SFD Report

Santa Teresa
Costa Rica

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SFD Report of Santa Teresa, Costa Rica, 2021

Towns of Bello Horizonte, Manzanillo, Santiago, Hermosa, Santa Teresa, Carmen and Malpaís. Cóbano District, Puntarenas, Costa Rica.

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FOREWORD

The Inter-American Development Bank (IDB), through the saniIDB platform, seeks to promote the development and implementation of optimal and non-conventional sanitation solutions in the Latin America region. The first step to identify solutions is to characterize the state of the sanitation situation that could serve as a baseline in the areas of intervention.

One well-known and globally accepted tool to analyse the sanitation service delivery chain to identify its strengths and weaknesses in any given area is the Shit Flow Diagram (SFD) graphic. The tool was developed by the SFD Promotion Initiative (SFD PI), a consortium of partners working together to improve excreta management in urban areas. The SFD PI is supported by the Bill & Melinda Gates Foundation and managed by GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH) as part of the Sustainable Sanitation Alliance (SuSanA).

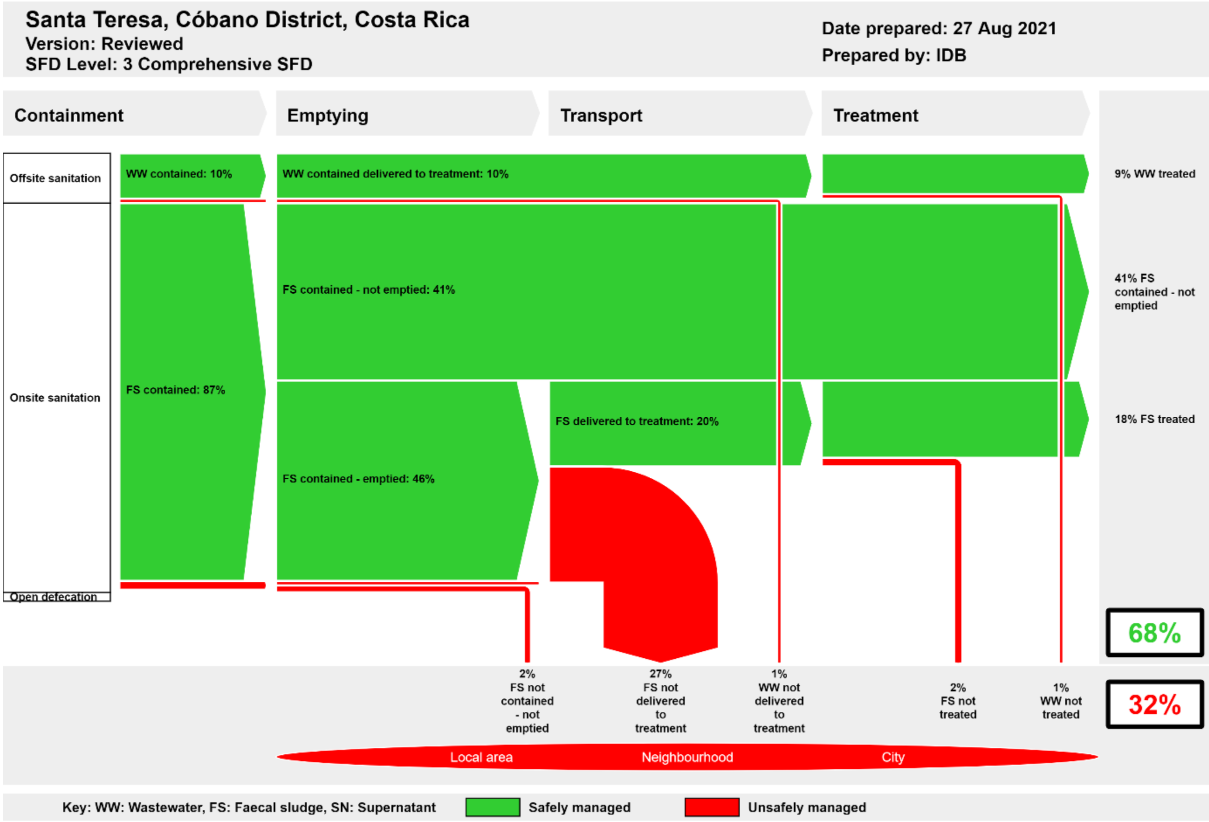
An SFD is an advocacy tool that aims to assist technical and non-technical stakeholders in order to implement plans and programs related to urban sanitation. The SFD methodology is increasingly being used to analyse the extent of safely-managed sanitation in urban areas, providing with a valuable picture of the prevailing sanitation condition from containment to disposal. So, it is a widely recognised advocacy and decision support tool that aims to understand, communicate, and visualize how the wastewater and faecal sludge moves within a city or town. As stated in the SuSanA website, the SFD methodology offers “a new and innovative way to engage sanitation experts, political leaders and civil society in coordinated discussions about excreta management in their city”.

The SFD graphic is made by a free online tool, the Graphic Generator (GG): https://sfd.susana.org/data-to-graphic and, to date, over 180 SFD reports, which must pass a review process before publication to assure the quality control mechanism of the SFD PI, have been uploaded in the SuSanA website.

The production and publication of an SFD report for Horizonte, Manzanillo, Santiago, Hermosa, Santa Teresa, Carmen and Malpaís, Distrito de Cóbano District, Putarenas (Costa Rica) would help to visualise the current sanitation situation in the city, resulting in a potential to shift the current activities and efforts towards more efficient investments in the places of the sanitation chain that need more attention, improving the urban sanitation situation and the surrounding environment of the study area.

The structure of this SFD report consists of an executive summary and the SFD report. The latter includes: i) general city information describing its main characteristics, ii) the sanitation service outcomes with a thorough explanation of the SFD graphic outcome and the assumptions made, iii) the service delivery context analysis which contains information on the regulatory framework of water and sanitation at country and city level, also describing the city plans, budget and future projects to improve the sanitation situation and iv) a detailed description of the surveys, Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) conducted, as well as the key stakeholders involved, field visits carried out and references used to develop this SFD report

1. The SFD Graphic



Produced with support from the SFD Promotion Initiative with funding from the Bill & Melinda Gates Foundation.
The SFD Promotion Initiative recommends that this graphic is read in conjunction with the city's SFD Report which is available at: sfd.susana.org

2. Diagram information

SFD Level:

This is an SFD level 3 - Comprehensive SFD.

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Diana Madrigal, Silvia Ortiz and Sergio Pérez, Inter-American Development Bank.

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3. General city information

The town of Santa Teresa is located in the extreme southwest of the Nicoya peninsula, in the canton and province of Puntarenas, in the North Pacific Region of Costa Rica. Santa Teresa administratively belongs to the Cóbano district.

Santa Teresa is formally only one of the towns of the district. However, Santa Teresa traditionally comprises the set of towns that extend linearly along the 15 km of the Pacific coast of Cóbano, limiting to the north with the province of Guanacaste and to the south with the Cabo Blanco Absolute Natural Reserve.

The entire Nicoya peninsula is located within a dry tropical climate zone, with less water resources than the country's average. Average annual precipitation in the Nicoya peninsula is 2,007 mm. During the dry season, there is practically no precipitation (IMN, 2007; CD, 2021).

Based on the cartographic data of the National System of Territorial Information of Costa Rica (SNIT) (SNIT, 2017), the National Institute of Statistics and Censuses (INEC) and field surveys, It is estimated that the resident population of Santa Teresa is 3,099 inhabitants, to which should be added a floating population of 3,575 people. The significant number of floating population is explained because Santa Teresa is a tourist area, which hosts 44 hotels, 59 tourist rental houses and 49 restaurants in the Santa Teresa area.

The economy of Santa Teresa is focused almost entirely on tourism and the economic activities derived from it. The kilometres of highly beautiful beaches located in the area of this study and the surrounding natural environment are elements that promote national and international tourism.

This study is a first step to identify viable solutions that can be replicated in other areas of the country to help reduce contamination by untreated wastewater and faecal sludge.

4. Service outcomes

Available data related to access to water and sanitation are scarce in the study area. Based on this, the Inter-American Development Bank (IDB), together with the local Non-Governmental Organization (NGO) Nicoya Peninsula Waterkeeper (WK) and a team of independent consultants, carried out a study during the first months of 2021 that consisted of three surveys (IDB and WK, 2021a; IDB and WK, 2021b; IDB and WK, 2021c): households, tourist places (restaurants, hotels, hostels and rental houses) and service providers (faecal sludge emptying companies), also including field visits and Key Informant Interviews (KIIs) to operators of Faecal Sludge Treatment Plants (FSTPs), Wastewater Treatment Plants (WWTPs), masons and engineering consultants in the area to triangulate all data compiled.

The results obtained show the following distribution and use of the sanitation systems in the study area.

Generation/Containment

In the study area, there is no sewage system. Most of the population is served by onsite sanitation systems, especially some type of tank (septic or with impermeable walls and open bottom), pit latrines in a few households and privately-owned WWTPs in some tourist places (IDB and WK, 2021a; IDB and WK, 2021b).

Emptying

After triangulating the data on the percentage of households that report that their onsite system has been emptied with the service providers survey and the interviews with the operators of the FSTPs/WWTPs, a consensus value of 54% was reached. Regarding pit latrines, none of them have been emptied (IDB and WK, 2021a; IDB and WK, 2021b).

The frequency of emptying the tanks, both septic and open-bottom, is similar in households and in tourist places, with an average of 1.7 years in households and 1.4 years in tourist places. The average tank volumes are 1,9 m^3 in the case of households and 3.0 m^3 in the case of tourist places (IDB and WK, 2021a; IDB and WK, 2021b).

There are around 15 private companies that enter the area to provide emptying services. However, only five of them were found to do it with a permission issued by the Ministry of Health (IDB and WK, 2021c). They all provide emptying services of septic tanks, grease traps and wastewater treatment plants in households, hotels, hostels, restaurants, and rental houses (IDB and WK, 2021c).

The fleet of vehicles is highly variable: from 1 to 9 per company. The age of the fleet is also variable, but most are over 15 years old, being all owned by the companies. The maintenance cost of the vacuum trucks varies from CRC 1,000,000 (US$ 1,622) to CRC 3,000,000 (US$ 4,868) per year. All vacuum trucks are equipped with a pump with a capacity ranging from 6.5 to 10 HP. The capacity of the vacuum trucks is also variable: it varies from 12m^3 to 40m^3, with the average being 20m^3 (IDB and WK, 2021c). The average emptying fee is 46,250 CRC/m^3 emptied, being the same for both households and tourist places (US$ 75/m^3).

Apart from the five registered companies, the emptying of onsite systems is also carried out by informal companies/individuals, not registered by the Ministry of Health. This way of emptying can be both mechanical, in a way similar to that described above, or manual, the latter form being carried out mainly by individuals who contact households or tourist places directly to carry out the service. An attempt was made to contact some of these companies/individuals to inquire about the service they provide, but all of them refused to participate in this study.

Due to this, the total percentage of faecal sludge emptied, transported and discharged untreated into the environment may have been underestimated and be greater than reflected in the SFD graphic.

Transport

The authorized service providers travel an average of 204 km from their base to the treatment point (this distance varies between 160-270 km). They usually spend a day, or two days at most, in the area emptying the faecal sludge from tanks of households and tourist places (IDB and WK, 2021c).

In the case of these authorized service providers, it is expected that the collected faecal sludge will be delivered to a FSTP or a WWTP for treatment. In the case of manual emptiers and company/individual providers who operate without a permit issued by the Ministry of Health, faecal sludge is usually disposed of untreated into streams (called *quebradas*), rivers, roads or directly onto the ground. This was deducted by the information collected in the surveys and by direct observations (IDB and WK, 2021a; IDB and WK, 2021b; IDB and WK, 2021c).

Treatment

In households and tourist places that have their own WWTP, the treatment consists of an aerobic treatment, usually an activated sludge or a fixed-bed type.

The surveyed service providers stated that the collected faecal sludge is delivered to a FSTP/WWTP where is further treated: in the central canton of the Alajuela province, or in the Carrillo, Liberia or Santa Cruz cantons in the Guanacaste province (IDB and WK, 2021c).

However, after interviewing the operators of the FSTPs/WWTPs, it was found that only one of the five service providers was actually delivering the faecal sludge to treatment. This clearly shows that even authorized service providers may be managing the disposal of the faecal sludge in an inappropriate way (KII 1, 2021).

One problem is the amount of untreated faecal sludge disposed of in the environment from manual emptiers and companies/individuals not authorized to operate by the Ministry of Health. This can have a negative impact on the aquatic ecosystem since contamination by *faecal coliforms* has been reported in several *quebradas*, beaches and rivers in the area (LNA, 2021; LNA and BioAnalítica, 2021). This contamination may also be due to those septic tanks that are in areas located at sea level characterized by the high-water table, or some tanks that do not have a sealed bottom and faecal matter may be infiltrating directly on these aquatic ecosystems.

On the other hand, according to the surveys, practically the entire population (96.68%) has a basic service level of drinking water, according to the Joint Monitoring Program (JMP) methodology developed by WHO/UNICEF. This reflects that the risk of groundwater contamination according to the factors of the SFD Promotion Initiative (SFD-PI): i) vulnerability of the aquifer, ii) lateral separation, iii) water supply and iv) water production is low.

Finally, the SFD graphic shows that 68% of the excreta generated is managed safely while 32% of the excreta generated is not safely managed.

5. Service delivery context

Costa Rica has a broad legal framework in terms of environmental protection, directly or indirectly related to wastewater and, to a lesser extent, to the management of faecal sludge.

The National Wastewater Sanitation Policy (2016) provides the framework to harmonize the actions that must be taken to ensure the well-being of the population and the environment through the treatment of wastewater and faecal sludge. The policy also establishes a guide for specific actions that the country needs to execute to achieve the Sustainable Development Goals (SDG). However, there is no specific mention about the management of faecal sludge or the sanitation service delivery chain.

Directly related to the management of faecal sludge is the *Reglamento para el Manejo y la Disposición final de Lodos Fecales y Biosólidos* (2015). This is the main regulation that directly addresses faecal sludge, focusing on the regulation of all services along the sanitation delivery chain, a service that can be provided by public or private companies. The regulation excludes wastewater from sanitary cabins or mobile latrines, which must be treated and comply with the provisions of the *Reglamento de Vertido y Reuso de Aguas Residuales* (2007).

6. Overview of stakeholders

Stakeholders can be divided into four main groups, as can be seen in Table 1 (public institutions, private sector, informal sector, and community and non-governmental organizations). Out of these, the Costa Rican Institute of Aqueducts and Sewerage (AyA) plays a key role as the main provider of water services in the canton.

In addition, the Nicoya Peninsula Waterkeeper organization also plays a key role and its scope covers all areas of this study. This organization is the link between the community and the public and private sector, promoting and raising awareness about the protection of water resources and the ocean. It mainly works in two major environmental problems in the area: the incorrect management of wastewater and the disposal of solid waste. Among other things, they also monitor the water quality in the main rivers in the area, ensure compliance with legislation, advise and train various target groups such as tourist places and households and manage the local recycling centre.

Following the sanitation service delivery chain, the private sector plays a fundamental role in making the chain work. Masons are key actors, given their role on the construction of onsite sanitation systems such as septic tanks. The private sector also plays an important role in the provision of faecal sludge emptying, transportation and treatment services.

There are also actors from the informal sector, specifically emptying service providers, who do not comply with some or any of the legal requirements established by law for the provision of these services.

Table 1. Key stakeholders.

Key stakeholders	Institutions/ organizations
Public institutions	Costa Rican Institute of Aqueducts and Sewerage (AyA), Municipal Council of Cóbano District
Private sector	*Sanitarios La Pampa*, *WWTP Playa Panamá, Carrillo*. *Servicios Sépticos Santa Cruz S.A.*, *Compañía de Aguas Sanitarias CASSA*, *Compañía ARCA S.A.*
Informal sector	Faecal sludge collectors not authorized by the Ministry of Health.
Community organizations and NGOs	Nicoya Peninsula Waterkeeper (NPWK), Inter-American Development Bank (IDB), Malpaís-Santa Teresa Integral Development Association (ADI), Chamber of Tourism of the Blue Zone (CATUZA).

