COMPARATIVE COST ANALYSES OF ALTERNATIVE WASTEWATER STABILIZATION LAGOONS IN BRAZIL

By

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Abstract

The future of the privatization of wastewater systems in Brazil will be decided in the next few years. The use of innovative technologies, such as Chemically Enhanced Primary Treatment (CEPT), will only be possible with private participation in future concessions of wastewater system. This thesis describes the possible savings of using CEPT for the upgrading of a wastewater treatment plant (WWTP) in Tatui, Brazil, through concessions. It is shown that the appropriate implementation of Tatui's WWTP with private participation will only be feasible with the creation of an effective regulatory framework and specific federal allocation of responsibilities for the water services.

The study contrasts the present legal background regarding privatization of water services and the expected policy requirements. To examine the CEPT upgrading alternatives for Tatui, costs are compared and the investment is analyzed in a concession scenario using several financial criteria.

It has been found that although CEPT could be an effective solution to the WWTP design, private participation still involves high investment risk. This thesis also describes the next steps for the transition from state administration of water services to municipal/private implementation, management and operation.

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I would like to dedicate this Thesis to my advisors Professor Harleman and Susan Murcott, without whose astute advice and tireless efforts this thesis could not have been written

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Chapter 1 - Introduction

The purpose of this theses is to present Chemical Enhanced Primary Treatment (CEPT) as an effective mean to upgrade lagoon treatment systems, specifically when applied through a concession of the wastewater treatment plant of growing municipalities. To accomplish it, an overview of the present situation of the water and sanitation sector, and an analysis of the regulatory framework of Brazil privatization process is described. The history and case studies of concession in the Country are presented as a mean to compare public and private administration of water services. Besides the required policy regulation for a successful concession of water and wastewater system, the financial analyzes of three upgrading alternatives for Tatui City's overloaded wastewater treatment plant is presented. This financial analysis relies on the comparison of some investment parameters: present value, payback period, benefit-cost ratio and internal rate of return. The result is a regulation framework and a cheaper budget for Tatui's concession using CEPT.

Chapter 2 - Brazil Background

National Characteristics

In terms of land area, Brazil is the biggest country in South America and the fifth largest in the world. It has the tenth GNP in the world. The population of Brazil is around 160 million inhabitants, ten percent located in the Greater São Paulo area.

The country is divided in five Macro Regions: North, Northeast, South, Southeast, and Midwest. The cultural, economic and social differences between these Regions are huge. Whereas the Northeast Region is the poorest in sanitation and water services, the South and Southeast Regions are the most developed. The greatest urban population densities occur in Southeast cities such as São Paulo and Rio de Janeiro. Therefore, in this study of the water and sanitation condition in Brazil I will present comparisons between Southeast and Northeast Regions as examples of statistic ranges in the Country.

In Brazil 31.5 million households are located in urban areas and 7.5 in rural areas (Gazeta Mercantil, 1998). The deficit in water and especially sanitation services in Brazil is mainly related to the migration of consumers from rural areas to the cities. From 1960 until 1990, the number of city households increased by 20 million while in the rural areas, the increase was only 400 thousand.

Water and Sanitation

It is important to notice that in most of the Brazilian Regions water problems are mainly related to sanitation and quality of service not scarcity, therefore, the number of

connection to water supply is related to public health and regional development. Table 2-1 shows the significant difference between urban and rural connections to water supply in Brazil

Table 2-1: Urban and rural connections to water supply in Brazil

Water Supply (1995)	Urban Areas	Rural Areas	**Total**
Connected to the network	90,4%	16,6%	**76,2%**
Other	9,6%	83,4%	**23,8%**

Source: FIBGE, PNAD (1995), And "Panorama Setorial" (Sectorial Panorama)

Regarding the evolution of water connections in the Country, despite the great increase in urban connections, it still cannot supply the population growth and migration. Table 2-2 shows how the percentage of connections evolved in the last few decades.

Table 2-2: Evolution of Water Connections in Urban Areas

1970	1980	1991
45,69%	66,06%	81,23%

Source: FIBGE, PNAD (1995), And "Panorama Setorial" (Sectorial Panorama)

As mentioned before, the distribution of water services varies per region. Table 2-3 represents the two extremes of the connection percentage.

Table 2-3: Number of Connections per Region

Region	1993	1995
Northeast	51,91%	59,84%
Southeast	86,89%	87,56%

Source: PNAD (1993/955), And "Panorama Setorial" (Sectorial Panorama)

As presented in Table 2-4, another characteristic of the variety of level of consumers in the country is the percentage of households with one tap (yard tap)

Table 2-4: Percentages of connections to yard tap in different Regions

1995	Northeast	Southeast
Total Percentage of connection	59.84	87.56
Connections to yard tap from the total	51.14	84.30

Source: PNAD (1993/955), And "Panorama Setorial" (Sectorial Panorama)

An important difference in water services for the Southeast and the Northeast is the percentage of connections in the city core compared to the suburb area. In some cities in the Northeast region the ratio between suburb and city connection can be 0.50 while in the Southeast region it is in the range of 0.75 to 0.91.

Sanitation

Despite the increase in sewage collection in Brazil in the last few years, the percentage of wastewater collection is lower than 40%. Table 2-5 shows the national variation as

well as the average.

Table 2-5: Sewage Collection

Region	1993	1995
Northeast	5,64%	5,11%
Southeast	66,31%	69,58%
Brazil	**38,66%**	**39,54%**

Source: FIBGE, PNAD (1995), And "Panorama Setorial" (Sectorial Panorama)

Unfortunately, sewage collection percentage is not related to wastewater treatment. In most cities, less than 10% of the wastewater collected is treated.

Health in Brazil

Studies show that investments between US$1 and US$4 in water and sanitation can save from US$4 to US$10 in health care (Gazeta Mercantil, 1998). Brazil 58th nation in the World Ranking for Quality of Life (UN) .One percent of improvement in water and sanitation for low income population reduces more than 6% in child mortality (Environmental Engineering Congress 1997, IPEA). Almost two thirds of hospitalizations in Brazil are of children under 10 years old with diseases related to water. Ten million Brazilians are presently infected with schistosomiases.

Child mortality is one of the most important parameters for the evaluation of water and sanitary services in developing countries. Table 2-6 shows the reduction of child mortality in the last few decades in absolute values.

Table 2-6 Child Mortality Rate (per 1000)

Region	1960/70	1994
Northeast	151,18	63,10
Southeast	100,24	26,40
Brazil	**116,94**	**40,00**

Source: Inquiry and Research Directory FIBGE, PNAD (1995), And "Panorama Setorial" (Sectorial Panorama)

Table 2-7 presents the percentage of child mortality due to inadequate water condition, and inadequate water and sanitation condition.

Table 2-7 Child Mortality due to Sanitary Conditions (1985/90)

	Adequate Service of	Inadequate Service of	
Region	Water & Sanitary	Water & Sanitary	Sanitary only
Northeast	20,3%	89,6%	51,9%
Southeast	23,2%	50,8%	49,9%
Brazil	**21,9%**	**59,1%**	**38,1%**

Source: "Diagnostico do Setor Saneamento," (Sanitary Sector Diagnosis) PMSS series, Vol. 7 , Elaborated by IPEA/CPS , and "Panorama Setorial" (Sectorial Panorama)

History of Sanitation in Brazil

In the beginning of 19th century water was supplied through springs and sewage was collected in tanks in some cities. Around 1830 fountains were installed in the center of main cities. At that time water vending was very common, it was sold in thirty

liters jars called "barrilote" in the main cities for the health of consumers. In the last two decades of the nineteenth century, epidemic diseases infected major cities especially during summer and autumn. It was the beginning of federal investments in infrastructure. As a result, in 1900 the first federal environmental companies were created. Meanwhile, in the beginning of the century, population growth and urban migration increased the importance of small municipalities.

During the Second World War, USA made the first international investment in infrastructure through the Public Health Special Service (SESP). This investment focused in Brazilian regions where military supplies were being produced for the USA (for example: rubber, quartz, mica). Since then, many other international loans started financing sanitary projects through international banks and agencies (for instance, Interamerican Development Bank, USAID and UNICEF). In 1964, after the military coup, the Nation started a centralization process that lasted for more than two decades. During the military dictatorship, all national and international investments had to be made through the federal government. By that time, a sequence of several governmental organizations and foundations were being created, restructured and inactivated, replacing and reorganizing the water service financing system. The most important governmental financing organ created was the Sanitary National Plan (Planasa), in 1969. Planasa's main responsibility was to create sanitary state companies in order to organize the allocation of loans. During the turning of the decade, Planasa had already set up and invested in 238 municipalities and created 27 State Environmental Agencies (Cesbs), which are still in existence today. From 1980 to 1990, the Brazilian economy went

through its worst period. During that decade, the average income per capita has decreased 0,4% (Silva, 1996) slowing down the pace of the water and sanitary development.

Most of the concession agreements granted to Cesbs in the 1970's are about to expire in the next few years. After the concession period, municipalities will have to decide whether to administer their own water system or privatize it. The privatization of water systems in Brazil is made through bids in which any appropriate company, national or international, private or public, can participate.

Chapter 3 - Administration Structure and Legislation

Organization of the Water and Sanitation Sector

The history of the water and sanitation sector in Brazil is recent. The sector evolution can be grouped in four stages, some of which overlapping others. During the first stage of development (from the Second World War until 1965), foreign companies were funding sanitary projects. The second stage occurred as a result of the dictatorship (around 1965/70) when the centralization and national security were principles, it was the federal intervention stage. The third was the decentralization stage when the administration of the water services returned to the municipalities (1970/80). Finally, the fourth stage represented the consolidation of a state administration structure responsible for the management of the water services (from 1980/85). The present set-up is the result of this evolution of administration structure. The three resulting models of administration of water services from this evolution of administration structure over the past 60 years follow. Non-Governmental Organization administrations are not considered as a model of service since in Brazil they are used only in few small communities.

State Environmental Companies (Cesbs)

This is the most important model of water and sanitation administration in Brazil. Around 1970, twenty seven state environmental agencies , "Companhias Estaduais de Saneamento Basico" (Cesbs,), were created in order to make local investments in water

and sanitation. Now some of them are among the biggest companies in the sector invoicing annually between US$ 1 and 2 B (for example: Cedae, the agency from Rio de Janeiro, Sabesp, the agency from Sap Paulo, etc.). Regarding their services, they have the concession for the operation, maintenance, management, construction, upgrading and commercialization of water and wastewater services in their respective states or regions. The concession period is approximately 20 to 25 years. Regarding their autonomy, the Cesbs can make investments and participate in bids according to their own planning program. They can raise international funds directly and define tariffs.

Presently, around 3.7 thousand municipalities (70%) have their water system concession managed by Cesbs. Almost ten percent of these municipalities are serviced by the "Servico de Abastecimento do Estado de São Paulo" (Sabesp), the São Paulo State Environmental Company. Sabesp is the biggest environmental company in South America. Its expenditure for 1995 was around US$ 2 B.. Sabesp has 18 thousand employees and provides service for 20 million customers. Municipal Management and Operation with FNS Financial Support

This is the administration model of water and wastewater service providing for almost 30% of the municipalities in the Country. In this model there is a partnership between the municipality and the "Fundacao Nacional de Saude" (FNS) National Health Foundation, The local authority is responsible for the administration and operation of the water and wastewater system while the FNS provides investments and stipulates tariffs. This model created the Autonomous Water and Sewer Municipal Service (Saae's, "Servco Autonomo de Aguas e Esgoto") to act as the local water and sanitary agencies.

Municipal Services

In this model, the operation and maintenance of water and sanitation services are done either directly by the municipal government or by autonomous agencies. The administration must provide funds for structural investments through specific federal or state loans, and through their municipal budget. This model of administration is not in use anymore.

Financing

The main differences between the two present models of public administration of water services are related to their funding history. Around 1970, the Cesbs were created as a pathway for the first major federal investments in the water and sanitation sector. At that time, municipalities had no autonomy, especially regarding financing from international loans. Some municipalities with enough technical and financial support (or potential), kept the control of their water services. Others (around 70%) handed their water system to the state administration, they became subject to their investment plan and agenda. The management, upgrading and maintenance of the city's water system would be the charge of Cesbs. All the revenues from water services would be responsibility of the state authority and the tariffs from profitable cities should subsidize small cities' water systems. Regarding municipal authorities (Saaes), around 30% of the municipalities presently, the budget of the city and fund from the FNS would pay for the city's water service.

The agreement between Cesbs and the municipal governments initially involved the

option of final choice of the head of the Saae. Presently all the staff of the municipal government water service company's of a municipality can be selected by the city, however, the sewage collection and treatment is a municipal responsibility. Some cities had their sewage systems built by the Cesbs, generally simple biological lagoons in suburban areas. Others are still struggling to finance their wastewater systems, either from their municipal budget or from possible federal investments.

Present Legislation Concerning Privatization and Concession (Law 8666/93)

It is important to understand the difference between privatization and concessions. In privatization, a private company buys the stock of a public service and/or utility, acquiring the "control" of it. In a concession, the respective governmental authority controls the public service and/or utility, however it is operated and/or maintained by a private company. Privatization can also be seen as a process, in which case concession is a step in the privatization process. To ensure the authenticity of a concession, a bid is required. Bids are a complex governmental procedure especially in bureaucratized countries such as Brazil. Nevertheless, they are crucial for credibility of the public contracts and represent the link between the private sector and the public services. Important sections of Law 8666/93, which regulates the bidding process in Brazil, are presented in Appendix B. Law 8666/93 provides the latest policy rules on "bidding and administrative contracts regarding works, services, including publicity, purchases,

disposals and leasing within the scope of the Powers of the Federation, the States, the Federal District and the Municipalities." (Sole Paragraph, Appendix B). The President signed it in June 21, 1993. As established in article 2, bids are mandatory for all administration entities when hiring outsource works or services, including publicity, purchases, disposals, concessions, permits and leases. Public agents are forbidden to restrain or frustrate the competitive character of a concession (Article 3 Appendix B). Article 5 provides the correction criterions for values or prices, and, therefore, would regulate also tariff changes for a concession.

Through publications and invitations, a public bid is "placed" in the market as a way to evaluate the best price and/or efficiency possible for a service and/or work from companies (public or private) and compare it with the present situation. During this stage of the bidding process, the scope of the bid is presented (Appendix G, Article 38 and 40) and the requirements for the adequate concessionaire are listed (Appendix G, Article 27 through 33). During the second stage of a bid process, all the proposals are analyzed and the "committee" grants the concessionaire according to the decision criterion proposed (Appendix G, Article 45 shows the criterion alternatives). The results must be published. Indeed, the public entity conducting the bid must give access to information regarding the process to anyone who requests it. This procedures, from the preparation of the bid until its conclusion, is expensive and time consuming. Until five days before the final contract signature, a bid can be suspended for undetermined period for many judicial reasons, in which case it is called "contested." These reasons range from impertinent requirements from the grantor to credibility of the proposals and

generally they are presented by competitors of the bid. The minimum term up to the receipt of bids or the occurrence of the event is presented in Article 22 of Law 8666/93 (Appendix B).

There are several types of bid: competitive bidding, price quotes, invitation, contest and auction (definitions are presented in Appendix G). As shown in Table 3-1 the type of bid is related to its price.

Table 3-1 Price Categories of bids according to Law 8666/93

	Engineering works and services	**Purchases and services**
Invitation	up to R$150.000,00	up to R$ 80.000,00
Price quotes	R$1.500.000,00	up to R$ 650.000,00
Competitive bidding	higher than R$ 1.500.000,00	higher than R$ 650.000,00

In circumstances when a bid values is much higher (around R$ 5.000.000,00) than those presented in the Table 3-1, International Invitations are required. They should be published in the three main languages and any other language pertinent to possible competitors.

A "Build Operate and Transfer" (BOT) contract would be categorized according to its present value of the whole project. Since generally it is higher than R$ 1.500.000,00, it would be a Competitive Bidding for engineering works, services, and purchase.

Policy and Regulation Requirements (World Bank)

The World Bank Site, at http://www.worldbank.org/html/fpd/wstoolkits has a set of toolkits to guide several aspects of contracts for privatization of public services or utilities. In this section on the Policy and Regulation Requirements for privatization in Brazil, I refer mainly to Toolkit 3 (http://www.worldbank.org/html/fpd/wstoolkits/Kit3/frame.html). However, toolkit 1 presents important steps to take in order to prepare a fair contract among public and private parties and can be used as a reference for policy planners and contract grantors. Toolkit 3 poses questions related to legal, financial and regulatory issues for Concession Arrangements, BOT Arrangements and Management Contracts (Appendix C). It also organizes a Key Risks Table (Risk Table, Appendix C) showing the expected World Bank allocation and mitigation of risk.

The three scenarios presented in the Word Bank Toolkit are meant to be general, but in fact are very similar to the present situation of many municipalities in Brazil (Appendix C). The questionnaire of Toolkit 3 refers to Concession, BOT, and Management Arrangements poses the following important questions:

1. Who are the parties to the contracts that constitute the arrangement?

2. What is the object and scope of the contractual arrangement?

3. What is the duration of the arrangement, and what circumstances will give rise to early termination?

4. What are the obligations and rights of the concessionaire?

5. What are the obligations of the grantor?

6. What are the key regulatory provisions?

7. How will key risks be managed?

8. How will performance be measured and monitored?

9. How will assets (including land) be transferred?

10. What consents are required?

11. Who will be responsible for past environmental liabilities?

12. How will disputes be resolved?

Law 8666/93 answers almost all this questions, however, the definition of: "Who are the parties to the contracts that constitute the arrangement?" is not precise, yet. Since there is not a specific present status for the Cesbs autonomy or responsibility, Question 1 still has no answer. It remains unknown whether Cesbs will play the rule of the grantor or the concessionaire, for many municipalities. Actually, the struggle now is to define if Cesbs will have to participate in municipal bids at all. Table 3-2 shows the issues of this struggle regarding the participation of Cesbs in municipal bids (i.e. "Bids for all"); whether there will be "No bids for Cesbs" (i.e. special previleges) or whether Cesbs will simply be responsible for the contract review or extension of concession.

Table 3-2 Aspects of Cesbs required participation in bids

	No bid for Cesbs	Bid for all
Legal Background	Local Services are a municipal responsibility (Article 30, 1988 Constitution)	Water and sanitation improvements are a obligation of the three levels of administration (Federal, State and Municipal) (Article 23, part IX)
	Cesbs were instituted before the Law 8666 in 1993	Cesbs were created for the development of specific metropolitan areas and, therefore, should be obliged to participate in bids for other municipal systems.
Biding Aspects	It is impossible for Cesbs to participate in bids due to their non-profitable philosophy	There should be no privileges between governmental entities
Political Implications	Coordination for the planning of water and sanitation improvements is essential	Liaisons between governmental agencies and local authorities can create conflicts of interest
	Universal access to water and sanitation policy (water is free or *underpriced*)	No water price control (cost and service are directly related instead of being subsidized).

Discussion

Despite the amount of investments required for the sanitary sector and the possible revenues from concession contracts in Brazil, the risks for private investors is still high.

In some municipal water systems the improvements in tariff collection and water metering could already make a concession a profitable investment. However, since public services in Brazil are nontransferable, tariff control must be a public responsibility, sometimes of Cesb, sometimes of a municipality. This responsibility includes collection and pricing.

Another aspect of the present situation of Cesbs is their consolidated relationship with municipal authorities. This relationship has some positive aspects such as technical improvements and planning integration, however, it also has also negative points, such as, corrupt liaisons and stagnation of innovation in sanitary system. Moreover, it has been proven that state investments can not meet the municipal growth demand (Gazeta Mercantil, 1998).

In the next hierarchy of water service figures, Figure 3-1 and 3-2, the present situation of Saaes and Cesbs is shown. Figure1 presents the situation of municipalities with the Cesbs concession of their water system regarding their hierarchy.

