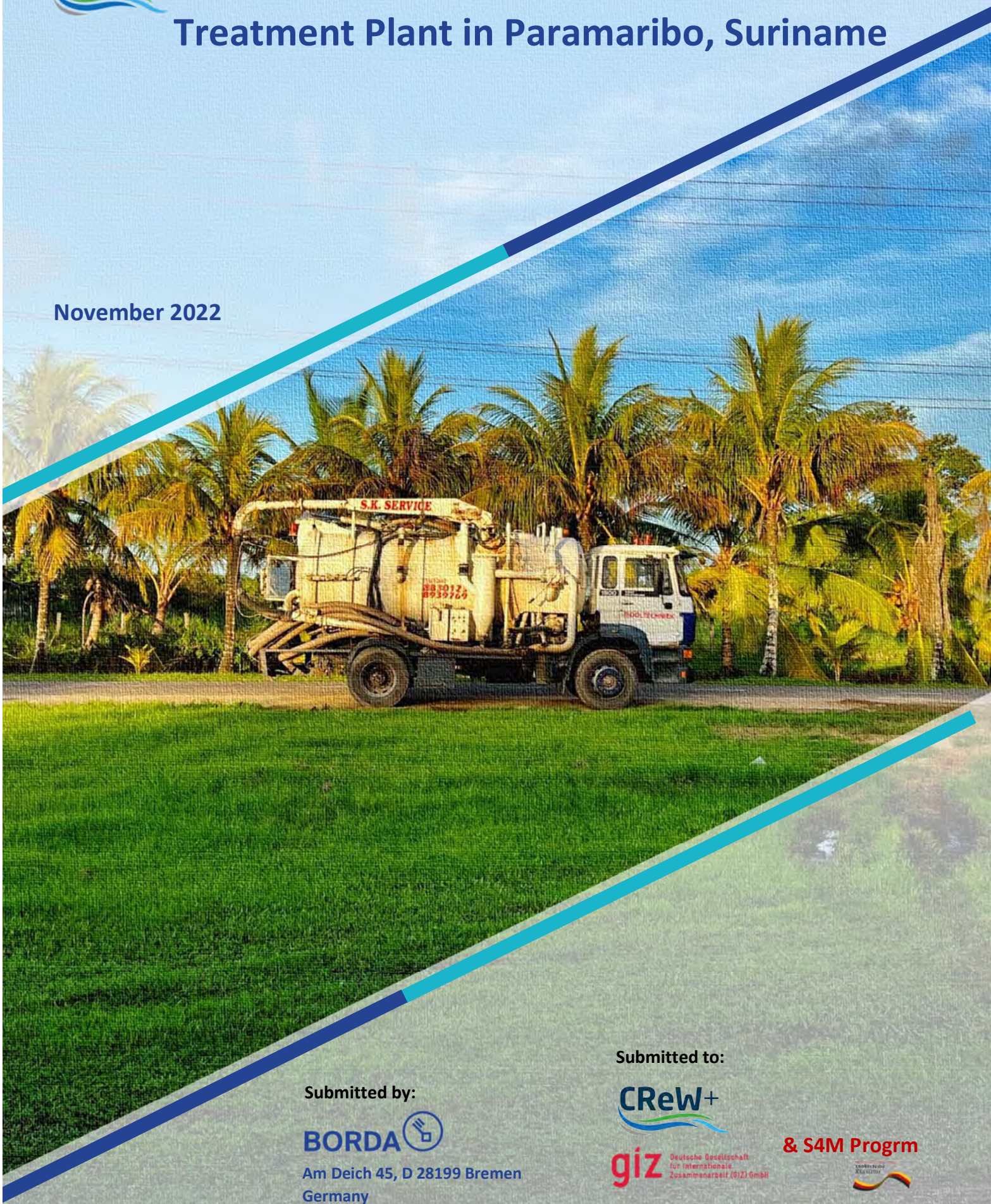
Detailed Design Concept for a Faecal Sludge Treatment Plant in Paramaribo, Suriname

November 2022



Submitted by:

BORDA

Am Deich 45, D 28199 Bremen
Germany

Submitted to:

CReW+

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

& S4M Progrm

The GEF CReW+ is a partnership project funded by the Global Environment Facility (GEF) that is being co-implemented by the Inter-American Development Bank (IDB) and the United Nations Environment Programme (UNEP) in 18 countries of the Wider Caribbean Region (WCR).

This project builds upon its previous successful phase "The Caribbean Regional Fund for Wastewater Management (CReW)" project (2011-2017). CReW+ is being executed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the Organisation of the American States (OAS) and the Secretariat of the Cartagena Convention (CAR/RCU) on behalf of the IDB and UNEP respectively.

The 18 participating CReW+ countries (Barbados, Belize, Colombia, Costa Rica, Cuba, Dominican Republic, Grenada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Panama, Saint Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname and Trinidad and Tobago) vary geographically from large, continental countries to small island states, with significantly different political, linguistic and cultural contexts.

About the GEF: The Global Environment Facility (GEF) has provided $22 million in grants and blended finance and mobilised nearly $120 billion in co-financing for more than 5,200 projects and programmes. The GEF is the largest trust fund focused on enabling developing countries to invest in nature and supports the implementation of international conventions on biodiversity, climate change, chemicals and deserti_cation. It brings together 184 governments, plus civil society, international organisations, the private sector and partners.

Financed by Co-implemented by Co-executed by

Acknowledgment

The implementation of this project would not have been possible without the support of many individuals and organizations, to whom we would like to extend our sincere gratitude.

First of all, we are thankful to the Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation) for approving the project and their financial and logistical support.

We owe special thanks to the Surinamese Ministry of Spatial Planning and Environment for leading the project from the Government side and providing unconditional support with a dedicated team throughout the entire project period. Equally so, the Ministry of Public Works supported us and provided us with key information to help us understand the contextualized requirements.

We also thank the Ministries of Agriculture, Livestock and Fisheries and Public Health for their cooperation and the National Institute for Environment & Development in Suriname (NIMOS) for their guidance on existing or foreseen national standards.

Of central importance for the project was the active support by the sludge service companies sharing insights into the desludging business, and their practical experiences, and assisting with sludge sampling.

To the Anton de Kom University of Suriname, we owe thanks for their advice and encouraging us by jointly lining out the first ideas to link the project goal to academic needs.

We are also grateful to ILACO Suriname N.V. and appreciate the great support we received from their team, which provided us with their expertise, technical assistance, accompaniment, and guidance every step of the way through the reality of Suriname.

Finally, we are very grateful to our colleagues from Aruba, South Asia, Mexico, and Germany for their professional kind cooperation as well as to our families for their often invisible, but pivotal support.

The Team

The core project team was confirmed by BORDA´s professionals from Aruba, Germany, India and Mexico, and by ILACO´s professionals from Suriname.

Index

1. Listings

1.1 Table of figures

1.2 Table of tables

1.3 Abbreviations

ABR	Anaerobic Baffle Reactor
ABS	General Bureau of Statistics
AF	Anaerobic Filter
ASTM	American Society for Testing and Materials
BOD	Biochemical Oxygen Demand
BOG	Bureau of Public Health
BORDA	Bremen Overseas Research and Development Association
CAR/ RCU	Secretariat of the Cartagena Convention
CARICOM	Caribbean Community
CB	Capacity Building
CC	Construction Companies
CELAC	Community of Latin American and Caribbean States
COD	Chemical Oxygen Demand
CREW+	Caribbean Regional Fund for Wastewater Management; GEF-project: Implementing water and wastewater solutions for a clean and healthy Caribbean Sea.
DC	District Commissioner
DEWATS	Decentralized Wastewater Treatment System
EFA	Environmental Framework Act
EHS	Environmental Health and Safety
ESIA	Environmental and Social Impact Assessment
FOG	Fats Oil and Grease
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSMS	Faecal Sludge Management System
FSTP	Faecal Sludge Treatment Plant
GBB	Ministry of Land Planning and Forest Management
GEF	Global Environmental Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPS	Global Positioning System
HH	Households
HRT	Hydraulic Retention Time
IADB	Inter-American Development Bank
ICAP	Instituto Centroamericano de Administración Pública
ICZM	Integrated Coastal Zone Management
IFC	International Finance Corporation
IWRM	Integrated Water Resource Management
LVV	Ministry of Agriculture, Livestock and Fisheries
MPN	Most Probable Number

NBS	Nature Based Systems
NH	Ministry of Natural Resources (Ministerie Van Natuurlijke Hulpbronnen)
NIMOS	National Institute for Environment and Development in Suriname
NMA	National Environment Authority
NRW	Non-Revenue Water
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
OAS	Organization of the American States
OW	Ministry of Public Works
OW	Ministry of Public Works (Ministerie van Openbare Werken)
PGF	Planted Gravel Filter
PPP	Public-Private Partnership
ROM	Ministry of Spatial Planning and Environment
ROS	Ministry of Regional Development and Sport
SCC	Sludge Service Companies
SME	Small and Medium-sized Enterprises
SRD	Suriname Dollar
SRT	Sludge Retention Time
SWM	Surinaamsche Waterleiding Maatschappij
SWOT	Strength Weakness Opportunities Threats
SWRIS	Suriname Water Resource Information System
TDS	Total Dissolved Solid (TDS)
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorous
TS	Total Solids
TSS	Total Suspended Solids
UNASUR	Union of South American Nations
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UPDB	Unplanted Drying Bed
VG	Ministry of Public Health
VS	Volatile Solids
WASH	Water Sanitation and Hygiene
WB	World Bank
WCR	Wider Caribbean Region
WFS	Foundation Waterforum Suriname
WHO	World Health Organization
WPI	Water Poverty Index

1.4 Glossary

Biochemical Oxygen Demand

Biochemical oxygen demand is an indicator obtained through laboratory testing to evaluate the total amount of biodegradable organics present in the waste. The BOD5 value is most expressed in milligrams of oxygen consumed per liter of sample during 5 days of incubation at 20°C and is often used as a surrogate of the degree of organic pollution of waste.

Bio-solids

They are nutrient-rich organic materials resulting from the treatment of domestic sewage in a treatment facility. When treated and processed, these residuals can be recycled and applied as fertilizers to improve and maintain productive soil and stimulate plant growth.

Chemical Oxygen Demand

The chemical oxygen demand is an indicator obtained by a laboratory test to evaluate the total amount of all possible organics present in the waste. It is commonly expressed in mass of oxygen consumed over the volume of solution which in SI units is mg/l. The most common application of COD is in quantifying the number of oxidizable pollutants found in wastewater.

Cistern Flush Toilet

It is the factory manufactured toilet with a cistern or flush tank attached to the bowl where the water is flushed by pulling or pushing the lever of the flush tank which releases the water to flush out the excreta from the toilet.

Desludging

Desludging refers to the process of removing the accumulated faecal sludge or septage from on-site sanitation technologies like e.g., septic tanks.

Desludging Operator

A person involved in the collection and cleaning of domestic or commercial septic tanks and pits using a vacuum suction vehicle.

Faecal Sludge

Faecal Sludge (FS) comes from on-site sanitation technologies and has not been transported through a sewer. It is raw or partially digested, a slurry or semi-solid, and results from the collection, storage, or treatment of combinations of excreta and black water, with or without grey water.

Faecal Sludge Management

Faecal Sludge Management (FSM) represents the storage, collection, transport, treatment and safe end-use or disposal of FS. FSM includes the storage, collection, transport and safe end use or disposal of FS. FS is highly variable in consistency, quantity, and concentration.

Grey water

The wastewater from bathroom, kitchen, washing areas and other anthropogenic activities other than wastewater coming from the toilet is called sullage or grey water.

On-site Sanitation Technologies

The on-site Sanitation Technologies use storage facilities in the house yard or its immediate surroundings. Examples of on-site technologies include pit latrines, holding tanks, septic tanks, and anaerobic filters.

Septage

Is the fluid mixture of partially treated or untreated sewage solids, liquids, and sludge of human or domestic residues. The holding thanks of this substrate.

Septic Tank

A septic tank is a watertight chamber made of concrete, fiberglass, bricks, or plastic, through which wastewater flow for primary treatment. Liquid generally flows through two chambers of the tank and heavy particles sink particularly in the first chamber to the bottom, while scum (mostly oil and grease) floats to the top. Over time, the solids that settle to the bottom are degraded anaerobically. The sludge must be removed periodically and treated offsite. The effluent, although clarified to a large extent, will still contain an appreciable amount of dissolved and suspended organic solids and pathogens. It can be used on-site with cautious measures or needs to be transported by sewers for further treatment to off-site treatment facilities. When there is no on-site use or transport through sewer possible for the effluent, the septic tank operates as a simple holding tank and must be emptied periodically.

Sanitation System

A Sanitation System is a series of technologies and services for the management of wastewater and faecal sludge i.e., for their collection, containment, conveyance, transformation, reuse, or disposal.

2. Executive summary

In the framework of the GEF Project CReW+ "Implementing Water and Wastewater Solutions for a Clean and Healthy Caribbean Sea", financed by the GEF in partnership with the IDB and executed in part by the GIZ, this GIZ is granting financial support to BORDA Las Americas A.C. to execute the project "Planning of a Detailed Concept for a Pilot Faecal Sludge Treatment Facility at Paramaribo, Suriname". The project aims to provide a solution to the current problem of disposal of untreated sludge from septic tanks into the Suriname River through the preparation of a detailed concept for a pilot Faecal Sludge Treatment Plant (FSTP).

The project developed in three phases from May to September 2022, with two site visits to Suriname in the greater Paramaribo area. In the preparatory phase, the focus was on general data collection and initial contact with stakeholders, while in the 2nd phase (the pre-feasibility phase) contacts were expanded and deepened, and a first draft concept for an FSTP in Paramaribo was developed. In the 3rd and last phase (pre-planning phase), the FSTP concept was further developed and discussed in detail with the stakeholders, also in the context of capacity-building measures. This report presents the respective outcomes.

The analysis of the legal framework for the construction of the FSTP has shown that the legislation for the water and sanitation sector is outdated and the new Environmental Framework Act has not yet been fully implemented and corresponding implementation measures and regulations have not yet been adopted. Therefore, a defined allocation of responsibilities and competencies between institutional stakeholders has not yet been done.

Suriname is one of the richest countries in the world in terms of water resources, but in the capital city of Paramaribo, in and around which 80% of the population of Suriname lives, there is a risk of water resource pollution due to the deficient management of wastewater and faecal sludge. Even though 90% of households have on-site treatment systems with septic tanks, these function deficiently due to a lack of maintenance. Also, the management of the faecal sludge is not sustainable because when the tanks are emptied by sludge service companies, this sludge is disposed without treatment into the canals resulting in significant pollution of the Suriname River. The same happens with sludge from containment tanks of small and medium-size enterprises, which is also discharged untreated into the canals.

Stakeholders involved in the sanitation system and faecal sludge management can be categorized into 5 groups: governmental institutions, private sludge service companies/construction companies, institution of higher education/Anton de Kom University, private households and involved communities, NGOs and other organizations. Their responsibilities, influence and interest concerning the project were analyzed and their role in the realization of a FSTP for Paramaribo was defined. The stakeholder group of financial institutions was not part of this project.

The key stakeholders that have a decisive impact on the project for the planning and implementation of an FSTP in Paramaribo are the Ministry of Spatial Planning and Environment (ROM), the Ministry of Public Works (OW), and the Sludge Service Companies (SSC). In addition, National Institute for Environment and Development in Suriname (NIMOS) as part of the ROM Ministry plays an important role as they are responsible for the establishment and monitoring of environmental standards. Soon this institution will be transformed into the new National Environment Authority (NMA).

The Ministry of Agriculture, Livestock and Fishery (LVV) is important for the implementation of options for the reuse of effluent and dried sludge to produce compost. Other Ministries such as the Ministry of Public Health (OV) and Natural Resources (NH) and the District Commissioners must be involved during the implementation of the FSTP.

To obtain more accurate data on the quantity and quality of sludge transported by the sludge service companies, they were approached during a survey and samples were taken from selected sludge loads and analyzed in a laboratory for essential pollution parameters. This is a prerequisite for an accurate design of the treatment plant. Based on the results of this survey and registered data at the official discharge site, the daily amount of sludge currently transported in Paramaribo by the sludge service companies can be estimated at 100 m^3. This sludge comes from a variety of sources and therefore has a very large variation in its quality and composition. For the planning, parameters were therefore used to ensure that even sludge with high pollution characteristics can be sufficiently treated in the FSTP to turn them into environmentally hazard-free products from which no health risks arise when reused or disposed.

The design of the FSTP aims at a operator-friendly and sustainable operation of the plant, ensuring at the same time quality and efficiency of the treatment system in the long term. The guiding principles for the design are: service-oriented operations, focus on reuse of treatment products, application of Nature-Based Solutions (NBS) for treatment technologies, gravity flow as the conveyance method, and a possible phase-wise implementation of the treatment system. The best fitting operation model seems so far to be a Public-Private Partnership.

For the design of a specific component of the sanitation service chain, in this case for the fecal sludge treatment facility, a general FSM concept where to embed this component is required. Although some components of the value chain are in place in Suriname, an overall FSM system has not been outlined for Paramaribo yet. Therefore, the team outlined a general basic FSM vision, intended on the one hand as a discussion basis for Suriname´s stakeholders involved in urban water and sanitation and on the other hand, to serve as a guideline to embedding the FSTP concept into a wider urban water and sanitation approach. The proposed FSM vision is presented along the four fecal-sludge related areas to be managed, namely the area of wastewater & sludge generators, area of emptying/desludging and transport, area of treatment facility and area of reuse. The vision also cuts across the different stakeholder's participation.

Based on a detailed understanding of the present FSM, its gaps and the expectations of the main stakeholder involved, a detail concept for a first FSTP for Paramaribo was developed. Technically, the conceived FSTP focuses on offering treatment to all sludges indifferently of its characteristics and has a treatment capacity of 100 m^3 per day (100% of the presently collected sludge). The technologies applied largely rely on nature-based systems. The facility also aims at taking care of basic needs of the desludging company drivers and trucks.

The operation model suggested for the FSTP relies on the co-management of a private operator, the supervision of the service by the Ministry of Public Works and the monitoring of compliance of health and environmental standards by the concerned authorities. The business model foresees the capital required for the establishment of the FSTP as a non-refundable investment from public funds. The operation and maintenance costs are expected to be covered 50% through discharge fees, 25% by the revenues from treatment products (compost) and the other 25% by government subsidy. The latest revenue may not be realized at the beginning, therefore increasing the need for subsidy. This model should be considered as a framework for further analysis by the main Surinamese stakeholder, rather than a finalized model. During the detailed design phase this model should be also further detailed out.

The concept integrates a future expansion area (Phase 2) that allows duplication of the treatment capacity.

To support the selection of a suitable site for the construction of the FSTP, site selection criteria were established; 7 locations were pre-evaluated, and 1 location was pre-classified as potentially suitable. It is being suggested to consider linking a planned Composting Project with the FSTP Project.

The financial requirements for capital investment and operation of the FSTP as presented, have been estimated. The establishment of a 100 m^3 FSTP will demand estimated USD 850,000. For the foreseen future expansion area, an amount of USD 200,000 for related land development costs would need to be invested within the first phase. Therefore, investments funds of around USD 1.1. million will need to be mobilized for the 1st phase. The O&M cost are estimated at USD 8,000 per month. 50% of this cost will require initial government subsidy.

A business model integrating the desludging service and the treatment service at the FSTP has been outlined. Key elements of this model are the suggested license for sludge service providers and the monitoring at 3 following levels: treatment efficiency and health and environmental standard compliance. Main revenues include the licensing fees, discharge fees and revenue from sale of treatment products, especially compost. Presently the compost has no established market in Suriname. Nonetheless, it must be viewed as a potential business that could lead the FS treatment facility to break even and then do without subsidies. However, this aspect requires further research.

Among all stakeholders, the Ministry of Public Works and the sludge service companies will be pivotal for the success of the FSTP.

A Rapid Environmental and Social Impact Assessment (ESIA) was conducted to identify potential risks and negative impacts at this early stage of the project and provide mitigation measures during the planning and design phases. It also enables to identify and estimate the positive impacts of the project and their chances of sustainability.

The results of the ESIA have been taken into account in the planning, although a more detailed assessment of the environmental and social impacts will only be possible once the exact location of the plant has been determined.

Capacity-building measures were implemented based on the capacity-building requirements identified at the beginning of the mission. This will help the stakeholders involved not only to have a deeper understanding of the needs arising from the situation analysis to improve faecal sludge management in Paramaribo but also a wider sense of the planning process of the FSTP. For information and awareness raising about the management of sludge in Paramaribo and the planning for a FSTP, a video was commissioned by the MSPE addressed to the general public.

The institutional stakeholders and the main sludge service companies see the need for changes in the current sludge management system that will both improve the sanitary conditions in Paramaribo and reduce or prevent environmental pollution. The task of the project to develop a detailed concept for a FSTP serving Paramaribo was met with great interest and approval, which was reflected in the intensive support provided. The construction and commissioning of a FSTP with a capacity of 100 m^3 sludge treatment per day would directly benefit over 25,000 households or 100,000 inhabitants as well as a relevant number of commercial operations in Paramaribo. With a future second phase increasing the treatment capacity by 100% the beneficiaries can reach 200,000 inhabitants, serving already the majority of the city of Paramaribo.

This detailed concept for a pilot faecal sludge treatment plant at Paramaribo will be presented to the ROM Ministry by GIZ and then to all stakeholders. After its general approval, the concept for the FSTP presented should be detailed out and a bankable and tender-ready project should be generated.

3. Introduction

3.1 Project background

In the Wider Caribbean Region (WCR), about 96% of the population has access to improved on-site sanitation (1) but about 80% of wastewater is discharged without further treatment into the environment, contaminating surface waters (lakes, rivers, and the sea), groundwater, and soils. These conditions are the cause of environmental and health risks for the population in the region. In Paramaribo, Suriname, the situation is no different. The city does not have a centralized sewerage system, and most residents have a septic tank as an on-site treatment system. However, due to a lack of maintenance and standards for construction and operation, malfunctions and low treatment efficiency are common and result in untreated wastewater being released into the environment.

The Global Environmental Facility (GEF) in partnership with the Inter-American Development Bank (IDB) and the United Nations Environment Programme (UNEP) have implemented in 18 countries of the region, including Suriname, the project Caribbean Regional Fund for Wastewater Management (CReW+), the continuation of the previous CReW project. The CReW+ Project is executed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the Organization of the American States (OAS) and the Secretariat of the Cartagena Convention (CAR/RCU) and aims to implement innovative technical small-scale solutions in the WCR using an integrated water and wastewater management approach based on sustainable financing mechanisms.

For the interventions in Suriname, the GIZ is granting financial support to BORDA Las Americas A.C. to execute the project “Planning of a Detailed Concept for a Pilot Faecal Sludge Treatment Facility at Paramaribo, Suriname”. The project aims to provide a solution to the current problem of disposal of untreated sludge from septic tanks into the Suriname River through the preparation of a detailed concept for a pilot faecal sludge treatment plant (FSTP) as the first step for the planning of the plant. The treatment plant will be part of an improved sustainable Faecal Sludge Management (FSM) system in the city. Therefore, the concept design is linked to capacity-building measures for relevant stakeholders related to the sanitation chain in the city including public institutions, private sludge service companies, the National University and civil society.

The project will contribute to the establishment of sustainable faecal sludge management in the city to mitigate environmental and health risks. The choice of technologies is based on nature-based solutions that focus on closing water and nutrient cycles through the reuse of treatment products.

3.2 Project location

The total project area of influence includes the city of Paramaribo and the district of Wanica as well as adjoining areas whereby the direct location for the construction of the treatment plant has not yet been determined. However, the plant will most likely be in the southern part

of the Wanica District (see

FSTP areas
1. Administration area
2. Resting area
3. Workshop
4. Truck cleaning area
5. Grit storage
6. Grit chambers
7. Storage
8. Settlers
9. Treated water tank for truck cleaning
10. Planted drying bed (PDB) roofed
11. Compost storage
12. Compost area
13. ABR and AF
14. Planted gravel filter (PGF)
15. Polishing pond
16. Treated water tank
17. Access

Figure 29: Future expansion area with the expansion area on the right (site plan)

6.2.4 Site selection process). The area of influence has an extension of approximately 260 km^2, where more than half of the total population of Suriname lives (more than 300,000 people).

The pilot project will directly benefit an important part of the population of the area of influence. The FSTP will improve the general sanitation conditions for the urban area of

Paramaribo and its surrounding through an improved FSM system and opens the way for further improvements toward a sustainable sanitation system for the whole city. The pilot project will serve the current sludge treatment needs and should be scaled up according to the expected gradual changes in the FSM and the projected population growth for a period of 10-15 years. In the subsequent chapters, projections, and design of FSTP will be discussed in more detail.

Figure 1: Geographical location of Suriname and its capital Paramaribo

For details on the project location at Greater Paramaribo (including the adjacent Wanica District) refer to Figure 30: “Main service area of the SSC and preferred area for the construction of a FSTP” at page 103 of this report.

3.3 Scope and approach of the project

The current project was planned in three phases to develop a detailed concept of a FSTP. Although the subsequent fourth phase of detailed, tender-ready design of the FSTP is not part of the project, it is the logical follow-up for the three project phases. The three phases are described below:

- **Preparation phase.** In the preparatory phase, the project team was brought together, and the contractual basis of the external consultants was concluded. First contacts with key stakeholders were established and the general project timeline was presented and agreed. Continuous coordination took place with GIZ as the direct contractual partner. The data collection on the general conditions for the project implementation was started with the support of the national partner ILACO Suriname N.V. The phase ended with the preparation of the first on-site visit to Paramaribo.
- **Pre-feasibility phase.** The phase started with the first on-site visit to Paramaribo to contact the stakeholders and present the project. Furthermore, a stakeholder analysis was prepared to identify, through a collaborative process, the interests of institutional and other stakeholders, their attitude towards the project and their willingness and capacity to support it. In addition to the institutional stakeholders, contact with private stakeholders was particularly sought, who play an important role as sludge service companies in the current as well as future sludge management system. This was at the same time done in view of future private management of the FSTP. Stakeholders related to the possible reuse of treatment end products were also contacted.

  In this phase, capacity-building requirements were analyzed, and measures were offered to stakeholders for the following visit to allow them a clear understanding of FSM and the FSTP planned for their city.

  Through the meetings and contacts, important planning data were compiled and options for sustainable management and business model for the FSTP could be analyzed. This was also an important basis for the preparation of the second on-site visit. Following the results of the first on-site visit to Paramaribo, the first drafts of the technical concept design and the business model could be elaborated, including the proposal for the operation and maintenance.

- **Pre-planning phase.** This phase started with the second on-site visit. The main objectives of the visit were:
  - Presentation and discussion of the first FSTP draft concept to the main stakeholders including the elements of an improved FSM system,
  - Data collection to further detail the concept,
  - Development of the detailed design concept and presentation to the Stakeholder,
  - Final preparation and implementation of capacity-building measures,
  - Data collection for the preparation of the final report with the Detailed Design Concept of the FSTP Paramaribo.

Part of the required detailed information was the quantity and quality of sludge transported by the sludge service companies. The necessary data were collected through sampling and laboratory analysis of the sludge and through a survey of the sludge service companies. In chapter 4.5 Faecal sludge: quantification and characterization, the process is described in detail. Further activities for the site selection were executed as mentioned before.

Prior to the implementation of the capacity-building activities during the second on-site visit, the content of the training was adapted, and the training measures were carried out. For two days, ministry personnel and students from the Anton de Kom University received information about FSM and a clear explanation of the concept of the FSTP. Printed materials such as a brochure and visual media such as a video were prepared to inform and explain the concept to other stakeholders. Chapter 8. Capacity-building – training measures describes in detail the training program, the components of each session, and the results of the capacity-building activities.

The third phase ends with the evaluation of the results of the second site visit and the preparation of the final report with the detailed design concept of the FSTP Paramaribo.

(1) IDB - Janson, N., Burkhard, L., Jones, S. (2021): *Caribbean Water Study*. Editors Cayetano, E., Cathala C. IDB Technical Note; 2320.


1933
SWM 2 SWM

4. General conditions for the planning of a FSTP in Paramaribo

4.1 General physical and demographic conditions

Suriname is a country in South America, neighboring French Guyana to the East, Guyana to the West and Brazil in the South; the northern border is the Atlantic coast. With 163,820 km², Suriname is the smallest sovereign state in South America, yet its population is one of the most ethnically diverse in the region and the only one that speaks Dutch as the official language.

The Republic of Suriname is a representative democratic republic, based on the Constitution of 1987. The National Assembly as parliament elects the president for a five-year term. Suriname is a member of several international organizations, including the United Nations, Organization of American States, the Caribbean Community (CARICOM), the International Monetary Fund, the Union of South American Nations (UNASUR) and the Community of Latin American and Caribbean States (CELAC).

The main industry in Suriname is the mining and processing of bauxite. There are an aluminum smelter and an alumina refinery in Paranam. Apart from the bauxite and wood-processing industries, manufacturing is limited to small import-substitution enterprises. Processed foods, clothing, cigarettes, and construction material are produced for the domestic market. Paramaribo exports bauxite, sugar cane, rice, cocoa, coffee, rum, and tropical timber. Cement, paint, and beer are made in the city.

4.1.1 Geographic conditions

Suriname can mainly be distinguished by three landscapes all with different topographic and geographic conditions: the coastal plains, the sparsely inhabited savannah along the border with Brazil and the Precambrian shield with tropical rainforest which occupies about 80 % of Suriname´s land surface. The coastal area can be also divided into the lower (young) coastal plain, the upper (older) plain. Most of the cultivated land is in the coastal area.

Suriname has seven major streams draining toward the Atlantic Ocean. The largest are the Marowijne and the Corantijn rivers that form the country's borders, respectively, in the east and the west. These two rivers flow northward and drain almost 58 % of the country. The Coppename and the Suriname river also flow northward and together drain about 24 % of the country. The smallest rivers are the Nickerie, the Saramacca and the Commewijne, which drain 16 % of the country. The final 2 % of the country consists of coastal areas with direct drainage into the Atlantic Ocean. The Suriname rivers drain on average about 4,800 m^3/s (756 mm/year) of freshwater into the Atlantic Ocean. The main rivers are tidal and contain brackish water in the coastal area.

Ninety-five percent of the country's total supply of potable water comes from groundwater. The groundwater resources of Suriname are used for public supply and to a lesser extent for the industry. Suriname contains two hydrologically distinct provinces, the Interior Precambrian Shield of crystalline rocks, comprising 80 percent of the country, and the coastal plain basin, comprising the remaining 20 percent. There is an abundance of good-quality

groundwater which is contained in the coastal basin. Groundwater in the young coastal plain is not renewable, groundwater in the old coastal plain and savannah belt area are renewable.

4.1.2 Climatic conditions

As indicated in the Suriname Water Resource Information System (SWRIS), the climate of Suriname is tropical, with daily temperatures varying between 23 and 31ºC. The relative humidity is about 80% a year, the sunshine is about 58% a year. The average annual rainfall in Paramaribo is about 2,200 mm. In the whole country, the rainfall varies from less than 1,750 to greater than 3,000 mm annually. The annual evaporation is about 1,700 mm. About 67% of the precipitated water on the Suriname river basins returns to the atmosphere by evapotranspiration and approximately 33% is drained off into the Atlantic Ocean. The year can be roughly divided into two wet seasons (April to mid-August and December to February) and two dry seasons (February to April and mid-August to December). According to the Water Poverty Index (WPI), Suriname belongs to the top 10 water-rich nations in the world (World Water Council, 3rd World Water Forum, 2002).

Around thirty percent of Suriname is within a few meters above mean sea level and it is therefore particularly susceptible to coastal flooding. That makes the country one of the most vulnerable countries in the world to the impact of coastal, fluvial, and pluvial floods.

Relatively frequent flooding is the result of poor drainage in the relatively densely populated urban areas along the coast and in the capital city of Paramaribo, exacerbated by high tides that reduce the effectiveness of the largely gravity-based drainage systems in the area. Urban flooding is frequent, with parts of the city and surrounding areas inundated each year.

4.1.3 Demographics

Suriname is one of the least densely populated countries in Latin America. Most of the inhabitants are concentrated along the roads and rivers of the coastal area and a southward-running area in the Para and Brokopondo Districts. Only in the vicinity of Paramaribo is there a relatively high population density.

When looking at the districts, it is noticeable that Paramaribo is the smallest district with the largest population, while Sipaliwini is the largest district with the smallest population. Paramaribo has the highest population density, although it only covers approximately 0.02 percent of the country. It can be concluded that the population is predominantly concentrated in areas around the districts Paramaribo and Wanica (together Greater Paramaribo).

Nearly all the inhabitants live within a 30-kilometer-wide coastal region. The capital Paramaribo lies about 20 kilometers south of the coast on the west bank of the Suriname River. The Interior is inhabited mainly by tribal people. Suriname is a country with very low population growth in the last years.

According to the 2012 census in Suriname, the district of Paramaribo had a population of that year 240,924. There was an average number of persons per household of 3.8 and a total household of 63,401. However, according to data from the General Bureau of Statistics

(Algemeen Bureau voor de Statistiek in Suriname), in 2017 Paramaribo has a population of 265,282, with an average number of persons of 4.1 and total households of 64,772.

Table 1: Population data from Paramaribo in 2012

Year	No. Households	Average size	Population
2012	63,401	3.8	240,924
2017	64,772	4.1	265,282

Based on the data above, the average annual growth rate is 1.94%. Using just this information, the population projection calculated for the next 20 years is:

Table 2: Population projection of Paramaribo until 2040 for design

Year	Population projection
2025	309,360
2030	340,556
2035	374,896
2040	412,700

Source: General Bureau of Statistics (GBS), *9th ENVIRONMENT STATISTICS PUBLICATION 2015* – 2019, General Bureau of Statistics (GBS)

(https://statistics-suriname.org/wp-content/uploads/2021/03/Final-9th-environment-pub-2020.pdf)

4.2 Legal and institutional framework

4.2.1 Legal framework

Suriname's legislation is exercised through a suite of different legislative instruments, including Laws or Acts of Parliament (Wet, also called Landsverordening prior to independence in 1975), Decrees 12 (Decreten), and regulations which are in the form of State Orders (Staatsbesluiten), Presidential Orders (Presidentiële besluiten), Presidential Resolutions (Presidentiële Resoluties) and Ministerial Orders (Ministeriële Beschikkingen). In general, legislation related to the management of the environment and natural resources is fragmented and scattered among various legislative texts.

The legislation for the water and sanitation sector in Suriname is outdated and does not meet current social requirements. Some shortcomings in the current legislation are the lack of rights and obligations of the water user, lack of control mechanisms, division of responsibilities and powers (no integration), lack of water quality standards, etc. Therefore, an adaptation or renewal is urgently needed. In Suriname, there are no specific laws regulating the entire water supply and sanitation sector. As for sanitation, there are even fewer legal instruments to regulate this subsector.

There are insufficient provisions for the assignment of competent authorities, rules for the discharge of domestic and industrial wastewater into the sewerage system, tariffs, etc.

Table 3: Current legislation in Suriname in the field of water and sanitation.

The Ancylostomiasis act (Anchylostoomwet)	Contains rules for the protection of water wells against contamination from ancylostomiasis. This act prohibits the use of faecal material as fertilizer and protects wells against contamination with this material.
The Building State Order (Bouwbesluit)	It prescribes that every building, intended for living, must have an adequate and separate discharge of black and grey wastewater into the municipal sewer system.
The Harbor Decree (Decreet Havenwezen)	Prohibits the discharge of waste, oil, oil-contaminated water, and condemned goods into public waters.
The Nuisance Act (Hinderwet)	Provides guidance to certain types of businesses about the environment, nuisance, and safety to the immediate environment.
Police Criminal Code (Politie Strafwet)	In this Code is stated that "The polluter of water in a well, water hole or a ditch or generally any water that will be used to drink or wash shall be punished with a fine or imprisonment not exceeding one month".
The Environment Framework Act (Milieu Raamwet)	Provides rules for the conservation, management, and protection of a healthy environment.

The Environmental Framework Act has been in force since 2020. National Institute for Environment and Development in Suriname (NIMOS), soon to be the NMA (National Environment Authority), is responsible for enforcing the law. The Environment Framework Act provides for several provisions that are directly aimed at waste management.

In addition, Article 33 states that the NMA establishes standards and procedures by Order (Beschikking) for the treatment of waste, including the collection, transport, transfer of waste, processing of waste and reuse in the environment.

It is intended that these standards and procedures will be part of the permit issued by the licensing authority. At this moment three draft legislation documents on water management have been prepared, namely: 1. draft act on the extraction of groundwater, 2. draft act on groundwater protection and 3. draft act on water supply supervision. These laws concern mainly ground and drinking water legislation. These new legislations should replace a part of the old legislation.

Another necessary legislation concerns surface waters. The process of drawing up this law has been started in 2022. None of the existing and draft laws are based upon Integrated Water Resource Management (IWRM).

In addition to national legislation, Suriname is a signatory to several international agreements and conventions in the areas of environmental management and occupational health and safety, including the Paris Agreement on Climate Change, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal and the Minamata Convention on Mercury.

Suriname lacks technical standards for wastewater discharge and effluent limitations. So international best practices are applied where national legislation, standards, or guidelines are lacking. International standards like World Bank standards are applied where applicable.

NIMOS has indicated that it is in a transition process in which they also pay attention to the formulation of national environmental quality requirements and standards. Those of the World Bank (2) are used as references. Efforts are also being made to set up and strengthen monitoring and enforcement thereof. It is expected that in the first quarter of 2023, the subsidiary legislation about pollution and contamination will be in place to complement the legislation framework.

Legislation with a direct impact on the project

Despite the lack of laws that fully regulate the water supply and wastewater sector, the following laws may affect the sludge treatment process, so this must be considered in this project.

- **The Ancylostomiasis act**

An example of an outdated law that may have some impact on this project is the Ancylostomiasis Law of 1917. According to Article 10 of this law, feces may not be used as fertilizer for agricultural purposes. In principle, this law is still in force and should be considered when reusing processed faecal sludge.

Further research should clarify whether this law is intended only for "raw" feces or also for treated feces. For this situation, treated feces specifically mean a "reduction" of pathogenic bacteria to an acceptable level.

- **The Building State Order**

The Building Decree includes guidelines that every building must have for faecal sludge collection and processing. According to Article 68, the following must be met:

A. A septic tank must provide sufficient drainage for toilets.
B. The connected toilets must be provided with water flushing, while no greywater or rainwater may be discharged into the tank.
C. The discharge of the tank must be connected via an oxidation bed to a sewer or public water designated by the Director of the Ministry of Public Works.

Due to the absence of a public sewer system, effluent flows into storm water drains. During heavy rain, the water may back up. The Bureau of Public Health (BOG) is responsible for sanitary inspection (monitoring) in households and public spaces but has no control over the construction and functioning of the septic tanks.

In general, it has been shown that if the design specifications are followed and the septic tank is of adequate size, the degree of treatment is satisfactory in removing solids and stabilizing organic wastes. However, the effect on pathogen removal is very moderate. Nevertheless, on-site treatment in a septic tank contributes to the improvement of environmental hygiene and public health.

4.2.2 Institutional framework

In Suriname, several government agencies and institutions are involved in the protection and monitoring of water resources without clearly defined assignments. This leads to fragmentation, sometimes duplication, and inefficiency in the water sector. The key institutions are mentioned here:

1. **Ministry of Spatial Planning and Environment (ROM)**
   Responsible for the preparation of environmental policy for the country and monitoring of its implementation.
2. **National Institute for Environment and Development in Suriname (NIMOS)**
   Functions as the environmental management agency in the country and administer the EIA process. The institute is under the responsibility of ROM.
3. **Ministry of Public Works (OW)**
   Responsible for policy, planning and development of general architectural structure, and other civil engineering infrastructure, flood control and drainage, surface water and urban drainage and management of waste as well as wastewater and sewage sludge.
4. **Ministry of Natural Resources (NH)**
   Responsible for the national policy with regards to minerals, water, and energy.
5. **Ministry of Public Health (VG)**
   Responsible for environmental health management, such as control of infectious disease, food and drinking water quality.
6. **Ministry of Regional Development and Sport (ROS)**
   Responsible for the development of rural areas and the provision of services outside Paramaribo. The District Commissioner is the most senior official in the district who represents the Ministry and is accountable to the Minister of ROS.

NIMOS, the executing arm of ROM, is responsible for advice and development of a variety of environmental standards and procedures, including waste management and environmental impact assessments. NIMOS will soon be converted into a National Environmental Authority (Nationale Milieu Autoriteit, NMA), responsible for enforcement of the Environmental Framework Act of March 2020 (Milieu Raamwet, S.B. 2020 no.79).

The organization of the sanitation and wastewater sector is fragmented horizontally as well as vertically within the governing structure. Horizontal means that several ministries, with one or more divisions each, are involved in the sanitation chain of water supply, sanitation, and wastewater management. On the other hand, the lower governments which are the

District Commissioners (DC's) of the 10 districts are also involved in all the aspects of the sanitation chain, depending on the area boundaries.

It is also evident that there is no leadership/ownership in the sanitation sector. Most of the institutions in the water supply and sanitation sector are weak. They are affected by a lack of financial means, a lack of sufficient qualified personnel and clear legislative direction. Most offer services that are not self-sustaining. At present, there is limited financing and limited financial resource allocation to the sector.

The four agencies closest to the core of sanitation are the:

1. Drainage Division (OW)
2. Building and House Inspection Division of the Ministry of Public Works (OW)
3. District Commissioners (DC's) of the Ministry of RO
4. Environmental Inspection Division (BOG) of the Ministry of Health.

The Building and Home Inspection Division and the DC's share the responsibility for permitting the installation of on-site wastewater systems. The installation and maintenance of combined sewers and secondary channels is the responsibility of either the DC's or the Drainage Division, depending on the administrative allocation of responsibility in the region. The establishment and maintenance of primary channels are the responsibility of the Drainage Division. The BOG, in cooperation with the DC's, is responsible for monitoring the functioning of the overall sanitation systems. The Divisions do not have a structurally well-defined system to perform their designated assignments.

Part 4.4 Stakeholder Analysis provides a detailed outline of the responsibility of these institutions and their role in relation to the project.

4.3 Urban sanitation of Paramaribo - situational analysis

4.3.1 Water provision

The coverage of water provision service in Suriname is around 79% in urban areas, meanwhile, in the whole Caribbean Region, the average cover is around 91% (1). SWM (Surinaamsche Waterleiding Maatschappij) is the sole water utility in Suriname. The wholly government-owned water utility has 131,711 water connections and reports an average of 22.54 hours of service per day. In urban areas and in coastal regions, groundwater is the primary source while in other rural areas and the interior of the country, surface water is the primary water source.

Surface water resources consist of seven major rivers, swamps, wetlands, man-made lakes, and channels. At Paramaribo city, these resources are parts of the Suriname River and the outfall of the Commewijne River. Groundwater as a source of water supply is found in the coastal zone, mostly in the western part of the country, with limited availability in the eastern zone and almost non-existent in the interior.

The A-Sand and Coesewijne aquifers supply water in the capital city of Paramaribo. According to the World Bank, Suriname uses less than 1% of its renewable water resources. The distribution of water use is 70% for agriculture, 22% for industry, and 8% for domestic use.

Regarding pollution problems in water resources, surface water is under high stress due to poor sanitation practices, and industrial and mining activities. Gold mining is responsible for contaminating the water with mercury. It is estimated that for every kilogram of gold extracted, 1 kg of mercury is released into the environment. More than 10 tons of mercury contaminate the air and water annually. Due to aquifer exploitation and limited recharge, groundwater faces saltwater intrusion, especially in coastal areas were saltwater infiltrates and mixes with underground freshwater reservoirs.

