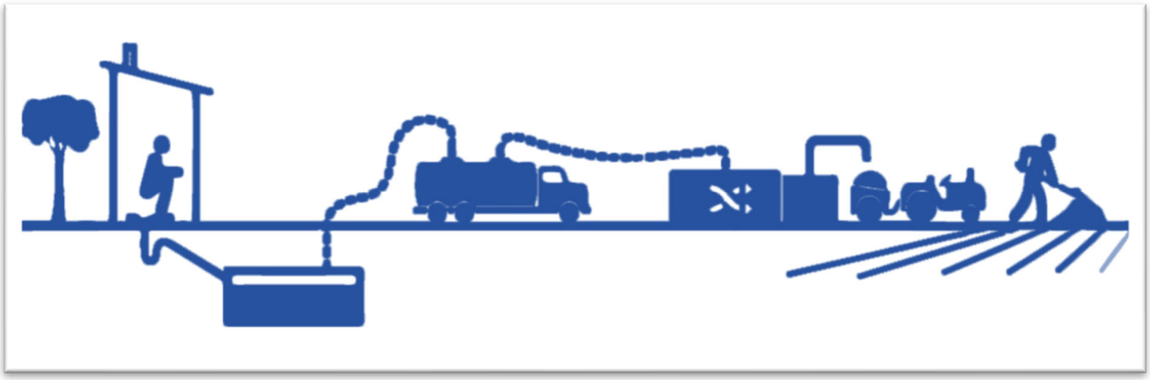
SIAP
Sustainable Infrastructure Assistance Program



SEPTAGE MANAGEMENT PLAN FOR THE CITY OF JAMBI

Final Report

May 2019

TRTA-8666-INO – INDONESIA

Capacity Development Technical Assistance

Metropolitan Sanitation Management Investment Project

Australian Government
Department of Foreign Affairs and Trade

ADB

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ACRONYMS AND ABBREVIATIONS

ABR	Anaerobic Baffled Reactor
ADB	Asian Development Bank
BLH	Local Environmental Unit (Badan Lingkungan Hidup)
BOD / BOD_5	(Five-Day) Biochemical Oxygen Demand
CDTA	Capacity Development Technical Assistance
COD	Chemical Oxygen Demand
CV	Commanditaire Vennootschap (Limited or Silent Partnership)
DGHS	Directorate General of Human Settlements (Cipta Karya)
DKPP	Cleanliness, Parks and Cemetery Agency (Dinas Kebersihan, Pertamanan dan Pemakaman)
DLH	Local Environmental Agency (Badan Lingkungan Hidup)
DPUPR	Public Works and Spatial Planning Agency (Dinas Pekerjaan Umum dan Penataan Ruang)
EA	Executing Agency
FS	Faecal Sludge
GIS	Geographic Information System
GoI	Government of Indonesia
GPS	Global Positioning System
ID	Identity Document or Identification (Number)
IPAL	Wastewater Treatment Plant (Instalasi Pengolahan Air Limbah)
IPLT	Septage Treatment Plant (Instalasi Pengolahan Lumpur Tinja)
IT	Information Technology
IUWASH	Indonesia—Urban Water, Sanitation, and Hygiene
LLTT/L2T2	Scheduled Desludging Service (Layanan Lumpur Tinja Terjadwal)
MCK	Public Bathing, Washing, and Toilet Facilities (Mandi, Cuci, Kakus)
MIS	Management Information Sysyem
MPWH	Ministry of Public Works and Housing
MSMIP	Metropolitan Sanitation Management Investment Project
O&M	Operation and Maintenance
PDAM	Local Government-Owned Water Supply Company (Perusahaan Daerah Air Minum)
PDPAL	Local Government-Owned Wastewater Management Company (Perusahaan Daerah Pengelolaan Air Limbah)
PEMDA	Local Government (Pemerintah Daerah)
PERDA	Local Regulation (Peraturan Daerah)
PERWALI	Mayor’s Regulation (Peraturan Walikota)
PPP	Public Private Partnership

PPLP	Directorate of Environmental Sanitation Development (Pengembangan Penyehatan Lingkungan Permukinan)
PUPR	Ministry of Public Works and Housing (Kementerian Pekerjaan Umum dan Perumahan Rakyat)
RT	Neighbourhood Association (Rukun Tetangga)
SATKER	Satuan Kerja
SDB	Sludge Drying Beds
SDO	Service Delivery Organization
SIAP	Sustainable Infrastructure Assistance Program
SMP	Septage Management Plan
SNI	Indonesian National Standard (Standar Nasional Indonesia)
SOP	Standard Operational Procedure
SSC	Solids Separation Chambers
TS	Total Solids
TSS	Total Suspended Solids
UPTD-PAL	Local Technical Implementation Unit for Wastewater Management (Unit Pelaksana Teknis Daerah – Pengelolaan Air Limbah)
USAID	United States Agency for International Development
WFPF	Water Financing Partnership Facility
WSP	Waste Stabilization Pond
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

Background

The Asian Development Bank (ADB) is implementing the INO 43251-025 - Metropolitan Sanitation Management Investment Project (MSMIP) to provide centralized (or off-site) sewerage and wastewater treatment facilities within the central districts of the cities of Jambi (Jambi Province), Makassar (South Sulawesi Province) and Pekanbaru (Riau Province) through a $200 million loan. Similar investments in Palembang (South Sumatra Province), also included in the MSMIP, will be financed through a separate grant from the Australian Government.

The new centralized off-site sewerage systems, however, will be available for less than 10% of the population in Stage 1. This means that on-site systems and septage management will remain the predominant method of sanitation for many decades in Jambi and elsewhere in Indonesia. Therefore, it is of crucial importance to regulate and develop appropriate on-site wastewater management septage collection and treatment practices at the local government level. The key element of such practices is an integrated septage management approach based upon scheduled desludging services (*layanan lumpur tinja terjadwal* or LLTT/L2T2), including regular collection, transport, treatment and adequate disposal and/or reuse of the extracted septage. The cost of the operation should be covered by a fee to be collected from all owners or occupiers of the premises equipped with on-site wastewater treatment facilities. Considering that the on-site wastewater service users constitute around 90% of the potential customers of the SDO, even after the implementation of the first stages of the new off-site sewerage systems, this service will make up the bulk of the SDO's activity and revenues.

It is important to note in this regard that the MPWH has made septage management one of its priority programs as part of their efforts to increase access to appropriate sanitation. As a first step, it was proposed to draft a Septage Management Plan for the City of Jambi as an additional task of the CDTA, which would then serve as an example and a model for the rest of the MSMIP target cities and elsewhere in Indonesia. In consequence, the City Government of Jambi requested ADB's assistance to prepare a Septage Management Plan for the city based upon a detailed survey covering 40,000 households or 200,000 beneficiaries. The plan, one of the first of its kind in Indonesia, should include provisions for the establishment of scheduled desludging of septic tanks, in line with the above-mentioned policy of the MPWH. The task is financed with funds available from the Water Financing Partnership Facility (WFPF).

Planning Process

The planning process commenced with the preparation of a Preliminary Report in November 2017. The report set out the bases and the main elements of septage management planning, providing a framework for an in-depth discussion of the key concepts and issues of septage management, both technical and financial and institutional, with the local government of Jambi. The second major activity was a detailed survey of 40,000 households carried out in 13 kelurahan of 5 kecamatan of the city, from the beginning of December 2017 to end February 2018, with a significant deployment of efforts and personnel. Data collection was performed using a mobile application connected to a GIS database, enabling a rapid data analysis and the assessment of the current status of septic tanks and their emptying. The third stage of the planning process was the drafting of an Interim Report that aimed to summarize the main findings that can be derived from the results of the survey, and on the Consultant's field enquiries and analysis, and it contained an assessment of the current situation derived from the findings and outlines the Consultant's approaches to the development of the Septage Management Plan for the City of Jambi.

Purpose

As the last stage of the planning process, this Final Report is to address the key activities involved in a Septage Management Plan, such as the assessment of the current situation, the design and construction and/or refurbishment of septic tanks, scheduled desludging, treatment and disposal of septage and all related institutional, financial and governance aspects, such as a new economic-financial model, socialization and participation of the private sector. Therefore, the report is to describe all these activities and explain the ways how the City Government of Jambi should gradually control the city's on-site wastewater treatment and disposal facilities, organize and implement scheduled desludging services and operate and maintain the septage treatment facilities and manage sludge disposal.

Rationale: Why and How To Manage Septage?

The main reason to manage septage in Jambi and in other cities of Indonesia is to reduce the highly negative impacts on public health and on domestic and urban environment caused by the presence of faecal matter in the surroundings of the habitations. Another reason for septage management is that despite the implementation of the new centralized off-site sewerage systems, on-site systems will remain the predominant method of sanitation for many decades in Jambi and elsewhere. In order to properly manage septage, local governments should set up a septage management service as part of an overall wastewater management service, together with the operation and maintenance (O&M) services of the centralized sewer network and the WWTP. This service should cover the whole septage management chain including mechanisms for the effective participation of private sector companies.

Survey of Existing On-Site Facilities and Data Management

The CDTA consultant has carried out a detailed survey of 40,000 households in the City of Jambi, to form the basis for the key assumptions and determinations in the city Septage Management Plan. The survey is one of the first of its kind in Indonesia and also aims at establishing a reference for future surveys in Jambi and the other CDTA cities to support the strategies for integrated urban wastewater management. The survey comprised 40,123 properties (equivalent to an estimated population of 185,000 inhabitants, i.e. approximately one-third of the total population of Jambi) throughout 13 kelurahan and 5 kecamatan of the city. It excludes districts that will be covered by the sewer network of the future MSMIP off-site project.

The survey was based on a comprehensive questionnaire that included questions ranging from the physical location of the property and the septic tank, through socio-economic characteristics of the dwelling to technical features of the on-site facility. The surveyors used the Android mobile phone application developed by IUWASH to record the answers given by the respondents, including the recording of GPS position. the survey team was comprised of a City Coordinator and 20 kelurahan coordinators (assistant professional staff) each of whom managed on average another 20 surveyors, all of them neighbours of the respective kelurahan of the survey area. This organizational scheme allowed the consultant a very direct approach to the communities affected by the survey and managed to involve the 13 lurah and 482 rukun tetangga heads (RTs).

The data obtained by the surveyors were instantly uploaded to a database hosted on a server that was managed by the CDTA consultant and accessible via a web-based portal, also developed by IUWASH, for consultation and processing. Overall, the database contains 40,123 records with 42 properties each record, i.e. approximately 1.68 million data items. Data processing has been performed using the QGIS software. This means that the processed data are installed in a geographical information system (GIS) using the open-source application Q-GIS. This software has the functionality to perform the visual and spatial analysis of the survey data and is the basis of Management Information System (MIS), an IT based septage management system developed to administer the city's septic tank desludging services.

Assessment of the Current Situation

Most premises in Jambi (89%) are equipped with what the occupants consider a septic tank, which means that 11% of the households in the survey area still have no toilets. The facts that the majority of existing septic tanks are older than five years (83%), are rather limited in size (72% < 3 m^3), and have never been emptied (92%), suggest that they produce effluents and/or overflows that do not receive an appropriate treatment and cause a negative impact on the environment and a high public health risk. Actually, most septic tanks are in fact cubluk, i.e. one-compartment, lined but bottomless pits allowing wastewater to seep to the ground and to the groundwater. The vast majority of them is not in line with the Indonesian Standard SNI 03-2398-2002 concerning the Procedure for the Design of Septic Tanks with a Percolation System: practically none of them seems to comply with size requirements, three-quarters of them receive only blackwater from the associated buildings and practically none has an associated percolation area or soak pit. As a consequence, most on-line facilities of the city produce overflows to drains and water bodies, and, actually, wastewater is omnipresent in the drains all over city.

The current desludging service is a remedial system for overflowing tanks functioning exclusively on demand. Although the desludging equipment owned by the Public Works and Spatial Planning Agency (DPUPR) is rather limited (only 3 vacuum trucks of 4 m^3 each), they are apparently under-utilized (less than three transports and discharges to the Septage Treatment Plant per day). There are also four private entrepreneurs providing the emptying of septic tanks, but they are not necessarily dump their loads to the IPLT. The lack of regular desludging contributes to increase the risks of faecal matter and pathogens remaining in the surroundings of the households and even re-entering the domestic environment causing waterborne diseases, such as diarrhoea, infectious hepatitis, typhoid and paratyphoid fever, mainly among children. Furthermore, the uncontrolled discharge of greywater and septic tank overflows into drains, trenches, ditches and to the ground in general result also in a highly negative impact on the urban environment. Many on-site facilities have problems of access for emptying vehicles, and even a great number of them is situated under the buildings, mainly in case of the so-called ruko (*rumah toko*, i.e. dwelling and shop).

The Talang Bakung Septage Treatment Plant (Instalasi Pengolahan Lumpur Tinja or IPLT), located just outside the city's boundary to the east of the kelurahan of Talang Bakung (actually in the desa or village of Tangkit, kecamatan of Sungai Gelam, kabupaten Muaro Jambi), some

14 km away from the city centre, consists of a waste pond stabilization (WSP) system preceded by a solids separation unit. The plant is in an acceptable physical state but is non-functional as a treatment facility. Although the septage input is very low, there is practically no dry sludge production due to the lack of solids removal and there is virtually no outflow. In consequence, the ponds that ought to treat the supernatant water separated from septage are only used for sludge storage. The main infrastructural deficiencies of the plant are the non-functional sludge removal at the so-called sludge separation chambers (SSC) due to design and maintenance problems, the total inadequacy and the consequent state of disuse of the sludge drying beds, the state of abandonment of the outlet pipe and the consequent complete lack of a plant effluent. The problems of operation of the IPLT can be attributed essentially to the lack of understanding of the principle of septage treatment and sludge disposal and to the total absence of definition of sludge disposal options.

Amendment of the Local Government Regulation for Wastewater Management

The City of Jambi has a Regulation on Domestic and/or Residential Wastewater Management, adopted on 30 December 2015 by the Mayor of Jambi. This regulation covers the entire scope of wastewater management, both on-site and off-site, and contains even provisions for wastewater network planning and development. It is understood, however, that there are certain gaps in the existing regulation that might be filled to allow the City of Jambi to improve their activity in all aspects of wastewater management regarding certain technical, legal and financial aspects. The key concepts and criteria proposed for the amendment of the existing regulation are: (i) the introduction of the concepts of wastewater management service provision and service users, (ii) clear distinction between domestic (household and other assimilable discharges) and non-domestic (industrial or commercial) effluents, (iii) the obligation of treatment of all wastewaters issued from a property, both blackwater and greywater, (iv) the specification of proper design and construction criteria for septic tanks based on the Indonesian Standard, (v) the implementation of scheduled desludging of on-site facilities, (vi) the mandatory nature of sewer connections, (vii) the implementation of the pretreatment obligation for industries before discharging into sewers, including prohibitions and effluent standards, (viii) the establishment of the right to enter private properties for local government, (ix) the setting up of permitting arrangements and financial provisions and (x) the establishment of enforcement procedures.

Design and Construction and/or Refurbishment of On-Site Wastewater Treatment and Disposal Facilities

To implement scheduled desludging in the city of Jambi, it is necessary that the deficiencies encountered in the survey should be remedied in the future, which means, on the one hand, that all new septic tanks need to be designed and constructed according to the standard and, on the other, that the existing septic tanks will have to be refurbished gradually in a way that they approach as far as possible to the requirements of the standard.

Based on the requirements and specifications of the standard and on some other standards and handbooks, the septage management planning report summarizes the main features and design considerations for septic tank systems stating that a septic tank is a primary settlement tank consisting of a watertight chamber with one, two or three compartments, made of concrete, brickwork, PVC or plastic, for the storage and treatment of wastewater, both blackwater and greywater, in which settling and anaerobic processes reduce solids and organics. The septic tank should be of sufficient volume to provide retention time for the settlement of the suspended solids (SS), while reserving an adequate volume for sludge storage. The volume required for sludge storage is the determining factor in sizing the septic tank, which depends on the potential occupancy of the building, estimated from the maximum number of people that the house can accommodate, and which determines also the desludging frequency of the tank. Septic tanks may be constructed on-site if they comply with the requirements specified in the above-mentioned standard and with the local wastewater management regulation or pre-fabricated tanks may be installed if they are adequately designed and manufactured by a specialist company.

Furthermore, detailed design and sizing criteria are given for not only septic tanks but also anaerobic baffled reactors (ABR) to be used for communal septic tanks, septic tanks combined with biofilters and twin cubluk to be implemented only in case of rural-type areas of the city requiring a specific approval of the City Government, as well as percolation areas and soak pits. Apart from these design and sizing requirements, the report highlights a number of construction considerations that need to be borne in mind when installing or rehabilitating a septic tank system, and also summarizes them as the “do’s and don’ts” for septic tank construction.

The refurbishment plan of the non-complying on-site facilities should include, among others, (a) the installation of access holes or manholes on the upper slab of the tanks, (b) the relocation of septic tanks to the front of the premises, (c) the reconstruction of clearly undersized septic tanks, (d) connection of all wastewaters to the septic systems, (e) construction of proper outlets and percolation systems, such as percolation areas or leach fields (individual or communal), (f) promotion of communal treatment and disposal systems to replace inappropriate individual facilities, (g) installation of ventilation pipes on the upper slabs wherever appropriate and (h) promotion of flush toilets in those households that currently lack them. Seen the current status of on-site facilities all over the city, however, it goes without saying that there is a long way to go to attain the goals of an appropriate septage management and of proper septic tank design all over the city. Therefore, the implementation of the refurbishment plan is an objective-oriented process taking several years involving multiple decisions and activities, which means that the refurbishment of the existing facilities should be carried out gradually, in the framework of a long-term plan, for which, such as for the implementation of the other aspects of the septage management plan, a time horizon of ten (10) years appears to be reasonable.

The implementation process of the refurbishment plan should include three stages and ten activities. The first stage, to be performed during the first year, would “set the framework” of the refurbishment plan, and include the amendment of the wastewater management PERDA, the setting up of the UPTD-PAL and the extension of the survey for the remaining two-thirds of the households of the city. The second stage, to be carried out during the second half of the first year, would “set the bases” of the plan, and include setting up inspection activities to be carried out by the UPTD-PAL, the definition of funding sources and arrangements by the City Government and the outline and classification of refurbishment works. Finally, the third stage, of nine years duration, would encompass the implementation of the works, including the definition of the necessary refurbishment works to be carried out and the setting up of funding arrangements on a yearly basis, the undertaking of the works proper by the owners and supervision and feedback to be performed by UPTD-PAL staff.

Implementation of Scheduled Desludging of On-Site Facilities

The implementation of scheduled desludging services in the city of Jambi should be based on a pre-determined schedule replacing the current remedial on-demand practices. Scheduled desludging should be set up as a public service to be provided by the City Government, through the UPTD-PAL, by their own means or using those of licensed private septage haulers. The PERDA should be amended to ensure this regular desludging as a local government service. In case of private sector involvement, the City Government should certify and license private septage transporters to desludge and transport septage to the designated treatment facility. Awareness generation activities should educate households about the need for regular cleaning.

Ideally, septic tanks should be emptied only when necessary based on the volume of accumulated sludge. Yearly desludging of septic tank is desirable. But if it is not feasible or economical, smaller domestic tanks should be cleaned at least once in 1 to 3 years, with a recommended average for Jambi of 2 years, provided the tank is not overloaded. Since families generate varying volumes of sludge at different rates and have varying sizes of septic tanks, scheduled desludging programs should be adjusted to the real needs base on regular inspection.

The City of Jambi should require additional trucks for the collection of septage and its transportation to the treatment and disposal sites. Vacuum trucks of different capacities can be used, from 2,000 to 12,000 litres, although in Jambi the currently available 2,500 and 4,000-litre trucks seem to be appropriate due to the limited capacity of septic tanks. The number of trucks required is 22. In case the City Government opted to provide the desludging service exclusively by their own means, they should acquire 20 more vehicles in addition to their existing three trucks (one of them in a rather bad state) and meet the related strong staff needs (one driver and one operator per vehicle) or to entrust the service substantially to licensed private waste hauler contractors, or again, as the most reasonable option, to implement a "mixed model", including public and private service providers. In any case, UPTD-PAL staff should ensure the planning, inspection and monitoring tasks.

Small scale, motorcycle-driven Vacutug-type devices are recommended for areas inaccessible to large vehicles. Transportation to the treatment and/or disposal site(s) should be done by larger vacuum trucks, so the transfer from the locally used small scale vehicle to the larger ones should be resolved by means of transfer stations located in each area.

Local fees should be levied by the City Government as per a specific PERDA or as part of a PERDA of fees for public services will be used to recover the operating expenses for regular desludging.

For the operational planning of scheduled desludging services, it is recommended to divide the city into zones of roughly similar population and characteristics and prepare a yearly plan. From the 13 kecamatan present in Jambi, it is proposed to establish 8 scheduled desludging zones comprising either individual kecamatan or the combination of two kecamatan. The number of desludging vehicles assigned to each zone is proposed to be roughly proportional to the population the zone while one Vacutug-type vehicle could be allocated to each zone. To operate with these, one transfer station per zone is also envisaged to allow the larger vehicles transport the collected septage to the treatment plant(s).

Regular desludging activities will require a well-organized City Government, a specialist public SDO and the contribution of licensed private waste haulers. To establish and organize of the Service Delivery Organization (i.e. the UPTD-PAL in Jambi), the basic principle to consider is integrated wastewater management. This means that the future organization should undertake both off-site and on-site wastewater management as these are nothing but the two facets of an overall sanitation service aimed to adequately collect, treat and dispose of the wastewaters produced in the city. Such an arrangement would also enable the UPTD-PAL to readily manage the transition from the on-site system to the future off-site system by promoting sewer connections. Furthermore, the centralized off-systems will be of a rather limited scope for a long time, on-site wastewater management ensure the financial feasibility of the organization by integrating the numerous on-site users. At the same time, this criterion implies that the structure needed for on-site wastewater management cannot be separated from the overall integrated management structure. The planning report includes a preliminary structure and staffing proposal, envisaging 42 people at the outset and 87 people at a fully developed stage. The staff needs of the On-Site and Communal Systems Division are not but mere estimates as the personnel dedicated to septic tank desludging (drivers and operators) alone might represent 25% of the total estimated staff of the UPTD-PAL. The real needs, however, will greatly depend on how the City Government decides to organize scheduled desludging. To complete scheduled desludging planning, detailed standard operational procedures (SOP) are also defined in the report. To deploy scheduled desludging it the city, it is proposed to adopt a gradual implementation process over a time horizon of five (5) years.

Septage Treatment and Disposal

According to the quantification of the septage produced in Jambi on the assumption of a full deployment of scheduled desludging, the total quantity of septage to be treated and disposed is 231 m^3/day. The existing Talang Bakung IPLT has a nominal capacity of 80 m^3/day. Although the current input is less than 10% of this capacity, around 7 m^3/day, and the plant is virtually non-functional despite the refurbishment works carried out in 2016, it is thought appropriate to upgrade it with relatively minor works that would allow it to be put into service. For the treatment and disposal of the remaining septage quantities, 151 m^3/day, the most rapid and cost-effective option would be undoubtedly their co-treatment with wastewater at the Kasang IPAL, to be completed, most likely, by 2021. In the absence of useable data in Jambi, the key parameters to characterize the quality of septage are taken from a 2014 World Bank study and are: total solids (TS) of 15,000 mg/l, total suspended solids (TSS) of 5,000 mg/l, BOD_5 of 1,000 mg/l, COD of 3,300 mg/l, BOD/COD of 1/3 and NH_3-N of 200 mg/l.

The main objective of septage treatment is to ensure the protection of human and environmental health. Alternatives for the treatment and disposal of septage fall into the following categories: (i) treatment at independent septage treatment plants, (ii) co-treatment with wastewater at wastewater treatment plants (WWTPs) and (iii) land application. At the moment option (i) is in place in Jambi, though non-functional. Based on the quantification of septage, option (ii) should also be implemented and option (iii), the most common means of septage disposal in the United States and in many countries and also most economical alternative, could also be considered.

The Talang Bakung IPLT consists of a waste stabilization pond system (WSP) including an anaerobic pond and three trains of facultative and maturation ponds, preceded by solids separation chambers (SSC). The main infrastructural and operational deficiencies to be restored are (i) the non-existent solids removal at the so-called sludge separation chambers (SSC) due to design and maintenance problems, (ii) the total inadequacy and the consequent state of disuse of the sludge drying beds, and the state of abandonment of the outlet pipe and the consequent complete lack of a plant effluent.

The SSCs are a modified version of a facility recommended in the PERMEN 04/PRT/M/2017 on wastewater management but the modification has proven to be a failure. The proposed remodelling of the SSCs should consist basically in removing the fiberglass plates permanently and setting up the arrangement recommended in the PERMEN: collect thickened sludge at the bottom through the pipes that were to convey water and, vice versa, collect supernatant water at the upper part through the holes, canal and pipes that were to convey sludge according to the original design. It is understood that the suggested refurbishment is relatively simple to perform, as it would require only minor plumbing and masonry works to be defined at the detailed design stage. Thickened sludge will be conveyed to new sludge drying beds to be situated below the platform on which the SSCs (and the anaerobic pond) are located ca. 1.50 m above the future ponds, which should allow gravity feed.

The sludge drying beds (SDBs) of the Talang Bakung IPLT are too small, practically inaccessible with machinery and, as a consequence, completely out of service. Nevertheless, the SDBs are one of the most, if not the most, important link of the septage treatment chain for they are the last one before the final product, the dried sludge, leaves the plant for its final disposal and/or its reuse on agricultural land. It is considered that the current undersized and ill-conceived facility cannot readily be refurbished and therefore it is proposed to build new and appropriate SDBs on the land of roughly 40x60 m, i.e. an area of 2,400 m^2, available within the IPLT parcel between the anaerobic and the waste treatment ponds. It is proposed to implement unplanted SDBs based on drainage of liquid through the sand and gravel to the bottom of the bed, and evaporation of water from the surface of the sludge to the air.

After the solids settling and thickening at the Solids Separation Chambers (SSCs) further treatment is performed in a waste stabilization pond system (WSP) comprising three trains of facultative and maturation ponds preceded by an anaerobic pond. These ponds, relined in 2015-2016, are capable of providing the treatment of supernatant water released from the SSCs but it is important to underline that only this supernatant water should be admitted into the pond system. It is, however, necessary to restore the water effluent outlet pipe lengthening it some hundred meters until the nearest channel or watercourse, most likely a tributary of the nearest significant watercourse of the region, Sungai Terap, affluent of Sungai Kumpeh, which is at a distance of about 2 km.

An additional 150 m^3/day of septage could be co-treated with wastewater at the Kasang WWTP by incorporating this flow into the water train provided that the plant inflow does not exceed 50% of the design flow. It is assumed that this will not happen at least during the first 4-5 years after the start-up of the WWTP. This result also means that the lacking septage treatment capacity could be resolved at the WWTP. A better and more sustainable option would be to incorporate septage to the solids handling train of the plant by installing a specific solids separation unit at the receiving station, including a screening and/or grit removal unit, a thickening unit usually consisting of a mechanical device that provides a solid fraction above 4% dryness and a system of conveyors or sludge pumps to transport the solid fraction directly to the drying beds. It is to be noted that such an equipment, a Rotamat ® Ro32 by Huber is currently installed at the Bekasi IPLT.

Septage and/or treated sludge must be disposed of in manner that poses no threat to public health and the environment. The most common disposal of septage and wastewater sludge has been to apply it to agricultural fields, forest land and reclamation sites as a soil conditioner and organic fertiliser, since excreta contain essential plant nutrients and organic matter that increases the water retaining capacity of soils. The use of septage as a soil conditioner can range from untreated septage to bagged compost that is sold as a commercial product for household level use in horticulture. The most common form of reuse, however, is dried sludge produced in sludge drying beds (or by more sophisticated electromechanical dewatering equipment in WWTPs), and this is the type of sludge both the Talang Bakung IPLT and the Kasang IPAL are expected to produce. In the specific conditions of Jambi land application of dried sludge, i.e. its disposal and/or reuse on nearby agricultural lands seems to be the most appropriate, if not the sole, option. The agricultural lands available are oil palm and perhaps also pineapple plantations located at a distance of a few km in kecamatan Sungai Gelam of kabupaten Muaro Jambi and the reuse of dried sludge may be feasible for both crops being, obviously, subject to agronomic considerations and restrictions.

The current situation of the Talang Bakung IPLT and the lack of disposal options and appropriate related equipment can give rise to another reflection: septage treatment is not an aim in itself. The aim is safe and environmentally friendly disposal of septage. The difference between liquid and dry septage is water (and the die off of pathogens), so if the UPTD-PAL has no means to extract and transfer dry sludge to trucks and transport it to the final disposal sites, they might opt for the land application of liquid septage. Land application of septage is currently the most commonly used disposal method in many countries, mostly in the United States. It is relatively simple and cost-effective, uses minimal energy, and recycles organic material and nutrients to the land. As already said, with proper management, domestic septage is a resource that contains nutrients that can condition the soil and decrease the reliance on chemical fertilizers for agriculture. Appropriate septage disposal should maximize these benefits of septage while protecting public health and the environment. Septage can be incorporated into the land basically by three methods: surface application, subsurface incorporation or burial. From among the surface application methods, the so-called ridge and furrow method is well suited to tree crops and could be recommended for possible septage application in the tree plantations at Jambi. The other methods require specific equipment and an intensive cooperation with farmers.

Economic and Financial Model

A simplified economic and financial model has been developed to help evaluate the fundamental economic and financial issues affecting the development of the septage management plan. This simplified model is for initial estimation of economic magnitudes and for scenario-building purposes, therefore should not be taken as a definite, detailed financial model for the operation of the septage management service. Such a model should be developed once the UPTD has been established.

In the meantime, the preliminary model may be a decision-support tool in the definition of the implementation strategy for the Jambi SMP, to be used, among others, to evaluate aspects such as the zoning strategy for the implementation of regular desludging, the estimation of user tariffs and potential subsidies, the capital investment requirements for the establishment and development of the desludging service, the operational budget requirements, the potential benefits of collaboration with the private sector in different scenarios, the estimation of the impact of introducing potential savings in the septage management chain, such as intermediate transfer stations, etc.

The model assumes a certain progression of human and material resources to be deployed during a 5-year septage programme implementation to achieve 40,000 households, in accordance with the scheduled desludging service established in the MSMIP Loan Agreement (Major Change in Project 2016), the organization and staffing recommended for the UPTD-PAL and the equipment requirements. Based on the CDTA study titled *Organization and Financing of the Wastewater Management Services in the City of Jambi* (under preparation), a desludging fee of Rp250,000 per service has been proposed. The investment cost for the upgrade of existing septic tanks and installation of new septic tanks is not included in the model.

The main conclusion that follows from the model is that the septage service is marginally financially viable in the long term with the user fees assumed (Rp10,000 per month for sewer connections, Rp250.000 per desludging service) and the investment and operating costs modelled. EBITDA (Earnings Before Interest, Tax, Depreciation and Amortization) becomes positive only in year 5; when depreciation of the assets is taken into account (EBIT) the service is in long-term deficit. Furthermore, the estimated capital needed for buying the additional trucks to cover the service targets is Rp2,400 million. The total funding needs to implement the 5-year SMP amount to Rp9,115 million, equivalent to approximately 0.6% of the local government budget for the year 2018, including a subsidy of Rp6,715 million over the same 5-year period to cover the operating costs -compensating the difference between service costs and fees collected- and make the service sustainable. The resulting wastewater service coverage at the end of year 5 would be 40% of the city, including the off-site users.

Private Sector Participation in Septic Tank Desludging

The possible involvement of the private sector in the septage chain is mainly in (i) supply and installation of septic tanks (masons and plumbers); and (ii) collection and transport of septage using vacuum trucks (septage haulers). Septic tanks are sold (prefabricated) at building material stores and installed by small contractors or, more frequently, directly built in situ (wood, brick, concrete). Bearing in mind that the majority of existing septic tanks do not comply with the national standard, the potential for business opportunities in the forthcoming years is notable. In the business of collection and transport of septage, there is a small number of companies, all of them owning one vacuum truck. The trucks usually have a capacity of 3 m^3. The firms are microenterprises (less than 5 employees) registered as CVs (*Commanditaire Vennootschap*) or sometimes cooperatives, most of them less than 10 years old, and many of them even less than 3 years old.

As for the current desludging practices in Jambi, private operators perform 2-3 services per day on average, reaching 4 services per day on busy days during the rainy season. Interviews with private desludging companies elsewhere (no such meetings could be arranged in Jambi) revealed that the key challenges that these entrepreneurs face in their businesses are (i) the uncertainty about demand, largely due to weak public awareness and enforcement; (ii) the lack of skilled labour, both in technical and customer relation aspects; (iii) problems performing the service and even getting payment from the user; (iv) high variable costs, mainly fuel and oil; (v) difficult access to affordable commercial loans; and (vi) the licensing process is cumbersome. The operators are expected to discharge the septage at the treatment plant but IPLT registers indicate that much of the septage is being dumped elsewhere illegally. Altogether, it can be stated that these businesses operate at marginal levels of profitability while facing significant commercial risks. Therefore, given the high uncertainty about demand and the relatively fixed cost structure of operators (except for fuel and oil), from the financial perspective there seems to be a greater need for demand certainty, regulatory coherence and good governance of the service.

Concerning the legal framework of private sector participation, Law 25/2009 on Public Services establishes that the administration may cooperate with other parties for the purpose of improving and accelerating the provision of the service, given the limited resources available to the LG. Furthermore, the PERMEN PUPR 16/2008 states in its mission the objective to improve and develop alternative sources of funding in the operation of wastewater management systems establishing several policies along with strategies and associated actions, including the promotion of public-private partnerships (PPP) in the implementation of wastewater facilities and infrastructure. In the case of septage management, PUPR's L2T2 guidelines establish that LGs must address cost recovery for service sustainability, including the cost of surveys, operation and maintenance, administrative costs, capacity building, socialization campaigns, promotion and collaborations that improve the access to sanitation. As for payments from the LG to a private company for the provision of a service must follow the public procurement law, PERPRES 54/2010 on Procurement of Government Goods and Services and its latest amendment PERPRES 4/2015. The law allows to appoint service providers directly (*pengadaan lansung*), without the need for a competitive tender, when (i) the contract value is below Rp300million; (ii) only small companies or cooperatives are involved; (iii) the service is required for operational needs; (iv) simple technologies and low risk are involved. Finally, there are currently no specific regulations on the use of treated sludge. PERMEN PUPR 9/2015 refers to the use of recycled wastewater as a resource but it is not specific to sludge.

The level of private participation depends mainly on the size of the market (potential number of customers and tariff), the expected growth, the cost to enter the market (investment required), how payment is received, the guarantees on payment and the operating costs. The possible forms of participation in wastewater management are many, with a wide range of levels of complexity in the arrangement (technical, administrative and financial) and different requirements to ensure the arrangement delivers the expected results, including, from most to least suitable, the following: (i) empty and transport, business as usual; (ii) empty and transport, regular desludging; (iii) installation of septic tanks, emptying and transport; (iv) operation of IPLT, with or without construction. All of these options require companies to obtain a business license and an environmental permit from the LG, as determined by the applicable local regulations. The licensing process can be cumbersome and expensive in some cases but not difficult to streamline. It is important to note that UPTDs are not allowed to enter into cooperation agreements. This is an obstacle to the participation of the private sector in regular desludging. The most effective option is to use a BLUD or a BUMD. As a matter of fact, the only current examples of cooperation between LGs and private haulers in Indonesia for scheduled desludging are those with BUMDs, as in the case of Bandung and Surakarta.

Therefore, option (ii) is considered the most viable for private sector participation in the short and medium term.

A successful cooperation between the private sector must be based on a clear understanding of the objectives, the roles, rights, obligations and working arrangements for all parties involved, arranged ultimately for the benefit of the people of Jambi. These issues should be reflected in a cooperation agreement endorsed by the City Mayor. The recommended process for preparing the agreement should include (i) a detailed study of the existing private firms operating in Jambi; (ii) the identification of those companies that are in a position to deliver the service in cooperation with the LG in a responsible, transparent, competent and sustainable manner; (iii) a definition of the areas that can served by each operator, in line with the zoning of the SMP, including a detailed estimation of the collection and transport costs to the IPLT in each area and sub-area; (iv) the definition of the subsidies that must be allocated for each operator, since those that serve the populations farther away from the IPLT will have higher costs associated, but the users will still pay the same tariff; (v) the definition of the payment mechanism; (vi) the definition of the minimum standards of operation; (vii) the definition of the incentive/penalty arrangements to ensure that the operators fulfill their obligations; and the design of the monitoring and evaluation mechanisms to measure the performance of the service and the benefits of the cooperation. These considerations above should be established in a cooperation agreement, to be signed collectively or individually with each operator.

Social Marketing Plan

Community participation as a service target is the key to the success of the LLTT program. The main factor of the current low interest in desludging in the community is the lack of public knowledge about good and proper sanitation, especially knowledge of septic tanks that are in accordance with the standards and the importance of managing septage well. Another factor is the condition of on-site facilities that are difficult to access by vehicles, and often under the building which requires demolition of the building floor to access the septic tank. Besides that, cultural factors and habits inherited from generation to generation are not conducive to managing septage properly, because it is something dirty and disgusting.

There are three determinants of whether someone is willing or not to be an LLTT customer: (i) the availability of LLTT service infrastructure, (ii) LLTT promotion factors, and (iii) supporting environmental factors. These factors are interrelated: if the service infrastructure is adequate, a regulation already exists, but the promotion is not on target, the intervention has to be a promotional program; if the LLTT infrastructure is inadequate, then there must be an intervention to improve the infrastructure before promotion.

The socialization and marketing of the LLTT program should be carried out in the following seven stages: (i) Organizing a Social Marketing Team, (ii) Determination of the Budget, (iii) Determination of Marketing Areas, (iv) Determination of Marketing Targets, (v) Target Market Analysis, (vi) Product Information Development, and (vii) Planning and Implementation of Socialization and Promotion.

Monitoring (supervision) is an activity of monitoring program implementation while it is in progress, whereas evaluation is the measurement of program impact after the program is completed. The point is to ensure that every activity in the program is carried out in accordance with the plan. If ineffective activities are identified, they need to changed. The point is to assess whether the work program implemented is in accordance with the results envisaged. The monitoring results are analysed as soon as possible with the aim of improving the program while running. The results of the monitoring analysis and improvements made are summarized in monthly, quarterly, or other periodical reports as agreed. The evaluation results are analysed after a complete evaluation process is carried out and summarized in the annual report.

I. BACKGROUND

1. The Asian Development Bank is implementing the RRP INO 43251-025 - Metropolitan Sanitation Management Investment Project (MSMIP) to provide centralized (or off-site) sewerage and wastewater treatment facilities within the central districts of the cities of Jambi (Jambi Province), Makassar (South Sulawesi Province) and Pekanbaru (Riau Province) through a $200 million loan[1]. Similar investments in Palembang (South Sumatra Province), also included in the MSMIP, are financed through a separate grant from the Australian Government.

2. The Capacity Development Technical Assistance (CDTA), also commissioned by ADB, is to support long-term sustainability of the MSMIP loan and grant by providing expert advice to (i) help establish the relevant agencies and wastewater management, (ii) create an operational framework for sanitation services including tariff structures and billing, and (iii) provide training to ensure continued sustainability of the services. The CDTA is a sub-project of the C-TA0013-INO - Sustainable Infrastructure Assistance Program (SIAP), which is a technical assistance cluster financed by DFAT and administered by ADB. The Executing Agency (EA) of the contract is the Directorate of Environmental Sanitation (PPLP) of the Directorate General of Housing Settlements (DGHS or Cipta Karya) of the Ministry of Public Works and Housing (MPWH)[2].

3. The original Wastewater Investment Master Plans (WWIMPs), funded and commissioned by IndII to outline the development of sanitation in the above-mentioned cities, and on which the MSMIP was based, contained a septage management program as Component 1. The information available on this component is a technical review comprised in the the MSMIP Project Preparation Technical Assistance (PPTA) 3 . Although the original septage management components were not known in detail, the reviews suggested that they were rather limited and disparate descriptions of what was considered to be a necessary investment for the improvement of septage management in terms of acquisition of desludging trucks, construction of on-site or communal systems and upgrading of existing septage treatment plants (IPLT), such as the one built and recently rehabilitated in Jambi. The available information also showed that these Components 1 were mere estimations and were not based on any specific analysis of the current situation and future needs of on-site wastewater management.

4. The new centralized off-site sewerage systems will not be available for more than 10% of the population in Stage 1. This means that on-site systems and septage management will remain the predominant method of sanitation for many decades in Jambi and elsewhere in Indonesia. Therefore, it is of crucial importance to regulate and develop appropriate on-site wastewater management septage collection and treatment practices at the local government level.

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[1] Initially, the city of Cimahi (West Java Province) was also included in the project. Due to issues related to the acquisition of land for the WWTP, ADB and the Executing Agency (EA), the Ministry of Public Works and Housing (MPWH) have agreed in September 2015 to defer the Cimahi subproject to a future sanitation investment program.

[2] Kementerian Pekerjaan Umum dan Perumahan Rakyat (PUPR).

[3] ADB TA 7993 – INDONESIA Metropolitan Sanitation Management Investment Project Final Report, Main Report, Lahmeyer IDP Consult Inc. in association with P.T. Bina Asih Consultants, Indonesia and P.T. Dwikarsa Envacotama, Indonesia, June 2013. The review was performed by Pöyry IDP Consult, Inc., together with the same Indonesian associated companies

5. The key element of such practices is an integrated septage management approach based upon scheduled desludging services (LLTT or L2T2). Scheduled desludging means that the Service Delivery Organization (SDO) of the Local Government (LG) that provides wastewater services to a city or a regency should provide desludging of all on-site treatment facilities of the city/regency at evenly spaced time intervals directly and/or through licensed sludge hauler contractors registered with the LG. The desludging operation should include collection, transport, treatment and adequate disposal and/or reuse of the extracted sludge. The cost of the operation should be covered by a fee to be collected from all owners or occupiers of the premises equipped with on-site wastewater treatment facilities. Considering that the on-site wastewater service users constitute around 90% of the potential customers of the SDO, even after the implementation of the first stages of the new off-site sewerage systems, this service will make up the bulk of the SDO's activity and revenues.

6. It is important to note in this regard that the MPWH has made septage management one of its priority programs as part of their efforts to increase access to appropriate sanitation, especially as to the implementation of scheduled desludging (LLTT) is concerned. In order to raise the awareness of LGs, the MPWH has issued a guidance document on septage management[4], and, more recently, held a two-day workshop titled Assistance for the Technical Optimization of Septage Management and for the Implementation Scheduled Septage Services[5], in Bandung, on 5-6 November 2016.

7. As a first step, it was proposed to draft a Septage Management Plan for the City of Jambi as an additional task of the CDTA, which would then serve as an example and a model for the rest of the MSMIP target cities and elsewhere in Indonesia. It was understood that this approach would offer the advantage of improving the knowledge on on-site sanitation systems and their management, which would enable SDOs to operate and maintain the overall sanitation system and ensure cost recovery of all operational costs.

8. In view of the foregoing, the City Government of Jambi requested ADB's assistance to prepare a Septage Management Plan for the city based upon a detailed survey covering 40,000 households or 200,000 beneficiaries. The plan, one of the first of its kind in Indonesia, should include provisions for the establishment of scheduled desludging of septic tanks, in line with the above-mentioned policy of the MPWH. Both the City Government of Jambi and the MPWH agreed to support this activity and has sent a formal request to ADB. The task is financed with funds available from the Water Financing Partnership Facility (WFPF).

[4] Pedoman Layanan Lumpur Tinja Terjadwal (Guidelines on Scheduled Septage Services). Kementerian Pekerjaan Umum dan Perumahan Rakyat, Direktorat Jenderal Cipta Karya, Direktorat Pengembangan Penyehatan Lingkungan Permukiman, December 2014 (only in Indonesian).

[5] Bantuan Teknis Optimalisasi Pelayanan Lumpur Tinja dan Penyiapan Penerapan Layana Lumpur Tinja Teryadwal.

II. RATIONALE: WHY AND HOW TO MANAGE SEPTAGE

9. There are many reasons to manage septage in Jambi and in other cities of Indonesia, the most important ones being as follows:

- (i) Despite the implementation of the new centralized off-site sewerage systems, on-site systems will remain the predominant method of sanitation for many decades in Jambi and elsewhere.
- (ii) On-site wastewater systems, such as septic tanks, pit latrines, dry latrines, MCK, or other types, accumulate septage or faecal sludge that needs to be removed periodically.
- (iii) If septage is not properly managed, discharges negative impacts on the urban environment and on public health may result.
- (iv) Improper handling of septage may cause risks of faecal matter re-entering the domestic environment and cause waterborne diseases, such as typhoid fever, gastroenteritis and all types of diarrhoea, within the households.
- (v) Private septage haulers often discharge collected septage into drains, waterways, open land and agricultural fields, posing a threat to the environment and health.

10. Based on these reasons, the aim of the Septage Management Plan for the City of Jambi is to set up a septage management service as part of an overall wastewater management service, together with the operation and maintenance (O&M) services of the proposed centralized sewerage system and the WWTP. This septage management service should encompass all the elements of the so-called septage management chain:

- (i) Permitting arrangements and implementation of design and construction requirements for new on-site sanitation systems.
- (ii) Inspection and upgrade of existing septic tanks and other on-site facilities.
- (iii) Scheduled desludging service using the SDO's own resources and/or through licensed septage haulers or emptiers.
- (iv) Transportation of septage to government-owned treatment facilities (IPLT and centralized WWTP).
- (v) Septage treatment at these facilities.
- (vi) Transportation to final disposal or end usage sites, with a preference for agricultural reuse on nearby farmlands as "biosolids" (fertiliser).

III. THE SEPTAGE MANAGEMENT PLANNING PROCESS

11. The planning process started with the preparation of a Preliminary Report in December 2017, aimed to briefly set out the bases and the main elements of the Septage Management Plan for the City of Jambi, providing a framework for an in-depth discussion of the key concepts and issues of septage management, both technical and financial and institutional, with the local government (Pemerintah Daerah, PEMDA) of Jambi. Bearing in mind that the current septic emptying activities involve several private companies, the main findings of an earlier report on Public Private Partnership (PPP) prepared under the CDTA were also incorporated into this report[6]. The Preliminary Report was presented at a held in Jambi on 12 December 2017 in the framework of ADB's project review mission of the Metropolitan Sanitation Management Investment Project.

12. The second major activity of the planning process was the above-mentioned detailed survey carried out on 40,000 properties in 13 kelurahan of 5 kecamatan of the City of Jambi, from the beginning of December 2017 to end February 2018, with a significant deployment of efforts and personnel. Data collection was performed using a mobile application connected to a GIS database, enabling a rapid data analysis and the assessment of the current status of septic tanks in the survey area. The survey was presented to the City Government and to the stakeholders, including representatives of the 13 kelurahan on the first day of a workshop held in Jambi on

13. Based on these activities, the Consultant prepared an Interim Report in March 2018, with the aim of summarizing the main findings that could be derived from the results of the survey and from the Consultant's field enquiries and analysis. Furthermore, it contained a brief assessment of the current situation based on the findings and outlined the Consultant's approaches to the development of the Septage Management Plan for the City of Jambi. The report was presented at the Interim Workshop held on 22 and 23 March 2018 in Jambi with the participation of the City Government, Cipta Karya and ADB as well as representatives of the kecamatan and kelurahan implied in the above-mentioned survey.

14. The drafting of this Final Report is the last step of the planning process that constitutes the planning report. It contains all the proposals and recommendations that should allow the City Government of Jambi to implement the septage management service including scheduled desludging and adequate septage treatment and disposal, as part of a comprehensive wastewater management service.

15. The planning report should be developed further into an "implementation road map" that shall comprise of:

- (i) an elaborated version of the plan (action plan) that incorporates the specific roles, procedures and targets of the forthcoming SDO (an UPTD-PAL)[7];
- (ii) a set of documents and tools that can be used separately by the UPTD-PAL (and potentially by other Indonesian cities), in relation with the key tasks and processes of the SMP; and
- (iii) training activities specifically targeting said key tasks and processes, including on-the-job training to support the initial implementation of the SMP.

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[6] Private Sector Participation in Septage Management in the Target Cities, SIAP, October 2016.

[7] Unit Pelaksana Teknis Daerah – Pengelolaan Air Limbah (Local Technical Implementation Unit for Wastewater Management)

IV. PURPOSE AND STRUCTURE OF THIS REPORT

16. The purpose of this Final Report is to address the key activities involved in a Septage Management Plan, such as:

(i) Assessment of the current situation by means of a detailed survey of 40,000 households and the Consultant's enquiries and analysis.
(ii) Design and construction and/or refurbishment of septic tanks.
(iii) Scheduled desludging.
(iv) Treatment and disposal of septage.

17. Therefore, the report is to describe all these activities and explain the ways how the City Government of Jambi should gradually control the city's on-site wastewater treatment and disposal facilities, organize and implement scheduled desludging services and operate and maintain the septage treatment facilities and manage sludge disposal.

V. KEY CONCEPTS: SEPTIC TANK AND SEPTAGE

A. What is a Septic Tank

18. Wastewater is produced by all water users with waterborne sanitation systems. The basic principle of modern wastewater management is that no wastewater can be discharged into the environment without treatment. While in case of discharges connected to a public sewerage system, end treatment at a WWTP is obvious, wastewaters issued from a building in unsewered areas should be treated and disposed in an adequate on-site system. The standard on-site wastewater treatment and disposal facility in urban areas should comprise a septic tank and a percolation area. These systems provide effective treatment and disposal of domestic wastewater when properly sited, sized, installed and maintained, in accordance with the Indonesian Standard No. SNI 03-2398-2002 titled Procedure for the Design of Septic Tanks with a Percolation System (Figure 1). No cesspools, septage pits, infiltration wells, free-surface wetlands or ponds should be allowed as on-site wastewater treatment and disposal facilities in urban areas.

19. A septic tank is a watertight underground tank made of masonry, cast in situ or precast concrete, fibreglass, PVC or plastic, in which wastewater (both blackwater and greywater) receives primary treatment. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate. Liquid flows through the tank and solids sink to the bottom, while scum (mostly oil and grease) floats to the top. Over time, the solids that settle to the bottom are degraded anaerobically. However, the rate of accumulation is faster than the rate of decomposition, and the accumulated sludge and scum must be periodically removed (Figure 2).

20. This technology is most commonly applied at the household level. Larger, multi-chamber septic tanks can be designed for groups of houses and/or public buildings (e.g., schools).

21. Generally, the removal of 50% of solids, 30 to 40% of BOD and a 1-log removal of E. coli can be expected in a well-designed and maintained septic tank, although efficiencies vary greatly depending on operation and maintenance and climatic conditions. They are not efficient at all at removing nutrients and pathogens.

22. Wastewater treated in on-site wastewater facilities should be disposed to the soil within the parcel where the building stands. Actually, the most important component of a septic tank system is the percolation area (also called the infiltration area or leach field), as it provides the majority of the treatment of the wastewater effluent. The percolation area comprises a simple perforated pipe network that can be subsurface or at ground level using in situ subsoil for treatment (Figure 1, c; Figure 3). The length of the percolation trenches is calculated as a function of the number of persons for which the house is designed. In parcels with limited space, a soak or seepage pit can be installed (Figure 4).

