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ECONOMIC BENEFITS OF SANITATION EXPANSION IN THE PINHEIROS RIVER BASIN

June 2025

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ANALYSIS PRODUCED BY:

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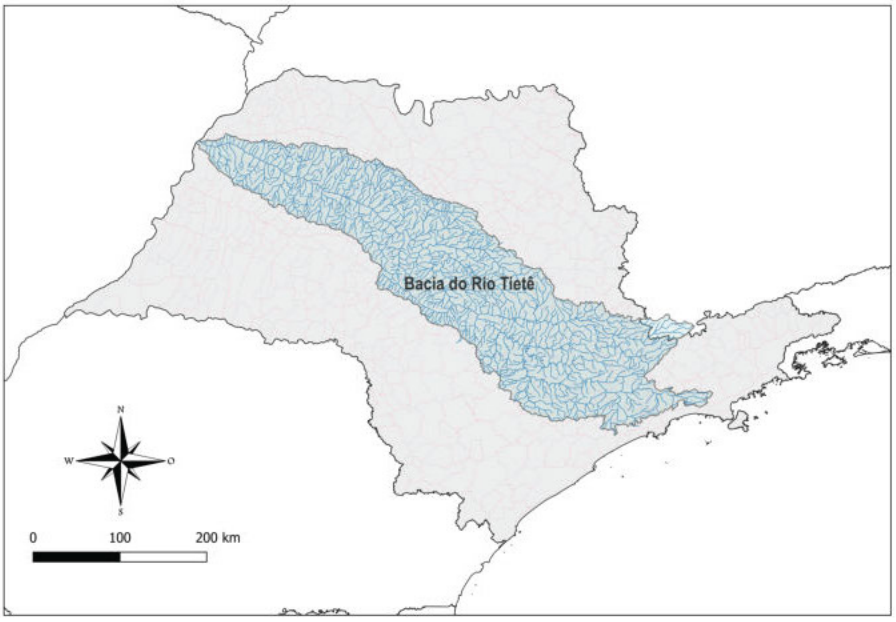
INTRODUCTION

The objective of this study is to assess the cost-benefit balance of universal sanitation access in the Pinheiros River Basin, located in the São Paulo Metropolitan Region, with an emphasis on the economic impacts of the Novo Rio Pinheiros Project, a sanitation initiative carried out by a consortium of public and private agents from the state of São Paulo between 2019 and 2022. This major urban intervention, whose characteristics will be detailed later on, made it possible to achieve universal sanitation coverage in a highly dense area surrounding the Pinheiros River, an urban watercourse of historical significance for the settlement of the São Paulo Metropolitan Region during the 20th century, but which has suffered from severely deteriorated environmental conditions for many years.

This first chapter presents, first, the location of the Pinheiros River Basin and its position within the hydrographic basins and sub-basins of the state of São Paulo. It also estimates the populations living in the basin and their historical growth. Next, an overview of the Novo Rio Pinheiros Project is presented, highlighting its key actions, agents, and goals. The third section presents the objectives and methodology of the study. Finally, the last section of this introduction outlines the structure of the analysis developed in the following chapters.

Map 1.1 The Tietê River Basin

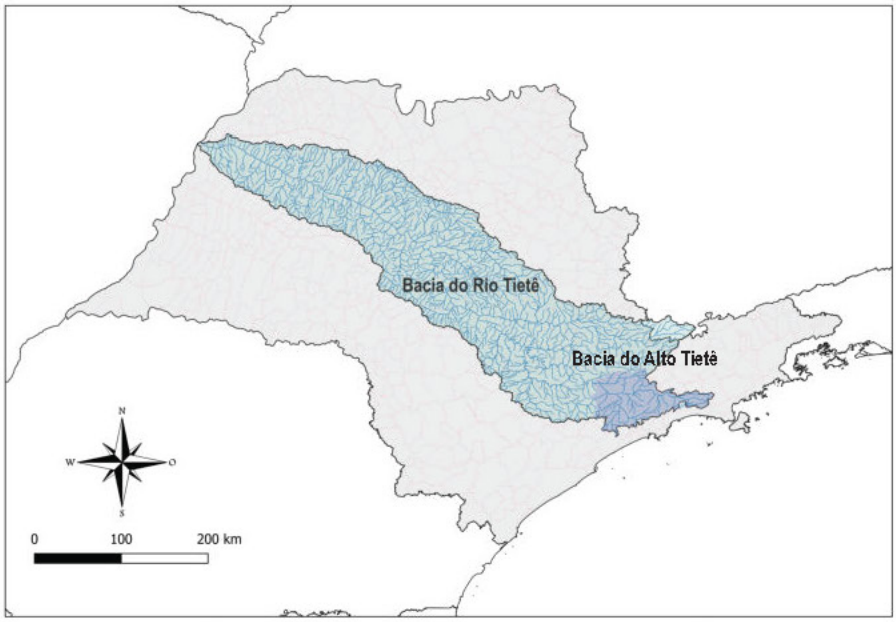


Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

1.1. The hydrographic basins in São Paulo

The Tietê is the main river of the state of São Paulo, extending 1,100 kilometers (**Map 1.1**). It rises in Salesópolis, in Serra do Mar, at an altitude of 1,120 meters, and flows westward, crossing the entire state until it meets the Paraná River at the border with Mato Grosso do Sul. Along its course, the Tietê passes through 62 municipalities in São Paulo. The river forms the state's main hydrographic basin, covering approximately 72,000 km², which corresponds to 29.0% of the total area of the state of São Paulo.

Map 1.2 The Upper Tietê Basin



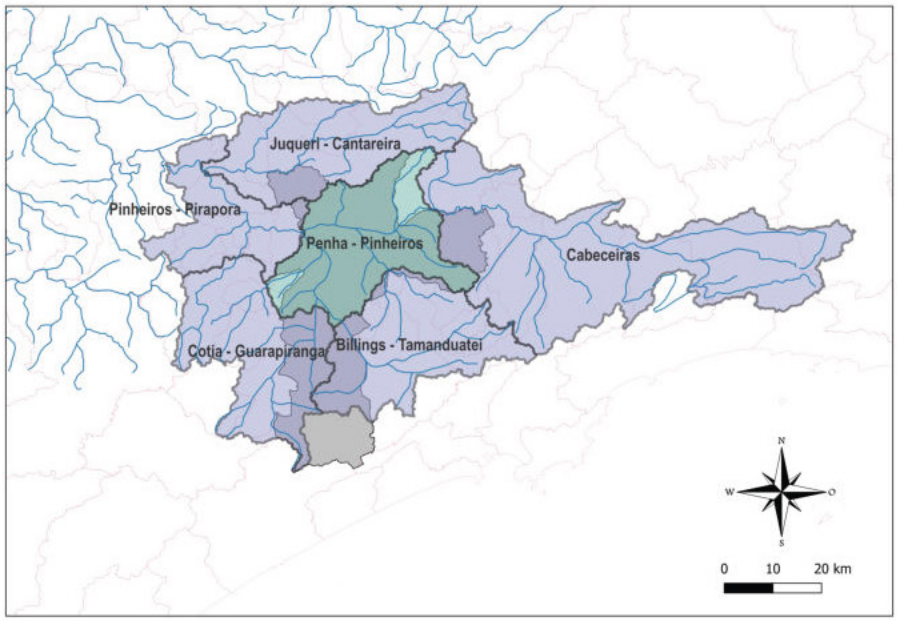
Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

The Tietê River Basin is divided into six sub-basins: 1. Upper Tietê, which includes the river's source; 2. Sorocaba/Middle Tietê; 3. Piracicaba-Capivari-Jundiaí; 4. Tietê/Batalha; 5. Tietê/Jacaré; and 6. Lower Tietê, where it flows into the Paraná River. The Upper Tietê Basin (**Map 1.2**) covers 5,776 km², which corresponds to 2.3% of the area of the state. It fully or partially includes 40 municipalities, of which only three are not part of the São Paulo Metropolitan Region. In 2022, the Upper Tietê Basin (UTB) was home to 20.4 million people, living in 8.6 million housing units (**Table 1.1**). This represents a population density of 3,528 inhabitants per km², which is 19.7 times the overall population density of the state of São Paulo.

The Upper Tietê Basin (UTB), in turn, is divided into six hydrographic sub-basins (**Map 1.3**): (i) Headwaters, which includes the source of the Tietê River; (ii) Billings-Tamanduateí; (iii) Juqueri-Cantareira; (iv) Penha-Pinheiros; (v) Pinheiros-Pirapora; and (vi) Cotia-Guarapiranga, where the UTB reaches its mouth. The Penha-Pinheiros Sub-basin covers 867.1 km², corresponding to only 0.3% of the state's area. It fully or partially includes 4 municipalities. In 2022, 8.9 million people lived in the Penha-Pinheiros Sub-basin, distributed across nearly 4.0 million housing units (**Table 1.1**). This results in a population density of 10,226 inhabitants per km², which is 2.9 times higher than the density of the Upper Tietê Basin and 57 times higher than the state of São Paulo's average.

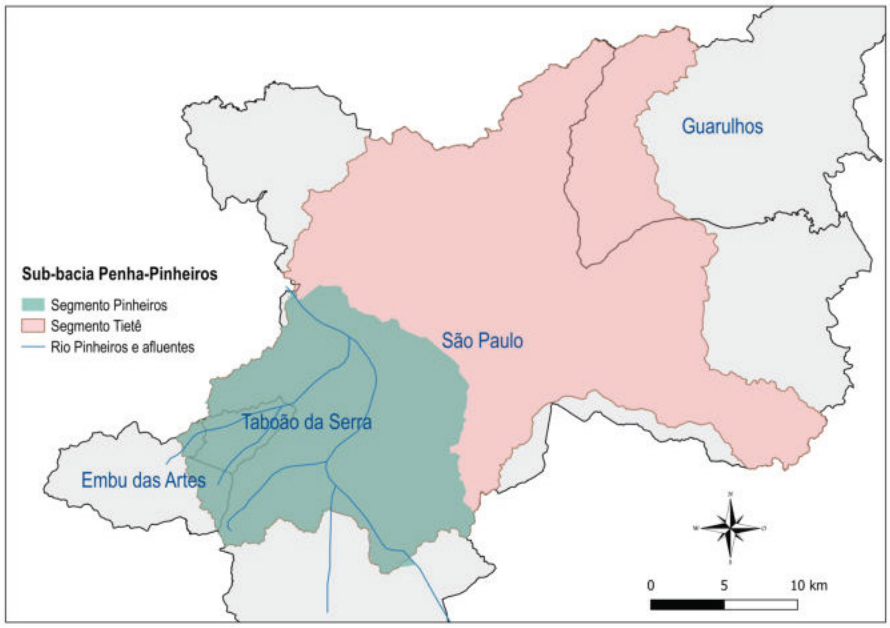
In the Penha-Pinheiros Sub-basin, the Pinheiros River is the main tributary of the Tietê River. In this section of the Sub-basin, also known as the Pinheiros River Basin (Map 1.4), 3.238 million people resided in 2022 across three cities: Embu das Artes, São Paulo, and Taboão da Serra. The population density reached 11,755 inhabitants per km² in 2022, exceeding the density of the Penha-Pinheiros Sub-basin by 15.0%.

Map 1.3 The Sub-basins of the Upper Tietê



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Map 1.4 The Penha-Pinheiros Sub-basin and its sections



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Table 1.1. Demographic indicators of hydrographic basins and sub-basins in the state of São Paulo, 2022

	Number of cities	Area (km²)	Housing units	Inhabitants	Population density (inhabitants/km²)
State of São Paulo	645	248,219.48	19,641,476	44,411,238	178.9
			Hydrographic basins and sub-basins		
Upper Tietê Basin	40	5,775.88	8,611,709	20. 374,486	3,527.5
(%) of the state*	6.2%	2.3%	43.8%	45.9%	1871.6%
Penha-Pinheiros Sub-basin	4	867.13	3,976,025	8. 866 . 943	10.22 5.6
(%) of the state*	0.6%	0.3%	20.2%	20.0%	5615.2%
Tietê Segment	2	591.66	2,526,806	5,628,951	9,513.8
(%) of the state*	0.3%	0.2%	12.9%	12.7%	5317.4%
Pinheiros Segment **	3	275.47	1,449,219	3,237,992	11,754.6
(%) of the state*	0.5%	0.1%	7.4%	7.3%	656 9.8 %

Source: IBGE. Prepared by: Ex Ante Consultoria Econômica. Notes: (*) In the case of the population density variable, the percentage refers to the ratio between the density of each area and the state's average population density. (**) Pinheiros River Basin.

Table 1.2. Population of the Pinheiros River Basin, 2022

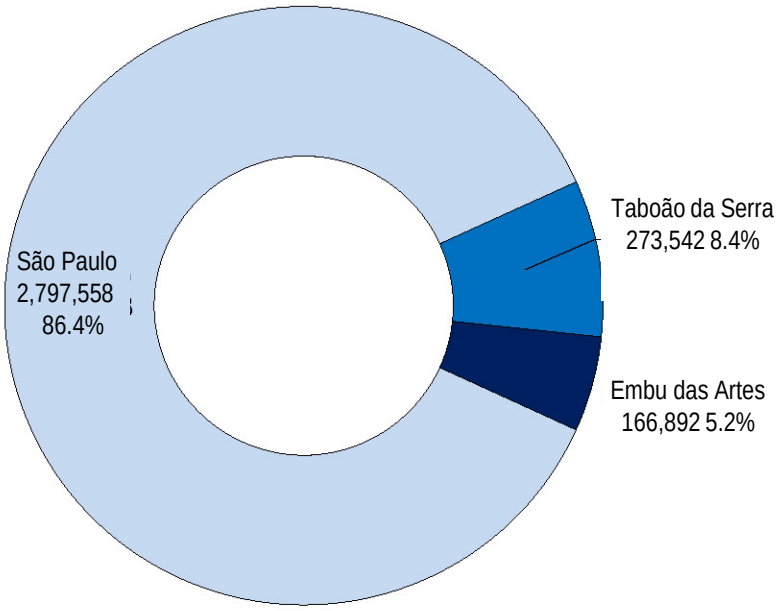
	Total population	Living in the Pinheiros River Basin	(%)
Total of the three cities	11,976,232	3,237,992	27.0%
Embu das Artes	250,691	166,892	66.6%
São Paulo	11,451,999	2,797,558	24.4%
Taboão da Serra	273,542	273,542	100.0%

Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Table 1.2 shows the population distribution of the Pinheiros River Basin among the three cities it encompasses. In 2022, out of the 3.238 million inhabitants of this hydrographic basin, 2.798 million lived in the city of São Paulo, accounting for 86.4% of the total population of the basin (**Chart 1.1**). This means that approximately one in every four residents of São Paulo lived in a household located within the Pinheiros River Basin. The second city with the largest share was Taboão da Serra, a city entirely located within the basin. There, about 274 thousand people lived, representing 8.3% of the basin's total population. Finally, 5.2% of the Pinheiros River Basin's population, or 167 thousand people, lived in Embu das Artes. This number corresponded to 66.6% of the city's total population in 2022.

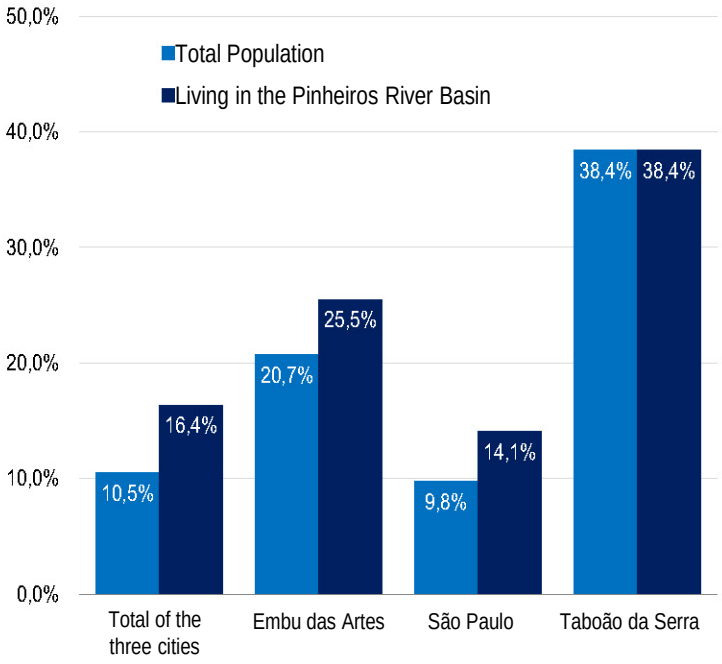
An important aspect to highlight is the accelerated growth of the city between 2000 and 2022, particularly in areas within the Pinheiros River Basin. Across the three cities that belong to the Pinheiros River Basin, the population grew by 10.5% over these 22 years, increasing from 10.8 million people in 2000 to nearly 12 million in 2022. The population of Taboão da Serra, which is entirely located within the Pinheiros River Basin, grew faster than the capital: 38.4% compared to 9.8%. Embu das Artes, where most of the population also resides within the basin, grew by 20.7%, a rate higher than that of the capital. This already indicates that demographic growth within the Pinheiros River Basin territory has been greater than the growth observed across the total area of the three cities.

Chart 1.1. Population distribution of the Pinheiros River Basin by municipality, 2022



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 1.2. Population distribution of the Pinheiros River Basin by municipality, 2022



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

As illustrated in **Chart 1.2**, however, demographic growth in the neighborhoods of Embu das Artes and São Paulo, located within the Pinheiros River Basin, was higher than the average demographic growth rates of these two cities. In the city of São Paulo, the population living within the basin increased by 14.1%, compared to 9.8% in the city as a whole. In Embu das Artes, the population living within the basin grew by 25.5%, compared to 20.7% in the city as a whole. As a result, demographic growth in the Pinheiros River Basin was 56.0% higher than the overall population growth of the three cities combined. This has also led to greater pressure on the basin's water resources and a faster pace of deterioration.

1.2. The Novo Rio Pinheiros Project

The **Novo Rio Pinheiros** Project was launched in 2019 with the specific objective of cleaning up the Pinheiros River and was part of a broader program targeting the Upper Tietê Basin. The depollution of the Pinheiros River had been a long-standing demand due to the severe environmental deterioration that emerged with the rapid urbanization of the São Paulo Metropolitan Region during the 20th century. During this period of expansion, the river and its tributaries were surrounded by new densely populated neighborhoods, industries, and commercial activities, and underwent major urban interventions. Streams were channeled, riverbeds were transformed, and even the course of the river was altered, redirecting its flow toward the coast, whereas originally it flowed inland. Between 1939 and 1940, two pumping stations (Traição and Pedreira) were built, reversing the flow of the Pinheiros and Tietê rivers toward the Billings Reservoir. Since the 1920s, this reservoir had been intended to store water for the operation of the Henry Borden Hydroelectric Plant in the Serra do Mar, but successive droughts caused instability in the power supply to the Baixada Santista region, indicating that reversing the Pinheiros River would serve as a means to ensure water storage in Billings. The reversal of the river's course also played a role in controlling flooding of the Pinheiros and Tietê rivers during the rainy seasons.

However, this accelerated process of urban expansion and intervention resulted in severe environmental degradation of the river. As stated by Baptistelli (2020), p.15: "... *by the late 1970s and 1980s, this river was already so polluted that diverting its waters to Billings compromised the quality of the reservoir's water. The Pinheiros River was being affected by domestic and industrial sewage discharges and by diffuse pollution carried by its main tributaries. Thus, this pollution of the river led to the prohibition of the practice of directing its flow to the Billings Reservoir...".* The continuous water transfer operation was discontinued in 1992, and new legislation was enacted to regulate the process, allowing flow reversal only in extreme flood situations.

The Novo Rio Pinheiros Project was developed under an innovative integrated management model that involved a partnership between the Government of the State of São Paulo, the Municipality of São Paulo, the Basic Sanitation Company of the State of São Paulo (Sabesp), the Environmental Company of the State of São Paulo (Cetesb), the Metropolitan Water and Energy Company (EMAE), and the Department of Water and Electric Energy (DAEE). The intervention model was also innovative in being structured around five action areas: (i) improvements in sanitation, (ii) maintenance of watercourses, (iii) improvements in solid waste collection, (iv) urban and landscape revitalization, and

(v) communication and environmental education.

The **sanitation improvement** axis was based on (a) expanding the collection of residential sewage in the Pinheiros River Basin, and (b) transporting this sewage for treatment at the Barueri Wastewater Treatment Plant (WWTP), operated by Sabesp. Previously, this sewage was discharged into the river without treatment, overloading the environment and causing the river's death since the early 1980s. To achieve this, works were required to collect and transport 2,800 liters of sewage per second to the WWTP. The implementation of this action area was under Sabesp's responsibility.

In addition to sewage collection and treatment, improving the environmental conditions of the Pinheiros River and its tributaries required the **maintenance of the watercourses**, which were silted up, with accumulated sediments, garbage, and other materials on their beds. In this area of action, dredging was carried out on the rivers and streams, which included the removal of sediments from the riverbeds, the excavation of three disposal sites and the transfer of material to the Carapicuíba pit, as well as the restoration of the slopes along the watercourses. The implementation of this second area of action was under the responsibility of EMAE.

Also aiming to improve environmental sanitation, the São Paulo City Hall implemented improvements in **solid waste collection and disposal,** directing to landfills the material retained in the grates and nets at the mouths of the tributaries flowing into the Pinheiros River. The removal of mosquitoes complemented this essential action to prevent vector-borne diseases.

The **urban and landscape revitalization** actions involved the expansion and integration of bike lanes around the Pinheiros River. In addition, the Parque Bruno Covas Novo Rio Pinheiros was created, the city's largest linear park, which follows the entire western bank of the river. The park offers various attractions: bike lanes, playgrounds, picnic areas, and trails. The creation of the Usina São Paulo Complex, a recreational area located on top of the Traição Pumping Station, completes the urban revitalization actions. The station will remain in operation, alternating the flow direction of the Tietê and Pinheiros Rivers, reversing the flow of waters during heavy rains to prevent the Tietê from polluting the Pinheiros, under the control of DAEE. The Usina São Paulo Complex is still in its implementation phase.

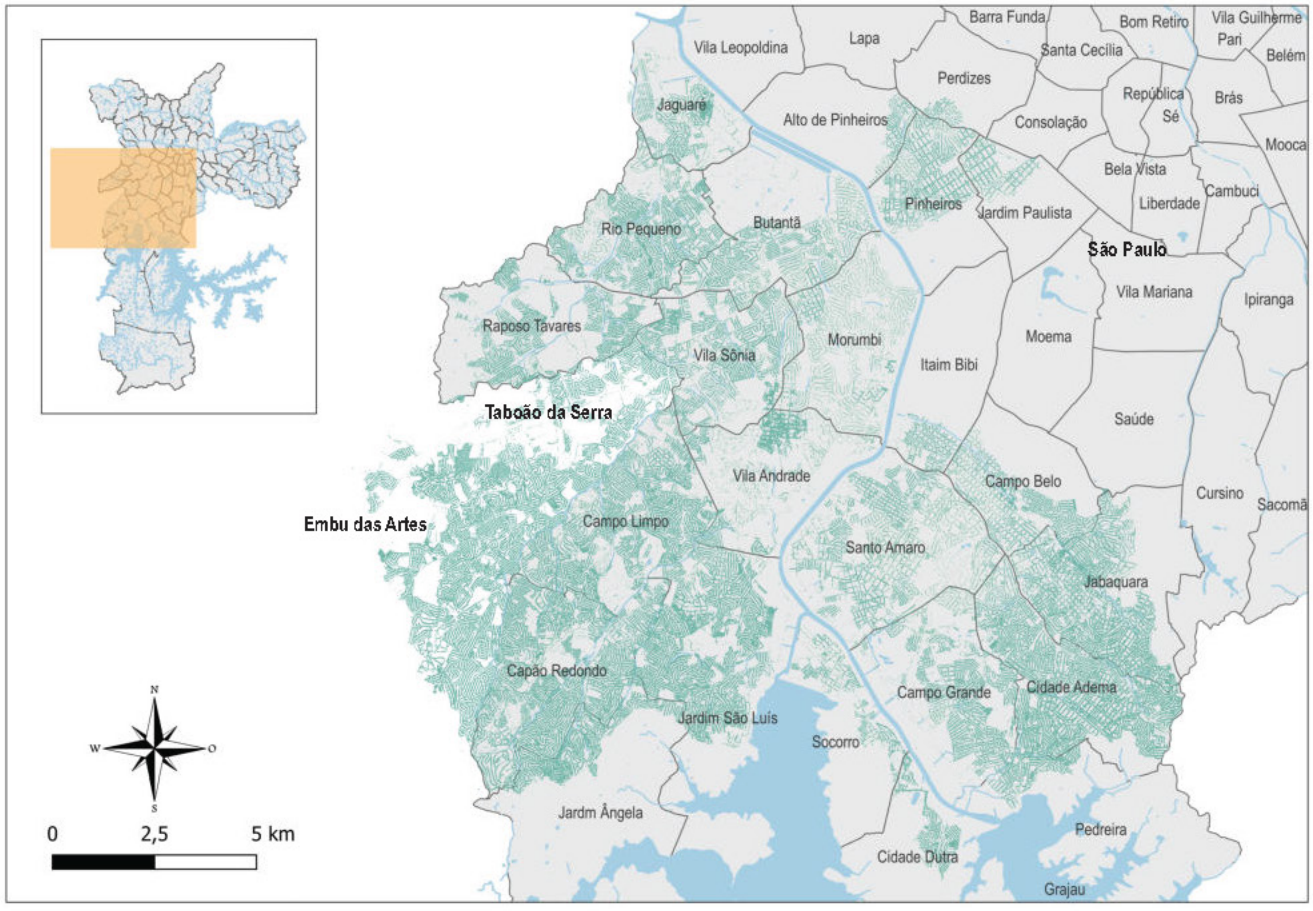
Finally, the **communication and environmental education** actions complete the five action areas, aiming at long-term behavioral change in society. These actions are under the responsibility of Sabesp and Cetesb, which remain in charge of monitoring the water quality of the Pinheiros River and its tributaries, an essential tool for environmental auditing.

