

VIII. THE B.H. WATER CIRCLE

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Autumn Semester 2013

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VIII.

THE BELO HORIZONTE

WATER CYCLE

THE RESOURCE'S DIVERSE ROLE IN URBAN GROWTH AND MANAGEMENT

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BETWEEN URBAN RELEVANCE

AND INSTITUTIONAL CHALLENGE

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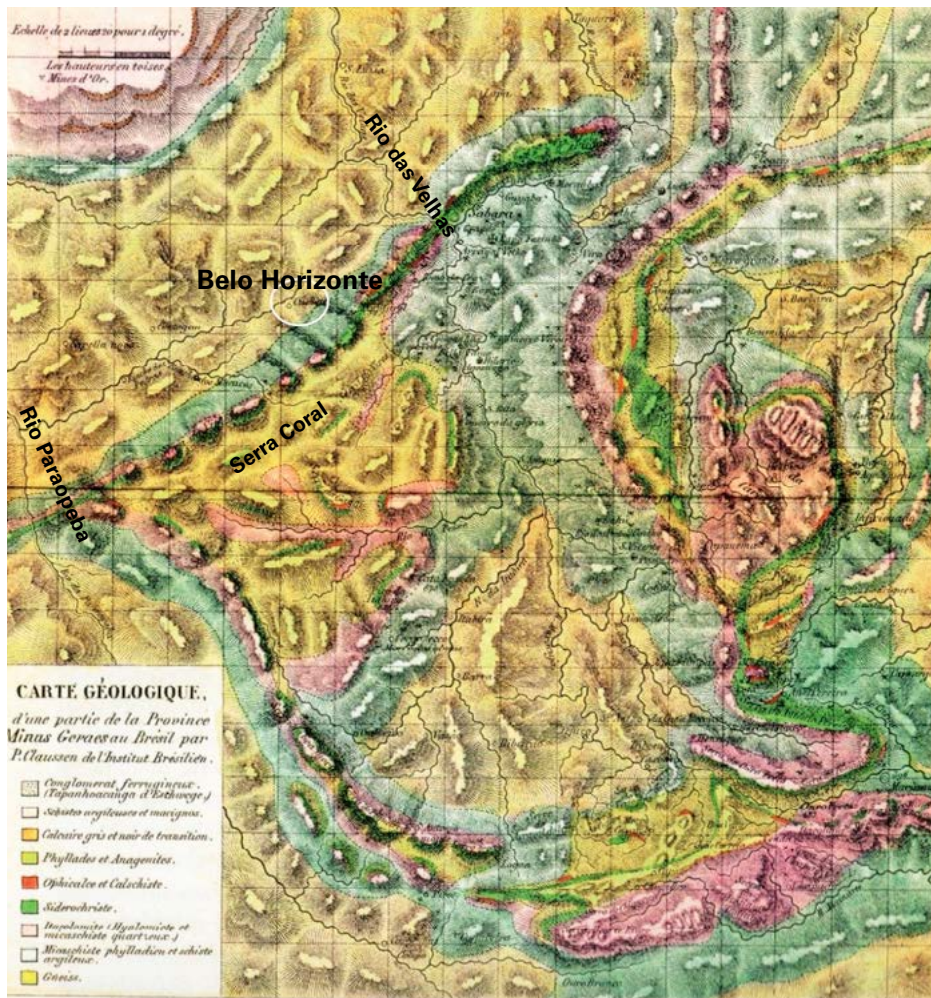
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HOW WATER SHAPES THE CITY

Belo Horizonte was founded in a territory of an abundance of water. While the resource water determined the location of the new city, its appearance in the landscape has the potential to significantly influence urbanisation processes. Proximity to water is an important factor for urban development and activities connected to water create a sort of lifestyle. An important role is played by the represas, the artificial reservoir lakes of the metropolitan region.





Natural Preconditions and their Impact on the new City

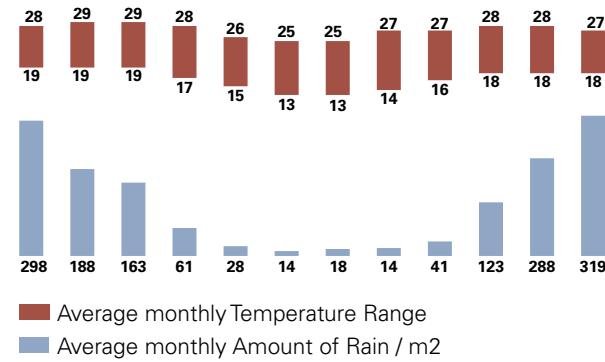
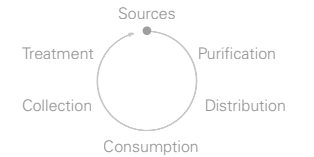
The mountain chains of the Serra do Curral mark the southern borders of today's Belo Horizonte. They gave name to the farms that first occupied the territory in the 19th century, before B.H. was founded in 1897. In the massive, many water courses originate. The dealing with topography and water is very present in the city's foundation histography and always played an important role in the city's development. The abundance of water, next to mild climate conditions, was a main argument for the selection of the site for the new capital.



0 5km 10km

Embedded in a mountainous Landscape: The Territory of Belo Horizonte

The extensions of the Serra do Curral stretch out north and are omnipresent in the city of Belo Horizonte. The complex topography not only is characteristic for the urban space but also is a challenge to the city's infrastructure, e.g. the water system.



Mild Weather Conditions

The climate in B.H. is mild and relatively balanced over the year. The temperature only varies little. There is a rain season from november till march. In that period, floodings can occur.



Topography - A Magnificent Panorama

The mountain panorama was already a popular subject on early drawings and emblems of the city and still is an important reference of identification for the city



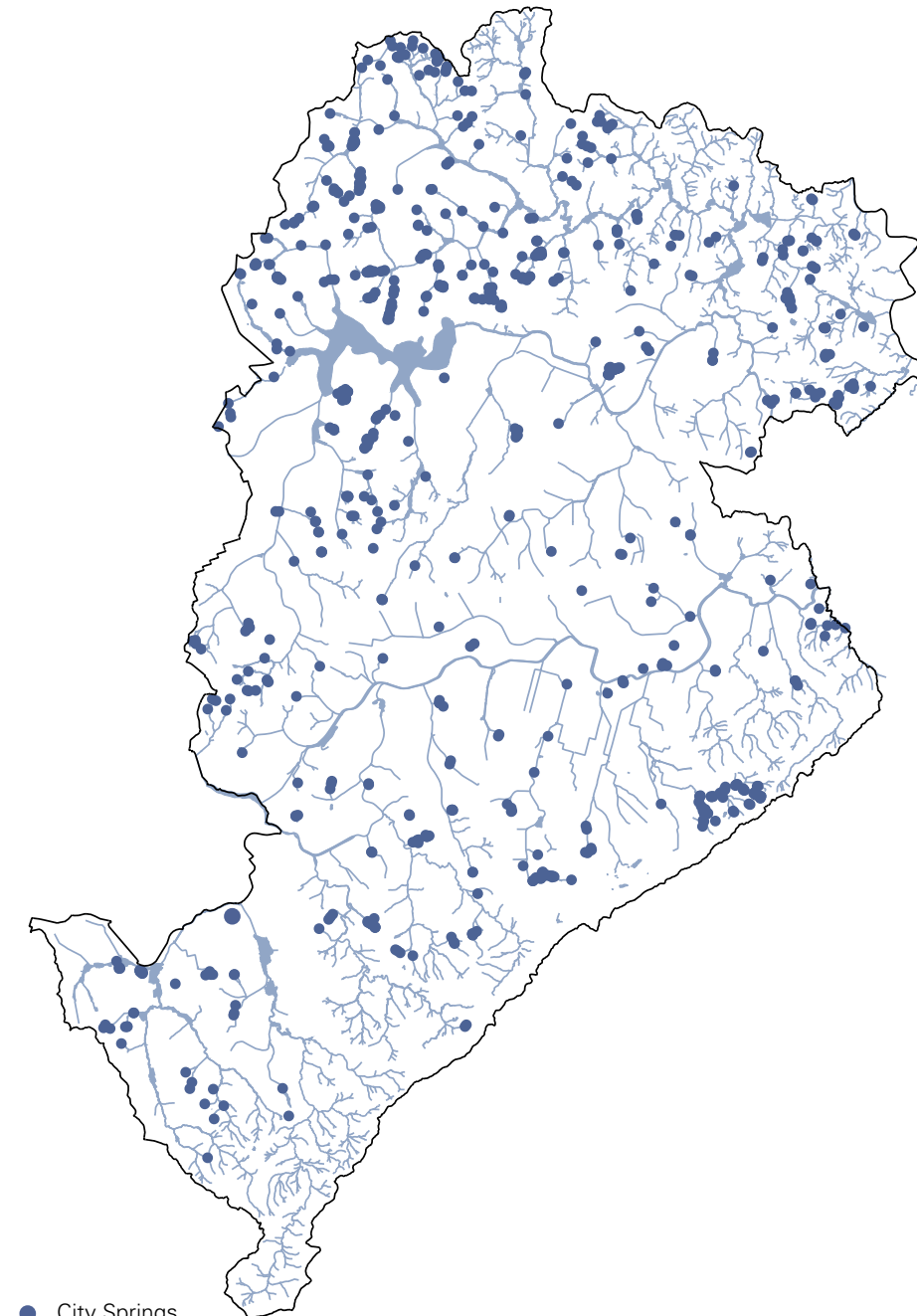
Oversized Basements as Reaction on Water and Topography

The city's groundwater is one of the reasons for the oversized basements of buildings as it makes underground-constructions very expensive. Also, large basements are a common way to deal with the steep slopes. In many apartment and office buildings, the parking area stretches



Springs in the City - Old Time Habit

Originally, there were more than 500 springs inside the city borders. While many have disappeared as their neighbourhoods were urbanized, others, like the "Bica da Petrolina" in the Sagrada Familia neighbourhood, remained accessible for the public after being canalised. Grabbing fresh water at a local well with a 20 or 30 litre storage bottle, for some inhabitants is still part of their daily routine. Believed by some to be healthier than tap water, the water quality of many wells is compromised by pollution caused by waste and by a leaking sewage system.



● City Springs

Abundance of Water - A capillary System

There is a large number of small water lines that run through the city but no big natural water bodies. The capillary system again mirrors the topography of the territory.

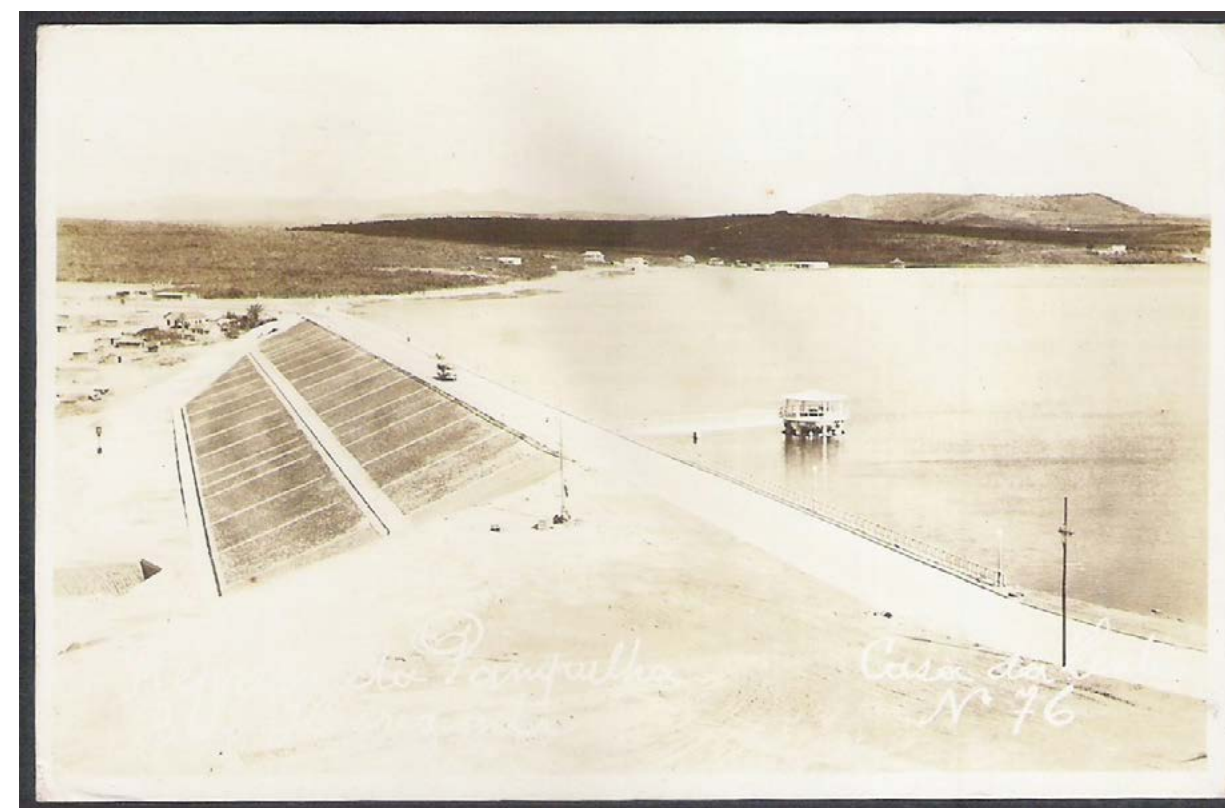




0 10km 20km

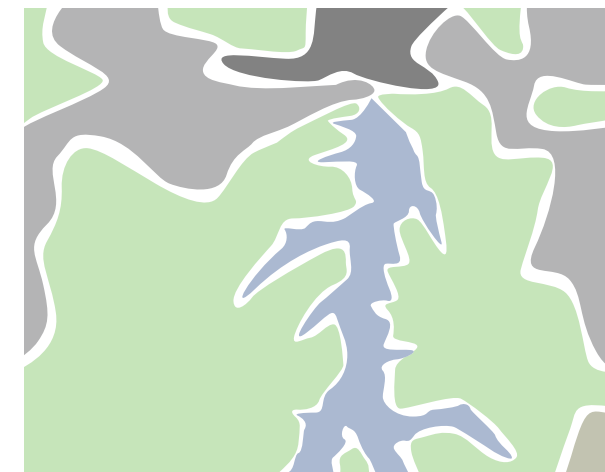
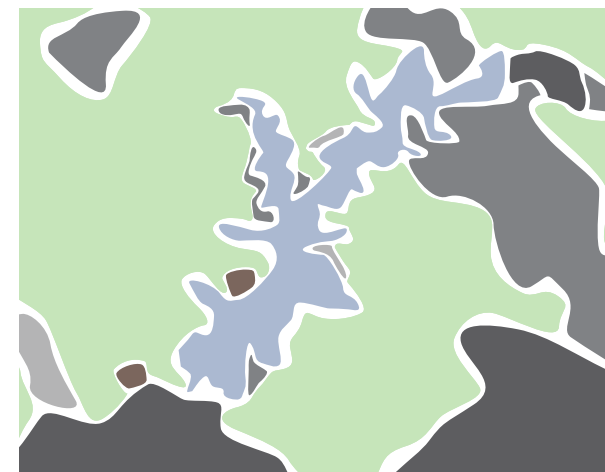
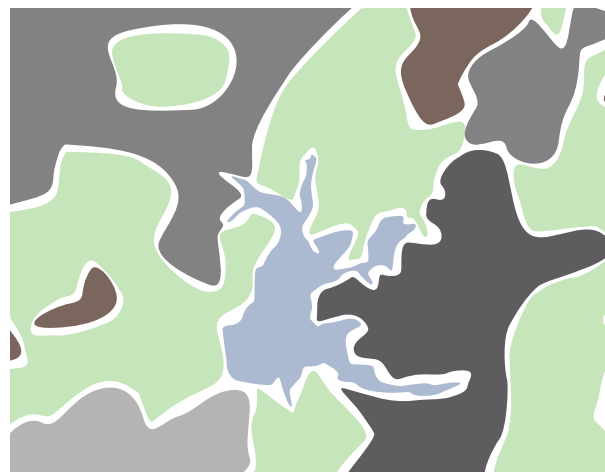
The Represa Type: Water Storage and Buffer

The urge for a steady and continuous water supply, on the background of a capillary water system and the absence of large water bodies close to the city, produced a specific type of water storage. Since the end of the nineteenthirties, fresh water is dammed and stored in artificial lagoons called represas. The forms of the represas represent the region's topography in their ramification and narrowness. While they were planned as part of a technical system, they are at the same time attractors and catalysts for urban development.