23. The design and construction considerations of these facilities are set out in Sections C and D of Chapter IX below.

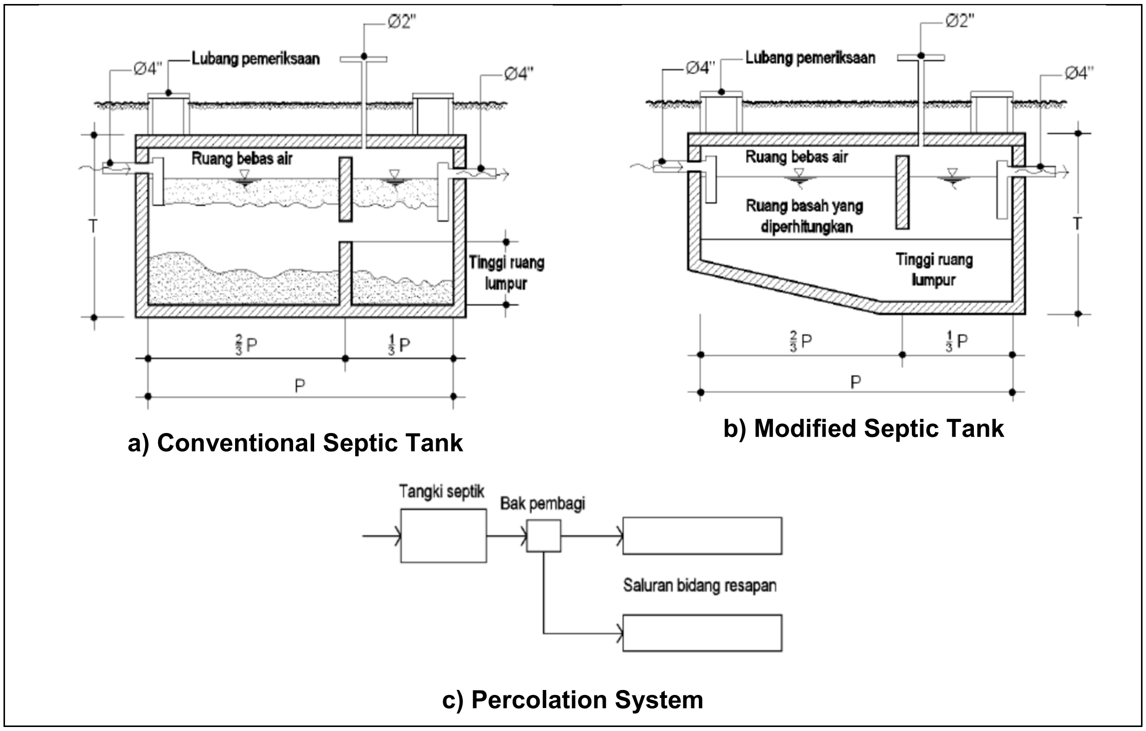

Figure 1: Septic Tank Design According to the Indonesian Standard SNI 03-2398-2002[8]

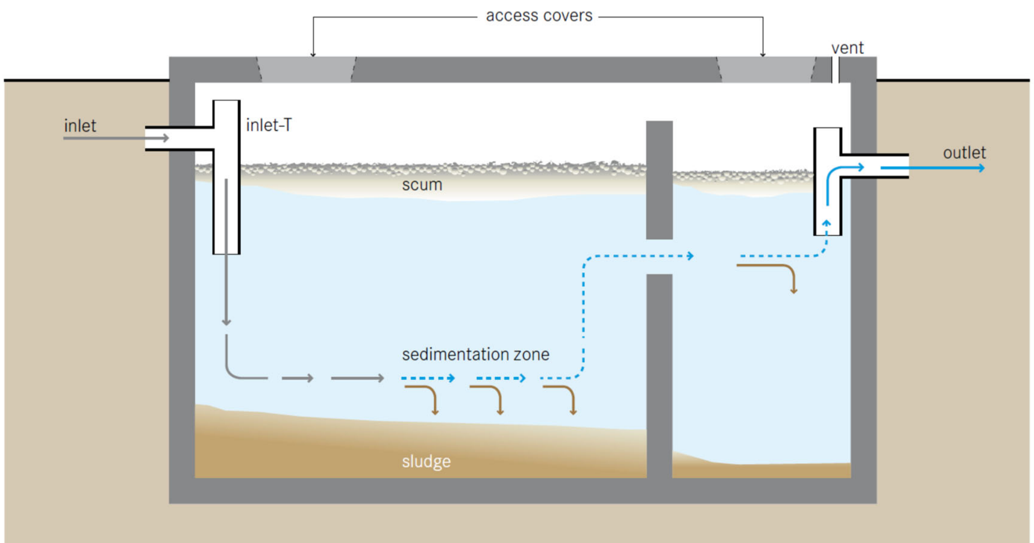

Figure 2: Main Features and Functionality of a Septic Tank[9]

8 Drawings taken from Sudarmadji and Hamdi, Tangki Septik dan Peresapannya Sebagai Sistem Pembuangan Air Kotor di Permukiman Rumah Tinggal Keluarga, PILAR Jurnal Teknik Sipil, Volume 9, No. 2, September 2013.

9 Source: Tilley, E., Ulrich, L., Lüthi, C., Reymond, P., Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies. Dübendorf: Swiss Federal Institute of Aquatic Science & Technology (EAWAG), 2nd revised edition.

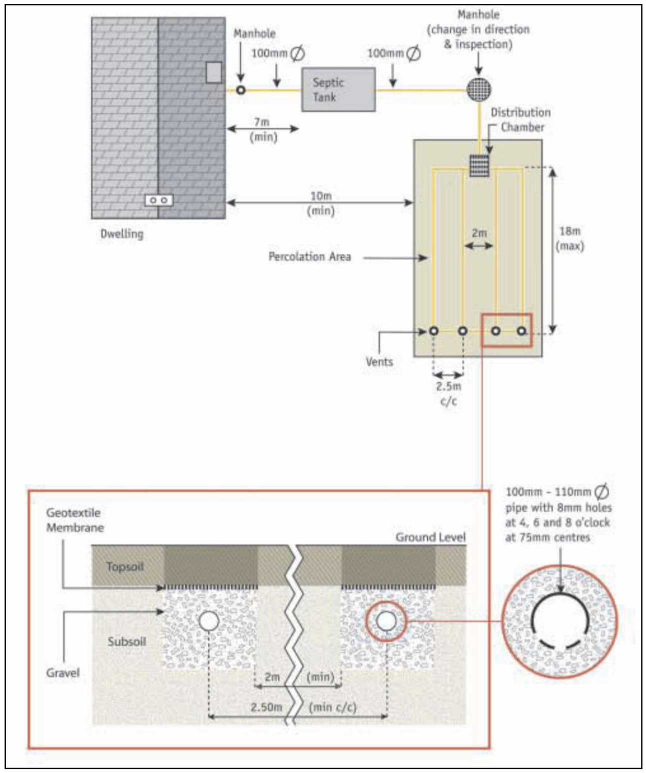

Figure 3: Plan and Section of Layout of a Typical Septic Tank System[10]

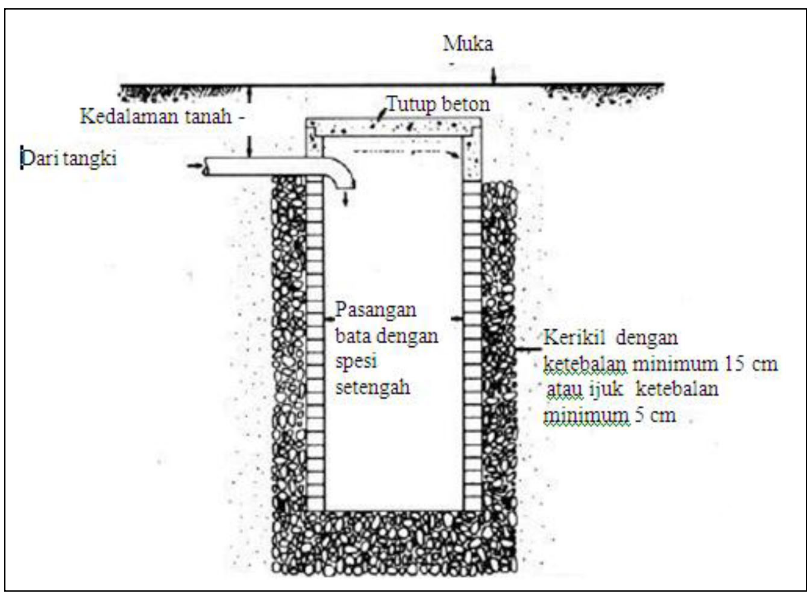

Figure 4: Typical Soak Pit[11]

24. A septic tank can be combined with a filter, usually called biofilter, because it consists of a biological treatment based on a biomass adhered to a support medium. The system comprises two generally cylindrical compartments, the proper septic tank and the biofilter, in

[10] Source: Code of Practice, Wastewater Treatment and Disposal Systems Serving Single Houses (p.e. ≤ 10), Environmental Protection Agency, Office of Environmental Enforcement, Wexford, Ireland, 2009

[11] Source: SNI 03-2398-2002, taken from Sudarmadji and Hamdi, 2013 (see footnote 11).

biological treatment of wastewater takes place. Actually, most of the compact prefabricated septic tank systems are of this kind, like the septic tank combined with an up-flow biofilter (Figure 5) promoted by IUWASH for small households (1 KK[12] = 5 persons)[13] and the other products available in Indonesia (APPENDIX 5).

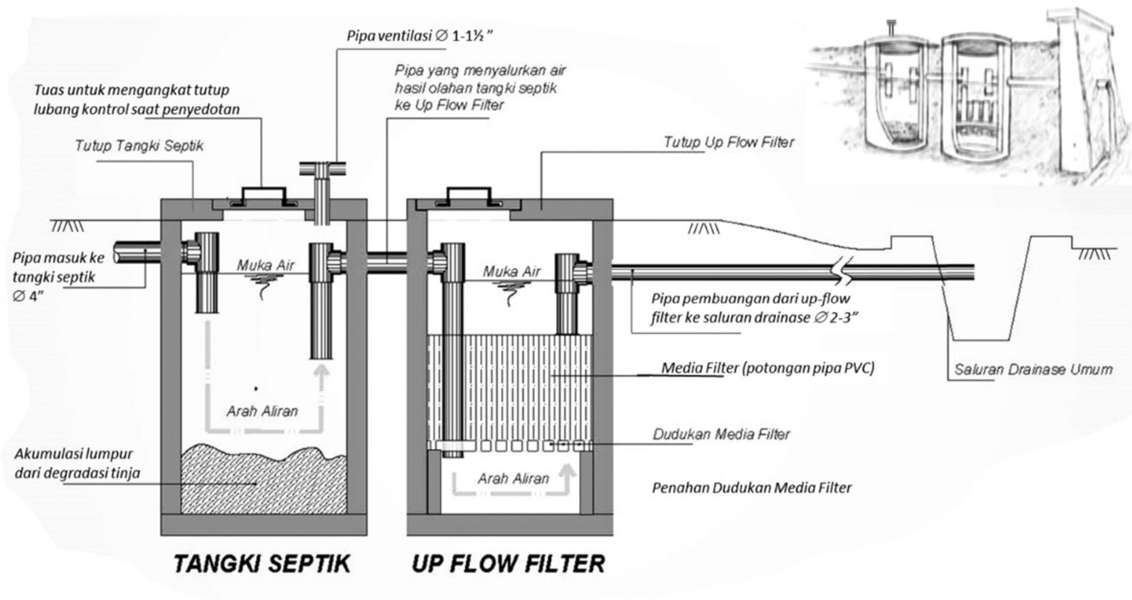

Figure 5: Cylindrical Septic Tank Combined with an Up-Flow Filter for Small Households[14]

25. An improved form of the septic tank is the Anaerobic Baffled Reactor (ABR) which can be readily applied in small neighbourhoods as the so-called communal septic tanks or for larger buildings (Figure 6). It is most appropriate where a relatively constant amount of blackwater and greywater is generated. This technology is suitable for areas where land maybe limited since the tank is most commonly installed underground and requires a small area. However, a vacuum truck should be able to access the location because the sludge must be regularly removed (particularly from the settler), which is not the case of some existing facilities in Jambi. The anaerobic baffled reactor (ABR) comprises a series of baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment. The up-flow chambers provide enhanced removal and digestion of organic matter. BOD may be reduced by up to 90%, which is far superior to its removal in a conventional septic tank.

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[12] Kepala Keluarga = Head of Family.

[13] MPWH (2016). Buku 2 - Sistem Pengelolaan Air Limbah Domestik-Setempat. Tangki Septik dengan Up-Flow Filter (Book 2 – On-Site Domestic Wastewater Management System. Septic Tank with an Up-Flow Filter). Ed. Lutz Kleeberg. Jakarta: Ministry of Public Works and Housing, 2016 (in Bahasa Indonesia). https://www.iuwashplus.or.id/cms/wp-content/uploads/2017/04/Buku-San1-SPALD-Setempat.pdf

[14] Source: Ibidem.

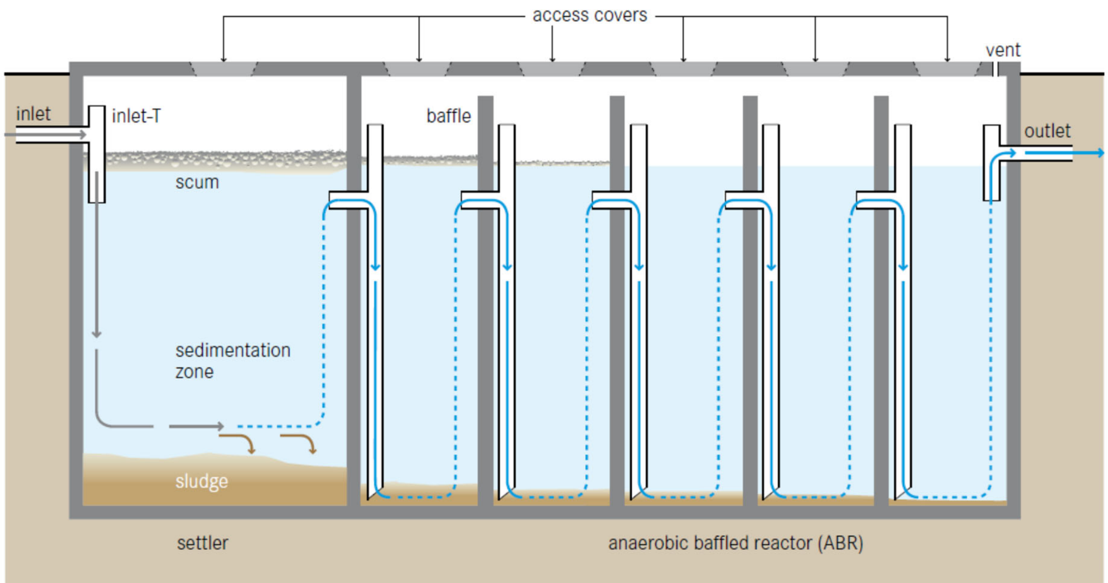

Figure 6: Anaerobic Baffled Reactor[15]

26. Apart from the proper septic tanks and the more advanced systems, the Regulation of the Minister of Public Works and Public Housing No. 04/PRT/M/2017 on the Implementation of Domestic Wastewater Management Systems (PERMEN 04/PRT/M/2017)[16], however, allows the implementation of the so-called twin cubluk systems (Figure 7). Nevertheless, the regulation specifies, in its Appendix II: Domestic Wastewater Management System Design, that these facilities should only be admitted in very low-density areas with less than 25 people per hectare (i.e. rural or rural-type urban areas), which is not the case of most of the city of Jambi. Therefore, the application of a system of this type should be explicitly approved by the City Government in the framework of a permitting arrangement to be implemented.

[15] Source: Tilley et al. (2014).

[16] Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 04/PRT/M/2017 tentang Penyelenggaraan Sistem Pengelolaan Air Limbah Domestik, Jakarta, 21 Maret 2017.

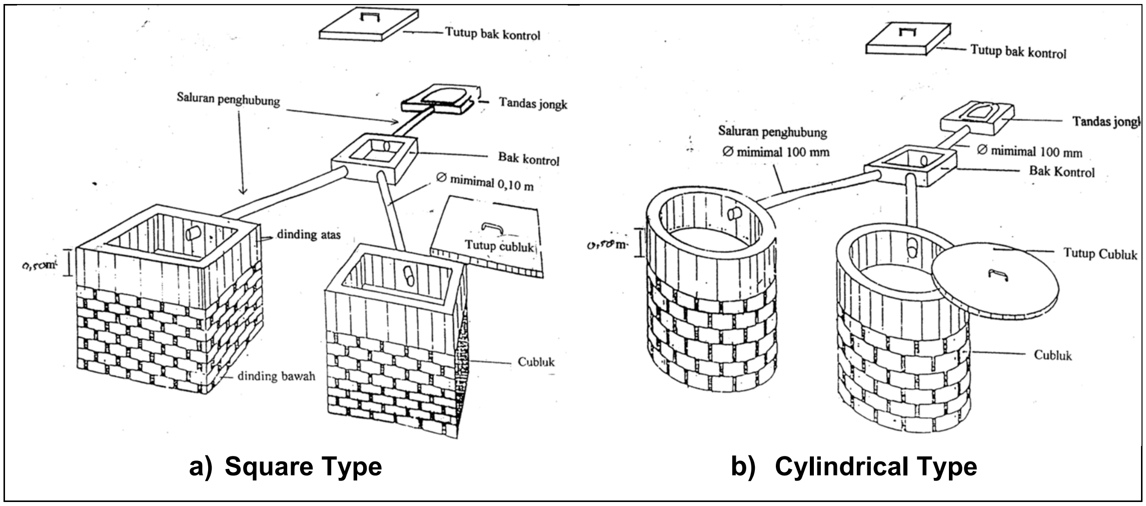

Figure 7: Twin Cubluk Systems for Rural or Rural-Type Urban Areas[17]

B. What is Septage

27. Septage is the settled solid matter, usually a mixture of solids and water, retained at the bottom of a septic tank. It is raw or partially digested sludge in a semisolid form. It results from the collection, storage or treatment of combinations of blackwater and excreta, with or without greywater. It has an offensive odour and appearance and is high in organics and pathogenic microorganisms (Figure 8).

28. There is a very slight difference between septage, generally used in relation to septic tanks in the narrow sense, and other outputs of on-site sanitation systems, such as cesspools or pit latrines, for which the terms faecal sludge or excreta are also used. Therefore, in this report and in further documents of the Septage Management Plan for the City of Jambi, the term septage is used for all types of sludge, slurry or human excreta collected from on-site sanitation systems, including wet and dry systems, and private or public toilets or Mandi, Cuci, Kakus (MCK), as they are called in Indonesia.

Figure 8: Discharge of Septage at the Talang Bakung IPLT in Jambi

29. The characteristics of septage can differ widely from household to household, city to city, region to region, and country to country. The physical, chemical and biological qualities of

[17] Source: PERMEN 04/PRT/M/2017.

faecal sludge are influenced by the duration of storage, temperature, soil condition, and intrusion of groundwater or surface-water in septic tanks or pits, the performance of septic tanks, and the tank-emptying technology and pattern.

30. The typical characteristics of septage are summarized in Table 1 below taken from a septage characterization study performed in Indonesia in 2014 and based on sampling in Jakarta, Bogor, Surakarta and Makassar[18]. The survey of households emptied found on-site systems were typically single leach pits rather than standard septic tanks, approximately 2.5 m^3 and on average operated for 6 years before emptying. The results show that most parameters are on the low end of international findings and can be classified as low strength septage.

Table 1: Summary of Septage Characteristics

Parameter	Existing International Data	Survey		
		N	Range	Mean
Total Solids (TS), mg/l	5,000-71,000	17	3,820-43,894	15,052
Total Suspended Solids (TSS), mg/l	5,000-52,000	15	274-11,383	2,664
Volatile Solids (VS), %TS	45-83%	9	56-84%	73%
COD, mg/l	1,200-83,000	24	549-17,875	3,284
BOD_5, mg/l	600-2,600	23	215-3,500	1,009
BOD/COD Ratio			0,1-0,75	0,3
pH	6-7.7	29	6.3-8.0	7.4
Ammonia (NH_3-N), mg/l	150-1230	16	96-398	200
Phosphate (PO_4), mg/l	70-185	14	37-277	153
Total Coliforms, MPN/100 ml	0.6-9 million	17	4000-39 million	8 million
Helminth Eggs Total No./l	16-91/gTS, 16-50/gFS	6	0-200	37/gFS

31. The total solids (TS) values of the survey were typically within the range but on the low side of international values and similar to previous analysis from Indonesia. However most of the results for total suspended solids were well below international levels, which are most likely due to the difficult of testing more dense faecal sludge with typical liquid filter methods. It is recommended that TS are determined separately rather than summing the results of Total Dissolved Solids (TDS) and TSS due to the difficulty measuring TSS in thick sludge.

32. The low COD values indicate that some stabilization has occurred and reduced the organic content of sludge. This accords with the low values of the volatile solids and as expected for on-site systems which had not been emptied for several and even many years and is also confirmed by the low BOD/COD ratio indicating very low and/or difficult biodegradability. Therefore, as also set out in specialized literature (Heinss et al., 1998; Strauss et al., 2000), the type of septage available in Jambi might be highly mineralized and little digestive or not digestive at all and the anaerobic pond might not be required.

33. From these results, it can be seen clearly, however, that there is a fundamental difference between sewage and septage. Sewage is untreated wastewater which contains faeces and

[18] Mills, F. Faecal Sludge Characterization in Indonesia. ADB, TA-7739 INO: Supporting Water Operators' Partnerships. Final Report. February 2014.

urine as well as greywater from the kitchen and bathroom and is discharged either into a centralized sewer system or into an on-site wastewater treatment facility. Generally, both biochemical oxygen demand (BOD) and total suspended solids content (TSS) of domestic sewage range from 200 to 350 mg/l and WWTPs are designed for this load.

34. Septage is sludge or slurry, emptied out of septic tanks or pit latrines, and is much more concentrated than sewage, its TSS being 10 to more than 100 times higher than that of municipal wastewater. Actually, in terms of solids content (TSS) it resembles to the sludge that is removed from the settling tanks of a WWTP, ranging from 2-10 g/l. Therefore, septage is sludge and not water, and should be treated as such, using the proper methods of the sludge treatment process, such as thickening, stabilization, dewatering and drying. The treatment process should be designed as a function of septage quality and quantity and, mainly, of its final disposal and/or end usage.

VI. SURVEY OF EXISTING ON-SITE FACILITIES AND DATA MANAGEMENT

A. Background

35. The CDTA consultant has carried out a detailed survey of 40,000 households in the City of Jambi, to form the basis for the key assumptions and determinations in the city Septage Management Plan. The survey is one of the first of its kind in Indonesia and also aims at establishing a reference for future surveys in Jambi and the other CDTA cities to support the strategies for integrated urban wastewater management.

B. Scope and Key Features

36. The survey comprised 40,123 properties (equivalent to an estimated population of 185,000 inhabitants, i.e. approximately one-third of the total population of Jambi[19]) throughout 13 kelurahan and 5 kecamatan of the City of Jambi, as shown in Table 2 and Figure 9. It excludes districts that will be covered by the sewer network of the future MSMIP off-site project. The work was carried out from the beginning of December 2017 to the end of February 2018.

Table 2: Summary of the Kecamatan and Kelurahan of the Survey Area

Kelurahan / Kecamatan	No. Households
1. Legok	3,005
2. Murni	1,274
3. Solok Sipin	2,071
I. Danau Sipin:	**6,350**
4. Lebak Bandung	2,250
5. Cempaka Patih	1,612
6. Jelutung	2,923
II. Jelutung:	**6,785**
7. Pakuan Baru	1,644
8. Tambak Sari	2,505
9. Pasir Putih	2,278
10. Thehok	5,674
III. Jambi Selatan:	**12,101**
11. Simpane Tiga Sipin	5,591
12. Paal Lima	3,375
IV. Kota Baru:	**8,966**
13. Talang Bakung	5,921
V. Paal Merah:	**5,921**
Total Survey:	**40,123**

19 583.487 inhabitants according to the 2016 census. The average number of persons by household is 4,6 as per the City Sanitation Strategy of 2008 (SSK, 2008).

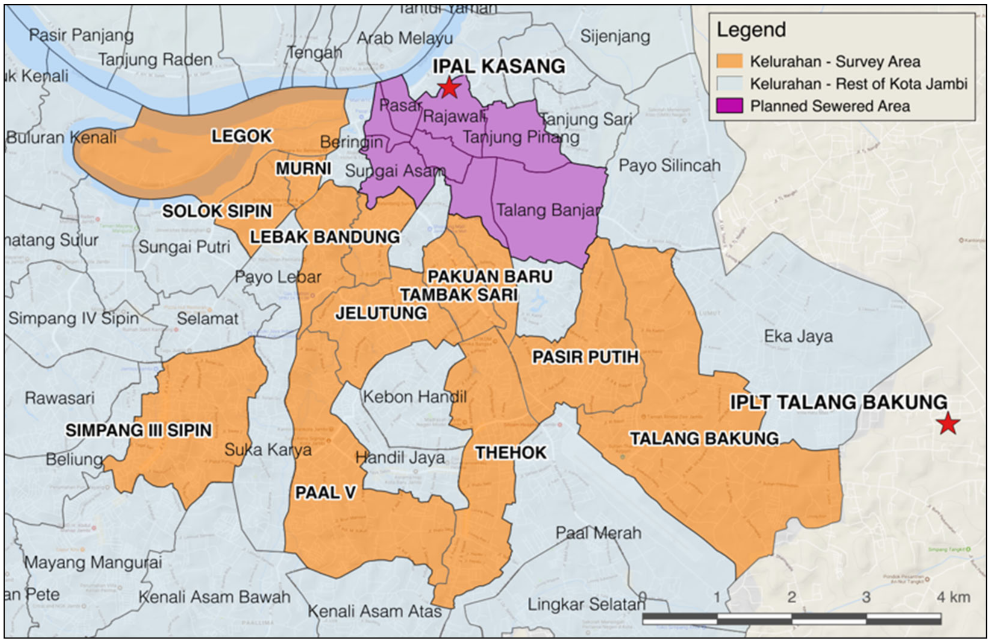

Figure 9: Kelurahan of the Survey Area

C. Material Resources and Techniques

37. The survey was based on a comprehensive questionnaire that included questions ranging from the physical location of the property and the septic tank, through socio-economic characteristics of the dwelling to technical features of the on-site facility. The form was designed based on the previous experiences of pilot studies carried out by IUWASH in Surakarta and Bandung, extended and adapted accordingly to the needs of the Jambi SMP. A sample of the questionnaire is shown in below.

38. The data collected by the interviewers for each property were:

- Name of the interviewee.
- House street name, number, RW (Rukun Warga) and RT (Rukun Tetangga).
- Kelurahan and Kecamatan.
- Postcode.
- Internal interview identification code: a unique code to identify the property in the database. This code is built by a combination of: i) the sequential number assigned to the corresponding kelurahan (1 to 13); ii) the RT number; and iii) the sequential number assigned to the interviewee.
- PDAM customer ID, if the property is connected to the municipal water supply service.
- Property ownership status: ownership, rental, other.
- Source of the drinking water in the house: PDAM, borehole, other.
- Distance from the septic tank (or pit) location to the house entrance.
- Type of building: residential, commercial, government.
- Is the house located in an area prone to flooding (Yes/No).
- Type of sanitation facility existing in the house: none, individual, communal.
- Does the property have a septic tank (or pit) (Yes/No)?
- Does the septic tank (or pit) have a manhole to access and inspect it (Yes/No)?
- Location of the septic tank (or pit): front, rear, side of the house, in the house.
- Distance from the septic tank (or pit) to the street.

- Width of the street.
- Type of wastewater that goes in the septic tank (or pit): blackwater, greywater.
- Material of the septic tank (or pit): masonry, earth, prefabricated concrete or plastic.
- Number of septic tanks (or pits) in the house.
- Age of the tank (years).
- Size of the tank (cubic meters).
- Point of discharge of the tank effluent: ground, ditch.
- Has the tank ever been desludged (Yes/No)?
- How long since the tank was last desludged (Years)?
- Form of payment for the last desludging service: one-off payment, regular payments, communal payments (shared).
- Fee paid for desludging (in Rupiah).
- Are you interest in owning a septic tank, if not already (Yes/No)?
- Geographical latitude of tank measured with GPS device in situ.
- Geographical longitude of tank measured with GPS device in situ.
- Date of the interview.

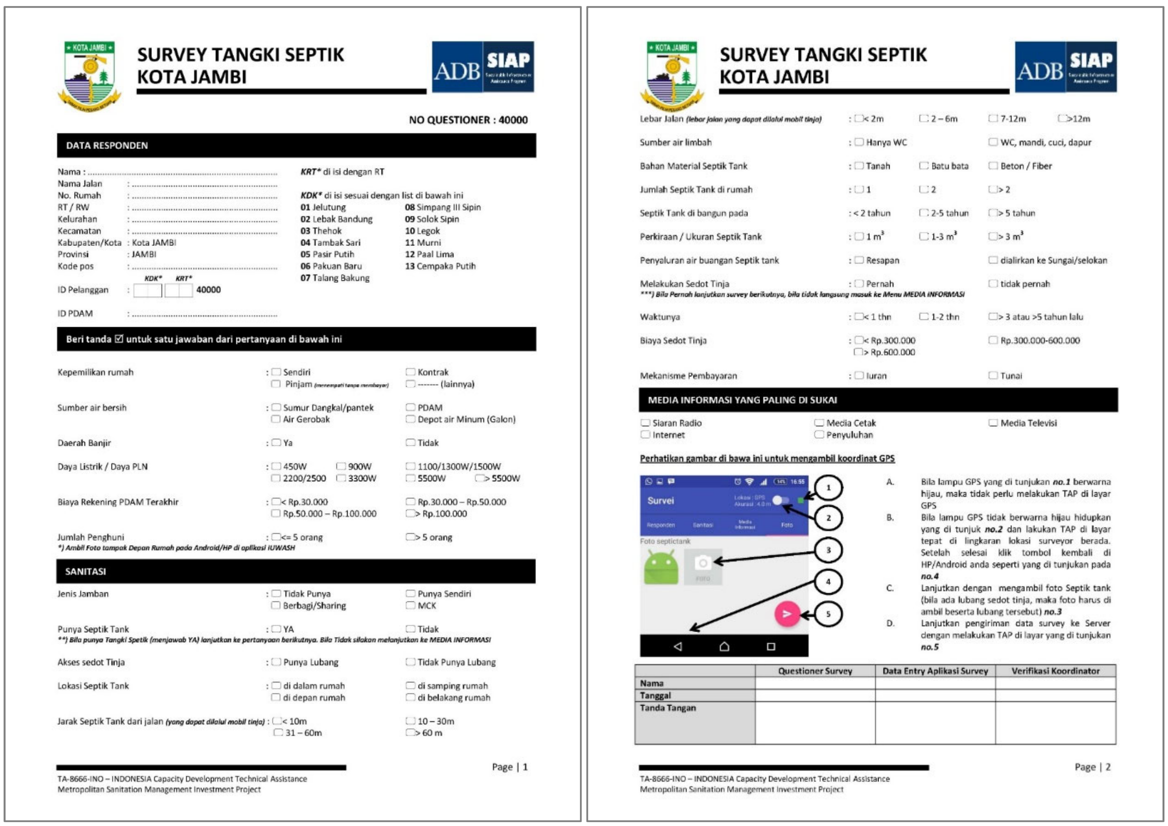

Figure 10: Questionnaire Used for the Survey

39. The surveyors used an Android mobile phone application to record the answers given by the respondents, including the recording of GPS position (Figure 11). The application used was originally developed and tested by IUWASH in Surakarta and Bandung as part of recent projects and was consequently adapted specifically to the needs of the Jambi SMP survey in a collaboration exercise. A guide (in Bahasa Indonesia) containing details of the features and use of the application is included in a supplement of this report on the tools used for the survey

of on-site facilities in Jambi. Moreover, the record of each property and septic tank surveyed included two pictures taken with the camera of the mobile phone used.

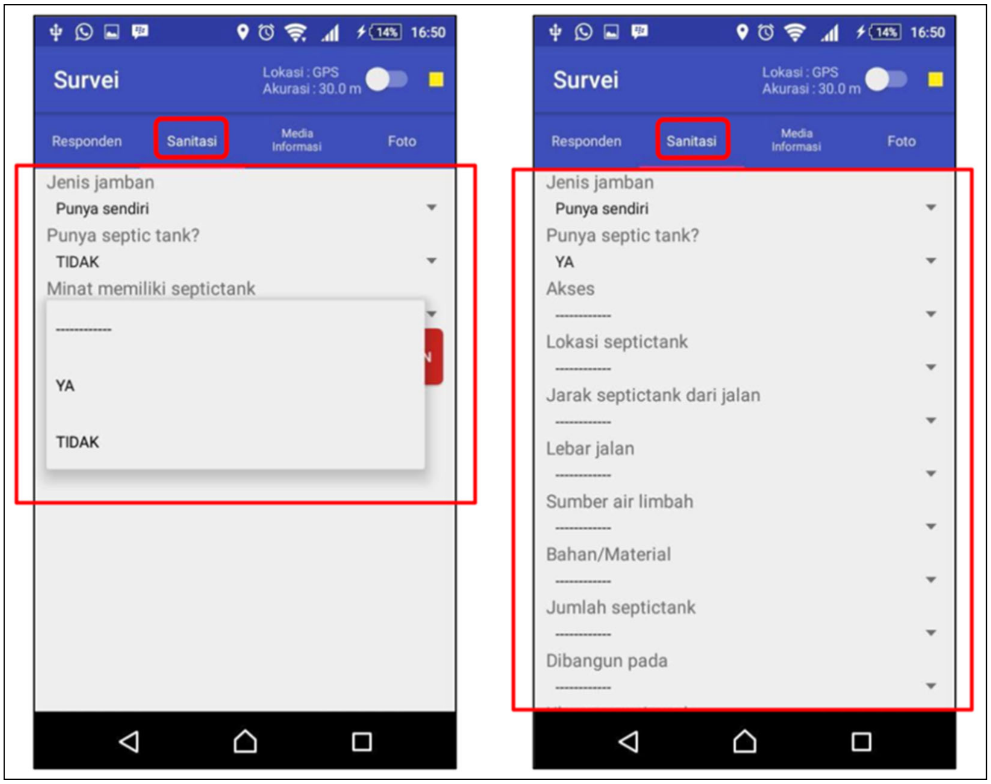

Figure 11: Sample Screenshots of the Android Application Used for the Survey

40. The data obtained by the surveyors were instantly uploaded to a database hosted on a server that was managed by the CDTA consultant and accessible via web-based portal -also formerly developed by IUWASH- for consultation and processing (Figure 12). Overall, the database contains 40,123 records with 42 properties each record, i.e. approximately 1.68 million data items.

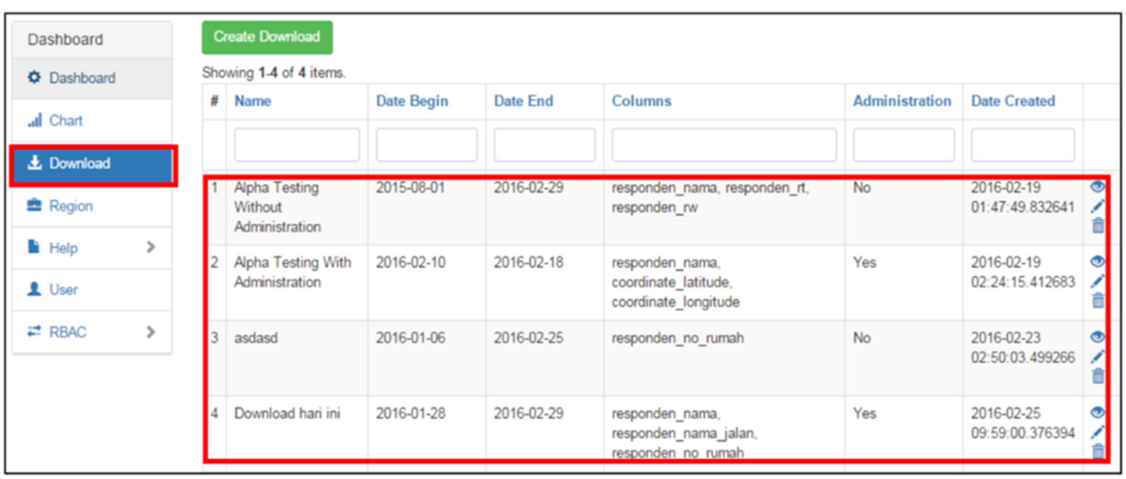

Figure 12: Sample Screenshot of the Web-Based Portal

D. Human Resources, Organization and Training

41. The survey team's organization and its working methodology were designed by the Consultants Project Director and its Team Leader with the support of Dinas PUPR. The team structure was conceived so that the team members and coordinators could work as closely as possible with the representatives of the kecamatan and the kelurahan involved, up to the Neighbourhood Association or Rukun Tetangga (RT) level.

42. Thus, the survey team was comprised of a City Coordinator and 20 kelurahan coordinators (assistant professional staff) each of whom managed on average another 20 surveyors, all of them neighbours of the respective kelurahan of the survey area (Figure 13). The preferred recruits for coordinators were former technical community facilitators of the SANIMAS Project having the necessary technical knowledge and experience in the field of urban wastewater, being familiar with the city environment and used to interact directly with community members.

Figure 13: Survey Coordinators

43. This organizational scheme allowed the consultant a very direct approach to the communities affected by the survey and managed to involve the 13 lurah and 482 rukun tetangga heads (RTs). In order to increase the level of awareness and engagement of the public in the execution of the survey, a socialization workshop was held on 8-9 November 2017 in the Aston Hotel, Jambi, with the participation of the 5 camat, the 13 lurah and the 21 survey coordinators that would be involved in the field survey. There were also representatives of Dinas PUPR attending the event, as portrayed in Figure 14 below.

Figure 14: Survey Workshop and Socialization on 8-9 November 2017

44. Furthermore, the training of the survey team members was undertaken in order to provide them an overview of the objectives of the survey and to instruct them in:

- The use and interpretation of the questionnaire;
- The use of the supporting software application;
- The quality control processes designed for the recording and database storage of the data in a reliable and practical fashion.

45. The training was delivered at two levels: in the first phase, the coordinators were trained by the central management team (the "training of trainers") (Figure 15, a) and, in the second phase, the coordinators trained their respective surveyor team members (Figure 15, b). The debriefing sessions were also attended by the 13 lurahs involved.

46. Once trained, the surveyors carried out the survey activities independently under the supervision of the survey coordinators. The survey was finalized on 28 February 2018 after 3 months of work.

47. The quality control was carried out by the survey coordinators, while the City Coordinator, supported by the Head Office, performed random checks on the field (Figure 16). Moreover, the certification by the lurah was necessary prior to the payment of the surveyor.

a) Training of Coordinators (“Training of Trainers”)

b) Training of Surveyors by Coordinators

Figure 15: Training of the Survey Team

Figure 16: Random Check Session with Head Office Members and the City Coordinator

E. Data Processing

48. After the database was fully populated with the 40,123 records, the data were exported onto a spreadsheet and processed for error-checking, integrity and standard formatting, for example:

- Allocation of unique IDs to each individual record, in addition to the values introduced by the surveyors and coordinators, to allow tracking of changes and correlation of records with the original survey data.
- Correction of upper/lower case differences in the input of text by the surveyor.
- Correction of spelling of names of the streets or kelurahan.
- Standardization of the answers.

49. The result of the data cleansing exercise was a coherent set of data that allows for systematic, computerised analysis.

50. Approximately 1,100 records were found to have clearly incorrect GPS coordinates, due to lack of mobile phone signal at the moment that the GPS position was recorded by the surveyor. These records have been processed individually and geographically located based on the address and other data provided.

51. Another 1,445 records were found to have GPS coordinated that located them outside (but not far off) the limits of the kelurahan surveyed, presumably due to low GPS accuracy of the devices (mobile phones) used. This fact does not have major implications for the preliminary data analysis but will have to be corrected later, in order to allow for geospatial analyses during the implementation phases of the SMP, such as clustering of services or the calculation of detailed schedules for desludging.

52. Table 3 below reflects the estimated number of data missing for each of the questions in the survey form. For the majority of fields, the proportion of data missing is negligible, with the exception of the following:

- House number: One-third of respondents did not provide a house name. However, it is understood that many of the properties are not identified by a house name, but by the name of the dweller instead. The data gap in this case can be complemented later by a cross-reference of GPS coordinates, RT, RW and respondent name.
- More than 12% of the respondents who declared to have access to municipal water supply did not or could not provide the PDAM customer identification number. This information is useful for future measures that target those citizens who have or do not have a connection to PDAM pipes. Nonetheless, the proportion of missing records is small.
- On the other hand, almost half of these respondents could not, did not or did not want to provide details of their monthly water bill. This is presumably related to the reluctance to provide details that might lead to an estimation of the household income, or more likely
- More than forty percent of the respondents who declared to own a septic tank did not or could not provide the distance from the tank to the building entrance.

- Three-quarters of the respondents who declared to have emptied their septic tank (approximately 2,500 properties) in the past did not provide the amount paid for the desludging service.

Table 3: Summary of Missing Data

Field	# of Missing Data	% Missing
Name of Respondent	1	0,00%
Street Name	3	0,01%
House Number	13,376	33,34%
RT	5	0,01%
RW	5	0,01%
Kelurahan	5	0,01%
Kecamatan	5	0,01%
Postcode	0	0,00%
Customer Id	26	0,06%
PDAM Customer Id	2,147	12,13%
Property Status	158	0,39%
Clean Water Source	248	0,62%
Distance to Entrance	15,614	43,87%
Building Type	263	0,66%
In Flood Area	317	0,79%
Power Installed	509	1,27%
Water Bill	7,853	44,35%
No of People in House	652	1,63%
Sanitation Type	47	0,12%
Has Septic Tank (ST)	60	0,15%
ST Has Access Manhole	250	0,70%
ST Location	178	0,50%
ST Distance to Road	209	0,59%
Road Width	220	0,55%
Wastewater Source	169	0,42%
ST Material	86	0,24%
Number of STs	290	0,81%
ST Age	175	0,49%
ST Size	218	0,61%
ST Discharge Medium	191	0,54%
ST Has Been Desludged	496	1,39%
For of Payment for Desludging	24	0,93%
Want a ST	248	5,55%
ST - Time With No Emptying	15	0,04%
ST Fee Paid for Desludging	1,920	74,65%

53. In summary, the completeness of the survey in terms of answers can be considered as adequate for analytical and planning purposes, with the exception of the data about fees paid

for the water supply service and the fees paid for desludging services in the past, which are necessary for the calculation of the willingness to pay.

54. Therefore, it is recommended that the implementation of the Jambi SMP addresses this data gap by means of additional surveys or other data collection methods, for example by cross-referencing data with the PDAM database or data from the public and private desludging operators.

55. Finally, it is worth noting that the processed data were input to a geographical information system (GIS) using the open-source application Q-GIS[20] for visual and spatial analysis, whose results are presented in Section G below.

F. Summary of the Survey Data Analysis

56. The following tables contain the most relevant results derived from a preliminary analysis of survey data, consisting in the aggregation of certain questions by kelurahan (Table 4). The percentages shown represent the proportion over the total of valid answers (i.e. excluding blanks and omissions). The interpretation of these results and the conclusions that can be derived from them are presented in Chapter VII below.

Table 4: Summary of Data Analysis at the Kecamatan Level

Table 4.a) Does the Property Have a Septic Tank?		
Kecamatan/Kelurahan	**No**	**Yes**
DANAU SIPIN		
LEGOK	42,4%	57,6%
MURNI	22,4%	77,6%
SOLOK SIPIN	24,5%	75,5%
JAMBI SELATAN		
PAKUAN BARU	9,6%	90,4%
PASIR PUTIH	4,6%	95,4%
TAMBAK SARI	8,4%	91,6%
THEHOK	7,5%	92,5%
JELUTUNG		
CEMPAKA PUTIH	12,5%	87,5%
JELUTUNG	12,4%	87,6%
LEBAK BANDUNG	18,9%	81,1%
KOTA BARU		
PAAL LIMA	5,3%	94,7%
SIMPANG III SIPIN	4,1%	95,9%
PAAL MERAH		
TALANG BAKUNG	2,0%	98,0%
Total	**11,2%**	**88,8%**

[20] Q-GIS is a professional GIS application that is built on top of Free and Open Source Software (FOSS). The file formats operated by Q-GIS and used by the CDTA team in the context of the survey and the Jambi SMP are 100% compatible and interoperable with the majority of the free and proprietary GIS software. More information about Q-GIS can be found at https://www.qgis.org/en/site/

Table 4.b) Electrical Power Available at the Property				
Kecamatan/Kelurahan	**450W**	**900W**	**1100/2200W**	**≥ 3300W**
DANAU SIPIN				
LEGOK	1,4%	2,9%	2,4%	0,1%
MURNI	0,5%	1,5%	1,1%	0,1%
SOLOK SIPIN	0,9%	2,4%	1,9%	0,1%
JAMBI SELATAN				
PAKUAN BARU	0,6%	1,5%	1,9%	0,1%
PASIR PUTIH	0,7%	2,1%	2,8%	0,1%
TAMBAK SARI	0,8%	2,6%	2,8%	0,2%
THEHOK	1,6%	4,2%	8,1%	0,4%
JELUTUNG				
CEMPAKA PUTIH	0,5%	1,5%	1,8%	0,2%
JELUTUNG	1,2%	2,6%	3,4%	0,2%
LEBAK BANDUNG	0,9%	2,2%	2,5%	0,1%
KOTA BARU				
PAAL LIMA	0,6%	2,2%	5,2%	0,3%
SIMPANG III SIPIN	1,4%	4,1%	8,3%	0,3%
PAAL MERAH				
TALANG BAKUNG	1,6%	4,7%	8,5%	0,2%
Total	**12,7%**	**34,4%**	**50,7%**	**2,2%**

Table 4.c) Distance From The Tank To The Road				
Kecamatan/Kelurahan	**< 10m**	**10 - 30m**	**30 - 60m**	**> 60m**
DANAU SIPIN				
LEGOK	26,0%	41,0%	16,7%	16,3%
MURNI	22,1%	52,4%	17,2%	8,2%
SOLOK SIPIN	26,6%	48,1%	14,7%	10,6%
JAMBI SELATAN				
PAKUAN BARU	33,4%	55,8%	8,1%	2,6%
PASIR PUTIH	26,3%	61,9%	10,4%	1,4%
TAMBAK SARI	25,9%	57,9%	14,4%	1,8%
THEHOK	24,4%	66,9%	6,8%	1,9%
JELUTUNG				
CEMPAKA PUTIH	22,6%	51,7%	13,5%	12,2%
JELUTUNG	38,1%	53,1%	5,8%	3,0%
LEBAK BANDUNG	21,9%	46,9%	17,9%	13,3%
KOTA BARU				
PAAL LIMA	40,7%	43,2%	11,2%	4,9%
SIMPANG III SIPIN	40,0%	49,2%	7,4%	3,4%
PAAL MERAH				
TALANG BAKUNG	34,1%	56,4%	7,1%	2,4%
Total	**31,3%**	**54,0%**	**10,0%**	**4,8%**

Table 4.d) Tank Material				
Kecamatan/Kelurahan	**Masonry**	**Concrete**	**Fiberglass**	**Earth**
DANAU SIPIN				
LEGOK	78,6%	17,2%	0,2%	4,0%
MURNI	88,2%	10,9%	0,0%	0,9%
SOLOK SIPIN	82,9%	14,5%	0,0%	2,6%
JAMBI SELATAN				
PAKUAN BARU	92,8%	6,6%	0,0%	0,6%
PASIR PUTIH	93,7%	5,5%	0,0%	0,7%
TAMBAK SARI	95,7%	3,6%	0,4%	0,3%
THEHOK	94,3%	5,1%	0,0%	0,7%
JELUTUNG				
CEMPAKA PUTIH	65,7%	33,5%	0,0%	0,8%
JELUTUNG	92,7%	5,7%	0,0%	1,6%
LEBAK BANDUNG	86,3%	12,0%	0,0%	1,6%
KOTA BARU				
PAAL LIMA	78,5%	20,5%	0,0%	0,9%
SIMPANG III SIPIN	87,5%	11,4%	0,0%	1,1%
PAAL MERAH				
TALANG BAKUNG	97,3%	1,5%	0,0%	1,2%
Total	**89,3%**	**9,5%**	**0,0%**	**1,2%**

Table 4.e) Tank Age			
Kecamatan/Kelurahan	**< 2 Years**	**2 - 5 Years**	**> 5 Years**
DANAU SIPIN			
LEGOK	8,0%	25,4%	66,6%
MURNI	4,0%	6,9%	89,1%
SOLOK SIPIN	3,8%	12,5%	83,7%
JAMBI SELATAN			
PAKUAN BARU	3,5%	10,7%	85,7%
PASIR PUTIH	3,0%	11,1%	85,9%
TAMBAK SARI	1,6%	9,0%	89,4%
THEHOK	3,9%	13,4%	82,7%
JELUTUNG			
CEMPAKA PUTIH	7,4%	5,9%	86,6%
JELUTUNG	3,2%	17,8%	79,0%
LEBAK BANDUNG	3,0%	13,0%	84,0%
KOTA BARU			
PAAL LIMA	5,9%	13,8%	80,3%
SIMPANG III SIPIN	2,7%	14,4%	82,9%
PAAL MERAH			
TALANG BAKUNG	4,3%	16,0%	79,6%
Total	**4,0%**	**13,9%**	**82,2%**

Table 4.f) Tank Size			
Kecamatan/Kelurahan	**Unknown**	**1 - 3m^3**	**> 3m^3**
DANAU SIPIN			
LEGOK	42,8%	47,2%	10,0%
MURNI	22,9%	64,5%	12,6%
SOLOK SIPIN	24,6%	52,6%	22,8%
JAMBI SELATAN			
PAKUAN BARU	9,7%	75,5%	14,8%
PASIR PUTIH	4,7%	61,3%	34,1%
TAMBAK SARI	8,6%	68,4%	23,1%
THEHOK	7,6%	70,6%	21,8%
JELUTUNG			
CEMPAKA PUTIH	17,4%	64,6%	18,0%
JELUTUNG	12,5%	77,1%	10,4%
LEBAK BANDUNG	18,9%	64,8%	16,2%
KOTA BARU			
PAAL LIMA	5,9%	75,6%	18,5%
SIMPANG III SIPIN	4,2%	80,3%	15,6%
PAAL MERAH			
TALANG BAKUNG	2,0%	79,1%	18,9%
Total	**11,5%**	**70,2%**	**18,3%**

Table 4.g) Has the Tank Ever Been Desludged?		
Kecamatan/Kelurahan	**Yes**	**No**
DANAU SIPIN		
LEGOK	2,7%	97,3%
MURNI	10,9%	89,1%
SOLOK SIPIN	5,9%	94,1%
JAMBI SELATAN		
PAKUAN BARU	8,2%	91,8%
PASIR PUTIH	8,5%	91,5%
TAMBAK SARI	8,5%	91,5%
THEHOK	7,7%	92,3%
JELUTUNG		
CEMPAKA PUTIH	9,4%	90,6%
JELUTUNG	9,1%	90,9%
LEBAK BANDUNG	7,2%	92,8%
KOTA BARU		
PAAL LIMA	8,6%	91,4%
SIMPANG III SIPIN	8,3%	91,7%
PAAL MERAH		
TALANG BAKUNG	4,0%	96,0%
Total	**7,3%**	**92,7%**

Table 4.h) Are You Willing To Own a Septic Tank (if not already)?		
Kecamatan/Kelurahan	**No**	**Yes**
DANAU SIPIN		
LEGOK	20,3%	79,7%
MURNI	28,2%	71,8%
SOLOK SIPIN	6,7%	93,3%
JAMBI SELATAN		
PAKUAN BARU	9,4%	90,6%
PASIR PUTIH	9,5%	90,5%
TAMBAK SARI	2,6%	97,4%
THEHOK	14,7%	85,3%
JELUTUNG		
CEMPAKA PUTIH	28,2%	71,8%
JELUTUNG	27,0%	73,0%
LEBAK BANDUNG	13,6%	86,4%
KOTA BARU		
PAAL LIMA	7,9%	92,1%
SIMPANG III SIPIN	10,8%	89,2%
PAAL MERAH		
TALANG BAKUNG	4,7%	95,3%
Total	**16,1%**	**83,9%**

Table 4.i) Has the Tank Ever Been Desludged? By Type of Building		
Type of Building	**Yes**	**No**
Government Building	14,8%	85,2%
Commercial	6,0%	94,0%
Hostel	5,6%	94,4%
Residential	7,4%	92,6%
Total	**7,3%**	**92,7%**

Table 4.j) Type of Wastewater Discharged into the Tank		
Kecamatan/Kelurahan	**Blackwater**	**Black and greywater**
DANAU SIPIN		
LEGOK	62,5%	37,5%
MURNI	48,1%	51,9%
SOLOK SIPIN	60,3%	39,7%
JAMBI SELATAN		
PAKUAN BARU	75,2%	24,8%
PASIR PUTIH	73,8%	26,2%
TAMBAK SARI	83,4%	16,6%
THEHOK	81,1%	18,9%
JELUTUNG		
CEMPAKA PUTIH	37,2%	62,8%
JELUTUNG	77,5%	22,5%
LEBAK BANDUNG	78,7%	21,3%
KOTA BARU		
PAAL LIMA	77,7%	22,3%
SIMPANG III SIPIN	86,6%	13,4%
PAAL MERAH		
TALANG BAKUNG	77,5%	22,5%
Total	**75,7%**	**24,3%**

Table 4.k) Time Since the Tank Was Last Emptied?			
Kecamatan/Kelurahan	**< 1 Year**	**1 - 5 Years**	**> 5 Years**
DANAU SIPIN			
LEGOK	11,6%	0,0%	88,4%
MURNI	7,8%	0,0%	92,2%
SOLOK SIPIN	22,2%	0,0%	77,8%
JAMBI SELATAN			
PAKUAN BARU	4,2%	0,0%	95,8%
PASIR PUTIH	12,5%	0,0%	87,5%
TAMBAK SARI	10,0%	0,0%	90,0%
THEHOK	14,6%	0,0%	85,4%
JELUTUNG			
CEMPAKA PUTIH	25,6%	0,0%	74,4%
JELUTUNG	14,2%	0,4%	85,4%
LEBAK BANDUNG	12,1%	0,0%	87,9%
KOTA BARU			
PAAL LIMA	25,7%	1,1%	73,2%
SIMPANG III SIPIN	14,2%	0,2%	85,6%
PAAL MERAH			
TALANG BAKUNG	25,3%	0,0%	74,7%
Total	**16,0%**	**0,2%**	**83,8%**

Table 4.l) Fee Paid for the Last Desludging Service (Indonesian Rupiah)		
Kecamatan/Kelurahan	**< Rp.300K**	**Rp.300K – 600K**
DANAU SIPIN		
LEGOK	74,4%	25,6%
MURNI	84,3%	15,7%
SOLOK SIPIN	52,8%	47,2%
JAMBI SELATAN		
PAKUAN BARU	64,7%	35,3%
PASIR PUTIH	76,1%	23,9%
TAMBAK SARI	62,3%	37,7%
THEHOK	78,5%	21,5%
JELUTUNG		
CEMPAKA PUTIH	86,0%	14,0%
JELUTUNG	59,5%	40,5%
LEBAK BANDUNG	63,6%	36,4%
KOTA BARU		
PAAL LIMA	60,1%	39,9%
SIMPANG III SIPIN	76,0%	24,0%
PAAL MERAH		
TALANG BAKUNG	66,1%	33,9%
Total	**70,1%**	**29,9%**

Table 4.m) Is There a Manhole To Access The Tank?			
Kecamatan/Kelurahan	**Don't Know**	**Yes**	**No**
DANAU SIPIN			
LEGOK	43,4%	29,0%	27,7%
MURNI	22,9%	50,0%	27,0%
SOLOK SIPIN	24,5%	52,9%	22,6%
JAMBI SELATAN			
PAKUAN BARU	10,0%	78,2%	11,8%
PASIR PUTIH	5,0%	66,7%	28,3%
TAMBAK SARI	8,6%	70,3%	21,1%
THEHOK	7,5%	74,5%	18,0%
JELUTUNG			
CEMPAKA PUTIH	14,6%	72,3%	13,1%
JELUTUNG	12,4%	65,7%	21,9%
LEBAK BANDUNG	18,9%	53,9%	27,2%
KOTA BARU			
PAAL LIMA	6,3%	71,1%	22,6%
SIMPANG III SIPIN	5,0%	75,6%	19,4%
PAAL MERAH			
TALANG BAKUNG	2,0%	74,6%	23,4%
Total	**11,6%**	**66,7%**	**21,7%**

Table 4.n) Point of Discharge of Tank Outlet		
Kecamatan/Kelurahan	**Ground / Soak pit**	**Stream / Drain**
DANAU SIPIN		
LEGOK	94,7%	5,3%
MURNI	93,0%	7,0%
SOLOK SIPIN	98,1%	1,9%
JAMBI SELATAN		
PAKUAN BARU	96,2%	3,8%
PASIR PUTIH	99,6%	0,4%
TAMBAK SARI	99,4%	0,6%
THEHOK	99,5%	0,5%
JELUTUNG		
CEMPAKA PUTIH	96,1%	3,9%
JELUTUNG	97,9%	2,1%
LEBAK BANDUNG	99,0%	1,0%
KOTA BARU		
PAAL LIMA	99,1%	0,9%
SIMPANG III SIPIN	99,7%	0,3%
PAAL MERAH		
TALANG BAKUNG	99,7%	0,3%
Total	**98,6%**	**1,4%**

Table 4.o) Is the Property Located in an Area Prone to Flooding?		
Kecamatan/Kelurahan	**No**	**Yes**
DANAU SIPIN		
LEGOK	36,5%	63,5%
MURNI	93,6%	6,4%
SOLOK SIPIN	87,2%	12,8%
JAMBI SELATAN		
PAKUAN BARU	92,7%	7,3%
PASIR PUTIH	92,8%	7,2%
TAMBAK SARI	92,7%	7,3%
THEHOK	89,1%	10,9%
JELUTUNG		
CEMPAKA PUTIH	91,3%	8,7%
JELUTUNG	86,1%	13,9%
LEBAK BANDUNG	87,3%	12,7%
KOTA BARU		
PAAL LIMA	90,5%	9,5%
SIMPANG III SIPIN	93,9%	6,1%
PAAL MERAH		
TALANG BAKUNG	93,6%	6,4%
TOTAL	**87,0%**	**13,0%**

G. Lessons Learnt from the Survey

57. The analysis and screening of the survey data described above show that the results of the survey are satisfactory both in terms of how the survey was planned and executed, and the consistency and sufficiency of the data collected for its use it in the planning and decision-making processes of the Jambi Septage Management Plan.