The sanitation axis of the Novo Rio Pinheiros Project focused on installing infrastructure and equipment to restore proper **aerobic conditions** to the Pinheiros River. The premise behind this approach is that, with good oxygenation, the river would regain its self-purification capacity, allowing the residual sewage discharged into its course to be naturally degraded and decomposed. This active self-purification process, in turn, sustains aquatic life downstream in the watercourses. The restoration of proper aerobic conditions would be achieved through the collection, removal, and treatment of sewage discharged into the Pinheiros River Basin. On one hand, projects were developed to expand conventional sewage collection networks and wastewater treatment plants;

on the other, direct interventions were carried out in streams through localized treatment, a non-conventional strategy adopted in the project due to the existence of extensive and densely populated informal urban areas within the basin's territory. Localized treatment was implemented through five Recovery Units (UR) installed along the banks of the main tributaries of the Pinheiros River: Jaguaré, Antonico, Pirajuçara, Cachoeira, and Água Espraiada. These units aim to remove from the streams the sewage that cannot be collected and directed to treatment through conventional methods.

All sanitation interventions (water and sewage) of the Novo Rio Pinheiros Project took place entirely within the Pinheiros River Basin, as illustrated in **Map 1.5.** The map shows the location of households, commercial, industrial, and service establishments whose sewage began to be collected and sent for treatment at the Barueri WWTP as a result of the works carried out between 2020 and 2022. In total, 890,070 residential and non-residential units were connected to the sewage collection network, increasing the volume of sewage collected and sent for treatment at the WWTP.

Map 1 .5. Intervention points of the Novo Rio Pinheiros Project, 2020 to 2022

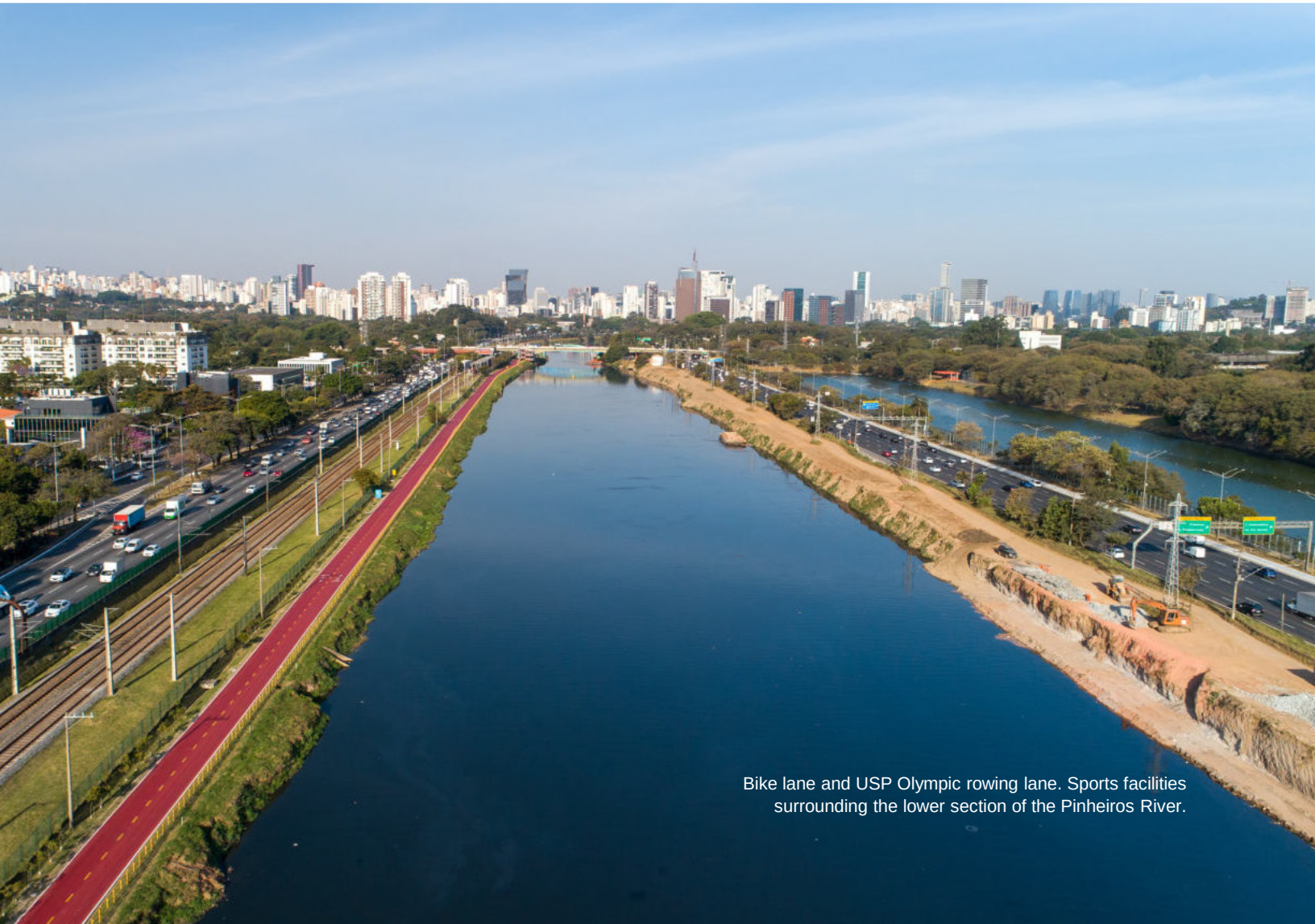


Source: Sabesp and IBGE. Prepared by: Ex Ante Consultoria Econômica.

1.3. Objective and Method

The objective of this study is to assess the effects of universal sanitation access in the Pinheiros River Basin, which was achieved through the Novo Rio Pinheiros Project and other system expansion actions carried out over the 22 years from 2000 to 2022. The study analyzes the impacts of the lack of sanitation on public health, with emphasis on the incidence of waterborne and respiratory diseases. It also examines the effects of these diseases on labor productivity, education among children and adolescents, and environmental valuation. These methodological approaches are described in detail in the publication "*Methodological Aspects of Social Cost-Benefit Analysis for Sanitation Investments*", produced by Instituto Trata Brasil in 2023, which provides the theoretical foundation for the analyses on this topic.

In the present study, aggregate data for the Pinheiros River Basin are analyzed, that is, for the total population of 3.2 million inhabitants within this territory, based on information from 2000 to 2022, the final year of the Novo Rio Pinheiros Project intervention. In a second publication on the topic, the distribution of benefits across different areas of the basin and various specific population groups – women, children and youth, the elderly, and residents of



Bike lane and USP Olympic rowing lane. Sports facilities surrounding the lower section of the Pinheiros River.

favelas and urban communities – will be analyzed in greater depth. In this other initiative, in addition to statistics from official data sources, information from a field survey designed to collect data on the perceptions and well-being of families living in favelas and urban communities within the Pinheiros River Basin will also be used.

The demographic and socioeconomic data for the present study come from IBGE databases. Sanitation statistics are sourced from the National Sanitation Information System (SNIS), supplemented with specific information about the project provided by Sabesp at the request of Instituto Trata Brasil. In addition to sanitation data, several IBGE surveys are used: the 2019 National Health Survey, the 2021 Brazilian National Accounts, the 2022 Annual Survey of Construction Industry, the 2022 Annual Survey of Services, the 2023 Continuous National Household Sample Survey, and the 2000, 2010, and 2022 Population Censuses. Information on the number and costs of hospitalizations due to waterborne and respiratory diseases covered by the Unified Health System (SUS) comes from DATASUS, as do mortality data. Information on ENEM performance was obtained from INEP (National Institute for Educational Studies and Research) of the Ministry of Education.

1.4. Analysis Outline

Chapter 2 of the report describes the demographic situation and the evolution of sanitation in the Pinheiros River Basin from 2000 to 2022, with emphasis on the three cities that comprise it.
In this analysis, the populations with and without access to sanitation services are identified, along with the evolution of indicators related to water consumption, sewage collection, and waste treatment.
Chapter 3 of the study presents estimates of the employment and income generation effects resulting from investments in the expansion of the sanitation system and from the subsequent operation of the newly installed infrastructure. This analysis includes data on investments from 2000 to 2022, with emphasis on the efforts made by the Novo Rio Pinheiros Project over the last three years (2020 to 2022). From its launch in 2019 to its completion in 2022, Sabesp invested nearly BRL 610 million in wastewater infrastructure works, a very significant number of resources.

Next, the indirect effects of the sanitation expansion are analyzed, including impacts on health, labor productivity, and environmental valuation (Chapters 4 and 5). Chapter 4 presents statistics on morbidity due to waterborne and respiratory diseases and the trend of declining incidence of these diseases observed from 2000 to 2023 in the Pinheiros River Basin area. Information on the labor market, education, leisure, and tourism is discussed in Chapter 5.

Finally, the cost-benefit balance of universal sanitation access in the Pinheiros River Basin is analyzed. First, the benefits and costs of sanitation expansion observed between 2000 and 2022 are assessed. Then, the legacy of this achievement for future generations of Pinheiros River Basin residents is evaluated.

PART 1

SANITATION ACTIVITIES IN THE PINHEIROS RIVER BASIN AND THE GENERATION OF INCOME AND EMPLOYMENT

2

EVOLUTION OF SANITATION IN THE PINHEIROS RIVER BASIN FROM 2000 TO 2022

2.1. Service Coverage Rates

According to SNIS data, and considering the methodology used to aggregate municipal data for the Pinheiros River Basin indicators – the methodology is described in Methodological Annex 1.1 – 99.4% of the population in the Pinheiros River Basin was supplied with drinking water, and 96.7% had sewage collection services at home in 2022. As illustrated in **Chart 2.1**, this is the result of progress made over the past 22 years (2000 to 2022). During this period, 589 thousand people gained access to a treated water supply, and 840 thousand people gained access to sewage collection services at home through collection networks.

The expansion of sanitation services is reflected in the network extension data shown in **Chart 2.2.** In 2000, the water distribution network in the Pinheiros River Basin was 4.6 thousand kilometers long, increasing to 6.7 thousand kilometers by 2022. The growth rate was 1.8% per year over these 22 years. The sewage collection network, in turn, expanded from 3.5 thousand kilometers in 2000 to 5.2 thousand kilometers in 2022, with an annual growth rate of 1.9%. These increases resulted from investments made during these years, especially the recent investments under the Novo Rio Pinheiros Program, which will be analyzed in the next section of this study.

It is worth noting that, despite the higher service coverage rates, the length of the water supply network per capita is lower than the averages for the state of São Paulo, the Metropolitan Region, and the national average, as shown in **Chart 2.3.** The same applies when comparing the lengths of sewage collection networks per capita. The reason for this is the high population density in the Pinheiros River Basin compared to other regions.

The volume of water consumed increased from 172.2 million m^3 in 2000 to 200.1 million m^3

Chart 2.1

Population served by water supply and sewage services (%) of total population, Pinheiros River Basin

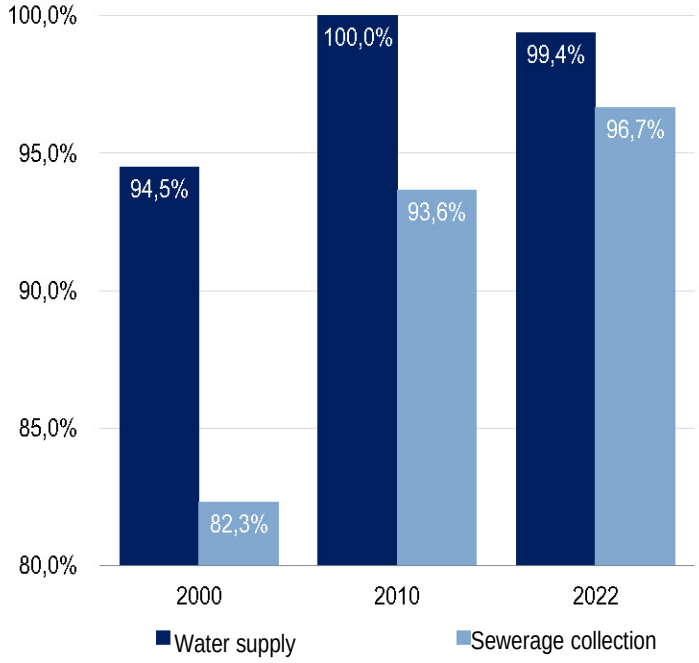


Chart 2.2

Length of water supply and sewage collection networks, kilometers, Pinheiros River Basin

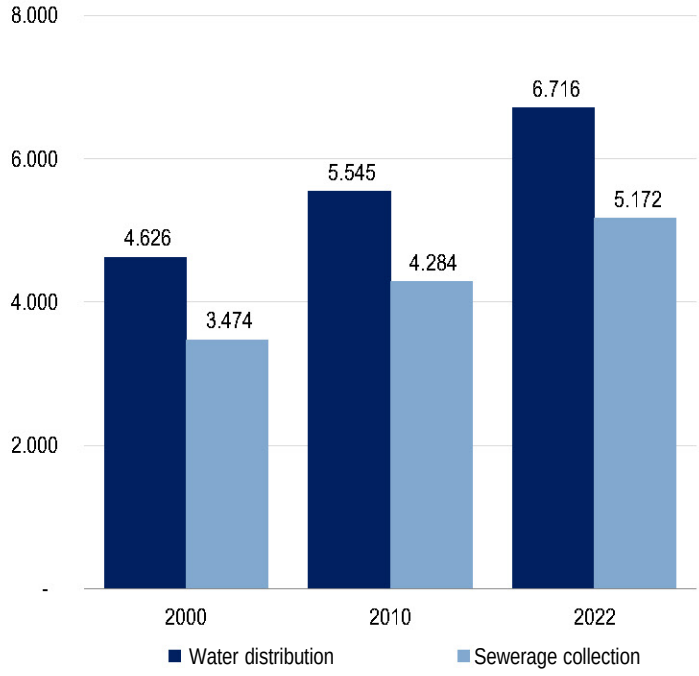


Chart 2.3

Length of water supply and sewage collection networks, meters per capita, Pinheiros River Basin

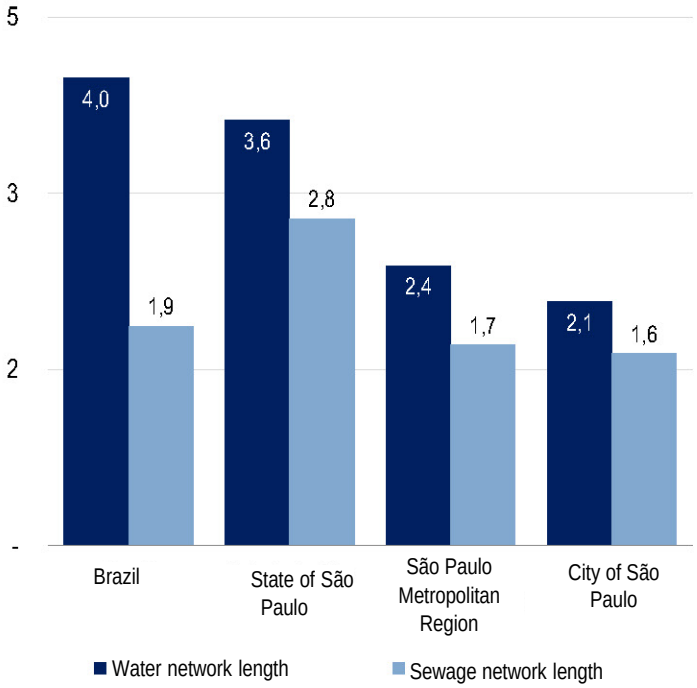
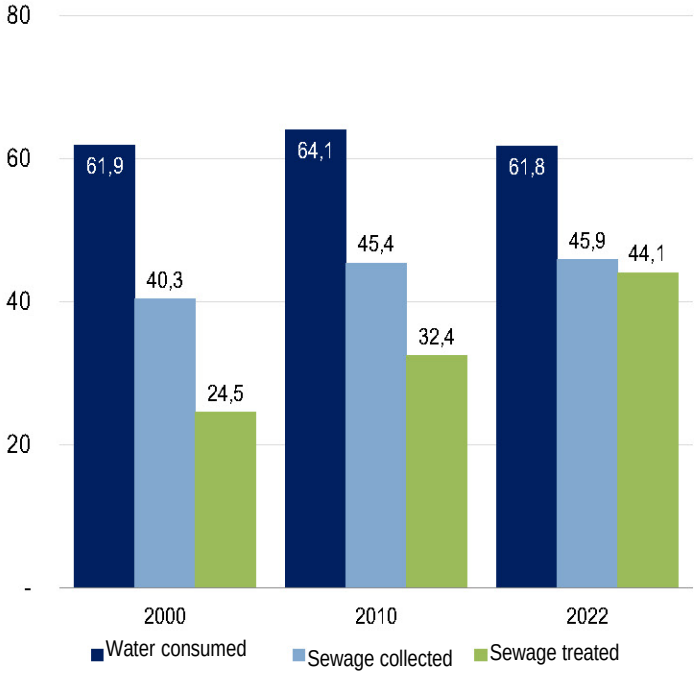


Chart 2.4

Water consumption and volume of treated sewage, m³ per capita per year, Pinheiros River Basin



Source: SNIS and IBGE. Prepared by: Ex Ante Consultoria Econômica.

in 2022, representing an annual growth rate of 0.7%. This rate is practically the same as that observed in the region's demographic growth, meaning that the volume of water consumed per capita remained relatively stable, ranging from 61.8 m³ to 64.1 m³ per capita, as shown in **Chart 2.4.**

The volume of sewage collected, in turn, increased from 112.3 million m³ in 2000 to 148.6 million m³ in 2022, indicating an annual growth rate of 1.3% over the period. The per capita volume of sewage collected rose from 40.3 m³ per capita in 2000 to 45.9 m³ per capita in 2022. The volume of treated sewage grew from 68.2 million m³ in 2000 to 142.7 million m³ in 2022, indicating an annual growth rate of 3.4% over the period. This explains the strong annual growth rate of 2.7% in treated sewage volume per capita, which rose from 24.5 m³ per capita in 2000 to 44.1 m³ per capita in 2022.

Table 2.1 shows the basic sanitation situation in Brazil, in the state of São Paulo, in the São Paulo Metropolitan Region, and in the cities that make up the Pinheiros River Basin. The most recent statistics are presented for the populations served by the treated water distribution system and sewage collection system, along with the absolute and relative service deficits.

In 2022, only 19.8 thousand people still lived in households without access to treated water in the Pinheiros River Basin, which corresponded to 0.9% of the water supply deficit in the state of São Paulo and just 0.1% of Brazil's total. The relative water supply deficit in the Pinheiros River Basin was 0.6% of the population, a figure much lower than the state of São Paulo's average of 4.9% and the national average of 15.8%. For this reason, water supply was effectively universalized in 2022.

In the case of sewage collection access, the deficit was greater: 107.9 thousand inhabitants lived in households without sewage collection in the Pinheiros River Basin. In relative terms, this indicates that 3.4% of the basin's population was not connected to the general sewage network. This rate was lower than the averages for both the state of São Paulo and Brazil.

Table 2.2 presents estimates of treated water consumption and volumes of sewage collected and treated in the same regions. First, there is a relatively high index of treated water supply in the region compared to the volumes consumed in the state of São Paulo and in Brazil as a whole. In per capita terms, it is estimated that the population of the Pinheiros River Basin consumed 165.6 liters per person per day in 2022. This level was higher than the average for the São Paulo Metropolitan Region, which was 159.9 liters per person per day.

The data in this table also indicate that, in 2022, 96.0% of the sewage collected in the Pinheiros River Basin was treated before being discharged, meaning that 142.7 million m³ out of the 148.6 million m³ collected were treated that year. On the other hand, it can be seen that the volume of treated sewage corresponded to 71.3% of the volume of water consumed, a fairly high ratio considering distribution losses and water evaporation.

It is important to note, however, that the recent works of the Novo Rio Pinheiros Project set aside the innovative solution of localized treatment in streams that cross favelas and urban communities. This procedure allowed a significant portion of the sewage generated in the Pinheiros River Basin, which is not collected by the traditional sewer network, to receive some level of treatment before being discharged, improving the water quality of the Pinheiros River and its tributaries. This reduced pollution by preventing most of the human waste and water used by this population from returning untreated to the environment, which had been greatly affecting the local environment and also the downstream municipalities within the Tietê River Basin.

Table 2.1
Population with access to sanitation and sanitation deficit, absolute and %), Pinheiros River Basin, 2022

	Population	Population with access to		Sanitation deficit		Relative deficit (%)	
		Treated water	Sewerage collection	Treated water	Sewerage collection	Treated water	Sewerage collection
Brazil	203,080,756	171,042,954	112,803,960	32,037,802	90,276,796	15.8%	52.8%
State of São Paulo	44,411, 238	42,232,443	40,173,545	2 . 17 8,795	4,237,69 3	4.9%	10.0%
São Paulo Metropolitan Region	20,731,920	20,248,464	19,161,609	48 3, 456	1,570,31 1	2.3%	7.8%
Embu das Artes	250,691	250,691	212,538	-	38.15 3	0.0%	15.2%
São Paulo	11,451,999	11,371,086	11,144,442	80,913	307,557	0.7%	2.7%
Taboão da Serra	273,542	273,542	266,203	-	7,339	0.0%	2.7%
Pinheiros River Basin	3,237,992	3,218,226	3,130,122	1 9, 76 6	107.87 0	0.6%	3.4%

Source: SNIS and IBGE. Prepared by: Ex Ante Consultoria Econômica.

Table 2.2
Water consumption and sewage collection and treatment, in 1,000 m³, Pinheiros River Basin, 2022

	-	Annual Volume (in thousand m³)			Per Capita Volume per Day (in liters)		
		Water treated	Sewage collected	Sewage treated	Water treated	Sewage collected	Sewage treated
Brazil	11,630,331	6,106,423	4,956,581	156.9	82.4	66.9	
State of São Paulo	2,834,904	2,315,700	2,011,702	174.9	142.9	124.1	
São Paulo Metropolitan Region	1,209,729	873,551	698,529	159.9	115.4	92.3	
Embu das Artes	12,531	7,057	5,974	136.9	77.1	65.3	
São Paulo	724,789	545,303	529,708	173.4	130.5	126.7	
Taboão da Serra	14,682	10,695	9,318	147.1	107.1	93.3	
Pinheiros River Basin	200,080	148,603	142,695	165.6	123.0	1 18.1	

Source: SNIS and IBGE. Prepared by: Ex Ante Consultoria Econômica.

2.2. Goals and Results

SNIS statistics also make it possible to evaluate the Novo Rio Pinheiros Project in terms of achieving the goals established when the project was launched. In 2019, the expectation was to add 73 thousand new active residential sewage connections by 2022. Based on the annual weighting of the populations of each of the three cities within the basin and the data on the number of active residential connections (variable ES008 from SNIS), an estimate of 89.2 thousand new residential connections to the collection network in the region between 2019 and 2022 is reached. This estimate allows us to state that the program's goal was met and very likely exceeded by more than 20% through the works carried out in the region between 2020 and 2022. The increase in the number of connections to the network allowed for an additional 15.5 million m³ of sewage to be treated between 2019 and 2022.