1938: The first big Reservoir in Pampulha

In the north of the city core, in Pampulha, the first big dam and artificial lake was planned. The goal was first to retention fresh water and second to solve the problem of flooding in the areas downstream. Later, more of these reservoirs, called represas, were built further away from the city center. Together these sources account for the biggest part of the drinking water in today's supply system.



1 - Pampulha

2 - Ibirité

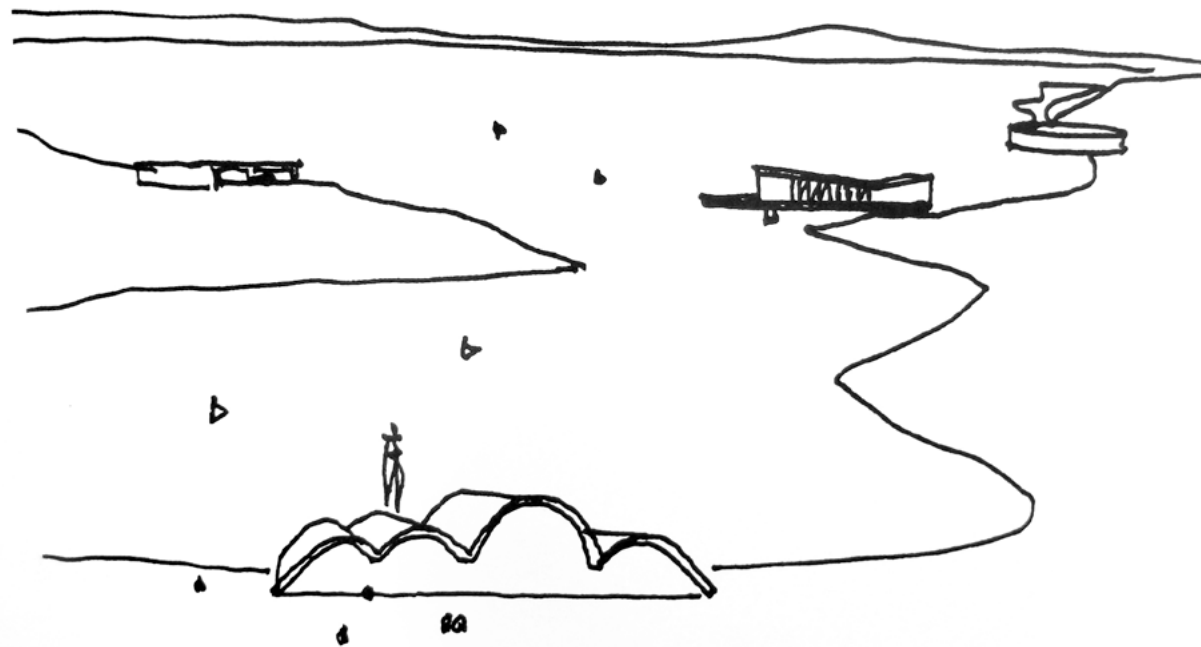
3 - Das Flores

4 - Serra Azul

Different Stages of Urbanisation

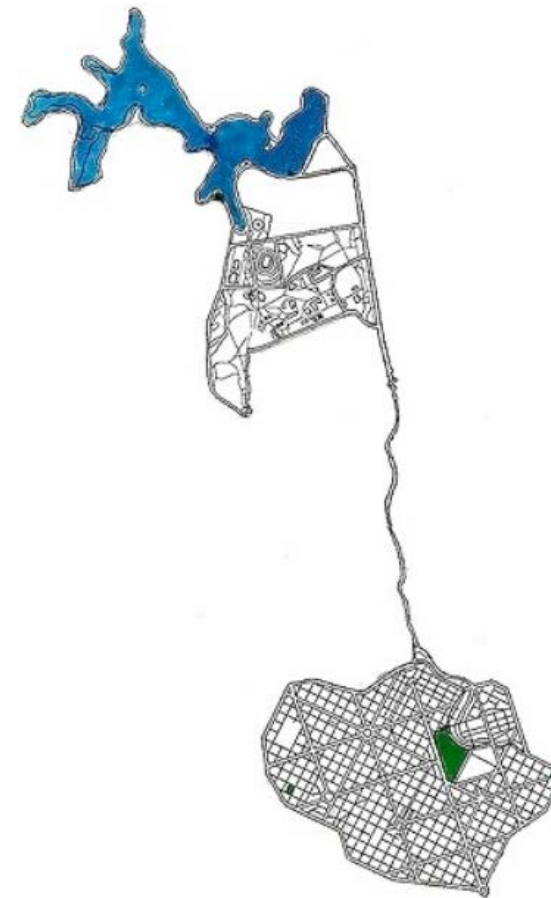
The Pampulha lake (1) is completely embedded in the dense urban structure. Next to the lagoon of Ibirité (2), there are industrial and dense living areas as well as large zones with ongoing developments. While the coastal area of Varzea das Flores (3) is partly occupied, Serra Azul (4) is surrounded by a robust green belt. The grade of urbanization increases with the proximity to the B.H. city core.

- Green Areas
- Dense urbanized Areas
- Loose urbanized Areas
- New Developpments
- Special Areas



Pampulha - The Lake as Stage for a Modernist Park and City Vision

After the completion of the dam, the idea to build a park and satellite city around the lagoon arose in the early forties. Pampulha should be developed into a recreation and tourism destination and into a loose residential area of high living qualities in accordance with modernist ideals and after plans by young Oscar Niemeyer. While the lagoon became very popular as a leisure site, its success led to accelerated urban growth, densification and pollution. Further boosted by new infrastructures such as the football stadium, the UFMG campus and the enlargement of the airport, the region experienced an extensive urbanisation in the following decades. While the prize for growth was the abandonment of the initial park idea, the satellite turned into a new centrality in the urban network of BH.



Park and Satellite in the North

The initial plans for Pampulha projected a leisure area around the lagoon, where citizens could swim, promenade, and enjoy various cultural offerings. Behind the coastal belt, the development of a loose residential area was projected. Along went the enlargement of the connection street from Pampulha to the city center, today Av. Antônio Carlos.



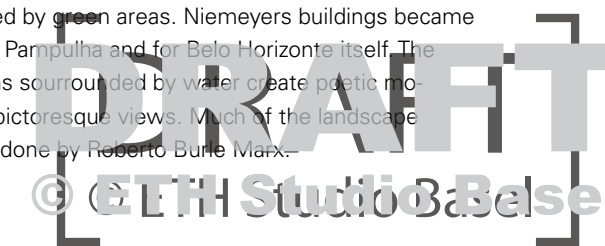
A momentous Friendship

The planning of the important public buildings and of the region's overall layout was mandated to Oscar Niemeyer by then city mayor Juscelino Kubitschek. Later, as president of the nation, he would again commission Niemeyer for the planning of the new capital, Brasília.



Objects, Space and Dialogue with the Water

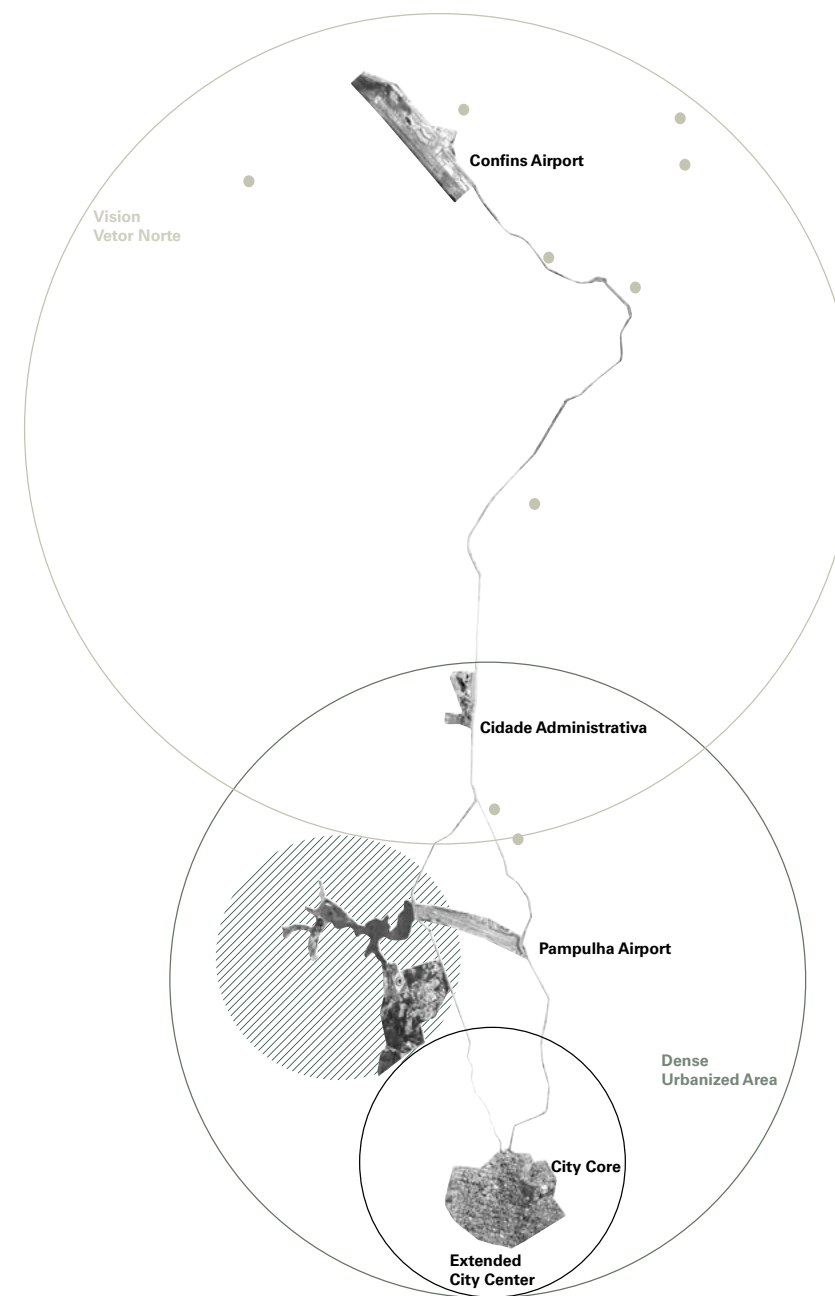
For JK, the proposed modernist architecture and layout should symbolize a fulminant break with the existing city structure. Niemeyer's public buildings are solitaires in a park landscape. The initially planned residential zones are loose and pervaded by green areas. Niemeyer's buildings became the icons of Pampulha and for Belo Horizonte itself. The curved forms surrounded by water create poetic moments and picturesque views. Much of the landscape design was done by Roberto Burle Marx.





From Park to City

Mainly in the seventies, the area around the lake densified rapidly. Eventually, the parallel extension of the historical center turned the former satellite into another part of city. Along with the growth of the city went a decay as a Park. Were the coasts of the lake once crowded by , the urban densification compromised the initial park idea.



Pampulha in the metropolitan Network

For the northern area between Pampulha and the Confins Airport there are huge development visions, summarized as Vektor Norte. They include large projects for housing as well as office and public use. Between the Vektor Norte perimeter and the city center, where still the majority of public functions and urban life takes place, there might be the potencial for a new kind of centrality in Pampulha.

- /// Potential for exclusive Centrality
- Large-scale Development Plans





0 5km 10km

Contemporary Pampulha

Around the lake there still is a belt of loose structures. These privileged areas are very expensive and popular. But these reminders of the park idea are not permeable for the public and don't contribute to an attractive urban space. The border towards the denser backrow is clearly visible.



Destinations - Not a Place to Promenade (1)

Unlike the proximity to the city center might suggest, the coastal area is not a stage for flaneurs. People nowadays, mostly by car, visit specified destinations like the architecture icons or the sports stadium. The area in that sense is not a successful large public space and cannot fulfil the role of a Central Park for the city.



Clubs and Villas (2) - Priviledged slope areas for Privats

Despite the loss of the role as city park, the hillsides in the north and west are very popular for privileged housing. Also, new small-scale condominium developpments are taking place. The built structure is scattered and not dense. Further, many exclusive clubs can be found in this region, e.g. the Rotary Club.



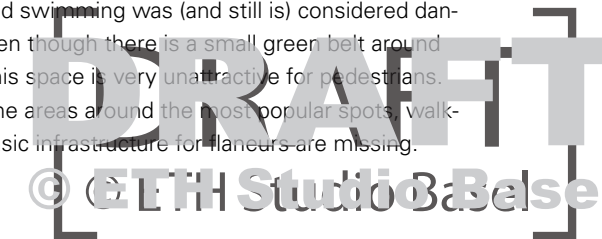
Event Site (3) - Centrality by Programs

While the spacial and environmental qualities don't allow the area to function as a city park, it's a popular site for sport and cultural events and celebrations. The Volta Internacional da Pampulha, a semi-marathon, takes place yearly.



Pollution and Decay (4)

The initially idyllic lake soon experienced heavy pollution, mainly due to the region's missing or lacking sewage system and waste problems. The bad water quality eventually made it impossible to use the represa as source for drinking water and swimming was (and still is) considered dangerous. Even though there is a small green belt around the coast, this space is very unattractive for pedestrians. Except for the areas around the most popular spots, walkways and basic infrastructure for flaneurs are missing.





Varzea das Flores - Appropriation, Protection and Development?

The idea to build the Represa Varzea das Flores was brought up in the 60ties by the municipalities Contagem and Betim. Construction works finished in 1972. The lagoon was later handed over to the state of Minas Gerais and to the then state-owned company Copasa. Its capacities can serve up to 400'000 people with drinking water. Initially, the lake was discovered for leisure activities. Even though large areas are protected, the popularity led to the occupation of parts of the coast by villas, resorts and leisure facilities and further triggered developments in the hinterland. While similarities to Pampulha can be recognized, the urban processes around Varzea das Flores happen on an informal basis.



Weekend Hot Spot

At weekends, the coast of the lagoon is crowded. For people from the nearby cities of Contagem and Betim as well as for tourists from further away it's a very popular destination for spending an afternoon swimming or a night partying and camping. Many Bars are located directly at the coast. The infrastructure is very basic and sometimes even misses sanitary installations. On usual weekdays, the area is calm.



Water as Leisure Magnet

The lake is popular for many sports and leisure activities connected to water. In the country instantly associated with Copacabana, Ipanema and alike, in Minas, inland lakes seem to take over the role of the missing sea.



