Government of
Sint Maarten

NRPB
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NATIONAL RECOVERY PROGRAM BUREAU

GOVERNMENT OF SINT MAARTEN

WASTEWATER MANAGEMENT PROJECT (SWMP)

PROJECT NO.: P179067

DESIGN AND SUPERVISION OF WASTEWATER NETWORK AND WWTP

CONTRACT NO.: SX-NRPB-367262-CS-QCBS

REHABILITATION OF A.TH. ILLIDGE ROAD WASTEWATER TREATMENT PLANT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

JUNE 2026

A project financed by:

THE WORLD BANK
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Implemented by:

ENGIDRO
engineering solutions

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With collaboration

Subsurface

Government of Sint Maarten

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ACRONYMS AND ABBREVIATIONS

BOD	Biochemical Oxygen Demand
CO	Carbon Monoxide
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EDMP	Emergency Debris Management Project
EHS	Environment, Health and Safety
E&S	Environmental and Social
ESIA	Environmental and Social Impact Assessment
EPRP	Emergency Preparedness and Response Plan
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
EU	European Union
HP	Hindrance Permit
IBA	Important Bird Area
IDS	Irma Disposal Site
IFC	International Finance Corporation
IU	Implementation Unit
GBV	Gender Based Violence
GHG	Greenhouse Gases
GoSM	Government of Sint Maarten
GRM	Grievance Redress Mechanism
KoN	Kingdom of Netherlands
NGO	Non-Governmental Organisations
N	Nitrogen
NH4	Ammonium
NO / NO2 / NO3	Nitrogen oxide / Nitrogen dioxide / Nitrate
NRPB	National Recovery Program Bureau
O&M	Operation & Maintenance
P	Phosphorus
SCADA	Supervisory Control And Data Acquisition
SDB	Sludge Drying Beds
SEA/SH	Sexual Exploitation Abuse/Sexual Harassment
SEP	Stakeholder Engagement Plan

SLR	Sea-level rise
SO2	Sulfur dioxide
ST	Supervision Team
STD	Sexual Transmitted Diseases
SWDS	Solid Waste Disposal Site
TSS	Total Suspended Solids
VOC	Volatile Organic Compounds
VROMI	Ministry of Public Housing, Spatial Planning, Environment and Infrastructure
WAS	Waste Activated Sludge
WB	World Bank
WHO	World Health Organization
WWTP	Wastewater Treatment Plant

Revision Registry		
Version	**Date**	**Description**
V0	26-09-2025	First Version
V01	07-11-2025	Revised version after NRPB revision
V02	28-11-2025	Revised version after NRPB revision
V03	05-02-2026	Revised version after WB revision
V04	20-03-2026	Revised version after WB revision

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EXECUTIVE SUMMARY

1 INTRODUCTION

This Executive Summary presents, in a concise manner, the background and rationale of the project, the environmental and social reference base, the table of national and international legal frameworks, the requirements of the Environmental and Social Impact Assessment (ESIA) and licensing, the definition of the areas of influence, public consultations, the justification and description of the project, the potential environmental and social impacts, and the environmental and social mitigation measures to be implemented.

2 GENERAL FRAMEWORK OF THE PROJECT

Sint Maarten's sewerage network coverage is very limited, covering only some districts and neighbourhoods. There is only one public biological treatment plant currently in operation (**A.TH. Illidge Road Wastewater Treatment Plant**) with a treatment capacity of approximately 4,500 m³ of sewage and septage per day. However, due to the incomplete sewerage network across Sint Maarten, the wastewater treatment plant is currently operating at about 65% of its hydraulic capacity and 80% of its pollution load capacity.

The Sint Maarten Recovery, Reconstruction and Resilience Trust Fund (the 'Trust Fund') was established to respond to the devastation caused by Hurricane Irma in September 2017. The Trust Fund is fully financed by the Government of the Netherlands for up to 470 million euros (US $553 million) and is administered by the World Bank. On behalf of the Government of Sint Maarten, the NRPB is responsible for the preparation, implementation and evaluation of most of the projects that are financed by the Trust Fund. The Wastewater Management Project, which is made up of three (3) components, including the upgrade and operation of the Wastewater Treatment Plant (WWTP) (Sub-component 1.2), is co-funded by the Sint Maarten Recovery and Reconstruction Trust Fund and the Government of Sint Maarten. Part of this funding is intended for consulting services, namely the "**Design and Supervision of Wastewater Network and Wastewater Treatment Plant**" and investments in wastewater are proposed to be funded under the Trust Fund.

The **A.TH. Illidge Road Wastewater Treatment Plant**, originally constructed in 1992, upgraded and enlarged in capacity in 2013, is designed to service the Greater Philipsburg area (including Upper Prince's Quarter and the Lower Prince's Quarter areas) and other sewered districts, included in the mostly residential Cul-de-Sac area.

Within the scope of the technical design of the **Rehabilitation of the A.TH. Illidge Road WWTP**, several visits were performed to the facilities, guided by the current Operator, and some issues were identified, regarding existing infrastructures status and operational process.

To overcome these issues, an upgrade of this WWTP was proposed. In considering the scope of the upgrade works at the WWTP, consideration was given to parallel projects for increasing the sewage flow treated at the plant, by initially expanding the sewerage network in Cul-de-Sac area, then connecting sewage flows from Lower Prince's Quarter district, and finally connecting Philipsburg by 2055. With the phased expansion of the network, the A.TH. Illidge Road WWTP inflow increases from 1,743 m3/day in 2025 to 4,613 m^3/day in 2030 and 6,451 m^3/day in 2055. This ESIA only considers the impacts of the upgrade/rehabilitation of the WWTP assuming a specific scenario of expansion of these household connections. However, the impacts and mitigation measures of the works to expand the sewerage network and increase household connections in Cul-de-Sac are described in a separate environmental and social management plan that has been prepared, for this parallel project.

The upgrade of the WWTP will therefore include improving septic trucks disposal arrangements, the preliminary treatment, the biological treatment and the sludge treatment infrastructure and processes, and introducing automatic and efficient control system of the complete operation of this facility. Effluent disinfection and phosphorus removal is also contemplated as future components, based on constant monitoring of discharged effluents. The main interventions at the WWTP that are considered in this ESIA are the following:

- The **physical barrier** to be built next to the truck discharge area creates a protection between the southern buildings and the trucks, mitigating the potential impacts on noise and wastewater runoff. The connection between the truck and the discharge pit will be through a pipe, which decreases substantially the odor. It is important to reinforce that as the sewage network expands, the number of trucks with septic flows arriving at the WWTP progressively reduces;

- The **new screen and grit removal equipment and the new fine screen line** proposed in the pre-treatment stage will improve the removal of solids and debris (that could negatively interfere with the downstream operation), with benefits for the wastewater treatment with positive impacts on the quality of the discharged water and sludges;
- The **new mechanical surface aerators**, will improve the current and future biologic treatment capacity, in terms of resilience of the equipment, which impacts the quality of the discharged water and sludges;
- The **new dewatering building** will improve the sludge treatment process (less volume) and the transference to the transportation trucks, with more controlled odor emissions and less trucks. The equipment predicted in this building will also allow that the existing sludge drying beds can be used only in emergency situations (as a redundancy), mitigating the odor emissions;
- Finally, the **automation and SCADA system** predicted in the rehabilitated WWTP will improve efficiency, reliability, costs saving, environmental compliance (accurate monitoring and control of key parameters), remote access & safety and predictive maintenance, with positive impacts either for the environmental aspects, as also for the socioeconomic aspects.

All these interventions will be located inside the current enclosure of the WWTP.

The **Rehabilitation of the A.TH. Illidge Road Wastewater Treatment Plant** project may have temporary negative impacts on the biophysical environment and/or the human and socioeconomic environment. This Environmental and Social Impact Assessment (ESIA) addresses those impacts and proposes the adequate mitigation measures; and a separate Environmental and Social Management Plan (ESMP) describes how the mitigation measures will be implemented during the rehabilitation of the WWTP.

3. GENERAL DESCRIPTION OF PROJECT LOCATION

The **A.TH. Illidge Road WWTP** is located at lower altitudes, between 0-40 m, and is over *Man made soils*.

The climate of Sint Maarten is a marine climate, tropical with hot and sunny weather all year around. The average daily temperature ranges from 25 degrees Celsius (°C) in the period from January to March, to 28 °C between June and October. Average annual rainfall is 1045 mm. The hurricane season in the Atlantic region (including the Caribbean), when tropical depressions and hurricanes become active, starts on 1 June and ends on 30 November (with most activity occurring between August to October). Most direct runoff occurs during the wet season, which lasts 3 to 4 months per year, and during the remaining months precipitation is low. When it is raining heavily, water runs down from the hills and accumulates throughout the various valleys (like Cul-de-sac) and the side gutters of the roadways (which overflow and flood the roads and other properties). The predicted climate changes in Sint Maarten correspond to a sharp rise in temperature and an increase in the frequency and intensity of hurricanes, which can bring extreme precipitation events. Sea levels (SLR) will also rise.

Near the **A.TH. Illidge Road WWTP** there are two natural ponds**.** In the West side is the Fresh Pond, an oblong shaped 2.5 km x 1 km pond, with a water surface of about 13.5 ha. The pond is divided by the Bernhard Bridge into a northern part and a southern part. Water depth varies from approximately 0.9 m near the bridge to 0.5 m in the north of the pond, however these values can be significantly lower in dry periods (about 0.40 m).

The Great Salt Pond, located in the East side, is a 2.25 square kilometer saltwater pond historically used for salt production, which is located in south-central Sint Maarten and is bordered on all sides by downtown Philipsburg and its suburbs. It is the largest permanent saline lagoon saltwater pond (bottom is 1 to 1.5 m below the mean sea level, and the water level is also below sea level) on the island, which serves as a natural water catchment basin for much of the runoff water from surrounding hills.

In 1792 a dam was built to separate the Fresh Pond from the Great Salt Pond (located at North of the WWTP), with the purpose to prevent fresh water from flowing into the Salt Pond. In 1850, an opening to the sea was established to conduct the flow of fresh water to the sea. Rainfall of approximately 10 mm or more causes flushing of pond water to the sea. The first flow of water occurs during the first period of heavy rainfall when the water level of the Fresh Pond rises faster than the level of Great Salt Pond. If rainfall continues, the level of both ponds eventually reaches their maximum capacity. When further rise of the water levels occurs, the sand ridge separating Fresh Pond from the sea is opened, resulting in a waterflow from both ponds to the sea. Although the quality of the marine area in Great Bay is affected for a period, these discharges do contribute to the reduction of the nutrient accumulation in the Fresh Pond.

Based on flood simulations performed by others, is possible to predict that the facilities of the **A.TH. Illidge Road WWTP** will not be affected by a major flooding event, in the current climate scenario. However, when considering the extreme events associated with the climate change where, under a worst-case scenario (SSP5-8.5: sea-level rise of 139 cm), the flood extent of Sint Maarten may increase by 68% from 2.72 km² to 4.56 km², this facility could be flooded.

The main air pollution sources in the **A.TH. Illidge Road WWTP** project area come from the emission of atmospheric pollutants (NO, CO, CO2, particles, etc.) from vehicles passing on the nearest roads, as well as some odour originated in the WWTP components, including the septic trucks.

A simulation with AERMOD software assessed the odor dispersion from the current WWTP to the surrounding buildings (a total of 99 selected, with residential and commercial function). It was confirmed the low impact of the WWTP, being well below the Netherlands limit of 1.0 ouE/m³ established for highly sensitive areas. The only three receivers which surpass this threshold, are two located in the south side of the WWTP, and one in the northeast opposite side of the A.TH. Illidge Road , but, due to their location in a mixed zone, with predominance of commercial areas, they comply with the legislated threshold of 3 ouE/m³ for mixed areas.

A social survey was performed, with enquiries on the several surrounding buildings in a 100 m buffer. Most of the respondents did not have any complaints regarding the WWTP (about 74%), but 5% of these referred to or mentioned the odor coming from the pond. Also mentioned by some respondent was the odor coming from the truck's disposal of the septic effluents and when the wind is calm. Most of those who reported odor issues do not link it to the WWTP. The time of year and day when the odor is most noticeable varies widely. This highlights the subjectivity of odor as a nuisance.

The water quality of the Fresh Pond downstream of Cul-de Sac is being deteriorated by urban runoff from two open channels, mainly Bush Road and Zagersgut. Most of the effluents to the Fresh Pond come from untreated sewage discharges, surface runoff, plastics and other litter from surrounding neighbourhoods. Although about 90% of the households in Sint Maarten have sewage system (septic tanks, soak-aways, and cesspits), a large portion still finds its way directly into the environment. When these tanks are not emptied regularly, they overflow, causing sewage to spill into streets, public spaces, and eventually ending up in beaches and ponds. This untreated wastewater carries harmful pollutants, chemicals, and diseases, posing serious risks to both human health and ecosystems.

Water quality analysis of Fresh Pond performed in several years concludes that this pond is a eutrophic pond, with high faecal contamination, not suitable for swimming or fishing. The Nitrogen and Phosphorus concentrations are also above the allowable limits, although lower than the Great Salt Pond. Sediments also contained high levels of the Heavy Metals Cadmium (Cd) and Zinc (Zn), probably related to surrounding runoffs. Assessment was also performed in Great Bay Beach, where both ponds discharge, and it was also confirmed the elevated coliform levels and Nitrogen.

Effluent quality from the A. TH. Illidge Road WWTP was also analysed and based on recent assessments, the concentrations of the main parameters (COD, BOD, P and N) comply with the Hindrance Permit.

In the project area, the main noise sources are the traffic from A.TH. Illidge Road and Zagersgut Road, and the WWTP itself. As for the traffic, the daily septage trucks that visit the WWTP are one of those noise sources (all weekdays, from 06:00 am until 06:00 pm). The WWTP operates 24 hr/day. Currently, at the WWTP, the main noise source comes from those septage trucks and from the anaerobic tank. All the other WWTP components are in enclosed structures or, when at open air, do not emit relevant sound (settling tank, the sludge thickener and the sludge drying beds, etc).

Noise measurements were performed in two nearby locations confirming that the ambient noise levels at the two specified locations in Sint Maarten currently exceed the applicable noise standards of Sint Maarten during the weekday daytime and evening periods.

This high noise environment is caused by road traffic and the septic trucks and their discharges (temporary, depending on their frequency). The maximum noise levels are always associated with traffic. During the evening period, when the septic trucks are not arriving (as mentioned before, only between 06:00 am until 06:00 pm, on weekdays), the road traffic still continue to contribute for the louder noise.

The **A.TH. Illidge Road WWTP** has specific containers on-site for daily trash (organic, paper, plastic), oils and lubricants and for the laboratory waste. No chemical waste is used for the treatment process. All the waste produced in this facility is deposited in the Pond Island Landfills by an authorized hauler.

The sludge produced from the WWTP system is treated in several drying beds (a total of 15 tanks and 1 emergency pond). An average of 15 monthly trucks is required to deliver the sludge to the municipal landfill. Grab samples of this sludge material were performed, determining that all heavy metals were well below the international regulatory limits outlined in US EPA 503 and no exceedances were observed for the other parameters compared. pH, Organic Matter, and Nutrients were in normal ranges and do not indicate any concern.

Fresh Pond and Great Salt Pond are classified as Important Bird Areas (IBA) and as Key Biodiversity Areas (IBAT). Fresh Pond, although exposed to several anthropogenic pressures, still is able to support an aquatic vegetation composed of mangrove species located in its margins. Regarding the project area, the **A.TH. Illidge Road WWTP** is located at densely populated area, with ruderal vegetation and garden trees or shrubs on the roadsides. The WWTP has several tree and shrub species in its enclosure that surrounds the various components of the WWTP and also its enclosure. Some bird species were observed near or in the WWTP, and also other fauna species, namely some reptiles (Iguana and turtles) and the fish Tilapia, all without protected status and invasive species.

Regarding land use, the area where the WWTP is located is a mixed urban area, mainly with commercial buildings but also with some residential settlements, restricted between the two natural ponds. The landscape of the project area can be classified as a semi-natural landscape (heterogeneous, with human occupation and natural elements).

For the social characterization of the surrounding population, a local survey was conducted within a 200 meters buffer around the **A. TH. Illidge Road WWTP**, with face-to-face enquiries to whom either live or run a business in this area, to assess the following aspects: a) the community's level of awareness about the WWTP facility; b) perceptions of its impacts; and c) the extent to which residents and business owners use (or avoid) available channels to report concerns. Adults were the main respondents, with nearly two-thirds of women, mostly not heads of household or business owners.

Most respondents are renters rather than owners and households are made of small to medium size families with 2–4 people and a median of 3.

Among those who answered on the employment, about two-thirds are employed. Reported occupations range from service jobs (housekeeping, retail, restaurants, security) to manual trades (mechanics, construction, car repair), with fewer in professional or managerial roles. Among business owners, activities are diverse, from small shops and services (bars, salons, supermarkets, restaurants) to some specialized fields (law, accounting, real estate, pharmacy distribution). Most businesses are very small**,** with two-thirds employing 4 or fewer people (median: 3). Only a few have more than 10 employees, and one reported up to 60.

There are some heritage monuments around the WWTP, but not in the WWTP project area.

For the Territorial planning, refers the *Spatial Development Strategy 2030 of Sint Maarten*, which defines several objectives that can be articulated with the upgrade of the sewerage network and the WWTP.

Finally, regarding Occupational Health and Safety of the **A. TH. Illidge Road WWTP**, the main hazards were identified and are managed by the Operator. The main emergency impacts are heavy rainfall and equipment damage. These emergency situations are managed immediately and according to the severity of the incident, based on Staff experience.

4. LEGAL AND INSTITUTONAL FRAMEWORK

The Sint Maarten Recovery, Reconstruction and Resilience Trust Fund is administered by the World Bank (WB) and is therefore subject to the requirements of the new World Bank (WB) Environmental and Social Framework, which came into effect on October 1, 2018. For the **Rehabilitation of the A.TH. Illidge Road WWTP**, only ESS5, ESS8 and ESS9 are not applied.

Sint Maarten became an autonomous country within the Kingdom of the Netherlands in 2010, with its Constitution mandating environmental protection and sustainability as a core government responsibility under article 22. While the Government of Sint Maarten (GoSM) has implemented some policies addressing environmental and social (E&S) issues, such as pollution control, labor, and public health, these measures are limited in scope and only partially fulfill constitutional obligations.

Existing legislation includes provisions under the National Ordinance on Spatial Development Planning (2021), which requires civil works permits for major development activities. This ordinance grants the Minister of VROMI discretion to approve or deny permits, impose conditions, and potentially require environmental and social assessments (e.g., ESIA/ESMP) to mitigate adverse impacts. However, there is no comprehensive environmental protection framework, and ESIAs are not directly legally mandated across all projects.

Despite some laws addressing impacts on biodiversity and critical habitats, environmental degradation persists due to weak enforcement. In practice, E&S safeguards are often driven by external requirements, such as those of the World Bank in this case, rather than national legislation.
If new environmental legislation is introduced during project implementation, the Project's Management Team will assess and ensure compliance. Overall, while some regulatory mechanisms exist, Sint Maarten's environmental governance remains fragmented and lacks a robust, enforceable

legal framework. All applicable legislation, specific requirements and implications on the Project are summarized in Section 4.2.

5. ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROJECT

The main impacts during the construction and operation phases were identified and assessed, and mitigation and compensation measures were presented, as well as measures to enhance the respective impacts.

The location of the construction site/material yard is not yet defined, but it is assumed that it will be located within the WWTP grounds, in an already impermeable area, without natural vegetation. The impacts associated with this structure are temporary, mitigable, local and limited.

Regarding the impacts on **geological formations**, the impacts, although direct and permanent, are not very significant, given that the affected formations do not present significant commercial and/or scientific interest. The excavation volume for the installation of foundations and trenches is expected to be reduced, as most of the excavated volume will be reused for subsequent trench filling. Excavations will be needed associated with the new infrastructures (mainly the new fine screen line and the dewatering building), because these are on not-used terrain. No changes to the **local geomorphology** are anticipated, given the flat nature of the area and the project's typology. During operation phase, In the case of sewage ducts, if maintenance work requires intervention, localized excavations will be carried out and the earth will be reused as cover. Since Sint Maarten is vulnerable to earthquakes, reinforced concrete construction with metal support reduces vulnerability to potential **seismic events**. Similarly, the location of these structures in flat areas minimizes the impact of landslides.

There are no agricultural **soils** on site, so the impacts are non-existent. During the construction phase and maintenance phase, accidental spills of pollutants may also occur during the movement and operation of machinery or through the discharge of effluent from the construction site. These impacts are not significant. It is reported that the WWTP equipment (the current and the new) are constructed over a sealed concrete base layer which prevents direct contact with the underneath soil and allows for repair time. Tanks and ponds are all sealed.

A dewatering mechanical belt system will be used to dry the **sludge** which will be discharged directly into waiting trucks or large dumper boxes by conveyers for easier handling and transport. The main impact for soil contamination will be accidental spills from the machine inside the dewatering building. It is mandatory to maintain good housekeeping to prevent spills, cleaning up any spilled water or chemicals immediately to keep floors dry. The dewatering building will have a proper drainage system to prevent pooling.

Construction activities can contribute to **greenhouse gas (GHG) emissions** from vehicles involved in the work, such as CO, CO2, NOx, and SO2. Emissions will depend on factors that are still unknown, such as the type and quantity of equipment used. However, these emissions are not expected to be significant, being temporary and mitigable. During operation phase, the new equipment will not cause any changes in the local microclimate. Regarding GHG emissions of the future upgraded WWTP, it was quantified that these emissions correspond to only 1.07% of this reference value and is irrelevant. The future value may also be overrated, since the proposed Improved sludge treatment enhances energy efficiency and lowers carbon emissions. Considering the adaptation to climate changes, the WWTP rehabilitation will not deteriorate the effluent quality (which is a positive impact for the Fresh Pond), will improve operations in terms of emissions and maintenance needs, and that the infrastructure itself is structurally adapted to the possibility of flooding, the impacts of climate change on the project are not expected to be significant.

During **construction phase**, changes in **surface drainage and runoff** are expected by the implantation of the new equipment which are moderately significant impact (new equipment localized on not-used terrain), if no mitigation measures are implemented. Water quality contamination during this phase will not be significant, as the contractor must ensure the adoption of appropriate domestic wastewater management measures and will have a dedicated area at the construction site for temporary waste disposal, complying with all measures related to waste and the use of machinery and vehicles.
For the **operation phase**, the main impacts of the A. TH. Illidge Road WWTP upgrade will be positive, as this project will result in the improvement of the efficiency and processing of the wastewater that the WWTP receives. Therefore, **the quality of discharged wastewater will improve** and the **amount** of untreated wastewater (pollutant load) reaching connected waters (i.e. the Fresh Pond, Great Salt Pond, and Great Bay Beach) will decrease. The **quality** of the discharged wastewater is further discussed in the last few paragraphs of this section as a cumulative impact of both the upgrade/rehabilitation of the WWTP project and the Network Expansion project.

Contamination of water by the disposal of sludge in the landfill is not expected. As previously described, the current sludges comply with the international parameters and do not indicate any concern, which is expected to be maintained in the future.

For the **groundwater**, the new buildings foundations may contact the water level, but this will not be significant given the highly localized interventions. The excavations for the trenches will be shallow (1.5 m), and no impact on the water table is expected. The reduction of infiltration will also not be significant, due to the very localized areas. During excavation work for the foundations and hydraulic system (including during maintenance activities), appropriate precautions must be taken to ensure foundation stability and aquifer contamination. These impacts are not significant.

Since the current **noise** levels already exceed the Sint Maarten legal threshold, is important to take precautions against construction noise emissions for the nearby buildings, complying with current legislation (*Environmental Standards Sint Maarten 2023*) and periodically monitoring noise levels (not exceeding 3dB above the current environmental noise). The use of quieter equipment, machinery, and vehicles (a "quiet plant") constitutes the first step, also using, if necessary, noise barriers. It is important to note that work should not be performed at night. Contractor is required to develop his own labour grievance redress procedures, to manage concerns from their employees. The mechanism shall also be able to receive complaints from community. NRPB's Labour GRM is available for contracted workers when they are not comfortable submitting a complaint at the Contractor and also for the public.

For the operational noise, the physical barrier that will be built between the septic truck disposal and the building located at the south, along with the already existing vegetation belt around the WWTP will mitigate the operation noise impacts. The noise of aeration tank will be maintained but is not expected to increase the current noise levels. It is also possible to select aerators with less noise power or insulate them with mufflers, if periodic noise monitoring confirms the impact of these components. The dewatering building will surround all the sludge treatment equipment, providing a soundproof enclosure. The impacts on noise will not be significant.

Regarding **air quality**, during the construction phase, the main impacts on air quality result from the emission of suspended particles originating from the excavations and earthmoving. In addition, there will be emissions of typical pollutants related to vehicle traffic and the operation of machinery involved in the construction. Mitigations measures can reduce these impacts to not significant.

During operation phase, the operation of the WWTP will have some direct and indirect emissions. It was concluded that the carbon footprint of these emissions was insignificant compared with Sint Maarten annual emissions. For the odor emissions, a quantitative simulation was performed for the upgrade WWTP without and with mitigation measures (namely the pipe for the septic discharges from the trucks, the non-use of the SDB and the covered dewatering building). In both cases it was concluded that the legal odor limits are met, and for the mitigated project odor emissions are expected to less leading to improvements.

Wastes produced in the construction and operation phases (either non-hazardous or not) will will be controlled to ensure its proper collection, transportation, recovery, and final disposal. The impacts are not significant. Regarding sludge production and transportation, the situation will improve, either because of the less volume caused by the dewatering, and also because of the covered trucks.

Regarding **biodiversity**, the installation of the new buildings and new pipes for the water system in the construction phase will not affect the trees, but may only slightly affect herbaceous vegetation, all without protected status, with not significant impacts. The impacts on fauna biotopes and on fauna communities are also not significant.For the operation phase, the treated effluents will continue to be discharged into the Fresh Pond, with its margins still occupied by a strip of mangroves. Based on referenced literature, these discharges could have an important role in the aquatic ecosystem, providing nutrients for the maintenance of a riparian vegetation that provides biotopes for different fauna species. In fact, bird fauna in Fresh Pond still persists, feeding on the benthic communities. This type of stabilized pond provides essential food sources (algae, plankton) and resting spots.

Regarding **land use**, the impacts during the construction phase are associated with the operations involved in the assembly and installation of new buildings and trenches for the new hydraulic system pipes. The areas are low, being the dewatering building the new component with higher area (247.5 m2). No sensitive land uses will be affected. The impacts on land use already occurs in the construction stage, so for the operation stage, the impacts are inexistent.

Regarding the **landscape**, the impacts resulting from construction activities are linked to the presence of structures, permanent or temporary, such as the construction site and machinery, which can cause an undesirable visual impact, altering the natural landscape characteristics of the area. For the permanent buildings of the WWTP, these will not change significantly the current landscape, being easily integrated with the existing buildings. The trees will not be removed, maintaining the aesthetic and function that already exists.

At the **socioeconomic and human health level**, the construction phase activities may have several negative impacts, related to the influx of non-resident workers, conflicts with the local population, changes in life quality of the surrounding communities (traffic, noise, air quality, etc.), and impact on individual and community health. With mitigation measures, these impacts are not significant. Positive impacts are related to employment (preferentially with local workers) and effect on economic activities.For the operation, the main objective of the WWTP improvement project is to ensure the treatment of wastewater in one of the most populated areas of Sint Maarten, increasing its capacity and resilience. It primarily aims to reduce risks to public health and protect Sint Maarten's surface waters and beaches from environmental degradation, which is further discussed in the last paragraph of this section discussing the cumulative (positive) impacts of the both the upgrade/rehabilitation of the WWTP and the Network Expansion projects). For community health and safety during operation, it was confirmed that the odor emissions will be reduced with the upgrade project. Noise levels from the trucks will also be mitigated, besides the positive evolution of the number of trucks entering and exiting the WWTP, which will be better than what currently occurs on a daily basis. For the daily operation of the WWTP, an Emergency Preparedness and Response Plan (EPRP) will be developed. Water analysis should be undertaken to establish the need of additional treatment of WWTP effluents, which equipment are already considered for a future stage of the WWTP.

There may be **cumulative** negative impacts, during **construction phase**, between the network sewerage expansion project (for which there is a separate ESMP) and the WWTP upgrade/rehabilitation project, such impacts may include noise, air quality, traffic, waste/soil collection and disposal, wastewater, stormwater runoff, etc., but are mostly temporary and not significant. For the **operation phase**, the cumulative impact from both projects will be the **increase in quantity treated and discharged by the WWTP.** There will be an increase in flow quantity due to the separate network expansion project increasing the number of household connections. Regarding this increase in quantity, with implications on the potential flooding of the surrounding areas, it was calculated that the current 23 discharges per year that occur when precipitation is higher than 10 mm per day will not be changed, so the current situation will not be worsened. Additionally, with the increase in household connections and the increase in efficiency of the WWTP, there will be a reduction in the number of septage trucks carrying wastewater from households to the WWTP, thereby reducing the risks of spillage caused and further reducing the amount of untreated wastewater reaching connected waters. Regarding noise impacts, the reduction in septic trucks will also reduce the impact of noise in the local areas. However, the number of trucks taking processed sludge for disposal will be slightly increased, associated with the greater volume of the produced sludge, with 1 truck per day (22 per month); even so, this increase along with the decrease of septic trucks will always be a better situation than what currently occurs on a daily basis. Furthermore, with regard to impacts of odor emissions, although the number of sludge trucks will increase because of the higher volume of produced sludge, they will be completely covered and will not result in any additional odor emissions.

For the **quality** of the aquatic ecosystem, it was assessed that the projected Phosphorus (P) load to the Fresh Pond by 2055 will decrease 3% and for Nitrogen (N) there will be an increase of 33%. It is not expected any accumulation of N in the Fresh Pond water, since N load entering the lagoon equals the load leaving it in suspended and soluble forms which are transported by the outlet flow into the sea (Great Bay Beach) or for Great Salt Pond. It was also concluded that the Fresh Pond has a renewal rate of 26 times per year by precipitation and flushing, which prevents persistent eutrophication caused by N accumulation and limits long-term ecological imbalance. The current ecological status will not change significantly with the cumulative impacts of both projects. Based on periodic monitoring results and if needed, the proposed WWTP upgrade system will allow for future implementation of P and N treatment (subject to a suitable source of financing), which would lead to an improvement of the discharge quality. Also, to control the impact of this N outflow into the Great Bay Beach, which already has levels of N above the recommended threshold, is important to maintain the periodic monitoring of nitrogen already ongoing to assess its evolution and impact on the existing seagrass beds that occur in this area.

In terms of cumulative socioeconomic impact of the sewerage network expansion and the upgrade/rehabilitation of the WWTP, by receiving and treating the sewerage of more households, that currently discharge directly into the Fresh Pond and the Great Salt Pond, and indirectly to the Great Bay Beach, without any treatment, is expected less contamination of coliforms and nutrients in these wetlands that will have a positive impact in the preservation of the country's extraordinary natural assets and enhance the sustainability of recreation for residents and the tourism economy, while also ensuring compliance with the Sint Maarten Sewage Policy 2022. Since about 23 times/year, during the rainy season, there may be discharges from the Fresh Pond (or through the Great Salt Pond) to the Great Bay Beach, it is important, for periods of 48 to 72 hours after these discharges, to implement a public health advisory system following international best practices. Monitoring of water quality (ponds and sea) must also be maintained to ensure that nutrient levels do not cause ecological damage, such as algal bloom, that have impact on the water quality and beach aesthetic. If needed, and when economically feasible, P and N additional treatment could be implemented in the WWTP. In this sense, the impacts of the WWTP rehabilitation will always be positive and highly significant, due to the better environment and associated economic growth. The sludge will also be improved (dewatered and correctly transported from the WWTP), which will positively impact their deposit locations, regardless of whether it is the Pond Island landfill or elsewhere.

Ultimately, both projects will contribute for a better collection of the wastewater from the surrounding neighbourhoods and a better treatment of these wastewaters, with positive impacts for the downstream environment, namely the Fresh Pond and the Great Bay, with positive consequences for tourism and aquatic and marine ecosystems.

6. PUBLIC CONSULTATIONS PERFORMED

The public consultation process was divided in two steps. The first one (individual meetings) to collect baseline information for the project and for the ESIA, and the second one (workshop) to present the updated project design and the ESIA findings based on that new design.

The individual meetings were arranged by NRPB with some stakeholders. In each presential meeting, the project was presented and contributions of each stakeholder in their area of interest were collected and discussed.

In a second stage, a formal public consultation was held on December 10th 2025, with the main stakeholders (VROMI, NRPB, ONGs, general public) to present the findings of the ESIA and the mitigation measures defined for the assessed impacts of the WWTP Rehabilitation project and other aspects of the project. The meeting gathered the contributions on the ESIA, which, when pertinent for the study, were incorporated in the ESIA. This formal public consultation was also arranged by NRPB, with the presence of the Consultant. All the elements from the Public Consultation can be consulted in Annex 6 of the ESIA.

7. MITIGATONS MEASURES

As already described in Section 2 of this Executive Summary, the updated project already incorporates, in its design, ways of mitigating some of the major impacts that are associated with the WWTP operation.

For the construction and operation stages, other mitigation measures were also proposed, as presented in the following tables A and B.

For both the construction and operation phases, mitigation measures have been proposed to lessen, minimize, and manage potential significant impacts in accordance with Sint Maarten legislation and World Bank ESF. These measures will be formalized in an Environmental and Social Management Plan that addresses environmental and social monitoring, the implementation of mitigation measures, and risk management. Adequate human resources should be allocated to monitor and manage the successful implementation of the proposed mitigation measures and immediate actions to address any risks.

After the implementation of the planned measures, the majority of the negative impacts are not significant, while in the case of positive impacts, the measures amplify these impacts, increasing their significance. The potential negative impact in the operation stage related to the increase of WWTP effluent discharges into the Fresh Pond (and the potential changes this may have to the nutrient and microbial load) is not expected to result in any significant change to the current situation.

Table A – Mitigation Measures and Significance of Residual Impacts in the Construction Phase

Impact			Significance before mitigation	Mitigation Measures
n	Impact	Description		
	Geological and Hydrogeological affectation	Buildings / trenches	(-) 15 (NVS)	**MC1 - Restrict work to the minimum necessary for the execution of the works.** **MC2 - Excavation and landfill work must be interrupted during periods of heavy rainfall and appropriate precautions must be taken to ensure the stability of the trenches** **MC3 - Use previously selected materials from excavations as backfill material to minimize the volume of excess soil and ensure proper soil management.**
		Construction site	(-) 10 (NS)	
	Soil contamination	Buildings / trenches / Construction site	(-) 8 (NS)	**MC4 - If the water table is affected, appropriate excavation methods must be selected to mitigate all possible contamination situations.** **MC5 - At the end of the work, the unpaved soils must be decompacted and turned over in the areas used to support the work, in order to decompress and aerate them, thus reconstituting, as far as possible, their structure and balance.** **MC6 - Before earthmoving work, strip the soil and store it in containers for later reuse in areas affected by the work.** **MC7 - Use existing accesses (Ilidge Road) to avoid creating new accesses** **MC8 - Have "Anti-Spill Kit" available in heavy vehicles and next to machines;**
	Emissions of GHG	Construction activities	(-) 14 (NVS)	**MC1 – (see above)** **MC9 - Perform periodic maintenance on machinery, heavy and light vehicles allocated to the work, to ensure good operating conditions, thus reducing noise and combustion gas emissions and avoiding spills.** **MC10 - Turn off machines and vehicles when not in use;** **MC11 - Establish fixed routes for the movement of machinery, heavy vehicles and light vehicles.**
c	Changes in surface drainage and runoff	Buildings / trenches	(-) 16 (MS)	**MC1 – (see above); MC2 – (see above)** **MC12 - In the works closest to Fresh Pond, install silt curtains to limit the dispersion of soil and pollutants in the water body.** **MC13 - Use permeable paving that allows water infiltration, using materials such as permeable concrete, which facilitates drainage and water absorption in the soil.** **MC14 - Generators must be stored in waterproof locations or on top of an oil and hydrocarbon retention basin.**
	Water quality	Construction site	(-) 14 (NVS)	
	Infiltration reduction	Buildings	(-) 14 (NVS)	**MC1 – (see above); MC4 – (see above); MC8 – (see above); MC9 – (see above); MC14 – (see above)**
	Water quality	Buildings / trenches / Construction site	(-) 10 (NS)	
	Increased noise levels	Construction activities	(-) 15 (NVS)	**MC7 – (see above); MC9 – (see above); MC10 – (see above); MC11 (see above)** **MC15 - Purchase, whenever possible, soundproofed equipment or implement soundproofing techniques in equipment;** **MC16 - Mandatory use of PPE - earplugs for workers handling heavy machinery and vehicles** **MC17 - Plan to monitor noise levels if there are complaints during construction.**

Impact			Significance before mitigation	Mitigation Measures
n	Impact	Description		
	Dust dispersion	Construction activities	(-) 13 (NVS)	MC7 – (see above); MC9 – (see above); MC10 – (see above); MC11 – (see above); MC18 - Mandatory use of PPE - masks by workers when carrying out activities that emit particles; MC19 - Carry out regular spraying, especially on dry and windy days, of work fronts to reduce dust; MC20 - Construction materials must be packaged and covered, such as with a tarpaulin, to prevent thinner materials, such as aggregates and other materials, from being blown away by the wind. Also, cover the open boxes of earthmoving vehicles;
	Pollutant gas emissions	Operation of machinery	(-) 14 (NVS)	
	Waste production and management	Construction activities	(-) 13 (NVS)	MC21 - Implementation of Waste Management Plan
	Vegetation and biotopes affectation	Buildings	(-) 14 (NVS)	MC1 – (see above); MC8 – (see above); MC9 – (see above), MC12 – (see above); MC15 – (see above); MC19 – (see above); MC20 – (see above) MC22 – All staff from the Contractor must be aware of the surrounding biodiversity, with special emphasis on Fresh Pond. Training sessions prior to works must be held. MC23 - Land clearing, with removal of vegetation, should only occur in areas strictly necessary for the work, avoiding, whenever possible, the felling of trees. MC24 - Carry out machinery movements and worker movements at times that minimize disturbance to wildlife, avoiding breeding periods or times when animals are most active. MC25 - Choose construction site locations with reduced vegetation, reducing interference with valuable soils and sensitive natural habitats, avoiding areas with high biodiversity and critical ecosystems;
		Construction site	(-) 10 (NS)	
	Fauna Disturbance and Mortality	Construction activities	(-) 13 (NVS)	
	Land use affectation	Buildings	(-) 16 (MS)	MC1 – (see above); MC25 – (see above)
		Construction site	(-) 11 (NS)	
	Visual intrusion	Buildings	(-) 13 (NVS)	MC1 – (see above); MC25 – (see above); MC26 - Whenever possible, position construction structures and materials in locations that minimize their visual impact, in areas that are already disturbed, reducing visibility in panoramic views.
		Construction site	(-) 10 (NS)	
	Improved Employment and Economy	Construction activities	(+) 14 (NVS)	MC27 - Implement a Recruitment and Vocational Training Plan that prioritizes the inclusion of local workforceand promotes equal employment opportunities for men and women, MC28 - Establish partnerships with local suppliers and companies in the project's areas of influence to purchase materials, goods, and services. MC29 - Implementation of Health&Safety Plan that include work procedures as well as a regular Training Plan on workplace safety and community relations (Code of Conduct) MC30 - Implement a Traffic Plan that establishes periods for the circulation of heavy vehicles as well as speed limits within the perimeters of the areas affected by the project. MC31 - Implement a Labour and Community Grievance Redress Mechanism (GRM) within the construction site, , under Contractor's responsibility
	Staff Circulation	Construction activities	(-) 13 (NVS)	
nd	Conflicts with the Local Population	Construction activities	(-) 15 (NVS)	
	Change in Quality of Life	Construction activities	(-) 15 (NVS)	
	Impact on Individual and Community Health	Construction activities	(-) 15 (NVS)	

Legend: NS – Not Significant; NVS – Not very Significant; MS – Moderately Significant; S - Significant

Table B – Mitigation Measures and Significance of Residual Impacts in the Operation Phase

Impact			Significance before mitigation	Mitigation Measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
Geology and Geomorphology	Geological affectation	Pipes maintenance	**(-) 8 (NS)**	**MO1 - Restrict work to the minimum necessary for the execution of the maintenance works.** **MO2 - Excavation and landfill maintenance work must be interrupted during periods of heavy rainfall and appropriate precautions must be taken to ensure the stability of the trenches.** **MO3 - Use previously selected materials from excavations as backfill material to minimize the volume of excess soil and ensure proper soil management.**	**(-) 5 (NS)**
	Seismic risk	Buildings	**(-) 13 (NVS)**		**(-) 10 (NS)**
Soil	Soil contamination	Accidental spills and Maintenance Actions	**(-) 8 (NS)**	**MO4 - Have "Anti-Spill Kit" available in heavy vehicles and next to machines;** **MO5 - Perform periodic maintenance on WWTP equipment, heavy and light vehicles allocated to the work, to ensure good operating conditions, thus reducing noise and combustion gas emissions**	**(-) 5 (NS)**

Impact			Significance before mitigation	Mitigation Measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
				and avoiding spills.	
		Sludge contamination	**(-) 12 (NVS)**	**MO6 - Proper deposition of sludge layers in the landfill**	**(-) 9 (NS)**
Climate Change	Effect on Climate Change (GHG Emissions)	Equipment operation	**(-) 15 (MVS)**	**MO5 – (see above);** **MO7 – Improvement of power consumption with more efficient aerators and SCADA system**	**(-) 12 (NVS)**
	Effect of Climate Change (project adaptation)	Structural and operational strategies	**(-) 14 (NVS)**		**(-) 11 (NS)**
Superficial Hydric resources	WWTP Discharges	Fresh Pond Quantity	**(-) 18 (MS)**	**MO2 – (see above); MO4 – (see above); MO5 – (see above)** **MO8 - Control trucks when unloading septic tanks**	**(-) 15 (NVS)**
		Fresh Pond Quality	**(+) 16 (MS)**	**MO9 - Maintain periodic monitoring of the quality of inlet and outlet water, as well as sludge, with the current frequency already ongoing**	**(+) 16 (MS)**
	Ponds discharge	Great Bay Quality	**(+) 15 (NVS)**	**MO10 - Maintain the period water quality monitoring of Great Bay, with the current frequency already ongoing**	**(+) 15 (NVS)**
	Sludge disposal	Quality	**(-) 16 (MS)**	**MO6 – (see above)**	**(-) 13 (NVS)**
Groundwater resources	Water quality	Possible rupture and maintenance activities	**(-) 9 (NS)**	**MO4 – (see above); MO5 – (see above)**	**(-) 6 (NS)**

Impact			Significance before mitigation	Mitigation Measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
Noise	Increased noise levels	Equipment operation	**(-) 14 (NVS)**	**MO5 – (see above)**	**(-) 11 (NS)**
Air quality	Pollutant gas emissions	Trucks circulation	**(-) 11 (NS)**	**MO5 – (see above); MO7 – see above** **MO11 - Keep trucks tightly covered during sludge transportation.**	**(-) 8 (NS)**
		WWTP emissions	**(-) 15 (NVS)**		**(-) 12 (NVS)**
	Odor emission	Equipment operation	**(-) 14 (NVS)**		**(-) 11 (NVS)**
		Sludge transportation	**(-) 11 (NS)**		**(-) 8 (NVS)**
Waste	Waste production and management	Operation activities	**(-) 14 (NVS)**	**MO12 - Implementation of Waste Management Plan** **MO13 - Documents related to the amount of sludge sent to the licensed disposal company and related documents shall be prepared for monitoring** **<u>MO14 – Articulation between the sludge disposal location and the closure process of Pond Island landfill</u>**	**(-) 11 (NVS)**
	Sludge production	Deposition	**(-) 12 (NVS)**		**(-) 9 (NVS)**
Biodiversity	Fresh Pond Ecosystem quality	Effluents discharge	**(+) 16 (MS)**	**MO1 – (see above); MO4 – (see above); MO5 – (see above); MO8 – (see above); MO9 – (see above)** **MO15 – Maintain bird monitoring in Fresh Pond and other IBAs, with the current frequency**	**(+) 16 (MS)**

Impact			Significance before mitigation	Mitigation Measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
				already ongoing **MO16 - Maintain the landscape setting of the facilities**	
	Great Bay Ecosystem quality	Ponds discharge	**(+) 14 (NVS)**	**MO10 – (see above)** **MO17 – Maintain the aquatic communities monitoring in Great Bay, with the current frequency already ongoing**	**(+) 14 (NVS)**
Socioeconomy and Public health	Improved Sanitation Conditions	Operation activities	**(+) 19 (MS)**	**MO8 – (see above); MO9 – (see above); MO10 – (see above); M11 – (see above);** **MO18 - Establish partnerships with local suppliers and companies in the project's areas of influence to purchase materials, goods, and services.** **MO19 - Implement a Recruitment and Vocational Training Plan that prioritizes the inclusion of local workforce and promotes equal employment opportunities for men and women.** **MO20 - Implementation of Health &**	**(+) 19 (MS)**

Impact			Significance before mitigation	Mitigation Measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
				Safety Plan that includes work procedures as well as a regular Training Plan on workplace safety and community relations (Code of Conduct) **MO21 - Establish a Labour and a Community Grievance Redress Mechanism (GRM) within the WWTP facility**	
	Improved Employment and Economy	Operation activities	**(+) 14 (NVS)**		**(+) 14 (NVS)**
	Health & Safety risks	Operation activities; Emergency situations	**(-) 13 (NVS)**		**(-) 10 (NS)**
		Use of Great Bay	**(-) 14 (NVS)**	**MO21 – (see above)** **MO22 - Implement a public health advisory system for the overflows of the Great Bay, whenever needed (based on water quality monitoring and/or precautionary measure)**	**(-) 11 (NS)**
	Communication	GRM	**(+) 24 (S)**	**MO21 – (see above)**	**(+) 24 (S)**

Legend: NS – Not Significant; NVS – Not very Significant; MS – Moderately Significant; S – Significant

Table C – Mitigation Measures and Significance of Residual Cumulative Impacts in the Operation Phase

Impact			Significance after mitigation	Mitigation measures (see Table B for detailed description)
Thematic area	**Impact**	**Description**		

Soil	Soil contamination	Sludge disposal	**(-) 10 (NS)**	**MO6**
Superficial Hydric resources	WWTP Discharges	Quantity in Fresh Pond	**(-) 17 (MS)**	**MO2; MO4; MO5; MO8; MO9**
		Quality in Fresh Pond	**(-) 15 (NVS)**	
	Ponds discharge	Quality in Great Bay	**(-) 14 (NVS)**	**MO10**
	Sludge disposal	Quality	**(-) 13 (NVS)**	**MO6**
Air quality	Pollutant gas emissions	Trucks circulation	**(-) 10 (NS)**	**MO5; MO7; MO11**
	Odor emission	Sludge transportation	**(-) 8 (NS)**	
Waste	Sludge production	Deposition	**(-) 9 (NS)**	**MO12; MO13**
		Articulation with Pond Island landfill closure	**(+) 14 (NVS)**	**MO14**
Biodiversity	Fresh Pond Ecosystem quality	Higher volumes of Effluents discharge	**(-) 16 (MS)**	**MO15; MO16**
	Great Bay Ecosystem quality	Ponds discharge	**(-) 12 (NVS)**	**MO17**
Socioeconomy and Public health	Improved Sanitation Conditions	Operation activities	**(+) 22 (S)**	**MO8; MO9; MO10; MO11; MO20; MO21**
	Health & Safety risks	Use of Great Bay	**(-) 13 (NVS)**	**MO22**

NATIONAL RECOVERY PROGRAM BUREAU

GOVERNMENT OF SINT MAARTEN

DESIGN AND SUPERVISION OF WASTEWATER NETWORK AND WWTP

CONTRACT NO.: SX-NRPB-367262-CS-QCBS

REHABILITATION OF A.TH. ILLIDGE ROAD WASTEWATER TREATMENT PLANT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

1. INTRODUCTION

1.1 Framework

Sint Maarten's sewerage network coverage is very limited, covering only some districts and neighbourhoods. There is only one public biological treatment plant currently in operation (**A.TH. Illidge Road Wastewater Treatment Plant**) with a treatment capacity of approximately 4,500 m³ of sewage and septage per day. However, due to the incomplete sewerage network across Sint Maarten, the wastewater treatment plant is currently operating at about 65% of its hydraulic capacity and 80% of its pollution load capacity.

The Sint Maarten Recovery, Reconstruction and Resilience Trust Fund (the 'Trust Fund') was established to respond to the devastation caused by Hurricane Irma in September 2017. The Trust Fund is fully financed by the Government of the Netherlands for up to 470 million euros (US $553 million) and is administered by the World Bank. On behalf of the Government of Sint Maarten, the NRPB is responsible for the preparation, implementation and evaluation of most of the projects that are financed by the Trust Fund. The Wastewater Management Project, which is made up of three (3) components, including the upgrade and operation of the Wastewater Treatment Plant (WWTP) (Sub-component 1.2), is co-funded by the Sint Maarten Recovery and Reconstruction Trust Fund and the Government of Sint Maarten. Part of this funding is intended for consulting services, namely the "**Design and Supervision of Wastewater network and Wastewater Treatment Plant**" and investments in wastewater are proposed to be funded under the Trust Fund. The consultancy aims to identify a viable, feasible, and responsible plan for upgrading the wastewater treatment plant (WWTP) and expanding the sewer network in the Greater Cul de Sac area, with the assessment of the environmental and social conditions, risks, and impacts of the WWTP and evaluation of the capacity of water bodies to handle effluent discharge.

The **Rehabilitation of the A.TH. Illidge Road Wastewater Treatment Plant** project may have impacts on the biophysical environment and/or the human and socioeconomic environment. This Environmental and Social Impact Assessment (ESIA) identifies s those impacts and proposes the adequate mitigation measures, which for the construction and operation phases will be further detailed in an Environmental and Social Management Plan (ESMP).

This ESIA considers only the impacts of the upgrade/rehabilitation of the WWTP assuming a specific scenario of expansion of the household connections. However, the impacts and mitigation measures of the works to expand the sewerage network and increase household connections in Cul-de-Sac are described in a separate environmental and social management plan that has been prepared for this parallel project.

1.2 Project Background and Justification

Sint Maarten is a constituent country of the Kingdom of the Netherlands and has the highest population density in the Caribbean. Spurred by economic development, the island's population has been steadily increasing over the past several decades, which in addition to the increase of tourism, causes notable pressure on the country's infrastructure and services (water, wastewater, electricity, health, etc.)

Sint Maarten is highly vulnerable to natural disasters and adverse climatic events due to its location within the hurricane belt. Due to the small size of the country, a single storm has the potential to impact the entire population directly. High winds, rainfall, and flooding are the principal risk factors while the country is also vulnerable to earthquakes. Coastal areas are exposed to flood risk from sea level rise, storm surge and potential tsunamis. Increased urbanization, climate change, and limited capacity in the country to build resilience adds to its vulnerability to natural hazards.

In April 2018, to support rapid and sustainable recovery from Hurricane Irma, the Government of the Netherlands established the Sint Maarten Recovery, Reconstruction and Resilience Trust Fund (Trust Fund) for up to EUR 470 million to be managed by the World Bank. The Trust Fund is governed by a Steering Committee composed of representatives from the Government of Sint Maarten (GoSM), the Netherlands, and the World Bank. Since July 2018 selected activities that include housing repair, school repair, health facilities and services improvement, and social safety nets have been implemented under the framework of the Sint Maarten National Recovery and Resilience Plan (NRRP). To carry-out the implementation of the Trust Fund, the Government of Sint Maarten established the National Recovery Program Bureau (NRPB), which serves as the Project Implementation Unit (PIU) for the Government of Sint Maarten.

Investments in wastewater are proposed to be funded under this Trust Fund, to reduce risks to public health and protect Sint Maarten's Surface waters, ground water and coastal areas (beaches etc.) from environmental degradation, preserving the country's extraordinary natural assets and enhancing the sustainability of recreation for residents and the tourism economy. The proposed project will directly contribute to the sustainable economic recovery of SXM, through resilient utility services and improved sanitation services.

The **A.TH. Illidge Road Wastewater Treatment Plant** (co-funded by GoSM and the Netherlands) is not currently operating at its full capacity. An improvement of the WWTP operation and maintenance practices (Sub-component 1.2) will contribute to balance overall performance as well as to reduce pollution risks of water bodies and allows compliance with the Sint Maarten Sewerage Policy 2022. This rehabilitation is required to bring proper treatment of both the flows from the existing network and additional wastewater flows that will be collected through the Project financed sewerage network expansion (Sub-component 1.1) in line with the existing effluent discharge requirements.

1.3 ESIA objective

The general objective of this Environmental and Social Impact Assessment (ESIA) is to identify the impacts of the proposed upgrading of the WWTP. It considers the risks and impacts that may arise during the construction of the upgrades and the operation after these improvements.

The impacts associated with the additional sewage inflow and discharges that will be part of the future operation of the upgraded WWTP are considered cumulative impacts, related to the parallel project of the sewerage network expansion.

The ESIA has the following specific objectives:

- Define the E&S baseline conditions within the project area of impact, considering direct and indirect risks and impacts of the project.
- Identify and assess potential negative and positive significant environmental and social impacts (biophysical, socioeconomic, and related to worker and community health and safety) arising from the construction and operational phases of the project;
- Identify measures that can mitigate negative impacts and increase positive impacts, and incorporate these into the technical design, construction and/or operational phases of the project. The construction and operational mitigation measures will be described in an Environmental and Social Management Plan (ESMP) developed by the NRPB.

Across the ESIA process, the public consultation was undertaken in parallel, collecting all the necessary information and feedback on proposals from the main stakeholders, with the consequent improvement of the environmental and social assessment and technical design.

1.4 Project Owner and ESIA Technical Team Identification

The **Rehabilitation of A.TH. Illidge Road WWTP** is the responsibility of the Minister of Public Housing, Spatial Planning, Environment and Infrastructure (VROMI). The Ministry of VROMI can be contacted via the following:

Address: Soualiga Road #1, Pond Island, Great Bay - Sint Maarten;

E-mail: info.vromi@sintmaartengov.org;
Website:https://www.sintmaartengov.org/Ministries/Public-Housing,-Spatial-Planning,-Environment-and-Infrastructure/Pages/default.aspx

The Ministry of VROMI is the specialized government department in Sint Maarten responsible for overseeing and managing matters related to public housing, spatial planning, environmental protection, and infrastructure development. Within these subject matters, the Minister of VROMI has various responsibilities including overseeing, planning, developing, and maintaining the infrastructure in Sint Maarten. This includes transportation networks, energy infrastructure, telecommunications, and water and sanitation systems. The Minister may collaborate with relevant stakeholders, including public and private entities, to improve infrastructure resilience, enhance connectivity, and promote sustainable infrastructure development

The preparation of the Technical Designs and the Environmental and Social Impact Assessment (ESIA) was carried out by the Consortium of two Portuguese companies ENGIDRO Engineering Solutions (Leader) & PROCESL Engenharia Hidráulica e Ambiental, with the collaboration of a Barbados company SUBSURFACE Imaging Co.

The contact details of the Consortium Consultants are as follows:

ENGIDRO	**PROCESL**
Rua Laura Alves 12, Piso 6 1050-138 Lisboa – PORTUGAL https://engidro.pt/	ALFRAPARK, Estrada do Seminário, 4 - Edifício C - Piso 1 Sul, 2614-519 Amadora - PORTUGAL https://www.procesl.pt/
SUBSURFACE The Cottage", Nursery Park, Nursery 2 - Four Roads, St Philip - BARBADOS https://subsurface.pro/	

The ESIA was prepared between August and September 2025, by the technical team indicated in Table 1-1.

Table 1-1 – Technical Team of ESIA

Experts	AFFILIATION	INTERVENTION AREAS
Susana Baptista	Consultant	General Coordination Environmental and Social Specialist / Occupational Health and Safety Specialist Public Consultations
Aline Pereira	Consultant	Social and Gender Specialist
Susana Costa	Consultant	Environmental Quality
António Jorge Monteiro	ENGIDRO / PROCESL	Hydric Resources / Water Quality
David G. Lee	Consultant	Biology and Ecology
Pedro Póvoa	Consultant	Wastewater Process Engineer
Margarida Collaço	Consultant	Environmental and Social Management Plan
Tiago Nogueira	Consultant	GIS and Mapping

1.5 ESIA Structure

The ESIA is developed and organized into (i) an Executive Summary (a summary of the main information contained in the ESIA); and (ii) an Environmental and Social Impact Study Report, including the necessary Annexes. The following table identifies the chapters included in the main documents.