7. Process of SFD development

The Inter-American Development Bank (IDB) funded and produced this report in conjunction with Nicoya Peninsula Waterkeeper and a team of independent consultants. The development of the SFD graphic has been carried out in several stages:

1. Reviewing bibliographic sources.
2. Gathering data on population obtained from the *Sistema Nacional de Información Territorial* and the National Institute of Statistics and Censuses of Costa Rica.
3. Gathering data on the type of services and average household water consumption of the AyA aqueduct.
4. Obtaining data from household, tourist places and service providers surveys conducted by Nicoya Peninsula Waterkeeper (WK) and the Inter-American Development Bank (IDB).
5. Performing 10 Key Informant Interviews (KIIs): 4 conducted with FSTPs/WWTPs operators; 3 with masons; and 3 with engineering consultants who build WWTPs in the area. In addition, one field visit to the water supply aqueduct was made.
6. Using the Graphic Generator to make the SFD graphic.
7. Conducting a *brain storming* session and a validation workshop in August 2021 with the participation of key stakeholders to validate the SFD graphic.

8. Credibility of data

The '*SFD Source Evaluation Tool*' has been used to score the credibility of the 20 data sources used. The score obtained has been: 18 sources with high credibility and 2 sources with medium credibility.

In addition, three surveys were conducted: households, tourist places and service providers in the first months of 2021 (IDB and WK, 2021a; IDB and WK, 2021b; IDB and WK, 2021c).

9. List of data sources

List of references used for the realization of this executive summary:

- Ballestero Vargas S.A. (2019). *Informe Final Consultoría Plan de Infraestructura y Gestión Integrada de Agua para la región Pacífico Norte 2020 – 2030. San José*. (In Spanish).
- IDB and WK, 2021a. *Household survey. 306 household surveys of a total of 897 households in the area carried out*. Field work conducted by WaterKeeper (WK) with the support of the IDB in the design of the survey and the subsequent analysis of the collected data.
- IDB and WK, 2021b. *Tourist places survey. 150 surveys (restaurants, hotels, hostels and rental houses) carried out*. Field work conducted by WaterKeeper (WK) with the support of the IDB in the design of the survey and the subsequent analysis of the collected data.
- IDB and WK, 2021c. *Service providers survey. Five surveys carried out (companies authorized by the Ministry of Health)*. Field work conducted by WaterKeeper (WK) with the support of the IDB in the design of the survey and the subsequent analysis of the collected data.
- CD, 2021. *Climate-Data (CD) Nicoya peninsula*. [Accessed October 15, 2021]. Available here: https://es.climate-data.org/america-del-norte/costa-rica/guanacaste/nicoya-51230/

- IMN, 2007. *Clima de Costa Rica y Variabilidad Climática*. Instituto Meteorológico Nacional de Costa Rica (In Spanish).
- KII, 1 (2021). Interviews conducted to FSTPs/WWTPs operators: Pedro Rodriguez, Owner of Servicios Sépticos Santa Cruz; Jorge Arias, CEO of CASSA; Heiner Rojas, WWTP Carrillo operator and Jason Chávez, owner of FSTP Liberia.
- LNA, 2021. *Análisis de calidad de agua de mar en Playa Malpaís, Playa Carmen, Playa Santa Teresa y Playa Manzanillo* (In Spanish).
- LNA and BioAnalítica, 2021. *Análisis de calidad de agua superficial de las quebradas Quebradas Danta y Carmen* (In Spanish).
- Madrigal, 2021. SFD Canton de Alajuela. IDB.
- Mora, 2020. *Informe agua para uso y consumo humano y saneamiento en Costa Rica. Instituto Costarricense de Acueductos y Alcantarillados* (In Spanish).
- SNIT, 2017. *Cartografía a escala 1:5000 del Sistema Nacional de Información Territorial de Costa Rica* (In Spanish).

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This Executive Summary and the SFD Report are available from: www.sfd.susana.org

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Abbreviations

ADI	Malpaís-Santa Teresa Integral Development Association
ARESEP	Regulatory Authority of Public Services
ASADAS	Associations of Communal Sewerage Systems
AyA	Costa Rican Institute of Aqueducts and Sewerage
CATUZA	Chamber of Tourism of the Blue Zone
CGR	Comptroller General of the Republic
CRC	Costa Rican Colon
FGDs	Focus Group Discussions
FS	Faecal Sludge
FSTP	Faecal Sludge Treatment Plant
GDP	Gross Domestic Product
GIAR	Wastewater Management Commission
IDB	Inter-American Development Bank
INDER	National Institute for Rural Development
INEC	National Institute of Statistics and Censuses of Costa Rica
IMAS	Institute of Social Aid
JMP	Joint Monitoring Program
KIIs	Key Informant Interviews
LNA	National Water Laboratory
masl	Metres above sea level
MINAE	Ministry of Environment
MINSA	Ministry of Health
MIVAH	Ministry of Housing and Human Settlements
NGO	Non-Governmental Organization
PIAAG	Water Supply Program for Guanacaste - North Pacific
SDG	Sustainable Development Goal
SFD-PI	Shit Flow Diagram Promotion Initiative
SNIT	National System of Territorial Information of Costa Rica
UNICEF	United Nations Children's Fund
$US	American dollar
WHO	World Health Organization
WK	Nicoya Peninsula Waterkeeper
WWTP	Wastewater Treatment Plant

1 City context

1.1 Location

The town of Santa Teresa is located in the extreme southwest of the Nicoya peninsula, in the canton and province of Puntarenas, in the North Pacific Region of Costa Rica, also known as the Chorotega region. Santa Teresa administratively belongs to the Cóbano district, a district with a total area of 317.06 km^2.

Figure 1: (Left) Map of the provinces of Costa Rica with the location of Santa Teresa; (Right) Cóbano district indicating the Santa Teresa territorial area, indicating the towns and some of the beaches located in the study area. Source: (SNIT 2017 and own elaboration).

Santa Teresa is formally only one of the towns[1] of the district, as recognized in the Executive Decree No. 40184-MGP of January 9, 2017, on the "Administrative Territorial Division of the Republic of Costa Rica". But Santa Teresa traditionally comprises the set of towns that extend linearly along the 15 km of the Pacific coast of Cóbano, limiting to the north with the province of Guanacaste and to the south with the Cabo Blanco Absolute Natural Reserve. Santa Teresa, understood as a linear coastal town, incorporates the towns of Bello Horizonte, Santiago, Hermosa, Santa Teresa, Carmen and Malpaís, in addition to the inhabited places of Playa Manzanillo, Playa Hermosa, Playa Santa Teresa, Playa Carmen and Playa Malpaís (Figure 1). A close-up of the area is also provided in Figure 3.

1.2 Main physical and geographical characteristics

The Cóbano district limits to the north with the Paquera and Lepanto districts of Puntarenas, to the South with the Pacific Ocean, to the east with the Pacific Ocean and Paquera, and to the West with the Pacific Ocean and the canton of Nandayure, Guanacaste. The territory is located between 0 and 300 metres above sea level (masl). The Cóbano plateau is an undulating surface with slopes of less than 60%, where the Pánica and Arío rivers have shaped its configuration. In the specific case of this system, due to the predominant type of soil and

[1]Definition of town according to Costa Rican regulations: "*conglomerate of dwellings within a rural environment, with the presence of buildings that provide basic services such as: health, education, recreation and some economic activities related to the primary and tertiary sector*. " (Administrative Territorial Division of the Republic of Costa Rica).

the agricultural practices carried out, it has suffered considerable erosion. The areas of high elevation and steep slopes are mostly home to fairly dense forested areas, many under protection regimes due to the importance of the ecosystem services they provide to the territory and to the country in general (CMDC, 2020).

The study area is located between two important terrestrial protected areas: the Cabo Blanco Absolute Natural Reserve and the Caletas-Arío National Wildlife Refuge, as well as in the Cabo Blanco Marine Management Area.

1.3 Topography

The soils of the district are alfisol type and present different characteristics according to the area (Figure 2). In the area between the central plateau and the low zone near the sea, there are superficial soils characterized by their steep topography, with a medium to moderately fine texture, with dark brown and brown dark yellowish colours, in addition to an excessive drainage, moderate permeability and low fertility. Moreover, they have abundant stones and the erosion is light to moderate. Due to these characteristics, the most convenient use of these soils is forestry, conservation of existing flora and fauna, ecotourism and scientific research (CMDC, 2020).

In the area near the sea, the soils are characterized by their moderately fine textures. They are moderately deep with dark brown to dark reddish colours, well drained, permeable and have medium fertility with low erosion (CMDC, 2020).

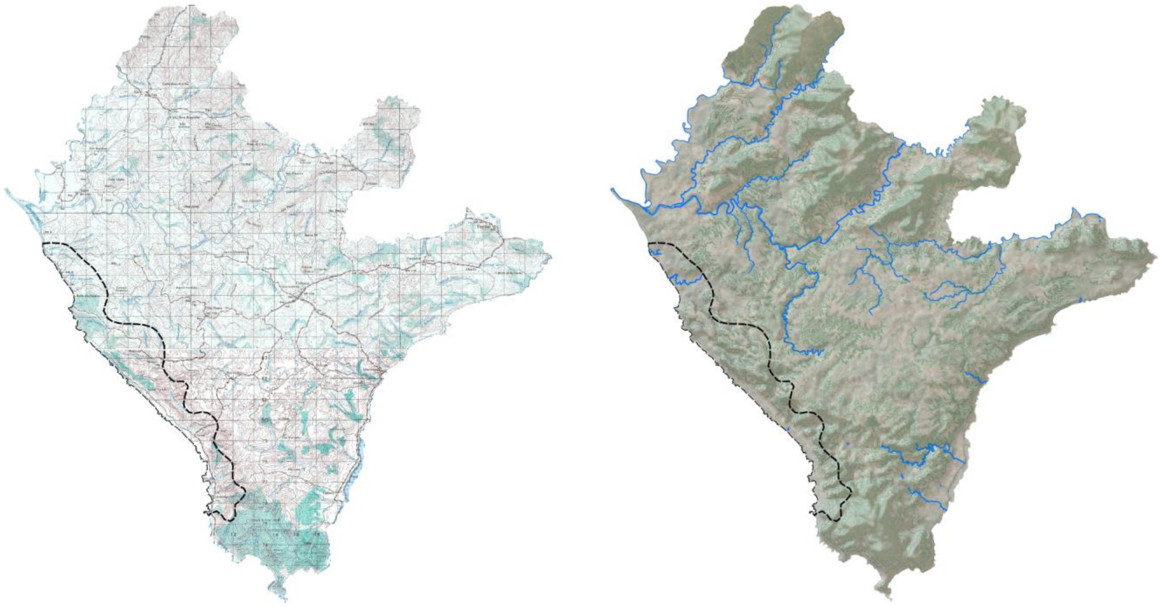

Figure 2: (Left) Cóbano district scale sheet (1:50000) from the SNIT indicating the Santa Teresa area; (Right) Orography and main hydrography of the Cóbano district indicating the Santa Teresa area. Source: SNIT and own elaboration.

1.4 Climate

The North Pacific region is the warmest area in the country and the one with the lowest rainfall. The climate in the Cóbano district is tropical, between dry and humid and, to a great extent, it is determined by the arrival of the trade winds from northwest directions, coming from the Atlantic Ocean and the west-equatorial winds from the Pacific Ocean. The dry season or summer extends from the end of October to the beginning of May. During this season, trade winds blow and prevent the entry of moisture from the Pacific (IMN, 2007; CMDC, 2020).

1.5 Temperature

The district's average annual temperature is 27 °C in areas with altitudes below 150 masl (most of the studied area is below 150 masl). The highest temperatures occur in the months of March and April, with averages of 28.5 ºC and the lowest in September and October (CMDC, 2020).

1.6 Precipitation regime

The entire Nicoya peninsula is located within a dry tropical climate zone, with less water resources than the country's average. Average annual precipitation in the Nicoya peninsula is 2,007 mm. During the dry season, there is practically no precipitation (IMN, 2007; CD, 2021).

1.7 Demography

According to the 2011 Census, the Cóbano district has a resident population of 7,494 inhabitants and 3,158 dwellings, of which approximately three-quarters (2,364) are inhabited (INEC, 2011). However, the floating population[2] should be added to the official population data, very relevant in the district due to the large tourist influx to Santa Teresa and other coastal areas, which occupies part of the 794 vacant dwellings (INEC, 2011), the 44 hotels and 59 rental houses of the area (IDB and WK, 2021b).

For this report, using a methodology to combine data from different sources, it has been estimated that there is a resident population in Santa Teresa of 3,099 people and a floating population of 3,575 people. There is also a total of 897 dwellings, of which 671 are inhabited by resident population.

The data used for these estimates are from 2005, 2011 and 2015, depending on the source, so it is expected that the current figure will be higher than the estimates (Figure 3). The methodology used to estimate the population and the number of dwellings is included in Appendix 2.

[2] For the purposes of this report, floating population is understood to be the estimate of people who, not being permanent residents of Santa Teresa, have a residence here where they spend a few days a year or spend a certain period of time for reasons such as holidays, work, academic or other.

Figure 3: Map of Santa Teresa with the dwellings and public areas of the cartography (1: 5000). Source: SNIT and own elaboration.

1.8 Economy

The economy of Santa Teresa is focused almost entirely on tourism and the economic activities derived from it. The kilometres of highly beautiful beaches located in the area of this study and the surrounding natural environment are elements that promote national and international tourism, with an offer that includes 44 hotels, 59 tourist rental houses and 49 restaurants in the Santa Teresa area. The tourist packages include water sports, adventure, nature, and hiking activities, among others. Another great attraction of Santa Teresa is the Cabo Blanco Absolute Natural Reserve, located in the south of the Nicoya peninsula, a protected park of important biodiversity with several trails for tourist visits.

2 Service Outcomes

Tourism in Costa Rica represents one of the largest sources of income in the country (6.3% of Gross Domestic Product (GDP) in 2016), which takes place mainly in coastal areas (ICT, 2017). Therefore, the protection and conservation of this natural heritage is essential. However, the management of sewage and faecal sludge in coastal areas has been historically inadequate, leading to at least five beaches not suitable for bathing and twenty-seven being reported in the country at sanitary risk due to raw sewage discharges (PEN, 2015). Moreover, in a more recent study, González-Fernández et al., (2021) found faecal microorganisms due to sewage contamination in more than 89% of ocean samples from a tropical beach located in Costa Rican coastal waters.

Scope of the study

The town of Santa Teresa was selected for this study due to this problem of raw sewage discharges, high tourist potential, medium level of development and high coverage of individual sanitation solutions. Santa Teresa, understood as a linear coastal town, incorporates the towns of Bello Horizonte, Santiago, Hermosa, Santa Teresa, Carmen and Malpaís, in addition to the inhabited places of Playa Manzanillo, Playa Hermosa, Playa Santa Teresa, Playa Carmen and Playa Malpaís. These towns were selected to improve the understanding of the sanitation situation in these areas, being a first step to identify viable solutions that can be replicated in other areas of the country to help reduce contamination by untreated wastewater and faecal sludge.

Based on this, the Inter-American Development Bank (IDB), together with the local Non-Governmental Organization (NGO) Nicoya Peninsula Waterkeeper (WK) and a team of independent consultants, carried out a study during the first months of 2021 that consisted of three parts: i) a household survey to know the population's access to water, sanitation and hygiene (IDB and WK, 2021a), ii) a tourist places survey (restaurants, hotels, hostels and rental houses) to know the access to water, sanitation and hygiene of the tourist population (IDB and WK, 2021b) and iii) a survey conducted to service providers (faecal sludge emptying companies) registered by the Ministry of Health that operate in the area (IDB and WK, 2021c).

The three surveys were conducted in field by the NGO Nicoya Peninsula Waterkeeper, supported by the Inter-American Development Bank (IDB) and the team of independent consultants who provided support in their design and implementation using the free software tool *KoBoToolbox*. The two main design criteria of the surveys were that they would allow the elaboration of an SFD graphic following the SFD Promotion Initiative (SFD-PI) methodology, as well as the construction of the service ladders proposed by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) Joint Monitoring Program (JMP) to monitor Sustainable Development Goal (SDG) number 6 on water, sanitation and hygiene.

