ANNEX IV - CONCESSION TECHNICAL SPECIFICATIONS

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1 INTRODUCTION

This report presents a description of the operational activities to be performed by the CONCESSIONAIRES in the operation of the various units integrating the water supply systems (WSS) and sanitation systems (SAS).

To this end, the present document describes the main typical operational routines for each type of facility/unit of the water supply and sanitation systems.

It is important to emphasize that this ANNEX should be understood as a collection of general guidelines, which aim to standardize practices and conducts in the operation of the water supply and sanitation systems, in order to achieve the established service and performance targets and best engineering, management, commercial, financial and socio-environmental practices.

The actions, strategies and investments required to achieve the established targets must be presented by each CONCESSIONAIRE in a Master Plan, covering each municipality of the respective concession block, over the 35 years of the concession.

The specific operational routines shall be detailed by the CONCESSIONAIRES, through Operation and Maintenance Manuals, for each of the existing operational facilities, as well as the monitoring of the results obtained.

Finally, this ANNEX also addresses other general aspects, such as: master plan, corporate governance and *compliance*, user awareness, maintenance deadlines - user interface, integrated information system, operational control center, energy efficiency optimization program, technical and consumer registration program, water loss reduction and control program, hydrometer coverage program, personnel training and qualification program, contingency plans, fraud elimination programs and social-environmental programs.

2 DESIGN AND CONSTRUCTION TECHNICAL OBLIGATIONS

Conceptually, a Standard is a document established by consensus and approved by a recognized body, which provides rules, guidelines or minimum characteristics for particular activities or their results, aiming to achieve an optimal level of orderliness in a given context.

The standard is, in principle, of voluntary use, but it is almost always used because it represents a consensus on the state of the art of a certain subject, obtained among specialists of the stakeholders.

In the development of the designs and construction of the various units that make up the water supply and sewage systems, the Standards of the Brazilian Association of Technical Standards (ABNT) applicable to each case, in its most recent versions, shall be followed. We highlight some of these standards below:

- NBR 5.681/80 - Technological Control of Execution and Landfills in Construction Works.
- NBR 6.122/80 - Design and Execution of Foundations.
- NBR 6.146/80 - Electrical equipment casings - Protection - Specification
- NBR 7968/83 - Nominal diameters in sewer pipes in the distribution network, pipelines, sewage collection networks interceptor sewer.
- NBR 6.459/84 - Soil - Determination of Liquidity Limit.
- NBR 6.493/84 - Employment of Fundamental Colors for Industrial Piping.
- NBR 9.649/86 - Sanitary sewer collection system design.
- NBR 9.814/86 - Execution of sanitary sewer collection system.
- NBR 10.844/89 - Stormwater service connections.
- NBR 12.207/92 - Interceptor sewer design.
- NBR 12.208/92 - Sewage lifting stations design.
- NBR 12.209/92 - Sewage treatment plants design.
- NBR 12.215/91 - Design of water pipeline for public supply.
- NBR 12.211/92 - Design studies of public water supply systems.
- NBR 12.213/92 - Design of surface water abstraction for public supply.
- NBR 12.214/92 - Design of water lifting system for public supply.
- NBR 12.216/92 - Design of water treatment plant for public supply.
- NBR 12.266/92 - Design and execution of trenches for the laying of water, sewage or urban drainage pipes
- NBR 12.586/92 - Water Supply System Registration.
- NBR 12.587/92 - Sanitation System Registration.
- NBR 7.195/93 - Colour in Occupational Safety.
- NBR 7.678/93 - Safety in the Execution of Construction Works and Services.
- NBR 7.229/94 - Design, construction and operation of septic tank systems.
- NBR 12.217/94 - Design of water distribution tank for public supply.
- NBR 12.218/94 - Design of water distribution network for public supply.

- NBR 13.133/94 - Execution of topographical survey.
- NBR 12.655/95 - Concrete - Preparation, control and receipt
- NBR 5.626/98 - Cold water service connections.
- NBR 7.367/98 - Design and laying of rigid PVC pipes for sanitation systems.
- NBR 8.160/99 - Sewer service connection systems.
- NBR 14.565/99 - Basic procedures for the preparation of cabling designs
- NBR 5.419/01 - Protection of structures against atmospheric discharges
- NBR 6.484/01 - Execution of Simple Soil Surveys.
- NBR 14.039/03 - High voltage electrical installations (from 1.0 kV to 36.2 kV).
- NBR 6118/04 - Design and execution of reinforced concrete works.
- NBR 10.004/04 - Solid waste.
- NBR 7.362/05 - Rigid PVC Pipe with Elastic Joint for Sewer Main.
- NBR 6.118//04 - Concrete structure design - procedure.
- NBR 5.410/05 - Low Voltage Electrical Installations.
- NBR 12.212/06 - Groundwater well design.
- NBR 7.212/12 - Execution of concrete batched in plant.
- NBR 12.655/15 - Portland cement concrete.
- NT-202.R-10 - Criteria and Standards for Discharge of Liquid Effluents into Inland or Coastal, Surface or Underground Water in the State of Rio de Janeiro.

For any services not covered by national technical standards, it is necessary to consider the criteria and parameters established in specialized literature.

3 TARGETS

3.1 Service Targets

The service targets established in the Project are 99% for the water supply system and 90% for the sanitation system.

The year that each municipality must achieve the stipulated targets is in accordance with the current service rate and the population of the municipality, according to the following criteria:

Service	Water Supply		Sewage Collection	
	> 70%	< 70%	> 70%	< 70%
Rio de Janeiro	8 years		15 years	
Municipality with population > average population - CEDAE Study Area	10 years	12 years	15 years	18 years
Municipality with population < average population - CEDAE Study Area	12 years	14 years	18 years	20 years

The population average refers to the average urban population of the municipalities served by CEDAE, based on the 2010 IBGE census, of approximately 103,250 inhabitants.

The municipalities whose river basins flow into the Guandu River are excluded from this general criterion in order to minimize, in the shortest term, the contamination of the main source of the RMRJ: Eng. Paulo de Frontin, Itaguaí, Japeri, Miguel Pereira, Paracambi, Piraí, Queimados, Rio Claro, Seropédica and Vassouras.

The following Table 1 to Table 4 are the WSS and SAS service targets for the locations covered, grouped by concession blocks, with year 1 being the year of start of the concession. The percentage of service is detailed for every five years for each municipality in the Performance Indicators Annex.

Table 1 - Year of concession for meeting the WSS and SAS universalization targets of the municipalities of Block 1

Municipality	Year of concession for meeting the Target		Municipality	Year of concession for meeting the Target	
	WSS	SAS		WSS	SAS
Aperibé	12	20	Natividade	12	18
BOM JARDIM	14	20	Porciúncula	12	20
Bom Jesus do Itabapoana	12	20	Quissamã	12	20
Cachoeiras de Macacu	12	20	Rio Bonito	12	18
Cambuci	12	20	Rio das Ostras	12	Note 1
Cantagalo	12	18	Rio de Janeiro Region I	8	15
Carapebus	14	20	Santa Maria Madalena	14	20
Cardoso Moreira	14	20	SÃO FIDÉLIS	12	18
Casimiro de Abreu	14	20	São Francisco de Itabapoana	12	20
Cordeiro	12	20	São Gonçalo	10	18
Duas Barras	14	20	São João da Barra	12	20
Itaboraí	10	18	São José de Ubá	14	20
Italva	12	18	São Sebastião do Alto	14	20
Itaocara	12	18	Sapucaia	12	20

Municipality	Year of concession for meeting the Target	
	WSS	SAS
Itaperuna	12	20
Laje do Muriaé	12	20
Macaé	10	Note 1
Macuco	12	20
Magé	10	18
Maricá	12	Note 2
Miracema	12	20
Saquarema	12	Note 1
Sumidouro	14	20
Tanguá	14	20
Teresópolis	10	18
Trajano de Morais	14	20
Varre-Sai	14	20

Note 1: Location with SAS under concession for private entity

Note 2: SAS operation with Maricá City Hall

Table 2 - Year of concession for meeting the WSS and SAS universalization targets of the municipalities of Block 2

Municipality	Year of concession for meeting the Target	
	WSS	SAS
Barra do Piraí	12	18
Miguel Pereira	12	5
Paraíba do Sul	12	20
Paty do Alferes	14	20
Pinheiral	12	20
Rio de Janeiro Region II	8	15
Valença	12	20
Vassouras	12	5

Table 3 - Year of concession for meeting the WSS and SAS universalization targets of the municipalities of Block 3

Municipality	Year of concession for meeting the Target	
	WSS	SAS
Angra dos Reis	10	18
Eng. Paulo de Frontin	5	5
Itaguaí	5	5
Mangaratiba	12	20
Paracambi	5	5
Pirai	12	5
Rio Claro	5	5
Rio de Janeiro Region III	8	Note 1
Seropédica	5	5

Note 1: Location with SAS under concession for private entity

Table 4 - Year of concession for meeting the WSS and SAS universalization targets of the municipalities of Block 4

Municipality	Year of concession for meeting the Target		Municipality	Year of concession for meeting the Target	
	WSS	SAS		WSS	SAS
Belford Roxo	10	18	Nova Iguaçu	10	18
Duque de Caxias	12	18	Queimados	5	5
Japeri	5	5	Rio de Janeiro Region IV	8	15
Mesquita	10	18	São João de Meriti	10	Note 1
Nilópolis	10	18			

Note 1: Local with sewerage under concession for private entity

3.2 Water Loss and Hydrometer Coverage Targets

The total water loss target (physical loss and apparent loss) is 25% and this target shall be measured from the 5th year of the AGREEMENT. A linear decrease over 10 years was considered, and the target for loss reduction shall be measured annually.

The physical or real loss refers to the volume of water made available in the system by the water contractors that is wasted during the distribution process, and the apparent or commercial water loss is the volume of water that, despite the water distribution arriving at the final consumer, the product is not properly billed, either due to technical problems in the measurement by the hydrometers, or for lack of measurement or consumer fraud.

The hydrometer coverage index target is 100% for all locations, to be achieved gradually within 5 years as from the start of operation of the system.

The tables with the respective annual water loss rates are presented for each municipality in the Performance Indicators annex.

3.3 Dry Weather Collector

In the following locations it is provided for the construction of dry weather collectors, to be implemented within the first 05 years of the concession: Belford Roxo, Duque de Caxias, Mesquita, Nilópolis, Nova Iguaçu, Rio de Janeiro, Itaboraí and São Gonçalo and their respective districts.

For these locations, the proposal is to postpone the extension of the sanitation system (*delay*) for 5 years, maintaining only the inertial growth while the dry weather collector system is under implementation.

The system consists of a structure for collecting (or intercepting) sewage in the stormwater galleries and in water courses that receive the sewage *in natura*, followed by screening of the coarse material and routing to the nearest sewage treatment plant, through existing or to be built sewer mains, lifting stations and discharge lines.

Extensions or renovations to existing Treatment Plants or the construction of new Treatment Plants shall not be considered as investments in dry weather collector system, as neither shall the interceptor sewers, lifting stations and their discharge lines, which will also be used by the separation network to be implemented.

The sewage interception structures are sized to collect water flow in dry weather periods and when it rains any excess follows the normal course of the mains or watercourses.

The implementation of the dry weather collector system is planned in order to minimize the pollution of the Guanabara Bay and its tributary bodies, the Guandu River, which is the main source of the RMRJ (Nova Iguaçu case) and to improve the balneability of the beaches and lagoons.

The site for the implantation of the dry weather collector structures shall result from a joint analysis of all available elements on the area reserved for this purpose.

The CONCESSIONAIRE will be responsible for defining the most appropriate and most pressing locations for the implementation of the dry weather collector structures as well as for designing and executing all the structures required for transportation to the existing or to be built treatment plants. In the preparation of the planning, the CONCESSIONAIRE should prioritize the following areas:

(i) Regions with a sewage system not connected to a STP; and

(ii) (ii) area without a sewage system, but with the possibility of sending the collected sewage through dry weather collector to an existing STP (even if the STP needs some intervention)

The CONCESSIONAIRE shall submit to the REGULATORY AGENCY, within 6 months after the execution of the AGREEMENT, an investment plan for the region, informing the list of works and the amounts to be invested, year by year, for 5 years, which shall be validated by the REGULATORY AGENCY within 30 (thirty) days.

On the occasion of each ORDINARY REVIEW, a new planning for the next 4 (four) year investment cycle will be presented.

The REGULATORY AGENCY may propose changes to the plan submitted, which should be discussed with the CONCESSIONAIRE. If there are conflicts, the dispute can be submitted to arbitration.

After the conclusion of the planning and insofar as the CONCESSIONAIRE starts to make the investments, there shall be a process of accountability on the part of the CONCESSIONAIRE, for the REGULATORY AGENCY to monitor the effective realization of the investments and disbursement of the amounts set out in this ANNEX; the REGULATORY AGENCY may use an INDEPENDENT CERTIFIER, pursuant to the guidelines of ANNEX VIII - MINIMUM TERMS AND CONDITIONS FOR HIRING INDEPENDENT VERIFIER AND CERTIFIER.