The SWM water utility is currently facing major problems. These include the age of the water infrastructure, as parts of the pipeline system are more than 50 years old. This leads to disproportionately high maintenance costs and high-water losses. Linked to this, another major problem is the high proportion of non-revenue water (NRW), which is a heavy burden on the utility's balance sheet. SWM reported NRW of 31 percent, equivalent to 241 liters per connection per day (1).

Several projects have been started and are ongoing to contribute to solving the problems in the water and sanitation sector. The project “WASH & Water Resources Management” is an initiative supported by UNICEF. The project addresses the need to create an intersectoral coordination mechanism to improve the coordination and performance of the water sector for better service delivery in the country.

The project “Integrated Water Resources Management (IWRM) in Suriname” aims to raise awareness of the importance of IWRM, increase existing knowledge of IWRM and improve the capacity of technical staff and key institutional stakeholders, as well as provide a roadmap for improved IWRM development and implementation in Suriname. The goal of the project is to develop an integrated water resources management plan for Suriname through a participatory and consultative process.

The second phase of this project called "Improved National Governance in Integrated Water Resources Management (IWRM) and Integrated Coastal Zone Management (ICZM)" aims to promote water resources management compatible with climate change. This is done by improving knowledge and capacity for IWRM at the national level and strengthening the regulatory framework for IWRM (surface water quality standards & surface water legislation) and enhancing its institutional capacity and coordination for IWRM in Suriname.

The objectives of the project "Improvement of Drinking Water Supply and Sanitation in the Coastal Region of Suriname" are to improve the water supply system by creating new production and distribution capacities in Paramaribo and Moengo and the strategic water supply planning by updating the Suriname Water Supply Master Plan for the Coastal Area. It includes measures to reduce the NRW. In addition, an integrated approach with respect to the entire water cycle will be pursued with a focus on wastewater in Paramaribo and Moengo.

This project is carried out with the support of the European Union and has a budget of 16 million euros. The project is underway about water supply but was interrupted due to the Corona pandemic. Regarding sanitation, there is no information available on the detailed planning or progress of this component of the project. In this regard, the water utility SWM

refers to the Ministry PW, which has this part of the project budget in hand, since it has the responsibility for wastewater.

The Inter-American Development Bank is supporting Suriname in a Water Supply Modernization program with a loan of USD 25 million. The objective is to improve the efficiency, quality, and financial and environmental sustainability of the drinking water services provided by SWM. This will be achieved by reducing NRW levels in the central and western regions, increasing the availability of water services in critical areas of Suriname by upgrading water production infrastructure and modernizing SWM's operations and management by implementing an institutional strengthening plan, and by developing an inland water supply strategy.

4.3.2 Solid waste management

In Paramaribo, the Ministry of Public Works is responsible for solid waste management which includes waste collection and disposal. For the collection, the Ministry contracts the private sector. Private companies are responsible for collecting solid waste from households and transporting it to the Ornamibo landfill. For waste transporting, the ministry has developed a macro routing system, dividing Paramaribo into three waste collection zones (north, mid, and south) and 74 residential collection areas (rayons).

The central waste disposal site of Ornamibo, located south of Paramaribo, serves the population of the districts of Paramaribo, Wanica, Para, Saramacca and Commewijne. Approximately 475,000 people live in the service area (2017), or more than 85% of Suriname's population. This centralized landfill, which has no surface cover or other sanitation facilities, poses a serious threat to the environment and public health. It is estimated that about 200,000 m^3 of solid waste is dumped here annually, mainly from households but also from stores, markets, offices, industries, and hospitals in the service areas (4). There is a second waste dump in Charlesburg. It is privately operated and receives mainly non-domestic waste.

Waste separation and recycling are non-existent. The waste is not seen as a potential resource that can be refined or recycled. Only products like oil, chemicals, batteries, or electronics are partially separated, but some of these waste flows end up finally as well at the Ornamibo landfill.

In 2018, a waste sector improvement project (4) concluded that greater investments and efforts are needed in most components of the waste sector to create more efficient, modern, and hygienic waste management conditions. The necessary improvements relate to waste collection, primary transfer, transportation, waste separation, composting and recycling, the establishment of adequate systems for the disposal of hazardous waste and healthcare waste and the creation of sanitary disposal conditions in the short and long term. In the project proposal, it is assumed that a maximum of 20 - 30% of the municipal waste generated can be reused as compost. The rest must be disposed of in landfills.

Finally, two project proposals for short-term implementation have been elaborated within the framework of this project. The first proposal refers to a pilot project on composting and the second on waste separation.

To demonstrate how the composting sector in Suriname could become successful, this composting project focuses on the realization of a pilot plant with a maximum production capacity of 10,000 tons of compost per year. It also includes an organic waste collection component that includes the separate collection of about 20,000 tons of organic waste per year. Some of the waste will be collected from households in a selected pilot urban area, some will be collected through the collection of organic waste from fruit and vegetable markets, and in addition, organic material is available from the cleaning of ditches and open channels in Paramaribo. The construction of such a pilot composting plant would allow the processing of the collected organic waste into up to 10,000 tons of compost.

The realization of the plant is intended to take place gradually, depending on the quantities of organic waste collected and the actual sales opportunities. So far up to now in 2022, no final decisions have been made on the realization of the project or on a timetable for its implementation.

4.3.3 Stormwater management

Paramaribo has average precipitation between 2,000 - 2,250 mm/year. The rainfall is highest between May and June, and lowest in September and October. The rainwater drains into ditches, open channels, and pipes. The effluent from septic tanks also flows into the same drainage system. Excessive rainfall and high seawater levels can overload the system and are the cause of frequent flooding during the rainy season. This is aggravated by the heavy vegetation growth in the channels, which is also caused by the nutrient charge carried by the effluent. In urban areas such as Paramaribo, floods damage frequently houses and public infrastructure and affect roads but also the sanitation infrastructure (septic tanks).

4.3.4 Wastewater management

Even though 95% of households have septic tanks as an on-site treatment system, wastewater is not safely managed in Paramaribo. Typically, septic tanks contain three chambers with a third chamber containing filter media to better treat the supernatant/effluent. These systems are only used for the primary treatment of wastewater from toilets (feces, urine, flush water and cleansing materials). According to the reports on sanitation in Paramaribo, many septic tanks do not function properly because they are not well maintained. Then the on-site treatment efficiency is low. They are emptied only when they are filled with sludge, which often leads to clogged pipes and leaks.

Even commercial businesses must have septic tanks to treat their wastewater on-site in septic tanks. These septic tanks are emptied regularly, but the sludge is then discharged untreated into the surface water. A more detailed description you can find below.

4.3.5 Faecal sludge management

Paramaribo currently has no treatment plant for wastewater or faecal sludge, even at the local level. Of the three wastewater treatment facilities that used to operate in the wider city area, two were out of service for long periods and have since been dismantled. The first was an activated sludge plant operated by the Suralco bauxite company in what was known as Suralco Village ("Via Bella") and served no more than fifty households. The second consisted of oxidation ditches in the Half Flora area to treat effluents before they were discharged into the Saramacca Canal. The third system, the lagoons collecting effluent from the Santo Boma prison, had already in the past a poor performance due to lack of maintenance. On-site sanitation systems are the only way black, and wastewater are partly treated in the city.

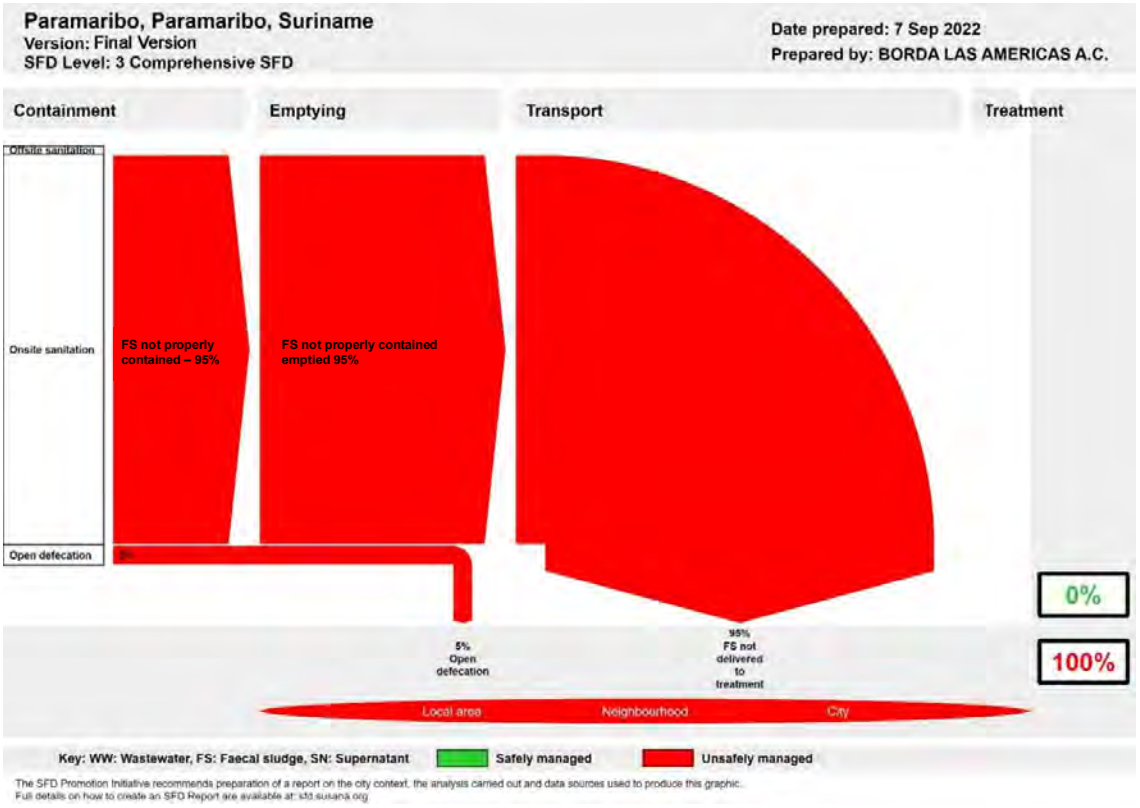


Figure 2: Excreta flow diagram- Paramaribo

The excreta flow diagram for Paramaribo reflects this situation in which no part of the faecal sludge is safely managed. The transport ends without treatment discharging the sludge into the environment.

The way in which faecal sludge is managed in the greater Paramaribo area, the current sanitation system, is characterized by the generation of wastewater using flush toilets in the households and its storage and on-site treatment in septic tanks. The effluent from the septic tanks flows into drains and open channels and the settled sludge is emptied by vacuum tank trucks and discharged without treatment into channels and the Suriname river.

The flush toilets (U.1) are the first stage of the sanitation system and are called user interfaces describing the part of the sanitation chain in which the users encounter the system. The excreta together with the flush water and toilet paper flows into the septic tank (S.3), the following stage of the chain where the wastewater is collected, partially treated and the liquid phase (effluent) separated from the sedimented sludge (faecal sludge).

The effluent is discharged into the ditches, open channels, or rainwater drainage systems alongside or under the roads which serve also for the disposal of the greywater that does not flow into the septic tanks. The emptying and transport of the sludge also called conveyance, is done by vacuum trucks (C.2). This is a necessary service to maintain the septic tanks and enable their proper functioning. Additionally, the vacuum trucks offer the service of cleaning tanks filled with grease trap residues or slaughterhouse sludge. In the current sanitation system, there is no treatment of the effluent or sludge, and the trucks discharge the faecal and other sludge directly into the river.

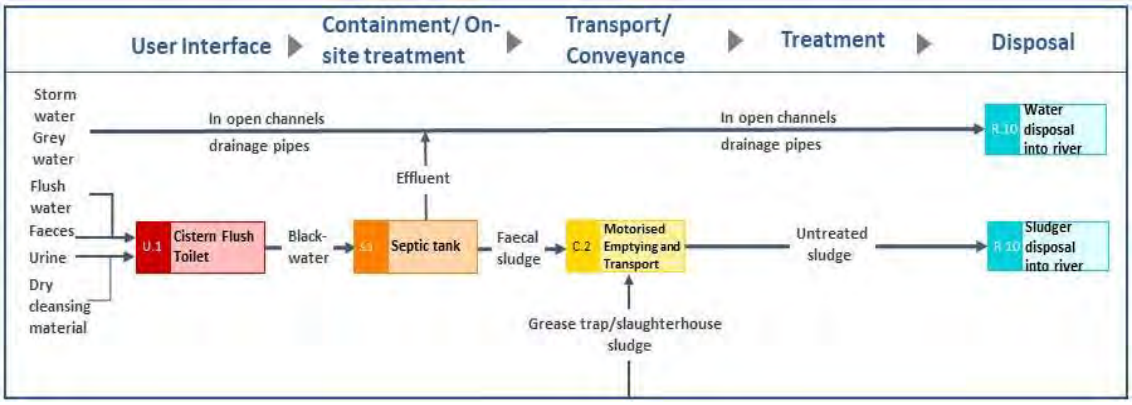


Figure 3: Current sanitation system in Paramaribo

4.3.5.1 User interface and containment

The most common user interface in Paramaribo is the flush toilet. The Suriname State Building Code states that the toilet must have a flush and be connected to a septic tank. The same law requires that every household and commercial establishment have a septic tank to treat wastewater on-site. The discharge from the septic tank must be connected through an oxidation bed to a sewer or open channel designated by the Director of the Department of Public Works. However, due to a lack of supervision and control, septic tanks are sometimes constructed without a bottom or without a filter bed and with leaking joints which leads to environmental contamination.

Approximately, about 90% of households use septic tanks and all businesses use also septic tanks as containment and on-site treatment systems to collect their wastewater. A well-designed and managed septic tank as an on-site wastewater collection and treatment system can help efficiently in reducing the risk of environmental pollution and health risks but the design and maintenance of these septic tanks are not always adequate. There is a lack of standardized design and regulations for septic tank construction. Proper maintenance includes emptying the tanks on a regular basis.

However, many homeowners consider the cost too expensive and delay sludge removal. They wait until the system is clogged, resulting in overflowing septic tanks, and posing environmental and health hazards.

Heavy rainfall can exceed the drainage capacity of the ditches and open channels and flooding can be caused. The occurrence of flooding and inundation in Paramaribo and other places in the coastal plain is common and the flooding risk in parts of the Greater Paramaribo area is high. As these ditches and channels are also used as a combined drainage system for greywater and effluent of the septic tanks, black and greywater contamination of surface water poses a risk to public health and the environment, especially in densely populated areas.

There is also a lack of comprehensive understanding of septic tank function and operation. Therefore, the maintenance requirements are not known. The most common are standard one- or two-chamber septic tanks with 2 to 3 m^3 volume. This type of septic tank often collects only a part of the solid components of household effluent. When not properly maintained the treatment efficiency is low. When the septic tank is filled with sedimented sludge, raw blackwater is discharged untreated into the drains and channels.

4.3.5.2 Transport/conveyance

The septic tanks from private households are emptied by private vacuum truck companies. Restaurants and food processing companies are also using the services of these companies to empty their septic tanks and grease traps. Commercial customers usually have their septic tanks and grease traps cleaned on a periodic basis with fixed contracts with the sludge companies. Private customers usually wait until the septic tank is filled with sediment sludge and the septic system is clogged before they call the emptying service. This complicates the emptying process and requires the injection of water to suck out the sludge.

The sludge service companies empty the septic tanks and grease traps according to their service demand which results in the mixing of different types of sludge in their tanks. Some sludge types tend to sediment heavily inside the tank, e.g., sludge from chicken slaughterhouses, which leads to increased cleaning efforts during emptying (see also 4.5.2 Quantification and qualification of sludge - data obtained from sludge service companies).

4.3.5.3 Treatment and Disposal

The sludge service companies were advised by the corresponding authority to empty their trucks at Tout Lui Faut beside the compound of the Staatsolie Company (Suriname's National Energy, Oil & Gas Company) at the end of a short unpaved road. They discharge the sludge there directly into the Surinam River. This disposal solution was introduced 15 years ago as an interim solution but has not been changed since then. The collection of fees introduced in 2022 by the district commissioner of Wanica has to a certain point officialized this solution. Records of the discharge registers at Tout Lui Faut and the total estimated daily truck loads, suggest that sludge companies discharge sludge also at other locations than the designated disposal site, even if it is illegal to do so.

The sludge of the septic tanks and grease traps reaches the site without any treatment. The pollution of the environment and the river is obvious, and this form of disposal poses serious health risks.

The pollution of the river water has an impact on the quality of fish caught in the river and can have an impact even on the water supply system of the city which is partly connected to the river water body.

4.4 Stakeholder analysis

4.4.1 Stakeholder listing

Stakeholders involved in the sanitation system and faecal sludge management in the greater Paramaribo area can be categorized into 5 groups, with public/institutional stakeholders, private companies, and educational institutions directly engaged in the ongoing pre-planning phase of the project. The involved communities are not clearly defined as stakeholders yet due to the lack of site selection for the FSTP (see 4.2 Site Selection Process). The stakeholder group Financial institutions was not part of this project and therefore not included.

A. Governmental institutions
B. Private sludge service companies/construction companies
C. Institution of Higher Education/ Anton de Kom University
D. Private households and involved communities
E. NGOs and other organizations

A. Governmental institutions

Following the results of the last elections on May 25, 2020, significant changes were made to the government administration, including the establishment of the Ministry of Spatial Planning and Environment (ROM, July 2020)) and the redistribution of mandates and responsibilities between ministries. The new ministry has taken over assignments and responsibilities from the former Environment Coordination in the President's Cabinet and other ministries. The National Institute for Environment and Development (NIMOS) is as well part of ROM's responsibilities from there on. The direct partner for the CReW+ project in Surinam is the ROM ministry.

Table 4: Governmental institutions

SL No.	Institution	Responsible	Contact persons
A.1	Ministry of Spatial Planning and Environment (ROM)	Minister Silvano Tjong-Ahin	Rathna Kewal (Deputy Director of Environmental Department)
	National Institute for Environment and Development in Suriname	Director: Mr. Cedric Nelom	Mr. Cedric Nelom (director)
A.2	Ministry of Public Works	Minister Riad Nurmohamed	Soeratmin Moestadj (Ministry Advisor)
	Directorate Civil Works	Director Mr. S. Mohan	Mr. S. Mohan (director)
	Directorate Public Green	Deputy director Waste Management Mr. Jason Gummels	Ms. Saskia Chote
A.3	Ministry of Natural Resources	Minister David Abiamofo	
	Directorate Water	Director Water: Mrs. Gonda Asadang	Mrs. Gonda Asadang (Director Water) Mrs. Reina Ormskirk (Deputy director Water)
	Surinaamse Waterleiding Maatschappij (SWM)	Director: Mr. Clifton Lienga	Wendell Purperhart (Head of the Department) Ms. Ashwinie Boedhoe-Hemai (Deputy Director Strategy and Policy)
A.4	Ministry of Public Health	Minister Amar Ramadhin	Mr. Rakesh Sukul
	Bureau of Public Health	Director Mr. Radjesh Orie	Stephanie Cheuk-Alam Head of Environmental Inspection
A.5	Ministry of Agriculture, Livestock and Fisheries	Minister Parmanand Sewdien	
	Directorate Agriculture	Director Mr. Soedeshchand Jairam	
	Deputy directorate Agricultural research, marketing, and processing	Deputy Director	Mrs. Soesila Udit-Ramautar (Head of Fruit Crop Division) Jacintha Vigelandzoon (Head of Research Division)
A.6	Ministry of Land Policy and Forest Management	Minister Dinoyha Vorswijk	Ms. Lavanda Koedemoesoe (Deputy Permanent Secretary)
A.7	District Commissioner Wanica Southeast	District Commissioner (DC) Shafiek Goelaman	Reita Joemratie (Assistant district commissioner)

B. Private sludge service companies/Construction companies

The sludge service companies are privately owned family businesses. Most companies have a multi-purpose operation that provides not only septic tank emptying service but also ditch and open channel cleaning or other infrastructure maintenance services. The regular business operations of most companies are based on on-call customer demand, while some companies provide regular service to commercial customers.

Some companies have more than one vacuum truck, which are used not only for emptying septic tanks but also for other services such as open channel cleaning. In companies with only one vacuum truck, the owner is also the driver of the truck. This is one of the reasons that make it difficult to contact this stakeholder group. Another reason is the competitive situation in the septic tank emptying business, which leads to a low willingness to share data with third parties.

Table 5: List of private sludge service companies/construction companies

SL No.	Company	Responsible
B.1	Bron Bere N.V.	Mr. Kramat Abdul (owner)
B.2	Akanharie Opruimingdienst	Mr. A. Q. Moentadj (owner)
B.3	Septic Service Akanswarie	Mr. Salamat (owner)
B.4	S.K. Service	Mr. Gobardhan (owner)
B.5	Farzand Ali	Mr. FarzandAli (owner)
B.6	Aflexion	Mr., Gokoelmissier (owner)
B.7	ICON N.V.	Mr. Gravenbeek (owner)
B.8	Flogo Flexy	Mr. Subhaas (owner)
B.9	Private construction companies	

Private construction companies design and build the septic tanks for households and commercial businesses. There are no binding detailed regulations and control for the construction of septic tanks and therefore not all designs meet the requirements for an efficient treatment of the wastewater.

C. Institution of Higher Education/Anton de Kom University

Anton de Kom University is the only university in Suriname. The university has not been involved in any activities or research in the field of wastewater or faecal sludge management but sees the need for the academic institution to be involved in this area to help solve problems and prepare future engineers in this field.

Two faculties see a direct link to their educational program, the Faculty of Infrastructure, and the Faculty of Environment. The dean of the Faculty of Environment, Prof. Max Huisden, is also chairman of the Stg. Waterforum, which has the competence and has already become active in this field.

Table 6: Institution of higher education/Anton de Kom University

SL No.	Institution	Responsible	Contact persons
C.1	Anton de Kom University Faculty of Infrastructure (Department of Infrastructure)	Chairman of the Board Mr. Ryan Sidin	Prof. Sun Kishoen Misier
	Faculty of Environmental Sciences		Prof. Max Huisden

D. Private households, business owners and involved communities

The household owners and members of the households are a large stakeholder group and a significant part of the population in the greater Paramaribo area. Since all households should have a septic tank, the responsibility for the first and second stages of the sanitation chain, the user interface, and the containment or on-site treatment system, i.e., the septic tank, lies in their hands. However, most homeowners are not aware of this responsibility and are not prepared for it in any way. As a result, the septic tank is poorly maintained, leading to malfunctions and poor treatment performance. These private households only become aware when the system is completely clogged, and the help of sludge service companies is needed.

Business owners or managers are much more concerned about keeping their containment system in good working conditions, knowing that the sanitary conditions of their business depend on it. Also, the supervision by the Ministry of Health forces the business to maintain good hygienic practices and the containment system of the wastewater is a crucial part of this.

Communities directly involved in a project to construct an FSTP may not be encountered until the final site selection is done. In the meantime, the community in general can be approached to inform the public and raise awareness of the need for proper faecal sludge management and the construction of a necessary faecal sludge treatment facility.

Table 7: Private households, business owners and involved communities

SL No.	Group of people	Responsible
D.1	Private households	Homeowner
D.2	Commercial businesses	Business owners or managers
D.3	Directly involved Communities	Community leaders

E. NGOs and other organizations

The Foundation Waterforum Suriname (WFS) is a group of experts in the water sector and aims to increase awareness of integrated and sustainable water management by exchanging knowledge, experience and expertise on surface water, wastewater, drinking water, etc. One of the secondary objectives is to contribute to national policy developments in water management in Suriname. For this purpose, various activities are undertaken, including information and educational activities. The Stg. Water Forum is involved in advising various ministries and therefore has a distinguished role in the implementation of integrated wastewater and faecal sludge management in Paramaribo.

Other non-governmental organizations have not yet been identified since the organization of population groups around common interests or for the implementation of common interests is not yet well developed.

Table 8: NGOs and other organizations

SL No.	Organization	Responsible	Contact persons
E.1	Stg. Waterforum	Chairman of the Board Prof. Max Huisden	Prof. Max Huisden (chairman)

4.4.2 Stakeholder analysis

In the following pages, a detailed analysis of the individual stakeholders was carried out using the SWOT method (Strength-Weakness-Opportunities-Threats). This is intended to show which are the key stakeholders for the planning and implementation of the project, which strengths and internal weaknesses are to be expected and how external circumstances affect these stakeholders. The results are summarized at the end of this analysis along with an assessment of the influence and interest of each stakeholder or stakeholder group in an Influence-Interest Assessment Matrix.

Table 9: Stakeholder SWOT analysis in relation to the FSTP project

SL No.	Stakeholder	Responsibility	Strength	Weakness	Opportunities	Threats
A.1	Ministry of Spatial Planning and Environment (ROM)	• Spatial planning in the territory of Suriname • Preparation of environmental policy for the country and monitoring of its implementation • Development of environmental legislation as well as the implementation of environmental conventions • Point of contact for International Cooperation	• Mandate to prepare legislation prohibiting sludge dumping in water bodies and instead its treatment at a treatment facility. • Mandate to approve land use. • Highly motivated personnel. • Awareness of the need for changes in the current faecal sludge management system	• Insufficient personnel resources • Lack of necessary capacity building • High workload due to a wide range of responsibilities	• Political in principle will to invest in FSTP and to enforce laws and regulations • The FSM topic is of public interest and raising awareness of the need for it could be politically rewarding.	• Long legislative procedure • Limited available budget • Difficult economic situation with fast raising dollar rates
	National Institute for Environment and Development (NIMOS)	• Environmental management agency in the country • Administrator of the EIA process • Provision of environmental permits • Preparation of environmental norms and standards • Is in the transition phase to be the new environmental authority NMA. • Construction and maintenance of parks and public gardens, government sites	• Mandate to approve the EIA • Expanded mandate through new environmental legislation • Mandate for environ-mental monitoring and enforcement of new laws.	• Insufficient human resources for the new assignment as NMA • Lack of necessary capacity building	• Opportunities of knowledge transfer through international cooperation • Raise of environmental awareness through successful projects in this area	• Natural disasters/flooding can result in environmental pollution • Budget limitations

SL No.	Stakeholder	Responsibility	Strength	Weakness	Opportunities	Threats
A.2	Ministry of Public Works (OW)	• Preparing and implementing the policy of public infrastructure • Planning and development of general architectural structures • Flood control and maintenance of drainage systems • Hydrological and meteorological monitoring • Wastewater and sludge management • Civil engineering for infrastructure • Technical provisions for traffic and public transport • Management of all harbours	• Mandate to prepare for necessary infrastructure and to tender construction of FSTP • Responsible for wastewater and sludge management • Expertise for design and construction supervision • Availability of personnel and machinery • Mandate to supervise contractors	• Budget limitations for the construction of a FSTP • Financial shortages for the management of a FSTP • Lack of qualified personnel to operate and manage a FSTP • Unclearness regarding responsibility to integrate FSM into existing organizational structure	• Public-Private Partnerships possible • Raising awareness of the need for changes in the current faecal sludge management system • Positive attitude of international banks towards investment in FSM infrastructure	• Political restrictions on the authorization to apply for loans • Critical situation of the economy due to high energy prices
A.3	Ministry of Natural Resources (NH)	• Preparing and implementing national policy on natural resources and energy • Water management and drinking water supply • Energy Supply • Monitoring land use and land issues • Monitoring compliance with rules and regulations regarding minerals, water management, biodiversity and energy supply	• Mandate for environmental monitoring • Mandate for protection of biodiversity • Mandate for protection of water bodies	• Lack of required capacity building	• Raising awareness for need of efficient natural resource management • Raising awareness for the protection of the natural resources and the need of a circular economy approaches, resource protection through reuse of treated waste products	• Limited available budget
A.4	Ministry of Public Health (VG)	• Supervision of public health, stimulate and promote public health • Health information and raising public awareness.	• Mandate to ensure sanitary conditions of septic tanks	• Lack of development of the necessary capacities • Lack of control mechanism for the	• Raise awareness for the need of hygienic controls of different parts of the sanitation chain	

SL No.	Stakeholder	Responsibility	Strength	Weakness	Opportunities	Threats
		• Ensuring availability of medicines and medical supplies	• Mandate for sanitary control of treatment end-products of a FSTP	safety requirements of each product (compost and water) • Lack of necessary equipment for enforcement of regulations • Large range of tasks with high personnel requirements		
A.5	Bureau for Public Health (BOG)	• Preparing and implementing environmental hygiene policies • Sanitary inspection and industrial hygiene • Sanitary control and supervision of the treatment/disposal of industrial waste	• Mandate to approve the use of the FSTP´s final products (compost) in agriculture and or its commercialization	• Lack of control mechanism to enforce health and environmental hygiene policies • Insufficient personnel for sanitary inspections	• Raising awareness among farmers and households for the use of natural compost instead of artificial fertilizers	• Limited government budget
A.6	Ministry of Agriculture, Livestock and Fishery (LVV)	• Preparing policy for management of agriculture, livestock, fisheries, and beekeeping • Supervision of the correct use of land and waters issued to the agricultural sectors. • Research and knowledge transfer • Controlling and preventing animal and plant diseases and pests • Establishment of quality standards	• Increasing interest in organic fertilizing in the ALF. • Mandate for knowledge transfer and promotion of compost technics. • Authority for the approval of the end-products of FSTP for	• Limited knowledge dissemination on techniques for composting organic residues • Lack of quality control mechanism for end-products from FSTPs	• Increasing prices for chemical fertilizers encourage the search for alternatives • Raising awareness among farmers and households for the use of natural compost instead of chemical fertilizers	• Lack of social acceptance of the use of organic fertilizer produced from human excreta

SL No.	Stakeholder	Responsibility	Strength	Weakness	Opportunities	Threats
		• Responsible of compliance control with agriculture legislations • Enhancing the cooperation between the sector organizations • Food product promotion for food supply and export	usage in the agriculture sector			
A.7	Ministry of Land Policy and Forest Management (GBB)	• Sound spatial planning in consultation with other ministries • Land use planning; in an inter-ministerial context, if necessary	• Competent authority together with ROM for granting the necessary land for the construction of a FSTP	• Automated land management data system is not available	• Ongoing change process on the responsibilities for environmental protection, land use planning and use of natural resources	• Ongoing change process on the responsibilities for environmental protection, land use planning and use of natural resources • Long legislative procedure for land issue
A.8	Regional Development and Sports (ROS) / District Commissioners	• Development of rural areas and the provision of services outside Paramaribo • Managing duties in each of the ten districts by the district admirations headed by District Commissioners	• Mandate to grant permission to set up and operate a FSTP in its district. • Authority to (Co-) determining fees for delivering sludge to a FSTP	• No effective mechanism to control illegal dumping of sludge in water bodies • Lack of development of the necessary capacities	• FSTP as alternative for illegal dumping of sludge into water bodies • Options for reuse of organic waste when co-composting with treated sludge	• Lack of legislation in defining responsibilities for FSM/FSTP
B.1-8	Sludge Service Companies (SSC)	• Emptying septic tanks and grease traps and transporting the sludge to the landfill site	• Independent companies following market´s demand and offer	• Not all companies interested in changes to the current FSM system	• FSTP project offers better facilities for sludge discharge	• High investment and operational costs • Difficult economic situation with fast raising dollar rates

SL No.	Stakeholder	Responsibility	Strength	Weakness	Opportunities	Threats
		• Desludging of blocked septic tank systems	• Most companies with long-standing experience	• Strong competence encourages illegal discharge of sludge (cost reduction)	• FSTP project reduces maintenance costs of the desludging vehicles. • FSTP project strengthen their capacities • FSTP is a new business opportunities	
B.9	Private Construction Companies (CC)	• Construction of septic tanks and other on-site containment systems	• Independent companies following market´s demand and offer • Most companies with long-standing experience	• Not all companies interested in changes and further regulations for on-site treatment and containment systems	• FSTP offers options for construction contracts	• Difficult economic situation with high inflation and fast raising exchange rate
C.1	Anton de Kom University (AdeK)	• Research and knowledge transfer in the field of environment and infrastructure • Formation of civil engineers	• Interest in contextual-lizing technologies to local conditions • Interest in information and knowledge transfer on sanitation technologies • Opportunity for student research studies in FSM • Highly motivated leading professor • Interested students	• Lack of necessary capacity building • Curriculum already very full • Limited equipment for research • Very limited budget for research projects	• Opportunities for international contacts and cooperation in research and teaching in water and sanitation • Job opportunities for graduates	• Tight university budget for research • High and competitive demand for graduates in various fields
D.1	Households	• As producer of wastewater, correct maintenance of toilet and septic tank	• High interest in functioning septic tanks	• Limited knowledge about proper	• Raising awareness of the need for changes in the current FSMS	• Difficult economic situation with high inflation rate

SL No.	Stakeholder	Responsibility	Strength	Weakness	Opportunities	Threats
		• Maintaining hygienic conditions in the home and on the property	and appropriated emptying service • Many have experienced effects of subserviced sanitary facilities	maintenance of septic tanks • Lack of knowledge about the sanitation chain and the consequences of mal use of the flush toilets		• Cleaning their septic tanks depending on the emptying fees of the SSC
D.2	Restaurants, hotels, and other commercial business	• As producer of wastewater, correct maintenance of toilets, septic tanks, and grease traps • Maintaining hygienic conditions in their business • Following the hygiene regulations and environmental laws	• Business operation depending on the correct maintenance of sanitary facilities • Financial strength allows for regular emptying of on-site sanitation systems • High interest in functioning septic tanks	• Limited knowledge about proper maintenance of septic tanks • Lack of knowledge about the sanitation chain and the consequences of mal use of flush toilets	• Raising awareness of the need for changes in the current faecal sludge management system • Promotion through ecological business management	• Difficult economic situation with high inflation rate • Raising fees for sludge emptying

SL No.	Stakeholder	Responsibility	Strength	Weakness	Opportunities	Threats
D.3	Residents (This stakeholder group will be determined when site for the FSTP is selected; if the location is far from residence areas may not apply	• Representing the interests of residents about the FSTP	• Potential for critical monitoring of the development of the FSTP (not confirmed)	• The potential "not in my backyard" attitude might lead to resistance against the FSTP (not confirmed)	• Participation and advice from residents regarding the development of FSTP • Job opportunities	• Increasing traffic in their environment and noise disturbance in the construction and operational phase • If necessary distance to FSTP is not maintained, possible odour nuisance
E.1	Stg.Waterforum	• Preparing recommendations on an integrated approach in water and wastewater policies and legislations • Promoting sustainable water management • Capacity building and knowledge transfer regarding integrated water management	• Committed experts in the field of water management and sanitation • Engaged in the Development of IWRM • Offers capacity building through education and awareness campaigns • Broad network within government and the private sector	• Group of volunteers highly dependent on outside funding (donors, funders, etc.)5	• Raising awareness on FSM as part of IRWM • Need for capacity building measures in IWRM • Need for the development of a sustainable water management	• Limited resources, no fixed budget • Long legislative procedures

4.4.3 Conclusion

The key stakeholders for the planning and implementation of an FSTP in Paramaribo are the Ministry of Spatial Planning and Environment (ROM), the Ministry of Public Works (OW), and the Sludge Service Companies (SSC) group. Since the beginning of the CReW+ project, the ROM Ministry has been the focal point for cooperation and the institution responsible for environmental planning and, through its integrated institution NIMOS, environmental monitoring of all projects that affect the environment. ROM, as a relatively new Ministry, is only gradually taking on all the responsibilities assigned to it. The new environmental legislation and the transformation of NIMOS into the new environmental institution NMA (National Environment Authority) is also only just in the process of implementation. The Ministry of Agriculture, Livestock and Fishery (LVV) plays an important role in the implementation of options for the reuse of effluent and dried sludge to produce compost.

Following the conclusion and the table of the influence-interest analysis (Annex 4.4-Interest-influence analysis) in the Annexure, the following chart was designed to finally characterize the stakeholders into 4 groups:

- Key Stakeholders that have a decisive impact on the project
- Important Stakeholders that must be involved during the project
- Involved Stakeholders that must find/develop their role during the project
- Participating Stakeholders that will be part during the project development

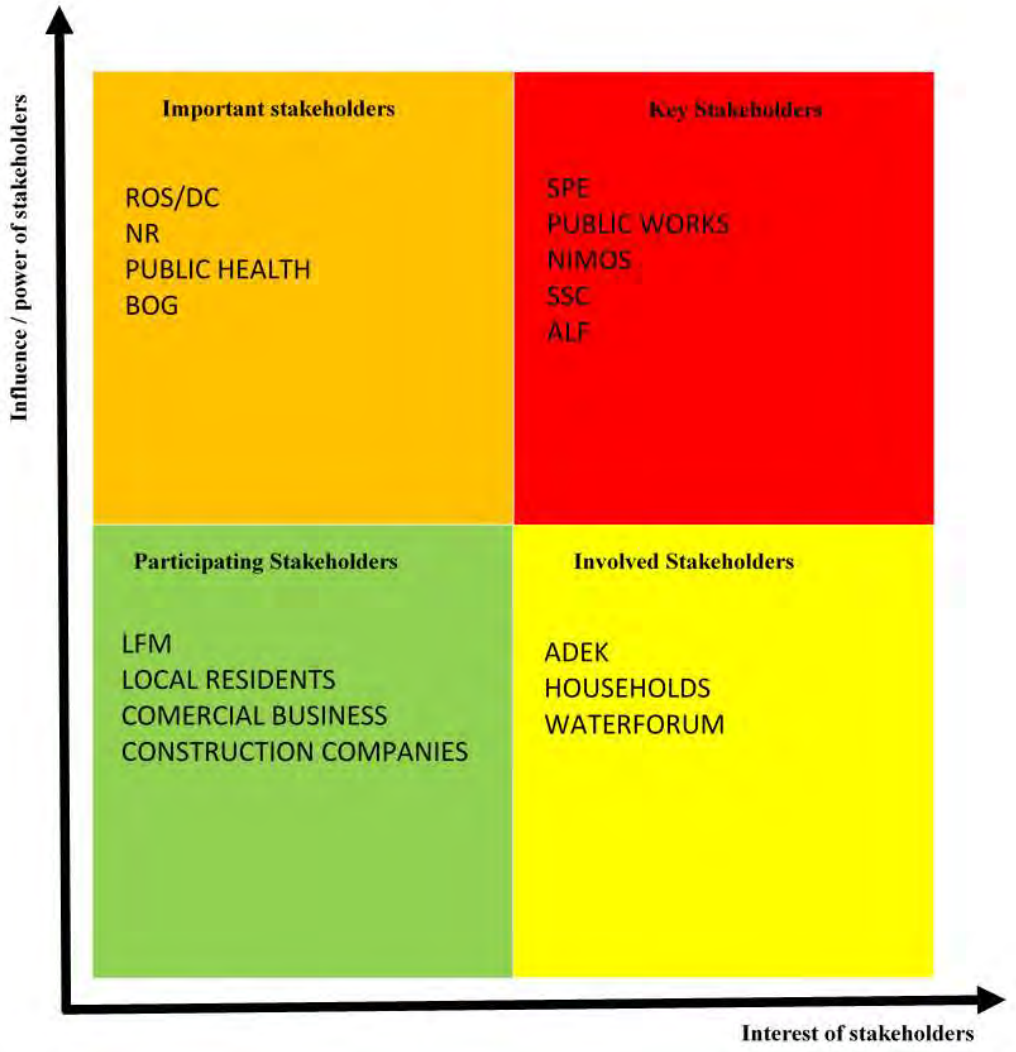


Figure 4: Influence-Interest Assessment Matrix

1. ROS/DC- Ministry of Regional Development and Sport/ District Commissioner
2. NH- Ministry of Natural Resources
3. BOG- Bureau for Public Health
4. ROM- Ministry of Spatial Planning and Environment
5. NIMOS- National Institute for Environment and Development in Suriname
6. SSC- Sludge service companies
7. LVV- Ministry of Agriculture, Livestock and Fishery
8. GBB- Ministry of Land Policy and Forest Management
9. AdeK- Anton de Kom University

4.5 Faecal sludge: quantification and characterization

4.5.1 Approach for data collection

Collecting reliable data on the amount of sludge moved daily in the greater Paramaribo area and the sludge characterization in a very short time posed a particular challenge to the project planning team. Reliable data could only be obtained from the Sludge Service Companies, a stakeholder group that is very skeptical of any government project planning. Nevertheless, it was possible to establish contacts already during the first on-site visit, which could then be continued by the local partner ILACO and deepened during the second on-site visit by the project team. In this way, it was possible to substantiate the initial estimates with more precise information and to verify them with analytical results.

For this purpose, a detailed questionnaire was developed that should make it possible to obtain more accurate data not only on the total amount of sludge moved daily in Paramaribo, but also information on the sludge material from different sources that make up the sludge loads in the vacuum trucks (Annex 4.5 Results survey-proportion sludge types). The survey results were compared to data received from the manual register of the District Commissioner compiled at the disposal site at Tout Lui Faut.

All Sludge Service Companies that are on the stakeholder list were approached to participate in completing the questionnaires but only 4 have shown a willingness to share the information. Other companies, especially the smaller ones with only one truck working and therefore the owner is also the driver, gave time constraints as reason for not being able to participate in an interview. These companies have also indicated that they are not willing to share company information (volumes, customers, prices).

The market for septic tank emptying and transport is highly competitive and only a few companies have long-term contracts with commercial customers. Private customers contact the companies by phone, usually when they have problems with their septic tanks because they are not working properly or are completely clogged. These customers first conduct market research and then place an order with the cheapest service provider.

The information from the sludge companies on sludge characteristics was complemented by laboratory analysis of sludge samples taken from trucks at the disposal site. Care was taken to ensure that the truckloads included only a specific type of sludge. It was clear that these analyses of 4 sludge samples only give a rough indication of whether the assumptions made about the sludge qualities are correct. Nevertheless, the sampling process and the analysis results allowed valuable conclusions to be drawn about the characteristics of sludge from different sources.

4.5.2 Quantification and qualification of sludge obtained from sludge service companies

The result of the questionnaire can be summarized as follows:

The service areas of the sludge service companies are mainly located in Paramaribo and Wanica. These companies do not have specific service areas and compete. The districts of Para, Commewijne, Coronie and Saramacca are also served when customers call from there. Some companies also provide service in the more distant districts such as Nickerie and Marowijne, but usually not to a single customer. Even sludge from other districts should be brought to the disposal site at Tout Lui Faut for discharge. It was not possible to confirm whether every service provider does so.

Sludge service companies are available an average of 6 working days per week, no service is provided on Sundays and holidays. Due to daily fluctuations in demand, company owners plan to fill the vacuum truck to at least 80% before unloading the load at Tout Lui Faut, preferably on the same day. If the vacuum trucks are left loaded overnight, there may be heavy sedimentation of sand and other materials, and there is the additional risk of gas evolution, which stresses the tank structure and poses explosion risks. The variations in the demand mean that out of 6 working days for each truck, waste is disposed of on average on 4 days.

The interviewed companies have more than one vacuum truck, but according to the general information we received, other companies have only one truck with a capacity of 10 m^3 which is primarily used for sludge emptying services. Not all vacuum trucks are used for emptying septic tanks or grease traps, some are used partially or exclusively for other services such as cleaning the drainage and sewage system. Sludge loaded by these vacuum trucks is usually disposed of next to the main channels or taken to the landfill.

If the demand for sludge to be emptied exceeds the 10 m^3, companies could plan to make more trips per day with the 10 m^3 truck or use a vacuum truck with a larger capacity, such as 15m^3, that a company has available. According to one of the companies, the need for sludge transport from one site can occasionally be as high as 40m^3/day. This cannot necessarily be done in one day.

