EVALUATION OF WASTEWATER TREATMENT ALTERNATIVES FOR DIFFERENT WATER REUSE APPLICATIONS WITH MODELING AND COST ANALYSIS

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ABSTRACT

EVALUATION OF WASTEWATER TREATMENT ALTERNATIVES FOR DIFFERENT WATER REUSE APPLICATIONS WITH MODELING AND COST ANALYSIS

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Wastewater reclamation can be a solution to water scarcity. Several wastewater treatment schemes exist for specific water reuse applications. This thesis aims to evaluate different wastewater treatment schemes for a range of water reuse applications through modeling and cost analysis. For this purpose, different secondary level treatment schemes as conventional activated sludge (TS_A), extended aeration (TS_B) and A2O (TS_C) were modeled using BioWin for three wastewater characteristics and three flowrates. Cost analysis for secondary treatment level, where BioWin modeling results were included, and tertiary, advanced treatment levels were done for 30 years period, including capital and operational costs. The total and unit costs of reclaimed water were calculated for different treatment schemes (TS_1 to TS_6) assigned to different water reuse applications such as groundwater recharge, urban, agricultural, industrial and environmental reuse.

The unit reclaimed water costs were found to range in $\$ 0.029/\text{m}^3$ to $\$ 0.601/\text{m}^3$ for different treatment schemes. If the user has a lower budget for water reuse application, such as unrestricted area irrigation or agricultural reuse, TS_1 (A2O + Filtration + UV + Cl), TS_3 (CAS/EXT/A2O + Filtration + UV + Cl), TS_4 (A2O/CAS/EXT) and TS_5 (CAS/EXT/A2O + UV + Cl) could be used. Reclaimed water from TS_2 (CAS/EXT/A2O + Filtration + UV + Cl + SAT) and TS_6 (A2O + MF + RO + UV + Cl) could be used as potable usage with higher unit treatment costs because of the requirement of a higher level of water quality. This thesis study revealed that the decision-maker can make a cost-benefit decision considering partial reuse to involve a low-cost alternative and decide on which process to follow depending on the water reuse application.

Keywords: Wastewater, Water Reuse, BioWin, Modeling, Cost Analysis

ÖZ

MODELLEME VE MALİYET ANALİZİ İLE SUYUN YENİDEN KULLANIMINDA FARKLI UYGULAMALAR İÇİN ATIKSU ARITMA ALTERNATİFLERİNİN DEĞERLENDİRİLMESİ

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Atıksuyun geri kazanımı, su kıtlığına bir çözüm olabilir. Geri kazanılan suyun kullanım uygulamaları için çeşitli atıksu arıtma dizinleri mevcuttur. Bu tez çalışmasının amacı, çeşitli su yeniden kullanım uygulamaları için farklı atıksu arıtma dizinlerini modelleme ve maliyet analizi yoluyla değerlendirmektir. Bu amaçla, geleneksel aktif çamur (TS_A), uzun havalandırma (TS_B) ve A2O (TS_C) gibi farklı ikincil seviye arıtma dizinleri, üç atık su özelliği ve üç debi için BioWin kullanılarak modellenmiştir.BioWin modelleme sonuçlarının dahil edildiği ikincil arıtma seviyesi, üçüncül ve ileri arıtma seviyeleri için maliyet analizi, sermaye ve işletim maliyetleri dahil olmak üzere, 30 yıllık dönem için yapılmıştır. Geri kazanılmış suyun toplam ve birim maliyetleri, yeraltı suyu deşarjı, kentsel, tarımsal, endüstriyel ve çevresel yeniden kullanım gibi farklı su yeniden kullanım uygulamalarına atanan farklı arıtma dizinleri (TS_1 ila TS_6) için hesaplanmıştır.

Geri kazanılmış su maliyetlerinin, farklı arıtma dizinleri için \$0,029/m³ ile \$0,601/m³ aralığında değiştiği bulunmuştur. Kullanıcının kısıtlanmamış alan sulama veya tarımsal yeniden kullanım gibi suyun yeniden kullanımı için daha düşük bir bütçesi varsa, TS_1 (A2O + Filtreleme + UV + Cl), TS_3 (CAS / EXT / A2O + Filtrasyon + UV + Cl), TS_4 (A2O / CAS / EXT) ve TS_5 (CAS / EXT / A2O + UV + Cl) kullanılabilir. TS_2 (CAS / EXT / A2O + Filtrasyon + UV + Cl + SAT) ve TS_6 (A2O + MF + RO + UV + Cl) 'dan üretilen arıtılmış su, daha yüksek kalitede olması gerektiğinden, daha yüksek birim arıtma maliyetleriyle içilebilir/ kullanma suyu olarak kullanılabilir. Bu tez çalışması, karar vericinin, düşük maliyetli bir alternatifi içerecek şekilde kısmi yeniden kullanımı düşünerek bir maliyet-faydasına ve suyun yeniden kullanım uygulamasına bağlı olarak hangi prosesin kullanılacağına karar verebileceğini göstermiştir.

Anahtar Kelimeler: Atıksu, Suyun Yeniden Kazanımı, BioWin, Modelleme,
Maliyet Analizi

To my family

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ABBREVIATIONS

A2O	Anaerobic / Anoxic / Oxic Process
AO	Anoxic / Oxic
ASM	Activated Sludge Model
BAR	Bardenpho
BIO	Bio Disk Reactor
BNR	Biological Nutrient Removal
BOD_5	Biological Oxygen Demand (5 days)
CAS	Conventional Activated Sludge
CEC	Contaminants of Emerging Concern
COD	Chemical Oxygen Demand
EPA	Environmental Protection Agency
EU	European Union
EXT	Extended Aeration
IPR	Indirect Potable Usage
MBR	Membrane Bioreactor
MDF	Micro Disk Filter
MF	Microfiltration
MWWTP	Municipal Wastewater Treatment Plant
NF	Nanofiltration
OP	Operational Costs

PE	Polyelectrolyte
RO	Reverse Osmosis
SAT	Soil Aquifer Treatment
SBR	Sequencing Batch Reactor
SP	Stabilization Ponds
TF	Trickling Filters
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TSS	Total Suspended Solid
UCT	University of Cape Down
UF	Ultrafiltration
UV	Ultraviolet
VSS	Volatile Suspended Solid
WAS	Waste Activated Sludge
WHO	World Health Organization
WL	Wetland
WW	Wastewater
WWTP	Wastewater Treatment Plant

CHAPTER 1

INTRODUCTION

Water scarcity results in increasing pressure on freshwater supplies in most parts of the world (Sanz et al., 2014). The rapid increase in population, overurbanization, industrialization and unforeseeable climate change are the main reasons for water scarcity (Meena et al., 2019). Climate change results in an imbalance between water demand and supplies caused by the unequal distribution of precipitation, abnormal temperature rise and increased demand for irrigation. To abate water scarcity, wastewater treatment and water reclamation can be an alternative solution (Hidalgo et al., 2005).

Wastewater recovery, in other words, reclamation, reuse and recycling, is a hot topic nowadays that can prove better management of the water resources which are diverted from the natural water cycle to the anthropic one (Salgot, 2008). Moreover, water reclamation can drop the cost of potable water by supplying reclaimed water for water uses at different applications (Salgot, 2008). In a study, the reuse capacity of European countries was mathematically modeled. According to the results, Spain has the highest capacity of water reuse potential of over 1200 Mm^3/year. Italy and Bulgaria follow Spain with a reuse capacity of 500 Mm^3/year for the project horizon of 2025. The water reuse potential of Turkey is estimated as 287 Mm^3/year, which is a significant value with respect to other European countries (Sanz et al., 2014).

Long before wastewater treatment plants were constructed, wastewater was directly used for irrigational purposes in Prague, Amsterdam and a few European countries as phosphorus and nitrogen resources (Solon et al., 2019). Current water reclamation and reuse projects aim to obtain acceptable water quality for potential water reuse applications such as agricultural and landscape irrigation, industrial uses and non-potable urban uses (Sala et al., 2004). Aside from conventional secondary treatment technologies, new treatment technologies may be needed to achieve a required water quality when the effluent is discharged to sensitive water bodies or water reuse is intended (Salgot et al., 2018). These practices may include secondary treatment processes such as activated sludge systems or rotating biological contractors, filtration practices such as sand filtration, disinfection practices such as chlorination and ozonation and tertiary/advanced treatments like carbon adsorption and membrane processes. By using one or a combination of these processes, the required water quality can be reached (Sanz et al., 2014).

The water reuse concept is always challenging from various aspects like social acceptance, land availability and cost issues. Among these aspects, the cost is the most difficult to cope with (Maryam & Büyükgüngör, 2017). Contrary to the thought that water reuse projects are costly, most of the time, water reuse is applicable for every budget with diverse treatment units and applications (Villar, 2018). In the literature, the cost of treating wastewater to achieve reclaimed water with alterations in treatment schemes, treatment capacity and wastewater characteristics is not studied in a comparative way. Since there are not enough studies and results in this concept, people are not aware of the benefits of water reuse because of the preconception and charge of the concept for different conditions at wastewater treatment plants. This thesis aims to evaluate different wastewater treatment schemes for a range of water reuse applications through modeling and cost analysis. At the end of this study, the user is empowered to make a cost-benefit decision on which process to follow depending on the water reuse application in case-specific situations like different wastewater flowrates and characteristics on newly constructed or existing plants that will be retrofit. In this thesis, the following studies were done.

- Required input data, that is, wastewater capacity of the treatment plant, scheme and wastewater influent characteristics were determined for BioWin modeling.

- BioWin simulations for secondary treatment technologies were modeled for different biological treatment scenarios.
- Cost analysis for a management period of 30 years was done, including capital and operational costs for secondary treatment where BioWin results were included.
- For the water reuse part, depending on the water reuse application, if necessary, tertiary and/or advanced treatment processes were examined.
- Cost analysis for a management period of 30 years for tertiary and/or advanced treatment was also done individually.
- Comparison of the costs of scenarios of secondary and tertiary and/or advanced treatment was done for current potable water, wastewater and reclaimed water charges in Turkey and different countries.

CHAPTER 2

LITERATURE REVIEW

2.1 Water Reuse Concept

Population growth and urbanization trigger the expansion of environmental problems, including abating natural water resources with the need for more water (Barcelo & Petrovic, 2011). Low quality and quantity of watershed light on the importance of exploring all other possible water sources before depletion of limited surface water and groundwater supplies (Chen et al., 2014).

Wastewater recovery — including reclamation, reuse and recycling — is nowadays one of the available resources that are for better management of the water resources redirected from the natural water cycle to human-made. For public perception, there are new words associated with this old practice, such as water recycling instead of water reuse or reclaimed water for reclaimed wastewater (Salgot, 2008). To consider wastewater treatment as sustainable and end-of-pipe technology, treatment steps must comply with environmental, social and economic requirements (Rodriguez-Garcia et al., 2011).

One of the three main purposes of treatment is to comply with discharge regulations, sanitation of cities and safe disposal of collected wastewater to receiving bodies such as streams and rivers, after necessary treatment (Meneses et al., 2010). The other purpose is a trend in many countries globally, which is wastewater reuse (Salgot et al., 2018). Wastewater reuse is performed unintentionally for more than 5000 years as a defacto phenomenon. It is an unplanned or indirect reuse of treated water that is used after dilution with surface water. After dilution, surface water is processed in potable water treatment at downstream (Mediterranean Wastewater Reuse Working Group, 2007).

Technology-based wastewater reclamation emerged during the 20^{th} century after the population increase. There is a large amount of treated wastewater available for reuse that is expected to increase soon, thus it can be called as a reliable water resource. Reclaimed wastewater use has some advantages that can reduce the amount of wastewater discharge and water pollution, and it can be economically feasible (Salgot et al., 2018). Water reuse could become a sufficient and stable resource to meet large quantities of water demand if it is treated to ensure the water quality appropriate for the end-use (Furumai, 2008).

2.2 Types of Water Reuse Applications

Reclaimed water can be applied in a large variety of applications. The most common reuse applications are irrigation, residential uses, urban and recreational uses, groundwater recharge, aquaculture, industrial cooling water and drinking water production (Dott et al., 2008). In the next chapters, the main water reuse applications such as non-potable urban reuse/residential reuse, irrigation, industrial reuse, groundwater recharge and indirect potable reuse are mentioned.

2.2.1 Non-potable Urban Reuse

Non-potable urban reuse application is mostly used in inaccessible to public areas. The usage of the reclaimed water must not have direct contact with humans. Most commonly, the area has physical barriers such as surrounding by fences or temporary access restrictions (EPA, 2012). Some examples of non-potable urban reuse applications can be vehicle washing, fire protection, toilet flushing, dust/heat control and street cleaning. As these applications have human contacts excessively, monitoring of the water quality has great importance (Vigneswaran et al., 2004).

2.2.2 Irrigation

Irrigation is a critical application to use reclaimed water to reduce water stress. Traditional irrigation systems use a high amount of water from surface and groundwater resources (Xu et al., 2016). 2010 data indicates that approximately 74 % of the water was used as agricultural irrigation in Turkey (Muluk et al., 2013). The decision for irrigation application depends on the location and quantity of wastewater available in the area for reuse (Vigneswaran et al., 2004).

The effluent from the wastewater treatment plant with the aim of use at irrigation; is a stable and reliable source by quantity and quality. Although complete removal of pollutants is not possible, the wastewater can be used as a source of water and fertilizer (Xu et al., 2016).

Irrigation with reclaimed water has some advantages such as;

- Reduction of pressure on water bodies,
- Reduction of synthetic fertilizers due to the presence of nutrients,
- Higher yields in crops rather than the freshwater-irrigated area (Intriago et al., 2018).

The quality of reclaimed water is different from other water supplies. It may contain high salts, heavy metals, pharmaceuticals and endocrine disruptors as Contaminants of Emerging Concern (CEC) and pathogens. Because some of the applications have direct contact with humans, continuous monitoring is required. Also, the safety of reclaimed water used in irrigation is always questioned by the public. Some concerns to use reclaimed water in irrigation are;

- Salination of soil and plant hazards,
- Accumulation of toxic metals in soil and transfer to the plant,
- Contamination of groundwater by salts and CEC,
- Public health problems because of pathogens (Chen et al., 2013).

2.2.3 Industrial Reuse

The industry is the sector that uses reclaimed water, most of the time, treated by themselves until the criteria of the water quality is reached. In Turkey, cooling and process water recycling count for approximately 11 % of the total freshwater consumed (Muluk et al., 2013). There is an opportunity for reusing of municipal wastewater in industrial applications like cooling or process water. Increasing wastewater discharge taxes, encouraging the use of alternative water resources and technology development may increase the tendency to use reclaimed water in industries (Wilcox et al., 2016).

2.2.4 Groundwater Recharge

Groundwater is used for municipal water supply, agricultural /landscape irrigation and industrial water supply system. Recharging of underground water supplies occurs very slowly. Therefore, excessive usage of groundwater causes a decrease in groundwater levels that leads to complete consumption of groundwater resources. Artificial recharge of water is essential in the management of groundwater and within the scope of integrated water resource management. Two types of groundwater recharge that are commonly used are surface spreading/ percolation and direct aquifer injection. Reclaimed water quality decides which method to be used. By groundwater recharge with reclaimed water, it is aimed to;

- Reduce, stop or reverse declines in groundwater levels,
- Protect underground water against salt intrusion,
- Store surface/reclaimed water for usage (Asano et al., 2004).

2.2.5 Indirect Potable Reuse

Indirect potable reuse (IPR) is used in two forms worldwide as planned and unplanned. Planned IPR differs from direct potable reuse by using an environmental buffer for further dilution, treatment and retention time. This practice is a well-known practice that is applied by recharging of reclaimed water to groundwater or surface water. In these two methods, planned and unplanned, treated water is abstracted from surface water for potable usage; if needed, further treatment should be applied (Wilcox et al., 2016).

2.3 Regulations on Water Reuse

Water reuse was requirement and opportunity through the years. Some of the motives were the same for the past 100 years. Agricultural irrigation with the use of low-quality wastewater was applied in some areas of Europe and the United States in the late 1800s. There were no specific criteria or restrictions for using treated water until the 20th century. Diseases from treated sewage made authorities to give importance to the establishment of regulations and guidelines for the use of reclaimed water. Therefore, regulations have been evolved for the most widely used application that is agricultural irrigation, which has direct contact with humans and can be dangerous to public health. Developing criteria for reuse has been a challenge because of a lack of international regulations and guidelines. Existing ones are based on to cope with negative impacts on humans and the environment instead of opportunities and encouraging reclaimed water usage (Angelakis et al., 2018). The timeline for water reuse regulations can be seen in Figure 2-1.

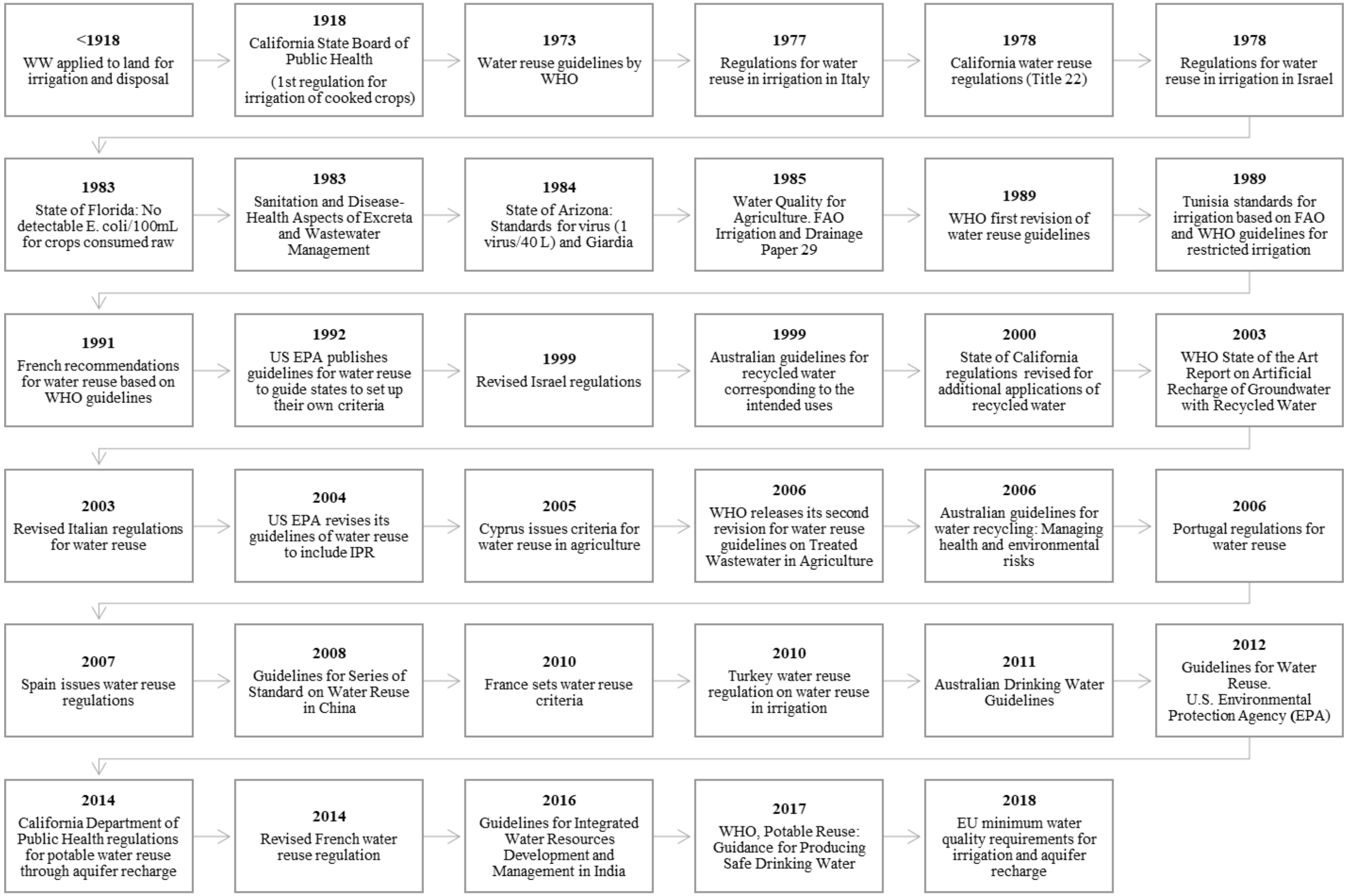

Figure 2-1 Timeline for water reuse regulations (adapted from Angelakis et al., 2018)

So far, two frameworks by the US EPA (2012) and WHO (2006) have addressed adequate water qualities for different water reuse applications. EPA guidelines are mainly used in states of the USA for reuse applications, some states have their standards for water reuse applications such as California and Florida (Wilcox et al., 2016). Existing water reuse regulations in the USA can be seen in Table 2-1.

Table 2-1 Existing water reuse regulations in the USA (Sanz et al., 2014)

States of the USA	**Regulation**
National: United States Environmental protection Agency (US EPA)	"Guidelines for water reuse" (2012)
Arizona	Title 18, Environmental quality: Article, reclaimed water quality standards - Permits required through Arizona Dept. of Water Quality
California	Groundwater Replenishment with Recycled Water -June 26, 2013 draft regulations Title 17 of the California Code of regulations - for cross-connections Title 22 - Water Recycling Criteria The compilations of recycled water-related laws once referred to as "The Purple Book," are described in "Statutes Related to Recycled Water & the California Dept. of Public Health, January 2011."
Colorado	Regulation 84 - Reclaimed Water Control Regulation (amended 6/10/13, effective 7/30/13
Florida	Chapter 62-610 F.A.C. "Reuse of Reclaimed Water and Land Application"
Georgia	Department of Natural Resources, 2002, Guidelines for Water Reclamation and Urban Water Reuse
New Mexico	Guidelines: NMED, Groundwater quality bureau guidance: Above ground use of reclaimed domestic wastewater, January 2007
Texas	Title 30 Texas Administrative Code Chapter 210, Subchapters A-F
Wyoming	Standards for the reuse of treated wastewater Chapter 21, December 2010

EPA guidelines can be seen in Table 2-2 for specific water reuse applications.

Table 2-2 Reclaimed water reuse criteria (EPA, 2012)

Reuse App.	**Treatment Level**	**Reclaimed Water Quality**
	Urban Reuse	
Unrestricted	• Secondary • Filtration • Disinfection	• pH = 6.0-9.0 • ≤ 10 mg/L BOD • ≤ 2 NTU • No detectable fecal col. /100 • 1 mg/L Cl_2 residual (min.)
Restricted	• Secondary • Disinfection/ Filtration	• pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col. /100 mL • 1 mg/L Cl_2 residual (min.)
	Agricultural Reuse	
Food Crops	• Secondary • Filtration • Disinfection	• pH = 6.0-9.0 • ≤ 10 mg/L BOD • ≤ 2 NTU • No detectable fecal col./100 mL • 1 mg/L Cl_2 residual (min.)
Processed Food Crops *Non-Food Crops*	• Secondary • Disinfection	• pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal coli/100 mL • 1 mg/L Cl_2 residual (min.)
	Impoundments	
Unrestricted	• Secondary • Filtration • Disinfection	• pH = 6.0-9.0 • ≤ 10 mg/L BOD • ≤ 2 NTU • No detectable fecal col./100 mi • 1 mg/L Cl_2 residual (min.)
Restricted	• Secondary • Disinfection	• ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL • 1 mg/L Cl_2 residual (min.)
	Environmental Reuse	
Environmental Reuse	• Secondary • Disinfection (min)	• Variable, but not to exceed: • ≤30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL • 1 mg/L Cl_2 residual (min.)

Table 2-2 (continued)

Reuse App.	Treatment Level	Reclaimed Water Quality
	Industrial Reuse	
Once-through Cooling	• Secondary	• pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL
Recirculating Cooling Towers	• Secondary • Disinfection (chemical coagulation and filtration may be needed)	• Variable depends on recirculation ratio: • pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL • 1 mg/L Cl_2 residual (min.)
	Groundwater Recharge	
Non-potable Reuse	• Site-specific and use-dependent. • Primary (min) for spreading • Secondary (min) for injection	• Site-specific and use-dependent
	Indirect Potable Reuse	
Groundwater Recharge by Spreading into Potable Aquifers	• Secondary • Filtration • Disinfection • Soil Aquifer Treatment (SAT)	Includes, but not limited to, the following: • No detectable total col./100 mL • 1 mg/L Cl_2 residual (min.) • pH = 6.5 – 8.5 • ≤ 2 NTU , ≤ 2 mg/L TOC of wastewater origin • Meet drinking water standards after percolation through the vadose zone
Groundwater Recharge by Injection into Potable Aquifers	• Secondary • Filtration • Disinfection • Advanced Wastewater Treatment	Includes, but not limited to, the following: • No detectable total col./100 • 1 mg/L Cl_2 residual (min.) • pH = 6.5 – 8.5 • ≤ 2 NTU • ≤ 2 mg/L TOC of wastewater origin • Meet drinking water standards
Augmentation of Surface Water Supply Reservoirs	• Secondary • Filtration • Disinfection • Advanced Wastewater Treatment	Includes, but not limited to, the following: • No detectable total col./100 mL • 1 mg/L Cl_2 residual (min.) • pH = 6.5 – 8.5 • ≤ 2 NTU , ≤ 2 mg/L TOC of wastewater origin • Meet drinking water standards

EPA guideline is used in many European countries, where specific regulations for reclaimed water did not exist (Wilcox et al., 2016). However, Europe is still working on its regulations on water reuse standards. In 2015, “Water Reuse in Europe - Relevant guidelines, needs for and barriers to innovation” was published. Analysis of technical, environmental and socioeconomic challenges was mentioned. In June 2016, “Guidelines for Integrating Water Reuse into Water Planning and Management in the context of the Water Framework Directive” was published. It proposed the development and implementation of reuse schemes. In October 2016, “EU Level Instruments on Water Reuse” was published. In January 2018, “EU Minimum requirements for water reuse in agricultural irrigation and aquifer recharge - Science for Policy Report” was published. In May 2018, “New rules to stimulate and facilitate water reuse for agricultural irrigation,” was published, which contained a legislative proposal for the reuse of treated water in irrigation. At last, in February 2019, “Proposal for a regulation of the European Parliament and the Council on minimum requirements for water reuse,” was published, which had rules for promoting agricultural reuse.

In Turkey, urban wastewater discharge to water bodies is regulated with the Regulation on Urban Wastewater Treatment, 2006, (Gazette No: 26047)(T.C. Çevre ve Şehircilik Bakanlığı, 2006). In this regulation, discharge standards are classified as secondary treatment effluent from urban wastewater treatment plants and biological nutrient removal urban wastewater treatment plants. In the first case, the treatment scheme is constructed for the removal of BOD, TSS and COD, and then these parameters’ standards are given (Table 2-3). Whereas in the second one, in biological nutrient removal urban wastewater treatment plants, apart from BOD, TSS and COD, phosphorus and nitrogen removal are also considered (Table 2-4).

Table 2-3 Discharge criteria for secondary effluent from urban wastewater treatment plants (T.C. Çevre ve Şehircilik Bakanlığı, 2006)(Regulation on Urban Wastewater Treatment, 2006, Gazette No: 26047)

Parameters	**Concentration (mg/L)**	**Min. Removal Efficiency (%)**
Biological Oxygen Demand (BOD_5) without denitrification (at 20 ºC)	25	70-90
Chemical Oxygen Demand (COD)	125	75
Total Suspended Solids (TSS)	35 35 (> 10000 PE) 35 (2000 - 10000 PE)	90 90 (> 10000 PE) 70 (2000 - 10000 PE)

*Concentration or removal efficiency will be used.

Table 2-4 Discharge criteria from biological nutrient removal urban wastewater treatment (T.C. Çevre ve Şehircilik Bakanlığı, 2006)plants (Regulation on Urban Wastewater Treatment, 2006, Gazette No: 26047)

Parameters	**Concentration (mg/L)**	**Min. Removal Efficiency (%)**
Total Phosphorus (TP)	2 mg/L P (> 100000 PE) 1 mg/L P (10000 - 100000 PE)	80
Total Nitrogen (TN)	15 mg/L N (> 100000 PE) 10 mg/L N (10000 - 100000 PE)	70-80

In Turkey, Regulation on Water Pollution Control was revised on 31.04.2004 (Gazette No: 25687), in article 28. It is mentioned herein that the use of effluent wastewater is encouraged to use in irrigational areas where water is not available for irrigation purposes and/or has economic value. Water quality criteria for reclaimed wastewater used in irrigation purposes are given in the "Technical Procedures Communique on Water Pollution Control Regulation (20.03.2010, Gazette Number: 27527)". In this communique, Appendix 7 is about "Reuse Criteria of Treated Wastewater as Irrigation Water." In this appendix, criteria on the water for irrigation purposes is given, which is adopted from EPA (2012) guideline. Reclaimed water is classified based on the crop type to be irrigated and the properties of the application area (restricted or not) for agricultural purposes. The tables given in the communique can be seen in Table 2-5 and Table 2-6.

Table 2-5 Classification of treated wastewater to be reused in irrigation (Table E7.1) (T.C. Çevre ve Şehircilik Bakanlığı, 2010)

Reuse Application	Treatment Type	Quality of reclaimed water [a]	Monitoring Period	Application Distance [b]
Class A				
a-Agricultural Irrigation: Non-processed food crops *b-Irrigation of urban areas*				
a) All kinds of food products that are irrigated by surface and sprinkler irrigation and can be directly eaten raw. **b)** Irrigation of all kinds of green areas (parks, golf courses)	-Secondary Treatment [c] -Filtration [d] -Disinfection [e]	-pH=6-9 - BOD_5 < 20 mg/L -Turbidity < 2 NTU -Fecal Coliform: 0/100 mL [g,h] - In some cases, a specific virus, protozoa and helminth analysis may be needed. -Residual Chlorine > 1 mg/L[i]	-pH: Weekly -BOD_5: Weekly -Turbidity: Continuously -Coliform: Daily -Residual Chlorine: Continuously	-At least 50 m distance from wells supplied with drinking water
Explanations: *-Heavy metal analysis should be done.* *-To meet standards, coagulants can be used before filtration.* *-Reclaimed water should be colorless and odorless.* *-Higher retention times for disinfection can be used for the removal of viruses and other parasites.* *-Residual chlorine should be higher than 0, 50 mg/L at the end of the collection system.* *-The high nutrient amount can affect crop growth.*				
Class B				
a- Agricultural Irrigation: Processed food crops [m] *b- Restricted irrigated areas* *c- Agricultural Irrigation: Nonfood crops*				
a) Irrigation of crops such as orchards and vineyards with keel irrigation **b)** Places where public access is restricted, such as grass production and cultivation **c)** Pasture irrigation for grassland animals	-Secondary Treatment [c] -Disinfection [e]	-pH=6-9 - BOD_5 < 30 mg/L -TSS < 30 mg/L -Fecal Coliform < 200 ad/100 mL [g,j,k] - In some cases, a specific virus, protozoa and helminth analysis may be needed. -Residual Chlorine > 1 mg/L[i]	-pH: Weekly -BOD_5: Weekly -TSS: Daily -Coliform: Daily -Residual Chlorine: Continuously	- At least 90 m distance from wells supplied with drinking water -If sprinkler irrigation is done, 30 m away from public
Explanations: **-** *The recommended limits for agricultural irrigation should be considered.* *- Id sprinkler irrigation is done TSS < 30 mg/L* *- The high nutrient amount can affect crop growth.* *- The entry of dairy animals into the pastures should be 15 days after irrigation. It this time is not reached, the Fecal Coliform amount should be a maximum of 14 pc/100 mL.*				

[a] *Wastewater characteristic unless mentioned otherwise.*
[b] *Limit for protection of water sources and human.*
[c] *Secondary Treatment, conventional activated sludge systems, bio disk, trickling filters, stabilization ponds or aerated lagoons.*
[d] *It can be sand filters or membrane filters like microfiltration or ultrafiltration.*
[e] *Usage of chlorine for disinfectant does not limit of usage of other disinfectants.* [f] *Recommended turbidity amounts should be met before disinfection and should not exceed 5 NTU. TSS concentration where Turbidity is not used, the concentration should not exceed 5 mg/L.*
[g] *Daily average levels are characterized.*
[h] *Fecal Coliform amount must not exceed 14 pc./100 mL.*
[I] *Residual Chlorine refer to after detention time of 30 minutes.*
[j] *Fecal Coliform amount must not exceed 800 pc./100 mL.*
[k] *Stabilization ponds can meet the Fecal Coliform standard without disinfection.*
[l] *Advanced treatment should be applied.*
[m] *Commercially processed food products are products that are physically or chemically processed to kill pathogenic microorganisms before they are sold to the public.*

Table 2-6 Chemical quality of irrigation water for assessment of quality (Table E7.2) (T.C. Çevre ve Şehircilik Bakanlığı, 2010)

			Degree of damage		
Parameters		**Units**	**None (Class I)**	**Low to medium (Class II)**	**Dangerous (Class III)**
Salinity					
Conductivity		µS/cm	< 700	700-3000	>3000
Total Dissolved Solids		mg/L	< 500	500-2000	>2000
Permeability					
Sodium absorption ratio (SAR)	0-3		EC ≥ 0.7	0.7-0.2	< 0.2
	3-6		≥ 1.2	1.2-0.3	< 0.3
	6-12		≥ 1.9	1.9-0.5	< 0.5
	12-20		≥ 2.9	2.9-1.3	< 1.3
	20-40		≥ 5.0	5.0-2.9	< 2.9
Specific ion toxicity					
Sodium (Na)					
Surface Irrigation		mg/L	< 3	3-9	> 9
Drip Irrigation		mg/L	< 70	> 70	
Chlorine (Cl)					
Surface Irrigation		mg/L	< 140	140 –350	> 350
Drip Irrigation		mg/L	< 100	> 100	
Boron (B)		mg/L	< 0.7	0.7-3.0	> 3.0

There are few drawbacks of using reclaimed water in daily life from the administration point of view. Firstly, lack of or misunderstanding of regulations is always an issue for the use of reclaimed water. For instance, for Turkey, limited regulations exist on reclaimed water to be used for agricultural purposes. However, this information is not sufficiently detailed. There is no regulation based on other reuse applications such as urban reuse or groundwater recharge. Another view is that governments in the world do not give enough importance to the water reuse concept to reduce water scarcity. Yet, it is impossible to progress on water reuse implementations without governmental support (Angelakis et al., 2008).