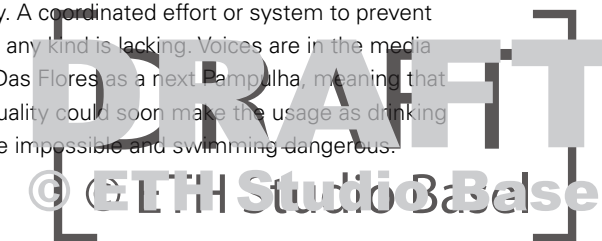
Dirt Race Track

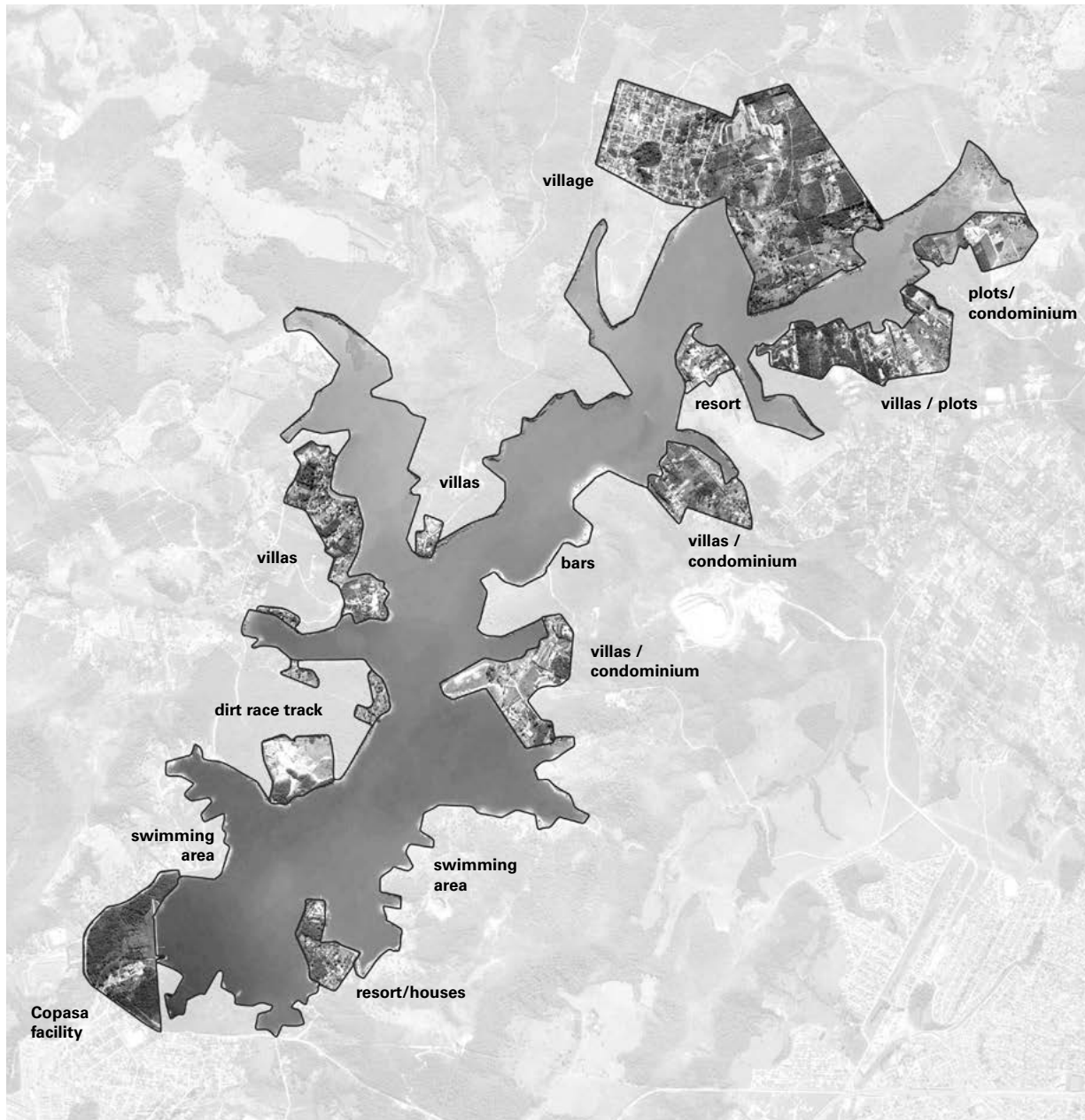
Right at the western shore, embedded in forest, there is a dirt race track. It's not officially indicated and seems to run informally. Traces at the site and fotos on the internet show its popularity.



Numerous Kinds of Pollution

The intensive stress by leisure programs led to a considerable pollution of the coastal areas and to a decrease of the water quality. A coordinated effort or system to prevent pollutions of any kind is lacking. Voices are in the media that foresee Das Flores as a next Pampulha, meaning that bad water quality could soon make the usage as drinking water source impossible and swimming dangerous.





Informal Building

Along the small roads, there are advertisements for parcels offered for sale. These plot was bought by an elderly couple. They are now constructing a small farm house for the time after their retirement. They explained that they didn't have a building permission. In many cases, houses around the lagoon are built without legal admission, often in protected zones. After ten years, it's possible to legalize a building by paying a penalty.



Cat and Mouse Game of Appropriation and Protection

Parcels in areas that are particularly delicate for the environment are bought by Copasa. Workers then dismantle the houses, of which most have been built without permission. As there is no sewerage system in the coastal area and houses in most cases don't have a special sewerage treatment, they heavily pollute groundwater as well as the water of the lagoon.



Protected Area

Some billboards announce that large parts around the lagoon are a Area Proteção Ambiental (APA). But this protection zone isn't marked on any zoning plan of Betim or Contagem neither is the fulfilment of the protection goals coordinated and controlled. Lately, after media echo about growing pollution, there have been meetings by stakeholders (NGOs, Copasa, municipalities, state government) to lift and better implement the protection status.



Back to Nature

Walls of dismantled houses remain as ruins in the woods. Copasa states to try to conserve as much of the delicate area as possible but that they were unable to stop big developments.

Contested Coastline

The attractive coastline is occupied at many places by single villas, groups of holiday houses, resorts and leisure facilities. Many plots are being developed at the moment, among them a couple of condominiums. Only in the north of the lagoon, there is a village like settlement. There is a road along the east coast, where the majority of the developments take place. The west side can only partly be passed by car and is far less developed. Here, some scattered traditional farms can be found.





Local's Perspective: An Unsited site for permanent Residence

Paola, 43:
 She lives here with here family becaus the house, an old farmhouse, belongs to relatives. Taking the single bus to Betim for work is very time consuming. All kinds of infrastructures are poor or missing, e.g. asphalt roads or a grocery store. The family is doing small farming to produce some food basic food at home. On weekends, the lake's coast is overcrowded, loud and visitors are leaving a lot of garbage.



Longterm Observer's Opinion: Missing Will to prevent Pollution

Jairo, 67:
 He is retired and lives in a nearby condominium. He has been fishin in the lake for many years. The water quality is very bad nowadays, which makes fishing more and more difficult and fishes smaller. In his opinion, Copasa is doing way too little to prevent pollution and to clean the coastal areas on a regular basis. Also, the volume of the water has diminished. This observation is confirmed by scientists.



Growth in the Wind Shadow of the Leisure Programs?

While in the immediate area around Varzea das Flores, the developments are numerous but small-scaled, the city of Betim itself experienced a fast growth in the last 20 years. Beneath the ongoing developments, there are large condominiums. The city dynamics and the boom of the leisure site seem to go hand in hand and might even boost each other.



Serra Azul - Protected Reserve and noble Residences

The Represa Serra Azul was constructed until 1982. With a capacity to serve 800'000 people with fresh water, it has the double volume of Varzea das Flores. The water is surrounded by a protected area, covered by forest. The later date of construction as well as the size and importance for the supply system favoured protection efforts. Next to the green belt, there are development areas for noble residences on large plots. While the built structure is still very loose, huge road networks with empty parcels announce that future development is expected.



Effective Green Belt and Wall

The green zone not only prevents development in the coastal area but also works like a barrier. The lake is difficult to reach and even to be seen from the surrounding villages. In addition, scattered farms and meadows surround the lake.



Large Countryside Residences

In lately developed areas there are residences on huge parcels. Most houses are only medium-sized but have big gardens. Entrances and connecting roads are taken care of exquisitely taken care of and show the image of a distinguished country house lifestyle.



Attending Growth - Constructing Infrastructure in Advance

In large areas, road networks have been constructed but a small part of the parcels is already built. Building infrastructures in advance seems to be common. The size and amount of the entities might announce considerable growth but also seem slightly speculative.



The Water Resource as Urban Catalyst

The availability of water in the time of the city foundation decided where settlement could take place. Water as an experienceable element, namely the artificially created represas, can catalyse urbanization processes in their surroundings. While in Pampulha the creation of a new city part was planned, in New Betim, a development on an informal basis is taking place that shows similarities: the boom of leisure activities around water might induce rapid growth. The artificial lake of Alphaville is not used for water supply and was constructed as major quality and marketing element of the condominium.



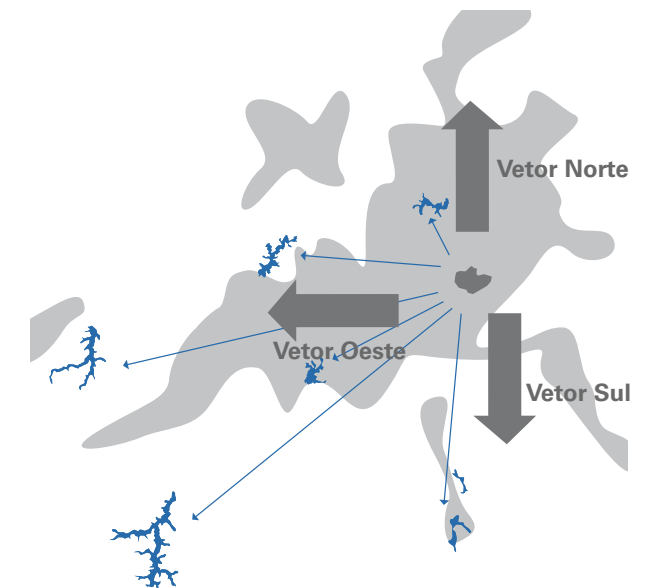
Attraction by the Lakes is stronger than Legal Framework

Next to the coast of Varzea das Flores, there are many parcels offered for sale. Many are in areas without access to sewerage system or even in the protected zone. That means that getting a building permit will be impossible. Still the attraction by the water seems to be stronger than regulations and zoning plans and informal constructing is usual practice.



Waiting for Growth

In Ibirité and Serra Azul, as well as in other locations close to water bodies, there are big areas with road networks and basic infrastructures around yet unbuilt parcels. The big number well as the huge size of some sites show that urban growth and development is expected in those regions. Some projects on the other hand seem speculative, their sites looking abandoned.



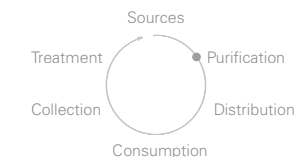
Water Lifestyle - A Vetor Agua?

Migration movements away from the city center towards the periphery have strongly influenced urbanization processes over the past years. An important reason for emigration is the wish to live closer to the nature in a loose urbanized area. The official planning of the RMBH anticipates a city extension along three vectors: towards the airport Confins in the north, in Nova Lima in the south and in Betim / Contagem in the west. The artificial lakes show how water can act as a magnet for urban growth. The question arises if besides the official promoting, there is a "vetor agua", meaning that water has a specific role as a magnet in the migration and city extension processes.

THE NATURE OF THE SUPPLY SYSTEM

The complex topography of the territory is a challenge to the distribution of fresh water. Following the circuit from the purification to the domestic consumer reveals a well elaborated supply system. Its components rank from technically simple facilities and tanks to high tech steering mechanisms. - And from towers that are landmarks to an invisible controlling network. The whole process is managed by the semi-privat company Copasa.





Steps in the Purification Process

Water from the lagoon is visibly polluted (1). After adding chemicals, concentrate and can be removed by skimming (2). The water is then run through a next filter (3). Water that is used for cleaning and that gets polluted during purification is currently released without treatment into the stream (4). An additional filter for cleaning it is projected to.



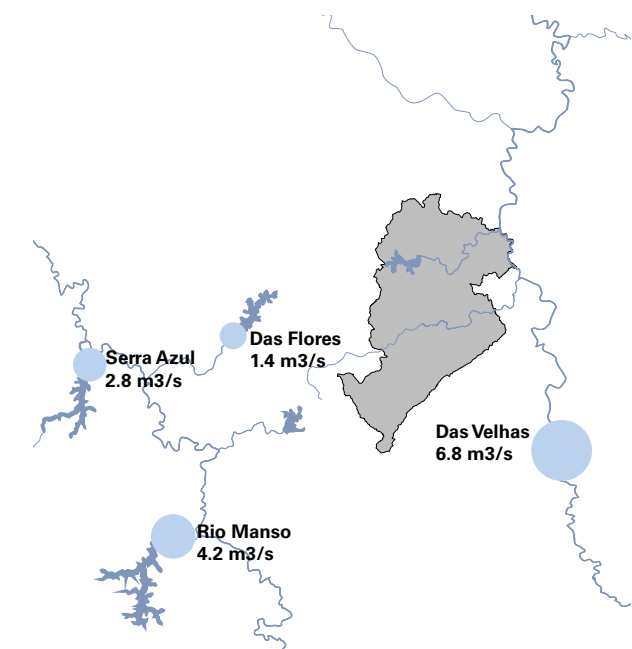
Rio das Velhas - The Old River

The das Velhas River is the most important fresh water source in BH. Visiting the river before and after the purification facility reveals that the amount of water taken out is very big compared to the size of the river.



Making water Drinkable: An old but established Technology

The different steps in the purification process at the Copasa Facility at Varzea das Flores reveal an old but established process. While the quality of the purified water almost reaches standards of modern European system, the cleaning process requires the addition of chemicals that - if not properly disposed - themselves pollute the downstream river. Four big facilities make up for the biggest part of the supply water of the Metropolitan Region.



The main Fresh Water Sources

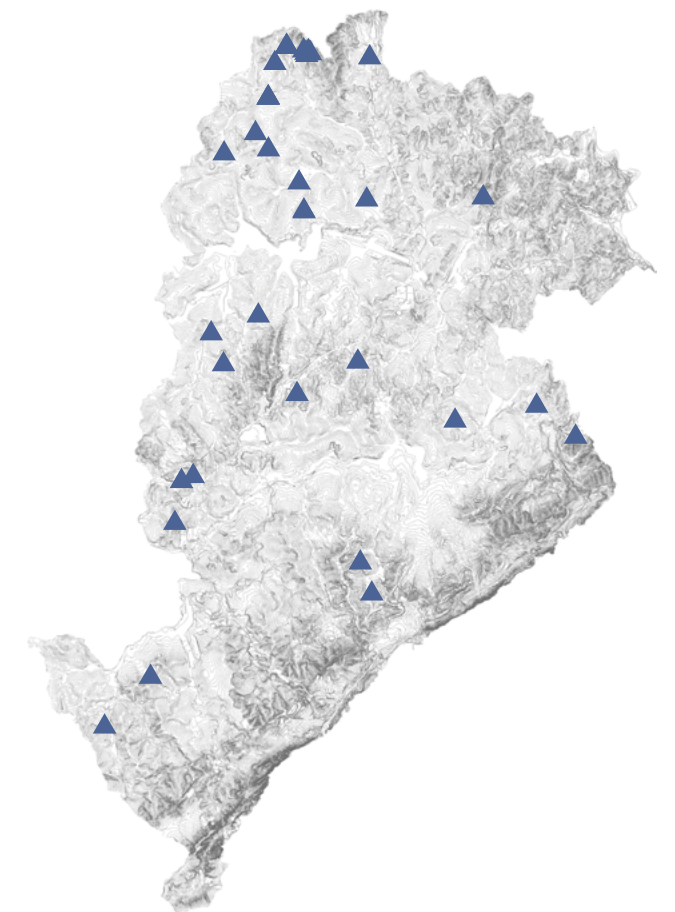
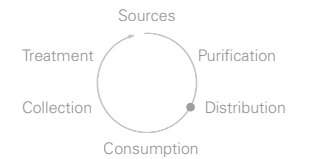
The three represas Rio Manso, Serra Azul and Das Flores together account for 55% of the drinking water supply. Capacities are planned to be raised up to 21 m³/s until 2030, to be able to supply enough water for the growing population. According to Copasa, at least for the next decades, the supply capacities are sufficient. After the planned upgrading of the systems though, the system will use the maximum available by the water bodies.