Sludge service companies have different types of customers, resulting in sludge loads with very different characteristics:

- Sludge from private customers with septic tanks that have not been emptied for several years, usually 5 or more years,
- Sludge from restaurants that have their tanks and grease traps emptied at short intervals of a few months, as do warehouses or hotels,
- Sludge from food processing plants, chicken slaughterhouses and fish processing industry.

When filling the tanks, no distinction is made between sludges from different sources. Most loads are mixed loads (commercial septic tanks, grease traps, and residential septic tanks).

Since there is no requirement or incentive to collect sludge separately, the mixed sludge loads are the primary material that can be expected as input to the FSTP. However, sludge company owners are not precluded from separating sludge by type and organizing loads accordingly.

Only, this would involve a higher management effort and thus certainly higher costs, which would then have to be passed on to the customers.

As a result of the mixed load, the composition of the sludge varies widely. Some mixtures are highly prone to sedimentation, such as sludge from chicken slaughterhouses or fish processing with a high percentage of mineral material that must be separated before the sludge can enter a treatment process. Currently, mineral residues are either dumped at the disposal site or brought to the waste dump.

Recently, the District Commissariat Wanica Sud-East has issued a new directive regarding the dumping site in Tout Lui Faut. Per truckload must be paid SRD 250 (USD 10). This amount must first be paid to the Commissariat in Lelydorp. To control the access to the disposal site, a barrier has been installed on the access road, which is operated by a gatekeeper. The hours of operation for the site are 07:00 - 15:00, Monday to Saturday.

This ordinance has generated opposition from sludge service companies, as the hours of operation represent a restriction on their service hours. In addition, the companies do not see any maintenance work on the disposal site, either on the access road or on the disposal site itself.

Since August a registration was made of the trucks that disposed of their load on the site. This allows obtaining official sludge volumes moved per day in Paramaribo. After contacting various officials of the district commissariat with a request for the data, the following information was provided by WhatsApp (08-09-22):

Table 10: Booklet registration gatekeeper Tout Lui Faut

Period	Total truck loads	Average loads p/d	Sludge volume discharged m^3/d
01-06 Aug.	15	2.5	25
08-13 Aug.	17	3	30
15-20 Aug.	23	4	40
22-27 Aug.	14	2.5	25
29-03 Aug.	23	4	40
05-07 Sept.	13	4	40

These figures reflect only the truckloads discharged at the official disposal site. It can be assumed that the actual amount of sludge discharged into channels and the river is at least 100% higher. This also corresponds to the estimates of the sludge operators.

The company owners specified that the color of the sludge from the domestic septic tanks indicates the retention time of sedimented sludge and thus the interval of emptying the tanks. A light brown color indicates that the tank was emptied before 0-3 years ago. Sludge from tanks that have not been emptied for 5 years has a dark color to a dark black color if the sludge remains in the tank for more than 5 years (up to 20 years). Well over 50% of private septic tanks have emptying intervals of more than 5 years.

The color of sludge from commercial septic tanks depends on the wastewater that enters the tank. The time between each cleaning is mostly between 3 - 6 months because of the need of trouble-free operation of the septic tank. Grease traps are emptied also in regular intervals. The color of this sludge depends on the time spent in the tank (usually 1-4 months) and is typically gray.

Some special properties and contents of sludge charges have been described by the company owners:

- The use of toilet paper, which does not dissolve, but tangles into a solid mass,
- Diapers and synthetic wipes, sanitary towels and other menstrual hygiene products found in the sludge from commercial companies; these products often lead to clogging of the local sewage system,
- Clay-like material, better known as pimba, found in the sludge in certain areas of Paramaribo,
- Heavy sedimentation of sand and grit in tank loads, especially sludge from slaughterhouses and food processing plants.

Based on the information and data collected and analyzed (Annex 4.5 Results survey-proportion sludge types) it can be concluded that:

- 40 – 50 m^3 of sludge is disposed of every working day at the official disposal site and an estimated 40 – 50 m^3 of sludge is disposed of illegally every day.
- Considering the sum of the available m^3 capacity of the vacuum trucks, assuming an availability of only 80% due to repair and maintenance requirements of the trucks, and if the trucks unload their tanks only on 4 of the 6 working days, the calculation of the maximum amount of sludge transported daily in the city is as well around 100 m^3.
- The composition and characteristics of the sludge loads vary greatly due to the different sources and types of sludge charged and the combination of sludges loaded in the day.
- The main types of sludges loaded in the vacuum tanks are from
  - Private septic tanks with great variations in their emptying intervals
    (Estimated average proportion between 29% and 39%)
  - Commercial septic tanks from restaurants, hotels, warehouses, and the airport
    Septic tanks from chicken slaughterhouses and food processing companies
    (Estimated average proportion between 34% and 46%)
  - Grease traps
    (Estimated average proportion between 24% and 26%)

4.5.3 Sludge characterization

The characteristics of sludge in Paramaribo vary widely depending on the different sources from which the sludge was loaded and the route of the truck. Some loads come from only one customer or one type of customer of the sludge companies, but most often there are mixed loads with different combinations of sludge types. This makes it difficult to characterize

the sludge by analyzing sludge samples. In addition, due to the tight time frame and limited budget, it was not possible to conduct a more in-depth study of the sludge characteristics.

In any case, it is doubtful that a more extensive investigation of sludge characteristics would have yielded more reliable results that would have justified the higher costs.

Nevertheless, the information from the survey of the sludge service companies was complemented by observations of sludge unloading at the disposal site in Tout Lui Faut and sludge sampling and laboratory analysis of tank loads that contained mostly only one type of sludge. Observations were made during the discharge of 5 truckloads and in 4 cases sludge samples were taken. The samples were transported to 2 different laboratories (FILAB and BOG) where important basic pollution parameters were analyzed.

The results of the observations and the laboratory analyses can only give an indication of the expected range of pollution parameters and verify the assumptions made. It is a very important basis for the planning of the treatment plant.

- Sample 1- HH Septic tanks
- Sample 2- Restaurant- Popeyes
- Sample 3- Warehouse- Kuldipsingh company
- Sample 4- Chicken slaughterhouse with HH septic tank
- No 5 (only observations) - Chicken Slaughterhouse

Another observation (No 5) was included in the sampling protocol list of a sludge load from a chicken slaughterhouse (see Annex 4.5.3 Sludge sampling protocol-lab analysis).

The color, consistency, and odor of sample 1 suggest that this sample comes from septic tanks that have not been emptied for a long time. The material is already mostly decomposed and stabilized. The results of the laboratory analysis show a higher concentration of total solids, as would be expected for this type of sludge. It is important to note that sludge companies use water to dilute the contents of sludge from private septic tanks when it is difficult to empty due to high viscosity.

Table 11: Observations on sludge samples

S. No	Origin	Observations			
		Aspects/color	Consistency	Odor	Sedimentation behavior[1]
1	Content of 7 household septic tanks	Uniform black color	Homogeneous liquid with low viscosity	Smell of humus almost no septic odor	No visible sedimentation after 1 min, no visible sedimentation after 60 min.
2	Grease trap Restaurant Popeyes (Fast food)	Light grey	Watery, oily	Oily, bad, and organic	150 ml out of 1500 ml in 45 mins
3	Warehouse-Kuldipsingh	Uniform black color	Homogeneous liquid with low viscosity	Smell of humus almost no septic odor	No visible sedimentation after 1 min, no visible sedimentation after 60 min.
4	Chicken slaughterhouse mixed with HH septic tank sludge	Blackish grey	Liquid mixed with solids	Strong odor of degrading organic material	Poor settling, floating materials (chicken waste) float on the top
5	Chicken slaughterhouse mixed with another sludge	non-uniform light beige-grey with white and other colored ingredients	Liquid part: inconsistent liquid mixed with solids	Strong odor of degrading organic material	not tested

Table 12: Laboratory analysis results of sludge samples

No	Parameter	Analysis	Unit	Results				Applied values
				Sample 01	Sample 02	Sample 03	Sample 04	
1.	pH	Potentiometry (pH meter)	pH	7.3	6.9	7.2	5.9	
2.	Conductivity	Potentiometry (Conductivity-meter)	µS/cm	9,680	2,860	2,050	4,400	
3.	Chemical Oxygen Demand (COD)	Colorimetry finish-ASTM D1252B	mg/l	1,026	1,914	2,616	11,751	6,000
4.	Biochemical Oxygen Demand (BOD_5)	Manometric method (Respirometry) ASTM D1252D	mg/l	1,080	4,180	1,080	5,290	3,000
5.a	Total Solids (TS)		mg/l	21,600	3,700	14,500	16,900	20,000
5.b	Total Suspended Solids (TSS)	Gravimetry ASTM D5907	mg/l	12,000	800	12,500	12,500	
5.c	Total Dissolved Solid (TDS)	Gravimetry ASTM D5907	mg/l	9,600	2,900	2,000	4,400	
6.	Total Kjeldahl Nitrogen (TKN)	Mineralization + steam distillation EPA 351-3	mg/l	421.40		200.20	569.80	
7.	Total Phosphate (TP)	Mineralization + steam distillation EPA 351-3	mg/l	67.63		29.68	167.09	
8	Faecal Coliform		Index/ 100ml	>160000	>160000	>160000	>160000	>160000

The conductivity value of sample 01 is the result of the advanced mineralization process and indicates that the sludge is highly mineralized. The value for BOD_5 should be evaluated with caution, as it is slightly higher than the value for COD and may be due to analysis errors. This possible analytic error is also confirmed in the values of sample 2, where the value of BOD_5 is more than twice that of COD.

The nutrient values of N and P in relation to the TS are low but still indicate the sludge fertilizing value when properly treated and dried to be reused for co-composting or direct in agriculture. As with all other samples, the faecal coliform concentration is above $1.6x10^5$ cfu/100 ml, a more detailed determination at high coliform concentrations is not possible due to the analysis method in the BOG laboratory. This means for all sludge types; treatment is required to reduce the faecal coliform concentration to allow reuse or safe disposal. The separation of solid and liquid parts for sample 1 is very slow as the sedimentation test has shown (the same could be observed for sample 3).

Sample 2 shows much lower mineralization indicated by the conductivity value. Even if the concentration of total solids is more than 5 times lower than sample 1, the COD value is nearly two times higher. Without taking into consideration the BOD_5 value, the analysis results show the need for treatment to stabilize the sludge. The relatively low value for TS confirms the observation made of the watery consistency.

Sample 3 shows similar characteristics to sample 1, not only in analytical results but also in observations. However, the lower conductivity value is a sign that the mineralization process is not as far as in sample 1, but it can also be due to the different composition of the sludge. The sedimentation behavior test of this sludge did not show any significant separation between the liquid and solid phases even after 96 hours (Annex 4.5.3 Sludge sampling protocol-lab analysis).

As expected, Sample 4 has a high concentration of organic matter and solids. This could be due to the higher concentrations of fresh organic matter and solids, characteristic of sludge from chicken slaughterhouses. The sludge from chicken slaughterhouses tends to form a thick layer of sedimented grit at the bottom of the vacuum tanks, which was observed during the unloading of the sludge from samples 04 and 05 (latter observations only). This grit is estimated to make up more than 5% of the total volume and must be cleaned manually or with pressurized water by truck operators after each tank is discharged. Similar sedimentation behavior in vacuum trucks can be expected when sludge from the fish processing industry is loaded.

The sedimentation behavior of this sludge is characterized by forming a scum layer on the top due to the high percentage of floating organic matter. It is worth noting that mixing this sludge with septic tank sludge from a warehouse result in faster separation of the solid and liquid phases due to coagulation and flocculation processes (see again Annex sludge analysis) However, during the field observations and interviews with the sludge service companies, it was observed that the sludge from containment systems of slaughterhouses from Paramaribo is limited and the number of loads could be on average less than one load per week.

It can be stated that the sludge that is currently delivered to the disposal site in Tout Lui Faut comes from very different sources. As mentioned before, the greatest fraction with 34% and 46% of the total sludge volume is coming from commercial septic tanks including sludge from restaurants, hotels, and warehouses and to a small portion also from slaughterhouses. 29% - 39% are sludge from residential septic tanks that is already stabilized and mineralized and an estimated 24% - 26 % comes as very liquid sludge from grease traps.

Based on the observations and analysis results, the scope of characteristics of the different sludge types can be estimated as the base of the treatment planning. Each type of sludge has specific characteristics that place different requirements on the treatment system. However, as this sludge reaches the FSTP as mixed loads, the treatment system must meet the requirements of these mixed loads.

The interactions between the different types of sludge must be considered. The treatment system must meet the requirements of the most demanding sludge type to convert it into valuable end products that can be reused. Hence, in a worst-case scenario, the sludge from different sources gets homogenized in the subsequent treatment modules before being treated in the FSTP in the first stage i.e., solid-liquid separation.

For designing the FS treatment systems, the essential design parameters are Biological (BOD_5) and Chemical Oxygen Demand (COD) as well as the Total Solids and the Total Faecal Coliforms. These parameters are directly applied for dimensioning the treatment systems for both technical and hydraulic designs. These parameters also provide the base for the selection and design of the required treatment modules oriented on the defined reuse and disposal of treatment end products.

Therefore, based on the existing engineering knowledge according to the literature review and practical experiences, the FS characteristics considered for designing the FSTP are listed in the column “Considered Value”.

(2) IFC (2007): *Environmental, Health, and Safety (EHS) Guidelines.* -International Finance Corporation, World Bank Group.

https://www.ifc.org/wps/wcm/connect/3d9a54ae-c44c-488d-9851-afeb368cb9f9/1-3%2BWastewater%2Band%2BAmbient%2BWater%2BQuality.pdf?MOD=AJPERES&CVID=nPtgvO

(3) United Nations Industrial Development Organization (UNIDO), 2018: Provision of Consultancy Services for the Design and Assessment of the BAT-BEP Solid Waste Demonstration Project in Paramaribo, Suriname. Landfill Site Selection. ILACO N.V., Royal HaskoningDHV, RFP-7000002034/CZ/AB.

(4) United Nations Industrial Development Organization (UNIDO), 2018: Provision of Consultancy Services for the Design and Assessment of the BAT-BEP Solid Waste Demonstration Project in Paramaribo, Suriname. Final Completion Report. ILACO N.V., Royal HaskoningDHV, RFP-7000002034/CZ/AB.

5. Planning approach and planning principals

5.1 Planning approach

The approach to developing the detailed concept for an FSTP in Paramaribo was driven by a very tight timeframe. This chapter focuses on the planning approach. The Figure 5 presents a step-by-step approach used to develop the FSTP concept for the Greater Paramaribo area. The entire project was planned in a very short interval of time however with eye to all the details required for a successful project. The individual steps were divided into three project phases as described in Chapter 3.3 Scope and approach of the Project.

Figure 5: The steps of the planning approach

This involved, preparation of the inception report which outlined the work that was to carry out during the project duration with the expected outcomes. Next was to undertake an on-site visit to the project location to understand the conditions for the planning of the FSTP and the existing infrastructure in relation to FSM components. Then, all secondary data from the project location were collected, analyzed, and evaluated to find the best treatment options as well as O&M options for a FSTP in Greater Paramaribo.

On this basis, a draft concept with solutions from a technical, financial, institutional, and legal point of view was developed. During a second on-site visit, stakeholder meetings and capacity-building workshops were conducted to present the draft concept and to find the optimum final FSM option for the city. The site identification and selection process for the establishment of the FSTP has been initiated in consultation with relevant stakeholders. Based on the results of the stakeholder meetings and further data collection, the Final FSTP Concept was then developed.

5.2 Planning principals

5.2.1 Service orientation

Sanitation is often viewed and evaluated only in terms of the infrastructure needed for the containment of wastewater, its transport to the treatment plant and the treatment plant itself. But sanitation is first a service offered to users. The user stands for the person(s) using the sanitation service usually as an individual or business owner/manager. As with the water supply service, it is important for the user to count on a reliable sanitation service that allows him/her to take full advantage of it. This is the prerequisite for assuming all other roles and responsibilities, such as respecting the terms and conditions and paying the tariffs. It is a shared responsibility that the service works.

The other key players are service providers who are responsible for offering a quality service at an affordable price to users, e.g., sludge service companies that empty septic tanks. They themselves are depending on facilities where they can discharge their loads. The tariffs and fees for this service must be such that the price for their services remains within a range affordable to the initial user. Thus, the sanitation chain in this way is also a sanitation service chain. The government must create the necessary infrastructure when private investment cannot do so, as well as monitor and regulate the entire sanitation system. After all, the planning of an appropriate FSM system must be orientated on the creation of a well-functioning sanitation service chain.

5.2.2 Focus on reuse

The main objective of the treatment is to transform unpleasant and potentially harmful faecal and sewage sludge into innocuous products that do not harm public health or the environment. This is possible if the pathogens present in the FS are eliminated and the organic pollution in the FS is reduced and brought to a stabilized form so that the quality of the treated residual water and dried sludge allows its reuse or safe disposal.

Resource recovery and reuse options are other necessary goals for sustainable management of faecal sludge, considering circular thinking for water and carbon/energy, as well as circular consumption and production patterns, e.g., through beneficial reuse of water and nutrients in horticulture and agriculture. Therefore, the necessary quality of the treated water and dried sludge depends on the form of handling and reuse of the final products.

For the planning process of the treatment and the entire sanitation system, it is important to focus on the necessary quality for the reuse possibilities of the end products. This means planning partly from the end of the sanitation chain and involving the potential users of the end products in the planning process, e.g., compost producers or farmers and horticultural producers.

5.2.3 Use of Nature-Based Solutions (NBS)

Nature-based solutions are inspired and supported by nature and incorporate natural features or processes into the built environment through the enhancement or creation of natural processes in modified or artificial ecosystems. It is not important whether an ecosystem used is completely 'natural', but whether natural processes are proactively managed to achieve a water-related objective, e.g., wastewater treatment.

The focus is on wastewater management processes that provide passive treatment with a minimum of mechanical elements. The use of these NBS often leads to more sustainable systems, as they require a low operational effort. Another key advantage of NBS is the way in which they contribute to building overall system resilience.

NBS can be applied in a built or grey infrastructure of a wastewater treatment system and used to treat different types of effluents such as municipal, agricultural, industrial, leachate and stormwater. NBS uses bacteria, plants, soil, porous media, and other natural elements and processes to remove pollutants in wastewater including suspended solids, organics, nitrogen, phosphorus, and pathogens. The application of NBS in wastewater treatment aims to develop engineered systems that mimic and utilize functioning ecosystems and focus on sustainability and resilience in planning and design.

5.2.4 Use of gravity flow

Focusing on systems with no or fewer mechanical elements also means favoring gravity for the internal flow of sludge and effluent to be treated. This makes the treatment plant independent of pumps and other mechanical devices. This ensures that the operation of the plant is guaranteed even if the electrical power supply is interrupted.

This may be associated with higher investment costs in the construction of the plant if natural slopes cannot be used due to a flat terrain structure. The higher operational safety and lower maintenance costs can compensate for these additional costs in the longer term. Sustainability and resilience are also key planning goals in this context.

5.2.5 Phase-wise implementation

Central wastewater treatment solutions with sewers and a central treatment plant have been shown to require high investment costs and work only when all elements are completed. This is for most low and medium-income countries not affordable. Decentralized solutions with phase-wise implementation are more feasible alternatives.

Planning is based on goals that can be achieved step by step, and at the end of each phase, a fully functional treatment unit is set up. The expansion or upgrade of this unit then allows for the expansion of the service area and the population to be served.

This form of planning enables the gradual introduction of changes, which are often also associated with a change in the behavior of those involved, over a longer period. At the same time, the necessary investment costs are spread over a larger time frame, making it easier to ensure the financial viability of projects, since the necessary financing is also spread over a longer period.

5.2.6 Operation as Public-Private Partnership (PPP)

Public-private partnerships in water and sanitation projects are strongly promoted by international financing institutions such as the World Bank (5) and the IDB. Although there are examples of successful PPP implementation in some countries, the understanding of PPP varies widely. The very different political, economic, social, technological, legal, institutional, procedural, and environmental frameworks make the implementation of PPP dependent on the specific conditions in each country.

Small private operators of publicly funded infrastructure are becoming increasingly common in low- and middle-income countries. Many donor-supported water and sanitation PPP projects in peri-urban areas have been successfully implemented and scaled up. This model has been shown to lead to more sustainable operating results and financial viability when operation and maintenance costs can be recovered through tariffs, subsidies, and other revenues.

(5) Victoria Rigby Delmon, 2020: *5 Trends in Public-Private Partnerships in Water Supply and Sanitation.* WB PPCLRC. *https://ppp.worldbank.org/public-private-partnership/5-trends-public-private-partnerships-water-supply-and-sanitation*

6. Concept of a FSTP for Paramaribo

6.1 Vision of fecal sludge management in Paramaribo, Suriname

In general, FSM is defined as the management of storage, collection, transport, treatment and safe end-use or disposal of fecal sludge. All together, these procedures constitute the "value chain" or "service chain" of fecal sludge management (2021).

Figure 6: A fecal sludge treatment plant is part of an overall fecal sludge management system

To allow for the design of a specific component of the service chain, e.g., the fecal sludge treatment facility, a general FSM concept to embed the component would be expected. Although some components of the value chain are in place, an overall FSM system has so far not been outlined for Paramaribo.

Therefore, the team entrusted with the FSTP conception design for Paramaribo, made a first attempt to express on a hypothetical basis a possible vision of a FSM in Paramaribo, indicating some desirable mid / long-term targets regarding the provision of sanitation for the city. It is a first declaration on how Paramaribo should/could develop in terms of urban sanitation and especially in those related to fecal sludge management. Therefore, what is presented under this chapter 6.1 should be read as a first basis to initiate the discussion among the key Surinamese stakeholder on the development of a consensual FSM Vision. The presented components are not meant to be recommendations, rather entry points for discussion.

This vision builds on the following assumptions:

- The understanding that the urban sanitation strategies of Paramaribo focus on decentralized sanitation systems, based primarily on septic tanks at household levels and storage devices partially linked to a settler in case of small and medium size enterprises. These systems are only partially and irregularly maintained.
- Stakeholder linked to urban sanitation and specially to FSM will participate in the strategic development and management of the system.
- A solid legal base related to norms, regulations and guidelines and its monitoring will be required for the FSM to be successful.
- Sanitation services linked to FSM need a fairly good level of quality to respond to the different levels of sustainability (financial, service, environmental, etc.).

- Treatment facilities need to be conceived in a way that its operation and maintenance can be ensured on the prevailing local conditions; therefore, priority should be given to nature-based approaches, less mechanized and energy-dependent technological solutions.
- The city aims at a water and sanitation strategy based on circular economy, resulting in attempting for a "0-Waste" approach for its FSM system. Therefore, aiming at the reuse of resources involved in urban sanitation.
- Paramaribo is a city that aims at conserving and protecting its environment.
- The presented FSM vision is not a recommendation, but rather a basis for the main actors to initiate the necessary discussion on the develop of their vision on faecal sludge management in Paramaribo.

As Figure 7 shows, the proposed FSM vision is presented along the four fecal sludge related areas to be managed and the involved stakeholder participation:

1. User interface and containment → Area of wastewater & sludge generators (❶)
2. Transport / conveyance → Area of emptying/desludging and transport (❷)
3. Treatment → Area of treatment facility (❸❹❺)
4. Reuse / Final disposal →Area of reuse (❺❻)
5. Stakeholder participation (❶❷❸❹❺❻)

Figure 7: Fecal sludge management system for Paramaribo

Below, potential elements of the FSM-Vision for each of the 5 areas have been detailed. It aims at supporting the understanding of the FSTP concept presented in chapter 6.2 and serves as an orientation for further work involved in the design of an FSM strategy for Paramaribo. It should be seen as a "work in progress"; not pretending to have covered here all components of an FSM system.

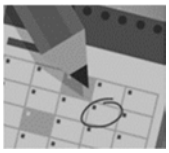
6.1.1 Area of wastewater & sludge generators

For the area of designing, establishing, and maintaining onsite sanitation systems in Paramaribo, the FSM-Vision includes:

a) Guidelines for septic tanks - onsite sanitation - design, its operation and maintenance:

The provision of sanitation services, mainly in new settlements, will be guided by standardized designs for septic tanks as well as other onsite sanitation solutions targeting SMEs; they will be supported by established calculation and construction guidelines. Besides this support to onsite system providers, the owners of the systems will be provided with guidelines for the maintenance of old and new septic tanks to minimize failures in the treatment process and functioning of these systems. The government through the Ministry of Public Works provides the necessary regulations, guidelines, approval and monitoring procedures, allowing private companies to offer optimized onsite sanitation systems and owners to get the required know-how to use them.

b) Scheduled desludging



An solid base of regulations for the construction and O&M of urban onsite sanitation systems, will claim for a next stage of the FSM-vision to be directed towards planning for optimal performance of the treatment systems. For it, scheduling the emptying of septic tanks in a defined interval (mainly shorter than presently) will be an important step. The treatment process and the functioning of the septic tanks will benefit from it since it will provide planning certainty to private desludging companies and less mineralized/stabilized substrate will be carried to the FSTP. Pivotal for this step of the FSM-vision will be the information provided to the onsite sanitation/septic tank owners concerning O&M requirements of their systems and the related need of periodical emptying. Support by related phone-based customer service systems will allow for managing these services.

c) Collection of sanitation tax:

Sanitation is a public service and needs to be financed just like the provision of water or electricity. It is possible to do it partially or fully by a dedicated tax. Tax collection is not very popular but should always be analyzed as an option for an effective FSM strategy.

This tax will be collected by the urban local government of Paramaribo through the water bill or property tax bill. It will be used for subsidizing payments for periodical desludging of septic tanks and supporting the FSTP operation to break even. The sanitation tax can be applied to improve the treatment facilities, finance future expansion, pay salaries for the personnel in the FSTP, etc. This tax is usually added to the water supply fee, providing the misleading impression to the clients that sanitation services are free of cost. Therefore, informing the clients/ owners/ citizens that sanitation services and other services they receive come at a cost will support generation of the necessary acceptance.

Sanitation tax can be one element of the financing mechanism to be developed for financing operation and maintenance of the FSMS.

6.1.2 Area of emptying/ desludging and transport

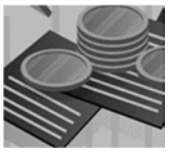
For the area of desludging and transporting the sludge of onsite sanitation systems in Paramaribo, the FSM-Vision includes:

a) Regulation and monitoring of emptying and transport:

A regulation establishing desludging/ emptying of onsite sanitation systems like septic tanks and grease traps as mandatory will guarantee a demand for the related service. Furthermore, the regulation will define the conditions under which sludge/wastewater desludging and transporting are guaranteed. The regulations in this area will also establish that the faecal sludge and other materials from septic tanks must be delivered to a proper facility for treatment, like an FSTP.

The FSM-vision for this area includes a monitoring system for septic tank owners through a service platform and of the desludging companies with the support of GPS localization. This will provide transparency about the quality of the service provided to all stakeholders involved.

b) Tariff scheme for services:



A city-wide tariff scheme will be established, like other basic services, ensuring the private sector can provide a quality and inclusive service. By a substantial increase of the desludging demand through the scheduled desludging, the related companies will profit from the economy-of-scale and be in the position of reducing the prices for their services. Concession models like the present solid waste management praxis in Paramaribo will be tested. The establishment of a tariff linked to the economic capability of the citizens, to the profitability need of the private companies and the operation of the FSTP will be developed.

c) Licensing of desludging companies:

The FSM-vision foresees the government issuing an Operation Guideline for Septage Management in Paramaribo. Based on this guideline, companies offering desludging services in the city of Paramaribo will require to obtain a service license. During the process of obtaining the license, operators and their staff will be instructed on potential hazards, safety rules and applicable regulations, as well as on basic safety equipment needed to have in the vehicle (mask, gloves, shoes, etc.). The operating companies will obtain a guideline on desludging work, documentation, and disposal obligations. Licensed operators will be obliged to equip the trucks with a GPS tracking device and through it ensure the discharge is done only at authorized disposal places (FSTP). A penalty system will enforce the acquisition of licenses. The access to FSTP will be granted only to licensed trucks and discharge at unauthorized locations will be punished with harsh penalties.

d) Marketing of services:

An especially installed platform for Paramaribo sanitation services will host the different mentioned FSM services and will actively promote desludging and other maintenance services for the onsite sanitation systems. The promotion will be linked with the direct booking of services and their payment.

6.1.3 Area of treatment facility

For the area of the treatment of sludge from onsite sanitation systems in Paramaribo, the FSM Vision includes:

a) Regulations and monitoring of the FSTP:

The treatment quality of the FSTP will be governed by wastewater discharge standards established by NIMOS. The treatment products of the solid fraction of the sludge treatments such as compost, will comply with quality standards by the European compost standards and further on, with standards also established by NIMOS. This will help to distinguish the treatment products like compost from other recycled wastes and common fertilizers.

The treatment quality and efficiency of the FSTP will be self-monitored on selected basic parameter at monthly interval and once a year controlled by NIMOS based on a larger set of parameters.

The Ministry of Public Works will monitor the quality of all the services offered at the facility, ensuring the operation of discharge and treatment of sludge follows established procedures, security standards are complied with, and storage and commercialization of treatment products follow established practices. Maintenance work will be conducted as calendarized procedures.

b) Discharge tariff scheme and the collection of fees:

The FSM-vision foresees the discharge fee as a source of financing the operation of the FSTSP. A differentiated tariff scheme will address in the beginning only different sludge volumes, but may expand in future to different sludge varieties, this linked to the establishments of differentiated treatment options.

The private companies will be responsible to pay the discharge fee. The tariff will be regulated and fixed by the Ministry of Public Works and balanced between the payment capability of the sludge generators and the requirements of the operation of the FSTP.

c) Collection of discharge/ treatment fee:

This fundamental part of the sustainability of the FSTP will generate a portion of the income required to operate, maintain, and improve the facility. A well-designed fee collection system will prevent low collection, a common issue with public services provision, reduce revenue losses and prevent corruption. The fee collection may be done pragmatically by a card system at the entry registry of the FSTP.

6.1.4 Area of reuse

For the area of reuse or final disposal of treatment products generated out of the sludge from onsite sanitation systems in Paramaribo, the FSM-Vision includes:

a) Guidelines for processing of treatment products:

The reuse potential of the products generated by the treatment of the sludge at the FSTP will be exploited based on the nutrients contained and the guaranteed sanitizing process. Guidelines for the appropriate process and quality standards to be followed depending on the targeted final use will be available. For different uses, different compost qualities will be generated.

b) Monitoring of treatment products:

An established monitoring system will provide the required quality information about the reuse potential of each treatment product at the FSTP. Mainly parameters that assess the content/stability of organic matter, phytonutrients and contaminants will be analyzed and through it the safe production of new agricultural products guaranteed and any health risks by handling or reusing treatment products avoided.

c) Market place for products.

The FSM-Vision foresees, the sale of products generated from the reuse of biosolids and treated water bringing new income for the FSTP. Agriculture has a big presence around the city of Paramaribo, and a market study has determined the characteristics of the clients, the production that can best use the treatment products of the FSTP, i.e., the specific fertilizers demand and the potential prices have been established. A virtual marketplace links agricultural fertilizer and soil conditioner production at the FSTP with different farms and markets quality products and generates business opportunities.

6.1.5 Stakeholder participation

The FSM system for Paramaribo concerns everyone; the citizens of Paramaribo as the owners of the septic tanks, the private companies for the construction and desludging of the tanks, the government that provides the sanitation services, as well as the Academy that teaches future professionals about sanitation management and research about urban fecal sludge management. Each group plays a defined role in the sanitation value chain and specifically at the fecal sludge management system of the city of Paramaribo, either as generators of sludge and wastewater, or as providers, managers, or supervisors of related (good) services.

The vision of the FSM for Paramaribo City contemplates the identification of roles of the main stakeholders associated with the sanitation value chain focused on fecal sludges is presented in the following table.

Table 13: Stakeholders linked to an FSM system for Paramaribo

	Stakeholder	Responsibility
General Public	Citizens of Paramaribo	Instalment of onsite sanitation systems (e.g., septic tanks) as per government guidelines. Maintenance of their septic tanks including periodical desludging.
Government	Ministry of Spatial Planning and Environment	In charge of planning and control of cities and rural zones, and the basic settlement services which includes the provision of water and sanitation, focusing on a strategy to link expansion of settlement areas with environmental protection. Ensures respective legislation and norms related to the sanitation services.
	Ministry of Natural Resources	In charge of the efficient use of the natural resources, focused on the protection and conservation of the ecosystems, the biodiversity, and the water bodies. Ensures respective legislation and norms related to the disposal and reuse of wastewater and waste.
	Ministry of Public Works	In charge of construction and maintenance of the infrastructure in the city to provide public services like water provision, electricity, sanitation, solid water collection, etc. Enforces norms related to installation of onsite sanitation

	Stakeholder	Responsibility
		systems, operation of FSTP and the collection and transport of sludge.
	Ministry of Public Health	In charge of ensuring a safe and hygienic environment for the citizens, which includes the establishment and monitoring of hygiene standards and procedures for sludge handling, and quality of products generated by sludge processing.
	Ministry of Agriculture	In charge of the regulation and monitoring of the activities related to the agriculture production, which includes quality of fertilizers, standard procedure for the reuse of products in agriculture.
Private Sector	Construction companies	Provide the services for construction and maintenance of septic tanks and sewerage according to established regulations.
	Desludging companies	Provide the service of emptying and transport of sludge according to established regulations.
Academia	Anton de Kom University	Forms the future professionals in new paradigms of the water and sanitation sector; fosters research, specially applied research for the contextualization of specific water and sanitation solutions for Surinam and specially for the city of Paramaribo.

The stakeholders identified play a specific role in the Fecal Sludge Management vision according to every stage of the fecal sludge processing chain: generation, emptying, transporting, treatment, and reuse/final disposal.

The next table shows the relations that every stakeholder could have with this hypothetical vision for FSM in Paramaribo.

Table 14: Activity-base stakeholder involvement in the FSM-vision for Paramaribo

	Activity	Stakeholder	Responsibility
1 Generation	Generation of fecal sludge and wastewater	Citizens	Users are well informed about the construction, use and maintenance of septic tanks and related norms.
	Construction of septic tank and other onsite sanitation facilities	Private construction companies and architectural offices	Constructor's design and build the septic tanks based on existing regulations and guidelines. Architects and urban planners include related infrastructure and services in their drawings/plans.
	Improve the regulations of the construction, operation and maintenance of septic tanks and other onsite sanitation facilities	Ministry of Public Works	The ministry establishes the guidelines and regulations for the design, construction and O&M of septic tanks and other onsite sanitation facilities. The ministry monitors these activities and collects sanitation taxes.
2 Emptying and transporting	Desludging of septic tanks, grease traps, pit latrines and other onsite sanitation facilities	Ministry of Public Works	The ministry regulates and monitors scheduled desludging of septic tanks, routes to use and discharge in the FSTP. The ministry establishes the tariffs for the related services
		Ministry of Public Health	The ministry regulates and monitors all related to standard procedures to ensure health and hygiene standards during the provision of the related services (protection equipment, maintenance of the vehicles, trained staff) and gives the license to the desludging companies.
		Private desludging companies	The companies are organized to provide a scheduled service (consortium, commercial group, cooperative, etc.), applying prescribed safety standard procedures and charging a fee for it to the customers. They ensure a safe delivery of the sludge at the FSTP.

	Activity	Stakeholder	Responsibility
3 Treatment	Reduction of contaminants in the sludge to allow for its safe final reuse or disposal	Ministry of Public Works	The ministry establishes the regulations and guidelines for the operation of the FSTP, including standard procedures to receiving sludge, monitoring the treatment efficiency, develops tariffs for discharge and treatment and manage fonds from collected sanitation tax.
		Private operator of the FSTP	A private company operates and maintains the FSTP, collects the discharge fee from trucks and reports to the MPW.
4 Reuse/Final disposal	Processing biosolids and treated water to reusable new products; selling these products; ensuring final disposal of biosolids and treated water if reuse is not viable	Ministry of Agriculture	The Ministry establishes and monitors the guidelines for processing biosolids and treated water and the use of the products; they establish norms for commercialization and marketplaces to sell the products.
		Private companies	Private companies do the processing, the distribution and commercialization of products.

The presented hypothetical vision for FSM at Paramaribo should serve as a first framework for discussion among the key stakeholders and initiate the development of an agreed vision for FSM in Paramaribo or even in Suriname.

On the other hand, this chapter has the propose to allow moving forward with the conception of a faecal sludge treatment plant for Paramaribo, seeing it as a part of a wider management system (FSMS) even if not yet outlined for Paramaribo.

6.2 Detailed concept for a FSTP at Paramaribo

6.2.1 Summary of the concept for a FSTP for Paramaribo

Technically the FSTP focuses on offering treatment to all sludges indifferently of its characteristics, with only a few exceptions. The treatment train carries out the following processes: triple screening of large inorganics, grit removal, grease separation, solid-liquid separation, sludge homogenization and thickening, sludge drying and co-composting, as well as supernatant/effluent and lixiviate treatment by two anaerobic and one aerobic process. Technologies applied largely rely on nature-based systems. It is suggested to link the FSTP with the treatment of other organic residues.

Apart from one pumping unit after the grit chamber, the system works by gravity generated by a partially artificial elevated terrain. The electromechanical equipment basically reduces to some pumps and a small articulated loader. The facility takes care of basic needs of the desludging company drivers and trucks.

The operation model suggested for the FSTP rely on co-management of a private operator, the supervision of the service by the Ministry of Public Works and the monitoring of the fulfilment of environmental requirements by the Environmental and Health Authorities.

At this conception stage, the business model foresees the capital required for the establishment of the FSTP as a non-refundable investment from public funds. The operation and maintenance costs are expected to be covered roughly to 50% by the discharge fees, to 25% by the revenues from treatment products (compost) and 25% by government subsidy. The treatment adheres to World Bank and NIMOS (future) standards.

6.2.2 Treatment requirement

Chapter 4.5 Faecal sludge: quantification and characterization describes in detail the quantity and characteristics of the sludge to be treated in the FSTP, providing clarity about the expected input to the plant. The vision of faecal sludge management in Paramaribo described in Part 6.1 Vision of fecal sludge management in Paramaribo, Suriname mentions the reuse of the products of the treatment process, effluent and treated sludge, in agriculture as a main pilar for sustainability of the approach. This also represents the guideline for what the treatment facility needs to accomplish. The treatment system must ensure that the sludge from the vacuum trucks discharged at the FSTP is treated and converted into end products (outputs) in a way that they can be safely reused to produce compost or treated effluent fit for use in agriculture or be disposed of without environmental or health risks e.g., as effluent to surface water bodies. The end products must therefore comply with existing norms and standards and those that are in preparation by NIMOS and likely to come into force soon.

Table 15: Indicative values for treated sanitary sewage discharge[a]

Parameter	Units	Guideline Value
pH	pH	6 - 9
BOD_5	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorous	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[b]/100 ml	400
Notes: [a]Not applicable to centralized municipal wastewater treatment systems [b]MPN = Most Probable Number		

Source: slightly adapted from (2)

NIMOS is currently preparing norms for the discharge of treated wastewater in surface water bodies and uses World Bank guidelines as shown in Table 15 to establish standards for Suriname. The values to be achieved in the treatment of the faecal sludge in the FSTP are based on the parameters recommended in this guideline. Solid treatment products such as compost must meet health standards. A reduction of the faecal coliform to a level of log 2-3 allows a safe handling and application of compost from co-composting of dried faecal sludge in agriculture.

Sludge loads to be discharged at the FSTP will vary widely in its characteristics and the plant must be able to treat the mixture of all different sludge types. Therefore, the sludge parameters applied for the design are based on the expected most difficult load mixture that may arrive at the FSTP. Some sludge loads are expected with sludge mixed with trash and grit that must be removed in a preliminary treatment process to prevent clogging of the treatment system. Sludge loads from grease traps contain a high percentage of oil and grease which needs also to be removed in a preliminary treatment step to facilitate the sludge treatment.

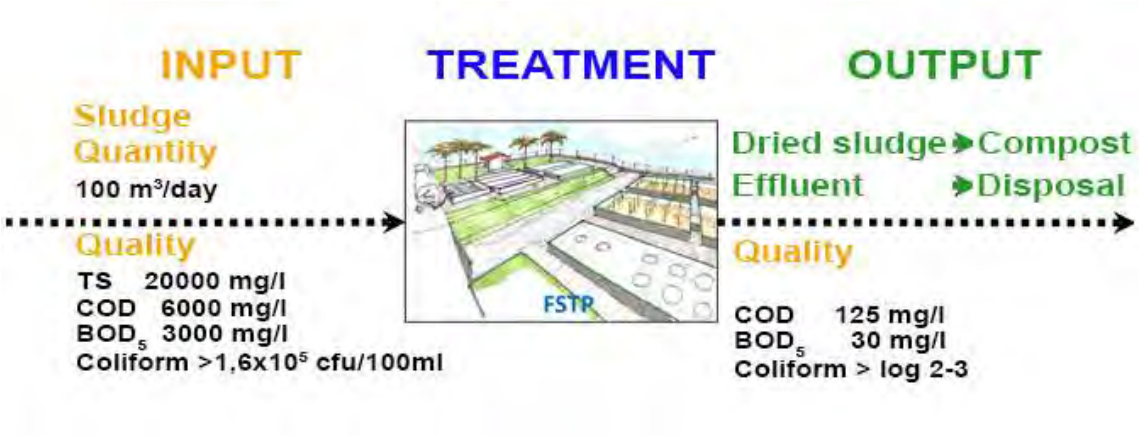


Figure 8: Treatment requirements for the FSTP Paramaribo

The treatment requirements can therefore be defined as follow:

- Separation of inorganic waste and grit from the sludge.
- Reduction of water content of sedimented sludge.
- Stabilization of the sedimented sludge by reduction of its easy biodegradable organic matter fractions.
- Minimization odor emissions by the mentioned stabilization and filtering related gases, allowing further treatment in a co-composting process.
- Reduction of pathogen concentration of dried sludge to log 3 to comply with the World Bank guidelines.
- Reduction of water content of dried sludge near to 50%.
- Reduction of the suspended solid content and the COD and BOD_5 to values of <125 mg/l and <30 mg/l respectively, to allow the reuse of the effluent in agriculture or and its safe disposal in surface water bodies (adhering to stipulated N and P values) to comply with World Bank guidelines.

- Reduction of pathogen concentration in the effluent to log 2 to comply with World Bank guidelines.

6.2.3 Technical concept

6.2.3.1 General criteria for the selection of FS Treatment Technologies

The selection of technologies suitable to treat the sludge at an FSTP in Paramaribo is based on criteria that consider operational, financial and land requirement aspects, as well as environmental impact and scalability. The following Figure 9 provides an overview of these selection criteria.

Figure 9: Criteria for the selection of the FSTP technologies

The technology selection has been guided along the following main criteria:

1 **Sustainability:** mainly referring to the capability of operating and maintaining the facility at a long run.
2 **Operation and maintenance cost (OPEX):** the capability of the Surinam government to finance the operation of the FSTP service is very limited. Therefore, low maintenance cost was a central criterion for technical decisions.
3 **Investment cost (CAPEX):** as the project caters only to a part of the potential sludge-treatment requirements of Paramaribo, a reinvestment requirement in 5 to 10 years must be considered when opting for technologies.