2.4 Water Reuse Challenges

Water reuse can be a crucial component in water resource management which has the capability of supplying the increasing water demand. Although wastewater treatment technologies exist to obtain the required quality, there are some challenges of using reclaimed water (Saliba et al., 2018). Public resistance, health risk and cost are some of them that need to be considered.

2.4.1 Acceptance

The public does not welcome wastewater throughout history. Thus, the usage of treated wastewater does not seem usable for most of the users. Emotional response to wastewater reuse is often referred to as the "yuck factor" which is named by Arthur Caplan. Earlier publications in the 1970s had physiological discussions for the usage of reclaimed water. This reaction by the public made the "reclamation concept" becomes hard to promote. This thought is most probably due to association of reclaimed water with sewage, urine or dirt, which are widely mentioned as disgusting (Rice et al., 2016).

In a study in Turkey about water reuse, participants were positive on reclaimed water usage by 64% for toilet flushing, 63% for cleaning of roads, 63% for use in construction works and 58% for use in firefighting (Buyukkamaci et al., 2013). The common thing in these applications is that they do not have direct contact with humans. When direct potable usage is asked to the participants, most of them disagreed with the idea. However, in the case where water quality is monitored and certified, some indicated that they might use reclaimed water in their daily lives (Buyukkamaci et al., 2013).

2.4.2 Health Risk

In the 19th century, the sanitary revolution began, which could be associated with water quality, population density and public health. The existing infrastructural system was forced to change by altering directions of pollutant flows for protecting potable water quality; in other words, public health. Reclaimed water is an evolution of the linear anthropogenic hydrological cycle. Closing the hydrological cycle enables to control water quality, safety and public health (Wilcox et al., 2016).

Pathogenic organisms are the primary concern of water reuse applications because of the severe human effects (EPA, 2012). The risk from several pathogens like viral, bacterial, protozoan and helminths are crucial when inhaled, absorbed from the skin and consumed. These pathogens may cause different health issues like acute sickness to chronical ones (Johson et al., 2012). Furthermore, the removal of pathogenic organisms is essential. For instance, if reclaimed water is used for agricultural purposes and agricultural workers, crop handlers and consumers are under the risk of exposing mentioned pathogens (Schaefer et al., 2004). When reclaimed water is intended for non-potable reuse, cross-connections between reclaimed water and potable water distribution system must be prevented. The risk of mixing reclaimed and potable water must be eliminated (EPA, 2012).

Another critical point is the monitoring of the reclaimed water quality. Depending on the reuse application, most of the time, microbial standards are close to potable water standards. Because the origin of reclaimed water is wastewater, which has higher pathogen concentrations, more extensive control and monitoring is required. Unfortunately, the monitoring of these pathogens is expensive and not real-time;

multi-barrier systems should be supplemented to guarantee continuous safe water access (Asano & Cotruvo, 2004).

Emerging contaminants increase concerns for treated wastewaters. Nanomaterials, disinfection by-products (DBP), perfluorinated compounds (PFCs), pharmaceuticals and personal care products (PPCPs), algal toxins, perchlorate, pesticides and microbes are examples of CEC (Roccaro, 2018). Some of the regulations in different countries set standards for these contaminants. As there had been limited information on emerging pollutants, existing conventional wastewater treatment plants were not designed for their removal in direct and indirect usage of reclaimed water (Norton-Brandão et al., 2013). Complete removal of CEC from wastewater is only valid with advanced treatment such as reverse osmosis (Roccaro, 2018). Besides, risk analysis studies were done for pharmaceuticals on reclamation systems in Orange County, California, for the aquifer recharge, the results indicated levels that pose no risk to public health (Sanz et al., 2014).

2.4.3 Cost

Water supply and wastewater sanitation is a public service. The current practice may not counterbalance the capital and operational costs of domestic wastewater management. For the usage of reclaimed water, the cost should be reasonable. Proper pricing is the key to the success of water reclamation with the supply-demand theory. Although reclaimed water price is less than potable water, water companies that construct reclaimed water treatment plants and market the water lack the motivation of taking an extra step (Yi et al., 2011). For example, in Spain, the cost to produce reclaimed water changes between $ 0.07/m^3 to $ 0.74/m^3 (Villar, 2018). In Orange County, USA reclaimed water is sold with the cost of $ 1.05 /m^3 (Orange County - Utility Rates & Charges, 2019), whereas, the reclaimed water charge in Singapore is $ 2.33 /m^3 (Singapore's National Water Agency, 2019).

2.5 Treatment Technologies for Water Reuse Applications

From the "no action" (no reuse or treatment) to more complex and expensive scenarios, proper technologies may be required for stakeholders to choose reclaimed water as a water resource. The effectiveness of decision making will depend on the preliminary studies which must be done to characterize the necessary technologies and treatment schemes (Dott et al., 2008).

In wastewater treatment plants, the unit operations and processes are different depending on the desired effluent characteristics. Different levels of treatment are classified as;

- Preliminary Treatment
- Primary Treatment
- Secondary Treatment
- Tertiary Treatment
- Advanced Treatment

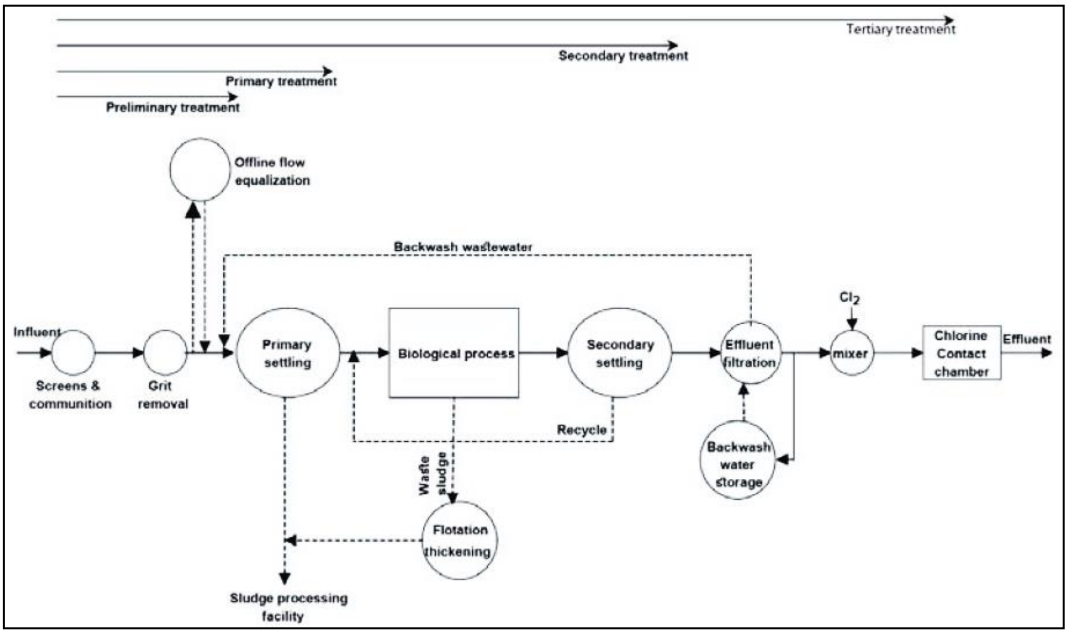

Figure 2-2 An example diagram of tertiary treatment level in a wastewater treatment plant (Mohammed et al., 2016)

As shown in Figure 2-2, in a typical treatment process, preliminary, primary and secondary treatments are used depending on the required effluent criteria. If effluent is used at different applications, further treatment, as tertiary and/or advanced treatment may be needed (Mohammed et al., 2016).

2.5.1 Preliminary Treatment

Preliminary treatment reduces and eliminates ominous substances that cause issues in operation or excessively increase the need for maintenance of downstream processes and equipment. These substances can be large solids, rags and grit. Preliminary treatment processes consist of physical unit operations such as screening to remove debris and rags, grit removal for the removal of coarse suspended matter. Other preliminary treatment operations are flotation for the removal of oil and grease, septage handling and flow equalization. In a typical conventional domestic wastewater treatment plant, screens and grit removal processes are used. Other units like floatation and flow equalization can be seen at most of the industrial wastewater treatment plants, where wastewater contains relatively higher concentration of grease and variable flowrates (Mohammed et al., 2016). In this thesis, screens and grit removal were used as preliminary treatment.

Screens

Screens are selected based on the size of the openings. For the removal of solids, such as rags and debris, bar racks or coarse screens can be used, typical opening varies from 6 mm to 75 mm. For further removal of substances, fine screens are used, which are traditionally followed by coarse screens. Their opening size differs between 1.5 to 6.0 mm for the elimination of smaller particles. If the following units require more substance-free wastewater, very fine screens of which typical opening size is 0.25 to 1.5 mm can be used. This type of screen reduces suspended solid concentration near to primary treatment level. Coarse and fine screens should be used to inhibit extra headloss and clogging problems (Davis, 2010).

Grit Chamber

Grit, which can be sand, gravel, eggshells or broken glass, is a material whose settling velocity is higher than organic materials. Removal of grit is required to protect mechanical equipment like pumps and reduction of deposit formations at pipes and channels. Another purpose for grit removal is to separate grit from organic substances from wastewater; with this separation, organic substances can be handled at different processes (Davis, 2010).

2.5.2 Primary Treatment

Preliminary treatment is followed by primary treatment in the wastewater treatment plant to remove organic particulate matter, which contributes to total suspended solids (TSS). Also, these suspended solids contribute to biological oxygen demand (BOD_5) in the wastewater. Thus, removing these organic particulate matters removes TSS and BOD_5 concentrations simultaneously. Removal of these substances has advantages for the downstream units of the plant, for example, decreasing the oxygen demand in following aerobic biological reactors. Besides, the rate of energy consumption and potential operational issues at biological processes also decrease (Davis, 2010).

2.5.3 Secondary Treatment

The level of wastewater treatment is determined for any project that depends on the end-use or discharge location. Secondary treatment is applied to achieve the removal of degradable organic matter and suspended solids. Required water quality can be obtained through conventional, widely-practiced secondary processes (Davis, 2010). Although not all constituents should be eliminated from wastewater, some are beneficial depending on the reuse application. For example, in agricultural irrigation, leftover nutrients are beneficial for the crops. Nevertheless, nutrient overloading can be harmful to aquatic ecosystems or drinking water resources (EPA, 2012).

The main goal of secondary treatment is to oxidize readily biodegradable BOD_5, that is not removed in preliminary and primary treatment and to remove suspended solids further. Some of the activated sludge configurations, which are conventional activated sludge, sequencing batch reactor, contact stabilization basins, extended aeration processes, are suspended growth processes that aim to remove BOD_5 and TSS.

Over the years, different modifications and variations have evolved for different performance aims (Tchobanoglus et al., 2014). If the end use or discharge location requirement needs phosphorus and nitrogen removal, secondary treatment with nutrient removal may be needed. Phoredox, anaerobic/anoxic/oxic (A2O) process, Bardenpho (5-stage), University of Cape Town (UCT) and Sequencing Batch Reactor (SBR) are widely used processes in the world (Davis, 2010).

In this thesis, to achieve the most applicable result in Turkey, the most commonly used biological wastewater treatment plants in Turkey were considered. Accordingly, conventional activated sludge (CAS), extended aeration (EXT) and anaerobic/anoxic/oxic (A2O) are discussed in this secondary treatment section.

2.5.3.1 Conventional Activated Sludge Process

The conventional activated sludge (CAS) process is widely used to serve large population areas and represent the standard technology for the treatment of wastewater. CAS systems include activated-sludge reactor and secondary sedimentation (Roccaro, 2018). CAS system is designed to remove mainly the organic matter and, to some extent, nutrients like nitrogen and phosphorus. However, they are not designed to eliminate nitrogen and phosphorus from the system. The treatment performance of the CAS system differs from 85 % to 97 %, depending on the incoming organic load (Roccaro, 2018).

The main advantages of the process are high-quality effluent and lower hydraulic retention time, which results in smaller aeration tank volume. The main disadvantages are higher amounts of sludge generated and the possibility of odor that may result from the mixture (Fatihah et al., 2010). In a typical CAS, settled wastewater and return activated sludge are transferred to the beginning of the aeration tank and mixed with inlet wastewater. Diffused air or mechanical aeration is used for aeration purposes (Asano et al., 2007). The typical flow scheme of CAS can be seen in Figure 2-3.

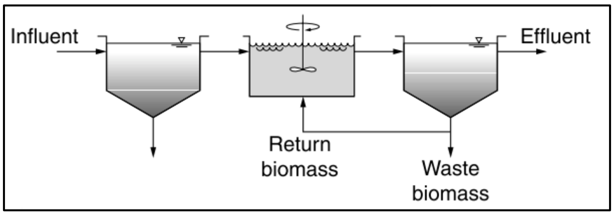

Figure 2-3 Typical flowchart of conventional activated sludge (CAS) process (Asano et al., 2007)

2.5.3.2 Extended Aeration Process

The extended aeration (EXT) process is a low-rate version of the activated sludge process. The process operates in low organic rates and food to microorganism ratio (F/M), high hydraulic retention times (HRT) and high sludge retention time (SRT) (Jafarinejad, 2017). Because the EXT system operates in a longer sludge age, relatively stabilized sludge is produced. The advantage of having longer HRTs is to operate varying flows and waste loadings. Another advantage is that odorous gas emission is low because of direct feed to the aeration tank because primary sedimentation is not applied together with EXT process. The main disadvantage is the low sludge dewaterability (Fatihah et al., 2010). The typical flow scheme of EXT can be seen in Figure 2-4.

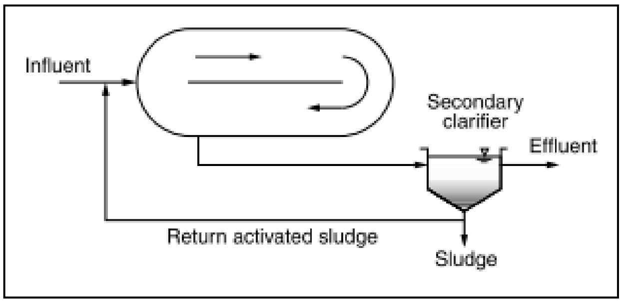

Figure 2-4 Typical flowchart of extended aeration (EXT) process (Asano et al., 2007)

2.5.3.3 Anaerobic/Anoxic/Oxic (A2O) Process

Anaerobic-anoxic-oxic (A2O) process is generally used in municipal wastewater treatment plants. This process enables the removal of nutrients, which are nitrogen and phosphorus. This removal of nutrients involves organic matter biodegradation, nitrification-denitrification and different from other processes; anaerobic phosphorus release and aerobic phosphorus uptake are valid (Zeng et al., 2011).

In the A2O process, the anoxic zone is used for the denitrification-nitrification process to remove nitrogen. This zone is located between anaerobic and aerobic zones. The retention time at anoxic zone is between 1 to 3 hours, which is altering with wastewater characteristics and the quantity of nitrate that need to be removed. Internal recycle, nitrate feed, is required to enhance nitrogen removal in the system. Primary clarifiers are not favored in this process (Tchobanoglus et al., 2014). The typical flow scheme of A2O can be seen in Figure 2-5.

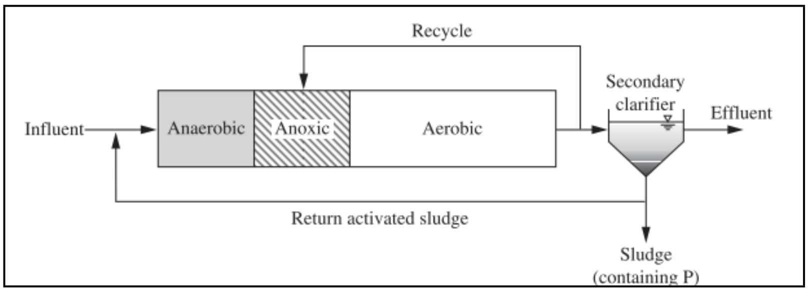

Figure 2-5 Typical flowchart of anaerobic/anoxic/oxic (A2O) process (Davis, 2010)

2.5.4 Tertiary Treatment

Secondary effluents contain residual particulate matter, which varies in size and composition depending on the secondary processes that are applied. These particles contain sub-colloidal, colloidal and suspended particles that should be eliminated if the water is used as reclaimed water. To eliminate these particles, physical operations used are depth, surface and membrane filtration. The typical range of effluent quality from case studies can be seen in Table 2-7. It can be seen that membrane filtration has a higher quality of water effluent if TSS concentration is taken as a decision parameter. The reason for better quality is that membrane filtration has smaller pores than depth or surface filtration processes (Asano et al., 2007). In this thesis, membrane and depth filtration technologies were studied, and thus, comparison of effluent quality is given in Table 2-7.

Table 2-7 Typical range of effluent quality variability observed from tertiary treatment (Asano et al., 2007)

Parameter	**Unit**		**Geometric standard deviation**	
			Range	**Typical**
Depth filtration following activated sludge process				
TSS	mg/L	2.0-8.0	1.3-1.5	1.4
Turbidity	NTU	0.5-4.0	1.2-1.4	1.25
Depth filtration following activated with BNR				
TSS	mg/L	1.0-4.0	1.3-1.5	1.35
Turbidity	NTU	0.3-2.0	1.2-1.4	1.25
Surface filtration following activated sludge process				
TSS	mg/L	1.0-4.0	1.3-1.5	1.25
Turbidity	NTU	0.5-2.0	1.2-1.4	1.55
Microfiltration following activated sludge process				
TSS	mg/L	0.0-1.0	1.3-1.9	1.5
Turbidity	NTU	0.1-0.4	1.1-1.4	1.3
Ultrafiltration following surface filtration of activated sludge				
TSS	mg/L	0.0-1.0	1.3-1.9	1.5
Turbidity	NTU	0.1-0.4	1.1-1.4	1.3
Membrane bioreactor				
BOD	mg/L	<1-5	1.3-1.6	1.4
TSS	mg/L	<1-5	1.3-1.9	1.5
Turbidity	NTU	0.1-1.0	1.1-1.4	1.3

Depth Filtration

Depth filtration was initially created for the treatment of surface water; now, it is adapted for wastewater treatment applications. Depth filtration is used to achieve further removal of suspended solids from secondary treatment effluent. Depth filtration enables more effective disinfection and pretreatment step for tertiary/advanced treatment such as carbon adsorption, membrane filtration or advanced oxidation (Asano et al., 2007).

Depth filters consist of a bed of porous materials such as sand and anthracite. Depending on the filter type, the adequate size of the media changes between 0.4 and 2.0 mm average diameter. Media filters consist of columns packed with an adequate height of different media and again depending on the filter configuration that works as a continuous, semi-continuous or batch backwash process (EPA, 2012).

Membrane Filtration

In wastewater treatment plants, to remove smaller size particles which cannot be removed in conventional activated sludge systems, membrane filtration systems are used. Membrane is defined as a thin film that separates two phases and acts as a selective barrier to the transport of substances (EPA, 2012).

In various filter types, significant differences in the pore sizes exist. The smaller the pore size, the higher the effluent quality is reached. The higher effluent water quality with either microfiltration (MF) or ultrafiltration (UF) membranes can be reached. Nevertheless, these technologies result in a higher cost of 1.5 to 2 times that of depth or surface filtration with the addition of energy and equipment costs (EPA, 2012).

Membrane filtration systems such as MF and UF are used in both water and wastewater treatment plants. MF and UF membrane filters have the same working principle as surface filtration, but they are different in pore sizes in the filter medium. The pore size can change from 0.005 to 2.0 micrometers. To remove particulate matter, organic matter and some nutrients that cannot be removed in the secondary treatment, MF and UF systems can be used. Effluent water from MF and UF may be used after disinfection, without further treatment, in different reuse applications (Asano et al., 2007).

Filtration equipment related to MF and UF is decided based on filtration rate and available surface area of the infiltration system. Manufacturers decide on the filter type depending on the product water quality and hydraulic loading rate. Moreover, there are rapidly developing new technologies to improve the performance of filters subject to fouling problems and economic issues (EPA, 2012).

2.5.5 Advanced Treatment

The quality and reliability of water quality are crucial for water reuse applications, such as some industrial uses or indirect potable uses. In these applications, further removal of dissolved solids and trace constituents may be needed. Membrane technologies such as nanofiltration, reverse osmosis and electrodialysis, can eliminate these constituents (Asano et al., 2007). General characteristics of membranes can be seen from Table 2-8.

Table 2-8 General characteristics of membrane processes (Asano et al., 2007)

Membrane Process	**Typical separation mechanism**	**Typical pore size µm**	**Typical operating range µm**
Microfiltration	Sleeve	Macropores (>50 nm)	0.008-2.0
Ultrafiltration	Sleeve	Mescopores (2-50 nm)	0.005-0.2
Nanofiltration	Sleeve + solution/diffusion +exclusion	Micropores (<2 nm)	0.001-0.1
Reverse osmosis	Solution/diffusion +exclusion	Dense (<2 nm)	0.0001-0.001
Dialysis	Diffusion	Mescopores (2-50 nm)	-
Electrodialysis	Ion exchange	-	-

Advanced treatment technologies are not limited to the membrane technology. Removal of dissolved solids/ trace substances is also possible by technologies such as adsorption, ion exchange, advanced oxidation processes, etc. In this thesis study, reverse osmosis was studied; therefore, only this technology is mentioned in detail within this section.

Reverse Osmosis and Nanofiltration

In reverse osmosis (RO) and nanofiltration (NF) processes, separation of dissolved ions from the feed stream occurs. These systems use hydrostatic pressure to overcome osmotic pressure. On the other hand, NF and RO systems separate and reject unwanted constituents depending on the pore size (Asano et al., 2007).

RO can be used after tertiary treatment steps like depth filtration, MF or UF. It is used in many applications in wastewater treatment and desalination processes. The removal efficiencies in RO are 95% to 99.5% of total dissolved solids and 95 % to 97 % of dissolved organic matter (Asano et al., 2007). The typical performance of NF and RO can be seen in Table 2-9.

Table 2-9 Typical performance for NF and RO (Asano et al., 2007)

Constituent	Unit	Rejection Rate	
		Nanofiltration	Reverse Osmosis
Total dissolved solids	%	40-60	90-98
Total organic carbon	%	90-98	90-98
Color	%	90-96	90-96
Hardness	%	80-85	90-98
Sodium chloride	%	10-50	90-99
Sodium sulfate	%	80-95	90-99
Calcium chloride	%	10-50	90-99
Magnesium sulfate	%	80-95	95-99
Nitrate	%	10-30	84-96
Fluoride	%	10-50	90-98
Arsenic (+5)	%	<40	85-95
Atrazine	%	85-90	90-96
Proteins	log	3-5	4-7
Bacteria	log	3-6	4-7 (in theory)
Protozoa	log	>6	>7 (in theory)
Viruses	log	3-5	4-7

2.5.6 Disinfection

In order to reduce pathogen levels to an acceptable level, disinfection is used. Disinfection is not the same as sterilization. In sterilization, the destruction of living organisms occurs. Disinfection is used to inactivate pathogenic microorganisms, including viruses, bacteria, protozoan oocysts and cysts and helminths that cause health risks. The most widely used reclaimed water disinfection method is chlorination. UV disinfection is a well-known and generally used system alternative to chlorine. Ozonation is also used for the disinfection of wastewater (Davis, 2010; EPA, 2012). In this thesis, chlorination and UV disinfection were examined for the general use of these technologies in the wastewater treatment plants. Ozonation is a new technology for wastewater disinfection, the comparison of these mentioned technologies can be seen in Table 2-10.

Table 2-10 Comparison disinfectants in water reclamation (Asano et al., 2007)

Characteristics	**Chlorine Gas**	**Chlorine Dioxide**	**Ozone**	**UV**
Deodorizing ability	High	High	High	NA
Interaction with organic matter	Oxidizes organic matter	Oxidizes organic matter	Oxidizes organic matter	Absorbance of UV irradiation
Corrosiveness	Highly corrosive	Highly corrosive	Highly corrosive	NA
Toxic to higher forms of life	Highly toxic	Toxic	Toxic	Toxic
Penetration into particles	High	High	High	Moderate
Safety concern	High	High	Moderate	Low
Solubility	Moderate	High	High	NA
Stability	Stable	Unstable	Unstable	NA
Effectiveness as disinfectant	Excellent	Excellent	Excellent	Good
Bacteria, protozoa	Fair to poor	Good	Good	Excellent
Viruses	Excellent	Excellent	Excellent	Good
By-product formation	THMs and HASS	Chlorite and Chlorate	Bromate	None known in measurable concentrations
Increase TDS	Yes	Yes	Yes	No
Use as a disinfectant	Common	Common	Common	Increasing rapidly

Chlorine Disinfection

In chlorine disinfection, free chlorine or chloramines are used. The effectiveness of chlorine disinfection relies on the water temperature, pH, degree of mixing, time of contact, presence of interfering substances, concentration and form of disinfection by-products (DBPs) (EPA, 2012).

Disinfection needs monitoring of total chlorine (which includes free chlorine, chloramines and other chlorine/organic compounds) and residual chlorine in the effluent water after required contact time. If ammonia exists in wastewater, it can combine with free chlorine to form chloramines, typically monochloramine, which is not effective as free chlorine yet still acts as a disinfectant. It requires a dose of an order of magnitude or more than free chlorine to achieve the same performance as that of free chlorine. Notably, free chlorine reacts with residual organic substances that cannot be treated in conventional treatment plants. As a result, combined chlorine residual causes health effects and low disinfection capability (EPA, 2012). Some advantages and disadvantages of using chlorine as a disinfectant can be seen in Table 2-11.

Table 2-11 Advantages and disadvantages of chlorine disinfection (adapted from Asano et al., 2007)

Advantages	**Disadvantages**
Well-established tech.	The hazardous chemical can be a threat to plant workers
Effective disinfectant	Relatively long contact time required
Chlorine residual can be sustained in long transmission lines	Formation of trihalomethanes and other disinfection by-products
Capital cost is relatively inexpensive	Not effective on removal of protozoa
Can be generated on-site	

UV Disinfection

Using UV disinfection in reclaimed water is a trend due to energy-efficiency and cost-efficiency. Large systems are currently operating in Roseville, California and Mesa/Gilbert, Arizona. Recently, UV is a well-proven and robust method.

Although the disinfection of wastewater by UV can be problematic, most of these problems are caused by the level of treatment before UV disinfection. The existence of particle-associated microorganisms and UV transmittance (turbidity) is the two main problems that can decrease the efficiency of the disinfection of treated wastewater. The remaining particles can shield microbes from UV light and bacteria can become embalmed in the particulate matter too. In these situations, UV efficiency is reduced significantly (EPA, 2012).

Open and closed contact chambers can be used for UV disinfection. The low pressure-low intensity and high pressure-high intensity UV lamps are used in open channel reactors whereas, in closed proprietary systems, low pressure-high intensity or medium pressure-high intensity UV lamps are used. The design of open and closed reactors for UV disinfection is crucial due to the short contact time, which is a few seconds (Asano et al., 2007). Some advantages and disadvantages of using UV disinfection can be seen in Table 2-12.

Table 2-12 Advantages and disadvantages of UV disinfection (adapted from Asano et al., 2007)

Advantages	Disadvantages
No hazardous chemicals	No immediate measure
Effective disinfectant	No residual effect
No residual toxicity	Energy-intensive
No formation of disinfection by-products	Fouling problem at UV lamps
Requires less space	The requirement of replacement of UV lamps

2.5.7 Soil Aquifer Treatment (SAT)

Soil Aquifer Treatment (SAT) is a well-known technology in wastewater treatment systems. The process is applied via spreading basins, where reclaimed water percolates through the soil, consisting of layers of loam, sand, gravel, silt and clay. While the reclaimed water filters into the soil through these layers, further physical, biological and chemical treatments occur. SAT systems require unconfined aquifers, vadose zones free of restricting layers and soils that are coarse enough to allow for enough infiltration rates but fine enough to provide adequate filtration. This process of filtration, in which the unsaturated or vadose zone acts as a natural filter and can remove necessarily all suspended solids, biodegradable materials, bacteria, viruses and other microorganisms, results in significant reductions in nitrogen, phosphorus and heavy metals concentrations (EPA, 2012).

The performance of the SAT is exceptionally dependent on influent water quality and site conditions like geology and hydrogeology. When the design is adequately done, pathogens, nitrogen, bulk organic matter and the majority of organic micropollutants can be removed. The difference from other mentioned technologies is that SAT enables multiple mechanisms in the removal of the pollutants mentioned above. Filtration, biodegradation, chemical precipitation, adsorption, ion exchange and dilution are some examples of mechanisms that are observed in SAT systems (Sharma & Kennedy, 2017).

2.6 Water Reuse Examples from Turkey

Municipal wastewater treatment plants (MWWTP) exist nearly in every city in Turkey, where the aim is to treat wastewater to meet the standards given by regulations. Existing wastewater treatment plants may not be capable of treating wastewater to reuse water quality, especially for applications, having direct human contact (Maryam & Büyükgüngör, 2017). Table 2-13 shows water reuse examples from Turkey. Cities are using treated water at different water reuse applications which require different levels of treatment processes. If the MWWTP has a biological nutrient removal (BNR) process, reclaimed water can be used for irrigation where no direct human contact exists. Some of the cities use reclaimed water for irrigational purposes, mostly for park and garden watering. When tertiary treatment is applied, reclaimed water can be used in industrial processes in İstanbul. The cities facing water scarcity more severely than other cities like Konya and Kırklareli use reclaimed water for irrigation in summer. Although there is not a reclaimed water treatment plant individually in Turkey, some municipalities use wastewater after secondary treatment, without any additional treatment such as Antalya and Edirne (Table 2-13).