58. The completeness of the survey in terms of answers can be considered as adequate for analytical and planning purposes, with the exception of the data about fees paid for the water supply service and the fees paid for desludging services in the past, which are necessary for the calculation of the willingness to pay.

59. Some records were found to have GPS coordinated that located them outside (but not far off) the limits of the kelurahan surveyed, presumably due to low GPS accuracy of the devices (mobile phones) used. This fact does not have major implications for the preliminary data analysis but will have to be corrected later, in order to allow for geospatial analyses during the implementation phases of the SMP, such as clustering of services or the calculation of detailed schedules for desludging.

60. These gaps should be addressed in future stages of the Jambi SMP and do not represent a major obstacle to the use of the vast amount of information collected from the 40,123 respondents.

61. The organization and execution of the survey have proven very successful overall, considering the scale of the exercise, which is the first of its kind in the field of septage management in Indonesia. This success can be attributed to the following elements:

(i) **Engagement and socialisation**: the survey has been carried out by citizens of Jambi for the citizens of Jambi. The surveyors employed were all neighbours of the kelurahan they covered. So were the coordinators, too, responsible for training and supervising the surveys. The lurahs played a decisive role in encouraging the neighbours to participate, by actively learning the importance of the exercise first and later promoting it among the people who would ultimately respond to the questionnaires. This engagement has proven essential in creating a feeling of legitimacy among the people of the kelurahan surveyed, who in most cases took part actively because they perceived the exercise will bring a genuine benefit to their lives.

(ii) **Collaboration**: The tools used in the survey are adaptations of tools developed and used by IUWASH in previous septage management projects in Surakarta and Bandung. The collaboration with IUWASH has been essential in this regard and will continue to be so in the data management stage and the implementation of the SMP, as well as in further surveys to be carried out in Jambi and other cities.

(iii) **Capacity development and governance mechanisms**: Training has been a core element in the planning and execution of the survey. All coordinators were trained before the surveyors were. Training covered collaborative and coordination aspects, and not only the tasks purely related to using the tools and filling in the questionnaires. Furthermore, the governance structure -along with the engagement approach mentioned above- has proven successful in guaranteeing that the results were achieved in time and form. Governance aspects include the designation of a city coordinator, kelurahan coordinators, engagement of lurahs, intensive support and supervision by the Head Office and the quality procedures performed by both the surveying team and the CDTA Project Team who later analysed and cleansed the vast amounts of data collected.

(iv) **Innovation**: The survey, unique in its kind and scale in Indonesia, was possible because of an innovative and bold approach that combines technology adapted ad-hoc, team building and collaboration, use of open source and free software, and governance structures designed specifically for the purpose.

H. Creation of a GIS Database

62. As explained in Section E above, data processing has been performed using the QGIS software. This means that the processed data are installed in a geographical information system (GIS) using the open-source application Q-GIS. This software has the functionality to perform a visual and spatial analysis of the survey data, provided that there are sufficient material and human resources to do so, including experienced systems and software engineers and GIS programmers.

63. The execution of the Jambi SMP must include a detailed, second review of the survey data to addresses the data gaps referred above, including additional surveys where necessary, and the use of other data collection methods, for example cross-referencing of data with the PDAM database or gathering information from the public and private desludging operators. This could be done by direct request, or -preferably- by activities that create stakeholder engagement such as training and discussion workshops.

64. The deficiencies about the existence and condition of septic tanks in the survey should be remedied in the future, which means, on the one hand, that all new septic tanks need to be

designed and constructed according to the standard and, on the other, that the existing septic tanks will have to be refurbished gradually. Therefore, a refurbishment plan of the non-complying on-site facilities must be developed, as part of the Jambi SMP.

65. In order to carry out the refurbishment plan, the City Government will need an updated and fully functional GIS database. For this aim, the GIS database of properties delivered in the framework of the survey and the SMP should be extended to the whole city. The CDTA team has used the open-source application Q-GIS, which is free, widely available and supported by millions of users and developers around the world.

66. The City Government will also need a database management tool to provide them with the ability to analyse the data collected in a simple and coherent manner. As a minimum, the GIS tool should address issues such as:

- Visualisation of data by area and characteristics of the respondents;
- Advanced reporting capabilities;
- Spatial queries, such as the search for properties or areas that meet specific criteria;
- Advanced spatial analysis, such as the determination of optimal routes for desludging;
- Integration with hand-held and desktop applications and platforms to be potentially used by public and private operators, government agencies and citizens.

67. The database management tool for septage management in Jambi will be developed by USAID/IUWASH in a separate assignment agreed with ADB. The specifications of this management tool are indicated in the following section. The functionality and final version of the tool will be defined in detail according to the needs and resources of the City Government during the implementation of the tool.

VII. DEVELOPMENT OF A MANAGEMENT INFORMATION SYSTEM FOR SEPTIC TANK DESLUDGING SERVICES

68. The MIS for desludging services prepared by the consultant is an IT based septage management system implemented with subscription and non-subscription (on call) models. The subscription model provides scheduled service and payment, while the non-subscription uses an on-call model and cash payment. This system is useful for domestic sanitation management institutions (UPTD-PAL, PD-PAL, etc.) in conducting septage management in a more effective, efficient and monitored manner.

69. The MIS for desludging services is designed by utilizing Geographic Information System (GIS) technology that records the geo-coordinate of customer location, IPLT and recording the ID of GPS tracking installed on each vacuum truck so that the work order can be designed with complete recommendation of truck movement route from the customer location to the IPLT. The locations and movements of the above trucks are displayed with digital maps on a computer screen, making it easier to monitor the execution of the desludging process and truck movements.

70. The operation of MIS Desludging Service application requires several devices including: Desktop Computer, Data Server and Smartphones. Additionally, a GPS tracker mounted on

each desludging truck will also be needed, to monitor the movement of the truck (Figure 17). Another necessary device is the barcode printer to be used for printing the customer barcode as Customer ID and truck barcode as truck ID, and an internet connection is required to connect each device with the data server. A data server containing the data base and MIS application and barcode printer have been provided by the consultant. The LG has installed the necessary internet connection. Staff of the UPTD under Dinas PUPR have been trained by the consultant. The system has been put in operation in May 2019.

Figure 17: Data Flow and Desludging Truck Movement

VIII. ASSESSMENT OF THE CURRENT SITUATION

71. An assessment of the current situation of septage management in a city with predominant on-site wastewater treatment and disposal facilities should respond basically to the following questions:

- (i) Are septic tanks built as per norms or specifications?
- (ii) Are they linked to percolation areas or soak pits and, if not, where does their effluent flow?
- (iii) How often are they cleaned?
- (iv) What happens to the sludge: is it treated and where is it disposed?

A. On-site Treatment and Disposal Facilities

72. Based on the survey data summarized in Table 4, the main findings related to on-site treatment and disposal facilities, the so-called septic tanks are set out in the following paragraphs and figures extracted from the GIS application used for the survey data analysis.

73. Most premises (89%) are equipped with what the occupants consider a septic tank (Figure 18). This also means that 11% of the households in the survey area still have no toilets.

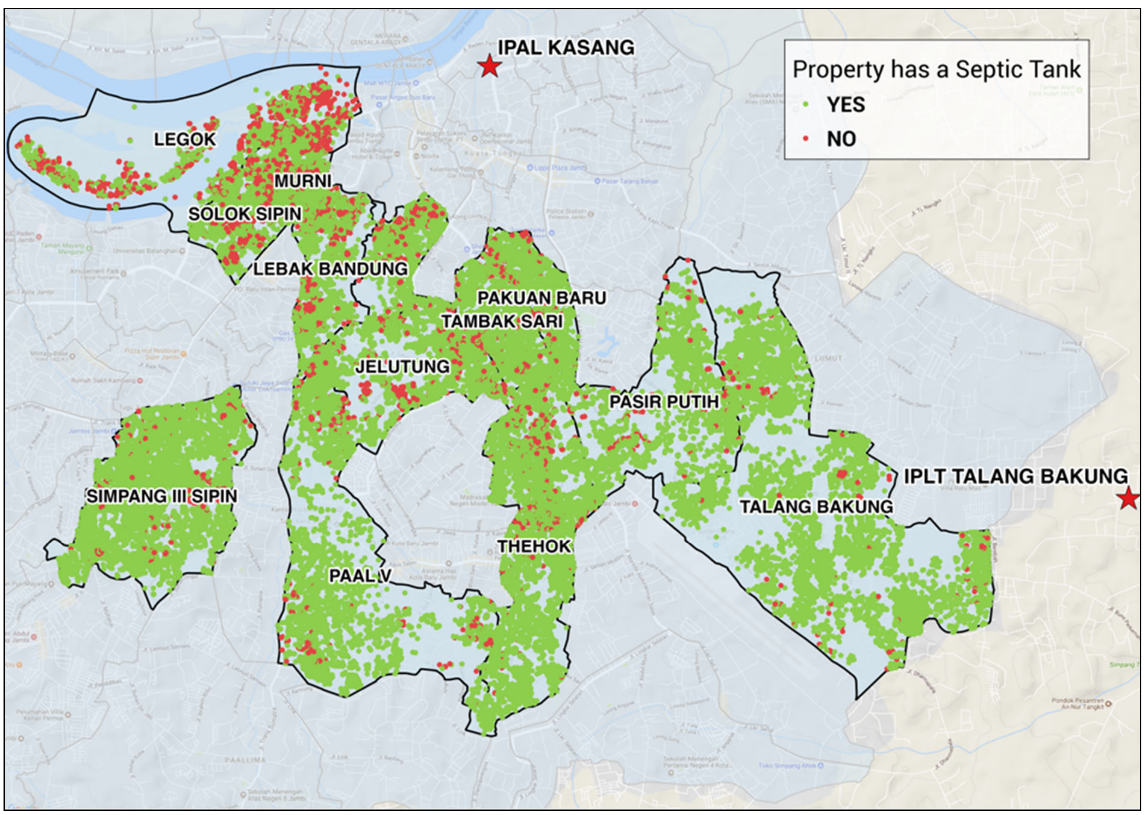

Figure 18: Presence of Septic Tanks

74. The septic tanks, however, are rather limited in size (72% less than 3 m^3) (Figure 19), are built almost exclusively with masonry (89%) (Figure 20), and a large proportion of them have no access through a (man)hole (Figure 21).

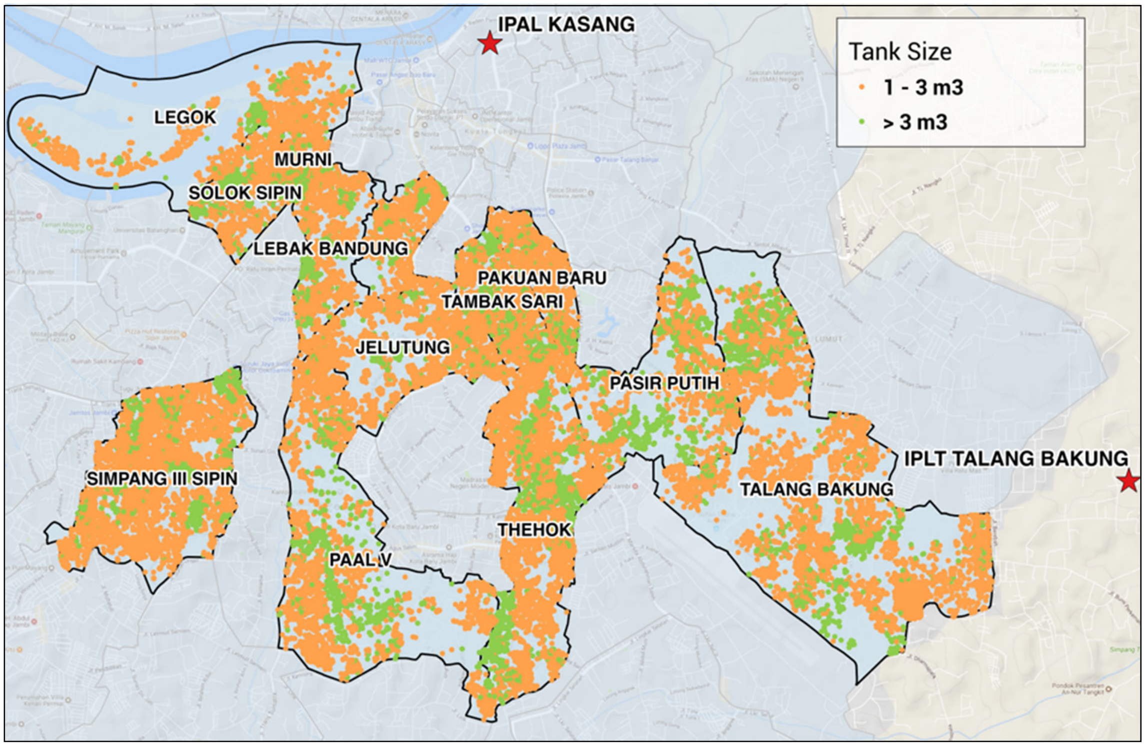

Figure 19: Septic Tank Sizes

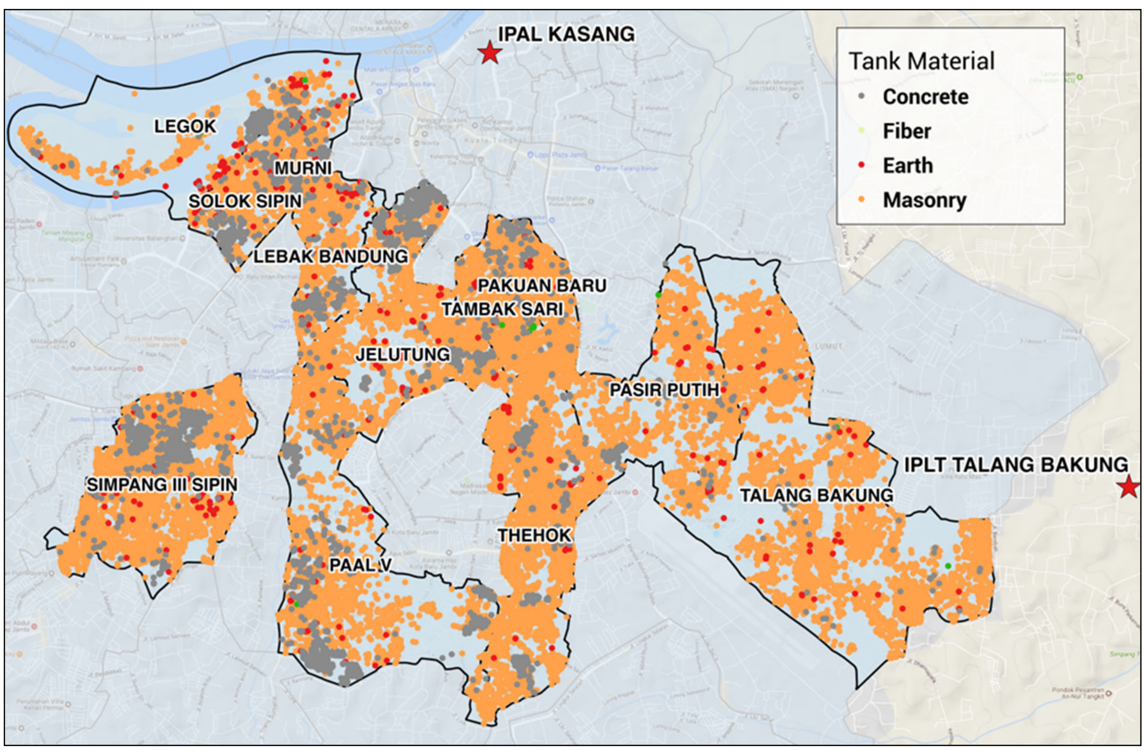

Figure 20: Septic Tank Materials

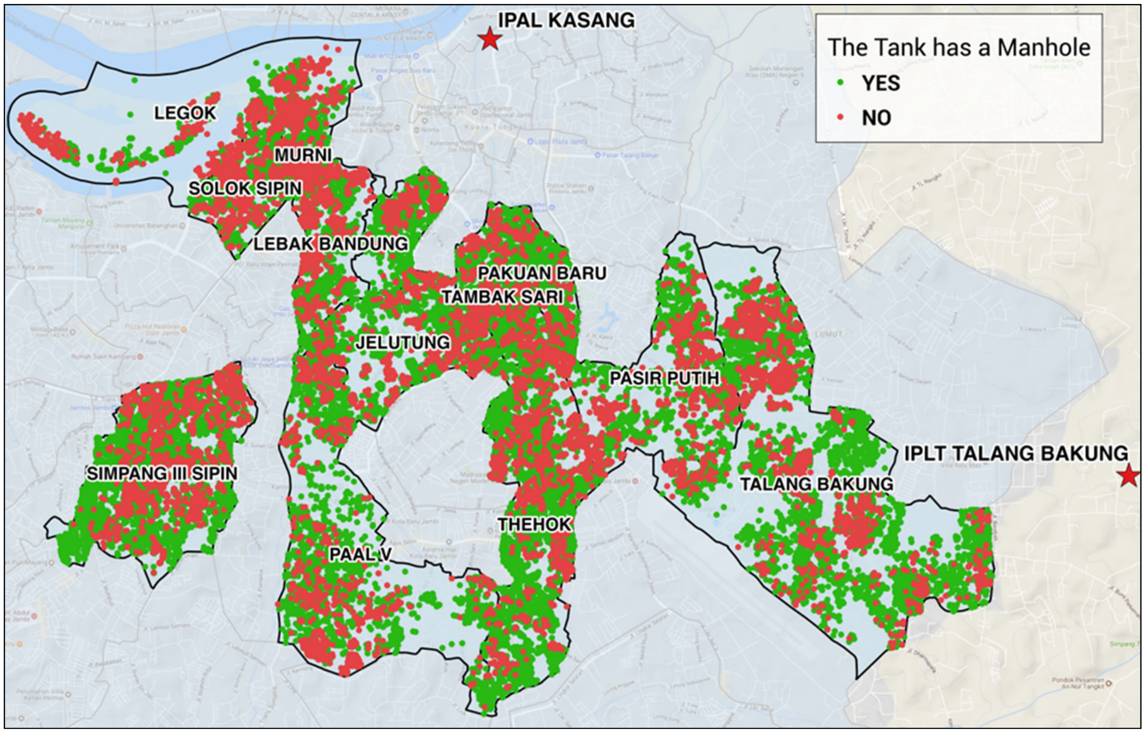

Figure 21: Existence of Manhole to Access the Tank

75. Most septic tanks (83%) are older than 5 years (Figure 22). In spite of that fact, the vast majority of them (92%) have never been emptied (Figure 23). From those that have been, the majority belong to government buildings (16%). This means that actually very few septic tanks (< 5%) are emptied annually or biennially.

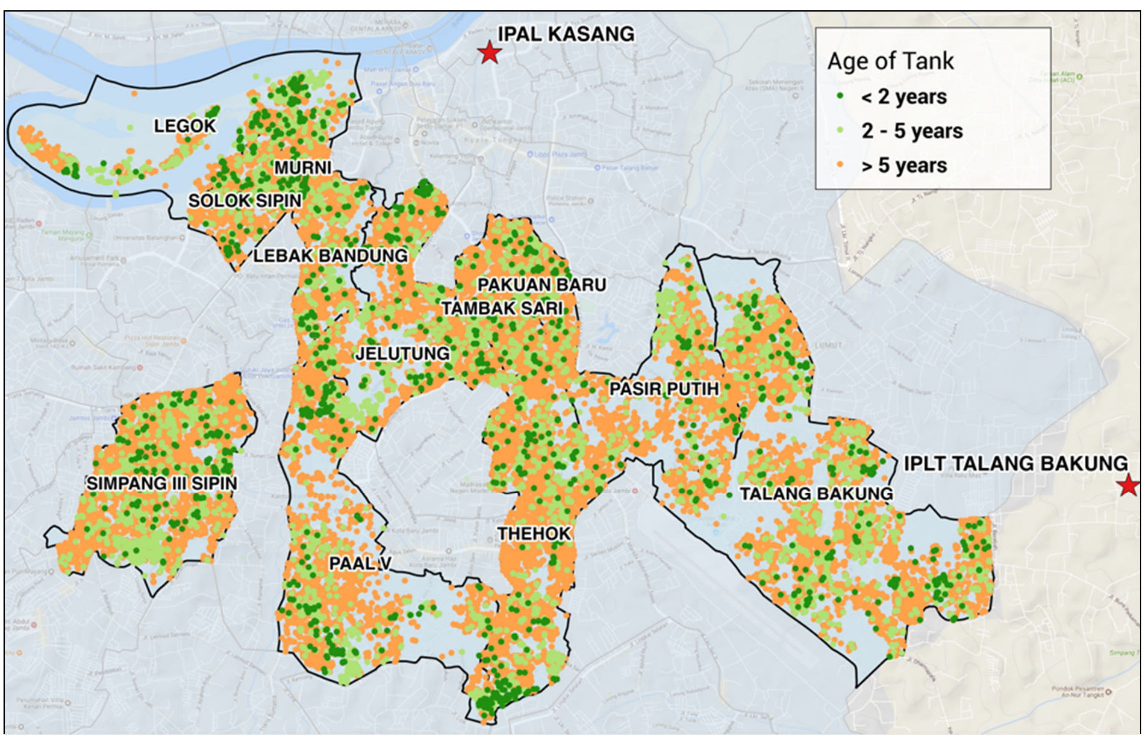

Figure 22: Septic Tank Age

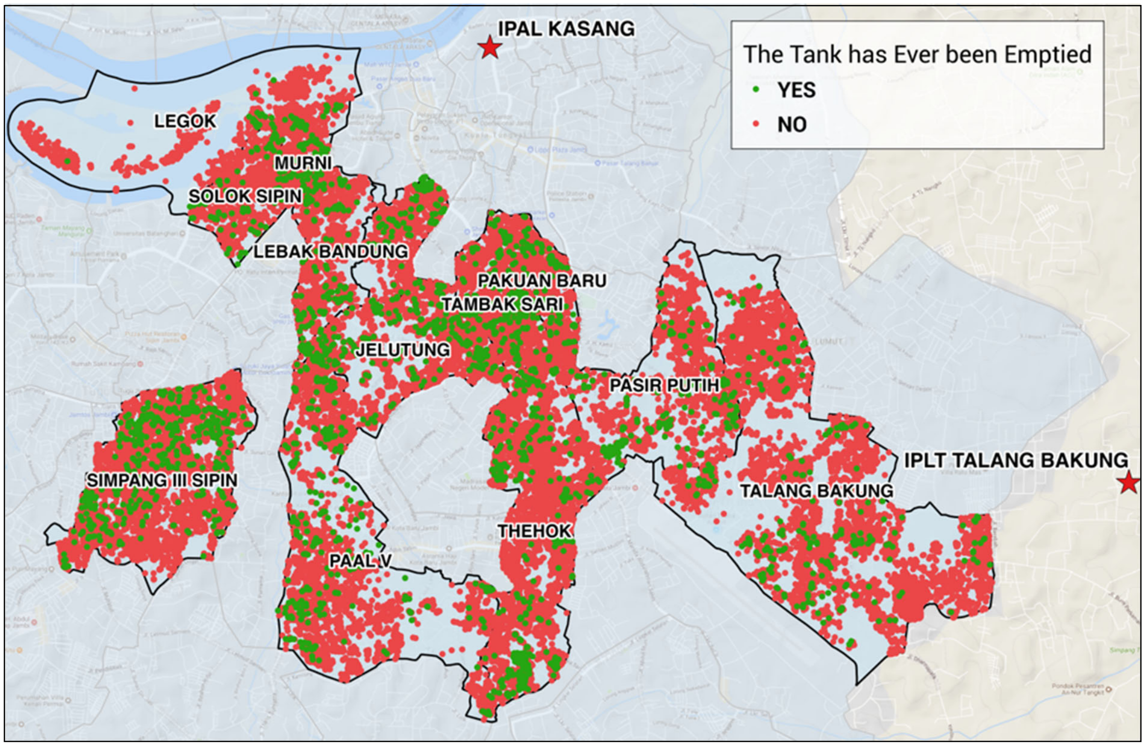

Figure 23: Septic Tank Emptying

76. A significant part of septic tanks (76%) receive only wastewater from toilets (blackwater), while the rest (24%) are said to receive both black and greywater (Figure 24).

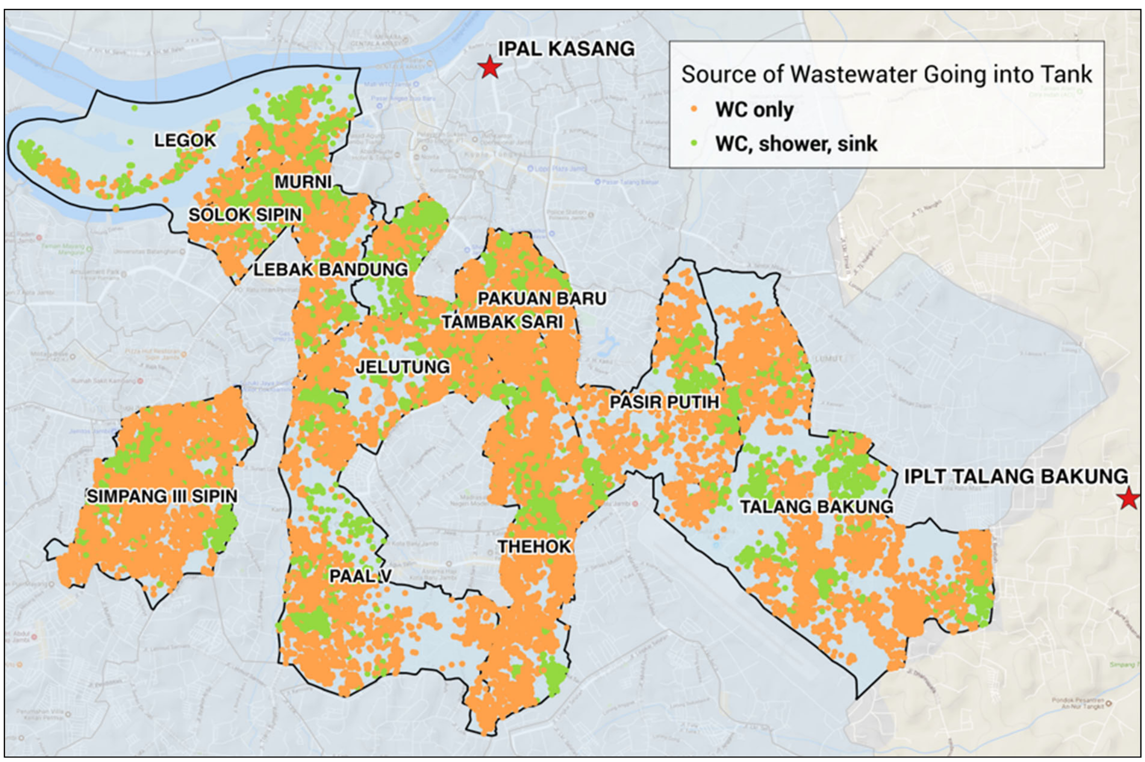

Figure 24: Origin of Wastewater

77. Practically all septic tanks (98%) are said to discharge their effluents to the ground, although on-site observation could not confirm the presence of wastewater pools or puddles in the gardens or yards (Figure 25). This means necessarily that most septic tanks are in fact cubluk, i.e. one-compartment, lined but bottomless pits allowing wastewater to seep to the ground and to the groundwater, and that practically none of them is connected to either a percolation area or a soak pit. Also, the vast majority of them produce overflows to drains and water bodies, and, actually, wastewater is omnipresent in the drains all over city.

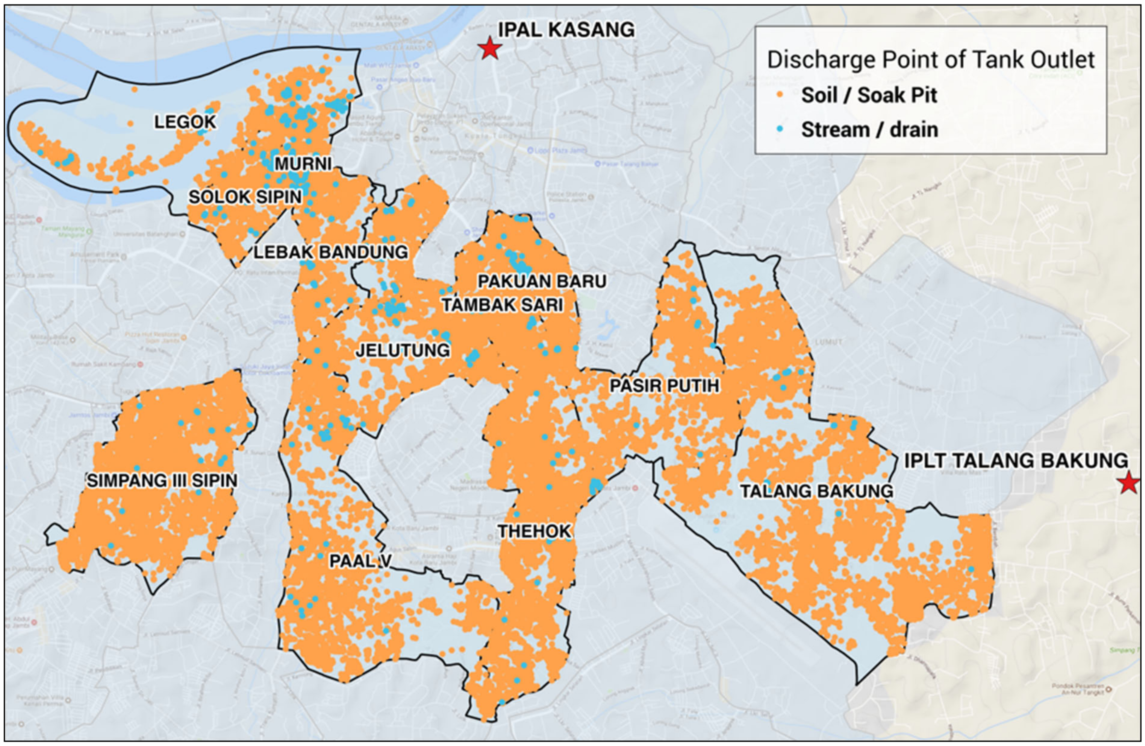

Figure 25: Septic Tank Effluent Discharge Disposal

78. Most septic tanks (85%) are said to be situated at a distance of less than 30 m to the streets (Figure 26). Many of these streets, mainly in the northern half of the city, however, are narrow lanes (less than 2 m) in the interior of kampungs delimitated by the main avenues of the city without access for the vacuum trucks (Figure 27). This is an important obstacle to septic tank desludging, which would require appropriate equipment.

79. It can be concluded that the vast majority of the septic tanks of the surveyed area in Jambi are no more than simple cubluk and do not appear to be in line with the Indonesian Standard, the SNI 03-2398-2002 concerning the Procedure for the Design of Septic Tanks with a Percolation System (Figure 1) at present. Practically none of them seems to comply with septic tank design requirements and, also, practically none has an associated percolation area or soak pit (Figure 1, c), and even a great number of them is situated under the buildings, mainly in case of the so-called ruko (rumah toko, i.e. dwelling and shop).

80. Moreover, the facts that (a) three-quarters of the surveyed septic tanks receive only blackwater from the associated buildings and (b) practically none of them has a percolation

area or a soak pit mean that both tank overflows and greywater are discharged to the drains, ditches, trenches or directly to the ground.

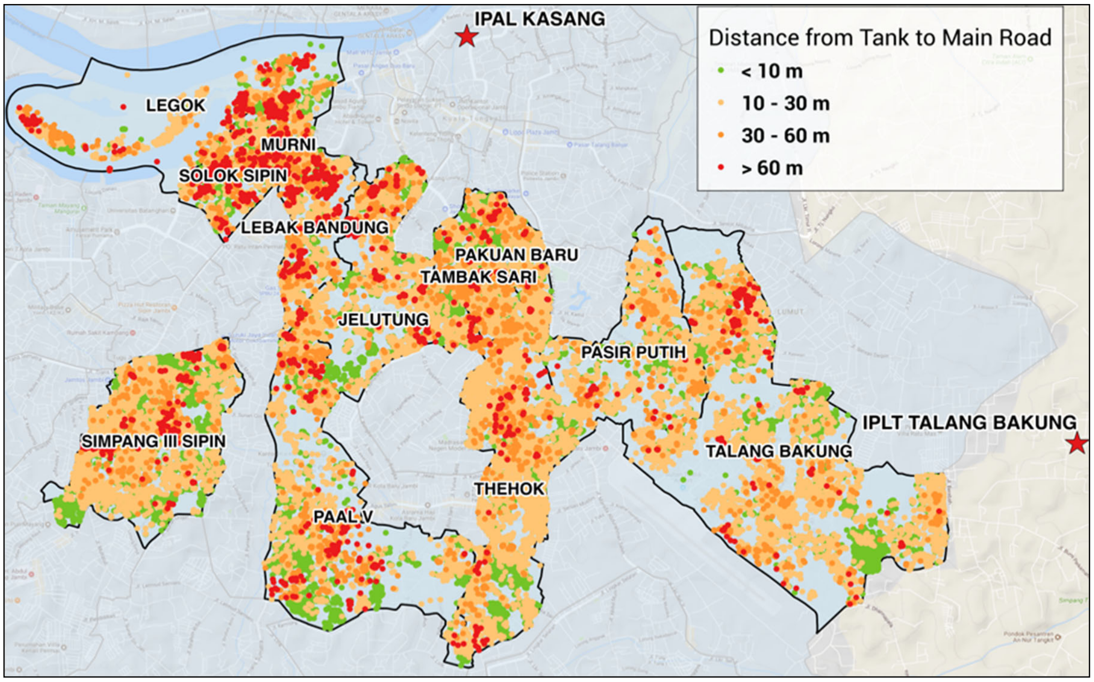

Figure 26: Distance of Septic Tanks from Streets

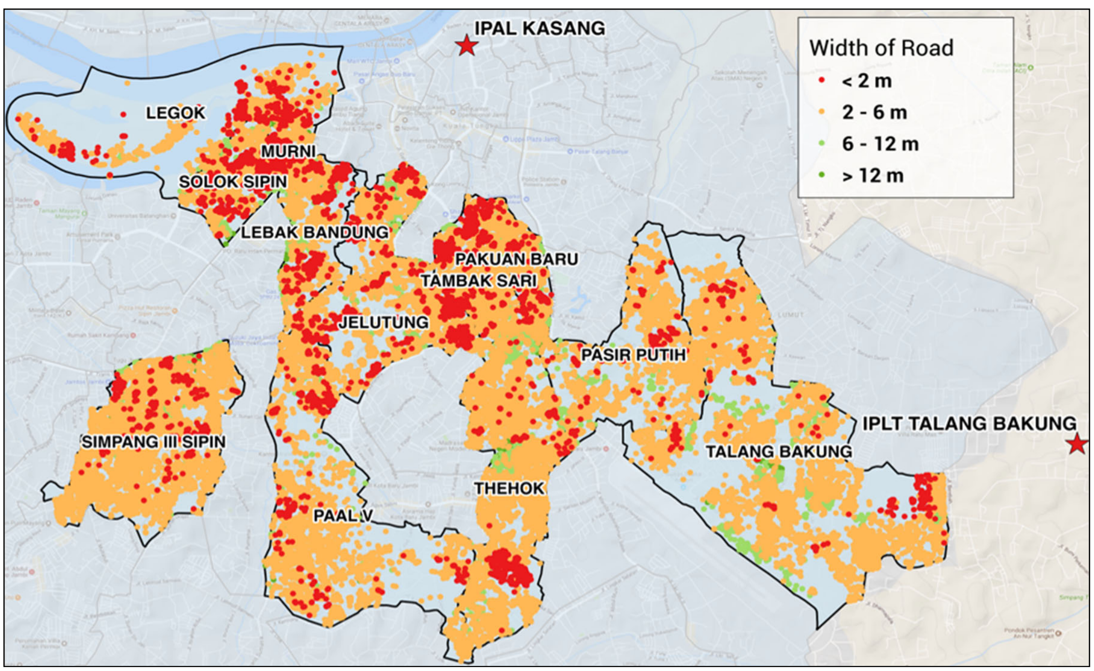

Figure 27: Street Widths in the Survey Area

81. The facts that the vast majority of existing septic tanks (a) are older than five years, (b) are rather limited in size, and (c) have never been emptied, suggest that they produce effluents and/or overflows that do not receive an appropriate treatment, constitute a major negative impact on the environment and a high public health risk.

82. All these deficiencies encountered by the survey should be remedied in the future, which means, on the one hand, that all new septic tanks need to be designed and constructed according to the standard and, on the other, that the existing septic tanks will have to be refurbished gradually. Therefore, a refurbishment plan of the non-complying on-site facilities will be developed as an integral part of this management plan.

83. Depending on the actual lacks and deficiencies, the refurbishment plan will include the following items:

- (i) Installation of access holes or manholes on the upper slab of the tanks.
- (ii) Relocation of septic tanks to the front of the premises.
- (iii) Construction of percolation systems (individual or communal).
- (iv) Promotion of communal treatment and disposal systems to replace inappropriate individual facilities.
- (v) Promotion of flush toilets in those households that currently lack them.

84. In order to carry out the refurbishment plan, the City Government will need an updated GIS database. For this aim, the GIS database of properties delivered in the framework of the survey and this management plan should be extended to the whole city.

85. Seen the current status of on-site facilities all over the city, however, it goes without saying that the refurbishment plan should be carried out gradually and that there is a long way to go to attain the goals of an appropriate septage management.

B. Current Desludging Practices

86. Since 2017, the Public Works and Spatial Planning Agency (DPUPR)[21] has been responsible for septic tank desludging[22]. The Agency owns three vacuum trucks of 4 m^3 capacity and two mobile toilets (Figure 28). One of the vacuum trucks was acquired in 2012, while the other two vehicles are nearly 30 years old and seem in acceptable to poor condition for operation. The desludging operation is carried out by a two-member crew, driver and operator.

87. The current desludging services are of remedial nature and exclusively on demand. Due to the limited size of the on-site facilities, the same truck usually carries out two or even three emptying operations before heading to the Septage Treatment Plant (IPLT[23]). The whole process typically takes 1½ to 2 hours and 40% of the time is spent in the journey from the city to the treatment plant.

88. Although the desludging equipment owned by the DPUPR is rather limited, they are apparently under-utilized: as can be seen in the data included in Appendix 2, the average number of transportations and discharges to the IPLT is 2,1 per day, which is the equivalent of 7 m^3/day, which, compared to the nominal capacity of the IPLT of 80 m^3/day, is a utilization of less than 10%. This suggests that either some of the discharges are not registered at the

[21] Dinas Pekerjaan Umum dan Penataan Ruang.

[22] Until 2017 sanitation and desludging was the responsibility of the Cleanliness, Parks and Cemetery Agency (Dinas Kebersihan, Pertamanan dan Pemakaman, DKPP)

[23] Instalasi Pengolahan Lumpur Tinja.

IPLT or most likely reveals that much of the septage collected, both by public and by private trucks, is in fact dumped elsewhere, either in water courses, drainage channels or fields.

89. There seem to be also four private entrepreneurs providing the emptying of septic tanks, but they are not necessarily dump their loads to the IPLT. Actually, as verified in the currently available IPLT log books (Appendix 2), there is only one of them, owning 3 trucks, that discharges septage to the plant.

Figure 28: Vacuum trucks owned by the Jambi DPUPR

90. There is a public price for desludging, determined in the local regulation on the retribution of public services, which varies depending on the type of premises (business, government building, house or public service place) and size or economic condition. For houses, it ranges between Rp 150,000 and Rp 200,000 per 2 m^3.

91. Private operators are usually required to pay a fee for discharging the sludge from the tanks into the IPLT inlet, the "dumping fee". The official fee established in the local regulation (PERDA Kota Jambi 12 of 2012[24]) is Rp 200,000 per truck, which seems rather excessive, although a 50% discount is currently applied. After the septage is discharged, they are required to go to the local government revenue collection office and pay the discharge tariff. At the end of each month DPUPR is supposed to cross-check the log book with the payment registry.

92. As said, desludging of on-site wastewater facilities is currently the responsibility of the DPUPR, to which the activity was transferred from the DKPP in 2017 but, apparently, the earlier management staff has been reassigned to other agencies of the PEMDA. As a consequence, the current staff has an insufficient understanding of sanitation and septage management.

93. Private haulers are not licensed with the DPUPR but are required to have business and environmental permits to operate, although these are not currently monitored by DPUPR. The agency has currently very little information on them altogether.

94. The private companies seem to charge users higher fees than the local government, presumably because the public service is subsidized and because of the lack of demand regularity for the entrepreneur. These businesses employ unskilled labour and take

[24] Peraturan Daerah Kota Jambi Nomor 2 Tahun 2012 tentang Retribusi Jasa Umum.

considerable risks to make a reasonable return in an environment that offers little incentive to comply with standards and regulations.

95. From the financial perspective, given the high uncertainty about demand and the relatively fixed cost structure of private operators (except for fuel and oil), there seems to be greater need for detailed analysis and measures on demand, regulations and governance than of costs.

96. A great number of septic tanks are situated along narrow lanes or passageways in the interior of large blocks delimitated by the main avenues of the city without access for the vacuum trucks. The desludging of their septic tanks will therefore require smaller equipment and a different organization of septage collection and transport to the treatment facilities and/or the reuse or disposal sites.

97. Due to the above-mentioned physical hindrances, the lack of adequate equipment and the total absence of an actual septage management service, the current desludging practices are extremely deficient.

98. These circumstances contribute to increase the risks of faecal matter and pathogens remaining in the surroundings of the households and even re-entering the domestic environment causing waterborne diseases, such as diarrhoea, infectious hepatitis, typhoid and paratyphoid fever, mainly among children. These diseases, among which typhoid fever has been considered historically as the touchstone of urban hygiene, are endemic in Indonesia and the figures of morbidity and mortality are among the highest in the world (a mean of 900,000 cases per year with over 20,000 deaths, with 91% of cases among children between 3 and 19 years)[25]. Furthermore, the uncontrolled discharge of greywater and septic tank overflows into drains, trenches, ditches and to the ground in general result also in a highly negative impact on the urban environment.

99. The objective of the Septage Management Plan is to transform the current remedial system for overflowing septic tanks into a regular desludging and maintenance service (LLTT), becoming part of a comprehensive wastewater management service, together with the operation and maintenance (O&M) services of the planned centralized sewer network and WWTP (IPAL[26]) to be implemented in the kelurahan of Kasang.

100. The implementation of scheduled desludging of septic tanks, pit latrines, toilets, MCK, etc. is the central issue of the Septage Management Plan for the City of Jambi, as periodical desludging will help remedy the above-mentioned public health risks and reduce the pollution levels in the environment.

101. Scheduling means setting up evenly spaced time intervals for the desludging of the City's septic tanks. This service requires the control of all septic tanks in the city and should be provided, by definition, by the City Government of Jambi, either with their own resources, through a specialist public SDO and/or through licensed sludge hauler contractors. According to the ongoing procedure under the MSMIP-CDTA, this organization will likely be an UPTD-

[25] Background document: WHO (2003). The diagnosis, treatment and prevention of typhoid fever. Geneva: World Health Organization.

[26] Instalasi Pengolahan Air Limbah.

PAL (Unit Pelaksana Teknis Daerah Instalasi Pengolahan Air Limbah), whose setting up has recently been approved by the Provincial Government.

102. To implement scheduled desludging, the SDO will need additional equipment which should include new vacuum trucks of 4 m^3 of capacity or more (Figure 28) as well as smaller Vacutug type motorcycle-driven vehicles of 1000 l of capacity to access narrow lanes and passageways in the interior of blocks or kampungs (Figure 29). The SMP will define the appropriate number and the specifications of all these vehicles, the adequate staffing, as well as the standard operational procedures relating to the desludging operations and to the transport of collected septage to the treatment and/or disposal facilities.

Figure 29: Vacutug-Type Desludging Vehicles for Septage Tanks with Difficult Access

C. Septage Treatment and Sludge Disposal

103. Scheduled desludging should include also the transportation of the collected septage to the treatment facilities owned by the City Government, such as the Talang Bakung IPLT and/or the future Kasang IPAL of the off-site sewerage system, and/or, if appropriate, to approved final disposal or reuse sites (agricultural land).