The investments established for the MUNICIPALITIES, including the respective districts, for the performance of the works for implementing the dry weather collector, are the as follows:

Block 1 - Rio de Janeiro region 1 - R$ 31,500,500.00

Block 1 - Itaboraí - R$ 141,492,950.00

Block 1 - São Gonçalo - R$ 563,378,450.00

Block 1 - Total - R$ 736,371,900.00

Block II: Rio de Janeiro region 2: R$ 445,247,470.00

Block IV - Rio de Janeiro region 4- R$ 129,030,900.00

Block IV - Belford Roxo - R$ 231,743,230.00

Block IV - Duque de Caxias - R$ 528,452,980.00

Block IV - Mesquita - R$ 97,075,480.00

Block IV - Nilópolis - R$ 80,811,950.00

Block IV - Nova Iguaçu - R$ 356,255,100.00

Block IV - Total - R$ 1,423,369,640.00

In the event that the CONCESSIONAIRE does not manage to carry out the planned investment in full, the REGULATORY AGENCY shall proceed with the rebalancing of the AGREEMENT.

The control of the targets will be through the analysis of the projected and approved investment in relation to the investments actually made.

3.4 Irregular areas in the municipality of Rio de Janeiro

Irregular areas in the municipality of Rio de Janeiro are those identified by the Pereira Passos Urbanism Institute, through SABREN - Low Income Settlements System, as slums and subnormal agglomeration areas.

In the irregular areas of the city of Rio de Janeiro, it is provided for the expansion of the water supply and sewage system and the respective operation and maintenance by the CONCESSIONAIRE. However, the investments to be made in these areas will not be quantified for the purpose of calculating the universalization targets described in ANNEX III - PERFORMANCE INDICATORS AND SERVICE TARGETS. The CONCESSIONAIRE's obligation will be linked to the realization of a certain volume of investments during the first 20 (twenty) years from the execution of the AGREEMENT.

The CONCESSIONAIRE will discuss with the STATE and the REGULATORY AGENCY which will be the irregular areas where the investments shall be made, prioritizing the areas that meet the requirements (i) of urbanization or planning by the public authority and (ii) of greater safety conditions.

After this alignment, the CONCESSIONAIRE will prepare an ACTION PLAN, informing how it intends to move forward with the investments in the regions defined in mutual agreement, prioritizing, whenever possible, investments in the sanitation system, and alternative solutions in place of the universal sewage collection system may be implemented in those locations where the implementation of the universal sewage collection system is technically unfeasible.

The CONCESSIONAIRE shall submit the ACTION PLAN within 180 (one hundred and eighty) days after signing the TERMS FOR THE TRANSFER OF THE SYSTEM, for analysis and approval by the REGULATORY AGENCY within the period set out in the AGREEMENT.

On the occasion of each ORDINARY REVIEW, a new planning for the next 4 (four) year investment cycle will be presented.

The REGULATORY AGENCY may propose changes to the plan submitted, which should be discussed with the CONCESSIONAIRE. If there are conflicts, the dispute can be adjudicated by the TECHNICAL BOARD or by arbitration.

After the conclusion of the planning and insofar as the CONCESSIONAIRE starts to make the investments, there shall be a process of accountability on the part of the CONCESSIONAIRE, for the REGULATORY AGENCY to monitor the effective realization of the investments and disbursement of the amounts set out in this ANNEX; the REGULATORY AGENCY may use an INDEPENDENT CERTIFIER, pursuant to the guidelines of ANNEX VIII - MINIMUM TERMS AND CONDITIONS FOR HIRING INDEPENDENT VERIFIER AND CERTIFIER.

The investments planned for each region of Rio de Janeiro for the works of expansion of the Water Supply System and the Sanitation System in the IRREGULAR AREAS are as follows:

Rio de Janeiro Block I (region 1) - Total - R$ 125,853,000.00

Rio de Janeiro Block II (region 2) - Total - R$ 258,175,000.00

Rio de Janeiro Block III (region 3) - Total - R$ 276,540,000.00

Rio de Janeiro Block IV (region 4) - Total - R$ 890.348.000,00

The above amounts must be implemented during the first 20 (twenty) years of the CONCESSION. The assessment of the investments will be made by the REGULATORY AGENCY every 4 (four) years, considering the proportion of 1/5 (one fifth) of the total investment projected.

In the event that the CONCESSIONAIRE does not manage to carry out the investment planned for each 4-year period in full, the REGULATORY AGENCY may postpone such investment for the next 4-year period, observing the maximum limit of twenty (20) years or proceed to rebalance the AGREEMENT.

4 WATER SUPPLY SYSTEMS

The source of water for water supply systems can be surface or underground.

In the first case, usually called the conventional standard water supply system, it consists of the following main units: surface collection, water supply, water treatment plant, reservoirs, distribution networks and household connections. The supply can be subdivided into raw water supply and treated water supply. Depending on local topographic conditions, there are also lifting stations or booster pump stations for pumping the water.

In the second case, the surface collection is replaced by a well and the treatment usually consists of water disinfection and fluoridation.

Particularly for the Metropolitan Region of Rio de Janeiro, Cedae shall supply drinking water in strategically located places where macrometers will be installed by CEDAE at the water delivery points, with the CONCESSIONAIRE of each BLOCK being responsible for the installation of macrometers at the infrastructure intersection points between the BLOCKS.

The rules governing the purchase and sale of water between the Concessionaire and CEDAE are set out in the interdependence agreement.

Cedae's water supply will serve the following municipalities:

- Guandu/Lajes/Acari System: Belford Roxo, Duque de Caxias, Itaguaí, Japeri, Mesquita, Nilópolis, Nova Iguaçu, Paracambi, Rio de Janeiro, São João do Meriti and Seropédica;
- Imunana-Laranjal System: São Gonçalo and Paquetá Island, in Rio de Janeiro.

Also through the Imunana-Laranjal System, CEDAE will supply raw water to Itaboraí, with the installation of a macrometer in the existing raw water pipeline that feeds this location.

The flow provided by Cedae will have instantaneous and continuous measurement, with *online* data transmission to the Operational Control Centers of each concessionaire.

In principle, the locations of interface between the CEDAE and the CONCESSIONAIRE are the following:

- Imunana/Laranjal System: delivery points located at the exit of the treated water pipeline from the Amendoeira reservoir, at Laranjal WTP; at the exit of the Inoã booster (provisional macrometer until the system starts operating from the reservoir on the Tanguá River); and in 03 (three) meters in the raw water sub-pipelines that feed the 3 water treatment plants in Itaboraí.

- Ribeirão das Lajes System: delivery points located at the exit of the Ribeirão das Lajes Treatment Unit (TU);

- Acari System: delivery points located at the exit of the 5 TUs: São Pedro, Rio d'Ouro, Tinguá, Xerém and Mantiquira.

The provisions of the INTERDEPENDENCE AGREEMENT must be observed with regard to the rules on the installation and maintenance of macrometers.

The following is a description, per unit, of the existing types, their purposes and the main operational routines, with emphasis on the fact that the concessionaire must detail the specific operational routines in the Operation and Maintenance Manuals, for each of the existing operational facilities.

4.1 Catchment

The catchment is the source of fresh surface water or groundwater used for human consumption or development of economic activities. Catchments are: rivers, lakes, dams, groundwater and aquifers.

The increase in demand for water, disorderly use of the soil, inadequate land and water use practices, lack of sanitation infrastructure, removal of vegetation, erosion and silting up of rivers and streams, and industrial activities that are carried out in violation of environmental legislation, among other factors, contribute to the increasing degradation of water sources.

The continuity of the adversities detailed above compromises water quality, exposing a significant portion of the population to diseases. Therefore, the catchment areas must be given specific attention, with the adoption of legal measures and the development of managerial instruments of protection, planning and use, in order to adapt the urban planning of the drainage basins to the uses of the water body.

4.1.1 Operational Routines of a Catchment

The operation of a catchment area is basically focused on protecting the quality of its waters. Therefore, appropriate measures must be taken so that no external actions to the environment of the source may alter or compromise the quality of the water. In this sense, despite not representing a regulatory obligation or deriving from Brazilian legislation, it is common to enclose the catchment areas, as well as to protect the riparian forests of the watercourses that are used as sources of supply.

Thus, the main operational routine of a catchment refers to the regular surveys of the area around the drainage basin used in order to identify activities or situations that may compromise the quality of the water of the source of supply. The main benefit of this inspection of the catchments the savings from a more rational use of chemicals in the treatment of the supply water. These surveys should be conducted quarterly, or at shorter periods depending on the occupation of the basin area.

4.2 Abstraction

The abstraction is the installation of a water system with the purpose to remove the water from the water supply source. It may be of a surface or underground type.

Surface abstraction is performed in springs, rivers, lakes or dams, and the water is abstracted by use of gravity or through a pumping system.

The underground abstraction is performed with wells, and the water is usually removed from the groundwater by motor pumps installed at the water level and sent to the surface by pipes.

Surface Abstraction

In the preparation of surface abstraction designs, which must observe the NBR 12.213/92, some quantitative and qualitative characteristics of the used catchments must be analyzed, of which we highlight: (i) survey of hydrological data of the basin or nearby basins; (ii) survey of fluviometric data of the watercourse under study and information on water level oscillations during periods of drought and flooding; (iii) physical, chemical and bacteriological characteristics of the water; (iv) location of current and potential polluting points in the basin; (vi) potential costs with expropriation; and (vii) availability of electric power to feed motor pump sets.

Still in the context of the surface abstraction, it is important to observe the following aspects:

- Ensure the necessary conditions for water input at any time of the year;
- Regular cleaning of level dams, water intakes and sand boxes;
- Ensure, as much as possible, the best water quality of the spring through actions of recovery and protection of surface sources;
- Ensure operation and protection against damage and obstructions;
- Favor the economy of the facilities;
- Facilitate operation and maintenance over time;
- Properly plan the construction of structures nearby or in the water, in order to facilitate possible expansions;
- Regular maintenance of floating raft structures and other equipment that might be present in the abstractions;
- Provide flood protection and
- Provide for road access throughout the year, regardless of rainfall incidence.

Underground Abstraction

With regard to underground abstraction, which must comply with NBR 12.212/06, they may consist of shallow wells or cisterns, manually excavated and covered with bricks or concrete rings, which remove water from the groundwater at depths of around 20 meters and are intended for small consumption.

For use in public supply, the underground abstraction is through deep tubular wells, geologically located, drilled with a drilling probe, with diameters ranging from 4" to 36" and depths of up to 200 meters. After drilling, cleaning is performed to remove the mud and other debris from the excavation. These wells are lined with pipes to support the walls and have filtration devices made with grooved pipes for the water passage. In addition, the wells also have a pre-filter, made with a gravel filling between the casing/filter and the well wall, whose function is to stabilize fine sediments. In addition to the structure, a cement slurry is injected between the lining and the well wall in the upper portion to prevent polluted water from entering and a concrete slab for sanitary protection is installed on site at the well entrance.

4.2.1 Operational Routines for Surface Abstraction

Generally, surface abstraction is composed of the following devices:

- Dams or spillways to maintain the level or to regulate the flow;
- Water intake units with devices to prevent floating or suspended materials from entering the water;
- Devices to control the entry of water at various levels;
- Bottom outlet devices in the case of dams;
- Suction wells and pump houses for the installation of lifting sets, when necessary.

The operation of surface abstraction is conditioned to the quality of the water collected form the catchment. Due to the variation of the room temperature, there is a recirculation of the water layers of a water body due to the change in the density of the water, thus promoting a revolving of the sedimented material at the bottom of the abstraction, making the water have different physical characteristics (color and turbidity) at different depths. Thus, the main operational routine is associated with the definition of the water intake to be used, when there are gates installed at different depths in the abstraction device.

In accumulation reservoirs, due to the fact that it works as a large sediment, a high concentration of sedimented materials near the dam may occur; in these situations, the bottom outlet of the dam or barrage must be operated in order to clean the area around the water intake, thus ensuring that the water abstracted has lower turbidity concentrations. This is a mere operational procedure and is not the subject of regulatory requirements or inspections. However, to ensure its practice as a preventive measure, the activity must be provided for in the Operation and Maintenance Manual of the operational facility, to be developed by the concessionaire.

4.2.2 Operational Routines for Underground Abstraction

Before commissioning, the deep tubular wells are submitted to a development phase that aims to increase the natural hydraulic conductivity near the well, the selective removal of fine sediments and to correct damage caused to the aquifer by the drilling (compaction, clogging, etc.). The development stabilizes the sandy formation around the well, increasing its porosity and permeability. For this purpose, regular maintenance in the well protection area (fences, floor, gates and easels) should be established.

The pumping equipment used to abstract water from tubular wells may be:

- **submerged pump** - used for pumping medium and large flows (over 3 m^3/h) at varying depths; it works with three-phase power; it is installed inside the well with an ejector tube (type of ejector that works as a jet type fluid pump) and a cable that connects the pump to a switchboard, existing on the surface;

- **injection pump** - used for pumping small and medium flows at varying depths; it usually works with three-phase power or fuel; its installation is with an injector nozzle (or foot valve) inside the well through two pipes (a thin injector tube and a coarse eductor tube), which connects the injector nozzle to the pump that is outside the well;
- **centrifugal pump** - used for pumping small flows at low depths; it works with three-phase power or fuel; it is installed outside the well with just one pipe (a thin eductor tube) that comes out of the well directly to the pump; and
- **compressor** - from an external motor (compressor) the compressed air is injected into the well through a small diameter pipe (air injector); the injected air causes the water to rise to the surface through another pipe with a larger diameter (eductor pipe).

