DATE OF RECEIPT:
ADAPTATION FUND PROJECT ID:
(For Adaptation Fund Board Secretariat Use Only)

PROJECT/PROGRAMME PROPOSAL

PART I: PROJECT/PROGRAMME INFORMATION

PROJECT/PROGRAMME CATEGORY:	Regular
COUNTRY/IES	Maldives
TITLE OF PROJECT/PROGRAMME	Increasing climate resilience through an Integrated Water Resource Management Programme in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo Island
TYPE OF IMPLEMENTING ENTITY	Multilateral Implementing Entity (MIE)
IMPLEMENTING ENTITY:	United Nations Development Programme (UNDP)
LEAD EXECUTING ENTITY:	Ministry of Housing and Environment
AMOUNT OF FINANCING REQUESTED:	US$ 8,989,225.-
CO-FINANCING	US$ 1,800,000.- (Government of Maldives, in kind)

PROJECT / PROGRAMME BACKGROUND AND CONTEXT:

Provide brief information on the problem the proposed project/programme is aiming to solve. Outline the economic social, development and environmental context in which the project would operate.

Geographic, Environmental and Socioeconomic Context:

The Republic of Maldives is an archipelago of 26 natural atolls and 1,192 small, low-lying, coral islands distributed along a chain that extends over 860 km from north to south in the Indian Ocean. The country has a combined land and sea area of 115,300 km^2 and an Exclusive Economic Zone (EEZ) of 859,000 km^2.[1] With an area in excess of 21,000 km^2, the Maldivian atolls are the seventh largest reef system in the world, and the largest in the Indian Ocean. Administratively, the country is divided into 7 regions/provinces, 20 atolls, 192 inhabited islands[2] and the capital Malé. The total population in 2008 was estimated at 298,968 people[3], over a third of which live in Malé.

[1] Statistical Yearbook of Maldives, 2006, http://www.planning.gov.mv
[2] Inhabited islands are where the main population lives and distinguished from islands used for tourism and other purposes, of which there are a further 168. The capital Malé is always treated separately and is not included among the inhabited islands.
[3] MPND 2008. Maldives at a Glance. July 2008.

The Maldives has a tropical monsoon climate, dominated by two monsoon periods: the northeast monsoon from January to March and the southwest monsoon from May to November. The southwest monsoon is the wetter of the two monsoons and is typically the period when most severe weather events occur. Average annual rainfall is 2,124 mm, with a gradient of increasing rainfall from north to south that varies between 1,786 mm and 2,277 mm, respectively. Daily temperature varies between 23^{o}C and 31^{o}C, with a mean daily minimum temperature of 25.7^{o}C, and a mean daily maximum temperature of 30.4^{o}C. Humidity ranges between 73% and 85% (National Adaptation Program of Action, 2007).

The only conventional water resources available on islands in Maldives are confined shallow groundwater aquifers, rainwater and small brackish/salt/fresh water ponds on some islands. The non conventional water resources include desalinated water, bottled water both from importation and local production. The main source of drinking water across Maldives still is rainwater and desalinated water especially on Male (capital of Maldives). In Villinigili and Hulhumale (two extended wards of Male), piped desalinated water is supplied to households on a 24hr basis and accounts for 25% coverage of safe secure water provision. In outer atolls, the main potable source of water is rainwater harvested on roof tops. However, the main concern is absence of water quality monitoring and assurance of water security measures on islands. Groundwater aquifers on islands from north to south are severely contaminated with untreated domestic wastewater discharged into ground due to absence of appropriate wastewater disposal systems on islands. For example, from 20 samples tested in north Ha.Dhidhoo, 30% of samples were identified with faecal coliforms; In tests from Ha.Nolhivaram, out of 17 samples 33% were found polluted by faecal coliforms.

The technology used in Maldives for water supply management includes low to high technology, ranging from roof top rainwater harvesting to seawater desalination. Water supply systems on outer islands are mainly from individual shallow hand dug groundwater wells, household and community rainwater tanks and water transportation on boats. Besides, there are no wastewater collections and treatment systems, except on a number of newly built resorts. Sewage treatment systems that are currently being designed and built are expected to minimize groundwater contamination. These schemes i are financed mainly from national budget (public sector investment-PSIP), loans, grants, development assistance and private sector investments.

Problem Statement: The Climate Change-induced Problem

The primary problem addressed by this project is climate change-induced decline of freshwater resources that is affecting the entire population of Maldives. Freshwater resources are scarce in the Maldives. As surface freshwater is generally lacking throughout the country (with the exception of a limited number of brackish water swampy areas in some of the islands), the key problems pertaining to freshwater security relate to the management of increasingly saline groundwater and increasingly variable rainfall patterns.

Groundwater is a scarce resource in Maldives, due to the hydrogeology of the country. The freshwater aquifer lying beneath the islands is a shallow lens, 1 to 1.5m below the surface, and no more than a few meters thick. The thickness of the groundwater aquifer in the islands is determined by the size of the island and the permeability of the soil column. Adding to this is the critical determinant of **net rainfall recharge,** which is becoming more variable in a changing climate. Over the last few years the National Disaster Management Center has transported potable water to many islands facing acute water shortages due to prolonged dry periods costing over US$ 2 million every year.

Many freshwater aquifers are already stressed from over-extraction and face the risk of total depletion. This already precarious hydrological system is further aggravated by climate change-induced effects of sea level rise and flooding during extreme weather events, which increases saltwater intrusion into the freshwater lens. **Salinization of groundwater** is affecting the quality of life in the islands, as people depend on groundwater for washing, bathing and other non-potable uses. Saltwater intrusion is also affecting soil and vegetation, causing impacts on agriculture and terrestrial ecosystems. In addition, groundwater is stressed from the effects of flood-induced pollution, especially spillovers of septic tanks and spillage of human, animal and household waste during periods of heavy rainfall and inundation.

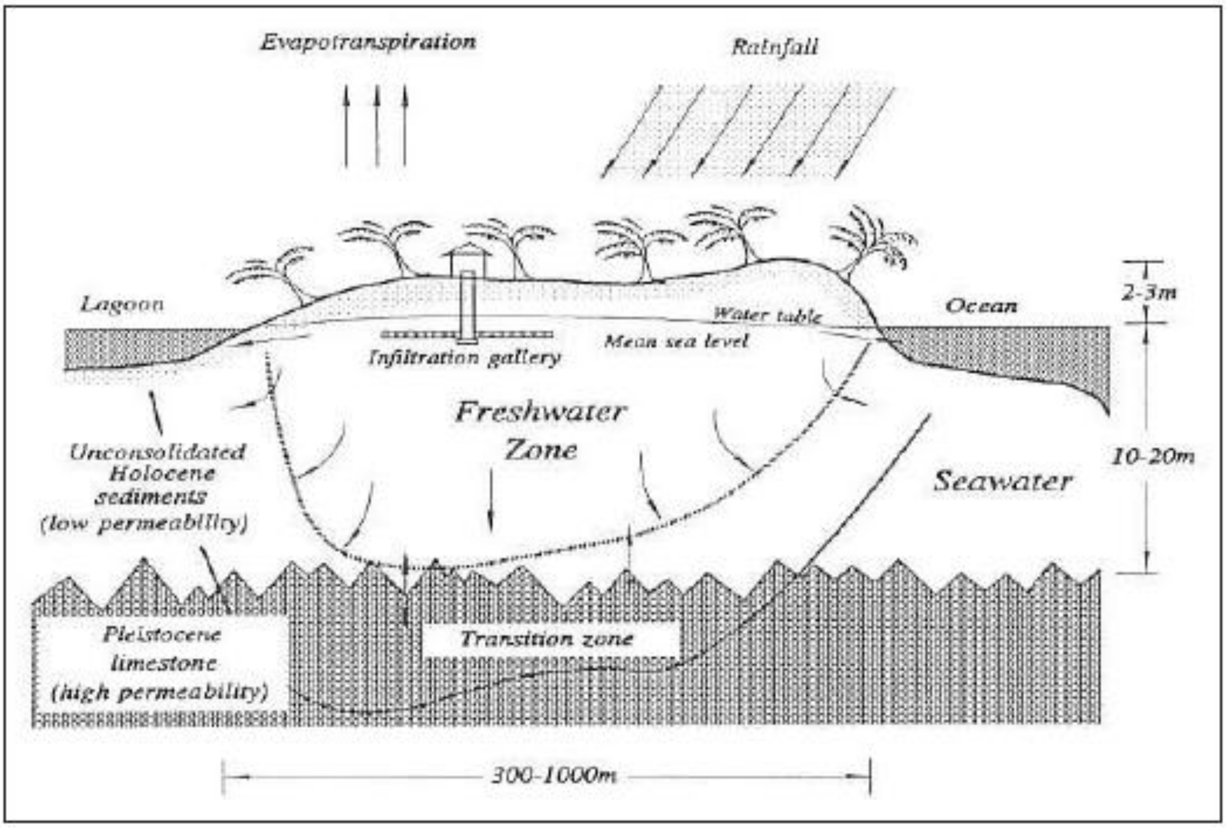


Fig.1: Typical groundwater lens on a small coral island, prone to salinization (Falkland et.al., 2007)

Roof top harvested rainwater is the main source of drinking water available on islands across Maldives. Overall, 77% of people in Maldives and more than 92% of households in outer atolls use rainwater for drinking (MPND 2006). However, due to limited storage capacity within house plots, householders can collect and store only a small quantity of water (the average household storage capacity on islands across

Maldives is 2500 liters). In dry periods, many householders experience a shortage of drinking water, which is due to shifting weather patterns and prolonged dry periods. In such instances, the government is called upon to transport potable water to the affected islands. Apart from water scarcity in dry periods, another major concern associated with rooftop harvested rainwater on islands is the absence of means to check water quality and employ biological or chemical water security measures: At present, no facilities are available on islands to test rainwater quality. In addition, the setup and design of existing rainwater storage facilities on many islands has proven to be vulnerable to loss and damage from flooding and high wave incidences, as demonstrated during events witnessed in 1987, 1991 and 1993.

Although the global average precipitation is projected to increase during the 21st century, a marginal decline in precipitation is projected for the Indian Ocean region (Nurse and Sem 2001). The predicted changes in precipitation have the potential to impact on rainwater harvesting across all the atolls. Drinking water shortages during dry periods will therefore prove to be a significant challenge for the atoll population.

Information derived from Climate Scenarios:

The adaptation rationale of the proposed project is confirmed by a number of climate change scenarios which are discussed in different sources:

- The First National Communication of Maldives to the UNFCCC (Ministry of Home Affairs, Housing and Environment, 2001);
- The Climate Risk Profile for Maldives, which was developed as input to the formulation of a National Adaptation Programme of Action (University of Waikato, 2006);
- A number of scientific publications about regional climate projections, which have contributed to the 4th Assessment report of the IPCC (e.g. Mitchell, 2002; Christensen et.al., 2007)

The First National Communication analyzes IPCC emission scenarios IS92a and IS92e to develop climate change scenarios using MAGICC and SCENGEN modeling software for the years 2025, 2050 and 2100. The models project that by the end of this century, the average mean temperature in Maldives will have increased between 2.0ºC and 3.8ºC, accompanied by sea level rise of 48cm to 95cm. The connection between increasing temperature, rising sea levels and declining freshwater resources was clearly made: The summary report highlighted that inundation of land and associated saltwater intrusion due to the predicted sea level rise will reduce the size of freshwater lenses and thus reduce fresh groundwater available in Maldives in the future. In addition, increasing temperatures have been related to greater heat stress of people and ecosystems, resulting in growing withdrawal of freshwater from aquifers and surface storage facilities. While the climate models interpreted by the National Communications project were not conclusive with regards to an overall decline or increase in rainfall, analysis of observational rainfall data for Malé between 1969 and 1998 has shown increasing variability and an average slight decrease in rainfall of 2.7 mm every year. Total annual rainfall for the meteorological station in Gan (southern Maldives) shows an average decrease of 7.6 mm of rainfall per year. The National Communication report concluded that “overall, local long term climate recordings for the Maldives show that there is an increase in atmospheric temperatures and sea level while a decrease in rainfall is observed."

The Climate Risk Profile (CRP) for Maldives, which was developed as scientific input to the formulation of a National Adaptation Programme of Action (Hay, 2006) confirms the findings from the First National Communication. The CRP's analysis of future climate risk is based on output from 4 global climate models (GCMs) and 6 different IPCC greenhouse gas (GHG) emission scenarios for an approximately 3.75 by 3.75 degree grid square, which covers a large portion of the Maldives. The climate hazards that were analyzed are: 1) high sea levels; 2) extreme rainfall events (both 3-hourly and daily); 3) drought; 4) extreme winds; and 5) extreme high air temperatures. Combining observational data from Male atoll (Hulhule) with the output from 4 GCMs, the CRP established a best estimate projection of the maximum and minimum rates of change in future risk levels. In summary, the CRP found that all evaluated climate risks, including sea level rise, extreme high air temperatures, extreme rainfall events, and drought, are expected to increase over time as a result of global warming. The CRP found relatively high confidence in projections of maximum temperature, with annual maximum daily temperature projected to increase by at least 1.5ºC by 2100. A maximum temperature of 33.5ºC is currently a 20-year event in Maldives, but will likely have a return period of just three years by 2025. With regards to sea level, the CRP found that the observed long-term trend in sea level rise of 1.7 mm/yr (based on data for Hulhulé from 1989-2005) confirms projections by climate models. Even more extreme high sea levels are evident in the mean hourly sea level data, which show that maximum hourly sea level is increasing by approximately 7 mm/yr, a rate far in excess of the observed local and global trends in mean sea level. The CRP concluded that such exceptionally high sea levels are associated with greater short-term flooding, accelerated coastal erosion and salt water intrusion into groundwater. With regards to rainfall, the CRP confirmed high variability in observed daily, monthly and annual rainfall, including maximum rainfall, and no significant long-term trends. While climate models produce inconclusive rainfall projections, observational data from weather stations indicated considerable inter-annual and inter-decadal variability.

A number of recent scientific publications which have contributed analysis of regional climate change models and scenarios to the 4th assessment report of the IPCC highlight the effects of rising temperatures and sea level rise on the hydrological cycle in Maldives. A synthesis of 9 GCMs from Tyndall Center (Mitchell, 2002) confirms projections in temperature between 2ºC and 3ºC, and divergent rainfall projections (ranging between -20% and +20%) by the end of the century. The regional projections for precipitation developed by Christensen et al. (2007) highlight that annual precipitation changes across climate models for Maldives average out at a median of a slight 4% increase, but that most models perform poorly in the simulation of monsoon dynamics (which are the most relevant factor influencing rainfall intensity and distribution in Maldives).

Ultimately, all analytical work on climate change models and scenarios for Maldives to date has concluded that:

a) Temperatures will increase
b) Sea level will rise

c) Hydroclimatic variability and extremes will increase, and
d) Climate models are no reliable source of information to project rainfall trends.

While long-term observational data from hydro-meteorological stations across Maldives confirm increasing rainfall variability, there is agreement among climate change scenarios that increasing temperatures are causing a number of follow-on effects on freshwater resources:

- Increasing temperatures result in greater heat stress of people and ecosystems, and consequently in increasing water withdrawal from groundwater aquifers and surface storage facilities.
- Increasing temperatures result in thermal expansion of sea water, which causes sea levels to rise and more saline water to infiltrate into groundwater aquifers.
- Increasing temperatures offset a portion of rainfall-induced groundwater recharge through effects of evapotranspiration (Jung, 2010; Wild, 2008). If future precipitation remains the same as today, freshwater recharge is expected to decrease due to an increase in evapotranspiration. Even if rainfall would increase slightly (as indicated by some climate change models at a low level of confidence), such gains would be offset by evapotranspiration in warmer temperatures.

Project Target Area:

The proposed initiative will increase the resilience of freshwater resources through an integrated management of ground- and freshwater resources in the islands of Mahibadhoo (Alifu Dhaalu Atoll), Ihavandhoo (Haa Alifu Atoll) and Gadhdhoo (Gaaf Dhaal Atoll). These three islands represent different geographical locations across the country, are densely populated and have a flat topography varying between 0-0.5m MSL. The geographical location and island settings are depicted in the following table:

	Longitude	**Latitude**	**No. of families**	**Population (2011)***
ADh. Mahibadhoo	72.969066	3.75722	361	2038
HA. Ihavandhoo	72.926103	6.953145	360	2640
GdDh. Gadhdhoo	73.456435	0.289472	543	2023
			1264	**6701**

*Extrapolated from census data 2006, based on annual growth rates

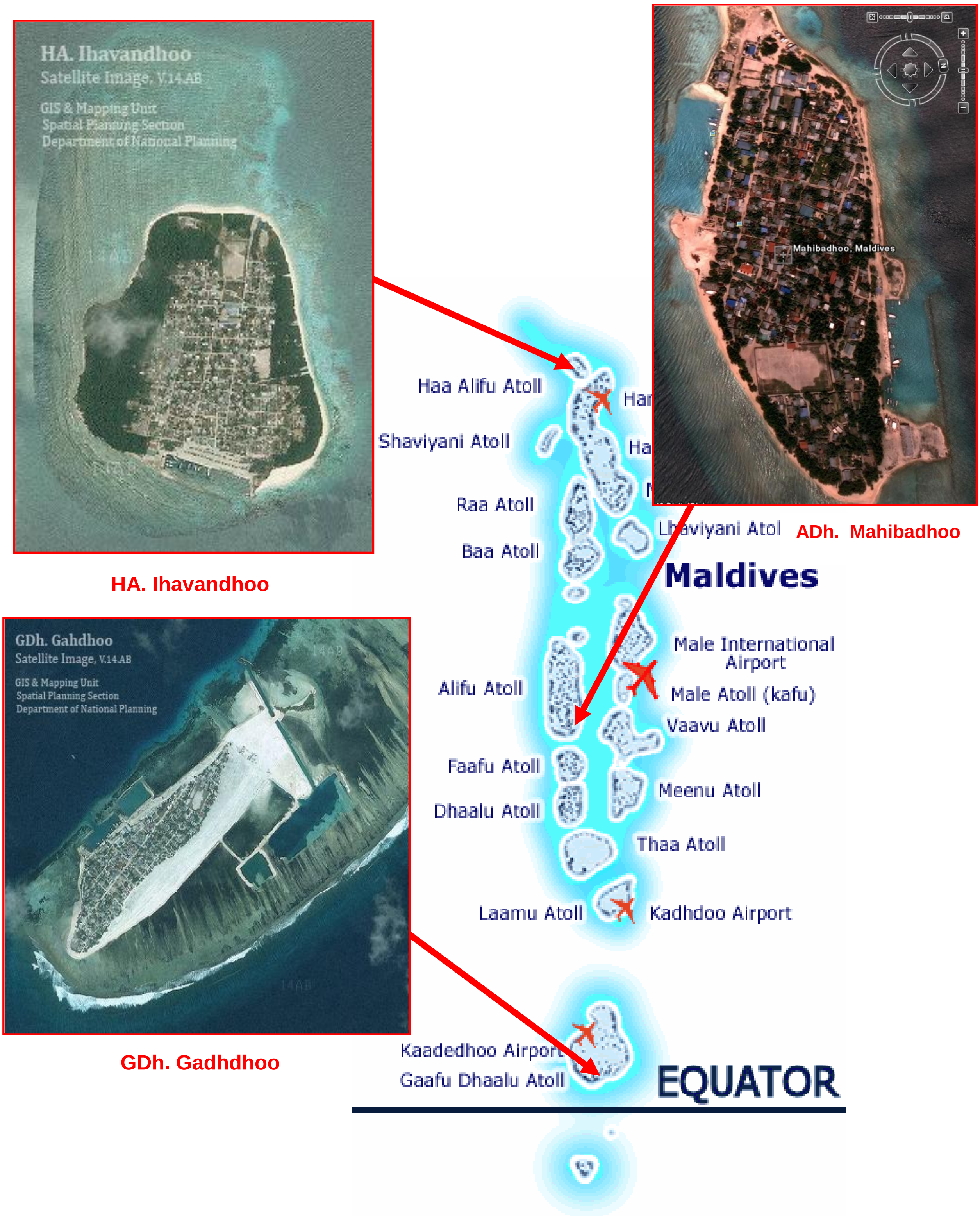


Fig.2: Target sites of the proposed project

After approval of the AF concept, an assessment mission was conducted to the 3 target islands to verify the situation of communities with regards to freshwater supply (see Annex D). These assessments have confirmed that at present, the inhabitants of Mahibadhoo, Ihavandhoo and Gadhdhoo rely on rain water for their drinking water needs and on ground water for other purposes. However, due to shifting rainfall patterns, the available quality and quantity of drinking water has been declining. Ground water salinity is increasing markedly as an effect of reduced recharge/increased outtake, sea level rise and high wave impacts. In addition, poor sanitation facilities (especially unsecured septic tanks) have increased the contamination of ground water sources and rendered this source of water virtually unusable for domestic purposes. In consideration of these climate-related factors, the Government of Maldives is obliged to introduce a systematic approach to the integrated management of freshwater resources in a changing climate. The proposed project represents the first example of an integrated water management project which is based on principles of climate risk resilience and adaptive capacity.

Barriers to addressing the Climate Change-induced Problems:

In Maldives, similar to many other small island states, the limited natural water resources have not been properly managed. There is no appropriate mechanism at present for sustainable management of these resources. Freshwater undoubtedly is a scarce resource which requires planned and regulated management. One of the major issues that have continued for decades on islands is inappropriate wastewater disposal and inefficient rainwater harvesting practices. MWSA (2001) reported that there are significant problems with the currently used technologies used for waste water disposal and also with the robustness of rainwater harvesting practices.

With regards to adaptive, integrated water resource management in Maldives, the following barriers seem apparent:

1) *Public financing shortfalls lead to insufficient coverage of islands with integrated, climate-resilient water management systems*

The Government of Maldives has undertaken substantial efforts to improve freshwater security in a number of islands, using different financial mechanisms. These include funding from the national budget (public sector investment-PSIP), loans, grants, development assistance and private sector investments. Key players who contribute loan and grant financing to water management projects include WHO, UNICEF, UNDP, the World Bank, the Asian Development Bank, the Islamic Development Bank, JBIC, JICA, and the Kuwait Fund.

With the exception of Male', Vilingili and Hulhumale, inhabited islands on Maldives do not have a functioning water supply and distribution network available that can ensure sufficient supply of safe freshwater during dry periods. This situation is rooted in a lack of financial resources to ensure comprehensive coverage in such a widely spread island nation; high initial investment costs for alternative water supply (e.g. desalination); high initial investment costs for wastewater treatment installations; and high operation and maintenance costs in connection with centralized water supply and management schemes (with state subsidies required to keep them going).

At present, water utilities are being established in seven provinces across the country, with utility managers in charge of developing and providing water supply, sewerage and electricity services. However, these utility companies lack the capacity to address the issues mandated to them by the government. As a result, the target islands under this project do not have a functioning freshwater management system that can buffer the effects of climate variability and change.

2) *Lack of awareness about the impact of climate change on freshwater resources*

Besides general aspects of environmental awareness (e.g. the impact of environmental pollution on protective ecosystem services, the relationship between water quality and public health, and the benefits of a clean environment to the economy and society as a whole), there is limited awareness in most communities about how climate change is affecting the reliability and quality of freshwater supply. According to a stocktaking report by ADB (2005), capacity-building and awareness raising activities across Maldives were more concentrated on hygiene education rather than on an inclusive environmental health and management program to develop widespread understanding of the interdependence between human activity and fragile ecological and natural resources. In order to advance climate change adaptation objectives, awareness programs need to propagate the following messages:

- Freshwater is a natural resource which will become much more variable in a changing climate;
- Interconnected freshwater collection and storage systems can be an effective community-based climate change adaptation measure;
- Improper management of wastewater reduces the effectiveness of the ecosystem (especially with regards to the filtration capacity of the groundwater aquifer and the health of the coral reef) to buffer against the impacts of extreme weather events; and
- Water users on inhabited islands, which are currently using decentralized, individual systems, can benefit from interconnected, more robust and integrated water management systems that can effectively buffer supply bottlenecks in dry periods.

