Guidance for monitoring safely managed on-site sanitation (SMOSS)

Draft prepared for Phase 2 pilots

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Photo: UNICEF Bangladesh, Phase 1 SMOSS Pilot

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Reference: This document along with the five annexes are available at https://washdata.org/monitoring/sanitation/safely-managed-on-site-sanitation

World Health Organization | WHO UNICEF JMP | unicef

Summary

Introduction

This document summarizes emerging best practice monitoring methods to inform the monitoring of safely managed on-site sanitation (SMOSS). Although globally more people use on-site sanitation services than have sewer connections, there are major gaps in monitoring SMOSS [1]. Estimates for excreta that were emptied and treated off-site are only available for 1% of the global population using on-site sanitation. The lack of data on SMOSS presents a major constraint for national and global monitoring of SDG indicator 6.2.1a: the use of safely managed sanitation services, as well as for monitoring of SDG indicator 6.3.1 on wastewater treatment.

This document describes the global indicators for SMOSS, proposes different methods to collect data and suggests core questions that could be integrated into existing national monitoring systems. While there is not one standard approach to monitoring SMOSS, this document consolidates methods and findings from the JMP SMOSS Monitoring Phase 1 pilots as well as experience from global and national monitoring. This guidance aims to support Phase 2 pilot countries, and others looking to improve national monitoring of SMOSS, to build from existing knowledge and address the many outstanding monitoring gaps. Many aspects of SMOSS monitoring are still under development, and this guidance remains a draft document that will continue to be updated with findings from Phase 2 pilots and other national examples.

Global indicators

The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP), requires consistent assessment across countries, with globally comparable indicators that can be drawn from national data. These are the **global indicators** (Table 1), which all countries should be able to report on during the SDG period. There are potentially many **local indicators**, that capture additional details of safely managed sanitation that countries may decide to monitor depending on their national sanitation policies, context, and resources. Examples of possible local indicators are provided in Table 3, however these are not used in global monitoring.

Table 1. Global indicators for monitoring SMOSS

Containment	Containment is not overflowing or discharging waste to the surface environment
Disposal in-situ	Contained, not emptied; OR Contained, emptied, buried in-situ
Emptying	If containment ever emptied
Transport	Excreta delivered to treatment facility
Treatment	Designed to provide treatment for both solid and liquid phase

Methods

Monitoring SMOSS requires a mixed methods approach since assessing safely managed services requires data at both individual and communal scale so cannot rely on household questionnaires alone. Table 2 summarizes the different data collection methods applied in the pilots and indicates which methods are best suited to inform each part of the service chain.

Table 2. Sources of data across the service chain

Data collection method	Facility type	Containment	Emptying	Transport	Treatment
Household questionnaire				*	
Household sanitation inspection					
Data from service authorities (e.g. Administrative data)					
Data from service providers (including via regulators)					
Spot checks / inspections of service chain					

* In-situ only

Levels of reliability and use of source

Low High

This guidance provides **recommended core questions** that correspond to the global indicators for all data collection methods. The questions for household questionnaires and sanitation inspections were tested through Phase 1 pilots and other monitoring efforts. The proposed core questions for the other methods have not been as widely tested and may be further refined after the Phase 2 SMOSS monitoring pilots or from other national examples. The analysis section provides steps to generate national estimates and suggestions for integrating data from different sources, which will be tested in Phase 2 pilots.

Contents

Introduction to SDG 6.2 monitoring

Goal 6: Ensure availability and sustainable management of water and sanitation for all.

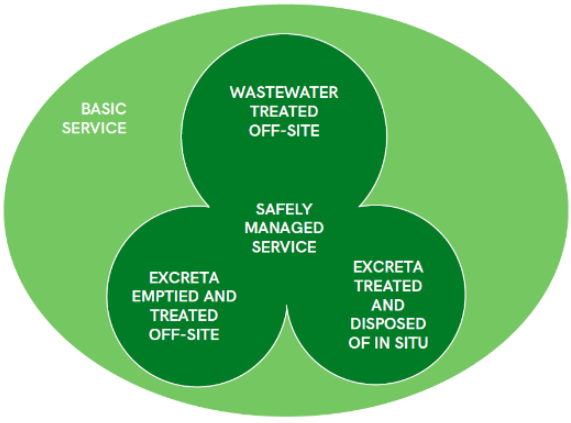
- **Target 6.2** By 2030, achieve access to **adequate and equitable** sanitation and hygiene for all and **end open defecation**, paying special attention to the **needs of women and girls** and those in vulnerable situations
  - **Indicator 6.2.1a** Proportion of population using safely managed sanitation services

The SDG global target 6.2 calls for use of safely managed sanitation services by all, as well as access to basic handwashing facilities with soap and water and the elimination of open defecation. This document focuses on safely managed sanitation, which requires that all excreta (wastewater, faecal sludge) be managed across all steps of the sanitation service chain: containment, emptying, transport and treatment. While previous global monitoring of sanitation focused on household access to improved toilets, the assessment of safely managed sanitation requires consideration of household level containment, emptying and disposal of excreta, as well as collection and treatment of wastes by formal or informal service providers at a community or larger scales. This reflects concerns relating to the poor management of faecal sludge in many parts of the world and the recognition that a large proportion of wastewater collected by sewer networks is not treated at all or receives insufficient treatment to protect public health [2]. Monitoring safely managed sanitation is complex as there are a variety of service options and criteria for assessing safe management at each step of the chain and data is needed for both on-site sanitation (i.e. excreta from septic tanks or pit latrines) and off-site sanitation (i.e. sewer systems).

The World Health Organization (WHO) and United Nations Children's Fund (UNICEF), through the Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene, track progress towards the SDG targets 6.1 and 6.2. Sanitation is monitored against the "service ladder" (Figure 1), which can be applied to all countries with different levels and types of sanitation. To be considered safely managed sanitation under SDG 6.2 requires that people use improved sanitation facilities that are not shared with other households (equivalent to the basic service level), and that the excreta produced should be managed through one of the three pathways shown on the right of Figure 1.

Figure 1. JMP ladder for sanitation services (left) and three pathways to safely managed services (right) [3]

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or removed and treated off-site
BASIC	Use of improved facilities that are not shared with other households
LIMITED	Use of improved facilities that are shared with other households
UNIMPROVED	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines
OPEN DEFECATION	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open places, or with solid waste



***Note**: Note: Improved facilities include: flush/pour flush toilets connected to piped sewer systems, septic tanks or pit latrines; pit latrines with slabs (including ventilated pit latrines); and composting toilets.*

Status of monitoring and need to focus on SMOSS

Despite being halfway through the SDG period, the 2020 estimates for SDG 6.2.1a compiled by the JMP found significant gaps in national data on the management of excreta from on-site sanitation systems (i.e. toilets or latrines connected to septic tanks, pits or other on-site containments). Excreta from toilets connected to sewers is considered off-site sanitation and is considered safely managed if excreta are transported through a sewer with wastewater and then treated off-site. Data on wastewater treated off-site were available for 91% of the global population with sewer connections [1]. On-site sanitation can be considered safely managed if excreta are either i) stored, treated and disposed of in situ, or ii) stored temporarily and then emptied, transported and treated off-site. Data on safe disposal in-situ were available for 59% and 69% of the urban and rural populations respectively, yet data on excreta that was emptied and treated off-site were only available for 1% of the global population using on-site sanitation. Given that more households use on-site sanitation than sewers, and the use of on-site sanitation facilities is increasing faster than sewer connections, this lack of data on SMOSS presents a major constraint for national and global monitoring of SDG 6.2.

Objective of this guidance

This guidance is designed to support the improvements to national monitoring of safely managed on-site sanitation (SMOSS). It details how SMOSS is monitored by the JMP at the global level, describes the steps to identify gaps and opportunities to improve national monitoring of sanitation, and supports the design of monitoring methods to track progress of SDG6.2. Many of the examples and suggestions in this guidance come from the Phase 1 SMOSS monitoring pilots, global examples and other material developed by WHO and UNICEF. The Phase 1 pilots were supported by the JMP through funding from the Bill and Melinda Gates foundation and were conducted in Bangladesh, Ecuador, Indonesia, Kenya, Serbia and Zambia between 2020-2022 and the methods and lessons documented in the Phase 1 Synthesis Report.[1] This guidance will inform Phase 2 pilots being implemented in 2022-2023.

There is not one standard approach to monitoring, particularly given the variability of SMOSS systems and services and available national data sources. This guidance does not prescribe a monitoring approach but instead aims to support improvements to national monitoring of SMOSS through this consolidation of existing methods, proposed pre-tested survey questions and steps for implementation to simplify survey design and optimize how Phase 2 pilots can address remaining monitoring gaps. As many aspects of SMOSS monitoring have not been widely tested or are still under development, this guidance remains a draft document that will be updated based on the findings of Phase 2 pilots or other national examples.