The first operational routine of an underground abstraction refers to the pumping test to determine the exploitation flow of the well (**Q**) and the hydrodynamic parameters relating to the static and dynamic levels. The **Static Level (SL)** is the depth of the water level inside the well when it is not being pumped for a good period of time; the **Dynamic Level (DL)** is the depth of the water inside the well when it is being pumped. The difference between the static and the dynamic level, represents the **Drawdown**, i.e. how much the water level lowered inside the well when it went into operation.

The operations to drive the electric commands for pumping equipment start-up depend on the levels of the reservoirs that receive the well supply. Thus, according to the demand of the system, the level control devices of the reservoirs that receive the production of the wells must be calibrated with specific set-points, in order to automatically trigger the entry into operation of the motor pumps of the wells. Telemetry is optional, however, highly recommended.

4.3 Pipeline

The pipeline connects the abstraction to the treatment plant and/or the treatment plant to the reservoirs or the distribution network, without the existence of branches for supplying distribution networks or household connections. The pipeline design must comply with NBR 12.215/91.

With regard to the nature of the water transported, the pipelines may be of raw water, when they interconnect the abstraction to the water treatment plant, or treated water pipelines, when they interconnect the water treatment plant to the reservoirs or the distribution network.

As for the energy of water movement, the pipelines can be by gravity (penstocks) or pressurized pipelines, when the water is transported by pumping.

Several types of materials can be used when running pipelines. The choice of the most suitable material depends on a number of aspects, of which the following stand out:

- not interfere with the physical and chemical properties of the water;

- change of roughness with time (incrustations);
- Watertight;
- Chemical and mechanical resistance;
- Water pressure resistance (static, dynamic and transient);
- Cost Benefit (cost of piping, installation, construction aspects, corrosion protection needs, maintenance, etc.).

Thus, the most common materials for pipelines are: Steel, Ductile Iron, High Density Polyethylene (HDPE), Polypropylene, PVC and Fiberglass Reinforced Polyester.

Steel pipelines have the following advantages: high resistance to internal and external pressures; water tightness due to the fact that the joints are welded; availability of various diameters; competitive price especially for larger diameters and pressures. As disadvantages: little resistance to external corrosion; precautions for transport and storage; attention to thermal expansion; sizing of the tube walls regarding collapse.

With regard to Ductile Iron pipes, the following points should be highlighted: they are available in 16 diameters, ranging from 50 to 1,200 mm; 6 and 8 meter pipes available; K-7, K-9 and 1 Mpa classes available; ductility and resilience; internal coating with cement mortar; and external coating with zinc and bituminous paint.

Regarding non-iron pipes, it is worth mentioning: they are light and flexible; water tightness; chemical and abrasion resistance; less roughness; low speed (transient); no internal or external coating; and limited length by transport with up to a hundred meters without joints (undersea outfalls).

The main special and protective devices of a pipeline are:

- Flow meters and pressure controllers;
- Gate valves and butterfly valves to control the operation;
- Suction cups for air elimination and intake;
- Pressure reducing valves (PRV);
- Transition tanks for interfaces between pressurized pipelines to penstocks;
- Bottom outlets, for cleaning the pipelines; and
- Hydraulic transient protection equipment - water hammer valves, hydropneumatic reservoirs (HPR), surge tanks, *one-ways*, among others.

4.3.1 Operational Routines of a Pipeline

The main operational routine of a pipeline is focused on its filling process. The raw or treated water pipelines must be watertight and enable the water to be transported safely and economically. Considering that the pipeline when empty is full of air, its charging process for entry into operation must be carried out with great care, promoting the slow filling of the pipeline with water, so that the existing air can be gradually expelled by the suction cups installed in the upper generator of the pipeline. In the case of pressurized pipelines, this process should be even more careful, and all suction cups and bottom outlets from the line should be opened during filling to ensure complete removal of air.

Another important operational routine refers to the steel pipelines, whose occurrences of negative pressures may cause the piping to collapse. Thus, weekly inspections should be carried out on the devices installed in relation to the hydraulic transients, in order to ensure their operation in situations where there are water hammers on the lines or interruption of the electrical power supply, interrupting pressure systems. This is a mere operational procedure and is not the subject of regulatory requirements or inspections. However, to ensure its practice as a preventive measure, the activity must be provided for in the Operation and Maintenance Manual of the operational facility, to be developed by the concessionaire.

Considering the need to keep the pipelines piezometric line within the desired pressure ranges, or those established by hydraulic modeling, an important operational routine is the verification and possible calibration of the pressure reducing valves (PRV) existing in the supply lines and the regular maintenance of connections, stop valves, suction cups and relief devices, where applicable.

In order to maintain the quality of the water in the pipes, another operational action concerns the regular emptying for cleaning of the pipes, thus promoting the removal of solid materials that may hve been deposited in the lower section of the pipes.

In addition, regular inspections should be carried out to control losses and correct leaks immediately.

4.4 Water Treatment

The Water Treatment Plant (WTP) is a facility that makes it possible to purify the water taken from the catchments, adapting its quality to the standards of potability established by the Ministry of Health, by Ordinance 2.914, of 12/12/2011, and which must comply with NBR 12.216/92, and thus make it fit for consumption.

Thus, the water treatment is performed to meet several aspects:

- **Hygienic** - removal of bacteria, protozoa, viruses and other microorganisms, harmful substances, reduction of excessive impurities and high levels of organic compounds;
- **Aesthetics** - correction of color, taste and odor; and
- **Economical** - reduction of corrosivity, color, turbidity, iron and manganese

Public services must always provide healthy and good quality water. Therefore, the treatment should only be adopted and carried out after the need for such a treatment has been demonstrated and, whenever it is performed, it should only include the processes essential to obtaining the desired water quality.

The need for treatment and the required processes should then be determined on the basis of health inspections and the results of analyses (physio-chemical and bacteriological) representative of the catchment to be used as a source of supply.

A conventional water treatment plant, with full cycle, is composed of the following steps:

- **Oxidation** - it is the first step in the treatment process and consists of mixing chlorine into the water to oxidize the metals present in the water, mainly iron and manganese, which are present dissolved in water;
- **Coagulation and Flaking** - the water is mixed with a coagulant that has properties that help to form gelatinous flakes; at these stages the impurities present in the water are grouped by the action of the coagulant, in larger particles (flakes) that can be removed by the decantation process; the flocculation consists in the agitation of the water with the help of rotating paddles or the passage in chicanes, favoring the formation of the flakes; the most used reagents are aluminum sulfate and ferric chloride; if the water is acidic, with values of $pH<7$, before the addition of the coagulant a correction of the pH is carried out, with the placement of a solution of hydrated lime or sodium carbonate;
- **Decanting -** at this stage, water slowly passes through the decanters (usually rectangular shaped tanks) and the flakes formed are separated by gravity;
- **Flotation with dissolved air -** besides decantation, the flakes can also be removed from the water by the flotation process, being collected in gutters;
- **Filtration -** after passing through the decanters, the water goes to the filters, where the impurities that remained in the water are removed; the filter consists of a porous granular medium, usually sand or activated carbon, of one or more layers, installed on a drainage system, capable of retaining and removing the impurities still present in the water;
- **Disinfection -** although the water is already clean at this stage, it still receives chlorine to eliminate germs that are harmful to health and ensure the water quality in the distribution networks and reservoirs; ozonation and exposure to ultraviolet radiation are also used in the disinfection process;
- **pH correction -** in this step, if necessary, more hydrated lime is added to correct the pH of the water; this action aims to protect the pipes of the distribution networks and of the households against corrosion or incrustation;
- **Fluoridation -** at the end of the treatment process, the water receives a dosage of fluoride compound (fluorosilicic acid), a requirement of the Ministry of Health; the presence of fluoride in water prevents tooth decay, especially during the period of formation of teeth, which happens from gestation until the age of 12.

Still in the context of water treatment, it should be noted that water collected from deep wells does not usually require full treatment, but only chlorine disinfection and fluoridation. Thus, the implementation of complete treatment systems will depend on the quality of the raw water abstracted from the groundwater

The legislation regulating the standard of potability of water for human consumption and which shall be observed by the Concessionaire during the term of the Agreement is Annex XX of the **Consolidation Ordinance no. 5/2017**, of the Ministry of Health. This Ordinance *"establishes the procedures and responsibilities related to the control and monitoring of water quality for human consumption and its standard of potability, and sets out other provisions"*.

4.4.1 Operational Routines for Water Treatment

Within the water treatment process there are several permanent operational routines that ensure its effectiveness, among which the following can be highlighted:

- **Control of WTP input flow -** in order to control the volumes produced by the treatment process, WTP operators need to control and record the input flow rates into the treatment plant; these flow rates can be measured by macrometers installed in the input pipelines of the WTP or by measurements made on the Parshall flume, usually existing at the entrance of the plants;
- **Water quality control at the WTP inlet -** in order to guide the concentration and dosages of coagulants applied at the inlet of the water to the plant, at specified times, the WTP operators shall collect samples of the raw incoming water or ensure that the system for collecting and transporting the raw water to the station control laboratory is working properly;
- **Preparation of the coagulant solution tanks -** based on the concentrations established by the WTP control laboratory, operators should prepare the coagulant solution tanks used in the treatment process, for dosing in the raw water, at the entry of the plant (preferably in the turbulence zone of the Parshall flume);
- **Control of the coagulant dosage -** the operators must check, at specified times, the proper functioning of the devices or pumps (control of their automation) for the application of the chemicals used as coagulants; depending on the variation in raw water quality;
- **Control of the flocculation and settling process -** at specified times, the WTP operators need to evaluate the flake formation process in order to control the effectiveness of the coagulation application, the flocculation process speed and the behavior of the settling system. The test to determine the optimum amount of coagulant to be used in order to obtain the best flocculation is called *jar-test*;
- **Control of the filter run and washing process -** according to pre-established rules, the WTP operators must follow the evolution of the load losses in the filtering system in order to determine the optimum time of the filter runs and to define the filter washing times;

- **Decanter emptying and cleaning process -** pursuant to the procedures established in the WTP Operation Manual, at specified times, the WTP operators shall perform a complete washing cycle of all tanks and decanter gutters and emptying accumulated sludge at the bottom of the tanks; the destination of discarded sludge shall be assessed by the WTP operation supervisors so that the operation is environmentally appropriate;
- **Filter washing process -** pursuant to the routines established for the WTP operation and in accordance with the set-points defined for maximum pressure losses, the operators must carry out the procedures established in the WTP Operation Manual in order to wash the filter units;
- **Control of the disinfection process -** at specified times, the WTP operators must evaluate the chlorine dosing systems used for disinfection in order to identify any leak points and correct them immediately;
- **Control of the fluoridation process and final pH correction -** at specified times, the WTP operators must evaluate the fluorosilicic acid dosing systems used for fluoridation and the hydrated lime dosing systems for pH correction, in order to identify any leak/clogging points and correct them immediately.
- **Regular preventive maintenance of pumps and dosers, control panels, stop valves, meters and other WTP equipment** - in accordance with the procedures established in the WTP Operation Manual.

4.5 Reservoirs

After being treated in the WTPs, the water is stored in closed and sealed reservoirs, which can be underground (subterranean and semi-subterranean), supported or elevated, depending on its position in relation to the soil, in which different volumes are provided according to technical standards. The reservoir design must comply with NBR 12.217/94.

The reservoirs are important to maintain the regularity of supply in a system, even when it is necessary to shut down some production unit for maintenance interventions. In addition, reservoirs are essential in order to meet extraordinary demands that can occur in periods of intense heat.

Depending on the location in the system, the reservoirs may be upstream (before the distribution network) or downstream or leftover (after the network).

The upstream reservoirs are characterized by the following features: all the water distributed downstream passes through it; they have the inlet over the maximum water level and outlet at the minimum level; they are sized to keep the flow and manometric height of the pipeline system constant.

Downstream reservoirs are characterized by the following features: they store water at times when the supply to the network is higher than demand, to supplement the supply when the situation is reversed; they reduce the physical height and initial diameters upstream the network; they have only one pipe serving as an inlet and outlet for the flows.

Distribution reservoirs are sized so that they have the capacity to accumulate a useful volume that exceeds the balance, emergency and firefighting demands.

The balance reserve is so called because it is accumulated at times of lower consumption to compensate for those times of higher demand, i.e., since consumption varies and the flow of the pipeline is constant, especially in the pressurized pipelines, at the times when consumption is lower than demand, then the reservoir fills up, so that at the times when consumption in the network is higher, the previously accumulated volume compensates the deficit in relation to the incoming flow.

In order to ascertain the firefighting reserve, the local fire department must be consulted. With the official norms of the FD and the norms of ABNT, it is then possible to, from the definition of the urban occupation of the area, estimate the volume to be stored in the reservoir intended for firefighting in the location.

The emergency volume is designed to prevent the distribution from collapsing in the event of unforeseen accidents in the supply system, e.g. a power failure or a break in the pipeline. Then, while providing the resolution to the problem, the volume stored for emergency supplies, also called accident reserve, will make up for the lack of water entering the reservoir, not letting consumers run out of water.

4.5.1 Reservoir Associated Operational Routines

The reservoirs must be watertight and protected to prevent contamination of the water after it has been properly treated.

In general, the operational routine associated with reservoirs concerns the process of feeding these units. When the supply of the reservoir is through a treated water pipeline by gravity, originating from a treatment plant, the maximum level of the reservoir is controlled by the WTP; when the supply is through a treated water pressurized pipeline, the maximum level of the reservoir is controlled by the lifting station that is carrying out the supply.