Key reasons why these messages are not yet propagated include weak political coherence for the message of integrated adaptation planning; lack of trained resource people available at island level who can guide inclusive participatory processes on water management issues; lack of local NGOs/CBOs with experience on integrated water resource management; and lack of adequate resource materials that addres water resource management questions at the interface with climate change and environmental protection.

3) *Current practices of wastewater management undermine the resilience of natural freshwater storage against climate change*

Shortages of clean and safe freshwater during dry spells are common across the country. As dry spells are becoming more pronounced with global warming, the water stored in rainwater tanks and the natural groundwater lens is crucial. In addition to unregulated extraction of groundwater from shallow aquifers, a major challenge for the conservation and protection of valuable groundwater resources during dry periods is the absence of appropriate means for domestic wastewater disposal. Sewerage systems built on islands discharge frequently untreated onsite and near shore, through brick masonry septic tank systems and near shore sewage outfalls, which heavily pollute island groundwater aquifers and the coastal environment with sewage. As such, these practices undermine the potential of the aquifer to buffer against climatic extremes and store sufficient freshwater for the affected island to make it through a dry spell without having to import bottled water.

Across Maldives, there are no large scale wastewater collections and treatment systems, except on a few newly built resorts. After the 2004 tsunami, with loans from development banks and support by donor agencies, sewerage systems have started to be built with fair treatment (e.g. gravel bed filters, vacuum systems etc) and central collection facilities with ocean outfalls. No considerations are still given to the relationship between growing freshwater stress in a changing climate and opportunities of wastewater reclamation and reuse. Hence, it is essential to connect wastewater treatment planning to considerations of long-term freshwater supply, and to make sure to treat the management of wastewater and the management of freshwater in an integrated manner. If this connection is not made, the lack of proper wastewater management planning will undermine all efforts of adaptive rainwater harvesting and groundwater management schemes to buffer against climate-related hazards.

4) Institutional Capacity Barriers

Outside the capital Malé, the Maldives has a shortage of professional capacity in all sectors and at all levels of environmental management, especially at the level of atoll and island administrations. The Climate Change and Energy Department (CCED) has limited staff and budget and its main role to date has been to develop climate change & energy policies, programs, projects, oversee implementation of climate change related projects and engage in the international climate change negotiations, in which the Maldives is actively and successfully engaged. The Water and Sanitation Department (WSD) is the lead government agency dealing with water and sanitation policies and programmes in the country. The Environmental Protection Agency (EPA), which is mandated to oversee the Environmental Impact Assessment (EIA) process, amongst other functions, has greater human resources than the CCED, but also suffers from severe technical capacity constraints. The EPA has few staff who can evaluate the implications of proposed water management projects in the context of a changing climate, or identify locally appropriate adaptation options in the field of water supply management. Generally, there is little knowledge available about the possible range of locally appropriate adaptation options for water resources planning, including the costs and benefits of different high-tech and low-tech options and how to combine them. These capacity gaps in climate risk planning are even more apparent with authorities at the atoll and island levels, as historically all development planning was done at the national level. Such capacity is increasingly critical, given that many national planning and decision-making functions will be devolved to the atolls and islands through a decentralization programme.

5) Insufficient Policy Implementation and Enforcement

Despite the existence of an Environmental Act adopted by the Peoples Majilis in 1993 for environmental protection, the apparent gap in the country's legal framework is the absence of relevant laws and regulations that enforce better environmental governance. Major causes of these weaknesses are the lack of stability within the government system and absence of institutional mechanisms for environment management at the community level. Written policy statements related to water resources (e.g. groundwater aquifers) protection in the country have for the first time been documented in 1989 in the First National Environment Action Plan, followed by other policy level documents namely the Second National Environment Action Plan 1999, the First Health Master Plan 1996 – 2005, the Fifth National Development Plan 1997 – 2000, the Sixth National Development Plan 2001 – 2005, the Seventh National Development Plan 2006 – 2010, the Five Year Activity Plan (MWSA) 2006 – 2010, the Water and Sanitation Master Plan 2008, the Maldives National Strategies for Sustainable Development 2009, and the Third National Environment Action Plan 2009.

Despite the fragmentations, the key national policy on water and sanitation has always been to provide access to safe drinking water and improved sanitation to all Maldivians.

Provision of access to safe water and adequate sewerage system to people in Maldives
became a constitutional right for the first time in 2008 under Article 23 of the new constitution. Yet, despite the availability of proper policies, policy compliance and enforcement is still weak across the country, which is mainly due to a lack of infrastructure for pollution monitoring, trained resource people at island level, and a shortage of finance for decentralized enforcement of compliance with environmental and water management guidelines. The country needs to find a comprehensive approach to the implementation of national water policy in highly decentralized settings, giving proper consideration to good practices of climate-resilient water governance that are suitable and appropriate for the situation in outer islands.

PROJECT / PROGRAMME OBJECTIVES:

The proposed project is responsive to objectives spelled out in the Government of Maldives Strategic Action Plan 2009, the 3rd National Environment Action Plan (NEAP -3, 2009), the National Sustainable Development Strategy (NSDS 2009), and the National Adaptation Programme of Action (NAPA, 2007). For details on policy coherence, please see Part II, Section D of this project concept.

Project Objective:

The objective of this project is to ensure reliable and safe freshwater supply for Maldivian communities in a changing climate.

Project Strategy:

The primary problem addressed by this project is a significant, climate change-induced decline of freshwater security that is affecting vulnerable communities in Maldives. As surface freshwater is generally lacking throughout the country, the key problems pertaining to freshwater security relate to the management of increasingly variable rainwater resources and increasingly saline and polluted groundwater. In order to reduce the aforementioned barriers to effective climate change adaptation in the water management sector, it is essential to reinforce the perspective of Integrated Water Resources Management (IWRM) on inhabited islands. This will ensure that measures responding to additional, climate change-related risks (such as greater rainfall variability, unreliable recharge of aquifers, longer dry periods, and increasing damage to infrastructure from extreme weather events) are addressed in concert with a response to basic development problems (such as insufficient sewage and wastewater treatment, lack of environmental awareness, lack of water conservation, and lack of comprehensive stakeholder participation in the design and monitoring of water management schemes).

Through the rollout of an integrated water resource management programme in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo, the project will ensure consistent, safe and equitable access of all island communities to safe freshwater in a changing climate. Through a targeted mix of the following investments, the project will address the effects of variable rainfall, extreme weather events, salinization and pollution of aquifers:

- Establishment of a sustainable freshwater supply system that incorporates and integrates rainwater harvesting and desalination technology;
- Improvement of groundwater quality through artificial groundwater recharge and better integration between freshwater and wastewater management;
- Increasing community participation in the development, allocation and monitoring of freshwater use in a changing climate;
- Replication and up scaling of climate-resilient freshwater management

PROJECT / PROGRAMME COMPONENTS AND FINANCING:

The following table has been prepared in alignment with the Adaptation Fund Strategic Results Framework. For details of Outputs and corresponding activities, please refer to Part II, Section A of this concept.

PROJECT COMPONENTS	EXPECTED OUTCOMES	EXPECTED CONCRETE OUTPUTS	AMOUNT (US$)
1. Establishment of integrated, climate-resilient water supply and -management systems in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo	1. Ground water aquifer rehabilitated and freshwater supply ensured in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo to provide reliable, equitable and cost-effective access to safe freshwater in a changing climate	1.1 Artificial groundwater recharge systems established to protect groundwater resources from salinization and improve aquifer yields in dry seasons	228,296
		1.2 Rainwater harvesting schemes redesigned, interconnected and structurally improved to buffer climatic extremes and ensure equal water supply for all households during dry periods	3,717,893
		1.3 Production and distribution system for desalinated water supply established	3,296,733
		1.4. Existing wastewater management systems redesigned and improved to ensure sufficient quantities of safe groundwater during dry periods	77,476
2. Increase participation in the development, allocation and monitoring of freshwater use in a changing climate	2. Strengthened local awareness and ownership of integrated, climate-resilient freshwater management	2.1. Community consultations on each target island ensure participative design, sustainability and continued maintenance of integrated water resource management schemes	70,000
		2.2.Targeted training events conducted in each region to strengthen water user participation and skills in adaptive, integrated water resource management	40,000
3. Replication and up scaling of climate-resilient freshwater management	3. Improved institutional capacity to promote and enforce climate-resilient freshwater management on all inhabited islands	3.1.Training of technicians in the design, operation and management of integrated water resource management systems	30,000
		3.2 Institutional mechanisms created to integrate adaptive management of freshwater resources into the design and rollout of new water management projects and schemes	30,000
		3.3. Action plan developed and financing mobilized to replicate integrated, climate-resilient freshwater management on at least 4 additional islands	20,000
		Project/Program Execution cost	774,602
		Total Project/Program Cost	8,285,000

Project Cycle Fee charged by the Implementation Entity (if applicable) [4]	704,225
Amount of financing Required	8,989,225

PROJECTED CALENDAR:

Indicate the dates of the following milestones for the proposed project/programme

MILESTONES	EXPECTED DATES
Submission of Concept to AF	October 2010
Approval of the Concept by the AF Board	December 2010
Commence Development of a Full Project	January2011
Submission to AF of a Full Project Proposal	June 2011
Start of Project/Programme Implementation	November 2011
Mid-term Review (if planned)	October 2013
Project/Programme Closing	October 2015
Terminal Evaluation	July 2015

[4] On the request of the Government of Maldives, the project will be implemented by UNDP using the MIE modality. UNDP is able to provide the following implementation services through its country office, regional and headquarters networks: project identification, formulation, and appraisal; determination of execution modality and local capacity assessment of the national executing entity; briefing and de-briefing of project staff; oversight and monitoring of AF funds, including participation in project reviews; receipt, allocation and reporting to the AF Board of financial resources; thematic and technical capacity building and backstopping; support with knowledge transfer; policy advisory services; technical and quality assurance; and troubleshooting assistance to the national project staff. The breakdown of specialized technical support services provided through the MIE fee is provided in Annex A.

PART II: PROJECT / PROGRAMME JUSTIFICATION

A. Describe the project / programme components, particularly focusing on the concrete adaptation activities of the project, and how these activities contribute to climate resilience. For the case of a programme, show how the combination of individual projects will contribute to the overall increase in resilience.

COMPONENT 1: Establishment of integrated, climate-resilient water supply and -management systems in Mahibadhoo, Ihavandhoo and Gadhdhoo

Component 1 focuses on the establishment of integrated water supply and -management systems in Mahibadhoo, Ihavandhoo and Gadhdhoo to meet the demand of reliable and safe freshwater supply in a changing climate. This effort will involve

a) the planning and installation of *groundwater protection and recharge* measures using surplus rainwater and improved management of wastewater;
b) the redesign of existing *rainwater harvesting* schemes, including optimization of total storage capacity to meet supply needs in dry periods; interconnection of isolated units to ensure equitable water supply in dry periods; improvement of structural integrity of rainwater collection and storage systems against extreme weather events; integration of filter elements to improve safety of freshwater supply
c) the systematic improvement of septic tank maintenance and redesign of *wastewater management* schemes to ensure sufficient quantities of safe groundwater during dry periods and prevent polluted wastewater to undermine freshwater stocks in time of climate-induced water scarcity
d) the application of *desalination* technology in the context of a diversified, integrated water supply and distribution infrastructure, ensuring supply capacity of at least 20 liters per person per day during dry spells and climatic extremes.

Under Component 1, the project will meet the domestic and economic water supply needs of 1264 families, thereby covering the water needs of all targeted island communities and benefiting 6209 people directly. This covers 24% of all rural Maldivians who are currently dependant on unsecured individual household systems outside of the capital zone.

After approval of the project concept by the AF Board, targeted assessment missions were conducted on each target island over the course of March 2011. The appropriate mix of the above components for each target island was established and will be reconfirmed through additional stakeholder consultations determining the location, setup, maintenance protocols and willingness to pay for integrated water management services. For additional information on assessment findings and technical design considerations, please refer to Annexes D (describing the baseline situation) and E (describing design characteristics and technical options for the proposed integrated systems).

With regards to overall design considerations, it is important to note that prior to any construction activities, an Environmental Impact Assessment (EIA) will be conducted under the leadership of the Maldives Environment Protection Agency (EPA). For all water resource planning purposes under this programme, the demand of water has been calculated for a 30 year time horizon on the minimum supply of 20 liters per person and day. This design integrates factors of population and economic growth, as well as migratory trends to the targeted islands. Proper buffer allowances for institutional and commercial demand, as well as basic pipeline losses have been factored into demand-side calculations. This means that the beneficiaries of the project do not only include the current population of the target islands, but also of people who migrate to these islands in search of economic opportunities or for reasons of increasing vulnerability.

Component 1 consists of the following Outputs and activities:

Output 1.1: *Artificial groundwater recharge systems established to protect groundwater resources from salinization and improve aquifer yields in dry seasons*

Artificial recharge of groundwater is the process of adding water to an aquifer through human effort. Under this project, the method of artificial recharge with surplus rainwater will be used to control sea water intrusion into aquifers and reduce pollution. Artificial recharge is recognized by many countries with recurrent water scarcity problems (including Indian ocean islands, Caribbean and Pacific SIDS) as an effective method to raise the ground water level and counter the intrusion of saline or polluted water into aquifers. Groundwater recharge reduces surface runoff which chokes storm water drains, and reduces flooding of roads. This reduces soil erosion and improves the overall quality of groundwater. Finally, groundwater recharge improves energy savings from groundwater extraction that is driven by electrical pumps: A one meter rise in water level saves about 0.40 KWH of electricity.

In the context of the 3 islands targeted under this programme, a number of methods have been evaluated which are potentially applicable to recharge aquifers and thereby increase groundwater supply in a changing climate. These methods include recharge pits, recharge trenches, recharge wells, dug wells, recharge through handpumps, recharge shafts and lateral shafts with bore wells. It was found that the most effective way to improve groundwater quality in the 3 target islands is the collection of overflow rainwater from rainwater harvesting systems to selected recharge pits and wells, coupled with systematic cleaning of septic tanks in connection with newly designed sewage and wastewater treatment systems (under Output 1.4). As spillovers of septic tanks during flooding events keep polluting groundwater and would undermine any groundwater recharge efforts, it is vital that septic tank systems are properly connected with sewage and wastewater treatment systems.

<u>Activities under Output 1.1 include:</u>

- Conduct regular benchmark groundwater tests (minimum every 6 months) to verify improvement of groundwater quality over the course of the project and beyond

- Install provisions in new and existing rainwater harvesting systems (both in individual households and public buildings) to capture and redirect excess rainwater for purposes groundwater recharge.

- Install a critical number of recharge pits consisting of perforated concrete pipes which are backfilled by gravel and sand to support infiltration: 700 household recharge pits and 30 communal recharge pits in HA. Ihavandhoo; 275 household recharge pits and 30 communal recharge pits in ADh. Mahibadhoo; and 495 household recharge pits and 30 communital recharge pits in GDh. Gadhdhoo.

Output 1.2: *Existing rainwater harvesting schemes are redesigned, interconnected and structurally improved to buffer climatic extremes and ensure equal water supply for all households during dry periods*

The prevailing rainwater harvesting technique in Maldives is the collection of rainwater in simple vessels at the edge of the roof. Variations on this basic approach include collection of rainwater in gutters which drain to a collection vessel through down-pipes constructed for this purpose, and/or the diversion of rainwater from gutters to containers for settling particulates before being conveyed to a storage container for domestic use.

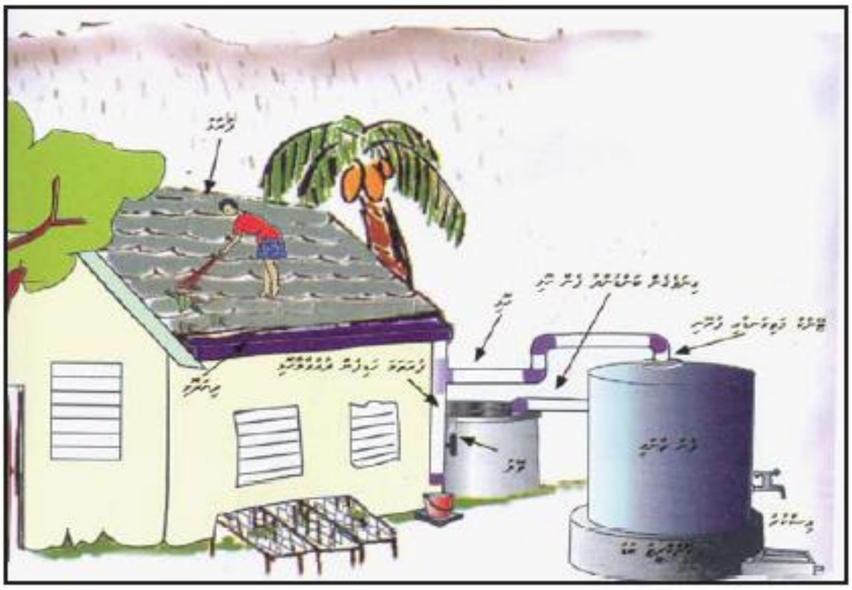


Fig.3:
Basic elements of a domestic rainwater harvesting scheme in the Maldivian context (WHO, 2007)

When analyzed vis a vis the challenges posed by a changing climate - most notably longer dry periods and more frequent and extreme weather events - the existing rainwater harvesting systems in Maldives display a number of important drawbacks:

- They are not yet systematically laid out to incorporate greater water resource needs and more uneven supply in a changing climate;
- They are largely disconnected from each other, thereby creating unequal distribution of available freshwater during dry periods;
- Not all rainwater harvesting installations are making full use of the available roof catchment area, thereby reducing freshwater yields;

- Public buildings are not yet systematically connected to central rainwater storage units;
- Not all rainwater harvesting systems are robust enough to withstand the impact of extreme weather events, such as storms and swell waves.

The proposed project will address these shortcomings by optimizing household and communal rainwater harvesting schemes on each island, and installing the minimum required capacity to meet all communal freshwater needs in a changing climate:

- 9,000 m^3 in HA. Ihavandhoo;
- 6,300 m^3 in ADh. Mahibadhoo;
- 6,300 m^3 in GDh. Gadhdhoo.

Basic design considerations of improved rainwater harvesting systems are summarized in Annex E, which follows from additional technical assessment missions that were conducted on each target island during project preparation. The basic design options that will be integrated into the rollout of improved rainwater harvesting systems on each island are as follows:

Option 1: Increasing the capacity of individual rainwater harvesting tanks in each household and optimizing water collection from individual rooftops. Connection of water collection with carbon activated and UV filter systems, as well as existing household piping and pumping networks. In this option, consumers are not required to pay water tariffs.

Option 2: Communal rainwater harvesting through collection from public facility roof areas (provided that land is available for large storage tanks). Pumping of raw water to a central tank for filtration and UV disinfection and further distribution. Elevated water tanks are required to distribute the water through gravity flow. This option will require metered connection to households, and agreement on a water tariff.

<u>Activities under Output 1.2. include:</u>

- Verify design considerations with island communities, based on Output 2.1

- Define localities for the installation of additional rainwater harvesting and storage capacities

- Design and install additional communal rainwater harvesting systems on public buildings (schools, mosques, clubs, community centers, hospital, council houses, etc.) with a large roof area covered with apposite roof materials and an economic distance from a water treatment area

- Install a water transmission and storage system (including transmission pumping pipeline running from a treatment site to elevated tanks providing a gravity distribution system)

- Install additional disinfection devices to treat freshwater to WHO standards before human consumption (using UV disinfection as close as possible to the consumers and preferably at the elevated reservoir outlet point).

- Establish a distribution network to transport potable water produced at the treatment plant (used for both rainwater and desalinated water) to elevated water storage tanks located near the center of the island for subsequent gravity distribution to consumers.

- Install flow meters in key locations of the distribution network to identify water losses.

- Improve individual house connections to enable potable water intake from both internal (household RWH) and external sources

- Improve water quality control in existing household rainwater harvesting systems by incorporating additional components such as first-flush diverters, UV disinfectant systems, inline demand pumps, improvement to gutter and downspouts, preliminary filtration systems, and additional storage tanks.

- Optimize use of solar energy in communal rainwater harvesting systems by installing solar-powered pumps wherever feasible and appropriate

Output 1.3: *Production and distribution system for desalinated water supply established*

Desalination technology is a vital component of an Integrated Water Resource Management (IWRM) scheme on the 3 target islands. Desalination is the only technology that works independently from climatic factors and can provide freshwater to the population irrespective of climatic extremes. Even in prolonged times of drought, when rainwater harvesting systems do not yield sufficient quantities of freshwater to the population, or in times of flooding, when saltwater infiltrates the recharge wells of an inhabited island, desalination technology can ensure consistent water supply. The diversification of different sources of freshwater supply is therefore a vital consideration in the design of an integrated, resilient water resource management system. The combination of rainwater harvesting, groundwater recharge and desalination technology will generate the necessary diversification and redundancy in the water supply system to ensure that no matter how the climate develops, there is always a sufficient supply of safe freshwater for the local population.

The assessment mission conducted to the 3 target islands in March 2011 has confirmed the need for sufficient desalination capacity to buffer times of insufficient or unpredictable rainfall. As desalination is a comparably expensive option, both in terms of fuel consumption cost and high carbon emissions (if run by diesel generators as opposed to solar or wind power), the project does not propose to make desalination plants the primary source of potable water on the target islands. Instead, it is proposed to resolve shortages of potable water during climatic extremes (drought, flooding, storm disasters) by tapping all available avenues with a view to minimizing the overall production cost and environmental risk. As discussed previously, the economically most resilient and viable approach is an integrated water supply system which integrates community-based rainwater harvesting systems, improved household rainwater harvesting systems, and sufficient desalination capacity to supply the minimum water requirement in critical situations of freshwater shortage. Under the proposed project, all potable water supplied by these three independent systems will be directly connected to each household to reach the overall aim of providing a safe and sustainable pipe-borne water supply system around the clock. The selection of a particular source for operations at any given time largely depends on the judgment of the operators and house owners; Ideally, the least expensive household rainwater harvesting system should be in operation during the rainy season and beyond, whilst moderately costly community-based rainwater harvesting should commence operations immediately after the rainy season has finished, supplemented by the more expensive desalinated water in times of drought.

The required desalination capacity on the 3 target islands was calculated on the basis of a minimum supply of 20 liters per person per day during times when no alternative source of freshwater is available. At present, no desalination capacity is available on HA. Ihavandhoo, whereas ADh. Mahibadhoo and GDh. Gadhdhoo both have small desalination capacities of 10 m^3 per day which were installed by the Red Cross after the 2004 Indian Ocean Tsunami. This capacity, however, is not fully operational due to a number of design and maintenance problems (see Annex D) and therefore insufficient to satisfy communal water demand in times of climatic extremes. To satisfy water demand of the 3 densely populated target islands, and avoid costs of importing bottled water, the proposed project will install 90 m^3 of desalination capacity per day on Ihavandhoo and upgrade existing desalination capacity on ADh. Mahibadhoo and GDh. Gadhdhoo from 10m^3 per day to 60m^3 per day. Previous shortcomings in the operation and maintenance of desalination systems (such as the non-availability of spare parts, intake clogging, affordability limits of operations and high maintenance costs) will be addressed through a participatory process in which the willingness of communities to pay for clean and safe freshwater supply is factored into operations and maintenance protocols of state-contracted water utility companies.