4 **Reliability:** it refers to the robustness of the technology to work under the existing climatic conditions and by changes of the substrate characteristics as well as to the resilience to deliver under adverse situation (power cuts, flooding, inadequate operation). Low dependency of the technological solution on electrical power supply has been an important selection criterion.
5 **Operation and maintenance effort:** it will influence the manpower in terms of time and skills. It was assumed that skilled operators could hardly be available; therefore, the technology options preferred will allow their operation by personnel who does not require a high level of training. Nevertheless, dedicated operators training will need to be offered.
6 **Environmental impact:** potential nuisance to residents in terms of noise, odor, visibility, and perception has been considered when selecting the site for an FSTP and by looking for technology configurations that minimize the nuisance.
7 **Value of end products:** this refers to the extent the technology option contributes to adhering to a circular economy approach, for example by returning valuable treatment products to the agriculture.
8 **Land requirement:** land-intensive, but technologically simpler solutions were preferred to possible compact but high-tech options.
9 **Upscaling potential:** given the uncertainty of whether and how the sludge-treatment demand will develop; technologies that allow for modular expansion of the treatment capacity have been favored.

6.2.3.2 Conceptual design

The first Faecal Sludge Treatment Plant (FSTP) for Paramaribo is designed to treat 100 m^3 of fecal sludge (FS) daily, six days a week. The treatment of the fecal sludge in the FSTP targets the a “0-waste” approach, to be carried out in several steps until the incoming residues turn into products ready for reuse or safe final disposal.

In this first FSTP, no distinction in made between distinguish different sludge types at the reception and discharge area. The area allows up to two trucks to deliver sludge at the time. The entire treatment process itself is divided in preliminary, primary, and secondary treatment.

The preliminary sludge treatment consists of two steps:

1) A screening unit with one basket screen and two manual bare-screen systems at the headwork, retains large solid particles
2) Following the screens, a set of horizontal grit-removal channels to separate sand and other inert material. One channel is additionally equipped with a grease trap catering to truckloads with high fat, oil, and grease (FOG) concentrations.

The primary treatment starts and operates in 4 parallel treatment lines providing flexibility and handling easiness. A collection tank receives the pre-treated different sludge types, and a pump elevates and distributes the sludge to 4 thickening/settler tanks. Here the solid-liquid phase separation takes place through sedimentation and flotation. By gravity, the solid phase in suspension of the sludge settles on the bottom of the tanks and thickens, thus, its TS content increases. Low-density components of the sludge and non-miscible liquids like

grease, will float and form a scum layer. This last part allows for further FOG management by skimming it this scum layer off. From this stage onwards, the settled sludge (the solid part) and the supernatant (the liquid part) will follow separate secondary treatment paths.

The treatment of the solid part: The settled sludge is conveyed by gravity for drying to planted drying beds (PDB). The PDBs get loaded in layers, allowing for the sludge to dewater and stabilize through multiple physical and biological processes. The dried sludge harvested after about one year, is then prepared to be co-composted with other green urban residues as the final treatment step.

The treatment of the liquid part: The supernatant from the solid-liquid separation unit and the lixiviate from the PDB are sent for secondary treatment to a DEWATS^{TM}. This wastewater mixture passes first through an anaerobic baffled reactor (ABR) followed by an anaerobic filter (AF) and subsequently it is treated aerobically in a planted gravel filter (PGF). At the final stage, the effluent flows into a polishing pond for further hygienization before being ready for reuse or safe disposal.

The flow diagram in Figure 10 provides an overview of the entire treatment train.

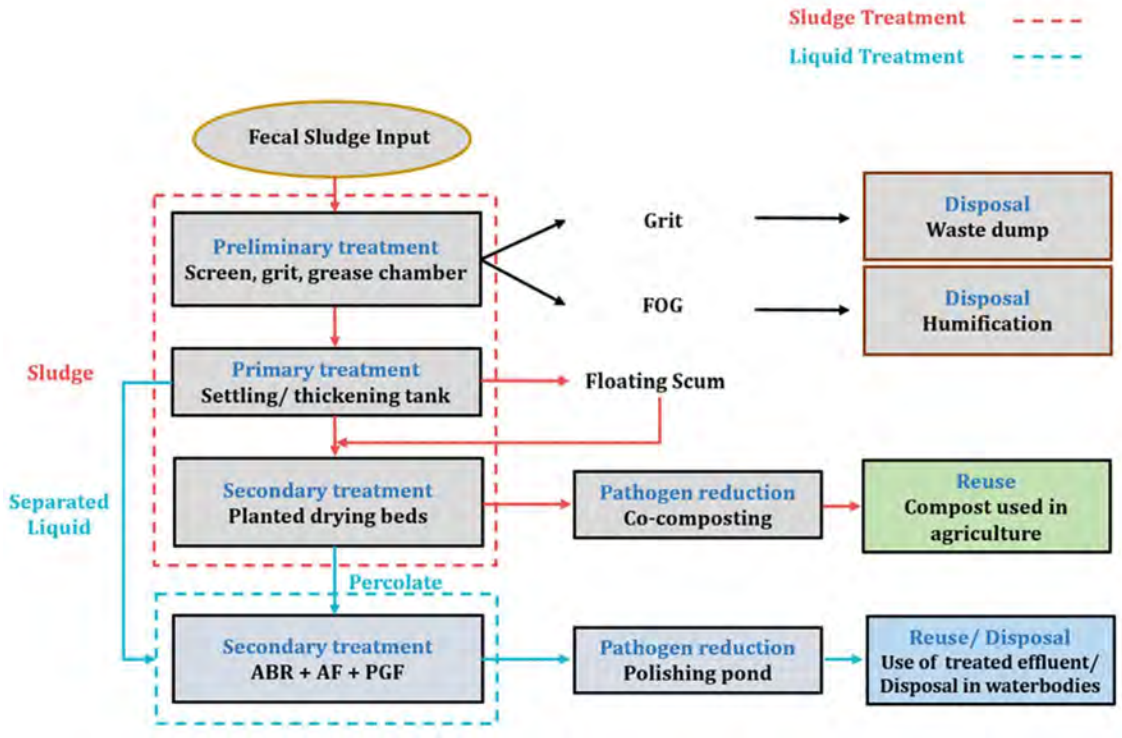


Figure 10: Overview of treatment train

FSTP areas
1. Administration area
2. Resting area
3. Workshop
4. Truck cleaning area
5. Grit storage
6. Grit chambers
7. Storage
8. Settlers
9. Treated water tank for truck cleaning
10. Planted drying bed (PDB) roofed
11. Compost storage
12. Compost area
13. ABR and AF
14. Planted gravel filter (PGF)
15. Polishing pond
16. Treated water tank
17. Access

Figure 11: Site plan of the 1st phase FSTP for Paramaribo

Figure 12: Cross-section view of the FSTP site for Paramaribo; includes expansion phase at the left

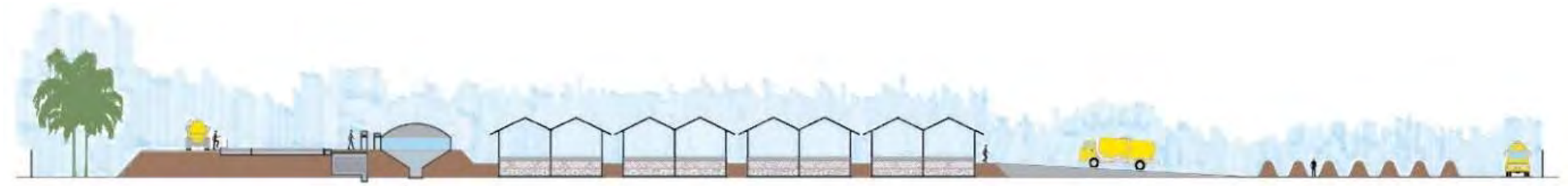


Figure 13: Longitudinal section view of the FSTP site for Paramaribo.

General layout of the FSTP

The FSTP area requirements is of around 10,000 m^2. The land in Paramaribo region is flat all over and there considerable flooding risk. Therefore, to maximize the gravity flow at the treatment facility, the layout includes two artificial terrain elevations, one of 2,500 m^2 at 2.50 m above ground and a second of 3,400 m^2 at 0.60 m above ground level. This allows the treatment system to be operated with one single pump station.

Delivery of the Sludge

Desludging trucks will arrive at defined operations hours of the FSTP. Trucks will carry different sludge varieties and volumes fluctuating between 3-15 m^3. After registration and payment (possible discharge fee) at the gate, the trucks enter the site through a ramp to reach the highest point of the FSTP to unload the sludge at the basket-screens provided at the first pre-treatment unit.

All trucks, independent of the sludge variety and the volume of the load, deliver their loads at either of the 3 basket-screens on top of the 3 receiving channels. The only exception are loads with high FOG concentration; they discharge only at the center basket with integrated grease trap. Two trucks can discharge at the same time.

If the trucks need to be cleaned after discharging, this can be done at the dedicated cleaning space at a side of the discharge area. For this purpose, recycled pressurized water is provided, and the resulting wastewater is directed to the treatment system. After discharging and cleaning the trucks drive down on the other side of the hill via the second ramp and around the entire treatment area until they reach the entrance of the FSTP again. There is a resting area with bathrooms and showers as well as some basic services such as water and beverage dispenser.

Figure 14: Entrance to the FSTP Paramaribo with administration building and registration counter

Figure 15: Sludge discharge point at the beginning of the pre-treatment

A. Pre-treatment Units

(1) Screening Unit

Screening aims to prevent coarse solids and inorganic wastes like plastic, fabrics, and other trash from entering in the treatment system to avoid clogging of subsequent treatment modules and to enhance the value of treated end-products.

The truck delivers the sludge directly into a basket screen positioned on top of the receiving channel. The basket screen retains trash of over 25 mm. Hinged and comfortably positioned at knee height, this screen is easily accessible for the unloading process as well as for emptying the retained solids.

The screen chamber located under the basket screen uses two inclined stainless-steel bar screens to retain coarse inorganic material. The spacing between the bars is 12-20 mm for the coarse screen, followed by a fine screen of 6-10 mm spacing. The trash is manually removed from the screens with rakes and deposited into the screen trash-tray. The incoming flow to the screen chamber is regulated by the valve at the unloading truck.

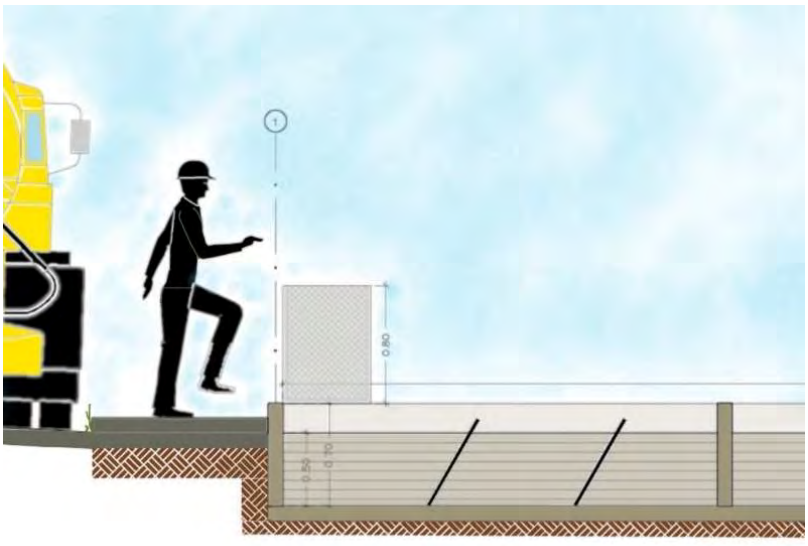


Figure 16: Screen chamber unit (cross-section)

Table 16: Screening Unit: Conceptual basic parameters

Parameters	Units	Tentative value
Material of screens	U	Stainless steel
Type of screens		Basket and bars
Number of screening units	U	3
Inlet flow	(m^3/truck load)	10-12
Discharge time	min	8-10
Total screen area per unit	m^2	1.2-1.6

(2) Grit Chamber

The grit chamber removes sand and other weighty inorganic materials such as metal fragments, etc.

The screened sludge flows into a horizontal flow grit chamber. The elongated design of the open chamber with smaller width and greater length reduces the flow velocity and allows heavier sand particles and other inorganic materials to settle. However, the organic particles remain in suspension. The design of the grit chamber allows a detention time of the sludge of 45 to 90 seconds to let the grit to settle.

A total of 5 parallel grit chambers allows for the discharge of two trucks at the same time and for continuous cleaning of the chambers. The grit chambers are cleaned manually, and the grit is disposed at the adjacent dedicated grit storage area. This area drains back into the end of the grit chamber, allowing active cleaning of the grit, if required. The truck cleaning station is also connected to one of the grit chambers and the grit storage platform. The (rain) washed grit is disposed safely in 3-6 months intervals.

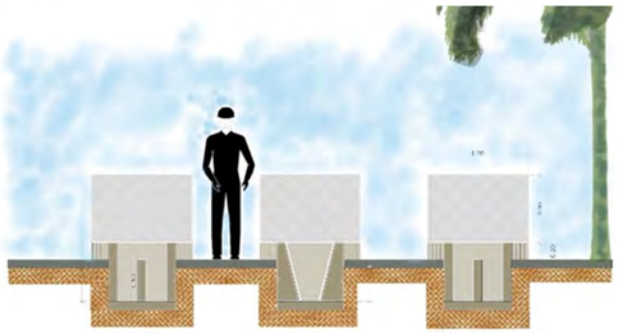


Figure 17: Grit chambers

Table 17: Grit chamber: Conceptional basic parameters

Parameters	Units	Tentative value
Number of grit chambers	U	5
Type of grit chambers		Horizontal flow: 2 Doble chamber, 1 Single chamber
Grit removal volume	m^3	0.5
Length of grit chamber	m	7.5
Depth of grit chamber	m	0.5

(3) Grease trap

The grease trap aims at providing the time necessary for gravity to act and produce an effective separation of FOG from the sludge, allowing for its removal before the sludge moves into the primary treatment.

A special grit chamber line with integrated grease trap volume is available for truckloads with declared high-FOG concentration. The water part already separated in the truck, is sent to the regular path and only the high-fat concentration part of the load is fed to the grease trap. After 10 minutes, the grease is skimmed of manually or with other support equipment into a storage container. The grease-reduced sludge is directed to the collection tank.

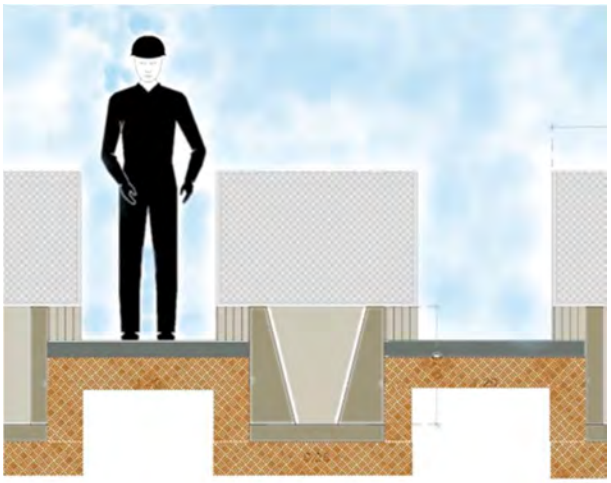


Figure 18: Grease trap (cross section)

Table 18: Grease trap: Conceptual basic parameters

Parameters	Units	Tentative value
Number of grease traps	U	1
Type of grease traps		Gravity
Volume of grease trap	m^3	6
Length of grease trap	m	7.5
Depth of grease trap	m	1.2

B. Primary Treatment Units

(1) Pump station

The topography of the Paramaribo region can be described as flat without exceptions and with high groundwater table. Therefore, regardless of the plot finally assigned to the project, to allow gravity flow for the functioning of the whole treatment process, one pumping station is required.

Figure 19: Pumping station with submergible cutter pump

The pump station is located after the pre-treatment and before the primary treatment unit and raises the sludge from nearly ground level to approximately 4 meter above ground. A 20 m^3 tank collects 2 or more pre-treated truckloads of sludge, acting also as a first mixing device. The storage capacity provides a buffer for possible irregularities of the power supply. The submergible cutter-pump set elevates the sludge from here to the distribution box located approximately 1.5 m above the surrounding finished ground level and acts as a second mixing and chopping device.

(2) Flow Distribution Box

The primary treatment of the sludge is provided by 4 parallel treatment lines. Consequently, the flow coming from the pump station is divided in 4 equal flow rates. This is accomplished at the gravity-flow distribution box, where also individual streams can be disconnected. From this distribution box each flow is sent to the inlet register of the 4 thickener/settler units

The overflow pipe of the flow-distribution box can be utilized also as bypass for the entire first primary treatment module (thickener/settler) and send the sludge directly to the planted drying beds.

The gas/air displaced from the collection tank and the distribution box is passed across a biofilter to avoid odor nuisances.

(3) Thickener/ Settler

This unit aims at:

a) Further homogenization of the sludge. The very heterogeneous sludge loads, mainly from its consistency and decomposition stage, make it necessary to homogenize the sludge material before further treatment. Moreover, a fast inoculation with anaerobic bacteria is pursued at this stage
b) Separation of the solid from the liquid fraction to allow for separate specific and efficient treatment of each fraction.

c) Increasing the TS concentration of the solid part of the sludge to allow for efficient use of the drying surface.

Gravity thickening of the sludge increases the solids concentration by allowing the particles to settle at the bottom of the tank, producing a concentrated (thickened) sludge stream there, a supernatant (diluted) stream at the upperpart and a floating scum layer on the surface.

The inlet registers of four circular settlers acting as gravity thickener will receive the pre-treated sludge from the flow distribution box. The inlet peak flow of 15-25 m^3/h directed into the "first compression layer" will allow for turbulence and mixing of fresh and settled sludge; hence, acting as 3rd mixing device. The-sludge mixing process enhances the settleability mainly of fresh sludge and reduces floating scum.

A good mixture and settleability is provided through a retention time of the fresh sludge of 2 to 3 days. On the other hand, the SRT of 6 days allows for thickening and a partial stabilization due to breakdown of fast degrading organic components. In weekly intervals, the settled sludge with TS concentration >6% will be extracted by gravity and sent to the PDB. The provision for recirculating sludge in the settler allows for additional agitation if required and as option for pressurized discharge. The design of the settler with dome allows for the biogas produced to be collected and the climate-damaging methane emissions to be neutralized by means of combustion.

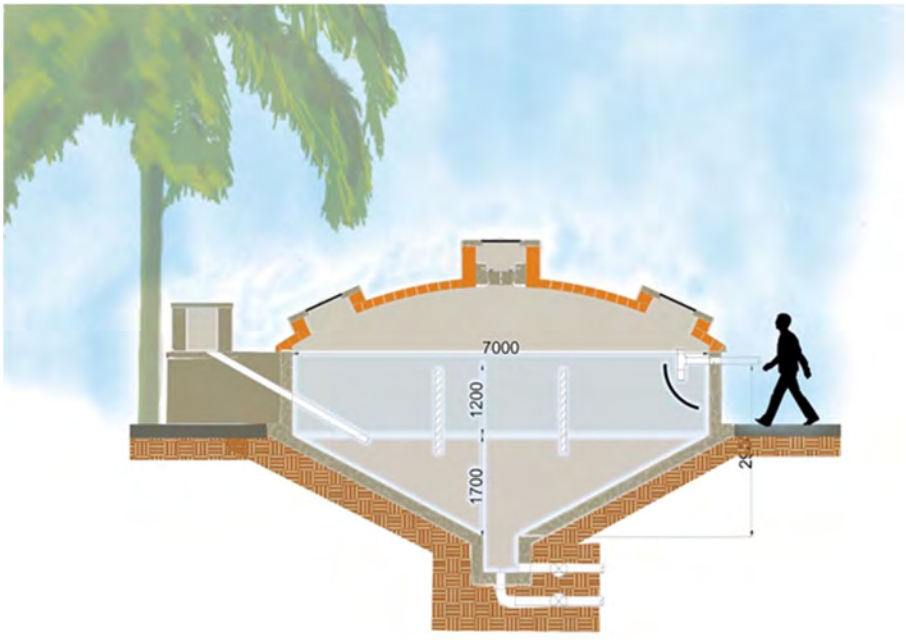


Figure 20: Thickener/settler (cross section)

Table 19: Thickener/settler: Conceptual basic parameters

Parameters	Units	Tentative value
Daily flow rate	m^3	100
Influent COD	mg/l	6,000
Number of thickeners/settlers	U	4
Diameter of the thickener/settler unit	m	7
Hydraulic retention time (HRT)	day	2-3
Volume of the thickener/settler unit	m^3	70
Solid retention time (SRT)	day	6+
Sludge withdrawal interval	day	6
Sludge volume withdrawn per interval	m^3	20
Pressure head	m	3+

C. Secondary Treatment Units – Solid Fraction

(1) Planted Drying Beds

Sludge drying beds aim to provide sludge dewatering by allowing the liquid to both drain off by gravity through a permeable medium on which the sludge sits, and to evaporate under the ambience conditions.

The 16 planted drying beds (PDB) provided are simple, permeable beds that, when loaded with sludge, allow it to dry by percolation and evapo-transpiration of the plant; the percolate (lixiviate) is collected and treated separately. About 75% to 85% of the sludge volume drains off or evaporates. Compared to unplanted drying beds, the PDB has two main advantages:

1) The transpiration and enhanced sludge treatment due to the plants.
2) The filter beds do not need to be desludged after each feeding cycle. New sludge is being directly applied onto the previous layer, while the plants and their root systems maintain the porosity in the filter media. In addition, the transpiration of the plants accelerates the drying process, and the plants also enhance the stabilization process of the sludge.

Following the treatment train, the thickened sludge with TS concentration >6% is extracted by gravity once a week from the bottom of the thickeners/settlers and conveyed to the PDB. Each thickener/settler unit alternately delivers to one of the two PDB linked to the unit. Each of the 8 PDBs is loaded once every other week, or about 13 times in half-a year and then left for a 6-month dormancy period. After the dormancy period, the accumulated stabilized and dried sludge is removed with the support of a compact wheel loader. The expected yield of this first set of PDBs is the range of 200-250 t. During the dormancy period the second set of 2 PDBs per thickener/settler unit are in use, leading to an annual yield in the range of 400-500 t dried sludge with a moisture content of 30-50%. The ample loading intervals and the dormancy period provide for high stabilization and pathogen reduction performance. Even so, the sludge is further sanitized at the co-composting unit.

Some of the macrophytes (plant species that can thrive in submerged conditions) used in the PDB units are canna indica, Cyperus papyrus, Colocasia and Echinochloa pyramidalis; they provide good percolation during the 6-month active operation period.

The percolate is collected by the drainage system at the bottom of the PDBs and conveyed by gravity for further treatment, together with the supernatant of the thickener/settler units, at the DEWATS (liquid-part treatment).

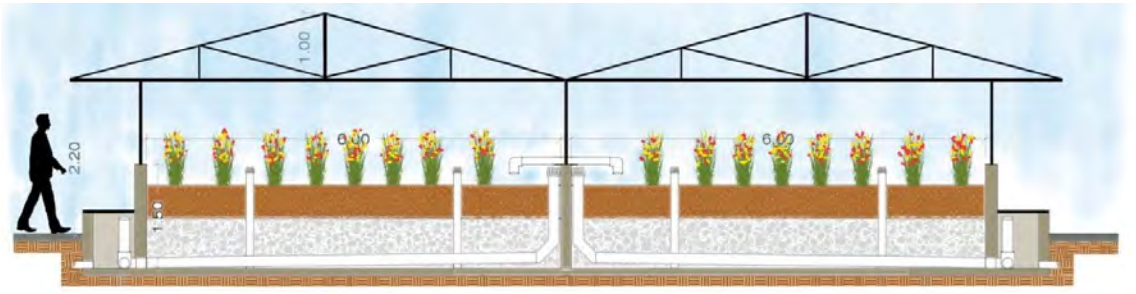


Figure 21: Planted drying bed (cross section)

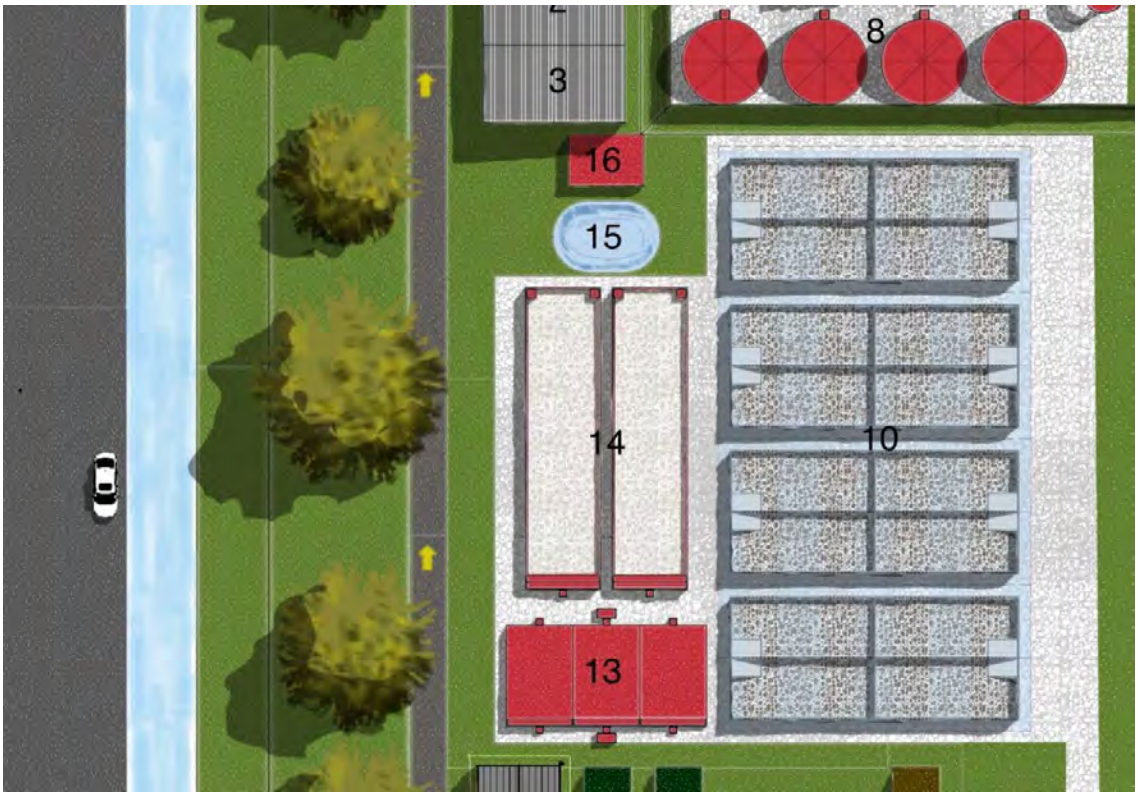


Figure 22: Planted drying bed (site plan)

3: Workshop; 8: Thickener/settler; 10: Planted drying beds roofed, 13: Anaerobic Baffle Reactor and Anaerobic Filter; 14: Planted Gravel Filter; 15: Polishing Pond; 16: Treated water tank

Table 20: Planted drying bed: Conceptual basic parameters

Parameters	Unit	Tentative values
Total number of PDB	U	16
Loading volume per application/PDB unit	m^3/load	22
Loading interval	weeks	2
Dormancy period	months	6
Total sludge retention time	months	12
Drying area per PDB	m^2	72
Sludge loading rate	kg TS/m^2/year	240
Sludge loading height	m	0.3
Sludge volume reduction		75-85%
Height of dried sludge at PDB	m	0.5
BOD of percolate effluent	mg/L	70 – 100
COD of percolate effluent	mg/L	350 – 400

(2) Co-Composting unit

Composting is controlled biological decomposition of solid organic matter by a natural aerobic process providing favorable conditions for bacteria and fungi to decompose organic material into a humus-rich product called compost It can be used for gardening, horticulture and as soil conditioner in agriculture. Co-composting is a composting process that uses more than one feedstock.

The co-composting unit of the faecal sludge treatment train targets the simultaneous composting of the dried and stabilized sludge produced at the PDB, together with Paramaribo's urban green waste. The following residues can be assigned to the category of urban green waste: tree limbs grass, wood chips weeds, green plants, dead plants, brush, garden trimmings, and leaves as well as organic residues from cleaning drainage canals. Co-composting these two substrates enhances the composting process. Faecal sludge has a high moisture and nitrogen content, while urban green waste is high in organic carbon and has good bulking properties (i.e., it allows air to flow and circulate). The mixed substrates have an optimized C/N ratio and moisture content for aerobic degradation.

This composting process reduces the volume, weight, moisture content and potential odor. Due to the high temperatures up to 65°C attained in the composting process, it effectively inactivates any pathogens that may have survived the previous treatment processes.

The co-composting unit has a designated area of 2,500 m^2. Green waste in the range of 1,000 tons per year is deviated from its way to the open landfill of Ornamibo, and received at the unit, shredded, and then mixed with dried sludge at the rate of 2:1. The compost windrows are covered with an air-permeable sheet to protect them against sun and heavy rainfall. To increase the air supply during the decomposition process and to ensure uniform exposure of the material under thermophilic conditions, the windrows must be turned at regular intervals. Semi-manual windrow turning is supported by a small front loader. The run-off is collected and treated.

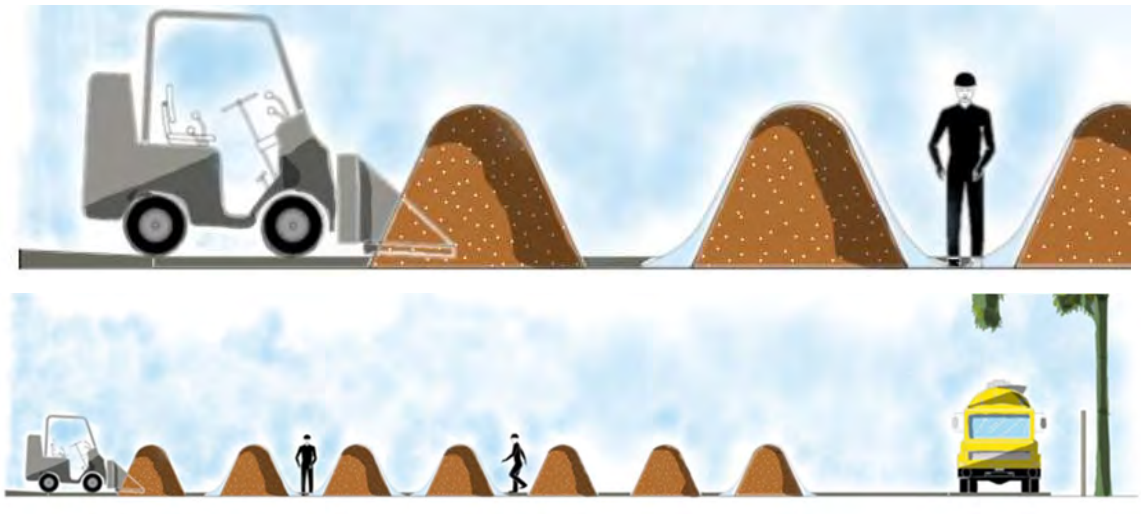


Figure 23: Co-composting unit, open windrows (cross section)

The product is a high-quality compost in the range of 750 tons per year. At an initial basic price of USD 88 / ton, it can contribute with USD 66,000 to the operation of the FSTP.

In future, the co-composting unit could expand or merge into a dedicated organic residues processing area, where all organic residues of the city are collected and processed to turn into different marketable products. A composting project is already in discussion as part of an improved waste management concept for Paramaribo.

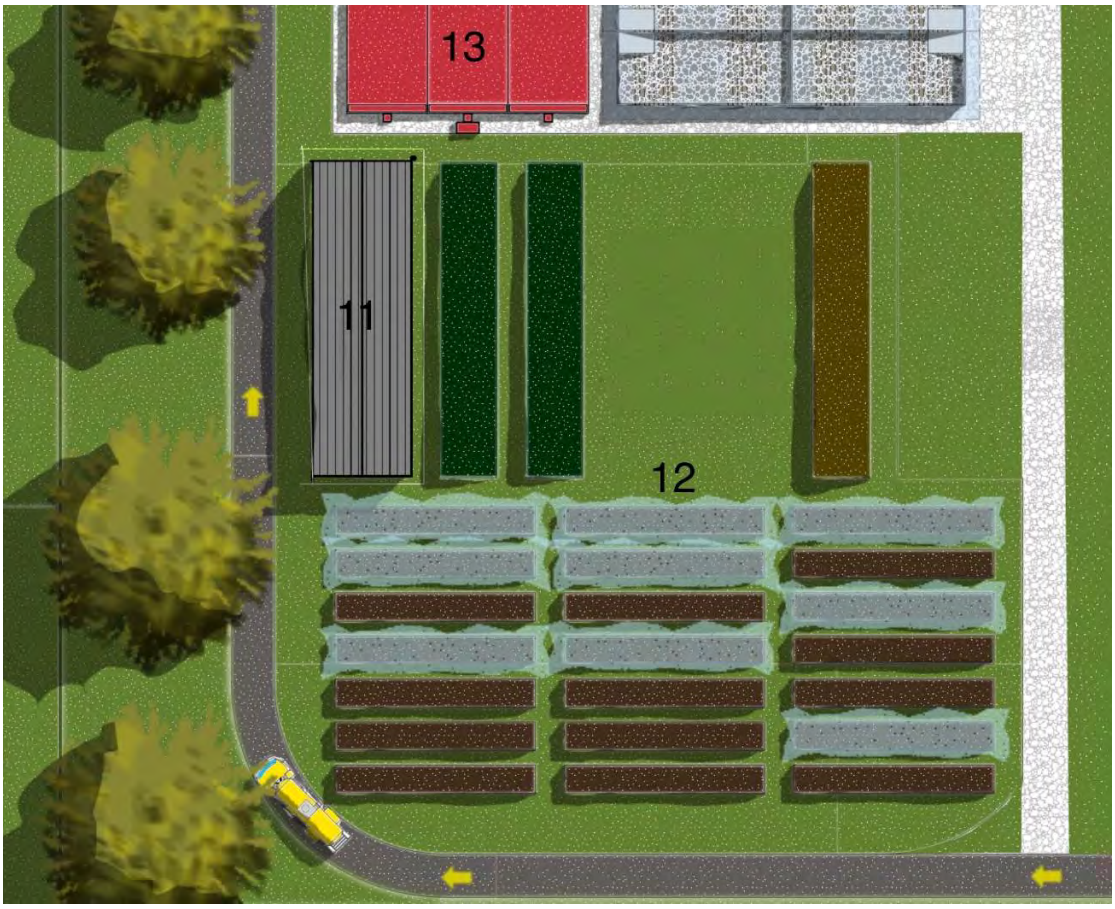


Figure 24: Co-composting unit (site plan)

11: Compost storage; 12: Compost area; below windrows partially covered with permeable sheets; above left green waste piles; above right dried sludge pile 13: Anaerobic Baffle Reactor and Anaerobic Filter

Table 21: Co-composting unit: Conceptual basic parameters

Parameters	Unit	Tentative values
Area	m^2	2,500
Feedstock dried sludge	t/year	500
Feedstock urban green waste	t/year	1,000
Thermophilic process	°C	50-65
Composting maturation time	Month	3-6
Quality compost yield	t/year	750

D. Secondary Treatment – Liquid Fraction

This component aims at providing secondary treatment to the 80m^3 liquid residues generated daily at the FSTP. The liquid part separated at the primary treatment unit, the thickener/settler units, together with the lixiviate from the planted drying beds are further treated to meet discharge standards (please, refer to chapter 6.2.2).

The selected treatment system DEWATS is based on natural treatment processes and is operated 100% by gravity. This secondary treatment combines anaerobic and aerobic treatment technologies and includes the following units:

1. Anaerobic Baffle Reactor (ABR)
2. Anaerobic Filter (AF)
3. Planted Gravel Filter (PGF)
4. Polishing Pond (PP)

The expected COD and BOD inlet values are in the range of 2000mg/l and 800 mg/l respectively.

(1) Anaerobic Baffle Reactor (ABR)

Anaerobic treatment method is energy-efficient and reduces the organic pollutant load (COD/BOD) of the wastewater through the metabolism activity of anaerobic bacteria, transforming it into biogas and a small amount of biosolids.

The settable solid- free wastewater moves from the overflow of the thickener/settling units and from drainage system of the PDB by gravity to the anaerobic baffled rector. In this case, the ABR consists of 3 chambers where the wastewater is forced through baffle pipes to the bottom of each chamber and flow through the activated sludge blanket. The bacteria use the organic pollutants for their metabolism and transformation into bacteria mass that settles at the bottom of the reactor. The turbulence generated at the chambers leads to increased contact time with the pollutant increasing the treatment efficiency. The suspended and dissolved solids present in the wastewater are degraded anaerobically by about 60%.

The operation of the ABR reduces usually to desludging of excess activated sludge in periods of 2-4 years.

Table 22: Anaerobic baffled reactor: Conceptual basic parameters

Parameters	Unit	Tentative values
Treatment capacity	m^3/day	85
Number of chambers	U	3
Dimension	(L x W x H) m	3 x 16 x 2
Hydraulic retention time	h	16
BOD removal rate	%	60
COD removal rate	%	55

(2) Anaerobic Filter (AF)

The outflow of the ABR enters directly into the anaerobic filter, the second anaerobic treatment unit. The 3 AF chambers loaded with filter material that serves as bacteria carrier,

have a hydraulic flow rate similar to that of the ABR. The wastewater passes through the filter media from bottom to top and the anaerobic bacteria feed on the organic pollutants.

This treatment module focuses on dissolved organic pollutants and is very efficient in reducing the organic load, being in the range of 75%-85%.

All tanks are vented, and the displaced gas is passed through a bio-filter to control the release of odorous and potentially harmful gases. Like the ABR, the operation requirement of the AF reduces usually to desludging of excess activated sludge in periods of 3-5 years. The anaerobically treated effluent is conveyed for further aerobic treatment to the Planted Gravel Filter unit.

Table 23: Anaerobic filter: Conceptual basic parameters

Parameters	Unit	Tentative values
Treatment capacity	m^3/day	85
Number of chambers	U	3
Dimension	(L x W x H) m	4.5 x 16 x 2
Hydraulic retention time	h	28
BOD removal rate	%	85
COD removal rate	%	75

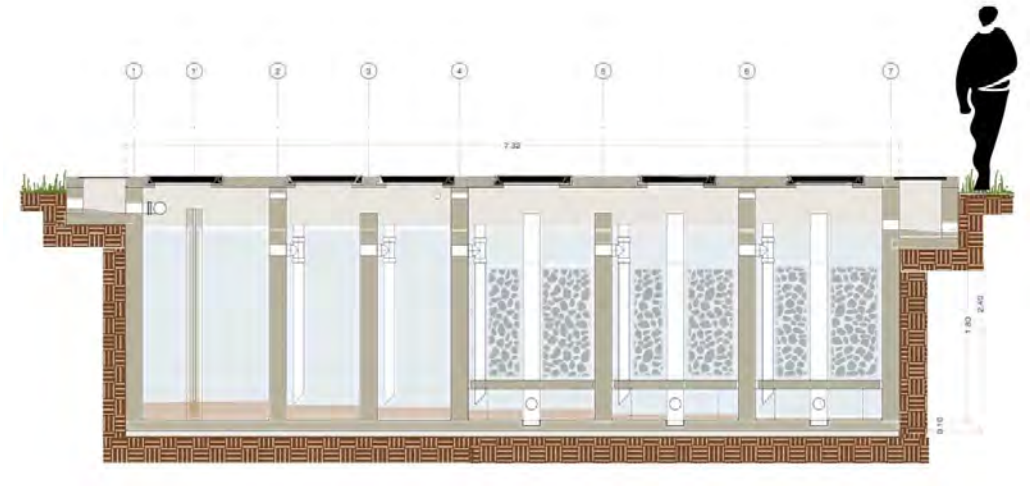


Figure 25: Anaerobic baffled reactor and anaerobic filter (cross section)

(3) Planted Gravel Filter (PGF)

Aerobic wastewater treatment is a biological method of breaking down organic and other pollutants such as nitrogen and phosphorus using oxygen. Nature based systems utilize among other plants and water surface to introduce the required oxygen into the treatment process. The PGF is an aerobic, nature-based treatment system.

The 2 PGF units are horizontal subsurface flow constructed wetlands. Its design is based on the treatment target and the quality of the influent. The 150m^2 large PGFs receive the anaerobically treated effluent from the AF by gravity with expected COD and BOD concentrations in the range of 150 to 200 mg/l and 40 to 80mg/l respectively. With a Hydraulic

Retention Time (HRT) between 1 and 2 days, this unit accomplishes a further reduction of the organic load to values below 100mg/l COD and 30 mg/l BOD.

At the same time this treatment unit has an important hygienization effect by reducing faecal coliform concentrations up to 99% equivalent to a reduction of up to 2 logs. The PGF is filled with gravel of different sizes and planted with locally available macrophytes. Some of the most used plants are phragmites australis (reed), Canna indica, Cyperus papyrus and Colocasia. The effluent from the PGF is conveyed for further hygienization into a polishing pond.

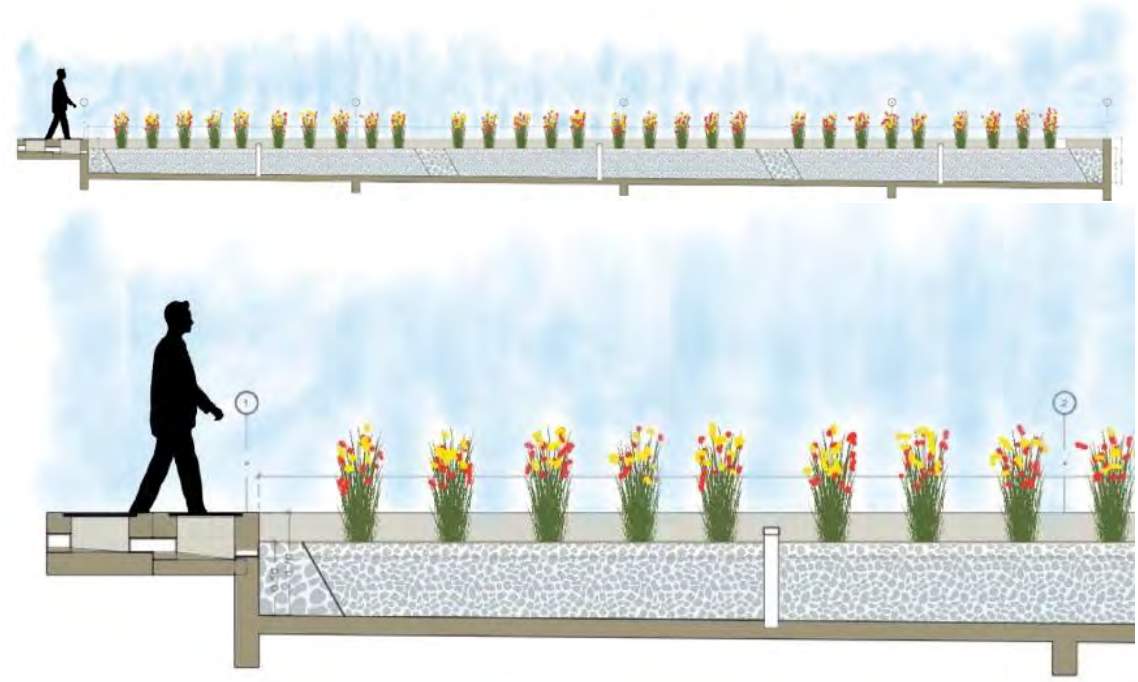


Figure 26: Planted gravel filter (cross section)

Table 24: Planted gravel filter: Conceptual basic parameters

Parameters	Unit	Tentative values
Treatment capacity	m^3/day	85
Total area	m^2	300
Number of units	U	2
Filter media height	m	0.6
Hydraulic retention time	day	1
BOD removal rate	%	45
COD removal rate	%	40
Reduction of faecal coliform concentration	log	Up to 2
Reduction of helminth eggs (Total treatment system)	%	95-100%

(4) Polishing Pond (PP)

A polishing pond is an anaerobic treatment system. In this treatment train, its application aims at final oxygenation for further hygienization by pathogen reduction of the treated effluent.