Thus, the operational routines are limited to inspections, at specified times, to check the safety and watertight conditions of the unit, the state of the concrete and metal structures and any leaks in the tank drains. Therefore, the following are the minimum actions to be taken by the Concessionaire to ensure such conditions:

- Control of the automation system, where applicable;
- Regular maintenance of connections, valves, stop valves, level indicator, and all existing equipment in the structure; and
- Regular inspections to ensure water tightness and control of losses.

As these units are linked to the maintenance of quality in a supply system, reservoir must be well protected against undue access by individuals unrelated to the service provider.

Regularly they should be emptied for cleaning and disinfection, a routine that should be performed in periods of lower water consumption.

4.6 Distribution Networks

A distribution system is a set of reservoirs and distribution network, subpipelines and lifting stations that receive water from distribution reservoirs, while a distribution network is a set of pipes and their accessory parts intended to make the water to be distributed available to consumers, continuously and at points as close as possible to their needs. The distribution network design must comply with NBR 12.218/94.

The concept of distribution flows, which is the distributed consumption plus the losses that normally happen in the supply pipelines, is also important. Distribution pipe is the penstock of the distribution network on which the service connections are made. This pipe can be classified into main pipes, those that by calculation allow water to reach the entire distribution network, and secondary, other pipes connected to the main pipes.

Another fundamental concept refers to pressure zones. In distribution networks they are each of the parts in which the network is subdivided in order to prevent the minimum dynamic and maximum static pressure from exceeding the recommended and pre-established limits. It is noted, then, that a network can be divided into as many pressure zones as necessary to meet the technical conditions, and it is essential to keep their registration updated.

Conventionally, the pressure zones in drinking water supply networks are between 15 and 50 mca (meters of water column), tolerating up to 60 mca in up to 10% of the area and up to 70 mca in up to 5% of the same zone, as maximum static pressure, and up to 10 mca in 10% and up to 8 mca in up to 5% of the same zone for minimum dynamic pressure.

Usually the distribution networks consist of main pipelines, also called *trunk sewers* or *mains*, fed directly by an upstream reservoir, or one upstream and one downstream reservoir, or even directly from the pipeline with a downstream reservoir. From these mains come the secondary pipelines, from which practically all the service connection branches come out.

4.6.1 Operational Routines Associated with Reservoirs and Distribution Networks

The distribution network is not composed only of pipes and connections. It also includes special parts that allow its functionality and the satisfactory operation of the system, such as maneuvering valves, suction cups, outlets and hydrants, requiring, at certain times, maintenance on existing equipment in the networks, such as stop valves and suction cups. The closed circuits have shut-off valves in strategic locations, in order to allow potential repairs or maneuvers in the downstream sections. In the secondary ducts these valves are located at the derivation points of the main.

Most of the operational routines of a distribution network are associated with its start-up, where the process of loading the network must be careful to prevent air pockets from causing disruption.

At some points outlet valves should be installed to allow for the emptying of the upstream sections in the event of any repairs. These valves can be replaced by hydrants. In these cases, care must be taken when locating and draining the site so that there is no danger of contamination of the network through the return of the sewered water. At the highest points suction cups should be installed to expurgate any accumulated air inside the pipe.

Thus another continuous operational routine in distribution networks should be the regular inspections of the network for leaks that are difficult to identify, the repair of any breakages and the immediate correction of any identified leaks. In these cases, the broken section must be identified, the mesh must be isolated by shutting off the control valves and the networks emptied through the available outlet stop valves. The re-entry into operation must be carried out with the outlet stop valves still open in order to avoid the return of the puddling water from the ditches open for the performance of repairs. If necessary, the network should be emptied in order to clean the pipes from any contamination.

These and other procedures that the CONCESSIONAIRE deems appropriate must be covered in the Operation and Maintenance Manual, to be prepared by each contractor. Said Manual should be aligned with the integrated information system, enabling the monitoring of the entire operation.

4.7 Household Connections

The household connection is an installation that links the distribution network to each consumer's internal network. Installed at the connection, the hydrometers control, measure and record the amount of water consumed in each property, in order to reduce waste, show water losses and provide a fair basis for billing the service. For this purpose, the hydrometers must be replaced periodically, at ages defined according to the conditions and technology of the park installed at the time, and with efficiency criteria assessed in accordance with the Regulatory Agency, and may not exceed the maximum age of 05 years at the end of the concession period.

4.7.1 Operational Routines Associated with Service Connections

The only routines associated with service connections are related to their implementation, which must comply with the installation standard of the service provider, and the potential identification and correction of leaks and irregularities that may occur in the service connection branch.

4.8 Water Lifting Stations

The lifting stations are made up of sets of pumps and accessories that make it possible to lift the piezometric quota of the water transported in public supply services, and thus make it possible to supply regions with higher quotas. In addition, lifting stations are designed to transport water to more distant points and to increase the flow rate in the pipelines. The water lift design must comply with NBR 12.214/92.

They present the obstacle of raising operating expenses due to power expenses and are vulnerable to interruptions and failures in the electric power supply. It also requires specialized operation and maintenance, further increasing personnel and equipment costs.

4.8.1 Operational Routines Associated with Lifting Stations

In view of the technological complexity of the equipment and facilities of a lifting station, the operational routines are specific to each facility and, to this end, the procedures established in the Operating Manual of each unit must be followed.

These procedures generally provide for checking gasket leaks, preventive maintenance and regular replacement of pumps, control panels and starting devices and other parts subject to wear and tear, measurement of vibration in motors, control of amperage and voltage of electrical equipment and of pump running time, control of pump automation systems, adoption of energy efficiency optimization techniques and the regular emptying and cleaning of suction wells, where applicable.

4.9 Water Quality Control Routines

The physical, chemical and bacteriological characteristics of water are associated with a series of processes that occur in the water body and its drainage basin. In a water supply system the treatment processes have the role of making the water drinkable and therefore suitable for human consumption.

As previously mentioned, the quality of the water distributed in a supply system must meet the standards of potability established by the Ministry of Health, through Annex XX of Consolidation Ordinance No. 5/2017, whose origin is Ordinance 2.914, of 12/12/2011. These standards of potability, which consider various criteria associated with the physical, chemical and bacteriological characteristics of water, are assessed and controlled at two different times: (i) generally, at the exit of the water treatment plants or after receiving a simplified treatment (disinfection and fluoridation); and (ii) at random points of the distribution system.

4.9.1 Water Quality Control in Treatment Units

To control the treatment process, there are several routines practiced in water treatment plants. For this purpose, in most of the facilities there are process control laboratories, which supervise the evolution of water quality through the stages of treatment.

At the entrance to the treatment units, physical parameters relating to color, pH and turbidity are checked in order to guide the application of coagulants (aluminum sulphate or ferric chloride and hydrated lime, for example) and bacteriological parameters for possible pre-disinfection with the application of chlorine, whenever necessary, depending on the concentration of algae and microorganisms; after the filtration stage, the physical parameters of color and turbidity are evaluated again to verify the efficiency of this treatment stage; finally, at the end of the treatment process, all the physical-chemical and bacteriological parameters provided for in Annex XX of the Consolidation Ordinance No. 5/2017, of the Ministry of Health are analyzed.

It is worth mentioning that at the exit of the treatment plant the water is checked to asses the levels of:

- Chlorine, as a disinfectant, in a dosage sufficient to maintain the bacteriological quality of the water (generally not more than 2.0 mg/l, for a residual necessary to counter any possible contamination in the distribution network);
- Hydrated lime or other alkaline material, for pH correction, making the distributed water neutral or alkaline, and thus preventing corrosion processes on the distribution networks and household connections; and
- Fluorine, as a sanitary agent for the prevention of tooth decay (usually dosed with 0.8 ppm fluosilicic acid).

In the context of monitoring water quality in the supply systems, it is worth noting that the regulatory control of the concessionaires is carried out using the compliance performance indicator, provided for in the Performance Indicators Report, considering the color, odor, turbidity and residual chlorine parameters in the treated water.

In order to guarantee the quality of the water to be distributed, an Operation Manual shall be prepared including the following minimum activities:

- Availability of a local laboratory and performance of control tests, stage by stage of the process, until the final water supply stage;
- Definition of the frequency of the analyses and operational control routines;
- Establishment of criteria for defining the time between washes of operational units and procedures for washing them;
- Routines for storage of chemical preparations;
- Routines for checking the useful life of reagents;
- Routines for gauging and calibration of equipment;

4.9.2 Water Quality Control in Distribution Networks

The control of water quality in distribution networks is one of the requirements for the consideration of water potability, provided for in Annex XX of the Consolidation Ordinance No. 5/2017 of the Ministry of Health. The Ordinance defines a Sampling Plan that establishes, for each type of evaluation (physical, chemical or bacteriological), the minimum number of samples and the frequency of collection, according to the population served by the system and the size of the distribution network (ANNEXES XI, XII, XIII, XIV and XV).

The minimum residual chlorine content in the distribution network is 0.2 mg/L.

5 SANITATION SYSTEMS

According to the Brazilian Association of Technical Standards (ABNT), a sanitation system is the set of pipelines, facilities and equipment designed to collect, transport, condition and route only the sanitary sewage to a convenient final disposal, in a continuous and hygienically safe manner, consisting of a sewage service connection branch, sewage collection and transportation system, sewage treatment and proper final disposal of the treated effluent and sludge resulting from the treatment. The sewage treatment design must follow NBR 12.209/92, the lifting station design the NBR 12.208/92, the interceptor sewer design the NBR 12.207/92, the final outlet design the NBR 12.207/92 and the sewage branches and collection network design the NBR 9.649/86.

The main operational routines are described below, and it should be noted that the CONCESSIONAIRE shall detail the specific operational routines in the Operation and Maintenance Manuals, for each of the existing operational facilities.

5.1 Operational Routines Associated with Sewer Service Connection Branches and Sewage Collection Network

The only standard operating routine defined for the sewer service connection branches and sewerage systems is the regular unblocking of the piping. This way, it is necessary to perform regular cleaning of manholes and network sections with low slope and/or with a history of high number of maintenances and immediate unblocking, eliminating overflows in the network and branches; thus the importance of keeping an updated registry'.

As this is an absolute separator type system, with treatment at the end, the introduction of stormwater will not be allowed under any circumstances, except for the collection in dry weather collector provided for in item 4.3 of this ANNEX. In order to guarantee this requirement, it will be up to the service provider to:

- When approving and performing the sewer service connection of domestic sewage, verify the existence of appropriate conditions for the collection and drainage of stormwater;
- Separate the existing sewerage systems that discharge into stormwater systems/galleries, route them and interconnect them to the trunk sewer;
- When connecting the collection system to the trunk sewer, check that there is no entry of stormwater in the sewerage system;
- Carry out the total separation between the sewage and stormwater system; and
- Adapt existing connections to meet the above topics.

To protect the system against the introduction of foreign objects, all inspection boxes must be provided with hermetic and plug-in plugs.

To comply with the requirements for protection of the public network, the service provider, when approving and performing the sewer service connection of domestic sewage, must verify the existence of appropriate conditions to meet the above-mentioned requirements.

Regularly, and every time there is suspicion of anomaly in the operation of the sewer service connection, the supervision staff of the service provider shall perform an inspection.

In order to comply with any requirements laid down in specific municipal laws, the pavement and streets must be recovered under the same conditions as before the intervention, unless prior agreement has been reached with the municipality.

5.2 Specific Operating Routines for Trunk Sewers

Trunk sewers, interceptor sewers and gravity outlets only need regular inspections to determine the need for repairs and cleaning of the main. The manholes and lines should be cleaned whenever they are silted up, which can be checked by drilling from the bottom of the manhole, or when they have crusts of fat or other materials.

At the discretion of the service provider and as convenient, regular cleaning can be scheduled on a preventive basis, reducing the likelihood of blockages.

In the case of pipelines located on the river/ream bank, the service provider shall regularly clean the area with vegetation removal, so as to ensure access to the manholes and inspection boxes.

In the cases of obstruction identified and claimed by users, cleaning and clearance teams must be activated, which will identify the causes and proceed to repair them. This service varies from a simple unblocking by pressure jet equipment to the replacement of the damaged section.

In cases where identification occurs during the preventive maintenance process, services are scheduled and executed according to the requirements of each case.

5.3 Operational Routines for Sewage Lifting Stations

For sewage lifting stations, the operational routines must follow the procedures established by the unit's Operation Manual and are analogous to the routines explained for water lifting stations, with the appropriate sanitary care, as follows:

- Control and maintenance of pump automation;
- Adoption of energy efficiency optimization techniques;
- Regular reading of electrical quantities (amperage, voltage) and of pump operating time;
- Preventive maintenance of pumps, control panels and starting devices; and
- Regular emptying and cleaning of the suction well and grid, and if necessary, desanders; for this purpose, a device for removing and moving pumps should be provided.

5.4 Operational Routines of Discharge Lines

The discharge lines are responsible for transporting the sewage to the Sewage Treatment Plant, Sewage Lifting Station or to some manhole of the nearest sub-basin and are essential components for the system in question, which must be operated according to its specifications. Proper operation of this system may require, for example, a control of the quality, quantity and speed of sewage outflow.

Therefore, the discharge line should also undergo regular inspections to verify the need for repairs, maintenance and cleaning.