Regarding continued operation of desalination plants after the project has ended, the Government of Maldives has recognized the need to systematize the follow-up maintenance of water supply and sanitation infrastructure across the country. As a result, the Government has established state-owned utility companies for all provinces and transferred available water and sanitation facilities (including desalination plants) to these utilities for continued and professional operation and maintenance. The operation and maintenance of desalination plants is not a new skill in Maldives; Following the 2004 Indian Ocean tsunami, a number of desalination plants have been installed across the country, and the Ministry of Housing and Environment continues to provide management and technical support to the new utility companies to ensure their sustained and smooth operation. Under the proposed project, the 3 target islands will be covered by 3 different utility companies. The project will involve these utility companies from the very initial stages to ensure that after the project has ended, operation and maintenance of water-related infrastructure on these islands is continuously ensured, based on actual willingness to pay for these services. So far, high initial investment costs have been a prohibitive factor for many utility companies to actively invest in water supply and distribution infrastructure; With AF financing reducing this barrier, utility companies have a strong business case to engage in the continued operation and maintenance of new infrastructure and draw up business models that meet the needs of the local population. The technical skills of utilities to effectively operate and maintain integrated water supply, storage, distribution and water quality testing will be addressed by Output 3.1 of the project; Consultations between utility companies and local communities to draw up participative water management schemes is targeted under Component 2.

Activities under Output 1.3 include:

- Verify population data and growth rates provided by the 2006 census on each target island and calibrate capacity of desalination plants to ensure minimum provision of 20 liters per person and day by 2030

- Bring existing desalination capacity on Mahibadhoo and Gadhdhoo to a functional state and upgrade to a total of $60m^3$ per day

- Install a new desalination plant on Ihabandhoo with a capacity of 90 m^3 /day

- Connect distribution system for desalinated water with distribution, filtering and collection systems for harvested rainwater

- Interconnect desalination plants with an environmentally safe wastewater disposal system

Output 1.4: *Existing wastewater management systems redesigned and improved to ensure sufficient quantities of safe groundwater*

The safe disposal of domestic and municipal wastewater/sewerage in densely populated communities has always posed a challenge in the Maldives. Although septic tanks are acceptable means of safe discharge of wastewater/sewerage to the environment, the improper use of septic tanks, the faulty construction of septic tanks or the flooding of septic tanks during periods of heavy rainfall and inundation can create hazardous conditions for communities, causing communicable diseases such as Cholera, Diarrhea, and Typhoid. Moreover, the use of septic tanks to dispose wastewater/sewerage safely can pose a serious challenge to communities with congested populations (such as the 3 target islands of this project) and may lead to serious pollution of ground water sources to a level that makes it unfit for hygiene or household uses.

The context in the target islands of Ha Ihavandhoo and Gdh. Gadhdhoo is no exception to the above phenomena. The ground water sources in the above islands have been badly deteriorated and become unfit for any domestic purpose due to contamination from sewage and salinization. Therefore, it has become imperative to find durable and lasting treatment process to dispose wastewater/ sewerage generated by the communities in these islands to the environment with safe BOD and COD levels. Without a systematic coupling of freshwater supply and wastewater disposal systems, as demonstrated by this project, the wastewater problem will continue to undermine any efforts of adaptive freshwater management. Hence, it is crucial to demonstrate how such coupling can be undertaken, from the design and planning to the maintenance and monitoring stages.

In the assessment phase of the proposed project, it was found that a new wastewater treatment plant is currently under construction in Mahibadhoo by an international contractor (Shin Nippon Air Technologies Co.Ltd.). The system has an estimated cost of 4.3 million US$ and is planned to be completed by September 2011. A gravity wastewater conveyance system with 3 pumping stations has been planned for transmission of sewage. Similar wastewater treatment plans (with costs of around 6 million US$ per plant) are currently being planned for Ihavandhoo and Gahdhoo.

For the proposed project, as other financing sources have already been allocated to address the investment costs for wastewater treatment plants on the target islands, AF funds will not be used to install anaerobic digesters, conventional wastewater treatment schemes or package plants with Membrane Bio Reactor technology. Instead, AF resources will be used to ensure that unsecured septic tanks do not continue to pollute groundwater and undermine groundwater recharge on the target islands, and that the Government has workable design options on how to integrate new wastewater engineering designs with climate-resilient freshwater supply and storage, groundwater protection, and artificial recharge.

Activities under Output 1.4 include:

- Establish a cleaning protocol for septic tanks in connection with groundwater quality testing and ensure regular cleaning of septic tanks before the wet season

- Ensure connectivity between sewage/wastewater management designs and new freshwater supply/storage and distribution installations on each target island

- Provide workable design options to MHE on how to integrate climate resilient freshwater supply systems (encompassing communal rainwater harvesting, household-based rainwater harvesting, groundwater recharge and desalination) with sewage and wastewater management schemes

COMPONENT 2: Increase participation in the development, allocation and monitoring of freshwater use in a changing climate

While the bulk of project inputs will be programmed for tangible adaptation measures that ensure adaptive management of freshwater resources on three densely populated islands, the project is also aiming to develop capacity at government, atoll and island level to increase water user participation in the planning, monitoring and maintenance of climate resilient freshwater management.

In this context, it is important to note that the project will not establish new decision-making structures. Instead, it will ensure equitable participation of local water users in the new local governance structures that are currently being established across the country. Maldives will be holding its first local elections in 2011 to elect local authorities (councils) at island and atoll level. These councils will be established as new constitutional bodies that have the authority to make their own local level decisions. In this context, through Component 2 of the project, the project will ensure that water users in local island communities can effectively engage with island councils and water utilities on all issues related to freshwater governance. This involves participation in technical training activities that explain the design and functioning of the local water supply and –distribution system; participation in the design of new agreements with water utility companies; and continued engagement in the monitoring of local water supply quantity and quality.

Along these lines, Component 2 of the project will introduce a range of communication, awareness and training activities which will enable public, private and communal stakeholders (including water suppliers, planners and users) to effectively engage with each other and participate in the inclusive development, allocation and planning of water resource schemes on their home islands.

Output 2.1.: *Community consultations on each target island ensure participative design, sustainability and continued maintenance of integrated water resource management schemes*

In line with the IWRM approach to water management, stakeholder identification and participation under the project will involve four steps:

1. Identifying key stakeholders from the large array of groups and individuals that could potentially affect, or be affected by, changes in water management on each island;
2. Assessing stakeholder interests and the potential impact of the project on these interests;
3. Assessing the influence and importance of the identified stakeholders in sustaining integrated freshwater and wastewater management on each island; and
4. Outlining a stakeholder participation and empowerment strategy (a plan to involve the stakeholders in different stages of the project and beyond) in alignment with the existing governance system.

Activities under Output 2.1. include:

- Facilitation of inclusive, participatory consultations between MHE, island councils, community representatives, civil society organisations, utility companies and project staff to present the project, verify assumptions and solicit additional feedback on technical design issues

- Conduct a “willingness to pay”-survey on each island to guide the design of a water supply service and maintenance scheme

- Devise a scheme to finance the continued operation and maintenance of integrated water resource management systems on each target island after the project has ended

- Integrate community representatives in project-related works, including construction, operation, maintenance and water quality testing

- Conduct regular feedback sessions between MHE, island councils, community representatives, civil society organisations, utility companies and project staff to enable analysis of project experiences and lessons learned

Output 2.2.:*Targeted training events conducted in each region to strengthen water user participation and skills in adaptive, integrated water resource management*

In all activities related to awareness, communication and training, the project will adopt the principles of Integrated Water Resources Management (IWRM). IWRM is widely recognized as a basis for the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives. The approach recognizes that water is a scarce natural resource, subject to many interdependencies in conveyance and use. There is a variety of different uses of water resources, and these uses are all interdependent. The failure to recognize such interdependency, coupled with unregulated use, can lead to water wastage and the unsustainability of water resources in the long term. This, in turn, will reduce resilience to the pressures exerted by a changing climate.

IWRM is cross-sectoral in nature and entails a departure from narrow professional and political boundaries and perspectives, broadening them to incorporate participatory decision-making among all stakeholders that have a stake in water supply, use and management on a targeted island. This means that different user groups (households, farmers, businesses, public and private entities) can actively influence strategies for water resource development and management. This brings additional benefits, as informed users apply local self-regulation in relation to issues such as water conservation, protection of aquifers and protection of sensitive ecosystems from water-borne pollution far more effectively than central regulation and surveillance can achieve.
In all participative processes facilitated under this project, the following perspectives will be integrated (applicable for each island separately):

- All water (spatial);
- All interests (social);
- All stakeholders (participatory);
- All levels (administrative);
- All relevant disciplines (organizational);
- Sustainability (in all senses: environmental, political, social, cultural, economic, financial and legal).

Across all components, this project will treat water as both an economic as well as a social good, which is sensitive to climate-related shocks and stresses and therefore needs to be managed responsibly. Output 2.2 is the main delivery vehicle to mobilize stakeholders for IWRM and convey this message.

<u>Activities under Output 2.2. include:</u>

- In cooperation with other specialized UN agencies (WHO, UNICEF), conduct a country-wide communication and awareness campaign about principles of Integrated Water Resource Management

- Organize targeted consultations between island councils, water utility companies, community representatives and the proposed project about IWRM design, installation, operation and maintenance. These consultations and trainings will benefit from UNDP Cap-Net's training materials and resources related to IWRM.
- Organizepublic debates and focus group sessions on the rights and responsibilities of different water users with regards to communal water use and water resource protection
- Arrange school presentations and field visits pertaining to water efficiency and groundwater pollution issues
- Arrange study visits and field excursions of political authorities from all regions and atolls to water supply, storage, treatment and distribution systems implemented by the project;
- Prepare project briefs for political authorities, parliamentarians, utility companies and industry representatives to highlight the economic, environmental and adaptation benefits of the installed systems
- Prepare local media news items about the project in local language
- Prepare and/or adopt training materials (leaflets, brochures, posters, DVDs) to describe the project in the context of IWRM and disseminate best practice IWRM guidance materials and tools (using synergies with complementary IWRM projects including the global project "Implementing Integrated Water Resource and Wastewater Management in Atlantic and Indian Ocean SIDS"
- Ensure visibility of the project on public websites, Email groups and discussion platforms

COMPONENT 3: Replication and upscaling of climate-resilient freshwater management

Building on participative processes initiated under Component 2 of the project, and drawing on the technical experiences in groundwater recharge, rainwater harvesting and coupled wastewater/groundwater management generated under Component 1, Component 3 will introduce targeted activities to enable the analysis, replication and up-scaling of the project approach on other inhabited islands. This will entail a campaign to present the findings from the project to different public entities, political authorities, utility companies and development partners, as well as other atolls and islands with similar degrees of vulnerability. This campaign will integrate all administrative regions and aim at the replication of the project approach in at least 4 other inhabited islands. Exchange programmes to the target sites in Mahibadhoo, Ihavandhoo and Gadhdhoo will be facilitated to promote learning and transfer of experience on climate-resilient freshwater management (especially with regards to the design of coupled rainwater harvesting/groundwater recharge schemes). At the level of the central government, a consultative mechanism will be created that allows the integration of project experiences into the design and rollout of new water management projects and schemes.

In connection with this project component, it is important that the Government of Maldives is willing to follow through on its commitment to adopting an integrated water resources management approach as a key strategy to address a critical, climate change-related challenge that lies at the heart of the country's survival. Consequentially, the issue commands priority attention at the highest levels of government. A concerted effort is under way to establish public-private partnerships with utility companies and mobilize resources from public, private, bilateral and multilateral sources to follow through with the constitutional obligation to provide access to safe and reliable freshwater to every Maldivian. This is reflected and formalized in a three year programmatic budget (based on the Strategic Action Plan). With AF resources catalyzing additional private investments from utility companies to operate and maintain climate-resilient freshwater supply and distribution systems, it is expected that water management in Maldives will be able to draw on more effective public private partnerships over the course of the next few years so as to sustain the system in the face of climate change. Considering this conducive policy environment, the Government has indicated very high confidence that co-financing can be mobilized for the replication of the project approach on 4 additional islands under Output 3.3 of the proposed project. If no additional investments from utility companies can be mobilized, the fallback option will be the use of public financing to leverage additional bilateral support, accompanied by continued technical and financial support by the United Nations system.

Output 3.1.: *Training of technicians in the design, operation and management of integrated water resource management systems*

The project will ensure that technicians from all utility companies that are currently engaged in the planning and/or implementation of dedicated water supply, sewage and drainage projects in Maldives are properly trained in the principles of climate-resilient, integrated water resources management. Utility companies will be exposed to the design principles employed by the project and visit the project sites. Targeted training activities will include guidance on water quality testing, environmental impact assessment, establishing connectivity and redundancy between individual water supply options, establishing connectivity between freshwater and wastewater systems, improving freshwater safety and quality, protecting groundwater resources, and maintaining communal buy-in and cooperation in the continued operation and maintenance of water supply systems.

<u>Activities under Output 3.1. include:</u>

- Selection of at least 5 representatives from each utility company to be trained

- Organizing exposure visits of utility companies to project sites, led by project engineers and technical experts involved in the design of the integrated systems

- Conduct targeted training modules in IWRM, design of climate-resilient freshwater supply systems, design of climate resilient wastewater management systems, provisions to ensure long-term safety of freshwater, groundwater protection, desalination design, operation and maintenance, environmental impact assessment

- Evaluate training through feedback forms and interviews

- Assess and define targeted support actions for concrete utility companies to improve the design of water supply projects which are currently in the pipeline

Output 3.2: *Institutional mechanisms created to integrate adaptive management of freshwater resources into the design and rollout of new water management projects and schemes*

In Maldives, there is no institutional mechanism which ensures that new water and wastewater management projects are subject to technical reviews on the basis of IWRM and climate resilience principles. Although the government solicits proposals from utility companies, there are no technical screening safeguards which ensure that the submitted designs are climate resilient, integrate the views of both water users and providers on the target islands, and can be operated and sustained after their installation is completed. Output 3.2 aims to establish a systematic screening routine in the MHE which can ensure that every single new water and sewage management proposal in Maldives can be reviewed and improved on the basis of lessons learned from Mahibadhoo, Gadhdhoo and Ihavandhoo.

Activities under Output 3.2. include:

- Synthesize technical and non-technical lessons learned from the project and make them available in a form suitable for practical screening purposes

- Evaluate existing proposals from water utility companies against principles of IWRM and climate resilience, based on lessons learned from the project

- Provide technical assistance to MHE on the design and/or improvement of at least 4 water resource management proposals

- Support the MHE in devising a systematic screening processes for new water supply and wastewater management proposals (training of trainers)

Output 3.3.: *Action plan developed and financing mobilized to replicate integrated, climate-resilient freshwater management on at least 4 additional islands*

The project will undertake a targeted effort to mobilize financing from other sources, using AF funds as leverage to work with private utility companies and development partners to replicate the project approach. Towards this end, a financing and action plan will be elaborated to ensure that the AF-funded project can be expanded into a fully-fledged water management programme that effectively connects with various pilot initiatives in other islands.

<u>Activities under Output 3.3. include:</u>

- Conduct targeted consultations with MHE, utility companies and development partners to define where the project approach should be replicated

- Undertake assessment missions on 4 additional target islands to evaluate the economic, social and technical context for integrated, climate resilient water resources management

- Frame and/or improve a project document for each island for discussion with political authorities and potential financing partners

- Draft and approve a financing plan for 4 additional water resources management projects which are designed and implemented on the basis of lessons learned from this project

B. Describe how the project / programme provides economic, social and environmental benefits, with particular reference to the most vulnerable communities.

In terms of social benefits, the project will provide safe and reliable freshwater supply to 1264 families (comprising 6701 people) who live on the 3 target islands of this project.[5] In relation to data from the updated MDG assessment (UNICEF, WHO; 2010), this represents 24% of all rural Maldivians who are currently dependent on unreliable and unsafe freshwater supply and experience water shortages during dry periods[6]. Through a dedicated Component focused on replication planning and financing (Component 3), the project is aiming to integrate at least 4 additional islands into a resilient water management programme, thereby benefiting at least 50% of all rural Maldivians who live outside the safe water capital zone and don't have access to an improved water source.

As highlighted previously, the target islands under this project do not have integrated water supply/waste water management schemes, and the inhabitants are compelled to rely on uncertain supplies of rain water for their drinking water needs, and polluted ground water for other needs. The lack of reliable rainfall quantities to produce adequate and reliable volumes of safe drinking water, coupled with increased contamination of ground water sources due to improper waste water and sewage disposal, have rendered drinking water unreliable and groundwater supply unhygienic.

[5] Updated calculation based on census data from 2006 (population status and growth rate on each island) and related to rural water supply data provided by the new MDG country report: 'Progress on Sanitation and Drinking Water' (UNICEF, WHO, 2010).

In terms of economic benefits, the project will increase water management efficiency on all 3 densely populated target islands, reducing energy requirements for groundwater extraction and reducing the need to import/transport freshwater from other places. In addition, the project will reduce costs to the public health system from water-borne diseases, which are related to the use of groundwater from over-used and polluted aquifers and rainwater tanks. Recent studies conducted by the Maldives Water and Sanitation Authority (MWSA) showed that over 30% of rainwater tanks and 40% of groundwater wells on a random sample of target islands were faecally contaminated. Comparison of these data and health statistics therefore confirms a direct correlation between unsafe rainwater harvesting and diarrheal diseases. Furthermore, the project will ensure that salinisation of groundwater on the target islands will be effectively reduced, thereby diversifying the different systems of freshwater supply in times of need. This will improve the security of livelihood assets in a changing climate.

Environmental benefits of the project include greater awareness across the country about the sensitive interface between water resources and the health of coral reefs, as well as tangible measures to reduce groundwater pollution and disposal of polluted waste water on sensitive coastal ecosystems.

C. Describe or provide an analysis of the cost-effectiveness of the proposed project / programme.

As discussed previously, the project will provide direct long-term, safe and reliable freshwater supply to 24% of all Maldivians who live outside of the fully serviced capital zone that encompasses Male, Hulhumale and Vilingili. Through a dedicated replication and upscaling plan, the project will aim to systematically increase the group of beneficiaries to at least 50% of all Maldivians who currently rely on unsafe and unreliable freshwater supply. By integrating 30 year planning parameters for population growth, economic growth and expected migratory shifts, the project will maintain water supply efficiency for not only the present, but also future generations. This is considered a critical impact of the AF investment in a country that is extremely vulnerable to climate change impacts and continually more reliant on imports to meet its basic needs.

This project represents a substantive impact for Maldives both in terms of the overall number of beneficiaries served, but also in terms of economic return on investment. Reducing long-term water insecurity in three of the most densely populated islands reduces a number of follow-up investments, including:

- transport and import of freshwater in times of water shortage (at present valued by the MHE at about 2 million USD per year);
- Public health costs from water-borne diseases, resulting from unsafe groundwater and rainwater storage[7];

[7] According to MCST (2002) recent studies conducted by the Maldives Water and Sanitation Authority (MWSA) showed that over 30% of rainwater tanks and 40% of groundwater wells were faecally contaminated. Comparison of these data and health statistics confirms a direct correlation of unsafe rainwater harvesting and diarrheal diseases.

- energy costs for the extraction of groundwater from depleted aquifers; and
- Reconstruction of insufficiently robust rainwater harvesting schemes after extreme weather events

In this context, it is important to mention that at present, thousands of litres of bottled water are imported into Maldives. The 2004 State of Environment report indicates that between 1996 and 2003 there was a sharp increase in the volume of water imported into the country. In 1996, nearly 1.2 million litres of mineral water was imported; In 2003, the volume has jumped close to 6 million litres. With the effects of global warming, this trend is projected to continue in an unabated manner.

Alternative project approaches have been considered, but deemed less cost-effective and beneficial than the proposed course of action. As there are only three major resources of water in Maldives (groundwater, rainwater and desalinated water), a diversified approach that integrates all 3 types was considered the most beneficial both in terms of diversity as well as cost efficiency. An exclusive focus on desalination technology (with an upfront investment of approximately 7 million USD) would have been an alternative to an integrated approach, but such a setup would not yield a number of critical economic benefits: Exclusive, stand-alone desalination would not address rising problems with soil and groundwater salinity (which is relevant for agricultural uses as well); it would not address problems arising from insufficient wastewater management (which is a key problem for public health as well as the integrity of ecosystem services provided by coral reefs); and it would not build on existing capacity that exists with rainwater harvesting technology that is already established in all outer atolls. Considering the benefits of a diversified approach that integrates an optimized mix of technologies in line with the specific context of each target island, it was assessed that the proposed course of action would yield a more sustainable return on investment and greater chances for replication.

In terms of cost-effectiveness, it is important to highlight that the proposed approach integrates readily available, low tech adaptation options such as rainwater harvesting, which can easily be adjusted to allow effective coupling with innovative groundwater recharge, wastewater treatment and desalination technology. Rainwater harvesting does not have a technology entry barrier for the Maldivian market, and can easily be adopted in various shapes and forms to accommodate the requirements of greater robustness and adaptive design.

In addition, the project is treating water as an economic good and prioritizes the principle of community participation and ownership. Users who have been properly involved and trained in integrated water management are much more likely to apply local self-regulation in relation to issues such as water conservation, protection of aquifers, and protection of coastal ecosystems from polluted effluents. In highly decentralized settings such as Maldives, this approach is much more likely to result in policy compliance than central regulation, surveillance and policing.

At the operational level, cost effectiveness of the project concept is reflected through the following characteristics:

- Throughout the project, AF resources will be aligned with the financing and delivery of project Outputs that have competitive procurement components to ensure best value for money. In this regard, the project will apply best practices identified by other, ongoing climate change adaptation projects (including the LDCF-funded project "Integrating Climate Change Risks into Resilient Island Planning").

- The project will undertake a targeted effort to mobilize co-financing for wastewater management-related components of the project. This will diversify financial risks and retain focus on AF funds on activities which correspond to the principle of additionality.
- The bulk of project financing will be directed to community-level activities and connect directly to local opportunities for the procurement of goods and services.

D. Describe how the project / programme is consistent with national or sub-national sustainable development strategies, including, where appropriate, national or sub-national development plans, poverty reduction strategies, national communications, or national adaptation programs of action, or other relevant instruments, where they exist.

The proposed initiative is responsive to the Government of Maldives Strategic Action Plan 2009, the 3rd National Environment Action Plan (NEAP-3, 2009), the National Sustainable Development Strategy (NSDS, 2009) and the National Adaptation Programme of Action (NAPA , 2007).

The National Adaptation Programme of Action of Maldives highlights 2 urgent and immediate adaptation priorities which correspond to the focus of this project:

- 'Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate technologies and improved storage facilities' (NAPA priority 4), and
- 'Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate wastewater treatment technologies' (NAPA priority 5).

The project is therefore fully compliant with 2 adaptation priorities which the Maldivian government has highlighted as urgent and immediate. In addition to the NAPA, integrated water resource management (IWRM) is featuring in various national policy documents, including the first Health Master Plan (1996 -2005). Some of the aspects identified include:

- Provision of sustainable freshwater on cost effective means
- Integrated water resource management and development of such strategies
- Development of water resource conservation strategies
- Establishment of groundwater protection zones on islands through land use plans

Similarly, the first (1989), second (1999) and third (2009) National Environment Action Plan (NEAP) gave emphasis to the importance of integrated water resource management across the country. The measures to manage water sector issues and concerns through the Ministry of Housing and Environment (MHE) are outlined in the following:

Key sector goals:

a. Ensure access to safe drinking water and sanitation as a basic human right
b. Protect and preserve the country's vital freshwater resources
c. Provide legislative support to improve sector performance
d. Strengthen institutional and financial capacity to meet growing needs and challenges
e. Enhance the role of private sector participation in the provision of water and sanitation services
f. Introduce the use of renewable energy and other modern technologies to minimize the cost of providing drinking water and sanitation systems and to protect groundwater.