The surveys included questions on the use of drinking water sources, location of the sanitation systems in use, the volume of faecal sludge generated, collected, and delivered to treatment, as well as information on the emptying of onsite systems, the fees charged, the equipment and maintenance of the vacuum trucks, among many others. Appendices 2 and 3 present a summary of the design of the three surveys, as well as some of the questions.

The total number of households in the study area is 897 and the total number of tourist places is 150 (see Appendix 2 for more information). To ensure that statistically significant information is gathered through the surveys, a total of 306 household surveys were conducted (Table 1). In the case of tourist places, all 150 tourist places in the study area were surveyed because it was a relatively small number, and some budget of the study was allocated to carry out all 150 surveys.

Table 1: Statistical summary of the household survey.

Town	Total Households	Inhabited Households	# Surveys carried out	Valid surveys	Representativity (valid surveys over the total inhabited households)
Santa Teresa (Includes all locations indicated in section 1.1)	897	671	306	301	44.86%

Source: Topological analysis carried out from the information on dwellings from the official national cartography (INEC, 2011). See Appendix 2 for more information.

The data collected through the surveys were triangulated with other sources such as reports, papers, information from stakeholders such as service providers and local authorities, field visits, Key Informant Interviews (KIIs) with Faecal Sludge Treatment Plant (FSTP) and Wastewater treatment Plant (WWTP) operators, masons and engineering consultants in the area.

2.1 Overview and study area

Costa Rica context

According to the *Política Nacional de Saneamiento en Aguas Residuales* (2016), in Costa Rica, 76.42% of the wastewater generated is treated through septic tanks, followed by a 21.43% discharged into the sanitary sewerage and the remaining 2.15% is captured by pit latrines and to a lesser extent, open defecation. Of the wastewater collected by the sanitary sewer system, only 14.4% is treated (AyA, 2016). In the Chorotega region, the use of the septic tanks is 91%, being the region with the highest coverage of septic tanks, being also the second region with the lowest percentage of population covered by sanitary sewers: only 6% of the households (Ballestero, 2019).

There are areas of the North Pacific where the water table is very high (mainly in the coastal areas), so the septic tanks do not work properly. Although the excreta are separated, there is no good drainage, creating a potential risk of contamination of surface waters and underground aquifers (Ballestero, 2019). According to interviews conducted to masons and engineering consultants in the area (KII 2, 2021), they all agree that the water table in the coastal area in Santa Teresa is less than 2 metres below the land surface.

The region still has 45% of rural population and wastewater collection systems such as sewerage networks are not viable due to the high-associated costs and for technical reasons. Therefore, onsite sanitation systems (like septic tanks) will continue to prevail in the area but requiring a behavioural change when managing these systems. In the region, and in the country in general, septic tanks are not designed and built following technical standards despite the existence of guidelines like the *Código de Instalaciones Hidráulicas y Sanitarias en Edificaciones.* In addition, septic tanks are not given the required annual maintenance since there is a wide lack of knowledge about the proper maintenance of the systems and a lack of monitoring from the authorities (Ballestero, 2019).

Regarding septic tanks, mechanical emptying predominates in the country. Despite this, it is not well known how many septic tanks are emptied or their frequency of emptying. Therefore, it is not possible to determine the status of these septic tanks, the frequency of emptying and the correct disposal of the faecal sludge. This is also mainly due to a lack of accountability of faecal sludge collectors, a sector with many informal service providers that do not bring the sludge to a FSTP. Moreover, there is no guideline for users of septic tanks, or any control mechanisms set by the government in terms of the frequency of emptying, so this frequency may vary depending on the capacity of the septic tank, its condition (the presence of cracks or if it is well built) and the knowledge of users regarding its maintenance (Madrigal, 2021).

<u>*Santa Teresa context*</u>

The Cóbano district, particularly the study area, is a tourist and coastal area. The 306 and 150 sampling points of the household and tourist places surveys in the study area are shown in Figure 4 (IDB and WK, 2021a; IDB and WK, 2021b).

Figure 4: (Left) Household sampling points in the study area; (Right) Points of tourist places in the study area (in white, residential rental houses; in yellow, restaurants; in blue, hotels and hostels). Source: own elaboration.

In the study area, there is no sewage system. All population is served by onsite sanitation systems, especially some type of tank (septic or with impermeable walls and open bottom), pit latrines in a few households and privately-owned WWTPs in some tourist places (IDB and WK, 2021a; IDB and WK, 2021b).

2.1.1 Generation/Containment

Off-site sanitation: According to survey data (see Appendix 2 for the population and housing estimation methodology), 10.4% of the population has its own WWTP to treat the wastewater generated. Most of this percentage corresponds to tourist places, being only 1% in case of households. In addition, 0.5% of the population use toilets connected to 'don't know where', considered as an off-site system by the SFD-PI methodology (IDB and WK, 2021a; IDB and WK, 2021b).

Onsite sanitation: The percentage of people who use onsite sanitation systems in the study area is around 88.6% according to the household and tourist places surveys carried out for the preparation of this report. Of that 88.6%, 87.6% have some type of tank and 1.0% of the population rely on latrines (IDB and WK, 2021a; IDB and WK, 2021b).

2.1.2 Emptying

Onsite sanitation:

According to interviews with masons and engineering consultants (KII 2, 2021), two types of prefabricated septic tanks are built in the study area: those made of concrete pipes known as *alcantarilla* (material made for storm sewers) and plastic ones. However, the *alcantarilla* ones are more frequently used. The practice of not sealing the tank at the bottom is common since it is considered that this helps to drain the water or even favours the sedimentation of the faecal sludge. Other people seal these tanks at the bottom with a layer of concrete, however this practice is not considered reliable because of the difficulty of checking if the tank is really sealed. It is common to use one, two or even three *alcantarillas* one above the other to give the tank more volume so it takes more time to fill up. There are also people who build custom septic tanks using concrete blocks, or even purchasing plastic septic tanks.

Most builders and masons do not use any code or regulations to make engineering calculations to build the tanks, and it is common for them to generically calculate the size of the septic tank depending on the number of *alcantarillas* they use, doing something similar with the dimensions of soak pits (KII 2, 2021).

Regarding the management of greywater, it is common practice to discharge it directly into a drain and not into the septic tank, contrary to what is indicated by national legislation (KII 2, 2021).

The materials used in the soak pits are stones and geotextile at the bottom. There are also people who use plastics or tires in the soak pits. It is not common to receive visits from an institution at the time of the installation of the systems, unless there is a health order issued by the Ministry of Health to mitigate potential contamination issues. In these cases, the works are monitored more closely (KII 2, 2021).

The percentage of households that report that their onsite sanitation system has been emptied varies between 30% and 37% in septic tanks and in lined tanks with open bottom, respectively. In the case of tourist places, these percentages are 44% and 36%, respectively. Regarding latrines, none have been emptied (IDB and WK, 2021a; IDB and WK, 2021b).

The frequency of emptying the tanks, both septic and open-bottom, is similar in households and in tourist places, with an average of 1.7 years in households and 1.4 years in tourist places. The average tank volumes are 1,9 m^3 in the case of households and 3.0 m^3 in the case of tourist places (IDB and WK, 2021a; IDB and WK, 2021b).

There are around 15 private companies that enter the area to provide with emptying services. However, only five of them were found to do it with a permission issued by the Ministry of Health (IDB and WK, 2021c). None of these five companies are based in the area, but come from other areas, travelling long distances to collect the faecal sludge. They all provide emptying services of septic tanks, grease traps and wastewater treatment plants in households, hotels, hostels, restaurants, and rental houses. All have a permission issued from the Ministry of Health to carry out the activity, provide an invoice and/or certificate of sludge treatment if the client requests it, and provide service to other cantons 5 to 7 days a week (IDB and WK, 2021c).

The fleet of vehicles is highly variable: from 1 to 9 per company. The age of the fleet is also variable, but most are over 15 years old, being all owned by the companies. The maintenance cost of the vacuum trucks varies from CRC 1,000,000 (US$ 1,622) to CRC 3,000,000 (US$ 4,868) per year. All vacuum trucks are equipped with a pump with a capacity ranging from 6.5 to 10 HP. The capacity of the vacuum trucks is also variable: it varies from 12m^3 to 40m^3, with the average being 20m^3 (IDB and WK, 2021c). Figure 5 shows a vacuum truck equipped with a suction hose from a private company operating in the area.

Figure 5: (Left) Vacuum truck equipped with a suction hose from a private company that operates in the area. (Right) Same truck emptying a tank. Source: (Sanitarios La Pampa, 2021).

Tanks emptied in households are mostly located behind the house, and vacuum trucks typically take between 10 and 45 minutes to empty the tanks. The average volume of faecal sludge transported per trip is 11m^3 (IDB and WK, 2021c). Two of these five companies provide sanitary protection to workers when emptying, one does not provide it, and two did not answer the question when the survey was conducted (IDB and WK, 2021c).

According to these companies, the emptying fee varies from CRC 12,000/m^3 (US$ 19/m^3) to CRC 75,000/m^3 (US$ 121/m^3), depending on the company. The average is CRC 46,250/m^3 (US$ 75/m^3) (IDB and WK, 2021c). According to the household survey (IDB and WK, 2021a), the average fee of emptying the tanks, which have an average volume of 1.9 m^3, is CRC 121,441 (US$ 198). The average fee of emptying the tanks in the tourist places (IDB and WK, 2021b), which have an average volume of 3.0 m^3, is CRC 159,234 (US$ 258). Although the values do not match exactly, they are quite similar, confirming the importance of data triangulation from different sources in this type of studies.

Regarding the difficulties that companies encounter in carrying out their activity, they stated that the service is expensive due to the location of the area and said that customers find it also expensive and want to pay less for it. As measures of publicizing their business, four companies have a *Facebook* page. Some also use *WhatsApp* and business cards (IDB and WK, 2021c). Figure 6 shows an example of one of these companies.

Figure 6: Example of a company authorized by the Ministry of Health to provide with emptying services in the study area: Sanitarios La Pampa. Website: https://www.facebook.com/sanitAríoslapampa/ (Reproduction made with permission of the company itself). Source: (Sanitarios La Pampa, 2021).

Apart from these five registered companies, the emptying of onsite systems is also carried out by informal companies/individuals, not registered or authorized by the Ministry of Health. This way of emptying can be both mechanical, in a way similar to that described above, or manual, the latter form being carried out mainly by individuals who contact households or tourist places directly to carry out the service. An attempt was made to contact some of these companies/individuals to inquire about the service they provide, but all of them refused to participate in this study.

13% of the households reported having seen emptying companies or individuals with a vacuum truck discharging faecal sludge into rivers, beaches and the ground directly without treatment. In addition, 75% of the households surveyed think that there is an incorrect management of wastewater in the area (IDB and WK, 2021a). Therefore, the total percentage of faecal sludge emptied, transported and discharged untreated into the environment may have been underestimated and be greater than the reflected in the SFD graphic (see section 2.1.5 for further details).

2.1.3 Transport

Faecal sludge transport:

The service providers that were interviewed reported to deliver the emptied faecal sludge to the cantons of Carillo, Liberia or Santa Cruz in the province of Guanacaste or to the canton of the province of Alajuela, travelling an average of 204 km (this distance varies between 160-270 km). This reflects the complexity of the work completed by the service providers in the area, also explaining the high costs of the service they provide. These service providers make a certain number of trips to the area, varying between less than once and three times a month, with once a month being the most frequent number. In addition, they usually spend a day, or two days at most, in the area emptying the faecal sludge from tanks of households and tourist places (IDB and WK, 2021c).

However, there may be cases of companies that are formally authorized to transport the faecal sludge but do not ultimately dispose of the faecal sludge they collect in a FSTP. In the case of manual emptiers and company/individuals not authorized to operate by the Ministry of Health, faecal sludge is usually dumped untreated into streams (called *quebradas*), rivers or directly onto the ground (IDB and WK, 2021a; IDB and WK, 2021b; IDB and WK, 2021c).

2.1.4 Treatment and end use/disposal

Wastewater treatment: In households and tourist places that have their own WWTP, the treatment consists of an aerobic treatment, usually an activated sludge or a fixed-bed type. The variation in the treatment systems depends on the company who builds the WWTP since different substrates such as films or plastic cells are used in the aeration tanks. This type of WWTPs are usually semi-buried and the treated wastewater is reused for gardening (IDB and WK, 2021a). Additionally, artificial wetlands or "bio-gardens" are also built to treat greywater. These artificial wetlands are located in places where sewage is treated separately in WWTPs or only with septic tanks. Figure 7 shows an example of this type of WWTP and an example of an artificial wetland in a hotel in the area.

Figure 7: Privately-owned WWTP to treat wastewater and artificial wetland to treat greywater in a hotel in the area. Source: (Kenneth Alfaro Alvarado, 2021).

Faecal sludge treatment: According to the surveys carried out, the faecal sludge collected from all registered companies is delivered to a Faecal Sludge Treatment Plant (FSTP). These FSTPs are located in the central canton of Alajuela or in the cantons of Carrillo, Liberia or Santa Cruz in Guanacaste.

FSTP *Servicios Sépticos Santa Cruz S.A.* (Santa Cruz)

The Santa Cruz Fecal Sludge Treatment Plant (FSTP) is a private plant called *Servicios Sépticos Santa Cruz S.A*. and located in the Santa Cruz canton, Guanacaste Province. The technology used is an aerobic activated sludge system. The FSTP has a capacity of 200 m^3/day, receiving only the faecal sludge collected by this company. Dried sludge or biosolids are disposed of directly into a sanitary landfill. Figure 8 shows two pictures of the unit systems used to treat the faecal sludge at this FSTP.

Figure 8: FSTP *Servicios Sépticos Santa Cruz S.A*. (Santa Cruz). Source: (Servicios Sépticos Santa Cruz S.A, 2021).

FSTP *Compañía de Aguas Sanitarias* (Coyol, Alajuela)

The FSTP located in Coyol, in the province of Alajuela, is a private plant called *Compañía de Aguas Sanitarias (CASSA)*. It is an activated sludge treatment plant with a capacity to treat 300 m^3/day of faecal sludge, receiving faecal sludge from all over the country. The dried sludge or biosolids are also disposed of directly to the sanitary landfill. Figure 9 shows two pictures of the unit systems used to treat the faecal sludge at this FSTP.

Figure 9: FSTP *Compañía de Aguas Sanitarias* (Coyol). Source: (Diana Madrigal, 2019).

FSTP *ARCA S.A.* (Liberia)

The FSTP located in Liberia, Guanacaste province, corresponds to a private plant called *ARCA S.A*. The technology used is a facultative anaerobic lagoon system. The FSTP has a capacity of 64 m^3/day, receiving faecal sludge from private trucks. Dried sludge or biosolids are used as a soil conditioner in agriculture.

WWTP *Carrillo* (Carillo)

This WWTP located in Carrillo, Guanacaste province, corresponds to a plant of a private condominium, designed to treat ordinary wastewater. Since the condominium is not at its maximum occupancy, they receive faecal sludge from a vacuum truck. The technology used is an activated sludge with recirculation, also equipped with regenerative blowers and drying beds. The WWTP has a capacity of 180-210 m^3/day. The sludge or biosolids are stabilized with lime and are used as a soil conditioner in agriculture. Figure 10 shows three pictures of the unit systems used to treat the faecal sludge at this WWTP.

Figure 10: WWTP *Carrillo* (Carrillo). Source: (Heiner Vega, 2021).

The surveyed service providers stated that the collected faecal sludge is delivered to a FSTP/WWTP where is further treated: in the central canton of the Alajuela province, or the Carrillo, Liberia or Santa Cruz cantons in the Guanacaste province (IDB and WK, 2021c). However, after interviewing the operators of the FSTPs/WWTPs, it was found that only one of the five service providers was actually delivering the faecal sludge to treatment. This clearly shows that even authorized service providers may be managing the disposal of the faecal sludge in an inappropriate way (KII 1, 2021).