104. Kota Jambi has a Septage Treatment Plant (IPLT) located just outside the city's boundary to the east of the kelurahan of Talang Bakung (actually in the desa or village of Tangkit, kecamatan of Sungai Gelam, kabupaten Muaro Jambi), some 14 km away from the city centre (Figure 30). The plant comprises three trains of a conventional waste stabilisation pond system (WSP) being a somewhat simplified version of the arrangement specified in an Indonesian technical guidance of 1999 titled Procedures for the design of septage treatment pond systems[27] (Figure 31; Figure 32). The facility has a nominal treatment capacity of 80 m^3/day serving a potential design population of about 300,000 people, i.e. around 56% of the total population of the city, although it is largely underutilized (estimated at 10-15% of its capacity).

[27] Tata Cara Perencanaan Instalasi Pengolahan Lumpur Tinja Sistem Kolam. Departemen Pekerjaan Umum, Direktorat Jendral Pekerjaan Umum, Jakarta, 1999.

105. The IPLT was built in 1996 and was extended and thoroughly refurbished in 2015-2016 with the financial support of the Ministry of Public Works and Housing (PUPR). The works consisted in the addition of a unit of solids separation chambers (SSC) and of an anaerobic pond, as well as in the relining of the facultative and maturation ponds and repair works in the sludge drying beds (SDB) (Figure 33). Although its physical state is fairly good, it is apparently non-functional as a treatment facility. The treatment process is halted and there is virtually no outflow, nor is there any usable dry sludge product, so the ponds are used as nothing but sludge storage basins without any particular operation.

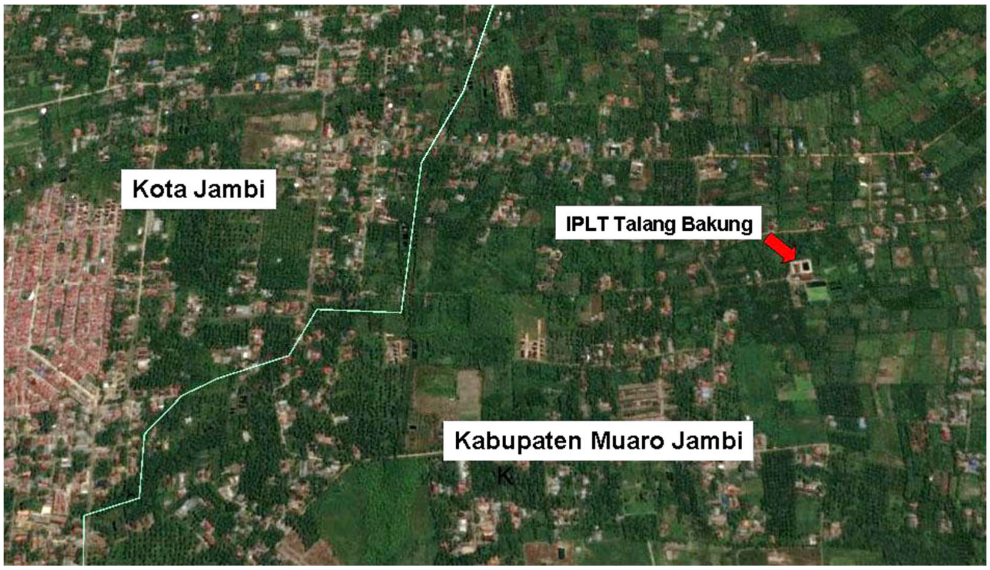

Figure 30: Location of the Talang Bakung IPLT[28]

Figure 31: Aerial View of the Talang Bakung IPLT[29]

[28] Google Earth.

[29] Ibidem.

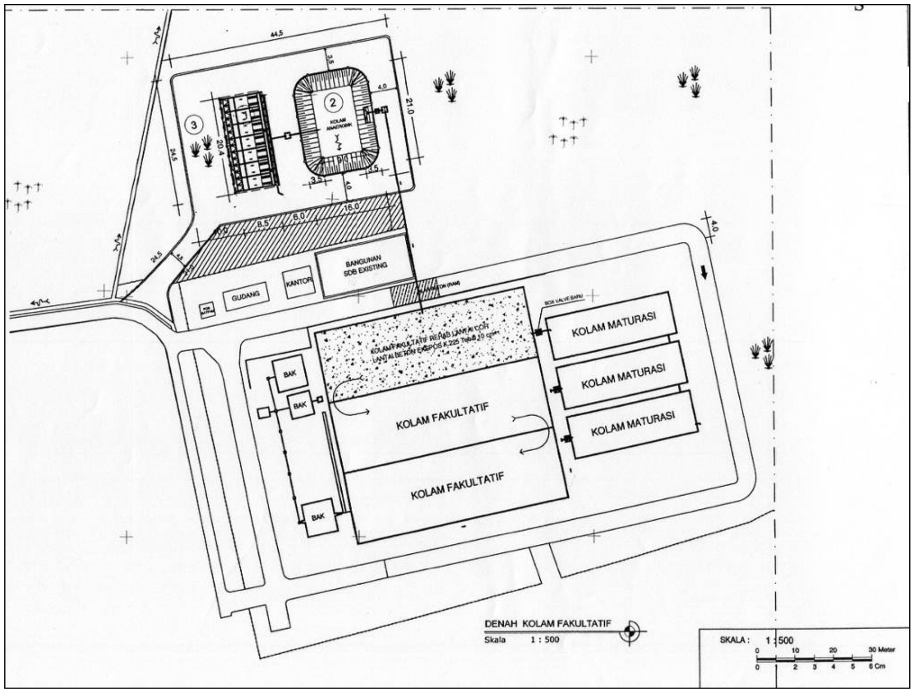

Figure 32: General Layout of the Talang Bakung IPLT[30]

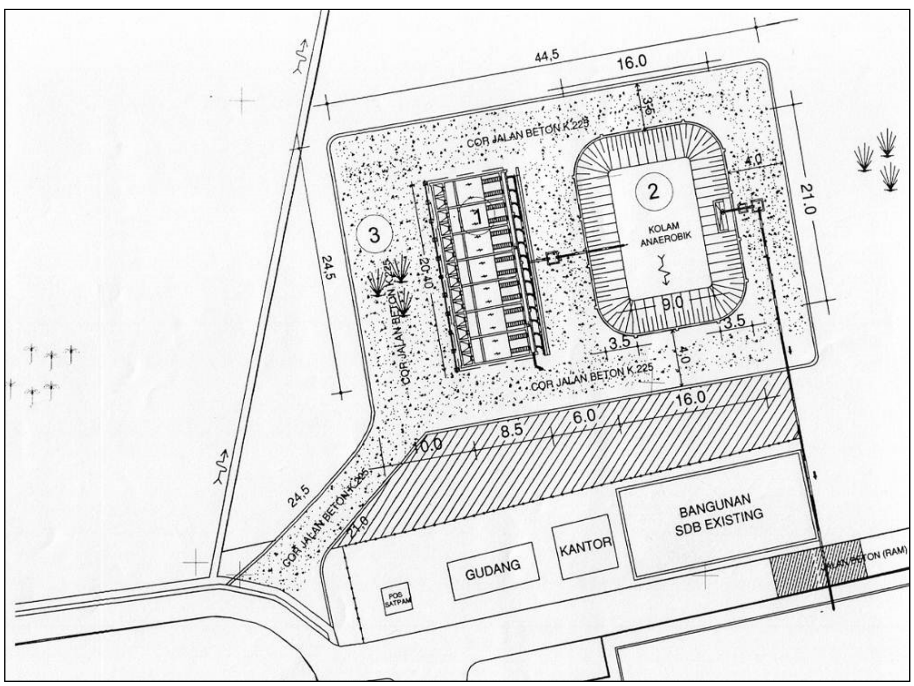

Figure 33: Extension and Refurbishment of the Talang Bakung IPLT[31]

30 MPWH-SATKER Provinsi Jambi (2016). As-Built Drawings IPLT.

31 Ibidem.

106. The operation of the plant is the responsibility of a unit under the DPUPR, the Local Technical Implementation Unit for Septage Treatment (UPTD-IPLT)[32], specifically set up for this purpose in 2009. The UPTD-IPLT currently employs 6 staff.

107. The Environmental Health Agency (DLH)[33] performs quality control checks at three points of the IPLT, viz. the solids separation chambers (SSC), the anaerobic pond and the sludge drying beds (SDB), and, since 2017, at the outlet, on a weekly basis. The parameters tested on the samples are BOD, COD, NH_3, TSS (not TS) and pH, as well as several irrelevant parameters like total dissolved solids TDS and half a dozen metals. The results consulted from October 2017 to March 2018 (see APPENDIX 3), however, are clearly inconsistent, many of them incoherent, and altogether unreliable, viz. very low TSS values (many of them < 200 mg/l), often contradictory BOD and COD values, higher values for TDS than TSS, incoherence between the values obtained at the different sampling points, etc. These values cannot be used for preliminary design purposes, so the calculations will be performed below using the average values of the Indonesian septage characterization study of 2014 (Table 1).

108. The Talang Bakung IPLT, which consists of a waste pond stabilization (WSP) system preceded by a solids separation unit, is in an acceptable physical state but is non-functional as a treatment facility. Although the septage input is very low, there is practically no dry sludge production due to the lack of solids removal and there is virtually no outflow. In consequence, the ponds, which ought to treat only the supernatant water separated from solids are only used for sludge storage (Figure 34).

a) Anaerobic Pond

b) Facultative Pond no. 1 and SDB

Figure 34: Waste Stabilization Ponds Used for Sludge Storage

109. The main infrastructural and operational deficiencies of the plant are:

- (i) the non-functional sludge removal at the so-called sludge separation chambers (SSC) due to design and maintenance problems (Figure 35);
- (ii) the total inadequacy and the consequent state of disuse of the sludge drying beds (Figure 36);
- (iii) the state of abandonment of the outlet pipe and the consequent complete lack of a plant effluent (Figure 37);
- (iv) the total absence of definition of sludge disposal options.

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[32] Unit Pelaksana Teknis Daerah Instalasi Pengolahan Lumpur Tinja.

[33] Dinas Lingkungan Hidup (since February 2017); before Environmental Health Agency (Badan Lingkungan Hidup or BLH).

Figure 35: Solids Separation Chambers

Figure 36: Sludge Drying Beds

Figure 37: Maturation Ponds and Outlet Area

110. The problems of operation of the IPLT can be attributed essentially to the lack of understanding of the principle of septage treatment and sludge disposal, i.e. to treat sludge as sludge and what should happen with the sludge produced:

(i) Septage is sludge and has to be treated as such. This means that it has to be thickened and solids be removed and transferred to the sludge drying beds at the initial stage of the treatment line, and only the supernatant water should be admitted to the actual WSP.

(ii) Sludge disposal and/or reuse is the critical phase in the whole operation as even the type of treatment depends on the disposal method, i.e. where and by what means treated sludge will be disposed of.

(iii) The most suitable option for the sludge produced in the IPLT seems to be its reuse as a fertilizer on the nearby farmlands (pineapple and oil palm plantations located in the same kecamatan of Sungai Gelam). The method of reuse and the necessary treatment depends on the cost factor and on the available equipment for sludge transport and disposal. For the time being, however, no disposal option has been defined.

111. As said, the existing IPLT is non-functional at the moment and needs refurbishment to fulfil its potential as a treatment plant. Further to the assessment set out above, the refurbishment of the plant should consist essentially in the remodelling of the SSCs and the construction of new SDBs on the plot adjacent to the anaerobic pond, although it would also require the construction of a new and adequate outlet pipe for the IPLT effluent. The remodelling of the SSCs should allow the extraction of the thickened sludge at the bottom of the chambers, as well as the removal of the supernatant water by overflow and its discharge to the waste stabilization ponds. The final planning report will include a pre-dimensioning of these refurbishments.

112. As for sludge disposal, the most suitable option for the sludge produced in the IPLT seems to be its reuse as a fertilizer (or “biosolids”) on nearby farmlands. This option will be analysed in detail and propose the necessary disposal methods and equipment below.

113. Although the pond system at the IPLT offers low operation costs and is relatively simple to operate, it requires, however, a specialized manager capable of taking the appropriate decisions. Septage treatment operation will have to be based on septage volume and quality monitoring, which is why the sampling and analysis capacity of DLH or of the future UPTD-PAL will have to be strengthened.

114. Another possible option, already analysed in an earlier stage of the CDTA, is to provide potential septage treatment at the is the future Kasang WWTP. This earlier analysis ended up in the proposal of a specific electromechanical equipment for grit removal and sludge thickening. This option will be taken up and developed below.

IX. AMENDMENT OF THE LOCAL GOVERNMENT REGULATION FOR WASTEWATER MANAGEMENT

A. Existing Regulation of the City of Jambi

115. The City of Jambi has a Regulation on Domestic and/or Residential Wastewater Management, adopted on 30 December 2015 by the mayor of Jambi and published in the Gazette of the City of Jambi No. 13 of 2015[34]. The regulation is divided into eleven chapters and comprises twenty-four articles. The chapters of the regulation are as follows:
Chapter I - General Conditions
Chapter Ii - Purpose And Goals
Chapter Iii - Domestic Wastewater Management
Chapter Iv - Domestic Wastewater Network Development And Maintenance
Part One - Centralized Wastewater Management
Part Two - On-site Wastewater Management
Chapter V - Planning Of Sanitation Environmental Plans
Chapter Vi - On-Site Wastewater Management Obligations
Chapter Vii - Technical Requirements For On-Site Waste Water Treatment
Chapter Viii - Guidance And Supervision
Chapter Ix - Rights, Obligations And Roles And Communities
Part One - Community Rights
Part Two - Community Obligations
Part Three - Community Participation
Chapter X - Administrative Sanctions
Chapter Xi - Closure

B. Rationale for the Amendment of the Existing Regulation

116. The above-mentioned existing local government regulation of the City of Jambi covers the entire scope of wastewater management, both on-site and off-site, and contains even provisions for wastewater network planning and development. It is understood, however, that there are certain gaps in the existing regulation that might be filled to allow the City of Jambi to improve their activity in all aspects of wastewater management regarding certain technical, legal and financial aspects. Although the present Septage Management Plan for the City of Jambi concerns basically on-site wastewater management, it might be considered useful to seize the opportunity to enhance the provisions of the regulation on off-site wastewater management as well as on institutional matters such as permitting, financial model and enforcement.

C. Key Criteria for the Amendment of the Existing Regulation

117. Based on the ADB document titled Urban Wastewater Management in Indonesia: Key Principles and Issues in Drafting Local Regulations, the key concepts and criteria proposed for the amendment of the existing regulation are as follows:

(i) **Wastewater Management Service and Users**. The amended regulation should establish that activities and efforts aimed to collect, treat and dispose

[34] Peraturan Daerah Kota Jambi Nomor 13 Tahun 2015 tentang Pengelolaan Air Limbah Domestik atau Permukiman.

wastewater to safeguard public health and safety and prevent water pollution and protect the environment constitute a wastewater management service that the City Government are obliged to provide to all citizens and entities producing wastewater within the city area. This wastewater management service comprises both on-site and off-site wastewater collection, treatment and disposal systems. At the same time, citizens and entities become automatically users of the service, and these two concepts, service provision and service users, constitute the basis of a local government wastewater management regulation.

(ii) **Purpose**. A local government regulation on wastewater management is intended to govern the relationship between the local government and/or its service provider and the users, establishing the rights and obligations of both. The regulation should also set forth uniform requirements for the users of the city's (or regency's) wastewater management services, both for existing on-site facilities and newly developed off-site sewer systems and wastewater treatment plants, to ensure public health and safety as well as the respect for the environment, in accordance with the legislation in force. The regulation, however, should not contain aspects that fall outside the scope of this relationship, such as wastewater system planning and development, as well as operation and maintenance of centralized sewerage systems and WWTP (Chapters III and V).

(iii) **Scope**. As wastewater management in Indonesia at the local level includes both on-site and off-site systems, local government wastewater regulations should deal with both systems, as is already done in the existing regulation of the City of Jambi.

(iv) **"Domestic" Wastewater Management**. The current regulation, such as practically all existing regulations in Indonesia, refers to "domestic" and/or "residential" wastewater management (pengelolaan air limbah domestik atau permukiman). Domestic wastewater is defined as "wastewater from household activities, including bathing, washing, and toilet, originating from settlements and/or other sources such as restaurants, offices, commercial establishments, hotels, apartments, dormitories, hospitals and industry". This definition, however, contains a semantic error, as the word domestic comes from Latin domus meaning home. It is therefore necessary to abandon the denomination "domestic" in the regulation and distinguish clearly between domestic (household and other assimilable discharges) and non-domestic (industrial or commercial) effluents, discharged from premises being used for business, commerce or industry, coming from both large and small premises, including businesses such as car washes and launderettes.

(v) **Obligation of Wastewater Treatment**. In a local wastewater management regulation, it is important to state that no wastewater, neither blackwater nor greywater, can be discharged into the environment without treatment and, as the concept of treatment in case of a public sewerage system is obvious, the right place to do it is in the chapter on on-site wastewater management. Accordingly, every residence, place of business, industry, or other activity wherever water is used for living, washing, cooling or manufacturing, must have an approved means of wastewater disposal. The treatment of wastewaters issued from a building in areas where no public sewerage system is available should be carried out by an approved on-site treatment and disposal system, or septic tank system, and the regulation should set up the criteria for mandatory sewer connections wherever sewers are available.

(vi) **Septic Tanks**. The regulation should include references to proper design standards for new septic tanks, especially to the Indonesian Standard No. SNI 03-2398-2002, Design Procedures for Septic Tanks with Percolation System. It should also state that a septic tank system should include a percolation area or, if not feasible owing to the lack of space in the parcel, at least a soak or seepage pit or pits as indispensable parts of an on-site wastewater treatment and disposal facility. The regulation should also specify that the technical characteristics and the sizing of the on-site treatment facilities have to be adapted to the building to serve, the number of inhabitants and/or the number of rooms, as well as to the characteristics of the parcel in which they are implemented, in particular its aptitude for percolation and the sensitiveness of the surrounding area.

(vii) **Scheduled Desludging**. Septic tanks and on-site wastewater treatment facilities are settlement tanks that produce sludge. The maximum amount of sludge that a septic tank can store is approximately a third of its total volume. If desludging is not carried out, the sludge level may exceed maximum level. When this happens, sewage retention time decreases causing an incomplete breakdown of sewage and thus, untreated sewage and sludge solids will be released from the septic tank into the percolation area or the drain. Therefore, regular desludging or removal of the accumulated sludge in the tank is critical to prevent water pollution and this regular or scheduled desludging is, actually, one of the key issues of the Septage Management Plan. Scheduled desludging means that the SDO directly and/or through licensed sludge hauler contractors will provide desludging of all on-site treatment facilities of the Regency/City at evenly spaced time intervals. The desludging operation will include collection, transport, treatment and adequate disposal of the extracted sludge. The cost of the operation will be covered by a fee to be collected from all owners or occupiers of the premises equipped with on-site wastewater treatment facilities. The wastewater management regulations should fix a regular time interval within which the SDO will carry out the desludging.

(viii) **Sewer connection**. The regulation should establish the mandatory nature of the connection to the public sewer network if a building or business that generates wastewater is adjacent to any street or easement where a public sewer pipeline is available within a given distance L of the property line. This distance L depends basically on urban structure and the density of the sewer network being developed. Taking account of the configuration of Indonesian cities, the adoption of 75 m seems reasonable connect to the centralized sewer network, where available. Furthermore, the regulation should set out technical specifications for the connections or laterals, specifying the responsibilities and obligation of the City Government and owners or occupants relating to the construction and maintenance of the public and private portions of the lateral.

(ix) **Joint Treatment and Pretreatment Programme**. Industries located within the range of an off-site public sewerage system will also be required to connect to the sewer network as it is usually unfeasible to provide adequate treatment and disposal in each industry, capable of complying with effluent discharge requirements. WWTPs, however, are generally designed to treat only domestic wastewater, or what they call conventional pollutants, characterized by BOD, TSS, faecal coliforms and oil and grease, and are not prepared to cope with most toxic or non-conventional pollutants that are present in industrial wastewater. Consequently, discharges from both industrial and commercial sources may cause problems at WWTPs and make the public system non-compliant with national effluent standards. The undesirable effects of those discharges can be prevented by using treatment techniques or management practices to remove the non-conventional pollutants discharge of the contaminants. The act of treating wastewater before discharge to a public sewerage network is called pretreatment and this general principle of urban wastewater management is often referred to as "joint treatment with a pre-treatment program". It is to be noted that the regulation of industrial discharges and the development of pre-treatment programmes is often the main issue of the local government regulations in most countries where centralized off-site treatment systems are overwhelming. Exceptions to this general principle are, of course, large industrial plants not integrated into the urban fabric, such as, e.g., Pertamina's oil refineries and petrochemical plants.

(x) **Prohibitions and Effluent Standards**. In order to safeguard the sewers and the treatment process from undesirable substances originating from non-domestic discharges, the regulation should establish a list of prohibited activities and substances. In order to admit wastewater discharges from any commercial or industrial activity the regulation should set up effluent limits for the substances susceptible of being present in the catchment.

(xi) **Right to Enter**. The regulation should set up the City Government's right to enter private property for inspection of individual sewerage facilities and household plumbing, as well as permanent easements for the City Government and its SDO to access all publicly owned sewer facilities that are located outside the public domain to carry out the operation, supervision, repairs and rehabilitation of the pipelines.

(xii) **Permitting**. Wastewater management, encompassing wastewater collection, treatment and disposal, is, in all its forms and activities, both on-site and off-site, a public service provided by the Local Government through the SDO. Water users, both residential and commercial or industrial, are at the same time producers of wastewater and, by this fact, become automatically users of this public wastewater management service. To control the access of users to the service and set out the conditions thereof, the Local Government has to issue permits. Therefore, the regulation should set out the different classes of permits to be implemented and establish the relating permitting procedures.

(xiii) **Financial Provisions**. On the assumption that the investments relating to wastewater system development will be supported by external sources, such as national government and international financing bodies, for the time being, the

SDO need to cover at least the annual operating costs of the public wastewater management services both on-site and off-site. For this aim the City Government must adopt wastewater management fees and the regulation should set out the different categories of fees the wastewater management service users will have to pay to benefit from the service being provided.

(xiv) **Enforcement**. Finally, the regulation should include the measures the City Government is entitled to take to implement the regulation, such as the establishment of the City Government's authority to monitor on-site facilities and sewer connections, to limit effluent quality parameters, to issue permits and to bill and collect fees, and different enforcement mechanisms from informal administrative action to formal legal prosecution.

D. Proposed Draft of the Amended Wastewater Management Regulation

118. The proposed draft of the amended Wastewater Management Regulation (PERDA) is developed as a supplement of this Septage Management Plan. The Table of Contents of the document is as follows:

X. DESIGN AND CONSTRUCTION AND/OR REFURBISHMENT OF ON-SITE WASTEWATER TREATMENT AND DISPOSAL FACILITIES

A. Completion and Update of the GIS Database

119. The survey of existing on-site facilities carried out in the 1st phase of the planning process has culminated in the creation of a GIS Database of the 40,123 households surveyed. The structure, characteristics and mode of application of this database are described in Chapter V, Section F.

120. As set forth therein, this database is conceived to support on-site wastewater management at the city level and contains the details on on-site treatment and disposal facilities, i.e. toilets, septic tanks and effluent discharges of each surveyed household. Accordingly, this database is intended to be used as a Management Information System (MIS) for the monitoring and inspections of on-site facilities by the SDO and serve as a starting point for the refurbishment plan of the non-complying installations and the basic tool for scheduled desludging.

121. As the total number of households in Jambi is around 125,000, i.e. three times more than those surveyed, the first task the City Government of Jambi should do to start septage management is to complete the GIS database. Later, the android-based MIS application, to be used for day-to-day management, will ensure the regular update of the database. It is recommended, however, to carry out a specific upgrade of the database every 4 years and/or using other Local Government surveys, such as local tax assessment.

B. Septic Tank Design Requirements

122. The septic tanks need to be designed and constructed as per the norms set out in:
- (i) Indonesian Standard SNI 03-2398-2002 concerning the Procedure for the Design of Septic Tanks with a Percolation System.
- (ii) Regulation of the Minister of Public Works and Public Housing No. 04/PRT/M/2017 on the Implementation of Domestic Wastewater Management Systems, Appendix II: Domestic Wastewater Management System Planning, Jakarta, 21 March 2017, pp. 38-81.
- (iii) Guidelines for Scheduled Desludging Services. Ministry of Public Works, General Directorate General Cipta Karya, Directorate of Environmental Sanitation Development, May 2015[35].

123. The Indonesian Standard SNI 03-2398-2002, in force since 2002, allows the implementation of a septic tank for a maximum of 50 people (10 KK or households) and requires a two-chamber rectangular septic tank (Figure 1) for the so-called mixed wastewaters (blackwater and greywater), although it admits small cylindrical tanks for small households (1 KK). The only criterion set out for the two chambers is that the proportion between the first and the second should be 2/3 and 1/3.

124. The standard gives two examples of septic tank size: for 1 KK (5 persons) and a 3-year desludging period and a mixed system (both blackwater and greywater), it is 2 m^3 (1.6 m long,

[35] Pedoman Layanan Lumpur Tinja Terjadwal, Kementerian Pekerjaan Umum, Direktorat Jenderal Cipta Karya, Direktorat Pengembangan Penyehatan Lingkungan Permukiman, Jakarta, Mei 2015.

0.8 m wide and 1.6 m deep), with a volume for water of 1,2 m^3, a volume for sludge of 0.45 m^3 and a space for freeboard of 0.4 m^3; and for 2 families and a separate system (only blackwater), it is 1,6 m^3 (1.6 m long, 0.8 m wide and 1.3 m high), with a wet space of 0.4 m^3, a space for sludge of 0.9 m^3 and a space for freeboard of 0.3 m^3. Moreover, it gives some indicative dimensions for the outlet and inlet pipes and their appurtenances and requires that the minimum distances of both the septic tank and the percolation area be 1,5 m to the adjacent building, 10 m to a water well and 5 m to a rainwater absorption well.

125. The standard requires that the effluent be discharged to a percolation area (Figure 1, c) without specifying any design criteria. The only requirement is that a percolation network containing more than 1 lane needs to be equipped with a distribution box.

126. The Regulation of the Minister of Public Works and Public Housing (PERMEN) quoted above does not provide any design criteria for septic tanks in its Appendix II. It only requires that a septic tank system should be designed based on the technical requirements and design criteria established in the relevant standards (Chapter III, p. 44).

127. The PERMEN, however, sets out fairly detailed design criteria for twin cubluk systems in the same Appendix II (Chapter III, pp. 40-44), based on the Ministry of Public Works Technical Instructions Pt-S-09-2000-C regarding the Specification of Twin Cubluk[36]. Nevertheless, the regulation specifies that these facilities should only be admitted in very low-density areas with less than 25 people per hectare (i.e. rural or rural-type urban areas), which is not the case of most of the city of Jambi.

128. The Ministry of Public Works Guidelines for Scheduled Desludging Services mentioned above do not provide any design or implementation criteria for septic tanks, but it is assumed throughout the whole document that the implementation of scheduled desludging should be accompanied by the adaptation of the septic tanks to the existing SNI standard. Thus, the document contains several indications regarding the importance of adequately surveying the non-complying septic tanks for further management.

C. Design Considerations for Septic Tank Systems

129. Based on the requirements and specifications of the Indonesian standard SNI 03-2398-2002 set out in the previous section and, without prejudice to this, on some other standards and handbooks, this section summarizes the main features and design considerations for septic tank systems.

130. As already explained in Section A of Chapter V, an on-site wastewater treatment or disposal system or a septic tank system should include the actual septic tank and a percolation area (or leach field) or, in parcels with limited space, a soak or seepage pit, in which the septic tank effluent is discharged for final treatment in the soil.

[36] Petunjuk Teknis Pt-S-09-2000-C, Spesifikasi Cubluk Kembar. Kementerian Pekerjaan Umum, Departemen Permukiman dan Prasarana Wilayah, Jakarta 2000.

1. Septic Tank Design Criteria

131. A septic tank is a primary settlement tank consisting of a watertight chamber with one, two or three compartments, made of concrete, brickwork, PVC or plastic, for the storage and treatment of wastewater, both blackwater and greywater, in which settling and anaerobic processes reduce solids and organics. The septic tank should be of sufficient volume to provide retention time for the settlement of the suspended solids (SS), while reserving an adequate volume for sludge storage. The volume required for sludge storage is the determining factor in sizing the septic tank, which depends on the potential occupancy of the building, estimated from the maximum number of people that the house can accommodate, and which determines also the desludging frequency of the tank. Septic tanks may be constructed on-site if they comply with the requirements specified in the above-mentioned standard and with the local wastewater management regulation or pre-fabricated tanks may be installed if they are adequately designed and manufactured by a specialist company.

132. A septic tank should have at least two chambers unless it is small (less than 2 m^3, i.e. for less than 5 persons, practically inexistent in Jambi). The first chamber should be at least 50% of the total length, and when there are only two chambers, it should be two thirds of the total length. Most of the solids settle out in the first chamber. A septic tank divided into two chambers has the advantage that most of the sludge is accumulated in the first chamber and, as sludge is more confined, its emptying is easier. A one-chamber modified septic tank is, however, included in the SNI 03-2398-2002 standard (Figure 1, b). As can be seen, the floor is inclined towards the outlet, so sludge tends to accumulate in that part.

133. The floor of the tanks should be of cement concrete and, whenever possible, sloped towards the sludge accumulation area. Both the floor and sidewall shall be plastered with cement mortar to render the surfaces smooth and to make them watertight. The baffle, or the separation between the chambers, is to prevent scum and solids from escaping with the effluent. A T-shaped outlet pipe further reduces the scum and solids that are discharged. Accessibility to all chambers (through access ports) is necessary for maintenance. Septic tanks should be vented for controlled release of odorous and potentially harmful gases (Figure 2).

134. Because the septic tank must be regularly desludged, a vacuum truck should be able to access the location. Often, as is also the case of Jambi septic tanks are installed in the home, under the building, which makes emptying difficult or even impossible.

135. The design of a septic tank depends on the potential occupancy of the dwelling or building, the amount of water used per capita, the average annual temperature (in colder climates, their efficiency can be lower), the desludging frequency and the characteristics of the wastewater.

136. The main design criteria for septic tanks, based on SNI 03-2398-2002 and similar standards or codes, are as follows:

- (i) The retention time should be at least 24 hours, although 48 hours are necessary to achieve adequate treatment[37].
- (ii) A minimum capacity of 2 m^3 should be provided on sites where the population is less than five.

[37] Tilley et al., 2014 (footnote 13, page 17).

(iii) Septic tanks should be divided into two chambers so that the effective capacity of the first chamber should be twice that of the second chamber, the length to width ratio should be not less than 2:1, and the effective liquid depth should not be not less than 0.9 m.
(iv) Sludge depth should not exceed one third of the useful height of the tank.
(v) To ensure good ventilation and avoid overflow, a minimum of 0,3 m of freeboard should be left between the maximum water level and the tank cover.
(vi) The minimum distance of both the septic tank and the percolation area should be 1,5 m from the building, 10 m from a water abstraction well and 5 m from a rainwater infiltration well.
(vii) The septic tank roof should be calculated for earth cover on the septic tank should not exceed 0,4 m.
(viii) The vent pipe should have a minimum diameter of 50 mm (2 ") and a minimum height of 25 cm from ground level.

137. Based on the number of users, the septic tank volumes and dimensions can be obtained from Table 5 (from SNI 03-2398-2002, quoted by Sudarmadji and Hamdi, 2013). These values assume that the septic tank receives a mixed influent (both blackwater and greywater) and that desludging of the septic tank is carried out at least once in every 36-month or 3-year period. Although this management plan proposes a 2-year desludging period which would require, theoretically, a lower septic tank volume, it is proposed to maintain these values for septic tank dimensioning in Jambi as water consumption might be expected to increase in the future. Furthermore, it goes without saying that oversized rather than undersized septic tanks are better because of greater settlement of solids and larger hydraulic retention time for liquid and solids.

Table 5: Septic Tank Volumes and Dimensions

No.	Number of Users (KK)	Water Volume (m^3)	Sludge Volume (m^3)	Air Volume (Freeboard) (m^3)	Tank Length (m^3)	Tank Width (m^3)	Tank Depth (m^3)	Total Volume (m^3)
1	1	1.2	0.45	0.4	1.6	0.8	1.6	2.1
2	2	2.4	0.9	0.6	2.1	1.0	1.8	3.9
3	3	3.6	1.35	0.9	2.5	1.3	1.8	5.8
4	4	4.8	1.8	1.2	2.8	1.4	2.0	7.8
5	5	6.0	2.25	1.4	3.2	1.5	2.0	9.6
6	10	12.0	4.5	2.9	4.4	2.2	2.0	19.4

138. The SNI 03-2398-2002 standard includes another table for septic tank design for separate influents (only blackwater). This table is not taken up in the present planning report as one of the criteria of this management plan is not to allow greywater discharges to the ground to the drains or to water courses.

2. Design Criteria for Anaerobic Baffled Reactors

139. As said in Section A Chapter V, an anaerobic baffled reactor (ABR) is an improved septic tank with a series of baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment. The up-flow chambers provide enhanced removal and digestion of organic matter. BOD may be reduced

by up to 90%, which is far superior to its removal in a conventional septic tank. The majority of settleable solids are removed in a sedimentation chamber in front of the actual ABR.

140. Typical inflows range from 2 to 200 m^3 per day. Critical design parameters include a hydraulic retention time between 48 to 72 hours, up-flow velocity of the wastewater below 0.6 m/h and the number of up-flow chambers (3 to 6). The connection between the chambers can be designed either with vertical pipes or baffles. Accessibility to all chambers (through access ports) is necessary for maintenance. Usually, the biogas produced in an ABR through anaerobic digestion is not collected because of its insufficient amount. The tank should be vented to allow for controlled release of odorous and potentially harmful gases.

141. For the design and implementation of larger facilities such as communal on-site treatment plants, the use of an engineering consultant is recommended.

3. Design Criteria for a Septic Tank Combined with Biofilter

142. The design criteria for a septic tank combined with biofilter, based on MPWH (2016), are as follows:

(i) Hydraulic retention time: 2-3 days; adopted 2 days.
(ii) Sludge quantity per person: 20 and 40 l/person/year; adopted 30 l/person/year.
(iii) Desludging period: 2-3 years; adopted 2 years.
(iv) Water use: 150 l/person/day.
(v) Mixed wastewater discharge: 80% x 150 l/ person/day = 120 l/person/day
(vi) Tank diameter: 1.2 m.
(vii) Tank wet area: 1,13 m^2.
(viii) Tank depth: 1.5 m
(ix) Capacity for 1 KK = 5 persons.
(x) Tank Capacity = Water Volume + Sludge Volume.
(xi) Water volume calculation:
Water volume = Mixed wastewater discharge x no. of persons x retention time = 120 x 5 x 2 = 1,200 l = 1.2 m^3
Water depth = Water volume / Tank wet area = 1.2 m^3 / 1.13 m^2 = 1.06 m
(xii) Sludge volume calculation:
Sludge volume = sludge quantity per person x person x desludging period = 30 l/person/year x 5 persons x 2 years = 300 l = 0.3 m^3
Sludge depth = Sludge volume / Tank wet area = 0.3 m^3 / 1.13 m^2 = 0.27 m
Freeboard height = Tank depth – water depth – sludge depth = 1.5 m - 1.06 m - 0.27 m = 0.17 m.

4. Percolation Area Design Criteria

143. As said, the most important component of a septic tank system is the percolation area (also called an infiltration area or leach field) as it provides most of the treatment of the wastewater effluent. It is a network of perforated pipes that are laid in underground gravel-filled trenches to dissipate the effluent from an on-site wastewater treatment facility (Figure 3; Figure 38).

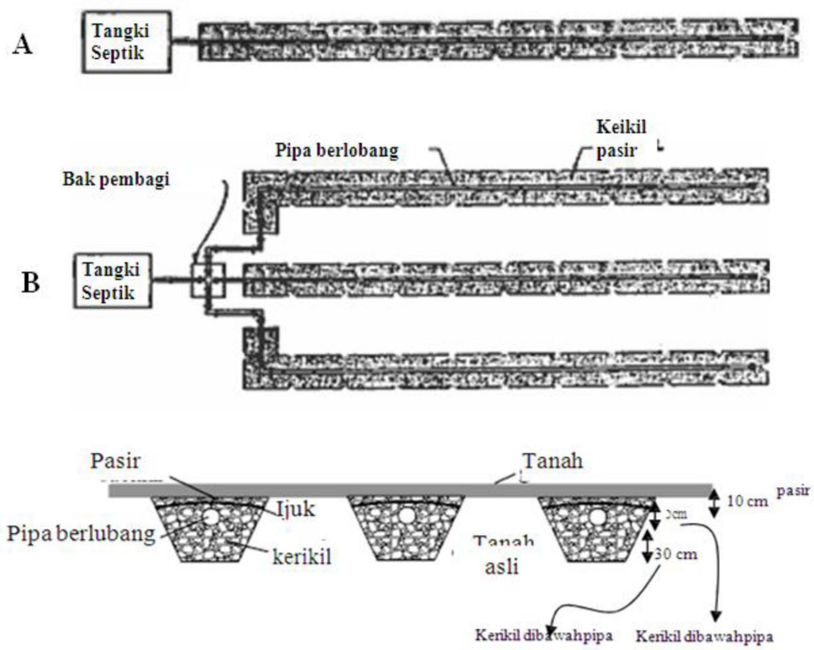


Figure 38: Typical Percolation Area[38]

144. The design criteria for percolation areas are as follows (SNI 03-2398-2002 and Tilley et al., 2014):

(i) The percolation rate of the soil should range between 0,5 and 24 min/cm with an optimum of 8 min/cm.

(ii) The maximum groundwater level should be at least 0.60 m below the bottom of the canal drainage plan or 1.0-1.5 m below the soil surface.

(iii) Each trench should be 0.3 to 1.5 m deep and 0.3 to 0.9 m wide:
- 0.45 m wide for percolation rates between 0.5 and 1 min/cm.
- 0.6 m for percolation rates between 1.5 and 3.5) min/cm.
- 0.9 m for percolation rates between 4 and 24 min/cm.

(iv) The bottom of each trench should be filled with about 15 cm of clean rock and a perforated distribution pipe is laid on top. More rock is placed to cover the pipe. A layer of geotextile fabric is placed on the rock layer to prevent small particles from plugging the pipe. A final layer of sand and/or topsoil covers the fabric and fills the trench to the ground level. The pipe should be placed at least 10-15 cm beneath the surface to prevent effluent from surfacing.

(v) The trenches should be no longer than 20 m in length and be separated at least 1 to 2 m from one another.

(vi) The minimum pipe diameter should be 100 mm.

(vii) The distance of perforation of the pipes should be between 3 and 6 mm.

(viii) The horizontal distance from the nearest water absorption well shall not be less than 10 m.

[38] Source: SNI 03-2398-2002.

145. A leach field should be laid out such that it will not interfere with a future sewer connection. In case of new installations, the septic tank that precedes the leach field should be equipped with a sewer connection so that if, or when, the leach field needs to be replaced, the changeover can be done with minimal disruption.

146. Percolation areas require a large area and unsaturated soil with good absorptive capacity to effectively dissipate the effluent. Due to potential oversaturation of the soil, leach fields are not appropriate (and sometimes not feasible) for dense urban areas.

147. A percolation area will become clogged over time, although this may take 20 or more years, if a well-maintained and well-functioning septic tank or other primary treatment technology is in place. Effectively, a percolation area should require minimal maintenance. However, if the system stops working efficiently, the pipes should be cleaned and/or removed and replaced. To maintain the percolation area, there should be no plants or trees on it. There should also be no heavy traffic above it because this could crush the pipes or compact the soil.

5. Soak Pit Design Criteria

148. In parcels with limited space, soak pits (also called seepage pits, leach pits or soakaways) can also be installed as means to dissipate the effluent from an on-site wastewater treatment facility. It is a covered, porous-walled chamber that allows water to slowly soak into the ground. Pre-settled effluent from a septic tank is discharged to the underground chamber from which it infiltrates into the surrounding soil (Figure 4).

149. Due to their limited space requirement, soak pits are suitable for urban and periurban areas. They are not appropriate, however, for areas prone to flooding or that have high groundwater tables.

150. As wastewater (greywater or blackwater after primary treatment) percolates through the soil from the soak pit, small particles are filtered out by the soil matrix and organics are digested by microorganisms. Thus, soak pits are best suited for soils with good absorptive properties, and are not appropriate for clay, hard packed or rocky soil.

151. It should be noted that the soak pit does not provide adequate treatment for raw wastewater and the pit will quickly clog. It should be used only for pre-settled wastewater discharged from a septic tank.

152. The design criteria for soak pits are as follows (SNI 03-2398-2002 and Tilley et al., 2014):

- (i) The percolation rate of the soil should range between 0,5 and 12 min/cm.
- (ii) The soak pit should be between 1.5 and 4 m deep, but as a rule of thumb, never less than 1.5 m above the groundwater table.
- (iii) It should be located at a safe distance from a drinking water source (ideally more than 30 m).
- (iv) It can be left empty and lined with a porous material to provide support and prevent collapse or left unlined and filled with coarse rocks and gravel. The rocks and gravel will prevent the walls from collapsing but will still provide adequate space for the wastewater. In both cases, a layer of sand and fine gravel should be spread across the bottom to help disperse the flow.

(v) The bottom should be laid with gravel of 12.5-25 mm, with a minimum thickness of 30 cm.

6. Twin Cubluk Design Criteria

153. As said in Section A of Chapter V, the twin cubluk or twin pit system might be appropriate for rural-type urban areas at the outskirts of Jambi but, as said above, the PERMEN 04/PRT/M/2017 only admits it for areas with a density lower of 25 persons per hectare. Therefore, it is up to the City Government's approval to admit the construction of a twin cubluk for certain households in rural-type areas.

154. The twin cubluk system is the simplest type of on-site wastewater treatment unit (Figure 7). This technology consists of two alternating pits lined with pervious walls made of hollow bricks connected generally to a pour flush toilet. The blackwater (and in some cases greywater) is collected in the pits where the faeces are settled while water is allowed to slowly infiltrate into the surrounding soil. Over time, the solids are sufficiently dewatered and can be manually removed with a shovel.

155. The twin cubluk can be arranged in various ways: the toilet can be located directly over the pits or at a distance from them; the superstructure can be permanently constructed over both pits or it can move from side to side depending on which one is in use. No matter how the system is designed, only one pit is used at a time. While one pit is filling, the other full pit is resting.

156. The pits must be regularly emptied (after the recommended two-year resting time), and care must be taken to ensure that they do not flood during rainy seasons. Emptying can be done manually using long handled shovels and proper personal protection.

157. Greywater can be co-managed along with the blackwater in the twin pits, especially if the greywater quantities are relatively small, and no other management system is in place to control it. However, large quantities of flush water and/or greywater may result in excessive leaching from the pit and possibly groundwater contamination. The dewatered, solid material can be manually emptied from the pits (dug, not pumped out), therefore, space is not necessarily required for vacuum trucks to access them.

158. The design criteria for twin cubluk, based on the Ministry of Public Works Technical Instructions Pt-S-09-2000-C and taken up in PERMEN 04/PRT/M/2017, are as follows:

(i) The pour flush toilet outlet should be equipped with a swan neck so that the water seal keeps out the odour arising from the cubluk.
(ii) The connections between the toilet and the cubluk should be of corrosion resistant (plastic) pipes.
(iii) The maximum distance between the toilet and the cubluk should be 8 meters and 90º turns should be avoided.
(iv) The diameter of the connection pipe should be minimum 100 mm with a slope of at least 2.5%.
(v) The cross section of the cubluk can be round or square (Figure 7).
(vi) The distance between the two cubluk should be at least equal to depth of the cubluk.

(vii) The minimum depth of the cubluk depends on the number of users: until 10 persons (2 KK) it should be 1.5 m while between 10 and 20 persons it should be 1,65 m.

(viii) The vertical distance between the base of twin cubluk and the water table should be a minimum of 2 m.

(ix) The minimum distance of the cubluk from a water source should be 10 m.

(x) The cubluk should be equipped with a 2-3-inch ventilation pipe made of pipe with a minimum height at the building toilet level. The top of the vent pipe should be provided with a T connection to prevent rain water entering into the pipe.

(xi) Based on the number of occupants or users, the twin cubluk volumes and dimensions for square and cylindrical cubluk shapes can be obtained from Table 6 below.

Table 6: Twin Cubluk Volumes and Dimensions

a) Cylindrical Shaped Cubluk

No. Users	**Cubluk Cycle (year)**	**Effective Dimensions**		**Observations**
		Diameter (m)	**Depth (m)**	
5	2	1.0	1.5	Absorption capacity of soil: 900 l/m²/day. Draining holes min. Ø 1 m divided into 2 parts. Height of impermeable wall 0.5 m.
10	2	1.0	1.5	
15	2	1.25	1.65	
20	2	1.40	1.65	

b) Square Shaped Cubluk

No. Users	**Cubluk Cycle (year)**	**Effective Dimensions**		**Observations**
		Side (m)	**Depth (m)**	
5	2	0.9	1.5	Absorption capacity of soil: 900 l/m²/day. Height of impermeable wall 0.5 m.
10	2	0.9	1.5	
15	2	1.0	1.65	
20	2	1.25	1.65	

Source: Technical Instructions Pt-S-09-2000-C

D. Construction Considerations for Septic Tank Systems

159. Apart from the design requirements and considerations set out above, there a number of considerations that need to be borne in mind when installing or rehabilitating a septic tank system. This section is intended to outline the most important ones.

160. Although the solutions outlined above and presented in Figure 1 Figure 2 suggest rectangular solutions cast in situ, septic tanks can also be prefabricated, be manufactured with a vertical or horizontal axis and be formed in a cylindrical, rectangular or other shape and be constructed with masonry, reinforced concrete, glass fibre reinforced plastic, injection moulded foam polypropylene, rotational moulded polyethylene or other materials and processes approved by the competent government authorities.

161. All septic tanks shall be constructed so that:

- there will be no structural failure or undue distortion under pressure when either full or empty and be protected from, or designed to withstand, loadings imposed by vehicles, buildings, soil and or ground waters and the internal loadings;
- the septic tank will be watertight and, whenever prefabricated, retain structural integrity during transportation, installation and operation;
- connections to the septic tank shall be such that they permit standard solvent welded joints or rubber ring joints and enable the inlet and outlet pipe to be
- installed at grade;
- connections for the inlet, outlet and inspection openings are integrally cast for concrete constructed septic tanks, and for plastic type materials the connections are to be mechanically and/or chemically sealed or bonded so as to be water-tight and have a strength equal to that of the parent material;
- where the inlet, outlet and inspection opening fittings for plastic type septic tanks are permitted to be installed at the place of installation, they shall be provided with fixing mechanisms and clear instructions to prevent incorrect installation with regard to grade and reversal of the inlet and outlet fittings.
- the septic tank must be installed on a compacted, level base and the top of the tank shall terminate at least 50 mm above the finished ground surface level, with the surrounding surface graded away from the septic tank and be provided with access covers as follows:
  - be constructed of a material as approved and be of sufficient strength to withstand all imposed loadings including vehicle loads where situated in vehicle access areas;
  - be constructed so as to be child proof and effectively sealed to prevent the ingress and/or egress of water or gas and be removable for maintenance purposes;
  - be positioned centrally over the dividing compartment wall and have an access opening of at least 900 mm long and 500 mm wide, or be positioned over the inlet and outlet fittings and have dimensions to ensure an access opening of at least DN 500 or 500 mm x 450 mm;
  - for septic tanks over 5 000 litres capacity, be provided with access opening of at least 900 mm long and 500 mm wide and be positioned centrally over the dividing wall or have access openings of at least DN 600 and be positioned to permit inspection of the inlet and outlet fitting and enable access to each compartment for maintenance;
- where it is not practicable to terminate the top of the septic tank at surface level it will be necessary to provide access shafts fitted with access covers and an inspection opening finishing at surface level in a manner as indicated above;
- the access shafts
  - shall have internal dimensions of at least 200 mm greater than the access opening in the top of the septic tank,
  - where deeper than 1200 mm, shall be provided with an access ladder; shall be effectively sealed to prevent the ingress or egress of water or gas;
  - shall be equipped with a cover to be constructed of the same material as the septic tank or be of sufficient strength to withstand all loadings imposed including vehicles where situated in vehicle access areas;

- on two compartment septic tanks of up to 5 000 litres capacity must be positioned over the dividing compartment wall and have an access opening of at least 900 mm x 500 mm and permit access by a person into each compartment;
- on two compartment septic tanks greater than 5 000 litres capacity must be at least 1,100 mm x 700 mm or DN 800 and be provided with child proof covers of at least 900 mm x 500 mm of DN 600 effectively sealed to prevent the ingress or egress of water or gas and be removable for maintenance purposes.

162. As for the positioning of the septic tanks, the following considerations should be observed:

- all septic tanks must be positioned at least 1.5 metres from all buildings, parcel boundaries and effluent disposal systems;
- a septic tank must not be installed where its position may affect the stability of any building on the site or adjoining sites; where appropriate it shall be positioned further than 1.5 metres from the building or buildings or adjoining sites;
- in situations where the placement of the septic tank intersects the angle of repose for the building footing or foundations, or its position may affect the stability of building footings and foundations, the excavation may be backfilled with lean
- mix concrete, e. g. 10 MPa;
- the septic tank shall be positioned as far as possible from a watercourse; in no case shall it be located less than 10 metres from a watercourse and it may be required to be positioned further away under the provision of the City Government and/or the river authority.

163. APPENDIX 1 comprises some typical design drawings for in situ masonry and cast reinforced concrete septic tanks as well as product information on prefabricated septic tanks.

164. Finally, Table 7 below summarizes the do's and don'ts for septic tank construction.

Table 7: Do's and Don'ts for Septic Tank Construction

Septic Tank ✓ Dos and	DON'Ts ✗
✓ Construct at least a two-chambered septic tank. ✓ Partition wall should be constructed at a distance of 2/3 of the inlet. ✓ The two chambers should be interconnected above the sludge storage level by means of a pipe or square opening of diameter or side length not less than 100 mm.	× Do not construct a one-chambered septic tank. × Do not construct a partition wall at an inappropriate distance. × Do not provide the interconnection at a level where the sludge or the scum is formed.
✓ The size of tank should be as per SNI and PU norms.	× Do not construct an undersized or an oversized tank.
✓ Always construct septic tank away from structures. ✓ Provide openable access covers for all chambers for inspection and desludging.	× Do not construct toilet over septic tank. × Do not completely seal septic tank on top.
✓ Septic tanks should be constructed in materials such as brick, stone, (reinforced) concrete (cast in situ or prefabricated) and prefabricated plastics.	× Do not use a dug trench as septic tank. × Tank should not leak.
✓ The base should be cement concrete and, in case of one-chambered tanks, sloped towards one of the ends allow sludge to accumulate.	× Do not construct tanks without a cement concrete base.

Septic Tank Dos	and DON'Ts
✓ The floor and sides should be plastered with cement mortar to render the surfaces smooth.	× In case of a one-chambered tank, do not construct a totally horizontal base. × The inside surfaces of the septic tank should not be rough.
✓ The inlet should be located significantly higher than the outlet. ✓ The inlet and the outlet should be below scum level and above sludge level. ✓ Baffles or T junctions should be provided at inlet and outlet.	× The inlet and the outlet should not be on the same level to prevent backflow or exit of solids. × The inlet and the outlet should not be placed at such levels where scum or sludge collects.
✓ Septic tank should be provided with ventilation pipes, the top being covered with mosquito proof wire mesh. ✓ The ventilation pipe should have a minimum diameter of 50 mm (2 ") and be as high as possible, with a minimum height of 25 cm from ground level.	× Do not construct tanks without ventilation pipe. × Do not leave the ventilation pipe unprotected against mosquitoes. × Do not keep the ventilation pipe too short.