Key sector policies:

a. Prioritize provision of safe water and sanitation when designing developmental projects
b. Establish effective operation and maintenance procedures for water and sanitation systems in the Maldives
c. Strengthen technical, financial and human resources capacity for water and sanitation sector
d. Facilitate private sector investment in the water and sanitation sector
e. Enhance community and civil society participation in the water and sanitation sector
f. Improve water resource management to preserve environment

Key sector strategies

a. Increase rainwater and desalinated water capacity in the islands;
b. Ensure availability of safe drinking water and establish adequate sanitation systems in the seven regions of the country;
c. Facilitate establishment of water stocks in designated regions of the country for use in emergency or during disasters;
d. Establish a system to manage and maintain the water and sewerage systems already established in islands through local governance systems;
e. Create a business- friendly environment for investing in the sector;
f. Conduct research on wastewater disposal technologies and assess the health and environmental impacts of using treated wastewater for different purposes, including recharging aquifers;
g. Strengthen and enforce protocols, procedures and capacity at water and sanitation regulatory authorities;
h. Enact the Water and Sanitation Act of Maldives;
i. Develop land use plans, taking into consideration the protection of natural freshwater resources;
j. Increase capacity at all levels for monitoring water quality, including establishing island level monitoring capacity;
k. Develop water safety plans for the islands.

In addition, the project is fully aligned with UNDAF Outcome 1: "Communities have access to safe drinking water and adequate sanitation and sustainably manage the natural environment to enhance their livelihoods".

E. Describe how the project / programme meets relevant national technical standards, where applicable.

The project will comply with the following technical standards relevant to freshwater and wasterwater management in Maldives:

- Drinking water guidelines (2006)
- Domestic wastewater guidelines (2006)
- Domestic and commercial effluent standards (2006)
- Guidelines on septic tanks and soakway construction, operation and maintenance (2003)
- Guidelines and manual for rainwater harvesting in Maldives (2009)
- Guidelines on Integrated Water Resources Management

The design of all technical elements under the project will be conducted in such a way to comply with these standards and ensure that there is thorough alignment with existing best practices. With regards to the quality of freshwater provided by this project, the following standards (approved by MHE according to WHO guidance) will apply:

No	Parameter	Unit	Maximum allowable limit
A	**Physical parameters**		
1	Colour		colourless
2	Taste & Odour		Not offensive
3	Turbidity	NTU	Less than 1
4	Electrical conductance	μS/cm	Less than 1500
5	pH		5.0 to 9.5
B	**Chemical parameters**		
1	Free chlorine	Mg/L	0.08 to 0.2
2	Chloride as Cl		Less than 250
3	Nitrates as NO_3		Less than 50
4	Ammonia as N		Less than 1.5

Tab.1: Freshwater standards applied by the proposed project

F. Describe if there is duplication of project / programme with other funding sources, if any.

A review of on-going projects funded by development partners shows that there is no duplication of the proposed project with other funding sources. With regards to NAPA follow-up, the project "Integrating Climate Change Risks into Resilient Island Planning in Maldives", which is jointly funded by the LDCF, UNDP and the Government of Maldives, focuses on coastal protection issues, thereby addressing

NAPA priority 1 ('Integration of Future Climate Change Scenarios in the Safer Island Strategy to Adapt to Sea Level Rise and Extreme Weather Risks Associated with Climate Change') and NAPA priority 2 ('Coastal Protection of Safer Islands to Reduce the Risk from Sea Induced Flooding and Predicted Sea Level Rise'). At present, no projects are under way to address NAPA priority 4 ('Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate technologies and improved storage facilities') and NAPA priority 5 ('Enhance adaptive capacity to manage climate change related risks to fresh water availability by appropriate wastewater treatment technologies'). These NAPA priorities represent the key focus of this project.

During the project formulation process, an assessment was carried out about any complementary development efforts that are currently under way in the target islands of Mahibadhoo (Alifu Dhaalu Atoll), Ihavandhoo (Haa Alifu Atoll) and Gadhdhoo (Gaafu Dhaalu Atoll). All government stakeholders listed under section H of this concept have been consulted, in order to avoid any potential duplication of efforts and geographical coverage. The project development phase has ensured that any initiatives that have been conducted on topics of rain- and groundwater management in the past, such as the work financed by WHO and UNICEF after the 2004 Tsunami, is adequately consulted and integrated into the project approach as appropriate. In doing so, specific benefits are expected with UNICEF in the cross-sharing of awareness materials on rainwater harvesting, waste management and IWRM and in the training of island authorities, atoll authorities and utility companies.

A special effort will be made to coordinate with the GEF-funded project "Implementing Integrated Water Resource and Wastewater Management in Atlantic and Indian Ocean SIDS", which has been submitted to the GEF CEO for endorsement in September 2010. This global project, which will jointly be implemented by UNDP, UNEP and UNOPS, incorporates a technical demonstration component that is aimed at the protection of the freshwater lens of Thoddoo Island from agro-chemical pollution and salinity. The project will employ IWRM principles, and hence provide an ideal interface for coordination and cooperation. The proposed AF project will thereby be able to benefit from inter-regional IWRM networks to share knowledge, experiences and best practices, and draw on a range of relevant awareness materials, training materials and policy guidelines on IWRM.

G. If applicable, describe the learning and knowledge management component to capture and disseminate lessons learned.

As discussed in Part II, Section A of this project concept, the project will employ the following learning tools (applied under Components 2 and 3):

- Local media news items in local language;
- Public & school presentations;
- School field visits;
- Public debates, focus group sessions;
- Water management briefs with industry;
- Water management briefs with tourism resorts and operators;
- Government newsletters;

- Awareness actions for parliamentarians;
- Awareness actions for water utilities;
- Training workshops and short courses for atoll, island and community officials;
- Field excursions and exchange visits between atolls and islands;
- Best practice guidance materials and tools;
- Websites and virtual fora; and
- Email groups and virtual discussion platforms.

Implementation of concrete adaptation actions on the ground will constitute the primary learning experience, which will feed into all awareness, training and knowledge management actions facilitated and conducted by the project. Apart from consultative face to face meetings and interactive events, the project will also prepare brochures, leaflets and posters on the effects of climate change on freshwater resources, and on the relationship between water management practices and the health of the coral reef ecosystem. Existing awareness materials on IWRM will be adopted from existing sources (such as the global project “Implementing Integrated Water Resource and Wastewater Management in Atlantic and Indian Ocean SIDS”, see section F).

H. Describe the consultative process, including the list of stakeholders consulted, undertaken during project preparation.

The scope of this initiative was defined in close consultation with the Minister of Housing and Environment; the Maldives’ Designated National Authority for the Adapation Fund; the UNFCCC focal point; the GEF Focal Point and a range of relevant UN agencies who provided baseline data and assessment information about the target islands (UNOPS, UNICEF, WHO). The initiative is based on analysis and recommendations of a number of official reports and studies, including:

- Draft technical concepts about methods of groundwater recharge, wastewater management and rainwater harvesting that are applicable to the Maldivian context (UNOPS, 2010);
- National IWRM Diagnostic Report (Environmental Protection Agency (EPA), 2010);
- Integrated Water Resource Management Report on 4 selected islands (MWSA, 2001);
- Selected case studies about water Management in Maldives (Mustafa M., 2009).

After approval of the project concept by the AF Board, an assessment mission was conducted in all target islands to confirm assumptions of the project and concretize a number of technical design issues with regards to Component 1 (see Annexes D, E).

The following stakeholders have been consulted in greater detail:

Stakeholders	Roles/Responsibilities
1. Ministry of Housing and Environment (MHE)	Integration of water and sewerage services with new housing development projects; land use planning (relevant for recharge planning).

2. Ministry of Fisheries and Agriculture	Ground water resource management; safe disposal of agricultural pesticides and use of fertilizers; promotion of water conservation practices; use of alternative technologies.
3. Ministry of Finance and Treasury	Resource mobilization and budgeting for public policy delivery
4. Dept. Of National Planning/Statistical Dept	Ensure water and sewerage services are integrated into national plans; collecting and disseminating relevant data.
5. Ministry of Economic Development (Invest Maldives)	Integrates water and sewerage delivery into public-private partnership schemes and facilitates the mobilization of investments for sector needs
6. Ministry of Health	a. Centre for Community Health and Disease Control: Responsible for disease control and improvements of community health b. Maldives Food and Drug Authority: Responsible for quality and safety of imported and locally bottled water.
6. Ministry of Tourism	Facilitates regulation of water and sanitation services by EPA in tourism resorts
7. National Disaster Management Centre	Facilitates provision of water and sanitation services and coordinates with the MHE to ensure water security of islands during emergencies.
8. Ministry of Education (Schools)	Promotes good hygiene practices and ensures provision of safe water and sanitation services to students, also during times of water insecurity.
9. Private Sector	Provides water supply and metering services and improves access to safe water and sanitation in all parts of the country through contractual agreements with provincial utilities' company.
10. Male' Water and Sewerage Company	Delivery of water and sanitation services in Male', and other regions
11. Provincial Utility Companies	Provide utility style water supply, sewerage and electricity services to inhabited islands
12. Island and atoll authorities	Responsible for administrative services of inhabited islands and overseeing the operation/maintenance of public infrastructure
13. Environmental NGOs	Raise public awareness on climate change and environment; Support participative processes; improve environmental awareness
14. UN Agencies: UNOPS, UNICEF, WHO	Providing baseline data and input to field assessment missions. Based on a request by MHE, UNOPS can provide direct implementation support services to component 1 of the project

I. Funding Justification

The following section is a summary of the baseline and additionality reasoning for each project component. They will be further expanded in the full project proposal submitted for final approval by the Adaptation Fund. The full proposal will outline any baseline development activities that are currently financed out of government funds and traditional ODA, and specify the value these initiatives can add to those outcomes that are financed with resources from the Adaptation Fund.

COMPONENT 1: Establishment of integrated, climate-resilient water supply and -management systems in Mahibadhoo, Ihavandhoo and Gadhdhoo

Baseline (without AF resources):

As discussed in previous sections, the three target islands under this project are not equipped with a climate-resilient water supply and wastewater management scheme. Existing rainwater harvesting systems are largely disconnected and sub-optimal in terms of their capacity and yield. Groundwater recharge is absent throughout the islands, and aquifers are saline and heavily polluted from unsecured septic tanks. No desalination capacity is presently available on the target island of HA. Ihavandhoo; ADh. Mahibadhoo and GDh. Gadhdhoo each have desalination capacities of 10 m^3 per day, which is insufficient to satisfy communal water demand in times of drought. At present, the Government of Maldives has to supply bottled water (financed from a national emergency fund) to all 3 islands in dry periods to ensure sufficient freshwater supply. Although the government has undertaken efforts to include these islands into a utility-driven water management scheme, the responses from the private sector to date have not been positive on economic grounds (especially a lack of consistent revenue from communities paying for water management services). As a result, freshwater supply and distribution systems remain ill-conceived in terms of their safety and collection/storage capacity, and are not able to meet the demands imposed by climatic extremes. In combination, the lack of reliable rainfall, increased salinity of soils and groundwater, and contamination of ground water sources with waste effluents are rendering freshwater supply highly unreliable and ground water supply highly unhygienic. Without AF support, the population of Mahibadhoo, Ihavandhoo and Gadhdhoo will not have a reliable supply of safe drinking water in the future. Wastewater effluent and sewerage management projects will fail to protect groundwater as a vital buffer stock for hygienic, agricultural and household purposes. Groundwater salinity will increase, affecting any agricultural use on these islands adversely. Public health will continue to deteriorate in line with current trends of diarrhoeal diseases on outer islands (MoH, 2009). Existing rainwater harvesting systems will remain disconnected, preventing some households from meeting their water needs during the dry season, while other households are still able to cover their needs. In times of drought, potable water will need to be transported from the capital to affected islands, incurring considerable costs to the public budget which could easily be avoided.

Adaptation Alternative (with AF resources):

AF resources will be used to create a diversified, adaptive freshwater supply system in three vulnerable, densely populated islands which is suitable for replication. This system will be characterized by a) increased storage capacity to buffer the effects of less reliable rainfall and lack of new freshwater supply during longer dry periods; b) improved quality and safety of harvested rainwater based on improved collection, treatment and storage systems; c) Improved robustness of interconnected rainwater storage schemes, especially on public buildings; d) Improved production and supply systems for desalinated freshwater; e) improved quality and quantity of freshwater which is stored in the natural aquifer, both in terms of reduced salinity as well as human contaminants; f) reduced contamination of household effluents which are discharged to the environment and would otherwise damage the sensitive reef ecosystem. In their integration, these elements provide a compound solution to a number of critical climate and non-climate-related problems and a suitable model for replication on other islands with similar vulnerabilities.

COMPONENT 2: Increase participation in the development, allocation and monitoring of freshwater use in a changing climate

Baseline (without AF resources):

At present, although the Maldives have made some progress in improving the stakeholder linkages within their water sector (especially between the public sector and private water utilities), linkages between water planners and users are largely fragmented on all inhabited islands. On the three target islands of this project, there are only very few formal or informal linkages between water service providers and water users, and water is not treated as a common social and economic good. As a result, the drive and purpose required for integrated, climate-resilient water resources management is lost and unsupported with dedicated human and financial resources. There are no consultative processes which are able to connect the needs of different water users and their actual willingness to pay for clean freshwater and safe groundwater with utility requirements that would sustain the continued operation and maintenance of integrated water management systems. Although capacity development for environmental management with stakeholders at all levels is a major component of the World Bank-supported Maldives Environment Management Programme (MEMP), there are no plans for in-depth technical training on climate change adaptation. The LDCF-funded project "Integrating Climate Risk into Resilient Island Planning" is the only project currently under implementation that has a fully resourced training and awareness component focusing on coastal zone adaptation. No equivalent capacity development activities are currently undertaken in the water management sector. The project "Implementing Integrated Water Resource and Wastewater Management in Atlantic and Indian Ocean SIDS", which has been submitted to the GEF CEO for endorsement in September 2010, is aiming to strengthen the capacity of government officials to fulfil their role in local, national and regional IWRM processes. As such, it represents a key baseline initiative that the proposed project can build on to create awareness about the interface between climate change and water supply, and about the relationship between IWRM and adaptive management of freshwater resources.

Adaptation alternative (with AF resources):

AF support will enable water users on the target islands to evaluate their freshwater supply needs vis a vis the additional freshwater supply options provided by the proposed project; contribute to the fine-tuning of the proposed integrated water supply systems; and articulate their collective willingness to pay for the continued operation and maintenance of water supply and management services. This will enable the definition of a tariff system which can sustain the continued operation and maintenance of integrated water management systems through government-contracted utility companies. Through this project, political and community representatives across all administrative regions in Maldives will be educated about the impact of climate change on the reliability and quality of freshwater supply, and enabled to consider freshwater as a natural resource which will become much more variable and precious in a changing climate. The importance of maintaining functional and safe rainwater harvesting operations will be emphasized, and communities will be made aware that the flooding of septic tanks and the disposal of untreated wastewater in near shore areas reduces the ability of the reef ecosystem to filter contaminants and buffer against the impacts of extreme weather events. Households will be empowered to participate in integrated water resources planning on their home islands, and encouraged to view water resources as an interconnected economic good that is valuable and needs to be managed jointly rather than individualistically in a changing environment.

COMPONENT 3: Replication and upscaling of climate-resilient freshwater management

Baseline (without AF resources):

Despite the absence of a comprehensive policy on water and sanitation, the provision of safe water and improved sanitation to all Maldivians became a constitutional right in 2008. As a result, the government is undertaking a number of efforts to mobilize financing for desalination plants and develop partnerships with water utility companies to increase the number of islands with safe freshwater supply. Considerations of climate change and the new demands it imposes on the layout of water supply and management systems are not yet integrated in these discussions. The prevailing investment strategy is to meet baseline water supply needs with whichever means possible (both technical and financial). This, in turn, prevents a consistent perspective of integrated and resilient water resource management to be realized in new projects. As a result, the development of water management systems on inhabited islands is still patchy, both in terms of technical approach as well as the consistency of the planning process. With limited participation by different water users and without successful models of adaptive design to draw on, development of freshwater management systems on inhabited islands will continue to display a lack of integration, consistency and resilience in a changing climate.

Adaptation alternative (with AF resources):

With AF resources, Maldives will be able to draw on concrete examples of integrated water resources management which are based on principles of adaptive design and equipped to handle the stresses exerted by a changing climate. As these systems are building on available technology, they are suitable for decentralized planning in remote settings and can be adopted by all types of islands. AF resources will enable exchange programmes between Mahibadhoo, Ihavandhoo, Gadhdhoo and other island authorities to promote mutual learning and transfer experience on how freshwater can be managed in a rapidly changing environment. AF funding will ensure that the planning and rollout of new water management projects is integrating considerations of adaptive design, diversification of freshwater sources and functions that preserve the integrity of the reef ecosystem. Finally, a fully resourced action plan will enable the replication of integrated, climate-resilient freshwater management on at least 4 additional islands.

PART III: IMPLEMENTATION ARRANGEMENTS

A. Project / programme management arrangements.

The Project will be implemented through UNDP's **National Execution Modality (NEX),** with the Ministry of Housing and Environment (MHE) serving as the designated national executing agency ("*Implementing Partner*") of the project. MHE will have the technical and administrative responsibility for applying AF inputs in order to reach the expected Outcomes/Outputs as defined in this project document. MHE is responsible for the timely delivery of project inputs and outputs, and in this context, for the coordination of all other responsible parties, including other line ministries, local government authorities and/or UN agencies.

Upon the request of the Government of Maldives, UNDP will serve as the Multilateral Implementing Agency (MIE) for this project. Services that UNDP will provide to the Implementing Partner in support of achieving project Outcomes are outlined in Annex A. UNDP's services will be provided by staff in the UNDP Country Office (Male), UNDP Asia Pacific Regional Centre (Bangkok) as well as UNDP Headquarters (New York).

A **Project Board** (PB), responsible to approve key management decisions of the project and will play a critical role in assuring the technical quality, financial transparency and overall development impact of the project, will be established as soon as this project is approved. The PB will be composed of designated senior-level representatives of the MHE and other key stakeholders as outlined in Part II/Section H of this project document. A complete list of PB members and their designated alternates will be provided after the project preparation phase has been completed.

The MHE will appoint a **National Project Director** (NPD), who will be designated over the course of the project inception phase. The costs of the NPD role will be borne by the Government of Maldives as in-kind contribution to the project.

National Project Manager (NPM): He/she will be a dedicated professional designated for the duration of the project. The PM's prime responsibility is to ensure that the project produces the results specified in the project document to the required standard of quality and within the specified constraints of time and cost.

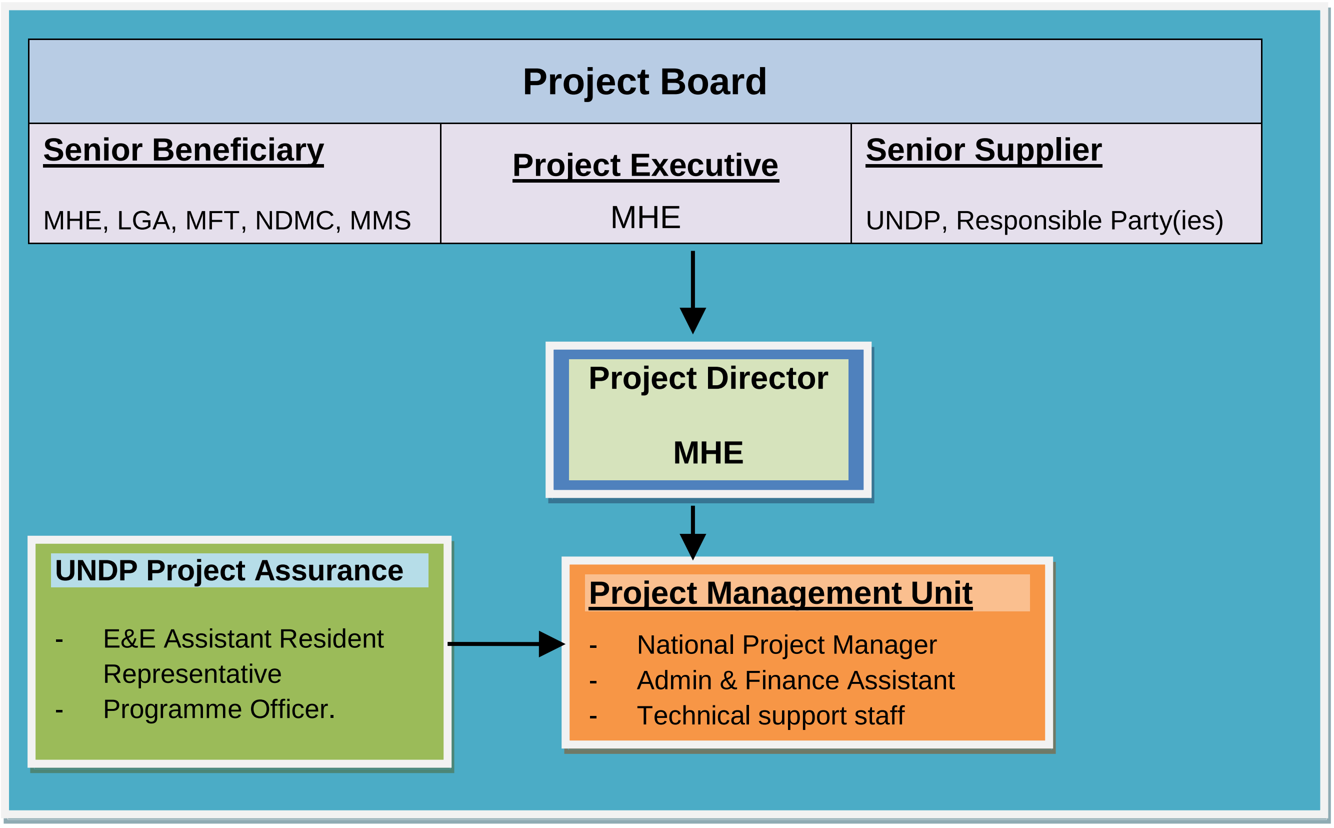
Project-Support: The NPM will be supported by a core team of technical and support staff forming the **Project Implementation Unit** (PIU) located at the MHE to execute project activities, including day-to-day operations of the project, and the overall operational and financial management and reporting. At the target demonstration sites, local coordinators will be recruited to oversee progress of technical project components.

Project assurance: UNDP Maldives will support project implementation by assisting in the monitoring of project budgets and expenditures, contracting project personnel and consultancy services, and subcontracting and procuring equipment at the request of the MHE. On the technical side, UNDP Maldives will monitor progress of project implementation and achievement of project outcomes/outputs as per the endorsed project document. A designated Programme Officer will be assigned in the

Country Office in Male to provide financial and technical monitoring and implementation support services.

To deliver specific Outputs as outlined in the logical framework, MHE can delegate such responsibilities to external partners (to be referred to as *Responsible Parties*) through direct contracting. MHE will bear responsibility for the delivery of those Outputs and put in adequate place measures to oversee such work. MHE has already identified relevant institutions, including UNOPS, for the expedited delivery of urgently required freshwater supply infrastructure on the target islands (relating to Component 1 of the project). Such institutions will be contracted through appropriate modalities (as advised by UNDP). The corresponding Letters of Agreement (LoA) will be annexed to the project document that will be signed between UNDP and the Government of Maldives after the AF project document has been endorsed.

The organigram of the project is as follows:



B. Measures for financial and project / programme risk management.

Key risks underlying the project have been analyzed during the formulation phase in connection with the target sites of the project. Over the course of the project, a UNDP risk log will be regularly updated in intervals of no less than every six months in which critical risks to the project have been identified.

