burned or disposed off in any area of the Maldives. While transporting hazardous waste, it must be in a closed container without any leaks. Further a sign must be on the container, specifying that it is hazardous waste. The import of any hazardous waste mentioned in Schedule J to Maldives is an offense.
- Article 11 states that waste generated at islands must be disposed off in areas specified for the purpose or areas approved by competent authority. Disposal of waste to following areas is prohibited under this regulation and is an offense;
    - Mangroves
    - Island Lagoon

- Reef
- Lagoon(falhu)
- Finolhu
- Beach
- Vegetation line
- Harbor
- Park
- Road

Approval to dispose waste to areas not approved by competent authority will be given under following circumstances;

1. Waste is disposed as a measure to protect human health
2. Situation created by natural disaster or a state of emergency

Approval to manage waste at household level is not required for the following actions;

1. Waste segregation at household
2. Composting at household

- Article 12 states that anybody responsible for public sites must place and manage a dustbin. The waste in these dustbins must be managed according to this regulation. Disposal of waste to public sites (besides the dustbin) is an offense.
- Article 16 states that approval must be taken from the competent authority for the following waste management works
    1. Waste collection
    2. Transportation of waste by land and sea
    3. Waste treatment
    4. Storage of waste
    5. Management of waste disposal sites
    6. Landfill

7. Handling of hazardous waste

The number of waste management approvals for a particular area or areas will be decided by the competent authority based on the following;

1. Waste generation
2. Economic gains from waste management actions
3. Environmental protection requirements for the area

- Article 25 states that waste must be transported from one place to another in accordance with the standards set in schedule A of this regulation. If waste is to be removed from an Island, it should be taken to a regional waste management facility.

3.2.2.1 1st amendment to waste management regulation (2014/R-10)

This amendment only included the amendment of dates to start implementing articles of this regulation (article 4).

3.2.2.2 2nd amendment to waste management regulation (2014/R-10)

This amendment also only included the amendment of dates to start implementing articles of this regulation (article 4). The date to implement the articles 13, 14, and 16 were amended to 05th October 2014.

3.2.2.3 3rd amendment to waste management regulation (2017/R-90)

This amendment included amendments to the schedule A and K of this regulation. Further article 25 was amended to include that action will be taken against parties which does not transport waste according to the standards set under this regulation.

3.2.2.4 4th amendment to waste management regulation (2018/R-63)

With this amendment the most notable, was the establishment of a system for fining offences under this regulation under Schedule N. Further article 25 was amended such that waste that needs to be removed from an Island must be taken to the nearest waste management center.

3.2.2.5 5th amendment to waste management regulation (2021/R-109)

With this amendment the most notable, was that waste management responsibility can be assigned to Councils and waste management plans need to be made at Island level.

3.2.3 Regulation on Environmental Liabilities (2011/R-9)

This regulation was made in order to emphasize on sustainable development according to Article 22 of the Constitution of the Republic of Maldives 2008 and penalize environmental offences to the regulations made under Environmental Protection and Preservation Act (4/93) in the intention to prevent such offences. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 5 states that this regulation will be implemented by the EPA on behalf of the Ministry of Environment, Climate change and Technology.

- Article 7 states that, if there is a potential environmental damage or if there was an environmental damage due to a project, then the proponent must report to the Competent Authority and take measures to prevent such damages. The Competent Authority must assert to the proponent to implement mitigation measures.
- Article 8 states that, instead of the proponent under following circumstances the Competent Authority reserves the right to implement measures to prevent or mitigate environmental damages;
    - In an emergency
    - The proponent did not implement the mitigation measures prescribed by the Competent Authority under article 7
    - The proponent must bear the cost of implementing the mitigation measures mentioned in article 7 and for inspection visits from the Competent Authority
- Article 9 states that, for potential environmental damages imposed for works done by getting written approval from a government institution or advice, the cost of mitigation measures implemented maybe reclaimed from the government institution that gave the approval.
- Article 10 and 11 states that, if the Competent Authority found that there were environmental damages due to the actions of anybody, the Competent Authority could ask them to submit the mitigation measures that could be implement along with the information mentioned in Schedule 6 of this regulation.
- Article 12 states that the proponent has the right to review the decisions of the Competent Authority to the Minister if;
    - The environmental damages were not due to the actions of the proponent
    - If the decisions of the Competent Authority regarding the environmental damages were questionable by the proponent
    - If the environmental damage was imposed due to the proponent following a regulation
    - If the environmental damage was imposed due to a third party while the proponent was diligently following all the mitigation measures

- Article 13 states that the Competent Authority has the right to visit and inspect the project sites, take copies of the documents photographs, and samples.
- Article 14 states that when inquired by the Competent Authority about information regarding any investigations under this regulation, correct information must be provided by the inquired entity or person.
- Article 15, 16 and 17 states the procedures for fining offences for environmental liabilities.

3.2.4 Regulation on Safety Standards for Construction Work (2019/R-156)

This regulation was made under the Building Act (4/2017) with the aims to improve working conditions for laborers and to protect the general public from potential health hazards due to construction activities. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 5 states that the following are Contractors responsibilities;
    - If the contractor’s work exceeds MVR 1,500,000 a health and safety plan has to be prepared and followed for the safety of employees as well as the public.
    - While handling construction materials, must ensure the safety of the workers and the general public
    - Informing the workers of any potential health hazards during construction works
    - Have an emergency response plan
    - Ensure that works are proceeding in accordance with the health and safety plan
    - Providing personal protective equipment for workers and they must be trained to use the equipment
    - Ensure construction site is safe for the workers and general public
    - Ensure that there is no disturbance to the general public from the construction site
    - Ensure waste is managed properly at the worksite
    - Ensure that the construction materials are properly stored

    - Ensure that safety boards and signs are installed around the construction site
- Article 6 states that if the contractor’s work exceeds MVR 1,500,000 an emergency response plan must be made and the following must be fulfilled accordingly;
    - Emergency response plan must be made available at the constructions site
    - Inform the workers on the emergency response plan and its protocols
    - Have at least 2 emergency response drills every year
    - Ensure that a first aid personnel is always available at all times at the construction site
    - First aid kit must be readily available at the construction site
    - Ensure that the equipment’s in the first aid kit is in proper condition
    - Installing safety boards at the construction site
    - Contacts for Emergencies must be available on a notice board at the construction site
- Article 7 states that the contractor must appoint a safety supervisor with more than five years of experience for the project.
- Article 8 states that the responsibilities of the site safety supervisor is to carrying out daily site inspections to ensure the proper measures are being taken to ensure safety and to report to the contractor/Competent Authority if the measures are not being implemented.
- Article 9 states that if the contractor’s work exceeds MVR 5,000,000, the contractor must have an insurance policy taken to compensate for any damages to the workers and the surrounding people.
- Article 10 states that all contractor’s must ensure that the general public is protected from the construction site by doing the following;
    - Installing pedestrian detour boards
    - Ensure construction materials and equipment’s are stored in a way that does not pose any difficulties to the general public
    - Installing safety boards, fences, tapes, sheets to protect the general public

- Article 11 states that the contractor should ensure that workers are always using personal protective equipment when on site. These include safety helmets, safety boots, safety goggles, noise cancellation headphones, gloves, masks, safety belt, and other safety equipment's necessary as per the type of work.
- Article 12 states that all construction sites must be fenced off. The article also explains in details how the fence must be erected.
- Article 13 states that the contractor must ensure the required safety equipment's are provided to the works if they are handling hazardous substances.
- Article 14 explains in detail the safety procedures that must be followed while working at higher than 3 m.
- Article 15, 16, and 17 explains in detail the safety measures that must be taken while working on an overhead platform, roofs, and ladders.
- Article 18, 19 explains how scaffolding are to be used.
- Article 20, 21, 22, 23 states the safety measures that must be followed for using electrical equipment's,
- Article 24 states that the contractor must implement a chemical handling procedure for handling chemicals. The article also explains in details what is to be included in the chemical handling procedure.
- Article 25, 26, 27, 28 states the safety measures that must be followed while working with asbestos, gas cutters, and compressed gas welding.
- Article 29 states that, if there are flammable materials at the construction site, fire prevention equipment must be made available.
- Article 30, 31, and 32 states the safety measures that must be followed for using equipment's powered by mechanical power and electricity, cranes,
- Article 33 states the safety measures that must be followed for while working in closed spaces.
- Article 34 states the measures that must be followed while decommissioning a building.

- Article 35 states the construction materials must be stored within a close area. Approval must be taken from the Competent Authority to store at the designated area and the approval must be shown on a board.
- Article 36 states the measures that must be followed while loading and unloading materials to a construction site.
- Article 37 and 38 explains the requirements for the safety board and other signs that must be installed at construction sites.
- Article 39 states that, when an accident occurs at a construction site, it must be immediately reported to the police. The record of accidents must be maintained by the contractor.
- Article 49 states that, if there is no entity responsible for implementing the measures mentioned under this regulation, then the proponent shall be responsible for implementing the measures. The proponent must report any offences against this regulation to the Ministry.
- Article 50 states that with the enforcement of this regulation the Male' Planning Regulation Chapter 3 is void.

3.2.5 Groundwater extraction and disposal regulation (2021/R-20)

The groundwater extraction and disposal regulation is enacted with aim of minimizing impacts to groundwater while carrying out dewatering activities. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 4 and 5 states that for any building construction or industrial use can only extracted and used after getting written approval from the competent authority, however, water can be extracted for domestic wells placement and cleaning
- Article 6 states that dewatering must be done only after getting the necessary approval from the competent authority. The proponent must inform the people living with 100 meters of the dewatering activity via the council using the application form mentioned in annex 1 of this regulation.

- Article 7 states that an administrative fee of MVR 100 has to be paid to the competent authority when submitting the form mentioned in article 7.
- Article 8 states that water samples must be tested from a certified laboratory and their results attached with the form in this regulations annex 1. The results must not be more than 45 days old from the tested date. The following parameters must be tested;
  - pH
  - Temperature, ^{0}C
  - TDS, mg/l
  - Dissolved Oxygen, mg/l
  - Electrical Conductivity, µS/cm
  - Turbidity, NTU
  - Salinity, ppm
  - Ammonia, mg/l
  - Fecal Coliforms 0/100
  - Hydrogen Sulphide, mg/l
  - Nitrates, mg/l
  - Phosphates, mg/l
  - Hydrocarbon, mg/l
  - Oil and grease, mg/l

If any of the parameters cannot be tested, then it should be mentioned in writing from the laboratory.

- Article 10 states that the approval for dewatering will be issued from the competent authority. Dewatering approval will be given for 28 consecutive days including public holidays. It also states that approval of discharge of groundwater to the sea must be given only in places where groundwater recharge is not feasible or where recharging might result in damage to the residents and the environment. For larger projects involving dewatering at different places, the places from where dewatering can be started with 28 consecutive days must be submitted as a single approval. The period of approval will be decided based on the following;

  - Size of proposed water discharge area
  - Water quality
  - Work schedule
  - Method of water discharge
  - Water discharge area
  - Article 11 states that designated impact radius from water discharge is 30 meters from the discharge point if the the water is not recharged within the aforementioned radius. The proponent must inform the houses within this radius by writing before 24 hours. During dewatering activities if a damage is caused to any of the houses within this radius, the proponent has to take responsibility and also if any of the houses face any difficulties getting groundwater from their wells the proponent has to provide no more than 250 liters of water per household or equivalent amount in payment.

- Article 11 states that an option other than draining water into the ground will be considered if the water quality tests mentioned in article 9 of this regulation shows that the waters quality is not adequate. Furthermore, it is stated that if a pipeline is to be established for the dewatering, the pipeline pathway shall be approved by the council. Moreover, ti is the responsibility of the proponent to maintain and decommission the pipeline after the dewatering period is over.
- Article 13 states that for any reason if the site engineer believes that the dewatering works will not be finished within the approval period, then the proponent must fill the form on annex 3 of this regulation and submit to competent authority before 3 days (the 3 days will be counted excluding public holidays) of approval deadline. Upon receival of the form and associated documents the competent authority will issue the approval within 2 working days. However, extension will be granted if the original approval granted under article 10 of this regulation is less than 6 months old, if more than 6 months then a new approval must be requested.

- Article 14 states that a non-refundable fee has to be paid to the competent authority according to following principle;
  - For the first 28-day approval MVR 500 per day
  - For the first addition of days to the approval MVR 1000 per day
  - For the second addition of days to the approval MVR 1500 per day
  - For the third addition and onwards with an increasing rate of MVR 2000 per day

However, if the works were delayed due to a natural hazard or bad weather, without any fee days will be added. These types of days will be decided by considering the information from the respective authority.

- Article 14 states that the competent authority has to maintain records about the dewatering approvals they give. If a sewerage service provider gives service of water discharging from dewatering activities, then they must provide those dewatering activity details before the 10 of each month for the previous month's activities.
- Article 15 states that the competent authority has the full discretion to stop any dewatering activities ongoing via formal documentation. Furthermore, it also states that the authority shall be indemnified from any claims arising from the halting of works.

Article 16 states that competent authority must inform the proponent via writing if they go against regulations.

3.2.6 Regulation on uprooting, cutting and transportation of palms and trees

This regulation was implemented on 1 February 2006 by the Ministry of Environment, Climate change and Technology, Energy and Water. The primary purpose of the regulation is to control and regulate large-scale uprooting, removal, cutting and transportation of palms and trees from one island to another. According to the regulation, certain types of trees and plants that have unique attributes are prohibited to be removed from its natural environment. Also, uprooting and removal of a vast number of trees and palms are subjected to an EIA, which is required to be submitted to the EPA and written approval is required prior to implementation of the project. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 3 states that the following types of vegetation is prohibited to be removed;
  - Vegetation found from 15 m inland of the vegetation line
  - Vegetation found on and around 15 m of wetlands and mangroves
  - Vegetation found on any protected areas of the Maldives
  - Any protected trees
  - Vegetation which has environmentally unique characteristics
- Article 5 (a) states that, to clear large number of trees for any purpose, an EIA must first be done and approval from the competent authority must be obtained. Article 5 (b) states that, if trees are to be transported with soil, the allowable limit is an 8-inch x 10-inch black bag. Article 5 (e) states that, trees larger than what is mentioned in article 8 (a) of this regulation, must be transported with only the soil in their root balls. Article 5 (f) states that, if machinery is to be used for uprooting trees, no damages must be done to any trees besides the trees concerned for uprooting.
- Article 6 states that, if the total number of a particular species of tree is less than 05 on an island, then this species of tree can only be transported with a special permit from the Ministry of Environment, Climate change and Technology. Furthermore, this applies to trees on which birds roost or live in inhabited and uninhabited islands.
- Article 7 states that, the maximum number of trees which could be removed from an island shall be declared by the Ministry of Environment, Climate change and Technology, based on the existing numbers of trees on the Island.
- Article 8 states that, coconut trees taller than 15 feet and other trees taller than 8 feet, their limit for removal is 10 trees, to uproot greater than 10 trees require an approval from Ministry of Environment, Climate change and Technology. Smaller trees could be removed by taking an approval from Island Council and the limit for uprooting is less than 1/3rd of the trees present in the area. For any purpose uprooting and transport of trees must be done under the supervision of the Island Council on inhabited Island; personnel responsible to manage the island in case of uninhabited Island.

- Article 9 states that, after uprooting trees, the holes must be backfilled with soil. It is prohibited to put in any waste into the holes.
- Article 10 states that, any offences against this regulation will be punishable under Act 4/93 accordingly.

3.2.6.1 1st amendment to regulation on uprooting, cutting and transportation of palms and trees (2014/R-7)

The amendment to this regulation has specified a set of categories and any tree falling under these categories is not allowed to be removed unless it is a project of the government, approved by the parliament. Relevant articles under this law pertaining to the proposed project are:-

- Article 3 was amended such that the prohibited trees for removal could be removed for a project approved by the parliament with the condition that the proponent must plant 6 trees for each tree removed instead of 2. Furthermore, a monitoring plan must be made and the proponent must implement it.
- Article 11 was amended to mention that this regulation will be enforced by the EPA on behalf of the Ministry of Environment, Climate change and Technology.

3.2.7 Regulation on management and conservation of water resources (2021/R-22)

This regulation has been formulated under the Article 17,18,19,20 and 23 of the Water and Sewerage Act (08/2020). The main purpose of the regulation is to ensure sustainable use, conservation, protection, improvement, and beneficial use of the water resources. Relevant articles under this regulation pertaining to the proposed project is:

Article 6:

- None shall do any harm or damage to the water resources.

- Groundwater and other naturally occurring water resources on the islands, shall not be utilised for any economic or business use.
- Dewatering for building construction shall be carried out as per the relevant regulation.

Article 10: All activities shall be carried out in a manner that would not contaminate the water resources in accordance to the clause 20 of the water and sewerage act (08/2020)

Article 12: Spillage of any oil and chemical to the ground is prohibited. Oil and chemical shall be store in shaded, appropriately bunded areas and in a manner that even if the total volume of the dedicated storage is leaked, the leaked volume is able to be recovered without contamination of the soil or the groundwater. Transfer of oil and chemical on land must be carried out with appropriate safety measures to prevent spillage. Discarding of waste oil and chemicals must be carried out in a manner that does not contaminate any of the water resource, and at a facility that is approved by the regulator.

Article 17: All responsibilities of rectification of a polluted groundwater resource from spillage of oil and chemicals shall be borne by the polluter. Any incidence of groundwater pollution from oil and chemical spillage should be reported to the regulator within 24 hours. The rectification works shall be carried as per the instruction of the regulator.

3.2.8 Regulation on protection of environmentally sensitive areas (2018/R-78)

This regulation was under article 4 of the Environmental Protection and Preservation Act (4/93) in order to declare standards to declare areas for protection, manage protected areas, establish environmentally sensitive areas, establish a network of protected areas, create public awareness and participation in management of protected areas, protection and preservation of Maldivian biodiversity for future generations. According to this regulation there are 7 types of protected areas; (1) Internationally recognized areas, (2) Strategic Nature Reserve, (3) Wilderness area, (4) National Park, (5) Natural Monument, (6) Habitat / Species Management area, and (7)

Protected Area with Sustainable use. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 12 states that a management plan must be made in order to manage the protected areas. This management plan must reflect on the developmental plans for the region.

3.2.9 Regulation on Construction Material Import and Production Control

The purpose of the regulation is to control the quality of imported and produced materials that are used in the construction industry. The regulation specifies the materials which would be controlled under the regulation in its annex 1. Furthermore, the regulation details out the registration requirements, permits, procedures, quality controls and applicable fine of those that breach the regulation.

3.2.10 Regulation on Construction Material and Construction materials testing facilities

Under the regulation all contractors involved in the construction industry are to be registered. The regulation includes the requirements of contractor's registration, grading, implications on participating in international tenders, insurance, project licenses, Joint venture registrations, responsibilities of the registered contractors and applicable fine for breaching the regulation.

3.2.11 Regulation on Preserving greenery and Vegetation in the Maldivian Islands (2022/R-92)

The purpose of this regulation is to encourage to plant more trees and increase greenery in the islands, protection of old trees, decentralisation of the approval process for removal of vegetation, reduction of environmental impact from vegetation removal and strengthen the reporting process of vegetation removal. According to the regulation, any tree beyond the age of

50 is protected under the regulation. The registry of trees must be maintained by the council. In islands leased for tourism and other economic ventures, the proponent must report the vegetation details annually to EPA. Furthermore, coastal vegetation belt of 20 meters must be ensured in each island. For any activity that involves removal 50-200 trees, approval of the agency must be acquired and for any activity that involves removal of more than 200 trees, an EIA must be carried out.

3.2.12 Regulation on Use, Handling, and Storage of Oil

The purpose of the regulation is to reduce fire hazards caused by the mishandling of oil, to raise awareness on the proper handling methods of oil and to standardize the infrastructure of oil handling and storage facilities.

- Article 2 of the regulation details out all the aspects of vehicles that handle and transport oil on land.
- Article 3 deals with all the aspects of petrol handling in storage areas and service centres.
- Article 4 highlights the aspects of fuel handling in diesel and kerosene service centres.

Article 5 highlights the aspects of fuel pipeline from storage to meters

3.2.13 Regulation on stone, sand and coral mining

This regulation specifies the articles regarding stone, sand and coral mining from the lagoons, reefs, and other areas and the conservation of these resources.

- Article 2 states that any stone, sand, or coral mining activities must be carried out after obtaining the required approval from the relevant authorities. If these activities are carried out in the inhabited islands and other leased uninhabited islands, these activities must comply with and Law on Stone, Sand and Coral Mining in Inhabited Islands (77/78) and Law on the Uninhabited Islands (20/98).
- Article 3 states that stone mining from any area of the Maldives is prohibited.

- Article 4 states that coral mining is prohibited from the following areas;
    - Islands and its beaches leased for industrial purposes
    - Areas on and beyond the atoll reef edge
    - Coral mining during dredging activities in harbour development projects, and beach / reef cleaning activities in industrial islands, approved by the relevant government authorities are excluded in this article.
- Articles 5 states that the sand mining from the islands leased for industrial purposes are prohibited. Permission to mine sand may be given for all other islands and those islands which lie on independent reef systems from other inhabited islands

3.2.14 Regulation on dredging and land reclamation (2013/R-15)

Regulation on Dredging and Land Reclamation was formulated under the Environment Act and this regulation came into force in 2013. The main purpose of the regulation is to minimize the negative environmental impacts from dredging and reclamation activities in islands and reefs across Maldives.

According to the regulation, all dredging and reclamation activities must be approved by the Environmental Protection Agency in writing. Application process for the permit for the reclamation and dredging includes the submission of the adequate information of the project to Environmental Protection Agency along with a scaled before and after map.

The regulation defines the rationales for reclamation and dredging as those absolutely necessary for social, economic developments. Under this regulation, dredging is restricted in the following areas:

-500m from the ocean side reef edge

-50m from island vegetation line

-Environmentally protected areas

Under this regulation, land reclamation is restricted within 200m of an environmentally protected area. And also, land reclamation cannot exceed beyond the 30 percent of the house reef area.

1st Amendment to regulation on Dredging and Land Reclamation (2014/R-13)

It is prohibited to undertake dredging and reclamation activities within the a radius of 200 meters of any place stated under the Clause 13 (noonu), section 4 of the regulation.

However, if the cabinet decides it be so for a development project, the proponent cold carry out dredging and reclamation in such places under the following conditions:

- Carry out an extensive baseline study of the protected area
- The organisms and the fragile ecosystem of the protected area must be;
    - Relocated
    - Acclimatized to site of relocation
    - Should be monitored according to a management plan
    - The monitoring plan must be approved
- Preparation, and implementation of a management plan for a similar area larger than the site or number of areas as approved by the government.
- Identify the impact the proposed change will have on the water table, implement recovery actions, and monitor the changes and report to the authorities.
- Identify potential flood episodes due to changes, and develop a flood drainage system on the island

3.2.15 Heritage Preservation Regulation (2020/R-37)

This regulation is brought forth under article 11 of Heritage Act (12/2019) to determine, protect, and preserve the heritage of Maldives.

- Article 4 states that cultural heritage can be portable artefacts, historical buildings, historical sites, and cultural skills or talents such as “kasabu viyun”.

- Article 5 states that the value of a heritage item or site will be determined depending on its historical importance, age, category, preservation of authentic condition, and amount of damage.
- Article 6 states that National Center for Cultural Heritage must be informed within 48 hours via the respective island (if from an inhabited island) or atoll council (if from an an inhabited island) if any historical items or sites that could be a heritage item or site is found. Portable artefacts must immediately be handed over to the island or atoll council without any damage.
- Article 6 also states that if the landowner refuses NCCH from assessing the site or items found or refuses to adhere to NCCH's advice on how to deal with items or site, NCCH can acquire a court order under the Heritage Act (12/2019).
- Article 8 states that a 50 feet distance surrounding a heritage site will be protected. And if this distance cannot be acquired, then an adequate distance will be determined by NCCH and council after assessing the importance of the site. No developmental plans aside from those decided by NCCH can be carried out in this area without approval from NCCH.
- Article 9 states that if anybody wishes to excavate or search for heritage artefacts from a predicted historical site, necessary permits must be taken from NCCH.
- Article 12 states no heritage artefacts can only be moved within the country or abroad by its legal owner or guardian with permit from NCCH.
- Article 16 states that:
    - Damaging historical artefacts or sites will be fined an amount between MVR200,000 and MVR1000,000, and trying to damage one will be fined an amount between MVR10,000 and MVR 500,000.
    - Changing the authentic form of any heritage artefacts or sites will be fined an amount between MVR100,000 and MVR800,000, and trying to change one will be fined an amount between MVR10,000 and MVR 300,000.
    - Illegally importing or exporting heritage artefacts of Maldives or any other country will be fined an amount between MVR100,000 and MVR500,000, and

trying to import or export will be fined an amount between MVR10,000 and MVR 100,000.

- Excavating sites to acquire valuable artefacts without the permission of NCCH will be fined an amount between MVR10,000 and MVR100,000, and trying to excavate without permission will be fined with MVR10,000.
- Not informing NCCH or the local council when an artefact or site is found while excavating any area in Maldives will be fined with an amount between MVR10,000 and MVR100,000.
- Spreading false rumors or information regarding heritage artefacts will be fined an amount between MVR10,000 and MVR50,000.

3.2.16 Built environment regulations

This regulation underlines the general guidelines for inhabited islands, uninhabited islands and islands used for other purposes to plan the development accordingly based on population, size, the type of works done on the island and other factors that should be taken into account. All islands are categorized according to the above-mentioned factors to regulate the development activities. Relevant articles under this regulation pertaining to the proposed project are:-

- Article 1.2 states that the Ministry of Housing and Urban Development shall be responsible for monitoring and implementation of Land Use Planning under this regulation with the directions from other relevant government Authorities.
- Article 12 states that if there are any environmentally sensitives sites on any island it shall be protected. However, this does not mean that these areas should be left untouched without any use, rather these areas shall be made use for recreational purposes or some other beneficial purpose without damaging these sites.
- Article 12.2 states that a 20 m buffer zone must be set around all Islands from the coast. However, at harbor area or other commercial areas, if adequate land is unavailable this buffer zone could be reduced.

Annex 1 of the regulation;

- Article 5.4 states that a minimum of 200 feet buffer zone must be set from an STP to residential areas, recreational areas, parks, social spaces, or any places that produce food or drink (fish drying, water storage tank).
- 5.5.1 states that maximum area that can be allocated for a powerhouse is 45m x 45m.
- 5.5.2 states that a distance of at least 200ft shall be kept between the residential area and the powerhouse.
- 5.5.3 states that if the criteria mentioned above is not met for the island, the Ministry of Housing and Urban Development shall be consulted.
- Article 5.6 states that land for Desalination plants shall be allocated by the Ministry of Housing and Urban Development as advised by Ministry of Environment, Energy and Water.

3.2.17 Maldives National Building Code (2019/R-1020)

The Maldives National Building Code R-1020 has been published in the year 2019 and consists of the following chapters.

Part I: building code for type 1 buildings.

- Clause A1 (Classified users): For the purposes of this building code, Type 1 Buildings are classified according to type, under seven categories. A building with a given classified use may have one or more intended uses. The seven categories are:
    - Housing
    - Communal residential
    - Communal non-residential
    - Commercial
    - Industrial
    - Outbuildings
    - Ancillary

- Clause A2 (Interpretation): In PART II of building code unless the context otherwise requires, words shall have the meanings given under this Clause
- Clause B1 (Structure): The objective of this provision is to:
    - Safeguard people from injury caused by structural failure,
    - Safeguard people from loss of amenity caused by structural behaviour, and
    - Protect other property from physical damage caused by structural failure
- Clause B2 (Durability): The objective of this provision is to ensure that a Type 1 Building will, throughout its life, continue to satisfy the other objectives of this code
- Clause C1(means of escape): The objective of this provision is to:
    - Safeguard people from injury or illness from a fire while escaping to a safe place
    - Facilitate fire rescue operation
- Clause C2 (spread of fire): The objective of this provision is to:
    - Safeguard people from injury or illness when evacuating a Type 1 Building during fire.
    - Provide protection to fire service personnel during firefighting operations.
    - Protect adjacent household units and other property from the effects of fire.
    - Safeguard the environment from adverse effects of fire
- Clause C3 (structural stability during a fire): The objective of this provision is to:
    - Safeguard people from injury due to loss of structural stability during fire, and
    - Protect household units and other properties from damage due to structural instability caused by fire.
- Clause C4 (access & facilities for the fire services): The objective of this provision is to:
    - Provide reasonable facilities to assist fire fighters in the protection of life
    - Enable fire appliances to gain access to the building.
- Clause D1(access routes): The objective of this provision is to:
    - Safeguard people from injury during movement into, within and out of Type 1 buildings,

  - Safeguard people from injury resulting from the movement of vehicles into, within and out of Type 1 buildings, and
  - Ensure that people with disabilities are able to enter and carry out normal activities and functions within Type 1 buildings.
- Clause D2 (mechanical installations for access): The objective of this provision is to:
  - Safeguard people from injury and loss of amenity while using mechanical installations for movement into, within and out of Type 1 buildings,
  - Safeguard maintenance personnel from injury while servicing mechanical installations for access, and
  - Ensure that people with disabilities are able to carry out normal activities and processes within Type 1 buildings
- Clause E1(surface water): The objective of this provision is to:
  - Safeguard people from injury or illness, and other property from damage, caused by surface water
  - Protect the outfalls of drainage systems.
- Clause E2 (external moisture): The objective of this provision is to safeguard people from illness or injury which could result from external moisture entering the Type 1 building
- Clause E3 (internal moisture): The objective of this provision is to:
  - Safeguard people against illness or injury which could result from accumulation of internal moisture
  - Protect household units and other properties from damage caused by free water from occupancy in the same building.
- Clause F1(hazardous agents on site): The objective of this provision is to safeguard people from injury or illness caused by hazardous agents or contaminants on a site
- Clause F2 (hazardous building materials): The objective of this provision is to safeguard people from injury and illness caused by exposure to hazardous building materials.

- Clause F3 (hazardous substances and processes): The objective of this provision is to safeguard people from injury or illness, and other property from damage, caused by hazardous substances or processes in buildings
- Clause F4 (Safety from Falling): The objective of this provision is to safeguard people from injury caused by falling
- Clause F5 (Construction and Demolition hazards): The objective of this provision is to safeguard people from injury, and other property from damage, caused by construction or demolition site hazards.
- Clause F6 (lighting for emergency) : The objective of this provision is to safeguard people from injury due to inadequate lighting being available during an emergency
- Clause F7 (warning systems) : The objective of this provision is to safeguard people from injury or illness due to lack of awareness of an emergency
- Clause F8 (signs) : The objective of this provision is to:
    - Safeguard people from injury or illness resulting from inadequate
    - identification of escape routes, or of hazards within or about the Type 1 building,
    - Safeguard people from loss of amenity due to inadequate direction, and
    - Ensure that people with disabilities are able to carry out normal activities and processes within buildings
- Clause G1(personal hygiene) : The objective of this provision is to:
    - Safeguard people from illness caused by infection or contamination,
    - Safeguard people from loss of amenity arising from the absence of appropriate personal hygiene facilities, and
    - Ensure people with disabilities are able to carry out normal activities and processes within Type 1 buildings.
- Clause G2 (laundering) : The objective of this provision is to ensure:
    - Adequate amenities for people to do laundering, and
    - That people with disabilities are able to carry out normal activities and processes within Type 1 buildings

- Clause G3 (food preparation and prevention of contamination) : The objective of this provision is to:
    - Safeguard people from illness due to contamination,
    - Enable hygienic food preparation without loss of amenity, and
    - Ensure that people with disabilities are able to carry out normal activities and processes within Type 1 buildings
- Clause G4 (ventilation) : The objective of this provision is to safeguard people from illness or loss of amenity due to lack of fresh air.
- Clause G5 (interior environment) : The objective of this provision is to:
    - Safeguard people from illness caused by excessive air temperature,
    - Safeguard people from injury or loss of amenity caused by inadequate activity space,
    - Ensure that people with disabilities are able to carry out normal activities and processes within Type 1 buildings
- Clause G6 (airborne and impact sound) : The objective of this provision is to safeguard people from illness or loss of amenity as a result of undue noise being transmitted between abutting occupancies
- Clause G7 (Natural Light): The objective of this provision is to safeguard people from illness or loss of amenity due to isolation from natural light and the outside environment.
- Clause G8 (Artificial light): The objective of this provision is to safeguard people from injury due to lack of adequate lighting.
- Clause G9 (Electricity): The objective of this provision is to ensure that: In Type 1 buildings supplied with electricity, the electrical installation has safeguards against outbreak of fire and personal injury
- Clause G10 (Piped service) : The objective of this provision is to safeguard people from injury or illness caused by extreme temperatures or hazardous substances associated with building services.
- Clause G11(gas as an energy source): The objective of this provision is to:
    - Safeguard people from injury arising from the use of gas as an energy source,

  - Safeguard people and other property from the risk of fire or explosion, and
  - Safeguard people from loss of amenity due to the gas supply being inadequate for the intended use.
- Clause G12 (water supplies): The objective of this provision is to:
  - Safeguard people from illness caused by infection from contaminated water or food,
  - Safeguard people from injury due to the explosion of a pressure vessel or from contact with excessively hot water,
  - Ensure that people with disabilities are able to carry out normal activities and functions within Type 1 buildings
- Clause G13(Foul water) : The objective of this provision is to:
  - Safeguard people from illness due to infection or contamination resulting from personal hygiene activities, and
  - Safeguard people from loss of amenity due to the presence of unpleasant odours or the accumulation of offensive matter resulting from foul water disposal
- Clause G14 (industrial liquid waste) : The objective of this provision is to safeguard people from injury or illness caused by infection or contamination resulting from industrial liquid waste
- Clause G15 (solid waste) : The objective of this provision is to safeguard people from injury or illness caused by infection or contamination from solid waste
- Clause H1 (energy efficiency) : The objective of this provision is to facilitate efficient use of energy.

3.3 Guidelines and Technical Specifications

This section describes the applicable guidelines and technical specifications pertaining to this proposed project.

3.3.1 Guideline for Uprooting, Cutting and Transportation of Palms and Trees (published on 06th June 2017)

This guideline was made under Article 5(a) of the regulation on uprooting, cutting and transportation of palms and trees, to specify the guideline for giving approval to uprooting, cutting and transportation of trees. Relevant articles under this guideline pertaining to the proposed project are:-

- Article 3 states that while giving approval for uprooting, cutting and transportation of trees for any project, the following must be fulfilled;
    - The project strictly requires land clearance
    - The budget for the project has been approved
    - Approval from the relevant government body for the project
- Article 4 states that, in order to obtain approval for uprooting, cutting and transportation of trees under this guideline, the proponent must apply for approval from EPA through the application form on Schedule 1.
- Article 5 states the procedure for giving approval for uprooting, cutting and transportation of trees. The first step is for the proponent to submit information on the type, size, numbers and location of trees to EPA. If there are no prohibited trees to be removed in the area and if the total number of trees to be removed is less than 200 or the land clearance area is less than 8250 m^2, then approval shall be given under this guideline with a set of mitigation measures to be followed by the proponent.

3.3.2 Guideline for power system approval

The guideline for power system approval highlights the sets of information required to be submitted to URA for the approval process which includes details about the generation system, generator control panel and distribution panel, fuel system, distribution network, electric cable, firefighting system and lighting protection, EIA of the generation facility, tariff and rules and regulations of powerhouse for consumers.

The registration process of the newly constructed powerhouse will commence as soon as the construction of the powerhouse is completed.

3.3.3 Waste Incinerator Guideline

The waste incinerator guideline (WIG) of the EPA Maldives came into effect in 2016 aimed at facilitating the construction and operation of incinerators safely and to mitigate the adverse environmental and health impacts that may arise. The objective of the guideline is to prevent or limit, as far as practicable, negative effects on the environment, in particular pollution by emission into air, soil, surface and groundwater, and the resulting risks to human health, from combustion of waste using incinerators.

As per article 4.1 of the WIG, the site for waste incinerators must be selected in ways that it would not pose any hazard to the surrounding environment and the local community. The proposed project complies with this article such that the chimneys of the powerhouses will be installed far away from the residential area and sensitive land uses. Additionally, the site is selected so that the prevailing winds carry the emitted gases away from the residential area/island. Preconstruction environmental clearance permits and monitoring will be carried out at the proposed location and background emissions established in order to enable future changes to be identified.

3.3.4 Requirement for Fire Prevention Equipment in the building

This is a guideline enforced by the Ministry of Defense and National Security of the Maldives which sets out a list of requirements and standards that need to be met in fire prevention equipment provided in buildings prone to fire hazards. As the whole guideline pertains to any power generating facility, hence to this project, the main points have been highlighted as follows:-

- **Hose reel**: Should comply with the specified standards under the guideline. The overall width of the reel should be no more than 850mm. The overall height of the Reel should be less than 850mm including Hose and integral Flexi guide for hose withdrawal guide.

The overall depth of the hose reel should be no more than 150mm. The colour of the Reel should be Red, fitted with an operating instruction plate. The Hose Reels nozzle retainer or hose guide and the inlet valve should be fitted at a height of about 900mm above floor level;

- **Hose reel cabinets**: The hose reel cabinet should be Recess mounting type with or without glass-paneled door for use with the above-mentioned sized Hose Reels. Hose Reel Cabinet dimension should be no more than 900mm in width, 900mm in height, 160mm in depth (including door). The colour of the cabinet should be Red. Special permission should be taken for other Colour. Recessed Latch Type handle should be installed. Hose reel signage should be in accordance with BS 5499 or any other equable International Standard. Fixing hole should be provided;
- **Water supply for hose reel system**: Should be such that when the two topmost reels in the building are used simultaneously, each should provide a jet of about 6 m in length and will deliver less than 0.5 L. Minimum storage required for the hose reel is 2275 L and 1137.5 L up to a maximum of 9100 L for each additional reel. Tanks supplying water for domestic purposes should not be used as a suction tank for hose reel installation. The pipings for the supply of water for hose reel should be in and out galvanized schedule 40. Diameter of the piping should not be less than 50 mm;
- **Hose reel booster pump system**: Hose reel booster pump set, complete with in and out galvanized steel pipework with or without expansion vessels;
- **Fire extinguishers**: 2kg CO_2 stored pressure Extinguisher approved to BS EN 3. Aluminium Alloy Body approved to BS5045 Part 3 or any other equable International Standard. Red body with black band or Black colored head cap, swivel Horn, English screen. Fully charged. 6 Kg DCP Extinguisher (Gas Cartridge Type) approved to BS EN 3 or any other equable International Standard. Blue Body Headcap, English Screen, Fully charged. 9 Liter Water Extinguisher (Gas Cartridge Type) approved to BS EN 3 or any other equable International Standard. Red Body Headcap, English Screen, Fully charged. Fire Extinguishers should be located in conspicuous positions on brackets or stands where they will be readily seen by person. The carrying handle of larger heavier

extinguishers should be about 01m from the floor level. But smaller extinguishers should be mounted so as to position the handle 1.5m from the floor level;

- **Cabinets for fire extinguishers**: Cabinets for fire extinguishers should be of stainless steel with or without glass-fronted doors. The colour of the cabinet should be Red or to suit the requirements of architectural surroundings. Recessed Latch Type handle should be installed. Fire Extinguisher Single Cabinets dimension should be no more than 190mm in width, 640mm in height, 180mm in depth (including door). Fire Extinguisher Double Cabinets dimension should be no more than 440mm in width, 640mm in height, 180mm in depth (including door);
- **Fire Blankets**: Fire Blankets should be certified to BS EN 1869: 1997 or any other equable International Standard. Fire Blankets should be extremely flexible and drape easily the slim pack of fire blanket should be Red or White;
- **Dry riser gate valve**: Dry riser gate valve to BS 5041/2, or any other equable International Standard, Gunmetal c/w Padlock strap, blank cap and chain. Inlet 2 ½” ASA 150 F/F. Outlet 2 ½” Inst. Female couplings to BS 336. Colour red;
- **Dry riser outlet box**: Dry riser outlet box for Dry Riser gate valve. Construction should be similar to BS 5041. Standard finish colour Red. Dry Riser outlet cabinet dimension should be as specified in the guideline;
- **Pumping in breeching**: Twin pumping in breeching, approved to BS 5041, or any other equable International Standard, Gunmetal inlets 2 x 2 ½” BS Instantaneous Male Coupling c/w non-return valves. Outlet 4” ANSI 150 F/F flange;
- **Dry riser inlet box**: Dry Riser inlet box for horizontal/vertical pattern. Double inlet to BS 5041 or any other equable International Standard finish color Red. Dry riser inlet cabinet dimension for flush mounting should be as specified in the guideline.
- **Air release valve**: Air release valve, Gunmetal, Inlet 1” BSP Male;
- **Piping for dry riser system**: The Piping for Dry Riser System should be In and Out Galvanized schedule 40. The diameter of the Piping should be not less than 100mm.
- **Fire doors**: All fire doors should be opened to the direction of the flow of people while on emergency. These doors should be installed with a self-closing device including the

Panic Latch. These Panic Latch devices should conform to BS 5725 Pt 1 or any other equable International Standard. Fire doors conforming to the method of construction as stipulated in the guideline;

- **Fire exit signs**: Photoluminescent Fire exit signs should sign each Fire Exit Door. The Symbol height should be no more than 100mm;
- **Fire detection and alarm system**: Fire Detection and Alarm System should conform to BS 5839 or any other equable International Standard. Fire Detection and Alarm System should be Analogue Addressable System with mimic diagram. A system in which signals from each detector and/or call point are individually identified at the control panel. Fire Detection and Alarm System should consist of Automatic Detectors, Manual Call Points, Control and Indicating equipment, etc. It should also cover System capable of providing signals to initiate, in the event of fire, the operation of ancillary services such as fixed fire extinguishing systems and other precautions and actions. Main Fire Control Panel should be located at the reception and the Repeater Panel should be located in the guardroom;
- **Installation and testing of wet riser system**: Wet rising systems shall be provided in every building in which the topmost floor is more than 30.5 meters above the fire appliance access level. A hose connection shall be provided in each firefighting access lobby. Wet risers shall be of minimum 152.4 millimeters diameter and shall be hydrostatically tested at a pressure 50% above the working pressure required and not less than 14 bars for at least twenty-four hours. Each wet riser outlet shall comprise standard 63.5 millimeters instantaneous coupling fitted with a hose of not less than 38.1 millimeters diameter equipped with an approved typed cradle and a variable fog nozzle. A wet riser shall be provided in every staircase which extends from the ground floor level to the roof and shall be equipped with a three-way 63.5 millimeters outlet above the roofline. Each stage of the wet riser shall not exceed 61 metres unless expressly permitted by D.G.F.S but in no case exceeding 70.15 meters;
- **Wet or dry rising systems for buildings under construction**: Where either wet or dry riser system is required, at least one rise shall be installed when the building under

construction has reached a height of above the level of the fire brigade pumping inlet with connections thereto located adjacent to a useable staircase. Such riser shall be extended as construction progress to within two floors of the topmost floor under construction and where the designed height of the building requires the installation of wet riser system fire pumps, water storage tanks, and water main connections shall be provided to serve the riser;

- **Wet riser booster pump system**: Wet riser booster pump set, complete with In and Out galvanized steel pipework with or without expansion vessel and specified in the guideline;
- Symbols, as well as installation of firefighting systems on the basis of building usage, are outlined on the table in the guideline; and
- All equipment mentioned above should be approved by the Maldives National Defense Force (MNDF) fire and rescue services before installation. Special permission should be taken if different from the guideline specifications.

3.4 International Conventions, Plans and Programs

This section describes international conventions, plans and programs that are relevant to the proposed development.

3.4.1 United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol

UNFCCC is the first binding international legal instrument that deals directly with the threat of climate change. It was enacted at the 1992 Earth Summit in Rio de Janeiro and came into force on the 21st of March 1994.

Signatory countries have agreed to take action to achieve the goal outlined in Article 2 of the Convention which addresses the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system," Thus all Parties to the Convention are committed under Article 4 to adopt national programs for mitigating climate change, promote sustainable management and conservation of greenhouse gas (GHG) sinks such as coral reefs, to develop adaptation strategies, to address climate change in relevant social, economic and environmental policies, to cooperate in technical, scientific and educational matters and to promote scientific research and exchange of information.

The Kyoto Protocol entered into force on the 16th of February 2005 and is an international and legally binding agreement to reduce GHG emissions globally. It strengthens the Convention by committing Annex I Parties to individual, legally-binding targets to achieve limitations or reductions in their GHG emissions. Maldives has signed and ratified both the Convention and the Protocol.

3.4.2 Paris Agreement

The Paris Agreement is also an agreement within the framework of the UNFCCC dealing with GHG emission mitigation, adaptation and finance proposed to start in the year 2020. Upon opening for signatories on 22 April 2016, 180 UNFCCC members have signed the treaty (including Maldives), however, only 22 of which ratified it so far which is not enough for the treaty to enter into force yet. The aim of the convention as described in Article 2 of the treaty is "enhancing the implementation" of the UNFCCC through:-

i. Holding the increase in global average temperature to well below 2° C above pre-industrial level and to pursue efforts to limit the temperature increase to 1.5° C above pre-industrial levels, recognising that this would significantly reduce the risk and impacts of climate change;
ii. Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and lower GHG emissions development in a manner that does not threaten food production; and
iii. Making finance flows consistent with a pathway towards low GHG emissions and climate resilient development.

3.4.3 The Vienna Convention for the Protection of the Ozone Layer

The Vienna Convention for the Protection of the Ozone Layer is a multilateral environmental agreement which entered into force in 1988. It acts as a framework for the international efforts to protect the ozone layer. In 2009, the Vienna Convention became the first convention of any kind to achieve universal ratification. The objective of the Convention were for the Parties to promote corporation by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer. Maldives has signed and ratified this convention and adheres to it.

3.4.4 The Montreal Protocol on Substances that Deplete the Ozone Layer

The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to reduce production and consumption of ozone depleting substances in order to phase out the production and abundance of substances that are responsible for depletion of the ozone layer. This protocol entered into force on 1 January 1989. Since its adoption, it has undergone 8 revisions and the Maldives abide by 4 of those addendums mentioned below:-

- The London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1990);
- The Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1992);
- The Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1997); and
- The Beijing Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1999).

3.4.5 Agenda 21

Agenda 21 is a non-binding voluntary implemented action plan of the United Nations (UN) with regards to sustainable development. It is a comprehensive plan of actions taken globally, nationally and locally by organizations of the United Nations System, Governments and Major Groups in every area in which humans impact on the environment. It is also an outcome of the Earth Summit (UN Conference of Environment and Development) held in Rio De Jeneiro, Brazil in 1992. Maldives is among the 178 countries which adopted this action plan. Out of the 4 sections it is grouped into, the proposed development pertains to:-

i. Section I: *Social and Economic Dimensions* which is directed towards combating poverty, especially in developing countries, changing consumption patterns, promoting health, achieving a more sustainable population and sustainable settlement in decision making; and
ii. Section II: *Conservation and Management of Resources for Development* which includes atmospheric protection, combating deforestation, protecting fragile environments, conservation of biodiversity, control of pollution and the management of biotechnology and radioactive wastes.

3.4.6 Sustainable Development Goals

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

The Sustainable Development Goals are:

- No Poverty

- Zero Hunger
- Good Health and Well-being
- Quality Education
- Gender Equality
- Clean Water and Sanitation
- Affordable and Clean Energy
- Decent Work and Economic Growth
- Industry, Innovation, and Infrastructure
- Reducing Inequality
- Sustainable Cities and Communities
- Responsible Consumption and Production
- Climate Action
- Life Below Water
- Life On Land
- Peace, Justice, and Strong Institutions
- Partnerships for the Goals

3.4.7 Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD), formally known as the Biodiversity Convention, is a multilateral treaty which entered into force on 29 December 1993. The convention has 3 main goals:-

i. Conservation of biodiversity;
ii. Sustainable use of its components; and
iii. Fair and equitable sharing of benefits arising from genetic resources.

The objectives of the convention is to develop national strategies for the conservation and sustainable use of biodiversity.

3.4.8 Washington Declaration on Protection of the Marine Environment from Land-based Activities

Maldives is a signatory to the Washington Declaration on Protection of the Marine Environment from Land-based Activities which intends at setting a common goal sustained and effective action to deal with all land-based impacts upon the marine environment, specifically those resulting from sewage, persistent organic pollutants, radioactive substance, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization, litter and physical alteration and destruction of habitat.

3.4.9 Regional plans and programs

In addition to the international treaties and conventions, Maldives is also a key player in the formulating and adopting of various regional plans and programs to protect the environment by actively participating in activities organised by several regional bodies. As such, Maldives is committed to the following which pertains to the proposed project: -

- South Asian Association for Regional Corporation (SAARC) Environment Action Plan adopted in Male' in 1997;
- SAARC Study on Greenhouse Effect and its Impacts on the Region;
- South Asian Regional Seas Action Plan and Resolutions concerning its implementation (1994); SAARC Study on Causes and Consequences of Natural Disasters;
- South Asian Seas Program; and
- Male' Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia (1998).

3.5 Required Permits and Approvals

The following permits and approvals shall be obtained from the relevant authority prior to commencement of construction phase of the project:-

Table 4. Permits and Approvals required for the proposed development

Permits/Approvals	Approving Agency/Authority	Status
EIA Decision Statement	EPA	Ongoing through the current EIA
Concept Approval	Ministry of Fisheries and Marine Resources	Acquired
Registration of facilities of RO plant and powerhouse	URA	To be applied for once construction is completed

3.6 Compliance of the Proposed Proposal to Statutory Requirements

All statutory requirements pertaining to this project shall be adhered to by the proponent during detail design phase, construction and operational phase. Furthermore, any changes to the legislative framework shall be considered and required changes shall be brought to project components as necessary.

4. PROJECT DESCRIPTION

This chapter describes the specific components of the proposed project in detail as per the approved ToR which is given the appendix section Appendix C of this EIA report.

4.1 Project location

The proposed agriculture development project is located in the island of Thun'buri in Hadhunmathi atoll (Laamu) at 2°04'28.47" N and 73°32'24.41" E. The nearest airport is L. Kahdhoo Airport approximately 22 km south of Thunburi. The closest islands to the project location are; inhabited island of L. Dhanbidhoo approximately 697 m north of Thun'buri. Next, Isdhoo and Kalhaidhoo which is approximately 3.34 km north of L. Thun'buri. The closest uninhabited islands to the project location are Hulhiyandhoo which is approximately 14 m north of L. Thun'buri and Dhonberahaa which is approximately 343 m southwest of L. Thun'buri. Holhurahaa which is approximately 300 m south of L. Thun'buri. There are no environmentally protection or sensitive areas within 5km of the project island.

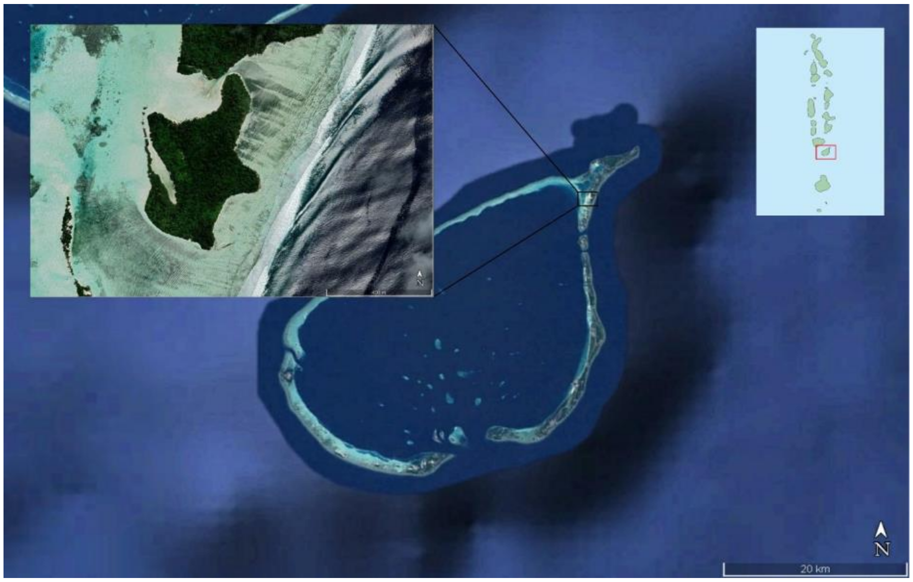
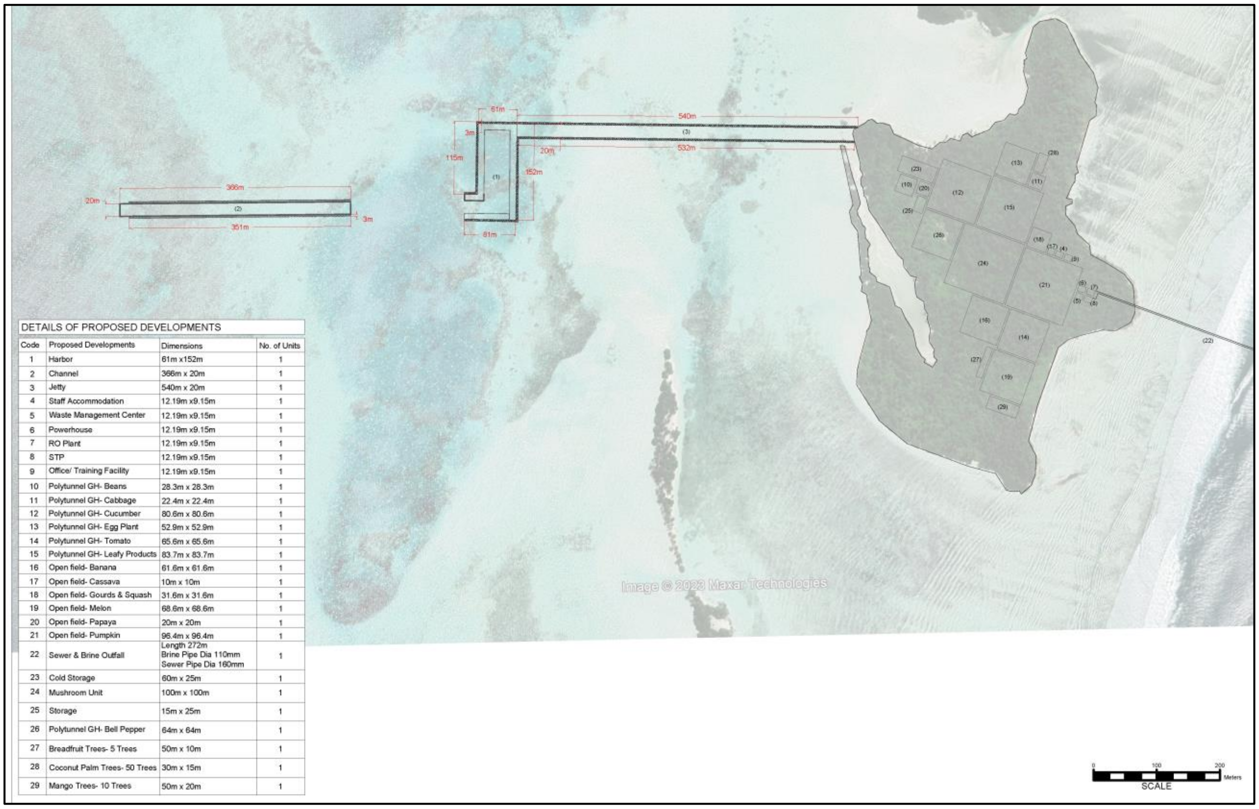


Figure 3: Location of proposed project island of Thunburi

4.2 Project overview

The government of the Maldives is in the processes of further strengthening food security and economic diversification process especially after the lessons learned from the recent pandemic. As such the Fisheries Ministry has leased several Island for agricultural purpose. The project Island is one such Island acquired by the proponent through competitive bidding. An Initial Environment Examination (IEE) has already been done during the acquisition of the Island. The following concept is proposed for the island. The Figure 4 shows a partial print of the proposed concept



DETAILS OF PROPOSED DEVELOPMENTS

Code	Proposed Developments	Dimensions	No. of Units
1	Harbor	61m x152m	1
2	Channel	366m x 20m	1
3	Jetty	540m x 20m	1
4	Staff Accommodation	12.19m x9.15m	1
5	Waste Management Center	12.19m x9.15m	1
6	Powerhouse	12.19m x9.15m	1
7	RO Plant	12.19m x9.15m	1
8	STP	12.19m x9.15m	1
9	Office/ Training Facility	12.19m x9.15m	1
10	Polytunnel GH- Beans	28.3m x 28.3m	1
11	Polytunnel GH- Cabbage	22.4m x 22.4m	1
12	Polytunnel GH- Cucumber	80.6m x 80.6m	1
13	Polytunnel GH- Egg Plant	52.9m x 52.9m	1
14	Polytunnel GH- Tomato	65.6m x 65.6m	1
15	Polytunnel GH- Leafy Products	83.7m x 83.7m	1
16	Open field- Banana	61.6m x 61.6m	1
17	Open field- Cassava	10m x 10m	1
18	Open field- Gourds & Squash	31.6m x 31.6m	1
19	Open field- Melon	68.6m x 68.6m	1
20	Open field- Papaya	20m x 20m	1
21	Open field- Pumpkin	96.4m x 96.4m	1
22	Sewer & Brine Outfall	Length 272m Brine Pipe Dia 110mm Sewer Pipe Dia 160mm	1
23	Cold Storage	60m x 25m	1
24	Mushroom Unit	100m x 100m	1
25	Storage	15m x 25m	1
26	Polytunnel GH- Bell Pepper	64m x 64m	1
27	Breadfruit Trees- 5 Trees	50m x 10m	1
28	Coconut Palm Trees- 50 Trees	30m x 15m	1
29	Mango Trees- 10 Trees	50m x 20m	1

Figure 4:Partial print of the proposed concept design

4.3 Scope of the EIA

Currently the proponent wishes to establish the utility services and the accessibility for the island and as such these components are the scope of the current EIA, with the addition of the land clearance for the proposed infrastructures. Therefore, the development areas included in the current EIA from the proposed concept (Figure 4) are the harbour, Channel, Jetty, Waste Management Center, Powerplant, RO Plant, STP, brine outfall and sewer outfall. A separate EIA will be submitted for the development and operation of farming facilities on the island.

4.4 Project components

This section describes in detail the project activities that are likely to cause significant impacts to the environment.

4.4.1 Water facility

The 150 TPD RO plant will be used to produce sufficient water to meet the peak demand supplemented by rainwater. A backup 50 TPD RO plant will also be established under the proposed project. No groundwater would be utilized for the proposed project.

4.4.1.1 Rainwater harvesting

The rainwater would be harvested from roofs of all the infrastructure to be established in the island. The water shall be collected through a gravity conveyance pipeline to an underground sump well located at the main water treatment plan (WTP) site. The collected water will then be lifted to raw water storage tank to maximize the feed of rainwater during showers. The rainwater will then be carried through ultrafiltration and disinfection process to remove components such as suspended particles, parasites, colloids and bacteria. First flush mechanism at infrastructure gutters and small underground maintenance shafts at the aforementioned institutions will be built for easier operation and maintenance of the rain water harvesting scheme. After treatment, the rainwater will be mixed with the desalinated water in a mixing tank.

4.4.1.2 RO plant

RO plant with a capacity of 150TPD with a stand by system of 50 TPD will be established RO plant will occupy an area of 111 sqm with dimensions of 12.19m x 9.15m. Five tanks of the capacity 10,000 L each will be installed with the RO plant to keep a storage of 50 m3 at all times. Feedwater for the plant will be taken through a beach-well constructed on the eastern side of the island.

4.4.1.2.1 *Pre-treatment*

The raw water from bore well will pass through primary filtration system which consists of filter or screen filter of 50 microns and bag filter with 5 microns. The primary filtration removes dirt, dust and other sediments in raw water before being fed to RO membranes. The primary filtration system protects high pressure pump and RO membranes from very fine particles.

The raw water may contain high amount of hardness which may tend to precipitate when concentrated by RO membranes. Thus, with the use of synthetic antiscalents it is possible to operate with a positive Langlier Saturation Index (LSI), a method of determining the scaling or corrosive potential of water based on the level of saturation of calcium carbonate. The antiscalents dosing shall be added to the pre-treatment consisting of an electronic dosing pump & HDPE/FRP solution preparation tank.

4.4.1.2.2 *Reverse Osmosis Filtration*

The pre-treated water will be led into the RO plant, where high pressure pumps will pump in pressurized water through pressure vessels with spiral wound RO membranes. Spiral wound reverse osmosis membranes filters the feed water, producing 40 percent of fresh water and the rest as concentrated brine or reject water.

The quality and quantity of permeate shall be supervised by the conductivity meter and flow meter. When the permeate water quality drops below the preset level, it will automatically divert to drain preventing low quality water to the storage tank. Furthermore, the plant shall be equipped with flow meters for feed water and permeates as well as pressure transmitter/switches shall be incorporated so that it can automatically stop the plant in case of failure of feed water (low inlet pressure) and back pressure in the permeate line (high outlet pressure).

4.4.1.2.3 *Post treatment*

The product water or permeate from the RO process is passed through a Degassifier to remove the dissolved Hydrogen Sulphide. It is then diverted to the storage tank by pumping. A disinfectant solution (Hypo Chloride) will be dosed in to the inlet water pipeline of the storage tank. The disinfectant dozing pump system is a system that feed with set points in order to maintain a constant level of disinfectant in the distributed water.

4.4.1.2.4 Description of RO plant operation

The operation of RO plant will be in two modes i.e. Automatic Mode and the Manual Mode. Below is a small description of the two modes.

4.4.1.2.4.1 Automatic mode

To start up the plant, operator has to select the operation mode to automatic. After that the microprocessor in the control panel will take care of the whole process until it is fully started. Success operation of each process triggers to follow the next process. Therefore, failure of one process will fail the next process, thus fails the startup. This is a safety precaution made during programming of the processor.

The starting sequence of the plant is as follows:

- Selection of the Automatic Mode by the operator.
- Starting of the feed water (bore well) pump. As this pump starts the sensor/transmitter checks the pressure across the Sand filter and the bag filter. If it is not within the set limits the plant will be tripped for the necessary action like backwashing of sand filter or changing of the bag filters. If it is through then it follows the next step.
- After the feed water is circulated through the membranes for the set time period to removes the airlocks. The pressure in the system will be raised to a few bars. After a time delay the next step will be triggered.
- Starting of the High Pressure (HP) pump. The HP pump speed will increase gradually until it reaches the set limit. This is to control the high starting current of the motor. As this is started the transmitters/sensor in the HP line will monitor the pressure increase of the system. If it goes beyond setting the plant will be tripped as a safety precaution. It will

monitor the membrane inlet pressure, pressure difference across the membrane modules, conductivity of the permeate etc.

- When the plant is stabilized, the permeate bypass valve will close and permeate valve in the permeate line will open and let the product water to flow to the Degassifier, dosing system and storage tank
- Treated Water storage tank is proposed to store water from RWH system and
- R.O. plant system. Pumped distribution system is proposed. Two pumps; one pump is in operation and the other work as standby is proposed. The control system designed tomaintain the constant pressure in the network hence standby pump will start automatically in any instance if the set pressure cannot be maintained by the pump in operation.

4.4.1.2.4.2 Manual Operation

Basically, in the manual operation each stage of the whole process will have to start and stop manually. This is risky since minimal alarms and protection is active.

Protections

The following protections are available in the system.

- Prevent operation of the plant with very low or no water flow to the system
- Very High pressure to the membranes
- Blockage/high pressure of the permeate line
- Low Quality water going in to the tanks

Alarms

The system will be designed and programmed to give the following alarms. Alarm LED will be ON in the control panel.

- Feed pump Failure
- Low feed pressure

- High Pressure Pump Failure
- High Membrane Inlet Pressure
- High Permeate Conductivity

4.4.1.2.5 Power supply

RO plants and equipment's will primarily be running from Island Power source. However, a Generator set to accommodate the power requirements as a backup system with capacity to run up to 8 hours will be established with capacity run in case of power failure from the Island Power Source.

4.4.1.2.6 Brine Disposal

A brine disposal line would be laid to dispose the reject water from RO plant deep into the sea. It is proposed to lay OD 160mm PE100 PN16 PE pipe. The location of the brine outfall pipeline is provided in Figure 4. The

Figure 6 provide the anchoring details while Figure 5provides the diffuser details.

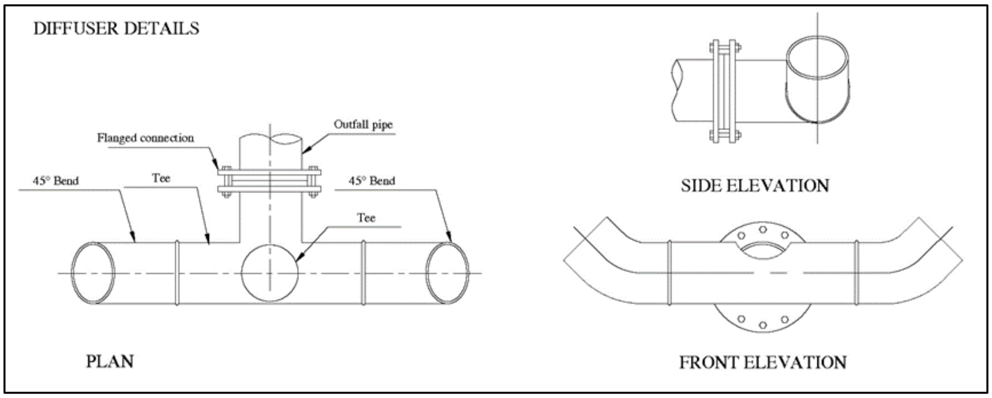


Figure 5: Brine diffuser details

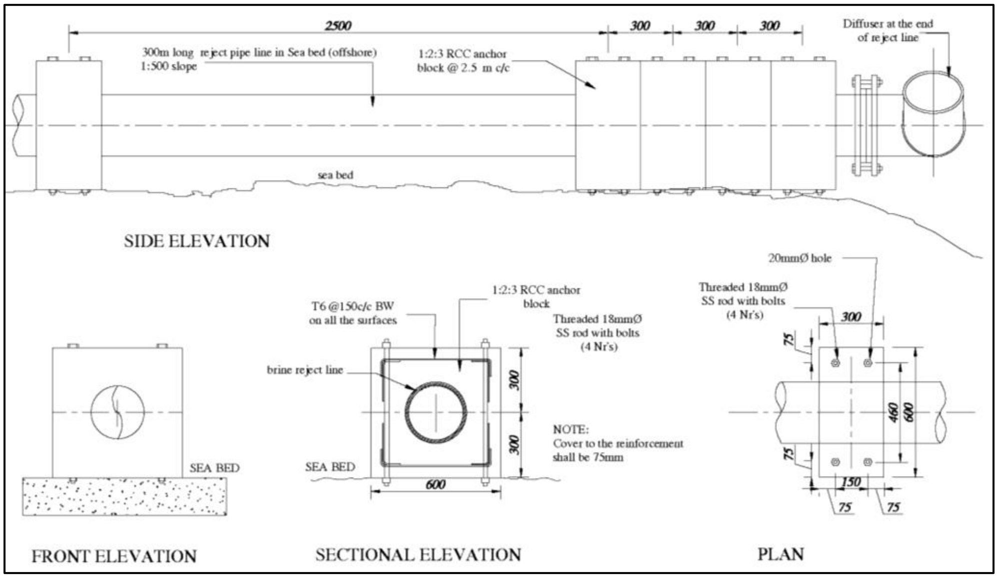


Figure 6: Anchoring details

4.4.1.2.7 Disinfection

The term ‘disinfection’ means the destruction of inactive organisms in water to such low levels that no infection of disease results when the water is consumed for drinking purpose. For small plants the following disinfectants are commonly used.

Ultra-violet radiation	• Ultraviolet radiation is suitable for disinfection of water which is free from suspended matter, turbidity and color. It is more effective against bacteria that viruses and bacterial spores. UV is best suited to ground waters which require disinfection only. • For Project Island disinfection by Ultraviolet (UV) radiation is proposed for RWH system and chlorination is proposed for RO system

Products releasing chlorine e.g. calcium hypo chlorite (Ca(OCl)2) sodium hypochlorite (NaOCl), chlorine tablets	• Sodium hypochlorite solution is available as a household disinfectant (bleach) under many brand names. It can be produced by electrolysis of brine and can be used for water work purpose; it is a clear solution containing 14-15% available chlorine. It can be supplied in small container or in bulk but loses its chlorine strength when exposed to atmosphere or sunlight. • Dosing of hypochlorite can be achieved by positive displacement, reciprocating diaphragm pumps.
Calcium hypochlorite in powder form commonly known as ‘Bleaching Powder’ is widely used for disinfection of water supplies	• A measured quantity of bleaching powder is mixed in the water tank and allowed to settle. The supernatant containing chlorine is drawn off and diluted to the dosing concentration in the storage tank. The supernatant is injected into the water to be treated by means of positive displacement, reciprocating pumps of the diaphragm type or constant level feeders. • Bleaching powder is an unstable compound and loses its available chlorine on storage. All these considerations make its use uneconomical

4.4.1.2.8 Output water quality

The output quality of the desalination plant shall comply to the supply water quality standards. The following parameters need to be tested in accordance to the below mentioned timelines during the operational phase.

4.4.1.2.8.1 Daily tests

Parameter	Reference range
Free Chlorine	0.04 - 0.2 mg/l
pH	6.5 - 8.5
Physical Appearance	Clear & Colorless
Electrical Conductivity	<1000 µs/cm
Total Coliform	0/100ml CFU
Fecal Coliform	0/100ml CFU
Turbidity	<1 NTU
Total Dissolved Solids	<500 mg/L

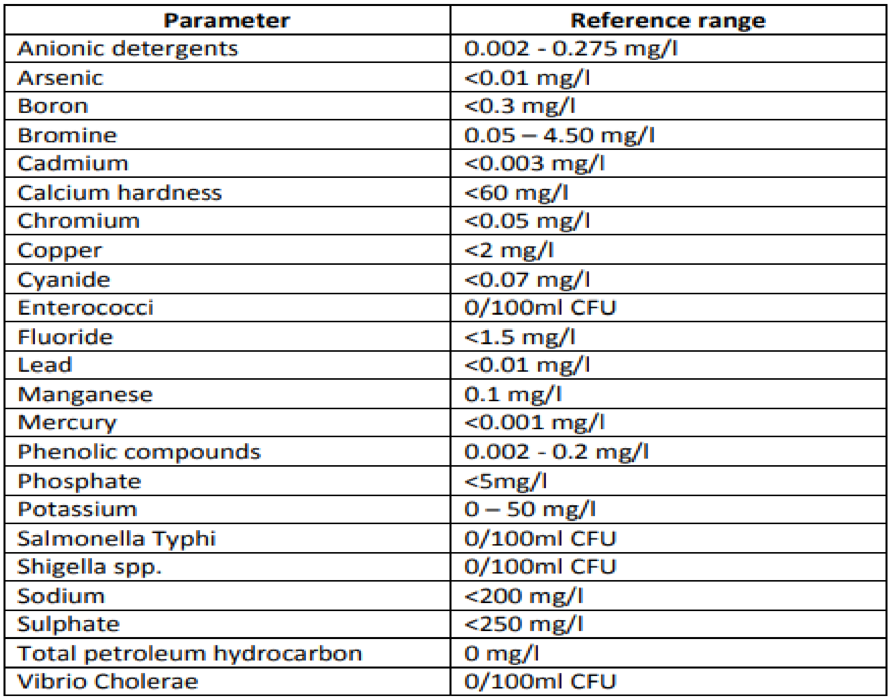
4.4.1.2.8.2 Monthly tests

Parameter	Reference range
Chlorides	<200 mg/l
Nitrates	<50 mg/l
Ammonia	<0.02 – 2.50 mg/l
Iron	<0.3 mg/l
Hydrogen Sulphide	0.05 mg/l
Total Hardness	<75 mg/l
Suspended Solids	5-750 mg/L

4.4.1.2.8.3 Bi-annual tests

Parameter	Reference range
Total viable count at 22°C	100/1ml CFU
Total viable count at 37°C	20/1ml CFU

4.4.1.2.8.4 Annual tests



Parameter	Reference range
Anionic detergents	0.002 - 0.275 mg/l
Arsenic	<0.01 mg/l
Boron	<0.3 mg/l
Bromine	0.05 – 4.50 mg/l
Cadmium	<0.003 mg/l
Calcium hardness	<60 mg/l
Chromium	<0.05 mg/l
Copper	<2 mg/l
Cyanide	<0.07 mg/l
Enterococci	0/100ml CFU
Fluoride	<1.5 mg/l
Lead	<0.01 mg/l
Manganese	0.1 mg/l
Mercury	<0.001 mg/l
Phenolic compounds	0.002 - 0.2 mg/l
Phosphate	<5mg/l
Potassium	0 – 50 mg/l
Salmonella Typhi	0/100ml CFU
Shigella spp.	0/100ml CFU
Sodium	<200 mg/l
Sulphate	<250 mg/l
Total petroleum hydrocarbon	0 mg/l
Vibrio Cholerae	0/100ml CFU

4.4.1.2.8.5 Emergency response

In case of failure of the desalination plant, the backup RO plant would start to function. In case the backup RO plant fails to function, supply water is to be provided to the island before the existing water storage runs out. This process would be continued until the all the RO plants are repaired and back to operations.

4.4.2 Sewerage facilities

The proposed project involves establishing a gravity-based sewer network and sewer facilities at the island. The selected is conventional system, the main components of the system are the pump station, network and a sewerage treatment plant with effluent disposing pipeline to open sea via sea outfall. Outfall pipe is inclined to a depth below 6m from MSL.

4.4.2.1 Excavation and Dewatering

The Maldives is a unique environment with respect to construction of wastewater systems due to the extremely high-water tables which on average are between 0.5 and 1.5m below ground level. Because of this, extensive dewatering is required during construction and installation of pipe networks which increases in intensity as depth increases. In addition, the instability of the prevailing sand/soil conditions of Coral Atoll Islands makes excessive dewatering extremely hazardous as increased dewatering with depth removes significant quantities of sand/soil further exacerbating the unstable soil conditions. Previous experience of sewer construction in the Maldives has indicated that excavation depths in excess of 3.5m are not recommended for conventional dewatering methods to avoid the risk of undermining and trench collapses.

Given the instability of the sand/soil conditions, trench shoring is to be used to maintain the vertical integrity of the sidewalls. All water removed during excavation for trenching and construction will be disposed of inland from the excavation for re-percolation back into the water table as outlined in the URA guidelines.

4.4.2.2 Sewerage Treatment Plant

The details of the proposed STP is given below. Furthermore, key maintenance activities and best practices in the operations of the aforementioned STP are detailed. This is due to the fact that the STP operations will be one of the most environmentally sensitive functions of the system during the operational phase.

4.4.2.2.1 The treatment processes

The proposed Wastewater Treatment Plant employ a biological process known as "extended aeration" or "aerobic digestion." In this process incoming wastewater enters an aeration tank where the contents are thoroughly mixed and aerated by large volumes of air which are pumped into the tank under pressure. As the air bubbles rise to the surface, oxygen is transferred to the tank liquids. Aerobic bacteria present in the activated sludge in the tank use this oxygen to convert the wastewater to inoffensive, clear, odorless liquids and gases. Sometimes this process is referred to as "wet burning" because the bacteria actually destroy the wastewater by using oxygen, just as fire uses oxygen to burn trash. After the treated liquid leaves Aeration Tank, it is held in a "settling" tank, which provides a quiescent zone for clarification. Here any partially treated particles settle to the tank bottom and are returned to the aeration tank for further treatment. This settling produces a clear, highly treated liquid which is ready for final discharge. Many refinement sand options can be used with extended aeration plants - especially with the larger ones. However, the basic process used in all extended aeration plants is as described here.

4.4.2.2.2 Extended aeration plants

Basically, extended aeration plants can be divided into four main elements. These elements are:

- Pre-Treatment
- Aeration
- Settling
- Optional Equipment

4.4.2.2.3 Pre-treatment

In this first stage, a pre-treatment device is used to physically break down the wastewater and trap untreatable material such as plastic or metal before it can enter the plant. The three basic types of pre-treatment devices are bar screens, comminutors, and trash traps. Bar screens are used to trap large objects and prevent them from entering the plant.