Table 2-13 Water reuse examples from Turkey (adapted from Maryam & Büyükgüngör, 2017)

<table>
<tr><th>City</th><th>Total No of WWTP</th><th>Type of WWTPs</th><th>Number of WWTPs</th><th>WW Reuse</th></tr>
<tr><td rowspan="4">Antalya</td><td rowspan="4">27</td><td>BNR</td><td>18</td><td rowspan="4">Irrigation of onsite green areas, vegetation and plantation</td></tr>
<tr><td>ADV</td><td>1</td></tr>
<tr><td>CW</td><td>7</td></tr>
<tr><td>PT & DSD</td><td>1</td></tr>
<tr><td rowspan="2">Balıkesir</td><td rowspan="2">15</td><td>BNR</td><td>14</td><td rowspan="2">For limited irrigation purposes</td></tr>
<tr><td>ELECTRO</td><td>1</td></tr>
<tr><td rowspan="2">Bilecik</td><td rowspan="2">2</td><td>PT</td><td>1</td><td rowspan="2">60 m^3/day of water used for irrigation in the summer season</td></tr>
<tr><td>BNR</td><td>1</td></tr>
<tr><td rowspan="2">Bitlis</td><td rowspan="2">2</td><td>ADV</td><td>1</td><td rowspan="2">Park, garden watering</td></tr>
<tr><td>BNR</td><td>1</td></tr>
<tr><td rowspan="2">Edirne</td><td rowspan="2">6</td><td>BNR</td><td>5</td><td rowspan="2">Agricultural Irrigation</td></tr>
<tr><td>CW</td><td>1</td></tr>
<tr><td rowspan="4">İstanbul</td><td rowspan="4">19</td><td>ADV</td><td>5</td><td rowspan="4">Industrial (cooling) processes and landscape irrigation</td></tr>
<tr><td>BNR</td><td>4</td></tr>
<tr><td>Pre-T & DSD</td><td>9</td></tr>
<tr><td>CW</td><td>1</td></tr>
<tr><td rowspan="3">İzmir</td><td rowspan="3">32</td><td>BNR</td><td>10</td><td rowspan="3">Irrigation</td></tr>
<tr><td>ADV</td><td>18</td></tr>
<tr><td>CW</td><td>4</td></tr>
<tr><td rowspan="2">Kırklareli</td><td rowspan="2">7</td><td>ADV</td><td>3</td><td rowspan="2">Green space irrigation in May, June, July and August</td></tr>
<tr><td>BNR</td><td>4</td></tr>
<tr><td rowspan="3">Konya</td><td rowspan="3">25</td><td>BNR</td><td>15</td><td rowspan="3">Irrigation of urban green space with 527,800 m^3 of reclaimed water for seven months/ year and onsite park irrigation</td></tr>
<tr><td>CW</td><td>9</td></tr>
<tr><td>ADV</td><td>1</td></tr>
<tr><td rowspan="5">Muğla</td><td rowspan="5">29</td><td>BNR + DSD</td><td>4</td><td rowspan="5">Irrigation of parks and gardens</td></tr>
<tr><td>ADV</td><td>2</td></tr>
<tr><td>BNR</td><td>19</td></tr>
<tr><td>Package T</td><td>2</td></tr>
<tr><td>CW</td><td>2</td></tr>
<tr><td>Osmaniye</td><td>3</td><td>BNR</td><td>3</td><td>Irrigation of parks and gardens</td></tr>
<tr><td colspan="5">ADV: Advance Treatment, BNR: Secondary Biological Treatment with Nutrient Removal, CW: Constructed Wetlands, DSD: Deep Sea Discharge, ELECTRO: Electro flocculation, Package T: Package Treatment, Pre-T: Pre-treatment, PT: Physical Treatment.</td></tr>
</table>

2.7 Water Reuse Examples from the World

There are variable reuse applications from urban reuse to irrigational purposes that are used worldwide. The water scarcity problem and development level of the country affect the water reuse applications. Below given examples are from different countries. The examples cover different applications like landscape/ agricultural irrigation, groundwater recharge and non-potable urban reuse.

Orange County Water District, California, USA, receives secondary treated wastewater effluent from the Orange County Sanitation District. The following processes are applied, screens for preliminary treatment, primary clarifiers, for secondary treatment; trickling filters and activated sludge system are used alternatively. In this facility, for reclamation purposes, tertiary and advanced levels of treatment are applied, such as microfiltration and reverse osmosis. After that, UV disinfection is used. Afterward, chlorination is applied. Above mentioned project is called Green Acres Project. Effluent water is sold to the customers for usage in landscape irrigation at parks, schools, golf courses, toilet flushing and power generation cooling (Green Acres Project, 2020; The Orange County Water District (OCWD), 2019).

In Florida, USA, collected wastewater is delivered to the Water Reclamation Facility of the city, of which capacity is 85000 m^3/day. The facility is designed to treat the wastewater until the standards allow for non-drinking purposes such as lawn irrigation. Wastewater treatment has the following treatment scheme; screening as a preliminary treatment, sedimentation tanks for primary treatment, activated sludge basins for secondary treatment and filtration. Finally, it is disinfected by chlorine to kill pathogens and bacteria (Sewer Collection, Altamonte Springs, Florida, 2020).

The St Marys Advanced Water Recycling Plant, Sydney, produces up to 50 million liters of highly treated recycled water each day. St Marys Advanced Water Recycling Plant is part of a project called The Replacement Flows Project. This project is designed to generate up to 18 billion liters as environmental flow annually. Afterward, water is further treated for potable usage. The St Marys Advanced Water Recycling Plant receives tertiary effluent from three water recycling plants at Quakers Hill, St Marys and Penrith. The plant is aimed to reduce the load of nutrients, including nitrogen and phosphorous, discharged into the river by using ultrafiltration and reverses osmosis (Engineering Excellence Awards for St Marys Water Recycling Project, Sydney, 2020; St Marys Advanced Water Recycling Plant, 2020).

Torreele water plant is in Koksijde on the Belgian North Sea coast. The capacity of the treatment plant is 6850 m^3/d. The units of the plant are screens, activated sludge tanks, after that effluent from secondary sedimentation tanks is further treated with MF, RO and UV. Effluent provides 40% of the current potable water demand, which is transferred to downstream of the discharge point. The rest of the effluent water is used as an artificial recharge of the sandy unconfined aquifer to aim sustainable groundwater management of the existing water catchment (Houtte et al., 2005).

The Water Reclamation Plant of Tossa de Mar, Spain, has a capacity of 840 m^3/day, which can be upgraded to a maximum capacity of 3360 m^3/day. This plant receives secondary effluent and includes coagulation-flocculation, lamella settling, rapid sand filtration and a combined disinfection process using sodium hypochlorite and UV light. After disinfection, reclaimed water is stored in a tank and pumped to the reclaimed water distribution network. Most of the time, reclaimed water is used for street cleansing, public gardens irrigation and other non-potable urban uses (Mujeriego et al., 2011).

Salitre WWTP, Bogotá, Colombia, units are screens, grit chamber, primary sedimentations, activated sludge tanks and secondary sedimentation tanks. Effluent is transferred to the Salitre River with an open channel. There are large agricultural areas near the Salitre WWTP called La Ramada irrigation district (Bogotá River Environmental Restoration Project: Upgrade/Expansion of Salitre WWTP, 2020).

This district currently uses approximately 1.7 m^3/s for irrigation purposes. The water used for irrigation purposes comes directly from the Salitre River (EPA, 2012).

At the moment, there are five NEWater treatment plants in operation in Singapore, with nearly the same treatment processes. These five reclaimed water treatment plants supply 40 % of Singapore's current water needs. Secondary effluent is further treated with microfiltration, reverse osmosis and UV disinfection. The reclaimed water is used directly by the industry for non-potable uses or discharged to surface water bodies for indirect potable reuse purpose (Johson et al., 2012; Singapore's National Water Agency, n.d.).

2.8 Modeling Tool: BioWin

For designing a wastewater treatment plant, biological modeling and process simulations are of fundamental importance for a realistic design. Model and process simulation of a wastewater treatment plant is always an asset for the operation stage of the treatment. These models can be built for the optimization of cost and effluent characteristics. Effluent water quality can be predicted with these models (Iordache et al., 2010).

There are plentiful simulators for wastewater modeling to run different combinations. Generally, simulators are user-friendly and have graphical interfaces so that the user can create different schemes. BioWin, GPS-X, West, Aquasim, Efor and Aquafas are among the widely used simulators (EPA, 2009; Iordache et al., 2010).

BioWin is a wastewater treatment process simulator that is used for designing, upgrading and optimizing wastewater treatment plants. Many modules like Conventional Activated Sludge Systems and Suspended Growth Reactors (diffused or surface aeration) are possible to use in BioWin (Envirosim, 2017; Yang, 2014).

Configuration of different wastewater treatment systems can be done in BioWin.

These processes are;

- Different types of activated sludge bioreactor modules – suspended growth reactors, SBRs, media reactors systems,
- Anaerobic and aerobic digesters,
- Diverse settling tank modules – primary, ideal and 1-D model settlers,
- Various input elements – wastewater influent (COD- or BOD-based), chemical phosphorus precipitation by metal addition (ferric or alum), methanol for denitrification,
- Other modules – equalization tanks, dewatering units, flow splitters and combiners (Elawwad, 2018; Envirosim, 2017).

The BioWin modeling tool can model activated sludge and anaerobic biological processes together. Furthermore, the model can integrate pH and chemical phosphorus removal into the model (Nhapi et al., 2016). The BioWin simulator can be operated in two modules, namely, a steady-state module and an interactive dynamic simulator. The steady-state module is used for constant influent loading with average time-dependent inputs. The interactive dynamic simulator is used for designing and analyzing systems, which includes time-varying inputs (Envirosim, 2017).

In BioWin, the Activated Sludge/Anaerobic Digestion (ASDM) model is used. ASDM includes 50 state variables and over 80 process interpretations. These interpretations are used to define basic processes that exist in the wastewater treatment plant. The following processes occur in activated sludge systems in BioWin (Barker & Dold, 1997; Envirosim, 2017; Liwarska-Bizukojc et al., 2013).

- Growth and decay of ordinary heterotrophic organisms, methylotrophs, ammonia oxidizing biomass, nitrite oxidizing biomass, anaerobic ammonia oxidizers (ANAMMOX)
- Hydrolysis, adsorption, ammonification and assimilative denitrification.

In a study, BioWin was used as a simulator for modeling Moreni, Romania

Wastewater Treatment Plant to understand suitable updates at the plant for meeting stricter environmental regulations. To increase effluent quality, different wastewater treatment plant schemes, A2O and VIP, were tried. The results were evaluated to use in designing a new stage for treatment and increasing the efficiency in operation (Iordache et al., 2010).

In another study done by Rathore (2018), BioWin was used to supervise the operational and control system for Valrico Advanced Wastewater Treatment Plant located in Hillsborough County, Florida. The full treatment scheme for Valrico WWTP was constructed with a biological nutrient removal system by anaerobic tanks and activated sludge tanks. The calibration of the model was done with real-time effluent characteristics and experimental data. As a result, it was seen that effluent concentrations for Total Nitrogen (TN), Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen (TKN) were less than the discharge limits (Rathore, 2018).

In another study, the effect of food waste on the improvement of wastewater effluent characteristics was searched (Kim et al., 2019). By using BioWin software, the use of food waste and its efficiency on nutrient removal, biogas generation and energy balance was aimed to foresee. Different scenarios were constructed by changing wastewater treatment schemes such as Modified Ludzack-Ettinger (MLE), anaerobic-anoxic-aerobic (A2O) and Bardenpho.

It should be noted that a wastewater reclamation and reuse plant might generally include tertiary treatment units in addition to secondary treatment. The secondary treatment processes can be modeled with BioWin. However, BioWin is not capable of modeling tertiary/advanced processes such as membrane technologies as for the case for the majority of relevant software. However, there are individual research studies that aim to simulate specific tertiary treatment technologies. In a study done by Jamal and his colleagues, a mathematical model for reverse osmosis systems was developed (Jamal et al. , 2004). In another study, Konieczny and her colleague tried to understand the membrane filtration processes by mathematical modeling (Konieczny et al., 2000).

CHAPTER 3

METHODOLOGY

3.1 General Framework of the Study

In this thesis, different wastewater treatment schemes were evaluated for various water reuse applications through modeling and cost analysis. Within the scope of this thesis, the following steps were followed. The general framework of the study is also given schematically in Figure 3-1.

BioWin was used for modeling of hypothetical wastewater treatment plants of the secondary level.

- For modeling, required input parameters, such as flowrate, treatment scheme and influent characteristics of the plant were initially determined.
  - Inflow rates of the wastewater treatment plants in Turkey were evaluated for flowrate selection.
  - Wastewater treatment schemes were selected considering the existing wastewater treatment schemes in Turkey.
  - Influent characteristics for WWTP were taken directly from literature.
- BioWin simulations were done for various scenarios by changing flowrates, wastewater characteristics and treatment schemes. A total of 27 scenarios were modeled for secondary treatment level.
- Capital and operational costs were evaluated for each scenario considering BioWin modeling results, for a management period of 30 years for secondary level treatment. Unit prices of secondary treatment processes for each scenario were calculated.

- Different water reuse applications were considered. With respect to the water reuse application type selected, the tertiary and/or advanced treatment processes were added to the wastewater treatment schemes.
- Cost analysis was also performed for tertiary and/or advanced treatment processes for a management period of 30 years. Unit prices of tertiary and/or advanced treatment were calculated.
- The unit price of reclaimed water was calculated for each wastewater treatment scheme.

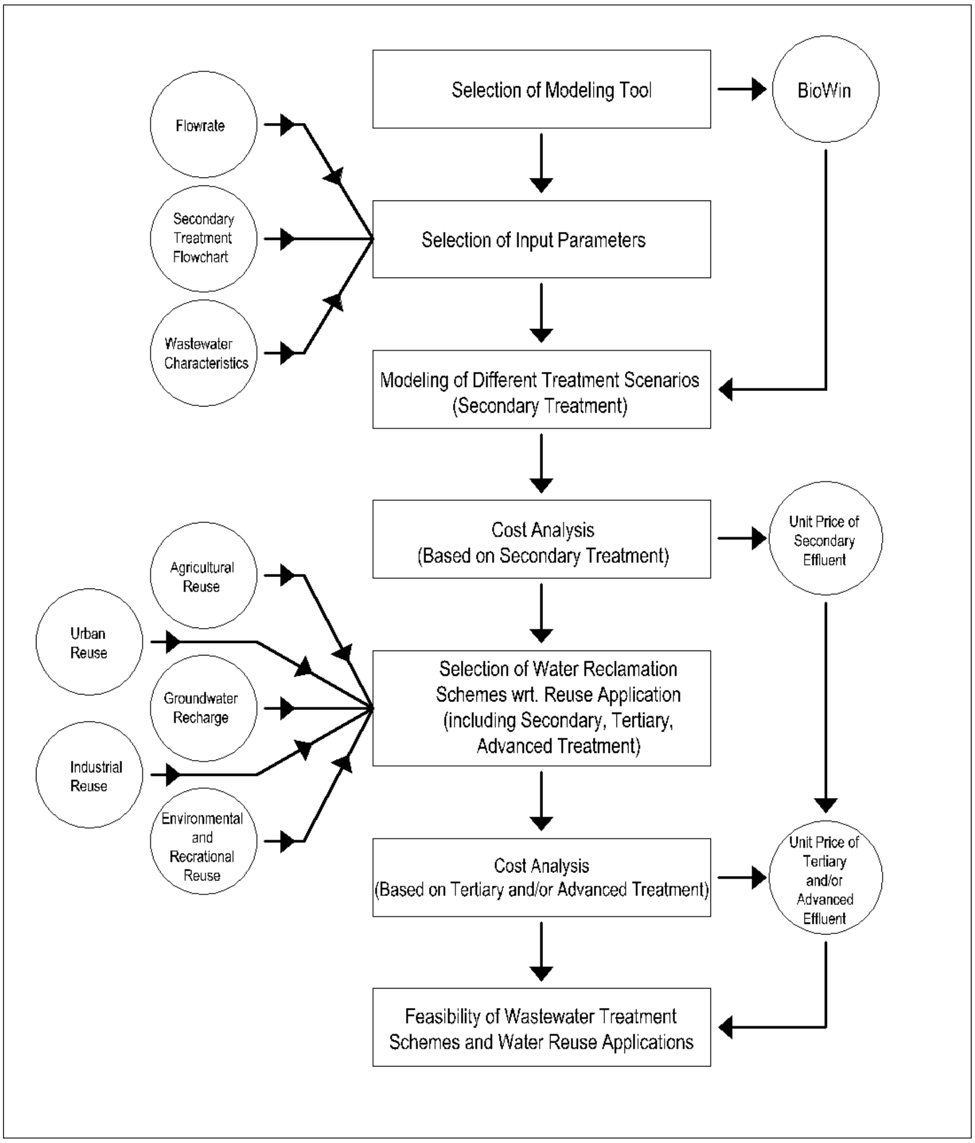

Figure 3-1 The general framework of the study

3.2 Wastewater Treatment Modeling

3.2.1 Input Data Preparation

BioWin was used as a model simulator for this study. BioWin has been used for modeling purposes in other countries such as the USA, there is a considerable number of BioWin modeling examples (Elawwad et al., 2017). BioWin can model many modifications on activated sludge systems, which is necessary for this thesis study. Besides, it is user-friendly. Lastly, sophisticated treatment plant schemes can be constructed rapidly.

For the BioWin model simulation, required input data was gathered. Therefore, initially, the wastewater characteristics, influent flowrate, in other words, the capacity of the plants to be simulated and the biological/ physical processes were determined.

3.2.1.1 Selection of Wastewater Characteristics

Wastewater is composed of various sources as domestic, municipal or industrial. The common practice for the characterization of the wastewater is in terms of its chemical and biological constituents (Tchobanoglus et al., 2014). In this study, both physical and biological variability of wastewater was considered. According to the concentration levels of the constituent, wastewater strengths are classified as low, medium and high (Table 3-1).

At BioWin simulator, only COD, TKN and TP data were entered into the model. Other parameters like pH, alkalinity, calcium, magnesium and dissolved oxygen concentrations were BioWin default values. Wastewater fractions, which were mainly biological parameters, were also accepted as BioWin default values. TSS and VSS values were taken directly from the BioWin model. The model itself calculated TSS and VSS concentrations with BioWin default fractions. Table 3-1 represents wastewater strengths and their corresponding constituents, which were used in BioWin simulations as influent data.

Table 3-1 Municipal wastewater constituents according to strength (Tchobanoglus et al., 2014)

Parameter	Concentration (mg/L)		
	Low	**Medium**	**High**
Chemical Oxygen Demand (COD) (1)	340	500	1000
Total Nitrogen (TN) (1)	25	35	69
Total Phosphorus (TP) (1)	3.7	5.5	11
Total Suspended Solids (TSS) (2)	135	198	317
Volatile Suspended Solids (VSS) (2)	180	243	363

(1) Selected concentrations

(2) Calculated concentrations by BioWin

3.2.1.2 Selection of Capacities of Wastewater Treatment Plants

The capacity and treatment schemes of wastewater treatment plants in Turkey were examined to decide on input data for the BioWin model construction. For this purpose, the project called "The Management of Domestic/ Urban Sludge, 2015" supervised by the Ministry of Environment and Urbanization was used (T.C. Çevre ve Şehircilik Bakanlığı, 2015). In that project, it was aimed to propose sludge management alternatives for Turkey. In the scope of that project, information about existing domestic/urban wastewater treatment plants and methods used for the treatment and disposal of sludge were examined.

To decide on the capacity of wastewater treatment plants in Turkey, the above-mentioned project was examined, and the related data was sorted. All wastewater treatment plants in all seven regions of Turkey were considered, regardless of the treatment type. A total of 201 wastewater treatment plants, of which capacities were different from each other and currently operating, were examined. The capacities ranged from 5.7 m^3/day to 765000 m^3/day, which meant the range is wide. The histogram was created for the capacities between 0-100000 m^3/day ranges, to account for every wastewater treatment plant, which can be seen in Figure 3-2. Treatment plants with higher capacities than 100000 m³/day were examined using a different method as will be given.

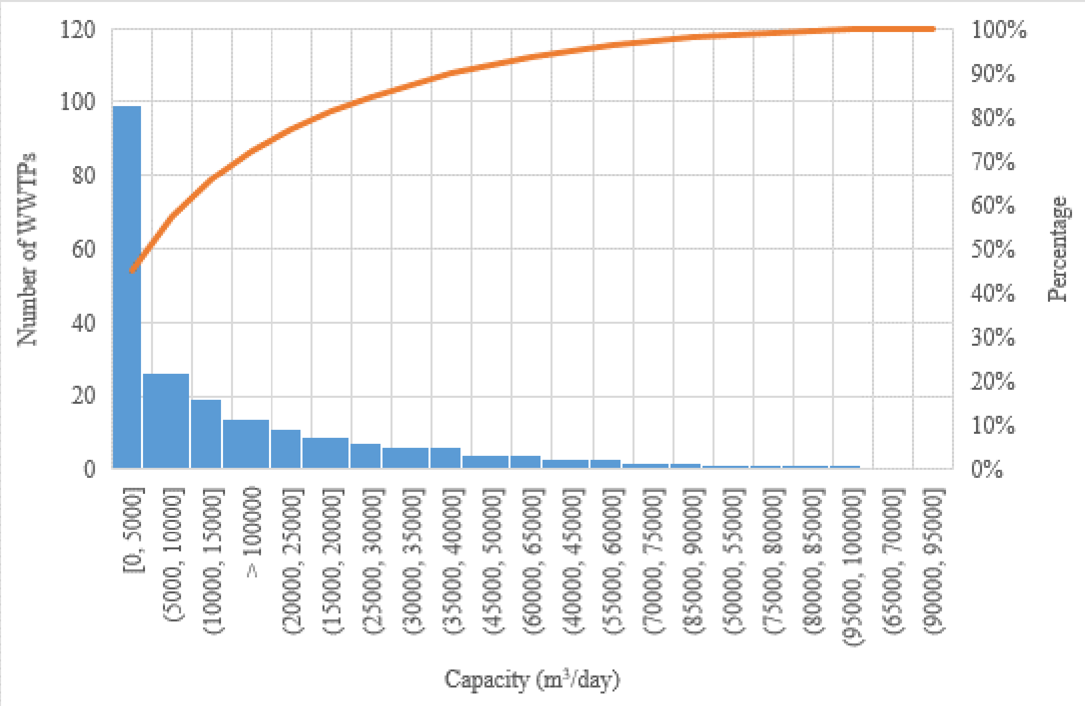

Figure 3-2 Distribution of flowrates (0-100000 m^3/day)

As seen in Figure 3-2, most of the WWTPs (88 %) have capacities between 0-5000 m^3/day. Turkey tends to build small capacity wastewater treatment plants. Nevertheless, regarding all 201 WWTPs, the average flowrate value is 29949 m^3/day, the minimum value is 5.7 m^3/day, the maximum value is 765000 m^3/day and the median is 6035 m^3/day. It is seen that the gap between minimum and maximum values is significant. Thus, the average and the median values were taken as representatives of the flowrates in Turkey.

To this point, two flowrates were selected for modeling; these flowrates represent small-capacity-but-high-in-number wastewater treatment plants. However, larger wastewater treatment plants, which serve metropolitan cities, cannot be ignored.

For justification, wastewater treatment plants in big cities were also examined. This approach aimed to understand whether these low-in-number-but-larger-capacity treatment plants should be taken into consideration in flowrate determination or not. The following thirty metropolitan cities that own larger wastewater treatment plants were examined (Table 3-2).

Table 3-2 Metropolitan cities in Turkey

1	Adana	**7**	Denizli	**13**	İstanbul	**19**	Malatya	**25**	Sakarya
2	Ankara	**8**	Diyarbakır	**14**	İzmir	**20**	Manisa	**26**	Samsun
3	Antalya	**9**	Erzurum	**15**	Kahramanmaraş	**21**	Mardin	**27**	Şanlıurfa
4	Aydın	**10**	Eskişehir	**16**	Kayseri	**22**	Mersin	**28**	Tekirdağ
5	Balıkesir	**11**	Gaziantep	**17**	Kocaeli	**23**	Muğla	**29**	Trabzon
6	Bursa	**12**	Hatay	**18**	Konya	**24**	Ordu	**30**	Van

Depending on the size and age of the wastewater treatment plant, some of the metropolitan cities own more than one wastewater treatment plant. Capacities and population served for each wastewater treatment plant were found in "Inventory of Wastewater Treatment Plant, 2018" (T.C. Çevre ve Şehircilik Bakanlığı, 2018). Information about treatment plants, which is not included in this reference, was found from the related website of the municipalities. Wastewater discharge from WWTPs in L/day.capita was sorted from the website of the Turkey Statistical Institute (TUIK, 2018b). It was needed to multiply the population and unit wastewater discharge (L/day.capita) to find the total wastewater discharged for a WWTP in each city. It was assumed that there was no loss in wastewater during the treatment process. Appendix A shows the mentioned calculations for each metropolitan city.

For metropolitan cities in Turkey, the total capacity of wastewater treatment plants is 6,884,565 m^3/day, the daily wastewater discharge by WWTPs is 4,905,601 m^3 and yearly wastewater discharge is 1,806,969 x 10^3 m^3. According to data taken from TUIK, wastewater discharged by all wastewater treatment plants in Turkey is 3,842,350 x 10^3 m^3 yearly (TUIK, 2018a). Therefore, 47.03% of total wastewater discharged is from metropolitan cities. The typical capacity for larger capacity treatment plants was determined by using the statistics from Appendix A. The minimum value is 17111 m³/day, the maximum value is 765000 m³/day, the average value is 163918 m³/day and the median value of these data is 130208 m³/day. The median value of the weighted distribution was determined as the third flowrate for modeling. As a result, three flowrates selected for the model can be seen in Table 3-3. Also, population equivalence of mentioned capacities were found by using daily generation of wastewater per person which is 100 L/day/capita which is mentioned in Regulation on Urban Wastewater Treatment (T.C. Çevre ve Şehircilik Bakanlığı, 2006).

Table 3-3 Determined flowrates of wastewater treatment plants for modeling

	Flowrate (m³/day)	**Wastewater Generation per Capita (L/day/capita)**	**Population Equivalence (capita)**
Capacity 1	6000	100	60,000
Capacity 2	30000	100	300,000
Capacity 3	130000	100	1,300,00

3.2.1.3 Selection of Treatment Schemes

Treatment schemes selection is essential for the wastewater treatment plant design; it changes with the project area or treated wastewater end-use. As mentioned before, "The Management of Domestic/ Urban Sludge" project included information about wastewater treatment plants in Turkey. It also contained biological wastewater treatment units used in Turkey, as mentioned below. The number of wastewater treatment plants utilizing these biological treatment units in each region in Turkey can be seen in Table 3-4.

- Conventional Activated Sludge (CAS)
- Extended Aeration (EXT)
- Anaerobic/ Anoxic / Oxic (A2O)
- Sequencing Batch Reactor (SBR)

- Bardenpho (BAR)
- Trickling Filter (TF)
- Bio disk Reactor (BIO)
- Anoxic/Oxic (AO)
- Stabilization Ponds (SP)
- Wetland (WL)
- Membrane Bioreactor (MBR)
- University of Cape Town (UCT)

Table 3-4 Number of WWTPs by regions of Turkey according to the biological treatment units used in the plant (T.C. Çevre ve Şehircilik Bakanlığı, 2018)

Treatment Units	**REGIONS OF TURKEY**							**TOTAL**
	MR	**BSR**	**AR**	**MR**	**CAR**	**SAR**	**EAR**	
CAS	15	6	8	8	7	1	2	47
EXT	27	4	16	22	6	1	2	78
A2O	2	1	7	4	4	0	0	18
SBR	3	1	1	0	0	2	0	7
BAR	4	0	0	1	1	1	0	7
TF	1	0	4	2	1	0	0	8
BIO	1	0	1	0	0	0	0	2
AO	0	2	1	2	8	1	0	14
SP	0	2	2	1	0	3	3	11
WL	0	0	4	0	3	0	0	7
MBR	0	0	1	0	0	0	0	1
UCT	0	0	0	0	1	0	0	1
TOTAL	53	16	45	40	31	9	7	201
MR: Marmara Region; BSR: Black Sea Region; AR: Aegean Region; MR: Mediterranean Region; CAR: Central Anatolia Region; SAR: Southeastern Anatolia Region; EAR: Eastern Anatolia Region								

A total of 201 wastewater treatment plants were examined. According to these data, the following percentages were calculated as shown in Table 3-5. The common treatment methods used in Turkey are extended aeration (EXT) by 38.81 %, conventional activated sludge (CAS) by 23.37 % and anaerobic/anoxic/oxic (A2O) by 8.96 %.

Table 3-5 Number and percentage of wastewater treatment plants in Turkey according to the biological treatment unit (T.C. Çevre ve Şehircilik Bakanlığı, 2018)

Biological Treatment Unit		**Number of WWTP**	**Percentage (%)**
Extended Aeration	EXT	78	38.81
Conventional Activated Sludge	CAS	47	23.38
Anaerobic / Anoxic / Oxic	A2O	18	8.96
Anoxic / Oxic	AO	14	6.97
Stabilization Ponds	SP	11	5.47
Trickling Filter	TF	8	3.98
Wetland	WL	7	3.48
Sequencing Batch Reactor	SBR	7	3.48
Bardenpho	BAR	7	3.48
Bio disk Reactor	BIO	2	1
Membrane Reactor	MBR	1	0.5
University of Cape Town	UCT	1	0.5
	TOTAL	**201**	**100**

Higher HRT and SRT values are seen in the EXT process with respect to other biological treatment units. Then, the higher sludge age results in stabilized sludge relatively. The reason for choosing the EXT process can be that the operation is more comfortable than the other mentioned ones (Fatihah et al., 2010).

Considering the biological treatment units in Turkey (Table 3-5), three mostly used treatment schemes (TS) with the following biological treatment unit was selected to be used in modeling as follows,

- **TS_A:** Wastewater treatment scheme with preliminary treatment, ***Conventional Activated Sludge (CAS)*** process and sludge treatment units scenario
- **TS_B:** Wastewater treatment scheme with preliminary treatment, ***Extended Aeration (EXT)*** process and sludge treatment units scenario
- **TS_C:** Wastewater Treatment scheme with preliminary treatment, ***Anaerobic / Anoxic / Oxic (A2O)*** process and sludge treatment units scenario

3.2.2 Configuration of Scenarios

Input data preparation for BioWin modeling was done by selecting wastewater characteristics, capacities and treatment schemes for the models. So far, three wastewater characteristics as *high, medium and low-strength*, three capacities as *6000, 30000 and 130000 m^3/day* and three treatment schemes as *TS_A (CAS), TS_B (EXT) and TS_C (A2O)* were selected.

For each treatment scheme, three capacities and three different wastewater characteristics were entered into BioWin. In other words, for each WWTP scheme (TS_A, TS_B and TS_C), three capacities and three wastewater strengths were used in the model. Thus, in total, 27 scenarios were modeled. To be an example, ***30KEXTLOW*** refers to a scenario where the capacity is 30000 m^3/day, the WWTP has the EXT process and the strength of the wastewater is low-strength.

All scenarios with respect to the selected capacity, strength and treatment scheme can be seen in Table 3-6.

Table 3-6 Scenarios for modeling

	No.	**Capacity 1 (6000 m³/day)**	**No.**	**Capacity 2 (30000 m³/day)**	**No.**	**Capacity 3 (130000 m³/day)**
TS_A (CAS)	***1***	6KCASLOW	***10***	30KCASLOW	***19***	130KCASLOW
	2	6KCASMED	***11***	30KCASMED	***20***	130KCASMED
	3	6KCASHIGH	***12***	30KCASHIGH	***21***	130KCASHIGH
TS_B (EXT)	***4***	6KEXTLOW	***13***	30KEXTLOW	***22***	130KEXTLOW
	5	6KEXTMED	***14***	30KEXTMED	***23***	130KEXTMED
	6	6KEXTHIGH	***15***	30KEXTHIGH	***24***	130KEXTHIGH
TS_C (A2O)	***7***	6KA2OLOW	***16***	30KA2OLOW	***25***	130KA2OLOW
	8	6KA2OMED	***17***	30KA2OMED	***26***	130KA2OMED
	9	6KA2OHIGH	***18***	30KA2OHIGH	***27***	130KA2OHIGH

3.2.3 Model Building with BioWin

BioWin models were built for 27 scenarios, as mentioned in Section 3.2.2. Models were only constructed for secondary treatment. BioWin results were used in the cost analysis. Tank volumes, oxygen amounts, sludge amounts and effluent values were taken from BioWin results directly.

As the first combination group, TS_A with the CAS process was configured. The representation of TS_A in BioWin is shown in Figure 3-3. In this configuration; grit chamber, primary clarifier, bioreactor, secondary clarifier, dewatering unit and sludge disposal as waste activated sludge (WAS) and grit disposal were used. Two dewatering units were used at BioWin to obtain approximately 20 % of dry solid content at sludge dewatering, but in the real case, this percentage can be obtained by adding organic polymer (Andreoli et al., 2007). Also, the manufacturer of decanters confirmed that the dry solid content of the sludge is achieved by the dewatering unit with the addition of organic polymer. In TS_A, return activated sludge (RAS) is recycled from the secondary clarifier. Primary and secondary sludges were mixed and dewatered at the same place. Supernatant, which was produced at the dewatering step as reject water, was transferred to bioreactor inlet. The effluent was discharged after the secondary clarifier.