No.	Type	Description	Rating	Risk Mitigating Actions
1	Institutional	Effective engagement and consensus building by different water users, public and private stakeholders to agree on an integrated approach to freshwater and wastewater management	Low	No infrastructure investments on target islands without comprehensive participatory consultations involving island councils, community representatives and utility companies (Output 2.1 to precede Outputs 1.1-1.4)
2	Institutional	Human resources capacity issues (e.g. staff turnover) in different government offices preclude effective engagement of particular stakeholders in the project	Medium	External recruitment of a new NPM to head a Project Management team which is hosted in MHE
3	Environmental	Extreme weather events during project implementation damage construction works;	Medium	Engineering safety plans, contingency plans for construction
4	Institutional	Delays in recruitment of qualified project staff may affect the timeframe of different project activities.	High	At the request of MHE, direct execution of Component 1 by UN to avoid implementation delays
5	Financial	Government is not able to leverage sufficient co-financing to increase and upscale project impact	Medium	UN support in the combination, sequencing and mobilization of climate change financing

B. Monitoring and Evaluation arrangements including a budget of M&E

Project monitoring and evaluation (M&E) will be in accordance with established UNDP procedures and will carried out by the Project team, verified by the MHE and the UNDP Country Office in Male. Dedicated support by the technical adaptation teams in the UNDP Asia-Pacific Regional Center and UNDP New York will be provided on a regular basis. A comprehensive Results Framework of the project will define success indicators for project implementation as well as the respective means of verification. A Monitoring and Evaluation (M&E) system for the project will be established, based on these indicators and means of verification. It is important to note that the Results Framework in Annex B, together with Output indicators, targets and means of verification, will be reconfirmed during the inception phase of the project. Any changes to the Results Framework require approval by the Project Board.

A Project **Inception Workshop** will be conducted within four months of project start up with the full project team, relevant government counterparts, co-financing partners, and UNDP. The Inception Workshop is crucial to building ownership for project results and to plan the first year annual work plan. A fundamental objective of the Inception Workshop will be to present the modalities of project implementation and execution, document mutual agreement for the proposed executive arrangements amongst stakeholders, and assist the project team to understand and take ownership of the project's goals and objectives. Another key objective of the Inception Workshop is to introduce the project team which will support the project during its implementation. An Inception Workshop Report will be prepared and shared with participants to formalize various agreements decided during the meeting.

A UNDP **risk log** will be regularly updated in intervals of no less than every six months in which critical risks to the project have been identified. **Quarterly Progress Reports** will be prepared by the Project team and verified by the Project Board. **Annual Project Reports** will be prepared to monitor progress made since project start and in particular for the previous reporting period. These annual reports include, but are not limited to, reporting on the following:

- Progress made toward project objective and project outcomes - each with indicators, baseline data and end-of-project targets (cumulative);
- Project outputs delivered per project Outcome (annual);
- Lessons learned/good practices;
- Annual expenditure reports;
- Reporting on project risk management.

Government authorities, members of the Project Board and UNDP staff will conduct regular field visits to project sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress.

In terms of financial monitoring, the project team will provide UNDP with certified periodic financial statements. Audits on the project will follow UNDP finance regulations and rules and applicable audit policies. During project implementation, Annual Work Plans (AWP's) and Quarterly Work Plans (QWP's) will be used to refine project delivery targets and realign project work upon consultation and endorsement by the Project Board.

The project will undergo an independent **Mid-Term Evaluation (MTE)** at the mid-point of project implementation, which will determine progress being made toward the achievement of outcomes and identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; highlight issues requiring decisions and actions; and present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for the final half of the project's term. A summative **terminal evaluation** will be conducted 3 months before project closure.

The budgeted M&E plan is as follows:

Type of M&E activity	Responsible Parties	Budget US$ *excluding project team staff time*	Time frame
Inception Workshop (IW)	▪ Project Manager ▪ UNDP CO	4,000	Within 4 months of start up
Inception Report	▪ Project Team ▪ UNDP CO	None	Within 1 month of IW
Measurement of Indicator status / Means of Verification	▪ Project Manager	Included in PMU budget	Start, mid and end-point of project implementation
Annual and Quarterly Progress reviews	▪ Project Team ▪ UNDP-CO	None	Quarterly and Annually
Project Board Meetings	▪ Project Manager ▪ UNDP CO	10,000	At least twice a year
Periodic status reports	▪ Project team	4,000	To be determined by Project team and UNDP CO
Technical reports on specific topics that arise over the course of project implementation	▪ Project team ▪ Consultants as needed	8,000	To be determined by Project Team and UNDP-CO
Mid-term External Evaluation	▪ Project team ▪ UNDP- CO ▪ External Consultants	20,000	At the mid-point of project implementation.
Terminal Report	▪ Project team ▪ UNDP-CO ▪ External Consultant	none	At least 1 month before the end of the project
Audit	▪ UNDP-CO ▪ Project team	8,000	Following UNDP finance regulations and rules
Visits to field sites	▪ Project staff ▪ Government representatives	40,000	At all stages of project implementation
Final Evaluation	▪ Independent external Consultants	20,000	6 months prior to the terminal tripartite review meeting.
TOTAL COST		**114,000**	

D. Project Results Framework Analysis

A detailed Project Results Framework, including quantified Outcome and Output targets as well as specific, measurable and time-bound indicators is provided in Annex B of this project document.

PART IV: ENDORSEMENT BY GOVERNMENT AND CERTIFICATION BY THE IMPLEMENTING ENTITY

A. RECORD OF ENDORSEMENT ON BEHALF OF THE GOVERNMENT[8] *Provide the name and position of the government official and indicate date of endorsement. If this is a regional project/programme, list the endorsing officials all the participating countries. The endorsement letter(s) should be attached as an annex to the project/programme proposal. Please attach the endorsement letter(s) with this template; add as many participating governments if a regional project/programme:*

Dr. Mohamed Shareef Minister of State for Housing and Environment & Designated Authority for the Adaptation Fund Ameenee Magu Male' 20392, Maldives Email: mohamed.shareef@mhte.gov.mv Tel.: +960 300 4300 Cell: +960 7775640	Date: *08 April, 2011*

B. IMPLEMENTING ENTITY CERTIFICATION *Provide the name and signature of the Implementing Entity Coordinator and the date of signature. Provide also the project/programme contact person's name, telephone number and email address*

I certify that this proposal has been prepared in accordance with guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans and subject to the approval by the Adaptation Fund Board, understands that the Implementing Entity will be fully (legally and financially) responsible for the implementation of this project/programme..	
Yannick Glemarec Director, Environmental Finance, UNDP	
Date: April 18, 2011	Tel. and email: +1-212-906-6843; yannick.glemarec@undp.org
Project Contact Person: Gernot Laganda	
Tel. and Email: +66 2288 2644; gernot.laganda@undp.org	

[6.] Each Party shall designate and communicate to the Secretariat the authority that will endorse on behalf of the national government the projects and programmes proposed by the implementing entities.

LIST OF ANNEXES

Annex A – UNDP fees for Support to Adaptation Fund Project

Annex B – Project Results Framework

Annex C – Project Budget

Annex D – Technical Baseline

Annex E – Design Considerations for an Integrated Water Resource Management System

Annex F – Terms of Reference for Project Staff

Annex G – Project Milestones and Disbursement Schedule

ANNEX A

UNDP Fees for Support to Adaptation Fund Project:

Increasing climate resilience through an Integrated Water Resource Management Programme in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo Island (PIMS 4582)

The implementing entity fee will be utilized by UNDP to cover its indirect costs in the provision of general management support and specialized technical support services. The table below provides a breakdown of the estimated costs of providing these services. Any additional Implementation Support Services (ISS) which have been requested by the national entity carrying out the project (MHE) are reflected directly in the project budget.

Category	Services[9] Provided by UNDP[10]	Estimated Cost of Providing Services[11]
Identification, Sourcing and Screening of Ideas	Provide information on substantive issues in adaptation associated with the purpose of the Adaptation Fund (AF). Engage in upstream policy dialogue related to a potential application to the AF. Verify soundness & potential eligibility of identified idea for AF.	$ 35,211
Feasibility Assessment / Due Diligence Review	Provide up-front guidance on converting general idea into a feasible project/programme. Source technical expertise in line with the scope of the project/programme. Verify technical reports and project conceptualization. Provide detailed screening against technical, financial, social and risk criteria and provide statement of likely eligibility against AF requirements. Determination of execution modality and local capacity assessment of the national executing entity. Assist in identifying technical partners. Validate partner technical abilities. Obtain clearances from AF.	$105,634
Development & Preparation	Provide technical support, backstopping and troubleshooting to convert the idea into a technically feasible and operationally viable project/programme. Source technical expertise in line with the scope of the project/programme needs. Verify technical reports and project conceptualization. Verify technical soundness, quality of preparation, and match with AF expectations.	$140,845

[9] This is an indicative list only. Actual services provided may vary and may include additional services not listed here. The level and volume of services provided varies according to need.
[10] Services are delivered through UNDP's global architecture and 3 tier quality control, oversight and technical support system: local country offices; regional technical staff; and headquarters specialists.
[11] The breakdown of estimated costs is indicative only.

Category	Services[9] Provided by UNDP[10]	Estimated Cost of Providing Services[11]
	Negotiate and obtain clearances by AF. Respond to information requests, arrange revisions etc.	
Implementation	Technical support in preparing TORs and verifying expertise for technical positions. Provide technical and operational guidance project teams. Verification of technical validity / match with AF expectations of inception report. Provide technical information as needed to facilitate implementation of the project activities. Provide advisory services as required. Provide technical support, participation as necessary during project activities. Provide troubleshooting support if needed. Provide support and oversight missions as necessary. Provide technical monitoring, progress monitoring, validation and quality assurance throughout. Allocate and monitor Annual Spending Limits based on agreed work plans. Receipt, allocation and reporting to the AFB of financial resources. Oversight and monitoring of AF funds. Return unspent funds to AF.	$316,901
Evaluation and Reporting	Provide technical support in preparing TOR and verify expertise for technical positions involving evaluation and reporting. Participate in briefing / debriefing. Verify technical validity / match with AF expectations of all evaluation and other reports Undertake technical analysis, validate results, compile lessons. Disseminate technical findings	$105,634
Total		***US$ $704,225***

ANNEX B PROJECT RESULTS FRAMEWORK

Project Strategy	Objectively verifiable indicators				
Goal	**To increase the adaptive capacity of Maldivian communities to the adverse effects of a changing climate**				
	Indicator	**Baseline**	**Target**	**Sources of verification**	**Risks and Assumptions**
Objective: **To ensure reliable and safe freshwater supply for Maldivian communities in a changing climate**	Number of Maldivians with safe and reliable freshwater supply in any extreme climatic condition	According to the 2010 MDG assessment for Maldives, 14% of all Maldivians living outside the capital zone lack reliable access to an improved freshwater source and face water shortages during climatic extremes	Integrated water resource management systems on Ihavandhoo, Mahibadhoo and Gadhdhoo provide 24% of all Maldivians who are vulnerable to water shortages and degrading water quality in a changing climate with a reliable supply of safe freshwater	MDG assessment Reports from water utilities and island councils	New island councils ensure continued operation and maintenance of integrated water management systems through water tariffs
			Replication of the project on 4 additional islands provides at least 50% of all Maldivians who are exposed to water shortages and degrading water quality in a changing climate with a reliable supply of safe freshwater	Design and investment plans for freshwater supply and wastewater management schemes Field surveys	The GoM is successful in mobilizing additional public and private financing for project replication

	Indicator	Baseline	Target	Sources of verification	Risks and Assumptions
Outcome 1: **Ground water aquifer protected and freshwater supply ensured in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo to provide reliable, equitable and cost-effective access to safe freshwater in a changing climate**	Number of people living on HA. Ihavandhoo, ADh. Mahibadhoo, and GDh. Gadhdhoo who have uninterrupted access to reliable and safe freshwater supply in extreme climatic conditions	6701 people living on HA. Ihavandhoo, ADh. Mahibadhoo, and GDh. Gadhdhoo are not able to meet their freshwater needs in a highly variable and changing climate. Water needs are met through unreliable supply of rainwater, which is frequently contaminated through insufficiently protected collection and storage systems. Total freshwater collection and storage capacity on each island is insufficient to address water needs during the dry season. Groundwater is highly saline and polluted and unfit for domestic use. Backup desalination systems do not supply the minimum humanitarian water requirements during climatic extremes and disaster events.	100% of the population living on HA. Ihavandhoo, ADh. Mahibadhoo, and GDh. Gadhdhoo will have uninterrupted access to reliable and safe freshwater supply of at least 20 liters per person per day at all times, including during extreme climate events	Reports from utility companies and island councils Field visits	Utility Companies and island communities successfully negotiate operation and maintenance schemes which sustain the provision of clean and safe freshwater

	Indicator	Baseline	Target	Sources of verification	Risks and Assumptions
Output 1.1: Artificial groundwater recharge systems established to protect groundwater resources from salinization and improve aquifer yields in dry seasons	Groundwater quality on each target island	Perception with target population of all islands that due to salinity and pollution, groundwater is unfit for consumption and most household uses. No current data available on the quality of groundwater in target islands Existing groundwater recharge capacity: *Ihavandhoo*: 0 m^3 *Mahibadhoo:* 0 m^3. *Gadhdhoo:* 0 m^3	By the end of the project, the quality of groundwater in each target island has improved to levels that are safe for hygiene and agricultural purposes *Ihavandhoo:* 700 groundwater recharge pits and 30 community recharge wells developed *Gadhdhoo:* 495 groundwater recharge pits and 30 community recharge wells developed; *Mahibadhoo*: 275 groundwater recharge pits and 30 community recharge wells developed	EPA technical tests of water quality Periodic water testing from utility companies and/or island communities Island council report at project competition	Island communities recognize the value of safe groundwater, participate in the regular monitoring of groundwater quality, and ensure proper maintenance of groundwater recharge systems
Output 1.2: Rainwater harvesting schemes redesigned, interconnected and structurally improved to buffer climatic extremes and ensure equal water supply for all households during dry periods	Volume of rainwater collected and stored to supply safe and clean freshwater during dry periods	Existing rainwater harvesting capacity: *Ihavandhoo*: 1,289m^3 (households) + 105m^3 (communal) *Gadhdhoo:* no data (individual systems only) *Mahibadhoo:* no data (individual systems only) Most existing rainwater harvesting systems have insufficient capacities of 2,5 m^3 per household and lack proper disinfection safeguards	Improved rainwater harvesting and storage capacity will be installed as follows: *Ihavandhoo*: 9,000 m^3 *Mahibadhoo:* 6,300 m^3. *Gadhdhoo:* 6,300 m^3 All new rainwater harvesting systems will be equipped with disinfection safeguards to ensure safety of water supply	Field visits Reports from utility companies and island councils	Island councils, community members and utility companies agree on preferred options of centralized vs. decentralized rainwater harvesting and allocate sufficient land for additional storage capacity

	Indicator	Baseline	Target	Sources of verification	Risks and Assumptions
Output 1.3 Production and distribution system for desalinated water supply established	Capacity of desalinated freshwater supply available during dry spells, drought and flooding	Existing capacity to generate freshwater supply from desalination: *Ihavandhoo:* $0m^3$ / day *Gadhdhoo:* $10m^3$ / day *Mahibadhoo*: $10m^3$ / day	The following minimum amounts of desalination capacity will be installed on each target island: *Ihavandhoo*: 90 m^3 *Mahibadhoo:* 60 m^3. *Gadhdhoo:* 60 m^3 Potable water quality levels will be in conformity with WHO standard at all times	Field visits Reports from island councils and utility companies	Utility companies and island communities monitor potable water quality at least twice per year and comply with their assigned responsibility for the maintenance of desalinization systems
Output 1.4 Existing wastewater management systems redesigned and improved to ensure sufficient quantities of safe groundwater during dry periods	Number of planned wastewater management and sewage systems which integrate targeted measures to reduce groundwater pollution	1 sewage treatment plant under construction by a contractor in ADh. Mahibadhoo 1 sewage treatment plant in design phase in HA. Ihavandhoo; 1 sewage treatment plant in design phase in GDh. Gadhdhoo Sea level rise and unsecured septic tanks pollute groundwater and render it unsafe for household uses	All sewage and wastewater management systems which are planned and/or constructed on the 3 target islands integrate targeted measures to reduce groundwater pollution All septic tanks on each target island are cleaned at least twice per year to prevent groundwater pollution from flooding events	EPA technical assessments Sewage and wastewater management design plans prepared by utility companies Island council reports	MHE can ensure that contractors engaged under the current and planned wastewater management projects will integrate project findings into the design of new sewage and wastewater management projects Utility companies and island communities ensure proper maintenance and functioning of wastewater systems

	Indicator	Baseline	Target	Sources of verification	Risks and Assumptions
Outcome 2: **Strengthened local awareness and ownership of integrated, climate-resilient freshwater management systems**	Number of integrated water management systems which are based on participatory planning between water users and water providers and can be sustained in line with actual willingness to pay for operation and maintenance	Willingness to pay for integrated water management services is unknown No participatory planning and design process for water supply and management schemes	Integrated water management systems on all target islands are designed and installed based on community participation, and their operation and maintenance is based on actual willingness to pay	Willingness to pay survey Reports from utility companies Infrastructure maintenance status at the end of the project	Operation and maintenance of IWRM systems can be sustained on the following basis: (Number of households) x (average cost value of willingness to pay) = total running cost of the IWRM system
Output 2.1: Community consultations on each target island ensure participative design, sustainability and continued maintenance of integrated water resource management schemes	Communal willingness to pay for continued operations and maintenance of freshwater supply on each target island	Willingness to pay for integrated water management services is unknown No participatory planning and design process for water supply and management schemes	Integrated water resources management systems on each target island are designed and installed on the basis of community input, and their continued operation is aligned with actual willingness to pay for the operation and maintenance of the installed infrastructure	Willingness to pay survey Reports from Island Councils and utility companies Observations from stakeholder consultations	Utility Companies and island communities successfully negotiate operation and maintenance schemes which sustain the provision of clean and safe freshwater (Number of households) x (average cost value of willingness to pay) = Total running cost of IWRM systems

	Indicator	Baseline	Target	Sources of verification	Risks and Assumptions
Output 2.2: Targeted training events conducted in each region to strengthen water user participation and skills in adaptive, integrated water resource management	Number of Maldivians which are aware about their rights, roles and responsibilities in the management of freshwater resources in a changing climate	Limited awareness across all islands and atolls about the value of water as both an economic as well as social good, which is sensitive to climate-related shocks and stresses and therefore needs to be managed responsibly.	At least 1 IWRM training campaign is conducted in each administrative region (7 total) to strengthen dialogue between water users and providers and increase sensitization about the economic, social and environmental role of water in a changing climate	Training protocols Attendance lists Training materials Feedback forms	Training materials from global IWRM projects can be adopted to support training purposes in Maldives
Outcome 3: **Improved institutional capacity to promote and enforce climate-resilient freshwater management on all inhabited islands**	Number of fully financed follow-up projects which adopt the climate resilient, integrated water resources management approach demonstrated by the project	Maldives has no integrated water resources management project in place that is suitable for replication and upscaling	Project approach is replicated on at least 4 islands	Design and investment plans	The GoM is successful in mobilizing additional public and private financing for project replication
Output 3.1: Training of technicians in the design, operation and management of Integrated Water Resource Management systems	Number of staff from water and sewage utility companies trained in the technical principles and skills required to design, implement and maintain climate-resilient and integrated water management systems	No staff of public or private utility companies in Maldives has received targeted training on IWRM	At least 5 staff from each water and sewage utility company currently active in Maldives are trained in the technical principles of integrated water resource management and recognize basic design principles which make water supply and sewage systems adaptive to a changing climate	Training protocols Attendance lists Training materials Feedback forms	Utility companies recognize the value of the training and designate senior technical staff to participate

	Indicator	Baseline	Target	Sources of verification	Risks and Assumptions
Output 3.2: Institutional mechanisms created to integrate adaptive management of freshwater resources into the design and rollout of new water management projects and schemes	Number of new water and sewage management projects which are reviewed and improved on the basis of lessons learned from the project	Maldives has no adaptive and integrated water resources management project in place that is suitable for replication and upscaling The government is not able to draw on best practices in the adaptive management of freshwater resources	Each new water and wastewater management project that is approved by the Government of Maldives is subject to technical reviews on the basis of IWRM and climate resilience principles	Design plans Expert reviews Government feedback Documented approvals of new projects	Lessons learned and design principles of the project are sufficiently codified to enable use by the Government in the approval and financing of new IWRM projects MHE establishes a systematic review process for new water management projects that integrates lessons learned from the project
Output 3.3 Action plan developed and financing mobilized to replicate integrated, climate-resilient freshwater management on at least 4 additional islands	Financing allocated to new water management projects which integrate climate resilient and integrated design and are approved by the government for implementation	The government is not able to draw on best practices in the adaptive management of freshwater resources to enable systematic planning and financing of additional projects	The government approves at least 4 new, fully financed freshwater and/or wastewater management projects on the basis of lessons learned and design principles replicated from the proposed project	Design plans Documented financial commitments	Financing is mobilized from public and private sources to replicate the project in other sites

ANNEX C

Project Budget

Award ID:	**TBC after AFB approval**
Project ID:	**TBC after AFB approval**
Business unit	**MDV10**
Project title:	**Increasing climate resilience through an Integrated Water Resource Management Programme in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo Island**
Implementing partner	**Ministry of Housing and Environment (MHE)**

Project Outcome/Atlas Activity	Responsible party/ implementing agent	Donor name	Budget description	Year 1	Year 2	Year 3	Year 4	Total (USD)	Cost Description
OUTCOME 1: Ground water aquifer rehabilitated and freshwater supply ensured in HA. Ihavandhoo, ADh. Mahibadhoo and GDh. Gadhdhoo to provide reliable, equitable and cost-effective access to safe freshwater in a changing climate									
Output 1.1 Artificial groundwater recharge systems established to protect groundwater resources from salinization and improve aquifer yields in dry seasons	MHE / Responsible Party	Adaption Fund	Contractual Services	37,357	4,358	500	500	42,715	A
			Materials and Goods	159,435	17,805	2,046	1,050	180,336	B
			In-country logistics	2,408	1,033	400	400	4,241	C
			IT and Communications	800	100	54	50	1,004	D
			Sub-Total Output 1.1	**200,000**	**23,296**	**3,000**	**2,000**	**228,296**	
Output 1.2 Rainwater harvesting schemes redesigned, interconnected and structurally improved to buffer climatic extremes and ensure equal water supply for all households during dry periods			Contractual Services	360,931	316,789	9,946	7,966	695,632	E
			Materials and Goods	1,563,650	1,337,427	22,300	13,458	2,936,835	F
			In-country logistics	36,617	31,455	500	500	69,072	G
			IT and Communications	8,802	7,448	54	50	16,354	H
			Sub-Total Output 1.2	**1,970,000**	**1,693,119**	**32,800**	**21,974**	**3,717,893**	
Output 1.3 Production and distribution system for desalinated water supply established			Contractual Services	423,494	176,350	9,083	7,905	616,832	I
			Materials and Goods	1,823,764	744,519	22,693	13,177	2,604,153	J
			In-country logistics	42,637	17,510	600	500	61,247	K
			IT and Communications	10,105	4,146	150	100	14,501	L
			Sub-Total Output 1.3	**2,300,000**	**942,525**	**32,526**	**21,682**	**3,296,733**	