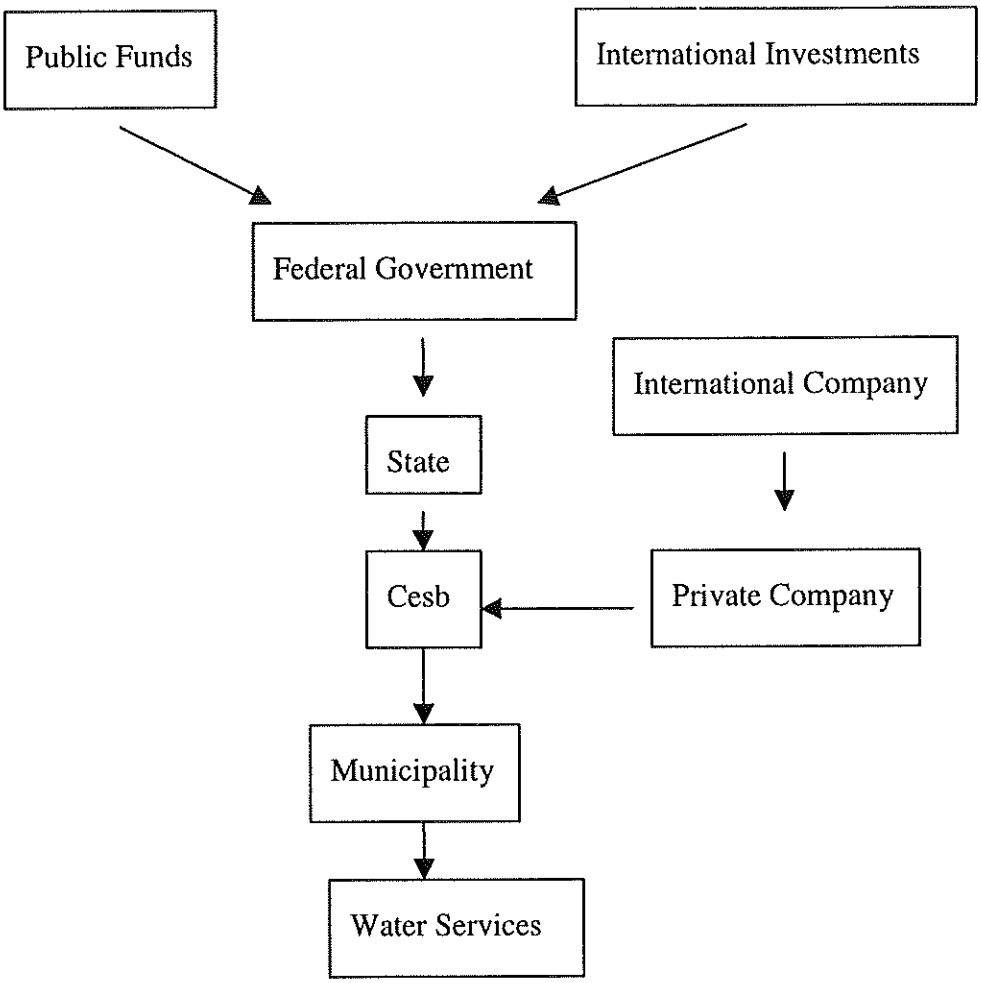

Figure 3-1: Present situation of water hierarchy, regarding Cesbs

Figure 3-2 presents the situation of municipalities with the Saaes concession of their water system regarding water service hierarchy.

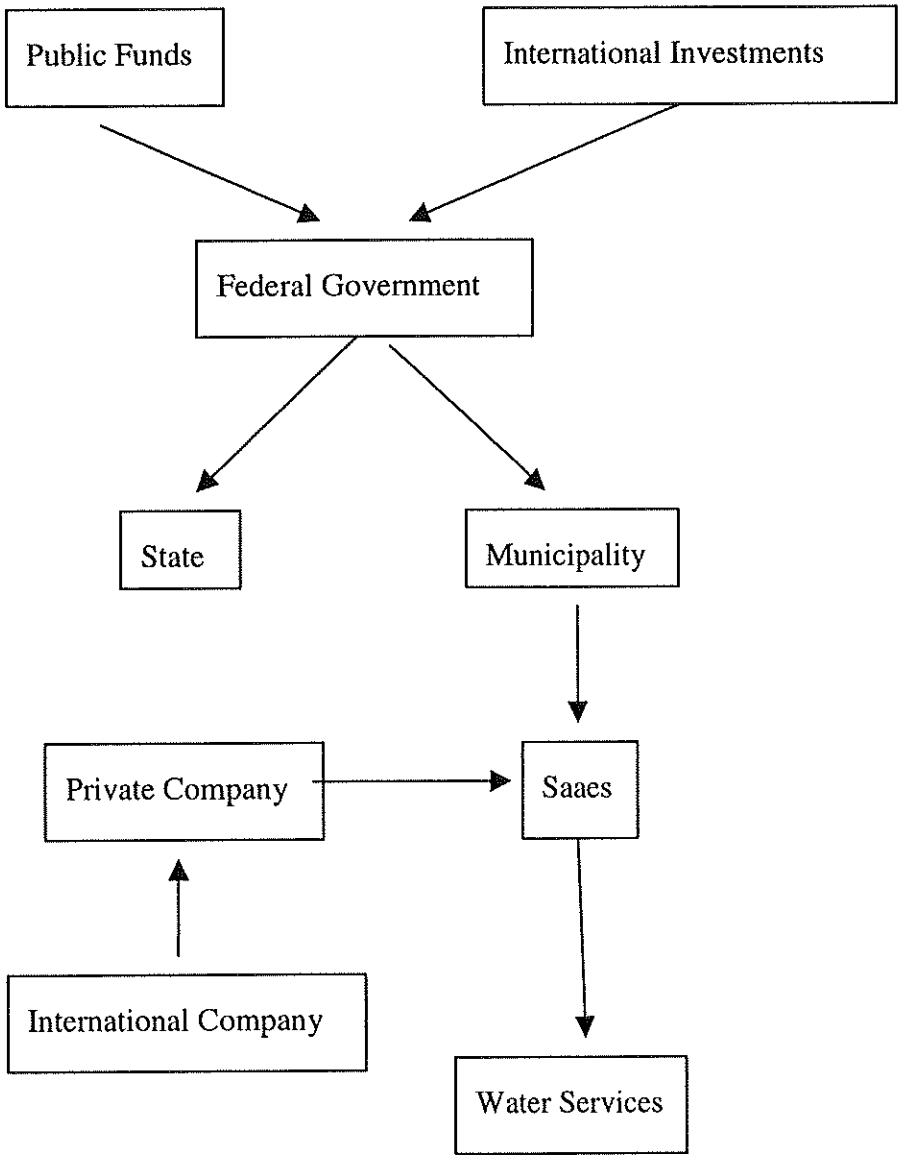

Figure 3-2 Present situation of water hierarchy, regarding Saaes

Figure 3-3 is a possible representation of a successful hierarchy situation for municipalities with respect to concession of their water or wastewater services.

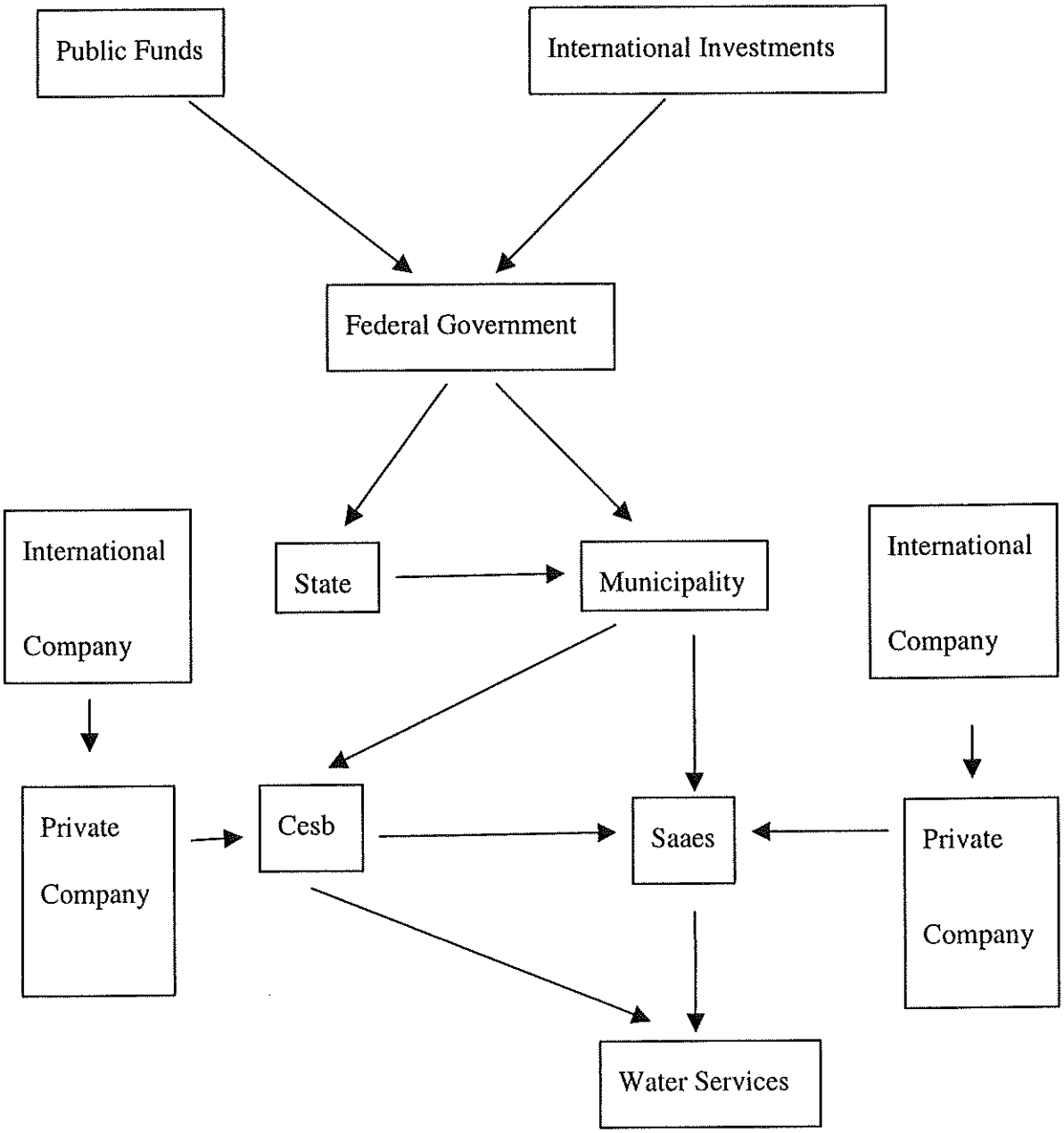

Figure 3-3: Proposed water hierarchy agreement for municipalities

The scenario presented in Figure 3-3 would respect the municipal autonomy, and allow Federal and state investments to be a municipal responsibility. This structure of water and sanitary administration would require bid for all companies, public or private. The participation of federal and state governments would ensure the credibility of the biding process and supply legal background and technical support.

Perhaps, the main point of this hierarchy structure is that the income from the water and wastewater services would be a municipal responsibility. In the other two existing structures, the revenues from the consumers tariff is not reinvested in the local system, it is a Cesb or Saae responsibility and their investment plan sometimes is not the appropriate for the Municipality.

The administration structure of Figure 3-3 allows the Urban Integrated Approach for all the sectors of the municipal infrastructure. This way, there would be two levels of subsidy. A local level of subsidy, where the municipal budget could integrate its revenues from all tariffs and reinvest in an appropriate manner, and a federal/state level subsidy, where the federal government could integrate the national and international investment and focus on a major developing plan, subsidizing low income municipalities. Applying for a federal or state loan would not mean receiving money for free. Municipalities where the revenues from their tariffs are not enough to sustain or develop the city's infrastructure could finance their water or wastewater system through a lease. This lease would be a financial obligation of the municipality for as long as it

takes to pay for the federal or state investment, however, the operation and maintenance of these systems would be local (with state technical support).

Chapter 4 - Concession of Water and Sewer Services

The Privatization Process

The national security and self-sustainability was the legacy from many years of dictatorship in Brazil, until 1990 when President Fernando Collor de Mello started privatizing sectors in the construction industry, metallurgical industry and power systems. However the presidential impeachment in 1992 stopped the process for three years. In 1995, sectors such as telecommunications and highways were being privatized with great success.

The financing of the water and sanitation sector in Brazil has developed from federal subsidy to international loans and private participation. However, by the beginning of the 21st century privatization will be clearly, defined and thus, the future of water and sanitation sector. Many municipalities will have to choose the best administration structures, private or public. This will require several improvements in privatization rules and also economic stability.

In the first section of this Chapter 2, I briefly describe the concession process and present examples of water and/or sewer privatization in Brazil (Gazeta Mercantil, 1998). Then, I provide the outline of the present legislation regarding privatization (Law 8666) . In a third section, the basics of policy and regulations requirements for the future of concession is analyzed.

Concessions of water services in Brazil

The granting criteria in the bidding process of a concession in Brazil have varied from case to case over time. The winning proposal of a concession has ranged from the one with greater welfare benefit (low water prices) to one with best "public" benefit (i.e. best financial agreement for City Hall).

Since the beginning of the water and sanitation sector privatization process of 1995/96, the financial sums in the awards of many concessions have been greatly overestimated. Indeed, it has been found that services rendered by the some private companies to which the concessions were awarded paled in comparison to the funds granted to them. As a result, there are many judicial and administrative issues are that currently being debated in an attempt to resolve the problem.

Table 4-1 shows all the Water and Wastewater Systems Concessions until 1997.

Table 4-1: Water and Sewage Concession

Municipality	State	Population	Company Granted	Type	Date	Years
Aracatuba*	SP	157.467	Amafi	Sewage	Mai/96	15
Campos dos Gpytacazes*	RJ	35.000	Developer/Quiros Galvao/Carioca...	Water and Sewage	Set/96	30
Itu	SP	112.939	Cavo/Camargo Correa	Sewage	Mar/96	20
Jau	SP	97.354	Amafi/Multiservice	Water	Nov/95	21
Jundiai	SP	288.644	Augusto Veloso/Tejofran	Sewage	Jan/96	20
Limeira**	SP	217.489	CBPO/Lyonnise des Eaus	Water and Sewage	Jun/95	20
Mineiros do Tiete	SP	9.462	Saneciste	Water and Sewage	Jul/95	30
Ourinhos	SP	79.148	Hidrogesp/Multiservice	Water	Fev/96	15
Ourinhos*	SP	79.148	Telar	Sewage	Fev/96	20
Pereiras	SP	4.850	Novacon	Water and Sewage	Set/94	20
Riberao Preto	SP	450.690	CH2M Hill/REK	Sewage	Set/95	20
Paranagua	PR	110.000	Carioca	Water and Sewage	Mar/97	28
Cajamar	SP	33.707	Multservice/REK/Hidrogesp	Water	Ago/96	20
Saquarema	RJ	110.000	Cowan/Queiroz Galvao/Erco...	Water and Sewage	Mai/97	25
Mairinque	SP	35.000	Vilanova	Water and Sewage	Fev/97	20
Tuiuti	SP	3.000	Novacon	Water and Sewage	Nov/96	20
Salto	SP	100.000	Saneciste	Sewage and others	Dez/96	20

* Administratively Pending
** Judicially Pending

The usual problems associated with the governmental administration of public services

include:

- The cost of the product is not related to its market price;
- The State Company can run/produce with a financial deficit;
- It is difficult to control the productivity of the staff and employees;
- Management turnover is not related to performance, but rather to the political agenda;
- The bureaucracy of public administration.

Following, are the case studies of six cities, Tuitui, Pereiras, Mairinque, Riberao Preto, Limeria and Itu, including financial data from the "Associacao Brasileira de Concessionarias" (ABCON) Brazilian Association of Concessionaires of Water and Wastewater.

Cities Concession Investment Description

The section does not intend to describe details about these cities financial agreement or services improvement but, instead points out few important results about their privatizing contracts (Gazeta Mercantil, 1998). These agreements are examples of existing concessions and show the importance of a regulatory structure in order to avoid irregular deals. The example of Limeira shows that the Municipality and the concessionaire had a financial agreement which suggest corruption and irregular bid. It was the first concession process in Brazil (1995) and authorities should learn from this

experience to avoid the same problems in the future.

Limeira

The Limeira municipal district privatized the city water and wastewater concession systems in 1995. The Municipality has awarded a 20-year concession to the consortium *Aguas de Limeira Partnership.*

Limeira Water Partnership is composed by *the Brazilian Company of Projects and Constructions* (CBPO, "Construtora Brasileira Projetos Obras", an affiliate of the *Odebrecht Group*) and *Suez Lyonnaise des Eaux.* The responsibilities of both companies in this project are equal. The contract to do services began in June 1995, and Limeira Water and Sewage Supply service did the supervision. The law number 8666/93 was used to establish the winner of the bid, one of the criteria was lowest price bid.

The concession had, and still has, some problems. These problems are related with the integrity of the concession. Regarding the contract value, interest and water prices, problems had to be solved by the judicial system. Table 2, Appendix D, contains the characteristics of the financial agreement of Limeira's concession.

When this program started, approximately 25% of the population had no access to water treatment services, due to the small reservoir capacity. Only 2~3% of the sewage was treated There were water losses of the order of 40%, due to the abundance of illegal connections. Presently, 100% of the population receive treated water and the sewage collection is approximately 92.5%.The losses were reduced to 27%.

The monthly income of the partnership is R$1.5 millions. The commitment of investments is R$100 millions, to be amortized in 10-15 years. During the first eight years (1995-2002), R$50 million is to be spent by the partnership. From 1995 to 1997 R$ 12.3 millions were invested, and the investment for 1998 were expected to be R$ 7 millions (new data not available).

Table 4-2: Limeira Water and Wastewater Concession

Concession General Characteristics		
Total Investment:	100	Million
Initial Investment:	6,15	Million
Upgrade Invest.	Varies	
Max. Concession Period	30	Years
Deferral Period	24	Months
Income		
Consumer Growth	1,50%	
Payments/month	R$1,50	Million
Payments/year	R$19,02	Million
Inflation/month	1%	
Insurance		
Project fraction	30%	
Insurance Tax	6%	
Interest/year	1,06	6%

Ribeirao Preto

Ribeirao Preto was one of the first cities to privatize their water treatment services (1994). The *Ambient Concessionaire of Ribeirao Preto* was the pioneer in

obtaining financial support from The National Bank of Development (BNDES, *Banco Nacional do Desenvolvimento Brasil*) to start building systems to treat the water and sewage. The concession was based on the "Build Operate and Transfer" (BOT) model. Today, Ribeirao Preto continues to operate its own water supply system.

The partnership is responsible for the construction of two wastewater treatment plants. The total investments expected are of the order of R$45 million, 70% of which will be supported by the BNDES. In addition to the plants, 27 Km of interceptors will be built.

The partnership will receive R$0.18 per cubic meter of treated sewage. The 500 thousand inhabitants of Riberao Preto produce an average of 4 thousand cubic meters of raw wastewater per hour. This amounts to 34.56 million cubic meters per year. Disregarding the expected population growth of 1.8% per year, the partnership's income in this period will be R$ 124.2 millions (R$6.21 millions per year). Table 4-3 shows the main characteristics of the concession contract of Ribeirao Preto.

Table 4-3: Ribeira Preto Sewage Concession

Concession General Characteristics		
Total Investment:	R$ 45,00	Million
Concession Period	20	Years
BNDES Financing		
Amortization Life	10	Years
Initial Value	R$ 30,00	M
Internal Return Rate	18,4%	
Payments	10	Years

Payment / year	(R$6,77)	M
Number of Payments	10	
Privet Banks		
Amortization Life	20	Years
Bank interest	6%	Years
Value	R$ 15,00	M
Payments	(R$1,31)	
Income		
Number of Costumers (base unit.)	450600	
Consumer Tax- Sewage	0,18	R$/ m3
Pop. Wastewater Production	34,56	Mm3/year
Consumer Growth	1,80%	
Water + Sewage Value	0,405	R$/ m3
Insurance		
Project fraction	30%	
Insurance Tax	6%	
Interest/year	1,08	8%

Itu

Cavo Itu won the bid in March 1996 for the water and sewage treatment concession in Itu. The concession period is 20 year and the new treatment station is already operating.