A comminutor is a wastewater grinder designed to grind or shred large solids into smaller pieces. Comminutors should have a bar screen by-pass for additional protection.

The third type of device is a pre-treatment tank or trash trap. Here untreatable material is settled out and organic solids are pre-treated and broken down both physically and bio-chemically before being passed on to the aeration tank.

4.4.2.2.4 Flow equalization

The aerated flow equalization chamber distributes the influent evenly over the course of a day. This optimizes the efficiency of the treatment plant. Even distribution is accomplished with time-dose pumps that are equipped with high water alarm.

4.4.2.2.5 Aeration

In the aeration tank, "aerobic digestion" or "wet burning" takes place. Here the pre-treated incoming wastewater is mixed and aerated by air diffusers, located in the bottom of the tank. These diffusers inject ample air to meet the oxygen demand of the aerobic digestion process as well as mix the entire tank contents.

4.4.2.2.6 Settling

The next step in the process takes place in the settling compartment. Here there is no circulation so any remaining solids can settle to the tank bottom and be returned to the aeration chamber by the sludge return.

4.4.2.2.7 Wastewater Disinfection system

Proposed wastewater disinfection system is a complete non-mechanical, gravity operated chlorine dispensing system, consisting of a Tablet Feeder and disinfection tablets. The system is capable of providing chlorination of flows up to 100,000 gallons per day.

4.4.2.2.8 De-Chlorination system

The de-chlorination System uses a compact, lightweight tablet feeder and long-lasting sodium sulfite tablets to remove chlorine in proportion to the flow of treated wastewater. Furthermore, the system is capable of providing chlorination of flows up to 100,000 gallons per day. Moreover, the system can de-chlorinate gas, liquid or tablet chlorinated wastewater. The systems tablets contain 85-90% active sodium sulfite.

4.4.2.2.9 *"Spray" foam control system*

Foam develops in many plants because of the mixing action and the large amounts of air being diffused into the aeration tank. During plant start-up, foam exists in almost all plants, but once activated sludge develops, this foaming normally subsides. On installations where organic loading is high or where a lot of detergents are used, such as restaurants or laundromats, foaming may be constant. In these cases, a spray system should be installed.

Basically, Foam Control System consists of a pump, piping, and spray nozzles. The pump transfers the clear liquid from the settling compartment to the spray nozzles, arranged above the surface of the aeration chamber. A fine spray produced by the nozzles knocks down the foam and prevents its build-up.

All Spray Systems are also equipped with a wash-water outlet which is convenient for cleaning and maintaining the plant.

4.4.2.2.10 *Surface skimmer*

Surface skimmers are used to remove any floating particles or material from the surface of the final settling tank. After it is removed, the material is returned to the aeration chamber for further treatment.

Skimmers are usually made up of an intake pipe and an air lift, which is an air-powered pumping device. The intake pipe is installed flush with the surface to draw in any floating particles and the air lift is used to pump these particles back to the aeration chamber.

Surface skimmers should be used wherever grease will be encountered. They are also extremely helpful maintenance tools because they eliminate the need for manually cleaning the settling tank surface. Most authorities feel they should be installed wherever possible.

4.4.2.2.11 Time clocks

The wastewater treatment plant is equipped with a 24-hour time clock that controls the plant's "on" and "off" cycles throughout the day. These time clocks permit a great variety of time cycles to be programmed during any 24-hour period, but once the program is chosen it remains the same for every day in the week. This is satisfactory for most loadings. The 24- hour time clock is available as an option on the 2000 Series plants. Certain installations such as schools, swimming pools, or churches have great fluctuations in flow and require longer treatment periods on some days than on others. For these installations, a seven day time clock can be installed to pennit different time cycles for different days of the week.

4.4.2.2.12 Standby Equipment

Duplicate mechanical components for stand-by operation are sometimes required. The plants are designed so that these duplicate mechanical components alternate operation, allowing no single set of components to sit idle for long. This special alternation keeps the "stand-by" equipment in as fine a running order as the other set of components and eliminates "freezing" and other problems that always seem to plaque mechanical equipment that is not used for long periods of time.

4.4.2.2.13 Sludge-holding tank

Sludge is pumped into the holding tank through auxiliary piping which is connected to the plant's sludge-return pump. The sludge is held here until it is hauled away or else it is returned to the plant for final treatment. Holding tanks equipped with “air seal diffusers” and is referred to as aerated sludge- holding tanks and are the most common type. Aerating a sludge- holding tank provides some treatment and eliminates the possibility of odor. All sludge -holding tanks have overflows that lead back into the treatment plant.

4.4.2.2.14 Flow meters

Flow meters or flow measuring weirs are optional devices used on plants where it is necessary to accurately determine plant flows.

4.4.2.2.15 Plant start-up

Wastewater treatment plant start-up is simply balancing the plant's variable capacities, such as mixing, aeration, and running time, against the load of the facility it serves. Since no two plant loads are ever exactly alike, it is impossible at the time a plant is installed to pre-set it to do the best job it is capable of. At first, all the operator can do is analyze the load, choose the correct plant size, and make some initial equipment settings. From here on out it is a matter of observing the plant's performance closely for up to ten weeks, and making adjustments based on these observations. Fine tuning a plant to accommodate the influent load is called plant "start-up." Plant start - up must be successfully completed before any plant will do the job it was intended to do. There is no question about the fact that all plants must receive regular start-up attention if they are to perform correctly. A conscientious start-up program will quickly bring a plant up to peak operating efficiency, but if there is no start-up program, or if it is drawn out or stopped, the plant will really never be efficient.

During start-up, the plant must be given daily attention by the operator or a representative, and it should be inspected frequently by the Service Provider / supplier. Normally the start-up period for a plant will last approximately ten weeks.

4.4.2.2.16 Activated Sludge

The incoming wastewater contains dormant bacteria that are quickly stimulated to activity by the abundant supply of oxygen in aeration tank. These bacteria are able to quickly absorb and digest the organic material in wastewater and they are the primary element in activated sludge. Since the aeration tank provides an ideal environment for the bacteria, they multiply rapidly and are soon plentiful enough to oxidize or "burn up" all wastewater that enters the plant. Activated sludge draws the very fine suspended particles in solution to it, just as a magnet draws iron particles. Often this suspended material is so small that it would not normally settle out by gravity. But because of this magnetic characteristic, as the sludge settles to the bottom of the final compartment, it takes the fine suspended matter with it, just as if a filter were being passed down through the liquid. Naturally, this is a great improvement over ordinary gravity settling.

A great deal of the time taken in plant start-up is spent developing a good activated sludge culture. In some situations, such as the early opening of a restaurant, the owner may want to accelerate the start-up process. This can be done by "seeding" the plant which is accomplished by taking sludge from a plant already in operation and adding it to the new plant. Although seeding can speed up a start-up program, it should be remembered that even a "seeded" plant will deteriorate and not work properly if it does not receive the necessary start-up adjustments.

4.4.2.2.17 Hopper Maintenance

During its development, activated sludge is very stringy and tends to cling and build up on the slanted walls of the hopper. Therefore, during the first few weeks of plant operation, the hopper should be gently scraped each day with a squeegee. This scraping should move the sludge in a slow, gentle motion to the bottom of the hopper. Never stir or push the sludge quickly because it may then float to the surface, in which case it will have to be dipped out and put back into the aeration chamber. Floating solids also increase the solids level near the surface and reduce the quality of the effluent.

If sludge is allowed to build up in the hopper, eventually large chunks will break loose, sink to the bottom, and clog the sludge return. A clogged return will result in poor wastewater treatment because of the lack of sludge in the aeration tank, and in a very poor effluent because of the abnormally high solids in the final tank. Naturally, a major malfunction such as this prolongs the start-up period too. After the activated sludge is fully developed, it becomes less stringy and does not tend to build up on the hopper walls.

When this occurs, it will be possible to eliminate daily hopper scraping. However, this can only be determined by careful examination. Although the hopper eventually will not have to be scraped every day, it should never be left unattended for longer than a week.

4.4.2.2.18 Air, mixing and cycle adjustments

Both the level of dissolved oxygen and the degree of mixing within Aeration Chamber are determined by the amount of air being diffused. For this reason, adjusting the aeration rate is the principal technique in plant start-up.

Minor air adjustments to provide even mixing can be made by regulating the individual valves for each diffuser bar assembly. Larger air adjustments, to alter the aeration rate, require the use of a time clock. These time clocks regulate the air supply by controlling the "on" and

"off" cycles of the blower. Time clocks are factory set to operate fifteen minutes out of every half hour and, although they can run longer or on other settings, they should never be set to operate less than 50% of the time.

The individual air valves should be used to regulate the air flow to pro- vide even mixing. Even mixing simply means that the air should move the tank contents so that they are rolling evenly all along the tank wall. The valves should never be "throttled down," however. If the aeration rate needs to be reduced or increased, it should be done primarily by regulating the time clocks. By using a time clock to regulate the aeration cycle rather than throttling down the valves, it is possible to maintain high mixing velocities in the aeration chamber and still con- trol and maintain a desired level of dissolved oxygen.

Any increase or reduction in the time cycle should equal 10% of the total running time. After a change is made, the plant should always be permitted to run at least 48 hours before any further adjustment. If the adjustment has been sufficient, improvement should be evident in the plant effluent within 48 hours.

4.4.2.2.19 Sludge return rates

An important factor in the treatment process is the return of the settled, activated sludge from the settling tank to the aeration tank. Sludge-Return Assembly, located in the final settling tank, is operated with air from the blower. This air is injected into the sludge-return assembly near the bottom of the hopper, causing settled sludge to be drawn in and up the pipe, where it is discharged back into the aeration chamber. A small valve installed on the sludge-return air-line is used to adjust the return rate. Jet's sludge-returns are capable of pumping in excess of the total daily plant flow but normally they are adjusted to pump considerably less.

Initially the sludge-return air-line valve should be turned all the way open. It should be left open for the first week or until the plant begins building up solids. This can be determined by the appearance and odor of the mixed liquor. As solids start to develop, the contents of the aeration chamber should lose their gray color and appear light brown. They should also develop a somewhat "earthy" odor and, as they continue to build up, the color should change to a richer brown.

An excessive sludge-return rate will cause the plant to lose solids over the weir. This can be easily detected by observing the effluent. If the sludge return is pumping too fast, it does not give the sludge time to settle, and creates a flow through the final tank which stirs up the solids and causes them to be discharged from the plant. If this happens, the air valve should be turned down one quarter turn each day until the plant stops losing solids. On the other hand, the return should never be adjusted too low and this should be checked by seeing that the end of the sludge-return outlet is never less than 1/4 full.

Always reduce the sludge-return rate slowly and carefully, because reduced return rates increase the chance of clogging. If clogging occurs, it can be corrected by back-washing, but before the correction it will have resulted in sharply lowered plant efficiency and a poorer quality effluent

4.4.2.2.20 Startup adjustments

Adjustments of a Plant during the start-up period are based mainly on the appearance of the plant and its effluent. Rates of aeration and sludge return should be adjusted until the plant reaches a level of efficient operation. The check list given here contains the start-up information needed to make plant adjustments and give each plant the "fine tuning" it needs to operate at peak efficiency.

The operators should have a focus on the following

- HOPPER: Scrape gently every day during start-up.
- AIR SUPPLY VALVES: Adjust for maximum air and even mixing. Use valves to adjust mixing. Control aeration by timer adjustments, if so equipped.
- TIME CLOCK ADJUSTMENTS: Increase or reduce aeration rate by adjusting time clock 10% of total running time. After an adjustment, allow 48 hours before further adjustment. Plant should never run less than 50% of the time.
- SLUDGE-RETURN VALVE: Leave 100% open until plant starts developing solids. Adjust valve down 1/4 turn each day until desired return rate is reached.

4.4.2.2.21 Routine Plant Maintenance

To continue operating at peak efficiency after start-up is completed, all wastewater treatment plants should receive daily maintenance. Performance of plants that ae not cleaned and adjusted daily will always be poorer than plants that are well maintained. Daily maintenance may seem like a little extra work, but it is well worth it. Because a well-cared for plant will provide better treatment results, will have fewer mechanical problems and will actually require less overall maintenance.

4.4.2.2.22 Check diffuser bars

All Commercial Wastewater Treatment plants are equipped with “air seal diffuers”. These are uniquely designed to use a trapped bubble of air to isolate and protect the air opening and air pipes from contact with the wastewater - even during shut-off periods. Because of this advantage. “Air seal diffusers” are truly non-clog and will normally not require cleaning. If something unforeseen should clog a diffuser or diffuser-bar, the lack of air and agitation will be quite evident. In this case, remove the diffuser bar and correct the blockage.

Each separate diffuser bar has an air-control valve, which you should adjust to control the mixing and to ensure a uniform roll of the tank contents. Uniform mixing and tank roll are absolutely necessary for efficient wastewater treatment, so adjust the air valves carefully to achieve this. Never use air valves to “throttle down" or turn off the plant since they are only there to adjust for even mixing and roll.

4.4.2.2.23 Inspect Sludge return

An air-lift sludge return, which uses air produced by the blower, pumps sludge from the settling chamber back into the aeration chamber. sludge-return pumps are equipped with an air valve that you should use to adjust the return rate. Check the sludge-return rate by seeing that the end of the sludge-return outlet is never less than 1/4 full. This rate is the minimum required to keep the plant in balance and will reduce chances of the return plugging up. The return may be set to operate at any point above the 1/4 mark that works best for the plant.

Occasionally a sludge return will clog. Usually this is because the settling hopper has not been well maintained. When this t1appe ns, the quickest and easiest way to unplug it is to backwash it. Backwashing is a simple operation in which you shut off the sludge flow for a short time and force large volumes of air back through the sludge return to blow any clogged material out the intake end. To backwash a sludge return, turn the large liquid-sludge control valve, if so equipped, in the sludge-return line "off" and turn the small air valve to the full "open" position, This will force air back through the air lift and out the intake. In extreme cases when the normal volume of air is not enough, you may shut off other air valves in the system so a larger supply of air Will be available for the backwash operation. To do this, simply shut off the valves for the individual diffuser bars, but be sure to note their settings before you change them so you can adjust them back to the original position. The 2000 series plants and some of the smaller 3000 series plants do not have liquid sludge -control valves. However, the procedure for back-washing these plants is also quite easy. First, shut the sludge-return air valve "off" and remove the plug in the tee, located at the top of the air-lift pipe. Now inflate a "plumber's stopper" below the tee and turn the air back on. The plumber's stopper will close the line here, just like a valve, and the air will be forced back out the intake of the pump, clearing the blockage.

4.4.2.2.24 Clean and Adjust weir

During every plant maintenance inspection, operator should check the weir to see that It is skimming evenly over its entire surface and clean it to keep it free of sludge build-up. Weirs are designed so they may be adjusted from side to side or end to end, and these adjustments may be made easily from above the surface. Operator can make large adjustments in the level of the weir by rotating the weir body back and forth in the outlet coupling. Finer ones can be made by moving the weir plates up or down. Because these plates can be adjusted from inside the weir, no tank pumping or special tools are required. These features are significant advantages since plants often settle enough after installation to put the weir out of adjustment.

4.4.2.2.25 Scrape hopper

To prevent sludge build-up, the slanted walls in the hopper should be scraped daily. Use the squeegee to gently move the sludge to the bottom of the hopper, where it will be picked up by the sludge-return pump. Be careful not to agitate the liquids in the settling chamber any more than necessary.

4.4.2.2.26 Clean final settling tank surface

If a plant has been equipped with a surface skimmer, it should be turned on daily, long enough to remove any particles floating on the settling tank surface. When a plant does not have a surface skimmer, you should dip any floating particles out of the settling chamber with a suitable tool, such as a piece of screen. After removal they can be placed back in the aeration tank or otherwise disposed of.

4.4.2.2.27 Inspection of air valves

Operator should check the plant air valves daily to be sure they are providing the correct mixing and sludge-return rates. They should be checked monthly to be sure they are not leaking.

To check for leaks, turn off all valves and observe the aeration chamber. There should be no bubbles rising to the surface. While the valves are "off", spray them with leak detector and watch for bubbles. Plastic squeeze bottles of leak detector are commercially available. Or, if you prefer, "paint" the valves with a solution of soapy water and watch for bubbles. Next, shut off the sludge-return air valve and check the outlet of the sludge return - it should not be pumping any liquid. Normally it will not be necessary to replace faulty valves since most leaks can be corrected by repacking the valve with grease or by installing a new rubber washer. Always shut the electrical power off before inspecting any mechanical or electrical equipment. Please ensure to keep the operators hands and all objects away from the equipment until you have shut off the main circuit breaker.

4.4.2.2.28 Inspect V-Belt.

Check the tension on the V-belt to be sure it is not slipping by turning the unit off, letting it come to a complete stop, and then turning it back on. If the belt is too loose, the pulley on the motor will turn several times before the blower pulley starts to turn. If this happens, shut off the main circuit breaker and tighten the belt, then check it again. Belts should be checked weekly because new ones stretch at first and all belts wear and loosen as they are used.

4.4.2.2.29 Inspection of electrical controls

You should check all time clocks once a week to be sure they are set for the correct time of day. All the disposable fuses for optional equipment should also be inspected weekly and replaced if necessary. Once a year, completely check over the electrical panel. Replace any worn or frayed leads and securely tighten all conduit fittings and connectors.

4.4.2.2.30 Servicing pre-treatment device

If a comminutor or bar screen is installed, operator should check and clean it daily. Follow the specific instructions for these devices given in their individual information sheets.

When a pre-treatment tank or "trash trap" is used, it requires an yearly inspection for blockages near the inlet and outlet. Pre-treatment tanks need not be pumped unless they have received a large quantity of untreatable material such as sand, rocks, metal, etc. They are designed to filter out untreatable materials as well as to break down and pre-treat wastewater before it enters the plant. They are not designed to prevent organic solids from passing through, as a septic tank is, and for this reason they do not have to be pumped as often as septic tanks.

4.4.2.2.31 Sample effluent

Operator should inspect the plant effluent daily to ensure that it is clear and odor-free. Weekly, the effluent should be given a relative stability test, which will indicate the level of treatment.

4.4.2.2.32 Repainting

Operator should check, clean and spot-paint all metal surfaces, at least once a year. This is normally a very short job.

4.4.2.2.33 Clean-up

The plant and surrounding area should be cleaned daily. When the plant is equipped with a wash-water outlet or if there is a water supply nearby, you should wash down the piping and inside sidewalls of the plant. Grass and weeds should be kept at least 3" away from the edge of the plant and the surrounding grade should always be maintained at least 3" below the tank top.

Once a month, you should lubricate all locks and hinges on the plant grating and equipment enclosures. Always be sure to replace and lock all panels and grating sections before leaving

4.4.2.2.34 Routine equipment maintenance

Equipment in a wastewater treatment plant requires a certain degree of maintenance just as all other mechanical equipment does. Plants have been designed to perform well with as little maintenance as possible. The service steps outlined t1ere are not difficult but are absolutely necessary to ensure proper plant operation and long equipment life.

Always shut off the electrical power before inspection of any of the mechanical or electrical equipment. Ensure to keep any personal and all objects away from the equipment until have the main circuit breaker on the control panel has been shut off. Check the manufacturer's equipment manuals provided for additional information.

4.4.2.2.35 Blower

Positive displacement blowers are used to supply air to tile treatment plant. These blowers contain two impellers, mounted on parallel shafts that rotate in opposite directions. As the impeller passes the blower housing inlet, it traps a small quantity of air between itself and the blower housing. It carries this air around to the outlet and discharges it.

Gears are installed on the end of each shaft to control the position of the impellers, with relation to each other, and thus maintain the clearances needed to assure maximum air flow efficiency, minimum wear, and long life. Since there is no contact between the impellers and the inside of the blower, internal lubrication is not needed and water sealing is not required. In fact, the blower is not able to handle liquids.

The blower gear housing should be checked weekly to be sure it is filled with synthetic oil (P/N 813-106) of correct viscosity. To do this, shut the blower off, remove the breather plug (25) and the oil overflow plug (21). Fill the reservoir up to the overflow hole. Do not over fill. Then replace the plugs.

Bearings at the gear housing end of the blower are lubricated with oil splashed from the gears, but the bearings at the drive end need to be manually lubricated with grease every month.

Use the grease gun and recommended grease listed in the Blower Operation Manual. Always remember to replace the yellow lubrication caps and square drain plugs when you are finished.

4.4.2.2.36 Motor

Clean all dust away from the ventilating openings on the motor shell at least once every month.

The motor bearings should be re-lubricated every five years. To do this, remove the motor end bells and clean old grease from the bearings and end bells. They must be kept completely free of dirt! Repack the bearings with GE D6A2C5 grease or equivalent and fill the lubrication cavity one-third full of grease. DO NOT overdo it, excessive or too frequent lubrication may damage the motor. This grease may be obtained through any GE motor repair station.

Well-maintained motors normally do not require repair, but if a motor does fail or if you are not equipped to re--lubricate it, fast, dependable service for your motor or any other component can be obtained through your Distributor.

4.4.2.2.37 Pressure relief valve

Pressure-relief valves are installed on all blowers to prevent excessive pressures from building up when valves are closed or partially closed during plant operation or maintenance. These relief valves are simple in construction and require very little attention. They should, however, be kept clean and they should be checked monthly to be sure no dirt or rust has accumulated that would interfere with their free operation To service them, simply remove the weights, take off the removable cap, clean all surfaces and apply a light coat of oil to the inside of the cap and the outside of the valve.

4.4.2.2.38 Air filter or inlet filter silencer

Air inlet filters are installed on all blowers to reduce noise and clean incoming air. Air filters should be cleaned monthly and when possible, two filters should be alternated in use so that one can be operating while the other is being soaked and cleaned. The filter can be cleaned by blowing it dry with an air gun.

4.4.2.2.39 Time clock

A time clock is installed in the proposed plant to control its operation. The 24-Hour dial has quarter-hour divisions and AM/PM indications. The time switch is programmed by pushing the captive trippers to the outer ring position for the entire period that the load is to be turned "ON", i.e., fifteen minutes for each tripper on the 24- Hour dial. When the tripper is pushed to the inside, the switch is in the "OFF" position. The main control panel timer is factory set to "OFF" for 15 minutes each day during the low flow period. The main and standby blowers alternate operation after every "OFF" cycle.

A 7-day time clock is provided. They have a patented skip-a-day feature that permits omission of any day or days of the week. This second clock permits two separate daily cycles, either of which may be used any day of the week.

Check the time clock trippers once a year to be sure they are either fully engaged or disengaged. If they are not fully engaged, they may turn the blower "on" during what should be an "off" period or vice versa. Also check the terminals of the clock once a year to make sure they have not loosened. Blower is "on" when clock trippers are pulled out and "off" when they are in

4.4.2.2.40 Pulleys and V Belts

Pulleys and V-belts are used to transfer power from the motor to the blower. The V-belts need to be kept just tight enough to prevent slipping. Never over-tighten a belt because this will considerably reduce its life. To insure maximum life from each belt, the pulleys must be kept in perfect alignment. They can be aligned by placing the flat side of a level against the front face of both pulleys, loosening the motor mounting bolts and rotating the back of the motor until both pulleys are flat against the level. If possible, it is an excellent idea to always keep an extra belt on hand as a spare.

4.4.2.2.41 Alternative to STP function failure

In case of emergency, whereby the STP fails to function, the STP will be bypassed and the sewage will go directly to the outfall. In such instances, the proponent shall make sure to repair the STP as soon as possible.

4.4.2.3 Outfall

The prime structure in a sea outfall system is the outfall itself. The stretch of pipe through which effluent leaves the outfall is known as the diffuser. The function of a diffuser is to mix the low-density waste with high density sea water at the bottom (about 5 to 100 m). At this point the plume will spread horizontally & disperse with little or no visual effects. When the wastewater enters the marine environment from the diffuser it is buoyant & tends to rise. This effluent initially travelling horizontally after leaving the holes or ports, in the diffuser, gradually ascends on a more vertical path. Throughout its path, whether largely horizontal or vertical, the effluent mixes with the ambient sea water. What was initially a highly concentrated wastewater becomes progressively more and more diluted with increasing distance of movement through the sea water.

4.4.2.3.1 Design factors

The following are the design factors regarding the outfall

- The overall design of an outfall system concerns location (& depth) of diffuser
- Determination of pipe & port sizes so that the effluent is efficiently passed at desired flow rates
- Hydraulic computations to compute the energy required at the shore line to transport desired flows to & out of the diffuser
- Type of pipe materials & joints that can be used & which combinations are suitable for specific types of situations

- Installation and Anchoring: Installation & anchoring of outfall & diffusers is especially important if strong currents prevail & additional problems such as erosion scour or transport to bed load. Outfall pipes are rock ballast or anchored to the sea bed
- Diffusers: Diffusers must disperse the effluent efficiently & evenly to achieve good mixing. Knowledge of density & temperature gradient as well as current & wind conditions that influence the dispersion in receiving waters is necessary
- Information of a geological nature is of vital importance to the design of the outfall. Sea bed materials must be able to support the pipe. Sub-bottom condition must also be known for the near-shore zone. The outfall will probably be buried to protect it from wave induced water motion. Whether there is bedrock close to the bottom or not is an important consideration.
- The stability of the bottom may be required the stability of the bottom material & of the beach area is of great concern. Since the natural cut of beach & near shore sediments under storm.
- Currents in the area are strong which will bring about significant advection and dispersion of the initial plume.

4.4.2.3.2 Technical Aspects

Outfall Configuration: The various outfall configurations available are single round port discharge with closed manifold, multiple diffuser arrangement. Since flow is less, single round port discharge with closed manifold configuration is considered as it is easiest terminus to build and maintain.

Sizing/Capacity: High density polyethylene (HDPE) pipe (black color) is proposed for submerged buried outfall. HDPE (PE100, PN16) is relatively light with a density slightly less than that of seawater. Its big advantage is that it is flexible and can be easily deployed.

Outfall Depth: The deeper the outfall better is the mixing. Outfall need to be at least 5.0 m deep below the low tide level for treated effluent.

Sewage Plume: Hydraulic performance of outfall is usually quantified in terms of the dilution. A minimum initial dilution of 100:1 is common for the ocean outfall superior to conventional waste treatment plants.

There are several mechanisms which govern the dilution characteristics of an ocean outfall. These are usually considered separately in three phases.

- Initial dilution which occurs in the 1st few minutes as the waste stream leaves the outfall diffuser & rises in the water column
- Horizontal transport
- Dispersion of the sewage field Kinetic reactions which take place in the sea

Initial dilution occurs due to 3 effects; jet mixing due to the momentum of the sewage stream as it leaves the diffuser part, the buoyancies effect resulting from density differences between the sewage & the ambient ocean water (temp. & salinity differences) which causes the sewage field to rise upward in the water column as an expanding plume, thus mixing with the sea water & finally the current effect causing the lateral entrainment of flash sea water into the sewage plume. The sewage plume may rise to the water surface or may be trapped below the surface depending on the degree of stratification of the water column. The horizontal transport and dispersion are governed by the local current regime & eddy diffusion (Lateral mixing due to eddy currents).

The pipeline will be ballasted with concrete ballast blocks, running on the surface of the lagoon bed; the pipe passing through the coral reef shall be placed on the reef exposed, but ballasted suitably with pre-cast concrete blocks 1 m intervals at the shoreline to prevent displacement. The weight of the ballast can be determined depending on the wave impact after an engineering design. The rest of the pipe line shall be laid till it reaches an average depth of 10 m below MSL and ballasted with 1800 kg concrete ballasts at 3m intervals. Following the emergence of the pipeline at the required depth, it will be secured with an anchor block of 2,500 kg in weight. A “T” head diffuser will be fixed to the discharge end of the OOF pipeline to increase dilution performance and dispersion of effluent. The diameter of the proposed pumping main is 160mm OD black PE100 HDPE pipes, complying with the URA Guideline

4.4.2.3.3 Effluent Discharge standard

The effluent discharge to the deep sea shall comply to the standards set by the EPA. The maximum allowable concentrations in domestic and industrial waste water for discharge into the deep sea is summarised in the table below.

Industrial Waste Water Quality Component	**Maximum concentration**	**Remarks**
Mercury as Hg	0.05 mg/l	
Selenium as Se	0.05 mg/l	
Nickel	10 mg/l	
Boron as B	0.5 mg/l	
Hexavalent Chromium as Cr	0.05 mg/l	
Total Chromium as Cr	3 mg/l	
Copper as Cu	3 mg/l	
Lead as Pb	5 mg/l	
Iron as Fe	5 mg/l	
Manganese as Mn	0.1 mg/l	
Magnesium as Mg	100 mg/l	
Aluminium as Al	0.3 mg/l	
Sum of metals	5 mg/l	i. Cadmium+Chromium+Copper+Mercury+Lead ii. Metals may be bio-accumulated and have a negative effect on the health of consumers of sea food
Acute toxicity	Zero	No constituents in concentrations which are poisonous or injurious to aquatic or human life

Industrial Waste Water Quality Component	**Maximum concentration**	**Remarks**
Faecal coliforms	100 org / 100 ml	For less than 95% of samples taken. Clinical infections unlikely in healthy adults, but may occur in sensitive groups If the waste water contains any hospital waste, the waste water should also be tested for other pathogens (Ref 1 & 2 and appendix A1).
E. coli	1 org / 100 ml	
Suspended solids	150 mg/l	Prevent sludge build-up in reef sections
Residual chlorine	0.2-0.8 mg/l	Disinfection good; insignificant risk of health effects
Temperature	Not more than 44°C	
pH	5 – 9.5	
Nitrates as N	15 mg/l	May result in biological growth
Free and saline Ammonia as N	10 mg/l	
Ortho-phosphate as P	10 mg/l	
Surfactants	10 mg/l	
Conductivity	Equal or less than receiving sea water	To prevent salt build-up
Soap, oils and grease (food related)	5 mg/l	
Oils, grease and waxes (mineral origin)	5 mg/l	
Chemical Oxygen demand	50 mg/l	After applying for chloride correction
Biological Oxygen demand	40 mg/l	Five-day test
Dissolved Oxygen	75% saturation	
Phenolic compounds as Phenol	1 mg/l	
Arsenic as As	2 mg/l	These concentrations will be allowed given that real time studies do indicate that there is not an increase in the concentration of these metals over time.
Calcium as Ca	80 mg/l	
Cyanides as Cn	10 mg/l	
Chloride as Cl	200 mg/l	
Sulphides as S	1 mg/l	
Sulphates as SO4	250 mg/l	
Fluorides as F	1 mg/l	
Sodium as Na	200 mg/l	
Zinc as Zn	20 mg/l	
Cadmium as Cd	0.05 mg/l	

4.4.2.3.4 Outfall maintenance

Regular inspections of the marine outfall should be carried out as part of a regular maintenance program to ensure there is:

(a) No physical damage to any components and

(b) No blockage of any outlet nozzles.

This can be carried out by divers although this is accompanied by substantial health and safety concerns (e.g., diving in contaminated waters, wave action, and decompression requirements for deep diving). If possible, it is preferred to carry out inspections using remotely operated vehicles. The frequency of maintenance inspections will depend on a range of factors such as environmental conditions and construction materials. Often, annual inspections are adopted. These would be detailed in the operation and maintenance manual that will be produced by the contractor at the end of civil phase of the project.

4.4.3 Harbour, jetty and access channel

Interconnection between islands within the atoll and other atolls are mainly dependent on sea transportation. The jetty/harbor component is vital while developing an island for any purpose and this proposal focuses on the development of Thun'buri island for agriculture. During the development and operational stages, the jetty will act as the pivoting point of all the operations carried out on the island

The proposed works under this component includes the following:

- A jetty will be constructed for approximately 540 m in length, including a quay wall (Appendix E) which can be extended during future development.
- The jetty is proposed to be built by reclaiming the area for jetty and rock boulders would be placed as protection along the jetty on either side. The sand required for the jetty area would be generated by the dredge material of the harbour (Appendix N).
- Dredging the entrance channel with approximately 366m in length.
- Development of a harbour which will have an area of approximately 100,000 sqft with dimensions of 500ft(152m) x 200ft (61m).
- Establishing rock boulder breakwater on both side of the entrance channel, jetty and harbour

The harbour basing and access channel will be dredged to a depth of -4 MSL. It is estimated that 14,384 m^3 of dredged material will be excavated from the harbour basing and 15,193 m^3 from the access channel (appendix N). The estimated fill material required for the jetty and harbour is 21,151 m^3 considering that the design height of harbour and jetty is +1.4m from MSL.

4.4.3.1 Equipment and method used for dredging

Methodology	Dredging will commence once the barge is anchored using the spud poles. Dredging will be carried on the barge. The dredged material would be reclaim the jetty area and to fill the geobags which will be submerged on either side of the entrance channel. In this project, to ensure safe dredging and sedimentation control, mitigation measures specified will be implemented.
Supporting method file	 *Figure 7: Example: Excavator on a barge, Photo taken Wednesday 2nd October 2019, Ha.Kelaa, Maldives, Harbour works, MTCC.*
Equipment	The proposed methodology will utilize one backhoe excavator.

4.4.4 Powerhouse and renewable energy

The powerhouse will be constructed by blockwork. The construction of the powerhouse includes a number of structures that will support the power generation including the boundary wall, bund area for fuel storage tank (50,000 ltrs), powerhouse, control room, office room, a chimney, transmission cables and related engineering works and earthworks. The building houses the powerhouse deck room, control room and office room. The powerhouse would host a total of 7 generator sets, which includes five 250kva generators and two 500 kva generators.

The powerhouse is designed in accordance with URA and EPA standards, details of which are summarized in the following sections. The components of the buildings will all comply with the BS (British Standards). The BS standard is a standardization made by the United Kingdom which sets out internationally agreed specifications for manufacturers. The British standards for electrical components are agreed in the Maldives which is mentioned in the URA regulations.

4.4.4.1 Design

The design of all structures will be performed in accordance with BS 449 and BS 5950. Grade 43C steel will be used or similar approved. Bolts, nuts, and washers will comply with BS 4190, BS 4320 / BS 4395. All welding consumables such as electrodes, filler rods, fluxes will comply with BS 5135.

Structures will be designed for the most critical combinations of dead loads, imposed loads, equipment loads, wind loads, seismic loads, and temperature loads.

All walls and roofs at the powerhouse building will have galvanized profiled sandwich steel sheet cladding with a paint system applied for the marine environment.

It is expected that the design will mitigate the noise propagation outside the building. All walls will provide delta 35 dB noise reduction.

The height of the stack chimney will be over 20m from ground level with a diameter of 600mm. It will be designed to withstand wind velocities up to 45m/s. The height is in accordance with EPA and URA standards.

4.4.4.2 Doors and Windows

Aluminum doors, windows and glass walls as well as aluminum frames will be anodized in accordance with BS 1615 or BS 3987. Sections of aluminum profiles will not be less than 50 mm deep and 2 mm thick. Door and window elements will be fixed to the structure by means of separate rectangular hollow galvanized steel or aluminum frame.

For air conditioning rooms, the aluminum windows will have double glazing. Glass wall on the wall, between the control room and the Genset room will have triple glazed.

All doors will have design to mitigate noise and heat by using necessary insulation material or techniques.

4.4.4.3 Roof and Wall Cladding system

All the walls and roofs will have insulated sandwich cladding. The roof and wall cladding will be multi-layered protected metal system consisting of a galvanized steel substrate, heavy epoxy base coat and high build exterior weather coat of polyurethane.

It is expected that the design will mitigate the noise propagation outside the building. All walls and roof will provide delta 35 dB noise reduction.

The cladding will be sealed with a non-drying, non-corrosive permanently elastic preformed metal sealing tape capable of performing at a temperature up to 100° C.

The external weathering sheet will be secured to the galvanized sub-girths or structural support with stainless steel hexagon headed self-tapping screws, each with an integral Ethylene Propylene Die Memonoma (EPDM) washer bonded to a dished aluminium washer.

Flashings required in connection with the external weather skin will be formed from > 0.5 mm thick material similar to claddings material.

Profiled filler pieces will be provided at all terminal positions on the roof and sidewall areas. The fillers will be of polyethylene form and be immune to birds and insect attack.

4.4.4.4 Lighting, small power, air conditioner and fans

All electrical installation at the building will comply with BS Standards. All electrical equipment, appliances and fittings and cables used will meet the standards. Furthermore, the electrical design of the building will be in accordance with URA standards.

Lights and sockets used for gen-set hall will be industrial type, design for hot and harsh environments. For outdoor applications, on gable end walls and corridors, only outdoor lights will be used. For all the rooms except the gen-set hall, lights design for office applications can be used.

The control room and Technical staff room will be fitted with air conditioners and ceiling fans. Storeroom and tool room will be fitted with air conditioners. The workshop will have ceiling fans.

Power sockets will be available on all walls of the rooms including the gen-set hall.

The mean illumination level will be as follows;

- Inside the Gen-set hall:	300 Lux
- Control room / SWG room:	350 Lux
- All other room:	250 Lux
- Corridors/walls:	200 Lux
- Inside the rooms/hall:	300 Lux
- Corridors / outside walls:	200 Lux

4.4.4.5 Depth of foundation

It is estimated that the minimum foundation depth will be 1.45m for the building. As such, any dewatering will only be done after acquiring dewatering permit.

4.4.4.6 Emergency power mechanism

Movable backup gen-sets with containerized generator and control panel.

4.4.4.7 Measures to increase power efficiency

Efficient diesel generator governor system and running time, and scheduled maintenances (de-carbonizing, top overhaul, full overhaul, and filter changes) at manufacturer recommended running intervals.

4.4.4.8 Safety components

4.4.4.8.1 Safety boards;

Posters outlining the rights and responsibilities of workers, supervisors, and employers as well as providing an emergency phone number to report critical injuries will be displayed at a conspicuous place. Additionally, printed color posters of work attires in English and *Dhivehi* script shall be displayed

4.4.4.8.2 Fire safety system;

Fire safety measures shall be designed and implemented in accordance with the requirement for fire prevention equipment in buildings enforced by the Ministry of Defense and National Security of the Maldives.

4.4.4.8.3 Lightening protection system.

It will be ensured that the measures meet the minimum requirements for lightening safety.

4.4.4.9 Fuel Management

- Reinforce concrete retaining wall is proposed to be constructed which will contain the volume of fuel during emergency spills
- Day tanks will be equipped with flow-meters and level detection. Tank will be installed with 150 mm concrete base;
- Fuel pipe line: GI Pipelines conforming to international standards. Pipes will be laid 300 mm above ground level. Leak detection and echo-sounding in main tanks and lines will be equipped with flow-meter; and
- Fuel to be transferred from transport vessel by barrels on a pickup truck to fuel tank at power house.

- Waste lubricant oil shall be stored in the store room in a closed labelled container over concrete floor. Waste lubricant oil will be transported to nearest regional waste management center..
- An air-cooling system will be utilized by all the generators for cooling of the systems.

4.4.4.10 Safety measures during construction and operation

All necessary precautions will be taken to protect personal and property from hazards due to falls, injuries, toxic fumes, or other harm. During construction works the necessary safety signboards will be put up in working areas. Further, safety gear would be used by laborers, for instance, safety boots and hard hats. All painting and corrosion protection work, including inside the building will be performed under strict safety conditions.

All necessary precautions will be taken to protect personal and property from hazards due to falls, injuries, toxic fumes, or other harm. All painting and corrosion protection work, including inside the building will be performed under strict safety conditions.

4.4.4.11 Solar panels for renewable energy

A 400kWp Grid-Tied Solar Photovoltaic System (PV) is proposed to be installed on 4000m2 roof space along with the Diesel Power Plant

4.4.5 Waste management Centre

Only organic waste will be managed at the island and all the inorganic waste will be shipped to nearest regional waste management center. As such waste segregation will happen on island. The organic waste that is supplied to the waste management facility will be fed to the biodigester. The inorganic waste will be further segregated into plastic, metal glass and other prior to shipping to the nearest regional waste management center. For the transfer of waste from Thunburi to regional waste management facility, if the WAMCO outer island waste collection mechanism is operational by then, this method is preferred, otherwise from the harbor the waste will be transferred on proponent's own vessel.

As for operating in unfavorable conditions, for the organic waste, if the primary biodigester fails, the waste will be transferred to standby one. If any equipment fails and needs repair, and the waste management facility cannot cater for the organic waste during this time, those waste will be safely shipped to the nearest regional waste management facility.

4.4.6 Vegetation clearance

Table 5 shows the approximate number of vegetation that needs to be removed for this project.

Table 5: Approximate vegetation that needs to be removed

Species	**Number**	**Building**
Cocos nucifera L.	2	Staff accommodation
Hibiscus tiliaceus	8	Staff accommodation
Cocos nucifera L.	1	Waste Management Center
Pandanus tectorus	2	Waste Management Center
Tournefortia argentea/Messerschimidia argentea	6	Waste Management Center
Cocos nucifera L.	1	Powerhouse
Hibiscus tiliaceus	14	Powerhouse
Cocos nucifera L.	1	RO Plant
Pandanus tectorus	2	RO Plant
Hibiscus tiliaceus	9	RO Plant
Cordia subcordata	1	RO Plant
Cocos nucifera L.	1	STP
Pandanus tectorus	4	STP
Hibiscus tiliaceus	9	STP
Tournefortia argentea/Messerschimidia argentea	2	STP
Pandanus tectorus	3	Office / Training Facility
Hibiscus tiliaceus	22	Office / Training Facility
Calophyllum inophyllum	3	Office / Training Facility
Pandanus tectorus	65	Polytunnel GH -Beans
Cocos nucifera L.	2	Polytunnel GH -Beans
Hibiscus tiliaceus	12	Polytunnel GH -Beans
Calophyllum inophyllum	7	Polytunnel GH -Beans
Scaevolo taccada Roxb.	7	Polytunnel GH -Beans
Hibiscus tiliaceus	10	Polytunnel GH – Cabbage
Cocos nucifera L.	13	Polytunnel GH – Cabbage
Pandanus tectorus	53	Polytunnel GH – Cabbage
Guettarda Speciosa L	8	Polytunnel GH – Cabbage
Cocos nucifera L.	99	Polytunnel GH – Cucumber
Pandanus tectorus	190	Polytunnel GH – Cucumber
Hibiscus tiliaceus	58	Polytunnel GH – Cucumber
Cocos nucifera L.	35	Polytunnel GH – Egg Plant
Hibiscus tiliaceus	73	Polytunnel GH – Egg Plant
Pandanus tectorus	133	Polytunnel GH – Egg Plant

Calophyllum inophyllum	9	Polytunnel GH – Egg Plant
Cocos nucifera L.	80	Polytunnel GH – Tomato
Pandanus tectorus	120	Polytunnel GH – Tomato
Calophyllum inophyllum	3	Polytunnel GH – Tomato
Hibiscus tiliaceus	56	Polytunnel GH – Tomato
Cocos nucifera L.	103	Polytunnel GH – Leafy Products
Hibiscus tiliaceus	119	Polytunnel GH – Leafy Products
Pandanus tectorus	308	Polytunnel GH – Leafy Products
Cocos nucifera L.	70	Open field - Banana
Calophyllum inophyllum	15	Open field - Banana
Hibiscus tiliaceus	61	Open field - Banana
Pandanus tectorus	119	Open field - Banana
Cocos nucifera L.	1	Open field – Cassava
Hibiscus tiliaceus	19	Open field – Cassava
Calophyllum inophyllum	5	Open field – Cassava
Cocos nucifera L.	21	Open field – Gourds & Squash
Hibiscus tiliaceus	47	Open field – Gourds & Squash
Pandanus tectorus	33	Open field – Gourds & Squash
Cocos nucifera L.	45	Open field – Melon
Hibiscus tiliaceus	61	Open field – Melon
Pandanus tectorus	167	Open field – Melon
Scaevolo taccada Roxb.	360	Open field – Melon
Cocos nucifera L.	8	Open field - Papaya
Pandanus tectorus	7	Open field - Papaya
Hibiscus tiliaceus	36	Open field - Papaya
Cocos nucifera L.	134	Open field – Pumpkin
Pandanus tectorus	213	Open field – Pumpkin
Hibiscus tiliaceus	175	Open field – Pumpkin
Cocos nucifera L.	4	Sewer & Brine Outfall
Hibiscus tiliaceus	17	Sewer & Brine Outfall
Pandanus tectorus	19	Sewer & Brine Outfall
Cocos nucifera L.	53	Cold Storage
Pandanus tectorus	44	Cold Storage
Scaevolo taccada Roxb.	17	Cold Storage
Cocos nucifera L.	144	Mushroom Unit
Hibiscus tiliaceus	225	Mushroom Unit
Pandanus tectorus	289	Mushroom Unit
Cocos nucifera L.	8	Storage
Hibiscus tiliaceus	11	Storage
Scaevolo taccada Roxb.	10	Storage
Pandanus tectorus	54	Storage
Cocos nucifera L.	58	Polytunnel GH – Bell Pepper
Scaevolo taccada Roxb.	240	Polytunnel GH – Bell Pepper

Pandanus tectorus	150	Polytunnel GH – Bell Pepper
Hibiscus tiliaceus	36	Polytunnel GH – Bell Pepper
Cocos nucifera L.	8	Breadfruit Trees – 5 Trees
Pandanus tectorus	59	Breadfruit Trees – 5 Trees
Hibiscus tiliaceus	49	Breadfruit Trees – 5 Trees
Cocos nucifera L.	18	Coconut Palm Trees – 50 Trees
Calophyllum inophyllum	2	Coconut Palm Trees – 50 Trees
Hibiscus tiliaceus	15	Coconut Palm Trees – 50 Trees
Pandanus tectorus	40	Coconut Palm Trees – 50 Trees
Cocos nucifera L.	26	Mango Trees – 10 Trees
Scaevolo taccada Roxb.	50	Mango Trees – 10 Trees
Hibiscus tiliaceus	39	Mango Trees – 10 Trees
Pandanus tectorus	127	Mango Trees – 10 Trees

4.4.7 Tasks already completed

The Island is already leased for The Hawks Pvt Ltd from November 2021 onwards as per an agreement with the Ministry of Fisheries, Marine Resources and Agriculture after doing an Initial Environmental Examination (IEE). The proponent is currently preparing to build the infrastructures for the agricultural Island. A team of workers has already been mobilized to the Island and the temporary facilities were already constructed on the Island. Furthermore, construction works of the accommodation building have already taken place by clearing the accommodation plot and excavation for the foundation which was observed during the survey trip (refer to section 5.4.1).

4.5 Project inputs and outputs

The following two tables details the estimated project inputs and outputs for the works to be undertaken in the proposed project.

Table 6: Major project inputs

Input resource(s)	Source/ type	Qty/Volume	Source of resource
Construction phase			
Man Power	Local and expatriate	30	Proponent
Water	Mobile RO plant	120 litres per	Local purchase or

		person per day for workforce Other construction works	import
Power	Mobile generator set	Large quantities	Local purchase or import
Machinery and equipment	General construction machinery and equipment (Excavator, Truck, Concrete mixer, General construction tools, Small lorry, forklift, Barge, Dewatering pump, total station, level gage, EF welding machine, Drilling Rig, Crane etc.)	Medium quantities	Local rent/ purchase or import
Construction Material	**Concrete works**: reinforcement steel bars, river sand, cement, aggregates	Large quantities	Local purchase or import
	Temporary site setup: Galvanized pipes, roofing sheets, cement, sand, timber, spun piles	Small quantities	Local purchase or import
	Electrical: electrical cables and wires, DBs, MMCBs and MCBs, PVC pipes, light weight, telephone cable CAT 5, PVC conduits, 4 core armored cables, PP-R pipe, Multi pump, UPVC (T1000, T600) for sewerage grid	Large quantities	Local purchase or import
	Water and Sewer: HDPE pipes, pumps, control panels, inspection chambers, aerobic tanks	Large quantities	Local purchase or import
	Finishing: floor and wall tiles, gypsum boards, calcium silicate boards, zinc coated corrugated metal roof, paint, varnish, lacquer, thinner, dry walls, carpet etc.	Large quantities	Local purchase or import
Nose and mouth covering (COVID19)	Face masks	Large quantities	Local purchase or import
Operation phase			
Electricity	Electricity grid	Large quantities	Proponent
Operators	Staff	25	Proponent
Machinery and equipment	biodigester, generator, RO plant 150TPD RO plant 50 TPD (standby) STP	2 7 1 1 1	Proponent

	Fuel tank Water tanks	1 (50,000 ltrs) 5 (50,000 ltrs)	
Maintenance material	Required for maintenance; lube oil, fittings, pipes, etc.	Small quantities	Proponent
Fuel	For electricity generation	Large quantities	Proponent

Table 7: Major project outputs

Project outputs	Method of generation/Qty	Method of control
Construction phase		
Construction wastes	Waste oils Wastewater Greenhouse gases, effluents General waste from workers – 44.2 kg per day	Green waste gathered at a local site and construction and waste oil transferred to Thilafushi for disposal.
Noise	Localized to the project site	Unavoidable, but could be minimized by limiting working hours to daytime only and completing the project within the earliest possible duration.
Operation phase		
New waste management center, RO plant facility, sewerage facility, powerhouse	Under works of the proposed project	NA
Electricity	From generators	NA
Waste oil	From mechanical equipment's, machinery and vehicles	Stored in barrels and transported to Thilafushi.
Waste in operational phase	operations	Managed in the waste management facility, any waste that is not able to cater in the on-island facility will be transferred to Thilafushi. All waste management activities shall adhere to the related regulations.
Waste water	From workers	Treated by STP and flushed through the outfall

4.6 Project Management

All the aspects of project construction and operational phase activities are described in detail under this section.

4.6.1 Temporary material storage and labour quarters

All temporary material storage and labour quarters will be established within the existing development footprint of the project and no new locations will be utilised as temporary facilities for the project.

4.6.2 Labour requirement

Labour requirement is largely dependent on the contractor and usually companies move specialists and labourer on a need basis. Typical development activity requires specialist operators for the equipment and a team of labourers aiding. Apart from the work labour site specific labourers are required for the management of the work camp/accommodation such as the kitchen. An overall manager and numerous work supervisors are permanently stationed from start to finish. During the construction phase, the following work profile will be utilized.

Table 8. Work profile required for implementation of the proposed project

Designation	Responsibility
Project manager	Overall responsibility for the implementation of the project
Project engineer	Ensure that works are in accordance to drawings and specifications
Surveyors	Provide layout and levels
Site manager	In charge of site work implementation and coordination
Implementation Supervisors	Ensures that works are carried out according to project managers instructions
Safety supervisors	Assess risk and ensure that everyone follows the safety rules and regulations.
Laborers	Carries out all the tasks

4.6.3 Construction and operational phase waste management

Any construction waste shall be properly managed and shipped routinely to Thilafushi for disposal. Proper construction sign boards shall be placed for the safety of the workers and general public who use the road.

Fuel and chemical management are to be handle with utmost care as spillage and contamination of the groundwater is prohibited under the new Water and Sewerage Act (08/2020). Spillage control mechanisms will be in place prior to execution of works and labour force will be trained prior to commencement of the work. A dedicated environmental and social safeguards officer will be employed by the proponent to ensure the safety checks are in place to ensure the implementation of the mitigation and monitoring measures specified in the current report.

If a spill does occur, following actions shall be followed;

- Spill clean-up kits are to be readily available at site
- Works are to be halted immediately and alert all the staff in the vicinity of the spill
- Staff are to take relevant personal protective measures to be ready for spill clean up
- Find the root cause of spill and mend effectively
- Clean up the spill
- Report the incident

4.6.4 Measures to protect human health during construction and operation

The proposed project site is on an uninhibited island. The proponent and the contractor are responsible for the safety of the staff, and visitors; health and safety rules must be followed strictly.

- The project site and the work area must be fenced.
- Safety signs and boards must be installed at work site.
- Fire extinguishers must be installed at site.
- The proponent and the contractor will ensure that all the supervisors are trained and qualified to identify, report, response to, and mitigate any health code violation on site.

- The proponent, contractor and other supervisory bodies will ensure all the health and safety procedures are followed while in the project site.
- All the precautions and steps will be taken to ensure the safety of the employees. Safety gear will be worn all the time.
- The proponent must ensure that the contractor provides numerous first aid kits on site.
- The proponent must ensure that the contractor trains enough staffs in basic first aid drills both terrestrial and marine. Hence making these staff available throughout the project work hours while setting the duty roster.
- The proponent must ensure that the contractor reports all medical emergencies to the hospitals.
- If the use of the equipment requires licenses or special permits, the contractor should ensure the staff are licensed.
- All tools and equipment will be handled by competent staff.
- All staff must be trained to follow the emergency plan
- Health checks and safety checks will be administered before commencement of work.
- All project activities will be carried out in the presence of a qualified supervisor.
- The staff will be trained in fire extinguishing drills and appropriate fire extinguishing equipment will be placed at easily accessible points.
- Flammable material if stored on site, will be stored at site appropriately.
- Any tools stored on site will be stored appropriately.
- Oils, grease and lubricants will be stored as specified above in section.

Mosquitoes, high temperature and drowning prevention measures are taken on site. Drugs are sprayed and mosquito nets are used in the accommodation area; Appropriate drugs are prepared in case of heatstroke. To prevent drowning, a strict management system is to be formulated and performed under supervision. Additionally, fencing the project site, set up entrance and exit, and arrange safety and civilization management personnel for on-site management.

Basic first aid facilities and safety gears shall be made readily available by the contractor during the construction phase of the project as per the regulation on safety standards for construction work. In case of an emergency, the workers shall be taken to nearest island health center and in case of major incidents they shall be taken to a hospital in the greater Male' region (IGMH / Tree top / ADK / Dharumavantha/ Hulhumale' hospital).

Special consideration will be given to take all possible preventive measures of the current pandemic of Covid-19 during the construction and operation phase of the project. As such, the recommendations of the Health Protection Agency will strictly be enforced whilst sensitisation sessions will be undertaken to internal controls of health and safety to all the work force

During the operational phase basic first aid facilities and safety gears shall be made readily available to the working staff at the facilities. Occupation health and safety guidelines shall be strictly followed by all personnel.

4.6.5 Potential accident and hazard scenarios and how to manage them

Potential hazard scenarios during this project include oil/chemical spills and injury to workers. Some of the potential hazard which are relevant to specific operations of the project has been described above (actions in case of RO plant failure, action in case of STP failure, fire safety of powerhouse, waste management equipment failure). These potential hazard scenarios and how to manage them are detailed in the emergency preparedness and response plan and the health and safety plan.

4.6.5.1 Emergency plan in case of spills

The proponent must ensure that the contractor has an emergency plan, an emergency coordinator and the alternative emergency coordinator.

4.6.5.1.1 Overall emergency plan

The overall emergency plan must be site specific and drafted upon by the contractor and the proponent considering the features of the island and the available facilities of the island. The emergency plan must be understood and followed by all staff. A typical emergency plan must include the following.

- The emergency plan should be followed and executed without delay in case of an emergency.
- Safety Sign Boards and Safety lights must be installed at the work site.
- Fire Extinguishers must be installed at work site.
- All staff must learn the basis of the emergency plan.
- Assembly points must be decided prior to mobilization
- Points of relief must be equipped with medical kits and fire safety kits
- Spill kits must be installed near the storage sites and in easily accessible areas.
- Alarms must be installed and tested
- Informed drills must be carried out at a schedule.
- All staff must be informed that they could call in an alarm.
- All emergency coordinators should be trained well with the alternative.
- In case of an emergency the point of reference must be the coordinator or the alternative.
- In case of an emergency, the emergency coordinator or the alternative must be informed primarily
- All staff must strictly follow the instructions of the emergency coordinator.
- Authorities must be informed by the coordinator or the alternative
- The contractor is required to take the following measures in order to ensure minimal pollution in case of a spill.
- Use serviced machinery to reduce toxic emissions
- Service the machines in use during the work process.
- Keep spill kits on the island and portable spill kits on the machines
- Bund all necessary lubricants and oils stored on site.

4.6.5.1.2 Emergency plan for spill response at the proposed project location

Spills on construction sites can have drastic consequences to people and the environment. Specifically on natural, moderate current, diverse, and remote zone such as the proposed island.

After a through analysis of the action in hand, the responsible party is to follow the action plan as specified. However, the best form of action is prevention therefore the following spill prevention measures must be implemented on site.

4.6.5.1.2.1 General Precautions

The following general precautionary measures shall be applied to all construction works areas to minimize the risk of accidental spillage;

- Maintain good site housekeeping practices and ensure all materials, chemicals and wastes are properly stored and placed in appropriate disposal areas onsite at the end of each day.
- Avoid disorder and storage of unnecessary materials in working areas.
- Open flames and smoking shall be prohibited within the construction site; smoking may be permitted only at designated smoking areas.
- Stacked containers should be secured from falling.
- Large / heavy containers should be stored on the floor as far as possible to prevent falling.
- Warning signs, fences and locks where appropriate should be deployed for storage place of hazardous materials, chemicals, fuel and oil, etc.

4.6.5.1.2.2 Construction Materials

Unexpected release of large amounts of suspended solids, in case of accidents, human negligence or mechanical failure would result in adverse water quality and marine ecology impacts. Hence, precaution and prevention measures are required to minimize the risk of such accidental spills. The following measures shall be applied to all construction vessels involving transport of materials that may give rise to unexpected release of large amounts of suspended solids;

Prior to transport of fill materials;

- Bottom opening of barges shall be fitted with tight fitting seals to prevent leakage of material.
- Vessels shall be regularly inspected to ensure no leakages and any leakages shall be repaired quickly prior to mobilization of the vessels.
- Barges or hoppers shall not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation.
- Excess materials shall be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessels are moved.
- Adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action.

During transport;

- Vessels shall follow the pre-defined routes and marine traffic arrangements to minimize the risk of collision.
- Vessels shall follow the designated entry / exit points into and out of the construction site boundary.
- Vessel speeds shall be limited to 10 knots or less within the construction works area and hotspots.
- Transits of vessels operating within the construction works areas will be monitored and managed

4.6.5.1.2.3 Chemicals, Oils and Fuels

For chemicals, oils and fuels (if used for the excavators, etc.) required and used onsite, the following measures shall be applied:

For procurement;

- Label all chemical storage containers and tanks in accordance with the EPD ‘Code of Practice on the Package, Labelling and Storage of Chemical Wastes’.

- An up to date list of chemicals, chemical waste and fuel oil should be maintained.

For storage;

- Suitable containers should be used which are resistant to the stored oil fuel, chemical / chemical waste to avoid leakage.
- Containers should be checked before use and container lids should be closed tightly to avoid leakage of chemicals and chemical waste.
- Chemical waste storage areas should be located in a designated area that is sheltered on at least 3 sides and the top, and is locked and kept clean and free from obstruction.
- Incompatible chemicals should be separated.
- Chemical, oil and fuel containers should be kept under eye level as far as possible.
- Drip trays or bunds should be used for storage containers of chemicals and oil / fuel tanks and should have a capacity equal to 110 % of the storage capacity of the largest tank.
- Chemical storage area and drip trays should be inspected daily to ensure the containers are in good condition and there are no openings which oil / chemicals can possibly leak out. Any damage / openings to the storage area and drip trays should be repaired or replaced immediately.
- Where chemicals are temporarily taken outside the sheltered chemical storage area, the chemicals including the drip trays / bund should be covered by waterproof tarpaulins and kept free of rainwater.

For transfer / transport;

- Pumps should be used to transfer large quantities of oil, fuel, chemical / chemical wastes instead of pouring.
- Oil, fuel, chemical / chemical wastes should be transferred slowly to prevent spillage or overfilling.
- Suitable trolley should be used to transport chemicals / chemical wastes to other location.

For use;

- Chemical quantities / dosage required during each use shall be carefully calculated / measured to prevent any excess chemicals being generated and released.
- Drilling fluid used in drilling activities should be reconditioned and reused as far as possible.

4.6.5.1.2.4 Spill response

Effective spill response comes down to the reediness of the contractor to a potential event. This in effect enables the contractor to respond to any related un identified event as well. Spill response simplified can be shown in as below.

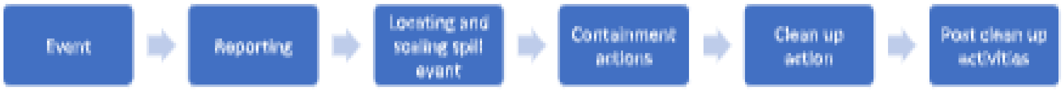


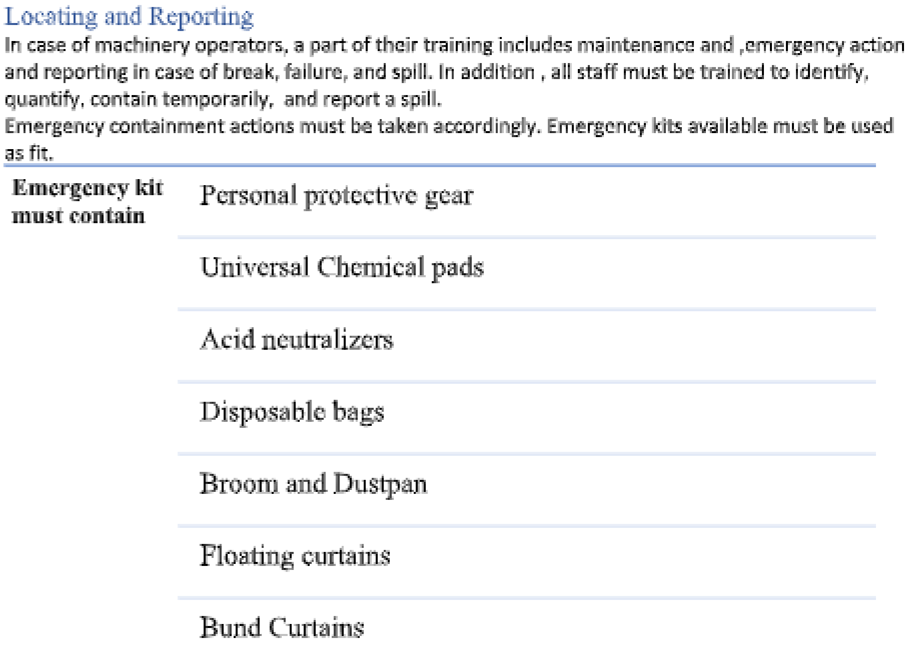
Figure 8: spill response procedure

In this specific project, three major types of spill involved are listed.

Construction Phase		
Spill Types	Land Based Activities	Marine based Activities
Fuel/ Oli	✓	✓
Chemicals	✓	✓
Fill materials	✓	✓

Locating and Reporting

In case of machinery operators, a part of their training includes maintenance and, emergency action, and reporting in case of break, failure, and spill. In addition, all staff must be trained to identify, quantify, contain temporarily, and report a spill. Emergency containment actions must be taken accordingly. Emergency kits available must be used as fit.



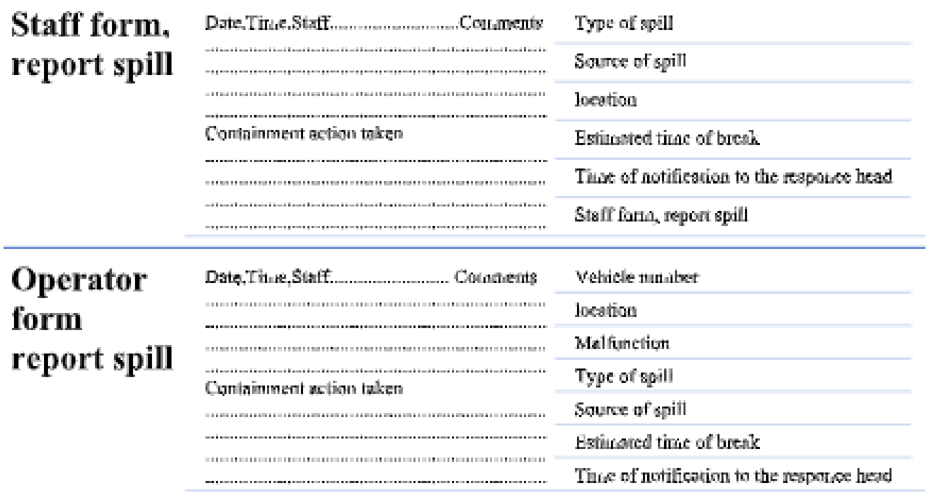
Locating and Reporting

In case of machinery operators, a part of their training includes maintenance and ,emergency action, and reporting in case of break, failure, and spill. In addition , all staff must be trained to identify, quantify, contain temporarily, and report a spill.

Emergency containment actions must be taken accordingly. Emergency kits available must be used as fit.

Emergency kit must contain	Personal protective gear
	Universal Chemical pads
	Acid neutralizers
	Disposable bags
	Broom and Dustpan
	Floating curtains
	Bund Curtains

Reporting must have the following parameters;



Staff form, report spill

Date,Time,Staff…………………….Comments
…………………………………………………………
…………………………………………………………
…………………………………………………………
…………………………………………………………
Containment action taken
…………………………………………………………
…………………………………………………………
…………………………………………………………
…………………………………………………………

Type of spill
Source of spill
location
Estimated time of break
Time of notification to the responce head
Staff form, report spill

Operator form report spill

Date,Time,Staff…………………… Comments
…………………………………………………………
…………………………………………………………
…………………………………………………………
…………………………………………………………
Containment action taken
…………………………………………………………
…………………………………………………………
…………………………………………………………
…………………………………………………………

Vehicle number
location
Malfunction
Type of spill
Source of spill
Estimated time of break
Time of notification to the responce head

After reporting, the response head must follow directions from the government to the fullest extent.

4.6.6 Decommissioning

Once the project has been completed, construction team leaves the site after performing the required site clearance. Any waste will be transported to nearest regional waste management center for disposal. All heavy machinery brought to the site will be demobilized.

4.6.7 Project duration and schedule of implementation

The construction will commence once the EIA process has been completed. Estimated date is July 2023. Construction works is expected to be completed by March 2024. Refer to Appendix H for a detailed work plan of the proposed project. The entire project is estimated to be completed within 184 days from project commencement date. A summary of the major milestones is provided in the following Table 9.

Table 9: major milestones of the project

Task Description		Duration / Days
Total Duration		184
Preliminaries	Mobilization	3
	In-survey and setting out	3
	Commencement	1
Harbor and Jetty Construction	Dredging	55
	Jetty and Quay wall construction	20
	Breakwater construction	35
	Backfilling and Finishing	15
Access Channel	Sand bunding	15
	Dredging	30
	Placing geobags	10
Powerhouse	Vegetation removal and site preparation	5
	Construction of powerhouse	55
	Transfer and placement of gensets	30
Waste Management Center	Site preparation	5
	Construction of sheds	20
	Installation of machinery	15

Water and Sewer	Site preparation	8
	Construction of Plant house	55
	Construction of Pump stations	30
	Construction of STP	25
	Pipe laying	35
	Installations	15
Demobilization	Site Clearance	2
	Out-survey	3
	Final Demobilization	2
	Final Inspection and Handover	2

5. EXISTING ENVIRONMENT

This chapter describes the existing environmental conditions of the proposed project site. Sections 5.1 describes the general environmental condition of the Maldives and 5.2 outlines the general climatic conditions by analyzing data from the meteorological center of the Maldives. Sections 5.3 to 5.6 details the specific environmental conditions at the proposed project site.

5.1 The Maldivian Setting

Maldives, officially known as the Republic of Maldives and sometimes referred to as the Maldive Islands, is an island nation (Zahid, 2011) consisting of nearly 1192 islands on a double chain of 26 natural atolls (administratively divided into 20 atolls), 80-120 km wide, in the Laccadive Sea in the Indian Ocean (State of the Environment 2004, 2004). Elevating less than 3 meters above mean sea level, with 80% of land area less than 1 m, Maldives is the flattest country in the world. The total area is about 107,500 km^2 of which roughly 300 km^2 of landmass (Zahid, 2011), with a population of about 338, 434 (as per September 2014 census) (Maldives' Population Dynamics: Policy Prospects for Human Growth and Opportunity, 2016) spread over 194 inhabited islands (Statistical Yearbook of Maldives 2010, 2010). Stretching 860 km from latitude 7°6"35"N, crosses the Equator to 0°42"24"S, and lies between 72°32"19"E and 73°46"13"E longitude (Zahid, 2011). These coral Atolls are located on the 1600 km long Laccadives-Chagos submarine ridge extending into the central Indian Ocean from the SW coast of the Indian sub-continent (State of the Environment 2004, 2004).

The Atolls vary greatly in shape and size as well as the characteristics of the Atolls, reefs and reef islands vary considerably from north to south. The northern atolls are broad banks, discontinuously fringed by reefs with small reef islands and with numerous patch reefs and faros in the Lagoon whereas in the southern atolls, faros and patch reef are rarer in the Lagoon, continuity of the atoll rim is greater and a larger proportion of the perimeter of the Atolls is occupied by islands. The islands also differ depending on location, form and topography. The islands vary in size from 0.5 km^2 to around 5.0 km^2 and in shape from small sandbanks with sparse vegetation to elongated strip islands. Many have storm ridges at the seaward edges and a few are characterized by swampy depressions in the center (State of the Environment 2004, 2004).

Located on the equator, Maldives experiences a warm, humid tropical climate or a monsoonal climate with two distinct seasons known as the northeast monsoon (dry season) from January to March and southwest monsoon (wet season) from May to November (State of the Environment 2004, 2004). The southwest season brings in torrential rain (Zahid, 2011) and rainfall varies from north to south along the atoll chain, with a drier north and wetter south (State of the Environment 2004, 2004). Rainfall varied from 1,407 mm to 2,707 mm interannually over the last 30 years. May, August, September and December are the wettest months and January to April the driest (State of the Environment 2004, 2004).

The annual and seasonal temperatures vary very little with a mean annual temperature of 28°C (State of the Environment 2004, 2004); however, the diurnal temperature fluctuates from 31°C during the day to 23°C at night. This is associated with the small size of the islands and the tempering of the hot days by cooling sea breezes surrounding the islands (Zahid, 2011). The highest and lowest temperatures on record are 36.8°C on May 1991 and 17.2°C on April 1978 respectively (State of the Environment 2004, 2004).

Ocean currents are driven by the monsoon winds with the westerly flowing currents dominating the northeast monsoon and easterly currents dominating the southwest monsoon. Changes in current flow patterns occur in April and December corresponding to the transition periods of the southwest and northeast monsoons respectively. Currents near the shoreline slightly differ from oceanic currents depending on the location, orientation and morphology of the reefs and underwater topography (Zahid, 2011).

Sea surface temperature (SST) is reasonably constant throughout the year and ranges between 28 to 29 °C. Mean monthly SST rises from December/January to April/May. However, May 1998 experienced a mean monthly SST of 30.3 °C which is expected to occur every 20 years. Furthermore, temperature drops rapidly to below 20 °C at a depth of 90-100 m (State of the Environment 2004, 2004).

5.1.1 Geology and Geomorphology

Earth's crust, called the lithosphere, consists of 15 to 20 moving tectonic plates. The plates can be considered as cracked shell that rest on the hot and molten rock of Earth's mantle and fit closely against one another. The heat from radioactive processes within the planet's interior causes the plates to move toward and away from each other which is known as tectonic shifts (NOAA, 2021).

Maldives in located on the Indo-Australian plate which is among the 7 major plate tectonic boundaries found on Earth. The Indo-Australia plate which is a combination Australian and Indian Plates covering a total area of about 58,900,000km^2. However, they are generally considered to be two separate plates (Earthhow, 2021).

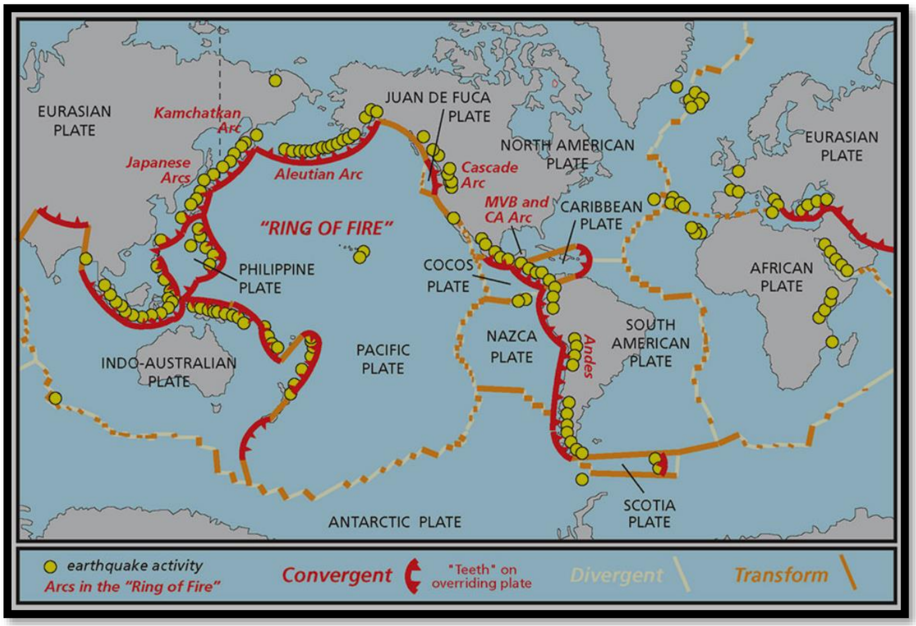


Figure 9 : Shows all the major tectonic plates and their general movements

Maldives is an archipelago of islands. Maldives is made up of 26 natural chain of atolls covering over 90000 square kilometer in the sea. The islands stretch for 822 km from north to south, with the greatest width from west to east being 130km. The land area of all the islands amounts to 298km2 (Belopsky & Droxler, 2004).

The inner sea of the atolls mostly have shallow depths compared to the rest of the outer sea with depths ranging from 300 to 500m (Purdy & Bertram, 1993). The following figure shows a general bathymetric map highlighting the changes in depth within and outside waters in and around Maldives.

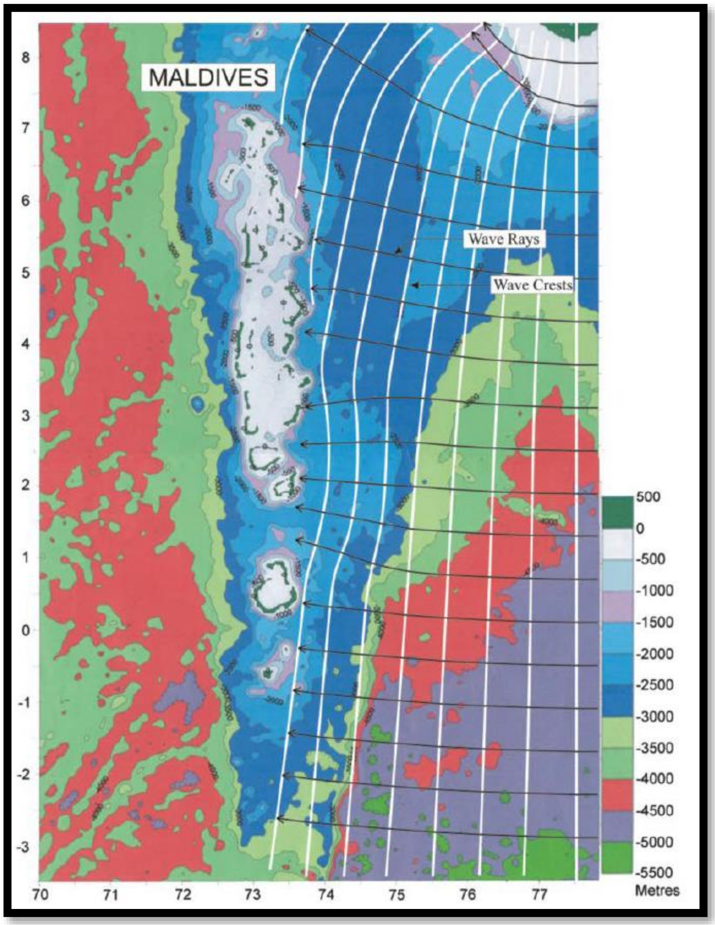


Figure 10: Shows the general bathymetry of Maldives (riyan Pte.Ltd, 2013)

Most of the islands have high peripheral storm berms formed due to overwash with maximum elevations of 2.2m above mean sea level (MSL). The present-day beach is deposited against the vegetation line of the island. The seaward boundary is defined by a distinct break in slope associated with the transition from unconsolidated beach sediment to the fixed reef flat substrate in which beach and shoreline move freely. Beach width varies considerably for each individual island (Kench, P S; Brander, R W, 2006).

