ENVIRONMENTAL IMPACT ASSESSMENT FOR EXTENSION OF KOODDOO DOMESTIC AIRPORT AND DEVELOPMENT OF A CITY HOTEL KOODDOO, GA. ATOLL

FINAL REPORT

PREPARED FOR
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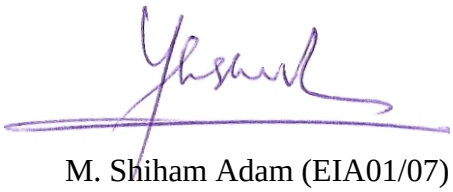
Declaration of the Consultant:

I certify that the statements made in this Environmental Impact Assessment are true, complete and correct to the best of my knowledge and available information at the time of writing this report.



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20 December 2013

Acronyms used in the text

BOD	Biological Oxygen Demand
BOH	Back of the House (all the utility function and its services on the resort)
CDE	Commerce Development and Environment Pvt Ltd.
COD	Chemical Oxygen Demand
DNP	Department of National Planning
EPA	Environmental Protection Agency
KFMP	Kooddoo Fisheries Maldives Private Ltd
EPAA	Environmental Protection and Preservation Act
MBR	Membrane Bioreactor (Sewage Treatment Plant)
MHTE	Ministry of Housing, Transport and Environment
MoFA	Ministry of Fisheries and Agriculture
MoFT	Ministry of Finance and Treasury
MoHE	Ministry of Housing and Environment
MoT	Ministry of Tourism,
MPL	Maldives Ports Limited (a state-owned enterprise)
MRC	Marine Research Centre
MSL	Mean Sea Level
NPC	National Planning Council
SBR	Sequence Batch Reactor (Sewage Treatment Plant)

1 NON TECHNICAL SUMMARY [DIVEHI]

1. ގދ. ކޫއްޑޫގެ ޑޮމެސްޓިކް އެއަރޕޯޓް ޤާއިމުކުރެވިފައި ވަނީ 2012 ވަނައަހަރުގައެވެ. މި އެއަރޕޯޓުގެ ރަންވޭގެ ދިގުމިނަކީ 1200 މީޓަރެވެ. ގދ. އަތޮޅުގެ އިތުރުމަށް ބޮޑުގާތާއި ހުޅު ސަރަހައްދުގައި ތަރައްޤީވަމުން އަންނަ ރިޒޯޓްތަކަށް ހިދުމަތް ފޯރުކޮށްދިނުމަށް ޤާއިމުކުރެވުނު މިއެއަރޕޯޓް ދެއަހަރަށް ދުވަހުގެ ބޮޑުތަކުގައި ދަތުރުގެ އެންމެ ދިރުމުގެ އެއަރޕޯޓަކަށް ވަނީ ވެފައެވެ. އަދި މިސަރަހައްދުގެ މިހާރު ހިނގަމުންދާ އަމަޒޫ ރިޒޯޓްތަކަށް ޖާގަކަށް ކުރާ މަގުޖަނ ދުއްސަރިންގެ އަދިއްޔަ މަރިންދާބިގައި ރާއްޖެ އައުމަށް އެދުމަށް ދާމީ އެއަރޕޯޓް ރަންވޭގެ ދާގަ ބޮޑުކުރުމަށްވަނީ ބޭނުންވެފައެވެ. އެއީ މުސްތަޤުބަލުގައި ބޮޑެތި ބޯޓްފަހަރު ޖެއްސުމާއި އަދި އެއަރޕޯޓަށް އަންނަ ފަތުރުވެރިންގެ އަދަދު މަތިންދާބޯޓު ފުރާ ކޮންފިއުރޭ ބޭއްވުމަށް ޓަކައެވެ.

2. ކޫއްޑޫ އެއަރޕޯޓުގެ ރަންވޭ ދިގުކުރުމާއި އެއަރޕޯޓް އިމާރަތް ތަރައްޤީކޮށް އެއަރޕޯޓުޓާމިނަލް ހިދުމަތް ބައިނަލްއަޤުވާމީ ފެންވަރަށް ގެނައުމުގެ މަސައްކަތް ކުރުމަށް ހުށަހެޅުއްވުން ބިލު، ކޮމްޕިއުޓަރ އެކުއިޕްމަންޓް، ކާމިޔާބު ކޮންފިއުރޭ ސިޓީހޮޓެލްގެ ކޮންޓްރެކްޓަރުންގެ ޕްރޮޖެކްޓް ހުށަހަޅާ ކޮންސަލްޓަންސީ ފުރަތަމަ ފިޔަވަޅު. މިބައި ކާމިޔާބުކުރުމަށް ފަހު ސަރުކާރާއި އެކު ވޯޓަށް ކޮންސަލްޓަންސީ އޮފީސް ހުސްކުރާ ހުޅުމާލޭ އެއަރޕޯޓް ތަރައްޤީ ކުރުމަށް ގދ. މާލޭގާ އާއި 50 އެކަރުގެ ބިމެއް ރާޖޭގެ ތަރައްޤީކުރުމަށް ސަރުކާރާއި ވަނީ އެއްބަސްވެފައެވެ. ބިމާއި ތަރައްޤީކުރުމަށް ހަމަޖެހިފައިވަނީ ކޫއްޑޫގެ ހުވަދު ދާއިރާ ސަރަހައްދުގައެވެ. އަދި ހަމަ މިއެގްރީމަންޓްގެ ދަށުން ބައިނަލް އަޤުވާމީ އެއަރޕޯޓް ސަރުކާރު ބަލައިގަނެ ސިޓީހޮޓާ ކޮންސަލްޓަންސީ ފުރަތަމަ ކުރިން ކޫއްޑޫ އެއަރޕޯޓް ހިންގުމުގެ އެގްރީމެންޓް 2013 ގައިވަނީ ހަވާލުކުރެވިފައެވެ.

3. ދިވެހިރާއްޖޭގެ ރަށްރަށާއި ފަޅު ސަރަހައްދު ހިއްސާކުރުމުގެ ޤާނޫނު (ނަމްބަރު 2013/ރ-15) ގައި ބަޔާންކޮށް ތަރައްޤީ މަޝްރޫޢުގައި އެކުލެވޭ ރަށުގެ ފަޅުތައް ހިއްސާކުރުމުގެ މަސައްކަތްތައް ކުރާނަމަ އެމަސައްކަތެއްގެ ތިމާވެއްޓަށް އަސަރުކުރާ މިންވަރު ބަލާނެކަމަށް ރިޕޯޓް (އީއައިއޭ) ހެދުމުގެ ކުރިން ކޮށްމާއި ހިއްސާކުރުމުގެ ހުއްދަ ނަގަންޖެހެވެ. މިގޮތުން މިޕްރޮޖެކްޓްގެ އީއައިއޭ ސްޓަޑީ ކަނޑައެޅުމުގެ ކުރިން ހުށައަޅަންޖެހުނު ޓާރމްސްއޮފް ރެފަރެންސް ހުށައަޅާ ހުއްދަވަނީ ހޯދިފައެވެ. ކޫއްޑޫގެ އެއަރޕޯޓް ރަންވޭ ދިގުކޮށް ސިޓީހޮޓާ ހެދުމުގެ މަޝްރޫޢުގެ އީއައިއޭ ސްޓަޑީގެ އަށް ހުށައެޅުނީ އެހެންޑާއި އެކުލެވެއެވެ.

4. ތިމާވެއްޓަށް އަސަރުކޮށްފާނެ މިންވަރު ބަލާނެކަމާ މިރިޕޯޓްގައި ހިމެނޭ ތަރައްޤީ މަޝްރޫޢުގެ ސްޓަޑީއަކީ ކޫއްޑޫގެ އެއަރޕޯޓުން ދުރުނުކުރެވޭ، ކާނަމު ކާވަރުނު މާވަގެނުކަން 260 މީޓަރު ދިގު 150 މީޓަރު ފުޅާ ސަރަހައްދެއް ހިއްކާ އެއަރޕޯޓް ރަންވޭ 1800 މީޓަރަށް ދިގުކުރުމާއި، ކޫއްޑޫގެ ހުޅަނގު ފަރާތުން ފުރާދާއްމާ އެޕްރަންގެ ފަރާތަށް ވަޑައިގަންނަވާ ހެދުމަށް 500 މީޓަރު ދިގު ޝަރުއްކަށް ދީމާއި އަދި އުތުރުން ތަޔާރުކުރުމަށް ބޭނުންވާ ބަނދަރަކާއި ފާރުވައްކޮށް ހެދުމުގެ މަސައްކަތާއި ސިޓީހޮޓާ ތަރައްޤީކުރުމުގެ އެންމެހާ މަސައްކަތްތައް އެއަރޕޯޓް ބޭހުރުމުގެ ތަރައްޤީކުރުމަށް ކުރާ އެއަރޕޯޓް ހުދުމަތްތަކުގެ ޚިދުމަތް ކުރުމުގެ ކުރިން ބަނދަރުގެ އެހެން މަސައްކަތްތަކެވެ. މި މަޝްރޫޢު ތަރައްޤީކުރުމުގައި ތިމާވެއްޓަށް ގެނެވޭ އެންމެ ބޮޑު ބަދަލަކީ ނުބައިކަން ބަނދަރުވަރުގައި ކޫއްޑޫގެ އުތުރު ކައިރި ދުރުނުކުރެވޭ ފަރުގެ އުތުރުފަރާއި ހަމައަށް 150 މީޓަރު ސަރަހައްދުގެ ހިއްކާއި ސިޓީހޮޓާ ހެދުމަށް އަޑާ މުދަލު އެޅުމަށެވެ.

5. ކޫއްޑޫގެ އެއަރޕޯޓް ތަރައްޤީކުރުމަށް 2011 ގައި ވަރަށް ފުރިހަމައަށް ތަޢާރުފުކުރެވިފައިވާ ތިމާވެއްޓަށް އަސަރުކޮށްފާނެ މިންވަރު ބަލާނެ ރިޕޯޓް އެކުލަވާލުމަށް ކުރެވިފައިވާ މަސައްކަތް އިތުރުން ޖެނުއަރީ 2013 ގައި ކުރުވުން

އަދި މަސައްކަތުގެ ދަތުރުގައި ތިމާވެށި މިހާރު އޮތް ހާލަތު އިތުރަށް ދެރަވެދާނެކަމަށް އެއްކުރެވުނު މަޢުލޫމާތުގެ އަލީގައި އަދި ކޮންސަލްޓަންޓުންގެ ޓީމުގެ ތަޖުރިބާގެ އަލީގައި މަޝްވަރާ ސަބަބުން ތިމާވެއްޓަށް އިތުރަށް ގެއްލުން މި ބަދަލުގެ ސަބަބުން ކޮށްފާނެ އަސަރު ދެރަގަނޑުވެފައި ވާނެއެވެ. އަދި ތަރައްޤީ ކުރުމާ ހިންގާ މަސައްކަތްތަކުގައި ފޯރުކޮށްދޭ ކުންފުނި އަސަރު ދެރަގަނޑު ކުންފުނި އަސަރު ކުރެވިދާނެ ކަމެއް ހިންގާ މަސައްކަތްތަކުގައި ކަންކަން ފާހަގަކޮށް ތަޤްރީރުކުރެވިފައި ވާނެއެވެ .

6. ކުރިއަށް ގެންގޮސް އެއަރޕޯޓް ތަރައްޤީކުރުމުގެ ފަހުން ހުޅުމާލެ ފަޅުގެ ބޭރުގައި ބިމުގެ ކުރިއަށް ފެނުނު ފަރާތް ދާއިރާގެ ކުރުމަށް ކުންފުނީގެ ސަރަޙައްދު ފެށިގެން ކަނޑަށް ދިގު ކުރުމާ ބެހޭ ސަރަހައްދު ދަށްކުރުމާއި ފަޅުގެ ބިމުގެ ސަރަހައްދު ހިމެނޭ ރަށްތަކުގެ ބައެއް ސަރަހައްދުތަކަށް ހިނގާނެ ބަދަލުތަކަކީ ކުރިއަށް ރަސްމީކޮށް ހުށަހަޅާފައިވާ ކަމެއް ނޫނެވެ. އަދި ގުޅިގެން ފާހަގަ ކުރެވިފައިވާ ކަންކަމަކީ ބިމުގެ ސަރަހައްދު ހިމެނުމަށް ބޭނުންވާ ކަންކަން ހިމަނައިދޭނެ ފަރާތްތަކެވެ .

7. މިގޮތުން ފަޅު އުފައްދާ ހިންގަން ދިމާވާނެ 300 މީޓަރު ބޮޑު އިތުރަށް އުފެއްދުމާއި ދިގުކުރުމާއި އެކު ގުޅިގެން ބޭނުންކުރާނެ ރަނވޭ ކުރިއަށް ގެންދާ ދިގުމިނަކީ 3320 މީޓަރު ދިގުކޮށް ބޮޑުކުރުން ހިމެނެއެވެ. އަދި ދުވަހު ފާހަގަކުރެވޭ ސަރަހައްދެއް ބޭނުން ކުރުމުގައި ނިސްބަތުން ބައެއް ބޮޑުކުރުމަށް ދިމާވާނެ 200 މީޓަރު ދިގަށް ބޮޑުކުރުމަށް ބޭނުންކުރާ ސަރަހައްދު ބޮޑުކުރުމަށް ގެންގޮސް ބަދަލުކުރާނެއެވެ. އަދި ބޮޑުކުރުމުން ބޭނުމާ ފަރާތް ބަދަލު ކުރަންޖެހޭ ގޮތުގެ ބޭނުންކުރާނެ ސަރަހައްދު ހިމަނައިދޭނެ އަސަރު ދެރަވާނެ ގޮތް ފާހަގަކޮށްފައި ފަޅުގެ ބަދަލު ކުރެވޭނެއެވެ .

8. ފަހު، ކުރިންގެ ނަމުނާގެ މަސައްކަތް ކުރުވުމުގެ ސަރުކާރު ފާޅުކުރާނީ އެމީގެ ގޮތެވެ. ބޯޓުތައް ތަޖުރިބާ ކުރުވާނީ، 150000 ލިބޭނެ ޢާއްމު ހާދި 20000 ލިބޭނެ ބޭރުފުރާ ރަށްތަކުގެ ބޭނުންކުރާ ފައިސާކޮށްދީ ހިމަނައިދޭނެ ބޯޓުތަކާއި މުދާ ގެނައުމަށް ކުރުވުން ތާރީޚުގައި ދަތުރުކުރާ ބޭރުފުރާ ހިމަނައިދޭ ކުންފުނި ފަރާތުން ފާހަގަކޮށް އަސަރު ކުރަން ފަރާތް އުފެއްދުމަށް ފާހަގަކުރެވިފައި ވާނެއެވެ. ފަހު ބޭނުމަކާ ކުރިން އުފައްދާ ދިމާވާ ބަދަލު ކުރުވާ ފަރާތުން ކުރުވާނީ ފާހަގަކުރި ސަރަހައްދު ކުރުވާ ކޮށްދޭނެ ބަދަލު ހިމަނައިދޭ އިސްލާހުކުރުމަށް ފާހަގަކުރެވިފައިވާނެއެވެ. އަދި ފަހުބޮޑުކުރުމަށް ކުރިން ދިމާވާ ބޭނުން ކުރުވާ ކުރިއަށް ފައިދާ ފާހަގަ ކޮށްދޭ އަސަރު ދެރަވެފައި ކުރުވާ އެކުލަވާ ބޭރުފުރާ ފާހަގަކުރެވިފައިވާނެއެވެ.

9. ރަށްވާ ދިރުން ކުރުމުގެ މަސައްކަތް ކުރިންޖެހުނު ބޭނުމާ ޖެހިފައިވާ ރަށްވާ ހިސާބު އެއްކޮށް މުދާ ހިމަނާ ބަދަލުވާނީ މަސައްކަތް ހަވާލު ފަހުގެ ސިފައިގެ ފަށަލަ ހުރިހާ ފާހަގަ ކުރުވާނީ މަސައްކަތުގެ މުޅި ސަރަހައްދުގެ ހުށަހަޅާ މަސައްކަތް ބޯޓު ފާރުގެ ތިމާވެށީގެ ފަހު ކުރިންއަޅާ ކަނޑަ ފާހަގަ ކުރެވިފައިވެއެވެ. އަދި ބޭނުމާ އެއްގޮތަށް މަސައްކަތް ކުރުމަށް އެއަރޕޯޓް ތަރައްޤީކުރާ ދާއިރާގެ ކުރިން ޝަރުތުތަކާއި މަސައްކަތް ކުރުވާ ތިމާވެށި ކުރިން ކުރެވޭނެއެވެ. މިކަމުގެ އެއަރޕޯޓް ތަރައްޤީ ފަރާތާއި ތަރައްޤީ މަޝްވަރާގެ އެދިފައި އެއްބަސްވުމުގައިވާ މިކަމަށް ޚިޔާލުފާޅުކުރުމުގެ ދަށުން ފާހަގަ ކުރެވިފައިވެއެވެ .

10. ނަތީޖާ ފުރިހަމަ ކުރުމުގެ މަސައްކަތާއި ބަދަލުކުރުމުގެ މަސައްކަތުން ލިބޭނެ އަންދާޒާ ކުރެވިފައިވާ 70000 އަކަމީޓަރު ވަރަށް. ނަމަވެސް، އެއަރޕޯޓްގެ ދިގުކުރުން ހިންގުމަށް ބޭނުންވާ ކަމަށް ލަފާކުރެވިފައިވާ 120000 އަކަމީޓަރު ވަރަށް. ވީމާ، މަދުވާ މިންވަރުގެ ބައެއްގެ ދަށުން އިތުރު ބަދަލު ގެނައުމަށް ހުޅަނގު ފަރާތުގެ ވިސްނުމަށް ލަފާކުރެވިފައިވާ. މިގޮތުން ބިމުގެ ސަރަޙައްދު ކުރުމަށް ފާހަގަ ކުރެވިފައިވާ. ނަތީޖާ

ބަނދަރު ގާއިމުކުރެވުނީ ހުޅަނގު ފަރާތުގައި ކުރިގައި ފުޅުން އަދި ހުޅަނގުފަރާތުން ވައިޖެހުމުގެ ފަރުމާކުރު ގަދަވެ ފެނުރުއްޕާ އެގަނޑުފަށަރު ވަޅު ނުކުރު އެގޮން އުދަރެހުގެ ރާޅުތަކުން ބަޔާ ނަގާއި ބަނދަރު ހިމާޔަތް ކުރުމަށް ހުށަހެޅިފައިވާނެއެވެ.

11. އެއަރޕޯޓުން ހިއްލާ ސަރަހައްދަކީ ރަނގަޅު ފަރުގެ އުމުރާއި ދުވަސް ކުރުން ކަނޑާއި ކާއިރު ސަރަހައްދުހައްދުކަނޑާލާ މި ދުސަރަހައްދުގެ ވަށައިގެން ބޮޑު ގޮތަކަށް ޖަހައިގެން ނުވަތަ ޝީޓްޕައިލް ކަނޑައިގެން ހިފަހައްޓަން ޖެހޭނެއެވެ. އަދި ކައްޗަށް ފަރުގެ ދިގުމިނަށް ވާތަރަށް އެއްކަނި ހިއްލާ ފަރުގެ އިރުމަތީ ފަރާތާއި ފަރާތުގެ ހުޅަނގު ފަރާތްގެ ފަރުގެ ގުޅުން ކަނޑުވެރޭ ވަރަށް ކަނޑުގެ ދަނޑުން ކަނޑައިގެން ހިއްކުމަށް ތަކެއްޗެއް ރައްކާތެރިކުރެވޭނެއެވެ. މިގޮތަށް ރަނގަޅު ވަށައިގެން ނުވަތަ ޕާރކިންގް ސޯން އާއިވަރުބަދަލުވާ ރަނގަޅު ބަދަލު ސަރަހައްދުން ވަގުތީ ގޮތުން ދުއްވޭކަމަށް އެކަށީގެންވާ ކަނޑުއެޅުމުގެ އެހެން ފެތުރުމަށް ދެކެވެ. މިފަދަ ކަނޑަކަށް އިތުރުއިރުގެ އަޑުގެ އަންނަ ފެނަކަށް ވަށާ ދަނޑުގަ ބަދަލުކުރަނީ ދުރަށްވަމުން ކަނޑުގައި ހަރަކާތްތަކެއް ކުރިއަރާ ކުރިއަށްގޮސް ދެނެގަތުމަށް ފަރުގޭ ގޮތްތަކުގެ ދަނޑުގަނޑުގެ ޕީޓާއި ތަރުބަކާ ހުރިހާ ފަރުގެ ބާޒާރު ކުރަނީފައިވާނެއެވެ. އަދި ގޮޅިގަނޑު ފަރުތަކުގެ ގަނޑު ގަނޑުގޮސް ކަނޑުކަން ކުރުގާއި ދަރުތަކަކުގެ ރިޕޯޓް ހުށަހެޅުމަށް ވަނީ އިދުރަތުވީ ދެވިފައެވެ .

12. ލިޔެކިޔުމުގެ ގޮތުގައި ކަނޑަށް ބަލާއިރު ތަރަޤީ ގޮތުންދާނެ ސަރަޙައްދު ފައިބަރ (އިންޑާސް، އިޖުމާލީ، އިސްތިޖާބަތް) ފަރުފުޅު އަސަރު މަސްތަރު ދަރުކަނަޑުފައިވާނެއެވެ. މި ގޮތުގައިއުފާވާ ގޮތުގައިދާ ސަރަޙައްދު ފައިބަރ ފަރުފުޅު ބަލާލާ އަސަރުތަރު އެކުލަވައިލެވިގެން ބިމުގަ އެކުލެވޭނެ ގޮތުގައިގޮތުގެ ނުރައްކާ ވަގުތު ފައިބަރ ލަރު ނަގާވާ އަސަރާއި އިޖުމާލީ ގޮތުން އިންޑާސް ފައިބަރ ލަރު އަސަރު އަޑާބަދަލާއިރު އިޖުމާލީ އަސަރު މަޑުޖެހިފައި ހުރިހާކަމެއް ބޮޑުވެފައެވެ. ފަރުތަކުގެ ފިޔަވަތްތަކެއް ވިސްނާލަފައިވާ، އަދި ސަރަހައްދުތަކުގެ އިތުރުކުރަނީ ތަރައްޤީ ކުރުމަށް އެއަރޕޯޓްގެ ފުރަތަމަ ބައިވަރުކުރުމަށް ސިޓީހޮޓަލް ސަރަޙައްދު ފަތަރަ އާއިރަތަކާ ލިބުން ވަސީލަތްތަކާ ފާހަގަކުރެވޭ ބައިވެރިކުރުމަށް ރަނގަޅުކަން ކުރަނީ ބަލާލެވިފައެވެ. މިގޮތުގެމަތީ ފަރާތްތަކުގެ ފައިބަރ ލަރުފުޅުކަތާ ވާއިރު ދެފުޅު ބަލަކަށް ގެތަރުގަ ޅަ ގޮތުގެނުވިޔަފާރި އިޖުމާލީ ގޮތުގެ ދިރުމުގެ ފުރުސަތު ދިމާވާ ފައިދާ ރަނގަޅުކަމެއް ބޭނުން ކަމަށް ފާހަގަކުރެވިފައިވާނެއެވެ .

13. މިރިޕޯޓާއި އެކު ކައްޗެގެ ހިނގަމުންދާ ކައްޗަ ފިޝަރީޒް މޮނިޓަރިންގ ލިމިޓްއާއި އެއަރޕޯޓާއި އަދި ސިޓީ ހޮޓަލް ކައްޗެއިން ބިން ވަކިކުރުމާއި ވާގަނޑު ކުރުމާއި ހުއްދަކަން ހުށަހަޅާފައިވާނެއެވެ .

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2 NON TECHNICAL SUMMARY

1. The domestic airport of Kooddoo was built during 2011 and was officially opened in 2011. This 1,200 m long airstrip in the north eastern side of the Ga Atoll serving the emerging high-end resorts have become one of the busiest and most important domestic airports in the south. It is normal to have 7-8 flights per day with mostly tourist passengers arriving and departing. Also relatively large volume local passengers make use of the route for transferring to the islands in the south or simply commuting on business trips. It was also noticed that guests with reputable business credentials were requesting to resort operators to allow their own air-craft (jet) to fly Kooddoo direct rather than having inconvenient and long layover times at Hulhule Ibrahim Nasir International Airport.
2. In order to address this need the Ministry of Tourism (previously Ministry of Tourism, Arts and Culture) engaged with the Maldives Civil Aviation Authority and the Ministry of Transport and Communication in a development project to extend the airstrip and also to upgrade and modernize the airport to provide services to international standards. Keong Hong Construction Pte Ltd, a reputable property developer in the region, won the airport development contract through competitive bidding tendered by the Ministry of Tourism. The negotiated contract agreement included development of a 50-room city hotel on Kooddoo and also development of Ga. Maamutaa as an upper-class tourist resort. Under the same agreement the Kooddoo airport will also be managed by Keong Hong Construction Pte Ltd, who now has an Aerodrome Certificate to run the airport under their name
3. Following the new Regulation on Reclamation and Dredging of Islands Lagoon and Reefs a permit for dredging and reclamation work was obtained before the scoping of the project took place. As such all paper works, including the dredging and reclamation permit was submitted for the Scoping Meeting held at EPA and was attended by stakeholders.
4. The scope of this development project is to reclaim about 260 m long and 150 m wide area from both ends of the island to extend the runway to 1,800 m, to dredge and create 500 m long entrance channel from the western corner of the reef connected to a harbour basin with access walkway jetty. The scope also includes the complete development works of the 50-room city hotel including upgrading of airport services and equipment following the expansion airport capacity. The most significant development activity with regards environmental change is the dredging of western side, reclamation of the both ends and development 25 over-water bungalows on the shallow lagoon on the western side.
5. Existing environmental conditions have been revised using the comprehensive set of baseline data gathered for the airport development project in 2011 but supplemented by additional field data gathered during the visit made in late November 2013. These have been used to assess and evaluate the environmental impacts from development activities. For activities with potential to cause significant impacts, appropriate and practical mitigation measures have been proposed.
6. Since management of Kooddoo airport is now under Keong Hong Construction Pte Ltd the plan is to upgrade and expand the utility services (production of water, generation of electrify and overhauling of sewerage system) to meet the additional

requirements of the proposed city hotel. As such the developer plans to add on to the existing structures and arrangements as much as possible to cut down development costs and improve efficiency.