The total amount invested is R$ 25.9 millions and from this money R$ 23.8 millions (90%) was invested in the pre-operational portion of the project. In 1996, R$ 2.38 million were invested (10%) and in 1997 R$ 16.66 million (70%) were invested. The

remaining 20% was invested in 1998. About R$ 2.2 million are programmed to be invested during the period of the concession, for the construction of additional sewage treatment stations.

The concession in Itu is based in the construction of three sewage treatment stations (Canjica, Pirajibu, São Miguel), pumping stations, conduits and iron pipe systems.

Mairinque

The concession for water and sewage treatment in Mairinque city belongs to *Ciagua* (a company specializing in these services). The contract was signed in February, 1997, but the system did not begin operation until May, 1997.

The company is committed to spend R $30 million during the concession period of 30 years. During the first two years, the investment is expected to be around R$ 8.6 million. 35% of this will be contributed by the city, the remaining will come from companies that are financing the project. Through January, 1998, the money spent in this project was around R$1.5 million.

Before the concession, the city had no sewage treatment. The number of water connections increased about 10% from May 1997 to January 1998 and the sewage collection increased 3% in the same period. Water losses dropped from 72% to 55%, while water metering increased 28%.

The BNDES bank financed R$ 5.37 million. *Ciagua* is to begin paying off its debt over a period of ten years, beginning two years after receiving the loan. The total investments

in water supply systems will be broken down into the following scheme: R$4.37 million will be spent on the water system, R$2.17 million will be spent on the sewage system and R$1.73 million will be spent on operation and management of the water and wastewater service. This totals R$ 8.27 million, of which 35% is to be contributed by *Ciagua*. The average monthly income in 1997 was R$120 thousand and the expected income for December 1998 is R$ 220 thousand.

Pereiras

The Pereira City concession contract was signed in 1994 with *Novacon*, date before which the town hall had the responsibility of water and wastewater treatment.

Up to 1996, the total amount of the investments was R$604 thousand. During the year of 1997, the investment was R$600 thousand, and in the future *Novacon* has the intention of investing around R$1.5 million to improve the water and waste water treatment.

In 1997, losses accounted for 30% of the total flow. The company is currently working on the possibility of a reduction to 15% of water loss. Also by 1997, all water consumption was already metered, and the next intended step of the company is now to replace all of the hydrometers to give the consumer and the service provider greater accuracy. With all of these improvements, the income of *Novacon* in Pereiras is R$25 thousand per month.

Tuiuti

Novacon is the company that operates the water and wastewater system in the city of

Tuiuti. The concession was signed in November of 1996. The municipal district has 800 water connections and two employees working on the system. The investments made since December, 1997 are between R$70 and R$80 thousand. The collection of taxes is done by "mediadores" (middlemen). The water intake is done through deep wells. The income is R$11 thousand a month. Sewage treatment has to be operated by the municipal district, while *Novacon* has the responsibility for the design of the sewage treatment plant.

Dicussion

The ownership of all the water/wastewater systems in Brazil will return to city hall in the next few years. At this junction, each city will decide what to do with its own water system. It is feasible to think of all the emerging Brazilian cities having their water systems privatized; but what about small non-profitable cities?

Maybe the answer for this question is federal management with local operation and/or subsides depending on the situation.

It is important to evaluate what level of investment is really required to the existing system. In order to improve the water system as a whole, it is necessary to implement the following actions: management improvements, control of illegal connections, reduction operational costs, installation of new connections, pipe system maintenance, pipe system installation, improvement of existing water treatment facilities, and construction of new water treatment facility. It should be mandatory for each city to

assess the operation thoroughly in order to evaluate what level of improvement will be necessary in each case.

Regarding the city's concession analysis, The City of Limeira is an inappropriate example of private participation in a concession. The NPV shows that after the second year the new administration is already receiving profits from the investment this is contrary to all other concessions in which a profit is not realized until the tenth year. See Appendix D for a different privatization agreement (for Limeira) with a much higher capital investment or tariff reduction. In alternative 1 the city hall could charge the concessionaire almost R$80 Million and the IRR would still be considered profitable (i.e., greater than 17%). In alternative 2 the wastewater tariff was reduced 70% and the investment is still payable in 12 years (considered a acceptable payback period). Riberao Preto financial spreadsheet is also presented in Appendix A as an example of expected investment characteristic from a concession. Table 4-4 shows the results from the financial spreadsheets presented in Appendix D.

Table 4-4: Result of Concession Agreement Analizys

Financial Index	Limeira	Limeira Alternative 1	Limeira Alternative 2	Riberao Preto
Payback Period	2 years	9 years	12 years	10 years
Internal Rate of Return	169 %	21 %	20 %	23 %
Benefit Cost Ratio	3.5	2.1	1.4	1.4

There is still much to learn about privatization, meanwhile public concession contracts are expiring. The question is not about the initial situation (a water system as

governmental property) or the final one (all public systems privatized). The main question is the transition.

Chapter 5 - Financial Analysis of CEPT in Tatui

Introduction

The purpose of this chapter is to evaluate the financial costs of the MIT-CEPT designs (Alternatives A2 and A3), and to compare them to the costs of the SABESP-Aerated lagoon design (Alternative A1). To accomplish a fair comparison, costs will be tallied using the same assumptions that the SABESP design does.

In Brazil, the design consultant firm is responsible for quantifying the design in terms of specific tasks (i.e. units of labor, equipment and material usage). Each of the tasks is included in a database managed by SABESP. This database provides cost per unit of these services.

Methods for Cost Comparisons

The SABESP cost database presents the aggregated cost to accomplish a specific task. For example, the cost of moving one cubic meter of soil includes the cost of labor and transportation of the soil, and its unit is currency per cubic meter of soil, per kilometer of distance to transport.

The method to compare the costs between the 2 MIT-CEPT designs and the SABESP design therefore relies on a comparison between the various SABESP units. Consequently, the MIT-CEPT design costs will be estimated using the SABESP standard, in order to provide an accurate cost comparison.

The cost comparison will rely on a quantitative comparison using the various SABESP task units (i.e. volume of earth moved, foundation reinforcements, etc.). The CEPT budget will neglect the differences in the predicted pipe installation as well as all items related to the power station construction since it would not be representative.

SABESP's quantifying system assumes that there are no unknown variables for the construction. This means, for instance, that all the information regarding quantities of rock demolition, although estimated, will represent the actual amount of worker and machinery rent hours, as well as the volume of rock demolished and transported.

Regarding special units for these quantities, global items (represented as GB, which is the Sabesp' unit for "global") include all services and/or amount of supplies necessary to accomplish the entire specified task. The lists presented in the page ahead use the same nomenclature as Sabesp's lists.

SABESP Pricing Structure

The SABESP pricing system represents the estimated price to accomplish a unit service including all the necessary related items. For example, the price of soil removal deeper that 4 meters includes: worker's hours, machinery rent hours, and material used. However, the unit is m^3 and the price corresponds to soil digging beneath four meters.

With this pricing structure, it is difficult to estimate price reduction factors, such as economies of scale, or the construction company profit. The service taxes also vary geographically, but the SABESP prices remain the same.

In this study two out of four SABESP's lists of services and equipment are important: list-3 , hydraulic equipment, and list-4, electric equipment. The price unit for these lists is GB (global). The services that are related to the installation of all the equipment included in those lists are evaluated in two different SABESP budget items. These items bear titles such as "installation of hydraulic equipment of list-3" or "installation of electrical equipment of list-4".

List-3 includes several items. Among them, there are three specifications related to aerator items: floating aerators (15hp), iron cables (diameter 3/16"), and aerator fixing structures. These items will be excluded from the Alternative A2 and A3 CEPT design budget, and the installation price will be reduced accordingly.

List-4, with all electrical equipment necessary for the whole wastewater treatment plant, will remain the same. However, it is important to notice that since no aerators will be used in the CEPT treatment system alternatives, there would be a slight decrease in this price. By using the same price, the MIT-CEPT budget will therefore be conservative. This can be seen as a buffer for any unexpected costs.

Moreover a fifth price list will be included for the MIT-CEPT design alternatives. This list will consist of all the equipment required for the coagulant addition: pumps, flow meter and storage tanks.

The Design Alternatives for Upgrading Tatui's WWTP

Tatui is a small city 120 km from São Paulo, with a population of 120,000 inhabitants and a overloaded wastewater treatment facility. The treatment system presently is

composed by two lagoons, one anaerobic and the other facultative, in a 5 ha area in the suburbs of the city. The efficiency and the condition of the WWTP CEAGESP was evaluated by Milton Tomoyuki Tsutiya and Orlando Zuliani Cassettari in 1992 (Appendix E presents the translation of their work). In 1998, a bid was placed in order to upgrade one of the City's WWTP (called CEAGESP).

The MIT CEPT Project consists of the study of the present design of the WWTP in Tatui and three alternatives for upgrading the system. The design alternative number 1 (A1) has been presented by Sabesp in the bid for the system's upgrading. It was designed by Ampi and approved by Eduardo Pericle Colzi in 1996. It consists of four tracks of two lagoons, one mechanically aerated followed by a settling tank. The sludge of A1 is pumped from the settling lagoons and dewatered in sludge drying beds (SDB). The two other alternatives, numbers 2 (A2) and 3 (A3) rely on Chemically Enhanced Primary Treatment (CEPT) for the removal of total suspended solids (TSS) and its related biological oxygen demand (BOD).

The alternatives A2 and A3 were designed by three MIT graduate students (Christian Cabral, Frederic Chagnon and Domagoj Gotovac) as the final project for the Master's of Engineering Program at MIT in 1999. Professor D. Harleman and research engineer Susan Murcott supervised the design. The details of the assessment conducted by the MIT group in Tatui and the design are presented in the MIT CEPT Project 1999. The project also gives the background of this treatment technology, which consists of the addition of chemicals to increase the efficiency of the settling tank or lagoon.

Alternative A2, adds chemicals in the conventional way, that is, in primary

settling tanks before the lagoon treatment. Alternative A2 is composed of a CEPT tank followed by an anaerobic lagoon of 1 ha and 3.3 ha of facultative lagoons, 3 ponds of 1.1 each. The sludge from the CEPT tank is dewatered in a filter press and then composted through windrows in a 0.6 ha area.

Alternative A3 consists of an anaerobic settling lagoon, where the CEPT chemicals would be added, followed by another anaerobic lagoon (1 ha) and finally three facultative lagoons (3.3 ha of total area, 1.1 each). In alternative A3, the chemicals are added in the first anaerobic lagoon's inlet, in-pond settling occurs, and the settled matter is biologically stabilized during a one-year period at the bottom of the lagoon. The sludge produced in the first lagoon, after anaerobic biodegradation during one year, would then be pumped to the sludge drying beds (SDBs). For the schematic of the three alternatives of treatment and the area distribution see Appendix F, Figures 1, 2 and 3. Table 5-1 presents the areas and depths required for each treatment for the three alternatives.

Table 5-1: Design areas and depths of A1, A2 and A3

Treatment	A1 Area (he)	A1 Depth (m)	A2 Area (he)	A2 Depth (m)	A3 Area (he)	A2 Depth (m)
Aerated	0.8	3.5	X	X	X	X
Settling	1.3	4.0	X	X	1.0	3.5
Anaerobic	X	X	0.6	3.5	0.6	3.5
Facultative	X	X	3.3	3.0	3.3	3.0

In the next section I estimate the capital cost (CC) and the operation and maintenance costs per month (O&M) for A1, A2 and A3. The first section presents the final table of total CC of the three alternatives. The services and supplies are grouped in 15 group items. In terms of CC, the differences in quantities between the three alternatives are seen in 5 items: Soil Movement, Foundations and Structures, Supplies, Sludge Treatment, and Other (installation of hydraulic and electric equipment).

Total Capital Cost for Alternatives A1, A2 and A3

The budget for the construction of lagoons treatment systems, neglecting the land price, consists essentially of land movement, foundations and structures, and wastewater treatment. The following sections divide the construction budget of three WWTP in 15

main items. Chart 5-1 shows the general distribution of costs for A1, A2 and A3.

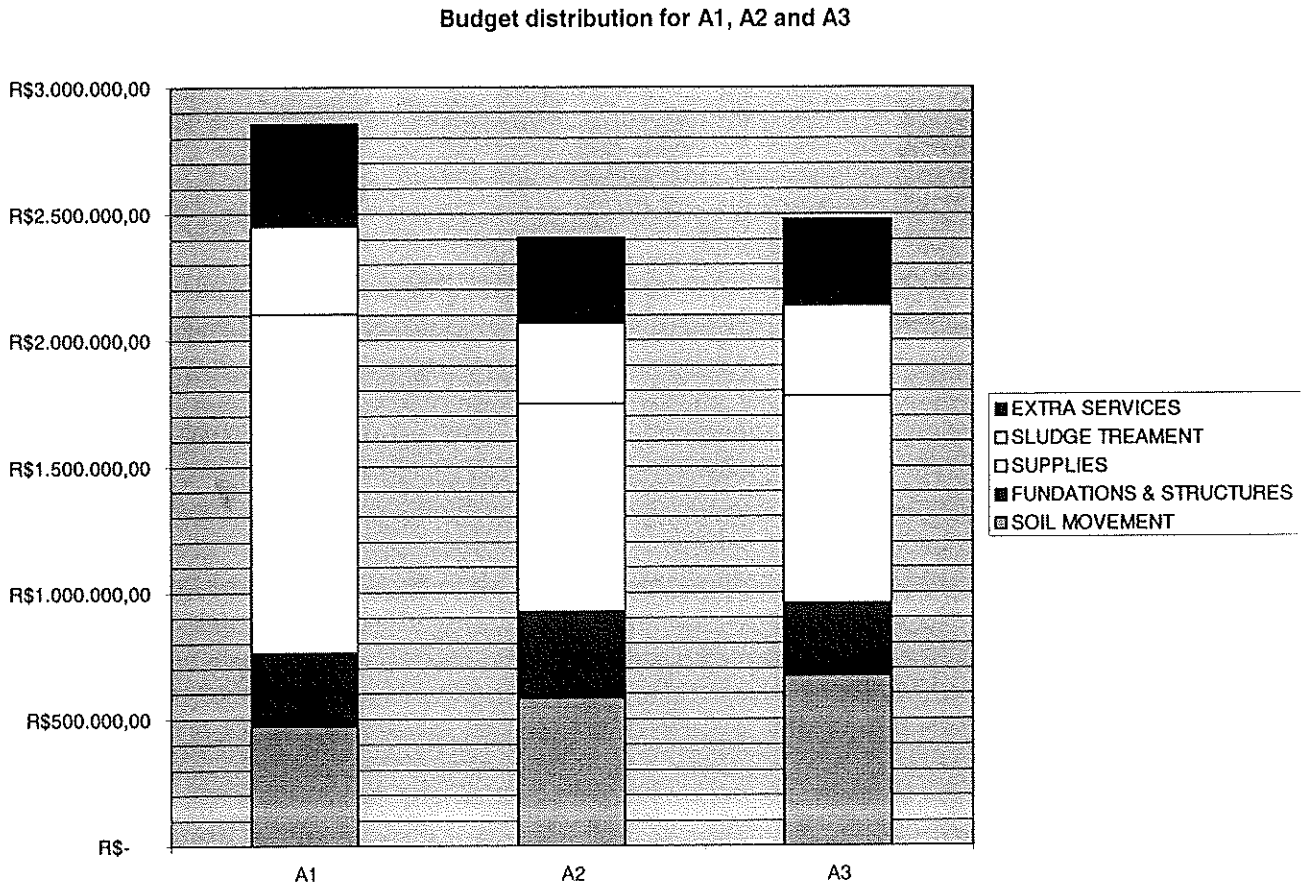

Chart 5-1 Capital Costs of Alternatives A1, A2 and A3

As mentioned in previous sections of this CC analysis, the cost of these WWTP options are ultimately a comparison between Sabesp's required services and materials, including equipment, and those of the CEPT designs. The Table 5-2 presents the construction budget for the three alternatives. All prices are given in Brazilian Reais. The exchange rate used is R$1.20 per US$ 1.00 referring to the year 1998.

Table 5-2 Construction Costs for A1, A2 and A3

		A1	A2	A3
ITEM	*ESPECIFICATION*	*TOTAL PRICE*	*TOTAL PRICE*	*TOTAL PRICE*
1 Total	ADM/GENERAL FACILITIES	R$ 16.926,22	R$ 16.926,22	R$ 16.926,22
2 Total	TECHNICAL SERVICES	R$ 8.045,70	R$ 8.045,70	R$ 8.045,70
3 Total	PRELIMINARY SERVICES	R$ 74.520,00	R$ 74.520,00	R$ 74.520,00
4 Total	SOIL MOVEMENT	R$ 473.825,53	R$ 583.002,82	R$ 670.761,97
5 Total	DRAINGE & PUMPING	R$ 3.581,50	R$ 3.581,50	R$ 3.581,50
6 Total	FUNDATIONS & STRUCTURES	R$ 287.347,45	R$ 340.901,15	R$ 283.415,55
7 Total	PIPE INSTALATION	R$ 14.059,23	R$ 14.059,23	R$ 14.059,23
8 Total	PAVEMENT	R$ 37.995,00	R$ 37.995,00	R$ 37.995,00
9 Total	ALVENARIA	R$ 35.458,81	R$ 35.458,81	R$ 35.458,81
10 Total	PAINTING	R$ 85.715,79	R$ 85.715,79	R$ 85.715,79
11 Total	URBANIZATON	R$ 27.422,46	R$ 27.422,46	R$ 27.422,46
12 Total	GENERAL SERVICES	R$ 1.500,00	R$ 1.500,00	R$ 1.500,00
13 Total	SUPPLIES	R$ 1.342.490,61	R$ 823.349,26	R$ 823.349,26
14 Total	SPECIAL SERVICES	R$ 1.270,00	R$ 1.270,00	R$ 1.270,00
15 Total	SLUDGE TREAMENT	R$ 347.103,93	R$ 320.000,00	R$ 360.765,97
16 Total	OTHER	R$ 98.620,17	R$ 31.526,40	R$ 31.526,40
Final Total	ETE - CEAGESP (1st STAGE)	R$ 2.855.882,39	R$ 2.405.274,34	R$ 2.476.313,86

Although the CC of alternatives A2 and A3 of CEPT WWTP upgrading are only about 10% cheaper than the SABESP design, the operational cost of A2 and A3 is much lower than SABESP's (as will be shown in the section "Operation and Maintenance" ahead). For the detailed costs for these alternatives, refer to Appendix G . Below I describe the items where CETP technology represented a capital cost change. For detailed budget for

each item of all three alternatives, refer to Appendix G.

Construction Budget

This section describes the 3 budgets. Most of the item's prices were based on using Brazilian suppliers. All the prices refer to 1998, when Sabesp evaluated the A1 budget. All the pipe installations for the filter press, CEPT tank and CEPT storage facility are included.

Soil Movement

Generally, the most expensive part of a lagoon system WWTP construction budget, 30% to 35%, is the soil movement. Since, lagoons are essentially topographic arrangements, its price is related to the volume of soil displaced (excavated, borrowed and filled), the amount of sludge dredged (and disposed), trench excavation (for the pipe system), and dikes (compacted and protected with pre-cast concrete slabs). Since lagoon treatment relies on natural stabilization, it requires more area than alternative A1 treatment. Indeed, the design criteria for facultative and anaerobic lagoons are area load and volumetric load, respectively. Aerated lagoons, on the other hand, base their design criterion on power for the mechanical aeration to stabilize (oxidize) the organic matter in the wastewater. The settling lagoons only have to maintain a minimum hydraulic detention time for the maximum flow. The result is that alternatives A2 and A3 requires 2 and 2.3 times, respectively, the area of alternative A1. Refer to MIT CEPT Project for the specifications and details of the design of the three alternatives. Pages X, X and X (Appendix G) presents the required areas, depths as well as an estimate of the amount of

required services and supplies, such as, excavation and dredging volumes, concrete slab areas, dike lengths, etc.

Foundations and Structures

Foundations and structures represent 20% to 30% of a WWTP budget. This item contains the concrete related sub-items including services and materials for the construction of the facility's devices and sub-items related to foundations. There are only two differences between the alternatives in respect to structures and foundations. In alternative A2, a R$ 80,000.00 CEPT tank is included and the length (and total price) of dikes is about 30% less than alternative A1. Since the chemical addition for A3 will occur in the inlet of the anaerobic lagoon, no CEPT tank is necessary.