This guidance includes a summary of the necessary global indicators used by the JMP to monitor SDG 6.2.1, possible local indicators that can be used for national targets or local planning, common methods for data collection and analysis of data to develop estimates of safely managed services. In some sections there are links to the Phase 1 synthesis report which provides greater detail on indicators and methods used to date. The Annexes include a draft set of recommended core questions for national monitoring of SMOSS, examples for existing national monitoring efforts and further details on survey design and the analysis of indicators to calculate national estimates for SDG indicator 6.2.1a. The annexes are available on the WASH data SMOSS monitoring webpage and can be accessed by the following links:

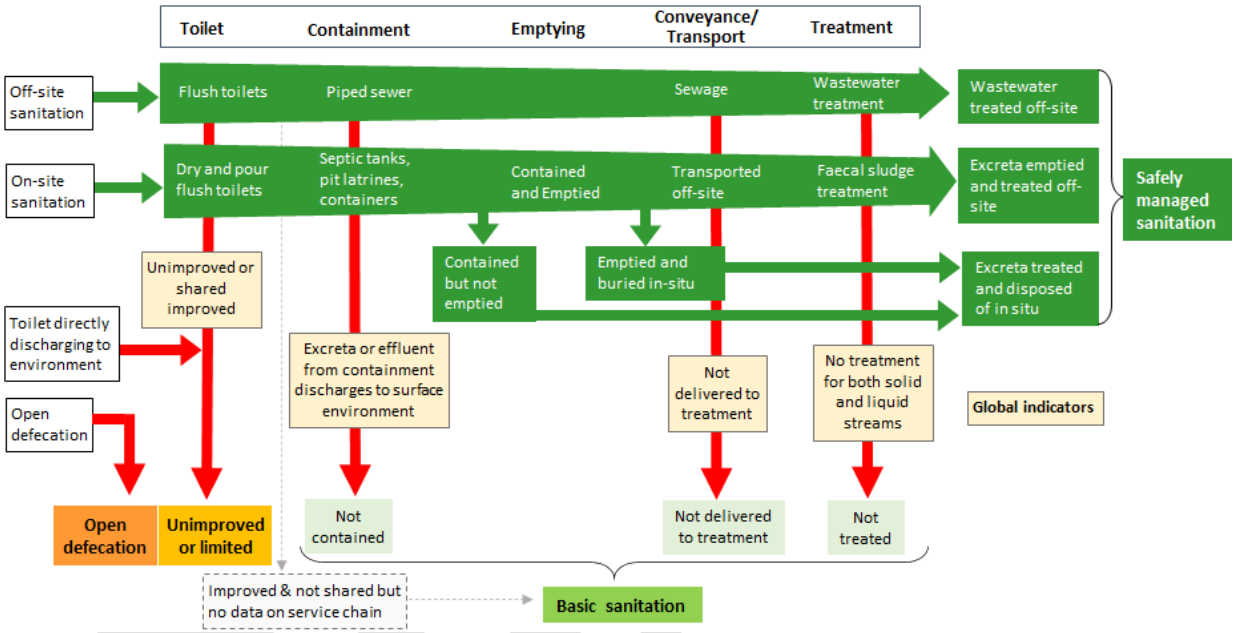
- A. Global indicators for monitoring SMOSS
- B. Data collection – Household questionnaire
- C. Data collection – household sanitation inspections
- D. Data collection - Service authority and service provider surveys
- E. Analysis to inform national estimates for SDG 6.2.1 – to be uploaded soon

[1] Monitoring safely managed on-site sanitation (SMOSS): Synthesis of lessons from phase 1 pilots and recommendations for phase 2 pilots. https://washdata.org/sites/default/files/2022-05/jmp-2021-smoss-synthesis-report.pdf

Indicators for monitoring SMOSS

Safely managed sanitation is the highest level on the JMP sanitation service ladder (Figure 1) and therefore requires that sanitation facilities already meet the criteria of the lower rungs: use of improved facilities that are not shared with other households (equivalent to the basic service level). To be considered safely managed sanitation requires that excreta are managed across all steps of the sanitation service chain from toilet to treatment or final disposal. As is shown in Figure 2 there are different pathways to achieve safely managed sanitation for on- and off-site sanitation, and within on-site sanitation there are three options (contained but not emptied, emptied and safely disposed in situ and emptied and treated off-site). Assessment must therefore be done systematically across each step.

Figure 2. Excreta flow diagram showing global indicators used for global monitoring of safely managed sanitation (adapted from [4], [5])



Global and local indicators for assessing SMOSS

JMP has defined **global indicators** for monitoring SDG 6.1 and 6.2 to allow a consistent assessment approach across countries with comparable indicators and adequate existing national data. Only a select few criteria currently meet these requirements for inclusion in the definition of the SDG 6.2.1a indicator. It is recognized that the global indicators do not capture all aspects of safety identified in the WHO guidelines on Sanitation and Health [4]. There are potentially many **local indicators**, that capture additional details of safe sanitation practices that countries may decide to monitor depending on their national sanitation policies, context, and resources. Description of the global indicators and example local indicators are presented Table 3. This list is not intended to be comprehensive but rather provides illustrative examples of the types of local indicators currently being considered for national and sub-national monitoring at different steps of the service chain.

As part of their national commitment to the SDGs, all countries should be able to report against these core SDG indicators. This requires that indicators assessed in national monitoring systems align in principle with the JMP indicators to enable consistent reporting on SDGs in a way that is comparable across countries. Governments are expected to localize the global SDG indicators and set their own national targets for progressively reducing inequalities in services towards safely managed services for all,

considering national contexts, capacities and levels of development, and respecting national policies and priorities [6].

In some countries nationally defined indicators may differ from the global SDG indicators. This may be due to ongoing use of old MDG indicators, or if national targets define safely managed sanitation differently from the JMP definition, often to meet specific national objectives. In the first case, a recent UNICEF review of monitoring SDG6 across eastern and southern Africa, noted that in many cases minor changes to national surveys, such as revising or adding survey questions, could improve alignment with JMP indicators [7]. Where the indicators used to monitor national targets differ, then monitoring systems should capture data for both national and global indicators, as global indicators would not be comparable if changed or interpreted differently for each context. Figure 3 shows an example of how local indicators could be included to develop an estimate of a national sanitation target or service standard that may differ from the JMP estimate for reporting on SDG 6.2.1. Clear communication will be necessary when reporting these different findings to improve understanding of the difference between national and global values. A few examples of national targets that differ from the global (JMP) definitions include:

- In Indonesia the national target requires on-site systems are emptied after 5 years to be considered safely managed, whereas the JMP indicators do not specify emptying frequency.
- In Bangladesh the national sanitation strategy 2005 considers latrines shared between a maximum of 2 households as improved [8] and therefore potentially safely managed, whereas JMP indicators consider shared facilities as a limited service and not eligible for safely managed sanitation.
- In Bolivia only sewerage (off-site sanitation) is considered improved sanitation for urban areas with all on-site sanitation considered not improved, which differs from the JMP definitions [9].

Figure 3. Example excreta flow diagram showing local indicators that may be considered for national and sub-national monitoring of safely managed sanitation

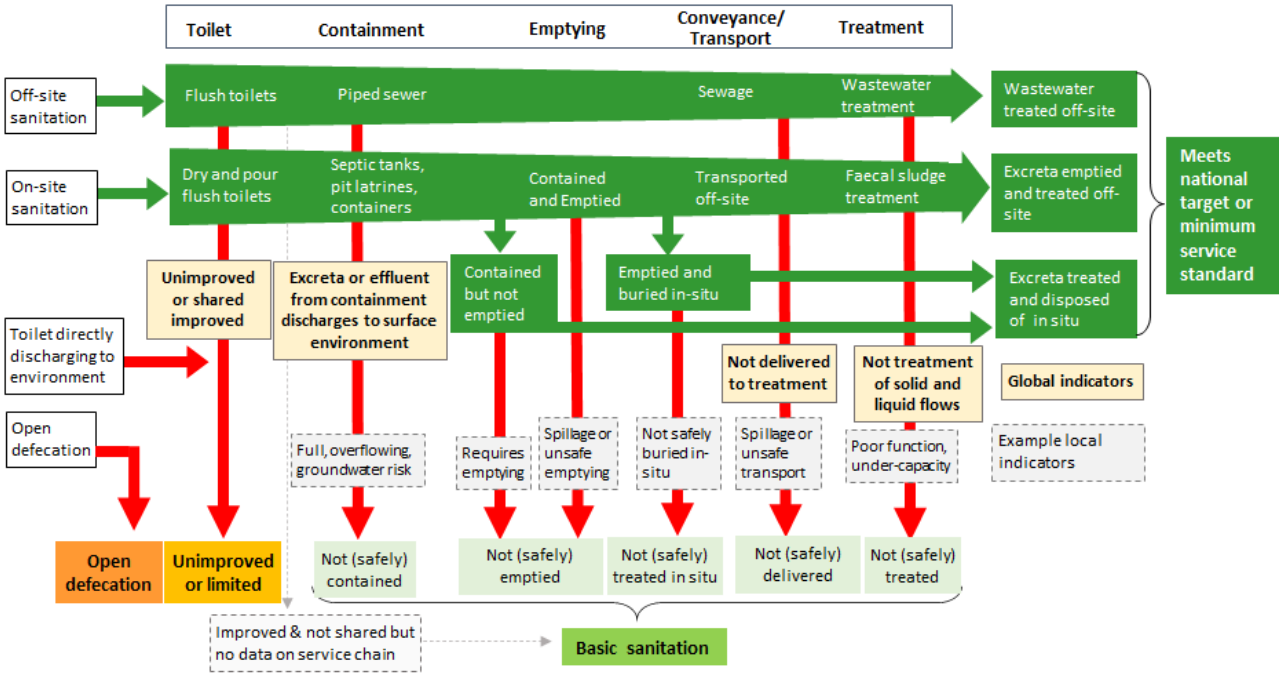


Table 3. Summary global indicators and example local indicators

	Global indicators	Example optional local indicators for national monitoring
Toilet facility	Use of improved facilities	- **Use:** all members using facility, child stool disposal, cleanliness - **Access:** Location, accessibility all times and to all, privacy, safety,
	Not shared with other households	- **Use:** all members using facility, number households sharing, restrictions, payment - **Safety:** Cleanliness, privacy, lockable doors, proximity, lighting, gender separated, - **Quality:** water access, tiling, handwashing
Containment	Containment[2] is not overflowing or discharging waste directly to the surface environment	- **Design standards:** sealed cover, wall and base material or permeability, chambers, dimensions, outlet type - **Functionality:** damage, blockage, leaks, sludge depth - **Groundwater risk**: proximity to wells, depth of groundwater, soil characteristics density (volume/area requirements for infiltration)
Disposed in-situ	Contained, not emptied	- **Function:** Years operation, size, sludge depth, - **Risks:** Groundwater risk, flood risk
	Contained, emptied, buried in-situ	- **Location:** on/off premises, distance from house - **Safety:** covered, how buried, buried in rainy season, groundwater risk, proximity to waterways / residents - **Reuse:** contents used after less than 2 years storage
Emptying	If containment ever emptied	- **Emptying frequency:** years, regular or scheduled - **Method**: manual, mechanical (type of equipment) - **Safety to workers:** PPE/protection, not entering pit - **Safety to user/public:** no spillage, flushed to drain - **Accessibility:** location of containment, presence of lid/manhole, street access
Transport	Excreta delivered to off-site treatment facility	- **Method of transport:** manual (cart), motorized, - **Safety to workers:** PPE/protection during transport - **Safety to user/public:** no spillage, covered transport, vehicles not used for water supply
Treatment	Designed to provide treatment for both solid and liquid phase	- **Design standards:** meets national standards for faecal sludge treatment facilities; treatment adequately level for the risk of exposure to the effluent - **Function:** Systems function, not overloaded/ reasonable capacity, not damaged, leaking, overflowing or bypassed.
Reuse	Not included in global indicators for SDG 6.2	- **Safety:** duration stored, compliance with quality standards, adequate treatment for intended reuse - **Use:** type of use, method of application,

[2] Containment is defined as a permeable or impermeable container for storing excreta close to the toilet or latrine. Examples of containments include latrines pits, cesspools, septic tanks, and holding tanks.