E. Refurbishment Plan of Non-Complying On-Site Facilities

165. To implement scheduled desludging in the city of Jambi, it is necessary that the deficiencies encountered in the survey should be remedied in the future, which means, on the one hand, that all new septic tanks need to be designed and constructed according to the standard and, on the other, that the existing septic tanks will have to be refurbished gradually in a way that they approach as far as possible to the requirements of the standard.

166. By way of a summary of the survey findings, following is a list of the main deficiencies encountered in the city of Jambi:

(i) Most septic tanks are undersized and comprise only one compartment without any baffle separating the tank into at least two compartments.
(ii) Most septic tanks have no outlet for the effluent, indicating that they may be bottomless or that the effluent is discharged to the ground or to a nearby drain or watercourse.
(iii) Most septic tanks have no associated percolation area or soak pit.
(iv) Many septic tanks are situated at a place inaccessible for any desludging vehicle or device.
(v) Although potentially accessible, a large proportion of septic tanks have no manhole or not even a hole on the upper slab of the tank to allow monitoring and desludging.
(vi) A significant part of septic tanks receives only wastewater from toilets (blackwater), while greywater is discharged to drains or to the ground in the surroundings of the houses.
(vii) A significant number of households still lack a proper flush toilet.

167. The objective pursued by the septic system refurbishment plan in Jambi is that the existing septic tanks will have to be refurbished gradually in a way that they approach as far as possible to the requirements of the SNI 03-2398-2002 standard and of the PERMEN 04/PRT/M/2017 or be constructed in accordance with more advanced septic systems approved by the competent national and/or local government authorities.

168. Seen the current status of on-site facilities all over the city, however, it goes without saying that there is a long way to go to attain the goals of an appropriate septage management and of proper septic tank design all over the city. Accordingly, the refurbishment of the existing facilities should be carried out gradually, in the framework of a long-term refurbishment plan, for which, such as for the implementation of the other aspects of the septage management plan, a time horizon of ten (10) years appears to be reasonable.

169. Accordingly, the refurbishment plan should encompass the following typical actions:

- (i) Installation of access holes or manholes on the upper slab of the tanks.
- (ii) Reconstruction of clearly undersized septic tanks.
- (iii) Promotion of communal treatment and disposal systems to replace clearly non-complying individual facilities.
- (iv) Relocation of septic tanks to accessible places, i.e. to the front of the premises.
- (v) Connection of all wastewaters to the septic system.
- (vi) Construction of proper outlets and percolation systems, such as percolation areas or leach fields (individual or communal).
- (vii) Installation of ventilation pipes on the upper slabs wherever appropriate.
- (viii) Promotion of flush toilets in those households that currently lack them.

170. The implementation of the refurbishment plan is an objective-oriented process taking several years involving multiple decisions and activities. These decisions and activities may be grouped in three stages: the first encompasses preparatory activities aimed at setting the legal, institutional and supervisory framework, the second sets the organizational, financial and technical bases necessary to undertake the refurbishment works and, finally, the third stage, carries out during the whole implementation period of the refurbishment plan, will include the refurbishment works and the necessary monitoring and feedback activities.

171. Therefore, the implementation process should include the following three stages and ten activities (Table 8):

- (i) Stage I: Setting the Framework.
  - (a) Amendment of the Wastewater Management PERDA.
    Setting up a wastewater management service for both on-site and off-site collection, treatment and disposal systems, specifying the basic requirements for septic systems, and establishing a permitting arrangement and adequate financial provisions. The new PERDA will serve as a legal framework for the implementation of the refurbishment plan and the septage management plan as a whole.
  - (b) Setting Up of the UPTD-PAL.
    Establishment and organization of a UPTD-PAL, responsible for wastewater management to conduct the refurbishment plan and the septage management plan as a whole.
  - (c) Survey Extension.
    Extension of the survey for the whole city and upgrade of the Management Information System (MIS) created in the first stage using appropriate consulting services.
- (ii) Stage II: Setting the Bases.
  - (a) Inspection Arrangements.

Setting up of septic tank inspecting activities to be conducted by the UPTD-PAL.

(b) Funding Sources and Arrangements.
Definition of funding sources and arrangements, such as Local Government, National Government and international donors.

(c) Outline and Classification of Refurbishment Works.
Outline and classification of types of refurbishment works, including cost estimates.

(iii) Stage III: Works Implementation

(a) Definition of the Necessary Refurbishment Works.
Task to be performed on a yearly basis.

(b) Setting Up of Funding Arrangements.
Task to be performed on a yearly basis.

(c) Undertaking of the Refurbishment Works.
Works to be carried out by the owners on a yearly basis.

(d) Supervision and Feedback.
Continuous activity during the entire Stage III of implementation of the refurbishment works.

172. The proposed total duration of the schedule is 10 years, with the following breakdown, where the indicated timescales mean maximum durations, except the times dedicated to the proper refurbishment works which are minimum durations:

(i) Stage I: Setting the framework: 1 year.
- (a) Amendment of the wastewater management PERDA: 6 months.
- (b) Setting up of the UPTD-PAL: 6 months.
- (c) Survey extension: 1 year.

(ii) Stage II: Setting the Bases: 6 months (second half of the 1st year)
- (a) Inspection arrangements: 6 months.
- (b) Definition and classification of refurbishment actions: 6 months.
- (c) Definition of funding sources and arrangements: 6 months.

(iii) Stage III: Refurbishment works: 9 years.
- (a) Definition of the yearly refurbishment plan: maximum duration of 3 months (first quarter of each calendar year).
- (b) Setting up of the yearly funding arrangements: 3 months (first quarter of each calendar year).
- (c) Refurbishment works: 9 months (the three last quarters of each calendar year).
- (d) Supervision and Feedback: 9 months (the last quarter of each calendar year and the first six months of the next one).

Table 8: Schedule of Activities for the Refurbishing of Septic Tanks

Stage	Years									
	1	2	3	4	5	6	7	8	9	10
Stage I: Setting the Framework										
1. Amendment of the Wastewater Management PERDA										
2. Setting Up of the UPTD-PAL										
3. Survey Extension										
Stage II: Setting the Bases										
1. Inspection Arrangements										
2. Definition and Classification of Refurbishment Actions										
3. Definition of Funding Sources and Arrangements										
Stage III: Refurbishment Works										
1. Definition of the Yearly Refurbishment Plan										
2. Setting Up the Yearly Funding Arrangements										
3. Refurbishment Works										
4. Supervision and Feedback										

F. On-Site Wastewater Treatment and Disposal Permit

173. In case of new buildings or buildings lacking wastewater treatment and disposal systems, where a public sewer is not available, the building sewer outlet will be connected to an on-site wastewater treatment and disposal facility complying with the specifications of Sections B, C and D above.

174. To do it, the owner will have to obtain, before commencement of construction, a written permit signed by the City Government. The application for such a permit shall be made on a form furnished by the SDO, similar to the template attached in APPENDIX 4, which the applicant should complete with any plans, specifications and other information as required by the City Government.

175. A permit for a new disposal system will not become effective until the installation is completed to the satisfaction of the SDO and/or inspected by the SDO as well as until the on-site wastewater management fee is paid by the applicant. The SDO may inspect the existing facilities as well as the work at any stage of construction. The applicant for the permit shall notify the SDO when the work is ready for final inspection, and before any underground portions are covered and the inspection shall be made within 48 hours of the receipt of written notice.

176. In case of existing on-site treatment and disposal systems, the owner or his or her agent should also apply for scheduled desludging and septage treatment services to be provided by the SDO and/or licensed waste hauler contractors. For the application, the same form should be used (template furnished in APPENDIX 4), in which the applicant should specify the main characteristics of the facilities, accompanied by a plan of the property showing accurately all existing on-site treatment and disposal systems, such as septic tanks, wells, percolation areas, outlets, drains, etc.

177. The need for and conditions of the implementation of an on-site wastewater management permitting arrangement should be set forth in the amended wastewater management regulation (PERDA Air Limbah), as described in Chapter VIII, with a template developed as a supplement of this report.

XI. IMPLEMENTATION OF SCHEDULED DESLUDGING OF ON-SITE FACILITIES

A. Basic Criteria for the Introduction of Scheduled Desludging Services

178. The basic criteria for the introduction of scheduled desludging services in the city of Jambi are listed as follows:

(i) Septic tanks should be desludged on a pre-determined schedule replacing the current remedial on-demand practices.

(ii) Scheduled desludging should be set up as a public service to be provided by the City Government, through the UPTD-PAL, by their own means or using those of licensed private septage haulers.

(iii) The PERDA should be amended to ensure this regular desludging as a local government service.

(iv) The City Government should either provide the emptying services themselves or enter into appropriate licensing arrangements with private entrepreneurs. In case of private sector contract, the City Government should certify and license private septage transporters to desludge and transport septage to the designated treatment facility.

(v) Awareness generation activities should educate households about the need for regular cleaning.

(vi) Ideally, septic tanks should be emptied only when necessary based on the volume of accumulated sludge. Yearly desludging of septic tank is desirable. But if it is not feasible or economical smaller domestic tanks should be cleaned at least once in 1 to 3 years, with a recommended average for Jambi of 2 years, provided the tank is not overloaded. Since families generate varying volumes of sludge at different rates and have varying sizes of septic tanks, scheduled desludging programs should be adjusted to the real needs base on regular inspection.

(vii) The City should require additional trucks for the collection of septage and its transportation to the treatment and disposal sites. Vacuum trucks of different capacities can be used, from 2,000 to 12,000 litres, although in Jambi the currently available 2,500 and 4,000-litre trucks seem to be appropriate due to the limited capacity of septic tanks (Figure 28). Small scale, Vacutug-type motorcycle-driven devices, developed by UN-Habitat and widely used all over the world, are recommended for areas inaccessible to large vehicles (Figure 29).

(viii) The number of desludging vehicles should be based on the frequency of emptying, the distance of the location from the treatment facility and local conditions.

(ix) Transportation to the treatment and/or disposal site should be done by larger vacuum trucks, so the transfer from the locally used small scale vehicle to the larger ones should be resolved adequately by means of transfer in each area.

(x) Local fees should be levied by the City Government as per a specific PERDA or as part of a PERDA of fees for public services[39] will be used to recover the operating expenses for regular desludging.

[39] E.g. updating the Local Regulation of the City of Jambi No. 2 of 2012 concerning Fees for Public Services (Peraturan Daerah Kota Jambi Nomor 2 Tahun 2012 tentang Retribusi Jasa Umum).

B. Quantification of Septage

179. The quantity of septage generated depends on a number of factors including the number of users, the sources of wastewater connected to a septic tank (only blackwater or blackwater and greywater), the volume of water used for flushing and ablution. The tank cleaning frequency increases if greywater (kitchen, bathrooms etc.) is also are connected to the septic tank. As seen Section A of Chapter VII, most septic tanks in Jambi are small, with their capacities ranging from 1–3 m^3 for houses, while the capacity of communal septic tanks or public toilets (MCK) may vary between 5 and 15 m^3, and those of government and commercial buildings between 10 and 100 m^3.

180. There are two ways to calculate the septage generation rate for a given city: the septage production method and the septage collection method.

181. The most accurate approach would be to collect direct information from actual records of local septage haulers, treatment plants receiving septage, and other sources. This approach has the advantage of taking into account the variations in septage generation rates and thus provides data specific to a municipality. These data, however are not available neither for Jambi nor for any other Indonesian city.

182. The septage generation method is based on the number of users and on the septage generation rate per person and year. The PERMEN 04/PRT/M/2017 (MPWH, 2017) requires a calculation based on the number of users connected to a septic tank and the drinking water consumption but this is not enough for the estimation of septage generation. There is no direct study on septage generation rate in Indonesia although the 2013 WSP Sludge Accumulation and Pit Emptying Study (Mills et al., 2014), based on the current state of septic tanks (pits or cubluk) and the strictly on-demand emptying practices, yielded extremely low “sludge accumulation rates”, with an average value of 25 l/person/year. These rates seem to refer to faecal sludge strictly speaking and be due to the deficient state of most septic tanks and to the rather precarious emptying practices, with very long emptying cycles (8 years found in the study), septic tanks very often completely full and constant overflows to drains where a large part of sludge is lost.

183. Taking into account, however, the refurbishment process to be initiated and the introduction of regular desludging, the “septage generation rate” (a preferable term for scheduled desludging) should be significantly higher. For this concept, the United States Environmental Protection Agency recommends an average value of 230 l/person/year (USEPA, 1994, p. 9), while a recent Indian septage management guide based on the BIS septic tank design code suggests 100-120 l/person year (Rohilla, 2017, p. 45). The average value of this range, i.e. 110 l/person/year is recommended to be adopted in this septage management plan.

184. Further criteria considered in the quantification of septage in Jambi are:

- The population of Jambi is taken form the Central Statistics Bureau (Badan Pusat Statistik) of Jambi City.
- The number of persons per household is 4.6 (KKSKJ, 2008).
- The total number of households includes both individual and communal septic tanks.

- The percentage of households without septic tanks is estimated to be 10% based on the survey results.
- It is assumed that 50% of households without toilets will be upgraded from pits to septic tanks.
- The septic tank cleaning cycle is taken to be 2 years.
- Considering that the proportion of 4 m^3 and 2,5 m^3 capacity vacuum trucks will be two-third and one-third, the average capacity of septic tanks is taken to be 3.5 m^3.
- The number of property connections to the future Stage 1 sewer network is taken from the MSMIP document titled CAPEX and Funding Arrangement Jambi (MWH, September 2015) comprising 10,300 house connections and 700 households serviced by local communal systems, i.e. a total number of households of 11,000.
- The number of workdays per year is calculated supposing 22 workdays per month and 24 official holidays per year (2018).
- The number of trips to the treatment plants (Talang Bakung IPLT and Kasant IPAL) possible per vehicle per day is estimated 3.5 (3 times from the zones situated on the western and southwestern areas of Jambi and 4 times from the zones located nearer to the facilities.

185. Applying the septage generation method with the above-mentioned criteria, the septage quantities produced in Jambi, the number of septic tanks to be emptied and the number of vacuum trucks needed are estimated for the City of Jambi in a tabulated form in Table 9 below.

Table 9: Calculation of Septage Produced and Desludging Vehicles Needed in Jambi

No.	Description	Value	Formula
A	Population	583,487	Input
B	Number of persons per household	4.6	Input
C	Total households (HH)	126,845	A/B
D	HHs having septic tanks with toilets	114,161	0,90*C
E	Upgrade of HHs with pits to toilets	6,342	0,50*(C-D)
F	Property connections to sewer network	11.000	Input
G	Total number of septic tanks to be desludged	109.503	D+E-F
H	Septic tank cleaning cycle (years)	2	Input
I	Septage generated (l/person/year)	110	Input
J	Total septage generated per HH (m^3)	0,51	B*I/1000
K	Total septage generated per HH after 2 years (m^3)	1,01	H*J
L	Number of workdays (per year)	240	11*22-24
N	Truck capacity (m^3)	3,5	Input
O	Number of HHs septic tanks to be annually cleaned	54.751	G/H
P	Number of septic tanks to be emptied daily	228	O/L
Q	**Total septage to be emptied (m^3/day) (every 2 years)**	**231**	**P*K**
R	Number of trips possible per vehicle per day	3,5	Input
S	Number of vehicles required	19	Q/(K*N)
T	Standby vehicles (10-25%)	15%	Input
U	**Total number of vehicles required**	**22**	**S*(1+T/100)**

186. From these calculations, the following conclusions can be derived for the planning of scheduled desludging services in the city of Jambi:

(i) To maintain a cycle of 2 years, roughly 55,000 septic tanks need to be desludged annually. Considering 240 working days[40], this means roughly 230 septic tanks to be emptied daily.

(ii) To desludge 230 septic tanks every day, 19 vacuum trucks of an average capacity of 3.5 m^3 (most of them with 4 m^3, and some with 2.5 m^3) will be required.

(iii) Due to the small size of septic tanks, the average volume to be desludged from the individual tanks every 2 years is roughly 1 m^3 (1/3 of the total volume of the tanks). This means that the vacuum trucks of 4 or 2.5 m^3 will have to empty several tanks before heading to the treatment plants while the smaller Vacutug-type vehicles may fill their tanks

(iv) Each vehicle needs to make an average of 3.5 trips daily (most of them 4 trips, while those attending the western and southwestern areas of the city, located farther away from the Talang Bakung IPLT and the future Kasang IPAL, both of them situated in the eastern edge of the city's limits.

(v) With an additional 10% of capacity for standby vehicles, 22 trucks of an average capacity of 3.5 m^3 (4 m^3 and 2.5 m^3) are required for desludging the septic tanks in the City of Jambi.

C. Acquisition of Desludging Vehicles

187. As said, the rendering of scheduled desludging services in the City of Jambi would require a total number of 22 desludging trucks. At present, the DPUPR owns 3 vehicles of 4 m^3 of capacity, one recently acquired and two nearly 30 years old. One of these seems to be in rather poor conditions for operation. In consequence, if the City Government decides to organize scheduled desludging essentially by the UPTD-PAL's own means they should acquire 19 or 20 more vacuum trucks (to replace the 30-year old truck in poor condition) similar to the one shown in Figure 39 below and meet the related strong staffing needs.

188. As the streets in Jambi City outside of the large avenues are predominantly narrow, it is suggested not to acquire larger trucks than 4 m^3. Furthermore, it is highly recommended to provide the desludging with smaller Vacutug-type vehicles of no more than 1 to access the household situated along narrow lanes and passageways, at least one for each operational zone defined below, which would amount to a total of eight vehicles.

189. At the same time, there are reported to be also seven private entrepreneurs providing the emptying of septic tanks, but they do not necessarily dump their loads to the IPLT. In fact, as verified in the currently available IPLT log books (APPENDIX 2), there are only three of them (1 of 2 m^3 and 2 of 2.5 m^3 of capacity) that discharge septage to the plant. One of the entrepreneurs is reported to own a smaller Vacutug-type vehicle.

190. In view of the above, the City Government might opt to provide the desludging service exclusively by their own means acquiring the above-mentioned vehicles and meeting the strong staff needs indicated in Table 12 below or to entrust the service substantially to licensed private waste hauler contractors or to implement a "mixed model", e.g. half public,

[40] 12 months per 22 days per month minus 24 official holidays (2018).

half private service providers. In any case, UPTD-PAL staff should ensure the planning, inspection and monitoring tasks.

Figure 39: Vacuum Truck with Complete Equipment[41]

D. Septage Transfer Stations

191. As both the IPLT and the future IPAL are situated at the eastern edge of the city limit (the IPLT even outside the city, in kecamatan Sungai Gelam of kabupaten Muaro Jambi), it is not reasonable that these smaller vehicles discharge their loads to the IPLT or the future IPAL. Furthermore, in case of small vehicles, large distances from the emptied tank to the disposal facility of greater than 500 m often result in illegal dumping of septage in creeks and rivers.

192. One response to this problem is to install septage transfer stations at adequately chosen points of the city, with the objective of creating a two-step process for septage handling. Septage can be safely offloaded at the transfer station by the Vacutug operators (primary transport) and temporarily stored. When the holding tank is full a larger vacuum truck transports it (secondary transport) to the treatment facility. Therefore, the transfer stations have the potential to significantly reduce the amount of faecal sludge entering the environment.

193. There are several options to implement transfer stations, among which three are worth considering:

- Mobile temporary transfer stations.
- Simple permanent transfer stations.
- Portable containers.

194. The permanent transfer stations generally require the acquisition of a parcel and the construction of a storage tank with connection points for discharge and extraction hoses, which may result difficult in Jambi. Therefore a mobile or a modular transfer station consisting of portable containers is recommended for the septage management in Jambi (Figure 40). In

[41] Source: IUWASH (2016).

any case, a transfer station needs to provide a parking place for the vacuum trucks and the Vacutugs.

a) Portable collection tanker b) Portable reinforced plastic tanks

Figure 40: Modular Transfer Stations[42]

E. Scheduled Desludging Services Planning

195. For the operational planning of scheduled desludging services, it is recommended to divide the city into zones of roughly similar population and characteristics and prepare a yearly plan. In Jambi there are 13 kecamatan with the distribution of population shown in Table 10. It is proposed to establish 8 scheduled desludging zones comprising either individual kecamatan or the combination of two kecamatan as shown in Table 11 and Figure 41.

Table 10: Total Population of Jambi City by Kecamatan in 2016

Kecamatan	Men	Women	Total (M+W)	Percentage of Total Population
Kota Baru	37,238	36,278	73,513	12,60%
Alam Barajo	48,086	46,687	94,773	16,24%
Jambi Selatan	30,120	31,002	61,122	10,48%
Paal Merah	45,045	43,957	89,002	15,25%
Jelutung	31,482	31,425	62,907	10,78%
Pasar Jambi	6,121	6,436	12,557	2,15%
Telanaipura	24,858	25,112	49,970	8,56%
Danau Sipin	23,826	23,912	47 738	8,18%
DanauTeluk	5,975	6,061	12 036	2,06%
Pelayangan	6,992	6,477	13 469	2,31%
Jambi Timur	33,474	32,926	66 400	11,38%
Total	**293,217**	**290,270**	**583 487**	**100,00%**

Source: BPS Jambi City (Population Projection)

[42] Mukheibir P. (2015).

Table 11: Septage Management Operational Zones in Jambi

Zones	Kecamatan	Population	Percentage of Total Population	No. Vacuum Trucks Assigned	No. Vacutug
1	Danan Teluk & Pelayangan	25,505	4,4%	2	1
2	Telanaipra & Danau Sipin	97,708	16,7%	3	1
3	Pasar Jambi & Jambi Timur	78,957	13,5%	1	1
4	Alam Barajo	94,773	16,2%	3	1
5	Kota Baru	73,513	12,6%	3	1
6	Jelutung	62,907	10,8%	2	1
7	Jambi Selatan	61,122	10,5%	2	1
8	Paal Merah	89,002	15,3%	3	1
	Total	**583,487**	**100,0%**	**19**	**8**

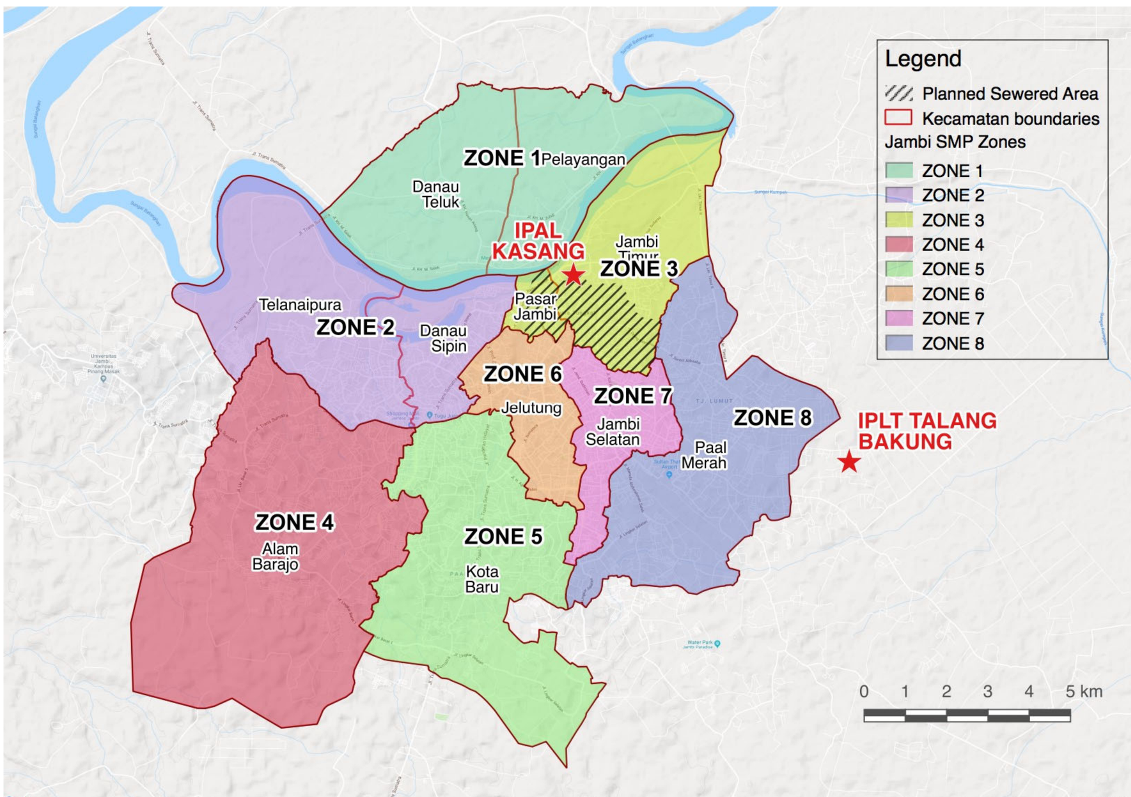


Figure 41: Septage Management Operational Zones in Jambi

F. Organization and Staffing of the UPTD-PAL

196. Regular desludging activities will require a well-organized City Government, a specialist public SDO and the contribution of licensed private waste haulers. In order to accomplish the objectives of the SMP, the key positions of the UPTD-PAL will have to be adequately staffed with specialized personnel and trained for the specific tasks involved in septage management, the key positions being, at least, the Head of the Unit and the Head of the Treatment Plants (IPAL and IPLT), as well as the staff dedicated to wastewater and sludge sampling and analysis at the Water Laboratory of the UPTD-PAL or the DLH.

197. To establish and organize of the Service Delivery Organization (i.e. the UPTD-PAL in Jambi), the basic principle considered in all CDTA documents, and, in particular, in a specific report titled Organization and Financing of Sanitation Services in the Target Cities (Revised Draft, June 2016) is integrated wastewater management. This means that the future organization should undertake both off-site and on-site wastewater management as these are nothing but the two facets of an overall sanitation service aimed to adequately collect, treat and dispose of the wastewaters produced in the city. Such an arrangement would also enable the UPTD-PAL to readily manage the transition from the on-site system to the future off-site system by promoting sewer connections. Furthermore, the centralized off-systems will be of a rather limited scope for a long time, on-site wastewater management ensure the financial feasibility of the organization by integrating the numerous on-site users. At the same time, this criterion implies that the structure needed for on-site wastewater management cannot be separated from the overall integrated management structure.

198. Based on this report and taking into account the experience of water and wastewater utilities worldwide[43], the following organization and structure is proposed for the UPTD-PAL in Jambi:

(i) Head of the UPTD, responsible for running and coordinating the different operational sections set forth below, and to define the operational policy, the staff management as well as the general objectives to be attained. Obviously, the Head of the UPTD is the key person of the whole organization and is usually assisted by a secretary.

(ii) Technical Operations Section, led by the Technical Head, another key person of the structure, will be responsible for the operation and maintenance of all sanitation systems, including the household and communal systems, the sewerage network and the WWTP, as well as for integrated septage management. The Technical Head will also be assisted by a Secretary. Due to these multiple and fairly different functions, it is recommended to divide the technical department in the following sub-sections:

    (a) IPLT Operations, Desludging and Septage Transport Sub-Section, responsible for the control of on-site household and communal facilities, for the scheduled desludging of septic tanks and latrines, as well as for septage treatment at the IPLT and sludge disposal.

    (b) Sub-Section for Technical Assistance to Communal Systems Management Groups, responsible for the control of communal networks and treatment facilities including public toilets, and for the technical assistance to communal user groups.

    (c) Sewer Network Operations Sub-Section, responsible for the cleaning and maintenance of the centralized public sewer system and for the inspection and maintenance of sewer connections.

    (d) WWTP Operations Sub-Section, responsible for the operation and maintenance of the WWTP; this Sub-Section includes the Water Laboratory, located at the WWTP, and responsible for wastewater and sludge sampling and analysis.

(iii) Customer Services Section, led by the Customer Services Head, responsible for social marketing and information, including two sub-sections:

[43] Valiron, F (dir.) (1986).

(a) Sub-Section for the Communal Systems Management Groups, dedicated to assist communities on the development of communal systems as a means to improve and refurbish obsolete on-site facilities.
(b) Social Marketing and Information Sub-Section, responsible for influencing households to adopt adequate sanitation practices, including the promotion of sewer connections, wherever available, and the refurbishment of non-complying on-site facilities.

(iv) Administration Section, led by the Administrative Head, will be responsible for all the administrative matters of the wastewater management service and the unit itself, including, as another key activity of the organization, user management. This section is to be divided in the following sub-sections:
(a) General Administration and Personnel Management Sub-Section, responsible for warehouse management, the vehicle fleet as well as human resources policy and management.
(b) Financial Management Sub-Section, responsible for general and analytic accounting, budgeting, cash-flow management and, whenever necessary, financing affairs.
(c) Customer Administration Sub-Section, responsible for the preparation and updating of the user data base, preferably in a GIS environment, as well as for billing and collection of rates.

Legal and tax matters might be covered by the LG directly or by adding a Tax and Legal Sub-Section.

199. It is understood that the UPTD will only be a starting point of the establishment of a well-organized specialist UPTD-PAL with financial management. The structure shown below, and the staffing set out below have been designed for the UPTD-PAL in accordance with the activities and functions necessary to operate the on-site and off-site systems in Stage 1, but it can be easily adapted to the structure necessary for a BLUD or PDPAL-type organization.

200. The proposed organization and structure is shown in the chart below in Figure 42. Based on the scope, criteria and proposed structure, as well as the calculation of necessary vacuum trucks and other equipment, described above, a preliminary staffing is presented below in a tabular form in Table 12 indicating the staff needs for each department and division. The staff figures have been worked out for two stages: a so-called minimum staff for the initial stage and a maximum staff for developed and consolidated UPTD-PALs. Wherever appropriate, the qualifications of staff members are also indicated.

201. The staff needs of the On-Site and Communal Systems Divisions are not but mere estimates. As can be seen from Table 12, the personnel dedicated to septic tank desludging (drivers and operators) alone might represent half of the total estimated staff of the UPTD-PAL. The real needs, however, will greatly depend on whether the City Government decides to organize scheduled desludging essentially by the UPTD-PAL's own means creating this strong need for staff or, alternatively, entrust the service substantially to licensed private waste hauler contractors, in which case the UPTD staff would only provide planning, inspection and monitoring tasks.

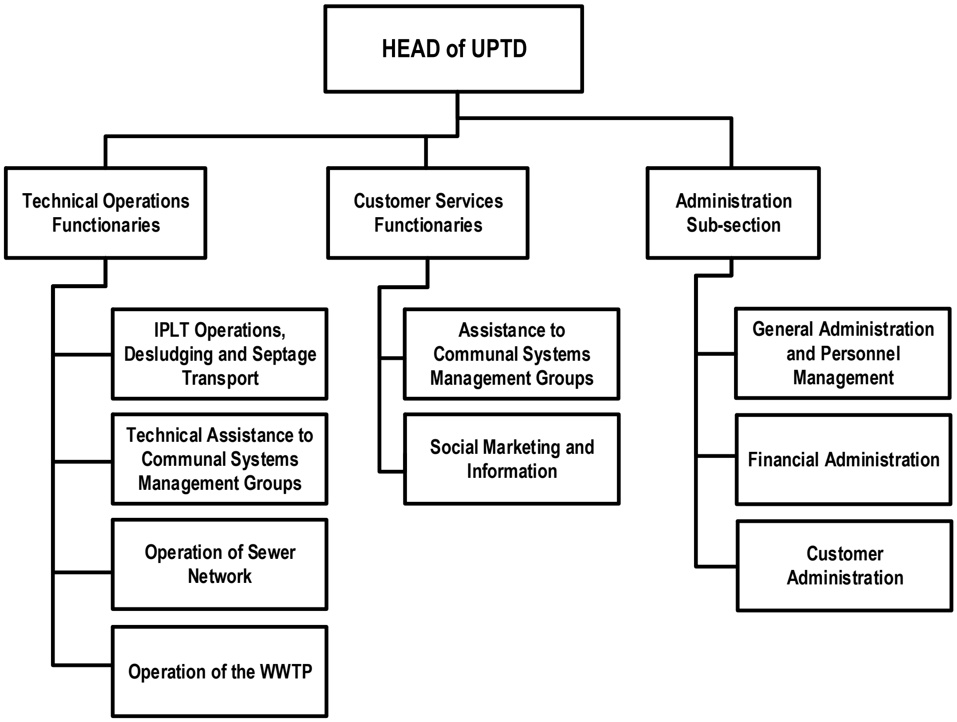


Figure 42: Preliminary Proposal for the Structure of the UPTD-PAL

Table 12: Preliminary Staffing of the UPTD-PAL in Jambi

Description	Qualification	Min.	Max.
Head of the UPTD		**2**	**2**
Head of the UPTD	Engineer specializing in water and/or waste water	1	1
Secretary		1	1
Technical Operations Section		**62**	**120**
Technical Head	Engineer specializing in water and/or waste water engineering and/or management	1	1
IPLT Operations, Desludging and Septage Transport Sub-Section		35	80
Sub-Section Manager	Engineering technician, preferably in hydraulics	1	1
Inspectors		2	4
Vacuum Truck Drivers		9	22
Operators		18	44
IPLT Supervisor		1	1
IPLT Maintenance Officials		1	2
IPLT Operators		1	2
IPLT Laborers		2	4
Sub-Section for Technical Assistance to Communal Systems Management Groups		2	3
Sub-Section Manager		1	1
Social Assistant		1	2

Description	Qualification	Min.	Max.
Sewer Network Operations Sub-Section	Engineering technician, preferably in hydraulics	13	18
Sub-Section Manager		1	1
GIS Specialist	Engineer, Geographer or IT Analyst	1	1
Inspectors		2	1
Backhoe % Crane Operators		2	3
Electrical Mechanic		2	1
Maintenance Officials		1	2
Operators		1	3
Laborers		3	6
WWTP Operations Sub-Section		11	18
Sub-Section Manager	Engineering Technician, Chemist or Biologist specializing in wastewater	1	1
Supervisor		1	2
Electrician		1	1
Mechanical Technician		1	1
Maintenance Officials		1	2
Operators		2	4
Laborers		3	6
Water Laboratory Analyst	Chemist	1	1
Customer Services Section		**5**	**7**
Customer Services Head		1	1
Sub-Section for the Communal Systems Management Groups		2	3
Sub-Section Manager		1	1
Social marketing assistant		1	2
Social Marketing and Information Sub-Section		2	3
Sub-Section Manager	Social marketing specialist	1	1
Social marketing assistant		1	2
Administration Section		**7**	**10**
Administrative Head	Economist or Business Administrator	1	1
General Administration and Personnel Management Sub-Section		2	3
Sub-Section Manager		1	1
Assistant Clerks		1	2
Financial Administration Sub-Section		2	3
Sub-Section Manager		1	1
Assistant Clerks		1	2
Customer Administration Sub-Section		2	3
Sub-Section Manager		1	1
Assistant Clerks		1	2
	Total:	**76**	**139**
	Total without On-site & Communal Systems Division :	**41**	**59**

G. Scheduled Desludging Operational Procedures: Emptying and Transportation

1. Procedures for Emptying Septic Tanks: Standard Operational Procedures

202. Standard Operational Procedures (SOP) for the emptying and transportation activities of septage management are developed as a supplement of this Septage Management Plan. The SOP contains specific procedures setting forth the different steps of the activities as well as safety and recordkeeping concerns.

203. The Septage Program Manager, i.e., in the case of Jambi, the UPTD-PAL's Technical Director, should update the SOP furnished in this report by first reviewing the operational procedures for each specific equipment and then documenting all aspects of the day-to-day procedures. These procedures should include:

- Daily preparation.
- Scheduling and routing for trucks.
- Operating the vacuum truck equipment for septic tank desludging.
- Transportation requirements, including rules of the road.
- Disposal procedures at the treatment facility.
- Safety concerns.
- Recordkeeping for all tanks emptied and wastes discharged at the disposal facility.

204. The SOP is an important document for the UPTD-PAL since it provides guidance for the equipment operators as they specify set procedures that employees should follow so that their work is done within specified guidelines.

2. Operating the Vacuum Truck Equipment

Daily Preparation

205. The following procedures should be followed in the daily preparation of desludging vehicles and equipment (Figure 39):

(i) Receive work orders for the day.
(ii) Check vacuum truck and equipment.
  - Check engine oil.
  - Check air pressure in tires
  - Check safety back up horn.
  - Check emptying truck equipment.

(iii) Check hoses: frequently inspect hoses for cracks and wear; discard or repair worn and broken hoses (Figure 43).
(iv) Check fittings: use of proper fittings is required for proper operation (Figure 44).
(v) Check personal protective equipment: all employees are responsible for maintaining their personal protective equipment in good condition, such as
  - gloves;
  - boots;
  - hard hat and face mask.

(vi) Check disinfecting and spill control equipment: operators should be trained on identifying spills and proper methods of disinfecting pavement and equipment in the event of a spill using

- bleach solution: typically one cup of bleach to 4 litres of water is a good solution for disinfecting surfaces;
- lime: only use outside; sprinkle over spilled area, wait 15 minutes, then wash with water;
- safety cones: set up safety cones around spilled areas until properly disinfected.

In Jambi, a great number of septic tanks are located under the houses (e.g. the typical ruko). Should spills occur while desludging septic tanks in the interior of houses, special care should be taken to clean and disinfect surfaces to maintain good customer relations and to avoid complaints.

(vii) Check tools: make sure the truck is equipped with

- shovel, digging bar;
- rake;
- broom;
- lifting bar for tank lids;
- screwdrivers, vice grips, pliers for opening tank lids;
- hand wash supplies (soap, towels, water, waterless hand washing soap);
- log book, work orders, extra forms, receipts, pens;
- work orders for the day: review for special instructions;
- maps.

(viii) Set schedule for the day: choose best route considering

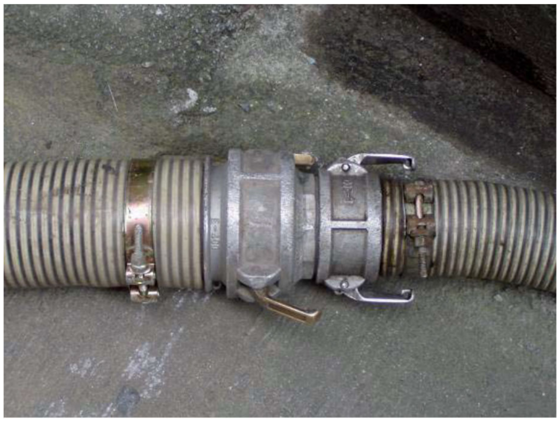
- traffic;
- most direct route;
- expected volumes of septage to empty;
- proximity to disposal site.

Correct: Proper Hose Connection

Improperly Maintained Hose Connection

Figure 43: Hose Connection to the Vacuum Truck[44]

[44] Strande et al., 2014, p. 84.



Correct: clamp-type fitting

Incorrect: "do-it-yourself"

Figure 44: Hose Connections[45]

Septic Tank Desludging

206. Operators should become familiar with the proper operation of the equipment in use for each operation. This includes the physical operation of the truck, and all valves, piping, power take-offs and ancillary equipment for the vacuum equipment, including the tank, valves, hoses, and fittings.

207. Desludging of septic tanks and operating the vacuum truck equipment should include the following steps:

(i) Proceed to first job.

(ii) Proceed with staging operations, which typically take place in the yard of the residence where the septic tank will be cleaned; the yard is where tools, equipment, and parts will be stored while the work is ongoing.

(iii) Greet the building owner: public contact is an important part of the job. Good rapport with customers means fewer complaints and goodwill between the UPTD-PAL and the public.

(iv) Have the building owner take the crew to the septic tank. The building owner is responsible for locating the tank lid and cleanout. The top of the tank lid should be less than 20 cm below natural grade. If it takes more than 15 minutes to locate or uncover the tank lid, the building owner should be billed for the time.

(v) Open the access covers.

(vi) Inspect the interior and exterior of the tank:

- Check the level of water or sludge up to the flow line of the outlet pipe: high levels (above outlet level) indicates a clogged outlet; low levels (below outlet level) indicate the tank leaks.
- Check to see if inlet pipe and sanitary tee are in place.
- Check the tank to look for obvious damage to the structure (cracks in the concrete and tank settling). Use of a mirror on a long pole can help to inspect the interior of the tank.

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[45] Source: Robbins, 2007.

- Check for drain back into tank during pumping and when pumping is complete; drain back may indicate a problem with plumbing in the house or clogged disposal.
- Number of compartments: if more than one, locate and remove lids from all compartments.
- Each compartment will require emptying.
- Indications of high groundwater, saturated soils: act with caution when emptying tanks during high groundwater conditions as unsecured tanks may float; ask for local knowledge of the area to obtain this information.

(vii) Position the truck and prepare the truck for emptying.

- Place safety cones around truck.
- Chock the wheels.
- Set parking break.

(viii) Remove the hoses and fittings required to complete pumping from the toolbox.

(ix) Probe the tank with the last length of hose; this will provide an indication on the volume of sludge to suck; to probe the tank, slowly lower the hose into the tank, and as it passes down the water column, the resistance increases when the sludge layer is encountered; the sludge layer exists from the depth at which resistance is first encountered to the bottom of the tank.

(x) Connect the hose to the truck tank. Screw or clamp fittings should be used in case back-pressure is required to break up sludge masses. Friction fittings may come apart during the pump back operation, thus exposing workers to a safety hazard.

(xi) Engaging the suction pump equipment, the operator will:

- Make sure there is suction and that the pump is operating. Volume in the tank should start decreasing rapidly.
- Use the hose to break up sludge and scum masses to the greatest extent possible.
- As emptying commences, the operator will monitor the vacuum truck tank level gauge, whenever available. Always ensure there is adequate volume in the septage tank to accommodate the load. If only a partial load can be pumped, monitor levels closely.
- Calibrated sight gauges (Figure 45) can be used not only to determine when the vacuum truck is full but also to estimate volume of septage emptied for recording on the manifest form.
- Monitor the septic tank as pumping progresses look for water flowing back from the outlet pipe or inlet pipe back to the tank as the water level decreases; such flows may indicate problems with the disposal field or clogs in outlet lines; if these are observed, note them on the manifest form in the "comments" section.

(xii) Pump-back procedure:

- After pumping is complete, check the tank for remaining sludge; if there are accumulated solids remaining, initiate the pump-back procedure, which is to send the pumped septage under pressure back into the tank and direct this flow toward the sludge mass.
- This will break up the mass, making it possible to pump out.
- It is not necessary to pump the complete volume back into the tank, as little as 200-300 litres will be enough to break up the mass.

(xiii) When pump-back is complete, pump out the tank again (suction). Repeat the above steps as needed; it is OK to leave as much as 100 to 200 liters of septage in the tank after cleaning.
(xiv) Never pump out the entire contents of a tank during periods of high groundwater; if the groundwater is higher than the bottom of the tank, the tank may float out of the ground which is why, in such conditions, leave enough contents in the tank to serve as ballast.
(xv) When pumping is complete, wash the hoses with water while directing the water stream back into the tank.
(xvi) Replace the clean hoses back in the truck toolbox.
(xvii) Replace the tank lids and secure.
(xviii) Clean up any spills and disinfect with lime or bleach solution. Spills exceeding 100 liters of septage must be reported to the City's health agency.

Figure 45: Calibrated Sight Gauge on Vacuum Truck to Estimate Tank Level[46]

3. Transporting the Septage to the Treatment and/or Disposal Site

208. The aspects that need to be considered for the transportation of septage include:
(i) the type of vehicle to be used including its road worthiness, maintenance, licenses and permits, and where it is kept when it is not in service;
(ii) the type of sludge removal equipment, including hoses, pumps, augers, and other tools of the trade;
(iii) the spill management equipment to be used including shovels, disinfectants, sorbents, and collection bags;
(iv) the skills of the operator including the training and certifications that might be required to perform the work;
(v) procedures that need to be followed including rules of the road and activities at the treatment plant; and
(vi) other aspects such as the use of transfer stations, worker health and safety, and emerging technologies.

209. The following procedures should be observed by vacuum truck drivers when transporting the emptied septage to the disposal and/or treatment site:

[46] Source: Robbins, 2007.

(i) Vacuum truck drivers are responsible for all rules of the road
(ii) Drivers should take the most expedient route to the disposal and/or treatment site considering traffic flows.
(iii) Drivers should plan their trip to arrive at the disposal site within the specified disposal site operating hours (8 a.m. to 4:30 p.m.)
(iv) In the event of an accident or moving violation (citation), drivers should cooperate with local authorities; therefore, they should be prepared to show driver's license, vehicle registration, and insurance if requested. A complete report will be required, and all incidents should be investigated.
(v) Drivers should report equipment malfunctions or required repairs immediately to supervisors at the UPTD-PAL.
(vi) Septage trucks are heavy vehicles requiring commercial operators' licenses. Therefore, supervisors at the UPTD-PAL's Management department should ensure the drivers' license is up-to-date and of the proper classification.

210. When discharging the septage at the treatment and/or disposal site drivers should
(i) check in with facility guard or operator;
(ii) carefully follow instructions regarding the sampling of septage; plant operators may request samples of the septage prior to allowing discharge if it is suspected that the septage may contain materials hazardous to the plant;
(iii) position the truck in the designated location for septage removal, park and take the truck out of gear, apply the parking brake, and chock the wheels;
(iv) remove the hose and make the connections;
(v) open the valve and allow the septage to flow via gravity into the inlet tank;
(vi) when the tank is empty, disconnect hose, clean with water (directing stream into
(vii) inlet tank) and replace in tool box;
(viii) clean up any spillage in the area around the inlet after completing the discharge of septage into the transfer station and re-seal the inlet;
(ix) use personal protective equipment such as gloves and hard hats, and do not smoke during the entire collection and discharge operation;
(x) replace hoses and equipment, following adequate hygiene practices (e.g. hand washing), and
(xi) complete the required paperwork.

211. Once the shift is finished and the vehicle is in the yard, drivers should
(i) fuel the vehicle at the end of the shift,
(ii) clean the truck inside and out,
(iii) replenish tools as needed,
(iv) submit the invoices and manifests to the yard manager.

4. Recordkeeping and Manifests

212. Keeping accurate records regarding tanks and volume pumped is important for billing and compliance. Recordkeeping and manifest forms are an integral part of a comprehensive septage management program.

213. Manifest forms are simple receipts that specify:

- the location or address of the pumped septic tank;
- septage characteristics (residential or commercial);
- the name and address of the property owner or occupier;
- he volume of septage emptied;
- any notes regarding tank deficiencies, missing pipes or fittings, improper manholes or access ports, any other cracks or damage observed.

A sample manifest form is attached in APPENDIX 6.

214. Once completed, a copy of the manifest is given to the owner as a receipt. When the load is delivered to the disposal site, the disposal site operator:

- accepts the load;
- verifies the volume;
- takes a sample if needed;
- signs the manifest proving receipt of the volume of septage disposed of.

215. It may be advantageous for the operator to pump out multiple tanks before going to the disposal site. In this case, a multiple-load manifest form should be completed as well as individual manifest or receipt forms.

216. The completed document or documents should be given to the UPTD-PAL as well as to the City Government for their records. The manifest system is a tracking and compliance tool. It helps ensure that all of the septage pumped arrives at the disposal site and minimizes the opportunity for illegal discharge. It is also a record that the UPTD-PAL may choose to use for paying septage hauling subcontractors, for example, based on the cubic meters of septage delivered to the disposal site as recorded on the manifest. This system accomplishes two main goals. First, it provides an incentive for haulers to make proper disposal at the treatment facility. Second, it provides an incentive for the emptier to suction as much volume out of the septic tank as possible. This is important since simply removing the liquid fraction of the septic tank doesn’t remove the sludge, which is the fundamental goal of the desludging service.

5. Safety Concerns

217. Operating septage emptying equipment is dangerous. Operators should be responsible for their personal safety as well as safety on the road.

218. Septage is infectious material. It can cause disease if ingested or if it comes in contact with broken skin. Hands must always be washed immediately after contacting septage or tools and equipment that may have contacted septage, and always before eating or drinking. Septage workers should be immunized for cholera, tetanus, typhoid fever, hepatitis A and hepatitis B.

219. Caution must be used around septic tanks and septic tanks must never be entered, all service activities must be performed from the ground surface. People are killed every year in septic tanks, because tanks are confined spaces that may contain toxic or oxygen-limited atmospheres. Smoking must be prohibited while operating septage equipment. Septic tanks may generate methane, an explosive gas. Smoking also promotes the hand-to-mouth route of infection.

220. Septic tanks also may collapse or break if excessive weight is place on the lid or manhole cover. Septic tank lids must be always secured with safety screws or locks. Keep children safe by keeping septic tank lids secure. Operators should never enter septic tanks for sludge removal or cleaning activities.

H. Private Sector Participation in the Desludging Services

221. Private sector participation is addressed in Chapter XIII below while a proposal for cooperation agreements with private septage haulers will be included as a supplement of this report.

I. Financial Provisions and Time Horizon

222. Local government fees and/or rates should be levied by the City Government to recover the operating expenses for regular desludging as per a specific PERDA and/or PERWALI or as part of a PERDA/PERWALI of tariffs for public services. See Chapter XII for a preliminary Economic and Financial Model.

223. To deploy scheduled desludging it the city, it is proposed to adopt a gradual implementation process over a time horizon of five (5) years.

XII. SEPTAGE TREATMENT AND DISPOSAL

A. Septage Quantities and Treatment Options

224. According to the quantification of the septage produced in Jambi on the assumption of a full deployment of scheduled desludging set out in Table 9 (Section B of Chapter X) above, the total quantity of septage to be treated and disposed is 231 m^3/day.

225. The existing Talang Bakung IPLT, assessed in Section C of Chapter VII above, has a nominal capacity of 80 m^3/day. Although the current input is less than 10% of this capacity, around 7 m^3/day, and the plant is virtually non-functional despite the refurbishment works carried out in 2016, it is thought appropriate to upgrade it with relatively minor works that would allow it to be put into service. The proposed refurbishment of the IPLT will be dealt with in Section D below.

226. For the treatment and disposal of the remaining septage quantities, there are three options:

(i) Extension of the existing IPLT.
(ii) Construction of another IPLT of similar characteristics at another location, e.g. at the western or southern edge of the city.
(iii) Co-treatment of septage at the Kasang IPAL, to be completed, most likely, by 2021.

227. Although the implementation of a specific IPLT at another end of the city would have the advantage of easing the transport of septage by the vacuum trucks, the Kasang option is undoubtedly the most rapid and cost-effective solution. Therefore, it will be analysed in detail in Section E below.

B. Septage Quality

228. As described in Section C of Chapter VII, the Environmental Health Agency (DLH) performs quality control checks at three points of the IPLT, viz. the solids separation chambers (SSC), the anaerobic pond and the sludge drying beds (SDB), and, since 2017, at the outlet, on a weekly basis. Although most of the parameters tested on the samples are correct (BOD, COD, NH_3, NO_3, TSS and pH, although some others like TDS, NO_2 and several metals are totally irrelevant), the available results are clearly inconsistent, many of them incoherent, and altogether unreliable, viz. very low TSS values (many of them < 200 mg/l), often contradictory BOD and COD values, higher values for TDS than TSS, incoherence between the values obtained at the different sampling points, etc. Therefore, these values cannot be used for preliminary design purposes, so the calculations below will be performed using the average values of the World Bank's Indonesian septage characterization study (Mills, 2014).

229. The sampling survey carried out in Jakarta, Bogor, Surakarta and Makassar shows the same situation found in Jambi: the on-site systems were typically single leach pits rather than standard septic tanks, approximately 2.5 m^3 of capacity, and on average operated for 6 years before emptying.