Another important goal of the program established during its planning phase was to send an additional 2,800 liters per second to the Barueri WWTP

compared to the volume being treated there in 2018. In part, this theoretical target was overestimated due to an overprojection of the population living in the Pinheiros River Basin in 2018, which had been based on trends observed in the 2000 and 2010 demographic censuses. Due to this fact, it is difficult to establish a precise metric to measure the degree of target achievement.

However, it is possible to assess the evolution of the volume of sewage treated at the WWTP and estimate the use of the installed non-conventional treatment capacity at the five Recovery Units. SNIS statistics from 2019 and 2022 indicate an increase of 492 liters per second in treatment capacity at the Barueri WWTP between 2019 and 2022, which was made possible by a nearly 70% expansion of the plant's installed capacity. By adding the increase in sewage treated at the WWTP to the production capacity of the five Recovery Units, which totals 1,560 liters per second, there was a total increase of 2,052 liters per second in sewage treatment for the Pinheiros River Basin. Considering that an average of 4,139 liters of sewage per second was treated in 2019, the additional processing provided by the program resulted in a 49.6% increase in the volume of sewage that received some form of treatment before being discharged.

As discussed in Chapter 1, the main objective of the Novo Rio Pinheiros Program was the depollution of the basin's water sources. The inland water quality monitoring data collected by Cetesb provide relevant information for estimating progress in this area. **Table 2.3** presents Cetesb's measurements of Dissolved Oxygen (DO), in mg per liter, at the four water quality monitoring stations installed along the Pinheiros River. The values are averages of the measurements taken during each sub-period.

It is noted that the average DO measurements decrease considerably between the uppermost point of the river, located near the Billings Reservoir, and the measurement point at the mouth of the Pinheiros River. Between 2014 and 2018, the average DO value was 4.1 mg per liter near the reservoir and only 0.7 mg per liter near the river's mouth. The values decrease progressively as the river flows downstream. The same phenomenon is observed in the period following the Novo Rio Pinheiros Project interventions (2022 and 2023). Another important fact is that desirable increases in DO were observed at all monitoring stations between the two sub-periods analyzed. In absolute terms, the improvement was greatest at the stations closer to the beginning of the canal, with a significant gain of 2.7 points, or 139.5%, at the Ponte do Socorro station. However, the gains were smaller at the stations further downstream, where the DO levels remained below the

Table 2.3.
Dissolved Oxygen Index in the Pinheiros River, 2014 to 2023

Measurement Points on the Pinheiros River	Dissolved Oxygen (mg/L)		Difference	
	2014-2018	2022-2023	Absolute	(%)
Pedreira Pumping Station	4.1	5.2	1.1	25.6%
Ponte do Socorro	1.9	4.6	2.7	139.5%
Ponte Ari Torres	0.8	1.3	0.5	54.8%
Estrutura de Retiro	0.7	0.9	0.2	34.3%
Average	1.9	3.0	1.1	58.5%

Source: Cetesb. Prepared by: Ex Ante Consultoria Econômica

desired threshold of 2 mg per liter. The final result was an increase of 1.1 points in DO at the average of the four stations, which corresponds to a 58.5% gain. On average along its length, the DO index reached 3.0 mg per liter in the measurements taken between 2022 and 2023.

On the other hand, **Table 2.4** presents Cetesb's measurements of Total Organic Carbon (TOC), in mg per liter, at the four water quality monitoring stations installed along the Pinheiros River. The values shown in the table are also averages of the measurements taken during each sub-period. In this case, TOC measurements began somewhat later, which explains the change in historical values.

For this water quality parameter, the average organic carbon levels increase between the uppermost point of the Pinheiros River and the measurement point at the mouth, indicating that the organic load rises along the course of the river. Between 2019 and 2020, a period during which the interventions had not yet been completed, the average TOC value was 13.0 mg per liter near the reservoir and 32.0 mg per liter near the river's mouth. The values increase progressively downstream, that is, as the Pinheiros River receives additional water from its tributaries, the organic load increases. Once again, the same pattern is observed in the period following the Novo Rio Pinheiros Project interventions (2022 and 2023), but it should be noted that desirable reductions in TOC were recorded at all monitoring stations between the two sub-periods analyzed. In absolute terms, the improvements were greater at the stations located in the middle sections of the river. The improvement was smaller at the measurement point near the mouth of the river. The final result was a decrease of 9 points in TOC on average across the four stations, corresponding to a reduction of 38.4% between the two sub-periods. On average along its length, the TOC index reached 14.5 mg per liter in the measurements taken between 2022 and 2023.

These statistics indicate that the environmental degradation of the Pinheiros River improved significantly after the intervention, but water quality levels remain low along much of the river's length. According to ANVISA's RDC Resolution No. 49/2010, the TOC limit for industrial water use is 10 mg/L, a level that was reached at only one of the four monitoring points. On the other hand, CONAMA Resolution No. 357/2005 establishes that a Class 4 river must have a DO index greater than 2 mg per liter, a condition that was met only at the first two monitoring points. This river class is defined as a water body that may be used for navigation, landscape harmony, industrial and domestic supply after advanced treatment, and for less demanding uses.

Table 2.4.
Organic Carbon Index in the Pinheiros River, 2019 to 2023

Measurement Points on the Pinheiros River	Total Organic Carbon (mg/L)		Difference	
	2019-2020	2022-2023	Absolute	(%)
Pedreira Pumping Station	13.0	7.5	-5.5	-42.3%
Ponte do Socorro	23.0	1 1.7	-11.4	-49.3%
Ponte Ari Torres	26.0	1 5.4	-10.7	-41.0%
Estrutura de Retiro	32.0	2 3.4	-8.6	-26.9%
Average	23.5	14.5	-9.0	-38.4%

Source: Cetesb. Prepared by: Ex Ante Consultoria Econômica.

3

INCOME AND EMPLOYMENT GENERATION IN SANITATION EXPANSION

This chapter addresses the direct economic gains resulting from investments and the expansion of sanitation operations in the Pinheiros River Basin. First, a theoretical overview is presented on the mechanisms through which investments in sanitation and the expansion of sector activities lead to employment and income generation in society. This theoretical foundation will be essential later on to measure the direct effects of sanitation expansion in the Pinheiros River Basin over the past 22 years, and in particular, the effects of the works carried out under the Novo Rio Pinheiros Project. Next, statistics on the evolution of investments and revenues from sanitation operations are presented, which serve to estimate the levels of employment and income supported: (i) by the works carried out between 2000 and 2022, and (ii) by the operations of water treatment and distribution and sewage collection and treatment in the serviced area. The methodology used to measure these effects is described in detail in the Methodological Annex. Finally, the chapter addresses the effects on tax revenues.

3.1. Classification of Effects

The expansion of sanitation involves substantial investments in civil construction, which have significant economic effects in the areas where the works are carried out and during the period of their execution. The installation of a sanitation system in a city includes construction works for water distribution networks, sewage collection networks, water intake and treatment plants, and wastewater treatment plants.

Investments in sanitation works create jobs and expand income in the economy. Conceptually, these impacts are classified as direct, indirect, and induced. Directly, the execution of works requires hiring

a construction company and employees, who receive wages. This is the economic activity sustained directly by the investments made by sanitation companies or governments during the expansion or installation of services.

The construction company hired to carry out the sanitation works, in turn, purchases construction materials and contracts services from other companies. This involves payments to suppliers before and during the execution of the works. Spending on suppliers and third parties indirectly supports jobs and income in the construction supply chain. These include, for example, jobs generated in the building materials industry or in engineering and architecture offices.

The third effect is called induced. This effect arises from the fact that, by hiring workers, whether for the construction works, the production of building materials, or support services, wages are paid. This labor income sustains workers' consumption. Their spending induces economic activity across various sectors of the economy, ranging from food production to home purchases. It is a dispersed effect but highly relevant, as wages account for a relatively large portion of the total value of sanitation works.

The direct, indirect, and induced effects of income and job generation may occur in the locations where the works are carried out or in other regions. Since the works are generally located in the city where the investments are made, the effects of these expenditures are considered local, as are the income and jobs sustained by the wages paid to employees of the construction companies performing the works.

On the other hand, employment and income in the construction supply chain (building materials and services) occur in the locations where the companies that produce these goods and services are located. For example, the cement used in a sanitation project carried out in the South of the country may be produced in another region, just as the engineering firm hired to perform the calculations may also be located elsewhere. Thus, jobs in these activities are generated in a dispersed manner across the national territory.

Once sanitation works are completed, the expansion of sanitation operations generates direct, indirect, and induced jobs. The income generated also follows this classification: there is direct income, generated and distributed within the sanitation operators; indirect income, generated in the sector's supply chain, composed of suppliers of raw materials and services to sanitation operators; and finally, induced income, sustained by the wages paid by sanitation operators to their employees and by suppliers in the chain to their workers.

The direct, indirect, and induced effects of job and income generation may occur in the locations where sanitation services are provided or in other regions. The direct effects of sanitation operations are generally local, while those generated in the sanitation supply chain occur where companies supplying inputs and services to sanitation operators are located. These companies are spread throughout the national territory, and their operations can only be measured in aggregate terms. A good example of this is the income and employment generated in the electricity sector. Sanitation companies, as is well known, are major consumers of electric power, which is used for pumping and machine operations for water treatment and distribution, as well as for sewage collection and treatment. However, this energy is generated through the grid, and it is not possible to determine whether it came from a nearby hydroelectric plant or another plant connected to the system.

3.2. Evolution of Investments and Operating Revenues

Between 2000 and 2022, investments in sanitation in the Pinheiros River Basin increased from BRL 76.285 million to BRL 608.393 million, representing

an annual growth rate of 9.9%. However, this growth includes inflation in the costs of installing sanitation infrastructure. Adjusting current prices to 2024 constant prices – see Methodological Annex 3.1 – sanitation investments in the Pinheiros River Basin increased from BRL 364.356 million to BRL 644.111 million, representing an annual growth rate of 2.6%.

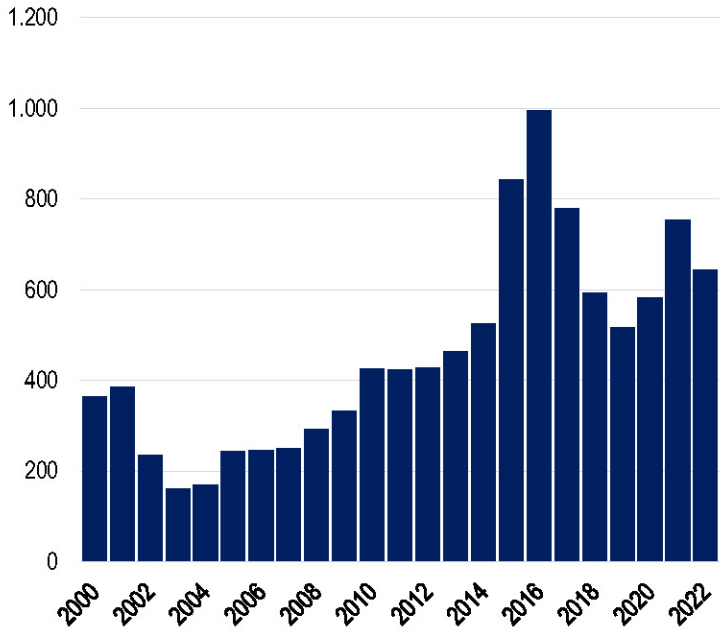
After adjusting for inflation, a total of BRL 10.949 billion was invested in maintenance and expansion works of the water and sewage networks in the Pinheiros River Basin between 2000 and 2022, which corresponds to an average of BRL 463.022 million per year over the period. Over these 22 years, the investment per resident amounted to BRL 3,450, which corresponds to approximately BRL 150.00 per capita per year. **Chart 3.1** shows the annual investment made in the Pinheiros River Basin for maintenance and expansion works of water and sewage networks in 2024 constant values.

Of the total invested during this period, Sabesp's disbursements for the Novo Rio Pinheiros works totaled BRL 779.730 million (at 2024 prices). Thus, the investments made during this final phase of the sanitation universalization effort in the Pinheiros River Basin accounted for 7.3% of the total invested in the region between 2000 and 2022. During these years (2020 to 2022), 12.3% of Sabesp's revenues in the region were allocated to Novo Rio Pinheiros investments, a rate that demonstrates a significant effort to achieve the project's targets.

The trajectory of operating revenues is shown in **Chart 3.2,** which presents the values at constant prices – see Methodological Annex for details on the adjustment method. On average over the period, total operating revenue was BRL 2.879 billion per year (at 2024 prices). Revenues grew steadily until 2015, with an average annual growth rate of 0.7% between 2000 and 2015, a period during which

Chart 3.1

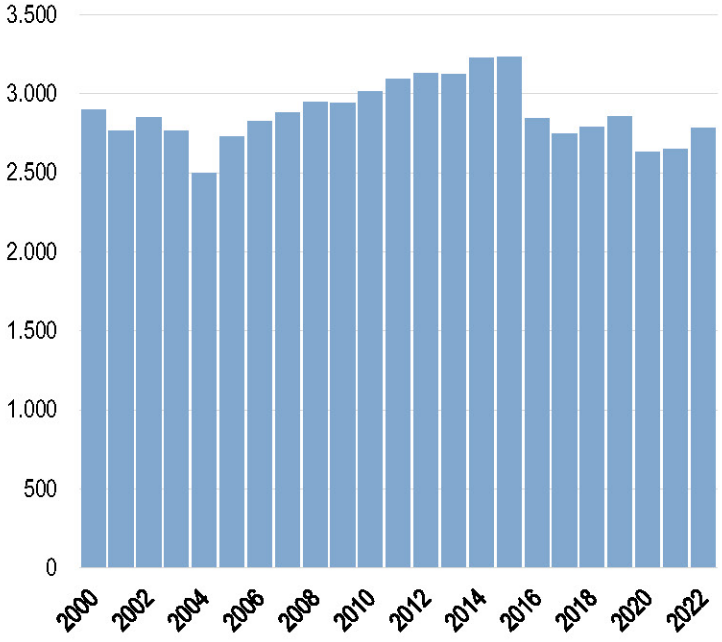
Sanitation investments, in BRL millions*, Pinheiros River Basin, 2000 to 2022



Sources: IBGE and SNIS, Ministry of Cities. Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

Chart 3.2

Sanitation operating revenue, in BRL millions*, Pinheiros River Basin, 2000 to 2022



Sources: IBGE and SNIS, Ministry of Cities. Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

Table 3.1

Sanitation investments, direct income and employment, Pinheiros River Basin, annual average from 2000 to 2022, BRL millions and people

	BRL millions*
Sanitation investments	463.022
Employed personnel (people)	1.89 9
Income (GDP)	120.193
Personnel expenses	78.738
Supplier expenses	342.829

Sources: IBGE and SNIS, Ministry of Cities.
Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

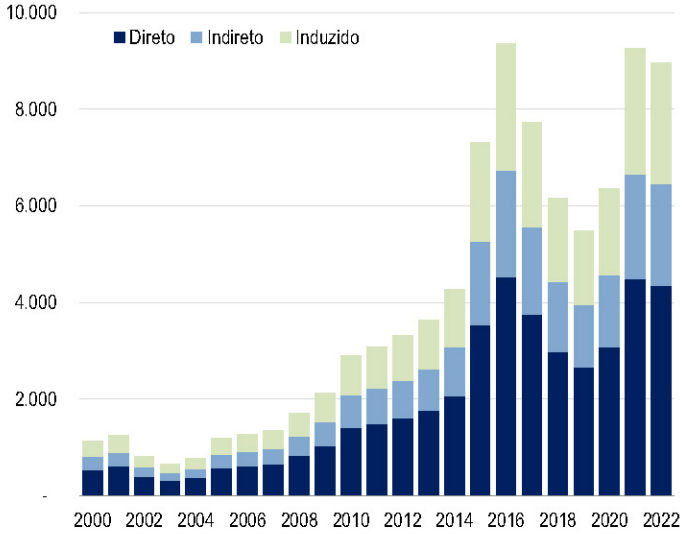
Table 3.2

Income and employment generated directly, indirectly, and induced by investments, Pinheiros River Basin, annual average from 2000 to 2022, BRL millions and people

	Employment (people)	Income (BRL millions*)
Direct	1,899	120.193
Indirect	922	85.050
Induced	1,096	121.787
Total	3,917	327.030

Sources: IBGE and SNIS, Ministry of Cities.
Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

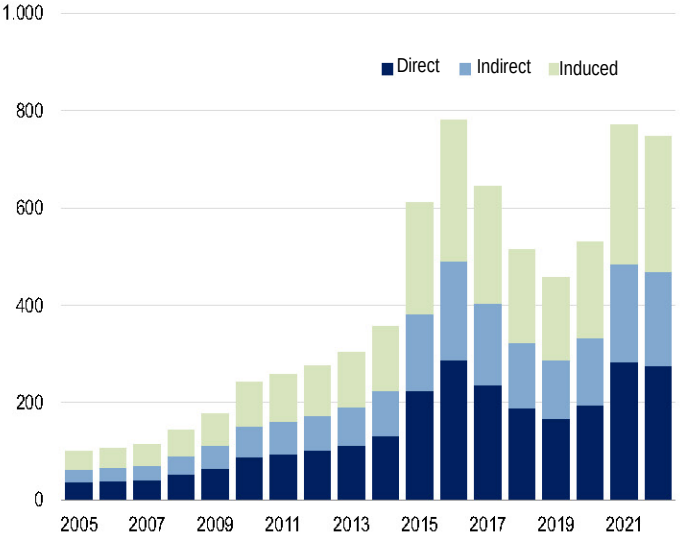
water supply was in the process of being universalized. However, the expansion process stagnated in 2016. The drought of 2014-2015 caused the sharpest decline ever recorded in the reservoir levels of the Cantareira system, leading to a reduction in both water supply and demand in the following years, with consequent revenue losses starting in 2016. As a result of this trend, per capita sanitation revenues



Sources: IBGE and SNIS, Ministry of Cities.
Prepared by: Ex Ante Consultoria Econômica.

Chart 3.4

Income generated by sanitation investments, Pinheiros River Basin, BRL millions*, 2000 to 2022



Sources: IBGE and SNIS, Ministry of Cities. Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

decreased over these 22 years, dropping from BRL 1,040.94 per capita in 2000 to BRL 859.00 per capita in 2022 (at 2024 constant prices).

3.3. Employment and Income Generation from Investments

Sanitation sector investments in the Pinheiros River Basin amounted to BRL 463.022 million per year between 2000 and 2022. It is estimated that, on average over the period, these works sustained 1,899 direct jobs per year in civil construction. These jobs paid BRL 78.738 million in wages, benefits, and labor contributions (**Table 3.1**).

In addition to labor expenses, it is estimated that the construction companies hired to carry out the works spent BRL 342.829 million on the purchase of construction materials and services. This corresponded to 74.0% of the total investment made on average during the period.

The income generated from the construction activity related to the expansion of sanitation networks in the region amounted to approximately BRL 120.193 million per year on average from 2000 to 2022. This amount is part of the region's construction sector GDP generated during this period.

Table 3.2 presents estimates of indirect and induced employment and income generated by sanitation investments, based on the methodology detailed in Methodological Annex 3.2 of the report. In addition to the 1,899 direct jobs generated annually by sanitation investments in the Pinheiros River Basin, it is estimated that 922 indirect jobs per year were generated in the construction supply chain on average over the period from 2000 to 2022. These jobs were generated both in the building materials industries and in construction-related service sectors, such as engineering and architectural firms. They also include companies that supply inputs to the direct suppliers of the contracted construction companies. As previously indicated, these jobs are distributed across the state and the country.

The indirect income generated by sanitation investments amounted to BRL 85.050 million per year between 2000 and 2022. This amount was lower than the expenditures on construction materials and services by the companies responsible for the works. The employment and income induced by sanitation investments, whether through wages paid by construction companies or through jobs sustained along the construction supply chain, reached approximately 1,096 people and BRL 121.787 million per year, respectively. In total, sanitation investments supported 3,917 jobs per year nationwide and generated BRL 327.030 million per year in income for the Brazilian economy between 2000 and 2022 (**Table 3.2**). **Charts 3.3** and **3.4** show the evolution of jobs and income sustained by investments made in the Pinheiros River Basin between 2000 and 2022.

Based on the values from **Tables 3.1** and **3.2**, it can be inferred that the investments made under the Novo Rio Pinheiros Project supported an estimated 1,066 direct construction jobs and generated BRL 67.469 million per year in construction sector GDP in the region. Considering indirect and induced effects, it is estimated that investments made under the Novo Rio Pinheiros Project supported a total of 2,199 jobs per year between 2020 and 2022 and generated BRL 183.547 million per year in GDP.

3.4. Employment and Income Generation from Operations

Between 2000 and 2022, sanitation operations in the Pinheiros River Basin generated average revenues of BRL 2.879 billion per year. These operations supported an estimated 1,388 direct jobs per year in the region. These jobs resulted in expenditures of BRL 415.152 million on wages, benefits, and labor contributions. Of this total, 77% was spent directly on employees and 23% on charges and social contributions.

Table 3.3

Sanitation operations, direct income and employment, Pinheiros River Basin, annual average from 2000 to 2022, BRL millions and

	BRL millions*
Total operating revenues	2.8 78.867
Employed personnel (people)	1,388
Income (GDP)	1.8 05.158
Personnel expenses	4 15.152
Supplier expenses	1.0 96.139

Sources: IBGE and SNIS, Ministry of Cities. Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

Table 3.4

Income and employment generated directly, indirectly, and induced by operations, Pinheiros River Basin, annual average from 2000 to 2022, BRL millions and people

	Employment (people)	Income (BRL millions*)
Direct	1,388	1,805.158
Indirect	1,168	878.959
Induced	2,385	1,258.617
Total	4,942	3,942.734

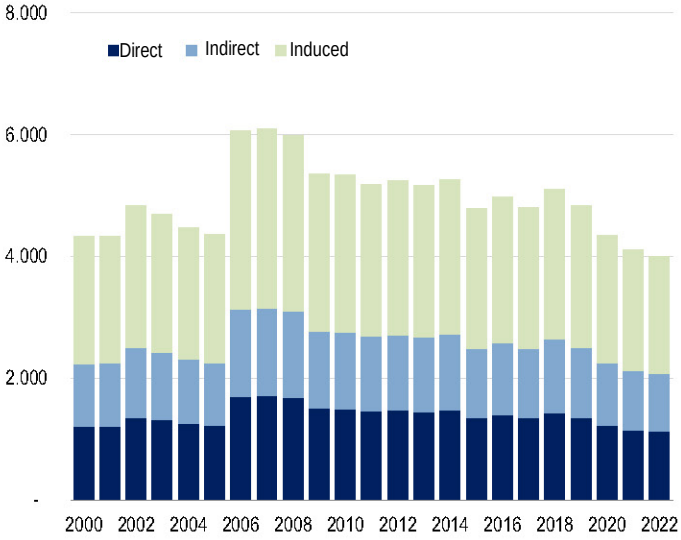
Sources: IBGE and SNIS, Ministry of Cities. Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

During this period, sanitation operations in the Pinheiros River Basin spent BRL 1.096 billion per year on the purchase of inputs and services required for treated water distribution and sewage collection and treatment operations. On average over the period, the income generated from sanitation activities reached BRL 1.805 billion per year – see **Table 3.3.**

Table 3.4 presents estimates of the indirect and induced effects of operations carried out by sanitation operators in the Pinheiros

Chart 3.5

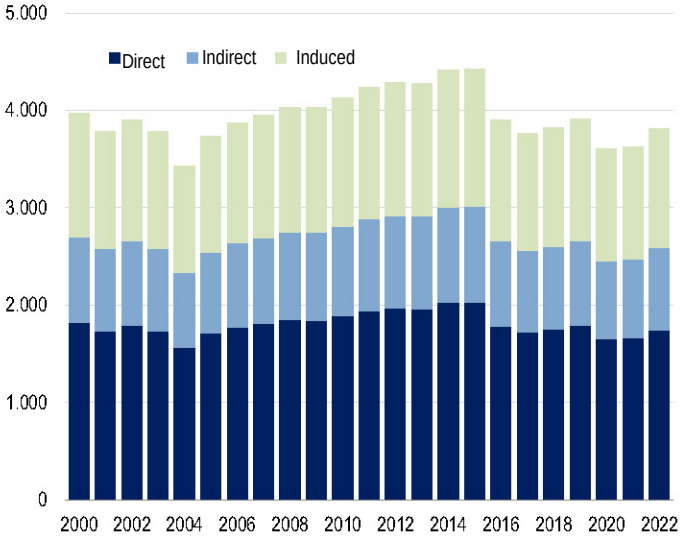
Jobs generated by sanitation operations, Pinheiros River Basin, in thousand people, 2000 to 2022



Sources: IBGE and SNIS, Ministry of Cities. Prepared by: Ex Ante Consultoria Econômica.