Table 4. Monitoring definitions for on-site sanitation (expanded from JMP 2018 Core questions - Table 3)

Definitions of improved sanitation facilities	Notes on classification
• **Flush/pour-flush toilet:** a flush toilet has a cistern or holding tank to store water for flushing and has a water seal (which is a U-shaped pipe below the seat or squatting pan) to prevent the passage of flies and odours. A pour-flush toilet also has a water seal but has no cistern and water is poured by hand for flushing. • **Flush to piped sewer system:** is a toilet that flushes excreta to a system of sewer pipes, also called sewerage, which is designed to collect human excreta (faeces and urine) and wastewater and remove them from the household environment. • **Flush to septic tank:** is a toilet that flushes excreta to a water-tight container, normally buried underground away from the dwelling, designed to separate liquids from solids which are then allowed to settle and decompose. • **Flush to pit latrine:** is a toilet that flushes excreta to a covered pit which retains solids. The base and sides of latrine pits may be permeable to allow liquids to percolate into the soil. • **Flush/pour flush to don't know where:** indicates that the household uses an improved sanitation facility but does not know whether it flushes to a sewer, septic tank or pit latrine. • **Pit latrine with slab:** is a dry sanitation system that collects excreta in a pit in the ground. The pit is covered by a squatting 'slab' or platform that is constructed from materials that are durable and easy to clean. The 'slab' has a small drop hole, or is fitted with a seat, allowing excreta to be deposited directly into the pit. • **Composting toilet:** is a dry toilet into which carbon-rich material (vegetable wastes, straw, grass, sawdust, ash) is added to the excreta and special conditions maintained to produce inoffensive compost. A composting latrine may or may not have a urine separation device. Optional response categories (to include if technology possibly in use in the survey area) • **Twin pit latrine with slab:** refers to a system where households use a second pit when the first one fills up and is designed to ensure that excreta are treated in situ for a sufficient amount of time before the wastes are evacuated safely. Twin pit latrines can be dry (double VIP, fossa alterna) or wet (offset pits connected to pour flush toilets). • **Container based sanitation:** refers to a system where toilets collect excreta directly in sealable, removable containers (also called cartridges) which are regularly collected by commercial service providers and delivered to treatment. If there is no active and functioning program for collection and treatment, the container should be classified as a bucket. • **Ventilated improved pit (VIP) latrines** (dry pits with ventilation pipes) are used in some parts of the world but neither ventilation nor superstructure design are part of the definition of an improved sanitation facility. Some latrines have tight-fitting lids to cover the drop hole when not in use, but such lids are not part of the definition of improved sanitation facilities.	1. **Improved sanitation facilities** are those designed to hygienically separate human excreta from human contact. These include wet sanitation technologies such as flush and pour flush toilets connected to sewers, septic tanks or pit latrines, and dry sanitation technologies such as dry pit latrines with slabs and composting toilets. 2. **Sewer systems** consist of facilities for collection, pumping, treating and disposing of human excreta and wastewater. Losses that occur during transport and treatment cannot be monitored through household surveys. 3. **Septic tanks** are designed to contain and treat excreta in situ and should have at least two chambers separated by a baffle and a T-shaped outlet pipe to reduce the scum and solids that are discharged. The effluent should infiltrate into the subsurface through a soak pit or leach field, or discharge to a sewer system. However most household survey respondents are not able to provide technical information on the design of and construction of storage tanks. 4. The principal difference between improved and unimproved pit latrines is the presence of a 'slab'. **Pit latrines with slabs** that completely cover the pit, with a small drop hole, and are constructed from materials that are durable and easy to clean (e.g. concrete, bricks, stone, fiberglass, ceramic, metal, wooden planks or durable plastic) should be counted as improved. Slabs made of durable materials that are covered with a smooth layer of mortar, clay or mud should also be counted as improved.
Definitions of unimproved sanitation facilities	**Notes on classification**
• **Flush/pour flush to open drain:** refers to households using toilets that discharge into uncovered drains which do not effectively contain excreta thereby exposing the community to faecal pathogens.	5. '**Flush/pour flush to elsewhere**' suggests that excreta is not being discharged into a sewer, septic tank or pit latrine) but into the local environment and should therefore be classed as unimproved.

• **Pit latrine without slab/open pit:** is a dry sanitation system that uses a pit in the ground for excreta collection and does not have a squatting slab, platform or seat. An open pit is a rudimentary hole in the ground where excreta is collected. • **Bucket:** refers to the use of a bucket or other container for the retention of faeces (and sometimes urine and anal cleaning material), which are periodically removed for treatment, disposal, or use as fertilizer. • **Hanging toilet/hanging latrine:** is a toilet built over the sea, a river, or other body of water, into which excreta drops directly. • **No facility/bush/field:** includes defecation in the bush or field or ditch; excreta deposited on the ground and covered with a layer of earth (cat method); excreta wrapped and thrown into garbage; and defecation into surface water (drainage channel, beach, river, stream or sea).	6. **Pit latrines with slabs (any other optional sanitation facilities)** that only partially cover the pit, or with slabs constructed from materials that are not durable and easy to cleanJ (e.g. sticks, logs or bamboo) **should be classified as 'pit latrine without slab'** and counted as 'unimproved', even if they are covered with a smooth layer of mortar, clay or mud. 7. The use of open '**buckets**', 'pans', 'trays' or other unsealed containers which are collected and emptied each day by informal service providers (including 'manual scavengers') presents significant health risks and is classed as an 'unimproved sanitation facility'.
Definition of contained	**Notes on classification**
"Contained on-site sanitation facilities" have containments that do not overflow or discharge excreta directly to the surface environment • **Containment:** permeable or impermeable containers for storing excreta close to the toilet or latrine. Examples of containments include wet or dry pit latrines, septic tanks, and holding tanks. • **Not overflowing or discharging excreta:** containment does not overflow or discharge waste to the surface environment including: from an outlet (or overflow) pipe to the surface or waterways, overflow or flushing out of excreta during flooding, and leakage of excreta due to cracks or collapse of containment. • **Directly to surface environment:** refers to direct discharges to surface environments (ground, floor, drains, waterways) which may expose the household to harmful pathogens . Does not include sub-surface infiltration. Not contained: • Containment has an outlet/overflow pipe that discharges excreta directly to the surface environment, or is broken/leaking/overflowing excreta, and may therefore expose the household to harmful pathogens	8. This applies to on-site sanitation (containment facilities) and not toilets connected to sewer (see above for classification of toilets that **flush/pour flush to open drain**). 9. Containment applies to both solid contents (settled sludge consisting of excreta along with hygiene or other waste products) and the liquid contents (supernatant consisting of excreta, flushing and ablution water, and occasionally also greywater from kitchen, washing, bathing, etc.). 10. **Dry pit latrines** (and container based sanitation) receive relatively little liquid inputs and are less likely to have outlet pipes for liquid effluent but may discharge excreta due to flooding or damages/collapse. 11. Many containments discharge liquid to the soil/ground through infiltration from the impermeable walls or base of the containment. For the purposes of SDG monitoring these are considered as 'contained', as long as the effluent does not contaminate the surface environment. In some contexts expanded indicators may be used to assess potential risk to groundwater.
Definition of emptied	**Notes on classification**
• **Emptied:** improved on-site sanitation storage facilities with containments (septic tanks or latrines) which have **ever** been emptied. • **Not emptied but covered and left undisturbed when full:** As all pit latrines and septic tanks could be emptied, the emptying question is typically asked to all respondents with improved containments. However dry pit latrines, particularly in rural areas where there is adequate space, are not emptied when the pit is full but instead covered and a new one built. While this is equivalent to never emptied, given previous confusion for respondents that do not expect their dry pit requires emptying, this response category is suggested.	12. It is recognized that some containments are designed for regular emptying (e.g. septic tanks) however this is not considered in the global indicator. Expanded indicators can be used to assess duration of operation (age) or time between emptying (emptying frequency) and compare these to the design emptying frequency from local standards. 13. All service providers (including private or informal) and methods of emptying (including manual /shovel) are included. 14. If survey respondents don't know if the containment has been emptied, the facility can be classified as 'not emptied'.
Definition of in-situ treatment and disposal	**Notes on classification**
Treatment and disposal in situ is classified as: • **Contained, not emptied:** All improved on-site systems that are contained but have never been emptied (see emptying definition above) are considered safely managed through treatment and disposed in-situ. • **Contained, emptied, buried in-situ** All improved on-site systems that are contained, emptied and disposed of in-situ.	15. **In-situ** is not limited to the household premises and can also include covered burial nearby to the household. There is no definition or limit on the proximity. 16. **Covered pit/trench elsewhere:** While similar to buried in-situ this is classified as delivered off-site. 17. **Arborloos:** the practice of planting a tree on-top of a covered pit fits into this category.