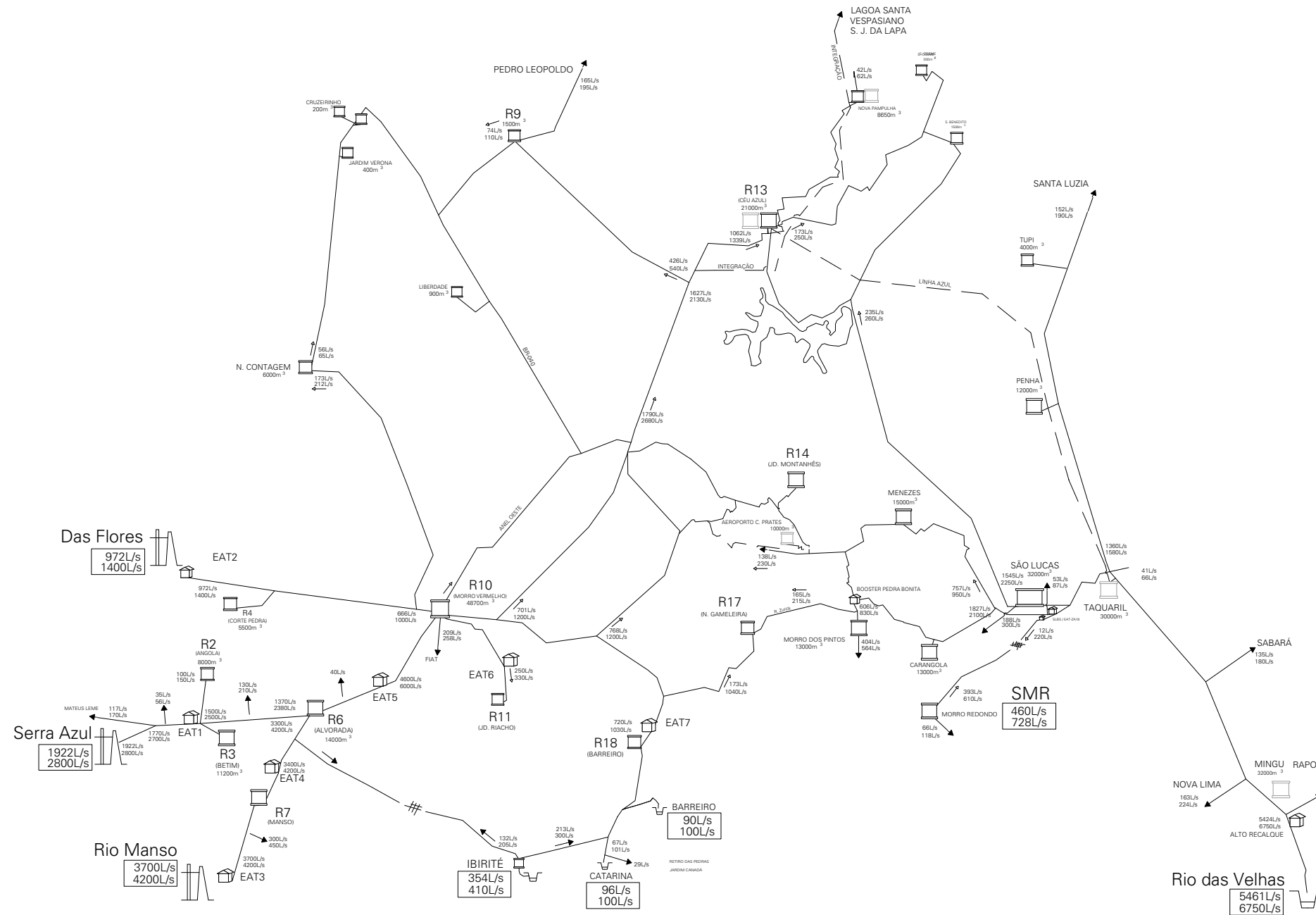
Overcoming the Topography

The distribution system of the water supply reacts on the mountainous landscape. Water is pumped upwards to cisterns situated on mountain ridges. From these intermediate buffers, it reaches the households by gravity. Cisterns are located all over the city. Besides the watertowers, a mostly invisible but smart network system allows for a flexible distribution despite of the separation of the different consumers by topographic barriers.

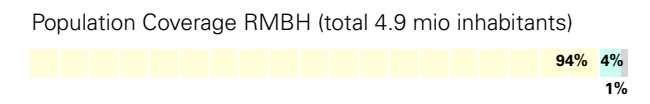
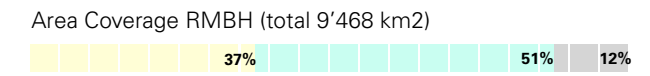


Towers along the Mountain Ridges

The cisterns are distributed along the numerous hill ridges of the complex topography. They can be seen all over the city and in the neighbouring municipalities that are as well connected to the supply system. They are specific landmarks in the topography.



- Integrated System Copasa
- Independant Systems Copasa
- Systems by Others



An Integrated System with a Large Coverage

The supply system not only covers the city of Belo Horizonte but the biggest parts of the metropolitan region. The system is operated by the semi-privat company Copasa that is also commissioned to operate smaller independant systems in bordering towns, e.g. Brumadinho.

Smart Invisible Network

The distribution is regulated by an elaborated system of pipelines, pumps and buffers. Its operated and controlled by highly modern technologies. The integrated system allows most destinations to be served by various sources.





Water Consumption

To be able to run the distribution system without additional pumping, fresh water is buffered in tanks on the rooftop of each building. Thus pressure imbalances can be compensated and the gravity is sufficient to bring it water from the cisternas to the final consumer. The tanks are very present in the urban landscape of Belo Horizonte. Fresh water reaches almost all inhabitants of the city and the quality is good.



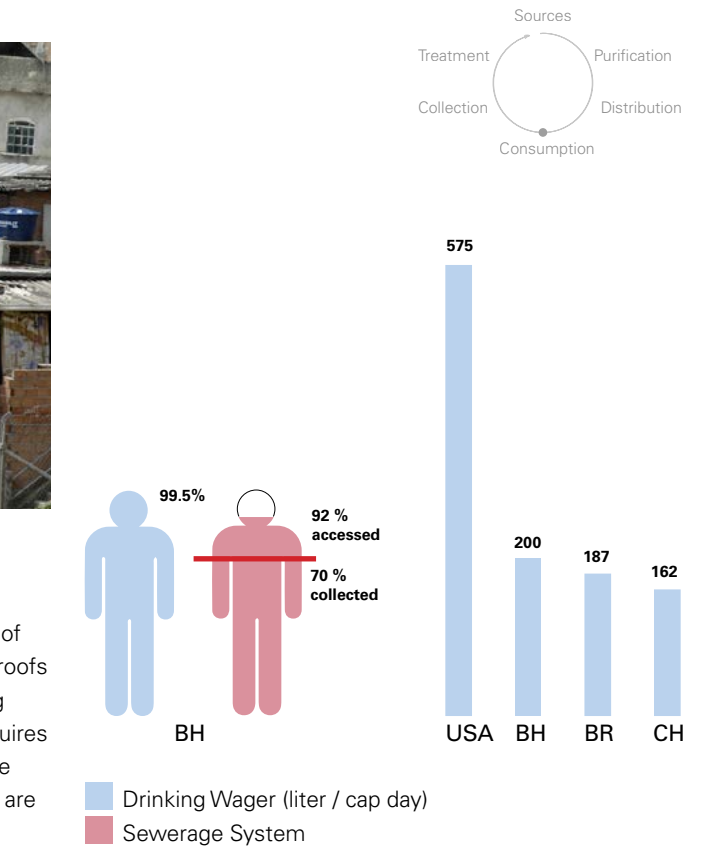
Home Storage and Filtering

Fresh water doesn't come to the tap directly from the distribution system but is stored in private tanks on top of the roofs. Tanks in all sort of sizes can be seen on the roofs of B.H., ranking from barrels in favelas to whole building storeys in apartment houses. This buffer system requires the water to be filtered from bacteria once more before consumption. Small and relatively inexpensive devices are installed for home filtering.



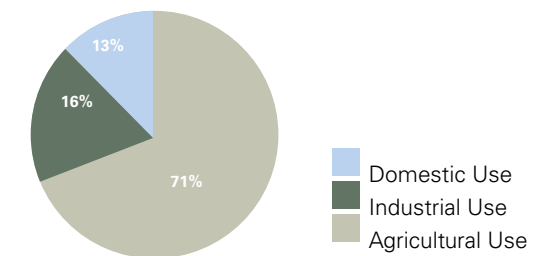
Informal Tapping and Social Tariff

In favelas, the distribution often doesn't reach each individual household. Instead, one official distribution pipe is tapped by many recipients at the same time, creating an informal fork system. The billing then is organized by the inhabitants themselves. In other cases, pipes are tapped illegally. Around 500'000 households profit by a social tariff system for water supply, around 300'000 for sewerage.



Water Access and Daily Consumption

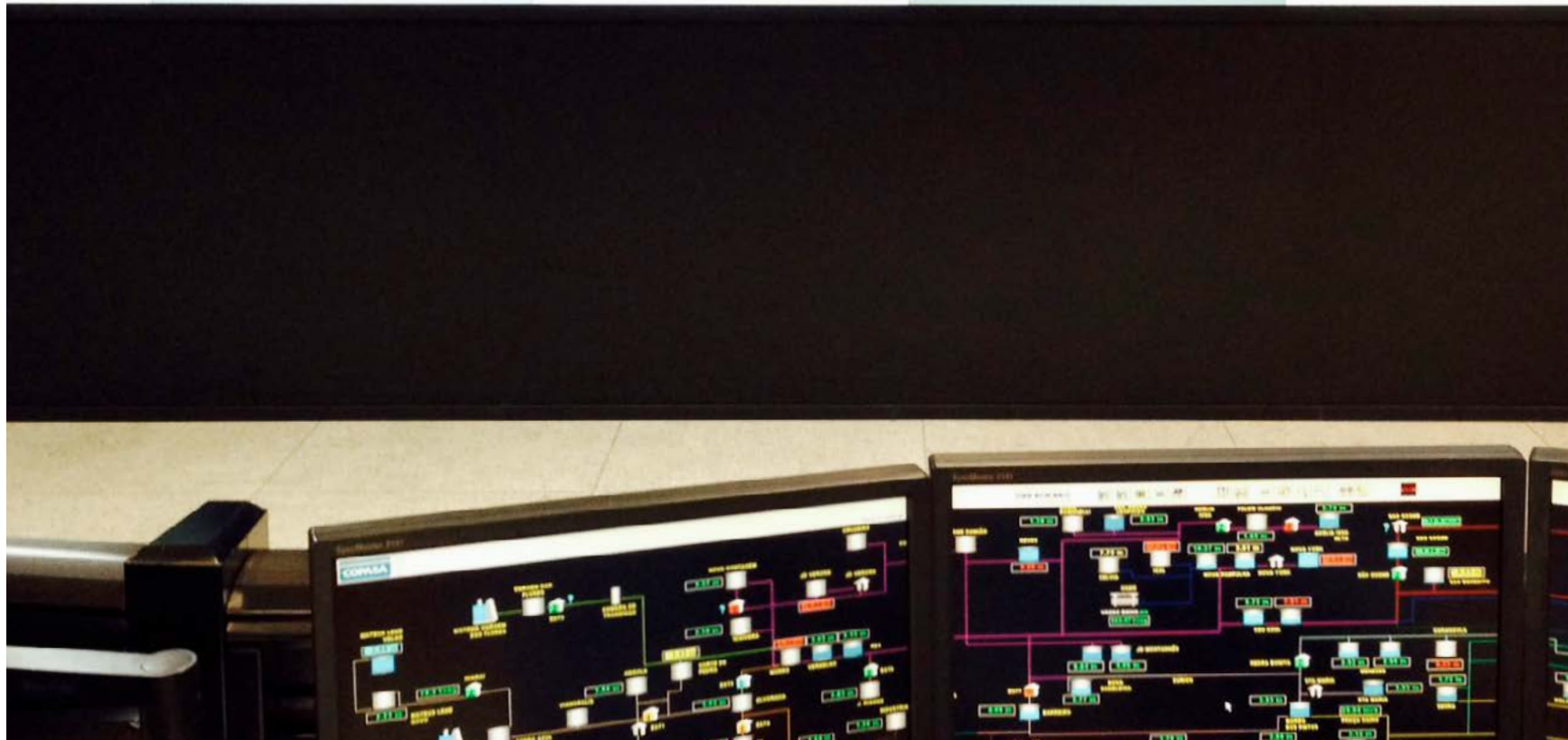
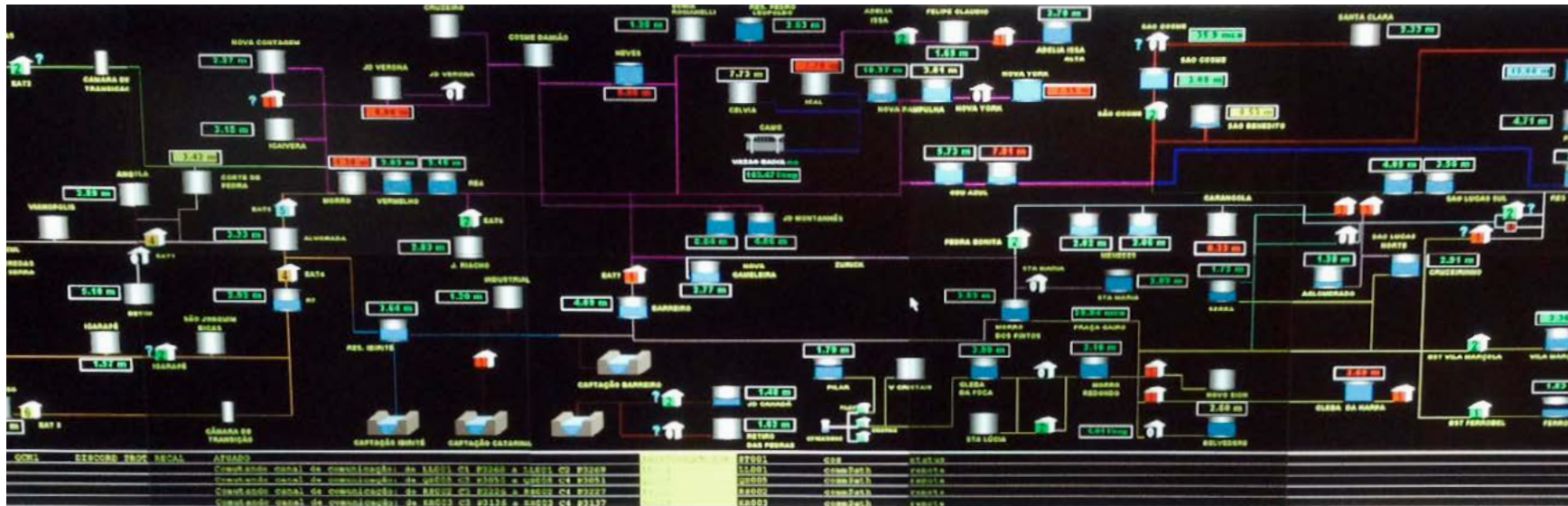
Following official statistics, access to drinking water is granted to almost all people of the city. Sewerage system on the other hand reaches 92% of the population. This hardly contrast with the amount of sewage water effectively collected. The difference of 22% is lost. The overall daily water consumption in B.H. is slightly higher than in whole Brazil.



Where the Water goes

Domestic consumption only makes up for 13% of the overall water usage. Major consumer with over 70% to 65% is the agriculture, its share presumably sinking in the upcoming years.





Between High Tech and Adaptation - A well controlled System

The supply system's control center at Copasa reveals a high technical standard and flexible regulation options. Besides modern technology, the system is also characterized by a longtime adaptation towards the territorial challenges, being the complex topography as well as the multiplicity of small sources. The system works very well, an important reason being that it's coordinated by one single powerful actor.