~~For cases where the pressure system uses a discharge line common to several lifting stations, there are two extreme conditions: (1) the situation where all the lifts are operating simultaneously; and (2) the situation where only one of the lifts, either one, is operating.~~

~~In the first case, with all the lifts operating simultaneously, there will be a hydraulic situation where the flow rates on the discharge line will be maximum and, consequently, the manometric heights to be overcome by each lift will also be maximum. The diameter adopted for the pipes should be calculated based on this situation, which is therefore the most favorable for the operation of the system, since it has speeds within the limit imposed by the standards.~~

~~In the second case, with only one operating lift, the hydraulic condition will be the opposite of the situation mentioned above, with minimum manometric height for the lift that is operational. In this case, the flow carried by the pipeline may be much lower than the expected for the first situation, resulting in low speeds. This situation requires special attention in the maintenance and cleaning frequency, since low speeds can result in deposit and accumulation of sediments along the network, however, this operating situation is not usual, only occurring in the event that several lifts and/or discharge line sections require maintenance at the same time.~~

In order to facilitate the operation and maintenance of the system, the design usually provides for stop valves along the discharge line, at the points where the lifts are interconnected to the single discharge line, in the interconnection boxes. Such stop valves allow the isolation of both the lifts and the sections between the lifts, facilitating the actions for emptying and cleaning the network.

The isolation of a stretch of the discharge line may be carried out after the shutdown of the lifts that contribute to this particular stretch, shutting off the stop valves of the interconnecting boxes; this closure must be slow so as not to cause disturbance in the hydraulic regime of the following stretch, if it is in operation.

It is worth mentioning that along the discharge sections, outlet valves are usually designed for emptying the line, as well as suction cups for air inlet and outlet. Both emptying and filling the discharge lines should be done gradually, so that there is full filling of the pipe with air - in case of emptying the line, and full expulsion of air - in case of line filling, in order to avoid damage to the pipes.

Throughout the years of operation it is common for sediments to get incrusted to the walls of the discharge pipes and, in this case, to clean the pressure pipe it is recommended the use of *Cleaning PIG* type devices for the scraping of the pipe. This device is projected into the discharge line by means of a launcher installed in the lift and, through hydraulic propulsion, runs the entire section to be cleaned until an exit point which can be a manhole or box.

Regular maintenance of connections, stop valves and suction cups of the discharge lines should also be provided for.

5.5 Operational Routines for Sewage Treatment Plant

The operational routines of the sewage treatment plants must be in line with the procedures established by the Operating Manual of the specific unit, the most common being the removal of the gridded and desanded material for final destination, the control of the sludge age, the oxygen content in the aeration tanks, the concentration of solids in the aeration tanks and the sedimented sludge, the preparation of the chemicals and verification for dosage adjustments, automation of pumps and dosing equipment, regular preventive maintenance of pumps and dosing equipment, UV lamps, control panels, valves, stop valves and other STP equipment, the quality of raw and treated effluent for final discharge, regular emptying and cleaning of reactors and decanters, the preparation and application of the Management Plan for Sludge and Solid Waste, among others.

Quality control in a sanitation system is correlated with the quality of the effluent from the sewage treatment plants, whose final discharge is usually in a watercourse.

In this context, Resolution 357, of 17/03/2005, of the National Council of the Environment (CONAMA), provides for the classification of water bodies and environmental guidelines, as well as establishes the conditions and standards for the discharge of effluents. In turn, CONAMA's Resolution 430, of 05/13/2011, provides for the conditions and standards for the discharge of effluents, complementing and amending CONAMA's Resolution 357; and NT-202.R-10 establishes the Criteria and Standards for the Discharge of Liquid Effluents into Inland or Coastal, Surface or Underground Waters in the State of Rio de Janeiro. The main control criteria are: (i) the Biological Oxygen Demand (BOD), which corresponds to the amount of oxygen consumed in the degradation of organic matter by biological processes, measured in mg/L O2; (ii) Chemical Oxygen Demand (COD), which evaluates the amount of dissolved oxygen (DO) consumed in acid medium, which leads to the degradation of organic matter, biodegradable or not, measured in mg/L O_2; and Total Suspended Solids (TSS), which represents the concentration of solids present in a sample, which may be in suspension or decanted.

All analyses must be performed in accordance with the latest edition of the *Standard Methods for the Examination of Water and Wastewater*, edited by the *American Water Works Association*.

In the context of monitoring the quality of treated sewage, it is worth noting that the regulatory control of the concessionaires is made through the compliance performance indicator, provided in the

ANNEX Performance Indicators, considering the $BOD_{5.20}$ parameter in a composite sample of the treated effluent.

6 GENERAL ASPECTS

6.1 Legal Obligations

The CONCESSIONAIRE shall comply with at least the following legal instruments or legislation that may replace them:

- Principles and guidelines of Federal Law 11,445, of 05/01/2007, which provides on the national guidelines for basic sanitation and the federal basic sanitation policy and the Regulatory Decrees 7,217/2010 and 9,254/2017;
- Principles and guidelines of State Law No. 1.988/1994, which provides on the State Environmental Policy in Rio de Janeiro;
- The quality control of the water distributed in the operated systems shall comply with the legal requirements set forth in Annex XX of the Consolidation Ordinance No. 5/2017, of the Ministry of Health;
- The discharge of effluents from sewage treatment plants shall comply with CONAMA Resolution 357/2005 and subsequent amendments and NT-202.R-10 - Criteria and Standards for the Discharge of Liquid Effluents into Inland or Coastal, Surface or Underground Waters in the State of Rio de Janeiro; and
- The systems must be operated in compliance with federal labor and occupational safety legislation.

6.2 Master Plan

The CONCESSIONAIRE shall develop a Master Plan for each municipality, which shall be in line with the provisions of the respective Municipal Sanitation Plan or the Regional Basic Sanitation Plan in the chapters related to water supply and sewerage, covering all the municipalities of the respective block, within a period of up to 01 (one) year after the assumption of the system, addressing the main actions to achieve the targets presented in chapter 4 of this ANNEX, consisting of a work plan, schedule and respective required investments, to be developed within the concession area, which shall enable the efficient management of the investments planned for the expansion and improvement of water and sewerage systems, as well as the control of the achievement of the planned service targets.

In addition, the Plan should also consider the development of corporate governance measures, as explained below, and the establishment of regulatory controls, necessary to maintain the balance of the concession agreement.

6.3 Corporate Governance and *Compliance*

Nowadays, transparency of companies is increasingly demanded by the market and society, thus it is important that CONCESSIONAIRE develops its activities observing the concepts of governance and *compliance*, as a way to ensure good management and the reputation of the company.

Governance refers to the way companies are run, which involves policies, regulations, culture and processes. In this context, it is essential that the CONCESSIONAIRE develops the following instruments: (i) the Services Regulations, approved by the granting authority, regulating all the company's processes; and (ii) its main policies, such as Personnel, Environmental, Procurement, Asset Control, Billing, Investments, and other policies - duly explained, known and observed by all employees.

Corporate governance concerns the relationship between internal stakeholders - partners, board of directors and executive board - and external stakeholders - supervisory bodies, regulators and government. In short, it brings together the company's strategies to demonstrate its value. Thus, governance encompasses actions aimed at strengthening the company's reputation, ensuring the internal benefits of working with ethics and competitiveness by being known as an honest and reliable company.

In turn, *compliance* is the way to ensure that the management and positioning of the concessionaire follow the rules in force, respecting the commitment to ethics and truth. The existence of a *compliance* program presupposes a guarantee that the laws and regulations for operations are strictly complied with. CONCESSIONAIRE, when developing *compliance* concepts, is responsible for identifying points of failure in its activity and resolving these issues. Thus, the company's image is strengthened with regard to the seriousness and commitment of what is executed.

In this context, the CONCESSIONAIRE shall develop a *compliance* policy, observing the applicable laws, and make all stakeholders fully aware of it, through the Internet and other means of communication.

6.4 User Awareness

Considering that the proper functioning of a sanitation system depends, mostly, on the proper use of the system by the serviced USERS, thus an important phase of the operation of the system refers to the process of sanitary education and awareness of the USERS.

This is one of the most important steps to achieve maximum benefit for as long as possible from the installed system. The CONCESSIONAIRE will have to prepare a Social Communication and Environmental Education Program, aiming at USER awareness and, therefore, their collaboration. The Program must be prepared within 3 months of the start of operation of the services and may follow the methodology below:

- **Promotion of the Regulations -** may be done through publication in booklets, or leaflets, which must be sent free of charge to the USERS, preferably together with the first bill for sewage service fees.
- **Discussion of sewage issues -** the discussion of the sewage issues can be done directly, through lectures or indirectly through the distribution of informative leaflets.

- **Direct Discussion -** can be done through lectures and round tables to be held regularly and which promote and discuss the problems related to domestic sewage. They may be directed at specific groups such as: primary and secondary schools; neighborhood associations and community leaders.
- **Indirect Discussion -** this can be done through the regular distribution of informative leaflets, containing information on such as the importance and the operation of a sewage system, how to avoid clogging and other damage to the system, pollution of catchments and other specific issues that might be deemed appropriate. The leaflets may be distributed together with the bills for sewage service fees, in schools and other convenient places.

It is important to stress the possibility of using more direct communication with the user, through apps, e-mail or messages. This information process may even include other relevant information for the USER, such as: average monthly water consumption; comparison of average consumption with standard groups; incentives for rational use of water; and warnings of possible leaks in internal service connections, in case of off-average consumption.

6.5 Maintenance Schedules - User Interface

Considering the need for shut down for maintenance interventions in the water and sewage systems to affect the USERS as little as possible, it is important that the CONCESSIONARIES implement appropriate structures for the execution of these services. These structures must be sized and implemented to meet the services within previously established deadlines. In this context, it is worth noting that such deadlines are considered regulatory requirements, subjecting the service provider to notifications and fines in cases of non-compliance.

The Ombudsman website and *app* should be created and announced, to receive inquiries on various information and inclusion of complaints / service requests.

In this sense, in short, it is the CONCESSIONAIRE'S responsibility: (i) to implement a *Call Center*, operating 24 hours a day, to receive, free of charge, the requests for services and information from the users of the concession; (ii) to implement in each city at least one physical store, for serving customers in person; (iii) to implement a virtual system of USER service, via the Internet; (iv) to size and structure maintenance teams appropriate to the size, quantity and types of services; (v) to provide the maintenance teams with the tools, equipment, vehicles and materials necessary for the performance of the services; (vi) to perform the services within a previous schedule, following up and monitoring, online, the teams in the field; (vii) to implement a performance management system of the services performed, verifying indicators and establishing any necessary adjustments.

All service channels must follow the instructions of Decree No. 6.523/2008 regarding the time of service to users or definitions established by the REGULATORY AGENCY.

6.5.1 Meeting Deadlines for Requests and Complaints

This obligation relates to compliance with the deadlines for services relating to complaints and/or requested and which must comply with the deadlines as set out in the Performance Indicators ANNEX. These services include, at least: a- Water connection; b- Repair of water leaks; Ridge repair; c- Local or general water shortage; Sewage connection; d- Clearance of sewage networks and branches and occurrences related to resurfacing; f- Checking water quality; g- Checking water shortage / low pressure; h- Resumption of water supply due to debt; i- Resumption of water supply on request; j- Commercial occurrences (review of reading, analysis of documentation and conditions for granting social tariff); k- Deployment of water branch; l- Ridge displacement; m- Replacement of hydrometer at customer's request.

To this end, the CONCESSIONAIRE shall establish at least the following procedures:

- Provision of personnel structure, vehicles and tools necessary for the execution of requests;
- Computerized Service Orders (SO) registration system, tracking the progress until resolution, in order to inform the applicant and the regulator on compliance with deadlines; and
- Statistical management report with summary of compliant and non-compliant deadlines.

As far as corrective maintenance is concerned, timeliness in correcting failures is of utmost importance, since it is strongly related to the user's perception and evaluation of the service provided. Thus, regarding corrective maintenance, the CONCESSIONAIRE shall propose, at least, the following deadlines:

Service	Deadline for service
Water or Sewer Connections	5 working days
Repair or unblocking of networks and water or sewer branches	2 days
Sewer Lifts	8 hours
Hydrometer replacement (except park renovation)	2 (two) working days
Water or sewer service connection inspection	8 (eight) working days
Resurfacing of roads or sidewalks	2 working days
Other services to USERS*	2 working days

* "Other services to the USERS" are the additional services, referring to the requests for services by the USERS, which may generate new demands.

The service deadline is defined as the time elapsed between the request of the service by the user and the date of its effective completion.

All occurrences of leaks, both those reported by USERS and those identified by the CONCESSIONAIRE itself, must be recorded in the integrated information systems and made available for access by the REGULATORY AGENCY.

6.6 Integrated Information System

In order to enable the full management of the operation and maintenance of the entire water and sewage infrastructure in operation, the CONCESSIONAIRE shall develop and implement an integrated information system that considers the main stages of operation, maintenance and marketing of the systems.

In this context, Operation and Maintenance Manuals should be prepared for the units that make up the existing water and sewerage systems, considering the *as-built* of the facilities, the performance and control indicators and the detailed description of the operation and maintenance routines of the units in operation. In the context of Maintenance, the corrective, preventive and predictive routines (maintenance based on the state of the equipment) should be considered.

As a result of the Integrated Information System, an Integrated Management System should be implemented, between the operation activities and the maintenance activities of the systems.

6.7 Operational Control Center

The CONCESSIONAIRE shall design and implement an Operational Control Center (OCC) sizing it feasibly for each operated site, to allow the remote supervision of the systems in operation, by obtaining the main data and quantities by telemetry, *online* analysis in previously developed modeling and the decision making and remote action in real time, via remote control.