Chart 3.6

Income generated by sanitation operations, Pinheiros River Basin, BRL millions, 2000 to 2022



Sources: IBGE and SNIS, Ministry of Cities. Prepared by: Ex Ante Consultoria Econômica.

River Basin between 2000 and 2022. It is estimated that, on average over the period, 1,168 indirect jobs were generated in the sanitation supply chain. These jobs were created both in industries producing inputs for water and sewage treatment and in service sectors related to sanitation. The main one is the electricity sector, which supplies the energy for pumping and operating machines and equipment.

The indirect income generated in this supply chain totaled BRL 878.959 million per year. This amount was slightly lower than the expenditures on inputs and services required for the provision of water and sewage services by sanitation operators. As a result, the sum of direct and indirect income reached BRL 2.684 billion per year during this period.

The induced income and employment reached BRL 1.259 billion and 2,385 people on average between 2000 and 2022. Thus, sanitation operations supported a total of 4,942 jobs and generated BRL 3.943 billion in income for the economy per year between 2000 and 2022 solely from sanitation activities.

The evolution of jobs and income (including all three effects: direct, indirect, and induced) sustained by sanitation operations in the Pinheiros River Basin is presented in **Charts 3.5** and **3.6**, respectively. An increase in the level of job and income generation has been observed in recent years, mainly driven by the rise in revenues from water distribution and sewage collection.

3.5. Tax and Contribution Collection

A portion of the revenue from companies that built and operated the water and sewage collection networks is directly collected by public authorities in the form of taxes and contributions on production. This category of taxation includes

Mural Panel by Ângelo Taccari, painting on tile. Sabesp Headquarters Building in São Paulo. The panel depicts an Araucaria field, a type of pine tree that was predominant in the region until the early 20th century and gave its name to the river and the neighborhood along its banks in the city of São Paulo.

Table 3.5

Taxes and contributions* collected from sanitation operations and investments, Pinheiros River Basin, annual averages from 2000 to 2022

Taxes	Investments		Operations	
	BRL Millions	% of Gross Revenue	BRL Millions	% of Gross Revenue
Production-related Taxes (A)	23.678	5.1%	131.873	4.6%
ICMS	-	0.0%	8.183	0.3%
IPI	-	0.0%	-	0.0%
Import tax	-	0.0%	-	0.0%
Other specific taxes	21.354	4.6%	99.061	3.4%
Other production taxes	2.324	0.5%	24.628	0.9%
Income and Property Taxes (B)	28.474	6.1%	295.510	10.3%
Property Tax (IPTU)	0.061	0.0%	0.773	0.0%
Vehicle Tax (IPVA)	0.027	0.0%	0.1 19	0.0%
Other (ITR)	-	0.0%	-	0.0%
Income Tax	9.546	2.1%	92.371	3.2%
Social Contribution on Net Profit (CSLL)	1, 556	0.3%	25.533	0.9%
Social Security and FGTS	17.283	3.7%	176.715	6.1%
Total Tax Burden (A) + (B)	52.152	11.3%	427.383	14.8%

Sources: IBGE and SNIS, Ministry of Cities. Note: (*) at 2024 constant prices. Prepared by: Ex Ante Consultoria Econômica.

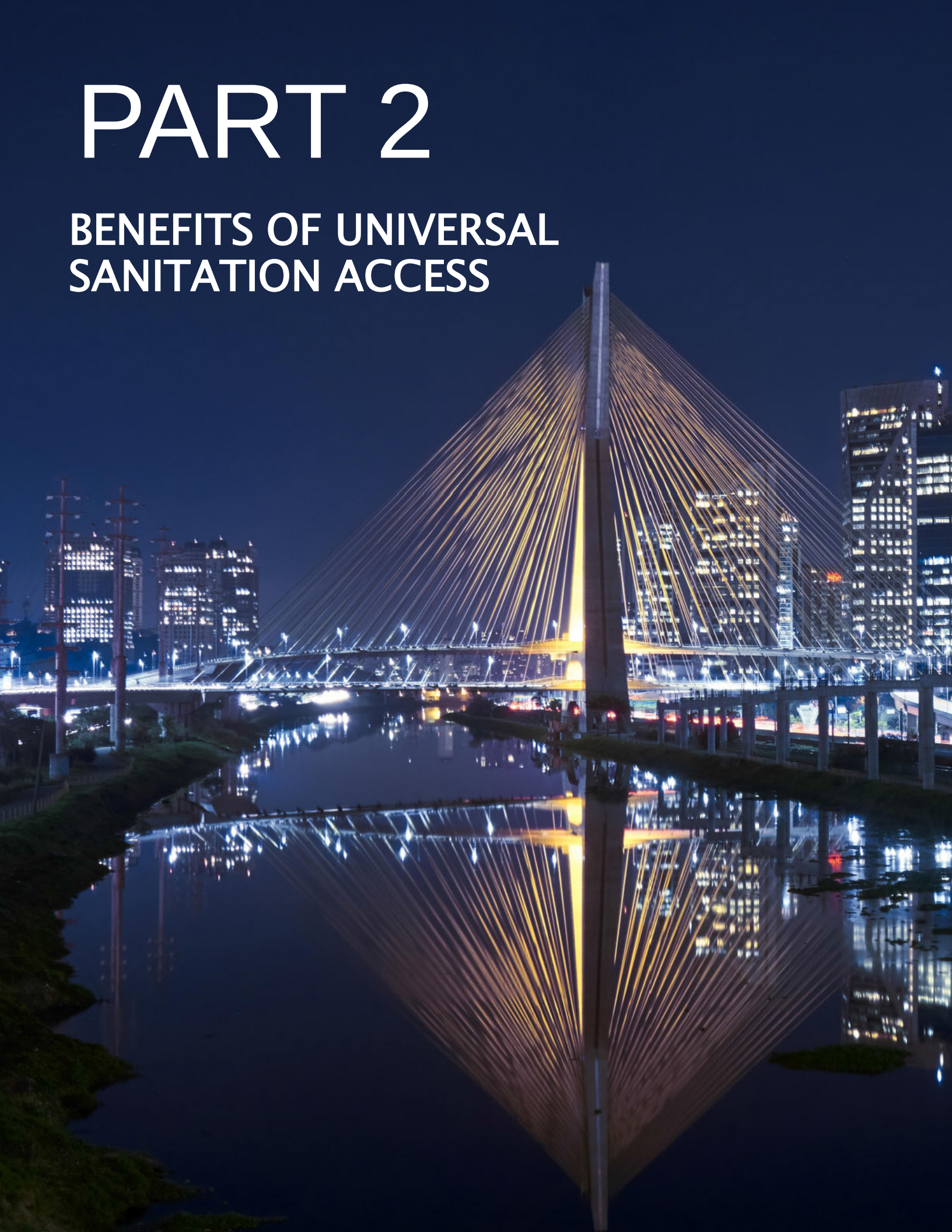
ICMS, PIS, and Cofins. On average, these three taxes represented 4.6% of the gross revenue of sanitation companies, according to IBGE data from the Annual Survey of Services and the 2021 Brazilian National Accounts. For sanitation infrastructure works, the tax burden was 5.1% of the gross revenue of construction companies (Annual Survey of the Construction Industry).

The direct income generated by sanitation operations is allocated partly to the payment of wages, partly to shareholders or reinvested into the company as after-tax profit, and partly to tax payments. This group of taxes includes income and property taxes: Property Tax (IPTU), Vehicle Tax (IPVA), Corporate Income Tax, Social Contribution on Net Profit (CSLL), Employer Social Security Contributions, and the Severance Indemnity Fund for Employees (FGTS). This set of taxes represented 10.3% of the gross revenue of sanitation companies in Brazil, according to IBGE data, resulting in a total tax burden of 14.8% of gross revenue. In the case of construction, income and property taxes accounted for 6.1% of gross revenue, resulting in a total tax burden of 11.3%.

Applying these percentages to the gross sanitation revenue of the Pinheiros River Basin, it is estimated that an average of BRL 403.383 million was collected per year between 2000 and 2022. From the amounts invested, it is estimated that BRL 52.152 million was collected per year. **Table 3.5** presents the distribution of these amounts among the taxes and contributions. These amounts were distributed among the three levels of government according to legal designations.

PART 2

BENEFITS OF UNIVERSAL SANITATION ACCESS



4

SANITATION AND HEALTH

The lack of sanitation has immediate implications for the health and quality of life of populations living in environmentally degraded areas. The absence of treated water has a direct impact on health, especially for the very young and the elderly, as it increases the incidence of waterborne and respiratory diseases. The lack of sewage collection and treatment services, even when treated water is available, also significantly affects the incidence of gastrointestinal infections and diseases transmitted by mosquitoes and animals.

The most serious problems arise along the banks of contaminated rivers and streams or on streets where sewage runs in the open – in ditches, gutters, streams, or rivers. But it is also present in the pollution of water reservoirs and water sources, whose quality has deteriorated over the years. Environmental exposure to sewage and the lack of treated water cause illnesses that harm the health of children, youth, and adults.

The recurrence of these diseases harms society by generating irreversible costs. There are two immediate channels linking the lack of sanitation to these costs:

i. By increasing the incidence of these diseases, the lack of sanitation leads to people being absent from their jobs, resulting in costs to society due to lost working hours; and

ii. Society incurs public and private expenses for the treatment of infected individuals.

This chapter analyzes the externalities of sanitation on population health. The analyses focus on national data, as well as data from the state of São Paulo, the metropolitan region, and the Pinheiros River Basin, allowing for the assessment of differences in indicators that may be associated with sanitation. This comparison makes it possible, on the one hand,

to assess the gains already achieved through the expansion of sanitation and, on the other hand, to estimate the legacy of universal access to basic sanitation in the areas analyzed.

4.1. Waterborne Diseases

Based on data from the 2019 National Health Survey (IBGE, 2020), it is possible to estimate the number of absences from routine activities due to waterborne diseases.[1] The survey asked a representative sample of the Brazilian population whether they had been absent from their routine activities during the two weeks before the interview date, the reason for the absences, and how many days they were absent.

In 2019, 1.688 million Brazilians reported having been absent from their activities during the two weeks prior to the interview due to the occurrence of waterborne diseases. Based on these data, it is estimated that there were a total of 43.374 million cases of absence due to these diseases throughout Brazil in 2019. In the Pinheiros River Basin, there were 78.1 thousand cases, equivalent to 1.0% of the total recorded in the Northeast region.

These reports of absence indicate an incidence rate of 206.9 cases per 1,000 inhabitants in Brazil in 2019 on average. As shown in **Chart 4.1**, the state of São Paulo recorded a higher incidence: 223.3 cases per 1,000 inhabitants. In the São Paulo Metropolitan Region, where the Pinheiros River Basin is located, the number of cases was even higher, at 225.8 cases per 1,000 inhabitants. The city of São Paulo recorded a lower incidence rate (152.3 cases per 1,000 inhabitants).

A portion of those who were absent due to waterborne diseases ended up bedridden due to the severity of the illness. **Chart 4.1** also presents the incidence rate of bedridden individuals due to waterborne diseases. In Brazil, there were 84.8 bedridden cases per 1,000 inhabitants, while in the state of São Paulo, there were only 80.1 cases per 1,000 inhabitants.

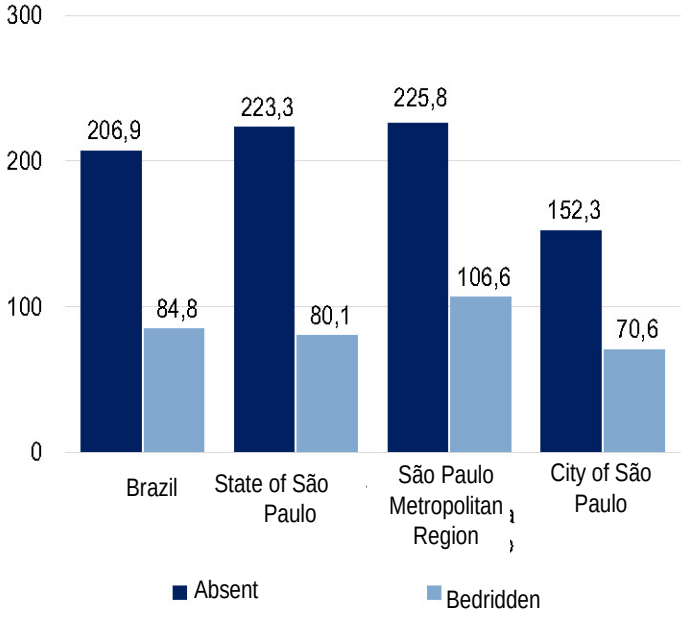
Chart 4.2 shows the incidence rate of absences due to waterborne diseases and the incidence rate of bedridden individuals due to these diseases by age group, in cases per 1,000 inhabitants throughout 2019, in the São Paulo Metropolitan Region. Throughout 2019, the incidence of absences was higher among children up to 14 years of age. For all age groups, the incidence rates of absences were higher than or equal to those of bedridden cases.

Based on microdata from the 2019 National Health Survey (IBGE, 2020), which provides a wide range of information on individuals, their households, and the occurrence (or not) of absences, it was found that **the probability of being absent from daily activities due to diarrhea or vomiting was negatively correlated with access to sewage collection and treated water services.** The greater the access to these services, the lower the probability of absence due to gastrointestinal illness – see details in **Methodological Annex 4.1.**

The 2019 National Health Survey (IBGE, 2020) indicated that individuals who were absent remained away from their activities for an average of nearly 4.6 days in the country. In the São Paulo Metropolitan Region, the absence period was longer than the national average: 5.2 days per absence. The incidence of absences and their duration resulted in a total of 25.5 million days of absence from routine activities over one year throughout the state. Had these individuals not contracted gastrointestinal infections, they could have worked, studied, or simply rested during the period they were ill.

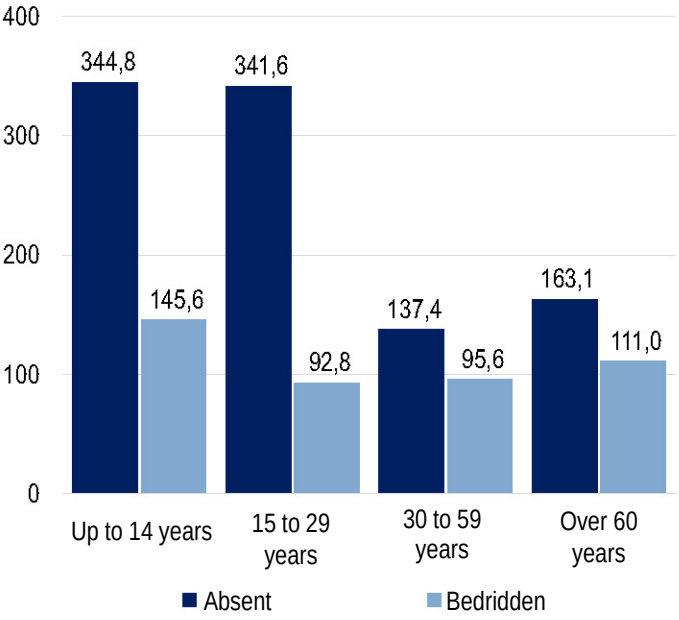
(1) The waterborne diseases considered in the 2019 National Health Survey include: gastrointestinal problems (diarrhea, vomiting, nausea, gastritis, and stomach ache) and infections transmitted by mosquitoes such as dengue, chikungunya, Zika virus, or yellow fever.

Chart 4.1 Absences and bedridden cases due to waterborne diseases, cases per 1,000 inhabitants, by region, 2019



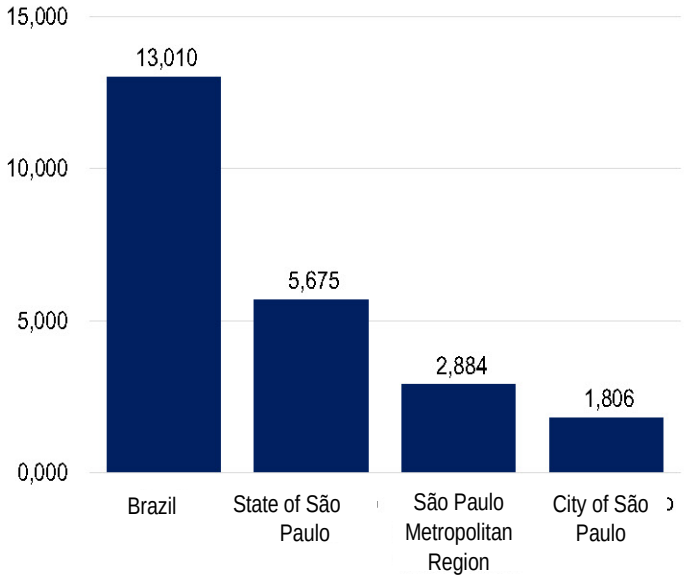
Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 4.2 Absences and bedridden cases due to waterborne diseases, cases per 1,000 inhabitants, by age group, São Paulo Metropolitan Region, 2019



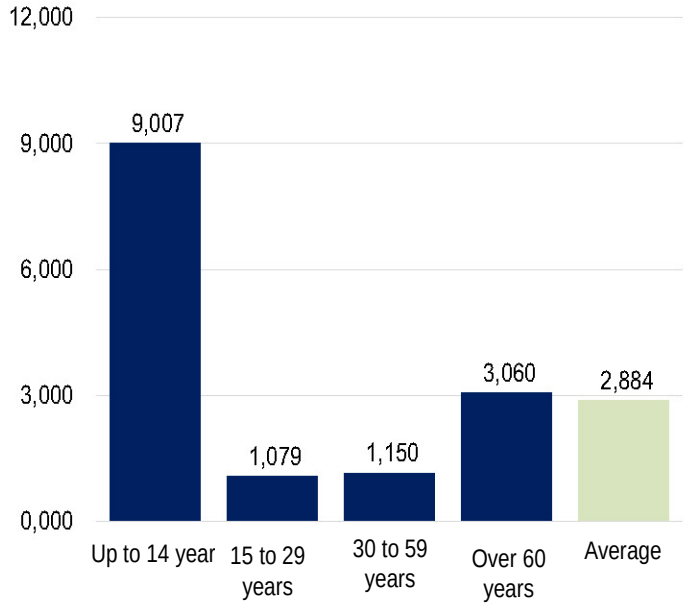
Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 4.3 Hospitalizations due to waterborne diseases, cases per 10,000 inhabitants, 2019



Source: Datasus and IBGE.
Prepared by: Ex Ante Consultoria Econômica.

Chart 4.4 Hospitalizations due to waterborne diseases, cases per 10,000 inhabitants, by age group, São Paulo Metropolitan Region, 2019 São Paulo Metropolitan Region, 2019



Source: Datasus and IBGE. Prepared by: Ex Ante Consultoria Econômica.

Based on data from the Unified Health System (SUS), there were 273.4 thousand hospitalizations due to waterborne diseases[2] in Brazil throughout 2019, with 26.1 thousand in the state of São Paulo and 6.3 thousand in the São Paulo Metropolitan Region. The hospitalization incidence rate in the São Paulo Metropolitan Region (**Chart 4.3**), which reached 2.884 cases per 10,000 inhabitants in 2019, was lower than that of the state of São Paulo as a whole (5.675 cases per 10,000 inhabitants) and the national average (13.010 cases per 10,000 inhabitants). It is worth noting that in the São Paulo Metropolitan Region, the incidence rate was much higher among children (9.007 cases per 10,000 inhabitants) – see **Chart 4.4.** Among the elderly, the incidence was also relatively high: 3.060 cases per 10,000 inhabitants.

4.2. Respiratory Diseases

In addition to waterborne diseases, the lack of sanitation affects the incidence of respiratory diseases. The most direct link between lack of sanitation and respiratory diseases lies in access to hand hygiene. Ryan et al. (2001) analyzed the effect of training on handwashing habits on the incidence of respiratory diseases in U.S. military personnel undergoing training between 1996 and 1998. The group that received training and had unrestricted access to water and hygiene products had an incidence rate 45% lower than the group without training or access to water and hygiene materials. Rabie and Curtis (2006) provide an extensive review of studies with diverse populations published up to 2004. These studies concluded that handwashing reduced the incidence of respiratory diseases by between 6% and 44%.

Based also on data from the 2019 National Health Survey (IBGE, 2020), it is possible to estimate the number of absences from routine activities due to respiratory diseases – flu, pneumonia, bronchitis, and asthma – in Brazil. It is estimated that there were a total of 92.130 million cases of absence due to respiratory diseases in the country throughout 2019, a volume 2.12 times higher than the number of absences caused by waterborne diseases. These reports of absence indicate an incidence rate of 439.6 cases per 1,000 inhabitants throughout 2019 in Brazil. In the state of São Paulo, the incidence of absences was higher: 467.5 cases per 1,000 people. In the São Paulo Metropolitan Region, the incidence reached 501.0 cases per 1,000 inhabitants (**Chart 4.5**).

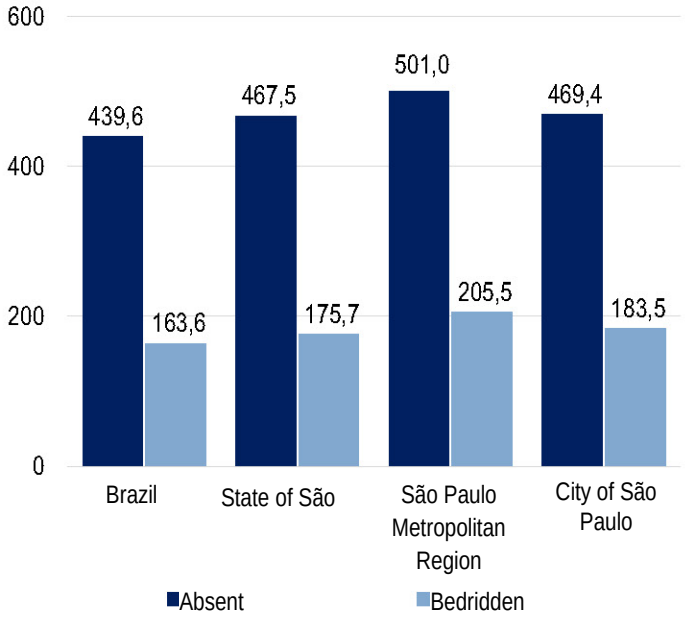
A portion of those absent due to respiratory diseases became bedridden due to the severity of the illness. **Chart 4.5** also shows the incidence rate of bedridden individuals due to respiratory diseases. In Brazil, there were 163.6 cases per 1,000 inhabitants, while in the state of São Paulo there were 175.7 cases per 1,000 inhabitants. The São Paulo Metropolitan Region presented a slightly higher bedridden rate: 205.5 cases per 1,000 inhabitants.

Chart 4.6 shows the incidence rate of absences and bedridden cases due to respiratory diseases by age group in the São Paulo Metropolitan Region. Throughout 2019, the incidence of absences due to respiratory diseases was very high among children, reaching 1,003.4 cases per 1,000 inhabitants.