Output 1.4 Existing wastewater management systems redesigned and improved to ensure sufficient quantities of safe groundwater during dry periods livelihood and infrastructure			Contractual Services	21,000	18,232	18,232	18,232	75,696	M
			In-country logistics	200	413	413	413	1,439	N
			IT and Communications	191	50	50	50	341	O
			Sub-Total Output 1.4	**21,391**	**18,695**	**18,695**	**18,695**	**77,476**	
			Sub Total Outcome 1	***4,491,391***	***2,677,635***	***87,021***	***64,351***	***7,320,398***	
OUTCOME 2: Strengthened local awareness and ownership of integrated, climate-resilient freshwater management systems									
Output 2.1 Community consultations on each target island ensure participative design, sustainability and continued maintenance of integrated water resource management schemes	**MHE**	**Adaption Fund**	Contractual Services	30,000	0	0	0	30,000	P
			Materials and Goods	6,000	0	0	0	6,000	Q
			Travel	34,000	0	0	0	34,000	R
			Sub-Total Output 2.1	**70,000**	**0**	**0**	**0**	**70,000**	
Output 2.2 Targeted training events conducted in all atolls to strengthen water user participation and skills in adaptive, integrated water resource management			Contractual Services	3,000	2,000	1,000	1,000	7,000	S
			Materials and Goods	2,000	2,000	2,000	1,000	7,000	T
			Travel	5,000	6,000	7,000	8,000	26,000	U
			Sub-Total Output 2.2	**10,000**	**10,000**	**10,000**	**10,000**	**40,000**	
			Sub Total Outcome 2	***80,000***	***10,000***	***10,000***	***10,000***	***110,000***	
OUTCOME 3: Improved institutional capacity to promote and enforce climate-resilient freshwater management on all inhabited islands									
Output 3.1 Training of technicians in the design, operation and management of Integrated Water Resource Management systems	**MHE**	**Adaption Fund**	Contractual Services	4,000	3,000	3,000	0	10,000	V
			Materials and Goods	3,000	4,000	3,000	0	10,000	W
			Travel	3,000	3,000	4,000	0	10,000	X
			Sub-Total Output 3.1	**10,000**	**10,000**	**10,000**	**0**	**30,000**	
Output 3.2 Institutional mechanisms created to integrate adaptive management of freshwater resources into the design and rollout of new water management projects and schemes			Contractual Services	0	5,000	0	15,000	20,000	Y
			Travel	0	5,000	0	5,000	10,000	Z
			Sub-Total Output 3.2	**0**	**10,000**	**0**	**20,000**	**30,000**	

Output 3.3 Action plan developed and financing mobilized to replicate integrated, climate-resilient freshwater management on at least 4 additional islands			Contractual Services	0	0	0	10,000	10,000	AA
			Travel	0	0	0	10,000	10,000	BB
			Sub-Total Output 3.3	**0**	**0**	**0**	**20,000**	**20,000**	
			Sub Total Outcome 3	***10,000***	***20,000***	***10,000***	***40,000***	***80,000***	
Project Execution, Monitoring and Evaluation									
Monitoring and Evaluation	**MHE**	**Adaption Fund**	Contractual Services	3,000	24,000	5,000	24,000	56,000	CC
			Materials and Goods	5,000	3,000	5,000	5,000	18,000	DD
			Travel	10,000	10,000	10,000	10,000	40,000	EE
			Sub-Total Monitoring & Evaluation	**18,000**	**37,000**	**20,000**	**39,000**	**114,000**	
Project Management Unit	**MHE / Responsible Party**		Local Technical Staff	66,000	66,000	21,000	21,000	174,000	FF
			Int'l Senior Technical Engineer	105,000	105,000	0	0	210,000	GG
	MHE		PM National Staff	42,000	42,000	42,000	42,000	168,000	HH
			Travel	12,000	12,000	12,000	12,000	48,000	II
			Materials & Goods	3,500	3,500	3,500	3,500	14,000	JJ
			IT and Communications	4,000	4,000	4,000	4,000	16,000	KK
			Miscellaneous	9,949	10,948	1,148	8,557	30,602	LL
			Sub-Total Project Management Unit	**242,449**	**243,448**	**83,648**	**91,057**	**660,602**	
			Sub-Total Project Execution, Monitoring and Evaluation	***260,449***	***280,448***	***103,648***	***130,057***	***774,602***	
			PROJECT TOTAL	**4,841,840**	**2,988,083**	**210,669**	**244,408**	**8,285,000**	

Budget notes:

A.	Contracts for the provision of groundwater provision in the three islands – small contractor for approx. 1555 artificial wells, and Implementation Support Services for procurement, contracting, and logistics
B.	Material cost associated with 1555 artificial wells
C.	Appropriated cost of logistics and transport for equipment and materials for the duration of the project – includes a share of a project boat, and project offices in each island
D.	Communication and IT service costs for the project duration – includes appropriated costs of IT equipment and 10 laptop computers, 4 printer/scanner/fax A4 in island offices, as well as IT and communication consumables
E.	Contracts for the provision of Rainwater harvesting in the three islands – small and medium contractors for the integration of household and community rainwater systems and Implementation Support Services for procurement, contracting, and logistics
F.	Correspondent materials for the integration of rainwater harvesting components of the project
G.	Appropriated cost of logistics and transport for equipment and materials for the duration of the project – includes a share of a project boat, and project offices in each island
H.	Communication and IT service costs for the project duration – includes appropriated costs of IT equipment and 10 laptop computers, 4 printer/scanner/fax A4 in island offices, as well as IT and communication consumables
I.	Contractual services for the provision of the integration of the desalination plant facilities into the island water network and the installation of the desalination plant in the islands, with the correspondent intakes, and related infrastructure and Implementation Support Services for procurement, contracting, and logistics
J.	Correspondent materials for the integration of desalination water sources into the project
K.	Appropriated cost of logistics and transport for equipment and materials for the duration of the project – includes a share of a project boat, and project offices in each island
L.	Communication and IT service costs for the project duration – includes appropriated costs of IT equipment and 10 laptop computers, 4 printer/scanner/fax A4 in island offices, as well as IT and communication consumables
M.	Contractual services related to the pumping of 2 times per year of the septic tanks in each island for 4 years = 24 times; and Implementation Support Services for procurement, contracting, and logistics
N.	Appropriated cost of logistics and transport for equipment and materials for the duration of the project – includes a share of a project boat, and project offices in each island
O.	Communication and IT service costs for the project duration – includes appropriated costs of IT equipment and 10 laptop computers, 4 printer/scanner/fax A4 in island offices, as well as IT and communication consumables
P.	Technical consultations on each target island between MHE representatives, island councils, community members, utility companies and project staff. Includes a questionnaire-based ‘willingness to pay’ survey
Q.	Materials & catering for at least 3 consultations per island
R.	Travel of project staff related to consultations with island councils, government authorities, utility companies
S.	Facilitator/Trainer for IWRM workshops
T.	Workshop materials (1000,- USD per region): Leaflets, brochures, DVDs
U.	Travel costs for workshop participants
V.	Workshop facilitation and resource people (2 workshops)
W.	Training materials (maps, plans, handbooks, water quality testing kits)
X.	Travel support to workshop participants
Y.	Expert review and input to make new water management / wastewater management proposals climate resilient and integrates
Z.	Exposure visits of government officials and private sector representatives to target islands
AA.	Assessment missions to 4 islands for follow-up project design and planning
BB.	Travel costs for assessment missions
CC.	Costs for external mid-term evaluation, terminal evaluation, specialized analytical/technical reports as required
DD.	Materials for Inception workshop and project launch, PB meetings, presentations to CC Council
EE.	Travel & DSA for external evaluators and technical analysts
FF.	1 International Senior IWRM engineer and 1 International Electromechanical Engineer supporting the PMU and the project implementation
GG.	Monitor and Quality Assurance on each island: 3 civil/mechanical engineers in different disciplines (Water-Sanitation); 1 community liaison officer and 1 logistics assistant. One engineer technical project officer in the PMU
HH.	1 National Project Manager (2500 USD per month), 1 Admin & Finance Assistant (1000 USD per month), 1 National Technical Officer
II.	PMU Travel for project monitoring, supervision, participation in technical consultations
JJ.	PMU office consumables
KK.	PMU communication costs (including 2 laptops, 1 fax/printer, cellphone)
LL.	Contingency amount to address currency fluctuations

Cost Estimates for Contractual Services and Equipment on each target island (excluding costs for transport, communication and technical supervision)

Preliminary Cost Estimate for Ihavandhoo Water Supply System-Table 1					
Item	**Description of Item**	**Unit**	**Quantity**	**Unit Rate in US $**	**Amount in US $**
1	Topographic Survey, water quality testing	LS	1	10,000	10,000
2	Construction of Intake Facilities	Nr	1	20,000	20,000
3	Construction of Intake pump house & generator house	Nr	1	50,000	50,000
4	Supply and Installation of Intake pumps (3.75m^3/hr, 10m head)	Nr	2	20,000	40,000
5	Supply & laying of 110mm dia PE Raw water pipe line from Intake to WTP	m	1,000	20	20,000
6	Provision of Desalination Treatment Plant of 90 cum capacity (Supply and installation)	m^3	90	3,700	333,000
7	Supply of 4 x 10 cum capacity CWT	Nr	4	1,250	5,000
8	Construction of clear water pump house	Nr	1	20,000	20,000
9	Supply and Installation of high lift pumps (4.5m^3/hr, 30m head) to convey water to elevated tank	Nr	2	20,000	40,000
10	Construction of elevated tank 30cum, height 20m	m^3	30	1,000	30,000
11	Transmission line to ET, 90mm	m	1500	15	22,500
12	Distribution network with PE pipes of dia. varying from 90mm to 50mm	m	18,000	10	180,000
13	Supply and Installation of Generator 40KVA capacity including panels and necessary cable connections to demand centers	Nr	2	25,000	50,000
14	House connections with water meter	Nr	700	75	52,500
15	Administration Building 1 Nr	m^2	30	600	18,000
16	DI Valves, fittings & accessories	LS	1	40,000	40,000
17	Improvement to household RWH system	Nr	700	460	322,000
18	Improvement to roofs for community RWH system	LS	1	50,000	50,000
19	Transmission pipeline 75mm to TP site	m	5000	15	75,000
20	Low lift pumps	Nr	6	15,000	90,000
21	Solar Panels	Nr	3	85,000	255,000
21	Filtration system	Nr	1	50,000	50,000
22	UV disinfection system	LS	1	2,500	2,500
23	Raw Water storage tank	m^3	9000	79	711,000
24	PE pipe welding plant	Nr	1	50,000	50,000
25	Groundwater recharge	Nr	730	116	84,680
26	Water quality testing equipment kit	Nr	1	400	400
27	Pumping of wastewater from septic tanks	Nr	8	3,000	24,000
				Grand Total	**2,645,580**

Preliminary Cost Estimate for Mahibadhoo Water Supply System: Table – 2					
Item	**Description of Item**	**Unit**	**Quantity**	**Unit Rate in US $**	**Amount in US $**
1	Topographic Survey, water quality testing	LS	1	10,000	10,000
2	Construction of Intake Facilities	Nr	1	20,000	20,000
3	Construction of Intake pump house & generator house	Nr	1	50,000	50,000
4	Supply and Installation of Intake pumps (2.5m^3/hr, 10m head)	Nr	2	20,000	40,000
5	Supply & laying of 90mm dia PE Raw water pipe line from Intake to WTP	m	1,000	20	20,000
6	Provision of Desalination Treatment Plant of 50 cum capacity (Supply and installation)	m^3	50	4,600	230,000
7	Supply of 2 x 10 cum capacity CWT	Nr	2	-	0
8	Construction of clear water pump house and generator house	Nr	1	20,000	20,000
9	Supply and Installation of high lift pumps (3.0m^3/hr, 30m head) to convey water to elevated tank	Nr	2	20,000	40,000
10	Construction of elevated tank 20cum, height 20m	m^3	20	1,000	20,000
11	Transmission line to ET, 90mm	m	1500	15	22,500
12	Distribution network with PE pipes of dia. varying from 90mm to 50mm	m	12,000	10	120,000
13	Supply and Installation of Generator 30KVA capacity including panels and necessary cable connections to demand centers	Nr	2	20,000	40,000
14	House connections with water meter	Nr	275	75	20,625
15	Administration Building 1 Nr	m^2	30	600	18,000
16	DI Valves, fittings & accessories	LS	1	30,000	30,000
17	Improvement to household RWH system	Nr	275	460	126,500
18	Improvement to roofs for community RWH system	LS	1	50,000	50,000
19	Transmission pipeline 75mm to TP site	m	5000	15	75,000
20	Low lift pumps	Nr	6	15,000	90,000
21	Solar Panels	Nr	3	85,000	255,000
21	Filtration system	Nr	1	50,000	50,000
22	UV disinfection system	LS	1	2,500	2,500
23	Raw Water storage tank	m^3	6300	79	497,700
24	PE pipe welding plant	Nr	1	50,000	50,000
25	Upgrading of existing desalination plant	LS	1	50,000	50,000
26	Water quality testing equipment kit	Nr	1	400	400
27	Groundwater recharge	Nr	305	116	35,380
28	Pumping of wastewater from septic tanks	Nr	8	3,000	24,000
				Grand Total	**2,007,605**

Preliminary Cost Estimate for Gadhdhoo Water Supply System: Table – 3					
Item	**Description of Item**	**Unit**	**Quantity**	**Unit Rate in US $**	**Amount in US $**
1	Topographic Survey, water quality testing	LS	1	10,000	10,000
2	Construction of Intake Facilities	Nr	1	20,000	20,000
3	Construction of Intake pump house & generator house	Nr	1	50,000	50,000
4	Supply and Installation of Intake pumps (2.5m^3/hr, 10m head)	Nr	2	20,000	40,000
5	Supply & laying of 90mm dia PE Raw water pipe line from Intake to WTP	m	1,000	20	20,000
6	Provision of Desalination Treatment Plant of 50 cum capacity (Supply and installation)	m^3	50	4,600	230,000
7	Supply of 4 x 10 cum capacity CWT	Nr	4	-	0
8	Construction of clear water pump house and generator house	Nr	1	20,000	20,000
9	Supply and Installation of high lift pumps (3.0m^3/hr, 30m head) to convey water to elevated tank	Nr	2	20,000	40,000
10	Construction of elevated tank 20cum, height 20m	Nr	20	1,000	20,000
11	Transmission line to ET, 90mm	m	1500	15	22,500
12	Distribution network with PE pipes of dia. varying from 90mm to 50mm	m	12,000	10	120,000
13	Supply and Installation of Generator 30KVA capacity including panels and necessary cable connections to demand centers	Nr	2	20,000	40,000
14	House connections with water meter	Nr	495	75	37,125
15	Administration Building 1 Nr	m^2	30	600	18,000
16	DI Valves, fittings & accessories	LS	1	28,959	28,959
17	Improvement to household RWH system	Nr	495	460	227,700
18	Improvement to roofs for community RWH system	LS	1	50,000	50,000
19	Transmission pipeline 75mm to TP site	m	5000	15	75,000
20	Low lift pumps	Nr	6	15,000	90,000
21	Solar Panels	Nr	3	85,000	255,000
21	Filtration system	Nr	1	50,000	50,000
22	UV disinfection system	LS	1	2,500	2,500
23	Raw Water storage tank	m^3	6300	79	497,700
24	PE pipe welding plant	Nr	1	50,000	50,000
25	Upgrading of existing desalination plant	LS	1	50,000	50,000
26	Water quality testing equipment kit	Nr	1	400	400
27	Groundwater recharge	Nr	525	116	60,900
28	Pumping of wastewater from septic tanks	Nr	8	3,000	24,000
				Grand Total	**2,149,784**

ANNEX D

Technical Baseline

A combined team of senior engineers from UNOPS and community development officers from UNDP undertook a field survey visit to all three targeted islands from 14th to 16th March 2011 to reconfirm the physical characteristics of each island, inventorize existing facilities, take stock of immediate requirements of the inhabitants, opinions and views of the islanders, and assess fresh- and wastewater management initiatives which are proposed or currently under implementation.

1. EXISTING FACILITIES

1.1 General

It was confirmed that the most important and urgent priority requirement of the inhabitants in all three islands is access to safe, secure, sustainable and non-interrupted potable pipe-borne water supply. Canvassed inhabitants stated that they are prepared to pay a tariff charged to cover the operational and maintenance costs of the system, this despite economical hardships faced by some. The islanders consulted were fully aware of the quality of the existing groundwater, and that this has been seriously contaminated by salinity intrusion and human waste, due to unsecured septic tanks. Traditional rainwater harvesting is the primary source of drinking water for the inhabitants throughout the year particularly during the rainy season. However, many are unable to store sufficient quantity of rainwater for the prolonged dry season period due to inadequate land space in their individual plots to install large capacity storage tanks. Moreover, they are understandably reluctant to use rainwater stored for a protracted period of time as no facilities are on hand at island level for water quality testing. It was reported that currently the dry period lasts for almost 5 to 6 months and there is a scarcity of safe drinking water during that time.

The current facilities in the three targeted islands, namely potable water supply, wastewater management and groundwater recharge, are very similar. The degree of hardship experienced every year by inhabitants during the prolonged drought periods are also similar. At present, no functional pipe-borne water supply scheme or wastewater treatment system exists in these islands, and the inhabitants are obliged to rely on traditional rainwater harvesting techniques for their drinking and cooking water requirements. Inhabitants use contaminated shallow groundwater for other domestic water needs such as washing of clothes and bathing. Imported and locally produced bottled-water is extensively utilized for drinking and cooking, particularly during dry season, as reported by the inhabitants during the site visit.

The rainwater harvesting system adopted for isolated islands of the Maldives as a primary source for drinking water is an acceptable low-cost solution with proven to provide good quality water, if the system is maintained regularly to acceptable standards. The 2,500litres capacity PE storage tanks commonly available to the islanders was reported by inhabitants during the site visit to be insufficient to cover the entire dry period for a standard size family to cater for drinking, cooking, etc. In Ihavandhoo, current figures provided by the MHE indicate that a total storage capacity on the island of approximately 134 m3. The total roof area of privately owned buildings is 19,483m2 and 611m2 for public buildings. Comparable information is currently being collated for Mahibadhoo and Gadhdhoo.

The inhabitants on all three islands are currently experiencing difficulties in storing large quantities of water in a small plot of land for utilization during a prolonged dry period of four to six months period. In addition, inhabitants are reluctant to drink water stored for a prolonged period of time as no disinfection facilities have been incorporated in the rainwater harvesting system. Furthermore, this is compounded by the lack of water quality testing equipment at island level. These three densely populated islands have been experiencing a significant potable water crisis and serious sanitation issues due to lack of available quality water as well as a proper wastewater disposal system. This has not only exposed these communities and their children to communicable diseases such as diarrhea, typhoid etc. which in turn may lead to other socio-economic effects such as loss of income, poor work turnouts, etc. in the long run.

1.2 Household Rainwater Harvesting

In the Maldives, rainwater collection is a generations old tradition which can be traced back to 3,000 years ago and has been a longstanding means of collecting high-quality water for domestic, drinking, agricultural and other uses. Maldives used to receive relatively regular and substantial rainfall amounts, however in the recent past declining and erratic rainfall patterns have become a major cause for concern, as reported by MHE officials. Despite experiencing substantial seasonal rainfall across all islands, inhabitants are becoming more and more reluctant to collect rainwater during the rainy season for year round consumption, due to the lack of large volume storage facilities needed for such a purpose. The cost of such large capacity storage tanks is high and it is technically complex to install such a tank on a small plot of land provided to each family.

1.2.1 Maintenance of Rainwater Harvesting System

The rainwater harvesting system, installed by island communities, is a traditional one and no effort has been made to upgrade the system to reflect recent innovations such as the incorporation of disinfection facilities with easily installable UV-ray and other components such as leaf guard, leaf screen, roof washer tank, etc. The removal of tree branches over-hanging the water capture area is not practiced regularly. Installation of a small on-demand in-line pump is very valuable as the water could be made to flow automatically into the water taps installed at each house for maximum convenience.

The first-flush diverter concept is practiced extensively, but without any systematic monitoring of the quantity of water diverted on each occasion. Thus, some important modifications have to be incorporated into the traditional household rainwater harvesting system with a view to improving water quality and maximizing expediency.

1.3 Groundwater

The freshwater lens is available on all three targeted islands, lying 1.0 to 2.0 meters beneath the existing ground surface in the coral that makes up the islands. A limited quantity is sandwiched between saline water below and human waste above. The proximity of groundwater to the land surface, and the porous nature of the sandy soil, makes it highly susceptible to pollution and contamination from human activities and saltwater intrusion. Most islander households use individual septic tanks that are poorly built and maintained. This has led to untreated sewage infiltrating and polluting the shallow fresh groundwater by seepage and leaching. Thus, all three islands groundwater has been severely contaminated by human waste. The contaminated groundwater is extensively used by the island community for bathing, washing of clothes, flushing of toilets, etc. Usage of contaminated groundwater for bathing and washing of clothes, presents a health hazard to inhabitants.

1.4 Desalinated Water Supply

Identical membrane reverse osmosis desalinization plants, with a production capacity of 10 m^3 per day each, have been installed aftermath of the 2004 Indian Ocean Tsunami in Mahibadhoo and Gadhdhoo.

The installation of these two plants was completed in 2006 / 2007 by the International Red Cross Federation and handed over to the respective communities. These plants have not been functional for more than a year due to several technical reasons. These include the non-availability of spare parts in the country, intake clogging, insufficient funds to cover operation and maintenance costs, etc. The desalinated water has been delivered to consumers through public standpipes for two hours each day whenever the plant is in operation. The average monthly energy cost for operating the plant for 8 hours a day is estimated at about MVR 30,000.00 (approximately USD 2,345.00), according to local sources

1.4.1 Mahibadhoo Desalination Plant

The desalination plant at this island is not in operation at present due to a problem associated with the intake pump. This pump has since repaired and the plant is ready to resume operations. An OD 75mm PE pipeline has been laid along the main road of the island from the desalination plant as a trunk main. A total of seven (07) public standpipes have been installed at different locations within the island with 25mm diameter branch pipelines. Water has been supplied to consumers between 16.00hrs and 18.00 hrs whenever the plant is in operation. The facilities incorporated in this water supply system are as follows:

- 10 m^3/day capacity RO desalination plant complete - 01 Nr
- Clearwater storage tanks, 10,000 litres capacity - 02 Nr
- Public standpipes - 07 Nr
- Recommended minimum quantity per capita consumption - 20litres
- Maximum quantity of water available per day - 10 m^3
- Minimum water demand / day (2,110 x 20/1000) - 42 m^3

The power required for the operation of the plant has been supplied by the island power station and no tariff is collected at present for the supply of water. No standby provision is available for almost all pumps except for the high lift installed at the desalination plant. The transmission pipelines already laid for the present water supply system will be incorporated into the new project wherever feasible.

1.4.2 Gadhdhoo Desalination Plant

The desalination plant at this island is not in operation at present due to a problem associated with its intake facility. The degree of salinity at its intake appears to be high at times for the plant to operate effectively. Modifications to the intake are necessary to resolve this problem, according to the plant operator. An OD 90mm PE pipeline has been laid along the main road of the island from the desalination plant as a trunk main and ten (10) public standpipes have been installed at different locations within the island with 25mm diameter branch pipelines. Water is issued to consumers between 16.00hrs and 18.00 hrs whenever the plant is in operation. The facilities incorporated into this water supply system are as follows:

- 10 m^3/day capacity RO desalination plant complete - 01 Nr
- Clearwater storage tanks, 10,000 litres capacity - 04 Nr
- Public standpipes - 10 Nr
- Minimum quantity per capita consumption - 20litres
- Maximum quantity of water available per day - 10 m^3
- Minimum water demand / day (2,850 x 20/1000) - 57 m^3
- RWH storage tank, 5,000 litres capacity - 06 Nr

The power required for the operation of the plant has been supplied by the island power station and no tariff is collected at present for the supply of water. No standby provision is available for almost all pumps, except for high lift installed at the desalination plant. The transmission pipelines already laid for the present water supply system will be incorporated into the new project whenever feasible.

1.5 Wastewater Treatment

The safe disposal of domestic and municipal wastewater / sewage to the environment in densely populated communities, always posed a challenge in the past, prior to the introduction of septic tanks. Though the septic tanks are an acceptable means of safe discharge of wastewater / sewerage to the environment, the improper use of septic tanks (which discharge untreated or partially treated effluents) may cause potentially hazardous environmental effects to the communities, risking an increased spread of communicable diseases such as cholera, diarrhea, typhoid, etc. Moreover, the use of septic tanks to dispose wastewater / sewage safely in an area housing a high-density population can pose a serious challenge and may often lead to serious pollution of groundwater sources to such an extent that it can no longer be used to meet the water needs of the communities.

Remote islands in the Maldives are no exception to the above phenomena, and the groundwater sources in such islands have been badly deteriorated and become unfit for any domestic purpose due to contamination from sewage and salinity intrusion. Therefore, it has become imperative to find a durable and sustainable treatment process to dispose wastewater/ sewage generated by the communities in these islands to the environment with safe BOD and COD levels. Functional wastewater treatment facilities are not in existence in any of the three targeted islands at present and sewage is discharged into unsecured and poorly built septic tanks that are prone to leaking and leaching into the shallow groundwater aquifer.