Table 1-2 – ESIA Structure

Main Report, subdivided into the following chapters
• Executive Summary, which summarizes the content of the ESIA;
• Chapter 1, corresponding to the General Introduction, where the Project, Scope, Proponent and Technical Team of the ESIA are identified, together with the framework and structure of the ESIA;
• Chapter 2, corresponding to the Project Description, where the project solutions are located and described;
• Chapter 3, where the project's direct and indirect areas of influence boundaries and the general methodology applied to the ESIA are identified
• Chapter 4, which characterizes the Legal, Regulatory and Political Framework for the implementation of the Project
• Chapter 5, corresponding to the Environmental Diagnosis, in its various components: physical factors, environmental quality, ecological, human and planning factors, and the evolution of the current situation without the project;
• Chapter 6, Public Participation, provides details of the stakeholder mapping and analysis and consultation undertaken as part of the ESIA;
• Chapter 7, corresponding to the Identification and Assessment of Project Impacts, with an assessment of impacts by thematic area, also including the No Project Situation and cumulative impacts.

Main Report, subdivided into the following chapters
• Chapter 8, which presents the Mitigation Measures to be adopted to decrease negative impacts and enhance positive impacts;
• Chapter 9, with the description of institutional responsibilities in terms of management of environmental and social procedures
• Chapter 10, which directs to the ESMP as an annex of the ESIA document
• Chapter 11 and Chapter 12, with the identification of information gaps and the main conclusions and recommendations
Annexes, with all specific studies, public participation documents and drawings

2. PROJECT DESCRIPTION AND CONSIDERED ALTERNATIVES

2.1 Project Location

The country's single existing public biological treatment plant located on **A. TH. Illidge Road** (originally constructed in 1992, upgraded and enlarged in capacity in 2013), is designed to service the Greater Philipsburg area (including Upper Prince's Quarter and the Lower Prince's Quarter areas) and other sewered districts, included in the mostly residential Cul-de-Sac area.

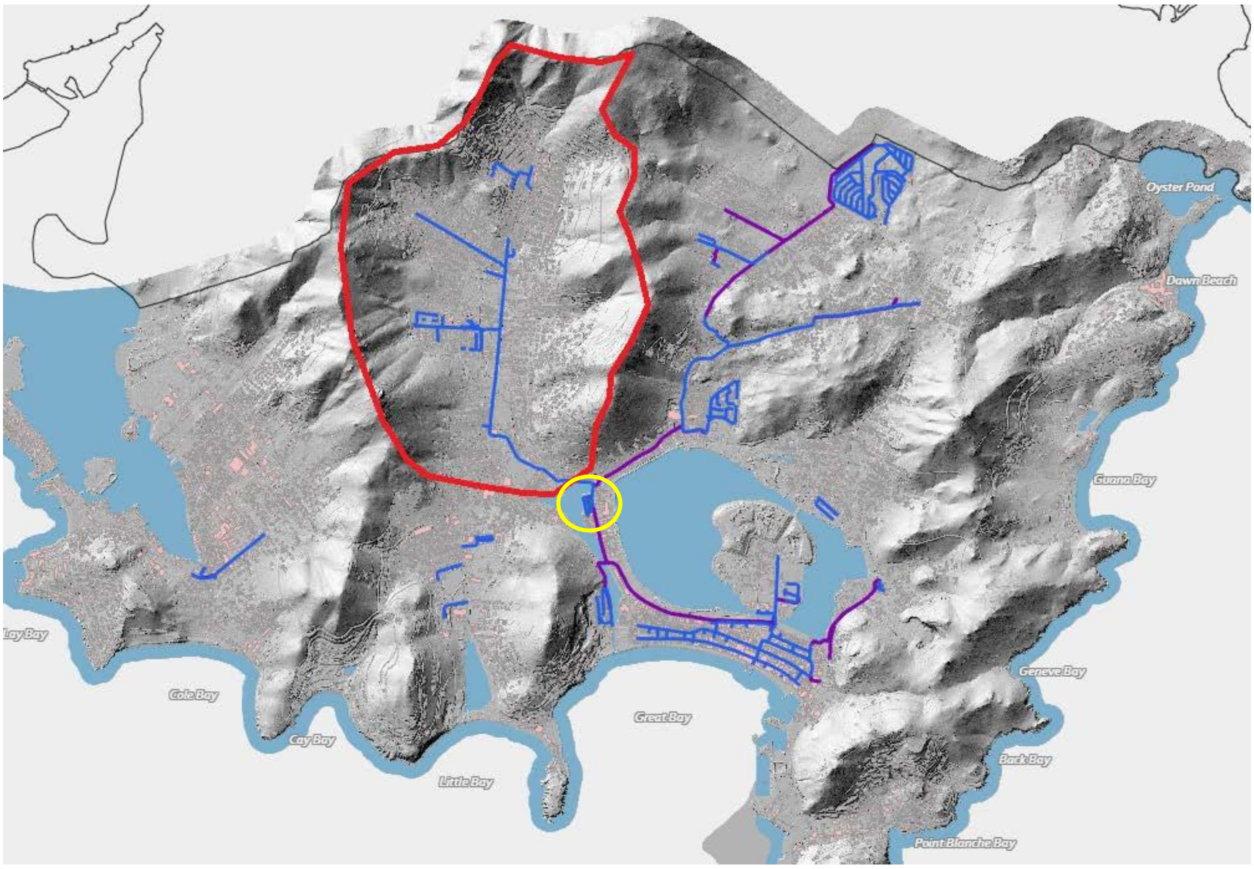

Figure 2-1 – Location of A.TH. Illidge Road WWTP (yellow circle). Cul de Sac Area is limited by the red line.

In **ANNEX 1**, a more detailed drawing is presented with the location of the WWTP and the main components currently existing.

2.2 Existing situation

2.2.1 Existing WWTP components

As previously mentioned, the current **A. TH. Illidge Road WWTP** is operating at about 65% of its hydraulic capacity, and at 80% of its pollution load capacity. The WWTP was originally constructed in 1992, upgraded and enlarged in capacity in 2013.

Figure 2-2 – Aerial photos from the WWTP location before and after the first upgrade and enlargement[1]

The WWTP influent arrives from different sources: a) Philipsburg; b) septic wastes from household and commercial activities transported by trucks and c) wastewater from Belvedere and the Dutch Quarter neighbourhood.

The current design capacity corresponds to 60,000 eq. inhabitants, with a hydraulic capacity of 4715 m3/day. The facility occupies a total site area of approximately 1.12 hectares

As is seen in Figure 2-3 (more detailed in **ANNEX 1**), the main components within the enclosure of the WWTP, divided by treatment stages, are:

[1] Photos grateful allowed to use by the WWTP Operator

Figure 2-3 – Current WWTP components

1 - Reception of wastewater by trucks

- Septic tank discharge sump (**04**) – location where the trucks discharge the effluents from domestic septic tanks. The number of daily truck discharges varies between 50 and 100, depending mainly on rainfall events. Simultaneous discharge of two trucks is possible.

  The type of effluent discharged from the trucks consists of typical brown sludge and in some cases yellowish wastewater, without the presence of sludge, but with some coarse solids.

  The connection between the septage truck reception system and the initial pumping station is made via a gravity-fed section.

Photo 2-1 - Septage tank discharge sump

Based on historical data, the typical number of trucks received during the dry season has remained in the range of 45–50 trucks/day, while during wet weather conditions the daily number may rise significantly, reaching 100–120 trucks/day. Assuming a typical median load of 10 m^3 per septage truck, this corresponds to an estimated daily septic volume of approximately 550 m^3/day under dry-weather conditions, increasing up to 1,200 m^3/day during wet weather.

2 - Pre-Treatment Stage

- Screen and Filter (**05**) - crucial initial step in wastewater treatment that protects downstream equipment and enhances process efficiency by removing large debris and heavy inorganic materials. At the influent pumping station, wastewater is lifted to a sufficient elevation to allow subsequent treatment processes to proceed by gravity flow. Following pumping, the influent passes through a coarse screen for the removal of large solids.

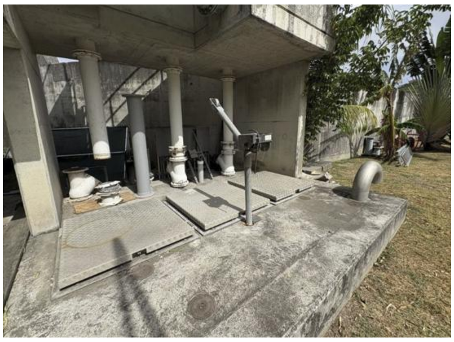

Photo 2-2 – Initial pumping station

3 - Primary Treatment

- Settling tank (**12**) – currently out of service. It is used to remove part of the suspended solids and the removal of organic matter linked to the suspended solids;

Photo 2-3 – Primary settling tank

- IMHOFF tank (**11**) – currently out of service. It's a two-story structure with an upper settling chamber and a lower sludge digestion chamber

Photo 2-4 – IMHOFF tank building

4 - Secondary Treatment

- Aeration (AT) tank (**06**) - Use aeration to introduce oxygen, which promotes the growth of bacteria and other microorganisms that break down organic matter (biologic treatment). The agitators of the 3 selectors are in operation.

  Within the Aeration tank, biological phosphorus removal is facilitated. Under anaerobic conditions, phosphorus-accumulating organisms (PAOs) take up readily degradable substrates while releasing orthophosphate into the liquid phase. In subsequent anoxic and oxic conditions within the Aeration Tank, the PAOs reabsorb phosphate in excess of the initial release, a mechanism commonly referred to as "luxury uptake."

  The mixed liquid subsequently enters the biological reactor, where biological treatment is carried out by the activated sludge biomass. The Aeration Tank is configured to facilitate simultaneous carbon, nitrogen, and phosphorus removal through the establishment of controlled oxic and anoxic zones. Aeration is provided by two vertical mechanical aerators, while a propeller mixer ensures adequate hydraulic mixing and flow velocity within the tank.

  In the aerobic zones, organic matter (COD/BOD) is biodegraded, and nitrification occurs, converting ammonium (NH_4-N) to nitrate (NO_3^-). Nitrate-rich mixed liquor is internally recirculated to the anoxic zones, where denitrification reduces nitrate to nitrogen gas under oxygen-limited conditions.

Photo 2-5 – Aeration tank with the biologic reactor

Within the structure of the Aeration tank (**06**), in its south limit, is the Selector, that promotes the formation of compact activated sludge flocs and suppresses the growth of filamentous bacteria, thereby enhancing sludge settleability. Excessive filamentous growth can result in floating sludge and washout of solids into the secondary settling tank, adversely impacting effluent quality.

Photo 2-6 – Selector tanks (located at the south limit)

- Settling tank (**07**) - secondary settling process usually after the biological process, where solid–liquid separation occurs under the influence of gravity**.** Here, the bacteria that have grown in the previous process precipitate to the lower part of the settling tank, generating a mixture of water and solids, which is called biological sludge. This mixture is extracted or flushed out through the lower part of the decanter and the purified water flows out through the upper part without most of the bacteria and solids, giving rise to clarified water.

  Clarified effluent, without any desinfection, is discharged by gravity into Fresh Pond, flowing from there via a channel towards the sea, while settled activated sludge is returned to the process via pumping to the Selector inlet to maintain biological activity and process stability.

Photo 2-7 – Secondary settling tank, with purified water (top photos) and control system before the discharge at Fresh Pond (down photos)

5 - Sludge Treatment

The bacterial mass in the aeration tank continuously grows when there is feeding (organic matter in the influent). The amount of biomass = activated sludge that is added daily, depends mainly on the amount of organic matter in the influent. The more organic matter, the more bacterial growth, the more activated sludge.

Since the dry matter content in the aeration tank must remain constant (design 3.5 g/L), the excess activated sludge must be removed. This occurs by withdrawing waste activated sludge (WAS) from the secondary settling tank. This surplus sludge is gravimetrically thickened in the Surplus Sludge Thickener (Photo 2-8). The thickened sludge is then periodically pumped to the sludge drying beds (SDB) where it dries (Photo 2-10) with 1+1 progressive cavity pumps. The dried sludge is periodically disposed of to the landfill.

The supernatant from the thickener and the drainage water from the sludge drying beds are returned via the site drainage system back to the influent pumping station.

Sludge generated in WWTP is processed as listed below:

1. Waste activated sludge (WAS):
    - Pumped from final sedimentation tank (FST - **08**) to static thickener
    - Manual operation of WAS pumps (1 duty plus 1 standby) to keep MLSS in the aeration tank within an appropriate range.
2. Static sludge thickening (**09**):
    - Designed to increase the concentration of solids in sludge, thereby reducing its volume and making it more manageable for subsequent treatment processes like digestion or dewatering
    - Thickened sludge is withdrawn from the bottom of the static thickener and conveyed to sludge drying beds (SDBs) using manually operated pumps (1 duty plus 1 standby).
    - Supernatant, together with floating material, is discharged by gravity from the static thickener into the inlet pumping station sump;
    - The static thickener shows a nominal capacity of about 5,500 kgDS/d, which is well above the solids load of approx. 900 kgDS/d as currently observed

Photo 2-8 – Sludge thickener

3. Sludge Dewatering in SDBs (**10**):

- Consists of 9 units | 10x10m | 100 m² each, and 6 units | 10x17m | 170 m² each, comprising a total of 15 units, plus one informal emergency pond, with a total capacity of 1,920 m3.
- After identifying a SDB ready for filling, operators open the gate valve in the thickened sludge transfer pipe located directly at the SDB inflow and start the thickened sludge transfer pump and stop it for finalizing the procedure.
- Once the SDBs are filled with thickened sludge, part of the sludge water percolates through a gravel layer into drainage hoses and is redirected to the WWTP inflow pumping station while another part evaporates from the sludge surface.

Photo 2-9 – SDB filling procedure (WINKLER, 2025[2])

[2] WINKLER, H. (2025). *Independent Assessment of the current sludge management practices*. Comprehensive Report – Part 1. NRPB. 30 pp

Photo 2-10 – Sludge drying beds (west and north side of the WWTP)

The sludge recirculation pumping station (**08**) has only one unit and no backup. The connection between the sludge pumping station and the final sedimentation tank (FST) is about 60 meters long and consists of buried piping.

Photo 2-11 – Sludge pumping station

4. Loading Dewatered Sludge from SDBs onto trucks

   - After the sludge has been adequately dewatered, it is excavated with a backhoe loader, loaded onto (tipper) trucks, and hauled away from the WWTP.

Photo 2-12 – Excavation and transport by trucks (WINKLER, 2025[3])

5. Sludge transport to designated sites.

    - Pond Island landfill.

6. Sludge unloading at designated site.

    - Procedure depends on local conditions.

7. Sludge handling at designated sites by landfill operator.

Within the enclosure of the WWTP refers also the operations and control building (**01**), the laboratory and gatehouse (**02**) and the power generator and diesel tank (**03**), all located in the eastern limit of the WWTP enclosure.

3 WINKLER, H. (2025). *Independent Assessment of the current sludge management practices*. Comprehensive Report – Part 1. NRPB. 30 pp

Photo 2-13 - Operation and control building

Photo 2-14 – Laboratory and gatehouse

Photo 2-15 – Power generator and diesel tank

Besides the effluents discharged by the trucks, the WWTP is also connected to the network sewage system.

Photo 2-16 – Site of connection with the existing sewage network

The combined inflows of municipal wastewater and septage sludge represent an estimated average hydraulic load of 1658 m³/day in dry weather, increasing to 1886 m³/day under wet weather conditions (with registered peak flows that vary from 2328 m³/day up to 6000 m³/day). The average flow is 1743 m3/day.

Septic truck deliveries contribute approximately 400–1,200 m³/day, corresponding to about 20–63% of the total influent volume (depending on the volume of trucks), but with disproportionately high organic loads.

Table 2-1 – Average flow 08/2024 – 6/2025

Average Flow (m³/d)	Rainfall Criteria (mm)	Average Flow on rainy days (m³/d)	Average Flow on dry days (m³/d)	Flow increase (%)
1 743	Rainy day: rainfall > 2.5 mm	1 886	1 658	14

2.2.2 Current WWTP operation

Within the scope of the technical design of the rehabilitation of the **A.TH. Illidge Road WWTP**, several visits were performed to the facilities, guided by the current Operator, and some issues were identified:

Existing Out-of-Service Infrastructure

The existing infrastructure from the design of the old WWTP (2006 Wastewater Treatment Plant) is present at the current WWTP and is out of service, with potential for reuse or complete demolition, namely:

- Imhoff tank followed by a percolating filter;
- Settling tank

Truck Reception System

- The septage truck reception system is not functioning properly. Trucks open manually the valves and discharge sewage over the open pit, instead of connecting through an inlet piping. This practice results in uncontrolled flow and is the primary source of odor emissions in that location;
- The coarse screening system consists of a manually cleaned basket, and there are no mechanical means for its handling;
- The trucks operate daily between 6 a.m. and 6 p.m., with tank capacities ranging from 6 m³ to 15 m³;
- The number of daily truck discharges varies between 50 and 100, depending mainly on rainfall events. Simultaneous discharge of two trucks is possible.

An assessment was carried out with three truck discharges, with the following notes:

    - Truck 1 – discharge volume of 5 m^3, non-tipping, discharge time of 3 minutes.
    - Truck 2 – discharge volume of 10 m^3, non-tipping, discharge time of 4 minutes.
    - Truck 3 – discharge volume of 15 m^3, tipping, discharge time of 2 minutes.
- The connection between the septage truck reception system and the initial pumping station is made via a gravity-fed section

Initial Pumping Station

- The pumping station has a 2+1 configuration, with 1 unit out of service due to repair of the check valve. Level measurement is done via hydrostatic level sensors, with 2 pumps providing redundancy.
- Sand sedimentation is frequent at the initial pumping station, where nighttime cleaning operations are carried out.

Screening

- The screening stage uses quality material but has the weakness of only one line, with no backup. As a result, interventions on the screen or occasional high head losses lead to some floating plastics entering the treatment system and eventually discharged into receiving waters, but the organic pollution removal is not affected. .

Oxidation Ditch

- The agitators of the 3 selectors are in operation.
- The sludge layer in the aerobic reactor appears to be composed of dead sludge, which may be related to dead zones and system management.
- The 2 surface aerators are in operation, running at frequencies around 30 Hz. They are locked to 2 oxygen probes, which were reading 0.27 mg/L.
- The flow generator was also operational.
- The concentration of solids was 4 g/L, but there was a recent issue with the sludge recirculation pump, which reduced the efficiency of the settling process

Secondary Clarifier

- The effluent was clear, indicating adequate carbon oxidation; however, the central skirt had aged sludge floating on the surface, and the settling tank showed patches of solids typical of denitrification processes.
  There was a recent issue with the sludge recirculation lift, which reduced the settling efficiency and may also explain the current situation.

- The connection between the return activated sludge (RAS) pumping station and Final Sedimentation Tank (FST)is about 60 meters long and consists of buried piping. The presence of filamentous organisms in this type of sludge is common, making blockages or flow restrictions in the Archimedes screw lift downstream likely.
- The sludge recirculation pumping station has only one unit and no backup.
- As such, blockages in this section or maintenance activities at the sludge recirculation station lead to limitations in the management of the sludge blanket in the settler, resulting in solids loss from the settling process.

Thickening

- The supernatant from the thickener had a whitish appearance, which may indicate uncontrolled discharges of non-domestic effluent (e.g. from laundries or recreational vessels). In the event of truck discharges containing non-domestic effluent with biocides, deflocculation and biomass loss can occur, which could have been the cause of the poor settleability observed at the WWTP. Low flow regime was applied probably due to sludge drying beds sludge restrictions.

Sludges

- Drying Beds are already overloaded at present and are not capable of drying even more sludge in future, once more residents are connected.
- A. TH. Illidge Road WWTP shows periodic bulking problems, most likely related to operational instability related to septage trucks and excessive sludge age, due to sludge extraction limitations from sludge drying beds.
- Limitations in sludge extraction create continuous pressure on WWTP treatment performance.
- Typically, an apparently dry crusty sludge layer on the surface covers jelly-type sludge after the dewatering procedure, which significantly reduces the removal efficiency of sludge liquor.
- Damage to sludge liquor drainage hoses appears to be an almost unavoidable side effect of the sludge excavation method currently applied. These damaged hoses, along with the gravel removed upon the sludge excavation must be trucked away and discharged to the Pond Island landfill.
- Operational adjustments (e.g., sludge wasting control, monitoring of sludge age, aeration timings and filamentous control strategies) are necessary to improve stability.

Automation and Scada

- Currently there is no digital data acquisition system in the plant with exception of treated flow datalogger, which are not working at the moment.
- Moreover, there is lack of automated time or process variable control of biological treatment and sludge system.
- Operational limitations in process and hydraulics control

Lab and operational procedures

- The lab equipment is state of the art (Hach Lange Spectrophotometer standard methods) for general parameters such as COD, TSS, Ntotal, Ptotal
- Analytical lab procedures assessment with fine tuning in current procedures

Civil works

- Overall, the concrete structures, including tanks, channels, and foundations, remain functional but show signs of aging typical of facilities of this type and age, with minor surface degradation;
- Hydraulic structures, such as inlet works and clarifiers, show wear of joints and minor leakage points, indicating the need for sealing and preventive maintenance.
- Access structures (walkways, handrails, and staircases) are generally intact but require localized repair and corrosion protection.

These aspects were the **basis to assess the most appropriate solutions for the rehabilitation project**.

2.3 Location alternatives

The rehabilitation of the **A.TH. Illidge Road Wastewater Treatment Plant** is developed within the current enclosure, and no additional areas will be needed outside this area.

Therefore, only one location will be assessed.

2.4 Project alternatives

Based on the findings described in Section 2.2.2, a technical design was proposed for the rehabilitation of the **A.TH. Illidge Road WWTP**, that was also dependent on the sewage network expansion. To guide investment planning, seven scenarios were analysed to align the proposed sewerage expansion with the existing and future treatment capacity of the A. TH. Illidge Road WWTP.

Is important to mention that, according to Census 2022, only about 14% of the population is connected to sewerage systems. The majority of households rely on septic tanks (64%), followed by cesspits (16%) and other solutions (6%). When these tanks are not emptied regularly, they overflow, causing sewage to spill into streets, public spaces, and eventually ending up in beaches and ponds, impacting both residents and the tourism sector. Therefore, this sewerage expansion is crucial for reduce pollution risks of water bodies and allows compliance with the Sint Maarten Sewerage Policy 2022.

Table 2-2 – Sewerage network expansion and impact on the A.TH. Illidge Road WWTP

Scenarios	Description	Impact on the WWTP
Current Scenario	Only 14% connected. A. TH. Illidge Road WWTP inflow is 1,743 m^3/day in 2025	Still below the maximum capacity of the WWTP, but large number of septic trucks and with open sludge dry beds
Scenario 1	Construction of the sewer network in Cul de Sac with no further coverage expansion planned until 2055. A. TH. Illidge Road WWTP inflow increases slightly from **3,563 m^3/day in 2030, to 3,845 m^3/day in 2040 and to 3,881 m^3/day in 2055**	Although is still below the maximum capacity of the plant, will be improved on the septic trucks' disposal, on the preliminary treatment and on sludge treatment
Scenario 2	Construction of the sewer network in Cul de Sac and the coverage expansion in this area to 100% until 2055. A. TH. Illidge Road WWTP inflow increases from **3,652 m^3/day in 2030, to 4,262 m^3/day in 2040 and to 4,717 m^3/day in 2055**	Needs improvements on the septic trucks' disposal, on the preliminary treatment and on sludge treatment
Scenario 3	Construction of the sewer network in Cul de Sac and the coverage expansion in this area and in Philipsburg to 100% until 2055. A. TH. Illidge Road WWTP inflow increases from **3,758 m^3/day in 2030, to 4,830 m^3/day in 2040 and to 6,009 m^3/day in 2055**	Needs improvements on the septic trucks' disposal, on the preliminary treatment, on the biological treatment and on sludge treatment
Scenario 3A	Construction of the sewer network in Cul de Sac and Lower Prince's Quarter district, and the coverage expansion in this area and in Philipsburg to 100% until 2055. A. TH. Illidge Road WWTP inflow increases from **4,613 m^3/day in 2030, to 5,580 m^3/day in 2040 and to 6,451 m^3/day in 2055**	Needs improvements on the septic trucks' disposal, on the preliminary treatment, on the biological treatment and on sludge treatment. Will include effluent disinfection and phosphorus removal
Scenario 4	New WWTP in the northern part of the country to serve the population of the Lower Prince's Quarter district, except for the neighbourhoods of Madame Estate and Over the Pond, which will continue to be served by the A. Th. Illidge Road WWTP. New East WWTP for Oyster Pond, Ocean Terrace, Dawn Beach, Red Pond Estate, Guana Bay, Geneve Bay and Back Bay. Cole Bay WWTP: New WWTP for Cole Bay, Simpson Bay and Lowlands. The remaining area served by A TH Illidge Road WWTP. Country Coverage of 100% until 2055. WWTP flow increases from **3,296 m^3/day in 2030, to 5,257 m3/day in 2040 and to 7,853 m^3/day in 2055**	Needs improvements on the septic trucks' disposal, on the preliminary treatment, on the biological treatment and on sludge treatment
Scenario 5	Expansion of the sewerage network coverage in Sint Maarten to 100% until 2055. New WWTP in Cole Bay to serve Cole Bay, Simpson Bay and Lowlands.	Needs improvements on the septic trucks' disposal, on the preliminary treatment, on the biological treatment and on sludge treatment.

Scenarios	Description	Impact on the WWTP
	New East WWTP for Oyster Pond, Ocean Terrace, Dawn Beach, Red Pond Estate, Guana Bay, Geneve Bay and Back Bay. A. TH. Illidge Road WWTP inflow increases from **4,154 m³/day in 2030, to 6,759 m3/day in 2040 and to 10,271 m³/day in 2055**	Needs new pumps

Although all scenarios are viable to be implemented, supported by adequate mitigation measures and management programs, Scenarios 4 and 5 have higher discharge rates into Fresh Pond, which may have consequences for the pond's capacity.

Considering the available budget of USD 20–25 million, it was recommended to proceed with the interventions foreseen in **Scenario 3A in the A. TH. Illidge Road WWTP**, which is within the financial envelope and ensure an increase in national coverage from the current 15% to approximately 30%.

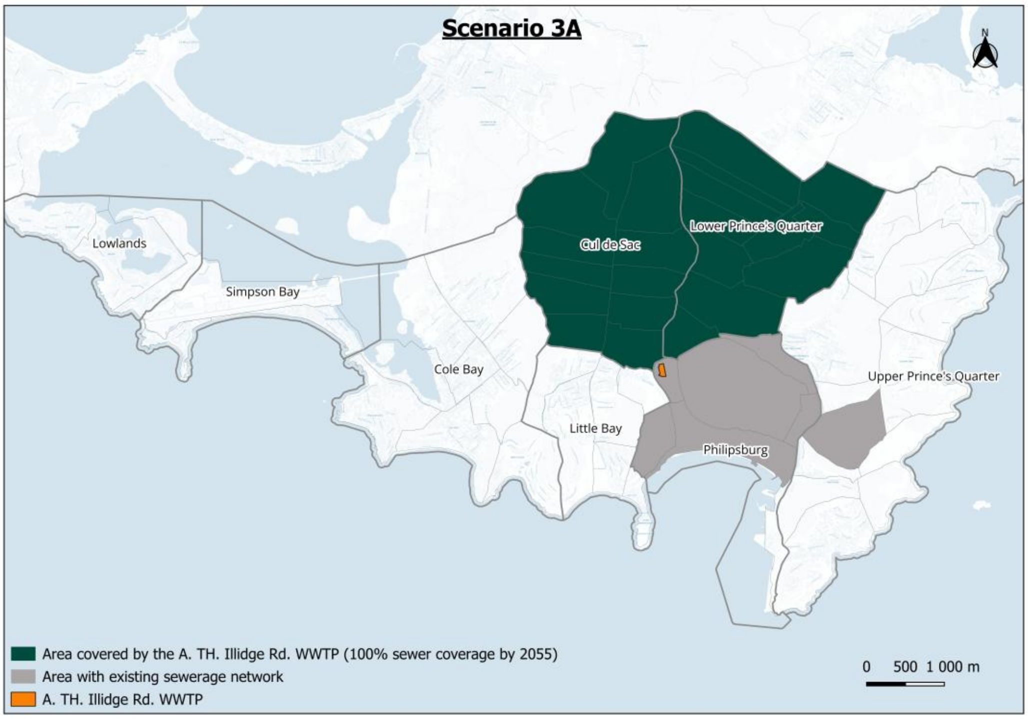

Figure 2-4 – Area covered by Scenario 3A, that will be served by the A. TH. Illidge Road WWTP

2.4.1 Scenario 3A

For this Scenario 3A, the Rehabilitation of the WWTP will involve the following interventions:

1) Septic trucks reception

- New concrete barrier to protect surrounded houses next to the fence
- The connection between the truck and the discharge pit will be through a pipe
- Installation of a new screen and grit removal equipment for septic trucks

Figure 2-5 – Example of a concrete barrier close to the truck disposal

Figure 2-6 – Example of a simple solution for screen and grit removal

2) Preliminary treatment

- New fine screen line
- Initial pump replacement

3) Biological treatment

- New mechanical surface aerators and recirculation pumps

4) Control and automation

- Automation and SCADA system

5) Sludge treatment

- New mechanical dewatering system belt filter
- The existing sludge drying beds will be maintained as redundancies for emergency situations.

The belt press dewatering process works as follows[4]:

- Flocculation: A selected polymer is mixed with the incoming sludge in a conditioning tank. This allows prepare the sludge for dewatering by making small particles clump together into larger flocs, which aids in both gravity drainage and mechanical pressing. It is estimated a consumption of 6067 kg per year (provided in bags of 50 kgs, kept in a dry and closed enclosure, over pallets).
- Gravity Drainage Zone: The conditioned sludge is spread evenly on moving permeable belts. Free water drains through the belts due to gravity, while solids are retained, forming a thickened sludge layer. This pre-dewatering stage prepares the sludge for subsequent pressure filtration;
- Low-Pressure Zone: The thickened sludge enters the low-pressure zone, where it is sandwiched between the two belts. A series of rollers with larger diameters apply gentle pressure, further squeezing water out of the sludge while maintaining the integrity of the belts and preventing excessive wear;
- High-Pressure Zone: The sludge is then conveyed to the high-pressure zone, featuring rollers with smaller diameters that apply higher pressure, forcing more water out and further compressing the sludge. The dewatered sludge cake is then discharged or removed by a scraper from the machine to a container for disposal or further treatment. The water is sent to the wastewater treatment plant for further treatment.

Figure 2-7 – Sludge treatment equipment (New mechanical dewatering system belt filter)

[4] https://www.elodeusa.com/glossary/belt-press

Figure 2-8 – Produced dewatered sludge cake (JOHNSONSCREENS, 2011 *in* [5])

Although not to be built within this initial investment, the updated layout also considers the location of two components for the tertiary treatment, a hypochlorite disinfection equipment (located before the effluent discharge) and a Phosphorus chemical removal system (including the reagents warehouse), located near the aeration tank.

All the interventions for the proposed scenario 3A are presented in Figure 2-9 and in **ANNEX 2.**

[5] https://sswm.info/water-nutrient-cycle/wastewater-treatment/hardwares/sludge-treatment/mechanical-dewatering

Figure 2-9 – New Components for Scenario 3A

2.5 Construction Phase

2.5.1 Main activities

The activities to be performed during the land preparation and construction phase can be summarized as follows:

- Site preparation
- Topsoil stripping and excavation activities for the dewatering equipment units to be added (or for concrete slabs beneath the dewatering equipment);
- Construction of reinforced concrete foundation structures for dewatering equipment (and also recommended for the proposed future hypochlorite equipment);
- Transportation of unit components (necessary machinery and tools);
- On site assembly of the units;
- Laying the underground pipes;
- Electrical works and installation of the control system;
- Connection to the system (SCADA);
- Testing and commissioning of all equipment;
- Works related to tanks sealing, rust removal, etc, if relevant.

Since the existing plant will continue to operate and construction work will be carried out at the same time, during the construction period, there may be some difficulties in accessing and controlling the work areas. The measures to be taken will aim to ensure that these two processes run smoothly, which should be specified in the Tender. Therefore, in an attempt to resolve this problem, there will be physical separations and working hours arrangements

Additionally, in order to protect public health and safety, access to work areas will be physically restricted during the construction and maintenance phases. Barriers, fencing, and signage will be installed to prevent unauthorized entry into construction zones. This will ensure the safety of the community by minimizing the risk of accidents and exposure to hazardous conditions associated with the ongoing work.

2.5.2 Construction Site/Material Park

To carry out the construction work (remodelling and expansion), a construction site will be necessary. The construction site will be located within the WWTP grounds, in a location yet to be determined. The construction site area includes, in addition to support containers, an area for temporary storage of various materials, such as waste and aggregates, and a parking area for vehicles and machinery used for the project.

The construction site, as well as any additional support areas, will be decommissioned at the end of the construction phase. All areas affected will be thoroughly cleaned and subsequently naturalized, in accordance with the minimization measures outlined in the corresponding chapter.

2.6 Operation Phase

The daily operation of the WWTP is already described in the previous sections.

The operational phase activities also involve maintenance of the various infrastructures that make up the WWTP (minor repairs or to replace a component), as well as maintenance of green spaces. The movement of heavy vehicles associated with transporting sludge, such as screenings sludge, to its appropriate final destination must also be considered.

The operation and maintenance (O&M) activities will be carried out by the WWTP employees. The existing workforce is experienced on the day-to-day O&M of a wastewater treatment plant. In any case, due to the new units to be added to the existing plant, there may be need for new employees to be recruited due to the capacity increase, and a set of training will be taken from third parties by all staff for capacity development purposes.

Similar to what currently occurs, occasionally during the operation phase of the WWTP, there will be times that the entire plant or specific units need shutdown due to excessive precipitation, planned or unplanned maintenance requirements, or any other foreseen or unforeseen challenges. However, the rehabilitation project includes increased redundancy in several stages of the process (e.g., screening, sludge circulation, dewatering, etc.) that will mitigate the impacts of these temporary shutdowns.

2.7 Decommissioning Phase

The project is expected to have a useful life of several decades (at least 30 years), so a deactivation plan will be drawn up in due time, with precise instructions for emptying and dismantling the equipment and structures, with the collection of all the materials and products that are not fully used.

2.8 Associated Facilities

According to the Environmental and Social Framework ESS1 guidance (WB, 2018), Associated Facilities are "*facilities or activities that are not funded as part of the project and that are: (a) directly and significantly related to the project; and (b) undertaken or planned to be undertaken concurrently with the project; and (c) necessary for the viability of the project and that would not have been constructed, expanded or undertaken if the project did not exist*." ESS1 also states that "*For facilities or activities to be Associated Facilities, they must meet the three criteria*."

There will be no associated facilities.

2.9 Accesses

Access to the WWTP is from A.TH. Illidge Road, either from north (roundabout between Zagersgut Road and A.TH. Illidge Road) or from south (intersection between Prince Bernard Bridge, Long Wall Road, Walter A. Nisbeth Road and A.TH. Illidge Road) .

2.10 Workforce

The workforce to be used during the WWTP rehabilitation will typically be those currently employed or hired by the selected Contractor. The Contractor may incorporate local resources into its team (including young people and women), provided they are qualified and competent for the work to be performed, through various types of engagements.

During the construction phase, it is estimated that the number of workers directly assigned to the project, among the various contractors (civil construction, assembly, among others), will be between 10 and 20 at the same time at the peak of the project. These workers are also joined by Supervision teams, the Project Promoter, and Environmental Monitoring

Regarding the operation workforce, O&M is done currently by a **total staff of six (6) people** at present, one belonging to VROMI (management) and the remaining are under a private company called 'Wastewater Maintenance & Management' (WWMM),

The staff, all with legal work contracts, include:

- 2 Managers (one from VROMI and other from WWMM)
- 1 Gardener
- 1 Laboratory technician
- 2 Operating staff for pumps and mechanics (O&M)

There are also security personnel from a outsource company.

For the upgrade WWTP, is expected an increase of 2 workers for the O&M.

2.11 Materials, waste, predicted emissions and energy

2.11.1 Construction phase

During the construction phase, the following types of effluents, waste, and emissions are expected:

- Wastewater from the construction site sanitary facilities;
- Wastewater from concreting, paving, and civil construction operations;
- Municipal waste from the construction site;
- Plastic, metal, and cardboard packaging, frames, formwork, wood, concrete, and other materials resulting from various civil works;
- Noise emissions with increased continuous and occasional sound levels due to the use of heavy machinery and vehicle traffic transporting people, materials, and equipment;
- Dust emissions resulting from the movement of vehicles and equipment on unpaved surfaces;
- Gas emissions generated by vehicles and heavy machinery used on the site.

Accidental spills of oils, fuels, and similar products may also occur. However, as long as proper mitigation measures are implemented, this situation will be avoided.

The execution of the work will also result in inert materials from excavations such as silts, clays and sand.

Reusable material, effluents, waste and emissions will be processed as follows:

- Regarding the construction site's sanitary facilities, portable sanitary facilities will be used;
- For wastewater resulting from civil construction operations, such as concreting operations, retention basins (2 m x 2 m) will be dug into which the water resulting from washing the concrete mixers will be discharged;
- Effluents such as machine oils, lubricants, and others common to any construction project will be properly stored within the construction site in dedicated containers and transported by a licensed company, currently to the landfill (or other authorized disposal site in the future);
- Waste such as plastics, wood, and metals will be stored in dedicated containers and transported by a licensed company to the landfill (or other authorized disposal site in the future).

Temporary waste storage will be carried out in the area designated for the construction site or in any additional support areas.

2.11.2 Operation phase

During the operation phase, the following types of effluents, waste, and emissions are expected:

- Production of treated wastewater and discharge into the receiving environment (Fresh Pond);
- Production of waste (sludge, screenings, sand);
- Oils and related products used to lubricate various WWTP components;
- Parts or components of replaced equipment;
- Leftover materials from maintenance;
- Gaseous emissions (emission of volatile compounds present in the effluents upon arrival at the WWTP or resulting from anaerobic degradation reactions of the effluents, particularly reduced nitrogen and sulfur compounds, which are associated with the perception of unpleasant odors);
- Noise and gaseous emissions resulting from traffic involved in maintenance;
- Noise from maintenance operations;
- Noise emitted by WWTP operation;
- Noise from septage trucks and sludge trucks.

Regarding the septage trucks, it is expected that, as the sewerage network expands, the number will decrease.

For the sludge disposal trucks, the estimated number will depend on the truck capacity (between 6 to 12 m3). According to site visit on Nov. 02, 2022 and March 13, 2023, made by World Bank, approximately 1200 m^3 of sludge were produced every year, representing an average of 15 monthly trucks required to deliver the sludge to its disposal location, i.e. to the municipal landfill. But from the missions made on June and July 2025 it is clear the lack of information available related with sludge management and disposal.

Considering the baseline values of 1200 m3/year and 15 trucks per month (of about 10 m3 each), the estimated sludge production for Scenario 3A will be (with the new dewatering system):7.4 m3/day (2701 m3/year), managed by 1 truck per day / 22 trucks per month, which is slightly higher than the current situation.

Specifically for the sludge disposal, the technical meetings associated with the present project decided as follows:

- Short-term – disposal in the landfill (until 2026)
- Medium-term – use as landscaping in the landfill (from 2027)
- In parallel: Integrated sludge with waste management

According to the Rehabilitation and Closure of Municipal Solid Waste Disposal Site ESIA[6] (Sint Maarten Emergency Debris Management Project - EDMP (P-167347)), is projected that the existing waste mass will be reprofiled for stable slopes and levelled. It is expected that the IDS side is closed permanently after a construction period of ~60 weeks. The SWDS is expected to be closed permanently ~52 weeks after landfilling operations cease. NRPB procured a design and build contractor to rehabilitate and close the landfill site. The tender requires the selected contractor to utilize the sludge for soil improvement after proper treatment as part of the rehabilitation and closure process.

The Government of Sint Maarten has committed in advancing reforms and maintaining a clear objective of achieving an alternative sustainable waste management system (AWMS) in SXM prior to the landfill's closure. The management of sludge is part of the long term AWMS system.

Regarding the energy used during the construction phase, energy consumption will primarily be related to the use of electricity for lighting and equipment operation, as well as the consumption of fossil fuels required to operate vehicles and machinery used in the construction process.

For the operation and maintenance phase, consumption will be associated with the necessary equipment, which will not be significant. The consumption 1642500 kWh/y (4500 kWh/day) is predicted for Scenario 3A.

2.12 Land Use Tenure

As mentioned, all the interventions will be developed within the current WWTP enclosure, which belongs to VROMI.

[6] COTERLET., G. van de, L. A. Valenzuela, M. Terasawa & Y. Roussos (2025). *Environmental Social Impact Assessment (ESIA) for Rehabilitation and Closure of Municipal Solid Waste Disposal Sites in Philipsburg, Sint Maarten*. National Recovery Program Bureau. 93 pp

2.13 Construction and Implementation Schedule

The construction phase is expected to last no more than 12 months and will cover all works and construction support activities.

2.14 Predicted Investment

In terms of specific investment for the rehabilitation of the A.TH. Illidge Road WWTP, a value of USD$4,955,252.50 is planned, where USD$487,675.00 refers to the tertiary treatment, to be developed in a future phase.

3. STUDY AREA AND GENERAL METHODOLOGY

3.1 Project Influence Area

This study area was delimited considering the area of direct impact of the WWTP facilities, an area of indirect impact, and a regional environment (at the municipal level), according to the following criteria:

1) Direct – essentially related to the area of direct intervention of the project, applied to geology and hydrogeology, soils, sediments, surface and groundwater resources, waste, terrestrial ecosystems, land use, landscape and heritage, as well as noise and vibrations and air quality. This 50 m buffer, will include all project infrastructure and temporary infrastructure to support the project during the construction phase, as well as any social and agricultural resettlement that may be necessary;
2) Indirect – essentially related to the Project's indirect intervention area (specifically, a buffer of up to 500 m), where impacts may affect aspects such as hydrology and socioeconomics. In this area, air quality, landscape, and land use planning and constraints are also considered;
3) Regional – related to a more variable area, larger than the Project area, which can be applied to hydrology and hydrogeology, socioeconomics, and climate change.

The delimitation of the area of direct influence is presented in **ANNEX 1**. The following table presents the geographic coordinates of each of the projects.

Table 3-1 – Central Coordinates of the Project

Name	X	Y
A. TH. Illidge Road WWTP	493924,58	1993896,45

Note – Coordinate System EPSG:32620 - WGS 84 / UTM zone 20N

3.2 General methodology of the studies developed

The ESIA process is a preventive environmental management tool that aims to identify and analyse the positive and negative significant environmental and social impacts of a proposed activity, as well as identify appropriate mitigation measures to minimize negative impacts and maximize positive ones.

The ESIA methodology adopted in this process complies with applicable environmental legal requirements in Sint Maarten, as well World Bank Environmental and Social Standards (ESS) and other international guidelines.

The Environmental and Social Impact Assessment (ESIA) aims to address the environmental, socioeconomic, and cultural situation at the project site and identify potential direct and indirect impacts, including potential cumulative impacts. It also includes appropriate measures to avoid, mitigate, or offset such impacts whenever possible and provides tools for their implementation, monitoring, and confirmation in the form of an Environmental and Social Management Plan (ESMP), which will be developed by NRPB.

Throughout the assessment process public consultation was undertaken in parallel, gathering all necessary information and feedback from key stakeholders, to ensure all risks and impacts have been identified and to improve the technical design of the project.

There is no specific structure for the ESIA within Sint Maarten legislation, but this document will follow the International guidelines, specifically the ESF ESS1 of the World Bank**,** which is the administrating entity of the Sint Maarten Recovery, Reconstruction and Resilience Trust Fund.

3.3 Public Participation

The **Stakeholders Engagement Plan (SEP)** prepared for the Sint Maarten Wastewater Management Project, by the NRPB, was followed. The identification of all potential and relevant stakeholders to the project is a key task to the success of all activities ahead and of the project itself. The objective of the SEP is to identify and establish a communication framework with key stakeholder organizations and entities to identify the key actors that must be consulted and participate in the development of the study.

The consultations were divided into two steps. The first one (individual meetings in NRPB facilities) to collect baseline information for the project and for the ESIA, and the second one (public consultation held on December, 10, 2026 in the Belair Community Center) to present the updated project design and the ESIA findings based on that new design.

For the final public consultation and in order to reduce and even eliminate the barriers to participation faced by vulnerable groups, specific methods and techniques were implemented to facilitate the collection of views and concerns from these stakeholders. These included: choosing an accessible and large venue for the event, printing posters and other informational materials on a larger scale and transmitting online the presentations and the Q&A stage on the NRPB Facebook page with direct reply during the public sessions and afterward.

More details are presented in Section 6 of the present document.

4. LEGAL ENVIRONMENTAL AND SOCIAL REQUIREMENTS

4.1 World Bank Environmental and Social Standards

The Sint Maarten Recovery, Reconstruction and Resilience Trust Fund is administered by the World Bank (WB) and is therefore subject to the requirements of the World Bank (WB) Environmental and Social Framework, which came into effect on October 1, 2018.

The following table assesses the applicability of each of the ESS in relation to the WWTP rehabilitation project.

Table 4-1 – Applicability of WB Standards to the Project under Evaluation

ESS	Applicability	Justification
ESS1: Assessment and Management of Environmental and Social Risks and Impact	YES	Rehabilitation work is expected to have environmental and social construction impacts, including potential noise and increased dust from vehicle and equipment movement. The potential presence of non-local construction workers (foreign workers, with special technical skills) is also considered, with social impacts at various levels. During the operational phase, the WWTP's operation may impact nearby receptors and may also impact the Fresh Pond downstream.
ESS2: Labour and Working Conditions	YES	The hiring of labour for the construction phase must comply with several appropriate standards, related to the relationship with the surrounding communities (potential conflicts, SH/SEA, etc), the age and gender of the workers, the complaints mechanism, the residency status, etc. In the operational phase, the working conditions of the facility's employees are important. Employment of local labour. LMP applicable to the project is developed and publicly disclosed, which will ensure compliance with national labor laws, including the national HIV and AIDS Workplace Policy (2012). Contractors must develop their own Labour Grievance Redress Mechanism (GRM) developed for workers complaints, which will further ensure compliance with national labor laws. In parallel, the NRPB's GRM includes the labour GRM and is open to receive worker complaints that might arise in the project.

ESS	Applicability	Justification
ESS3: Resource Efficiency and Pollution Prevention and Management	YES	There are potential sources of pollution from the construction and operation of WWTP. Emissions to air, wastewater discharges and noise levels will need to comply with World Bank EHS Guidelines. Construction waste will be properly disposed of as needed. Operation water discharges, odour and noise need to be below nuisance level.
ESS4: Community Health and Safety	YES	Construction works may impact the urban community around the WWTP, increasing traffic/congestion and road accidents risks, noise & vibration levels, releasing dust to air and creating nuisance to sensitive receptors. During operation, noise, odour and water quality must be below nuisance level.
ESS 5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	NO	The project activities will be located within the WWTP enclosure. No additional land will be required, with no resettlement
ESS6 Biodiversity Conservation and Sustainable Management of Living Natural Resources	YES	The discharge effluents from the WWTP may affect the IBA Fresh Pond (and the Great Salt Pond, which is interconnected and in close proximity to the Fresh Pond.)
ESS 8: Cultural Heritage	NO	The WWTP enclosure is man-made land, therefore no chance finds are expected. No additional area is required.
ESS9: Financial Intermediaries	NO	There are no financial intermediaries
ESS10: Stakeholder Engagement and Information Disclosure	YES	The project will follow the guidelines of the Stakeholder Engagement Plan

In addition to the E&S Standards, the IFC/WB Environment, Health, and Safety (EHS) Guidelines are followed. The EHS Guidelines are technical reference documents that provide general and specific examples of Good International Industry Practices, performance levels, and measures generally considered to be achieved at reasonable cost.

For the WWTP update project, the relevant General EHS Guidelines are:

1. Environmental Guidelines

1.1 Air Emissions and Ambient Air Quality

1.3 Wastewater and Ambient Water Quality

1.4 Water Conservation

1.5 Hazardous Materials Management

1.6 Waste Management

1.7 Noise

2. Occupational Health and Safety Guidelines

3. Community Health and Safety Guidelines

4. Construction and Decommissioning Guidelines

The Environmental, Health, and Safety Guidelines for Water and Sanitation were also considered. The EHS Guidelines for Water and Sanitation include information relevant to the operation and maintenance of (i) potable water treatment and distribution systems, and (ii) collection of sewage in centralized systems (such as piped sewer collection networks) or decentralized systems (such as septic tanks subsequently serviced by pump trucks) and treatment of collected sewage at centralized facilities.

World Health Organization:

The World Health Organization (WHO) Guidelines are primarily intended for water and health regulators, policymakers, and their advisors to assist in the development of national standards. The Guidelines and associated documents are also used by many others as a source of information on water quality and health, and on effective management approaches.

For the project under assessment, the following are relevant: Drinking Water Quality Guidelines; Air Quality Guidelines; and Noise Guidelines.

4.2 National Environmental Legislation

Sint Maarten, previously part of the Netherlands Antilles, became an autonomous country within the Kingdom of the Netherlands on 10 October 2010. The Kingdom of the Netherlands remains the 'State' under international law and is therefore constitutionally responsible for foreign relations (such as treaty-making affairs) and defence (for more information see section 4.3). However, the government of Sint Maarten has full autonomy over internal affairs, including (inter alia) the realization of applicable international environmental obligations and developing, implementing and enforcing domestic environmental legislation.

According to Article 22 of the Constitution of the Country of Sint Maarten (the Constitution), 'it shall be the government's constant concern to keep the country habitable and to protect and improve the environment and of the living environment and the welfare of animals'. The GoSM has established some existing policies and regulations regarding E&S management, such as pollution, labor and health issues, which uphold part of article 22 of the Constitution. There are also laws regarding development activities impacting critical habitats and biodiversity, however, degradation continues because of the lack of enforcement. Furthermore, there is still no comprehensive legislative framework related specifically to environmental protection, including no direct legal requirement for carrying out Environmental Impact Assessments (EIAs) for any development projects. Instead, Article 28a of the National Ordinance on Spatial Development Planning (AB 2021, no. 06) paragraph 1 states that written consent in the form of a civil works permit is required for works and activities of a substantive/intrusive nature7 (hereinafter referred to as 'major civil works') that will be carried out in areas for which no preparatory decision or (finalized) development plan applies (see Table 4 for more details). More specifically, article 28a grants the Minister of VROMI discretion to decide whether to grant or withhold written consent for specific works and activities that fall under the six categories listed in paragraph 1 (excavation, road construction, water-related works, tree removal, demolition, water-drainage) and under what conditions. As stipulated under paragraph 4, a civil works permit may be withheld if the proposed works and activities would, from the standpoint of public interest, give rise to serious objections8 because of irreversible damage to nature or the environment, the current use of the land and the surrounding lands, or irreversible infringement of the expected spatial development of the land and surrounding land9. In accordance with paragraph 5, the Minister of VROMI can attach certain conditions to the permit to prevent such serious objections. For example, the Minister may set the condition that an ESIA and an ESMP is required as part of the application for a civil works permit (although the ordinance does not prescribe specific instruments). However, such E&S instruments are already required under the World Bank's regulations and may already be in line with article 28a.

Should the GoSM establish any relevant legislation on environmental protection during the implementation of this Project, the Project's Management Team will determine what the project will require to do to adhere to these policies. Although specific environmental protection laws are limited or non-existent, the GoSM has some existing legislation on the management of E&S issues. All applicable legislation, specific requirements and implications on the Project are summarised in the table below.

The following table describes the relevant national legislation and its implications for the project.

Table 4-2 - National Legal Framework implications for the project

Applicable Legislative Instrument: Applicable Scope / Specific Requirements	Implication(s) for Project
Permits/Licensing	
♣ St. Maarten adopted its own Planning and Zoning Ordinance in 1993 (Eilandsverordening Ruimtelijke Ontwikkelingsplanning St. Maarten,"EROP") and it is updated in 2013 which is the National Ordinance Spatial Development Planning (AB 2013, GT no. 144). ♣ National Ordinance of 8 March 2021 amending the National Ordinance on Spatial Development Planning in connection with the reintroduction of Art. 28a Article 28a. regulates the requirements for a civil works permit, which will allow the Minister to review certain planned works prior to approval. This will ensure that the works will not cause undesirable and irreversible damage to the environment and are executed with concern to the environment and that the	A *Civil Works Permit* will need to be obtained prior to the start of the network expansion. Project team must prepare and submit any documentation required under any conditions that may be set by the Minister of VROMI for the application for the civil works permit. Statutory timeline for application process needs to be taken into consideration. ○ Decision on granting the civil works permit can take up to 60-days (with possible 30-day extension) ○ If granted (or refused), the decision must be made public at the administrative office for 6 weeks for public inspection. Only after this period the works for the project can start.

[7] Article 28a of the National Ordinance on Spatial Development Planning (AB 2021, no. 06), para. 1, English translation of Dutch text: 'ingrijpende aard'.

[8] Ibid, para. 4, English translation of Dutch text: 'ernstig bezwaar'.

[9] Ibid, English translation of Dutch text: 'onherstelbare aantasting van de natuur of het milieu; het huidige gebruik van de grond en de omringende gronden; of, onherstelbare inbreuk op de te verwachten ruimtelijke ontwikkeling van de grond en de omringende gronden'.

Applicable Legislative Instrument: Applicable Scope / Specific Requirements	Implication(s) for Project
works fit within the Government Spatial Development Vision. In addition, the article allows the government to impose conditions on the execution of the works. Approval by the Minister would be required for the following works: • The excavation, raising, levelling or explosion of land; • The construction of roads and other pavements; • Works and projects that impact the water management and the groundwater level; • The felling and clear-cutting of trees or other cultivation; • The demolition of structures; • The filling and/or dredging of water. Written consent in the form of a *civil works permit* is required for *major civil works* and activities, including excavation, road construction, water-related works, tree removal, demolition, and water drainage, performed in areas where no preparatory decision or (finalized) development plan applies (para. 1). Must meet any conditions set forth by the Minister of VROMI for the application of the civil works permit (para. 4). ♣ National ordinance, concerning Building- and Public Housing a.k.a. Building Ordinance (AB 2013, GT no. 136). There are two National Decrees for execution of Article 19 (AB 2013, GT no. 146) and Article 43 (AB 2013, GT no. 401) of the Building Ordinance.♣ Spatial Development Strategy 2030 (August 2022), which intends to provide a coherent and comprehensive direction for sustainable spatial development of Country Sint Maarten until 2030, with sub-objectives that focus on: 1. Sustainable development; 2. Enhancement of the resilience of the country; 3. Enhance the quality of life for citizens. Proposals have been drafted on three main sustainable pillars: the economic, social and environment pillar.	
♣ Nuisance Regulation (AB 2013, GT no. 139) ♣ Hindrance Ordinance and derivative regulations. (AB 2013 GT nr. 139 and AB 2013 GT nr. 140). A Hindrance Permit is required for facilities that may cause danger, damage or nuisance. Hindrance Permit is already obtained for WWTP: HP.12.006.	Component 1.2 must continue to adhere to requirements set forth in permit HP.12.006 as upgrades are implemented.
Labor legislation	
♣ Labour Legislation of St Maarten ♣ National ordinance concerning safeguarding labor in enterprises: Safety Ordinance (AB 2013, GT no. 438). ♣ Safety Decrees I-III (AB 2013 GT no. 348; no. 280; no. 350) ♣ A National HIV and AIDS Workplace Policy (2012) The current labour legislation covers the topics of minimum wages, employee dismissal, prohibition of child labor, occupational injury, holidays and special leaves etc.	Project must comply with all applicable labor laws.
Waste & Pollution Legislation	
♣ Waste Ordinance (AB 2013, GT no. 135).	