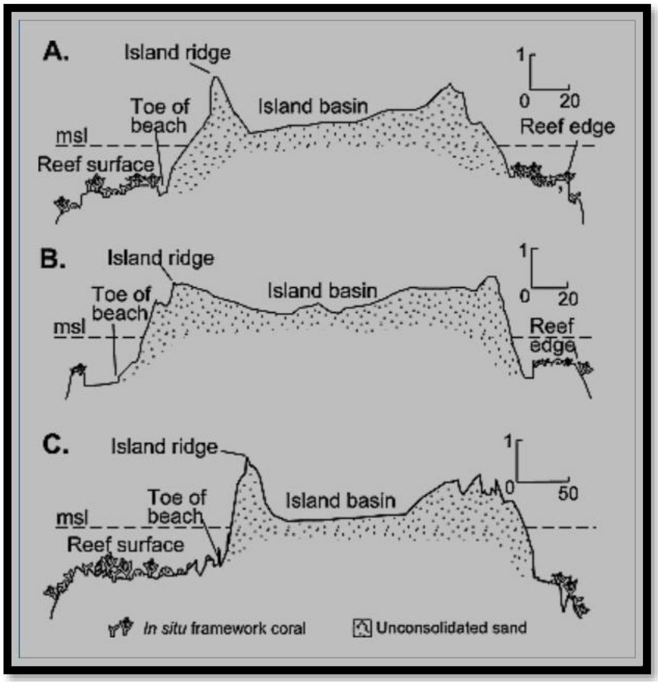


Figure 11: Shows some morphological features in an island system (Kench, P S; Brander, R W, 2006).

5.1.2 Waves

Hydrodynamics features in Maldives have been very poorly studied. (Young, 1999) shows wave climate data for a ten-year period for each world regional zone. Wave height was measured by satellite (Radar Altimeter), whereas a global wave model was used to precise wave directions. It indicates that the dominant swell approaches from southerly directions (Figure 10). On a seasonal basis, swell is from the south-southwest from April to November (SW monsoon) with a peak significant wave height (Hs) of 1.8m in June, and from the south to southeast directions from November to March (NE monsoon) with minimum Hs of 0.75m in March.

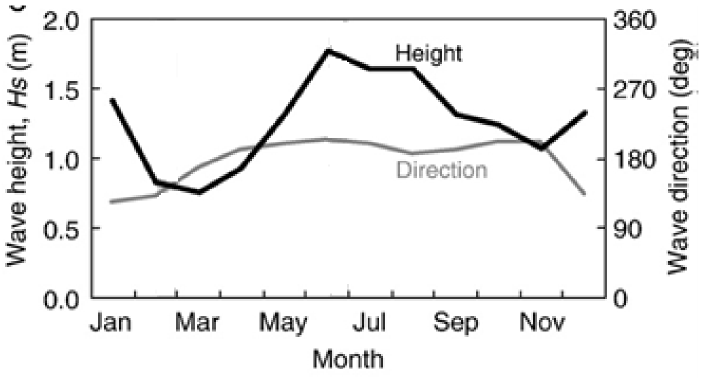


Figure 12: Ten year mean monthly wave height and direction for the central Maldives. Source: Young (1999).

The work of (Contestabile, Lauro, Galli, & Vicinanza, 2017) in a report published in 2017 regarding wave energy in the Maldives showed that Young's findings were accurate. They showed that the wave energy in the South (average significant wave height 1.5 m) is higher and diminishing towards the Northern islands (average significant wave height 1.3 m). Furthermore, there is a change in wave energy in the Eastern and Western side of the Maldives which are much more evident for extreme events. The maximum significant wave height in the West is 3.59 m and 3.05 in the East. The main reason for these difference in wave energy is because the majority of the swell waves approach the Maldives from the S-SW direction.

In addition to the swell waves Maldivian islands are impacted by local wind generated waves. Wind waves are generated due to monsoonal winds in the Maldives. Therefore, the strength and direction of wind waves is dictated by the strength and direction of the winds. Since the monsoonal winds are strongest in the SW monsoon between April-July, it is during this period the strongest wind waves would be generated.

5.1.3 Currents

In the Indian Ocean the Maldivian archipelago has relatively stronger currents (Riyaz, 2016). Current speeds in the channels between the atolls can vary between 0.51-0.77 m/s while the currents in the channels within the atolls are stronger and the E-W oriented channels having the strongest currents between 1.5-2.6 m/s (Rober Gordon Univeristy, 2011).

In the Maldives currents are predominantly caused by the complex interaction of oceanic currents, tidal currents and local wind induced currents. The major current that flows through the Maldives is caused by the monsoonal winds. During the SW monsoon the currents flow from W-E and during the NE monsoon from E-W (Rober Gordon Univeristy, 2011). Other factors which influence the currents are waves, local bathymetry and topography. The resultant currents at a specific location in the Maldives is determined by the complex interaction among the aforementioned factors.

Tidal currents are caused by the horizontal movement of water which is caused by the regular rise and fall of the sea level due to tides (Riyaz, 2016). The strength of the tidal currents are determined by the tidal ranges and follow the same periodicities as the tide meaning the tidal currents would be weaker during low tide and vice versa. In general, the tidal currents flow eastward during flood and westward during ebb.

5.1.4 Tides

The tides in the Maldives are semi-diurnal with diurnal inequalities meaning there are two high and two lows everyday with different heights (Rober Gordon Univeristy, 2011). In addition to the daily variation in tides, there are variations in tides due to the lunar cycle which are caused by the varying gravitation pull of the moon due to the position of the moon. When the moon and the sun is aligned in a straight line the gravitational pull is greatest and this causes a spring tide. When the moon and the sun are aligned at 90^0 their combined gravitational pull is at the minimum and this causes a neap tide.

With reference to mean sea level (MSL) the mean higher high water is +0.34 m and mean lower low water is -0.36 m (Riyaz, 2016). However, it has been reported that the highest astronomical tide was at +0.64 and lowest astronomical tide at -0.56.

Table 10: mean tidal variations in the Maldives (Riyaz, 2016).

Tide Level	*Referred to MSL*
highest astronomical tide (HAT)	+0.64
mean higher high water (MHHW)	+0.34
mean lower high water (MLHW)	+0.14
mean sea level (MSL)	0.00
mean higher low water (MHLW)	-0.16
mean lower low water (MHLW)	-0.36
lowest astronomical tide (LAT)	-0.56

5.2 Climatic Conditions

The Bureau of Meteorology of Maldives has compiled a range of climate variables since 1975 from five different meteorological stations located across the Maldives. Climate variables including temperature, rainfall, and wind were analyzed for the nearest meteorological station to L. Thun'buri, which is Kahdhoo meteorological center at geographic coordinates of 335667.13 m E, 205498.67 m N, about 23.84 Km from L.Thun'buri. Location of Kahdhoo meteorological center with respect to L. Thun'buri is shown on Figure 13 below.

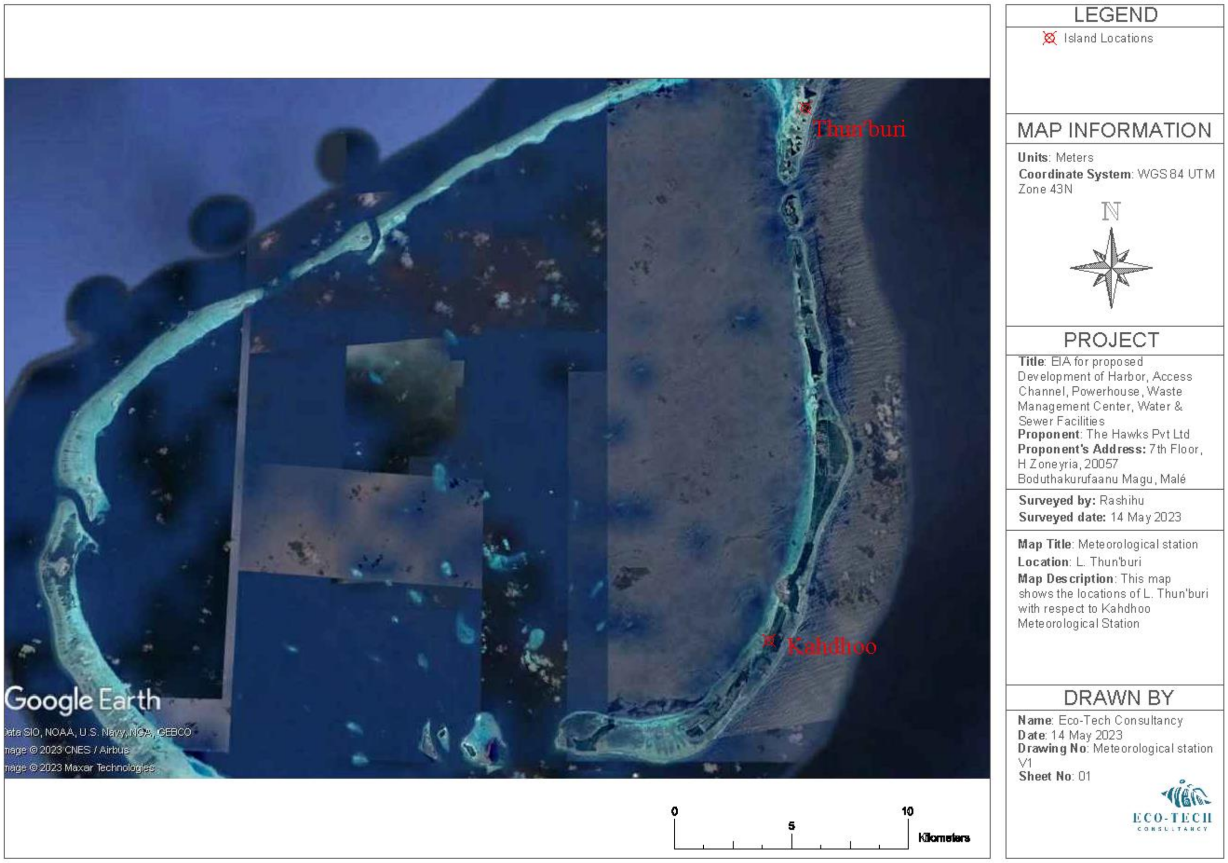


Figure 13: Location of L. Thun'buri with respect to Kahdhoo meteorological center

5.2.1 Temperature

Analysis of temperature data shows that the variation in temperature throughout the year is generally very minimal, however, daily temperature ranges from 36.0°C during the day to 20.0°C at night. Looking at the monthly variation in temperature, the highest temperature was recorded for the month of April from the meteorological station in Kahdhoo reading 32.3°C over the past 31 years. With regards to the minimum temperature, the lowest temperature at Kahdhoo, 24.8°C was recorded for December.

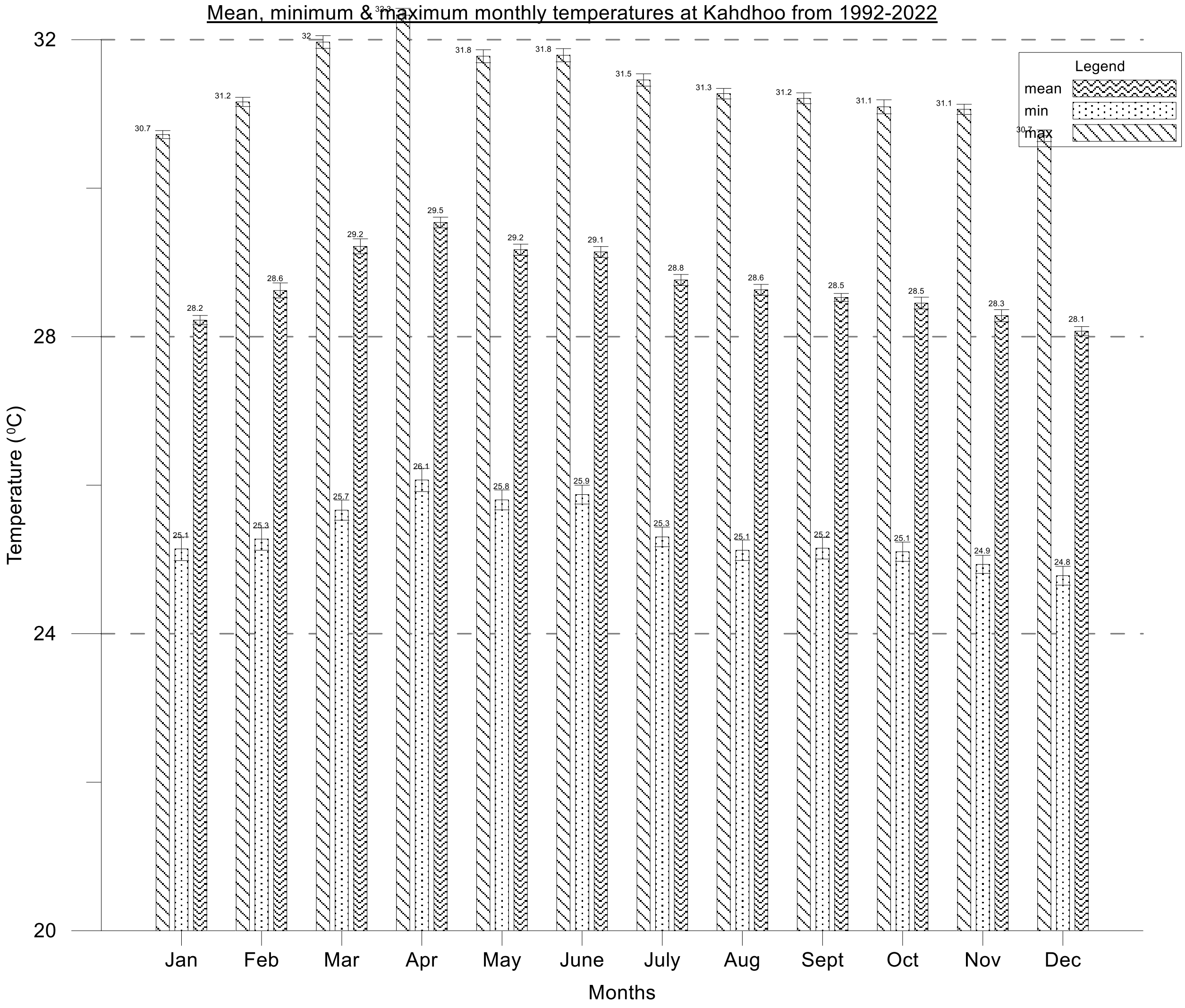


Figure 14. Mean, minimum, and maximum monthly temperatures for Kahdhoo from 1992 to 2022 (Data obtained from the Maldives Meteorological Service)

5.2.2 Rainfall

Maldives experiences a monsoonal climate due to it being located on the equator. The wet season (Northeast monsoon) marked from mid-May to November and the dry season (Southwest monsoon) from January to March used to see distinct rainfall patterns. Climate change has made the monsoons and rainfall patterns slightly unpredictable the past few years, but the trends have stayed fairly similar. Analysis of rainfall data from 1992 to 2022 at Kahdhoo meteorological station shows that the mean monthly rainfall follows the traditionally defined seasons with most rain occurring from April to May, July to December and lower rain falling outside these months. The highest amount of rain was observed during the month of May with 292 mm of rain on average and the lowest rain was experienced in February, averaging at 83.5 mm of rain over the past 31 years.

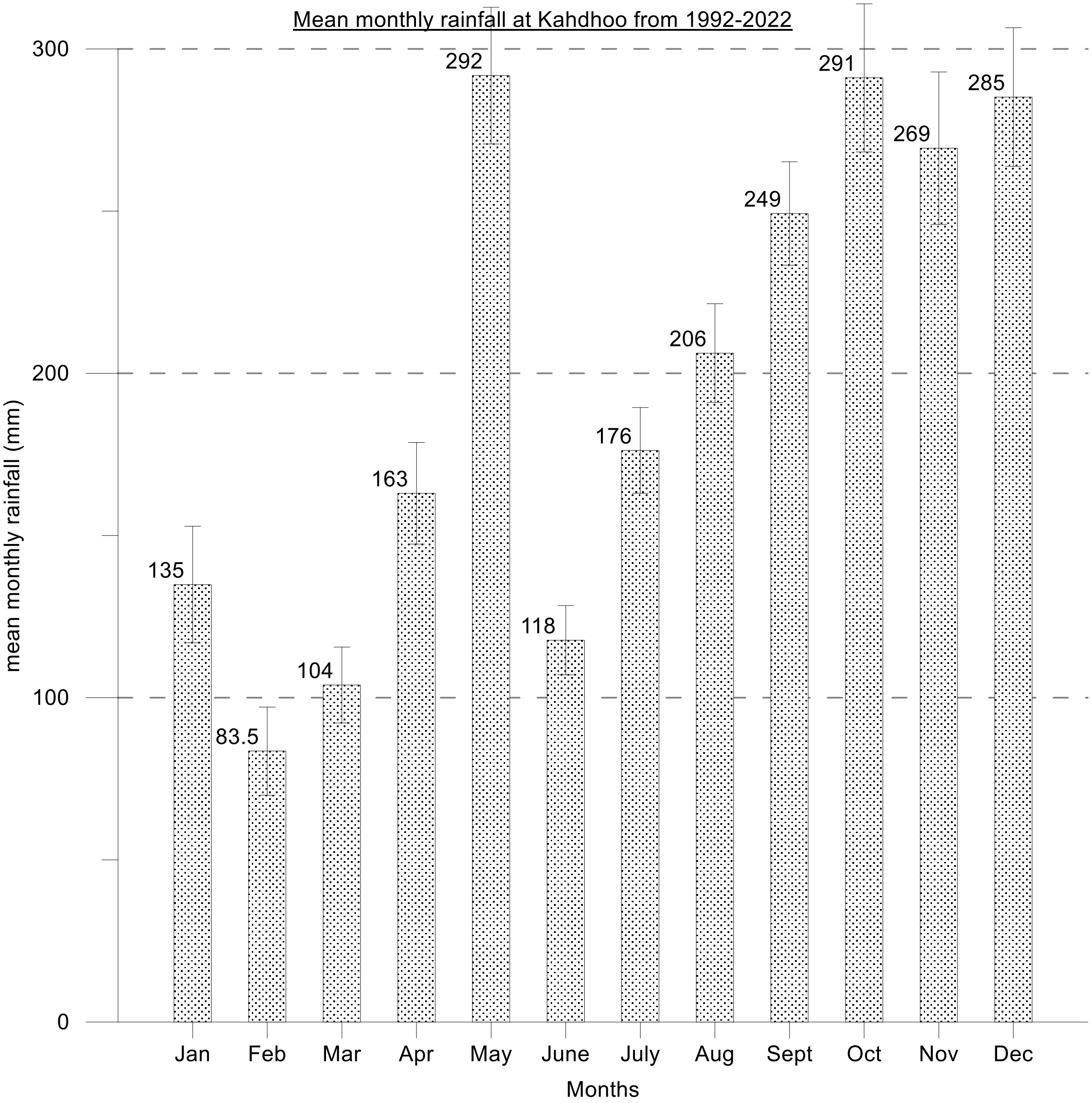


Figure 15. Mean monthly rainfall (mm) for Kahdhoo from 1992 to 2022 (Data obtained from the Maldives Meteorological Service)

5.2.3 Wind

Climate in the Maldives is dominated by the Indian monsoon climate South West (SW) monsoon and North East (NE) monsoon. The Indian monsoon system is one of the major climate systems of the world, impacting large portions of both Africa and Asia.

The period of the year during which prevailing winds are from south to westerly direction is known as the SW monsoon (Kench, P.S., Parnell, K.E. & Brander, R.W., 2009). The period during which prevailing winds are from north-easterly directions is known as NE monsoon. Transitions from NE to SW monsoon and vice versa are distinctly different from SW or NE monsoon. During these transition periods the wind becomes more variable.

The SW monsoon lasts between May and September while the NE monsoon lasts between December and February. The period between March and April is the transition period from the NE monsoon to SW monsoon known locally as the *Hulhangu Halha*, while the transition period from SW monsoon to NE monsoon is known as *Iruvai Halha*. *Iruvai Halha* is from October to November (Table 11). SW monsoon is generally rough and wetter than the NE monsoon. Storms and gales are infrequent in this part of the globe and cyclones do not reach as far south as the Maldivian archipelago.

Table 11: The four seasons in the Maldives. Source (Danish Hydraulic Institute, 1999)

Season	Month
NE-Monsoon	December
	January
	February
Transition Period 1	March
	April

SW-Monsoon	May
	June
	July
	August
	September
Transition Period 2	October
	November

By analyzing the available wind data from the meteorological station, a windrose was drawn (Figure 16 and Figure 17). The wind speed classes have been categorized according to the beaufort wind scale (Trujillo & Thurman, 2016). According to this scale wind speeds of 4-6 knots are light breeze, 28-47 knots are gales and wind speeds greater than 48 knots are considered as storm. The following table shows the beaufort wind scale.

Table 12: beaufort wind scale

Beaufort number	Descriptive term	Wind Speed (knots)
0	Calm	0-1
1	Light air	1-3
2	Light breeze	4-6
3	Gentle breeze	7-10
4	Moderate breeze	11-16
5	Fresh breeze	17-21

6	Strong breeze	22-27
7	Near gale	28-33
8	Gale	34-40
9	Strone gale	41-47
10	Storm	48-55
11	Voilent storm	56-63
12	Hurricane	64 +

Looking at the mean wind speeds and direction for Kahdhoo, it was observed that the strongest wind occurs from W direction (in the SW monsoon) and from NE direction (in the NE monsoon). Majority of the times, winds occur at a speed of 7 to 16 kn which is generally known as gentle to moderate breeze. Mean wind speeds above 22 kn occurred from the Western quadrant (W) to a very low occurrence.

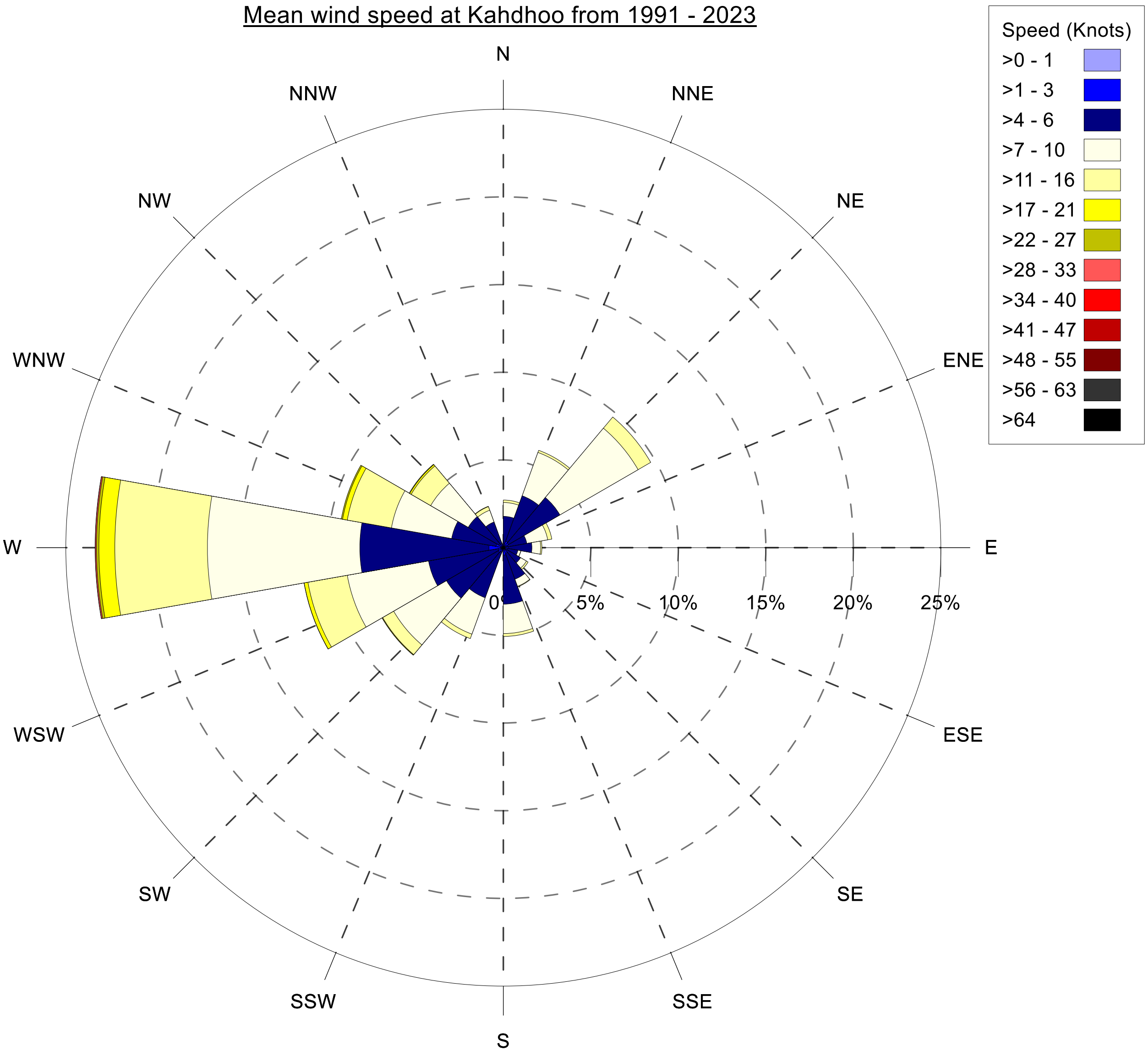


Figure 16. Mean wind speeds for Kahdhoo from 1991 to 2023 (Data obtained from the Maldives Meteorological Service)

With respect to maximum wind speeds, visual inspection of the wind rose plot coincides with that of the mean wind speeds. Approximately 1% of the times, wind speeds had gone as high as >40 kn at this region. The highest recorded maximum wind speed for the region was 60 kn which has been recorded once during the 32-year period (30th August 1992). The most common maximum wind speed is between 11-27 kn.

Wind rose plots for both maximum and mean wind speeds show that winds from the West are dominant (approximately 22 % of the time).

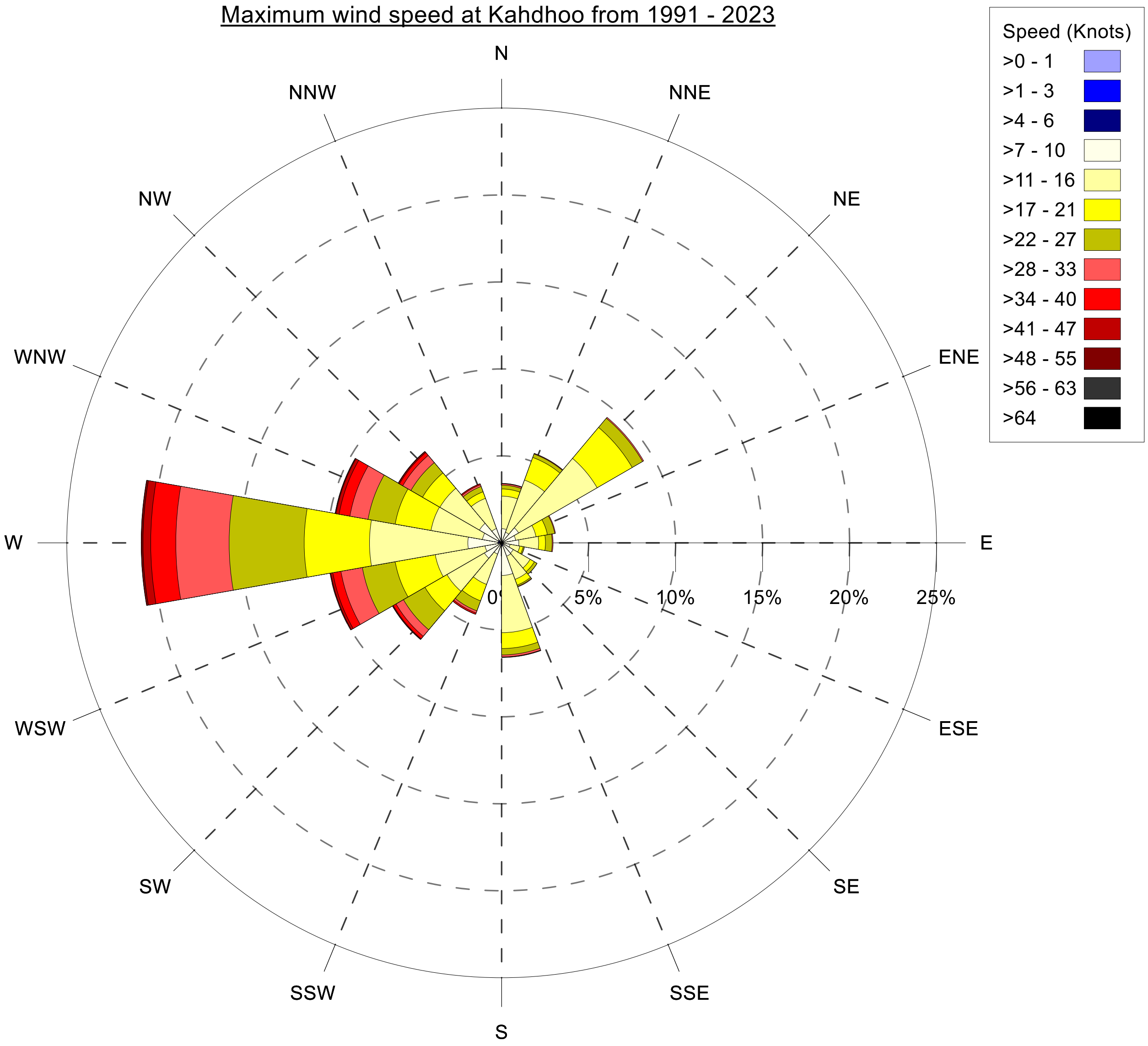


Figure 17: Maximum wind speeds for Kahdhoo from 1991 to 2023 (Data obtained from the Maldives Meteorological Service)

5.3 Marine Environment of Laamu Thun'buri

This section describes the site-specific marine environmental conditions of the proposed project site. The general setting of L. Thun'buri, seasonal erosion, bathymetry, sea bed sediments, benthic substrates, fish census, and marine water quality near the proposed project site is presented.

5.3.1 General Island Setting

Located in the Laamu Atoll, Thun'buri is situated at a distance of 23.84 km from L. Kahdhoo. It is located on north eastern periphery of Laamu atoll at geographic coordinates of 337668.52 m E and 229377.88 m N. The reef system hosting the island is shared by 12 other islands. The land area of L. Thun'buri is only about 18 ha.

The Island is an uninhabited Island with minimal human intervention. The vegetation cover of the Island is extensive and dense at most of the areas. The surrounding reef flat is very shallow and a huge area gets completely exposed in low tide. There are extensive seagrass beds on the Eastern side reef flat of the Island. The Western side is mostly sandy bottom with patched seagrass beds on the shallow reef flat. However, on the deeper lagoon environment there is live coral cover. The Island has an embayment on the Western side, no true mangrove species were identified.

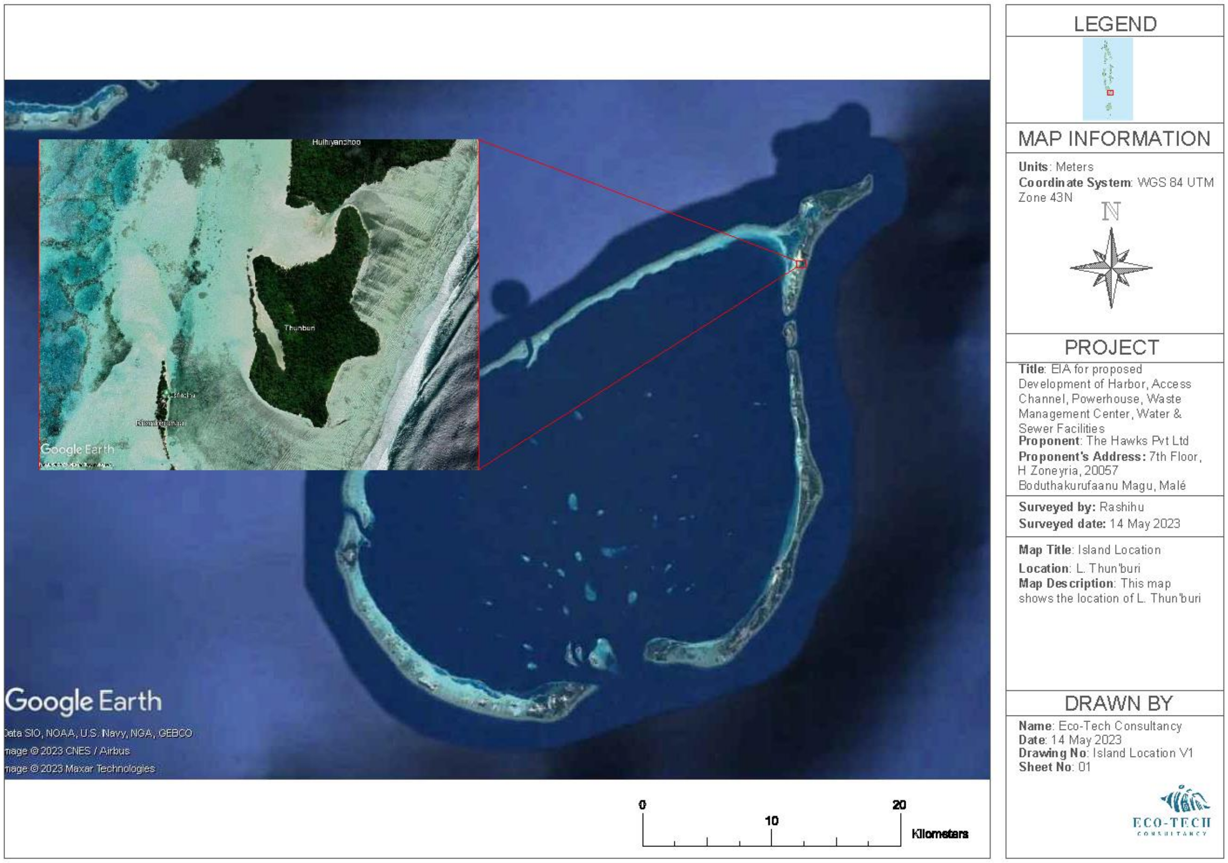


Figure 18. Location of Thun'buri in Laamu atoll.Currents and Coastal Dynamics

5.3.2 Currents and Coastal Dynamics

Thun'buri is located on the north eastern rim of Laamu atoll. To the S-SE direction of the Island there are no islands or reefs that would obstruct the incoming swells from SE direction. Furthermore, as there are no further atolls found SE of the island, the intensity of the Swell waves reaching the Island in the NE monsoon would be high.

During the NE monsoon the winds predominantly blow from NE. Towards this direction there are no Atolls, Island or Reefs. Therefore, the effective fetch from this direction would be very high and hence the Island would experience strong wind waves from this direction.

Figure 19. Approach of wind and swell waves to Thun'buri in NE monsoon

During the SW monsoon, swells would approach the island from south to SW directions. To the S-SW lies part of Laamu Atoll with extensive reef systems and Islands mainly found at the atoll periphery, the intensity of swell waves reaching the island from this direction would be low.

The strongest winds during SW monsoon comes from the W direction. In this direction there are no reefs or Island within the Atoll basin, therefore wind waves generated within the Atoll basin would approach the Island without any obstruction, however the strength of the wind waves would be much lower than in a setting where wind waves would be generated beyond the Atoll periphery. Nonetheless due to the wide reef flat on the Western side, it is expected that a very low waves energy would actually be reaching the shoreline of the Thunburi.

Overall, the strongest waves to L. Thun;buri would most likely come from the SE and NE direction.

Figure 20: approach of wind and swell waves to Thun'buri in SW monsoon

The current measurements were taken during the transitional period from NE to SW monsoon when the general pattern of currents through the Maldives starts to change from west to east direction. During this period currents general flow starts to change to eastwards during high tide. During data collection period the tide was low. The results show a westerly flowing current as expected of the SW moon and low tide. The northward flowing current measured near the eastern reef edge is shown as the strongest current speed recorded from the drogue runs at 0.254 m/s.

Schematic diagrams showing the measured current patterns on Thun'buri reef is shown in below.

Figure 21: measured currents around Thun'buri

5.3.3 Seasonal Erosion

From the aerial images it can be observed that Thun’buri exhibit slight changes to the shoreline between seasons. According to the images there is no long-term erosion. However, there were some disturbances to the island at year 2011 where a large area of land was cleared. The cleared area was not utilized for any purpose in particular (as per the following aerial images) and the vegetation have mostly recovered since then.

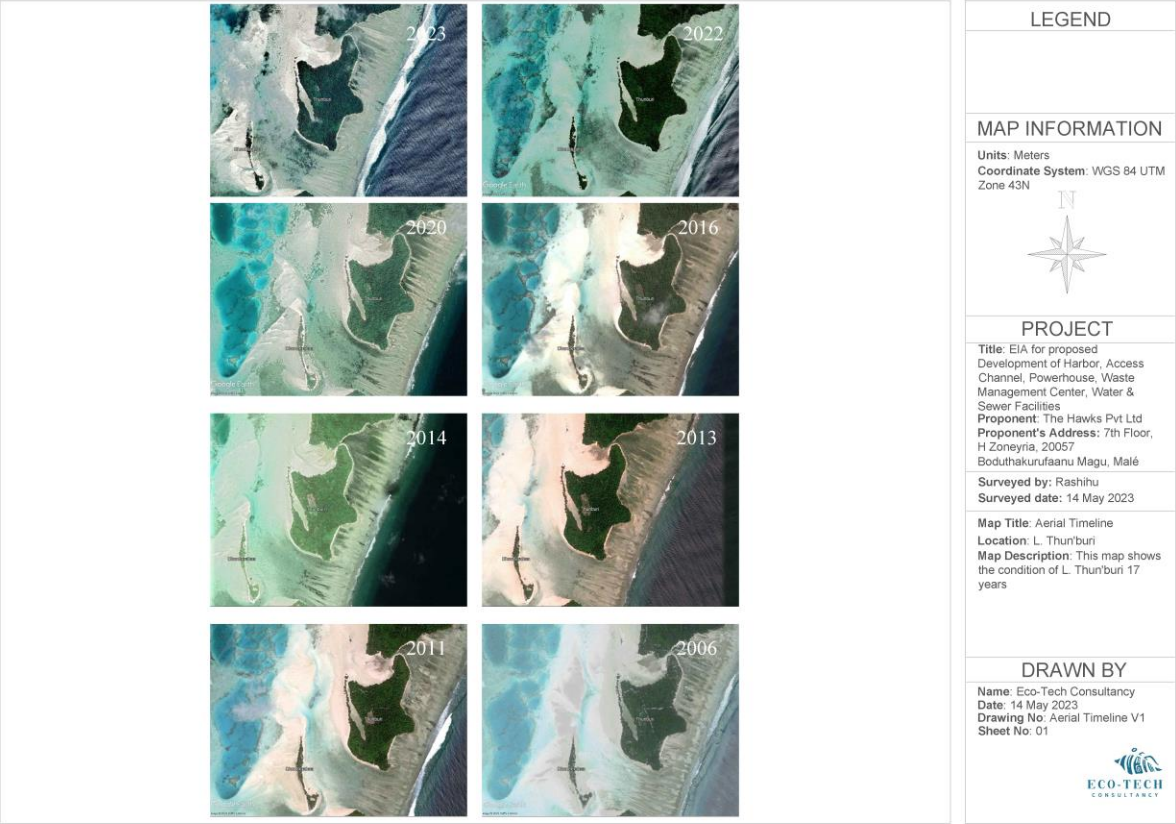


Figure 22: Aerials images of Thun'buri over the past years (adopted from google earth)

5.3.4 Bathymetry

The western reef flat is very shallow, from the shoreline of the Island until the proposed harbour location ranging from -0.01 to -1.34 meters in depth. However, the proposed harbour location, which is deep lagoon was at -3 m. The proposed entrance channel which is the reef flat is shallow exhibiting depths between -1.15 to 1.46m until the inner reef slope.

The bathymetry report is given in appendix N.

5.3.5 Seabed Sediments

Upon visual inspection of the seabed sediments on the reef flat of the Island from different locations, it seems that sediments are coarser in the lagoon area and finer near the coast. The embayment has the finest sand with muddy characteristics.

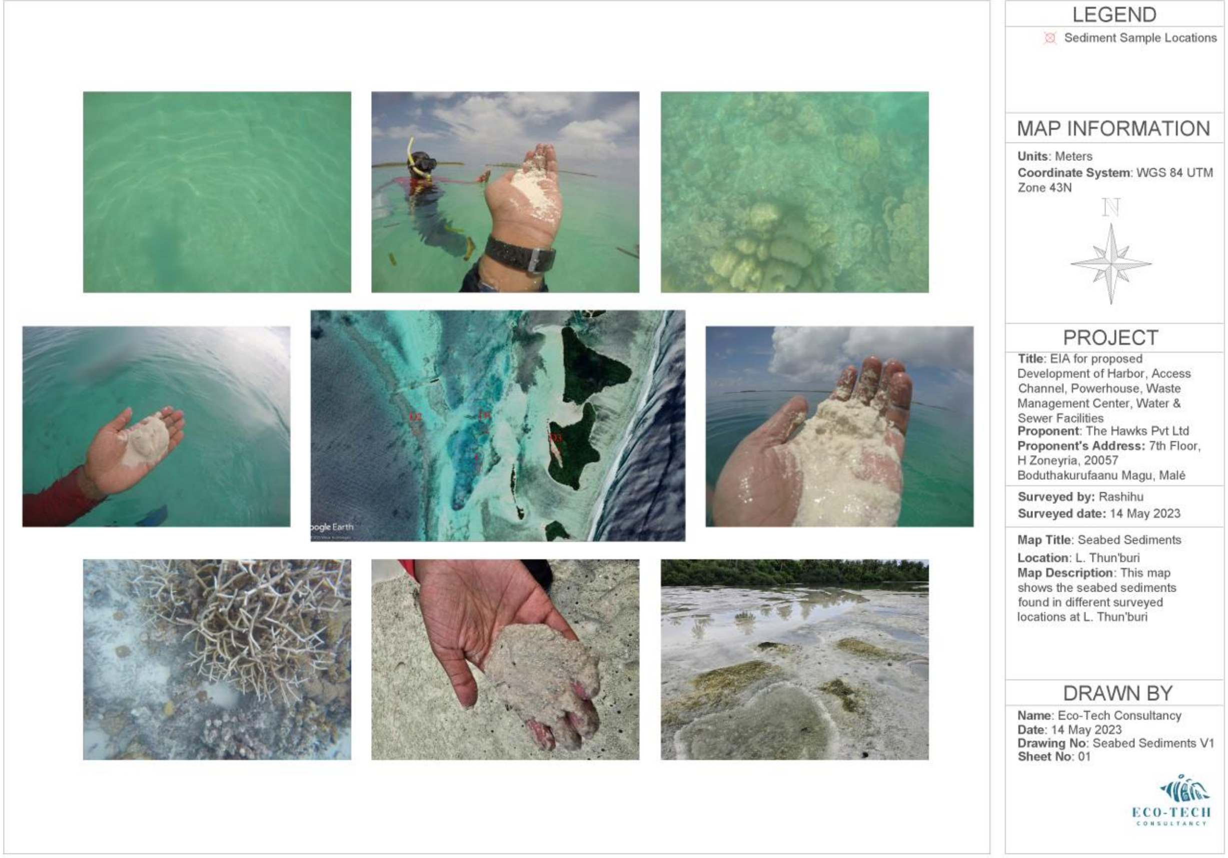


Figure 23: seabed sediments on the western reef flat and embayment of Thun'buri

5.3.6 Benthic Substrate

During the snorkeling session, it was observed that the proposed project area had overall poor live coral cover, except for the entrance channel (site D2). At site D1 the majority of the area was covered in sand. At site D4 and C some amount of coral cover was observed while D2 showed high coral cover.

5.3.6.1 Major coral categories

The results show that the mean live coral cover of the project area was poor (18.3%), the dominant substrate is rock (40.0%) followed by sand (38.1%). Live coral cover was highest at Site D2 (40.8%). D4 was mostly dominated by rock (86.8%) while D1 was dominated by sand (99.6%). The detailed percentages of coral cover in transects are shown in Table 13 and Figure 24 below.

Table 13: Major benthic categories

MAJOR CATEGORY (% of transect)	**C**	**D1**	**D2**	**D4**	**Mean**	**CI 95%+**	**CI 95%-**
Coral (HC)	19.2	0.0	40.8	13.2	18.3	26.8	9.8
Soft Coral (SC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Others (OT)	1.6	0.0	0.4	0.0	0.5	0.9	0.1
Nutrient Indicator Algae (NIA)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Recently Killed Coral (RKC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sponge (SP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rock (RC)	33.2	0.0	40.0	86.8	40.0	57.9	22.1
Rubble (RB)	10.8	0.4	1.2	0.0	3.1	5.7	0.5
Sand (SD)	35.2	99.6	17.6	0.0	38.1	59.8	16.4
Silt (SI)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

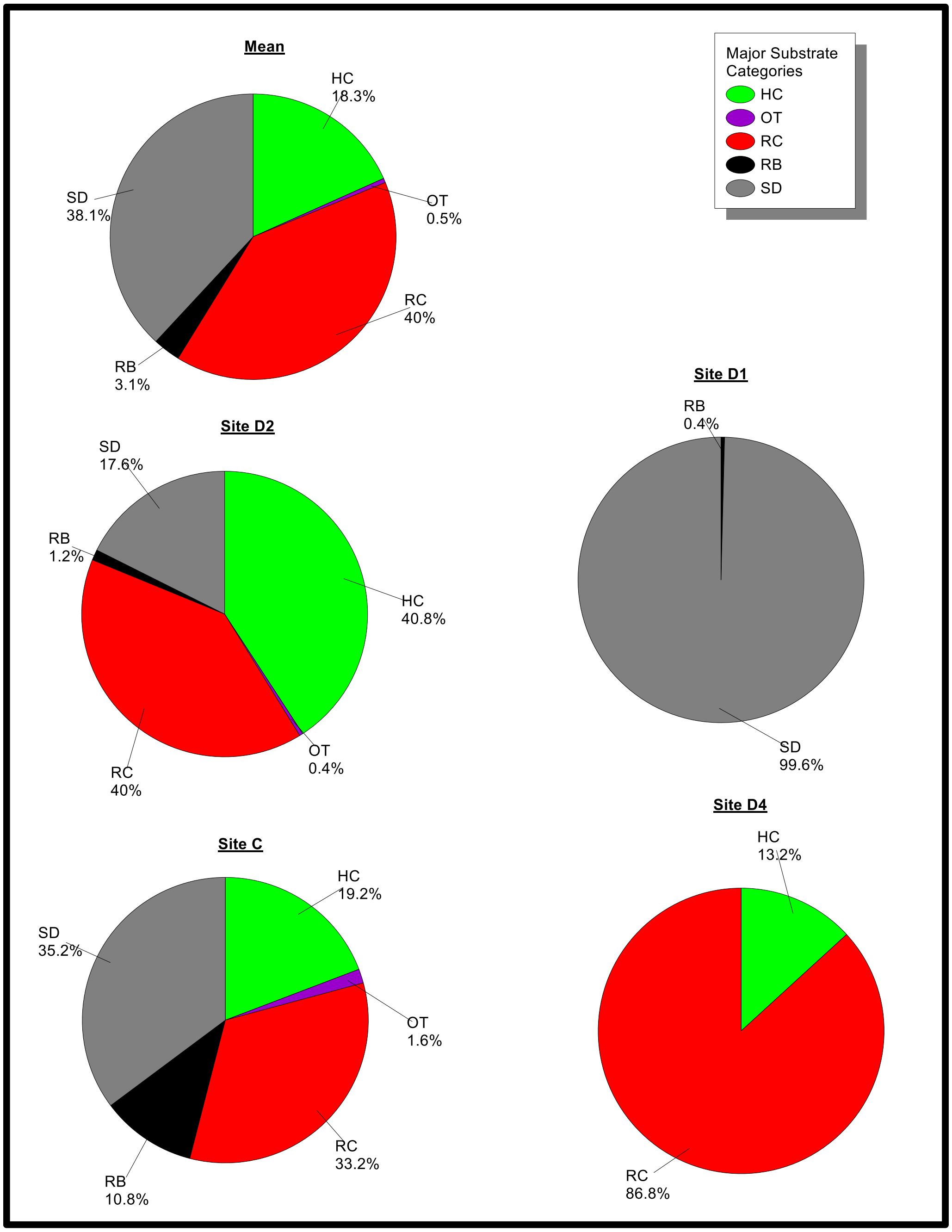


Figure 24: Major substrate categories of all transects and their mean (top left)

5.3.6.2 Sub categories

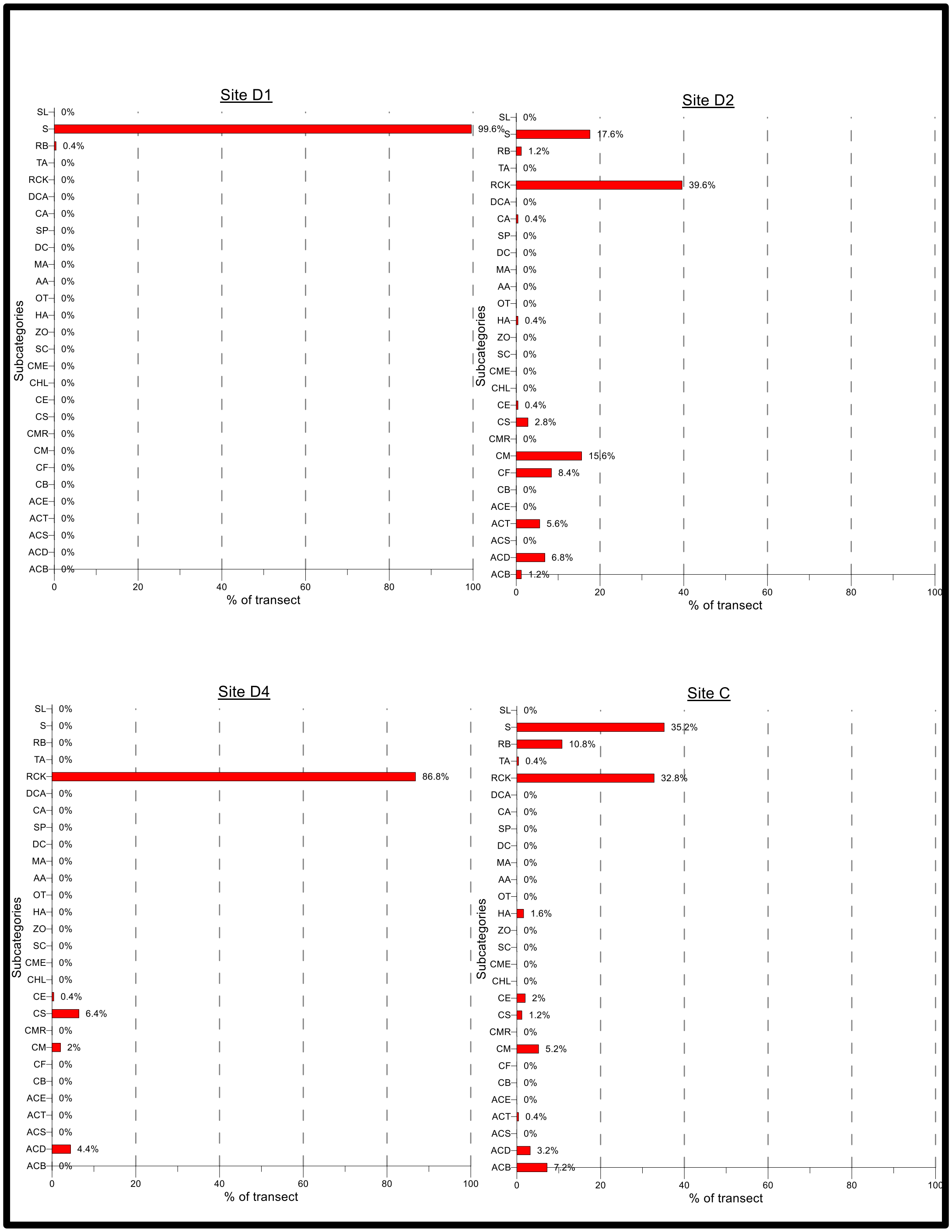
The results show that proposed project area had low coral diversity. The coral categories found at the lagoon and reef flat were *Coral Massive* (5.7%), *Acropora Digitate* (3.6%), and *Coral Submassive* (2.6%).

Details are shown in Table 14 and Figure 25 below.

Table 14. Percentage of substrate subcategories at Thun'buri project area

SUBCATEGORIES (% of transect)	**C**	**D1**	**D2**	**D4**	**Mean**	**CI 95%+**	**CI 95%-**
Acropora Branching (ACB)	7.20	0.00	1.20	0.00	2.10	3.82	0.38
Acropora Digitate (ACD)	3.20	0.00	6.80	4.40	3.60	5.01	2.19
Acropora Submassive (ACS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acropora Tabular (ACT)	0.40	0.00	5.60	0.00	1.50	2.87	0.13
Acropora encrusting (ACE)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral Branching (CB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral Foliose (CF)	0.00	0.00	8.40	0.00	2.10	4.20	0.00
Coral Massive (CM)	5.20	0.00	15.60	2.00	5.70	9.17	2.23
Coral Mushroom (CMR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral Submassive (CS)	1.20	0.00	2.80	6.40	2.60	3.99	1.21
Coral encrusting (CE)	2.00	0.00	0.40	0.40	0.70	1.14	0.26
Heliopora (CHL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Millepora (CME)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soft Coral (SC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zoanthid (ZO)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Halimeda (HA)	1.60	0.00	0.40	0.00	0.50	0.88	0.12
Other (OT)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Algal Assemblage (AA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Macraoalgae (MA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dead Coral (DC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sponges (SP)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coralline Algae (CA)	0.00	0.00	0.40	0.00	0.10	0.20	0.00
Dead coral with Algae (DCA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rock (RCK)	32.80	0.00	39.60	86.80	39.80	57.69	21.91
Turf Algae (TA)	0.40	0.00	0.00	0.00	0.10	0.20	0.00
Rubble (RB)	10.80	0.40	1.20	0.00	3.10	5.68	0.52
Sand (S)	35.20	99.60	17.60	0.00	38.10	59.82	16.38
Silt (SL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00


Site D1
Subcategories
% of transect
SL 0%
S 99.6%
RB 0.4%
TA 0%
RCK 0%
DCA 0%
CA 0%
SP 0%
DC 0%
MA 0%
AA 0%
OT 0%
HA 0%
ZO 0%
SC 0%
CME 0%
CHL 0%
CE 0%
CS 0%
CMR 0%
CM 0%
CF 0%
CB 0%
ACE 0%
ACT 0%
ACS 0%
ACD 0%
ACB 0%
0 20 40 60 80 100
Site D2
Subcategories
% of transect
SL 0%
S 17.6%
RB 1.2%
TA 0%
RCK 39.6%
DCA 0%
CA 0.4%
SP 0%
DC 0%
MA 0%
AA 0%
OT 0%
HA 0.4%
ZO 0%
SC 0%
CME 0%
CHL 0%
CE 0.4%
CS 2.8%
CMR 0%
CM 15.6%
CF 8.4%
CB 0%
ACE 0%
ACT 5.6%
ACS 0%
ACD 6.8%
ACB 1.2%
0 20 40 60 80 100
Site D4
Subcategories
% of transect
SL 0%
S 0%
RB 0%
TA 0%
RCK 86.8%
DCA 0%
CA 0%
SP 0%
DC 0%
MA 0%
AA 0%
OT 0%
HA 0%
ZO 0%
SC 0%
CME 0%
CHL 0%
CE 0.4%
CS 6.4%
CMR 0%
CM 2%
CF 0%
CB 0%
ACE 0%
ACT 0%
ACS 0%
ACD 4.4%
ACB 0%
0 20 40 60 80 100
Site C
Subcategories
% of transect
SL 0%
S 35.2%
RB 10.8%
TA 0.4%
RCK 32.8%
DCA 0%
CA 0%
SP 0%
DC 0%
MA 0%
AA 0%
OT 0%
HA 1.6%
ZO 0%
SC 0%
CME 0%
CHL 0%
CE 2%
CS 1.2%
CMR 0%
CM 5.2%
CF 0%
CB 0%
ACE 0%
ACT 0.4%
ACS 0%
ACD 3.2%
ACB 7.2%
0 20 40 60 80 100

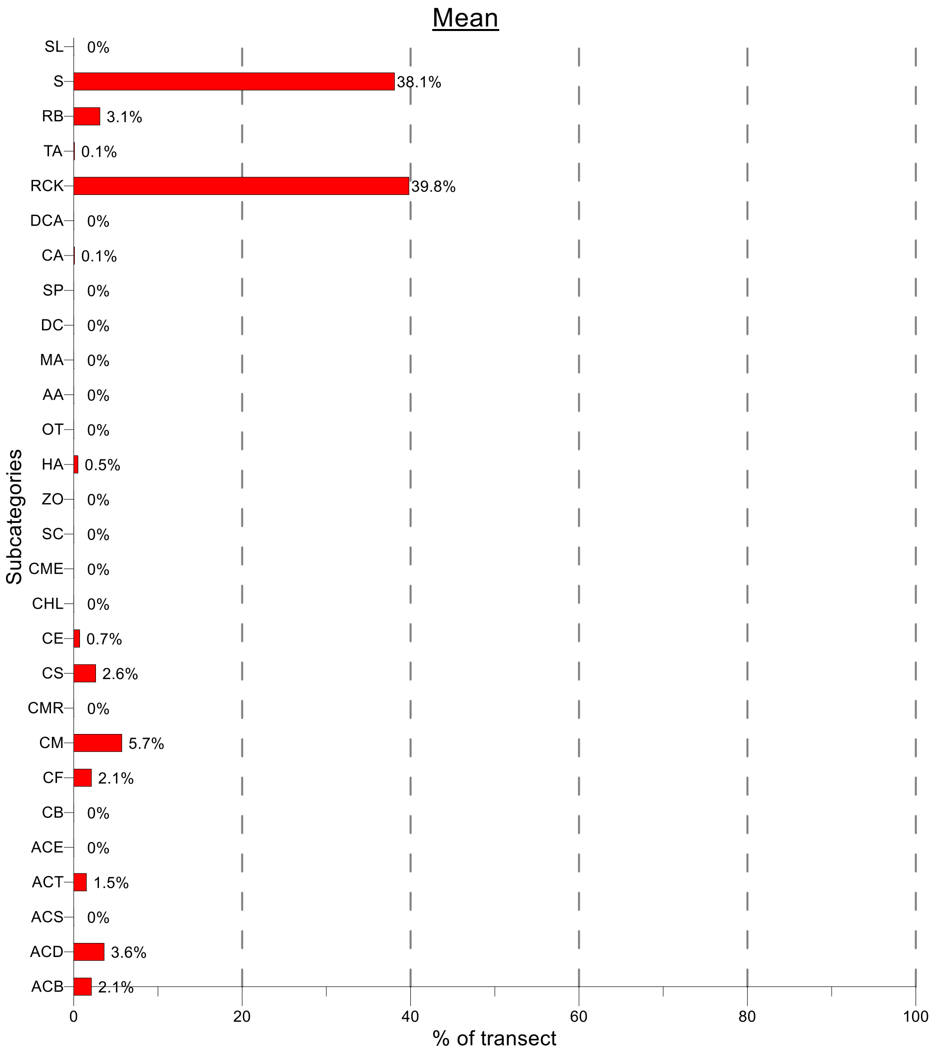


Figure 25: Subcategories of each transect and their mean

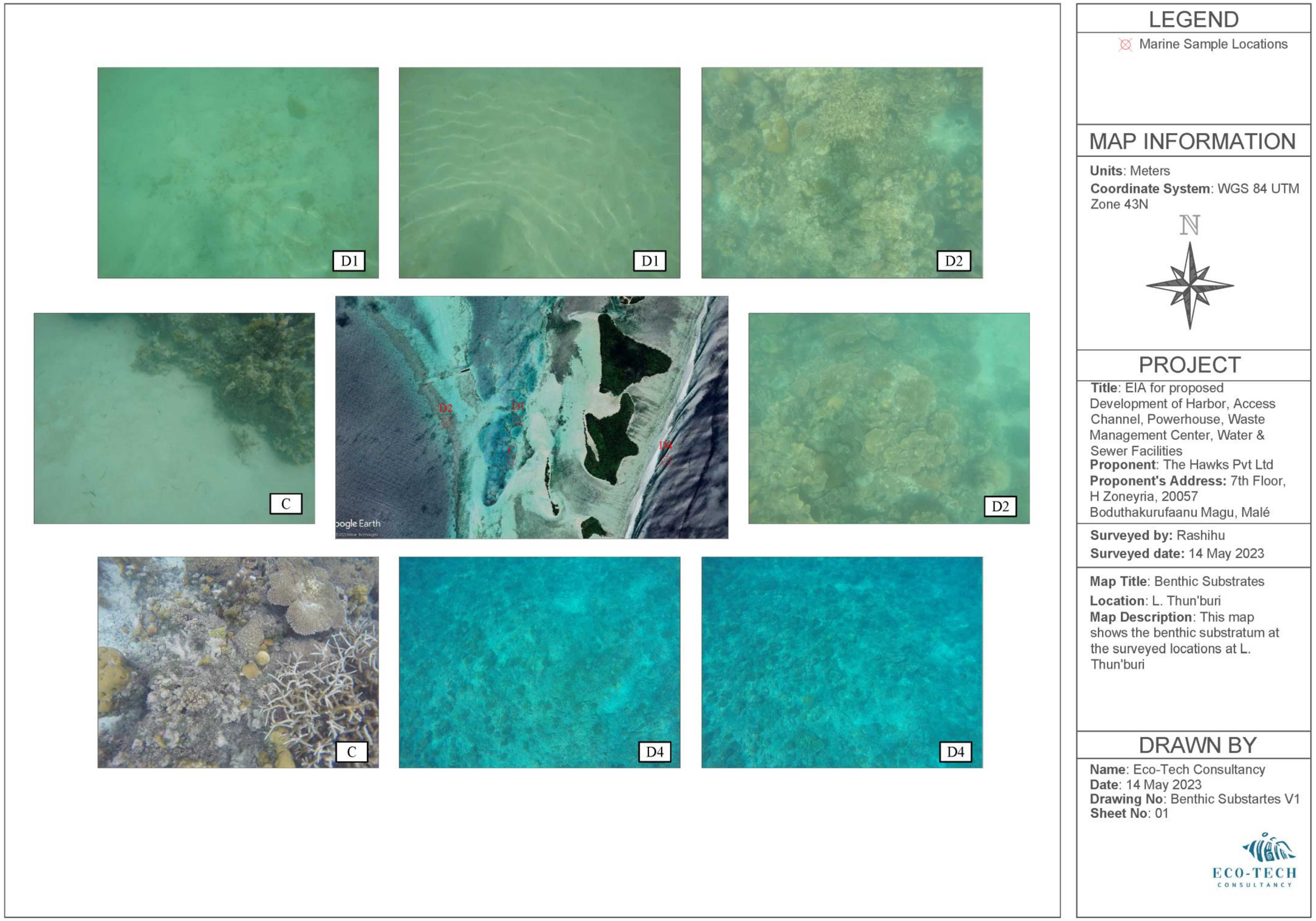


Figure 26: benthic substrates at the surveyed location in Thun'buri

5.3.7 Fish Census

A total of 314 individuals were recorded at the proposed project area on the lagoon and reef flat of Thun'buri from the 4 fish visual census that were conducted, they represent 24 species from 22 genera, and 16 families. The most abundant species were *Pomacentridae* (abundance 142), followed by *Scaridae* (abundance 64) and *Acanthuridae* (abundance 48).

The most abundant families of fish were *Pomacentridae* (relative abundance 45.2%) followed by *Scaridae* (relative abundance 20.4%).

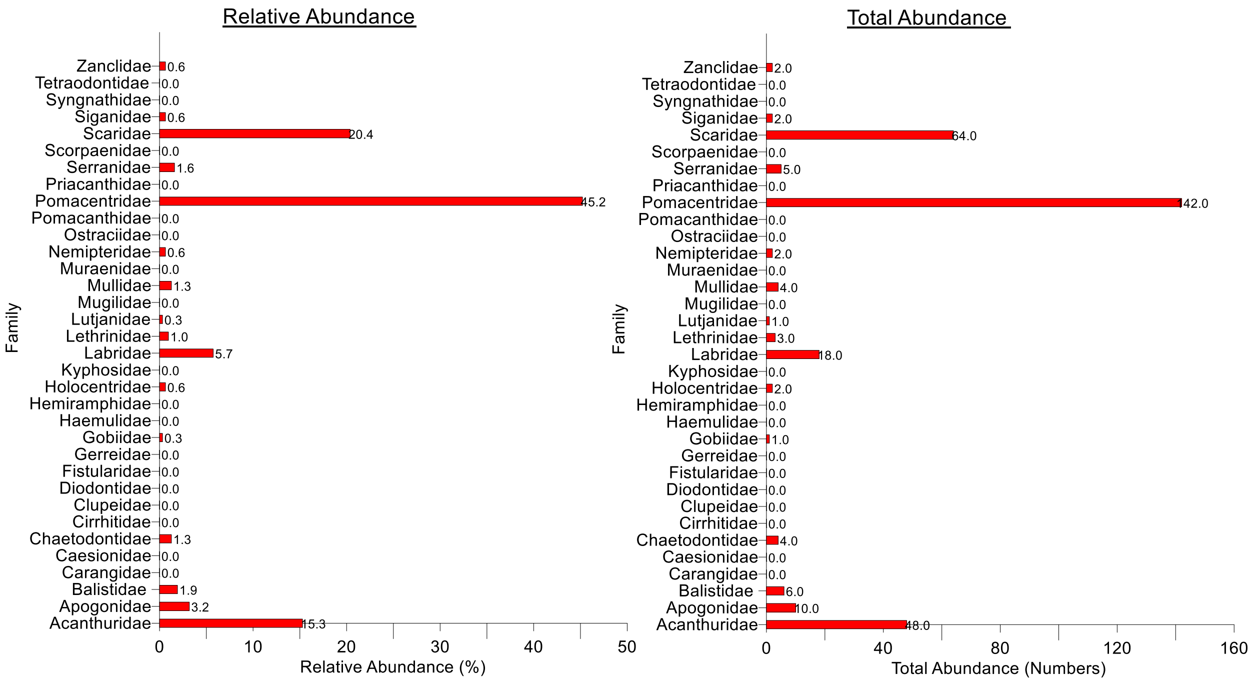
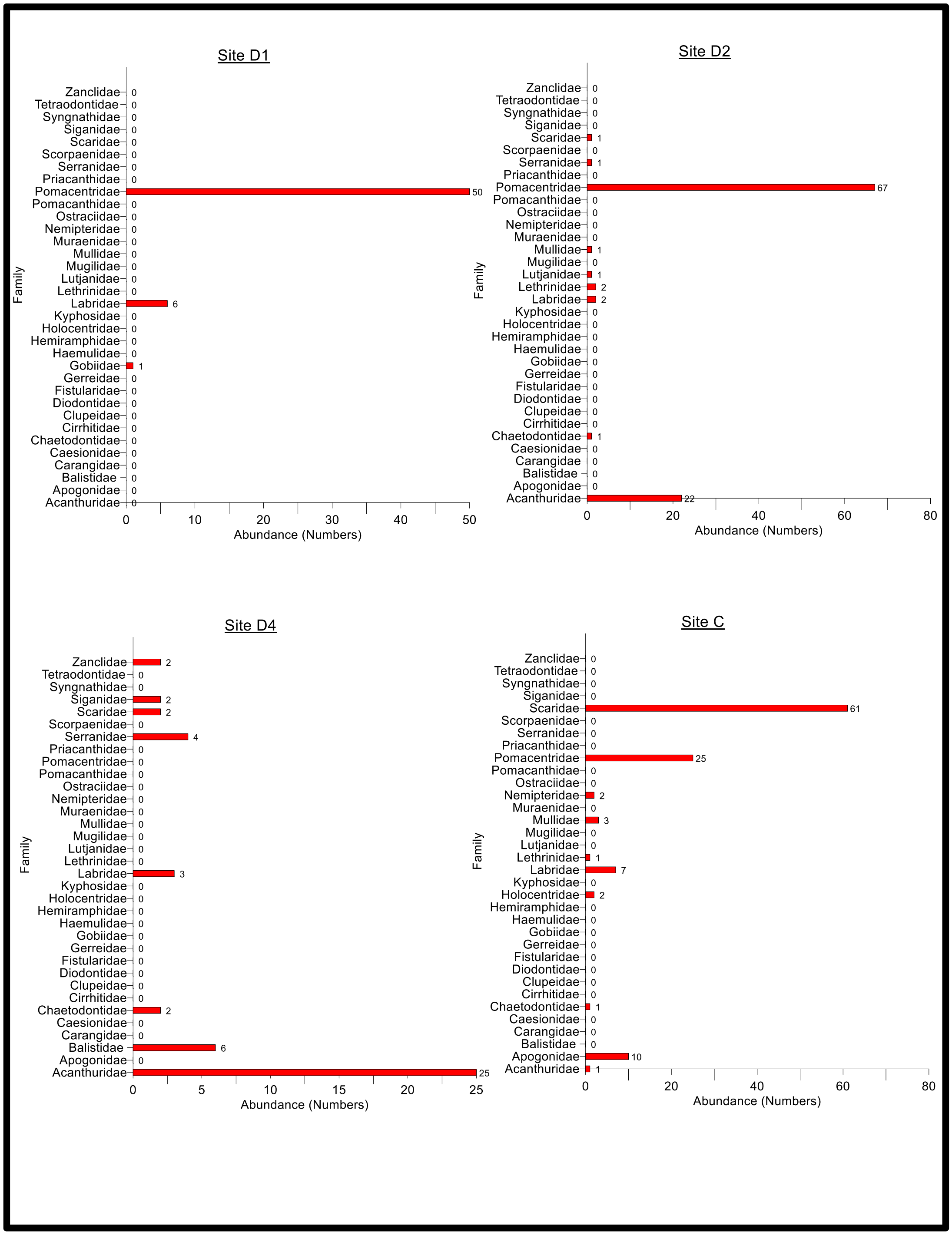


Figure 27: Total abundance (right) and relative abundance (left) of fish at Thun'buri reef

Looking at the differences in fish abundances at different sites, site D2, D4 and C displayed similar number of families except for site D1 where the fish diversity is poor; at this site only 3 family was found. It was observed that site D2 and C had the highest fish diversity with 9 families.


Site D1
Family
Abundance (Numbers)
Zanclidae 0
Tetraodontidae 0
Syngnathidae 0
Siganidae 0
Scaridae 0
Scorpaenidae 0
Serranidae 0
Priacanthidae 0
Pomacentridae 50
Pomacanthidae 0
Ostraciidae 0
Nemipteridae 0
Muraenidae 0
Mullidae 0
Mugilidae 0
Lutjanidae 0
Lethrinidae 0
Labridae 6
Kyphosidae 0
Holocentridae 0
Hemiramphidae 0
Haemulidae 0
Gobiidae 1
Gerreidae 0
Fistularidae 0
Diodontidae 0
Clupeidae 0
Cirrhitidae 0
Chaetodontidae 0
Caesionidae 0
Carangidae 0
Balistidae 0
Apogonidae 0
Acanthuridae 0
0
10
20
30
40
50
Site D2
Family
Abundance (Numbers)
Zanclidae 0
Tetraodontidae 0
Syngnathidae 0
Siganidae 0
Scaridae 1
Scorpaenidae 0
Serranidae 1
Priacanthidae 0
Pomacentridae 67
Pomacanthidae 0
Ostraciidae 0
Nemipteridae 0
Muraenidae 0
Mullidae 1
Mugilidae 0
Lutjanidae 1
Lethrinidae 2
Labridae 2
Kyphosidae 0
Holocentridae 0
Hemiramphidae 0
Haemulidae 0
Gobiidae 0
Gerreidae 0
Fistularidae 0
Diodontidae 0
Clupeidae 0
Cirrhitidae 0
Chaetodontidae 1
Caesionidae 0
Carangidae 0
Balistidae 0
Apogonidae 0
Acanthuridae 22
0
20
40
60
80
Site D4
Family
Abundance (Numbers)
Zanclidae 2
Tetraodontidae 0
Syngnathidae 0
Siganidae 2
Scaridae 2
Scorpaenidae 0
Serranidae 4
Priacanthidae 0
Pomacentridae 0
Pomacanthidae 0
Ostraciidae 0
Nemipteridae 0
Muraenidae 0
Mullidae 0
Mugilidae 0
Lutjanidae 0
Lethrinidae 0
Labridae 3
Kyphosidae 0
Holocentridae 0
Hemiramphidae 0
Haemulidae 0
Gobiidae 0
Gerreidae 0
Fistularidae 0
Diodontidae 0
Clupeidae 0
Cirrhitidae 0
Chaetodontidae 2
Caesionidae 0
Carangidae 0
Balistidae 6
Apogonidae 0
Acanthuridae 25
0
5
10
15
20
25
Site C
Family
Abundance (Numbers)
Zanclidae 0
Tetraodontidae 0
Syngnathidae 0
Siganidae 0
Scaridae 61
Scorpaenidae 0
Serranidae 0
Priacanthidae 0
Pomacentridae 25
Pomacanthidae 0
Ostraciidae 0
Nemipteridae 2
Muraenidae 0
Mullidae 3
Mugilidae 0
Lutjanidae 0
Lethrinidae 1
Labridae 7
Kyphosidae 0
Holocentridae 2
Hemiramphidae 0
Haemulidae 0
Gobiidae 0
Gerreidae 0
Fistularidae 0
Diodontidae 0
Clupeidae 0
Cirrhitidae 0
Chaetodontidae 1
Caesionidae 0
Carangidae 0
Balistidae 0
Apogonidae 10
Acanthuridae 1
0
20
40
60
80

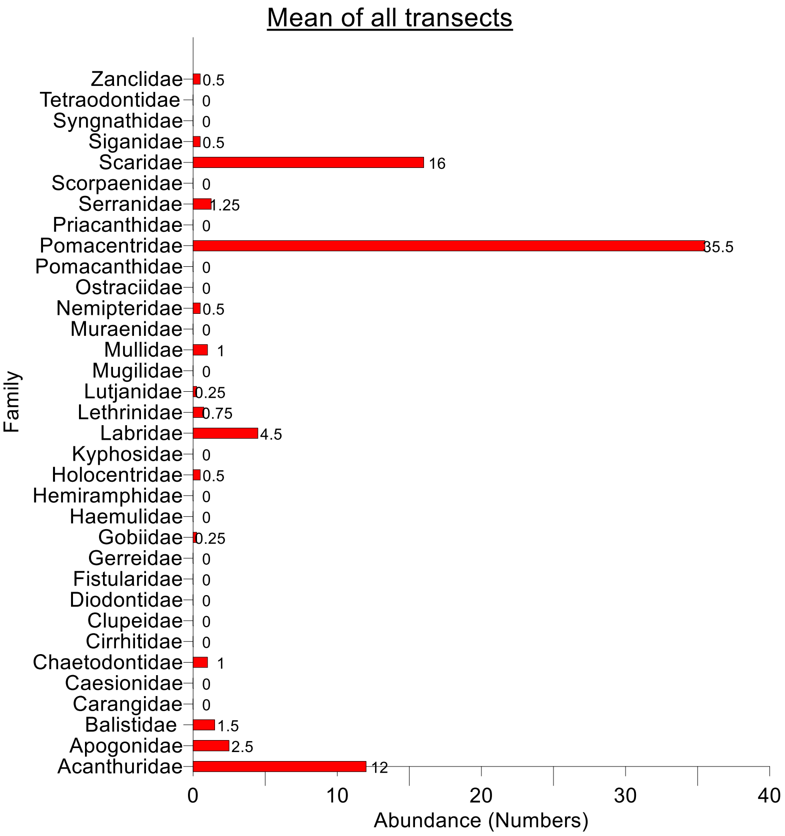


Figure 28: abundance of fish at the surveyed locations in Thun'buri reef

5.3.8 Marine Water Quality

Marine water quality was compared with a set of internationally agreed optimal ranges as follows;

Table 15: marine water quality optimal ranges

Location	Optimal Range	Reference
pH	8.0-8.3 *Levels below 7.4 pH cause stress	EPA

Salinity (%)	3.2% - 4.2%	GBRMPA, 2009
Turbidity (NTU)	3-5 NTU >5 NTU causes stress	Cooper et al. 2008
Total Coliforms (CFU/100ml)	<5000 CFU/ml	Malaysian interim water quality standard (Paryus & Nandini, 2014)
Fecal Coliforms (CFU/100ml)	<400 CFU/ml	Malaysian interim water quality standard (Paryus & Nandini, 2014)

Marine water test results from MWSC water quality assurance laboratory is attached in Appendix I of this report.

pH was within optimal range for all tested location except for D5 where the pH was at 7.7. Salinity was below the optimal range at two locations; D2 (3.192%) and D1 (3.184%). Turbidity and coliforms are within optimal range at all tested locations.