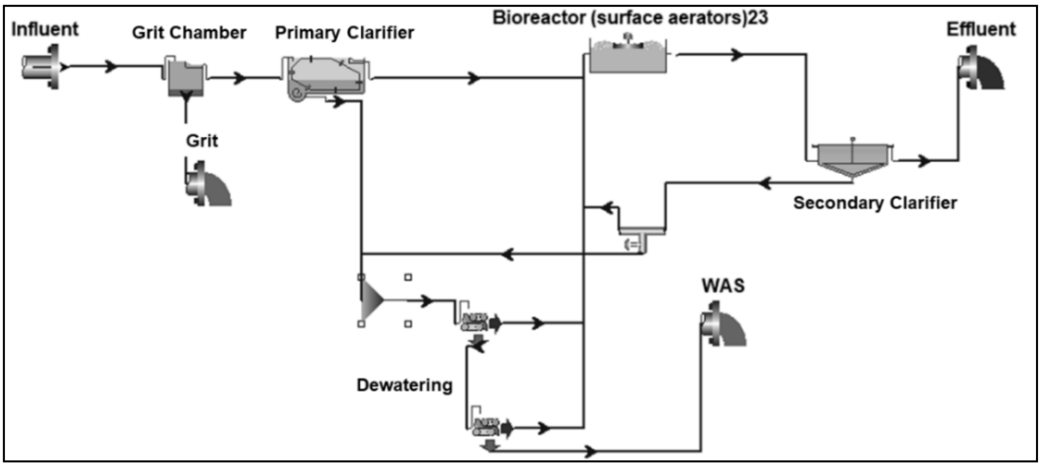

Figure 3-3 Configuration of BioWin model for TS_A (CAS)

As the second combination group, TS_B (EXT) process was configured. The representation of TS_B at BioWin is shown in Figure 3-4. In this process, grit chamber, bioreactor, secondary clarifier, dewatering unit and sludge disposal as WAS and grit disposal were used. The difference from TS_A was that there were no primary tanks used. To obtain approximately 20 % of dry solid content at sludge disposal, the organic polymer was added. In TS_B, RAS is recycled from the secondary clarifier. Supernatant, which was produced at the dewatering step, was transferred to bioreactor inlet. The effluent was discharged after the secondary clarifier.

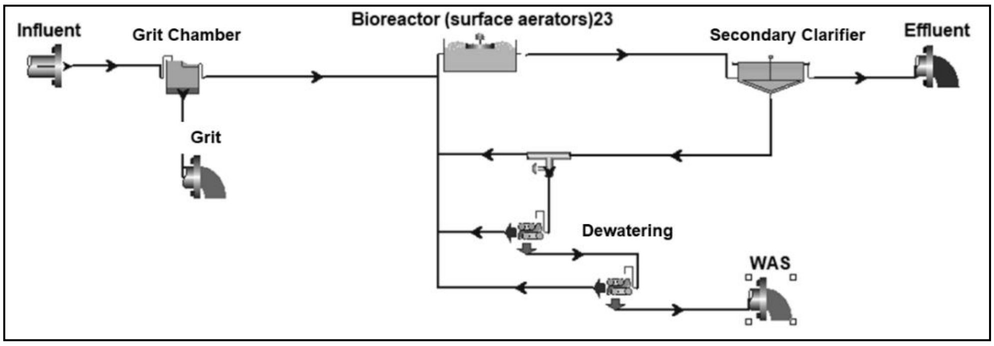

Figure 3-4 Configuration of BioWin model for TS_B (EXT)

As the third combination group, TS_C (A2O) process was configured. The representation of TS_C at BioWin is shown in Figure 3-5. In this process, grit chamber, anaerobic reactor and bioreactor, which consist of anoxic/aerobic (oxic) zones, secondary clarifier, dewatering unit and sludge disposal as WAS and grit disposal were also used. Internal recycle was available in this scheme. The difference from TS_A was, there were no primary tanks and the difference from TS_B, there was another tank for phosphorus removal, i.e. anaerobic reactor. Same with other treatment schemes to obtain approximately 20 % of dry solid content at sludge dewatering, the organic polymer was added. In TS_C, RAS is recycled from the secondary clarifier. From the exit of the aerobic tank, internal recycle (IR) was provided. Supernatant, which was produced at the dewatering step, was transferred to the anaerobic reactor inlet. The effluent was discharged after the secondary clarifier.

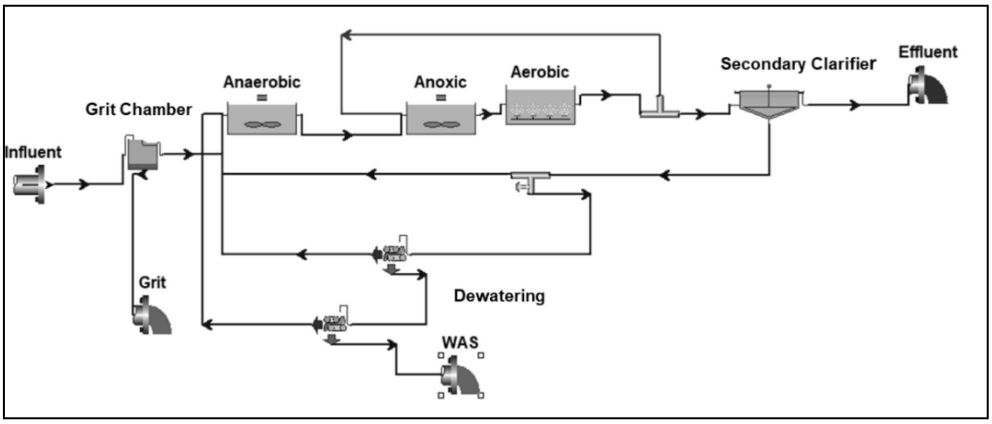

Figure 3-5 Configuration of BioWin model for TS_C (A2O)

After these three configurations, namely, TS_A, TS_B, TS_C, were set, other scenarios were ready to build. An example of input data for 6000 m^3/day and low-strength can be seen in Figure 3-6. Total COD, Total Kjeldahl Nitrogen and Total P values were entered into the model. Other parameters were default values. It was assumed that Total Nitrogen (TN) is equal to Total Kjeldahl Nitrogen (TKN).

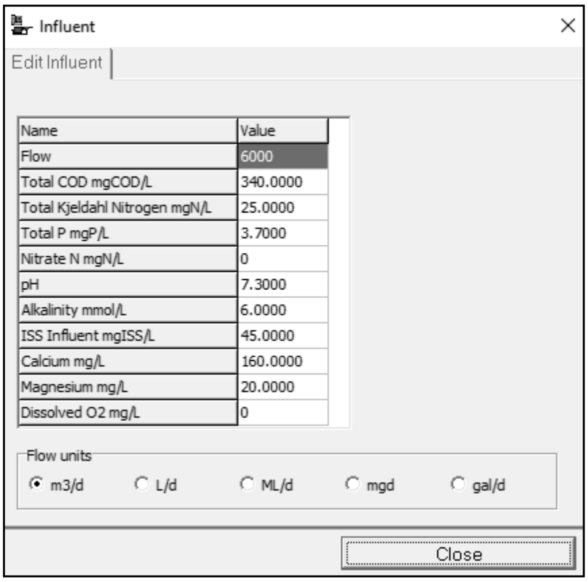

Figure 3-6 Input Data for the scenario 6KCASLOW at BioWin

The biological treatment units in the treatment plant was designed with respect to the design criteria, which was given in literature values (Table 3-7). Also, the effluent criteria were checked with Turkish regulations (Table 2-3 and Table 2-4) for each scenario. The design criteria for other units in the treatment plant have mentioned above.

In BioWin modeling, after influent data was entered and the flowchart was constructed, total tank volumes needed to be entered for each unit. The volumes of the grit chamber and bioreactor volume were selected based on the HRT (in hours) given in the literature (Tchobanoglus et al., 2014). For clarifiers, surface overflow rate (SOR) (m^3/m^2.day) were checked. For selected wastewater treatment schemes (CAS, EXT and A2O), the design criteria used in the model are given in Table 3-7.

Table 3-7 Design criteria for the biological reactors in secondary treatment (Tchobanoglus et al., 2014)

	Solids Retention Time (SRT) (day)	**MLSS (mg/L)**	**Hydraulic Retention Time (HRT) (hr)**			**Recycle Ratio % of influent**	
			Anaerobic Reactor	**Anoxic Reactor**	**Oxic Reactor**	**RAS**	**IR**
CAS	3-15	1500-4000	-	-	3-6	-	-
EXT	20-40	2000-4000	-	-	20-30	-	-
A2O	5-25	3000-4000	0.5-1.5	1-3	4-8	25-100	100-400

While designing units, assumptions were made depending on the design criteria. By using these assumptions, volumes of each unit were found. These assumptions are as follows,

- For the grit chamber, 15 minutes of HRT was assumed (Tchobanoglus et al., 2014). For the calculation of the volume, retention time was multiplied with the capacity of WWTP for each scenario.
- While sizing of the primary sedimentation for TS_A (CAS), the SOR was intended to keep around 28 m^3/m^2.day (Tchobanoglus et al., 2014).

- To size the secondary sedimentation for TS_A, the SOR is intended to be kept around 30 m^3/m^2.day where a criterion is 16-30 m^3/m^2.day. For TS_B (EXT), SOR is intended to be kept at approximately 11 m^3/m^2.day where the criterion is 8-16 m^3/m^2.day. Lastly, for TS_C (A2O), SOR is intended to be kept around 15 m^3/m^2.day where the criterion is 15-30 m^3/m^2.day. (Tchobanoglus et al., 2014).
- The HRT was assumed as 90 minutes for the anaerobic tank and 3 hours for the anoxic zone (Tchobanoglus et al., 2014). For the calculation of the volume, retention time was multiplied with the capacity of WWTP for each scenario.
- Different HRTs for different schemes were used by considering the design value in Table 3-7 to determine aerobic tank volume (Tchobanoglus et al., 2014).
- RAS and IR ratios were selected by considering literature values (Tchobanoglus et al., 2014).

After volume data was selected, SRT values were designated in BioWin scenarios. By using the trial-error method, SRT, tank volumes and MLSS concentration in the oxic tank were calibrated according to the literature values (Table 3-7) to obtain the best effluent quality. This process was applied for all 27 scenarios.

The capacity of the treatment plant affects the volume of the units regardless of the wastewater strength. The volumes entered to BioWin were total volumes of the tanks. Numbers of tank used in WWTPs were determined by considering the total volume. After deciding on total tank volumes, numbers and dimensions of the units were determined. The dimensions of the units, such as the length, width and height, were assumed with design experience. This design was not only done on paper; additionally, preliminary drawings of the tanks were formed by AutoCAD as a conceptual design to be sure about the applicability of the selected dimensions. Drawings can be seen for every scenario in Appendix B. Foundations and the wall thicknesses of these units were assumed with design experience. Reinforced concrete shear walls were used, namely (P1) and (P2) and (F) represents the foundation of the tanks in the drawings. Tank volumes with these dimensions were checked with the volumes obtained from BioWin.

For the calculation of the concrete and steel amount, which was for the construction of the wastewater treatment plant, the dimensions of wall height, width and length were used, which was calculated in the previous step. Based on the design experience of wastewater treatment plants, 80-120 kg of steel is needed for 1 m^3 of concrete. For this thesis study, 100 kg of steel was assumed for 1 m^3 of concrete. After the concrete amount was calculated, the steel amount was calculated with this correlation.

As an example, the design of the 6KA2O process was shown in Table 3-8. Calculations for other scenarios can be seen in Appendix C.

Table 3-8 Concrete and steel amount calculation for 6KA2O

6000 m³/day - A2O

Grit Chamber

Foundation	0.5	m
Wall Thickness	0.4	m
Volume	**50**	**m³**
Height	3	m
Area	16.67	m²
Free board	0.7	m
Number of Double Tanks	0.5	Pcs.
Width	2.2	m
Length	8	m
Area	17.6	m²
Volume	52.8	m³
P1		
Width	8	m
Length	3.7	m
Height	0.4	m
Pcs.	4	
Concrete Volume	23.68	m³
P2		
Area	2.2	m²
Length	3.7	m
Height	0.4	
Pcs.	4	
Concrete Volume	6.512	m³
Foundation		
Area	66	m²
Height	0.6	m
Pcs.	1	
Concrete Volume	39.6	m³
P1+P2+Foundation	69.792	m³
Tank Amount	1	Pcs.
Unexpected	0.2	
Concrete Volume	41.88	m³
Amount of steel rebar	4.188	ton

Anaerobic Tank

Foundation	0.6	m
Wall Thickness	0.5	m
Volume	**480**	**m³**
Height	5.5	m
Area	87.27	m²
Free board	1	m
With between walls (W)	2	m
Middle Wall Width	0.25	m
Tank Length (L)	17	m
R1	4.25	m
hwater	5.5	m
Tank Surface Area Calculation		
Area of rectangular shape	2 x 2 x 17 = 34 m²	
Area of circular shape	(3.14 x 4.25^2)/4 = 14.19 m²	
Middle Wall Area	2 x 17 x 0.25 = 4.25 m²	
Tank Surface Area	34 + 14.19 - 4.25 = 43.94 m²	
	43.94 x 2 = 87.88 m²	
Tank Amount	2	pcs.
1 Tank Volume	43.94 x 5.5 = 241.67 m³	
Twin Tank Volume	241.67 x 2 = 483.34 m³	
Twin Tank Amount	1	Pcs.
Total Volume	483.3	m³
P1		
Width	17	m
Length	6.5	m
Height	0.5	m
Pcs.	3	
Concrete Volume	165.75	m³
P2		
Area	7.46	m²
Height	0.5	m
Pcs.	4	
Concrete Volume	14.92	m³
Foundation		
Area	212	m²
Height	0.6	m
Pcs.	1	
Concrete Volume	127.2	m³
P1+P2+Foundation	307.87	m³
Tank Amount	1	Pcs.
Unexpected	0.2	
Concrete Volume	369.44	m³
Amount of steel rebar	36.944	ton

Anoxic - Aerobic Tank

Foundation	0.7	m
Wall Thickness	0.6	m
Volume	**3400**	**m³**
Height	6	m
Area	566.67	m²
Free board	1	m
With between walls (W)	4.5	m
Middle Wall Width	0.3	m
Tank Length (L)	24	m
R1	9.3	m
hwater	6	m
Tank Surface Area Calculation		
Area of rectangular shape	2 x 4.5 x 24 = 108 m²	
Area of circular shape	(3.14 x 9.3^2)/4 = 67.93 m²	
Middle Wall Area	2 x 24 x 0.3 = 7.2 m²	
Tank Surface Area	108 + 67.93 - 7.2 = 168.73 m²	
	168.73 x 2 = 337.46 m²	
Tank Amount	2	pcs.
1 Tank Volume	168.73 x 6 = 1012.38 m³	
Twin Tank Volume	1012.38 x 2 = 2024.76 m³	
Twin Tank Amount	2	Pcs.
Total Volume	4049.5	m³
P1		
Width	24	m
Length	7	m
Height	0.6	m
Pcs.	3	
Concrete Volume	302.4	m³
P2		
Area	18.66	m²
Height	0.6	m
Pcs.	4	
Concrete Volume	44.78	m³
Foundation		
Area	661	m²
Height	0.7	m
Pcs.	2	
Concrete Volume	925.4	m³
P1+P2+Foundation	1272.58	m³
Tank Amount	2	Pcs.
Unexpected	0.2	
Concrete Volume	3054.19	m³
Amount of steel rebar	305.419	ton

Secondary Sedimentation

Foundation	0.4	m
Wall Thickness	0.4	m
Height	**1.5**	**m**
Area	**210**	**m²**
Free board	0.3	m
Pcs.	2	Pcs.
Diameter	8.18	m
Selected diameter	8.5	m
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m
P1 - CYLINDRICAL PART		
Area	49.87	m²
Length	1.8	m
Height	0.4	m
Pcs.	1	
Concrete Volume	35.91	m³
P2 - CONIC PART		
Area	49.87	m²
Length	0.5	m
Height	0.4	m
Pcs.	1	
Concrete Volume	9.97	m³
P3 - SLUDGE COLLECTION PART		
Area	8.51	m²
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	31.91	m³
Foundation		
Area	8.55	m²
Height	0.4	m
Pcs.	1	
Concrete Volume	3.42	m³
P1+P2+P3+Foundation	81.21	m³
Tank Amount	2	Pcs.
Unexpected	0.2	
Concrete Volume	194.9	m³
Amount of steel rebar	19.49	ton

3.3 Further Wastewater Treatment Schemes for Water Reuse

It is possible to use secondary effluent in some water reuse applications (Z. Wang et al., 2017). The reclaimed water quality for some of the reuse applications is high; therefore, secondary treatment was not enough for the required quality. To increase the reuse application potential and types, tertiary and/or advanced treatment can be applied (Figure 3-7). According to pollutants in the wastewater and end-use applications of the reclaimed water, tertiary and/or advanced treatment technologies are used worldwide after conventional treatment (Maryam & Büyükgüngör, 2017).

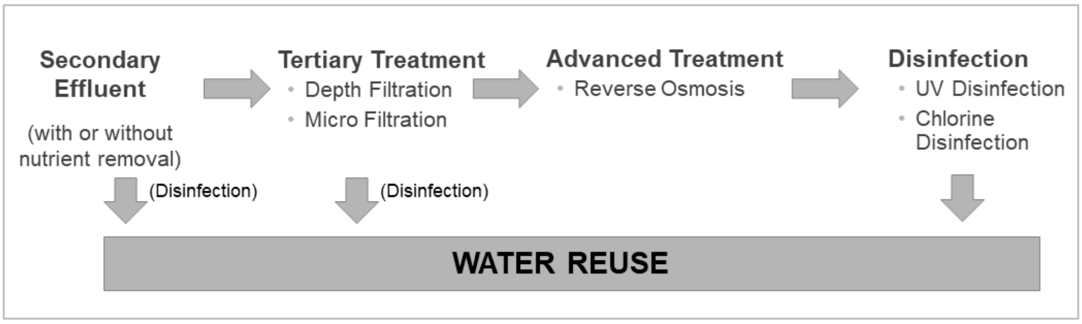

Figure 3-7 Treatment alternatives for water reuse applications

For tertiary and advanced treatment units, since no modeling tool is available, each unit was performed regarding the capacity, i.e., wastewater flowrate, instead of using BioWin simulations. The effluent of tertiary and advanced treatment units, removal efficiencies (Table 2-7 and Table 2-8) and concentrations were assumed to be attained. The design of these unit operations was done on a capacity basis instead of removal capability. In other words, after selecting needed tertiary and/or advanced treatment schemes, these units were designed depending on the capacity of the wastewater treatment plant.

In Table 3-9, water reuse applications are given for secondary, tertiary and/or advanced treatment levels. Treatment levels for given reuse applications are obtained from EPA Guideline and other sources (Asano et al., 2007; EPA, 2012; Iglesias et al., 2010; Maryam & Büyükgüngör, 2017; Roccaro, 2018). Among those treatment levels and related schemes, six possible treatment schemes were selected as TS_1 to TS_6. The configuration of treatment schemes can be seen in Figure 3-8, Figure 3-9, Figure 3-10, Figure 3-11, Figure 3-12 and Figure 3-13.

Table 3-9 EPA's required treatment levels, reclaimed water qualities for various reuse applications and treatment schemes (TS_1 – TS_6) selected for this thesis study (Asano et al., 2007; EPA, 2012; Iglesias et al., 2010; Maryam & Büyükgüngör, 2017; Roccaro, 2018)

Reuse Application	Treatment Level	Reclaimed Water Quality	Possible TS	References
		Urban Reuse		
Unrestricted	• Secondary • Filtration • Disinfection	• pH = 6.0-9.0 • ≤ 10 mg/L BOD • ≤ 2 NTU • No detectable fecal col. /100 1 mg/L Cl_2 residual (min.)	• TS_1	(1) (2) (4)
Restricted	• Secondary • Disinfection/ Filtration	• pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col. /100 mL • 1 mg/L Cl_2 residual (min.)	• TS_3 • TS_5	(2) (3) (4)
		Agricultural Reuse		
Food Crops	• Secondary • Filtration • Disinfection	• pH = 6.0-9.0 • ≤ 10 mg/L BOD • ≤ 2 NTU • No detectable fecal col./100 mL • 1 mg/L Cl_2 residual (min.)	• TS_1	(1) (2) (4)
Processed Food Crops *Non-Food Crops*	• Secondary • Disinfection	• pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal coli/100 mL • 1 mg/L Cl_2 residual (min.)	• TS_5	(2) (3) (4)
		Impoundments		
Unrestricted	• Secondary • Filtration • Disinfection	• pH = 6.0-9.0 • ≤ 10 mg/L BOD • ≤ 2 NTU • No detectable fecal col./100 mi • 1 mg/L Cl_2 residual (min.)	• TS_1	(1) (2) (4)
Restricted	• Secondary • Disinfection	• ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL • 1 mg/L Cl_2 residual (min.)	• TS_5	(2) (3) (4)

Table 3-9 (continued)

Reuse Application	Treatment Level	Reclaimed Water Quality	Possible TS	References
		Environmental Reuse		
Environmental Reuse	• Secondary • Disinfection (min)	• Variable, but not to exceed: • ≤30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL • 1 mg/L Cl_2 residual (min.)	• TS_5	(2) (3) (4)
		Industrial Reuse		
Once-through Cooling	• Secondary	• pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL • 1 mg/L Cl_2 residual (min.)	• TS_4	(3)
Recirculating Cooling Towers	• Secondary • Disinfection (chemical coagulation and filtration may be needed)	• Variable depends on recirculation ratio: • pH = 6.0-9.0 • ≤ 30 mg/L BOD • ≤ 30 mg/L TSS • ≤ 200 fecal col./100 mL • 1 mg/L Cl_2 residual (min.)	-	(2)
		Groundwater Recharge		
Non-potable Reuse	• Primary (min) for spreading • Secondary (min) for injection	• Site-specific and use-dependent	• TS_4	(3)
		Indirect Potable Reuse		
Groundwater Recharge by Spreading into Potable Aquifers	• Secondary • Filtration • Disinfection • Soil Aquifer Treatment (SAT)	Includes, but not limited to, the following: • No detectable total col./100 mL • 1 mg/L Cl_2 residual (min.) • pH = 6.5 – 8.5 • ≤ 2 NTU • ≤ 2 mg/L TOC of wastewater origin • Meet drinking water standards after percolation through the vadose zone	• TS_2	(2) (3)

Table 3-9 (continued)

Reuse Application	**Treatment Level**	**Reclaimed Water Quality**	**Possible TS**	**References**
Indirect Potable Reuse				
Groundwater Recharge by Injection into Potable Aquifers	• Secondary • Filtration • Disinfection • Advanced Wastewater Treatment	Includes, but not limited to, the following: • No detectable total col./100 mL • 1 mg/L Cl_2 residual (min.) • pH = 6.5 – 8.5 • ≤ 2 NTU • ≤ 2 mg/L TOC of wastewater origin • Meet drinking water standards	• TS_6	(1) (3) (4)
Augmentation of Surface Water Supply Reservoirs	• Secondary • Filtration • Disinfection • Advanced Wastewater Treatment	• Includes, but not limited to, the following: • No detectable total col./100 mL • 1 mg/L Cl_2 residual (min.) • pH = 6.5 – 8.5 • ≤ 2 NTU • ≤ 2 mg/L TOC of wastewater origin • Meet drinking water standards	• TS_6	(3) (4) (5)
(1) (Iglesias et al.,2010) **(2)** (EPA, 2012) **(3)** (Asano et al., 2007) **(4)** (Maryam & Büyükgüngör, 2017) **(5)** (Roccaro, 2018)				

In the disinfection step of the scenarios, both chlorination and UV disinfection was used. Because the combination of two types of disinfectant agents is effective to conserve public health due to each agent acts in different removal degree against the different microorganisms (Montemayor et al., 2008). The effectiveness of using chlorination and UV disinfection sequentially is more effective than a standalone process (Rattanakul et al., 2014). According to Zyara and his colleagues, using first chlorine and then UV in disinfection is recommended (Zyara et al., 2016). Another reason is that usage of chlorination and UV light together can decrease chlorine consumption, which leads to a decrease in DBP that ended up in nature (H. Wang et al., 2014; X. Wang et al., 2012). Other than that, UV treatment also changes the water quality, which decreases the causes of corrosion at the distribution pipes (H. Wang et al., 2014).

TS_1 includes the A2O process with filtration, chlorination and UV (Figure 3-8). Tertiary effluent can be used for urban reuse, where the area is unrestricted and for agricultural reuse like irrigation of food crops. It can also be used at impoundments, which are unrestricted.

For TS_2, which is more complicated than TS_1, the secondary treatment can be A2O or CAS or EXT followed by disinfection via UV and chlorine and finally, Soil Aquifer Treatment (SAT) (Figure 3-9). This treatment scheme can be used if the reuse application is indirect potable usage like groundwater recharge by spreading into potable aquifers.

In TS_3, wastewater is treated by A2O, CAS or EXT, followed by filtration to remove remaining solid particles (Figure 3-10). With these treatment processes, reclaimed water can be used as urban reuse in restricted areas after disinfection.

In TS_4, secondary treatment like A2O, CAS or EXT is used (Figure 3-11). The effluent wastewater can be used at industrial reuse, once-through cooling and groundwater recharge when the groundwater is used for non-potable purposes. In the USA, 47 power plants were reported as using treated secondary municipal wastewater in their cooling systems (Hsieh et al., 2010). Other than that, some developing countries like Uganda, who need water for irrigation, use secondary effluent directly, although that can affect human health (Fuhrimann et al., 2014; Qadir et al., 2010).

In TS_5, wastewater is treated after secondary treatment (i.e., by A2O or CAS or EXT) with disinfection via chlorination and UV (Figure 3-12). The effluent can be used in the restricted areas, for agricultural irrigation where processed food crops or non-food crops are planted, in impoundments that have restricted usage and for environmental reuse applications. Secondary effluent is applied in many locations in the world without causing severe public health issues and environmental effects, but also increasing the yield of numerous crops (A. N. Angelakis & Durham, 2008). In Bogota, Columbia, treated water from a similar treatment scheme is used for irrigational purposes (Houtte et al., 2005). Also, it is indicated that secondary treated municipal wastewater with proper disinfection can be used at the cooling system makeup water (Dzombak et al., 2012).

TS_6 is different from other schemes because of its complexity. Because the effluent water will be used for indirect potable usage, advanced treatment is needed. Microfiltration and reverse osmosis were used after secondary treatment. Permeate water of reverse osmosis was disinfected by UV and chlorine (Figure 3-13). It is recommended that effluent water can be diluted/ buffered with surface water. Then, surface water can be distributed to households after being treated in a conventional water treatment plant. This reuse application is named as augmentation of surface water supply reservoirs (Chalmers et al., 2011; EPA, 2012). In addition to that, effluent water can be used in groundwater recharge by injection into potable aquifers (EPA, 2012). Several countries use identical reclaimed water treatment schemes. NEWater treatment plants in Singapore, Torreele water treatment plant in Belgium and Orange County Water Reclamation Plant in the USA are some example treatment plants that use secondary effluent, which is further treated with MF, RO and disinfected (Bogotá River Environmental Restoration Project: Upgrade/Expansion of Salitre WWTP, 2020; Green Acres Project, 2020; EPA, 2012; Houtte et al., 2005; Johson et al., 2012; Singapore's National Water Agency, n.d.; The Orange County Water District (OCWD), 2019).

Figure 3-8 Schematic view of Treatment Scheme 1 (TS_1)

Figure 3-9 Schematic view of Treatment Scheme 2 (TS_2)

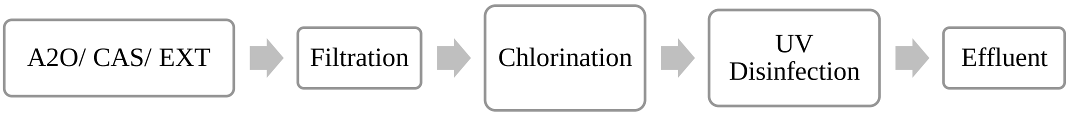

Figure 3-10 Schematic view of Treatment Scheme 3 (TS_3)

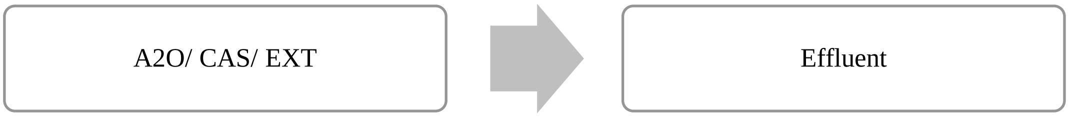

Figure 3-11 Schematic view of Treatment Scheme 4 (TS_4)

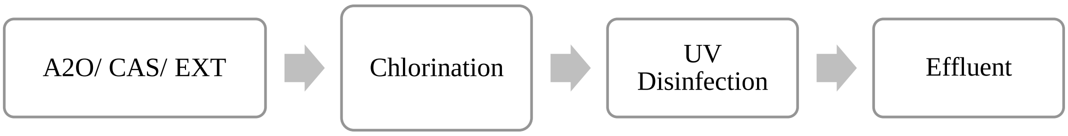

Figure 3-12 Schematic view of Treatment Scheme 5 (TS_5)

Figure 3-13 Schematic view of Treatment Scheme 6 (TS_6)

3.4 Cost Analysis

Wastewater treatment and reuse projects are not one-time paid investments. They need regular expenditures in operation, maintenance and rehabilitation related to capital cost (Hernández-Sancho et al., 2015). In this thesis study, the cost analyses were performed for each scenario considering the 30 years of operation period with an additional 1 year of design period and 2 years of construction. Capital costs and operational costs for secondary treatment (biological), tertiary and advanced treatments were initially calculated. After calculating total and unit prices for secondary treatment level (TS_A, TS_B, TS_C), depending on the treatment scheme (i.e., TS_1 to TS_6), if needed, the tertiary and advanced treatment costs were added to secondary treatment level costs in order to calculate the total unit cost of the reclaimed water (Figure 3-1).

In costs analysis for secondary treatment level, capital costs such as reinforcement / civil costs, mechanical costs, piping costs, electrical and sanitary costs and replacement costs, and operational costs such as maintenance costs salary of the staff, energy costs, chemical costs and sludge costs were considered (Table 3-10).

Table 3-10 Items for cost analysis for secondary treatment level

Capital Cost	Reinforcement / Civil Costs	(BioWin - Excel)	
	Mechanical Costs	(Firms)	
	Piping Costs	(16 % of mechanical cost)	
	Electrical and Sanitary Costs	(20 % of mechanical cost)	
	Replacement Costs	(30 – 60 % of capital cost at Year 10 and Year 20)	
Operational Cost	Maintenance Cost	(2 – 4 % of capital cost)	
	Salary of the Staff	(depending on the treatment scheme)	
	Energy Costs	(From gates, mixers, pumps, decanter, blower– firms)	**Increase by 1.36 % every year after 2022**
	Chemical Cost	Organic Polymer for sludge – (1 kg PE for 5 ton DS)	**Increase by 1.36 % every year after 2022**
	Sludge Costs	Transfer and incineration of the sludge	**Increase by 1.36 % every year after 2022**

In costs analysis for tertiary/advanced treatment level, capital costs such as reinforcement / civil costs, mechanical costs, piping costs, electrical costs and replacement costs, and operational costs such as maintenance costs and energy costs were considered (Table 3-11).

Table 3-11 Items for cost analysis for tertiary/advanced treatment level

Capital Cost	Reinforcement / Civil Costs	(Building Costs)	
	Mechanical Costs	(Firms)	
	Electrical and Sanitary Costs	(3 % of mechanical cost)	
	Replacement Costs	(30 – 100 % of capital cost at Year 10 and Year 20)	
Operational Cost	Maintenance Cost	(2-6% of capital cost)	
	Energy Costs		**Increase by 1.36 % every year after 2022**

In the cost analysis, inflation was taken into consideration, where interest rate was assumed to be equal to inflation rate for that purpose the net present factor was calculated. *Net Present Value Factor* reduces the total annual expenses or total annual benefits of each year of the project within the economic analysis period to the beginning of the project investment, i.e., in this thesis study year 2020. It is calculated using the inflation rate and distance from the beginning of the income or expense to the project. By multiplying the current cost with the net present value factor, the net present value of cost is found, which is given in Equation 3-1.

$$\text{Net Present Value Factor} = \frac{1}{(1+i)^n} \qquad \text{(Equation 3-1)}$$

n: period (year) i: inflation rate (%) (taken as 2.08 %)

The inflation rate was taken as 2.08 %, which is the inflation average between 2005 and 2019 in the USA (FRED, 2018). For the worst case scenario, inflation rate for Turkey was examined in different case, also total unit treatment costs were calculated for inflation rate of 9.86 % (TCMB, 2020).