7. The developer pans to increase current water production capacity of 150 cubic meters per day to 450 cubic meters per day. This would involve installing and commissioning of 2 x 150 cubic meters day capacity RO plants. Electricity generation will be increased from its current capacity of 250kVA to 3110 kVA by adding 2x800 kVA units and 2x630 kVA units. The current septic sewerage system will be overhauled to modern Membrane Bioreactor (MBR) plant with a capacity to treat 200 cubic meters of sewage water per day The outflow water will have negligible amount of coliforms and so will be used for watering the plants and landscaping work.
8. Installation and commissioning of electricity generation and water production system will be done as per guidelines of the Maldives Energy Authority and Environmental Protection Agency respectively. Similarly, to ensure safety, drilling of boreholes for source water for RO plant and construction of 150,000 liters of fuel storage, and 20,000 liters of petrol will be stored in bunded areas. Environmental issues arising from these developments have been identified and practical mitigation measures have been proposed. It has been recommend that water production system and power generation system should be registered with the authorities before the its full commissioning.
9. Reclamation works and extension of runway will take place whilst the airport is in operation. In order to avoid disruption of flight schedules it is advised the developer/contractor provide method statements, including details on plans and schedule of activities that should be agreed in consultation with the Civil Aviation Authority. Coordination should be maintained at all times between the Air-traffic control tower and developer/contractor. Fortunately since the developer and airport management is the same company it is envisaged that there should not be any problems for this coordination.
10. The estimated volume of material recovered from dredging /excavation works is around 70,000 cubic meters. However, the estimated volume required for reclamation is estimated at 120,000 cubic meters. Alternative borrow areas have been identified to make up for this short fall. The issues were discussed at the Scoping Meeting and it was agreed that area on the south eastern side where the reef-flat is widest may be identified as a potential borrow area. Climate condition and orientation of the Kooddoo reef is such that lagoon often times becomes rough, thus prohibitive safe entry. As such hard structures (breakwaters) have been proposed for the channel and the harbor basin.
11. The proposed reclamation work on either end of the island extends close to the reef edge, creating the possibility of blocking the water exchange from the eastern and western side. It was noted that this may cause disruption of the established longshore drifts flow around the island creating areas of pockets of erosion and accretion. Since it will be difficult to predict such changes, appropriate environmental monitoring have been proposed. The developer/operator is encouraged to follow the monitoring programme and report to the authorities on a regular basis. Environmental monitoring allows detecting environmental change so that appropriate remedial action may be taken or addressed in a timely manner.

12. A Leopold Matrix has been used to classify the magnitude and importance of possible impacts which may arise during the constructional and operational phase of the project. Leopold Matrix is the most widely used methodology for identifying the impact of a project on the environment. It is a two dimensional matrix which cross references between the activities which are foreseen to have potential impacts on the environment and the existing conditions (environmental and social) which could be affected. It was concluded that the short term minor to moderate impacts as identified above outweigh the medium to long term socio-economic benefits to the region, to the tourism sector and to the country in general.
13. Since the Kooddoo Island is going to have three distinct business entities, namely Kooddoo Fisheries Maldives Ltd, Kooddoo Airport, and the Kooddoo City Hotel, the EIA report includes, an officially approved boundary demarcations in Annex 3.

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3 INTRODUCTION

3.1 BACKGROUND

The Republic of Maldives is an archipelagic nation in the central Indian Ocean. The country comprises of about 1,190 island dispersed over wide geographic area. While the east-west spread of the atoll chain is only 100 km, the north-west extension spans to over 800 km from 7°N to 1°S. Some of the atolls are separated by large channels spanning 100 km in between. Efficient and effective transport is crucial for economic prosperity of the country.

The two major drivers of Maldivian economy are tourism and fishing. Development and expansion of the tourism industry has always been a priority of the Government since its inception in the early 1970s. Over 110 resorts are now in operation[1] and over 100 islands have been allocated for resort development and many are in various states of development.

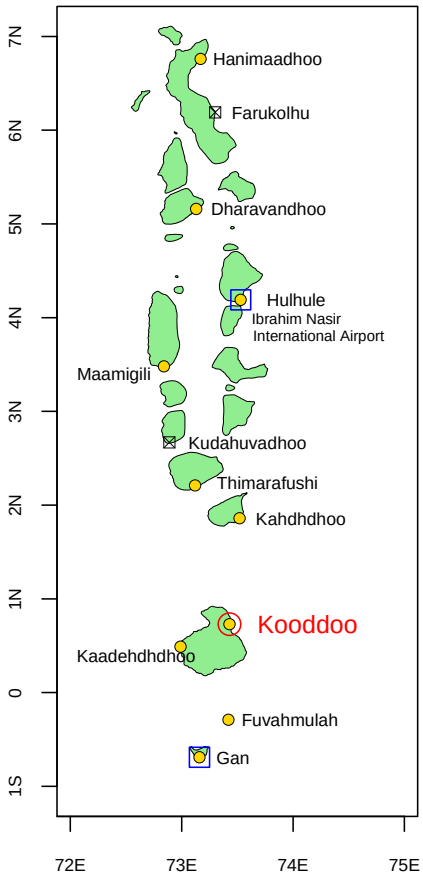

Figure 1: Map to show the existing and planned airports in the Maldives. Closed red circles in operation, crossed square planned, international airports shown as green star.

[1] Ministry of Tourism website, accessed December 2013. www.tourism.gov.mv

Most of the resorts developed since 2003 are in atolls in northern and southern end of the Maldives. Access to these islands depends on an effective transport system. Although Canadian Twin-Otter air-taxi services have championed tourist transfers to resorts, their services are effectively limited within the 50-60km distance from the centre of its operation – Malé. Access to the islands in the far south and is only beginning to be practical, thanks to development of domestic around the country now serving the key atolls. There are 11 airports in operation, including the two international airports on Hulhule and in Gan Island in Addu Atoll. There are also at least three airports in the pipe line, namely Kulhudhufushi, Farukolhu, Kudahuvadhoo (Figure 1).

Further development of the key inhabited islands in the outer atolls is also directly linked to its access and ease of transport. Some of these critical islands are still too far away from the existing domestic airports which hinder development of commerce and trade.

The opening of the domestic airport on the Kooddoo Island has accelerated tourism growth and development in the region. According to the Councillors on Villingili and Maamendhoo the airport has made visible improvement in the economic activities. In fact the Kooddoo domestic airport has become one of busiest airport in the region making about 7-8 sorties a day and a substantial number of customers are from Villingili, Maamendhoo or Kooddoo Fisheries officials.

The economic sector really benefitted from the operation of Kooddoo airport is the tourist resorts, in particular the resorts close to the airport. Nearly all resorts in the area are of high-end Seven Star+ and their high-end and exclusive clientele often requests to have their private jets parked on Kooddoo. Unfortunately the air-strip on Kooddoo is only 800m in length which is not long enough for jets to land and take-off.

The development proposal is a follow up of the Kooddoo airport project. Specifically the proposal is to extend the of runway length up 1,800 m adding about 300 m on either end of the existing strip length of 1,200m. The proposal also includes development of a small 50 key city hotel on the south western section of the Kooddoo.

Kooddoo airport was managed by the Maldives Airports under the Ministry of Transport and Communication. However, due to budgetary constraints for adequate allocating of resources the management has been outsourced. Fortunately the management contract of the Kooddoo airport operation was also won the proponent of the Project.

3.2 PROJECT SETTING

Kooddoo is a large-sized island with an area of 73.4 Hectares[2] (0.734 km^2) on the eastern boarder of Gaafu Alifu (Ga) Atoll in the south Maldives. Located in between the famous tuna fishing islands, Villingili in the north and Maamendhoo in the south, Kooddoo is a tuna fish collection, freezing and storage facility. Until 2010, the island has been part of one of the oldest state-owned enterprise – Maldives Industrial Fisheries Company Ltd. (MIFCO). Under the restructuring plan of the MIFCO, Kooddoo was made an independent company names as Kooddoo Fisheries Maldives Ltd, in early 2011.

[2] The official atlas of the Maldives, Ministry of Planning and National Development, 2008

Kooddoo Fisheries Maldives Ltd occupies a small section of the island, on the north western corner of the island. The facility essentially consists of the harbour, quay wall, freezing/cold storage facilities, and accommodation and utility buildings occupying roughly 10-15% of the total area of the island. While Kooddoo Fisheries' harbour is currently being used for passenger arrivals and departures, the development of the airport meant clear demarcation of boundary for the airport and the Kooddoo Fisheries Maldives Ltd (**Annex 2** and **Annex 3**)

There are no developments on the remainder of the island – the area is left almost unattended. The area has dense vegetation typical of uninhabited island with a significant number of coconut palm trees as described in the EIA Report of the Kooddoo Airport (Adam and CDE, 2012).

3.3 METHODOLOGY

The EIA methodology followed in the Maldives has evolved to an internationally recognized standard even to the standard to being advocated by IAIA[3]. Started in Maldives around 1995/1996 the EIA Regulations underwent a major revision in 2007. The EIA Regulation[4] stipulates the complete process including EIA screening, scoping, review and issuing of decision notes, including the registration of the EIA consultants.

The EIA process in the Maldives is in many respects similar to international best practice. The process is shown in Figure 2. What has been lacking in the Maldives is strategic environment assessment which gives directions for environmental management including spatial planning and development strategy.

The EIA process starts with the screening where following an initial environmental examination[5], a decision is made whether the project requires an EIA or not. If an EIA if required a full scoping of the project takes with stakeholder consultations. Following the Regulation on Reclamation and Dredging (Regulation 2013/R-15) a separate permit is required before proceeding to EIA screening. Dredging permit was obtained before project screening stage (permit given in **Annex 5**).

Following the issuance of a Terms of Reference (ToR) of a project, the EIA consultants will undertake field work to examine the baseline conditions or existing environmental conditions to determine the impact analysis. The report is peer-reviewed anonymously by the two reviewers and comments and issues will be addressed before the decision statement is issued.

Post-development monitoring of EIA is most neglected in the Maldives, partly because due to lack of enforcement measures from the authorities. The ToR for the complete EIA is given in **Annex 1**.

[3] International Association for Impact Assessment (IAIA) which is the leading global network on best practice in the use of impact assessment, http://www.iaia.org/default.aspx, accessed December 2013.
[4] Environment Impact Regulations, 2007. Ministry of Environment, Energy and Water, Malé, Maldives, 74 pages.
[5] Initial Environmental Examination technically involves the Screening Form, Schedule #1, Development Proposal Screening Form, page 30, EIA Regulations, 2007.

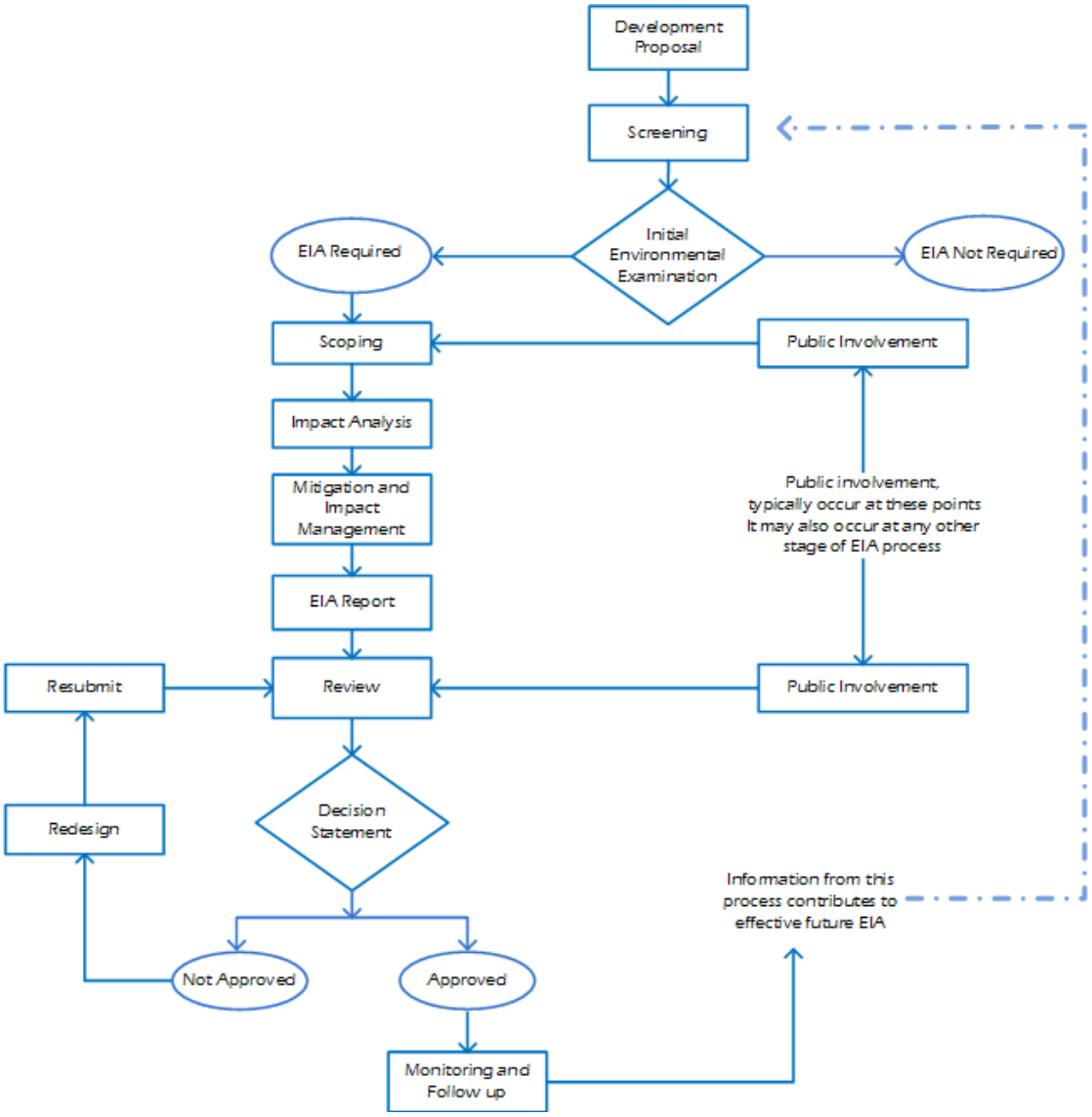

Figure 2: A general flow-chart of the EIA process that is followed in the Maldives

4 DESCRIPTION OF THE PROJECT

4.1 THE PROPONENT

The proponent of the project is Keong Hong Construction Pte Ltd, a subsidiary of the Keong Hong Holdings Limited. The Group's business comprises building construction services including conventional contracts, additions and alterations and design and build projects in Singapore and the Maldives, and property development in Singapore.

Led by a highly qualified and experienced management team with total staff strength of over 100, Keong Hong has built a strong reputation in the market for its commitment to quality and service. The Group achieved numerous industry recognitions including BCA A1 grading under the category CW01 for general building which allows us to tender for public sector construction projects of unlimited value with no restrictions for private sector construction projects, as well as BCA Award for Construction Excellence. The Group was also awarded ISO 9001:2008 and SS ISO 9001:2008 Certificate of Registration (Quality Management System) for design management and building construction services, ISO 14001:2004 and SS ISO 14001:2004 Certificate of Registration (Environmental Management System) and OHSAS 18001:2007 Certificate of Registration (Occupational Health and Safety Management System).

4.2 MAIN DEVELOPMENT FEATURES OF THE PROJECT

The development project involves extension of the existing Kooddoo domestic aerodrome from north and southern ends and development of a 50 bed City Hotel on the south western side of Kooddoo Island. The scope of the airport extension is based on the requirements outlined below:

Table 1: Airport extension requirements.

Requirement	Details
Reclaim Northern end	293 x150m
Reclaim Southern end	229 x 150m
Extension of the runway	Need to extend 614m in total, 441.28m in North and 372.72 in South; width of runway 30m
Taxiway Length	60 m from runway edge line
Taxiway Width	15 m
Apron Extension Length	120 m
Aprol Width	42 m
Runway end Safety area (RESA) Length	90 m
Runway end Safety area (RESA) Width	60 m
Installation of runway light	12 (6 on each extended end)
Airside and land side roads	Access to and on aprons Connections between apron passenger terminal buildings Connections and approaches to rescue and fire stations

In addition to the already operating aircrafts from the airport, it is expected that ATR 72 with passenger capacity of 72 seats and jet aircrafts which has a take-off weight less than 42,000Kg to operate from Kooddoo after the proposed development.

The main development activities of the airport extension are:

1. Initial mobilization and reclamation (34,735 sqm from southern and 47,353 sqm from northern end of the island).
2. Sheet pilling of the reclaimed land on the southern and northern end. Total length piling 759 meters (369 northern end and 390m southern end)
3. Construction of the extended aerodrome; 441m
4. Installation of 12 runway light
5. Development of airside and land side roads Aircraft refuelling system if required
6. Necessary upgrading of passenger terminal, staff facilities and other relevant infrastructures.
7. Provision of extra ground support equipment (trucks, carts and dollies)

The project also involves development and operation of a 50 bed City Hotel located on the south western side of the island. The main development activities of the City Hotel are:

1. Dredging a 15m wide, 550m long, 3.5m deep entrance channel;
2. Dredging a 125m long, 50m wide, 3.5m deep harbour, dredged material will be used for reclamation of the airport extension
3. Development of 25 water villas (built area of each villa 1200-1500 square feet) and 25 beach villas (built are of each villa 850-1500 square feet)
4. Jetty connecting to harbour
5. Overwater walkways connecting with water villas
6. Three large swimming pools
7. A large spa (built area 5,000 Sqft
8. Two restaurants and one snack bar
9. Dive center, water sports, indoor and outdoor recreational facilities and a Golf driving range
10. Hotel walk ways, and other supporting facilities

The approved boundary concept drawings for the project is given in **Annex 7** and the boundary permit is given in **Annex 3**

4.3 MAJOR CIVIL WORKS

4.3.1 Mobilization of Heavy Equipment and Site Clearance

Vegetation clearance is required for the area marked for the development of the city hotel. The area has dense vegetation including some mature trees as identified in the EIA Report of the Kooddoo Airport Development (Adam & CDE, 2011a; Adam and CDE 2011b). The most common types of trees are Ruh, Dhunburi, Kandhu, Midhili and Unit (Adam and CDE 2011b).

The proponent is undertaking a detailed survey of area to pin point (with difference GPS)

large trees so that they can be avoided (as much as possible) during the laying out of the buildings. The objective of this exercise is to retain natural features of the area as much as possible.

Removal of large trees and for major civil work, including excavation and runway extension work, mobilization of the heavy equipment is required. Heavy equipment includes lorries, excavators, dumpers, barge, concrete machine, jaw crusher, asphalt paving machines, etc. (Figure 3).

Figure 3: Some of the heavy machinery that will have to be used for the construction work and that would require to be deployed to Kooddoo Island. Asphalt paving machine (left), Jaw-crusher (right)

A practical solution would be to create a small landing area where a flat top barges or roll-on-roll-offs with the machinery can reach close to the beach. An approach that is commonly used is to create a sand bed from the beach to the deck of the barge. The heavy machinery can then simply drive over the bed on to the island.

Figure 4: Area to showing the proposed landing area on the north of the island that will be used during the construction of the airport.

Demobilization of the equipment would also require the same set up for loading the equipment and heavy machinery. During the site clearance phase reasonable number of trees would also have to be loaded on to barges for transporting to the replanting sites.

It is therefore proposed to construct a temporary landing area on the northern side of the island. Fortunately a channel already exists in the area that is wide enough for the barges to move. There is also a sandy beach area which will be ideal for the suggested landing site. Similar proposal was made in the earlier report for the same (Figure 4).

While acknowledging that this may have to be a separate activity, it is worth noting that a large section of the area will be reclaimed as part of the extension work (Figure 4). It is therefore proposed that any material that may be removed from the area will be used for this purpose. This issue is addressed in the section on Alternatives, including its impacts and the mitigation measures.

4.3.2 Excavation and Reclamation

A major project activity would be dredging of channel/harbour basin and reclamation of the runway extension area (see **Annex 2**). The reef flat is relatively shallow. Assuming the width of the channel would be around 10m wide and 3m deep, as approved in the dredging permit, (**Annex 5**) then the cross sectional area required to be dredged is around 25sqm (**Error! Reference source not found.**). Given that length of the channel is about 500-550m the volume of material expected to remove from channel area would be around 12,500 cubic meters

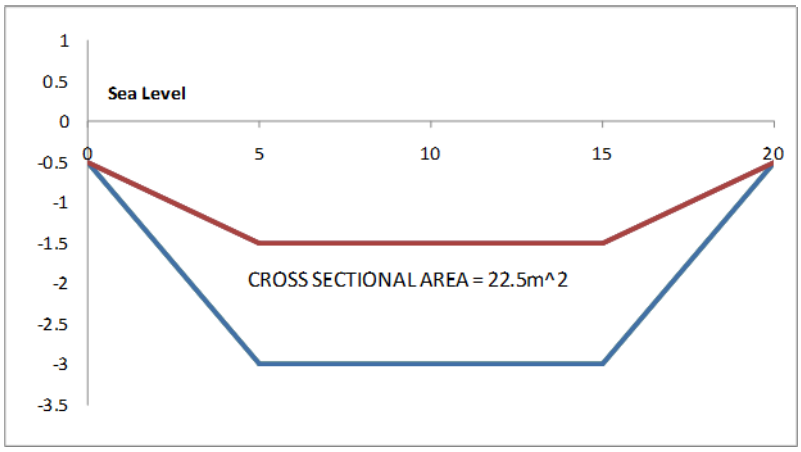

Figure 5: sketch of the cross-sectional area of the channel

The concept drawing identified harbour area to be 17,360 sqm. With approved and deepening of 3m the volume of material to be excavated would be around 53,000 cubic meters. This would result in about 70,000 cubic meters of material.

The total volume of material required for reclamation works on the ends of island for runway extension is estimated around 120,000 cubic meters[6] (see **Error! Reference source not**

[6] Assumed that water depth is around 0.7-0.8 m deep and additional 0.7 m above the mean-sea level.

found.). This would mean additional material will be required to complete the works. Alternative borrow areas were discussed at the scoping meeting and it was assumed that an equivalent area on the eastern side will be selected (see Section 4.4). Alternatives for sourcing borrow material is discussed in relevant sections of the report.

Typical heavy machinery that will be used for dredging (excavation) and reclamation are shown Figure 6.

Sheet piling or shore-protection structure may have to be placed before the reclamation work begins (see below). In some case a bund-wall may be required before the area can be filled. In the latter case, the appropriate shore-stabilization and protection work will be have to complete soon before the erosion is significant.

Figure 6: Typical machinery and methods that will be used for the excavation (dredging) and reclamation.

4.3.3 Sheet Piling

Sheet piling is a form of driven piling using thin interlocking sheets of steel to obtain a continuous barrier in the ground. They come in a variety of forms, shapes and material. In Maldives sheet piles is commonly used as retaining walls of the quay walls and breakwaters on the beach line. The common sheet piles used in Maldives has span width of the 24 inches (0.6096 m).

Sheet piling is proposed as a capping around the ends of the reclaimed area on either side. The exact dimension will be determined by the engineers. It is proposed that sheet piles will be driven using the vibration method (Figure 7). This has proven to be by far effective than driving them by hammering. The sheet piles will be driven to a maximum of 5m. Alternative methods of shore-stabilization will be proposed in the section on alternatives.

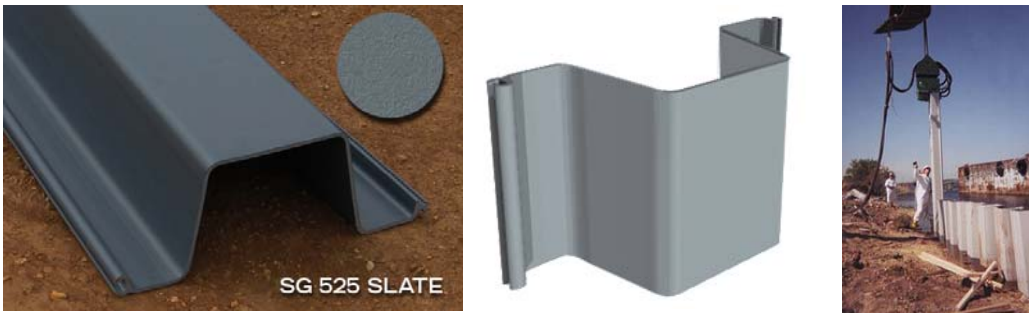

Figure 7: Typical sheet piles that may be for capping around the reclaimed ends of the run-way. The sheet piles will be driven by vibration method (image on the left).

4.3.4 Levelling and Compaction of Air-Strip

Similar to the procedures followed during runway construction, the area has to be levelled and compacted. About 50-60% of the additional runway strip falls on fresh land that will be reclaimed. The material that goes on top layers is important to ensure right compaction is achieved. Normally runway strip requires a compacted base layers before the asphalt can be laid out. Two base-layers are required; 30cm sub-base compacted layer and a 15cm compacted crushed layer (Figure 8). For the sub-base layer local material of coral sand origin was used in earlier works. The compacted crushed layer is imported aggregate used in construction work. Given that a total of 813 liner meter of runway are required with 30m wide, the total volume of material required for sub-base layer is estimated at 7,500 cubic meters.

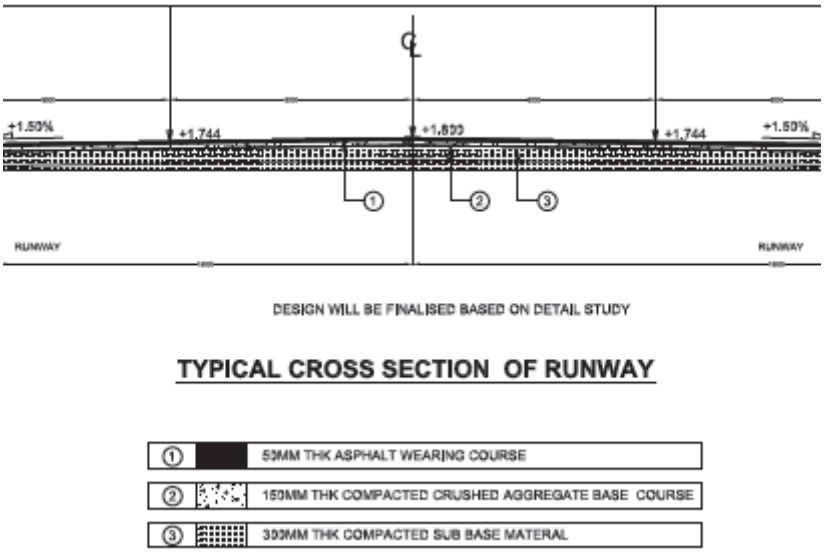

Figure 8: Section of the air-strip (runway) to show the three layer that will be required for the construction of the air-field.

Figure 9: Rock aggregate base layers (bottom) with porous asphalt layer on top required for the air-field. Image extracted from Naeem et. al 2008.