2.5.1 Mahibadhoo Sewage Treatment Plant (STP)

A new wastewater treatment plant is currently under construction at Mahibadhoo by an international contractor “Shin Nippon Air Technologies Co. limited” at an estimated cost of US$ 4.3 million due to be completed by September 2011. A gravity wastewater conveyance system with three dedicated pumping stations has been planned for transmission of sewage. The depth of pipelines below the ground level is limited to a maximum of 2.0m in view of the shallow ground water table and the minimum depth of the pipeline is about 0.5m to create anticipated gravity flow. µPVC pipes have been used for the gravity conveyance pipelines while PE pipes have been used for the pressure lines.

In addition, the treated sludge from the STP will be deposited by pumping into the sludge drying beds located near the plants and naturally composted with the bio - degradable waste on the islands. Humus generated from this composting process will be utilized to improve soil conditions on the islands and to promote and increase agriculture and home gardens. The quality of effluent anticipated from the anaerobic / aerobic sewage treatment system is in excess of BOD $\geq$ 20 and cannot be utilized for the watering of plants and recharging of ground water in the islands. Thus, it has been planned to safely discharge effluent into the brackish water at the periphery of the island with a suitably constructed outfall structure. It would be possible to improve the quality of the effluent in the future with additional secondary and tertiary treatment of the wastewater.

The µPVC pipes used for the gravity conveyance system are likely to crack under heavy loads and are prone to leak through the socket and spigot type joints. In consideration of this situation, UNOPS would use PE pipes for the new water supply transmission and distribution network in Mahibadhoo.

1.5.2 Ihavandhoo and Gadhdhoo STP

Government of Maldives MoHE officials confirmed that similar wastewater treatment plants have been planned for Ihavandhoo and Gadhdhoo and the engineering designs have been already completed with implementation anticipated in the near future. The estimated cost of each plant is about US$ 6.0million.

In consideration of the prevailing groundwater situation, the construction of wastewater treatment plants for the three targeted islands are in the pipeline and will be financed by other means. Hence, and to avoid unwarranted duplication of efforts, no action is required under this project for this particular component. However some specific activities are required and will be undertaken through this project to integrate cleaning mechanisms to improve groundwater pollution, and ensure synergies between the operation of freshwater management and wastewater management systems.

1.6 Groundwater Recharge

The coastal areas of the targeted islands are very fragile and continuously threatened by migration of sea water inwards and saline water intrusion into the shallow freshwater aquifer, primarily due to over exploitation. In addition, leaking wastewater from household septic tanks contaminates the scarce groundwater source.

No concrete initiatives have been taken to artificially recharge the ground water to reduce the likely ground water pollution by saline water and wastewater. Only natural groundwater replenishment and recharging is occurring during each rainy season at present.

ANNEX E

Design Considerations for an Integrated Water Resource Management System on Ihavandhoo, Mahibadhoo and Gadhdhoo

1. General

The traditional rainwater harvesting system extensively practiced on all three targeted islands as a primary source for potable water supply is becoming more and more unpredictable due to changes in rainfall patterns. Thus, identifying an alternate fully independent option for the supply of drinking water is imperative. A relatively expensive option is desalination, both in terms of fuel consumption cost, and high carbon emissions if desalination plants are run by diesel generators as opposed to solar or wind power. Under this scenario, UNOPS proposes to resolve this acute shortage of potable water by tapping all available avenues with a view to minimizing the overall production cost and environmental risk with a view to cutting carbon emissions. The economically viable approach of a combined water supply system within the context of fully Integrated Water Resource Management (IWRM) consists of the following list of sources:

- Community-based rainwater harvesting system
- Modernized household rainwater harvesting system
- Desalination Plant to supply the minimum water requirement only in critical situations

It is not intended that desalination plants become the primary source of potable water. That said, all potable water supplied by the three independent systems recommended above would be directly connected to each household to reach the overall aim of providing a safe and sustainable pipe-borne water supply system operational around the clock. The selection of a particular source for operations at any given time largely depends on the judgment of the operators and house owners. Ideally, the least expensive household rainwater harvesting system should be in operation during the rainy season and beyond, whilst moderately costly community-based rainwater harvesting should commence operations immediately after the rainy season has finished, supplemented by the more expensive desalinated water.

2. Design Standards

It is important to select an appropriate design horizon in the planning and design of any infrastructure project. In consideration of the Maldivian context and the nature and magnitude of municipal infrastructure, this comprises a considerable amount of electromechanical equipment that having a lifespan of not more than 20 years. Thus, it is appropriate to design an IWRM system for a midterm period of 20 years with the option to expand it in the future.

2.1 Water Supply

The system will be designed in a manner to provide sustainable potable water to the consumers within the supply area on a continuous basis under normal circumstances. The system in general will comply with the following conditions:

- All inclusive consumption rates per person from each house connection are expected to vary between 20 and 45 litres per day.

- Non Revenue Water (NRW) shall be limited to 5% for these new water supply schemes.
- No public standpipes to be provided as 100% house connections envisaged. Commercial and industrial demand to be determined for each scheme individually as a percentage of population water demand in conjunction with local trends, development patterns and historical records.
- Service coverage ratio will be 100% on completion of the project.
- Pumping efficiency will be in the region of 50% to 75%.
- Bulk water meters will be installed at all strategic locations including raw water, treated water and reservoir outlets.

2.2. Pipelines

The design concept adopted for sizing the pipes for raw water transmission, treated water transmission, distribution network etc. will be generally in compliance with the provisions set out by local specifications and other internationally recognized standards.

Hazen Williams Pipeline Friction Factor (C) for various pipe materials are given below:

- DI pipe (mortar lined): New - 130
  Old - 120
- PVC pipe: New - 140
  Old - 130
- PE pipe: New - 150
  Old - 150
- Velocity of liquid flow in pumping main will be limited to 1.5m/s.
- Losses at fittings and specials would be either computed separately item by item or allowed as an overall percentage of 10 for DI, PVC and PE pipe materials.
- The size of the washout pipe will be between 1/3 and 1/6 of the diameter of the main transmission pipe.
- The normal depth of earth cover for the pipeline will be maintained at a minimum of 0.5m for 50mm diameter and increased further for larger pipes according to local standards.
- Transmission pipeline capacity will be 1.20 times the daily average production capacity for the year 2030.
- Distribution pipeline capacity will be 2.0 times the daily average flow capacity for the year 2030 to allow for the peak hourly flow.
- Residual pressure head at connections to distribution mains will be a minimum of 10m.

2.3 Storage Reservoirs

Service reservoirs in the form of elevated towers or ground level tanks have to be provided in the vicinity of the supply area at the highest ground elevation to minimize construction costs. The shape of reservoirs will be determined taking into account site conditions and cost. In consideration of the low-lying flat nature of the islands in question, an elevated tank is required for the proper distribution of water by gravity, with sufficient residual pressure. A maximum pressure of three bars would be allowed for in this project with a minimum pressure of one bar.

- A minimum reservoir storage capacity of at least 30% of the daily average demand for the year 2030 including that of the clear water tank would be provided to account for the variable demands from the consumers.
- The storage capacity of the elevated tank shall be limited to 20% of the daily average demand for the year 2030 due to the high cost of construction.

- A dedicated transmission main for each service storage reservoir will be provided, if economically viable.

The reservoir types of foundation, either pad or raft, will be determined based on the results of the geotechnical investigations. The inlet, outlet, overflow and drain pipes will be provided for the tank. Service access to the tank will be incorporated for maintenance purposes.

3. Area of Coverage

The shallow groundwater sources available for the inhabitants of these islands have been completely contaminated by the intrusion of saline water and leaking from poorly constructed septic tanks. Hence, a larger section of the population within the supply areas needs to be provided with potable water from the proposed water supply systems. The coverage area will be 100% and the minimum per capita consumption will be limited to 20 litres initially and gradually increased to 45 litres by 2030, as described into the proposed strategy below.

3.1. Raw Water Source

Identification of the most appropriate and reliable raw water source of acceptable quality, adequacy in quantity and optimal distance from the service area is of paramount importance to the development of any cost-effective water supply system. Since the availability of surface water is virtually non-existent in these islands and ground water is contaminated with salinity intrusion and fecal coli-forms, the use of such sources for treatment cannot be considered favorably. In this context, the treatment of rainwater collected through household / community level rainwater harvesting systems, supplemented by the use of combined sea water desalination treatment through reverse osmosis process are considered advantageous.

Desalination has been in use successfully and is seen as a favorable option in bigger and more populated islands such as the capital Male', Hulhumale', Villinigili and some tourists' resorts in the Maldives during last decade due to the abundance of available seawater. The high energy costs and hi-tech operation of such plants make desalination an unfavorable option for small and remote communities. While desalination plants can provide the minimum potable water requirement in all conditions, the maximum exploitation of low-cost and hassle-free rainwater harvesting in the targeted islands will be the main focus of the project. Rainwater harvesting is a more environmentally sound option that protracted over reliance on desalination plants with their inherent high running costs and problematic ongoing maintenance challenges.

3.2. Population Forecast and Water Demand

The daily production capacity of the proposed water supply system is primarily influenced by the projected population and the corresponding daily water usage pattern of the affected community. The actual population of the targeted islands for the year of 2000 and 2006 (census) has been obtained from the Department of National Planning (DNP). The project population of each selected island has been computed and presented below using the formula: $[P_n = P_o(1+R/100)^{n-1}]$

Where	P_n	-	Population after n years
	P_0	-	Population of base year
	R	-	Annual population growth
	N	-	Period

	Ihavandhoo	Mahibadhoo	Gadhdhoo
Population 2000	2062	1714	1701
Population 2006 (census)	2447	1780	1439
Growth rate %	2.840	0.630	(2.78)
Growth rate % (Design)	2.500	1.750	1.750

Island	**Growth Rate in %**	**Actual Population**		**Projected Population**				
		2000	**2006**	**2011**	**2015**	**2020**	**2025**	**2030**
Ihavandhoo	2.50	2062	2447	2640	2914	3296	3730	4220
Mahibadhoo	1.75	1714	1780	2038	2185	2383	2599	2835
Gadhdhoo	1.75	1701	1439	2023	2169	2365	2580	2813
Consumer Demand = 45 litres per day				**Total Water Demand in** m^3				
Ihavandhoo				119	131	148	168	190
Mahibadhoo				92	98	107	117	128
Gadhdhoo				91	98	106	116	127
Consumer Minimum Demand = 20 lit per day				**Minimum Demand - Desalination Plant**				
Ihavandhoo				53	58	66	75	85
Mahibadhoo				41	44	48	52	57
Gadhdhoo				41	44	47	52	57

Based on the computation shown in the table above, the capacity of the proposed system for each island per day will be as follows:

	Ihavandhoo	Mahibadhoo	Gadhdhoo
Required Desalination Plant	90.0	60.0	60.0
Capacity of existing plant	00.0	10.0	10.0
Capacity of the proposed new plant	90.0	50.0	50.0

Consequently, the remaining potable water supply requirement shall be met from the community based rainwater harvesting system.

	Ihavandhoo	Mahibadhoo	Gadhdhoo
Community RWH system	100.0	70.0	70.0

Conflicting data from different sources on population figures for Gadhdhoo has emerged during preliminary research, thus further investigation is recommended during the detailed design stage to accurately determine the actual and projected population figures for this island.

4. *Water Treatment Facilities - Desalination Plant*

The desalination plant capacity of the proposed water supply schemes for the targeted three islands Ihavandhoo, Mahibadhoo and Gadhdhoo is based on a design horizon of the year 2030. A limited usage of potable water is estimated at 90 m^3, 60 m^3 and 60 m^3 respectively each day. The plant capacity will be designed to produce 3.75/ 2.5 m^3/hour of fully treated water. The initial daily operating time of the plant is estimated at about 14 to 16 hours in the year 2011 and gradually increases to 24 hours by the year 2030. The saline water required for the production of drinking water has to be obtained from the ocean or brackish lagoon or beach wells. The cost of desalination plant is significantly impacted by the degree of water salinity. Hence, the location of the water abstraction point has to be carefully determined based on detailed investigation and appropriate laboratory water quality analysis.

Desalination plants using different technologies such as multi-stage flash distillation (thermal distillation), membrane process, ion exchange, freezing, etc. are available on the international market. Membrane technology-based desalination plants consume relatively little energy for the amount of water produced. The optimum cost (capital investment and energy consumption) for an effective desalination plant has to be identified for this project during the detailed design stage. The proposed desalination treatment process of the systems [90 m^3/day and 60 m^3/day] comprises the following major components of works:

- Intake works
- Raw water pumps to transmit water to the desalination plant (abstraction velocity shall be about 0.10m/s to facilitate fish escape, if direct abstraction from ocean or lagoon is opted for)
- Raw water conveyance main of OD 110mm / 90mm PN 10, PE 100 pipe (based on low velocity abstraction) of about 1,000 m long
- Desalination plant of production capacity 3.75 / 2.50 m^3/hour (maximum 24 hrs of operation)
- 40 /30 m^3 capacity of clear water tank
- Clear water pump house and generator house (standby provision)
- Variable speed pumps with standby provision for direct pumping to supply area [or alternatively 30 / 20 m^3 capacity elevated storage tank, 1.5km of OD 90mm PN6 PE80 pumping main and standard centrifugal pump with standby provision for gravity distribution]
- Standby generator
- Concentrated safe wastewater disposal system
- Distribution system of pipe sizes varying from 90mm to 50mm PE 80, PN 6 pipes of about 18 / 12 km length
- Administrative building for operations and maintenance

Approximately 3.70 kWh of energy is required daily to run the desalination plant to produce one m^3/day of drinking water. The required power supply has to be obtained from the island power supply with provision for a standby generator.

5. *Water Treatment Facilities – Rainwater Harvesting (RWH)*

Following an IWRM approach, the project will work closely with local authorities and utility companies to ensure that the rainwater harvesting scheme and groundwater recharging activities are linked directly with provision for safe disposal of wastewater. The project recommends rainwater harvesting systems as the most feasible cost effective solution for isolated island communities in Maldives. This is a consumer friendly and acceptable option already used by inhabitants. Thus the project will advocate for a rainwater harvesting system as the primary option for supply of potable water with a desalination plant in addition as a supplementary measure to ensure potable water security. Two possible rainwater harvesting systems could be considered for this project:

- o Individual household system
- o Community-based centralized system

Household rainwater harvesting is extensively practiced in the targeted islands and the improvements needed to this existing system will be discussed in more detail separately.

5.1. Community-Based Centralized System

The community-based centralized rainwater harvesting system is an essential extension of the traditional household system, but with operations and maintenance carried out by properly trained personnel. Rainwater will be collected from selected buildings (schools, mosques, clubs, community centers, hospital, council houses, etc.) with a large roof area covered with apposite roof materials, an economic distance from the water treatment area, etc. All rainwater transmitted to the central treatment area will be subject to sand filtration / activated carbon, disinfection and dispensed to consumers through a distribution network to individual households. The quality of water produced at the centralized water treatment plant is expected to be very high and to conform to WHO standard at all times with the close monitoring of all components of the system including roof catchment area by operating and maintenance staff.

The total requirement of water for 90 days of continuous dry period shall be approximately (100 x 90 = 9,000) 9,000 m3 for Ihavandhoo and (70 x 90 = 6,300) 6,300 m3 for the other two islands of Mahibadhoo and Gadhdhoo. This requirement may need to be adjusted during the design period if required based on the actual population forecast.

5.2. Catchment Area

It is reasonable to assume that the improved household rainwater harvesting system would be used exclusively by the islanders during the rainy season and rainwater harvesting from the centralized system is needed only during the estimated dry period of up to 90 days. Thus the roof area required to capture rainwater for the dry period consumption could be estimated from the formulae Q = CIA, where,

Q	=	Total rainfall volume
I	=	Rainfall
A	=	Roof area
C	=	Run off coefficient (this is taken as 0.85)

Roof area required for Ihavandhoo	A = 9,000 / 1.407 / 0.85 = 6,400m^2
Roof area required for the other 2 islands	A = 6,300 / 2.124 / 0.85 = 3,490m^2

Any excess water must be channeled through the groundwater recharge system (filtered pits/well/infiltration) introduced by the project as much as possible at pre-determined times to improve the groundwater quality and increase its quantity.

The public buildings managed by central and local governments with large roof catchment areas have to be identified for collection of rainwater at 3 to 4 locations based on the Islands available infrastructure facilities. These collection points shall be interconnected and water pumped to the central treatment plant and subjected to filtration and disinfection. Both desalination and community based rainwater treatment systems shall be located at the same place for ease of operations. A major challenge posed by this system is the provision of a large cost effective raw water storage facility at a suitable location/s.

The sedimentation or clarification process is usually incorporated in conventional water treatment system for the separation and removal of larger solid particles from the raw water. The raw water turbidity during this process is anticipated to decline well below 10 NTU in order to maximize the benefits of filtration. The rainwater utilized for this project would not have any heavy sediment and hence clarification process is not required. Filtration is the most essential component of the water treatment process and the final solid-liquid separation stage. The rainwater collected from the roof is anticipated to contain some finer suspended solid matters with an average turbidity level of less than 5 NTU and it has to be removed during the filtration process. Rapid gravity sand filtration system has not been considered for this project due to its complexity in the backwashing process. Slow sand filter or other more advanced filters such as a dyna-sand filter will be evaluated during the detailed design stage for incorporation.

5.3. Transmission System

The transmission pumping main of OD 90mm PN6 PE 80 pipeline running about 1.5km long may have to be laid from the treatment plant site to the elevated tank provided a gravity distribution system is adopted for the project. Similarly, OD 75mm PN6 PE80 pipeline of about 5km may be required for the conveyance of raw water from rainwater harvesting storage tanks to the treatment plant site.

The single largest and most expensive component of the water supply system is the provision of large capacity storage tanks for raw water produced from rainwater harvesting. It is proposed that raw water storage tanks are provided in steel or HDPE prefabricated tanks. This will not only reduce the project’s construction costs but saves substantial time frame during implementation. Other available options such as ferro-cement, buried hume pipes, etc. will be evaluated during detailed design stage.

5.4. Disinfection

The need to disinfect the final treated water before distributing to the consumers cannot be overemphasized. Some of the current technical approaches available to provide effective drinking water disinfection techniques are highlighted below:

- Chlorine is the most commonly used disinfectant as it treats larger organisms and offers residual chlorine to cater for the tail end of the distribution system disinfection, but can be expensive with its need for a specially trained operator; and its environmentally detrimental supply chain of a potentially hazardous material;
- Boiling water over a biomass cook-stove, the most well known and reliable treatment method, demands labor, and imposes high economic, environmental, and human health costs.
- UV rays disinfection

It is proposed that the proven cost-effective UV rays disinfection system will be used for this project to disinfect final water. The disinfection location shall be as close as possible to the consumers and preferably at the elevated reservoir outlet point.

5.5. Distribution Network

Potable water produced at the treatment plant (desalination and/or rainwater harvesting) will be transmitted to the elevated water storage tank located at the center of the island for subsequent gravity distribution to consumers. Alternatively, the pumping of water from the treatment plant directly to the distribution system, with the aid of variable speed pumps, will also be evaluated. In the event the latter option is selected, the need for elevated water tower would be eliminated from the system. Pipes made of PE or PVC material will be utilized for the distribution and transmission lines.

WatCad software will be utilized for the sizing of various pipelines identified for the system. A minimum pipe diameter of 90mm will be used for all major roads within the supply area and 63mm / 50mm diameter for minor roads. The distribution network would be carefully planned to cover the entire developed area and potential development areas. Minimum requirement for laying of a distribution line along a particular street will be to have at least six houses per hundred meters.

The piping system will be incorporated with air valves and washout valves to improve pumping efficiency and cleaning of pipelines respectively. Furthermore, isolation valves will be used in all important stretches of the pipelines in order to isolate a particular section of pipeline during repair and/or maintenance without affecting other areas of the network. Flow meters will also be used in key locations of the distribution network to identify water losses.

5.6. House Connection

An individual house connection with a 19mm / 25mm pipeline from the water main to the household incorporating water meters is proposed under this project. Potable water from both internal (household RWH) and external sources would be connected to the same inlet pipeline to the household with a provision to measure the quantity of water consumed from external source separately.

5.7. Improvements to Household RWH

Individual household rainwater harvesting systems are already practiced in these islands extensively by utilizing traditional methods (collection, transmission, storing and distribution) with minimum or no water quality control. This potentially causes health hazards due to the unchecked spread of water borne diseases. The system may have been constructed without much technical input currently available in the market. Under this program, it is proposed to upgrade the existing system to the present standard of rainwater harvesting for potable water by incorporating additional components such as first-flush diverters, UV disinfectant system, inline demand pump, improvement to gutter and downspouts, preliminary filtration system, additional storage tank, etc.

5.8. Power Supply

Water pumps working with solar energy will be used for the pumping of water from the community rainwater harvesting collection reservoirs to the treatment plant area. Similar pumps will be utilized for transmitting the treated water to the relevant storage reservoir or directly to the distribution system. The project will establish minor pump houses at each location where lifting of water is absolutely necessary.

The electricity requirements to run the system and plant shall be sourced from solar panel where possible and economically viable; when a solar panel is inactive during the monsoon or overcast weather conditions, power will be obtained from island grid.

6. Groundwater Recharge

The project will integrate groundwater recharging system to enhance the capacity of each household to extract adequate groundwater to use for washing clothes and toilet flushing through a well or borehole (with a pump). The groundwater recharging system should contemplate adequate measures to ensure that no more human waste is leaking or leaching from existing septic tanks. It is highly desirable to empty all the existing septic tanks and close them down with backfilling on completion of the proposed sewage system (to be executed by the government selected contractors). This action will significantly contribute to the gradual improvement of groundwater quality in the near future through persistent recharging process. It is pertinent to mention here that the quality of the groundwater should ideally be clean enough for bathing purposes. Some water is consumed by the users (with or without their knowledge) during the bathing process, and this consumption of contaminated water may lead to health problems.

The groundwater recharge system will be adopted using simple techniques in 2 (two) options:

- Use overflow of rainwater during rainwater harvesting to selected wells
- Recycle the wastewater, after appropriate treatment, from the sewage treatment plant. It is acceptable by Maldives Environmental authority that the BOD<20 can be discharged to sea outfall. However, this water cannot be recycled for groundwater recharge; as this requires more tertiary treatment to reduce the BOD<5.0. This treatment will be expensive in the context of the project.

Benchmark groundwater quality tests will be conducted for all 3 Islands and monitored each half year (or annually) to verify the improvement of the ground water quality. Testing equipment shall be provided by the project to the Utility companies or island community members in charge of the freshwater supply. However, this groundwater will not be suitable for drinking purposes.

6.1 Benefits of Groundwater Recharging

The following benefits may be achieved from groundwater recharging:

- An ideal solution to water problems in areas having inadequate water resources.
- A solution to reduce the intrusion of saline water in agricultural land and to reduce groundwater contamination by sewage, saltwater or other factors.
- The ground water level will rise.
- Mitigates the effects of drought.
- Reduces the runoff which chokes storm water drains.
- Quality of water improves.
- Soil erosion will be reduced.
- Saving of energy per well for lifting of ground water – a one meter rise in water level saves about 0.40 KWH of electricity.

6.2 Source of water used for recharge:

Rainwater harvesting supplemented by a quantity of quality water available for recharging during the rainy season using the overflow from the rainwater harvesting tank. It is recommended to integrate the system in each household and public facilities (Schools, Mosques, Health centers/Hospitals, Community Centers etc.).

6.3 Number of groundwater recharge systems:

The main source of groundwater pollution is at household level and from public buildings on the islands. Hence, groundwater will be recharged at household level and at community facility buildings.