Table 16: marine water quality test results for Thun'buri

Location	D1	D2	D3	D5	DC1
Temperature (^{0}C)	22.8	22.7	22.7	23.9	22.8
pH	8.0	8.0	8.0	7.7	8.0
Salinity (%)	3.224	3.192	3.176	3.344	3.184
Turbidity (NTU)	0.183	0.177	0.200	0.203	0.211
Total Petroleum Hydrocarbon (mg/L)	<0.036	0.294	0.441	0.587	0.1
Total coliform	-	30	-	-	24
Faecal coliform	-	Not detected	-	-	Not detected

**Ex-situ temperature readings*

5.4 Terrestrial Environment of Thun'buri

This section describes the site-specific terrestrial environmental conditions of the proposed project site. The structural environment, ground condition, air quality, noise levels, types of vegetation and ground water quality results are presented.

5.4.1 Structural Environment at Project Site

There are 2 main modifications currently being made on the island. First is the temporary site. Second is the proposed accommodation plot for this project. The condition and use of the buildings near the proposed WMF are summarized on the Table 17

Table 17: Condition and use of buildings near and on project site

Building or Equipment Name	Location	Condition	Use	Pictures
Temporary site (toilet under construction)	Project site	-Functional	To keep equipment/materials, eat and rest	

Accommodation	Project site	- Prepared for foundation placement	To be used for accommodation	

5.4.2 Ground Condition

Ideally, soil has 5 different master horizons or layers which is O, A, E, B, and C, where O is the organic horizon (Soil Management, n.d.), A-horizon which contains significant organic matter, E-horizon which is the eluviation zone where organic matter accumulation has not occurred, B-horizon which is the zone of maximum clay accumulation, C-horizon which is a subsurface layer of soil forming parent materials which could be weathered rock, unconsolidated sediments or loose sands, and R-horizon which is not soil and is the hard bedrock (Figure 29)

- O = The layer of organic matter on the surface of a mineral soil
- A = Topsoil. The mineral soil horizon on the surface with organic matter and low clay
- E = The horizon of maximum leaching. Not in all soils, but if present, is located just below the "A" horizon
- B = Subsoil. Horizon most often located below A horizon. The zone of maximum clay accumulation
- C = Weathered rock. Lies below the "A" and/or "B" horizons and has NOT been acted upon by the soil forming processes
- R = The hard, consolidated rock beneath the soil

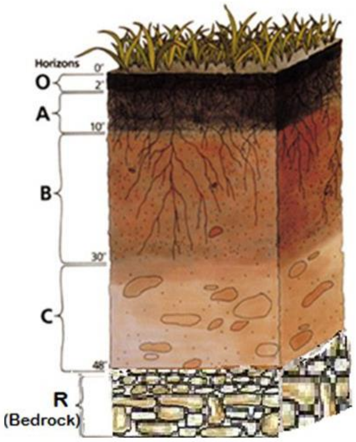


Figure 29: Typical soil profile

At the project site (staff accommodation) of Thunburi, the soil profile showed only three distinct soil horizons. The soil did not have an O-horizon, but had an A-horizon followed by an E and R horizon.

Figure 30: Condition of ground at project site

5.4.3 Ground Water Quality

Ground water quality was compared with the URA supply water quality standard guideline value as follows: -

Table 18: ground water quality optimal ranges

Parameter	Optimal Range	Reference
Temperature(^{0}C)	NA	URA
pH	6.5-8.5	URA
Electrical Conductivity (max allowable range)	<1000 µs/cm	URA
Electrical Conductivity (recommended range)	300 - 700 µs/cm	URA
Total Petroleum Hydrocarbon(mg/L)	0 mg/l	EPA
Total Coliform (MPN/100ml)	0/100ml CFU	URA
Faecal Coliform (MPN/100ml)	0/100ml CFU	URA

Groundwater test results from MWSC water quality assurance laboratory is attached in Appendix I of this report.

Some the tested parameters were within optimal ranges. Conductivity and coliform readings were above optimal ranges. Conductivity might have increased due to extraction of groundwater for work and sanitary purposes. Both total and faecal coliform readings could be triggered from faecal wildlife as well as humans.

All of the parameters except for pH were above the optimal ranges. Conductivity was very high at both tested locations which is very alarming and surprising as this indicates that the groundwater is either being extracted. Coupled with the high level of coliforms, this indicate that the groundwater of the Island is already contaminated.

Table 19: Groundwater quality test results (parameters exceeding EPA standards are highlighted in red)

Location	**G1**	**GC**
Temperature(^{0}C)	24.0	24.0
pH	7.3	7.0
Conductivity (µS/cm)	**6400**	**11390**
Total Petroleum Hydrocarbon(mg/L)	**0.703**	**0.31**
Total coliform (MPN/100ml)	**>2420**	**>2420**
Faecal coliform (MPN/100ml)	**>2420**	**>2420**

**Ex-situ temperature readings*

5.4.4 Vegetation

11 different types of vegetation species were found on Thun'buri at the vegetation transect and land clearance locations, the scientific name and Dhivehi names of these are listed in Table 21.

At vegetation transect 1 which is near the proposed jetty, there was dense vegetation mostly composed of *Pemphis acidula*. The transect could not be completed beyond 10m as it was inaccessible.

At vegetation transect 2 which is near the outfall location, had thick vegetation. This area is mostly composed of *Cocos nucifera L.* and *Pandanus tectorus.* The transect could not be completed beyond 15m as it was inaccessible.

At vegetation transect 3 which was at embayment site away from the proposed developments on the SW side of the Island, there was dense vegetation. This area is mostly composed of *Pemphis acidula, Cocos nucifera L. and Pandanus tectorus.*

The control transect was on the north side away from any development. Vegetation transect 4 had *Pandanus tectorus, Cocos nucifera L. and Hibiscus tiliaceus* as major vegetation.

Table 20: vegetation found on transects

Vegetation Transect 1 Code: VT1 (Near jetty area)				
Distance (m)	Ground	1st Storey (0-2 m)	2nd Storey (2 -4m)	3rd Storey (4 m >)
0-5		*Pemphis acidula*	*Pemphis acidula*	
5-10			*Pemphis acidula* *Pandanus tectorus*	*Cocos nucifera L.*
10-15	Inaccessible due dense vegetation			
15-20	Inaccessible due dense vegetation			
20-25	Inaccessible due dense vegetation			
25-30	Inaccessible due dense vegetation			
Vegetation Transect 2 Code: VT2 (Near outfall area)				
0-5	*Cocos nucifera L.* *Hibiscus tiliaceus* *Pandanus tectorus*	*Hibiscus tiliaceus* *Pandanus tectorus* *Cocos nucifera L.* *Cordia subcordata* *Guettarda Speciosa L.*		
5-10	*Pandanus tectorus* *Cocos nucifera L.*	*Cocos nucifera L.*	*Pandanus tectorus*	*Ochrosia borbonica* *Cocos nucifera L.*

10-15			*Guettarda Speciosa L.* *Pandanus tectorus*	*Cocos nucifera L.*
15-20	Inaccessible due to dense vegetation			
20-25	Inaccessible due dense vegetation			
25-30	Inaccessible due dense vegetation			
Vegetation Transect 3 Code: VT3 (Coastal embayment)				
0-5	*Cocos nucifera L.*	*Pemphis acidula*		
5-10	*Guettarda Speciosa L.*	*Pandanus tectorus* *Pemphis acidula*	*Cocos nucifera L.*	
10-15		*Pemphis acidula* *Hibiscus tiliaceus*		
15-20		*Hibiscus tiliaceus* *Pemphis acidula*		*Cocos nucifera L.*
20-25		*Pemphis acidula*		
25-30		*Pemphis acidula*		*Cocos nucifera L.*
Vegetation Transect 4 Code: VC (Control eastern side)				
0-5	*Cocos nucifera L.*			
5-10	*Pandanus tectorus*	*Hibiscus tiliaceus*	*Hibiscus tiliaceus*	
10-15	*Cocos nucifera L.*	*Cocos nucifera L.*	*Hibiscus tiliaceus*	*Cocos nucifera L.*
15-20	*Cocos nucifera L.*			
20-25	*Pandanus tectorus*	*Guettarda Speciosa L.*	*Guettarda Speciosa L.*	
25-30	*Pandanus tectorus*			

Dhivehi and scientific names for vegetation

Table 21 shows the different species of trees which were encountered on the vegetation transects and those during the field surveys.

Table 21: Dhivehi and scientific names for vegetation species encountered on Thun'buri

Dhivehi Name	**Scientific Name**
Ruh	*Cocos nucifera L.*
Boa kashikeyo	*Pandanus tectorus*
Kandhu	*Hernandia nymphaeifolia*
Kuredhi	*Pemphis acidula*
Uni	*Guettarda Speciosa L.*
Kaani	*Cordia subcordata*
Dhun'buri	*Ochrosia borbonica*
Dhiggaa	*Hibiscus tiliaceus*
Boashi	*Tournefortia argentea/Messerschimidia argentea*
Funa	*Calophyllum inophyllum*
Magoo	*Scaevolo taccada Roxb.*

LEGEND

☒ Vegetation Transect Locations

MAP INFORMATION

Units: Meters
Coordinate System: WGS 84 UTM Zone 43N

PROJECT

Title: EIA for proposed Development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water & Sewer Facilities
Proponent: The Hawks Pvt Ltd
Proponent's Address: 7th Floor, H Zoneyria, 20057 Boduthakurufaanu Magu, Malé

Surveyed by: Rashihu
Surveyed date: 14 May 2023

Map Title: Vegetation transects
Location: L. Thun'buri
Map Description: This map shows all vegetation transect locations at L. Thun'buri

DRAWN BY

Name: Eco-Tech Consultancy
Date: 14 May 2023
Drawing No: Vegetation Transects Locations V1
Sheet No: 01

Figure 31: vegetation found at the surveyed locations on Thun'buri

5.4.5 Terrestrial Megafauna

During the surveys on the Island, *Corvus splendens (Kaalhu), Koveli (Eudynamys scolopaceus), Ardea Cinerea (Maakana) and Bubulcus ibis (iruvaahudhu)* were encountered and ghost crabs were observed on the beach. Mouses (*Mus musculus*) were also found on the island and can be a pest in the future if not dealt properly.

5.4.6 Air Quality

Air pollution can become an environmental problem in the future, primarily as a byproduct of increasing number of vehicles, increase in construction sites and increase in population. Furthermore, with gradual increase in population density, the impact on air quality due to pollution of the island would gradually increase. Hence, it is very important to monitor air quality on an island level when tourism is a major contributor to the island's economy. Five major air pollutants are highlighted in this study to monitor the air quality. These are PM2.5, PM10, Carbon Monoxide (CO), Sulfur Dioxide (SO2), and Nitrogen Dioxide (NO2).

5.4.6.1 PM2.5 and PM10

Particulate matter or PM gives an indication of the level of pollution in the air. PM is a mixture of solid particles and liquid droplets found in the air; aerosols. Particles which are large or dark enough particles such as dust, dirt, soot or smoke can be seen via naked eye. Others, however, are so small they can only be detected using an electron microscope. Aerosols or PM originate from both natural and anthropic sources.

Primary natural sources are emitted directly and are usually large (>1 µm), these include volcanic eruptions, forest fires, mineral dust, sea salt, pollen and biological debris (Millero, 2013). Primary anthropogenic sources are also emitted directly and are also usually large (>1 µm), these include powerhouses, automobiles, agricultural lands, construction sites, unpaved roads, fields, smoke stacks or fires (United States Environmental Protection Agency, n.d.). Whether the particles were anthropogenic or natural in origin, they sometimes undergo gas reactions and gas to particles conversion in the atmosphere to form fine (<100 nm) particles also known as photochemical smog, which is a secondary source of particles in the atmosphere. Additional secondary sources of particles come from biological activity in the marine environment such as Sulfates from Dimethyl sulphide and Organic aerosol from biogenic Volatile Organic Compounds (VOC). Among all the sources sea salt by far contributes to the atmospheric PM the most. This should be especially prevalent in the Maldivian setting as the sea would be always less than 500 m from any given location.

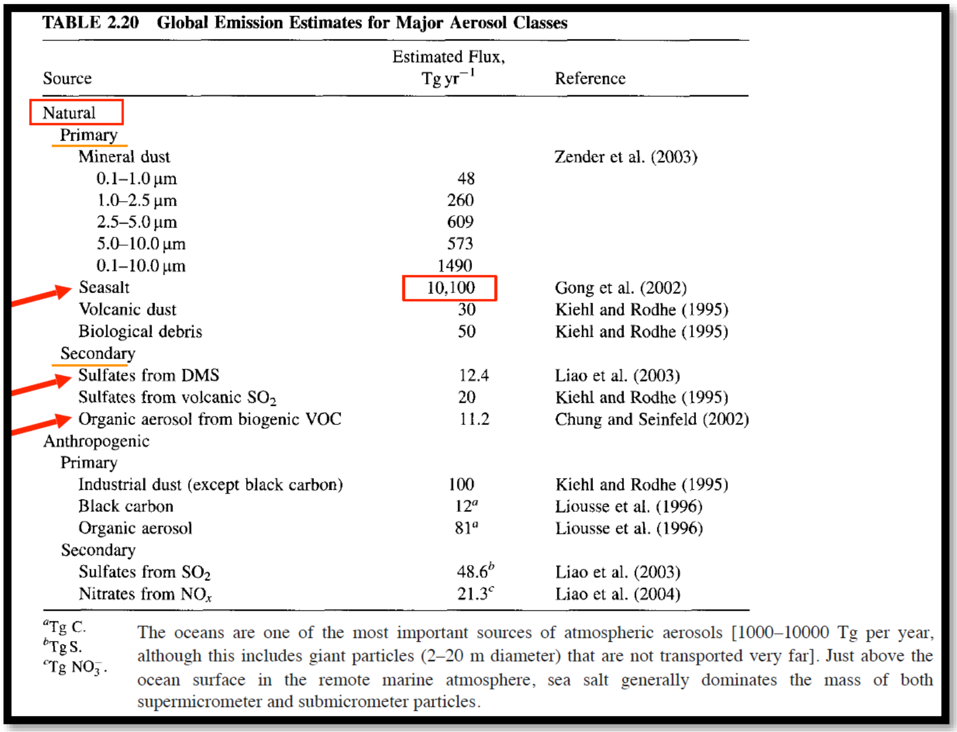


TABLE 2.20 Global Emission Estimates for Major Aerosol Classes

Source	Estimated Flux, Tg yr^{-1}	Reference
Natural		
Primary		
Mineral dust		Zender et al. (2003)
0.1–1.0 µm	48	
1.0–2.5 µm	260	
2.5–5.0 µm	609	
5.0–10.0 µm	573	
0.1–10.0 µm	1490	
Seasalt	10,100	Gong et al. (2002)
Volcanic dust	30	Kiehl and Rodhe (1995)
Biological debris	50	Kiehl and Rodhe (1995)
Secondary		
Sulfates from DMS	12.4	Liao et al. (2003)
Sulfates from volcanic SO_2	20	Kiehl and Rodhe (1995)
Organic aerosol from biogenic VOC	11.2	Chung and Seinfeld (2002)
Anthropogenic		
Primary		
Industrial dust (except black carbon)	100	Kiehl and Rodhe (1995)
Black carbon	12^a	Liousse et al. (1996)
Organic aerosol	81^a	Liousse et al. (1996)
Secondary		
Sulfates from SO_2	48.6^b	Liao et al. (2003)
Nitrates from NO_x	21.3^c	Liao et al. (2004)

[a] Tg C.
[b] Tg S.
[c] Tg NO_3^-.

The oceans are one of the most important sources of atmospheric aerosols [1000–10000 Tg per year, although this includes giant particles (2–20 m diameter) that are not transported very far]. Just above the ocean surface in the remote marine atmosphere, sea salt generally dominates the mass of both supermicrometer and submicrometer particles.

Figure 32: global estimated of major aerosol classes, figure adopted from (Ferrero, 2018)

Therefore, when we measure PM, it would always show the natural and anthropogenic sources together. Furthermore, (Budhavant, et al., 2015) have shown that transboundary pollution is much more prevalent than local pollution in the Maldives. However, this is not to say that there are no local sources of pollution as one study conducted by (Colombo, et al., 2014) showed that Persistent Organic Pollutants (POPs) were present in Maldivian soil exceeding international guidelines which originated from waste combustion. Hence it is very important to monitor the changes during construction and operational stage of the projects to determine whether there is an influx of anthropogenic PM.

The potential for health problems caused by PM is directly related to the size of the PM. Small particles which are less than 10μm in diameter pose the greatest problem as they can penetrate deep into the lungs and even enter the blood stream. Numerous scientific studies have linked exposure to PM to variety of health problems to lungs and heart. They include:-

- Premature death in people with respiratory or heart diseases;
- Myocardial infarction;
- Arrhythmias;
- Decreased lung function;
- Aggravated asthma; and
- Increased respiratory symptoms, such as irritation of the airways, coughing or difficulty in breathing (United States Environmental Protection Agency, n.d.)

Particles can be carried over long distances by wind and then settle on ground or water surfaces. Depending on their chemical composition, this settling can lead to:-

- Making open water sources acidic;
- Changing nutrient balance in coastal waters;
- Depleting nutrients in soil;
- Damaging sensitive forests and farm crops;
- Affecting the diversity of ecosystems; and
- Contributing to acid rain effects.

Measure of particle pollution includes:-

- PM_{10}: inhalable particles, with diameters that are generally 10μm or smaller; and

- $PM_{2.5}$: fine inhalable particles with diameters that are generally 2.5µm and smaller (United States Environmental Protection Agency, n.d.).

5.4.6.2 CO

Carbon monoxide is an odorless gas that is deadly if inhaled. The most common source of CO is combustion either from fires or appliances that burn gas, wood or oil. Symptoms of CO poisoning include headache, dizziness, confusion, shortness of breath, chest and muscle pain (Carbon monoxide poisoning, 2022) etc.

5.4.6.3 SO2

Sulphur dioxide is the indicator gas from the group of sulfur oxides (SO_x) and is of the greatest concern as this is the component that is found in the highest concentration in the atmosphere and control measures that reduce SO2 also reduce all other gaseous sulfur oxides (EPA, Sulfur Dioxide Basics, 2022). The largest anthropogenic source of the gas is from combustion at power plants. Smaller sources are from vehicles that burn fuel with high sulfur content. Natural sources are from volcanoes. Short-term expose to the gas can damage the respiratory system and the effect can be more prevalent in asthma patients and children. Higher emissions of the gas can lead to the formation of photochemical smog forming small particulate matter that can contribute to PM pollution. Higher concentration of SO2 in the atmosphere can also cause acid rain.

5.4.6.4 NO2

Nitrogen dioxide belong to a group of highly reactive gases known as nitrogen oxides (NO_x) where NO_2 gas is used as the indicator. Compounds in this group include nitrous acid and nitric acid. Primary anthropogenic source for this gas is combustion from vehicles and power plants (Nitrogen Dioxide (NO2) Pollution, 2022). Short exposure to the gas can induce respiratory symptoms such as coughing, wheezing or difficulty breathing, and asthma. Long exposure can lead to development of asthma and respiratory infections. NO_2 with other NO_x can react with other chemicals in the atmosphere to form ozone, particulate matter and cause acid rain.

5.4.6.5 Air quality optimal ranges

Currently there are no air quality standards established in the Maldives, therefore the standards set by the US EPA has been used to compare the data collected from the surveyed locations as given below.

Table 22: air quality optimal ranges

Pollutant	Optimal Range	Reference
Carbon Monoxide (CO)	<9 ppm	US EPA (EPA, NAAQS Table, 2022)
Nitrogen Dioxide (NO_2)	<0.053 ppm	US EPA (EPA, NAAQS Table, 2022)
HCHO	<0.1 ppm (120 µg/m^3) given only for indoors	USA (California) (Friedman, 2022)
$PM_{2.5}$	<12.0 µg/m^3	US EPA (EPA, NAAQS Table, 2022)
PM_{10}	<150 µg/m^3	US EPA (EPA, NAAQS Table, 2022)
Sulfur Dioxide (SO_2)	<0.5 ppm	US EPA (EPA, NAAQS Table, 2022)

The above table is a simplified version of the detailed reference ranges (of US EPA given below) in order for ease of comparison due to the limited quality of the data collected because of the lack of data collection time and equipment employed for this survey.

The US EPA has identified two types of national ambient air quality standards; primary standards that relate to public health protection for example sensitive groups of asthmatics, children and elderly and secondary standards that relate to protection of physical environment for example buildings, vegetation, crops, animals, and decreased visibility.

Periodically these standards are reviewed and revised. The most recently established standards are listed below (accessed on December 2022).

The units of measure for the standards are parts per million (ppm), parts per billion (ppb), micrograms per cubic meter of air (µg/m^3)

Table 23: detailed air quality reference ranges

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
		Outdoor	Not given	Not given	11-20 ppb detected outdoors in urban areas
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (0.053 ppm)	Annual Mean
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 $\mu g/m^3$	annual mean, averaged over 3 years
		secondary	1 year	15.0 $\mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

5.4.6.6 Air quality at surveyed locations

Among the tested indicator pollutants, only PM2.5 was above the optimal range at all locations. The optimal range for PM2.5 is below 12 $\mu g/m^3$ while all measured locations exhibited concentration of 20 $\mu g/m^3$ and above. Although all the other parameters were within the optimal range, the coastal embayment area had the highest relative humidity at 81%, TVOC at 0.085 mg/m^3 and HCHO at 0.013 mg/m^3.

Table 24: ambient air quality at surveyed locations

Code	Location	Parameters									
		Temp. (°C)	Humidity (%RH)	PM2.5 (ug/m^3)	PM10 (ug/ m^3)	CO (ppm)	NO_2 (ppm)	SO2 (ppm)	TVOC (mg/ m^3)	HCHO (mg/ m^3)	CO_2 (ppm)
AQ 1 & AQ2	Near powerhouse & RO Plant	36	70	27	35	1	0	0	0.006	0.001	409
AQ 3	Near jetty area.	34	66	21	27	3	0	0	0.007	0.002	404
AQ 4	Coastal embayment	33	81	24	31	2	0	0	0.085	0.013	411

5.4.7 Noise

Noise, defined as unwanted sound, is perceived as an environmental stressor and nuisance and is associated with physical, mental and psychological stresses in humans. Exposure to continuous noise over 85-90 dB over a lifetime can lead to progressive hearing loss with an increased threshold of hearing sensitivity. Indirect effects of noise pollution include inducing non-auditory effects such as sleep disturbance and annoyance which eventually lead to stress responses, then symptoms and possibly illness. Noise exposure during sleep may increase blood pressure, heart rate and finger pulse amplitude as well as body movements. Physiological symptoms associated with noise exposure include nausea, headache, argumentativeness, mood changes and anxiety (Stansfeld & Matheson, 2003).

Noise levels requisite to protect public welfare and health against hearing loss, annoyance and activity interference as identified by the EPA of the United States specified noise levels of 70 dB as the level of environmental noise which will prevent any measurable hearing loss over a lifetime. Likewise, levels of 55 dB outdoors and 45 dB indoors are identified as preventing activity interference and annoyance. The latter are considered those which will permit spoken conversation and other activities such as sleeping, working and recreation which are part of the daily human activities (EPA Identifies Noise Levels Affecting Health and Welfare, 2016).

Children in particular are extremely vulnerable to both auditory and non-auditory health effects of noise. Studies of children exposed to environmental noise have consistently found effects on cognitive performance, decreased motivation, cardiovascular effects, endocrine disturbances as well as noise annoyance (Stansfeld & Matheson, 2003).

Table 25 shows the ambient noise level in and around the proposed project site and control location. The geographic coordinates for the locations are given in Figure 2 and Table 3. The noise average levels at all surveyed locations were between 40-55 dB. Higher noise was triggered due to natural causes like waves breaking or bird calls in all location except for N3.

Table 25: ambient noise levels in Thunburi

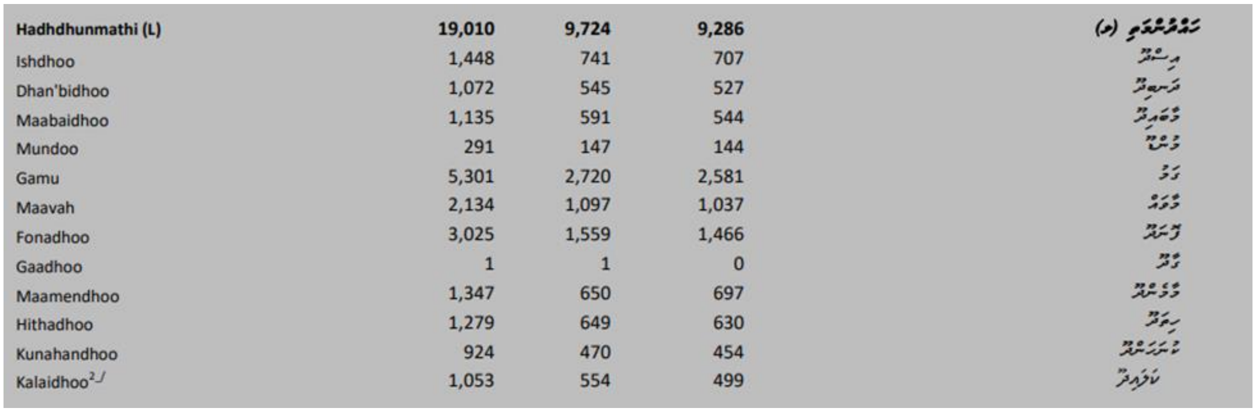
Code	Time	Location	Noise level (dB)			Observations
			Min	Max	Avg	
N 1 & N2	09:48	Near powerhouse	54.0	56.7	55.1	Wave breaking
N3	10:37	Near jetty area.	42.7	75.4	53.4	Bird call Drone
N 4	09:08	Coastal embayment (Control)	34	44.2	40.2	Noise from crabs moving Waves breaking from eastern side Crow calls

5.5 Socioeconomic Environment

This section describes the socioeconomic environment of the Laamu atoll. Information on socioeconomic status of Laamu atoll was obtained from Maldives Population and Housing Census 2022 and 2014.

5.5.1 Demography

From 2006 to 2014 the population has increased gradually at an annual population growth rate of 0.1%. The population from year 2006 to 2014 increased from 11,743 to 11,841. According to the latest publications for 2022 Laamu Atoll population have increased to 19,010 where 9,724 are males and 9,286 are females (Statistical Yearbook, 2023).



Hadhdhunmathi (L)	**19,010**	**9,724**	**9,286**	**ހައްދުންމަތި (ލ)**
Ishdhoo	1,448	741	707	އިސްދޫ
Dhan'bidhoo	1,072	545	527	ދަނބިދޫ
Maabaidhoo	1,135	591	544	މާބައިދޫ
Mundoo	291	147	144	މުންޑޫ
Gamu	5,301	2,720	2,581	ގަމު
Maavah	2,134	1,097	1,037	މާވަށް
Fonadhoo	3,025	1,559	1,466	ފޮނަދޫ
Gaadhoo	1	1	0	ގާދޫ
Maamendhoo	1,347	650	697	މާމެންދޫ
Hithadhoo	1,279	649	630	ހިތަދޫ
Kunahandhoo	924	470	454	ކުނަހަންދޫ
Kalaidhoo$^{2/}$	1,053	554	499	ކަލައިދޫ

Figure 33: population of Laamu atoll in 2022 ((Statistical Yearbook, 2023))

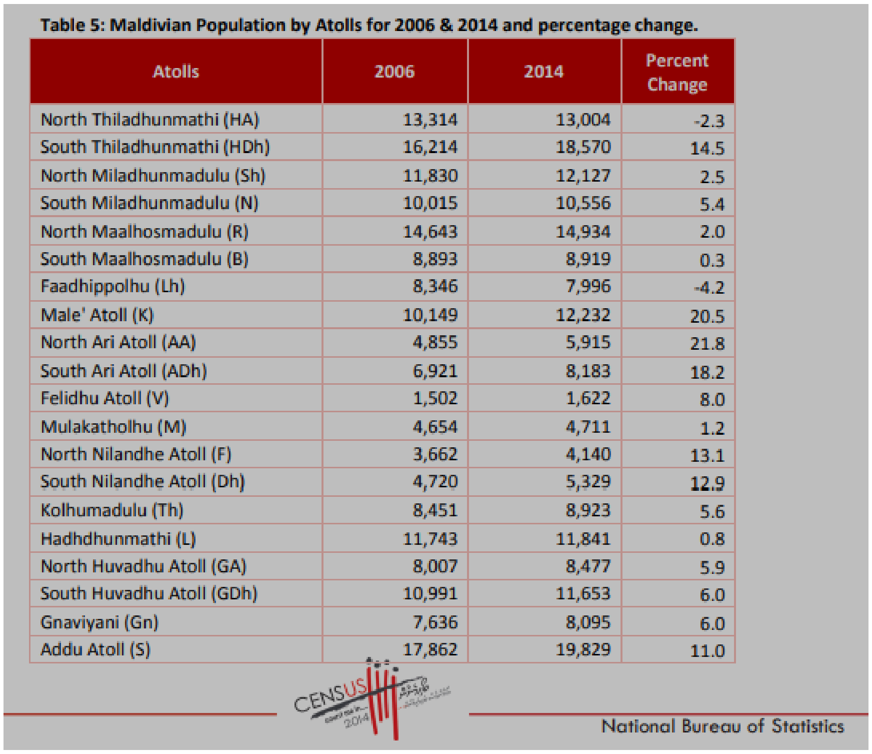


Table 5: Maldivian Population by Atolls for 2006 & 2014 and percentage change.

Atolls	2006	2014	Percent Change
North Thiladhunmathi (HA)	13,314	13,004	-2.3
South Thiladhunmathi (HDh)	16,214	18,570	14.5
North Miladhunmadulu (Sh)	11,830	12,127	2.5
South Miladhunmadulu (N)	10,015	10,556	5.4
North Maalhosmadulu (R)	14,643	14,934	2.0
South Maalhosmadulu (B)	8,893	8,919	0.3
Faadhippolhu (Lh)	8,346	7,996	-4.2
Male' Atoll (K)	10,149	12,232	20.5
North Ari Atoll (AA)	4,855	5,915	21.8
South Ari Atoll (ADh)	6,921	8,183	18.2
Felidhu Atoll (V)	1,502	1,622	8.0
Mulakatholhu (M)	4,654	4,711	1.2
North Nilandhe Atoll (F)	3,662	4,140	13.1
South Nilandhe Atoll (Dh)	4,720	5,329	12.9
Kolhumadulu (Th)	8,451	8,923	5.6
Hadhdhunmathi (L)	11,743	11,841	0.8
North Huvadhu Atoll (GA)	8,007	8,477	5.9
South Huvadhu Atoll (GDh)	10,991	11,653	6.0
Gnaviyani (Gn)	7,636	8,095	6.0
Addu Atoll (S)	17,862	19,829	11.0

Figure 34: Population growth rate from year 2006-2014 in Maldives (Statistical Yearbook, 2023)

5.5.2 Income Situation and Distribution

With the unavailability of sufficient data regarding the income situation and distribution of the island specifically, Maldives population and Housing Census 2014 and Household Income & Expenditure Survey (HIES) 2016 report published by National Bureau of Statistics were used to reflect on the current income status in terms of atoll locality.

According to Census 2006, manufacturing industry provided the most employment opportunities to the residents of Maldives. However, tourism being the most rapidly expanding industry and being the highest contributing sector to the Maldivian GDP, the results of Census 2014 revealed its vital role in creating employment opportunities for the country. More than a fifth of the employed Maldivians are engaged in the tourism industry and of the total employed, 27,837 or 14 percent work in the resorts (Maldives Population & Housing Census, 2014).

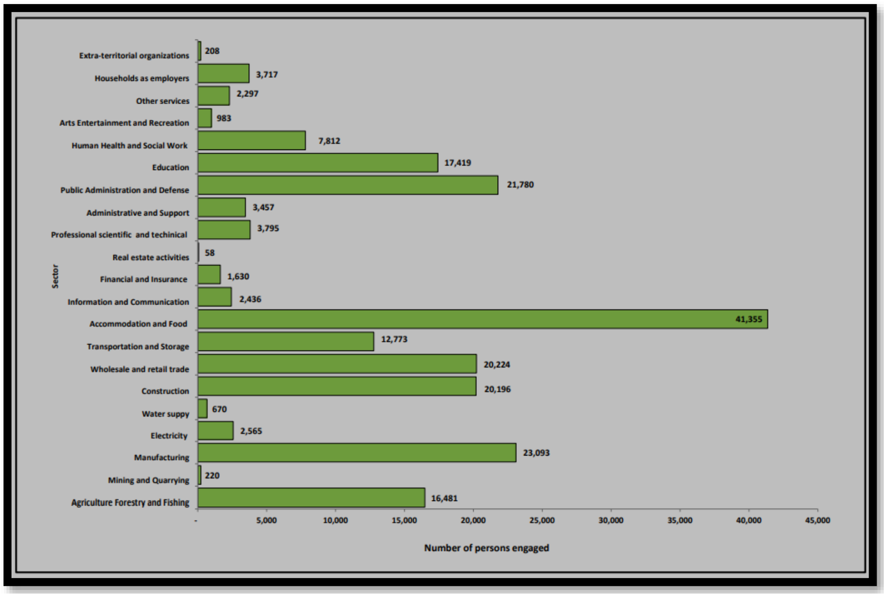


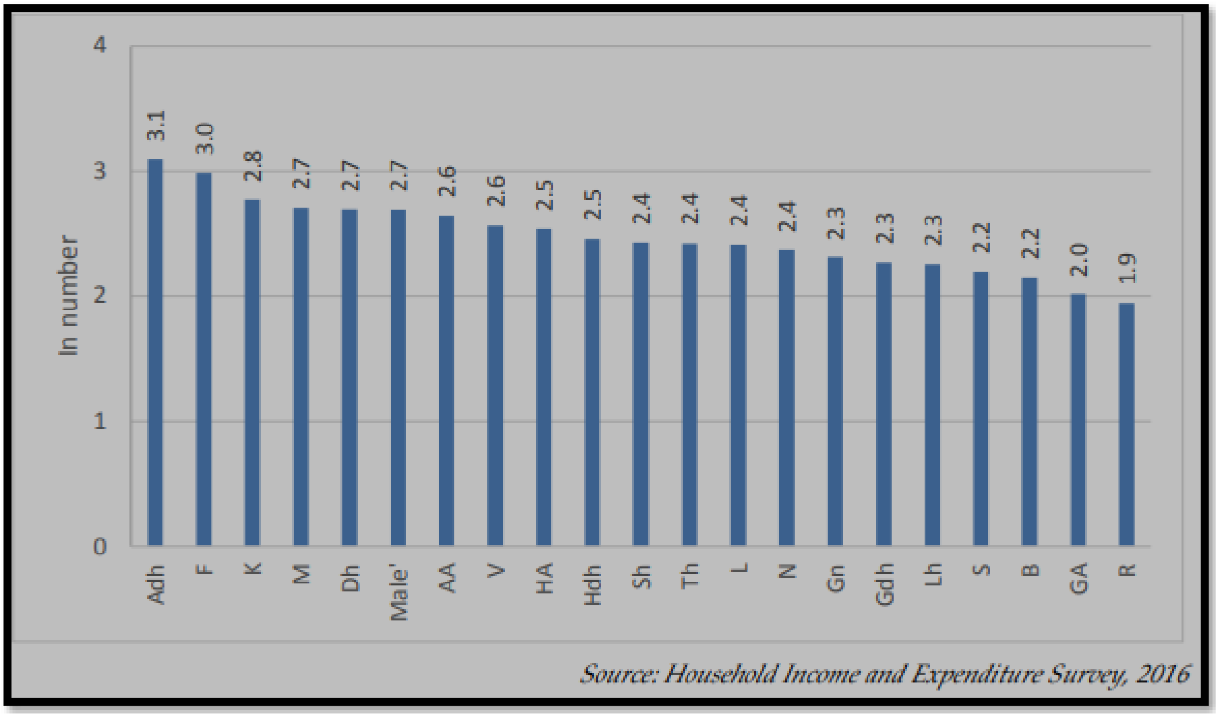
Figure 35: resident employed population by sector (Maldives Population & Housing Census, 2014)

HIES 2016 report states that out of the working age population (15 years and above) of Maldives, 66 percent were income earners. Earners also include those people not in employment but receives transfer incomes (eg: basic pension for the elderly). The report highlighted that on average 5.0 earners of Laamu Atoll generates income in information and communication, 4.2 from Construction and 5.0 as household owners (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016). This might not reflect Laamu atoll income distribution specifically as the atoll is more diverse, but a rough estimate can be determined of how the income generated is distributed in the atoll. The details of earner distribution on an atoll level is provided below.

Locality	Average number of earner by sector from the main Job																				
	A – Agriculture, forestry and fishing	- Fishing	B - Mining and quarrying	C – Manufacturing	D - Electricity, gas, steam and air conditioning supply	E - Water supply; sewerage, waste management and remediation activities	F – Construction	G - Wholesale and retail trade; repair of motor vehicles and motorcycles	H – Transportation and storage	I – Accommodation and food service activities	J – Information and communication	K - Financial and insurance activities	L - Real estate activities	M – Professional, scientific and technical activities	N – Administrative and support service activities	O - Public administration and defence; compulsory social security	P – Education	Q - Human health and social work activities	R - Arts, entertainment and recreation	S - Other service activities	T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	U - Activities of extraterritorial organizations and bodies
Republic	2.9	2.9	3.0	3.0	2.8	3.1	3.1	3.2	3.0	3.1	2.8	3.4	3.0	3.3	2.7	3.0	3.0	3.0	3.9	3.2	2.8	4.0
Male’	3.5	3.4	0.0	3.1	2.8	3.5	3.0	3.3	3.1	3.1	2.8	3.6	3.0	3.3	2.7	3.2	3.4	3.1	3.9	4.2	3.0	0.0
Atolls	2.9	2.9	3.0	2.9	2.8	2.7	3.2	3.1	2.8	3.1	3.0	2.5	0.0	2.2	2.8	2.8	2.8	2.9	3.8	2.4	2.6	0.0
HA	2.9	2.8	3.9	3.4	3.1	5.0	2.7	3.0	2.3	2.7	0.0	0.0	0.0	2.0	2.6	2.8	3.0	2.2	1.5	1.8	3.2	0.0
Hdh	2.7	2.9	2.0	2.7	2.8	0.0	4.2	3.3	2.8	2.8	2.6	4.0	0.0	1.0	3.3	2.5	2.4	2.7	0.0	2.4	3.5	0.0
Sh	3.0	2.9	1.7	2.8	2.6	0.0	3.1	3.0	2.6	3.2	0.0	1.0	0.0	0.0	3.2	2.7	2.8	2.8	3.0	2.0	1.5	0.0
N	2.5	2.1	4.0	2.8	2.7	0.0	4.5	2.7	3.1	2.3	0.0	0.0	0.0	3.0	2.1	2.4	2.6	2.6	0.0	0.0	1.8	0.0
R	2.4	2.3	0.0	2.3	2.3	2.0	1.9	2.6	1.9	2.5	2.4	0.0	0.0	0.0	3.0	2.4	2.6	2.8	4.0	3.1	1.6	0.0
B	2.5	2.3	2.0	2.1	2.5	0.0	2.5	3.6	2.8	3.4	3.0	5.0	0.0	0.0	2.3	2.7	3.0	2.6	0.0	2.0	3.4	0.0
Lh	2.3	2.5	0.0	2.4	3.0	1.5	2.7	2.7	2.9	1.9	1.7	1.9	0.0	2.9	0.0	2.8	2.6	2.6	0.0	1.0	2.9	4.0
K	3.6	3.6	0.0	3.1	3.2	4.0	3.5	5.1	3.1	4.0	2.5	0.0	0.0	0.0	3.3	3.8	3.5	3.7	4.5	5.0	1.6	0.0
AA	3.2	3.7	4.0	3.9	3.4	1.0	2.2	3.4	4.2	3.9	0.0	0.0	0.0	0.0	1.3	3.2	3.2	4.5	4.4	0.0	4.2	0.0
Adh	3.7	3.6	4.0	3.5	2.8	4.7	4.2	3.9	4.0	3.3	4.2	3.0	0.0	2.5	4.0	3.3	3.5	3.9	2.0	2.6	4.2	0.0
V	2.7	2.8	0.0	2.9	2.9	2.0	3.6	2.8	2.3	3.1	6.0	4.0	0.0	0.0	2.8	3.1	2.8	3.7	3.3	0.0	1.7	0.0
M	3.4	3.4	0.0	3.7	4.3	0.0	2.8	3.2	3.3	6.0	3.0	4.0	0.0	0.0	2.7	3.3	3.3	3.1	0.0	2.2	1.0	0.0
F	3.4	3.3	0.0	3.4	2.2	3.2	3.4	3.2	5.5	3.9	0.0	5.0	0.0	0.0	4.1	3.3	3.5	3.7	0.0	2.9	0.0	0.0
Dh	3.6	3.6	0.0	3.3	3.7	3.0	4.1	3.3	4.9	2.5	0.0	3.5	0.0	0.0	3.2	3.0	3.1	2.7	13.0	3.0	4.4	0.0
Th	2.6	2.4	3.0	3.0	3.2	0.0	2.9	2.8	3.3	3.7	0.0	2.0	0.0	2.0	2.0	2.9	2.6	3.0	0.0	2.5	3.5	0.0
L	2.7	2.8	0.0	3.0	2.7	2.6	4.2	3.6	3.3	4.0	5.0	1.6	0.0	0.0	3.3	3.2	3.4	3.2	0.0	2.5	5.0	0.0
GA	2.1	2.1	3.0	3.1	1.8	4.0	1.3	2.4	2.2	2.8	0.0	1.0	0.0	1.0	3.8	2.0	2.6	2.3	0.0	3.5	1.6	0.0
Gdh	2.4	2.5	2.0	3.1	2.6	0.0	3.4	3.2	2.6	3.9	2.6	1.6	0.0	0.0	2.7	2.7	2.7	2.2	0.0	1.9	3.0	0.0
Gn	2.4	2.0	0.0	3.8	2.4	0.0	2.0	2.1	1.6	2.1	2.3	4.1	0.0	2.3	3.5	2.2	2.5	1.9	4.0	2.4	1.2	0.0
S	2.7	2.9	0.0	2.4	2.3	0.0	2.4	2.8	2.0	2.3	2.4	1.4	0.0	0.0	1.6	2.2	2.5	2.7	1.0	0.0	2.3	0.0

Figure 36: average number of earner by sector from the main Job (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016).

HIES 2016 report further highlighted that, Laamu Atoll has the 12th highest number of earners on average with 2.4 person per household, earning approximately 8,797 MVR per earner matching Thaa, Seenu and Noonu Atoll. The following figures provides the atoll level breakdown with respect to average number of earners and their average income (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016).



Source: Household Income and Expenditure Survey, 2016

Figure 37: average number of earners by Atoll, 2016 (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016).

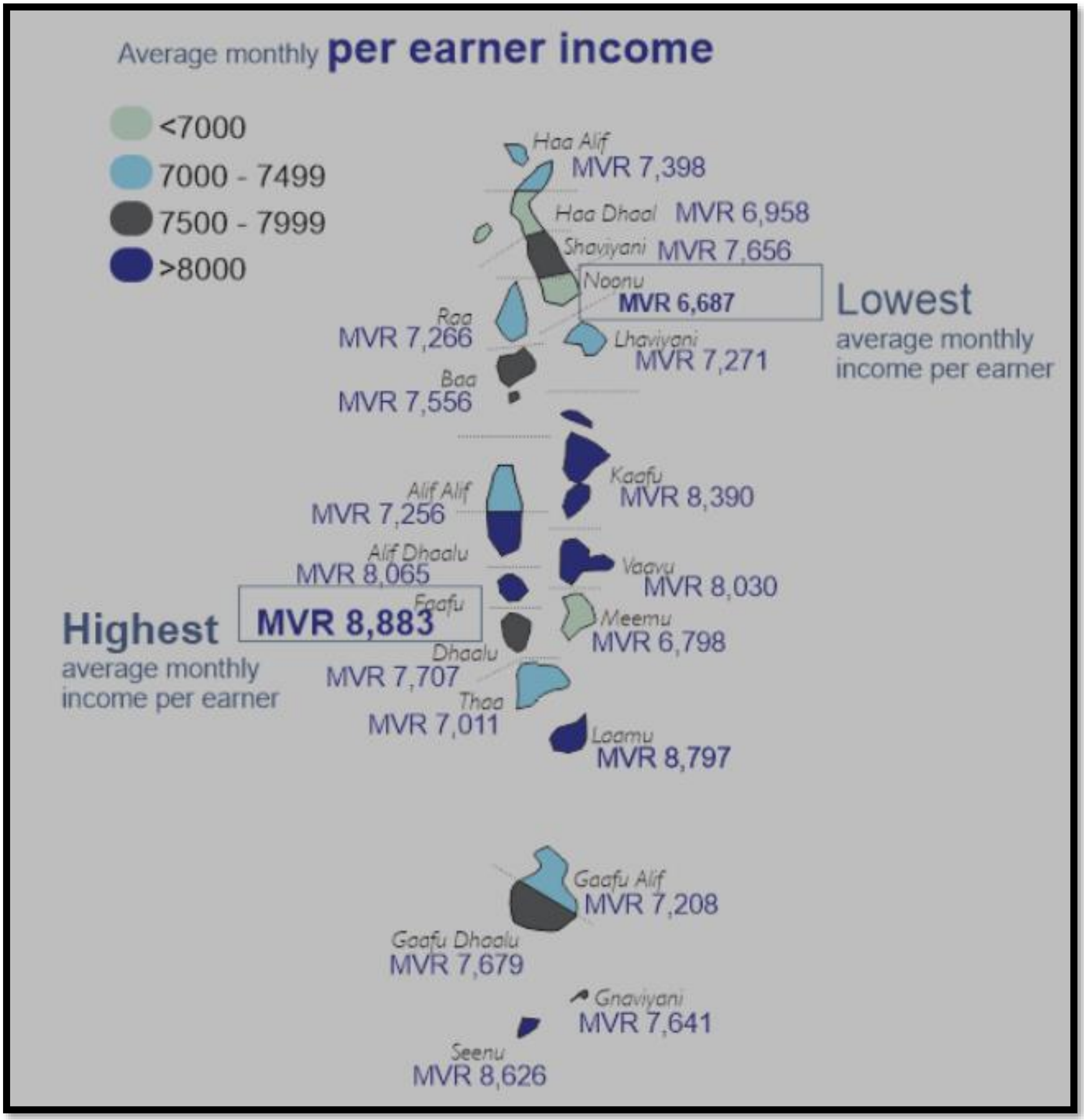
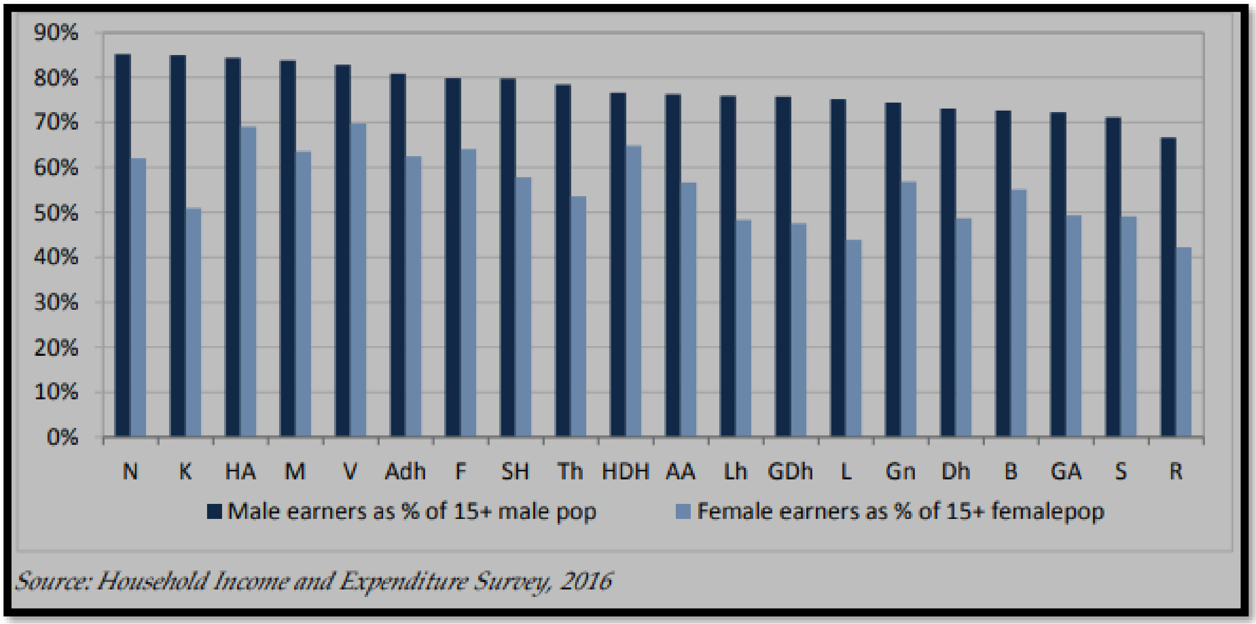


Figure 38: average monthly income per earner (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016).

Moreover, figure provided below compares the earners by sex as a proportion of 15 years and above population of the respective sex. On average 79% of the 15 years and above male population are earners in Maldives. Laamu Atoll is one of the atolls which reportedly have approximately 75% of 15 years and above male population as earners. Furthermore, it is reported that 42% of 15 years and above female population in Laamu Atoll were recorded as earners (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016).



Source: Household Income and Expenditure Survey, 2016

Figure 39: earners aged 15 and above population by sex and locality, 2016 (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016)

When it comes to unemployment rates, all the Atolls with the exception of Addu (S), Gnaviyani (Gn), Male' Atoll (K), Faadhippolhu (Lh) and Male' shows lower unemployment rates in 2014 compared to 2006. Laamu Atoll reported an unemployment rate of 4.0 % in (Household Income and Expenditure Survey (HIES) Analytical Report: Household Income, 2016).

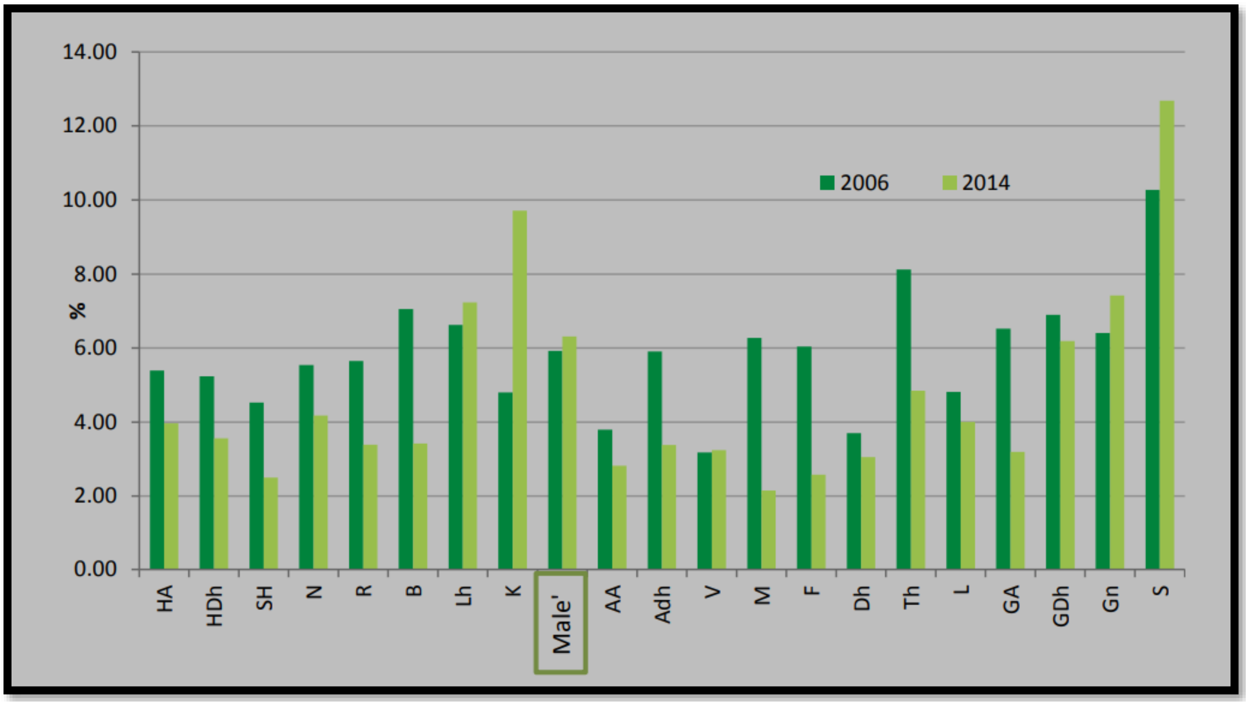


Figure 40: unemployment rate by locality, 2006 & 2014 (Maldives Population & Housing Census, 2014)

5.5.3 Healthcare Facilities

The following figure shows which regional and referral facility is available in each zone. Laamu Atoll is located in zone 4. Zoning starts from the north.

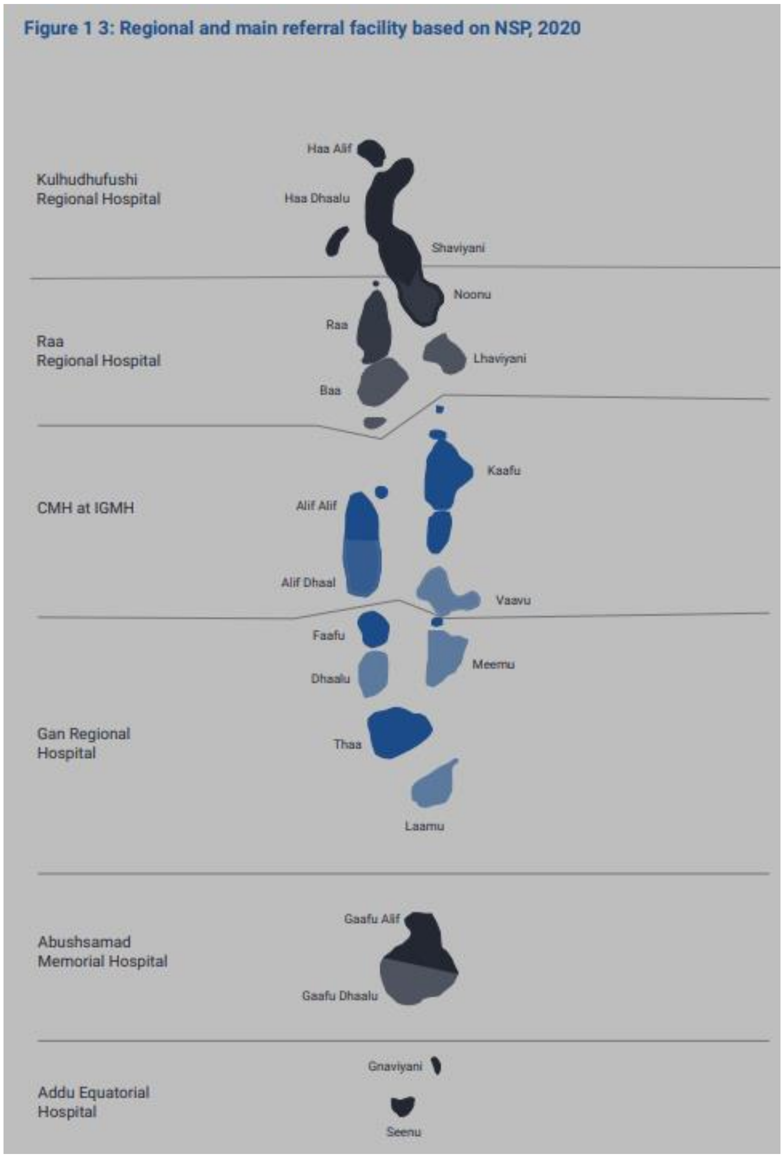


Figure 41: Regional and main referal facility found in each zone (Maldives Health Statistics, 2020).

Zone 4 where Laamu Atoll is located have 42 public infrastructures with 5 hospitals and 37 healthcare centers. In the private sector 7 resort clinics, 4 allopathic clinic and 1 dental clinic were reported. This can provide a general idea of which facilities are available in the region.

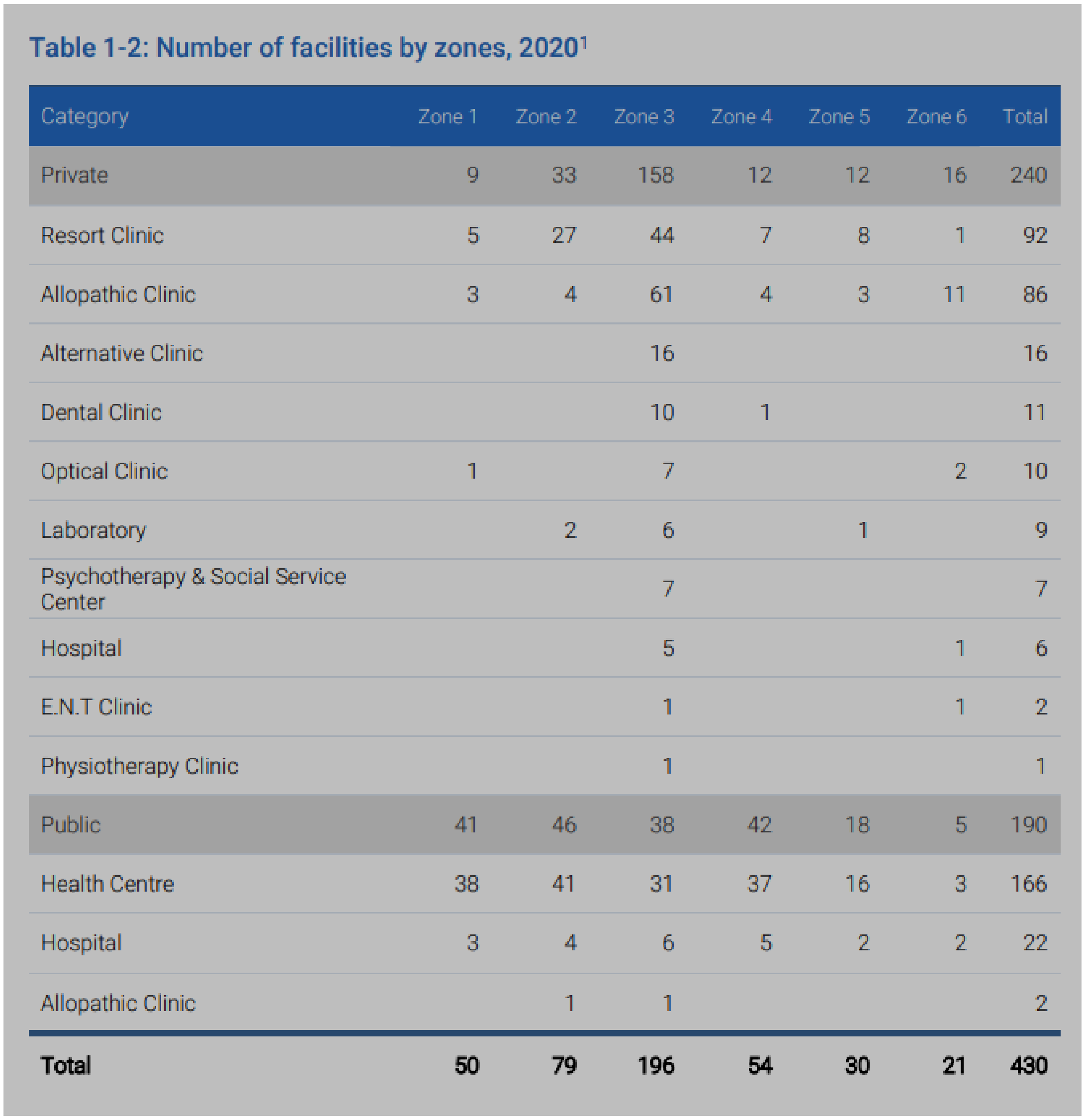


Table 1-2: Number of facilities by zones, 2020[1]

Category	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Total
Private	9	33	158	12	12	16	240
Resort Clinic	5	27	44	7	8	1	92
Allopathic Clinic	3	4	61	4	3	11	86
Alternative Clinic			16				16
Dental Clinic			10	1			11
Optical Clinic	1		7			2	10
Laboratory		2	6		1		9
Psychotherapy & Social Service Center			7				7
Hospital			5			1	6
E.N.T Clinic			1			1	2
Physiotherapy Clinic			1				1
Public	41	46	38	42	18	5	190
Health Centre	38	41	31	37	16	3	166
Hospital	3	4	6	5	2	2	22
Allopathic Clinic		1	1				2
Total	**50**	**79**	**196**	**54**	**30**	**21**	**430**

Figure 42: Healthcare facilities available in each zone (Maldives Health Statistics, 2020).

5.5.4 Accessibility and Public Transport

According to the statistical yearbook of 2018 Laamu Atoll has 14 registered vessels. The atoll has 8 launches, 2 boats (Dhoni) and 3 small boats (Bokkura).

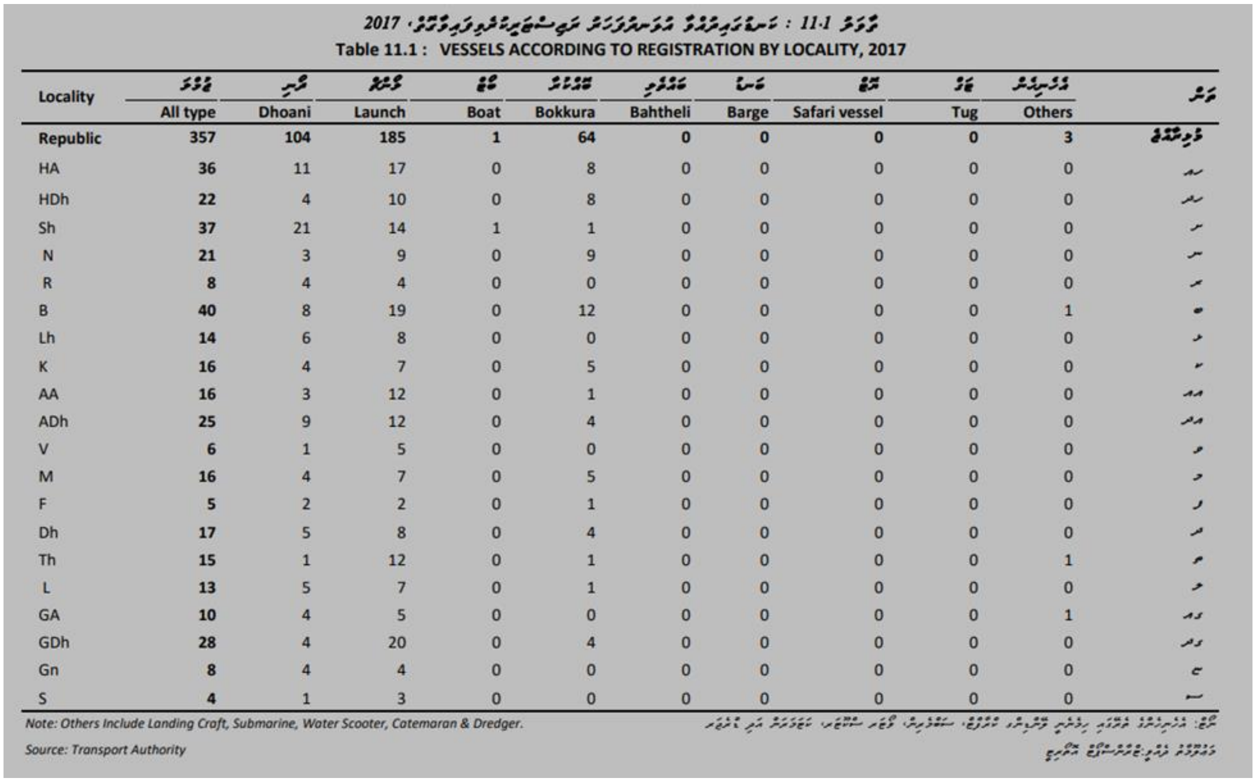


Table 11.1 : VESSELS ACCORDING TO REGISTRATION BY LOCALITY, 2017

Locality	All type	Dhoani	Launch	Boat	Bokkura	Bahtheli	Barge	Safari vessel	Tug	Others
Republic	**357**	**104**	**185**	**1**	**64**	**0**	**0**	**0**	**0**	**3**
HA	**36**	11	17	0	8	0	0	0	0	0
HDh	**22**	4	10	0	8	0	0	0	0	0
Sh	**37**	21	14	1	1	0	0	0	0	0
N	**21**	3	9	0	9	0	0	0	0	0
R	**8**	4	4	0	0	0	0	0	0	0
B	**40**	8	19	0	12	0	0	0	0	1
Lh	**14**	6	8	0	0	0	0	0	0	0
K	**16**	4	7	0	5	0	0	0	0	0
AA	**16**	3	12	0	1	0	0	0	0	0
ADh	**25**	9	12	0	4	0	0	0	0	0
V	**6**	1	5	0	0	0	0	0	0	0
M	**16**	4	7	0	5	0	0	0	0	0
F	**5**	2	2	0	1	0	0	0	0	0
Dh	**17**	5	8	0	4	0	0	0	0	0
Th	**15**	1	12	0	1	0	0	0	0	1
L	**13**	5	7	0	1	0	0	0	0	0
GA	**10**	4	5	0	0	0	0	0	0	1
GDh	**28**	4	20	0	4	0	0	0	0	0
Gn	**8**	4	4	0	0	0	0	0	0	0
S	**4**	1	3	0	0	0	0	0	0	0

Note: Others include Landing Craft, Submarine, Water Scooter, Catemaran & Dredger.

Source: Transport Authority

Figure 43: Registered vessels by locality (Statistical Yearbook of Maldives, 2018)

5.6 Hazard Vulnerability

The United Nations Development Program (UNDP) has compiled a very thorough study to develop a risk profile for the Maldives in order to determine the probability of hazards across different regions of Maldives based on geological evidence, historical data and projections derived from theoretical analysis (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006). Likelihood of storm hazards for the island under concern are analyzed using this disaster risk management study done by the UNDP and likelihood of flooding is analyzed using rainfall data from the nearest meteorological center to each island. Some project site specific data are also obtained from consultation with the relevant stakeholders.

5.6.1 Storms

In addition to monsoonal heavy rains and strong winds, hazardous weather events which regularly affect the Maldives are tropical storms or tropical cyclones and severe local storms (thunder storms/thunder squalls) (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006).

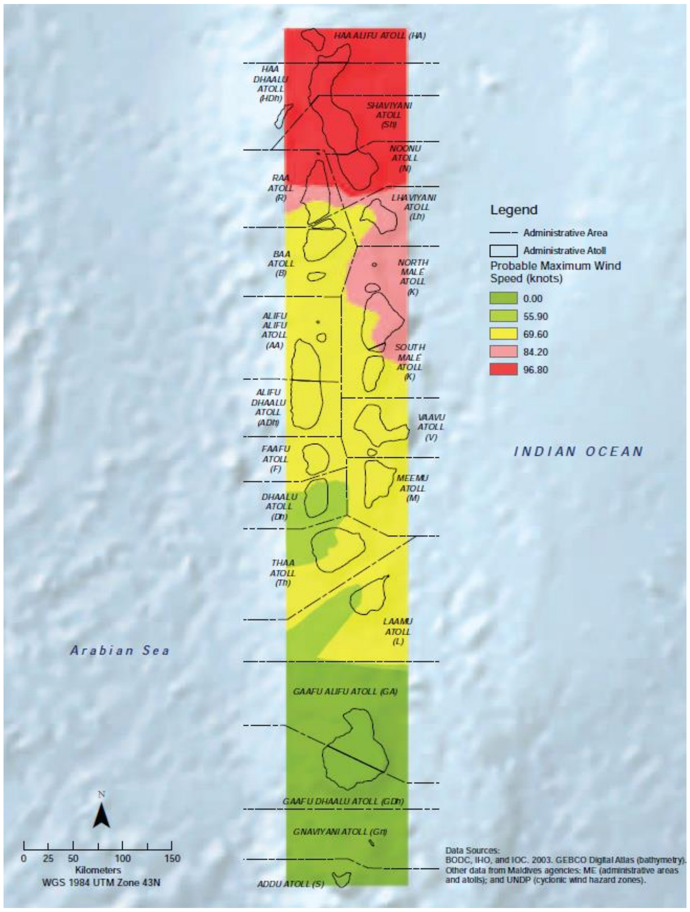
Every so often, tropical cyclones hitting the Maldives are highly destructive due to associated strong winds that exceed a speed of 150 km/hr, heavy rainfall of above 30-40 cm in 24 hrs and storm tides that often exceed 4-5 m. Strong winds often damage vegetation, houses, communication networks and roads. Heavy rainfall is associated with serious flooding. Cyclonic winds can sometimes cause a sudden rise in sea level along the coast, leading to a storm surge. The combined effect of surge and tide, which is known as 'storm tide', can cause catastrophic events in low lying areas, flat coasts and islands such as the Maldives (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006).

Hazards associated with thunder storms include strong winds often exceeding a speed of 100 km/hr, heavy rainfall, lightning and hail. Such thunder storms are very frequent in the equatorial region, which is where the Maldives lie, however, they are less violent at this region. Moreover, land areas are more frequently hit by thunder storms than the open ocean. Strong winds generated by severe local storms generate large wind-driven waves which are hazardous for the Maldives (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006).

5.6.2 Cyclonic Winds

Studies of historic data suggests that even though the northern islands of the country were affected by weak cyclones which formed in the southern part of Bay of Bengal and the Arabian Sea, in general the Maldives islands were less prone to tropical cyclones. According to the cyclonic wind hazard zone classification, the north most islands represent the highest risk region and the hazard risk decreases moving down south (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006).

On a scale of 1-5, with 5 being the highest risk zone, L. Thun'buri falls under the moderate-risk zone (Figure 26) (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006).

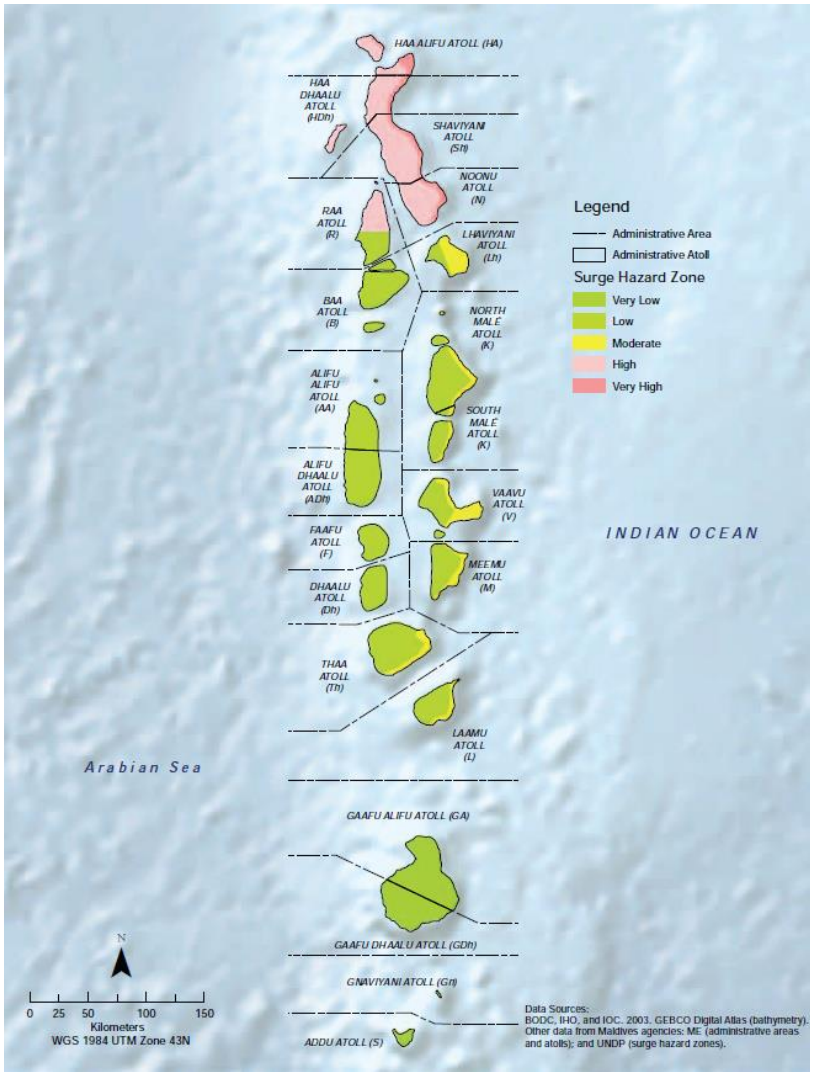


Data Sources:
BODC, IHO, and IOC. 2003. GEBCO Digital Atlas (bathymetry).
Other data from Maldives agencies: ME (administrative areas and atolls); and UNDP (cyclonic wind hazard zones).

Figure 44: Cyclonic wind hazard map of the Maldives; from red to green, red being the highest at risk (Multihazard Risk Atlas of Maldives, 2020)

5.6.3 Storm Surge

According to the bathymetric surveys of the entire Maldives, the ocean slope towards the eastern side is steeper than the west coast which indicates that the eastern islands of the Maldives are more vulnerable to higher surge hazard compared to the western islands. Accordingly, the country has been divided into 5 broad storm surge hazard zones from 1-5, with 5 being the highest risk category. According to this zoning, L. Thun'buri is in moderate risk zone (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006).



Data Sources:
BODC, IHO, and IOC. 2003. GEBCO Digital Atlas (bathymetry).
Other data from Maldives agencies: ME (administrative areas and atolls); and UNDP (surge hazard zones).

Figure 45: Storm hazard map of the Maldives from pink to green, pink being highest risk (Multihazard Risk Atlas of Maldives, 2020)

5.6.4 Flooding

Rainfall data from Kahdhoo meteorological station representing the study area has been used to analyze the flood and drought years at this region. Data has been standardized against the overall mean. Deducing from standard deviation of rainfall from long-term mean, it can be concluded that if the difference between long-term mean and standard deviation is >1, that corresponding year is a flood year whereas if this difference is <-1 it may be considered a drought year.

Geographically, L. Thun'buri are located at the Southern quadrant of the Maldives near Kahdhoo meteorological station. Analysis of rainfall data from Kahdhoo station showed that this part of the Maldives experienced more rain deficient (17) years than heavy rainfall (14) years. As for flooding, 4 years observed rainfall >1 standard deviation from the long-term mean (Figure 46indicating that flooding is an uncommon occurrence at this part of the Maldives. Even though, the past 03 years have shown a decrease in heavy rainfall, the 10-year moving average still predicts that 2023 will receive higher rainfall than normal rainfall.