In broad statistical terms, the microdata from the 2019 National Health Survey indicate that **the probability of being absent from daily activities due to respiratory diseases was also negatively correlated with access to sewage collection and treated water services.** The greater the access

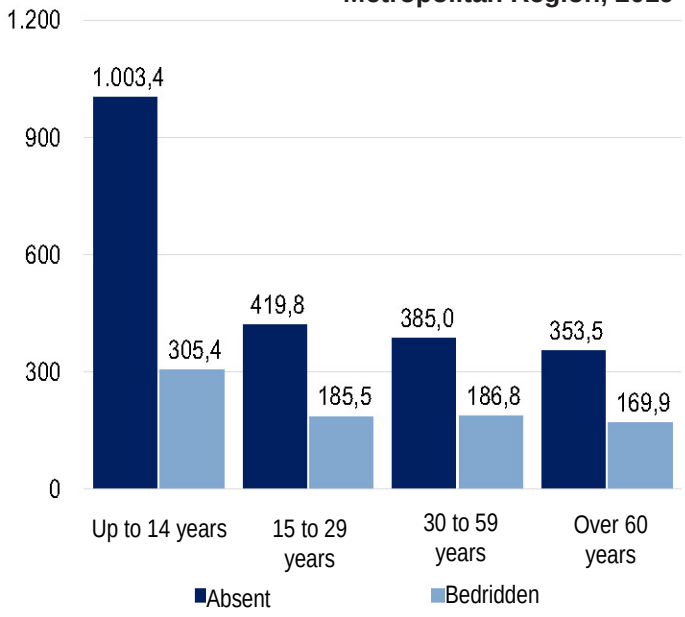
(2) Waterborne diseases include: cholera, typhoid and paratyphoid fevers, shigellosis, amebiasis, diarrhea and gastroenteritis of presumed infectious origin, other intestinal infectious diseases, icterohemorrhagic leptospirosis, other forms of leptospirosis, unspecified leptospirosis, yellow fever, dengue, dengue hemorrhagic fever, malaria caused by Plasmodium falciparum, malaria caused by Plasmodium vivax, malaria caused by Plasmodium malariae, other forms of malaria confirmed by parasitological tests, unspecified malaria, and schistosomiasis.

Chart 4.5 Absences and bedridden cases due to respiratory diseases, cases per 1,000 inhabitants, 2019



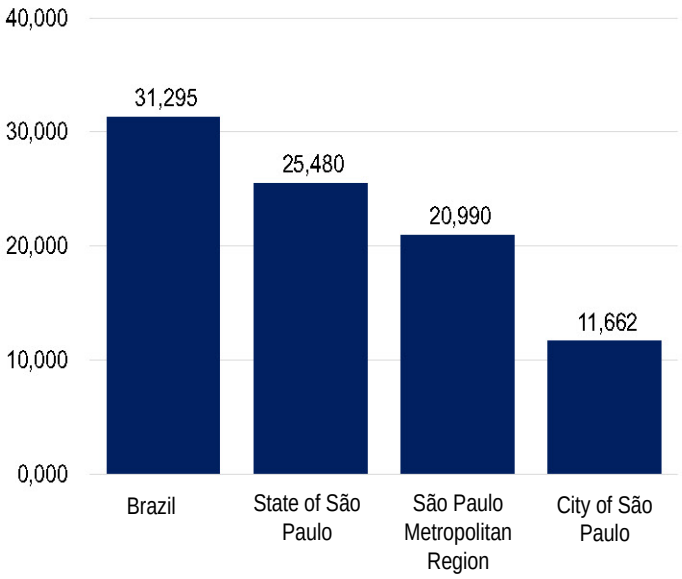
Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 4.6 Absences and bedridden cases due to respiratory diseases, cases per 1,000 inhabitants, by age group, São Paulo Metropolitan Region, 2019



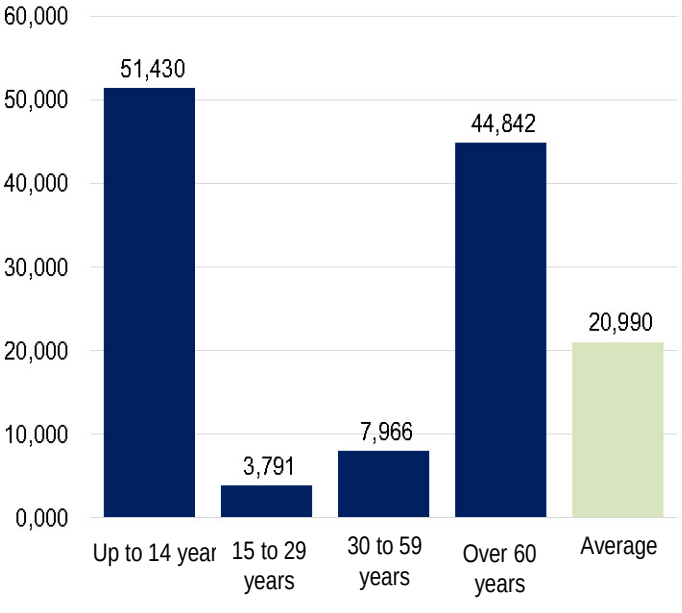
Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 4.7 Hospitalizations due to respiratory diseases, cases per 10,000 inhabitants, 2019



Source: Datasus and IBGE.
Prepared by: Ex Ante Consultoria Econômica.

Chart 4.8 Hospitalizations due to respiratory diseases, cases per 10,000 inhabitants, by age group, São Paulo Metropolitan Region, 2019



Source: Datasus and IBGE
Prepared by: Ex Ante Consultoria Econômica

to these services, the lower the probability of absence due to respiratory diseases – see details in **Methodological Annex 4.2.** In this analysis, unlike that which relates sanitation availability to absences due to waterborne diseases, the availability of water is relatively more important, which is consistent with the idea that regular water supply is a precondition for handwashing, a practice that reduces the incidence of respiratory diseases.

Based on data from the Unified Health System, there were 657.6 thousand hospitalizations due to respiratory diseases[3] throughout 2019 in Brazil. In hospitals accredited by SUS, 61 thousand deaths from respiratory diseases were recorded. In the state of São Paulo, there were 117.0 thousand hospitalizations due to respiratory diseases in 2019. In the São Paulo Metropolitan Region, there were 45.6 thousand hospitalizations for these diseases, and in the capital city, 25.3 thousand.

The hospitalization incidence in the São Paulo Metropolitan Region, which was 20.990 cases per 10,000 inhabitants in 2019, was lower than the national average (**Chart 4.7**). In terms of age groups (**Chart 4.8**), the highest incidence of these hospitalizations in the state occurred among children and the elderly: 51.430 cases per 10,000 inhabitants among children (under 14 years old), and 44.842 cases per 10,000 inhabitants among the elderly (over 60 years old).

4.3. Access to Sanitation and Health

Table 4.1 presents the number of hospitalizations and incidence rates for waterborne diseases and respiratory diseases in 2023 for Brazil, the state of São Paulo, the São Paulo Metropolitan Region, and the capital city. In addition to these regional breakdowns, the table also provides an estimate of the number of hospitalizations for the population of the Pinheiros River Basin. The estimate was made based on Datasus data for the three municipalities within the basin and the proportion of their populations located within the basin area.

In the Pinheiros River Basin, the total number of hospitalizations for waterborne and respiratory diseases was 7,721 in 2023. This corresponds to an incidence rate of 22.908 cases per 10,000 inhabitants, a figure very close to that recorded for the São Paulo Metropolitan Region that year. It should be noted that this rate was lower than the average for the state of São Paulo (28.805 cases per 10,000 people) and for Brazil (42.049 cases per 10,000 people). These other regional breakdowns presented higher deficits in water supply and sewage collection and treatment compared to the Pinheiros River Basin (see **Table 2.1**). This fact suggests that greater coverage of basic sanitation services leads to visible reductions in the incidence of waterborne and respiratory diseases.

This relationship is supported by the statistics presented in **Chart 4.9**, which shows the relationship between the expansion of sanitation in the state of São Paulo, measured by the share of the population with access to sewage collection, and the decline in the incidence of waterborne and respiratory diseases between 2005 and 2022. During this period, the incidence of waterborne and respiratory diseases dropped from 39.658 cases per 10,000 inhabitants in 2005 to 27.565 cases per 10,000 inhabitants in 2022. This represents a 30.5% reduction between 2005 and 2022. During this time, there was a simultaneous increase in the sanitation service coverage rate in the state of São Paulo. The percentage of people living in households with sewage collection rose from 69.0% in 2005 to 90.5% in 2022.

(3) Respiratory diseases include only flu and pneumonia.

Table 4.1 Hospitalizations due to respiratory diseases, total cases and incidence rate, cases per 10,000 inhabitants, 2023

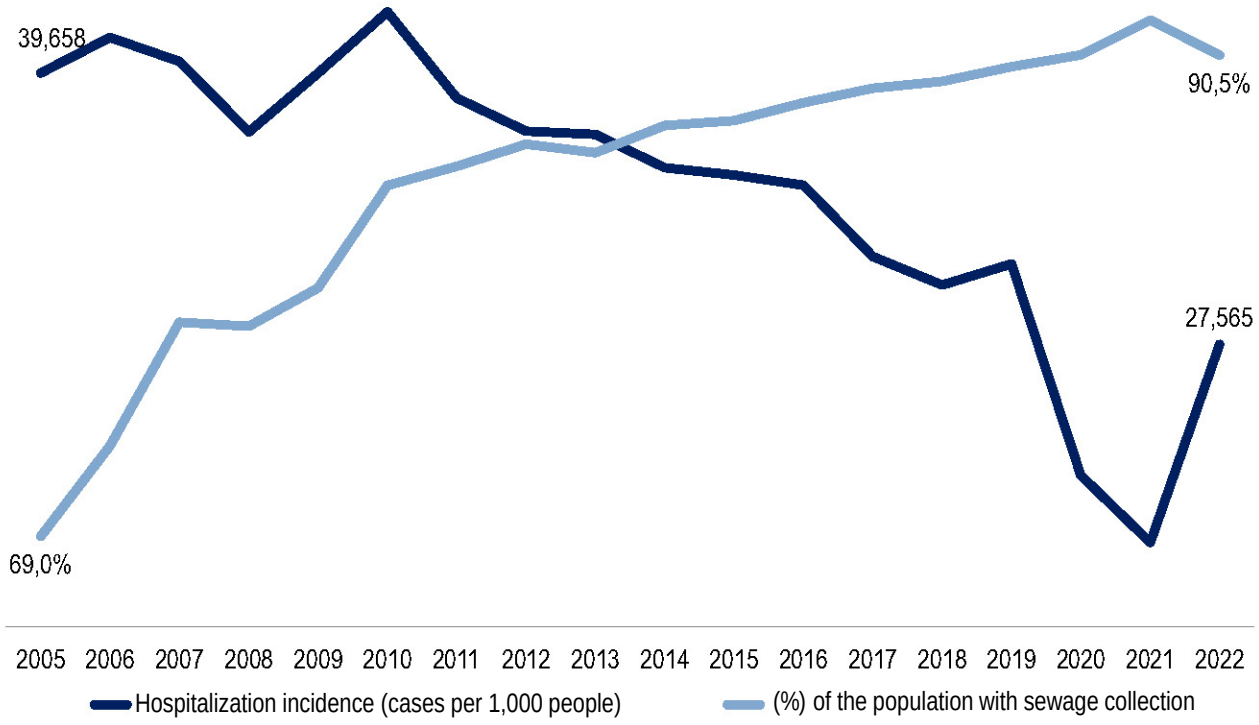
	Population (N)	Hospitalizations			Incidence (per 10,000 people)		
		Waterborne (A)	Respiratory Diseases (B)	Total (C=A+B)	Waterborne (A/N)	Respiratory Diseases (B/N)	Total (C/N)
Brazil	211,695,158	197,470	692,681	890,151	9.328	32.721	42.049
State of São Paulo	45,850,570	17,415	114,658	132,073	3.798	25.007	28.805
São Paulo Metropolitan Region	21,515,186	4,530	42,878	47,408	2.105	19.929	22.035
Embu das Artes	259,681	67	831	898	2.580	32.001	34.581
São Paulo	11,930,850	2,798	22,422	25,220	2.345	18.793	21.138
Taboão da Serra	282,910	63	899	962	2.227	31.777	34.004
Pinheiros River Basin	3,370,321	791	6,930	7,721	2.347	20.561	22.908

Source: Datasus and IBGE.
Prepared by: Ex Ante Consultoria Econômica.

Parque Villa-Lobos. Leisure facilities surrounding the Pinheiros River near its confluence with the Tietê River.

Chart 4.9

Hospitalization rate for waterborne or respiratory diseases and access to sewage collection services, State of São Paulo, 2005 to 2022



Sources: DATASUS, SNIS, and IBGE.
Prepared by: Ex Ante Consultoria Econômica.

5

PRODUCTIVITY AND ENVIRONMENTAL ENHANCEMENT

In addition to the immediate impacts on the health and quality of life of people living in degraded areas, the lack of treated water and sewage collection and treatment has a direct impact on the labor market and on economic activities that depend on good environmental conditions for their proper functioning. From the labor market perspective, the lack of sanitation affects labor productivity and student performance, with significant long-term effects on household income. There are two immediate channels linking the lack of sanitation to productivity loss:

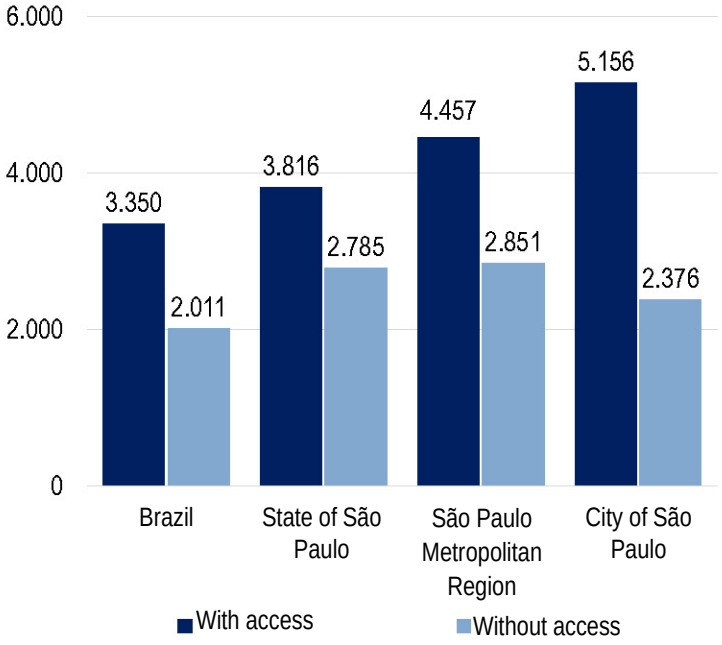
i. Workers more susceptible to diseases caused by lack of sanitation experience poorer health and, consequently, lower productivity, which ultimately affects their career prospects and earning potential in the labor market; and

ii. Recurrent infections keep children and young people away from school activities, harming their educational performance and, consequently, their future potential in the labor market.

From the environmental perspective, sanitation enhances the value of urban land, impacting the activities developed on it. Sanitation increases the value of existing buildings and allows for higher value-added construction, which results in an increase in the real estate capital of cities. In addition to raising the value of real estate assets and developments, sanitation enables the growth and enhancement of economic activities that depend on adequate environmental conditions, such as tourism.

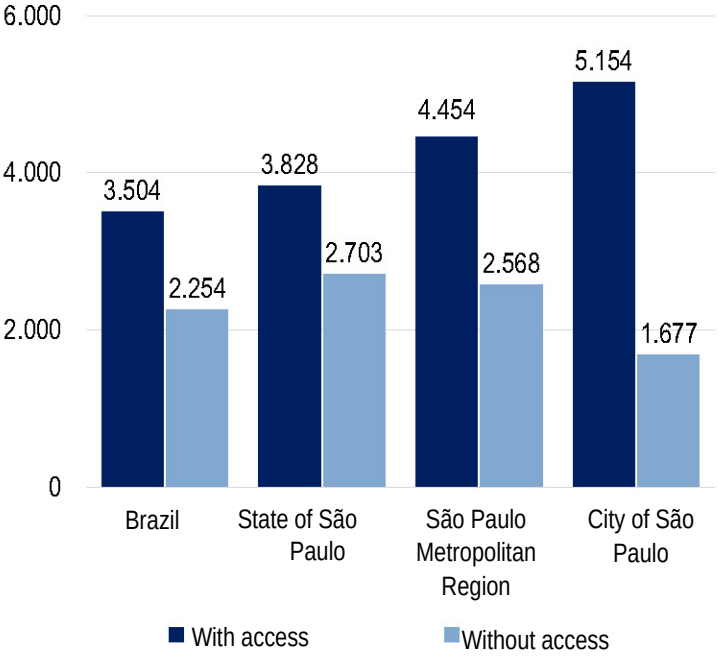
This chapter analyzes the externalities of sanitation on labor productivity,

Chart 5.1
Average labor income by group according to access to water supply services, in BRL per month, 2023



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 5.2
Average labor income by group according to access to sewage collection services, in BRL per month, 2023



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

education, and environmental enhancement. The analyses focus on national data, as well as data from the state of São Paulo, the metropolitan region, and the Pinheiros River Basin, allowing for the assessment of differences in indicators that may be associated with sanitation. This comparison allows, on the one hand, an evaluation of the gains already achieved through the expansion of sanitation in the country, and on the other hand, an estimate of the legacy of universal basic sanitation achieved in the region. These analyses are the subject of the next chapter, which presents the balance between costs and benefits of universal sanitation in the state.

5.1. Effects on Productivity

Reductions in the incidence and severity of waterborne and respiratory diseases have economic effects that go beyond the reduction of health care expenditures and losses from days not worked, which increase the costs of economic activities in the country. Improvements in health systematically increase workers' productivity.

Chart 5.1 presents the average monthly labor income in 2023, highlighting the income averages for individuals living in households with access to a treated water supply on one hand, and for those living in households without access to basic sanitation on the other. The data are striking: in the São Paulo Metropolitan Region, people living in households without access to treated water earned an estimated 36.0% less than those living in homes with treated water. In Brazil, the difference was even greater: 40.0% lower income. In the state of São Paulo on average, the difference was smaller, at 27.0%, but still quite significant. The largest difference was observed in the city of São Paulo, where the gap in monthly labor income between the population without and with water supply reached 53.9%.

The same occurs when comparing the average income of people living in households with sewage collection to the average income of those living in households without access to basic sanitation (**Chart 5.2**). In all regions, the average income is higher for people living in households with sewage collection. In the São Paulo Metropolitan Region, this difference was 42.3%, and in the capital city, the difference reached 67.5% in 2023.

The analysis conducted by Instituto Trata Brasil on this topic – Instituto Trata Brasil (2022) – supports this relationship. The study identified a very strong link between access to sanitation and the wages of Brazilian workers. The analysis, based on data from the 2019 Continuous National Household Sample Survey (PNADC), isolated the effect of access to sanitation on workers' income through a comprehensive statistical model addressing the determinants of productivity and labor income. By considering all factors together, it is possible to separate the specific effect of each one, isolating the particular contribution of sanitation to labor productivity. **Methodological Annex 5.1** updates this statistical analysis with 2023 PNAD data, indicating the broad set of control variables (economic and social) used to identify income determinants and their partial effects on labor income.

Based on this more detailed information on housing and employability conditions, it was found that workers living in areas with access to sewage collection services had, on average, wages 5.8% higher than those who, under the same employability conditions (education, experience, etc.), lived in areas without sewage collection. Workers living in areas with access to the water distribution network had, on average, wages 5.7% higher than those who, with the same work conditions, did not have access to treated water. The lack of an exclusive-use toilet in the household also affected labor income by 24.9%.

This difference, as previously mentioned, already reflects the partial effect of sanitation on productivity. Thus, the income differential has a direct interpretation: if sewage collection service is provided to a worker living in an area without access to this service, it is expected that the general improvement in their quality of life – reflected in lower morbidity from diarrhea or respiratory diseases, reduced frequency of absences, and fewer days missed at work, among other factors – will allow for higher productivity, with a corresponding increase in income. In this sense, it can be confidently stated that the universalization of sanitation in the Pinheiros River Basin in recent years has enabled higher income for the workers living there.

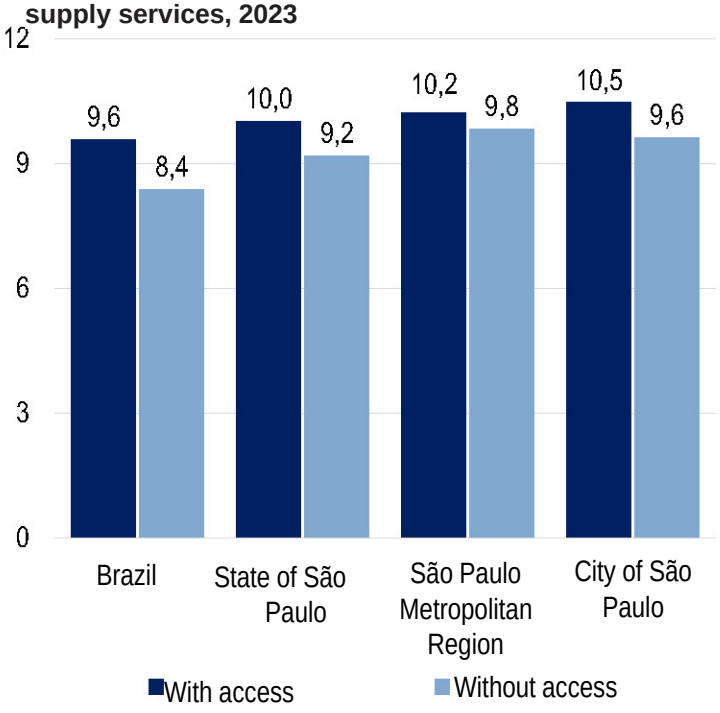
5.2. Sanitation and Education

In addition to the effects on the productivity of the current workforce responsible for generating income in the country today, the expansion of sanitation services enables productivity gains for future generations of workers. This is because sanitation has a significant effect on school performance, as indicated by the study conducted by the Center for Social Policies (CPS-FGV, 2008).

The present study presents a similar statistical model, which is analyzed in detail in **Methodological Annex 5.2.** Based on data from the 2023 Continuous National Household Sample Survey (IBGE, 2024), the effect of sanitation on school delay among young people was isolated from the effects of other socioeconomic variables on this performance indicator. The results confirm that school delay is greater among populations without access to sanitation. It was found that children and young people living in areas with access to sewage collection services had, on average, 2.2% less school delay compared to those living in areas without sewage collection. Greater school delay indicates lower educational attainment. Those living in areas without access to the water distribution network had, on average, a school delay 0.4% greater than that of children and young people living in areas

Chart 5.3

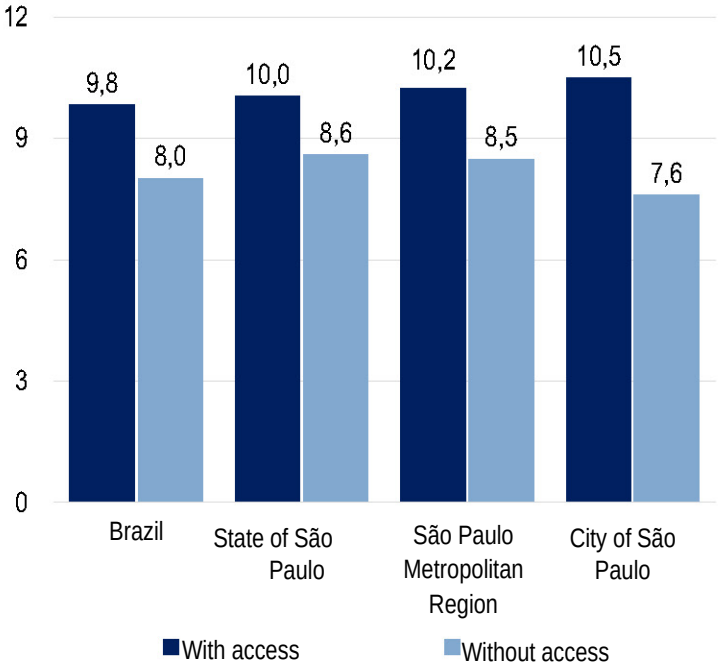
Average educational attainment, in years of schooling, by group according to access to water supply services, 2023



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 5.4

Average educational attainment, in years of schooling, by group according to access to sewage collection services, 2023



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

with access to the public water supply network. The absence of a bathroom in the household increased school delay among young people by 20.2%.

Charts 5.3 and **5.4** present the average educational attainment of the Brazilian population, the state of São Paulo, its metropolitan region, and the capital city. For each area, estimates are provided for the educational attainment of people living in households with access to treated water (**Chart 5.3**) and with access to sewage collection services (**Chart 5.4**). Once again, the differences are striking: In the São Paulo Metropolitan Region, those living in households without access to water or sewage collection services had, respectively, 3.9% and 17.1% less schooling than individuals living in households with access to these sanitation services. In the capital city, the differences in educational attainment were even greater: 8.1% and 27.6% less, respectively.