Supplies

In the item called Supplies, all the piping system is included. I estimate the same budget for the pipe network for the three alternatives, however the lists of hydraulic equipment change (List 3, Appendix G). In alternative A1, List 3 includes general hydraulic parts and all the aerators related equipment, for alternatives A2 and A3 the price of this equipment is deducted from the final price of the list (List 3 without aerators, Appendix G). List 4, with the electrical equipment, assumes the same price for the three alternatives. List 5 consists of the pumps, chemical tanks and other equipment related to the CEPT technology so these costs are included in alternatives A2 and A3. The overall cost of supplies is approximately the same for alternatives A1 and A2. However, the cost of supplies for alternative A3 is 40% less than A1. Appendix G shows the description

and price of all the lists of prices (Lists 3, 5 and 6, Appendix G).

Sludge Treatment

The item called Sludge Treatment includes all the structure, foundations and equipment for the sludge handling. The sludge treatment system used for A1 is the same as the one used for A3, i.e. a pump boat to pump the sludge from the bottom of the lagoon and SDBs to dewater the sludge. Alternative A2, however, uses composting instead of pump boat. For A3 the sludge is pumped from the CEPT tank to the filter press. After dewatering it is mixed with wood chips or ashes and set on windrows for the final stabilization. The price of composting, is a rough estimate since there is no previous Brazilian experience using it in municipal wastewater treatment.

Installation of Hydraulic and Electric Equipment

The installation of hydraulic and electric equipment item is considered as 10% and 20%, respectively, of the price of the equipment.

Operational and Maintenance Costs

This section will price the monthly operation and maintenance expenditures of operation of the three alternatives. Sabesp's design requires a complex operation because of the aeration system. The calibration of aerators requires a permanent efficiency control executed by the WWTP staff. The calibration of this equipment is based on the efficiency of the volume of air mixed, however, their efficiency changes during their lifetime use. Generally, the lifetime of an aerator ranges from 6 to 10 years, for the O&M evaluation of the alternative A1 it will be considered as 10 years. In alternative

A1 the aerators energy consumption and maintenance are estimated to be around R$25,000.00. On the other hand, operation of a lagoon wastewater treatment system is simple. In Brazil, it generally requires one operation assistant to control the vegetation growth at the borders of the lagoons and the alga growth in the lagoons and to maintain the site (fences, cleaning of facilities, etc.). The operation of a CEPT tank was designed to require one sludge removal per day. The experience of the operation staff also could reduce the chemical consumption by learning about low loading hours. For A2 and A3, the chemical concentration would initially be 50 ml/L and 25 ml/L, respectively, 12 hours per day. The pump boat used in alternatives A1 and A3 to remove the sludge from the settling lagoons and its O&M would cost R$ 3.000,00/month.

The total O&M cost varies among the three alternatives. The price of the CEPT's O&M alternatives is lower because is consists mainly of labor, which in Brazil is low. However, for alternative A2 the price of O&M is 2.3 times the O&M cost for A3 due to the inclusion of composting which is estimated as the salary of two extra assistants, the maintenance of the filter press and the biosolids handling (tractor and conductor). Nevertheless, both final CEPTs alternatives' O&M costs are lower than Sabesp's. A2 is 28% lower and A3 is 69% lower.

Alternative #1

In the Sabesp design the considerations for the monthly cost of the O&M of the facility essentially include staff salary, aerators energy consumption and maintenance. Table 5-3 shows the O&M for alternative A1

Table 5-3: O&M for A1

	Unit	Quantity	Price/unit	Total price/month
Pump Boat consumption & maitenance	R$/month	1	R$3.000,00	R$ 3.000,00
Energy consumption of aerators	hp	300	R$ 76,67	R$ 23.000,00
Assistants	R$/month	2	R$1.200,00	R$ 2.400,00
Engineer	R$/month	1	R$3.000,00	R$ 3.000,00
TOTAL				**R$ 31.400,00**

Alternative #2

The operation of a CEPT facility is simple and relatively cheap. The typical CEPT plant would have a monthly cost as a function of the price and quantity of chemicals used as well as the operational staff salary. The pumps used to ensure the proper chemical dosage and mixing require very low energy consumption and the price of chemicals represent around 10% of the final cost of O&M.

Table 5-4 has the cost of the optimum dosage of iron-salts chosen for the treatment. It was determined through jar tests (MIT CEPT Project, 1999). The price of the ferric chloride was considered US$ 180/ton.

Table 5-4: Optimum dosage of iron-salts chosen for the A2 treatment

Cost assuming 50 mg/L ($FeCl_3$)				
Mass of chemical		Volume of chemical		Price
Kg/day (dry)	Kg/month (dry)	l/day	l/month	R$ / month
348	10,433	248	7452	1,565

The price of composting was estimated based in two main aspects: the resulting biosolids have no market and the composting process is basically hand labor. Sludge from WWTP in Brazil is not commonly commercialized for agriculture and, in this budget analysis, it is not considered. The composting requires two assistants for the filter press and a tractor with operator. The time constrains for the preparation of this theses and the MIT CEPT Project resulted in a rough estimation of composting price in Brazil. Table 5-5 presents a estimation of monthly cost of A2.

Table 5-5: O&M for A2

	Unit	Quantity	Price/unit	Total price/month
Energy consumption of pumps	R$/month	1	R$ 500,00	R$ 500,00
Chemical consumption	kg	10,433	R$ 0,15	R$ 1.564,92
Energy consumptio of dewatering system	R$/month	1	R$ 2.000,00	R$ 2.000,00
Composting (tractor maintenance& fuel, operator,and related items)	R$/month	1	R$10.000,00	R$ 10.000,00
Pump Boat energy&maitenance	R$/month	1	R$ 3.000,00	R$ 3.000,00
Assistants	R$/month	2	R$ 1.200,00	R$ 2.400,00
Engineer	R$/month	1	R$ 3.000,00	R$ 3.000,00
TOTAL				**R$ 22.464,92**

Alternative #3

For Alternative A3 the optimal chemical concentration required for the settling of the

particles in the lagoon is much lower than in A2 since the detention time is much higher than in the settling tank. The detention time in the Alternative A2 is around one hour while in the Alternative A3 it is around 1,5 days. Refer to the MIT CEPT Project for details about optimum chemical dosage. Table 5-6 is the cost of the optimum dosage of iron-salts and polymer chosen for the treatment.

Table 5-6: Optimum dosage of iron-salts chosen for the A3 treatment

Cost assuming 25 mg/L ($FeCl_3$)				
Mass of chemical		Volume of chemica		Price
Kg/day (dry)	Kg/month (dry)	L/day	L/month	R$ / month
174	5216	124	3726	938,952

Alternative A3 requires mainly an assistant to maintain the facility, the chemicals, and an engineer to supervise. Table 5-7 shows the monthly expenditure f A3.

Table 5-7: O&M for A3

	Unit	Quantity	Price/unit	Total price/month
Energy consumption of pumps	hp	1	R$ 500,00	R$ 500,00
Pump Boat (depretiation, consumption and maitenance)	R$/month	1	R$3.000,00	R$ 3.000,00
Chemical consumption	kg	5216,4	R$ 0,18	R$ 938,95
Assistants	R$/month	2	R$1.200,00	R$ 2.400,00
Engineer	R$/month	1	R$3.000,00	R$ 3.000,00
TOTAL				**R$ 9.838,95**

Concession Analysis for Tatui

There are several possible criteria for the choice of the best alternative, the one with the best overall efficiency, the one with the minimal environmental impact, the one with the minimal required area, etc. Since the overall efficiencies of the three alternatives are similar (Gotovac, 1999), and they occupy the same area, the goal in this thesis is to select the best alternative using cost as the screening mechanism. To accomplish it, investments parameters such as capital cost, operation and maintenance cost, present value, payback period, internal rate of return and benefit cost ratio are compared in a 10-year concession scenario

A concession is a effective way to analyze the investment for the construction and operation of a WWTP in Brazil. In this section, I present a comparison of the three hypothetical concession alternatives as a means to evaluate the CEPT designs. To accomplish this financial comparison, I chose three investment parameters: present value (PV), internal rate of return (IRR) and payback period (PP). The revenues of these hypothetical concessions would come from 50% of a wastewater treatment tariff of R$ 0,50, i.e. R$ 0,25/m3 of wastewater treated. I am assuming an average population growth for the concession period of 1,5% per year. The PV of a project is the most important parameter for an investment analysis, it considers the CC plus all the O&M annual costs. Both CEPT designs, A2 and A3, have significant reduction in PV (21% and 37%, respectively), relative to A1 largely because of the difference in the O&M costs. The IRR is the standard comparison index for long term projects. In general, a concession IRR has to be greater than 15% to be considered profitable. The PP is the

number of years required for a investment to be "bankable." This means the number of years to pay the initial investment and return some profit to the investor after the concession is over. In alternative A1, the revenues will never pay the initial investment. The Table X presents the PV, IRR and PP for A1, A2 and A3 considering a 10-year project life and a financing of 12% percent per year. This relatively short project design period of 10 years was selected at the recommendation of the Sabesp staff from Tatui. There is no insurance or inflation considered, since both these items can vary considerably.

Table 20 presents the PV, IRR and PP for A1, A2 and A3

Table 5-8: PV, IRR and PP for A1, A2 and A3

	A1	A2	A3
O&M (/year)	R$ 376.800,00	R$ 269.579,04	R$ 118.067,42
Capital Cost (CC)	R$ 2.855.882,39	R$ 2.405.274,34	R$ 2.476.313,86
Present Value	R$4.984.886,43	R$3.928.456,04	R$3.143.421,13
CC amortization	R$505.445,96	R$425.695,47	R$438.268,34
Payback Period	non payable	12	5
Internal Rate of Return (IRR)	3%	13%	20%
Present Value of Revenues	R$6.180.154,76	R$6.180.154,76	R$6.180.154,76
Benefit Cost Ratio	1,2	1,6	2,0

Chapter 6 - Summary and Conclusion

Summary

In this theses, the water and sanitation sector in Brazil is described in order to evaluate the present situation of legal structure of the sector and the policy requirements for a successful concession in the case study of the upgrade of Tatui WWTP upgrading. Chapter 2 – Brazilian Background presents the relation between health and water and sanitation development, using child mortality statistics. It also briefly explores the history of the water and sanitation sector.

In Chapter 3, I analyze the present models of public administration and introduce Brazilian water services authorities, such as, Cesbs and Saaes. I also show their differences regarding their financing. Chapter 3, points out important sections of Law 8666/93, which regulates the legislation concerning privatization and concession. Finally, the World Bank privatization policy is shown and compared with the present situation of the privatization process in Brazil.

In Chapter 4, several examples of concessions in the water and/or sewer sector are listed. Some of these concessions have been highly successful and one, Limeira's, suggests possible contract problems between the Municipality and the concessionaire.

Chapter 5 provides an overview of a possible technology (CEPT) as an upgrading alternative for overloaded wastewater lagoons. The chapter describes the budget comparison of two CEPT designs and the proposed SABESP design. The most

important expenditures of a concession are the O&M costs, which, as estimated in this chapter, are much lower for the CEPT alternatives. O&M is an important parameter because when calculating the present value of a project, which is composed of capital cost and the O&M expenditures during the life of the project, it can represent from 43% (for A1) to 21% (for A3) of the present value of the investment. Chapter 5 shows the possible savings using CEPT in lagoon treatment systems when compared to aerated lagoons followed by sedimentation basins. Finally the chapter describes a hypothetical concession of Tatui WWTP as a means to compare the three alternative investments.

Conclusion

I have used cost (PV, IRR, PP and BC) as the most important criterion to screen treatment alternatives. Applying this criterion leads us to the conclusion that alternative A3 is the most suitable one, since the O&M cost for alternative is around 1/3 of Sabesp's expected monthly expenditure. However, to be able to introduce this technology in a concession in Brazil, several regulatory improvements would have to be achieved. Policy changes required for improvement in the concession process are related to the definition of the Federal-State-Municipal-Concessionaire responsibility.

The federal government will play the most important role in order to achieve the required decentralization degree of water and wastewater services. Municipalities must be aware of their water and wastewater service responsibility and the federal government must give them the tools to do so.

In order to prepare municipalities for their water and wastewater service privatization,

the Federal government is obliged to provide:

- Definition of environmental standards;
- Responsibility over interstates water bodies;
- Cross subsidies in the national economy level;
- Bids credibility;
- Technical guidance;
- Regulatory support;
- Funds provision (national/international) for non-profitable water systems;
- General planning of the sector development;

State participation during the privatization process of municipalities will be mainly related to monitoring of:

- Water and wastewater system performance;
- National environmental standards enforcement;
- Investments planning;

Municipalities will have to learn about their role and responsibilities, since their efforts must be towards the determining the best concession agreement for their water system, and the local supervision of the service.

Once decentralization measurements are taken, it will be up to the intended concessionaires to present the suitable financial agreement and/or technical alternative to the municipality.

Only then will appropriate technologies, such as CEPT, be applied successfully!

Appendix A

Table 1: Price of base consumption (R$/10m3) for all Cesbs

Caern (RN)	16,85
Corsan (RS)	10,20
Cesan (ES)	12,45
Casan (SC)	8,30
Saneatin (MG)	7,65
Sanepar (PR)	7,21
Caerd (RO)	7,20
Cedae (RJ)	6,83
Saneago (GO)	6,20
Casal (AL)	6,00
Sanemat (MT)	6,00
Saneatins (TO)	6,00
Cosanpa (PA)	5,80
Copasa (MG)	5,74
Sabesp (SP)	5,50
Agespisa (PI)	5,35
Cagepa (PB)	5,04
Deso (SE)	4,94
Cosama (AM)	4,80
Caesa (AP)	4,73
Caema (MA)	4,31
Embasa (BA)	4,25
Saneago (AG)	3,77
Compesa (PE)	3,60
Caesb (DF)	3,47
Caer (RR)	3,43
Cagece (CE)	2,80

Appendix B

PRINCIPLES

Article 1 - This Law establishes general rules on bidding and administrative contracts regarding works, services, including publicity, purchases, disposals and leasing within the scope of the Powers of the Federation, the States, the Federal District and the Municipalities.

Sole Paragraph - Besides direct Administration entities, special funds, government agencies, public foundations, state-owned companies, private and public joint stock companies and other entities directly or indirectly controlled by the Federation, the States, the Federal District and the Municipalities shall also comply with this Law.

Article 2 - Public Administration's works, services, including publicity, purchases, disposals, concessions, permits and leases, where outsourced, shall be mandatorily preceded by bidding, with due regard to the exceptions herein provided for.

Sole Paragraph - For the purposes of this Law, contract means every and all agreement between agencies or entities of the Public Administration and private entities, to establish a relationship and reciprocal obligations, regardless of the denomination used for such purpose.

Article 3 - The bidding aims at guaranteeing compliance with the constitutional isonomy principle and at selecting the most advantageous offer for the Administration, and shall be considered and decided on pursuant to the strict principles of legality, impersonality, morality, impartiality, publicity, administrative probity, binding to the invitation to bid, objective judgment and related principles.

§ 1 Public agents are forbidden to:

I - admit, plan, include or tolerate, in the bidding notice acts, clauses or conditions that impair, restrain or frustrate the competitive character thereof or that establish priorities or privileges as regards the nationality, head office or domicile of the bidders or as regards any other inappropriate or irrelevant condition for the specific object of the contract;

II - establish a discriminatory treatment of commercial, legal or labor nature, or to give priority to Brazilian or foreign companies as regards currency, modality and local for payment, even when financing from international agencies are involved, except for the provisions set forth in the next paragraph and in article 3 of Law No 8.248 of October 23, 1991.

Article 4 - All of the participants to the bidding sponsored by the agencies or entities referred to in Article 1 have the public right, subject to due compliance with the pertinent procedures set forth herein, and any citizen may follow the progress of such procedures, provided that he/she does not cause any disturbances nor prevents the development of the works.

Sole Paragraph - Bidding procedures provided for by this Law characterize formal administrative acts, irrespective of the level of the Public Administration in which it takes place.

Article 5 - Any and all values, prices and costs used in the bidding shall be expressed in domestic currency, except for the provisions of article 42 of this Law, and each unit of the Administration shall, upon payment of the obligations related to the supply of goods, leasing, completion of works and service rendering, comply with, depending on each different source of resources, the strict chronological order of the date of its obligations, except when material reasons of public interest are present and upon prior justification by the pertinent authority, duly published.

§ 1 - The credits referred to in this article shall be corrected by criteria provided for in the invitation to bid and such criteria shall preserve their values.

§ 2 - The correction mentioned in the above paragraph, whose payment shall be made together with the principal, shall comply with the same budget appropriation related to the credits to which it refers.

DEFINITIONS

Article 6 - For purposes of this Law, the following terms shall mean:

I - Work - any construction, refurbishment, manufacture, recovery or enlargement, directly or indirectly carried out;

II - Service - every activity aimed at obtaining a specific benefit of the interest of the Administration such as: demolition, repair, installation, assemblage operation, conservation, repair, adaptation, maintenance, transportation, lease of assets, publicity, insurance or technical-professional works;

III - Purchase - every remunerated acquisition for the supply of goods, to take place just once or in as many times as necessary;

IV - Disposal - every transfer of the ownership of assets to their parties;

V - Large scale works, services and purchases - those whose estimated value is higher than twenty five times (25) the limit established in sub-item "c" of paragraph 23 of this Law;

VI - Performance Bond - the bond that guarantees due compliance with the obligations assumed by companies in the bid and contracts;

VII - Direct Execution - the one carried out by the Administration's agencies and entities, with their own resources;

VIII - Indirect Execution - the agency or entity that contract third party's services, under any of the following systems:

a) contract work for a global price - work or service contracted for a fixed and global price;

b) contract work for a unit price - work or service contracted for a fixed price regarding specific units;

c) (vetoed)

d) task contract - labor contracted for small services, for a fixed price, whether including or not the supply of materials;

e) total contract work - work contracted in its entirety, including all of its stages, the necessary services and installations, under the total responsibility of the contractor until delivery of the work to the client, and in conditions to start operation pursuant to technical and legal requirements for its use under structural and operational safety conditions and having the characteristics adequate to the purposes to which it was contracted.

IX - Final Design - a set of essential and sufficient elements with the adequate level of precision to characterize the work or service, or the group of works or services object of the bidding, prepared according to the preliminary technical studies that guarantee the technical feasibility and the adequate treatment of the work's environmental impact and which allows for an assessment of the work cost and the definition of the methods and term for the execution. The Final Design shall include the following items:

a) development of the selected solution so as to provide for a global overview of the works and clear identification of all its components;

b) global and focused technical solutions, described in sufficient details so as to minimize the need of reformulating or adopting alternatives during the various stages of the detailed design and performance of works and assemblage;

c) identification of the types of services to be executed and the material and equipment to be incorporated to the works, as well as their respective specifications, in order to ensure the best results for the enterprise, without impairing the competitive character of its execution;

d) information that allow for the study and assumption of constructive methods, temporary facilities and organizational conditions for the work, without impairing the competitive character of its execution;

e) subsidies for the preparation of the bid's plan and management of works, including its time schedule, supply strategy, rules for inspection and other essential data for each case;

f) detailed budget of the works' global cost, based on duly appraised quantity of services and supplies;

X - Detailed Design - the set of essential and sufficient elements for the complete execution of the work, according to applicable rules set forth by the *Associação Brasileira de Normas Técnicas* - ABNT (The Brazilian Association of Technical Standards);

XI - Public Administration - the Federation, States, Federal District and Municipalities' direct or indirect Administration, including public legal entities under the control of the

public power or of the foundations created or maintained by it;

XII - Administration - agency, entity or administrative unit through which the Public Administration effectively operates and acts;

XIII - Official Press - official press used to publicize acts of the Public Administration, where the "Federal Official Gazette" is the one used by the Federation; and the ones determined in the respective laws are used by the States, the Federal District and the Municipalities;

XIV - Client - entity or agency undersigning the contractual instrument;

XV - Contractor - individual or legal entity undersigning the contract entered into with the Public Administration;

XVI - Committee - permanent or special committee, established by the Administration with the purpose of receiving, examining and judging all of the documents and procedures related to bidding and the registration of bidders.