This includes buried in a covered pit at or near the household.	18. Potential risk to groundwater from in-situ disposal is not considered**.**
Definition of transported to treatment	
• **Transported to treatment**: Excreta and other materials (faecal sludge) removed from containments and delivered to an off-site treatment plant or designated disposal site. • **Buried in a covered pit/trench elsewhere** (not at or near household) is considered transported to treatment.	19. **Transport** does not consider the level or type of treatment, therefore faecal sludge discharged at the follow sites can be considered transported: treatment plants (all types), piped sewer networks connected to treatment, or designated sites for faecal sludge treatment and disposal (i.e. landfill, drying beds, constructed wetlands, trenches) 20. **Transported and discharged to open drains, water body or open ground (including agriculture fields) are considered not transported to treatment**. While on-site sanitation facilities provide some minimal treatment, faecal sludge is unlikely to be adequately treated for direct use **in agriculture or disposal in the environment.** **21.** All methods of transport (manual cart, truck or tanker) are included
Definition of treated	**Notes on classification**
• Faecal sludge is considered treated if delivered to a treatment plant that is designed to treat both solid and liquid phases, and is treated. • Types of treatment accepted for faecal sludge are summarised Figure A3. Solid-liquid fraction separation alone is not considered treated.	22. For SDG 6.2 (safely managed sanitation) only the specified type and level of treatment is considered. Performance of the treatment plant and exposure risk of disposal and reuse are not considered for SDG 6.2. 23. For SDG 6.3 (safely treated wastewater) performance of treatment plants against national standards is considered. Exposure risk of disposal and reuse are not considered for SDG 6.3. **24.** Faecal sludge can be treated at a faecal sludge treatment plant, a wastewater treatment plant, or co-treated with solid waste/composting (provided both solids and liquids are treated). 25. Transport response category “Buried and covered in a pit/trench elsewhere” can be considered off-site treatment as per safe burial and storage (e.g deep row entrenchment).

Data collection methods and sources

Monitoring safely managed sanitation requires information about household sanitation systems and their management at an individual scale as well as services that are shared at a communal or city scale. To capture information from different groups and at different scales requires a mixed methods approach, recognizing that traditional household questionnaires cannot reliably inform safe transport and treatment steps. Table 5 summarizes different methods to collect sanitation data and which are best suited for informing each part of the service chain.

Table 5. Potential sources of data for different steps of the service chain

Service chain / Data collection method	Facility type	Containment	Emptying	Transport	Treatment
Household questionnaire				In-situ only	
Household sanitation inspection					
Data from service authorities (e.g. Administrative data)					
Data from service providers (e.g. via regulators)					
Spot checks / inspections of service chain					

Levels of reliability and use of source Low  High

There remain significant gaps in global data on emptying, transport and treatment of excreta from on-site sanitation facilities, with JMP data on excreta emptied and treated off-site only available for 1% of the relevant global population [1]. In most countries additional sources of data will be needed to supplement household surveys for monitoring across the entire service chain. This section summarizes the steps of identifying the coverage and gaps of existing national monitoring systems, provides steps and core questions to expand existing monitoring to capture all SMOSS indicators and an overview of considerations for each data collection method detailed in Table 5.

Assessment of existing national monitoring systems

Coverage and gaps in current sanitation monitoring

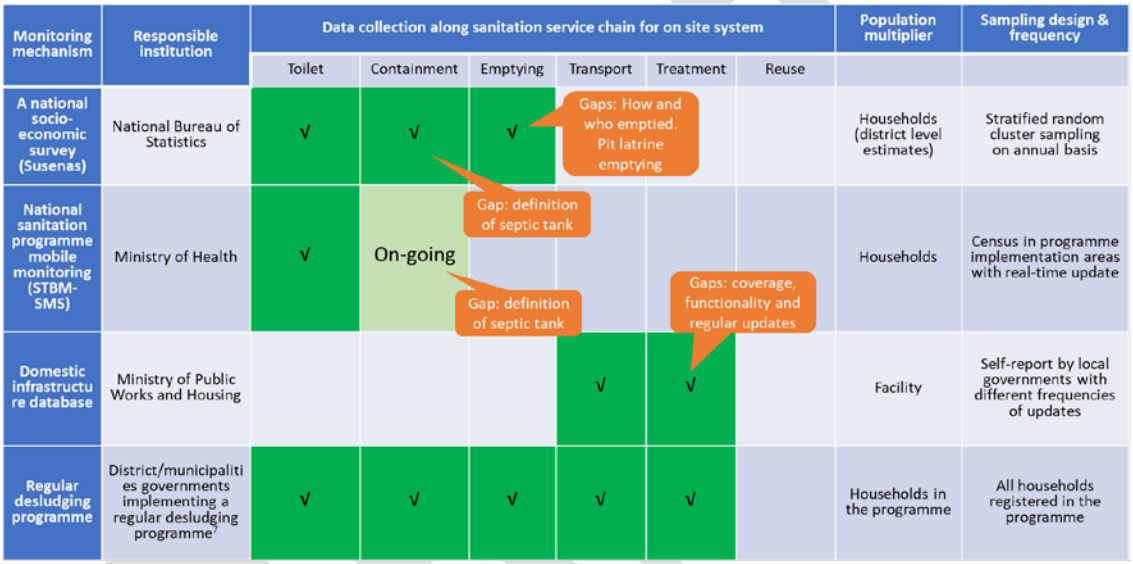
To identify how to improve SMOSS monitoring an **assessment of existing monitoring systems** is needed to understand how it aligns with global SMOSS indicators, whether data is captured all service steps and for all population groups. In the phase 1 pilots, compilation of relevant data sources and tools was an important initial activity that typically included a desktop assessment followed by interviews or a stakeholder workshop to identify lesser-known sources. A range of stakeholders were included given the responsibility for on- and off-site sanitation in urban and rural areas is often fragmented across many actors. It was also important to include relevant service or environmental regulators and the bureau of statistics. In Ecuador the analysis of the existing data sources and identification of gaps resulted in increased awareness in the SMOSS pilot from the involved governmental institutions, principally the National Institute for Statistics and Census (INEC) and the Water Regulation and Control Agency (ARCA). In Indonesia mapping of data gaps for national and global monitoring led to the allocation of different government and non-government agencies to be responsible for collecting data and reporting on different parts of the service chain.

Assessing alignment of existing survey questions with the global indicators or core questions requires attention to the nuanced wording and objective of the indicators. Often questions appear similar but may

not provide the necessary information for reporting against the global indicators for SMOSS. For example, some household questionnaires collect information on septic tank emptying but not of pit latrines, or whether full but not if emptied; or administrative data may indicate the sludge treatment design capacity but not whether both the solid and liquid fractions are treated (global indicator). Comparison of existing survey questions with the core questions provided in Annex B could identify what changes (minor amendments to wording, additional response categories) or additional questions are needed.

Figure 4 presents an example from Indonesia of their assessment of monitoring across the sanitation service chain and their identification of monitoring gaps relevant to global and local indicators. The data on population, sample design and frequency are also valuable to inform how this data relates to the national population and how it can be integrated with other sources. For example, data on emptying, transport and treatment may only be available for urban areas, or regular household monitoring may exclude certain minority populations, such as informal settlements. The JMP 2017 update and baseline includes a summary of criteria for data acceptance for JMP estimates [10].

Figure 4. Assessment of SMOSS in existing data and potential data sources, Indonesia



Integration of global indicators into national monitoring systems

Once these gaps are identified it is then valuable to identify how additional core questions or new methods can be integrated into existing national monitoring systems. Given the objective of these pilots is to inform and improve national monitoring of SMOSS, this integration is important to enable regular data collection at scale. Discussions with stakeholders at the outset of the pilots helped to identify the regular, or soon to be implemented, monitoring which new questions or tools could be integrated or tested within the pilot projects. Discussions with the national statistics bureau provided information on the timing and steps required to test or validate new questions before they could be integrated into large national surveys. The pilots could then focus on testing and justifying additions for future surveys.

As detailed for each data collection method below, there were There are various approaches to integrate SMOSS monitoring into existing data collection efforts, including:

- **Update or add questions to existing sources of sanitation data**: In Indonesia, the Bureau of Statistics required that a SMOSS questions were tested in a national water quality survey before they could be added to the national household survey (SUSENAS). Household sanitation inspections tested in the pilot will be integrated into the public health inspections part of existing monitoring for the national program to end open defecation.

- **Add SMOSS component to an unrelated survey** that samples the same participants, will be implemented in the short-term and accepts addition of new questions. In Ecuador, SMOSS questions were added to a household employment survey as it was conducted annually and permitted additional questions.
- **Use existing communication channels** or platforms to distribute SMOSS related service authority or service provider surveys. For example, the pilot in Serbia engaged a local NGO forum supporting local government units to distribute sanitation related surveys to the local government and service providers.

For the pilots, an alternative to integration into existing national monitoring systems was to conduct dedicated surveys for one-time data collection. Reasons integration was not feasible was due to lack of suitable monitoring mechanisms, poor timing or needing to test questions at scale before integration. The dedicated surveys gave pilots the flexibility to conduct the surveys within the pilot period and allowed testing of a larger range of questions than often permitted when integrating in existing surveys. In order to inform ongoing routine monitoring, dedicated surveys should be designed with the objective of refining questions or methods to integrate into routine data collection and inform national monitoring and reporting on safely managed sanitation.

Data collection methods

The following section describes the proposed five data collection methods for informing SMOSS. For each method there is a summary of the type of sanitation services they are best suited to monitor, examples of how they have been implemented and considerations for survey design. Countries should determine what methods best suit their institutional context and existing monitoring systems, informed by the previously mentioned monitoring gaps assessment. To date there are many more examples of the application of household questionnaires to monitoring SMOSS that the other methods, however household questionnaires alone will not fill the important data gaps on emptying and treatment from on-site sanitation.