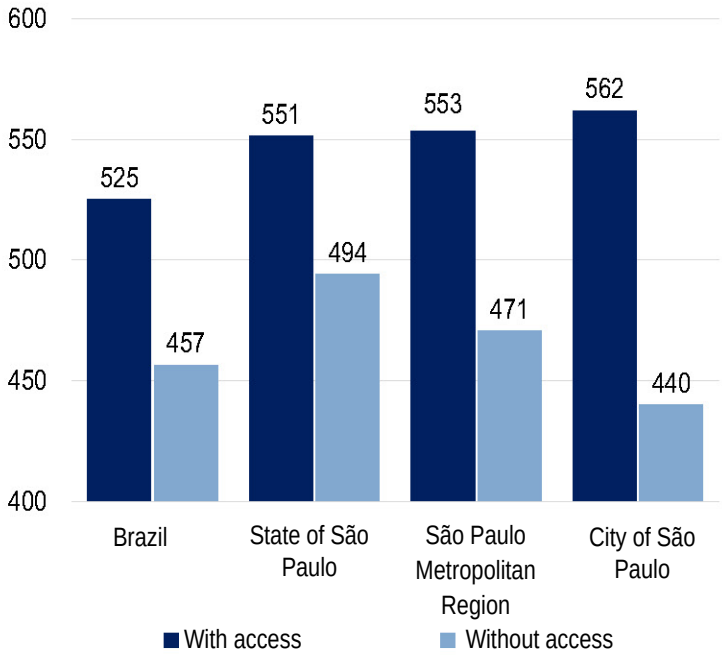
But there is another, more immediate effect of the lack of sanitation on students: sanitation affects the chances of progressing to higher education and the qualifications of young people who have just entered the labor market. This happens because sanitation influences students' average academic performance in terms of grades. Data from the High School National Exam (ENEM) show that young people living in households without an exclusive-use bathroom performed worse than those living in households with a bathroom (**Chart 5.5**). This relationship was true for Brazil, for the state of São Paulo, for its metropolitan region, and for the capital city.

Table 5.1 presents the estimated test scores, by subject and overall average, for residents of the Pinheiros River Basin who took the 2023 ENEM, according to their level of access to sanitation. Young people

living in the Pinheiros River Basin who resided in households without an exclusive-use bathroom had an average score 20.0% lower than those who had a bathroom in their home. This difference was significantly greater for the Mathematics test score, in which young people living in the Pinheiros River Basin who resided in households without an exclusive-use bathroom had an average score 50.5% lower than those who had a bathroom in their home.

The statistical analysis confirmed the positive influence of access to sanitation on ENEM performance – see **Methodological Annex 5.3.** One consequence of this finding is that children and young people without access to basic sanitation will have lower professional qualifications than others when they enter the labor market.

Chart 5.5 Average ENEM scores by group according to access to sewage collection services, 2023



Source: Instituto Nacional de Ensino e Pesquisas Educacionais Anísio Teixeira (INEP). Prepared by: Ex Ante Consultoria Econômica

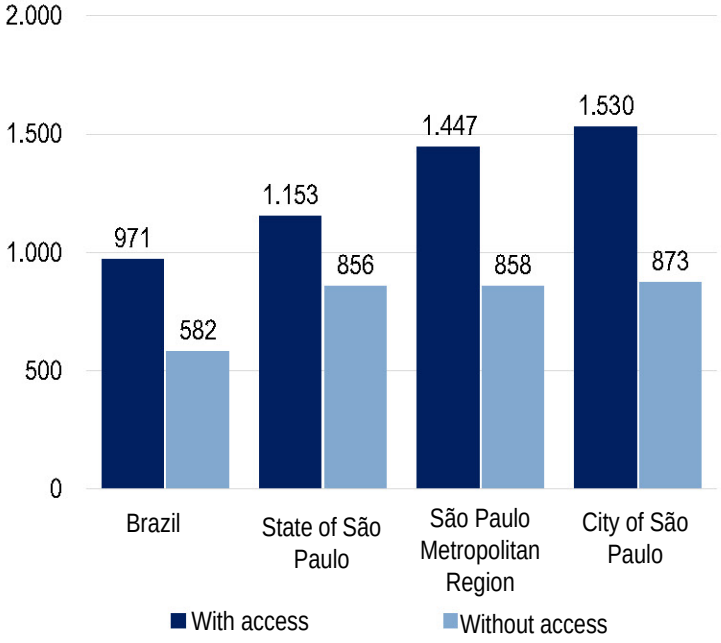
Table 5.1.
Average ENEM scores by sanitation access groups, Pinheiros River Basin, 2023

	With a bathroom in the residence (A)	Without a bathroom in the residence (B)	Difference (A-B)
Average	555.13	444.35	110.78
Natural Sciences	501.19	360.74	140.44
Human Sciences	529.89	450.15	79.74
Language and Codes	536.63	492.69	43.94
Mathematics	562.08	277.95	284.13
Written Essay	645.85	497.85	148.00

Source: Instituto Nacional de Ensino e Pesquisas Educacionais Anísio Teixeira (INEP). Prepared by: Ex Ante Consultoria Econômica.

Chart 5.6

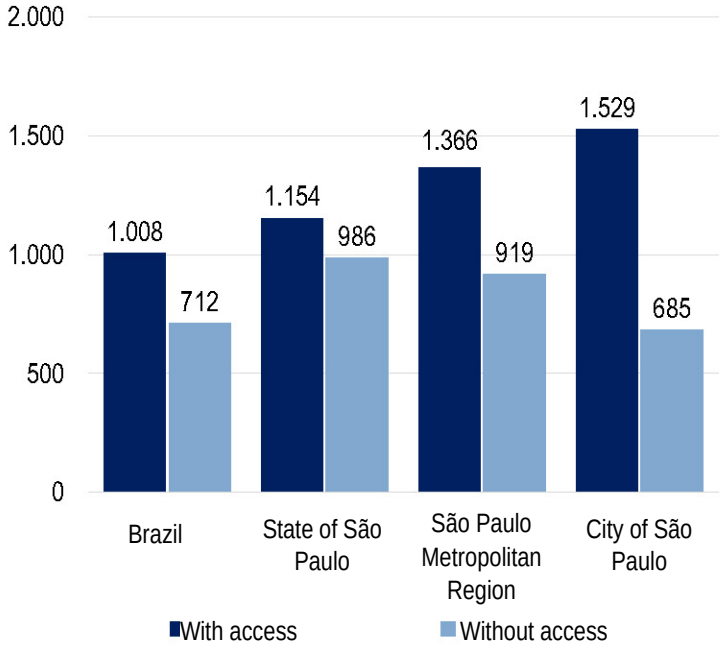
Average rental or mortgage value of residential properties by group according to access to water supply services, in BRL per month, 2023



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Chart 5.7

Average rental or mortgage value of residential properties by group according to access to sewage collection services, in BRL per month, 2023



Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

5.3. Real Estate Appreciation

As previously mentioned, sanitation enhances the value of urban land, increasing property values. Data illustrating this relationship are presented in **Chart 5.6.** In 2023, the average rent paid for Brazilian homes with access to treated water was 66.9% higher than that of homes without this service. When comparing homes with sewage collection to those without, this difference was 41.6% (Chart 5.7). In the São Paulo Metropolitan Region, these differences are also evident. For example, in 2022, the average monthly rents for homes with access to treated water and sewage collection in the São Paulo Metropolitan Region were BRL 1,446.60 and BRL 1,366.20, respectively. For homes without access to these services, average monthly rents were lower: BRL 858.47 and BRL 918.62, respectively. The same pattern is observed in the capital, but with even greater differences.

The statistical analysis based on IBGE data, conducted in the Instituto Trata Brasil (2022) study, confirmed this relationship by identifying a significant impact of sanitation on the value of real estate assets and income generated by the sector. In this study, the analysis is updated with 2023 PNADC data and is presented in **Methodological Annex 5.4.** From the analyses, it was found that, considering two properties differing only in terms of access to sanitation, the one connected to the general sewage collection network had, on average, a 5.0% higher value than the one that was not connected. In the case of access to treated water, the value difference was 6.9% on average nationwide. The absence of a bathroom reduced the property value by 18.5%. This indicates that proper sanitation, connecting a residence to the water distribution and sewage collection networks, could increase the property's value by an additional 30.3%.

5.4. Urban Environment and Tourism

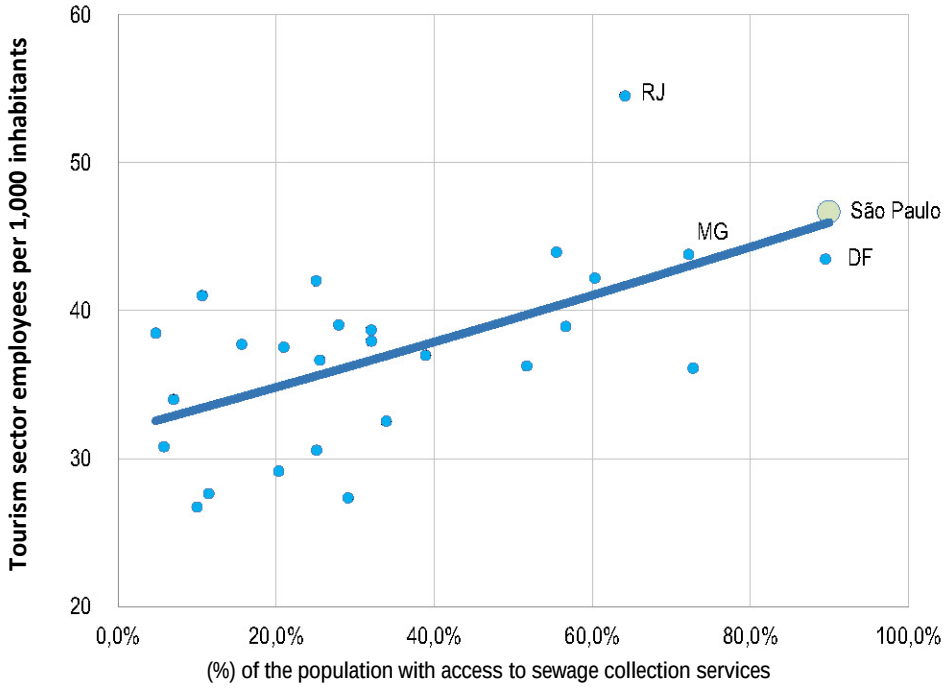
In addition to increasing property values, sanitation enables the development of economic activities that depend on adequate environmental conditions for their operation, such as tourism. Tourism is, as is well known, an economic activity that does not develop properly in regions lacking sewage collection and treatment or treated water. Environmental contamination by sewage compromises, or even nullifies, a region's tourism potential.

The international statistics cited in the Instituto Trata Brasil (2022) study confirmed this idea. In 2019, according to data from the World Development Indicators (World Bank, 2021), countries with higher sanitation service coverage rates had better tourism performance, with proportionally higher numbers of foreign tourist arrivals. In contrast, nations with poor sanitation recorded fewer foreign visitors per inhabitant that year.

The loss of tourism potential is not only observed in international comparisons. Within the country itself and its regions, it is possible to identify the influence of sanitation on tourism development. The statistical analysis conducted in the Instituto Trata Brasil (2022) study to assess this issue identified a very strong relationship between access to sanitation and job creation in the tourism sector. For the country as a whole, areas with water distribution and sewage collection and treatment networks have, on average, higher volumes of tourism activity.

The estimates, based on data from the 2019 Continuous National Household Sample Survey (IBGE, 2020), indicated that an individual's probability of working in tourism activities, given their personal employability characteristics (age, education, gender, etc.), the region where they live, and their housing conditions, is affected by sanitation access conditions. For classification purposes, following the study on tourism in

Chart 5.8
Tourism share in employment and basic sanitation, 2022



Source: IBGE and SNIS. Prepared by: Ex Ante Consultoria Econômica.

Brazil conducted by the National Confederation of Services (CNS, 2022), the tourism sector includes the following activities: accommodation and food services; travel agencies; land passenger transportation; air transportation; and recreational, cultural, and sports activities.

In the present study, this model was updated with data from the 2023 Continuous National Household Sample Survey (IBGE, 2024). The estimates presented in **Methodological Annex 5.5** indicated that, on the national average, individuals living in areas with access to basic sanitation had a higher likelihood of being employed in tourism-related activities. In other words, if a municipality lacks sanitation, the share of its population employed in tourism activities tends to be lower, reducing opportunities for both workers and entrepreneurs. Without adequate environmental conditions, tourism cannot fully develop its potential, as degraded areas fail to attract Brazilian or foreign tourists. Thus, there are lost business and employment opportunities.

Chart 5.8, based on data from the 2023 Continuous National Household Sample Survey (IBGE, 2024), illustrates the positive relationship between sewage collection service coverage and the share of people employed in the tourism sector across Brazilian states in 2023. States with greater access to basic sanitation services, such as Rio de Janeiro, São Paulo, and Brasília, had higher proportions of people working in tourism. The southern states of Brazil, partly due to deficiencies in sanitation, had relatively smaller shares of people involved in tourism. The same reasoning applies to the Pinheiros River Basin, which showed relatively high levels of tourism employment per 1,000 inhabitants and a high share of the population with access to sanitation. In this sense, the advancement of sanitation in the state is expected to have even more positive effects on the region's tourism potential.

But just as important as generating jobs in tourism is the gain in terms of access to leisure provided by rivers, lakes, and beaches with a preserved environment. In the case of Novo Rio Pinheiros, this issue is clear. The urban intervention project not only directly addressed leisure and tourism around the Pinheiros River as one of its five areas of action, expanding park areas and recreational facilities in the region, but the environmental improvements achieved, with reduced organic carbon load and increased dissolved oxygen, have contributed decisively to reducing the persistent odor in the area. The results of these advances are already being felt and will have significant long-term effects. In the case of homes located near the river, odor reduction also has an impact on property values.

6

ECONOMIC COST-BENEFIT BALANCE OF UNIVERSAL ACCESS TO SANITATION

This chapter presents estimates of the economic cost-benefit balances of sanitation investments and the universalization of services in the Pinheiros River Basin between 2000 and 2022. Past gains provide a sense of the increase in wealth in this region that can be attributed to the effort to bring sanitation to a larger number of people over these 22 years, while future gains should be viewed as the expected benefits for the coming years due to the legacy of universal sanitation for future generations.

The historical estimates are based on data from the National Sanitation Information System (SNIS), the 2000, 2010, and 2022 population censuses, the IBGE annual household sample surveys, and databases from the Ministry of Health (Datasus) and the Ministry of Finance. The steps used to estimate the cost-benefit balances presented in the tables of this chapter are detailed in the **Methodological Annex 6.1.**

6.1. The Balance of Results between 2000 and 2022

Table 6.1 presents the estimates of the benefits and costs of the sanitation expansion that took place between 2000 and 2022 in the Pinheiros River Basin. Over this period, the benefits totaled BRL 25.005 billion, of which BRL 22.303 billion came from direct benefits (income generated by investment and sanitation activities, as well as consumption and production taxes collected) and BRL 2.702 billion resulted from the reduction of losses associated with the negative externalities of the lack of sanitation. The social costs incurred during the period amounted to BRL 17.044 billion. Thus, benefits exceeded costs by BRL 7.961 billion, indicating a very positive social balance for the population of the Pinheiros River Basin.

These figures indicate that, over the past 22 years, every BRL 1.00 invested in sanitation generated social gains of BRL 1.70. This figure is considered relatively good when compared to national and state-level data, given that in 2000, the situation in the Pinheiros River Basin was already better than the average for the country, the state, and the state capital. In the study by Instituto Trata Brasil (2022), the cost-benefit balance for Brazil reached BRL 3.45 in social gains for every BRL 1.00 invested, while in the state of São Paulo, the ratio was BRL 2.60 in social gains for every BRL 1.00 invested. In the same study, the city of São Paulo showed gains of BRL 1.41 for every BRL 1.00 invested in sanitation between 2005 and 2022.

The following section presents in greater detail the values of each component of the costs and benefits of sanitation progress.

REDUCTION IN HEALTHCARE COSTS

Between 2000 and 2022, there was an annual 3.7% decrease in hospitalizations for waterborne and respiratory diseases among the population residing in the Pinheiros River Basin. This led to a reduction in costs related to paid hours lost due to absences caused by waterborne and respiratory diseases. In addition, there was a decrease in expenses related to hospitalizations for gastrointestinal and respiratory infections within the SUS healthcare network. The present value of total savings from improved health conditions for the state's population between 2000 and 2022 was BRL 1.503 billion, resulting in an annual gain of BRL 68.329 million.

INCREASE IN PRODUCTIVITY

To estimate the effect of sanitation improvements on labor productivity,

Table 6.1
Costs and benefits of sanitation expansion in the Pinheiros River Basin, 2000 to 2022

Costs and Benefits	in BRL million*	
	per year	2000-2022
Reduction in healthcare costs	68.329	1,503.242
Increase in labor productivity	30.078	661.718
Income from real estate appreciation	2.268	49.901
Tourism income	22.133	486.933
Subtotal externalities (A)	122.809	2,701.793
Income generated by investment	783.938	17,246.628
Income generated by increased operations	175.530	3,861.652
Taxes related to production**	54.302	1,194.647
Subtotal income (B)	1,013.769	22,302.927
Total benefits (C=A+B)	1,136.578	25,004.720
Investment cost	-667.591	-14,687.003
Increase in household expenses	-107.119	-2,356.627
Total costs (D)	-774.710	-17,043.630
Balance (E=C+D)	361.868	7,961.091

Estimates: Ex Ante Consultoria Econômica. (*) present values at 2024 prices. (**) from sanitation investments and operations and real estate activities.

data from IBGE household sample surveys conducted between 2000 and 2022 were used. Based on the statistical model of labor productivity and wage determinants, it is estimated that productivity increased due to the dynamics of sanitation in the Pinheiros River Basin. The present value of the increase in labor income from the sanitation expansion between 2000 and 2022 was BRL 661.718 million, resulting in an annual gain of BRL 30.78 million (**Table 6.1**).

REAL ESTATE APPRECIATION

In terms of real estate income, there were gains for property owners who rent or live in their own homes, despite the slow progress of sanitation between 2000 and 2022. Over the entire period, residents experienced an income gain of approximately BRL 49.901 million. This amount was calculated based on the estimated housing stock in 2022 and the average rents – paid or implicit, that is, the opportunity cost for owners of self-occupied properties – in 2022, compared to what would have prevailed in 2000 had sanitation conditions remained unchanged between 2000 and 2022.

TOURISM INCOME

Between 2000 and 2022, the present value of tourism gains reached BRL 486.933 million, indicating an average annual flow of BRL 22.133 million during the period. This gain resulted from the environmental improvements achieved through the cleanup of rivers and streams in the capital and the expansion of universal access to treated water in some areas.

INCOME GENERATED BY INVESTMENT

As discussed in **Chapter 3**, investments in sanitation generate jobs and income along the construction sector's production chain. This income represents a direct benefit of the investments which, when subtracted from the cost of these investments, provides a direct estimate of the net benefits from the expansion of sanitation infrastructure. Between 2000 and 2022, the present value of sanitation investments in the Pinheiros River Basin reached BRL 14.687 billion. The direct, indirect, and induced income generated by these investments totaled BRL 17.246 billion. Thus, the income surplus generated by the investments amounted to approximately BRL 2.560 billion over the period.

INCOME FROM OPERATIONS

Likewise, sanitation operations generate jobs and income along the water and sewage sector's production chain. The increase in income results from the sector's increased revenues, which must be subtracted from the operational costs borne by households to obtain a direct estimate of the net benefits from sanitation operations. In this case, however, it is not the total income and expenses incurred by society that are summed, but rather the incremental gains over time. Between 2000 and 2022, the present value of the increase in income from sanitation operations in the Pinheiros River Basin reached BRL 3.862 billion. The present value of the increase in household expenses related to these operations totaled BRL 2.357 billion. Thus, the income surplus generated by the increase in operational revenues amounted to BRL 1.505 billion in the period from 2000 to 2022.

6.2. The Legacy of Universal Sanitation

The analysis developed in the previous section allows us to infer that the population of the Pinheiros River Basin has already experienced gains during the period from 2000 to 2022. However, there is an important difference when looking toward the future. In addition to the cost-benefit balance during the past process of universalizing sanitation, a period in which greater investments were made to reduce the historical deficits in sanitation in the basin, especially in sewage collection and treatment, one must also consider the legacy that

Table 6.2
The legacy of universal sanitation in the Pinheiros River Basin, post-2022

Costs and Benefits	in BRL million*	
	per year	Perpetuity
Reduction in healthcare costs	42.354	727.150
Increase in labor productivity	171.394	2,942.526
Income from real estate appreciation	23.767	408.033
Tourism income	79.736	1,368.933
Subtotal externalities (A)	317.251	5,446.640
Income generated by investment	438.270	7,524.320
Income generated by increased operations	202.279	3,472.781
Taxes related to production**	35.637	611.830
Subtotal income (B)	676.187	11,608.931
Total benefits (C=A+B)	993.438	17,055.571
Investment cost	-373.225	-6,407.613
Increase in household expenses	-150.780	-2,588.630
Total costs (D)	-524.005	-8,996.243
Balance (E=C+D)	469.433	8,059.329

Estimates: Ex Ante Consultoria Econômica. (*) present values at 2024 prices. (**) from sanitation investments and operations and real estate activities.

■ A large number of high-rise buildings are located around the Pinheiros River. In the background, the Traição Pumping Station can be seen, where a new commercial, leisure, and cultural center will be built.

universal sanitation will leave for the future. After universalization, the gains from reducing negative externalities in health, productivity, and environmental enhancement will last indefinitely, exceeding the very period of universalization, which was achieved in 2022.

This section analyzes the legacy of universal sanitation in the Pinheiros River Basin. The value of the externalities' legacy is calculated as the present value of the perpetual income from the benefits after universalization, based on the same financial conditions previously described. The costs and benefits of investments after 2022 are calculated considering an annual investment sufficient to offset a depreciation rate of 5.0% per year and a still positive but decreasing demographic growth rate in the region. The discount rate applied is 5.8% per year.

Table 6.2 presents the estimates of the future legacy for the population following the universalization of sanitation in the Pinheiros River Basin. The reduction in healthcare costs, considering both hospitalization expenses and the loss of paid working hours due to illness, is expected to generate a total gain of BRL 727.150 million for the population of the Pinheiros River Basin. The increase in labor productivity is expected to amount to BRL 2.943 billion. The projected increase in real estate income has a total present value of BRL 408.033 million. The projected increase in tourism income has a total present value of BRL 1.369 billion. Thus, the present value of the externalities associated with universal access to basic sanitation in this region is estimated at BRL 5.447 billion.

In addition to the benefits of externalities, there are income gains from ongoing investments after universalization for system maintenance and from the continued growth of sanitation operations. It is estimated that total income gains will reach BRL 11.609 billion in the post-2022 period. With this, total benefits will amount to BRL 17.056 billion.

The total costs of maintaining universalization will be approximately BRL 8.996 billion after 2022. Thus, following the approach previously analyzed, a perpetuity balance of BRL 8.059 billion should be added to the sanitation universalization balance. Taking into account the gains obtained up to 2022, the total net welfare gain amounts to BRL 16.020 billion since 2000. Considering the total gross gains, the ratio reaches BRL 2.00 in gains for every BRL 1.00 invested in sanitation since 2000. Once again, it can be stated that this ratio is relatively high, given that the Pinheiros River Basin was already at a more advanced stage of basic sanitation provision in 2000.

6.3. The Contribution of the Novo Rio Pinheiros Project

As discussed in the previous chapters, the Novo Rio Pinheiros Project was part of the sanitation universalization process in the Pinheiros River Basin, with a specific focus on cleaning up the Pinheiros River by directing residential sewage produced in the region for treatment. Part of the sewage generated began to be collected from residences in the region and was routed through the network to the Barueri Wastewater Treatment Plant. Another portion of the sewage, specifically from homes in favelas and informal urban communities, was treated at five Recovery Units installed in tributary streams of the Pinheiros River. The works of the Novo Rio Pinheiros Project were carried out between 2020 and 2022, that is, during the final period of the sanitation universalization analysis in the Pinheiros River Basin.

In this final subsection of the chapter, estimates are presented for the economic cost-benefit balance of this set of works. The values are organized in the same way as the balances for the Pinheiros River Basin, with the difference that, in this case, two periods are considered: (i) the 2020–2022 period, when the works were carried out and some gains were already observed, and (ii) the post-2022 period, when the

project's legacies will be noticed. In these estimates, the investment amounts and the project's contribution to reducing the number of households without sanitation access and to increasing the volume of treated sewage in the Pinheiros River Basin were taken into account. **Table 6.3** presents the estimates.