Applicable Legislative Instrument: Applicable Scope / Specific Requirements	Implication(s) for Project
♣ National Ordinance Wastewater (AB 2013, GT no. 142) ♣ The National Ordinance for Nature Protection and Management (AB 2013, GT no. 809) ♣ The National Ordinance for the Prevention of Pollution from Ships (AB 2013, GT No. 298) ♣ National Ordinance Clearance of Ships and Wrecks (AB 2013, GT no. 314) ♣ Environmental Norms for Air & Sound, Water & Wastewater, Waste ♣ National Ordinance of 8 March 2021 amending the National Ordinance on Spatial Development Planning in connection with the reintroduction of Art. 28a Promotes sustainable water use and determines how pollution created from waste and wastewater shall be managed. Article 8 of the National Ordinance Wastewater is essentially the legal basis for component 1 of the project. It creates a legal obligation for households to be connected to the sewage system and forbids the discharge of wastewater in any other manner. General measures laying out how these obligations and prohibitions shall be handled will be determined in a national decree (currently being developed). In accordance with the Waste Ordinance, the Contractor is required to ensure that excavation and construction waste, as well as wastewater discharges are properly managed and disposed of. Although not applicable for the implementation of sub-components 1.1 or 1.2. of this project, The National Ordinance for the Prevention of Pollution from Ships may be triggered should any sludge be shipped off the island in the future.	Excavation and construction waste and wastewater discharges in the Fresh Pond will need to be managed (including removal) in accordance with national legislation.
Energy Legislation	
♣ National Energy Policy (2014) ♣ The current Electricity Concessions Ordinance (AB 2013, GT no. 147) and the Electricity Concession of N.V. GEBE Policies and ordinances are in place to promote sustainable energy use. While there are no obligations to implement sustainable energy use in the project, the national energy policy encourages such practice.	Potential power outages due to load shedding should be taken into consideration for the planning of project operations and further encourages the use of renewable energy alternatives (which must comply with the concessions ordinance).
Public health Legislation	
♣ National Ordinance Public Health (AB 2018, 20). ♣ National Decree of the Governor of Sint Maarten Concerning Public Health Rules National Decree on Public Health (AB 2017, GT No. 33). There are various provisions in the National Public Health Decree, in line with World Health Organization standards, that sets forth obligations for the protection of public health. There are no current regulations that require facilities to inform adjacent communities of potential risks and hazards including hazardous wastes, traffic safety, impacts of labor influx and issues associated with security personnel.	To ensure compliance with the National Public Health Decree, health and safety measures must be in place at project site. To implement such measures and ensure compliance, the Contractor should engage experienced and qualified ESHS personnel, prepare MSIPs and develop a Health and Safety Manual.
Biodiversity Legislation	

Applicable Legislative Instrument: Applicable Scope / Specific Requirements	Implication(s) for Project
♣ The *general duty of care* principle is a precautionary legal principle and obligation that is either explicitly or implicitly found in all national environmental laws on Sint Maarten. Two are highlighted below. This principle/obligation is applicable to the public (including the Contractor). ♣ National ordinance, concerning management of nature and protection of the prevalent fauna and flora (AB 2013, GT no. 809). ♣ National Decree, entailing general measures, concerning management and protection of flora and fauna as well as nature parks (AB 2013, GT no. 143). - Article 2, *general* ***duty of care*** states: *'Everyone is obliged to observe such care for nature that adverse effects on nature, which may be caused by his/her actions or omissions, insofar as this can reasonably be required of him/her, are prevented or, if this is not possible, limited as much as possible.'*[10] ♣ There are two relevant island policies that are not covered by legislation; • Beach Policy (Public notice August 1994). • Hillside Policy (Public notice No. 986/98). ♣ Temporary Fishing Prohibition Cartilage Fish Decree (AB 2011, no. 35). ♣ Fisheries Land Decree (AB 2013, GT no. 405). ♣ Fisheries Products National Decree (AB 2013, GT no. 354). ♣ National Nature Conservation Ordinance – Ao2001, No. 41; ♣ Nature Conservation Ordinance St, Maarten- AB2003, No. 35 - In line with the general precautionary principle and obligation of the ***duty of care****:* Article 2 states that '*each person has a duty, as far as can be reasonably expected from him, to avoid, or, if this is unavoidable, to minimize any negative effects caused to nature by his actions or negligence* ♣ St Maarten Proposed Land Parks Management Plan (2009); ♣ Sint Maarten Nature Policy Plan 2021-2025 has been drafted under the legal basis of the above Ordinances; but not yet finalized. - The management of protection of flora and fauna, including vulnerable and endangered species, is the responsibility of the GoSM - Measures to protect, conserve, maintain and restore natural habitats and biodiversity have been proposed in the Sint Maarten Nature Policy Plan 2021 - 2025; however, it has not been legalized.	The ***duty of care*** found in national environmental legislation listed on the left, including the National Conservation Ordinance and legislation on the management and protection of flora and fauna, requires the Contractor to observe such care for nature and mitigate any adverse effects on nature which may be caused by individual or collective actions/activities (in this case the project works), insofar as reasonably possible. If this is unavoidable, then negative impacts to nature must be minimized as much as possible. In this case, this is especially applicable to the Fresh Pond, , an IBA. For the operation phase and in line with this duty of care (and the requirements of a hindrance permit), monitoring of biodiversity and water quality of the Fresh Pond (an IBA), Great Salt Pond (an IBA) and Great Bay Beach should be maintained to ensure negative impacts to nature (either directly or indirectly) is either avoided or minimized. In line with the Nature Conservation Ordinance and the legislation on the management and protection of fauna and flora, the Contractor must ensure that actions/activities will not result in killing/harm/disturbance to any protected species, such as birds nesting near the construction works.

10 English translation of Dutch text: '*Eenieder is verplicht zodanige zorg voor de natuur in acht te nemen dat nadelige gevolgen voor de natuur, die door zijn handelen of nalaten kunnen worden veroorzaakt, voor zover dat in redelijkheid van hem kan worden gevergd, worden voorkomen dan wel, indien dit niet mogelijk is, zo veel mogelijk worden beperkt'*, National Decree, entailing general measures, concerning management and protection of flora and fauna as well as nature parks (AB 2013, GT no. 143), Art. 2.

Applicable Legislative Instrument: Applicable Scope / Specific Requirements	Implication(s) for Project
Incorporating ecosystem services into national capital is not required under current legal mandates.	

4.3 International Agreements

As mentioned, under international law, the Kingdom of the Netherlands (KoN) is considered as the 'State'. In accordance with article 3(1)(b) of the Charter of the Kingdom of the Netherlands (2010), foreign relations, including (inter alia) international agreements (such as treaties and conventions) are considered as 'Kingdom Affairs'. Consequently, the local governments of the four individual autonomous countries, including Sint Maarten, are (usually) not authorized under Kingdom law to independently conclude treaties (except in particular subject matters). Instead, this is a collective process and carried out by the Kingdom Government, which is made up of representatives of all four autonomous countries within the KoN, including Sint Maarten. During the treaty making process, governmental consultations take place and each Kingdom partner decides whether a territorial limitation will be placed on the 'applicability' of the treaty (i.e. whether it will extend to all territories of the KoN or only some). As a result, this determines whether a treaty, once signed and ratified, will be implemented on the islands, including Sint Maarten. Thus, not all treaties become applicable to Sint Maarten. Although a treaty is signed and ratified by the KoN, this does not automatically mean that Sint Maarten is bound by this treaty. Two prime examples are the Paris Agreement[11] and the Basel Convention, as the KoN is a party and these treaties have been implemented in the Netherlands, but have yet to be extended to the Dutch Caribbean, including Sint Maarten. Nonetheless, some environmental treaties, including some pertaining to waste (water) management are applicable (although not entirely transposed to domestic law), these include (inter alia):

- The Convention on International Trade of Endangered Species (CITES) - prevent the over-exploitation of endangered species through international trade.
- The Convention on Biological Diversity (CBD) – states that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live
- The Convention on Migratory Species (CMS) (also known as Bonn Convention) - global platform for conserving migratory animals and their habitats across national boundaries;
- The London Dumping Convention - control all sources of marine pollution and prevent pollution of the sea through regulation of dumping into the sea of waste materials;
- The Convention on Wetlands of International Importance (RAMSAR) - conservation and sustainable use of Ramsar sites (wetlands)

[11] Johnson, D. 'To be Bound or Not to Be Bound.' *A critical assessment of the 'Territorial Limitation' on the UNFCCC & the Paris Agreement in the Kingdom of the Netherlands (2024).* https://www.dcbd.nl/resource/3981

- The Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) - promotes the protection, conservation, and recovery of sea turtles and the habitats they depend on;
- Cartagena Convention (the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region) - protection of the Caribbean Sea, the Gulf of Mexico and a portion of the adjacent Atlantic Ocean, amended by the Oil Spills Protocol, the Specially Protected Areas and Wildlife Protocol and the Pollution from Land-Based Sources and Activities Protocol;
- Protocol concerning Pollution from the Land-Based Sources and Activities (LBS Protocol) - mandates that signatories reduce, control, and prevent marine pollution from agricultural runoff, domestic sewage, and industrial activities using best management practices and regional effluent limitations;
- International Agreement on Transboundary Shipments of Waste (OECD) - controls the transboundary movement of hazardous and other wastes;
- MARPOL convention - prevention of pollution from ships caused by operational or accidental causes.

The rehabilitation of A.TH. Illidge Road WWTP will have direct impact on the quality of Fresh Pond and an indirect impact on the Great Salt Pond (both of which are Important Bird Areas (IBAs)), which are shelters for several bird species; and other ecologic groups, mainly aquatic species. The water quality of this wetland is important therefore to directly comply with the objectives of the CBD and CMS, and indirectly to those of the IAC, the Cartagena Convention and the LBS. There is currently no designated RAMSAR site that will be directly or indirectly impacted by the works of this project.

For the WWTP sludge, is important that its disposal meet the quality requirements of the selected disposal site, even if it needs to be transported abroad, complying with the London Dumping Convention, the Cartagena Convention, the LBS and the MARPOL convention.

5. ENVIRONMENTAL AND SOCIAL DIAGNOSIS

5.1 Physical Environment

5.1.1 Geology, Geomorphology and Seismicity

The bedrocks of Sint Maarten consist primarily of andesite tuff and tuff breccia from Eocene volcanic events. These have been intruded by basalt, quartz diorite, and andesite. Later volcanic activity caused intrusions which metamorphosed the rock and caused the tuff to tilt and fold. Limestone and marl were deposited on the eroded surfaces of these materials. There are limestone caverns on Sint Maarten/St. Martin where the softer limestone was exposed (SMG, 2023[12]).

At the end of the Pleistocene glaciation, ice melted and the sea level rose. The large, single island flooded and only the highest parts remained above sea level – forming the islands of Sint Maarten/St. Martin, Anguilla and St. Barthélemy as they are known today. The tuffs form the Pointe Blanche formation, which is most visible at the southern end of the island. The Simpson Bay Lagoon, Great Salt Pond, Great Bay and other bays and lagoons are drowned valleys (SMG, 2023).

The island has hilly terrains where elevation ranges from near sea level to about 420 m above mean sea level. Based on a publication of ABEBE *et al.* (2019), the study area of Cul de Sac is limited by two upland areas reaching 360 m. The **A.TH. Illidge Road WWTP** is located at lower altitudes, between 0-40 m.

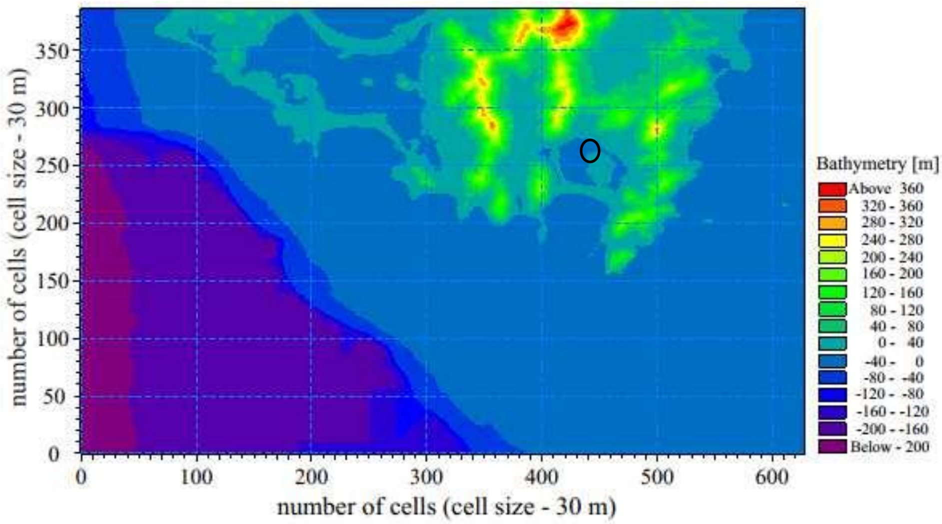

Figure 5-1 – Topography and Bathymetry of Sint Maarten and specifically at the study area (black circle) (ABEBE *et al.*, 2019[13])

[12] SINT MAARTEN GOVERNMENT. *Installation of a Temporary Weighbridge and Reconstruction of the Access road to the MSW Site. Daily Management of the MSW Site Operations including Fire Suppression and Slope Recontouring*. Environmental and Social Impact Assessment (ESIA). 662 pp

[13] ABEBE, Y.A., A. Ghorbani, I. Nikolic, Z. Vojinovica and A. Sanchez (2019). *Flood risk management in Sint Maarten – A coupled agent-based and flood modelling method*. https://www.elsevier.com/open-access/userlicense/1.0/

The coastline is a series of beaches, coastal lagoons, rocky areas and salt and fresh water (brackish) ponds, and the interior is characterized by many valleys surrounded by hills.

The country is vulnerable to earthquakes. The island is located in the Eastern Caribbean, which is an island arc system formed at a convergent plate boundary, more specifically, at a subduction zone where two tectonic plates meet and the denser plate is forced beneath the lighter plate. This phenomenon is the main cause of seismic activity resulting in earthquakes (and volcanoes) in the Eastern Caribbean. (UNDRR, 2022[14]).

5.1.2 Soils

The soils of St. Maarten are in a young stage of development. This is demonstrated by the shallowness of the soils, the poor development of the subsoils and the presence of shell and rock material in the soils.

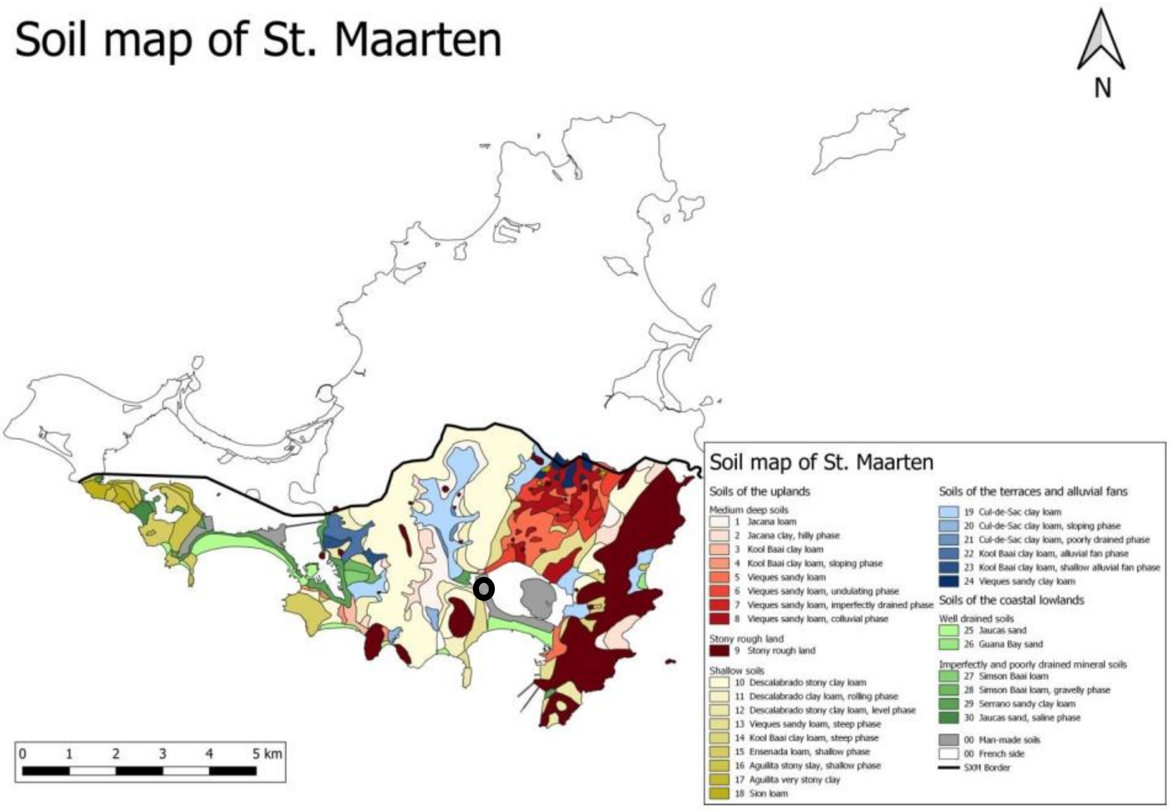

Figure 5-2 – Soil map of St. Maarten (slightly adapted from VEENENBOS 1955 *in* FREITAS *et al*., 2020[15]) (project location: black circle)

[14] UNDRR (2022). *Disaster Risk Reduction in Sint Maarten, Situational Analysis 2022*. United Nations Office for Disaster Risk Reduction (UNDRR). 58 pp

[15] FREITAS, J.A., A.C. Rojer, B.S.J. Nijhof, E.A.T. Houtepen & A.O. Debrot (2020). *Landscape ecological vegetation map of St. Maarten (Lesser Antilles)*. Caribbean Research and Management of Biodiversity Foundation, Curaçao Wageningen University & Research, Netherlands. 78 pp

The soils of the Cul-de-Sac area corresponds to Shallow soils, namely stony clay loam and clay loam, with some areas of Soils of the terraces and alluvial fans, particularly Cul-de-Sac clay loam.

The **A. TH. Illidge Road WWTP** is located on *Man made soils*.

Regarding Fresh Pond bottom sediments, DUNGEN (2023[16]) collected three sediment cores where two distinct lithological zones can be distinguished. Zone 1 (45 – 95 cm depth) is composed of cm-thick laminated sediments, while zone 2 (0 – 45 cm depth), is composed of more homogeneous sediments. The boundary at 45 cm is sharp, and most likely indicates the depth of dredging in 1999. The mean sedimentation rate for the top 45 cm is therefore 2.0 cm yr-1. The 210Pb dating suggests a slight decrease in sedimentation rate for the upper 15 cm of the core.

5.1.3 Climate and Climate Changes

The **climate** of Sint Maarten is a marine climate (classifies as "Am" on the classification scheme of Köppen), tropical with hot and sunny weather all year around. The average daily temperature ranges from 25 degrees Celsius (°C) in the period from January to March, to 28 °C between June and October. The night temperature rarely drops below 20°C, while sometimes it can reach 35/37 °C during the day, from June to November.

Average annual rainfall is 1045 mm. The hurricane season in the Atlantic region (including the Caribbean), when tropical depressions and hurricanes become active, starts on 1 June and ends on 30 November (with most activity occurring between August to October). Sint Maarten is located within the Atlantic hurricane belt, and hence, subject to frequent hurricanes during this period. Hurricane Irma was the last hurricane to make landfall on Sint Maarten in 2017, which caused immense damage and loss to the island, including damage to major components of the island's infrastructure. A total of 34,000 people collectively suffered US$2.7 billion in economic losses; that is about 80% of the island's population[17]. The GoSM has stated in the Nature Policy Plan that the detrimental impacts of hurricane Irma have only emphasised the 'dire need to increase resilience and adaptive capacity'[18]. The damage due to hurricanes is associated with one or a combination of strong wind, storm surge, pluvial flooding and mudslides. The compounding effect of these extreme weather events, storm surges, and sea level rise in the Caribbean would affect – on average for small island tourism economies – an estimated 10 percent of the population and at least 50 percent of tourism resort infrastructures (UNDP, 2010 *in* [19] PETERSON, 2019).

[16] DUNGEN, E.v.d. (2023). *Reconstructing the impact of land-use changes on coastal lagoons in the Caribbean*. MSc Thesis. 81 pp

[17] Sint Maarten Government (2019), *Sint Maarten National Recovery and Resilience Plan, A Roadmap to Building Back Better*, NRPB. pp. 17.

[18] Ministry of Public Housing, Spatial Planning, Environment and Infrastructure (Ministry of VROMI), 'Nature Policy Plan 2021-2025' (approved October 2021) p. 13.

[19] PETERSON; R.R. (2019). *Whence the twain shall meet: Weathering overtourism and climate change in small island tourism economies*. The 51st Annual Monetary Studies Conference St. Kitts, November 2019. 68 pp

Wind direction is prevailing from the east to northeast (Figure 5-3), with consistent monthly average of about 5 m/s at an elevation of 10 m above the ground. In the study area, the winds do not exceed 6.5 m/s. This parameter is important for odour dispersion.

Although there is no *National Adaptation Plan (NAP) for Climate Changes*, the *National Development Vision 2020-2030* recognizes climate change as a major challenge and emphasizes the need for sustainable infrastructure and improved disaster resilience. in renewable energy and sustainable waste management also exist. For example, Moreover, the *National Energy Policy 2014* states that dependence on fossil fuels must be reduced and the energy infrastructure must be more resilient. Additionally, the Wastewater Management Project is working on improving wastewater processing, which indirectly contributes to climate adaptation. Reference is also made to the *Disaster Risk Reduction in Sint Maarten* (UNDRR, 2022[20]) that also addresses the climate change risks.

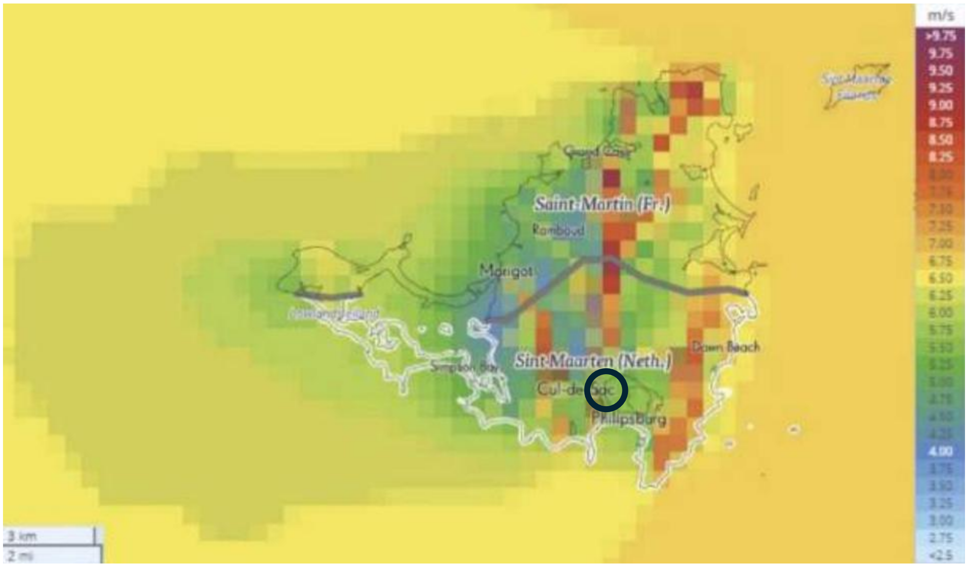

Figure 5-3 – Average wind speed at a height of 50 m above the ground (SMG, 2023[21]). Project location -black circle

Taking advantage of its geographic proximity, the predicted climate changes for the island of Anguilla can be extrapolated to the island of Saint Martin, and in particular to Sint Maarten.

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20 UNDRR (2022). *Disaster Risk Reduction in Sint Maarten, Situational Analysis 2022*, United Nations Office for Disaster Risk Reduction (UNDRR).

21 SINT MAARTEN GOVERNMENT. *Installation of a Temporary Weighbridge and Reconstruction of the Access road to the MSW Site. Daily Management of the MSW Site Operations including Fire Suppression and Slope Recontouring*. Environmental and Social Impact Assessment (ESIA). 662 pp

Table 5-1 – Predicted Climate Changes for Anguilla, which can be extrapolated for Sint Maarten22

Temperature Increased hot season	Temperatures will continue to rise. Further intensification of the hot season, high to extremely high heat impact potential by 2030, along with more frequent and more intense heat waves. The number of extreme heat events will increase roughly 15-fold by the 2020's and become a nearly year-long occurrence by the 2040s.
Hurricanes Major hurricanes	The frequency of category 4 and 5 hurricanes is expected to increase by 25%–30%. Storms are likely to become 2% to 11% stronger in terms of maximum wind speeds and possibly more frequent
Sea level rise Sea level rise	Continued sea level rise of 11 to 25cm. Rising sea levels combined with stronger winds during the strongest storms substantially increase the potential impact of storm surge and coastal inundation.
Sea temperature Warmer oceans	Warmer oceans along with steadily rising sea levels, even if global warming is halted in the foreseeable future. Trends in sea surface conditions include a projected rise of 0.77°C to 2.5°C by the end of the 21st century.
Rainfall Increasing flash floods	Changes in precipitation are more difficult to project; a slight decrease in total rainfall is anticipated, while single rain events will become more intense. Rainfall rates inside hurricanes could increase by up to 30%, increasing flash flood potential
Droughts Droughts	More prevalent. However, the trend may only become a major issue from the 2050s onward

With respect to water resources and sanitation services, changes in temperature, rainfall and extreme weather events (such as droughts) will inevitably lead to reductions in water availability and quality. This may be as a result both of damage to service infrastructure as well as due to reduced water quality through siltation of gutters and channels via landslides and destructive floods, and soil and groundwater contamination through the septic tanks.

Poor sanitation is strongly linked to dengue outbreaks because it creates breeding grounds (stagnant water) for the *Aedes aegypti* mosquito. Temperature is an important determinant of biting rate and mosquito development. Precipitation provides habitats for the aquatic stages of the mosquito life cycle and strongly influences vector distribution. Changes in climate are already altering the spatial and temporal dynamics of dengue ecology, potentially increasing vector ranges, lengthening the duration of vector activity, and increasing the mosquito's infectious period.

Extreme events can easily damage or destroy critical infrastructure serving the entire country, besides overwhelming the emergency services.

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[22] ARTELIA & THE CARIBBEAN INSTITUTE FOR METEOROLOGY AND HYDROLOGY (CIMH) (2021). *Territorial analysis: Resilience to climate change at a glance - Anguilla*.17 pp. https://rcc.cimh.edu.bb/files/2021/08/LW-ANGUILLA_V3.pdf

5.1.4 Hydric Resources

5.1.4.1 Superficial Resources

When it is raining heavily, water runs down from the hills and accumulates throughout the various valleys (like Cul-de-sac) and the side gutters of the roadways (which overflow and flood the roads and other properties).

As mentioned before, the Simpson Bay Lagoon, Great Salt Pond, Fresh Pond, Great Bay and other bays, ponds and lagoons are drowned valleys. Rainfall and runoff are likely the most important flushing forces in the ponds, sometimes causing them to overflow, impacting the surrounding areas. Wind, the major factor moving water in the shallow ponds, provides sluggish circulation. Because of the poor exchange water and the poor circulation, the pond systems are very sensitive to changes in water quality and quantity (ECOVISION, 1995[23]).

In the West side of the **A. TH. Illidge Road WWTP** is the Fresh Pond, an oblong shaped 2.5 km x 1 km pond, with a water surface of about 13.5 ha. The pond is divided by the Bernhard Bridge into a northern part and a southern part. Water depth varies from approximately 0.9 m near the bridge to 0.5 m in the north of the pond, however these values can be significantly lower in dry periods (about 0.40 m).

The Great Salt Pond, located in the East side of the **A. TH. Illidge Road WWTP**, is a 2.25 square kilometer saltwater pond historically used for salt production, which is located in south-central Sint Maarten and is bordered on all sides by downtown Philipsburg and its suburbs. It is the largest permanent saline lagoon saltwater pond (bottom is 1 to 1.5 m below the mean sea level, and the water level is also below sea level) on the island, which serves as a natural water catchment basin for much of the runoff water from surrounding hills.

In 1792 a dam was built to separate the Fresh Pond from the Great Salt Pond (located at North of the WWTP), with the purpose to prevent fresh water from flowing into the Salt Pond. In 1850, an opening to the sea was established to conduct the flow of fresh water to the sea (Photo 5-1). Rainfall of approximately 10 mm or more causes flushing of pond water to the sea.

The first flow of water occurs during the first period of heavy rainfall when the water level of the Fresh Pond rises faster than the level of Great Salt Pond. If rainfall continues, the level of both ponds eventually reaches their maximum capacity. The dynamics of the ponds occur on both sides. When one of the ponds overflows, VROMI opens the floodgates to compensate from the Great Salt Pond to the Fresh Pond and vice versa. The Great Salt Pond discharges into the Great Bay from a pumping system located in the southeast corner of the pond. It passes through a channel under a bridge. The Fresh Pond can be discharged through the “sand plug” on the western side of the beach, when removed manually.

[23] ECOVISION (1995). *The Ponds of Sint-Maarten. Sustainable Development and Management*. Report prepared for the Department of VROM Sint-Maarten. 138 pp

Because the existing pumps in Great Salt Pond are not currently working, , when further rise of the water levels occurs, the sand ridge separating Fresh Pond from the sea is opened, resulting in a waterflow from both ponds to the sea. Although the quality of the marine area in Great Bay is affected for a period, these discharges do contribute to the reduction of the nutrient accumulation in the Fresh Pond.

Photo 5-1 – First row Left: Fresh Pond; First row Right: Current gate system between Fresh Pond and Great Salt Pond; Second row Left: Channel to Great Salt Pond; Second Row Right: Great Salt Pond; Third row: Connection of the Fresh Pond to the sea (photos from June 2025)

The watershed of the Fresh Pond is relatively large (605 ha) (Figure 5-4), with rainwater and effluents collected in a watercourse running north-south along the L.B. Scott Road and Coralita Road. This watercourse ends up in the Zagers Gut which is in open connection with the northern part of the Fresh Pond. The other channel inlet point enters the Fresh Pond from the Bush Road (or from the Western side of the Fresh Pond). The watershed of Fresh Pond covers the Cul de Sac area.

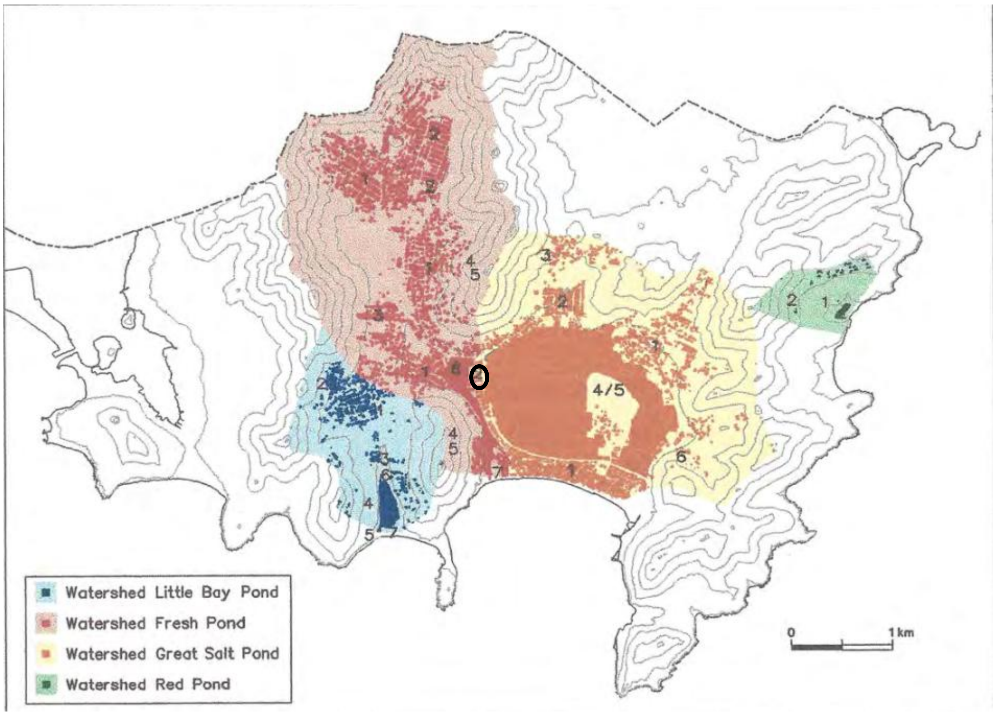

Figure 5-4 – Watershed of Fresh Pond (ECOVISION, 1995). Project location: black circle

The stormwater catchments and streams in Sint Maarten have several unique characteristics that contribute to the severity of flood-related impacts. As urban environments are usually situated in low-lying areas with little consideration for stormwater drainage, they are subject to flash flooding from surrounding hills or extreme rainfall events such as thunderstorms. The stormwater channels or streams are often short, entering the ocean as low or mid-order streams. They are typically inadequate to convey runoff due to their limited capacity and obstructions. In addition, hurricane-induced storm surges may also cause coastal flooding (ABEBE *et al.,* 2019[24]).

This Cul de Sac catchment has several characteristics contributing to flood risk. For instance, urban areas are situated on low-lying zones (Figure 5-5). Besides, the existing drainage system, which is composed by channels, has insufficient capacity to avoid flooding. In addition, most of the streets are narrow, limiting the enlargement of these drainage channels. Recurrent inconveniences such as transport

[24] ABEBE, Y.A., A. Ghorbani, I. Nikolic, Z. Vojinovic & A. Sanchez (2019). *Flood risk management in Sint Maarten – A coupled agent-based and flood modelling method*. https://www.sciencedirect.com/science/article/pii/S0301479719310199. 31 pp

disruptions occur during small rainfall events, whereas heavy rainfall causes large-scale flooding with damage to residential and commercial buildings (ALVES *et al.,* 2019).

An assessment of the predicted the rainwater flow that is directed to the Fresh Pond is presented in section 7.2.4.2.

Figure 5-5 – Cul De Sac aerial visualisation (ALVES *et al*., 2019[25]). Project location: yellow arrow

Based on a flood simulation performed by ABEBE and colleagues[26] for Sint Maarten (Figure 5-6), it is possible to predict that the facilities of the **A.TH. Illidge Road WWTP** will not be affected by a major flooding event, in the current climate scenario.

However, when considering the extreme events associated with the climate change where, under a worst-case scenario (SSP5-8.5: sea-level rise of 139 cm), the flood extent of Sint Maarten may increase by 68% from 2.72 km² to 4.56 km², this facility could be flooded (Figure 5-7).

[25] ALVES, A., Z. Vojinovic, Z. Kapelan, A. Sanchez & Berry Gersonius (2019)., Exploring trade-offs among the multiple benefits of green-blue-grey infrastructure for urban flood mitigation, *Science of the Total Environment*, https://doi.org/10.1016/j.scitotenv.2019.13498

[26] ABEBE, Y.A., A. Ghorbani, I. Nikolic, Z. Vojinovic & A. Sanchez (2019). *Flood risk management in Sint Maarten – A coupled agent-based and flood modelling method*. https://www.sciencedirect.com/science/article/pii/S0301479719310199. 31 pp

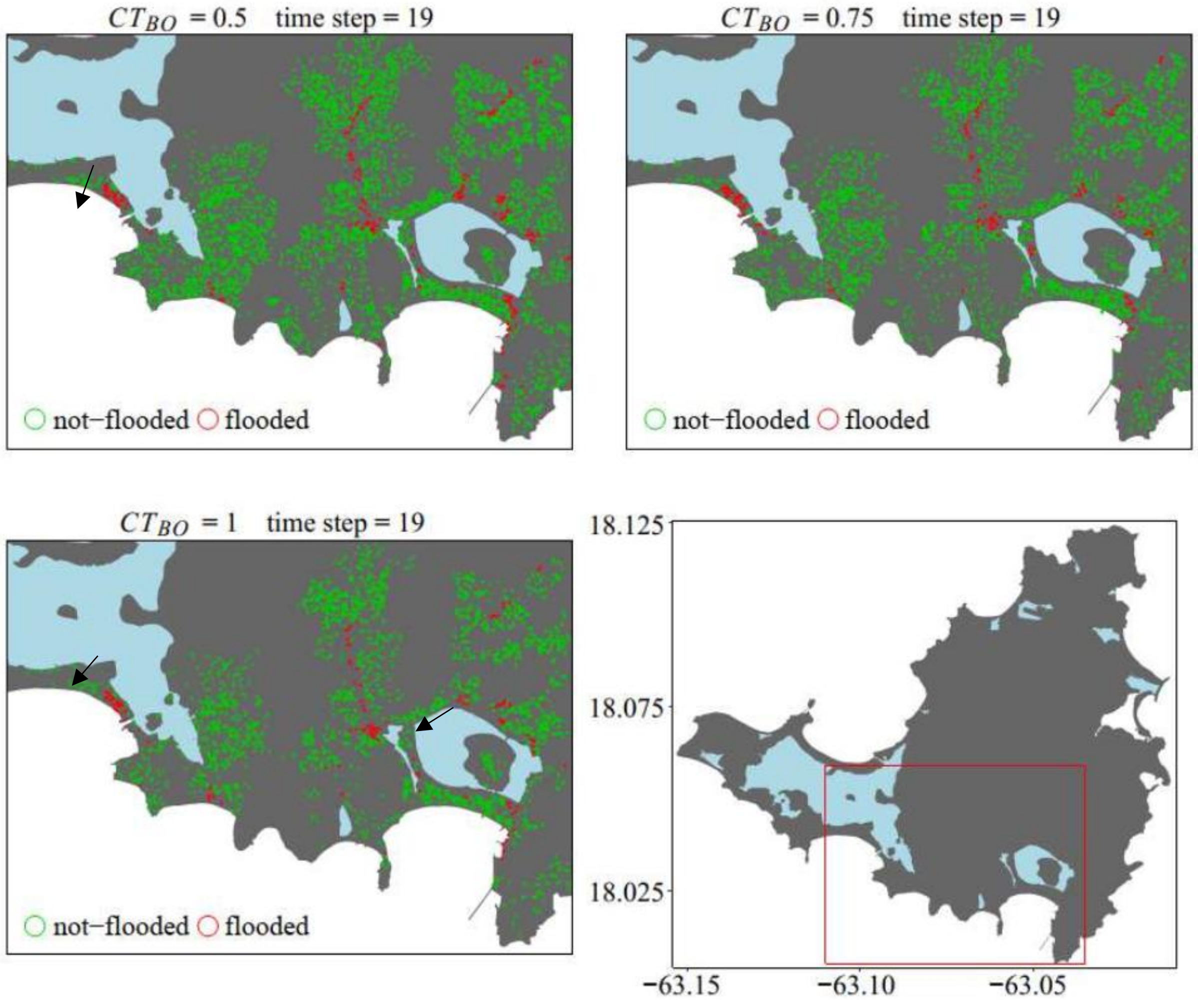

Figure 5-6 – Flood hazard probability in the central region of Sint Maarten, after a major flooding event. CT_{BO} – Building Ordinance Compliance Threshold. Project location – black arrow

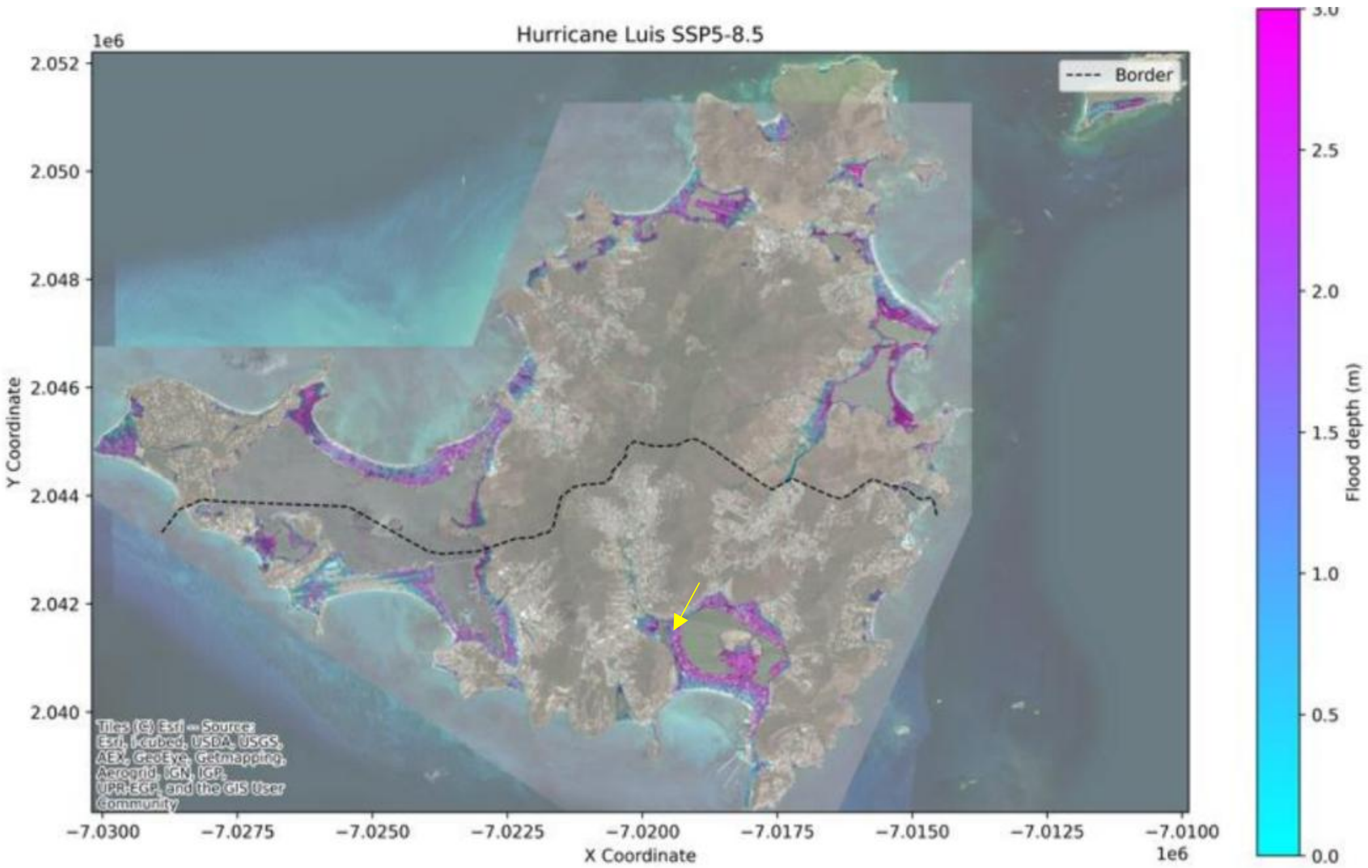

Figure 5-7 - Flood map for Hurricane Luis under the most pessimistic SLR scenario simulated in CORENA study (2025[27]). Project location: yellow arrow

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27 IMPACT HOUSE (GRANT THORTON) & VRIJE UNIVERSITEIT AMSTERDAM (2025). *An assessment of the coastal resilience of Sint Maarten. An assessment of natural capital and coastal flood risk to inform spatial planning as part of the CORENA project*. 82 pp

The bottom of the Fresh Pond partly lies below sea level, indicating the possibility of underground influx of seawater. However, this process as a flushing factor is insignificant compared to the influx of fresh water, based on the low salinity of the pond water (ECOVISION, 1995).

5.1.4.2 Underground Resources

Sint Maarten has aquifers, but they are relatively small and can be susceptible to saltwater intrusion from the surrounding sea.

Water wells have been historically present in the Cul de Sac area (Figure 5-8), but the number currently used is limited. The groundwater wells that are still in use today are mainly located in St. Peters, south of Cupper Drive, and are mainly used for water for carwashes and swimming pools.

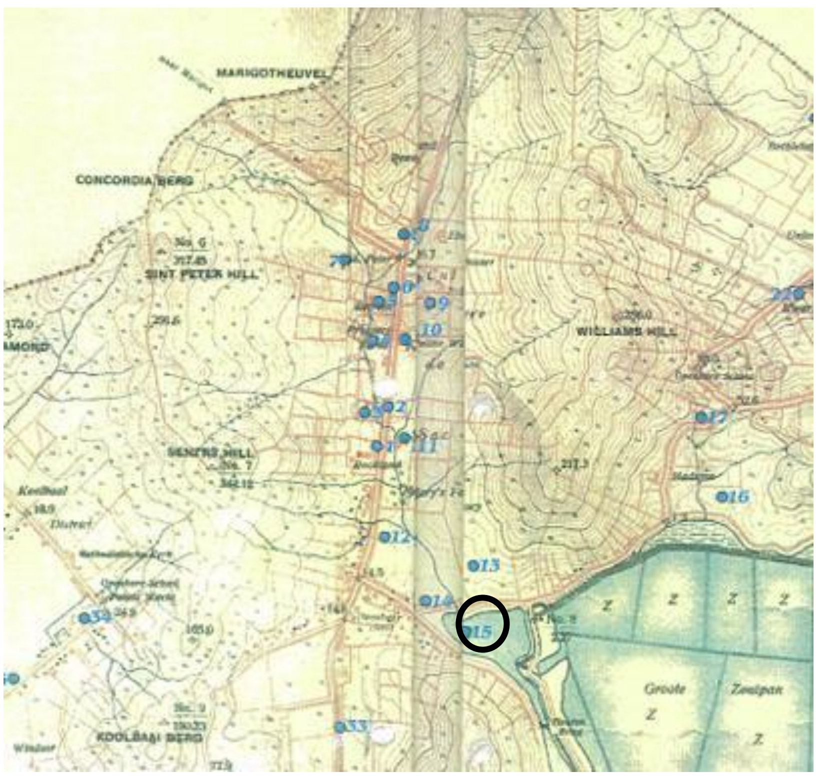


Figure 5-8 – Sint Maarten historic map of wells in the Cul De Sac Area[28]. Project location – black circle

[28] Location map of the 40 wells of St. Maarten, The Daily Herald, October 2007 (base data supplied by VROMI, July 2025)

An assessment of groundwater quality was made on two of these wells, one upstream, located in L.B. Scott Road (Well#2) and other downstream, near the WWTP (Well #14) to understand the quality of the groundwater that also contributes for the discharges into the Fresh Pond.

Table 5-2– Groundwater analysis results

Parameters	Units	6th November 2025	4th November 2025
		Well #14	Well #2
CODtot	mgO2/L	18.9	29.6
Ptot	mgP/L	0.079	4.5
NO3-N	mgN/L	9.78	0.501
NO2-N	mgN/L	0.057	0.279
Cond	uS/cm	1787	8680
Ecoli	/10 mL	~1050 ± colonies TNTC	~700 ± colonies TNTC
Coliform	/10 mL	~1050 ± colonies TNTC	~700 ± colonies TNTC
		Down Stream	Up Stream

Note: TNTC - Too Numerous To Count

These values were compared with Water Drinking Guidelines from the following documents:

- Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the *quality of water intended for human consumption* (recast) Annex 1 - Minimum Requirements For Parametric Values used to Assess the Quality of Water Intended for Human Consumption
- World Health Organization (WHO) *Guidelines for drinking-water quality* (2008 and 2022);
- Interim Guideline Value (EPA[29])
- World Bank. *Determinants of Declining Water Quality* (2019)

The assessment of each parameter is presented below:

- Chemical oxygen demand (COD) expresses the contents of organic matter, which can be caused by agriculture or septic tanks pollution. The WHO set a maximum limit for COD in drinking water at 10 mg/L. Both wells are above this limit;
- Phosphorus is typically found in low concentrations in groundwater because soils effectively retain it through adsorption (low to natural: generally less than 0.05 mg/L). However, excessive application of fertilizers and animal waste, and leaks from septic systems, can lead to elevated phosphorus levels. Values above 0.1 mg/L are considered high and can be indicative of pollution, such as from agricultural

[29] McCLOY Consulting (n/date). *Dungarvan Closed Landfill. Q1 Water Quality Monitoring Results and Trend Analysis. Groundwater*. 9pp

runoff or septic systems. The downstream well (#14) are above the lower limit but below the higher limit, but the upstream well (#2) is very high, indicating possible leaks from septic tanks;

- Nitrates (NO3) and nitrites (NO2) normally show fertilizer infiltration or liquid waste discharged from septic tanks. Both WHO and EU guidelines refers a limit of 50 mg/L for nitrate, which is complied in both wells. For nitrite, the limit value is 2 mg/L for WHO and 0.50 mg/L for EU which are also both complied by the two wells;
- Electrical conductivity reflects the concentration of dissolved ions in the water. High conductivity levels can signal increased salinity, which may indicate contamination or changes in the natural mineral composition of the groundwater, detecting pollution from agricultural runoff, industrial discharges, or wastewater. According to the EU Directive, a limit of 2500 uS/cm is allowable for drinking water. At Well #14 the conductivity value is high for fresh groundwater, but within normal values. For Well #2, on the other hand, the conductivity value is well above typical values for groundwater, which indicates the presence of a source of contamination.
- Faecal coliform densities are strongly related with proximity to areas with septic tanks, rainfall, and runoff from urbanized areas. EU Directive determines a zero concentration of both *E. Coli* and coliform for drinking water. Therefore, both wells are not suitable for drinking

5.2 Environmental Quality

5.2.1 Air Quality

The main air pollution sources in the **A.TH. Illidge Road WWTP** project area come from the emission of atmospheric pollutants (NO, CO, CO2, particles, etc.) from vehicles passing on the nearest roads, as well as some odour originated in the WWTP components, including the septic trucks.

The air quality standards for the islands of the Netherlands Antilles set by the Working Group on Environmental Standards Netherlands Antilles - Milieunormering Nederlandse Antillen (WMNA) (Eindrapport Milieunormen Nederlandse Antillen, 11 June 2007) are the most relevant standards for air quality in Sint Maarten. The WMNA includes air quality standards for dust, Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2), Ozone (O3), Methane (CH4), Carbon Monoxide (CO), Lead (Pb), Chlorine (Cl), Volatile Organic Substances (VOS), and odor.

Table 5-3 - Air quality norms (in µg/m3)

Parameter	Time unit	Limit values 2020
Total suspended particles (TSP	Year Day	75 150
PM10	Year Day	20 50
PM 2.5	Year	10
SO2	Year Day 1-hrs 10 minutes	50 20 350 500
NO2	Year 1-hrs	40 200
O3	8 – hrs 1 hr	100 235
Hydrocarbons (excluding CH4)	3 hrs	160
CO	12 hrs 8 hrs 1 hrs 30 minutes 15 minutes	10,000 10,000 22,900 60,000 100,000
Pb	Year	0,5
Cl	Year 30 minutes	10 300
BaP	-	1 ng/m3
Volatile Organic Substances	-	150
Odour	-	Max 1 smell unit

Since no major changes have occurred around the WWTP area since the passing of Hurricane Irma in 2017, the study developed by the Dutch National Institute for Public Health and the Environment (RIVM) published in 2019 was used for the baseline characterization with the results presented in the ESIA for the Municipal Solid Waste (MSW) site project (SMG, 2023[30]). Air quality measurements were performed during two weeks (between January 24 and February 6, 2019) in the locations shown in Figure 5-9.

30 SINT MAARTEN GOVERNMENT. *Installation of a Temporary Weighbridge and Reconstruction of the Access road to the MSW Site. Daily Management of the MSW Site Operations including Fire Suppression and Slope Recontouring*. Environmental and Social Impact Assessment (ESIA). 662 pp

Sample locations (A-D) are fixed monitoring locations with 24/7 sampling equipment and Sample locations (1-14) are historical and instantaneous locations using other techniques. Within the study area limit (black circle in Figure 5-9), there are four measurements sites that were used as baseline data for the present project. (B – Miss Lalie, 3 – W.A. Nisbeth Road, 5 - Roundabout near the A.TH. Illidge Road WWTP, 9 – Uphill east of Welgelegen Road[31]).

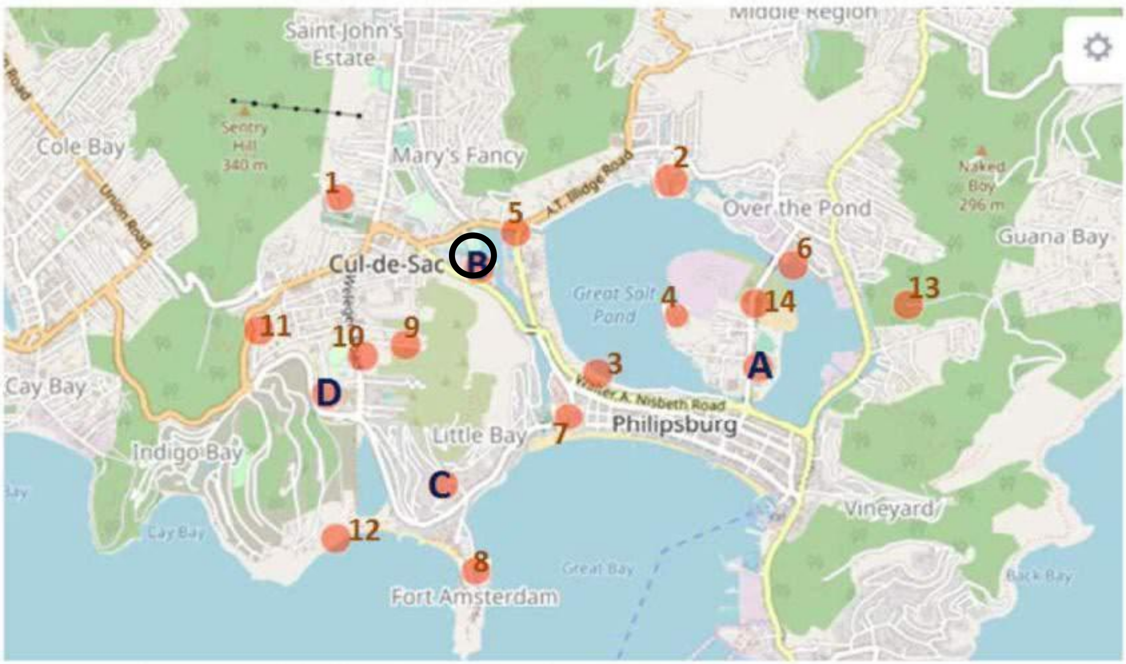


Figure 5-9 – Sampling points by RIVM, 2019 (*in* SMG, 2023[32]). Project location – black circle

Site B had continuous sampling of particulate matter (PM10), Site 3 was used to monitor the emission from the landfill under smouldering conditions, including also VOC samples and wipe samples, Site 5 was used as indicator for local traffic conditions (a passive VOC sampler) and Site 9 was used to get a more complete

[31] Site B – Situated on the rooftop in order to minimize influence of traffic emissions. Expected to be exposed to the highest concentration in the event of a fire when wind is from a SE-E direction; Site 3 – This site will be exposed to emission from the landfill when winds are from a E-NE direction and under these conditions, the highest concentrations are expected here. The site is not influenced by traffic emissions; Site 5 – Located near a roundabout with a lot of traffic; Site 9 – Is used as an indication of the ambient levels at a more remote location and should give an indication of the spatial distribution along the slopes of the valley. Contribution of traffic to the air quality is expected to be limited at this site

[32] SINT MAARTEN GOVERNMENT (2023). *Installation of a Temporary Weighbridge and Reconstruction of the Access road to the MSW Site. Daily Management of the MSW Site Operations including Fire Suppression and Slope Recontouring*. Environmental and Social Impact Assessment (ESIA). 662 pp

impression of the spatial distribution of compounds, with only VOC sample measurements and wipe samples taken.

Photo 5-2 – Air quality measurements sites (First row – B and 3; Second row – 5 and 9) (SMG, 2023[33])

The main results are summarized below (for further details, consult Annex G of SMG, 2023):

- The concentration of PM10 in Site B (12 µg/m^3) is below the European Union (EU) annual average exposure limit of 40 µg/m^3 and also the Sint Maarten annual average limit of 20 µg/m^3;
- Sites B and 3 have some elements in the PM10 above the detection limit. Some originated from sea salt and sand (boron, calcium, potassium, magnesium and silicon). Aluminium exceeded the tolerable level, but it was not considered a public health risk.
- Regarding coarse dust, with hand-to-mouth exposure, Site 3 had some elements above the detection limits. However, most of the elements were from sea salt and sand and all had low concentrations, with no health risk.
- Site B and 3 had PAHs (Polycyclic Aromatic Hydrocarbons) from PM10 above analytical and reporting threshold. However, none exceeded the EU target values and the increased lung cancer risk. The same was true for PAHs in the coarse dust of Site 3;

33 SINT MAARTEN GOVERNMENT (2023). *Installation of a Temporary Weighbridge and Reconstruction of the Access road to the MSW Site. Daily Management of the MSW Site Operations including Fire Suppression and Slope Recontouring*. Environmental and Social Impact Assessment (ESIA). 662 pp

- Site B and 3 had also Dioxins and Dioxins-like PCBs (Polychlorinated Biphenils) in Particulate matter above bound values. But it was concluded that these values were well below the allowable total weekly intake (TWI); The same is true for the concentration of these elements in the coarse dust samples of Site 3;
- Volatile Organic Compounds (VOCs) permitted limits were only exceeded in Site B, but the concentrations were very low, namely regarding benzene, with no impact on chronic exposure;
- Site B had detectable acetone levels, but the measured values were well below the time-weight average concentration for occupational exposure;
- Site 5 and Site 9 did not have any air pollutants with concentrations above the permitted threshold.