The Control Center presupposes the implementation of a measurement and automation infrastructure, which considers flow meters, pressure meters, level meters, control valves and other equipment necessary for the supervision and remote control of the systems in operation.

The OCC must be structured for 24-hour operation and, in addition to controlling the operating status of the water and sewage systems, it must, through closed circuit television (CCTV), perform continuous surveillance and monitoring of the operating units, preserving the integrity of the facilities against invasions and depredations.

The CONCESSIONAIRE should install sensors at the operational units, preferably in:

a) Substations and Units in General - the electrical variables (voltage, current, power), rotation, operating status, bearing temperature, vibration, level sensors and spillage shall be controlled, including presence sensor and remote control through a supervisory system;

b) Surface Water Abstraction, Wells, Lifts, WTPs and Reservoirs - sensors should be installed at characteristic points to monitor flows, to allow control operations in normal operational situations, as well as in emergencies;

c) Rivers, Catchment Dams and Treated Water Reservoirs - level sensors to allow visualization of the available volume in the units;

d) Pipeline and Distribution Network - flow and pressure sensors at strategic points, macrometers and pressure regulating valves to allow the management and balance of pressures and flows of the distribution system;

e) Hydrometers - it is desirable that the micrometer is telemetric and integrated with the CCO controls;

f) Water Treatment Station and Wells - a set of sensors should be installed to monitor electrical variables (voltage, current, power, etc.), hydraulic (flow, pressure, etc.), mechanical (rotation, vibration, temperature), treatment parameters (residual chlorine, pH, color, turbidity, hardness and specific conductivity) defined for each type of equipment, as well as the control of the environment (presence sensor and video camera) in the main points of operation that are integral parts of the treatment process and with remote control of the OCC to manage the operation through a supervisory system;

g) Sewage Collection Network and Interceptor Sewers - flow sensors shall be installed at strategic points to monitor the flow rates, especially in periods of exceptional load (rain, etc.), to allow control operations in situations of operational anomaly, and level sensors in strategic manholes to anticipate possible overflows;

h) Sewage Lifting Stations - level, flow and pressure sensors should be installed in the discharge lines; and

i) Sewage Treatment Station - a set of sensors should be installed to monitor electrical variables (voltage, current, power, etc.), hydraulic (flow, pressure, etc.), mechanical (rotation, vibration, temperature), treatment parameters (DO, BOD, SS, etc.) defined for each type of equipment, as well as the control of the environment (presence sensor and video camera) in the main points of operation that are integral parts of the treatment process and with remote control of the OCC to manage the operation through a supervisory system.

6.8 Energy Efficiency Optimization Program

Considering the second most relevant operational expenditure of a sanitation service provision, each CONCESSIONAIRE shall implement an Energy Efficiency Optimization Program that considers, in the facilities in operation, measures to reduce unit consumption (R$/m^3) and specific consumption (KWh/m^3).

With this approach, CONCESSIONAIRES shall assess the technical and financial feasibility of migrating existing units to the Free Energy Market Environment, in order to reduce expenditure on this important operational input. Depending on the hydraulic characteristics of the systems, the opportunity for self-generation of energy should also be analyzed.

On the other hand, in order to reduce the specific consumption indicator, measures should be taken to modernize and increase the operating efficiency of the electrical equipment in operation, such as the *retrofitting* of motor-pump sets, switchboards, control panels and the installation of frequency inverters, among other actions.

6.9 Technical and USER Registration Program

In order to maintain reliable information on the operational infrastructure in operation and on the USERS benefitting from the services provided, each CONCESSIONAIRE shall maintain permanent routines to update the technical registration of the operational assets of the concession and the registration of the USERS.

In this context, the systems must be georeferenced with GIS (*Geographic Information System*), and the USER registration must be interconnected with the geographical basis of the water distribution and sewage collection systems and with the billing and collection system.

The implementation of permanent routines to update the information resulting from the implementation of new systems (*as-built*), as well as of data collected during network maintenance interventions, will enable the continuous updating of the infrastructure databases. Likewise, the systematic updating of the USERS' information, at the time of monthly reading and billing, will ensure the reliability of the USERS' data, allowing the billing and collection process to be effective.

6.10 Water Loss Reduction and Control Program

Considering the high rates of water losses in water supply systems, the CONCESSIONAIRE shall develop and implement a Water Loss Reduction and Control Program that establishes specific actions to prevent losses, such as implementation of flow, pressure and level macrometers for measuring all hydraulic quantities; implementation of pressure reducing valves; implementation of *datalogers* for obtaining and storing operational data; sectorization of distribution networks; micrometer programs; implementation of Measurement and Control Districts (MCDs); research and elimination of invisible leaks (geophoning) and other measures in order to reduce losses, in addition to universalizing the micrometer measurement.

Depending on the age of the networks, the materials used and the operating conditions, there should be an analysis on the feasibility of replacement of older pipes and service connection branches, which present frequent rupture and leakage issues.

Still in the context of losses, it is essential that the concessionaires operate the water systems based on results obtained in hydraulic modelling, which ensure the efficient operation of the systems, under appropriate flow and pressure conditions.

6.11 Hydrometer Coverage Program

The presence of a hydrometer in the service connection, besides the fair billing of consumption, promotes the dissemination of practices of rational use of water.

With this approach, water supply systems should preferably be 100% fitted with hydrometers, with the fitted meters working properly. To this end, the CONCESSIONAIRES must develop programs that consider, at least, the following activities: (i) installation, within a period of up to 5 years, of hydrometers in all connections not currently measured; (ii) replacement within a period of up to 5 years of all hydrometers that present reading issues - stoppage, blurred dome, damaged meter, etc.(iii) scheduled replacement of all hydrometers that have exceeded their useful life - usually around 7 years; (iv) scheduled replacement of hydrometers that have exceeded their ability to record consumption, according to previously established limits; and (v) installation of hydrometers with remote reading transmission mechanisms, for recording and monitoring consumption of connections of large consumers.

Adding on to the points mentioned above, the CONCESSIONAIRE shall also: have an adequate minimum stock in order to ensure that no new connection is implemented without a meter; have operational facilities with benches that allow the performance of gauging and calibration tests of the meters; and have standardized systems that allow the performance of commissioning and quality tests in hydrometer factories, in the case of calls for bids for the purchase of new hydrometers.

The permanent execution of all mentioned actions will enable the concessionaires to reduce apparent water losses, with the elimination of consumption sub-measures and waste prevention.

6.12 Staff Training and Qualification Program

As a way to ensure that the activities within the CONCESSION are carried out in accordance with the best practices established in the operation and maintenance manuals, each CONCESSIONAIRE shall develop a broad Training and Qualification Program, with the objective of developing the technical skills and competencies of its employees.

The Program should consider actions at the various levels of service provision, thus contributing to increased productivity, improved performance, reduced errors within operational routines, reduced costs, improved performance, motivation of people and teams and a reduction in the number of accidents during working hours.

6.13 Contingency Plans

Considering the priority and indispensable nature of the provision of sanitation services, the CONCESSIONAIRE should develop Contingency Plans for the strategic units, defining the responsibilities within the organization, for the operation of these systems in emergency situations.

With this approach, Contingency Plans should consider: (i) what risks may cause the systems to shut down and what effects this might entail; (ii) when the risk occurs what can be done to mitigate its effects; and (iii) what can be done before the risk occurs to prevent its occurrence.

Contingency Plans shall objectively describe the actions that will be executed in emergency situations and have the purpose of training, organizing, expediting and standardizing the actions necessary to control and respond to anomalous situations. Thus the Plans deal with the consequences of an accident and prevent them from happening as a result of the conditions generated.

Once the risks are identified, the Plans should structure the strategies, gather the human, technical and logistical resources and disseminate and train the organization through simulations.

6.14 Fraud Elimination Program

In order to optimize the billing and collection process, the CONCESSIONAIRE must implement programs to detect and eliminate by-passes and other commercial fraud. Such frauds are identified by the average consumption analysis, by comparisons between areas of the concession, by tests in the service connection branches, to identify the existence of by-pass or fraud in hydrometers, and by visual inspection.

The systematic implementation of this type of survey, its dissemination within the concession and the imposition of fines, curbs the proliferation of the practice among USERS.

6.15 Socio-environmental Programs

Socio-environmental programs can be defined as management tools that make it possible to potentialize the positive impacts and to mitigate/control the negative impacts of a given development .

These programs originate from the environmental licensing, through Installation Licenses (IL) and Operating Licenses (OL), and are based on the rationale of continuous improvement, guided by the ISO 9001 and 14001 Standards.

Within this approach, contractors must implement programs such as: Environmental Education; Water Quality Control; Effluent Quality Control; and Dam Safety, among others. The development and implementation of these programs should be laid down in separate manuals and should comply with the best practices and technical standards involved.

6.16 Environmental Guidelines

The development of the design, implementation and operation of WATER SUPPLY SYSTEMS and SANITATION SYSTEMS requires that the current environmental guidelines be observed, as provided for in the legal and regulatory provisions at federal, state and municipal levels, as well as the dictates of best practices and competent environmental agencies. The CONCESSIONAIRE has the obligation to comply with such provisions, in connection with the developments for which it will have environmental liability.

For liability and obligation purposes, the CONCESSIONAIRE is strictly liable for the civil redress of environmental liabilities originated during the term of the AGREEMENT and related to its operation.

In addition to the obligations related to the legality of the operations, the CONCESSIONAIRE must be committed to good practices in the use and preservation of natural resources.

6.16.1 Environmental Licensing and Permits

For purposes of environmental good standing, all infrastructure and activities under implementation and/or operation by the CONCESSIONAIRE must meet the legal requirements of licensing, authorizations, certifications, registrations and concession fees required at the federal, state and municipal levels, of the validity of said documents, and the respective guidelines (such as technical conditions and validity requirements).

The CONCESSIONAIRE, at the end of its contract, must deliver the facilities in full environmental compliance, with licenses and concessions valid for a minimum period of 6 (six) months, or with a request for renewal filed within the legal deadline.

6.16.2 Regularization

Part of the infrastructure currently operated by CEDAE and that will be transferred to the CONCESSIONAIRE is not currently environmentally compliant, and may require partial licensing (from the Installation License) or a preliminary authorization request until the effective regularization in compliance with the applicable environmental norms and guidelines.

In many cases licensing is pending due to the need for improvements or specific technical studies to comply with the technical requirements of the licensing bodies.

It is the CONCESSIONAIRE's obligation to take the necessary measures for the full regularization of these facilities and of the operation, which may involve the identification and resolution of any liabilities and obtaining all licenses, permits or concessions from the competent authorities.

The start of the regularization process should occur within a maximum period of 01 (one) year from the execution of the agreement, and the CONCESSIONAIRE should act together with CEDAE to establish the terms of a Cease and Desist Agreement (Termos de Ajustamento de Conduta - TAC) with the licensing bodies and Public Prosecutor's Office, if necessary.

Any costs relating to fines and charges for environmental liabilities prior to the date of transfer of operational responsibility to the concessionaire will be the responsibility of CEDAE, even if found after the transfer.

Any costs relating to obligations, compensation and conditions of any kind arising from the TACs entered into to remedy such environmental liabilities prior to the date of transfer of operational liability will also be the responsibility of the CEDAE.

All costs related to mitigating, corrective, compensatory measures, fees and charges, studies and designs, renovations or expansions required for environmental regularization not directly related to pre-existing liabilities, are the responsibility of the CONCESSIONAIRE.

6.16.3 Renewal

Upon the transfer of operational responsibility, the CONCESSIONAIRE shall submit the request for change of ownership of all existing licenses, authorizations or concessions.

From this act on, the renewal of these licenses and maintenance of their validity is the entire responsibility of the CONCESSIONAIRE.

6.16.4 Infrastructure Expansion

The environmental regularity of the expansion of the systems infrastructure is the entire responsibility of CONCESSIONAIRE.

6.17 ENVIRONMENTAL LICENSING PROCESS

The environmental licensing process for water supply systems and sanitation systems includes, on the part of the CONCESSIONAIRE, the request to the competent environmental body for licenses in accordance with the stage of the development. It may involve the application for Preliminary License (PL), Installation License (IL), Operating License (OL) and renewal of the IL and OL.

The competence of the licensing must be verified considering the activity to be developed, the size of the undertaking, the polluting potential and the scope of the impact, thus, the licensing may be requested at the federal (IBAMA), state (INEA) or municipal (Municipal Environmental Secretariat) level.

It is the CONCESSIONAIRE's responsibility to comply with environmental norms at all licensing stages of the development under its environmental liability.

6.18 CONCESSION FOR USE PROCEDURE

Water abstraction and effluent discharge are regulated by the water abstraction and effluent discharge concessions.

The concession of water bodies are issued at the state level by INEA.

It is the CONCESSIONAIRE's responsibility to comply with environmental norms at all licensing stages of the development under its environmental liability.

For existing concessions, the CONCESSIONAIRE will be responsible for providing the registration in its name.

7 BLOCK-SPECIFIC ASPECTS

7.1 Block 1

As seen in Table 1 - Year of concession for meeting the WSS and SAS universalization targets of the municipalities of Block 1 , the CONCESSIONAIRE responsible for the regionalized provision of water supply and sanitation services shall service the urban areas of the municipalities of Macaé, Rio das Ostras and Maricá.