230. The typical characteristics of septage are shown in Table 1 above. The results indicate that most parameters are on the low end of international findings and can be classified as low strength septage.

231. The principal parameters to be used in preliminary design considerations are:

- Total Solids (TS): 15,000 mg/l.
- Total Suspended Solids (TSS): 5,000 mg/l[47].
- BOD_5: 1,000 mg/l.
- COD: 3,300 mg/l.
- BOD/COD: 1/3.
- NH_3-N: 200 mg/l.

This BOD/COD value indicates the fairly stabilized nature of septage in Jambi due to the long sludge retention times (several years), while the high ammonia value (NH_3-N), typical in septage, is important to consider as it is a potentially toxic component in anaerobic processes.

232. For an up-to-date septage management (and wastewater management as a whole), it is absolutely indispensable to enhance wastewater sampling analysis capabilities based on the Standard Methods for the Examination of Water and Wastewater. In view of the above, the parameters necessary for septage management and septage treatment are: TS, TSS, BOD, COD, NH_3.

233. As recommended in Section F of Chapter X above, it would be reasonable to create the UPTD-PAL's own Wastewater Laboratory, responsible for wastewater and sludge sampling and analysis, preferably located in the WWTP where most sampling and analysis is going to take place in the future. This laboratory could then perform the septage sampling and analysis tasks. As shown in the chart of Figure 42 above, this laboratory could be integrated into the Wastewater Treatment Division, as a sub-division.

C. Basic Criteria for Septage Treatment

234. The main objective of septage treatment is to dispose treated sludge into nature without harming human and environmental health.

235. According to USEPA (1994), the main alternatives for the treatment and disposal of septage fall into the following categories:

- Land application.
- Treatment at wastewater treatment plants (WWTPs).
- Treatment at independent septage treatment plants.

236. Land application of septage, the most common means of septage disposal in the United States (also widely practised in Australia and in many countries of Europe), is likely to be the most economical alternative. The main concerns related to this method are the availability of suitable land with adequate buffer separation from residential areas. Therefore, its application is limited in many urban and suburban areas, and the public is often concerned about the odour

[47] Estimated value, somewhat higher than the average value of the Indonesian septage quality survey, due to the difficulty measuring TSS in thick sludge (see Mills, 2014, p. 16).

and health impacts of such practices (Ibidem). This option has not been chosen so far anywhere in Indonesia despite that, such as in the case of Jambi, there could be available agricultural land and plantations (e.g. oil palms) near many cities. Anyhow, this option will be analysed in Section G below for the conditions of septage management in Jambi.

237. Disposal at an existing WWTP is a viable and economical option if the plant is reasonably close to the source and has adequate facilities to handle the material. Actually, most plants are capable of handling some septage (ibidem). Septage may be added to the plant headworks, upstream manhole, or sludge handling process for co-treatment with sewage or sludge. Septage volumes that can be accommodated depending on plant capacity and types of unit processes employed. This option presents a further advantage of centralizing all wastewater treatment activities of the municipality. As already said above, Jambi will have a new centralized WWTP, the Kasang IPAL, which will offer an additional capacity necessary to complete septage treatment in the city. Among the different options to incorporate septage into a WWTP, its addition to the sludge handling train seems the most suitable.

238. According to USEPA (ibidem), independent septage treatment plants are the most costly of the three categories as they require high capital and operation and maintenance (O&M) costs and specific skills for operation. Nonetheless, due to the lack of WWTPs and also to the lack of willingness or inclination to address the option of land application, the independent septage treatment plants, the so-called IPAL, have become the predominant solution in Indonesia so that there are roughly 170 plants of this kind all over the country. The above-mentioned economic disadvantages were intended to be counterbalanced by adopting simple Waste Stabilization Pond (WSP) systems in most cities and regencies, which required relatively low investment costs and skilled labour. The result is, however, not very encouraging as more than 90% of these 170 IPLTs are currently out of operation (AECOM-EAWAG, 2010).

239. Legislation that establishes regulations specifically for the treatment and discharge, disposal or reuse of septage is essential. However, as it happens in many other countries, there is no specific regulation on septage in Indonesia, except that which is borrowed from wastewater treatment objectives or discharge limits, such as the fairly demanding effluent standards established in PERMEN P.68/MENLHK/SETJEN/KUM.1/8/2016[48] (Table 13). This regulation, however, does not take the very different nature of septage into account. Therefore, treatment targets for septage should be set based on the intended disposal or reuse goal of the produced sludge, and only the liquid effluents should comply with the above-mentioned standards.

[48] MEF (2016).

Table 13: Discharge Limits for Wastewater Effluents as per PEMEN 68/2016

Parameter	Units	Maximum Limits
pH	–	6 – 9
BOD	mg/l	30
COD	mg/l	100
TSS	mg/l	30
Oil and Grease	mg/l	5
Ammonia	mg/l	10
Total Coliforms	Number/100 ml	3000
Flow	l/person/day	100

240. When designing and operating a septage treatment facility, it is essential to consider the differences between septage and wastewater as designers and operators often fall into the trap of proposing treatment systems developed for wastewater. Septage is the settled solid matter, usually a mixture of solids and water, retained at the bottom of a septic tank or a pit latrine. It is raw or partially digested sludge in a semisolid form. The characteristics of septage can differ widely from household to household, city to city, and country to country. As shown in Section C above, septage is much more concentrated than sewage, its total solids or total suspended solids (TS or TSS) content being 10 to more than 100 times higher than that of municipal wastewater. This means that septage is sludge and not water, and should be treated as such, using the proper methods of the sludge treatment process, such as thickening, stabilization, dewatering and drying, always as a function of its final disposal and/or end usage.

241. In consequence, the mean treatment objectives are thickening and dewatering of septage, as it contains a high proportion of liquid, and the reduction in this volume (or the increase of its dryness) will greatly reduce the cost of transporting water weight and simplify subsequent treatment steps. Environmental and public health treatment objectives are achieved through pathogen reduction, stabilisation of organic matter and nutrients, and the safe disposal or reuse of the sludge product.

242. Common methods for dewatering of septage include gravity settling and thickening, sludge drying in beds, by way of evapotranspiration and/or evaporation, whether or not the beds are planted with vegetation. Septage has different dewatering characteristics compared to wastewater sludge, in that it tends to foam upon agitation, and resist settling and dewatering (USEPA, 1999).

243. Settling-thickening tanks, called solids separation chambers in the Talang Bakung IPLT in Jambi, are used to achieve separation of the liquid and solid fractions of septage. They were first developed for primary wastewater treatment, and for clarification following secondary wastewater treatment, and it is the same mechanism for solids-liquid separation as that employed in septic tanks. Settling-thickening tanks for septage treatment are rectangular tanks, where septage is discharged into an inlet at the top of one side and the supernatant exits through an outlet situated at the opposite side, while settled solids are retained at the bottom of the tank, and scum floats on the surface (Figure 46). During the retention time, the heavier particles settle out and thicken at the bottom of the tank as a result of gravitational forces. Lighter particles, such as fats, oils and grease, float to the top of the tank. As solids are collected at the bottom of the tank, the liquid supernatant is discharged through the outlet.

244. The liquid stream that is produced during the settling-thickening process, the supernatant water floating above the sludge blanket and generally beneath the scum cover (Figure 46), also requires further treatment, as it is still high in organic matter (BOD), suspended solids (TSS), ammonia, and often also in pathogens. When treating septage in waste stabilization ponds (WSPs), such as in case of the Talang Bakung IPLT and in most IPLTs in Indonesia, settleable solids must be separated in the above-mentioned settling-thickening units in order to guarantee an undisturbed treatment of the liquid fraction. Inexistent or poor solids separation underlie most of the treatment failures occurring all over the country. Therefore, it is important to highlight that only water coming from this supernatant layer should be admitted to the ponds or other wastewater treatment processes. Figure 47 synthesizes the different treatment options for the solid and the liquid fraction.

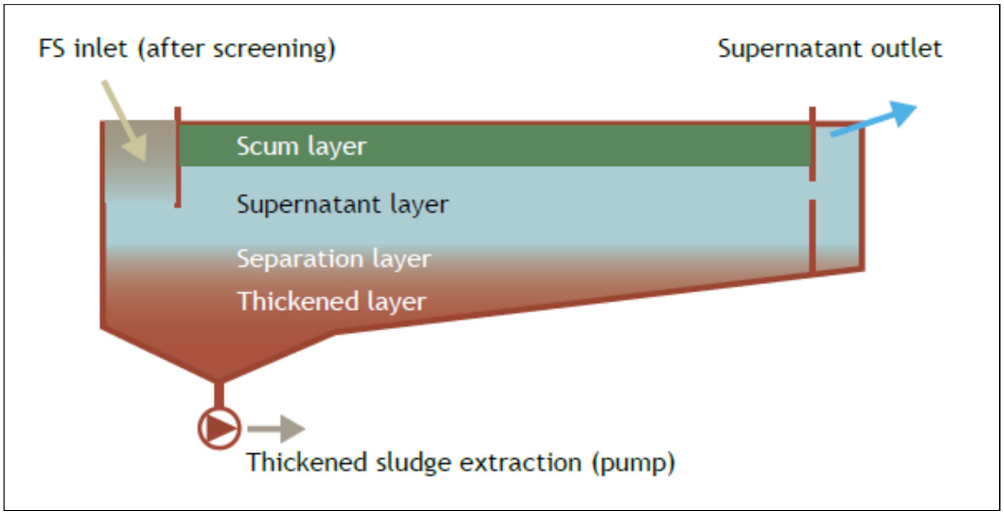


Figure 46: Schematic of the Layers in a Solids Separation Tank[49]

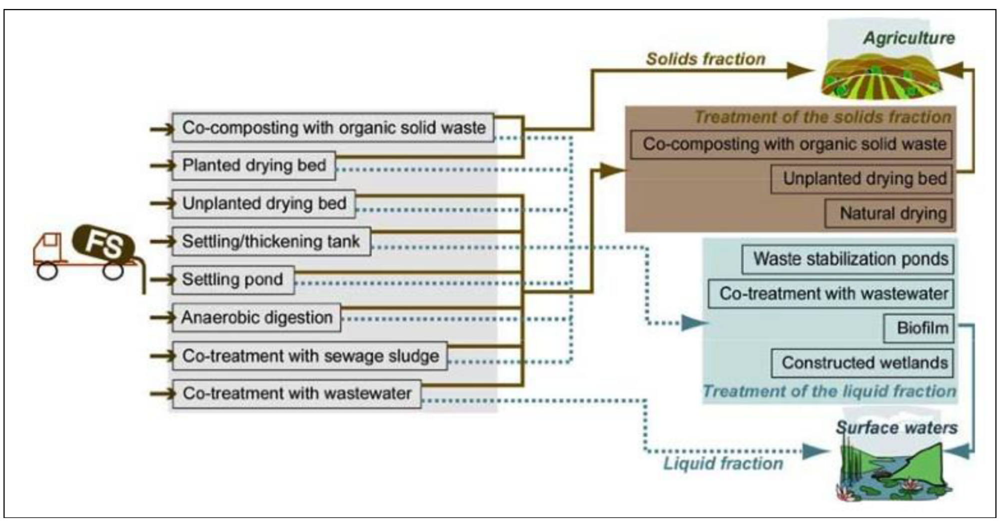


Figure 47: Septage Treatment Options[50]

[49] Source: Strande et al. (2014).

[50] Mbégueré (2016).

245. Septage contains large amounts of microorganisms, mainly originating from the faeces. These microorganisms can be pathogenic, and exposure to untreated septage constitutes a significant health risk to humans, either through direct contact, or through indirect exposure. Septage needs to be treated to an adequate hygienic level based on the disposal or reuse option.

246. Septage also contains significant concentrations of nutrients, which can be harnessed for beneficial resource recovery, but if not properly managed can result in environmental contamination. The nutrients in septage can supplement synthetic nitrogen-based fertilizers that are heavily dependent on fossil fuels and phosphorus, a mined resource with ever diminishing availability. Environmental impacts from nutrients include eutrophication and algal blooms in surface waters and contamination of drinking water (e.g. nitrates leading to methemoglobinemia).

247. Untreated septage has a high oxygen demand due to the presence of readily degradable organic matter that consumes significant amounts of oxygen during aerobic respiration. If septage is discharged to the environment in an uncontrolled way, it can result in depletion of oxygen in surface waters. The process of stabilisation results in a septage containing organic, carbon-based molecules that are not readily degradable, and which consists of more stable, complex molecules (e.g. cellulose and lignin). Stabilisation is achieved through the biodegradation of the more readily degradable molecules, resulting in a septage with a lower oxygen demand. A common indicator of stabilisation is a low BOD/COD ratio (say around 1/3-1/5). In addition, stabilisation ensures that organic forms of nutrients present in treatment end-products are stable and can be more predictably and reliably used. Stabilisation also reduces foaming of septage, leading to better dewatering.

D. Refurbishment of the Existing Talang Bakung Septage Treatment Plant

1. Refurbishment Approach

248. The Talang Bakung IPLT consists of a waste stabilization pond system (WSP) including an anaerobic pond and three trains of facultative and maturation ponds, preceded by solids separation chambers (SSCs) (Figure 48).

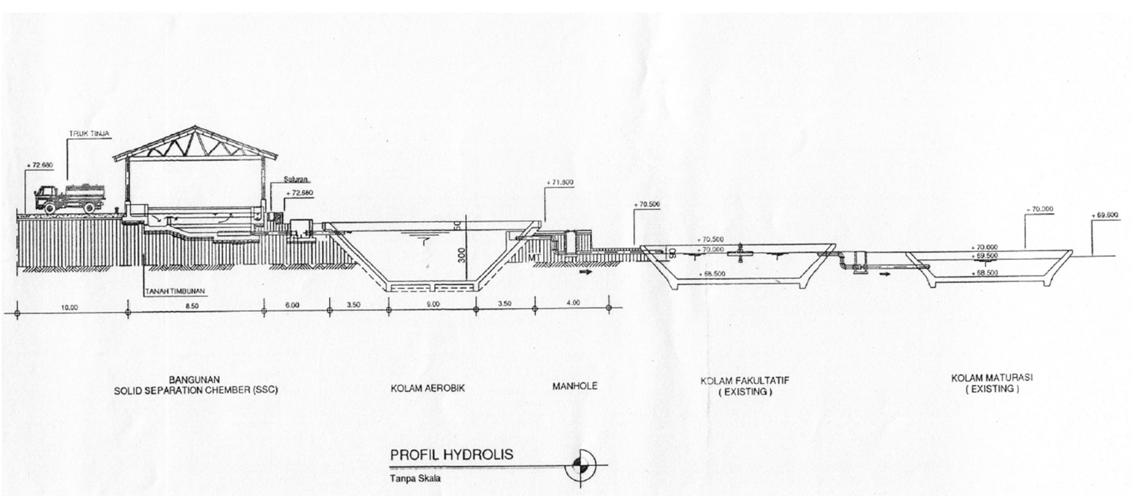


Figure 48: Hydraulic Profile of the Talang Bakung IPLT

249. Despite recent refurbishment works in 2015-2016 financed by the MPWH, the IPLT is currently non-functional as a septage treatment plant. This fact can be attributed essentially to the lack of understanding of the principle of septage treatment and sludge disposal and how this should be performed in the existing treatment system. WSPs are to treat water and not sludge. Settleable solids must be therefore separated in the pretreatment stage, at the SSCs, then thickened and transferred to the sludge drying beds, and only the supernatant water should be admitted to the actual WSP.

250. As envisaged in the assessment stage of this planning process and set out in Section C of Chapter VII above, the IPLT needs refurbishment to be put back into service. The main infrastructural and operational deficiencies to be restored are:

(i) the non-existent sludge removal at the so-called sludge separation chambers (SSC) due to design and maintenance problems;
(ii) the total inadequacy and the consequent state of disuse of the sludge drying beds;
(iii) the state of abandonment of the outlet pipe and the consequent complete lack of a plant effluent.

The necessary refurbishment works will be defined and pre-dimensioned in this section below. Furthermore, the study will also include the verification of the capacity of the WSP (facultative and maturation ponds) to comply with the new effluent limitations (MEF, 2016). The key assumptions to be used in these analyses are set out in Sections A and B above.

2. Remodelling of the Solids Separation Chambers

251. The Talang Bakung solids separation chambers (SSC) were implemented as part of the 2015-2016 refurbishment works (MPWH-SATKER Provinsi Jambi, 2016). The SSCs is made up of seven rectangular chambers 2.60 m wide, 7.25 m long and 1.70 m deep at their deeper end (inside dimensions), with a useful surface of 132 m^2 and a useful volume of approximately 190 m^3 (Figure 50). The SSCs are a modified version of the SSCs recommended in the MPWH regulation on wastewater management (PERMEN 04/PRT/M/2017, MPWH, 2017) shown in Figure 1Figure 51. This configuration comprises four chambers 3,00 m wide, 10,50 m long and a rather inclined bottom 2,85 m deep at the deeper end, with a useful surface of 126 m^2 and a useful volume of approximately 78 m^3.

252. As can be well appreciated in the cross section of the SSC (Figure 50, c), the modification introduced in the Talang Bakung structure consists in placing a 5 mm thick perforated fiberglass plate at 1 m below the upper edge of the chambers with the aim of retaining the solids (thickened sludge) above the plate and collect water at the bottom. Sludge is then conducted to the sludge drying beds and water to the anaerobic pond through the respective canals and pipelines. The solution was meant to turn upside-down the process recommended in the PERMEN, which is, by the way, the usual way to separate sludge from water in the so-called thickeners, as set out in Section C and shown in Figure 46 above.

253. This arrangement, however, has proven to be a failure. The perforations of the plate became clogged, water was retained in the chambers together with sludge and, finally, as can be seen in the photos of Figure 35, the plates were removed and all the sludge was being conducted to the anaerobic pond and, from there, to the facultative ponds (Figure 34). At the moment, the SSCs are practically non-functional: they receive the load of a few trucks per day (two on the average) but septage just flows through the chambers without any separative function whatsoever.

254. The proposed refurbishment of the SSCs would therefore consist basically in removing the fiberglass plates permanently and setting up the arrangement recommended in the PERMEN: collect thickened sludge at the bottom through the pipes that were to convey water and, vice versa, collect supernatant water at the upper part through the holes, canal and pipes that were to convey sludge according to the original design. It is to be highlighted that supernatant water outlets from the chambers should be located above the sludge blanket and below the scum layer, as indicated in Figure 46.

255. It is understood that the suggested refurbishment is relatively simple to perform, as it would require only minor plumbing and masonry works to be defined at the detailed design stage. These would consist of revising and, if necessary, reshaping the sludge and water outlets from the chambers and installing new pipeline connections: the sludge pipe to the sludge drying beds and the water pipe both to the anaerobic pond and directly to the facultative ponds, allowing to by-pass the anaerobic pond, whenever it proves appropriate (see Section 4 below). Thickened sludge will be conveyed to new sludge drying beds to be situated below the platform on which the SSCs (and the anaerobic pond) are located ca. 1.50 m above the future ponds, which should allow a gravity feed.

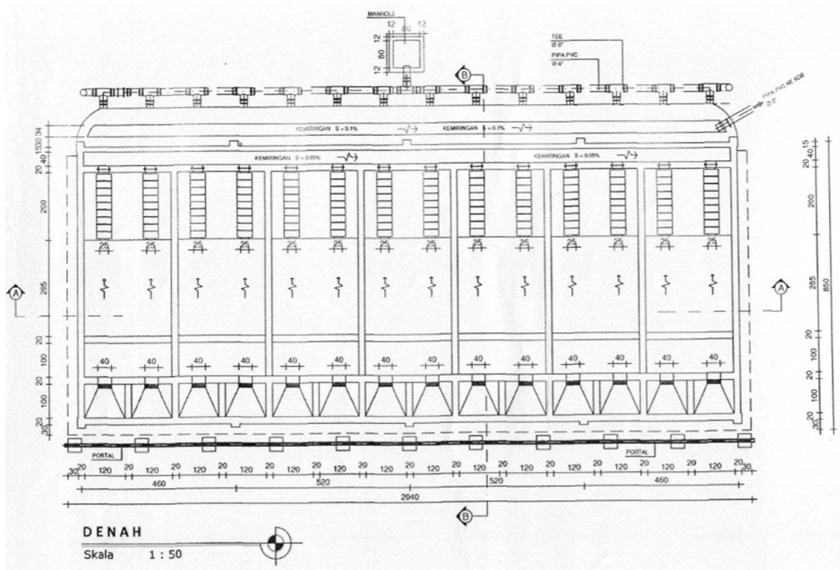
256. It should be noted, finally, that an advanced though substantially more costly alternative could consist in installing an electromechanical sludge thickener similar to what is proposed for the Kasang WWTP (Section C.1 and Figure 59 below).

3. Verification of Design Parameters of the Solids Separation Chambers[51]

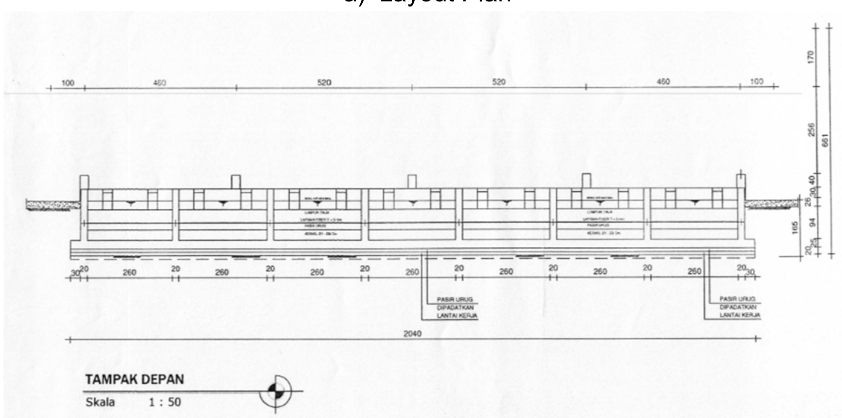
257. The design of settling-thickening tanks involves calculating the basin surface, the zone volumes and the hydraulic configurations. In a real-life situation, sufficient preliminary studies are needed to allow for the specific design according to the local context characteristics. Apart from the basic determinations (TS, TSS, BOD_5, COD, NH_4 and NT), the most important parameter to follow in a septage treatment plant (IPLT) is the sludge volume index (SVI). This is a laboratory method to empirically determine the settling ability of sludge based on the amount of suspended solids that settle out during a specified amount of time using a so-called Imhoff cone (Figure 49). This method, however, has never been used at the Jambi IPLT.

Figure 49: Imhoff Cones To Be Used for Determination of Sludge Volume Index

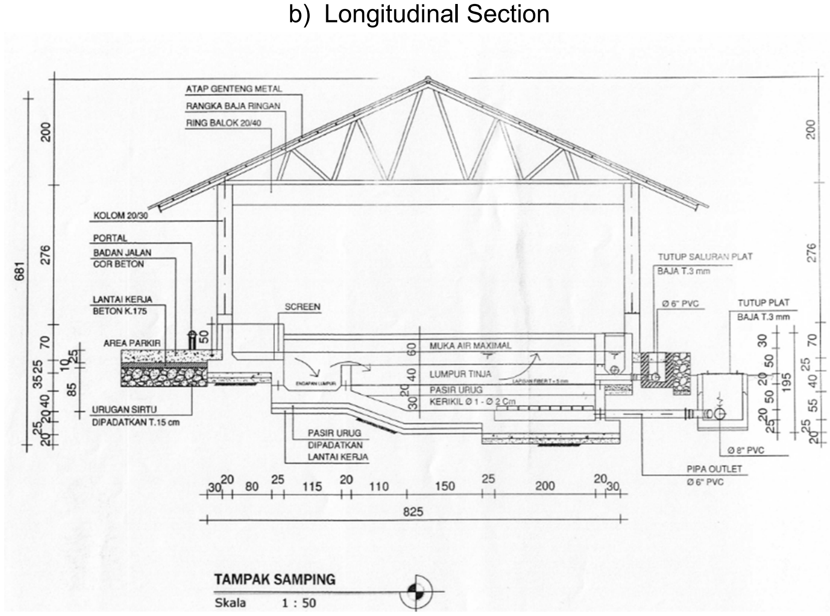
[51] Based upon Strande et al. (2014), Sections 6.5-6.7, pp. 135-138.



a) Layout Plan

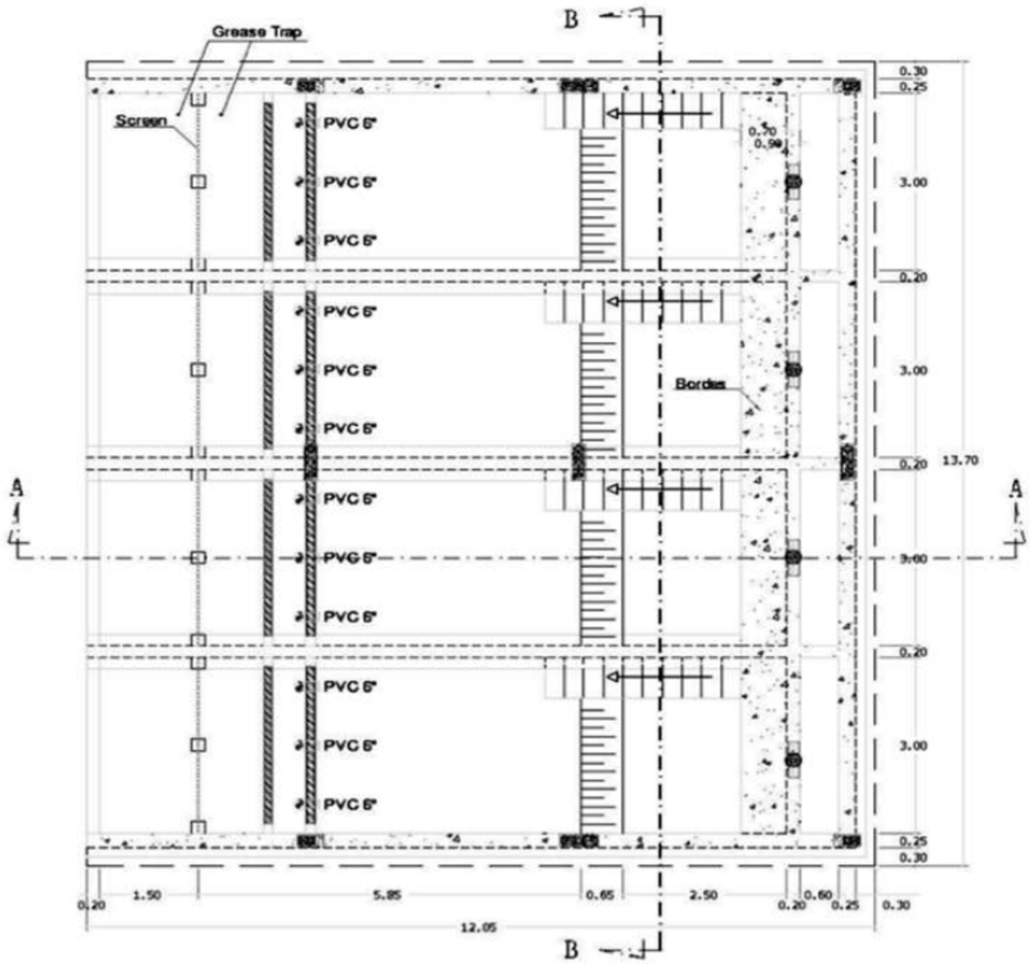


b) Longitudinal Section

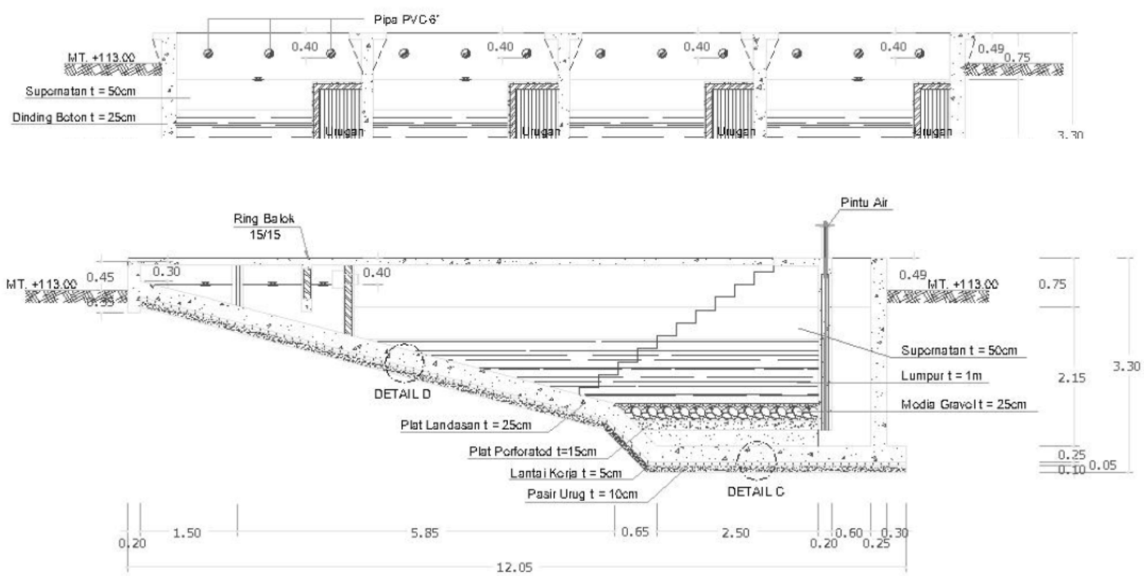


c) Cross Section

Figure 50: Solids Separation Chambers at the Talang Bakung IPLT



a) Layout Plan



b) Longitudinal and Cross Sections

Figure 51: Solids Separation Chambers According to PERMEN 04/PRT/M/2017

258. The basic design data and key assumptions are as follows:

(i) Design data:

- Influent flow: $Q = 80\ m^3/day$
- Initial raw septage concentration:
  $C_{i(TS)} = 15$ g TS/l;
  $C_{i(TSS)} = 5$ g TSS/l.
- Septage origin: Mainly septic tanks (stabilized septage).
- Total volatile solids percentage < 70%.
- IPLT opening time: 8 h/day, 5 days/week, 52 weeks/year.
- Daily peak flow coefficient: C_p=1.6 (peak flow is often in the morning, after the first trucks rotation).

(ii) Key assumptions based on results taken from specialized literature:

- Concentration of thickened sludge (1 l Imhoff cones): C_t = 60 g TSS/l (6% dryness).
- Settling ability (1 l Imhoff cones): good (SVI = 23 << 100).
- Final settling velocity, V_c = 0.5 m/h based on SVI tests and experience.
- Expected settling efficiency, e = 80% of TSS (in the literature often 60% is considered more realistic).
- The number of parallel tanks (seven) allows the cleaning of 2-3 during the loading of the remaining ones.
- Short compaction period of 2-3 days; hence, the removal of thickened sludge and scum occurs every 10 days by gravity, as the thickened sludge is still sufficiently liquid.
- The operator has experience in wastewater treatment and therefore the thickened sludge emptying and tank cleaning is likely to be carried out correctly.

259. The tank surface (S) needed to allow for the selected final settling velocity (V_c) is estimated based on the influent peak flow (Q_p) as shown in the following equations:

- $Qp = Q\ .\ C_p / 8 = 16\ m^3/h$, where 8 = number of IPLT opening hours per day.
- $S = Q_p / V_c = 32\ m^2$, meaning that to achieve the settling velocity, two chambers of 2.6 x 7.25 m = 18.85 m^2 should be used together.

260. The thickening zone volume is calculated as follows:

The daily TSS quantity of septage discharged (M) is calculated from the initial septage concentration (C_i):

- $M = Q \times C_{i(TSS)}$ = 400 kg TSS/day.
- The daily SS mass of thickened sludge (M_t) is then deduced from the TSS settling efficiency (e): $M_t = M \times e$ = 320 kg TSS/day, where e = 80%.
- The volume of the thickening sludge storage zone (V_t) is related to the mass of the particles trapped in the thickening zone (M_t) and the TSS concentration achieved in the thickened sludge (C_t = 60%): $V_t = M_t \times N / C_t = 27\ m^3$.

261. The following design characteristics should be ensured for each zone of Figure 46:

- Scum zone: 0.4 m (based on a 1-week cycle);
- Supernatant zone: 0.5 m (Heinss et al., 1998);
- Thickening sludge zone: 0.70 m (based on 27 m^3 storage in a 38 m^2 double tank).

These layers can be readily ensured at the remodelled SSCs by fixing adequately the supernatant water outlet and controlling sludge extraction.

262. The mass flow analysis of septage treatment at the Talang Bakung IPLT, i.e. the distribution of flows and solids between the Sludge Drying Beds (SDBs) and the Waste Stabilization Ponds (WSP) is as follows:

- Inlet: 80 m^3/day and 5 g TSS/l, 104 t TSS/year.
- Solids separation chambers (SSC): 60% of TSS removal.
- Supernatant to further treatment in WSPs: 76 m^3/day at 2 g TSS/l.
- Thickened sludge to further treatment in SDBs: 20 m^3/week at 60 g TSS/l, 62 t TSS/year.

4. Sludge Drying Beds

263. As described in the assessment stage, the sludge drying beds (SDBs) of the Talang Bakung IPLT are too small, practically inaccessible with machinery and, as a consequence, completely out of service (Figure 36). The installation is full of dry sludge that has not been emptied for months, if it has ever been at all (Figure 52). These pictures show by themselves the failure of treatment at the Talang Bakung IPLT and the total lack of sludge output: little dry sludge is produced but, as no final disposal sites have been defined, even this little has no possibility to arrive at its final destination.

Figure 52: Dry Sludge Accumulated in the Sludge Dying Beds at the Talang Bakung IPLT

264. This situation can give rise to another reflection: septage treatment is not an aim in itself. The aim is safe and environmental friendly disposal of septage. The difference between liquid and dry septage is water (and the die off of pathogens), so if the UPTD-PAL has no means to extract and transfer dry sludge to trucks and transport it to the final disposal sites, they might opt for the land application of liquid septage, as explained in Section F below.

265. Nevertheless, the SDBs are the most important link of the septage treatment chain for they are the last one before the final product, the dried sludge, leaves the plant for its final disposal and/or, as will be seen in Sections E below, its reuse on agricultural land. It is considered that the current undersized and ill-conceived facility cannot readily be refurbished and therefore it is proposed to build new and appropriate SDBs on the land of roughly 40x60 m, i.e. an area of 2,400 m^2, available within the IPLT parcel between the anaerobic and the waste treatment ponds (see Figure 32).

266. Sludge dying beds (SDBs) can be either unplanted or planted. Unplanted SDBs are shallow filters filled with sand and gravel with a drain at the bottom to collect leachate (Figure 53, a). Sludge is discharged onto the surface for dewatering. The drying process in an SDB is based on drainage of liquid through the sand and gravel to the bottom of the bed, and evaporation of water from the surface of the sludge to the air. Planted drying beds (PDBs), also sometimes referred to as planted dewatering beds, vertical-flow constructed wetlands and sludge drying reed beds, are beds of porous media (e.g. sand and gravel) that are planted with emergent macrophytes (Figure 53, b). PDBs are loaded with layers of sludge that are subsequently dewatered and stabilized through multiple physical and biological mechanisms.

267. Planted SDBs require specific skills both for the implementation and the operation, therefore, it is proposed, initially to set up unplanted SDBs at the Talang Bakung IPLT. A pre-dimensioning of this facility is included as follows.

a) Unplanted

b) Planted

Figure 53: Sludge Drying Beds

268. The basic design data and key assumptions are as follows:

(i) Design data (from Section D.4 above):
- Sludge characteristics: thickened sludge of mostly stabilized septage, transferred from SSCs via gravity pipes.
- Thickened sludge flow: 20 m^3/week.
- Solids concentration: 60 g TSS/l, equivalent to 62 t TSS/year (52 weeks per year).
- Solids concentration in terms of TS (3 times TSS): 180 g TS/l, equivalent to 187 t TS/year.

(ii) Key assumptions (based on Strande et al., 2014, Table 7.1, p. 144):
- Sizing of the beds: 25 – 30 cm sludge layer on beds.
- Application rate: 100-200 kg TS/m^2/year (TS stands for total solids).
- Drying bed removal efficiency: 97% SS (suspended solids), 90% COD (chemical oxygen demand), 100% HE (helminth eggs).
- Dry sludge production: 0.1 m^3 per m^3 fresh septage.
- Sand characteristics: sand particles do not crumble; sand easily available locally; sand thoroughly washed prior to application onto the gravel base.
- Leachate characteristics: quality fairly comparable to tropical wastewater; salinity too high for irrigation.

269. Based on these data and assumptions, the necessary area for the SDBs at the Talang Bakung IPLT are 187 t TS/year / 200 kg TS/m^2/year = 935 m^2. The surface area adopted is 20 x 50 m = 1,000 m^2, implemented in the zone available at the IPLT parcel and highlighted in green on Figure 54. It is proposed to build 5 beds of 10 x 20 m, with a typical cross section shown in Figure 55.

270. Another result to underline is that the daily dry sludge output of the IPLT would be approximately 0.1 m^3 per m^3 fresh septage, i.e. 8 m^3 dry sludge per day the UPTD-PAL will have to dispose in an appropriate manner as set forth in Sections F and G below.

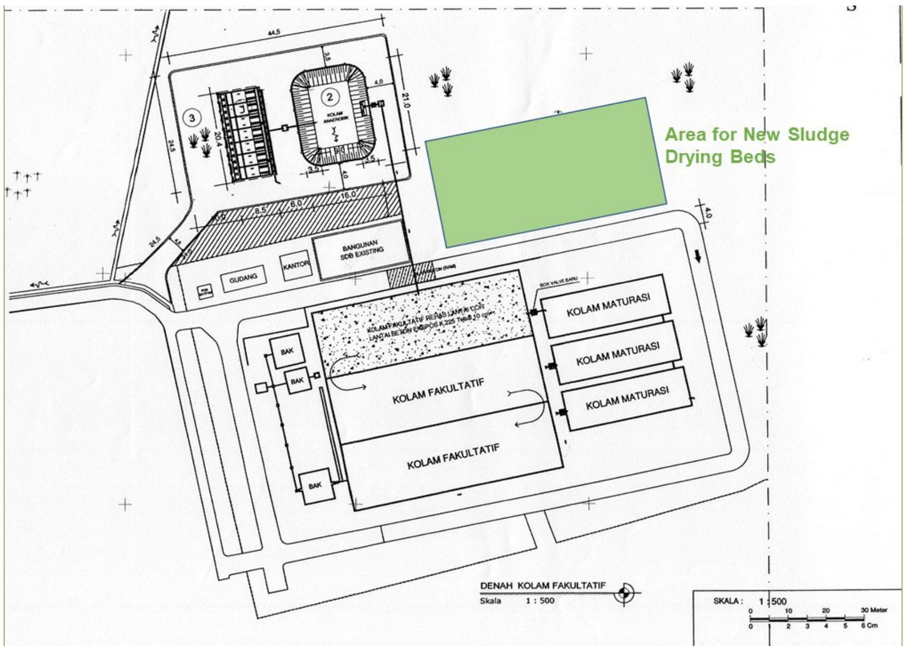


Figure 54: Location of New Sludge Drying Beds at the Talang Bakung IPLT

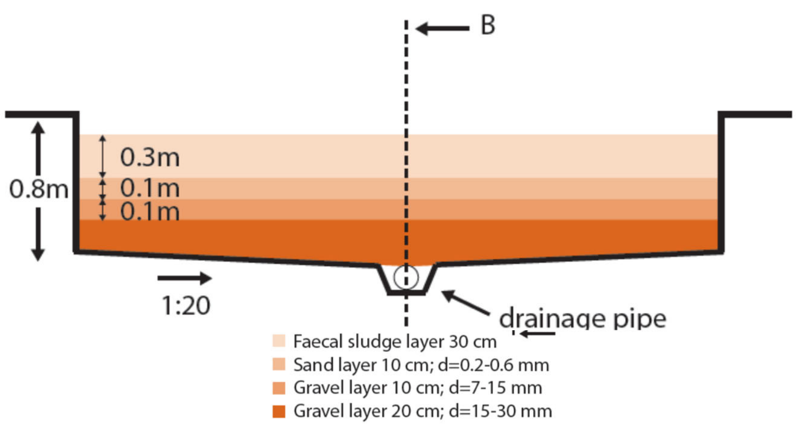


Figure 55: Typical Cross Section of an Unplanted Sludge Drying Bed

5. Waste Stabilization Ponds

271. After the solids settling and thickening at the Solids Separation Chambers (SSCs) further treatment is performed in a waste stabilization pond system (WSP) comprising three trains of facultative and maturation ponds preceded by an anaerobic pond. It is a somewhat simplified

version of the arrangement specified in an Indonesian technical guidance of 1999 titled Procedures for the design of septage treatment pond systems (Figure 31 and Figure 32). The hydraulic profile of the WSP system is shown in Figure 48.

272. The facultative and maturation ponds were built in 1996, while the anaerobic pond was added in the framework of the 2015-2016 refurbishment works, which included also the relining of the facultative and maturation ponds (Figure 33). As said in the assessment stage, the physical state of the ponds is fairly good, but no actual wastewater treatment is taking place due to the deficient solids separation and the ponds are used as nothing but sludge storage basins without any particular operation.

273. WSP systems are essentially conceived to treat wastewater. Septage, however, typically exhibits total (TS) and suspended solids (TSS) contents, which are very high compared to wastewater. When treating septage in ponds, be it separately or in conjunction with wastewater, settleable solids must be separated in primary treatment units, such as the solids separation chambers (SSCs) described and analysed above, in order to guarantee an undisturbed treatment of the liquid fraction (Strauss et al., 2000). It is therefore important to underline that only supernatant water should be admitted into the WSP. As this is not happening at the IPLT, the current treatment process is greatly disturbed.

274. The different pods have the following characteristics and dimensions:

(i) Anaerobic pond:
- 1 unit.
- Dimensions: 16 x 21 m at ground level, 9 x 14 m at the base, 3.5 m deep with 1:1 slopes.
- Reinforced concrete lining structure on piles.
- Volume: 779 m^3.
- Retention time for 76 m^3/day supernatant water flow: roughly 10 days.

(ii) Facultative ponds:
- 3 units.
- Dimensions: 3 x 56 x 18 m at ground level, 3 x 51 x 15 m at the base, 1.5 m deep with a 1:1 slope.
- Relined with concrete within the refurbishment works.
- Surface: 3,024 m^2.
- Volume: 3 x 1,326 m^3 = 3,977 m^3.
- Retention time for 76 m^3/day supernatant water flow: roughly 52 days.

(iii) Maturation ponds:
- 3 units.
- Dimensions: 3 x 34 x 11 m at ground level, 3 x 32 x 9 m at the base, 1.0 m deep with 1:1 slopes.
- Relined with concrete within the refurbishment works.
- Surface: 1,122 m^2.
- Volume: 3 x 1,326 m^3 = 3,977 m^3.
- Retention time for 76 m^3/day supernatant water flow: roughly 4 days.

275. Waste stabilisation ponds are designed for organic loading rates. Anaerobic ponds between 2-3 m depth, remove 60-70 % of BOD and produce limited odour when loaded with

250-350 g BOD_5/m^3/day. Facultative ponds are 1-2 m deep and should be loaded with 350 kg BOD/ha/day (35 g BOD_5/m^2/day). Following experiences taken from the literature (Strauss et al., 2000), a significant BOD_5 removal is taking place in the settling-thickening tanks. Supposing a 60% removal in the SSCs of the Talang Bakung IPLT, the resulting BOD_5 in the supernatant water would be 400 mg/l, i.e. 30,400 g/day for 76 m^3/day supernatant water flow. This would give 10 g BOD_5/m^2/day for the facultative ponds and a very low value, 39 g BOD_5/m^3/day for the anaerobic ponds.

276. In consequence, the WSP characteristics comply with the criteria set forth in the specialized literature (Strande et al., 2014, Section 5.3.2, pp. 102-103) and are capable of providing adequate treatment of the supernatant water. It is necessary to insist, however, that they can only be used for the treatment of the effluent following solid-liquid separation of septage in the solids separation chambers.

277. Additionally, the need for anaerobic treatment of supernatant water should be examined with more accurate treatment studies, as septage in Jambi, such as in many other cities in Indonesia, may not be but little digestible having undergone extensive storage before collection (Strauss et al., 2000). At the same time, the possibility of using this pond as interim storage for land application of liquid septage could also be considered (see Section G below) .

6. Effluent Outlet Pipe

278. The effluent outlet pipe is currently abandoned and was not replaced as part of the refurbishment works. Actually, with the current way of functioning, there is practically no effluent discharged from the plant and the outer end of the maturation ponds is surrounded by a swampy area with no channel or watercourse to be seen (Figure 37). Occasional discharges from the plant (most likely containing solids) are reported to cause nuisance in the nearby kampung resulting in protests from the neighbours.

279. It is therefore necessary to restore the effluent outlet pipe and lengthen it some hundred meters until the nearest channel or watercourse, most likely a tributary of the nearest significant watercourse of the region, Sungai Terap, affluent of Sungai Kumpeh, which is at a distance of about 2 km.

E. Septage Treatment at the Future Kasang Wastewater Treatment Plant

1. Treatment Options and Allowable Loads

280. As set out in Section C above, co-treatment of septage at the future Kasang Wastewater Treatment Plant (WWTP or IPAL) is a reasonable option and even a necessary option for the quantities of septage that cannot be admitted to the Talang Bakung IPLT.

281. Co-treatment simply means treating septage along with wastewater at a wastewater treatment plant. It is an option which can be considered in Indonesia: since as most WWTPs are underutilized, adding septage into existing WWTPs can be a quick solution to the safe management of septage. provided the characteristics of the septage are known, it is diluted with sewage to avoid shock load, and the STP has enough capacity to take the extra load. Broadly, co-treatment can be carried out in two ways:

(i) Septage directly mixed with sewage, incorporating it into the so-called water train, i.e. co-treatment with sewer-based wastewater treatment technologies.
(ii) Septage treated with the sludge of a WWTP, incorporating it into the so-called solids handling or sludge train.

282. It is, however, common knowledge that many wastewater treatment plants in low-income countries have failed, and improper co-treatment with septage has even been the cause of some failures. WWTPs are typically not designed for septage loadings, and process disruptions and failures are frequently observed. Common problems with co-treatment of septage in WWTPs range from the deterioration of the treated effluent quality to overloading tanks and inadequate aeration (Strande et al., 2014, p. 178). Despite the potential operational problems, certain guidelines indicate that low volumes of septage can be co-treated in municipal WWTP water trains.

283. Thus, the Handbook of the Water and Sanitation Operator (Memento de l'exploitant des eaux et de l'assainissement) of the large French private water and environmental utility Lyonnaise des Eaux, now Suez Environnement (Valiron, 1987, p. 444), recommends that a maximum 20% of the total pollutant load, i.e. roughly 2% of the total influent flow can be admitted to the water train of a wastewater treatment plant.

284. The USEPA Guide to Septage Management and Disposal (1994, pp. 35-36) provides a chart (Figure 56) to estimate the allowable rates of septage addition, assuming that a holding (equalizing) tank is provided and that septage is added to the sewage on a semicontinuous basis. This chart takes into account the current loadings to the plant compared with its design loadings. Package plants or other activated sludge processes that do not employ primary treatment are the least amenable to septage handling while aerated lagoons are capable of receiving more quantities. Thus, an aerated lagoon system, operating at 50% of capacity (which might well be the case of the Kasang WWTP in a few years) could receive a septage flow of 1.8% of design capacity. Allowable septage volumes may be reduced due to septage characteristics, treatment plant operations, and sewage flow patterns. Moreover, a factor of safety should always be included in establishing allowable septage volumes. This chart has also been recommended by several other guidelines and manuals, mainly in India (NUSP, 2013).

285. The comprehensive Faecal Sludge Management book (Strande et al., 2014) is, however, rather prudent concerning direct treatment of septage in the water train of a WWTP, warning that the discharge of septage for its co-treatment in WWTPs can lead to severe operational problems when even low volumes of high-strength fresh septage are discharged (e.g. 0.25% of the total influent). This is mainly caused by the relatively higher strength of septage compared to that of municipal wastewater, which can easily lead to higher loads exceeding the plant capacity. The most common problems are the overloading of solids, COD or nitrogen compounds. They can lead to serious operational problems ranging from incomplete removal of organics to cessation of nitrification, which can take several weeks to recover. Therefore, if in spite of the apparent limited benefits, septage co-treatment is to be practiced in municipal WWTPs, the allowable septage volumes will probably need to be restricted to rather low volumes so that WWTPs do not get overloaded with total suspended solids, high COD and nitrogen loadings or high concentrations of toxic or inhibitory compounds. Moreover, septage loadings need to be added gradually and as slowly as possible to avoid overloads and shocks.

All the previous aspects need to be carefully addressed but, overall, the benefits do not seem to be attractive enough to support the co-treatment of septage with wastewater in municipal WWTPs as a predominant method, particularly when dealing with digested septic tanks from septic tanks which contains low concentrations of biodegradable compounds but high concentrations of solids that will tend to overload the treatment systems.

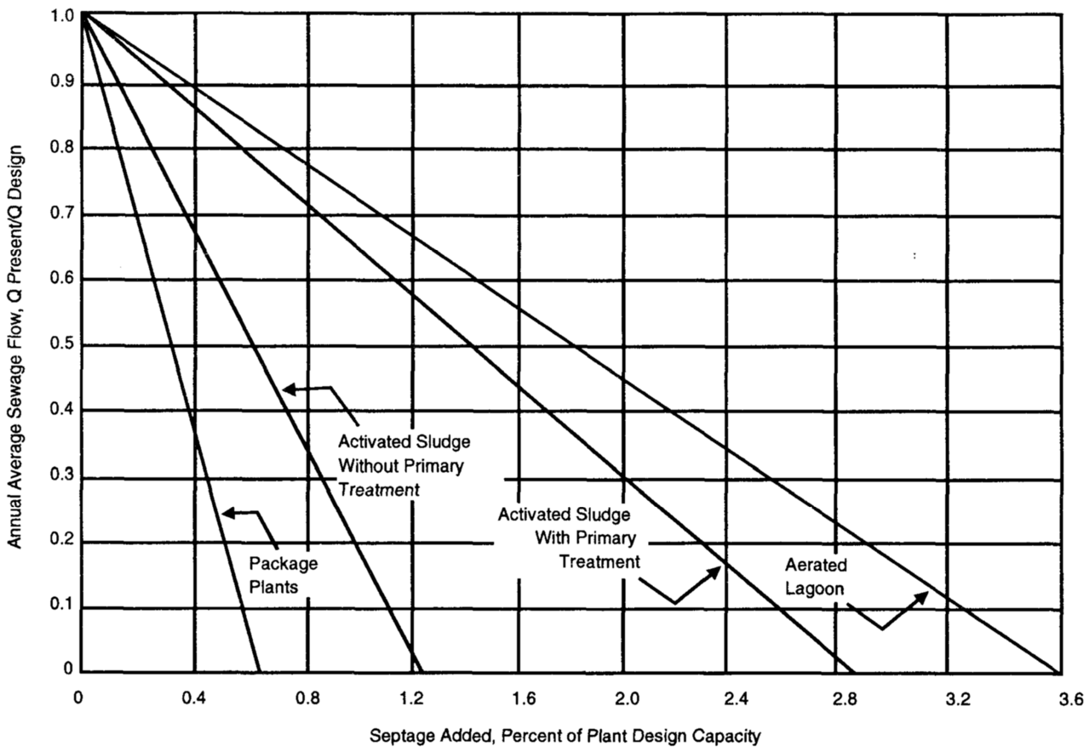


Figure 56: Allowable Septage Loadings to a Wastewater Treatment Plant[52]

286. Due to the above-mentioned operational difficulties, co-treatment of septage with wastewater is not recommended for many cases, at least not in the water train. If a co-management option is desired, a better option would be co-management of septage with the sludge produced during wastewater treatment (i.e. biosolids). Therefore, instead of directly discharging septage into the plant headworks, a better practice would be installing a solids separation unit, and then treat the liquid fraction together with wastewater and the solids fraction with the sludge treatment train. This strategy allows a higher quantity of septage to be admitted into the WWTP, as the organic load of the liquid fraction is 7 to 10 times lower than that of the raw septage. The global scheme of a complete sludge/septage treatment facility is presented in the chart of Figure 57.