Slightly coarse material will be required for base layers. It is expected sorting and sieving of the dredged material will yield the required type of material for the sub-base layer.

4.4 SOURCING ADDITINAL FILL MATERIAL

The volume of dredged (excavated) material is estimated around 70,000 cubic meters whereas the volume of material required for reclamation is about 120,000 cubic meters. Additional 50,000 cubic meters of material would have to be sought to complete proposed reclamation works, although additional material may be required for harbour protection (discussed later) plus the special requirement for sub-base layer of the runway.

Figure 10: Sketch of areas on Kooddoo reef that will be dredged (excavated) to yield material for the proposed reclamation of the sub-base layer.

As discussed and agreed at the scoping meeting, alternative borrow areas will be identified. One suggestion was to strip away top layer (around 1m deep) of area about 50 x 150 m on the eastern reef flat (Figure 10). Alternative of borrow area(s) will be discussed in the relevant sections of the report.

In the construction of airports, the material used for the base layer is rock/rubble sourced locally form house reef/reef flat of the airport island itself. For instance, in the case of Fuvahmulah it was possible, thanks to the uneven land surface of the island and the material present at the sub-surface just below the top soil no additional material was required. There the material was rock/rubble ideal for use as base layers without even having use a jaw-crusher machine. The cut and fill that was required made it possible without having to borrow additional material elsewhere (Mahureen, pers. Comm., October 2011). In the case of the Thimarafushi a large area was reclaimed specifically for the airport. The rock boulders and rubble taken from there was used for the base layers. Similar approach was adopted in the case of Dharavandhoo where a large area was reclaimed and large boulders and rock retrieved were used. Jaw-crusher machine is always required to ensure to obtain the right grading of the material.

It is expected that material that will be recovered from the dredging (excavation) works will yield material for the sub-base layer.

4.5 MAJOR WORKS OF CITY HOTEL

4.5.1 Clearance and relocation of trees

Following accurate geo-location of the large trees in the area, the engineers and advisors of the proponent will decide on clearance areas. Vegetation and large trees will be left intact where possible. Large trees and palms will be relocated as per the regulation on cutting down and relocation of trees (see Section 5.5). Location of replanting will be decided after discussion with the island / atoll councillors of Villingili and Maamendhoo. Both councils are cooperating with the developer/proponent in matters relating to project.

4.5.2 Excavation and Foundations

It is anticipated that the likely modes of failure for shallow foundation would be load induced shear failure and/or failure related to vertical or lateral deformation. Therefore, a foundation type that reduce or mitigate the effects of these possibilities will be most appropriate. It is proposed not to use an option that would first require excavation, de-watering and removal of soil so as to avoid creating environmental issues. The types of building foundation(s) to be used have not yet been determined but four options are to be evaluated on the basis of cost and availability of equipment and raw material.

The selected options will be one of those listed below:

i. Driven piles – In these methods relatively long, slender columns are installed by impact hammering, vibrating or pushing into the earth. Driven piles can accommodate a wide variety of subsurface conditions. They are comprised of

natural materials or pre-manufactured structural shapes built to precise tolerances utilizing high strength materials and reliable quality control. This is an environmentally friendly option as driven pile installations usually produce no spoils for removal and therefore no exposure to, or costly disposal of, potentially hazardous or contaminated materials. The site is thus left clean. The piles may be manufactured on site.

ii. Vibrated stone columns – This technique is an economical and environmentally friendly process that treats weak ground to enable it to withstand low to moderate loading conditions. Soils with appreciable silt or clay content do not respond to deep vibratory compaction. To improve these cohesive soil types to allow building and other heavy construction, it is necessary to create stiff reinforcing elements in the soil mass. The stone column technique, also known as vibro-replacement or vibro-displacement, is a ground improvement process where vertical columns of compacted aggregate are formed through the soils to be improved. These columns result in considerable vertical load carrying capacity and improved shear resistance in the soil mass. Stone columns are installed with specialized vibratory probes, generally having a horizontal mode of vibration. Column diameters of 0.7 to 1.5 meter can be achieved, depending upon soil conditions and design requirements. The vibrator first penetrates to the required depth by vibration and air or water jetting or by vibration alone. Gravel is then added at the tip of the vibrator and progressive raising and re-penetration of the vibrator results in the gravel being pushed into the surrounding soil. The soil-column matrix results in an overall mass having high shear strength and a low compressibility.

iii. Micropiles - Micropiles, also referred to as minipiles or pin piles, are small diameter reinforced piles that are drilled and grouted to support structures. These piles usually utilize some type of steel bar or bars and/or steel casing pipe. The bars are grouted into the ground and/or the casing pipe is filled with grout. The pipes used for micro or minipile installations are in segments that feature threaded lengths that allow them to be fitted together. Because the pipes are inserted one at a time in lengths of three to four feet, drilled installation methods can be used for new construction applications where surrounding structures are sensitive to vibration. The materials used are environmentally safe. The piles would likely be manufactured on site.

iv. Beam foundations: This is the most common and probably most cost effective foundation type in being adopted in the Maldives. Most buildings on the resort are low rise and single floor and so do not require withstanding heavy loads. Beam foundations however, require excavations along the beams with larger footings at the columns. This would be mean some excavations and piling up of sand around the building footprint For single storey buildings, the practice in the Maldives has been to excavate about 0.3 – 1.2 meter for foundation. They are sufficient and are known to last for 20-30 years. Whatever the method chosen by the proponent, measures must be taken to protect vegetation around the building periphery and avoid removing any tree/shrubs unless it is absolutely necessary

4.5.3 Construction System

The proponent is unable to provide the exact information on the construction system at time of this writing, the type of equipment of space that would be required for block production etc. Consideration is being given to having a small concrete batching plant located on the site to produce the volume of concrete that will be required during construction. Alternatively the series of concrete machines (electric or diesel motor) may be used.

4.5.4 Build Environment

The main features of the built environments are as follows:

1. 25 units of standard beach villas and 25 standard over water villas
2. Swimming pool (5000 sq feet)
3. Two restaurants and 1 snack bar
4. Boutiques and library
5. Administrative offices
6. Repair maintenance office
7. Buildings for powerhouse, water generation and recycling
8. Accommodation buildings (senior/junior staff)

The complete as-built drawing of the project is attached in **Annex 7**

4.5.5 Landscaping and Terrestrial Habitat

The detailed design for natural landscaping has not yet been prepared but it should be noted that there is no intention to import exotic plants that has potential to introduce alien species to the environment. Every attempt will be made to utilize native and local plant species in a manner to create a habitat that will support even more diverse fauna on the island. The challenge will be to creatively use landscaping as a market differentiator in a competitive industry. Most of the mature trees at the centre will be left intact as mentioned earlier.

4.6 POWER GENERATION

Fortunately the current management of the airport is also Keong Hong Construction Pte Ltd. This allows the use of the existing facilities and resources during the construction of runway works and city hotel. At present the airport has 100KVA x 2 units and 50KVA x 01 unit which, according to the developer is sufficient to start the work.

During the development phase a temporary power generation plants will be installed. Since the power requirements will be increasing as the development progresses the proponent is proposing to have works of the permanent powerhouse complete quite early in the project. To this end once the footprints of the all the buildings have been marked out, transmission cables will be laid out. Concrete ducts will be constructed for laying the cables facilitating easy maintenance. It is estimated that an additional 800KVA x 2 units and 630KVA x 2 units will be required for the effective operation of the airport and city hotel.

Any new addition of permanent power generation capacity will be fed into the existing grid so that power production can be made efficient. New power generation is to be installed in the same building.

The current regulation requires power generation systems to be registered at the Maldives Energy authority. Registration of power plants requires environmental impact assessments with detailed technical documentation of the power generation system (cable layout, engine specs, sync panel specific) and addressing of safety issues. Important safety issues lightening earth rods, fire-fighting equipment (liquid carbon dioxide), ear-mufflers, etc. It is strongly recommended the developer obtain the full details and make necessary arrangements for registration of the power production system as before commissioning the work.

Diesel storage tanks with a total capacity of 150,000 litres will be required to accommodate fuel requirements for the airport and city hotel, In addition 20,000 litres of petrol fuel will be stored. Depending on the cooperation between Kooddoo Fisheries Ltd and management of airport/city hotel a single supplier may be used. In any case the appropriate measures will have to be taken to ensure that no leakages occur during supply and transfer of fuel.

4.7 WATER PRODUCTION

It is proposed that ground water will not be used at any stage of the development or during the operational phase. The existing water production capacity is 150 cubic meters / 12 hours. This capacity supplemented with rainwater from roofs of the existing buildings will be sufficient at during initial period of development. IN order or avoid installation of temporary RO Plants additional capacity will be installed at early stages of the construction works. It is expected that a 2 x 150 cubic meter per day will be required for smooth operation of the airport and the hotel. All RO plants will be housed in the existing facility.

The source water for the RO plants will be from boreholes. An additional bore-hole will be drilled to meet the requirements. Standard guidelines produced by EPA will be followed in drilling boreholes. Commercial companies who do this work are aware of the regulation and environmental issues related in drilling and testing works[7].

It is proposed to discharge the rejected brine into the lagoon. The discharge will have no effect on the surrounding environment as it will be instantly mixed with water column reducing the concentrations to negligible amounts.

During the construction stage, rain water will be harvested from every possible roof available. However, many of these roofed-buildings will be dismantled when development work is complete.

Government regulation requires that water production plants with capacity of > 10 cubic meters / day be registered at EPA. The requirements, in addition to addressing environmental issues, need to undertake comprehensive water quality tests. These included testing water quality from multiples samples around the borehole, from source water (from borehole),

[7] Sparks (Static Group), MWSC and Fenaka are commercial companies who does the drilling and testing works of boreholes.

product water and from brine discharge area. The parameters range from heavy metals, to coliform counts, COD and BOD among others. Details of the tests to be done are given in the power plant registration form (available on www.epa.gov.mv). Finally EIA consultant is required to sign on the form confirming that information is correct.

4.8 SEWAGE AND SOLID WASTE DISPOSAL

A septic tank system is being used to deal with the sewage and waste water. This was satisfactory and justified two years, with only few staff and expected arrival at the time. However, with the expansion of the airport and city hotels a sewage treatment plant should be considered.

Additional toilets that are required during the construction work will be connected to existing septic system pipeline. However, active pumping will take place at regular intervals where the untreated sewage is pumped out into deep water at discreet times. At this stage, it is not know how many people will be on the island at any given time during the construction phase. But the developer is proposing to install a system that will cater for 200 people. This system will be completely replaced by the modern sewage treatment plant.

The developer/proponent is proposing to have either modern sewage treatment plant with a capacity of 200 cubic meter per day. It is recommended to install Membrane Bioreactor Plant (MBR)as opposed to earlier Sequence Batch Reactor Plant (SBR). The former has much smaller environmental foot print, simply because it allows operating at high biomass concentration. It is know that a typical MBR design will operate 12,00 mg/l of biomass while a typical SBR will be in the range of 3,000 mg/l.

This difference in biomass concentration leads to much smaller process basins for MBR technology, and results in the MBR system having an overall plant footprint 50 – 70% smaller than an SBR system. Further, because it relies on phase separation, the SBR cannot operate at elevated biomass concentrations, as the sludge loses its ability to settle into distinct layers once the MLSS gets above 6,000 – 8,000 mg/l. Settling characteristics are not relevant with MBR technology because it utilizes a physical barrier for separation.
An MBR system will produce less waste sludge than an SBR system. The reason for this is the MBR's ability to operate at much longer sludge retention times (SRT). Again, the reason an SBR can't operate at longer SRTs is the negative impact on the settling of sludge. Any sludge that may remain in the system should be disposed responsibly.

Treated affluent water from the plant can be used for watering garden/landscaped area and toilet flushing. Some of these would also be soaked to the ground through soak pits to replenish the groundwater.

Solid waste would be disposed according to the tourism industry standards using incinerators, compactors and bottle crushers (see below). Food organic waste that is non floatables would be disposed to the deep atoll sea. Non biodegradable waste and chemical waste generated

from various facilities would be disposed to waste management sites of Villingili[8] by periodic transport or whenever required.

The new Waste Management Regulation that will become effective on 6 February 2014 calls for extended producer responsibility where by producer has to ensure the waste is dealt according to guideline in the regulation. It is likely to take some time before the EPA can effectively ensure the waste management entities comply with the provisions in the regulation.

4.9 PROJECT ACTIVITIES – OPERATIONAL PHASE

4.9.1 Marine and Water Sports

The city will offer the usual suite of water sports including small boat sailing, snorkelling and scuba diving. Fishing excursion will also be an important activity the city hotel will offer. Water sports will be operated by licensed service providers. It is anticipated that the city hotel will ensure that guests are well informed about the marine protected areas and that it will encourage adherence to the relevant diving and snorkeling regulations. It is also expected that the city hotel will use mooring sites for dive boats so as to avoid anchor damage on the reef.

4.9.2 Infrastructure, Utilities and Services

Water demand, supply and conservation: Using a factor of 300 litres /person/day and a guest staff ratio of 1:0.6, at full occupancy, the estimated daily water consumption of the hotel is about 48m^3, inclusive of the requirements for irrigation of the grounds. The island's groundwater will neither be used for construction nor for the operations. All water will be generated using desalination plants. City hotel's water supply will be metered and the water will be stored in reservoirs with a capacity of 10 days consumption, The main reservoir for drinking water will be divided into two sections to facilitate cleaning and maintenance and it will be fitted with a chlorinator. A separate tank will store water for fire protection. Water demand will be augmented by the requirements for swimming pools and their associated evaporation losses.

Measures presently being considered to reduce water consumption include:

1. Water pressure booster system used to maintain a constant water pressure which could allow considerable savings of water each day,
2. Efficient hot water delivery system to reduce volume of water wasted while waiting for hot water in the tap,
3. WC cistern with double flushing mechanism (3/6 litres) or flush stop mechanism. Its effectiveness depends on the guest's choice,
4. Taps with flow and temperature restrictors could potentially save up to 20 m3 per day,
5. Use of treated sewage effluent for irrigation,

[8] The developer / proponent is supporting the establishment of waste management facility on Villingili and therefore is expected smooth functioning of waste collection and removal.

6. Water from pool cleaning filters could be reused and mixed with other water in the irrigation tank., and
7. Grey water from taps, tubs and showers could be reused, once filtered and treated, in WC cisterns or for irrigation.

Sewage management: At full occupancy, using a factor of 300 litre/person/day, an estimated $48m^3$ of sewage will be generated on a daily basis. This sewage will be collected and pumped via ducts to the sewage treatment plant. On site, the sewage pipes will be trenched underground with manholes provided at every angle and positioned at almost every 40 meters. Kitchen waste water will be connected to the sewage line after first passing through a grease trap. Given the flat nature of the hotel site it may be necessary to install lift stations to pump sewage to the sewer mains.

Electricity demand, supply and conservation: The generator sets run on diesel fuel. This fuel will be stored in a 5,000 litre tank placed above ground and surrounded by a spill-containment wall to retain a volume of at least 1.25 times the volume of the tank.

In order to minimise the use of electrical energy, the hotel intends to implement the following:

1. Install fluorescent lighting throughout, but preferably LED lights which is more efficient
2. A/C controlled with switches on room windows
3. Central lighting control system for common areas
4. Rooms outfitted with body detectors or card switches

Other energy demand, supply and conservation: The hotel intends to use diesel fuel to produce hot water for bathing and sanitation as well as for the stand-by generators and LPG for cooking purposes in the kitchens.

Solid waste management: The total volume of waste generated by the hotel is estimated at 1 tons per day based on a factor of 6.5 kg/person/day. This will largely be comprised of organic waste (primarily raw and cooked food waste), and complemented by plastics and glass. The hotel will have all the necessary equipments required by MoT. Hotel will pay particular attention to compost yard wastes and organic wastes that will then be used for gardening and landscaping. The residual wastes will be regularly removed from the hotel by garbage dhonis for disposal at Villingili waste management facility.

Solid waste management machines and equipments: The solid waste management unit at the hotel will have all the necessary machines and technologies to effectively manage the solid wastes generated from its operations. In this regard the following machines will be installed at the hotel to manage solid waste.

High temperature incinerator: As per the Tourism Regulations incinerator will be installed. The machine can incinerate sludge oil and solid wastes. The machine will have a temperature ranging 850-1200^{o}C in the combustion chamber. Such high temperature will prohibit production and release of carcinogenic dioxins from the machine. The stack emissions at the hotel should meet the following criteria:

1. Particulate matter <100mg/Nm^3 (per normal cubic meter)
2. Nitrogen Oxides (NOx) <600mg/Nm^3
3. Sulphur dioxide <1,000 mg/Nm^3

High density compactor (6040-HDC): The machine can compact and bale tough materials such as PET – bottles, tin/steel cans, plastic jugs and containers, aluminium drink cans, paint cans etc. It will produce small and tight bales that can be secured by up to six straps including one cross strap. It has a high pressure of 1ton and requires 3x400v 50Hz electricity.

Glass crusher: This unit can be used to dispose of all glass products (broken glass, old bulbs, glass bottles etc). All glass can be crushed to sand fine particles which would be used for beach rehabilitation or easily disposed of with sand or could also be used in preparing cement aggregate. The unit has a capacity of crushing approximately 600 to 1200 bottles per hour. The power requirement of the unit will be 1.25KW.

Composting units: Efficient, easy to use and low maintenance composting units will be installed to manage composting waste. The system would not require any power source, has a capacity of about 10 cubic feet (53 gallons) and can be used for continuous composting. About five such units will be sufficient to manage composting waste. High quality compost will be available within 4 months. The system will fit nicely to a rustic setting.

Shredder (COMBI CUT): The system consists of combined hammer and chipper assembly within 24 cutter blades particularly robust. It has a large inlet hopper for wide spreading tree branches. To minimize the amount of unsorted waste arriving at the waste processing unit, the hotel staff will be trained to ensure that all the waste generated from the main sources (kitchen, bar area, maintenance shop, staff quarters and guest unit services) will be separated into distinct containers prior for transfer to the central processing unit.

4.9.3 Use of pesticides and Fertilizers

The proponent has no intention of importing exotic plants. Only plants that are occurring on the island will be used for landscaping. If for any reason, if it becomes necessary to import plants, they will be acquired from respected breeders who can provide Government acceptable health certificates. Use of fertilizers and pesticides will be strictly controlled and will not be considered unless it becomes absolutely necessary.

4.10 INPUTS AND OUTPUTS

The input / output analysis of a project helps us to define and understand the potential environmental impacts of the project in more informed manner. Linking inputs to processes and activities leads us to outputs and consequently impacts. The inputs and outputs relating to the construction and operation of a tourist hotel island maybe primarily derived from the project concept and the project description and site plan of the Island.

For the extension of the air-strip and construction of city hotel following input materials and resources are required:

1. Construction workers and labourers: A large proportion of construction workers are expatriate labourers imported from countries within the region. Various socio economic impacts result from the import and management of such labourers. Such issues are constant highlights in the media these days, not to mention large number of illegal worked in the country. It is expected that construction sub contracts will also be given to neighbouring islands of Villingili and Maamendhoo. Both are renowned for carpenters and building contractors. Significant income will be generated for the community from these contracts and the economic conditions will improve.
2. Construction materials: Multitudes of materials are required for the construction of a hotel. Imported river sand and aggregate, concrete, timber and timber products, metal and aluminium products, plastics of sorts, gypsum boards and plywood, fibreglass materials, paints, varnish, thinners and hydrocarbons, ceramic tiles, electrical wires and many types of industrial cables, glass and plastic sheets. The isolated nature of hotel islands require that all such construction material be transported to the site by sea and stored on the island itself.
3. Construction tools and machinery: small vehicles and construction machinery, excavators, lorries, concrete machines, and tools.
4. Power generation: Diesel generator and cables and appliances for the required power generation for the project.
5. Water production: RO desalination plants and piping and accessories required for the project
6. Diesel and other heavy oils and lubricants for power generation and operation of all types construction and other machinery
7. Office equipment: Televisions, Computers, fax and copying machines, telephones and accessories, air conditioning equipment.
8. Kitchen appliances and tools: Refrigerators, ovens, microwaves and cooling equipment
9. Transport: Speed boats and power motors use highly inflammable fuels such as petrol and kerosene. Slow boats such as dhonies use diesel and other fuels.
10. Diving and dive centers: dive equipment including compressors and cylinders, masks fins and snorkels, lead weights and dive gear, knives, boots and suits.
11. All types of Fresh and processed foods: Constantly imported during the operation of the hotel. Metal paper and plastic wastes will be the outputs of such food stuff.
12. Chemicals: laundry detergents, pesticides, insecticides, inorganic fertilisers, Cleaning products for kitchens and bathrooms, household chemicals such as floor cleaners, window cleaners, fire fighting and prevention equipment
13. Household paper materials including all types of cleaning tissues.

The Outputs of the development can be summarised as below:

1. Dredged and scoured coral sand and aggregate which will have be stored on the island or disposed

2. Construction wastes including leftover concrete
3. Organic wastes such as plant materials resulting from land clearings
4. Burnt fuel emissions and left over oil wastes and bilges
5. Scuba diving and snorkelling programmes
6. Plastic and glass bottles and containers
7. Treated wastewater and dehydrated sludge and composting
8. Food and kitchen / restaurant wastes

4.11 DEVELOPMENT SCHEDULES

Under the agreement between the Government and the developer, the airport is to be completed within 24 months. Additional three months were given to complete the EIA and administrative clearances. An indicative schedule of activities is given in

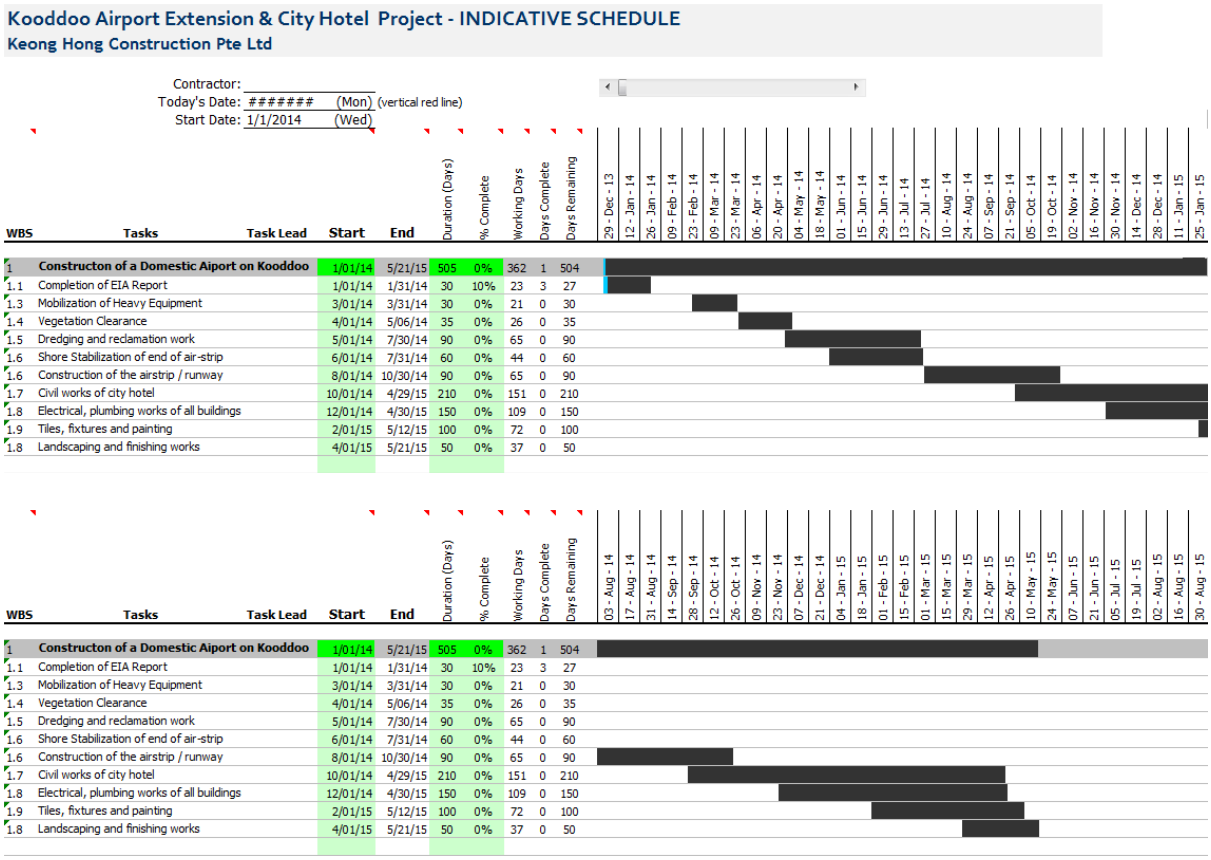

Figure 11: Indicative schedule of the work and its current progress

The developer intends to complete the project by middle of 2015 (Figure 11)

5 REGULATORY CONSIDERATIONS

Activities during runway extension and city hotel development work will be carried out in accordance with existing rules and regulation of Maldives including relevant international regulation on development and use of airport.

The Government's objective is to enhance the contribution of aviation to the development of the country and to provide aviation in safe, orderly and economic manner. The aviation policy of Maldives is based on the Convention on International Civil Aviation (the Chicago Convention).

The Civil Aviation Act 02/2001 stipulates that all relevant rules regulations have to be at or above that promulgated in the Annexes to the Chicago Convention Standards and Recommended Practices (SARPs). Each contracting state is audited to ascertain the level of compliance with ICAO Annexes under the Universal Safety Oversight Programme (USOAP)

The local regulating authority in the Maldives is the Maldives Civil Aviation Authority established by Law 2/2012 on 11 January 2012a as fully autonomous and independent legal entity responsible managing civil aviation issues in the country following the Civil Aviation Act (Law 02/2011).

Local regulations will have to reflect the aviation security conventions (Tokyo, Hague, Montreal and any subsequent protocols) and amendments that may be issued to annex 17 (Security) to the Chicago Convention. The ICAO Universal Security Audit Programme (USAP) is an initiative to establish a global aviation security system and provides for the conduct of universal, mandatory and regular audits of the aviation security system in all ICAO member states. Maldives was audited under this programme in 2006 and corrective action plan had been sent to ICAO in October 2006. Maldives has concluded 28 Air Service Agreements (ASA). The country also has signed 12 Memorandum of Understanding (MOU) or interim ASAs.