The final treatment unit, the polishing pond, reduces pathogen concentration through UV exposure and ensures the required discharge standards for its reuse in agriculture or even safe disposal into open water bodies. Thus, the treated effluent is retained for 1 to 2 days in a shallow lined pond with a surface area of around 60 m^2 and with a plug-flow favoring design.

The wastewater treated this way is fed into a collection tank, from where a pump lifts the water up to the overhead tank located at the truck cleaning area. The daily surplus of about 50 to 70 m^3 of treated wastewater can be reused in agriculture or safely disposed into an open water body.

Figure 27: Polishing Pond

Table 25: Polishing Pond: Conceptual basic parameters

Parameters	Unit	Tentative values
Treatment capacity	m^3/day	80
Area	m^2	4.5 x 16 x 2
Hydraulic retention time	h	28
Reduction of faecal coliform concentration	log	1

6.2.3.3 Other service areas

Beside the main treatment facility, the proposed FSTP offers other important convenience services. These service areas are also related with infrastructure, other than that for the treatment area described in the chapter before.

The areas with brief descriptions are listed below.

A. Entrance

The entrance to the facility is equipped for easy registration of the truck loads and payment (of potential discharge fees). Updated information on all subjects related to Surinam´s FSM is accessible or actively provided. A boom gate provides access to the sludge-loaded vacuum trucks, allowing them to drive up the ramp to reach the discharge area. Trucks bringing urban green waste for the co-composting unit turn at the entrance right heading to the respective discharge point.

B. Circulation

The main vehicle circulation is in one direction and on a paved single-lane road that surrounds the entire FSTP site. A 30-meter ramp leads to the elevated sludge discharge point and to another one down on the other side. At certain points, the road is designed with double width to allow unhindered stopping at action points.

C. Discharge Area

Two discharge areas are available:

- Discharge area for vacuum trucks to unload sludge. For more details refer to section 6.2.3.3
- The co-composting unit has a separate access to facilitate the reception of the organic material and the transport of the final compost.

D. Truck Cleaning Area

Sludge-carrying vacuum trucks require often direct cleaning after discharging. Directly adjacent to the unloading area, the facility provides a convenient service area for truck drivers to accomplish the task. For more details, refer to section 6.2.3.3

E. Parking

The facility provides a parking area for at least 4 trucks, next to the administration and resting area.

F. Resting Area

The truck drivers as well as the FSTP staff have at their disposition an area with basic facilities to enjoy work breaks, eat or get refreshments. This area also offers additional services to the drivers such as bathrooms, showers, and lockers.

G. Administration Building

All administrative work, including, among others, registration of trucks, payment, reporting to the respective authorities, personnel management, accounting, complaint management, etc., will be handled in a separate administrative building at the entrance to the plant. The organization of this area will be in the hands of the private operator of the plant.

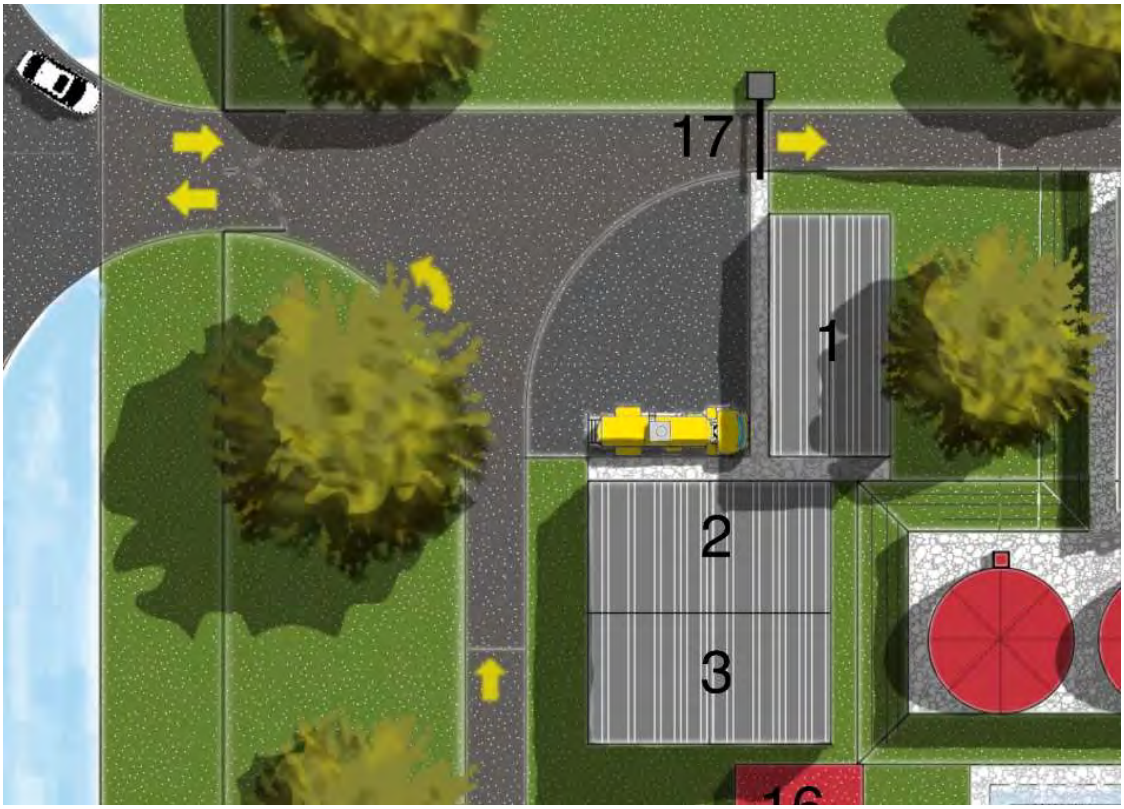


Figure 28: Entrance area to the FSTP including administration and resting and parking area. Administration building; 2: Resting area; 3. Workshop; 17: Boom gate.

H. Future Expansion Area

As explained in section 6.2.3.2 under "General layout of the FSTP", in future a 2nd phase will be required to treat 100% of the sludge generated in the wider Paramaribo area. The required land needs to be assured already in the 1st phase. Therefore, at least 20,200 m^2 should be secured in the 1st phase, also considering the expansion of the greater Paramaribo region. 15,000 m^2 will be developed during the 1st phase (including routes and elevations for both phases) and approximately 5.200 m^2 will be reserved for core elements of the 2nd phase.

With the implementation of a dedicated composting site for urban organic waste as part of a larger solid waste management project, the dried sludge from the FSTP could be co-composted there, thus externalizing the co-composting unit of the plant. This would also make room for future expansion of the sludge treatment plant. A physical proximity of the composting unit to FSTP would be a prerequisite for this.

FSTP areas
1. Administration area
2. Resting area
3. Workshop
4. Truck cleaning area
5. Grit storage
6. Grit chambers
7. Storage
8. Settlers
9. Treated water tank for truck cleaning
10. Planted drying bed (PDB) roofed
11. Compost storage
12. Compost area
13. ABR and AF
14. Planted gravel filter (PGF)
15. Polishing pond
16. Treated water tank
17. Access

Figure 29: Future expansion area with the expansion area on the right (site plan)

6.2.4 Site selection process

Site selection criteria were established, 7 locations were pre-evaluated, and 1 location was pre-classified as potentially suitable. It is being suggested to consider linking a planned Composting Project with the FSTP Project. The Ministry GBB has been requested to provide further information on some of the locations.

6.2.4.1 Precondition for the site selection process

The site selection process was initiated during the first on-site mission with the visit of two sites pre-selected by the Ministry of Public Works as possible sites for the construction of a FSTP. One was the waste dump site in Ornamibo and the other was the current disposal site for faecal sludge in Tout Lui Faut.

The Ornamibo waste dumpsite is located south of Paramaribo and serves more than 85% of Suriname's population or around 475,000 people. The dumpsite seems to have no internal organization and a complete lack of sanitary facilities. It is estimated that about 200,000 m^3 of solid waste is dumped here annually originating mainly from households, but also from shops, markets, offices, industries, and hospitals in the service areas. There is no waste separation visible.

The second site in Tout Lui Faut is right beside the compound of the Staatsolie Company (Suriname's National Energy, Oil & Gas Company) accessible only by a small, unpaved road. The sludge is discharged at a small weir at the end of an open channel that flows directly into the Suriname River. Some sludge companies empty their tanks into the channel before the end of the road, especially when the road conditions make it difficult to reach the weir.

Based on first impressions, both sites do not have the prerequisites for the construction of an FSTP. The first site with almost uncontrolled deposited waste and mounds of waste covered with sand, soil, and vegetation around is not a possible building ground for an FSTP. The site has a strongly negative image among the population which would highly influence the acceptance of an FSTP. In addition, the extreme odor of the waste dump would make a visit to a pilot sludge treatment plant a negative experience.

The Tout Lui Faut site has no directly available land near the discharge point. The Staatsolie Company site limits the availability of land on the side of the road. On the other side of the channel, a private company is currently building a small river port. Nevertheless, both sites were revisited during the second site visit to Suriname and examined in more detail for their suitability as building sites for the FSTP (see below).

No other site options were presented by institutional or private stakeholders. Due to the tight timeframe of the project, it was very difficult to find a suitable construction site for the FSTP. Nevertheless, the site selection process was continued by reviewing land proposed for the construction of a landfill and determining its suitability for the construction of a FSTP. It should be remarked that a normal site selection process for a FSTP can take months to years before a suitable site is found, legally secured, and accepted by all parties.

6.2.4.2 Approach and procedure for the site selection process

As a first step in the site selection process, the key stakeholders were asked whether suitable sites were available or already pre-selected. Specific site selection criteria for Surinam were prepared and served as a guideline during the selection process. The ministries of ROM and PW only named as options sites that were already in the discussion for the location of the landfill.

A list of criteria was developed addressing the specific conditions of Paramaribo and Wanica and based on the information and data collected during the initial site visit (Annex 6.2.4

Criteria catalog for site selection). The criteria catalog was designed to assist decision-makers in determining the suitability of a specific site, but not as a direct decision tool for selection. Therefore, no value nor weighting is assigned to the criteria and no direct scored result can be derived.

With the support of ILACO, all available information on landfill site options was compiled and evaluated according to the previously set criteria. Four sites were selected which, according to the available information, could also be possible sites for a FSTP. Table 26 shows the total number of locations that were considered in the selection of a possible site for the landfill. Of the sites, Charlesburg (privately owned land, located in the north), Braamshoop (former mining area, private houses close by), and BHP Billiton Mines (distance and access) were excluded from the initial selection.

The remaining sites were first checked to see if they were located within or in the vicinity of the area indicated by the sludge service companies as their main service area. During the survey, the sludge company indicated the area shown in Figure 30 as their main service area and within it the preferred area for a FSTP. The expressed preferences were based on their experience with driving distance and traffic flow, distance to customers, available sites, and nuisance to residents.

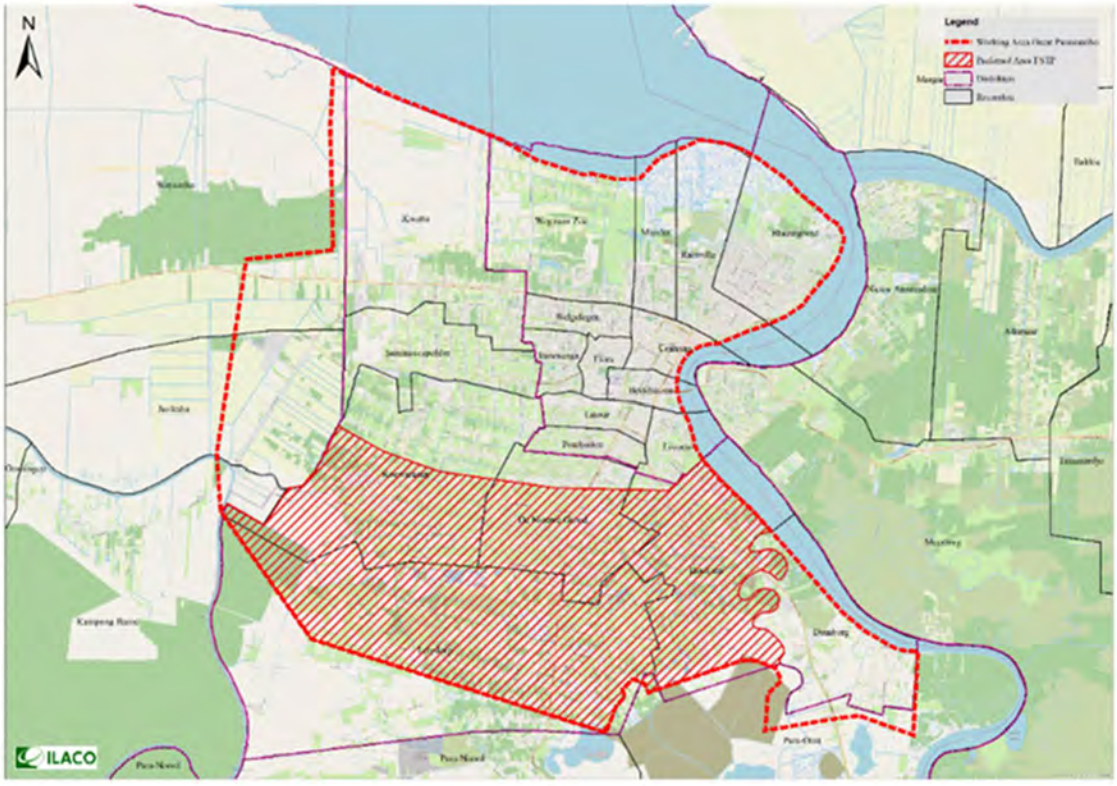


Figure 30: Main service area of the SSC and preferred area for the construction of a FSTP

Table 26: Site descriptions of potential locations for the landfill in Paramaribo

	1. Charlesburg	2. Leiding 20	3. Tawajarie Polder	4. Braamshoop	5. BHP Billiton Mines	6.A Ornamibo (Landfill)	6.B Ornamibo (Sand Pits)
Summary	This site is located near the existing private dump site of Charlesburg. It is selected since there would be sufficient land available near the area, and the region is already impacted by the current dumping activities. However, in this northern part of Paramaribo the land is privately owned and relatively expensive.	This site is in a stretch of land between three road, called Leiding 20 / 22. It has been selected since there would be sufficient land available near the area. However domestic houses are not far away.	This site is in the western part of the Greater Paramaribo region, where still large amounts of pristine lands can be found. This means sufficient land is available with no domestic houses in the direct vicinity. On the other hand, the land has still a natural and untouched character, which would be affected by the landfill.	This site is in a stretch of land between two main roads, called Braamshoop. It has been selected since there would be sufficient land available in this the area. However domestic houses are not too far away.	This site is located at the former BHP Billiton mines are in the district of Para. The area to the north and east is currently a swamp area, where water is drained and discharged into the river. The site has been selected here since the region is already impacted by these economic activities and domestic houses to further away.	This site is located near the current dump site of Ornamibo. Under this option the current dump site would be compacted, closed, and sealed, while a new sanitary landfill would be constructed next to, and on the flanks of this sealed dumpsite	This alternative site at Ornamibo is located a bit more to the south of the current dump site, where more space is available. Under this option it might also be possible to treat the leakage and landfill gas generated by the closed dumpsite in conjunction with the new sanitary landfill, however against higher costs than under option 6a
	GPS: 5° 51' 59" N, 55° 10' 11" W	GPS: 5° 48' 30" N, 55° 16' 29" W	GPS: 5° 43' 38" N, 55° 19' 27" W	GPS: 5° 41' 8" N, 55° 16' 7" W	GPS: 5°38' 54" N, 55° 10' 37" W	GPS: 5° 43' 28" N, 55° 8' 8" W	GPS: 5° 42' 26" N, 55° 8' 4" W
	Access route via: Van het Hogerhuysstraat, Keizerstraat, Johan Adolf Pengelstraat, Nieuwe Charlesburgweg	Access route via: Van het hogerhuysstraat, Willem Campagnestraat, Jaggernath Lachmon straat, Commissaris Weytinghweg, Bomaweg, Nieuw Weergevondenweg. Area of land can also be accessed via the Saramacca Canal.	Access route via: Van het hogerhuysstraat, Martin Luther Kingweg, Tout Lui Fautkanaalweg, Vredenburg weg, Indira Gandhiweg, Java weg, Reeberg weg	Access route via: Van het hogerhuysstraat, Martin Luther Kingweg, Tout lui fautkanaalweg, Vredenburg weg, Indira Gandhiweg, Van Hattenweg	Access route via: Van het Hogerhuysstraat, Martin Luther Kingweg, the Meursweg.	Access route via: Van het hogerhuysstraat, Martin Luther Kingweg	Access route via: Van het hogerhuysstraat, Martin Luther Kingweg

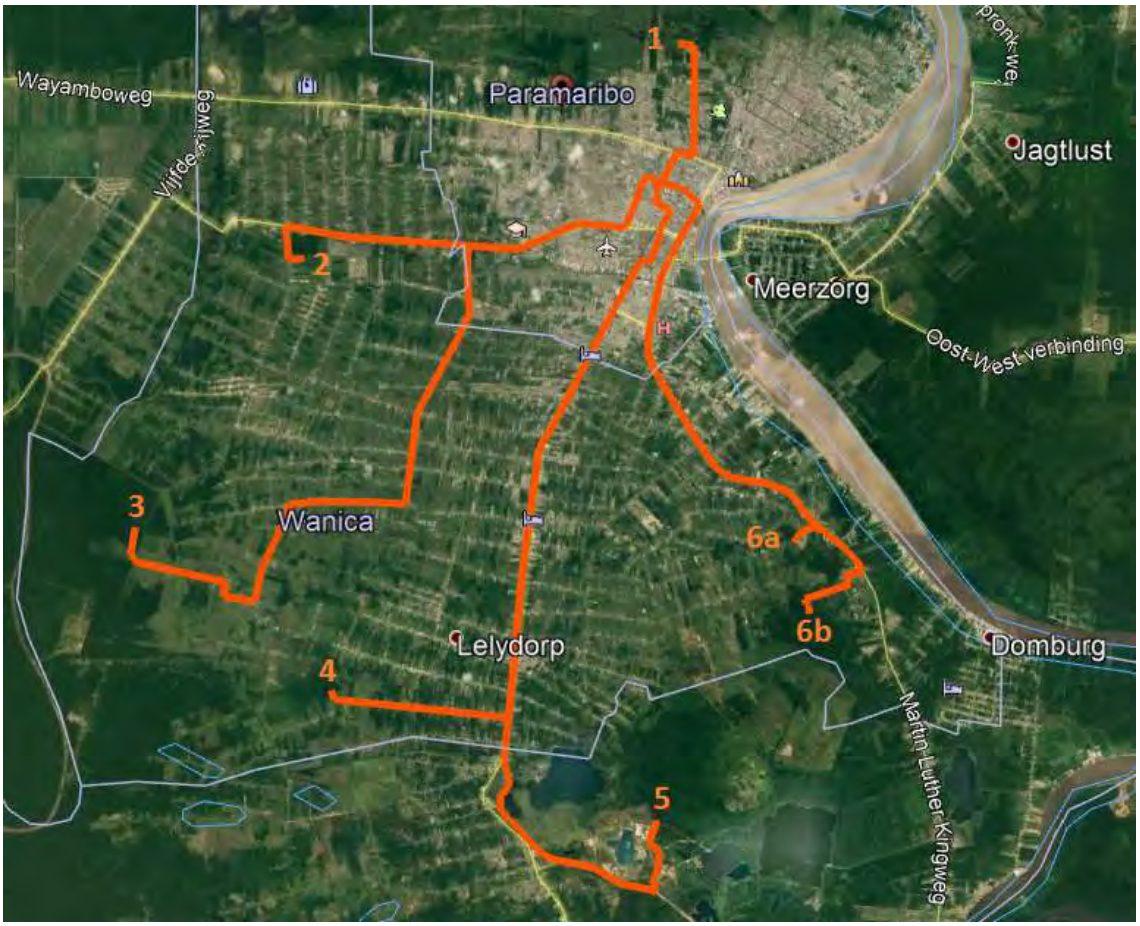


Figure 31: Alternative landfill locations and their transportation routes (3)

The potential sites, 2. Leiding 20, 3. Tawajarie Polder, 6a. Ornamibo A (Landfill) and 6b. Ornamibo (Sand Pits) were visited to get an on-site impression and to partially assess the suitability of the site for the construction of a FSTP based on the criteria catalog. Field observations were then complemented with data from the Landfill Project (3).

6.2.4.3 Results of the site evaluations

Location 2 - Leiding 20

The land is located between the roads Leiding 20 and 22, behind the office of the District Commissioner Wanica. The hitherto unsettled land is about 65 ha in size, but the ownership is up to now not clearly determined. The advantages are the good access to the main road and the size of the site, which would allow the selection of a suitable location for the FSTP. Also, the possible connection to the Saramacca Channel, which borders the site to the north, is an advantage.

The necessary extension of a direct access road and the site development are possible with not too high costs. However, the proximity of a residential area and their expansion apparent through the visible clearing of land make this site unsuitable. Detailed aspects of the site evaluation can be found in the Annexure (Annex 6.2.4 Criteria catalog Leiding 20).

Figure 32: Location 2 - Leiding 20

Location 4 - Tawajarie Polder

The land is in a cattle farming area accessible only over an unpaved road. The road made a well-maintained impression, but the road width allows only limited truck traffic. The site is several kilometers away from the nearest main road. The necessary investment in road infrastructure is significant to ensure year-round access for sludge trucks. Tawajarie polder is an agricultural area with cattle farming, without nearby residential area and only a few individual houses over 200 m away. Nevertheless, the increased truck traffic of a FSTP would lead to noise nuisance for the residents.

The location offers options for the reuse of treatment products for fertilizing farmland, but no specific information is available about the interest or willingness of farmers to use these products.

It was not possible to visit the site because of a private property road sign prohibits final access. Following the information from ILACO (3), the location has no flooding risk and there is a connection to electricity and water through the access road. The land is covered with high vegetation and the distance to a potential discharge point (Saramacca Channel) is around 3 km far (see Annex 6.2.4 Criteria catalog Tawajarie Polder).

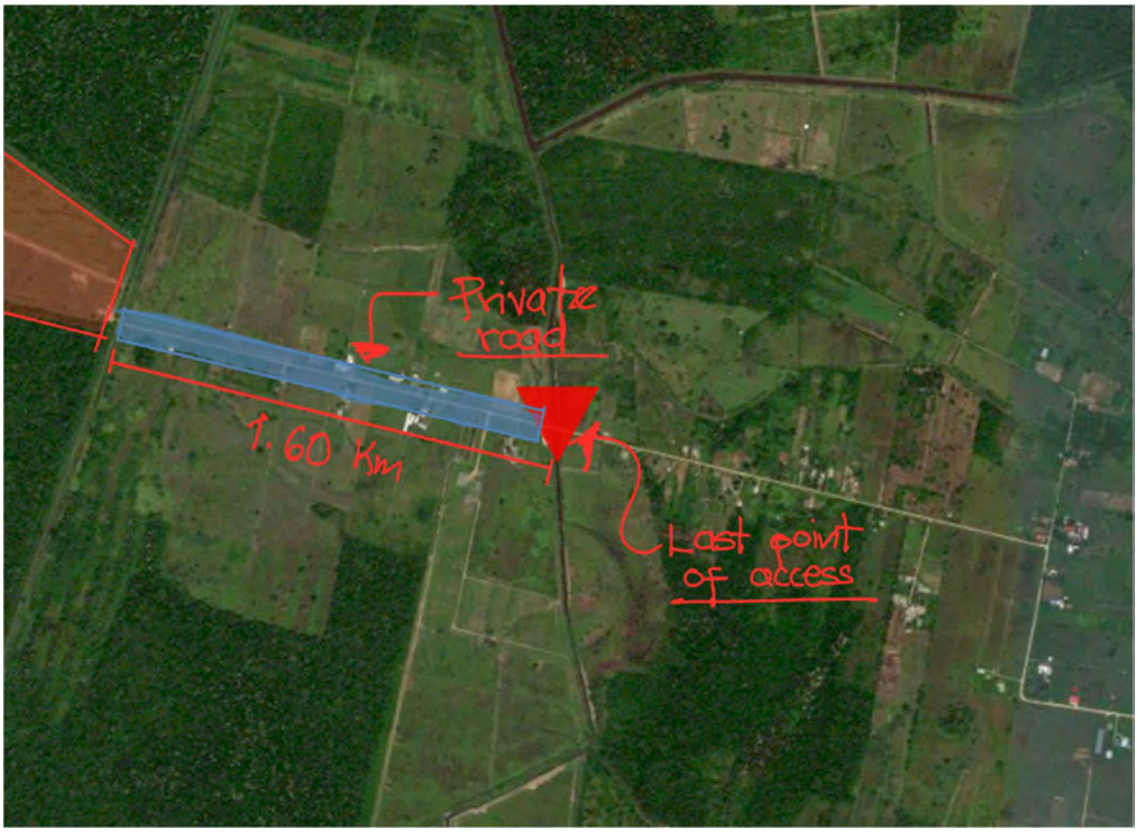


Figure 33: Location 4 - Tawajarie Polder

Location 6 A – Ornamibo (Landfill)

The site of the current landfill (6.A Ornamibo Landfill) was revisited also during the second site visit to Paramaribo mainly to evaluate the surrounding area as well for its suitability for the construction of an FSTP. But the site was also found unsuitable for the reasons mentioned above.

Figure 34: Location 6A - Ornamibo landfill site and 6B - Ornamibo sand pits

Location 6 B - Ornamibo (Sand Pits)

The Ornamibo Sand Pits area was included in the list of sites to be visited, as the official authorities were favoring a location close to the current landfill. It is believed that this would result in a lower probability of opposition to the construction of a FSTP.

The site is less than 1 km in a straight line from the access road and 1.5 km from the main road. The availability of extensive land is an advantage of the site. Only the directly visible area in Figure 35 is about 25 ha. The location has a low risk of flooding and is in preference of the Sludge service companies for the FSTP.

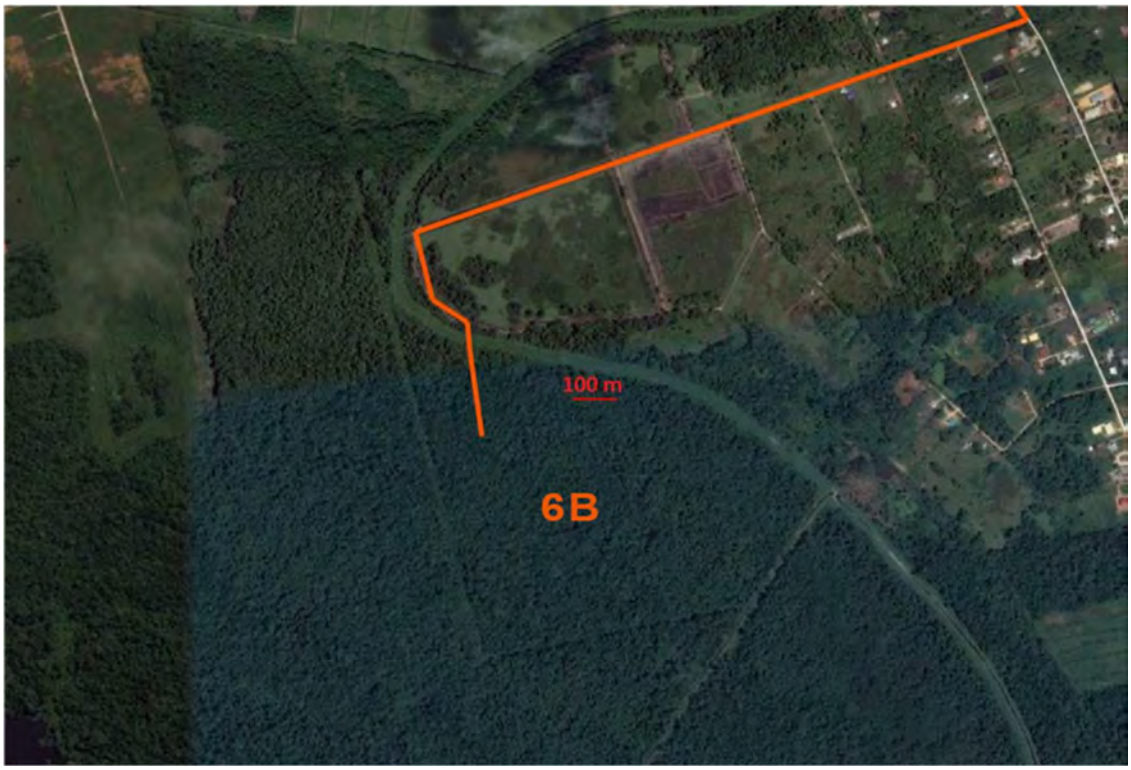


Figure 35: Location 6 B - Ornamibo sand pits (modified from [3])

The site close to the landfill site (at around 2 km) would offer opportunities especially as the new landfill project includes the separation of organic waste. Today, organic residues from gardening, maintenance of urban greening and similar end up in the landfill. A larger pilot composting project is already under discussion (4) as part of the Landfill Project. The FSTP could be located nearby, allowing the end products of the treatment, especially the dried sludge, being co-composted with the mentioned other organic residues. The FSTP could also share access infrastructure with such a compost project.

The site could not be accessed for evaluation as so far, no road is available. Therefore, the selection criteria catalog could not be applied on-site, but the data from the landfill planning were used (Annex 6.2.4 Criteria catalog Ornamibo 6). Significant investment is required to construct a road for sludge trucks to reach the treatment plant.

Location Tout Lui Faut

The current sludge disposal site at Tout Lui Faut and its immediate vicinity was also reviewed as potential locations for a FSTP. The desludging companies stated that this site was convenient and with good road access for the sludge discharge. Two sites were identified as possible locations for an FSTP. The Ministry of ROM was asked to contact the Ministry of Land Planning and Forest Management (GBB) for information on land ownership and availability.

Figure 36: Selected sites for evaluation of ownership and availability in Tout Lui Faut

The ministry's informed that one site is from Suriname's National Energy, Oil & Gas Company (Staatsolie N.V.) and the other is leased by the state-owned Energiebedriven N.V., the provider of electric power (see Annex 6.2.4 kwestie water-, afvalwater- en afvalbeheersystemen). Both sites were declared as not available.

6.2.4.4 Current stage of the site selection process

After the negative response about the availability of the two sites in Tout Lui Faut, the Ministry of Public Works, when asked by the Ministry ROM about alternative sites, again referred to all sites considered in the selection process for the landfill. In addition, another site was mentioned without further details on Suralco´s (Suriname Aluminum Company) land.

1. Charlesburg
2. Leiding 20/22
3. Tawajarie Polder
4. Braamshoop
5. Billiton mines (old mines)
6. B Ornamibo Sand Pits (South of Ornamibo)
7. Suralco LCC terrain

Based on the comment from the Ministry PW and ILACO, the site.1 Charlesburg (housing development nearby) and site 2. Billiton mines (driving distance) were already declassified.

Accurate data on ownership and availability for each site is still missing and therefore the Ministry GBB has been requested to provide them. The response is currently being processed by the Ministry.

Considering the available data, location 6.B Ornamibo-Sand Pits appears to be a possible location for the construction of an FSTP. The possibilities of combining the processing of organic waste and end-products of sludge treatment appear to be easiest to implement there. The size of the available land and the absence of residential areas around allows optimal placement of the plant in the terrain.

The location requires significant investment for the construction of a road connection and other necessary basic services. If combined with other projects such as the Pilot Composting Project, the cost-benefit ratio of the infrastructure investments will improve.

However, further on-site, ownership and availability status evaluation are required to assess the suitability of the sites and allow for final recommendations on site selection for the FSTP.

6.3 Financial requirements

The following economic figures are based on similar construction and service management experiences in different parts of the world and its contextualization to Suriname. They are all indicative and could be subject to change once the detail design is commissioned. Therefore, the costs presented should be seen as best estimates for an initial decision - making.

6.3.1 Investment cost

The following are the factors affecting the initial investment cost of setting up a FSTP in Paramaribo:

a) Treatment capacity of the Plant

The suggested capacity of 100 m^3 for the FSTP has been selected based on requirement considerations rather than on economic considerations. Nevertheless, the size of the FSTP is considered economic-efficient as several modules have been divided in most effective parallel operation lines; thus, an optimization of construction costs is implicit.

b) Technology (Nature based vs. mechanical)

The selected technologies have a low level of mechanization, but for certain components, it come with a higher land requirement. Operation and maintenance of all components are comparatively low, up to 80% lower than for mechanical alternatives.

c) Costs of land

Land costs have not been taken into consideration because a private investment in the setting up of a FSTP is considered not feasible. Additionally, the real value of the land could not be determined as land selection has not been completed yet.

d) Contracting model

The contracting model will affect the investment cost but was not taken in consideration during this preliminary cost estimates. However, potential market prices have been applied as far as possible.

Total capital cost is divided into three main parts:

I. Treatment infrastructure cost

The capacity of the treatment system defines the hydraulic designs and the size of the different treatment modules. In the case of the FSTP, the concept demands very little excavation cost; however, a larger amount is necessary for the required embankments. The final construction cost will vary based on the type of structure (RCC, concrete block masonry, etc.); this will be defined during the detail design and after the site is selected. The final design itself will depend on final inputs from the Surinamese Partners and accordingly influence the infrastructure cost.

II. Non-treatment infrastructure cost

The FSTP will also have non-treatment related infrastructures; the main ones are internal roads, ramps, compound fencing, convenience area, electrical works, water supply system etc. The ratio between the treatment and non-treatment infrastructure is approximately 55:45. Major investment is planned for soil filling, ramps, compound fencing, internal road, and ramps for the trucks.

III. Taxes

Taxes as applicable

The following table shows the estimated investment costs for the 1st phase and for a future 2nd phase. Included in the investment cost of the 1st phase are costs of USD 240,000 for site preparation and administration as well as convenience infrastructure to be used also for the 2nd phase.

Table 27: Breakdown of capital cost 1st phase FSTP Paramaribo
(including estimate for 2nd phase)

S. No.	Description	Cost 1st phase (USD)	2nd phase Cost (USD)
1	Land preparations and inner roads	**381,000**	10,000
2	Infrastructure - Treatment Plant	**492,000**	490,000
3	Infrastructure - Administration and Convenience Areas	**32,000**	-
	Subtotal	**905,000**	500,000
	Taxes provision (20%)	**181,000**	100,000
	Total	**1,086,000**	600,000

The Table 28 below shows the breakdown of the estimated investment costs for the main infrastructure areas. It reflects the relation between the treatment-related infrastructure costs and the ones for non-treatment infrastructure as mentioned above.

Table 28: Breakdown capital cost 1st phase FSTP Paramaribo

S. No.	Description	Cost estimate (USD)
1	Preliminaries	68,000
2	Platform 2.50 m	188,000
3	Platform 0.60 m	61,000
4	Vehicular pavement & sidewalk	32,000
5	Fence & access	32,000
6	Screening & grit chamber	12,000
7	Settlers/thickeners	35,000
8	Sludge tank & distribution chamber	4,000
9	Grit storage	6,000
10	Storage at discharg area	7,000
11	Planted drying beds (16 pzs)	259,000
12	ABR & AF	46,000
13	PGF	33,000
14	Polishing pond	2,000
15	Treated water tank	7,000
16	Compost storage	32,000
17	Pipes, equipment and machines	49,000
18	Administration area	8,000
19	Resting area + workshop	24,000
	Subtotal (rounded)	905,000
	Taxes (provision) 20%	181,000
	Total	**1,086,000**

Land preparations and inner roads
Infrastructure - Treatment plant
Infrastructure - Administration and convenience

The FSTP is estimated to serve 100,000 people. The resulting required per-capita investment of USD 11 is considered low, even if cost of land is not included. The related authorities consulted have confirmed this assessment indicating that the level of investments seems reasonable compared with the health and environmental improvements attained and, with a bankable project in hands, probably manageable.

Note:

The above-mentioned costs are based on the experience of implementing several treatment plants across India/South Asia and Mexico/Central America" These may be only used as indicative costs for a planning exercise. Actual costs may vary as per the geoclimatic conditions, soil conditions and identified location for the setting up of the FSTP, applicable local area wage and taxes.

6.3.2 Operation and maintenance cost

The concept design of the FSTP for Paramaribo aims at transforming the residues into useful products after being treated and ensuring a low cost and easy operation of the plant.

The main operation and maintenance(O&M) cost of the FSTP for Paramaribo can be divided into 3 main categories:

I. Human resources

The overall responsibility of operation of the FSTP rests by the Plant Manager. This person oversees all operations required to provide the services as foreseen. This may not be a full-time assignment and linked with other responsibilities at the company in charge with the O&M of the FSTP. One operator is mainly responsible of attending the sludge discharge point and the sludge preliminary and primary treatment units, as well as the secondary wastewater treatment units. A second operator handles the planted drying beds and the co-composting unit. An administrator is responsible for administrative duties, including future marketing of treatment products 4 helpers assist the operators with the different activities. This means a total work force of 8 persons operating the plant.

A dedicated training for the different positions is provided to each of the staff. The elaboration of training materials and operation and management guides is part of the preparation for the commissioning of the plant. It is useful, to accompany the commissioning of the plant by a practical consultancy. A refresher training is provided after 3 months and after 1 year. Performance indicators are defined, and the responsible Ministry (probably Ministry of Public Works) will periodically control if the established indicator targets are achieved and rules are followed. Time and related cost need to be considered in the respective O&M plans.

It is estimated that approx. 80-90% of the operating costs are spent for personnel cost.

II. Operation activities

This category agglomerates all the expenses related to the daily operation. 4-8% of related costs are for electric power consumption that is low because the plant operates mainly by gravity flow and due to the moderate kWh price in Suriname. Performance monitoring cost, mainly for testing compliance with the given discharge and compost-quality standards in defined intervals, is expected to require 6-12% of the operation activity costs. Fuel for the support machines, mainly front loader and green waste shredder may consume 50% of the operation activity budget. Finally, for all sort of consumables required to provide the different services offered by the FSTP, 35% of the designated budget maybe utilized.

III. Maintenance activities

This category foresees expenditures for all items that are worn out due to wear and tear, addressing all small and larger equipment. An established maintenance plan will be secured with the budget foreseen for this cost category.

Not included in this calculation are some long-term, regular maintenances tasks that may or may not be required for some treatment units, e.g., cleaning the filter material of the PGF after about 5 years or similar.

A separate, adequate working capital reserve should be established and maintained for this purpose; an additional 2% of the annual maintenance costs would be reasonable to feed such a reserve.

As Table 29 shows, the monthly expenditures to operate and maintain the FSTP presented for Paramaribo, are estimated at USD 8.000, adding up to a yearly cost of nearly USD 100.000. The revenue calculations presented in 6.4 Business model for the FSTP show that at the beginning, this amount must be subsidized by the government with about 50% of the O&M cost while the other 50% is expected to be covered by the revenues generated through license and discharge fees as well as sale of compost. On the long term, the government subsidy will reduce due to expected increased revenues for the sale of compost.

Table 29: Estimated O&M costs – 100 m^3 faecal sludge treatment plant, Paramaribo

Category	Year I (USD)	Year II (USD)	Year III (USD)	Year IV (USD)	Year V (USD)
1 Human Resources (A)					
4 Main staff (Manager, Administrator, Operators)	64,800	68,000	71,000	74,000	77,000
4 Support staff (permanent and temporary)	21,600	22,500	23,600	24,700	25,800
Sub Total (A)	**86,400**	**90,500**	**94,600**	**98,700**	**102,800**
2 Operation Activities (B)					
Power consumption	250	300	400	500	600
Performance monitoring (Lab test)	500	530	560	590	680
Fuel cost	3,100	3,200	3,300	3,400	3,600
Consumables	2,150	2,300	2,400	2,500	2,600
Sub Total (B)	**6,000**	**6,330**	**6,660**	**6,990**	**7,480**
3 Maintenance Activities (C)					
Repair of equipment	4,600	4,400	4,600	4,800	5,000
Sub Total (C)	**4,600**	**4,400**	**4,600**	**4,800**	**5,000**
Total yearly (A+B+C)	**97,000**	**101,230**	**105,860**	**110,490**	**115,280**
Total monthly	**8,083**	**8,436**	**8,822**	**9,208**	**9,607**

Note:

The above-mentioned costs are based on preliminary collected information. Once agreed on the final concept and during the preparation of detailed engineering designs the O&M cost could change. Further alignment of O&M expenditures and their cost to the local requirements and rates will be made.

6.4 Business model for the FSTP

The development of a business model for the FSTP cannot only refer to treatment but must consider all other parts of the sanitation service chain. Based on the current situation outlined in section 4.3.5, the business model of the existing FSM system needs to be accommodated for the introduction of the sludge treatment plant to ensure its sustainable operation and maintenance, this on a technical, financial and institutional level. Some adjustments of the current model must be made directly with the commissioning of the FSTP while other will be evolve on medium term with phase-wise implementation.

The accommodated business model presented in Figure 37 was developed in alignment with the existing conveyance business model (existing desludging service), integrating the treatment of the sludge and the reuse and/or safe disposal of the treatment end-products; mainly compost and treated effluent.

The proposed business model has two main parts. The business of the sludge emptying and transportation service and the business of the operating the FSTP. At least at the beginning, it is suggested to consider both components as separate businesses but well engrained. In future other models may emerge that merged both components into one business.

The model for the first component is similar to the existing private emptying and transportation model. The key difference lies in the introduction of a license/permit issued by the Ministry of PW, that authorizes private sludge companies to operate the emptying businesses. Licensing helps in accounting for all emptying businesses in the city, and can potentially track them to prevent illegal disposal of FS. The license/permit is linked with an annual fee paid by the truck operators. The public authority issuing the license establishes the rules/regulations under which the desludging business has to operate and monitors compliance. The license can be revoked, if the sludge company is found to be violating any regulations, especially if involved in the illegal disposal of FS other than at the FSTP.

For the operation of the FSTP, the second business component, also the Ministry of Public Works is the main institutional stakeholder, controlling and monitoring it. The plant is operated by a private company under a public-private partnership agreement that derives its revenue from disposal fees, license fees collected by the Ministry of Public Works from the sludge operators and past to the FSTP operator, potential revenues from compost sales to private or public consumers and if necessary public subsidies.

The proposed business model provides the government with a better understanding of the nature and number of desludging companies, revenue transparency and an increased competition, thereby ensuring an improved FSM service to residents.

Other three ministries must take responsibility in this model as institutions that control the work of the sludge service companies in terms of occupational safety (PH) and environmental protection (NIMOS/NR). The process in the FSTP must also be supervised by these ministries in terms of occupational safety, environmental protection, and the quality of the final treatment products. This includes the Ministry of ALF, which controls the reuse of compost in food production.