The annexes B-D provide the proposed core questions for each data collection method, example expanded questions and a summary of sampling considerations.[3] The SMOSS monitoring pilot phase 1 synthesis report provides details of the methods used by each pilot country, their approach to implementation and sampling.[4]

[3] Annexes available at https://washdata.org/monitoring/sanitation/safely-managed-on-site-sanitation

[4] Monitoring safely managed on-site sanitation (SMOSS) : Synthesis of lessons from phase 1 pilots and recommendations for phase 2 pilots. https://washdata.org/sites/default/files/2022-05/jmp-2021-smoss-synthesis-report.pdf

Household questionnaire

Censuses and nationally representative household surveys make up around 50% of the national data sources contained the JMP global databases for monitoring water and sanitation [4]. Household questionnaires are often based on those of international survey programs (e.g. MICS, DHS or a combination of modules) and ask questions about the household's sanitation facilities, their use and function and related social-economic information. The scale of household questionnaires and inclusion of socio-economic questions enables sanitation data to be disaggregated to assess inequalities between population sub-groups (e.g. urban/rural, sub-national region, wealth quintiles, ethnicity, education).

What parts of SMOSS are monitored: Household questionnaires typically rely on self-reporting, which is effective for easily understood questions, however, can be less reliable when questions become more technical or relate to services occurring outside their household. For this reason, household surveys are an effective means to capture data about access, the use and function of sanitation facilities. They can provide some information on the type of containment, emptying occurrence and in-situ disposal practices, yet are considered unreliable for assessing transport, disposal and treatment of excreta off-site (see Table 5 above). Proposed core questions for household surveys and how they inform SMOSS indicators are provided in Annex B Table B1. Examples of expanded questions that could be used to monitor local indicators or inform service delivery are provided in Table B2. The additional time for data capture and analysis should be considered when selecting expanded questions and inclusion of core questions should be prioritized as these are necessary to inform estimates for SDG 6.2.1.

Implementing household surveys in SMOSS Pilots: In the phase one pilots, household questionnaires were either integrated into existing national monitoring or conducted as a dedicated survey for the pilot. As noted above, there are a range of options for integrating household survey questions into national monitoring systems and for the pilots, the timing of existing surveys and ability to add new questions were important considerations. Dedicated household surveys were either implemented by the pilot partners (Bangladesh pilot was implemented by UNICEF staff and volunteers), by local environmental health staff (Serbia and Zambia) or contracted to an independent organization managing survey design and implementation (Ecuador and Kenya). The enumerators' experience and knowledge about sanitation and the extent of training they received on the survey were important to ensure quality data collection, particularly for the assessment of technical aspects of sanitation (e.g. type of facility, discharge of effluent or sludge). To improve data quality, it was important to adequately pilot-test questions to confirm interpretation and reduce ambiguity. Supplementary explanations were sometimes provided to enumerators to address common assessment challenges or a systematic approach to clarifying.

Survey design: To improve the quality of questionnaires and ensure they can provide data needed for SDG estimates, some important survey design steps include:

1. Confirm list of indicators and analysis plan prior to data collection to ensure questions can inform global indicators, and if needed also local indicators. This may require updating or adding new questions to existing national surveys (see suggested core questions in Annex B Table B1).
2. Clear question and response wording and piloting questions to confirm correct interpretations. Piloting surveys can also identify additional response categories to reduce use of "other" responses, which were time consuming at the interview and analysis stages. A table of definitions is provided in Annex A Table A3 that should support accurate interpretation of the intention and conditions of each indicator. A summary of ambiguous survey questions to demonstrate common challenges in terminology is provided in Annex B section B.3.
3. Adequate training of enumerators and pre-testing to confirm enumerators understand survey intention and terminology, particularly related to facility types and discharge from containment.

Sampling: The scale and sample size were chosen based on the objective of the survey and budget. Some pilots conducted nationally representative surveys that could inform national estimates (e.g. Bangladesh, Serbia and Zambia), while others conducted targeted surveys to test methods in greater detail and include priority demographical contexts (e.g. Kenya). Information on sample design and identification are provided in Annex B section B.4.

Household sanitation inspections

Household sanitation inspections are an observational technical and risk assessment of toilet facilities and containments that can capture more technical details than household questionnaires or validate what is self-reported by households. Inspections can also be conducted for treatment plants, see below.

What parts of SMOSS are monitored: The ability of household questionnaires to accurately assess sanitation facilities depends on how well enumerators are able to explain the nuances of technical sanitation features, which may not always align with common interpretations (e.g. many types of containment are interpreted to be "septic tanks"). Inspections are therefore useful to provide a more accurate assessment of the technical aspects of household sanitation facilities, that may not be answered reliably in a questionnaire. Aside from inaccuracies in technical classification, self-reporting by households may not be valid when there is known non-compliance with regulations (e.g. effluent discharge to drain) or embarrassment (e.g. containment damaged or overflowing). Inspections can therefore be used to assess facility type, containment and effluent discharge, issues with system function or health risks. Inspections often go beyond monitoring and discuss follow up actions to improve containments or reducing risks. Inspections have also been used to monitor toilet accessibility, cleanliness, privacy, and handwashing facilities and materials, but this report just focuses on their use in assessing containment.

Implementing sanitation inspections: Inspections can be implemented as part of a larger household questionnaire or conducted as dedicated sanitation inspection. Depending on the scope and objective of the household questionnaire, integrating inspections may mean fewer observations can be included and that the enumerators are not necessarily technically trained. However, integrating inspections into large scale household surveys will likely enable large sample sizes and minimum additional cost to the standard questionnaire. In Annex C Table C1 we have proposed the minimum **core questions** for household sanitation inspections that could be integrated into a household questionnaire to assess the global indicator for containment. Dedicated inspections could be conducted by a technically skilled enumerator and go into more detail, such as conducting more detailed risk assessments, with example **expanded questions** provided in Annex C Table C2. There are examples of dedicated sanitation inspections conducted in France, Ireland and Japan which are summarised in Annex C section C.3.

Enumerators and training: These inspections could be conducted by environmental health inspectors (in countries where these exist) or community health extension workers (e.g. Indonesia). The former are more likely to have specialist technical knowledge but can only visit a small number of households each year. The latter are less likely to have specialist technical knowledge but are able to continuously collect information at scale. Detailed training is required even for enumerators with an environmental health background, to ensure their assessments align with the core indicators and definitions, not influenced by their personal perceptions of "good" sanitation systems. Photos of different response options or diagrams of critical inspection points can be used to support the enumerator, with the WHO sanitation inspection checklists including a diagram of typical sites to assess for each sanitation facility type [11].

Survey design: A range of methods can be integrated into inspections including taking photos, measuring containment sizes or distance to critical points, or internal tanks inspections. However, the value of these expanded methods to inform SMOSS global indicators, compared with the time and challenge in data collection and analysis, requires further assessment. Some of these may be useful for initial formative research but not needed for ongoing monitoring. The synthesis of Phase 1 pilots includes details of various expanded indicators and challenges faced with internal inspections, including the low acceptance rate. In Indonesia, only 25% of households permitted inspection and of these less than one third were accessible.

Sampling: For inspections conducted with household surveys, a portion of samples could be chosen for conducting the inspection. The Bangladesh pilot conducted inspections for one third of surveyed households. The sampling approach or size to be nationally representative remains a knowledge gap that could be investigated by Phase 2 pilots. It depends on the variability of responses and how the data will be analysed and used. For example, either integrated with household survey responses or to form a general national assumption (i.e. a country specific estimate for the portion of uncontained septic tanks. Annex C.4 provides examples of sampling methods and size from Phase 1 pilots as well as Ireland and France national monitoring.

Service authority surveys (Administrative data, local government surveys)

Administrative data refers to the routine data collected by governments and service providers in the course of their day-to-day business (registration, record keeping, service delivery) [12, 13]. Although administrative data are primarily collected with a specific decision-making objective in mind, they can be processed to respond to many national statistical needs [14]. Administrative data forms an important part of JMP monitoring with 38% of national sources used for the 2021 JMP progress report for sanitation coming from administrative data sources [1]. For monitoring SMOSS, administrative data is valuable to inform service indicators that are beyond the household scale (e.g. emptying, transport, treatment).

There are very few examples of the use of administrative data from service authorities or service providers to inform SMOSS indicators, most data relates to wastewater. Therefore the core questions and methods to collect and use administrative data proposed in this guidance have not been widely tested and are considered still in development. Recognizing that approaches and sources of administrative data vary widely, the questions and approach proposed are generally applicable and should be adapted to the national sanitation and monitoring context.

Target audience: Given local authorities (local government, municipality, etc.) are ultimately responsible for overseeing the sanitation services provision, this section outlines how data to inform global indicators on SMOSS could be collected from local **service authorities**. While the service authority can also act as the service provider, this section focuses on their role as the authority and data relevant to sanitation services within the administrative jurisdiction (e.g. district, city, province). The following section details data collection from **service providers** about their individual service provision. Further explanation of the division of these roles are provided in Annex D.

Sources of administrative data: Ideally local governments are routinely collecting and storing data on all steps of the sanitation service chain as part of their oversight and management of services. Central government may require all local government units to periodically report on a small number of key sector performance indictors via a sector information management system. Ministries of local government, infrastructure, health and environment may also periodically send out questionnaires in order to compile information on specific topics. Where this data is consistently collected nationally, this can be a valuable data source for monitoring the SDGs. For the JMP global monitoring administrative data have come from regional programs (EUROSTAT, IB-NET, other) or directly collected from reports by national authorities, statistical offices, ministries, and regulators. Other examples of administrative data sources for SMOSS could include building registers, environmental compliance of septic tank inspections (see Box 1), emptying service records or business registers or national databases of treatment facilities. For the core questions we assume that the service authority should be able to routinely provide updated data every 1-2 years on the main types of services provided and the populations served within their administrative jurisdiction, even if doing so requires adapting existing data collection systems.