A single big Actor - Copasa

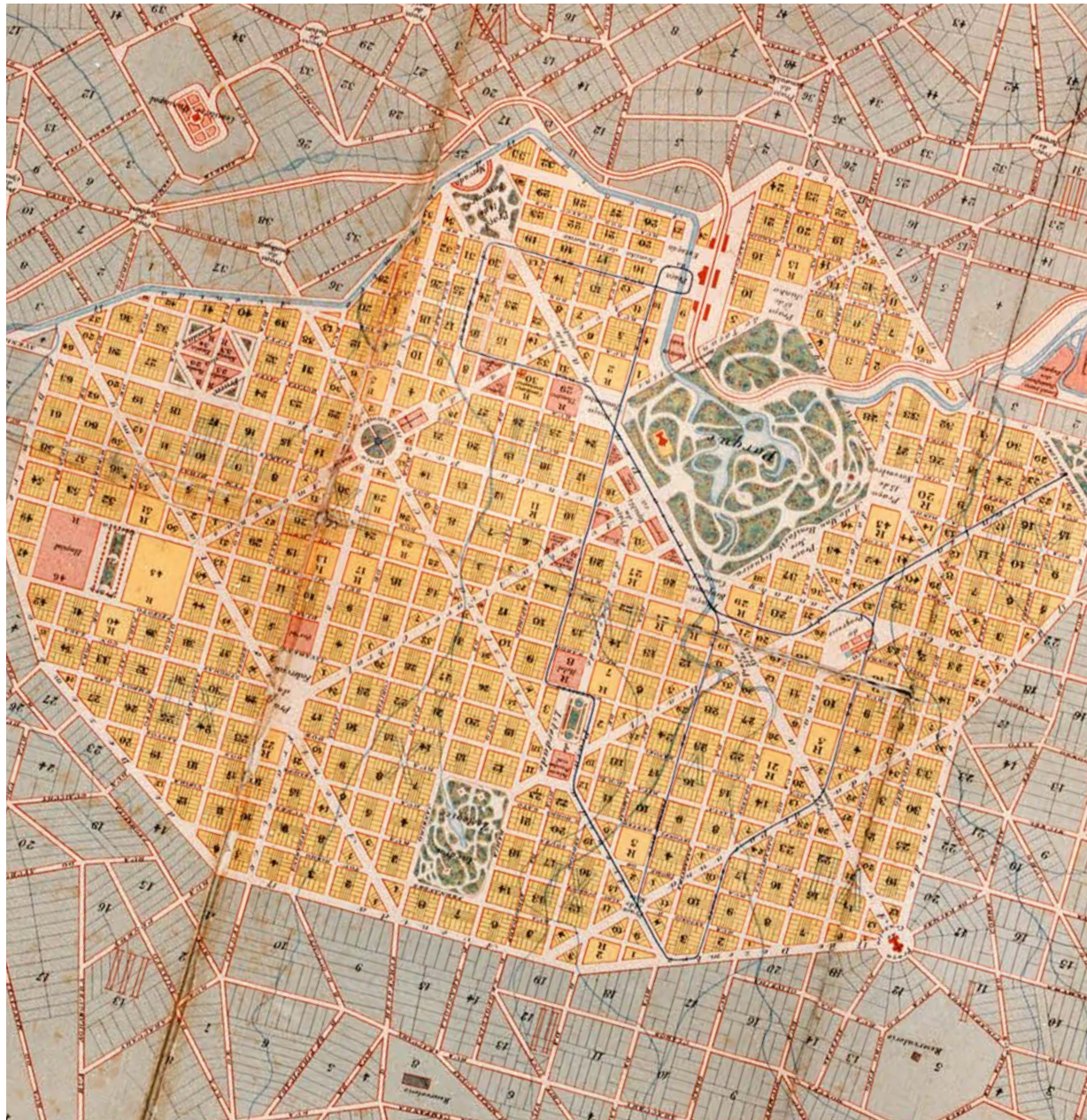
The supply system almost all municipalities in the B.H. metropolitan region and is operated by Copasa. Copasa was founded as state company in the time of the military dictatorship. Only in 2006 followed a part privatization with - at least theoretically - leaving the state of Minas Gerais the major control over the company. The public heritage makes Copasa a monopolist in the water business. At the same time, the coordination of the whole system lies in one hand and seems well coordinated.



HOW THE CITY SHAPES WATER

By generating the urban forms or project design elements, water affects the aesthetic quality of visual representation of the city's silhouette – urban matrix, it provides a course for future expansion, by its macro-spaces it defines the functionality and space size. Regarding the micro-plan, in urban plan or within physical structures as ambience units, water completely defines the visual character and ambient quality. Morphology (Greek morphé: shape) of urban space, as a field of built space, depending on the presence of water, endeavors to explain the nature of the “form” of a city.





Negating and Hiding the natural Water Courses

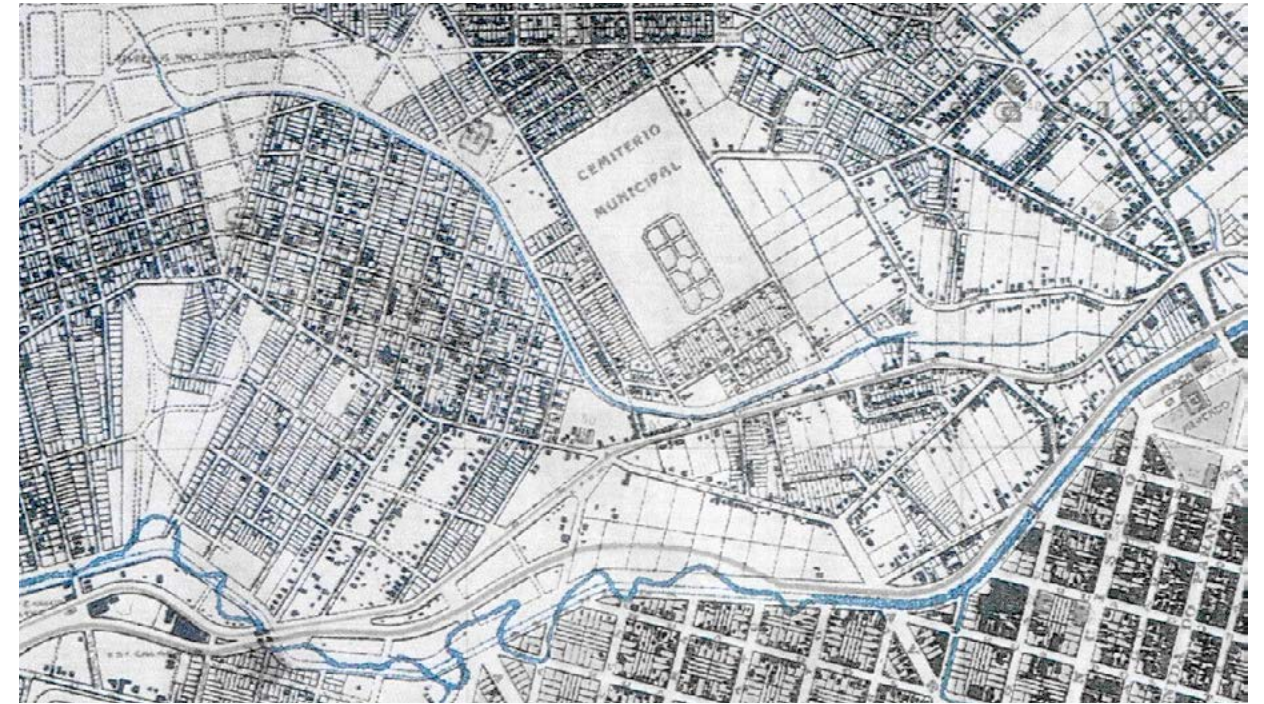
The Masterplan from 1893 reveals impressively how the artificial grid negates the existing natural waterways and topography of the territory. Most of the city's worldwide are on the opposite classified as geometrically irregular. Presence of water often disturbs the geometric austerity, which gives particular attraction to cities. Belo Horizonte was planned totally geometrically regular by hiding the water in the grid.



Engineered Waterways in the City Grid

The natural watercourses are pressed under the surface. Only at the central city park, water is used as a visible and experientiable element in the public space.





The Domestication of the Water

The Rio Arrudas as the most important water transport artery in that region gets tamed and canaled in 1923. For establishing an urban environment the whole region gets engineered with infrastructure buildings. Urban water has a significant aesthetic potential for an urban area, for instance by open views over water ways combined with the dreary traffic infrastructure. The visible water in the city forms a public space.

Lined Creek Rio Arrudas

The plan shows how the former natural water course of the Rio Arrudas was engineered into the city grid.





Creek Typologies

Water in the contemporary Belo Horizonte means a complex network of artificial water ways of different sizes and functions. Due to the topography the most important water way - the west-east flowing Rio Arrudas creek collects all the stormwater and sewage from the city center.

The creek of the Rio Arrudas occurs in different stages of engineered structures. In the outer districts of the city it's a mixture of soil and stone (A) before it changes to a concrete shell closer to the city center (B). In the highly densed center the increased volume capacity structure gets supported by reinforced concrete beams (C) and partially disappears in the underground in favor of road widening measures (D).

- stormwater, open
- stormwater, covered and visible
- stormwater, covered and invisible
- natural creek



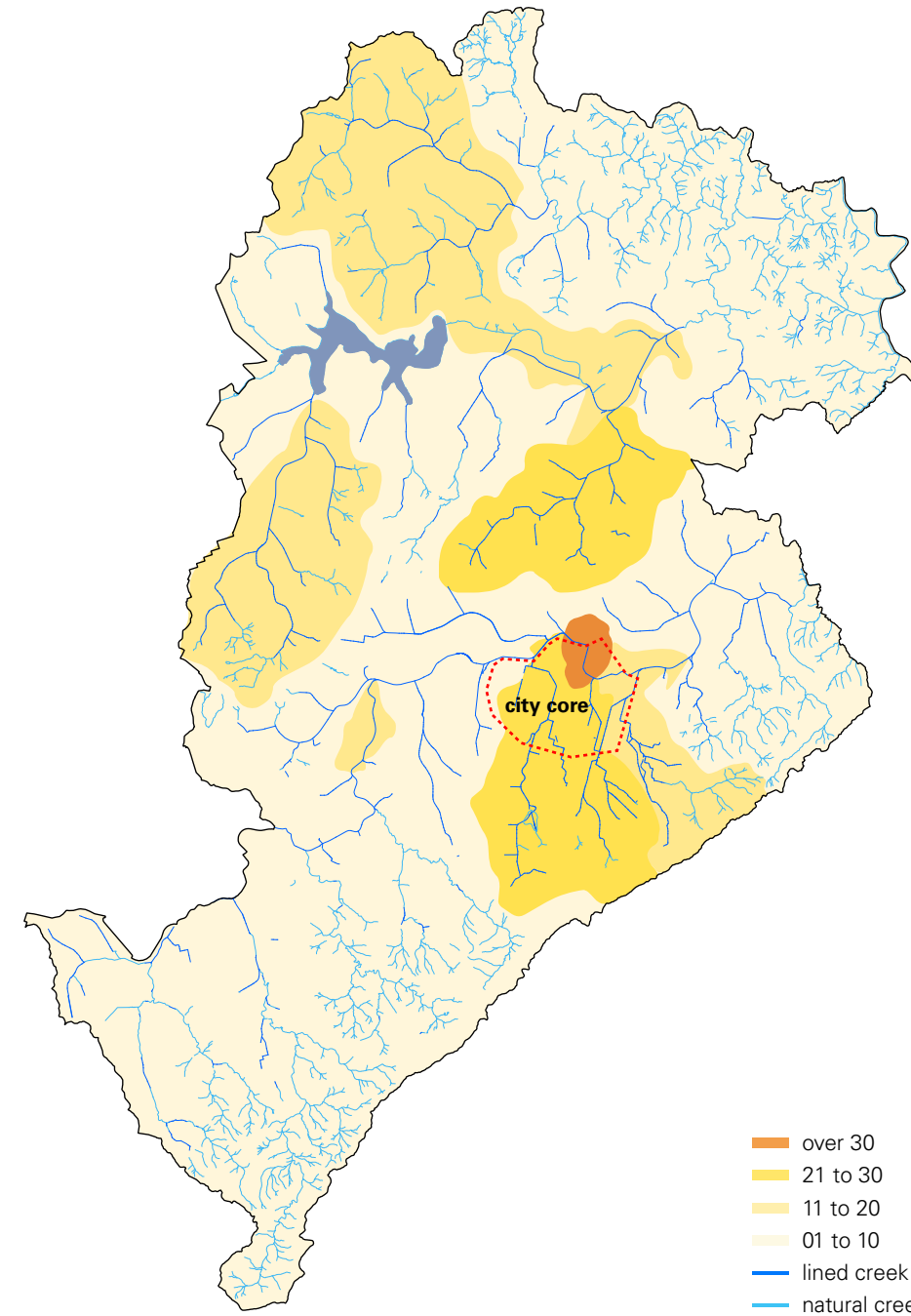
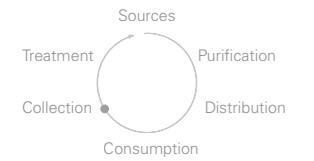
Lined Creeks and Stormwater

The lining of the canals increased risk of flooding massively. Floods occurs on a regular basis.



Risk Areas and Informal Settlements

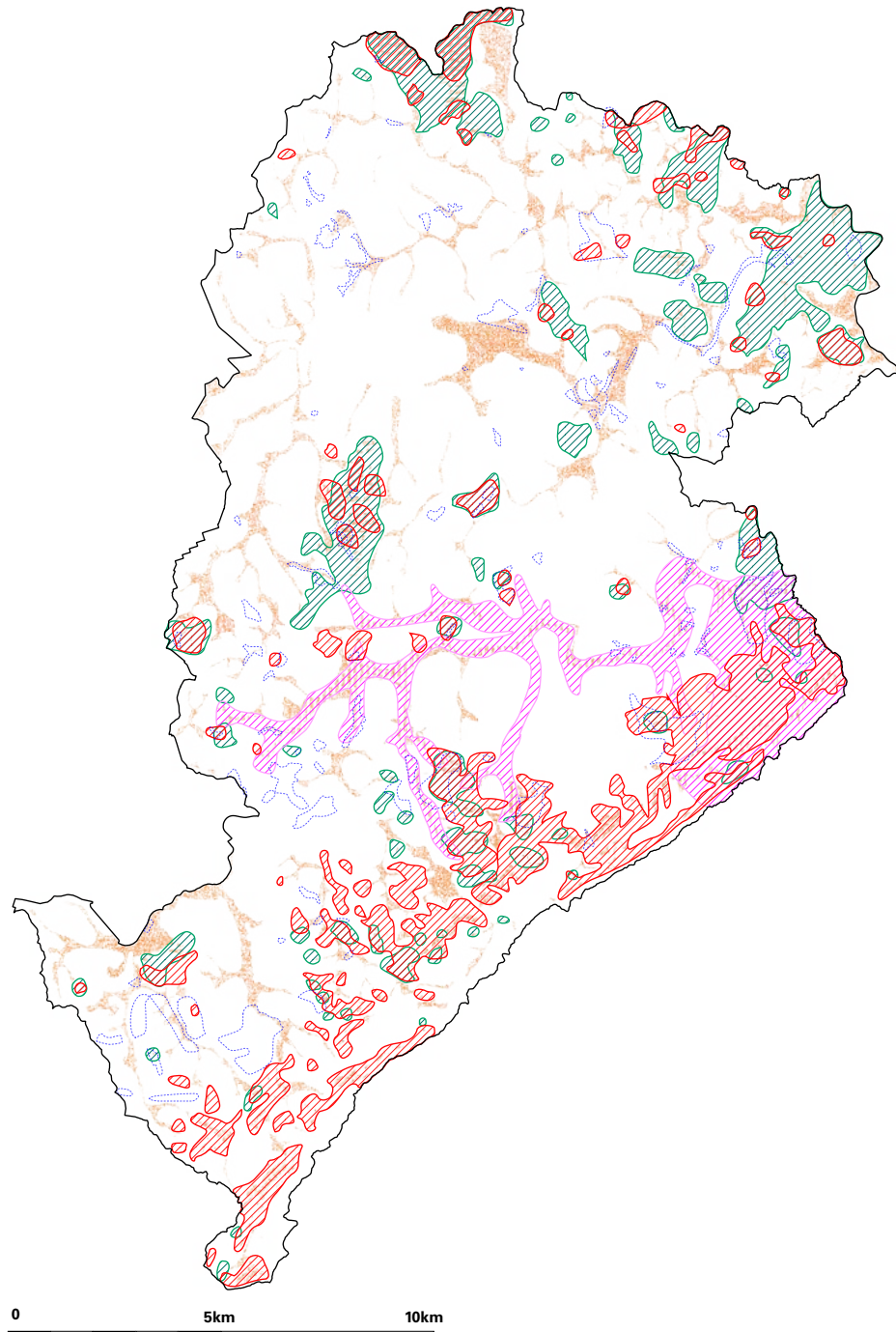
Buffer areas for floods are getting rapidly occupied in Belo Horizonte by informal settlements which leads to sealed grounds and reduces stormwater compensation space. This phenomenon in the outer districts again increases the pressure on the stormwater canals in the city center.



0 5km 10km

Flood Frequency

Every region of the city were affected by floods in the periode of 1922 to 2002.