Another added problem is the amount of untreated faecal sludge disposed of in the environment from manual emptiers and companies/individuals not authorized to operate by the Ministry of Health. This can have a negative impact on the aquatic ecosystem since contamination by *faecal coliforms* has been reported in several *quebradas*, beaches and rivers in the area (LNA, 2021; LNA and BioAnalítica, 2021). Figure 11 shows two *quebradas* in the area where this contamination has been reported. Additional information of these studies on water quality has been included in Appendix 9.

Figure 11: Streams, called *quebradas,* where contamination by *faecal coliforms* has been reported. (Left): *Quebrada* Carmen; (Right): *Quebrada* Danta. Source: (Kenneth Alfaro Alvarado, 2021).

2.1.5 Data triangulation and validation

An important aspect of the SFD-PI methodology is the data triangulation from all the data sources used in order to reach a final consensus on the value of the variables necessary for the elaboration of the SFD graphic.

In the elaboration of the SFD graphic for Santa Teresa, data obtained in the household and tourist places surveys have been taken as a basis for the input data into the Graphic Generator. These data have been triangulated with data obtained from the service providers surveys, field visits and KIIs to operators of the FSTPs/WWTPs, masons and engineering consultants in the area. The discrepancies found were presented in a '*brain storming*' session and a final validation workshop attended by a total of 20 people from different institutions: representatives of IDB, WK, Ministry of Health, AyA, Municipal Council of Cóbano District, local organizations such as the Santa Teresa-Malpaís Development Association, the Chamber of Tourism of the Blue Zone, the service provider *Servicios Sépticos Santa Cruz* and the US organization Global Water Stewardship. At the end of both sessions, consensus values for all variables were reached and those were the ones finally used in the final SFD graphic.

Estimation of the amount of faecal sludge emptied and delivered to treatment:

According to the household and tourist places surveys, 186 tanks are emptied/year with an average emptying frequency of 1.7 years. This means that 651 m^3/year of faecal sludge are collected, of which 263 m^3/year are delivered to treatment and treated (IDB and WK, 2021a; IDB and WK, 2021b). A more detailed calculation of these values is found in Appendix 4 and Appendix 5.

According to an estimate made, based on the data obtained from the service providers survey, 660 m^3/year of faecal sludge are delivered to treatment and treated (IDB and WK, 2021c) (Appendix 6) and according to the data from the interviews with operators of the FSTPs (Appendix 7), 600 m^3/year of faecal sludge are delivered to treatment and treated (KII 1, 2021).

It can be seen that the amount of faecal sludge delivered to treatment and treated according to the household and tourist places surveys is lower (263 m^3/year) than the amount estimated according to the data from the service providers survey and the interviews with operators of the FSTPs (660 m^3/year and 600 m^3/year, respectively). Some possible reasons of this discrepancy are due to:

i. High percentage of 'don't know' responses in the household survey to questions related to the frequency of emptying the tanks and the amount of faecal sludge delivered to treatment. Around 75% of the people interviewed had no clue about this information.

ii. The use of informal and unregulated services varies between 36% and 64% depending on the type of sanitation system and whether it is a household or a tourist place. This can mean that responses of the users of this service are not entirely representative or reliable. Therefore, the percentage of faecal sludge emptied could be greater than the percentage reported in the surveys.

Given that the data obtained from the interviews with the operators of FSTPs come from their records (they monitor the number of vacuum trucks that arrive at the plants), therefore, the amount of faecal sludge delivered to treatment and treated estimated from their records has been taken as the most representative value. Moreover, this value is similar to that estimated by the service providers survey (600 and 660 m^3/year, respectively).

This implies that around 1,500 m^3/year of faecal sludge would have to be emptied instead of the value of 651 m^3/year reported from the household and tourist places surveys, assuming that the value of variable F4 is 53% and 37% for septic tanks and tanks with an open bottom, obtained according to the procedure shown in Table 2 (section 2.2). This assumption implies that, according to the household and tourist places surveys, around 334 m^3/year and 317 m^3/year of faecal sludge are collected by service providers authorized by the Ministry of Health and by non-regulated services, respectively. This means that around 51% of the emptied faecal sludge is delivered to treatment (the service providers authorized by the Ministry of Health should deliver to treatment the faecal sludge collected despite the fact that only one of the five companies actually do so, as indicated in section 2.1.4).

Therefore, the real values of variable F3 must be higher than those reported in the household and tourist places surveys. The final combined value of variable F3 has to go from 37% (according to the household and tourist places surveys) to 54% (according to the service providers survey and the interviews with operators of the FSTPs/WWTPs) in order to have around 1,500 m^3/year of emptied faecal sludge.

Finally, it should be noted that, due to the existence of an informal and unregulated service for emptying the onsite sanitation systems, an attempt was made to contact some of these companies/individuals to ask them about the service they provide, but all of them refused to participate in this study, as indicated in section 2.1.2. Due to this, the total percentage of faecal sludge emptied, transported and discharged untreated into the environment could not be fully quantified due to the lack of information, and could have been underestimated and be higher than the one finally reflected in the SFD graphic.

2.2 SFD Matrix

The sanitation system selection grid in Santa Teresa, taking into account both the household and tourist places surveys (IDB and WK, 2021a; IDB and WK, 2021b), is shown in Figure 12.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B				T1A1C4	Significant risk of GW pollution Low risk of GW pollution				T1A1C9	Not Applicable
Septic tank					Significant risk of GW pollution T1A2C5				T1A2C9	
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution					
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution T1A4C5				T1A4C9	Significant risk of GW pollution Low risk of GW pollution
Lined pit with semi-permeable walls and open bottom	Not Applicable									Significant risk of GW pollution Low risk of GW pollution
Unlined pit										Significant risk of GW pollution T1A6C10
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution T1B7C10
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										T1B8C10
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable									Not Applicable

Figure 12: Sanitation system selection grid.

To combine both surveys, the resident population in the households of the study area (3,099 inhabitants) has been considered together with the floating population (3,575 inhabitants), adding up to a total of 6,674 inhabitants. More information on how these data have been estimated can be found in Appendix 2. When combining the percentages of each of the variables in one SFD graphic, the weighted average of each variable has been calculated based on the number of inhabitants. For this, each weighting factor has been calculated as follows:

-Households = 3,099/6,674 = 0.464

-Tourist places = 3,575/6,674 = 0.536

Because the populations are very similar, this factor is almost the same, close to 0.5. A summary of the systems and variables of each SFD graphic, as well as the total weighted mean with respect to the population is shown in Table 2.

Table 2: Variables of each SFD graphic, as well as the total mean weighted with respect to the population (IDB and WK, 2021a; IDB and WK, 2021b; IDB and WK, 2021c; KII 2, 2021).

System	% of population			Variable F3+			Variable F4		
	Households	Tourist places	Mean	Households	Tourist places	Mean	Households	Tourist places	Mean
T1A1C4	1%	20%	10.4%	-	-	-	-	-	-
T1A1C9	1%	1%	1.0%	-	-	-	-	-	-
T1A2C5	17%	44%	30.4%	30 (48)	44 (60)	37 (54)	54	52	53
T1A2C9	0%	1%	0,5%	0	77	77*	0	16	16*
T1A4C5	76%	33%	54.7%	37 (48)	36 (60)	37 (54)	41	33	37
T1B7C10	1%	1%	1.0%	-	-	-	-	-	-
T1A4C9	2%	0%	1.0%	0	-	-	-	-	-
T1A6C10	1%	0%	0.5%	0	-	-	-	-	-
T1B8C10	1%	0%	0.5%	-	-	-	-	-	-
Total	**100%**	**100%**	**100%**	-	-	-	-	-	-

* In this case, as this system only exists in tourist places, the mean is not computed.
+In parentheses the final consensus value of variable F3 after triangulating the data as explained in section 2.1.5. This consensus value is the one finally used in the elaboration of the SFD graphic.

Variables W4b (100%), W5b (90%) and F5 (90%) are the same in both surveys for all the systems in which they appear, so no weighted average is required. The SFD matrix for Santa Teresa, taking into account the household and tourist places surveys (IDB and WK, 2021a; IDB and WK, 2021b), is shown in Table 3.

Table 3: SFD matrix.

Santa Teresa, Cóbano District, Costa Rica, 27 Aug 2021. SFD Level: 3 - Comprehensive SFD
Population: 6674
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

Containment						
System type	Population	WW transport	WW treatment	FS emptying	FS transport	FS treatment
	Pop	W4b	W5b	F3	F4	F5
System label and description	Proportion of population using this type of system (p)	Proportion of wastewater in sewer system, which is delivered to decentralised treatment plants	Proportion of wastewater delivered to decentralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C4 Toilet discharges directly to a decentralised foul/separate sewer	10.4	100.0	90.0			
T1A1C9 Toilet discharges directly to 'don't know where'	1.0					
T1A2C5 Septic tank connected to soak pit	30.4			54.0	53.0	90.0
T1A2C9 Septic tank connected to 'don't know where'	0.5			77.0	16.0	90.0
T1A4C5 Lined tank with impermeable walls and open bottom, connected to a soak pit	54.7			54.0	37.0	90.0
T1A4C9 Lined tank with impermeable walls and open bottom, connected to 'don't know where'	1.0			0.0	0.0	0.0
T1A6C10 Unlined pit, no outlet or overflow	0.5			0.0	0.0	0.0
T1B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow	1.0					
T1B8C10 Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil, no outlet or overflow	0.5					

2.2.1 Description of sanitation systems

According to the results obtained in the surveys carried out (IDB and WK, 2021a; IDB and WK, 2021b), the sanitation systems in use in the study area, as well as their equivalence with the SFD-PI methodology, are shown in Table 4.

Table 4: Sanitation technologies and their equivalence with the SFD-PI methodology, including the percentage of the population that uses each technology and the risk of groundwater contamination.

Sanitation system	Where is it connected to?	Risk of groundwater contamination	SFD reference variable	SFD variable description	% of population
Pour-flush toilet	*Privately-owned WWTP*	-	*T1A1C4*	*Toilet discharges directly to a decentralised foul/separate sewer*	10.4%
Pour-flush toilet	*'don't know where'*	-	*T1A1C9*	*Toilet discharges directly to 'don't know where'*	1.0%
Pour-flush toilet	*Septic tank*	Low	*T1A2C5*	*Septic tank connected to soak pit*	30.4%
Pour-flush toilet	*Septic tank + 'don't know where'*	Low	*T1A2C9*	*Septic tank connected to 'don't know where'*	0.5%
Pour-flush toilet	*Septic tank (open bottom)*	Low	*T1A4C5*	*Lined tank with impermeable walls and open bottom, connected to a soak pit*	54.7%
Pour-flush toilet	*Septic tank (open bottom)+ 'don't know where'*	Low	*T1A4C9*	*Lined tank with impermeable walls and open bottom, connected to 'don't know where'*	1.0%
Cesspit	-	Low	*T1A6C10*	*Unlined pit, no outlet or overflow*	0.5%
Pour-flush toilet	*Tank was abandoned when full, sealed and another one was built*	Low	*T1B7C10*	*Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow*	1.0%
Pour-flush toilet	*Tank was abandoned when full, was not sealed and another one was built*	-	*T1B8C10*	*Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil, no outlet or overflow*	0.5%
TOTAL	-	-	-	-	**100%**

Figure 13 shows two examples of lined tanks with open bottom connected to a soak pit (system T1A4C5) and two examples of septic tanks connected to a soak pit (system T1A2C5), both in households and in tourist places.

Figure 13: Above: Example of the soak pit of a lined tank with open bottom from a tourist place (left) and a household (right). Bottom: Example of a soak pit of a septic tank from a tourist place (left) and a household (right). Source: (IDB and WK, 2021a; IDB and WK, 2021b).

2.2.2 Groundwater risk contamination

Drinking water supply in the area:

All the households and tourist places in Santa Teresa have water service, a service that in 99.34% of the households is located inside the household (IDB and WK, 2021a). The main potable water supply service in Santa Teresa is provided by the Arío - Santa Teresa - Malpaís Integral Aqueduct, operated by the AyA. This infrastructure captures water (up to a maximum potential of 59l/s) in several wells drilled in the community of Bajos de Arío, located in the north of the district. From there, a pipeline of approximately 25 km runs through the communities of Manzanillo, Bello Horizonte, Playa Hermosa, Santa Teresa, Playa Carmen and Malpaís. The aqueduct has a chlorination disinfection plant and two storage tanks along the network (PIAAG, 2015).

Figure 14: Arío - Santa Teresa - Malpaís Integral Aqueduct; (Above) Field of wells drilled in Bajos de Arío; (Below) Aqueduct deposits, located in Villalta and Santiago. Source: (AyA and PIIAG, 2015).

55.81% of households and 73.33% of tourist places are connected to this aqueduct (Figure 14, Figure 15).

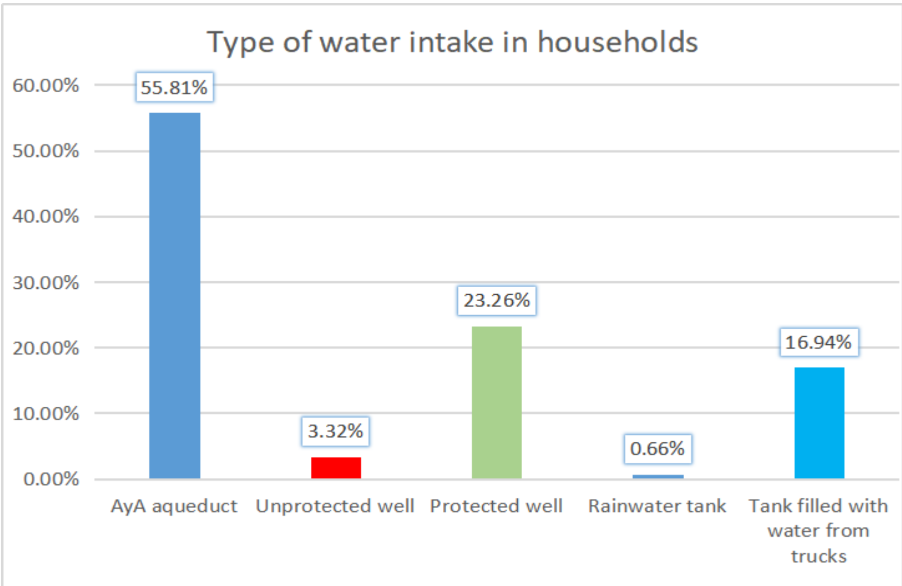

Figure 15: Distribution of water supply solutions according to the type of water intake in Santa Teresa households (IDB and WK, 2021a).

16.94% of households use their own tanks in their homes. These tanks are periodically filled with treated water supplied by trucks (Figure 16), a solution used by 4.67% of tourist places (IDB and WK, 2021a; IDB and WK, 2021b).

Figure 16: (Left) Example of a well drilled for domestic water supply; (Centre) Example of a water tank filled by trucks; (Right) Water delivery truck in Santa Teresa. Source: (Kenneth Alfaro Alvarado, 2021).

Selection of level of risk of groundwater contamination for onsite sanitation systems:

There is only around 3% of households that use unprotected wells. Of this 3%, 30% use an unprotected well with a minimum depth of 10m, reaching up to 20m in some cases, and 40% use bottled water for human consumption. That is, 70% of that 3% use water sources that can be considered protected for human consumption, leaving 30%, i.e., 0.9% of households that could be at potential risk. However, these households did not report on their drinking water source. As it is a percentage less than 1% and, without additional data to prove this potential risk (analysis of the water quality of these non-protected wells, any data/study that could have identified some type of health problem in those households, etc.), it has been considered that 100% of the households use protected water sources.

Therefore, for the purposes of making the SFD graphic, it has been considered that all onsite sanitation systems are located in areas with low risk of groundwater contamination.

2.2.3 Emptying, transport and treatment

Assumptions for off-site systems:

- ✔ 1% of the population has toilets connected to 'don't know where' (system T1A1C9), considered as an off-site system by the SFD-PI methodology.

- ✔ 10.4% of the population has its own WWTP (system T1A1C4). Being a privately-owned system located inside the household/tourist place premises, it has been assumed that the percentage of wastewater that is delivered to treatment is 100% (variable W4b = 100%) with a treatment efficiency of 90% (variable W5b = 90%) .