QUALIFICATION

Article 27 - In order to qualify for the bidding the interested parties shall only be required to submit the following documents:

I - legal capacity;

II - technical ability;

III- economic and financial ability;

IV - regular tax status.

Article 28 - Documents related to legal capacity, as the case may be, shall include:

I - Identity card;

II - trade registration, in the case of individual company;

III - duly registered articles of incorporation, bylaws or articles of association in force, in the case of business companies and documents evidencing the election of directors, in

the case of joint stock companies;

IV- registration of the articles of incorporation, in the case of civil associations, together with evidence of election of the board of officers presently in office;

V - authorization decree, in the case of a foreign company operating in the country and the registration or authorization issued by the proper agency, where the activity so requires.

Article 29 - Documents related to regular tax status, as the case may be, shall include:

I - evidence of enrollment in the taxpayers' list (*Cadastro de Pessoas Físicas* - CPF - *Cadastro Geral de Contribuintes* - CGC);

II - evidence of regular status as regards payment of federal, state or municipal taxes in the place in which the bidder is domiciled or headquartered, or equivalent, pursuant to the law;

IV - evidence of regular status as regards payment of the Employee's Dismissal Fund (*Fundo de Garantia por Tempo de Serviço*- FGTS), showing the regular payment of

social charges determined by law;

BIDDING PROCEDURES AND DECISION

Article 38 - Bidding procedures shall start with the opening of a duly announced, officially recorded and numbered administrative proceeding containing the respective authorization, a concise indication of its object and of own provisions for expenses and the following documents shall be attached to it:

I - invitation to bid or invitation and respective attachments, as the case may be;

II - evidence of the publications of the abridged invitation to bid, pursuant to article 21 of this Law or evidence of the delivery of the invitation;

III - act for the appointment of a bidding committee, of the administrative or official auctioneer or persons responsible for the invitation;

IV - original copy of the proposals and the documents attached thereto;

V - minutes, reports and resolutions by the Judging Committee;

VI - expert or legal opinions issued on the bidding, bidding exemption or non-requirement;

VII - awarding acts regarding the object of bidding and respective homologation;

VIII - appeals eventually submitted by bidders and their respective opinions and decisions;

IX - order for bidding cancellation or revocation, as the case may be, well-founded on detailed conditions;

X - contract or equivalent instrument, as the case may be;

XI - other evidence of publications;

XII - other documents regarding the bidding.

Sole paragraph - The drafts of the invitations to bid, as well as the drafts of contracts, agreements, covenants or arrangements shall be previously examined and approved by the Administration's legal staff.

Article 40 - The preamble to the invitation to bid shall contain the number of the order, in annual series, the name of the interested division and its sector, the modality, the system of execution and the type of bidding, the indication that the bidding shall be governed by this Law, the local, date and time for receiving the documentation and the proposal as well as for the opening of the envelopes and shall, mandatorily, include the following:

I - a concise and clear description of the object of the bidding;

II - the term and conditions for the performance of the contract, or withdrawal of the documents, as provided for in article 64 hereof, for the performance of the contract and for the delivery of the object of the bidding;

III - penalties for events of default;

IV - place at which the Final Design may be examined and acquired;

V - if a Detailed Design is available on the date of the publication of the invitation to bid and the place where it may be examined and acquired;

VI - conditions for participation in the bidding, according to articles 27 to 31 of this law and form to submit the proposals;

VII - criterion for decision, including clear provisions and objective parameters;

VIII - place, time and access codes of the remote media which shall supply the elements, information and clarification regarding the bidding and the conditions to meet the obligations necessary for the performance of the object of the bidding;

IX - equivalent payment conditions for Brazilian and foreign companies, in the case of international bidding;

** XI - adjustment criterion that shall reflect the effective production cost variation. The adoption of specific or sectoral indexes from the date scheduled for submitting the proposal or the budget to which this proposal refers to until the date of the performance of each installment shall be allowed ;

§ 1 - The original copy of the invitation to bid shall be dated, and all of its pages shall be initialed by the authority that issued it and shall be kept attached to the bidding proceedings. Integral or concise copies of the invitation to bid may be taken for its publicity and supply to the interested parties.

§ 2 - The following are attachments to the invitation to bid and shall be an integral part thereof:

I - the basic and/or detailed Design, including all of its parts, drawings, specifications and other complements;

II - estimated budget, in spreadsheets, containing the quantities and unit prices;

III - a draft of the contract to be entered into by and between the Administration and the bid winner;

IV - complementary specifications and performance rules relevant to the bidding;

Article 45 - Judgment of the proposals shall be objective and the Bidding Committee or entity responsible for the invitation shall render such decision in compliance with the type of concession and criteria previously established during the summoning act and pursuant to the factors exclusively referred to in such act, in order to ensure bidders and

controlling entities the means to verify the decision.

§ 1 - For purposes of this article, the following are types of bidding, except in the case of a contest:

I - lowest price bidding - whenever the selection criteria for choosing the most advantageous proposal for the Administration determines that the winner shall be the one who submits a proposal according to specifications set forth in the invitation to bid and offers the lowest price;

II - the best technique bidding;

III - price and technique bidding;

IV - highest bidding or offer - in the case of disposal of assets or concession of real right to use *(direito real de uso).*

Appendix C

Table 1: World Bank web page :Toolkit 3

(http://www.worldbank.org/html/fpd/wstoolkits/Kit3/frame.html)

Concession Arrangements: Legal, Financial, and Regulatory Issues

Who are the parties to the arrangement?

What are the object and scope of the agreement?

What is the duration of the concession, and what might lead to early termination?

What are the obligations of the concessionaire?

What are the obligations of the grantor?

What are the key regulatory provisions?

How will key risks be managed?

How will performance be measured and monitored?

How will assets be transferred to the concessionaire?

What consents are required?

Who will be responsible for environmental liabilities?

How will disputes be resolved?

Build-Operate-Transfer Arrangements: Legal, Financial, and Regulatory Issues

Who are the parties to the contract?

What are the object and scope of the BOT arrangement?

What is the duration of the BOT arrangement, and what might lead to early termination?

What are the obligations of the BOT operator?

What are the obligations of the grantor?

What are the key regulatory provisions?

How will key risks be managed?

How will performance be measured and monitored?

How will assets be transferred to the BOT operator?

What consents are required?

Who will be responsible for environmental liabilities?

How will disputes be resolved?

Management Contracts: Legal, Financial, and Regulatory Issues

Who are the parties to the contract?

What are the object and scope of the management contract?

What is the duration of the contract?

What are the rights and obligations of the operator?

What are the obligations of the grantor?

How will performance be measured and monitored?

What consents are required to operate the facility?

Who will be responsible for environmental liabilities?

How will disputes be resolved?

Table 2: Risk Allocation on Privatization Processes according to the World Bank

Key risks					
What is the risk?	**How does it arise?**	**What steps can mitigate the risk?**	**Who typically bears the remaining risk?**	**In what types of contract does the risk arise?**	**What steps can minimize risks?**
Design and development risk					
Design defects in water or sewerage plant.	Design fault in tender specifications.	Require the public sector to provide a remedy or compensate the project company.	The public sector.	BOT, concession (especially with new infrastructure).	Check tender specifications.
	Design contractor fault.	Include provisions in the design contract requiring the contractor to provide a remedy or pay damages (insurance cover).	The design contractor. Once liquidated damages are exhausted, finance from project lenders is drawn down.*	BOT, concession (especially with new infrastructure).	Monitor design work; replace contractors insurance.

Construction risk					
Cost overrun.	Within the construction consortium's control—inefficient working practices, waste of materials.	Provide for cost overrun in fixed lump sum price in the construction contract.	The construction contractor. Once liquidated damages are exhausted, standby finance is drawn down.	Concession, BOT.	Monitor and inspect construction work; provide for early warning mechanisms in the contract.
	Beyond the construction consortium's control—changes in a law, delays in obtaining approvals or permits, increased taxes.	Allocate cost overruns in the concession contract; purchase business interruption insurance.	The insurer. Once insurance proceeds are exhausted, the investor's return might be eroded because of timing effects.	Concession, BOT.	Obtain approvals in advance; anticipate problems and allocate risk in contract; use insurance.

Delay in completion.	Within the construction consortium's control—lack of coordination of subcontractors.	Require liquidated damages from the turnkey contractor under the construction contract (sufficient to cover interest due to lenders and fixed operating costs).	The constructor. Once liquidated damages are exhausted, standby finance is drawn down.	Concession, BOT.	Monitor and inspect construction work; provide for early warning mechanisms in the contract.
	Beyond the construction consortium's control—insured force majeure event.	Draw on proceeds from business interruption insurance policy.	The insurer. Once insurance proceeds are exhausted, standby finance is drawn down, debt service coverage ratios will be reduced, and investor's return might be eroded.	Concession, BOT.	Rely on insurance.

Failure of plant to meet performance criteria at completion tests.	Within the construction consortium's control—quality shortfall, defects in construction.	Require liquidated damages payable by the construction consortium, supplemented by insurance.	The construction consortium and, once liquidated damages are exhausted, the insurer. Once insurance proceeds are exhausted, investor return is eroded.	Concession, BOT.	Monitor and inspect construction work; provide for early warning mechanisms; use insurance.
Operating risk					
Operating cost overrun.	Change in operator's practices at project company's request.	Require project company to provide a remedy or compensation under the operating contract.	The project company bears the risk under the operating contract; debt service coverage ratios are reduced; sponsor's return is eroded.	Operation and maintenance, concession, BOT.	Build flexibility into contract; cost changes in practices in advance; define acceptable reasons for changes; provide for changes in remuneration after initial period.

	Operator failure.	Require liquidated damages payable by the operator under the operating contract.	The operator. Once liquidated damages are exhausted, debt service coverage ratios and return are reduced.	Operation and maintenance, concession, BOT.	Monitor and inspect operating practices; provide for early warning mechanisms.
Failure or delay in obtaining permissions, consents, approvals.	Public sector discretion.	Allocate risk in the operating contract.	The public sector. Where there is no public sector discretion, licenses are processed quicker by the project company, so the project company bears the risk.	Operation and maintenance, concession, BOT.	Obtain approvals in advance where possible; ensure clear division of responsibilities in the contract.

Shortfall in water quality or quantity.	Operator's fault (malpractice).	Require liquidated damages payable by the operator.	The operator. There is no effect on other parties until liquidated damages are exhausted, when debt service coverage ratios are reduced and the owner's return is eroded.	Operation and maintenance, concession, BOT.	Monitor and sample water quality and quantity; provide for early warning mechanisms.
	Project company's fault.	Require liquidated damages payable by project company to the public authority.	The project company. There is no effect on other parties until payment of liquidated damages completely erodes shareholder returns, when cash flow may become insufficient and the project company's return is eroded.	Operation and maintenance, concession, BOT.	Quantity: ensure security of supply; enter into bulk water supply contract. Quality: monitor and sample water quantity; provide for early warning mechanism.

Revenue risk					
Increase in bulk water supply price.	Service difficulties; no security of supply.	Allocate risk by contract; adjust tariffs; if there are off-take and bulk water supply agreements, both guaranteed by the government, pass through the price increase.	As allocated by contract; bulk water supplier.	Lease, concession, BOT.	Fix price by contract and pass through price increase.
Change in tariff rates.	Fall in revenue.	Risk depends on extent of government support. There is usually no market risk in water prices if an off-take agreement is in place. If not, owners may use hedging facilities such as forward sales, futures, and options.	The project company. There is no effect unless there is no common off-take agreement and unless hedging facilities are not in place or do not compensate for losses, in which case the return can be severely reduced.	Lease, concession, BOT.	Ensure a clear regulatory regime.

Water demand.	Decreased demand.	Risk depends on extent of government support. Use shadow tolls; use long-term take-or-pay off-take agreement that leaves the demand risk with the public utility (guaranteed by the government).	Risk depends on extent of government support. If there is no support and no off-take agreement, the risk is borne by the project company.	Lease, concession, BOT.	Ensure exclusivity of supply.
Financial risk					
Exchange rate.	Devaluation of local currency, fluctuations in foreign currencies.	Include in security package hedging facilities against exchange rate risks such as currency rate swaps, caps, and floors.	There is no effect unless hedging facilities are not in place or do not compensate for losses, in which case the return can be severely reduced.	Operation and maintenance, concession, BOT.	Require loans in local currency and same currency as revenue.

Foreign exchange.	Nonconvertibility or nontransferability.	Have the government guarantee availability, convertibility, and transferability (with the ministry of finance a party to the contract); if the government defaults, the project company can terminate. Have the central bank ensure the continuing availability of foreign exchange.	The government. If the government defaults on its guarantee and the project company terminates, the government pays compensation for termination.	Operation and maintenance, concession, BOT.	Transfer funds offshore as much as possible.
Interest rate.	Fluctuations in interest rates.	Same as above (for hedging facilities against exchange rate risks).	See above (exchange rates).	Operation and maintenance, concession, BOT.	Negotiate fixed rate loans.
Force majeure risk					

Force majeure.	Flood, earthquake, riot, strike.	If risk relates to an insured event (such as earthquakes in certain regions), the policy is called; if not, standby finance is drawn down.	The insurer. There is no effect unless the event is not insured or is uninsurable. If the insurance policy is exhausted, there might be a severe impact on project returns.	Operation and maintenance, concession, BOT.	Use insurance and government guarantees; clearly define force majeure in contract; include provision in contract that if the changes are specific to the project (rather than general), the government bears the risk.
Legal and regulatory.	Changes in tax law, customs practices, environmental standards.	If during the operating period, adjustment is possible (see provisions in contract on compensation).	The project company or operator.	Operation and maintenance, concession, BOT.	
		If during the construction period, draw down standby finance.	The contractor. Standby finance could be required.	Operation and maintenance, concession, BOT.	

Political.	Breach or cancellation of the concession.	The project company is entitled to terminate if the government defaults.	The government pays compensation to the project company if the company terminates.	Operation and maintenance, concession, BOT.	Use insurance.
	Expropriation.	Take out political risk insurance with official bodies, such as export credit agencies, with private companies, orinvolve multilateral agencies (IBRD, IFC) in the financial package.	Once the insurance policy is exhausted, the project company bears the risk. See clause in contract on expropriation.	Operation and maintenance, concession, BOT.	Use insurance.
	Failure to obtain or renew approvals.	See contract.	The government.	Operation and maintenance, concession, BOT.	Obtain approvals in advance where possible.

	Creeping expropriation (discriminatory) taxes, revocation of work visas, import restrictions.	See contract.	See contract. If the government has discretion, it should bear the risk.	Operation and maintenance, concession, BOT.	
	Interference causing severe prejudice (sometimes referred to as force majeure).	See contract.	The government.	Operation and maintenance, concession, BOT.	
Insurance risk					
Uninsured loss or damage to project facilities.	Accidental damage.	Insure against all the main risks.	Once standby debt finance is drawn down, the project company's return is reduced.	Operation and maintenance, concession, BOT.	Quantify and allocate risk in advance in the contract.
Environmental risk					

Environmental incidents.	Operator's fault.	Require indemnity from the operator.	The operator. There is no effect unless the operator's payments are exhausted and standby finance is drawn down, in which case the project company's return is reduced.	Operation and maintenance, concession, BOT.	Use insurance.
	Preexisting environmental liability.	Provide for public sector cleanup or compensation.	The public sector.	Operation and maintenance, concession, BOT.	Carry out detailed environmental survey; use insurance.

* Liquidated damages are payments that the contractor or operator is required to make to the sponsor of the project if specified performance targets or milestones are not reached. They are capped at a percentage of the contract's value. The amount of the liquidated damages is agreed at the contract's signing.

Concession Arrangements: Legal, Financial, and Regulatory Issues

Scenario

A public utility provides water and sanitation services to customers through an inadequate and outdated distribution network. Substantial capital investment is needed to make up for years of underinvestment: only a small number of people in the service area have sewerage connections, and the water supply cannot meet rapidly increasing demand. The distribution reservoirs, pumping stations, water treatment plants, and distribution network all need upgrading. The government has determined that it can gain stakeholder and political support for involving the private sector in the provision of water and sanitation services. It has also found that the country's broad regulatory framework is consistent with private sector involvement and that private investment in water and sanitation will not involve undue risks to consumers or to private investors, and it has established that the tariffs necessary to cover the required investments are politically and economically feasible. So it has decided to seek a concession for operation and expansion of water and sanitation services.

Build-Operate-Transfer Arrangements: Legal, Financial, and Regulatory Issues

Scenario

The systems for supplying bulk water and treating wastewater cannot keep pace with demand—new capacity is needed. The water distribution and sewage collection systems are functioning well, however, with low physical and commercial losses. And tariffs

allow full cost recovery—or could readily be raised to a level at which they would. These are conditions conducive to private sector involvement, a possibility for which there is reasonable political support. So the public authority turns to the private sector to provide the new capacity needed by constructing and operating a new plant for bulk water supply and sewage treatment on a greenfield site—under a build-operate-transfer (BOT) arrangement.

Management Contracts: Legal, Financial, and Regulatory Issues

Scenario

A management contract might be chosen as a means of improving operational efficiency in a mature water and sanitation utility, where there is no need for substantial new investment, or where there is insufficient political support for moving to a lease arrangement (in which the private sector would take on commercial risk). More often, however, management contracts are seen as an initial step toward more substantial private sector involvement in countries or cities where initial conditions are not conducive to private sector investment and risk-taking because, for example:

"The information available about the state of the system is poor. Tariffs are below cost recovery levels and can be raised only slowly, and there are no government budgetary resources for substantial subsidies. The government lacks the capacity to administer a complex arrangement for private sector participation over the long term.

The government has no track record as a regulator, or a poor one, and there is no credible regulatory framework."

In such cases a management contract can allow gains in the efficiency of service delivery and in the quality of services, and provide a "window" during which deficiencies in the regulatory framework can be remedied and information about the system improved.

Appendix D

Table 1: Limeira concession of water and wastewater system

Concession General Characteristics		
Total Investment:	100	Million
Initial Investment:	6,15	Million
Upgrade Invest.	Varies	
Max. Concession Period	30	Years
Deferral Period	24	Months
Income		
Consumer Growth	1,50%	/year
Payments/month	R$1,50	Million
Payments/year	R$19,02	Million
Inflation/month	1%	
Insurance		
Project fraction	30%	
Insurance Tax	6%	
Interest/year	6%	

Table 2: Present agreement of Limeira's concession

Date	Year	Income	Investments	Insurance	Operation Costs	Total Cost	Net Benefit	NPV	Cost/ Benefit
1995	1		-4.10	-1.80	-1.90	-7.80	-7.80	-7.80	3.5
1996	2	19.02	-4.10		-2.05	-6.15	12.88	4.61	
1997	3	20.47	-4.10		-2.20	-6.30	14.17	19.05	
1998	4	22.02	-7.54		-2.37	-9.91	12.11	32.30	
1999	5	23.69	-7.54		-2.55	-10.09	13.60	47.84	
2000	6	25.49	-7.54		-2.74	-10.28	15.21	65.92	
2001	7	27.43	-7.54		-2.95	-10.49	16.93	86.81	
2002	8	29.51	-7.54		-3.17	-10.71	18.79	110.82	
2003	9	31.75	-7.14		-3.42	-10.56	21.19	138.65	
2004	10	34.16	-7.14		-3.67	-10.82	23.34	170.31	
2005	11	36.75	-7.14		-3.95	-11.10	25.65	206.18	
2006	12	39.54	-7.14		-4.25	-11.40	28.14	246.69	
2007	13	42.54	-7.14		-4.58	-11.72	30.82	292.31	
2008	14	45.77	-7.14		-4.92	-12.07	33.70	343.55	
2009	15	49.24	-7.14		-5.30	-12.44	36.80	400.97	
2010	16	52.98			-5.70	-5.70	47.28	472.30	
2011	17	57.00			-6.13	-6.13	50.87	551.51	
2012	18	61.33			-6.60	-6.60	54.73	639.33	
2013	19	65.98			-7.10	-7.10	58.88	736.57	IRR
2014	20	70.99			-7.64	-7.64	63.35	844.12	169%

Table 3: Concession alternative number 2 for Limeira's agreement, with an initial investment of R$80 million.