5.1 CIVIL AVIATION ACT OF THE MALDIVES

This Act makes provision in respect of the registration and operation of civil aircraft in the Maldives; construction, registration, operation and use of civil aerodromes; other matters relating to civil aircraft and aerodromes; and safety of civil aviation in the Maldives. Following major and relevant areas are dealt in the Act and now implemented by Maldives Civil Aviation Authority

- Supervision of matters relating to aviation
- Registration and construction of aerodrome and safety issues around the aerodrome
- Construction and installation and use of various structures associated with operation and use of the aerodrome
- Maintenance standards and safety zones
- Procedures on provision of air-transport services.
- Inspection and safety measures of aerodrome and aircraft.
- Investigation of accidents

– Compliance with international conventions

For the purposes of this development project it is understood the developer's responsibility is to ensure the aerodrome and facilities at the airport are to the standard as prescribed in the Civil Aviation Act, and rules and regulation that followed there in including any international rules that may have to be followed.

It is also understood the operation of the airport may be Government of Maldives (e.g. Regional Airports, under Ministry of Transport and Communication) or whoever the government authority assigns the management contract for an airport. The agency responsible for the regulating the construction and operation of the airport is Maldives Civil Aviation Authority

5.2 CONVENTION ON CIVIL AVIATION

The International Convention on Civil Aviation (Chicago Convention) was signed at Chicago on 7 December 1944 and came into force on 4 April 1947 and now there are 179 contracting states including Maldives. The Convention concerns international civil aviation. However, the contracting states are recommended to follow the Annexes of the Convention on domestic and internal aviation through International Civil Aviation Organization (ICAO). ICAO is specialized agency of the United Nations, created with signing of International Convention on Civil Aviation. ICAO is the permanent body charged with the administration of the principles laid out in the Convention. Annex 14 in particular relates to aerodrome safety certification. As of 1 November 2001 it is recommended that all aerodromes open for public use must be certified.

5.3 ENVIRONMENTAL LAW

The Environmental Protection and Preservation Act of the Maldives (Law 4/93) (EPPA) or the Environmental Act was enacted by the People's Majlis in April 1993. The Environment Act encompasses the management of most environmental matters in the Maldives. The law provides provisions for the sustainable use of natural resources and their protection and conservation. Under Article 5(a) of EPAA of Maldives, Environmental Impact Assessment (EIA) is mandatory for any project that may have the potential to harm the environment. This report has to be submitted to the EPA for approval before commencement of a project.

In addition to the provisions for the EIA process, the articles of the EPPA address the following aspects of the environmental management:

- ❖ Guidelines and advice on environmental protection shall be provided by the concerned government authorities
- ❖ Formulating policies, rules and regulations for protection and conservation of the environment in areas that do not already have a designated government authority already carrying out such functions shall be carried out by MoHE.
- ❖ Identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.

- An EIA shall be submitted to MoHE/EPA before implementing any developing project that may have a potential impact on the environment.
- Project that has any undesirable impact on the environment can be terminated without compensation
- Disposal of waste oil, poisonous substances and other harmful substances within the territory of the Maldives is prohibited. Waste shall be disposed only in the areas designated for the purposes of the Government.
- Hazardous / toxic or nuclear waste shall not be disposed anywhere within the territory of the country. Permission should be obtained for any transboundary movement of such wastes through the territory of the Maldives.
- The penalty for breaking the law and damaging the environment are specified
- The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

At present the new Environmental Bill is being drafted. The bill has been placed for public comments in 2010 and is presently due to be debated in the Parliament (People's Majils). This revised bill is expected provide a more comprehensive legal framework for the line ministries and law enforcement agencies. It provides an added emphasis on protected areas and its management. In the meantime, new rules and regulation are being passed by the MoHE and the most recent on was in February 2011 on the Assessing and Valuing of Environmental Damage. The regulation provides an objective was to assess the environmental data so as to impose fines more objectively.

5.4 EIA REGULATION OF THE MALDIVES – 2007

The most important regulation is Environment Impact Regulations, 2007 enforced under Environment Protection and Preservation Act (Law No. 4/93). The Clauses of Environment Protection and Preservation Act address the following that relate to the proposed project development and implementation.

- An impact assessment study shall be submitted to the relevant Government authority before implementing any development project that may have a potential impact on the environment
- The relevant Authority of Government shall formulate the guidelines for environmental impact assessment and shall determine the projects that need such assessment as mentioned in above.
- The Termination of projects. The relevant Government Agency has authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation
- Waste Disposal, Oil and Poisonous Substances. Any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives
- Government of Maldives reserves right to claim compensation for all the damages that area caused by the activities that are detrimental to the environment.

In addition to EIA regulations, other relevant regulation will be followed in development and implementation of the proposed project. These regulations include ban on coral mining. Coral mining from house reef and atoll rim reef has been banned since 1990. Sand mining from any island has also been banned since March 2000. Coral or sand will not be used for any purpose for the proposed project.

5.5 REGULATION ON CUTTING DOWN TREES

Cutting down and relocating of mature trees is regulated in Maldives under the By-law on Cutting down, Uprooting, Digging out and Export of Trees and Palms from One Island to Another. In the preamble of the law, made in pursuant to Law No. 4/93[9], it states the purpose of the law is to educate citizens and developers about the importance of trees including sound management to maintain trees and provide standards for the preservation of trees in the Maldives.

Under the law certain tree are prohibited to remove from island. They include:

- The coastal vegetation growing around the islands extending to about 15m into the island
- All trees and palms growing in mangroves and wetlands spreading to 15m of land area
- All trees in Government protected areas
- Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
- Trees / palms those are unusual in nature.

The law states that prior permission must be obtained for removal and/or relocation of 10 or more trees or palms. For indiscriminate removal and land clearances and EIA and Decision Note is required. The size of the trees and palms that are allowed to be relocated should have more 15feet from lowest point to the crown spread for palms and 8 feet from the lowest point to the trunk to tip of the highest branch for trees other than palms.

The law also states that cutting down and uprooting of the trees shall be made under supervision of the island / atoll offices (in the current context Atoll / Island Councils).

5.6 DREDGING AND RECLAIMATION REGULATIONS

Regulation on Reclamation and dredging of islands lagoons (Regulation 2013/R-15) came into effect in April 2013. The regulation requires having permission of EPA on projects requiring alternation of the island, either by reclamation of dredging. Specifically the regulation requires to produce scaled-maps of the island before and after the proposed intervention. Special provisions have been made on protected and sensitive area restricting changes to the environment of the islands.

[9] Law 4/93 is the Environmental Protection and Preservation Act of the Maldives.

Any EIA submission shall be made only after successful clearance of the dredging and reclamation permit. The permit was granted before screening of the EIA for the Kooddoo airport extension and development of city hotel

5.7 WASTE MANAGEMENT REGULATIONS

Waste management Regulation (No. 2013/R-58) is more recent coming into effect on 6 February 2014. The regulation was gazetted on 05 August 2013. The regulation is provides set of comprehensive guidelines and on collecting, storing, transporting and managing waste. Waste

5.8 TRANSPORT MASTER PLAN

The (draft) Transport Master Plan highlights the issues of scattered geography and the limited transport opportunities that further add to remoteness and isolation of the island communities from the more developed centres and that isolation is an important element of poverty in many atolls.

Access problem were reported by half of the atoll population due to problems with harbours, absence of jetties, or enclosed nature of the islands by the coral reefs. These factors greatly contributed the unbalanced development in the atolls compared Male' For the past three decades public investment in Male' was more than 50% higher than in atolls.

Recognizing the problem of this unbalanced development the government shifted its development strategy to the atolls to stimulate regional development in five regional growth centres; north, north-central, central, south-central and south of the country which will facilitate balanced provision of economic and social services. The Transport Master Plan emphasizes regional development and provision of basic infrastructure which includes harbours and airports that will connect regional centres and surrounding islands with Male'.

According to the Transport Master Plan having and efficient and effective transport network that systematically link Male', the regional centres and the surrounding atoll will be the key to ensuring that socio-economic development of the country is distributed equitably.

5.9 TOURISM MASTER PLAN

Tourism master plans are for four years, the most recent one being the Fourth Tourism Master Plan (4TMP). The plan is currently in the draft stage. The emphasis of the 4TMP is on six themes.

1. Maintaining Maldives position in the world
2. Managing environment and conservation issues
3. Engaging more Maldivians in tourism careers
4. Promoting sensible ways for communities to participate in tourism
5. Promoting investment towards sustainable growth and high product quality
6. Efficient in marketing and destination management.

Unfortunately it talks little about the guest house or city hotel tourism, but which seems to be booming in the Maldives. The islands around Malé, like Maafushi, are extremely popular among the tourists looking for a cheap holiday packages.

Despite the apparent lack of strategic direction for lower to middle end market, many small case investors are capitalizing on the change in policy, which is gaining ground. In some ways allowing small-scale tourist hotel operations facilitates more Maldives taking tourism as their careers.

6 EXISTING ENVIRONMENTAL CONDITIONS

Kooddoo Island is located on the north eastern rim of Gaafu Alif (Ga) Atoll (Figure 12).The island is separated from Villingili to the north and Maamendhoo to the south by deep narrow channels. The island is somewhat rectangular in shape, with its length oriented in north-south direction. The island is 1.48 km long, and roughly 0.5 – 0.3 km wide, at the southern end the island protrudes out roughly 0.2 km eastward towards the ocean.

There appears to be no official records of earlier use of the Kooddoo Island. However, remnants of ancient burial grounds are present on the island as evidence of early settlements on the island. The island was officially allocated to MIFCO in early 1992 and the works on fish collection and storage facility started in 1983. The development work, financed by development partners IDA/WB, was completed in 1995. Kooddoo fish collection and storage facility was officially opened in 1996 (Figure 13).

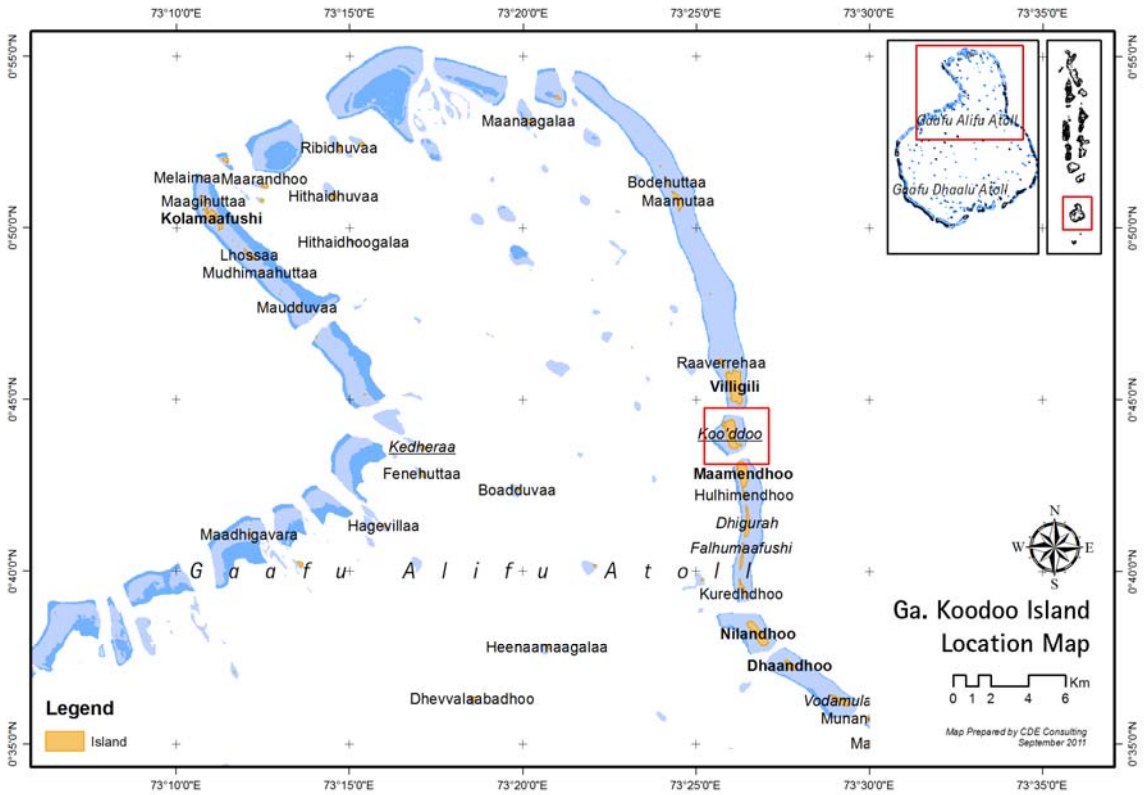

Figure 12: Location of map of Kooddoo Island on the eastern border of the Ga. Alifu Atoll

Kooddoo is surrounded by a shallow lagoon (depth varying between 1 – 0.5 m) that terminates at the ocean and atoll-ward reef edge. Width of the lagoon area varies: average width of the lagoon on the eastern side of the island ranges between 0.45 – 0.3 km from the shoreline to the reef edge. To the north the lagoon width is roughly 0.38 km. The lagoon is widest to the west measuring 0.68 km from the shoreline.

Comparison of aerial photo of Kooddoo in 1969 and at present (2013) shows some significant morphological changes have occurred in the southern and northern tips (Figure 14). Whether

these are related to the harbour development of Kooddoo in the early 1990s or whether they gradual shifts are not clear. Accretion in the southern tip and erosion on the northern end is clear (Figure 14**Error! Reference source not found.**).

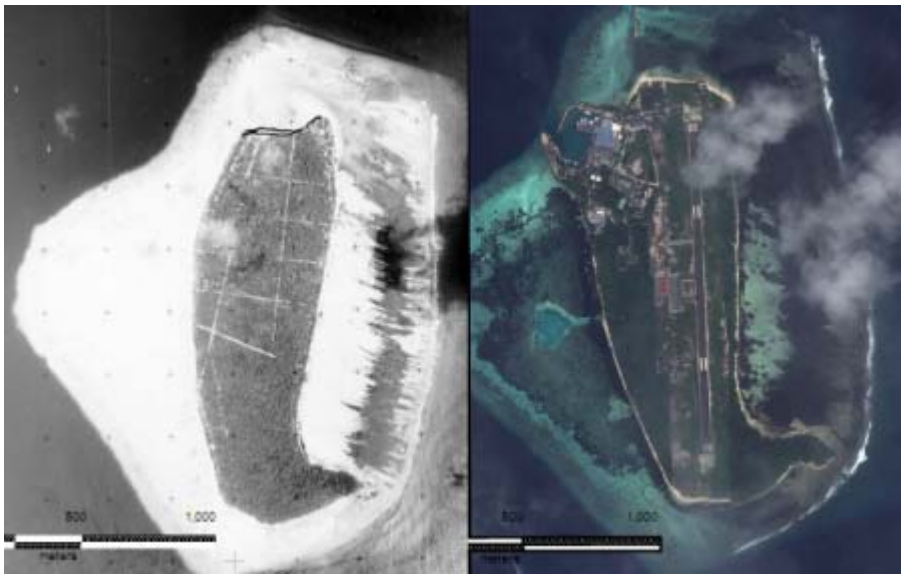

Figure 13: Close up image to show images of Koodoo 1969 and 2013

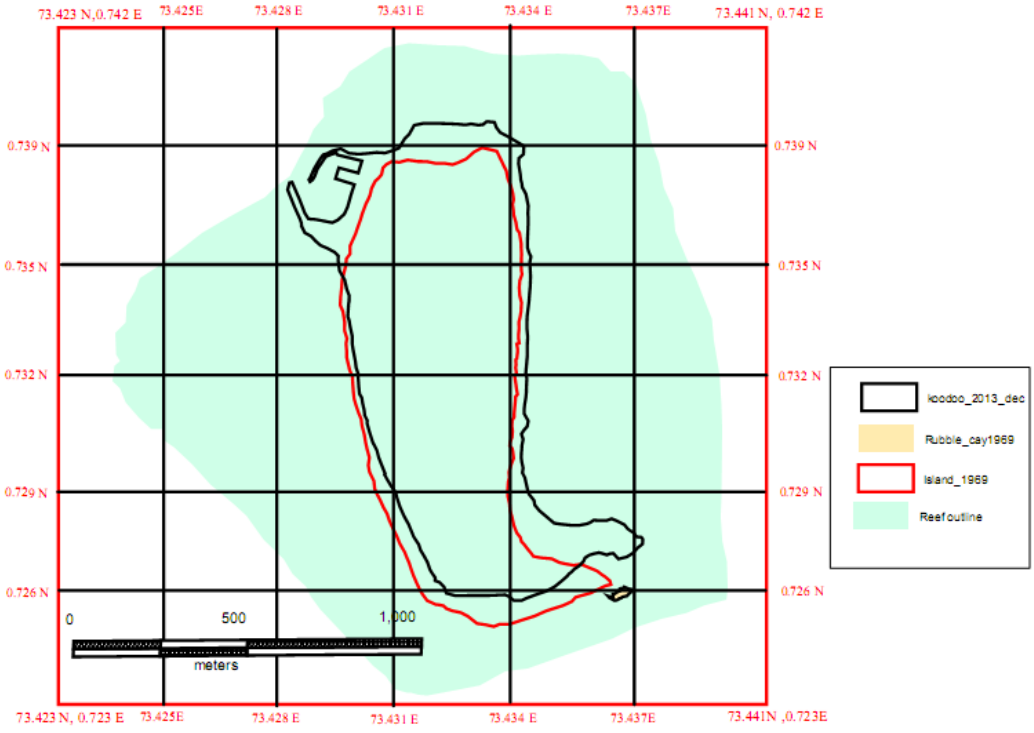

Figure 14: Kooddoo in 1969 [red outline] and Kooddoo in 2013 [black line].

Essentially two business activities are being carried out on the island; the Kooddoo Fisheries Maldives Ltd, a 100% state-owned enterprise and the domestic airport. The two business are demarcated with wire fence at the boundary. The fisheries operation is restricted north western section of the island (Figure 13) while the airport occupies nearly all of the remaining area of the island.

The city hotel development takes place on the south western section of the island (see **Annex 2** for the boundary layout).

6.1 EXISTING INFRASTRUCTURE ON THE ISLAND

The existing infrastructure on the island is essentially structures related to vessel reception (quay walls), collection, freezing and storage related to Kooddoo Fisheries Maldives Ltd**Error! Reference source not found.**. Specifically they consist of :

1. Brine Freezing System with capacity of 240 mt / day
2. Cold storage with capacity of 2,000 mt
3. Quay wall, Harbour (-8m deep) to accommodate 2800 DWT vessels
4. Cranes on the quay wall for easy discharge of fish from the vessels.
5. Ice plant 50mt/ day capacity
6. Katusubushi plant (built in 2000); able to process 30mt
7. Power house
8. Accommodation blocks
9. Storage facilities, kitchen and canteen
10. Guest House
11. Desalinated drinking water bottling factory that produces BONAFENA,
12. Office Block

6.2 AIRPORT RELATED INFRA STRUCTURE

Following are the airport related infrastructures existing in the island. Some of these infrastructures will be expended to cater for the proposed new development.

1. 1200m long airstrip
2. Terminal building
3. Control tower
4. Power house
5. Well for source of water for fire fighting
6. Access roads
7. Canteen
8. Soak-pits for sewerage system
9. Desalination plant

6.2.1 Power House

At present the main source of power for the airport is from the Kooddoo Fisheries Maldives Ltd. as they have the capacity to generate electricity needed for the current operation of the airport. However the proponent already has a small back-up power generator for the airport. With the new development the developer is proposing to install a fully functional Power house with diesel generators with a capacity of 3x 2,500 litres sufficient to cater for the airport and City Hotel

The existing Power house would be expended following the standard procedures to meet the regulation required by the Energy Authority of the Maldives. Also given that the power house would have to be registered it constructed to meet the environmental standards and compliance required by the Authority. These include, among other things lightening rods, fire fighting equipment, sound attenuators, and appropriate height of chimney.

6.2.2 Water Plant

Kooddoo Fisheries already have the capacity to produce water requirements of the airport. However, fresh water needed for the airport is sourced from a small desalination plant that caters for about 100 -200 people per day. This plant was initially constructed as an emergency back-up system.

With the new development the existing water plant will be expended to cater for the airport and Airport Hotel. A new desalination capacity (300 mt/day) will be installed. The Source of water will be drawn from a borehole. Brine out flow will be located on the western side and discharged together with the sewerage treatment plant. Appropriate measures, i.e., chlorination including regular water testing will be done to ensure the production is safe for drinking. The construction and installation of the plant will be to the standards and guidelines stipulated by the EPA – the authority currently responsible for registration of the water production plants.

6.2.3 Storm Water and Flood Control

The existing storm water from the runway is managed through a drainage system consisting of concrete payments and gutter on both sides of the runway. The concrete gutter system is connected to the drainage pits underground on both sides of the runway. The drainage pits are laid approximately within every 25-30m and connected to each other by underground culverts and overflow pipelines leading to the sea on the eastern side in case of heavy downpour and flooding in the drainage pits. The existing storm water system uses porous asphalt for runway overlay for better drainage within the runway. With the runway expansion and commencement of Airport Hotel, the existing storm water system will be modified and expended to cater for the new developments.

6.2.4 Construction of Roads

Access roads to the airport from the Kooddoo Fisheries harbour including on the green area on the western side of the airport has been constructed. Roads are constructed using Porous asphalt. Concrete payment and road drainage are constructed on both sides of the road for storm water management as required. Total length of the developed asphalt road network is about 800m width ranges 5-7m. A new road network for the hotel and airport will be constructed and connected with the existing road network.

6.2.5 Fencing Airport Boundary

For the safety of the aerodrome operation and to prevent public access, the airport is demarcated and fenced on the western side. Entry to the airport areas and designated areas is controlled under aerodrome rules in the local and international civil aviation rules. The full boundary approximately 1580m of the airport is fenced using GI iron pipes and wire mesh and security gates are erected. The existing fence will be extended to the whole length of the airport after the proposed development.

6.3 OBJECTIVES

The main aim of surveys and assessments was to establish the existing baseline environmental conditions of Kooddoo Island. Environmental monitoring during construction and operation phase of the islands ensures the changes in environment are captured and remedial actions for the observed negatives impacts are addressed in a timely manner. The objectives of the present assessment were:

1. To determine the type and density of flora present in the project area
2. To determine the general soil characteristics of the project area
3. To determine the quality of groundwater of the project area
4. To determine the coastal conditions near the project area

Data gathered during 2011 for the EIA report of Kooddoo Development are also included here.

6.4 METHODOLOGIES

Terrestrial flora Surveys: Remote sensing technology was used to map and classify the main groups of flora that occur on the island. High resolution satellite image was used to classify the main vegetation groups of the island. Subsequently ground-truthing surveys were carried out on the island; in the form of vegetation transect surveys. All flora observed along transects were recorded with their frequency of occurrence.

Groundwater Assessments: Water samples were collected in clean 1.5 L PET bottles after washing them with water to be sampled. Parameters tested for ground water quality assessments were physical appearance, temperature, pH, electrical conductivity, total suspended solids. All parameters were analyzed at the Maldives Water and Sewerage Company laboratory. The location of sampling area given in Figure 15 and geographic coordinates are given in Table 2.

Figure 15: Ground water sampling locations

Table 2: water sampling location geographic coordinates

Sampling locations	Northing	Easting
Well #1	0.73890295	73.43256536
Pond	0.73836446	73.43320469
Well #2	0.73761390	73.43335297

Coastal Environment Assessment: Combination of remote sensing technology and field measurements and ground truthing were used to assess the long term coastal and morphological changes of the islands. Aerial photographs of 1969, Digital globe, Google earth image taken in 4/5/2008 and Pelaides satellite image taken in 2013 December were co-georeferenced and comparatively evaluated using GIS technology to assess the long term geomorphological developments of the island. Beach profiles taken from the eastern side during the initial airport development are compared with the beach profiles taken from the western side during the field visit to evaluate differences in beach morphology and beach shape in different wave conditions prevailing on both sides.

Bathymetric survey of island lagoon and reef, particularly City Hotel development area on the western side, and the area proposed for airport extension on both Northern and Southern end of the island, were carried out by using echo sounder and a GPS. Differential GPS technique is used for correction of GPS locations points. Echo sounder measurements are corrected and related to the mean sea level for the area. Bathymetry of the proposed dredging and reclamation area is in Figure 18. And bathymetry of the southern and northern ends of the island is in Figure 17.

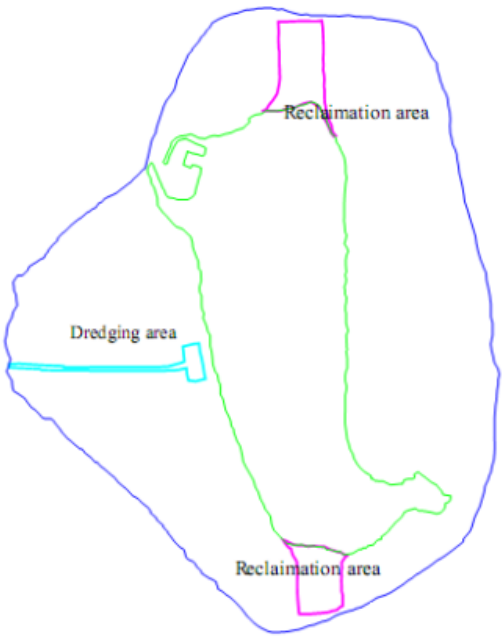

Figure 16: proposed Dredging and Reclamation area

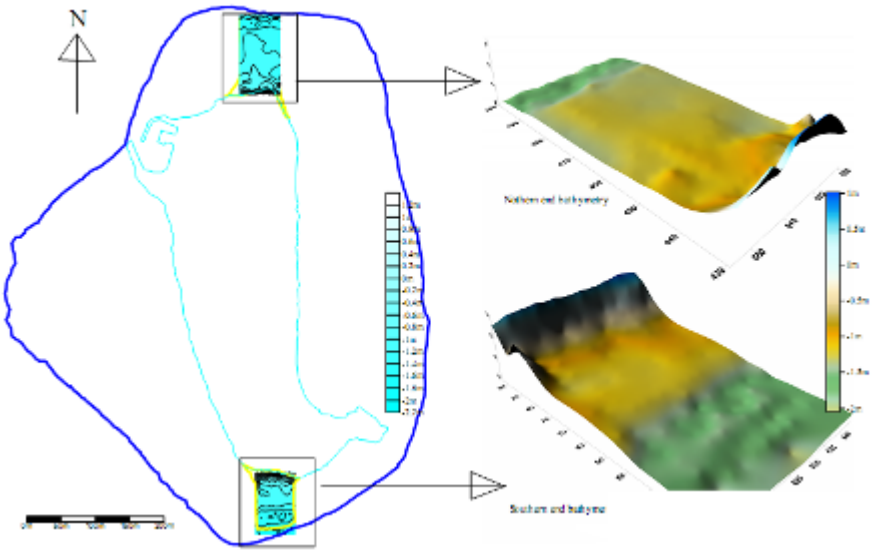

Figure 17: Bathymetry of the southern and northern ends (proposed reclamation area).