[52] Source: USEPA, 1994, Part III, Section 10.1, p. 36.

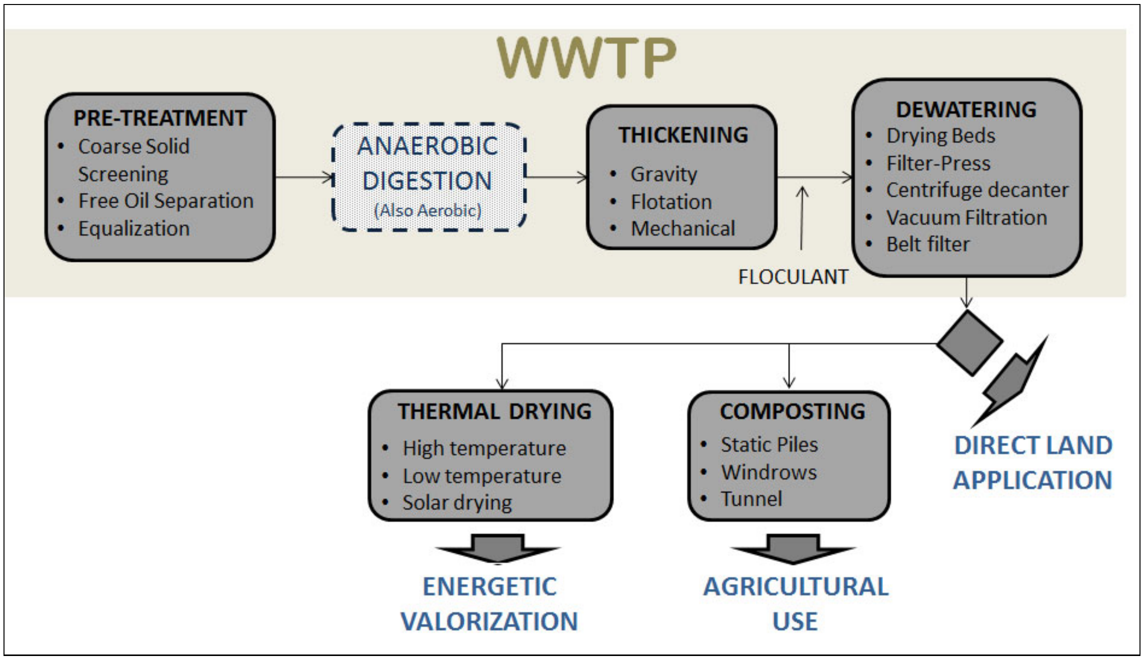


Figure 57: Sludge/Septage Treatment Processes at a WWTP[53]

2. Septage Treatment in the Water Train of the Kasang WWTP

287. Based on the design parameters taken from the detailed design review and the above-mentioned criteria, the calculation of the allowable septage flow to the water train of Kasang WWTP is performed in Table 14 below using the following two different criteria:

(i) USEPA (Figure 56): 1.8% of design flow (aerated lagoon operating at 50% of design flow).

(ii) Lyonnaise des Eaux (LdE): 10% of total pollutant load.

Table 14: Calculation of Allowable Septage to the Water Train of the Kasang WWTP

Stage	No. Connections	Design Flow (m^3/day)	Pollutant Load ($kgDBO_5$/day)	Allowable Septage Flow (m^3/day)	
				USEPA	LdE
Stage 1	11,000	7,650	1,530	138	153
Stage 2	3,700	2,750	550	49	55
Total	**14,000**	**10,400**	**2,080**	**187**	**203**

288. This means that roughly an additional 150 m^3/day of septage could be treated at the Kasang WWTP by incorporating this flow into the water train provided that the plant inflow does not exceed 50% of the design flow. It is assumed that this will not happen at least during the first 4-5 years after the start-up of the WWTP. This result also means that the lacking septage treatment capacity could be resolved at the WWTP.

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[53] Source: IDOM.

289. To do this, a septage receiving facility should be installed near the plant headwork including a septage holding or equalization tank. Such receiving facilities vary in design depending on the volume of septage received, the location of the facility, and the method for processing the septage. Essential elements of a septage receiving station include a concrete pad, an inlet box, pipe, and/or quick-disconnect fitting to receive the septage, a trash rack to remove rags and debris, and wash-down facilities (USEPA, 1994, Part III, p. 26). Other features include holding tanks or systems designed for finer screening and/or grit removal, metering, and odour control. A typical layout of the septage receiving station is shown in Figure 58.

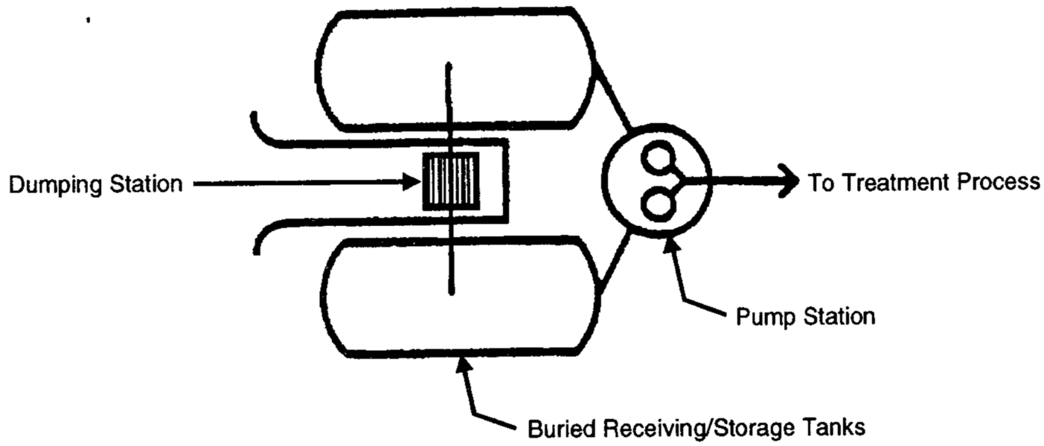

Figure 58: Septage Receiving Facility with Holding Tanks[54]

290. As shown in this section, the Kasang WWTP could, in theory, receive the excess quantities of 150 m^3/day by incorporating them into the water train of the plant through a receiving station. As explained in Section 1 above, however, this practice is liable of disrupting the treatment process in WWTPs. Moreover, septage has very similar characteristics to sewage sludge. For these two reasons, it is reasonable and preferable to co-treat septage with the sludge produced in the WWTP incorporating it into the solids handling or sludge train, in accordance with Figure 57. This option will be set forth in the next section.

3. Septage Treatment in the Sludge Train of the Kasang WWTP[55]

291. There are now specific criteria for allowable septage quantities to a sludge train of a WWTP. Allowable loadings must be estimated based on site-specific information and will vary depending on both the existing solids handling processes used at the plant and their design capacity.

[54] Source: USEPA (1994), Part III, p. 27.

[55] Based on the CDTA report Study on the Septage Treatment Capacity of the WWTP in Palembang, Pekanbaru, Jambi and Makassar, Oct. 2015.

292. Therefore, it is recommended to install a specific solids separation unit at the receiving station. This unit should provide basically grit removal and thickening, and include:

(i) A screening and/or grit removal unit.
(ii) A thickening unit usually consisting of a mechanical device that provides a solid fraction above 4% dryness.
(iii) A system of conveyors or sludge pumps to transport the solid fraction directly to the drying beds.
(iv) In some cases, when dewatering is performed with mechanical devices, such as press or belt filters or a centrifuge, a flocculation unit is required to prepare solids prior to their dewatering.

293. Typical equipment of this kind is shown in Figure 59. It is to be noted that a Rotamat ® Ro32 by Huber is currently installed at the Bekasi IPLT.

294. This solids separation process allows to reduce the organic pollutant load of the liquid fraction up to 30-35% of the total inlet (similar to the rates obtained for wastewater in a primary settling tank). Thus, the expected content of BOD5 in the liquid fraction of septage would be around 650-700 mg/l.

295. Thus, considering the same assumptions made in Table 14 above, but simply changing the values of BOD loading input into the facility, the septage quantities allowable to the Kasang WWTP are shown in Table 15:

Table 15: Calculation of Allowable Septage to the Sludge Train of the Kasang WWTP

Stage	No. Connections	Design Flow (m^3/day)	Pollutant Load (kgDBO_5/day)	Allowable Septage Flow (m^3/day)	Allowable Trucks (Unit/day)
Stage 1	11,000	7,650	1,530	204	73
Stage 2	3,700	2,750	550	73	26
Total	**14,000**	**10,400**	**2,080**	**277**	**99**

296. These results indicate that the option of incorporating septage into the solids handling train by installing a solids separation equipment would provide an excess capacity at the Kasang WWTP even at Stage 1 without disturbing the wastewater treatment process as only the liquid fraction is introduced into the water treatment train of the plant.

WASTEMASTER® TSB1 by WAM

For pre-treatment of septage or industrial plants collected by special purge tankers. It carries out two different processes: separation of solids in effluents as well as de-watering and compacting of the extracted solids.

NTO-Comes S.A

Screening technology for septage, based upon the use of different kinds of endless screw, capable to separate solid from liquid and adding a thickening effect on the solid part.

ROTAMAT® Ro32 by HUBER

Screening technology and sand separation unit for septage. It can include a liquid-solid separation and thickening process for separated solids.

ULTRAPURE Tech by HIDRO WATER

Compact and robust septage technology including screening, sand and grit separation and waste removal. Trucks can be directly discharged into the vessel, lowering operational response times.

Figure 59: Septage Pretreatment Equipment

F. Final Disposal and/or Reuse of Treated Septage Sludge

297. Septage and/or treated sludge must be disposed of in manner that poses no threat to public health and the environment. The most common disposal of septage and wastewater sludge has been to apply it to agricultural fields, forest land and reclamation sites as a soil conditioner and organic fertiliser, since excreta contain essential plant nutrients and organic matter that increases the water retaining capacity of soils. There are also several other options

that allow for resource recovery, such as production of biogas during anaerobic digestion of septage, with the remaining sludge also being used as a soil conditioner, and recovery of end products as a biofuel, for example pyrolysis, gasification, incineration and co-combustion.

298. Using septage as a soil amendment has many benefits over using chemical fertilisers alone. Organic matter in septage can increase soil water holding capacity, build structure, reduce erosion and provide a source of slowly released nutrients. When using septage as a soil conditioner, the fate of and exposure to pathogens and heavy metals needs to be taken into consideration, and social acceptance should also be considered. Other factors that need to be considered include nutrients, which may or may not be available in the ratio required by soil and crop systems.

299. Septage contains large amounts of microorganisms, mainly originating from the faeces. The microorganisms can be pathogenic, and exposure to untreated septage constitutes a significant health risk to humans, either through direct contact, or through indirect exposure. Pathogens are transmitted and spread through the faecal-oral cycle, which includes different stages and hosts: pathogen-containing faeces → water or food contamination → oral ingestion → infected individual → pathogen-containing faeces, etc. The faecal-oral transmission cycle of pathogens can be interrupted by putting barriers in place to block transmission paths and prevent cycle completion. The first barrier for beneficial use is provided by the level of pathogen reduction achieved through septage treatment. Further post-treatment barriers may include restriction of use on crops that are eaten raw, withholding periods between application and harvest to allow pathogen die-off, drip or subsurface irrigation methods, restricting worker and public access during application, use of personal protective equipment and safe food preparation methods such as thorough cooking, washing or peeling.

300. In the absence of Indonesian regulations, the USEPA federal guidelines can be used for monitoring pathogens in dried septage sludge to be used as a fertilizer in agriculture. According to these, dried sludge should satisfy criteria of Class A Biosolids:

(i) Fecal coliform density < 1000 MPN/g total dry solids.
(ii) Salmonella sp. Density < 3MPN/4g total dry solids
(iii) Helminth egg concentration < 1/g total dry solids (WHO, 2006).
(iv) E. Coli of 1000/g total solids (WHO, 2006).

301. Heavy metals are a concern due to their toxicity and long-term negative effects on soils. Heavy metals should be evaluated on a case by case basis but are only a major concern if septage is mixed with industrial effluents that are not adequately pretreated, which is not the case of Jambi for the time being. Heavy metals can also enter the system at the household level through the relatively common practice of improper disposal of wastes containing heavy metals (e.g. batteries, solvents, paints) into the system.

302. Another important factor that need to be considered includes nutrients, which may or may not be available in the ratio required by soil and crop systems, generally in excess. Therefore, nutrients and, basically, nitrogen is the main limiting factor for land application of septage and sewage sludge. It is therefore important to determine the appropriate agronomic rate for the land application of treated sludge to maximise benefits, and to prevent environmental contamination from excessive application of nutrients. Nutrients in sludge are present in both organic and inorganic forms. Inorganic forms are more readily available than organic nutrients for plants and microbes to assimilate (e.g. NH_4/NH_3, NO_3). Nutrients bound to organic matter

are slowly released over time through mineralisation to become biologically available. If nitrogen is applied in excess of plant and soil microbial demand, ammonia can be lost due to volatilisation, and nitrates by leaching through the soil profile. Leaching can lead to the eutrophication of surface waters, and nitrate contamination of drinking water.

303. Many countries have set limits for the land application of septage and sewage sludge (e.g. South Africa and China). However, these are typically the maximum allowed rates (i.e. the volume of septage allowed per land area). Estimates for rates of land application can be based on experience; for example, it is estimated that 56 m^3 of septage are required to fertilize one hectare of land when cultivating cereal crops such as maize, millet and sorghum in tropical climates (Strande et al., 2014).

304. The key elements of a successful operation and maintenance (O&M) program for a septage land application site are as follows:

- (i) Provision of septage receiving and holding facilities to provide operational flexibility (optional).
- (ii) Proper septage treatment prior to application as required to meet national regulations, whenever available. Need for treatment depends basically on requirements of application method.
- (iii) Control of septage application rates and conditions in accordance with national regulations or, in their absence, reliable international rules, such as those of USEPA.
- (iv) Availability and proper operation and maintenance of the application equipment adequate for the application method.
- (v) Monitoring of septage volumes and characteristics, soil, plants, surface water, and ground water as required by national regulations or, in their absence, reliable international rules, such as those of USEPA.
- (vi) Odour control.
- (vii) Good recordkeeping and retention for at least 5 years.

305. The use of septage as a soil conditioner can range from untreated septage to bagged compost that is sold as a commercial product for household level use in horticulture. The most common form of reuse, however, is dried sludge produced in sludge drying beds (or by more sophisticated electromechanical dewatering equipment) in WWTPs, and this is the type of sludge both the Talang Bakung IPLT and the Kasang IPAL are expected to produce.

306. In the specific conditions of Jambi land application of dried sludge, i.e. its disposal and/or reuse on nearby agricultural lands seems to be the most appropriate, if not the sole, option. The agricultural lands available are oil palm and perhaps also pineapple plantations located at a distance of a few km in kecamatan Sungai Gelam of kabupaten Muaro Jambi (Figure 60) and the reuse of dried sludge may be feasible for both crops being, obviously, subject to agronomic considerations and restrictions.

307. To handle dry sludge, it is necessary to dispose of adequate equipment. The availability of equipment and the application method associated to it are essential for determining the septage treatment process itself and the quality (dryness) of the end product. Treated septage with a solid content of 30% or more are handled with conventional front-end-loading equipment, transported by trucks to the application sites, and applied with agricultural manure spreaders. If no such equipment is available, septage may be applied in a liquid form, typically

with solid content less than 6%, which should be managed and handled by normal hydraulic equipment. In this case, however, it is necessary to ensure the above-mentioned interruption of the faecal-oral transmission cycle. This question will be set forth in the following Section G.

308. It is important to highlight that land application of septage is, in both cases, i.e. either in dried or in liquid form, nothing else but a cost-effective method of sludge disposal, which means that it cannot be traded under no circumstances. Land application of septage has to be negotiated between the UPTD-PAL and the farmers under the auspices of the Local Governments concerned, should be always in accordance with the characteristics of soils and the agronomic needs of crops and their exploitation.

309. A different approach is the production of bagged compost through an industrial-type process that can be sold as a commercial product for household level use in horticulture. This approach, however, is not proposed in the context of septage management for the time being.

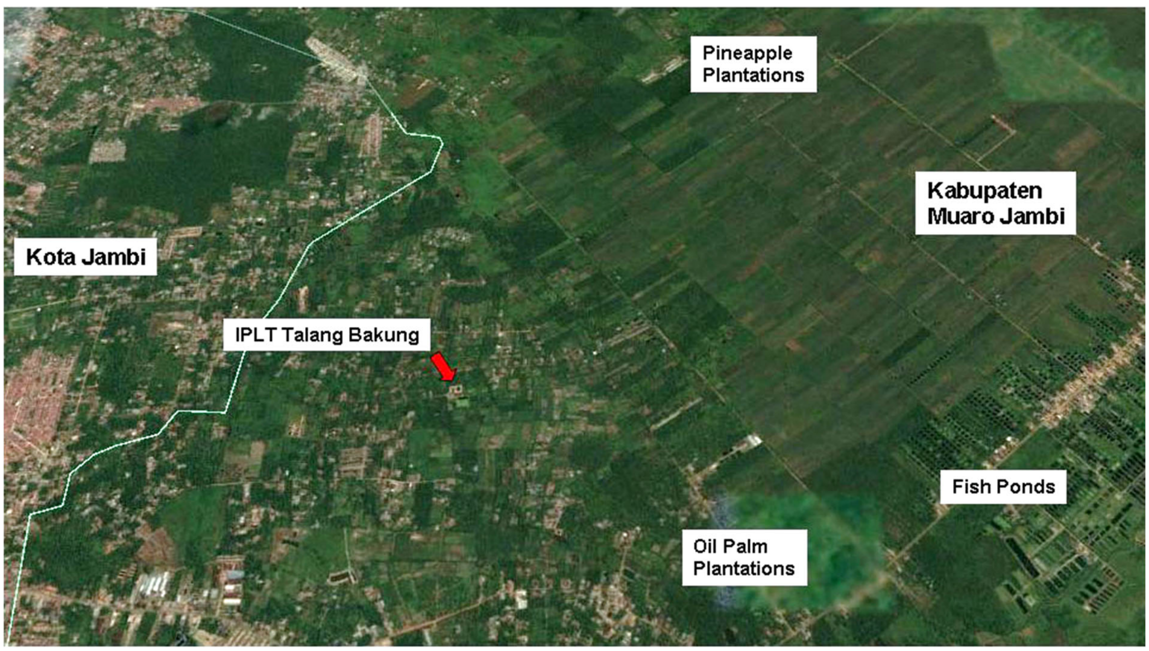

Figure 60: Location of the Talang Bakung IPLT and Nearby Farmlands

G. Land Application Option of Liquid Septage[56]

310. As set out in Section C above, septage is sludge and should be treated as such. Furthermore, sludge treatment should always be conceived depending on the final disposal and/or reuse options, methods and requirements. Considering that land application, principally on agricultural land, is the main option for sludge produced in both treatment plants in Jambi, the characteristics of the sludge output should depend on the needs and methods available in the agricultural fields near the city. Therefore, in some cases, it might be suitable to reuse septage in a liquid form provided that it poses no threat to public health and to the environment.

311. Surface application can be used as a fertilizer and soil conditioner. Application rates depend on the slope, soil type, method and depth of application, drainage class and, as one

[56] Based on USEPA (1994), Part III, Chapter 9, pp. 30-34, and USEPA (1999).

of the main limiting factors, nitrogen content (see below). Septage must not be applied before or during rainfall. Thus, an interim storage facility might very often be needed.

312. The maximum annual volume of domestic septage applied to all but land reclamation sites depends basically on septage nitrogen content, the amount of nitrogen required by the crop, and the planned yield of the crop. Nitrogen requirements of a crop depend on expected yield, soil conditions, and other factors such as temperature, rainfall, and length of growing seasons. Local agricultural extension agents should be contacted to determine the appropriate septage (and nitrogen) application rates, which may vary from 100 to 1,000 m^3/ha/year. In the absence of Indonesian standards, the following U.S. federal guidelines can be used for estimating septage application rates based on nitrogen loading (USEPA, 1994, p. 32):
$AAR = N / 0.02170$,
where: AAR = Annual Application Rate (l/ha·year); N = Net Nitrogen Requirement (kg N/ha·year).

313. Land application of septage is currently the most commonly used disposal method in many countries, mostly in the United States. It is relatively simple and cost-effective, uses minimal energy, and recycles organic material and nutrients to the land. As already said, with proper management, domestic septage is a resource that contains nutrients that can condition the soil and decrease the reliance on chemical fertilizers for agriculture. Appropriate septage disposal should maximize these benefits of septage while protecting public health and the environment. Septage can be incorporated into the land basically by three methods: surface application, subsurface incorporation or burial.

314. As for surface application, there are basically four methods (USEPA, 1999):

(i) Spray Irrigation. Pretreated (e.g. screened) septage is pumped at 6-7 bar through nozzles and sprayed directly onto the land. Spray irrigation can be used on steep or rough land and minimizes disturbances to the soil by trucks. It is important to consider the wind patterns and the site location when using spray irrigation because of the offensive odours associated with septage (Figure 61, a).

(ii) Ridge and Furrow Irrigation. This is used for relatively level land, with slopes no greater than 0.5 to 1.5%. In this disposal method, pretreated septage is applied directly to furrows or to row crops that will not be directly consumed by humans. This method is well suited to tree crops and is recommended for possible septage application in the tree plantations at Jambi.

(iii) Hauler Truck Spreading. Septage is applied to the soil directly from a hauler truck that uses a splash plate to improve distribution. The same truck that pumps out the septic tank can be used for transporting and disposing the septage. This method is most suited to open-field crops, such as cereals or forage.

(iv) Farm Tractor and Wagon Spreading. Liquid septage or septage solids are transferred to farm equipment for spreading. This allows for application of liquid or solid septage. However, if the septage was not lime stabilized, then the septage must be incorporated into the soil within 6 hours.

315. Subsurface incorporation places untreated septage just below the soil surface, reducing odours and health risks while fertilizing and conditioning the soil. Septage can be applied to soil using injection knives (Figure 61, b). The depth of injection may range from 20 to 30 cm. Septage can only be applied to slopes less than 8%, and the soil depth to seasonal high water-

table must be at least 50 cm. A holding facility is required during periods of wet ground. To prevent soil compaction and allow sufficient infiltration, equipment must not be driven over the site until 1 to 2 weeks after application. This method requires an intensive cooperation from the farmers.

316. Septage burial includes disposal in holding lagoons, trenches, and sanitary landfills. There is a high odour potential during septage application until a final cover is placed on top. It is essential to select an appropriate site for disposal not only to control odours, but to avoid groundwater pollution. Due to the high water-table level in the surroundings of Jambi, this method would not be recommended for septage sludge disposal.

317. To implement land application of liquid septage in Jambi, this option might be feasible in oil palm plantations but it would not be recommended for the pineapple plantations in Sungai Gelam, due to the risk of direct contact between septage and the fruit itself. In any case, a storage facility is likely to be necessary which could be installed in or near the plantations or at the IPLT. Another option would be to use some of the tanks or ponds as interim storage facility, e.g. the anaerobic pond that might be, as envisaged in Section A, unnecessary for the treatment of rather digested septage inflows.

a) Surface Application of Septage Waste   b) Subsurface Application of Septage

Figure 61: Land Application of Septage[57]

[57] Source: Michigan Department of Environmental Quality (2015).

XIII. ECONOMIC AND FINANCIAL MODEL

A. Introduction

318. The CDTA Consultant has developed a simplified model to help evaluate the fundamental economic and financial issues affecting the development of the septage management plan. This simplified model is for initial estimation of economic magnitudes and for scenario-building purposes, therefore should not be taken as a definite, detailed financial model for the operation of the septage management service. Such a model requires a much more detailed analysis of the institutional, technical and financial arrangements of the local government and the private sector, and therefore should be developed once the UPTD has been established.

319. In the meantime, the preliminary model may be a decision-support tool in the definition of the implementation strategy for the Jambi SMP. It can be used to evaluate aspects such as:

- (i) Zoning strategy for the implementation of regular desludging;
- (ii) Estimation of user tariffs and potential subsidies;
- (iii) Estimation of the impact of dumping fees for private septage haulers;
- (iv) Capital investment requirements for the establishment and development of the desludging service;
- (v) Operational budget requirements;
- (vi) Impact of external financing (debt);
- (vii) Potential and benefits of collaboration with the private sector in different scenarios;
- (viii) Estimation of the impact of introducing potential savings in the septage management chain, such as intermediate transfer stations.

320. The modelling results must not be taken as granted, because the key input variables are mostly subject to uncertainty and depend on many aspects. Therefore, the results should be interpreted with caution and with great attention to the initial assumptions, for example how much money the local government can spend on trucks, the volume of septage that can be treated at the IPLT, the ability of the LG to collect the payments, deliver the service to the user and treat the septage, the degree of compliance of private septage haulers, etc. All these considerations should be studied carefully by means of a risk and sensitivity analysis that provides some guidance about what aspects are most critical and what are the key issues that may become success factors or obstacles to the SMP.

B. Basic model characteristics

321. The model includes a number of input variables to cover issues about population, number of households served by the SMP, operational capacity and efficiency, dedication of resources, financial parameters, etc, many of them already described above. The following Table 16 lists these variables.

Table 16: Model – Basic Input Variables

MODEL INPUTS	Value	Unit
Start year	2020	
Households in Jambi	126,845	houses
Timeframe	5	year
Onsite Coverage target	40,000	units
Emptying cycle	2	year
Average desludging tariff	250,000	Rp/service
Average ST volume	1.5	m3
Trips/day	3.5	trips/day
Average truck volume	4	m3
No. working days	282	days/year
Trips/year per truck	2,632	trips
Cost of purchasing 1 truck	400	Rp million
Number of trucks existing	3	trucks
Cost of 1 ST	3.5	Rp million
Staff overhead ratio	30%	% over wage value
Vehicle maintenance cost	15%	of initial cost, annually
Vehicle useful life	10	years

322. The model also assumes a certain progression of human and material resources to be deployed during a 5-year septage programme implementation to achieve 40,000 households, in accordance with the scheduled desludging service established in the MSMIP Loan Agreement (Major Change in Project 2016), the organization and staffing recommended for the UPTD-PAL and the equipment requirements. The investment cost for the upgrade of existing septic tanks and installation of new septic tanks is not included in the model.

323. The model assumptions are shown in the following Table 17.

Table 17: Model Assumptions

a) Number of Services Per Year by Zone

SERVICE COVERAGE		2020	2021	2022	2023	2024
Users covered	*#users*	8,000	16,000	24,000	32,000	40,000
Total services in year	*#services*	8,000	8,000	16,000	16,000	24,000

b) Government Staff Resources

STAFF COUNT	Y1	Y2	Y3	Y4	Y5
Management & Admin					
Director General	1	1	1	1	1
Heads of Division	5	5	5	5	5
GIS Specialist	1	1	2	2	2
Design Engineer	1	1	2	2	2
Secretary	2	2	2	2	2
General Services Officials	2	2	3	3	3
Draftsmen	2	2	3	3	3
Assistants	2	2	3	3	3
Septage collection & transport					
Inspectors	1	1	1	1	2
Truck drivers	3	3	6	6	9
Truck operators	6	6	12	12	18
IPLT					
Plant manager	1	1	1	1	1
Maintenance officials	1	1	2	2	2
Laypeople	2	2	3	3	3

Note: The figures shown in “Management & Admin” are for the wastewater service unit as a whole, including off-site service.

c) Government Staff Costs

STAFF COST (Rp million/year)	Y1	Y2	Y3	Y4	Y5
Management & Admin					
Director General	240	240	240	240	240
Heads of Division	900	900	900	900	900
GIS Specialist	60	60	120	120	120
Design Engineer	100	100	200	200	200
Secretary	170	170	170	170	170
General Services Officials	140	140	210	210	210
Draftsmen	120	120	180	180	180
Assistants	90	90	135	135	135
Septage collection & transport					
Inspectors	120	120	120	120	240
Truck drivers	144	144	288	288	432
Truck operators	180	180	360	360	540
IPLT					
Plant manager	150	150	150	150	150
Maintenance officials	88	88	176	176	176
Laypeople	176	176	264	264	264

C. Financial Analysis

1. Overview

324. Based on the model assumptions described earlier, we have carried out a basic financial analysis to estimate certain key financial figures, namely:

(i) Estimated revenues.
(ii) Estimated investment and operating cost profile.
(iii) Resulting cash flows.
(iv) Need for operational subsidies to the service delivery organization (SDO) to compensate for the difference between costs and income from user tariff.
(v) Investment capital required for vehicles.

325. It is important to highlight that each of the key input variables carries a degree of uncertainty, and the values proposed in the model represent the likely and representative values in the opinion of the Consultant, taking into account the knowledge of the subject and the work carried out thus far in the CDTA project. That does not mean, however, that these values should be taken for granted. For instance, the proposed service fee of Rp250,000, or any other fee that the LG considers to use in the financial model, will only become revenue after the necessary supporting mechanisms are implemented, such as: large-scale household surveys; socialisation plans; passing of the necessary local regulations; setting up of the payment collection administrative and financial arrangements; and so on.

326. In summary, it is important to understand that any use of the financial model implies a clear understanding of the key input variables and the conditions that need to be in place for their assumed values to represent reality. The model should be evolved further into detail as the UPTD is established and specific information is gathered, so that a range of likely input values can be tested.

327. The model does not consider the possibility of obtaining other commercial income or truck dumping fees. An example would be the selling of dried sludge after treatment at the IPLT.

328. It must be pointed out that, as mentioned previously, the model does not account for the cost of renewing the existing septic tanks or for installing new ones.

2. Results

329. The financial projections for the Government resulting from the model are shown in the following table.

Table 18: Financial Analysis Outputs – Profit and Loss

		2020	2021	2022	2023	2024
INCOME						
Dumping fee and other commercial	*Rp million*	-	-	-	-	-
User fees	*Rp million*	2,000	2,000	4,000	4,000	6,000
Total Income	*Rp million*	2,000	2,000	4,000	4,000	6,000
OPERATING EXPENDITURE						
Onsite system	*Rp million*	1,295	1,295	2,125	2,125	2,882
Management & Administration	*Rp million*	2,366	2,366	2,802	2,802	2,802
Total OpEx	*Rp million*	3,661	3,661	4,927	4,927	5,684
Expenditure inc. Depreciation Provision	*Rp million*	3,936	3,936	5,322	5,322	6,199
CAPITAL EXPENDITURE						
Septic tank upgrade	*Rp million*	-	-	-	-	-
New Trucks	*Rp million*	-	-	1,200	-	1,200
Total CapEx	*Rp million*	-	-	1,200	-	1,200
FINANCIAL RESULT						
EBITDA	*Rp million*	- 1,661	- 1,661	- 927	- 927	316
EBIT (including depreciation)	*Rp million*	- 1,936	- 1,936	- 1,322	- 1,322	- 199
OPERATIONAL FUNDING NEEDS		**- 6,715**	Rp million			
TOTAL CAPITAL INVESTMENT		**- 2,400**	Rp million			

330. The key considerations that follow the results above are:

(i) The septage service is marginally financially viable in the long term with the user fees assumed (Rp10,000 per month for sewer connections, Rp250,000 per desludging service) and the investment and operating costs modelled. EBITDA (Earnings Before Interest, Tax, Depreciation and Amortization) becomes positive only in year 5; when depreciation of the assets is taken into account (EBIT) the service is in long-term deficit, as can be seen in Table 18.

(ii) The estimated capital needed for buying the additional trucks to cover the service targets is Rp2,400 million. This is capital does not consider the cost of septic tanks.

(iii) To cover the operating costs -compensating the difference between service costs and fees collected- and make the service sustainable, the LG would need to provide an additional Rp6,715 million over the 5-year period.

(iv) The total funding needs to implement the 5-year SMP amount to Rp9,115 million, equivalent to approximately 0.6% of the local government budget for the year 2018. The resulting wastewater service coverage at the end of year 5 would be 40% of the city, including the off-site users.

XIV. PRIVATE SECTOR PARTICIPATION IN SEPTIC TANK DESLUDGING

A. Purpose

331. Bridging the gap between the existing service coverage and the targets will require a substantial amount of resources and skills. Even if the desludging service were articulated and well-functioning and the political commitment were strong, reaching those targets would require increasing the coverage by several fold, while it seems unlikely that the local government be able to commit the required level of funding for investment and running costs.

332. On the other hand, there are private companies that offer desludging services for a fee. These private sludge haulers are often poorly regulated, operating informally and usually charging higher fees than those of the public service, mainly due to subsidized government prices and high uncertainty about demand regularity. It is commonly accepted that much of the sludge collected by these companies is illegally dumped in water bodies, channels or onto fields to save costs, with the corresponding environmental and health risks.

333. It then becomes necessary to assess the current status of the on-site sanitation supply chain in Jambi and identify ways in which private sector operators can effectively contribute to the achievement of service targets and the improvement of sanitation, with a particular focus on the collection and transport of septage.

334. The objectives of this chapter are to (i) report on the current involvement of private companies in septage management, based on field research; (ii) understand the existing policy and regulatory framework for private sector participation in septage; (iii) map out and assess the options for effective private sector engagement; and (iv) describe the most effective forms of collaboration in the medium and long term; and (v) make recommendations to enable an environment that maximises the impact of collaboration.

B. Current situation

335. The diagnosis of how septage is being managed in Jambi has been described and discussed at length in the previous chapters. In this chapter we will focus specifically on what the private sector is currently doing in relation with septage management in the City. Many of the facts and figures in this section are based on the research done by the Project's International Regulatory and PPP Specialist during his field visits to the MSMIP cities in September 2016 and 2018.

336. The involvement of the private sector in the septage chain is mainly in (i) supply and installation of septic tanks (masons and plumbers); and (ii) collection and transport of septage using vacuum trucks (septage haulers).

337. Septic tanks are sold (prefabricated) at building material stores and installed by small contractors or, more frequently, directly built in situ (wood, brick, concrete). Bearing in mind that the majority of existing septic tanks do not comply with the national standard, the potential for business opportunities in the forthcoming years is notable. Septage is usually a small part of the business for companies selling and installing septic tanks, therefore not generally involved in the day-to-day provision of the service. For this reason, the main focus of the assessment of private sector participation is on the septage haulers.

338. In the business of collection and transport of septage, there is a small number of companies, all of them owning one vacuum truck. The trucks usually have a capacity of 3 m3. The firms are microenterprises (less than 5 employees) registered as CVs or sometimes cooperatives. It is believed that some firms operate informally as it happens with other small businesses in Indonesia, although the proportion is undetermined. Research by the CDTA consultant shows that most of the companies are less than 10 years old, with a good proportion of them being less than 3 years old. A number of these companies also provide building services for septic tanks and small wastewater treatment plants (for housing and office estates).

339. The reported investment required to purchase a vacuum truck is approximately Rp400 million, and the trucks are usually purchased from regional workshops that assemble the units on semi-new standard truck bodies and sell them, or the entrepreneur buys the truck body and vacuum units and the workshop assembles them together. Repairs and maintenance are also carried out at local shops. Imported vehicles specifically manufactured for vacuum cleaning are much more expensive and rarely found.

340. Private operators perform 2-3 services per day on average, reaching 4 services per day on busy days during the rainy season. Some of the companies advertise on the internet through advertising websites or social networks, but the use of technology is scarce.

341. Interviews with private desludging companies in Makassar (no such meetings could be arranged in Jambi) revealed the following key challenges that these entrepreneurs face in their businesses:

(i) Uncertainty about demand, largely due to weak public awareness and enforcement;

(ii) Lack of skilled labour, both in technical and customer relation aspects. Septage workers enjoy little recognition and their skills are among the lowest in the workforce. It is likely that some workers are employed informally – especially if the company is not constituted legally - and have salaries below the minimum wage.

(iii) Problems performing the service and even getting payment from the user.

(iv) High variable costs, mainly fuel and oil.

(v) Difficult access to affordable commercial loans.

(vi) The licensing process is cumbersome.

342. Table 19 and Figure 62 below summarise the basic market research done by the CDTA consultant.

343. Private operators are expected to discharge the septage at the treatment plant. We reviewed the IPLT registers and found discharge frequencies that differ considerably with the number of services to customers indicated by the companies. It is suspected that much of the septage is being dumped elsewhere illegally. Undigested sludge is thought to be used for fertilization of fields and fish ponds, although this could not be verified. This might provide extra income to the companies while avoiding the dumping fee, as well as saving the time and fuel to go to the IPLT, which in many cases is far from customers. The time required to drive the trucks to IPLTs is on average 45 minutes each way, with the estimated total time for the service being 2.5 hours.

Table 19: Main Data and Features of Private Waste Haulers in Jambi

References	1	2	3	4	5	6	7
Commercial Name	Sedot WC Kota Jambi	Jasa Sedot WC Jambi	Harga Sedot WC Jambi	CV Relopa Jaya Proteksi	Sedot WC Muaro Jambi Termurah	Jasa Sedot WC Jambi Professional	Sedot WC Jambi Murah
Registered Name	CV JASATAMITA	CV Doremon		CV Relopa Jaya Proteksi		CV Trio Mandiri	
Contact person		Ibu Nur		Pak Ade			
Telephone 1	085367867828	085295240026	081396908910	085266613128	0856-9619-4177	081224240007	08127833375
Telephone 2	0811741554	08562090482					0741671211
Address	Mayang Mangurai	Jl Ir Juanda Mayang					
Map		Map2					
Website	Web1	Web2	Web3		Web5		Web7
Facebook		@jasasedotwcjambi					
Twitter							
Other networks				Network4			
#Trucks	1	1			1	1	1
Truck Type	Regular body	Pickup with tank		Regular body	Regular body	Regular body	Small regular body
Truck Capacity (m3)	3			3	2	2	1
Service area	City and surroundings	City and surroundings	City	City and surroundings	City and surroundings	Jambi Province	City and surroundings
Price					550000		
Last updated	04/01/2016	19/11/2018	2018	27/02/2018	30/03/2018	27/10/2016	18/08/2016

Company #1

Company #2

Company #3

Company #4

Company #5

Company #6

Company #7

Figure 62: Desludging Equipment Operated by the Jambi Waste Hauler Companies

344. A 2016 study carried out by the CDTA's International Regulatory and PPP Specialist[58] included an estimation of the commercial and financial performance of the private septage haulers in the MSMIP cities, including Jambi. This study concluded that these businesses operate at marginal levels of profitability while facing significant commercial risks. Other detailed studies[59] carried out recently on the subject have reached similar conclusions.

345. However, the fact that the number of septage businesses is growing – albeit slowly - suggests that several factors did not come to light in the field research, i.e. there is information missing. Possible causes are:

(i) The nature of the volume and price variables is complex and requires more granularity in the data collection and the analysis. For instance, one truck may be performing more than one service to fill one tank, e.g. emptying 3 pit latrines of 1 m^3 each instead of 1 septic tank of 3 m^3, charging the same price as the Government and receiving three payments but still make a single journey out of the city to the IPLT and pay the dumping fee once. This is related to truck capacity, seasonality (pits are more full in the rainy season), type of sludge and size of pits (larger pits for large houses, estates or commercial areas, smaller pits in houses).
(ii) Uncertainty about compliance. The trucks may be dumping all or part of the sludge illegally, avoiding the dumping fee, saving on fuel and maintenance costs and providing additional time to serve more customers, therefore increasing the number of trips per day. There is also the potential source of revenue from plantation and fish farmers when the sludge is dumped on their fields or ponds.
(iii) The companies may be using the trucks for other activities when not used for septage. Note that the model assumption of 3 trips per day equals to using the truck for 6 to 9 hours a day depending on the traffic, location of the customers and the IPLT, leaving enough idle time to do other jobs.
(iv) The companies may have additional sources of income (e.g. building services) to mitigate the seasonality and lack of regularity in demand.
(v) Some companies may not be using commercial loans at all, or only marginally.
(vi) Companies may be paying salaries below the statutory minimum. We consider this likely for those companies that are not formally constituted but less likely otherwise.
(vii) Some companies may be avoiding tax.

346. The cost of borrowing seems to be less a profitability factor and more a competition factor for new businesses who are likely to encounter a barrier to enter the sector, or for existing businesses to expand their operations. Businesses that have already reached a steady flow of income may enjoy a competitive advantage, something that should be considered carefully when setting up septage management plans that involve the private sector.

347. Additionally, there seem to be other economies of scale, since the companies that own more than one truck will be able to plan their journeys more effectively when the demand is sufficient. In order to maintain a fair competitive level that results in a better, affordable service

58 Private Sector Participation in Septage Management in the Target Cities. TA-8666-INO – INDONESIA Capacity Development Technical Assistance Metropolitan Sanitation Management Investment Project, October 2016

59 Tapping the markets: Opportunities for domestic investment in water and sanitation for the poor. World Bank 2014; Business Analysis of Fecal Sludge Management: Emptying and Transportation Services in Africa and Asia, Bill & Melinda Gates Foundation 2012; and Development of urban septage management models in Indonesia, World Bank 2012.

for the user, the licensing and contracting mechanisms for private operators may consider including measures to encourage the participation of small companies, provided that they meet the minimum specifications set for all contractors.

348. Overall, given the high uncertainty about demand and the relatively fixed cost structure of operators (except for fuel and oil), from the financial perspective there seems to be greater need for demand certainty, regulatory coherence and good governance of the service.

C. Legal framework

349. UU 25/2009 on Public Services establishes (article 13) that the administration may cooperate with other parties for the purpose of improving and accelerating the provision of the service, given the limited resources available to the LG. The law stipulates the following conditions for this kind of cooperation:

- (i) The cooperation agreement must comply with the existing regulations and be based on service standards;
- (ii) The LG must inform the public about the cooperation agreement, the service and the identities of the parties;
- (iii) The LG has the overall responsibility of the cooperation, whereas the other party is responsible for implementing the agreement.

350. PERMEN PUPR 16/2008 states in its mission the objective to improve and develop alternative sources of funding in the operation of wastewater management systems. The GoI identifies "a lack of interest by the private sector to invest in wastewater", concluding that "access sources of funds for investment and operation from the private sector in synergy with the gradual implementation of cost recovery is a challenge that must be addressed with a win-win solution". This regulation establishes several policies along with strategies and associated actions, as shown in the following Table 20.

Table 20: National Wastewater Policy and Strategy – Private Sector Participation

Policy	Strategy	Specific Actions
Enhance the role of the public and businesses in the implementation of wastewater systems	Promote the participation of the public and businesses	Socialize the investment potential in the sector
Establish a regulatory framework for wastewater management	Issue regulations that promote the management of wastewater	Provide incentives and disincentives to the local governments and the private sector parties involved
Improve funding and develop alternative sources of funding for wastewater facilities and infrastructure	Support the access to different funding sources	Promote public-private partnerships (PPP) in the implementation of wastewater facilities and infrastructure

351. In the case of septage management, PUPR's L2T2 guidelines establish that LGs must address cost recovery for service sustainability, including the cost of surveys, operation and maintenance, administrative costs, capacity building, socialization campaigns, promotion and collaborations that improve the access to sanitation.

352. If the private sector is engaged to finance, build and operate the infrastructure, the cooperation is subject to PERPRES 38/2015 on Public Private Partnerships (PPP) in the provision of infrastructure. This law, however, is intended for the engagement of the private sector in building and operating large infrastructure. This type of participation involves lengthy and costly project preparation, procurement and implementation activities and requires a reasonable degree of development and institutional capacity of the sector. Therefore, it is not currently advised to use it in septage management[60], at least in the short and medium term.

353. Any option involving payments from the LG to a private company for the provision of a service must follow the public procurement law, PERPRES 54/2010 on Procurement of Government Goods and Services and its latest amendment PERPRES 4/2015. The law allows to appoint service providers directly (*pengadaan lansung*), without the need for a competitive tender when the following conditions take place:

- (i) Contract value below Rp300million;
- (ii) Small companies or cooperatives only;
- (iii) Required for operational needs;
- (iv) Involving simple technologies;
- (v) Involving low risk.

354. Local government-owned enterprises (BUMDs, including PDAMs and PD-PALs) can establish their own independent procurement regulations and not use PERPERS 54/2010, provided that the source of funding is their operational revenue, and not APBN or APBD. If no specific regulation is in place, they should follow PERPRES 54/2010.

355. Finally, there are currently no specific regulations on the use of treated sludge. PERMEN PUPR 9/2015 refers to the use of recycled wastewater as a resource but it is not specific to sludge.

D. Possible Forms of Private Participation

356. The level of private participation depends mainly on the size of the market (potential number of customers and tariff), the expected growth, the cost to enter the market (investment required), how payment is received, the guarantees on payment and the operating costs.

357. The possible forms of participation in wastewater management are many, with a wide range of levels of complexity in the arrangement (technical, administrative and financial) and different requirements to ensure the arrangement delivers the expected results. Table 21 lists the cooperation options for septage haulers, from most to least suitable to the current status of the septage sector.

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[60] Infrastructure PPPs are complex legal and financial structures. As of 2018 there are very few cases of PPP projects that have reached operational stage, none of them in the sanitation sector. The amount of skills and resources required to structure and procure these projects makes them feasible typically above a certain level of investment, in the order of USD 50 million or more.

Table 21: Cooperation Options for Septage Haulers

	Option	Description	Complexity	Assessment
1	Empty and transport. Business as usual	Private serves users on demand. No relation with LG other than licenses and regulations.	Low	Demand uncertainty. High risk for private. If poorly regulated and enforced, service coverage stalls and compliance is absent (illegal dumping).
2	Empty and transport. Regular desludging.	Private serves users regularly based on LG schedule. Payment may be from user or from LG.	Low to Medium	Mitigates demand uncertainty. Encourages new companies and competition, reducing prices. Requires tariff regulation and strong enforcement. Payment from the LG is more attractive to private but implies more complex legal and technical arrangement.
3	Installation of septic tanks, emptying and transport	Private finances and installs facilities, then provides regular emptying and transport and receives regular payments from users or LG.	High	Encourages service coverage making it easier for users to have compliant septic tanks. Option of payment from user has a higher risk and is less likely, unless strong enforcement by the government. Additional finance from the private, higher risk that requires a strong regulatory and enforcement framework, possibly involving LG guarantees. Not recommended as short-term measure.
4	Operation of IPLT, with or without construction	Private builds and operates or only operates the IPLT, in return for regular payments based on input or performance.	Very high	Large investment required in the case of build+operate. This case is regulated by PERPRES 38/2015. Complex, lengthy and expensive project preparation. Input-based scheme needs guarantee of continuous sludge input from LG. Performance-based requires regular payments from LG, possibly with guarantees. Strong knowledge and skills in septage management required from private sector. Not feasible in the short or medium term.

358. All of the options require companies to obtain a business license and an environmental permit from the LG, as determined by the applicable local regulations. The licensing process can be cumbersome and expensive in some cases but not difficult to streamline.

359. If the private sector is to build and operate the IPLT (Option 4), the cooperation is subject to PERPRES 38/2015, this type of participation is not applicable to septage management in practice, at least in the short and medium term.

360. Any option involving payments from the LG to a private company for the provision of a service must follow the public procurement law, PERPRES 54/2010 and its latest amendment PERPRES 4/2015. This is the case for options 2 and 3 above, as well as option 4 if the cooperation is for operation of the IPLT only (excluding construction). As explained, the law allows to appoint service providers directly (pengadaan langsung), for simple contracts with small companies or cooperatives and a value below Rp 300 million.

361. Option 1 is the status quo, where the private haulers provide their service on demand. There is no relation with the LG apart from having to obtain a business licenses and comply

with the regulations. This way of doing things does not provide any strong incentives to increase service coverage to the levels required by the SMP. The users may get a quicker service but also more expensive, as the private operator fees include the premium for demand uncertainty and other eventualities. Furthermore, this option does not create any long-term cooperation between the different parties. If any, it might foster competition and mistrust, as there are no common interests or shared incentives.

362. Option 2 is a more complex form of engagement because the company commits to deliver services for a certain period of time, in exchange for regular payments. This requires the LG and the company or companies to sign a cooperation agreement (perjanjian kerjasama). The agreement should include, as a minimum, the scope, rights and obligations of the parties, duration, termination, tariff, payment mechanism, service standards, penalties and force majeur.

363. It is important to note that UPTDs are not allowed to enter into cooperation agreements. This is an obstacle to the participation of the private sector in regular desludging. The most effective option is to use a BLUD or a BUMD. As a matter of fact, the only current examples of cooperation between LGs and private haulers in Indonesia for scheduled desludging are those with BUMDs, as in the case of Bandung and Surakarta.

364. A possible solution is for the companies to cooperate directly with the LG (and not with the technical unit responsible for septage), but this creates additional bureaucratic processes that must be studied and addressed in detail.

365. Options 3 and 4, finally, require a relatively large amount of risk capital to be advanced by the private sector, which will only happen if the right risk mitigation mechanisms are in place, such as government guarantees.

366. With the above in mind, we consider Option 2 the most viable for private sector participation in the short and medium term.

E. Cooperation Arrangements

367. A successful cooperation between the private sector must be based on a clear understanding of the objectives, the roles, rights, obligations and working arrangements for all parties involved, arranged ultimately for the benefit of the people of Jambi. These issues should be reflected in a cooperation agreement endorsed by the City Mayor.

368. The recommended process for preparing the agreement can be summarized as follows:

- (i) Detailed study of the existing private firms operating in Jambi, to confirm and complement the details shown in the tables above. The study should include details about the firm, company registration, location, number of employees, vehicles, equipment, fees currently charged to users, area where they operate, policies and procedures for health and safety, quality, etc.
- (ii) Identification of those companies that are in a position to deliver the service in cooperation with the LG in a responsible, transparent, competent and sustainable manner.
- (iii) A definition of the areas that can served by each operator, in line with the zoning of the SMP, including a detailed estimation of the collection and transport costs to

the IPLT in each area and sub-area. The price paid to each operator must recover the specific costs for the area they operate, in order to guarantee the viability of the business and its continuity. The allocation of services to each company will depend on:

(a) The size of the fleet.
(b) Whether the LG decides to implement scheduled desludging or not. If L2T2 is implemented, the LG is in a position to assign the monthly or weekly schedules of a certain neighborhood to a specific firm. Otherwise, the operators may get on-demand calls from the UPTD to deliver the service as the users request it.
(c) The level of demand by the users, if desludging happens on-demand.
(d) The performance of the operator in the previous months.
(e) The LG policy for incentivizing competition and promoting the growth of local business.