Box 1 Administrative data on containment inspections

The 2021 JMP report summarized the data sources for assessing containment, with administrative data available for various European, including data from Statistics Norway on direct discharges from individual treatment plants (on-site containments) (WHO/UNICEF 2021). Elsewhere, France's Office for Biodiversity manages an online data portal on public water and sanitation services where municipalities submit data regularly on the status of collective and non-collective (i.e. on-site) sanitation. In Ireland the national environmental authority requires local authorities to self-report against an annual quota of inspections. In Japan the Johkasou decentralized treatment plants are legally obligated to be inspected annually to confirm adequate maintenance and desludging. This inspection is conducted by a specified inspection agency which is a public service corporation of the prefecture.[1]

An assessment of existing national administrative sources could identify both existing sources of sanitation data and potential administrative sources that sanitation questions could be integrated into. Possible sources could be identified from the stakeholder mapping and could include data from specific departments (e.g. Departments of Infrastructure, Water, Health or Environment), regulators, departments or associations supporting local authorities, amongst others. Given administrative data is

not specifically designed for statistical analysis, this assessment may need to review the following aspects to identify the data's potential to inform national estimates: alignment of concepts and definitions with SMOSS indicators; comparable reference periods; complete coverage of the population; linkable indicators and units; response rate; accuracy; or completeness [12].

Adding SMOSS questions to existing administrative data systems: The availability of relevant data to inform SMOSS indicators from administrative data has been limited. Therefore, we expect for many existing administrative sources, additional core questions on emptying, transport and faecal sludge treatment will need to be added. Suggested questions are included in Annex D Table D1. In the Phase 1 pilots, Ecuador added 19 questions related to on-site sanitation to an existing administrative data collection by the association of municipalities of Ecuador (AME) (further details in Annex D.6). The survey was sent out to the 221 municipalities and was implemented in coordination with the national institute for statistics and censuses (INEC) and the Water Regulation and Control Agency (ACRA).

Conducting dedicated surveys of service authorities in the absence of administrative data: Compared with water and sewage data, administrative data for on-site sanitation are less commonly available, particularly in low- and middle-income countries where oversight and regulation of on-site sanitation may be weak. The recent GLAAS report found that less than 10% of countries have regulatory authorities that fully publish publicly accessible reports on the service quality of septic tank and pit latrine emptying services in either urban or rural areas [15]. When suitable administrative sources don't exist, surveys of local government can capture one-off data and provide an example for future administrative data collection. Proposed core indicators for service provider surveys for emptying and transport, and for treatment are provided in Annex D Sections D.3 and D.4 respectively. In the Phase 1 pilot, Serbia's initial policy review identified there was no national agency responsible for sanitation and no regular national data collected on sanitation services. Serbia therefore implemented a dedicated survey of local government units and service providers using an online form distributed by the Standing Conference of Towns and Municipalities, an NGO that is closely connected with and supporting local government units.

Survey design: The design of the survey will depend on how it is being distributed and who is expected to input the data. The surveys should prioritize capturing data on core questions to inform global indicators, however they can include expanded questions if needed for local indicators. Often service provider surveys also capture details on finance, policy, regulation, however these do not specifically inform service delivery outcomes for SMOSS and are instead covered by other monitoring programs [15]. From the findings of the Ecuador and Serbia pilots presented in the Phase 1 synthesis report, following quality assurance aspects should be considered in designing and implementing local government surveys:

- Provision of adequate details to explain the indicators and ways to collect data, particularly if the survey is asking for data that has not been previously reported. In Serbia and Ecuador the surveys were distributed by an independent organisation, and it was not possible to provide training or real-time support on the technical questions. Low response rate or missing questions may have been due to poor understanding by those completing the survey or difficulty sourcing relevant data.
- Low response rate, particularly to questions relating to safe disposal and treatment. Due to the survey design it was not possible to differentiate between no data, not relevant or just not answered questions (e.g. rather than enter non-compliant data). Improved survey design and better explanation of the survey objective could reduce accidental or intentional skipping of questions.
- Validation could confirm the accuracy of self-reporting. This could be done through inspections / spot checks or comparison of service authority and service provider data (see the analysis section below).

Scale: Ideally administrative data is nationally representative, however given responsibility for sanitation is often fragmented, some data may cover parts of the service chain (i.e. only treatment), or parts of the population (i.e. only urban populations, or populations connected to piped water). Existing national or regional approaches could inform the sampling approach, such as Eurostat data collection on water and wastewater suggesting efforts focus on larger towns as these populations will have more impact on the national estimate [16]. This occurred in Serbia where 50% of local governments responded yet this represented 80% of the population and was therefore deemed nationally representative. Examples of sampling for service authority surveys are presented in Annex D Section D.6.

Service provider surveys

Service providers are the entities responsible for delivering sanitation services. They may be large or small, public or private, formal or informal. In some countries service provision is regulated through licenses and permits but there may also be unlicensed service providers. Data from service providers covers a similar scope of the sanitation chain to the service authority data, however the sampling and type of data can differ. Service providers for sanitation can cover all steps of the chain: toilet pan manufacturers, septic tank and pit latrine masons, emptying and transport providers and operators of treatment plants. This guidance provides core and expanded questions for emptying and treatment providers. Where service authority data reports on the entire population in an area, the service provider data provides information on that specific service and their service coverage. A greater detail of information on services can be collected but sampling and analysis are more complicated as the data may only represent part of the population.

Administrative data on service providers: Administrative data on service providers could come from regulators or local governments. Licensed service providers may be required to routinely provide information to the service authority issuing their license to operate. Local government authorities and regulators may also conduct random spot checks to assess compliance with agreed standards of service provision. The scope of this data may be limited to the providers recognised by the local government. Other sources of administrative data on private or informal service providers could be collected from business registers, associations or other organizations that are supporting non-government service providers. The quality and acceptance of these sources to inform JMP estimates may need to be approved by national statistical authorities. For the core questions we assume the service providers should be able to routinely provide data on the quantity and quality of services they provide each year (e.g. populations served, containments emptied, sludge treated), and describe the type, function and performance of services provided.

Implementing service provider surveys: Given the lack of examples to date, in many countries routine administrative data from emptying, transport and treatment service providers may not exist due to weak regulation of on-site sanitation services. In these cases, dedicated data collection could allow a one-off capture of this information and provide an example of how this data could be integrated into regular monitoring systems. Dedicated surveys of service providers are more challenging than for service authorities, as more steps are needed to identify the sampling frame of all possible national service providers and identify mechanisms to distribute surveys to them. While local governments or regulators may have access to data from formalized or registered service providers, different approaches may be required to engage with informal or independent providers. Household surveys could inform which service providers they have engaged with, and stakeholder mapping and interviews may be needed to inform the suitable approach to identifying and accessing all providers.

Sampling: The sampling approach for service provider surveys is also more complex as the population they serve is not fixed, may overlap with other providers or may cross administrative boundaries. Compared with an off-site network where it is clear which households are served by a treatment plant, the populations served by a service provider will need to be identified. In addition, selecting a sampling strategy may require some understanding of the possible data variability between service providers, which could be informed by previous studies or secondary data. Understanding of the regulations may also be important as these may influence the chosen sample. For example, in Serbia private emptying providers are not permitted to deliver sludge to the treatment plant, therefore only government providers were sampled as private providers will always be considered unsafe. For local indicators or planning, it may be useful to collect data from these operators to understand where they dispose of excreta, even if illegal. Sampling will need to be representative for both the district and also representative for national estimates and will depend on the scale of existing services. For example, a country with 10 sludge treatment plants will have a different sampling approach to a country with 150 sludge treatment plants. An understanding of how the data will be analysed will inform the sampling approach and is discussed in the following chapter. Annex D.7 provides examples of sampling strategies including UN-Habitat guidance on nationally representative sampling from cities which could be relevant to service provider surveys [17].

Service chain inspections / spot checks

What parts of SMOSS are monitored: Similar to the household sanitation inspections, a visual inspection and technical assessment, or "spot check", can be used to assess the emptying, transport, treatment and reuse services. Observations are often coupled with a questionnaire with the operator(s) and collection of relevant data records, providing both qualitative and quantitative data. Given inspections and spot checks are unlikely to be feasible to complete at scale to be a primary data source, they are proposed to be used to validate other sources. This could be due to concerns about quality, for example due to the service provider not having an in-depth understanding of the potential risks or low trust in the validity of self—completed survey responses when practices are unsafe.

Implementing spot check/ inspections: Regulators or service authorities could regularly conduct inspections to ensure compliance of services. Examples of service inspections include environmental regulator inspecting and monitoring treatment effluent water quality and sludge by-product quality, or inspections of package treatment plants by the fabricator. However, there are limited examples of regular inspections of emptying and transport services or assessments of treatment relevant to global indicators. Implementing inspections requires some level of sanitation technical knowledge to assess treatment type, risks and function. Options for implementing service chain inspections at a national scale could include training local government engineers to self-implement the inspection, or centrally train inspectors that can be deployed to conduct national monitoring. Alternatively, if on-site skilled inspectors are not feasible, a detailed guide of what to assess coupled with photos or videos could be implemented by a less technically trained local staff and assessed remotely by an expert. Implementing emptying and transport inspections requires planning and coordination with the emptying service provider so inspections can occur when on-site systems are being emptied.

Survey design: While there were no examples of service chain inspections in the phase one pilots, draft core and expanded questions (Annex D.5) are suggested to inspect treatment against the global indicators. These questions expanded on draft service provider surveys developed by WHO and UNICEF in 2016 which have not been widely tested. Inspections are not only valuable for providing monitoring data, but also to identify opportunities to improve services. Most inspections therefore include sections on what needs to be done to mitigate any risks or issues identified in the inspection and decide on steps to achieve this with the operator, including follow-up reporting on progress. Coordinating with the responsible agency on how this data can be used to directly address service issues should be determined during survey design.

Sampling: As per service provider surveys, consideration should be given to identify the range of service services that exist and how sampling and implementation of inspections includes a representative sample, not avoiding the harder to reach respondents, such as manual emptiers or private service providers. The frequency of such inspections depends on whether it serves as a primary data source, in which a representative sample is needed, or for validating other data, in which a smaller sample may be adequate. It also depends on the level of trust by environmental health staff in the service providers and the potential hazards arising from non-compliance [16].