First, it is noted that most of the present value of the Novo Rio Pinheiros costs had been incurred by 2022 (92%), but most of the benefits (52%) are still to be realized due to the project's positive legacy. This is a typical feature of long-term projects like this one. For this reason, the balance is much more favorable in the post-2022 period than during the years when the works were carried out.

Adding both portions, the gains for the population residing in the Pinheiros River Basin will amount to BRL 1.088 billion since 2000, a figure that corresponds to 6.8% of the total net economic benefits of sanitation universalization in the Pinheiros River Basin since 2000. This contribution can be considered very good, given that the share of Novo Rio Pinheiros in the present value of the investment cost in the Pinheiros River Basin since 2000 was only 5.7%. In general, the welfare contributions achieved by projects implemented in the final stages of sanitation universalization are smaller than the share of investment they represent.

The reduction in healthcare costs promoted by the Novo Rio Pinheiros Project, considering both hospitalization expenses and the loss of paid working hours, is expected to generate a total gain of BRL 107.852 million for the population of the Pinheiros River Basin. The increase in labor productivity is expected to amount to BRL 350.957 million. The projected increase in real estate income promoted by the Novo Rio Pinheiros Project has a total present value of BRL 40.066 million. The projected increase in tourism income has a

Wastewater treatment plant.

Table 6.3

Costs and benefits of sanitation expansion in the Pinheiros River Basin promoted by the Novo Rio Pinheiros Project, 2000 to 2022 and legacy

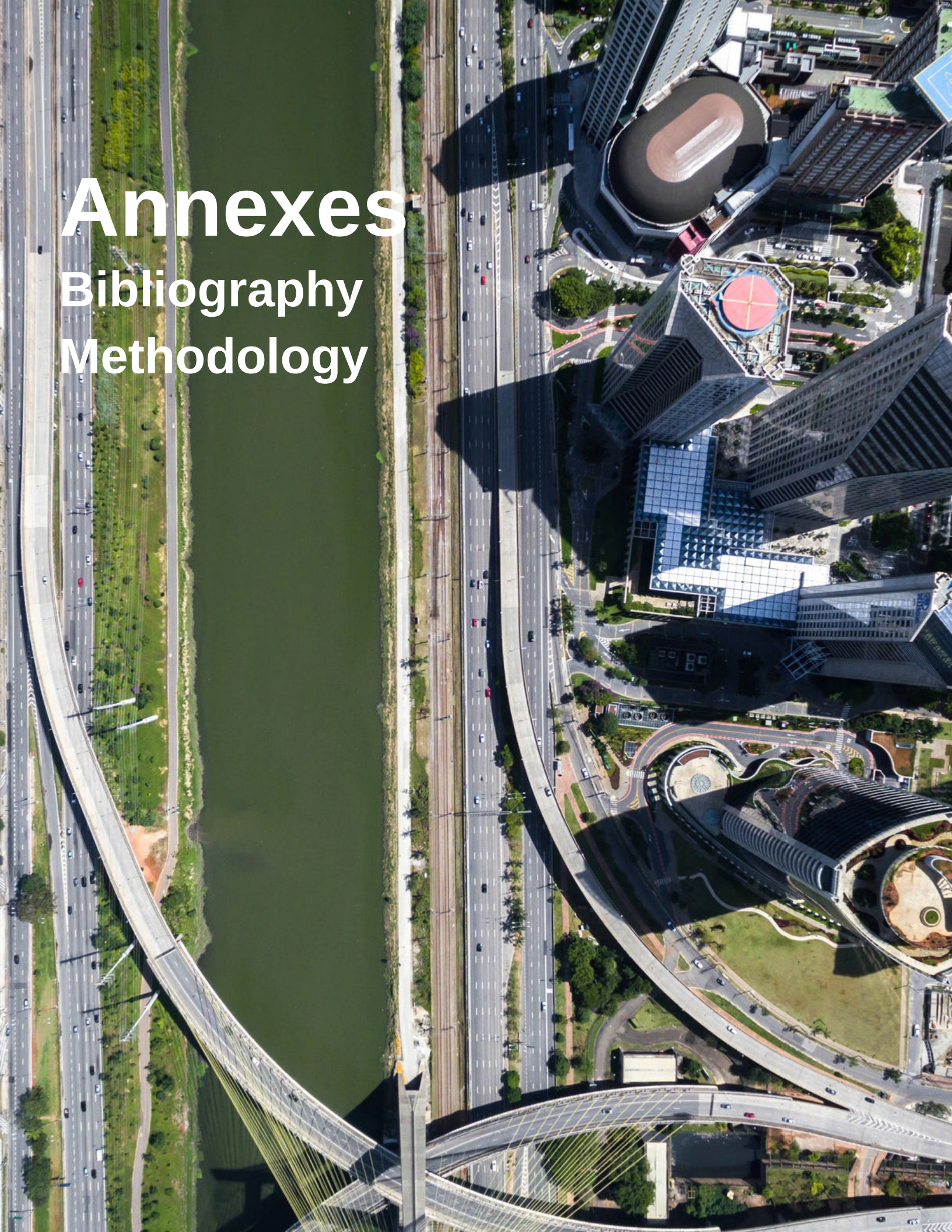
Costs and Benefits	in BRL million*		
	2020-2022	Legacy	Total
Reduction in healthcare costs	23.703	84.149	107.852
Increase in labor productivity	10.434	340.523	350.957
Income from real estate appreciation	0.787	47.219	48.006
Tourism income	7.678	158.419	166.097
Subtotal externalities (A)	42.602	630.311	672.912
Income generated by investment	836.396	764.053	1,600.449
Income generated by increased operations	55.985	369.515	425.500
Taxes related to production**	18.366	69.035	87.401
Subtotal income (B)	910.748	1,202.603	2,113.350
Total benefits (C=A+B)	953.349	1,832.914	2,786.263
Investment cost	-779.730	-608.974	-1,388.704
Increase in household expenses	-34.166	-275.438	-309.604
Total costs (D)	-813.896	-884.413	-1,698.309
Balance (E=C+D)	139.453	948.501	1,087.954

Estimates: Ex Ante Consultoria Econômica. (*) present values at 2024 prices. (**) from sanitation investments and operations and real estate activities.

total present value of BRL 166.097 million. Thus, the present value of the externalities from universal access to basic sanitation promoted by the Novo Rio Pinheiros Project in this region is estimated at BRL 672.912 million.

In addition to the benefits from externalities, there are income gains generated by the investments made up to 2022 and those that will be made in the future for the maintenance of sanitation equipment and networks. Total income gains are estimated to reach BRL 2.133 billion in the post-2020 period. As a result, total benefits will amount to BRL 2.786 billion from 2020 onward.

The total costs related to the Novo Rio Pinheiros Project will be approximately BRL 1.698 billion, with BRL 813.896 million incurred between 2020 and 2022 and BRL 88.413 million incurred after 2022. Considering the gross gains obtained from the Novo Rio Pinheiros Project, the total net welfare gain amounts to BRL 1.088 billion since 2020, as previously mentioned.



Annexes

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Methodology

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METHODOLOGICAL ANNEX

1.1.METHODOLOGY FOR COMPILING MUNICIPAL DATA IN THE PINHEIROS RIVER BASIN INDICATORS

To estimate the populations present in the Alto Tietê Basin, the Penha-Pinheiros Sub-basin, and the Pinheiros River Basin, data from the 2000, 2010, and 2022 population censuses by census tracts were used. Residents of census tracts located within the area of each respective basin were considered part of that basin. This overlay was performed using the Q-GIS tool with layer overlapping and intersection extraction.

However, some census tracts extended beyond the strictly defined boundaries of the basins, meaning they were not entirely contained within them. In these cases, each census tract was manually reviewed to determine whether it should be included in the basin area. The general validation criterion was the presence of urban areas with a relatively high population concentration within the basin area. The verification was visual and performed by observing aerial layers using Google Maps images.

Table A.1.1 *presents the population statistics for the Pinheiros River Basin during the three periods analyzed and the share that this population represented within the demographic totals of the three municipalities located in the basin.*

Table A.1.1

Number of residents in the Pinheiros River Basin by municipality and share of total population in these cities

	2000	2010	2022	Annual Growth (%)
Penha-Pinheiros Sub-basin	2,782,786	3,097,757	3,237,992	0.7%
Embu das Artes	132,997	156,862	166,892	1.0%
São Paulo	2,452,145	2,696,367	2,797,558	0.6%
Taboão da Serra	197,644	244,528	273,542	1.5%
	Share (%) of Total Population*			
Penha-Pinheiros Sub-basin	25.7%	26.4%	27.0%	1.4%
Embu das Artes	64.0%	65.3%	66.6%	2.5%
São Paulo	23.5%	24.0%	24.4%	0.9%
Taboão da Serra	100.0%	100.0%	100.0%	0.0%

(*) in the case of the share of total population data, the growth refers to the variation in percentage points between 2000 and 2022. Prepared by: Ex Ante Consultoria Econômica.

3.1.EFFECT OF SANITATION INFRASTRUCTURE INVESTMENTS AND SEWAGE COLLECTION AND TREATMENT OPERATIONS ON EMPLOYMENT AND INCOME

The methodology used to estimate the impacts of sanitation infrastructure investments and sewage collection and treatment operations on employment and income generation is based on the Leontief Model of fixed-coefficient production. This annex details the theoretical concepts, databases, and methodological procedures applied in this study.

Theoretical Model

The Leontief Model is based on the input-output matrix, which represents the various intersectoral transactions within an economy over the course of a year. The economy consists of m productive sectors, or activities, which participate in the flow of goods and services used as inputs and outputs. The intersectoral flows have the typical structure described in Figure A.1.

The main variables that define the input-output relationships are:

X_{ij}: the amount of input, in monetary value, produced by sector i and purchased by sector j;
X_i: the total monetary value of production in sector i;
DF_i: the monetary value of final demand for sector i's input, which corresponds to the sum of household consumption of this input (C_i), private investment (I_i), government spending (G_i), and exports (E_i);
V_j: the value added by sector j.

In row i, the sales of sector i to each of the other sectors of the economy are shown, such that:

$$X_i = \sum_{j-1} X_{ij} + (C_i + I_i + G_i + E_i)$$

, or even:

$$X_i = \sum_{j-1}^{m} X_{ij} + DF_i$$

total demand equals total supply, which is composed of final demand, made by consumers, investors, and the government, and intermediate demand, also called intermediate consumption.

the input-output model assumes that the quantity of input from sector i consumed by sector j (X_{ij}) is proportional to the total production of sector j (X_j). In the model, $X_{ij} = a_{ij}$. X_j, where a_{ij} is a constant that expresses the amount of input i required to produce one unit of output j. In other words, the consumption by sector j of inputs from sector i is a linear function of its own level of production. Thus,

to double its production, for example, sector j requires twice the amount of inputs from sector i. The matrix A = (a_{ij}) is known as the technology matrix, and its elements 'a_{ij}' are called direct input technical coefficients.

From these relationships, a linear system of m equations with m unknowns is obtained:

$$X_i = \sum_{j}^{m} X_{ij} + DF_i = \sum_{j}^{m} a_{ij} X_j + DF_i \,, \; i = 1, 2, \ldots, m,$$

that is, $a_{i1}X_1 + a_{i2}X_2 + ... + a_{in}X_n + DF_i = X_i$, i = 1, 2, 3, ...,m. In matrix form, this system can be written as:

AX + DF = X, or equivalently, (I - A).X =DF

where A is the technology matrix, a square matrix of dimension m×m; X is a column vector m×1 whose elements are the production values of the various sectors; DF is the column vector m×1 corresponding to final demand; I is the identity matrix, also of dimension m×m.

Note that, in general, the intermediate consumption of a sector does not exceed its total production, that is:

$$X_j > \sum_{i-1}^{m} X_{ij} \;\; , j = 1, 2, 3, \ldots, m.$$

This means that,**1** > X j = 1,2, 3, ..., m. Thus, the system above can be solved for X: as described by equation (1). The matrix L = (I - A)-1 is called the Leontief inverse matrix. System (1) shows how much the economy produces of each good and service to meet the economy's total demand.

$$X = (I - A)^{-1}.DF = L.DF \qquad (1)$$

Figure A.1
Input-Output Table

	Sector j Consumption	Final Demand	X
	$\begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1j} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2j} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{i1} & X_{i2} & \cdots & X_{ij} & \cdots & X_{im} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mj} & \cdots & X_{mm} \end{bmatrix}$	$\begin{bmatrix} C_1 & I_1 & G_1 & E_1 \\ C_2 & I_2 & G_2 & E_2 \\ \vdots & \vdots & \vdots & \vdots \\ C_i & I_i & G_i & E_i \\ \vdots & \vdots & \vdots & \vdots \\ C_m & I_m & G_m & E_m \end{bmatrix}$	$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_i \\ \vdots \\ X_m \end{bmatrix}$
	$\begin{bmatrix} CI_1 & CI_2 & \cdots & CI_j & \cdots & CI_m \\ V_1 & V_2 & \cdots & V_j & \cdots & V_m \\ M_1 & M_2 & \cdots & M_j & \cdots & M_m \end{bmatrix}$		
M	$\begin{bmatrix} X_1 & X_2 & \cdots & X_j & \cdots & X_m \end{bmatrix}$		

In order to measure economic impacts on income and employment using the input-output matrix, employment and income multipliers are constructed. The direct employment coefficient CED_j, j = 1, 2, ..., m is obtained by dividing the number of workers in each sector j, N_j, by the corresponding production value, X_j. By composing a row vector (1×m) with these ratios, we have:

$$CED = (N_1/X_1 \;\; N_2/X_2 \;\; \ldots N_m/X_m) \qquad (2)$$

That is, to produce one unit of output in sector j, CED_j workers are required in sector j itself, following the Leontief assumption of linear relationships. In addition to the direct impact, there is an indirect employment effect throughout the economy, since the sector in question requires inputs from other sectors. To calculate this effect, the L matrix is multiplied by the demand column vector (m×1), that is, Z = L.DF. Thus, employment generated by the demand is given by P= CED.Z =(CED.L).DF = CEDI.DF. The row vector CEDI (1xm), which equals CED.L, is known as the vector of direct and indirect employment coefficients.

$$CEDI = CED \,.\, L \qquad (3)$$

Similarly, it is also possible to calculate the direct income coefficients based on the “Value Added” row from Figure A.1, as well as the direct and indirect income coefficients. These values are expressed in equations (4) and (5).

$$CRD = (V_1/X_1 \;\; V_2/X_2 \ldots V_m/X_m) \qquad (4)$$

$$CRDI = CRD.L \qquad (5)$$

Induced employment and income generated by an activity in a given location are calculated by applying the direct and indirect multipliers to the demand generated by the consumption of workers employed in that activity. By assumption, the additional consumption of workers in activity i (CF_i) is proportional to the income of these workers: CF_i = l.W, where W is the payroll of sector i and l is the propensity to consume, which is a constant greater than zero and less than 1. Thus, to calculate the induced employment and income generated by an activity, it is sufficient to multiply the vector CF_i by the direct and indirect employment and income coefficients (expressions 3 and 4).

Databases

To estimate the impacts of investments in sewage collection networks and wastewater treatment plants, data from the 2022 Annual Survey of the Construction Industry, conducted by IBGE, were used. This survey provides the direct income and employment coefficients for sanitation works, as well as the wages paid by construction companies to carry out these projects. The 2021 supply and use tables from Brazil’s National Accounts, also provided by IBGE, offer the data needed to estimate the L matrix, indirect employment and income coefficients, and households’ propensity to consume.

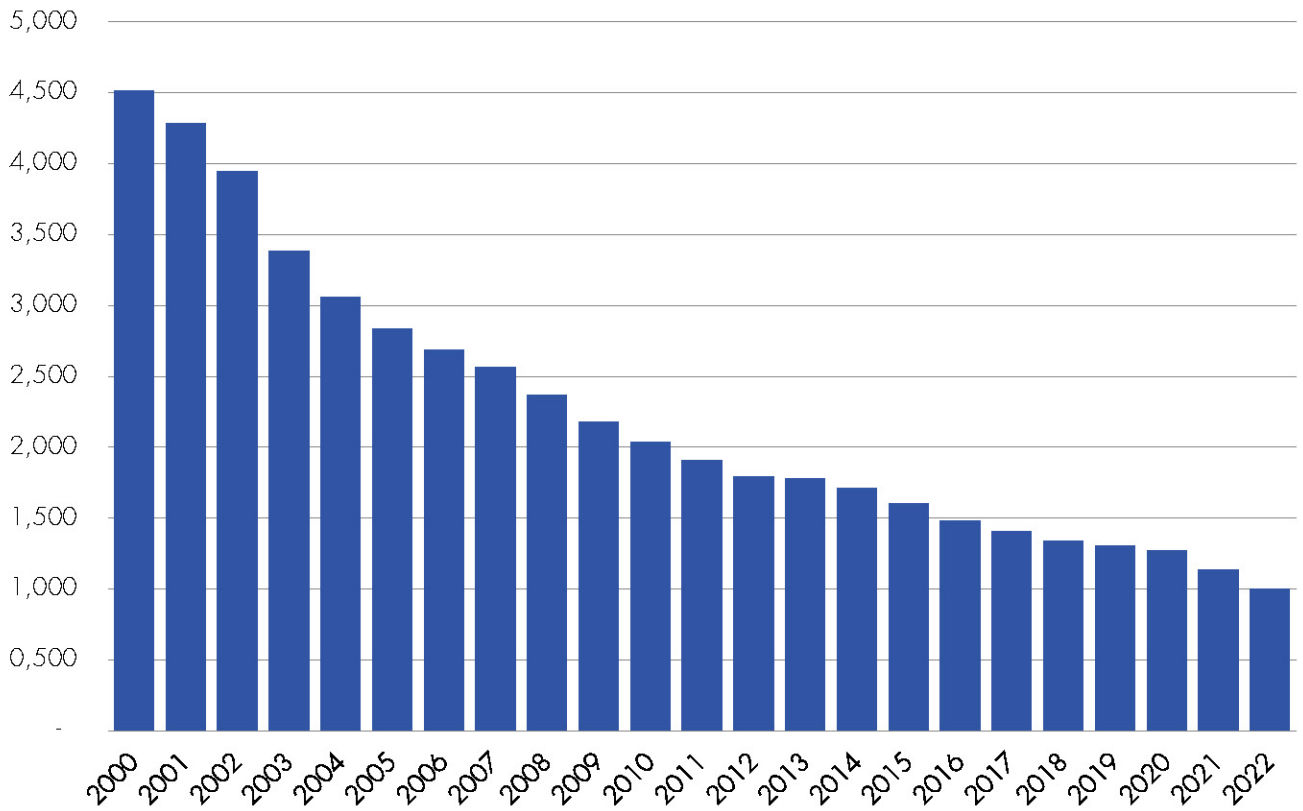
For sewage collection and treatment operations, the data on production value, employment, income, and wages required for calculating the direct and induced coefficients come from the 2022 Annual Survey of Services, also conducted by IBGE. Similarly to the previous case, the data used to estimate the L matrix, indirect employment and income coefficients, and households’ propensity to consume were taken from the 2021 supply and use tables of Brazil’s National Accounts.

Investment Deflator

To estimate the value of sanitation investments in constant prices, investment deflators were created to convert past current values into constant 2022 prices. For this purpose, data from two surveys were used: (i) the Annual Survey of the Construction Industry (PAIC), from 2005 to 2022, conducted by IBGE (IBGE, various years), which provides information on material and labor costs for sanitation network works; and (ii) data from the National System of Costs Survey and Indexes of Construction (SINAPI), available on the IBGE website, which provide estimates of labor and material cost trends for construction in Brazilian states and the Federal District.

The values of sanitation works recorded in PAIC were used to estimate the weight of labor and materials in total investment costs. SINAPI data were used to calculate the estimated annual variations of these components. The variation of the investment deflator is the weighted average of the variations in labor and materials for each region, according to their respective weights. Based on these variations, an index was created with a base value of 1 for 2022. The constant investment value is obtained by multiplying the current value by the corresponding deflator.

Chart A.1. Investment Deflator, 2022 = 1

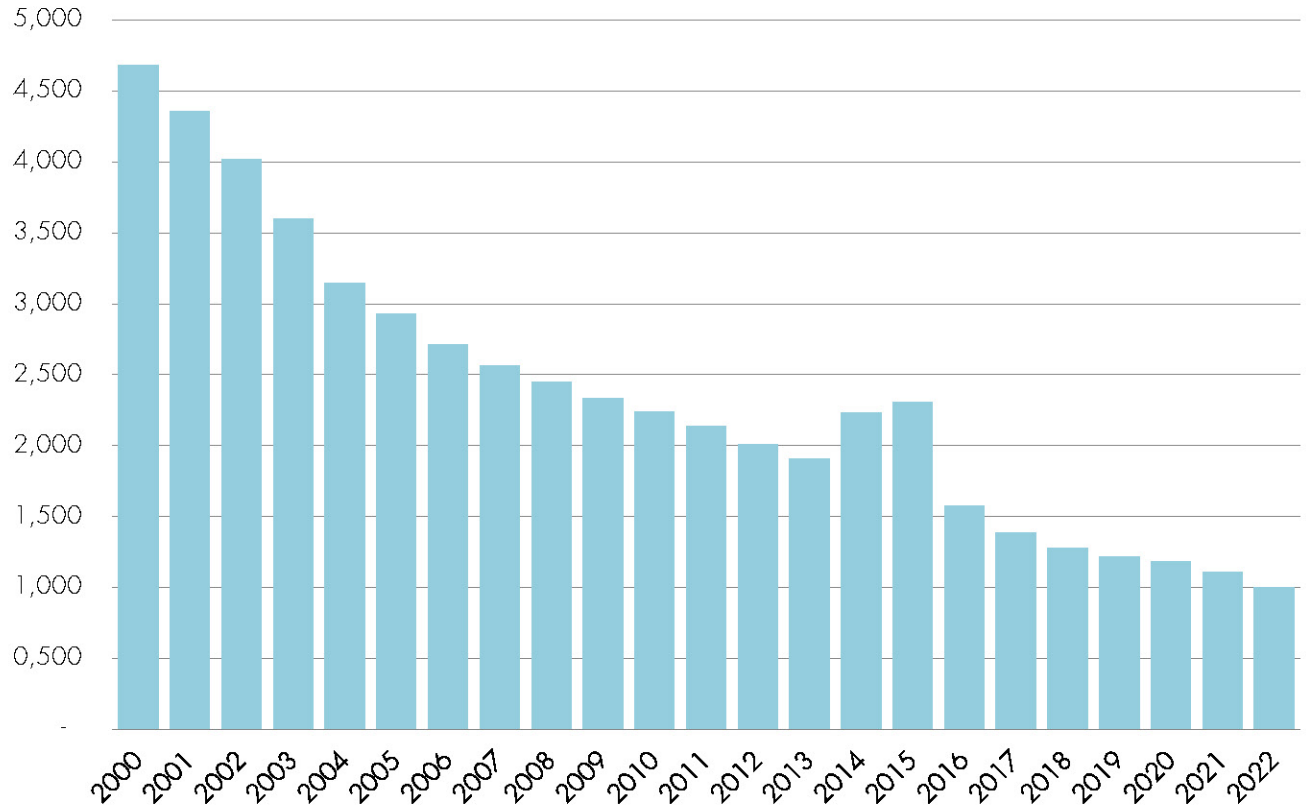


Source: IBGE. Prepared by: Ex Ante Consultoria Econômica.

Revenue Deflator

To estimate sanitation revenues at constant prices, an index was created based on the evolution of the weighted average tariff for water and sewage services in Brazil. The index has a base of 2022 = 1, and the tariffs were obtained from IBGE's IPCA.

Chart A.2. Revenue Deflator, 2022 = 1



Source: SNIS. Prepared by: Ex Ante Consultoria Econômica.

4.1. SANITATION AND WATERBORNE DISEASE MORBIDITY

The assessment of the effects of lack of sanitation on population health was based on the analysis of factors determining the incidence of waterborne diseases (diarrhea and vomiting, or diseases transmitted by insect vectors) that led individuals to be absent from their routine activities. The deprivation variables used in the analysis are: lack of access to the public treated water supply network, lack of access to the sewage collection network, and lack of access to a bathroom. In addition to these variables, some socioeconomic indicators were used as control variables. The socioeconomic indicators used in the econometric models are: (i) individual information: gender, age group, and education level; and (ii) household information: type of residence (apartment, house, or room), wall material, roofing material, flooring material, geographic location (state and rural or urban area), type of garbage collection, and existence of piped water in the residence. Data from the 2019 National Health Survey conducted by IBGE were used.