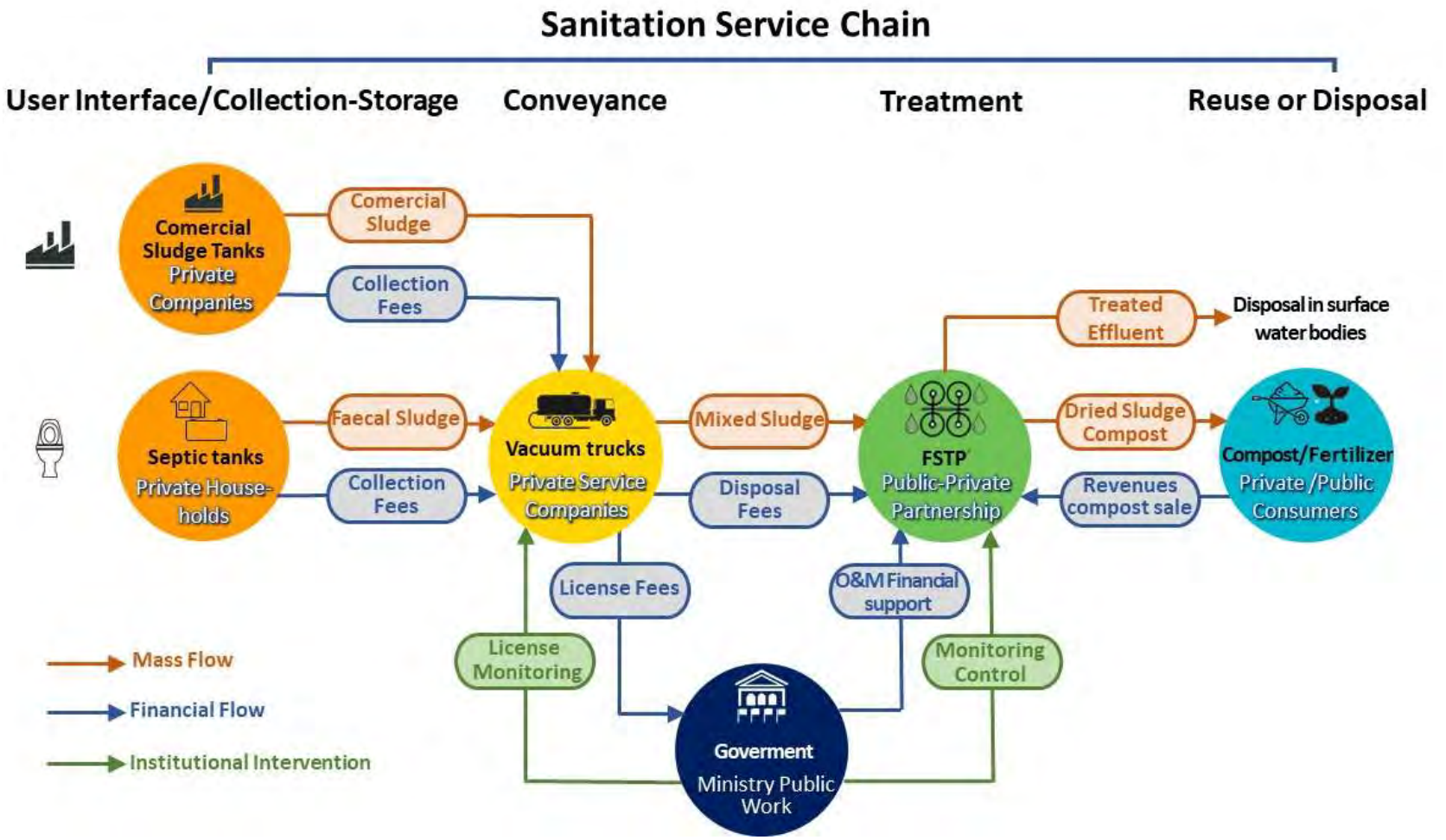


Figure 37: Business model for a FSTP in Paramaribo

6.4.1 Management concept of FSTP

The conversion of the mixed sludge into the end-products of dried sludge/compost and treated effluent is described in detail in the previous part of the report. The CAPEX and OPEX costs of a FSTP are estimated in section 6.3. The level of investment required for the establishment of the FSTP for Paramaribo is in a range that makes the mobilization of private investment for it unrealistic. Here, the state government must secure financing out of public interest.

For the sustainable operation of a faecal sludge treatment plant, trained workers and support staff are required who can perform the daily operation tasks and have the necessary skills and knowledge to perform the regular maintenance work. The personnel costs and all other costs for O&M must be covered by the discharge fees, the potential revenues from the sale of the final products of the treatment process, and these must be supplemented by government subsidies if necessary. Just as transport service is in private hands, the operation of the FSTP can also be put in private hands, reducing the administrative burden, and making it easier to take advantage of commercial opportunities. This could be done in the framework of a public-private partnership.

A successful PPP needs to secure private operator of a FSTP to cover all O&M costs of the plant and allow for additional income gains through entrepreneurial skills, for example through the commercialization of the treatment end-products. In principle interest in operating a treatment plant was generally expressed by sludge service companies during the survey.

The price for emptying private septic tank in September 2022 is quoted at SRD 1,500 to 2,000, (USD 60 - 80) per septic tank emptying. For commercial customers the price is SRD 1,750 – 2.250 (USD 70 - 90) and for emptying a grease trap the service charge is SRD 2,250 – 2,500 (USD 90 – 100). Relating the annual cost of licensing for a sludge service provider with the revenue generated from septic tank desludging, the licensing fee for a 10-m^3 truck could be about USD 150 payable to the Ministry of PW. This would generate an estimated annual revenue for 12 truck licenses of about USD 1.800, which would be passed on to the FSTP for operational costs.

Currently in Tout Lui Faut, a uniform fee of SRD 250 (USD 10) per load is charged for the unloading of sludge, not considering the origin or quality of the sludge. With a daily discharge rate of 8-10 trucks per day, the total discharge fees per day would be SRD 2,000 – 2,500 (USD 80 – 100). Since septic tank emptying prices are high compared to other Caribbean countries and usually several emptied septic tanks are loaded into one vacuum tank, emptying fees for the FSTP could be set higher, also because the treatment plant offers additional services to the sludge companies. Thus, the fees for discharge at the FSTP could initially be set at USD 15 per truck load, accounting for daily revenues of USD 120 – 150. The potential income from discharge fees would therefore be USD 2,880 – 3,600/month or USD 34,560 – 43.200 /year.

In the 2018 project proposal for a compost project (4), the price of compost is estimated at SRD 40 per 20 kg of compost, which corresponds to a price per t of SRD 2.000 (USD 268, exchange rate 2018). However, this compost price should be used with caution as compost is not currently a commercial product in Suriname. Moreover, the use of treated sludge in compost production can lead to social barriers to purchase such a product. Therefore, the estimate of revenue from the sale of compost has been based only on a bulk price (without bagging) of compost of USD 88 per ton. Still a relevant market for compost needs to be assured in Paramaribo.

Depending on the availability of organic material for co-composting, the annual produced dried sludge of 450–550 tons will be mixed with 900–1,100 tons of the organic material at a ratio of 1:2 for co-composting. Even if the mass reduction during composting varies widely, a reduction during the composting process of 50% can be assumed. Therefore, 675 – 825 tons of quality co-compost can be produced every year. At a price of USD 88/ton, this generates a revenue of USD 59,400 – 72,600 per year. This is the potential revenue if the co-compost can be sold in the market. The potential FSTP revenues are offset to O&M costs, as shown in the Table 30 and Table 31.

Table 30: Potential yearly revenues of the FSTP (USD)

Area of revenue	Revenue/year (USD)
License fee	1,800
Discharge fee	38,880 (34,560 to 43,200)
Compost sale	65,900 (59,200 to 72,600)
Total with compost revenues	**106,580** (95,560 to 117,600)
Total without compost revenues	**40,680** **(36,360 to 45,000)**

Table 31: Yearly income and expenditure balance of the FSTP (USD)

	With compost revenues	Without compost revenues
Income	106,580 (95,560 to 117,600)	40,680 **(36,360 to 45,000)**
O&M Expenditure	97,000	97,000
Balance	**9,580** **(- 1,440 to 20,600)** lost/gain	**- 56,320** **(- 60,640 to -52,000)** lost

The above tables show that the sale of compost can potentially generate substantial gains when operating a FSTP. However, this is only possible if the revenue from the sale of compost can be fully realized. Until then, the operation is dependent on government subsidies for the operation in the order of USD 50,000 to 60.000 per year.

The O&M of the FSTP is only of interest for a private operator if a profit can be generated. This will be only possible with a medium-term government financial support for O&M of the FSTP and linking the FSTP to an expanded composting with the processing of other organic residues. The subsidy is justified by environmental and health benefits for the population.

6.4.2 Management concept conveyance

The management concept for conveyance in the proposed Licensing Model does not differ essentially from the existing model, only the monitoring and control from the governmental institutions are increased. Currently, there is no control of the sludge loading and it is difficult to control the correct discharge at the designated site. This also leads to a situation where sludge companies illegally discharge to avoid disposal costs and gain a competitive advantage. This can be better controlled if the companies are licensed on a regular basis, as envisaged in the licensing-based business model.

The sludge companies are looking for their customers independently and competitively through their prices. The prices are fixed individually. While the companies relate to commercial customers more by time-based contracts, private customers are served more on call request. Private septic tanks are emptied irregularly and usually only when they are completely clogged and no longer fulfills its function. This leads to considerable hygienic hazards and environmental pollution.

There are opportunities to further improve FSM by controlling the emptying process of onsite treatment systems and establishing a sanitation tax to fund the transport of sludge to the FSTP. Under the Scheduled Desludging Sanitation Tax Model (6), the sludge producers pay a sanitation tax based on the amount of sludge produced and the interval of desludging.

The sanitation tax can be collected by the municipality either as part of property taxes or by the public utilities as a surcharge on water bills. Desludging becomes mandatory at a set interval. This interval is monitored by a government institution and can be controlled, for example, by scanning a special barcode at each site (in the hand of the sludge producer) when the septic tank (collection tank) is being emptied. This allows the control of each tank load, and it would even allow to control the segregation of sludge from different sources.

Partial or full funding of the sludge transport through a sanitation tax would control the price for emptying and transport of sludge through a state institution and significantly increase the volume of the sludge transport business by emptying all septic tanks on a regular basis. The challenge of this model lies in the administrative requirements necessary to make this model work. The water utility SWM is not responsible for wastewater management and has no interest in getting involved but represents the natural partner for it. The problem with the part of non-revenue water (NRW) due to not paying for the water supply is furthermore an example of possible difficulties linked to the establishment of a sanitation tax.

Even if the volume of business for sludge companies increases and sludge load planning can be made more efficient, the influence of government in regulating prices for emptying and transport could distort market competition, which could lead to resistance from sludge companies. Therefore, in case of opting for government subsidies in whatever form and scheduled desludging system, this should be done in coordination with all stakeholders and the preparation of the involved institutions supported with personal resources and capacity-building.

6.5 Stakeholder involvement and legal requirements

6.5.1 Stakeholder involvement

A functioning FSTP for Paramaribo needs the well-coordinated participation of 6 key stakeholder groups:

- Paramaribo's households as owners of the septic tanks,
- The private commercial businesses as another sludge producers,
- The private sludge service companies,
- The companies for the construction of the septic tanks,
- Government institutions responsible for securing funding for the necessary investments in the FSTP and for monitoring and control of every step of the sanitation service chain
- The academic institutions that should train future professionals on wastewater management in the classrooms and conduct research on topics related to the management of faecal sludge at the city level.

Each group plays a specific role in the phases of planning and commissioning the FSTP, and therefore adapting the existing FSM system of the City of Paramaribo.

At the public institution level, the ROM Ministry is a key stakeholder and contact for the CReW+ project. It is the responsible ministry in the planning phase and must mobilize the financial resources to secure funding once the respective design concept and detailed planning have been completed and agreed upon. Thereafter, the project will have to pass into the hands of the Ministry of Public Works (OW), which has the competence and the responsibility for tendering, construction supervision of the project and the implementation of the FSTP operation. However, the operation and maintenance of the FSTP should be placed in the hands of a private company, as the MPW lacks capacity to offer similar services. Supervision of operations should remain the responsibility of the ministry, which would require appropriate training for its staff.

Sludge service companies are a critical component of the operation of a FSTP. Since there is no government supply for the transportation of sludge, the proper disposal of sludge at the treatment plant is solely in their responsibility. In the current situation, SSCs must already pay a fee for discharging into the river at the Tout Lui Faut site. Some companies evade this obligation by illegally discharging the sludge loads into the channels. To prevent this in the future, NIMOS is responsible for monitoring and control of the sludge transport together with the District Commissioners. So far, they are not prepared for this due to lack of trained personnel. There is an absence of suitable control mechanisms and the relevant legislation is still being formulated.

The Ministry of Agriculture (LVV) is important for the implementation of options for the reuse of sludge and effluent. The Ministry has good experience with composting organic residues and promotes the use of compost in agriculture. The Ministry also has the necessary expertise to use the treated and dried sludge for co-composting with other organic residues. Co-composting is an excellent option for the reuse of dried sludge as it is linked with the treatment process for the final elimination of residual pathogens. Adequate operation and control of the composting process are essential for this.

In this context, the MPW is another important partner, as it not only has its own experience in the production and use of compost, but also has the necessary organic material for co-composting available through the maintenance of the city's green spaces. In addition, green waste is also available through the cleaning of sewers in the city, which is mostly carried out by private companies on a contract basis.

Monitoring and control of the quality of final products from the sludge treatment plant must be carried out by the Ministry of Public Health (MVG) for the hygienic aspects and by NIMOS for the environmental aspects. The latter institution is therefore in the process of elaborating appropriate norms and standards. Both ministries do not have the corresponding personnel capacities for monitoring and control. There is also a lack of laboratory capacity to carry out the necessary control analyses.

The sustainable use and protection of the natural water resources falls under the mandate of the Ministry of Natural Resources and in this context also involved in monitoring the site selection as well as the operation of the FSTP. As far it concerns the protection of water resources, this ministry will also need to monitor the use of the end-products of the treatment process.

The Ministry of Land Policy and Forest Management is involved in the site selection process. This ministry can prove the availability of land for the construction of the FSTP and together with the ROM Ministry issue the respective land use permission.

The responsibility of households and other wastewater producers is to properly manage on-site treatment and containment systems. They are the users of the wastewater treatment system and must learn to assume the associated responsibility. This includes the necessary awareness raising by the relevant institutions and the necessary training. Here, the university is also in demand as an institution for knowledge transfer, but so are other official institutions. In addition, the Waterforum can also play an important role, as their assignments also include advising ministries and other official institutions.

Good coordination among all mentioned stakeholders will be pivotal for the functioning of a FSTP and its sustainable integration in the FSM system of the city. Coordination is currently the responsibility of the ROM Ministry, but even after the planning phase is completed and funding is secured, this coordination should be ensured, probably best in the hands of the PW Ministry.

Table 32: Necessary stakeholder involvements for a functioning FSTP for Paramaribo.

Stage	Service/Activity	Stakeholder	Involvement
1 Generation	Generation of fecal sludge and wastewater	Private households, Commercial businesses	Users are informed of the use and maintenance of on-site treatment and containment systems and maintain septic and holding tanks well.
2 Emptying and transporting	Desludging of septic tanks, grease traps, and other containment systems	Ministry of Public Works	The ministry establishes: • Regulations for the transport and discharge of faecal sludge and commercial sludge to the FSTP, as well as monitoring and control mechanisms to ensure compliance with them. • Norms and regulations for the vacuum trucks and the sludge service companies and provide respective licenses.
		Sludge Service Companies	They ensure the safe collection and delivery of the sludge to the FSTP in compliance with the safety standards and regulations of the ministries and pay the discharge fees.
		Ministry of Public Health	They control of sludge service companies for compliance with Health regulations.
3 Treatment	Treatment of sludge by reducing pollution parameters to convert it into products that allow safe final reuse or disposal	Ministry of Public Works	The ministry establishes the regulations and guidelines for the operation of the FSTP, including standard procedures for receiving sludge, monitoring the treatment efficiency, development of tariffs for the discharge at the FSTP.
		Private FSTP operator company	The private company operates and maintains the FSTP including the co-composting unit, collects discharge fees from sludge operators, receives financial support from the MPW, and reports to this ministry.
		Ministry of Agriculture	The ministry establishes and monitors the guidelines for processing biosolids in the co-composting process.

Stage	Service/Activity	Stakeholder	Involvement
4 Reuse/Final disposal	Promoting the use of compost and its commercialization and safe disposal of treated effluent if reuse is not viable	Ministry of Agriculture	The ministry establish norms for commercialization and promotes the compost in potential marketplaces.
		Private FSTP operator company	The private FSTP operator company do the final processing of the products, the distribution and commercialization.
		NIMOS / Ministry of Public Health	They control compliance of the products with norms and standards.

To accomplish the institutional responsibilities a well-coordinated policy is needed to overcome the current more fragmented governance in the water and sanitation sector. A clear definition of the responsibilities of each institution and a better-defined assignment of primary responsibility for wastewater and faecal sludge management to one government agency seems a necessary step in this direction. Even if private companies play a substantial role in a sustainable FSTP, the governmental support is strongly needed not only for the investment in the necessary infrastructure but also in terms of setting policies and guidelines and monitoring and control the services and processes.

In this context, the following are some concrete recommendations for institutional actions:

1. To improve the awareness of the septic tank owners, it is useful to start an awareness campaign to increase the knowledge about the function and proper maintenance of their on-site treatment system, which will lead to an improvement of the hygienic conditions in the households and reduce environment hazards.
2. The training of governmental officials started during the actual project with the training “Introduction to Faecal Sludge Management at City Level” (refer to Chapter 8) needs to be continued based on the concept and detailed planning of the FSTP to prepare the officials to future assignments.
3. Initiate actions to promote the use of compost in agriculture, including compost made from organic waste and products of FSTP, to foster the nutrient cycles with an approach of environmentally friendly circular economy.

6.5.2 Legal requirements

The required stakeholder involvement for the operation of a FSTP in a corresponding FSM, described in the previous chapter, requires a legal framework that places the assignments of the various stakeholders on a legal basis. The current legislation is partly based on very old laws such as the Ancylostomiasis Act from 1917 (prohibition of the use of faecal material as fertilizer) and characterizes the lack of important provisions in the areas of wastewater management and sanitation in general. On the other hand, new legislation such as the Environmental Framework Act (EFA) is still in the phase of formulation and new responsibilities arising from the law have not yet been adopted in detail, for example in the transformation of NIMOS into the new National Environment Authority (NMA).

The construction and commissioning of the FSTP makes it necessary to adapt this legal framework and supplement existing laws with promulgation of implementing regulations that allow the plant to operate efficiently. In this regard, it is necessary for the state to take into account and reconcile private and public interests. The main goal will be the interest of the population in a sustainable environment and healthy living conditions.

As part of a general policy for integrated waste and wastewater management, regulations are needed at each step of the sanitation service chain. However, the needs and urgencies for the functioning of the FSTP vary and the introduction of these regulations requires different time frames.

The functioning of an on-site treatment system such as the septic tank depends heavily on its correct maintenance. There are currently no regulations on O&M of septic tanks, which means that tanks with long emptying intervals have a very low treatment efficiency, leading to environmental pollution and health hazards. It is necessary to regulate the maximum emptying intervals and to define the exact assignments of the ministries such as Public Work, Public Health and NIMOS/NMA in monitoring compliance and find ways of enforcement. However, this makes it necessary to inform and sensitize households beforehand as suggested in the previous chapter, since shortened cleaning intervals are most probably associated with increased costs for the users. In a second step detailed regulations for the construction of septic tanks are required to optimize their functioning involving construction companies for the construction of the septic tanks and the Ministry of Public Works (OW) for its control.

In the area of transport, regulations are required to ensure compliance with quality standards for the safe transport of sludge in vacuum tanks. The standards must be defined and the control of compliance must be documented with a license issued by the Ministry OW. This can be done annually. To achieve the mandatory disposal of the sludge at the FSTP, legislation on the transport and disposal of sludge is needed, with a ban on the disposal of sludge in places other than the FSTP and the imposition of fines in the event of a violation. Clearly defined responsibilities for monitoring and control are critical to ensure enforcement. The necessary staffing of the control authorities and good cooperation with the civil police force are also prerequisites for successful enforcement.

The implementing regulations related with the FSTP must define treatment quality to be achieved as well as the necessary occupational safety standards for the safe operation and maintenance of the plant. The Labor Act of 1963 of Suriname and the Occupational Safety and Health Act of 1947 are the main acts containing provisions in relation to occupational safety and health. The detailed regulations should be based on these acts. The Environmental Framework Law directs the detailed implementation requirements necessary for the environmentally sound operation of the FSTP. The formulation and monitoring of the regulations are in the hands of NIMOS/NMA.

The same NIMOS/NMA institution is also responsible for setting the norms and standards for safe reuse and disposal of treatment products and defining the mechanisms for their control. NIMOS is currently in the definition of discharge standards for treated wastewater.

When defining discharge standards based on international guidelines, it is necessary to take into account the current situation of Suriname, which is just introducing standards for the first time, whose compliance must be achievable by the target groups.

For the supervision and control of these norms and standards are also involved the Ministry PH and the Ministry of Agriculture whereby the determination of the rules for the use of compost from sludge co-composting must be in the hands of the latter ministry. In this regard, quality standards for compost must be defined and compliance with them monitored and controlled. This is particularly important for the commercialization of such compost.

Preparation of government agencies in the area of compliance monitoring and control requires capacity building and provision of necessary equipment, for example, provision of laboratory capacity. The associated costs make the implementation and enforcement of the relevant regulations' dependent on the availability of financial resources. Here, step-by-step implementation with long-term budgetary security is probably the way to achieve compliance.

The following is a summary of some of the necessary legal requirements:

1. Standards and guidelines for septic tanks,
2. Regulations (and licensing) for collecting, transport and discharge of sludge,
3. Regulations and guidelines for the treatment of sludge,
4. Definition of occupational health regulations for the FSTP,
5. Standards for disposal of effluent,
6. Regulations for reuse of sludge treatment products and definition of quality standards.

(6) Rao, K. C.; Kvarnström, E.; Di Mario, L.; Drechsel, P. 2016. Business models for fecal sludge management. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 80p. (Resource Recovery and Reuse Series 6). doi: 10.5337/2016.213

7. Environmental and social impact assessment

The rapid Environmental and Social Impact Assessment (ESIA) allows for identifying potential risks and negative impacts at an early stage in the project and including mitigation measures from the planning and design phase; also, it enables the identification of the positive impacts of the project and their opportunities for sustainability.

The EIA for the pilot FSTP at Paramaribo has been conducted based on the previously developed Detailed Concept information. The mitigation measures regarding the technical aspects of the FSTP facilities have been taken into consideration in the concept design. Additional measures, mostly related to monitoring, enforcement of regulations, capacity-building and awareness raising, are to be designed in detail and executed once the project reaches further phases of implementation.

The assessment conducted is based on the concept design, including the technical features, previously defined planning tools (e.g., site selection criteria), and comprehensive analysis of the environmental and social context (geographical, geological, topographical, and hydrological regional conditions, legal framework, institutional arrangement, socio-economic characteristics, existing sanitation services, etc.). However, it lacks analysis of a specific geographical area, as the site for the construction of the FSTP has not been selected at this stage.

The methodology undertaken for the present rapid EIA is based on national regulatory requirements such as the EA guidelines of the National Institute for Environment and Development in Suriname (NIMOS, 2009). Furthermore, relevant international best practice standards, such as the guidelines of the Word Bank (WB) Group/the International Finance Corporation (IFC) are also considered.

Limitations of the present assessment:

- The assessment is conducted based on expert judgment. No baseline and/or field studies have been conducted because the site for the FSTP has not yet been selected.
- Stakeholder consultation is limited to one-on-one consultations. Public consultation meetings have not yet been conducted.
- A simplified version of the assessment method included in Annex 7.-Impact assessment methodology has been used to determine the significance of potential risks and impacts.

It is worth mentioning that, in compliance with national environmental regulations, the Environmental Impact Assessment Screening Application Form (Annex A-7.-Screening Application EIA.docx) has been sent to the Ministry of Spatial Planning and Environment (ROM) to be submitted to the corresponding government agency, the National Institute for Environment and Development in Suriname (NIMOS), for evaluation and indications on the necessary further steps to be followed once the site has been finally selected.

.

7.1 Environmental impact

The following table presents the potential environmental risks and impacts (positive and negative), including the proposed mitigation measures for the construction phase of the project.

Table 33: Possible environmental impacts and mitigation measures during the construction phase

No.	Impact	Mitigation measures	Comments	Status
Environmental				
1	Vegetation loss through site clearance, construction of access roads, fences, and other earthworks	• The selected site is to be approved by the local authorities. • Limit vegetation clearance to the area necessary for the construction of the FSTP. • Use of natural and existing vegetation for buffer zones. • Landscaping and revegetation of the site after actual construction of the FSTP	Direct impact localized and with extremely low significance. Within Paramaribo, there are no sites with a natural protected area status. Deforestation is not an issue in the district or its surroundings. The site selection will comply with land-use regulations.	Negative, negligible
2	Soil erosion	• Avoid excessive clearance of vegetation and enhance tree planting and landscaping. • Plan construction activities especially excavation of trenches and pits in the dryer seasons.	Direct impact localized and of temporary duration. Moderate significance.	Negative, Moderate
3	Noise and vibration from construction equipment	• Use of properly serviced and well-maintained equipment. • Limit use of noisy equipment such as generators and compressors • Sensitization of the adjacent communities on vibrations and increased noise resulting from construction activities. • Provide construction crew with necessary PPE	Direct impact, limited to the project site and immediate surroundings and of temporary duration. Low significance.	Negative, minor
4	Contamination of surface water, shallow groundwater, and soil from leakages of fuels and lubricants	• Use of properly serviced and well-maintained equipment. • In case of spills, collect the contaminated soils to prevent the hydrocarbons from being washed away in stormwater to the nearby water bodies.	Direct impact, limited to the project site and of temporary duration. Very low significance.	Negative, negligible
5	Air pollution from dust and emissions around the construction site and material hauling routes	• Water sprinkling to reduce the dust at the construction sites. • Provide construction crew with necessary PPE • Use of properly serviced and well-maintained equipment. • Limit the speed of vehicles on the project site • All vehicles hauling construction materials shall be covered with tarpaulins.	Direct impact, limited to the project site and immediate surroundings and of temporary duration. Moderate significance.	Negative, Moderate
6	Waste generation	• Provide waste bins to minimize waste littering and to stimulate waste segregation and recycling. • Place signs to alert the construction crew • Timely disposal of waste at a government-approved disposal site	Direct impact localized and of temporary duration. Low significance.	Negative, minor

The table below presents the potential environmental risks and impacts (positive and negative), including the proposed mitigation measures for the operational phase of the project.

Table 34: Possible environmental impacts and mitigation measures during the operational phase

No.	Impact	Mitigation measures	Comments	Status
		Environmental		
1	Pollution to nearby soil and water resources: Leakage and breakdowns in the treatment plant because of improper O&M Overloading of the system causes deterioration of treatment efficiency and overflowing of sludge from the facility into the surroundings	• Monitoring and regulation of the amount of sludge coming into the treatment plant in compliance with the designed capacity of the treatment plant. • Controlled collection, treatment and drainage of leakage or overflow are considered in the FSTP design. • Close monitoring of the facility to ensure it functions as planned, this involves monitoring of ground and surface waters in the surroundings of the FSTP and ensuring that the facility's effluent complies with the applicable effluent standards. • Routine maintenance and inspection activities. • Have qualified staff and funds for O&M (previous training measures are considered during implementation phase) • Qualified monitoring/inspection authority (previous training measures are considered during implementation phase) • Establishment of emergency procedures in case of breakdowns or overload of the FSTP. • Include in the design swift adjustment of the treatment process to cater for overloads in effluent quality. • In the medium term, inclusion of an adjustment of the treatment process in the planning to avoid overloading the plant capacity when intake volumes increase.	Direct impact can go beyond the immediate surroundings. Medium significance In case of failure of properly functioning of the FSTP, pollution of soil and water may cause significant impact. Poor management of the facility may result to sludge treatment overflowing of untreated sludge which may find its way to the surrounding environment. Overload of the plant capacity may result in poor treatment efficiency	Negative, moderate
2	Air pollution (bad odor) from the treatment plant and frequent dumping of sludge	• Proper cleaning and maintenance of the facility, including avoidance of pools of dirty stagnant waters and spills. • The treatment plant facilities include bio-filters at all reactors to prevent bad odors to be released at the atmosphere, as well as covers for the drying beds. The outlets of the ventilation pipes are installed high enough to release the gases above the human activity realizations. • Consider the wind direction and try covering the drying beds and grit material storage with a layer of earth or sand. • Sufficient distance to populated areas (200m according to site selection criteria) • Consider buffer zones • Monitoring of complaints and maintain complaint register	Direct impact, localized, continuous effect. Medium significance	Negative, moderate

No.	Impact	Mitigation measures	Comments	Status
		Environmental		
3	Methane gas generation (greenhouse gas emission)	• The methane produced in the tanks of the FSTP will be to a wide extent collected and burned to prevent its release into the atmosphere.	Direct impact, long-term effect. Medium significance	Negative, moderate
4	Sludge with some concentration of industrial contaminants like heavy metals reach the FSTP, which cannot treat these components	• Monitoring and regulation of the source of sludge discharged at the FSTP. The septic tank emptying service focuses on private households and small to medium businesses (organic residues). • Continuous control of incoming sludge and output products to prevent the presence of these materials before their release into the environment or further reuse. • Prevent the input of materials with such contaminants in the FSTP.	Direct impact, localized, short term. Minor significance	Negative, minor
5	Noise and vibration from plant operations and frequent dumping of sludge	• Use of properly serviced and well-maintained equipment. • The FSTP design is based on nature-based solutions and gravity flow, preventing the requirement of generators, pumps, compressors, or other electromechanical equipment that could generate noise or vibration • Provide operation crew with necessary PPE	Direct impact, limited to the project site and immediate surroundings. Low significance.	Negative, minor
6	Mosquito breeding: the settling pond may form a suitable breeding ground for mosquitos and diseases.	• Proper maintenance of the facility, including avoidance of pools of dirty stagnant waters and spills. • The design of the FSTP components such as the polishing pond considers low retention time, allowing the continuous flow of the treated water (no stagnant water)	Direct impact, limited to the project site. Low significance.	Negative, minor
7	Waste generation	• Provide waste bins to minimize waste littering and to stimulate waste segregation and recycling. • Timely disposal of waste to an approved disposal site	Direct impact localized and of temporary duration. Low significance.	Negative, minor

7.2 Social impact assessment

The following table presents the potential social risks and impacts (positive and negative), including the proposed mitigation measures during the construction phase of the project.

Table 35: Possible social impacts and mitigation measures during the construction phase

No.	Impact	Mitigation measures	Comments	Status
Social				
1	Disturbance to cultural, historical, and archaeological artefacts	• Site selection criteria take into consideration not implementing in historical or archaeological sites or its surroundings. However, if encountered of historical or archaeological artefacts, the local authorities are to be informed immediately for further actions.	Direct impact localized and of temporary duration. Very low significance.	Negative, negligible
2	Deterioration of scenic and visual quality/land use	• The design blends well with the surrounding environment. • Landscaping and revegetation of site to match surroundings after actual construction of the FSTP • Site selection complies with land-use regulations/spatial panning demarcations.	Direct impact localized and of temporary duration. Low significance.	Negative, minor
3	Resettlement or compensation to Project Affected Persons	• The selected site for the FSTP is a minimum of 200 m distance from any human settlements, according to the site selection criteria. • Have a grievance or complaint mechanism in place	Direct impact localized and of temporary duration. Low significance	Negative, negligible
4	Increase in traffic levels	• Only essential traffic will be allowed in the project area • Sensitization of the nearby communities about the increased traffic due to the transport of construction materials. • Materials hauling to the site and vice versa is to be done during off-peak periods during the day.	Direct impact, limited to the project site and immediate surroundings and of temporary duration. Low significance. No alarming increase in traffic is expected for the construction of the FSTP.	Negative, minor

No.	Impact	Mitigation measures	Comments	Status
		Social		
5	Spread of diseases	• No influx of foreign workers is expected. • Sensitization and health awareness campaigns to all involved in the project. • Have proper worker's facilities in place (mobile toilets/resting places/first aid kit etc.). • Provide construction crew with necessary PPE. • Provide appropriate hygienic measures like disinfection of the foreseen areas for food consumption.	Direct impact localized and of temporary duration. Very low significance.	Negative, negligible
6	Safety: falling into trenches and open pits and other injuries	• Place barricades around trenches and pits. • Conduct JSA, toolbox meetings and daily safety talks (training). • Provide PPE to the construction crew. • No access for unauthorized persons.	Direct impact localized and of temporary duration. Low significance.	Negative, minor
7	Vandalism and damage to project goods and material	• Fencing-off and guarding of the site • Regular inspections (e.g., by a security guard)	Direct impact localized and of temporary duration. Low significance.	Negative, minor
8	Conflict with locals	• Ensure equitable opportunity for employment for the locals and continue consultation with local representatives and community regarding social issues	Indirect impact and of temporary duration. Low significance.	Negative, minor
9	Local temporary job options		Direct impact localized and of temporary duration. Jobs are generated through construction works. Local engineers, architects, builders, etc. will be hired	Positive, minor

The table below presents the potential social risks and impacts (positive and negative), including proposed mitigation measures for the operational phase of the project.

Table 36: Possible social impacts and mitigation measures during the operational phase

No.	Impact	Mitigation measures	Comments	Status
		Social		
1	Deterioration of scenic and visual quality/land use	• The design blends well with the surrounding environment. • Landscaping and revegetation of site to match surroundings after actual construction of the FSTP.	Direct impact, localized. Very low significance.	Negative, negligible
2	Increase in traffic levels	• Sensitization of the nearby communities about the increased traffic. • Properly designed and maintained roads to avoid damage.	Direct impact, limited to the project site and immediate surroundings, long-term. Medium significance.	Negative, moderate
3	Health issues and illness of FSTP operation crew by the handling of faecal sludge	• Sensitization and health awareness campaigns to all involved in activities related to direct contact with sludge. • Provide PPE to the operation crew and ensure its adequate use. • Provide facilities for workers and emptying companies staff (washing stations, toilets, resting places, drinking water etc.) • Regular health screening and medical checks.	Direct impact, localized. Medium significance. The inappropriate handling of untreated faecal sludge always imposes health risks.	Negative, moderate

No.	Impact	Mitigation measures	Comments	Status
		Social		
4	Social rejection towards the disposal of the treatment products in the environment or for reuse	• Sensitization and health awareness campaigns • Stakeholder consultation and engagement (participatory approach) • Information-Education-Communication measures regarding the function of the FSTP and the characteristics of its treatment products. • Training of the FSTP workers on the functioning of the different components of the FSTP and the characteristics of the treatment products • Training of workers to deal with unexpected situations when working in a hazardous environment. • Ensure that all workers comply with regulations on labor protection and safety. • Provide necessary PPE for workers. • Monitoring of certain parameters before releasing into the environment or before re-use. • A study should be conducted to assess and include recommendations on safe compost use.	Indirect impact can go beyond the immediate surroundings. Moderate significance The dried sludge is often reused as soil adamant and the treated wastewater is reused for irrigation or just released as effluent. Although, these recovered products are beneficial for urban agriculture (co-composting etc.); however, giving the case that the FSTP is not removing pathogens or certain compounds, such practices might pose risks for human and environmental health.	Negative, Medium
5	Safety: falling into ponds and open pits and other injuries	• Place guardrails around ponds and open pits • Conduct JSA, toolbox meetings and daily safety talks (training) • Provide PPE to operation crew • No access for unauthorized persons	Direct impact, localized. Low significance.	Negative, minor
6	Local employment generation		Direct impact localized and long-term duration. Moderate significance The FSTP staff are people from the district or its surroundings	Positive, Medium

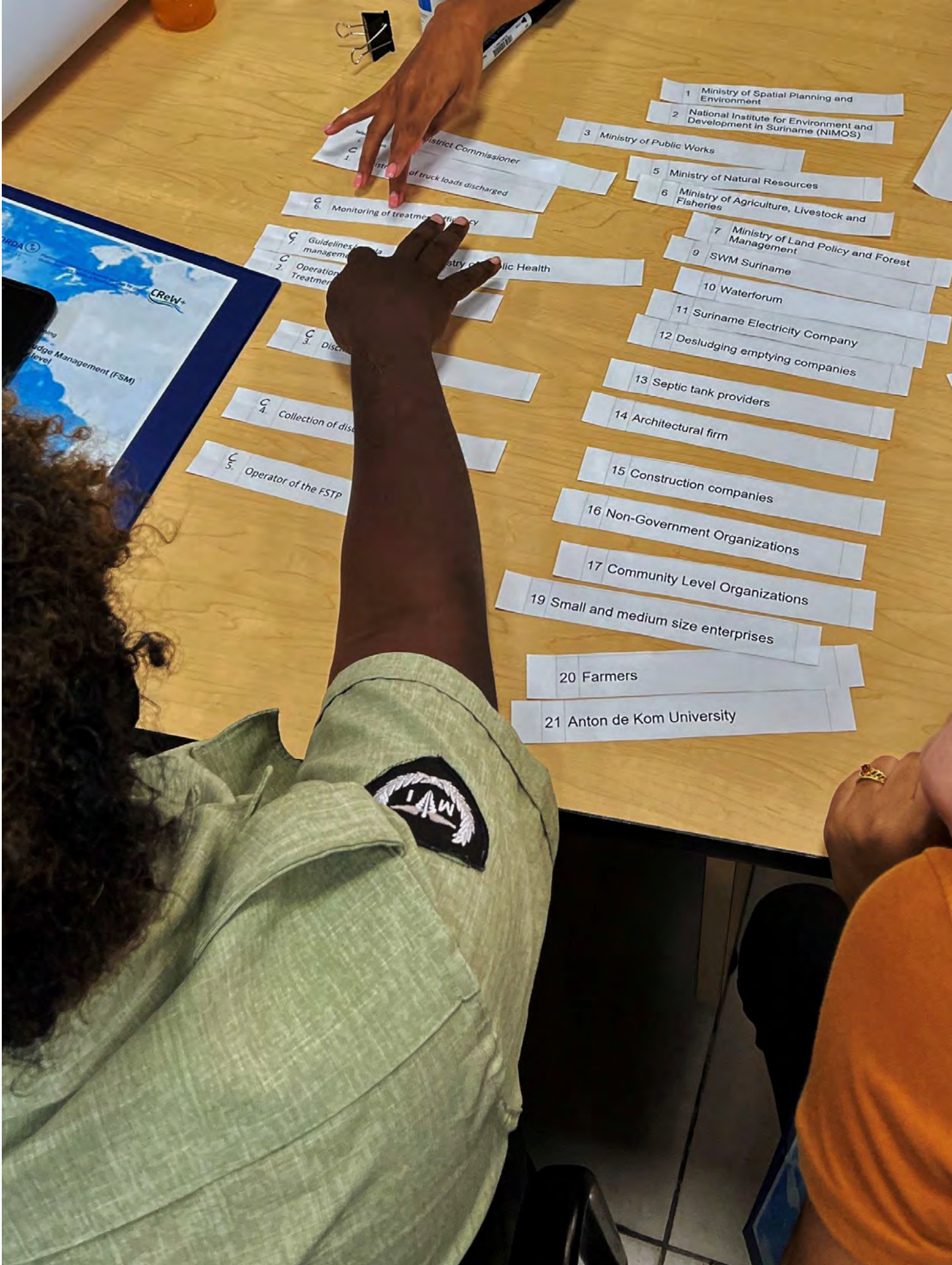
7.3 Environmental & social impact assessments conclusions and remarks

Risks and impacts both on the environment and social aspects are anticipated in the construction and operational phase of the project. The construction and operation of the treatment plant may potentially have negative impacts, but most of these are of a low to a moderate significance and all can be mitigated to acceptable levels and limited costs through adequate measures and corresponding monitoring systems. Moderate negative impacts are related to pollution of soil and water resources due to leakage and/or overloading of the FSTP due to breakdowns or operation errors, air pollution (bad odor) due to poor maintenance and the risks of health hazards from handling of faecal sludge.

All these risks and impacts can also be significantly reduced by implementing adequate mitigation measures (most of them are already considered in the FSTP design). One of the main challenges is the social acceptability of reusing or disposing of treatment products in the environment, for which various awareness-raising and information-education-communication measures aimed at different target groups need to be considered.

The positive impacts both on the environmental and social aspects are at a larger scale (regional and national) and long-term. The FSTP will bring benefits to species, habitats, and natural resources with significant opportunities for sustainability, as well as it will bring benefits to the local community and beyond by improving health and safety conditions related to safe sanitation. However, proper monitoring and adequate measures are crucial to making positive impacts sustainable.

The overall positive impact is related to a substantial improvement in faecal sludge management through the whole sanitation chain (collection, transport, treatment and reuse or safe disposal), with additional positive impacts through the safe reuse of the treatment products (nutrient-rich treated water and compost, as the product of the co-composting process). The improvements in the environment and sanitary conditions occur from the beginning of the treatment plant, as it will prevent the discharge of untreated sludge directly into the Suriname River, as is currently the case. This leads to improved water quality, increased agricultural production due to the availability of fertilizers (treated water and treated sludge/compost), and employment and business opportunities during the construction and operation phase of the project. Further detailed environmental and social impact assessments will need to be conducted for the area where the site is selected for the construction of the pilot FSTP.


1 Ministry of Spatial Planning and Environment
2 National Institute for Environment and Development in Suriname (NIMOS)
3 Ministry of Public Works
5 Ministry of Natural Resources
6 Ministry of Agriculture, Livestock and Fisheries
7 Ministry of Land Policy and Forest Management
9 SWM Suriname
10 Waterforum
11 Suriname Electricity Company
12 Desludging emptying companies
13 Septic tank providers
14 Architectural firm
15 Construction companies
16 Non-Government Organizations
17 Community Level Organizations
19 Small and medium size enterprises
20 Farmers
21 Anton de Kom University
C 5. Operator of the FSTP
CReW+

8. Capacity-building – training measures

8.1 Capacity building requirements

Onsite sanitation represents a practical solution for providing the service to wider population segments with lower immediate capital expenditure, becoming the principal sanitation alternative in many urban and rural areas. However, onsite sanitation in low- and middle-income countries often focuses only on the user interphase and waste containment, abandoning the later steps of the sanitation chain such as treatment or reuse. The lack of technical know-how, local capacities and resources are some reasons that lead to unsafely managed wastewater in the sanitation chain. Paramaribo, where most of the population has septic tanks and sludge and effluent are discharged without further treatment, is a clear example of this worldwide situation.

The incorporation of FSM practices and technologies, such as a pilot FSTP, needs to be built upon common knowledge and understanding of the existing needs and the technical, operational, and financial alternatives that can deliver a proper sanitation solution. Moreover, the introduction of new technologies requires the development of local capacity building from the beginning of the project, contributing to a clear understanding of sanitation solutions and their further ownership, acceptance, sustainable management, operation, and maintenance.

An overview of previous training measures in Suriname shows that there are few investments in strengthening local capacities concerning safely managed sanitation. Although other developments and humanitarian projects mention the current need for increasing capacity-building and formal and informal education programs (related to environmental issues, climate change adaptation measures, water management, sanitation, and hygiene, etc.), little evidence has been found on the implementation of these activities.

Moreover, during the first on-site visit (July 2022) and further online communication, the interest and manifested need for introducing sanitation measures accompanied by capacity-building processes were highly noted by different key stakeholders, including representatives of different government agencies, operators of desludging companies and University professors.

8.2 Training measures

The capacity-building and training measures proposed for the present project aim at improving local knowledge about sanitation solutions among key stakeholders, as well as contributing to the implementation of sustainable water and sanitation management. The capacity-building measures included raising awareness on sustainable FSM, as part of a citywide sanitation planning approach, aside from introducing technologies and systems alternatives for septage transport, treatment, and reuse of end-products of treatment processes.

Overall, the different measures focused on generating awareness of the current sanitation situation in Paramaribo and the importance of safe sanitation management; creating a clear understanding of the proposed FSM system and the pilot FSTP; and aspects of the operation/business model for this pilot FSTP at Paramaribo. This allowed for the initial identification of potential roles and responsibilities among stakeholders in the implementation of a new urban FSM system.