Cost analysis was done in Dollar ($) basis. The costs that were taken from Turkish firms, in Turkish Lira (TL) or Euro (€), were converted into Dollar to be on the same basis. Currencies from Turkish Lira to Dollar and Turkish Lira to Euro were kept constant, which were 25.02.2019 currencies (TCMB, 2019). The currencies are,

1 $ = 5.31 TL

1 € = 6.03 TL

1 € = 1.14 $

3.4.1 Capital Costs

Capital costs cover;

- Reinforcement / Civil Costs
- Mechanical Costs
- Piping Costs
- Electrical and Sanitary Costs
- Replacement Costs

Initial capital costs were mainly civil, mechanical, electrical/sanitary and piping costs. These costs were allocated in different years at the construction step. It was assumed that construction was completed in 2 years. The summary table for the project timeline can be seen in Table 3-12. In the 1st year (2020) of construction, 50 % of the civil work and 50% of the piping work were done. For 2nd year (2021), it was assumed that the rest of the civil, piping, mechanical and electrical/sanitary works were completed.

Table 3-12 Timeline for construction

Construction Items	Capital Cost ($)	Years	
		1st Year (2020)	2nd Year (2021)
Civil	A	0.50 x A	0.50 x A
Mechanical	B	-	B
Electrical-Sanitary	C	-	C
Piping	D	0.50 x D	0.50 x D
TOTAL	A + B + C + D	0.50 x (A + D)	(0.50 x (A + D)) + B + C

3.4.1.1 Reinforcement/ Civil Work Costs

Civil work costs for the secondary treatment level were calculated by using BioWin results. The concrete and steel amounts were calculated in the design step of the wastewater treatment plants. To find the reinforcement/ civil work costs, concrete and steel costs were considered. Concrete and steel prices were taken from Unit Price Tables, which are published by the Environment and Urbanization Ministry, Turkey, 2019. The prices of concrete and steel are 189.53 TL/m^3 ($ 35.69/m^3) and 3548.84 TL/ton ($ 668.33/ton), respectively (T.C. Çevre ve Şehircilik Bakanlığı, 2019). With calculated unit concrete and steel costs, the civil work cost of each unit was found.

For reinforcement/ civil work costs of advanced and tertiary treatment level, by assuming these technologies would be placed in separate buildings, reinforcement/ civil work costs of the buildings were included. The civil work costs for buildings were determined by examining approved projects by the State of Hydraulic Works and Bank of Provinces.

3.4.1.2 Mechanical Costs

For the mechanical costs of the secondary treatment level, mechanical equipment needed in the wastewater treatment plant was listed. The offers were taken directly from sale firms. Some of the mechanical equipment were gate valves, coarse screens, fine screens, conveyors, inlet pumps, monorail cranes, scrapers, grit separators, mixers, sludge pumps (excess and return), scum pumps, blowers, decanters, etc.

Blower, mechanical aerators and decanters were selected with respect to tank volume, required aeration capacity and the amount of sludge produced. Blowers were selected for the TS_C process with the air capacity obtained from BioWin. Mechanical aerators were selected for TS_A and TS_B processes with respect to the aeration tank volume.

For mechanical costs of advanced and tertiary treatment level, there were not enough bids for all flow scenarios because of challenging conditions with individual firms about offers. The unit cost ($\$/m^3$) for related technology was calculated using the given bid ($) for the given flowrate (m^3) from firms.

3.4.1.3 Piping and Electrical/Sanitary Costs

Piping and electrical/sanitary costs were addressed differently. In this study, piping and electrical/sanitary costs were taken as a percent of the capital cost. By examining approved projects by the State of Hydraulic Works and Bank of Provinces, the relation between capital costs and mechanical costs were determined. As a result, 16 % of the mechanical costs were taken as piping cost, while 20 % of the mechanical costs were taken as electrical and sanitary costs.

3.4.1.4 Replacement Costs

Replacement costs showed up in specific years like year 10 and year 20. The lifetime of the facility was assumed as 30 years. For replacement costs, percentages of capital costs were taken. Thus, for year 10 and year 20, replacement costs were added. Also, for ***unknown expenses*** which may come up in the operation phase, 15 % of the capital cost was added to the replacement cost to be on the safe side. The summary table of replacement costs is given in Table 3-13.

Table 3-13 Replacement costs summary table

Construction Items	A	B	C	D	E	F	YEAR 10	YEAR 20
							G	H
						D+E	C x F/100	C x F/100
Civil	30	30	30	-	-	-	-	-
Piping	30	30	30	-	-	-	-	-
Mechanical	20	20	60	-	-	-	-	J
Electrical-Sanitary	10	10	40	-	-	-	K	K
TOTAL	-	-	-	-	-	-	K	J + K

A: Lifetime (years)
B: Replacement Time (years)
C: Replacement Percent (%)
D: Capital Cost ($)
E: Unknown Costs (D x 0.15)
F: Investment Cost ($) (D+E)
G, H: Costs in years (10,20) ($)
J: Replacement Cost of Mechanical Works ($) (C x F/100)
K: Replacement Cost of Electrical-Sanitary Works ($) (C x F/100)

3.4.2 Operational Costs

As mentioned earlier, construction would be done in 2 years that is during 2020-2021. The operation period started after that, in 2022. Operational costs cover;

- Maintenance Costs
- Salary of the Staff
- Energy Costs
- Chemical Costs
- Sludge Costs

Operational costs were evaluated in two parts. Operational Costs 1 include energy, chemical and sludge costs, which increased with population growth. Operational

Costs 2 includes salary and maintenance cost, where no increase by population growth was assumed. The details of the assumptions are given below.

- In 2019 (year = 0), there were no operational costs and the design period was planned.
- In 2020 (year = 1), there were no operational costs and the treatment plant was on construction.
- In 2021 (year = 2), there were no operational costs and the treatment plant was still on construction.
- In 2022 (year = 3), there were operational costs and treatment plant construction was complete.

It was assumed that the energy required in each year increased with the same rate as population growth. Energy cost, chemical cost and sludge cost were included in the total cost calculations after the year 2021. From the year 2022, the energy and chemical required and the sludge generated were increased by 1.36 %, which was the average population growth between 2007 and 2018 (TUIK, 2019).

Every year, energy, chemical and sludge costs were multiplied with population growth constant to include population growth into these terms. The population growth constant was calculated as shown in Equation 3-2.

$$\text{Population growth constant} = \left(1 + (\text{Population growth})\right)^{t} \quad \text{(Equation 3-2)}$$

Population Growth Rate = 0.01363 t = year

- For 2022 (year =3), Population $\text{growth}_{2022} = (1 + (0.01363))^{t=0} = 1.0000$
- For 2023 (year =4), Population $\text{growth}_{2023} = (1 + (0.01363))^{t=1} = 1.0136$

3.4.2.1 Maintenance Costs

Maintenance should be done regularly to keep the functioning of the wastewater treatment plant properly. In this study, maintenance cost was taken as a percent of the capital cost. Maintenance cost is estimated as 2-6 % of the capital cost (Wendland, 2005). The percentage is selected according to the treatment scheme. The more complex the treatment is, the higher the percentage would be. Maintenance costs were included in the total cost calculations after the year 2021. Selected percentages for different secondary and tertiary/ advanced treatment levels can be seen in Table 3-14. The maintenance cost was assumed to be the same throughout the years. Example calculation can be seen in Table 3-15.

Table 3-14 Selected percentages for maintenance cost for secondary and tertiary/ advanced treatment level

Construction Items	Percentages of Capital Cost									
	Range (%)	Selected Value (%)								
		Secondary Treatment Level			Tertiary/ Advanced Treatment Level					
		TS_A	TS_B	TS_C	CL	UV	PSF	RSF	MDF	RO
Civil	2.0-4.0	3.0	2.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0
Mechanical	2.0-6.0	3.0	2.0	4.0	3.0	3.0	3.0	3.0	5.0	6.0
Electrical-Sanitary	2.0-6.0	3.0	2.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0
Piping	2.0-6.0	3.0	2.0	4.0	-	-	-	-	-	-

Table 3-15 Example calculation for maintenance cost of TS_C

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	A	2.0-4.0	4	A x 0.04
Mechanical	B	2.0-6.0	4	B x 0.04
Electrical-Sanitary	C	2.0-6.0	4	C x 0.04
Piping	D	2.0-6.0	4	D x 0.04
			TOTAL	**0.04 x (A+B+C+D)**

3.4.2.2 Salary of the Staff

The number of employers differed in treatment schemes (TS_A, TS_B, TS_C) because of the alteration in the complexity and capacities of the treatment plants. The smaller-sized treatment plants need fewer workers, whereas larger facilities need more workers (Guerrini et al., 2017). While the salary of the workers was kept constant, the number of workers was changed. The salaries of the staff were included in the total cost calculations after the year 2021. An example calculation of salary on a monthly and yearly basis can be seen in Table 3-16. The number of workers in each scenario can be seen in Table 3-17.

Table 3-16 Example calculation for salary

	Number of people	**Salary per month ($)**	**Total Salary per month ($)**	**Total Salary per year ($)**
Worker	A	1,500	A x 1,500	A x 1,500 x 12
Safeguard	B	1,500	B x 1,500	B x 1,500 x 12
Engineer	C	2,500	C x 2,500	C x 2,500 x 12
Technician	D	1,500	D x 1,500	C x 2,500 x 12
Manager	E	3,500	E x 3,500	E x 3,500 x 12
TOTAL	**A + B + C + D + E**	**-**	**-**	**-**

Table 3-17 Number of staff at different treatment schemes

	Worker	**Safeguard**	**Engineer**	**Technician**	**Manager**	**Total**
6KCAS	1	2	1	2	1	**7**
30KCAS	2	2	2	4	1	**11**
130KCAS	4	3	3	6	1	**17**
6KEXT	0	1	1	1	1	**4**
30KEXT	1	2	2	2	1	**8**
130KEXT	2	3	3	3	1	**12**
6KA2O	2	2	1	3	1	**9**
30KA2O	4	4	2	6	2	**18**
130KA2O	8	8	4	6	2	**28**

3.4.2.3 Energy Costs

For energy cost calculations, the energy need for mechanical equipment was evaluated. The full list of calculations can be seen in Appendix D. Power of the equipment was taken from firms. From these data, the power required per day for each scenario was calculated. The unit energy price was taken from Turkey Energy Market Regulatory Authority on 01.01.2019, which is 0.364509 TL/kWh ($ 0.068/kWh).

3.4.2.4 Chemical Costs

Chemical costs consisted of organic polymer that was used in the dewatering of sludge. Chemical amounts were calculated by using sludge amounts that were taken directly from BioWin results. The polymer amount required was 5 kg polymer for each ton of dry solids, which was the amount that the individual firm advised. The price of the organic polymer was 28.50 TL/kg ($ 5.37/kg), which was taken from the supplier.

3.4.2.5 Sludge Costs

Sludge costs covered the transfer and incineration of the sludge. The transfer of the sludge for 100 km distance was accepted as 18.53 TL/ton. The price of the incineration at the concrete batching plant was taken as 250.00 TL/ton with respect to the personal communication with the plant manager. Sludge costs (TL/day) were calculated using sludge amounts (ton/day) and unit cost of sludge management (268.53 TL/ton) ($ 50.57/m^3). Because the facility started to operate in 2022, sludge cost appeared at 2022 on the first hand.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Wastewater Treatment Modeling – BioWin Modeling Outcomes

A total of 27 scenarios were modeled with the BioWin simulation tool, which were different in capacity, wastewater strength and treatment scheme (i.e., TS_A, TS_B and TS_C). BioWin modeling results for all three wastewater strengths and three capacities (flowrates) of TS_A, TS_B and TS_C are given in Table 4-1, Table 4-3 and Table 4-5, respectively. Removal efficiencies obtained in TS_A, TS_B and TS_C, are given in Table 4-2, Table 4-4 and Table 4-6, respectively.

For all BioWin simulations, it was observed that SRT value decreased with increasing wastewater strength. The reason may be due to the capability of biosynthesis; short SRT results in faster-growth rates and faster soluble substrate degradation rates. Then, with increasing strength, decreasing SRT results in higher removal rates (Wang et al., 2009).

For the same capacity, wastewater treatment plants with higher strength resulted in a higher sludge production (Appendix E). Additionally, higher strength wastewater resulted in higher amount of energy required for aeration and mixing processes (Table 4-1, Table 4-3 and Table 4-5).

In Table 4-1, BioWin results were listed, TS_A, for the wastewater treatment scheme with conventional activated sludge (CAS) scenario as secondary treatment. In this scheme, phosphorus and nitrogen removal were not aimed. Yet, their removal occurs simultaneously with carbon removal, being limited to the microbial growth. In this TS_A scheme, internal recycling is not applicable, while the RAS ratio was selected as 50 %. The SRTs changed between 3.5 to 5.5 days; it was selected as 5.5 days, 4.5 days and 3.5 days for low-strength, medium-strength and high-strength, respectively. Daily sludge production changed from 900 to 56208 kg/day. Higher sludge quantities are expected in CAS systems because of smaller SRT values compared to EXT and A2O systems with higher SRT values.

Table 4-1 BioWin results for TS_A scenarios

TREATMENT TYPE			**TS_A**								
STRENGTH			**LOW**			**MEDIUM**			**HIGH**		
FLOW RATE (m³/day)			**6K**	**30K**	**130K**	**6K**	**30K**	**130K**	**6K**	**30K**	**130K**
Influent	**COD**	**mg/L**	340	340	340	500	500	500	1000	1000	1000
	TN	**mg/L**	25	25	25	35	35	35	69	69	69
	TP	**mg/L**	3.7	3.7	3.7	5.6	5.6	5.6	11	11	11
	VSS	**mg/L**	134	134	134	198	198	198	316	316	316
	TSS	**mg/L**	180	180	180	243	243	243	362	362	362
Effluent	**COD**	**mg/L**	27.3	27.3	27.2	36.0	36.0	35.9	62.1	62.1	62.1
	TN	**mg/L**	16.2	16.2	16.2	21.5	21.5	21.5	40.6	40.6	40.6
	TP	**mg/L**	1.0	1.0	1.0	1.4	1.4	1.4	2.3	2.3	2.3
	BOD	**mg/L**	4.7	4.7	4.7	5.2	5.2	5.2	5.7	5.7	5.7
	TSS	**mg/L**	5.8	5.8	5.8	6.0	6.0	6.0	6.6	6.6	6.5
Grit Chamber	**HRT**	**hr**	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Volume	**m³**	50	250	1000	50	250	1000	50	250	1000
Primary Sed.	**Depth**	**hr**	4	4	4.5	4	4	4	4	4	4.5
	Area	**m²**	210	1100	4000	210	1100	4000	210	1100	4000
	SOR	**m³/m².d**	28.1	27.2	28.9	28.1	27.2	28.9	28.1	27.2	28.9
	Q downflow	**m³/day**	19.2	96	416	27	135	585	42	210	910
Aerobic Tank	**HRT**	**hr**	4	4	4.06	4	4	4.06	4	4	4.06
	Volume	**m³**	1500	7500	33000	1500	7500	33000	1500	7500	33000
Secondary Sed.	**Depth**	**m**	4	4	4.5	4	4	4.5	4.5	4.5	4.5
	Area	**m²**	400	2000	8700	400	2000	8700	400	2000	8700
	SOR	**m³/m².d**	14.9	14.9	14.9	14.7	14.9	14.9	14.8	14.8	14.7
RAS		**%**	50	50	50	50	50	50	50	50	50
SRT		**day**	5.5	5.5	5.5	4.5	4.5	4.5	3.5	3.5	3.5
VSS		**mg/L**	1714	1714	1689	2197	2198	2165	4280	4281	4217
Sludge Amount		**m³/day**	4.2	21.1	92.6	5.4	26.9	117.8	7.3	35.6	160.3
		%	21.3	21.3	21.6	24.7	24.7	24.4	35.5	35.5	35.1
		kg/day	899	4498	19497	1329	6646	28806	2593	12969	56208

The design criteria for biological units were kept constant for all TS_A scenarios; the only changing variable was SRT. Thus, altering SRT value changed effluent characteristics and removal efficiency of the treatment plant. As shown in Table 4-1, effluent values (COD, BOD_5 and TSS parameters) were abiding Turkish standards, which were mentioned in Table 2-3. As shown in Table 4-2, COD removal efficiency changed between 92.0 and 93.8 %, BOD_5 removal efficiency changed between 96.5 and 98.2 % and TSS removal efficiency changed between 96.8 and 98.2 %. It shows that the capacity of the plant does not have a significant impact on removal efficiency and the strength slightly affected the removal efficiency. The greater strengths resulted in slightly higher removal efficiencies. Because TS_A does not aim for direct removal of nitrogen and phosphorus, it is reasonable to have low removal efficiencies for nutrients. However, in this case, on average, 70-80 % phosphorus removal was observed because of high carbon (C) removal. Total Phosphorus (TP) is removed with respect to the ratio C:TP of 100:1 with the removal of carbon due to microbial growth. TP was well decreased to the levels less than 2 mg/L without the need of enhanced biological phosphorus removal systems.

Table 4-2 Removal efficiencies in percentages for TS_A scenario

TREATMENT TYPE			**TS_A**								
STRENGTH			**LOW**			**MEDIUM**			**HIGH**		
FLOW RATE (m^3/day)			**6K**	**30K**	**130K**	**6K**	**30K**	**130K**	**6K**	**30K**	**130K**
Removal Efficiency	**COD**	**%**	92.0	92.0	92.0	92.8	92.8	92.8	93.8	93.8	93.8
	TN	**%**	35.4	35.4	35.4	38.6	38.6	38.6	41.2	41.2	41.2
	TP	**%**	71.9	71.9	71.9	74.6	74.6	74.6	79.0	79.0	79.1
	BOD	**%**	96.5	96.5	96.5	97.4	97.4	97.4	98.2	98.2	98.2
	TSS	**%**	96.8	96.8	96.8	97.5	97.%	97.6	98.2	98.2	98.2

In Table 4-3, BioWin results were listed for TS_B, the wastewater scheme with extended aeration (EXT) scenario as secondary treatment. Same for TS_A, phosphorus and nitrogen removal were not aimed herein and there was no anaerobic tank. In TS_B being different from TS_A, primary sedimentation tanks were not used. The HRT of the aerobic tank was selected much higher than that of CAS (around 20 hours). In EXT, primary sedimentation is not used because of the high HRT of aerobic tanks. RAS ratio was selected as 50 % of the influent, whereas IR was not used. The SRTs changed between 20 to 30 days, which was higher than that of SRTs of TS_A scenarios. SRTs of the TS_B scenarios were selected as 30 days, 25 days and 20 days for low-strength, medium-strength and high-strength, respectively. Daily sludge production changed from 502 to 31662 kg/day. This amount is approximately half of the amount that is generated in TS_A.

Table 4-3 BioWin results for TS_B scenarios

TREATMENT TYPE			TS_B								
STRENGTH			LOW			MEDIUM			HIGH		
FLOW RATE (m³/day)			6K	30K	130K	6K	30K	130K	6K	30K	130K
Influent	COD	mg/L	340	340	340	500	500	500	1000	1000	1000
	TN	mg/L	25	25	25	35	35	35	69	69	69
	TP	mg/L	3.7	3.7	3.7	5.6	5.6	5.6	11	11	11
	VSS	mg/L	134	134	134	198	198	198	316	316	316
	TSS	mg/L	180	180	180	243	243	243	362	362	362
Effluent	COD	mg/L	24.3	24.3	24.2	32.8	32.8	32.7	58.6	58.6	58.4
	TN	mg/L	18.1	18.1	18.1	24.5	24.5	24.5	46.5	46.5	46.4
	TP	mg/L	2.0	2.0	2.0	3.0	3.0	3.0	5.3	5.3	5.3
	BOD	mg/L	2.1	2.1	2.1	2.3	2.3	2.2	2.6	2.6	2.6
	TSS	mg/L	4.7	4.7	4.7	4.8	4.8	4.7	5.0	5.0	4.9
Grit Chamber	HRT	hr	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Volume	m³	50	250	1000	50	250	1000	50	250	1000
Aerobic Tank	HRT	hr	20.01	20.01	20.07	20.01	20.01	20.07	20.01	20.01	20.07
	Volume	m³	7500	37500	163000	7500	37500	163000	7500	37500	163000
Secondary Sed.	Depth	m	4	4	4.5	4	4	4.5	4	4	4.5
	Area	m²	500	2500	11000	500	2500	11000	500	2500	11000
	SOR	m³/m².d	11.9	11.9	11.7	11.9	11.9	11.7	11.9	11.9	11.7
RAS		%	50	50	50	50	50	50	50	50	50
SRT		day	29.8	29.8	29.8	24.9	24.9	24.9	20.0	20.0	20.0
VSS		mg/L	2013	2013	2008	2563	2563	2556	4332	4334	4321
Sludge Amount		m³/day	3.2	16.1	69.9	3.9	19.5	84.8	4.9	24.7	107.3
		%	15.6	15.6	15.6	18.7	18.7	18.6	29.6	29.6	29.5
		kg/day	502	2510	10885	729	3645	15806	1461	7304	31662

Effluent wastewater characteristics are different in TS_B scenarios and still comply with Turkish standards in terms of COD, BOD_5 and TSS parameters. When removal efficiencies were examined in Table 4-4, it is seen that the percentages are relatively high, when compared with TS_A removal percentages (Table 4-2). COD removal efficiency changed between 92.9 to 94.2 %, BOD_5 removal efficiency changed between 98.5 to 99.2 % and TSS removal efficiency changed between 97.4 to 98.7 %. Removal percentages of phosphorus and nitrogen are not satisfying as expected; however, because of the microbial growth, some of the phosphorus and nitrogen are simultaneously removed from the system to some extent. TP is removed with respect to the C:P ratio of 100:1 of and total nitrogen (TN) is removed with respect to the C:TN ratio of 100:5 of with the removal of carbon due to microbial growth.

Table 4-4 Removal efficiencies in percentages for TS_B scenario

TREATMENT TYPE			**TS_B**								
STRENGTH			**LOW**			**MEDIUM**			**HIGH**		
FLOW RATE (m^3/day)			**6K**	**30K**	**130K**	**6K**	**30K**	**130K**	**6K**	**30K**	**130K**
Removal Efficiency	**COD**	**%**	92.9	92.9	92.9	93.4	93.4	93.5	94.1	94.1	94.2
	TN	**%**	27.4	27.4	27.4	30.1	30.1	30.1	32.7	32.7	32.7
	TP	**%**	45.4	45.4	45.4	46.8	46.8	46.8	51.5	51.5	51.5
	BOD	**%**	98.5	98.5	98.5	98.8	98.9	98.9	99.2	99.2	99.2
	TSS	**%**	97.4	97.4	97.4	98.0	98.0	98.1	98.6	98.6	98.6

In Table 4-5, BioWin results were listed for TS_C, the wastewater scheme with Anaerobic/Anoxic/Oxic (A2O) scenario as secondary treatment. Different from TS_A and TS_B, nutrient removal, that is the removal of phosphorus and nitrogen is intended in this TS_C scheme. For this purpose, anoxic tank for nitrogen removal and anaerobic tank for phosphorus removal exist in the scheme. Primary sedimentation may not be used in order not to remove organic matter beforehand. If these are removed in primary sedimentation, extra carbon resources may be needed for nutrient removal. RAS ratio was selected as 25 % of the influent. At the same time, the IR ratio was selected in the range of 100 to 400 % of the influent for different strengths. The increase in IR ratio results in higher removal efficiencies in wastewater. For high-strength wastewater, thus, a higher IR ratio was used (Baeza et al., 2004). The SRTs changed between 11 to 20 days; they were selected as 20 days, 15 days and 11 days for low-strength, medium-strength and high-strength, respectively. Daily sludge production changed between 562 to 39588 kg/day, which were higher than TS_B and smaller than TS_A. When nutrient removal and SRT of the system were taken into consideration, compared to that of TS_B, higher sludge generation was expected for TS_C because of high removal potential.

Table 4-5 BioWin results for TS_C scenario

TREATMENT TYPE			TS_C								
STRENGTH			LOW			MEDIUM			HIGH		
FLOW RATE (m^3/day)			6K	30K	130K	6K	30K	130K	6K	30K	130K
Influent	COD	mg/L	340	340	340	500	500	500	1000	1000	1000
	TN	mg/L	25	25	25	35	35	35	69	69	69
	TP	mg/L	3.7	3.7	3.7	5.6	5.6	5.6	11	11	11
	VSS	mg/L	135	135	135	198	198	198	316	316	316
	TSS	mg/L	180	180	180	243	243	243	363	363	363
Effluent	COD	mg/L	38.4	39.4	40.1	45.5	46.6	45.8	70.8	73.1	72.1
	TN	mg/L	9.9	9.9	10.0	9.8	9.9	9.9	12.3	12.4	12.3
	TP	mg/L	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0
	BOD	mg/L	5.2	5.5	5.7	5.3	5.6	5.4	5.7	6.4	6.1
	TSS	mg/L	15.2	16.1	16.6	13.4	14.4	13.6	12.5	14.3	13.5
Grit Chamber	HRT	hr	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Volume	m^3	50	250	1000	50	250	1000	50	250	1000
Anaerobic Tank	HRT	hr	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Volume	m^3	480	2300	10000	480	2300	10000	480	2300	10000
Anoxic Tank	HRT	hr	3	3	3	3	3	3	3	3	3
	Volume	m^3	1700	8400	37000	2400	12000	53000	4000	20000	85000
Aerobic Tank	HRT	hr	4	4	4	4	4	4	4	4	4
	Volume	m^3	2300	11500	49000	3250	16500	70000	5200	26000	115000
Secondary Sed.	Depth	m	4	4	4.5	4	4	4.5	4	4	4.5
	Area	m^2	210	1000	4500	210	1000	4500	210	1000	4500
	SOR	$m^3/m^2.d$	28.4	29.7	28.7	28.3	29.7	28.6	26.8	29.5	28.4
IR		%	100	100	100	200	200	200	400	400	400
RAS		%	25	25	25	25	25	25	25	25	25
SRT		day	19.9	19.9	19.9	14.9	14.9	14.9	10.9	10.9	10.9
VSS		mg/L	2398	2398	2402	2143	2110	2142	2217	2211	2200
Sludge Amount		m^3/day	1.8	9	38.9	3.3	16.8	72.0	7.2	35.8	155.5
		%	30.9	30.9	30.9	26.3	25.9	26.3	25.7	25.6	25.5
		kg/day	562	2782	12036	873	4337	18915	1600	7961	39588

For different combinations in TS_C scenarios, SRT, IR ratio and tank volumes were altered for the required quality in the effluent. Because there were many variables like IR that affected the removal efficiency, the trend in TS_C was different from TS_A and TS_B. For low-strength TS_C scenarios, COD, BOD_5 and

TSS showed a slightly decreasing pattern in removal efficiencies within the increasing capacity, and for the medium and high-strength, the capacity of 30000 m^3/day had the lowest removal efficiency which is just the opposite of TS_A and TS_B scenarios (Table 4-2 and Table 4-4). For TN and TP removal percentages, higher strength wastewater resulted in higher removal percentages, regardless of the capacity of the wastewater treatment plant. COD removal efficiency changed from 88.2 to 92.9 %, BOD_5 removal efficiency changed from 95.8 to 98.2 % and TSS removal efficiency changed from 91.1 to 96.6 %. Even the removal efficiencies are lower; still, effluent concentrations for COD, BOD_5 and TSS comply with the standards. TS_C is a biological nutrient removal process that aims for carbon, phosphorus and nitrogen removal. Except for TS_C scenarios with high-strength wastewater effluent, TN values of which are slightly above 10 mg/L, all scenarios met the discharge TN and TP standards (Table 2-4). High-strength wastewater should be further treated for direct discharge to surface waters. Removal efficiencies calculated for TS_C were higher than other treatment schemes. TN removal efficiency changed between 60.2% and 82.2%, whereas TP removal efficiency changed between 75.4% and 91.8%.

Table 4-6 Removal efficiencies in percentages for TS_C scenario

TREATMENT TYPE			**TS_C**								
STRENGTH			**LOW**			**MEDIUM**			**HIGH**		
FLOW RATE (m^3/day)			**6K**	**30K**	**130K**	**6K**	**30K**	**130K**	**6K**	**30K**	**130K**
Removal Efficiency	**COD**	**%**	88.7	88.4	88.2	90.9	90.7	90.8	92.9	92.7	92.8
	TN	**%**	60.6	60.4	60.2	71.9	71.7	71.9	82.2	82.0	82.2
	TP	**%**	76.5	75.7	75.4	83.9	83.4	83.8	91.8	91.3	91.4
	BOD	**%**	96.1	95.9	95.8	97.3	97.2	97.3	98.2	98.0	98.1
	TSS	**%**	91.6	91.1	90.8	94.5	94.1	94.4	96.6	96.1	96.3

4.2 Wastewater Treatment Schemes for Water Reuse Application

Wastewater schemes for specific reuse applications were developed by using Water Reuse Guidelines (US EPA, 2012) and other literature studies (Asano et al., 2007; Iglesias et al., 2010; Maryam & Büyükgüngör, 2017). The following configurations of the treatment schemes were developed for specific water reuse applications, which were examined in the methodology part (Section 3.3).

Table 4-7 Configurations of treatment scheme scenarios selected for water reuse applications (Asano et al., 2007; EPA, 2012; Iglesias et al., 2010; Maryam & Büyükgüngör, 2017; Roccaro, 2018)

TS No.	Treatment Scheme Configurations	Reuse Applications
TS_1	A2O + Filtration + Disinfection (Cl and UV)	• Urban Reuse – Unrestricted • Agricultural Reuse – Food Crops • Impoundments – Unrestricted
TS_2	CAS/EXT/A2O + Filtration + Disinfection (Cl and UV) + SAT	• Indirect Potable Reuse – Groundwater Recharge by Spreading into Potable Aquifers
TS_3	CAS/EXT/A2O + Filtration + Disinfection (Cl and UV)	• Urban Reuse – Restricted
TS_4	A2O/CAS/EXT	• Industrial Reuse – Once-through Cooling • Groundwater Recharge – Non-potable Reuse
TS_5	CAS/EXT/A2O + Disinfection (Cl and UV)	• Urban Reuse – Restricted • Agricultural Reuse – Processed Food / Nonfood Crops • Impoundments – Restricted • Environmental Reuse
TS_6	A2O + MF + RO + Disinfection (Cl and UV)	• Indirect Potable Reuse – Groundwater Recharge by Injection into Potable Aquifers • Indirect Potable Reuse – Augmentation of Surface Water Supply Reservoirs

It should be noted that the treatment performances of the tertiary and advanced treatment processes, as well as disinfection units cannot be modeled with BioWin. As stated previously in Section 3.2.3, it was assumed that these units are working in ideal conditions with the aim to achieve the required effluent qualities appropriate for the defined reuse application. In other words, they were not modeled with respect to the effluent quality criteria and removal efficiency of the units. Other than that, they were designed with respect to wastewater flowrates (capacities).

Accordingly, the effect of using each unit in these six treatment schemes (TS_1 to TS_6) was compared considering the cost of each unit and the treatment scheme, which was water reclamation cost. The cost of reclaimed water was also analyzed considering the partial use of reclaimed water; in other words, the tertiary/ advanced treatments of a portion of secondary treated wastewater for water reuse purposes. In this way, it might be possible to decrease the capacity of the tertiary and advanced treatment units, in turn, the water reclamation cost.

4.3 Cost Analysis

Models based on secondary treatment were constructed with the BioWin modeling tool. From these models, tank volumes, sludge amounts, energy amounts from blowers were extracted. Furthermore, for advanced/ tertiary treatment, capital and operational costs were examined separately for each unit.

4.3.1 Cost Analysis based on Secondary Treatment Level

In this part capital and operational costs were evaluated for secondary treatment.

4.3.1.1 Capital Costs

As mentioned in Section 3.4.1, capital costs involve reinforcement / civil costs, mechanical costs, piping costs, electrical/ sanitary costs and replacement costs, where sample calculations were given in the following sections.

4.3.1.1.1 Reinforcement/ Civil Work Costs

Civil work costs were evaluated for every treatment scheme; volumes from BioWin were used. As shown in Table 4-1, Table 4-3 and Table 4-5 (Section 4.1), tank volumes did not change with the change in wastewater strength; they only changed with the wastewater treatment capacity. The difference in the wastewater strength only affected the effluent concentration; in other words, removal efficiencies. Therefore, regardless of the wastewater strength, capacity-based civil work costs were evaluated.