(iv) Definition of the subsidies that must be allocated for each operator, since those that serve the populations farther away from the IPLT will have higher costs associated, but the users will still pay the same tariff.
(v) Definition of the payment mechanism. This mechanism must be specified in detail in the agreement, including the technologies and protocols that will be used to verify that the service is requested, delivered and completed.
(vi) Definition of the minimum standards of operation.
(vii) Definition of the incentive/penalty arrangements to ensure that the operators fulfill their obligations. There should be mechanisms in place to ensure that those firms that meet the obligations and objectives with great satisfaction to the users and the LG are rewarded. On the other hand, those firms that do not provide the service in accordance with the agreement can be penalized, for example for not dumping the septage at the IPLT or for providing a poor-quality service. Elements that may be used to incentivize or disincentivize include the possibility of extending or cancelling the agreement, increasing the fee received, imposing fines, withdrawing the business license, etc. The measures must be studied in detail and allocated fairly and proportionally.
(viii) Design of the monitoring and evaluation mechanisms to measure the performance of the service and the benefits of the cooperation. A full performance evaluation should be done at least annually, although the satisfaction of the customers and the compliance with the obligation to discharge at the IPLT should be monitored weekly as a minimum.

369. The considerations above should be established in a cooperation agreement, to be signed collectively or individually with each operator. An example of a cooperation agreement developed by IUWASH is included as an appendix to this chapter for reference only. The terms and conditions specific to the city of Jambi must be studied in detail and thus reflected in the agreement. The minimum stipulations should include:

(i) Parties
(ii) Vision, mission and objectives
(iii) Scope of cooperation
(iv) Rights and obligations of the parties
(v) Fees
(vi) Payment mechanism

(vii) Reporting mechanisms
(viii) Monitoring and evaluation mechanisms
(ix) Incentives and penalties
(x) Termination clauses
(xi) Detailed work schedules
(xii) Technical specifications for labor, equipment and tasks.

XV. SOCIAL MARKETING PLAN

A. Background

370. The main reason for managing septage in Jambi City is to reduce the negative impact on public health, the domestic and urban environment due to the presence of faeces in the neighbourhood. Poorly managed septage can potentially pollute the environment, especially groundwater, rivers and other water bodies. This can cause clean water sources to be contaminated by faecal material, which can affect health if consumed. To properly manage septage, of course, cooperation is needed for both the Local Government as the implementer of septage management services, the private sector as partners and especially the residents who are targeted for service.

371. Community participation as a service target is the key to the success of the LLTT program. One of the obstacles for the program is the lack of public knowledge about standard septic tanks. The general presumption is that a good septic tank does not require periodic desludging. Septic tanks are often not sealed so that the faecal material can seep to the groundwater. In addition, septic tanks are often only desludged when there is a blockage and is not carried out periodically. Another obstacle is the lack of cooperation between the local government and private septage haulers. Violations in the form of vacuum trucks disposing of the septage into rivers, lakes, gardens or rice fields are still commonly found.

B. Present Conditions

1. On-site Wastewater Treatment Facilities

372. Most of the buildings in Jambi City (89%) are equipped with what is considered by the occupants as septic tanks. The majority of septic tanks are more than 5 years old (83%), the size is still limited to less tahn 3 m3 (72%), and the majority has never been desludged (92%), indicating that the existing systems produce overflows not properly treated and potentially causing negative impacts to the surrounding environment and high public health risks.

2. Current Septic Tank Desludging Practice

373. Septic tank desludging services currently function on an on-call basis exclusively managed by the Public Works and Spatial Planning Department (DPUPR). Private septage haulers in Jambi City do not always dispose of the septage at the IPLT.

374. The low interest in desludging in the community can be caused by several factors. The main factor is the lack of public knowledge about good and proper sanitation, especially knowledge of septic tanks that are in accordance with the standards and the importance of managing septage well. Another factor is the condition of on-site facilities that are difficult to access by vehicles, and often under the building which requires demolition of the building floor to access the septic tank. Besides that, cultural factors and habits inherited from generation to generation are not conducive to managing septage properly, because it is something dirty and disgusting.

C. LLTT Marketing Plan

375. According to a Social Marketing of Septic Tank Desludging Services guideline published by IUWASH[61], there are three determinants of whether someone is willing or not to be an LLTT customer. These three factors are the availability of LLTT service infrastructure, LLTT promotion factors, and supporting environmental factors. These three factors are interrelated. If there are parts that are lacking, the Local Government needs to intervene. If the service infrastructure is adequate, a regulation already exists, but the promotion is not on target, the intervention has to be a promotional program. If the LLTT infrastructure is inadequate, then there must be an intervention to improve the infrastructure before promotion.

376. The socialization and marketing of the LLTT program should be carried out in the following seven stages:

(i) Organizing a Social Marketing Team and determining the Budget
The LLTT Program Socialization and Marketing Team is recommended to be a separate entity because the tasks are specific and have target numbers of customer numbers. If the target customers have been reached, the marketing task can be switched to the customer service section of the UPTD PAL.
The members of the LLTT socialization core and marketing team must be at the LLTT organizing agency. However, in the initial stages the LLTT socialization and marketing program should be made into a regional program so as to facilitate the involvement of sanitation related SKPDs (eg. the Health Department) and other relevant institutions. If it involves a party other than the LLTT organizer, approval is required from the Mayor.

(ii) Determination of Budget
The budgeting for socialization and marketing activities shal be carried out based on annual activity plans. The amount of the budget should be directly proportional to the desired potential customer target.
The source of the marketing budget needs to be included in the LLTT program budget. If it involves other institutions or SKPDs which in their activities support LLTT marketing, funds owned by the relevant institution / SKPD might be used. For example, if the socialization and sales activities are carried out by a Puskesmas cadre, then the promotion activities use the Health Department budget. LLTT promotion activities can also be a Local Government Public Relations program.

(iii) Determination of Marketing Areas
Determination of marketing areas can refer to the service areas that have been identified. To maximize operational efficiency of septic tank desludging, marketing activities need to be divided according to the marketing areas. Division of marketing areas can facilitate the collection of information on community characteristics as a basis for preparing promotional strategies and facilitate the implementation of socialization and marketing activities.

(iv) Determination of Marketing Targets
LLTT marketing requires clear target numbers of potential customers to be reached within a certain period of time, for example, one year. The marketing target is part of the magnitude of the target coverage for LLTT services for the city.

[61] Pemasaran Layanan Lumpur Tinja Terjadwal, IUWASH, USAID, September 2016

(v) Target Market Analysis
   (a) Determination of Potential Target Groups and Expected Behaviour Changes
   (b) Identification of Information Needs
   (c) Market Research
   (d) Analysis of Research Results
(vi) Product Information Development
   (a) Compilation of Product Information
   (b) Formulation of Price Information and Payment Procedures
(vii) Planning and Implementation of Socialization and Promotion
   (a) Promotion and Promotion Planning
   (b) Implementation of Socialization and Promotion.

D. Monitoring and Evaluation

377. Monitoring (supervision) is an activity of monitoring program implementation while it is in progress. Here the point is to ensure that every activity in the program is carried out in accordance with the plan. If ineffective activities are identified, they need to changed. On the other hand, evaluation is the measurement of program impact after the program is completed. Here the point is to assess whether the work program implemented is in accordance with the results envisaged.

378. To conduct a program assessment, the organizer needs to prepare measurable indicators. The easiest way to prepare program indicators is to compare the activity plan with its implementation.

379. The monitoring results are analysed as soon as possible with the aim of improving the program while running. The results of the monitoring analysis and improvements made are summarized in monthly, quarterly, or other periodical reports as agreed. The evaluation results are analysed after a complete evaluation process is carried out and summarized in the annual report.

XVI. CONCLUSIONS AND RECOMMENDATIONS

380. Most premises in Jambi (89%) are equipped with what the occupants consider a septic tank but practically none of these comply with the Indonesian Standard SNI 03-2398-2002. Actually, most septic tanks are in fact cubluk, i.e. one-compartment, lined but bottomless pits allowing wastewater to seep to the ground and to the groundwater.

381. The facts that the majority of existing septic tanks are older than five years (83%), are rather limited in size (72% < 3 m3), and have never been emptied (92%), suggest that they produce effluents and/or overflows that do not receive an appropriate treatment and cause a negative impact on the environment and a high public health risk.

382. The current desludging practices consist of a remedial system for overflowing tanks functioning exclusively on demand.

383. Although there is very limited desludging equipment available, they are considerably under-utilized.

384. The septage input into the IPLT is very low (2 trucks/day or 7 m3/day on the average), much of the sludge apparently being dumped elsewhere.

385. Despite its relatively good physical status, the IPLT is non-functional as a treatment plant. The main infrastructural deficiencies of the plant are the non-functional sludge removal at the so-called sludge separation chambers (SSC) due to design and maintenance problems, the total inadequacy and the consequent state of disuse of the sludge drying beds, the state of abandonment of the outlet pipe and the consequent complete lack of a plant effluent. The problems of operation of the IPLT can be attributed essentially to the lack of understanding of the principle of septage treatment and sludge disposal and to the total absence of definition of sludge disposal options.

386. The on-site wastewater treatment and disposal facilities will have to be adapted to the Indonesian Standard but, seen their current status all over the city, it goes without saying that there is a long way to go.

387. The refurbishment plan of the non-complying on-site facilities should include, among others, (a) the installation of access holes or manholes on the upper slab of the tanks, (b) the relocation of septic tanks to the front of the premises, (c) the reconstruction of clearly undersized septic tanks, (d) connection of all wastewaters to the septic systems, (e) construction of proper outlets and percolation systems, such as percolation areas or leach fields (individual or communal), (f) promotion of communal treatment and disposal systems to replace inappropriate individual facilities, (g) installation of ventilation pipes on the upper slabs wherever appropriate and (h) promotion of flush toilets in those households that currently lack them. The implementation process of the refurbishment plan should include three stages and ten activities and have a duration of ten (10) years.

388. The current remedial system and on demand practices of septic tank emptying should be transformed into a scheduled desludging and maintenance service (LLTT), becoming part of a comprehensive wastewater management service.

389. This service should be assumed, by definition, by the City Government through a well-organized and specialized UPTD-PAL. Private entrepreneurs should be able to provide desludging services as licensees of the City Government.

390. To undertake scheduled desludging, the City of Jambi should require additional vacuum trucks similar to the currently available 2,500 and 4,000-litre trucks seem to be appropriate due to the limited capacity of septic tanks. Small scale, motorcycle-driven Vacutug-type devices are recommended for areas inaccessible to large vehicles.

391. The number of vacuum trucks required for Jambi is 22. It is recommended, however, that the City Government opt for a "mixed model" including public and private service providers, which would allow to reduce the need for acquisition of new vehicles and the related strong staff needs (one driver and one operator per vehicle).

392. For the operational planning of scheduled desludging services, it is recommended to divide the city into eight (8) zones of roughly similar population and characteristics and prepare a yearly plan.

393. Local fees should be levied by the City Government as per a specific PERDA or as part of a PERDA of fees for public services will be used to recover the operating expenses for regular desludging.

394. The septage quantity to be collected and treated is estimated at roughly 230 m3/day. This means that the Talang Bakung IPLT of 80 m3/day nominal capacity should be completed by an additional capacity of 150 m3/day at the Kasang WWTP.

395. The IPLT should be refurbished to improve, above all, its solids separation and sludge drying performance. For this aim the solids separation chambers (SSC) should be remodelled and new sludge drying beds should be installed within the IPLT grounds.

396. Septage treatment at the future Kasang WWTP could be performed in the water train until the plant is below 50% capacity. A more sustainable solution could be achieved by installing a specific electromechanical equipment for grit removal and sludge thickening.

397. It is indispensable to define and implement sludge disposal options, the most suitable of which appears to be its reuse as a fertilizer (or "biosolids") on nearby oil palm and pineapple plantations in kabupaten Muaro Jambi.

398. Septage treatment, however, is not an aim in itself. The aim is safe and environmentally friendly disposal of septage, so if the UPTD-PAL has no means to extract and transfer dry sludge to trucks and transport it to the final disposal sites, they might opt for the land application of liquid septage, the most commonly used disposal method in many countries, mostly in the United States.

399. The operational costs of septage management should be covered by a rate to be collected from all owners or occupiers of the premises equipped with on-site wastewater treatment facilities, preferably on a monthly basis.

400. The implementation of the Septage Management Plan will also require the extension and upgrade of the GIS database to be furnished in this plan and the amendment of the existing PERDA on wastewater management.

401. It is proposed to adopt a gradual implementation process for the different aspects of the Septage Management Plan over a time horizon of five (5) years, except the septic tank refurbishment plan for which a time horizon of ten (10) years is proposed.

402. Based on the CDTA study *Organization and Financing of the Wastewater Management Services in the City of Jambi*, under preparation, a desludging fee of Rp250,000 per service has been proposed (equivalent to an average monthly rate of Rp10,000 for a desludging service every two years).

403. The septage service is marginally financially viable in the long term with the user fees assumed (Rp10,000 per month for sewer connections, Rp250.000 per desludging service) and the investment and operating costs modelled. EBITDA (Earnings Before Interest, Tax, Depreciation and Amortization) becomes positive only in year 5; when depreciation of the assets is taken into account (EBIT) the service is in long-term deficit.

404. The total funding needs to implement the 5-year SMP amount to Rp9,115 million, equivalent to approximately 0.6% of the local government budget for the year 2018, including a subsidy of Rp6,715 million over the same 5-year period to cover the operating costs - compensating the difference between service costs and fees collected- and make the service sustainable. The resulting wastewater service coverage at the end of year 5 would be 40% of the city, including the off-site users. Furthermore, the estimated capital needed for buying the additional trucks to cover the service targets is Rp2,400 million.

405. The possible involvement of the private sector in the septage chain is mainly in supply and installation of septic tanks (masons and plumbers); and collection and transport of septage using vacuum trucks (septage haulers).

406. There is a small number of companies involved in the business of collection and transport of septage, all of them owning one vacuum truck. They are recently microenterprises (less than 5 employees) registered as CVs or sometimes cooperatives, most of them less than 10 years old, and many of them even less than 3 years old.

407. The private operators perform 2-3 services per day on average, reaching 4 services per day on busy days during the rainy season, and are expected to discharge the septage at the treatment plant but IPLT registers indicate that much of the septage is being dumped elsewhere illegally.

408. The level of private participation depends mainly on the size of the market (potential number of customers and tariff), the expected growth, the cost to enter the market (investment required), how payment is received, the guarantees on payment and the operating costs.

409. To carry our scheduled desludging, the companies should obtain a business license and an environmental permit from the LG, as determined by the applicable local regulations.

410. UPTDs, however, are not allowed to enter into cooperation agreements, which is an obstacle to the participation of the private sector in regular desludging, the most effective option being a BLUD or a BUMD.

411. A successful cooperation between the private sector must be based on a clear understanding of the objectives, the roles, rights, obligations and working arrangements for all parties involved, arranged ultimately for the benefit of the people of Jambi. These issues should be reflected in a cooperation agreement endorsed by the City Mayor and signed collectively or individually with each operator.

412. Community participation as a service target is the key to the success of the LLTT program. The main factor of the current low interest in desludging in the community is the lack of public knowledge about good and proper sanitation, especially knowledge of septic tanks that are in accordance with the standards and the importance of managing septage well.

413. There are three interrelated determinants of whether someone is willing or not to be an LLTT customer: (i) the availability of LLTT service infrastructure, (ii) LLTT promotion factors, and (iii) supporting environmental factors.

414. The socialization and marketing of the LLTT program should be carried out in the following seven stages: (i) Organizing a Social Marketing Team, (ii) Determination of the Budget, (iii) Determination of Marketing Areas, (iv) Determination of Marketing Targets, (v) Target Market Analysis, (vi) Product Information Development, and (vii) Planning and Implementation of Socialization and Promotion.

415. Monitoring (supervision) is an activity of monitoring program implementation while it is in progress, whereas evaluation is the measurement of program impact after the program is completed. In monitoring, the point is to ensure that every activity in the program is carried out in accordance with the plan, whereas, in evaluation, the point is to assess whether the work program implemented was in accordance with the results envisaged.

APPENDIX 1: REFERENCES

The following is a list of references that have been used in the preparation of this report. The references follow an alphabetical order of the publishing institution or the last name of the first author. The internet links, where provided, are valid as of May 2018.

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APPENDIX 2: VACUUM TRUCK DISCHARGES TO THE TALANG BAKUNG IPLT

VACUUM TRUCK DISCHARGES TO IPLT						
Date	**No. Trucks**	**Total Volume (m3)**	**Detail**			
10/10/2017	4	14,5	3x4+2,5			
11/10/2017	2	6,5	4+2,5			
12/10/2017	6	21,0	2x2,5+4x4			
13/10/2017	1	2,5				
14/10/2017	1	4,0				
17/10/2017	2	5,0	2x2,5			
18/10/2017	12	34,0	8x2,5+6x4			
19/10/2017	7	20,5	2x4+5x2,5			
20/10/2017	6	18,0	2x4+4x2,5			
23/10/2017	2	19,5	3x4+3x2,5			
25/10/2017	4	14,5	3x4+2,5			
27/10/2017	5	15,5	2x4+3x2,5			
28/10/2017	4	14,5	3x4+2,5			
29/10/2017	1	2,5				
30/10/2017	2	8,0	2x4			
31/10/2017	1	2,5				
01/11/2017	2	5,0	2x2,5			
02/11/2017	3	7,5	3x2,5			
03/11/2017	3	7,5	3x2,5			
04/11/2017	1	2,5				
06/11/2017	4	10,0	4x2,5			
07/11/2017	3					
08/11/2017	5					
09/11/2017	2					
10/11/2017	2					
11/11/2017	5					
13/11/2017	3					
14/11/2017	2					
15/11/2017	4					
16/11/2017	3					
17/11/2017	1					
18/11/2017	3					
20/11/2017	4					
21/11/2017	3					
22/11/2017	1					
23/11/2017	2					
24/11/2017	1					
25/11/2017	2					
27/11/2017	2					
28/11/2917	1					
29/11/2017	1					
30/11/2017	1					
01/12/2017	2					
03/12/2017	2					
04/12/2017	3					
05/12/2017	2					
06/12/2017	1					
07/12/2017	2					

VACUUM TRUCK DISCHARGES TO IPLT						
Date	No. Trucks	Total Volume (m3)	Detail			
08/12/2017	2					
09/12/2017	2					
10/12/2017	2					
11/12/2017	2					
12/12/2017	1					
13/12/2017	1					
14/12/2017	2					
15/12/2017	2					
16/12/2017	2					
18/12/2017	1					
19/12/2017	3					
20/12/2017	2					
23/12/2017	2					
24/12/2017	1					
25/12/2017	3					
26/12/2017	3					
27/12/2017	3					
29/12/2017	3					
30/12/2017	3					
31/12/2017	2					
01/01/2018	2					
02/01/2018	2					
03/01/2018	3					
04/01/2018	2					
05/01/2018	2					
06/01/2018	2					
07/01/2018	2					
08/01/2018	3					
09/01/2018	2					
10/01/2018	1					
11/01/2018	2					
12/01/2018	2					
13/01/2018	3					
14/01/2018	4					
15/01/2018	1					
16/01/2018	2					
Total:	**213**					
Data Summary:						
Period: 10 Oct. 2017 - 16 Jan. 2018 = 99 days						
Total number of trucks: 213						
Number of trucks per day: 2,1 trucks/day						
Average volume per truck = 3,23 m^3/truck (based on data between 10 Oct. and 6 Nov.)						
Average volume per day = 6,8 m^3/day, rounded to 7 m^3/day.						

APPENDIX 3: SEPTAGE SAMPLING AND ANALYSIS AT THE TALANG BAKUNG IPLT

SEPTAGE SAMPLING AND ANALYSIS AT THE TALANG BAKUNG IPLT (MG/L)												
INLET												
Date	Solids Separation Chambers				Sludge Drying Beds				Anaerobic Pond			
	TSS	BOD	COD	BOD/COD	TSS	BOD	COD	BOD/COD	TSS	BOD	COD	BOD/COD
22/01/2016	1.067	484			1.067	484						
07/03/2016	1.067	ttd	1.650		324	348	865	0,40	86	70	265	0,26
14/03/2016	923	324	1.650	0,20	407	222	933	0,24	89	26	313	0,08
21/03/2016	325	37	972	0,04	58	52	529	0,10	561	29	561	0,05
28/03/2018	1.067	746	1.650	0,45	447	416	1.650	0,25	111	264	272	0,97
04/04/2016	580	74	1.296	0,06	590	64	1.262	0,05	126	30	333	0,09
11/04/2016	1.067	120	1.650	0,07	813	74	1.140	0,06	233	10	334	0,03
18/04/2016	1.067	206	1.650	0,12	1.067	194	1.149	0,17	258	64	403	0,16
25/04/2016	132	146	347	0,42	52	37	247	0,15	132	146	347	0,42
02/05/2016	543	156	740	0,21	1.067	292	1.650	0,18	264	30	376	0,08
09/05/2016	135	92	443	0,21	56	116	199	0,58	161	96	374	0,26
16/05/2016	300	18	1.157	0,02	369	98	782	0,13	225	48	444	0,11
23/05/2016	277	362	991	0,37	850	188	1.368	0,14	178	168	422	0,40
30/05/2016	1.067	502	1.650	0,30	1.067	224	1.650	0,14	144	20	399	0,05
06/06/2016	1.067	252	1.650	0,15	347	220	1.650	0,13	163	20	548	0,04
13/06/2016	105	128	422	0,30	148	130	626	0,21	181	88	472	0,19
20/06/2017	ttd	ttd	ttd		432	240	432	0,56	162	80	85	0,94
27/06/2016	164	182	648	0,28	101	162	228	0,71	191	120	185	0,65

11/07/2016	1.067	94	1.650	0,06	142	158	1.092	0,14	130	64	401	0,16
18/07/2016	249	106	904	0,12	243	124	1.120	0,11	191	100	840	0,12
25/07/2016	1.067	216	496	0,44	279	94	1.650	0,06	200	316	559	0,57
01/08/2016	207	24	371	0,06	36	22	126	0,17	221	322	511	0,63
08/08/2016	232	54	244	0,22	400	170	998	0,17	100	68	546	0,12
15/08/2016	ttd	ttd	ttd		66	36	542	0,07	224	56	191	0,29
22/08/2016	263	124	1.650	0,08	122	262	781	0,34	202	34	461	0,07
29/08/2016	920	150	932	0,16	90	40	376	0,11	179	2	476	0,00
05/09/2016	ttd	ttd	ttd		222	82	170	0,48	52	122	466	0,26
13/09/2016	198	84	881	0,10	62	58	247	0,23	192	10	539	0,02
19/09/2016	236	128	563	0,23	43	92	256	0,36	80	52	494	0,11
26/09/2016	236	148	1.650	0,09	681	986	1.650	0,60	308	16	16	1,00
03/10/2016	359	116	1.650	0,07	225	14	330	0,04	270	24	695	0,03
10/10/2016	1.067	150	936	0,16	190	398	427	0,93	82	94	477	0,20
17/10/2016	106	848	480	1,77	65	134	662	0,20	89	66	422	0,16
24/10/2016	408	134	400	0,34	190	158	315	0,50	241	80	197	0,41
31/10/2018	46	74	131	0,56	71	58	187	0,31	243	48	480	0,10
07/11/2016	52	110	258	0,43	54	112	184	0,61	186	26	479	0,05
14/11/2016	789	160	1.129	0,14	43	74	140	0,53	217	68	437	0,16
21/11/2016	157	170	1.650	0,10	187	22	585	0,04	229	18	699	0,03
28/11/2016	180	656	720	0,91	82	240	410	0,59	83	78	391	0,20
24/02/2017	424	74	905	0,08	72	58	194	0,30	375	114	1.424	0,08

26/05/2017	305	548	1.684	0,33	149	698	1.177	0,59	53	144	521	0,28
24/08/2017	558	88	725	0,12	316	146	701	0,21	629	12	1.076	0,01
24/11/2017	1.067	434	1.650	0,26	116	90	626	0,14	162	166	1.650	0,10
Mean	**529**	**218**	**1.031**	**0,26**	**312**	**183**	**745**	**0,29**	**195**	**81**	**490**	**0,24**

SEPTAGE SAMPLING AND ANALYSIS AT THE TALANG BAKUNG IPLT (MG/L)					
OUTLET					
Date	**TDS**	**TSS**	**BOD**	**COD**	**BOD/COD**
24/02/2017	467	97	30	230	0,13
27/03/2017	-	165	40	-	-
26/05/2017	442	70	24	186	0,13
18/07/2017	-	290	10	424	0,02
24/08/2017	411	35	12	281	0,04
14/09/2017	-	81	16	343	0,05
24/11/2017	526	59	132	1229	0,11
Mean	**462**	**114**	**38**	**449**	**0,08**

APPENDIX 4: TEMPLATE FOR ON-SITE WASTEWATER TREATMENT AND DISPOSAL PERMIT APPLICATION

ON-SITE WASTEWATER TREATMENT AND DISPOSAL PERMIT APPLICATION

To the Government of the City of Jambi:

A. THE UNDERSIGNED, being the ____
(Owner, Owner's Agent)

of the property located at ____
Number Street

DOES HEREBY REQUEST a permit to ______________________________ an on-site
(Install, Use)

wastewater treatment facilities to serve the

____ at said location.
(Residence, Commercial Building, etc.)

1. The proposed and/or existing facilities include: __________________________________

____

2. A plan of the property showing accurately all on-site treatment systems and appurtenant facilities, such as septic tanks, wells, percolation areas, outlets, drains, etc. now existing is attached hereunto as Appendix "A".

3. Plans and specifications covering any work proposed to be performed under this permit is attached hereunto as Appendix "B".

4. The area of the property is ________ square meters (m^2).

5. The existing facility has a volume of about ________ cubic meters (m^3, and the

   effluent ____
   (is discharged to a percolation area, stormwater drain, channel, creek, etc.; has no outlet)

6. The name and address of the person to be served by the proposed facilities is:

____.

7. The maximum number of persons to be served by the proposed facilities is: ___________.

8. The locations and nature of all sources of private or public water supply within the thirty (30) meters of any boundary of said property are shown on the plat attached hereunto as Appendix "B".

B. In consideration of the granting of this permit, THE UNDERSIGNED AGREES:

1. To furnish any additional information relating to the proposed work that shall be

   requested by the ______________________________________.
   (City Government, Service Delivery Organization)

2. To accept and abide by all provisions of the Regulation of the City of Jambi on Urban Wastewater Management as well as of all other pertinent regulations or ordinances that may be adopted in the future.

3. To operate and maintain the wastewater disposal facilities covered by this application in a sanitary manner at all times, in compliance with all requirements of the City of Jambi and at no expense to the City of Jambi.

4. To notify the City Government at least twenty-four (24) hours prior to commencement of the work proposed, and again at least twenty-four (24) hours prior to the covering of any underground portions of the installation.

5. To notify the City Government at least forty-eight (48) hours prior to the necessity of scheduled or unscheduled desludging.

6. To pay the on-site wastewater management fee set up in the wastewater management regulation and all other fees that may be adopted in the future in order to cover scheduled desludging and septage transport and treatment.

DATE: ______________________________ SIGNED: ____________________________

(Applicant)

____

(Address of Applicant)

Rp. ______________________ on-site wastewater management fee paid.

____

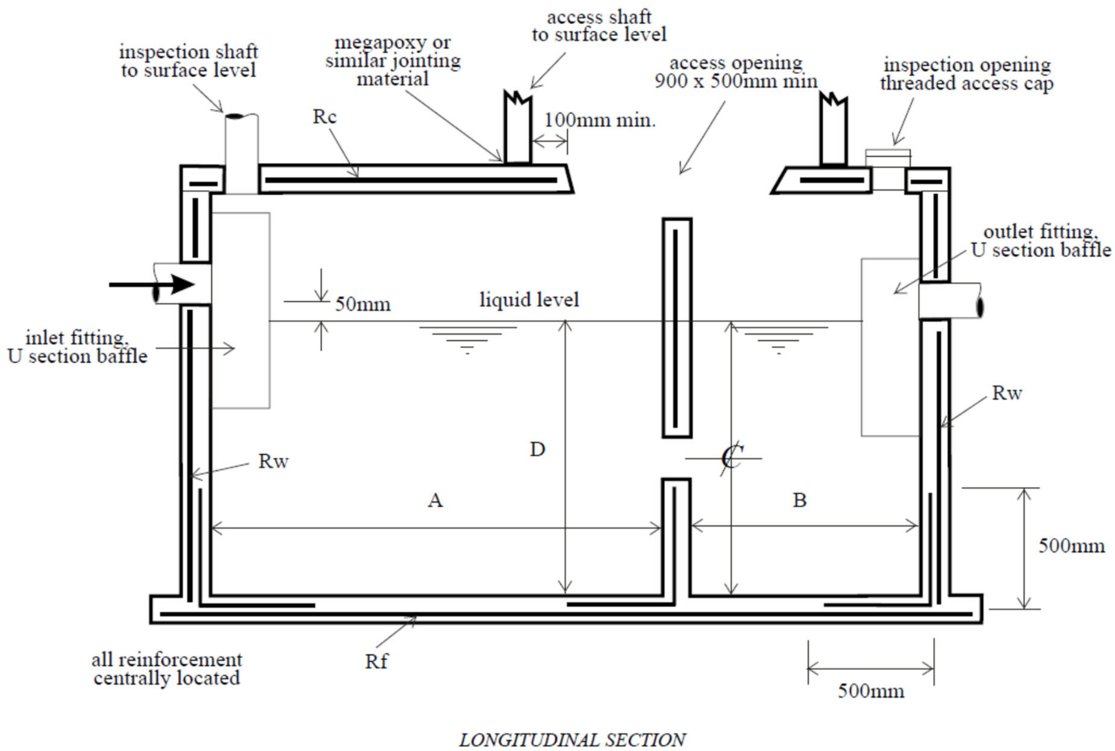
(Certification by the Treasurer of the City of Jambi)

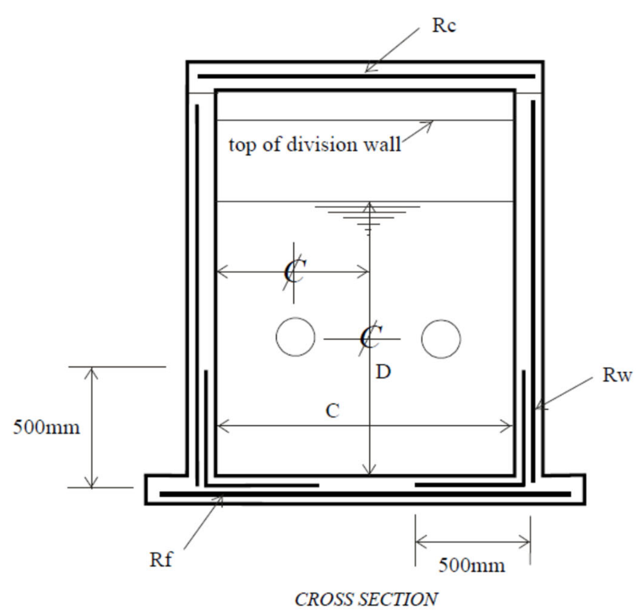
Application approved, and permit issued:

DATE: ______________________________ SIGNED: ____________________________

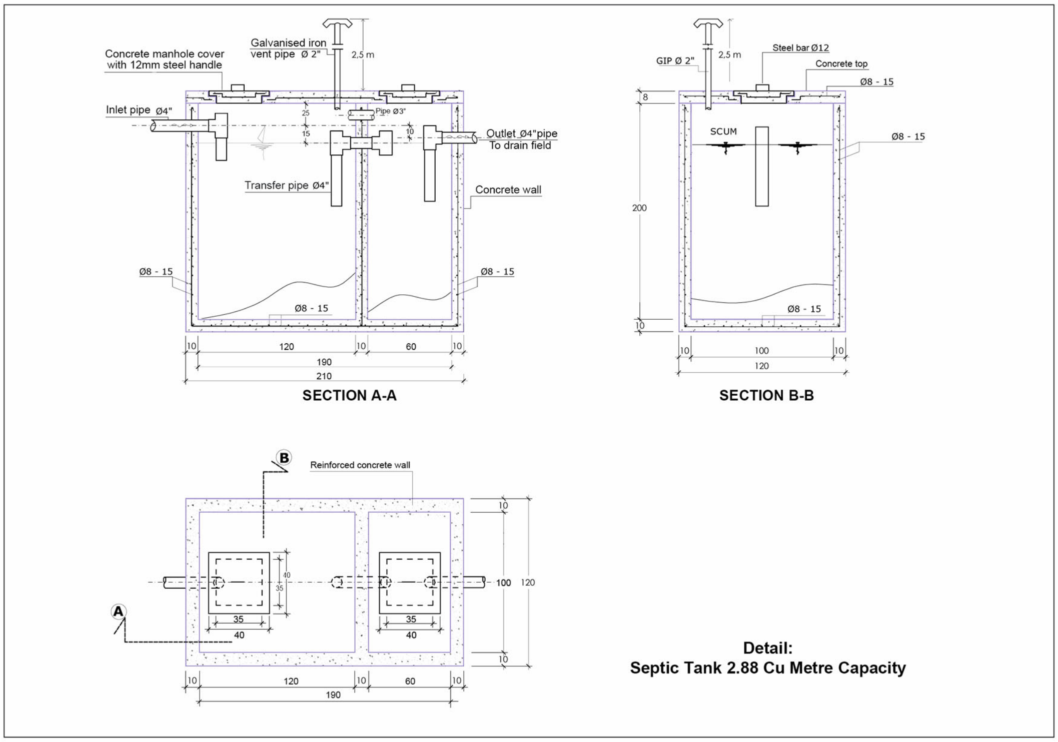
(Government of the City of Jambi)

APPENDIX 5: TYPICAL SEPTIC TANK SYSTEM DESIGN DRAWINGS

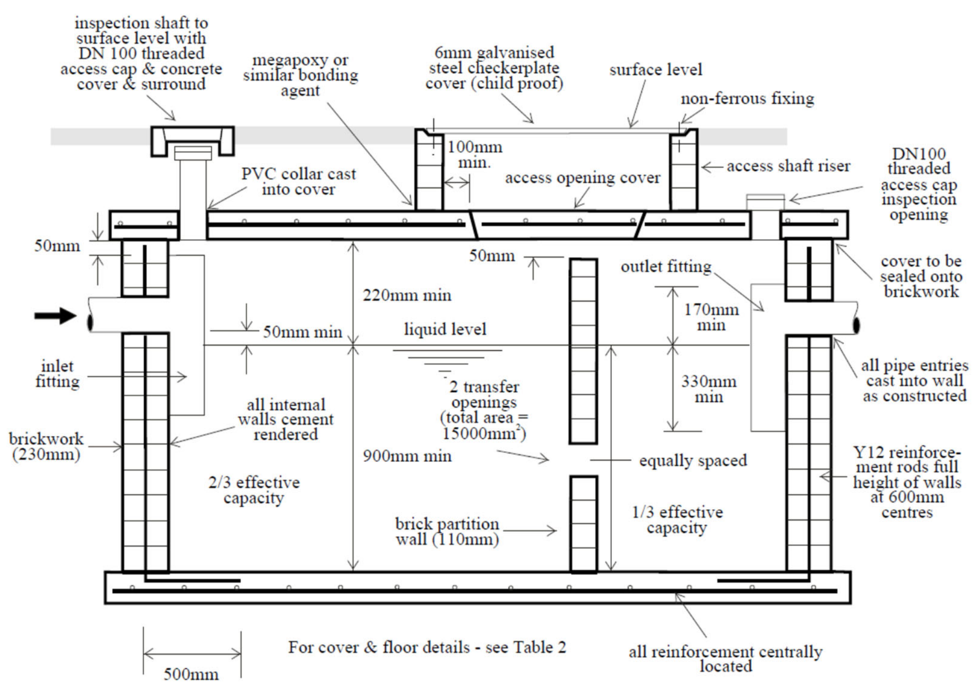




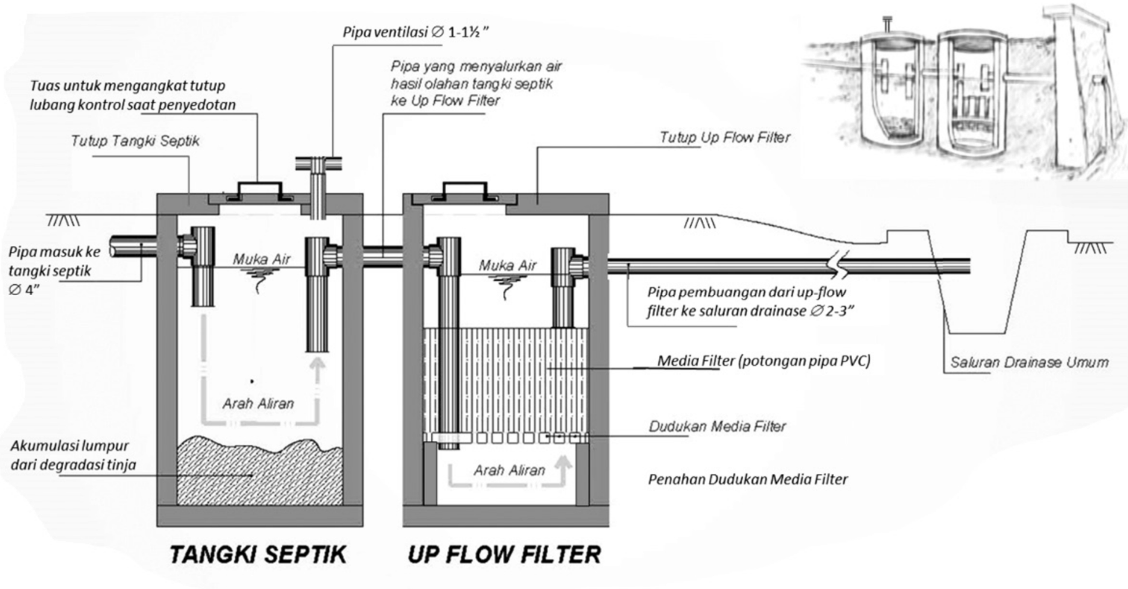
Cast In Situ Reinforced Concrete Septic Tank (Source: South Australian Health Commission Code, 1995)



Typical Two-Chambered Reinforced Concrete Septic Tank Drawings (Source: http://cm-bbs.net/)



Typical Rectangular Brick Septic Tank (Source: South Australian Health Commission Code, 1995)



Cylindrical Septic Tank Combined with an Up-Flow Filter for Small Households (Source: MWPH, 2016)

Installation of Control Box, Septic Tank and Up-Flow Filter (Source: Ibidem)

Filter Media for Up-Flow Filter (Source: Ibidem)

PT Biosung Fibertek Indonesia

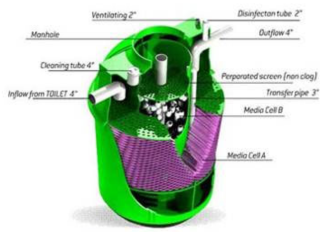
SEPTIC TANK BIOTECH

Jalan Raya Kosambi Timur no.23. Dadap, Kosambi, Tangerang, 15212

Telp : 0812 991 992 00 / 0878 8608 3000 Fax : 021-29 300 900

DAFTAR HARGA SEPTIC TANK BIOTECH TIPE BT SERIES

1. BT - 06
   - Kapasitas : 2 – 4 orang
   - Dimensi : T (120 CM), D (90 CM)
   - Volume : 800 Liter
   - Harga : Rp 4.000.000
2. BT - 08
   - Kapasitas : 6 – 8 orang
   - Dimensi : T (140 CM), D (110 CM)
   - Volume : 1200 Liter
   - Harga : Rp 5.000.000
3. BT - 12
   - Kapasitas : 8 – 12 orang
   - Dimensi : T (160 CM), D (120 CM)
   - Volume : 1800 Liter
   - Harga : Rp 6.000.000
4. BT - 15
   - Kapasitas : 15 – 25 orang
   - Dimensi : T (200 CM), D (220 CM)
   - Volume : 4000 Liter
   - Harga : Rp 25.000.000
5. BT - 16
   - Kapasitas : 25 – 35 orang
   - Dimensi : T (230 CM), D (220 CM)
   - Volume : 5000 Liter
   - Harga : Rp 30.000.000



Keterangan :

- Harga Diatas BELUM termasuk diskon (Franco Jakarta)
- Diskon Tergantung dari jumlah order
- Free Ongkir khusus wilayah JABODETABEK
- Hubungi segera untuk info DISKON (0812 991 992 00)

SEPTIC TANK BIOFIL

Telp. 021 - 2903 0818, 0852 11 300 300 , Fax. 021 - 2903 0817, Email: biofil@yahoo.co.id

DAFTAR HARGA SEPTIC TANK BIOFIL

1 **BF - 03**
- Kapasitas : 2 - 4 Orang
- Dimensi : 0,90 x 0,90 x 1,25 m
- Volume : 1,000 lt
- Harga : Rp. 8.300.000,-

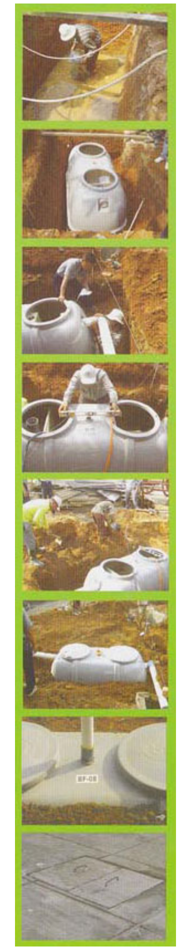
2 **BF - 04**
- Kapasitas : 4 - 6 Orang
- Dimensi : 1,175 x 1,05 x 1,5 m
- Volume : 1,850 lt
- Harga : Rp. 9.600.000,-

3 **BF - 06**
- Kapasitas : 6 - 8 Orang
- Dimensi : 1,43 x 1,00 x 1,5 m
- Volume : 2,145 lt
- Harga : Rp.11.700.000,-

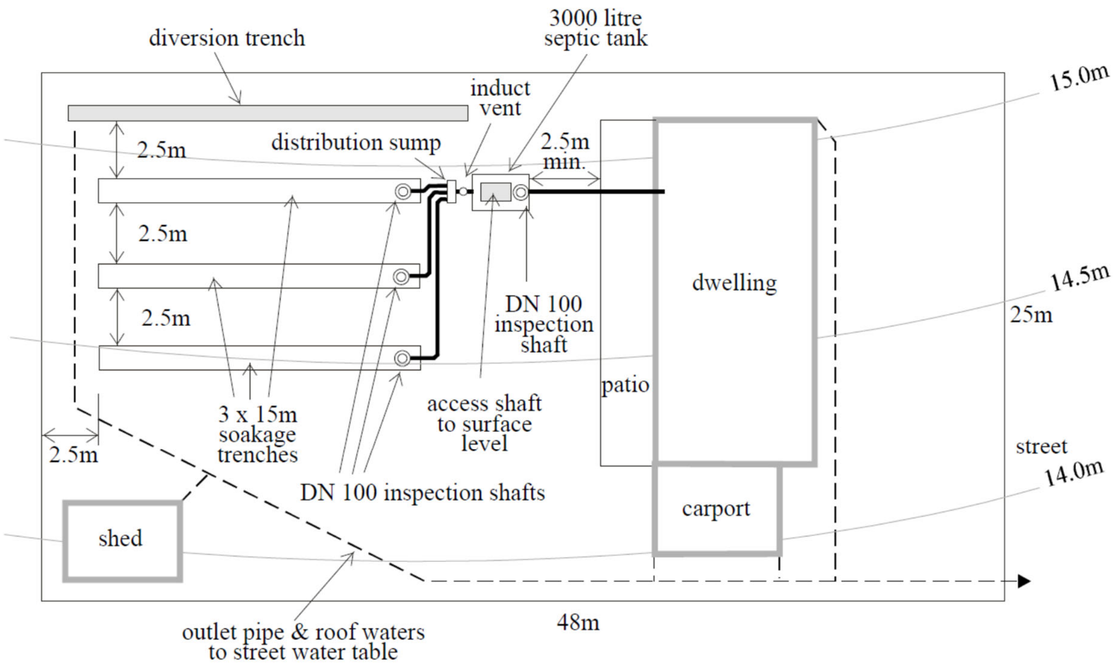
4 **BF - 08**
- Kapasitas : 8 - 12 Orang
- Dimensi : 2,00 x 1,00 x 1, 5 m
- Volume : 3,000 lt
- Harga : Rp. 13.600.000,-

Catatan:

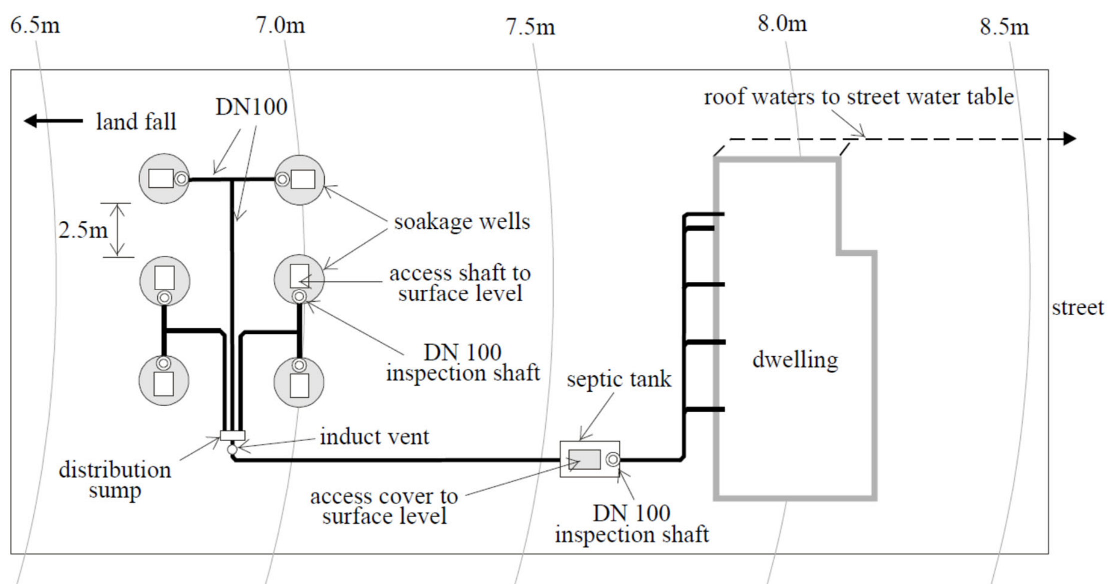
- Harga dan Spesifikasi diatas sewaktu waktu dapat beruah tanpa pemberitahuan terlebih dahulu
- Franco Jakarta



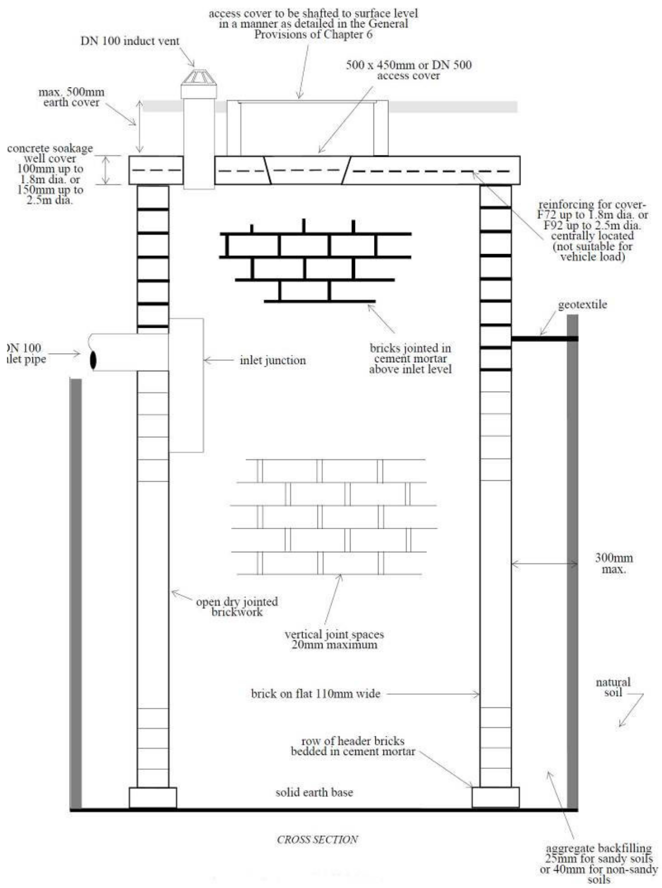
Prefabricated Compact Fiberglass Septic Tanks Combined with Biofilters Available in Indonesia



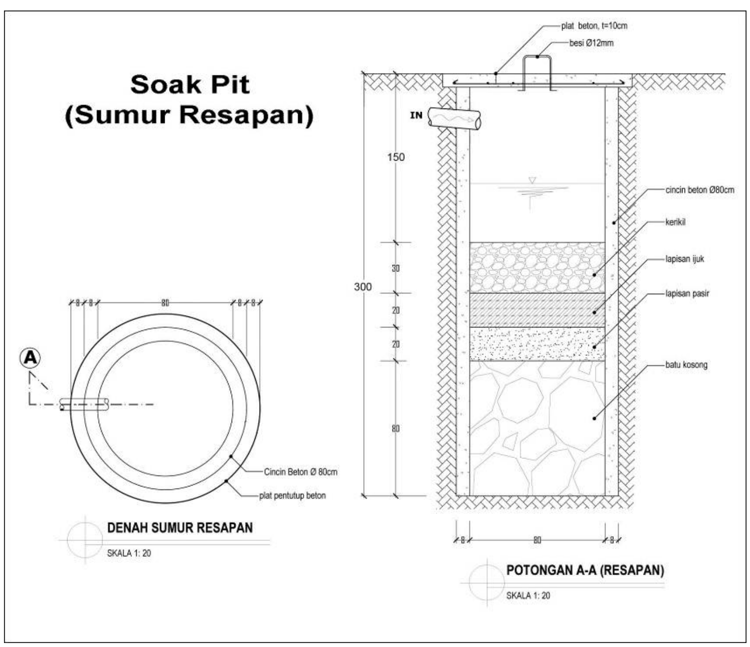
Typical Percolation System Layout with Soakage Trenches (Source: South Australian Health Commission Code, 1995)



Typical Percolation System Layout with Soak Pits (Source: South Australian Health Commission Code, 1995)



Typical Soak Pit Design (Source: South Australian Health Commission Code, 1995)



Typical Soak Pit Design (Source: http://cm-bbs.net/)

APPENDIX 6: SAMPLE HAULED WASTEWATER DISCHARGE MANIFEST

SAMPLE HAULED WASTEWATER DISCHARGE MANIFEST

1. WASTEWATER STREAM IDENTIFICATION (MUST BE COMPLETED BY HAULER)

a) Volume (liters) ______

b) Type: ___ Holding Tank ___ Septic Tank ___ Other

c) Source: ___ Resident ___ Restaurant ___ Office/commercial

___ Portable toilet ___ Industrial ___ Other

2. GENERATOR OF WASTEWATER

a) Complete name: ____

b) Phone number: ____

c) Complete pick up address:

____

NOTE: ALL WASTEWATERS ARE SUBJECT TO THE RULES AND REGULATIONS AND TERMS AND CONDITIONS OF THE JAMBI CITY GOVERNMENT.

The undersigned being duly authorized does hereby certify to the accuracy of the source and type of hauled wastewater identified above and subject to this manifest.

Date: ______________ Signature: _________________________________

3. HAULER OF WASTEWATER

a) Company Name: ____

b) HWD Permit #: ______ c. Vehicle License #: ______

d. Desludge date: _______

4. ACCEPTANCE BY UPTD-PAL OF THE CITY OF JAMBI

The above hauler delivered the described wastewater to this disposal facility and it was accepted.

Disposal date: ________________ Sample ID# (if required): _________

Signature of authorized agent and title: ___________________________

The above described wastewater was picked up and hauled by me to the disposal facility name below and was discharged. I certify under penalty of perjury that the foregoing is true and correct:

Signature of authorized agent and title: ___________________________