In these Municipalities, the CONCESSIONAIRE shall be responsible for providing water supply services, since the sanitation services and commercial management activities are currently operated by other contractors or, in the case of Maricá, by the city hall.

During the term of the respective agreements, executed by the municipalities of Rio das Ostras and Macaé, those contractors shall continue responsible for the maintenance and operation of the sanitation system, as well as for the performance of supplementary services related to the reading of hydrometers, inspection, billing and commercial management.

At the end of the term of the respective agreements, the STATE may, in accordance with clause 5.4 of the AGREEMENT, include the provision of the services in the scope of the CONCESSIONAIRE, with the CONCESSIONAIRE becoming responsible for the operation of the sanitation system, including the full assumption of the commercial management and becoming entitled, at this moment, to receive the sanitation tariffs.

The CONCESSIONAIRE of Block 1 is responsible for executing the works related to the Guapiaçu dam, within a maximum period of 5 years. To this end, it will be up to the STATE to declare the areas around the dam as public utility. The compensation for the expropriation of this area shall be borne by the CONCESSIONAIRE.

7.2 Block 3

As seen in Table 3 - Year of concession for meeting the WSS and SAS universalization targets of the municipalities of Block 3, the CONCESSIONAIRE responsible for the regionalized provision of water supply and sanitation services shall service the urban areas of the region of the city of Rio de Janeiro that includes the Planning Area no. 05 (AP5).

In this area, the CONCESSIONAIRE shall be responsible for providing water supply services, since the sanitation services and commercial management activities are currently operated by another contractor.

During the term of the respective agreement, said contractor shall continue responsible for the maintenance and operation of the sanitation system, as well as for the performance of supplementary services related to the reading of hydrometers, inspection, billing and commercial management.

At the end of the term of the respective agreements, the STATE may, in accordance with clause 5.4 of the AGREEMENT, include the provision of the services in the scope of the CONCESSIONAIRE, with the CONCESSIONAIRE becoming responsible for the operation of the sanitation system, including the full assumption of the commercial management and becoming entitled, at this moment, to receive the sanitation tariffs.

In view of the pre-existence of the aforementioned concession agreement, the CONCESSIONAIRE will succeed CEDAE in providing water supply services, assuming the rights and obligations of the Company in the existing interpendence agreement.

7.3 Block 4

Pursuant to Table 4 - Year of concession for meeting the WSS and SAS universalization targets of the municipalities of Block 4, the CONCESSIONAIRE responsible for the regionalized provision of water supply and sanitation services shall service the urban area of the municipality of São João do Meriti.

In this area, the CONCESSIONAIRE shall be responsible for providing abstraction, piping, treatment and distribution of drinking water, since the sanitation services and commercial management activities are currently operated by another contractor.

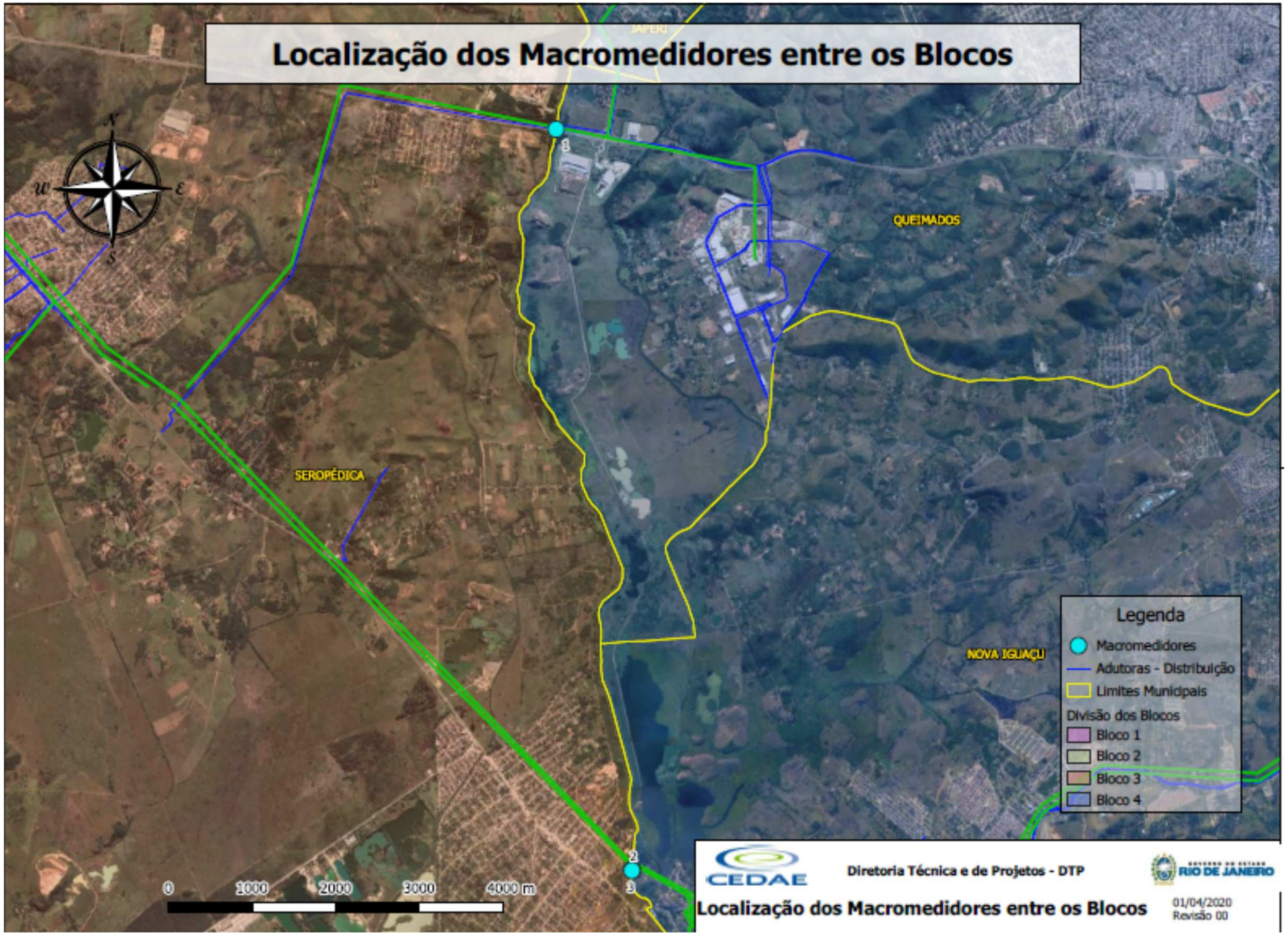
During the term of the respective agreement, said contractor shall continue responsible for the maintenance and operation of the sanitation system, as well as for the performance of supplementary services related to the reading of hydrometers, inspection, billing and commercial management.

At the end of the term of the respective agreements, the STATE may, in accordance with clause 5.4 of the AGREEMENT, include the provision of the services in the scope of the CONCESSIONAIRE, with the CONCESSIONAIRE becoming responsible for the operation of the sanitation system, including the full assumption of the commercial management and becoming entitled, at this moment, to receive the sanitation tariffs.

In view of the pre-existence of the aforementioned concession agreement, the CONCESSIONAIRE will succeed CEDAE in providing water supply services, assuming the rights and obligations of the Company in the existing interpendence agreement.

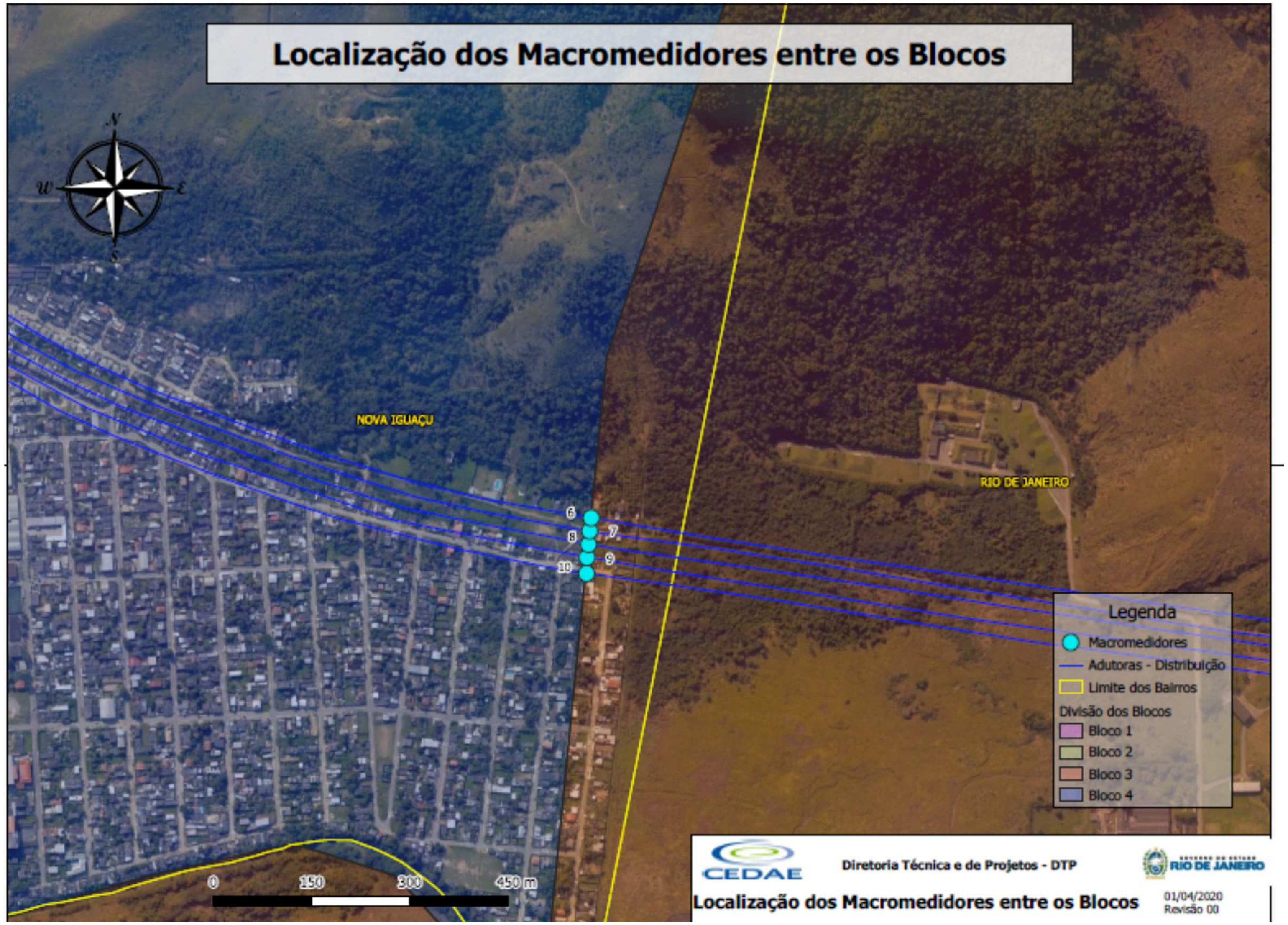
APPENDIX - GUIDE MAPS FOR THE LOCATION OF MACROMETERS