It can be concluded that although there are some air pollutants elements with relevant concentrations in the project area (mainly near the WWTP – Site B, and in the Southeast of the WWTP – Site 3) related to vehicle emissions and environmental conditions (sea salt and sand), they do not pose any risk for the community public health.

Regarding Site 9, which is located in the West side of the WWTP, is important to reinforce that no VOCs above level were detected, nor any coarse dust with higher levels of heavy metals. This finding is relevant, since WWTP can also produce VOCs, as benzene, toluene, xylene, methane and hydrogen sulfide. As demonstrated in the air quality assessment presented in the landfill EIA study, no detectable concentrations of benzene, toluene, xylene and methanol (derived from methane) were detected in this western area of the **A.TH. Illidge Road WWTP**, allowing for the assumption that this facility is not impacting the air quality of this surrounding area.

For the hydrogen sulphide, with its characteristic rotten egg odor, along with other 2 pollutants that also may origin odor nuisance (NH3 – ammonia and CH_3SH – Methanethiol), a quantitative comparison (AERMOD software) of the current situation of the WWTP with the updated project is presented in **ANNEX 3** and discussed in Chapter 7 (Impact Assessment).

Regarding the current situation, the performed simulation confirms the low impact of the WWTP, being well below the Netherlands limit of 1.0 ouE/m^3 established for highly sensitive areas. The only three receivers (in a total of 99 simulated) with higher concentration (1.5 ouE/m^3) are two located in the south side ofthe WWTP, and one in the northeast opposite side of the A.TH. Illidge Road. However, due to its location in a mixed zone, with predominance of commercial areas, the legislated threshold of 3 ouE/m^3 is complied.

Therefore, no significant odor nuisances are expected in either the residential areas or mixed areas.

5.2.1.1 Baseline Survey Results

To support this quantitative assessment, a field survey was carried out in a 200 m buffer around the WWTP, where a total of 120 face-to-face enquiries to residents and business owners were performed (and 82 stickers with contacts were left, when residents were not at home). Besides census data (described in Section 5.4.3), several questions were related to the WWTP nuisance (**ANNEX 4**).

In general terms, the surrounding community is aware of the WWTP presence, and for the majority the plant was already constructed when they moved to the surrounding area.

Most of the respondents did not have any complaints regarding the WWTP (about 74%), but 5% of these referred to or mentioned the odor coming from the pond. For the remaining respondents, the main complaints are related to odor and dust, mostly related to the truck's disposal of the septic effluents and when the wind is calm. Other relevant nuisance relates to the presence of pests, rodents and mosquitoes, mainly related with the sewage splashed from the trucks.

Most of those who reported odor issues do not link it to the WWTP. The time of year and day when the odor is most noticeable varies widely. This highlights the subjectivity of odor as a nuisance.

Also, based on the survey results, the health impact of this nuisance is seemingly negligible, with only 10% of the respondents referring to some headaches, nausea and respiratory issues. In this percentage, is also included the impact on outdoor activities. Health impacts should be further assessed by the appropriate health authorities.

In conclusion, based on the quantitative and qualitative assessment, it is confirmed that the current operation of the WWTP does not have a significant impact on the air quality of the surrounding neighborhood, namely on the odor nuisance. The trucks disposal process needs to be improved, and as already described in Section 2, is predicted a physical barrier between this site and the nearby southern buildings, where the impacts of odor and splashed effluents are more relevant, in addition to the introduction of a pipe for the discharges from the trucks which will contain the odor.

5.2.2 Water Quality

The water quality of the Fresh Pond downstream of Cul-de Sac is being deteriorated by urban runoff from two open channels, mainly Bush road and Zager's Gut. Most of the effluents discharged directly or indirectly into the Fresh Pond come from untreated sewage discharges, surface runoff, plastics and other litter from surrounding neighborhoods. Although about 90% of the households in Sint Maarten have sewage system (septic tanks, soak-aways, and cesspits), a large portion still finds its way directly into the environment. When these tanks are not emptied regularly, they overflow, causing sewage to spill into streets, public spaces, and eventually ending up in beaches and ponds. This untreated wastewater carries harmful pollutants, chemicals, and diseases, posing serious risks to both human health and ecosystems.

Treated effluent from the **A.TH. Illidge Road WWTP** is discharged by gravity into the Fresh Pond, flowing from there via a canal towards the sea, which is normally closed off and opened during periods of heavy rainfall. Based on the water levels management, this flow can also be discharged to the Great Salt Pond and from there to the sea. Currently, the pumps in this last pond are not working, therefore the discharges are through the Fresh Pond.

Figure 5-10 – Flow directions of the WWTP effluent[34]

[34] WORLD BANK (2023). *Annex 2: Technical assessment and CAPEX analysis for the WWTP at A.T. Illidge Road.* 15 pp

No industries could be identified, which might discharge relevant pollution loads or even problematic/ toxic substances to the sewer network

The wastewater flows reaching the WWTP are primarily of residential origin, from day tourists (mostly small ships, not cruise ships) or from small commercial facilities.

According to the Country Regulation AB 2015, Chapter IV[35], National Waste Ordinance (AB 2013, GT nr. 135) and the National Wastewater Ordinance (AB 2013, GT no. 142[36]), it is prohibited to discharge and or store environmentally untreated, damaging and or dangerous substances (liquids) into the soil or surface waters.

The Council Decision AB 2013, nº 137[37], implementing Article 17 of the Waste Management Ordinance, refers that Liquid waste—from trucks carrying the contents of cesspools, septic tanks, or similar contents that cannot be discharged to the sewage treatment plant—may be disposed of at the public landfill in the Great Salt Pond, provided the driver or owner of the truck has paid the rate specified in the Bylaws before discharging.

Table 5-4presents the St. Maarten Water Quality Standards for Surface Water according to the Final Report Environmental Norms, Netherlands Antilles, June 11, 2007, which is followed by St. Maarten.

Table 5-4 - Surface water St. Maarten quality standards

Parameters	Oxygen (DO)	Total N	Total P	Faecal Coli	Oil/vegetable	Transparency
Water types	mg/l	mg N/l	mg P/l	x/100 ml	mg/l*	(meter)
Recreation	>5	0.10	0.02	5	0.5	5-25**
Nature	>5	0.014	0.003	100	0.1	25
Industry	>0.8	1.27	0.10	100	3	5
Other (lagoons, lakes,	>4	0.15	0.02	200	0.5	5-25**

35 Landsverordening houdende regelen inzake het inzamelen en zich ontdoen van huisvuil, grof vuil, vloeibaar vuil, bedrijfsvuil, autowrakken en andere categorieën van vuil, AB 2015, no. 9; [Afvalverordening]. Country Regulation concerning rules on the collection and disposal of household waste, bulky waste, liquid waste, industrial waste, end-of-life vehicles and other categories of waste [Waste Regulation] https://lokaleregelgeving.overheid.nl/CVDR208510/2

36 Landsverordening, ter bescherming van het milieu en de belasting daarvan door afvalwater te beperken en zoveel mogelijk te voorkomen en daartoe regels te stellen met betrekking tot het afvalwater, AB 2013, GT no. 142.[Landsverordening Afvalwater] Country Regulation, for the protection of the environment and the burden thereof by limiting and avoiding as far as possible waste water and to lay down rules for this with regard to waste water [National Ordinance Wastewater] https://lokaleregelgeving.overheid.nl/CVDR208544/3

37 Landsbesluit Houdende Algemene Maatregelen, ter uitvoering van artikel 17 van de Afvalverordening, AB 2013, GT no. 137; Council Decision, concerning general measures, implementing Article 17 of the Waste Regulation. https://lokaleregelgeving.overheid.nl/CVDR208540/1

Parameters / Water types	Oxygen (DO) mg/l	Total N mg N/l	Total P mg P/l	Faecal Coli x/100 ml	Oil/vegetable mg/l*	Transparency (meter)
estuaries, other sea)						

Explanation of Table V: * also: no observable (visible or odorous) pollution ** highly dependent on water type - surface water: seawater and inland waters (lagoons, ponds, bays, salinas, etc.)
- standards are limit values that may not be exceeded unless otherwise indicated. Oxygen (DO) is the minimum permissible value
- in addition to these standards, the standstill principle (open standard) applies: maintain the current quality if it is better
- further explanation of the table: see Frequently Asked Questions question 8

In 2009, NV GEBE, the company responsible for the electricity production and water distribution, carried out water quality analysis in several locations, including Fresh Pond and Great Salt Pond, focusing on *Eschericha coli,* a faecal bacterium, associated with HPC test which estimates the total number of aerobic heterotrophic bacteria in a water sample. These bacteria are not necessarily harmful, but their presence and concentration can indicate the overall health of the water system and potential issues. Data for the two ponds are presented in the following table.

Table 5-5 – GEBE data of water analysis at Fresh Pond and Great Salt Pond in 2009

DATE	OBJECT	SAMPLE #	E.COLI cfu/100ml	HPC cfu/ml
23-Mar	Salt pond	8a	<100	2000
23-Mar	Salt pond	8b	2100	31000
23-Mar	Salt pond	8c	9100	54000
23-Mar	Salt pond	8d	100	4300
23-Mar	Salt pond	8e	<100	700
23-Mar	Fresh pond	9b	110	10800
23-Mar	Fresh pond	9c	1200	2400

Legend: HPC - heterotrophic plate count - elevated HPC levels can sometimes be associated with the presence of opportunistic pathogens, and high HPC can also hinder the detection of other pathogens like coliforms

The first conclusion is that none of the ponds are suitable for drinking water (0 cfu/ml – WHO, 2017[38]). Using the threshold limit of 200 cfu/100 ml set out in the above **Error! Reference source not found.** and also in the table 3.5 of Article 3.5 of the *Final Report Environmental Standards Sint Maarten 2023* (VROMI & VNG, 2023[39]), it can be concluded that, at that time, some of the samples, in both Ponds, were above this allowed concentration, so bathing should also not be allowed. Assuming the upper limit of 500 cfu/ml for HPC of drinking water, none of the samples complied with this limit. The values obtained for HPC are within the range values for ponds, which are influenced from several factors, including temperature, nutrient availability, and the presence of organic matter.

[38] WHO (2017). *Guidelines for drinking-water quality: fourth edition incorporating the first addendum*. 134 pp
[39] VROMI & VNG (2023). *Final Report Environmental Standards Sint Maarten 2023*. 134 pp

On July 22, 23 and 24, 2012, the St. Maarten Nature Foundation tested water quality at eight sites on the island to determine the quality of water for bathing (at swimming beaches) and for general water quality at various bodies of water throughout the island. The Fresh Pond and the Great Salt Pond were two of those sites. Water samples were tested for the following parameters: Nitrates, Phosphates, Nitrogen, Dissolved Oxygen, Alkalinity, and Temperature. The following results were obtained:

- The Great Salt Pond had the highest levels of both phosphates and nitrates in samples tested, which suggested that there was a presence of various types of pollutants and sewage which can cause algal blooms and mortality events (fish, turtle and crabs) in wetlands and coastal areas;
- The Great Salt Pond also had the highest level of nitrogen (6 parts per million, ppm), which is a relatively high number; the presence of elevated nitrogen levels can pose a threat to aquatic organisms and can cause massive fish die-offs in wetlands and coastal areas.
- The Fresh Pond had the following concentrations: Nitrates: 0.4 ppm, Phosphates: 0.3 ppm, Nitrogen: 1 ppm, DO 7 ppm, Faecal Coliform: Present

A recent survey (2023[40]) analysed the water flowing from the trench that runs alongside Welgelegen Road, past Raoul Illidge Stadium and St. Maarten Medical Center and ends up in the Fresh Pond. As a result of discharge from different channels to the Pond, the water near the roundabout had an uncountable total coliform. The BOD (Biochemical Oxygen Demand) was at 121, meaning more than four times the limit.

Reference is also made to the study developed by DUNGEN (2023[41]), which concluded, based on sediments collected at the Fresh Pond, that this pond is strongly influenced by human impacts. High sedimentation rates, elevated levels of heavy metals (copper - Cu, chromium - Cr, nickel Ni and zinc - Zn*)*, phosphorus (P) and nitrogen (N), a low SDI (Shannon Diversity Index), and the dominance of planktonic species are indicators of a degraded waterbody with eutrophic conditions.

Sediments were also collected from six other wetlands of the island (both in the Dutch and French sides), with similar analysis. The author grouped these wetlands in two groups, the saline lagoons (Simpson Bay, Mullet Bay, Étang aux Poissons and Oyster Pond) and the brackish to freshwater lagoons (Fresh Pond, Little Bay Pond and Great Salt Pond). These later sites are characterized by a low SDI, and are dominated by the planktonic species *Actinocyclus normanii,* and *Stephanocyclus meneghiniana*, which indicate eutrophic conditions. The surface sediments at all three sites also have a high concentration of heavy minerals. The Fresh Pond shows the strongest signs of eutrophication, and has the highest P concentration of 2158 ppm. Also, the highest concentrations of diatoms were found at Fresh Pond.

40 https://www.thedailyherald.sx/islands/dangerous-levels-of-contamination-of-run-off-well-water-and-open-water

41 DUNGEN, E.v.d. (2023). *Reconstructing the impact of land-use changes on coastal lagoons in the Caribbean*. MSc Thesis. 81 pp

Within the scope of NRPB targets, a recent survey (between April to June 2025) on the quality of water and sediments (CARIRI, 2025[42]) was developed for several sites in Sint Maarten, including the Fresh Pond with 5 sites sampled (composite sample) and 3 for grab samples (Figure 5-11) to determine Bacteria in water, Nutrients & Pollutants in water and heavy metals in sediments[43]

All Microbial counts significantly exceeded the acceptable limits, with average Faecal Coliform levels ranging from 10,123 to 23,857 CFU/100ml and *Enterococcus* levels ranging from 973 to 4,067 CFU/100ml. Generally, the average Coliform counts were greater than the *Enterococcus* counts.

Regarding Physicochemical parameters, pH indicates the water's acidity or alkalinity, which can affect the toxicity of substances and the wellbeing of aquatic organisms. DO levels are critical for the survival of fish and other aerobic organisms, and low values may signal pollution. Electrical conductivity reveals the presence of dissolved ions and salts, often pointing to runoff or industrial discharge. Temperature influences chemical reactions, biological processes, and oxygen solubility, making it a key parameter in understanding ecosystem stability and water quality.

For the Fresh Pond, all pH and dissolved oxygen readings were within acceptable limits of pH 6.5-8.5 and DO >5mg/l. Measured temperatures were consistent with typical ambient conditions for the region.

Regarding Nutrients and Pollutants, all parameters exceeded the acceptable limits, with the exception of Oil & Grease (Table 5-6).

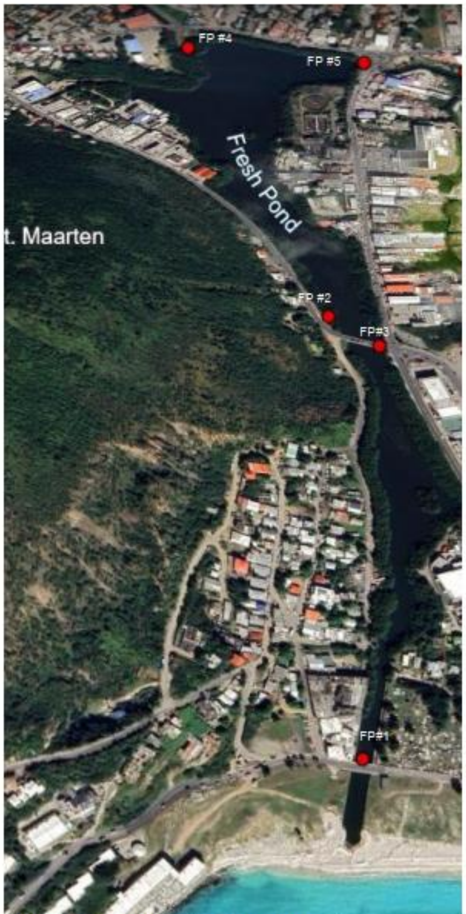
The various studies carried out regarding the water quality at the Fresh Pond lead to the conclusion that the level of nutrients at the Fresh Pond are that of an eutrophic water, strongly influenced by the discharges from the WWTP. However, results show that, although the dissolved oxygen levels of the treated wastewater are 2mg/l, aeration at the Fresh Pond is sufficient to raise DO levels up to 5-7 mg/l, which is expected due to its shallow depth (up to 0.9m) and mixing caused by wind.

For the Heavy Metals in the sediments collected in the Fresh Pond, the composite sample had a cadmium level of 1.83 mg/kg and zinc level of 129 mg/kg, which, though still below PEC, exceeded the conservative TEC equivalent. This suggests potential ecological impairment and warrants further evaluation and risk analysis. The higher concentration of Zinc is in consonance with those obtained by DUNGEN (2023), described above.

[42] CARIRI (2025). *Assessment of Seawater Quality Testing of Six (6) Areas to Establish a Baseline*. Final Report (draft version). 62 pp

[43] Bacteria in water - Enterococci, Faecal Coliform, E. Coli, pH, Oxygen, Water Temperature; Nutrients & Pollutants - Electric Conductivity, Total Nitrogen, Total Suspended Solids (TSS), Total Phosphorus, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD5), oil & grease, (plus polychlorinated biphenyls – PCB - for the Fresh Pond); Heavy metals - Cadmium, Copper, Nickel, Lead, Zinc, Mercury, Chromium

MAP 2: Fresh Pond with sample point markers.



Photograph 1:
Fresh Pond – Zagersgut Road Bridge – top of the pond

Photograph 2:
Fresh Pond – Bus Shed signage by fire hydrant

Pt #	Easting (WGS84)	Northing (WGS84)	Site ID	Description
1	494121	1992946	FP # 1	Fresh Pond South
2	494001	1993527	FP # 2	Bush Shed signage by fire hydrant
3	494063	1993491	FP # 3	Traffic Light by bridge
4	493726	1994050	FP # 4	Top of the pond by bridge – Zagersgut Road
5	493965	1994068	FP # 5	Sluice gate by roundabout

Figure 5-11 –CARIRI sampling sites at Fresh Pond

Table 5-6 – CARIRI data of water analysis at Fresh Pond in 2025

	Electrical Conductivity (uScm-1)	Total Nitrogen (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorous (mg/l)	Chemical Oxygen Demand (mg/l)	Biological Oxygen Demand (mg/l)	Oil & Grease (mg/l)	PCB (µg/l)
Average values	**1443.5**	**13.63**	**64.21**	**3.27**	**87.19**	**27.05**	**1.56**	**<0.057**
Acceptable levels	**<400**	**<1.5**	**<25-30**	**<0.1**	**<50**	**<3-5**	**<10**	**< 0.064**

Cadmium (Cd) and Zinc (Zn) may appear elevated in comparison to other heavy metals due to several possible environmental and anthropogenic reasons (CARIRI, 2025[44]):

- Source-Specific Pollution – Cd and Zn are common in urban runoff due to corrosion of galvanized sheets and pipework, batteries, paints, tires, and coatings, Informal disposal or leaching from electronic waste.
- Contaminant fate and transport – Cd and Zn are more mobile in aquatic environments, in comparison to heavier, particle-bound metals like Lead and Chromium.

This assessment also performed similar analysis in the Great Beach Bay, with 5 discrete grab samples and 1 composite, composed of 10 locations along the bay. This site is important as receives the outflows from Fresh Pond and Great Salt Pond.

Its regular tidal exchange flushes sediment and urban runoff into the nearshore zone. Also, during heavy rainfall, stormwater runoff from the Philipsburg area, including discharges from Rolandus Canal that outflow the Great Salt Pond, introduces untreated or partially treated wastewater, sediments, and floating debris directly into the nearshore waters of Great Bay Beach.

Post-rainfall sampling by the Nature Foundation in 2019 identified sewage contamination, flagged by elevated coliform bacterial levels following stormwater runoff and floodgate discharge events (CARIRI, 2025[45]).

CARIRI sampling in 2025 also found coliform bacterial levels elevated (mostly *Enterococcus* sp.). Regarding nutrients, nitrogen and TSS was also above recommended thresholds.

[44] CARIRI (2025). *Assessment of Seawater Quality Testing of Six (6) Areas to Establish a Baseline*. Final Report (draft version). 62 pp

[45] CARIRI (2025). *Assessment of Seawater Quality Testing of Six (6) Areas to Establish a Baseline*. Final Report (draft version). 62 pp

5.2.3 Effluent Quality

Regarding the WWTP effluent discharges quality, it was assumed the environmental standards for treated wastewater discharge from Saint Maarten correspond to the *Hindrance Permit*. Treated effluent quality requirements, according to the Hindrance Permit HP.12.006, are presented in Figure 5-12.

F2. Effluent Quality

1. The following table (1) denotes the maximum quantity of the mentioned parameters allowed for the Effluent Quality discharges of the STP

Table 1

Parameter	Unit	Value (yearly average)	General Max. Value*
BOD	mg O_2/l	5	7
COD	mg O_2/l	100	150
Nitrogen	mg N/l	10	12
Phosphorus	mg P/l	2	4
Fecal Coli form	100 ml^{-1}	300	350
Chlorine	mg/l	1,5	2
Suspended Solid	mg/l	10	15
pH	-	6-9	-

* Maximum value at any given moment.

Figure 5-12 –A. TH Illidge Road WWTP Effluent Quality Requirements (Hindrance Permit HP.12.006)

The World Bank Group EHS (Environmental Health and Safety) Guidelines for wastewater (2007) provides information relevant to the operation and maintenance of (i) potable water treatment and distribution systems, and (ii) collection of sewage in centralized systems (such as piped sewer collection networks) or decentralized systems (such as septic tanks subsequently serviced by pump trucks) and treatment of collected sewage at centralized facilities. Regarding wastewater, recommended measures are provided for the design, construction, operation, and maintenance of wastewater treatment facilities to achieve effluent water quality consistent: with applicable national requirements and/or internationally accepted standards, and; with effluent water quality goals based on the assimilative capacity and the most sensitive end use of the receiving water. The Guidelines also recommend discharging treated wastewater to natural or constructed wetlands (which can buffer the impact from discharge directly to the aquatic environment), unless the wetland itself would be degraded by the discharge.

Regarding quality parameters, the Guidelines present the following indicative values for treated sanitary sewage discharges, which, however, are not applicable to centralized municipal wastewater systems, as is the case with the A.TH. Illidge Road WWTP.

Table 1.3.1 Indicative Values for Treated Sanitary Sewage Discharges[a]		
Pollutants	**Units**	**Guideline Value**
pH	pH	6 – 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[b] / 100 ml	400[a]

Notes:
[a] Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation.
[b] MPN = Most Probable Number

Figure 5-13 – WBG ESH G threshold values for wastewater discharges

Besides the Hindrance Permit, comparison was also made with the recent Urban Wastewater Treatment Directive (UWTD[46]) that came into force on January 1, 2025, replacing the old directive from 1991. Member states must transpose the new rules into their national laws by July 31, 2027. This updated Directive makes significant changes to the overall approach of wastewater treatment and sets challenging goals for UE Member States wastewater infrastructure and management. According to this Directive, for agglomerations with population equivalent (p.e.) between 10,000 and 150,000 (within the Cul de Sac and Lower Prince's Quarter range), it assumes a reduction of the phosphorus concentration limit in the effluent from 2 g/m^3 to 0.7 g/m^3 and for nitrogen from 15 to 10 g/m^3. The BODs limit is 25 mg/l O_2 and COD is 125 mg/l O_2. The Directive also refers that the "tertiary treatment" (process that reduces nitrogen or phosphorus, or both) will be mandatory for p.e. ≥150,000 beyond 2039 or in the case of sensitive areas, for p.e. ≥10,000, phased until 2045.

In addition to these references, the "*Eindrapport Milieunormen Nederlandse Antillen*[47]", drafted in 2007, is being updated for 2025, wastewater with a pollutant value of 2,000 population equivalents or more undergoes treatment in a treatment plant such that prior to discharge into a surface water body it complies at least with the following limit values.

46 EU 2024/3019, Directive (Eu) 2024/3019 Of The European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment, 〈https://eur-lex.europa.eu/eli/dir/2024/3019/oj/eng〉

47 Translation to "Final report on environmental standards for the Netherlands Antilles"

Table 5-7 – Wastewater limits of the *Final report on environmental standards for the Netherlands Antilles* (2025 version)

Parameters	**Limit value in 24-hour sample**	**Limit value as a rolling annual average**
Biochemical oxygen demand (BOD5 at 20 °C) without nitrification	20 mg O2 per litre	
Chemical oxygen demand (COD)	125 mg O2 per litre	
Total amount of undissolved substances	30 mg per litre	
Total phosphorus (design capacity exceeding 100,000 population equivalents)		1.0 milligram per litre
Total phosphorus (design capacity of 2,000 to 100,000 population equivalents)		2.0 mg per litre
Total nitrogen (design capacity of 20,000 population equivalents or more)		10 milligrams per litre
Total nitrogen (design capacity of 2,000 to 20,000 population equivalents)		15 milligrams per litre

Table 5-8summarizes the threshold values for these mentioned guidelines.

Table 5-8 – Wastewater Threshold Values for different sources

Parameter	**HP**	**WB**	**EU Directive (1991)**	**EU Directive (2025)**	**Final Report Antilles (2025)**
BOD	5 mgO2/l	30 mg/l	25 mg/l	25 mg/l	20 mg/l
COD	100 mgO2/l	125 mg/l	125 mg/l	125 mg/l	125 mg/l
Nitrogen	10 mgN/l	10 mg/l	15 mg/l	10 mg/l	10mg/l
Phosphorus	2.0 mgP/l	2.0 mg/l	2 mg/l	0.7 mg/l	2.0 mg/l
Faecal Coliform	300 (100 ml-1)	400 (MPN/100 ml)	-	-	-
TSS	10 mg/l	50 mg/l	35 mg/l	35 mg/l	30 mg/l

For the purpose of the baseline situation, the values from the 1991 Directive were considered, which are equal to the HP for phosphorus and higher for nitrogen (less restrictive)[48]. For BOD and COD, the HP is also more restrictive.

[48] mg/L = g / m³

According to the technical assessment and CAPEX analysis performed during Nov.02, 2022 and March 13, 2023[49] it could be checked in Figure 5-14 that WWTP A TH Illidge Road had a good performance for COD, according to the Hindrance Permit HP.12.006 and also the 1991 EU Directive. Regarding P and N, the average values are higher than both legislations thresholds, associated to some temporary high values probably related to a higher number of septic trucks.

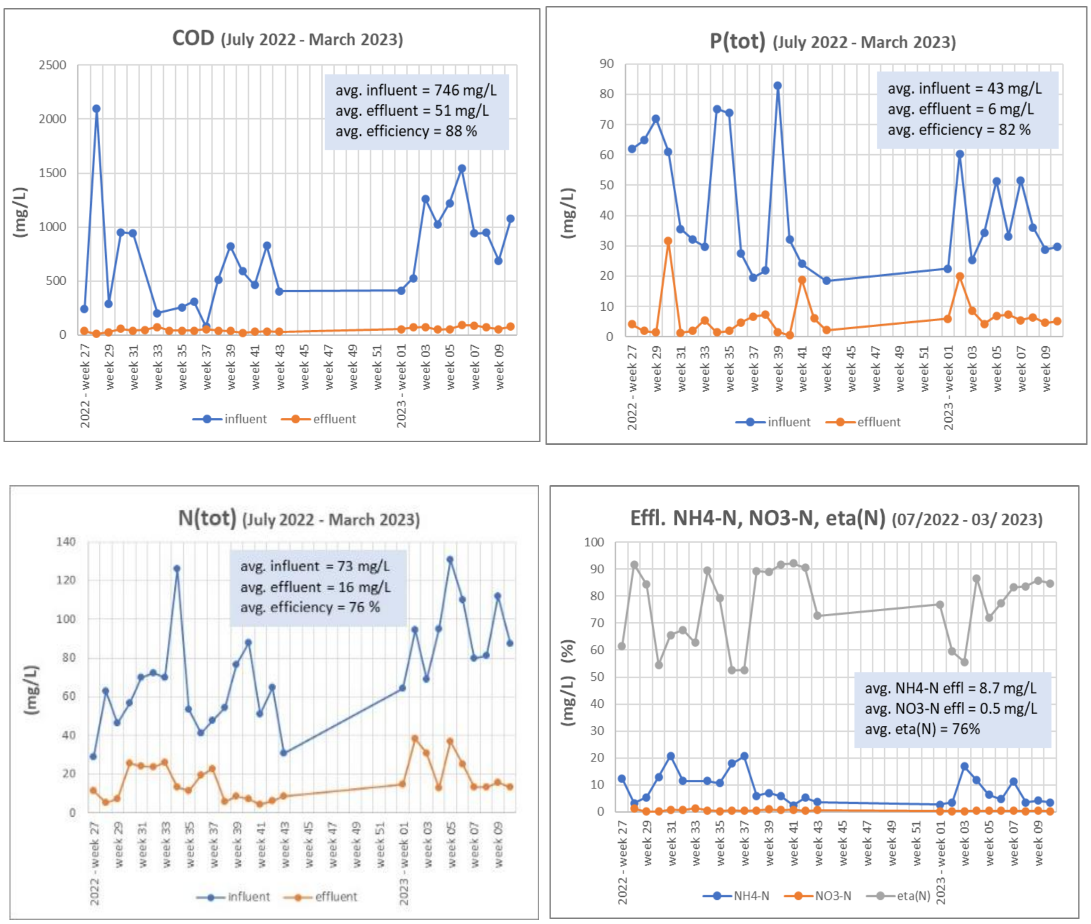


Figure 5-14 – Influent and Treated Effluent quality 01/2022 – 04/2023

[49] WORLD BANK (2023). *Annex 2: Technical assessment and CAPEX analysis for the WWTP at A.T. Illidge Road.* 15 pp

In October-November 2025, a sampling campaign was carried out by the Consultant where composite samples were collected and analysed once weekly, during 4 weeks. Results of the influent are presented in Table 5-9 and results of the effluent are presented in Table 5-10 (which also indicates the threshold values in the Hindrance Permit).

Table 5-9– WWTP influent - pollutant concentration historical data and recent campaign in 2025

Parameter	Units	DHV Project 2012**	Site technical visits 2022***	Campaign October / November 2025
Pop eq. (COD based)	**Hab.**	38760	17407	6081
Average daily flow	**m³/day**	4715	2800	2110
	L/s	54.6	32.4	24.4
Peak flow	**m³/h**	485	228	200
	L/s	134.7	63.3	55.4
BOD	**Kg/day**	2093.00	1044.40	
	mg/l	443.90	373.00	
COD	**Kg/day**	6061.00	1477.08	729.72
	mg/l	1285.47	746.00	345.84.00
TSS	**Kg/day**	2684.00	947.08	523.28
	mg/l	569.25	478.32	248.00
Ntotal	**Kg/day**	446.00	144.54	185.68
	mg/l	94.59	73.00	88.00
Ptotal	**Kg/day**	75.00	85.14	12.03
	mg/l	15.91	43.00	5.70
O&g	**Kg/day**	377.20	158.40	
	mg/l	80.00	80.00	

Table 5-10– WWTP effluent - pollutant concentration 2025 sampling

Treated effluent	Units	Hindrance Permit	Local WWTP Grab sampling Quality data 2025 (Jan – Aug)	Campaign October / November 2025				
				Composite 24 h sample 28/10/2025	Composite 24 h sample 1/10/2025	Composite 24 h sample 04/11/2025	Composite 24 h sample 07/11/2025	Average of Composite 24 h sample
COD	mg/l	100	96.3	72.9	61.8	18.7	38.5	48.0
TSS	mg/l	10		2	0	1	4	1
Ntotal	mg/l	10	34.6	25.4	6.14	7.72	6.63	11.47
Ptotal	mg/l	2	6.43	1.47	1.93	1.21	1.38	1.50
NH4-N	mg/	-		0.44	0.35	2.62	2.49	1.48
NO3-N	mg/	-	0.39	2.52	4.16	1.75	1.96	2.60

Treated effluent	Units	Hindrance Permit	Local WWTP Grab sampling Quality data 2025 (Jan – Aug)	Campaign October / November 2025				
				Composite 24 h sample 28/10/2025	Composite 24 h sample 1/10/2025	Composite 24 h sample 04/11/2025	Composite 24 h sample 07/11/2025	Average of Composite 24 h sample
NO2-N	mg/	-		0.062	0.132	0.092	0.104	0.098

In the above table, the treated-effluent quality results are presented, distinguishing between the historical WWTP grab-sample data collected between January and August 2025 and the 24-hour composite sampling campaign conducted on 28 and 31 October and on 4 and 7 November 2025.

This separation enables a comparative assessment of recent operational performance against previously recorded conditions.

It should also be noted that the Consultant implemented a set of operational optimizations in June 2025, which contributed to the improved effluent-quality results observed in the subsequent sampling period.

The historical grab-sample dataset indicates higher pollutant concentrations in the treated effluent. The average COD concentration was 96.3 mg/L, remaining within the permit limit of 100 mg/L but reflecting greater operational variability.

Total Nitrogen and Total Phosphorus had concentrations with average values of 34.6 mg/L and 6.43 mg/L, respectively, both exceeding the permit thresholds of 10 mg/L for Total Nitrogen and 2 mg/L for Total Phosphorus. Nitrate levels were low (0.39 mg/L), while ammonium and nitrite concentrations were not reported. Overall, these historical results indicate reduced nutrient-removal performance during the first half of 2025.

In contrast, the 24-hour composite sampling campaign demonstrated a substantially improved and more stable treatment performance. COD concentrations ranged from 18.7 to 72.9 mg/L, with an average of 48.0 mg/L, representing a significant reduction compared to historical values and consistently remaining within regulatory requirements. TSS concentrations were consistently low, between 0 and 4 mg/L, with an average of 1 mg/L, confirming effective solids removal.

Total Nitrogen concentrations varied between 6.14 and 25.4 mg/L, with an average of 11.47 mg/L. Although one daily sampling slightly exceeded the permit limit, the remaining values complied with the regulatory requirement and showed a marked improvement relative to the earlier grab-sample dataset.

Total Phosphorus concentrations ranged from 1.21 to 1.93 mg/L, with an average of 1.50 mg/L, fully complying with the 2 mg/L limit and demonstrating significantly better performance than the historical average.

The distribution of nitrogen species during the composite sampling campaign indicates an active and balanced nitrification process. Ammonium concentrations ranged from 0.35 to 2.62 mg/L (average 1.48 mg/L), nitrate concentrations from 1.75 to 4.16 mg/L (average 2.60 mg/L), and nitrite concentrations remained low and stable (0.062–0.132 mg/L; average 0.098 mg/L). This profile is consistent with effective biological oxidation and stable process conditions.

5.2.4 Noise

Noise is influenced by land use and occupation activities. Outdoor noise standards in Sint Maarten are guided by the *Final Report Environmental Standards Sint Maarten 2023* (VROMI & VNG, 2023[50]), in its Table 2.30a of Article 2.30. Refers also the limits for the Hindrance Permit of 2007. The following table presents these limits from both sources.

Table 5-11 – Sint Maarten Noise standards

Noise periods	07:00-19:00 hours		19:00-23:00 hours		23:00-07:00 hours	
	HP 2007	ES 2023	HP 2007	ES 2023	HP 2007	ES 2023
L_{AR}, L_T at the façade of sensitive buildings	50 dB(A)	50 dB(A)	45 dB(A)	45 dB(A)	40 dB(A)	40 dB(A)
L_{AR}, L_T in adjacent sensitive buildings	-	35 dB(A)	-	30 dB(A)	-	25 dB(A)
LA_{max} on the façade of sensitive buildings	60 dB(A)	70 dB(A)	55 dB(A)	65 dB(A)	50 dB(A)	60 dB(A)
LA_{max} in adjacent sensitive buildings	-	55 dB(A)	-	50 dB(A)	-	45 dB(A)

The Sint Maarten noise standards are defined in terms of the Rated Noise Level (LAR,LT), which requires corrections to be added to the measured LAeq,T (LAR,LT = LAeq,T + Kt + Ki).

The *Residential Economic Policy (REP)* of 2009 also mentions that existing businesses within residential areas are required to soundproof and insulate the dwelling from noise caused by its activities in order to mitigate the exposure of its residents to noise levels.

[50] VROMI & VNG (2023). *Final Report Environmental Standards Sint Maarten 2023*. 134 pp

The following table presents the noise limits for the WB/IFC EHS guidelines for noise.

Table 5-12 – Noise level IFC guidelines.

Receptor	One hourLAeq (Dba)		Measurement base duration (hour)
	Daytime (07:00 – 22:00)	Nighttime (22:00 – 07:00)	
Residential; Institutional; Educational	55	45	16
Industrial; commercial	70	70	24

Source: General EHS guidelines: environmental noise management.

WHO has also stipulated that the annoyance threshold for continuous noise should be below 55 dB(A), daytime LAeq. At night, sound levels must be between 5 and 10 dB below daytime values, to ensure a balanced sound environment

In the project area, the main noise sources are the traffic from A.TH. Illidge Road and Zagersgut Road, the WWTP itself. As for the traffic, the daily septage trucks that visit the WWTP are one of those noise sources (all weekdays, from 06:00 am until 06:00 pm). The WWTP operates 24 hr/day.

Currently, at the WWTP, the main noise source comes from those septic trucks and from the anaerobic tank. All the other WWTP components are in enclosed structures or, when at open air, do not emit relevant sound (settling tank, the sludge thickener and the sludge drying beds, etc).

The number of truck discharges varies between 50 and 100 per day, depending mainly on rainfall events (4 to 8 trucks/hour, in the 12h opening period). Assuming a noise level from these tanker trucks of 112 dB (DSPA, 2017[51]) and that each truck will be at most 10 minutes at the WWTP (from entering the premises, discharging and exit the premises), which corresponds to about 70% in each hour for the lower limit of trucks and about 130% in each hour for the upper limit of trucks, this will corresponds to an onsite average hourly noise level of (logarithmic sum) of:

- 4 trucks/hour – 115.8 dB(A)
- 8 trucks/hour – 126.2 dB(A)

[51] DSPA (2017). *Instruções para Avaliação de Impacto pelo Ruído*. Macau

Normally anaerobic tanks operate at around 35-55 decibels[52] when measured from a distance of one meter, which will decrease with distance.

In addition to these septage trucks, also the sludge trucks that enter/exit the WWTP facility, which is performed during 15 days per month.

The closest sensitive receivers are located at south of the WWTP and on the west side, mostly commercial, but some residential. For the southern buildings, the closest distance varies from 6 m to the WWTP entrance where the trucks pass to 35 m to the anaerobic tank. For the western buildings, the closest distance is 28 m to the WWTP entrance and 45 m to the anaerobic tank.

Photo 5-3 –Nearest sensitive receivers from the West side (left photo) and from the South side (right photo) (photos from June 2025)

It can be assumed that the major noise sources will be the septic trucks and only for the southern buildings. This is not a permanent noise, as it depends on the frequency of the trucks. The noise was not a complaint mentioned by the local social survey to the surrounding community as described in **ANNEX 4**.

It is also important to mention that the WWTP enclosure is already surrounded by trees and shrubs that create a natural curtain and mitigate slightly the noise propagation for the exterior, including around the southern limit where the trucks operate, where the fence is covered by some shrubs.

52 PILING, P. (n/date). *Are Sewage Treatment Plants Noisy? What You Need to Know*. https://www.adpenviro.co.uk/services/sewage-treatment-plants/advice/are-sewage-treatment-plants-noisy/

Photo 5-4 –South fence covered with shrubs (photos from October 2025)

No noise maps for Sint Maarten exists and specifically for this neighbourhood. For that reason, and to better understand the current situation in the project nearby area, two noise measurements were performed in two different periods of the day. The two sites were selected based on the major noise sources and wind direction, one at south of WWTP (closest buildings) and other in the west side of the Fresh Pond.

ANNEX 9 presents the report regarding these two measurements, which is summarized in this section.

The measurements were compared to Sint Maarten noise standards (Table 5-11), but a comparison with the IFC and WHO limits are also presented.

Figure 5-15 – Noise measurement locations. Project location: yellow elipse

The environmental noise measurement campaign confirms that the ambient noise levels at the two specified locations in Sint Maarten currently exceed the applicable noise standards of Sint Maarten (both HP 2007 and ES 2023) during the weekday daytime and evening periods. Statistical analysis confirms that the baseline background noise (L90) at both sites is severely non-compliant.

The same is true for the WBG EHSG and WHO limits regarding Location #1, which are both overpassed, either in the daytime as in the evening period. For location #2, a commercial receiver, the WBG EHSG is more permissible being the measurements still below the noise limit for daytime and evening. The WHO limit is only complied during daytime, but not in the evening.

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Table 5-13– Noise measurement results

Time of measurement	Measured LAeq (dB(A))	Kt (dB)	Ki (dB)	Calculated LAR,LT (dB(A))	Standard Guidelines (dB(A))	Exceedance	Primary Noise Source	Measured LAmax (dB(A))	Standard Guidelines	Exceedance	Notes
Location #1 - Residential											
10:00-12:00	63.6	0	5	68.6	(A) / (B) 50 (C) 55 (D) 55	(A) Yes (+18.6) (B) Yes (+13.6) (C) / (D) Yes (+8.6)	Heavy Trucks & Water Discharge, Road Traffic (Tonal/Impulsive)	91.0	(A) 70 (B) 60	(A) Yes (+21.0) (B) Yes (+31.0)	Caused by extreme vehicle noise (e.g., loud exhaust, air horn)
20:00-22:00	54.8	0	5	59.8	(A) / (B) 45 (C) 45 (D) -5/-10	(A) Yes (+14.8) (B) Yes (+9.8) (C) Yes (+9.8) (D) Yes (+9.8)	Non distinguishable	93.7	(A) 65 (B) 55	(A) Yes (+28.7) (B) Yes (+38.7)	Caused by extreme vehicle noise; critical for sleep disturbance
Location #2 - Commercial											
10:00-12:00	53.3	0	5	58.3	(A) / (B) 50 (C) 70 (D) 55	(A) Yes (+8.3) (B) Yes (+3.3) (C) No (-16.7) (D) No (-1.7))	Non distinguishable	76.6	(A) 70 (B) 60	(A) Yes (+6.6) (B) Yes (+16.6)	-

Time of measurement	Measured LAeq (dB(A))	Kt (dB)	Ki (dB)	Calculated LAR,LT (dB(A))	Standard Guidelines (dB(A))	Exceedance	Primary Noise Source	Measured LAmax (dB(A))	Standard Guidelines	Exceedance	Notes
20:00-22:00	55.9	5	5	65.9	(A) / (B) 45 (C) 70 (D) -5/-10	(A) Yes (+20.9) (B) Yes (+10.9) (C) No (-14.1) (D) Yes (+10.9)	Non distinguishable	73.8	(A) 65 (B) 55	(A) Yes (+8.8) (B) Yes (+18.5)	-

Note: **Applied Penalties:** ● **10:00-12:00 (Daytime):** Kt = 0 dB(A) and Ki = 5 dB(A) (Total: **5 dB(A)**) due to persistent, noticeable impulsive road traffic characteristics. ● **20:00-22:00 (Evening):** Kt = 0 dB(A) and Ki = 5 dB(A) (Total: **5 dB(A)**) due to persistent, noticeable impulsive road traffic characteristics / ● **20:00-22:00 (Evening):** Kt = 5 dB(A) and Ki = 5 dB(A) (Total: **10 dB(A)**) due to persistent, noticeable tonal and impulsive road traffic characteristics

(A) Sint Maarten limits 2023; (B) HP 2007; (C) IFC limits; (D) WHO limits

As seen, the main noise comes from the septage trucks entering the WWTP, but the traffic road in the A. TH Illidge Road is also a major source of noise. During the evening period, when the septage trucks are not arriving (as mentioned before, only between 06:00 am until 06:00 pm, on weekdays), the road traffic still continue to contribute for the louder noise, including in Location #2.

Reinforces that, with the updated WWTP, a wall will be built between the discharge area of the septic trucks and the nearest building in the south limit. Also, the dewatering system, located in the northeast part of the WWTP will be fully covered.

5.2.5 Waste management

Sint Maarten is among the highest solid waste generators in the Caribbean region. The current waste value chain in Sint Maarten is linear: products are imported; after usage, most products end up as waste on the disposal sites. VROMI is responsible for collection services at households, institutions, and public cleaning. The collection system comprises seven areas and covers nearly 100% of Sint Maarten. Current technical challenges for collection are difficulty accessing streets, a lack of dedicated facilities, and no support for home composting.

The island does not have transfer stations. Commercial waste collection services are provided by private haulers and the waste is disposed of at the MSW/IDS Sites.
The **A.TH. Illidge Road WWTP** has specific containers on-site for daily trash (organic, paper, plastic), oils and lubricants and for the laboratory waste. No chemical waste is used for the treatment process. All the waste produced in this facility is deposited in the Pond Island Landfills by an authorized hauler.

5.2.6 Sludge management

The sludge produced from the WWTP system is treated in several drying beds (a total of 15 tanks and 1 emergency pond). Drying beds are simple sealed shallow ponds filled with several drainage layers as shown in Photo 5-5.

Photo 5-5 –Sludge drying beds (photos from June 2025)

Sludge is applied on the top and dried by percolation and evaporation. Advantages of sludge drying beds are: drying beds are the simplest treatment method, no artificial energy requirements, only evaporation and gravity drainage, besides having lower maintenance needs and less costs. They can also be used in combination of a prior mechanical sludge dewatering method to obtain optimum results and save energy costs. On the other hand, the disadvantages of sludge drying beds are: need very large surface are, need extensive time spans especially in rainy season and the quality of the treated sludge is not within the best range of other treatment technologies.

Regarding the dry sludges from the WWTP, is estimated that approximately 1200 m^3 of sludge are now produced every year[53]. An average of 15 monthly trucks is required to deliver the sludge to its disposal location, i.e. to the municipal landfill[54]., where the material is used as cover of the landfills.

The Sludge Drying Beds have not experienced a replacement / cleaning of the filter media for many years (if ever), and were informed to require up to 3 months for proper sludge drying. They prove insufficient under peak load, and overflow occasionally. A makeshift overflow lagoon has been established to minimize any environmental impacts during such events[55].

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53 Sewerage Master Plan 2020 – 2030
54 WB Mission. *Annex 2: Technical assessment and capex analysis for the WWTP at A.T. Illidge Road*. 15 pp
55 WB Mission. *Annex 2: Technical assessment and capex analysis for the WWTP at A.T. Illidge Road*. 15 pp

As described by WINKLER (**ANNEX 11**) the current SDBs are already heavily overloaded and therefore cannot achieve state-of-the-art sludge water removal under current operating conditions in general.

At present, dewatered sludge removed from the drying beds is hauled in open trucks to designated disposal or reuse destinations. So far, no complaints have been documented regarding odor nuisance or sludge liquor leakage from truck loading platforms along the sludge transport routes. It is nevertheless recommended that transport routes be carefully selected, considering both the characteristics of the material transported and the prevailing route conditions.

Within the scope of NRPB targets, a recent survey (between May and June 2025) on sludge quality (CARIRI, 2025[56]) was developed for the **A.TH. Illidge Road WWTP** (Table 5-14).

All heavy metals were well below the international regulatory limits outlined in US EPA 503. No exceedances were observed for the other parameters compared. pH, Organic Matter, and Nutrients were in normal ranges and do not indicate any concern.

The sludge may be considered suitable for beneficial reuse (e.g., land application) depending on local policy and soil conditions. The Total Phosphorus (TP) and Total Nitrogen (TN) content in fertile agricultural soils can vary widely depending on crop type, soil texture, and climate. General target ranges considered adequate for most agricultural purposes: Total Phosphorus (TP): 300 – 1000 mg/kg and Total Nitrogen (TN): 1000 – 3000 mg/kg.

Table 5-14 - Sludge analysis tests results and comparative standards/guidelines (CARIRI, 2025 adapted by WINKLER, 2025[57])

		Sludge Samples		Heavy metal limit values			
Heavy Metals		**May 12 2025**	**Jun 10 2025**	**Germany**	**US EPA 40 CFR 503**	**EU 86/278/EEC**	**EU 86/278/EEC**
Name	dim	**WWTP**	**WWTP**	**AbfKlärV**	**Class A**	**max**	**min**
Cadmium	mg/kg	N/D	N/D	10	39	40	20
Copper	mg/kg	**69**	**109**	800	1 500	1 750	1 000
Nickel	mg/kg	N/D	N/D	200	420	400	300
Lead	mg/kg	N/D	N/D	900	300	1 200	750
Zinc	mg/kg	**680**	**907**	2 500	2 800	4 000	2 500
Mercury	mg/kg	N/D	N/D	8	17	25	16
Chromium	mg/kg	**182**	**87**	900	-	-	-
N/D … Not Detected							
DS content	%DS	**23,21%**	**46,34%**				

[56] CARIRI (2025). *Assessment of Seawater Quality Testing of Six (6) Areas to Establish a Baseline*. Final Report (draft version). 62 pp
[57] CARIRI (2025). *Assessment of Seawater Quality Testing of Six (6) Areas to Establish a Baseline*. Final Report (draft version). 62 pp

5.3 Biologic Environment

5.3.1 Protected Areas

At present, Sint Maarten is home to one marine park (Man of War Shoal Marine Park, located in the south coast of Sint Maarten) and one wetland of recognized international importance RAMSAR Site, namely the Mullet Pond an area within the Simpson Bay Lagoon, located in the west side of Sint Maarten). At present there are no terrestrially **protected areas** (nature parks), aside from the protection afforded to Fort Amsterdam through zoning plans which designate the area as a registered historical site and as a nature conservation zone.

St. Maarten pond areas are also important for the biological ecosystems of the island. Together with Fort Amsterdam and Pelican Rock, the ponds of Little Bay Pond, the Great Salt Pond and Fresh Pond form the five Important Bird Areas (IBA) of St Maarten (DCNA, 2013[58]) (Figure 5-16), which were defined in 2007[59].

The significance of the Fresh Pond IBA (AN002) was due to the population of Near Threatened Coot (*Fulica caribaea*), currently with *Least Concern* Status. Nesting occurs in the area and over 50 coots have been recorded for the IBA. All five Lesser Antilles Endemic Bird Areas restricted range birds occurred at the site. Fresh Pond also supported populations of many waterbirds including Snowy Egret (*Egretta thula*), Pied-billed Grebe (*Podilymbus podiceps*), Great Egreat (*Casmerodius albus*), White-cheeked Pintail (*Anas bahamensis*) and Ruddy Duck (*Oxyura jamaicensis*).

Great Salt Pond IBA (AN003) was significant for the Laughing Gull (*Larus atricilla*) population. Prior to breeding season, about 5,800 gulls congregated at the IBA. About 50 pairs of Black-necked Stilt (*Himantopus mexicanus*) bred at the site and was the only species confirmed to do so within the IBA.

Sint Maarten has several Key Biodiversity Areas (IBAT), some of them falling within the limits of the mentioned IBAs, with special emphasis for Fresh Pond and Great Salt Pond, the nearest ponds of the **A.TH. Illidge Road WWTP.**

[58] DCNA (2013). *Important Bird Areas in the Dutch Caribbean*. 18 pp
[59] https://datazone.birdlife.org/search?search=Sint%20Maarten

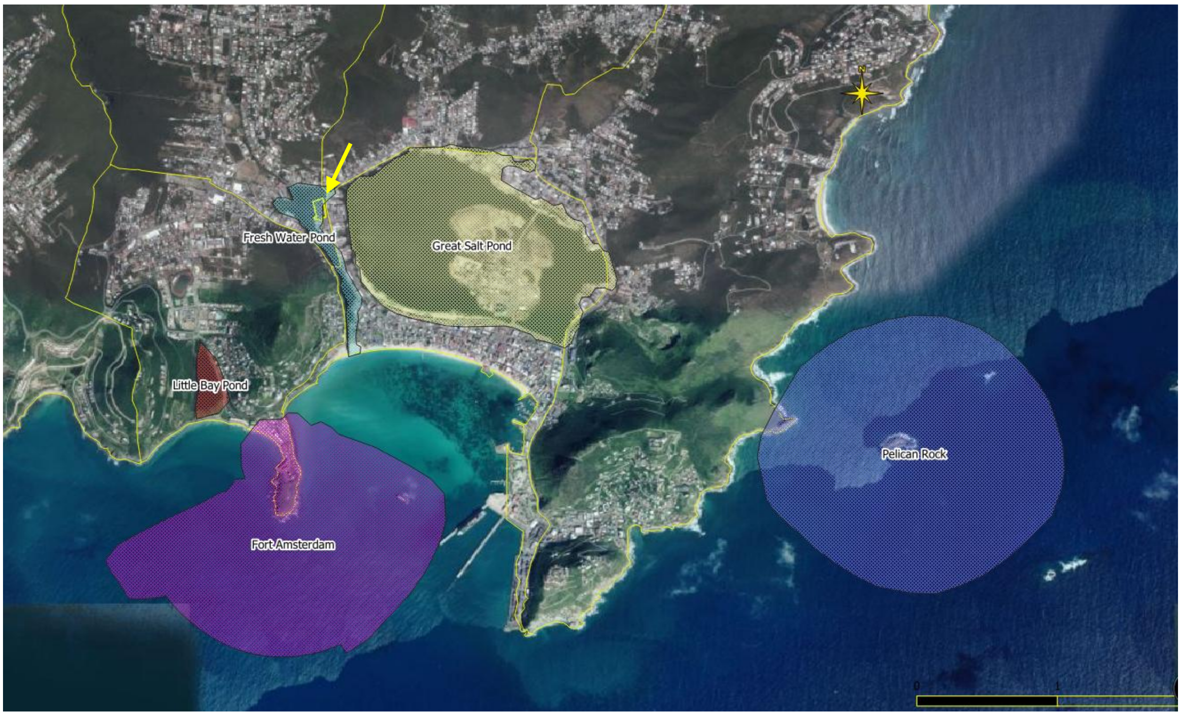


Figure 5-16 – Important Bird Areas of Sint Maarten. Project location: yellow arrow

5.3.2 Ecosystem Services

Sint Maarten's coastal and terrestrial ecosystems provide a range of vital ecosystem services, including coastal protection, water quality maintenance, fisheries support, recreation, and biodiversity conservation. These ecosystems, such as coral reefs, seagrass beds, mangroves, and hillsides, are crucial for the island's ecological health and the well-being of its inhabitants.

Mangroves occur in along the island's ponds and lagoons including the Fresh Pond and Great Salt Pond, they provide the following ecosystem services: protect the banks from erosion, water quality maintenance by filtering pollutants from runoff, provide water catchment/retention and offer habitats for various species (biodiversity conservation). The Ponds provide also aesthetic services for the human population, besides contributing to carbon storage, helping to mitigate climate change (fixation of carbon in the sediments) and also to regulate local climate by influencing temperature and humidity.

Regarding the WWTP, is also able to provide several ecosystem services, primarily related to water purification and nutrient cycling and indirectly support, by improving water quality, other ecosystem functions, such as providing habitat for aquatic organisms and maintaining biodiversity.

5.3.3 Flora

The major part of Sint Maarten is covered with secondary vegetation derived from either seasonal formations or dry evergreen formations. Only on the top of the hills, some more or less original semievergreen seasonal forest (tropical deciduous forest) is found. This type of forest has regionally become extremely rare too. Because of its small area, this forest formation is very vulnerable.

On the higher hills of the two ridges in the middle part of the island, and the hills of the eastern ridge, dense secondary woodland vegetation is growing (mainly acacia), preventing erosion and with a high scenic value. Refers also the patches of savanna dominated by tall grass. Along the coast and inland waterways there are remains of mangrove forests and other types of coastal vegetation survive, which are of high ecological, aesthetic and recreational value.

There are numerous salt or brackish ponds on the island, and most are ringed with mangrove wetlands. In coastal areas that are not developed, littoral (seaside) forest or scrub can be found.