Analysis

Systematic assessment across the service chain

Analysis of SMOSS data requires systematic assessment of excreta flows considering the global indicators at each step of the sanitation service chain and the pathways to safely managed sanitation (i) excreta not emptied but stored/treated and disposed in-situ, (ii) excreta emptied and disposed in-situ, or (iii) excreta emptied and treated off-site. Estimates of the population with access to each type of safely managed services (SDG 6.2) are informed by the global indicators presented in Table 7, which are calculated from the core questions. As detailed in the above section on Global and local indicators for assessing SMOSS, while additional local indicators may have been collected to meet national definitions or monitoring needs, these are not included in the national estimate used for global monitoring of SMOSS, and should be reported as a separate local assessment (see Figure 3). This section presents how the core questions and global indicators are calculated and used to inform the national estimates. Based on the suggested core questions (Annex B-D), we propose the specific question and response categories that inform each indicator (Table 7) and ratio (Table 6). These are then analysed across each step of the sanitation service chain as per the decision tree shown in Figure 5. Given multiple data sources could be used for certain indicators (e.g. the indicators for containment S8 or emptying S9) and some rely on combining data from different sources, it is important to develop an analysis plan as the data collection methods are being developed to identify how these data will be combined. This ensures that there are consistent key indicators that can join datasets and clarity that data is collected for all indicators. Suggestions on approaches to bring together multiple data sources are presented at the end of this section.

Table 6. Ratios for analysis of core indicators

Ratio	Definition	Calculation of ratio from core questions
RS1	% improved sanitation facilities that are shared	H1 (improved) AND H2 (shared) / H1(improved) = SUMIF [H1(11,12,13,16,21,23,51,52,53,96) AND H2(1)] / H1(11,12,13,16,21,23,51,52,53,96) Ratio includes both on- and off-site improved. Assumes H2 is asked to both improved and unimproved.
RS2	% improved on-site sanitation facilities that are contained	= 1 – {SUMIF [H4(22,23,31,32,96,98) OR H5(at least one of A,B,C,D)]} / S7 Alternatively use inspection questions IH3 and IH4
RS3	% improved on-site sanitation facilities that are emptied	= H6(1 emptied) / S7 Assumes H8 was just asked to respondents with improved on-site sanitation.
RS4	% improved on-site sanitation facilities that are emptied and disposed of in-situ	= H8(3) / H6(1 emptied) Assumes H8 just asked to those who emptied.
RS5	% improved on-site sanitation facilities from which excreta are emptied and delivered to designated off-site treatment or disposal location	= H8(1) / H6 (1 emptied) Assumes H8 just asked to those who emptied If H8 not included/reliable, then use service authority and service provider data, for example: = H6(3 off-site)/ H6 (1) * (SA30: a+b+c+d+e+g+h)
RS6	% excreta received from on-site sanitation facilities (faecal sludge) that is treated	Service authority survey: = SA 40 (a,b) (FSTP) + SA41 (a,b) (WWTP and sewer) Other disposal sites: individual assessment needed to confirm proportion receiving adequate treatment at other disposal sites.
RS7	% wastewater that is delivered to treatment plants	From local government and service provider data (e.g. sewer leakage and overflow rates). Not detailed in this guidance.
RS8	% wastewater delivered to treatment plants that receives treatment	From local government and service provider data (e.g. proportion of wastewater that receives at least secondary treatment). Not detailed in this guidance.

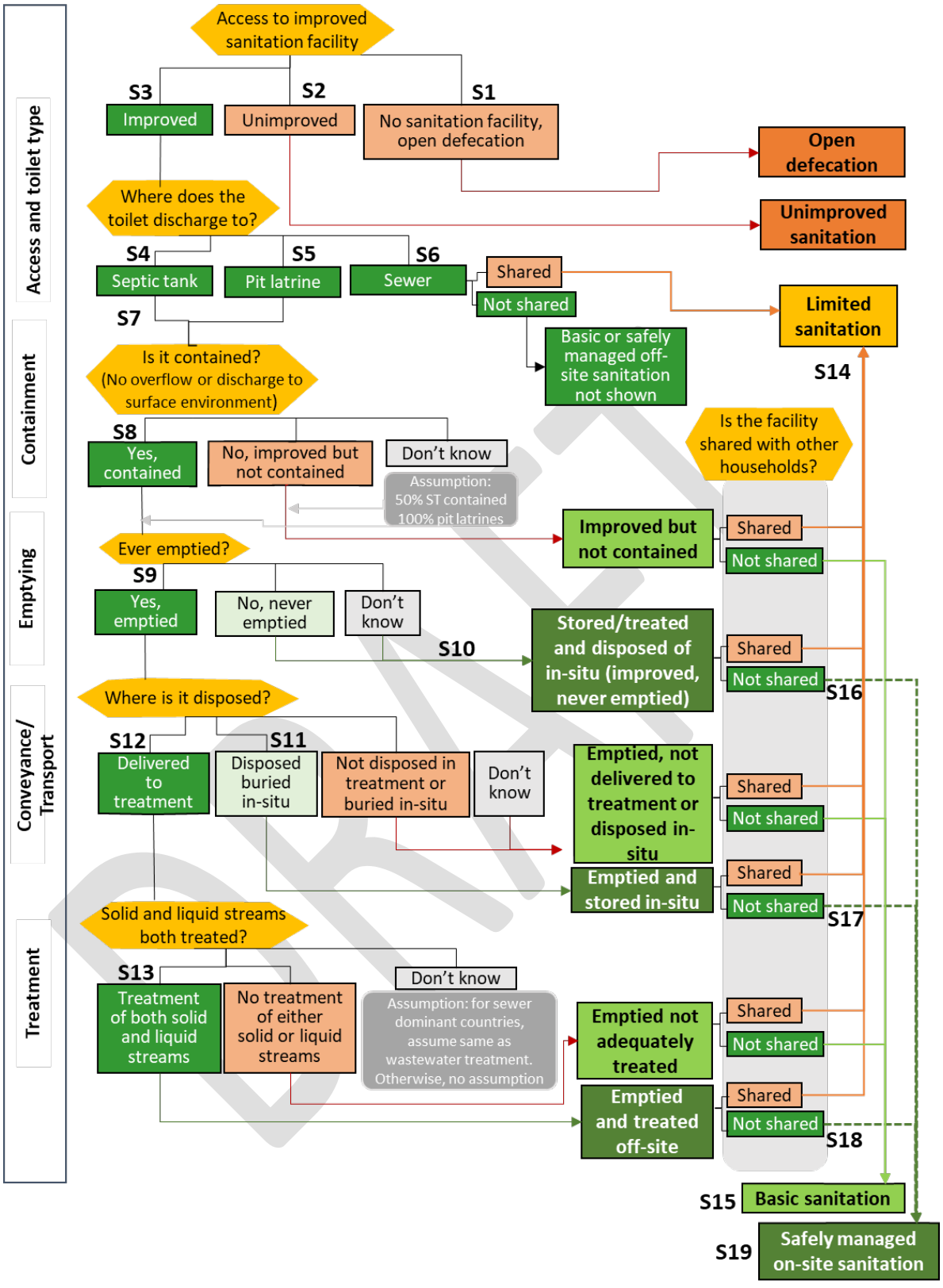
Table 7. Global indicators for monitoring SMOSS in SDG6.2 and link to core questions

Indicator	Definition: the proportion of the population using…	Core questions[1]
S1	No sanitation facility (open defecation)	H1 (41)
S2	Unimproved sanitation facilities	H1 (14,15,22,31,32)
S3	Improved sanitation facilities	=All HH-S1-S2
*	*Note S4-S13 do not include unimproved facilities but do include shared improved facilities*	
S4	Improved sanitation facilities connected to septic tanks	H1 (12)
S5	Improved pit latrines or other improved sanitation facilities	H1 (13,16,21,23,51, 52,53)
S6	Toilets connected to sewers	H1 (11)
S7	Improved on-site sanitation facilities	=(S4+S5)/All HH
S8	Improved on-site sanitation facilities that are **contained**	=RS2 x S7
S9	Improved on-site sanitation facilities that are contained and **emptied**	=RS3 x S8
S10	Improved on-site sanitation facilities that are contained, not emptied and stored on-site **(treated and disposed of in-situ**)	=(1-RS3) x S8
S11	Improved on-site sanitation facilities that are contained and from which excreta are **emptied and buried in situ**	=RS4 x S9
S12	Improved on-site sanitation facilities from which excreta are **emptied and delivered to treatment** or designated disposal site)	=R5 x S9
S13	Improved on-site sanitation that are contained and from which faecal sludge delivered to treatment are treated **(excreta emptied and treated off-site)**	=RS6 x S12
S14	Improved sanitation facilities which are shared (**Limited sanitation services)**	=RS1 x S3
S15	Improved sanitation facilities which are not shared but are not safely managed **(Basic on-site sanitation services[2])**	=(1-RS1) x S7-S19
S16	Improved on-site sanitation facilities which are not shared, and from which excreta are treated and disposed in-situ (**Safely managed on-site sanitation)**	=(1-RS1) x S10
S17	Improved on-site sanitation which are not shared, and from which excreta are emptied and disposed in-situ (**Safely managed on-site sanitation)**	=(1-RS1) x S11
S18	Improved on-site sanitation which are not shared, and from which excreta are emptied and treated off-site (**Safely managed on-site sanitation)**	=(1-RS1) x S13
S19	**Safely managed on-site sanitation**	=S16+S17+S18
S20	Toilets connected via sewers to treatment plants	=R7 x S6
S21	Toilets connected via sewers to treatment plants where wastes are treated	=R8 x S30
S22	Sewer connections that are not shared but are not safely managed (**Basic off-site sanitation services**)	=(1-RS1) x S6 -S23
S23	Sewer connections that are not shared and wastewater are treated off-site **(Safely managed off-site sanitation)**	=(1-RS1) x S21
S24	**Basic[2] sanitation services** (total on and off-site)	=S15+S22
S25	**Safely managed sanitation services** (total on and off-site)	=S19+S23

Notes:

1. In the first phase SMOSS pilots, most countries did not use a data analysis software to analyse survey data for individual households and instead used a spreadsheet to calculate aggregate proportions for each category. This approach is adequate for national and global monitoring but has some limitations, particularly in the assumption that shared systems are evenly distributed across safe and unsafely managed practices. A data analysis software would enable assessment of multiple criteria for each respondent and therefore provide a more detailed assessment which may be useful for programming.
2. Since households with safely managed services also meet the criteria for basic services, the two levels can be grouped together as '**at least basic'** which is the indicator used for monitoring SDG target 1.4 (universal access to basic services) . In the above Table At least basic = S24 and S25 (basic + safely managed).