Date	Year	Income	Investments	CC	Operation Costs	Total Cost	Net Benefit	NPV	Cost/ Benefit
1995	1	0.00	-4.10	-80.00	-1.90	-86.00	-86.00	-86.00	2.1
1996	2	19.02	-4.10		-2.05	-6.15	12.88	-78.29	
1997	3	20.47	-4.10		-2.20	-6.30	14.17	-68.82	
1998	4	22.02	-7.54		-2.37	-9.91	12.11	-60.83	
1999	5	23.69	-7.54		-2.55	-10.09	13.60	-50.88	
2000	6	25.49	-7.54		-2.74	-10.28	15.21	-38.73	
2001	7	27.43	-7.54		-2.95	-10.49	16.93	-24.11	
2002	8	29.51	-7.54		-3.17	-10.71	18.79	-6.77	
2003	9	31.75	-7.14		-3.42	-10.56	21.19	14.01	
2004	10	34.16	-7.14		-3.67	-10.82	23.34	38.19	
2005	11	36.75	-7.14		-3.95	-11.10	25.65	66.14	
2006	12	39.54	-7.14		-4.25	-11.40	28.14	98.25	
2007	13	42.54	-7.14		-4.58	-11.72	30.82	134.96	
2008	14	45.77	-7.14		-4.92	-12.07	33.70	176.76	
2009	15	49.24	-7.14		-5.30	-12.44	36.80	224.17	
2010	16	52.98			-5.70	-5.70	47.28	284.89	
2011	17	57.00			-6.13	-6.13	50.87	352.86	
2012	18	61.33			-6.60	-6.60	54.73	428.75	
2013	19	65.98			-7.10	-7.10	58.88	513.36	IRR
2014	20	70.99			-7.64	-7.64	63.35	607.51	21%

Table 4: Concession Alternative 2 for Limeira agreement with wastewater tariff reduced 70%

Date	Year	Income	Investments	Insurance	Operation Costs	Total Cost	Net Benefit	NPV	Cost/ Benefit
1995	1		-4.10	-1.80	-0.57	-6.47	-6.47	-6.47	1.4
1996	2	5.71	-4.10		-0.61	-4.71	0.99	-5.87	
1997	3	6.14	-4.10		-0.66	-4.76	1.38	-4.84	
1998	4	6.61	-7.54		-0.71	-8.25	-1.64	-6.77	
1999	5	7.11	-7.54		-0.76	-8.30	-1.20	-8.38	
2000	6	7.65	-7.54		-0.82	-8.36	-0.72	-9.59	
2001	7	8.23	-7.54		-0.89	-8.43	-0.20	-10.37	
2002	8	8.85	-7.54		-0.95	-8.49	0.36	-10.63	
2003	9	9.52	-7.14		-1.02	-8.17	1.36	-9.91	
2004	10	10.25	-7.14		-1.10	-8.25	2.00	-8.50	
2005	11	11.02	-7.14		-1.19	-8.33	2.70	-6.32	
2006	12	11.86	-7.14		-1.28	-8.42	3.44	-3.26	
2007	13	12.76	-7.14		-1.37	-8.52	4.25	0.79	
2008	14	13.73	-7.14		-1.48	-8.62	5.11	5.95	
2009	15	14.77	-7.14		-1.59	-8.73	6.04	12.35	
2010	16	15.89			-1.71	-1.71	14.18	27.27	
2011	17	17.10			-1.84	-1.84	15.26	44.17	
2012	18	18.40			-1.98	-1.98	16.42	63.24	
2013	19	19.79			-2.13	-2.13	17.66	84.70	IRR
2014	20	21.30			-2.29	-2.29	19.01	108.79	20%

Riberao Preto privatization is an example of a regular concession agreement.

Table 5: Ribeira Preto Sewage Concession

Concession General Characteristics		
Total Investment:	R$ 45,00	Million
Concession Period	20	Years
BNDES Financing		
Amortization Life	10	Years
Initial Value	R$ 30,00	Million
Internal Return Rate	18,4%	
Payments	10	Years
Payment / year	(R$6,77)	Million
Number of Payments	10	
Privet Banks		
Amortization Life	20	Years
Bank interest	6%	Years
Value	R$ 15,00	Million
Payments	(R$1,31)	
Income		
Number of Costumers (base unit.)	450600	
Consumer Tax- Sewage	0,18	R$/ m3
Pop. Wastewater Production	34,56	Mm3/year
Consumer Growth	1,80%	/year
Water + Sewage Value	0,405	R$/ m3
Insurance		

Project fraction	30%	
Insurance Tax	6%	
Interest/year	8%	

Table 6: Riberao Preto concession analizes

Date	Income	Insurance	Privet Banks	BNDES	Operation	Total Cost	Net Benefit	NPV	Cost/ Benefit
1996	0	-0.81	-1.31	-3.89		-6.00	-6.00	-6.00	1.4
1997	6.22		-1.31	-3.89	-0.62	-5.81	0.41	-5.96	
1998	6.33		-1.31	-3.89	-0.63	-5.83	0.51	-5.81	
1999	6.45		-1.31	-3.89	-0.64	-5.84	0.61	-5.55	
2000	6.56		-1.31	-3.89	-0.66	-5.85	0.71	-5.17	
2001	6.68		-1.31	-3.89	-0.67	-5.86	0.82	-4.66	
2002	6.80		-1.31	-3.89	-0.68	-5.87	0.93	-4.01	
2003	6.92		-1.31	-3.89	-0.69	-5.89	1.04	-3.21	
2004	7.05		-1.31	-3.89	-0.70	-5.90	1.15	-2.25	
2005	7.18		-1.31	-3.89	-0.72	-5.91	1.26	-1.12	
2006	7.30		-1.31		-0.73	-2.04	5.27	4.08	
2007	7.44		-1.31		-0.74	-2.05	5.38	9.71	
2008	7.57		-1.31		-0.76	-2.06	5.50	15.79	
2009	7.71		-1.31		-0.77	-2.08	5.63	22.37	
2010	7.84		-1.31		-0.78	-2.09	5.75	29.46	
2011	7.99		-1.31		-0.80	-2.11	5.88	37.11	
2012	8.13		-1.31		-0.81	-2.12	6.01	45.34	
2013	8.28		-1.31		-0.83	-2.14	6.14	54.21	
2014	8.42		-1.31		-0.84	-2.15	6.27	63.73	IRR
2015	8.58		-1.31		-0.86	-2.17	6.41	73.97	23%

Appendix E

The Tatui Wastewater Treatment System 1992 Report

This appendix summarizes the Tatui Report from 1992, which contains the most recent information, found in the literature, regarding Tatui main wastewater treatment lagoon, ETE CEAGESP. It was prepared by Milton Tomoyuki Tsutiya and Orlando Zuliani Cassettari as a response to an assessment required by Sabesp in 1992 (the report was translated by Christian Cabral).

The CEAGESP wastewater treatment plant began operating in 1978. At that time the service population was approximately 20,000 inhabitants and the anaerobic and the facultative lagoon were approximately 2.5 meters deep.

Since the treatment plant has no provision for sludge removal, the sludge accumulation in these lagoons has decreased the detention time of the system and, therefore, its efficiency.

The population by the year of 1992 using this facility was around 49,000 and the overall BOD removal efficiency only 60%. At that time, depth of the anaerobic pond was 1.5m and the facultative, only 1.3m.

The major problems related to the maintenance of the lagoons are: short circuiting, due to the irregular sludge settling and overflow rates, and short detention time, related to the sludge accumulation in the bottom of these lagoons.

The collection system

The Tatui Report also evaluated the city's wastewater collection system and its performance. The flow ranged from 88.06 to 176.18 L/sec/inhab in 1992. The sewage return coefficient (the volume of sewage produced divided by amount of water

consumed) varied from 0.52% to 0.84%, which is considered normal. The averages of maximum flow coefficient and the minimum flow coefficient per hour was 2.69 and 0.37. Regarding the condition of the collection system, the infiltration rate was 0.33 l/sec/km of pipe. Compared to Brazilian standards these results are considered as normal, except for the infiltration rates, which is considered high.

The Lagoons

The report also shows the characteristics of the wastewater and sludge based on this analyzes pH and temperature measurements made every 30 minutes during one week (09/14/92 until 09/21/92):

	Minimum	Maximum	Unit.
Values of pH	4	7	[pH]
Air temperature	12	30	Celsius
Water temperature	17	30	Celsius

Although the variation of pH is unusual (too acid for tropical ponds) 90% of the measurements were around pH 7.

Wastewater Measurements

To represent the influent wastewater conditions several parameters were chosen and the average is shown in the following tables.

Suspended Solids, BOD and COD averages:

	Averages	Unit
BOD	73.5	Grams/inhabitant/day
BOD filtered	37.5	Grams/inhabitant/day

TSS	35.8	Grams/inhabitant/day
VSS	44.0	Grams/inhabitant/day

The average BOD in Brazil is 54 grams/inhabitant/day; therefore these results indicate that these lagoons were already working over their capacity in 1992.

Sludge Analyses

The following data about the anaerobic and facultative lagoons gives the average depth of the sludge accumulated through 14 years:

Anaerobic Lagoon Sludge Accumulation:

Initial Lagoon Volume (1978)	35,326 m3	Final Lagoon Volume (1992)	23,786 m3
Area	23,551 m2	Final Sludge Volume	11,540 m3
Average Sludge Depth	49 cm	Sludge Percentage	31.2 %
Average Sludge Accumulation	Per year	3.9	Cm/year

Facultative Lagoon Sludge Accumulation:

Initial Lagoon Volume (1978)	32,765 m3	Final Lagoon Volume (1992)	26,060 m3
Area	25,204 m2	Final Sludge Volume	67,10 m3
Average Sludge Depth	26.6 cm	Sludge Percentage	17.7 %
Average Sludge Accumulation	per year	2.2	Cm/year

The solids composition of the sludge is shown in the next table:

Total Solids	9.26 %
Fixed Solids	5.28 %
Volatile Solids	3.98 %
Total Suspended Solids	8.54 %
Fixed Suspended Solids	5.53 %
Volatile Suspended Solids	3.01 %

The Biological Analyses of the Sludge:

The report from 1992 also analyses the pathogenic microorganism concentration of the sludge as follows:

Salmonellas	<2	To	9	MPN/100ml	
Total Coliforms	8	To	24	MPN/100ml	10^5
Fecal Coliforms	2.2	To	17	MPN/100ml	10^5
Ascaris Lumbricoides	70	To	110	/100mg of sludge	
Enterobius Vermiclaris	0	To	90	/100mg of sludge	
Trichuris Trichiura	0	To	10	/100mg of sludge	
Hymendepis Nana	0	To	40	/100mg of sludge	

Clonorchis Simensis	10	To	20	/100mg of sludge
Anacilostomideos	0	To	10	/100mg of sludge
Balantiduim Coli	0	To	10	/100mg of sludge

Although the Salmonellas count represents a normal concentration, the concentration of the rest of the pathogenic organisms is considered too high for agricultural application on vegetable crop according to Sabesp's standards.

Present Situation

Nowadays, these lagoons are less efficient than in 1992. From our visual observation we noticed some extra factors that appear to interfere in the wastewater treatment efficiency.

First, the condition of the algae growth on the surface of the lagoons and vegetation all over the margins suggests that there is a lack of proper maintenance (cleaning).

Second, the access to this facility is in bad conditions making it more difficult to maintain the area.

Third, some of the inlets to the anaerobic and facultative lagoons are blocked and the effect of hydraulic short circuiting is aggravated on account of this.

Fourth, the permanent usage of the discharge of river from the first lagoon is damaging the condition of the receiving body (River Manduca) suggesting necessary corrections to clean up the pollution to the river.

Despite these negative aspects of the present situation of the lagoon, there is almost no odor problem even when there is no wind.

Appendix F

Schematic of the three alternatives treatment and the area distribution

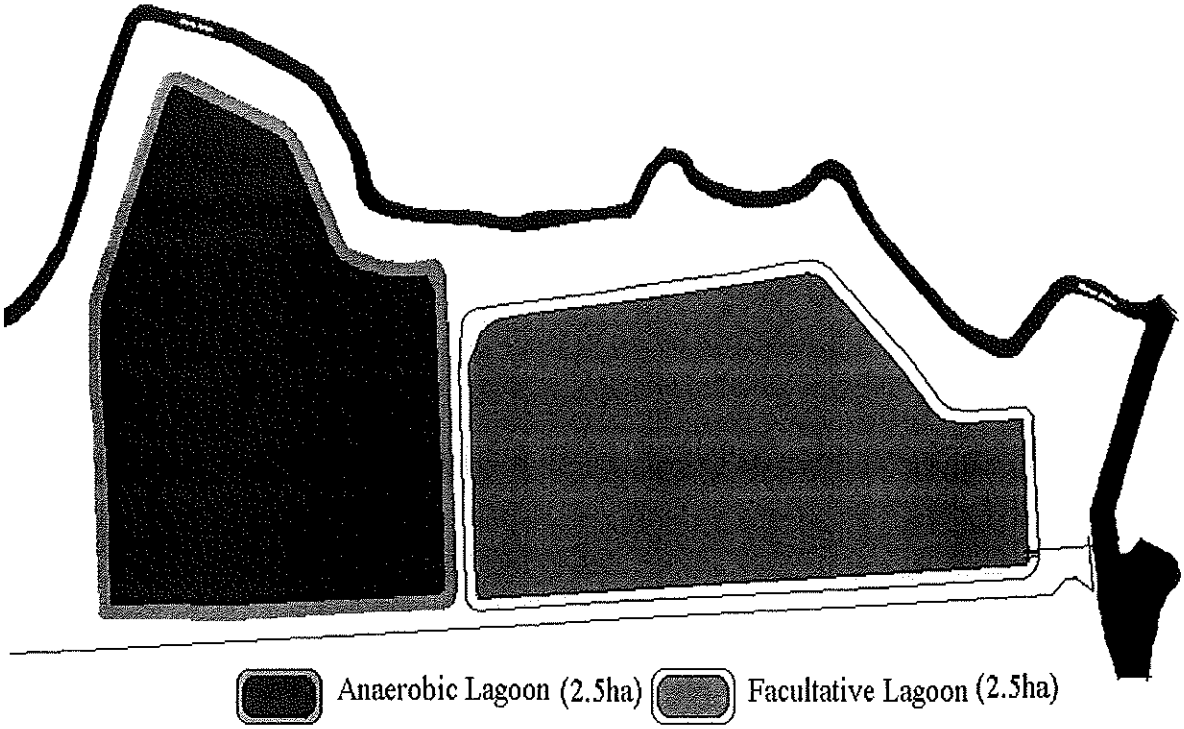

Figure 1: Schematic of the existing treatment and the area distribution of WWTP CEAGESP

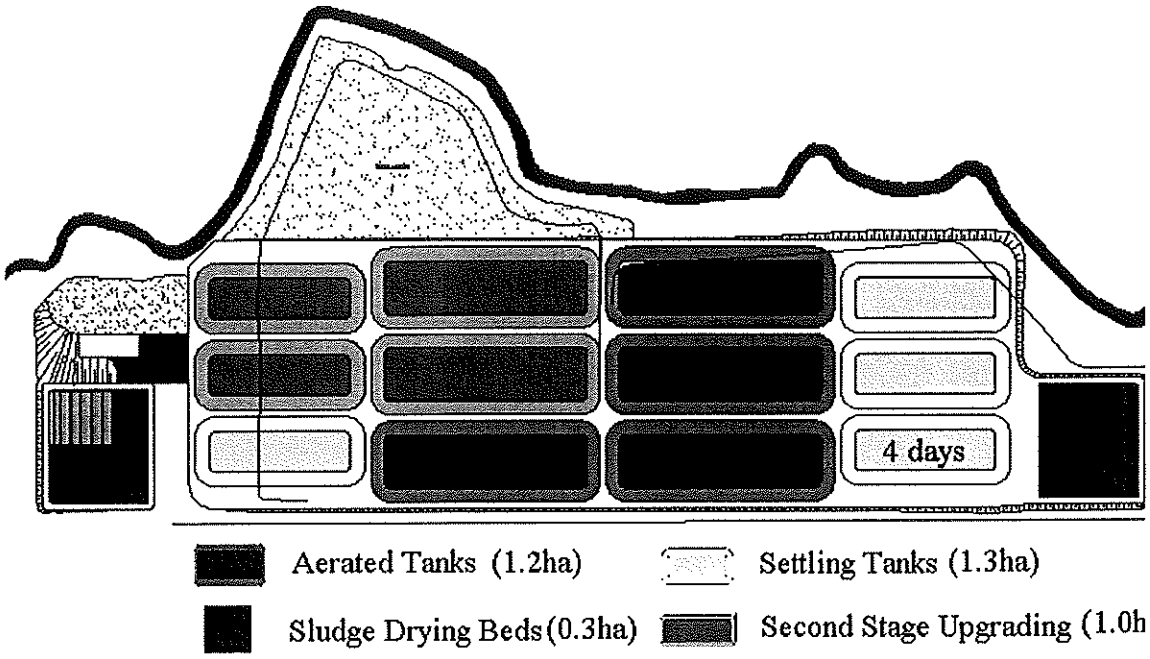

Figure 2: Schematic of the alternative A1 treatment and the area distribution

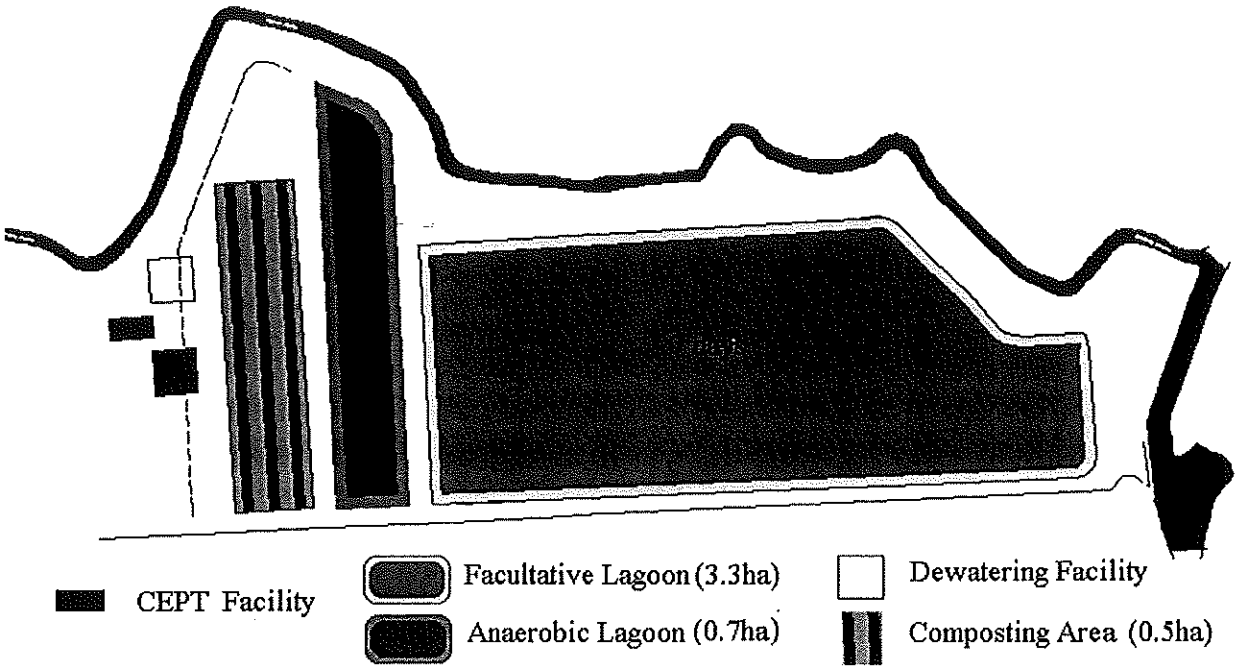

Figure 3: Schematic of the alternative A2 treatment and the area distribution

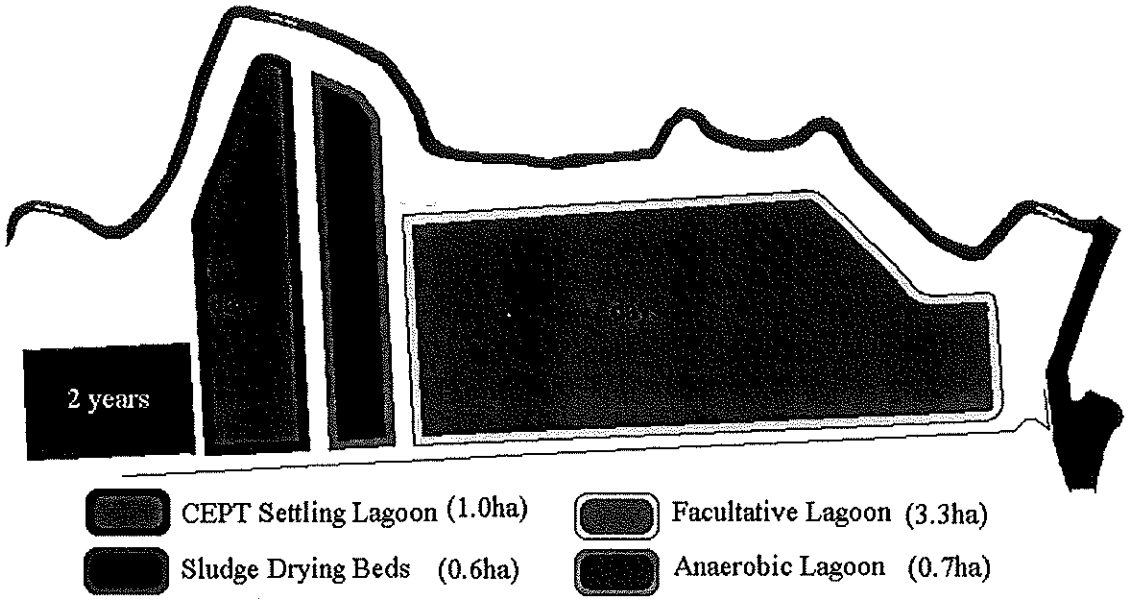

Figure 4: Schematic of the alternative A3 treatment and the area distribution

ETE CEAGESP

Appendix G SARTSP Design Characteristics

Sludge hight 0.4
Water hight 2
Border 0.6

Lagoons
Aerated

Number	Area	total area	depth	Volume
of lagoons	hec	hec	m	m3
4	0.19	0.76	4.1	31160