- 1.0 meter diameter and 0.50 meter length of perforated pre-cast pipe will be installed at household level and filled by gravel/sand for infiltration. One in each household.
- 1.5 meter diameter and 0.75 meter length of perforated pre-cast pipe will be installed at public building facilities and filled by gravel/sand for infiltration. Several at each facility.

	No. of Houses	1.0 dia	1.5 m dia
Haa. Ihavandhoo	700	700	30
Ada. Mahibadhoo	275	275	30
Gda. Gahdhoo	495	495	30

7. Wastewater Management Improvement

The project will include a small parallel component to the current government plan on the construction of the wastewater systems in the three islands, as follows:

7.1. Integration of planned and proposed wastewater systems into the IWRM process

The project aims to ensure that the current planned wastewater systems espouse the principles and components of a holistic IWRM process. Specifically the project will revise the designs planned for these systems and will integrate the provision of proper wastewater management systems.

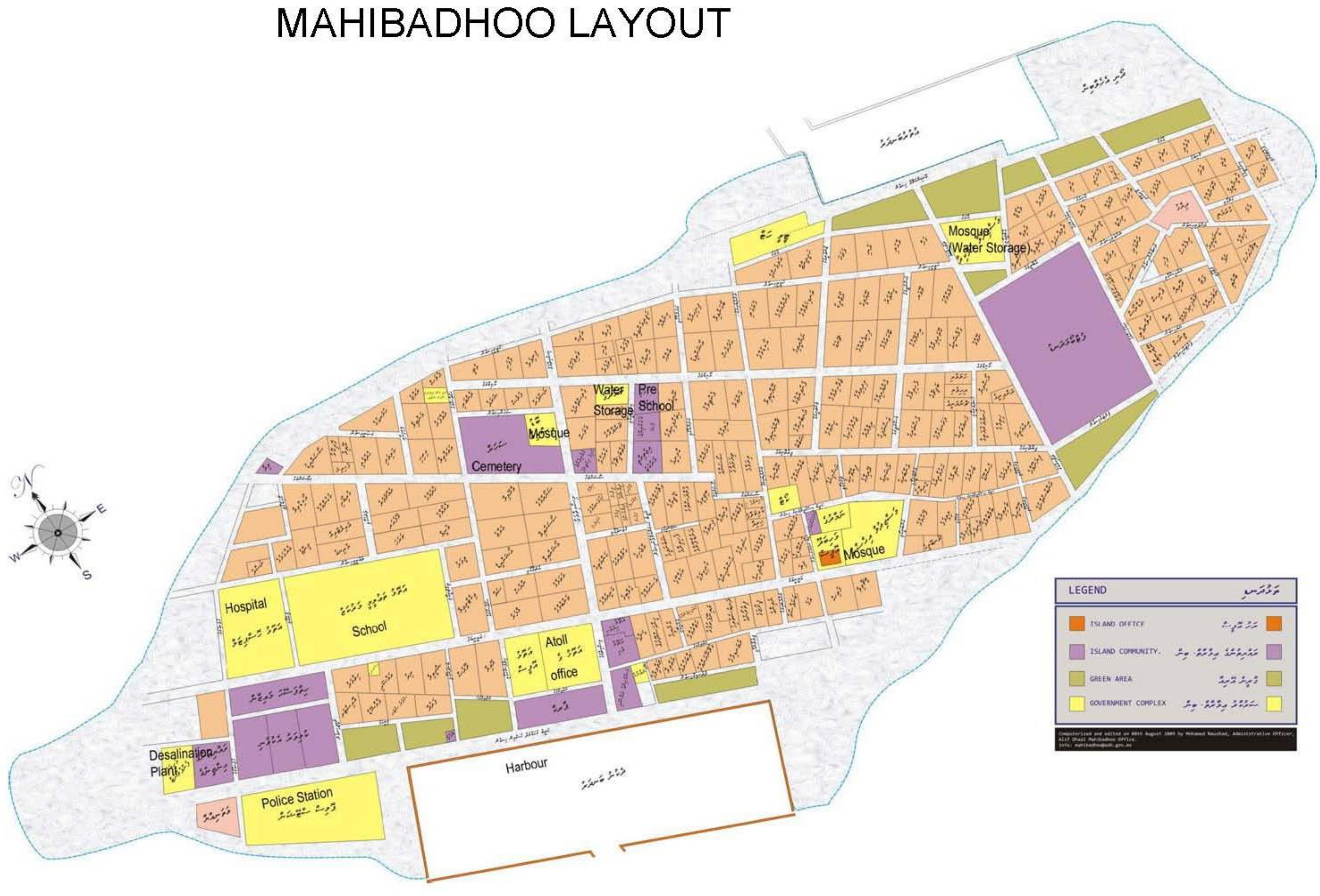
7.2 Cleaning the existing septic tanks:

The existing household septic tanks are the main source of groundwater contamination due to the lack of appropriate sewage system in all three islands. The sewage construction system will be implemented by other agencies appointed by the MHE. The project will assist the MHE to ensure that all sewage construction contractors include additional provisions in contracts to allow for the following scope of work: the cleaning up, flushing and filling with sand of all septic tanks (especially septic tanks open to ground infiltration) to successfully recharge and protect the groundwater.

8. Island Layout Plans

LAY OUT PLAN FOR IHAVANDHOO ISLAND

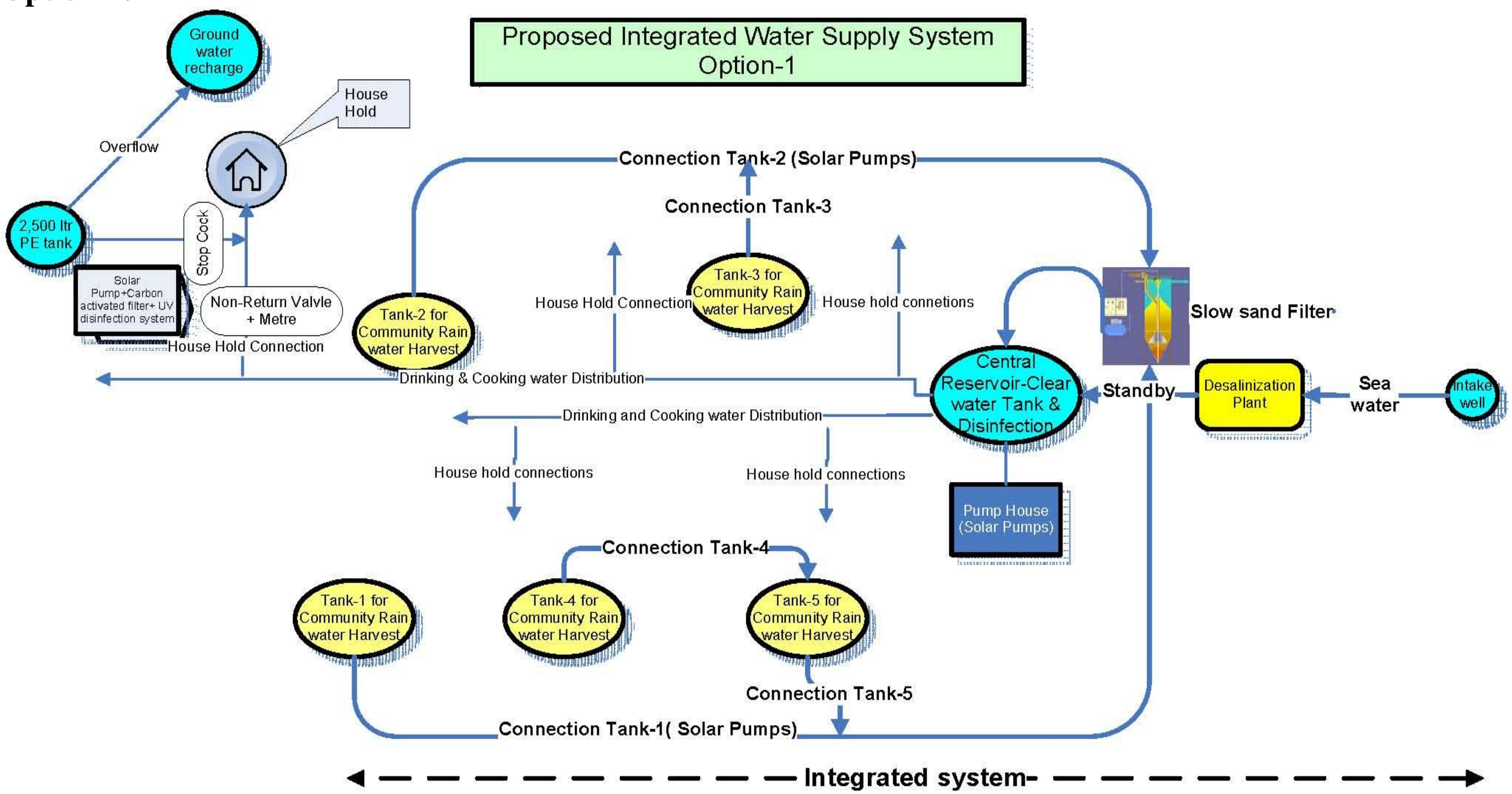
LAY OUT PLAN FOR MAHIBADHOO ISLAND



LAY OUT PLAN FOR GADHODHOO ISLAND

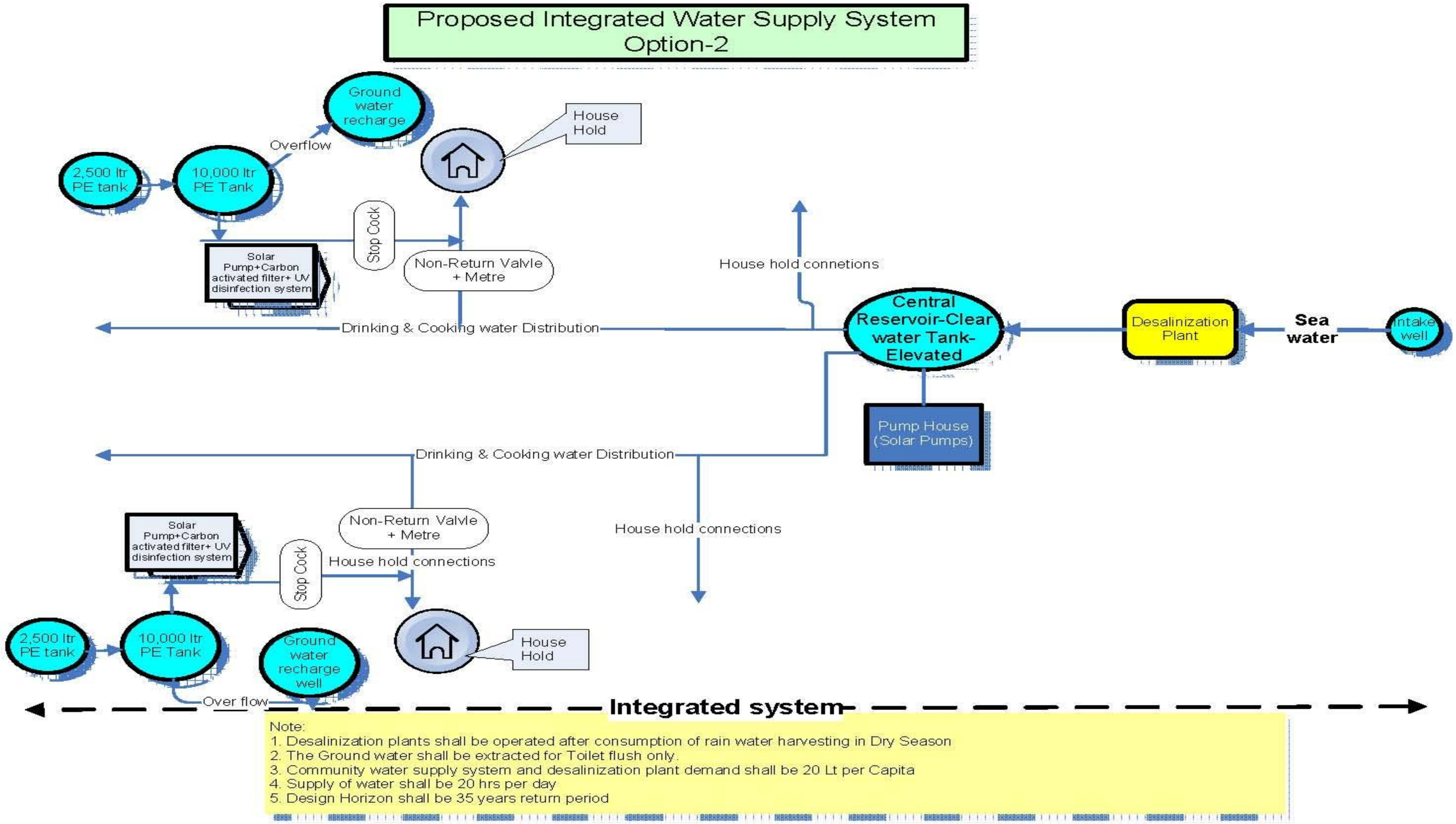
9. Design Options for Integrated Water Supply System on Target Islands

Option-1:



Note:
1. Desalinization plants shall be operated after consumption of rain water harvesting in Dry Season
2. The Ground water shall be extracted for Toilet flush and bathing only.
3. Community water supply system and desalinization plant demand shall be 20 Lt per Capita
4. Supply of water shall be 20 hrs per day
5. Design Horizon shall be 35 years return period

Option-2:



Proposed Integrated Water Supply System
Option-2
Ground water recharge
House Hold
Overflow
2,500 ltr PE tank
10,000 ltr PE Tank
Stop Cock
Solar Pump+Carbon activated filter+ UV disinfection system
Non-Return Valvle + Metre
House hold connetions
Drinking & Cooking water Distribution
Central Reservoir-Clear water Tank-Elevated
Desalinization Plant
Sea water
Intake well
Pump House (Solar Pumps)
Drinking & Cooking water Distribution
House hold connections
Solar Pump+Carbon activated filter+ UV disinfection system
Non-Return Valvle + Metre
Stop Cock
House hold connections
2,500 ltr PE tank
10,000 ltr PE Tank
Ground water recharge well
House Hold
Over flow
Integrated system
Note:
1. Desalinization plants shall be operated after consumption of rain water harvesting in Dry Season
2. The Ground water shall be extracted for Toilet flush only.
3. Community water supply system and desalinization plant demand shall be 20 Lt per Capita
4. Supply of water shall be 20 hrs per day
5. Design Horizon shall be 35 years return period

ANNEX F

Terms of Reference

Project Management

Project Board (PB)

The Ministry of Housing and Environment will be responsible for establishing the Project Board. The board will meet at least twice a year, with more frequent meetings held when necessary. The Project Board will be chaired by the Minister of Housing and Environment. The National Project Director will be the Executive Member nominated by the MHE and is expected to be a senior official not below the rank of Deputy Minister. The Members of the Project Board include representatives from the Implementing Partner (MHE), UNDP, designated Responsible Parties and other important stakeholders and Island Council members from the demonstration islands. The list of PB nominees (including alternates) will be prepared and approved over the course of the project inception workshop.

Responsibilities

- Provide strategic guidance and direction to the project, ensuring it remains within any specified constraints of time, scope and budget;
- Provide advice and guidance on efficient and timely execution of the project, when required;
- Establish policies when required to define the functions, responsibilities, and delegation of powers for the implementing agencies and the Project Management Unit;
- Ensure that project's policy recommendations are integrated within the policies of respective sectors each member represents;
- Address project issues as raised by the National Project Manager including approval of major project revisions;
- Provide guidance and agree on possible countermeasures/management actions to address major issues and risks;
- Ensure that AF resources are committed exclusively to activities that relate to achievement of the project objective;
- Resolve significant conflicts within the project, and negotiate a solution to major problems that may arise between the project and external bodies;
- Appraise the Project progress and make recommendations for next steps.

National Project Director (NPD)

The National Project Director (NPD) will be a state employee appointed by the Ministry of Housing and Environment to be responsible, on behalf of the government, for the project. The NPD will be responsible for overseeing overall project implementation on a regular basis and ensuring that the project outcomes are achieved. This function is not funded through the project and will be covered as in-kind contribution. On behalf of the Implementing Agency, the NPD is accountable to the UNDP for the appropriate use of the project resources provided by AF. The

NPD, assisted by the National Project Manager, will report to the Project Board on the progress of the Project. The NPD will be responsible for coordinating the flow of results and knowledge from the project to the members of the Project Board.

Responsibilities

- Review project activities, and their adherence to the work plan set forth in the project document;
- Approve project Annual work plans and budget revisions.
- Approve annual project status and financial reports.
- Ensure that Maldivian legislation, rules and procedures are fully met in the course of the project implementation;
- Oversee implementation of Project Board directives;
- Facilitate government support to EIA processes;
- Report to UNDP and the Project Board on the use of the project resources and achievement of the project outputs.

National Project Manager

The National Project Manager (NPM) is a full-time, project-funded staff who will be responsible for the day-to-day management, administration, coordination, and technical supervision of project implementation. He/she will implement guidance from the National Project Director and Project Board, and lead the project team through the timely planning, implementation, and delivery of project Outputs and Outcomes as indicated in the Strategic Results Framework. S/he will be responsible for financial management and disbursements, with accountability to the government and UNDP. The NPM will be appointed by the Implementing Agency and coordinate with any technical staff who is provided to the PMU through direct implementation support services from UN agencies (envisaged under this project for Outcome 1).

In carrying out her/his responsibilities, s/he will advocate and promote the work of adaptation to climate change in Maldives and will also closely work and network with the relevant government agencies, UNDP, UNOPS, the private sector, NGOs, and civil society organizations.

Responsibilities

- Facilitate the day-to-day functioning of the PMU, supervision and coordination of PMU staff;
- Coordinate the distribution of responsibilities amongst team members and organize the monitoring and tracking of all project management services;
- Manage human and financial resources provided by the project, in consultation with the project’s senior management, to achieve results in line with the Outcomes and Outputs outlined in the project document;
- Plan the activities and inputs provided by the project and monitor progress against the initial quality criteria;
- Mobilize goods and services to initiative activities, including drafting TORs and work specifications;

- Facilitate and organize events as determined in the Project Monitoring Plan, and update the plan as required;
- Manage requests for the provision of financial resources by UNDP, using advance of funds, direct payments, or reimbursement using the FACE (Fund Authorization and Certificate of Expenditures);
- Monitor financial resources and accounting to ensure accuracy and reliability of financial reports;
- Prepare and submit financial and technical reports to UNDP on a quarterly and annual basis;
- Manage and monitor the project risks initially identified, submit new risks to the Project Board for consideration and decision on possible actions if required; update the status of these risks by maintaining the Project Risks Log;
- Be responsible for managing issues and requests for change by maintaining an Issues Log;
- Prepare regular progress reports (progress against planned activities, update on Risks and Issues, expenditures) and submit the report to the Project Board, NPM and UNDP;
- Prepare the AWP for the following year, as well as Quarterly Plans if required;
- Update the Atlas Project Management module if external access is made available;
- Work with all co-financing partners to ensure that their activities/programs are integrated and complementary with those of the AF-funded project.
- Support linkage of project activities with related and parallel activities within MHE;
- Support the NPD in organizing Project Board meetings;
- Manage relationships with project stakeholders including NGOs, government agencies, atoll and island councils and others as required.

Qualifications/ Requirements

- University graduate with at least 5 years working experience in project management within the disciplines of engineering, environmental science, geography, or natural resource management
- Sound understanding of water management issues in Maldives and basic knowledge of the international climate change discourse
- Extensive business and information exchange contacts with national and international partners involved in water resources and waste management planning;
- Excellent inter-personal, communication and negotiating skills
- Previous work experience in the country on issues relevant to the project
- Ability and willingness to travel within and outside the Maldives
- Demonstrable skills in office computer use – MS-Word, MS-Excel, Powerpoint
- Proven track record of project management and project team experience working with government, NGOs, and other key stakeholders in Maldives
- Excellent verbal and written skills in English and Dhivehi

Administrative and Finance Assistant

The Administrative & Finance Assistant will undertake administration of the day-to-day operations of the project office. The Administrative Assistant will report to the National Project Manager.

Responsibilities

- Set up and maintain all files and records of the project in both electronic and hard copies
- Collect and inventorize project related data pertaining to stakeholder consultations
- Prepare minutes of meetings
- Organize Project Board meetings in coordination with the National Project Manager
- Establish document control and assurance procedures
- Compile, copy and distribute project-related reports
- Provide logistical support to the National Project Manager, and national/international consultants in organising training events, workshops, and seminars
- Assist short-term consultants by organizing their travel schedules, arranging meetings with different stakeholders, and booking hotel accommodations
- Prepare monthly leave records for the project staff and long-term national/international consultants
- Provide support in the use of Atlas for monitoring and reporting
- Review layout, spelling and formatting of project-related reports in coordination with the NPM
- Assist the NPM to monitor technical activities carried out by responsible parties
- Draft necessary correspondence with local and international project stakeholders

Qualifications

- At least 3 years of relevant administrative or program experience at the national or international level
- Undergraduate degree and/or certificate in secretarial or computer training
- Demonstrated experience in using computers and office software packages, particularly word processing and spreadsheets (MS Word, Excel)
- Knowledge of database packages and web-based management systems
- Excellent inter-personal and communication skills
- Proficient verbal and written English and Dhivehi skills

ANNEX G **Project Milestones and Disbursement Schedule**

	Year 1				Year 2				Year 3				Year 4			
MONTHS	1 2 3	4 5 6	7 8 9	10 11 12	13 14 15	16 17 18	19 20 21	22 23 24	25 26 27	28 29 30	31 32 33	34 35 36	37 38 39	40 41 42	43 44 45	46 47 48
PROJECT OUTPUT																
Output 1.1 Artificial groundwater recharge systems established to protect groundwater resources from salinization and improve aquifer yields in dry seasons	20,000	80,000	60,000	40,000	20,297	1,000	1,000	1,000	1,000	1,000	1,000		1,000		1,000	
Output 1.2 Rainwater harvesting schemes redesigned, interconnected and structurally improved to buffer climatic extremes and ensure equal water supply for all households during dry periods	20,000	150,000	1,000,000	800,000	700,000	663,000	280,000	50,119	10,826	10,987	10,987		10,987		10,987	
Output 1.3 Production and distribution system for desalinated water supply established		150,000	1,300,000	850,000	600,000	246,900	75,625	20,000	10,842	10,842	10,842		10,842		10,840	
Output 1.4 Existing wastewater management systems redesigned and improved to ensure sufficient quantities of safe groundwater during		12,043	9,348		9,348		9,348		9,348		9,348		9,348		9,348	
Output 2.1 Community consultations on each target island ensure participative design, sustainability and continued maintenance of integrated water resource management schemes	40,000	30,000														
Output 2.2 Targeted training events conducted in each region to strengthen water user participation and skills in adaptive, integrated water resource management				10,000				10,000				10,000				10,000
Output 3.1 Training of technicians in the design, operation and management of integrated water resource management systems			10,000				10,000				10,000					
Output 3.2 Institutional mechanisms created to integrate adaptive management of freshwater resources into the design and rollout of new water management projects and schemes												10,000	10,000	10,000		
Output 3.3 Action plan developed and financing mobilized to replicate integrated, climate-resilient freshwater management on at least 4 additional islands														10,000	10,000	
Project Execution, M&E	65,112	65,112	65,112	65,112	65,112	65,112	65,112	65,112	25,912	25,912	25,912	25,912	25,912	25,912	25,912	52,321

Disbursement schedule:

	Upon MoU signed (July 2011)	Jul-11	Oct-11	Oct-12	Oct-13	Oct-14	Total
Project Funds	0	145,112	4,696,728	2,988,083	210,669	244,408	8,285,000
IA Fee	281,690	7,401	239,533	152,392	10,744	12,465	704,225
TOTAL	281,690	152,513	4,936,261	3,140,475	221,413	256,873	8,989,225
	Transferred by Trustee in a single tranch		Transferred by Trustee in 4 tranches				