Urban Risks

Besides the floods there are more urban risks like erosion, landslide on steep slopes and above former mines. The Risk areas coincidence with the areas of informal settlement.

- █ favela area
- █ landslide mining
- █ landslide
- █ erosion
- █ groundwater contamination



Informal City Growth on steep Slopes

The typically Brazilian informal settlements Favela on steep slopes live with the danger of large scale landslides especially during the rainy season.



Pampulha: Ecological Park on the re-gained Area

The Ecological Park was built directly on the sediment area and provides eco-education for school classes.

Water Volume Loss due to Sedimentation

The massive entry of sediments from the catchment has led to a strong reduction of the storage capacity of Pampulha as well as of other represas. The annual entry of sediments is estimated to be at least 200,000 to 400,000 m³. The estimates show that in the years 1957 - 1999 were registered almost 2 million sediment - 1994 a total of 8.8 million m³ and 1994. Thus, a reduction in the storage capacity of 18.1 million m³ originally by more than 8.5 million m³ (47%) had taken place.

The main source of sediments are barren soils, which form a significant proportion of area in the catchment. The erosion- induced sedimentation is considered to be the biggest problem of the Lagoa da Pampulha, since the preservation of the water storage capacity is urgently needed and it is therefore necessary to remove the sediments are carried out at great expense.



Capacity Reduction

A representation of changes over the last decades on the lake basin due to permanent fillment with sediments.



Installation of a new Sediment Filter System

The recent strategy for prevent from future lake fillment is a natural filter system which allows to carry out the sediment when its entering the area.

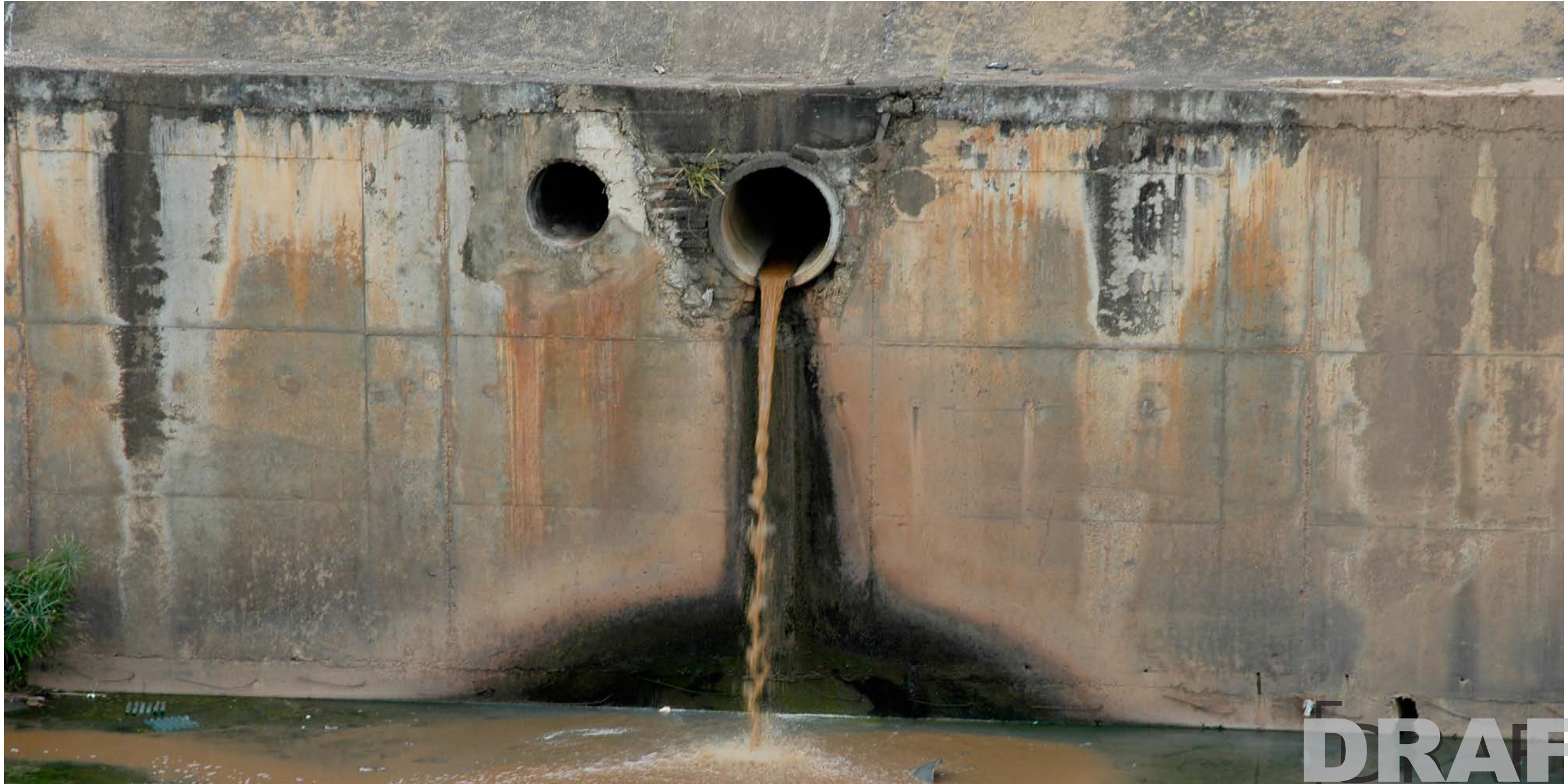


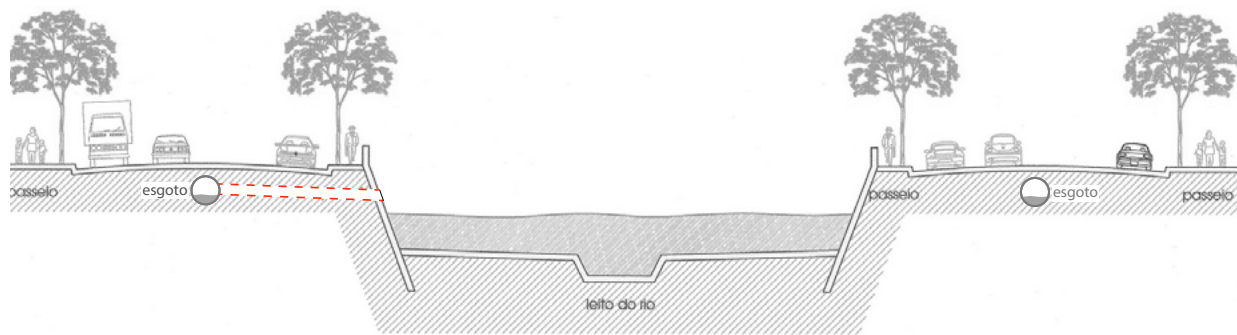
Banning Water from Urban Space

The former rivers gets hidden and pressed into the artificial city grid but they are far from gone. It is very hard to stop a river from flowing, so they have merely been diverted into the sewer system. To deal with water as an urban element in Belo Horizonte means to negate and hide their appearance.

THE DIFFERENT LEVELS OF WATER TREATMENT

Before 1963, Minas Gerais didn't have a sanitation policy and Water and Sewerage Municipal Departments were in charge of water supply and sanitation. Conditions of water supply and sewerage were not very good. In 1974 the foundation of a new company takes place the "Minas Gerais Sanitation Company" or COPASA is responsible for water treatment, a mixed company, in which state of Minas Gerais is the major shareholder, for drinking water and sanitation. COPASA has a quasi monopole in Minas Gerais, where water supply and wastewater are municipal matters.



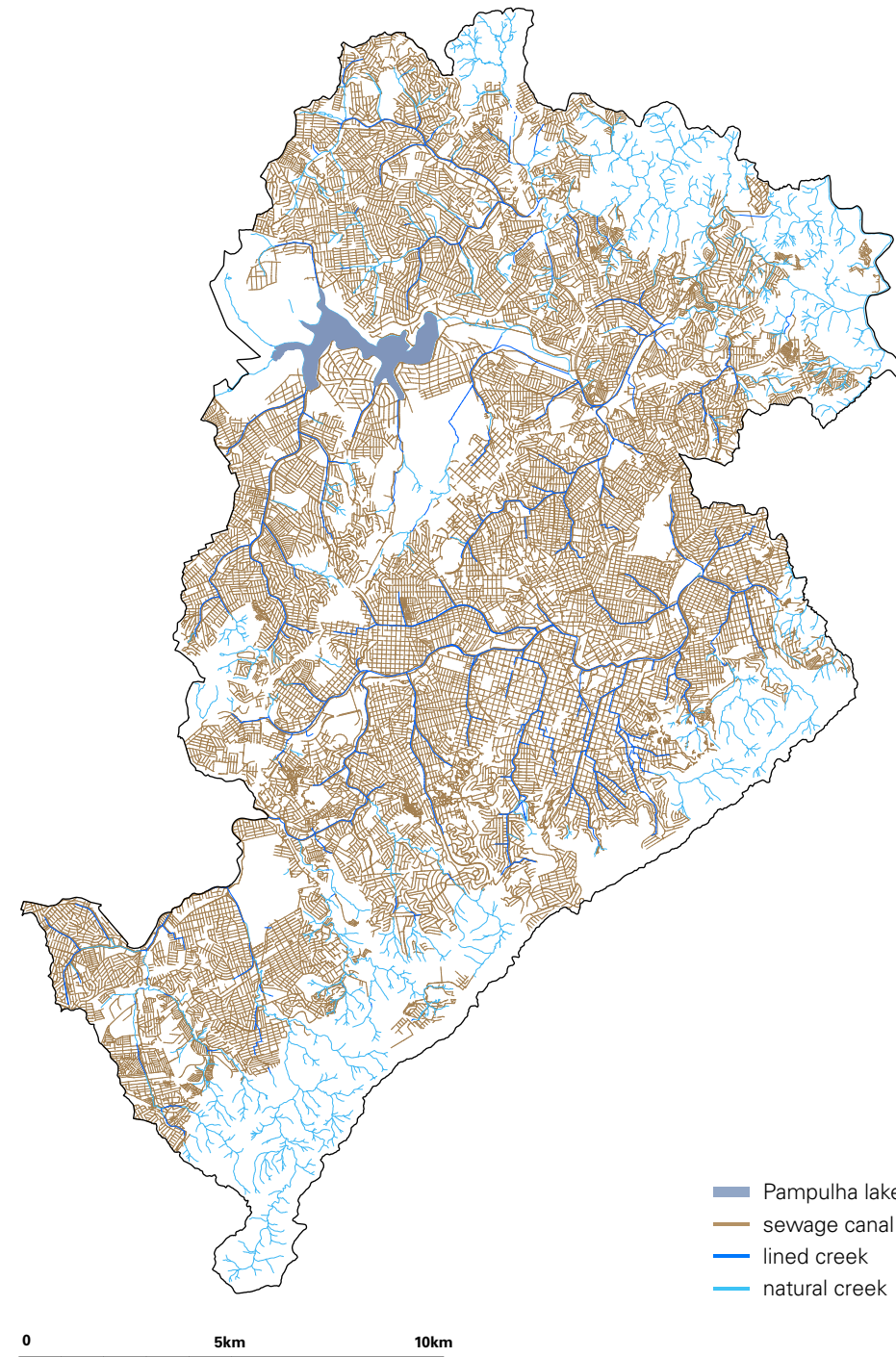


Stormwater and Sewage - a separated System?

Conventional sewerage is also termed deep sewerage because the sewerage pipes are laid deep beneath the ground. The larger the population served by the sewerage system, and the longer the planning horizon is to cope with future population increases, the larger the diameter of the final pipes becomes. The costs of the pipes, inspection manholes, pumps and pumping stations and their construction/ installation are therefore high. The costs of operation and maintenance are correspondingly high because of very conservative design assumptions.

Stormwater flows through the landscape's natural drainage system. Piped stormwater collection was a development in European cities to overcome odour and improve aesthetic appearance of wastewater disposed with stormwater. The covering of ditches used for combined sewerage was an intermediate step in using natural drainage to construct sewerage for combined wastewater and stormwater. Piped sewerage also allows more land area for road and footpaths. With the separate collection of wastewater there is an opportunity to return some stormwater flow path to its more natural state to improve urban amenity value.

In Belo Horizonte the system is separated - at least theoretically - because of missing links and un-connected informal and formal settlement areas there is still a huge percentage of sewage water flowing directly into the stormwater creeks.



- Pampulha lake
- sewage canal
- lined creek
- natural creek

City Sewage System

This map shows impressively the areas without any sewerage system like the region around the Pampulha lake and on the slopes of the hills where the Favelas are located.



**PREFEITURA
BELO HORIZONTE**

The Stormwater Authority

The Prefeitura of Belo Horizonte is responsible for the stormwater management of the city. In general Belo Horizonte has a separate stormwater drainage system. There are some 700 km of perennial creeks in the municipal area. Parts of these creeks have been lined to the extent of nearly 200 km, most of them as culvert concrete channel.

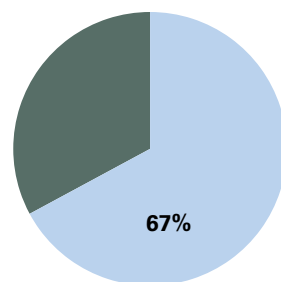


A água de Minas

The Supply and Sanitation Company

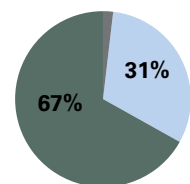
COPASA produce more than 230 million cubic meter drinking water per year, but only 65% are consumed and 35% represented losses. It is a better efficiency than in other places in Brazil (e.g. 60% of losses in Rio) but it could be improved.

The situation is more complicated for the wastewater: only 61% of the produced volume was collected and only 40% was treated in 2009. To improve this situation, a new treatment plant was built in 2010 and should permit to treat the totality of the collected volume. To conclude, COPASA in Belo Horizonte has, for the moment, no particular problem of water supply but there are some future challenges: to reduce losses of drinking water, to improve customer service and to modernize operating systems.



operat. revenues
2'768 mio Reais

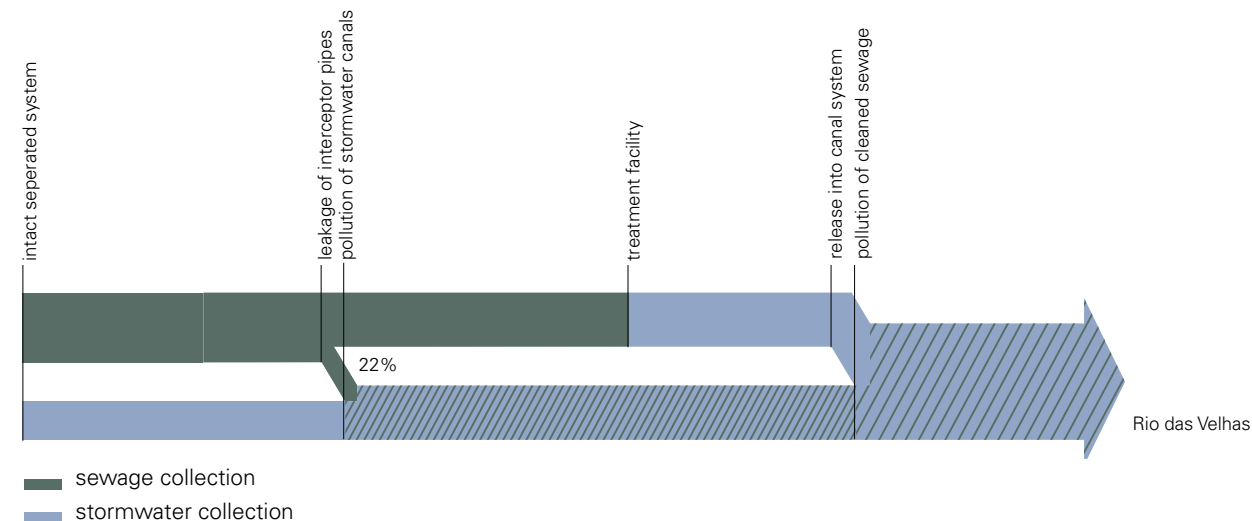
- sewerage
- fresh water
- others



investments
754 mio Reais

Profitable supply, less interesting Sewage System

Regarding Copasas operational revenue numbers published on the company's website, the supply system accounts for two thirds, the sewage branch of the company accounts for one third. The investment side shows an exactly opposite picture: One third of the investments is spent for supply system improvements, two thirds into the sewage system.