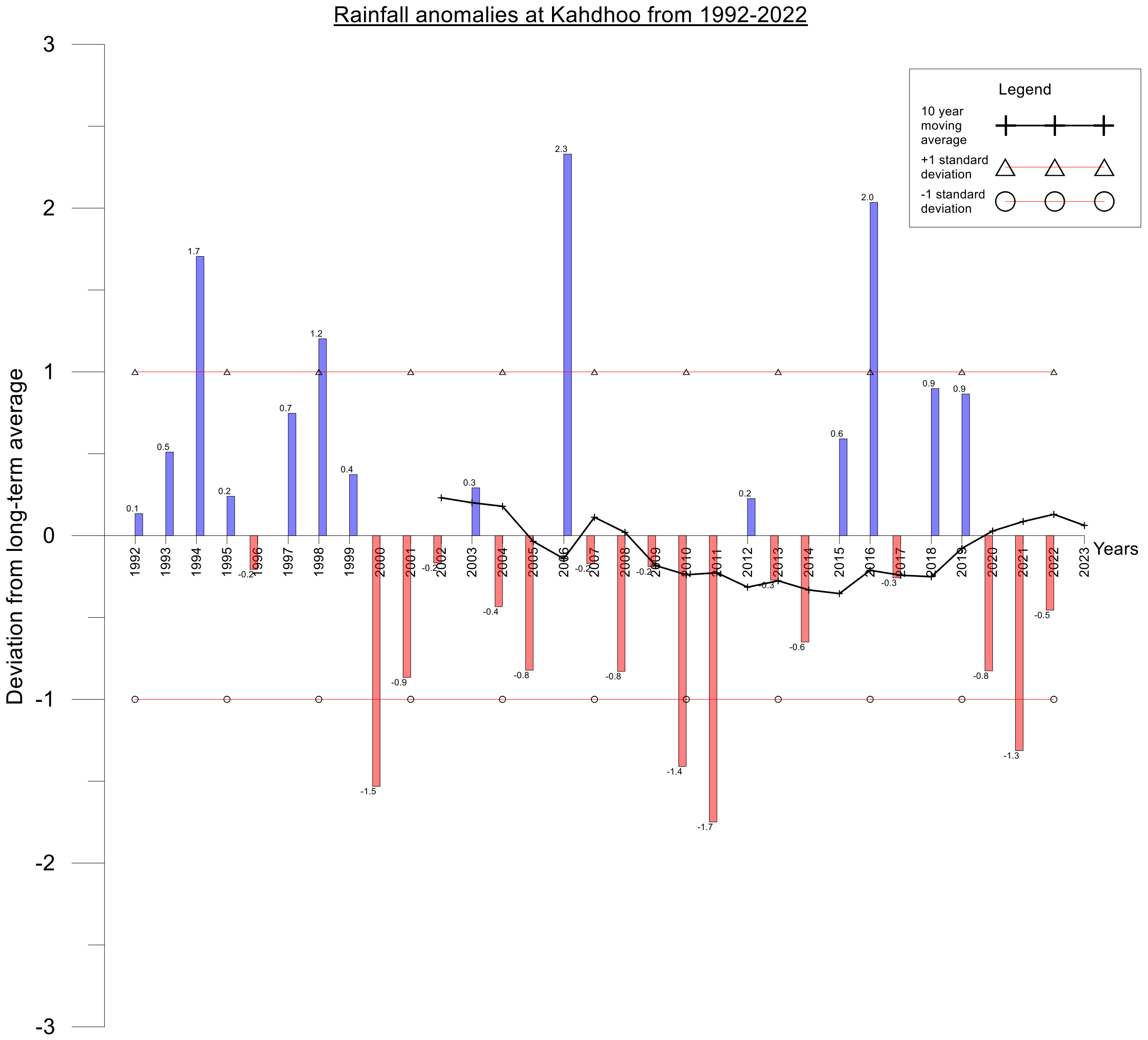


Figure 46: Rainfall anomalies for Kahdhoo from 1992 to 2022 with the 10-year moving average. Red lines indicate +1 and -1 standard deviations from the mean. (Data obtained from the Bureau of Meteorology, Maldives).

However, there are other factors that greatly influence risk of flooding for instance, alterations to the islands size, width and topography, an island's risk to flooding may vary despite similar rainfall patterns.

5.6.5 Seismic Activity

Seismic waves are created when the earth’s lithosphere releases a sudden burst of energy shaking the surface of the planet. Earthquakes are manifested when fault lines or tectonic plates move due to these seismic waves. When this occurs at large magnitudes at the seabed, it can cause tsunamis. Only three major events of magnitude above 7.0 had struck the region between 1979 and 2004 (Developing a Disaster Risk Profile for Maldives, Volume 1: Main report, 2006). L. Thun’buri is located in the low-risk zone.

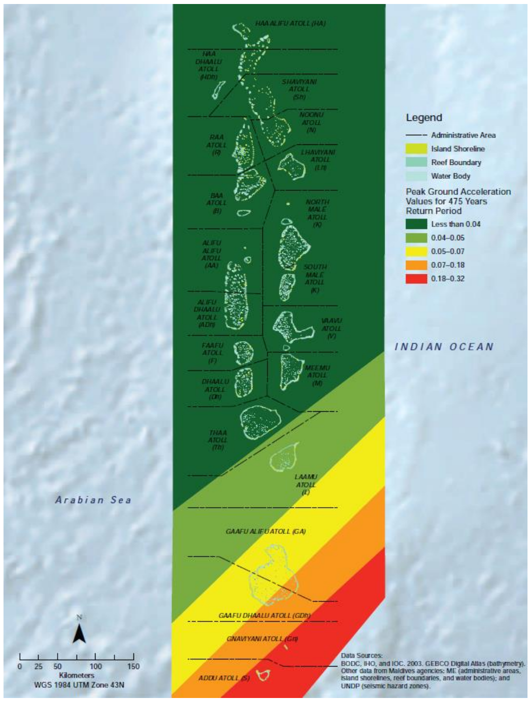


Figure 47 Seismic hazard zoning map of the Maldives from green to red, red being the highest at risk (Multihazard Risk Atlas of Maldives, 2020)

5.6.6 Tsunami

Tsunamis are destructive oceanic waves generated due to disturbances on the sea floor such as earthquakes, volcanic eruptions, underwater landslides, or even meteorite impacts.

In 2004 the second largest tsunamigenic earthquake globally recorded hit Indonesia and generated tsunamis 3-10 meters high travelling across the Indian Ocean striking Maldives with waves ranging 1.2-4.2 m. Out of 198 inhabited islands, 13 were destroyed, 56 sustained major physical damage, and 121 faced moderate damage from flooding.

95% of tsunamis that effect Maldives are generated from the eastern source zones. The risk is high for eastern fringe of eastern atolls, though eastern fringe of some western atolls is also at high risk. By observing bathymetric contours, the islands have been categorised into 5 zones with 1 being the lowest hazard level. L. Thun'buri is in a very high-risk zone.

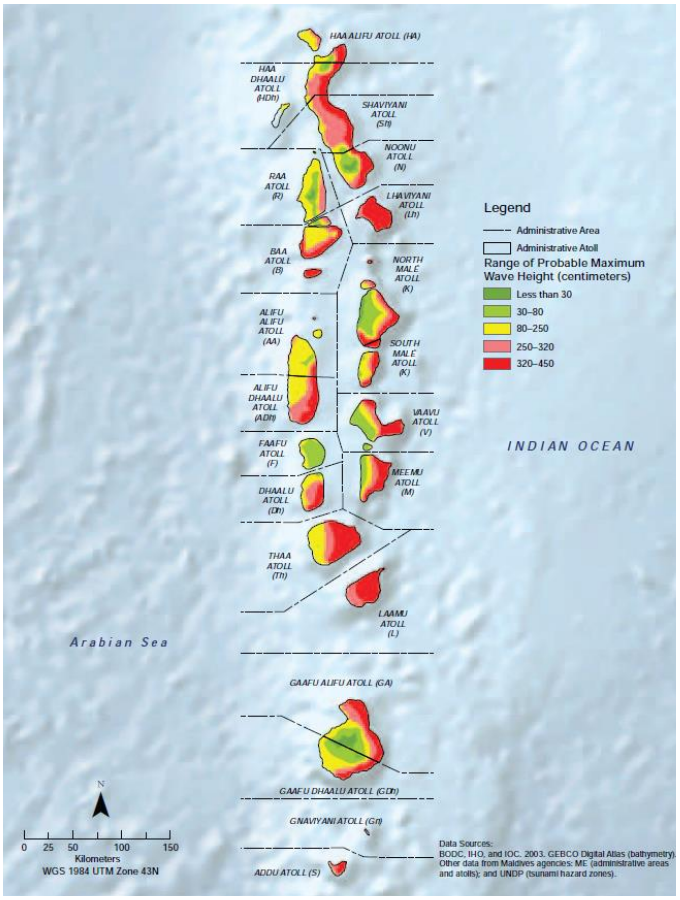


Figure 48: Tsunami hazard zoning map of Maldives (Multihazard Risk Atlas of Maldives, 2020)

6. STAKEHOLDER CONSULTATION

This section describes the stakeholder consultation method and the summary of the outcomes from each of the consulted stakeholders.

6.1 Consultation Method

An email request for stakeholder consultation was sent out to the relevant stakeholders with the approved ToR and a project brief. If the stakeholder wishes for a stakeholder consultation meeting, a meeting was supposed to be held at a convenient time and venue. An option was also given to provide the recommendations and suggestions regarding the proposed project to us in writing, whereby the stakeholder could send us an email highlighting their concerns and recommendations.

6.1.1 Invitations

The following table highlights the email requests sent out to stakeholders inviting for the stakeholder consultations. For the stakeholders that did not respond, the table shows the date at which the invitation was initiation sent and any follow up reminders. The proof for the invitations and reminders is given in the section 6.1.5 under the table Table 30.

Table 26: invitations sent out to stakeholders

Stakeholder	Initial Invitation Sent Date	Reminders	Responded Date
Laamu Atoll Council	17th April 2023	First reminder; 08th May 2023, in addition the council was called via telephone at 09:16 on the same day. The council informed that they had received our invitation and will respond to us. Second reminder; 14th May 2023	No official response
Ministry of Fisheries,	17th April 2023	None	25th April 2023

Marine Resources and Agriculture			
EPA, ERC section	17th April 2023	First reminder; 14th May 2023	14th May 2023

6.1.2 Consulted Date and Venues

The following table gives the consulted date, time and venues for each responded stakeholder(s).

Table 27: consultation date, time and venues

Stakeholder	Date	Time	Venue
Ministry of Fisheries, Marine Resources and Agriculture	25th April 2023	11:42 AM	E-mail response
EPA, ERC section	16th May 2023	13:05 – 14:00	EPA meeting room

6.1.3 Contact Details for all Participants attended to Consultations

The following table gives the contact details of all participants which have attended the consultation meeting(s) for this EIA or contributed via email response.

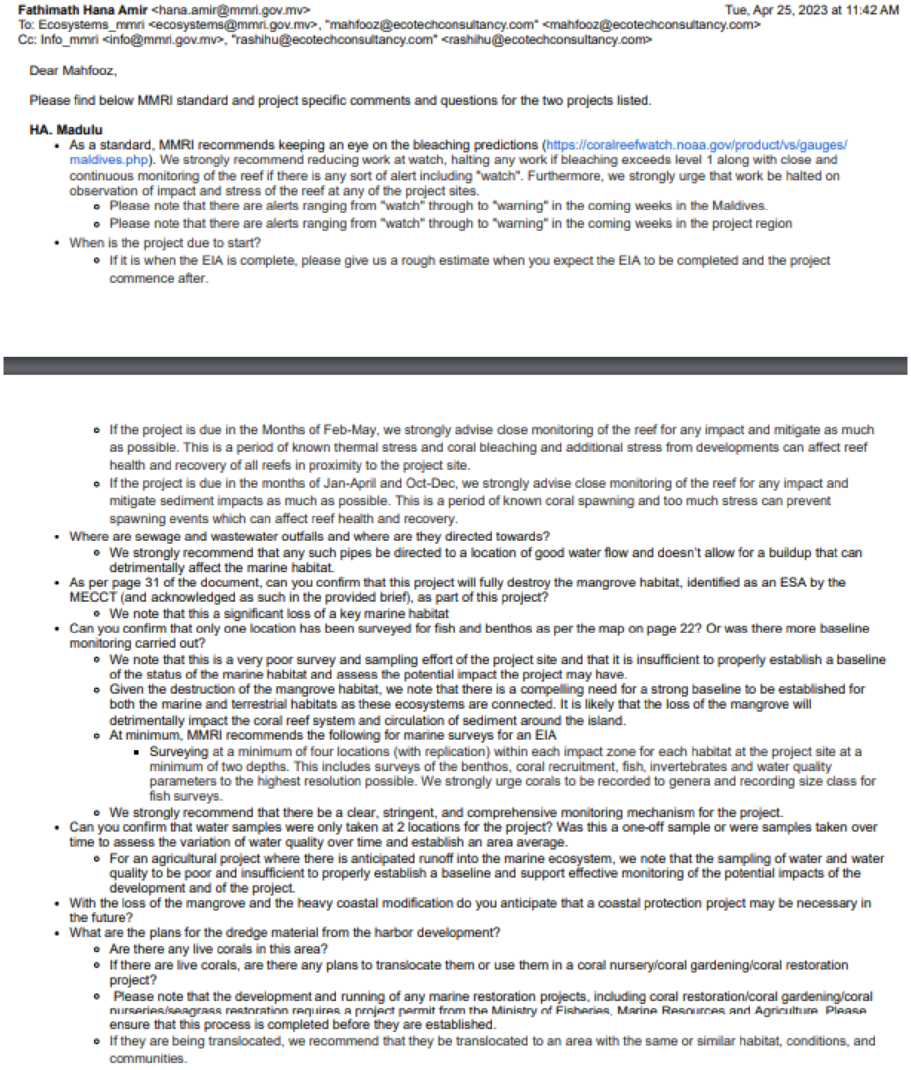
Table 28: contacts of all stakeholders consulted

Stakeholder	Name	Designation	Contact
Coral Reefs Section, MMRI, Ministry of Fisheries, Marine Resources and Agriculture	Hana Amir	Marine Biologist	hana.amir@mmri.gov.mv 3028708
EPA	Ahmed Leevan	Surveyor	Ahmed.leevan@epa.gov.mv
EPA	Aishath Amjidha	Legal Officer	Aishath.amjidha@epa.gov.mv
EPA	Mariyam Shaaha. H.	-	Mariyam.shaahahussain@epa.gov.mv
Eco-Tech Consultancy	Mahfooz A. Wahhab	EIA Consultant	mahfooz@ecotechconsultancy.com

6.1.4 Attendance Sheets for Consultation Meetings or proof of consultations

The following table shows the attendance sheets for consultation meetings (if any) and email proof of consultations with stakeholders.

Table 29: Attendance sheets (if any) and email proof for stakeholder consultations

Stakeholder	Attendance Sheet
Ministry of Fisheries, Marine Resources and Agriculture	

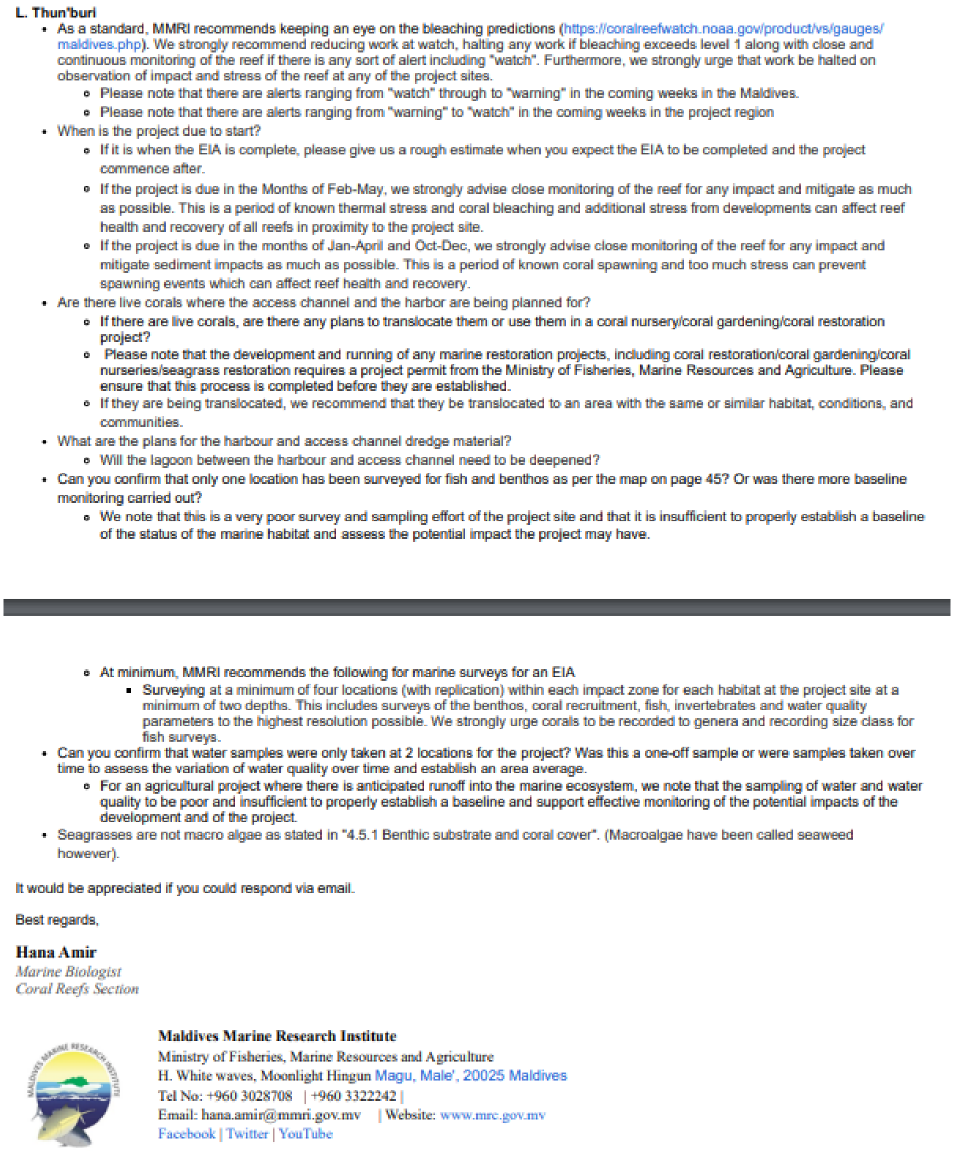
Fathimath Hana Amir <hana.amir@mmri.gov.mv> Tue, Apr 25, 2023 at 11:42 AM
To: Ecosystems_mmri <ecosystems@mmri.gov.mv>, "mahfooz@ecotechconsultancy.com" <mahfooz@ecotechconsultancy.com>
Cc: Info_mmri <info@mmri.gov.mv>, "rashihu@ecotechconsultancy.com" <rashihu@ecotechconsultancy.com>

Dear Mahfooz,

Please find below MMRI standard and project specific comments and questions for the two projects listed.

HA. Madulu

- As a standard, MMRI recommends keeping an eye on the bleaching predictions (https://coralreefwatch.noaa.gov/product/vs/gauges/maldives.php). We strongly recommend reducing work at watch, halting any work if bleaching exceeds level 1 along with close and continuous monitoring of the reef if there is any sort of alert including "watch". Furthermore, we strongly urge that work be halted on observation of impact and stress of the reef at any of the project sites.
  - Please note that there are alerts ranging from "watch" through to "warning" in the coming weeks in the Maldives.
  - Please note that there are alerts ranging from "watch" through to "warning" in the coming weeks in the project region
- When is the project due to start?
  - If it is when the EIA is complete, please give us a rough estimate when you expect the EIA to be completed and the project commence after.
  - If the project is due in the Months of Feb-May, we strongly advise close monitoring of the reef for any impact and mitigate as much as possible. This is a period of known thermal stress and coral bleaching and additional stress from developments can affect reef health and recovery of all reefs in proximity to the project site.
  - If the project is due in the months of Jan-April and Oct-Dec, we strongly advise close monitoring of the reef for any impact and mitigate sediment impacts as much as possible. This is a period of known coral spawning and too much stress can prevent spawning events which can affect reef health and recovery.
- Where are sewage and wastewater outfalls and where are they directed towards?
  - We strongly recommend that any such pipes be directed to a location of good water flow and doesn't allow for a buildup that can detrimentally affect the marine habitat.
- As per page 31 of the document, can you confirm that this project will fully destroy the mangrove habitat, identified as an ESA by the MECCT (and acknowledged as such in the provided brief), as part of this project?
  - We note that this a significant loss of a key marine habitat
- Can you confirm that only one location has been surveyed for fish and benthos as per the map on page 22? Or was there more baseline monitoring carried out?
  - We note that this is a very poor survey and sampling effort of the project site and that it is insufficient to properly establish a baseline of the status of the marine habitat and assess the potential impact the project may have.
  - Given the destruction of the mangrove habitat, we note that there is a compelling need for a strong baseline to be established for both the marine and terrestrial habitats as these ecosystems are connected. It is likely that the loss of the mangrove will detrimentally impact the coral reef system and circulation of sediment around the island.
  - At minimum, MMRI recommends the following for marine surveys for an EIA
    - Surveying at a minimum of four locations (with replication) within each impact zone for each habitat at the project site at a minimum of two depths. This includes surveys of the benthos, coral recruitment, fish, invertebrates and water quality parameters to the highest resolution possible. We strongly urge corals to be recorded to genera and recording size class for fish surveys.
  - We strongly recommend that there be a clear, stringent, and comprehensive monitoring mechanism for the project.
- Can you confirm that water samples were only taken at 2 locations for the project? Was this a one-off sample or were samples taken over time to assess the variation of water quality over time and establish an area average.
  - For an agricultural project where there is anticipated runoff into the marine ecosystem, we note that the sampling of water and water quality to be poor and insufficient to properly establish a baseline and support effective monitoring of the potential impacts of the development and of the project.
- With the loss of the mangrove and the heavy coastal modification do you anticipate that a coastal protection project may be necessary in the future?
- What are the plans for the dredge material from the harbor development?
  - Are there any live corals in this area?
  - If there are live corals, are there any plans to translocate them or use them in a coral nursery/coral gardening/coral restoration project?
  - Please note that the development and running of any marine restoration projects, including coral restoration/coral gardening/coral nurseries/seagrass restoration requires a project permit from the Ministry of Fisheries, Marine Resources and Agriculture. Please ensure that this process is completed before they are established.
  - If they are being translocated, we recommend that they be translocated to an area with the same or similar habitat, conditions, and communities.



L. Thun'buri

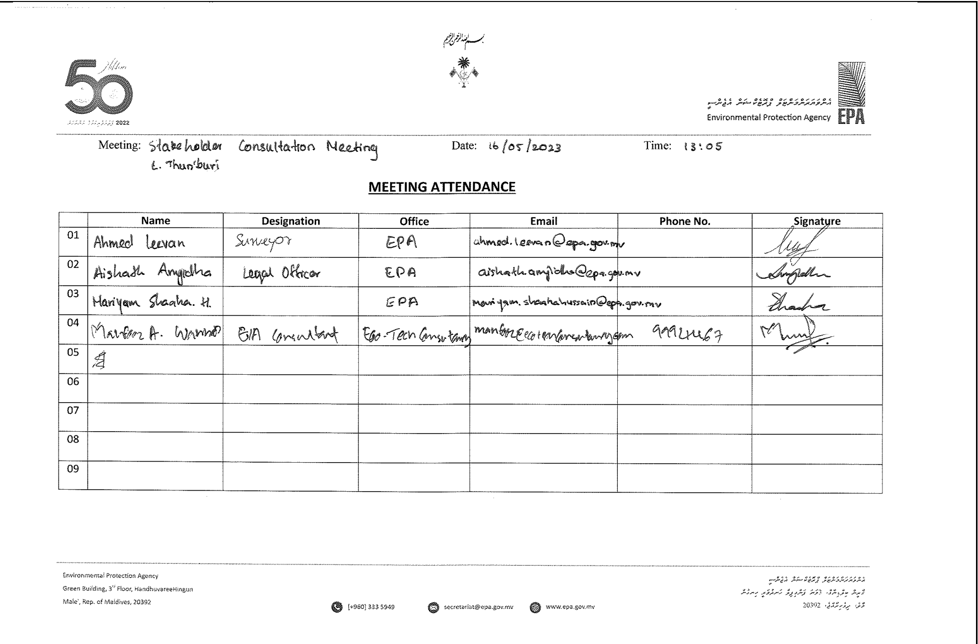
- As a standard, MMRI recommends keeping an eye on the bleaching predictions (https://coralreefwatch.noaa.gov/product/vs/gauges/maldives.php). We strongly recommend reducing work at watch, halting any work if bleaching exceeds level 1 along with close and continuous monitoring of the reef if there is any sort of alert including "watch". Furthermore, we strongly urge that work be halted on observation of impact and stress of the reef at any of the project sites.
  - Please note that there are alerts ranging from "watch" through to "warning" in the coming weeks in the Maldives.
  - Please note that there are alerts ranging from "warning" to "watch" in the coming weeks in the project region
- When is the project due to start?
  - If it is when the EIA is complete, please give us a rough estimate when you expect the EIA to be completed and the project commence after.
  - If the project is due in the Months of Feb-May, we strongly advise close monitoring of the reef for any impact and mitigate as much as possible. This is a period of known thermal stress and coral bleaching and additional stress from developments can affect reef health and recovery of all reefs in proximity to the project site.
  - If the project is due in the months of Jan-April and Oct-Dec, we strongly advise close monitoring of the reef for any impact and mitigate sediment impacts as much as possible. This is a period of known coral spawning and too much stress can prevent spawning events which can affect reef health and recovery.
- Are there live corals where the access channel and the harbor are being planned for?
  - If there are live corals, are there any plans to translocate them or use them in a coral nursery/coral gardening/coral restoration project?
  - Please note that the development and running of any marine restoration projects, including coral restoration/coral gardening/coral nurseries/seagrass restoration requires a project permit from the Ministry of Fisheries, Marine Resources and Agriculture. Please ensure that this process is completed before they are established.
  - If they are being translocated, we recommend that they be translocated to an area with the same or similar habitat, conditions, and communities.
- What are the plans for the harbour and access channel dredge material?
  - Will the lagoon between the harbour and access channel need to be deepened?
- Can you confirm that only one location has been surveyed for fish and benthos as per the map on page 45? Or was there more baseline monitoring carried out?
  - We note that this is a very poor survey and sampling effort of the project site and that it is insufficient to properly establish a baseline of the status of the marine habitat and assess the potential impact the project may have.
  - At minimum, MMRI recommends the following for marine surveys for an EIA
    - Surveying at a minimum of four locations (with replication) within each impact zone for each habitat at the project site at a minimum of two depths. This includes surveys of the benthos, coral recruitment, fish, invertebrates and water quality parameters to the highest resolution possible. We strongly urge corals to be recorded to genera and recording size class for fish surveys.
- Can you confirm that water samples were only taken at 2 locations for the project? Was this a one-off sample or were samples taken over time to assess the variation of water quality over time and establish an area average.
  - For an agricultural project where there is anticipated runoff into the marine ecosystem, we note that the sampling of water and water quality to be poor and insufficient to properly establish a baseline and support effective monitoring of the potential impacts of the development and of the project.
- Seagrasses are not macro algae as stated in "4.5.1 Benthic substrate and coral cover". (Macroalgae have been called seaweed however).

It would be appreciated if you could respond via email.

Best regards,

Hana Amir
Marine Biologist
Coral Reefs Section

Maldives Marine Research Institute
Ministry of Fisheries, Marine Resources and Agriculture
H. White waves, Moonlight Hingun Magu, Male', 20025 Maldives
Tel No: +960 3028708 | +960 3322242 |
Email: hana.amir@mmri.gov.mv | Website: www.mrc.gov.mv
Facebook | Twitter | YouTube

EPA ERC Section	

Environmental Protection Agency
EPA

Meeting: Stakeholder Consultation Meeting L. Thunburi
Date: 16/05/2023
Time: 13:05

MEETING ATTENDANCE

	Name	Designation	Office	Email	Phone No.	Signature
01	Ahmed Leevan	Surveyor	EPA	ahmed.leevan@epa.gov.mv		
02	Aishath Angidha	Legal Officer	EPA	aishath.angidha@epa.gov.mv		
03	Mariyam Shaaha. H.		EPA	mariyam.shaahahussain@epa.gov.mv		
04	Manfooz A. Waheed	EIA Consultant	Eco-Tech Consultancy	manfooz@ecotechconsultancy.com	9994467	
05						
06						
07						
08						
09						

Environmental Protection Agency
Green Building, 3rd Floor, HandhuvareeHingun
Male', Rep. of Maldives, 20392

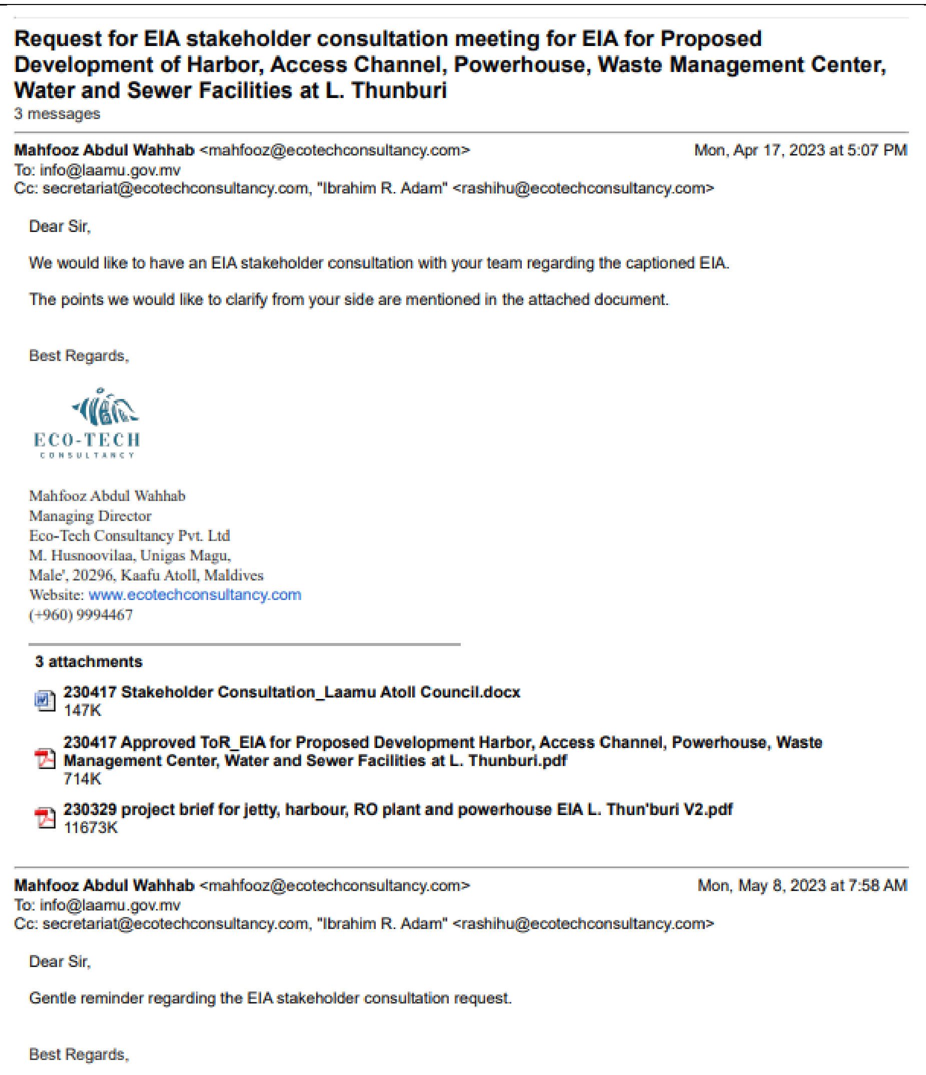
☎ [+960] 333 5949
secretariat@epa.gov.mv
www.epa.gov.mv

6.1.5 Proof of Invitations sent out for not responded stakeholders

The following table shows the proof of email invitations sent out for the stakeholders that did not respond.

Table 30: proof of invitation sent out to stakeholders

Stakeholder	Partial print of invitations sent out

Laamu Atoll Council	

Request for EIA stakeholder consultation meeting for EIA for Proposed Development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at L. Thunburi
3 messages

Mahfooz Abdul Wahhab <mahfooz@ecotechconsultancy.com> Mon, Apr 17, 2023 at 5:07 PM
To: info@laamu.gov.mv
Cc: secretariat@ecotechconsultancy.com, "Ibrahim R. Adam" <rashihu@ecotechconsultancy.com>

Dear Sir,

We would like to have an EIA stakeholder consultation with your team regarding the captioned EIA.

The points we would like to clarify from your side are mentioned in the attached document.

Best Regards,

ECO-TECH
CONSULTANCY

Mahfooz Abdul Wahhab
Managing Director
Eco-Tech Consultancy Pvt. Ltd
M. Husnoovilaa, Unigas Magu,
Male', 20296, Kaafu Atoll, Maldives
Website: www.ecotechconsultancy.com
(+960) 9994467

3 attachments

230417 Stakeholder Consultation_Laamu Atoll Council.docx
147K

230417 Approved ToR_EIA for Proposed Development Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at L. Thunburi.pdf
714K

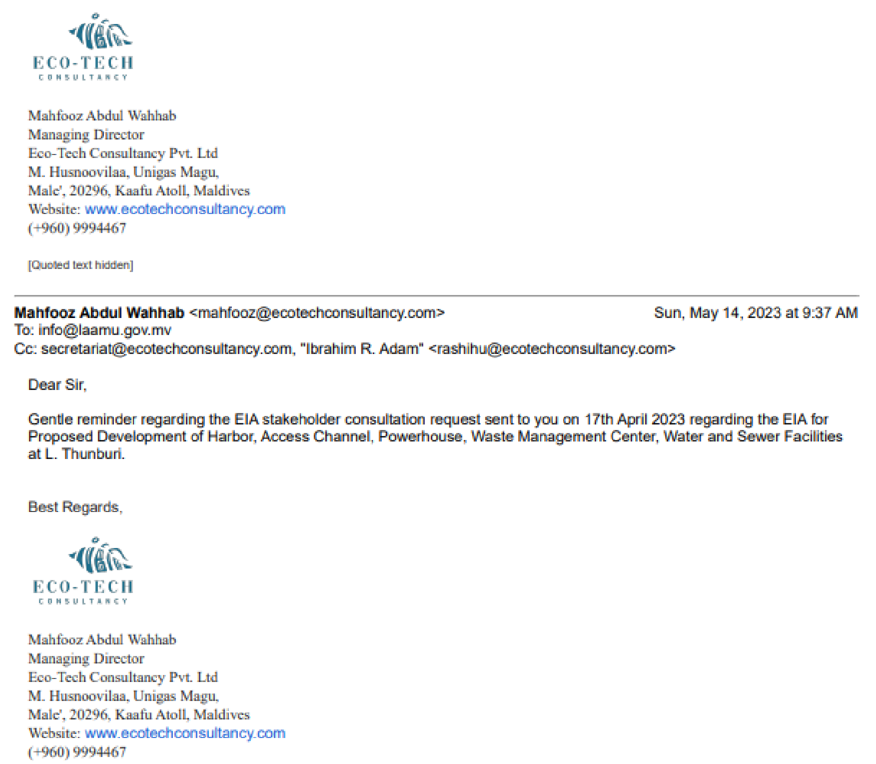
230329 project brief for jetty, harbour, RO plant and powerhouse EIA L. Thun'buri V2.pdf
11673K

Mahfooz Abdul Wahhab <mahfooz@ecotechconsultancy.com> Mon, May 8, 2023 at 7:58 AM
To: info@laamu.gov.mv
Cc: secretariat@ecotechconsultancy.com, "Ibrahim R. Adam" <rashihu@ecotechconsultancy.com>

Dear Sir,

Gentle reminder regarding the EIA stakeholder consultation request.

Best Regards,

Mahfooz Abdul Wahhab
Managing Director
Eco-Tech Consultancy Pvt. Ltd
M. Husnoovilaa, Unigas Magu,
Male', 20296, Kaafu Atoll, Maldives
Website: www.ecotechconsultancy.com
(+960) 9994467

[Quoted text hidden]

Mahfooz Abdul Wahhab <mahfooz@ecotechconsultancy.com> Sun, May 14, 2023 at 9:37 AM
To: info@laamu.gov.mv
Cc: secretariat@ecotechconsultancy.com, "Ibrahim R. Adam" <rashihu@ecotechconsultancy.com>

Dear Sir,

Gentle reminder regarding the EIA stakeholder consultation request sent to you on 17th April 2023 regarding the EIA for Proposed Development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at L. Thunburi.

Best Regards,

Mahfooz Abdul Wahhab
Managing Director
Eco-Tech Consultancy Pvt. Ltd
M. Husnoovilaa, Unigas Magu,
Male', 20296, Kaafu Atoll, Maldives
Website: www.ecotechconsultancy.com
(+960) 9994467

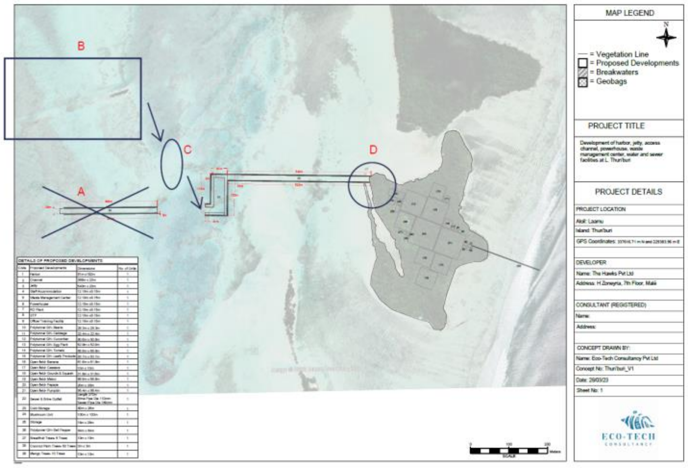
6.2 Consultations Undertaken

Stakeholder consultations were undertaken with the MFMRA and EPA ERC Section. The summary of outcomes is given for each stakeholder below and the responses from the proponent for the concerns raised.

6.2.1 EPA ERC Section

The table below shows the concerns, suggestions and recommendations made by EPA ERC Section regarding the proposed project along with the responses for the concerns (if any) which were raised.

Table 31: outcomes of the consultation with EPA ERC Section

Concerns / Suggestions raised	Response
If the proposed connection road/ jetty between the harbour and the island does not allow current and water to flow beneath it properly it will negatively impact the dynamics of the Beach of the island. Because it will essentially be acting as a groyne, it may cause stagnation of the waters on the western side of the island and cause major erosion to the beach of Thunburi. By blocking the natural water movement, it may divert the currents to flow between the narrow channel in between Thunburi and Hulhiyandhoo, resulting in erosion of the land near the channel. In order to avoid such drastic changes, we recommend that the jetty/road between the harbour and the island be a concrete stilt jetty, to minimise the disturbance to the flow of currents around the island. Alternatively, if the stilt jetty is not suitable for the purposes of the project, then a sand bridge may be built with proper gaps/channels that allow water to circulate beneath the bridge. the channels must either be wide enough or frequent enough to not disrupt the current flow. Lastly, the land connection point in the concept drawing for the bridge shows that it will close the mouth of the bay/inlet (D). Please make sure that when building the bridge/stilt jetty, that the mouth of the bay/inlet remains open. 	The EIA consultants are in agreement with the highlighted concerns and have recommended alternatives that allow for water flow in the EIA report.
The channel proposed to be dredged to the west of the proposed harbour (A) is an area with a high biodiversity and healthy coral reef, therefore we suggest that the already existing channel (B) adjacent to Hulhiyandhoo be maintained and used instead. To allow vessels to approach the proposed harbour, another smaller channel can be dredged in the sandy area (C) between the proposed harbour	The proponent has proposed to construct an additional access channel in line with Thunburi, as the adjacent Islands maybe leased to different parties and during the operation this may cause conflicts if the proponents vessels go through another

and the existing channel.	party's jurisdiction (option C).
All dredging and reclamation/sand filling operations must employ proper mitigation measures to minimize the impacts to the surrounding area. The details of the mitigation measures must be highlighted in the report. eg: silt screens to minimize sedimentation	Will be addressed in the EIA report.
As this project involves a significant amount of vegetation clearance, the removed vegetation should be relocated to other areas of the island where possible. In the event that there isn't enough space left for relocation, then the Trees must be relocated to another island, preferably nearby inhabited islands with low vegetation coverage.	

6.2.2 Ministry of Fisheries, Marine Resource and Agriculture

The table below shows the concerns, suggestions and recommendations made by MFMRA regarding the proposed project along with the responses for the concerns (if any) which were raised.

Table 32: outcomes of the consultation with MFMRA

Concerns / Suggestions raised	Response
As a standard, MMRI recommends keeping an eye on the bleaching predictions (https://coralreefwatch.noaa.gov/product/vs/gauges/maldives.php). We strongly recommend reducing work at watch, halting any work if bleaching exceeds level 1 along with close and continuous monitoring of the reef if there is any sort of alert including "watch". Furthermore, we strongly urge that work be halted on observation of impact and stress of the reef at any of the project sites. Please note that there are alerts ranging from "watch" through to "warning" in the coming weeks in the Maldives. Please note that there are alerts ranging from "watch" through to "warning" in the coming weeks in the project region	These mitigation measures will be incorporated into the EIA report.
When is the project due to start? If it is when the EIA is complete, please give us a rough estimate when you expect the EIA to be completed and the project commence after. If the project is due in the Months of Feb-May, we strongly advise	End of May or Early June 2023. These mitigation measures will be incorporated into the EIA report.

close monitoring of the reef for any impact and mitigate as much as possible. This is a period of known thermal stress and coral bleaching and additional stress from developments can affect reef health and recovery of all reefs in proximity to the project site. If the project is due in the months of Jan-April and Oct-Dec, we strongly advise close monitoring of the reef for any impact and mitigate sediment impacts as much as possible. This is a period of known coral spawning and too much stress can prevent spawning events which can affect reef health and recovery.	
Where are sewage and wastewater outfalls and where are they directed towards? We strongly recommend that any such pipes be directed to a location of good water flow and doesn't allow for a buildup that can detrimentally affect the marine habitat.	Out of the back reef and into the atoll basin. The outfall location was already chosen as per the mentioned recommendation.
Are there live corals where the access channel and the harbor are being planned for? If there are live corals, are there any plans to translocate them or use them in a coral nursery/coral gardening/coral restoration project? Please note that the development and running of any marine restoration projects, including coral restoration/coral gardening/coral nurseries/seagrass restoration requires a project permit from the Ministry of Fisheries, Marine Resources and Agriculture. Please ensure that this process is completed before they are established. If they are being translocated, we recommend that they be translocated to an area with the same or similar habitat, conditions, and communities.	Access channel; yes Harbour; No The EIA consultants recommend to translocate them or use them in coral restoration project.
What are the plans for the harbour and access channel dredge material? Will the lagoon between the harbour and access channel need to be deepened?	Stockpiled on the side of entrance channel or Island. Most likely.
Can you confirm that only one location has been surveyed for fish and benthos as per the map on page 45? Or was there more baseline monitoring carried out? We note that this is a very poor survey and sampling effort of the project site and that it is insufficient to properly establish a baseline of the status of the marine habitat and assess the potential impact	The attached IEE was done by another consultancy firm when the Island was initially acquired from the MoFMRA. However, under our EIA study a comprehensive environmental study will be done.

the project may have. At minimum, MMRI recommends the following for marine surveys for an EIA Surveying at a minimum of four locations (with replication) within each impact zone for each habitat at the project site at a minimum of two depths. This includes surveys of the benthos, coral recruitment, fish, invertebrates and water quality parameters to the highest resolution possible. We strongly urge corals to be recorded to genera and recording size class for fish surveys.	
Can you confirm that water samples were only taken at 2 locations for the project? Was this a one-off sample or were samples taken over time to assess the variation of water quality over time and establish an area average. For an agricultural project where there is anticipated runoff into the marine ecosystem, we note that the sampling of water and water quality to be poor and insufficient to properly establish a baseline and support effective monitoring of the potential impacts of the development and of the project.	
Seagrasses are not macro algae as stated in "4.5.1 Benthic substrate and coral cover". (Macroalgae have been called seaweed however).	As mentioned previously the IEE was done by another consultancy firm. The IEE was approved by MoFMRA and the Island was leased to the proponent.

7. POTENTIAL IMPACT ANALYSIS

The impacts from any project can be categorized into two broad categories; constructional and operational impacts. Constructional impacts are the potential impacts which might arise during the construction stage of the proposed project. Operational impacts are the potential impacts which might arise once the newly constructed project facilities become operational.

7.1 Impact Assessment Methodology

The proponent and the consultants have conducted a risk-based environmental review as part of the planning process (Risk Management-Principles and Guidelines, 2011). Data has been drawn from a wide range of sources, including existing similar EIA reports. Similar EIA reports reviewed for the formulation of this EIA include but not limited to the reports mentioned under section 1.5.

The impact assessment was conducted based on professional judgment and expertise of the consultants as well as evaluation of the baseline data and consultation with the stakeholders. This provides an outline on how to identify potential impacts associated with the proposal and evaluate the likelihood and consequences. The impact assessment methodology utilized was also consistent with the methodology outlined in AS/NZS ISO31000 (AS/NZS ISO 31000 : 2009 Risk management - Principles and guidelines, 2009).

The first stage of this methodology was to identify potential impacts. To ensure that all potential impacts were identified, it was important that any specific environment and/or community impact issues were determined based on the locations of the project components as well as type of service to be provided (Wild Environment, 2012). As such, the impacts identified were:-

1. Construction Phase Impacts:-
    - Mobilization impacts- Direct damage to benthos and sedimentation
    - Mobilization impacts- Noise

- Mobilization impacts- Dust
- Mobilization impacts- Oil spills at sea
- Mobilization impacts- Oil spills on ground
- Mobilization impacts- workforce; covid episode, negative social impacts, illegal labor
- Generation of site clearance, demolition and constructional waste
- Vegetation clearance
- Vibration impacts
- Air Quality-GHGs
- Air Quality-Dust
- Noise Pollution
- Groundwater quality- oil and chemical spills
- Groundwater quality- salinization
- Impacts on marine environment
- Impacts on terrestrial environment- soil and ground
- Impacts on coastal environment
- Risk of accidents and pollution on workers
- Impacts on landscape integrity and scenery
- Socio-economic impacts

2. Operational Phase Impacts:-
    - Air Quality- GHGs
    - Air Quality- dust
    - Noise Pollution
    - Ground and marine water quality- negative
    - Groundwater quality – positive
    - Groundwater quality- positive
    - Impacts on marine environment
    - Impacts on hydrodynamics

- Impacts on terrestrial environment - soil and ground
- Impacts on coastal environment
- Impacts from vibration
- Impacts from waste
- Health and safety of working staff
- Impacts on landscape integrity and scenery
- Socio-economic impacts - negative
- Socio-economic impacts - positive
- Risk of hazards; weed growth
- Risk of hazards; pest out break
- Risk of hazards- storm surge
- Risk of hazards- sea level rise
- Risk of hazards- fire and other workplace accidents

The significance of impacts was assessed using the following matrix (Table 33).

Table 33. Impact assessment matrix (Wild Environment, 2012)

		Consequences				
		Minimal (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Likelihood	Remote (1)	Negligible	Negligible	Very low	Low	Medium
	Unlikely (2)	Negligible	Very low	Low	Medium	High
	Possible (3)	Very low	Low	Medium	High	Very high
	Likely (4)	Low	Medium	High	Very high	Significant
	Certain (5)	Medium	High	Very high	Significant	Significant

Characteristics of the impacts on Table 34 is used to determine the consequences (minimal (1), minor (2), Moderate (3), Major (4), Catastrophic (5)) of each identified impact. For each specific consequence there is 5 likelihood categories (Table 33). Therefore, if an impact has Moderate (3) consequence but a likelihood of Remote (1), then that impact would have “very low” significance. However, if the likelihood is Certain (5) then the impact would have “Very high” significance

Criteria used for assessing the identified impacts are as follows. Note that likelihood and consequences were judged based on the design consideration for the proposed development. These criteria were measured against the impact (if the impact occurred), to ecological and/or human health (Wild Environment, 2012):-

- Likelihood:-
  - Remote- May occur only in exceptional circumstances;
  - Unlikely- Could occur at some time;
  - Possible- Might occur at some time;
  - Likely- More likely to happen than not (i.e. a probability of > 50 %); and
  - Certain- Will probably occur in most circumstances.
- Consequences:-
  - Minimal- Impact has no significant risk to environment either short term or long term;
  - Minor- The impact is short term and causes very limited risk to the environment;
  - Moderate- Impact gives rise to some concern, may cause long term environmental problems but are likely short term and acceptable;
  - Major- Impact is long term, small scale and environmentally risky. Impact severely damages the environment; and
  - Catastrophic- Impact is long term and irreversible, large scale and detrimental to the environment.

The likelihood measures the probability of occurrence of an event whereas consequences evaluate the significance of impact on the environment in the event of an incident. Based on the likelihood and consequences for each of the identified impacts, the significance level is determined (Table 33).

Impact characteristics such as the type of impact, nature of the impact, impact range, impact duration as well as reversibility of the impacts were assessed using the grading scales for which are given on Table 34 below.

Table 34. Grading scale of the characteristics of impacts

Characteristic of impact	Grading	Explanation
Type	Direct	Direct impacts without intervening factors or intermediaries
	Indirect	Triggered by but not immediate effect of the proposed project
Nature	Positive	Impacts resulting in a desirable effect
	Negative	Impacts resulting in an undesirable effect
	Cumulative	Impacts of an action when combined with impacts from projects or actions that have been undertaken recently or will be carried out in the near future.
Range	Local	Impacts limited to project site
	Island	Impacts of importance at island level
	Atoll	Impact of importance at Atoll level
	Nation	Impacts of national character
Duration	Short-term	Occurring over a short period of time
	Intermittent	Impacts occurring at irregular intervals
	Long-term	Occurring over a long period of time
	Continuous	Impacts occurring continuously
Reversibility	Reversible	Previous state (or equivalent) can be restored
	Irreversible	Not able to alter the consequence of impact

7.2 Justification for selected Impact Prediction and Assessment Method

The most common methods of impact prediction include the usage of checklist, matrices, networks, overlays, GIS and computer expert systems. The use of any single method has its disadvantages for instance checklist maybe easy to understand and use but it does not distinguish between direct and indirect impacts (UNEP, 2002). Matrices are good for displaying EIA results and links actions to impacts however have the disadvantage of double-counting of impacts. Networks can distinguish between direct and indirect impacts but can be very complex. Overlays are good at displaying spatial impacts but does not address impact duration and probability. GIS and computer expert systems are good for impact identification and spatial analysis but requires a lot of data.

The employed method in this EIA is a combination of all of the above-mentioned methods with the addition of profession judgement of the consultant from past experiences that provide an easy and simple method to analyze impacts with limited data. The method can distinguish between direct, indirect and cumulative impacts while linking project activities to impacts. The method distinguishes impacts that can realistically be detrimental to the environment by linking consequences of an impact to its probability of occurrence. Finally, this method consumes very less time and hence rapid assessments can be made which is especially advantageous in the Maldives where EIA consultants are expected to complete EIAs in a very short duration.

7.3 Limitations and Uncertainties in Impact Prediction and Assessment Method

Risks and uncertainties are inherent in any environmental and ecological problem-solving technique and needs to be acknowledged and incorporated in any decision-making process. Risk is the chance that an adverse outcome occurs while uncertainty arises from an imperfect understanding of a system due to uncertainty about facts (McAlpine, et al., 2010). Our understanding of the environment is limited mainly due to the lack of long-term data and complexity of the ecosystem. For example, the assessments were done during one season and impacts are predicted based on these assessments. However, how the magnitudes of these impacts and how they behave in nature during the other season is quite uncertain.

The potential environmental impacts from the proposed project are all predicted, hence there may be variables affecting the accuracy of these impacts due to natural variations such as site conditions and uncertainties in scales and magnitudes. While every attempt has been made to accurately predict the potential impacts from this project, there are unforeseen and uncertain factors which might cause deviations in the impacts outlined herein. For instance, a natural phenomenon.

Moreover, assessment of existing conditions requires a benchmark against which these conditions can be compared, however, lack of such benchmarks is a great hindrance to analyzing the environmental impacts in some instances. In addition to this, limited time availability and lack of available factual information are among major limitations to impact predictions. In the Maldives, more often than not, limited availability of published information on environmental and social environment of the islands has led to the dependency on verbal communication with locals and other stakeholders which are not always very accurate.

To add, a major uncertainty arises from the lack of information about the project activities from developers which leads to assumptions being made based on the experience of consultants, for example the proposed development will be designed and built conforming to international standards, the working staff at the facility will be well trained, will follow O&M procedures and operational plan diligently and the prescribed mitigation measures in this EIA report will be followed by the proponent

Anyhow, based on the risk assessment outlined above, the environmental impact assessment is set out below:-

7.4 Construction Phase Impacts

This section describes the significance (Table 35) and impact characteristics for the construction phase impacts.

Table 35. Predicted impacts and anticipated significance of impacts during construction phase of the project

Potential Impacts	**Likelihood**	**Consequence**	**Significance**
Mobilization impacts- Direct damage to benthos and sedimentation	Certain	Major	Significant
Mobilization impacts- Noise	Certain	Minor	High
Mobilization impacts- Dust	Possible	Minor	Low
Mobilization impacts- Oil spills at sea	Possible	Moderate	Medium
Mobilization impacts- Oil spills on ground	Possible	Major	High
Mobilization impacts- workforce; covid episode, negative social impacts, illegal labor	Possible	Moderate	Medium
Generation of site clearance, demolition and constructional waste	Possible	Moderate	Medium
Vegetation clearance	Certain	Catastrophic	Significant
Vibration impacts	Remote	Moderate	Negligible
Air Quality-GHGs	Certain	Catastrophic	Significant
Air Quality-Dust	Certain	Minor	High
Noise Pollution	Certain	Minor	High
Groundwater quality- oil and chemical spills	Possible	Major	High
Groundwater quality- salinization	Certain	Major	Significant

Impacts on marine environment	Certain	Catastrophic	Significant
Impacts on terrestrial environment- soil and ground	Certain	Major	Significant
Impacts on coastal environment	Certain	Major	Significant
Risk of accidents and pollution on workers	Possible	Catastrophic	Very High
Impacts on landscape integrity and scenery	Certain	Catastrophic	Significant
Socio-economic impacts	Possible	Minor	Low

Impacts during construction phase of the project are mainly anticipated to be short-term and reversible (Table 36) as most impacts will last only for the duration of the construction phase of the project.

Table 36. Characteristics of predicted impacts during the construction phase of the project

Potential Impact	**Type**	**Nature**	**Range**	**Duration**	**Reversibility**
Mobilization impacts- Direct damage to benthos and sedimentation	Direct & Indirect		Local	Short-term	Irreversible
Mobilization impacts- Noise	Direct	Negative	Local	Short-term	Reversible
Mobilization impacts- Dust	Direct	Negative	Local	Short-term	Reversible
Mobilization impacts- Oil spills at sea	Direct & Indirect	Negative	Local	Short-term	Reversible
Mobilization impacts- Oil spills on ground	Direct	Negative	Local	Short-term	Irreversible
Mobilization impacts- workforce; covid episode, negative social impacts, illegal labor	Direct	Negative	Island	Short-term	Reversible
Generation of site clearance, demolition and constructional waste	Direct	Negative	Local	Short-term	Reversible
Vegetation clearance	Direct	Negative	Island	Long-term	Reversible
Vibration impacts	Direct	Negative	Local	Intermittent	Reversible
Air Quality-GHGs	Direct	Negative	Nation	Long-term	Irreversible
Air Quality-Dust	Direct	Negative	Local	Intermittent	Reversible
Noise Pollution	Direct	Negative	Local	Intermittent	Reversible
Groundwater quality- oil and chemical spills	Direct	Negative	Local	Short-term	Irreversible
Groundwater quality- salinization	Direct	Negative	Local	Short-term	Irreversible
Impacts on marine environment	Direct & Indirect	Cumulative	Nation	Long-term	Irreversible
Impacts on terrestrial environment- soil and ground	Direct & Indirect	Negative	Local	Long-term	Irreversible

Impacts on coastal environment	Direct	Negative	Local	Long-term	Irreversible
Risk of accidents and pollution on workers	Direct	Negative	Local	Short-term	Irreversible
Impacts on landscape integrity and scenery	Direct		Island	Long-term	Irreversible
Socio-economic impacts	Direct	Positive	Local	Short-term	Reversible

7.4.1 Mobilization impacts – Direct damage to benthos and sedimentation

Impacts on the marine environment due to mobilization arises from three aspects; firstly, direct damage to sessile marine organisms. Secondly, from turbidity and sedimentation. Thirdly indirect impacts arising from increasing GHGs which is discussed under impacts on marine environment. Direct damages to sessile marine organisms and benthic substrates can be caused during the mobilization of the barge. As currently there is no deepened access channel that reaches up to the Island, the seagrass beds and the corals on the mobilization route will be destroyed. Additionally indirect damages are envisaged from the turbidity and sediment plume that will be generated during the mobilization activities. The range of the impact would be localized to the area around the mobilization route. The impact is expected to be short-term as the mobilization will be completed within a short period of time. This impact is irreversible as even though the seagrass may bounce back quickly, the destroyed corals would take a long time to grow back. Considering the aforementioned characteristics of the impact, the consequences from the impact is considered major. The likelihood of this impact occurring is certain as the corals on the footprint of barge mobilization route will be destroyed. Therefore, the significance score for this impact is significant.

7.4.2 Mobilization Impacts - Noise

Noise is expected to be generated due to the direct activities of the project from the mobilization of barge, high-bed excavator and other heavy vehicles, machinery and materials to the Island. The impact is expected to be negative as the noise generated may scare away birds and other species that are sensitive to loud noises. The impact is also relevant for marine environment as loud noises may negatively impact vagile organisms causing it to flee. The range of the impact would be localized to the area around the mobilization route and the temporary site setup location within the Island. The impact is expected to be short-term as the mobilization will be completed within a short period of time. This impact is reversible as once the mobilization is over, the impact ceases, the birds and marine organisms that were scared away would potentially return. Considering the aforementioned characteristics of the impact, the consequences from the impact is minor as it does not pose a significant risk to the environment. The likelihood of this impact occurring is certain as noise would definitely be generated during the mobilization activities. Therefore, the significance score for this impact is high.

7.4.3 Mobilization impacts – Dust

Dust is expected to be generated when the vehicles are operated within the Island. The impact is negative as the dust generated may become a nuisance to the working staff and in some cases continued exposure to dust may cause allergic reactions in people who are sensitive to dust. The range of the impact would be localized to the mobilization route within the Island. The impact is expected to be short-term as the mobilization will be completed within a short period of time. This impact is reversible as once the mobilization is over, the impact ceases. Considering the aforementioned characteristics of the impact, the consequences from the impact is minor as it does not pose a significant risk to the environment. The likelihood of this impact occurring is possible as the Island is a vegetated uninhabited Island, the humous layer of the soil and the leaf litter above would minimise release of dust. Also, any dust released will be very localized due to vegetation and as there are no residents except the workforce there won't be a nuisance to the public. Therefore, the significance score for this impact is low.

7.4.4 Mobilization impacts – Oil spills at sea

The potential for oil spills at sea arises due to the direct activities of this project from the operation of barge and vehicles. Indirect impacts are also envisaged to marine life due to pollution from spills reducing the marine water quality. The impact is of negative nature as the marine environment would be polluted. However, the impact would be localized to the mobilization route. The impact is expected to be short-term as the mobilization would be completed on a short period of time and reversible as water quality will revert back to normal but the damages done to marine organisms during the deteriorated water quality period may not. Considering the aforementioned characteristics of the impact, the consequences from the impact is moderate. The likelihood of this impact occurring is possible, hence the significance score for this impact is medium.

7.4.5 Mobilization impacts – Oil spills on ground

The potential for oil spills on ground arises due to the direct activities of this project from the operation of vehicles on land. The impact is of negative nature as the groundwater would be polluted. However, the impact would be localized to the mobilization route. The impact is expected to be short-term as the mobilization would be completed on a short period of time. The impact is considered irreversible as contaminated groundwater takes a long time to recover and a lot of money have to be spent on rehabilitation. Considering the aforementioned characteristics of the impact, the consequences from the impact is major. The likelihood of this impact occurring is possible. The significance score for this impact is high.

7.4.6 Mobilization impacts – workforce; covid episode, negative social impacts, illegal labor

There are three aspects of impacts that could arise due to mobilization of a workforce. Firstly, negative social impacts due to the workers not behaving as per the social norms and regulations of the Maldives. Secondly implication due to illegal labour. The potential for an outbreak of covid19 arises due to the direct activities of this project from the mobilization of workforce to the Island for the proposed project. The impact is negative as spread of covid within the mobilized workforce could practically halt the project. Since the whole workforce maybe effected due to covid spreading, the range of this impact is at Island level. The impact is expected to be short-term as the workforce will be mobilized for a set duration for the construction phase. Now that the majority of people are vaccinated the covid19 virus is not life threatening as such the impact is considered reversible however still considering that a covid episode within the mobilized workforce could halt the project, the consequences were considered moderate. The likelihood of this impact occurring is possible, hence the significance score for this impact is medium.

7.4.7 Generation of site clearance, demolition and constructional waste

Green waste would be generated due to the direct activities of the project from the vast vegetation clearance for the construction of the required infrastructures on the Island. No demolition waste is expected as there are no structures to be demolished on the Island. Large volume of packaging waste and construction waste is expected to be generated during the construction of the proposed harbour, jetty, waste management center, water and sewer facilities. The impact is of negative nature as if not properly managed it is aesthetically not pleasing and has potential to pollute and contaminate surrounding areas. It is anticipated that only the project sites and surrounding areas will be impacted hence the range is local. The impact is short-term and reversible as will be alleviated once waste is removed. However still considering that improper management of waste could pollute the surrounding environment, the consequences were considered moderate. The likelihood of this impact occurring is possible as there is always potential for workers negligence to properly manage waste. The significance score for this impact is medium.

7.4.8 Vegetation clearance

This impact arises due to the direct activities of the project which requires removal of vegetation for construction of the infrastructures on the Island. The impact is of negative nature as the vegetation cover of the Island will be reduced. The impact is of Island level range as a huge area of vegetation is required to be removed in order to construct the infrastructures on the Island. The impact itself is short-term as the land clearance works will be completed in a short duration However due to the huge scale of vegetation clearance required, it is not possible to replant the lost trees within a short period of time and hence is considered irreversible and long-term impact. Hence, the consequences from this impact were considered as catastrophic. The likelihood of this impact occurring is certain as trees on the footprint of the infrastructures will be cleared. The final significance score for this impact is significant.

7.4.9 Vibration impacts

This impact arises due to the direct activities of the project from the operation of vehicles. The impact is of negative nature as the vibrations may damage any nearby buildings. The range of this impact is local as the buildings adjacent to any operating heavy vehicles or machinery will be impacted. This impact would be intermittent as vibration would be generated during operation of heavy vehicles and machinery only and will cease once the operation stops (reversible). Since vibrations could causes structural damages to buildings, the consequences from this impact were considered at moderate level. The likelihood of this impact occurring is remote as there are no buildings within the Island. The final significance score for this impact is negligible.

7.4.10 Air quality – GHGs

Impacts on air quality during the constructional phase is a direct impact generally credited to operation of machinery and equipment which require electricity and vehicles which burn fuel. The main contributor would be the operation of barge/tug boats or other heavy vehicles that will be used to transfer heavy machinery and equipment to the project site. Additionally, the high bed excavator, dump truck and other machinery that use fuel for power during the construction works. The negative impact to air quality would be due to the release of GHGs and any other air pollutants to the atmosphere. Release of GHGs into the atmosphere during the construction phase is low when compared to the nations carbon budget but it would still contribute to the nations carbon budget. As such, the effects of the released GHGs concerns the entire Nation, the range of this impact was considered at National level. Even though GHGs will be released for a short period of time, regardless this would contribute to the GHG emission of the nation; hence the cumulative nature of this impact. And since the released GHGs will stay in the atmosphere for a long period of time this impact was considered long-term. The rise in concentration of GHGs in the atmosphere has been a huge global environmental issue which is responsible for global warming, ocean acidification and many other irreversible environmental issues. Considering the aforementioned characteristics of the impact, the consequences from the impact is considered catastrophic as it is long term, irreversible, large scale and detrimental to environment. The likelihood of this impact occurring is certain as GHGs would definitely be generated from the operation of machinery. Therefore, the significance score for this impact is significant.

7.4.11 Air quality – Dust

Impacts on air quality during the construction phase also arise due to the release of dust during excavation for foundations and pumpstation construction and trenching for pipes of water, sewer system and cables for powerhouse. The impact is of negative nature as it pollutes the air and cause nuisance to workers. However, the range of the impact would be limited to the project sites. This impact would be intermittent as dust would be generated during operation of heavy machinery only. This impact is reversible as dust would not be generated once the construction works are completed. Therefore, the consequences from this impact are minor. The likelihood of this impact occurring is certain as dust would definitely be generated from the operation of machinery. Therefore, the significance score for this impact is high.

7.4.12 Noise pollution

Similar to air quality, impacts on noise level during the constructional phase is a direct impact generally credited to operation of machinery, equipment and vehicles. The highest noise would most likely be generated from the excavator that would be used to load and unload the heavy machinery and equipment at the project site and operation of vehicles/machinery for excavation of seabed during the dredging for access channel and harbor/jetty construction. Furthermore, on land during the construction of powerhouse, water, sewer and waste management facilities. The impact is of negative nature as it has the tendency to disturb workers and wild life nearby on land. Additionally, the noise generated underwater may scare away the marine life in close proximity of the project site. The range of the impact will be localized to a small area surrounding the project site at irregular intervals as noise would be generated when heavy machinery is operational and would cease once operation of machinery stops, hence the consequences from this impact is deemed minor. The likelihood of this impact occurring is certain and the final significance score for this impact is high.

7.4.13 Groundwater quality – oil and chemical spills

Impacts to ground water quality during the constructional phase is a direct impact credited to the operation of land-based machinery that will be used during the construction of the proposed infrastructures. The impact arises from the potential for occurrence of oils and chemical spills during the operation of machinery and construction works. Even though it could be minimized with regular maintenance, in the event that oils and chemicals do spill, the impacts could have moderate to major negative effects on the groundwater quality due to porous nature of soil on the Island. The range of the impact will be localized to a small area surrounding the project sites. The impact itself is expected to be short-term as construction of infrastructures will be completed in a short period of time, however if a spill does occur, the effects would be irreversible as contaminated groundwater takes a long time to recover. Hence the consequences from this impact are deemed major. The likelihood of this impact occurring is possible and as such this impact scored a significance rating of high.

7.4.14 Groundwater quality – salinization

Another direct impact to groundwater quality arises due to dewatering for laying foundation for the proposed infrastructures, during construction of pumpstations and pipe laying for sewer system. The impact is of negative nature as dewatering causes groundwater salinization. The range of the impact will be localized to a small area surrounding the project sites where dewatering is carried out. The impact itself is expected to be short-term as dewatering will be completed in a short period of time, however the effects to groundwater is considered irreversible. hence the consequences from this impact are deemed major. The likelihood of this impact occurring is certain and as such this impact scored a significance rating of significant.

7.4.15 Impacts on marine environment

Impacts on the marine environment due to this project arises from five aspects; firstly, direct damage to sessile marine organisms. Secondly, from turbidity and sedimentation. Thirdly, changes in currents. Fourthly, indirect impacts arising from increasing GHGs. Fifth is from the potential for oil and chemical spills during the construction works at sea. Direct damages to sessile marine organisms and benthic substrates can be caused from the operation of the excavator during the mobilization and construction of the access channel (dredging), harbour, jetty, outfall, stockpiling footprint of dredge material. Turbidity and sedimentation are caused due to the sediment plume that will be generated due to the operation of the excavator and due to excavation of seabed. The sediment plume will impact corals and other marine organisms. The negative impacts include stress on photosynthetic organisms due to increased turbidity as a result of re-suspension of excavated material. Increased turbidity levels of the water decrease intensity of light through the water column which reduces photosynthesis rates. In addition, sessile marine organisms maybe smothered due to sedimentation which could again hinder its metabolic processes increasing stress on them further. The end result is the loss of marine biodiversity for example baitfish which could in turn impact fisheries. Seasonal currents will have a major impact as the proposed project can trigger a major change in the flow velocity and direction near the harbour/jetty as the jetty is proposed to be completely filled such that currents won't flow. While the contribution to GHGs from this project may be negligible, it is the cumulative nature of the impact that is concerning which arises from global warming and ocean acidification. The reason why there is so much concern about global warming is that it increases the temperature of the oceans as the ocean absorbs more heat. While many of the fishes may be able to tolerate the rise in temperature, the corals are less tolerant. Nonetheless many of the reef fish species depend on the coral reef as a home and few fish species even depend directly on the corals for food and shelter. In a recent paper published by (Strona, et al., 2021) states that in a hypothetical world where coral reefs are not present the local tropical fish richness across the globe would decline by half. Ocean acidification is the process by which the pH of the oceans decreases due to more dissolving of CO2 from the atmosphere into the oceans (Ferrero, 2018). Apart from impacts from temperature, the corals and other Calcium Carbonate skeleton based marine organisms are at great risk as lower pH would mean that these organisms would have a hard time maintaining their Carbonate skeletons. Therefore, just as higher temperatures threaten the marine organisms, ocean acidification also threatens marine life to a great extent. Hence the range of this impact is considered at national level with long-term impacts which are irreversible, giving this impact a consequence rating of catastrophic. The likelihood of this impact occurring is certain and the final significance rating is significant.

7.4.16 Impacts on terrestrial environment – soil and ground

Impacts to soil and ground are envisaged due to direct activities of the project. Compaction of ground is anticipated due to operation of heavy machinery. Excavation, trenching and paving works will also compromise the soil profile. The indirect impact from the compaction of ground maybe flooding due to reduced percolation of rainwater. The impact is of negative nature and with a range limited to the project sites. While the impact itself is short-term as the construction works will be completed within a set period, the impacts from soil compaction is long-term. The impact was as such considered irreversible. hence the consequences from this impact are deemed major. The likelihood of this impact occurring is certain and as such the final significance score for this impact is significant.

7.4.17 Impacts on coastal environment

Impacts on the coastal environment are envisaged due to the direct activities of the project which involves the construction of an outfall and jetty. During the construction of the outfall the beach rock will be destroyed. And during the construction of the jetty the coastal zone of the jetty footprint will be compromised. This includes the entrance to the mangrove on the Island. The proposed jetty will hinder the flow of water into the mangrove which can drastically impact the mangrove ecosystem. The impact is of negative nature and with a range limited to the project sites and nearby areas. While the impact itself is short-term as the construction works will be completed within a set period, the impacts from the destruction of the beach rock and compromised coastal zone is long-term. The impact was as such considered irreversible. hence the consequences from this impact are deemed major. The likelihood of this impact occurring is certain and as such the final significance score for this impact is significant.

7.4.18 Risk of accidents and pollution on workers

As typical of any construction project, there lies the risk of accidents and pollution on workers from this project as well due to the construction activities. There is always the inherent risk of health and safety due to workplace incidents. Furthermore, due to improper living conditions provided to the workers by the proponent as this is very common in the Maldives. The proponent must ensure that the workers are well taken care of. The impact is of negative nature as any accidents in work place or improper living conditions at provided will lead to health risks to workers. The range of the impact is limited to project site and small surrounding area, hence it is extremely important to monitor unauthorized access into the project sites. The impact itself is short-term and reversible as once construction is finished the impact is alleviated, however is considered irreversible as injuries to people can be fatal. Hence the consequences from this impact are deemed catastrophic. Since the likelihood of these impacts are possible given that proper mitigation measures would be followed, the final significance of this impact is very high.

7.4.19 Landscape integrity/ scenery

Negative impacts to the landscape integrity and scenery are anticipated from the direct activities of the project, where the mobilization of materials and vehicles to the project site could cause the scenery to be compromised. During the construction works at sea, the sediment plume created is aesthetically not pleasing. Furthermore, the huge vegetation clearance on land for the construction of the proposed infrastructures mean that the aesthetics on land will also be compromised. The impact is of Island level range as a huge area of vegetation is required to be removed in order to construct the infrastructures on the Island. And a large sediment plume is expected to be created during the dredging works. This impact is considered long-term and irreversible. The overall consequence from this is catastrophic, with a likelihood of certain, giving it a final significance rating if significant.

7.4.20 Socio-economic impacts

This impact arises due to the direct activities of the project requiring labour force to carry out the works under the project. It is of positive nature as people has the opportunity to get temporary jobs. Since a limited number of people could potentially get the job, it is of local level range. The impact is short-term and reversible as one the project is completed the jobs will be done. The final consequences rating for this impact is minor. The likelihood of this impact occurring is possible. Hence, the final significance rating for this impact is low.

7.5 Operational Phase Impacts

This section describes the significance (Table 37) and impact characteristics for the operational phase impacts.

Table 37. Predicted impacts and anticipated significance of impacts during operation phase of the project

Potential Impacts	Likelihood	Consequence	Significance
Air Quality- GHGs	Certain	Catastrophic	Significant
Air Quality- dust	Possible	Minor	Low
Noise Pollution	Certain	Minor	High
Ground and marine water quality- negative	Unlikely	Catastrophic	High
Groundwater quality- positive	Possible	Major	High
Impacts on marine environment	Certain	Catastrophic	Significant
Impacts on hydrodynamics	Likely	Catastrophic	Significant
Impacts on terrestrial environment - soil and ground	Likely	Major	Very High
Impacts on coastal environment	Likely	Major	Very High
Impacts from vibration	Unlikely	Major	Medium
Impacts from waste	Unlikely	Minor	Very Low
Health and safety of working staff	Possible	Major	High
Impacts on landscape integrity and scenery	Certain	Major	Significant
Socio-economic impacts - negative	Certain	Major	Significant
Socio-economic impacts - positive	Certain	Catastrophic	Significant

Risk of hazards; weed growth	Unlikely	Minimal	Negligible
Risk of hazards; pest out break	Unlikely	Moderate	Low
Risk of hazards- storm surge	Possible	Major	High
Risk of hazards- sea level rise	Unlikely	Major	Medium
Risk of hazards- fire and other workplace accidents	Unlikely	Major	Medium

Unlike constructional impacts, operational impacts are anticipated to be more long-term but irreversible (Table 38). It should be noted that with the application of proper mitigation measures as outlined in section 9.1 of this report, almost every negative impact could be minimized.

Table 38. Characteristics of the predicted impacts during the operation phase of the project

Potential Impacts	**Type**	**Nature**	**Range**	**Duration**	**Reversibility**
Air Quality- GHGs	Direct & Indirect	Negative	Nation	Continous	Irreversible
Air Quality- dust	Direct	Negative	Local	Continous	Reversible
Noise Pollution	Direct	Negative	Local	Long-term	Reversible
Ground and marine water quality- negative	Direct & Indirect	Negative	Local	Long-term	Irreversible
Groundwater quality- positive	Direct	Positive	Island	Long-term	Reversible
Impacts on marine environment	Direct	Negative	Local	Short-term	Reversible
Impacts on hydrodynamics	Direct	Negative	Island	Long-term	Irreversible
Impacts on terrestrial environment - soil and ground	Direct	Negative	Local	Intermittent	Irreversible
Impacts on coastal environment	Direct		Island	Long-term	Irreversible
Impacts from vibration	Direct	Negative	Local	Long-term	Irreversible
Impacts from waste	Direct	Negative	Local	Long-term	Reversible
Health and safety of working staff	Direct	Negative	Local	Long-term	Reversible
Impacts on landscape integrity and scenery	Direct	Negative	Island	Long-term	Irreversible
Socio-economic impacts - negative	Direct	Negative	Atoll	Long-term	Reversible
Socio-economic impacts - positive	Direct & Indirect	Positive	Atoll	Long-term	Reversible
Risk of hazards; weed growth	Direct & Indirect	Negative	Local	Short-term	Reversible
Risk of hazards; pest out break	Direct	Negative	Island	Long-term	Reversible
Risk of hazards- storm surge	Direct	Negative	Island	Long-term	Irreversible
Risk of hazards- sea level rise	Direct	Negative	Island	Long-term	Irreversible

Risk of hazards- fire and other workplace accidents	Direct	Negative	Island	Long-term	Irreversible

7.5.1 Air Quality - GHGs

Impacts to air quality arises from the direct activities of the project from the operation of the powerhouse. The negative impact to air quality would be due to the release of GHGs and any other air pollutants to the atmosphere. Release of GHGs into the atmosphere during the operational phase is low when compared to the nations carbon budget, however it would still contribute to the nation's overall carbon budget and hence the range of this impact was considered at national level. The impact would be continuously occurring as long as the powerhouse is in operational condition but would cease if the powerhouse operations stops or the agricultural Island. However, the already released GHGs will stay in the atmosphere for a long period of time and would contribute to global warming, ocean acidification and other related cumulative environmental impacts, as such the impact was considered irreversible. Considering the aforementioned characteristics of the impact, the consequences from the impact is considered catastrophic as it is long term, irreversible, large scale and detrimental to environment. The likelihood of this impact occurring is certain, hence the significance score for this impact is significant.