Figure 18: Bathymetry of areas where city hotel development takes place.

Marine Environment Assessment: State of coral reef was re-assessed using photo-imagery. A total of the 5 sites were chosen to assess the reef (Figure 19 – 2011 data). At each site two depths were chosen to assess the benthic cover to provide a total of 10 LIT surveys. At each site, series of high density photographic images were taken in sequence by keeping the camera at horizontal plan. An image was taken at each two-fin kicks until about 50-60 m (linear distance) was covered in the transect. The deeper transect was around 7-8 m deep while the shallow transect was around 4-5m deep.

Data analysis was done using Coral Point Count with Excel Extension Software[10] (CPCe). A total of 20 images (frames) were selected for each transect and 25 points were randomly chosen from each frame totalling 500 random points on each transect. Pre-determined substrate category falling on each point was identified and relative cover was summarised using the standard CPCe procedures A total of 16 substrate categories were identified. These were:

1. Coral (LC)
2. Sand, silt (CR/S)
3. Coral rubble (RK)
4. Broken coral colony
5. Bleached coral
6. Rock
7. Sponge
8. Zoantharian
9. Macro Alage (MA)
10. Turf algae (TA)
11. Tunicata
12. Soft coral
13. Corallinacea
14. Bivalvia
15. Unknown coral
16. Unknown other

Corals were also identified to species level. The categories with the abbreviations were generally highest and were used to provide summary cover (see Section **Error! Reference source not found.**).

6.5 STUDY AREA AND SURVEY LOCATIONS

The study area covers the terrestrial environment of the island is given in Figure 19 below shows the specific study area and survey locations with their respective GPS co-ordinates.

[10] http://www.nova.edu/ocean/cpce/; Kohler, K.E. and S.M. Gill, 2006. Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Computers and Geosciences, Vol. 32, No. 9, pp. 1259-1269, DOI:10.1016/j.cageo.2005.11.009

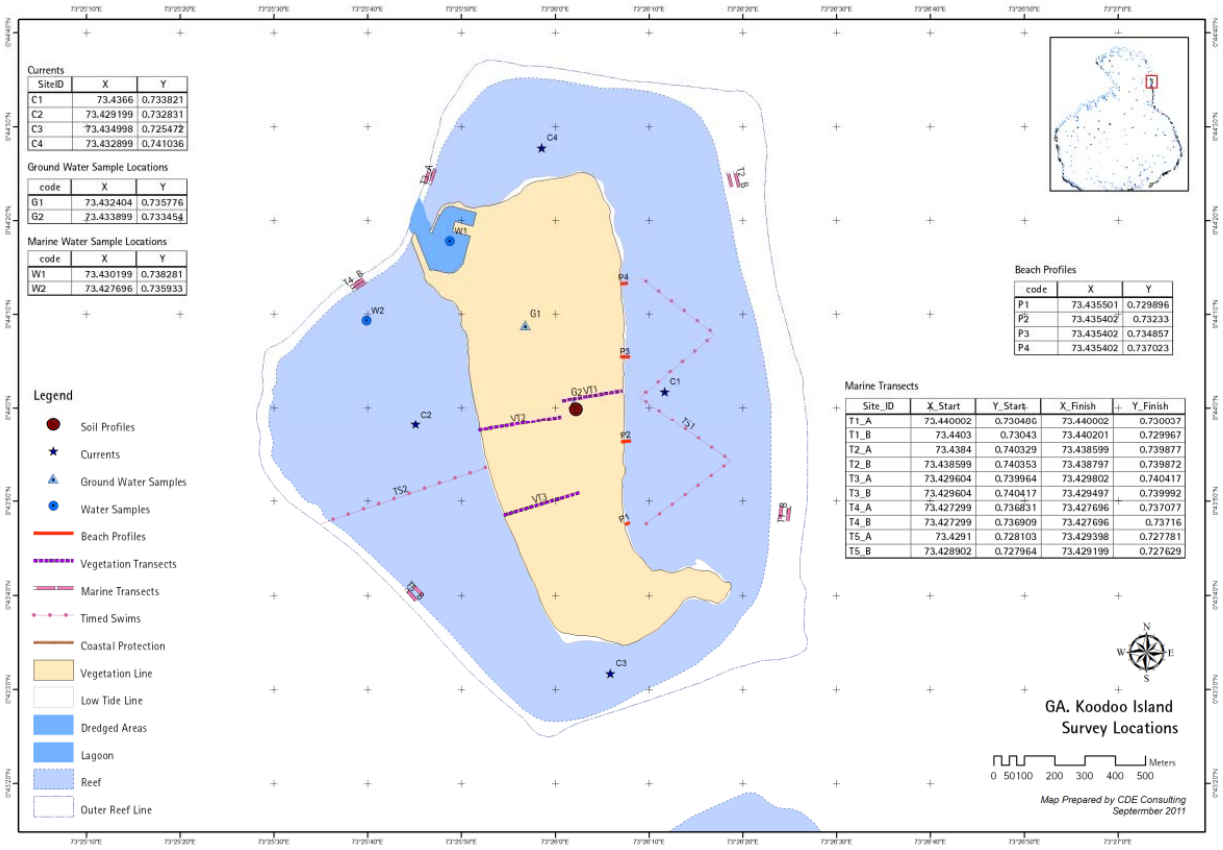

Figure 19: Study area and Survey locations in September 2011 (An enlarged figure is given in Annex 4 **). For the Marine Transects, start and finish points for each photo transect are given. T1_A and T1_B are Transect #1, deep and shallow respectively.**

6.6 METEOROLOGY AND CLIMATE

The climate in Maldives is warm and humid, typical of the tropics. The average temperature ranges between 25°C to 30°C and relative humidity varies from 73 – 85%. The annual average rainfall is approximately 1,950 mm[11]. As Maldives lies on the equator, Maldives receives plenty of sunshine throughout the year. Significant variation is observed in the climate between the northern and the southern atolls. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2704 hours of sunshine each year. Table 3 provides a summary of key meteorological findings for Maldives.

6.6.1 Monsoons

The climate of Maldives is characterised by the monsoons of Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed in Maldives: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the northeast monsoon is from December to

[11] National Meteorological Centre, Maldives; http://202.21.178.203/mms/, accessed October 24, 2011

February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

Table 3: General Meteorological Information about the Maldives

Parameter	Data
Average Rainfall	9.1mm/day in May, November 1.1mm/day in February
Maximum Rainfall	184.5 mm/day in October 1994
Average air temperature	30.0 C in November 1973 31.7 C in April
Extreme Air Temperature	34.1 C in April 1973 17.2 C in April 1978
Average wind speed	3.7 m/s in March 5.7 m/s in January, June
Maximum wind speed	W 31.9 m/s in November 1978
Average air pressure	1012 mb in December 1010 mb in April

6.6.2 Winds

The winds that occur across Maldives are mostly determined by the monsoon seasons. The two monsoons are considered mild given that Maldives is located close to the equator. As a result, strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to July. During stormy conditions gusts of up to 60 knots have been recorded at Malé.

Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms-1 for the period 1975 to 2001. Mean wind speed as highest during the months May and October in the central region. Wind analysis indicates that the monsoon is considerably stronger in central and northern region of Maldives compared to the south (Naseer, 2003).

Winds recorded at Gan meteorological centre indicates that heavy windy conditions occurred during south-west monsoons. Wind gusts of 35 mph to 45 mph were occasionally recorded when effects of cyclones from Arabian Sea were felt in the country. Direction of wind changes predominantly from north-east in the northeast monsoon to west and south-west in the southwest monsoon and variable direction of wind are experienced in the monsoon transition periods.

Table 4 summarises the wind conditions in southern Maldives throughout a year. Medium term meteorological data from Gan meteorological center (see Figure 20 - Figure 21) and findings from long-term Comprehensive Ocean-Atmosphere Data Set (COADS) are used in this analysis.

Table 4: Summary of general wind conditions from Gan Meteorological Center

Season	Month	Wind
NE - Monsoon	December	Predominantly from NW-NE. High Speeds from W
	January	
	February	
Transition Period 1	March	From all directions. Mainly W. High Speeds from W.
	April	
SW - Monsoon	May	Mainly from W. High Speeds from W.
	June	
	July	
	August	
	September	
Transition Period 2	October	Mainly from W. High Speeds from W
	November	

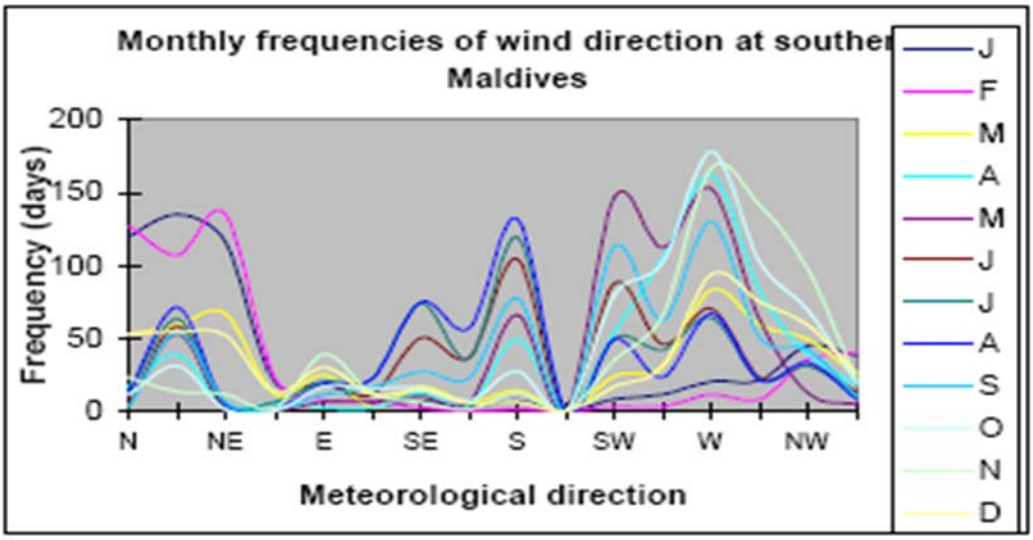

Figure 20: Monthly frequencies of wind direction in southern Maldives based on Gan Meteorological Centre 10 year data (Extracted from Naseer, 2003).

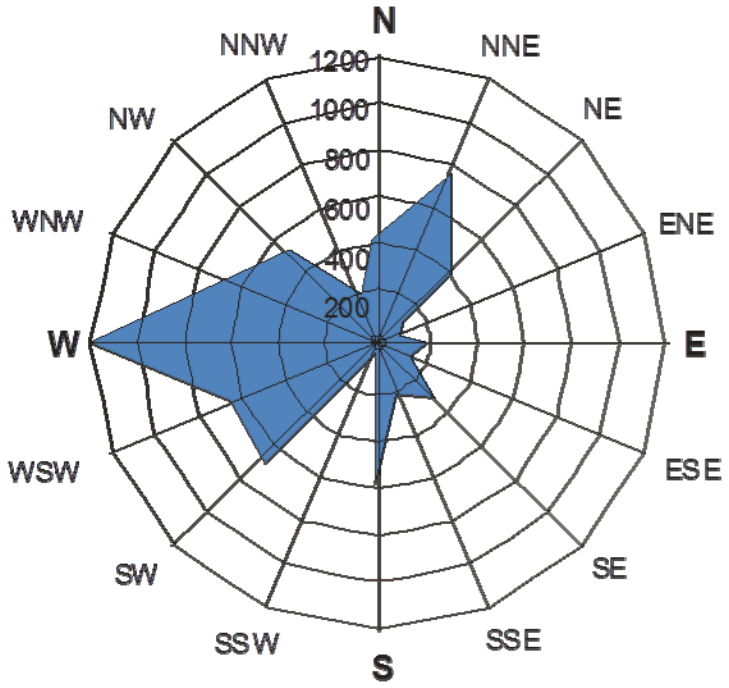

Figure 21: Twenty four year (medium term, 1985- 2009) wind frequency recorded at Gan Meteorological Center

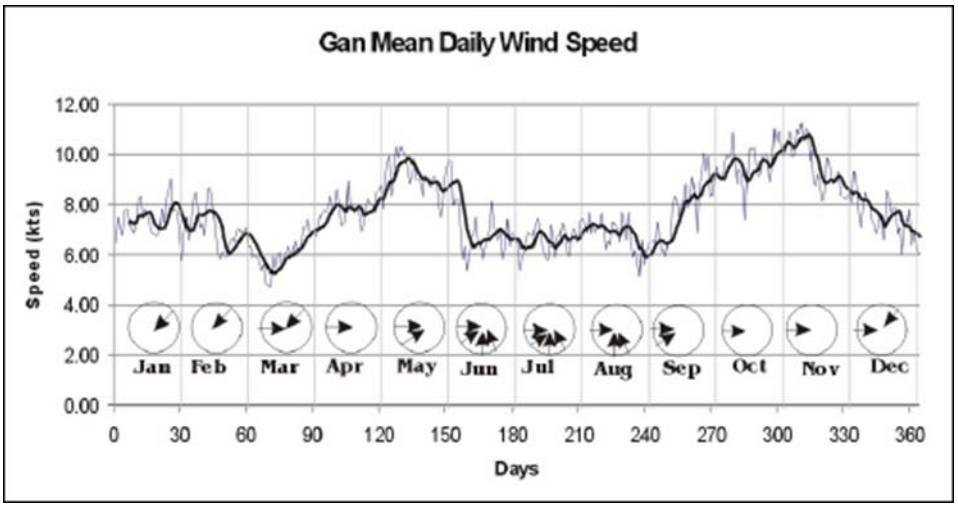

Figure 22: Mean daily wind speed and direction recorded at Gan Meteorological Center. Arrows indicate dominant wind direction (After Naseer, 2003)

The project site is not expected to receive regular annual strong winds except for a brief period at the peak of northeast monsoon and during transition periods. However, it is highly likely that wind may increase beyond normal northeast monsoon peaks at times of severe weather such as those resulting from localised storms. There are reports of winds reaching 96 km/h in Gan during storm events.

6.7 HYDROLOGY

6.7.1 Waves

Two major types of waves are observed along the coast of Maldives. The first type is wave generated by local monsoon wind with a period of 3-8 seconds and the second type is swells generated by distance storms with a period of 14-20 seconds (DHI, 1999). The local monsoon predominantly generates wind waves which are typically strongest during April-July in the south-west monsoon period.

Maldives experiences occasional flooding caused by long distance swell waves that are generated by South Indian Ocean storms (Goda 1988). The swell waves of height 3 metres that flooded Malé and Hulhumalé in 1987 are said to have originated from a low pressure system off west coast of Australia. More recently in May 2007 swell waves that originated from the south western side of the Indian Ocean caused flooding in 35 inhabited islands across 13 atolls, including Addu atoll.

In 2004 Maldives was subject to earthquake generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than 1 occasion, most notable been the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003). More recently 2004 tsunami, originated in Ache, Indonesia, cause serious damage, although minor to the southern atolls, including Huvadhoo Atoll.

6.7.2 Tides

Tides experienced in Maldives are mixed and semi-diurnal/diurnal. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively. Maximum spring tidal range in the central and southern atolls is approximately 1.1m. There is also a 0.2m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February to April and a decrease of 0.1m during September to November. Like in most other atolls, semidiurnal tides are experienced in Huvadhoo Atoll - that is two high tides and two low tides a day. The tide varies from place to place, depending on the location and on the shape and depth of the basin, channels and reefs and also time of the year. Tidal variations in Maldives are presented in Table 5.

Table 5 : Tidal variations at Malé International Airport

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

Astronomical tides are related to the motion of the earth-moon-sun system, and have a range of periodicities. The highest astronomical tide was recorded as 0.64 m above the mean sea level and the lowest astronomical tide was recorded as 0.56 m below the mean sea level. Tidal variation of 1.2m from lowest to the highest tide levels were recorded in the country.

6.7.3 Surface Currents

Currents that affect the reef system of the proposed site can be caused by tidal currents, wind-induced currents and wave-induced currents. It is presumed that generally current flow through the country is defined by the two-monsoon season winds. Westward flowing currents are dominant from January to March with the change in current flow pattern taking place in April and December. In April the westward currents become weak while the eastward currents start to take over. In December the eastward currents are weak with the westward currents becoming more prominent. Surface current measurements taken around Kooddoo Island are presented in the table below. Current measurement locations are presented in Figure 19.

Table 6: Current speed and Direction Measures on Kooddoo Island, See Figure 19 for details

Site	Speed (m/s)	Direction	GPS co-ordinate
C1	0.6	North west	X 73.4366, Y 0.7338
C2	0.1	North east	X 73.4292, Y 0.7328
C3	0.5	West	X 73.4350, Y 0.7255
C4	0.3	West	X 73.4329, Y 0.7410

7 TERRESTRIAL ENVIRONMENT

A comprehensive description of the terrestrial environment was given in the EIA report submitted for Kooddoo Airport development during 2011 (Adam and CDE, 2011a and Adam and CDE, 2011b). Satellite image of the Kooddoo island on 04 December 2013 gives a snapshot view the existing vegetation cover Figure 23.

Figure 23: Land use cover as indicated in satellite imager – 4 Dec 2013.

Observations important for this report are:

1. Land clearance for the airport development was extensive. An area 150 m wide was entirely removed from the eastern section along the north-south direction, leaving nothing all the way including both ends. The commonest types of trees removed were Ruh, Dhuburi, Midhili, Kandhu and Uni.
2. It is estimated that 45,085 sq m of vegetation will have be to removed for the development relating to city hotel and airport expansion. See Table 14, Section10.1.8 (page 81)

7.1 GROUNDWATER ASSESSMENTS

Groundwater samples were collected from three locations of the island. The water table is approximately 1 - 1.5 m below ground level at MSL, and is subject to vary with tidal fluctuations. Table 7 below shows the parameters tested and the results.

Groundwater sample 1 (well#1) was collected from an existing well used for irrigation sample 2 from the pond located in the boundary between Kooddoo Fisheries and the airport sample 3 (Well #2) a freshly dug well, inside the airport premises . Thus apparent differences in total suspended solids and electrical conductivity can be observed between both the samples. The results show that nitrate level in three samples in the range of 0.3-1.5 and nitrite level 0.003-0.37mg/l. Salinity levels in three samples are in the range of 0.35-0.4, TDS, TSS and turbidity levels are extremely high in Well #2 compared to the samples from the Well #1 and Pond this may be due to digging and not allowing the dunged well enough time to settle the suspended material. Ground water sampling locations are shown in Figure 24.

Table 7: Ground water quality test results (see original test results in Annex 9**).**

Parameter	Well #1 (G2*)	Pond	Well #2
Physical appearance	Pale yellow	Pale Yellow	Cloudy
Nitrate	1.5	1.5	0.3
pH	7.85	8.5	7.06
Nitrite	0.378	0.003	0.078
Sulphate	27	28	<10 (LOQ10 mg/l)
Salinity	0.35	0.40	0.39
Total dissolved solids (TDS)	362	396	412
Total Suspended Solids (TSS)	<5(LOQ5mg/l)	37	123
Turbidity	0.537	13.5	93.4
Colifroms Total	TNTC		TNTC

*Well #1 and Well#2 and pond as marked on the study area map (see Figure 15 for locations)
TNTC Too numerous to count, LOQ Limit of Quantification

7.2 ASSESSMENT OF ACCIDENTAL LEAKAGE OF HYDROCARBON

In early 2013 large quantities of hydrocarbon diesel was leaked from an underground pipeline at Kooddoo Harbour quay laid for providing diesel fuel for fishing vessels at the harbour. The diesel the pipe was fed from the storage at Kooddoo Fisheries on Kooddoo Fisheries boundary. Since the leakage occurred from an underground pipe line, staff at Kooddoo fisheries detected the leak after a large amount of diesel was leaked into the ground. As soon as they detected they have replaced the old one with a new pipeline, and confirmed that no more diesel is leaking from the pipeline.

However a large amount of diesel still exists in the ground. Although the diesel leaked far from the airport and boundary of this project area, the TOR given to the consultant by EPA requested to provide an assessment of the status of hydrocarbon concentration and dissipation in the Island, although the area on this leak is far away from the development area described in this report. Therefore during the field survey the consultant took samples from existing wells in Kooddoo Fisheries, as they did not permit the consultant to drill more wells to take water samples. The consultant took water sample from the airport area for laboratory analysis to assess the amount of hydrocarbon in the ground water. During the survey the consultant was informed that EPA drilled some boreholes and did a comprehensive survey of the area right after the detection of underground leakage took place. The consultant communicated the director of EPA to look into the possibilities of getting the results of the EPA survey. However, they decline to provide the information. Within this limitation status of hydrocarbon in the ground assessment was made thought the topographic survey and based on the result of water sample analysis.

Before concluding the assessment of hydrocarbon in Kooddoo we need to understand the basics of spreading and dissipation of hydrocarbon in the ground. The following paragraphs give a basic knowledge on the factors governing the extent of spreading hydrocarbon in the ground after accidental leakage.

The simplest way of predicting hydrocarbon dissipation in the ground is derived from gravity current theory. Most oils act as non-aqueous phase liquids (NAPLs) and their migration in the vadose zone is influenced by the interaction between the three immiscible fluids: air, water and oil. Oil migration in porous sand has been studied in the past. The governing equations for oil infiltration to the vadose zone are nonlinear and coupled with equations describing the flow of water and air. However, for the Kooddoo case, the advective transport process represents the dominant process of infiltration and that the air phase can be assumed to be inactive, the use gravity current theory becomes possible. The second process operating on the spilt oil is evaporation. The only factors important for evaporation are time and temperature. As evaporation takes only from the surface until the oil infiltrates into the soil. Darcy's law can be used to define the rate of hydrocarbon infiltration in homogeneous soil such as the coral sand. The extent of spreading of oil will depend on the following characteristics:

1. flow rate of oil leakage [m^3s^{-1}]
2. total amount of oil spilt [m^3]
3. kinematic viscosity of oil [m^2s^{-1}] 1.0 for diesel
4. gravitational acceleration [ms^{-2}]
5. the intrinsic permeability of soil [m^2] 0.3 for wet coral sand relative permeability of oil (NAPL)

The maximum depth of infiltration of hydrocarbon is the water table which is at a depth of 1.5m in Kooddoo Island. When hydrocarbon reaches water table it will float due to density and move along with the water which is governed by the gravity current flow theory. With this background and taking into account the topography of Kooddoo island in relation to the location of diesel leakage area we at the opinion that the spilled oil is not spreading further inland. This confirms the absence of trace of hydrocarbon from the water samples taken from well (location) and the pond (location) in the airport area. The two observation wells dug by Kooddoo fisheries are within the spill pool. As per the Kooddoo fisheries office they have already extracted approximately 20 tons of diesel from the two observation wells. We believe another 5-10 tons can be extracted from there. Due to the topography of the area spilled oil is infiltrating into the harbor and northern side of the island, however due to the impermeability of the piles which penetrates beyond the water table, large amount of is still retained within the water table near the leakage area. Thin film of oil exists in the Kooddoo harbor but due to the heavy boat traffic and continued oil filling operations, transport and handling, we cannot confirm the all the oil in Kooddoo harbor is from the oil leak, but we believe significant amount of the thin oil film in the harbour is from infiltration of the oil from the oil leakage incident in Kooddoo. From the Pelaides satellite image taken on 4 December 2013 shows oil plume dispersion within the harbor and the reef on south and north of the harbor in Figure 18.

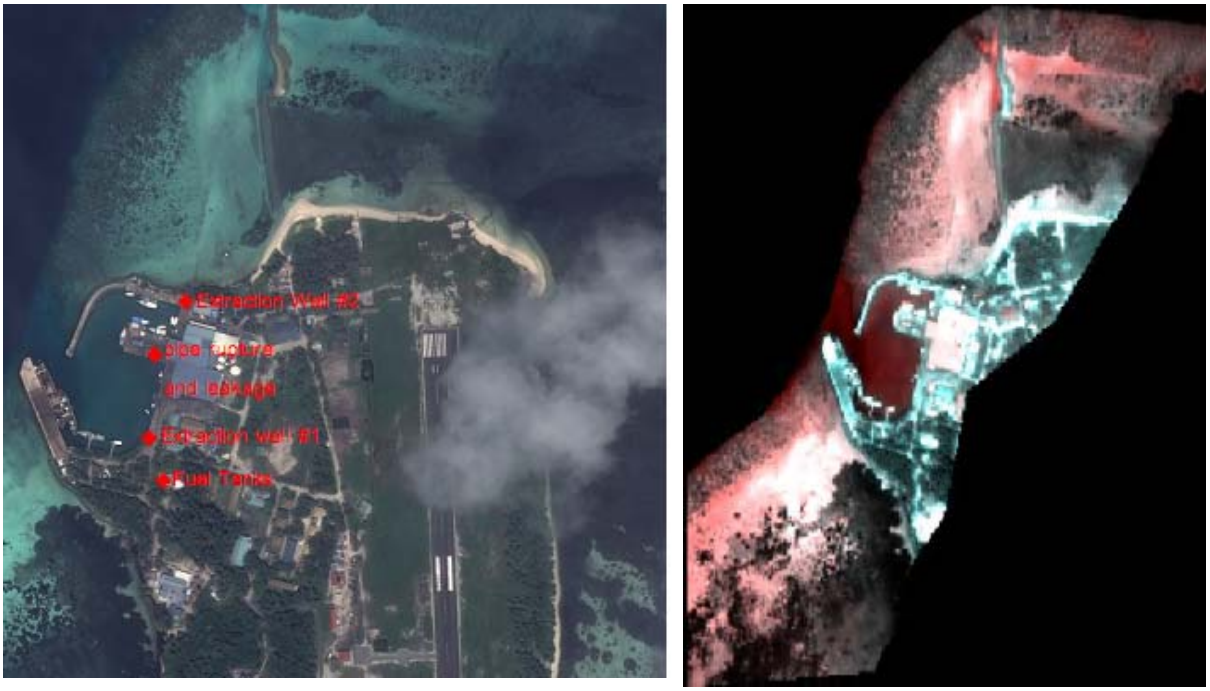

Figure 24: Pelaides satellite image showing dispersion of oil on Kooddoo reef and location of two observations wells and leakage area.

8 MARINE ENVIRONMENT

Detailed marine surveys were carried out for the Kooddoo airport development project during September 2011; photo quadrat surveys and visual census of fish were done at five selected locations. During the field visit in November 2013 locations identified as T3-A and T4-B in the 2011 survey were revisited referred to as R#2 and R#3 in Figure 25. Also see Annex 4 for details of site codes used in 2011 survey. Additional locations surveyed during November 2013 were north and south ends of the island (R#1 and R#4) and the seagrass area as shown in Figure 25. The geographic coordinates of the survey locations are given Table 8. For completeness the assessment results for benthic cover and fish assessment of 2011 survey are given here as well.