Soil Managing

	Escavation		Dredging	
area	depth	volume	depth	volume
7600	2.7	20520	0.4	3040

Concrete pile area

Perimeter	Width	Area
768	2	1536

Settling

Number	Area	total area	depth	Volume
of lagoons	hec	hec	m	m3
4	0.315	1.26	4.6	57960

Soil Managing

	Escavation		Dredging	
area	depth	volume	depth	volume
12600	3.2	40320	0.4	5040

Concrete pile area

Perimeter	Width	Area
1040	2	2080

Total Volume

Soil Managing

	Escavation		Dredging	
area	ave. depth	volume	depth	volume
20200	3.01	60840	0.4	8080

Total concrete pile area 3616

Filling Material

Diques

Section	length	volume
37.5	590	22125
Regularization		8375
Total volume required		30500

Sludge Drying Beds

Number	Area	total area	depth	Volume
SDB	m2	m2	m	m3
24	125	3000	4.1	12300

Materials

Sand	0.12	360
gravel1&2	0.12	360
grave3&4	0.24	720
grave<4	0.25	750
Bricks	area	3090

ETE CEAGESP
CEPT Tank Design Characteristics
Present condition

	meters
Lagoons	
Sludge hight	0.4
Water hight	2
Border	0.6

CEPT Tank

	meters
Sludge hight	1
Water hight	3.5
Border	0.5
Length	20
Width	4

CEPT Tank

Number of Tanks	Area m2	total area m2	depth m	Volume m3
3	70	210	4.5	945

Soil Managing

	Escavation	
area	depth	volume
210	4.8	1008

Structure — Concrete

Perimeter	total h	Area	thickness	volume
104	5	520	0.3	156

Lagoons
Anaerobic

Number of lagoons	Area hec	total area hec	depth m	Volume m3
1	0.64	0.64	4	25600

Soil Managing

	Escavation		Dredging	
area	depth	volume	depth	volume
6400	2.6	16640	0.4	2560

Concrete pile area

Perimeter	Width	Area
443	2	886

Facultative

Number of lagoons	Area hec	total area hec	depth m	Volume m3
1	3.31	3.31	3	99300

Soil Managing

	Escavation		Dredging	
area	depth	volume	depth	volume
33100	1.6	52960	0.4	13240

Concrete pile area

Perimeter	Width	Area

818	2	1636

Total Volume

Soil Managing

	Escavation		Dredging	
area	ave. depth	volume	depth	volume
39,710	1.8	70,608	0.4	15,884

Total concrete pile area 2522

Filling Material

area	depth	volume
17000	0.5	8500

Diques

Section	length	volume
37.5	510	19125
Regularization		8,500
Total volume required		27625

Transportation of fill/borrow material 90% of soil movement 110,203 M3XKM

Composting

Windraw	length	total length	ave width	total area
lines	m	m	m/line	m2
3	150	450	10	4500

Equipment

Filterpress	1	150000
Tractor full eq.	1	80000

Coagulant Tank Facility Area	400	m2
Filter press Facility Area	400	m2

ETE CEAGESP
In pond CEPT Design Characteristics

Lagoons	meters
Sludge hight	0.4
Water hight	2
Border	0.6

Lagoons
CEPT settling lagoon

Number	Area	total area	depth	Volume
of lagoons	hec	hec	m	m3
1	0.97	0.97	4	38800

Soil Managing

	Escavation		Dredging	
area	depth	volume	depth	volume
9700	2.6	25220	0.4	3880

Concrete pile area

Perimeter	Width	Area
485	2	970

Anaerobic

Number	Area	total area	depth	Volume
of lagoons	hec	hec	m	m3
1	0.64	0.64	4	25600

Soil Managing

	Escavation		Dredging	
area	depth	volume	depth	volume
6400	2.6	16640	0.4	2560

Concrete pile area

Perimeter	Width	Area
443	2	886

Facultative

Number	Area	total area	depth	Volume
of lagoons	hec	hec	m	m3
1	3.31	3.31	3	99300

Soil Managing

	Escavation		Dredging	
area	depth	volume	depth	volume
33100	1.6	52960	0.4	13240

Concrete pile area

Perimeter	Width	Area
818	2	1636

Total Volume

Soil Managing

	Escavation		Dredging	
area	ave. depth	volume	depth	volume
49,200	1.9	94,820	0.4	19,680

Total concrete pile area 3492

Filling Material

area	depth	volume
17000	0.5	8500

Diques

Section	length	volume
37.5	345	12937.5
Regularization		8,500
Total volume required		21437.5

Transportation of fill/borrow material 90% of soil movement 110,203 M3XKM

Sludge Drying Beds

Number	Area	total area	depth	Volume
SDB	m2	m2	m	m3
27	125	3375	4.1	13837.5

Materials

Sand	0.12	405
gravel1&2	0.12	405
grave3&4	0.24	810
grave<4	0.25	843.75
Bricks	area	3399

A1 Capital Cost

ITEM	SPECIFICATION	QUANT	UNIT	UNIT.PRICE	TOTAL PRICE
1 Total	**ADM/GENERAL FACILITIES**				**R$ 16,926.22**
2 Total	**TECHNICAL SERVICES**				**R$ 8,045.70**
3 Total	**PRELIMINARY SERVICES**				**R$ 74,520.00**
	SOIL MOVEMENT				
	MECHANICAL EXCAVATION IN ALL KINDS OF SOIL EXCEPT ROCKS	57484.18	M3	R$ 2.30	R$ 132,213.61
	DREDGING	7641.88	M3	R$ 14.04	R$ 107,292.00
	FILL MATERIAL	30487.41	M3	R$ 2.64	R$ 80,486.76
	TREANCH EXCAVATION				
	UNTILL 2.00 M DEEP	564.35	M3	R$ 2.68	R$ 1,512.46
	FROM 2.00 TILL 4.00 M DEEP	300.60	M3	R$ 3.71	R$ 1,115.23
	GREATER THAN 4.00 M	107.81	M3	R$ 7.82	R$ 843.07
	UNCONPACTED FILL MATERIAL	1070.28	M3	R$ 3.39	R$ 3,628.25
	COMPACTED MATERIAL				
	DYKE	26714.67	M3	R$ 2.20	R$ 58,772.27
	LOADING / TRANSPORTATION / UNLODING OF MATERIAL				
	TRANSPORTATION OF FILL/BORROW MATERIAL	141874.00	M3XKM	R$ 0.62	R$ 87,961.88
4 Total	**SOIL MOVEMENT**				**R$ 473,825.53**
5 Total	**DRAINGE & PUMPING**				**R$ 3,581.50**
	FUNDATIONS & STRUCTURES				
	CONCERTE PILE (DIAM.=20cm)	960.00	M	R$ 18.87	R$ 18,115.20
	SUBGRADE				
	GRAVEL SUBGRADE	1.00	M3	R$ 53.49	R$ 53.49
	CONCRETE FORMS				
	WOODEN FORMS (STANDARD)	64.00	M2	R$ 15.14	R$ 968.96
	WOODEN FORMS (STRUCTURAL)	2338.83	M2	R$ 24.99	R$ 58,447.36
	REINFORCEMENTS/REBAR				
	REBAR (CA-50)	13633.87	KG	R$ 2.08	R$ 28,358.45
	NON ESTRUCTORAL CONCRETE				
	NON ESTRUCTORAL CONCRETE (MINIMAL CONCENTRATION 150kg of CEMENT/M3)	8.93	M3	R$ 146.84	R$ 1,311.28
	ESTRUCTURAL CONCRETE FOR AGRESSIVE INVIRONMENTS				
	FCK = 20,0 MPA (W/C MAX. 0,50 L/KG MINIMAL CONCENTRATION 350 KG of CIMENT/M3	269.67	M3	R$ 219.19	R$ 59,108.97
	LAGOON DEVIECES				
	PRE CAST CONCRETE SLABS	3609.30	M2	R$ 33.52	R$ 120,983.74
6 Total	**FUNDATIONS & STRUCTURES**				**R$ 287,347.45**
7 Total	**PIPE INSTALATION**				**R$ 14,059.23**
8 Total	**PAVEMENT**				**R$ 37,995.00**
9 Total	**ALVENARIA**				**R$ 35,458.81**
10 Total	**PAINTING**				**R$ 85,715.79**
11 Total	**URBANIZATON**				**R$ 27,422.46**
12 Total	**GENERAL SERVICES**				**R$ 1,500.00**

A1 Capital Cost

ITEM	*SPECIFICATION*	*QUANT*	*UNIT*	*UNIT.PRICE*	*TOTAL PRICE*
	GENERAL SUPPLIES				
	IRON PIPE (PBJE - K7, 400MM DIM.)	67.00	M	R$ 165.78	R$ 11,107.26
	IRON PIPE (PBJE - K7, 500MM DIM.)	213.00	M	R$ 225.25	R$ 47,978.25
	IRON PIPE (PBJE - K7, 700MM DIM.)	984.00	M	R$ 374.24	R$ 368,252.16
	HYDRAULIC EQUIPMENT AND MATERIALS SUPPLY (LIST 3)	1.00	GB	R$ 865,047.35	R$ 865,047.35
	ELECTRIC EQUIPMENT AND MATERIALS SUPPLY (LIST 4)	1.00	GB	R$ 50,105.59	R$ 50,105.59
13 Total	**SUPPLIES**				**R$ 1,342,490.61**
14 Total	**SPECIAL SERVICES**				**R$ 1,270.00**
	INSTALATIONS				
	SLUDGE DRYING BADS				
	SAND	370.80	M3	R$ 59.98	R$ 22,240.58
	AGREGATE #1 AND #2	370.80	M3	R$ 47.76	R$ 17,709.41
	AGREGATE #3 AND #4	741.60	M3	R$ 47.76	R$ 35,418.82
	AGREGATE #4 AND BIGGER	772.51	M3	R$ 77.02	R$ 59,498.72
	BRICK (CERAMIC 5X10X20 CM)	3090.00	M2	R$ 3.96	R$ 12,236.40
	PUMP BOAT	1.00	GB	R$ 200,000.00	R$ 200,000.00
15 Total	**SLUDGE TREAMENT**				**R$ 347,103.93**
	HYDRAULIC EQUIPMENT AND MATERIALS INSTALATION (LIST 3 W/T AERATORS)	1.00	GB	R$ 86,093.77	R$ 86,093.77
	ELECTRIC EQUIPMENT AND MATERIALS INSTALATION (LIST 4)	1.00	GB	R$ 12,526.40	R$ 12,526.40
16 Total	**OTHER**				**R$ 98,620.17**
Final Total	**ETE - CEAGESP (1st STAGE)**				**R$ 2,855,882.39**

A2 Capital Cost

ITEM	ESPECIFICATION	QUANT	UNIT	UNIT.PRICE	TOTAL PRICE
1 Total	**ADM/GENERAL FACILITIES**				**R$ 16,926.22**
2 Total	**TECHNICAL SERVICES**				**R$ 8,045.70**
3 Total	**PRELIMINARY SERVICES**				**R$ 74,520.00**
	SOIL MOVEMENT				
	MECHANICAL EXCAVATION IN ALL KINDS OF SOIL EXCEPT ROCKS	70608.00	M3	R$ 2.30	R$ 162,398.40
	DREDGING	15884.00	M3	R$ 14.04	R$ 223,011.36
	FILL MATERIAL	27625.00	M3	R$ 2.64	R$ 72,930.00
	TREANCH EXCAVATION				
	UNTILL 2.00 M DEEP	564.35	M3	R$ 2.68	R$ 1,512.46
	FROM 2.00 TILL 4.00 M DEEP	300.60	M3	R$ 3.71	R$ 1,115.23
	GREATER THAN 4.00 M	107.81	M3	R$ 7.82	R$ 843.07
	UNCONPACTED FILL MATERIAL	1070.28	M3	R$ 3.39	R$ 3,628.25
	COMPACTED MATERIAL				
	DYKE	19125.00	M3	R$ 2.20	R$ 42,075.00
	LOADING / TRANSPORTATION / UNLODING OF MATERIAL				
	TRANSPORTATION OF FILL/BORROW MATERIAL	121756.54	M3XKM	R$ 0.62	R$ 75,489.05
4 Total	**SOIL MOVEMENT**				**R$ 583,002.82**
5 Total	**DRAINGE & PUMPING**				**R$ 3,581.50**
	FUNDATIONS & STRUCTURES				
	CEPT TANK	1.00		R$ 90,000.00	R$ 90,000.00
	CONCERTE PILE (DIAM.=20cm)	960.00	M	R$ 18.87	R$ 18,115.20
	SUBGRADE				
	GRAVEL SUBGRADE	1.00	M3	R$ 53.49	R$ 53.49
	CONCRETE FORMS				
	WOODEN FORMS (STANDARD)	64.00	M2	R$ 15.14	R$ 968.96
	WOODEN FORMS (STRUCTURAL)	2338.83	M2	R$ 24.99	R$ 58,447.36
	REINFORCEMENTS/REBAR				
	REBAR (CA-50)	13633.87	KG	R$ 2.08	R$ 28,358.45
	NON ESTRUCTORAL CONCRETE				
	NON ESTRUCTORAL CONCRETE (MINIMAL CONCENTRATION 150kg of CEMENT/M3)	8.93	M3	R$ 146.84	R$ 1,311.28
	ESTRUCTURAL CONCRETE FOR AGRESSIVE INVIRONMENTS				
	FCK = 20,0 MPA (W/C MAX. 0,50 L/KG MINIMAL CONCENTRATION 350 KG of CIMENT/M3	269.67	M3	R$ 219.19	R$ 59,108.97
	LAGOON DEVIECES				
	PRE CAST CONCRETE SLABS	2522.00	M2	R$ 33.52	R$ 84,537.44
6 Total	**FUNDATIONS & STRUCTURES**				**R$ 340,901.15**
7 Total	**PIPE INSTALATION**				**R$ 14,059.23**
8 Total	**PAVEMENT**				**R$ 37,995.00**
9 Total	**MASONRY**				**R$ 35,458.81**
10 Total	**PAINTING**				**R$ 85,715.79**
11 Total	**URBANIZATON**				**R$ 27,422.46**
12 Total	**GENERAL SERVICES**				**R$ 1,500.00**

A2 Capital Cost

ITEM	*ESPECIFICATION*	*QUANT*	*UNIT*	*UNIT.PRICE*	*TOTAL PRICE*
	GENERAL SUPPLIES				
	CEPT EQUIPMENT AND FACILITY (LIST 5)	1.00	GB	R$ 155,906.00	R$ 155,906.00
	IRON PIPE (PBJE - K7, 400MM DIM.)	67.00	M	R$ 165.78	R$ 11,107.26
	IRON PIPE (PBJE - K7, 500MM DIM.)	213.00	M	R$ 225.25	R$ 47,978.25
	IRON PIPE (PBJE - K7, 700MM DIM.)	984.00	M	R$ 374.24	R$ 368,252.16
	HYDRAULIC EQUIPMENT AND MATERIALS SUPPLY (LIST 3 W/T AERATORS)	1.00	GB	R$ 190,000.00	R$ 190,000.00
	ELECTRIC EQUIPMENT AND MATERIALS SUPPLY (LIST 4)	1.00	GB	R$ 50,105.59	R$ 50,105.59
13 Total	**SUPPLIES**				**R$ 823,349.26**
14 Total	**SPECIAL SERVICES**				**R$ 1,270.00**
	DEWATERING AND COMPOSTING (EQUIPMENT AND FACILITY LIST 6)	1.00	GB	R$ 320,000.00	R$ 320,000.00
15 Total	**SLUDGE TREAMENT**				**R$ 320,000.00**
	HYDRAULIC EQUIPMENT AND MATERIALS INSTALATION (LIST 3 W/T AERATORS)	1.00	GB	R$ 19,000.00	R$ 19,000.00
	ELECTRIC EQUIPMENT AND MATERIALS INSTALATION (LIST 4)	1.00	GB	R$ 12,526.40	R$ 12,526.40
16 Total	**OTHER**				**R$ 31,526.40**
Final Total	**ETE - CEAGESP (1st STAGE)**				**R$ 2,405,274.34**

A3 Capital Cost

ITEM	ESPECIFICATION	QUANT	UNIT	UNIT.PRICE	TOTAL PRICE
1 Total	**ADM/GENERAL FACILITIES**				**R$ 16,926.22**
2 Total	**TECHNICAL SERVICES**				**R$ 8,045.70**
3 Total	**PRELIMINARY SERVICES**				**R$ 74,520.00**
	SOIL MOVEMENT			R$ -	R$ -
	MECHANICAL EXCAVATION IN ALL KINDS OF SOIL EXCEPT ROCKS	94820.00	M3	R$ 2.30	R$ 218,086.00
	DREDGING	19680.00	M3	R$ 14.04	R$ 276,307.20
	FILL MATERIAL	21437.50	M3	R$ 2.64	R$ 56,595.00
	TREANCH EXCAVATION				
	UNTILL 2.00 M DEEP	564.35	M3	R$ 2.68	R$ 1,512.46
	FROM 2.00 TILL 4.00 M DEEP	300.60	M3	R$ 3.71	R$ 1,115.23
	GREATER THAN 4.00 M	107.81	M3	R$ 7.82	R$ 843.07
	UNCONPACTED FILL MATERIAL	1070.28	M3	R$ 3.39	R$ 3,628.25
	COMPACTED MATERIAL				
	DYKE	12937.50	M3	R$ 2.20	R$ 28,462.50
	LOADING / TRANSPORTATION / UNLODING OF MATERIAL				
	TRANSPORTATION OF FILL/BORROW MATERIAL	135826.24	M3XKM	R$ 0.62	R$ 84,212.27
4 Total	**SOIL MOVEMENT**				**R$ 670,761.97**
5 Total	**DRAINGE & PUMPING**				**R$ 3,581.50**
	FUNDATIONS & STRUCTURES				
	CONCERTE PILE (DIAM.=20cm)	960.00	M	R$ 18.87	R$ 18,115.20
	SUBGRADE				
	GRAVEL SUBGRADE	1.00	M3	R$ 53.49	R$ 53.49
	CONCRETE FORMS				
	WOODEN FORMS (STANDARD)	64.00	M2	R$ 15.14	R$ 968.96
	WOODEN FORMS (STRUCTURAL)	2338.83	M2	R$ 24.99	R$ 58,447.36
	REINFORCEMENTS/REBAR				
	REBAR (CA-50)	13633.87	KG	R$ 2.08	R$ 28,358.45
	NON ESTRUCTORAL CONCRETE				
	NON ESTRUCTORAL CONCRETE (MINIMAL CONCENTRATION 150kg of CEMENT/M3)	8.93	M3	R$ 146.84	R$ 1,311.28
	ESTRUCTURAL CONCRETE FOR AGRESSIVE INVIRONMENTS				
	FCK = 20,0 MPA (W/C MAX. 0,50 L/KG MINIMAL CONCENTRATION 350 KG of CIMENT/M3	269.67	M3	R$ 219.19	R$ 59,108.97
	LAGOON DEVIECES				
	PRE CAST CONCRETE SLABS	3492.00	M2	R$ 33.52	R$ 117,051.84
6 Total	**FUNDATIONS & STRUCTURES**				**R$ 283,415.55**
7 Total	**PIPE INSTALATION**				**R$ 14,059.23**
8 Total	**PAVEMENT**				**R$ 37,995.00**
9 Total	**ALVENARIA**				**R$ 35,458.81**
10 Total	**PAINTING**				**R$ 85,715.79**
11 Total	**URBANIZATON**				**R$ 27,422.46**
12 Total	**GENERAL SERVICES**				**R$ 1,500.00**