Concrete and steel bar amounts and their costs can be seen in Table 4-8 and Table 4-9, respectively. These costs were calculated not only for secondary level unit costs, i.e., primary sedimentations, bioreactors, secondary sedimentation tanks etc. but also for preliminary units like screens and grit chamber. Preliminary units and their costs were the same in different treatment schemes, TS_A, TS_B and TS_C, and wastewater strengths (low, medium, high). Therefore, their costs changed with respect to the capacity of the wastewater treatment plant. Then, for the total cost of concrete and steel bar, preliminary and secondary level treatment costs were calculated. For unit costs, \$35.69/m³ (289.53 TL/m³) and \$668.33/ton (3548.84 TL/ton) were used for concrete and steel (T.C. Çevre ve Şehircilik Bakanlığı, 2019).

Table 4-8 Concrete and steel bar amounts used for different scenarios

Treatment Scheme	Concrete (m^3)	Steel bar (ton)
6KCAS	2146	215
30KCAS	6871	687
130KCAS	27544	2754
6KEXT	3185	319
30KEXT	14578	1458
130KEXT	58046	5805
6KA2O	3660	366
30KA2O	27498	2750
130KA2O	122404	12240

Table 4-9 Civil work costs for different scenarios

Treatment Scheme	Concrete ($)	Steel Bar ($)	Total ($)
6KCAS	$ 76,598	$ 143,425	$ 220,022
30KCAS	$ 245,237	$ 459,192	$ 704,430
130KCAS	$ 983,128	$ 1,840,851	$ 2,823,979
6KEXT	$ 113,684	$ 212,868	$ 326,552
30KEXT	$ 520,327	$ 974,283	$ 1,494,610
130KEXT	$ 2,071,852	$ 3,879,423	$ 5,951,275
6KA2O	$ 130,651	$ 244,637	$ 375,288
30KA2O	$ 981,489	$ 1,837,782	$ 2,819,271
130KA2O	$ 4,368,958	$ 8,180,623	$ 12,549,581

Regardless of the secondary wastewater treatment scheme, higher capacities resulted in higher civil work costs because the dimension of the tanks got larger while retention time was kept constant. The capacity of 130000 m^3/day for the A2O process had the highest civil work cost of $ 12,549,581, which is much greater than that of CAS and EXT processes of the same capacities (Figure 4-1). The existence of an anoxic tank and an anaerobic tank resulted in a higher civil work cost. EXT process followed A2O; it had the highest retention time of 20 hours, which resulted in the higher volume required. CAS process followed EXT with an aerobic retention time of 4 hours, leading to lower civil work costs for the same wastewater capacity.

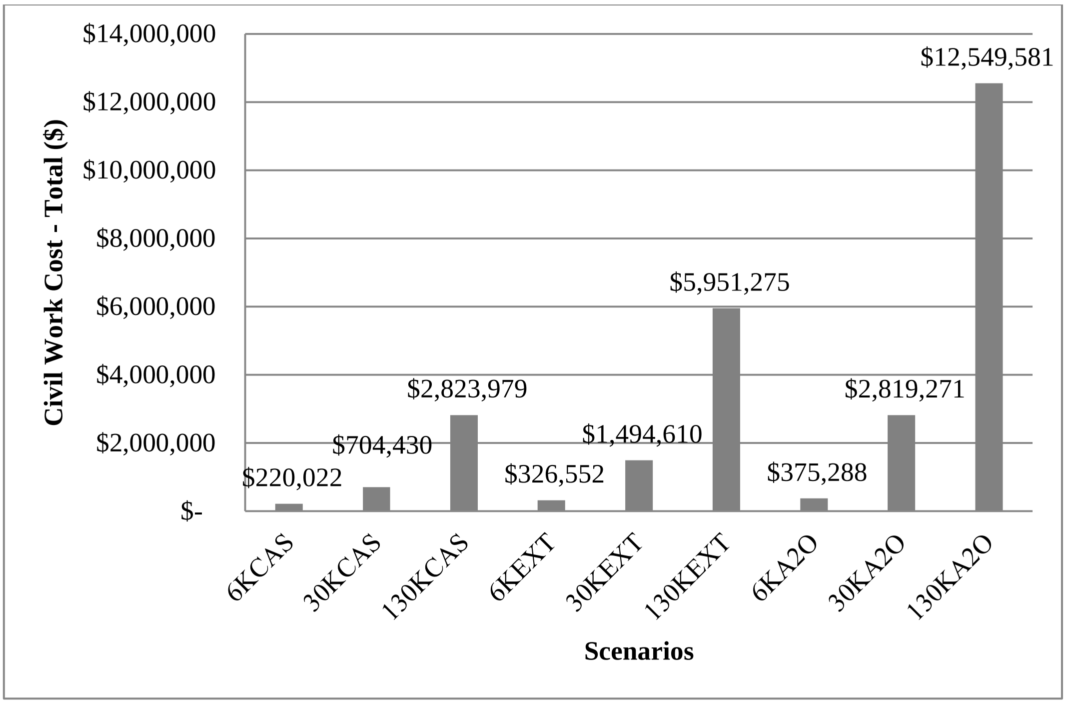

Figure 4-1 Total cost of civil works ($) for different scenarios

As a result, not surprisingly, higher capacity wastewater treatment plants had higher civil work costs. Extra tank amount and longer HRTs resulted in larger tank volumes, then a higher civil work cost.

4.3.1.1.2 Mechanical Work Costs

Mechanical work costs were evaluated based on the capacity and treatment scheme; it should be noted that treatment plant design did not change with respect to the wastewater strength. As an example, the mechanical work costs of 6KCAS, 6KEXT and 6KA2O processes are shown in Table 4-10, Table 4-11 and Table 4-12, respectively.

The mechanical equipment selected differed with the treatment scheme. Screens, inlet pumping station, grit chamber, inlet flowmeter, primary sedimentation tanks, aerobic tanks, secondary sedimentation tanks, and return and excess sludge pumping station are units in TS_A (Table 4-10). For screen and inlet pumping station and grit unit in the treatment schemes, selected equipment were lift gate, coarse screen, fine screen, conveyor, inlet pumps, crane and others. Equipment like small valves, reduction parts, pumps, small diameter pipes of all units in the treatment scheme were included in the "others" section for all units. For the grit chamber, scrapper, grit pumps, grit separator, lift gates and blowers were required. For primary and secondary sedimentation tanks, scum pumps and scrappers were used. For aerobic tanks, lift gates, mixers and jib cranes were used. For sludge pumping, excess and return sludge (RAS) pumps were used.

Table 4-10 Mechanical costs for 6KCAS scenario

Equipment used in each unit	**Equipment properties**			**Cost per Pcs.**	**Total Cost**
	kW	prime	backup	$	$
Screens and Inlet Pumping Station					
Lift Gate	0.55	4	0	$ 7,651.06	$ 30,604.24
Coarse Screen	1.50	2	1	$ 14,755.61	$ 44,266.84
Fine Screen	1.50	2	1	$ 17,331.99	$ 51,995.97
Conveyor	1.50	2	0	$ 11,710.81	$ 23,421.61
Inlet Pumps	15.00	2	1	$ 10,032.26	$ 30,096.77
Crane	5.50	1	0	$ 2,190.42	$ 2,190.42
Others	0	1	0	$ 3,534.36	$ 3,534.36
Grit Chamber					
Scrapper	0.55	2	0	$ 25,997.99	$ 51,995.97
Grit Pumps	1.1	2	1	$ 1,943.99	$ 5,831.98
Grit Separator	0.55	1	0	$ 10,539.72	$ 10,539.72
Lift Gate	0.55	2	0	$ 6,714.19	$ 13,428.39
Blower	7.5	1	1	$ 3,906.72	$ 7,813.45
Others	0	1	0	$ 21,669.33	$ 21,669.33
Flowmeter	0	2	0	$ 743.68	$ 1,487.36
Primary Sedimentation Tanks					
Scum Pumps	1.1	2	2	$ 5,371.36	$ 21,485.42
Scrapper	1.1	2	0	$ 59,022.46	$ 118,044.92
Aerobic Tanks					
Lift Gate	1.5	2	0	$ 10,617.80	$ 21,235.59
Jib Crane	2.2	2	0	$ 2,190.42	$ 4,380.84
Mixer	2.2	4	0	$ 16,129.68	$ 64,518.73
Others	0	1	0	$ 18,013.21	$ 18,013.21
Secondary Sedimentation Tanks					
Scum Pumps	1.1	2	2	$ 1,943.99	$ 7,775.97
Scrapper	1.5	2	0	$ 59,022.46	$ 118,044.92
Others	0	1	0	$ 4,667.69	$ 4,667.69
Return and Excess Sludge Pumping Station					
Return Sludge Pumps	11	3	1	$ 9,477.94	$ 37,911.78
Excess Sludge Pumps	1.1	3	1	$ 1,943.99	$ 7,775.97
Others	0	1	0	$ 4,416.15	$ 4,416.15
				TOTAL	**$ 727,148**

TS_B units include screens, inlet pumping station, grit chamber, inlet flowmeter, aerobic tanks, secondary sedimentation tanks and return and excess sludge pumping station (Table 4-11). The equipment of screens and inlet pumping station and grit chamber were selected the same as TS_A. For aerobic tanks, lift gates, mixers and jib cranes to remove mixers were used. For primary and secondary sedimentation tanks, scum pumps and scrappers were used. For sludge pumping, excess and return sludge pumps were used.

Table 4-11 Mechanical costs for 6KEXT scenario

Equipment used in each unit	**Equipment properties**			**Cost per Pcs.**	**Total Cost**
	kW	prime	backup	$	$
Screens and Inlet Pumping Station					
Lift Gate	0.55	4	0	$ 7,651.06	$ 30,604.24
Coarse Screen	1.50	2	1	$ 14,755.61	$ 44,266.84
Fine Screen	1.50	2	1	$ 17,331.99	$ 51,995.97
Conveyor	1.50	2	0	$ 11,710.81	$ 23,421.61
Inlet Pumps	15.00	2	1	$ 10,032.26	$ 30,096.77
Crane	5.50	1	0	$ 2,190.42	$ 2,190.42
Others	0	1	0	$ 3,534.36	$ 3,534.36
Grit Chamber					
Scrapper	0.55	2	0	$ 25,997.99	$ 51,995.97
Grit Pumps	1.1	2	1	$ 1,943.99	$ 5,831.98
Grit Separator	0.55	1	0	$ 10,539.72	$ 10,539.72
Lift Gate	0.55	2	0	$ 6,714.19	$ 13,428.39
Blower	7.5	1	1	$ 3,906.72	$ 7,813.45
Others	0	1	0	$ 21,669.33	$ 21,669.33
Flowmeters	0	2	0	$ 743.68	$ 1,487.36
Aerobic Tanks					
Lift Gate	1.5	2	0	$ 10,617.80	$ 21,235.59
Jib Crane	1.5	3	0	$ 2,190.42	$ 6,571.26
Mixer	2.2	3	0	$ 16,129.68	$ 48,389.05
Others	0	1	0	$ 16,011.74	$ 16,011.74
Secondary Sedimentation Tanks					
Scum Pumps	1.1	2	1	$ 1,943.99	$ 5,831.98
Scrapper	1.5	2	0	$ 84,317.80	$ 168,635.59
Others	0	1	0	$ 4,618.28	$ 4,618.28
Return and Excess Sludge Pumping Station					
Return Sludge Pumps	11	2	1	$ 9,477.94	$ 28,433.83
Excess Sludge Pumps	1.1	2	1	$ 1,943.99	$ 5,831.98
Others	0	1	0	$ 3,925.46	$ 3,925.46
				TOTAL	**$ 608,361**

TS_C units include screens, inlet pumping station, grit chamber, inlet flowmeter, anaerobic tanks, anoxic/ aerobic tanks, secondary sedimentation tanks, and return and excess sludge pumping station (Table 4-12). The equipment of screens and inlet pumping station and grit chamber were selected as the same as for TS_A and TS_B. For anaerobic and anoxic/ aerobic tanks, lift gates, mixers and jib cranes were used. For secondary sedimentation tanks, scum pumps and scrappers were used. For sludge pumping, excess and return sludge pumps were used.

Table 4-12 Mechanical costs for 6KA2O scenario

Equipment used in each unit	**Equipment properties**			**Cost per Pcs.**	**Total Cost**
	kW	prime	backup	$	$
Screens and Inlet Pumping Station					
Lift Gate	0.55	4	0	$ 7,651.06	$ 30,604.24
Coarse Screen	1.50	2	1	$ 14,755.61	$ 44,266.84
Fine Screen	1.50	2	1	$ 17,331.99	$ 51,995.97
Conveyor	1.50	2	0	$ 11,710.81	$ 23,421.61
Inlet Pumps	15.00	2	1	$ 10,032.26	$ 30,096.77
Crane	5.50	1	0	$ 2,190.42	$ 2,190.42
Others	0	1	0	$ 3,534.36	$ 3,534.36
Grit Chamber					
Scrapper	0.55	2	0	$ 25,997.99	$ 51,995.97
Grit Pumps	1.1	2	1	$ 1,943.99	$ 5,831.98
Grit Separator	0.55	1	0	$ 10,539.72	$ 10,539.72
Lift Gate	0.55	2	0	$ 6,714.19	$ 13,428.39
Blower	7.5	1	1	$ 3,906.72	$ 7,813.45
Others	0	1	0	$ 21,669.33	$ 21,669.33
Flowmeters	0	2	0	$ 743.68	$ 1,487.36
Anaerobic Tanks					
Lift Gate 1	0.55	4	0	$ 12,803.81	$ 51,215.25
Lift Gate 2	0.55	4	0	$ 7,651.06	$ 30,604.24
Jib Crane	1.5	4	0	$ 2,186.02	$ 8,744.07
Mixer	3	4	0	$ 5,129.33	$ 20,517.33
Aerobic Tanks					
Lift Gate 1	0.55	4	0	$ 10,617.80	$ 42,471.19
Lift Gate 2	0.55	2	0	$ 6,245.76	$ 12,491.53
Jib Crane	1.5	4	0	$ 2,190.42	$ 8,761.68
Mixer	3	8	0	$ 16,129.68	$ 129,037.46
Others	0	1	0	$ 20,014.68	$ 20,014.68
Secondary Sedimentation Tanks					
Scum Pumps	1.1	2	1	$ 1,943.99	$ 5,831.98
Scrapper	0.55	2	0	$ 84,317.80	$ 168,635.59
Others	0	1	0	$ 4,717.10	$ 4,717.10
Return and Excess Sludge Pumping Station					
Return Sludge Pumps	11	3	1	$ 9,477.94	$ 37,911.78
Excess Sludge Pumps	1.1	3	1	$ 1,943.99	$ 7,775.97
Others	0	1	0	$ 4,906.83	$ 4,906.83
				TOTAL	**$ 852,513**

The cost and amount of the decanters can be seen in Table 4-13. Sludge flowrates were taken directly from BioWin simulations. After that, the operation hour time was adjusted with capacities to find the number of the decanters. Then the cost for each scenario was calculated.

Table 4-13 Numbers and costs of decanters for different scenarios

Scenarios	Capacity of the decanter (m^3/hr)	Prime (Pcs.)	Backup (Pcs.)	Cost ($/piece)	Total Cost ($)
6KCASLOW	10	1	1	$ 47,240	$ 94,481
30KCASLOW	50	1	1	$ 120,057	$ 240,113
130KCASLOW	70	3	1	$ 193,051	$ 772,203
6KCASMED	25	1	1	$ 98,870	$ 197,740
30KCASMED	50	2	1	$ 120,057	$ 360,170
130KCASMED	70	4	1	$ 193,051	$ 965,254
6KCASHIGH	25	1	1	$ 98,870	$ 197,740
30KCASHIGH	50	2	1	$ 120,057	$ 360,167
130KCASHIGH	70	4	1	$ 193,051	$ 965,254
6KEXTLOW	10	1	1	$ 47,241	$ 94,481.
30KEXTLOW	25	2	1	$ 98,870	$ 296,610
130KEXTLOW	50	3	1	$ 120,057	$ 480,226
6KEXTMED	10	2	1	$ 47,241	$ 141,722
30KEXTMED	50	2	1	$ 120,057	$ 360,170
130KEXTMED	50	4	1	$ 120,057	$ 600,282
6KEXTHIGH	10	2	1	$ 47,241	$ 141,722
30KEXTHIGH	50	2	1	$ 120,057	$ 360,170
130KEXTHIGH	70	4	1	$ 193,051	$ 965,254
6KA2OLOW	10	1	1	$ 47,241	$ 94,481
30KA2OLOW	25	1	1	$ 98,871	$ 197,740
130KA2OLOW	50	2	1	$ 120,057	$ 360,170
6KA2OMED	10	1	1	$ 47,241	$ 94,481
30KA2OMED	50	1	1	$ 120,057	$ 240,113
130KA2OMED	70	3	1	$ 193,051	$ 772,203
6KA2OHIGH	25	1	1	$ 98,870	$ 197,740
30KA2OHIGH	50	2	1	$ 120,057	$ 360,169
130KA2OHIGH	70	4	1	$ 193,051	$ 965,254

Mechanical aerators were used in TS_A and TS_B. The costs of mechanical aerators were 30,000.00 TL ($ 5,649.72) and 20.000,00 TL ($ 3,766.48) for TS_A and TS_B, respectively. These mechanical aerator costs were taken from individual firms by personal communication. The numbers of mechanical aerators used were decided with respect to the number of aerobic tanks (bioreactors) that were designed at the treatment plant. Mechanical aerator cost calculation can be seen in Table 4-14.

Table 4-14 Mechanical aerator numbers and costs for TS_A and TS_B scenarios

TS	Scenarios	Total (Pcs.)	Cost ($/piece)	Total Cost ($)
TS_A	6KCASLOW	2	$ 5,649	$ 11,299
	6KCASMED	2	$ 5,649	$ 11,299
	6KCASHIGH	2	$ 5,649	$ 11,299
	30KCASLOW	8	$ 5,649	$ 45,198
	30KCASMED	8	$ 5,649	$ 45,198
	30KCASHIGH	8	$ 5,649	$ 45,198
	130KCASLOW	32	$ 5,649	$ 180,791
	130KCASMED	32	$ 5,649	$ 180,791
	130KCASHIGH	32	$ 5,649	$ 180,791
TS_B	6KEXTLOW	6	$ 3,767	$ 22,599
	6KEXTMED	6	$ 3,767	$ 22,599
	6KEXTHIGH	6	$ 3,767	$ 22,599
	30KEXTLOW	24	$ 3,767	$ 90,396
	30KEXTMED	24	$ 3,767	$ 90,396
	30KEXTHIGH	24	$ 3,767	$ 90,396
	130KEXTLOW	96	$ 3,767	$ 361,582
	130KEXTMED	96	$ 3,767	$ 361,582
	130KEXTHIGH	96	$ 3,767	$ 361,582

Blower capacities were found with respect to the air requirement at TS_C, which was the output of the model, and then costs were taken from individual firms. The capacity and the number of blowers were calculated by checking air requirements, which was the output of the model. Blower cost calculation can be seen in Table 4-15.

Table 4-15 Blower numbers, capacity and costs for TS_C scenarios

TS	Scenarios	Capacity of the blower (m^3/hr)	Prime (Pcs.)	Backup (Pcs.)	Cost ($/piece)	Total Cost ($)
TS_C	**6KA2OLOW**	780	2	1	$ 6,814	$ 20,441
	30KA2OLOW	4500	2	1	$ 93,687	$ 281,059
	130KA2OLOW	13200	3	2	$ 310,734	$1,553,672
	6KA2OMED	780	3	2	$ 6,814	$ 34,068
	30KA2OMED	4500	2	1	$ 93,687	$ 281,059
	130KA2OMED	22000	2	1	$ 310,734	$1,208,475
	6KA2OHIGH	4500	1	1	$ 6,814	$ 187,373
	30KA2OHIGH	13200	2	1	$ 93,687	$ 932,203
	130KA2OHIGH	22000	4	2	$ 310,734	$2,416,949

It is expected to have higher costs when the capacity of the treatment plant was increased. In TS_A and TS_B, HRT is the main design criteria of the aerobic tanks design, then for three strengths (low, medium and high) in the same treatment scheme, aerobic tank volumes were kept constant which was one of the outputs of BioWin models. Therefore, no change in the mechanical cost for aerators in changing strength was observed. For TS_C, rather than HRT, parameters such as IR affects the aerobic tank volume. In TS_C, more aeration was needed at high-strength wastewater, as a result higher capacity/ numbers of blowers were required for high-strength wastewater.

The summation of mechanical equipment costs for all scenarios can be seen in Figure 4-2. As in civil/ reinforcement costs, TS_C was the most expensive one because of the complexity of the system; it needed more equipment in number and capacity. TS_A and TS_B processes followed TS_C, different from civil work costs calculations.

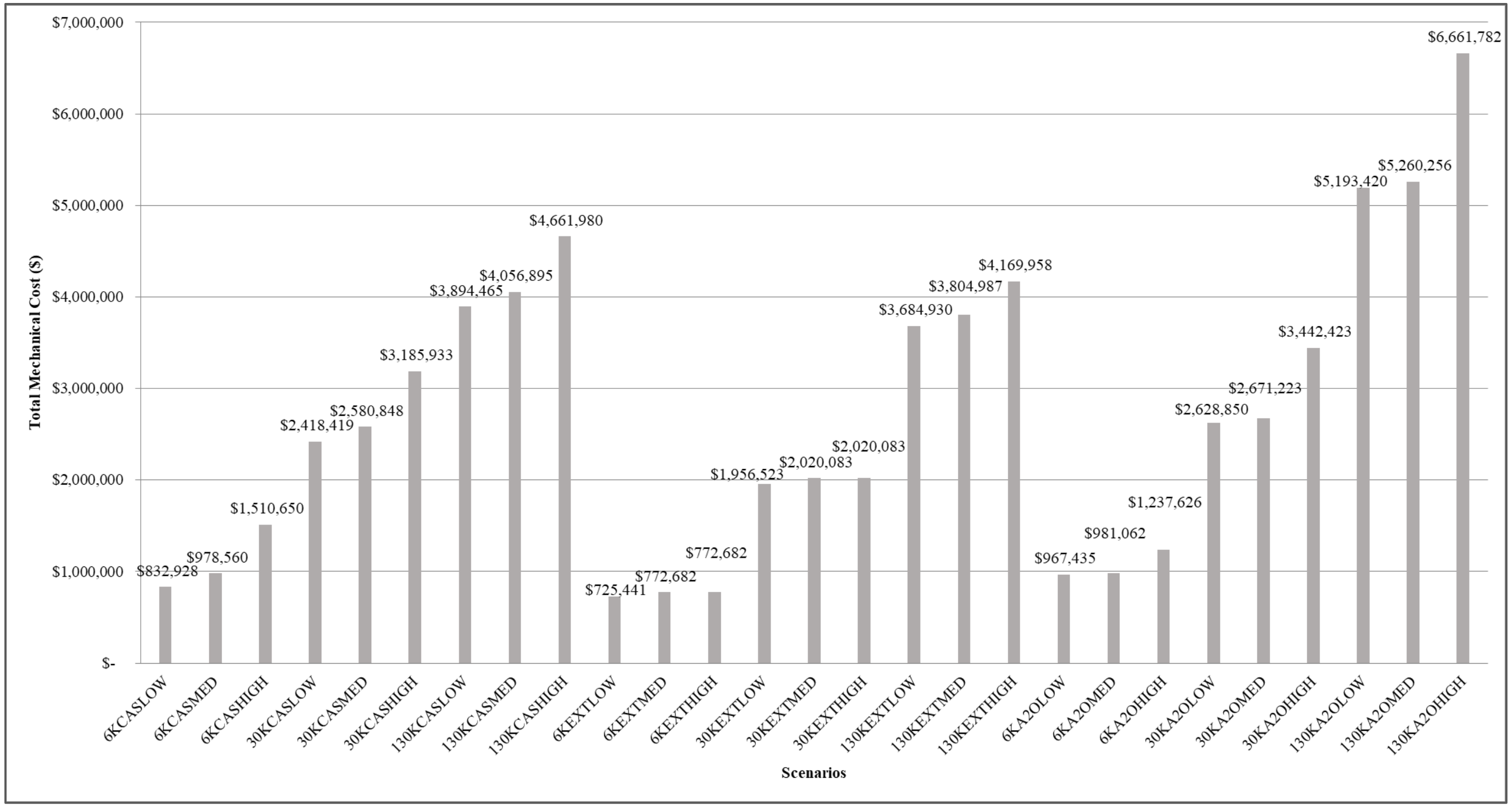

Figure 4-2 Cost of mechanical works ($) for different scenarios

4.3.1.1.3 Piping and Electrical/Sanitary Costs

Piping and electrical/sanitary costs were calculated differently. 16 % of the mechanical costs were taken as piping cost, while 20 % of the mechanical costs were taken as electrical and sanitary costs. Piping and electrical/sanitary costs were shown in Table 4-16.

Table 4-16 Total piping and electrical/sanitary costs calculation

Scenarios	**Total Mechanical Cost ($)**	**Total Piping Cost ($)**	**Total Electrical/Sanitary Cost ($)**
	MC	**MC x 0.16**	**MC x 0.20**
6KCASLOW	$ 832,928	$ 133,269	$ 166,586
6KCASMED	$ 978,560	$ 156,570	$ 195,712
6KCASHIGH	$ 1,510,650	$ 241,704	$ 302,130
30KCASLOW	$ 2,418,419	$ 386,947	$ 483,684
30KCASMED	$ 2,580,848	$ 412,936	$ 516,170
30KCASHIGH	$ 3,185,933	$ 509,749	$ 637,187
130KCASLOW	$ 3,894,465	$ 623,114	$ 778,893
130KCASMED	$ 4,056,895	$ 649,103	$ 811,379
130KCASHIGH	$ 4,661,980	$ 745,917	$ 932,396
6KEXTLOW	$ 725,441	$ 116,071	$ 145,088
6KEXTMED	$ 772,682	$ 123,629	$ 154,536
6KEXTHIGH	$ 772,682	$ 123,629	$ 154,536
30KEXTLOW	$ 1,956,523	$ 313,044	$ 391,305
30KEXTMED	$ 2,020,083	$ 323,213	$ 404,017
30KEXTHIGH	$ 2,020,083	$ 323,213	$ 404,017
130KEXTLOW	$ 3,684,930	$ 589,589	$ 736,986
130KEXTMED	$ 3,804,987	$ 608,798	$ 760,997
130KEXTHIGH	$ 4,169,958	$ 667,193	$ 833,992
6KA2OLOW	$ 967,435	$ 154,790	$ 193,487
6KA2OMED	$ 981,062	$ 156,970	$ 196,212
6KA2OHIGH	$ 1,237,626	$ 198,020	$ 247,525
30KA2OLOW	$ 2,628,850	$ 420,616	$ 525,770
30KA2OMED	$ 2,671,223	$ 427,396	$ 534,245
30KA2OHIGH	$ 3,442,423	$ 550,788	$ 688,485
130KA2OLOW	$ 5,193,420	$ 830,947	$ 1,038,684
130KA2OMED	$ 5,260,256	$ 841,641	$ 1,052,051
130KA2OHIGH	$ 6,661,782	$ 1,065,885	$ 1,332,356

4.3.1.1.4 Replacement Costs

Replacement costs were calculated for year 10 and year 20. The lifetimes of related works and their replacement percentages are given in Table 3-13, Section 3.4.1.4. The summary table for replacement costs of 6KA2OLOW scenario is given in Table 4-17. For other scenarios, summary tables can be seen in Appendix F.

Table 4-17 Replacement costs summary table for 6KA2OLOW scenario

Construction Items	Rep. Percent (%) (C)	Capital Cost ($) (D)	Unknown (D x 0.15) (E)	Investment Cost ($) (F)	Year 10	Year 20
					G	H
				D+E	C*F/100	C*F/100
Civil	30	$375,288	$56,293	$431,581	-	-
Piping	30	$154,790	$23,218	$178,008	-	-
Mechanical	60	$967,435	$145,115	$1,112,550	-	$67,530
Electrical-Sanitary	40	$193,487	$29,023	$222,510	$89,004	$89,004
TOTAL	100	$1,691,000	$53,650	$1,944,650	**$89,004**	**$56,534**

4.3.1.2 Operational Costs

As mentioned in Section 3.4.2, operational costs involve maintenance costs, the salaries of the staff, energy costs, chemical costs and sludge costs where sample calculations are given in the following sections.

4.3.1.2.1 Maintenance Cost

Maintenance cost was selected as 3.0 %, 2.0 % and 4.0 % of the capital cost for the scenarios based on TS_A, TS_B and TS_C, respectively (Table 3-14 in Section 3.4.2.1). Summary table for maintenance costs of scenario 6KA2OLOW is given in Table 4-18. For other scenarios, summary tables can be seen in Appendix G.

Table 4-18 Maintenance cost calculation for scenario 6KA2OLOW

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	375,288.00	2.0-4.0	4	15,012.00
Mechanical	967,435.00	2.0-6.0	4	38,697.00
Electrical-Sanitary	193,487.00	2.0-6.0	4	7,793.00
Piping	154,790.00	2.0-6.0	4	6,192.00
			TOTAL	**67,640.00**

4.3.1.2.2 Salary of the Staff

The number of employers differed in each scenario because of the different complexity and the capacities of the treatment schemes (Wendland, 2005). Staff numbers and salaries can be seen in Table 3-16 and Table 3-17 in Section 3.4.2.2. The summary table for salary costs of scenario 6KA2OLOW is given in Table 4-19. For other scenarios, summary tables can be seen in Appendix H.

Table 4-19 Salary cost calculation for scenario 6KA2OLOW

	Number of people	Salary per month	Total Salary per month	Total Salary per year
Worker	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Safeguard	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Engineer	1	$ 2,500.00	$ 2,500.00	$ 30,000.00
Technician	3	$ 1,500.00	$ 4,500.00	$ 54,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	**9**	**-**	**$ 16,500.00**	**$ 198,000.00**

4.3.1.2.3 Energy Cost

In previous sections, mechanical equipment were already listed. In order to calculate the energy cost related to the usage of these equipment, the powers were attained from firms and their daily operation hour in a day were determined. As an example, the daily power requirement of a lift-gate was calculated as follows:

Power = 0.55 kW

Number of Equipment = 4 + 0 spare

Installed Power = 4 x 0.55 = 2.2 kW

Efficiency = 90 %

Operation hour = 1 hr / day

Daily Power Requirement = 4 x 0.55 kW x 0.90 x 1 hr = 1.98 kWh

The same calculation was done for other equipment in all scenarios. The summary table for energy requirement costs of 6KA2OLOW scenario is given in Table 4-20. For other scenarios, summary tables can be seen in Appendix E.

Table 4-20 Energy requirement calculation for 6KA2OLOW scenario

Treatment Scheme	6KA2O						
Equipment used in each unit	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption
	kW	prime	backup	kw	%	hr	kWh.day
Screens and Inlet Pumping Station							
Lift Gate	0.55	4	0	2.20	90%	1	1.98
Coarse Screen	1.50	2	1	4.50	90%	24	64.80
Fine Screen	1.50	2	1	4.50	90%	24	64.80
Conveyor	1.50	2	0	3.00	90%	24	64.80
Inlet Pumps	15.00	2	1	45.00	90%	24	648.00
Crane	5.50	1	0	5.50	90%	1	4.95
Others	0	1	0	0.00	0%	0	0.00
Grit Chamber							
Scrapper	0.55	2	0	1.10	90%	24	23.76
Grit Pumps	1.1	2	1	3.30	90%	12	23.76
Grit Separator	0.55	1	0	0.55	90%	12	5.94
Lift Gate	0.55	2	0	1.10	90%	1	0.99
Blower	7.5	1	1	15.00	90%	24	162.00
Others	0	1	0	0.00	0%	0	0.00
Anaerobic Tanks							
Lift Gate 1	0.55	4	0	2.20	90%	1	1.98
Lift Gate 2	0.55	4	0	2.20	90%	1	1.98
Jib Crane	1.5	4	0	6.00	90%	1	5.40
Mixer	3	4	0	12.00	90%	24	259.20
Aerobic Tanks							
Lift Gate 1	0.55	4	0	2.20	90%	1	1.98
Lift Gate 2	0.55	2	0	1.10	90%	1	0.99
Jib Crane	1.5	4	0	6.00	90%	1	5.40
Mixer	3	8	0	24.00	90%	24	518.40
Others	0	1	0	0.00	0%	0	0.00
Secondary Sedimentation Tanks							
Scum Pumps	1.1	2	1	3.30	90%	6	11.88
Scrapper	0.55	2	0	1.10	90%	24	23.76
Others	0	1	0	0.00	0%	0	0.00
Return and Excess Sludge Pumping Station							
Return Sludge Pumps	11	3	1	44.00	90%	24	712.80
Excess Sludge Pumps	1.1	3	1	4.40	90%	24	71.28
Others	0	1	0	0.00	0%	0	0.00
			TOTAL	**198.35**	**-**	**-**	**2,725.11**

The energy requirements of decanters, mechanical aerators and blowers were calculated separately in the same way. Installed power for mechanical aerators and blowers were directly taken from BioWin outputs. Daily power consumption was found by multiplying installed power with efficiency. The daily power consumption of decanters is shown in Table 4-21, blowers and mechanical aerators in Table 4-22.