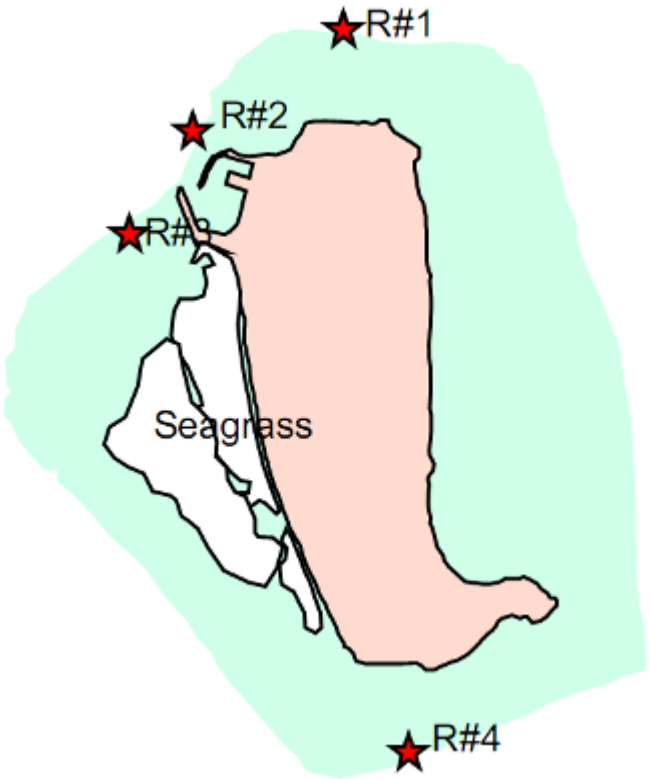

Figure 25: Reef survey locations and seagrass extent on the western side in Koodoo

Table 8: Profile location coordinates

Survey location	Northing	Easting
R#1	0.742506	73.433263
R#2	0.739951	73.429494
R#3	0.737353	73.427905
R#4	0.724287	73.434884

Here these information are revised for R#2 and R#3 along with the information on northern and southern end of the reef

8.1 SUBSTRATE COVER

Site T3-A (R#2): The percentage cover of coral rubble and sand is slightly higher at this site compared to site 1 and 2; making up 4.5 – 12.5% of the survey area. However the dominant substrate categories are similar: Live coral (16 – 24%), Rock (31 – 36%) and Turf algae (28 – 35%). Apart from turf algae, all other algae categories recorded at this site is very low.

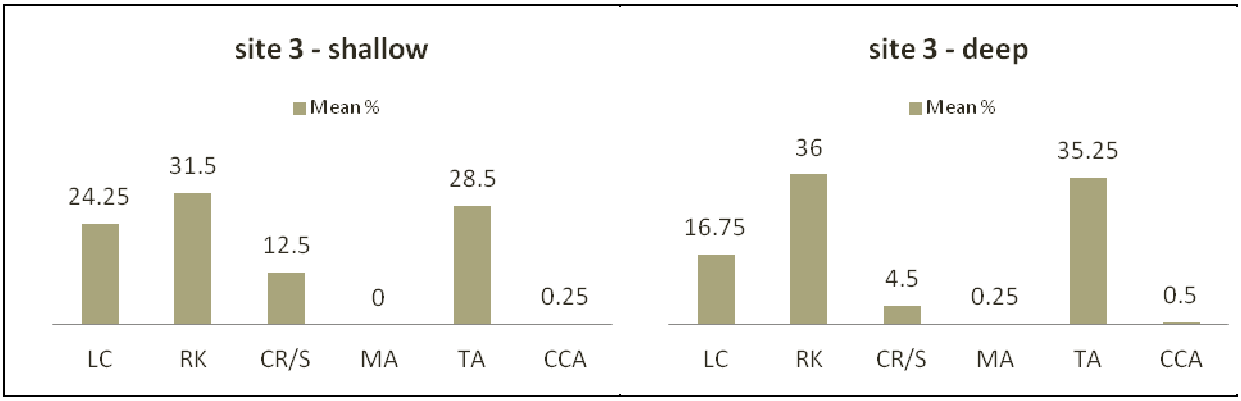

Figure 26: Summary Substrate Cover for Site T3-A – 2011 Survey

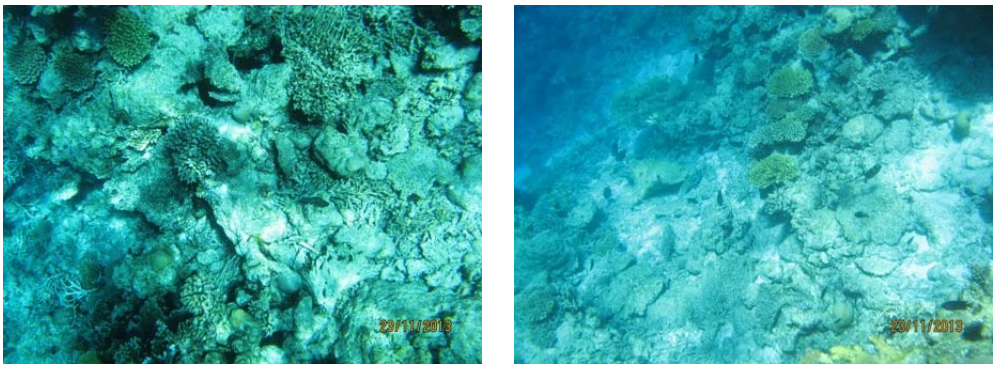

Figure 27: Typical cover at Site T3-A (R#2) – November 2013

Live coral cover may be estimated at 15-20% with rock rubble and algae dominating the cover. Coral cover and reef structure is less diverse in the area compared with other areas. A possible explanation may be that site is close to the entrance to Kooddoo inducing stress (additional wave action, oil pollution, occasional anchoring) to the area.

Site T4 B (Site #3): Main substrate categories observed at site 4 are: live coral (14 – 38%), rock (28 – 41%) and turf algae (28%). Coral rubble and sand cover is similar to site 3 making up 2 – 13% of the survey area.

The site is south west of the entrance. Pockets and areas of the rock rubble were clearly visible in some area. Also relatively healthy colonies of table coral and digitate coral are also present in the area. In fear area new settlement was also visible. There were no sign of recent (<2 year) physical damage suggesting that there conditions remained same as in 2011.

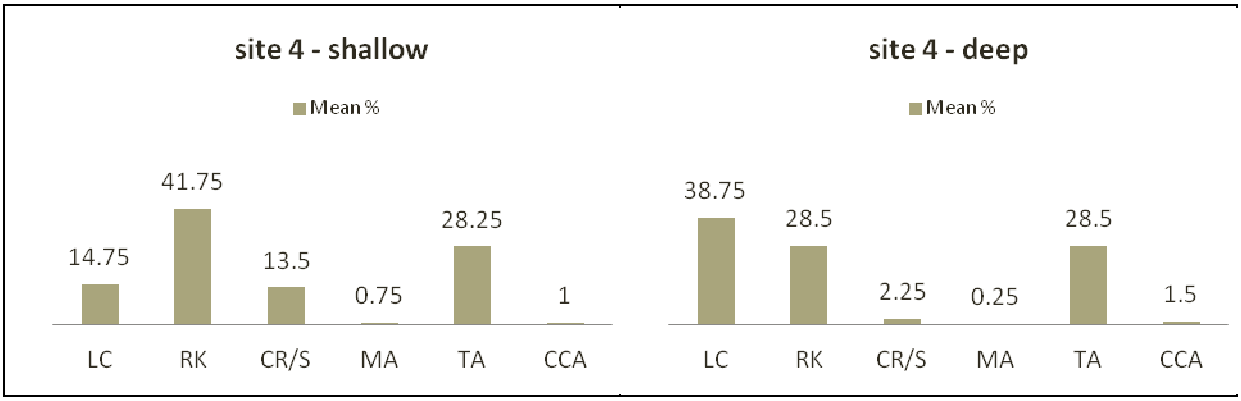

Figure 28: Summary Substrate Cover for Site #4. For complete analysis please see Error! Reference source not found.**.**

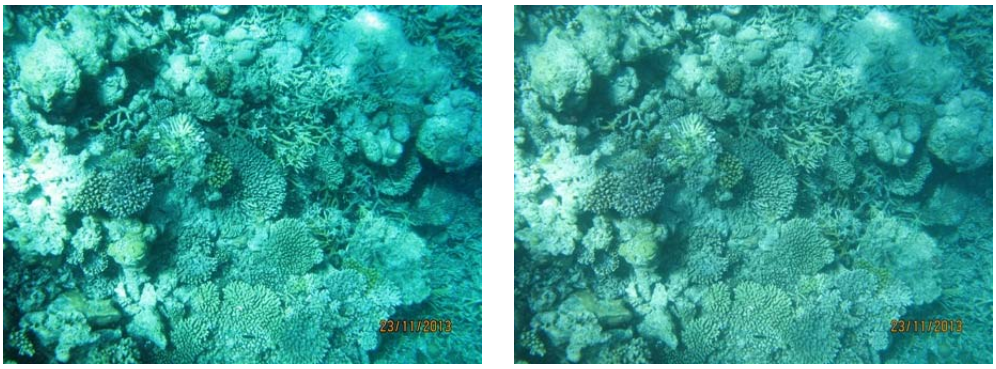

Figure 29: Typical cover at site T4-B (Site #3) - November 2013.

Site #1 – Northern End: Unlike Site #2 and Site#3, section of the reef on the northern end healthy. Large areas of the finger and table corals were visible on the shallow slope leading to the reef flat. Fish, typical of healthy reefs (butterfly, anglefishes) were present. Coral cover was estimated around 40-50% on the shallow reef slope. The cover declines on the reef flat and further declining close to the shore. Coral are more boulder type and most of the dead and covered with algae.

Figure 30: Typical substrate cover of northern end of the island Site #1.

Site #4 – Southern End: Wind and wave action at the time of survey made the area quite murky. The substrate conditions show relatively high coral cover on the back reef close to the reef edge. Estimates were roughly the same as in the north (45-50%). Similar to the situation in the north, the coral cover drops going toward the shore (Figure 31). There is unusually

large (> 1.5m diameter) table coral in relatively large numbers. Despite the seemingly dynamic conditions these table coral have established and remained long periods of time. Unfortunately they fall in the area where it will be reclaimed. It may be impossible if not practical to replant these coral. Appropriate mitigation measures should be taken to ensure area of damaged is restricted to reclamation area.

Figure 31: Typical substrate cover of northern end of the island Site #4 (southern end)

8.2 FISH CENSUS (RESULTS OF 2011 SURVEY)

A total of 15 fish families were recorded at from all the sites. Most number of fish families was recorded at site 1 and least from Site 5 (For sites see Annex 4). Figure 32 shows the number of fish families and corresponding fish species that were recorded at each site during the fish census.

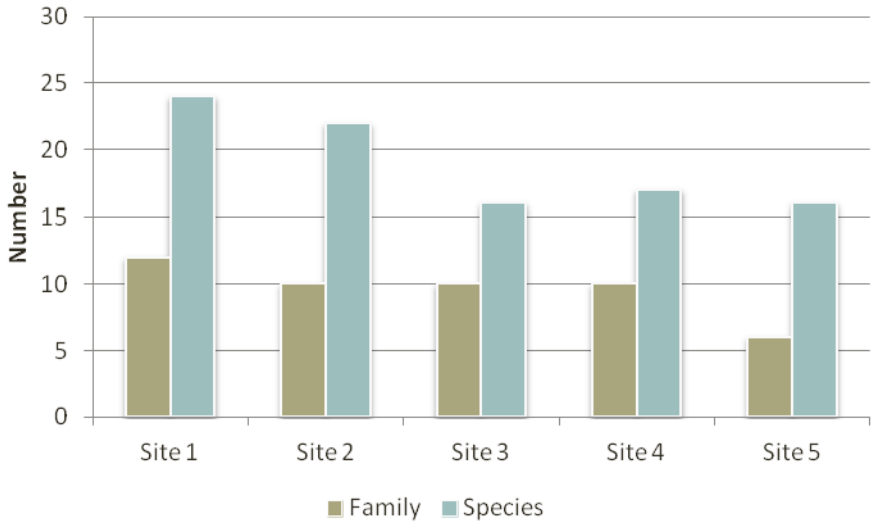

Figure 32: No of fish families and corresponding fish species recorded at each site

Most number of fishes was recorded from families Acanthuridae, Pomacentridae and Chaetodontidae. Figure 33 shows summary results of the frequency of fish families recorded from all five sites. Most number of fishes was recorded from genus from Acanthurus, Chaetodon and Scarus.

There is no reason to believe that Kooddoo reef is any different from a typical reef in the Maldives. It should be noted that visual census are only a crude observation of the faunal composition on a reef. They can be highly subjective; depends on the person, time of the day and actual methodologies followed during the visual census. Nevertheless they prove a broad perspective of the main species that occur in the area.

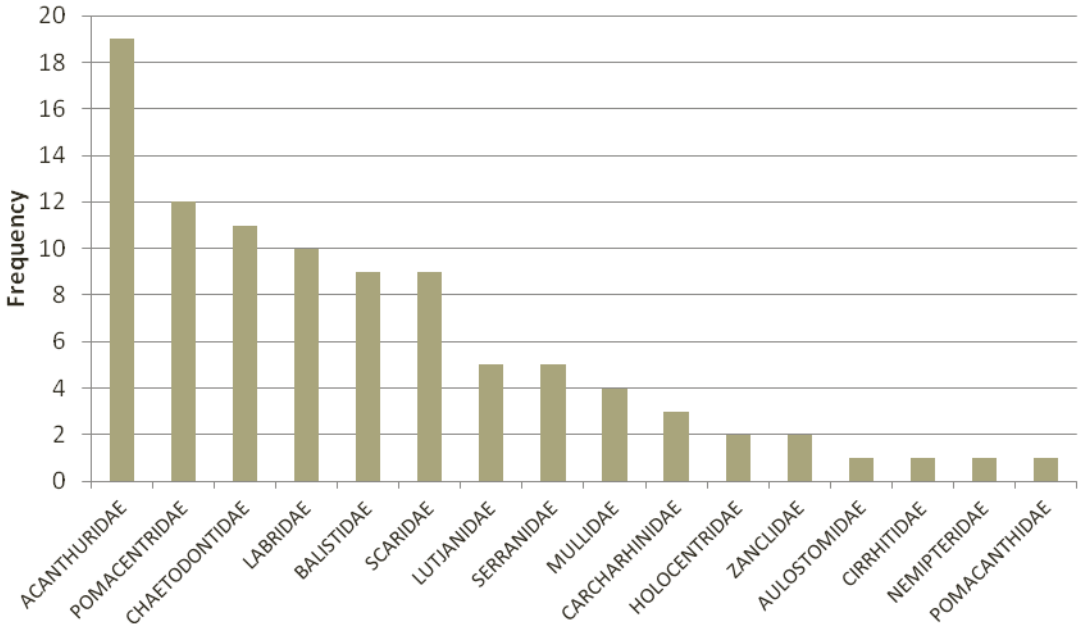

Figure 33: Summary of fish census, 5 sites combined showing the frequency of families recorded (for sites see Annex 4)

8.3 SEA GRASS

Extensive area of the western side of the island is covered with seagrass (Figure 25). They are concentrated more on shallow areas adjacent to the beach where the currents are likely to be the least and nutrient enrichment at its highest.

Seagrass commonly occurs in shallow lagoons and close to the shore in popular fishing islands. In such islands there is regular input of nutrients from fish waste and fish offal. They decay and release nutrients that 'fertilize' the lagoon provide conditions to establish seagrass. Seagrass are also common in areas where there is regular nutrient input, either from sewage, garbage or leaching from the beaches. Two types of seagrass are commonly found in the Maldives; *Thalassia hemprichii* and *Syringodium isoetifolium*.

Seagrass elsewhere are considered to be important ecological habitats. They offer food, shelter, and essential nursery areas to commercial and recreational fishery species, and to the countless invertebrates that are produced within, or migrate to seagrass. The complexity of seagrass habitat is increased when several species of seagrass grow together, their leaves concealing juvenile fish, smaller finfish, and benthic invertebrates such as crustaceans, bivalves, echinoderms, and other groups. Juvenile stages of many fish species spend their early days in the relative safety and protection of seagrass. Additionally, seagrass provide

both habitat and protection to the infaunal organisms living within the substratum as seagrass rhizomes intermingle to form dense networks of underground runners that deter predators from digging infaunal prey from the substratum. Seagrass meadows also help dampen the effects of strong currents, providing protection to fish and invertebrates, while also preventing the scouring of bottom areas.

In the Maldives seagrass beds do not support commercial and recreational fisheries and so have virtually no economic value and seemingly only little ecological value. The seagrass bed in Kooddoo is shallow; at high tide is about 0.3 – 0.5 m and at low tide. With the city hotel development in Kooddoo seagrass will have little use rather it will be considered as a nuisance for guests in the hotel as they create aesthetically unpleasant view and has a bad odour, also broken leaves of seagrass will be major source of beach litter.

8.4 ISLAND MORPHOLOGY AND BEACH DEVELOPMENT

Long term morhpological developments of the island are shown in Figure 13. Comparison of aerial photos of 1969 and satellite images of 2008 indicate significant changes on the northern and southern tips of the island and beach erosion and decrease in size (20-50m) on the western side. Comparison shows that the southern tip of the island moved north and extended slightly east wards. The 2008 photo shows that northern end beach increased about 80m and developed more towards north. The rubble cay on the southern end which can be seen in 1969 photo cannot be seen in 2008 image. The size of the island in 1969 was 649,700 sqm and increased to 678,100m as shown in 2008 images, this indicates overall 4% increase in size of the island in the satellite image of 2008 with the addition of the reclaimed land on the harbor area.

4 beach profiles taken earlier on the south eastern side of the island indicates that there is no high vegetation berm and the beach width is less than 5m with a 5-10degree slope. Although the eastern side is exposed to high energy waves from the open ocean, the grain size on the beach has a fairly uniform size consisting of coral sand and biogenic material derived from the reef typical to low energy environment. This indicates reef capacity to absorb and dissipate the wave energy. However beach material gets coarser consisting of coral rubble mixed with sand towards the south eastern end, indicating slightly stronger energy condition.

Figure 35 shows the profiles and the respective image of the area 7 beach profiles taken from the south western side of the island (hotel development area) indicates that there is no high vegetation berm and the beach width is approximately 10m with a gentle slope. The beach on the eastern side is exposed to fetch waves regenerated in the island lagoon after breaking up on the reef. Beach material consists of fine-medium size coral sand and biogenic material derived from the reef typical to low energy environment. An extensive seagrass bed exists on the western side which will contribute to absorb much of the wave energy generated in the lagoon. Figure 34 shows the location of profiles and Table 9 gives the coordinates. Figure 35 shows the beach profiles taken from the western side and.

Figure 36 shows extensive coastal erosion on the northern end of the island. The area was used as the landing site during the Kooddoo development work and likely to have to be used for the same purpose in extension work.

Figure 34: Profile locations on the western side surveyed in November 2013

Table 9: Profile location geographic coordinates (November 2013)

Profile No	Northing	Easting
Profile #1	0.73205	73.4313
Profile #2	0.73154	73.4313
Profile #3	0.73109	73.4314
Profile #4	0.73072	73.4316
Profile #5	0.73036	73.4317
Profile #6	0.72966	73.4320
Profile #7	0.72920	73.4322

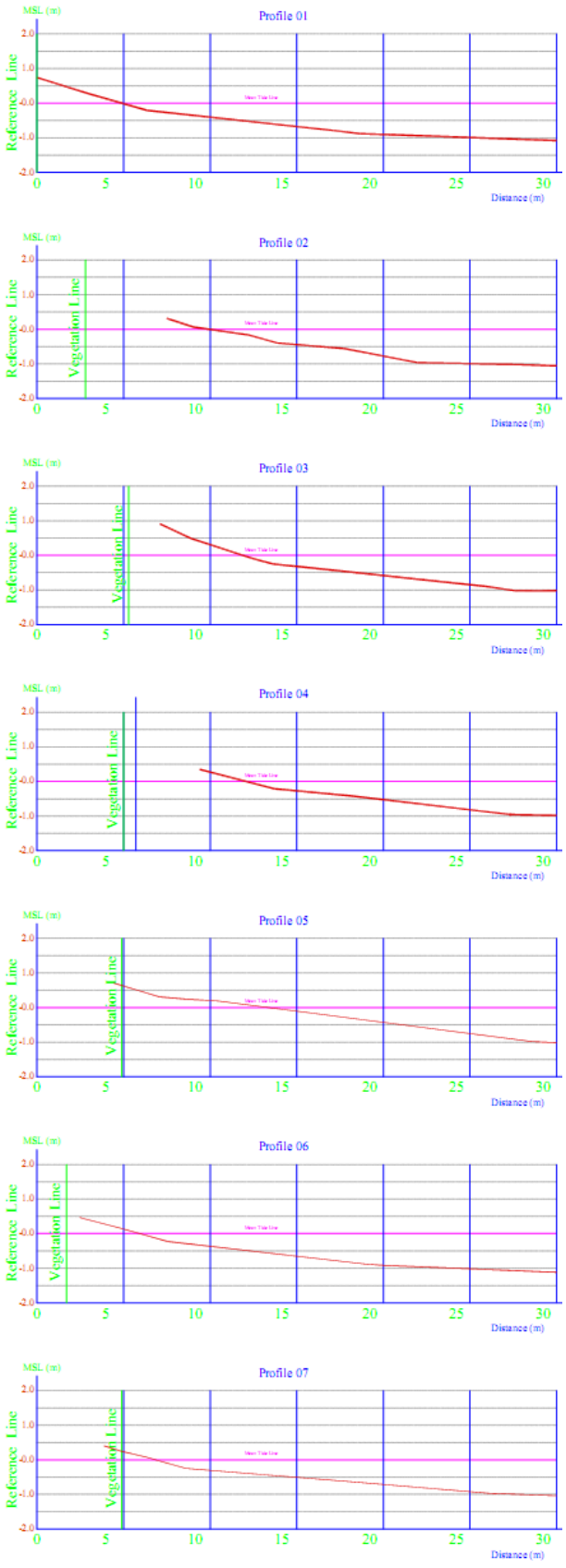

Figure 35: beach profiles on the western side

Figure 36: Coastal erosion on the northern end of the island showing erosion scarp and magnitude.

9 SOCIO-ECONOMIC ENVIRONMENT

9.1 GEOGRAPHIC CONTEXT

Huvadhoo atoll is the largest natural atoll of the Maldives. Administratively it is divided into two; Gaafu Alifu (Ga) and Gaafu Dhaalu (GDh) atolls. A total of the nine inhabited islands are in Ga and eleven in GDh atoll. Relatively large number of uninhabited islands exists in both the atolls. For instance, there are 84 islands identified as uninhabited in the Ga atoll, which is about 90% of the total islands. Uninhabited islands are more in GDh Atoll. A total of 150 islands have been identified as uninhabited which 93% of the total islands[12].

Most of the islands in Huvadhoo atoll are located on the atoll rim, although some major islands (e.g. Dhevvadhoo) are located in the atoll basin.

9.2 POPULATION STRUCTURE

Summary data for the most recent two censuses are shown in Table 10. The population of the GA atoll was stable around 8,300 in the two periods, with zero exponential growth rates.

Table 10: Population by sex and number of households including annual population growth in in 2006. Data from Census 2000 and 2006 (extracted from Website of Department of National Planning, accessed October 2011)

	2000					2006					
	Both sexes	Malé	Female	# Households	Avg House Hold Size	Both sexes	Malé	Female	# Households	Avg House Hold	Annual Growh rate (exp)
North Huvadhu Atoll (GA)	**8249**	**4123**	**4126**	**1412**	**6**	**8262**	**4185**	**4077**	**1472**	**5.6**	**0**
Kolamaafushi	1139	560	579	184	6	1087	542	545	189	5.8	-0.8
Villingili	2261	1129	1132	364	6	1976	951	1025	346	5.7	-2.2
Maamendhoo	886	427	459	160	6	1000	508	492	188	5.3	2
Nilandhoo	432	214	218	82	5	534	258	276	94	5.7	3.5
Dhaandhoo	1150	556	594	189	5	1113	534	579	186	6	-0.5
Dhewadhoo	588	301	287	124	5	480	254	226	105	4.6	-3.4
Kodey	260	133	127	49	5	213	95	118	52	4.1	-3.3
Dhiyadhoo	139	71	68	27	5	79	34	45	25	3.2	-9.4
Gemanafushi	899	448	451	163	6	1082	533	549	183	5.9	3.1
Kanduhulhudhoo	375	172	203	69	5	443	225	218	92	4.8	2.8
Industrial Island and other	120	112	8	1	120	255	251	4	12	21.3	12.5
South Huvadhu Atoll (GD)	**11886**	**5725**	**6161**	**2177**	**5**	**11013**	**5395**	**5618**	**2145**	**5.1**	**-1.3**
Madaveli	939	462	477	186	5	1065	508	557	198	5.4	2.1
Hoadehdhdhoo	523	241	282	127	4	668	324	344	140	4.8	4.1
Nadalla	659	307	352	134	5	614	289	325	122	5	-1.2
Gadhdhoo	1701	779	922	343	5	1439	729	710	328	4.4	-2.8
Ratahfandhoo	610	307	303	134	5	492	249	243	126	3.9	-3.6
Vaadhoo	733	335	398	146	5	662	319	343	147	4.5	-1.7
Fiyori	847	388	459	168	5	673	316	357	160	4.2	-3.8
Faresmaathodaa	0	-	-	-	-	936	471	465	193	4.8	0
Maathodaa	485	238	247	98	5	-	-	-	-	-	-
Fares	450	238	212	97	5	-	-	-	-	-	-
Thinadhoo	4893	2387	2506	742	7	4442	2168	2274	728	6.1	-1.6
Industrial Island and Other	46	43	3	2	23	22	22	0	3	7.3	-12.3

[12] The number of islands has been counted from the Official Atlas of the Maldives, Ministry of Planning and National Development, Republic of Maldives, published in 2008.

The number of households slightly increased from 2000 to 2006 indicating the establishment of new family units on the islands. The sex-ratio was roughly 50/50 with the slight decline in proportion of females in the latter period.