Macrometer location 1 to 3



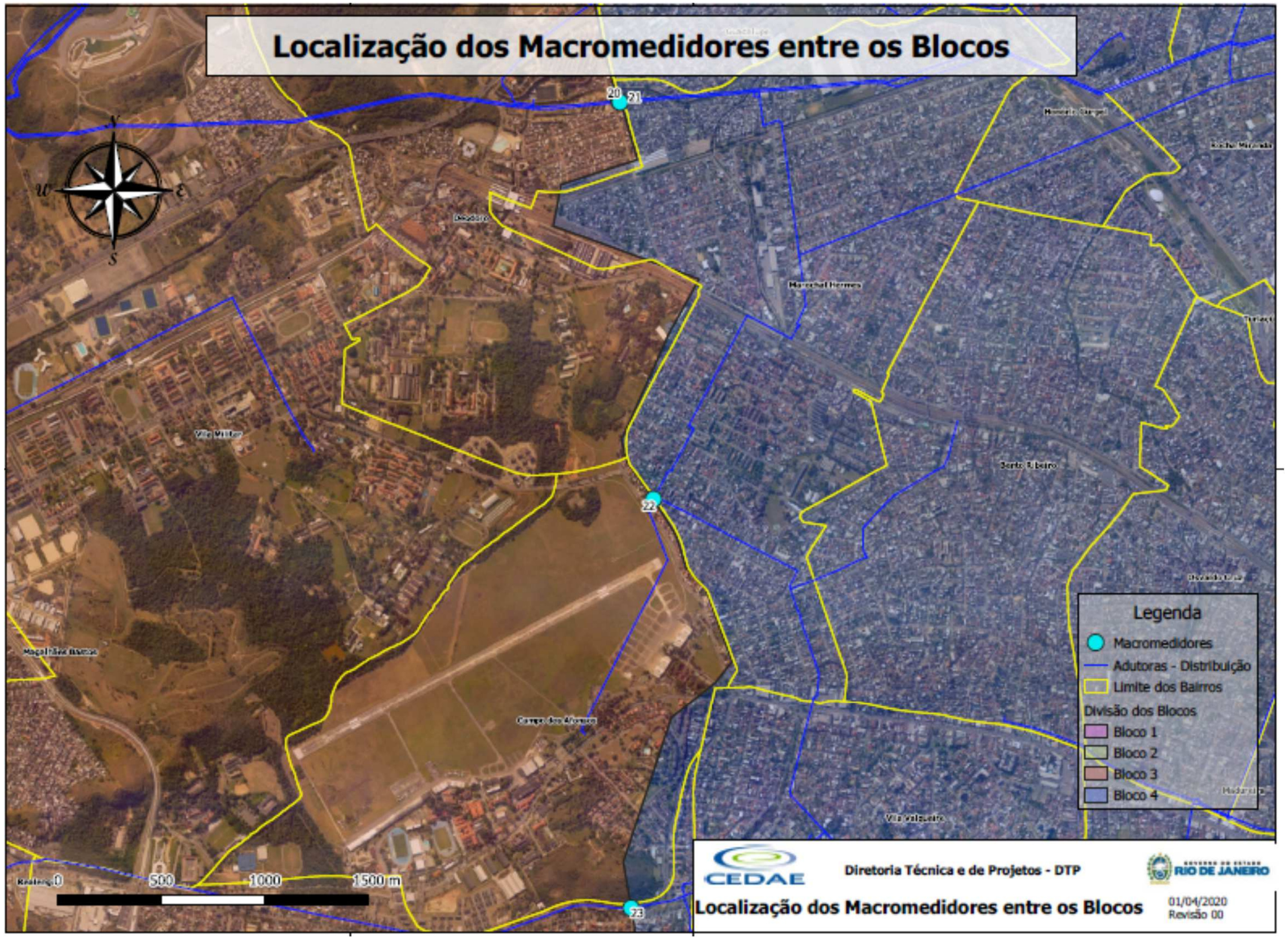
Macrometer location 4 and 5

Macrometer location 6 to 10

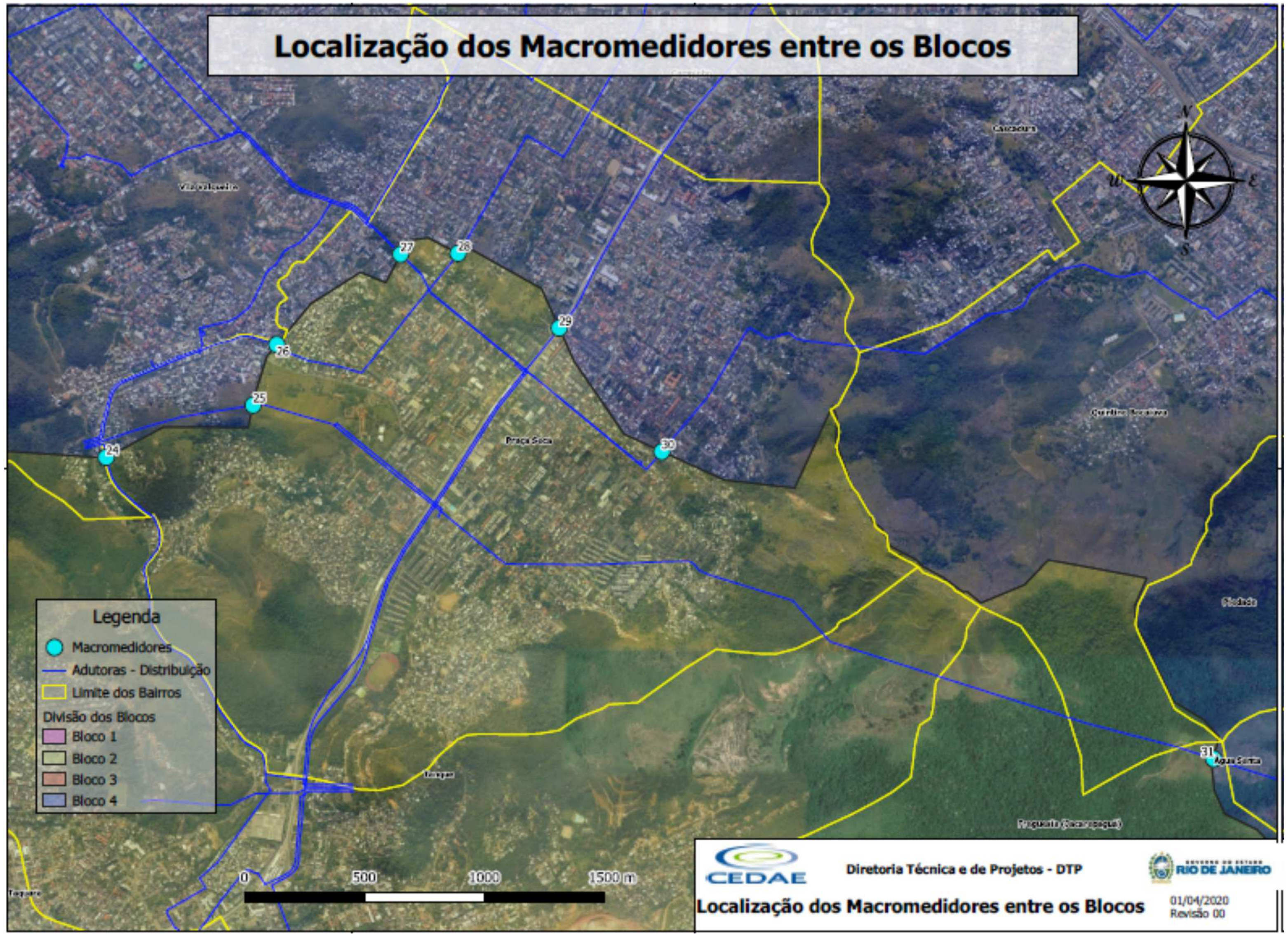


Macrometer location 11 to 19

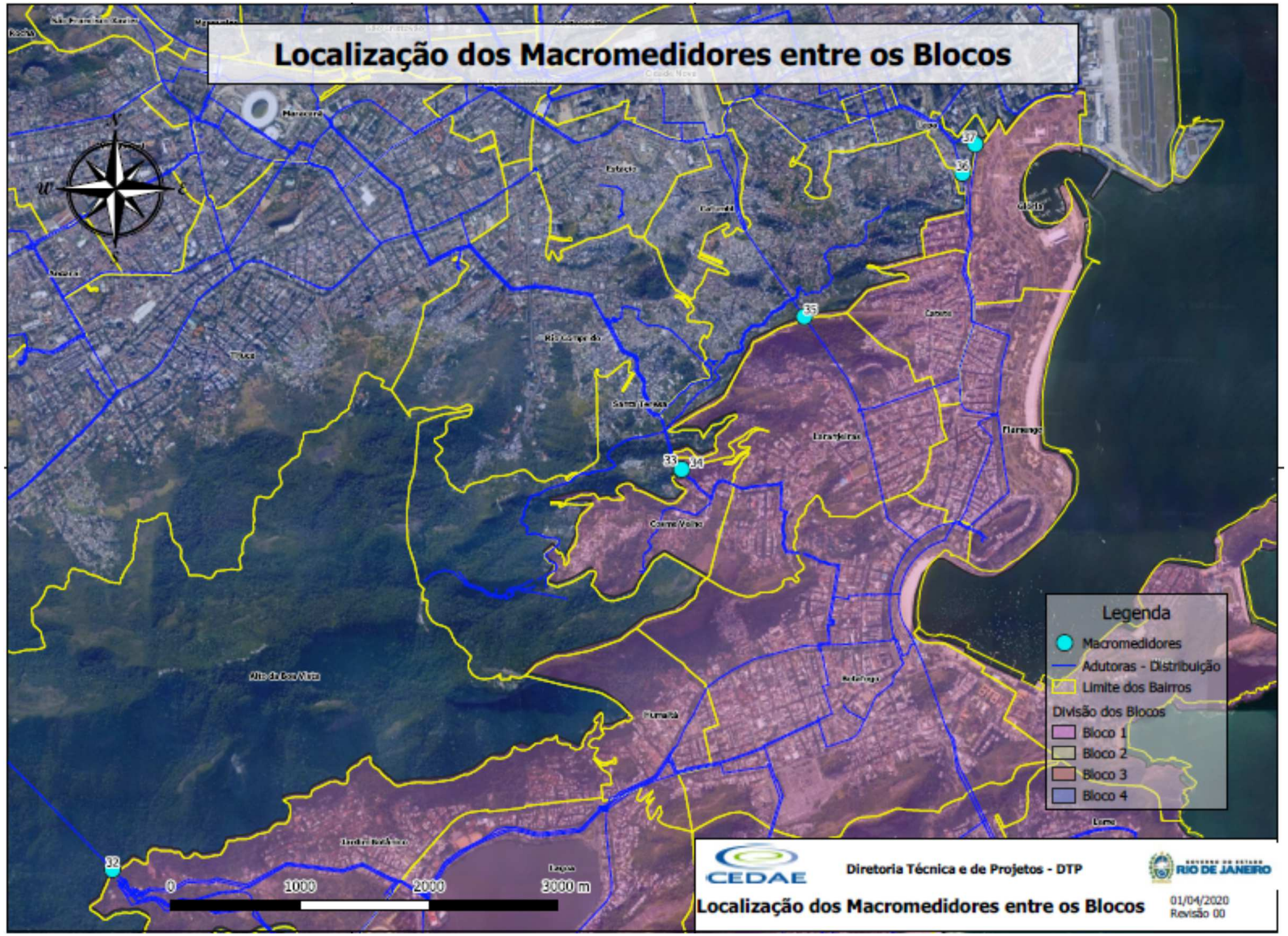
Macrometer location 20 to 23



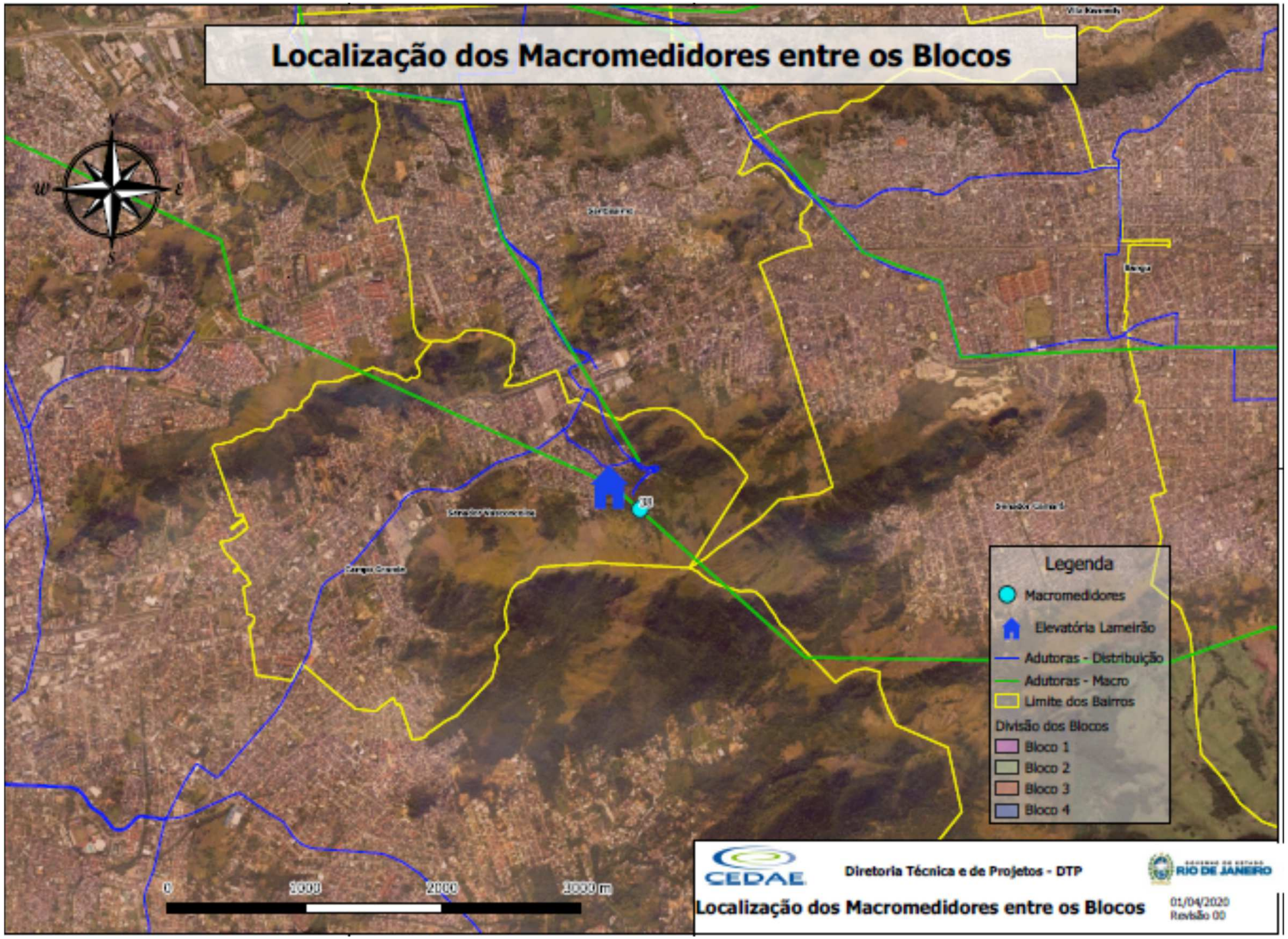
Macrometer location 24 to 31



Macrometer location 32 to 37



Macrometer location 38



Macrometer location 59 to 66