Table 4-21 Daily power consumption for decanters of different scenarios

Scenarios	Working time interval (hr)	Prime (Pcs.)	Backup (Pcs.)	Installed Power (kW)	Efficiency (%)	Daily Power Consumption (kWh)
6KA2OLOW	6	1	1	22	90%	118.8
30KA2OLOW	9	1	1	42	90%	340.2
130KA2OLOW	10	2	1	52	90%	936
6KA2OMED	9	1	1	22	90%	178.2
30KA2OMED	9	1	1	52	90%	421.2
130KA2OMED	9	3	1	71	90%	1725.3
6KA2OHIGH	8	1	1	42	90%	302.4
30KA2OHIGH	9	2	1	52	90%	842.4
130KA2OHIGH	13	4	1	71	90%	3322.8
6KEXTLOW	8	1	1	22	90%	158.4
30KEXTLOW	9	2	1	42	90%	680.4
130KEXTLOW	12	3	1	71	90%	2300.4
6KEXTMED	6	2	1	22	90%	237.6
30KEXTMED	9	2	1	52	90%	842.4
130KEXTMED	12	4	1	71	90%	3067.2
6KEXTHIGH	8	2	1	22	90%	316.8
30KEXTHIGH	9	2	1	52	90%	842.4
130KEXTHIGH	12	4	1	71	90%	3067.2
6KCASLOW	9	1	1	22	90%	178.2
30KCASLOW	9	1	1	52	90%	421.2
130KCASLOW	9	3	1	71	90%	1725.3
6KCASMED	6	1	1	42	90%	226.8
30KCASMED	7	2	1	71	90%	894.6
130KCASMED	10	4	1	71	90%	2556
6KCASHIGH	7	1	1	42	90%	264.6
30KCASHIGH	9	2	1	52	90%	842.4
130KCASHIGH	14	4	1	71	90%	3578.4

Table 4-22 Energy requirement calculation for blowers and mechanical aerators of different scenarios

Scenarios	Working time interval (hr)	Prime (Pcs.)	Backup (Pcs.)	Installed Power (kW)	Efficiency (%)	Daily Power Consumption (kWh)
6KA2OLOW	24	2	1	23	90%	496.8
30KA2OLOW	24	2	1	114	90%	2462.4
130KA2OLOW	24	3	2	492	90%	10627.2
6KA2OMED	24	3	2	32	90%	691.2
30KA2OMED	24	2	1	159	90%	3434.4
130KA2OMED	24	2	1	590	90%	12744
6KA2OHIGH	24	1	1	64	90%	1382.4
30KA2OHIGH	24	2	1	318	90%	6868.8
130KA2OHIGH	24	4	2	1381	90%	29829.6
6KEXTLOW	12	-	-	70	90%	756
30KEXTLOW	12	-	-	348	90%	3758.4
130KEXTLOW	12	-	-	1507	90%	16275.6
6KEXTMED	12	-	-	100	90%	1080
30KEXTMED	12	-	-	498	90%	5378.4
130KEXTMED	12	-	-	2158	90%	23306.4
6KEXTHIGH	12	-	-	193	90%	2084.4
30KEXTHIGH	12	-	-	964	90%	10411.2
130KEXTHIGH	12	-	-	4179	90%	45133.2
6KCASLOW	18	-	-	41	90%	664.2
30KCASLOW	18	-	-	206	90%	3337.2
130KCASLOW	18	-	-	892	90%	14450.4
6KCASMED	18	-	-	57	90%	923.4
30KCASMED	18	-	-	286	90%	4633.2
130KCASMED	18	-	-	1239	90%	20071.8
6KCASHIGH	18	-	-	113	90%	1830.6
30KCASHIGH	18	-	-	567	90%	9185.4
130KCASHIGH	18	-	-	2460	90%	39852

Energy costs were calculated using unit energy prices ($ 0.068) by multiplying unit cost with daily power consumption. Total energy requirements and energy costs can be seen in Table 4-23. The table below only shows the first-years' energy costs.

Table 4-23 Energy costs for various scenarios ($) at the 1st year

Scenarios	Daily Power Consumption (kWh)	Yearly Power Consumption (kWh)	Energy Cost ($)
6KCASLOW	2962.44	1081291	$ 73,528
6KCASMED	3270.24	1193638	$ 81,167
6KCASHIGH	4215.24	1538563	$ 104,622
30KCASLOW	12342.56	4505033	$ 306,342
30KCASMED	14111.96	5150864	$ 350,259
30KCASHIGH	18611.96	6793364	$ 461,949
130KCASLOW	37997.06	13868925	$ 943,087
130KCASMED	44449.16	16223942	$ 1,103,228
130KCASHIGH	65251.76	23816891	$ 1,619,549
6KEXTLOW	914.4	333756	$ 22,695
6KEXTMED	1317.6	480924	$ 32,703
6KEXTHIGH	2401.2	876438	$ 59,598
30KEXTLOW	11570.72	4223311	$ 287,185
30KEXTMED	13352.72	4873741	$ 331,414
30KEXTHIGH	18385.52	6710713	$ 456,328
130KEXTLOW	34581.92	12622399	$ 858,323
130KEXTMED	42379.52	15468523	$ 1,051,860
130KEXTHIGH	64206.32	23435305	$ 1,593,601
6KA2OLOW	3340.71	1219359	$ 82,916
6KA2OMED	3594.51	1311996	$ 89,216
6KA2OHIGH	4409.91	1609617	$ 109,454
30KA2OLOW	14248.58	5200730	$ 353,650
30KA2OMED	15301.58	5585075	$ 379,785
30KA2OHIGH	19157.18	6992369	$ 475,481
130KA2OLOW	31764.02	11593865	$ 788,383
130KA2OMED	34670.12	12654592	$ 860,512
130KA2OHIGH	53353.22	19473923	$ 1,324,227

4.3.1.2.4 Chemical Cost

Chemical cost consisted of the cost of the organic polymer, which was used in the dewatering of sludge. The organic polymer (polyelectrolyte), PE had a cost of $ 5.37 /kg. The chemical costs can be seen in Table 4-24. The table below only shows the first year PE costs. To include population growth, it was assumed that PE was increased by 1.36 % every year, which is the average population growth constant for years 2007-2018 (Section 3.4.2).

Table 4-24 Organic polymer (PE) costs for different scenarios as $/year at the 1st year

Scenarios	Sludge Amount (ton/day)	Organic Polymer Amount (kg/day)	Organic Polymer Amount (kg/year)	PE Cost ($/year)
6KCASLOW	0.90	4.50	1642.50	$ 8,820
6KCASMED	1.33	6.65	2427.25	$ 13,034
6KCASHIGH	2.59	12.97	4734.05	$ 25,422
30KCASLOW	4.50	22.49	8208.85	$ 44,082
30KCASMED	6.65	33.23	12128.95	$ 65,132
30KCASHIGH	12.97	64.85	23670.25	$ 127,109
130KCASLOW	19.50	97.49	35583.85	$ 191,085
130KCASMED	28.81	144.03	52570.95	$ 282,306
130KCASHIGH	56.21	281.04	102579.60	$ 550,852
6KEXTLOW	0.50	2.51	916.15	$ 4,920
6KEXTMED	0.73	3.65	1332.25	$ 7,154
6KEXTHIGH	1.46	7.31	2668.15	$ 14,328
30KEXTLOW	2.51	12.55	4580.75	$ 24,599
30KEXTMED	3.65	18.23	6653.95	$ 35,732
30KEXTHIGH	7.30	36.52	13329.80	$ 71,581
130KEXTLOW	10.89	54.43	19866.95	$ 106,686
130KEXTMED	15.81	79.03	28845.95	$ 154,903
130KEXTHIGH	31.66	158.31	57783.15	$ 310,296
6KA2OLOW	0.56	2.81	1025.65	$ 5,508
6KA2OMED	0.87	4.37	1595.05	$ 8,565
6KA2OHIGH	1.60	8.00	2920.00	$ 15,680
30KA2OLOW	2.78	13.91	5077.15	$ 27,264
30KA2OMED	4.34	21.69	7916.85	$ 42,513
30KA2OHIGH	7.96	39.81	14530.65	$ 78,030
130KA2OLOW	12.04	60.18	21965.70	$ 117,956
130KA2OMED	18.92	94.58	34521.70	$ 185,382
130KA2OHIGH	39.59	197.94	72248.10	$ 387,972

4.3.1.2.5 Sludge Cost

Sludge cost represented the transfer and incineration of sludge. Transfer of the sludge for 100 km distance was accepted as $ 3.49/ton and the price of incineration was determined as $ 47.08/ton. Sludge costs can be seen in Table 4-25. The table below only shows the first year sludge costs, by including population growth, it was assumed that sludge generation was increased by 1.36 % every year.

Table 4-25 Sludge costs for different scenarios as $/year at 1st year

Scenarios	Sludge Amount (ton/day)	Sludge Amount (ton/year)	Sludge Cost ($/year)
6KCASLOW	0.90	328.14	$ 16,594
6KCASMED	1.33	485.09	$ 24,531
6KCASHIGH	2.59	946.45	$ 47,863
30KCASLOW	4.50	1641.77	$ 83,026
30KCASMED	6.65	2425.79	$ 122,675
30KCASHIGH	12.97	4733.69	$ 239,387
130KCASLOW	19.50	7116.41	$ 359,884
130KCASMED	28.81	10514.19	$ 531,713
130KCASHIGH	56.21	20515.92	$ 1,037,511
6KEXTLOW	0.50	183.23	$ 9,266
6KEXTMED	0.73	266.09	$ 13,456
6KEXTHIGH	1.46	533.27	$ 26,968
30KEXTLOW	2.51	916.15	$ 46,331
30KEXTMED	3.65	1330.43	$ 67,281
30KEXTHIGH	7.30	2665.96	$ 134,820
130KEXTLOW	10.89	3973.03	$ 200,920
130KEXTMED	15.81	5769.19	$ 291,754
130KEXTHIGH	31.66	11556.63	$ 584,430
6KA2OLOW	0.56	205.13	$ 10,374
6KA2OMED	0.87	318.65	$ 16,114
6KA2OHIGH	1.60	584.00	$ 29,533
30KA2OLOW	2.78	1015.43	$ 51,351
30KA2OMED	4.34	1583.01	$ 80,054
30KA2OHIGH	7.96	2905.77	$ 146,947
130KA2OLOW	12.04	4393.14	$ 222,165
130KA2OMED	18.92	6903.98	$ 349,141
130KA2OHIGH	39.59	14449.62	$ 730,732

4.3.1.3 Present Value Calculation of Secondary Treatment Level

In this section, a 30 year cost, which is the lifetime of a given facility, was evaluated by present value cost analysis. As an example, the present value cost calculation for the 6KA2OLOW scenario was done as shown below; calculations for other scenarios can be seen in Appendix I.

Capital costs of the 6KA2OLOW scenario were calculated in previous sections (Section 4.3.1.1). It was assumed that civil works and piping lasted for two years, whereas mechanical and electrical-sanitary work was completed in the 2nd year. 1st and 2nd year capital costs are given in Table 4-26. Replacement costs are given in Table 4-27.

Maintenance costs that occurred every year are given in Table 4-28. Lastly, the salary of the staff is given in Table 4-29 for the 6KA2OLOW scenario.

- The energy required (for 6KA2OLOW for the 1st year) = 1219359 kWh
- Energy Unit Price = $0.068 / kWh
- Energy Cost (for 6KA2OLOW for the 1st year) =1219359x0.068 = $ 82,916.42
- Chemical Cost (for 6KA2OLOW for the 1st year) = $ 5,508.00
- Sludge Cost (for 6KA2OLOW for the 1st year) = $ 10,383.30

Table 4-26 1st and 2nd year capital costs for 6KA2OLOW scenario

Construction Items	Capital Cost ($)	Years	
		1st Year	2nd Year
Civil	$ 375,288	$ 187,644	$ 187,644
Mechanical	$ 967,435	-	$ 967,435
Electrical-Sanitary	$ 193,487	-	$ 193,487
Piping	$ 154,790	$ 77,395	$ 77,395
TOTAL	**$ 1,691,000**	**$ 265,039**	**$1,425,961**

Table 4-27 Replacement costs of 6KA2OLOW scenario for year 10 and 20

Construction Items	Replacement Costs ($)	
	YEAR 10	YEAR 20
Civil	-	-
Mechanical	-	$ 667,530
Electrical-Sanitary	$ 89,004	$ 89,004
Piping	-	-
TOTAL	$ 89,004	$ 756,534

Table 4-28 Maintenance cost for 6KA2OLOW scenario

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 375,288	2.0-4.0	4	$ 15,012
Mechanical	$ 967,435	2.0-6.0	4	$ 38,697
Electrical-Sanitary	$ 193,487	2.0-6.0	4	$ 7,793
Piping	$ 154,790	2.0-6.0	4	$ 6,192
			TOTAL	**$ 67,640**

Table 4-29 Salary calculation for 6KA2OLOW scenario

	Number of people	Salary per month	Total salary per month	Total salary per year
Worker	2	$ 1,500	$ 3,000	$ 36,000
Safeguard	2	$ 1,500	$ 3,000	$ 36,000
Engineer	1	$ 2,500	$ 2,500	$ 30,000
Technician	3	$ 1,500	$ 4,500	$ 54,000
Manager	1	$ 3,500	$ 3,500	$ 42,000
TOTAL	**9**	-	**$ 16,500**	**$ 198,000**

Operational costs were evaluated in two parts. Operational Costs 1 (OP1) includes energy, chemical and sludge costs, which increased with population growth. Operational Costs 2 (OP2) includes salary and maintenance cost, where no increase by population growth was assumed. The summation of OC1 and OC2 was evaluated as the total operational cost for the selected scenario.

The net present value was calculated for every year by multiplying the cost with the net present value factor, where inflation (i) was taken as 2.08 %. An example table for the 6KA2OLOW scenario can be seen in Table 4-30.

Table 4-30 Operational Costs 1 for 6KA2OLOW scenario

YEAR	Population Growth Constant	Energy Req'd (kWh/day)	Energy Req'd (kWh/year)	Energy Cost ($/year)	Chemical Cost ($/year)	Sludge Cost ($/year)	1/(1+i)^n	Operational Cost 1 ($/year)
2019	-	-	-	-	-	-	1.00	$ -
2020	-	-	-	-	-	-	0.98	$ -
2021	-	-	-	-	-	-	0.96	$ -
2022	1.0000	3,340.71	1219359	$82,916.42	$ 5,508.00	$10,373.30	0.94	$ 92,869.36
2023	1.0136	3,386.24	1235979	$84,046.57	$ 5,583.07	$10,514.69	0.92	$ 92,213.33
2024	1.0274	3,432.40	1252825	$85,192.13	$ 5,659.17	$10,658.00	0.90	$ 91,561.95
2025	1.0414	3,479.18	1269901	$86,353.30	$ 5,736.31	$10,803.27	0.88	$ 90,915.16
2026	1.0556	3,526.60	1287210	$87,530.29	$ 5,814.49	$10,950.52	0.87	$ 90,272.94
2027	1.0700	3,574.67	1304755	$88,723.33	$ 5,893.74	$11,099.78	0.85	$ 89,635.26
2028	1.0846	3,623.39	1322539	$89,932.63	$ 5,974.07	$11,251.07	0.83	$ 89,002.08
2029	1.0994	3,672.78	1340565	$91,158.41	$ 6,055.50	$11,404.42	0.81	$ 88,373.38
2030	1.1144	3,722.84	1358837	$92,400.90	$ 6,138.04	$11,559.86	0.80	$ 87,749.12
2031	1.1296	3,773.58	1377358	$93,660.32	$ 6,221.70	$11,717.42	0.78	$ 87,129.26
2032	1.1450	3,825.02	1396131	$94,936.91	$ 6,306.50	$11,877.13	0.76	$ 86,513.79
2033	1.1606	3,877.15	1415160	$96,230.90	$ 6,392.46	$12,039.01	0.75	$ 85,902.66
2034	1.1764	3,930.00	1434449	$97,542.53	$ 6,479.59	$12,203.11	0.73	$ 85,295.85
2035	1.1924	3,983.56	1454001	$98,872.04	$ 6,567.90	$12,369.43	0.72	$ 84,693.33
2036	1.2087	4,037.86	1473819	$100,219.66	$ 6,657.43	$12,538.03	0.70	$ 84,095.06
2037	1.2252	4,092.90	1493907	$101,585.66	$ 6,748.17	$12,708.92	0.69	$ 83,501.02
2038	1.2419	4,148.68	1514269	$102,970.27	$ 6,840.14	$12,882.15	0.68	$ 82,911.17
2039	1.2588	4,205.23	1534908	$104,373.75	$ 6,933.37	$13,057.73	0.66	$ 82,325.50
2040	1.2759	4,262.55	1555829	$105,796.37	$ 7,027.88	$13,235.71	0.65	$ 81,743.95
2041	1.2933	4,320.64	1577035	$107,238.37	$ 7,123.67	$13,416.11	0.64	$ 81,166.52
2042	1.3110	4,379.53	1598530	$108,700.03	$ 7,220.76	$13,598.97	0.62	$ 80,593.17
2043	1.3288	4,439.23	1620318	$110,181.61	$ 7,319.18	$13,784.33	0.61	$ 80,023.86
2044	1.3469	4,499.73	1642403	$111,683.39	$ 7,418.94	$13,972.21	0.60	$ 79,458.58
2045	1.3653	4,561.06	1664789	$113,205.63	$ 7,520.06	$14,162.65	0.58	$ 78,897.29
2046	1.3839	4,623.23	1687480	$114,748.63	$ 7,622.56	$14,355.68	0.57	$ 78,339.97
2047	1.4028	4,686.25	1710480	$116,312.65	$ 7,726.46	$14,551.35	0.56	$ 77,786.58
2048	1.4219	4,750.12	1733794	$117,897.99	$ 7,831.77	$14,749.69	0.55	$ 77,237.10
2049	1.4413	4,814.86	1757426	$119,504.94	$ 7,938.51	$14,950.72	0.54	$ 76,691.50
2050	1.4609	4,880.49	1781379	$121,133.79	$ 8,046.72	$15,154.50	0.53	$ 76,149.76
2051	1.4808	4,947.01	1805659	$122,784.85	$ 8,156.39	$15,361.06	0.52	$ 75,611.84
							TOTAL	**$ 2,518,660**

For Operational Costs 2, it was assumed that there was no increase with population growth in years. Operational Costs 2 can be seen in Table 4-31.

Table 4-31 Operational Costs 2 for 6KA2OLOW scenario

YEAR	Salary	Maintenance Cost	1/(1+i)^n	Operational Cost 2
	($/year)	($/year)		($/year)
2019	-	-	1.00	$ -
2020	-	-	0.98	$ -
2021	-	-	0.96	$ -
2022	$198,000.00	$ 67,640.00	0.94	$ 249,700.25
2023	$198,000.00	$ 67,640.00	0.92	$ 244,602.45
2024	$198,000.00	$ 67,640.00	0.90	$ 239,608.73
2025	$198,000.00	$ 67,640.00	0.88	$ 234,716.96
2026	$198,000.00	$ 67,640.00	0.87	$ 229,925.06
2027	$198,000.00	$ 67,640.00	0.85	$ 225,230.99
2028	$198,000.00	$ 67,640.00	0.83	$ 220,632.75
2029	$198,000.00	$ 67,640.00	0.81	$ 216,128.39
2030	$198,000.00	$ 67,640.00	0.80	$ 211,715.98
2031	$198,000.00	$ 67,640.00	0.78	$ 207,393.66
2032	$198,000.00	$ 67,640.00	0.76	$ 203,159.58
2033	$198,000.00	$ 67,640.00	0.75	$ 199,011.94
2034	$198,000.00	$ 67,640.00	0.73	$ 194,948.98
2035	$198,000.00	$ 67,640.00	0.72	$ 190,968.97
2036	$198,000.00	$ 67,640.00	0.70	$ 187,070.21
2037	$198,000.00	$ 67,640.00	0.69	$ 183,251.05
2038	$198,000.00	$ 67,640.00	0.68	$ 179,509.86
2039	$198,000.00	$ 67,640.00	0.66	$ 175,845.05
2040	$198,000.00	$ 67,640.00	0.65	$ 172,255.06
2041	$198,000.00	$ 67,640.00	0.64	$ 168,738.36
2042	$198,000.00	$ 67,640.00	0.62	$ 165,293.45
2043	$198,000.00	$ 67,640.00	0.61	$ 161,918.88
2044	$198,000.00	$ 67,640.00	0.60	$ 158,613.20
2045	$198,000.00	$ 67,640.00	0.58	$ 155,375.00
2046	$198,000.00	$ 67,640.00	0.57	$ 152,202.92
2047	$198,000.00	$ 67,640.00	0.56	$ 149,095.60
2048	$198,000.00	$ 67,640.00	0.55	$ 146,051.71
2049	$198,000.00	$ 67,640.00	0.54	$ 143,069.97
2050	$198,000.00	$ 67,640.00	0.53	$ 140,149.10
2051	$198,000.00	$ 67,640.00	0.52	$ 137,287.86
			TOTAL	**$ 5,643,472**

As shown in Table 4-32, prepared as an example of the total cost calculation of the 6KA2OLOW scenario, capital costs were only involved in the construction period, which was 2020 and 2021. Moreover, calculated replacement costs were involved at Year 10 (2031) and Year 20 (2041). The total cost was calculated by the summation of capital and replacement costs. Then, by multiplying with the net present value factor, $(1/(1+i)^{n})$, net present value ($) was found.

In Table 4-32, cost analysis calculations, capital costs (1st column) include; civil, mechanical, electrical and piping/sanitary costs, whereas replacement costs (2nd column) showed up in specific years like year 10 and year.

Table 4-32 Total flowrates and cost analysis of 6KA2OLOW scenario

YEAR	Capital Cost	Replacement Cost	Total Cost	1/(1+i)^n	Net Present Value	Flowrate	Population Growth Constant	Total Flowrate
	($)	($)	($)		($)	(m³/day)		(m³/year)
2019	$ -	$ -	$ -	1.00000	$ -	0.00	-	0.00
2020	$ 265,038.73	$ -	$ 265,038.73	0.97958	$ 259,627.79	0.00	-	0.00
2021	$ 1,425,960.89	$ -	$ 1,425,960.89	0.95959	$ 1,368,331.36	0.00	-	0.00
2022	$ -	$ -	$ -	0.93999	$ -	**6,000.00**	1.000	2,190,000.00
2023	$ -	$ -	$ -	0.92080	$ -	6,082	1.014	2,219,930.00
2024	$ -	$ -	$ -	0.90201	$ -	6,165	1.027	2,250,225.00
2025	$ -	$ -	$ -	0.88359	$ -	6,249	1.041	2,280,885.00
2026	$ -	$ -	$ -	0.86555	$ -	6,334	1.056	2,311,910.00
2027	$ -	$ -	$ -	0.84788	$ -	6,420	1.070	2,343,300.00
2028	$ -	$ -	$ -	0.83057	$ -	6,508	1.085	2,375,420.00
2029	$ -	$ -	$ -	0.81361	$ -	6,596	1.099	2,407,540.00
2030	$ -	$ -	$ -	0.79700	$ -	6,686	1.114	2,440,390.00
2031	$ -	$ 89,004.03	$ 89,004.03	0.78073	$ 69,488.30	6,777	1.130	2,473,605.00
2032	$ -	$ -	$ -	0.76479	$ -	6,870	1.145	2,507,550.00
2033	$ -	$ -	$ -	0.74918	$ -	6,963	1.161	2,541,495.00
2034	$ -	$ -	$ -	0.73388	$ -	7,058	1.176	2,576,170.00
2035	$ -	$ -	$ -	0.71890	$ -	7,155	1.192	2,611,575.00
2036	$ -	$ -	$ -	0.70422	$ -	7,252	1.209	2,646,980.00
2037	$ -	$ -	$ -	0.68985	$ -	7,351	1.225	2,683,115.00
2038	$ -	$ -	$ -	0.67576	$ -	7,451	1.242	2,719,615.00
2039	$ -	$ -	$ -	0.66197	$ -	7,553	1.259	2,756,845.00
2040	$ -	$ -	$ -	0.64845	$ -	7,656	1.276	2,794,440.00
2041	$ -	$ 756,534.27	$ 756,534.27	0.63521	$ 480,561.47	7,760	1.293	2,832,400.00
2042	$ -	$ -	$ -	0.62225	$ -	7,866	1.311	2,871,090.00
2043	$ -	$ -	$ -	0.60954	$ -	7,973	1.329	2,910,145.00
2044	$ -	$ -	$ -	0.59710	$ -	8,082	1.347	2,949,930.00
2045	$ -	$ -	$ -	0.58491	$ -	8,192	1.365	2,990,080.00
2046	$ -	$ -	$ -	0.57297	$ -	8,303	1.384	3,030,595.00
2047	$ -	$ -	$ -	0.56127	$ -	8,417	1.403	3,072,205.00
2048	$ -	$ -	$ -	0.54981	$ -	8,531	1.422	3,113,815.00
2049	$ -	$ -	$ -	0.53859	$ -	8,648	1.441	3,156,520.00
2050	$ -	$ -	$ -	0.52759	$ -	8,765	1.461	3,199,225.00
2051	$ -	$ -	$ -	0.51682	$ -	8,885	1.481	3,243,025.00
				TOTAL	**$ 2,178,008.92**		**TOTAL**	**80,500,020**

The present value calculation results for the 6KA2OLOW scenario can be seen in Table 4-33. For 30 year period, capital cost was $ 2,178,009 and operational cost (OC 1 + OC 2) was $ 8,162,132, with a total of $ 10,340,141. Total flowrate, which was the total amount of wastewater for 30 years, was calculated as 80,500,020 m³. Accordingly, considering the total flowrate of 80,500,020 m³, the unit cost of secondary treatment was calculated as $ 0.128 /m³.

Table 4-33 Cost analysis results for 6KA2OLOW scenario

Total Flowrate (m³)		80,500,020
	Cost ($)	**Unit Cost ($/m³)**
Capital Costs	$ 2,178,009	$ 0.027
Operational Costs	$ 8,162,132	$ 0.101
Total Costs	$ 10,340,141	$ 0.128

This calculation was applied for 27 scenarios. Calculation steps can be found in Appendix I. In the end, capital, operational and total costs based on secondary treatment level in $ (Table 4-34 to Table 4-37) and capital, operational and unit costs based on secondary treatment level in $/m³ (Table 4-38) were obtained.

Table 4-34 Capital costs based on secondary treatment level ($)

Treatment Scheme	**Capital Costs**			
	Civil Work Cost	**Mechanical Costs**	**Piping Costs**	**Electrical/ Sanitary Costs**
6KCASLOW	$ 220,022	$ 832,928	$ 133,269	$ 166,586
6KCASMED	$ 220,022	$ 978,560	$ 156,570	$ 195,712
6KCASHIGH	$ 220,022	$ 1,510,650	$ 241,704	$ 302,130
30KCASLOW	$ 704,430	$ 2,418,419	$ 386,947	$ 483,684
30KCASMED	$ 704,430	$ 2,580,848	$ 412,936	$ 516,170
30KCASHIGH	$ 704,430	$ 3,185,933	$ 509,749	$ 637,187
130KCASLOW	$ 2,823,979	$ 3,894,465	$ 623,114	$ 778,893
130KCASMED	$ 2,823,979	$ 4,056,895	$ 649,103	$ 811,379
130KCASHIGH	$ 2,823,979	$ 4,661,980	$ 745,917	$ 932,396
6KEXTLOW	$ 326,552	$ 725,441	$ 116,071	$ 145,088
6KEXTMED	$ 326,552	$ 772,682	$ 123,629	$ 154,536
6KEXTHIGH	$ 326,552	$ 772,682	$ 123,629	$ 154,536
30KEXTLOW	$ 1,494,610	$ 1,956,523	$ 313,044	$ 391,305
30KEXTMED	$ 1,494,610	$ 2,020,083	$ 323,213	$ 404,017
30KEXTHIGH	$ 1,494,610	$ 2,020,083	$ 323,213	$ 404,017
130KEXTLOW	$ 5,951,275	$ 3,684,930	$ 589,589	$ 736,986
130KEXTMED	$ 5,951,275	$ 3,804,987	$ 608,798	$ 760,997
130KEXTMED	$ 5,951,275	$ 4,169,958	$ 667,193	$ 833,992
6KA2OLOW	$ 375,288	$ 967,435	$ 154,790	$ 193,487
6KA2OMED	$ 375,288	$ 981,062	$ 156,970	$ 196,212
6KA2OHIGH	$ 375,288	$ 1,237,626	$ 198,020	$ 247,525
30KA2OLOW	$ 2,819,271	$ 2,628,850	$ 420,616	$ 525,770
30KA2OMED	$ 2,819,271	$ 2,671,223	$ 427,396	$ 534,245
30KA2OHIGH	$ 2,819,271	$ 3,442,423	$ 550,788	$ 688,485
130KA2OLOW	$ 12,549,581	$ 5,193,420	$ 830,947	$ 1,038,684
130KA2OMED	$ 12,549,581	$ 5,260,256	$ 841,641	$ 1,052,051
130KA2OHIGH	$ 12,549,581	$ 6,661,782	$ 1,065,885	$ 1,332,356

Table 4-35 Operational costs based on secondary treatment level ($) for the 30 year period

Scenarios	Operational Costs				
	Energy Cost	Chemical Cost	Sludge Cost	Salary	Maintenance Cost
6KCASLOW	$ 1,874,451	$ 224,849	$ 423,004	$ 3,441,660	$ 862,221
6KCASMED	$ 2,069,208	$ 332,277	$ 625,388	$ 3,441,660	$ 988,436
6KCASLHIGH	$ 2,667,146	$ 648,086	$ 1,220,162	$ 3,441,660	$ 1,395,402
30KCASLOW	$ 7,809,613	$ 1,123,787	$ 2,116,604	$ 5,226,224	$ 2,545,235
30KCASMED	$ 8,929,181	$ 1,660,417	$ 3,127,311	$ 5,226,224	$ 2,686,003
30KCASHIGH	$ 11,776,506	$ 3,240,403	$ 6,102,765	$ 5,226,224	$ 3,210,495
130KCASLOW	$ 24,042,210	$ 4,871,349	$ 9,174,526	$ 7,775,601	$ 5,175,512
130KCASMED	$ 28,124,704	$ 7,196,855	$ 13,555,032	$ 7,775,601	$ 5,316,302
130KCASHIGH	$ 41,287,315	$14,042,926	$ 26,449,318	$ 7,775,601	$ 5,840,794
6KEXTLOW	$ 1,709,591	$ 125,426	$ 236,253	$ 2,294,440	$ 557,953
6KEXTMED	$ 1,964,711	$ 182,378	$ 343,075	$ 2,294,440	$ 585,273
6KEXTHIGH	$ 2,650,347	$ 365,265	$ 687,452	$ 2,294,440	$ 585,273
30KEXTLOW	$ 7,321,240	$ 627,105	$ 1,181,081	$ 4,079,004	$ 1,765,635
30KEXTMED	$ 8,448,780	$ 910,919	$ 1,715,187	$ 4,079,004	$ 1,802,367
30KEXTHIGH	$ 11,633,228	$ 1,824,822	$ 3,436,981	$ 4,079,004	$ 1,802,367
130KEXTLOW	$ 21,881,318	$ 2,719,757	$ 5,122,113	$ 5,863,568	$ 4,658,074
130KEXTMED	$ 26,815,162	$ 3,948,958	$ 7,437,751	$ 5,863,568	$ 4,727,438
130KEXTHIGH	$ 40,625,825	$ 7,910,407	$ 14,898,951	$ 5,863,568	$ 4,938,335
6KA2OLOW	$ 2,113,797	$ 140,416	$ 264,448	$ 4,206,473	$ 1,436,999
6KA2OMED	$ 2,274,386	$ 218,348	$ 410,815	$ 4,206,473	$ 1,452,742
6KA2OHIGH	$ 2,790,321	$ 399,732	$ 752,866	$ 4,206,473	$ 1,749,277
30KA2OLOW	$ 9,015,626	$ 695,044	$ 1,309,118	$ 8,412,946	$ 5,434,019
30KA2OMED	$ 9,681,900	$ 1,083,788	$ 2,040,862	$ 8,412,946	$ 5,482,989
30KA2OHIGH	$ 12,121,487	$ 1,989,227	$ 3,746,186	$ 8,412,946	$ 6,374,272
130KA2OLOW	$ 20,098,324	$ 3,007,064	$ 5,663,663	$ 12,746,887	$ 16,666,662
130KA2OMED	$ 21,937,126	$ 4,725,962	$ 8,900,680	$ 12,746,887	$ 16,743,908
130KA2OHIGH	$ 33,758,648	$ 9,890,609	$ 18,628,574	$ 12,746,887	$ 18,363,655