Assumptions for onsite systems:

- ✔ 88.6% of the population depends on toilets connected to a septic tank or latrine.
- ✔ The proportion of Faecal Sludge (FS) in septic tanks, fully lined tanks and lined tanks with open bottom/all types of pits is considered 100%, as per the guidance given in the Frequently Asked Questions (FAQs) in the Sustainable Sanitation Alliance (SuSanA) website.
- ✔ It has been assumed a treatment efficiency of 90% for all the FSTPs/WWTPs where faecal sludge is being delivered for treatment. Therefore, variable F5 for all onsite systems has been set to 90%.

Septic tanks and tanks with open bottom

- ✔ According to the household survey (IDB and WK, 2021a), regarding septic tanks (T1A2C5) and tanks with an open bottom (T1A4C5), 34% and 41% have been emptied, respectively. Therefore, also assuming an emptying efficiency of 90%, the variable F3 has been calculated as F3 = 34% * 0.9 = 30% for septic tanks and F3 = 41% * 0.9 = 37% for tanks with open bottom. After triangulating these values with the service providers survey and the interviews with the operators of the FSTPs/WWTPs, a consensus value for variable F3 was reached, setting it to 48% for both systems. In addition, 54% and 41% of the faecal sludge collected from septic tanks and tanks with open bottom is delivered to treatment, respectively (variable F4 = 54% and 41%, respectively).
- ✔ According to the survey of tourist places (IDB and WK, 2021b), regarding septic tanks (T1A2C5) and tanks with an open bottom (T1A4C5), 48% and 40% have been emptied, respectively. Therefore, also assuming an emptying efficiency of 90%, variable F3 has been calculated as F3 = 48% * 0.9 = 44% for septic tanks and F3 = 40% * 0.9 = 36% for tanks with open bottom. After triangulating these values with the service providers survey and the interviews with the operators of the FSTPs/WWTPs, a consensus value for variable F3 was reached, setting it to 60% for both systems. In addition, 52% and 33% of the faecal sludge collected from septic tanks and tanks with open bottom is delivered to treatment, respectively (variable F4 = 52% and 33%, respectively).
- ✔ The final weighted value of variable F3 is 54% for septic tanks (T1A2C5) and 54% for tanks with open bottom (T1A4C5).
- ✔ The final weighted value of variable F4 is 53% for septic tanks (T1A2C5) and 37% for tanks with open bottom (T1A4C5).

Septic tanks connected to 'don't know where'

- ✔ 0.5% of the population uses these systems (T1A2C9), but only in tourist places. According to the survey of tourist places (IDB and WK, 2021b), 85% have been emptied. Therefore, also assuming an emptying efficiency of 90%, variable F3 has been calculated as F3 = 85% * 0.9 = 77%. However, only 16% of the emptied faecal sludge is delivered to treatment (variable F4 = 16%).

Other systems

- ✔ 0.5% of the population uses latrines (T1A6C10) but no emptying has been reported (IDB and WK, 2021a). Therefore, variables F3, F4 and F5 for this system are considered equal to 0%.
- ✔ 1% of the population abandoned their tanks when they were filled, sealed them and built another one (T1B7C10).
- ✔ 0.5% of the population abandoned their tanks when they were full, they did not seal them and built another (T1B8C10).
- ✔ 1% of the population use a tank with open bottom connected to 'don't know where' (T1A4C9) but no emptying has been reported (IDB and WK, 2021a). Therefore, variables F3, F4 and F5 for this system are considered equal to 0%.
- ✔ No open defecation practices have been observed or reported, so it can be considered a zone free of this practice (IDB and WK, 2021a; IDB and WK, 2021b).

2.2.4 Credibility of data

The preparation of this SFD report is based on three surveys (household, tourist places and emptying companies) carried out by the NGO Nicoya Peninsula Waterkeeper in collaboration with the IDB and a team of independent consultants in 2021, on reports prepared by the entities responsible for water and sanitation management in the area, as well as the triangulation of data through field visits and KIIs to FSTP/sWWTPs operators, masons and engineering consultants.

In the preparation of this SFD report of Santa Teresa, no Focus Group Discussions (FGDs) were held. All the pertinent and necessary information for the preparation of the report and the SFD graphic was obtained from the rest of the sources: three surveys to households, tourist places and service providers, one field visit, 10 KIIs to operators of the FSTPs/WWTPs, masons and engineering consultants in the area, and complemented by references that included documents, studies and reports on the state of the access to water and sanitation in the country and in the study area.

The greatest source of uncertainty is the estimate of the amount of faecal sludge collected due to the existence of an informal and unregulated service for emptying the onsite systems. None of the companies/individuals that provide this service agreed to participate in this study, as indicated in sections 2.1.2 and 2.1.5. This means that the total percentage of sludge emptied, transported and discharged untreated into the environment has not been fully quantified due to lack of information. Thus, this percentage may have been underestimated and be higher than the one finally reflected in the SFD graphic.

The '*SFD Source Evaluation Tool*' has been used to score the credibility of the 20 data sources consulted. The score obtained has been: 18 sources with high credibility and 2 sources with medium credibility.

2.3 SFD Graphic

Figure 17 shows the SFD graphic for the study area where 68% of the excreta generated are safely managed while 32% of the excreta generated are unsafely managed. Two disaggregated SFD Graphics were developed (one for households and one for tourist places) and are presented in Appendices 4 and 5. The outcome of both graphics were quite similar to each other and to the one presented below.

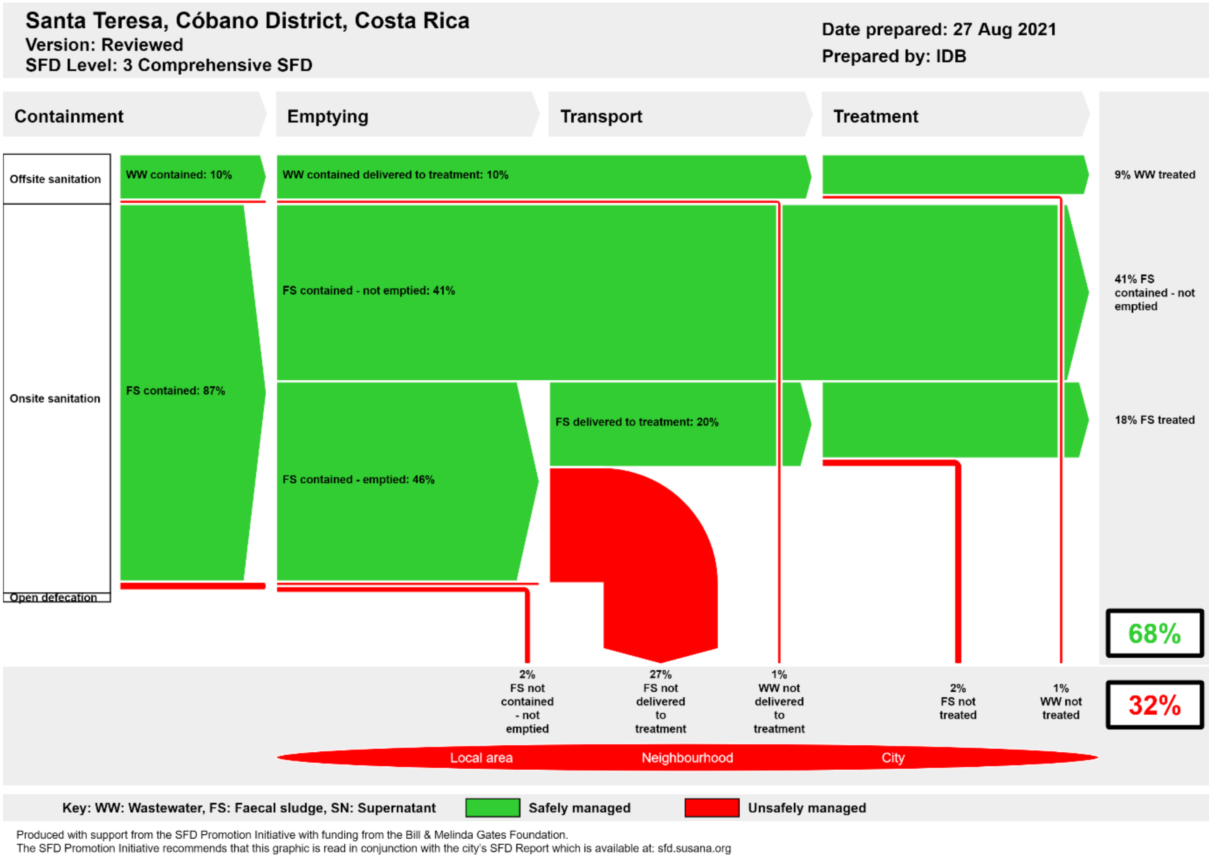

Figure 17: SFD Graphic.

32% of the unsafely managed excreta originate from: wastewater delivered to treatment but not treated (1%) due to the 90% treatment efficiency assumed; wastewater not delivered to treatment due to toilets connected to "don't know where" (1%); FS delivered to treatment but not treated (2%); FS emptied but not delivered to treatment (27%) and FS not contained - not emptied (2%).

68% of the safely managed excreta originate from: wastewater delivered to treatment and treated in privately-owned WWTPs (9%); FS contained - not emptied from onsite systems such as septic tanks, tanks with open bottom and pits (41%) and FS form those onsite systems delivered to treatment and treated (18%).

It is noteworthy that most of the safely managed faecal sludge (41%) comes from septic tanks, lined tanks with impermeable walls and open bottom and latrines which are not emptied or abandoned when they fill up. This FS is considered as contained since these systems are located in places with a low risk of groundwater contamination (section 2.2.2).

However, it is important to highlight several aspects:

- There are companies and/or individuals, in addition to manual emptiers, that are not authorized by the Ministry of Health but operate in the study area carrying out emptying services. Therefore, the percentage of faecal sludge contained - emptied may have been underestimated.
- Systems such as tanks and pits will require emptying services in a short to medium term as they fill up. Therefore, it is necessary to implement a faecal sludge management plan in Santa Teresa to meet this future demand for emptying services.
- Although the SFD-PI methodology takes into account the contamination of groundwater only if these waters are going to be used for human consumption, it should also be noted that 5% of households reported that the water table was reached when their tanks were built (83% reported that they did not know this fact and 12% that it was not reached), while this percentage rises to 13% in the case of tourist places (87% reported that they did not know this fact). Therefore, according to the SFD-PI methodology there is no risk of groundwater contamination since drinking water sources are protected from contamination (section 2.2.2) but these onsite systems could be contaminating groundwater by infiltrations into the subsoil of organic matter, mineral salts (e.g. nitrates), non-biodegradable compounds, as well as viruses and faecal microorganisms (f*aecal coliforms*, etc.).
- This potential source of environmental contamination justifies a subsequent study to evaluate the groundwater contamination in the area, as well as in the surrounding coastal waters. This potential contamination could be affecting the aquifers and influencing the quality of the bathing waters in the area, with the consequent potential risk to people in addition to a potential economic impact. This is especially critical in the study area, due to its important natural richness and the importance of tourist resources, which include all the coastal areas located in Santa Teresa, such as the beaches of Manzanillo, Hermosa, Santa Teresa, Carmen and Malpaís, and even the Cabo Blanco Absolute Natural Reserve in the Playa Suecos sector.

3 Service delivery context

3.1 Policy, legislation and regulation

Costa Rica has a robust and internationally recognized environmental framework. The 2016 National Wastewater Sanitation Policy (*Política Nacional de Saneamiento en Aguas Residuales*) regulates sanitation and wastewater. This policy, however, does not address in much detail individual sanitation systems or faecal sludge treatment. Following the sanitation chain, the national legal framework leaves unprotected the issue of supervision of the construction, use and proper maintenance of individual sanitation systems, which, as mentioned before, represents around 70% of the country's sanitation systems. This stage of the sanitation chain is guided only by the *Código de Instalaciones Hidráulicas y Sanitarias en Edificaciones*, as well as the *Reglamento de Aprobación de Sistemas de Tratamiento de Aguas Residuales N° 39887-S-MINAE* and more recently the *Reglamento para la disposición al subsuelo de aguas residuales ordinarias tratadas N° 42075- S-MINAE.* However, little or no enforcement/monitoring is carried out, which ultimately falls to municipal inspectors.

Regarding the transport and treatment of faecal sludge, these activities are regulated by the *Reglamento para el Manejo y Disposición Final de Lodos y Biosólidos N° 39316-S*. This regulation places, in an indirect way, the task of treating faecal sludge in the hands of the private sector since it does not delegate this responsibility to any government institution (Madrigal, 2021).

3.1.1 Policy

Legislation that addresses wastewater and faecal sludge sanitation directly or indirectly is shown in Table 5.

Table 5: Laws and regulations related to wastewater and faecal sludge.

Year	Policy or regulation	Institutions with mandates in accordance with the Law / Regulation	Details or objectives
1942	*Ley de Aguas No. 276*	MINAE	It defines the nature of public domain of the state waters, as well as the conditions for their use and protection.
1968	*Ley General de Salud No. 5395*	MINSA	Article 276 establishes that only with the permission of the Ministry of Health it is possible to drain or discharge solids, liquids or other wastes or residues that may contaminate surface, underground or marine waters. Article 292 of the *Ley General de Salud Nº 5395* of 1973 prohibits the discharge of wastewater or industrial waste to the storm drain.
1992	*Ley de Conservación de Vida Silvestre No. 7317*	MINAE	This law prohibits the dumping of wastewater, waste or any polluting substance in springs, rivers, streams, permanent or non-permanent streams, lakes, marshes and natural or artificial reservoirs, estuaries, bogs, swamps, fresh, brackish or salty waters.
1992	*Reglamento para el manejo de lodos procedentes de tanques sépticos*	MINSA	Derogated by *Reglamento para el Manejo y Disposición Final de Lodos y Biosólidos (2015).*

1995	*Ley Orgánica del Ambiente No. 7554*	MINAE	Article 50.- Public domain of water. Water is of public domain. Its conservation and sustainable use are of social interest.
2002	*Reglamento de Vertido y Reúso de Aguas Residuales*	MINSA- MINAE	The regulation establishes physicochemical and microbiological parameters that those waters discharged to receiving bodies must comply with. In Article 4, it indicates that all generating entities must treat their wastewater so that they comply with the provisions of the regulation and thus, avoid damage to the environment, health, or human well-being. Considering as generating entity any natural or legal person, public or private, responsible for the reuse of wastewater or its discharge into a receiving body or sanitary sewer.
2002	*Reglamento Sectorial para la Regulación de los Servicios de Acueducto y Alcantarillado Sanitario*	MINAE - MEIC	It establishes the general conditions and parameters in which the technical standards and the methodology for setting rates and fees that regulate the activities of the providers of public water supply and sanitary sewerage services will be applied. It establishes the relations between them and the Regulatory Authority. It also establishes in its Article No. 6 the quality parameters of water supply and sewer services.
2004	*Declaratoria de interés público y necesidad social el diseño, financiamiento, ejecución, operación y mantenimiento de obras para la recolección, tratamiento y disposición final de aguas residuales, generados en centros urbanos.*	MINSA-MINAE	Article 1-The design, financing, execution, operation and maintenance of the works required for the collection, treatment and final disposal of ordinary wastewater generated in urban centres is declared of public interest and social need since Individual solutions for the disposal of wastewater are not suitable.
2007 y 2010	*Reglamento de Vertido y Reúso de Aguas Residuales y su Reforma*	MINSA-MINAE	The Regulation aims to protect public health and the environment, through a proper management of wastewater. Article 4-Obligation to treat wastewater. All generating entities must treat their wastewater so that they comply with the provisions of this Regulation and thus, avoid damage to the environment, health, or human well-being.
2008	*Reglamento del Canon Ambiental por Vertidos*	MINAE	Article 1.-Object of regulation. The purpose of this regulation is to regulate the canon for the use of water resources to dump polluting substances. From now on it will be called Environmental Canon for Discharges.
2015	*Reglamento para el Manejo y Disposición Final de Lodos y Biosólidos*	MINSA	It regulates: 1) The final disposal of biosolids from agro-industrial activities in order to improve the physicochemical condition of soils. 2) The final disposal of ordinary and special biosolids in sanitary landfills and also its use as alternative fuels. 3) The contamination of water resources and soils by the disposal of sludge without previous treatment. 4) The provision of the collection, transportation, treatment and final disposal service of sludge and biosolids from septic tanks and

			treatment plants. This service can be provided by public or private companies.
2016	*Reglamento De Aprobación De Sistemas De Tratamiento De Aguas Residuales*	MINAE- MINSA	Applicable for all treatment systems that are used in the purification of wastewater and that are discharged or reused in the national territory.
2017	*Código de Instalaciones Hidráulicas y Sanitarias en Edificaciones*	CFIA	Its objective is to establish the minimum requirements to protect public health, security, and general well-being in buildings destined for human use built in the Republic of Costa Rica.
2020	*Reglamento de Aprobación de Sistemas de Tratamiento de Aguas Residuales*	MINSA	Its objective is the protection of public health and the environment, through a rational and environmentally sound management of wastewater. It will be applicable to all treatment systems that are used in the purification of wastewater discharged or reused in the national territory.
2020	*Reglamento para la disposición al subsuelo de aguas residuales ordinarias tratadas*	MINSA	Its purpose is to regulate the final disposal of treated wastewater into the subsoil, through a drainage system. Specifically, it establishes regulations for the infiltration into the subsoil of effluents from individual treatment systems, as well as wastewater treatment plants. It also establishes guidelines for the design and construction of septic tanks.