Due to the relatively shallow depths surrounding Sint Maarten, the marine environment is characterized by expansive seagrass beds. Seagrass ecosystems are considered to be amongst the most productive ecosystems in the world. The seagrass beds of Sint Maarten provide a biological filter system for the waters within the bays and lagoons, besides providing a nursery and habitat for certain commercially and recreationally valued species.

Regarding the project area, the **A.TH. Illidge Road WWTP** is located at densely populated area, with ruderal vegetation and garden trees or shrubs on the roadsides. The WWTP has several tree species in its enclosure, namely *Eucalyptus* spp, Coconut palm (*Cocos nucifera*), Mango trees (*Mangifera indica*), Tamarind trees (*Tamarindus indica*), Soursop tree (*Annona muricata*), Jicaros (*Crescentia alata*), etc, along with several shrubs (e.g. Black fruit *Chrysobalanus icaco,* several Mangrove species, etc) that surrounds the various components of the WWTP and also its enclosure.

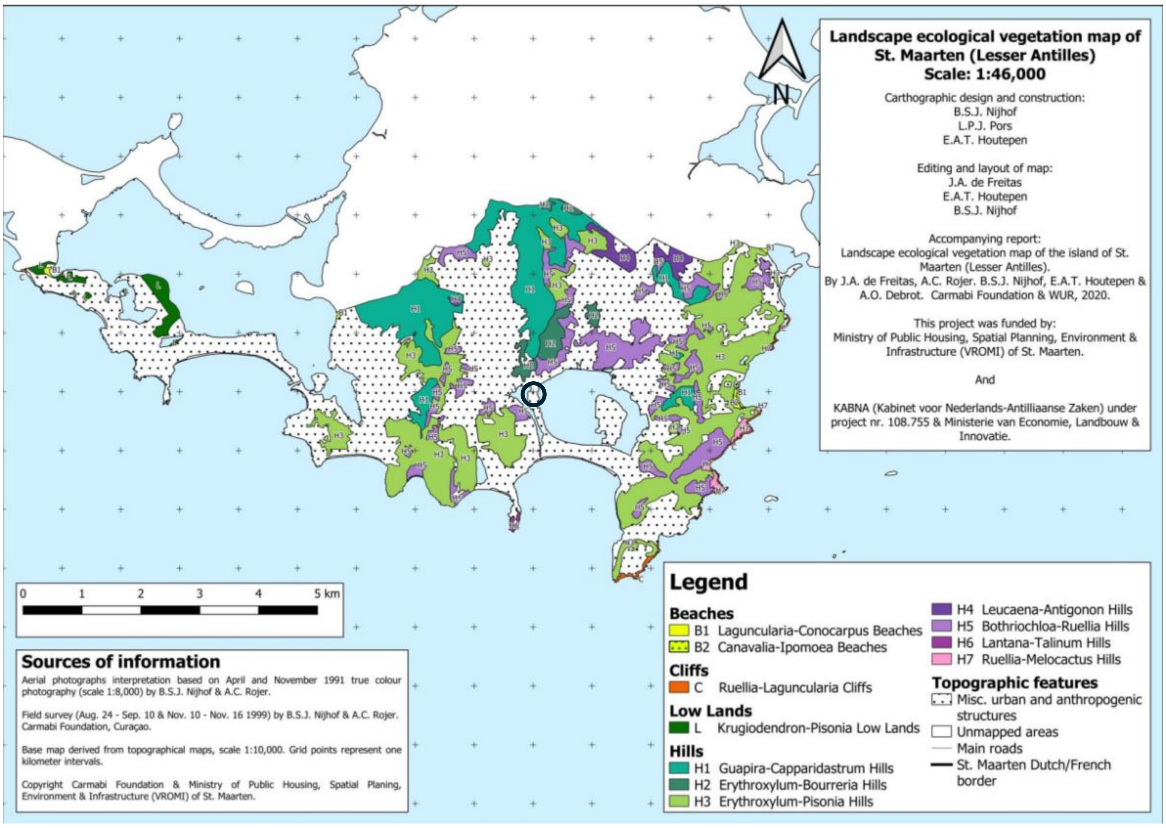


Figure 5-17 – Landscape ecological vegetation map of St. Maarten (1:46,000) (FREITAS *et al*., 2020[60]). Project location: black circle

[60] De FREITAS, J.A., A.C. Rojer, B.S.J. Nijhof, E.A.T. Houtepen & A.O. Debrot (2020). *Landscape Ecological Vegetation map of St. Maarten (Lesser Antilles).* Caribbean Research and Management of Biodiversity Foundation, Curaçao Wageningen University & Research, Netherlands. 78 pp

Photo 5-6 – Several trees and shrubs identified within the WWTP enclosure (photos from June 2025)

Fresh Pond, although exposed to several anthropogenic pressures, still is able to support an aquatic vegetation composed of mangrove species located in its margins. In the northern margin, along the Zagersgut Road, there is a dense cover of white mangrove (*Laguncularia racemosa*) (left photo of Photo 5-7). This patch of mangrove extends to the western margin of the pond, along Brush Road. The eastern margin near the WWTP is narrower, with some coconut trees (right photo of Photo 5-7).

Photo 5-7 – Mangrove banks at Northen Fresh Pond (photos from June 2025)

At North and South of Bernhard Bridge, there are patches of white mangrove along the road. Grass land occurs in the waterfront. Trees of sea grapes (*Cocoloba uvifera)* and plam trees occur at high elevations.

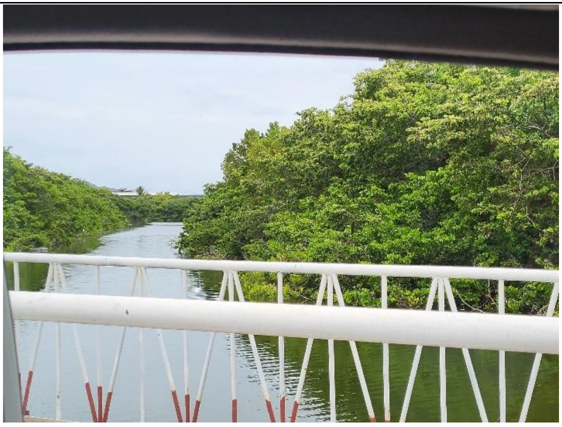



Photo 5-8 – Mangrove banks of Fresh Pond near Bernhard Bridge (north and south, respectively) (photos from June 2025)

According to the recent assessment of Nature Foundation (MATHON, 2025[61]), the mangroves in Fresh Pond were quite dense (8-92 adult trees per 100m2) and continuous around the pond, although they formed just a thin layer in some stations. The total surface area of the mangroves in Fresh Pond was 5.28ha. It was composed predominantly of mid-height to tall white mangroves (3.5-6m tall, circumference between 27-100cm), with a few buttonwood trees. The trees were in good health, and hosted many bird species (egrets, kingbirds, herons). However, several invasive species were detected (green iguana, slider turtle) and the human impact was significant, mostly through large amounts of trash around the site.

5.3.4 Fauna

The fauna in Sint Maarten is limited, with a relatively low diversity of native fauna, particularly those that cannot fly. The introduction of nonnative animals, both accidental (rats, mice) and deliberate (livestock, mongoose) has also been implicated in the destruction of habitat and the extinction of native species. More recently, development for tourism has resulted in further habitat destruction and degradation of habitats such as the lagoon and the numerous salt ponds on the island.

Mangroves provides the necessary habitat for roosting, nesting and migrating birds, with special emphasis at the Great Salt Pond, located at east of the WWTP. Despite the development of the surrounding area and subsequent stress to the ecosystem, the Great Salt Pond provides important foraging areas for many birds and the brackish and sometimes hypersaline conditions give rise to a unique wildlife community that includes several fish species, turtles, snails and insects.

[61] MATHON, L. (2025). *Marine and Coastal Biodiversity Assessment of Sint Maarten. Habitat mapping, seagrass monitoring, mangrove assessment, and species inventory.* Nature Foundation Sint Maarten (Publs). 178 pp

As the waters around St. Maarten are relatively shallow, without much exchange between coastal and deep-water currents, corals and other organisms on reefs are exposed to any terrestrial influences including freshwater runoff, sedimentation, nutrients, etc.

St. Martin is one of the few islands in the mostly dry region of the eastern Caribbean containing expansive wetlands, making it critical habitat for transient, over-wintering, and resident waterbird species. This habitat is used as nesting grounds by the Snowy Plover (*Charadrius alexandrinus*), the American Oystercatcher (*Haematopus palliatus*), Wilson's Plover (*Charadrius wilsonia*), and Stilt Sandpiper (*Calidris himantopus*). The first three species are classified as *Least Concern* (LC) status by IUCN Red List of Threatened Species, being the Still Sandpiper with a *Near Threatened* (NT) status, based on a severe decrease of its global population.

Depending on water depth, the ponds also shelter populations of fish, molluscs, and small invertebrates, which provide the diet for most birds of the ponds.

Species of high concern using these areas include Stilt Sandpiper and Greater Yellowlegs (*Tringa melanoleuca – NT* status*)*. Water grasses are also present and provide nutritional value to such species as Caribbean Coot (*Fulica caribaea – LC* status), American Coot (*Fulica americana – LC* status), and Common Moorhen (*Gallinula chloropus – LC* status).

For the Fresh Pond, and for Great Salt Pond and Phillipsburg area (both by the proximity to the project area[62]), surveys were conducted from January-March 2008 (BROWN & COLLIER, 2008[63]), which were updated with consultation of the Ebird website (data from 2013 to 2025) and field data collected in June and October 2025. The following table presents a list of birds that were confirmed in both ponds or crossed this area where the **A.TH. Illidge Road WWTP** is located.

Table 5-15 – List of bird species confirmed in the project area

Species	Source	Local	IUCN Status
Pied-billed grebe (*Podilymbus podiceps*)	(A)	Fresh Pond	LC
		Great Salt Pond	
Brown Pelican (*Pelecanus occidentalis*)	(A)	Fresh Pond	LC
	(A) / (B) / (C)	Great Salt Pond	
Great Blue Heron (*Ardea herodias*)	(A)	Fresh Pond	LC
	(A) / (B)	Great Salt Pond	
Black-crowned Night Heron (*Nycticorax nycticorax*)	(B)	Great Salt Pond	LC
	(C)	Connection between Fresh and Great Salt Pond	
Great Egret (*Ardea alba*)	(A) / (C)	Fresh Pond	LC
	(C)	Great Salt Pond	
	(B)	Phillipsburg area	
Snowy Egret (*Egretta thula*)	(A) / (B) / (C)	Fresh Pond	LC

[62] Refers that the Waste landfills at Pond Island were constructed in the early 1970s
[63] BROWN, A.C., N., Collier. 2008. *Pond Surveys of St. Martin :2008 report*. Unpublished Report.

Species	Source	Local	IUCN Status
	(A)	Great Salt Pond	
Little Blue Heron (*Egretta caerulea*)	(B)	Pond Island	LC
Cattle Egret (*Bubulcus ibis*)	(A)	Fresh Pond Great Salt Pond	LC
Green Heron (*Butorides virescens*)	(A) (B)	Great Salt Pond Phillipsburg area	LC
American Widgeon (*Mareca americana*)	(A) / (B)	Great Salt Pond	LC
White-cheeked Pintail (*Anas bahamensis*)	(A) (A) / (B)	Fresh Pond Great Salt Pond	LC
Green-Winged Teal (*Anas crecca*)	(B)	Phillipsburg area	LC
Mallard (*Anas platyrhynchos*)	(B)	Phillipsburg area	LC
Blue-winged Teal (*Spatula discors*)	(A)	Great Salt Pond	LC
Ruddy Duck (*Oxyura jamaicensis*)	(A)	Fresh Pond Great Salt Pond	LC
Ring-necked Duck (*Aythya collaris*)	(A)	Great Salt Pond	LC
Lesser scaup (*Aythya affinis*)	(B)	Pond Island	LC
Red-breasted Merganser (*Mergus serrator*)	(B)	Great Salt Pond	LC
Common Moorhen (*Gallinula chloropus / galeata*)	(A) / (B) / (C) (A) / (C)	Fresh Pond Great Salt Pond	LC
Purple Gallinule (*Porphyrio martinicus*)	(B)	Phillipsburg area	LC
American Coot (*Fulica americana*)	(A)	Fresh Pond Great Salt Pond	LC
Caribbean Coot (*Fulica caribae*)	(A)	Fresh Pond Great Salt Pond	LC
Black-bellied Plover (*Pluvialis squatarola*)	(A)	Great Salt Pond	**VU**
Black-necked Stilt (*Himantopus mexicanus*)	(A) / (B)	Great Salt Pond	LC
White-rumped Sandpiper (*Calidris fuscicollis*)	(B)	Great Salt Pond	**VU**
Stilt Sandpiper (*Calidris himantopus*)	(B) / (C)	Pond Island	**NT**
Upland Sandpiper (*Bartramia longicauda*)	(B)	Great Salt Pond	LC
Greater Yellowlegs (*Tringa melanoleuca*)	(A) (B)	Great Salt Pond Phillipsburg area	**NT**
Lesser Yellowlegs (*Tringa flavipes*)	(A)	Great Salt Pond	**VU**
Spotted Sandpiper (*Actitis macularius*)	(A) / (B)	Great Salt Pond	LC
Ruddy Turnstone (*Arenaria interpres*)	(A)	Great Salt Pond	**NT**
Semipalmated Plover (*Charadrius semipalmatus*)	(B)	Great Salt Pond	LC
Wilson's Plover (*Charadrius wilsonia*)	(B)	Great Salt Pond	LC
Snowy Plover (*Charadrius nivosus*)	(B)	Great Salt Pond	NT
Wilson's Snipe (*Gallinago delicata*)	(B)	Great Salt Pond	LC
Laughing Gull (*Leucophaeus atricilla*)	(A)	Great Salt Pond	LC
Herring Gull (*Larus argentatus*)	(A)	Great Salt Pond	LC
Ring-billed Gull (*Larus delawarensis*)	(A)	Great Salt Pond	LC
Lesser Black-backed Gull (*Larus fuscus*)	(A)	Great Salt Pond	LC
Great Black-backed Gull (*Larus marinus*)	(A) (B)	Great Salt Pond Near the Fresh Pond beach connection	LC
American Herring Gull (*Larus smithsonianus*)	(B)	Great Salt Pond	LC
Black-backed Gull (*Larus ridibundus*)	(B)	Great Salt Pond	LC
Royal Tern (*Thalasseus maximus*)	(A)	Great Salt Pond	LC
Sandwich tern (*Thalasseus sandvicensis*)	(B)	Fresh Pond	LC
Least Tern (*Sternula antillarum*)	(B)	Great Salt Pond	LC
Mute Swan (*Cygnus olor*)	(A)	Great Salt Pond	LC

Species	Source	Local	IUCN Status
Rock Pigeon (*Columba livia*)	(B)	Fresh Pond	LC
Scaly-naped Pigeon (*Patagioenas squamosa*)	(B)	Great Salt Pond	LC
Eurasian Collared-Dove (*Streptopelia decaocto*)	(B)	Phillipsburg area	LC
Green-throated carib (*Eulampis holosericeus*)	(B)	Great Salt Pond	LC
Common Yellowthroat (*Geothlypis trichas*)	(B)	Great Salt Pond	LC
Rose-ringed Parakeet (*Psittacula krameri*)	(B) Exotic	Great Salt Pond	LC
Brown-throated Parakeet (*Eupsittula pertinax*)	(B) Exotic	Great Salt Pond	LC

Legend: (A) BROWN & COLLIER, 2008; (B) EBird.org (2013 – 2025); (C) Field observations June/October 2025

From this list, there are 6 species with international protected conservation status, mostly related rapid decline population, due to habitat loss and degradation, disturbance and hunting.

Regarding the field surveys of June and October 2025, developed within the present EIA, the following photos were taken of the bird species found in both ponds, and also in the WWTP.

Common Moorhen (*Gallinula galeata*)

Snowy Egret (*Egretta thula*)

Great Egret (*Ardea alba*)

Black-crowned Night Heron (*Nycticorax nycticorax*)

	
Snowy Egret + Black-crowned Night Heron	Brown Pelican (*Pelecanus occidentalis*)

Photo 5-9 – Bird species observed during field surveys of June 2025

Photo 5-10 – Stilt Sandpiper observed in the WWTP sludge beds in October 2025

Other fauna species were also observed, in the project area, namely some reptiles (Iguana and turtles) and the fish Tilapia, all without protected status and invasive species.

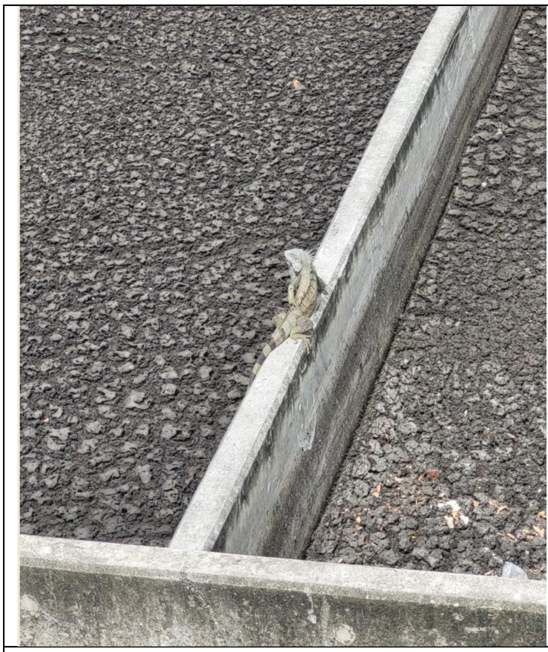
	
Iguana (*Iguana iguana*)	
	
Red-eared Slider pond turtles (*Trachemys scripta elegans*)	Tilapia

Photo 5-11 – Other Fauna species observed during field surveys of June 2025

Regarding the **aquatic ecosystems**, the current situation of Fresh Pond was already described in Section 5.2.2, based on the study of DUNGEN (2023[64]), which concluded, based on sediments collected at Fresh Pond, that this has a low SDI (Shannon Diversity Index), with dominance of planktonic species (*Actinocyclus normanii,* and *Stephanocyclus meneghiniana*). The Fresh Pond was classified with euthrophic state (high amount of biological productivity, "poor" water quality.

64 DUNGEN, E.v.d. (2023). *Reconstructing the impact of land-use changes on coastal lagoons in the Caribbean*. MSc Thesis. 81 pp

Zone 1 (45 – 95 cm depth) is characterized by a lower concentration of diatoms, and a lower relative abundance of planktonic species. Throughout zone 1, planktonic species *Stephanocyclus meneghiniana* was observed in a high relative abundance. In zone 1a (90 – 95 cm), besides *Stephanocyclus meneghiniana, Nitzschia angustata* has a high relative abundance. In zone 1b (45 – 90 cm), the relative abundance of Nitz*schia angustata* decreases, whereas the relative abundance of *Nitzschia palea* rapidly increases. All three of these species are associated with eutrophic conditions.

In Zone 2 (0 – 45 cm), a transition towards a system in which the planktonic marine species *Actinocyclus normanii* dominates is found. *Actinocyclus normanii* dominates in Zone 2a. This species is associated with aquatic degradation, eutrophication and contamination. Zone 2b show a strong increase in the concentration of diatoms. Furthermore, the relative abundance of *Pleurosira laevis,* an indicator species for eutrophication, strongly increases in zone 2b. *Pleurosira laevis* is also found to be highly tolerant to heavy metals and elevated N concentrations.

It was found that dredging activities (in 1999) created extreme changes between the two above zones, rather than gradual changes.

5.4 Human Environment

5.4.1 Land Use

The Cul-de Sac area has four land use categories, namely natural space, residential, freeway and commercial. Recreational areas are also identified.

The forest, underdeveloped, the urban green areas and the ponds are considered open space.

The roads, public transportation lines and pathways are considered freeway.

The residential building can be subdivided into low-intensity residential (LIR) and high-intensity residential (HIR). High-intensity residential is assumed to have 80–100% of the urbanized area and less than 20% of vegetative or green area, and the low-intensity residential falls between 30% to 80% of urban area and 20% to 70% green area.

The commercial areas are mainly located near the main roads, especially at the A.TH. Illidge Road.

Recreational areas of Cul-de-Sac includes the urban gardens and sports fields (e.g. John Cooper Jose Lake Sr. Balpark).

The area where the WWTP is located is a mixed urban area, mainly with commercial buildings but also with some residential settlements, restricted between the two natural ponds.

In **ANNEX 5** is presented a Land Use Map for the **A.TH. Illidge Road WWTP** Project area, where commercial land and the ponds are the main land use, followed by residential use (at North and West sides).

5.4.2 Landscape

The A. TH. Illidge Road WWTP is located in the northeastern corner of Fresh Pond, well delimited by a border of large trees and bushes that limit visibility from both the outside and the inside to the surroundings. Even within the WWTP enclosure there are several ornamental trees that surpass, for instance, the height of the anaerobic tank or the settling tank, creating a visual barrier from outside.

The equipment of the WWTP are mostly of low height (no more than 4 m above ground), being the IMHOF building the highest one, but does not stand out from the surrounding buildings.

The closest permanent observers are located at 7 to 13 m apart, respectively on the south side and on the east side.

The landscape of the project area can be classified as a semi-natural landscape (heterogeneous, with human occupation and natural elements).

	
View for the West side	View for the North side

View for the South side

View for the Northeast side

Photo 5-12 – Tree visual barriers around the WWTP

In terms of visual analysis of the different landscapes identified in the study area of the **A. TH. Illidge Road WWTP**, the following parameters are identified: visual quality, visual absorption capacity, and visual sensitivity:

- Regarding **Visual Quality**, as this characteristic depends on subjective values, its assessment is fundamentally based on qualitative criteria, and it is not possible to obtain an absolute estimate of this parameter.
- **Visual absorption** capacity is understood as the greater or lesser ability of a landscape to integrate certain changes or modifications without diminishing its visual qualities.
- Finally, the concept of **Visual Sensitivity** of a landscape, a parameter that indicates the degree to which a landscape is affected by the alteration/introduction of a certain external action, varies inversely with the visual absorption capacity. This means, in principle, that the greater the overlap of visual basins in a given space, and therefore the greater the number of receptors, the greater its sensitivity. Not entirely independent of this principle, simultaneously and generally, the greater the visual quality of a given landscape, the greater its sensitivity.

Table 5-16 – Landscape Sensitivity Matrix

Absorption Capacity	Visual Quality		
	High	**Medium**	**Low**
High	Medium	Low	Low
Medium	High	Medium	Low
Low	Very High	Medium	Medium

Based on these parameters, the local landscape can be classified as having medium visual quality (natural areas and urban areas), medium absorption capacity and medium visual sensitivity.

5.4.3 Socioeconomy

5.4.3.1 Administrative Division

Sint Maarten is a small Caribbean country with a land area of 42.73 km2[65], situated in the northern Leeward Islands, just east of the U.S. Virgin Islands. Sint Maarten shares the island with the French collectivity of Saint Martin (53.09 km2), with no physical border.

Figure 5-18 – Map of Sint Maarten[66]

The island of Sint Maarten was first claimed by Spain in 1493 following the voyage of Christopher Columbus. Dutch settlers arrived in 1631 to exploit salt deposits, but Spanish forces soon regained control. Spain eventually withdrew, and in 1648 the territory was formally divided between France and the Netherlands[67]. Over the next two centuries, the border shifted frequently due to rivalries between the two powers, before settling into the current arrangement: the Dutch administer about 39 percent of the island, the territory now known as Sint Maarten. In 1954, Sint Maarten became part of the Netherlands Antilles, a collection of Caribbean territories within the Kingdom of the Netherlands. A referendum in 2000 paved the way to greater autonomy, and in 2010 Sint Maarten achieved its present status as a constituent country within the Kingdom.

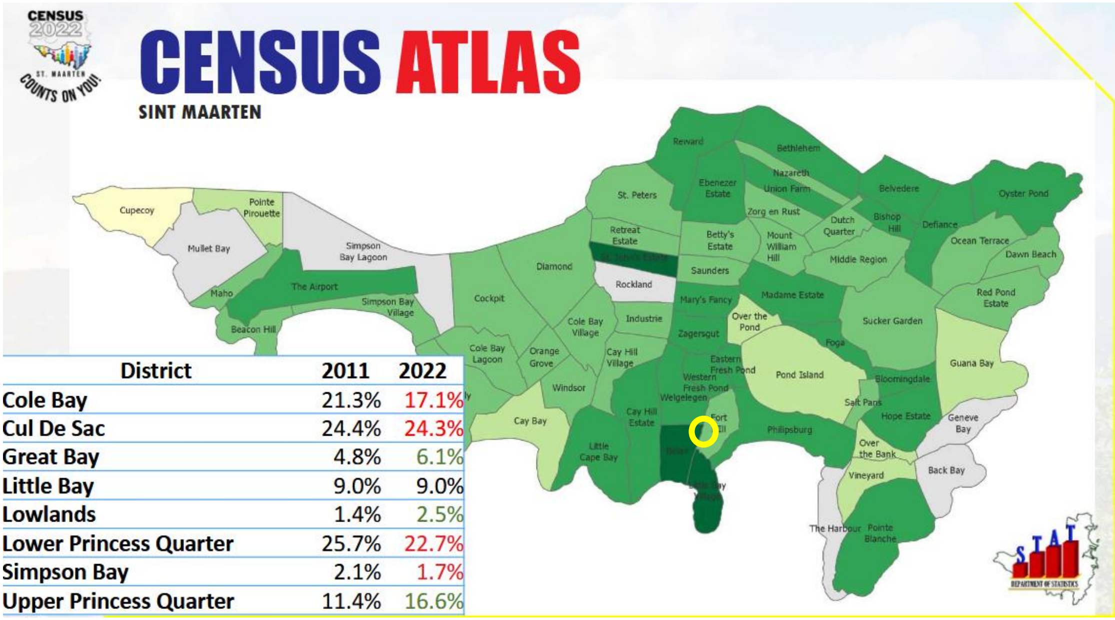
The political system is a parliamentary democracy under a constitutional monarchy. Alongside the Netherlands, Aruba, and Curaçao, it forms one of the four constituent countries of the Kingdom of the Netherlands.

65 https://www.sintmaartenmuseum.org/about-sint-maarten

66 CIA WORLD FACTBOOK (2023). *Sint Maarten – People and Society*. Available at: https://www.cia.gov/the-world-factbook/countries/sint-maarten/

67 CIA WORLD FACTBOOK (2023). *Sint Maarten – People and Society*. Available at: https://www.cia.gov/the-world-factbook/countries/sint-maarten/

The capital is Philipsburg, and the country is divided into 8 Districts and 57 neighbourhoods (Figure 5-19). The **A. TH. Illidge Road WWTP** is located in the Little Bay District and the Western Fresh Pond neighbourhood.



District	2011	2022
Cole Bay	21.3%	17.1%
Cul De Sac	24.4%	24.3%
Great Bay	4.8%	6.1%
Little Bay	9.0%	9.0%
Lowlands	1.4%	2.5%
Lower Princess Quarter	25.7%	22.7%
Simpson Bay	2.1%	1.7%
Upper Princess Quarter	11.4%	16.6%

Figure 5-19 – Administrative Division of Sint Maarten[68]. Project location – yellow circle

5.4.3.2 Demography

The population of Sint Maarten grew from 30,773 inhabitants in 2000 to about 43,350 in 2024, an overall increase of 40.9%. The demographic profile has shifted markedly over this period: the share of older adults (65+) rose from 2.9% in 2000 to 13.9% in 2024, reflecting rapid population aging. In 2024, the age distribution was 18.5% under 15, 67.2% between 15 and 64, and 14.3% aged 65 or older, underscoring the predominance of the working-age group[69]. The average annual population growth rate is estimated at 1.4 percent. Based on the population assessment for the Sewerage network and WWTP project, an increase of the population of an overall 16% is expected from 2025 to 2055 (Figure 5-21). Cul de Sac area is expected to have a 19% population increase.

[68] STAT (2022) *Sint Maarten Population 2022*. 66 pp. Available at: https://stats.sintmaartengov.org/reports.php

[69] CIA WORLD FACTBOOK (2023). *Sint Maarten – People and Society*. Available at: https://www.cia.gov/the-world-factbook/countries/sint-maarten/

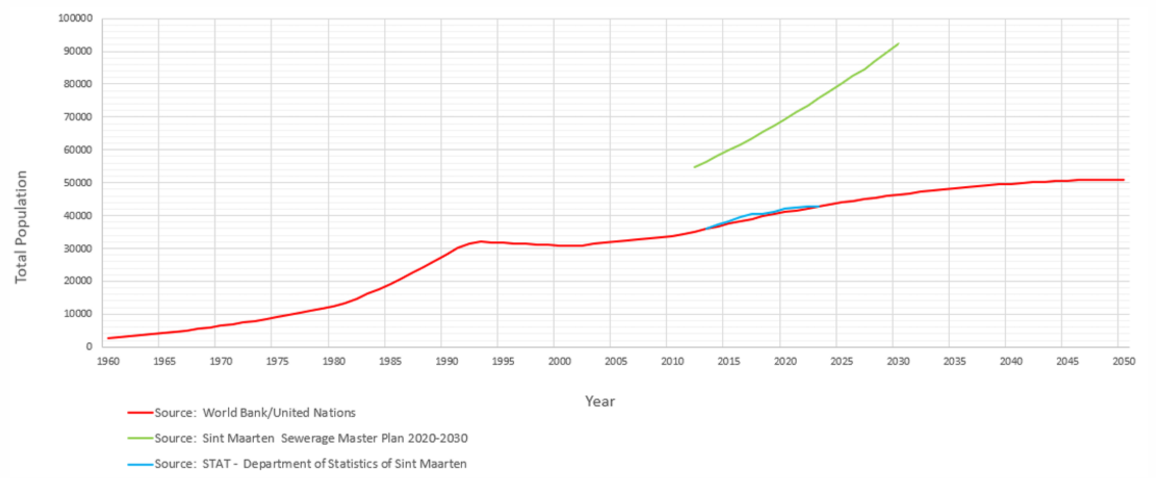


Figure 5-20 – Expected evolution of Sint Maarten population based on different sources

Registered Population Projections (pop.)

Districts	2 025	2 030	2 035	2 040	2 045	2 050	2 055	Growth 2025-2055 (%)
Cul de Sac	10 741	11 446	12 007	12 443	12 704	12 820	12 821	19%
Lower Prince´s Quarter	10 082	10 829	11 422	11 883	12 160	12 282	12 284	22%
Upper Prince´s Quarter	7 279	7 657	7 957	8 190	8 330	8 392	8 393	15%
Great Bay	2 625	2 676	2 716	2 747	2 766	2 774	2 774	6%
Little Bay	3 908	4 045	4 153	4 237	4 288	4 310	4 310	10%
Cole Bay	7 440	7 724	7 950	8 126	8 231	8 278	8 279	11%
Simpson Bay	734	751	765	776	782	785	785	7%
Lowlands	1 114	1 203	1 274	1 329	1 362	1 376	1 376	24%
Total	**43 923**	**46 331**	**48 243**	**49 730**	**50 622**	**51 017**	**51 022**	**16%**

Figure 5-21 – Population projections

Gender balance is relatively even, with approximately 98 men per 100 women, though women slightly outnumber men overall. The dependency ratio in 2024 stood at 41 dependents (under 15 or over 65) per 100 working-age individuals, almost unchanged from 40.8 in 2000. Life expectancy at birth reached 76.5 years in 2024 (79.7 years for women and 73.8 years for men) — an increase of 2.1 years since 2000—though still lower than the average for the Region of the Americas[70].

The territory is highly multicultural: only 29.9 percent of residents were born in Sint Maarten, with people originated from the Dominican Republic (10.2 percent), Haiti (7.8 percent), Jamaica (6.6 percent), Guyana (5 percent), Curaçao (4.1 percent), among others. UN data indicate that in 2024 nearly 67.3 percent of the population consisted of immigrants, highlighting the strong weight of migration in the local demographic structure.

70 HEALTH IN THE AMERICAS (2024). *Sint Maarten - Territory Profile*. https://hia.paho.org/en/country-profiles/sint-maarten

Table 5-17- Summary of Main Socio-Demographic Indicators of Sint Maarten71

Indicator	Value	Year / Estimate
Population (total)	45,677	2023 estimate
Population by sex	~22,300 men (49%), ~23,400 women (51%)	2024 estimate
Ethnic composition (by country of birth)	Sint Maarteners 29.9%, Dominican Republic 10.2%, Haiti 7.8%, Jamaica 6.6%, Sint Maarten 5.9%, Guyana 5%, Dominica 4.4%, Curaçao 4.1%, Aruba 3.4%, others	2011 estimate
International migrant stock	~67.3% foreign-born (28.8k of 42.9k population)	2024 estimate
Population growth rate (average annual)	1.4%	2024 estimate
Life expectancy at birth	Females ~79.7, Males ~73.8	2024 estimate

According to non-official sources and during the interviews during the fieldwork performed after Hurricane Irma, the research team estimates that around 10,000 illegal immigrants might be living in the Dutch part of the island before Hurricane Irma struck on September 2017. Previous figures put the number of undocumented immigrants close to 20,000 people [GEERDS *et al*, 2011 *in* MEDINA *et al.,* 2020[72]).

Population assessment developed for the present project assumed a total of 8,785 non-registered people in 2025 which is expected to increase to a total of 10,204 people in 2055.

71 CIA WORLD FACTBOOK **(2023).** *Sint Maarten – People and Society*. Available at: https://www.cia.gov/the-world-factbook/countries/sint-maarten/ and UNData (2024). Available at: https://data.un.org/en/iso/sx.html

72 MEDINA, N., Y. A. Abebe, A. Sanchez & Z. Vojinovic (2020). Assessing Socioeconomic Vulnerability after a Hurricane: A Combined Use of an Index-Based approach and Principal Components Analysis. *Sustainability*, **12**, 1452

5.4.3.3 Economics

Table 5-18 outlines key macroeconomic indicators that map Sint Maarten's trajectory of recovery in recent years[73]. Following a sharp economic contraction of 24% in 2020—driven by the dual shocks of the COVID-19 crisis and the lingering effects of Hurricane Irma—the economy began a steady rebound. GDP rose from US$0.89 billion in 2020 to an estimated US$1.45 billion in 2024, supported by the recovery of core industries. Growth was particularly dynamic in 2021 (7.1%) and 2022 (13.9%) before moderating to 3.5% in 2023 and stabilizing at around 3.3% in 2024. Inflationary pressures remained relatively contained, peaking at 4.6% in 2022 and easing thereafter. These figures underscore both the resilience of Sint Maarten's economy and its persistent exposure to external shocks that weigh on its tourism-dependent model.

Table 5-18 – Sint Maarten: Economic Indicators

Indicator	2020	2021	2022	2023	2024*	Source
GDP (current US$, billions)	0.89	0.96	1.35	1.40	~1.45	IMF (2024, 2025); STAT (2024)
GDP growth (annual %)	-24.0	7.1	13.9	3.5	3.3	IMF (2024, 2025)
Inflation, GDP deflator (annual %)	0.7	1.1	4.6	2.1	3.6	IMF (2024, 2025)

* 2024 values are estimates.

Business Landscape in Sint Maarten[74]

Sint Maarten's economic profile continues to be shaped by its heavy reliance on tourism, which functions as the island's main growth driver. When the sector came to a standstill in 2020, the impact reverberated across related industries such as construction, transport, retail trade, and the rental market, amplifying the downturn that had already been set in motion by the 2017 hurricanes. A turnaround began in 2021, as visitor arrivals picked up again and reconstruction efforts accelerated, supported in large part by resources from the Sint Maarten Trust Fund. This combination of renewed tourist activity and rebuilding projects helped stimulate job creation and household income. By 2024, the economy had returned to a steadier pace, recording growth of 3.3%, underpinned by strong tourism inflows, expanding transport services, and major construction initiatives, including the modernization of the airport.

73 IMF (2025). *Sint Maarten: Staff Concluding Statement of the 2025 Article IV Mission.* Real GDP growth at 3.3% in 2024; inflation at 3.6%; tourism demand strong, especially stay-over; current account nearly balanced. Available at: https://www.imf.org/en/News/Articles/2025/06/24/kingdom-of-the-netherlands-sint-maarten-staff-concluding-statement-2025-art-iv-mission

74 IMF (2025). *Sint Maarten: Staff Concluding Statement of the 2025 Article IV Mission.* Real GDP growth at 3.3% in 2024; inflation at 3.6%; tourism demand strong, especially stay-over; current account nearly balanced. Available at: https://www.imf.org/en/News/Articles/2025/06/24/kingdom-of-the-netherlands-sint-maarten-staff-concluding-statement-2025-art-iv-mission

Table 5-19 – Contribution of the Main Industries to GDP and Employment

Sector	Contribution to GDP	Other Indicators
Tourism (hotels, restaurants, services)	≈ 45%	Generates ~73% of foreign exchange; ~1/3 of jobs75
Cruise industry	Part of tourism	Employs ~1/3 of total workforce76
Construction (linked to tourism & recovery)	N/A (supportive)	Key role in post-disaster recovery and airport projects77
Short-term rentals (Airbnb, VRBO)	≈ 5.5%78	Rapidly growing tourism segment

Source: World Bank and IMF data

The distribution of companies[79] across economic sectors in Sint Maarten reflects the island's strong dependence on commerce and tourism, alongside a smaller but notable presence of professional and support services. Retail dominates the business landscape, accounting for more than one-third of all registered companies, followed by hotels, accommodation, food services, and other tourism-related activities. Sectors such as construction, real estate, healthcare, and financial services contribute moderately to the economy, while industries like manufacturing, education, and culture remain very limited. This structure highlights both the centrality of tourism and retail and the relatively narrow base of economic diversification.

Table 5-20 - Number of Companies by Sector of Primary Operation

Sector	Number of Companies	% of Total
Retail	246	34.4%
Hotels, accommodation & food services	103	14.4%
Tourism (other)	83	11.6%
Professional services (incl. transport)	50	7.0%
Real estate & housing	45	6.3%
Healthcare	35	4.9%
Construction / energy, gas & water	33	4.6%
Financial services	30	4.2%

75 WORLD BANK (2023). *Sint Maarten Overview – Tourism share of GDP and employment*. Available at: https://www.worldbank.org/en/country/sintmaarten/overview

76 Ibid

77 IMF (2023), *Kingdom of the Netherlands-Curaçao and Sint Maarten: 2023 Article IV Consultation Discussions-Press Release; and Staff Report***. Issue 285.** https://www.elibrary.imf.org/view/journals/002/2023/285/article-A001-en.xml

78 IMF (2024). *Kingdom of the Netherlands-Curaçao and Sint Maarten: 2024 Article IV Consultation Discussions-Press Release and Staff Report*. **Issue 296** – https://www.elibrary.imf.org/view/journals/002/2024/296/article-A001-en.xml

79 GRIJPSTRA, D., P. Vroonhof, P. de Klaver, T. Kwaak & T. de Winter (2023).Labour Market Analysis Report. Government of Sint Maarten, National Recovery Program Bureau (NRPB). 204 pp. Available at: https://www.sintmaartengov.org/Documents/Reports/LabourMarketAnalysisSXM.pdf

Sector	Number of Companies	% of Total
Beauticians	24	3.4%
Cleaning	22	3.1%
Repair	21	2.9%
Security	7	1.0%
ICT / Media	6	0.8%
Temping agencies	5	0.7%
Manufacturing	2	0.3%
Education (non-public)	2	0.3%
Culture	1	0.1%
Total	715	100%

Source: Panteia Report

Tourism projections developed for the present project considered a total of 13,222 tourists in 2025, that will increase to 23,900 in 2055. Of 2025 values, 9,039 and 4,183 are tourists from stay-over guests and cruise passengers.

5.4.3.4 Working Population

The workforce is highly diverse: over half of employees hold Dutch nationality from Sint Maarten, around a third originate from other Caribbean countries, and roughly 10% are from Europe or the United States. This demographic composition illustrates the central role of migration and mobility in shaping the island's labor supply.

Sint Maarten has long experienced steady levels of inward migration, with several hundred new arrivals recorded annually in the mid-2010s (Statistical Yearbook 2017)[80]. More recent estimates indicate a net migration rate of about 5.8 migrants per 1,000 population as of 2022[81], reflecting the island's continued role as a destination for newcomers. A significant share of the youth population is either foreign-born or has one or both parents from major sending countries. For those from non-Dutch backgrounds, access to residency permits and ultimately Dutch nationality depends on official procedures, often linked to family reunification.

80 MECYS (2017). *Integrated Youth Police Plan 2020-2025*, p. 10. Available at: https://youthsxm.com/wp-content/uploads/2024/07/Integrated-Youth-Policy-Plan-2020-2025.pdf

81 GRIJPSTRA, D., P. Vroonhof, P. de Klaver, T. Kwaak & T. de Winter (2023).Labour Market Analysis Report. Government of Sint Maarten, National Recovery Program Bureau (NRPB). 204 pp. Available at: https://www.sintmaartengov.org/Documents/Reports/LabourMarketAnalysisSXM.pdf

Employment is concentrated in specific sectors: around 20% of workers are employed in the public and semi-public sectors, another 20% in construction, and approximately 15% in food services and accommodation. Given the economy's strong reliance on tourism, a large proportion of employment across sectors is indirectly tied to this industry. However, unemployment remains relatively high, disproportionately affecting women, young people, and those with low educational levels, thereby deepening social inequalities.

Employment trends improved [82], though formal job creation lagged behind growth, leaving unemployment at about 8.6 percent in 2023 — still above pre-Irma levels. Income sources are relatively uniform: over 80% of households rely primarily on wages and salaries. Around 13% of individuals receive pensions, while only 2% were on welfare in 2018. Self-employment accounted for roughly 20% of the working population in 2017, but opportunities for sustainable self-employment likely declined following the 2017 hurricanes and the COVID-19 crisis.

5.4.3.5 Accesses and Infrastructures

The main **road network**, with few exceptions, has hardly changed since the 1960's. The capacity of the road system is not sufficient and the need for an adequate road network is felt more and more. Also, it is not suited for the heavy traffic volumes it has to cope with today. For instance, A.TH Illidge Road is frequently congested, mainly in the sector bordering the Great Salt Pond.

The country has about 295 km of roads, of which 43 km are primary roads and the rest are secondary. The (main) road network is generally well maintained, with about 75 percent already paved by asphalt and concrete.

Energy and fuel supply is provided from the Cay Bay area, which supply all of Sint Maarten, based on the N.V. GEBE power plant (80 MW) and fuel supply (oil terminals). Fuel supply on Sint Maarten is currently in the hands of the companies SOL (former Shell) and GB Group (former Texaco). They serve the domestic market and supply fuel for GEBE's power plant, service stations, marinas, aviation fuel for the airport and cooking gas.

Drinking water comes exclusively from the desalination plant, operated by Seven Seas Water. GEBE is responsible for its distribution (currently of about 20000 connections, part of them with smart meters). In 2011, this distribution reached 83.5% of the living accommodations, with 7.4% using groundwater or cistern. The percentage of water leaks reaches 20% (according to information provided in the GEBE meeting of 19th June 2025)

82 IMF's Staff Concluding Statement (2024) *Article IV Mission—Kingdom of the Netherlands including Sint Maarten*). Available at: https://www.imf.org/en/News/Articles/2024/06/25/mcs062524-kingdom-netherlands-sint-maarten-2024-art-iv-consult-mission

Regarding **sanitation**, the GoSM has made several wastewater investments over time including construction of wastewater treatment plant (WWTP) and development of sewerage infrastructure in various residential and commercial districts. However, the sewage system is not updated with the residence increase and overflows to the surrounding soil and aquifer (according to information provided in the VROMI meeting of 16th June 2025).

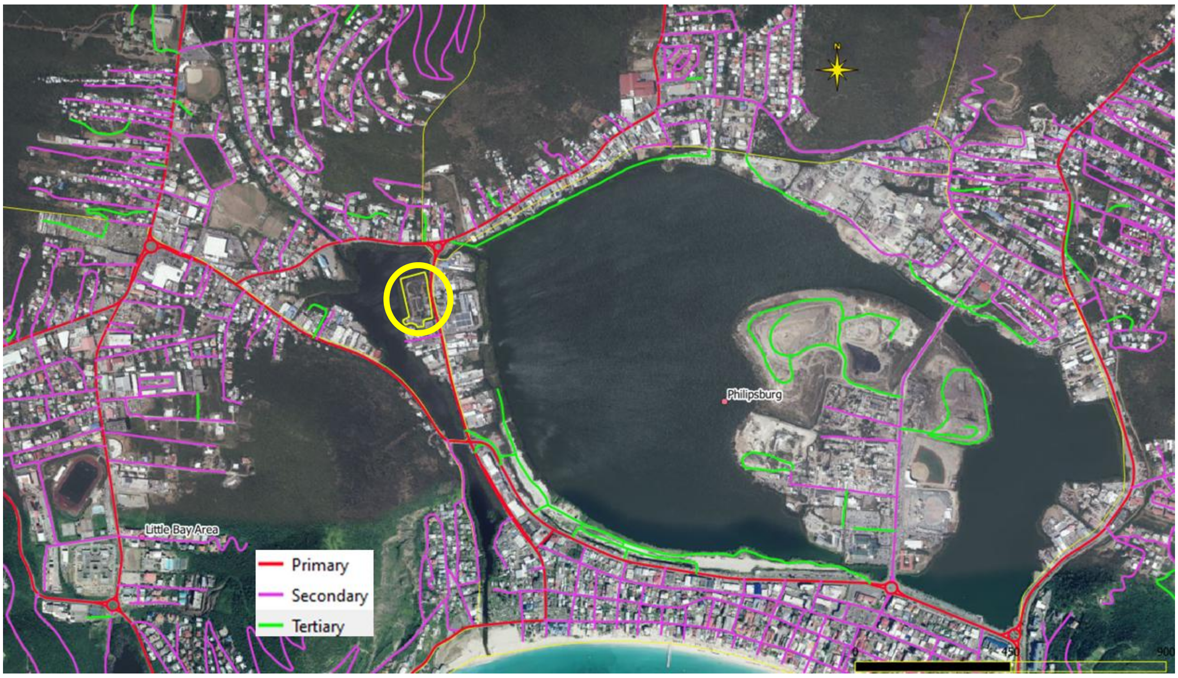


Figure 5-22 – Main Road network around the WWTP (yellow circle)[83]

Based on the technical assessment for the present project, only 15% of the properties included in the eight districts are connected to the wastewater system, with the Cul de Sac area reaching 20%.

Table 5-21 – Population served by sewerage service

Districts	% Pop served
	2 025
Cul de Sac	20%
Lower Prince´s Quarter	32%
Upper Prince´s Quarter	0.4%
Great Bay	42%
Little Bay	0%
Cole Bay	0%
Simpson Bay	0%
Lowlands	0%
Total	**15%**

83 Cartographic data provided by VROMI for the present consultancy

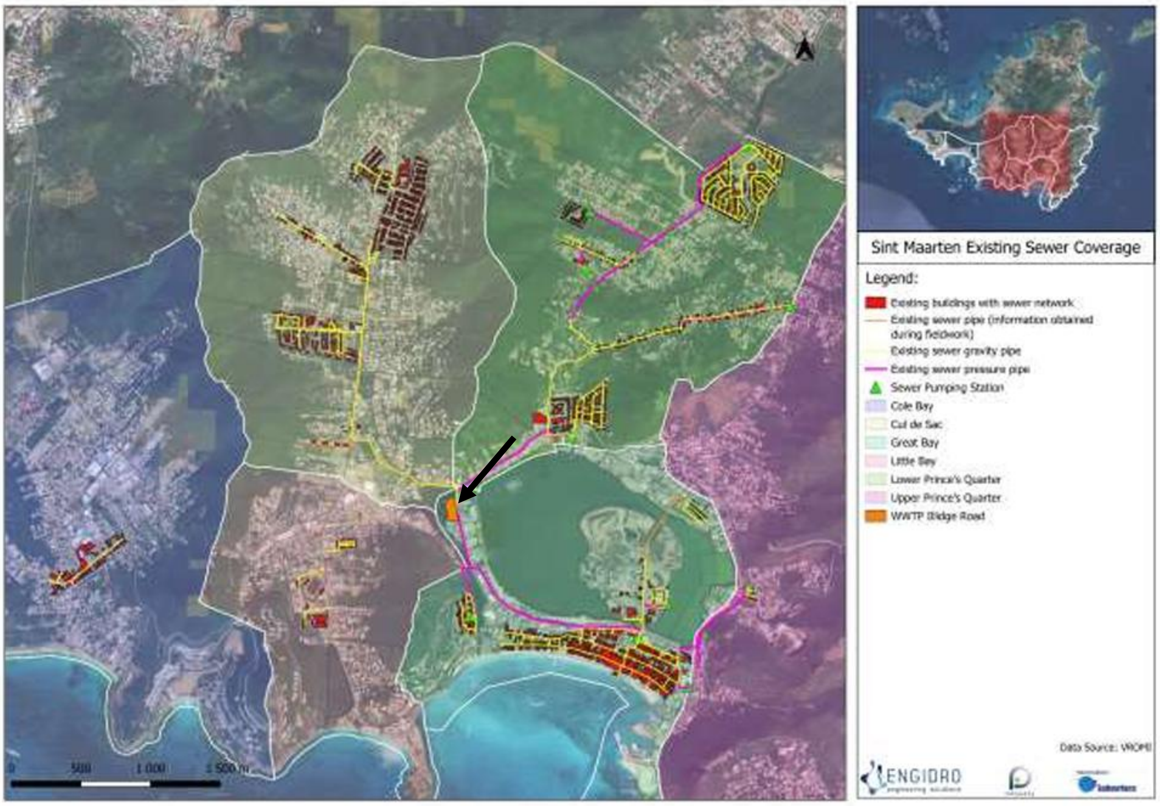


Figure 5-23 – Current sewerage network around project area. Project area (black arrow)

Included in the sewage system, is the current **A.TH. Illidge Road WWTP**, built in 1992 and upgraded in 2013, which operation process is already described in Chapter 2.2.1

5.4.3.6 Education

According to 2022 Census, only 10% of the population has no formal education, most of them attaining the secondary education level (54%), with a stable evolution since 1992[84].

In terms of educational attainment of the working population[85], nearly two-thirds of workers have completed secondary education, but only about one-third of this group pursued vocational training—equivalent to just 20% of the total workforce. Meanwhile, 30% of the employed labor force did not reach secondary level, highlighting persistent skills gaps, while 20% attained tertiary education. The limited capacity for professional internships and training programs further constrains opportunities for both students and unemployed workers, perpetuating structural mismatches between education and labor market needs.

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84 STAT (2022) *Sint Maarten Population 2022*. 66 pp. Available at: https://stats.sintmaartengov.org/reports.php

85 GRIJPSTRA, D., P. Vroonhof, P. de Klaver, T. Kwaak & T. de Winter (2023).Labour Market Analysis Report. Government of Sint Maarten, National Recovery Program Bureau (NRPB). 204 pp. Available at: https://www.sintmaartengov.org/Documents/Reports/LabourMarketAnalysisSXM.pdf

Higher education represents another structural challenge. The island offers limited university-level courses, which pushes many students to study abroad, particularly in the Netherlands and the United States, often supported by bursary programs. However, the majority of these graduates do not return, drawn by higher salaries and similar living standards overseas. While linguistic assets (English fluency and, in many cases, Dutch proficiency) facilitate their integration abroad, their absence reduces the pool of highly skilled labor available locally, reinforcing dependency on external labor and migration flows.

5.4.3.7 Health

Health indicators in Sint Maarten reveal both progress and ongoing challenges. Life expectancy at birth is estimated at 79.7 years for women and 73.8 years for men, while the infant mortality rate stands at 6.2 deaths per 1,000 live births—figures that are broadly in line with regional averages but still point to vulnerabilities in healthcare provision (UNData, 2024).

According to UNICEF86, nutritional health has become a growing concern. Approximately 29% of adults are obese and 38% are pre-obese, while childhood obesity has also risen in parallel with regional trends. These patterns have been aggravated by sustained increases in food prices over the last decade, as mentioned in the “Economics” section, disproportionately affecting low-income households and widening health inequalities. In fact, according to 2022 Census, diabetes, high blood pressure and cholesterol are the main health issues reported[87].

Respiratory diseases, which could be caused by environmental pollutants, were only reported in 2% of the population, according to the 2022 Census.

Reproductive and maternal health indicators highlight important demographic and healthcare developments. By 2024, the total fertility rate had declined to 1.4 children per woman, well below replacement level. Adolescent fertility fell sharply, from 42.1 live births per 1,000 women aged 15–19 in 2000 to 16.6 in 2024, a reduction of more than 60%, reflecting advances in reproductive health and family planning. Between 2013 and 2018, antenatal care coverage rose from 90% to 100%, and by 2018 all births were attended by skilled health professionals, underscoring major improvements in maternal care[88].

In the area of communicable diseases, Sint Maarten has achieved significant progress: in 2020, the HIV incidence rate was estimated at zero new cases per 100,000 inhabitants, suggesting that prevention and treatment strategies have been effective[89].

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86 UNICEF (2020). *Situation Analysis on children and adolescents 2020*. *Sint Maarten (Dutch Side).* 4 pp. Available at: https://app-sncu01saas51g0rp001.cms.optimizely.com/globalassets/files/wat-we-doen/nieuws/factsheet_situation-analysis_st-maarten2020_en.pdf

87 STAT (2022) *Sint Maarten Population 2022*. 66 pp. Available at: https://stats.sintmaartengov.org/reports.php

88 HEALTH IN THE AMERICAS (2024). *Sint Maarten - Territory Profile* https://hia.paho.org/en/country-profiles/sint-maarten

89 HEALTH IN THE AMERICAS (2024). *Sint Maarten - Territory Profile* https://hia.paho.org/en/country-profiles/sint-maarten

The main vector-borne diseases present in Sint Maarten are dengue fever, chikungunya, and Zika virus, which are transmitted by mosquitoes (*Aedes aegypti*)[90]. Although there is no official data from Sint Maarten, the Health bulletin from the French Part[91] of the Island refers that the situation regarding Dengue is calm and the territory is currently in phase 1 (sporadic cases and isolated outbreaks or without epidemiological link(s)), which can be extrapolated for Sint Maarten.

5.4.3.8 Poverty and Vulnerable Population

Over the past decade, Sint Maarten has made notable strides in strengthening the protection of children's rights. Key achievements include high levels of primary school enrolment, near-universal vaccination coverage, the approval of a national action plan on children's rights, and important legal reforms such as protocols for reporting child abuse and the revision of the Penal Code to address juvenile justice separately. These measures reflect strong government commitment. At the same time, progress has been uneven. As noted by UNICEF (2017) and the IMF (2025), the 2017 hurricanes and subsequent political instability posed significant challenges to service delivery and infrastructure recovery, contributing to delays in achieving broader development goals[92].[93]

The demographic profile itself highlights the scale of the challenge: Sint Maarten has a population of around 40,600, of which nearly 10,000 are under 18. Within this group, an estimated 20% are undocumented, and therefore excluded from key entitlements such as social health insurance and opportunities for higher education abroad. Adolescents face particularly concerning risks, with 31% of those aged 15–24 not engaged in education, training, or paid work.

Poverty compounds these challenges: more than a quarter of households live below the poverty line, and 38% of households are headed by women, many of whom shoulder economic hardship alone in the aftermath of repeated natural disasters.

In sum, Sint Maarten's framework for children's rights combines real progress in policy and legal reform with persistent social and structural weaknesses. Addressing poverty, reducing inequalities for undocumented children, strengthening care systems, and investing in robust data collection will be crucial steps in ensuring that children and adolescents are not left behind, particularly in a society highly exposed to climate and economic shocks.