Sewage System Losses

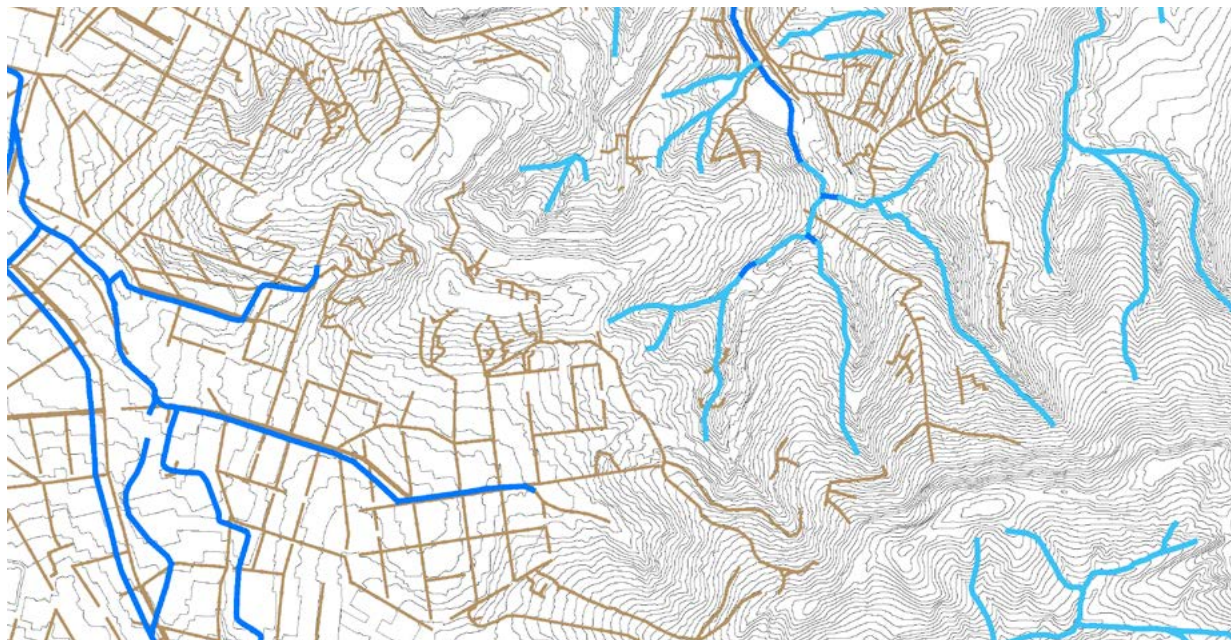
The bad state of affairs of the not lucrative stormwater management in the responsibility of the city government on the one hand side and the highly profitable sanitation business on the other hand side is visible in the city.





ZoomIn - Pampulha

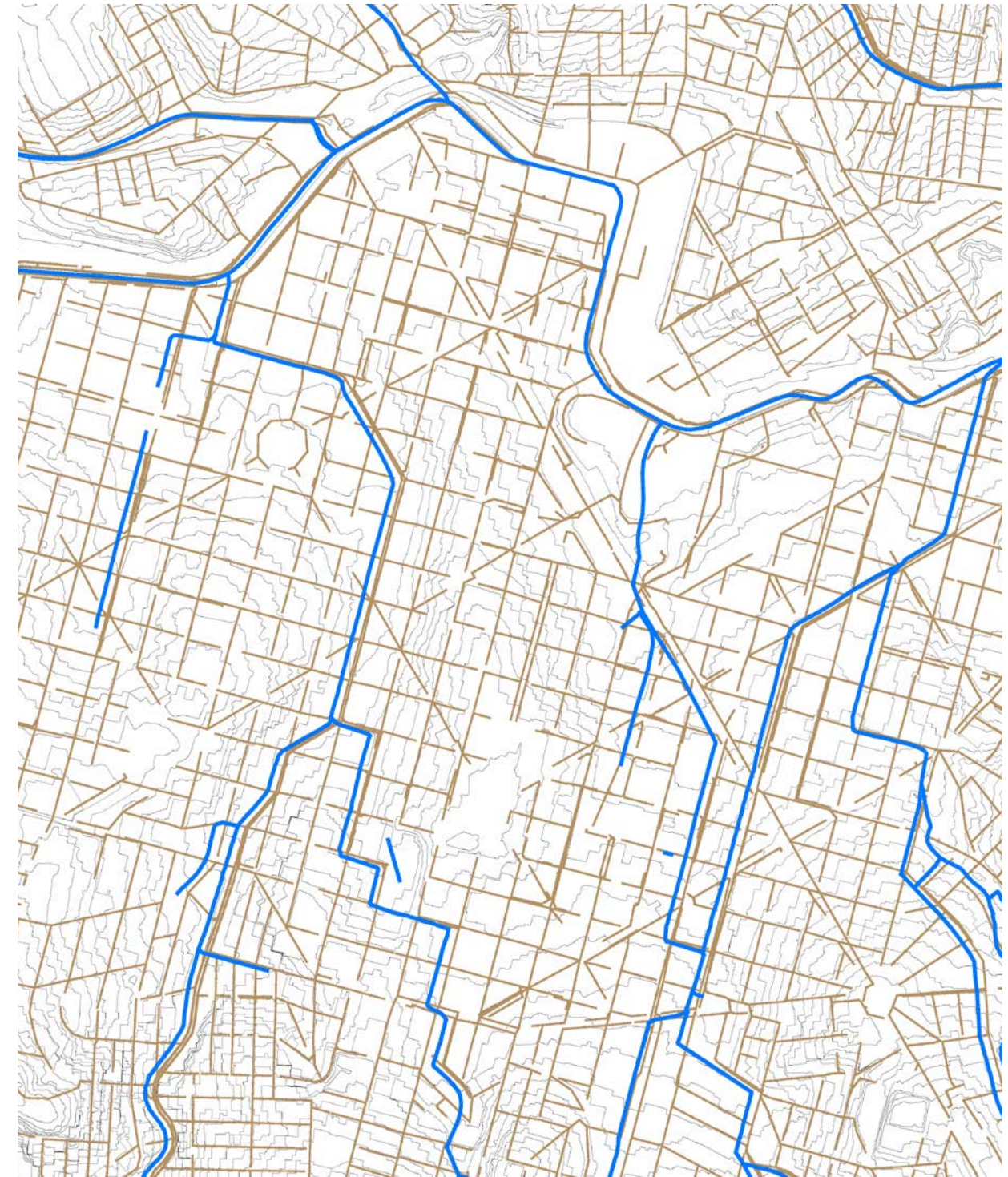
The sanitation situation in the rich residential area around the lake is alarming because of a partially totally missing sewage system: sewage flows untreated into the lake.



ZoomIn - Favela

Another concerning situation are the informal settlement areas. Mostly grown on steep slopes, the conventional sanitation infrastructure reaches the limit of supply.

- Pampulha lake
- sewage canal
- lined creek
- natural creek



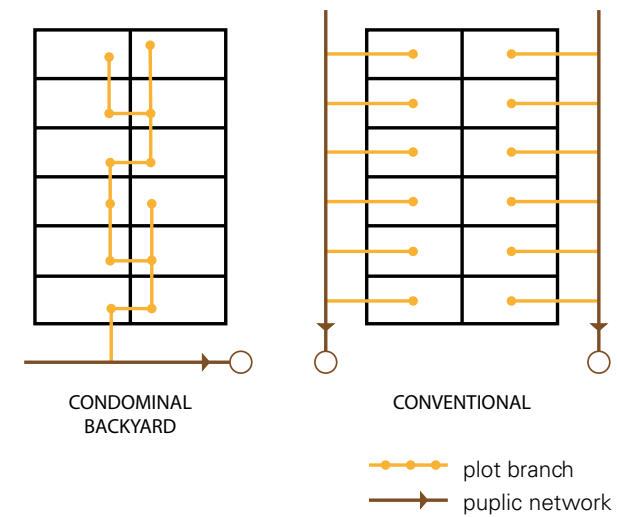
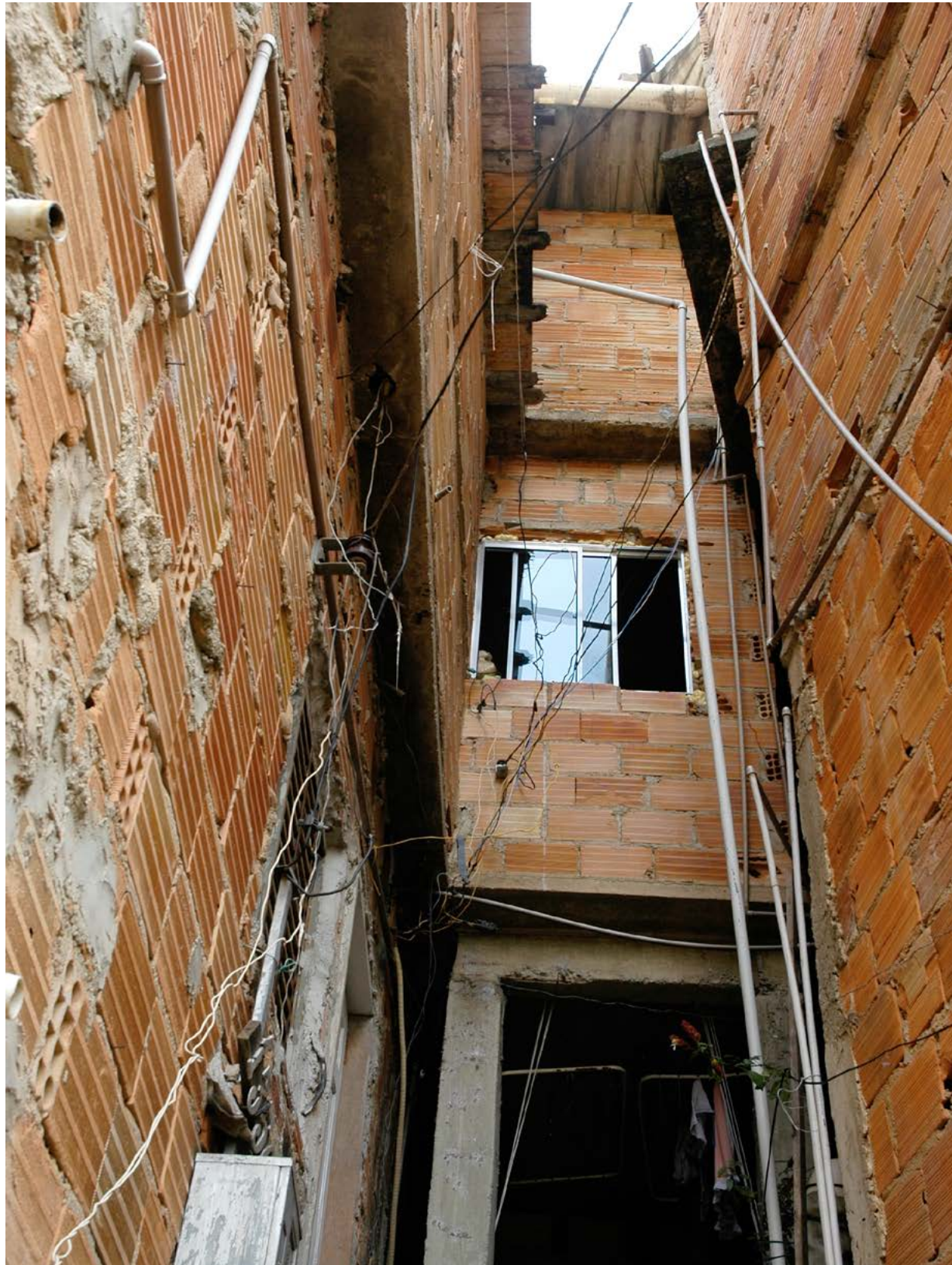
ZoomIn - Centro

The city center of Belo Horizonte is well connected to the sewage canal system and the drinking water supply which simply follows underneath the city grid.



Improvized Sewage System in informal Settlements

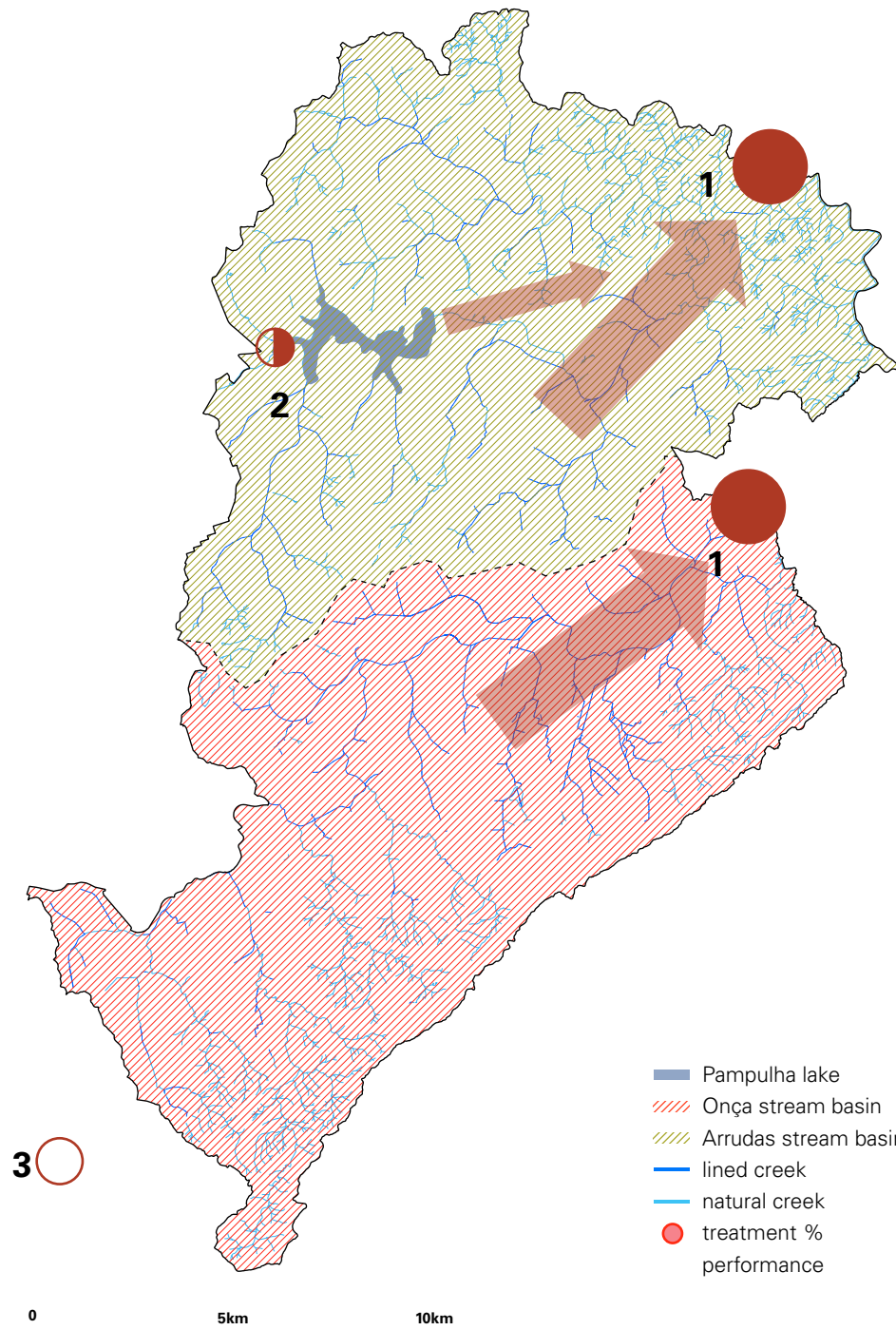
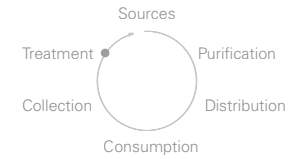
In this neighbourhood an improvized pipe system transports both sewage and stormwater. Each household is responsible for their own sewage and stormwater management. Finally, the combined waste water will end up unfiltered in the canal network of the city. The improper draining further accelerates erosion on the steep slope.