3.1.2 Institutional roles

At national level, the structure of sanitation sector institutions and their functions are summarized below. Their roles can be divided into four categories: management and policy, regulation, monitoring and control, and operation. It is important to note that the competences of these institutions are often mixed, generating duplication of their functions.

1) <u>Management and policy</u>

Ministry of Environment (MINAE): According to the *Ley de Aguas No. 276*, *Ley Orgánica del Ambiente No. 7554* and the *Ley ARESEP No. 7593*, MINAE is responsible and the governing body of all centralised, decentralised, and public water and sewerage service providers. In these terms, it has the power to determine the use water, governance, protection, and monitoring of public waters.

Ministry of Health (MINSA): According to the *Ley Orgánica de Salud Nº 5.395*, MINSA is responsible for controlling water pollution, as well as regulating and monitoring the quality of the water the population receives, especially with regard to drinking water supply services, disposal of faecal sludge and sewage and waste management services. It is also responsible for approving and monitoring projects for sanitary sewerage, excreta disposal and wastewater (both domestic and industrial) treatment and their location; and for authorizing the discharge of wastewater into the sanitary sewerage system. Since the political function in the country corresponds to the country's ministries, the MINSA and the MINAE are responsible for issuing the National Wastewater Sanitation Policy.

Costa Rican Institute of Aqueducts and Sewerage (AyA): AyA is the largest service provider of drinking water and sanitation services at national level. It is also the entity responsible for the management of drinking water supply and the collection and disposal of wastewater.

2) Regulation

Ministry of Environment (MINAE): MINAE issues standards and regulations regarding the management and protection of surface and underground water resources.

Ministry of Health (MINSA): MINSA issues standards and regulations regarding the quality of drinking water and wastewater treatment, guaranteeing public health.

Costa Rican Institute of Aqueducts and Sewerage (AyA): AyA establishes and applies rules and regulations, focusing on the technical criteria of water and sanitation services.

Regulatory Authority of Public Services (ARESEP): ARESEP is the economic regulator in charge of setting fees for public services, including the provision of water and sanitation services. Given the relationship that must exist between fees and quality of service, it has the power to regulate the quality of services.

3) Monitoring and control

Ministry of Environment (MINAE): The surveillance and control of the sanitation sector is the responsibility of MINAE, which ensures the protection of the environment.

Ministry of Health (MINSA): MINSA guarantees the protection of health.

Costa Rican Institute of Aqueducts and Sewerage (AyA): AyA must guarantee the operation and maintenance of wastewater treatment plants in public and private urbanizations.

Regulatory Authority of Public Services (ARESEP): ARESEP supervises service providers and the quality of the service provided.

Comptroller General of the Republic (CGR): CGR controls and supervises the use of public funds.

4) Operation

There are different drinking water and sanitation service providers, which are described in section 3.1.3.

3.1.3 Service provision

The AyA is the main water and sanitation operator in the country (48%), followed by the Associations of Communal Sewerage Systems (ASADAS) (30.8%), the Municipalities (14.3%) and the Public Services Company of Heredia (4.4%) (Mora, 2020).

The main potable water supply service in Santa Teresa is provided by the Arío - Santa Teresa - Malpaís Integral Aqueduct, operated by the AyA. This infrastructure captures water (up to a maximum of 47 l/s) in several wells drilled in the community of Bajos de Arío, north of the district. From there, a pipeline of approximately 25 km runs through the communities of Manzanillo, Bello Horizonte, Playa Hermosa, Santa Teresa, Playa Carmen and Malpaís. The aqueduct has a chlorination disinfection plant and two storage tanks along the network (PIAAG, 2015).

Regarding sanitation services, 88.6% of the population has a septic tank and only 10.4% has a private treatment plant. The emptying, collection and transport of this sludge is managed by private service providers, both formal and informal. This was verified through interviews with sludge collectors and residents living in the area. On average, the cost to provide the emptying service is US$ 75 per system emptied.

Faecal sludge emptying is carried out by 15 private companies that enter the area to provide emptying services of septic tanks, grease traps and wastewater treatment plants in households, hotels, hostels, restaurants and rental houses. However, only five of them have a permission issued by the Ministry of Health (see section 2.1.2 for further details).

Collected faecal sludge is delivered to a FSTP/WWTP where is further treated in the central canton of the Alajuela province, or in the Carrillo, Liberia or Santa Cruz cantons in the Guanacaste province (see section 2.1.4 for further details).

3.1.4 Service standards

As indicated in section 3.1, there is a solid legal framework that, through various regulations, establishes the parameters for the discharge of wastewater and the treatment of faecal and biosolids sludge. MINAE and MINSA not only issue these regulations, but also have the difficult task of enforcing them.

There is an important gap in terms of service standards related to faecal sludge management, given that, beyond the *Código de Instalaciones Hidráulicas y Sanitarias en las Edificaciones*, (which is seen mainly as a manual of good practices), and the *Reglamento para el Manejo y Disposición Final de Lodos Fecales y Biosólidos*, which addresses the management and final disposal of faecal sludge, there is no entity that ensures and enforces the construction, proper maintenance and compliance of onsite sanitation systems. There is no service standard or regulatory entity that guarantees the quality and cost of emptying and transporting faecal sludge, either.

3.2 Planning

3.2.1 Objectives

The study area has an aqueduct managed by the AyA. It is also the responsibility of this institution to build a sanitary sewer system in the area, however, there is no pre-feasibility study that demonstrates the plans of this institution to implement this solution.

3.2.2 Investments

According to AyA estimates from the document "*Proyectos de saneamiento de aguas residuales a mediano y largo plazo gestionados por el AyA. Período 2023-2030*", the construction of a sanitary sewer for Santa Teresa and neighbouring communities would cost at least US$ 6,000,000, however, no source of financing was identified for the execution of this project (Ballestero, 2019).

3.3 Equity

3.3.1 Current choice of services for the urban poor

In the study area, the water service is accessible to the entire population, either directly through the aqueduct, wells or tanks that are informally distributed by trucks.

In addition to this, in terms of sanitation conditions, inequities persist mainly in the so-called *caseríos,* which are private properties that are rented to people with limited resources not having the optimal conditions of decent housing due to the overcrowded conditions in which people live in. They also have precarious sanitation systems because in these areas, although they have some basic sanitation solution such as septic tanks, these usually do not work correctly as they get overloaded since they are used by more people than they were designed for. These tanks are generally located in places where the entrance of a vacuum truck is not feasible. There is also an inadequate handling of the greywater that is usually disposed of directly into the ground or in a water body.

3.3.2 Plans and measures to reduce inequity

To date, there is no study showing the total number of households in these conditions, but they are located throughout the entire coastal area with a special concentration around the centre of Santa Teresa. There is no plan to directly address these inequities, either. So, in order to address this problem, it is necessary to coordinate the work of institutions such as the Municipal Council of Cóbano District, the Ministry of Health and also the national institutions in charge of housing such as the Institute of Social Aid (IMAS) and the Ministry of Housing and Human Settlements (MIVAH).

3.4 Outputs

3.4.1 Capacity to meet service needs, demands and targets

The study area is a community in continuous development that generates increasing pressure on the services, especially in terms of water supply coming from the Arío – Santa Teresa – Malpaís Integral Aqueduct which uses three wells located in the area of Bajos de Arío. This aqueduct is designed to operate with a flow of 59l/s, sufficient to meet the demand up to year 2030 (AyA, 2017). However, in a field visit carried out in 2021, it was found that the real flow was between 42l/s and 47l/s according to the aqueduct operators. Considering this lower but real flow and also the increasing water demand, the AyA and the Municipal Council of Cóbano District must elaborate a coordinated planning schedule to meet this increasing demand for water supply in the area.

The IDB and Nicoya Peninsula Waterkeeper are key actors supporting the search for future sanitation solutions in the area to meet service needs, demands and targets. The Ministry of Health is starting to monitor the illegal operation of services providers and and also the dumping of faecal sludge into the environment.

3.4.2 Monitoring and reporting access to services

There is no monitoring to know the current status of the sanitation systems in the area, especially septic tanks and drainage systems. There is no record at institutional level on this. Therefore, it is not possible to know what the current state of the installed systems is. There is no control system either on the whole sanitation chain, from containment to end use or disposal. This study was the first attempt to address these issues.

3.5 Expansion

3.5.1 Stimulating demand for services

Nicoya Peninsula Waterkeeper offers advice and support to the population of the area who wishes to install their sanitation systems in accordance with national legislation in a proper way.

3.5.2 Strengthening service provider roles

Nicoya Peninsula Waterkeeper are in touch with companies that legally provide the emptying service in the area in order to provide the population with the appropriate list of service providers. In addition, capacity development workshops are organized to train different target groups and to raise awareness on proper faecal sludge management through social networks. Finally, there is coordination with the Ministry of Health and the police to prevent illegal service providers from operating in the area.

4 Stakeholder Engagement

4.1 Key Informant Interviews (KIIs)

Interviews and surveys were carried out with different key actors. They included: public institutions, households and tourist places, service providers for emptying, collecting and transporting of the faecal sludge, operators of FSTPs/WWTPs, masons and engineering consultants.

Meetings with institutional actors: This study was presented to the Wastewater Management Commission (GIAR) of the Cóbano district. The *Área Rectora de Salud Peninsular* from the Ministry of Health and also the Municipal Council of Cóbano District participated in this meeting.

In addition, two meetings were held to present the objectives of this study with representatives of the AyA from the central offices of San José and from the offices of the central pacific zone located in Puntarenas.

Surveys conducted to service providers:

According to the data from the household and tourist places surveys, as well as from the inspection of community groups on social networks, a total of 15 companies or individuals were identified as service providers in the area. However, only five service providers agreed to participate in the service providers survey.

Interviews to operators in charge of FSTPs/WWTPs:

Four operators in charge of FSTPs/WWTPs where the faecal sludge is delivered for treatment were interviewed.

Interviews to masons and engineering consultants:

Three interviews were conducted with masons who build or maintain sanitation systems in the area, as well as three engineering consultants who build WWTPs in the area.

4.2 Field visits

A field visit was organized to gain a better understanding of the infrastructure of the Arío-Santa Teresa-Malpaís Integral Aqueduct. The field with wells located in the Bajos de Arío community was also visited, as well as the main storage tank and the facilities of the chlorine disinfection system.

4.3 Validation workshops

On August 26, 2021, a final validation workshop held virtually was attended by a total of 20 people from different institutions: representatives of IDB, WK, Ministry of Health, AyA, Municipal Council of Cóbano District, local organizations such as the Santa Teresa-Malpaís Development Association, the Chamber of Tourism of the Blue Zone, the service provider *Servicios Sépticos Santa Cruz* and the United States organization Global Water Stewardship. At the end, consensus values for all variables were reached and those were the ones finally used in the final SFD graphic.

This workshop allowed the IDB to present its interest in supporting the search for sanitation solutions in the area, as well as the Nicoya Peninsula Waterkeeper organization to be the counterpart that facilitates the coordination between the various key stakeholders.

Some highlights from the workshop were:

-On behalf of AyA, it was suggested to carry out a study to gain a better knowledge in the management of greywater in the area, since it is not depicted in the SFD graphic. In addition, the AyA highlighted that the situation at country level is somehow similar to the situation described in Santa Teresa.

-The findings of this study were very interesting, highlighting the need to continue articulating actions to find solutions. It was pointed out by the company *Servicios Sépticos Santa Cruz* S.A. that the presence of illegal vacuum trucks In the area favours unfair competition, affecting companies with all the requirements set by the Ministry of Health. Representatives from the Ministry of Health stated that they are working on monitoring these illegal practices and have already fined two of these companies, also saying that they need the collaboration of the community to support and notify the Ministry when they notice the presence of illegal vacuum trucks, so the Ministry can take legal actions against these companies and also against those who hire them.

-The IDB stressed that the next step to be taken in the area would be to carry out an Optimal Sanitation Strategy with the support of the key stakeholders.

-The Municipal Council of Cóbano District stated that it is important to link the initiatives to the work of the Territorial Rural Councils of the National Institute for Rural Development (INDER) and also considering the needs of the neighbouring districts of Paquera and Lepanto in Puntarenas.

5 Acknowledgements

The authors would like to thank everyone who participated in the meetings and in the preparation of this SFD report. We especially thank the Nicoya Peninsula Waterkeeper volunteers for helping in data collection in field, as well as the people and local tourist places in the communities of Malpaís, Santa Teresa, Hermosa and Manzanillo for their willingness to respond to our surveys.

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IDB and WK, 2021b. *Tourist places survey. 150 surveys (restaurants, hotels, hostels and rental houses) carried out.* Field work conducted by WaterKeeper (WK) with the support of the IDB in the design of the survey and the subsequent analysis of the collected data.

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7 Appendix

7.1 Appendix 1: Stakeholder identification and engagement

Table 6: Stakeholder identification and engagement.

Name of the person	Institution	Position	Date	Purpose
Carolina Chavarría Pozuelo	Nicoya Peninsula Waterkeeper	Director	2021	Incidence with SFD graphic and develop follow-up projects.
Germán Arias, Ronald Rojas, Carlos Rodriguez, Lothar Spoerl, Carlos Carranza and Eduardo Berrocal.	Private sector service providers	Masons and engineering consultants	2021	Gain knowledge on the construction practices of onsite sanitation systems.
Pedro Rodriguez, Jorge Arias, Heiner Rojas and Jason Chávez	FSTP CASSA, WWTP Carillo and FSTP Liberia	Operators of FSTPs/ WWTPs	2021	Gain knowledge on the type of treatment of faecal sludge and the amount of it which is treated.
Alberto Vásquez, María Fernanda Arrieta, Karla Ordoñez, Magaly Rodriguez, Manuel Ovares and Mauricio Duarte.	GIAR from Cóbano district	Representatives of GIAR (AyA, Municipal Council of Cóbano District and Ministry of Health)	2021	Support in the construction and implementation of an optimal sanitation strategy.
Juan Gabriel Ledezma	Ministry of Health	Director of *Área Rectora de Salud Peninsular*	2021	Support in the follow-up of pollution complaints. Increase monitoring and control actions.
Álvaro Araya and Fernando Araya	AyA	Director of *Saneamiento en Sistemas Periféricos*, Director of Central Pacific Area	2021	Prioritization of Santa Teresa on the list for community sanitation solutions.
Roberto de la Ossa	ADI Malpaís Santa Teresa	President	2021	Community support for initiatives.
Nathaniel Grew	Chamber of Tourism of the Blue Zone	President	2021	Encourage support from local entrepreneurs to implement sanitation solutions.

Key Informant Interviews (KIIs)

KII, 1 (2021). Interviews conducted to FSTPs/WWTPs operators: Pedro Rodriguez, Owner of *Servicios Sépticos Santa Cruz;* Jorge Arias, CEO of *CASSA;* Heiner Rojas, WWTP *Carrillo* operator and Jason Chávez, owner of FSTP *Liberia*.