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[90] SINT MAARTEN GOVERNMENT (2025). *Dengue*. https://www.sintmaartengov.org/Ministries/Public-Health,-Social-Development-and-Labor/Pages/Dengue.aspx

[9191] SANTÉ PUBLIQUE FRANCE (2025). Surveillance épidémiologique de la dengue Semaine 25 (du 16 au 22 juin 2025). *Dengue aux Antilles*. **Bulletin du 26 juin 2025,** 6 pp. https://www.santepubliquefrance.fr/regions/antilles/documents/bulletin-regional/2025/dengue-aux-antilles.-bulletin-du-26-juin-2025

[92] UNICEF (2020). *Situation Analysis on children and adolescents 2020. Sint Maarten (Dutch Side).* 4 pp. https://app-sncu01saas51g0rp001.cms.optimizely.com/globalassets/files/wat-we-doen/nieuws/factsheet_situation-analysis_st-maarten2020_en.pdf

[93] IMF (2025). Kingdom of the Netherlands – Sint Maarten: Staff Concluding Statement of the 2025 Article IV Mission. https://www.imf.org/en/News/Articles/2025/06/24/kingdom-of-the-netherlands-sint-maarten-staff-concluding-statement-2025-art-iv-mission

Table 5-22 - Welfare Issues in Sint Maarten

Area	Key Findings
Education & Youth	High enrolment in primary education; near-universal vaccination coverage; 31% of youth (15–24) are not in education, training, or paid work (NEET).
Child Rights Policies	Action plan approved; Penal Code revised for juvenile justice; child abuse protocol implemented.
Impact of 2017 Hurricanes	Increase in child neglect cases; worsened mental health; setbacks in child rights progress.
Households & Poverty	27% of households live in poverty, with greater hardship since the 2017 hurricanes; 38% of households are headed by women.

5.4.3.9 Gender Parity

From a gender perspective, Sint Maarten continues to grapple with entrenched structural disparities that cut across education, employment, and protection from violence.

Violence remains a pervasive challenge for children, adolescents, and women in Sint Maarten. UNICEF has documented widespread perceptions that child sexual abuse is a common issue within families and communities, while many young people report either direct exposure to domestic violence or growing up in households where such violence was a regular occurrence[94]. The World Bank also highlights that domestic and gender-based violence constitute recognized and persistent social challenges in Sint Maarten[95]. In response, initiatives supported by the Sint Maarten Trust Fund/WB—such as the Resources for Community Resilience (R4CR) project, including the Safe Haven Foundation, which operate shelters, offer counselling, and run public awareness campaigns.

At the institutional level, policy steps have been taken. In June 2021, the Ministries of Justice and Public Health, Social Development, and Labor jointly adopted a structured policy framework to address Domestic Violence, Gender-Based Violence, and Child Abuse[96]. This policy establishes a graduated classification of offenses, ensuring sanctions are proportionate to the severity of the act, and provides for preventive measures, confidential reporting channels, and integrated support services for victims, witnesses, and even perpetrators.

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94 UNICEF (2020). *Situation Analysis on children and adolescents 2020. Sint Maarten (Dutch Side).* 4 pp. https://app-sncu01saas51g0rp001.cms.optimizely.com/globalassets/files/wat-we-doen/nieuws/factsheet_situation-analysis_st-maarten2020_en.pdf

95 WORLD BANK (2022). *Tackling Gender-Based Violence in Sint Maarten*. Available at: https://www.worldbank.org/en/news/feature/2022/04/22/tackling-gender-based-violence-in-sint-maarten

96 SINT MAARTEN GOVERNMENT (2025). *Strengthening Partnerships for a Safer Sint Maarten: Victim Support Services and the Ombudsman of St. Maarten Join Forces to Address Domestic Violence***.** https://www.sintmaartengov.org/news/pages/Strengthening-Partnerships-for-a-Safer-Sint-Maarten-Victim-Support-Services-and-the--Ombudsman-of-St--Maarten-Join-Forces-t.aspx

In politics, women have played increasingly visible roles in leadership, holding parliamentary seats and ministerial portfolios. Following the January 2024 elections, women accounted for 7 of the 15 members of parliament (46.7%)[97], a figure that illustrates tangible progress toward gender parity in governance while also reflecting continuing structural imbalances in representation. Finally, from an international perspective, Sint Maarten, as a constituent country within the Kingdom of the Netherlands, falls under the Netherlands' commitment to the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), signed on 17 July 1980 and ratified on 23 July 1991.

5.4.3.10 Local Survey

A local survey was conducted within a 200 meters buffer around the **A. TH. Illidge Road WWTP** (Figure 5-24), with face-to-face enquiries to whom either live or run a business in this area.

The questionnaires were performed between August 26th to September 3rd, 2025, to assess the following aspects:

- the community's level of awareness about the WWTP facility;
- perceptions of its impacts;
- and the extent to which residents and business owners use (or avoid) available channels to report concerns.

ANNEX 4 presents the results of 120 questionnaires. In terms of characterization of the local population (Households and Businesses) around the WWTP regarding demographic and socioeconomic characteristics such as age, gender, length of residence, roles, employment, household size, and business attributes, the main results were:

- The survey analysis mainly reflects the views of working-age adults; almost 70% are aged 35 to 64. Women make up nearly two-thirds of participants.
- In terms of household or business roles, less than half identified themselves as primary decision-makers (either heads of household or business owners). Most respondents are renters rather than owners;
- Where household data were provided, families are generally small to medium-sized, with 2–4 people and a median of 3;
- Employment details are limited, but among those who answered, about two-thirds are employed. Reported occupations range from service jobs (housekeeping, retail, restaurants, security) to manual trades (mechanics, construction, car repair), with fewer in professional or managerial roles.

[97] IFES (2024).. ElectionGuide. Country of Sint Maarten: https://www.electionguide.org/elections/id/4447

- Among business owners, activities are diverse, from small shops and services (bars, salons, supermarkets, restaurants) to some specialized fields (law, accounting, real estate, pharmacy distribution). Most businesses are very small**,** with two-thirds employing 4 or fewer people (median: 3). Only a few have more than 10 employees, and one reported up to 60.

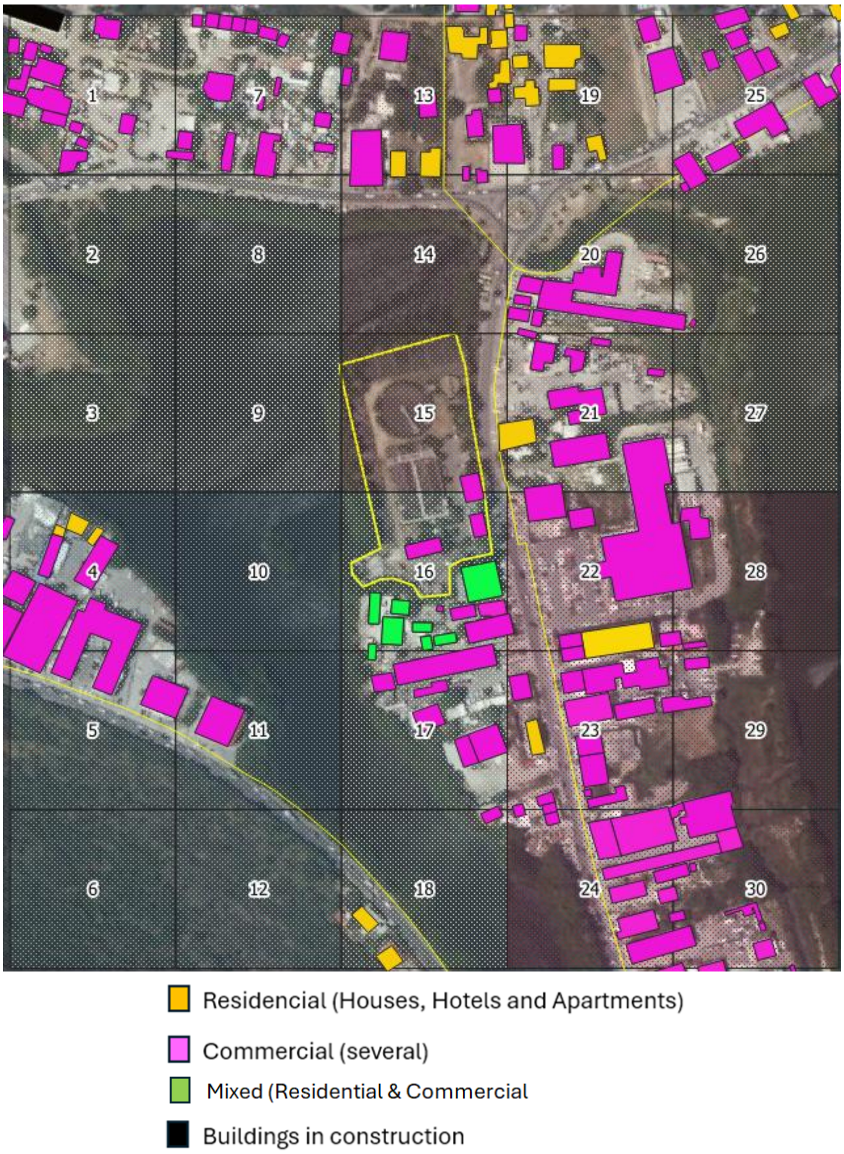

Figure 5-24 – Buffer of 200 m around the WWTP boundaries

5.4.4 Heritage

The Cul-de-Sac area was the site of the first major Dutch colonial settlement on the island of Sint Maarten, featuring the early 17th-century Cul-de-Sac Graveyard and ruins of a Dutch Protestant Church.

It served as the island's capital until the early 18th century, when Governor John Philips moved the capital to Philipsburg on the coast. The Cul-de-Sac valley later became home to sugar plantations and is now partly preserved as the Emilio Wilson Historical and Cultural Park.

Cul de Sac Dutch area has 5 registered monuments, as described in the following table and located in Figure 5-25

In the northeast and east side of the A. TH. Illidge Road WWTP, refers also the Lower Prince's Quarter, Phillipsburg monuments and in the southwest side, Little Bay monuments.

Table 5-23 – Cul de Sac Monuments[98][99][100][101][102]

Designation	Location	
CUL DE SAC DUTCH AREA		
B-008 - # 105 Monument	L.B. Scot Road (no Coordinates)	This is a designated monument which is an early 20th century wooden house structure on a stone-mortar foundation, with traditional Caribbean ornamentation, from outside the city area.
B-010 - Mary's Fancy Plantation	L.B. Scott Road (see **Error! Reference source not found.**)	The Mary's Fancy Plantation was constructed in the 18th century and initially grapes were grown. But when the sugar industry began on St. Maarten the Plantation made large investments to build a sugar factory on the grounds. This location is now a designated monument that is purchased by the Algemeen Pensioenfonds Sint Maarten who are in the process of restoring it
B-012 - Ebenezer Plantation	S. Hazel / R. Mayan Roads, St. Peter (see **Error! Reference source not found.**)	A 19th century complex of structural ruins from a Sugar Plantation, early owned by the Weymouth family
B-007 - Dutch Reformed Cemetery	L.B. Scott Road (see **Error! Reference source not found.**)	This monument is an early 18th century cemetery, with the graves of many early St. Maarten families, including the grave of John Philips, founder of Philipsburg. This location continues to be used as a public cemetery, and also has large trees present
B-009 - Emilio Wilson Estate	L.B. Scott Road (see **Error! Reference source not found.**)	This monument consists of two sugar plantation complexes situated on one ownership property, these plantations are called Industry/Rockland and Golden Rock, which date from the 18th-19th centuries. Historic structural ruins are noted at each of the plantation complex areas, with associated various plantation activity areas, as well as the remnants of the plantation African slave village area

[98] List of designated monuments of Sint Maarten https://en.wikipedia.org/wiki/List_of_designated_monuments_in_Sint_Maarten

[99] SINT MAARTEN GOVERNMENT. *Installation of a Temporary Weighbridge and Reconstruction of the Access road to the MSW Site. Daily Management of the MSW Site Operations including Fire Suppression and Slope Recontouring*. Environmental and Social Impact Assessment (ESIA). 662 pp

[100] *St. Maarten / St. Martin Monuments*. https://www.visitstmaarten.com/sxm-mnt/monuments/

[101] *Sint Maarten National Heritage Museum*. https://www.sintmaartenmuseum.org/national-symbols/1000

[102] *Sister Borgia Elementary School*. https://skos-sxm.org/school/sr-borgia-elementary/

Designation	Location	
Fresh Pond	Downstream Cul de Sac (see **Error! Reference source not found.**)	Also known as an Important Bird Area, is located near the sewage treatment plant and receives effluent, as well as runoff from a major road in the Cul de Sac area, making it a significant focus due to its potential environmental impact and its significance as a habitat for unique bird species and surrounded by reeds, mangroves, and coconut palms
LOWER PRINCE'S QUARTER		
B-015 - Madam Estate	A.T. Illidge Road (no Coordinates)	This plantation is one of the oldest ones on the island. Before the sugar trade, grapes were grown on the plantation that was sold to rich merchants on Sint Eustatius. Eventually they evolved to making sugar in 1725 and in 1870 sold the building to the salt company which they used as their headquarters. Predominantly residential, Madame Estate has an area that is built in Amsterdam gable shape. To further illustrate this "touch of Dutch" neighborhood, it also contains the island's sole "Dutch Brown Café" Rembrandt, and a typical Dutch snack bar.
B-018 - Bishop Hill Plantation	Bishop Hill Road (no Coordinates)	Historical ruins on Bishop Hill, a location known for its gardens and proximity to the Parrot Ville Bird Sanctuary
B-016 - Union Farm Estate	Dutch Quarter (no Coordinates)	The Union Farm plantation was probably built around 1680 and in 1924 it was renovated. It is one of the best-conserved buildings on the island.
B-017 - Bethlehem Plantation	Dutch Quarter-French Quarter (no Coordinates)	This plantation was first mentioned in a deed from 1835 by the merging of the Estates Reeds and Madame Barton. The plantation complex comprised a curing house, a boiling house, a plantation house, a sick house, cotton processing facilities, a cattle mill, a cistern, and a burial site. It is located in Lower Prince's Quarter near the Dutch and French border on top of a small hill. It is an excellent example of a sugar cane processing complex that is common in the North Eastern Caribbean.
PHILLIPSBURG		
Great Salt Pond	Center of Phillipsburg (see **Error! Reference source not found.**)	There are three monumental objects from 18 and 19th century related to salt pans and dikes, the salt of which has been exploited since pre-historic times and was one of the primary attractions to initially settle St. Maarten by the Dutch. Is is also considered an Important Bird Area because it supports a large seasonal aggregation of laughing gulls
B-020 - Foga Salt Factory	Arch Road (no Coordinates)	In the North-East corner of the Great Salt Pond is a mysterious ruin, generally referred to as the Salt Factory. It is also known as the Foga Ruins. It was built by a Dutch and French salt company on the island. The ruins date back to around 1862. The remaining ruins are an impressive reminder that salt was the backbone of Sint Maarten's economy. It has been in ruins for more than a century.
P-094 – Zoutpakhuis (*Salt Warehouse*)	6 Hendrikstraat (see **Error! Reference source not found.**)	Salt mining was one of the reasons for the founding of Philipsburg in 1631 and was the backbone of the island's economy for centuries. Salt mining has ceased (the last production ceased around 1949/1967).
B-021 - Verkavelingen Zoutpannen Great Salt Pond en dijk (*Salt pans*)	north/east Great Salt Pond (no Coordinates)	The Dutch settled on the island in 1631 because of the salt extraction from the Great Salt Pond, which was an important commercial objective. Production was organized through a system of dams and "crystal houses" to obtain high-quality salt.
P-006	28 Back Street (no Coordinates)	No description found
P-013	44 Back Street (no Coordinates)	No description found
P-017 - Dollison Family House	88 Back Street (see **Error! Reference source not found.**)	No description found
P-018	93 Back Street (see **Error! Reference source not found.**)	No description found
P-032	152 Back Street (no Coordinates)	No description found

Designation	Location	
P-033	153 Back Street (see **Error! Reference source not found.**)	No description found
P-171	171 Back Street (no Coordinates)	No description found
P-092 - Sweet Repose/ Sr Borgia School	Cannegieter Street (see **Error! Reference source not found.**)	This school was one of the Catholic schools established in August 1978, to cater to the growing school population of St. Maarten in the late seventies.
B-001 - Vineyard Estate	East Philipsburg (no Coordinates)	The area was named after the estate, which probably got its name from the grapes that were cultivated around the house. The estate house has a twin on Martha's Vineyard USA, off the coast of Massachusetts. In 1871, the van Romondt family imported the house from Baltimore, Maryland USA
P-047 - Pasanggrahan Royal Guest House	Front Street (no Coordinates)	The first Pasanggrahan was located in the office building of Oranje School. In 1939 the current Pasanggrahan was built on Front Street. Currently it is a hotel.
P-058 - Courthouse	Front Street (see **Error! Reference source not found.**)	The Courthouse was built in 1793. The plans were drawn by John Handleigh by order of commander Rink. During the last renovation in 1966 the Courthouse obtained its present form. This building houses the court of Sint Maarten. Until its completion in 1793, Fort Amsterdam was the seat of government on Dutch side St. Maarten.
P-045 - Guavaberry Emporium	8 Front Street (see **Error! Reference source not found.**)	The Guavaberry factory shop was built in the 1830s. At first it was a house that was eventually turned into a restaurant. Nowadays, it houses the Guavaberry Emporium, center of a national liquor based on a local fruit.
P-048 - St. Joseph Convent	26 Front Street (no Coordinates)	The Dominicanessen Nuns built the Convent in 1954. These Dutch nuns came to Sint Maarten in 1890 and started a school and a hospital across the street. Nowadays, the top of the convent is in use as the Permanent Representation office or "Permanente Vertegenwoordiging", of the European Netherlands in St Maarten.
P-050 - St. Joseph School	28 Front Street (see **Error! Reference source not found.**)	This building is one of the few two-story wooden buildings left in Philipsburg. It was built in 1923 as a Roman Catholic boarding school. From 1930 it was the St. Joseph School, it even hosed Sister Marie Laurence school until it moved to a new location in 1994.
P-052 - Rink House	37 Front Street (see **Error! Reference source not found.**)	This building use to be the home of Commander Rink. He used to be the owner of Retreat Estate/Plantation. The house was built around the end of the 18th century. It was constructed with natural stone. The building use to be twice its current size.
P-054 - St. Martin of Tours' Church	51 Front Street (see **Error! Reference source not found.**)	One of the three Catholic churches in the Dutch part of the island being the other two, Mary Star of the Sea in Simpson Bay and Christ Risen in South Reward.
P-056	56 Front Street (no Coordinates)	No description found
P-057	57 Front Street (see **Error! Reference source not found.**)	No description found
P-059	59 Front Street (see **Error! Reference source not found.**)	No description found
P-060 - Methodist Church	90 Front Street (see **Error! Reference source not found.**)	The Methodist Church complex consists of three buildings of historical and architectural interest. First the church that was originally built in 1851. 'The Manse' (or minister's house) is not a replica of the former manse pulled down in 1931 although it was built on the same spot. This was done by Lionel Bernard Scott, an important historic figure for both St Maarten and the kingdom of the Netherlands.
P-061 - Methodist Manse	In Methodist Church yard (no Coordinates)	
P-062 - Brick Building	Back Street (no Coordinates)	The first Methodist Church on the island was in a building made out of red bricks, known today as the Brick Building. It is located in the Methodist church

Designation	Location	
		compound. It is the only building of its kind. It was built around 1785. In World War 2 it housed French soldiers who occupied the Dutch Side.
P-063 - L'Escargot	84 Front Street (see **Error! Reference source not found.**)	This house painted in the red, white, and blue colors of the Dutch and French flags was one of the most famous restaurants of the island.
P-065 - Oranje School	88 Front Street (see **Error! Reference source not found.**)	The Oranje School was originally built as a church in 1738. When the English took over, the church was demolished and all that was left were the foundations. In 1938 the building became a Government School.
P-068	113 Front Street (see **Error! Reference source not found.**)	No description found
P-073	134 Front Street (no Coordinates)	No description found
P-074 - The White House	122 Front Street (see **Error! Reference source not found.**)	The 'Great House' due to its color and size, is often called 'The White House'. The house was built in 1904 and has been well maintained.
P-080 - De Weever House	171 Front Street (no Coordinates)	No description found
P-093	4 Hendrikstraat (see **Error! Reference source not found.**)	No description found
P-099 - Van Putten House	3 Smid Steeg (see **Error! Reference source not found.**)	No description found
LITTLE BAY AREA		
B-005 - Fort Willem	Fort Hill (see **Error! Reference source not found.**)	Fort Willem was built in 1801 by the British as Fort Trigge, presumably named after the person ordering its construction. Expanded reach of the newest types of cannons allowed the fort to be placed higher up the hill compared to nearby , whilst still controlling and with its strategic supplies and natural harbor. Revived as "Fort Willem", named after the Dutch king, it functioned until 1846. After this, the fortress deteriorated and is now predominantly a target for experienced
B-004 - Fort Amsterdam	Little Bay Peninsula (see **Error! Reference source not found.**)	The fort located on the peninsula between Great Bay and Little Bay was built in 1631 by the Dutch. It was their first Fort in the Caribbean named after the Chamber of Amsterdam. The fort was besieged by amongst others Peter Stuyvesant, trying to retake the fort from the Spanish, and losing the leg in the process. The fort was partially demolished after Stuyvesants failed attempt to take the island back. John Philips, the commander after which Philipsburg was named, reinforced the fort in 1737. It was symbolically reopened on the last day of that year as "Fort Amsterdam", not named after the Dutch capital, but after the namesake Amsterdam Chamber (division) of the West India Company. Until the opening of the "council house", now the Courthouse 55 years later, Fort Amsterdam was the seat of government of Dutch side St. Maarten.

As it can be seen, the WWTP has no heritage sites in the closest surroundings. Refers also that the WWTP was built on land reclaimed from Fresh Pond (early 2000), with recent soils. Nevertheless, according the SIMARC information (meeting of 18th June 2025), there was an ancient Dutch mill nearby the current WWTP.

The multiculturalism of St. Maarten springs from its historic role as a crossroads for visitors to the New World. Dutch, French and British traders brought European traditions, while Afro-Caribbean people brought the language and culture of West Africa.

Today the variety of influences is shown in the number of languages spoken. Dutch is the main language, but English is taught in schools and spoken everywhere, while other typical languages are Spanish, Haitian Creole and Papiamento, the dialect of the Netherlands Antilles.

The island culture has its roots mostly in African, French and Dutch influences, though ratings of more current immigrants have added their own components to this multicultural society.

Figure 5-25 – Location of Heritage monuments, around the project area (yellow circle)

5.4.5 Territorial Planning

Regarding national planning, refers the *Spatial Development Strategy 2030 of Sint Maarten*, that is intended to provide a coherent national policy framework until 2030, integrating various topics such as: nature, environment, economy, traffic, and housing. For all of these topics there is an emphasis on the aspects that are directly related to *spatial* issues, the competition for space and the need for balance in (spatial) allocation for often competing needs.

The physical living environment is used more intensively. Intensive in a way that places both the ecological sustainability, as well as the social appreciation of the living environment under pressure. A new balance is needed between 'use value' (economic utilization) and 'experience value' (citizen's perspective) and 'future value' (ecological sustainability) of that environment.

This Spatial Development Strategy indicates *possibilities* and *suggestions* for the spatial development of Sint Maarten for the coming years. It does not make specific choices or indicate specific (concrete) directions to take, nor entail any binding rules for citizens. The Spatial Development Strategy provides an indication to citizens about the manner in which the Government envisions the spatial development of the country and that citizens may expect that the Government will act in a consistent and consequent manner when making decisions on spatial planning.

With respect to the **A.TH. Illidge Road WWTP** operation, several topics discussed in this planning document can be assumed:

- WWTP capacity - The stay-over tourism will continue to be fomented,; there is need to increase the connections between the (main) sewage line and the individual homes with respect to the existing sewage treatment plant (A. TH. Illidge Road);
- Sludge transportation - Road network – the construction of a parallel road at the East side of A.TH. Illidge Road (Link 3) will alleviate the heavily congested Walter A. Nisbeth Road and the southern section of A.TH. Illidge Road.
- Discharge into the Fresh Pond – need to protect the pond from further filling to maintain the buffer capacity for rainwater runoff and as a collection area for silt and erosion material, to prevent pollution of the marine environment;
- Achievement of the SGD Goal 6 (Ensure access to water and sanitation for all) – need to improve by 2030 the water quality by reducing pollution and halving the proportion of untreated wastewater

For a more local planning, refers the *Cul-de-Sac Development Plan*, published in 2014 and with an extension over a 10-year horizon. Although not directly related to the WWTP implementation area, the proposed solutions for the upper part of Cul-de-Sac related to drainage and protection of natural areas will contribute for the sustainability of the Fresh Pond.

5.4.6 Current WWTP occupation health and safety procedures

Types of general hazards in WWTP can be categorized as follow[103]:

- Obvious hazards: such as moving machinery, unstable ground, explosive and misfire,
- Hidden hazards: related with unseen hazards such as gas leaks, electric faults, hydraulic pressure and weather conditions,
- Trivial hazards: produced minor injuries such as slipping, spillage and housekeeping

Currently, and specifically for the A. TH. Illidge Road WWTP, the main hazardous substances required for operation processes include diesel for standby generators, lubricating oils and laboratory chemicals (included in the Obvious hazards and Trivial Hazards categories).

Diesel and lubricating oils usually have some hazardous and toxic properties. However, the workers handling them already have high awareness regarding their risks, using gloves whenever needed. These wastes are properly disposed.

Same is true for the laboratory reagents, properly handled by the lab technician of the WWTP according to the recommended procedures.

Also, the first route of exposure to the volatile compounds of the sewage (odor) is by inhalation from the workers because sewage treatment plant has many open tanks for treatment operations. Workers may suffer from various health symptoms because they are facing many airborne contaminants (biological hazards) in the treatment plant.

In relation to physical hazards, and as mentioned above, these could include falling in slippery floors, hazards resulting by falling heavy articles or moving equipment/vehicles (e.g sludge trucks), exposure to high noise level from machine and the sludge trucks, falls into the tanks, electric shocks, etc.

[103] DANNOUN, Y. & F. Nouban (2021). Occupational health hazards and risk assessments in a wastewater treatment plant. *International Journal of Advanced Engineering, Sciences and Applications (IJAESA)* Volume 2, Issue 2: 21-25

All the staff in the WWTP have a good perception of these health and safety hazards. Perceived control of the WWTP workers has a significant influence on safety performance through safety attitude (HUANG *et al.*, 2021[104]).

Regarding the operation workforce, O&M is done currently by a **total staff of six (6) people** at present, one belonging to VROMI (management) and the remaining are under a private company called 'Wastewater Maintenance & Management' (WWMM).

Entrance of the personnel and third persons to the plant is controlled by security staff.

The main emergency impacts occurring in the **A.TH. Illidge Road WWTP** are heavy rainfall and equipment damage. These emergency situations are managed immediately and according to the severity of the incident, based on Staff experience. It is reported that during peak flows, the existing wastewater pumping stations of the sewerage network discharge it through the existing emergency overflows, reaching the Fresh Pond or Great Salt Pond. If the WWTP was receiving the entire peak flow, the data would show it, but this was not observed in the data assessment

There is no Emergency Preparedness Plan in the current WWTP. The current Manager (from the company 'Wastewater Maintenance & Management' - WWMM), is well familiar with the community wastewater systems and is able to foresee various types of potential problems and causes that could lead to untreated spills. There is a close articulation with VROMI, for trouble shooting, servicing and assistance.

The WWTP system is periodically inspected and, although there is a need for a more rapid replacement of damaged pieces (geographic and bureaucratic reasons), the staff is able to manage the operation, creating alternatives to address these occasional deficiencies. There is a workshop onsite for these repairs. Oil spills from mechanical issues are very rare and are usually immediately contained.

The existence of a back-up generator is also a mitigation measure for power failures. Exterior lights are supplied by solar panels.

The Operator also follows the recommendations of Sint Maarten Government regarding mosquito breeding, avoiding standing water in artificial recipients.

5.5 Evolution of the Study Area without the Project

As mentioned before, the current **A.TH. Illidge Road WWTP** is operating at about 65% of its hydraulic capacity, and at 80% of its pollution load capacity.

104 HUANG, C-F, Y-L. Tsai & W-H. Lu (2021). Relationships among Perceived Control, Safety Attitude, and Safety Performance: A Case Study on Wastewater Treatment Plant Workers. *Sustainability*, **13**, 12573.

According to the Sint Maarten Sewerage Policy 2022, the goal of this Policy is to provide *"adequate and sustainable sanitary facilities for all houses by 2030, whereby the plots are connected to wastewater collection and treatment systems. In addition, we strive to ensure that at least 40% of the plots are connected to (semi) central sewerage and therefore to wastewater treatment*".

Without the update of the current WWTP to allow an increase in the capacity to receive this addition of wastewater, this goal may not be fully compliant. On the other hand, although the levels of pollution discharged by the WWTP to the Fresh Pond nowadays are still under control, an increase of the wastewater flow may alter this situation.

Therefore, maintaining the current situation is adequate in a short-term, but on the longer term it will not be able to sustain the increase of the sewerage network.

6. PUBLIC CONSULTATION PROCESS

6.1 Framework

Public participation is an essential formality of the Environmental Impact Assessment procedure, ensuring the participation of interested parties in the decision-making process.

Of the various forms of public participation in the decision-making process, the most prominent has been public consultation (PC), which is the process of consulting interested citizens, residents of the area, and those affected by the project. This process also involves associations representing citizens' rights, including environmental, youth, political, religious, human rights, and community development organizations, as well as local government bodies in the affected area and representatives of traditional government institutions, to provide clarification on matters related to the project.

There is no national law or regulation regarding Public Consultation process in Sint Maarten. The World Bank's Environmental and Social Framework's (ESF) Environmental and Social Standard (ESS) 10, "Stakeholder Engagement and Information Disclosure", recognizes "the importance of open and transparent engagement between the Client and project stakeholders as an essential element of good international practice", which will have the following purposes:

- Collect opinions, suggestions, and other input from interested parties on projects subject to Environmental Impact Assessment;
- Ensure the participation and consultation of holders of subjective rights or legally protected interests, within the scope of decisions made in the administrative procedure of Environmental Impact Assessment;
- Identify, as broadly as possible, all relevant aspects of the project subject to Public Consultation;
- Consider and assess any representations and complaints submitted and related to the project;
- Ensure that information on projects subject to Environmental Impact Assessment is disclosed and made available to the public;

6.2 Stakeholders Identification

The figure below presents the main stakeholders that may be related to the project, along with their categorization (beneficiary/interested) and influence/importance for the project:

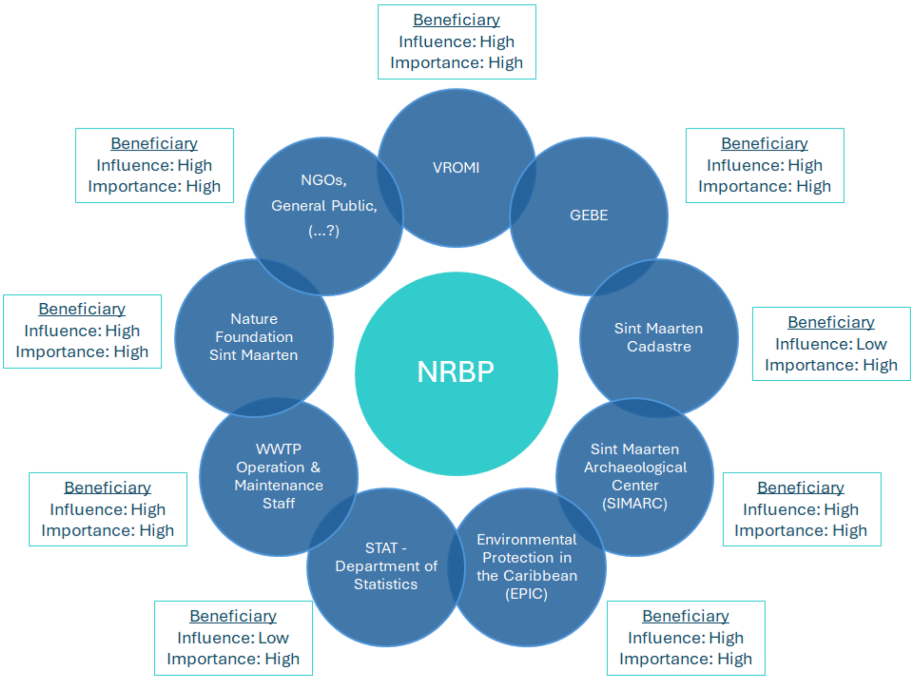

Figure 6-1 – Stakeholders Identification, Categorization and Involvement in the Project

The following table also describes the stakeholders:

Table 6-1 – Main Interested Parties of the Project

(a) (A) INTERESTED PARTIES who may be directly or indirectly affected by the project	**(b) OTHER INTERESTED PARTIES**	**(c) VULNERABLE INDIVIDUALS OR GROUPS**
- Community residents of the affected neighborhood and neighbors of the project implementation area - WWTP staff	- VROMI - Community councils of Cul de Sac district, - GEBE - Kadastre - STAT - NGOs (EPIC, Nature Foundation) - General Public	- Women, heads of household - People with disabilities - People with chronic illnesses - Elderly - Children - Migrants

6.3 Stakeholder Engagement

As mentioned in Section 3.3, the public consultation process was divided in two steps. The first one (individual meetings) to collect baseline information for the project and for the ESIA, and the second one (workshop) to present the updated project design and the ESIA findings based on that new design.

The individual meetings were arranged by NRPB with some of the stakeholders indicated above in Figure 6-1. In each presential meeting, the project was presented and contributions of each stakeholder in their area of interest were collected and discussed.

In a second stage, a formal public consultation was held with the main stakeholders to present the findings of the ESIA and the mitigation measures defined for the assessed impacts of the WWTP Rehabilitation project and other aspects of the project.

The meeting gathered the contributions on the ESIA, which, if pertinent for the study, were incorporated in the final version.

This formal public consultation was also arranged by NRPB, with the presence of the Consultant.

6.4 Public Consultations Developed

Description of individual meetings with the main stakeholders

The individual meetings were held during the week of 16 to 20th June 2025. The minutes of those meetings are presented in **ANNEX 6.1**.

Table 6-2 – Individual meetings with institutional entities

Stakeholder	Attendant	Meeting Date
VROMI	[redacted]	16th June 2025
Nature Foundation	[redacted]	16th June 2025
STAT	[redacted]	17th June 2025
EPIC	[redacted]	18th June 2025
SIMARC (remote)	[redacted]	18th June 2025
Kadaster	[redacted]	18th June 2025
GEBE	[redacted]	19th June 2025
Seven Seas	[redacted]	19th June 2025

Description of Final consultation Summary

A public consultation was held at the Belair Community Centre on December 10, from 6:00 p.m. to 9:00 p.m. The purpose of the consultation was to present the updated project design and the Environmental and Social Impact Assessment (ESIA) findings based on the revised design, in accordance with World Bank requirements.

Approximately 50 participants attended the consultation in person. In addition, a live stream was provided through NRPB's online platform to allow individuals who were unable to attend physically to participate remotely. Approximately 15 participants joined the session online. An estimated 15 of the total participants were women.

The presentations delivered during the consultation, along with the associated questions and answers, (Q&A) are provided in **ANNEX 6.2**. A full recording of the consultation, as well as the presentation materials, were put available on NRPB's website to ensure continued public access to the information shared during the session.

6.5 Public Consultation Results

The general outcome from the institutional stakeholders and general public is that they really welcome the project and they will support it. There was generally a positive reception of the project, and everyone understood the benefits that would come with the project.

In general, from the public consultations, the stakeholders and general public were able to express their expectations and voice their concerns. Two questions were asked regarding the rehabilitation of the WWTP:

- *What exactly is being expanded at the wastewater treatment plant in terms of capacity?Is there any dollar value that can generated from waste collected? For instance reselling the byproduct of waste to regional or international markets*.

For the first question it was replied that mathematical modelling of the processes in the WWTP were done. The current system in the plant is resilient and has been tested for maximum flows and organics loads that can be supported for wastewater. This project will increase the flow to the plant by expanding the coverage in the Cul de Sac area. The upgrade will be more environmentally friendly with the reduced use of the sludge drying beds, and the new dewatering component in the system will be an added advantage. The project will replace equipment where needed. All new components will have a standard of 15-year service life to ensure continuity.

For the second question, it was mentioned that sludge can be used for composting. With a focus on circular economy principles, organic waste could support beautification projects and other local agricultural uses before considering export. The reuse of waste is something that is being explored for the local market.

In summary, there were no concerns that could imply changes in the WWTP project, but is important to guarantee the quality of the treatment process.

7. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

7.1 Methodology

7.1.1 Impact-Generating Activities

This section identifies, characterizes and evaluates the environmental impacts resulting from the implementation of the **A. TH. Illidge Road WWTP** project, analyzing the adopted technical design (**ANNEX 2**).

A WWTP will create safer and more stable healthy aquatic ecosystems by reducing the amount of wastewater released into the environment without any treatment. Any wastewater treatment provides an opportunity for sustainable solution to some aspects of the water scarcity problem. As such, the proper management of wastewater develops a sustainable and healthy environment.

On the other hand, they also have high energy consumption, have air quality issues (odour), require chemical usage, may have sludge disposal challenges, can result in nutrient pollution leading to eutrophication, and may disrupt ecological systems due to residual contaminants in treated water.

In the specific case of the A.TH. Illidge Road WWTP, the technical design for Scenario 3A incorporates specific measures that mitigate the main operational impacts arising from the upgraded WWTP, and will bring notable improvements to the current condition. The design measures that are incorporated include:

- The **physical barrier** to be built next to the septage truck discharge area creates a protection between the residential and commercial buildings to the south of the WWTP and the location where the emptying of the septic trucks occurs, mitigating the potential impacts on noise and wastewater runoff.
- The **connection between the truck and the discharge pit will be through a pipe**, which decreases substantially the odor. It is important to reinforce that as the sewage network expands, the number of trucks with septic flows arriving at the WWTP progressively reduces;
- The **new screen and grit removal equipment and the new fine screen line** proposed in the pre-treatment stage will improve the removal of solids and debris (that could negatively interfere with the downstream operation), with benefits for the wastewater treatment and improving the quality of the discharged water and sludges;
- The **new mechanical surface aerators**, will improve the current and future biologic treatment capacity, in terms of resilience of the equipment, which improves the quality of the discharged water and sludges;
- The **new dewatering building** will improve the sludge treatment process, reducing the volume of sludge generated and the need to use the sludge drying beds (which will only be used in emergency situations, as a redundancy).
- The **transportation trucks for disposing of the treated sludge will be upgraded**, leading to fewer journeys and more controlled odor emissions as a result of the use of bed covers;

- Finally, the **automation and SCADA system** to be provided in the rehabilitated WWTP will improve efficiency, reliability, costs saving, environmental compliance (by accurate monitoring and control of key parameters), remote access & safety and predictive maintenance, with positive impacts for the environmental aspects and for the socioeconomic aspects.

Table 7-1 presents the estimate areas for the new components, based on Drawing 02 of ANNEX 3. The septic truck concrete barrier (A) and the new surface aerators (D) were not quantified.

Table 7-1 - Estimated areas of the new components of Scenario 3A

New components	m2
B - New screen and grift removal equipment	70
C - New fine screen line	10.5
E - New dewatering building	112
Disinfection system	25
P precipitation system	30

The project will result in the improvement of the efficiency and processing of the wastewater that the WWTP receives. Therefore, **the quality of discharged wastewater will improve** and the **amount** of untreated wastewater (pollutant load) reaching connected water (i.e. the Fresh Pond, Great Salt Pond, and Great Bay Beach) will decrease. The **quantity** and **quality** of the discharged wastewater related to the Network Expansion project is further discussed in Section 7.4 as a cumulative impact of both the upgrade/rehabilitation of the WWTP project and this parallel project.

Other important negative impact will be finding means of disposal of sludge, given the uncertain future of the landfill site. More detailed assessment is provided in Section 7.2.8.2.

Taking into account the various activities planned for the project described in Section 2, the main activities and their respective expected impacts are summarized in the table below, divided by negative and positive impacts for each Phase

Table 7-2 - Summary of Impact-Generating Activities and Forecast of Their Impacts

ACTIVITIES (project)	Description	Predicted Impacts
I – CONSTRUCTION PHASE		
Negative Impacts		
Land use changes	Temporary (machinery) or permanent (new buildings) occupation of land use	(-) Affectation of geological formations (-) Affectation of soils (-) Increase in the impermeable area (decrease in infiltration capacity and increase in surface runoff) (-) Affectation of landscape
Cleaning, and Clearing of land	Vegetation Removal and Land Clearing	(-) Affectation of soils (-) Reduced soil water infiltration capacity and increased surface runoff (-) Potential contamination of surface and groundwater

ACTIVITIES (project)	Description	Predicted Impacts
		(-) Particle emissions due to earthworks (-) Increased noise levels (-) Waste production (-) Vegetation impact (-) Wildlife disturbance
Earth-moving	Stripping, Excavation, Compaction for the building's foundations and process hydraulic circuits	(-) Affectation of soils (-) Increase in the impermeable area (decrease in infiltration capacity and increase in surface runoff) (-) Potential contamination of surface and groundwater (-) Particle emission from earth moving (-) Increased noise levels (-) Wildlife disturbance (noise)
Construction site Presence and Operation and Work Fronts Material Storage	Occupation of areas for the installation of construction support structures	(-) Increase in the impermeable area (decrease in infiltration capacity and increase in surface runoff) (-) Potential soil contamination due to accidental spills, waste disposal, etc. (-) Potential contamination of surface and groundwater (-) Emission of particles, GHG and other pollutants (-) Increased noise levels (-) Waste production (-) Potential nursery sites for vector-borne mosquitoes
Circulation of vehicles for transporting materials, equipment and workers and moving machinery	Movement of different types of vehicles and machines on work fronts	(-) Potential soil contamination due to accidental spills (-) Potential contamination of surface and groundwater (-) Emission of particles, GHG and other pollutants (-) Increased noise levels (-) Wildlife disturbance (-) Increased Traffic - potential increase in road accidents and run-overs.
Recruitment of Labor	Hiring local and external workers	(-) Potential low-level social impacts related to the integration of a small, temporary foreign workforce within host communities.
Health & Safety	Hiring local and external workers Construction activities	(-) Potential impact on human health, with an increase in sexually transmitted diseases (HIV/AIDS and STDs) due to the possible flow of non-resident population (-) Potential increase in Sexual Abuse and Exploitation (SEA) and Sexual Harassment (SH) situations, particularly among vulnerable groups (-) Worker safety risks including occupational diseases and accidents
	Positive impacts	
Recruitment of Labor	Hiring local and external workers	(+) Increase in local employment (+) Increasing the capacity of the local population (+) Promotion of the local economy due to the increased flow of non-resident population

ACTIVITIES (project)	Description	Predicted Impacts
Purchase of Materials and Equipment	Process of acquiring materials and equipment necessary for the execution of the Project	(+) Promotion of the local economy
II –OPERATION PHASE		
Negative impacts		
Discharge of treated effluents	Occasional occurrences of water quality not meeting the standards Insufficient capacity of the WWTP to treat increased quantities of WW in emergency situations.	(-) Potential occasional contamination of Fresh Pond (and indirectly also in Great Salt Pond and Great Bay) (-) Aquatic flora and fauna disturbance (-) Impact on tourism and leisure activities at Great Bay (-) Potential human health risks due to ingestion of fishes and contact with low quality water
Accidental discharges **Repair and/or maintenance interventions**	Occasional soil, superficial and groundwater contamination	(-) Potential soil contamination due to accidental spills (-) Potential contamination of Fresh Pond (-) Potential contamination of groundwater (-) Aquatic flora and fauna disturbance
Daily operation of the WWTP	Septic effluents discharge, outdoor equipment (anaerobic tanks, dewatering building, disinfection, P precipitation)	(-) GHG emissions generated from operation activities (-) Odors resulting from WWT plant activities (-) Noise resulting from WWT plant activities (-) Chemical waste from P precipitation
Daily operation of the WWTP (trucks movement)	Potential congestion of traffic situation in the area during WWTP operation	(-) Dust and gaseous from traffic emissions (-) Noise from traffic emissions (-) Community health and safety risks
Sludge reuse and disposal	Sludge transport to final destination Better sludge quality Occasional occurrences of sludge quality not meeting the standards	(-) Potential soil contamination (-) Odors resulting from sludge transportation and disposal (-) Gaseous emissions generated from sludge transport (-) Potential human health risks if sludge quality does not comply with agriculture standards
Generation of different types of waste, including hazardous	Daily activities of the WWTP and workers	(-) Potential soil contamination (-) Potential contamination of Fresh Pond (-) Potential ingestion by fishes (microplastics) (-) Worker health and safety risks
Health and safety risks	Workers' exposure to work Community exposure	(-) Worker safety risks including occupational diseases and accidents (-) Community health and safety risks
Excessive precipitation,		(-) Disturbance on the biologic process of pollutant removal (-) Emergency discharges of the non-treated effluents

ACTIVITIES (project)	Description	Predicted Impacts
Planned or unplanned maintenance requirements Power or Traffic disruptions	**Uncontrolled shutdowns in the operation of the WWTP**	(-) Increased odour (-) Community health and safety risks
Positive impacts		
Discharge of treated effluents	No negative changes in water quality	(+) Maintenance of current water quality of Fresh Pond (+) Maintenance of ecosystem services (+) Lower human health risks (
Sludge reuse and disposal	Sludge transport to final destination Better sludge quality	(+) Full coverage of the sludge trucks (+) Less volume and better quality
Recruitment of Labor	Hiring local and external workers	(+) Increase in local employment (+) Increasing the capacity of the local population (+) Promotion of the local economy

7.1.2 Impact assessment criteria

The **impact assessment** will take into account the two specific phases of the upgrade project:

- The Construction Phase, with the construction of the new equipment and buildings, the movement of vehicles and people, as well as the operation of temporary support facilities;
- The Operation Phase, with the change in operation of the rehabilitated WWTP, with its impact on wastewater quality and , and sludge disposal.

Given the nature of the project, and the long-term sustainability of the equipment, the decommissioning phase was not considered.

In this ESIA, the **alternatives** evaluated are project implementation (**Scenario 3A**) and the "No Action" option. The "No Action" alternative represents the current situation, with the current capacity of the WWTP.

Mitigation and enhancement measures will be presented in Section 8 of this document, which will be the basis of the Environmental and Social Management Plan.

To standardize the analysis, the following approach structure was included for each environmental factor:

- Impact identification, forecasting, and assessment – structured for the construction and operation phases. This assessment prioritizes quantitative aspects whenever possible, taking into account the project actions and their relationship to the thematic area in question. The identified impacts include the project considered, as well as all measures associated with the application of legislation and good environmental practices.

- Conclusion – the main impacts associated with the environmental factor are determined, systematized, and classified based on a set of predefined assessment parameters presented in Table 7-3.

To assess the impacts, and to provide a comprehensive understanding of them, a final weighting is performed to determine the significance of the impact. The impact is then classified as **Not significant (NS), Not Very Significant (NVS), Moderately significant (MS), or Significant (S)**.

Table 7-3 – Criteria used for impact classification

Classification criteria	Scale	Value (for calculating Impact Significance)
Nature	Positive or Negative	Non applicable
Effect	Direct, Indirect	Non applicable
Probability of Occurrence	Unlikely / Slightly Likely Likely Certain	1 2 3
Duration	Temporary Permanent	1 2
Frequency	Rare Occasional/Seasonal Daily	1 2 3
Reversibility	Reversible Partially reversible Irreversible	1 2 3
Magnitude	Low Moderate High	1 3 5
Value of the affected resource and/or environmental sensitivity of the impact area	Low Moderate High	1 3 5
Scale	Confined to the facility Not confined but localized Not confined	1 2 3
Mitigation and compensation capacity	Mitigatable and compensable Non-mitigable and non-compensable	-3 -1

Table 7-4 – Significance classes

	Negative	Positive

Significant (S) if the score exceeds 20 values		
Moderately significant (MS) if the score is greater than 15 and equal to or less than 20 points.		
Not very significant (NVS) if the score is greater than 11 and equal to or less than 15 points		
Not significant (NS) if the score is less than or equal to 11 points		

Initially, the classification of identified impacts does not take into account the implementation of mitigation measures (the last parameter in the above scale in Table 7-3), as these are intended to eliminate them or reduce their magnitude and significance, leading to residual impacts. Subsequently, the impact assessment considers the integration of measures that allow for the avoidance, reduction, or elimination of identified negative impacts, as well as the enhancement of positive impacts.

Cumulative impacts between projects and other existing or planned projects are also assessed. The impacts associated with the additional sewage inflow and discharges that will be part of the future operation of the upgraded WWTP are considered cumulative impacts, related to the parallel project of the sewerage network expansion. The quantity and quality of the discharged wastewater related to the Network Expansion project is further discussed in Section 7.4 as a cumulative impact of both the upgrade/rehabilitation of the WWTP project and this parallel project. The sludge disposal and the closure of the Pond Island landfill were also assessed as a cumulative impact.

The identification and assessment of impacts during the construction and operational phases can be found in the following section.

The quantitative assessment is presented in **ANNEX 7**.

7.2 Identification and Assessment of Environmental and Social Impacts

7.2.1 Geology, Geomorphology and Seismicity

7.2.1.1 Construction Phase

During the construction phase, the main direct geological impacts are essentially associated with the excavations required for the installation of the buildings associated with the new equipment, which will lead to the local and irreversible occupation of existing geological formations and alteration of the geomorphology. Regarding the hydraulic process pipelines, trenches up to 1.5 m deep will be excavated, and the excavated earth will be replaced to cover the pipelines.

<u>Geological and Geomorphological Changes</u>

Regarding the impacts on geological formations, the impacts, although direct and permanent, are **not very significant**, given that the affected formations do not present significant commercial and/or scientific interest.

The excavation volume for the installation of foundations and trenches is expected to be reduced, as most of the excavated volume will be reused for subsequent trench filling. Excavations will be needed associated with the new infrastructures (mainly the new fine screen line and the dewatering building), because these are on not-used terrain.

No changes to the local geomorphology are anticipated, given the flat nature of the area and the project's typology, with specific and highly localized interventions, but without significant changes to the relief. Excavations will be carried out mechanically, with the anticipated need for a small backhoe.

<u>Construction site</u>

The construction site will not be located in geological sensitive areas, does not require any changes in the terrain morphology and no excavations are anticipated. The impacts, besides temporary, are not significant.

7.2.1.2 Operation Phase

<u>Maintenance activities</u>

At this stage, **no impacts** on geology and geomorphology are expected due to the presence and operation of the new equipment, as their maintenance will not require interventions in the geological substrate.

In the case of sewage ducts, if maintenance work requires intervention, localized excavations will be carried out, and the earth will be reused as cover. The impacts are **not significant**.

Seismic risk

As mentioned in Section 5, Sint Maarten is vulnerable to earthquakes. Construction materials and methods must take this into account to avoid the destruction of buildings and, in its worst case, the discharge of polluted water into the surrounding environment. Reinforced concrete construction with metal support reduces vulnerability to potential seismic events. Similarly, the location of these structures in flat areas minimizes the impact of landslides.

The potential impacts can be considered **not very significant**.

7.2.2 Soils

7.2.2.1 Construction Phase

Soil affectation

During the construction phase of new equipment, the main activity likely to cause impacts on the soil involves excavations and earthmoving, and the value of the soil for agricultural use is taken into account in this assessment.

There are no agricultural soils on site, so the impacts are **non-existent**.

The construction site will also be implanted within the existing facilities, and the impacts are also **non-existent.**

Soil contamination

During the construction phase, accidental spills of pollutants may also occur during the movement and operation of machinery or through the discharge of effluent from the construction site. This risk, in the specific case of the project under consideration, can be considered minimal or even non-existent, since vehicles and machinery must meet the required standards for their intended use. Furthermore, the winning bidder is limited to any maintenance work, including oil changes, on-site and within the construction site.

Containers for sorting and temporarily storing waste should be placed at the construction site, and workers should be provided with adequate training on waste management.

Given the existing soil types and the limited area of the construction site to be affected, the impacts of potential spills during the construction phase, while negative and direct, are **not significant.**

Refers that WWTP equipment (the current and the new) are constructed over a sealed concrete base layer which prevents direct contact with the underneath soil and allows for repair time. Tanks and ponds are all sealed.

7.2.2.2 Operation Phase

Accidental spills and Maintenance Actions

During maintenance or repair/replacement of materials and equipment, accidental oil and/or fuel spills may occur. These spills must be immediately contained in accordance with the proposed mitigation measures. Proper disposal of waste during the operation phase is also crucial to minimizing impacts.

Maintenance and repair operations that may be necessary during this phase will be very limited and restricted, involving a small number of workers. Therefore, **no significant** impacts on the soils are expected during the operation phase, for all Alternatives.

Sludge disposal

A dewatering mechanical belt system will be used to dry the sludge (description of the process was provided in Section 2.4.2). The mechanically dewatered sludges will discharge directly in a container, supported by removal with specialized scraper blades to scrape the solid cake from the surface of each belt.

After the sludge is removed, the belts are cleaned with spray nozzles to remove any remaining residue before the next batch of sludge is fed onto them.

Figure 7-1 – Discharge of the mechanically dewateredsludge to a container[105]

This process does not serve the treatment of wastewater; it only separates solids from liquids. Both solid and liquid parts still contain pathogens and pollutants. The sludge tested in the SDB had all heavy metals well below the international regulatory limits outlined in US EPA 503 and no exceedances were observed for the other parameters compared. pH, Organic Matter, and Nutrients were in normal ranges and do not indicate any concern, which is expected to be maintained in the future.

105 https://www.youtube.com/watch?v=Rb70LF_CEFk

In addition, this sludge with low moisture content is easier to handle by the operators to the container trucks. The sludge cake can be discharged directly into waiting trucks or large dumper boxes by conveyers for easier handling and transport.

The main impact for soil contamination will be accidental spills from the machine inside the dewatering building. Is mandatory to maintain good housekeeping to prevent spills, cleaning up any spilled water or chemicals immediately to keep floors dry.

The dewatering building will have a proper drainage system to prevent pooling.

7.2.3 Climate and Climate Changes

7.2.3.1 Construction Phase

Effect on Climate Change (GHG Emissions)

Greenhouse gas emissions from construction activities will be temporary and minor, arising mainly from fuel combustion by construction equipment and vehicles. Given the small scale and short duration of works, a quantitative GHG assessment is not required.

The resulting impacts of these emissions are, therefore, **not very significant**.

7.2.3.2 Operation Phase

Microclimate Change

Given that the new equipment is located within the existing WWTP facilities and that the tree barrier at its edge also remains, the introduction of these new obstacles is not expected to impact air circulation and thus the microclimate. Impacts are therefore **non-existent**.

Effect on Climate Change (Mitigation of GHG emissions)

WWTPs are energy-intensive facilities, accounting for approximately 3% of global electricity consumption. For instance, during high-rainfall events, case studies have shown that energy consumption in WWTPs can increase from 0.36 kWh/m³ to 0.51 kWh/m³ due to elevated pumping and treatment need (HOSSAIN, 2024[106]).

106 Hossain, K. M. I. (2024). Resilience of wastewater treatment plants to climate change: Challenges and adaptive strategies. *International Journal of Business, Social and Scientific Research*, **12**(2), 41–48

Based on the *Greenhouse Gas Protocol* (2012) definitions, the *carbon footprint* is defined as the total greenhouse gas emissions (reported in carbon equivalents) associated with a product, service, business, or other entity, such as a household or a wastewater treatment plant. It consists of direct and indirect greenhouse gas emissions. Direct emissions are from sources owned or controlled by the reporting entity (e.g., gas combustion for heating, cooking, treatment solutions, etc.). Indirect emissions are a consequence of the reporting entity's activities but occur from other sources owned or controlled by another entity. In this case, direct emissions will be related to the treatment method for wastewater and sludge. The electricity that supplies the WWTP will be an indirect emission.

For a first estimation of direct emissions, was used the methodology given by the European Investment Bank EIB[107], where the carbon footprint is calculated as follows.

CF= (CFWW + ID + CFSD) x PE (population equivalent), where:

- CF is the carbon footprint of the project expressed in t CO2e/year.
- CFWW is the CO2e emitted per PE and per year in the wastewater treatment process (including CH4 and N2O);
- ID is the CO_2e indirect emissions produced by the consumed electricity per PE. The electricity was evaluated for every process, and for the emissions the grid factor used was the EU average of 245 gCO_2/kWh. ID can be increased or reduced proportionally to the grid factor of the country's project. In the case of Sint Maarten, the country grid factor is 463 gCO_2/kWh, then the ID has to be multiplied by the factor 463/245 = 1.89;
- CFSD is the CO_2e indirect emissions produced by the sewage sludge disposal and depends on the final destination of the sludge (landfill, land use, composting etc.).

The current and the rehabilitated scenario were assessed for comparative analysis. The results are presented in
Table ***7-5***. The differences between current situation to Scenario 3A are mostly associated with the population equivalent values.

For the indirect emissions (energy consumption), the total amount of electricity used was multiplied by the Sint Maarten electricity grid conversion factor (0.463 kgCO2/kWh).

Below, comparison of the current situation and Scenario 3A is presented.