The capacity-building measures addressed four target groups: relevant public/government institutions, sanitation service providers (desludging service companies), target community (Paramaribo's citizens), and academic institutions. The training measures are directed to representatives of the different target groups, aiming for further dissemination of knowledge, and understanding about sanitation solutions among each group and enhancing the involvement of the different stakeholders even in the planning phase, which will later benefit a possible implementation of an FSM system at the city level with the treatment of the sludge in a pilot FSTP.

The capacity-building concepts were developed based on the information gathered during the first on-site visit, as well as subsequent communication with the local partners and key stakeholders involved in the planning of the training measures. These measures were shared, discussed, and approved with representatives of the targeted groups and the local team.

In continuation, a detailed description of the capacity-building measures carried out according to each target group.

8.2.1 Capacity-building measures for relevant government departments

The training concept was developed, and the different relevant government ministries of Suriname were invited to participate. The training concept comprised the training purpose, the target audience, the learning outcomes, and the training modules/program (Annex 8).

In preparation for the training, meetings were held with various representatives of the ministries to discuss details about the content of the training as well as logistical aspects (date and location of the training and number of participants per ministry). The participants who confirmed their attendance at the training sessions were from the following government agencies:

- Ministry of Public Works
- Ministry of Spatial Planning and Environment
- Ministry of Natural Resources
- Ministry of Public Health
- Ministry of Agriculture, Animal husbandry and Fisheries
- National Institute for Environment and Development in Suriname (NIMOS)

Two sessions of 5 hours each were conducted on September 5th and 7th (a total of 10 hours) to accommodate all the participants interested in the training. In total, 37 participants from the different government offices attended (Annex 8-CB measures: Training participants list).

The training gave a detailed introduction to Faecal Sludge Management, the current situation in Paramaribo, and explained in detail the sanitation chain. In working-groups, different topics

related to stakeholders and their participation in the sanitation system were worked on, and the results were presented and discussed with the whole group.

Furthermore, the concept of FSTP was presented in the context of a sustainable FSM system (for details Annex 8).

A certificate of attendance was issued to the training participants (Annex 8). In addition, a training evaluation and feedback form was presented to and completed by participants (Annex 8). The resonance and feedback were consistently very positive, with participants particularly highlighting the group discussions and the presentations and explanations provided by the speakers. Recommendations for improving the execution of the course were mainly to extend the time frame and to allow more time for the training sessions.

8.2.2 Capacity-building measures for potential target communities

The initial training concept for the target community was designed to address the specific community nearby the site where the pilot FSTP could be implemented. However, considering that the site selection process was not finished at the time of the visit which means no directly involved communities could be identified, the capacity-building approach was adjusted and directed to reach all citizens of the district of Paramaribo and its surroundings.

This measure aimed to raise awareness of the current sanitation situation in Paramaribo and the potential alternative solution in which all stakeholders, including the community, will be part of it. The key message included the consequences of the current mismanagement of faecal sludge from the septic tanks, which is discharged directly into the river resulting in hazards for the environment and human health. As a solution, a sustainable FSM was presented, including the proposal for the pilot FSTP as a key component for sludge treatment and the conversion of this sludge into valuable products that can be used, for example, in agriculture.

8.2.3 Capacity-building measures for sludge service providers

The operators of the desludging companies were initially contacted during the first on-site visit to identify technical aspects related to sludge characteristics. This was required for the development of the FSTP detail concept, as well as to know the service providers' needs and aspirations regarding their day-to-day job.

The initial information exchanges made it possible to develop a questionnaire to determine the amount of sludge that the different companies empty every day, identifying the regulations to which they are currently subjected, the tariffs for both emptying and discharging the waste, the day-to-day working schedule, and the difficulties that they face in the daily work. This information was useful for the concept design of the FSTP and its operation/business model, as well as for the identification of the capacity-building requirements and for designing a strategy for addressing this target group.

The initial capacity-building measure for this target group (Annex 8) Annex 8-CB measures: Trainings conceptswas also adjusted to the context situation and the interest and availability of the service providers. The final capacity-building measure comprised the development of an informative-graphic material of the initial concept for the FSM system at the city level and the overall concept design of the pilot FSTP, emphasizing a service area designed for meeting some of the needs of the staff from the desludging companies and the emptying/discharge processes. The informative material was in the format of a leaflet, both in English and in Dutch. During the personal handover of the leaflet to the owner of the sludge companies, the FSM system and the FSTP concept were explained in detail.

This measure resulted in individual information and training of at least one-hour sessions according to the agendas of 4 service providers from different companies (Akanharie, Icon, SK Service and Farzand). Answers to the questions posed further provided insights into the challenges and benefits of the FSM system. In addition, the specific aspects to be considered when implementing such sanitation solutions were discussed together (roles of the various players, business model, details on the tariff system, regulatory measures required, etc.). During the sessions, the company owner provided valuable information to be considered in the business/operation model of the FSM system and the FSTP. Furthermore, and despite the identified challenges, there was a clear interest and commitment from these service providers to being part of the change in the sanitation system in Paramaribo. This results in a clear opportunity that should be considered when the project reaches further stages in the implementation process.

Additionally, three of the operators of the desludging companies attended, together with other relevant stakeholders, the final presentation of the “Preliminary detailed concept design for a FSTP at Paramaribo” on September 8th, 2022.

8.2.4 Capacity-building measures for academic institutions

An initial training concept was developed specifically for students and professors from the University of Suriname. However, after online communication exchange and a personal meeting with the representative of the Infrastructure Department of the Anton de Kom

University, some obstacles were identified which could hinder the implementation of training measures in the University:

- The end of the academic semester by the first week of September results in a very busy schedule for the whole university community.
- The explicit expression of no possible execution of a training course only for the University community in the time frame of the present project phase.

Other aspects concerning capacity building in FSM in the university were identified:

- No interest in having an online course for the students, given that they have previous experiences that suggest that those measures have not been successful nor academically effective for the students.
- Strong interest in further development of a more detailed and longer (16 hours) training, together with the University, with credits and certification for the participants.
- Interest in having training measures which bring together different stakeholders, not only the University, to enrich the discussions and the information exchange between the participants.

As a result, it was finally agreed with the representative of the University to invite the students of the Infrastructure Department of the University to participate in the training program organized for the representatives of the Ministry of Public Works.

In total, 6 students and 1 professor of Anton de Kom University van Suriname participated in the 6-hour training session (Annex 8). However, the interest in further collaboration with Anton Kom University remains to develop a training course of at least 16 hours with academic credits for the participants and a course certificate.

8.2.5 Overview of the capacity-building measures implemented

The following Table 37 summarizes the total participant or persons reached through the different capacity-building measures, as well as the total time allocated to each.

Table 37: Summary of participants and time designated to the CB measures per target group

CB measure according to the target group	Total number of participants/ persons reached	Number of sessions	Time per session (min)	Total time (min)
1. Relevant government departments	37	2	280	560
2. Target community	More than 1500	NA	NA	NA
3. Sanitation service providers	4	4	60	240
4. Academic institutions	7	1	280	280

Below, the summary of the learning and awareness outcomes achieved through the different capacity-building measures implemented:

All the learning outcomes of the capacity-building measures for relevant government departments and academic institutions were achieved:

- Understanding of Faecal Sludge Management contextualization, needs and benefits in urban sanitation strategies.
- Understanding the steps in the sanitation value chain
- Understanding the basis and main steps for FSM planning approach
- Identifying challenges in sanitation systems, and key stakeholders' roles distribution for FSM, specifically for Paramaribo's context
- Identifying and understanding FSM treatment approaches and technologies suitable for Paramaribo's context and corresponding advantages and limitations

Although the results of the awareness-raising activities directed at the community could not be measured directly, it can be assumed that elements of the targeted outcomes were achieved:

- Awareness of the current sanitation situation in Paramaribo and its link to environmental and human health: lack of regulation in the design and operation of the septic tanks, consequences of mismanagement of septic tanks, transport, and direct discharge of sludge in the effluent of the Suriname River, etc.
- Understanding of the presented solution proposal: FSM vision for Paramaribo where everyone can be part of, having a role and responsibility for its functioning along the sanitation value chain.
- Understanding of the presented project of the pilot FSTP: as a key component of the FSM vision for Paramaribo, the FSTP is the facility that will allow to treat the sludge and generate valuable nutrient recycling products or allow for safe disposal back to the environment.

The following outcome of the information and discussion sessions with the sanitation service providers can be stated:

- Understanding of the presented vision of the FSM system at the city level for Paramaribo and concept design of the FSTP facilities.
- Understanding the possible business model, where the involvement of the desludging companies is pivotal.
- Obtaining insights on challenges and advantages of the proposed sanitation measures perceived by the operators of the desludging companies.
- A fruitful discussion on key stakeholders to be involved in the proposed sanitation measures and regulations and institutional arrangements needed.
- Identification of the interest of the operators of the desludging companies in being part of the proposed sanitation measures.

9. Conclusion

The current faecal sludge management system with the disposal of untreated sludge in the canals is not sustainable and leads to health hazards and serious environmental pollution of the canals, the Suriname River and finally the Atlantic Ocean. The institutional stakeholders and also the main sludge service companies see the need for a solution that will both improve the sanitary conditions in Paramaribo and reduce or prevent environmental pollution. The task of the project to develop a detailed concept for a FSTP serving Paramaribo was therefore met with great interest and approval, which was reflected in the intensive support provided.

The need for a solution to the sludge problem is also recognized by the population and would rise further as soon as they are informed more in detail about the current situation.

The construction and commissioning of a FSTP with a capacity of 100 m^3 sludge treatment per day would directly benefit over 25,000 households or 100,000 inhabitants as well as a relevant number of commercial operations in Paramaribo. With a future second phase increasing the treatment capacity by 100% the beneficiaries can reach 200,000 inhabitants, serving already the majority of the city of Paramaribo.

The present design concept is therefore an important step to show the possibility of a concrete solution for the treatment of sludge in the framework of an improved faecal sludge management for the city of Paramaribo. The cost estimate for the establishment of such a FSTP was discussed with relevant stakeholders and at different levels, showing a great willingness to seek the necessary funding to finance the CAPEX of the plant. However, moving beyond the respective authorities requires the detailed tender-ready project proposal.

Operation of the FSTP by a private company and the associated costs appear to be a feasible option for Suriname under the proposed business model, institutionally, operationally, as well as financially. In this context, it will be important to tender out the operation of the plant at the same time as the construction to guarantee sustainable operation from the day of its commissioning.

The commissioning requires the establishment of the necessary institutional and legal framework. It would be advisable, to provide forehand dedicated support to the respective government departments, for the task of formulating and establishing specific FSM regulations required to allow the FSTP business model to work. Also, specific preparation of the stakeholders involved for their tasks of operating, monitoring and control of the FSTP will need to be considered. Here, training and advisory services, with the support of international organizations and consultants will be required.

The expectations raised by the different planning and capacity-building interventions of this project are high. It is advisable to leverage these expectations and the readiness of all stakeholders to foster the collective ownership of the project and the willingness to cooperate. After its general approval, the concept for the FSTP presented should be detailed out and a bankable and tender-ready project generated.

References

(1) IDB - Janson, N., Burkhard, L., Jones, S. (2021): *Caribbean Water Study*. Editors Cayetano, E., Cathala C. IDB Technical Note; 2320.

(2) IFC (2007): *Environmental, Health, and Safety (EHS) Guidelines.* -International Finance Corporation, World Bank Group.

https://www.ifc.org/wps/wcm/connect/3d9a54ae-c44c-488d-9851-afeb368cb9f9/1-3%2BWastewater%2Band%2BAmbient%2BWater%2BQuality.pdf?MOD=AJPERES&CVID=nPtgvO

(3) United Nations Industrial Development Organization (UNIDO), 2018: Provision of Consultancy Services for the Design and Assessment of the BAT-BEP Solid Waste Demonstration Project in Paramaribo, Suriname. Landfill Site Selection. ILACO N.V., Royal HaskoningDHV, RFP-7000002034/CZ/AB.

(4) United Nations Industrial Development Organization (UNIDO), 2018: Provision of Consultancy Services for the Design and Assessment of the BAT-BEP Solid Waste Demonstration Project in Paramaribo, Suriname. Final Completion Report. ILACO N.V., Royal HaskoningDHV, RFP-7000002034/CZ/AB.

(5) Victoria Rigby Delmon, 2020: *5 Trends in Public-Private Partnerships in Water Supply and Sanitation.* WB PPCLRC. *https://ppp.worldbank.org/public-private-partnership/5-trends-public-private-partnerships-water-supply-and-sanitation*

(6) Rao, K. C.; Kvarnström, E.; Di Mario, L.; Drechsel, P. 2016. Business models for fecal sludge management. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 80p. (Resource Recovery and Reuse Series 6). doi: 10.5337/2016.213

Annexes

Annex 4.4-Interest-influence analysis

SL No.	Stakeholder	Influence	Interest
A.1	Ministry of Spatial Planning and Environment (ROM)	• Responsible for law and regulations regarding environment/ waste management, • Focal point regarding FSTP, • Lead in integrated approach to fecal sludge treatment within government.	• Encouraging the use of environmentally friendly technologies • Promote FSTM for responsible handling of fecal sludge • The collaboration within and between institutions for FSM
	National Institute for Environment and Development (NIMOS)	• Environmental Agency • Coordinating the preparation of environmental policy • Responsible voor EISA process • Set standards for the safe operation of the FSTP, together with other institutions.	• Environmentally responsible waste processing • Monitoring and enforcement of waste and wastewater management/ FSTP • Awareness by training and information regarding waste and wastewater treatment
A.2	Ministry of Public Works (OW)	• Responsible for the civil engineering works and infrastructural facilities, including the future FSTP • Responsible for Procurement of FSTP • Responsible for the maintenance of the urban green and the canals • Promoting co-composting with green residual waste from MPW management areas	• To fulfil their responsibility in wastewater management • Technical (alternative) knowledge for FSTP design • Technical alternatives for FSM • Conduct a feasibility study on the costs and benefits of FSTP • Experience with Operations and Maintenance of waste treatment plants

SL No.	Stakeholder	Influence	Interest
A.3	Ministry of Natural Resources (NH)	• Efficient use of natural resources through policies and regulations, • Checking compliance with rules and regulations relating to water management • Approve and regulate the reuse of effluent and biosolid, together with other institutions	• Reduction of the use of natural resources by reuse of faecal sludge • Contribution to improve nature management and conservation • Contribution to improve water and wastewater management • Avoiding pollution of waterbodies (channels and rivers)
A.4	Ministry of Public Health (VG)	• Provide an optimal external living and living environment • Compliance monitoring of the legal regulations relating to a safe living environment	• Encouraging the treatment of faecal sludge by environmentally friendly technologies for improvement of safe living environment • Avoid health risk for population
	Bureau for Public Health (BOG)	• Set health standards for the safe operation of the FSTP, together with other institutions, • Guidelines with environmental hygiene quality requirements and standards for reuse of the FSTP end products.	• That the standards and procedures are followed. • Well-functioning septic tanks for a safe and environmentally hygienic living environment • Monitoring that the end products remain within the safe margins for health.
A.5	Ministry of Agriculture, Livestock and Fishery (LVV)	• Promoting the production and use of compost in agriculture and horticulture • Recommending co-composting with product from the FSTP • Producing guidelines for quality standards of compost	• Offer the farmers an alternative to the use of expensive fertilizers • Sharing knowledge of the process of co-composting • Contribution to circular agriculture

SL No.	Stakeholder	Influence	Interest
A.6	Ministry of Land Policy and Forest Management (GBB)	• Research into suitable locations and making this location available	• Following the legal procedure in the site location process
A.7	Ministry of Regional Development and Sports (ROS) Districts Commissioners	• Ensure regional development and improving the living and living climate of residents in the districts (except Paramaribo) • Responsible for all secondary and tertiary civil engineering facilities (except Paramaribo) • Cooperate in granting permission for an FSTP for Paramaribo outside Paramaribo. • Permitting the installation of on-site wastewater system (in the districts except Paramaribo) • Monitoring of the functioning of the overall sanitation systems • Management responsibility over the sludge dump site	• Encouraging the treatment of faecal sludge by environmentally friendly technologies for improvement of safe living environment • Well-functioning septic tanks for a safe and environmentally hygienic living environment • Functioning of the Faecal Sludge Management System.
B.1-8	Sludge service companies (SSC)	• The SSC is the main (potential) customer of the FSTP • Involvement to participate in development of FSTP • Important stakeholder in the sanitation chain	• Improved sludge treatment plant /service for discharge of sludge • Contribution to environmentally friendly processing of sludge • Controllable exploitation costs (clear fees and clear benefits) • Discharge of the total amount of the sludge to the FSTP

SL No.	Stakeholder	Influence	Interest
C.1	Anton de Kom University (AdeK)	• Identifying, preparing, and implementing education, training, and programs to strengthen capacity for environmental institutions and organizations	• Gain new knowledge on faecal sludge treatment • New curriculum on faecal sludge management • FSTP as study case • New research areas
D.1	Households	• Contribution to the new policy regarding fecal sludge management • Improvement of septic tanks operations • Presenting the public interest	• Environmentally friendly processing of faecal sludge • A safe living environment for household
D.2	Restaurants, hotels, and other commercial business	• Contribution to the new policy regarding fecal sludge management • Better management of onsite systems • Important customer in the sanitation chain	• Environmentally friendly processing of faecal sludge • Contribute to a safe environment
D.3	Residents	• Participate in the process of accepting an FSTP in the neighborhood • Presenting the public interest	• Environmentally Friendly Processing Plant • Employment opportunities • Promoting reuse of end products
E.1	Stg. Waterforum	• Contributing to the update and renewal of laws and regulations regarding wastewater and sludge processing. • Contribute to awareness by lobbying within government	• Contribution to IWRM process • Improving sanitation • Contribution to improve the quality of fresh water • Functioning of the FSTP

Annex 4.5 Results survey-proportion sludge types

Item	**Unit**	**Interviewed Sludge Service Companies**						**Estimation for 4 other small Sludge Companies**		**All Sludge Companies**	
		A	B	C	D	Total		Total		Total	
		weekly amount (6 days)				weekly	Daily	weekly	Daily	weekly	Daily
Commercial											
Septic (Hotel+ Rest)	m^3	30	24	30	5	89	15	20	3	109	18
Grease trap	m^3	15	9	14	9	47	8	36	6	83	14
Commercial Total	m^3	45	33	44	14	136	23	56	9	192	32
Residential											
Household septic	m^3	15	14	10	17	56	9	68	11	124	21
Total	**m^3**	**60**	**47**	**54**	**31**	**192**	**32**	**124**	**21**	**316**	**53**
						Average		**Average**		**Average**	
Commercial septic	%	50	51	56	16	**46**		16		**34**	
Commercial grease	%	25	19	25	29	**24**		29		**26**	
Household septic	%	25	30	19	55	**29**		55		**39**	

Conclusions:

- These estimated amounts are based only on numbers quoted by the interviewed SSC, which is 50% of the total number of Sludge Service Companies including the 3 bigger companies (A, B, C)
- Company D is a company with only 1 vacuum truck with the owner as driver, which mainly focuses on services to households and less on commercial customers.
- The larger companies (A, B, C) have more equipment and work with contracts with commercial customers.
    - The bigger companies transport en average 1,7 times the volume of the smaller companies
- Other 4 small sludge service companies can be compared with company D, and it is assumed that they collect a comparable amount from customers every week.
- All sludge companies together collect and discharge in average 316 m^3 a week or 53 m^3 a day. If the values reflect only about 50% of the really collected quantity, the maximum total quantity transported per day can be estimated at 100 m^3
- If the 4 smaller companies collect the same amount daily/weekly as company D and the 5 small companies together collect nearly the same amount as the 3 bigger companies together, the proportion of sludge for commercial septic tanks is between 34 and 46 %, the grease traps between 24 and 26% and the residential septic tanks between 29 and 39%.
- In general, the management and maintenance of residential septic tanks in Suriname is deficient. With regular cleaning and preventive maintenance, the proportion of sludge from these tanks would increase.

Annex 4.5.3 Sludge sampling protocol-lab analysis

Sludge Sampling Protocol

Date: 27-08-2022
BORDA Sample No.: 01

Description

Start and finishing sampling procedure:	10:50 - 12:33
Site:	Tout Lui Faut (Discharge site for sludge)
Sludge Service Company:	Akanswarie
Truck load:	10 m^3
Origen of sludge:	Emptying 7 household septic tanks
Unloading time	Started 11:24 - finished 11:33
(Only the time to empty tank):	10 min.

Observations:

Aspect/color:	Uniform black color
Consistency:	Homogeneous liquid with low viscosity
Odor:	Smell of humus almost no septic odor
Sedimentation properties (tested in a water bottle):	No visible sedimentation after 1 min, no visible sedimentation after 60 min.

General observations:

1. Sludge was black in color signifying septic condition and digested
2. There was "NO" odor present during the disposal of sludge
3. Poor settleability of the sludge up on testing in a measuring jar
4. Very little sediments found after 45 mins of retention in the measuring jar

Sludge Analysis Results

Date:

BORDA Sample No.: 01

Filab

No	Parameter	Analysis		Results
1.	pH	Potentiometry (pH meter)	pH	7.3
2.	Conductivity	Potentiometry (Conductometer)	µS/cm	9680
3.	Chemical Oxygen Demand (COD)	Colorimetry finish- ASTM D1252B	mg/l	1025.55
4.	Biochemical Oxygen Demand (BOD_5)	Manometric method (Respirometry)- ASTM D1252D	mg/l	1080.00
5.a	Total Solids (TS)	-	mg/l	21600
5.b	Total Suspended Solids (TSS)	Gravimetry – ASTM D5907	mg/l	12000
5.c	Total Dissolved Solid (TDS)	Gravimetry – ASTM D5907	mg/l	9600
6.	Total Kjeldahl Nitrogen (TKN)	Mineralization + steam distillation- EPA 351-3	mg/l	421.40
7.	Total Phosphate (TP)	Mineralization + steam distillation- EPA 351-3	mg/l	67.63

Central Lab

No	Parameter	Analysis		Results
9	Faecal Coliform		Index/100ml	>160000

Sludge Sampling Protocol

Date: 01-09.2022

BORDA Sample No.: 02

Description

Start and finishing sampling procedure:

Site:	Tout Lui Faut (Discharge site for sludge)
Sludge Service Company:	Akhanhari
Truck load:	10 m^3
Origen of sludge:	Restaurant- Popoyes
Unloading time	10 mins
(Only the time to empty tank):	7 mins

Observations:

Aspect/color:	Light grey
Consistency:	Watery
Odor:	Oily, bad, and organic
Sedimentation properties (tested in a water bottle):	150 ml out of 1500 ml in 45 mins

General observations:

1. Sludge was grey in color and was oily in nature upon collecting in bucket
2. There was "strong organic" odor present during the disposal of sludge signifying it as a fresh sludge
3. Poor settleability of the sludge up on testing in a measuring jar. There was a thick layer of grease formed after 45 mins of retention in measuring jar
4. Sediments of 150 ml found after 45 mins of retention in a 1500 ml measuring jar

Sludge Analysis Results Date:

BORDA Sample No.: 02

Filab

No	Parameter	Analysis		Results
1.	pH	Potentiometry (pHmeter)	pH	6.9
2.	Conductivity	Potentiometry (Conductometer)	µS/cm	2860
3.	Chemical Oxygen Demand (COD)	Colorimetry finish- ASTM D1252B	mg/l	1913.73
4.	Biochemical Oxygen Demand (BOD_5)	Manometric method (Respirometry)- ASTM D1252D	mg/l	4180
5.a	Total Solids (TS)	-	mg/l	3700
5.b	Total Suspended Solids (TSS)	Gravimetry – ASTM D5907	mg/l	800
5.c	Total Dissolved Solid (TDS)	Gravimetry – ASTM D5907	mg/l	2900
6.	Total Kjeldahl Nitrogen (TKN)	Mineralization + steam distillation- EPA 351-3	mg/l	
7.	Total Phosphate (TP)	Mineralization + steam distillation- EPA 351-3	mg/l	

Central Lab

No	Parameter	Analysis		Results
9	Faecal Coliform		Index/100ml	>160000

Sludge Sampling Protocol

Date: 03.09.2022

BORDA Sample No.: 03

Description

Start and finishing sampling procedure:

Site:	Tout Lui Faut (Discharge site for sludge)
Sludge Service Company:	Akhanhari
Truck load:	10 m^3
Origen of sludge:	Warehouse- Kuldeep Singh
Unloading time	10 mins
(Only the time to empty tank):	8 mins

Observations:

Aspect/color:	Uniform black color
Consistency:	Homogeneous liquid with low viscosity
Odor:	Smell of humus almost no septic odor
Sedimentation properties (tested in a water bottle):	No visible sedimentation after 1 min, no visible sedimentation after 60 min.

General observations:

1. Sludge was black in color signifying septic condition and digested
2. There was "NO" odor present during the disposal of sludge
3. Poor settleability of the sludge up on testing in a measuring jar
4. Very little sediments found after 45 mins of retention in the measuring jar

Sludge Analysis Results

Date:

BORDA Sample No.: 03

Filab

No	Parameter	Analysis		Results
1.	pH	Potentiometry (pHmeter)	pH	7.2
2.	Conductivity	Potentiometry (Conductometer)	µS/cm	2050
3.	Chemical Oxygen Demand (COD)	Colorimetry finish- ASTM D1252B	mg/l	2616.20
4.	Biochemical Oxygen Demand (BOD_5)	Manometric method (Respirometry)- ASTM D1252D	mg/l	1080.00
5.a	Total Solids (TS)	-	mg/l	14500
5.b	Total Suspended Solids (TSS)	Gravimetry – ASTM D5907	mg/l	12500
5.c	Total Dissolved Solid (TDS)	Gravimetry – ASTM D5907	mg/l	2000
6.	Total Kjeldahl Nitrogen (TKN)	Mineralization + steam distillation- EPA 351-3	mg/l	200.20
7.	Total Phosphate (TP)	Mineralization + steam distillation- EPA 351-3	mg/l	29.68

Central Lab

No	Parameter	Analysis		Results
9	Faecal Coliform		Index/100ml	>160000

Sludge Sampling Protocol

Date: 03.09.2022
BORDA Sample No.: 04

Description

Start and finishing sampling procedure:

Site:	Tout Lui Faut (Discharge site for sludge)
Sludge Service Company:	Faranzan Ali
Truck load:	10 m^3
Origen of sludge:	Chicken slaughterhouse mixed with HH septic tank sludge
Unloading time	Started 12:00 - finished 12:30
(Only the time to empty tank):	30 min.

Observations:

Aspect/color:	Blackish grey
Consistency:	Liquid mixed with solids
	Sediment in the tank: sedimented solids with sand
Odor:	Strong odor of degrading organic material
Sedimentation properties (tested in a water bottle):	Poor settling, floating materials (chicken waste) float on the top

General observations:

1. Sludge was blackish grey in color

2. There was "strong organic" odor present during the disposal of sludge signifying it as a fresh sludge

3. Poor settleability of the sludge up on testing in a measuring jar. There was a thick layer of grease formed after 45 mins of retention in measuring jar

Sludge Analysis Results

Date:

BORDA Sample No.: 04

Filab

No	Parameter	Analysis	Unit	Results
1.	pH	Potentiometry (pHmeter)	pH	5.9
2.	Conductivity	Potentiometry (Conductometer)	µS/cm	4400
3.	Chemical Oxygen Demand (COD)	Colorimetry finish- ASTM D1252B	mg/l	11751.10
4.	Biochemical Oxygen Demand (BOD_5)	Manometric method (Respirometry)- ASTM D1252D	mg/l	5290.00
5.a	Total Solids (TS)	-	mg/l	16900
5.b	Total Suspended Solids (TSS)	Gravimetry – ASTM D5907	mg/l	12500
5.c	Total Dissolved Solid (TDS)	Gravimetry – ASTM D5907	mg/l	4400
6.	Total Kjeldahl Nitrogen (TKN)	Mineralization + steam distillation- EPA 351-3	mg/l	569.80
7.	Total Phosphate (TP)	Mineralization + steam distillation- EPA 351-3	mg/l	167.09

Central Lab

No	Parameter	Analysis		Results
9	Faecal Coliform		Index/100ml	>160000

Sludge Sampling Protocol/ no sampling

Date: 27-08-2022

BORDA Sample No.: 5

Description

Start and finishing sampling procedure:	No sludge sampling
Site:	Tout Lui Faut (Discharge site for sludge)
Sludge Service Company:	Faranzan Ali
Truck load:	10 m^3
Origen of sludge:	Chicken slaughterhouse mixed with another sludge
Unloading time	Started 12:00 - finished 12:30
(Only the time to empty tank):	30 min.

Observations:

Aspect/color:	Liquid part: non-uniform light beige-gray with white and other colored ingredients Sediment in the tank: slightly grayish with remnants from the slaughter process such as feathers and feeds
Consistency:	Liquid part: inconsistent liquid mixed with solids Sediment in the tank: sedimented solids with sand
Odor:	Strong odor of degrading organic material
Sedimentation properties (tested in a water bottle):	Not tested
General observations:	The truck was met up at the discharge site and the unloading process was observed. The observation is recorded here. The unloading process was characterized by the liquid portion flowing by gravity through the truck pipe into the canal. The sediment in the tank was emptied by means of a water jet after opening an unloading hatch. The unloading process of the liquid part took 10 min., and the cleaning of the sediment another 16 min.

S. No	Origin	Observations			
		Aspects/color	Consistency	Odor	Sedimentation behavior[1]
1	Content of 7 household septic tanks	Uniform black color	Homogeneous liquid with low viscosity	Smell of humus almost no septic odor	No visible sedimentation after 1 min, no visible sedimentation after 60 min.
2	Grease trap Restaurant Popoyes (Fast food)	Light grey	Watery, oily	Oily, bad, and organic	150 ml out of 1500 ml in 45 mins
3	Warehouse- Kuldeep Singh	Uniform black color	Homogeneous liquid with low viscosity	Smell of humus almost no septic odor	No visible sedimentation after 1 min, no visible sedimentation after 60 min.
4	Chicken slaughterhouse mixed with HH septic tank sludge	Blackish grey	Liquid mixed with solids	Strong odor of degrading organic material	Poor settling, floating materials (chicken waste) float on the top
5	Chicken slaughterhouse mixed with another sludge	non-uniform light beige-gray with white and other colored ingredients	Liquid part: inconsistent liquid mixed with solids	Strong odor of degrading organic material	

1 **General observations:**
1. Sludge was black in color signifying barely any septic conditions and highly digested
2. There was "NO" odor present during the disposal of sludge
3. Poor settleability of the sludge up on testing in a measuring jar
4. Very little sediments found after 45 mins of retention in the measuring jar

2 **General observations:**
1. Sludge was grey in color and was oily in nature upon collecting in bucket
2. There was "strong organic" odor present during the disposal of sludge signifying it as a fresh sludge
3. Poor settleability of the sludge up on testing in a measuring jar. There was a thick layer of grease formed after 45 mins of retention in measuring jar
4. Sediments of 150 ml found after 45 mins of retention in a 1500 ml measuring jar

3 **General observations:**
1. Sludge was black in color signifying septic condition and digested
2. There was "NO" odor present during the disposal of sludge
3. Poor settleability of the sludge up on testing in a measuring jar
4. Very little sediments found after 45 mins of retention in the measuring jar

4 **General observations:**
1. Sludge was blackish grey in color
2. There was "strong organic" odor present during the disposal of sludge signifying it as a fresh sludge
3. Poor settleability of the sludge up on testing in a measuring jar. There was a thick layer of grease formed after 45 mins of retention in measuring jar

5 **General observations:**
The truck was met up at the discharge site and the unloading process was observed. The observation is recorded here. The unloading process was characterized by the liquid portion flowing by gravity through the truck pipe into the canal. The sediment in the tank was emptied by means of a water jet after opening an unloading hatch. The unloading process of the liquid part took 10 min., and the cleaning of the sediment another 16 min.

Annex 6.2.4 Criteria catalog for site selection

Criteria catalogue for site selection– FSTP, Paramaribo									
C.N:			**Coordinates:**						
Plot designation:			**Nearby landmarks:**						
Location:	(Description)		**Update:**	dd/mm/yy					
Location	**Criteria**	**Requirement**	**Parameter**	**Comment**	**Rate**	**Very Good**	**Good**	**Sufficient**	**Elimination**
1.1	Land use type	Preference not in residential area	Land use categories		Agric	Agric	Indust	Resid low	Resid high D
1.2	Groundwater level-depth to aquifer	More depth better;	m		175	>150	100-150	50-99	<50
1.3	Highest potential groundwater level-depth	More depth better;	m	My not be of relevance as probably similar on all locations	0	>1,5	1,1-1,5	0,6-1	<0,6
1.4	Flooding susceptibility	Low risk of flooding	Flooded in 10/5 years	4-flooded every year, 3-flooded 3 times last 10 years, 2-flooded 1 time last 5 years, 1-not at risk of flooding	1	1	2	3	4

1.5	Distance to main common service area of desludging companies*	Within or close to the main common service area of the different sludge companies	Km	Main common service area of Sludge Service Companies determined by Questionnaire / 0 - in the main common service area	0	0	1-5	6-15	> 15
1.6	Time to access site by desludging trucks	Shortest possible during rush hours	Min	Measured during rush hours	30	1-30	31-60	61-90	> 90
2	**Vicinity**								
2.1	Distance to houses / commercials / Industrial building	Min > 200 m	m		400	>350	251-350	200-250	< 200
2.2	Distance to drinking water sources (250 m)	Min > 250 m	m		351	>350	300-350	250-300	< 250
2.3	Distance to churches / hospitals / schools (250 m)	Min > 250 m	m		351	>350	300-350	250-300	< 250
2.4	Distance to agricultural farms		Km		0.3	<0,5	0,5-10	>10	

3	**Size/Topography**								
3.1	7.000 – 15.000 m^2	Min 7.000 m^2	m^2		15001	>15000	10000-15000	7000-9999	<7000
3.2	Elevation over surrounding area	ideal: plot higher than the surrounding	yes or no		yes	yes	no		
3.3	Shape of the plot	Preferred close to 2:1 side relation	side relation		1	1=near to 2:1	2= near to 3:1	3= near to 1:1	
3.4	Main wind direction	from front towards backside	direction		1	1=from front	2=from side	3=from back	
4	**Infrastructure**								
4.1	Access by road	Accessibility all year round, no flooding risk	Accessibility		1	1 = good connexon to access/main road	2 = good access/distant to main road	3 = accessible to road but long distance	4 =No safe access all year round
4.2	Access road conditions (paved or secured road surface)	Paved or secured road surface for heavy vehicles	Road condition		1	1 = Paved	2 = Compacted gravel		4 = Muddy Road
4.3	Access to electricity services	Must be ensured	Complexity/cost of access		1	1 = <50 m distance to power line	2 = 50-150 m distance to power line	3 = 151-400m distance to power line	4 = Connection to power line not possible
4.4	Access to water services	Must be ensured	Complexity/cost of access		1	1 = <50 m distance to public water	2 = 50-150 m distance to public water	3 = 151-400m distance to public water	4 = Connection to public water not possible
4.5	Access to surface water	Necessary	m		1	1 = <100 m distance surface water	3 = 100-300 m distance to surface water	3 = 300-1000m distance to surface water	4= >1000 m

5	**Pilot plant demonstration value**								
5.1	Accessibility for visitors (according to 4.2)	Easy drive for visitors	Good road condition for light vehicles	Follows 4.2	1	1 = Paved	2 = Compacted gravel		4 = Muddy Road
5.2	Inherent attractivity of the area	Area is inherently attractive	Attractiveness		1	1 = Clean attractive environment	2= Surroundings has a poor look, but clean		4 = Waste, smell, do not allow demonstration visits
6	**Ownership**								
6.1	Owner of the plot	Preferably government owned land	Ownership	If private owner, should be related to the FSM service	1	1 = Government	2 = Operator/Service provider		4 = Service unrelated private
6.2	Clarity of ownership	Must be clear	clarity	yes or no		yes			no
7	**Plot conditions/maintenance**								
7.1	Easiness to clear from vegetation cover	Current vegetation cover	Complexity of site clearance		1	1 = cleaned terrain	2 = low gras-bush vegetation	3 = higher tree vegetation	
8	**Reuse options**								
8.1	For treated wastewater	Possible reuse options around (agriculture production)	probability		1	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.2	For stabilized sludge (compost)	Possible reuse options around (agriculture production)	probability		1	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.3	Biogas	Possible reuse options around	probability		1	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	

9	**Legal /Political situation**								
9.1	Legal / Political situation	To be favorable	probability		1	1 = all institution involved in favor	2 = no official denial of the location/plot	3 = possible institutional denial could be resolved	4 = official institution against location
*** Common service area of desludging companies is determined as result of the Sludge Service Companies Questionnaire**									

Annex 6.2.4 Criteria catalog Leiding 20

Criteria catalog for site selection – FSTP, Paramaribo									
C.N:	2			**Coordinates:**	5°48'30" N, 55°16'29"W				
Plot designation:	Leiding 20			**Nearby landmarks:**	Office DC Wanica				
Location:	Between roads Leiding 20 and 22			**Update:**	220923				
S. No.	**Criteria**	**Requirement**	**Parameter**	**Comment**	**Rate**	**Very Good**	**Good**	**Sufficient**	**Elimination**
1	**Location**								
1.1	Land use type	Preference not in residential area	Land use categories		Resid low	Agric	Indust	Resid low	Resid high D
1.2	Groundwater level- depth to aquifer	More depth better;	m	Depth to aquifer	100	150	100	50	0
1.3	Highest potential groundwater level- depth	More depth better;	m	My not be of relevance as probably similar on all locations	0	>1,5	1,1-1,5	0,6-1	<0,6
1.4	Flooding susceptibility	Low risk of flooding	Flooded in 10/5 years	4-flooded every year, 3-flooded 3 times last 10 years, 2-flooded 1 time last 5 years, 1-not at risk of flooding	3	1	2	3	4

1.5	Distance to main common service area of desludging companies*	Within or close to the main common service area of the different sludge companies	Km	Main common service area of Sludge Service Companies determined by Questionnaire / 0 - in the main common service area	0	0	1-5	6-15	> 15
1.6	Time to access site by desludging trucks	Shortest possible during rush hours	Min	Measured during rush hours	0	1-30	31-60	61-90	> 90
2	**Vicinity**								
2.1	Distance to houses / commercials / Industrial building	Min > 200 m	m		500	>499	400-499	300-399	< 300
2.2	Distance to drinking water sources (250 m)	Min > 250 m	m		351	>350	300-350	250-300	< 250
2.3	Distance to churches / hospitals /	Min > 250 m	m		351	>350	300-350	250-300	< 250

	schools (250 m)								
2.4	Distance to agricultural farms		Km		1	<0,5	0,5-10	>10	
3	**Size/Topography**								
3.1	7.000 – 15.000 m^2	Min 7.000 m^2	m^2		16000	>15000	10000-15000	7000-9999	<7000
3.2	Elevation over surrounding area	ideal: plot higher than the surrounding	yes or no		no	yes	no		
3.3	Shape of the plot	Preferred close to 2:1 side relation	side relation		0	1=near to 2:1	2= near to 3:1	3= near to 1:1	
3.4	Main wind direction	from front towards backside	direction		0	1=from front	2=from side	3=from back	
4	**Infrastructure**								
4.1	Access by road	Accessibility all year round, no flooding risk	Accessibility		1	1 = good connection to access/main road	2 = good access/distant to main road	3 = accessible to road but long distance	4 =No safe access all year round
4.2	Access road conditions (paved or secured road surface)	Paved or secured road surface for heavy vehicles	Road condition		0	1 = Paved	2 = Compacted gravel		4 = Muddy Road

4.3	Access to electricity services	Must be ensured	Complexity/cost of access		1	1 = <50 m distance to power line	2 = 50-150 m distance to power line	3 = 151-400m distance to power line	4 = Connection to power line not possible
4.4	Access to water services	Must be ensured	Complexity/cost of access		1	1 = <50 m distance to public water	2 = 50-150 m distance to public water	3 = 151-400m distance to public water	4 = Connection to public water not possible
4.5	Access to surface water	Necessary	m		2	1 = <100 m distance surface water	2 = 100-300 m distance to surface water	3 = 300-1000m distance to surface water	4 = >1000 m
5	**Pilot plant demonstration value**								
5.1	Accessibility for visitors (according to 4.2)	Easy drive for visitors	Good road condition for light vehicles	Follows 4.2	1	1 = Paved	2 = Compacted gravel		4 = Muddy Road
5.2	Inherent attractivity of the area	Area is inherently attractive	Attractiveness		1	1 = Clean attractive environment	2= Surroundings has a poor look, but clean		4 = Waste, smell, do not allow demonstration visits
6	**Ownership**								
6.1	Owner of the plot	Preferably government owned land	Ownership	If private owner, should be related to the FSM service	0	1 = Government	2 = Operator/Service provider		4 = Service unrelated private

6.2	Clarity of ownership	Must be clear	clarity	yes or no		yes			no
7	**Plot conditions/maintenance**								
7.1	Easiness to clear from vegetation cover	Current vegetation cover	Complexity of site clearance		3	1 = cleaned terrain	2 = low gras-bush vegetation	3 = higher tree vegetation	
8	**Reuse options**								
8.1	For treated wastewater	Possible reuse options around (agriculture production)	probability		3	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.2	For stabilized sludge (compost)	Possible reuse options around (agriculture production)	probability		3	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.3	Biogas	Possible reuse options around	probability		3	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
9	**Legal /Political situation**								
9.1	Legal / Political situation	To be favorable	probability		0	1 = all institution involved in favor	2 = no official denial of the location/plot	3 = possible institutional denial could be resolved	4 = official institution against location
*** Common service area of desludging companies is determined as result of the Sludge Service Companies Questionnaire**									

Annex 6.2.4 Criteria catalog Ornamibo 6B

Criteria catalog for site selection – FSTP – Paramaribo			
C.N:	1	**Coordinates:**	5°42´26"N, 55° 8´ 4"W
Plot designation:	6.B Ornamibo Sand Pits	**Nearby landmarks:**	
Location:	South of the Ornamibo Landfill	**Update:**	23-09-2022

S. No.	Criteria	Requirement	Parameter	Comment	Rate	Very Good	Good	Sufficient	Elimination
1	**Location**								
1.1	Land use type	Preference not in residential area	Land use categories		Resid low	Agric	Indust	Resid low	Resid high D
1.2	Groundwater level- depth to aquifer	More depth better;	m		175	>150	100-150	50-99	<50
1.3	Highest potential groundwater level- depth	More depth better;	m	My not be of relevance as probably similar on all locations	0	>1,5	1,1-1,5	0,6-1	<0,6
1.4	Flooding susceptibility	Low risk of flooding	Flooded in 10/5 years	4-flooded every year, 3-flooded 3 times last 10 years, 2-flooded 1 time last 5 years, 1-not at risk of flooding	2	1	2	3	4