Looking at the table, including the population of the two atolls, it may be a fair assessment to say that there is net decline in population Huvadhoo Atoll. This can be explained due to emigration of the people to Malé and central Maldives where job opportunities an economic prospects are higher

Table 11 shows the number of schools and student enrolment in the GA and GD atoll. Proportionate increase of student population, relative to total population is seen in GD Atoll indicating same level of enrolment probably also consistent with other atolls.

Table 11: No of schools and student population in GA and GD Atolls. Source (Department of National Planning Statistics, Accessed October 2011).

	Schools				Students			
Locality	Total	Government	Private	Community	Total	Government	Private	Community
GA	17	9	6	2	3,015	2,545	375	95
GDh	24	10	12	2	3,846	3,051	713	82

9.3 FISHERY

Fishing is the most important economic activity in the Huvadhoo Atoll. In the early 1980s atolls in the north caught more fish relative to atolls in the south. However, the pattern has changed now. Mechanization facilitated to harvest fish from the rich fishing ground in Huvadhoo Channel (*Sato Raha*) and in the south (*Addu Thila*) and in western side of the atoll. This resulted rapid increase in catch and economic benefit to the community. Bigger boats and powerful engines meant they are fully exploring the rich fishing grounds in the area. In fact the largest sized boats are now most common in Villingili (Ga) and Thinadhoo (GDh)

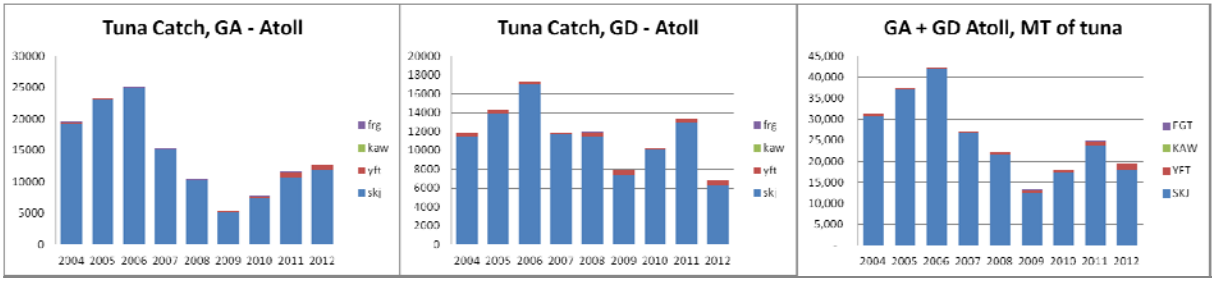

Figure 37: Tuna catch by species for GA, GD and GA+GD. Around the peak catches more about 50% of the recorded landings were from Huvadhoo Atoll. Source: MoFA Fisheries Statistics. SKJ = Skipjack, YFT = Yellowfin tuna, KAW = Kawakawa, and FGT = Frigate Tuna.

Similar to the national trends, the total tuna catches rose to a peak, with dramatic increase in fishing efficiency (larger boats, with powerful engines and large bait holding capacity with the possibility of multi-day fishing). Catches rose to a peak in 2006 declining rapidly. Nationally recorded tuna catches were around 135,000 t 2006 and in 2010 the figure dropped

to 59,000 t. During the 2006 close to 50% of the total tuna production came from Huvadhoo Atoll. Thanks to larger number of vessel being registered (Figure 38) and increasing size of the fishing vessels (Figure 39**Error! Reference source not found.**) in the area.

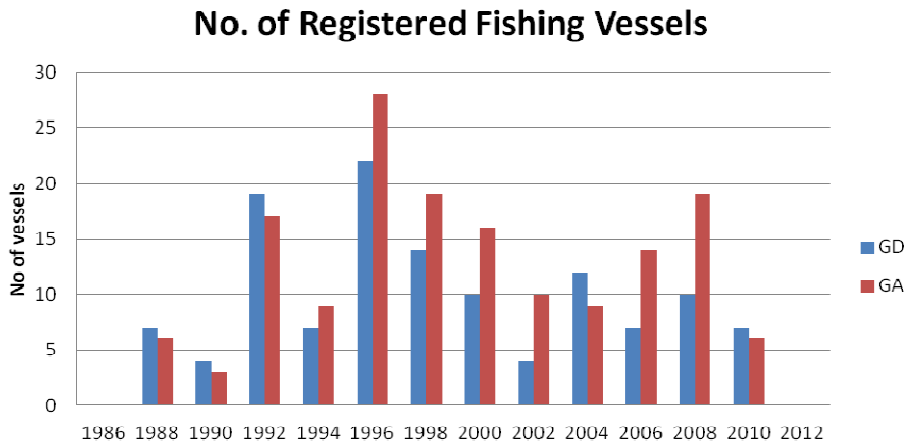

Figure 38: Number of Registered Fishing Vessel at MoFA by TWO-YEAR bins, Note 2011 data is exclude (source: MoFA)

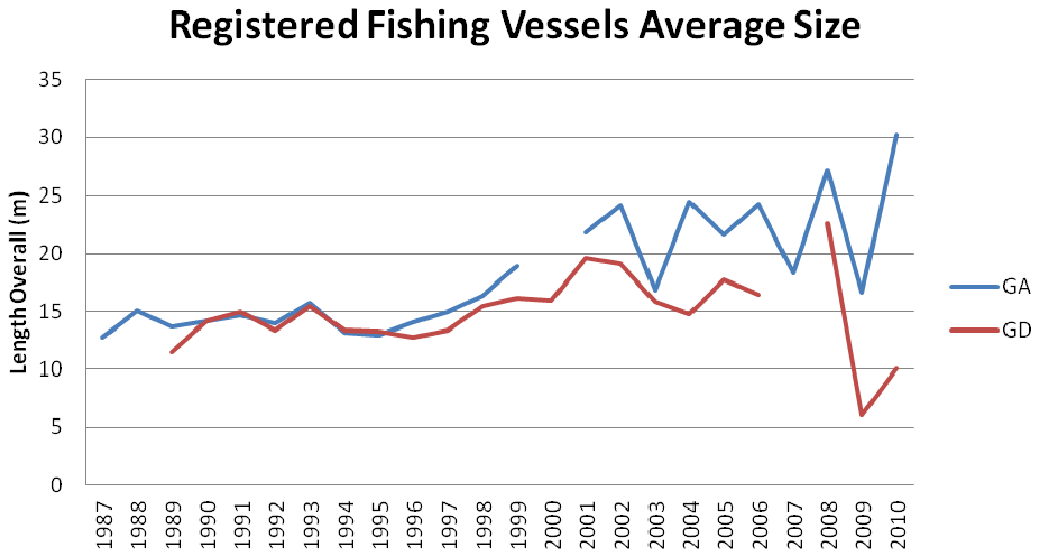

Figure 39: AVERAGE Size of fishing vessel in Huvadhoo Atoll, Source: MoFA

The declining tuna catches and catch rates have been a major concern for all communities in Huvadhoo Atoll. For island likes to Villingili, which depends on tuna fishing, the declining catches have hit to the community.

The boat owners and crew of large vessels (>85 feel LoA) have been hardest hit. The overheads and fixed costs are higher. It has been said about 2.5 – 3.0 mt of catch would be required for day of fishing in order to make the trip economically viable.

During 2011 government announced the 'back to longline fishing' programme where vessel owners and captains are being encouraged to uses of the large vessels for longlining. In the early part of 2012 longline training has been conduced targeted on modified pole-and-line vessels. The economic impact however, has yet to be seen. As of this writing about 12 Maldivian owned longline vessels are licensed to fishing. However, none of these vessel are ex-pole-and-line vessels.

An alternative use of these large pole-and-line vessels has been to use as large yellowfin handline vessels, which is popular in the north and central atolls. Although pole-and-line fishing still remains to be the most important some vessel in the Ga and GDh also have started handline fishing. Large, > 80cm total length, yellowfin tuna are caught from surface school using scads (*rimmas* / *mushimas*) which are sold to fresh exporters. Current rates of large yellowfin range from MVR 40-60 MVR per kg. Data shows that handline yellowfin tuna fishing are more popular in GD Atoll (cf. Figure 37).

9.4 TOURISM ACTIVITIES

An alternative economic activity in the region has been the tourism. It has been fortunate that poor fishing coincided with the start of the tourism in the atoll. It is believed the reasonable amount of young fishermen left to work on resorts. Presently there are five resorts in operation with a reported bed capacity of 884.

Table 12: Resort development activities in the Huvadhoo Atoll. A total 16 islands have been ear-marked for development around 2008/2009, but only 5 resorts are in operation. Data from www.tourism.gov.mv (accessed December 2012).

Atoll	Name	Operation / Status	Bed Capacity
GA	Hadahaa	Yes	100
GA	Funamaudua	Yes	202
GA	Meradhoo	Yes	74
GA	Dhigurah	Planned 2014	?
GA	Falhumaafushi	Yes	108
GA	Kerehdhoo	No	?
GA	Vodamula	No	?
GA	Munandhuvaa	No	?
GA	Mahahdhoo	No	100
GA	Kodeymatheelaabadhoo	No	?
GD	Kaashidhoo	No	?
GD	Odagalla	No	?
GD	Lonudhuhutta	Construction (?)	?
GD	Magudhuvaa	Yes	200
GD	Vatavarehaa	No	?
GD	Konotta	No (?)	100

A total of the 16 islands have been ear-marked for resort development. However, today only 5 resorts are in operation.

9.5 MAIN OBSERVATIONS

Tuna fishing is the most important economic activity in the region. Declining trend in the total population suggest there is net emigration of population, particularly youth to Malé and central region for better economic opportunities. Public infrastructure development activities[13] and start of tourism has helped to offset the economic loss of poor fishing in the region.

The development airport in 2012 has provided additional jobs for the region. Most of staff who works in the airport is from Villingili.

There is no doubt that opening of the Kooddoo airport had a direct positive impact on tourisms in the region. Resort operators are now more confident about of their investments. Presently 7-8 flights are being made every day bringing tourists to the islands. With the opening of Koodddoo airport the importance of Kaadehdhoo airport slightly diminished

The opening of airport has also helped Kooddoo Fisheries Maldives Ltd for cutting down costs (otherwise their staff flies to Kaadehdhoo and transfer on vessels lasting one hour). The airport has also helped bolster narrow islands economies by facilitating trade.

Further expansion and development of airport along with the city hotel will increase job opportunities for the youth in the region. Large number of job is expected to available immediately when the project starts in 2-3 months time.

[13] Isles website maintained by President's Office; http://isles.egov.mv/, accessed October 2011.

10 POTENTIAL IMPACTS AND MITIGATION MEASURES

Various methods are available to identify the extent, magnitude and significance of socio-economic and environmental impacts of a development project, for instance checklists, matrices, expert opinion, modelling etc. Impacts from various activities of the proposed project both construction and operational phases have been identified through consultation with the project management team, field surveys, observations and assessment, as well as based on field experience and expert opinion on similar development projects in the country.

Other sources of information have been used wherever possible. Data collected during field surveys can be used to predict outcomes of various operational and construction activities on the various related environmental components. Data presented in this report can also be used as a baseline for environmental monitoring of the project activities.

Possible impacts arising from the construction and operation works are categorized into reversible and irreversible impacts. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories

- **Negligible:** the impact is too small to be of any significance (Reversible)
- **Minor:** the impact is undesirable but accepted (Reversible)
- **Moderate:** the impact give rise to some concern but is likely to be tolerable in short-term, or will require value judgment as to its acceptability (May or may not be Reversible)
- **Major:** the impact is large scale giving rise to great concern; it should be considered unacceptable and requires significant change or halting of the project (Irreversible)

Leopold Matrix (Leopold et al. 1971) has been used to classify the magnitude and importance of possible impacts which may arise during the constructional and operational phase of the airport extension and city hotel project. Leopold Matrix is the most widely used methodology for identifying the impact of a project on the environment. It is a two dimensional matrix which cross references between the activities which are foreseen to have potential impacts on the environment and the existing conditions (environmental and social) which could be affected. Leopold Matrix of Koodoo airport extension and City Hotel development project is provided in Annex 10.

The impact matrix should not be misinterpreted to mean that all the identified impacts would occur during implementation of the project. However, the matrix does serve to identify the potential impacts and significant concerns and this leads to the next step of the EIA process, mitigation, which considers the appropriate measures to remove or ameliorate the adverse impacts that have been identified. At this stage measures to enhance the positive aspects of the development can also be devised.

The development project involves extension of the existing Kooddoo domestic aerodrome from north and southern ends and development of a 50-room City Hotel on the south western side of Kooddoo Island. The project involves Dredging a 15m wide, 550m long, 3.5m deep entrance channel and a 125m long, 50m wide, 3.5m deep harbour, dredged material will be

used for reclamation of (34,735 sqm from southern and 47,353 sqm from northern end of the island). Sheet pilling of the reclaimed land on the southern and northern end. Total length piling required is 759 meters; 369 northern end and 390m southern end. Construction of the extended aerodrome; 441m. Development of City Hotel with 25 water villas (built area of each villa 1200-1500 square feet) and 25 beach villas (built are of each villa 850-1500 square feet) and other supporting facilities. With respect to coastal and reef areas, the direct impact would mainly be from dredging and reclamation areas and overwater structures such as, water villas, jetties and overwater walkways. For the terrestrial environment the major impact would be from vegetation clearance for construction of the City Hotel and other impacts related to earth work for installation of sewerage, water plant, powerhouse, extension of storm water system, asphalt road development etc.

Severity of impact is assessed by reviewing the engineering design, detailed site plan as well as comparison of development with the existing environment and construction methodologies employed. Mitigation measures are derived based on the site specific assessment as well as similar project elsewhere in the Maldives.

10.1 IMPACTS AND MITIGATION MEASURES CONSTRUCTION PHASE

Construction phase can be considered as the period in any developmental project that causes major direct and indirect long and short-term impacts on the environment. Anticipated potential direct and indirect environmental impacts from the proposed airport extension and City Hotel development in Kooddoo is includes the following:

- Mobilization of Equipment and Labour
- Dredging, reclamation and subsequent sedimentation
- Hydrodynamic regime
- Marine habitat and coastal environment
- Ground water contamination
- Noise, Vibrations and Air Pollution
- Loss of Flora and Fauna
- Greenhouse Gas Emissions
- Equipment & vehicle maintenance
- Impact from waste
- Installation of water, powerplant,
- Sewerage and storm water system
- Socioeconomic impacts

The following paragraphs will provide detailed impacts and mitigation measures during the construction phase of the project.

10.1.1 Impacts from Mobilization of Equipment and Labour

Heavy machinery equipment and material needed for the airport extension and City Hotel development will be transported to Kooddoo via barges and cargo boats. Since the Kooddoo airport already has some of the equipment needed for construction work, transport of heavy equipment will be to the minimal. Kooddoo harbour can access and accommodate large

vessels and barges and already have crane facilities use of Kooddoo fisheries harbor will minimize the physical damage to the reef that may cause if barges carrying heavy equipment and material tried to access the island from elsewhere.

Influx of workers to the island would inevitably have negative impacts on the terrestrial environment. Disposal of hazardous waste and sewage may be a concern but use of the existing systems in the airport, eg: sewerage system, desalinated water and waste disposal mechanism will minimise the impact of workers on island resources. If proper attention is not paid such a large number of workers in the island could easily disturb the island fauna.

Temporary accommodation will require additional land clearing and establishment of facilities for water sourcing, sewerage and waste management. The contractor is planning to have the temporary accommodation within airport accommodation facilities to avoid land clearance. Vehicle transportation and movement of large number of workers and material may interfere with the smooth operation of the airport activities.
Mitigation Measures:

- Areas should be clearly marked for construction activities.
- A specific area should be designated in the coastal area for landing and material loading/unloading.
- For the City Hotel development area vegetation that needs to be retained must be clearly marked and communicated to the construction workers.
- Signs should guide workers to proper environmental care.
- Use water from the existing desalination plant for potable water
- Transportation of vehicles , heavy equipment and movement of workers should be coordinated with the air traffic control
- Special arrangements should be made to use the existing harbour for loading and unloading.
- The supervisor should check compliance of the workers to the environmental guidelines set for the project including avoidance of removal of unmarked vegetation, proper waste management, marine water pollution and ground water pollution.

Table 13: Impacts of mobilization of labourers, machineries and equipment

Impacts	Causes	Significance	Mitigation measures
Degradation of existing groundwater	- Increased abstraction of groundwater for the use of labourers. - Oil spillage from vehicles (lorries, excavators) - Mishandling of solid (non-biodegradable) waste - Vegetation clearance to make roads	- Minor adverse	- Use water from the existing desalination plant - Fuel handling should be done under careful supervision and regular monitoring - use existing sewerage system in the airport - Litter bins should be kept at easily

			accessible locations with proper warning signs to reduce littering and dumping waste on the island
Shift in existing ecological regime of the island	- Disturbances to the existing fauna on the island by the labourers (e.g. collection of turtle eggs, birds etc., increased noise and vibration levels) - Lack of awareness or concern to preserve the environment may lead to deliberate or inadvertent damages to the existing flora and fauna of the island	- Minor adverse	- Areas should be clearly marked for tree clearance area - Vegetation that needs to be retained should be clearly marked and communicated to the workers - Signs should be placed to guide the workers on proper environmental care - Project managers should control the workforce and confine their activities to the project area

10.1.2 Dredging, reclamation and subsequent sedimentation

Dredging of entrance channel and harbour on the south western side to provide access to the airport and City Hotel and reclamation of southern and northern ends for airstrip extension will have a direct irreversible negative impact to the ecological habitat in the area. Direct impact of this activity is limited to Kooddoo reef only and to the island.

Given below are relevant impacts that should be considered:

1. Physical damage on live coral and loss of live coral: The effect of this would be in the immediate to medium term with the loss of substrate and its fauna.
2. Disturbance to the area during dredging activity: Normal procedure for dredging using excavator involves creating temporary causeway or beds to move the excavator to the required site. This involves shifting of material to several places to transfer the material. Release of sediments and potential loss of the faunal composition underneath sediment material will undoubtedly occur.
3. Dredging and reclamation will change in the flow patterns. Tidal flows can be quite significant on the shallow reef flats and deeper areas will dampen the flow. The unexpected outcome may be erosion or accretion of the island or coastal areas.
4. Alteration of reef flat and lagoon substrate habitat and infauna approximately 14,500 m^2 will be altered from dredging of the channel and harbor, 82,088 m^2 will be altered from reclamation from both northern and southern ends of the Island.

Mitigation Measures: A range of possible outcomes is expected as have been mentioned. The most important mitigation measure is to monitor the area and respond to the changes in

the coast line. The airport operator should be aware of this and should be prepared to for potential shore-protection and stabilization measures in the future.

In order to minimize the impact from sediment, dredging should be completed in shortest time possible. Dredging ought to take place during low tides or slack tides to minimize the release of sediment to the area.

As a mitigation measure it is recommended to relocate the live corals on both dredging and reclamation area to the shallow reef flat on the south western side near the proposed water villa development areas prior to starting dredging and reclamation activities.

10.1.3 Sedimentation

The principal determinant of sediment mobility during dredging and reclamation process is wave and current action. Suspended sediment mobilised by wave and current action is determined by the prevailing wave energy and the depth. The wave induced water particle motion drops off with the depth. Sediment disturbed in the relatively shallow waters of Kooddoo lagoon will drop out of suspension in the deeper water in the atoll lagoon or the deeper reef. It should be noted that the closer to the reef edge, the higher the wave energy. The increased energy may offset the increase in depth, the sediment may stay in suspension. In its fluid state however the sediment is readily disturbed by any significant wave action anywhere in the lagoon, particularly along the reclamation area on the northern and southern side of the island. The tidal currents however are not strong enough to mobilise the sediment from the substrate into suspension by themselves, they act only to transport the sediment once suspended. Therefore conducting the dredging and reclamation during low tides will help to limit the mobility of suspended sediments in the area. If dredging and reclamation work is conducted during the SW monsoon period suspended sediments from dredging will be moving towards northwest into the atoll lagoon, but suspended sediments from reclamation will be moving towards the outer atoll. Therefore coral reef-flat on the western side will be impacted mainly from the dredging activities while reef-flat on eastern side will be impacted from reclamation activities. Direct impacts related to sedimentation will be limited to Kooddoo reef however nearby reefs in Villingili and Maamendhoo reefs might be impacted with sedimentation. Impacts of excessive sedimentation on corals include:

- Direct Physical smothering of corals and benthic organisms
- Reduced light penetration and subsequent reduction in photosynthesis productivity of coral reef growth, calcification and reproduction
- Shifting unstable sediments will form a false bottom
- Increased amount of sediment will cause eutrophication which will increase the amount of nutrients and lead to algal blooms
- Formation of anoxic black bottom beneath the fine sediment
- Suspended sediment in the sediment plume may trap pollutants which are absorbed into the sediments.
- Short term turbidity increase in lagoon water column during dredging and reclamation will result in decrease in fish and other pelagic populations.

Mitigation measures: To reduce the impact of sedimentation dredging work will be carried during low tide and calm water condition to minimize effects on the reef. Construction of sand bunds at the outer boundary of the dredging area will reduce the sedimentation however

sand bund itself will cause some degree of sedimentation but not as extensive as dredging. To reduce the sedimentation from bund, rock boulders on top of geotextile can be used. Later this can be incorporated into the channel and harbor protection revetment structure. Sedimentation on airport extension reclamation area can be reduced, if proposed pile driving is conducted prior to filing with the dredged sand. This will completely contain the sediment plume with the piled area and sedimentation can be minimal.

10.1.4 Hydrodynamic regime

The proposed reclamation on the southern and northern end of the island to extend the airstrip can only influence the wave energy environment in the around the island through reflection and refraction of the incident waves. The reclamation fills and will extend the 293 meter from the northern and 229 m from the southern end.

Waves within Kooddoo generally fall into two categories, locally monsoon derived wind generated waves with a period of 3-8 seconds and swell waves from more distant storms with a period of 14-20 seconds (DHI, 1999) in the eastern side which breaks on Kooddoo eastern reef. The wave directions exhibit seasonal variations with local monsoon generated wind waves which are typically strongest during April-July in the south-west monsoon period.

The extended part being long and narrow effectively acts as a wave direction filter and only waves aligned with the extended area axis can pass into the Atoll lagoon. In reality this is not much of a restriction on wave energy as long period swell waves from the east can refract around reclaimed area to run straight into the atoll lagoon. Only waves from the west are filtered out by the reclaimed area break on the western shore of the reclaimed land. The long period swell can partially reflect off the piled protection on the existing reclamation. The significance of wave reflection is that the incident wave energy is applied to the same area of seabed twice – as the incident wave passes then again as the reflected wave travels back in the opposite direction. This forces more seabed sediment into suspension. This change can be limited to Kooddoo and the channels on both northern and southern side of the island. Refracted waves from the east may change the wave regime within the two channels on north and south hence not major significance to the atoll or neighbouring islands.

10.1.5 Marine habitat and coastal environment

Direct impact to Kooddoo marine and coastal environment associated with the proposed project will mainly be from dredging and reclamation work. This includes:

- Loss of habitat in reef scope reef flat and lagoon area
- Physical damage to live corals and loss of live corals
- Change of near shore hydrodynamic and longshore current pattern
- Degradation of sea water quality due to turbidity
- Sedimentation and associated impacts explained in 9.1.3
- Physical disturbance of the lagoon substrate will result in loss of habited for some lagoon infauna such as polychaete amphipods, worms, seagrass and mollusks etc.

Mitigation Measure: to relocate the live corals on proposed dredging and reclamation area to the shallow reef flat on the south western side near the proposed water villa development areas prior to starting dredging and reclamation activities

10.1.6 Ground Water Contamination

Groundwater contamination is an irreversible impact due to the absence of impermeable layers to separate the freshwater lens in independent reservoirs. Accordingly, any point sources of pollution would cause the contamination of the entire island groundwater resources. Accidental leakage of large amount of diesel has been reported from Kooddoo Fisheries Complex, our assessment shows that the leaked oil would not spread further inland due to the topography of the island, see 6.3. Although ground water will not be used for human consumption in the island, it is important for the ongoing agriculture activities and for the trees and shrubs in the island. Therefore, special care should be taken when handling oil, solid waste and hazardous waste to entirely avoid any accidental spills and leakage.

Mitigation measures:

- All paints, lubricants, and other chemicals used on site will be stored in secure and bunded location.
- Oil, solid waste and hazardous waste will be handled carefully and transported in sealed containers in properly bunded vehicles/vessels
- Construction activities will be carried out under the supervision of a suitably experienced person.
- Vessels, equipment and machinery used for the work should be properly maintained at all times during the operation.
- Littering and accidental disposal of any construction wastes can be avoided by pre-planning modalities for waste disposal or re-use wherever possible. Careful planning of the work activities can also reduce the amount of waste generated.

10.1.7 Noise, Vibrations and Air Pollution

During the mobilisation of equipment and operation of heavy machinery for dredging and reclamation work and vegetation removal, it is anticipated that significant noise will be generated ground vibration is anticipated during the pile driving process in the reclaimed area. Furthermore, noise vibrations may alter species behaviour. In addition, dust and emissions from vehicle and machinery exhausts will degrade the air quality. However, these adverse impacts will be short term and can be mitigated to avoid nuisance to the existing fish processing plant. With proper mitigation measures, it is unlikely that noise, vibration and air pollution impacts will cause long term effects such as human health risks leading to increased public and private health costs. Minor surface cracking may occur due to vibration during the pile driving process particularly in buildings adjacent to the area on the northern side.

Removal of vegetation will create potholes on the ground, loosen the soil and significantly reduce the amount of nutrients supplied to the soil in the form of dead leaves, fruits, dead insects and animals.

The net amount of carbon dioxide emitted to the atmosphere will inevitably increase if large trees are removed. Even though the number of trees cleared for the City Hotel development project is small, this will contribute to increase in CO_2 emission and subsequently global warming. Hence, special precaution needs to be taken to reduce the number of trees that killed during the clearance process, and these trees need to be replanted at a suitable location.

Mitigation measures:

- All construction works will be carried out during day time to minimise nuisance to the fish processing plant workers and disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication.
- All vehicles and machinery will be tuned and well maintained to minimise air pollution
- To minimize dust from construction works close to the fish processing plant, ground/soil will be kept damp.
- Workers operating equipment that generate noise should be equipped with noise protection gear. Workers operating equipment generating noise levels greater than 80 dBA continuously for 8 hours or more should use earmuffs. Workers experiencing prolonged noise levels of 70 – 80 dBA should wear earplugs

10.1.8 Loss of Flora and Fauna during City Hotel construction

- Vegetation clearing is one of the most significant impacts associated with the proposed City Hotel development. Details of vegetation clearance required for the City Hotel development is given in the Table 14 below:

Table 14: Vegetation clearance from the proposed area

Vegetation clearance purpose	Area m^2
25 Beach Villas	3483
Roads	2096
Walk ways	1524
Spa	464
Other hotel facilities	37,500
Total clearance area	**45,085**

- It is anticipated that a total of 45,100m^2 area have to be cleared for the City Hotel development on the south western side of the island. Further 7,555m^2 has to be cleared for apron extension which mainly includes small bushes and low lying trees. These are irreversible losses as the area has to be left cleared for the rest of the airport and City Hotel operation period.
- Loss of vegetation means, loss of fauna that depend on those vegetation. Such species include birds, rats, fruit bats and invertebrates.
- Degradation of the topsoil due to exposure to sunlight and heavy rainfall.
- Changes to the vegetation regime of the island. The dominant species on the island will be replaced by busy vegetation, grass and creeper varieties.