- Current situation – 609 000 kWh/y x 0.463 = 281 967 kgCO2/ /y (**281.97 tonCO2/ /y**)
- Rehabilitated situation (Scenario 3A) – 1 642 500 kWh/y x 0.463 = 760 477 kgCO2/ /y (**760.48 tonCO2/ /y)**

[107] EIB Project Carbon Footprint Methodologies (2023). *Methodologies for the Assessment of Project GHG Emissions and Emission Variations*. 66 pp

Table 7-5 – Expected Carbon footprint for all the project alternatives

Scenario (Alternative)	PE	Treatment Process	(CFWW + ID + CFSD)					CF (t CO2e/year)
			CFWW	ID	CFSD (#)	Total (t.CO2e/PE.y)	Proportion	
Current ("No Action" Alternative)	17407	23% Septic tanks	0.091	0.000	0.194	0.285	0.1821	**3169.3**
		77% Secondary treatment without anaerobic digestion	0.014	0.025	0.112	0.151		
Scenario 3	37046	5.3% Septic tanks	0.091	0.000	0.194	0.285	0.1584	**5868.5**
		94.7% Secondary treatment without anaerobic digestion	0.014	0.025	0.112	0.151		

Legend: Deposition: Landfill

Figure 7-2 below shows the total emissions values (direct and indirect) for both these alternatives evaluated.

In terms of associated CO_2 emissions, WWTP's electricity will come primarily from fossil fuels (oil). There is no updated data on total CO_2 emissions in Sint Maarten. For the purposes of this EIA, a value of 0.62 Mt/y for the year 2022 was assumed[108].

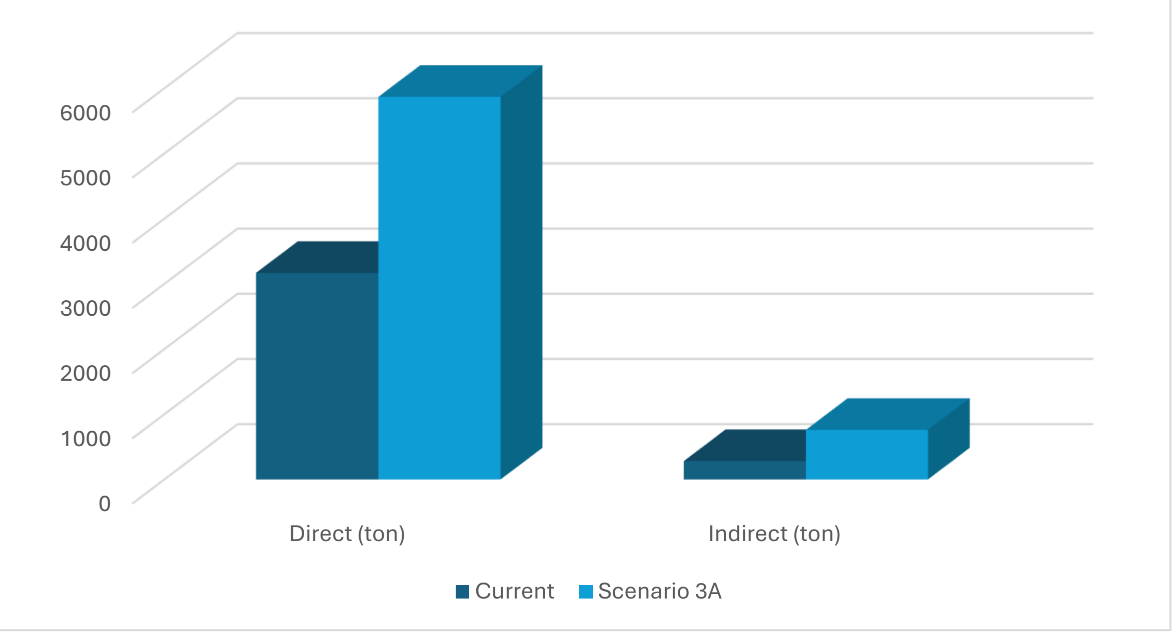

Figure 7-2 – Total Emissions of the WWTP

It appears that the WWTP's emissions for Scenario 3A correspond to only 1.07% of this reference value and is irrelevant. The future value may also be overrated, since the proposed Improved sludge treatment, enhances energy efficiency and lowers carbon emissions.

Marine and coastal ecosystems (where Fresh Pond and its mangroves are included), with the services they provide, can reach a carbon sequestration of 0.073 $MtCO_2$/year[109]. With the improvement of the WWTP effluent, these ecosystems can be enhanced and therefore contribute to counterbalance the predicted emissions from the O&M

108 https://www.green-overseas.org/en/pays-et-territoires/sint-maarten

109 CORENA (2025). *An assessment of the coastal resilience of Sint Maarten. An assessment of natural capital and coastal flood risk to inform spatial planning as part of the CORENA project*. 82 pp

Effects of Climate Change (project adaptation)

As described in the baseline situation, the predicted climate changes in Sint Maarten correspond to a sharp rise in temperature and an increase in the frequency and intensity of hurricanes, which can bring extreme precipitation events. Sea levels (SLR) will also rise.

Wastewater treatment plants (WWTPs) are frequently located in low-lying zones and are vulnerable to flooding during intense rainfall and extreme weather events. In coastal cities, WWTPs are also exposed to flood risk due to SLR and storm surges during extreme weather events (e.g., hurricanes and cyclones) (HUGHES *et al.,* 2021[110]; HYDE-SMITH *et al*., 2022[111]; HOSSAIN, 2024[112]).

Flood waters may cause damage to WWTP infrastructure and equipment, where inundation with seawater seems to be more damaging to equipment than freshwater inundation. The increase in concentration of fats, oils, grease, organic and solid matter can result in blockages, early system corrosion and/or severe health and environmental impacts. Corrosion of treatment equipment is also reported due to drought, causing more concentrated and corrosive influent to WWTPs. Water scarcity has usually low impact on the operation, mainly related to the velocity-controlled grit chambers.

Currently, when peak flow occurs, the existing wastewater pumping stations of the sewerage network will discharge it through the existing emergency overflows, reaching the Fresh Pond or Great Salt Pond. It was confirmed, with the data analysis, that the WWTP does not receive the entire peak flow. A more detailed description of the current and future situation in terms of quantity and quality of these flows is presented in the Section 7.2.4.2.

Flood events may also cause road disruption which may have impacts on the sludge emptying trucks, which enhances the vulnerability of Sludge Management to climate changes.

SLR-induced rising groundwater levels might generate buoyant forces in areas not designed for high groundwaters and thus damage buried infrastructure such as pipes. SLR in combination with high tides may also limit the ability to discharge treated wastewater into water bodies by gravity and cause backflow into the system.

Climate change-related impacts on the efficacy of treatment systems include extreme rainfall events during which increased pollutant loads of the influent can exceed the biological treatment capacities of the WWTP and reduce retention times leading to reduced nutrient removal. However, high-intensity rainfall events are also associated with more diluted inflow into WWTPs, positively affecting effluent quality.

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110 HUGHES, J., K.C.-Heays, E. Olesson, R. Bell & A. Stroombergen (2021). Impacts and implications of climate change on wastewater systems: A New Zealand perspective. *Climate Risk Management* **31**: 100262

111 HYDE-SMITH, L., Z. Zhan, K. Roelich, A. Mdee, & B. Evan (2022). Climate Change Impacts on Urban Sanitation: A Systematic Review and Failure Mode Analysis. *Environ. Sci. Technol*., **56**, 5306-5321

112 HOSSAIN, K. M. I. (2024). Resilience of wastewater treatment plants to climate change: Challenges and adaptive strategies. *International Journal of Business, Social and Scientific Research*, **12**(2), 41–48

Temperature variations can positively or negatively impact the efficacy of treatment processes. Several studies linked moderate temperature increases to improved removal efficiencies in WWTPs and FS treatment systems. However, more extreme temperature shocks were found to reduce biological treatment efficiency, by decreasing oxygen in aeration tanks, reducing aerobic treatment efficiency. Excessive heat can impact sludge characteristics, affecting BOD and COD removal efficiency, and contribute to greenhouse gas (GHG) emissions, particularly methane (CH4) and nitrous oxide (N2O), both of which have high global warming potential. Treatment efficacy is interlinked with the dilution capacity of receiving water bodies, which is expected to decrease for drier weather.

During warmer temperatures, increased strength of wastewater and changes in WWTP performance may likely increase odor.

Temporary system failures are mostly due to flooding of facilities or overloading of sewers resulting in bypassing treatment. Flood events also cause road interruptions and closures that lead to disruption in staff and supply access to WWTPs and electricity outages caused failures of pumps and pond aeration.

As with other types of infrastructure, high winds and storminess can raise the likelihood of windfall from trees. This raises the risk of power outages, causing disruption to the operation of plants and reliance on back-up generator systems.

Exposure of residents to untreated wastewater resulting from spills poses an immediate threat to public health and associated deteriorating water quality can also be a source of illness over the short- and medium-term infections. Repeated exposure to odor can lead to respiratory disorders and have a negative impact on mood. These implications can lead to further reduced mental health in the community over the medium to longer term.

There are many adaptations that will be performed at the A.TH. Illidge Road WWTP that will improve the odor emissions, namely the installation of a fully automated containerized belt filter press module for sludge dewatering, the conduction of the mechanically dewatered sludge (MDS) directly from the belt filter press into covered truck transport containers to mitigate odor emissions during transport and terminate sludge dewatering in SDBs once the belt filter press is in regular operation.

In addition, reduced odor emissions can be expected from the transport of MDS in covered containers compared to the current practice of transporting partially dewatered sludge from Sludge Drying Beds (SDBs) in open tipper trucks.

The implementation of a Supervisory Control and Data Acquisition (SCADA) system is expected to facilitate process optimization by enabling standardized evaluation of automatically collected operational data.

The main components are already elevated to overcome potential floodings and there is a backup generator in case of power disruption. In the future, based on the national strategy for climate changes, is possible that, by incorporating renewable energy technologies such as solar or wind power, dependence on fossil fuels can be reduced and enhance the resilience of the plant during power outages or disruptions.

Considering that the WWTP rehabilitation will not decrease the effluent quality (with a positive impact on Fresh Pond), will improve operations in terms of emissions and maintenance needs, and that the infrastructure itself is structurally adapted to the possibility of flooding, the impacts of climate change on the project **are not expected to be significant**.

7.2.4 Superficial Hydric Resources and Water Quality

7.2.4.1 Construction Phase

Changes in surface drainage and runoff

It is important that excavation work for new buildings and water circuits be carefully planned to prevent or reduce sediment runoff into Fresh Pond, which could compromise its quality. These potential impacts are temporary and limited to the construction phase, as the growth of herbaceous vegetation will reduce the risk of sediment drift.

For instance, is noted that there is currently a buffer zone of at least 10 m between the banks of Fresh Pond and WWTP facilities, creating a vegetated zone that helps maintain the natural water quality by absorbing and filtering sediments before they reach the watercourse. This zone will be maintained with the new buildings of the rehabilitated project.

The buildings will cause a permanent change in the surface drainage which, although localized, may be a **moderately significant** impact (new equipment localized on not-used terrain), if no mitigation measures are implemented. As presented in Table 7-1 , is estimated a total area of 247.5 m2, being the new dewatering building the component with more affectation.

Water quality

Regarding water quality, potential negative impacts are associated with the installation and operation of the construction site and material park and the circulation/use of machinery and equipment, with possible accidental spills of lubricants and fuels. However, **no such significant negative impacts** are expected, as the contractor must ensure the adoption of appropriate domestic wastewater management measures and will have a dedicated area at the construction site for temporary waste disposal, complying with all measures related to waste and the use of machinery and vehicles.

Construction sites and material parks must be equipped with and/or connected to basic sanitation infrastructure.

Regarding machinery and equipment associated with the construction activities, it is important to note that these must be maintained off-site, in licensed workshops. This reduces the occurrence of accidental contamination resulting from spills in the project installation area.

7.2.4.2 Operation Phase

<u>Discharge quantity and quality</u>

As described in Section 5, rainfall and runoff are the important flushing forces in the Fresh Pond.

Runoff is dependent on the infiltration rate of the soils. A higher infiltration rate reduces runoff by allowing more water to soak into the ground, eventually reaching aquifers via the water table, while a lower rate increases runoff and potential erosion.

Soils from the Cul-de-Sac area are predominantly clay loams, which typically have a low infiltration rate, increasing the runoff potential and therefore the amount of water reaching Fresh Pond, in addition to the already visible impermeabilization of the valley, with the paved roads and dwellings.

Sedimentation in the Fresh Pond was high after its dredging in 1999, but seems to be decreasing in the past few years, corresponding to the upper 15 cm layer. There are no data regarding infiltration rates of Fresh Pond. Usually, the infiltration rate in a pond decreases over time as soil pores fill with water, transitioning from a higher initial rate to a slower, steady "basic" infiltration rate, creating a balance between the effluent water and the infiltration volume. Assuming the ground water table is close to the water level of the Fresh Pond, and that the bottom sediments are of clayish nature, the infiltration rates are expected to be low.

The distinguishing physical features of ponds include relatively low flow through velocities and the development of significant vertical gradients in water quality variables, particularly in deep ponds. Ponds, therefore, often become sinks for nutrients, toxicants and other substances present in the incoming flows. As a result, eutrophication is one of the most significant water quality problems in these aquatic ecosystems.

With this framework in mind, taking also into account the specific hydrological and ecological characteristics of the receiving water body (Fresh Pond), a hydrological and contamination study was conducted and described as follows:

1 Hydrological Renewal Capacity of the Fresh Pond

The Fresh Pond is a shallow lentic water body with an area of 13.5 hectares and depths ranging from 0.4 m to 0.9 m. This results in a volume below 121,500 m^3. Despite its lentic nature, the pond exhibits high renewal rates due to direct runoff from a 614 ha watershed and treated effluent discharges from the Illidge Road WWTP.

Based on Climate data for Saint Martin (Princess Juliana International Airport) (1991–2020 normals, extremes 1971–2020) as present in next Figure **7-3** and Table 7-6, the pond undergoes complete volume renewal due to surface (storm water) runoff, of approximately 23 times per year, with an average of 1,88 renovations per month.

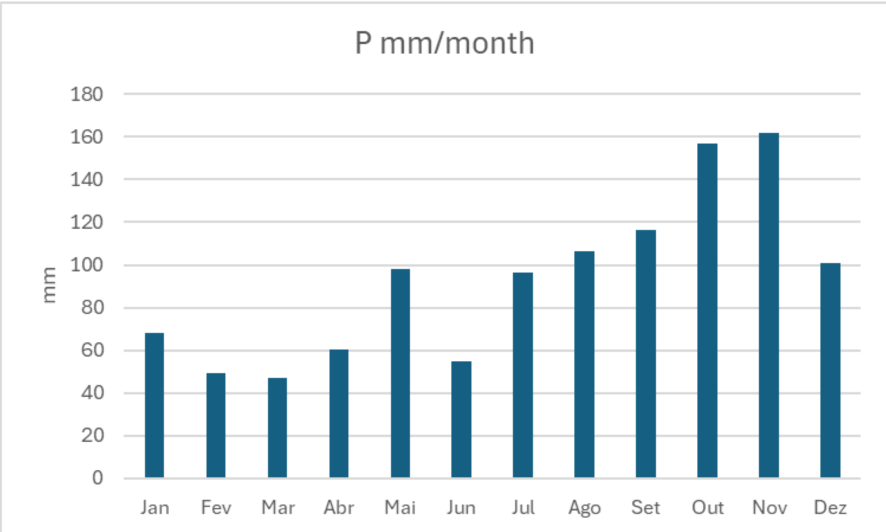

Figure 7-3 – Precipitation data for Saint Martin (Princess Juliana International Airport) (1991–2020 normals, extremes 1971–2020[113])

Table 7-6 – Estimated Renovations for the Fresh Pond

	mm/month	Monthly Flow Precipitation (m3/month)	Number of Complete volume renovation / month
Jan	67,90	166834,6	1,37
Fev	49,40	121378,9	1,00
Mar	46,90	115236,2	0,95
Abr	60,10	147669,5	1,22
Mai	98,00	240792,2	1,98
Jun	55,00	135138,5	1,11
Jul	96,60	237352,3	1,95
Ago	106,20	260940,1	2,15
Set	116,10	285265,0	2,35
Out	157,00	385758,9	3,17
Nov	162,00	398044,2	3,28

113 https://en.wikipedia.org/wiki/Saint_Martin_(island)

Dez	101,00	248163,3	2,04
	mm/year	Annual Flow Precipitation (m3/month)	Number of Complete volume renovation / year
Total	**1 116,20**	**2 742 573,50**	**23**

On the other hand, considering an average treated WWTP discharge daily flow of 1743 m^3/day, this results in a 41% complete volume of Fresh Pond monthly, which corresponds to 5 complete volume renewals per year. In a hot and humid tropical climate with high solar radiation, and moderate winds, which means the annual evaporation (ET_0) values are relatively high and show little variation throughout the year of about 130 mm/month in average. So, the evaporation losses are estimated in 1.8 complete Fresh Pond volume per year.

Assuming both flow contributions (run off from precipitation and treated WWTP discharge) and the potential evaporation, the expected complete Fresh Pond renewals occur at an average of 26 per year that occurs with this amount of freshwater flux to the sea and Salt Pond.

This high turnover rate significantly reduces the potential for nutrient accumulation and eutrophication.

With this monthly mass balance of freshwater, it becomes also clear that there are no situations where this pond has the risk of becomes completely dry. In addition, as its name suggests (Fresh Pond), salinity is very low (also confirmed by the recurrent water analysis described in Section 5.2.2) this pond is in all months a constant supply of fresh water to the ocean or the Salt Pond even in the driest months.

2 Hydraulic Capacity of the Fresh Pond to receive the WWTP flow

Flooding of surrounding roads have been recorded around Fresh Pond and opening the gate between the two ponds is usually the main operational measure.

Currently, the pumps in Great Salt Pond are out of service. The Fresh Pond discharges directly (or indirectly, if through Great Salt Pond when pumps are working) to the Great Bay with events of precipitation higher than about 10 mm.

This emphasises what was previously mentioned, regarding the discharge of the peak flows through the existing wastewater pumping stations of the sewerage network (emergency overflows), reaching the Fresh Pond or Great Salt Pond. It has been confirmed, with the data analysis, that the WWTP does not receive the entire peak flow.

3. Historical Proposals and Their Limitations

The 1995 technical review (ECOVISION, 1995[114]) suggested interventions such as redirecting stormwater to the Salt Pond, dredging, and planting of mangroves. Whilst dredging could improve depth and reduce

[114] ECOVISION (1995). *The Ponds of Sint-Maarten. Sustainable Development and Management*. Report prepared for the Department of VROM Sint-Maarten. 138 pp

accumulation of organic matter, these measures introduce significant artificiality and conflict with the principles of Nature-Based Solutions. Preventing natural flushing would require extensive hydraulic modifications, increase the risks of eutrophication and transform the Fresh Pond into a stagnant water system.

3 Phosphorus and Nitrogen Load Projections

The baseline data regarding water quality of the Fresh Pond described in Section 5.2.2 confirms that this pond is not complying with legal thresholds for production of drinking or for bathing. Both N and P play a major role for the quality/status of recipient waters, and for the likelihood of algal blooms.

Table ***7-7*** below shows the water analysis results from sampling carried out in the Fresh Pond in 2025. These results show that the water quality at Fresh Pond is similar to the treated WWTP effluent and is thereby heavily influenced by this discharge.

Table 7-7 – CARIRI data of water analysis at Fresh Pond in 2025

	Electrical Conductivity (uScm-1)	Total Nitrogen (mg/l)	Total Suspended Solids (mg/l)	Total Phosphorous (mg/l)	Chemical Oxygen Demand (mg/l)	Biological Oxygen Demand (mg/l)	Oil & Grease (mg/l)	PCB (µg/l)
Average values	**1443.5**	**13.63**	**64.21**	**3.27**	**87.19**	**27.05**	**1.56**	**<0.057**
Acceptable levels	**<400**	**<1.5**	**<25-30**	**<0.1**	**<50**	**<3-5**	**<10**	**< 0.064**

Currently, the effluent discharged by the WWTP already complies with the national legislation. The update/rehabilitation of the WWTP will improve the existing treatment and is therefore expected that the discharged wastewater will not reduce the water quality of the Fresh Pond, being these impacts **positive and significant**.

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4 Microbial Load and Natural Disinfection Potential

According to Census 2022, only about 14% of the population is connected to sewerage systems. The majority of households rely on septic tanks (64%), followed by cesspits (16%) and other solutions (6%). When these tanks are not emptied regularly, they overflow, causing sewage to spill into streets, public spaces, and eventually ending up in beaches and ponds, impacting both residents and the tourism sector.

The existing secondary treatment in A.TH. Illidge Road WWTP removes fecal bacteria using biological processes, primarily the activated sludge process (aeration tanks), where microorganisms consume organic matter, followed by the secondary settling stage where the bacteria-rich sludge sinks to the bottom, allowing the cleaner water to flow out. During aeration, the organisms that live in the aeration basin can break down larger material during mixing. The more these solids are broken down, the better they can settle to the bottom of the clarifier in the next chamber, and not float to the surface. Currently, the clear water from the clarifier is skimmed right below the surface and sent directly to the Fresh Pond without disinfection.

As such, the microbial load at the Fresh Water Pond can be estimated, based on typical values achieved by secondary activated sludge treatment systems.

General bibliography report *E. Coli* concentrations in untreated municipal wastewater varying between 10^6 and 10^8 CFU/100 ml (example: HACHICH *et al*. (2012[115]), PAYMENT & LOCAS (2011[116]) — typical values around 10^7 CFU/100 ml).

Secondary biological treatment systems, with no disinfection, typically achieve a 1 to 2 $\log_{10}$ reduction of *E. coli*, meaning that the *E. coli* present in the wastewater may be reduced from 10^7 to approximately 10^6 or 10^5 CFU/100ml (sources: U.S. EPA, Wastewater Technology Fact Sheets; Metcalf & Eddy, Wastewater Engineering, 5th Ed.).

Septic tanks have lower removal rates, thereby the present situation, where overflows from septic tank are transported to the Fresh Pond via surface runoff, impacts the microbial load into the Fresh Pond. As septic tanks are decommissioned, the microbial load into the Fresh Pond is expected to lower.

As described in Section 5.2.2, the recent CARIRI sampling in Fresh Pond confirmed average Faecal Coliform levels ranging from 10,123 to 23,857 CFU/100ml and *Enterococcus* levels ranging from 973 to 4,067 CFU/100ml.

The Hindrance Permit (HP.12.2016) mentions that the maximum faecal coliform concentrations of effluents discharged from WWTP is 300 UFC/100 ml (yearly average). This value is very stringent, taking into account the nature of the receiving water body, namely the Fresh Pond, a lentic water body where wildlife populations are encouraged, but not used for recreational purposes (bathing or other indirect contact), fish farming or other such economical activities, due to unsuitable water quality. Natural lotic water bodies typically have coliform levels up to 10^4 CFU/100ml. Standards for faecal coliforms in bathing waters with full body contact vary from 100 to 2000 CFU/100ml (500 to 10,000 CFU/100ml for total coliforms).

Given the shallow depth of Fresh Pond, sunlight penetration is sufficient to allow for some natural disinfection of the treated effluent. Maturation ponds, widely used as a final polishing step to improve microbial quality of treated wastewater, reduce the presence of coliforms by 1 $\log_{10}$ CFU/100ml (VON SPERLING, 2005). Furthermore, the riparian vegetation occupied by the mangrove, although already very limited but without no change caused by the rehabilitation project, is also capable of absorb those excess nutrients from wastewater through plant uptake and microbial activity in the sediments, acting as natural fertilizers (OUYANG & GUO, 2016)[117] .

However, during dry periods, eutrophication and growth of algae will reduce the water transparency and the sunlight penetration due the chlorophyll concentration reducing significantly natural disinfection. This contamination will not affect the Fresh Pond ecosystem, but it will limit the beach

115 HACHICH, E.M., M.D. Bari, A.P.G. Christ, C.C. Lamparelli, S.S. Ramos & M.I.Z. Sato (2012). Comparison of Thermotolerant Coliforms and Escherichia coli densities in freshwater bodies. *Brazilian Journal of Microbiology*: 675-681

116 PAYMENT, P. & A. LOCAS (2011). Pathogens in Water: Value and Limits of Correlation with Microbial Indicators. *Groundwater*, **49**(1): 4-11

117 OUYANG, X. & F. Guo (2016). Paradigms of mangroves in treatment of anthropogenic wastewater pollution. *Science of the Total Environment,* **544** (15): 971-979

recreational area use of Great Bay after rainfalls >10 mm, which lead to the overflow of the Fresh Pond directly into the Great Bay (or indirectly through Great Salt Pond) for periods of 48 to 72 hours (occurring ~23 times/year).

It is relevant to highlight that those overflows are a natural process, ensuring full water renewal of Fresh Pond.

It is recommended to implement a public health advisory system like international best practices:

- Issue alerts immediately after overflow events, warning that water quality at Great Bay beaches may not meet recreational standards;
- Post signage at beach access points and update official websites and social media platforms.
- Recommended advisory duration: 48 to 72 hours, based on WHO[118];
- Provide clear messaging on risks (e.g., gastrointestinal illness, skin infections) and precautions (avoid swimming, especially for children and immuno-compromised individuals);

These advisories are consistent with WHO recommendations to proactively inform the public when contamination risk is high, even before laboratory confirmation.

Implementing such a protocol complements Nature-Based Solutions by mitigating health risks without resorting to artificial hydraulic interventions and it seems more cost-benefit than installing artificial disinfection systems at WWTP.

5. Technical Assessment of Proposed Measures

The proposed interventions in the rehabilitation of the A.TH. Illidge Road WWTP aim to correct deficiencies rather than increase the overall treatment level of the WWTP. Specifically, the replacement of the aerators will be with units of equivalent treatment capacity, solely because the existing equipment has reached the end of its operational life. This replacement does not introduce any technical advantage or disadvantage compared to the current configuration, but will improve the resilience of the WWTP.

For the tertiary treatment, related to the pollution control, the following table synthetizes the advantages and disadvantages of this treatment considered in the WWTP, against maintaining natural flushing for the downstream quality in Great Bay.

Table 7-8 – Technical assessment of the proposed solutions for pollution control downstream

Phosphorus Removal	Disinfection	Maintaining Natural Flushing
Against: ♦ Increase significantly the volume of sludge produced. ♦ Chemical removal entails high capital and operational costs, plus environmental risks.	Against: ♦ Investment and operational costs, with no beneficial impact during dry weather or small rain events. ♦ ♦ High energy consumption if the technology is filtration and UV lamps.	Against: ♦ Contribute to temporary deterioration of Great Bay water quality during overflow events.

118 World Health Organization (WHO) – Guidelines for Safe Recreational Water Environments

Phosphorus Removal	Disinfection	Maintaining Natural Flushing
	♦ Discharge of chlorine into the natural environment, if the technology used is chlorination.	
For: ♦ Could mitigate eutrophication during dry periods. ♦ Potentially reduces nutrient discharge to Great Bay.	For: ♦ A residual reduction of contamination of Great Bay during high storm water events.	For: ♦ Aligns with NbS principles; ensures periodic renewal and nutrient export.

6. Nature-Based Solutions and Adaptive Management

Global best practices favor solutions that respect natural hydrological cycles. Artificial interventions (e.g., increasing depth) introduce complexity and ecological risk. Instead, adaptive management—monitoring key indicators and implementing phased upgrades—offers resilience and cost-effectiveness.

Considering budgetary constraints and the hydrologic and environmental characteristics of Fresh Pond it is recommended that the WWTP upgrade be designed with flexibility to accommodate future integration of phosphorus removal and disinfection units but not implement that immediately. The monitoring program already ongoing should also be implemented for:

- Nutrient concentrations in Fresh Pond and Great Bay.
- Frequency and impact of overflow events.
- Public health indicators.
- Define adaptive triggers for intervention (e.g., sustained algal blooms, regulatory changes, tourism impacts).:

This approach ensures environmental protection while delivering priority improvements that are affordable at this stage. It also aligns adaptive management principles, allowing decisions to evolve based on evidence and changing conditions.

7. Conclusion

Fresh Pond's occasional phytoplankton blooms during dry periods are driven by strong solar radiation, a common feature in tropical environments. These short-term events should not be interpreted as permanent eutrophication, since the lagoon undergoes complete water renewal 26 times per year—on average at least once per month—due to precipitation and flushing. This high renewal rate prevents persistent ecological imbalance. Attempting to eliminate them through artificial measures contradicts NbS principles and may exacerbate ecological imbalance. Current evidence supports a pragmatic approach: maintain natural dynamics, avoid premature investments, and prepare for adaptive responses based on future data.

Given that Fresh Pond discharges into Great Bay approximately 23 times per year following rainfall greater than 10 mm, it is recommended to implement a public health advisory system similar to international best practices.

The baseline seawater testing across the six monitored coastal areas shows that while most of Sint Maarten's beaches remain safe and attractive, some locations, especially Great Bay, show signs of contamination linked to ageing or incomplete wastewater connections. This is not a crisis, but a call to action. The results provide a credible, data-driven basis to accelerate ongoing reforms, prioritize targeted infrastructure upgrades, and demonstrate to the public and to Sint Maarten tourism partners that the Government is taking decisive steps to protect both public health and the national economy. With the wastewater treatment improvements planned under the project, there is a clear continuation of previous investments that show measurable progress, reassure investors, and strengthen Sint Maarten's position as a clean, competitive, and world-class tourism destination.

With the update/rehabilitation of the WWTP is expected that the discharges for the Fresh Pond have greater quality, being positive and **be moderately significant**.

Is important to reinforce that the upgrade will allow for future fitting of phosphorus removal and disinfectant systems, when they can be technically and financially justified.

<u>Sludge disposal</u>

As mentioned, the mechanically dewatered sludge will be transported to the landfill to be disposed until the landfill closure. The current sludge, although not treated,_had all heavy metals well below the international regulatory limits outlined in US EPA 503 and no exceedances were observed for the other parameters compared. pH, Organic Matter, and Nutrients were in normal ranges and do not indicate any concern, which is expected to be maintained in the future.

The landfill site is not lined and consequently leachate is discharged into the Great Salt Pond causing pollution. The landfill is expected to start its closing in the end of 2026. The landfill will be reprofiled, levelled and capped for preventing rain infiltration which is expected to reduce leachate production by 80%. Alternative management options for sludge could be implemented afterwards or in parallel, as proposed in section 7.2.8.

NRPB procured a design and build contractor to rehabilitate and close the landfill site. The tender requires the selected contractor to utilize the sludge for soil improvement after proper treatment as part of the rehabilitation and closure process.

7.2.5 Groundwater Hydric Resources and Water Quality

7.2.5.1 Construction Phase

<u>Infiltration reduction</u>

As previously mentioned, the new buildings foundations may contact the water level, but this will be **not significant** given the highly localized interventions. The excavations for the trenches will be shallow (1.5 m), and no impact on the water table is expected.

Any potential impacts are related to the creation of impermeable areas, which may potentially disrupt groundwater recharge through precipitation. This impact will be higher, the larger the area to be impermeable, as well as the nature and uses of the aquifer system. It is important to remember, however, that the areas to be addressed are very confined, related to the new buildings and the new ducts for the hydraulic system. The impact can be classified as negative and direct, permanent and irreversible, but limited and **not very significant**.

Contamination

During excavation work for the foundations and hydraulic system, appropriate precautions must be taken to ensure foundation stability and aquifer contamination.

If this situation occurs, the potential contamination impacts will be negative, local, direct, likely, limited, and **not significant,** given the possibility of mitigation.

7.2.5.2 Operation Phase

Impacts on groundwater during the operation phase may only occur in accidental situations involving a possible rupture of tanks that could contaminate the surface aquifer, or during maintenance actions with accidental oil spills.

Both these impacts have low probability of occurrence, being **not significant** and mitigable.

7.2.6 Noise

7.2.6.1 Construction Phase

Increased Noise Levels

The construction phase of the new buildings and associated ducts will have noise emissions due to temporary noise activities, particularly the use of heavy machinery in excavation, earthmoving, and concreting operations, as well as the movement of heavy vehicles to transport materials and equipment, and light vehicles to transport workers.

Noise levels generated during construction are typically temporary and intermittent depending on several factors, such as the type, mode of use, and condition of the equipment used, the type of operations performed, and the duration of the work. Therefore, they may vary within a wide range of values.

The equipment will also not be in simultaneous operation, and its activity, and consequent noise emissions, will not be constant throughout the day, nor throughout the entire period established as the reference for the construction phase.

The noisiest construction operations are often associated with earthmoving and the movement of heavy construction vehicles and machinery. In general, the noisiest equipment used in this type of work can produce average noise levels of 80 to 85 dB(A) at a distance of approximately 10 to 15 meters.

In long-distance propagation, the effects of the noise generated by each of these pieces of equipment—"point" sources—tend to attenuate relatively quickly. The decay (attenuation) of the intensity of point acoustic sources with distance from the source can be calculated at approximately 6 dB(A) per doubling of the distance, not accounting for other effects that influence propagation (physical barriers, for example).

As a guide Table 7-9 presents the average sound pressure levels - in dB(A) - typically emitted by some equipment currently used in construction activities, as a function of the distance from the source. The values presented take into account not only the attenuation effects due to divergence, but also the effects of additional attenuation introduced by acoustic absorption in the ground.

Table 7-9 - Typical LAeq sound levels (average values) at various distances from construction equipment, in dB(A)

Equipment	Distance from noise source					
	15 m	30 m	60 m	120 m	250 m	500 m
Excavators	85	81	75	67	< 58	< 52
Trucks	82	78	72	64	< 55	< 50
Cranes (fixed or mobile)	75	71	65	57	< 48	< 42
Generators	77	73	67	59	< 50	< 44
Compressors	80	76	70	62	< 53	< 47

NOTE: Average values for sound sources with omnidirectional emission, at heights of 1.5 m from the ground, and moderately absorbent terrain between sources and receivers.

The vulnerable groups who are susceptible to the construction noise are the following:

- Neighbouring communities;
- Onsite workers, who are the most exposed to noise levels generated from different construction activities due to their proximity to the noise sources.

The closest sensitive receivers of the surrounding community are located at south of the WWTP and on the west side, mostly commercial, but some residential. For the southern buildings, the closest distance varies from 6 m to the WWTP entrance where the trucks pass to 35 m to the anaerobic tank. For the western buildings, the closest distance is 28 m to the WWTP entrance and 45 m to the anaerobic tank. The current noise levels already exceed the Sint Maarten legal threshold.

For nearby buildings, it is important to take precautions against noise emissions, complying with current legislation (*Environmental Standards Sint Maarten 2023*) and periodically monitoring noise levels.

The use of quieter equipment, machinery, and vehicles (a "quiet plant") constitutes the first step, also using, if necessary, temporary noise barriers that will reduce sound directly at the source or by creating visual/sound barriers between the construction site and the receivers (with focus at the nearest houses at south of the WWTP). Depending on the selected barriers, it is possible to reduce the noise generated by construction activities by up to -15 dB.

It is important to note that work should not be performed at night.

It is also recommended that a Complaints Response Office be established at the construction site to immediately respond to any inconvenience caused by the work, which will also be available at the Proponent's facilities.

Construction phase impacts are therefore considered negative, temporary, certain, local, mitigable, minor, and **not very significant** for all the Alternatives.

7.2.6.2 Operation Phase

<u>Equipment noise</u>

The rehabilitation project will not create a significant change in the noise environment. As explained in Section 5.2.3, the WWTP is in a high noise environment that currently exceeds Sint Maarten legislation and WB/WHO guidelines, where the maximum noise levels are associated with road traffic (including septic trucks entering and exiting the WWTP). Noise from the WWTP was not mentioned as a nuisance from the surrounding residents or traders.

The physical barrier that will be built between the septic truck disposal and the building located at the south, along with the already existing vegetation belt around the WWTP will mitigate the operation noise impacts. Also, more important, as the sewerage network expands, the number of septic trucks decrease, and this local impact will be reduced (to remember that currently the number of daily truck discharges varies between 50 and 100, depending mainly on rainfall events and simultaneous discharge of two trucks is possible).

The number of sludge disposal trucks will have a slight increase, associated with the greater volume of the produced sludge, with 1 truck per day (22 per month, against the current 15 trucks per month). Even so, this increase along with the decrease of septic trucks will always be a better situation than currently occurs on a daily basis.

The aeration tank, totally open, is the equipment inside the WWTP with a constant audible noise, which may contribute for the “Non distinguishable” sources in the evening. As mentioned, this sound decreases with distance and the southern buildings are 35 m apart from the aeration tank, and the western buildings are 45 m apart, which are already relevant distances. With the upgrade, the predicted new aerators will have the same capacity as the current ones, so no changes in the noise is expected. It is also possible to select aerators with less noise power or insulate them with mufflers, if periodic noise monitoring confirms the impact of these components.

The dewatering building will surround all the sludge treatment equipment, providing a soundproof enclosure.

The noise impacts expected for the operation phase are negative, direct, and **not very significant**.

7.2.7 Air Quality

7.2.7.1 Construction Phase

Dust Dispersion

During the project's construction phase, actions likely to impact air quality are expected, namely:

- Earthmoving and excavation;
- Circulation of heavy vehicles and non-road machinery;
- Wind erosion;
- Application of concrete for the new buildings.

The main pollutants associated with the actions described are the emission of suspended particles (dust) and gases from vehicle engine combustion.

The main sensitive receptors in the study area can be considered:

- Construction workers, who will be most exposed to these effects on a daily-base;
- Residents in the nearest buildings;
- Vegetation in the surrounding area.

These emissions are expected to increase with construction activities, but they can be mitigated. It should be noted that sprinkling circulation routes with water during dry periods can reduce particle emissions by more than 50%, depending on the amount of water applied and the frequency with which the spraying is performed.

It is assumed that the particle size of the particulate matter emitted during earthmoving and construction activities will be largely greater than the fraction considered inhalable (diameter less than 10 µm), and they are expected to remain largely confined to the areas adjacent to the emission sites.

The impacts are negative, local, certain, reversible, mitigable, limited, and **not very significant** for all Alternatives.

Pollutant Gas Emissions

The circulation of trucks will result in the emission of pollutants typical of internal combustion engines, notably carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), and respirable particulate matter (PM10). However, these will be very small contributions, compared to the surrounding traffic of this area of Sint Maarten.

Therefore, the potential negative impact is direct, certain, temporary, reversible, and minimizable, of limited magnitude and **not very significant**.

7.2.7.2 Operation Phase

Dust and Gas emissions

As mentioned in Section 7.2.3.2, the operation of the WWTP will have some direct and indirect emissions. It was concluded that the carbon footprint of these emissions were insignificant compared with Sint Maarten annual emissions.

Refers also the air emissions stand-by diesel generator. The impacts of such emissions are considered to be **not significant** as the generator will be only turned-on during power cut-offs and complies with the required standards.

The fugitive emissions from the septic trucks will not be too different from the current situation, and probably will be lower because of the more direct connections of the households to the public sewage system. The impacts are therefore **not significant**.

Odour emissions from WWTP operation

In the baseline situation (Section 5.2.1) and **ANNEX 3**, an assessment of the odor conditions for the current plant has already been presented, verifying that the legally defined odor thresholds of the Netherlands, adopted in this study, are not exceeded. This conclusion is also corroborated by surveys of the surrounding population, who do not report many odor complaints, and when they do, they are unsure whether it comes from the WWTP or from the pond.

A similar assessment was performed for the rehabilitation project, for Scenario 3A, with the results presented also in **ANNEX 3**.This assessment considered the worst scenario (septic truck discharges without pipe, total use of the SDB and the dewatering system totally open) and the mitigated scenario (septic truck discharges with pipe, no daily use of SDB and the dewatering system totally closed) It was concluded that the new layouts will not contribute to any significant changes compared with the current situation in the worst (unmitigated) scenario. The only three receivers with higher odor concentration (still below the legal limits), will have a slight increase when considering the not-mitigated project, but never overpassing the *Medium sensitivity* legal limits. For the mitigated project, which is the one to be implemented, the values will decrease substantially compared with the current situation.

Although odors will always be produced, even if only occasionally, during container handling (dewatering system) and manual sludge levelling operations of the SDB (only in emergency situations or maintenance activities), they are expected to be perceived only by the WWTP workers or the trucks drivers. The impact of sludge odors will be less compared to the current situation.

The impacts of the WWTP operation will **not be very significant**.

Sludge transportation

The transportation of the mechanically dewatered sludge will require the use of trucks to move the sludge from the WWTP to the landfill area. These vehicles are an emission source that will affect the air quality. There is a potential risk of soil contamination and odor emissions if the vehicles are not completely closed during transport. However, in general, air emissions from sludge transport are not significant.

Although the number of trucks for sludge transportation will increase with Scenario 3A, n (7.4 m3/day – 22 trucks per month), these trucks will be completely closed, with containers filled with the mechanically dewatered sludges from the dewatering building. The negative impacts can be considered non-existent, but will be an improvement compared with the current situation.

7.2.8 Waste management

7.2.8.1 Construction Phase

<u>Waste Production and Management</u>

The waste produced in this phase essentially results from excess raw materials, damaged materials, losses inherent to construction techniques and solutions, and land clearing. This will generate different types of waste, which can be aggregates of varying size and composition, municipal solid waste, and hazardous waste.

Among the anticipated waste, those considered hazardous waste stand out, such as used oils and oil filters (primarily resulting from maintenance operations on machinery and vehicles used on the project) and bituminous mixtures.

Used oils, whose production is not expected to be significant, will be easily collected and temporarily stored, and then transported for recycling by a duly licensed company. It is also important to note that maintenance operations will be carried out in areas prepared for this purpose, minimizing the potential for spills into the soil or surface waters.

As described in Section 7.2.1.1, most of the excavated volume for the installation of foundations and trenches will be reused for subsequent trench filling. The remaining soils (silts, clays and sand) will be taken to the landfill as cover material.

During the construction of the project, a waste management system must be adopted that complies with the provisions of current legislation (Waste Ordinance (AB 2013, GT no. 135).

Therefore, all these types of waste will be segregated, collected, and sent to appropriate destinations, meaning that the impacts are negative, direct, of limited magnitude, and **not very significant**.

7.2.8.2 Operation Phase

Waste production

In the current operation, no chemicals are used to treat effluents and/or sludge, as there is no hazardous waste.

During the operational phase, maintenance operations are responsible for the production of waste, which primarily consists of plastic packaging, wood, metals, and some contaminates solid particles (from the cleaning and scrubbing of inlet filters). These wastes are not considered hazardous. However, spent oils used in the system lubrification are considered hazardous waste.

For the rehabilitation project, polymers for sludge dehydration will be used to reduce sludge volume, making it easier and more cost-effective to handle and dispose of. These chemicals are not hazardous waste, but need to be properly contained to avoid any accidental spills to the soil and water.

All of these wastes (either non-hazardous or not) have specific management systems implemented nationwide or is managed by duly licensed waste management operators, who will ensure its proper transportation, recovery, and final disposal. As in the construction phase, a waste management system must be adopted during the project's operation phase, complying with the general waste management regulations.

The impacts associated with waste management during the operational phase are therefore classified as negative, direct, but **not very significant**.

Sludge production and disposal

Typical values for biological secondary treatment with belt filter press dewatering are in the range of 45–55 g TS per capita per day, corresponding to approximately 0.18–0.30 kg of wet sludge (18–25% TS) per capita per day. For 2055 projection Scenario 3A sludge production, was estimated in 7,4 m3/day of dewatered sludge, which will be transported for the landfill on a daily basis (1 truck per day, 22 trucks per month)

Sludge management in Sint Maarten faces several structural challenges that require tailored and sustainable solutions. The island’s limited land availability significantly constrains options for long-term sludge disposal, while high transport costs to the mainland reduce the feasibility of external treatment routes. In addition, the risk of marine pollution is a constant concern due to the island’s geographic setting and dependence on coastal ecosystems.

Seasonal variations linked to tourism peaks further increase sludge generation, creating additional stress on treatment and disposal systems. These challenges are compounded by limited technical infrastructure for advanced sludge management.

Also, Landfill has a limited lifespan, being the beginning of closure predicted at the end of 2026. It is expected that the IDS side is closed permanently after a construction period of ~60 weeks (~14 months).

The SWDS is expected to be closed permanently ~52 weeks (~12 months) after landfilling operations cease

To address these constraints, a combination of volume reduction, resource recovery, and integrated disposal strategies is required.

Specifically for the sludge disposal, the technical meetings associated with the present project decided as follows:

- Short-term – disposal in the landfill (until 2026)
- Medium-term – use as landscaping in the landfill (from 2027)
- In parallel: Integrated sludge with waste management

It is recommended also to integrate the final disposal of dewatered WWTP sludge into the MSW management system. This ensures cost efficiency, avoids duplication of infrastructure, and leverages the same environmental safeguards already required for MSW (liners, leachate collection, monitoring).

NRPB procured a design and build contractor to rehabilitate and close the landfill site. The tender requires the selected contractor to utilize the sludge for soil improvement after proper treatment as part of the rehabilitation and closure process.

The impacts of the sludge management are **not significant** and mitigable.

7.2.9 Biodiversity

7.2.9.1 Construction Phase

Vegetation and biotopes affectation

The vegetation at the WWTP facilities is primarily low-lying grass, with a few trees planted. The installation of the new buildings and new pipes for the water system will not affect the trees, but may only slightly affect herbaceous vegetation.

Since these are common species without protected status, the impacts of this impact are assumed to be negative, direct, permanent or temporary, mitigable, and **not significant** or **not very significant**,.

The destruction of this vegetation will not affect sensitive biotopes for fauna. The WWTP is close to areas with human presence, where fauna is common, with more opportunistic species. However, is also close to Fresh Pond, an IBA area, so the expected impacts in terms of habitat impact are negative, direct, and **not very significant**.

The construction site will be located wherever possible in previously developed infrastructure, so no significant impact on new areas is expected, with implications for flora and vegetation. The impact is therefore expected to be negative, direct, and **not significant**.

Fauna Disturbance and Mortality

The disturbance caused by the movement of machinery and people in the project area can manifest itself through noise impact, the human presence observable by animals, and the increased risk of being run over.

Noise production at this stage is primarily due to machinery activity and vehicle traffic in the construction area. This effect can be felt by mammals and birds, causing the displacement of individuals with reasonable mobility.

Although this is an area with human presence and considering that construction activities will be temporary and restricted to the existing facilities, where vehicles already circulate, this disturbance is not considered to have a significant impact.

Regarding the risk of being run over, no significant negative impacts are expected, provided that appropriate mitigation measures are taken, especially in terms of access, restricting vehicle movement to the designated paths to the construction site.

The impact of fauna disturbance and mortality will therefore be classified as negative, direct, and **not very significant**.

7.2.9.2 Operation Phase

Ecosystem quality

Protecting mangroves and improving the Sint Maarten WWTP are interconnected goals. By addressing pollution from the WWTP and strengthening legal protections for mangroves, the island can work towards a more resilient and sustainable future for its unique coastal ecosystems.

The treated effluents will continue to be discharged into the Fresh Pond, with its margins still occupied by a strip of mangroves. CAPDEVILLE and colleagues (2018[119]) hypothesized that mangroves, tropical wetlands, could be used for the finishing treatment of domestic wastewaters. Their aim was to determine if a nutrient-stressed mangrove could tolerate long-term discharges of pretreated wastewater (PW). Since 2008, in an *in situ* experimental system set up in Mayotte Island (Indian Ocean), domestic PW were discharged into two impacted areas (675 m^2) dominated by different species of mangrove trees. Anthropogenic inputs during > 4.5 years led to an increase in vegetation growth associated with an increase in leaf pigment content, leaf surface and tree productivity. A marked increase in tree mortality was observed. There was no effect on crabs and meiofauna densities, but significant modifications of community structures. These effects may be directly linked to PW inputs, or indirectly to the modifications of the environment associated with higher tree growth. However, their results indicate that there was no major dysfunction in the ecosystem.

A similar situation is expected to occur in the project area, where the bird fauna still persists, feeding on this benthic communities. This type of stabilized pond provides essential food sources (algae, plankton) and resting spots.

Is important to reinforce, and as already acknowledged, that the current pollution of the Fresh Pond comes not only from the WWTP, and the current mangrove barrier may not be sufficient to overcome the overload of pollutant nutrients (which was confirmed by the water quality assessment and the eutrophic state). Therefore, the periodic opening of the Fresh Pond to the sea at the rainfall season, which is important to reduce this nutrient accumulation should be maintained, especially because the extreme events will become more frequent with the predicted climate changes.

Considering budgetary constraints and the hydrologic and environmental characteristics of Fresh Pond, it is recommended that the WWTP upgrade be designed with flexibility to accommodate future integration of phosphorus removal and disinfection units, but not implement that immediately. Monitoring of water quality, frequency and impact of overflow events, public health indicators should be maintained and implemented, besides the definition of adaptive triggers for intervention (e.g., sustained algal blooms, regulatory changes, tourism impacts). Maintenance of mangrove margins is also recommended. This approach ensures environmental protection while avoiding unnecessary complexity and cost at this stage. It also aligns adaptive management principles, allowing decisions to evolve based on evidence and changing conditions.

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119 CAPDEVILLE, C., K. Abdallah, E. Buffan-Dubau, C. Lin, F. Azemar, L. Lambs, F. Fromard, J.L. Rols & J. Leflaive (2018). Limited impact of several years of pretreated wastewater discharge on fauna and vegetation in a mangrove ecosystem. *Marine Pollution Bulletin*, **129**(1): 379-391

Also, the high renewal rate of Fresh Pond prevents persistent eutrophication and limits long-term ecological imbalance. Therefore, while temporary algal growth is expected, the system's natural dynamics provide effective self-regulation without requiring artificial interventions.

The impacts are positive and **moderately significant**.

7.2.10 Land Use

7.2.10.1 Construction Phase

Land use affectation

Regarding land use, the impacts during the construction phase are associated with the operations involved in the assembly and installation of new buildings and trenches for the new hydraulic system pipes.

Given the limited area occupied by these structures, these impacts are considered direct, permanent, and **moderately significant** justified by the location of the new buildings in non-used terrain, where the new dewatering building will have the main affectation (see Table 7-1)

Regarding the location of the construction site, it is recommended that it be implanted in areas that have already been artificially developed, with no economic or natural use, as the negative impact would be direct, but **not significant**.

7.2.10.2 Operation Phase

Land use affectation

The impacts on land use already occurs in the construction stage, so for the operation stage, the impacts are **inexistent**.

7.2.11 Landscape

7.2.11.1 Construction Phase

When assessing landscape impacts, it is important to consider the following:

- The presence of observers sensitive to landscape changes resulting from the project's construction and operation;
- The sensitivity/absorptive capacity of the landscape to visual intrusion (presence of areas of high sensitivity and/or low visual absorption capacity);
- The visual quality of the landscape;
- The magnitude and significance of the visual intrusion, which will be greater the greater the sensitivity and visual quality of the landscape and the lower absorption capacity;
- The intended use is temporary or permanent;

- The impact is reversible or irreversible.

Visual intrusion

The local landscape of the WWTP, located in a plain area, was classified as having medium visual quality (natural areas and urban areas), medium absorption capacity and medium visual sensitivity. Currently, the WWTP facilities are surrounded by a tree barrier that mitigates the visual impact of this infrastructure on observers of the surrounding area.

Most of these observers will be temporary, associated with commercial establishments and users of A.TH. Illidge Road (pedestrians and vehicles).

It is during the construction phase that most of the permanent actions will be implemented, which will be transferable to the operational phase and, therefore, will give the landscape a new interpretation. However, the new buildings **will not change significantly** the current landscape, being easily integrated with the existing buildings. The trees will not be removed, maintaining the aesthetic and function that already exists.

Some of the construction actions are temporary, such as the construction site and the movement of machinery, vehicles, and people. This period of visual disturbance and impairment may result in minor, reversible, and **not significant** impacts.

7.2.11.2 Operation Phase

Visual intrusion

It is during the operational phase that the process of adapting the landscape to the new reality will occur, resulting from the introduction of new constructed elements.

As mentioned, despite these new structures, it is not expected to have a significant visual impact, particularly because the socioeconomic benefits of the WWTP rehabilitation outweigh the visual intrusion of these new buildings.

7.2.12 Socioeconomy and Public Health

7.2.12.1 Construction Phase

Improved Employment and Economy

The most significant impact at this stage is the creation of jobs (between 10 and 20 at the same time at the peak of the project) and the increase in local commerce, resulting from the workforce that will use these businesses (restaurants, lodging, groceries, etc.) and the raw materials and materials needed for the project.

These are positive, **not very significant** impacts (is not a large project), with a duration that depends on the project, but they are still relevant.

Staff Circulation

Although some of the construction works will need skilled personnel (that could be non-resident), is important to employ primarily local workers.

If non-resident workers are needed, there might be limited and temporary slight negative impacts on housing availability, and increased pressure on Government services such as Immigration, may occur. However, these impacts will be negligible.

The project should contribute to the social integration of migrant workers and local communities to ensure mutual and equal access to existing socioeconomic opportunities.

These efforts will be supported through the Contractor's social mobilization activities, in coordination with local authorities and community representatives, including community leaders, to ensure open communication, address concerns proactively, and maintain a harmonious community environment.

The impacts will be local, direct, probable, minimal, mitigable, and **not very significant**.

Conflicts with the Local Population

During the construction phase, there may be an increase in gender-based violence, sexual exploitation, and abuse of women and children, leading to early pregnancy and fatherhood avoidance. During this phase, the Contractor should conduct SEA/SH/SA awareness and prevention activities, specifically holding sessions with workers, the community, and others. They should also monitor prevention activities, verify that all workers have signed the Code of Conduct, identify existing support services, carry out these activities, and implement a Grievance Resolution Mechanism to receive complaints from the community and other affected parties, among other activities.

The impacts will be local, direct, probable, minimal, mitigable, and **not very significant**.

Change in Quality of Life

In terms of quality of life/human health, traffic, environmental noise, and air quality are expected to be slightly affected, potentially causing discomfort to the surrounding population.

This impact is negative, local, likely, minor, and **not very significant**.

Impact on Individual and Community Health

Implementation of the proposed project, with increased economic activity in the area, may also increase the likelihood of workers becoming infected sexually transmitted infections (STIs), or, conversely, more seriously, infecting the local population, although is not expected to be a significant issue

The Contractor should avoid accumulating water in containers or trash to mitigate the proliferation of vectors, namely mosquitoes.

In terms of occupational health and safety, all hygiene and safety conditions for construction workers must be implemented, related for instance to hazards such as open trenches, slippery walkways, working at high altitude, powered circuits, and heavy equipment.

These impacts are negative, local, likely, minor, and **not very significant**.

7.2.12.2 Operation Phase

Improved Sanitation Conditions and Economic growth

The main objective of the WWTP improvement project is to ensure the treatment of wastewater in one of the most populated areas of Sint Maarten, increasing its capacity and resilience. It primarily aims to reduce risks to public health and protect Sint Maarten's surface waters and beaches from environmental degradation, . The expected less contamination of coliforms and nutrients will have a positive impact in the preservation of the country's extraordinary natural assets and enhance the sustainability of recreation for residents and the tourism economy, while also ensuring compliance with the Sint Maarten Sewage Policy 2022.

Monitoring of water quality (ponds and sea) must also be maintained to ensure that nutrient levels do not cause ecological damage, such as algal bloom, that have impact on the water quality and beach aesthetic. If needed, and when economically feasible, P and N additional treatment could be implemented in the WWTP.

In this sense, the impacts of the WWTP rehabilitation will always be positive, direct and indirect, local to regional, of high magnitude and **moderately significant**, due to the better environment and associated economic growth.

The final sludge will also be improved, which will **positively impact** their deposit locations,

In terms of direct employment, the size of the WWTP, even with the new equipment, will not require a large number of workers, therefore the employment, although a positive impact, will be **not significant**.

Presence and operation of the WWTP – Health and Safety

As described in the baseline situation, it was confirmed, both in a quantitative as qualitative manner, that the current operation of the WWTP does not have a significant impact on the air quality of the surrounding neighborhood, namely on the odor nuisance. Dust and presence of pests, rodents and mosquitoes, mainly related with the sewage splashed from the trucks, are the other nuisances revealed in the local social survey.

Similar to what was performed for the current situation, a quantitative assessment of the odor impacts was developed for the rehabilitation project. The results are described in **ANNEX 3** and confirmed that the upgrade project will improve the situation compared with the current situation.