KII, 2 (2021). Interviews to masons and engineering consultants: Germán Arias, Ronald Rojas, Carlos Rodriguez, Lothar Spoerl, Carlos Carranza and Eduardo Berrocal.

Field Visits (FVs)

FV, 1 (2021). Field visit to the Arío-Santa Teresa-Malpaís Integral Aqueduct.

7.2 Appendix 2: Gathering of information

7.2.1 Population and housing estimation methodology

The population and housing figures for Costa Rica are not disaggregated at village level, so there is no official data on the number of inhabitants, households or floating population, specifically in Santa Teresa.

Having the floating population data is as important as having the resident population data. 89.67% of the 794 non-inhabited households are located in rural areas. The reason for not being inhabited is not indicated for the Cóbano district, but it is indicated for the province of Puntarenas, in which 33.82% of the rural households are empty because their use is for holidays, and another 21,72% are for rent or sale, usually for long-stay tourists (INEC, 2011). These numbers indicate the importance of the floating population in the district.

For this report, the figures for the resident population, floating population and number of households have been inferred from two official sources complementary to INEC: i) technical documentation of the AyA project for the '*Arío - Santa Teresa - Malpaís Integral Aqueduct*', which It is part of the PIAAG. This AyA project serves the Santa Teresa area established in this SFD report; ii) 1: 5000 cartography of the SNIT from years 2005 to 2017, which contains vector and alphanumeric data of households in the Cóbano district (Figure 18).

Figure 18: Dwellings of the SNIT (1: 5000) cartography in Santa Teresa. It can be seen how some dwellings are not included in the cartography. Source: SNIT and own elaboration.

AyA calculates that by in 2030, there will be 10,692 people in Santa Teresa, of which 46.44% would be resident population and the remaining 53.56% floating population, mainly linked to tourism. The AyA document estimates the current population in Santa Teresa areas at 6,674[3]. Assuming that the 2030 percentages between the resident and floating population are proportional to the current percentages, the estimate of the current inhabitants of Santa Teresa is 3,099 resident people and 3,575 floating people[4].

To estimate the number of households, a topological analysis on the information on dwellings from the official national cartography was carried out. It was obtained that 28.40% of the dwellings classified by the SNIT as "building/house" are located in the area of Santa Teresa. In addition, crossing the SNIT and INEC data, 54.52% of the “buildings/houses” are households (INEC, 2011), so the final estimate of households in Santa Teresa is 897.

As a contrast mechanism, incorporating the percentage of inhabited households, which is 74.86% (INEC, 2011) and the data of people per household obtained from the household survey (BID and WK, 2021a), the resident population would be similar than the figure estimated by AyA, being the AyA estimate 19.97% higher (this result is consistent, taking into account that the SNIT dwelling data are mainly from 2015 and, in recent years, Santa Teresa has continued to grow, and thus, the real number of dwellings is higher than the estimated). A second contrast mechanism is the unofficial figure indicated by the Cóbano District Administration, which estimates the number of resident population in the Santa Teresa area at 3,365.

7.2.2 Survey sampling methodology

The household survey and the tourist places survey followed these criteria:

Household survey:

The sample surveyed represented more than 33% of the inhabited households in the Santa Teresa area. The survey reached 301 valid surveys in inhabited households, which represents 44.86% of the estimated households in the area. The selection of the sample was made in field, trying a proportional distribution among all the towns and main neighbourhoods of the inhabited households.

Tourist places survey:

All 150 tourist places including restaurants, hotels, hostels and rental houses were surveyed.

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[3]AyA documentation does not indicate the date of writing of the report, but 2015 has been estimated as a possible date because it is the year in which the PIAAG began.

[4]The results of the survey of tourist places indicate a potential maximum occupancy of hotels and rental houses of 2,548 people (IDB and WK, 2021b). The people who have their second residence here or vacant homes that are occupied at certain times of the year should be added to this figure. Therefore, the estimated figure in the report of 3,575 is consistent with that collected in the surveys.

7.3 Appendix 3: Sample questions from the surveys

61 questions were included in the household survey, 38 questions in the tourist places survey and 35 questions in the service providers survey. Table 7 shows a selection of the questions included in the household survey, Table 8 shows a selection of the questions included in the tourist places survey and Table 9 shows a selection of the questions included in the service providers survey.

Table 7: Selection of the questions included in the household survey.

Question	Answers
Where does the water collected outside the household usually come from?	a. Aqueduct of the Costa Rican Institute of Aqueducts and Sewers (AyA) b. Protected well c. Bottled water or cans d. Water from tanks e. Stream / river water f. Other
What is the main type of water source in the household?	a. Connection to the AyA aqueduct b. Connection to a private tank in the household d. Own protected well e. Own well (not protected)
What is the average water consumption in a month in the household?	[ ] cubic metres
What type of sanitary service for the disposal of excreta (urine and faeces) do you have in this household?	a. Pour-flush toilet b. Latrine c. Cesspit d. Don't know
Where is the sanitation system connected to?	a. Sewerage system b. Septic tank c. Tank with open bottom d. Cesspit e. Open storm drain or sewer f. Body of water (river, stream, sea) g. Directly to the ground or to a field h. Don't know
In the case of having a sewerage network, do you know where the sewage from the network goes?	a. WWTP b. Soak pit c. Body of water (river stream, sea) d. Directly to the ground or to a field e. Don't know

Do you know where the greywater generated in the household is drained?	a. WWTP b. Storm drain/sewer c. Septic tank d. Drain built just for these waters e. Ground f. River or stream g. Don't know
Do you know the volume of the tank? Indicate volume approximately:	a. Yes b. No [ ] cubic metres
Do you know if the construction of the tank reached the groundwater table (the layer where the water is)?	a. Yes, it was reached b. No, it was not reached c. Don't know
What did you do when the tank filled up?	a. Still not filled up b. It was emptied/cleaned c. It was sealed and another one was built d. It was abandoned, not sealed and another one was built e. Don't know
How often do you usually do the emptying?	a. Once or more per year b. Every 2 years c. Every 3 years d. Every 4 years or more e. Don't know
What type of emptying was made?	a. Manual b. Vacuum truck equipped with a hose c. A combination of both ways d. Don't know
Do you remember what the cost of emptying your tank was? Can you facilitate it?	a. Yes b. Don't remember it c. No cost Cost: [ ]
Do you consider that in your community there is an incorrect wastewater management?	a. Yes b. No
Is there a hand washing facility located less than 10 metres away from the sanitary service?	a. Yes b. No c. Don't know
Is it a permanent hand washing facility?	a. Yes b. No c. Don't know

Table 8: Selection of the questions included in the tourist places survey.

Question	Answers
Where does the drinking water in your tourist place come from?	a. Aqueduct of the Costa Rican Institute of Aqueducts and Sewers (AyA) b. Protected well c. Bottled water or cans d. Water from tanks e. Stream / river water f. Other
Where is the wastewater discharged to?	a. In a septic tank b. To a water treatment plant c. In the storm drain or sewer d. To a body of water (river or stream) e. Directly to the ground f. Don't know
Where is the wastewater from tanks discharged to?	a. Soak pit B. Storm drain or sewer c. Body of water (river or stream) d. Straight to the ground
Do you know the volume of the tank/s?	a. Yes b. No Indicate the volume approximately:
How many years ago was your septic tank built?	Months: ____. Years: ____.
How often do you usually do the emptying?	a. Once a year b. Every 2 years c. Every ___ years d. Don't know
Do you remember what the cost of emptying your septic tank was?	a. Yes b. No Cost: _______
Do you know where the faecal sludge that you extract from your treatment plant goes to?	a. Don't know b. To a field c. To agricultural land (without prior treatment) d. A river e. A drain f. A faecal sludge treatment plant g. A sanitary landfill
Do you consider that in your community there is an incorrect wastewater management?	a. Yes b. No c. Don't know

Table 9: Selection of the questions included in the service providers survey.

Question	Answers
Company name:	Please, specify ()
Emptying procedure:	Mechanical ( ) Manual ( ) A combination of both ( )
From which canton do you come?	Please, specify ()
How many trips on average do you make to the area in 1 month?	Please, specify ()
What types of systems do you clean?	-Only grease traps () -Septic tanks and grease traps () -Septic tanks and WWTPs () -Septic tanks, grease traps and WWTPs ()
What are your types of clients? Multiple choice.	-Households ( ) -Restaurants ( ) -Hotels ( ) -Rental houses ( ) -Public toilets ( ) -Other:
Fee per m^3 collected	CRC: _______
Vacuum truck capacity	m^3:_______
Pump power	HP:_______
Maintenance cost of the vacuum trucks	CRC/year: _______
Time it takes to empty the sanitation system:	Please, specify ()
Do you or your workers apply any sanitary protection measures when carrying out the emptying service?	Please, specify ()
Do you have the operating permit from the Ministry of Health?	-Yes ( ) -Approval procedure in progress ( ) -No ( ) -No answer ( )
Do you carry out any marketing strategy? Which one? Do you have pages on social networks or a website?	Please, specify ()

7.4 Appendix 4: SFD graphic for households and analysis of the most relevant data

1. **Summary data**

- ✔ 306 household surveys carried out (301 valid).
- ✔ Four communities in the Cóbano district (Puntarenas canton, Puntarenas province).

2. **Water supply system:**

- ✔ 56% have connection to AyA, 23% to a protected well, 3% to an unprotected well, 17% use tanks and 1% use a tank filled with rainwater.
- ✔ Only 36% know the depth of the wells (15.5m on average).

3. **Sanitation systems:**

- ✔ ~ 100% households: Pour-flush toilet.
- ✔ Only 2% of toilets are shared.
- ✔ 98.3% have the toilet in good condition.
- ✔ 8% of septic tanks discharge to a a soak pit.

A. <u>Containment:</u>

- ➢ 97% have septic tanks.
  - ◆ 98% discharge to a soak pit and 2% don't know (T1A4C9).
  - ◆ 5% reached the water table (87% don't know).
    - ✔ No septic tank reached the water table (88% don't know).
    - ✔ 5% of the tanks with open bottom reached the water table (87% don't know).
  - ◆ 18% are septic tanks (T1A2C5) and 82% are tanks with open bottom (T1A4C5).
    - ✔ 1% was abandoned, not sealed and another one was built (T1B8C10).
    - ✔ 1% was abandoned, sealed and another was built (T1B7C10).
  - ◆ Only 9.6% of households know the volume of the tanks.
    - ✔ The average volume of the septic tanks is 2.0 m^3.
    - ✔ The average volume of tanks with open bottom is 1.8 m^3.
  - ◆ 68% of households know the age of construction of the tanks.
    - ✔ The average age of septic tanks is 12.8 years.
    - ✔ The average age of tanks with open bottom is 12.2 years.
  - ◆ Age of construction and emptying of tanks:
    - ✔ The average age of septic tanks not emptied is 11.5 years.
    - ✔ The average age of tanks with open bottom not emptied is 10.6 years.
    - ✔ The average age of septic tanks emptied is 15.2 years.
    - ✔ The average age of tanks with open bottom emptied is 13.4 years.
  - ◆ Waterproof material on the lining and at the bottom of the tanks:
    - ✔ 7% keep it, 12% do not keep it and 41% don't know (septic tanks).
    - ✔ 17% keep it, 16% do not keep it and 67% don't know (tanks with open bottom).
- ➢ 1% of households have their own WWTP (T1A1C4). Treatment efficiency = 90% (assumption).
- ➢ 1% of households don't know where the wastewater from the sanitary service is going (T1A1C9).

- 1% of households have a cesspit (T1A6C10, none have been emptied: F3, F4 and F5 = 0%).

B. *Emptying of tanks:*

- F3 (septic tanks) = 34% * 0.9 (emptying efficiency, assumption) = 30% (consensus value = 48%).
- F3 (tanks with open bottom) = 41% * 0.9 (emptying efficiency, assumption) = 37% (consensus value = 48%).
- F3 (tanks connected to 'don't know where') = 0%
  - Emptying of tanks:
    - ✓ 43% is emptied by a company authorized by the Ministry of Health (septic tanks).
    - ✓ 47% is emptied by a company authorized by the Ministry of Health (tanks with open bottom).
  - Access to the emptying of the tanks:
    - ✓ 71% is easily accessible (septic tanks).
    - ✓ 72% is easily accessible (tanks with open bottom).
  - Average fee for emptying the tanks:
    - ✓ CRC 66,800 (US$ 108) (septic tanks).
    - ✓ CRC 133,619 (US$ 217) (tanks with open bottom).

C. *Transport of faecal sludge:*

- F4 (septic tanks) = 54% of emptied faecal sludge is delivered to treatment.
- F4 (tanks with open bottom) = 41% of emptied faecal sludge is delivered to treatment.
- F4 (tanks connected to 'don't know where') = 0% of emptied faecal sludge is delivered to treatment.
  - 75% of households think that there is an incorrect management of wastewater in the area.
  - 13% of households reported seeing vacuum trucks of service providers discharging faecal sludge into rivers, *quebradas*, beaches and the soil without treatment.

D. *Faecal sludge treatment:*

- The faecal sludge treatment efficiency is 90% (assumption).

4. Emptied faecal sludge

Frequency of tank emptying	# Total responses	%
Once or more per year	32	32%
Every 2 years	13	13%
Every 3 years	10	10%
Every 4 years or more	3	3%
When filled + don't know (1.7 years)	41	41%
Total	**99**	**100%**

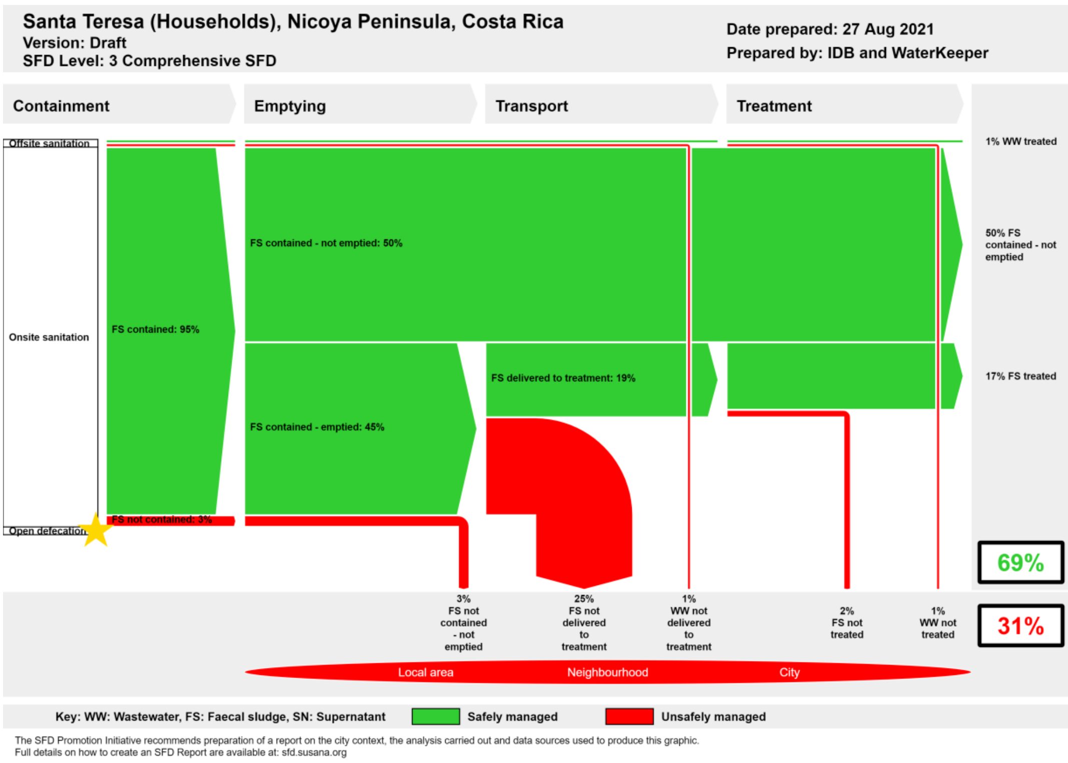
- ✓ 186 tanks/year are emptied.
- ✓ The average emptying frequency is every 1.7 years.
- ✓ 353 m^3/year of faecal sludge are emptied (90% emptying efficiency).