System Condominial - Favela 2.0

The so-called condominial approach to the construction of water and sewerage networks was developed in Brazil during the 1980s as a response to the challenges posed by expanding services into peri-urban neighborhoods. While the condominial model has proved capable of meeting the considerable social and engineering challenges posed by these areas, it is also a generic alternative to the design of water and sewerage systems.

As for the location of the condominial branches, the requirements established by the local government permitted a great deal of flexibility. The location alternatives were offered to the population: routing through the backyard had the advantage of being significantly cheaper to build due to shorter lengths and shallower depths of excavation. However, the potential disadvantage is that they are inaccessible to utility company staff, placing the responsibility for maintenance on the household.



Different Standards in the Sewage Treatment

The Belo Horizonte territory locates at two main catchments (Arrudas creek and Onça creek catchments), each representing at about 50% of the total municipal area. There are no rivers in the municipal territory, although Arrudas and Onça are direct tributaries of the Velhas River, which itself is the tributary of the Sao Francisco River, the longest one entirely within Brazilian territory.

100% - Professional Treatment (1)

The two large scale sewage treatment facilities Onça and Arrudas located on the east side of Belo Horizonte providing a western country like performance.



50% - Improved Pampulha (2)

The facility located between the ecological park and the affluent neighborhood receives the water from two creeks. It provides only half of the capacity needed for the region. It is an attempt to deal with the missing sewage network around the lake.



0% - Stakeholder Conflict Ibirite (3)

A treatment facility lacks completely and waste water is released directly into a dirty pond. An attempt to install a new facility was made twenty years ago by the municipality of Ibirite but was never completed. Because of the rapid growth already during the projecting phase capacities turned out to be too small. Later Sewerage commission was mandated to Copasa. They abandoned the old project and now finally started building a new facility.



PETROBRAS

Water Use for Industrial Processes

Petrobras' most important assets are petroleum reserves in Brazil. Its oil field in the Campos Basin accounts more than 80 percent of the Brazilian oil production. The company also works on developing the "green energy", including biodiesel fuel.



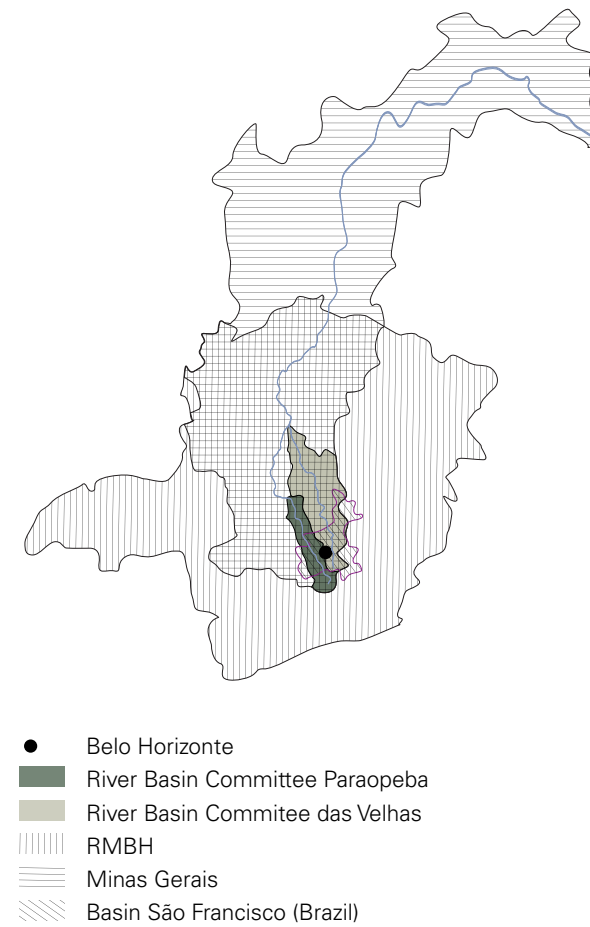
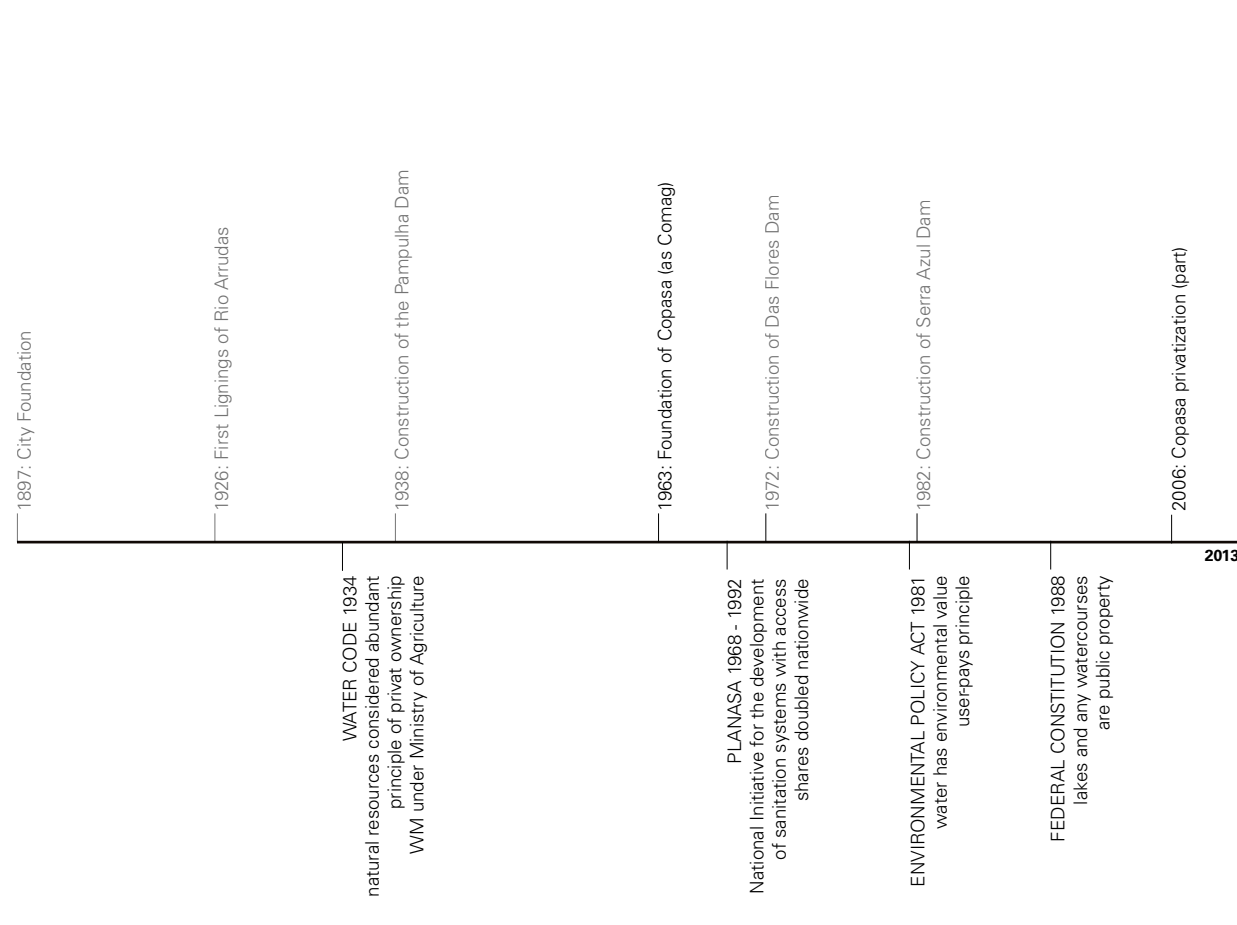
Water under the Influence of the Industry

The industrial processes for oil production need a lot of water which is taken out of the lake Ibirite. There are two water treatment facilities located at the site: the first one purifies the needed water before it flows into the industrial process. The other facility filters the used water before it runs back into the lake.



Pollution by Mining

The chemical processes and the washing in many cases bring heavy pollution and as well endangers the groundwater. Mining is connotated very positively and companies as a consequence enjoy loose controlling by authorities.



A solid legal and institutional Framework but ineffective Implementations
 Brazil for the Portuguese Emperors was a land of unlimited natural treasuries. As a heritage, resources such as water for a long time were considered abundant in modern Brasil. But regulations and laws improved considerably and today's legal framework enables enough possibilities to prevent the multiple sorts of water pollution and enforce the following of respective regulation. The example of the lacking sewage system shows, how institutional conflicts, missing initiatives and unsuccessful coordination prevents a successful solution for a technically simple problem.

On the national like on the regional Scale: Overlapping Responsibilities

Water breaks administrative and political borders. The institutions of the River Basin Committees about 10 years ago were installed to ensure the consideration of whole water bodies and their issues across those barriers. Still the government of water on the urban, regional and national scale shows conflicts of competencies and a field of many stakeholders being involved but ineffective.



Informal Appropriation beats Regulation

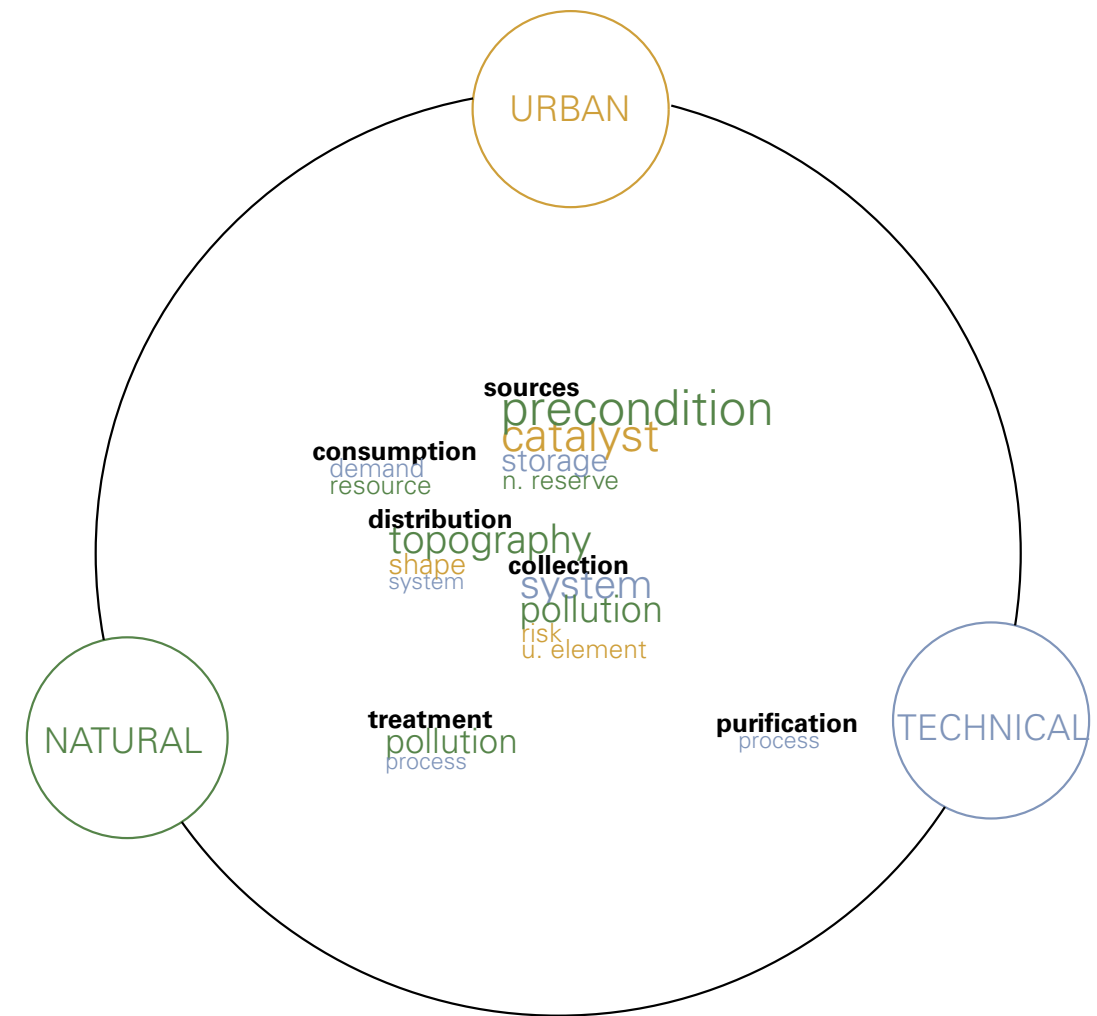
Urban growth around the represa Varzea das Flores happens in a field of tolerated legal uncertainties. As such the phenomena of informal appropriation of land can be seen in the same light as the separation issue of sewage and stormwater.



BETWEEN URBAN RELEVANCE AND INSTITUTIONAL CHALLENGE

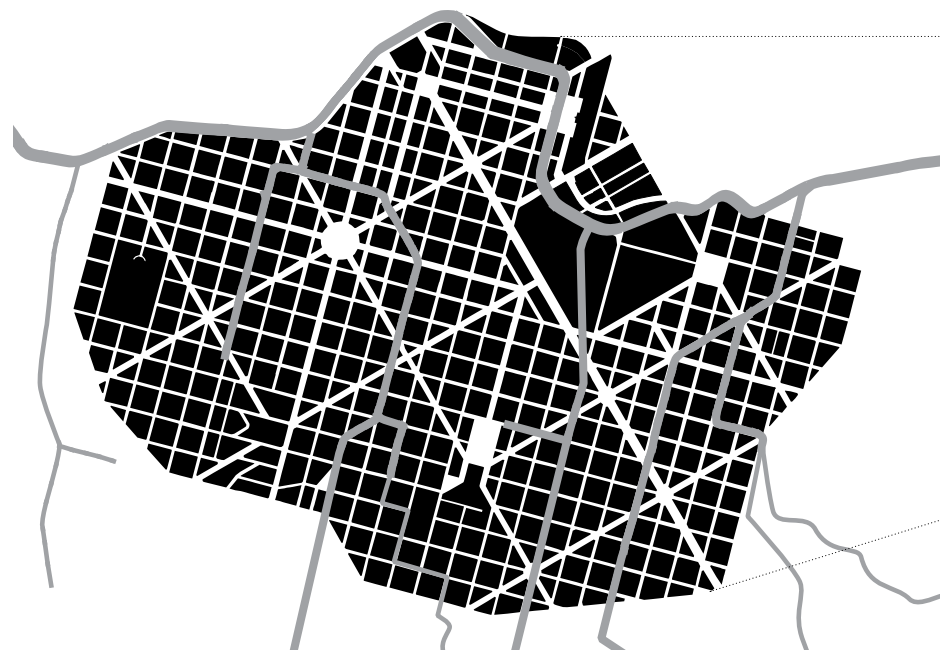
All along its seemingly simple circle, water has many more facets and in many more ways impacts urban processes than as a more technical system. Water lies in the peculiar field of tension between being a stressed resource and acting itself as a catalyst for urban growth. While the water supply system of Belo Horizonte is well established and controlled, the collection part of the circuit reveals structural difficulties that in the end cause environmental pollution.





Water as Resource, Technical System and Urban Catalyst

The represas show water in the tension between being a delicate natural resource, part of a technical system and itself a catalyst for development.



Urban Space and Layout: The City domesticates the water on the Regional and small Scale

The original city plan of Belo Horizonte ignored topographic conditions. From foundation times, the dealing with water was regarded as technical problem. Water in the city has shapes produced by technical necessities or is invisible. Water in that sense is more a risk factor than a potential for the urban space. This attitude towards water is not only applicable for the city core but predominates throughout its expansion. One big exception is Pampulha. The idea of a park and loose satellite city integrated the visual and programmatic potential of the lagoon as integral part in the planning.

Urban Dynamics and Extension: Water shapes the City on the Metropolitan Scale

The attraction by water catalyses urban processes. While in Pampulha or Alphaville this potential is used deliberately, in the case of Varzea das Flores, the appropriation of the water and the impacts on the urban dynamic happen on an informal basis and in conflict with official planning and protection efforts.

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