A3 Capital Cost

ITEM	*ESPECIFICATION*	*QUANT*	*UNIT*	*UNIT.PRICE*	*TOTAL PRICE*
	GENERAL SUPPLIES				
	CEPT EQUIPMENT AND FACILITY (LIST 5)	1.00	GB	R$ 155,906.00	R$ 155,906.00
	IRON PIPE (PBJE - K7, 400MM DIM.)	67.00	M	R$ 165.78	R$ 11,107.26
	IRON PIPE (PBJE - K7, 500MM DIM.)	213.00	M	R$ 225.25	R$ 47,978.25
	IRON PIPE (PBJE - K7, 700MM DIM.)	984.00	M	R$ 374.24	R$ 368,252.16
	HYDRAULIC EQUIPMENT AND MATERIALS SUPPLY (LIST 3 W/T AERATORS)	1.00	GB	R$ 190,000.00	R$ 190,000.00
	ELECTRIC EQUIPMENT AND MATERIALS SUPPLY (LIST 4)	1.00	GB	R$ 50,105.59	R$ 50,105.59
13 Total	**SUPPLIES**				**R$ 823,349.26**
14 Total	**SPECIAL SERVICES**				**R$ 1,270.00**
	INSTALATIONS				
	SLUDGE DRYING BADS				
	SAND	405.00	M3	R$ 59.98	R$ 24,291.90
	AGREGATE #1 AND #2	405.00	M3	R$ 47.76	R$ 19,342.80
	AGREGATE #3 AND #4	810.00	M3	R$ 47.76	R$ 38,685.60
	AGREGATE #4 AND BIGGER	843.75	M3	R$ 77.02	R$ 64,985.63
	BRICK (CERAMIC 5X10X20 CM)	3399.00	M2	R$ 3.96	R$ 13,460.04
	PUMP BOAT	1.00	GB	R$ 200,000.00	R$ 200,000.00
15 Total	**SLUDGE TREAMENT**				**R$ 360,765.97**
	HYDRAULIC EQUIPMENT AND MATERIALS INSTALATION (LIST 3 W/T AERATORS)	1.00	GB	R$ 19,000.00	R$ 19,000.00
	ELECTRIC EQUIPMENT AND MATERIALS INSTALATION (LIST 4)	1.00	GB	R$ 12,526.40	R$ 12,526.40
16 Total	**OTHER**				**R$ 31,526.40**
Final Total	**ETE - CEAGESP (1st STAGE)**				**R$ 2,476,313.86**

	Unit	Quantity	Price/unit	Total price/month
Pump Boat consumption&maitenance	R$/month	1	3000	R$ 3,000.00
Energy consumption of aerators	hp	300	R$ 76.67	R$ 23,000.00
Assistants	R$/month	2	R$ 1,200.00	R$ 2,400.00
Engineer	R$/month	1	R$ 3,000.00	R$ 3,000.00
TOTAL				**R$ 31,400.00**

Flow	161	l/sec	
Dosage	50	mg/l	
Hours per day	12	hours	
Price of chemical	180	US$/ton	(dry basis)
Average daily dosage	25	mg/l	
Price of chemical	150	R$/ton	(R$1,2/US$)
Density	1.4	kg/l	

		Cost		
Mass of chemical		Volume of chemica		price
Kg/day (dry)	g/month (d	l/day	l/month	R$ / month
347.76	10432.8	248.4	7452	1564.92

	Unit	Quantity	Price/unit	Total price/month
Energy consumption of pumps	R$/month	1	R$ 500.00	R$ 500.00
Chemical consumption	kg	10432.8	R$ 0.15	R$ 1,564.92
Energy consumptio of dewatering system	R$/month	1	R$ 2,000.00	R$ 2,000.00
Composting (tractor maintenance& fuel, operator,and related items)	R$/month	1	R$10,000.00	R$ 10,000.00
Pump Boat consumption&maitenance	R$/month	1	R$ 3,000.00	R$ 3,000.00
Assistants	R$/month	2	R$ 1,200.00	R$ 2,400.00
Engineer	R$/month	1	R$ 3,000.00	R$ 3,000.00
TOTAL				**R$ 22,464.92**

Flow	161	l/sec	
Dosage	25	mg/l	
Hours per day	12	hours	
Average daily dosage	12.5	mg/l	
Price of chemical	180	R$/ton	(R$1,2/US$)
Density	1.4	kg/l	

		Cost		
Mass of chemical		Volume of chemica		price
Kg/day (dry)	Kg/month (dry)	lday	l/month	R$ / month
173.88	5216.4	124.2	3726	938.952

	Unit	Quantity	Price/unit	Total price/month
Energy consumption of pumps	hp	1	R$ 500.00	R$ 500.00
Pump Boat (depretiation, consumption and	R$/month	1	R$ 3,000.00	R$ 3,000.00
Chemical consumption	kg	5216.4	R$ 0.18	R$ 938.95
Assistants	R$/month	2	R$ 1,200.00	R$ 2,400.00
Engineer	R$/month	1	R$ 3,000.00	R$ 3,000.00
TOTAL				**R$ 9,838.95**

List 3 with aerators.

ITEM	*QUANT*	*UNIT*	*UNIT.PRICE*	*TOTAL PRICE*
GENERAL EQUIPMENT	1	GB	R$ 103,805.68	R$ 190,310.42
AERATORS & RELATED ITEMS	20	UN	R$ 33,736.85	R$ 674,736.93
Total				**R$ 865,047.35**

List 3 without aerators.

ITEM	*QUANT*	*UNIT*	*UNIT.PRICE*	*TOTAL PRICE*
GENERAL EQUIPMENT	1	GB	R$ 103,805.68	R$ 103,805.68
Total				**R$ 103,805.68**

Flow Meter

Item	Brazilian Supplier	Estimated Cost
ISCO 4210 Ultrasonic Flow Meter for open channel flow Part # 68-4210-001	Jundilab Rua Nossa Senhora da Aparecida No. 190 - Vial Rami 13,206,310 Jundiai - SP tel:55-11-7397-2622 fax:55-11-7397-1362	R$ 3,720.00
Two (2) internal 4-20 milliamp signals Part # 60-3214-148	Jundilab (see above)	R$ 660.00
Ultrasonic sensor monitoring bracket Part # 60-2443-148	Jundilab (see above)	R$ 24.00
Ultrasonic sensor sunshade Part # 60-3004-142	Jundilab (see above)	R$ 42.00
120 Volt Hi-Capacity power pack Part # 60-1684-088	Jundilab (see above)	R$ 240.00

Chemical Pump

Item	Brazilian Supplier	Estimated Cost
LMI Series "L" Pump Model #L122-44 Size: 1,680 gallons per day (6,250 L/day) Part # 60977	Vibropac Commercial Equipments Ind. LTDA Rua Gal.Eugenio de Melo 85 - Vila Monumento 01553-010 São Paulo, SP tel:55-11-914-8255 fax:55-11-636-888	R$ 5,000.00
LMI Pressure Relief Valve for L122 1 inch polyproplene (PP) Part # 60998	Vibropac (see above)	R$ 348.00
LMI Injection Check Valve Assembly Part # 26674	Vibropac (see above)	R$ 72.00

Chemical Storage Tank

Item	Brazilian Supplier	Estimated Cost
15 m3 storage tank, corrosion resistant (Minimum 7-day storage capacity at a dose of 50 mg/l primary coagulant)	Interfibra Industrial S A (no address or telephone number)	R$ 10,800.00

Storage tanks facility

Item	Brazilian Supplier	Estimated Cost
Facility (400m2)	local contractor	R$ 135,000.00

TOTAL LIST 5	**R$**	**155,906.00**

Tractor

Item	Brazilian Supplier	Estimated Cost
Tractor	local suppliers	R$ 35,000.00
Grade		
Container		
Related items		

Filter press

Item	Brazilian Supplier	Estimated Cost
Filte press	undefined	R$ 150,000.00

Filter press facility

Item	Brazilian Supplier	Estimated Cost
Facility (400m2)	local contractor	R$ 135,000.00

Concession

Concession Characteristics			
Concession period		10	years
Interest		12.0%	/year
Financing period		10	years
Consumers (1992)		49000	consumers
Average flow		0.17	m3/sec
Total flow		5,361,120	m3/year
Price of water		0.5	R$/m3
Wastewater treatment price		0.25	R$/m3
Concessionary percentage	50%	0.125	R$/m4
Population Growth		1.5%	/year

Results of Concession Analizys			
	A1	A2	A3
O&M (/year)	R$ 376,800.00	R$ 269,579.04	R$ 118,067.42
Capital Cost (CC)	R$ 2,855,882.39	R$ 2,405,274.34	R$ 2,476,313.86
Present Value	R$4,984,886.43	R$3,928,456.04	R$3,143,421.13
CC amortization	R$505,445.96	R$425,695.47	R$438,268.34
Payback Period (years)	non payable	12	5
Internal Rate of return (RR)	3%	13%	20%
Present Value of Revenues	R$6,180,154.76	R$6,180,154.76	R$6,180,154.76
Benefit Cost Ratio	1.2	1.6	2.0

A1 Concession

Year	Revenues	O&M	CC amortization	Total Cost	NPV	Net Benefit	CC+O&M	R-(CC+O&M)	IRR
			R$505,445.96	R$505,445.96	R$ (505,445.96)	R$(505,445.96)	R$(2,855,882.39)	R$(2,855,882.39)	
1	R$670,140.00	R$376,800.00	R$505,445.96	R$882,245.96	R$ (778,205.43)	R$(212,105.96)	R$ (376,800.00)	R$ 293,340.00	
2	R$680,192.10	R$376,800.00	R$505,445.96	R$882,245.96	R$(1,073,643.94)	R$(202,053.86)	R$ (376,800.00)	R$ 303,392.10	
3	R$690,394.98	R$376,800.00	R$505,445.96	R$882,245.96	R$(1,394,332.19)	R$(191,850.98)	R$ (376,800.00)	R$ 313,594.98	
4	R$700,750.91	R$376,800.00	R$505,445.96	R$882,245.96	R$(1,743,147.11)	R$(181,495.05)	R$ (376,800.00)	R$ 323,950.91	
5	R$711,262.17	R$376,800.00	R$505,445.96	R$882,245.96	R$(2,123,308.55)	R$(170,983.79)	R$ (376,800.00)	R$ 334,462.17	
6	R$721,931.10	R$376,800.00	R$505,445.96	R$882,245.96	R$(2,538,420.43)	R$(160,314.86)	R$ (376,800.00)	R$ 345,131.10	
7	R$732,760.07	R$376,800.00	R$505,445.96	R$882,245.96	R$(2,992,516.77)	R$(149,485.89)	R$ (376,800.00)	R$ 355,960.07	
8	R$743,751.47	R$376,800.00	R$505,445.96	R$882,245.96	R$(3,490,113.28)	R$(138,494.49)	R$ (376,800.00)	R$ 366,951.47	
9	R$754,907.74	R$376,800.00	R$505,445.96	R$882,245.96	R$(4,036,265.08)	R$(127,338.22)	R$ (376,800.00)	R$ 378,107.74	1%
10	*R$766,231.36*	*R$376,800.00*		*R$376,800.00*	*R$(4,131,185.54)*	*R$ 389,431.36*	*R$ (376,800.00)*	*R$ 389,431.36*	*3%*
11	R$777,724.83	R$376,800.00		R$376,800.00	R$(4,226,002.97)	R$ 400,924.83	R$ (376,800.00)	R$ 400,924.83	5%
12	R$789,390.70	R$376,800.00		R$376,800.00	R$(4,320,532.63)	R$ 412,590.70	R$ (376,800.00)	R$ 412,590.70	6%
13	R$801,231.56	R$376,800.00		R$376,800.00	R$(4,414,564.98)	R$ 424,431.56	R$ (376,800.00)	R$ 424,431.56	7%
14	R$813,250.03	R$376,800.00		R$376,800.00	R$(4,507,862.75)	R$ 436,450.03	R$ (376,800.00)	R$ 436,450.03	8%
15	R$825,448.79	R$376,800.00		R$376,800.00	R$(4,600,157.49)	R$ 448,648.79	R$ (376,800.00)	R$ 448,648.79	9%
16	R$837,830.52	R$376,800.00		R$376,800.00	R$(4,691,145.87)	R$ 461,030.52	R$ (376,800.00)	R$ 461,030.52	9%
17	R$850,397.97	R$376,800.00		R$376,800.00	R$(4,780,485.40)	R$ 473,597.97	R$ (376,800.00)	R$ 473,597.97	10%
18	R$863,153.94	R$376,800.00		R$376,800.00	R$(4,867,789.70)	R$ 486,353.94	R$ (376,800.00)	R$ 486,353.94	10%
19	R$876,101.25	R$376,800.00		R$376,800.00	R$(4,952,623.22)	R$ 499,301.25	R$ (376,800.00)	R$ 499,301.25	11%
20	R$889,242.77	R$376,800.00		R$376,800.00	R$(5,034,495.23)	R$ 512,442.77	R$ (376,800.00)	R$ 512,442.77	11%

A2 Concession

Year	Revenues	O&M	CC amortization	Total Cost	NPV	Net Benefit	CC+O&M	R-(CC+O&M)	IRR
			R$425,695.47	R$425,695.47	R$ (425,695.47)	R$(425,695.47)	R$(2,405,274.34)	R$(2,405,274.34)	
1	R$670,140.00	R$269,579.04	R$425,695.47	R$695,274.51	R$ (501,913.43)	R$ (25,134.51)	R$ (269,579.04)	R$ 400,560.96	
2	R$680,192.10	R$269,579.04	R$425,695.47	R$695,274.51	R$ (577,225.45)	R$ (15,082.41)	R$ (269,579.04)	R$ 410,613.06	
3	R$690,394.98	R$269,579.04	R$425,695.47	R$695,274.51	R$ (651,372.03)	R$ (4,879.53)	R$ (269,579.04)	R$ 420,815.94	
4	R$700,750.91	R$269,579.04	R$425,695.47	R$695,274.51	R$ (724,060.28)	R$ 5,476.40	R$ (269,579.04)	R$ 431,171.87	
5	R$711,262.17	R$269,579.04	R$425,695.47	R$695,274.51	R$ (794,959.85)	R$ 15,987.66	R$ (269,579.04)	R$ 441,683.13	
6	R$721,931.10	R$269,579.04	R$425,695.47	R$695,274.51	R$ (863,698.44)	R$ 26,656.59	R$ (269,579.04)	R$ 452,352.06	2%
7	R$732,760.07	R$269,579.04	R$425,695.47	R$695,274.51	R$ (929,856.69)	R$ 37,485.56	R$ (269,579.04)	R$ 463,181.03	6%
8	R$743,751.47	R$269,579.04	R$425,695.47	R$695,274.51	R$ (992,962.53)	R$ 48,476.96	R$ (269,579.04)	R$ 474,172.43	9%
9	R$754,907.74	R$269,579.04	R$425,695.47	R$695,274.51	R$(1,052,484.80)	R$ 59,633.23	R$ (269,579.04)	R$ 485,328.70	11%
10	*R$766,231.36*	*R$269,579.04*		*R$269,579.04*	*R$ (682,130.66)*	*R$ 496,652.32*	*R$ (269,579.04)*	*R$ 496,652.32*	*13%*
11	R$777,724.83	R$269,579.04		R$269,579.04	R$ (255,840.55)	R$ 508,145.79	R$ (269,579.04)	R$ 508,145.79	14%
12	R$789,390.70	R$269,579.04		R$269,579.04	R$ 233,270.24	R$ 519,811.66	R$ (269,579.04)	R$ 519,811.66	15%
13	R$801,231.56	R$269,579.04		R$269,579.04	R$ 792,915.19	R$ 531,652.52	R$ (269,579.04)	R$ 531,652.52	16%
14	R$813,250.03	R$269,579.04		R$269,579.04	R$ 1,431,736.01	R$ 543,670.99	R$ (269,579.04)	R$ 543,670.99	16%
15	R$825,448.79	R$269,579.04		R$269,579.04	R$ 2,159,414.08	R$ 555,869.75	R$ (269,579.04)	R$ 555,869.75	17%
16	R$837,830.52	R$269,579.04		R$269,579.04	R$ 2,986,795.25	R$ 568,251.48	R$ (269,579.04)	R$ 568,251.48	17%
17	R$850,397.97	R$269,579.04		R$269,579.04	R$ 3,926,029.61	R$ 580,818.93	R$ (269,579.04)	R$ 580,818.93	17%

A3 Concession

Year	Revenues	O&M	CC amortization	Total Cost	NPV	Net Benefit	CC+O&M	R-(CC+O&M)	IRR
			R$438,268.34	R$438,268.34	R$ (438,268.34)	R$(438,268.34)	R$(2,476,313.86)	R$(2,476,313.86)	
1	R$670,140.00	R$118,067.42	R$438,268.34	R$556,335.76	R$ (377,056.30)	R$ 113,804.24	R$ (118,067.42)	R$ 552,072.58	
2	R$680,192.10	R$118,067.42	R$438,268.34	R$556,335.76	R$ (298,446.72)	R$ 123,856.34	R$ (118,067.42)	R$ 562,124.68	
3	R$690,394.98	R$118,067.42	R$438,268.34	R$556,335.76	R$ (200,201.11)	R$ 134,059.22	R$ (118,067.42)	R$ 572,327.56	
4	R$700,750.91	R$118,067.42	R$438,268.34	R$556,335.76	R$ (79,810.09)	R$ 144,415.14	R$ (118,067.42)	R$ 582,683.48	
5	R$711,262.17	R$118,067.42	R$438,268.34	R$556,335.76	R$ 65,539.10	R$ 154,926.41	R$ (118,067.42)	R$ 593,194.75	5%
6	R$721,931.10	R$118,067.42	R$438,268.34	R$556,335.76	R$ 238,999.14	R$ 165,595.34	R$ (118,067.42)	R$ 603,863.68	10%
7	R$732,760.07	R$118,067.42	R$438,268.34	R$556,335.76	R$ 444,103.34	R$ 176,424.31	R$ (118,067.42)	R$ 614,692.64	14%
8	R$743,751.47	R$118,067.42	R$438,268.34	R$556,335.76	R$ 684,811.45	R$ 187,415.71	R$ (118,067.42)	R$ 625,684.05	17%
9	R$754,907.74	R$118,067.42	R$438,268.34	R$556,335.76	R$ 965,560.80	R$ 198,571.98	R$ (118,067.42)	R$ 636,840.32	18%
10	*R$766,231.36*	*R$118,067.42*		*R$118,067.42*	*R$ 1,729,592.03*	*R$ 648,163.93*	*R$ (118,067.42)*	*R$ 648,163.93*	*20%*

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