The facilities of the WWTP are integrated in the local landscape, so no major visual intrusions are expected with the rehabilitation.

Although the noise above limits caused by the trucks, this was not considered a significant impact in the responses of the population enquired during the local survey. The rehabilitation project will contemplate a barrier between the south closest building and the trucks discharge site to mitigate not only the noise impacts, but also the splashed septic flows during discharges which will reduce the contaminated water puddles and consequently the proliferation of pests and rodents.

Reinforces that as the sewerage network expands, the number of septic trucks will decrease until complete elimination. For the sludge trucks, although increasing their number, the transportation to the landfill will be tightly covered in containers to mitigate odor emissions along the main roads. It is important to reinforce that this increase along with the decrease of septic trucks, will always be a better situation than currently occurs on a daily basis.

These negative impacts are all of low-magnitude and **not very significant**.

For the operational and emergency hazards, the current situation is being managed on an action – reaction procedure, based on the extensive experience of the WWTP Director. Nevertheless, is recommended that an Emergency Preparedness and Response Plan (EPRP) shall be created against any emergency. The measures to be taken will be determined, and the employees will be provided to comply with the EPRP by providing the necessary trainings on these issues and to act in accordance with this plan.

For instance, for the new mechanical belt dewatering system, OHS includes managing **crushing and entanglement hazards** from the belts and rollers, **chemical exposure** from polymers, **slips and falls** from wet surfaces, **noise**, and **ergonomic risks** from lifting and maintenance. Key safety measures are emergency stops, guards, regular maintenance, proper personal protective equipment (PPE), and clear procedures for operation and cleaning

The elements that should be included in the Emergency Response Plan are listed below:

- Determining the Emergency Response Team
- Making job descriptions
- Creating subordinate levels (rescue, first aid, intervention etc.)
- Identification of relevant institutions / organizations and coordination issues within itself

- Determination of the service (transportation, supplies, supply, maintenance etc.), allocation protocols that will need
- Determining the daily working principles of the personnel to work

The emergency response plan at the facility shall also include the following topics;

- Occupational safety and first aid plans,
- Protection-safety and security plan for the facility and its surroundings against sabotage and attacks,
- Incidental discharges,
- Resilience against natural disasters and extreme weather events,
- Flooding,
- Fire,
- Spills,
- Equipment failures.

For the quality of the operation is recommended a proper and periodic maintenance. This requires a budget that is always available and without delays in the approval in the purchases of material, which is currently an issue and needs to be overcome.

These negative impacts can be considered **not very significant**, especially due to the low concentrations of nutrients. Water analysis should be maintained to establish the need of additional treatment of WWTP effluents, which equipment are already considered for a future stage of the WWTP.

Labour and Community Grievance Redress Mechanism for WWTP Complaints

The main objective of a Grievance Mechanism (GM) is to assist in the resolution of complaints and grievances in a timely, effective and efficient manner that satisfies all parties involved.

NRPB has a Grievance Redress Mechanism (GRM) in place and available for all stakeholders. The updated GRM is disclosed on NRPB's website at: Complaints Procedure – National Recovery Program Bureau (https://nrpbsxm.org/complaints-procedure/).

The procedures of this GRM are provided in the Stakeholder Engagement Plan for the Sint Maarten Wastewater Management Project (NRPB, 2024[120]).

The complaints regarding the WWTP are currently received by VROMI. NRPB GRM will be used for the WWTP updated project construction and VROMI will use the SXM Government GRM during WWTP operation. This operation GRM is mostly for Community grievance.

120 NRPB (2024). *Stakeholder Engagement Plan.* Sint Maarten Wastewater Management Project. 57 pp

Contractor is required to develop his own labour grievance redress procedures, to manage concerns from their employees. The mechanism shall also be able to receive complaints from community. NRPB's Labour GRM is available for contracted workers when they are not comfortable submitting a complaint at the Contractor and also for the public.

Regarding labour grievance, VROMI will also have the responsibility to receive and respond to all grievances from their workers. This procedure shall be known to workers at the moment of hiring and accessible without fear of retaliation.

7.2.13. Impact magnitude

Based on the impact assessment methodology described in Section 7.1.2 of this ESIA, a quantitative impact matrix was developed, taking into account the environmental and social baseline information described throughout Chapter 5 and all project interventions and their potential consequences, as described along this chapter.

Impacts were assessed by thematic descriptor and project activity, for the construction and operational phases, without any mitigation measures considered.

The cumulative impacts assessment and their significance is presented in Section 7.4.

For more details on the classification, see **ANNEX 7** for the quantitative assessment of the impacts and also **ANNEX 8** with the Environmental and Social Impact Identification and Assessment Matrices for the Construction and Operation Phases.

It is confirmed that during the construction phase, negative impacts are mostly not very significant and not significant for most activities, with only three moderately significant impact related to the implantation of the new buildings in the change of surface drainage and runoffs and the land use, but these impacts can be mitigated. Regarding positive impacts, they are moderately significant to significant, especially during the operation phase.

Table 7-10 - Identification and Assessment of Environmental and Social Impacts in the Construction Phase (without mitigation measures)

Impact			Significance before mitigation
Thematic area	**Impact**	**Description**	
Geology and Geomorphology	Geological and Hydrogeological affectation	Buildings / trenches	**(-) 15 (NVS)**
		Construction site	**(-) 10 (NS)**
Soil	Soil contamination	Buildings / trenches / Construction site	**(-) 8 (NS)**
Climate Change	Emissions of GHG	Construction activities	**(-) 14 (NVS)**

Impact			Significance before mitigation
Thematic area	**Impact**	**Description**	
Superficial Hydric resources	Changes in surface drainage and runoff	Buildings / trenches	**(-) 16 (MS)**
	Water quality	Construction site	**(-) 14 (NVS)**
Groundwater resources	Infiltration reduction	Buildings	**(-) 14 (NVS)**
	Water quality	Buildings / trenches / Construction site	**(-) 10 (NS)**
Noise	Increased noise levels	Construction activities	**(-) 15 (NVS)**
Air quality	Dust dispersion	Construction activities	**(-) 13 (NVS)**
	Pollutant gas emissions	Operation of machinery	**(-) 14 (NVS)**
Waste	Waste production and management	Construction activities	**(-) 13 (NVS)**
Biodiversity	Vegetation and biotopes affectation	Buildings	**(-) 14 (NVS)**
		Construction site	**(-) 10 (NS)**
	Fauna Disturbance and Mortality	Construction activities	**(-) 13 (NVS)**
Land Use	Land use affectation	Buildings	**(-) 16 (MS)**
		Construction site	**(-) 11 (NS)**
Landscape	Visual intrusion	Buildings	**(-) 13 (NVS)**
		Construction site	**(-) 10 (NS)**
Socioeconomy and Public health	Improved Employment and Economy	Construction activities	**(+) 16 (NVS)**
	Staff Circulation	Construction activities	**(-) 13 (NVS)**
	Conflicts with the Local Population	Construction activities	**(-) 15 (NVS)**
	Change in Quality of Life	Construction activities	**(-) 15 (NVS)**
		Aerators replacement	**(-) 14 (NVS)**
	Impact on Individual and Community Health	Construction activities	**(-) 15 (NVS)**

Legend: NS – Not Significant; NVS – Not very Significant; MS – Moderately Significant; S - Significant

Table 7-11 - Identification and Assessment of Environmental and Social Impacts in the Operation Phase (without mitigation measures)

Impact			Significance before mitigation
Thematic area	**Impact**	**Description**	
Geology and Geomorphology	Geological affectation	Pipes maintenance	**(-) 8 (NS)**
	Seismic risk	Buildings	**(-) 13 (NVS)**
Soil	Soil contamination	Accidental spills and Maintenance Actions	**(-) 8 (NS)**
		Sludge disposal	**(-) 12 (NVS)**
Climate Change	Effect on Climate Change (GHG Emissions)	Equipment operation	**(-) 15 (NVS)**
	Effect of Climate Change (project adaptation)	Structural and operational strategies	**(-) 14 (NVS)**
Superficial Hydric resources	WWTP Discharges	Quantity in Fresh Pond	**(-) 18 (MS)**
		Quality in Fresh Pond	**(+) 16 (MS)**
	Ponds discharge	Quality in Great Bay	**(+) 15 (NVS)**
	Sludge disposal	Quality	**(-) 16 (MS)**
Groundwater resources	Water quality	Possible rupture and maintenance activities	**(-) 9 (NS)**
Noise	Increased noise levels	Equipments operation	**(-) 14 (NVS)**
Air quality	Pollutant gas emissions	Trucks circulation	**(-) 11 (NS)**
		WWTP emissions	**(-) 15 (NVS)**
	Odor emission	Equipments operation	**(-) 14 (NVS)**
		Sludge transportation	**(-) 11 (NS)**
Waste	Waste production and management	Operation activities	**(-) 14 (NVS)**
	Sludge production	Deposition	**(-) 12 (NVS)**
Biodiversity	Fresh Pond Ecosystem quality	Effluents discharge	**(+) 16 (MS)**
	Great Bay Ecosystem quality	Ponds discharge	**(+) 14 (NVS)**
Socioeconomy and Public health	Improved Sanitation Conditions	Operation activities	**(+) 19(MS)**

Impact			Significance before mitigation
Thematic area	**Impact**	**Description**	
	Improved Employment and Economy	Operation activities	**(+) 14 (NVS)**
	Health & Safety risks	Operation activities; Emergency situations	**(-) 13 (NVS)**
		Use of Great Bay	**(+ 14 (NVS)**
	Communication	GRM	**(+) 24 (S)**

Legend: NS – Not Significant; NVS – Not very Significant; MS – Moderately Significant; S - Significant

7.4 No Action Alternative

For the majority of the thematic areas, the non-implementation of the project under study maintains the characteristics described in the reference situation.

This will mean that the current treatment, although complying with the legal permits in terms of water quality and odor, will not be able to support the increase of effluent that the expansion of the sewerage network will contribute to.

Therefore, maintaining the current situation is adequate in a short-term, but on the longer term it will not be able to sustain the increase of the sewerage network, with negative and **significant** impacts for the population, tourism and aquatic environment.

7.3 Identification of other situations that induce Environmental Risks

According to the literature, there are potential hazards associated with a Wastewater Treatment Plant. PANKHOW and colleagues (2024[121]) synthetizes these hazards as presented in Figure 7-4.

[121] PANKOW, N., S. Krause & C. Schaum (2024). Resilience Adaptation Through Risk Analysis for Wastewater Treatment Plant Operators in the Context of the European Union Resilience Directive. *Water* **16**: 3098

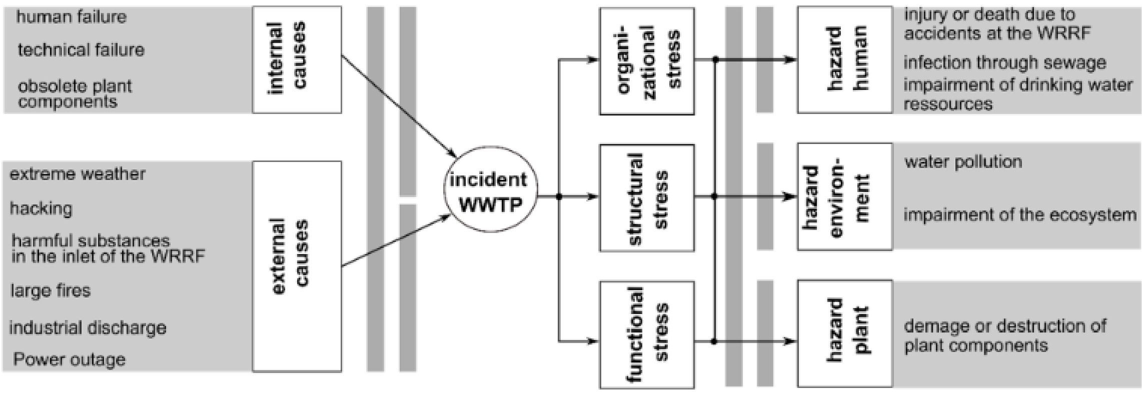

Figure 7-4 – Potential hazards for a WWTP

In the following table, these hazards are analysed for the A.TH. Illidge Road WWTP, regarding the specific risks to the environment arising from the presence and operation of the facility, as well as environmental risks to the project in situations of serious accidents or natural disasters, with recommendation of appropriate preventive or mitigating measures.

Table 7-12 – Assessment of the potential hazards

Risks	Preventive measures	Impact Significance
Risks for Environment from the WWTP		
Human failure	♦ Capacitation of the staff ♦ Management with roles and responsibilities ♦ Simulation of warning systems procedures	**Low**
Technical failure	♦ Asset management, redundancy and maintenance (periodic) ♦ Process management ♦ Advanced process control	**Low**
Obsolete plant components	♦ Asset management, redundancy and maintenance (periodic)	**Low**
Risks from Environment to the WWTP		
Extreme weather	♦ Simulation of warning systems procedures ♦ Capacitation of the staff ♦ Management with roles and responsibilities	**Medium**
Hacking	♦ Process management ♦ Advanced process control	**Low**
Harmful substances in the inlet of the WWTP	♦ Process management ♦ Advanced process control	**Low**
Large fires	♦ Simulation of warning systems procedures ♦ Capacitation of the staff ♦ Management with roles and responsibilities	**Low**
Industrial discharges	♦ Process management	**Low**

Risks	Preventive measures	Impact Significance
	♦ Advanced process control	
Power outage	♦ Simulation of warning systems procedures ♦ Capacitation of the staff ♦ Management with roles and responsibilities ♦ Asset management, redundancy and maintenance (periodic)	**Low**

7.4 Cumulative Impacts

Cumulative impacts are defined as "*the incremental impact of the project when added to the impacts of other relevant past, present, and reasonably foreseeable developments, as well as of unplanned but foreseeable activities enabled by the project that may occur later or in a different location. Cumulative impacts can result from individually smaller but collectively significant activities occurring over a period of time*."

As already mentioned, the **A.TH. Illidge Road WWTP** is not currently operating at its full capacity. The rehabilitation is required to bring proper treatment of both the flows from the existing network and additional wastewater flows that will be collected through the Project financed sewerage network expansion in line with the existing effluent discharge requirements.

Proposed projects to expand the sewerage network may have cumulative impacts if the construction phase of both projects is coincidental, and during operation. According to the ESMP[122] already developed for this network project, "*the potential adverse risks and impacts on the environment during the implementation phase of the first sub-component related to network expansion, will be temporary in nature and mainly localized around the project area of works. The environmental impact is mainly related to traffic hindrance, air emissions from vehicles, dust generation from earth works, construction waste/soil collection and disposal, wastewater collection and disposal, hazardous materials accidental spillage, stormwater runoff and noise pollution from construction activities which will potentially occur during works in the urban area where the works will take place. During operation phase, main environmental impacts are indirect and related to the sewage treatment, such as increased resources consumption (e.g. energy consumption, chemicals usage), increased treated effluent disposal, and increased sludge from the operation of the WWTP. Overall, the Project will have significant positive environmental impact on ground, surface and marine waters, recreation, tourism and public hygiene*."

The similar cumulative negative construction impacts from the sewerage network and the WWTP rehabilitation can be mitigated and are mostly temporary and **not significant**.

The A.TH. Illidge Road WWTP will continue to operate while the upgrade construction activities are ongoing. The main cumulative impacts of these two actions will relate to the increase of traffic in the area, either from the current trucks traffic (septic tanks and sludge transportation), but also from the

122 NRPB (2024). *Preliminary Environmental and Social Management Plan (ESMP) for the Expansion of the Sewerage Network*. Sint Maarten Wastewater Management Project. 156 pp

vehicles and machinery from the construction site. This traffic increase, although temporary, may potentially cause an increase of noise and pollutant air emissions, with **negative and moderately significant impacts** for the workers and surrounding buildings. Is important to adopt the proposed mitigation measures defined in the ESMP.

For the operation stage, the upgrade/rehabilitation of the WWTP and the expansion of the sewerage network will contribute for a better collection of the wastewater from the surrounding neighbourhoods and a better treatment of these wastewaters, with **positive impacts** for the downstream environment, namely the Fresh Pond and the Great Bay, with positive consequences for tourism and aquatic and marine ecosystems.

As described before, the WWTP discharge flow for Scenario 3A will increase from 4,613 m^3/day (1,683,745 m3/year) in 2030 to 6,451 m^3/day (2,354,615 m3/year) in 2055. The current effluent daily average volume of the WWTP is 1743 m3/day (636,195 m3/year).

This means the increase of the daily flow into the Fresh Pond will be 4,708 m3/day (6,451 – 1743) which is equivalent to the runoff produced by an event of precipitation of 1.9 mm/day.

With this flow increase from the WWTP, the discharges in the Great Bay may occur when the precipitations events are higher than 8 mm per day, which does not significantly increase the present number of overflow discharges of about 23/year.

Regarding the impact of this network expansion in the Phosphorus and Nitrogen load over Fresh Pond, **Error! Reference source not found.** presents the phosphorous load projections, for the present situation and under scenario 3A, assuming that 75% of phosphorus discharged by the population not served by the WWTP (i.e., with septic tanks) is retained in the wastewater systems (precipitates in the soil and not transferred into the pond). This assumption strongly minimizes the impact of phosphorus from the un-served population when compared to the population served by the WWTP, and assumes that soil natural treatment is favourable to phosphorus removal at the WWTP.

Table 713 – Contributions of Phosphorus and Nitrogen of Scenario 3A

Scenario 3A			
Population	**2025**	**2055**	
Pop. Served by WWTP	15,235	38,299	
Pop. not served by WWTP, located in Fresh Pond Catchment	13,932	4,931	
P (g/hab.day)	4	4	
N (g/hab.day)	12	12	
Total population	29,167	43,230	
Average annual flow (m3/d)	**2025**	**2055**	
Pop. Served by WWTP	1,743	6,451	
Pop. not served by WWTP, located in Fresh Pond Catchment	1,628	843	
Total Flow	3,371	7,294	
Fresh Pond - without Phousphorous removal without chemicals	**2025**	**2055**	
P (mg/L) StormWater	0.45	0.45	
P (mg/L) Treated WWTP effluent	2.0	2.0	**% Increase**
Total contributions of Ptotal Pop. Eq (kg/ano)	**6719**	**6523**	-3.21
Total contributions of Ptotal Pop. Eq + Stormwater (kg/ano)	**7080**	**6884**	
Total contributions of Ptotal Pop. Eq treated WWTP effluent (kg/ano)	1272	4709	
Total contributions of Ptotal Pop. Eq Not served + Stormwater (kg/ano)	5446	1814	
Total contributions of Ptotal Stormwater (kg/ano)	361	361	
Total contributions of Ptotal Pop. Eq treated WWTP effluent (%)	18	68	
Total contributions of Ptotal Pop. Eq Not served + Stormwater (%)	77	26	
Total contributions of Ptotal Stormwater (%)	5	5	
Fresh Pond - Total Nitrogen	**2025**	**2055**	
Ntotal (mg/L) StormWater	3	3	
Ntotal (mg/L) Treated WWTP effluent	10.0	10.0	**% Increase**
Total contributions of Ntotal Pop. Eq (kg/ano)	**24026**	**31354**	33.55
Total contributions of Ntotal Pop. Eq + Stormwater (kg/ano)	**26434**	**33762**	
Total contributions of Ntotal Pop. Eq treated WWTP effluent (kg/ano)	6362	23547	
Total contributions of Ntotal Pop. Eq Not served + Stormwater (kg/ano)	17664	7808	
Total contributions of Ntotal Stormwater (kg/ano)	2408	2408	
Total contributions of Ntotal Pop. Eq treated WWTP effluent (%)	24	70	
Total contributions of Ntotal Pop. Eq Not served + Stormwater (%)	67	23	
Total contributions of Ntotal Stormwater (%)	9	7	

The projected phosphorus load to Fresh Pond **by 2055 is less 3.21% than the current situation.** This decrease does not justify the immediate implementation of chemical phosphorus removal, particularly considering the associated capital investment, operational complexity, increment in sludge production and environmental risks linked to chemical storage and handling. However, the upgrade allows for chemical phosphorus removal to be added in the future, as it becomes financially feasible.

Regarding the expected increase in nitrogen concentrations in the lagoon (approximately **33.6%**, as also presented in **Error! Reference source not found.**), a mass-balance comparison was performed for the nitrogen loads under the 2025 baseline and Scenario 3A. Both calculations assume a lagoon volume of 121,500 m^3 and a total nitrogen concentration of 10 mg/L in the Fresh Pond, consistent with the applied discharge limits for total nitrogen (aligned with CARIRI data of water analysis at Fresh Pond in 2025).

As shown in the following table, under the current operating conditions **no accumulation of nitrogen is expected in the lagoon for either scenario**. This results from the fact that the nitrogen load entering the lagoon equals the load leaving it in suspended and soluble forms which are transported by the outlet flow into the sea, provided that no internal removal or transformation processes are considered.

Table 714 – Bass-balance for the nitrogen loads between current scenario (2025) and scenario 3A (2055)

Current Scenario 2025

Inflow load Ntotal	Total inflow (Stormwater + WWTP) m3/month	Mass Stormwater Ntotal enter (kg/month)	Mass WWTP Ntotal enter (kg/month)	Mass Ntotal Fresh Pond (2025) kg	Mass Stormwater Ntotal exit (kg/month)
3.0	219124.6	125.1	522.9	-328.2	2191
3.5	173668.9	91.0	522.9	-1451.0	1737
3.6	167526.2	86.4	522.9	-2516.9	1675
3.2	199959.5	110.8	522.9	-3882.9	2000
2.4	293082.2	180.6	522.9	-6110.2	2931
3.3	187428.5	101.4	522.9	-7360.2	1874
2.4	289642.3	178.0	522.9	-9555.7	2896
2.3	313230.1	195.7	522.9	-11969.4	3132
2.2	337555.0	213.9	522.9	-14608.1	3376
1.9	438048.9	289.3	522.9	-18176.4	4380
1.8	450334.2	298.5	522.9	-21858.3	4503
2.4	300453.3	186.1	522.9	-24153.8	3005
Total annual	**3370053.5**	**2056.9**	**6274.8**		

Scenario 3A 2055

Inflow load Ntotal	Total inflow (Stormwater + WWTP) m3/month	Mass Stormwater Ntotal enter (kg/month)	Mass WWTP Ntotal enter (kg/month)	Mass Ntotal Fresh Pond (2025) kg	Mass Stormwater Ntotal exit (kg/month)
5.7	360367.5	125.1	1935.3	-328.2	3604
6.4	314911.8	91.0	1935.3	-1451.0	3149
6.5	308769.1	86.4	1935.3	-2516.9	3088
6.0	341202.4	110.8	1935.3	-3882.9	3412
4.9	434325.1	180.6	1935.3	-6110.2	4343
6.2	328671.4	101.4	1935.3	-7360.2	3287
4.9	430885.2	178.0	1935.3	-9555.7	4309
4.7	454473.0	195.7	1935.3	-11969.4	4545
4.5	478797.9	213.9	1935.3	-14608.1	4788
3.8	579291.8	289.3	1935.3	-18176.4	5793
3.8	591577.1	298.5	1935.3	-21858.3	5916
4.8	441696.2	186.1	1935.3	-24153.8	4417
Total	**5064968.3**	**2056.9**	**23223.9**		

Although is not predicted any accumulation of N in the Fresh Pond, the outflow that is discharged into the Great Bay may contribute to increase the concentration of N, which is already over the recommended limits. As nitrogen is a crucial element for photosynthesis and primary production, its significant enrichment in the water medium directly alters fundamental processes of the aquatic ecosystem, originating, for instance algal blooms that decrease water quality through oxygen depletion.

It is important to maintain the periodic monitoring of nitrogen to assess its evolution and avoid these algal blooms.

The sewerage network expansion that will connect to the WWTP will also have a positive impact on the sea water quality, as it decreases the currently non-treated direct discharges into the Fresh Pond and Great Salt Pond, which outflow both to the Great Bay Beach.

As mentioned in Section 7.2.4.2, the WWTP effluent discharge will still have some microbial load, due to absence of disinfection and was recommended the implementation of a public health advisory system like international best practices.

Considering the higher wastewater flow that will arrive from the expanded sewerage network, it was determined that this contamination will not affect the Fresh Pond ecosystem, but it will limit the beach recreational area use of Great Bay after rainfalls >10 mm, which lead to the overflow of the Fresh Pond directly into the Great Bay (or indirectly through Great Salt Pond) for periods of 48 to 72 hours (occurring ~23 times/year).

The same public health advisory system is recommended for when these new connections are in place. However, it is recommended that, as more houses are connected to the WWTP and other diffused pollution sources (e.g. landfill leachate) are solved, the conditions can be created for further upgrades in the treatment plant (namely disinfection process) be justifiable.

In terms of the impact of the expanded sewerage network on the biodiversity and specifically on the aquatic ecosystem of Fresh Pond, Great Salt Pond and Great Bay, the rehabilitation of the WWTP will not change the treatment process, but will improve the resilience of this infrastructure. Two main impacts can be mentioned regarding the effect on the biodiversity of the Fresh Pond, namely:

- The increment of its capacity related to the upgrade of the sewer network system will reduce accidental discharges from septic tanks or from open sewers, therefore, reducing the pollutant influents to the pond. This will have positive impacts for the aquatic ecosystem, with benefits for the mangrove and the birds;
- The increase in WWTP flow will not change the current number of openings to the sea (about 23x per year), therefore the pond level will maintain the current periodic variations. For the quality of the aquatic ecosystem, it was assessed that the projected P load to the Fresh Pond by 2055 will decrease 3% and for N there will be an increase of 33%. As already mentioned above, is not expected any accumulation of N in the Fresh Pond water, since nitrogen load entering the lagoon equals the load leaving it in suspended and soluble forms which are transported by the outlet flow into the sea (Great Bay Beach) or for Great Salt Pond. It was also concluded that the Fresh Pond has a renewal rate of 26 x per year by precipitation and flushing, which prevents persistent eutrophication caused by N accumulation and limits long-term ecological imbalance.

Therefore, it can be concluded that the cumulative expansion project of the sewerage network will not significantly change the current situation, maintaining the ecologic balance that already exists, and also the ecologic status of this wetland.

Although the N increase in the Fresh Pond does not cause significant problems for this wetland, its discharge into the Great Bay Beach, which already has levels of N above the recommended threshold, may contribute for further changes in the fundamental processes of the aquatic ecosystem.

Great Bay is home to seagrass beds (MATHON, 2025[123]). These habitats are essential for maintaining the stability of the seafloor and sediments in case of storms, but they also provide shelter and nutrients for many animals, such as juvenile fish, sea turtles, and conchs. The native seagrasses have a higher ecological value due to their higher nutritive contents and nursery role. Currently, the invasives species are more prevalent in this coastal area and are attributed to human activities, particularly commercial and recreational boat traffic. However, these species adapt well to eutrophic conditions, allowing them to form dense mats, particularly in areas affected by nutrient loading and sediment disturbance, which can poses challenges to native ecosystems, reducing biodiversity. Also, they are more susceptible to uprooting during storms, which can increase the vulnerability of the seabed to erosion.

As N load can enhance these invasive species, is important to maintain the periodic monitoring of nitrogen already ongoing to assess its evolution and impact on the existing seagrass beds that occur in this area.

[123] MATHON, L. (2025). *MARINE AND COASTAL BIODIVERSITY ASSESSMENT OF SINT MAARTEN. Habitat mapping, seagrass monitoring, mangrove assessment, and species inventory.* Published by Nature Foundation Sint Maarten. *178 pp*

In order to assess the future impacts of the sewerage network expansion and the operation of the rehabilitated WWTP in the biodiversity of the Fresh Pond, a Biodiversity Management Plan is presented in **ANNEX 10**, with the purpose of:

- Identifying the key biodiversity issues that require control measures;
- Developing strategies to manage impacts on biodiversity and implementing those strategies;
- Assigning responsibilities for impact monitoring and management;
- Providing sufficient information to assist with auditing the implementation of the BMP; and
- Establishing a biodiversity monitoring program and management measures.

The higher capacity to receive the sewerage of more households that currently discharge directly into the Fresh Pond and the Great Salt Pond, and indirectly to the Great Bay Beach will also have cumulative positive impacts in the social and economic environment related to the impact in the preservation of the country's extraordinary natural assets and enhance the sustainability of recreation for residents and the tourism economy, while also ensuring compliance with the Sint Maarten Sewage Policy 2022.

However, since about 26 times/year, during rainy season, there may be discharges from the Fresh Pond (or through the Great Salt Pond) to the Great Bay Beach, it is important, for periods of 48 to 72 hours after these discharges, to implement a public health advisory system like international best practices:

- Issue alerts immediately after overflow events, warning that water quality at Great Bay beaches may not meet recreational standards;

- Post signage at beach access points and update official websites and social media platforms.
- Recommended advisory duration: 48 to 72 hours, based on WHO[124];
- Provide clear messaging on risks (e.g., gastrointestinal illness, skin infections) and precautions (avoid swimming, especially for children and immuno-compromised individuals);

These advisories are consistent with WHO recommendations to proactively inform the public when contamination risk is high, even before laboratory confirmation, mitigating this temporary direct impact in the community health of the users of Great Bay and indirectly on the tourism economic activity of Sint Maarten.

Cumulative impacts may also occur between the sludge disposal in the Pond Island landfill and its ongoing closure.

Currently the dried sludges are placed in the Pond Island landfill, where only basic quality requirements are needed and impacts regarding soil contamination are **non-existent**.
As described in Section 7.2.8.2, is predicted that the sludges will continue to be disposed in the landfill until 2026, and from 2027 (medium-term) the sludges will be used as landscaping of the landfill. In parallel, it was proposed that the sludges management will be integrated with waste management, to

124 World Health Organization (WHO) – Guidelines for Safe Recreational Water Environments

ensure cost efficiency, avoid duplication of infrastructure, and leverage the same environmental safeguards already required for MSW (liners, leachate collection, monitoring).

As mentioned in Annex 11, if the measures foreseen in the future sludge management strategy are fully implemented, the remaining risks are consistent with proven international standards. Such risks could only be further reduced with considerable additional effort. Such effort would, in any case, require additional budgetary resources.

If other uses are predicted, for instance their reuse in agriculture, it is important that the sludges are sufficiently dried and treated/stabilized, prior to being reused (i.e. applied to land), upon condition that sample analysis proves that sludge does not possess hazardous characteristics, including pathogenic microorganisms.

Potential health hazards to human and animal health could arise from the application of sludge to agricultural crops because dumping raw sludge on agricultural lands could lead to the production of contaminated crops, especially if applied directly to plants. The consumption of these crops (if consumed raw), their handling by vendors, and any contact with soil by farmers may also have biological and health impacts.

The recent grab analysis performed between May and June 2025 determined that the sludges have no exceedances for heavy metals, pH, Organic Matter, and Nutrients and may be considered suitable for beneficial reuse (e.g., land application) depending on local policy and soil conditions.

The significance of the cumulative impacts between the upgrade/rehabilitation of the WWTP and the expansion of the sewerage network and also the disposal of sludge and the closure of Pond Island is assessed in the specific thematic areas, as presented in the table below.

Table 7-15 - Identification and Assessment of Cumulative Environmental and Social Impacts in the Operation Phase (with mitigation measures)

Impact			Significance before mitigation	Mitigation measures (see Table 8.2 for detailed description)
Thematic area	**Impact**	**Description**		
Soil	Soil contamination	Sludge disposal	**(-) 10 (NS)**	**MO6**
Superficial Hydric resources	WWTP Discharges	Quantity in Fresh Pond	**(-) 17 (MS)**	**MO2; MO4; MO5; MO8; MO9**
		Quality in Fresh Pond	**(-) 15 (NVS)**	
	Ponds discharge	Quality in Great Bay	**(-) 14 (NVS)**	**MO10**
	Sludge disposal	Quality	**(-) 13 (NVS)**	**MO6**
Air quality	Pollutant gas emissions	Trucks circulation	**(-) 10 (NS)**	**MO5; MO7; MO11**
	Odor emission	Sludge transportation	**(-) 8 (NS)**	
Waste	Sludge production	Deposition	**(-) 9 (NS)**	**MO12; MO13**
		Articulation with Pond Island landfill closure	**(+) 14 (NVS)**	**MO14**
Biodiversity	Fresh Pond Ecosystem quality	Higher volumes of Effluents discharge	**(-) 16 (MS)**	**MO15; MO16**
	Great Bay Ecosystem quality	Ponds discharge	**(-) 12 (NVS)**	**MO17**
Socioeconomy and Public health	Improved Sanitation Conditions	Operation activities	**(+) 22 (S)**	**MO8; MO9; MO10; MO11; MO20; MO21**
	Health & Safety risks	Use of Great Bay	**(-) 13 (NVS)**	**MO22**

8. ENVIRONMENTAL AND SOCIAL MEASURES FOR PREVENTION AND MITIGATION AND RESIDUAL IMPACTS

ANNEX 8 presents the impact matrices with and without mitigation measures for each of the impacts described throughout Chapter 7.

The following table summarizes these impacts, calculating the significance of residual impacts after the implementation of mitigation measures.

It can be seen that after the implementation of the planned measures, the majority of the negative impacts are not significant, while in the case of positive impacts, the measures amplify these impacts, increasing their significance. The most significant negative impact in the operation stage is related to the increase of WWTP effluent discharges into the Fresh Pond, associated with the maintenance of nutrients and microbial load, but as mentioned, will not change the current situation.

Table 8-1 – Mitigation Measures and Significance of Residual Impacts in the Construction Phase

Impact			Significance before mitigation	Mitigation Measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
Geology and Geomorphology	Geological and Hydrogeological affectation	Buildings / trenches	**(-) 15 (NVS)**	**MC1 - Restrict work to the minimum necessary for the execution of the works.** **MC2 - Excavation and landfill work must be interrupted during periods of heavy rainfall and appropriate precautions must be taken to ensure the stability of the trenches** **MC3 - Use previously selected materials from excavations as backfill material to minimize the volume of excess soil and ensure proper soil management.**	**(-) 12 (NVS)**
		Construction site	**(-) 10 (NS)**		**(-) 7 (NS)**
Soil	Soil contamination	Buildings / trenches / Construction site	**(-) 8 (NS)**	**MC4 - If the water table is affected, appropriate excavation methods must be selected to mitigate all possible contamination situations.** **MC5 - At the end of the work, the unpaved soils must be decompacted and turned over in the areas used to support the work, in order to decompress and aerate them, thus reconstituting, as far as possible, their structure and balance.** **MC6 - Before earthmoving work, strip the soil and store it in containers for later reuse in areas affected by the work.** **MC7 - Use existing accesses (Illidge Road) to avoid creating new accesses** **MC8 - Have "Anti-Spill Kit" available in heavy vehicles and next to machines;**	**(-) 5 (NS)**
Climate Change	Emissions of GHG	Construction activities	**(-) 14 (NVS)**	**MC1 – (see above)** **MC9 - Perform periodic maintenance on machinery, heavy and light vehicles allocated to the work, to ensure good operating conditions, thus reducing noise and combustion gas emissions and avoiding spills.** **MC10 - Turn off machines and vehicles when not in use;** **MC11 - Establish fixed routes for the movement of machinery, heavy vehicles and light vehicles.**	**(-) 11 (NS)**
Superficial Hydric resources	Changes in surface drainage and runoff	Buildings / trenches	**(-) 16 (MS)**	**MC1 – (see above); MC2 – (see above)** **MC12 - In the works closest to Fresh Pond, install silt curtains to limit the dispersion of soil and pollutants in the water body.** **MC13 - Use permeable paving that allows water infiltration, using materials such as permeable concrete, which facilitates drainage and water absorption in the soil.** **MC14 - Generators must be stored in waterproof locations or on top of an oil and hydrocarbon retention basin.**	**(-) 13 (NVS)**
	Water quality	Construction site	**(-) 14 (NVS)**		**(-) 11 (NS)**
Groundwater resources	Infiltration reduction	Buildings	**(-) 14 (NVS)**	**MC1 – (see above); MC4 – (see above); MC8 – (see above); MC9 – (see above); MC14 – (see above)**	**(-) 11 (NS)**
	Water quality	Buildings / trenches / Construction site	**(-) 10 (NS)**		**(-) 7 (NS)**
Noise	Increased noise levels	Construction activities	**(-) 15 (NVS)**	**MC7 – (see above); MC9 – (see above); MC10 – (see above); MC11 (see above)** **MC15 - Purchase, whenever possible, soundproofed equipment or implement soundproofing techniques in equipment;** **MC16 - Mandatory use of PPE - earplugs for workers handling heavy machinery and vehicles** **MC17 - Plan to monitor noise levels if there are complaints during construction.**	**(-) 12 (NVS)**

Impact			Significance before mitigation	Mitigation Measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
Air quality	Dust dispersion	Construction activities	**(-) 13 (NVS)**	**MC7 – (see above); MC9 – (see above); MC10 – (see above); MC11 – (see above);** **MC18 - Mandatory use of PPE - masks by workers when carrying out activities that emit particles;** **MC19 - Carry out regular spraying, especially on dry and windy days, of work fronts to reduce dust;** **MC20 - Construction materials must be packaged and covered, such as with a tarpaulin, to prevent thinner materials, such as aggregates and other materials, from being blown away by the wind. Also, cover the open boxes of earthmoving vehicles;**	**(-) 10 (NS)**
	Pollutant gas emissions	Operation of machinery	**(-) 14 (NVS)**		**(-) 11 (NS)**
Waste	Waste production and management	Construction activities	**(-) 13 (NVS)**	**MC21 - Implementation of Waste Management Plan**	**(-) 10 (NS)**
Biodiversity	Vegetation and biotopes affectation	Buildings	**(-) 14 (NVS)**	**MC1 – (see above); MC8 – (see above); MC9 – (see above), MC12 – (see above); MC15 – (see above); MC19 – (see above); MC20 – (see above); MC21 – (see above)** **MC22 – All staff from the Contractor must be aware of the surrounding biodiversity, with special emphasis on Fresh Pond. Training sessions prior to works must be held.** **MC23 - Land clearing, with removal of vegetation, should only occur in areas strictly necessary for the work, avoiding, whenever possible, the felling of trees.** **MC24 - Carry out machinery movements and worker movements at times that minimize disturbance to wildlife, avoiding breeding periods or times when animals are most active.** **MC25 - Choose construction site locations with reduced vegetation, reducing interference with valuable soils and sensitive natural habitats, avoiding areas with high biodiversity and critical ecosystems;**	**(-) 11 (NS)**
		Construction site	**(-) 10 (NS)**		**(-) 7 (NS)**
	Fauna Disturbance and Mortality	Construction activities	**(-) 13 (NVS)**		**(-) 10 (NS)**
Land Use	Land use affectation	Buildings	**(-) 16 (MS)**	**MC1 – (see above); MC25 – (see above)**	**(-) 13 (NVS)**
		Construction site	**(-) 11 (NS)**		**(-) 8 (NS)**
Landscape	Visual intrusion	Buildings	**(-) 13 (NVS)**	**MC1 – (see above); MC25 – (see above);** **MC26 - Whenever possible, position construction structures and materials in locations that minimize their visual impact, in areas that are already disturbed, reducing visibility in panoramic views.**	**(-) 10 (NS)**
		Construction site	**(-) 10 (NS)**		**(-) 7 (NS)**
Socioeconomy and Public health	Improved Employment and Economy	Construction activities	**(+) 16 (MVS)**	**MC27 - Implement a Recruitment and Vocational Training Plan that prioritizes the inclusion of local workforce, focusing on youth from nearby communities; promotes equal employment opportunities for men and women, with special attention to the recruitment of vulnerable groups, such as people with disabilities.** **MC28 - Establish partnerships with local suppliers and companies in the project's areas of influence to purchase materials, goods, and services.** **MC29 - Implementation of Health&Safety Plan that include work procedures as well as a regular Training Plan on workplace safety and community relations (Code of Conduct)** **MC30 - Implement a Traffic Plan that establishes periods for the circulation of heavy vehicles as well as speed limits within the perimeters of the areas affected by the project.** **MC31 - Implement a Labour and Community Grievance Redress Mechanism (GRM) for the construction site, under Contractor's responsibility**	**(+) 16 (MVS)**
	Staff Circulation	Construction activities	**(-) 13 (NVS)**		**(-) 10 (NS)**
	Conflicts with the Local Population	Construction activities	**(-) 15 (NVS)**		**(-) 12 (NVS)**
	Change in Quality of Life	Construction activities	**(-) 15 (NVS)**		**(-) 12 (NVS)**
	Impact on Individual and Community Health	Construction activities	**(-) 15 (NVS)**		**(-) 12 (NVS)**

Table 8-2 – Mitigation Measures and Significance of Residual Impacts in the Operation Phase

Impact			Significance before mitigation	Mitigation measures	Significance after mitigation
Thematic area	**Impact**	**Description**			
Geology and Geomorphology	Geological affectation	Pipes maintenance	**(-) 8 (NS)**	**MO1 - Restrict work to the minimum necessary for the execution of the maintenance works.** **MO2 - Excavation and landfill maintenance work must be interrupted during periods of heavy rainfall and appropriate precautions must be taken to ensure the stability of the trenches.** **MO3 - Use previously selected materials from excavations as backfill material to minimize the volume of excess soil and ensure proper soil management.**	**(-) 5 (NS)**
	Seismic risk	Buildings	**(-) 13 (NVS)**		**(-) 10 (NS)**
Soil	Soil contamination	Accidental spills and Maintenance Actions	**(-) 8 (NS)**	**MO4 - Have "Anti-Spill Kit" available in heavy vehicles and next to machines;** **MO5 - Perform periodic maintenance on WWTP equipment, heavy and light vehicles allocated to the work, to ensure good operating conditions, thus reducing noise and combustion gas emissions and avoiding spills.**	**(-) 5 (NS)**
		Sludge contamination	**(-) 12 (NVS)**	**MO6 - Proper deposition of sludge layers in the landfill**	**(-) 9 (NS)**
Climate Change	Effect on Climate Change (GHG Emissions)	Equipment operation	**(-) 15 (MVS)**	**MO5 – (see above);** **MO7 – Improvement of power consumption with more efficient aerators and SCADA system**	**(-) 12 (NVS)**
	Effect of Climate Change (project adaptation)	Structural and operational strategies	**(-) 14 (NVS)**		**(-) 11 (NS)**
Superficial Hydric resources	WWTP Discharges	Fresh Pond Quantity	**(-) 18 (MS)**	**MO2 – (see above); MO4 – (see above); MO5 – (see above)** **MO8 - Control trucks when unloading septic tanks**	**(-) 15 (NVS)**
		Fresh Pond Quality	**(+) 16 (MS)**	**MO9 - Maintain periodic monitoring of the quality of inlet and outlet water, as well as sludge, with the current frequency already ongoing**	**(+) 16 (MS)**
	Pond discharges	Great Bay Quality	**(+) 15 (NVS)**	**MO10 - Maintain the period water quality monitoring of Great Bay, with the current frequency already ongoing**	**(+) 15 (NVS)**
	Sludge disposal	Quality	**(-) 16 (MS)**	**MO6 – (see above)**	**(-) 13 (NVS)**
Groundwater resources	Water quality	Possible rupture and maintenance activities	**(-) 9 (NS)**	**MO4 – (see above); MO5 – (see above)**	**(-) 6 (NS)**
Noise	Increased noise levels	Equipment operation	**(-) 14 (NVS)**	**MO5 – (see above)**	**(-) 11 (NS)**
Air quality	Pollutant gas emissions	Trucks circulation	**(-) 11 (NS)**	**MO5 – (see above); MO7 – see above** **MO11 - Keep trucks tightly covered during sludge transportation.**	**(-) 8 (NS)**
		WWTP emissions	**(-) 15 (NVS)**		**(-) 12 (NVS)**
	Odor emission	Equipment operation	**(-) 14 (NVS)**		**(-) 11 (NVS)**
		Sludge transportation	**(-) 11 (NS)**		**(-) 8 (NVS)**
Waste	Waste production and management	Operation activities	**(-) 14 (NVS)**	**MO12 - Implementation of Waste Management Plan** **MO13 - Documents related to the amount of sludge sent to the licensed disposal company and related documents shall be prepared for monitoring** **MO14 – Articulation between the sludge disposal location and the closure process of Pond Island landfill**	**(-) 11 (NVS)**
	Sludge production	Deposition	**(-) 12 (NVS)**		**(-) 9 (NVS)**

<table>
<tr><th colspan="3">Impact</th><th rowspan="2">Significance before mitigation</th><th rowspan="2">Mitigation measures</th><th rowspan="2">Significance after mitigation</th></tr>
<tr><th>Thematic area</th><th>Impact</th><th>Description</th></tr>
<tr><td rowspan="2">Biodiversity</td><td>Fresh Pond Ecosystem quality</td><td>Effluents discharge</td><td>(+) 16 (MS)</td><td>MO1 – (see above); MO4 – (see above); MO5 – (see above); MO8 – (see above); MO9 – (see above)
MO15 – Maintain bird monitoring in Fresh Pond and other IBAs, with the current frequency already ongoing
MO16 - Maintain the landscape setting of the facilities</td><td>(+) 16 (MS)</td></tr>
<tr><td>Great Bay Ecosystem quality</td><td>Ponds discharge</td><td>(+) 14 (NVS)</td><td>MO10 – (see above)
MO17 – Maintain the aquatic communities monitoring in Great Bay, with the current frequency already ongoing</td><td>(+) 14 (NVS)</td></tr>
<tr><td rowspan="5">Socioeconomy and Public health</td><td>Improved Sanitation Conditions</td><td>Operation activities</td><td>(+) 19 (S)</td><td rowspan="3">MO8 – (see above); MO9 – (see above); MO10 – (see above); M11 – (see above); MO18 - Establish partnerships with local suppliers and companies in the project's areas of influence to purchase materials, goods, and services.
MO19 - Implement a Recruitment and Vocational Training Plan that prioritizes the inclusion of local workforce, focusing on youth from nearby communities; promotes equal employment opportunities for men and women, with special attention to the recruitment of vulnerable groups, such as women heads of households and people with disabilities.
MO20 - Implementation of Health&Safety Plan that includes work procedures as well as a regular Training Plan on workplace safety and community relations (Code of Conduct)
MO21 - Establish a Labour and a Community Grievance Redress Mechanism (GRM) within the WWTP facility (Operator) and in VROMI facilities</td><td>(+) 191 (S)</td></tr>
<tr><td>Improved Employment and Economy</td><td>Operation activities</td><td>(+) 14 (NVS)</td><td>(+) 14 (NVS)</td></tr>
<tr><td rowspan="2">Health & Safety risks</td><td>Operation activities; Emergency situations</td><td>(-) 13 (NVS)</td><td>(-) 10 (NS)</td></tr>
<tr><td>Use of Great Bay</td><td>(+) 14 (NVS)</td><td>MO201 – (see above)
MO22 - Implement a public health advisory system for the overflows of the Great Bay, whenever needed (based on water quality monitoring and/or precautionary measure)</td><td>(+) 14 (NVS)</td></tr>
<tr><td>Communication</td><td>GRM</td><td>(+) 24 (S)</td><td>MO21 – (see above)</td><td>(+) 24 (S)</td></tr>
</table>

9. MANAGEMENT AND INSTITUTIONAL RESPONSIBILITIES IN THE IMPLEMENTATION OF ENVIRONMENTAL AND SOCIAL MEASURES

This section addresses Management and Institutional Responsibilities in the implementation of Environmental and Social Measures, emphasizing the importance of effective coordination between the entities involved to ensure the success of the proposed actions.

The NRPB will be the implementing agency for the project. NRPB will be responsible for reporting and monitoring and evaluation, financial management, contracts management, Environmental and Social risk management oversight, and procurement processing. Execution of activities for the project will be carried out by the NRPB in collaboration with VROMI, with the support from the World Bank.

The NRPB Implementation Unit (IU) will have overall responsibility for implementing this project's ESIA and ESMP, as well as the project's related environmental and social instruments and measures, through its environmental and social safeguard specialists.

The IU, through its safeguard specialists, also ensures the preparation of environmental and social documents, the obtaining of licenses and authorizations required by relevant national legislation before any action, reports to the Steering Committee on all due diligence, and ensures that the Bank and other stakeholders receive all environmental and social monitoring reports. To this end, it must have an environmental and social unit staffed by qualified experts in the areas of environmental protection and social development.

The collaboration between the NRPB and the related Government Ministries will continue as the project proceeds throughout the project life cycle. Each ministry has oversight and will contribute efforts and resources to ensure that the requirements of the ESIA and ESMP are met, but the NRPB is accountable for the commitments in both documents. During operation, the Ministry of VROMI is and will be the operator of the WWTP (delegating through a private partner), acting as the national authority and will continue their operations overseeing and monitoring the daily WWTP management activities. VROMI is also the operator of the MSWDS (regarding sludge disposal).

Execution of activities under the Component 1.2 will be carried out by the NRPB with technical input from Ministry of Public Housing, Spatial Planning, Environment and Infrastructure (VROMI), Ministry of Public Health, Social Development and Labour (VSA), Ministry of Education, Culture, Youth and Sport (MECYS), Ministry of Justice and Ministry of General Affairs, with the support from the World Bank.

The NRPB will maintain an organizational structure with qualified staff and resources to support management of E&S risks and preparation and implementation of the Environmental and Social Risk Management instruments/documents needed for the Project. E&S team is also supported by the project manager, project coordinator, procurement specialists, communications, financial, legal and M&E departments.

Additionally, works Contractor and Supervisor are required to have ESHS Specialists (at least a Social Specialist and an OHS Specialist) as key personnel.

Approving or modifying site specific environmental mitigation measures for the WWTP operations are the responsibility of VROMI. Collaboration with national NGOs (like Nature Foundation) for biodiversity and water quality periodic monitoring will also be a responsibility of VROMI.

The table below presents the responsibilities of each institutional person responsible for implementing the ESMP and the respective ESIA.

Table 9-1 - Organizations and responsibilities (institutional arrangement for the implementation of the ESIA/ESMP)

Organization	Responsibility
NRPB	♣ Overall oversight of ESIA/ESMP implementation of the project ♣ Periodic monitoring and reporting of ESCP (every 6 months). ♣ Ensure that the Labour Management Procedures (LMP) that have been developed for the project are implemented. ♣ Ensure that the Stakeholders Engagement Plan (SEP) that has been developed for the project is implemented. ♣ Prepare and submit to the Bank bi-annually monitoring reports on the environmental, social, health and safety (ESHS) performance of the Project, including, the implementation of the ESCP and the ESMP, stakeholder engagement activities, status of complaints received by the grievance mechanism(s), and other aspects of monitoring ESHS as detailed in the ESMP. ♣ Promptly notify the Bank of any incident or accident related to the project which has, or is likely to have, a significant adverse effect on the environment, the affected communities, the public or workers, such as possible impact of natural hazards during Project implementation or any violations of the Code of Conduct. ♣ Investigate and report all significant incidents related to environmental, social and health aspects. Carry out root cause analysis for all major incidents, and recommended actions to be taken to rectify the failure that led to these incidents. ♣ Carry out periodic site inspections to ensure ESHS compliance in workplaces. ♣ Review the Contractor's E&S documents, including OHS Manual, MSIPs and monthly ESHS Reports, and C-ESMP if that is requested to the contractor ♣ Manage the grievance mechanism for the project, as described in the SEP. ♣ Review tender documents and ensure compliance with the ESMP.
Supervisor	♣ Supervise ESHS compliance of Contractor ♣ Provide guidance to the contractor on implementation of ESHS aspects and provide training to the contractor's staff

Organization	Responsibility
	♣ Review and approve Contractor's E&S documents, and advise NRPB on compliance. ♣ Review Contractor's monthly ESHS Reports and advise NRPB on compliance. ♣ Carry out regular site inspections and periodic ESHS audits if needed to ensure ESHS compliance in workplaces. ♣ Engage an ESHS Specialist responsible for environmental and social risk compliance. ♣ Report and Investigate all incidents. Carry out root cause analysis for all incidents, and advise on the recommended actions to be taken to rectify the failure that led to these incidents.
Contractor	♣ Prepare the E&S documentation required by the contract, including OHS Manual and MSIPs prior to works commencement for Supervisor's approval, and the C-ESMP if that is requested to the contractor. ♣ Implement mitigation and monitoring measures as agreed and ensure they deliver performance required by the contract. ♣ Review the E&S documentation periodically, at least quarterly, and update in a timely manner. ♣ ♣ Prepare monthly ESHS reports. ♣ Promptly notify NRPB & Supervisor for accidents or incidents related to environmental, social and health aspects. ♣ Engage an ESHS Specialist responsible for Environmental and Social compliance. ♣ Report and Investigate all incidents. Carry out root cause analysis for all incidents, and recommend actions to be taken to rectify the failure that led to these incidents
VROMI	♣ Preparation of the site-specific ESHS management plans (detailed in the ESMP) for continued WWTP operations ♣ Monitor WWTP operation ESHS plans (detailed in the ESMP) and advise NRPB on compliance ♣ Supervise day to day WWTP management activities outside the scope of the Operator ♣ Liaise with External Entities on ESHS cross-cutting issues (for instance, with Nature Foundation regarding biodiversity and water quality aspects of IBAs and Great Bay)

Without prejudice to the enumeration of the entities' responsibilities according to each specific activity in the various phases of the project, the project managing entity must assess the needs and expectations of key stakeholders and relevant parties within the organization and define which activities will be adopted/prioritized to ensure the continuous improvement of the project.

Technical competence is one of the elements to be taken into account in project sustainability and to ensure that the organization provides products and services that consistently meet the needs and expectations of all stakeholders.

Technical competence should be seen as a priority objective that can only be achieved with the involvement and commitment of senior project management.

It is recommended that Environmental and Social Specialists of NRPB, Supervisor and Contractor undergo training on the understanding and implementation of the ESIA/ESMP. This training will ensure that all these entities are capable of managing and monitoring the environmental and social aspects of the A.TH. Illidge Road WWTP rehabilitation activities.

10. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

ESMP is developed by NRPB based on ESIA findings and key recommendations.

11. CONCLUSIONS

The **A.TH. Illidge Road Wastewater Treatment Plant** (co-funded by GoSM and the Netherlands) is not currently operating at its full capacity. An improvement of the WWTP operation and maintenance practices (Sub-component 1.2) will contribute to balance overall performance as well as to reduce pollution risks of water bodies and allows compliance with the Sint Maarten Sewerage Policy 2022. This rehabilitation is required to bring proper treatment of both the flows from the existing network and additional wastewater flows that will be collected through the Project financed sewerage network expansion (Sub-component 1.1) in line with the existing effluent discharge requirements.

With the preparation of the Environmental and Social Impact Assessment (ESIA) and the Environmental and Social Management Plan (ESMP), it was possible to identify and assess the impacts resulting from the specific activities of each phase (construction and operational phases) generated by the rehabilitation project of the WWTP. A series of management measures, strategies, and actions were also defined to address potential environmental and social impacts, with the aim of minimizing or enhancing their effects. These measures were formalized in an Environmental and Social Management Plan, accompanied by proposals for environmental and social monitoring, with the implementation of mitigation measures and risk management

It is therefore considered that this document offers clear and concrete guidelines to mitigate and offset all negative environmental and social impacts, as well as to reinforce positive impacts.

It is recommended that, during the design phase, prior to construction commencement, this document be reviewed and updated to include the specific conditions of project execution. The Contractor should also consider developing an ESMP based on the information contained in this document to ensure the active and effective implementation of all mitigation and mitigation measures for the environmental and social impacts anticipated for this project.

In summary, although there are impacts associated with the project's development, this document demonstrates that, with commitment and strong leadership, these impacts can be managed, with negative impacts becoming virtually non-existent and positive impacts becoming more pronounced.

ANNEXES

ANNEX 1 – WWTP LOCATION AND MAIN COMPONENTS

ANNEX 2 – PROJECT INTERVENTIONS

ANNEX 3 – ODOR ASSESSMENT

ANNEX 4 – LOCAL SURVEY

ANNEX 5 – LAND USE MAP

ANNEX 6 – MEETINGS (PUBLIC CONSULTATION)

ANNEX 6.1 – INDIVIDUAL MEETINGS

ANNEX 6.2 – PUBLIC CONSULTATION

ANNEX 7 – IMPACT QUANTIFICATION

ANNEX 8 – MATRIX OF ENVIRONMENTAL AND SOCIAL IMPACTS, MITIGATION AND ENHANCEMENT MEASURES AND RESPONSIBILITIES

ANNEX 9 – NOISE STUDY

ANNEX 10 – BIODIVERSITY MANAGEMENT PLAN

ANNEX 11 – SLUDGE MANAGEMENT STRATEGY