7.5.2 Air quality; dust

Impacts to air quality due to the release of dust (and soot) arises from the direct activities of the project from the operation of the waste management center and powerhouse. The impact is of negative nature as release of dust would be a nuisance to nearby workers. The impact range is localized to the powerhouse and waste management center location on the Island. It is anticipated that minimal dust would be generated as proper mitigation measures will be implemented for the operation of the powerhouse and waste management center. The impact would be continuously occurring as long as the powerhouse is in operational condition. But dust from waste management center is anticipated to be intermittent. The impact is reversible as released dust would quickly disperse in the open Maldivian setting and also due to the fact an adequate chimney will be installed in the powerhouse. Furthermore, release of dust would cease if the operations halts. Hence, the consequences from this impact are minor. The likelihood of this impact occurring is possible, hence the significance score for this impact is low.

7.5.3 Noise pollution

Noise pollution arises due to the noise generated from the direct activities of the project from the operation gensets at the powerhouse, pumps in the water and sewer system, heavy machinery in the waste management center. Furthermore, noise is expected to be generated at the harbor due from the vessels and vehicles that use the jetty. The impact is of negative nature as the noise would be a nuisance to workers nearby and also the noise may disturb wildlife such as birds. The impact range is localized to a small area surrounding the project sites. The impact at the harbor and jetty would be intermittent but continuous noise would be generated from the powerhouse and water system as long as they are operational. The impact is reversible as noise would be generated would cease upon discontinuation of the operations. Hence, the consequences from this impact are minor. The likelihood of this impact occurring is certain, hence the significance score for this impact is high.

7.5.4 Ground and marine water quality; negative

Negative impacts to ground and marine water quality arises due to the potential for leaks and spills to occur in the utilities established and the harbor. The negative impact would be the contamination of water due to the leakage of sewerage, and oil/chemical spills at the harbor from vessels. And oil/chemical spills at the powerhouse workshop during maintenance and during transfer of fuel to the fuel storage tanks. Additionally, from the leachate management system at the waste management center and during operations for example washing of bins. Depending on where the leakage occurs, the range of this impact maybe local or at Island level. If the leaks occur at the harbor, it contaminates marine waters. However, if the leaks occur within the utilities on land, then it may contaminate the groundwater. While the impact may occur for a short duration as the management would quickly rectify any leaks or spills, any unnoticed or unidentified leaks would continue to detriment water quality. Furthermore, as contaminated groundwater from any leaks would take a long time to recover and contamination of marine water quality could lead to irreversible impacts, this impact was considered as a long-term and irreversible impact. As such the consequences from this impact is considered catastrophic but it is unlikely to occur as proper systems and mitigation measures would be installed and implemented at the utility systems and harbor, hence the final significance rating for this impact is high.

7.5.5 Groundwater quality; positive

Positive impacts to groundwater are envisaged from the operation of this project if the proposed IWRM principles are established.

7.5.6 Impacts on marine environment

Impacts on marine environment is envisaged due to the discharge of sewer and brine from the outfalls. Although the effluents discharged will be quickly diffused, it would still cause significant deterioration of the marine water quality at the outlet. The main change in the chemical parameters of marine water would in the BOD due to the faecal matter in the sewerage. High BOD concentration would favour the growth of green algae at the outfall location which might inhibit coral growth. Furthermore, anions like sulphates and phosphates maybe present in sewerage which come from the washing powders used at laundry, would alter the pH of the water which might intern alter the composition of the microbial communities. Lastly the high saline brine will increase the salinity at the outlet which will negatively impact corals and other marine organisms that are sensitive to changes in salinity. The impact is considered long-term and irreversible. Hence, the consequences envisaged are catastrophic and with a likelihood of certain the impact scored a significance rating of significant.

7.5.7 Impacts on hydrodynamics

Impacts on hydrodynamics is envisaged due to the direct activities of the proposed project which involves the construction of a backfilled jetty that does not allow water to pass through. The impact is of negative nature as the jetty would completely stop the natural flow of water in the area which in turn would disrupt the natural sediment patterns. The impact is of Island level importance as this has the potential to cause sever erosion of the Island and accretion on the other side. The impact would be long-term and irreversible. Hence, the consequences envisaged are catastrophic and with a likelihood of likely the impact scored a significance rating of significant.

7.5.8 Impacts on terrestrial environment – soil and ground

Impacts to soil and ground are envisaged due to direct activities of the project. Compaction of ground is anticipated due to operation of vehicles. The indirect impact from the compaction of ground maybe flooding due to reduced percolation of rainwater. The impact is of negative nature and with a range limited to the routes the vehicle would be using. The duration of the impact is intermittent as ground will be compacted every time vehicles are operational. The impact is irreversible and the consequences major. The likelihood of this impact occurring is likely and as such the final significance score for this impact is very high.

7.5.9 Impacts on coastal environment

Impacts to the mangrove area is anticipated due to the construction of a fully backfilled jetty. The jetty will restrict water flow into the mangrove which will negatively impact the mangrove ecosystem. The impact of Island level important as any impacts to the mangrove ecosystem could in turn affect the entire Island. The impact would be long-term and any damages irreversible. The consequences from this impact are major. The likelihood of this impact occurring is likely. The final significance rating of this impact is very high.

7.5.10 Impacts from vibration

The impact arises due to the direct activities of the project from the operation gensets at the powerhouse and pumps in the water, sewer system. The impact is of negative nature and localized to the project site. The impact is considered long-term and irreversible as it will be very costly to construct new infrastructure in the event there was significant structural damage to nearby infrastructures due to vibrations. The consequences from this impact are major. However, the likelihood of this impact occurring is unlikely. As such the significance of this impact is medium.

7.5.11 Impacts from waste

This impact arises due to the direct operation of the utilities. Waste oil will be generated from the operation of powerhouse. Organic waste and non-organic waste will be generated during the operational stage of the Island as an agricultural Island. The impact is of negative nature as if the waste water, waste oil, organic waste, sludge generated from STP is not managed properly it could lead to environmental issues. For example, bad odour from organic waste. The range of the impact will be local as the waste from the agricultural Island would be taken to the waste management centre and STP of the Island. The impact will be long-term as waste would be generated as long as the agricultural Island is in operational and would cease once the operation of either the utilities or the agricultural Island stops. The consequences from this impact are minor as this agricultural Island will be fully equipped to manage the waste. Hence, a scenario where the Island is unable to manage waste is unlikely to happen. Hence, the final significance score for this impact is very low.

7.5.12 Health and safety of working staff

This impact arises due to the direct operations of the utilities. During maintenance and cleaning of pump stations, and sewer network, the working staffs is at a risk of major health issues in case safety gear is not used. The risks include contact with harmful disease-causing agents, inhalation of gases which may lead to even respiratory infections. As for the staff working in the

RO plants, during the operation and maintenance works, the risks include coming in contact with chemicals causing skin irritation and inhalation of fumes which may lead to even respiratory infections. In the case of the powerhouse staff, they may be exposed to high noise and oil/chemicals during maintenance works. The staff at the waste management centre maybe exposed to bad odour and chemicals. The impact is of negative nature as this poses significant health risks to the workers. This impact is limited to the staff which will engage in the aforementioned activities and for a long period of time as the staff would be continuously working every day. The impact is irreversible as any injuries to working staff would have lifelong health implications. Therefore, the consequences from this impact are “major’ but the likelihood of it occurring is possible, earning a significance rating of high.

7.5.13 Impacts on landscape integrity and scenery

This impact arises from the direct activities of the project from the operation of the utilities, harbour and jetty. The impact is of negative nature as the natural beauty will be compromised with the addition of the infrastructures under this EIA and due to the vegetation clearance. The range of this impact would be at Island level as the entire Island and surrounding marine environment will be affected. The impact will be long-term and irreversible. Hence, the consequences envisaged are major and the likelihood of this impact occurring is certain, giving this impact a significance rating of significant.

7.5.14 Socio-economic impacts- negative

Negative impacts to socioeconomics are envisaged due to the direct activities of the project to the previous resource users of the Island. For instance, people that have previously used the Island to gather palm leaves for thatch making cannot do so now. Additionally, bait fishers, reef fishers and snorkelling visits from nearby tourism ventures. The range of this impact would be at Atoll level with long-term implications. The impact is considered reversible as once the access to the Island and surrounding waters can be easily granted. The consequences from this impact are major negative as the Atoll locals loses a valuable resource and with a likelihood of certain, the significance of this impact is significant.

7.5.15 Socio-economics – positive

Positive impacts are envisaged to the socioeconomics due to direct activities of the project to the proponent as the proponent will have easy safe access to the Island. Furthermore, all the utilities required to run the agricultural Island will be established. Additionally, there is the potential for job opportunities for people from nearby Islands to work on the Island, of course this depends entirely on the proponent. The range of this impact would be at Atoll level with long-term implications. The impact is considered reversible as once the operation of utilities ceases or the harbor/access channel/jetty gets compromised the impact ceases. The consequences from this impact are catastrophic positive as this allows the proponent to efficiently manage the operations at the agricultural Island and with a likelihood of certain, the significance of this impact is significant.

7.5.16 Risk of Hazards - weed growth

Weed is not likely to grow as most of the WMF will be concrete floored and running of vehicles will compact soil and also kill weeds. The impact is of negative nature, localized to project site and can be considered short-term and reversible as can be controlled easily with proper mitigation measures. The consequences from this impact are minimal and with a likelihood of unlikely the significance is negligible.

7.5.17 Risk of Hazards - pest outbreak

Species which could become pests like rats were found during survey at the Island. The impact is of negative nature as a pest outbreak could have indirect health implications as well in addition to damaging equipment at WMF as rats could eat cables and other plastic accessories. An outbreak also has the potential to impact the entire Island depending on the magnitude of the outbreak. The impact is considered long-term as may require sometime to control the rats if an outbreak occurs. The impact can be reversible as chemicals can be used to control. The consequences from this impact are moderate. The likelihood of this impact is unlikely as no organic waste will be in the open for a long duration, hence the significance of this impact is low.

7.5.18 Risk of Hazards - storm surge

Thunburi is located at a moderate risk zone for local storm surges compared to the rest of Maldives. The impact is of negative nature as a storm surge event may cause elevated sea levels and with strong waves could damage the harbor/jetty or flood the infrastructure of the utilities. While the impact maybe localized to the harbor/jetty and utilities, any damages to these infrastructures could in turn impact the entire Island as the proponent may lose safe access to the Island or discontinuation of utility services. As such the impact range was considered to be at Island level. Any damages due to a storm surge event may be long-term and irreversible depending on the gravity of damages. The consequences from such an event are major but with the possible likelihood of occurrence, this impact significance is high.

7.5.19 Risk of Hazards – Sea level rise

With the accelerated sea level rise due to global warming, the risk of hazards due to an event like storm surge as described in the above section is more probable. While the impacts due to this hazard is evaluated for the proposed project, sea level rise could potentially impact the entire agricultural Island as such the range of this impact is considered at Island level. This hazard has long-term and irreversible environmental implications. The consequences from such an event are major but with the unlikely likelihood of occurrence as the infrastructures would be elevated adequately above the sea level (even with projected increase in sea level), this impact significance is medium.

7.5.20 Risk of Hazards - fire and other workplace accidents

This impact arises due to the direct operations of the utilities and harbor/jetty. Potential workplace accidents include electrocution during servicing of electrical equipment's, chemical spills during servicing of utilities, vehicle flipping into the sea from the jetty, fire in the utilities or vessels in the harbour etc. All of these hazards are negative in nature as it poses health risk to workers in addition to damages to the infrastructures. The impact is of Island level range, long-term and irreversible. The consequences from this impact are major but the likelihood of occurrence is unlikely as proper mitigation measures will be implemented in the Island operations, hence the significance of these hazards is medium.

7.6 Impact Boundary

As shown in Figure 49 primary impact area for the project is the footprint of the proposed infrastructures. The secondary impact area is the area that will be impacts by the sediment plume. Additionally, areas surrounding the infrastructures on land will be subjected to secondary impacts like noise and air pollution.

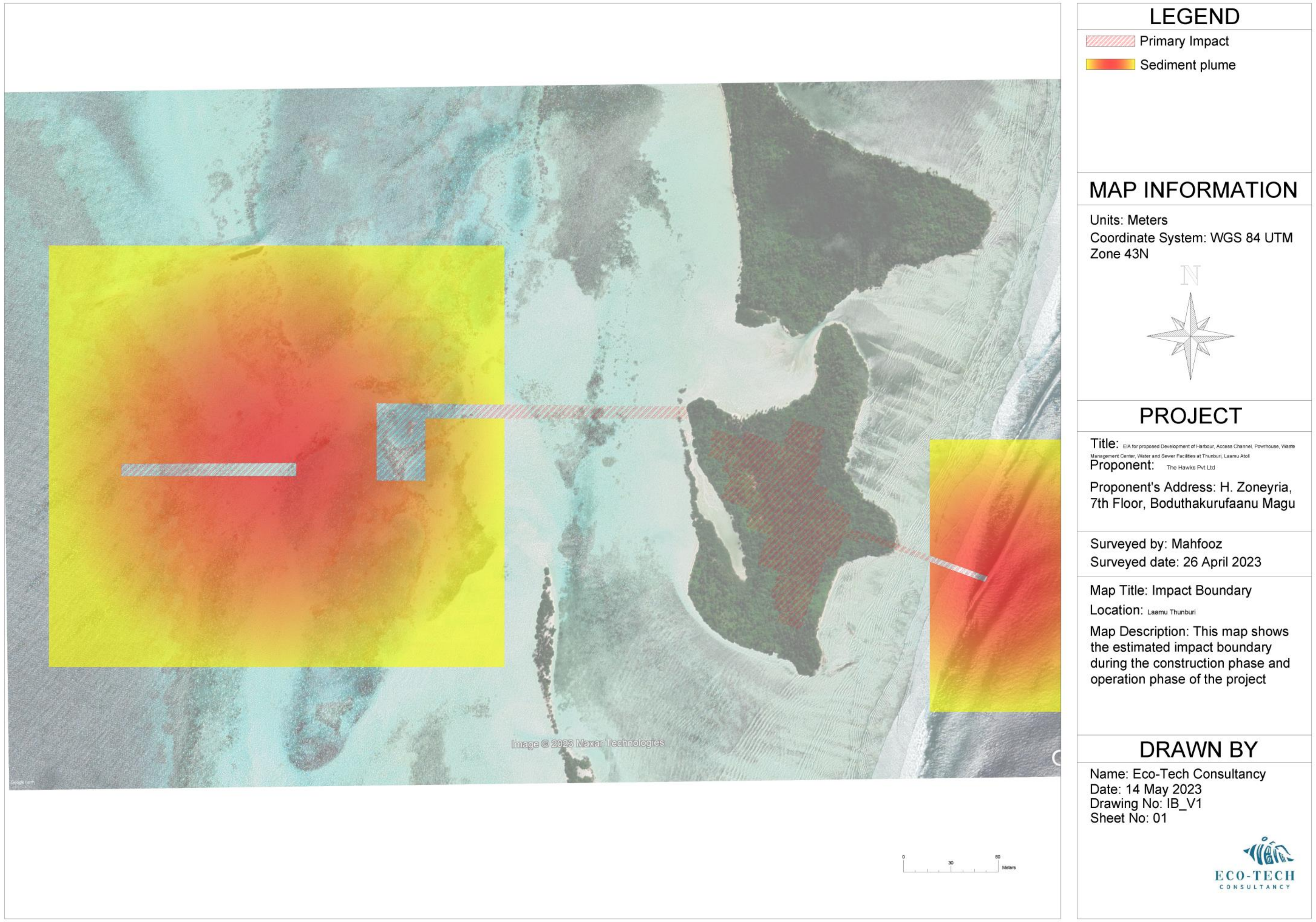


Figure 49: estimated impact boundary for the proposed project

8. OPTIONS ASSESSMENT

The possible causes of actions, in place of another that would meet the same purpose and need, otherwise known as alternatives, have been well considered in this study as alternatives are essential to a sound decision-making process and central to an effective EIA.

With due consideration to the purpose and need for the proposed project, there are six alternatives identified for this project. The "no project" option, alternative for design of the jetty, alternative orientation for access channel, alternative water intake method, alternative water storage tank material, alternative sewer treatment option and alternative outfall location. Details of which are further discussed below:-

8.1 Options

This section describes the alternatives that were considered for the proposed development under this EIA.

8.1.1 Option 1: Maintain status-quo

The "do-nothing" option would mean that the island would be left without proper utility and accessibility facilities that would be vital for the agricultural practice that the island was leased for. Although the negative impacts related to the construction of the project is avoided, the purpose of the lease would go unattained with potential opportunity loss for the agricultural industry, food security and economic diversification of the country.

8.1.2 Option 2: Alternative design for the jetty

Currently the contractor has proposed to establish the jetty by reclaiming it with rock boulder revetment on either side of the jetty. This would effectively become a groyne in the area disrupting the longshore current and sediment transport. It is envisaged that this would cause significant changes to the erosion and accretion dynamics of the island and should be avoided at all costs. Therefore, as an alternative it is proposed to build a jetty on pillars which would ensures passage of water and sediment movement through the area

8.1.3 Alternative orientation for access channel

As the predominant wind direction is from the west for the region, with the currently proposed orientation of the channel, it would pose difficulties for the vessels to navigate with the channel and access the harbour. Furthermore, as the proposed harbour location is mostly protected from incoming swell waves, the major factor for vessel movement would be the wind generated waves. Therefore, it is proposed to reorient the access channel as shown in figure below.

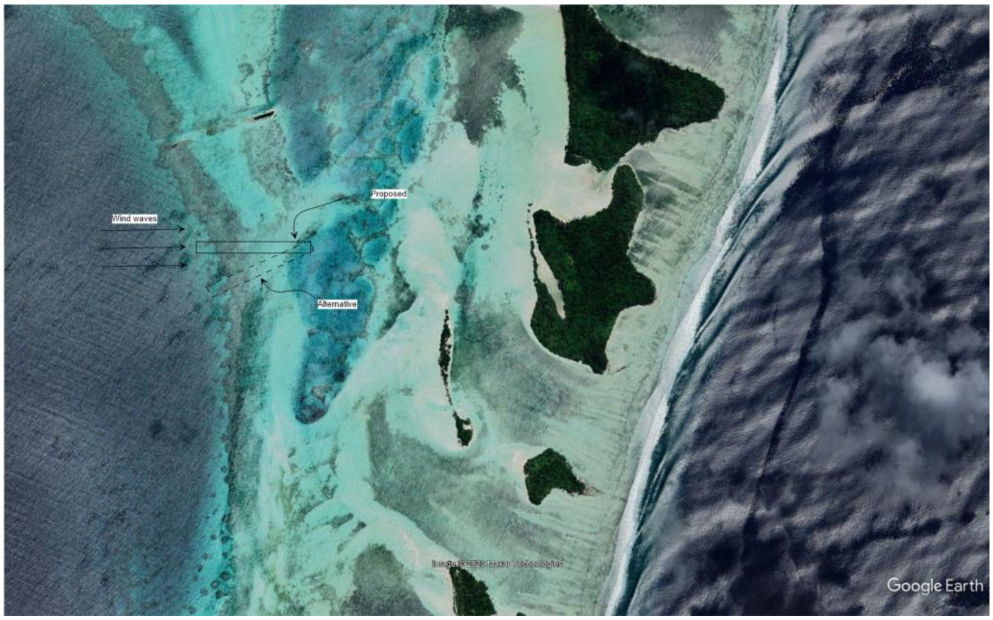


Figure 50: Alternative orientation of access channel

8.1.4 Option 3: Intake water method for the desalination plant

As of now, the proposed methodology is taking water through a beach well for the desalination plant. Although the capital investment of this method maybe low, this could cause an increase of operational costs due to frequent blockage of the intake line through molluscs and other such organisms. The alternative is to establish a borehole. Feed water for the reverse osmosis plant can be pumped from borehole. If the borehole method is to be adopted, the borehole shall be drilled to 35 meters' depth and pump shall pump out required raw water for the RO plant. The Boreholes conductivity shall reach 50,000µS/cm at 35m depth, if not it shall be drilled to reach the required conductivity. Detailed methodology for borehole drilling is provided below. Even though on a longer term, the borehole is the better option, as this option does have a significant impact on the capital investment, the preferred alternative is the proposed method, whilst this option can be considered at a later stage.

8.1.4.1 Borehole drilling method

Location of the bore hole shall be worked out from the approved drawing and marked on the top of the existing ground profile. Drilling shall be carried out at these marked locations. 5m X 5m area surrounding the drilling location shall be cleaned before set up of drilling machine.

Two mud pit(1.0X0.5X0.5 M) shall be made by using shovel and spade in front of drilling location and connected each other by a drain and canvas lining shall be done to prevent fluid loss. Drilling mud shall be prepared by mixing of bentonite with water with a proportion of 1:2 before 12 hours of starting of borehole. Thickness of the mud shall be controlled as per the strata encountered during drilling. If there is severe caving encountered during drilling through a particular stratum then 150gm poly-anionic cellulosic polymer shall be used by mixing with 50 Kg bentonite and 100 liter water. Drilling rig is placed on the drilling spot with proper platform and verticality alignment of the machine is done by using spirit level. During the whole drilling process this is checked frequently to maintain the verticality and alignment of borehole.

After attaching the mud pump and drilling machine with 50 mm hoses drilling shall be started with 300 mm reamer bit up to the loose formation or overburden and 350mm DIA steel temporary casing will be placed up to the hard formation. The depth of outer casing shall be decided as per geological strata encountered at site.

After placing of temporary outer casing up to required depth drilling shall be continued with rotary mud circulation with 300 mm drag & rock roller bit. The suitable bit to be employed according to the hardness of lime rock.

Soil and rock samples shall be collected from return water from borehole at every 1.5 m interval or change of strata. Soil/rock samples will be preserved in polythene bags marked with borehole number and depth and date of collection. Bore Log shall be prepared as per the sample received during drilling from different depth. Soil samples shall be kept 3 months for future references if required.

After drilling is completed to 35 meter depth hole shall be flushed well until most of drilled particles are removed from hole prior to install the casing. The standard threaded type bore well pvc casings to be installed with necessary screened casings according to the strata of the location. The screened casings to be placed in target aquifer to obtain the maximum yield of the well.

After casings are placed the filter gravel of 4-6mm to be packed up the required height through grain pipe. Commonly the height of the filter pack to be 1.5m above the screen casing. After poring the filter pack surging and bailing to be done with drilling machine to compact the filter media.

Flushing of borehole shall be carried out after installing the filter pack by using the compressed air until sand particles are less than 2mg per liter of water.

The 24 hour yield test to be carried out by using multi stage pump and water levels to be taken as prior to pumping, while pumping and after pumping. The water level drawdowns and recoveries to be recorded as per the instructions of hydro-geologist. A digital water meter to be installed at pumping main to record the output and this readings to be marked on an every hour with water level of the well. The pumping water to be delivered and disposed at minimum 100m from the test well. Once the pumping test is conducted the records to be submitted to the geologist to decide and recommend the pump installation depth and safe yield.

After completion of pumping test the borehole head will be closed and locked for safety and perimeter fence to be install to avoid unwanted stress pass.

At final stage of pumping test water sample shall be collected in a sterilized 1liter capacity bottle from outgoing water of borehole and sample shall be sent to chemical lab within a day for chemical and micro biological testing as per specification. The following tests of water like pH, EC, Temperature, Taste, Odor & Color shall be conducted at site and that report shall be submitted along with drill-log.

Daily Progress Report (DPR) shall be submitted regular basis. After completion of borehole drilling log along with stratification, ROP, casing details and water analysis at site shall be submitted. Laboratory Water & Soil Testing reports shall be provided after completion of the relevant tests

8.1.5 Option 4: Storage tank material

As per the proposed method, there are 5 separate tanks to be built for the proposed project. With the correct material, the total proposed storage could be built in one or two tanks with the option to increase the vertical height of tanks if need be to increase the storage at a later time. This could be done by rolled, tapered panel (RTP) tanks.

These tanks are easy to construct and low maintenance. The tank construction procedure is as follows:

- Tank installation begins with the “starter” ring that is anchored to the foundation. Next, the tank jacks are located in position
- Field installation begins with the top ring of the tank attached to the synchronized hydraulic screw jack system. The specialized jacking system is anchored to both the concrete foundation and the tank “starter” ring
- Sidewall sheets are added from the ground level until each ring assembly is completed. The installed tank structure is then raised with the jacks and the next lower ring assembly is installed. The process is repeated until the tank is completed

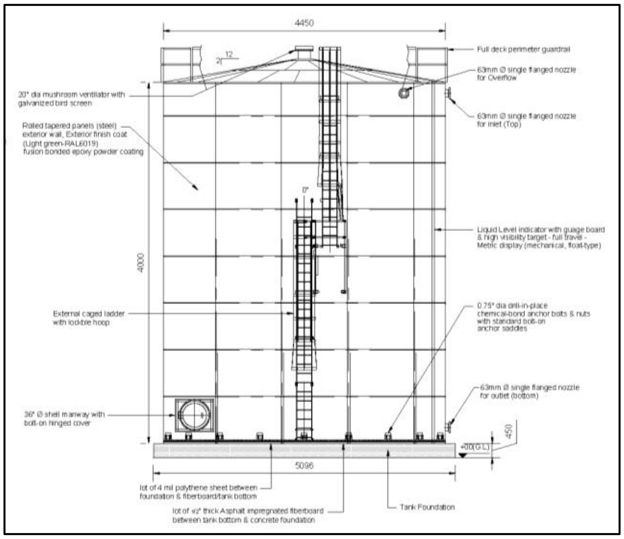


Figure 51: Sample image of an RTP tank

8.1.6 Option 5: Alternative Sewerage treatment methods

The three common options for sewerage treatment process are given below.

- Aerobic Treatment Process; Extended Aeration Plants, MBBR, SBR
- Anaerobic Treatment Process (U.A.S.B. Reactor Systems), and,
- Mobile Sewage Treatment Plants (Fluidized Bed Reactors).

8.1.6.1 Extended Aeration System

The advantages and disadvantages of the above Aerobic treatment processes are as follows:

Advantages:

- Plants are easy to operate, as many are manned for a maximum of two or three hours per day.

- Extended aeration processes are often better at handling organic loading and flow fluctuations, as there is a greater detention time for the nutrients to be assimilated by microbes.
- Systems are easy to install, as they are shipped in one or two pieces and then mounted on an onsite concrete pad, above or below grade.
- Systems are odor free, can be installed in most locations, have a relatively small footprint, and can be landscaped to match the surrounding area.
- Extended aeration systems have a relatively low sludge yield due to long sludge ages, can be designed to provide nitrification, and do not require a primary clarifier.

Disadvantages

- Extended aeration plants do not achieve de-nitrification or phosphorus removal without additional unit processes.
- Flexibility is limited to adapt to changing effluent requirements resulting from regulatory changes.
- A longer aeration period requires more energy.
- Systems require a larger amount of space and tankage than other "higher rate" processes, which have shorter aeration detention times

8.1.6.2 Sequencing batch reactors (SBR)

Advantages

SBRs can consistently perform nitrification as well as de-nitrification and phosphorous removal.

SBRs have large operational flexibility.

- The ability to control substrate tension within the system allows for optimization of treatment efficiency and control over nitrogen removal, filamentous organisms, and the overall stability of the process.

- Since the entire unit processes are operated in a single tank, there is no need to optimize aeration and decanting to comply with power requirements and lower decant discharge rates.
- Sludge bulking is not a problem.
- Significant reductions in nitrate nitrogen can occur by incorporating an anoxic cycle in the system.
- SBRs have little operation and maintenance problems.
- Systems require less space than extended aeration plants of equal capacity.
- SBRs can be manned part time from remote locations, and operational changes can be made easily.
- The system allows for automatic and positive control of mixed liquor suspended solids (MLSS) concentration and solids retention time (SRT) through the use of sludge wasting.

Disadvantages

- It is hard to adjust the cycle times for small communities.
- Post equalization may be required where more treatment is needed.
- Sludge must be disposed frequently.
- Specific energy consumption is high.

8.1.6.3 Moving Bed Biofilm Reactor (MBBR)

Advantages

- Wastewater Solution for Space Constraints
- Resistant to Shock Loads
- Works Quickly with a Low Hydraulic Retention Time

Disadvantages

- Manual monitoring
- Skilled experts

- Escaping carriers

The preferred alternative is the proposed method of extended aeration system due to the mentioned advantages over the other similar system.

8.1.7 Option 6: Alternative sewer outfall

The following Figure 50 highlights the area of proposed alternative outfalls.

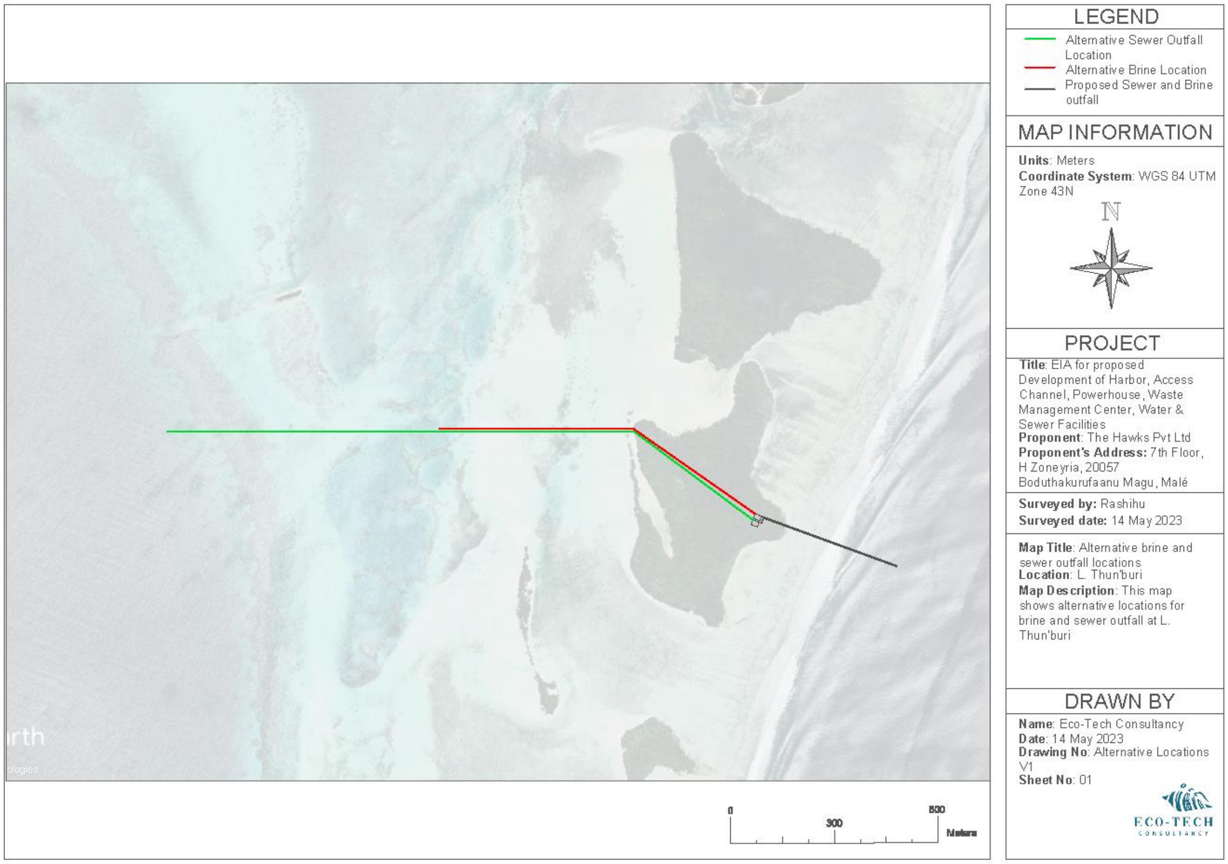


Figure 52: Alternative outfall location

As demonstrated in the existing environment section of the report, the alternative locations demonstrate low currents (alternative sewer locations: 0.026m/s, alternative brine location: 0.033 m/s) in comparison to the proposed outfall location (0.254m/s). Furthermore, given that the proposed outfall location is in outward side of the atoll in comparison to the alternative sites (inward side of the atoll), the provided observation of proposed location having more mixing potential in comparison to alternative sites is envisaged to remain true across the year. In terms of coral cover, the proposed outfall location has lower coral cover (13.2%) than the alternative outfall location for sewer (40.8%). However, the proposed location of outfalls has a higher coral cover in comparison to the alternative brine outfall location (0%). Nevertheless, with due consideration to lower currents and mixing potential at the alternative sites, the proposed option is preferred.

8.2 Preferred Options

Due to the aforementioned reasons, the alternatives of proceeding with the project in comparison to the no project option, choosing the alternative jetty design, alternative access channel orientation, the proposed sewer treatment methodology and the proposed outfall are preferred. As for the intake water for the RO plant and the material for the tanks, since there is not such a huge environmental impact due to the options and the increases in the potential capital cost of the project, the preference of these two options are left for the proponent.

8.2.1 Mitigation measures for preferred options

No new impacts were identified for the preferred options, hence the mitigation measures outlined in the section 9.1 shall be followed.

9. ENVIRONMENTAL MANAGEMENT

This section describes the environmental and operational management systems and plans for the proposed development including practical mitigation measures for all identified impacts, a risk management plan, measures for sustainable development as well as environmental monitoring programs.

9.1 Proposed Mitigation Measures

The mitigation measures outlined in Table 27 and Table 28 below is proposed with due consideration to their cost effectiveness and feasibility to be implemented. The mitigation measures mainly relate to handling practices, design and quality of the proposed development and appropriate trainings which would ensure that environmental impacts would be minimized as effectively as possible.

It is the responsibility of the implementing agency to adhere to the proposed mitigation measures and bear any costs related to establishing them. If the proponent hires a contractor, then it is the responsibility of the proponent to include these mitigation measures in the project contract.

9.1.1 Construction Phase

The following table describes the preferred mitigation measures for the identified impacts during the construction phase of the proposed project.

Table 39: proposed mitigation measures for the identified impacts during the construction phase of the proposed project

Impact	Mitigation Aspect	Proposed Mitigation Measures	Timing	Required manpower	Expertise	Equipment	Technology	Estimated Cost	Implementing Agency	Performance Indicator
Mobilization impacts- Direct damage to benthos and sedimentation	Minimize direct damage to benthos	Anchorage of barges and carrier vessels should be limited to a smaller area	During mobilization	Boat Captain	Boat captain that understands bathymetry and knows how to use GPS aided navigation	GPS, Eco-Sounder	Bathymetry and global positioning	GPS and Eco-Sounder prices may vary depending on brand, typical price ranges are from 500 USD to few thousand. Typical salary of a boat captain is between MVR 20,000 to MVR 35,000 per month	Proponent	Length and extent of mobilization route
		Take shortest mobilization route with least coral cover	During mobilization	Boat Captain	Boat captain that understands bathymetry and knows how to use GPS aided navigation	GPS	Global positioning	GPS and Eco-Sounder prices may vary depending on brand typical ranges are from 500 USD to few thousand. Typical salary of a boat captain is between MVR 20,000 to MVR 35,000 per month	Proponent	Length and extent of mobilization route
	Sedimentation control	Take deepest route to the project construction site while mobilizing the barge	During mobilization	Boat Captain	Boat captain that understands bathymetry and knows how to use GPS aided navigation	GPS, Eco-Sounder	Bathymetry and global positioning	GPS and Eco-Sounder prices may vary depending on brand typical ranges are from 500 USD to few thousand. Typical salary of a boat captain is between MVR 20,000 to MVR 35,000 per month	Proponent	Extent of sediment plume created
Mobilization impacts- Noise	Reduce noise disturbance from mobilization of barge, heavy vehicles, machinery and materials	Restrict mobilization to daytime	Continuous during construction phase	Project Manager, Drivers	Experienced project manager to plan mobilization activities	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600. The price of microsoft projects perpetual license is for about USD 620.	Proponent	Complains from staff or tourists for disturbance
		Avoid unnecessary use of machinery			Diligent staff					Machinery in optimal condition
		Ensure shortest mobilization route is chosen			Experienced project manager to plan mobilization activities					Complains from staff or tourists for disturbance
		Ensure mobilization in one go as much as possible to avoid repeated transfer of materials or vehicles			Experienced project manager to plan mobilization activities					Injuries to hearing among staff
Mobilization impacts- Dust	Minimize release of dust	Ensure shortest vehicle transfer routes are established within the Island	Continuous during construction phase	Project Manager, Drivers	Experienced project manager to plan access routes	Computer	Aerial imagery of the Island	The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600.	Proponent	Extent of dust released
Mobilization impacts- Oil spills at sea	Minimise likelihood of oil spills occurring during operation of barge and vehicles at sea	Ensure that there is no leakages from any of the vessels or vehicles and that the structural integrity of the vessels/vehicles in optimal condition	Prior to mobilization	Marine Engineer	Engineer that is capable of thorough inspections	leak detection and structural integrity inspection equipment	Inspection of structural integrity of vessels/vehicles	Cost of leak detection and structural integrity inspection equipment on vessels can vary depending on the specific equipment and its capabilities	Proponent	Spills or leaks at sea/land

Mobilization impacts- Oil spills on ground	and on land. Contain any spills that does occur (if any).	Have emergency oil spill cleanup crew on standby	Continuous during construction phase	Oil spill cleanup crew, Operator	Vehicle operator that is able to detect leakages	Spill cleanup materials	Spill cleanup technology	The cost of spill cleanup operations can vary widely depending on the size, location of spill, type of substance spilled, etc. Small spills on land/water can cost from few thousand o tens of thousands of dollars. Medium spills on coastal waters can cost from tens of thousands to several hundred thousand dollars	Proponent	Water quality assessments to detect contamination
Mobilization impacts- workforce; covid episode, negative social impacts, illegal labor	minimize likelihood of a covid episode due to the mobilization of workforce, avoid social negative impacts and prevent illegal labor	Screening as per HPA guidelines	Prior to mobilization	HR staff	HR staff that can read PCR tests	PCR test kit	PCR testing at an HPA approved facility	The cost of PCR test may vary depending on the institution from which it is done, typical ranges are USD 30 to USD 100 per test	Proponent	Complains from staff or tourists for disturbance
		Illegal or undocumented labors shall not be allowed	Prior to mobilization	HR staff	HR staff that is aware of immigration policies	Office	Office administration	The salary for an HR staff may vary depending on the proponent, typically a mid level HR staff salary is from MVR 12,000 to MVR 18,000 per month		Verified immigration documents
		Laborers shall be supervised by the site supervisor to avoid any socially or culturally or legally unacceptable behavior	Prior to mobilization	Supervisor, HR staff	Capable supervisor	No additional equipment required	No additional technology required	The salary of a site supervisor can vary depending on the proponent, typical salary is from MVR 15,000 to MVR 25,000 per month		Number of Complains
		Laborers shall be made aware of the sociocultural and legally unacceptable behavior	Prior to mobilization	HR staff	HR staff that can conduct awareness sessions and that is aware of Maldivian sociocultural norms and legal setting	Projector, Computer	Presentation	The salary of a site supervisor can vary depending on the proponent, typical salary is from MVR 15,000 to MVR 25,000 per month		Behavior of workers
Generation of site clearance, demolition and constructional waste	Prevent littering and pollution of surrounding environment	Ensure efficient planning of project activities to ensure minimal waste generation and management of any waste generated on-site by segregation, reuse, recycling as much as possible	Prior to mobilization	Project Manager, Drivers	Experienced project manager	Waste collection and transfer equipment	Waste reuse or recycling	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. The prices of waste collection and transfer equipment's are highly variable depending on the type, brand, specifications and size. A rear-loading garbage truck price is typically between USD 100,000 to USD 300,000. Compactors and balers are between USD 1000 for small portable units to 10k to 1000k USD for larger units. A 10 cubic yard skip container can cost between USD 1000 to USD 2000.	Proponent	No waste in the open
		Following existing waste management legislations	Continuous during construction phase							
		Ensure efficient waste transfers to minimize accidental disposal/spillage	Continuous during construction phase							
		Designate waste collection/storage areas to minimize littering	Continuous during construction phase							

		Solid waste, oil and hazardous materials needs to be carefully handled and transported in sealed containers	Continuous during construction phase							
Vegetation clearance	Reduce the number of trees removed and minimize number of trees completely removed from the Island	Removed vegetation should be disposed as green waste	Prior to construction	Excavator operator, Lorry driver	Driver that can drive in difficult environment	Excavator, Lorry, Waste transfer vessel	Digging and uprooting trees	Price of excavators depend on brand, size and specifications. A mini excavator that is suitable for landscaping can be for USD 20,000 to USD 90,000. A pickup trucks price maybe between USD 20,000 to USD 50,000. A 70 feet waste transfer vessel can be between USD 500,000 to USD 2 million depending on the specifications.	Proponent	No waste in the open
		Replanting any trees that can be replanted	Continuous during construction phase	Excavator operator, Lorry driver	Operator that can uproot and plant trees	Excavator, Lorry, supports	Planting trees	Supports for trees can be either wooden or metal stakes. The prices will vary depending on the size. The prices maybe between USD 1 to USD 10 per stake.	Proponent	Number of trees replanted
		All vehicles and machinery must be restricted to the proposed access tracks and sites	Continuous during construction phase	Project Manager, Drivers	Experienced project manager to plan access routes	Computer	Aerial imagery of the Island	The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600.	Proponent	Percentage of untouched vegetation on the Island
		Only removing plants on the footprint of development.	Prior to construction	surveyor	Surveyor that can establish boundaries of development footprint	GPS	RTK GPS	Rover RTK GPS prices maybe between USD 5000 to USD 20,000 depending on the brand and specifications. The salary of a surveyor may vary depending on the proponent, typical salary maybe between MVR 15,000 to MVR 35,000.	Proponent	Extent of vegetation cleared beyond development footprints
Vibration impacts	Minimize damage to buildings	Ensure the access routes for vehicles are not too close to buildings being constructed	Prior to construction	Project Manager, Drivers	Experienced project manager to plan access routes and delimiting boundaries of infrastructures	Computer	Aerial imagery of the Island	The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600.	Proponent	Complains from staff or tourists for disturbance
Air Quality-GHGs	Minimize release of GHGs	Use of fuel low sulfur content	Continuous during construction phase	Procurement Manager	Procurement of low sulfur content fuel.	Low sulfur fuel	Equipment and machinery should able to handle low sulfur fuel	The price difference between low sulfur content fuel and normal fuel can vary depending on the region. As of May 2023 the global average price for low sulfur fuel is around USD 1.1 to USD 1.5 per liter and the global average price for gasoline is around USD 1.2 to USD 1.6 per liter.	Proponent	Concentration of air pollutants in project areas

		Avoid unnecessary use of machinery		Project Manager, Supervisor	Efficient planning of project activities. Supervising.	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600. The price of microsoft projects perpetual license is for about USD 620.		Hours of operation
		Daily maintenance of vehicles and machinery		Mechanical Engineer	Capable of maintenance of vehicles and machinery	Spares and tools	Detection of faults and rectifying them	The approximate average salary of a mechanical engineer is MVR 290,000 per year. The cost of spares and tools required for the maintenance of machinery/equipment's is not known at this stage and should be included in the project value. The costs maybe obtained by consulting with the manufacturer or qualified service provider.		Vehicles in optimal condition
Air Quality- Dust	Minimize release of dust	Cover the waste on the transfer vehicles and ensure shorted transfer routes are taken	Continuous during construction phase	Laborer, Driver	Experienced Project Manager	Covering cloth, Waste Transfer Vehicles	Waste transfer vehicles that is able to operate in unpaved and challenging environment	A rear-loading garbage truck price is typically between USD 100,000 to USD 300,000.	Proponent	Level of dust at construction sites
		spraying the ground before excavation works with water		Laborer	Laborer who is able to operate water horse	Water horse, water pump, water supply, Electricity	RO	Cost of RO plants may vary depending on brand, size and specifications. Typically the price of a 10T RO plant is from USD 5000 to USD 50,000.		
		Ensuring that the trenches are backfilled as soon as possible by finishing works efficiently		Project Manager, Laborers	Experienced Project Manager	Excavator	No additional technology required	A mini excavator that is suitable for landscaping can be for USD 20,000 to USD 90,000.		
Noise Pollution	Minimize noise generated and duration of noise generated. Limit the noise generation hours to times that will cause minimum disturbance.	Usage of heavy machinery and equipment should be restricted to smaller areas (eg take the shortest route possible when accessing to work site)	Continuous during construction phase	Project Manager	Experienced project manager	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600. The price of microsoft projects perpetual license is for about USD 620.	Proponent	Measurement of noise levels around construction sites
		Park the heavy machinery within the work site (if possible) to avoid unnecessary transfer								
		Ensure project is completed as soon as possible								
		Restrict working hours to daytime only								
Groundwater quality- oil		Establish Oil/chemical handling procedures and ensure no spills occur	Continuous during	Environmental safeguard	Environmental officer	Oil spill cleanup kits	Spill cleanup technology	The cost of spill cleanup operations can vary widely depending on the	Proponent	Spills and remediation

and chemical spills	Minimize risk of oil and chemical spills	Workers should be well trained about proper use of machinery and equipment relevant to them Have emergency oil spill cleanup crew on standby during construction All machinery and equipment should be well maintained to avoid accidental spillage	construction phase	officer and oil spill cleanup crew		and chemical handling procedures		size, location of spill, type of substance spilled, etc. Small spills on land/water can cost from few thousand o tens of thousands of dollars. Medium spills on coastal waters can cost from tens of thousands to several hundred thousand dollars. Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month.		
Groundwater quality-salinization	Minimize groundwater salinization from dewatering	Water extracted from dewatering should be recharged back to the ground to a designated area after checking the water quality	Continuous during construction phase	Laborers, Environmental safeguard officer	Environmental officer	Pump, water horse	Water quality testing	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. Water testing costs are depended on the parameters being tested. The costs can be obtained from MWSC laboratory.	Proponent	Groundwater salinity
		Efficient planning of foundation and pipe laying works to ensure least number of dewatering days	Prior to dewatering	Project Manager, Laborers	Experienced project manager	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600. The price of microsoft projects perpetual license is for about USD 620.	Proponent	Number of dewatering days
Impacts on marine environment	Minimize direct damages to benthic substratum.	Limit access routes of vessels, excavators and heavy machinery to a small area Avoid dragging of anchors over the sea bed and should be carefully placed at the exact location Ensure all project activities remain within the project boundary	Continuous during construction phase	Environmental safeguard officer, Project Manager	Environmental officer, Experienced project manager	Dingy, GPS, Computer	Global positioning, aerial imagery	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000.	Proponent	Extent of direct damages to surrounding reef
		Take permit from MMRI for coral translocation (if any) and ensure that they be translocated to an area with the same or similar habitat, conditions, and communities.	Continuous during construction phase	Environmental safeguard officer, laborers	Environmental officer, workers that can work in the marine environment	Dingy, snorkeling kits, coral frame, cable ties	Coral transplantation by using coral frames	Depending on the size and specifications of the coral frame, the price can vary between USD 50 to USD 350 per frame.		
	Minimize sedimentation and control the sediment plume triggered during construction.	Use of sedimentation control measures such as sand bunds and silt screens	Prior to dredging	Environmental safeguard officer, laborers	Environmental officer	silt screen	sediment control	Depending on the size, material and features of the silt screen the prices may vary. A basic silt screen made of polypropylene fabric maybe available for USD 0.50 per square foot, while reinforced PVC material screen may cost USD 2 to USD 3 per square foot.	Proponent	Extent of sediment plume created

		Dredge material shall be stockpiled at a designated area and the stockpiled material shall be protected or is placed in geotubes	Continuous during dredging	Environmental safeguard officer, laborers	Environmental officer	Geotube, excavator	No additional technology required	The cost of geotube may vary depending on the material and specifications. Typically the cost is from USD 3 to USD 20 per cubic foot.	Proponent	Extent of sediment plume created
		Ensure all work is carried out during low tide and in calm weather conditions	Continous during construction	Project Manager	Experienced project manager	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600. The price of microsoft projects perpetual license is for about USD 620.	Proponent	Extent of sediment plume created
		Halt construction if sedimentation is too high	Continuous during dredging	Environmental safeguard officer, laborers	Environmental officer	Sediment traps	Sedimentation measurement	A PVC sediment trap could be made roughly for USD 20.	Proponent	Sedimentation rate higher than 15 mg/cm3/day
	Minimize changes in currents	Explore alternative jetty design that allows water to pass under it	Project planning stage	Coastal Engineer	Coastal engineering	Computer	Engineering software	The salary for a coastal engineer may vary depending on their experience, qualification and proponent. Typical salaries maybe from MVR 20,000 to MVR 35,000 per month	Proponent	Deviations in current patterns from baseline
	Mitigate or avoid spillages	Following fuel/chemical handling procedures	Continuous during construction	Environmental safeguard officer, laborers	Environmental officer	Fuel/chemical handling procedures	No additional technology required	The cost of spill cleanup operations can vary widely depending on the size, location of spill, type of substance spilled, etc. Small spills on land/water can cost from few thousand o tens of thousands of dollars. Medium spills on coastal waters can cost from tens of thousands to several hundred thousand dollars. Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month.	Proponent	Number of spills
		Emergency cleanup crew shall be on standby at all times	Continuous during construction	Spill cleanup crew	Spill cleanup	Spill cleanup materials	Spill cleanup technology		Proponent	Test of water quality
	Minimize stress on corals	Keep an eye of coral bleaching predictions. Reduce work at watch, halting any work if bleaching exceeds level 1 along with close and continuous monitoring of the reef if there is any sort of alert including "watch". Work to be halted on observation of impact and stress of the reef at any of the project sites.	Continuous during construction phase	Environmental safeguard officer	Environmental officer	Dingy, snorkeling kits, Underwater camera	Underwater photography	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month.	Proponent	Coral bleaching

		If the project is due in the Months of Feb-May, ensure close monitoring of the reef for any impact and mitigate as much as possible. This is a period of known thermal stress and coral bleaching and additional stress from developments can affect reef health and recovery of all reefs in proximity to the project site								
		If the project is due in the months of Jan-April and Oct-Dec, ensure close monitoring of the reef for any impact and mitigate sediment impacts as much as possible. This is a period of known coral spawning and too much stress can prevent spawning events which can affect reef health and recovery.								
Impacts on terrestrial environment-soil and ground	Minimize area of ground compaction and extent of damages to soil profile	Ensure shortest accessibility to construction sites	Prior to construction	Experienced Project Manager	Project management skills	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. The cost of a computer may vary depending on the brand and computing power, typically one could get a basic desktop computer from around USD 300 to USD 600. The price of microsoft projects perpetual license is for about USD 620.	Proponent	Extent of ground compaction and soil profile compromised
		Plan for bulk transport of construction materials to ensure trips are more efficient and fewer trips are needed	Continuous during construction phase							
		Ensure number of waste transfer are low by making sure that vehicles are full	Continuous during construction							
Impacts on coastal environment	Minimize impacts to mangrove	Delimit a 15m no development buffer zone from the mangrove area	Prior to construction	Environmental Safeguard Officer	Environmental management	Computer, GPS	Aerial imagery of the Island	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. Georeferenced aerial model of the Island may cost about USD 2000 to USD 3500.	Proponent, EPA, MFMRA	Distance to closest development area to mangrove
		Avoid any activities that might bring about adverse impacts in the mangrove area	Prior to construction	Environmental Safeguard Officer, Project Manager	Environmental management, Project management	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month.	Proponent	Damages to mangrove
		Explore alternative jetty design that allows water to pass under it	Project planning stage	Coastal Engineer	Coastal engineering	Computer	Engineering software	The salary for a coastal engineer may vary depending on their experience, qualification and proponent. Typical salaries maybe from MVR 20,000 to MVR 35,000 per month	Proponent	Test of water quality inside mangrove

	Reduce area of beachrock destroyed	Restrict the path of excavator only to outfall footprint	Project planning stage	Project Manager	Experienced project manager	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month.	Proponent	Extent of damages to beachrock
Risk of accidents and pollution on workers	Minimize risk of accidents to non-relevant personnel	Construction site fenced off	Prior to construction	Laborers	No additional expertise required	Aluminium sheets, metal poles	No additional technology required	The cost of a fence may vary highly depending on the materials used. An aluminium fence may cost from USD 20 to USD 50 per linear foot.	Proponent	Unwanted entries to project site
		Unauthorized entry of unwanted people must be restricted	Prior to construction	Security guard	Experience in security management	Camera and other security management equipment	Camera system	The cost of a camera system may vary depending on the brand and specifications. Basic entry level camera system with 2-3 cameras may cost from USD 1000 to USD 300.		
		Sign boards at construction site	Prior to construction	Laborers	No additional expertise required	Sign boards	No additional technology required	Cost of sign boards will vary depending on size and material used. In general a small sign board made from materials like PVC, metal or aluminium will cost from USD 10 to USD 50.		
	Minimize risk of accidents to workers	All working staff must be well trained and avised on the importance of occupational health and safety	Prior to construction	Safety Officer	Environmental and safety officer	Safety, first aid kits and PPE equipment's	Safety and spill cleanup technology	The cost of PPE may vary depending on the type of equipment needed. Some approximate costs for common PPE are; Disposable masks: USD 0.20 to USD 1 per mask N95 masks: USD 2 to USD 5 per mask Face shields: USD 5 to USD 20 per shield Disposable gloves: USD 0.05 to USD 0.50 per pair Reusable gloves: USD 5 to USD 20 per pair Disposable gowns: USD 5 to USD 15 per gown Reusable gowns: USD 30 to USD 100 per gown. These prices may vary highly depending on the brand, quality and quantity purchased.	Proponent	Accidents and injuries to workers
		Ensure all workers are provided with PPE	Continuous during construction phase	Environmental Safeguard Officer						
		In case of oil/chemical spills, clean up kits shall be available at all times		Environmental Safeguard Officer						
		In case of accidents, workers should be taken to the nearest hospital immediately and if the need be to Male'		Environmental Safeguard Officer						
		Firefighting equipment must be made available at work site		Safety Officer						
		Trenched material should be stockpiled at a designated area		Environmental Safeguard Officer						
		Backfilling any trenches made during the day before night by careful planning of pipe laying works		Environmental Safeguard Officer						
		Safety lights at night to avoid people from falling into open trenches		Environmental Safeguard Officer						
		Shoring for adjacent buildings during excavation if there is any risk of collapse	Prior to construction	Environmental Safeguard Officer						

Impacts on landscape integrity and scenery	Minimize aesthetically displeasing view for any people that can see project area	Project area shall be fenced off and informing of the project construction works	Prior to construction	Laborers	No additional expertise required	Aluminium sheets, metal poles	No additional technology required	The cost of a fence may vary highly depending on the materials used. An aluminium fence may cost from USD 20 to USD 50 per linear foot.	Proponent	Number of Complains
Socio-economic impacts	Increase the chance of local workers/ contractors being hired	Work with locals and local businesses so that the needs of the project can be addressed by them	Prior to construction	Project manager, HR/PR staff	People skills	Computer	Ads, presentations	The salary for an HR staff may vary depending on the proponent, typically a mid level HR staff salary is from MVR 12,000 to MVR 18,000 per month	Proponent	Local workers hired
		Inform the local businesses about the construction works and its schedule	Prior to construction	Project manager, HR/PR staff	People skills	Computer	Ads, presentations			
		Give priority to local contractors	Prior to construction	HR staff	No additional expertise required	No additional equipment required	No additional technology required			

9.1.2 Operational Phase

The following table describes the preferred mitigation measures for the identified impacts during the operational phase of the proposed project.

Table 40: proposed mitigation measures for the identified impacts during the operation phase of the proposed project

Impact	Mitigation Aspect	Proposed Mitigation Measures	Timing	Required manpower	Expertise	Equipment	Technology	Estimated Cost	Implementing Agency	Performance Indicator
Air Quality-GHGs	Reduce volume of GHGs released	The generators at powerhouse is well maintained	Continuous during operations	Mechanical engineer, laborers	Servicing of gen-sets	Spares, specialized tools and equipment's required for maintenance work	workshop facilities	The cost of maintenance for generators will vary depending on the brand, frequency of maintenance, availability of spare parts and maintenance personnel. A general estimate for a basic annual maintenance service for a small generator is for roughly USD 500, while large generators can be for thousands of USD.	Proponent	Percentage contribution of renewable energy
Air Quality-dust	Ensure dust, bad odor, VOCs and other pollutants are not released	Ensure optimal operations at the waste management center at all times	Continuous during operations	Operations Manager	Management skills	Computer	Operations software	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities. The cost covering material for the waste transfer vehicle shall be included in the operational costs.	Proponent	Air quality parameters in within thresholds
		Ensure that waste is transferred in a closed vehicle	Continuous during operations	Operations Manager	Management skills	Covering material	No additional technology required			
		All exhaust pipes will be fitted with filters and according to URA standards at the powerhouse	Design stage	Design consultant	Engineering	Filters, Computer	Designing software	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities. The cost of an exhaust filter may vary depending on type, size and specific requirements of the powerhouse. Without knowing these details it is difficult to provide an estimate and hence the cost shall be included within the project value.		
		Raising the chimney height above canopy of the island	Design stage	Design consultant	Engineering	Chimney, Computer	Designing software			
		Well maintenance of exhaust pipes and the filters	Continuous during operations	Workers	No additional expertise required	Cleaning equipment's, Computer	Maintenance logs	A typical salary for general staff would be between MVR 10,000 to MVR 20,000 per month based on qualifications and responsibilities.		
		Dislodging of soot or any harmful chemicals should be immediately reported	Continuous during operations	Environmental safeguards officer	Environmental management	Visual inspection, Computer	Logs	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month.		
		Blower with vent pipe installed at the pump stations	Design stage	Design consultant	Engineering	Blower system, Vent pipe, Computer	Designing software	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities. The cost of blowers in pumpstations may vary depending on the brand, size etc. A general estimate is between a few thousand to tens of thousands of dollars for a blower system.		
		Aerators installed in pump stations	Design stage	Design consultant	Engineering	Aerators, Computer	Designing software			

Noise Pollution	Minimize noise generated	Ensure that the heavy machinery at WMF is operated during daytime	Continuous during operations	Operations Manager	Management skills	Computer	Operations management software	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities.	Proponent	Noise level
		Ensure shortest waste transfer route is chosen and the route will cause least disturbance	Continuous during operations	Operations Manager	Management skills	Computer	Operations management software			
		Waste transfers can be schedule to daytime	Continuous during operations	Operations Manager	Management skills	Computer	Operations management software			
		Regular servicing and maintenance of pumps and generators	Continuous during operations	Technical staff	Capable of mechanical/electrical servicing works	Spares, specialized tools and equipment's required for maintenance work	workshop facilities	A general estimate for a basic annual maintenance service for a small generator is for roughly USD 500, while large generators can be for thousands of USD. The cost of maintenance for pumps in a pump station may vary depending on type of maintenance task to be done. Some of the common maintenance tasks include regular cleaning and inspection, lubrication which can cost from a few hundred to few thousand dollars per year,	Proponent	
		Powerhouse to be soundproofed	Project planning stage	Engineer	Civil engineering	Soundproofing materials	Sound attenuation	The cost of soundproofing a powerhouse may vary depending on the size of the powerhouse, the level of noise reduction required, the materials used. The cost of soundproofing can be as much as 20-30% of the cost of the powerhouse itself. General estimate is from few thousand dollars to tens of thousands of dollars or more.	Proponent, URA	
Ground and marine water quality-negative	Minimize risk of leaks within the utility systems	Ensure that leak detection systems are working	Continuous during operations	Technical staff	Water and sewer technicians	No additional equipment required	Leak detection	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities. Typical salary for technical staff maybe between MVR 10,000 to MVR 20,000. The cost of spares and specialized tools are highly variable and details are not available at this stage to provide an estimate as such these costs shall be included within the operational costs.	Proponent	Logs
		Routine maintenance and monitoring of the utility system	Continuous during operations	Technical staff	Water and sewer technicians	O&M equipment's	No additional technology required			Logs
	Minimize risk of leachate, waste water and storm water percolating into the ground	Ensure that leachate collection and treatment, waste water and storm water management systems are installed within the WMF	Prior to operations	Design consultant	Engineering	Computer	Designing software			Reports
		In case of leakages, proper maintenance shall be done to prevent further leaks	Continuous during operations	Technical staff	Water and sewer technicians	Spares, specialized tools and equipment's required for maintenance work	workshop facilities			Leakages

	Minimize risk of leachate, waste water and storm water washing into the nearby marine environment	Ensure proper operation and maintenance of systems of WMF	Continuous during operations	Operations Manager	Management skills	Computer	Operations management software			Condition of infrastructures and facilities
		Ensure that waste transfer vehicles are closed vehicles such that waste is not exposed	Continuous during operations	Operations Manager	Management skills	Computer	Operations management software			Leakages
		Materials used for the project shall be inspected and approved by supervision engineers to ensure their water tightness and leak proof	At project planning stage	Engineer	water and sewer engineer	material testing equipment	workshop facilities			Logs
		Proper leak testing shall be carried at out prior to the operation of the systems and the rectification measures shall be implemented in areas where leaks are found	Commissioning	Engineer	water and sewer engineer	Pressure testing equipment	pressure test			Logs
		Account for the storm water flow during the final detail design of the sewer system	Design stage	Design consultant	water and sewer engineer	Computer	Designing software			Overflows
		Account for the increases in flow in the final design of the sewer system	Design stage	Design consultant	water and sewer engineer	Computer	Designing software			Overflows
		Monitor pumpstations in close proximity to shoreline and if the area is eroding, implement approximate shore protection measures	Continuous during operations	Workers	No additional expertise required	Visual inspection, Computer	Logs			Erosion
		water quality monitoring according to operation and maintenance manual	Continuous during operations	Environmental safeguards officer	Environment management	Water sampling equipment's	water testing facility			Reports
Groundwater quality-positive	Encourage protection and preservation of groundwater resources	Implement IWRM principles	At the design stage	Design consultant	Engineering	Computer	IWRM concepts	The salary for a design consultant may vary depending on their experience, qualification and proponent. Typical salaries maybe from MVR 20,000 to MVR 35,000 per month	Proponent	water quality
Impacts on marine environment	Minimize deterioration of marine water quality at outfall discharge location	Ensure outfall pipes are directed to a location of good water flow and doesn't allow for a buildup that can detrimentally affect the marine habitat.	Continuous during operations	Environmental safeguards officer	Environment management	Diving equipment, underwater camera, Water sampling equipment's	Logs	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. Marine water testing as per operating license shall be included within the operational costs.	Proponent	water quality
		Wastewater shall be treated prior to disposal								
		Ensure the condition of the outfall is good and functional								
		Marine water testing according to operating license and EIA								

Impacts on hydrodynamics	Ensure no scouring behind coastal structures	Routine monitoring by a snorkeler to see if there is scouring and apply protection measures if necessary	Continuous during operations	Staff who can snorkel	Swimming	Snorkeling equipment and underwater camera	Underwater photography	The cost of underwater camera maybe highly viable depending on factors such as image quality, resolution, depth rating, features, and brand. The cost of basic models are around USD 100 and several thousand dollars for high-end professional cameras.	Proponent	Underwater photos
	minimize erosion	If there is significant changes in currents resulting in erosion, immediately report to authorities and coastal engineer for advise	Continuous during operations	Environmental safeguards officer, Surveyor, engineer	Environment management, land surveying, coastal engineering	Drone, Drogue	using aerial imagery to draw shorelines	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. Georeferenced aerial model of the Island may cost about USD 2000 to USD 3500.	Proponent	Erosion
		Explore alternative jetty design	Project planning stage	Coastal Engineer	Coastal engineering	Computer	Engineering software	The salary for a coastal engineer may vary depending on their experience, qualification and proponent. Typical salaries maybe from MVR 20,000 to MVR 35,000 per month		
		Ensuring the outer vegetation zone is well maintained	Continuous during operations	Workers	Landscaping and gardening	Landscaping equipment's	No additional technology required	The cost of landscaping and gardening can vary depending on size of the area, the complexity of the design, the types of plants and materials used, and the region. A small scale landscaping project can cost between USD 2000 to USD 5000.		Vegetation on the outer perimeter of Island
Impacts on terrestrial environment - soil and ground	Minimize area of ground compaction	Ensure shortest access routes, minimise use of vehicles by efficient planning	Continuous during construction phase	Operations Manager	Management skills	Computer	Operations management software	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities.	Proponent	Flooding
Impacts on coastal environment	Minimize impacts to mangrove	Enforce the 15m no development buffer zone from the mangrove area	Continuous during operations	Environmental Safeguard Officer	Environmental management	Computer, GPS	Aerial imagery of the Island	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. Georeferenced aerial model of the Island may cost about USD 2000 to USD 3500.	Proponent, EPA, MFMRA	Distance to closest development area to mangrove
		Explore alternative jetty design that allows water to pass under it	Project planning stage	Coastal Engineer	Coastal engineering	Computer	Engineering software	The salary for a coastal engineer may vary depending on their experience, qualification and proponent. Typical salaries maybe from MVR 20,000 to MVR 35,000 per month	Proponent	Test of water quality inside mangrove
		Prohibit any activities that might bring about adverse impacts in the mangrove area	Continuous during operations	Environmental Safeguard Officer, Project Manager	Environmental management, Project management	Computer	Project management software	The salary of a project manager would vary depending on the proponent, typical salary of a project manager can range from MVR 25,000 to MVR 50,000. Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month.	Proponent	Damages to mangrove

Impacts from vibration	Ensure no buildings are damaged due to vibrations	Ensure shortest waste transfer routes are taken	Continuous during operations	Operations Manager	Management skills	Computer	Operations management software	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities.	Proponent	Vibrations
		Design of powerhouse shall reduce vibrations	Project planning stage	Engineer	Civil	Computer	Designing software	Typical salary of a civil engineer is from MVR 15,000 to MVR 25,000 per month	Proponent, URA	
		Ensure that a 200 ft buffer zone is established around the powerhouse	Project planning stage	Engineer	Civil	Computer	Designing software		Proponent, URA	
Impacts from waste	Ensure waste is managed properly	Ensure the waste management center and STP is functioning as per the national standards	Continuous during operations	Operations Manager	Management skills	Computer	Operations management software	A typical salary for a operations manager would be between MVR 15,000 to MVR 35,000 per month based on their qualifications and responsibilities.	Proponent	Logs
		Waste oil should be well contained and stored safely at a designated area	Continuous during operations							
		Waste oils should be taken to Thilafushi for proper disposal at regular intervals or sold as per company policies	Continuous during operations							
Health and safety of working staff	Minimize risk of workplace accidents	Ensure staff are provided with PPE	Continuous during operations	HR staff	Health and safety	PPE equipment's	No additional technology required	The salary for an HR staff may vary depending on the proponent, typically a mid level HR staff salary is from MVR 12,000 to MVR 18,000 per month	Proponent	Staff wearing PPE at all times
Impacts on landscape integrity and scenery	Ensure that the infrastructures are operating at optimal conditions such that the scenery is not compromised any further	Routine maintenance such that the outlook of the new infrastructures are at optimal condition	Continuous during operations	Technical staff	Technicians in relevant field	Spares, specialized tools and equipment's required for maintenance work	No additional technology required	The salary of technical staff may vary depending on the field. A general estimate is MVR 15,000 to MVR 30,000 per month.	Proponent	Outlook of infrastructures
Socio-economic impacts - negative	Minimize impact to previous resource users	After discussions with previous resource users, allowing them access to gather resources from the Island and surrounding waters in way that does not disrupt the Islands operations	Project planning stage	Project Manager, Natural resource use planner	Community development skills	Computer	Natural resource use planning	A typical salary for a natural resource use planner maybe between MVR 20,000 to MVR 35,000 per month.	Proponent, MFMA, Atoll Council	Access for resource users
Socio-economic impacts - positive	Ensure that the infrastructures and facilities are operating at optimal conditions	Routine maintenance such that the infrastructures and facilities are operational at optimal condition	Continuous during operations	Technical staff	Technicians in relevant field	Spares, specialized tools and equipment's required for maintenance work	No additional technology required	A typical salary for a natural resource use planner maybe between MVR 20,000 to MVR 35,000 per month.	Proponent	Condition of infrastructures and facilities
		All machinery and equipment's shall conform to international minimum standards	Project planning stage	Procurement consultant	Knowledge in relevant field of water/sewer/waste/coastal	Computer	No additional technology required	A typical salary for a procurement consultant is roughly MVR 370,000 per year.	Proponent	

		Ensure that the utilities, harbour, jetty and access channel is designed taking into consideration for the projected increase in their use in the future	Project planning stage	Design consultant	Consultant in relevant field of water/sewer/waste/coastal	Computer	Designing software	A typical salary for a design consultant maybe between MVR 20,000 to MVR 35,000 per month.	Proponent, URA	
		Obtain all the legal approval and permits for the operation of all utilities	Prior to operations	Manager	Knowledge in relevant field of water/sewer/waste/coastal	Computer	No additional technology required	A typical salary for a manager maybe between MVR 15,000 to MVR 25,000 per month.	Proponent, URA	Operating license
		Ensure that in the design of all facilities, there is adequate access for heavy vehicles to move	Project planning stage	Design consultant	Consultant in relevant field of water/sewer/waste/coastal	Computer	Designing software	A typical salary for a design consultant maybe between MVR 20,000 to MVR 35,000 per month.	Proponent	Accidents
		Ensure that systems are installed to manage by-products from waste management center and STP	Project planning stage	Design consultant	Consultant in relevant field of water/sewer/waste/coastal	Computer	Designing software	A typical salary for a design consultant maybe between MVR 20,000 to MVR 35,000	Proponent	Sludge management
		If leachate is intended to be disposed, it shall comply with the wastewater quality standards of URA	Project planning stage	Design consultant, Environmental safeguard officer	Environmental management	Water sampling equipment's	water testing facility	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. Water sampling costs shall be included within operational costs.	Proponent, URA	water quality
		have detailed operation and maintenance manuals for the utilities	Prior to operations	Engineer	Knowledge in relevant utility field	Obtain manuals from manufacturer	No additional technology required	A typical salary for an engineer maybe between MVR 20,000 to MVR 35,000 per month.	Proponent, URA	O&M manuals
		have a detailed operations plan made to the utilities	Prior to operations	Engineer, design consultant	Knowledge in operations of utilities and coastal infrastructures	Computer	No additional technology required	A typical salary for a design consultant maybe between MVR 20,000 to MVR 35,000 per month.	Proponent, URA	Operations plans
		Detailed process flow shall be made for the utilities and harbor operations detailing how all the processes will be undertaken and vehicles pathways within the them	Prior to operations	Engineer, design consultant	Knowledge in operations of utilities and coastal infrastructures	Computer	No additional technology required	A typical salary for a design consultant maybe between MVR 20,000 to MVR 35,000 per month.	Proponent	Process flow diagrams
Risk of hazards; weed growth	Minimize risk of weed overgrowth	Monitor and control growth of weeds on the WMF	Continuous during operations	Workers	No additional expertise required	Landscaping equipment's, pesticides	No additional technology required	A typical salary for non-technical staff maybe between MVR 10,000 to MVR 15,000 per month.	Proponent	Weed growth
Risk of hazards; pest out break	Minimize risk of pest outbreaks	Ensure that organic waste is not in the open for long periods of time	Continuous during operations	Workers	No additional expertise required	Pesticides	No additional technology required	A typical salary for non-technical staff maybe between MVR 10,000 to MVR 15,000 per month.	Proponent	Pests
Risk of hazards- storm surge	Minimize damages from storm surge event and sea level rise	Ensure that the structural integrity of the infrastructure holds	Continuous during operations	Technical staff	Technicians in relevant field	Underwater camera, diving equipment's	No additional technology required	The salary of technical staff may vary depending on the field. A general estimate is MVR 15,000 to MVR 30,000 per month.	Proponent	Logs
Risk of hazards- sea level rise		Ensure that the coastal structures are adequately elevated above the mean sea level and anticipated increase in sea level due to a storm surge event/sea level rise	Prior to construction	Design consultant	Consultant in relevant field of water/sewer/waste/coastal	Computer	Designing software	A typical salary for a design consultant maybe between MVR 20,000 to MVR 35,000 per month.		Elevated coastal infrastructure

Risk of hazards- fire and other workplace accidents	Minimise risk of fire and other workplace accidents	Ensure all firefighting and lightning protection equipment's/systems are installed in all facilities and operational for example smoke detectors, fire extinguishers	Continuous during operations	Environmental safeguards officer	Health and safety, environmental science	PPE, Manuals	No additional technology required	Typical salary of an environmental safeguard officer is between MVR 15,000 to MVR 30,000 per month. Cost of PPE equipment's and manuals shall be included within operational costs.	Proponent	Health and safety manuals, Emergency Response plans, Chemical handling procedures, logs
		Ensure personal protective equipment is made available to all staff and they use them properly								
		Establish emergency preparedness response plans, health and safety manuals, fuel handling procedures								
		Ensure emergency procedures, O&Ms are readily available								
		Ensure staff are adequately trained for emergencies, health and safety procedures, oil/chemical handling								
		Rescue buoys with rope available on the jetty and harbour								
		All personnel must strictly abide COVID 19 guidelines set by HPA – social distancing, wearing masks and regular hand washing or sanitization								
		Ensure that the access channel orientation is such that minimal waves reach the harbour basin	Prior to construction	Design consultant	Coastal engineering	Computer, Bathymetry	Designing software	A typical salary for a design consultant maybe between MVR 20,000 to MVR 35,000 per month.	Proponent	Strength of waves within harbour basin

9.2 Location for silt screen placement

Silt screens maybe placed as shown in the figure below during the construction of the access channel.

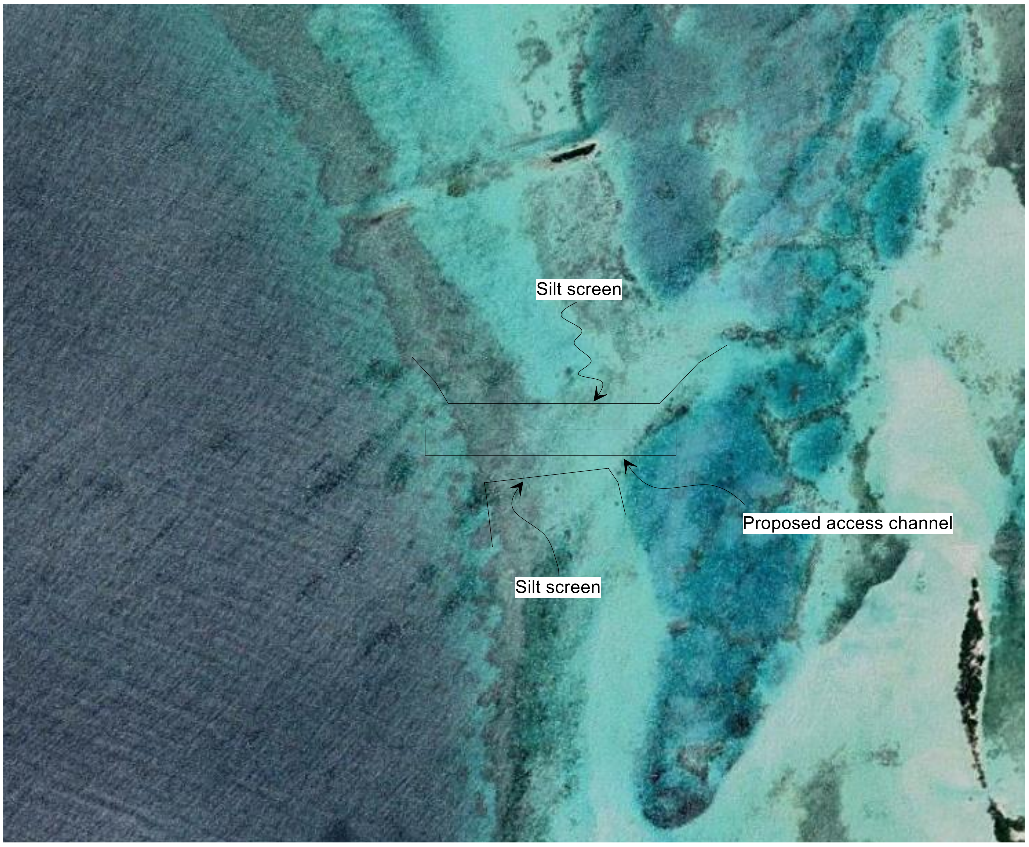


Figure 53: Potential location for placement of silt screens during dredging

9.3 Location for replanting trees

The Island is completely covered with vegetation with no room to plant any further trees. Therefore, the proponent shall give priority to divert the trees uprooted during this project to vegetation replantation programs from nearby Islands or to resorts.