A logistic regression model was applied, where the probability of being absent from activities due to diarrhea is a binary variable with values (1) for absence and (0) for no absence. The logistic regression model is described by equation (6):

$$P(y=1 \mid x_1, x_2, ..., x_k) = G(\beta_0 + \beta_1 x_1 + ... + \beta_k x_k) \quad (6)$$

where y represents the dependent variable (probability of absence due to diarrhea), xj are the explanatory variables, with j = 1, 2, ..., k, and b are the coefficients quantifying the relationships between these variables and the dependent variable. G is a function that takes strictly positive values between zero and one: $0 < G(z) < 1$, for all real numbers z. This ensures that the estimated probabilities lie strictly between zero and one.

The model estimated to analyze the effect of sanitation deprivation on the probability of absence from routine activities due to diarrhea or vomiting produced highly satisfactory results. The greater the share of the population with access to treated water and sewage collection networks, the lower the probability of absence from routine activities due to diarrhea or vomiting. The coefficients are presented in Table A.M.1. The remaining control variables showed the expected signs and are statistically significant.

Table A.M.1
Regression results for absence due to diarrhea, Brazil, 2019

Dimension	b	Standard Deviation	*z*	*p* -value	Odds Ratio
Lack of access to treated water supply network	0.0510	0.0063	8.11	0.0%	5.2%
Lack of bathroom	0.1146	0.0077	14.88	0.0%	12.1%
Lack of access to sewage collection network	0.2153	0.0068	31.72	0.0%	24.0%

Sources: PNS (IBGE, 2020).
Prepared by: Ex Ante Consultoria Econômica.

4.2. SANITATION AND RESPIRATORY DISEASE MORBIDITY

The assessment of the effects of a lack of sanitation on population health was based on the analysis of factors determining the incidence of respiratory diseases (pneumonia and flu) that led individuals to be absent from their routine activities. The deprivation variables used in the analysis are: lack of access to the public treated water supply network, lack of access to the sewage collection network, and lack of access to a bathroom. In addition to these variables, some socioeconomic indicators were used as control variables. The socioeconomic indicators used in the econometric models are: (i) individual information: gender, age group, and education level; and (ii) household information: type of residence (apartment, house, or room), wall material, roofing material, flooring material, geographic location (state and rural or urban area), type of garbage collection, and existence of piped water in the residence. Data from the 2019 National Health Survey conducted by IBGE were used.

A logistic regression model was applied, where the probability of being absent from activities due to respiratory diseases is a binary variable with values (1) for absence and (0) for no absence. The logistic regression model is described by equation (7):

$$P(y=1 \mid x_1, x_2, ..., x_k) = G(\beta_0 + \beta_1 x_1 + ... + \beta_k x_k) \quad (7)$$

where y represents the dependent variable (probability of absence due to respiratory diseases), xj are the explanatory variables, with j = 1, 2, ..., k, and b are the coefficients quantifying the relationships between these variables and the dependent variable. G is a function that takes strictly positive values between zero and one: 0 < G(z) < 1, for all real numbers z. This ensures that the estimated probabilities lie strictly between zero and one.

The model estimated to analyze the effect of sanitation on the probability of absence from routine activities due to respiratory diseases produced highly satisfactory results. The greater the share of the population with access to treated water and sewage collection networks, the lower the probability of absence from routine activities due to respiratory diseases. The coefficients are presented in Table A.M.2. The remaining control variables showed the expected signs and are statistically significant.

Table A.M.2
Regression results for absence due to respiratory diseases, Brazil, 2019

Dimension	b	Standard Deviation	*z*	*p* -value	Odds Ratio
Lack of access to treated water supply network	0.0911	0.0046	20.01	0.0%	9.5%
Lack of bathroom	0.1101	0.0054	20.32	0.0%	11.6%
Lack of access to sewage collection network	0.0005	0.0049	0.1	91.8%	0.1%

Sources: PNS (IBGE, 2020).
Prepared by: Ex Ante Consultoria Econômica.

5.1. SANITATION AND PRODUCTIVITY

The analysis of the effects of sanitation on labor income was based on the combination of hourly wage data with information on access to sewage, access to treated water, availability of a bathroom in the residence, and a broad set of socioeconomic control indicators. The database used for this evaluation was the 2023 Continuous National Household Sample Survey. The control variables were: (i) age; (ii) age squared; (iii) gender; (iv) color or race; (v) education level; (vi) economic activity sector; (vii) occupational position; (viii) household condition; (ix) wall material of the residence; (x) roofing material of the residence; (xi) garbage collection system; (xii) state of residence; (xiii) area of residence (rural or urban); and (xiv) place of residence (capital city, metropolitan regions, or interior regions).

$$(8) \quad \ln y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + m.$$

Two econometric models were estimated: the first, using an ordinary least squares (OLS) estimator; and the second, a linear model estimated by maximum likelihood with correction for sample selection bias, in which the dependent variable, average hourly wage, was transformed into ln for better statistical fit. The regression results are presented in Table A.M.3. The estimated models produced highly satisfactory results. The greater the share of the population with access to sewage services, the higher the labor income. Access to treated water also positively affects workers' income. The absence of a bathroom in the residence reduces the expected average hourly wage.

Table A.M.3
Productivity regression, Brazil, 2023

OLS	Coefficient	Standard Error	p-value
Access to treated water*	0.0425	0.0002	0.0000
Access to sewage network	0.0360	0.0002	0.0000
Availability of bathroom	0.2183	0.0007	0.0000
Sample Selection Correction			
Access to treated water*	0.0566	0.0002	0.0000
Access to sewage network	0.0575	0.0002	0.0000
Availability of bathroom	0.2486	0.0007	0.0000

Source: PNADC 2023 (IBGE, 2024). Prepared by: Ex Ante Consultoria Econômica.
(*) Daily access to water supplied through the public network.

5.2 SANITATION AND SCHOOL DELAY

The analysis of the effects of sanitation on school performance was based on the dependent variable school delay, constructed from the difference between the individual's years of schooling and the grade level they should be attending. This analysis was applied only to individuals of school age, that is, children and adolescents aged 5 to 20 years. The database used was the 2022 Continuous National Household Sample Survey, and the control variables were: (i) gender; (ii) self-reported color or race; (iii) wall material; (iv) roofing material of the residence; (v) garbage collection system; (vi) state of residence; (vii) area of residence (rural or urban); (viii) place of residence (capital city, metropolitan regions, or interior regions); and (ix) household per capita income (in ln).

The econometric model used was a Poisson model, which is applied when the dependent variable is a count variable, such as the number of days absent from activities due to diarrhea or vomiting. This technique models the expected value as an exponential function according to equation (9):

$$E(y \mid x_1, x_2, ..., x_k) = \exp(\beta_0 + \beta_1 x_1 + ... + \beta_k x_k) \quad (9)$$

Since exp(.) is always positive, equation (9) ensures that the predicted values of y will always be positive. For inference processes using the Poisson model, see Wooldridge (2006).

The estimated model produced highly satisfactory results. The greater the share of the population with access to sewage services, the lower the school delay; in other words, access to this service contributes positively to school performance. Access to treated water also had the same effect, contributing to a reduction in school delay. The remaining control variables showed the expected signs and are statistically significant.

Table A.M.4
School delay regression, Brazil, 2023

	Coefficient	Standard Error	p-value
Access to treated water*	-0.0043	0.0003	0.0000
Access to sewage network	-0.0217	0.0003	0.0000
Availability of bathroom	-0.1682	0.0007	0.0000

Source: PNADC 2023 (IBGE, 2024). Prepared by: Ex Ante Consultoria Econômica. (*) Daily access to water supplied through the public network.

5.3. SANITATION AND SCHOOL PERFORMANCE – ENEM

The analysis of the effects of sanitation on school performance was based on the combination of ENEM 2023 test scores with information on the availability of a bathroom in the home and a broad set of socioeconomic control indicators. The analyzed population was between 19 and 29 years of age. The database used for this evaluation was the ENEM 2022 microdata provided by INEP. The control variables were: (i) age; (ii) gender; (iii) color or race; (iv) father's education level; (v) mother's education level; (vi) household income class; (vii) availability of a washing machine; (viii) availability of a dishwasher; and (ix) place of residence (capital city, metropolitan regions, or interior regions).

The econometric models used were linear equations estimated by OLS, in which the dependent variables are the test scores (Di) for: natural sciences (NS), human sciences (HS), language and codes (LC), mathematics (MT), and essay writing (EW). A regression was also estimated for the average score across the five tests (mean). The following equation describes the statistical model:

$$(10)\ \mathbf{D_i = b_0 + b_1x_1 + b_2x_2 + ... + m}, \text{ i = NS, HS, LC, MT, EW, Mean.}$$

The regression results are presented in Table A.M.5. The estimated models produced highly satisfactory results. As expected, the absence of a bathroom in the candidate's home reduces their scores across all ENEM tests.

Table A.M.5
School performance regression in ENEM, Brazil, 2023

Partial effect of the presence of a bathroom in the home	Coefficient	standard error	p-value
Human Sciences	-6.4880	1.0808	0.0001
Natural Sciences	-6.4880	1.0808	0.0001
Language and Codes	-17.5560	1.1543	0.0003
Mathematics	-11.9746	1.7092	0.0001
Written Essay	-40.5755	3.2287	0.0002
Average	-17.8869	1.2832	0.0003

5.4. SANITATION AND REAL ESTATE APPRECIATION

The analysis of the effects of sanitation on property values was based on microeconomic data on rental values, access to sewage, and other socioeconomic indicators of Brazilian residences. The database used was the 2023 Continuous National Household Sample Survey, which contains information on Brazilian households in both urban and rural areas across all regions of the country. Equation (11) describes the statistical model, in which the variable being explained is the monthly real estate income (estimated by rental value). Several variables were used to explain the behavior of this variable: (i) type of residence (apartment or house); (ii) predominant material of exterior walls; (iii) predominant roofing material; (iv) predominant flooring material; (v) number of bedrooms; (vi) existence of regular garbage collection at the residence; (vii) state of residence; (viii) area of residence (rural or urban); (ix) place of residence (capital city, metropolitan regions, or interior regions); (x) access to treated water; (xi) access to the public sewage network; and (xii) availability of a bathroom in the residence.

The econometric model used to assess the effect of this broad set of variables on real estate income (in In scale) was the ordinary least squares (OLS) model. Equation (11):

The estimated model shows a positive influence of sanitation on property values and the income that can be earned from these assets. Considering two identical properties, one with sanitation access and one without, the property with access to the public sewage network is expected to have a higher rental value than the one without sewage collection access. Access to treated water also has a positive effect on rental value, and the presence of a bathroom increases real estate income. The remaining control variables also produced statistically significant coefficients with the expected signs.

Table A.M.6
Real estate appreciation regression, Brazil, 2023

OLS	Coefficient	Standard Error	p-value
Access to treated water*	0.0686	0.0005	0.0000
Access to sewage network	0.0502	0.0004	0.0000
Availability of bathroom	0.1846	0.0024	0.0000

Source: PNADC 2023 (IBGE, 2024). Prepared by: Ex Ante Consultoria Econômica. (*)
Daily access to water supplied through the public network.

5.5. SANITATION AND TOURISM

The analysis of the effects of sanitation on employment in the tourism sector was based on a logistic regression model that considers, on one hand, the categorical variable of whether or not the individual works in the tourism sector, and on the other, access to water supply and sewage collection services, along with a set of socioeconomic variables. The following economic activities were considered: accommodation and food services; recreational, cultural, and sports activities; travel agencies; passenger land transportation; and air transportation. The database used was the 2023 Continuous National Household Sample Survey, and the explanatory variables included: (i) age and age squared; (ii) gender; (iii) color or race; (iv) education level; (v) predominant exterior wall material; (vi) predominant roofing material; (viii) existence of regular garbage collection at the residence; (ix) state of residence; (x) area of residence (rural or urban); (xi) place of residence (capital city, metropolitan regions, or interior regions); (xii) access to treated water; (xiii) access to the public sewage network; and (xiv) availability of a bathroom in the residence. The regression results are presented in Table A.M.7. The logistic regression model used is described by equation (12):

$$P(y=1 \mid x_1, x_2, ..., x_k) = G(\beta_0 + \beta_1 x_1 + ... + \beta_k x_k) \quad (12)$$

The estimated model produced highly satisfactory results. The greater the share of the population with access to sewage services, the higher the number of workers in the tourism sector. Access to treated water also had the same effect, contributing to an increase in tourism sector employment. The availability of a bathroom also showed a strong coefficient. The remaining control variables showed the expected signs and are statistically significant.

Table A.M.7
Tourism employment regression, Brazil, 2023

	Coefficient	Standard Error	*p* -value	Odds Ratio
Access to treated water network	0.0407	0.0013	0.0000	1.0415
Access to sewage network	0.0406	0.0011	0.0000	1.0415
Availability of exclusive bathroom	0.1065	0.0057	0.0000	1.1124

Source: PNADC 2023 (IBGE, 2024). Prepared by: Ex Ante Consultoria Econômica.
(*) Daily access to water supplied through the public network.

6.1. METHODOLOGY FOR CALCULATING THE SANITATION COST-BENEFIT BALANCE

Annex 6.1 describes the steps for estimating the cost-benefit balance of costs. The estimation methodology takes into account the social benefits and costs of sanitation investments and operations. Among the benefits are the externalities: (a1) reduction in healthcare costs, (a2) increase in labor productivity, (a3) increase in income due to real estate appreciation, and (a4) increase in tourism income. In addition, there is income generated by investments (b1), income generated by revenue expansion (b2), and taxes on consumption and production collected from these two activities (b3). Social costs include: the value of investments (d1) and the increase in household expenditures (d2).

All values are expressed in constant 2022 prices, based on the unit price of water and sewage services (IBGE) and the unit costs of sanitation works, which were estimated using data from the Annual Survey of the Construction Industry and the National System of Construction Costs (SINAPI), with weights for materials, labor, and services estimated by the 2021 Annual Survey of the Construction Industry (IBGE). The constant values were converted to present values in 2022.

Table A.M.8 illustrates the sanitation benefit and cost flows in Brazil from 2005 to 2022, in BRL billions. Each column presents one of the flows, and the last column shows the balance. The values for each year are shown in the rows. The last row provides the sum for the entire period. In addition to the benefit and cost estimates, there are subtotals for each group. The letters indicate the formulas that make up the subtotals, totals, and balance.

The externalities were calculated based on the econometric models described in Methodological Annexes 2 to 8 and the sanitation coverage rates for each specific period. It should be noted that the flows represent interannual differences between the estimates for two years. For example, in the case of variable a2, the value for 2006 refers to the difference in labor income between 2006 and 2007 that can be attributed to changes in the water and sewage service coverage rates. For all variables from a1 to a4, the portions attributable to sanitation are calculated through the partial derivatives of the econometric models and the variation in coverage rates.

The incomes generated by investment and by revenue growth from sanitation operations are calculated by applying the income multipliers from Tables 3.1 to 3.4, which were calculated according to the methodology described in Methodological Annex 1. The tax revenue comes from previous estimates and the tax burden presented in Table 3.5.

The investment cost (d1) is the present value of the amounts actually invested. The increase in household expenditures is calculated based on the interannual difference in the municipalities' direct and indirect operational revenues, as published by SNIS.

The following describes the procedures adopted to obtain the current values used to calculate the constant and present values of the variables in the projection of the cost-benefit balance of sanitation universalization between 2022 and 2040.

a1. The value of healthcare savings in each area (capital cities, metropolitan regions, and interior municipalities)

corresponds to the sum of expenses related to hours not worked due to absences caused by diarrhea or vomiting, or by respiratory diseases, along with hospitalization costs for these diseases. To estimate the expenses related to hours not worked, the projected number of people absent in 2040 was used. This number was estimated by multiplying the projected 2040 population by the labor force participation rate and by the absence probabilities estimated in Methodological Annexes 2 and 3. The probability of absence in 2040 was estimated by imputing basic sanitation access (water and sewage) for all residents who did not have access to sanitation in 2022. The number of absent individuals was then multiplied by the average number of hours missed and by the average hourly wage in each area, according to IBGE statistics. The reduction in hospitalization costs was calculated proportionally to the expected reduction in work absences.

a2. The value of the productivity increase corresponds to the expected income increase for the entire employed population in each area in 2040. To estimate the average income with sanitation universalization, basic sanitation access (water and sewage) was imputed for all workers in areas that lacked sanitation access in 2022. The productivity increase was calculated as the difference between aggregate income in 2022 and the income that would prevail in 2040 if the access rates to the system that existed in 2022 were expanded.

a3. The value of the real estate income increase corresponds to the expected increase in real estate income for all residential properties in the areas in 2040. To estimate aggregate real estate income with sanitation universalization, the equation from Methodological Annex 7 was applied, imputing basic sanitation access (water and sewage) for all households that lacked sanitation access in 2022. The real estate income increase was calculated as the difference between the aggregate real estate income and the income that would prevail in 2040 with universalization.

a4. The increase in tourism income corresponds to the expected increase in income for the sector in 2040 due to sanitation universalization. To estimate aggregate tourism income with sanitation universalization, equations combining average income and the probability of working in the tourism sector were used, which calculate the average labor income in the tourism sector and the probability of a worker being employed in the sector. The calculations were performed by imputing basic sanitation access (water and sewage) for all workers in areas that lacked sanitation access in 2022. The increase in labor income in the sector was calculated as the difference between the current average income and the income that would prevail in 2040 with universalization. With the expansion of sanitation, the number of people employed in the sector also changes.

b1. The income generated by sanitation investment in each year corresponds to the multiplication of the projected investment value for that year by the direct, indirect, and induced income coefficient for sanitation works, estimated using the methodology presented in Methodological Annex 1.

b2. The income generated by the increase in operations corresponds to the multiplication of the projected revenue increase between 2022 and 2040 by the direct, indirect, and induced income coefficient for water distribution and sewage collection and treatment activities, estimated using the methodology presented in Methodological Annex 1.

b3. The tax revenue comes from the previous estimates (b1 and b2) and the tax burden presented in Table 3.5.

d1. The cost of sanitation investment in each year corresponds to the projected investment value for each year between 2022 and 2040.

d2. The increase in household expenditures in each year corresponds to the projected revenue increase between 2022 and 2040.

The annual flows in present values are summed to estimate the costs and benefits in each area. The following tables provide an example of the estimates for the period from 2005 to 2022 for Brazil as a whole.

Table A.M.8

Benefit and cost balance flows of sanitation expansion in Brazil, 2005 to 2022, in BRL million*

	Reduction in healthcare costs	Increase in labor productivity	Income from real estate appreciation	Income from tourism	Subtotal externalities (A)	Income generated by investment	Income generated by increased operations
2005	10,118.003	29,982.603	266.121	3,168.168	43,534.895	28,402.354	7,555.578
2006	9,202.068	27,385.855	511.375	2,874.782	39,974.080	32,427.407	13,797.122
2007	8,162.103	24,916.297	736.990	2,599.539	36,414.929	27,632.451	20,458.455
2008	7,347.057	22,568.683	944.128	2,341.467	33,201.334	32,448.198	25,662.006
2009	6,693.297	20,337.965	1,133.892	2,099.642	30,264.796	41,876.893	29,749.399
2010	5,971.530	18,219.286	1,307.326	1,873.186	27,371.328	43,009.701	58,561.717
2011	5,014.620	16,207.977	1,465.417	1,661.266	24,349.281	35,511.249	65,761.273
2012	4,267.823	14,299.543	1,609.104	1,463.090	21,639.559	38,070.220	75,309.791
2013	3,691.444	12,489.663	1,739.272	1,277.905	19,198.284	38,005.515	81,779.806
2014	3,018.634	10,774.181	1,856.760	1,104.998	16,754.572	41,375.742	85,247.508
2015	2,455.187	9,149.100	1,962.363	943.691	14,510.341	37,187.176	88,020.583
2016	1,972.540	7,610.579	2,056.831	793.338	12,433.288	33,976.393	105,182.455
2017	1,443.268	6,154.923	2,140.877	653.329	10,392.396	28,603.673	112,888.530
2018	1,025.113	4,778.579	2,215.171	523.083	8,541.946	30,885.376	124,331.906
2019	723.462	3,478.133	2,280.349	402.051	6,883.995	32,118.368	137,955.461
2020	8.355	2,250.304	2,337.013	289.710	4,885.381	28,116.387	97,538.478
2021	228.532	1,091.936	2,385.728	185.563	3,891.760	24,376.864	9,933.947
2022	-	-	2,427.032	89.142	2,516.174	27,237.058	29,331.803
Average	3,963.502	12,871.978	1,631.986	1,352.442	19,819.908	33,403.390	64,948.101

continued

continuation

	Taxes related to production**	Subtotal income (B)	Total benefits (C=A+B)	Investment cost	Increase in household expenses	Total costs (D)	Balance (E=C+D)
2005	1,957.411	37,915.344	81,450.239	-23,559.32	-4,784.31	-28,343.630	53,106.609
2006	2,512.744	48,737.273	88,711.353	-27,038.17	-8,584.65	-35,622.820	53,088.534
2007	2,608.908	50,699.814	87,114.743	-23,023.66	-12,641.00	-35,664.660	51,450.083
2008	3,151.634	61,261.839	94,463.173	-26,889.06	-15,808.80	-42,697.859	51,765.314
2009	3,886.317	75,512.609	105,777.405	-34,423.89	-18,296.28	-52,720.161	53,057.244
2010	5,496.892	107,068.310	134,439.638	-35,235.49	-35,856.49	-71,091.980	63,347.658
2011	5,474.325	106,746.847	131,096.128	-29,209.54	-40,241.39	-69,450.932	61,645.196
2012	6,127.338	119,507.350	141,146.909	-31,330.14	-46,058.36	-77,388.505	63,758.404
2013	6,471.577	126,256.897	145,455.181	-31,225.08	-49,998.74	-81,223.822	64,231.360
2014	6,842.047	133,465.296	150,219.869	-34,226.09	-52,108.97	-86,335.063	63,884.806
2015	6,762.331	131,970.090	146,480.431	-30,925.38	-53,795.84	-84,721.222	61,759.209
2016	7,509.438	146,668.287	159,101.576	-28,185.09	-64,254.39	-92,439.480	66,662.096
2017	7,630.202	149,122.405	159,514.801	-23,656.62	-68,948.66	-92,605.287	66,909.514
2018	8,369.922	163,587.204	172,129.150	-25,499.31	-75,921.33	-101,420.645	70,708.506
2019	9,169.552	179,243.382	186,127.377	-26,472.26	-84,223.15	-110,695.406	75,431.971
2020	6,778.500	132,433.365	137,318.746	-23,172.04	-59,581.27	-82,753.307	54,565.439
2021	1,865.386	36,176.198	40,067.957	-20,077.09	-64,103.28	-84,180.373	-44,112.416
2022	3,064.267	59,633.128	62,149.301	-22,449.89	-74,434.10	-96,883.993	-34,734.692
Average	5,315.488	103,666.980	123,486.888	-27,588.785	-46,091.167	-73,679.952	49,806.935

Source: Ex Ante Consultoria Econômica. (*) present values at 2022 prices. (**) from sanitation investments and operations and real estate activities.

THE SHARE OF THE POPULATION WITH ACCESS TO TREATED WATER DISTRIBUTION SERVICES IN THE **PINHEIROS RIVER BASIN** INCREASED FROM 94.5% IN 2000 TO 99.4% IN 2022. THIS MEANT THAT 589 THOUSAND PEOPLE GAINED ACCESS TO THIS FUNDAMENTAL AND HUMANITARIAN SERVICE OVER THESE 22 YEARS. THE SHARE OF THE POPULATION IN THE BASIN WITH ACCESS TO SEWAGE COLLECTION SERVICES INCREASED FROM 82.3% TO 96.7% BETWEEN 2000 AND 2022. A TOTAL OF 840 THOUSAND PEOPLE WERE INCORPORATED INTO THE COLLECTION SYSTEM.

THIS STUDY AIMS TO ASSESS THE EFFECTS OF THE UNIVERSALIZATION OF SANITATION IN THE PINHEIROS RIVER BASIN, WHICH WAS ACHIEVED THROUGH THE **NOVO RIO PINHEIROS PROJECT** AND OTHER SYSTEM EXPANSION ACTIONS CARRIED OUT OVER THE 22 YEARS. THE STUDY ANALYZES THE COST-BENEFIT BALANCES OF SANITATION EXPANSION OBSERVED IN THE PAST AND THE LEGACY OF THIS ACHIEVEMENT FOR FUTURE GENERATIONS OF RESIDENTS IN THE PINHEIROS RIVER BASIN.

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