Figure 5. Decision tree for analysis of core questions to inform SMOSS global indicators


Access and toilet type
Containment
Emptying
Conveyance/ Transport
Treatment
Access to improved sanitation facility
S3
Improved
S2
Unimproved
S1
No sanitation facility, open defecation
Open defecation
Unimproved sanitation
Where does the toilet discharge to?
S4
Septic tank
S5
Pit latrine
S6
Sewer
Shared
Not shared
Limited sanitation
S7
Is it contained? (No overflow or discharge to surface environment)
Basic or safely managed off-site sanitation not shown
S14
Is the facility shared with other households?
S8
Yes, contained
No, improved but not contained
Don't know
Assumption: 50% ST contained 100% pit latrines
Improved but not contained
Shared
Not shared
Ever emptied?
S9
Yes, emptied
No, never emptied
Don't know
S10
Stored/treated and disposed of in-situ (improved, never emptied)
Shared
Not shared
S16
Where is it disposed?
S12
Delivered to treatment
S11
Disposed buried in-situ
Not disposed in treatment or buried in-situ
Don't know
Emptied, not delivered to treatment or disposed in-situ
Shared
Not shared
Emptied and stored in-situ
Shared
Not shared
S17
Solid and liquid streams both treated?
S13
Treatment of both solid and liquid streams
No treatment of either solid or liquid streams
Don't know
Assumption: for sewer dominant countries, assume same as wastewater treatment. Otherwise, no assumption
Emptied not adequately treated
Shared
Not shared
Emptied and treated off-site
Shared
Not shared
S18
S15
Basic sanitation
S19
Safely managed on-site sanitation

Assumptions

In many cases there are gaps in suitable data to inform some steps of the service chain. For the JMP global estimates, the following assumptions are applied to develop estimates in the absence of suitable national data. These are general global assumptions and where adequate data is available locally, these assumptions replaced by the analysed survey data or with updated assumptions coming from this data.

Table 8. Analysis assumptions

	Global indicators	Analysis and assumptions used for global monitoring
Toilet facility	Use of improved sanitation facilities	Disaggregation of septic tanks and pit latrines essential. Further disaggregation of wet and dry pits desirable.
	Not shared with other households	Improved facilities shared with other households do not contribute to safely managed sanitation.
Containment	Containment[5] is not overflowing or discharging excreta directly to the surface environment	In the absence of containment data assume that excreta are contained in all latrines and half (50%) of septic tanks. Note: only systems assessed as contained can contribute to safely managed sanitation.
Disposal in-situ	Stored/treated and disposed of in-situ	Contained facilities that have never been emptied are considered stored/treated and disposed in-situ.
	Contained, emptied, disposed of in-situ	Contained facilities that have been emptied and buried are considered disposed of in-situ
Emptying	If containment ever emptied	If onsite is dominant estimates are only made if data available on emptying. 'Don't know' considered never emptied. If sewer connections dominant, in the absence of emptying data 50% of onsite considered safely managed.
Transport	Excreta delivered to treatment facility	In the absence of transport data assume all excreta removed by service providers are delivered to treatment facility. Emptied to 'other/don't know where' are considered unsafe and highlight the problem of unaccounted-for faecal waste.
Treatment	Designed to provide treatment for both solid and liquid phase	In absence of faecal sludge treatment data: - If sewer connections are more common than on-site sanitation, faecal sludge assumed to receive the same level of treatment as sewered wastewater. - If on-site sanitation is more prevalent, no estimate is made unless data are available on faecal sludge treatment.
Reuse	Not included in global indicators for SDG 6.2	- Not assessed

Analysis of multiple data sources

Given there are multiple sources of data needed to inform the various steps in the sanitation service chain, it is important to assess how each source can best be used generate the estimates. The table of methods mapped to sources (Table 2) shows that at least two sources are possible for each step of the service chain, and this may require a decision upfront in the design which data source will be used or may depend on the quality of data obtained.

There are various uses of data for analysis, and some sources may be better suited to particular uses. Application of data to inform SMOSS estimates could include:

- **Direct estimation of indicators**: the most evident where representative data directly informs the estimate, such as is common with household questionnaires informing indicators S1-S6.
- **Input to ratios or assumptions**: Some data may not be available at a granular per person scale but instead inform a generic ratio or assumption that applies to the entire population or a population sub-set (e.g. certain region, urban/rural households, households with septic tanks,

[5] Containment is defined as a permeable or impermeable container for storing excreta close to the toilet or latrine. Examples of containments include latrines pits, cesspools, septic tanks, and holding tanks.

households emptied with an informal service provider). These can then inform the ratios or assumptions.

- **Validate other data**: Non-representative data may also be used to validate or confirm accuracy of other data sets, such as an inspection confirming household response to sanitation type, or spot checks validating service provider responses.
- **Inform sampling frame**: Administrative data or household questionnaires conducted for a large sample size could inform the sampling frame for inspections or service provider surveys (e.g. identify the proportion of tanks accessible or different types of emptying service providers)
- **Key indicators to join datasets:** Some questions may be included for the purpose of joining data sets. Household questionnaire responses on the emptying service provider do not influence the assessment of SMOSS but allow this data to be combined with the relevant service provider survey responses.

Deciding which data source to use for different purposes should also consider the sampling, including if the data is nationally representative with regards to population groups, geographical areas and coverage. The JMP will include datasets in its database when they represent at least 20% of the population of interest [10]. Understanding the reliability and quality of different data sources is also important, as often one data source needs to be selected as the more reliable one that the other will be updated to match if there are differences. This may vary between indicators, for example household questionnaire responses are considered reliable for data on use of shared facilities but less reliable than household inspections for assessing the type of sanitation facility and containment. The 2017 JMP methodology update provides an explanation of data acceptance and examples of why some datasets (or particular questions within datasets) are excluded from use in estimates [10].

Bringing datasets together

In developing the JMP methods the taskforce recognized there will be difficulties integrating and combining new data sources, especially when these cannot be linked to individual households and the facilities they use [17]. Although there has been limited testing of methods to integrate different SMOSS datasets, below is a summary of strategies drawn from general guidance on use of administrative data to inform national estimates, with further details and examples provided in Annex E.

- **Integrating datasets** requires common identifiers in both data sets to allow linking to either allow exact matching (e.g. household identification) or a common variable (i.e. administration unit). For administrative data this could be geographic areas which could also be reported in household surveys using the same geographic categories. For other sources of non-household data, it is important to consider how these datasets will be linked when designing the data collection methods so that unique identifiers or variables are included in both sources.
- **Alignment and reliability:** Consistency of the data with JMP indicators and definitions needs to be considered when assessing whether a secondary or administrative data source can be used for national SMOSS estimates. A challenge with secondary data from different sources is potential inconsistency in definitions, terminology or methods that makes comparison with JMP definitions difficult [19]. The JMP suggests that if information from small studies or those conducted by academic institutions or NGOs is to be incorporated into estimates, the data should be verified with the national statistical office [17].
- **Dealing with non-responses:** A systematic approach should be used to deal with data gaps or non-responses that were common in the Serbia and Ecuador local government surveys. Non-responses can be ignored, assumed consistent with responses or investigated further to establish their characteristics [20]. Given the potential for non-reported data to be a lack of service or unsafe services, it is recommended that no responses are not assumed consistent with responded questions and further surveys or other methods should be used to investigate further.

Nationally representative estimates from non-household data

Transforming administrative data or local government surveys to inform national estimates is more complex than analysis of nationally representative household surveys, as administrative data is often not collected with the intention of statistical analysis. Considerations for analysing non-household SMOSS data are summarized below and in more detail in Annex E.

- **Data captured for subs-sets of the population**. Depending on the sampling unit, administrative data or local government surveys may be large scale and represent the national population or they may be limited to certain population sub-sets. For example, local government may only report on formal hosueholds or registered emptying providers and therefore miss the informal sectors. Regulatory data may only be available in areas with a water or wastewater authority or just cover the households connected to these. Even if the sample is expected to be national, the representation of the reported data may be restricted. UN-Habitat guidance on nationally representative sampling of cities has many steps applicable to service administrator and provider data for SMOSS [15].
- **Defining service coverage**: A particular challenge for monitoring sanitation is translating data from treatment plants or emptying providers to population relevant estimates. For water supply or wastewater service provision the service area and frequency of service are relatively clearly defined by infrastructure boundaries (location of pipes) and consistent daily services. For on-site sanitation, there is more uncertainty on which area is served as there can be multiple providers serving different or same areas of a city or crossing administrative boundaries. Frequency of provision is also uncertain, as most containments do not need to be emptied every year and therefore the frequency of emptying needs to be considered in analysing annual emptying or treatment data.
- **Low response rate.** The Ecuador and Serbia pilots both faced challenges with low response rates for either the entire survey or particular questions. Discussions with stakeholders will be necessary to identify what response rate or representation of the population is acceptable for national estimates. Some countries may have target response rates for national surveys which, if deemed reasonable, should be adopted. Further data collection may be needed to identify if there are trends in the non-response, for example are local governments more likely to not answer than respond truthfully about poor quality or missing services.
- **Varied units:** It is likely that data from service providers or service authorities is reported in units other than population and transformation of data into more comparable units are typically needed. For example, emptying and transport may be reported as cubic meter of sludge or number of trucks, which will need to be converted to a population or household unit. This requires local data on the size of containers and expected quantity of emptied sludge.

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