5. SFD Matrix

Santa Teresa (Households), Nicoya Peninsula, Costa Rica, 27 Aug 2021. SFD Level: 3 - Comprehensive SFD
Population: 3099
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

Containment						
System type	Population	WW transport	WW treatment	FS emptying	FS transport	FS treatment
	Pop	W4b	W5b	F3	F4	F5
System label and description	Proportion of population using this type of system (p)	Proportion of wastewater in sewer system, which is delivered to decentralised treatment plants	Proportion of wastewater delivered to decentralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C4 Toilet discharges directly to a decentralised foul/separate sewer	1.0	100.0	90.0			
T1A1C9 Toilet discharges directly to 'don't know where'	1.0					
T1A2C5 Septic tank connected to soak pit	17.0			48.0	54.0	90.0
T1A4C5 Lined tank with impermeable walls and open bottom, connected to a soak pit	76.0			48.0	41.0	90.0
T1A4C9 Lined tank with impermeable walls and open bottom, connected to 'don't know where'	2.0			0.0	0.0	0.0
T1A6C10 Unlined pit, no outlet or overflow	1.0			0.0	0.0	0.0
T1B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow	1.0					
T1B8C10 Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil, no outlet or overflow	1.0					

6. SFD Graphic



7.5 Appendix 5: SFD graphic for tourist places and analysis of the most relevant data

1. Water supply system:

- ✔ 73% have a connection to AyA, 20% to a protected well, 1% to an unprotected well, 1% to a tank filled with rainwater and 5% use tanks.
- ✔ Only 7 tourist places know the depth of the protected well (17m on average).

2. Extraction of fats and solids:

- ✔ 54% have a grease and solids trap and 98% do manual cleaning daily or frequently.
- ✔ The disposal of fats and solids extracted is: 30% (garbage), 15% (removed by an authorized truck), 10% (Ns / Nc), 7% (removed by an unauthorized truck), 13% (composted it) and 25% (buried it).

3. Sanitation systems:

- ✔ 98% have pour-flush toilets and 100% are in adequate condition.
- ✔ 1% have a cesspit and 1% don't know.

A. *Containment:*

- ➢ 79% of tourist places have some type of tank.
  - ◆ 98% discharge to a soak pit, 1% to their own WWTP and 1% don't know.
  - ◆ 8% reached the water table (92% don't know).
  - ◆ 58% are septic tanks and 42% are tanks with open bottom.
  - ◆ The average volume of the tanks is 3.0 m^3.
  - ◆ The average age of tanks is 10 years.
  - ◆ On average, there are 2.4 tanks per tourist place.
- ➢ 20% of tourist places have their own WWTP. Treatment efficiency = 90% (assumption).
- ➢ 1% of tourist places don't know their sanitation system.

E. *Emptying of tanks:*

- ➢ F3 (septic tanks) = 48% * 0.9 (emptying efficiency, assumption) = 44% (consensus value = 60%).
- ➢ F3 (tanks with open bottom) = 40% * 0.9 (emptying efficiency, assumption) = 36% (consensus value = 60%).
- ➢ F3 (tanks connected to 'don't know where') = 85% * 0.9 (emptying efficiency, assumption) = 77%
- ➢ 1% of tourist places sealed the tank when filled and built another one.
- ➢ The average emptying fee is CRC 159,234 (US$ 259).

B. *Transport of faecal sludge:*

- ➢ F4 (septic tanks) = 52% of emptied faecal sludge is delivered to treatment.
- ➢ F4 (tanks with open bottom) = 33% of emptied faecal sludge is delivered to treatment.
- ➢ F4 (tanks connected to 'don't know where') = 16% of emptied faecal sludge is delivered to treatment.

C. *Faecal sludge treatment:*

- ➢ The faecal sludge treatment efficiency is 90% (assumption).

4. Emptied faecal sludge:

Frequency of tank emptying	# Total responses	%
Once or more per year	22	39%
Every 2 years	9	16%
Every 3 years	2	4%
When filled + don't know (1.4 years)	23	41%
Total	**56**	**100%**

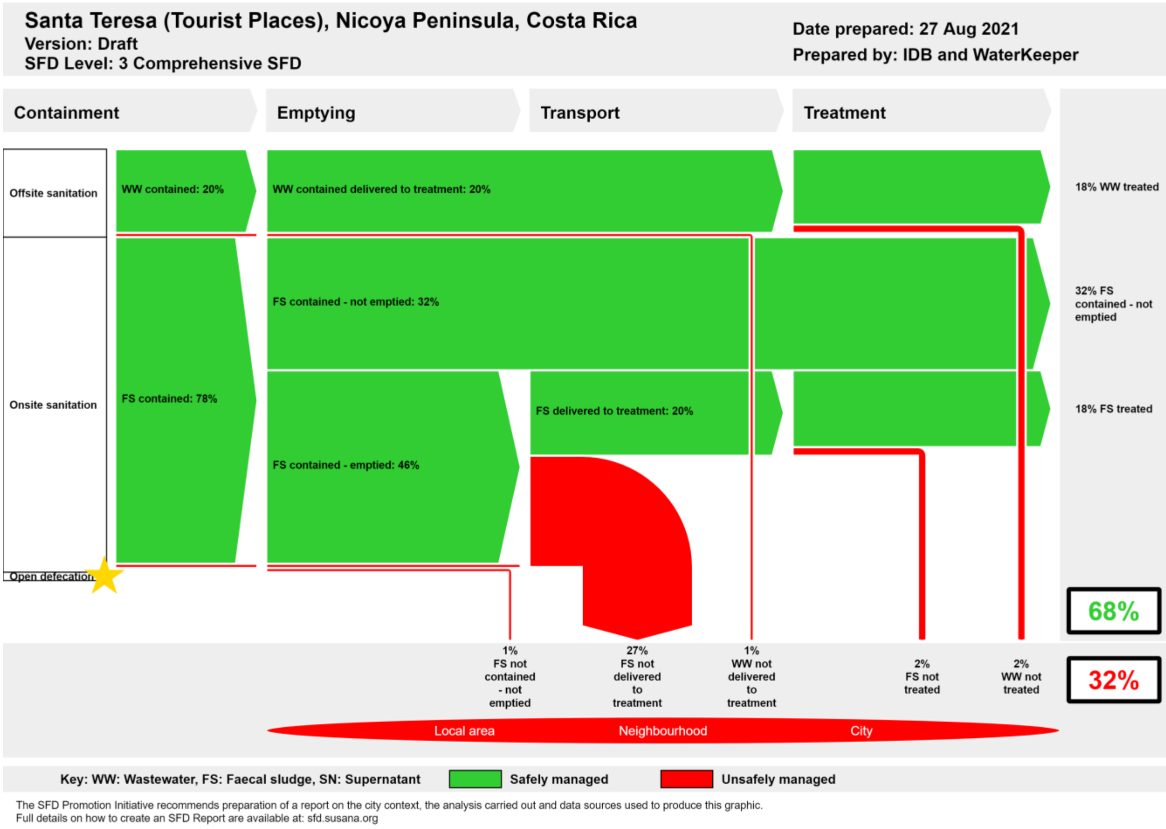
- ✔ 94 tanks are emptied every year.
- ✔ The average emptying frequency is every 1.4 years.
- ✔ 298 m^3/year of faecal sludge are emptied (90% emptying efficiency).

5. SFD Matrix

Santa Teresa (Tourist Places), Nicoya Peninsula, Costa Rica, 27 Aug 2021. SFD Level: 3 - Comprehensive SFD
Population: 3575
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

Containment						
System type	Population	WW transport	WW treatment	FS emptying	FS transport	FS treatment
	Pop	W4b	W5b	F3	F4	F5
System label and description	Proportion of population using this type of system (p)	Proportion of wastewater in sewer system, which is delivered to decentralised treatment plants	Proportion of wastewater delivered to decentralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C4 Toilet discharges directly to a decentralised foul/separate sewer	20.0	100.0	90.0			
T1A1C9 Toilet discharges directly to 'don't know where'	1.0					
T1A2C5 Septic tank connected to soak pit	44.0			60.0	52.0	90.0
T1A2C9 Septic tank connected to 'don't know where'	1.0			77.0	16.0	90.0
T1A4C5 Lined tank with impermeable walls and open bottom, connected to a soak pit	33.0			60.0	33.0	90.0
T1B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow	1.0					

6. SFD Graphic



7.6 Appendix 6: Summary and analysis of the most relevant data from the surveys to service providers

The estimate of the volume of emptied faecal sludge delivered to treatment through the data collected from the service providers survey is shown below:

- ✓ Volume of faecal sludge transported:11 m^3/truck.
- ✓ Number of trips: 1 trip per month and per company to Santa Teresa.
- ✓ Each company uses one truck to go to Santa Teresa.

<u>Volume of sludge delivered for treatment</u> = 11 m^3/truck x 1 trip/month x 5 trucks (1 per company)

Faecal sludge delivered for treatment = 55 m^3/month (660 m^3/year)

7.7 Appendix 7: Summary and analysis of the most relevant data from KIIs to FSTP operators

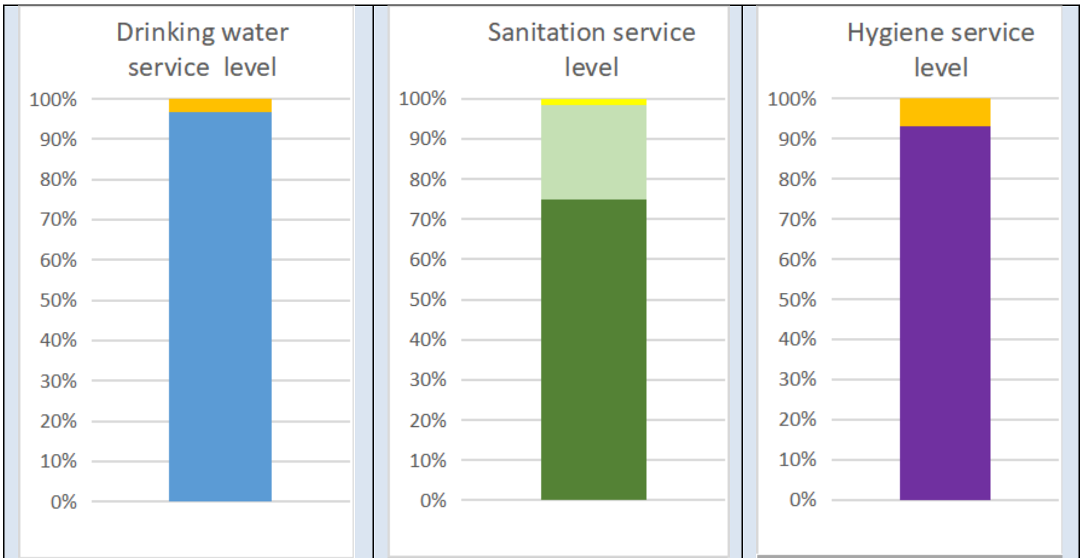
The estimate of the volume of faecal sludge delivered for treatment and treated in the FSTPs/WWTPs using the data collected from the KIIs to the FSTPs/WWTPs operators is shown below:

- ✓ WWTP *Carillo*: They receive 200 m^3/month from *Sanitarios La Pampa* (only 50m^3 are from Santa Teresa).
- ✓ FSTP *Servicios Sépticos Santa Cruz*: No estimate is available since vacuum trucks are not arriving regularly at the FSTP and currently, they do not have a record of the amount of faecal sludge delivered for treatment.
- ✓ FSTP *Alajuela*: No estimate is available since there are no vacuum trucks from Santa Teresa currently arriving at this FSTP despite some service providers stated that they deliver emptied faecal sludge to this FSTP.
- ✓ FSTP *Liberia*: No estimate is available since there are no vacuum trucks from Santa Teresa currently arriving at this FSTP despite some service providers stated that they deliver emptied faecal sludge to this FSTP.

Faecal sludge delivered for treatment = 50 m^3/month (600 m^3/year)

7.8 Appendix 8: JMP service ladders for water, sanitation and hygiene

As a complement to the SFD graphic, Figure 19 shows the service levels of water, sanitation and hygiene according to the Joint Monitoring Program (JMP) methodology developed by WHO/UNICEF.



Service levels	%
Safely managed	-
Basic	96.68%
Limited	-
Unimproved	3.32%
Surface water	-

Service levels	%
Safely managed	75.00%
At least basic	23.31%
Limited	1.69%
Unimproved	0.00%
Open defecation	0.00%

Service levels	%
Basic	93.00%
Limited	0.00%
No installation	7.00%

Figure 19: Water, sanitation and hygiene service ladders in households, according to the Joint Monitoring Program (JMP) methodology developed by WHO/UNICEF.

Regarding the water service level, 96.68% of households have at least a basic level. Only 3.32% have an unimproved level. However, as water quality analyses were not carried out, it is not possible to know the safely managed level.

Regarding the sanitation service level, 98.31% of households have at least a basic level. However, 1.69% of the population has limited access. No households have been found using unimproved facilities or practising open defecation. Incorporating the percentage of excreta safely managed according to the SFD graphic, 75.00% of households could have a safely managed level.

Finally, 93.00% of households have a permanent hand washing installation with soap and water, while 7.00% do not have it. No household with limited access has been found. Of this percentage of 7.00% who affirm that they do not have a hand washing installation with soap and water, it is likely that there are households that have access to soap and water, but more than 10 metres away from the sanitation system.

7.9 Appendix 9: Water quality analyses carried out in the study area

Freshwater quality:

Freshwater quality analyses have been carried out in the main streams called *quebradas* in the area where the highest number of direct discharges of untreated wastewater are found. The highest levels of contamination, classified according to the *Reglamento de Clasificación de Cuerpos de Agua Superficial 33903-MINAE-S*, are found in the Danta and Carmen *quebradas*, located in the Playa Carmen sector, Santa Teresa, where levels of contamination ranging from class 3 (moderate pollution), to class 5 (highly polluted) have been reported, according to the Dutch Index on which this regulation is based.

In March 2021, the highest pollution value was recorded in these *quebradas*. Dissolved oxygen of 36%, BOD of 19 mg/l, NH3-N of 13 mg/l, phosphorus of 5.8 mg/l and *faecal coliforms* of 860,000 CFU/100ml were reported for *Quebrada* Carmen. In *Quebrada* Danta, dissolved oxygen of 24.9%, BOD of 33 mg /l, NH3-N of 19 mg/l, phosphorus of 4.3 mg/l and *faecal coliforms* of 1,240,000 CFU/100m were reported. Both cases correspond to class 5, highly polluted waters.

These studies have been carried out through participation in the program *Bandera Azul Ecológica categoría Microcuencas* with analyses carried out by the AyA National Water Laboratory, as well as analyses carried out by the private laboratory *BioAnalítica*.

Marine water quality:

As part of the AyA *Bandera Azul* program, in the beaches category, water quality analyses have been carried out in the area since 2006. According to historical data registered by the National Water Laboratory, *faecal coliforms* and *streptococci* have been detected in waters of the area. In the case of Playa Malpaís, samples were positive for *faecal coliforms* in 83% of cases and for *streptococci* in 58% of cases, with maximums of more than 2,400 CFU/100ml. In Playa Carmen, samples were positive for *faecal coliforms* in 57% of cases with a maximum of 1,100 CFU/100ml and for *streptococci* in 53% of cases, with a maximum of 9,204 CFU/100ml. In Playa Santa Teresa, samples were positive for *faecal coliforms* in 48% of cases with a maximum of 1,100 CFU/100ml and for *streptococci* in 49% of cases, with a maximum of 2,400 CFU/ml. Finally, in Playa Manzanillo, samples were positive for *faecal coliforms* in 64% of cases with a maximum of 2,400 CFU/100ml and for *streptococci* in 77% of cases, with a maximum of 3,578 CFU/100ml.

In March 2021, a record value of 13,000 CFU/100ml was registered in Playa Carmen, Santa Teresa. According to the *Bandera Azul* program, highly polluted waters are those with values above 1,000 CFU/100ml.

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