1.5	Distance to main common service area of desludging companies*	Within or close to the main common service area of the different sludge companies	Km	Main common service area of Sludge Service Companies determined by Questionnaire / 0 - in the main common service area	0	0	1-5	6-15	> 15
1.6	Time to access site by desludging trucks	Shortest possible during rush hours	Min	Measured during rush hours	30	1-30	31-60	61-90	> 90
2	**Vicinity**								
2.1	Distance to houses / commercials / Industrial building	Min > 200 m	m		400	>350	251-350	200-250	< 200
2.2	Distance to drinking water sources (250 m)	Min > 250 m	m		351	>350	300-350	250-300	< 250
2.3	Distance to churches / hospitals /	Min > 250 m	m		351	>350	300-350	250-300	< 250

	schools (250 m)								
2.4	Distance to agricultural farms		Km		10	<0,5	0,5-10	>10	
3	**Size/Topography**								
3.1	7.000 – 15.000 m^2	Min 7.000 m^2	m^2		15001	>15000	10000-15000	7000-9999	<7000
3.2	Elevation over surrounding area	ideal: plot higher than the surrounding	yes or no		no	yes	no		
3.3	Shape of the plot	Preferred close to 2:1 side relation	side relation		0	1=near to 2:1	2= near to 3:1	3= near to 1:1	
3.4	Main wind direction	from front towards backside	direction		0	1=from front	2=from side	3=from back	
4	**Infrastructure**								
4.1	Access by road	Accessibility all year round, no flooding risk	Accessibility		2	1 = good connection to access/main road	2 = good access/distant to main road	3 = accessible to road but long distance	4 =No safe access all year round
4.2	Access road conditions (paved or secured road surface)	Paved or secured road surface for heavy vehicles	Road condition		1	1 = Paved	2 = Compacted gravel		4 = Muddy Road
4.3	Access to electricity services	Must be ensured	Complexity/cost of access		3	1 = <50 m distance to power line	2 = 50-150 m distance to power line	3 = 151-400m distance to power line	4 = Connection to power line not possible

4.4	Access to water services	Must be ensured	Complexity/cost of access		3	1 = <50 m distance to public water	2 = 50-150 m distance to public water	3 = 151-400m distance to public water	4 = Connection to public water not possible
4.5	Access to surface water	Necessary	m		3	1 = <100 m distance surface water	3 = 100-300 m distance to surface water	3 = 300-1000m distance to surface water	4= >1000
5	**Pilot plant demonstration value**								
5.1	Accessibility for visitors (according to 4.2)	Easy drive for visitors	Good road condition for light vehicles	Follows 4.2	1	1 = Paved	2 = Compacted gravel		4 = Muddy Road
5.2	Inherent attractivity of the area	Area is inherently attractive	Attractiveness		2	1 = Clean attractive environment	2= Surroundings has a poor look, but clean		4 = Waste, smell, do not allow demonstration visits
6	**Ownership**								
6.1	Owner of the plot	Preferably government owned land	Ownership	If private owner, should be related to the FSM service	0	1 = Government	2 = Operator/Service provider		4 = Service unrelated private
6.2	Clarity of ownership	Must be clear	clarity	yes or no	0	yes			no
7	**Plot conditions/maintenance**								
7.1	Easiness to clear from	Current vegetation cover	Complexity of site clearance		2	1 = cleaned terrain	2 = low gras-bush vegetation	3 = higher tree vegetation	

	vegetation cover								
8	**Reuse options**								
8.1	For treated wastewater	Possible reuse options around (agriculture production)	probability		3	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.2	For stabilized sludge (compost)	Possible reuse options around (agriculture production)	probability		1	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.3	Biogas	Possible reuse options around	probability		3	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
9	**Legal /Political situation**								
9.1	Legal / Political situation	To be favorable	probability		0	1 = all institution involved in favor	2 = no official denial of the location/plot	3 = possible institutional denial could be resolved	4 = official institution against location
*** Common service area of desludging companies is determined as result of the Sludge Service Companies Questionnaire**									

Annex 6.2.4 Criteria catalog Tawajarie Polder

Criteria catalog for site selection – FSTP – Paramaribo									
C.N:	3			**Coordinates:**	5°43'38" N, 55°19'27"W				
Plot designation:	Tawajarie Polder			**Nearby landmarks:**					
Location:	Western part of Greater Paramaribo			**Update:**	23-09-2022				
S. No.	**Criteria**	**Requirement**	**Parameter**	**Comment**	**Rate**	**Very Good**	**Good**	**Sufficient**	**Elimination**
1	**Location**								
1.1	Land use type	Preference not in residential area	Land use categories		Agric	Agric	Indust	Resid low	Resid high D
1.2	Groundwater level- depth to aquifer	More depth better;	m		120	>150	100-150	50-99	<50
1.3	Highest potential groundwater level- depth	More depth better;	m	My not be of relevance as probably similar on all locations	0	>1,5	1,1-1,5	0,6-1	<0,6
1.4	Flooding susceptibility	Low risk of flooding	Flooded in 10/5 years	4-flooded every year, 3-flooded 3 times last 10 years, 2-flooded 1 time last 5 years, 1-not at risk of flooding	1	1	2	3	4

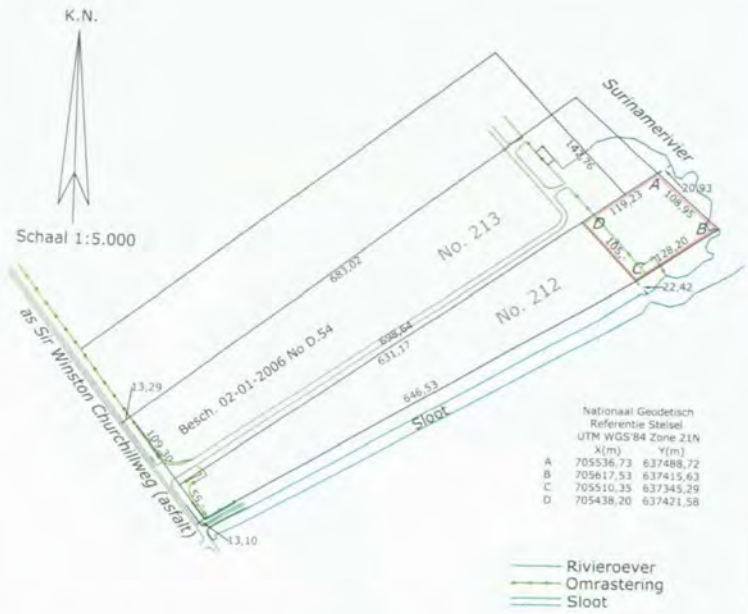
1.5	Distance to main common service area of desludging companies*	Within or close to the main common service area of the different sludge companies	Km	Main common service area of Sludge Service Companies determined by Questionnaire / 0 - in the main common service area	0	0	1-5	6-15	> 15
1.6	Time to access site by desludging trucks	Shortest possible during rush hours	Min	Measured during rush hours	0	1-30	31-60	61-90	> 90
2	**Vicinity**								
2.1	Distance to houses / commercials / Industrial building	Min > 200 m	m		500	>499	400-499	300-399	< 300
2.2	Distance to drinking water sources (250 m)	Min > 250 m	m		351	>350	300-350	250-300	< 250
2.3	Distance to churches / hospitals / schools (250 m)	Min > 250 m	m		351	>350	300-350	250-300	< 250
2.4	Distance to agricultural farms		Km		1	<0,5	0,5-10	>10	
3	**Size/Topography**								
3.1	7.000 – 15.000 m^2	Min 7.000 m^2	m^2		15001	>15000	10000-15000	7000-9999	<7000

3.2	Elevation over surrounding area	ideal: plot higher than the surrounding	yes or no		no	yes	no		
3.3	Shape of the plot	Preferred close to 2:1 side relation	side relation		0	1=near to 2:1	2= near to 3:1	3= near to 1:1	
3.4	Main wind direction	from front towards backside	direction		0	1=from front	2=from side	3=from back	
4	**Infrastructure**								
4.1	Access by road	Accessibility all year round, no flooding risk	Accessibility		3	1 = good connection to access/main road	2 = good access/distant to main road	3 = accessible to road but long distance	4 =No safe access all year round
4.2	Access road conditions (paved or secured road surface)	Paved or secured road surface for heavy vehicles	Road condition		2	1 = Paved	2 = Compacted gravel		4 = Muddy Road
4.3	Access to electricity services	Must be ensured	Complexity/cost of access		3	1 = <50 m distance to power line	2 = 50-150 m distance to power line	3 = 151-400m distance to power line	4 = Connection to power line not possible
4.4	Access to water services	Must be ensured	Complexity/cost of access		3	1 = <50 m distance to public water	2 = 50-150 m distance to public water	3 = 151-400m distance to public water	4 = Connection to public water not possible
4.5	Access to surface water	Necessary	m		4	1 = <100 m distance surface water	3 = 100-300 m distance to surface water	3 = 300-1000m distance to surface water	4= >1000 m
5	**Pilot plant demonstration value**								

5.1	Accessibility for visitors (according to 4.2)	Easy drive for visitors	Good road condition for light vehicles	Follows 4.2	2	1 = Paved	2 = Compacted gravel		4 = Muddy Road
5.2	Inherent attractivity of the area	Area is inherently attractive	Attractiveness		1	1 = Clean attractive environment	2= Surroundings has a poor look, but clean		4 = Waste, smell, do not allow demonstration visits
6	**Ownership**								
6.1	Owner of the plot	Preferably government owned land	Ownership	If private owner, should be related to the FSM service	0	1 = Government	2 = Operator/Service provider		4 = Service unrelated private
6.2	Clarity of ownership	Must be clear	clarity	yes or no		yes			no
7	**Plot conditions/maintenance**								
7.1	Easiness to clear from vegetation cover	Current vegetation cover	Complexity of site clearance		3	1 = cleaned terrain	2 = low gras-bush vegetation	3 = higher tree vegetation	
8	**Reuse options**								
8.1	For treated wastewater	Possible reuse options around (agriculture production)	probability		3	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.2	For stabilized sludge (compost)	Possible reuse options around (agriculture production)	probability		2	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	
8.3	Biogas	Possible reuse options around	probability		3	1 = interest in reuse identified	2 = reuse option identified	3 = no reuse option identified	

9	**Legal /Political situation**								
9.1	Legal / Political situation	To be favorable	probability		0	1 = all institution involved in favor	2 = no official denial of the location/plot	3 = possible institutional denial could be resolved	4 = official institution against location
*** Common service area of desludging companies is determined as result of the Sludge Service Companies Questionnaire**									

Annex 6.2.4 kwestie water-, afvalwater- en afvalbeheersystemen



Kaart van een stuk grond, groot 1,2939 ha., instede van 1,29 ha., aangeduid met de letters ABCD, gelegen in het distrikt Wanica aan de linkeroever van de Surinamerivier, deel uitmakende van het perceelland, bekend als Afd. II Sectie Tout Lui Faut No. 1 en grenzend aan het perceelland bekend als Afd. II Sectie Tout Lui Faut No. 212.

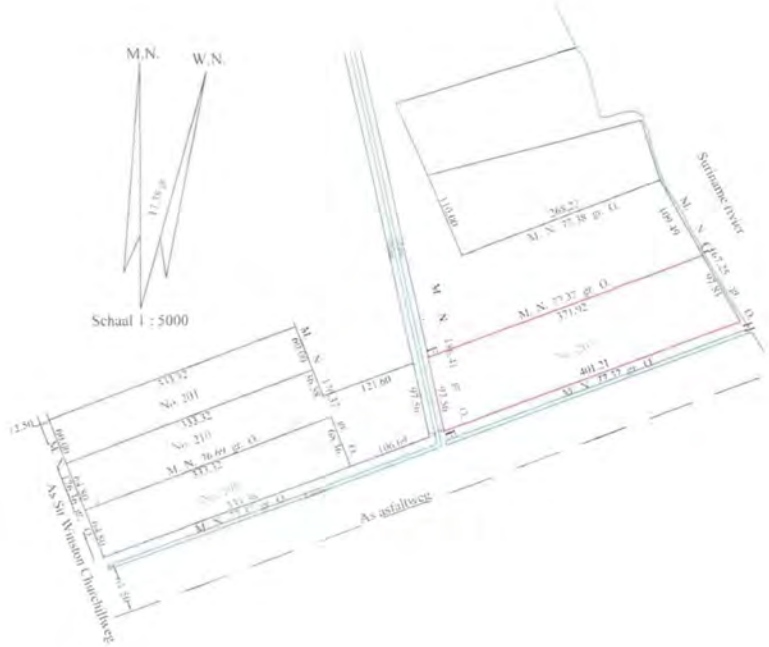
Ten verzoeke van STAATSOLIE MAATSCHAPPIJ SURINAME N.V., heb ik ter voldoening aan punt III-1 van de beschikking d.d. 13 april 2017 No. D 358, dit stuk grond opgemeten en deze kaart vervaardigd, rekening houdende met de bestaande erfscheidingen en met gebruikmaking van de gegevens voorkomende op mijn kaart d.d 08 juni 2015.

Paramaribo, 28 augustus 2017
De Beëdigde Landmeter,

PERCEELSID: HT-5526-7417
Datum: 07-09-2017

De GLIS-landmeter
F.M. Sanrawi MSc

N. Kalpoe, BSc.



Kaart van een stuk grond, groot 3,7332 ha., aangeduid met de letters EFGH, gelegen aan de Sir Winston Churchillweg in het distrikt Wanica, deel uitmakende van het perceelland bekend als Afd. II Sectie Tout Lui Faut No.1 en thans bekend als Afd. II Sectie Tout Lui Faut No. 207 (C1228/689).

Ten verzoeke van Energie Bedrijven Suriname N.V., heb ik deze kaart vervaardigd met gebruikmaking van gegevens voorkomende op de kaarten van de landmeters P.W. Kalk d.d. 18 juni 1994 en J.O.A. Mans d.d. 16 juni 1993.

Paramaribo, 28 mei 2012
De Landmeter in Suriname.

Annex 7.-Impact assessment methodology

The impacts identification methodology used consider all the potential impacts using a standard matrix approach which considers impacts on the physical environment (e.g., air quality, surface water quality, soil etc.) and impact on the human socio-economic setting. The assessment considers contribution to local and national environmental and socio-economic issues as well as global environmental issues.

The significance of all potential impacts that would result from the proposed project is determined to assist managers in the decision making. Key issues identified require further studies to determine whether they are likely to occur and to assess how they will manifest themselves.

For key potential impacts identified, it will be necessary to determine the significance of each impact, based upon qualitative or quantitative assessment of the following attributes:

- Magnitude
- Geographical scale
- Duration
- Probability of occurrence

The resulting impact will be indicated by their significance class, which classes are defined as:

Table 38: Classes of impact significance

< Impact significance >
Major (significant) effect: effect expected to be permanent or continuous and non-reversible on a national scale and/or have international significance.
Moderate (significant) effect: long-term or continuous effect, but it is reversible and/or it has regional significance.
Minor (not significant) effect: effect confined to the local area and/or of short duration, and it is reversible.
Negligible (not significant) effect: effect not detectable.
Unknown effect: insufficient data available to assess the significance of the effect.

In addition, impacts have been classified as:

- Positive: indicating whether the impact will have a positive (beneficial) effect; or
- Negative: indicating whether the impact will have a negative (adverse) effect on the environment, including affected people.

The degree of detail will enable the determination of required mitigation and possible enhancement measures, respectively to prevent or reduce significant negative impacts and to promote any positive impacts already in the planning phase. The implementation of mitigation measures will reduce negative environmental impacts to an acceptable level as much as possible. After implementation of mitigation/enhancement measures the significance of the impacts will again be determined.

The impact assessment methodology is described below.

The significance of an impact is defined as a combination of the severity of the impact occurring and the probability that the impact will occur. The significance of each identified impact will be rated according to the methodology set out below:

First the intensity/magnitude/size, scale and duration of the impact are determined according to Table 39 and Table 40.

Table 39: Defining the intensity / magnitude / size of the negative impacts

Rating	Description of Rating for		
	Natural environment	Socio-cultural	Health/safety
High	Irreversible damage to highly valued species, habitats, or ecosystems	Irreparable damage to highly valued items of cultural significance, or social functions or processes are severely altered	Event resulting in loss of life, serious injuries, or chronic illness; hospitalization required
Medium	Reversible damage to species, habitats, or ecosystems	Repairable damage to items of cultural significance, or impairment of social functions and processes	Event resulting in moderate injuries or illness; may require hospitalization
Low	Limited damage to biological or physical environment	Low-level damage to cultural items, or social functions and processes are negligibly altered (nuisance)	Event resulting in annoyance, minor injuries, or illness, not requiring hospitalization
Negligible	No relevant damage to biological or physical environment	No damage is done to cultural items and social functions and processes are not altered	Event is not experienced by receptors or only occasional minor annoyance

Table 40: Defining the intensity / magnitude / size of the positive impacts

Rating	Description of Rating for		
	Natural environment	**Socio-cultural**	**Health/safety**
High	Direct benefits to species, habitats, and resources with significant opportunities for sustainability	Benefits to local community and beyond	Health and safety will be significantly improved
Medium	Moderate benefits to species, habitats, and resources with some opportunities for sustainability	Benefits to many households or individuals	Health and safety will be improved
Low	Minor benefits to species, habitats, and resources with possible opportunities for sustainability	Benefits to few households or individuals	Health and safety will be slightly improved

Then the Severity Rating of the impact is determined by combining the magnitude of the impact with duration and scale of the impact Table 41 as set out below Table 42**.**

Table 41: Defining duration and scale of the impact

Rating	**Definition of Rating**
***Duration*– the time frame for which the impact will be experienced**	
Short-term (ST)	Up to 6 months
Medium-term (MT)	6-12 months
Long-term (LT)	More than 12 months
Scale– the area in which the impact will be experienced	
Small (SS)	Localized spot (FSTP)
Medium (MS)	Site (the selected site)
Large (LS)	Study area or beyond

Table 42: Rating the severity of the impact

Magnitude	High	Medium	Low	Negligible
Duration and/or Scale				
LT-LS, LT-MS, or MT-LS	High	High	Medium	Negligible
LT-SS, MT-MS, MT-SS, ST-MS, or ST-LS	High	Medium	Low	Negligible
ST-SS	Medium	Low	Negligible	Negligible

The next step is to define the **probability** of an impact to occur, as defined below.

Probability– *the likelihood of the impact occurring*	
High	Sure to happen, or happens often
Medium	Could happen, and has happened in Suriname
Low	Possible, but only in extreme circumstances

Finally, the overall **significance** of the impact is determined as explained below Table 43

Table 43: Determination of the overall significance of the impact

Severity	High	Medium	Low	Negligible
Probability				
High	Major	Moderate	Minor	Negligible
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible

Annex 7.-Screening application EIA

Table 44: Environmental impact assessment screening application form

Date of submission	September XX, 2022
Name of the project	Pilot Faecal Sludge Treatment Plant (FSTP) for Paramaribo City
Name Project applicant	……
Company name	Ministry of Spatial Planning and Environment
Contact person	
Name	……
Phone number	……
Email address	……
Location	
District name (or Exclusive Economic Zone)	*"e.g., Marowijne District"* Wanica District
Resort name(s)	*"e.g., Moengo Resort"*
Detailed site plan and a map of the project	*"This can be included as an Annex to the application. The coordinates according to the Global Positioning System (GPS) and the trade winds must be clearly indicated"* Annex

Project area	1.5 – 2.0 ha
The Project	
Project Design	*"In the absence of a detailed project design, a general description is sufficient"* The project is part of the Ministry of Spatial Planning and Environment´s efforts to improve the urban sanitation system of the city of Paramaribo. It is part of the Regional Project CReW+ financed by GEF and executed by the IDB and the GIZ. Under the scope of Suriname´s intervention under this program, a Pilot Faecal Sludge Treatment Plant (FSTP) should be designed and later established. The German technical Association BORDA e.g., / BORDA Las América A.C. is supporting the Government in designing such a FSTP. The envisaged timeline of the project: • September 2022: Detailed Design Concept for pilot FSTP • February 2023: tentatively Detail Project Report (DPR) for pilot FSTP; documents ready for tender. • 2223/2024: tentatively construction of the FSTP The aim of the project is to implement a pilot Faecal Sludge Treatment Plant (FSTP) which design capacity allows the treatment of 100m^3 of sludge per day. The technology enables the removal of pathogens, organic contaminants, and nutrients through nature-based treatment methods; furthermore, it also includes the possibility for further reuse of the treatment products (compost and treated residual water). The FSTP foresees to provide the following services: a) Faecal sludge treatment area b) Organic residues processing area c) Convenience area d) Future expansion area. Details below. a) Faecal sludge treatment area Components: • Double screen and 4 grit chambers

	• Homogenization tanks (4 lines) • 4 Settling/thickening tanks • Planted drying beds (PDB) • 1 Sludge compost harvesting area • 1 Decentralised Wastewater Treatment System (DEWATS) Description: The FSTP treatment processes rely on 2 basic principles: physical separation and organic degradation. The physical separation starts at the double screen and grit chambers, where large solids (garbage), grease and sand are separated from the sludge. After this first separation, homogenization tanks receive the materials, where diverse types of sludge get mixed. Then, the product enters the settling/thickening tanks, where liquid (effluent) and solids (sludge) are separated for subsequent separate treatment. The liquid part, the effluent, is treated by organic degradation of the wastewater through a Decentralized Wastewater Treatment Plant (DEWATS^{TM}), which consists of 2 anaerobic and 1 aerobic treatment processes. The solid part, the sludge, is treated in 8 planted drying beds (PDB) with a 12-months retention time. The last step of the treatment process happens in the dry sludge harvesting area. b) Organic residues processing area The area receives selected organic residues ~~from various sources~~ from various sources (e.g., gardening waste, channel cleaning residues, etc.). The treatment process is based on co-composting, which offers advantages for the post-treatment of the sludge and the conversion of organic residues into compost. The products generated can be reused as fertilizers and soil conditioner. c) Convenience area Components: • Entrance to the FSTP • Circulation • Discharge area for faecal sludge • Truck cleaning area • Parking • Resting area

	• Administration building Description: The components in the convenience area are designed to facilitate the controlled discharge of vacuum trucks, as well as other activities associated with arriving, discharging, cleaning, and leaving the site. The design allows entry, traffic and exit with safety and sufficient space, including a roundabout circulation system and a ramp for 2 trucks. The unloading and truck cleaning areas consider the efficient disposal of sludge and provide the opportunity to clean the vehicles. A parking area for 4 trucks next to the rest area offers drivers a place to rest and clean themselves. d) Finally, the administrative building is an area intended for administrative control and facilitate the necessary records of the discharge processes, the communication and the office and rooms of the operation personnel. e) Future expansion area This area is intended for further expansion of the treatment plant to accommodate additional sludge volumes, or to increase treatment intensity to meet higher treatment standards, or to provide the opportunity to increase plant efficiency in the future through separate specific treatment of sludges with distinctive characteristics.
Need and justification of the project	In Paramaribo city, the total of the population (including households, services and small commerce and industries) is served by septic tanks which receive black water (from toilets), whereas grey water (from sinks, showers, laundry) is discharged directly in the open channels. The existing sanitation system with on-site treatment of wastewater in septic tanks is a practical solution to provide the service to broader segments of the population with low immediate investment costs. It is the main sanitation alternative in urban and rural areas. However, on-site sanitation in low-income countries often focuses only on the user interface and the containment/on-site treatment of the wastewater, ignoring the entire wastewater chain, including treatment and reuse (or safe disposal). There is neither a standardized design of septic tanks nor control over their maintenance and emptying according to technical requirements. Therefore, the septic tanks do not function properly, preventing the wastewater from being undergoing an efficient primary treatment. Private companies provide the service of emptying the septic tanks and transporting the sludge using vacuum trucks. Most of these companies do not follow safety standard procedures for the emptying and discharge of sludge, and the personnel do not use proper personnel protective equipment.

	Since there are no alternatives, the sludge loads are discharged directly into the Suriname River without treatment, neither partial nor complete. A reasonable response to the situation described is to plan and implement a faecal sludge management system and associated infrastructure to allow for proper transport, treatment, and reuse or safe disposal of septic tank products. Implementation of a FSTP is necessary for the protection of public health, the water bodies, and the environment.
Non-technical explanation and purpose of the project	*"This can be added as an annex to the application"* The aim of the project is to contribute to closing the sanitation value chain. The project will provide a scientifically well-designed treatment facility for faecal sludge. The FSTP is designed based on the following principles: • Service oriented, • Cost-efficiency, • Nature-based treatment systems, • Circular economy, • Phase-wise implementation, • Cero waste, • Prepared to allow operation as PPP.
Possible Impacts on the environment	*"This is a general description of the impacts and can be added to the application as an annex"* Positive impacts on the environment: 1. Treatment of the faecal sludge and other wastewater from households, services, and small businesses as well as small industries, enabling the removal of organic pollutants, pathogens, and reuse of nutrients. 2. Whenever possible, resource recovery and reuse (nutrients, water). 3. Where reuse is not feasible, safe disposal of treated water and treated sludge into the environment (water bodies or land). 4. Reduction of the number of contaminants discharged into the Suriname River. Risks on the environment and mitigation measures: • Odors: The odor nuisance is inevitable, now of discharging the content of the vacuum trucks. Therefore, the FSTP shall be in a plot 200m away from households, businesses, schools, and other human settlements. Additionally, the facility will be equipped with several devices to minimize odor nuisance to a considerable extent at the source, like bio-filters for exhaust pipes of reactors and registers, as well as covers of drying beds. • Greenhouse gas methane: The methane produced in the tanks of the FSTP will be to a wide extent collected and burned

	to prevent its release to the atmosphere. • The risk is very low that charges of sludges with a concentration of industrial contaminants like heavy metals reach the FSTP, because the sludge emptying service focuses on private households and small to medium businesses. However, the operation of the plant considers continuous testing of incoming sludge and output products to prevent the presence of this materials before its release into the environment or further reuse.
Submitted applications to the other agencies	
"This regards application for the specific project e.g., to the District Commissioner, Ministries, etc."	
Annexes	
Annex 1: Detailed site plan and map of the project Annex 2: Non-technical explanation and purpose of the project Annex 3: Possible Impacts on the environment Any other attachments that the applicant wants to add	

FSTP areas
1. Administration area
2. Resting area
3. Workshop
4. Truck cleaning area
5. Grit storage
6. Grit chambers
7. Storage
8. Settlers
9. Treated water tank for truck cleaning
10. Planted drying bed (PDB) roofed
11. Compost storage
12. Compost area
13. ABR and AF
14. Planted gravel filter (PGF)
15. Polishing pond
16. Treated water tank
17. Access

0 10 20 30 40 50

Figure 38: Master plan FSTP

Annex 8-CB measures: Certificate of participation

Annex 8-CB measures: Photos

1) CB measures for relevant government departments


Introduction to Faecal Sludge Management
(FSM) at city level
September 2022
giz
BORDA


Introduction to Faecal Sludge Management
(FSM) at city level
giz


Introduction to Faecal Sludge Management
(FSM) at city level
giz

2) Media resonance

DAGBLAD SURINAME
DE STEM VAN HET VOLK

VOORPAGINA BINNENLAND BUITENLAND REDACTIONEEL VRIJE TRIBUNE

Komst faciliteit voor verwerken fecaliën noodzakelijk

Geplaatst op september 8, 2022

Het opzetten van een faciliteit voor de duurzame verwerking van menselijke uitwerpselen oftewel fecaliën, is noodzakelijk om de gezondheid en het milieu te

Culturu.com
Suriname altijd dichtbij

22,700 ABONNEES 15,500 VOLGE

HOME SURINAME NEDERLAND CRIME BUITENLAND SPORT ENGELS RADIO V

LEES OOK Regionieuws TV Suriname dinsdag 20 september 2022

5 (1)

Bouw moderne verwerkingsfaciliteit voor ontlasting noodzakelijk voor gezondheid

Plan voor milieuvriendelijke verwerking fecaliën in voorbereiding

09 Sep, 13:39

Het ministerie van Ruimtelijke Ordening en Milieu (ROM) is bezig met een plan voor een milieuvriendelijkere ophaal en verwerking van fecaliën. Het Duitse adviesbureau Bremen Overseas Research and Development Association (BORDA) is belast met de voorbereiding van het project. In aanloop naar het aanbestedingsproces van de nog op te zetten faciliteit voor het verantwoord verwerken van dit afval, heeft het ministerie donderdag een presentatie gehouden voor stakeholders.

Stakeholders krijgen informatie van het ministerie van Ruimtelijke Ordening en Milieu over een plan voor milieuvriendelijke verwerking van fecaliën. (Foto: CDS)

Gedurende 18 maanden zal het adviesbureau in samenwerking met stakeholders werken aan een plan voor de modernisering van de verwerking van fecaliën. Als onderdeel van de voorbereidingen heeft het bedrijf testen uitgevoerd op de kwaliteit van uitwerpselen in Suriname. Dit, omdat de afval verwerkt zal worden tot meststof. Het project wordt gefinancierd door de Global Environment Facility (GEF) is samenwerking met de Inter-American Development Bank (IDB) en het United Nations Environment Programme (UNEP).

3) Sessions with the sanitation service providers

4) Meeting with University representative and participation of university students during the training session

.

Annex 8-CB measures: Form evaluation and feedback

BORDA LAS AMÉRICAS CReW+ giz

Training evaluation and feedback

Training: ***Introduction to Faecal Sludge Management (FSM) at city level***
September 2022, Paramaribo

1. Name (optional): _____
2. Organisation (optional): _____
3. For each question, please check the box of the option that you most relate to:

		Agree	Partially Agree	Neutral	Partially Disagree	Disagree
a.	The training met my expectations					
b.	I felt interested and involved throughout the training					
c.	The materials helped me understand the content of the training better					
d.	The activities helped me understand the content of the training better					
e.	According to the subject, the duration of the training was good enough					
f.	The programme followed the time assigned per each topic					
g.	The explanations from the resource persons were clear and understandable					
h.	The resource persons were well informed on the subject					
i.	This training is relevant for me and my work					
j.	I would be interested in participating in further trainings on Faecal Sludge Management and Sanitation systems					
k.	I would recommend this training to other colleagues					

4. What did you liked the most about the training?

5. What did you liked the least about the training? What would you change?

6. Other comments and suggestions....

Annex 8-CB measures: Trainings concepts

Introduction

The integrated water resource management approach "promotes the coordinated development and management of water, land and related resources, to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (UNEP). The basis of this approach is that many different uses of finite water resources are interdependent. In this regard, wastewater and faecal sludge management become a key component for integrated water resources management at different scales, contributing to the sustainable use and care of water.

Onsite sanitation represents a practical solution for providing the service to wider population segments with lower immediate capital expenditure, becoming the principal sanitation alternative in many urban and rural areas. However, onsite sanitation in low-income countries often focuses only on the user interphase and waste containment, abandoning the later steps of the sanitation chain such as product treatment or reuse. The lack of technical knowledge, local capacities and resources are some of the reasons that lead to an unsafely managed sanitation service. Paramaribo, where most of the population has septic tanks and products are discharged without further treatment, is a clear example of this worldwide situation.

BORDA Las Americas, as part of the CReW+ Project in Suriname, is developing the design and concept for a pilot Sludge Treatment Facility at Paramaribo (FSTP). However, the incorporation of faecal sludge management practices and technologies, such as the pilot FSTP, needs to be built upon common knowledge and understanding of the existing needs and the technical, operational, and financial alternatives that can deliver a proper sanitation solution. Moreover, the introduction of modern technologies requires the development of local capacities from the beginning of the project, contributing to its further ownership, acceptance, sustainable management, operation, and maintenance.

In this regard, BORDA Las Americas offers training measures for Paramaribo's key stakeholders such as government representatives from ministries linked to spatial planning and environmental affairs, natural resources management, agriculture, public works, and public health, as well as the private sector (sanitation service providers) and the Universities and Education Institutions. The capacity building measures aim to introduce the participants to Faecal Sludge Management (FSM) at the city level, and sludge and wastewater treatment alternatives according to Paramaribo's context and current sanitation situation.

Training 1: Introduction to FSM at the city level

Training Purpose

The training aims at introducing the participants to the need and benefits of Faecal Sludge Management (FSM) in urban sanitation strategies, as well as generate a common understanding of the sanitation chain and alternatives for septage transport, treatment, and reuse of by-products, referencing to Paramaribo's context and the pilot faecal sludge treatment plant (FSTP). The training goal is to guide the active participation of the partakers during the process of planning and implementation of the pilot FSTP and sanitation system for the specific context of Paramaribo.

Target audience

Paramaribo government representatives, such as personnel of the Ministry of Spatial Planning and Environment, Ministry of Natural Resources, Ministry of Public Works, Ministry of Agriculture, Ministry of Public Health, etc.

Learning Outcomes

- Understanding of Faecal Sludge Management contextualization, needs and benefits in urban sanitation strategies.
- Identifying challenges in sanitation systems, FSM enabling environment and key stakeholders' roles distribution for FSM
- Understanding the steps on the sanitation chain and overview of faecal sludge and septage management technology options
- Identifying and understanding FSM treatment approaches and technologies suitable for Paramaribo's context and corresponding advantages and limitations
- Understanding the basis and main steps for FSM planning

Table 45: Training modules- I

Topic	Time
a. Welcome and introduction	15 min
b. Introduction to Sanitation and FSM	20 min
c. Paramaribo's current sanitation situation	30 min
d. Group discussion (activity 1)	50 min
e. Planning approach for FSM and FSTP	40 min
f. FSM and FSTP concept for Paramaribo	45 min
g. Group discussion (activity 2)	45 min
h. Faecal sludge treatment technologies (other alternatives)	30 min
i. Case studies	30 min

Training 2: Introduction to FSM as a service

Training Purpose

The training main objective is raising awareness of the needs and benefits of sanitation measures and FSM, mainly focusing on socioeconomic, environmental and health impacts. It will introduce the FSM system approach and the roles of different stakeholders, and extend on the participatory process for FSM planning, including the identification of needs, addressing concerns, and visualizing of possible solutions. The training is conducted in a workshop format, enhancing the participation and the discussion with the participants.

Target Audience

Potential target communities to be provided with FSM and the pilot FSTP sanitation services: Community leaders, neighborhood organizations, teachers, etc.

Learning Outcomes

- Understanding of sanitation measures needs and benefits linked to socioeconomic, environmental and health impacts.
- Identification of key stakeholders for FSM in Paramaribo's context.
- Identification of needs and concerns related to the sanitation context in Paramaribo.
- Identification of workable solutions to the sanitation issues in Paramaribo.

Table 46: Training modules- II

Topic	Time
a. Socializing the approach of the planned FSM system • Introduction to Sanitation and FSM • Paramaribo's current sanitation situation (needs and challenges)	75 min
b. Participatory process introducing to FSM planning. • Identification of Paramaribo's key stakeholders for FSM (relevance of the community and overall district's citizens involvement) • Solution identification: FSM (discussion pros/cons) • Alternatives for Paramaribo's FSM (FSTP)	90 min

Training 3: FSM as a business opportunity

Training Purpose

The training measure focus on enhancing the partnerships required for the whole sanitation chain service provision in Paramaribo's context, from desludging and transport of septic tanks products, treatment-units operation services, and takers and users of treatment by-products. The training covers the pilot FSTP approach, the services required and the potential operational and business model, as well as the readiness of the existing service providers linked to the operation of the FSTP and the use of treatment by-products.

Target Audience

Potential service providers: Septic tank desludging companies, potential FSTP operators, etc.

Learning Outcomes

- Understanding the general approaches for FSM and specifically for the pilot FSTP
- Understanding overall requirements and costs for collection, transport, and treatment of septage and faecal sludge.
- Identifying possible operation and business models for collection, transport, and treatment of septage and faecal sludge.
- Understanding overall requirements and costs treatment by-products utilization.
- Identifying possible operation and business models for treatment by-products utilization.

Table 47: Training modules- III

Topic	Time
a. Overall approach pursuit by the pilot FSTP • Approach to Faecal Sludge Treatment • FSTP technologies (including reuse options) • Paramaribo's FSTP concept (simplified) • Expectations: relations to the current businesses model (address specific concerns)	75 min
b. Services required and potential business options linked to the operation of the FSTP and septic tank emptying and transportation service providers • Collection, transport, and treatment of septage and faecal sludge: Requirements and overall costs (referred to Paramaribo's FSTP concept) • Potential Revenue sources - Business options • Activity / Discussion: readiness of service providers	120 min
c. Service required and potential business options linked to the utilization of the FSTP treatment product • Use of treatment products: Requirements and overall costs (referred to Paramaribo's FSTP concept) • Potential Revenue sources - Business options • Case study • Activity / Discussion: readiness of service providers	120 min

Training 4: FSM and Wastewater treatment in Paramaribo

Training Purpose

The training aims at introducing the participants to the sanitation situation in Paramaribo and the FSM approach in a citywide sanitation strategy. The session will allow for an overview of basic treatment approaches and technologies, as well as FSM needs and benefits regarding socioeconomic, health and environmental impacts.

Target Audience

Academic institutions and University community: professors, educators, researchers and students of relevant areas and programmes such as Civil Engineering, Environmental Sciences, Public Health, Sustainable Management of Natural Resources, etc.

Learning Outcomes

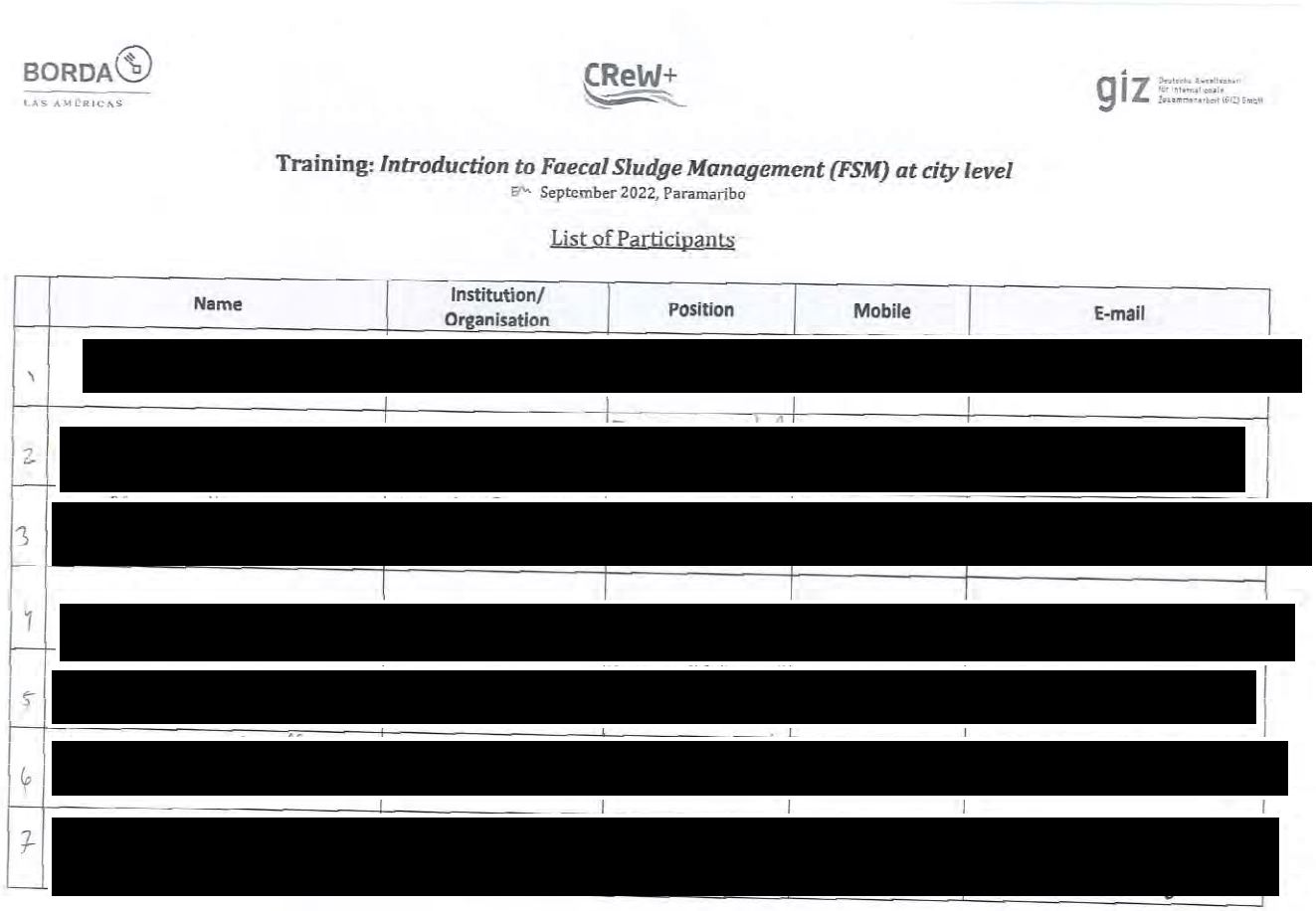
The training aims to convey the following learning:

- Identifying the current sanitation context in Paramaribo
- Understanding the needs and benefits of FSM and wastewater treatment
- Overview of approaches for FSM in a citywide sanitation strategy
- Overview of technology options for FSM and sludge treatment
- Identifying and understanding the relevance of an interdisciplinary approach and multi-stakeholder participation for FSM sustainability, including the academia

Table 48: Training modules- IV

Topic	Time
a. Paramaribo's sanitation situation	45 min
b. Introduction to sanitation and FSM • Linking sanitation and health, environmental and socioeconomic impacts • FSM approach in a citywide sanitation strategy	
c. FSM systems and technologies • Alternatives for Paramaribo • Alternatives advantages and limitations	45 min
d. Academia's role, opportunities, and contributions for the improvement of Paramaribo's sanitation system	

Annex 8-CB measures: Training participants list



Training: ***Introduction to Faecal Sludge Management (FSM) at city level***

September 2022, Paramaribo

List of Participants

	Name	Institution/ Organisation	Position	Mobile	E-mail
1	[redacted]				
2	[redacted]				
3	[redacted]				
4	[redacted]				
5	[redacted]				
6	[redacted]				
7	[redacted]				

BORDA LAS AMÉRICAS CReW+ giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Training: ***Introduction to Faecal Sludge Management (FSM) at city level***

8th September 2022, Paramaribo

List of Participants

	Name	Institution/ Organisation	Position	Mobile	E-mail
8	[redacted]				
9	[redacted]				
10	[redacted]				
4	[redacted]				
12	[redacted]				
13	[redacted]				
14	[redacted]				

BORDA LAS AMÉRICAS

CReW+

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Training: ***Introduction to Faecal Sludge Management (FSM) at city level***

5th September 2022, Paramaribo

List of Participants

	Name	Institution/ Organisation	Position	Mobile	E-mail
15	[redacted]				
16	[redacted]				
17	[redacted]				
18	[redacted]				
19	[redacted]				
20	[redacted]				
21	[redacted]				

BORDA LAS AMÉRICAS

CReW+

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Training: ***Introduction to Faecal Sludge Management (FSM) at city level***

5th September 2022, Paramaribo

List of Participants

	Name	Institution/ Organisation	Position	Mobile	E-mail
22	[redacted]				
23	[redacted]				
24	[redacted]				
25	[redacted]				

BORDA LAS AMÉRICAS CReW+ giz

Training: ***Introduction to Faecal Sludge Management (FSM) at city level***

7th September 2022, Paramaribo

List of Participants

	Name	Institution/ Organisation	Position	Mobile	E-mail
1	[redacted]				
2	[redacted]				
3	[redacted]				
4	[redacted]				
5	[redacted]				
6	[redacted]				
VR					

BORDA LAS AMÉRICAS CReW+ giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Training: ***Introduction to Faecal Sludge Management (FSM) at city level***

7th September 2022, Paramaribo

List of Participants

	Name	Institution/ Organisation	Position	Mobile	E-mail
7	[redacted]				
8	[redacted]				
9	[redacted]				
10	[redacted]				
11	[redacted]				
12	[redacted]				
13	[redacted]				

BORDA LAS AMÉRICAS CReW+ giz

Training: ***Introduction to Faecal Sludge Management (FSM) at city level***

7th September 2022, Paramaribo

List of Participants

	Name	Institution/ Organisation	Position	Mobile	E-mail
14	[redacted]				
15	[redacted]				
16	[redacted]				
17	[redacted]				
18	[redacted]				
19	[redacted]				
20	[redacted]				

BORDA

Am Deich 45, D 28199 Bremen Germany