9.4 Justification for the selected mitigation measures

The abovementioned mitigation measures for the construction and operational phase of the project were selected as those mitigation measures requires the least additional manpower, expertise, equipment, technology, and costs. Additionally, because the mitigation measures fulfil the initial principle of avoidance followed by minimisation in the cases where the impact could not be avoided and lastly compensation in those cases where avoidance and minimisation were not possible.

9.5 Effectiveness of mitigation measures

The effectiveness of proposed mitigation measures in the Maldivian setting is very difficult to ascertain due to the lack of monitoring data that is available. As such the full effectiveness of the proposed mitigation measures will be determined by the follow-up surveillance of the performance indicators that is highlighted for each mitigation measure and by monitoring of the parameters that is highlighted in section 9.9.1 under the Table 41.

9.6 Risk Management and Incident Response

Risk management procedures in this project are strengthened by adopting a more systematic risk management approach to safety. This is achieved by identifying all foreseeable impacts (as stated in section 7 of this report), assessing the risk of each impact and providing a means to control the impacts (mitigation measures).

9.7 Sustainable Development Management Policy

The design and implementation of the project ensures that the proposed project is sustainable. As such, measures adopted to promote sustainable development include some guiding principles as well as components incorporated into the project design. These include:-

- Ensure environmental compliance with the Governmental policies and regulations;
- Protect people, property and the local environment;

- Reduce ecological impacts of the services provided; and
- Increase customer satisfaction.

9.8 Managing Uncertainties in Impact Prediction

Uncertainty is an integral part of an EIA as EIA preparation involves prediction. The two types of uncertainties associated with the EIA process include those associated with the process and those associated with predictions. With the former, the question is whether the most important impacts have been identified and whether the recommendations will be acted upon. In order to reduce such uncertainties, a wide range of stakeholders have been consulted (Section 6) in the EIA process in order to minimize the risk of missing important impacts. For the latter, the uncertainty is in the accuracy of the findings. This can be improved by research and quality of the survey, and by follow-up monitoring.

It should also be noted that even though EIA cannot give a precise picture of the future, it enables uncertainties to be better managed and is an aid to better decision making.

9.9 Environmental Monitoring

Monitoring is an essential part of the EIA and project implementation and serves 3 purposes:-

- Ensures that the proposed mitigation measures are being implemented;
- Evaluates whether the proposed mitigation measures are working effectively; and
- Validates the accuracy of models or projections that were used during impact assessment process.

The purpose of monitoring is to compare the predicted impacts with that of the actual impacts, particularly if the impacts are either very important or the scale of the impact cannot be predicted accurately. The results of monitoring can then be used to manage the environment, particularly to highlight problems early on so an action can be taken.

Monitoring should not be seen as an open-ended commitment to data collection and to minimize the expenses associated with collecting unnecessary data, the data collection should cease when the need for monitoring ceases. Therefore, it is important that a proper monitoring schedule is adhered to. Conversely, monitoring may also indicate the need for more intensive study. The information obtained from monitoring can be extremely useful for future EIAs in making them more accurate as well as more effective.

9.9.1 Monitoring Parameters

The baseline data collection for the proposed development was undertaken in April 2023. Baseline surveys were conducted to determine the reference range, so that comparisons can be made during the monitoring to determine the change.

All monitoring activities must be carried out under supervision of a registered EIA consultant. Details of the monitoring program are given in Table 41 below.

It is the responsibility of the implementing agency to adhere to the monitoring program and bear any costs related to reporting them.

Table 41. Environmental monitoring plan proposed for the proposed development

Parameter	Locations	Method	Indicators	Frequency	Cost / MRF	Staff requirement
CONSTRUCTION PHASE						
Marine environment	Construction sites and Control	Water quality test Benthic substrate Analysis Fish census	Compare with baseline	Every 3 months during construction	15000	2 surveyors
Ground water	Construction sites and Control	Water quality test	Compare with baseline	Every 3 months during construction	8000	1 surveyor
Turbidity	Construction sites and Control	Water quality test	Compare with baseline	Every 3 months during construction	500	1 surveyor

Waste	Construction sites	Visual inspection	Improper management of waste	Every 3 months during construction	500	1 surveyor
Accidents	Project site	Workplace accidents	Number of incidents	Every 3 months during construction	1000	1 surveyor
Noise	Project site and Control	Decibel meter or any other equipment that can measure sound levels	Compare with baseline	Every 3 months during construction	500	1 surveyor
OPERATIONAL PHASE						
Air quality	Powerhouse and Control	Air quality measurement	Compare with baseline	Every 3 months after construction for 1 year and annually for 5 years	12000	1 surveyor
Ground water	Powerhouse, Pumpstations and Control	Water quality test	Compare with baseline	Every 3 months after construction for 1 year and annually for 5 years	8000	1 surveyor
Supply water monitoring	RO Outlet, Storage tank Inlet, Storage tank outlet, Distribution network	Water quality test	Compare with URA supply water standards	Testing frequency as per URA standards	25000	2 surveyors
Waste	Islands waste management center	Visual	Management of waste at WMC	Every 3 months after construction for 1 year and annually for 5 years	1000	1 surveyor

Shoreline	Around the Island	Aerial imagery	Erosion/ accretion	Every 3 months after construction for 1 year and annually for 5 years	30000	1 surveyor
Marine environment	Outfall, Harbor and Control	Water quality test Benthic substrate Analysis Fish census Current measurements	Compare with baseline	Every 3 months after construction for 1 year and annually for 5 years	18000	2 surveyors
Accidents	Project site	Workplace accidents	Number of incidents	Every 3 months after construction for 1 year and annually for 5 years	1000	1 surveyor

9.9.2 Environmental Monitoring Report Submission Schedule

Monitoring reports must be submitted to the EPA as specified under the monitoring schedule below:-

Table 42. Monitoring schedule recommended for the proposed development assuming that the project commences in July 2023 and completes on March 2024

Description	Date
EIA Decision statement issued	July-23
Project commencement	July-23
Monitoring report during construction- 1	October-23
Monitoring report during construction- 2	January-24
Monitoring report during construction- 3	March-24
Monitoring report during operation – 1	April-24
Monitoring report during operation – 2	July-24
Monitoring report during operation – 3	October-24
Monitoring report during operation – 4	January-25
Monitoring report during operation – 5	April-25
Monitoring report during operation – 6	April-26

Monitoring report during operation – 7	April-27
Monitoring report during operation – 8	April-28
Monitoring report during operation – 9	April-29
Monitoring report during operation – 10	April-30

9.9.3 Environmental Monitoring Report Format

Following is the environmental monitoring report format expected for this project. The report will include the details of the methods used to collect data, sampling sites, sampling frequency, results and analysis. All data collected in the monitoring period shall be presented in the monitoring report without bias and data shall be compared with the baseline values presented in this EIA report. For the preparation of this monitoring report a surveyor and an environmental consultant will be required.

Introduction

Purpose of the monitoring report

Introduction of consultant and proponent

Methodology

Describe the methods used to collect data

Sampling sites

Geographic coordinates

Results

Present results for the monitoring period

Comparison with baseline

Conclusion

Specify if environmental thresholds are being exceeded

Propose any additional mitigation measures

10. JUSTIFICATION AND CONCLUSION

The purpose of this EIA is to critically analyze and assess the potential environmental impacts associated with the proposed proposed project to establish utility service (power, water, Sewerage, waste management) with island accessibility (harbor and access channel) at L. Thunbir and propose the solutions and preferred alternatives as well as mitigation measures to minimize any negative impacts whilst trying to derive the maximum positive impacts from the project.

The proposed agriculture development project is located in the island of Thun'buri in Hadhunmathi atoll (Laamu) at 2°04'28.47" N and 73°32'24.41" E. The nearest airport is L. Kahdhoo Airport approximately 22 km south of Thunburi. The closest islands to the project location are; inhabited island of L. Dhanbidhoo approximately 697 m north of Thun'buri. Next, Isdhoo and Kalhaidhoo which is approximately 3.34 km north of L. Thun'buri. The closest uninhabited islands to the project location are Hulhiyandhoo which is approximately 14 m north of L. Thun'buri and Dhonberahaa which is approximately 343 m southwest of L. Thun'buri. Holhurahaa which is approximately 300 m south of L. Thun'buri. There are no environmentally protection or sensitive areas within 5km of the project island.

The Government of Maldives has initiated many policies, programmes and projects to ensure the food security of the country. This includes establishment of Agro-National Corporation (AgroNat) which develops the capacity of the local farmers by ensuring their produce will have a reliable market demand. The proposed agriculture development project in L.Thunburri is expected to contribute to the policies of food security by the Government of Maldives. This project is phase 1 of the project which aims to achieve the establishment of the accessibility and the utility services required for the operations of the project.

Interconnection between islands within the atoll and other atolls are mainly dependent on sea transportation. The jetty/harbor component is vital while developing an island for any purpose and this proposal focuses on the development of Thunburi island for agriculture. During the development and operational stages, the harbor will act as the pivoting point of all the operations carried out on the island.

The 150 TPD RO plant will be used to produce sufficient water to meet the peak demand when any other water source is not available. As the water requirement of the farm will be met with combination of desalinized water and harvested rainwater, no ground water will be pumped.

7 generators in the powerhouse would provide the energy necessary to function without causing any setbacks. The development of the RO plant and powerhouse would provide the island the necessary means to implement the rest of the project swiftly and effectively during phase 2. Furthermore, with the solar panels being installed along with the powerhouse would provide the island with clean energy reducing the load on the diesel generators and release of GHGs with air pollutants.

The major regulatory requirements for the project involve obtaining the EIA decision statement to go ahead with the project as per the EIA regulation, following with the legislations pertaining to electricity provision, waste management, water and sewerage services and dredging.

In order to assess the existing environment of the project site, various aspects were studied under the EIA. Some of them are structural environment, terrestrial megafauna, air quality, noise, socioeconomic environment, water quality and hazard vulnerability.

The major impacts highlighted for the construction phase of the project is the impact on marine environment, damages to the benthos, sedimentation, impacts due to noise, impacts on soil /ground and risk of accidents on workers. The major impacts during operational phase are on air quality, marine environment, hydrodynamics, and the beneficial socioeconomic impacts

Major mitigation measures proposed in the construction phase is to ensure the sedimentation impacts are mitigated appropriately. Further mitigation measures include that the vehicles are maintained properly, avoiding unnecessary use of vehicles, taking dust suppression actions such as spraying water on ground, restriction of work hours to during day time following oil and chemical handing procedures and having emergency spill clean-up crew at site. And during operational phase it is proposed to ensure that the generators at the powerhouse are well maintained, ensure optimal operations at the waste management center at all times, raising chimney above the canopy of the island, ensure leak detection systems are working and ensure leak repairs are done timely to avoid further incidents, ensure timely outfall inspections and attend to repairs timely if need be and monitoring the water quality of the supplied water to ensure safety of the supplied water.

Main alternatives that were studied were the no-project option, alternative to jetty design, alternative intake method for the desalination plan, alternative material for storage tanks, alternative sewer treatment technology and alternative location for outfalls. The environmental monitoring formulated in the EIA includes to monitor marine environment, groundwater, turbidity, waste generation, incident occurrence and noise generation during construction phase and air quality, groundwater, waste, shoreline, marine environment, supply water quality and incident occurrence during operational phase of the project.

The socioeconomic benefits during the operations outweigh the negative impacts of the construction phase of the proposed project. Hence, with the mitigation measures (and preferred alternatives) outlined in the report, it is recommended to proceed with the project as planned.

11. ACKNOWLEDGEMENTS

Consultants would like to extend sincere gratitude to everyone who have contributed to this report. Thanks are due to the stakeholders who kindly contributed their expertise and fair judgement regarding this project. Representatives of proponent are highly appreciated for their generosity in providing any requested information for the compilation of this EIA report.

12. APPENDICES

APPENDIX A. REFERENCES

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APPENDIX B. LIST OF ABBREVIATIONS

AS/NZS : Australia / New Zealand Standard 260

AS/NZS ISO : Joint Australian New Zealand International Standard 35

CBD : Convention on Biological Diversity 110

CO : Carbon Monoxide 222

DS : Decision Statement 32

EIA : Environmental Impact Assessment 28

EPA : Environmental Protection Agency 32

GHG : Greenhouse gas 107

HIES : Household Income & Expenditure Survey 232

IEE : Initial Environmental Examination 158

IT : Information Technology 33

MFDA : Maldives Food and Drug Authority 56

MFMRA : Ministry of Fisheries, Marine Resources and Agriculture 255

MNDF : Maldives National Defense Force 106

MPHRE : Ministry of Planning, Human Resource and Environment 48

MWSC : Male’ Water and Sewerage Company 212

NO2 : Nitrogen Dioxide 222

NWSSP : National Water and Sewerage Strategic Plan 60

PM10 : Particulate Matter less than 10 microns 222

PM2.5 : Particulate Matter less than 2.5 microns 222

RO : Reverse Osmosis 33

SAARC : South Asian Association for Regional Corporation 111

SDG : Sustainable Development Goal.. 109

SO2 : Sulfur Dioxide 222

ToR : Terms of Reference... 32

UN : United Nations 109

UNDP : United Nations Development Program 241

UNEP : United Nationas Enironment Programme 35

UNFCCC : United Nations Framework Convention on Climate Change 106

APPENDIX C. TERMS OF REFERENCE

بسم الله الرحمن الرحيم

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Environmental Protection Agency
EPA

No: **203-ECA/PRIV/2023/266**

Terms of Reference for the Environmental Impact Assessment for proposed of Development Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at Thunburi, Laamu Atoll

The following is the Terms of Reference (ToR) issued following the scoping meeting held on **2nd March 2023** for undertaking the **EIA for proposed Development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at L. Thun'buri.** The proponent of the project is **The Hawks Pvt Ltd**. The EIA consultant of this project is **Mahfooz Abdul Wahhab (EIAP22/2016).**

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 and rationale** – Describe the purpose of the project with the rationale and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific and if possible quantified. Define the arrangements required for the environmental assessment including how work carried out under this contract is linked to other activities that are carried out or that is being carried out within the defined project boundary. Identify the donors and the institutional arrangements relevant to this project.

2. **Study area** – Submit a minimum A3 size scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should include adjacent or remote areas, such as relevant developments and nearby environmentally sensitive sites (e.g. coral reef, sea grass, mangroves, marine protected areas, special birds site, sensitive species nursery and feeding grounds) if deemed significant for the study. 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. The following tasks shall be completed**:**

   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. The following should be provided (all inputs and outputs related to the proposed activities shall be provided):

   Desalination plant design

   - Submit an A3 size site plan of the RO plant house with labelled drawings;

- Submit a process flow diagram of the RO system;
- Describe the technology and production capacity and how it is justified;
- Water storage capacity and how it relates to predicted water consumption;
- Water quality monitoring systems and water security logistics;
- Dewatering and excavation/trenching for pump station and pipeline installations if required;
- Specify materials, equipment, heavy machinery, staff estimate, key personnel, positions, technical expertise required;
- Describe disinfection method and its alternatives
- Describe various chemicals that would be dozed to product water and how the chemical would be stored.
- Overall landscaping.

Proposed Sewerage System

- Type of collection (gravity or vacuum);
- Expected number and specifications of lifting stations;
- Describe operations for dewatering and excavation for pump station;
- Mechanism used to avoid pipe leakages.

Sewage outfall

- Justify outfall site selection including distance form reef and depth of the pipe using oceanographic and ecological information;
- Describe equipment needed and construction methodology for laying the pipe including handling and transportation.

STP Plant Facility Design

- Describe treatment technology and capacity
- Describe operations for dewatering excavations for pump stations and sewer trenches.
- Mechanisms used to avoid pipe leakages protecting groundwater contamination.
- Specify an emergency plan if system fails.

Water Storage Tanks

- Water storage tank details and justifications (size and location)
- Construction method and machinery along with their justifications

Water intake and brine discharge pipe

- Justify pipe locations, provide depth and distance from shore using oceanographic and ecological information;
- Currents and waves ought to disperse the discharged water with minimum impacts on marine ecosystems and economic activities;
- Description of intake method
- Alternative location for the outfall pipeline

Proposed Waste Management Centre

- Describe the capacity of the waste management centre
- Describe the technology that will be used to manage waste

Proposed Powerhouse

- Location and capacity of generators and facility;
- Access to power plant;
- Noise attenuation measures;
- Cooling water system including cooling pipe location (if any) and justification;
- Cabling installation operations: man power, area required, excavations, land clearance requirements;
- Emergency power supply plan;
- Low energy consumption ventures and awareness;
- Chimney height and justification on how the height was determined based on relevant local and international standards;

Solar installation

- Location and capacity of solar installation.
- Details of battery setup (if any), including capacity, maintenance, construction, and disposal

Fuel Management

- Volume required for plant operation;
- Rate of waste lube oil generation its collection, storage and disposal;
- Fuel storage tank details (size, location, method of transportation from harbour to storage plant);
- Fuel transport and pipeline drawings and specification especially leakage proofing;
- Measures of fuel containment;
- Method of fuel transport from harbour to storage
- Fuel handling and management plan during operations;
- Mitigations in a case of fuel spillage

Harbour Quaywall and Pavement construction

- Justification for the harbour including location and design.
- Submit A3 size plan of proposed harbour quaywall site plan with labelled drawings.
- Methodology of quaywall construction
- Design of quaywall
- Specify materials, equipment, heavy machinery, staff estimate (quantity and period of time)
- Measures to minimize environmental impacts during construction of harbour

Dredging/excavation (if any)

- Location and size of harbour basing, reef entrance and other dredge areas on a scaled map

- Justification for the selection of the location, depth and size of dredge area
- Equipment used for dredging and justification
- Exact method and processes of dredging/excavation
- Dredged material disposal/usage details
- Alternative methods/equipment for dredging

Temporary facilities

- Construction methods, scheduling and operation of temporary facilities including power generation, oil storage, water supply, wastewater treatment, accommodation facilities, waste management and decommissioning.
- Labour requirements;
- Material storage;
- Housing of temporary labour;
- Waste management at the temporary facility.

Vegetation Clearance

- Locations to clear vegetation marked on an A-3 size map with regards to proposed infrastructures
- What would be done with the removed vegetation?
- Location to plant the replacement vegetation, and the source.

Hazard Vulnerability

- Fire, electrical and explosion hazard;
- Vulnerability of area to flooding and storm surge.

Health and Safety

- Availability of basic first aid facilities;
- Availability of safety gears.

Waste Management

- Details of waste management during construction and operational phase;
- Waste fuel and oil management details.

Project Management

- Project work schedule: Include project progress, target dates and duration of works, construction/operation/closure of labor camps, access to the site, safety, equipment and material storage, waste management from construction operations, power and fuel supply;
- Specify an emergency water supply plan if the system fails.

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. All survey locations shall be referenced with Geographic Positioning System (GPS) including water sampling points, reef transects, vegetation transects and manta tows sites for posterior data comparison. Information should be divided into the categories shown below:

Climate
- Temperature, rainfall, wind, waves, evaporation rates;
- Risk of hurricanes and storm surges.

Geology and geomorphology
- Offshore/ Coastal geology and geomorphology (use maps to show major zones or geomorphological features such as reef line, vegetation line);
- Bathymetry (at the proposed harbor, entrance channel, intake locations (if any), outfall location and alternative locations).

Hydrography/hydrodynamics (use maps)
- Tidal ranges and tidal currents;
- Surface water currents and on spot current measurements;
- Wind induced seasonal currents;
- Wave climate and wave induced currents (in relation to outfall locations);
- Depths at brine discharge locations

Ecology

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered species (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles; and significant inland flora; Include description of commercial species with potential to become nuisances or vector. Include maps to illustrate the extent of this component within the pocket boundary;
- Quantitative marine assessments: Marine habitat status including coral reef health, sea grass beds and benthic and fish community description at outfall location and a control site. Select a control site far from the outfall location and a test site at representative distance from the outfall discharge site;
- Assessment of terrestrial vegetation from areas that need to be cleared for the purpose of the project to include, area, number, and type of trees to be cleared.

- Assessment of the environmentally sensitive areas of the island including the flora and fauna of the mangrove areas.
- Identify locations where any uprooted trees are to be transplanted.

Physical Parameters

- Seawater quality measuring these parameters: temperature, pH, salinity, turbidity, TPH (from all outfall sites, and alternative sites. Control site will be the site that the project components are not developed in);
- Ground water quality assessment of desalination plant site, powerhouse and from 1 additional location in the island, measuring these parameters: temperature, pH, E-conductivity, TPH;
- Noise measurement at the proposed desalination plant area and powerhouse and from one control site.
- Air quality measuring the following parameters: Particulate matter (PM10 and PM2.5), Carbon monoxide (CO), nitrogen oxide (NO) and sulphur dioxide (SO2) (from proposed project site and one control site).

Socio-economic environment of the Atoll

- Demography: total population, sex ratio, density, growth, and pressure on land and marine resources;
- Income situation and distribution;
- Economic activities of both men and women;
- Seasonal changes in activities;
- Land use planning and natural resource use;
- Accessibility and public transport within and to other islands;
- Services quality and accessibility including health care facilities;
- Community needs;
- Sites with historical or cultural interest on the proposed project Island (if any).

Hazard vulnerability:

- Vulnerability of area to flooding, storm surge and tsunami events.

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.

- Concept approval from Ministry of Fisheries, Marine Resources and Agriculture.
- Dredging permit (if applicable)
- Other approvals from relevant government authorities (if applicable).

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

Impacts on the natural environment

- Loss of vegetation and fauna from land clearance activities;
- Impacts on the environmentally sensitive areas of the island including the flora and fauna of the mangrove areas.
- Sediment plume extent should be delimited so that effects from nutrient inputs (change of water quality) on local reefs, fish and invertebrate communities can be identified;
- Impacts on groundwater quality;
- Impacts from marine habitat destruction which may affect fish stocks and species diversity and density of invertebrates.
- Impact from installing the brine discharge pipe.
- Increased turbidity and changes in sediment transport due to harbour.
- Equipment, technical and spillage impacts during construction;
- Impacts on marine water quality;
- Impacts of noise, vibration and disturbances;
- Impacts on landscape integrity/scenery;
- Impacts on soil.
- Impacts on air quality

Impacts on the socio-economic environment

- Impacts on employment and income, potential for local people to have (temporary or long term) job opportunities (and what kind) in the execution of the works;
- Disturbance to local natural resource users such as fishing areas, other tourism ventures nearby;
- Impact equity (economic activities, employment, income);
- Odour and noise impacts;
- Land use displacement and economic opportunities and opportunity costs;

Construction related hazards and risks

- Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
- Risk of accidents and pollution on workers
- Impacts of noise and work-related safety issues.

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". Environmental, social and economic factors should be taken into consideration. The report should highlight how the various alternatives were determined. 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. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given. Mitigation measures shall be detailed to include expected costs of implementation and the personnel responsible for undertaking the mitigation measures.

Task 7. Development of monitoring plan – Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for ground water and sea water quality. Ecological monitoring will be submitted to the EPA to evaluate the damages during construction, after project completion and annually up to one year and then on a yearly basis for five years after. The baseline study described in task 2 of section 2 of this document is required for data comparison. 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. A special attention shall be given to the following:

- Physical parameters such as ground and seawater quality assessments and oceanographic studies shall be provided as required by EPA;
- Biological parameters such as terrestrial monitoring, coral reef and benthic monitoring, fish community census and terrestrial monitoring shall be provided as per guidelines of EPA.

Task 8. Stakeholder consultation, Inter-Agency coordination and public participation) – EIA report should include a list of people/groups consulted and what were the major outcomes. Identify appropriate mechanisms to supply stakeholders and the public with information about the development proposal and its progress. Major stakeholder consultation shall include relevant government ministries, government agencies, engineers/designers, Atoll Council and Utility service providers. The following parties should be consulted;

- Atoll Council

- Ministry of Fisheries, Marine Resources and Agriculture
- Environmental Protection Agency (ERC section)

If the surveys are undertaken at a time where public health emergency is declared due to COVID 19, consultation with stakeholders can be undertaken via conference calls. Public consultations instead of community gatherings can be undertaken as one on one surveys in person, through telephone or through online surveys (evidence and records of this need to be presented). The EIA report needs to be submitted to island council and atoll council and evidence of submission needs to be included in the report. EIA report needs to include a list of those who are consulted, moreover, the report needs annex minutes of any meetings held.

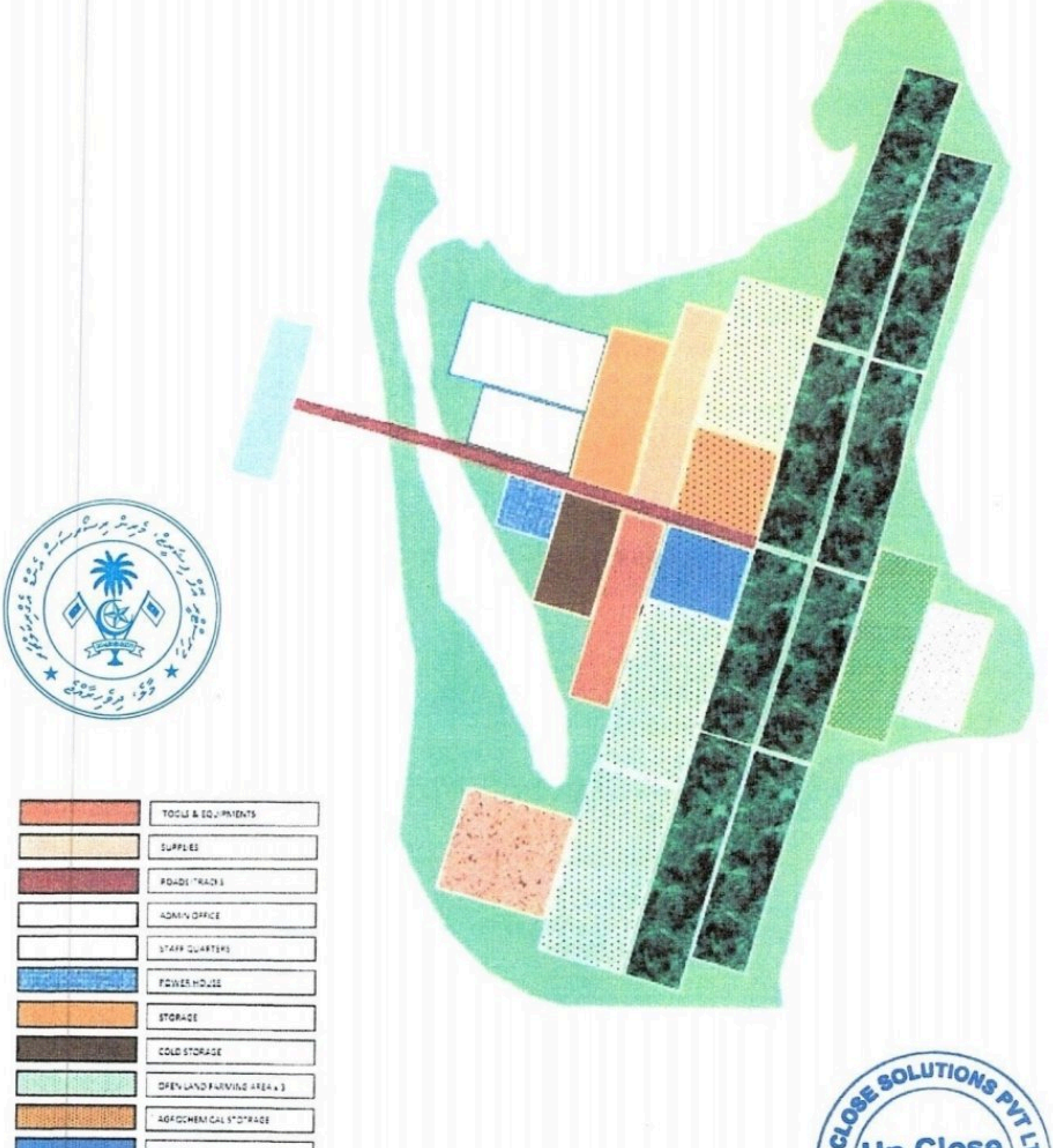
Presentation- The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used 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 and the subsequent amendments.

Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 6 months from the date of this Term of Reference.

17th April 2023

APPENDIX D. APPROVED CONCEPT

Annexure V - Layout of Agricultural Development in Thun'buri Island

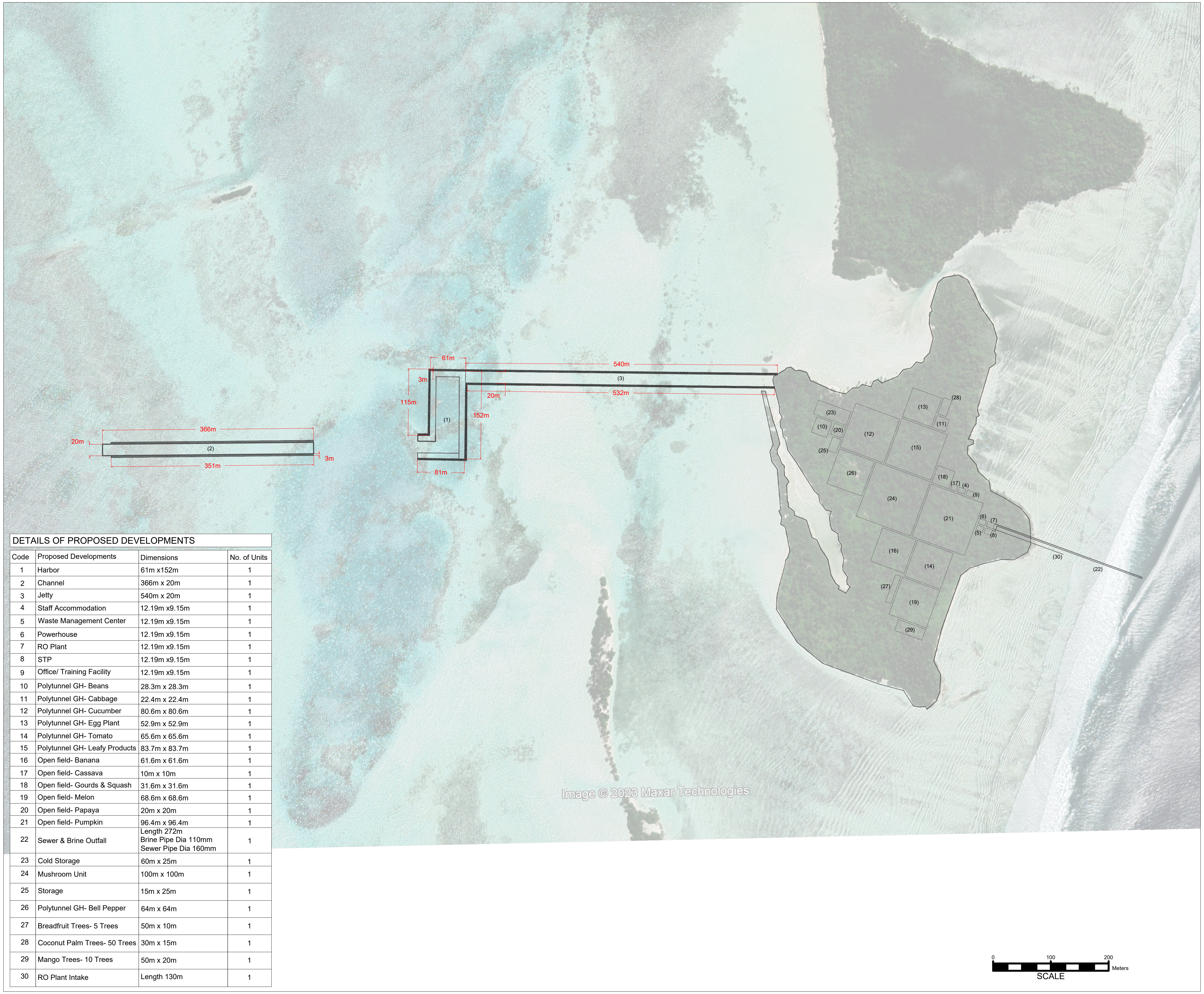


Note: This is a concept drawing and it is not to scale.

Up Close Solutions PVT LTD
C06082022

The Hawks Private Limited
C-109/2007

APPENDIX E. SITE PLAN



DETAILS OF PROPOSED DEVELOPMENTS

Code	Proposed Developments	Dimensions	No. of Units
1	Harbor	61m x152m	1
2	Channel	366m x 20m	1
3	Jetty	540m x 20m	1
4	Staff Accommodation	12.19m x9.15m	1
5	Waste Management Center	12.19m x9.15m	1
6	Powerhouse	12.19m x9.15m	1
7	RO Plant	12.19m x9.15m	1
8	STP	12.19m x9.15m	1
9	Office/ Training Facility	12.19m x9.15m	1
10	Polytunnel GH- Beans	28.3m x 28.3m	1
11	Polytunnel GH- Cabbage	22.4m x 22.4m	1
12	Polytunnel GH- Cucumber	80.6m x 80.6m	1
13	Polytunnel GH- Egg Plant	52.9m x 52.9m	1
14	Polytunnel GH- Tomato	65.6m x 65.6m	1
15	Polytunnel GH- Leafy Products	83.7m x 83.7m	1
16	Open field- Banana	61.6m x 61.6m	1
17	Open field- Cassava	10m x 10m	1
18	Open field- Gourds & Squash	31.6m x 31.6m	1
19	Open field- Melon	68.6m x 68.6m	1
20	Open field- Papaya	20m x 20m	1
21	Open field- Pumpkin	96.4m x 96.4m	1
22	Sewer & Brine Outfall	Length 272m Brine Pipe Dia 110mm Sewer Pipe Dia 160mm	1
23	Cold Storage	60m x 25m	1
24	Mushroom Unit	100m x 100m	1
25	Storage	15m x 25m	1
26	Polytunnel GH- Bell Pepper	64m x 64m	1
27	Breadfruit Trees- 5 Trees	50m x 10m	1
28	Coconut Palm Trees- 50 Trees	30m x 15m	1
29	Mango Trees- 10 Trees	50m x 20m	1
30	RO Plant Intake	Length 130m	1

MAP LEGEND

N

— = Vegetation Line
☐ = Proposed Developments
▨ = Breakwaters
☒ = Geobags

PROJECT TITLE

Development of harbor, jetty, access channel, powerhouse, waste management center, water and sewer facilities at L. Thun'buri

PROJECT DETAILS

PROJECT LOCATION

Atoll: Laamu

Island: Thun'buri

GPS Coordinates: 337616.71 m N and 229383.96 m E

DEVELOPER

Name: The Hawks Pvt Ltd

Address: H Zoneyria, 7th Floor, Malé

CONSULTANT (REGISTERED)

Name:

Address:

CONCEPT DRAWN BY:

Name: Eco-Tech Consultancy Pvt Ltd

Concept No: Thun'buri_V1

Date: 28/03/23

Sheet No: 1

ECO-TECH
CONSULTANCY

APPENDIX F. THUNBURI LEASE AGREEMENT

"ޅ. ގުނބުރި" ކުއްޔަށް ދިނުމުގެ އެއްބަސްވުން

21 ނޮވެންބަރު 2022

بسم الله الرحمن الرحيم

މިނިސްޓްރީ އޮފް ފިޝަރީޒް، މެރިން ރިސޯސަސް އެންޑް އެގްރިކަލްޗަރ
މާލެ، ދިވެހިރާއްޖެ.

ނަންބަރު: (AGR)30-E/PRIV/2022/80

"ށ. ފުނަދޫ" ކުއްޔަށް ދިނުމުގެ އެއްބަސްވުން

މިއެއްބަސްވުމަކީ 21 ޑިސެންބަރު 2022 މީލާދީގައި، މިނިސްޓްރީ އޮފް ފިޝަރީޒް، މެރިން ރިސޯސަސް އެންޑް އެގްރިކަލްޗަރ، މާލެ، ދިވެހިރާއްޖެ މެދުވެރިކޮށް ދިވެހި ސަރުކާރު (މީގެ ފަހުން، **"މިނިސްޓްރީ"** ކަމުގައި ބަޔާންކޮށްފައިވާ) އާއި، (ދަ ހޯކްސް ޕްރައިވެޓް ލިމިޓެޑް (ރަޖިސްޓްރީ ނަންބަރު C-109/2007)، ހ. ޗޭނާރީއާ، މާލެ (މީގެ ފަހުން، **"ކުއްޔަށް ހިފާ ފަރާތް"** ކަމުގައި ބަޔާންކޮށްފައިވާ) އާ ދެމެދު ކުރެވޭ އެއްބަސްވުމެކެވެ.

ދެން ފަހު:

ދިވެހި ދައުލަތުގެ މިލްކިއްޔާތުގައިވާ ށ. އަތޮޅުގައިވާ "ފުނަދޫ" އެވް ހިއާ (މީގައި މާނަކޮށްފައިވާ ފަދައިން، މީގެ ފަހުން **"ރަށް"** ކަމުގައި ބަޔާންކޮށްފައިވާ) ރަށަކީ، ދަނޑުވެރިކަމާގުޅޭ މަސައްކަތްތަކަށްޓަކައި ކުރުމަށް ކުއްޔަށް ދިނުމަށް ސަރުކާރުން ނިންމާފައިވާ ރަށަކަށްވީ ހިނދު، އަދި

މިގޮތުން ދަނޑުވެރިކަމުގެ މަސައްކަތްތަކަށް ކުރުމަށް ރަށް ކުއްޔަށް ހިފުމަށް އެދި ބީޑު ޝާއިއުކުރުމާ (މިއެއްބަސްވުމުގެ ޖަދުވަލު 1 ގައި ހިމެނޭފައިވާ، މީގެ ފަހުން، **"ބީޑު ޝާއިއުކުރުން"** ކަމުގައި ބަޔާންކޮށްފައިވާ) ހުށަހެޅުމުން ކުއްޔަށް ހިފާ ފަރާތުން ހުށަހެޅި ބީޑު ޝާއިއުކުރުމުގެ މިނިސްޓްރީން ދޫކުރި ލެޓަރ އޮފް އެވޯޑު އިން ފާސްވެފައިވާ (ބާރާން ކުރުވުން ސިޓީގެ ކޮޕީ މިއެއްބަސްވުމުގެ ޖަދުވަލު 2 ގައި ހިމެނޭފައިވާ) ކުއްޔަށް ހިފާ ފަރާތަށް ރަށް ކުއްޔަށް ދިނުމަށް ނިންމާފައިވާ ހިނދު،

މީގައި ކަނޑައަޅާފައިވާ ޝަރުޠުތަކާއި މާއްދާތަކާ އެއްގޮތްވާ ގޮތުގެ މަތިން، މިނިސްޓްރީން ކުއްޔަށް ހިފާ ފަރާތަށް ރަށް ކުއްޔަށް ދިނުމަށް އަދި ކުއްޔަށް ހިފާ ފަރާތުން މިނިސްޓްރީގެ ކިބައިން ރަށް ކުއްޔަށް ހިފުމަށް އެއްބަސްވެއެވެ.

1. ތަޢުރީފު

1.1 މި އެއްބަސްވުމުގައި ހިމެނޭ ވަކި ބަހެއް ނުވަތަ އިބާރާތެއް މި ތަޢުރީފުގައި މާނަކޮށްދީފައިވާނަމަ، އެ ބަހަކަށް ނުވަތަ އެ އިބާރާތަކަށް ދެވިގެންވަނީ މީގައި އެ ބަހަކަށް ނުވަތަ އިބާރާތަކަށް ދީފައިވާ މާނަ ކަމުގައެވެ.

މަތީގައި ބަޔާންވެގެންދިޔަ ކަންކަމަށް އެއްބަސްވެ، މި އެއްބަސްވުމުގައި މިނިސްޓްރީއާއި ކުއްތަން ހިފާފަރާތް ސޮއި ކޮށްފައިވަނީ 21 ނޮވެންބަރު 2022 މިތާރީޚްގައި، އެއްވެސް ފަރާތެއްގެ މަޖުބޫރުކުރުމެއް ނެތި، އަމިއްލަ އިޚްތިޔާރުގައެވެ.

މިނިސްޓްރީ

ސޮއި:

ނަން: އިލްޔާސް ނަސީރު

މަޤާމް: ޑިރެކްޓަރ

މިނިސްޓްރީ އޮފް ފިޝަރީޒް، މެރިން ރިސޯސަސް

އެންޑް އެގްރިކަލްޗަރ

ވެލާނާގެ 7 ވަނަ ފަންގިފިލާ

ކުއްތަން ހިފާ ފަރާތް

The Hawks Private Limited
C-109/2007

ސޮއި:

ނަން: ފާތިމަތު އާނިސާ

މަޤާމް: ޑިރެކްޓަރ އޮފް ފައިނޭންސް

އައި.ޑީ. ކާޑު ނަންބަރު: A110819

އެޑްރެސް: މިރްނިކް، ބ. ކަމަދޫ

(ދަ ހޯކްސް ޕްރައިވެޓް ލިމިޓެޑްގެ ފަރާތުން ޕަވަރ

އޮފް އެޓަރނީ ލިބިފައި)

ހެކިން

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ނަން: އަލީ ޝާމިން

އައި.ޑީ. ކާޑު ނަންބަރު: A212716

ދާއިމީ އެޑްރެސް: ޓޫކާވިލާ، ސ. ހިތަދޫ

ހެކިން

ސޮއި:

ނަން: އަބްދުލް އަލީމް އަބްދުލް ޣަފޫރު

އައި.ޑީ. ކާޑު ނަންބަރު: A070745

ދާއިމީ އެޑްރެސް: ފިރިސް، ތ.ވޭމަންޑޫ

APPENDIX G. APRROVED IEE REPORT

2. PROJECT DESCRIPTION

2.1 Project Location

The proposed agriculture development project is located in the island of Thun'buri in Hadhunmathi atoll (Laamu) at 2°04'28.47" N and 73°32'24.41" E. The nearest airport is L. Kahdhoo Airport approximately 22 km south of Thunburi.

The closest islands to the project location are; inhabited island of L. Dhanbidhoo approximately 697 m north of Thun'buri. Other inhabited islands in the project area are; Isdhoo and Kalhaidhoo which is approximately 3.34 km north of L. Thun'buri.

The closest uninhabited islands to the project location are Hulhiyandhoo which is approximately 14 m north of L. Thun'buri and Dhonberahaa which is approximately 343 m southwest of the L. Thun'buri. Holhurahaa which is approximately 300 m south of the L. Thun'buri.

The following figure 1 illustrates the location of L. Thun'buri in Laamu atoll. The figure 2 is an aerial photograph of the L. Thun'buri Island.

Figure 1: Location of L. L. Thun'buri in Laamu atoll

Figure 2: Aerial view of L. L. Thun'buri

2.2 Need and Justification for the project

Agriculture is one of the most important sectors of the Maldivian economy. However, the agriculture sector requires significant development in the Maldives. The contributions of the agriculture sector and fishery sector to GDP have been declining (agriculture 1.3% and fishery 4.2% of GDP as of 2018). Due to this decline in agriculture, large quantities of fruits and vegetables are imported to the country. These include stable crops, vegetables and fruits which can be grown in the Maldives. Furthermore, significant quantities of poultry products are imported to the country.

The COVID19 pandemic has exposed the vulnerability of the country in terms of food security. The Government of Maldives has initiated many policies, programmes and projects to ensure the food security of the country. This includes establishment of Agro-National Corporation (AgroNat) which develop the capacity of the local farmers by ensuring their produce will have a reliable market demand. The proposed agriculture development project in L. Thun'buri is expected to contribute the policies of the Government of Maldives to ensure the food security. This project aims to achieve this through establishment of adequate facilities for poultry farming and cultivation of crops which would increase the import of these products from abroad.

2.3 Project Components

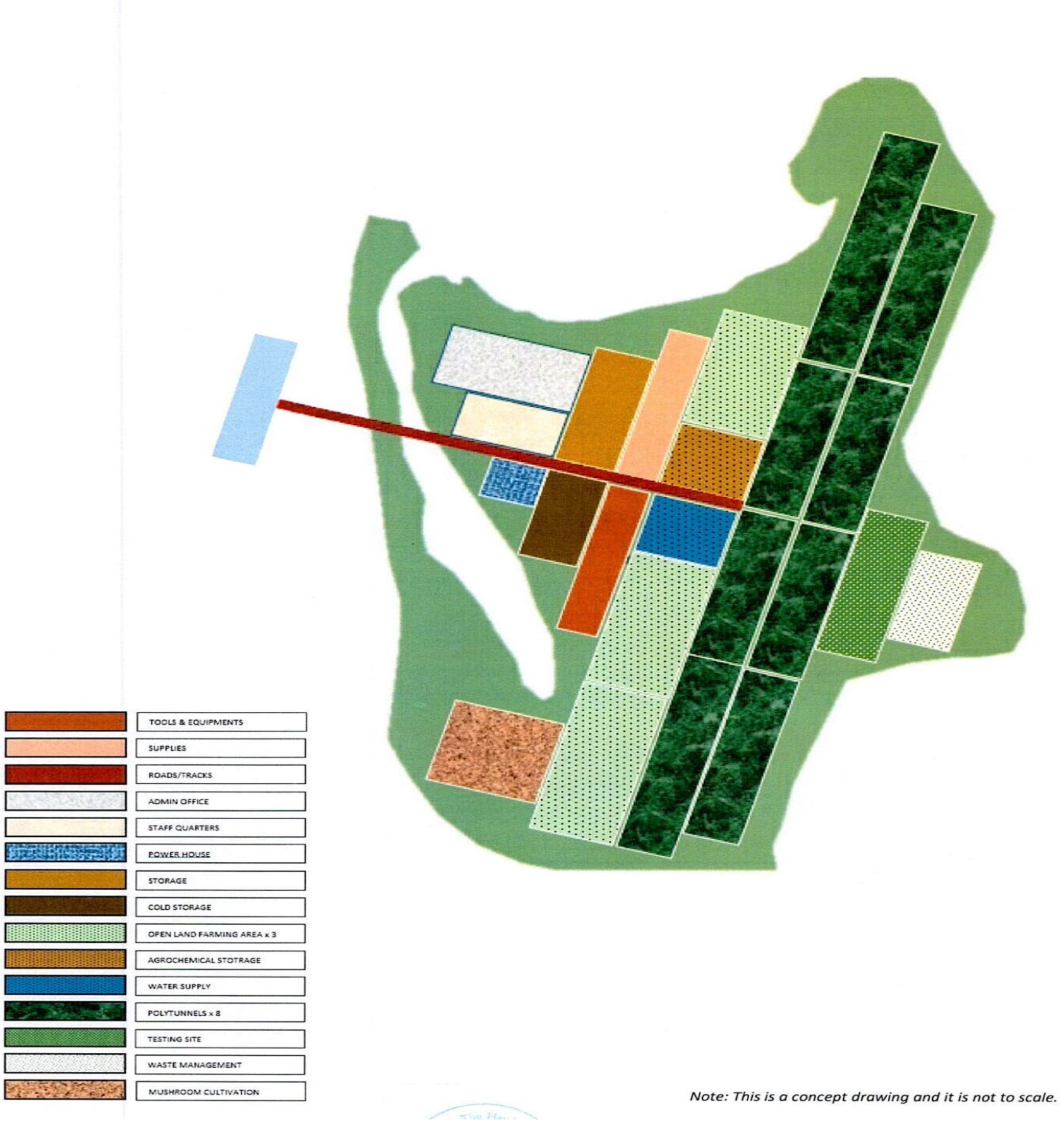
The project mainly involves agricultural developments in L. Thun'buri. The main componnents of the projects include;

- Develop environment friendly and sustainable agriculture in L. Thun'buri integrating three main goals; environmental stewardship, agriculture profitability and contribution to local and national economy. Sustainable agriculture in the island will facilitate to grow vegetables, fruits, etc without causing irreversible damage to ecosystem health.

- Develop agriculture production in the island with state-of-the-art technology and giving preference to environmentally friendly production principles (i.e. preserving natural vegetation as a natural wind break and as a mean of biodiversity conservation, rainwater harvesting to minimize use of water from desalination plants, minimize waste disposal, use of efficient modern technology in water and energy management.
- Produce agricultural products (Vegetables, Mushrooms etc.) to cater to the demands of the resorts and the country and save foreign exchange on imports of such produces.

2.4 Site Plan

The following figure 03 illustrates the layout plan for the proposed infrastructure which will accompany the agriculture development project in L. Thun'buri.



Note: This is a concept drawing and it is not to scale.

Figure 3: Layout plan for the infrastructure proposed at L. Thun'buri

The schematic diagrams for the proposed infrastructure have been included in the Annex 4 of this IEE report.

2.5 Availability of water, electricity, and other utility services

The following table 01 include information availability of the utility services such as water and electricity and how they will be obtained during construction and operational phase of the project.

Table 1: Information on utility services during construction and operational phase of the project

Utility Service	Construction Phase	Operational Phase
Water	Will be obtained from a desalination plant established in the island. The water and sewerage Act (2020) prohibits utilization of any groundwater for agricultural or industrial purpose.	Will be obtained from a desalination plant established in the island. The water and sewerage Act (2020) prohibits utilization of any groundwater for agricultural or industrial purpose.
Electricity	A stand-alone generator system will be established in the island during construction phase.	A powerhouse will be constructed and all the infrastructure will be connected via an electricity grid.
Sanitation	On temporary site-septic tank will be established.	A wastewater collection system and wastewater treatment plant will be established in the island.
Waste Management	Will be collected and transferred to island waste management centre in L. Dhanbidhoo.	Will be collected in a designated area and transferred to island waste management centre in L. Dhanbidhoo. Hazardous waste such as pesticides will be stored in accordance with the Waste Management Regulation 2013.

3. SURVEY METHOLOGIES

This section of the report will describe the survey methods used by the Environmental Consultants to collect and record the baseline environmental conditions in L. Thun'buri.

3.1 General Methodology of Data collection

The methodologies used for scientific analysis of the environment are standard and internationally accepted methods of environmental assessment. Coastal and marine environment was studied using the methods and parameters that is widely practiced.

3.2 Mapping and location Identification

The reef line, shoreline and vegetation line and existing infrastructure were mapped. Mapping was undertaken using standard DGPS and mapped on AutoCAD and ArcGIS.

3.3 Marine Survey

3.3.1 Photo Quadrat Methodology

An underwater drone was utilized instead of the snorkeler taking the photo from GoPro Digital Camera. However, in shallow areas GoPro Digital Camera was used to take photograph.

Equipment

- Gladius Mini Underwater Drone with Camera
- GoPro Digital Camera

Figure 4: Photograph of the underwater drone used

Procedure

- Survey sites were selected, and at each site the start point was marked, and the geographical coordinates were recorded.
- Underwater photographs were taken using the aforementioned underwater drone every 5 meters.
- On completion of the survey, the digital photographs were processed using Coral Point Count with Excel extension. For each quadrat image 20 random points were selected, and counted using the software.

- The mean count for each substrate type (e.g. Live Coral, Dead Coral with Algae (DCA), Sand/Rubble/Rock (SPR) etc.) was then calculated for the respective sites.

3.3.2 Fish Belt Transect Methodology

Similar method used for the photo quadrat survey was used to determine the quantitative assessment of the fish census.

Equipment

- Gladius Mini Underwater Drone with Camera
- GoPro Digital Camera

Procedure

- Fish belt transect surveys were carried out during day time hours
- The same starting point was used for the transect as
- The Underwater Drone was run for a distance of 5 meters while recording the video.
- Abundance categories recorded: Single (S - 1 Fish), Few (F - 2-10 Fishes), Many (M - 11 – 100 Fishes), and Abundance (A - > 100 Fishes)

3.4 Water Quality

The quality of the marine water in the proposed development site was assessed by testing water samples at location shown in figure 06. The samples were tested at the MWSC laboratory. The parameter that was tested are temperature, pH, salinity, turbidity, conductivity, Total Suspended Solids (TSS), Nitrate, Nitrite, Nitrogen Ammonia, Sulphate and Phosphate.

3.5 Uncertainties in Data Collection Method

Since most of the data on the existing environment was collected manually, human error could be the biggest uncertainty with reference to the data collection methods. However, Global Positioning System (GPS) coordinates have been recorded for future monitoring purposes. This utilization of GPS will reduce human error as exact GPS points can be monitored in future to assess changes as the result of project interventions.

Other uncertainty in the field data collected could be the timing in which assessments were conducted. The conditions in the existing environment such as waves, currents and fish populations changes from season to seasons. Nonetheless, the methods used for collection of data is very popular for environmental monitoring endeavors.

Another aspect which requires special consideration which may affect the uncertainty of the data collected is limited time spend on field for environmental data collection. As a result of this, some of the assessments especially on the marine environment were done rapidly as a vast area from the surrounding environment has to be covered as part of this IEE.

4. DESCRIPTION OF EXISTING ENVIRONMENT

This section of the report will focus on the existing environment at L. Thun'buri. The main focus will be given to the existing terrestrial environment, beach environment, marine aquatic environment and sea/ground water quality of the island.

4.1 Survey Locations

The following table 02 enlist the geographical coordinates of surveyed locations. This include the marine transects and marine and ground water quality. Map showing the surveyed locations including locations of water samples is given in Annex 4 of this IEE report.

Table 2: Geographical coordinates of surveyed locations during field visit

Location	Significance	GPS Coordinates
WS1	Marine Water sample location 1 Marine Transect and Fish Census Survey Location	E 337388.6 N 229294.0
WS2	Marine Water sample location 2	E 337829.9 N 229507.6
Ground Water Well	Groundwater Sample Location	E 337607.4 N 229486.5

4.2 Terrestrial Environment

The terrestrial environment of the island consisted of two main components; they are the beach environment and the vegetation. The vegetation consisted of coastal vegetation and the inner vegetation. Some grass areas are within the island however, these area is significantly small. These grass areas are due to vegetation clearance for agricultural purposes by previous users of the island. The beach environment consisted of sandy beach areas, boulders and rubble area and beach-rock areas.

4.2.1 Vegetation

The vegetation area of the island was estimated as approximately 17.6 hectares. A detailed map showing the vegetation line of the island is attached in the Annex 4 of this IEE report. The coastal vegetation is intact throughout the island. The coastal vegetation is dominated by *Scaevola taccada* (Magoo), *Pemphis acidula* (Kuredhi) and *Guettarda speciosa L.* (Uni gas). The mangrove area was dominated by *Pemphis acidula* (Kuredhi). There were no mangrove species found at the mangrove area such as *Rhizophora mucronta* (Randoo) and *Bruguiera cylindrica* (Kandoo).

Figure 5: Coastal vegetation found at L. Thun'buri

Figure 6: The vegetation found at the Mangrove area at L. Thun'buri

The inland vegetation was dominated by Cocos nucifera L. (Coconut Palm), *Pendanus tectoris* (Screwpines), and *Heliotropium foertherianum* (Boashi).

Figure 7: In land vegetation found in L. Thun'buri

4.3 Beach Environment

There is no major beach area in L. Thun'buri. Only a minor beach area is present at the southeastern side of the island. This area beach is also mainly dominated by coarse pebbles (hakiri) sediments. All the other areas consisted only consisted of rubble and boulder beach.

Figure 9: The beach area at southeastern side of the island

Figure 8: Beach environment at other locations of L. Thun'buri

4.4 Coastal Dynamics

Figure 10: Satellite image of L. Thun'buri 2006, 2011, 2020 and 2016 (Clockwise)

The satellite imagery suggests that there are no major accretion and erosion events taking place in L. Thun'buri. This may be due to intact nature of the coastal vegetation throughout the island due to minimal anthropogenic activities. However, due to development of agricultural facilities it is expected to have impact on the coastal dynamics especially due to the construction of a harbour in the island.

4.5 Marine Environment

Due to the nature of the project interventions, only the location where the proposed harbour construction is analyzed. No major impacts are anticipated on the remaining locations of the marine environment since the project will only involve construction of facilities in the terrestrial environments. The proposed location for the harbour construction is shown in the Annex 4 of this IEE report.

4.5.1 Benthic Substrate and Coral Cover

The main category of substrate found in the marine survey location is Sea Grass (Macro Algae) which accounted for 52% of the total coral cover. The species which was abundant at the proposed harbour site was Halimeda *minima.* Sand, Rubble and Pavement was observed at the marine survey location which accounted for 48% of the coral cover. There were no live coral observed in the marine survey location.

The following figure 11 illustrates the percentages of categories of the coral cover found at the marine survey location and Figure 12 are photographs taken from the marine survey locations.

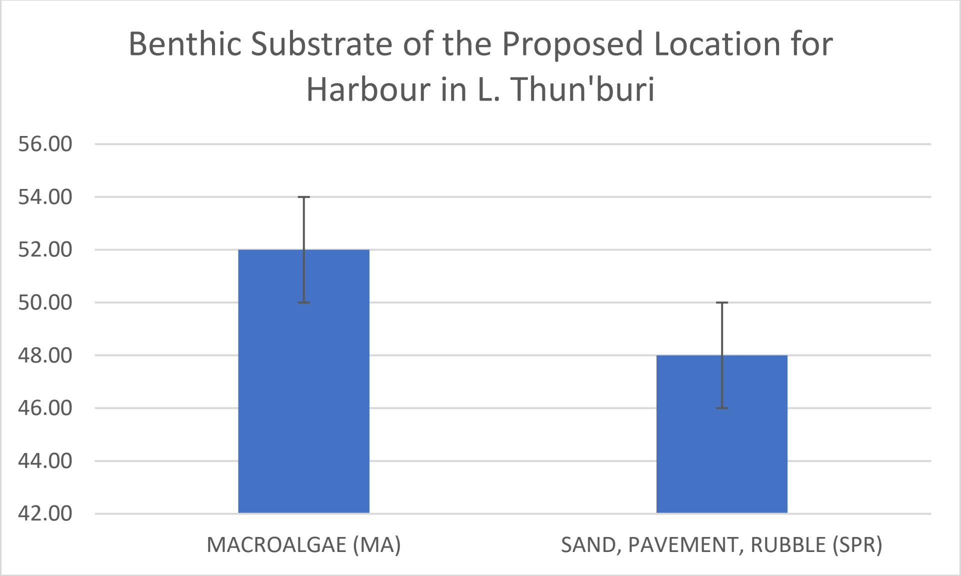


Figure 11: Percentage of Categories of Coral Cover found at the Marine Survey Location

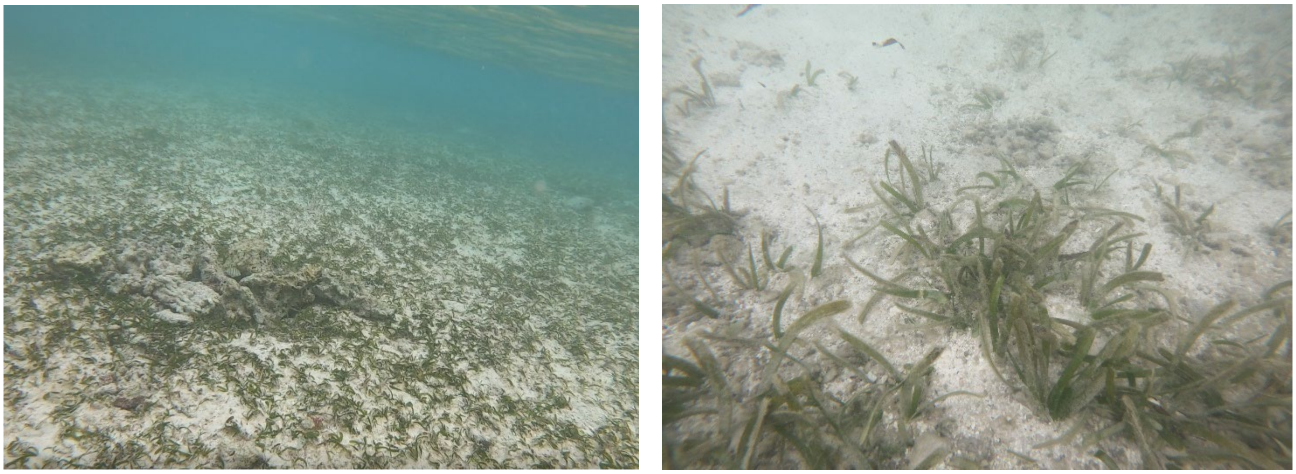


Figure 12: Benthic substrate found at the proposed location for harbour construction

4.5.2 Fish Census Survey

The fish census survey was conducted at the marine survey location. Dominant fish types observed across all sites were *Chaetodon ocellicaudus* (Spot-tail butterfly fish) and *Lethrinus erythracanthus* (Spotted emperor). A summary of fish species recorded at each survey location is presented in table 2 below.

Table 3: Fish Species Abundance at Marine Survey Location (S: 1, F: 2-10, M: 11-100, A: > 100)

Fish Species	Abundance Category
Chaetodon ocellicaudus	M
Lethrinus erythracanthus	M
Abudefduf saxatilis	S
Abudefduf bengalensis	S
Chrysiptera brownriggii	S
Chaetodon ocellatus	S
Halichoeres scapularis	S
Chaetodon lunula	S
Acanthurus triostegus	S
Acanthurus thompsoni	S

4.6 Marine Water Quality

Marine water quality was taken from two different locations from the lagoon in L. Thun'buri. It was analysed in the Water Quality Assurance Laboratory of Male' Water and Sewerage Company (MWSC). The Water Quality test reports has been attached to the Annex 2 of this IEE report.

The table 05 illustrates the water quality results from L. Thun'buri. The parameters are well within the acceptable ranges for marine water quality except for Sulphate which was very high in both of the tested location. Sulphate concentration shall be less than 250 mg/L according to Wastewater quality guideline (2007). The sulphate concentration was found to be 1350 mg/L at WS01 and 1300 mg/L at WS02. pH range of 8.10 – 8.21 which is within the optimal range for pH in marine water. The level of turbidity was found between 0.410 NTU at the WS01 and 0.167 NTU at the WS2 respectively which is within the acceptable range for sediment level in marine waters.

Table 4: Results of the Marine Water Quality Analysis

Parameter	**WS01**	**WS02**
GPS Coordinates	E 337388.6 N 229294.0	E 337829.9 N 229507.6
Physical Appearance	Clear with particles	Clear with particles
Temperature (° C)	25.0	25.1

pH	8.21	8.10
Conductivity (µS/cm)	51400	51400
Turbidity (NTU)	0.410	0.167
Salinity (%)	33.80	33.74
Total Suspended Solid (TSS) (mg/L)	< 5 (L_0Q 5 mg/L)	5
Nitrate (mg/L)	4.4	4.3
Nitrite (mg/L)	0.009	0.006
Nitrogen Ammonia (mg/L)	0.10	0.05
Sulphate (mg/L)	1350	1300
Phosphate (mg/L)	0.05	0.06

4.7 Groundwater Quality

The groundwater quality was analyzed from a sample taken from an existing well in the island used for agricultural purposes. The Table 05 includes the results of the groundwater quality tests. The results suggest high level of Total Suspended Solids (TSS) which may be due to accumulation of sediments since the well from which water samples were collected has not be used for some period of time. High levels of Phosphates and Nitrigen Ammonia was recored which is consistent with agricultural fertilizers being used in the island by previous users of L. Thun’buri.

Table 5: Groundwater quality test results for L. Thun'buri

Parameter	GW01	Permissible Level[1]
GPS Coordinates	E 337607.4 N 229486.5	
Physical Appearance	Pale yellow with particles	
Temperature (° C)	24.6	Not more than 3°C above the receiving water
pH	7.7	6-9
Conductivity (µS/cm)	9240	Equal or less than receiving groundwater
Turbidity (NTU)	0.142	N/A
Salinity (%)	5.55	N/A

---

[1] Regulation for protection and conservation of groundwater resources (2021/R-21). The permissible level is for groundwater recharging purposes.

Total Suspended Solid (TSS) (mg/L)	**24800**	15
Nitrate (mg/L)	4.7	6
Nitrite (mg/L)	0.225	N/A
Nitrogen Ammonia (mg/L)	**24.5**	5
Sulphate (mg/L)	188	250
Phosphate (mg/L)	**1.24**	1

5. ENVIRONMENTAL IMPACTS

This section of the report will describe the potential environmental impacts anticipated due to the proposed project activities. The table 06 illustrates the main environmental impact predicted due to the project interventions. Table 06 is the prescribed template for Initial Environmental Examinations as per the Schedule E2 of the Environmental Impact Assessment Regulation (2012).

Table 6: The predicted environmental impacts anticipated with the project interventions

Environmental Component	No Impacts	Positive Impact	Negative Impact	Direct Impact	Non-direct impact
Seabed			Direct habitat destruction in the location where the harbour construction is proposed.	Direct habitat destruction in the location where the harbour construction is proposed.	
Marine Water Quality			Temporary deterioration of marine water quality due to sedimentation due to dredging for harbour construction.	Temporary deterioration of marine water quality due to sedimentation due to dredging for harbour construction.	Runoff of fertilizers and pesticides used for cultivation of the crop.
Marine Life			Direct habitat destruction in the location where the harbour construction is proposed.	Direct habitat destruction in the location where the harbour construction is proposed.	Vibration and noise pollution. Deterioration of water quality.
Wide Beaches			Changes in erosion and accretion pattern due to harbour construction.	Changes in erosion and accretion pattern due to harbour construction.	
Reefs			Temporary impacts due to sedimentation.	Temporary impacts due to sedimentation.	

Seagrass Beds	Complete destruction of sea grass bed from harbour construction.				
Wetlands and Mangroves			Complete destruction of the mangrove area in L. Thun'buri	Complete destruction of the mangrove area in L. Thun'buri	Loss of biodiversity of mangrove flora and fauna.
Vegetation			Complete clearance of natural vegetation found in L. Thun'buri.	Complete clearance of natural vegetation found in L. Thun'buri.	Loss biodiversity
Introduction of alien species			Introduction of pest and alien species due to cultivation activities.		
Changes to natural environment			Complete change to the natural terrestrial environment including significant vegetation clearance and destruction of mangrove ecosystem.		
Air Quality			Temporary deterioration of air quality due to construction activities including		

			vegetation clearance.		
Groundwater Quality			Seepage of fertilizers and pesticides from cultivation of crops.		
Availability of Freshwater			Demand on groundwater due to agricultural activities.		
Noise Pollution			Noise pollution during the construction phase and operation of poultry farm.		
Public Health	L. Thun'buri is an uninhabited island.				
Public Safety	L. Thun'buri is an uninhabited island.				
Public Transport	L. Thun'buri is an uninhabited island.				
Employment Opportunities		The employment opportunity for the residents of nearby island to work in the agricultural island and also during construction phase.			
Livelihood					Due to production of crops and poulty products at large

					scale may impact the livelihood of farmers in nearby inhabited islands.
Public Perspective		The project is expected to improve the food security of the country and reduce dependence on imported agricultural products.			Negative perception of project due to destruction of mangrove ecosystem.

ADDITIONAL INFORMATION

Laamu. THUNBURI (Republic of Maldives)

— LOW TIDE LINE
AREA= 194400 Sqm (19.4 Ha)

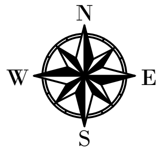
— HIGH TIDE LINE
AREA= 163221 Sqm (16.3 Ha)

— VEGETATION LINE
AREA = 175620 Sqm (17.6 Ha)

▨ Beach Rocks

— LOW TIDE LINE
length 2394m

— HIGH TIDE LINE
length 2570m



No.	Revision/Issue	Date

PROJECT TITLE
Topographic Survey for
L.Thunburi (Maldives)

CLIENT NAME AND ADDRESS
Hawks Pvt Ltd

Surveyed by: Qismath Qasim
Date : June 2022
Reg.Surveyor : Qismath Qasim
Checked by : Mohamed Haikal Ibrahim
Scale : AS SHOWN
Sheet Name : Site Layout

Drawn by: QISMATH
Date : June 2021
Dwg no: 01-2022/SUV-QQ
Sheet 1 / 3

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
Quality Assurance Building, 1st Floor, Male' Hingun, Vilimale', Male' City, Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

LB-TEST-090

WATER QUALITY TEST REPORT
Report No: 500192020

Customer Information:
Hamdhoon Mohamed (A076983)
G.Maavaarulu
Shabnam Magu
-

Report date: **04/07/2022**
Test Requisition Form No: **900194865**
Sample(s) Recieved Date: **30/06/2022**
Date of Analysis: **30/06/2022 - 30/06/2022**

Sample Description ~	GW01	**TEST METHOD**	**UNIT**
Sample Type ~	Ground Water		
Sample No	83230375		
Sampled Date ~	29/06/2022 09:30		
PARAMETER	**ANALYSIS RESULT**		
Physical Appearance	Pale yellow with particles		
Conductivity *	9240	Method 2510 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	µS/cm
pH *	7.7	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	-
Salinity	5.55	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	‰
Temperature	24.6	Electrometry	°C
Nitrate *	4.7	HACH Method 8171	mg/L
Nitrite	0.225	HACH Method 8507	mg/L
Nitrogen Ammonia	24.5	HACH Method 8038	mg/L
Sulphate *	188	HACH Method 8051	mg/L
Phosphate *	1.24	HACH Method 8048	mg/L

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

Checked by

Aminath Sofa
Laboratory Executive

Approved by

Nihaz A. Zahir
Assistant Quality Manager

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 provided by the customer. This information may affect the validity of the test results.
*Parameters accredited by EIAC under ISO/IEC 17025:2017

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

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
Quality Assurance Building, 1st Floor, Male' Hingun, Vilimale', Male' City, Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

LB-TEST-090

WATER QUALITY TEST REPORT
Report No: 500192019

Customer Information:
Hamdhoon Mohamed (A076983)
G.Maavaarulu
Shabnam Magu
-

Report date: **04/07/2022**
Test Requisition Form No: **900194865**
Sample(s) Recieved Date: **30/06/2022**
Date of Analysis: **30/06/2022 - 03/07/2022**

Sample Description ~	WS01	WS02	**TEST METHOD**	**UNIT**
Sample Type ~	Sea Water	Sea Water		
Sample No	83230373	83230374		
Sampled Date ~	29/06/2022 09:00	29/06/2022 09:00		
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Clear with particles	Clear with particles		
Conductivity *	51400	51400	Method 2510 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	µS/cm
pH *	8.2	8.1	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	-
Salinity	33.80	33.74	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	‰
Temperature	25.0	25.1	Electrometry	°C
Total Suspended Solids	<5 (LoQ 5 mg/L)	5	HACH Method 8006	mg/L
Turbidity *	0.410	0.167	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Nitrate *	4.4	4.3	HACH Method 8171	mg/L
Nitrite	0.009	0.006	HACH Method 8507	mg/L
Nitrogen Ammonia	0.10	0.05	HACH Method 8038	mg/L
Sulphate *	1350	1300	HACH Method 8051	mg/L

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

Checked by

Aminath Sofa
Laboratory Executive

Approved by

Nihaz A. Zahir
Assistant Quality Manager

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WATER QUALITY TEST REPORT

Report No: 500192019

Customer Information:
Hamdhoon Mohamed (A076983)
G.Maavaarulu
Shabnam Magu
-

Report date: **04/07/2022**
Test Requisition Form No: **900194865**
Sample(s) Recieved Date: **30/06/2022**
Date of Analysis: **30/06/2022 - 03/07/2022**

Sample Description ~	WS01	WS02	**TEST METHOD**	**UNIT**
Sample Type ~	Sea Water	Sea Water		
Sample No	83230373	83230374		
Sampled Date ~	29/06/2022 09:00	29/06/2022 09:00		
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Clear with particles	Clear with particles		
Phosphate *	0.05	0.06	HACH Method 8048	mg/L

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

Checked by

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

5.2.2 Soil

The soils are geologically young and consist of substantial quantities of the unweathered coral parent material, coral rock, and sand. In most of the places, soils are coarse in texture and shallow in depth with a top layer of brown soil (0 to 40 cm in depth) followed by a transition zone on top of the underlying parent material of coral reef limestone (MFAMR, 1995). The water-holding capacity of the soil is very poor due high porosity and very high infiltration rates.

The soils of the Maldives are generally alkaline with pH values between 8.0 and 8.8. This is mainly due to the presence of excess calcium. The soils are generally poor and deficient in nitrogenous nutrients, potassium, and several micronutrients particularly iron, manganese, and zinc. Though the phosphorus content of the soils is high, it is present mostly in the form of calcium phosphate and, thus, remains unavailable to plants (Selvam, 2007).

The soils of Thun'buri island are relatively fertile. In terms of fertile soil and humus contents, the soils in the central areas are more fertile whereas the soils in the periphery are less fertile like other islands in the country. The waterlogged area of the Island has considerable amount of muddy soil, more humus and water. In general, the soils of the Island can be categorized as fertile and suitable for agriculture.

Table 5.2 : Average Reference Crop Evapotranspiration at Male, Maldives

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Reference Evapotranspiration* (ET_o) (mm/day)	4.88	5.24	5.34	5.13	4.70	4.53	4.58	4.59	4.66	4.50	4.29	4.32

**Reference crop evapotranspiration calculated based on FAO Penman-Monteith Method for Male, Maldives using FAO CropWat 8.0 model (using CLIMWAT 2.0 for CropWat 8.0) (Muñoz and Grieser, 2006; Clarke et al., 2001).*

6 INVESTMENT ON SUPPORT INFRASTRUCTURE

An investment of MVR 19.8 million will be made to the Support Infrastructures within the first 3 years period (Refer 9.2.1 Projected Capex Budget, Page 36 & 37 under Financials). Details of these investments are given below.

6.2 General Infrastructure

6.2.1 Jetty

Interconnection between islands within atoll and other atolls are mainly dependent on sea transportation. The Jetty component is vital while developing an island for any purpose and this proposal focuses on the development of Thun'buri island for agriculture. During the development and operational stages, the jetty will act as the pivoting point of all the operations carried out on the island.

The northwestern side is selected to build the jetty (Annexure II) by considering the orientation of the Island. At the initial stage of the development, the jetty will be constructed for approximately 60 m in length, including a quay wall (Figure 6.1 and 6.2) which can be extended during future development. This component will consist of an enclosed area for boats to dock, a ramp to enable landing craft operation, and a quay wall for further loading and unloading operations of vessels. The jetty is designed and located so that the beach sediment dynamics will not be obstructed hence potential risk of beach erosion due to the jetty is minimized.

The jetty design will comply with British Standard Specifications or Coastal Engineering Manual (US Army Corps of Engineers, 2008) published by the US Army Corps of Engineers. Furthermore, Concrete 'L' Blocks will be used to construct the 45 m length docking area, and capping beams on top of sheet piles would be used for the rest of the extension. Sea bathymetry will be deepened depending on the requirement to ensure safe maneuver of dhoanies, boats, and other vessels to the island.