- Equipment mobilisation for the proposed project is substantial. This may require additional vegetation clearance on the sides of the roads, noise pollution and dust pollution on the island.
- Earth work and ground excavations will completely denude epifauna, borrowing and sedentary organism on the substrate. Mobile fauna, such as fish will swim away and will not be affected.

Mitigation measures:

- The City Hotel facilities are designed in such a way that Most of the old and mature trees are kept untouched.
- If large trees are removed for a necessary reason it will be made available for the neighbouring Villingili Island for replanting elsewhere. The transport arrangements should be negotiated between the two parties. Removal of trees will be undertaken with to ensure that it could be replanted.
- In the City Hotel development area vegetation clearing will be only done for the trees that will require clearing. Any trees that can be retained will be retained.
- Strict guidelines and construction monitoring is required during the vegetation removal stage to ensure that every single large tree could be replanted.
- All clearing works will be carried out during day time to minimise disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication, turtles nesting on the eastern side and to the fish processing plant workers.
- A draft landscape plan for the City Hotel should be prepared prior to commencement of site clearance that identifies those existing trees that it would be possible to protect.
- Those trees that can be protected in situ should be marked, clearly identified on the site construction plan, and properly protected with hoarding or a fence prior to the commencement of construction.
- The building contractor should be made subject to punitive penalties for any breaches of the tree protection plan and for damage to protected plants. These penalties should be an integral part of the works contract and specifications.
- The landscape plan should seek to utilize low-maintenance native species tolerant of typical coastal conditions which are attractive to birds. It must not include imported and invasive species.
- Based on the landscape plan, an inventory and collection of selected plants and ecologically valuable trees on the site should be made. These plants should be correctly removed, stored and maintained at a properly appointed plant nursery until they can be transplanted back on the site as stipulated by the landscape plan.

10.1.9 Greenhouse Gas Emissions

Vegetated areas are known to act as carbon sinks for greenhouse gases particularly carbon-dioxide. The proposed project involves clearing of vegetation during site preparation.

However, the removed large trees are planned to be replanted in other islands.

Mitigation Measures:

- Only vegetation that is absolutely necessary to be removed will be cleared.
- Waste will be properly stockpiled temporarily on site and disposed at a designated disposal site.

10.1.10 Equipment & vehicle maintenance

Impacts: All sorts of motorized equipment, from generators to trucks, requiring fuel, lubrication and maintenance will be used on the construction site. Many will be fitted with lead batteries. Therefore the potential will exist on the site for spillage and contamination of the soil and the sea by hydrocarbons as well as the careless disposal of batteries.

Mitigation measures:

- Confine vehicle maintenance to specially prepared areas with impermeable pads.
- Ensure changed engine oil is collected in drip pans and stored in covered drums until it can be properly removed from the site for appropriate disposal
- Ensure used batteries are properly stored and kept under cover.

10.1.11 Impacts from Waste

A significant volume of green waste will be generated from the City Hotel development project. These need to be managed to avoid major environmental problem on Kooddoo. Managing this waste should be a priority in the construction stage.

Solid waste, waste water and sewage generated by the workforce may affect the groundwater and general terrestrial environment of the island.

Mitigation measures:

- A waste management center has been established in nearby Villingili Island. During the EIA consultation the atoll council and island council suggested to make transportation and management of waste generated from the City Hotel for a nominal fee. They also suggested that the management of the City Hotel to place equipment such as incinerator, bottle crusher, shredders etc in Villigili waste management center.
- Staff training to ensure appropriate and efficient separation of solid wastes at the point of source;
- High temperature incinerators will be continually tested to ensure that the stack emission meets international quality criteria.
- A solid waste reduction strategy will be implemented with the goal of decreasing the amount of packaging materials arriving on the island, with specific attention to cans, bottles, and plastics.
- Containment and control of waste
- Frequent waste clean-up, collection, containment, removal and disposal
- Awareness of potential waste issues among employees and workers
- Commitment to good solid waste management practice
- The green waste shredder or equivalent will be used to shred the larger and stronger material for disposal.

10.1.12 Impacts from Water and Power Plant

The existing water production capacity of Kooddoo airport will be increased by installation of extra plant to be able to cater for the needs of Airport Hotel. Impacts water production plant would be related to intake, brine outfall, noise and issues relating to water quality. Each issue is dealt below.

Intake: The proposed method for water intake is direct from the sea. The intake from sea requires expensive maintenance and additional load to membranes – expensive maintenance due to bio-fouling and additional load to the membranes due sediment concentration.

Brine outfall: An inevitable by-product of reverse osmosis is the concentrated brine which is high in salt content. In most cases brine outflow is located in harbour in to a place where there is reasonable amount of water flow. It is unlikely that brine discharge to seas would cause any noticeable detrimental impact as the concentrate becomes immediately diluted on release. On Kooddoo it is proposed that brine outfall be on the western side, just off the lagoon.

Noise: Similar to the power generation facility water production facility generated noise from the electric motors. It is recommended that noise level immediately outside the facility be maintained below 65dBA.

Water Quality: A number of precautions have been proposed to be put in place to ensure water quality is maintained to the highest standards. Chlorination and UV filtration before the being store or released to the main pipeline ensure that water is safer. To ensure the quality is maintained regular water testing is required and should keep logs of these records.

The construction, installation, distribution and use of power plant would ensure the power generation facility is safe and secure and that environmental standards are met in the operational phase. Operational aspects that are likely to cause environmental impact would be noise, exhaust fumes, transport and use of fuel, handling of waste oil, safety and security of the operation of the power house, and maintenance of distribution network.

Noise: Power generation facilities Kooddoo will operate in wide open space. Therefore the location and operational aspects of the power house should not be a problem with regards to noise. Use of duct splitter type sound attenuators are common and should be used to keep the noise levels around 65 dBA in the immediate surroundings (3-5 m distance from the power house).

Exhaust: The diesel engine exhaust is a mixture of hundreds of constituents in either gas or particle form. Among the gaseous hydrocarbon components of diesel engine exhausts that are individually known to be of toxicologic relevance are the aldehydes (e.g., formaldehyde, acetaldehyde, acrolein), benzene, 1,3-butadiene, and polycyclic aromatic hydrocarbons (PAHs) and nitro-PAHs. It is know that emissions vary significantly in chemical composition and particle sizes between different engine types (heavy-duty, light-duty), engine operating conditions (idle, accelerate, decelerate), and fuel formulations (high/low sulphur fuel).

Given these observations the exhaust fumes would have to be released to a high enough, ideally above the canopy of the Kooddoo, so that fumes will be quickly carried out by the

wind. Use of the high-grade fuels and appropriate filters would minimize the release of these substances. Regular service of the engine is equally important is the minimizing the release of these substances.

Transport and use of fuel: Environmental impacts relating to fuel transport and usage during the construction phase is understandably high as permanent storage and transport services are not in place. It is recommended that arrangements from Kooddoo be made for supplying fuel to the power house of the airport.

Waste oil:. The waste oil should be disposed to site used by the Kooddoo Fisheries Maldives Pvt Ltd.

Safety and Security: It is common practice to have the standard safety equipment in the power house. These include firefighting equipment (liquid carbon dioxide, fire blankets) hard hats, and ear plugs for those who on service duty. In addition earth-rods are required to comply for power plant registration.

10.2 POTENTIAL POSTIVE IMPACTS

The development of City Hotel would have positive socio-economic impacts in that increased scale of operation would mean increased employment opportunities. Like many resorts most of the labor force is foreign (not exceeding 50% of the total as the tourism law permits). The developer has plans to attract locals to increase proportion of the local employees in the resort. The way to achieving this would be to provide training, but equally making the work environment more attractive.

Airport extension together with City Hotel development will have a noticeable impact economically to the South and particularly Ga Atoll, the overall impact would be positive; City Hotel supplies from nearby islands, possibly making use of local travel agents, fishermen, transport sector, all will benefit directly and indirectly. Improve small business sales and marine transport services in Villingili and nearby islands due the presence of the workforce is considered a key benefit.

10.3 OPERATIONAL PHASE IMPACTS

Impacts of operation phase will be minimal. These include:

- Impacts relating to increased transport traffic: It is inevitable that additional transport traffic will increase due to arrival and departures of the passengers and also of the commuting staff who may be based in nearby islands. Development of a habour on the southwestern side to cater for the City Hotel and he airport would reduce congestion at the existing harbour on Kooddoo and potential inconvenience to passengers.
- Impacts relating to operation of airport. In the short term it is unlikely that air-traffic will be of any significance. However, given the landing path is not too far from Villingili, particularly Kooddoo Fisheries Maldives Pvt Ltd minor disturbance may occur.

Environmental impacts associated from the operational phase of the City Hotel operation activities can cause short term to long term impacts on the islands geography, marine and land flora and fauna. Below are some of the possible impacts:

Mitigation Measures:

- Solid waste generated by the restaurant, kitchen and other service facilities
- Sewage and waste water disposal will be treated and used for flushing and gardening, Ground water contamination from accidental oil spills or mishandling of oil and other
- chemicals
- Impacts from snorkelling or diving activity on the reef
- Possible sedimentation impact from dredged channel and harbor
- Beach erosion due to change in hydrodynamic condition of the island

10.3.1 Use of water & resource depletion

As indicated earlier the City Hotel existing water production capacity is sufficient to meet the demands of the hotel. Since no water will be abstracted from the island's aquifer no negative impact on the groundwater resource is anticipated.

If the operation of the hotel implies a net increase water usage due to better services and increased number of up-market visitors to the island will mean an increase in the demand for water resources. The Hotel should put the following water conservation devices or technologies in place.

Mitigation measures:

- Provide adequate water storage facilities to ensure adequate supplies for the resort.
- Install aerators/flow restrictors on all taps.
- Install low flush toilets.
- Collect grey-water separately from sewage effluent and re-use for irrigation.
- Install gutters and collect rainwater from building roofs and store for grounds irrigation.

10.3.2 Use of electricity

Power for the City Hotel will be supplied by increasing the electricity generation capacity of the existing powerhouse. However, this increased demand will commensurately increase the utility's use of fossil fuel to generate that electricity, and thus the project will indirectly incur negative impacts associated with greenhouse emissions.

- **Mitigation measures** relate to incorporating and improving energy management and conservation practices and consideration of renewable energy such as solar power.

- Sub-meters and real-time energy monitoring equipment, timers, photoelectric cells, thermostats, etc. should be installed in the room blocks and other facilities.
- Install translucent shades and fluorescent lighting.
- Pipe insulation, tank lagging (not asbestos!) and heat recovery systems should be installed wherever it is practical to do so.

10.3.3 Solid waste management & disposal

As described earlier the Hotel will generate a significant quantity of solid waste per day, comprised mainly of organic food waste. Poor waste management at the Hotel would lead to unsanitary conditions including vermin and fly infestation, odours and unsightly conditions. However, garbage management and good housekeeping will be practiced at the hotel and potential issues related to improper solid waste storage will therefore be avoided. It is anticipated that dedicated waste Dhoni will be engaged to collect and dispose of waste from the Hotel on a regular basis to Villingili water management Center.

Mitigation Measures:

- Ensure all waste management equipment required by the Ministry of Tourism are put in place and maintained in working order and dedicated waste management staff be employed by the Hotel management and EPA waste regulation is strictly followed.
- Awareness raising among guests are conducted on ways to reduce and avoid solid waste
- Composting be encouraged on the island
- Ensure residual waste is disposed of at the Villingili and waste dhoni to maintain a regular log of waste.

10.3.4 SCUBA & snorkelling - misuse of coral reef resources

One of the main natural attractions that will be available to guests at the Hotel who can SCUBA dive and snorkel is the nearby coral reef. Unless the marine resource is properly managed, the increased use of the site for recreational purposes could result in degradation of the habitat by damage to corals from boat anchors, souvenir collection, and poor diving practice.

Mitigation measures:

- Provide educational and environmental sensitization material on coral reefs for guests and for hotel staff.
- Promulgate user guidelines.
- Install boat mooring buoys for use of dive boats and ban boat anchoring on coral substrate.
- Ban collection of coral reef souvenirs.

– Institute and support coral reef monitoring programmes.

10.3.5 Mosquito fogging

Hotels in coastal areas where mosquitoes are prevalent often use insecticide foggers as a technique to control the pest populations. This of course kills other beneficial insects, such as butterflies, as well. This causes a serious negative impact, especially in a situation where it is desirable to encourage and maintain butterfly populations.

Mitigation Measure: Use trapping as an effective and alternative method to control mosquito populations.

11 ALTERNATIVES

11.1 NO DEVELOPMENT OPTION

With the current airport traffic in Kooddoo Island it is necessary to expend the airport to cater for the jets that are bringing high-end tourist to the resorts in North and South Huvadhu Atoll.

A strategic approach the government has been using recently is give concessions on the land for Hotel development in lieu with the national infrastructure developments. Development of City Hotel on the South Western side of Kooddoo was allocated for Keong Hong Construction Pte Limited of Singapore in return for investments of the airport extension.

Under no-development scenario high-end tourists coming by jets will not be able to land, park and get the services to the jets from Kooddoo airport and they have to take a journey to Gan International or INIA for parking. This will not be an attractive option for the high-end tourist arriving by private jets. This will not be acceptable and therefore the no-development option will not hold.

11.2 DEVELOPMENT OPTION

Having decided and followed the development option for Kooddoo airport extension one has to consider the alternative options in Kooddoo that would have least environment impact. Following have been considered for the alternatives.

11.2.1 Access channel and harbour development

The proposed access channel development for the City Hotel and airport involves dredging the channel only. If the channel is left without proper coastal protection, the channel is expected to be filled soon. Also during the western monsoon accessibility would be difficult. If proper protection is not in place there might be a need to undertake maintenance dredging of the access channel frequently which will lead to frequent exposure to sedimentation and associated impacts. Therefore as an alternative it is recommended to construct channel protection as in Figure 48 below:

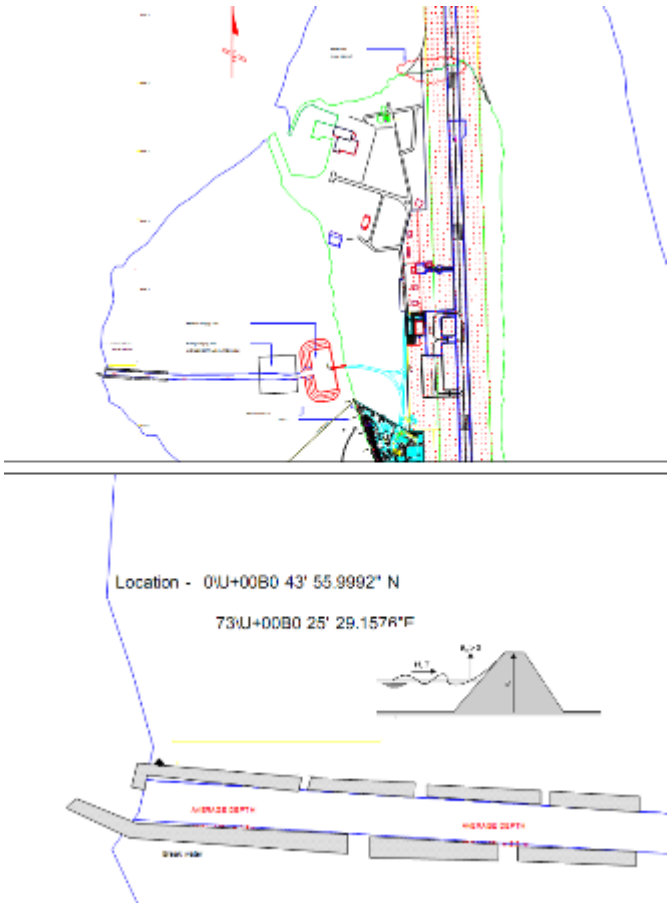

Figure 40: Breakwater protection for the channel

11.2.2 Order of developmental activities

Depending on the order of developmental activities environmental impacts associated with the dredging and reclamation could be minimized. Therefore to minimized the impacts it is recommended to transport and transplant the corals in the proposed reclamation and dredging area to the lagoon on the south western side of the island, period to starting the work. To minimize the sedimentation from reclamation sediments can be contained if pile driving takes place prior to reclamation. Similarly if the bund wall is constructed prior to dredging will significantly contribute to the reducing environmental impacts associated with sedimentation. Therefore it is recommended to undertake the dredging and reclamation work in the following order

1- Translocation and transplantation of corals on the southern and northern end (reclamation area) and dredging area to the western side of the Island.
2- Pile driving in the proposed reclamation areas on the southern and northern side before starting the filling activities
3- Construction of sand bunds at the outer boundary of the dredging area prior to dredging activities, To reduce the sedimentation from bund, rock boulders on top of geotextile can be used.

11.2.3 Location of Source Material for Base Layers

There could be three options for obtaining the material for the base layer

1. Importing aggregate from nearby country
2. Transporting material from the dredging area (ongoing dredging project)
3. Sourcing material locally

Importing aggregate is the most expensive option, but this is also the best in terms of aggregate quality. However, this may be prohibitively expensive given the limited amount agreed to complete the investment.

Transporting material from a dredging area may be feasible, but depends on the distance and also if the dredged material is not going to be used for project activities. It is often the case the material is always used for reclamation. For all practical purposes the sourcing material from different project is also not feasible and.

The third option which is sourcing material from the local house reef is the most economical, practical and probably the only means to effectively obtain material..

11.2.4 Waste Management

A waste management center has been established in nearby Villingili island. During the EIA consultation the atoll council and island council suggested to make transportation and management of waste generated from the City Hotel for a nominal fee. They also suggested that the management of the City Hotel to place equipment such as incinerator, bottle crusher, shredders etc in Villingili waste management center.

During the operational phase of the City Hotel will generate a significant quantity of solid waste per day, comprised mainly of organic food waste. Poor waste management at the Hotel would lead to unsanitary conditions including vermin and fly infestation, odors and unsightly conditions. However, garbage management and good housekeeping will be practiced at the hotel and potential issues related to improper solid waste storage will therefore be avoided. It is anticipated that dedicated waste dhoni will be engaged to collect and dispose of waste from the Hotel on a regular basis to Villingili waste management Center.

12 MONITORING

Environmental monitoring is essential to ensure that post-construction and operational impacts are known and eliminated in a timely manner. Dealing with impacts earlier would save money and also help planning and operationalize the process.

Shoreline, Beach Profiles and Coastal Process:

Parameter	Indicators	Baseline / Reference Values	Method / Technique	Frequency	Estimated cost in USD
Shorelines (high / low tides)	Beach morphology	Baseline to be re-established immediately after construction is complete	Differential GPS	Bi-annually in the first two year and yearly thereafter	400/ trip
Beach profiles	coastal changes	Requires to re-establish the baseline following the construction	Beach profile surveys	Bi-annually in the first two year and yearly thereafter	500 / trip
Currents	Nearshore currents	Baseline to be collected immediately constructions are over, especially on western side	Drogue survey	Bi-annually in the first two year and yearly thereafter	500/trip

Reef Surveys:

Parameter / Method	Frequency of Monitoring	Purpose	Estimated cost (USD)
Benthic cover by major life forms (live, dead, rock rubble and sand)	Annually	Indicative of the changes in the live coral cover	300/trip
Fish population / visual census	Annually	To assess broad scale change in the ecological status of the coral reefs (increase / decrease of herbivores, etc)	

Water Quality:

Type	Parameters	Locations	Frequency	Estimated cost (USD)
In situ monitoring / sampling and testing from a laboratory	Dissolved oxygen Turbidity (NTU) Nitrates Sulphates COD TDS	All locations marked	Bi-annually	500/ set of tests

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include ground water (pH, dissolved oxygen, electrical conductivity, total oil (Hydrocarbon) and faecal coliforms), water quality (turbidity, dissolved oxygen, phosphates, nitrates and BOD), and sediment deposition. Also are the shoreline changes that may occur due to the medium to long term impacts from the changes in coastal processes.

12.1 MONITORING COSTS

It is understood that costs of monitoring be borne by the airport operator and the developer / propoenet. It is also understood the mitigation measures would be accommodated in the contract costs. A commitment letter confirming compliance on mitigation measures is given in **Annex 6**.

13 STAKEHOLDER CONSULTATION

The stakeholder consultation undertaken for this EIA report as decided at the Scoping Meeting included GA. Villingili, and GA. Maamendhoo. The procedure adopted for the consultation was that first a letter was first sent to the respective political appointee of the island explaining the project and requirement for the consultation. It was through this contact point the meetings were organized in various islands.

Meetings were held in each island and the invitation to attend the meeting was open to everyone interested in the development project. It is therefore assumed NGOs and community groups attended the meeting. The full list of participants at the meetings is in **Annex 8**. At the meeting, the project was introduced and plans for construction were presented. Following that, the floor was opened for the questions and questions were responded, either with the help of political appointees or by the Consultant's team.

Notes were kept for the each meeting. Major concerns raised by the council members from Villingili are:

1. 150 long Villingili Media centre antenna which provides radio and TC signals for the island and the atoll is within the flight path of the aircrafts coming to land on Kooddoo airport. AS per the council the Civil Aviation Authority has asked them to either relocate or remove the Antenna. The council members said they don't have the financial means or capacity to undertake this action. If the media centre were to allocated in another part of Villingili this will cost a significant amount of money which they don't have, therefore the council is requesting the proponent to undertake this measure if necessary. We are unable to confirm the matter from the Civil Aviation Authority.
2. The urbanised area of Villingili falls into the flight path of aircrafts landing in Kooddoo, therefore the council is concerned that the area would have limitation in their development in the future as multi-storey buildings and antennas cannot be erected in the area.
3. The Channel between Villingili and Kooddoo has a heavy traffic of cargo vessels coming to Kooddoo for loading/unloading also dhonis and small boats which will have erected poles of significant that may be at risk of accidents once the jets start to land in Kooddoo. The council suggested establishing a communication and traffic management mechanism with the ATC in Kooddoo.
4. Villingili council requested to strengthen the existing waste management center in the island and provide the necessary equipment incinerators bottle crushers, and shredders etc to the center as part of CSR. They suggested that instead of managing the City Hotel waste in Kooddoo transport them to Villingili Island for a nominal fee.
5. Location of the proposed harbour and entrance channel is very rough therefore they suggested either to relocate or to provide proper protection for the access channel and harbour.

Consultation with the Maamendhoo council

1- Maamendhoo council did not raise a particular issue, they think the location of the harbour is fine however they also think that the harbour and access channel needs proper protection.
2- The flight path of the plans taking off from Kooddoo are not within the urbanised area of the island therefore they have not major issue with that
3- Maamendhoo council requested to provide a desalination plant to the island and establishing a waste management center in the island as part of the CSR of the development.

Figure 41: Community Consultation at the islands; Villingili (right); Maamendhoo (left).

13.1 SUGGESTED RECOMMENDATIONS

Some communities were particular about making sure certain things are developed or certain services were started. Following are the major requests that came out from the meeting.

1. Direct ferry access to the airport from all the islands
2. Fair job opportunities for all islanders.
3. Establishing a waste management center and installation of desalination plant in Maamedhoo as part of the CSR

Provide equipment for the waste management centre in Villingili. City Hotel waste management to be contracted with Villingili council

There is no doubt that job opportunities will be created. It is likely that 50-100 new jobs will be created with scope of additional opportunities of employment due to spill-over effect of the development.

14 CONCLUSIONS

The environmental impact assessment study for the Extension of Kooddoo Domestic Airport and Development of City Hotel Project on Kooddoo Island shows there are three main activities that would cause significant negative environmental impacts. Those, in order of significance, are:

1. Dredging of entrance channel and harbour area on the western side on the shallow reef flat and in the process borrowing material for reclamation for airport extension works. Additional dredging proposed on the eastern side to supplement dredging material
2. Sheet pilling of the reclaimed land on the southern and northern end. Total length piling 759 meters (369 northern end and 390m southern end)
3. Clearance of vegetation of more than 45,085m^2 of the island for City Hotel development.

Of these a long term impact would be dredging of reef flat. Fortunately the dredging area is not too extensive. However, impacts on the coastline of the island (potential erosion/accretion) are likely in the medium to long term. These impacts would be cumulative occurring over long period of time and so can be managed through proper monitoring and addressing them in a timely manner. Based on the scale of infrastructure and development and reclamation work projects that is taking place in Maldives at the time of this writing, impacts associated with this dredging on Kooddoo reef flat may be considered insignificant.

Clearance of vegetation is significant in terms of loss of ecological habitat and it is an irreversible loss as the area has to be left cleared for the rest of the airport and City Hotel operation period. However, the positive economic impacts from the airport outweigh the loss of habitat and potential future agricultural land.

The study has evaluated alternative options for the project activities and has suggested that the path proposed in this EIA report is the best option as it is moderate and environmental impacts is minimal with significant positive socioeconomic benefit. Also the study found, based on the similar project activities elsewhere in the Maldives, the island and the reef will recover from the expected impacts rapidly and will re-establish a new ecological balance soon. However, the report has come-up with an extensive monitoring programme that will keep on monitoring the environmental changes associated with the development and make necessary adjustment to the activities of the project based on the findings of various measured environmental parameters suggested in the monitoring plan.

On the basis this environmental impact assessment study and the impact mitigation measures proposed in the report will be duly implemented and recommendations are given due consideration, it is concluded that the benefits of the proposed development will substantially outweigh its imposition on the environment.

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16 ANNEXES

Annex 1: Approved Terms of Reference (ToR) for the Project
Annex 2: Approved hotel boundary layout
Annex 3: Copy of letter from MoTAC on approval of boundary
Annex 4: Locations for survey undertaken in 2010
Annex 5: Dredging permit for the Project
Annex 6: Commitment letter from the proponent – Keong Hong Construction Pte Ltd.
Annex 7: Approved city hotel concept master plan
Annex 8: List of Attendees at the scoping meetings - Villingili and Maamendhoo
Annex 9: Water quality tests results from Kooddoo Island – November 2013.
Annex 10: Leopold Matrix of summary of impacts of project – development and operation