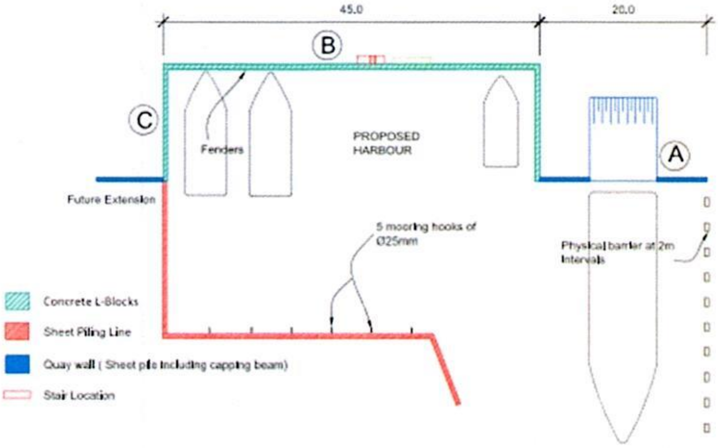


Figure 6.1. Schematic diagram of the proposed jetty

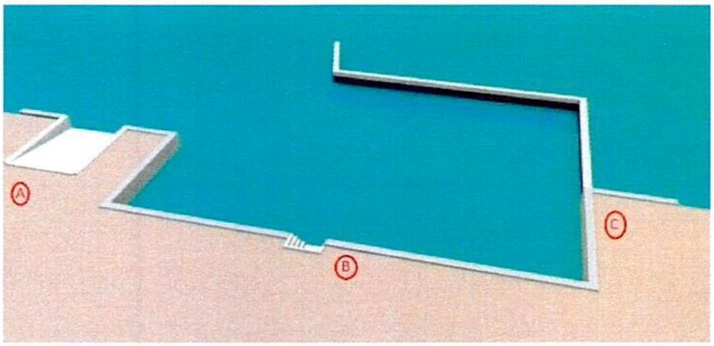


Figure 6.2. Jetty

6.2.2 Common Roads

The internal roads are provided for vehicle movements to and from the site, and the accommodation of farm vehicles on site. The objectives of the internal roads and parking areas are to ensure the movement of vehicles for farm operations, support the safe and efficient operation of the farm, and minimize adverse impacts on nearby operation units. Internal roads and parking areas are designed to ensure efficient traffic flow and to reduce the need for vehicles to reverse. The layout allows ease of access to the site, avoids the use of sharp turns, provides sufficient road width for truck turning movements and for vehicles to leave the farm travelling in a forward direction. The proper handling of internal road transportation is important for biosecurity.

A three-meter-wide ABC and Interlocking pavement road will be constructed from jetty to the agricultural area (approximately 150 m). Coral sand stabilized road of the width of 3 m will be provided within the agricultural area (approximately 1000 m). The roads will be concreted to allow easy movement of vehicles and agricultural machinery to facilitate convenient transportation of inputs and products.

6.2.3 Power plant

For electricity generation, three 600 kW Diesel Generators will be installed together with solar panels at the site to cater for all the power needs. One of the two Generators will operate at a given time and other one will serve as a standby Generator. The Generators will be housed within a powerhouse with attenuator, chimney, and insulated walls. It is anticipated that around 5,000 litres of diesel per day will be consumed. A fuel storage tank available with the company with a storage capacity of 50,000 litres will be positioned to store fuel.

6.2.4 Solar Power

The Thun'buri Island belongs to 'Laamu' atoll is dense with existing natural trees. Development of this island for agriculture requires removal of natural habitat trees to obtain required space for cultivation. Even though agriculture is an essential element for the country, it is the utmost requirement to minimize the impact caused to the environment due to disturbance for the fauna and flora. Throughout this development proposal for the island, The Hawks Pvt. Ltd has taken several steps to implement various interventions to reduce the impact caused to the environment. In this process, The Hawks have planned to utilize a considerable investment in solar photovoltaics to harness solar power to provide a portion of electrical power required for the plants and equipment used in the greenhouses and other agriculture production.

Solar energy is one of the cleanest and easily accessible renewable energy sources available in Maldives. Solar Photovoltaic Panels are used to harness and transform the continuous flow of energy from the sun to electricity. Unlike diesel power plants, no harmful greenhouse emissions are released into atmosphere when electricity is generated from the Solar Panels.

A 400kWp Grid-Tied Solar Photovoltaic System (PV) is proposed to be installed along with the Diesel Power Plant to generate the required electricity for the island. The proposed PV system is expected to produce and cater at least 30 percent of the electricity load utilized in the Island during the daytime. It is planned to use the available roof space of $4000m^2$ from the office, and accommodation buildings to install Solar Panels required to deploy the PV System. It is recorded in the Maldives that 1kW of Solar Panels installed on the rooftop can generate approximately 4.5kWh of energy in a fair-weather day.

The proposed PV System has a lifespan of 25 years with a degradation of performance less than 1% per year. By installing the proposed PV System, it is expected to produce 771,750kWh of energy annually. The same amount of energy can be produced from a Diesel Power Plant by burning 237,250 litres of diesel and releasing 2,507.01 tonnes of carbon dioxide to the atmosphere. Considering the environmental impact, it will require at least 28 matured trees to neutralize such amount of carbon dioxide from the air.

Operation and maintenance of the PV System is extremely low compared to producing electricity from a diesel power plant. The Solar Panels are guaranteed to work for its life span of 25 years with a little or less maintenance work. The operation costs of the PV System are less than 90% of the operation costs of a diesel power plant.

The proposed PV System is scalable and extensible. In the future, the clean energy contribution to the project's electricity infrastructure can be increased by utilizing Energy Storage Systems and additional Solar Panels. With integration of such equipment, solar energy harnessing can be further extended up to 100% load of the project's electricity demand.

6.2.5 Water treatment plant

A containerized desalination solution with Reverse Osmosis membrane process with a capacity of 150 TPD is proposed with a stand-by system of 50 TPD (a sample schematic diagram of a system is given in Figure 6.3). The expected output water quality is with Salinity (TDS) <500mg/L, pH 6-8 and Turbidity <0.2NTU. An RO plant with following features is proposed.

- 3 steps filtering process including sand filter, pre-filter, and main filter to ensure better protection for high pressure pump, energy recovery device and RO membrane.
- Quick installation and commissioning (A system where most of the installation is completed before delivery)
- Wet parts are made of duplex, SS904L, UPVC or other plastics and the heavy-duty marine paint is used for frame and container.
- User friendly control by touch screen with remote control
- In case of malfunction, the whole system can be restored quickly by using standard parts.

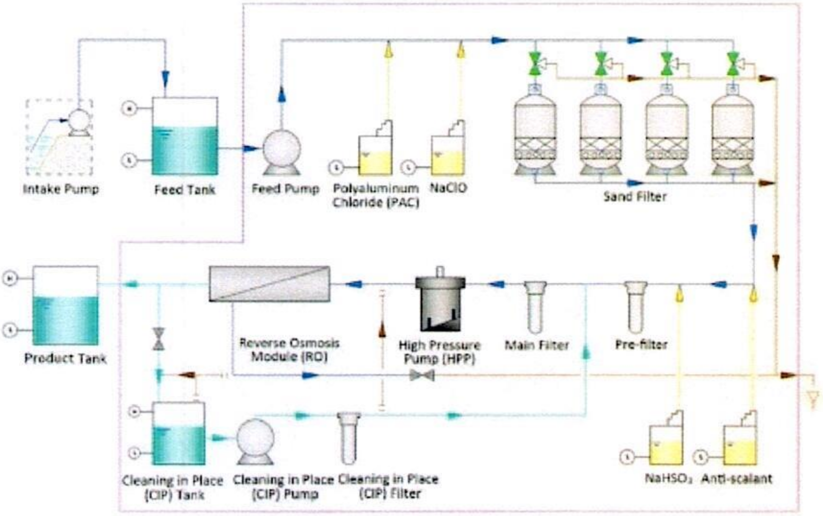


Figure 6.3: Schematic diagram of the proposed RO system (Source: www.idesalt.com)

The 150 TPD RO plant will be used to produce sufficient water to meet the peak demand when any other water source is not available (rainwater harvested, treated wastewater). As the water requirement of the farm will be met with combination of desalinized water, harvested rainwater and treated wastewater, no ground water will be pumped. As a considerable amount of harvested rainwater will be used, the RO plant will be operated when and where necessary. Five tanks of the capacity 10,000 L each will be installed with the RO plant to keep a store of 50 m^3 at all the times. Hence, the RO plant will be operational in most instances during off peak hours.

6.2.6 Rainwater Harvesting and Reuse of Treated Wastewater

A considerable amount of rainfall is received distributed in nine months. Rainwater harvesting is proposed, as a considerable amount of rainwater can be captured using the roofs. The proposed infrastructure provides a total of 27,700 m^2 of roof catchment. Considering the long-term average rainy days and the average rainfall received during these rainy days, and considering a runoff coefficient of 0.8, the rainwater amounts that can be captured were calculated. Based on the amounts of water that could be harvested, 10 numbers of 10,000 L water tanks are proposed to be installed enabling to store 100 m^3 of rainwater. When accommodation building and office building space are considered, additional amounts of rainwater can be harvested by providing storage tanks.

Based on the calculations, a minimum of 17,710 m^3 of water can be harvested and used for agricultural purposes. This amount contributes to 35% of the annual total water requirement of the farm.

The only freshwater resource on these islands is a groundwater lens, which floats atop a denser salt-water layer. Because of the size of the islands and the low elevation, the aquifer capacity is limited and can support only a modest population on each island (Wickramagamage, 2017). Only viable options were rainwater harvesting and desalinization. Most economical option is rainwater harvesting. Depletion of the freshwater lens in small islands is faster than in large islands (Bailey, Khalil and Chakitavajin, 2014). Therefore, the groundwater lens will be kept intact to preserve the quality of soil specially to prevent from salinization of the soil.

6.3 Staff infrastructure – office, accommodation, and training facility

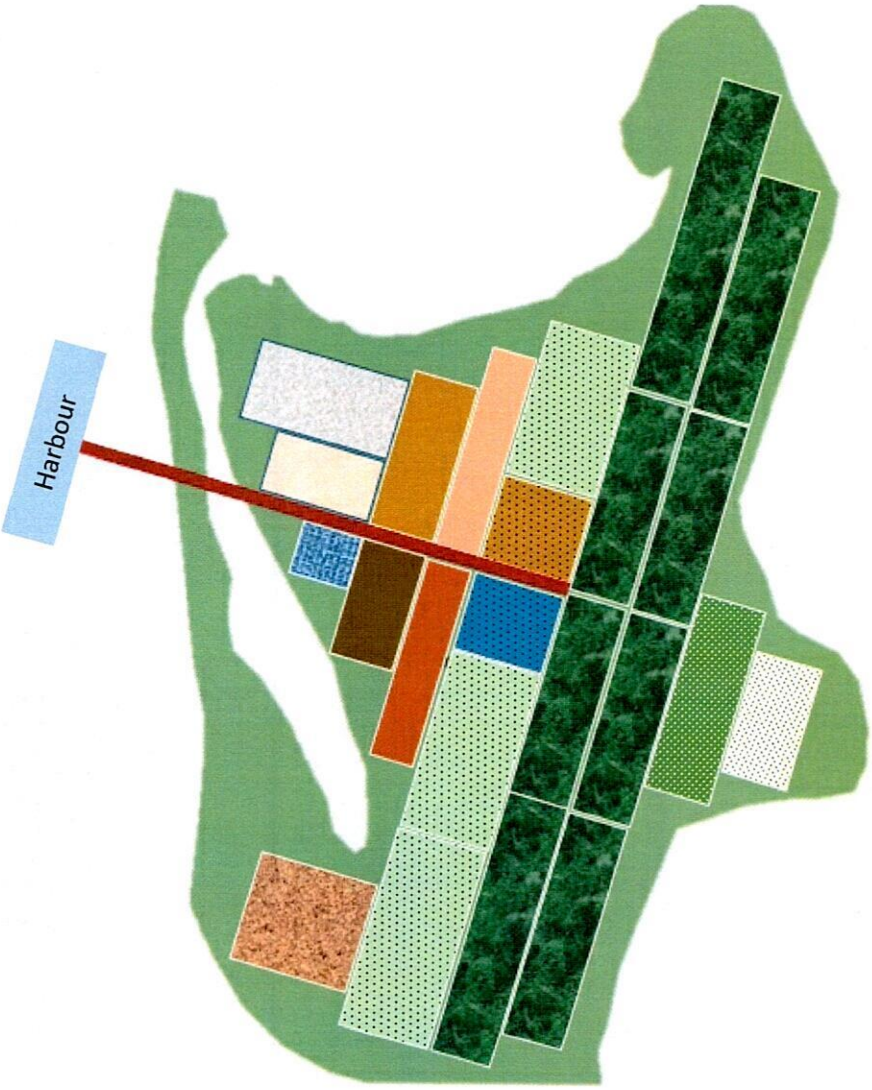
6.3.1 Office Space provision

Office space is provided (225 m^2) with all the needed infrastructure such as office furniture, computers, printers, internet, and phone connectivity, etc. (refer drawing no. DWG – 03 and DWG – 04 in Annexure III for details on office space which will also be used for training).

Annexure II - Location, Size, Wind Direction and Location of Jetty/Harbour

Thun'buri

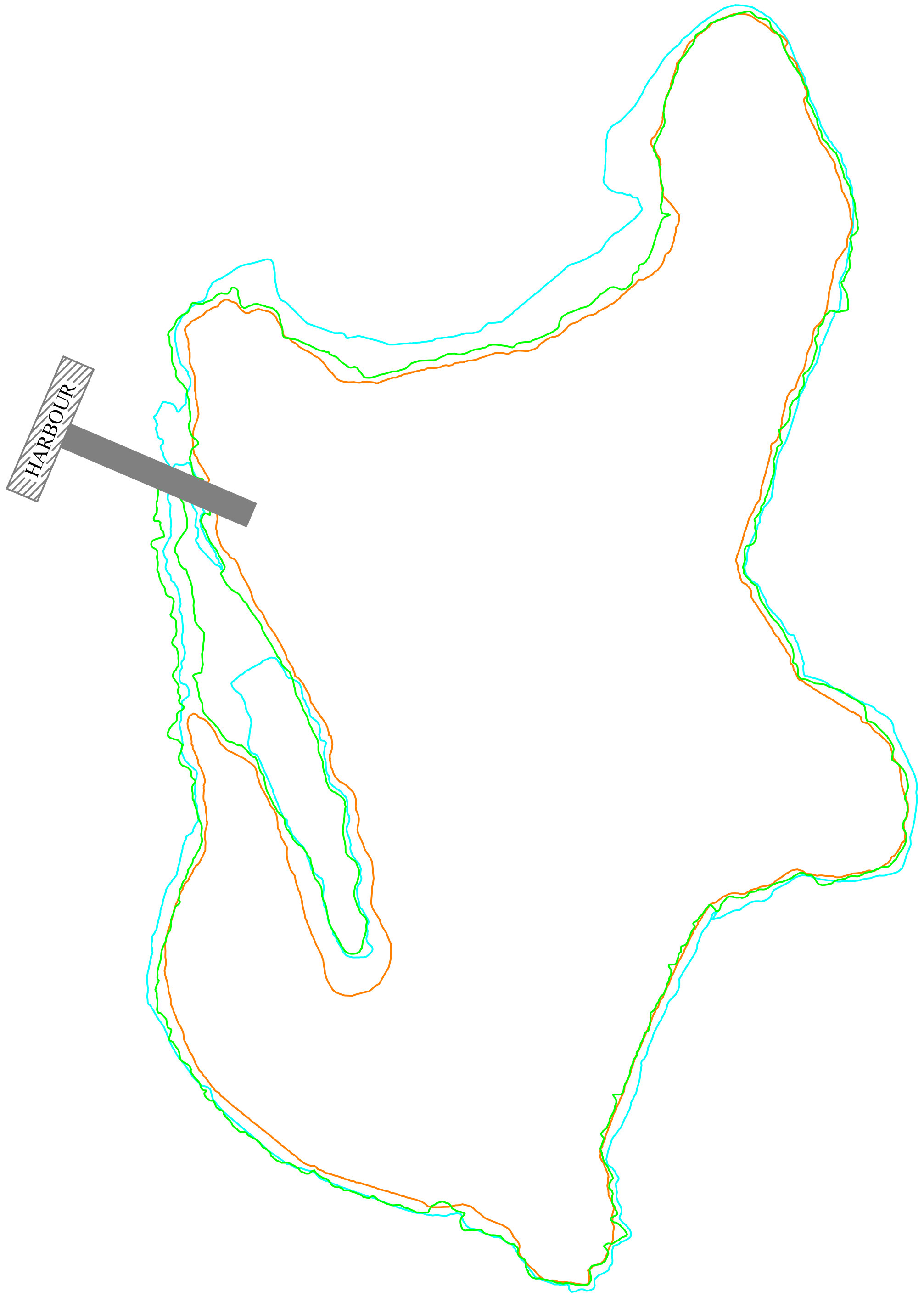
Island Name & Estimated Area	Thun'buri (18.48 hectares)
Atoll	Laamu
Atoll Capital	Fonadhoo
Location	2° 4' 29" N, 73° 32' 24" E
Island Status	Uninhabited



Annexure V - Layout of Agricultural Development in Thun'buri Island

Note: This is a concept drawing and it is not to scale.

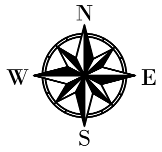
C-169/2007 The Hawks Private Limited



ADDITIONAL INFORMATION

Laamu. THUNBURI (Republic of Maldives)

— LOW TIDE LINE
AREA= 194400 Sqm (19.4 Ha)
— HIGH TIDE LINE
AREA= 163221 Sqm (16.3 Ha)
— VEGETATION LINE
AREA = 175620 Sqm (17.6 Ha)
▬ Beach Rocks
— LOW TIDE LINE
length 2394m
— HIGH TIDE LINE
length 2570m



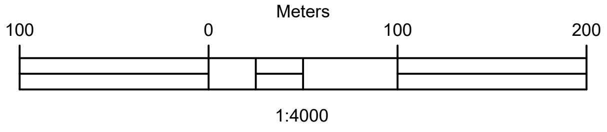
No.	Revision/Issue	Date

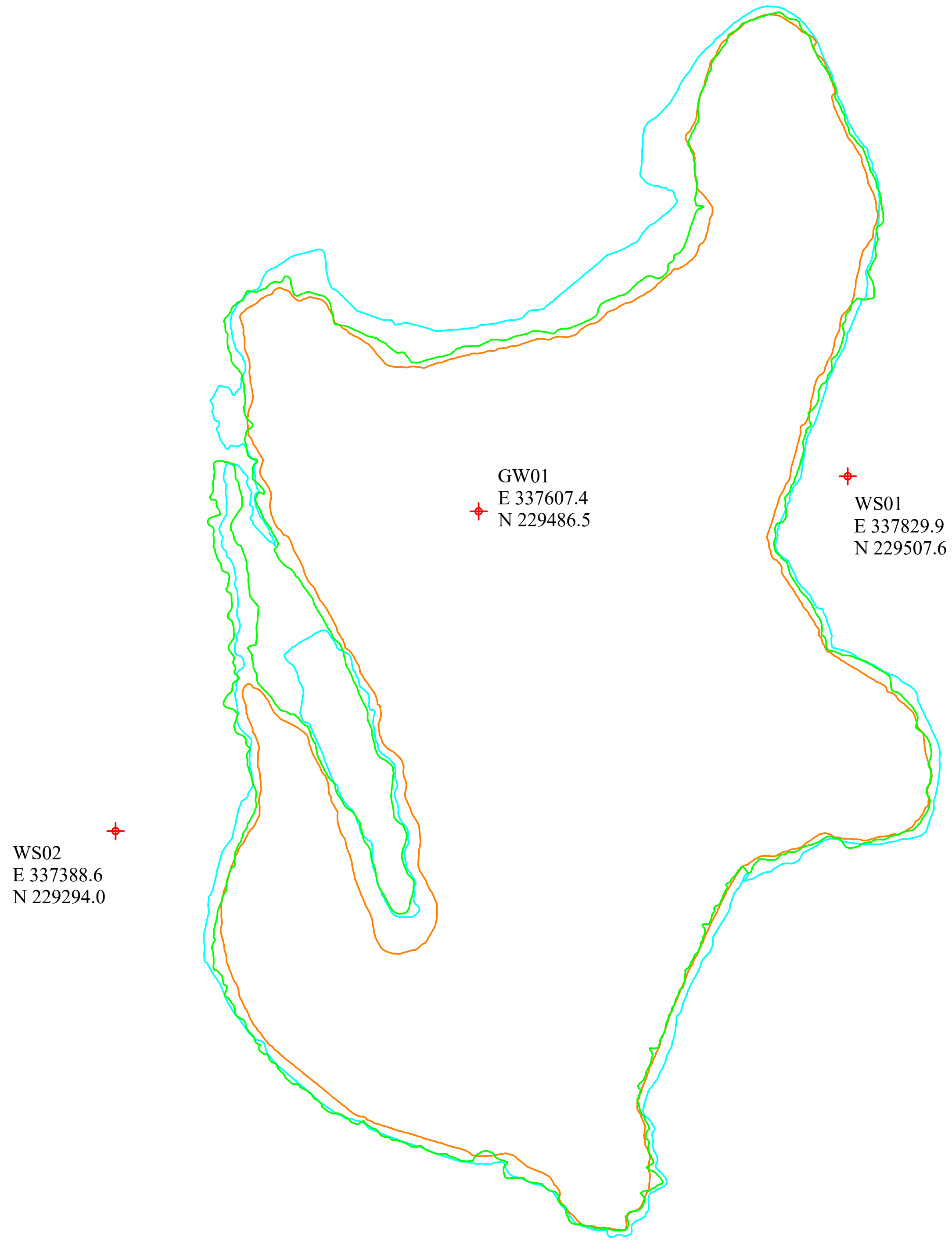
PROJECT TITLE
Topographic Survey for
L.Thunburi (Maldives)

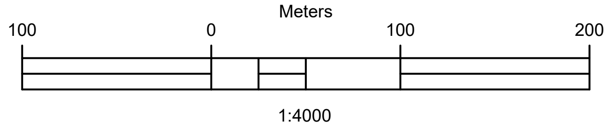
CLIENT NAME AND ADDRESS
Hawks Pvt Ltd

Surveyed by: Qismath Qasim
Date : June 2022
Reg.Surveyor : Qismath Qasim
Checked by : Mohamed Haikal Ibrahim
Scale : AS SHOWN
Sheet Name : Proposed Harbour Location

Drawn by: QISMATH
Date : June 2021
Dwg no: 01-2022/SUV-QQ
Sheet
3 / 3







ADDITIONAL INFORMATION

Laamu. THUNBURI (Republic of Maldives)

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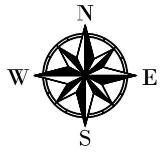

No.	Revision/Issue	Date

PROJECT TITLE
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L.Thunburi (Maldives)

CLIENT NAME AND ADDRESS
Hawks Pvt Ltd

Surveyed by: Qismath Qasim
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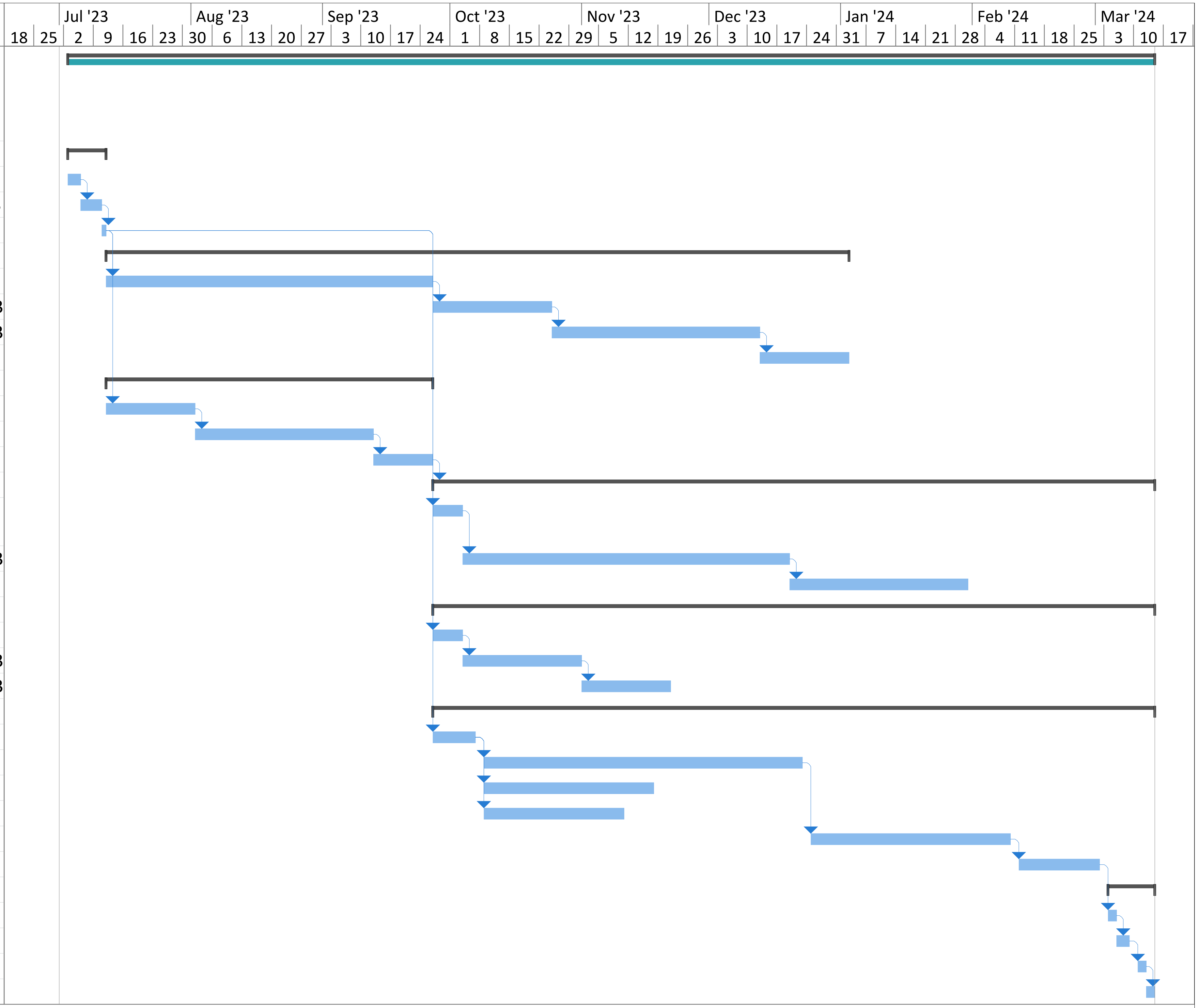
Checked by : Mohamed Haikal Ibrahim
Scale : AS SHOWN
Sheet Name : Water Sample Locations

Drawn by: QISMATH
Date : June 2021
Dwg no: 01-2022/SUV-QQ
Sheet
2 / 3

APPENDIX H. DETAILED WORK SCHEDULE

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at Thunburi, Laamu Atoll**	**184 days**	**Mon 7/3/23**	**Thu 3/14/24**
2		**Preliminaries**	**7 days**	**Mon 7/3/23**	**Tue 7/11/23**
3		Mobilization	3 days	Mon 7/3/23	Wed 7/5/23
4		In-survery and setting out	3 days	Thu 7/6/23	Mon 7/10/23
5		Commencement	1 day	Tue 7/11/23	Tue 7/11/23
6		**Harbour and Jetty Construction**	**125 days**	**Wed 7/12/2**	**Tue 1/2/24**
7		Dredging	55 days	Wed 7/12/2	Tue 9/26/23
8		Jetty and Quay wall construction	20 days	Wed 9/27/2	Tue 10/24/23
9		Breakwater construction	35 days	Wed 10/25/	Tue 12/12/23
10		Backfilling and Finishing	15 days	Wed 12/13/	Tue 1/2/24
11		**Access Channel**	**55 days**	**Wed 7/12/2**	**Tue 9/26/23**
12		Sand bunding	15 days	Wed 7/12/2	Tue 8/1/23
13		Dredging	30 days	Wed 8/2/23	Tue 9/12/23
14		Placing geobags	10 days	Wed 9/13/2	Tue 9/26/23
15		**Powerhouse**	**122 days**	**Wed 9/27/2**	**Thu 3/14/24**
16		Vegetation removal and site preparation	5 days	Wed 9/27/23	Tue 10/3/23
17		Construction of powerhouse	55 days	Wed 10/4/2	Tue 12/19/23
18		Transfer and placement of gensets	30 days	Wed 12/20/	Tue 1/30/24
19		**Waste Management Center**	**122 days**	**Wed 9/27/2**	**Thu 3/14/24**
20		Site preparation	5 days	Wed 9/27/2	Tue 10/3/23
21		Construction of sheds	20 days	Wed 10/4/2	Tue 10/31/23
22		Installation of machinery	15 days	Wed 11/1/2	Tue 11/21/23
23		**Water and Sewer**	**122 days**	**Wed 9/27/2**	**Thu 3/14/24**
24		Site preparation	8 days	Wed 9/27/2	Fri 10/6/23
25		Construction of Plant house	55 days	Mon 10/9/2	Fri 12/22/23
26		Construction of Pump stations	30 days	Mon 10/9/2	Fri 11/17/23
27		Construction of STP	25 days	Mon 10/9/2	Fri 11/10/23
28		Pipe laying	35 days	Mon 12/25/	Fri 2/9/24
29		Installations	15 days	Mon 2/12/2	Fri 3/1/24
30		**Demobilization**	**9 days**	**Mon 3/4/24**	**Thu 3/14/24**
31		Site Clearance	2 days	Mon 3/4/24	Tue 3/5/24
32		Out-survey	3 days	Wed 3/6/24	Fri 3/8/24
33		Final Demobilization	2 days	Mon 3/11/2	Tue 3/12/24
34		Final Inspection and Handove	2 days	Wed 3/13/2	Thu 3/14/24



Date: Thu 6/1/23

Task	▬	Project Summary	┌─┐	Inactive Milestone	◇	Manual Summary Rollup	▬	Deadline	⇩
Split	┈	External Tasks	▬	Inactive Summary	┌─┐	Manual Summary	┌─┐	Progress	─
Milestone	◆	External Milestone	◆	Manual Task	▬	Start-only	[	Manual Progress	─
Summary	┌─┐	Inactive Task	▭	Duration-only	▬	Finish-only	]		

APPENDIX I. WATER QUALITY ASSESSMENT RESULTS

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
Quality Assurance Building, 1st Floor, Male' Hingun, Vilimale', Male' City, Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

LB-TEST-090

WATER QUALITY TEST REPORT

Report No: 500195871

Customer Information:
Eco-Tech Consultancy Pvt Ltd
M. Husnoo villa, Unigas Magu,

Report date: **03/05/2023**
Test Requisition Form No: **900197441**
Sample(s) Recieved Date: **30/04/2023**
Date of Analysis: **30/04/2023 - 01/05/2023**

Sample Description ~	Thun'buri D1	D3	**TEST METHOD**	**UNIT**
Sample Type ~	Sea Water	Sea Water		
Sample No	83238459	83238461		
Sampled Date ~	28/04/2023 09:30	28/04/2023 09:30		
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Clear with particles	Clear with particles		
pH *	8.1	8.8	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	-
Salinity	33.66	32.90	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	‰
Temperature	24.0	24.0	Electrometry	°C
Turbidity *	0.295	0.192	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Total Petroleum Hydrocarbon (TPH)	<0.036 (LoQ 0.036 mg/L)	0.441	UV Fluorescence	mg/L

Keys: ‰ : Parts Per Thousand, **°C** : Degree Celcius, **NTU** : Nephelometric Turbidity Unit, **mg/L** : Milligram Per Liter

Checked by

Aminath Sofa
Senior Laboratory Executive

Approved by

Nihaz A. Zahir
Assistant Quality Manager

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 provided by the customer. This information may affect the validity of the test results.
*Parameters accredited by EIAC under ISO/IEC 17025:2017

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

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
Quality Assurance Building, 1st Floor, Male' Hingun, Vilimale', Male' City, Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

LB-TEST-090

WATER QUALITY TEST REPORT

Report No: 500195872

Customer Information:
Eco-Tech Consultancy Pvt Ltd
M. Husnoo villa, Unigas Magu,

Report date: **03/05/2023**
Test Requisition Form No: **900197441**
Sample(s) Recieved Date: **30/04/2023**
Date of Analysis: **30/04/2023 - 01/05/2023**

Sample Description ~	D2	D4	C	**TEST METHOD**	**UNIT**
Sample Type ~	Sea Water	Sea Water	Sea Water		
Sample No	83238460	83238462	83238463		
Sampled Date ~	28/04/2023 09:30	28/04/2023 09:30	28/04/2023 09:30		
PARAMETER	**ANALYSIS RESULT**				
Physical Appearance	Clear with particles	Clear with particles	Clear with particles		
pH *	8.1	8.2	8.2	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	-
Salinity	33.64	33.35	34.13	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	‰
Temperature	24.0	24.0	24.0	Electrometry	°C
Turbidity *	0.105	0.194	0.140	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Total Petroleum Hydrocarbon (TPH)	0.249	0.1	<0.036 (LoQ 0.036 mg/L)	UV Fluorescence	mg/L
Total Coliforms	30 (30/04/2023 15:00)	24 (30/04/2023 15:00)	66 (30/04/2023 15:00)	HACH Method10029	CFU/100ml
Faecal Coliforms	Not Detected (30/04/2023 15:00)	Not Detected (30/04/2023 15:00)	Not Detected (30/04/2023 15:00)	HACH Method 8074	CFU/100ml

Keys: ‰ : Parts Per Thousand, **°C** : Degree Celcius, **NTU** : Nephelometric Turbidity Unit, **mg/L** : Milligram Per Liter, **CFU/100ml** : Coliform Forming Unit

Checked by

Aminath Sofa
Senior Laboratory Executive

Approved by

Nihaz A. Zahir
Assistant Quality Manager

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Water Quality Assurance Laboratory
Quality Assurance Building, 1st Floor, Male' Hingun, Vilimale', Male' City, Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

LB-TEST-090

WATER QUALITY TEST REPORT

Report No: 500195873

Customer Information:
Eco-Tech Consultancy Pvt Ltd
M. Husnoo villa, Unigas Magu,

Report date: **03/05/2023**
Test Requisition Form No: **900197441**
Sample(s) Recieved Date: **30/04/2023**
Date of Analysis: **30/04/2023 - 01/05/2023**

Sample Description ~	G1	GC	**TEST METHOD**	**UNIT**
Sample Type ~	Ground Water	Ground Water		
Sample No	83238464	83238465		
Sampled Date ~	28/04/2023 10:40	28/04/2023 10:40		
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Cloudy with particles	Pale yellow with particles		
Conductivity *	6400	11390	Method 2510 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	µS/cm
pH *	7.3	7.0	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	-
Temperature	24.0	24.0	Electrometry	°C
Total Petroleum Hydrocarbon (TPH)	0.703	0.31	UV Fluorescence	mg/L
Total Coliforms	>2420 (30/04/2023 15:00)	>2420 (30/04/2023 15:00)	Colilert®-18/Quanti-Tray®2000	MPN/100ml
Faecal Coliforms	>2420 (30/04/2023 15:00)	>2420 (30/04/2023 15:00)	Colilert®-18/Quanti-Tray®2000	MPN/100ml

Keys: µS/cm : Micro Seimen per Centimeter, **°C** : Degree Celcius, **mg/L** : Milligram Per Liter, **MPN/100ml** : Most Probable Number

Checked by

Aminath Sofa
Senior Laboratory Executive

Approved by

Nihaz A. Zahir
Assistant Quality Manager

Notes:
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Water Quality Assurance Laboratory
Quality Assurance Building, 1st Floor, Male' Hingun, Vilimale', Male' City, Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

LB-TEST-090

WATER QUALITY TEST REPORT

Report No: 500196304

Customer Information:
Eco-Tech Consultancy Pvt Ltd
M. Husnoo villa, Unigas Magu,

Report date: **31/05/2023**
Test Requisition Form No: **900197677**
Sample(s) Recieved Date: **24/05/2023**
Date of Analysis: **24/05/2023 - 24/05/2023**

Sample Description ~	Thun'buri Intake	**TEST METHOD**	**UNIT**
Sample Type ~	Sea Water		
Sample No	83239223		
Sampled Date ~	05/05/2023 09:30 AM		
PARAMETER	**ANALYSIS RESULT**		
Physical Appearance	Clear with particles		
pH *	7.7	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	-
Salinity	33.44	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 23rd edition)	‰
Temperature	23.9	Electrometry	°C
Turbidity *	0.203	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Total Petroleum Hydrocarbon (TPH)	0.587	UV Fluorescence	mg/L

Keys: ‰ : Parts Per Thousand, **°C** : Degree Celcius, **NTU** : Nephelometric Turbidity Unit, **mg/L** : Milligram Per Liter

Checked by

Aminath Shahidha
Laboratory Executive

Approved by

Nihaz A. Zahir
Assistant Quality Manager

Notes:
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************************** END OF REPORT **************************

APPENDIX J. FORMAT FOR FUEL HANDLING PROCEDURE

Following is the fuel handling procedure format expected for this project. The procedure shall include the following;

Introduction
    Name and contacts of the applicable facility
    Major aims and objectives
Applicability and scope
Proposed fuel delivering and dispensing procedure for construction phase
Proposed fuel delivering and dispensing procedure for operational phase
Emergency Protocols
    In case of spills

APPENDIX K. FORMAT FOR HEALTH AND SAFETY MANUAL

Following is the health and safety manual format expected for this project. The manual shall include the health and safety policy of the proponent, roles and responsibilities of key personnel, detailed health and safety procedures.

Introduction
    Name and contacts of the applicable facility
    Major aims and objectives
Applicability and scope
Health and safety policy
Roles and responsibilities
    Organizational chart
    Describe in detail the responsibilities of each personnel
Health and safety procedures
    Describe in detail the health and safety procedures for all key works at the applicable facility for instance procedure for;
handling electrical appliances
chemical handling
preventive procedures
employee behavior and attitude
handling accidents
training
waste disposal
latest first aid procedure

APPENDIX L. FORMAT FOR EMERGENCY PREPAREDENESS AND RESPONSE PLAN

Following is the emergency preparedness and response plan format expected for this project. The plan shall include the following;

- Introduction
  - Name and contacts of the applicable facility
  - Major aims and objectives
- Applicability and scope
- Roles and responsibilities
  - Organizational chart
  - Describe in detail the responsibilities of each personnel
- Emergency reporting procedures
  - Communications hierarchy for reporting incidents
  - Emergency communications methods
- Emergency contact directory
- Locations of important items
  - Procedures for media inquiries
  - Test, training and exercises
- Emergency Protocols
  - Identify and describe in detail how to tackle all the possible emergency scenarios for example;
  - If someone is injured or ill
  - Electrocution
  - Failure or significant interruption in key system processes
  - Chemical spill

APPENDIX M. EVIDENCE OF EIA REPORT SUBMISSION TO ATOLL COUNCIL

Environmental Impact Assessment for proposed development of Harbor, Access Channel, Powerhouse, Waste Management Center, Water and Sewer Facilities at Thunburi, Laamu Atoll

1 message

Mahfooz Abdul Wahhab <mahfooz@ecotechconsultancy.com> Thu, Jun 1, 2023 at 10:01 AM
To: info@laamu.gov.mv
Cc: Eco-Tech Consultancy <secretariat@ecotechconsultancy.com>, "Ibrahim R. Adam" <rashihu@ecotechconsultancy.com>

Dear Sir,

Please follow the link below for the captioned EIA report.

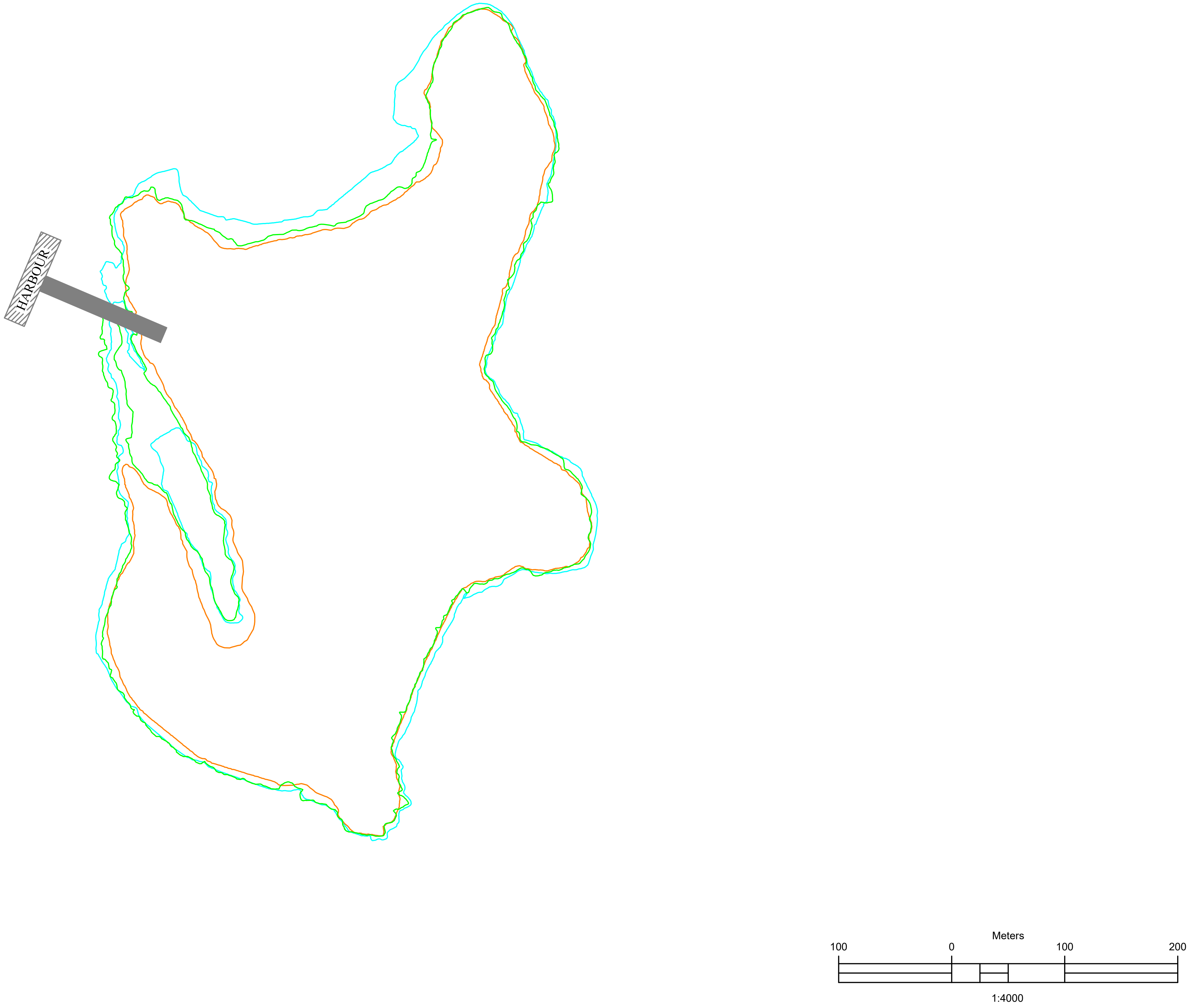
https://drive.google.com/drive/folders/1YF6JtsgbKkiF4dJjLE4cokkM8z0PwhBn?usp=drive_link

Best Regards,

ECO-TECH
CONSULTANCY

Mahfooz Abdul Wahhab
Managing Director
Eco-Tech Consultancy Pvt. Ltd
M. Husnoovilaa, Unigas Magu,
Male', 20296, Kaafu Atoll, Maldives
Website: www.ecotechconsultancy.com
(+960) 9994467

APPENDIX N. LAND AND HYDROGRAPHIC REPORTS



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- ▬ Beach Rocks
- LOW TIDE LINE
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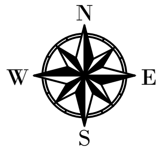


No.	Revision/Issue	Date

PROJECT TITLE
Topographic Survey for
L.Thunburi (Maldives)

CLIENT NAME AND ADDRESS
Hawks Pvt Ltd

Surveyed by: Qismath Qasim

Date : June 2022

Reg.Surveyor : Qismath Qasim

Checked by : Mohamed Haikal Ibrahim

Scale : AS SHOWN

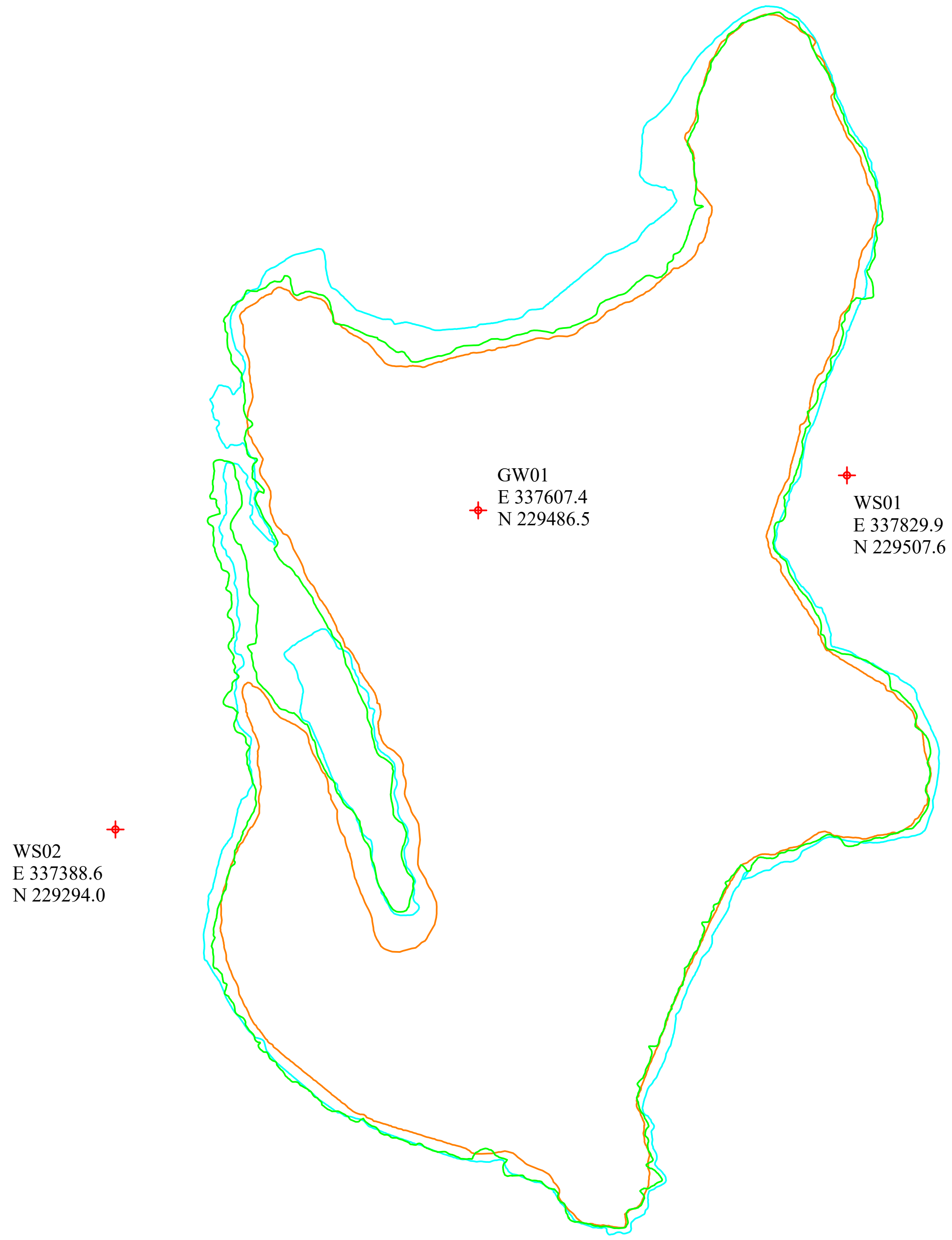
Sheet Name : Proposed Harbour Location

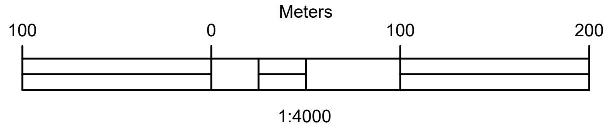
Drawn by: QISMATH

Date : June 2021

Dwg no: 01-2022/SUV-QQ

Sheet 3 / 3





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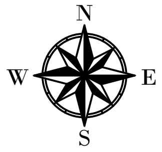
▬ Beach Rocks
— LOW TIDE LINE
length 2394m
— HIGH TIDE LINE
length 2570m



No.	Revision/Issue	Date

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Topographic Survey for
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Date : June 2022
Reg.Surveyor : Qismath Qasim
Checked by : Mohamed Haikal Ibrahim
Scale : AS SHOWN
Sheet Name : Water Sample Locations

Drawn by: QISMATH
Date : June 2021
Dwg no: 01-2022/SUV-QQ
Sheet
2 / 3

L. THUNBURI BATHYMETRY

Elevations Table

NO	Minimum Elevation	Maximum Elevation	Colour
1	−20.00	−18.00	🟪
2	−18.00	−16.00	🟪
3	−16.00	−14.00	🟦
4	−14.00	−12.00	🟦
5	−12.00	−10.00	🟦
6	−10.00	−8.00	🟦
7	−8.00	−7.50	🟦
8	−7.50	−7.00	🟦
9	−7.00	−6.50	🟦
10	−6.50	−6.00	🟦
11	−6.00	−5.50	🟦
12	−5.50	−5.00	🟦
13	−5.00	−4.50	🟦
14	−4.50	−4.00	🟩
15	−4.00	−3.50	🟩
16	−3.50	−3.00	🟩
17	−3.00	−2.50	🟩
18	−2.50	−2.00	🟩
19	−2.00	−1.50	🟩
20	−1.50	−1.00	🟨
21	−1.00	−0.50	🟨
22	−0.50	0.00	🟧
23	0.00	0.50	🟧
24	0.50	1.00	🟥

Cut/Fill Summary

Name	2d Area	Cut	Fill	Net
Cut&Fill_Jetty (1.4m from MSL)	10800sq.m	0 Cu. M.	21151 Cu. M.	21151 Cu. M.<Fill>
Cut&Fill_Harbour Basin (-4m from MSL)	10174sq.m	14387 Cu. M.	0 Cu. M.	14387 Cu. M.<Cut>
Cut&Fill_Channel (-4m from MSL)	6741sq.m	15193 Cu. M.	0 Cu. M.	15193 Cu. M.<Cut>
Totals	27715sq.m	29580 Cu. M.	21151 Cu. M.	8429 Cu. M.<Cut>

mapscape

CELL: +960779099/+9607784350
EMAIL: INFO@MAPSCAPE.NET

LEGEND

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- GNSS RTK POSITIONING AND ECO SOUNDER USED FOR BATHYMETRY
- PSM 5161 WAS USED AS A REFERENCE

REVISIONS

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PROJECT TITLE

DEVELOPMENT OF HARBOR, ACCESS CHANNEL, POWERHOUSE, WASTE MANAGEMENT CENTER, WATER AND SEWER FACILITIES AT L. THUN'BURI

CLIENT

THE HAWKS PVT LTD

DRAWING TITLE

L. THUNBURI BATHYMETRY

SHEET TITLE

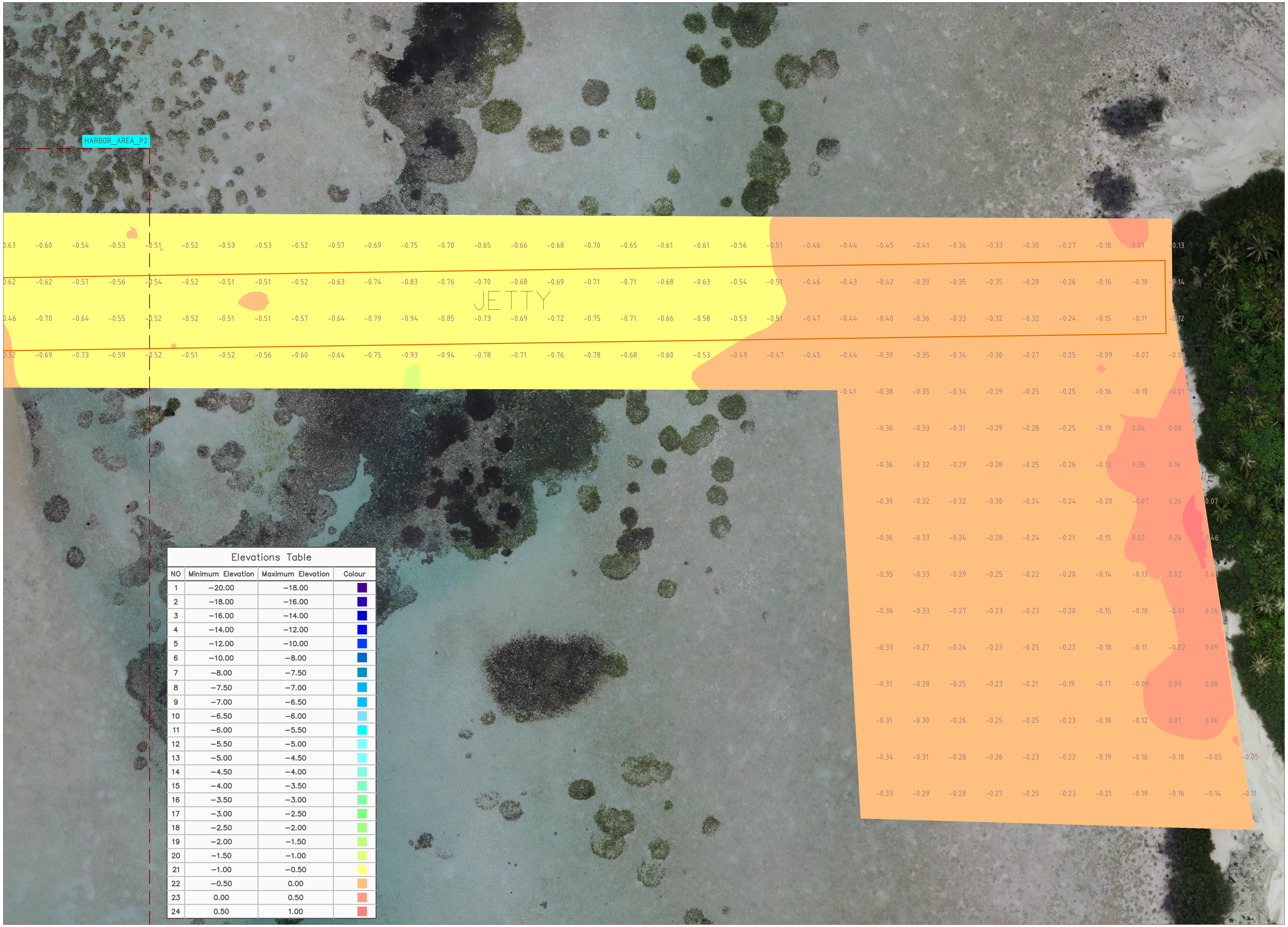
INDEX MAP

SURVEYOR AHMED NASHiD	S/L # BP02006
SURVEYED DATE	APRIL 27-28 , 2023
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	MAY 11 , 2023
SCALE	1:6000
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

MS/2023/242

L. THUNBURI BATHYMETRY



Elevations Table

NO	Minimum Elevation	Maximum Elevation	Colour
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2	−18.00	−16.00	🟪
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7	−8.00	−7.50	🟦
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22	−0.50	0.00	🟧
23	0.00	0.50	🟥
24	0.50	1.00	🟥

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LEGEND

NOTE
- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
-GNSS RTK POSITIONING AND ECO SOUNDER USED FOR BATHYMETRY
-PSM 5161 WAS USED AS A REFERENCE

REVISIONS

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-	-

PROJECT TITLE

DEVELOPMENT OF HARBOR, ACCESS CHANNEL, POWERHOUSE, WASTE MANAGEMENT CENTER, WATER AND SEWER FACILITIES AT L. THUN'BURI

CLIENT

THE HAWKS PVT LTD

DRAWING TITLE

L.THUNBURI BATHYMETRY

SHEET TITLE

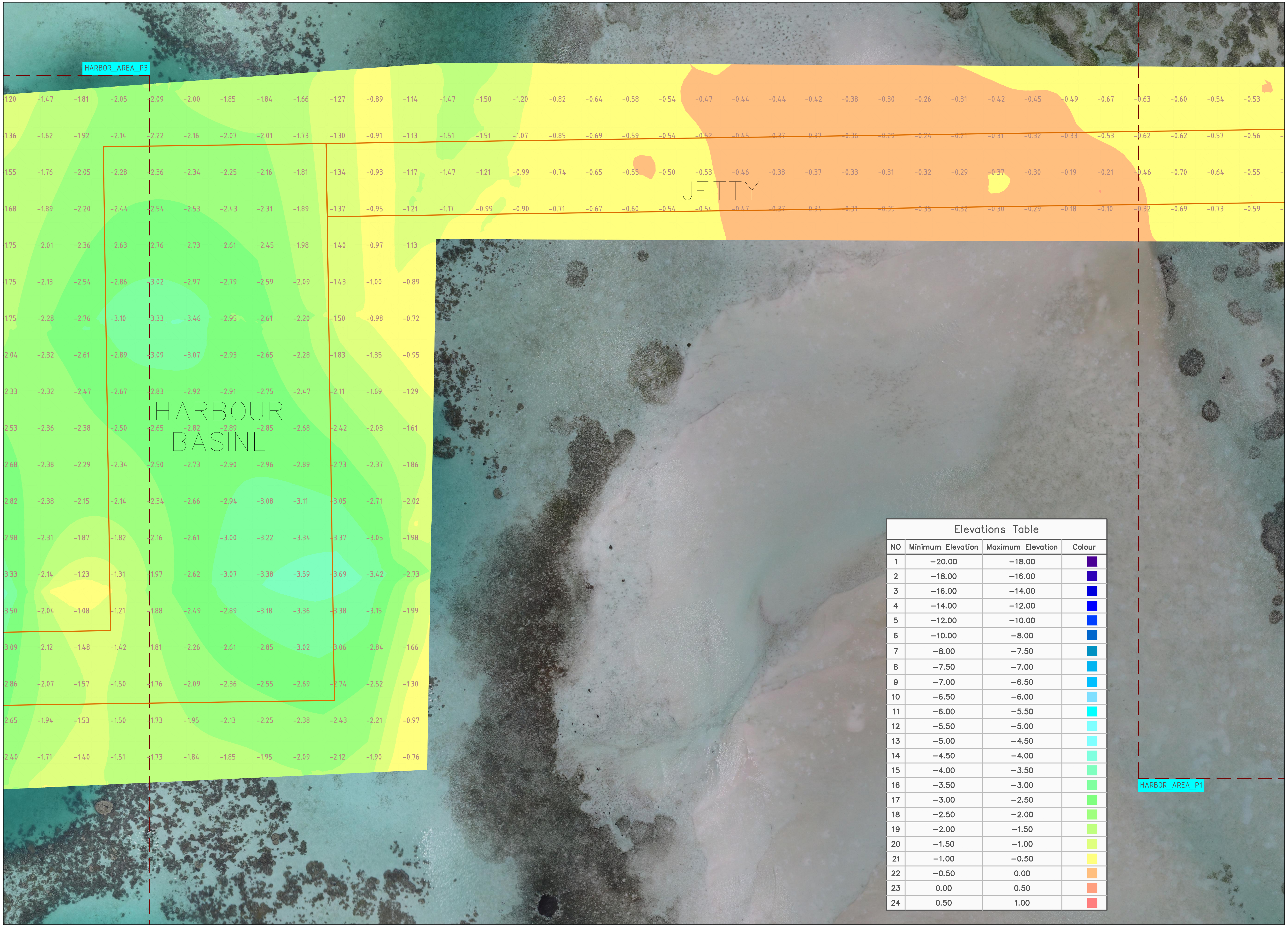
HARBOR_AREA_P1

SURVEYOR AHMED NASHID	S/L # BP02006
SURVEYED DATE	APRIL 27-28 , 2023
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	MAY 11 , 2023
SCALE	1:1000
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

MS/2023/242

L. THUNBURI BATHYMETRY



Elevations Table

NO	Minimum Elevation	Maximum Elevation	Colour
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10	−6.50	−6.00	🟦
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14	−4.50	−4.00	🟩
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23	0.00	0.50	🟥
24	0.50	1.00	🟥

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LEGEND

NOTE
- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- GNSS RTK POSITIONING AND ECO SOUNDER USED FOR BATHYMETRY
- PSM 5161 WAS USED AS A REFERENCE

REVISIONS

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PROJECT TITLE

DEVELOPMENT OF HARBOR, ACCESS CHANNEL, POWERHOUSE, WASTE MANAGEMENT CENTER, WATER AND SEWER FACILITIES AT L. THUN'BURI

CLIENT

THE HAWKS PVT LTD

DRAWING TITLE

L. THUNBURI BATHYMETRY

SHEET TITLE

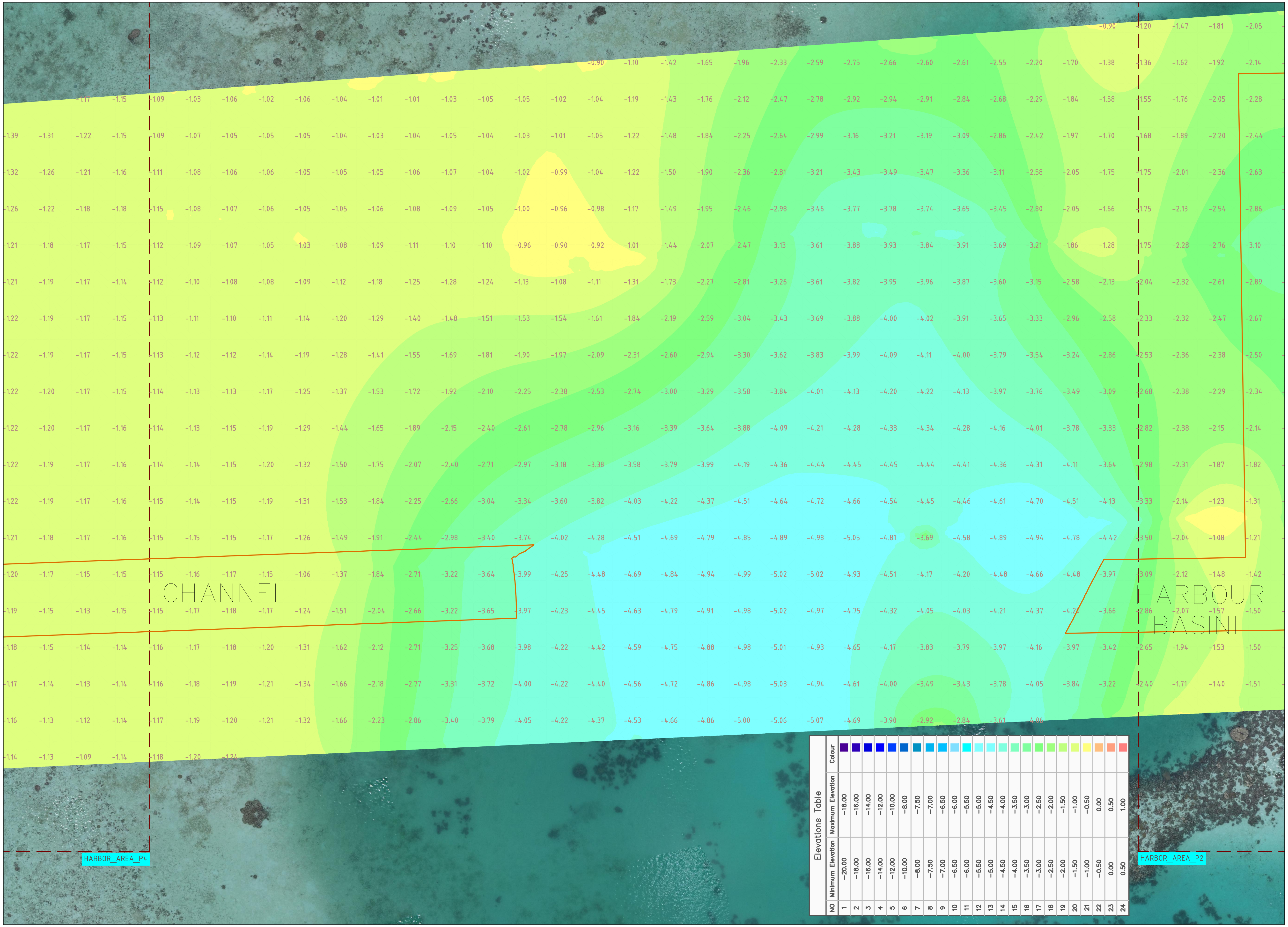
HARBOR_AREA_P2

SURVEYOR AHMED NASHID	S/L # BP02006
SURVEYED DATE	APRIL 27-28 , 2023
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	MAY 11 , 2023
SCALE	1:1000
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

MS/2023/242

L. THUNBURI BATHYMETRY



Elevations Table

NO	Minimum Elevation	Maximum Elevation	Colour
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10	-6.50	-6.00	🟦
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12	-5.50	-5.00	🟦
13	-5.00	-4.50	🟦
14	-4.50	-4.00	🟩
15	-4.00	-3.50	🟩
16	-3.50	-3.00	🟩
17	-3.00	-2.50	🟩
18	-2.50	-2.00	🟩
19	-2.00	-1.50	🟩
20	-1.50	-1.00	🟨
21	-1.00	-0.50	🟨
22	-0.50	0.00	🟨
23	0.00	0.50	🟧
24	0.50	1.00	🟥

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LEGEND

NOTE
- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
-GNSS RTK POSITIONING AND ECO SOUNDER USED FOR BATHYMETRY
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REVISIONS

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PROJECT TITLE

DEVELOPMENT OF HARBOR, ACCESS CHANNEL, POWERHOUSE, WASTE MANAGEMENT CENTER, WATER AND SEWER FACILITIES AT L. THUN'BURI

CLIENT

THE HAWKS PVT LTD

DRAWING TITLE

L. THUNBURI BATHYMETRY

SHEET TITLE

HARBOR_AREA_P3

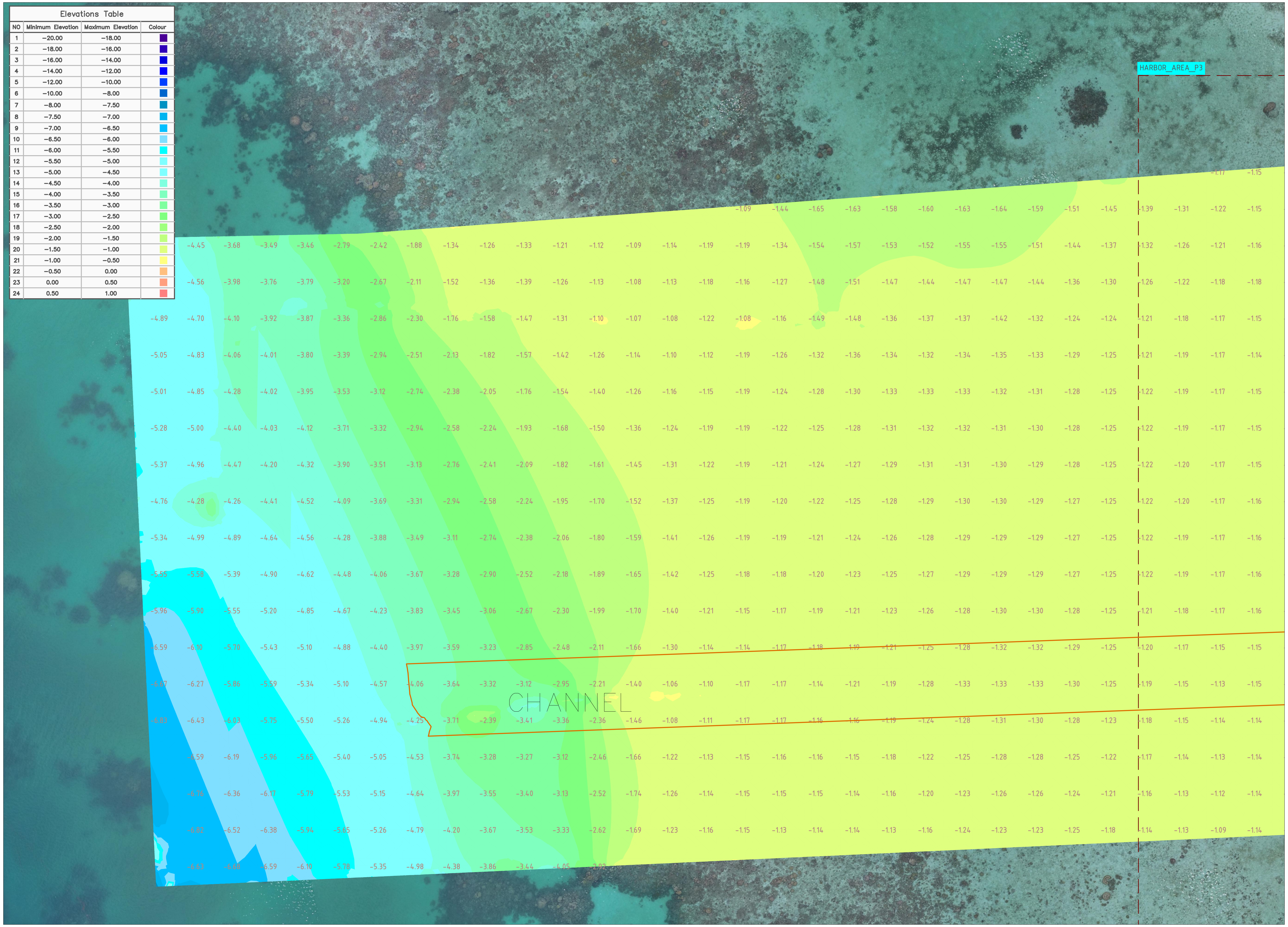
SURVEYOR AHMED NASHID	S/L # BP02006
SURVEYED DATE	APRIL 27-28 , 2023
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	MAY 11 , 2023
SCALE	1:1000
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

MS/2023/242

PAGE 4 OF 6

L. THUNBURI BATHYMETRY



Elevations Table

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6	−10.00	−8.00	🟦
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23	0.00	0.50	🟧
24	0.50	1.00	🟥

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LEGEND

NOTE
- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
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REVISIONS

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PROJECT TITLE

DEVELOPMENT OF HARBOR, ACCESS CHANNEL, POWERHOUSE, WASTE MANAGEMENT CENTER, WATER AND SEWER FACILITIES AT L. THUN'BURI

CLIENT

THE HAWKS PVT LTD

DRAWING TITLE

L. THUNBURI BATHYMETRY

SHEET TITLE

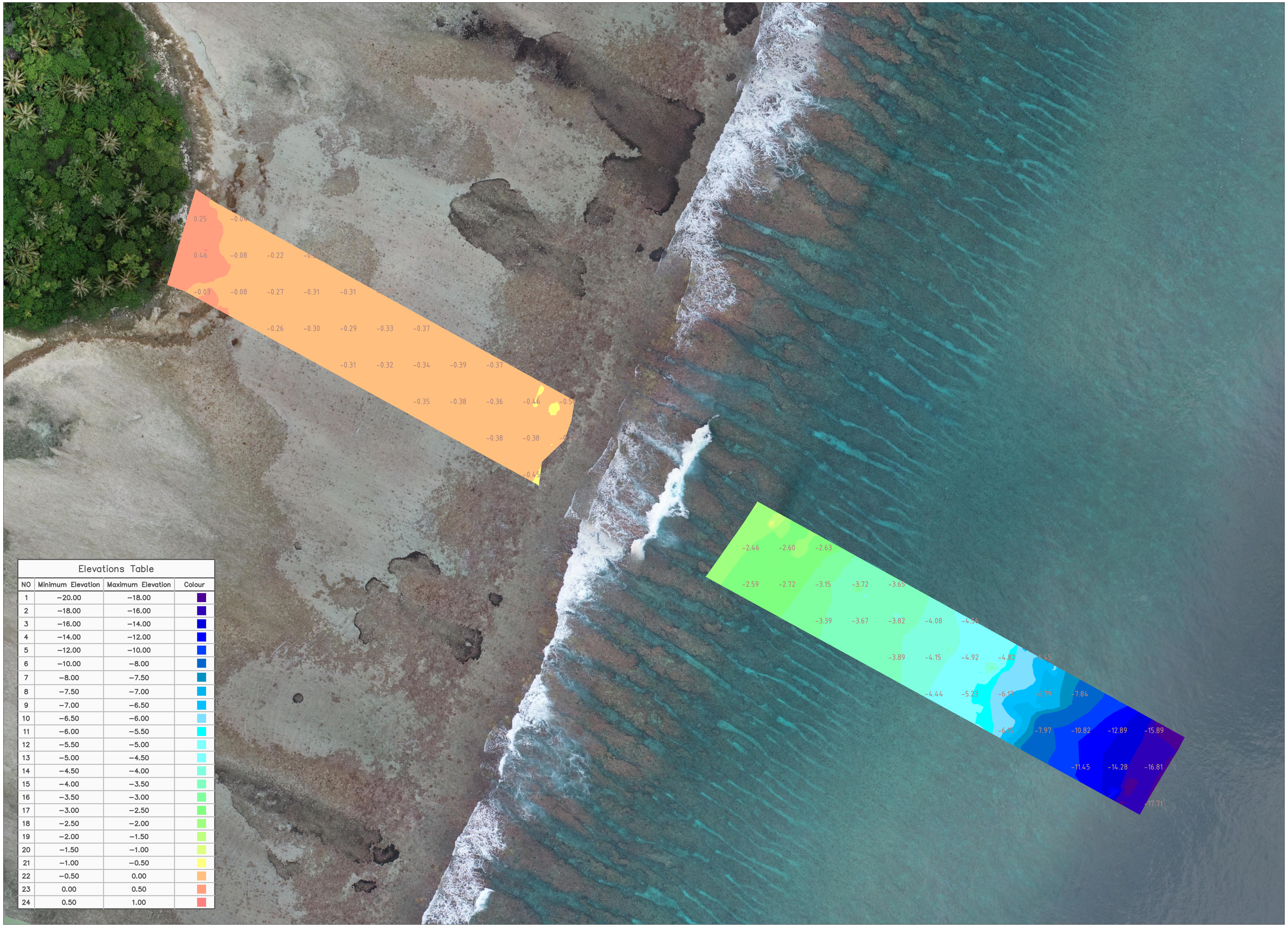
HARBOR_AREA_P4

SURVEYOR	AHMED NASHiD	S/L # BP02006
SURVEYED DATE	APRIL 27-28 , 2023	
DRAWN BY	NASHID,LATHEEF	
DRAWN DATE	MAY 11 , 2023	
SCALE	1:1000	
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)	

DRAWING NUMBER

MS/2023/242

L. THUNBURI BATHYMETRY



Elevations Table

NO	Minimum Elevation	Maximum Elevation	Colour
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2	−18.00	−16.00	🟪
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4	−14.00	−12.00	🟦
5	−12.00	−10.00	🟦
6	−10.00	−8.00	🟦
7	−8.00	−7.50	🟦
8	−7.50	−7.00	🟦
9	−7.00	−6.50	🟦
10	−6.50	−6.00	🟦
11	−6.00	−5.50	🟦
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24	0.50	1.00	🟥

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LEGEND

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
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REVISIONS

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PROJECT TITLE

DEVELOPMENT OF HARBOR, ACCESS CHANNEL, POWERHOUSE, WASTE MANAGEMENT CENTER, WATER AND SEWER FACILITIES AT L. THUN'BURI

CLIENT

THE HAWKS PVT LTD

DRAWING TITLE

L. THUNBURI BATHYMETRY

SHEET TITLE

OUTFALL

SURVEYOR AHMED NASHiD	S/L # BP02006
SURVEYED DATE	APRIL 27-28 , 2023
DRAWN BY	NASHID,LATHEEF
DRAWN DATE	MAY 11 , 2023
SCALE	1:1000
PAPER	ISO FULL BLEED A3 (297.00 X 420.00 MM)

DRAWING NUMBER

MS/2023/242

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