Table 4-36 Operational costs percentages

Scenarios	**Operational Costs**				
	Energy Costs	**Chemical Costs**	**Sludge Costs**	**Salary Costs**	**Maintenance Costs**
6KCASLOW	27.5	3.3	6.2	50.4	12.6
6KCASMED	27.7	4.5	8.4	46.2	13.3
6KCASLOW	28.5	6.9	13	36.7	14.9
30KCASLOW	41.5	6	11.2	27.8	13.5
30KCASMED	41.3	7.7	14.5	24.2	12.4
30KCASHIGH	39.8	11	20.6	17.7	10.9
130KCASLOW	47.1	9.5	18	15.2	10.1
130KCASMED	45.4	11.6	21.9	12.5	8.6
130KCASHIGH	43.3	14.7	27.7	8.2	6.1
6KEXTLOW	34.7	2.5	4.8	46.6	11.3
6KEXTMED	36.6	3.4	6.4	42.7	10.9
6KEXTHIGH	40.3	5.5	10.4	34.9	8.9
30KEXTLOW	48.9	4.2	7.9	27.2	11.8
30KEXTMED	49.8	5.4	10.1	24.1	10.6
30KEXTHIGH	51.1	8	15.1	17.9	7.9
130KEXTLOW	54.4	6.8	12.7	14.6	11.6
130KEXTMED	55	8.1	15.2	12	9.7
130KEXTHIGH	54.7	10.7	20.1	7.9	6.7
6KA2OLOW	25.9	1.7	3.2	51.5	17.6
6KA2OMED	26.6	2.5	4.8	49.1	17
6KA2OHIGH	28.2	4	7.6	42.5	17.7
30KA2OLOW	36.3	2.8	5.3	33.8	21.9
30KA2OMED	36.3	4.1	7.6	31.5	20.5
30KA2OHIGH	37.1	6.1	11.5	25.8	19.5
130KA2OLOW	34.5	5.2	9.7	21.9	28.6
130KA2OMED	33.7	7.3	13.7	19.6	25.7
130KA2OHIGH	36.1	10.6	19.9	13.6	19.7

Table 4-37 Capital, operational and total costs based on secondary treatment level ($)

TS	Scenarios	Capital Cost ($)	Operational Cost ($)	Total Cost ($)
TS_A	**6KCASLOW**	$ 1,775,239	$ 6,826,185	$ 8,601,423
	6KCASMED	$ 2,048,327	$ 7,456,968	$ 9,505,295
	6KCASHIGH	$ 2,963,559	$ 9,372,455	$ 12,336,014
	30KCASLOW	$ 5,218,026	$ 18,821,463	$ 24,039,489
	30KCASMED	$ 5,522,614	$ 21,629,136	$ 27,151,749
	30KCASHIGH	$ 6,657,269	$ 29,556,392	$ 36,213,661
	130KCASLOW	$ 10,040,994	$ 51,039,199	$ 61,080,193
	130KCASMED	$ 10,345,581	$ 61,968,495	$ 72,314,076
	130KCASHIGH	$ 11,480,237	$ 95,395,954	$ 106,876,191
TS_B	**6KEXTLOW**	$ 1,676,969	$ 4,923,662	$ 6,600,631
	6KEXTMED	$ 1,765,554	$ 5,369,876	$ 7,135,431
	6KEXTHIGH	$ 1,765,554	$ 6,582,777	$ 8,348,331
	30KEXTLOW	$ 5,118,027	$ 14,974,065	$ 20,092,092
	30KEXTMED	$ 5,237,213	$ 16,956,259	$ 22,193,472
	30KEXTHIGH	$ 5,237,213	$ 22,776,402	$ 28,013,616
	130KEXTLOW	$ 12,680,252	$ 40,244,831	$ 52,925,083
	130KEXTMED	$ 12,905,382	$ 48,792,878	$ 61,698,260
	130KEXTHIGH	$ 13,589,778	$ 74,237,087	$ 87,826,865
TS_C	**6KA2OLOW**	$ 2,178,009	$ 8,162,132	$ 10,340,141
	6KA2OMED	$ 2,203,563	$ 8,562,764	$ 10,766,326
	6KA2OHIGH	$ 2,684,671	$ 9,898,668	$ 12,583,340
	30KA2OLOW	$ 7,663,145	$ 24,866,753	$ 32,529,898
	30KA2OMED	$ 7,742,603	$ 26,702,484	$ 34,445,087
	30KA2OHIGH	$ 9,188,759	$ 32,644,118	$ 41,832,877
	130KA2OLOW	$ 21,906,592	$ 58,182,600	$ 80,089,193
	130KA2OMED	$ 22,031,923	$ 65,054,564	$ 87,086,487
	130KA2OHIGH	$ 24,660,065	$ 93,388,373	$ 118,048,439

Table 4-38 Capital, operational and total unit costs based on secondary level treatment ($/m³)

TS	Scenarios	Capital Unit Cost ($/m³)	Operational Unit Cost ($/m³)	Total Unit Cost ($/m³)
TS_A	**6KCASLOW**	$ 0.022 /m³	$ 0.085 /m³	$ 0.107 /m³
	6KCASMED	$ 0.025 /m³	$ 0.093 /m³	$ 0.118 /m³
	6KCASLOW	$ 0.037 /m³	$ 0.116 /m³	$ 0.153 m³
	30KCASLOW	$ 0.013/m³	$ 0.047 /m³	$ 0.060 /m³
	30KCASMED	$ 0.014 /m³	$ 0.054 /m³	$ 0.067 /m³
	30KCASHIGH	$ 0.017 /m³	$ 0.073 /m³	$ 0.090 /m³
	130KCASLOW	$ 0.006 /m³	$ 0.029 /m³	$ 0.035 /m³
	130KCASMED	$ 0.006 /m³	$ 0.036 /m³	$ 0.041 /m³
	130KCASHIGH	$ 0.007 /m³	$ 0.055 /m³	$ 0.061 /m³
TS_B	**6KEXTLOW**	$ 0.021 /m³	$ 0.061 /m³	$ 0.082 /m³
	6KEXTMED	$ 0.022 /m³	$ 0.067 /m³	$ 0.089 /m³
	6KEXTHIGH	$ 0.022 /m³	$ 0.082 /m³	$ 0.104 /m³
	30KEXTLOW	$ 0.013 /m³	$ 0.037 /m³	$ 0.050 /m³
	30KEXTMED	$ 0.013 /m³	$ 0.042 /m³	$ 0.055 /m³
	30KEXTHIGH	$ 0.013 /m³	$ 0.057 /m³	$ 0.070 /m³
	130KEXTLOW	$ 0.007 /m³	$ 0.023 /m³	$ 0.030 /m³
	130KEXTMED	$ 0.007 /m³	$ 0.028 /m³	$ 0.035 /m³
	130KEXTHIGH	$ 0.008 /m³	$ 0.043 /m³	$ 0.050 /m³
TS_C	**6KA2OLOW**	$ 0.027 /m³	$ 0.101 /m³	$ 0.128 /m³
	6KA2OMED	$ 0.027 /m³	$ 0.106 /m³	$ 0.134 /m³
	6KA2OHIGH	$ 0.033 /m³	$ 0.123 /m³	$ 0.156 /m³
	30KA2OLOW	$ 0.019 /m³	$ 0.062 /m³	$ 0.081 /m³
	30KA2OMED	$ 0.019 /m³	$ 0.066 /m³	$ 0.086 /m³
	30KA2OHIGH	$ 0.023 /m³	$ 0.081 /m³	$ 0.104 /m³
	130KA2OLOW	$ 0.013 /m³	$ 0.033 /m³	$ 0.046 /m³
	130KA2OMED	$ 0.013 /m³	$ 0.037 /m³	$ 0.050 /m³
	130KA2OHIGH	$ 0.014 /m³	$ 0.054 /m³	$ 0.068 /m³

As can be seen from Figure 4-3, the treatment plans with a capacity of 130000 m³/day have lower treatment unit cost than for those with 6000 or 30000 m³/day. It seems feasible to build larger wastewater treatment plants rather than smaller ones. Other studies support the same results, that volume treated is directly proportional to cost-effectiveness (Kihila et al., 2014; Villar, 2018). It should be noted that, in this study, collection/ sewerage works were not included in the unit price of the wastewater treatment. For pilot-scale implementation, collection works should also be considered.

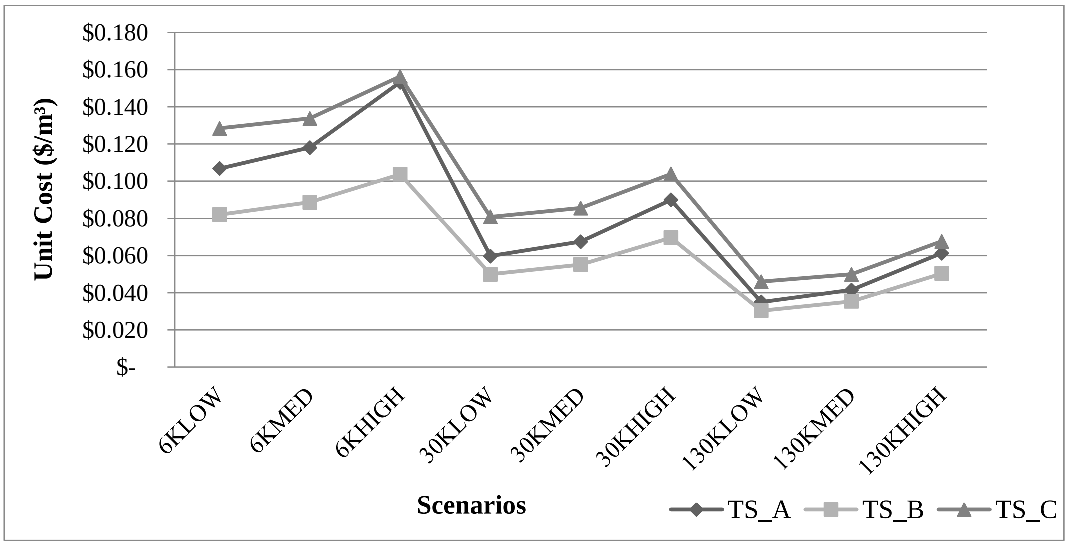

Figure 4-3 Unit costs of secondary treatment TS_A (CAS), TS_B (EXT) and TS_C (A2O) ($/m³)

When the effect of wastewater strength was examined, it is seen for all treatment scenarios that the high-strength wastewater had the highest cost (Table 4-34). It was an expected result because high-strength wastewater needs more aeration and chemical for the treatment, which were the main reasons for higher operating costs (Table 4-37). For the same capacity, as the strength of the wastewater increased, the unit cost of the treatment increased.

For the studied biological treatment systems (CAS/EXT/A2O), operational costs were mainly composed of energy costs (Wendland, 2005). Energy costs were highest in TS_B (EXT) systems because of high aeration requirements in large aeration tanks with high retention times. TS_A and TS_C systems followed TS_B with respect to energy requirements (Table 4-35). As expected, higher capacities resulted in higher percentages of energy costs (Table 4-36). The varying amounts of sludge production or the need for aeration can be the reason for not having a trend. Considering all scenarios, the percent of energy cost in operational costs changed from 25.9 to 55.0 %, which was reasonable; in literature, the energy cost percentages are reported to change between 15 and 53 % (Friedler & Pisanty, 2006; Wendland, 2005). In energy cost calculation, the unit price of energy in Turkey was used, which is $ 0.068/kWh. It was comparably lower than USA energy costs, $ 0.1089/kWh (Electric Power Monthly - U.S. Energy Information Administration (EIA), 2020). It was mentioned that energy costs could cover up to 53% of the operational costs. Then, unit energy costs have an enormous effect on treatment costs.

Chemical costs were proportional to the sludge costs due to the fact that chemicals were used for the conditioning of the produced sludge. The percent of chemical and sludge cost in operational costs changed by 1.7 to 14.7 % and 3.2 to 14.7 %, respectively. In previous parts, it was mentioned that the sludge production amount was the highest in TS_A scenarios and the lowest in TS_B scenarios. Thus, it was expected to see higher percentages of chemical costs and sludge costs in TS_A scenarios than TS_B scenarios. Similar results were obtained as in energy costs (Table 4-35). Higher capacity results in higher chemical and sludge costs. According to the study done by Wendland (2005), chemical costs and sludge costs had percentages of 5-7 % and 15-50 % in operational costs, respectively.

Salary percentages in operational costs were different from energy, chemical and sludge percentages; it decreased with the increased treatment plant capacity and wastewater strength (Table 4-35). Because other costs became significant in larger treatment plants, the salary cost percentage become smaller, other costs like energy and sludge had a more major percentage. Like in the total cost results, the highest percentage of salary costs was found at TS_C scenarios; the lowest one was TS_B scenarios (Table 4-36). The complexity of the treatment scheme influenced the number of staff and, in turn, totals salary. In a study, staff charges differed between 15 to 40 % of the operational costs with decreasing serving population (Wendland, 2005). In this study, the salary of the staff changed from 7.9 to 51.5 % of the operational costs. Similar to energy costs, the salary of the staff may differ in different countries. It is also supported by this thesis that salary costs in operational costs have a considerable percentage. Then, salary costs have an immense effect on treatment costs.

Maintenance costs were assumed to be 2 to 6% of the total cost (Wendland, 2005). Accordingly, total maintenance costs at scenarios were 6.1 to 21.9 % of the total cost (Table 4-36). These percentages become higher in lower capacity and lower strength wastewater treatment scenarios. In treatment schemes with high-strength wastewater and high capacity, there were other constituents such as energy cost being greater than maintenance cost.

TS_B was found to have lower unit treatment cost (\$ 0.104 /m^3 - \$ 0.030 /m^3) than TS_A (\$ 0.153 /m^3 - \$ 0.035 /m^3) and TS_C (\$ 0.156 /m^3 - \$ 0.056 /m^3) (Table 4-38). Although TS_B had the largest tanks, because of the other capital costs and then operational costs, the 30 year cost for the treatment was the lowest. TS_A and TS_C scenarios followed TS_B. TS_C scenarios had the highest cost because of the complexity of the system. This result was also supported by other researches (Jafarinejad, 2017). Given all the information, one can select the best treatment scenario depending on the discharge quality and budget required as given in Figure 4-3.

Total unit cost for secondary level treatment was also calculated for a different case where the inflation rate was taken as 9.86 % which is the average value for inflation rate in Turkey between years 2005 and 2009 (TCMB, 2020). It was observed in Table 4-39 that there was no obvious change in capital unit costs. On the other hand, drastic decrease in operational unit costs was noticed. Inflation rate had more effect on operational costs because these costs were appeared for 30 years period of operational period. When total unit costs were examined, the difference in operational costs affects the total unit cost with decreasing involvement. Therefore, it was observed that increasing inflation rate changed the total unit treatment costs with approximately half of its base scenario where inflation rate is 2.08 %.

Table 4-39 Total unit costs for different inflation rates

CASE 1 : BASE SCENARIO				CASE 2 : WORST CASE SCENARIO			
USA inflation rate: 2.08 %				TR inflation rate: 9.86 %			
Scenarios	**Capital Unit Cost ($/m³)**	**Operational Unit Cost ($/m³)**	**Total Unit Cost ($/m³)**	**Scenarios**	**Capital Unit Cost ($/m³)**	**Operational Unit Cost ($/m³)**	**Total Unit Cost ($/m³)**
6KCASLOW	$ 0.022	$ 0.085	$ 0.107	**6KCASLOW**	$ 0.015	$ 0.031	$ 0.046
6KCASMED	$ 0.025	$ 0.093	$ 0.118	**6KCASMED**	$ 0.018	$ 0.034	$ 0.051
6KCASHIGH	$ 0.037	$ 0.116	$ 0.153	**6KCASHIGH**	$ 0.025	$ 0.042	$ 0.067
30KCASLOW	$ 0.013	$ 0.047	$ 0.060	**30KCASLOW**	$ 0.009	$ 0.017	$ 0.026
30KCASMED	$ 0.014	$ 0.054	$ 0.067	**30KCASMED**	$ 0.010	$ 0.019	$ 0.029
30KCASHIGH	$ 0.017	$ 0.073	$ 0.090	**30KCASHIGH**	$ 0.012	$ 0.026	$ 0.038
130KCASLOW	$ 0.006	$ 0.029	$ 0.035	**130KCASLOW**	$ 0.004	$ 0.010	$ 0.015
130KCASMED	$ 0.006	$ 0.036	$ 0.041	**130KCASMED**	$ 0.004	$ 0.013	$ 0.017
130KCASHIGH	$ 0.007	$ 0.055	$ 0.061	**130KCASHIGH**	$ 0.005	$ 0.019	$ 0.024
6KEXTLOW	$ 0.021	$ 0.061	$ 0.082	**6KEXTLOW**	$ 0.015	$ 0.022	$ 0.037
6KEXTMED	$ 0.022	$ 0.067	$ 0.089	**6KEXTMED**	$ 0.016	$ 0.024	$ 0.040
6KEXTHIGH	$ 0.022	$ 0.082	$ 0.104	**6KEXTHIGH**	$ 0.016	$ 0.029	$ 0.045
30KEXTLOW	$ 0.013	$ 0.037	$ 0.050	**30KEXTLOW**	$ 0.009	$ 0.013	$ 0.023
30KEXTMED	$ 0.013	$ 0.042	$ 0.055	**30KEXTMED**	$ 0.010	$ 0.015	$ 0.025
30KEXTHIGH	$ 0.013	$ 0.057	$ 0.070	**30KEXTHIGH**	$ 0.010	$ 0.020	$ 0.030
130KEXTLOW	$ 0.007	$ 0.023	$ 0.030	**130KEXTLOW**	$ 0.006	$ 0.008	$ 0.014
130KEXTMED	$ 0.007	$ 0.028	$ 0.035	**130KEXTMED**	$ 0.006	$ 0.010	$ 0.016
130KEXTHIGH	$ 0.008	$ 0.043	$ 0.050	**130KEXTHIGH**	$ 0.006	$ 0.015	$ 0.021
6KA2OLOW	$ 0.027	$ 0.101	$ 0.128	**6KA2OLOW**	$ 0.019	$ 0.037	$ 0.056
6KA2OMED	$ 0.027	$ 0.106	$ 0.134	**6KA2OMED**	$ 0.019	$ 0.039	$ 0.058
6KA2OHIGH	$ 0.033	$ 0.123	$ 0.156	**6KA2OHIGH**	$ 0.023	$ 0.045	$ 0.068
30KA2OLOW	$ 0.019	$ 0.062	$ 0.081	**30KA2OLOW**	$ 0.014	$ 0.022	$ 0.037
30KA2OMED	$ 0.019	$ 0.066	$ 0.086	**30KA2OMED**	$ 0.019	$ 0.066	$ 0.086
30KA2OHIGH	$ 0.023	$ 0.081	$ 0.104	**30KA2OHIGH**	$ 0.017	$ 0.029	$ 0.046
130KA2OLOW	$ 0.013	$ 0.033	$ 0.046	**130KA2OLOW**	$ 0.010	$ 0.012	$ 0.022
130KA2OMED	$ 0.013	$ 0.037	$ 0.050	**130KA2OMED**	$ 0.010	$ 0.013	$ 0.023
130KA2OHIGH	$ 0.014	$ 0.054	$ 0.068	**130KA2OHIGH**	$ 0.011	$ 0.019	$ 0.030

Referring to the approved projects by the State of Hydraulic Works and Bank of Provinces the relation between capital costs and mechanical costs were determined. Accordingly, 16% of the mechanical costs were taken as piping cost, while 20% of the mechanical costs were taken as electrical and sanitary costs. On the other hand, the sensitivity of these assumptions was investigated for total and unit treatment costs. For this reason, another cost analysis was performed with ± 5% change in these (accepted) percentages. Case 1 was accepted as the base case, where 16 % of the mechanical costs were taken as piping cost and 20 % of the mechanical costs were accepted as electrical and sanitary costs. For Case 2, 11 % of the mechanical costs were taken as piping cost, while 15 % of the mechanical costs were taken as electrical and sanitary costs. Moreover, for Case 3, 21 % of the mechanical costs were accepted as piping cost, while 25 % of the mechanical costs were taken as electrical and sanitary costs. The results are shown in Appendix J. It was observed that there was no radical change between Case 1, Case 2 and Case 3 when unit treatment costs were examined. The unit cost difference was calculated as $ 0.001/m^3 at most for every case when the assumed percentages were either increased or decreased. It could be concluded that assumed costs, which were piping, electrical and sanitary costs, did not have an immense effect on total and unit treatment costs. The reason for this was that the unit costs were mostly affected by operational costs.

4.3.2 Cost Analysis based on Tertiary/ Advanced Treatment Level

In this section, capital and operational costs were evaluated for tertiary/ advanced treatment units. Different from cost analysis employed for secondary treatment level, in this section, for tertiary and advanced level treatment technologies, limited offers could be obtained. The design capacities of the technologies are as follows,

- Chlorination (Cl) : 5000 m^3/day
- Ultraviolet Disinfection (UV): 72000 m^3/day
- Pressurized Sand Filter (PSF): 8000 m^3/day

- Rapid Sand Filter (RSF): 69600 m^3/day
- Micro Disc Filter (MDF): 10000 m^3/day
- Reverse Osmosis (RO): 24720 m^3/day

The following costs were obtained from special firms for the full package of related technologies. To find the wastewater treatment unit costs for tertiary/ advanced treatment for each technology above, mentioned flowrates were considered; in the end, the unit cost of tertiary/ advanced treatment level technologies was found.

4.3.2.1 Capital Costs

For advanced and tertiary treatment levels, capital costs were considered on a capacity basis.

4.3.2.1.1 Reinforcement/ Civil Work Costs

For reinforcement/ civil work costs of advanced and tertiary treatment level, building reinforcement/ civil work costs were included by assuming these technologies would be placed in separate buildings.

By referring to the confirmed projects of the General Directorate of State Hydraulic Works, civil works costs for tertiary/ advanced treatment were as follows,

- Chlorination building: $94,161.96 (500,000.00 TL)
- UV structure: $24,482.11 (130,000.00 TL)
- PSF building, $56,497.18 (300,000.00 TL)
- RSF building, $696,798.49 (3,700,000.00 TL)
- MDF structure: $24,482.11 (130,000.00 TL)
- RO building: $56,497.18 (300,000.00 TL)

4.3.2.1.2 Mechanical Work Costs

Chlorination

Chlorination requires mechanical equipment such as booster pumps, chlorinator and aspirators. “Others” include small-diameter pumps, valves and pipes. Related equipment names, numbers and costs can be seen in Table 4-40.

Table 4-40 Mechanical cost – Chlorination

Q = 5000 m³/day	**Chlorination**					
	Equipment			**Installed Power**	**Cost per piece**	**Total Cost**
Equipment Name	kW	prime	backup	kw	$	$
Booster Pumps-1	1.50	2	1	4.50	$ 468.43	$ 1,405.30
Booster Pumps-2	1.50	2	1	4.50	$ 921.25	$ 2,763.75
Chlorinator	1.50	4	0	6.00	$ 4,931.51	$ 19,726.05
Crane	5.50	1	0	5.50	$ 2,220.37	$ 2,220.37
Aspirator -1	0.00	1	0	0.00	$ 377.09	$ 377.09
Aspirator -2	0.00	1	0	0.00	$ 377.09	$ 377.09
Chlorine Sensor	0.00	2	0	0.00	$ 3,122.88	$ 6,245.76
Sprinkler System	0.00	1	0	0.00	$ 13,607.96	$ 13,607.96
Others	0	1	0	0.00	$ 75,898.95	$ 75,898.95
					TOTAL	**$ 122,622**

Ultraviolet Disinfection (UV)

UV disinfection offers mechanical equipment such as UV lamps, clamping modules, control cabinet, sensors. Offers from individual firms include all the equipment needed for a UV disinfection unit. The offer was taken as 341,500.00 €.

Pressurized Sand Filter (PSF)

Pressurized sand filter includes mechanical equipment such as feed pumps, filters, blowers. “Others” included small diameter pumps, valves and pipes. Related equipment names, numbers and costs can be seen in Table 4-41.

Table 4-41 Mechanical cost – PSF

Q = 8000 m³/day	Pressurized Sand Filter					
	Equipment			Installed Power	Cost per piece	Total Cost
Equipment Name	kW	prime	backup	kw	$	$
Feed Pump	5.50	4	1	27.50	$ 22,571.05	$ 112,855.25
Backwash Pumps	5.50	4	1	27.50	$ 22,571.05	$ 112,855.25
Discharge Pump	1.50	1	0	1.50	$ 457.64	$ 457.64
Blower	7.50	3	0	22.50	$ 4,864.88	$ 14,594.64
Filter	0.00	3	0	0.00	$ 22,144.07	$ 66,432.20
Crane	1.50	1	0	1.50	$ 5,642.42	$ 5,642.42
Others	0.00	1	0	0.00	$ 35,355.83	$ 35,355.83
					TOTAL	**$ 348,193**

Rapid Sand Filter (RSF)

Rapid sand filter (RSF) includes mechanical equipment such as feed pumps, filters, blowers. “Others” include small-diameter pumps, valves and pipes. Related equipment names, numbers and costs can be seen in Table 4-42.

Table 4-42 Mechanical cost - RSF

Q = 69600 m³/day	Rapid Sand Filter					
	Equipment			Installed Power	Cost per piece	Total Cost
Equipment Name	kW	prime	backup	kw	$	$
Rapid Sand Filter Building						
Feed Pump	75.00	2	1	225.00	$ 40,020.97	$ 120,062.92
Backwash Pumps -1	75.00	2	1	225.00	$ 56,175.17	$ 168,525.51
Blower	75.00	2	1	225.00	$ 18,809.11	$ 56,427.34
Lift Gate	0.75	12	0	9.00	$ 1,500.13	$ 18,001.50
Crane	5.50	1	0	5.50	$ 10,870.62	$ 10,870.62
Monorail	0.55	1	0	0.55	$ 2,190.42	$ 2,190.42
Others	0.00	1	0	0.00	$ 261,202.05	$ 261,202.05
Backwash System						
Backwash Pumps -2	4.00	2	0	8.00	$ 1,709.78	$ 3,419.56
Sludge Pumps	1.50	2	0	3.00	$ 1,500.15	$ 3,000.31
Lift Gate	1.50	2	0	3.00	$ 1,793.00	$ 3,586.00
Jib Crane	1.50	2	0	3.00	$ 1,042.25	$ 2,084.50
Others	0.00	1	0	0.00	$ 9,519.66	$ 9,519.66
					TOTAL	**$ 658,890**

Micro Disc Filter (MDF)

Micro disc filter offers mechanical equipment such as MDF, backwash pumps, control cabinet, sensors. Offers from individual firms include all equipment needed for the MDF unit. The offer was taken as 530,000.00 €.

Reverse Osmosis (RO)

Reverse osmosis offers include mechanical equipment such as RO, backwash pumps, control cabinet, sensors. Offers from individual firms include all equipment needed for the RO unit. The offer was taken as $ 172,500.00.

4.3.2.1.3 Electrical Costs

Different from calculations done for secondary treatment, 3 % of the mechanical cost was accepted as the electrical costs of tertiary/ advanced wastewater treatment units. This information was obtained via personal communication with firms.

4.3.2.1.4 Replacement Costs

Replacement costs were calculated for Year 10 and Year 20. As mentioned before, the lifetime of the facility was assumed as 30 years. Replacement time for civil work was 30 years; replacement percent was 30%. On the other hand, the lifetime of the equipment of electrical works was 10 years and the replacement percent was 40%.

Chlorination

For chlorination, the lifetime of the mechanical equipment was 10 years and replacement percent was 60%. Summary table for “Chlorination” replacement costs are given in Table 4-43.

Table 4-43 Replacement costs – Chlorination

Construction Items	Capital Cost ($)	Unknown (Capital Cost x 0.15)	Capital Cost ($)	YEAR 10	YEAR 20
Construction	$ 94,162	$ 14,124	$ 108,286	$ -	$ -
Mechanical	$ 122,622	$ 18,393	$ 141,016	$ 84,609	$ 84,609
Electrical	$ 3,679	$ 552	$ 4,230	$ 1,692	$ 1,692
TOTAL	**$ 220,463**	**$ 33,069**	**$ 253,532**	**$ 86,302**	**$ 86,302**

Ultraviolet Disinfection (UV)

For ultraviolet disinfection, the lifetime of the mechanical equipment was 10 years and replacement percent was 100%. Summary table for “UV Disinfection” replacement costs are given in Table 4-44.

Table 4-44 Replacement costs - UV Disinfection

Construction Items	Capital Cost ($)	Unknown (Capital Cost x 0.15)	Capital Cost ($)	YEAR 10	YEAR 20
Construction	$ 24,482	$ 3,672	$ 28,154	$ -	$ -
Mechanical	$ 387,805	$ 58,171	$ 445,976	$ 445,976	$ 445,976
Electrical	$ 11,634	$ 1,745	$ 13,379	$ 5,352	$ 5,352
TOTAL	**$ 423,921**	**$ 63,588**	**$ 487,510**	**$ 451,328**	**$ 451,328**

Pressurized Sand Filter (PSF)

For the pressurized sand filter, the lifetime of the mechanical equipment was 10 years and the replacement percent was 60%. Summary table for “Pressurized Sand Filter” replacement costs are given in Table 4-45.

Table 4-45 Replacement costs - PSF

Construction Items	Capital Cost ($)	Unknown (Capital Cost x 0.15)	Capital Cost ($)	YEAR 10	YEAR 20
Construction	$ 56,497	$ 8,475	$ 64,972	$ -	$ -
Mechanical	$ 348,193	$ 52,229	$ 400,422	$ -	$ 240,253
Electrical	$ 10,446	$ 1,567	$ 12,013	$ 4,805	$ 4,805
TOTAL	**$ 415,136**	**$ 62,270**	**$ 477,407**	**$ 4,805**	**$ 245,058**

Rapid Sand Filter (RSF)

For rapid sand filter, the lifetime of the mechanical equipment was 10 years and the replacement percent was 60%. Summary table for "Rapid Sand Filter" replacement costs are given in Table 4-46.

Table 4-46 Replacement costs - RSF

Construction Items	Capital Cost ($)	Unknown (Capital Cost x 0.15)	Capital Cost ($)	YEAR 10	YEAR 20
Construction	$ 696,798	$ 104,520	$ 801,318	$ -	$ -
Mechanical	$ 668,259	$ 100,239	$ 768,498	$ -	$ 461,099
Electrical	$ 20,048	$ 3,007	$ 23,055	$ 9,222	$ 9,222
TOTAL	**$ 1,405,153**	**$ 210,773**	**$ 1,615,926**	**$ 9,222**	**$ 470,321**

Micro Disc Filter (MDF)

For micro disc filter, the lifetime of the mechanical equipment was 5 years and the replacement percent was 100%. The summary table for "MDF" replacement costs is given in Table 4-47.

Table 4-47 Replacement costs - MDF

Construction Items	Capital Cost ($)	Unknown (Capital Cost x 0.15)	Capital Cost ($)	YEAR 5	YEAR 10	YEAR 15
Construction	$ 24,482	$ 3,672	$ 28,154	$ -	$ -	$ -
Mechanical	$ 601,864	$ 90,280	$ 692,144	$ 692,144	$ 692,144	$ 692,144
Electrical	$ 120,373	$ 18,056	$ 138,429	$ -	$ 55,372	$ -
TOTAL	**$ 746,719**	**$ 112,008**	**$ 858,727**	**$ 692,144**	**$ 747,516**	**$ 692,144**

Construction Items	Capital Cost ($)	Unknown (Capital Cost x 0.15)	Capital Cost ($)	YEAR 20	YEAR 25
Construction	$ 24,482	$ 3,672	$ 28,154	$ -	$ -
Mechanical	$ 601,864	$ 90,280	$ 692,144	$ 692,144	$ 692,144
Electrical	$ 120,373	$ 18,056	$ 138,429	$ 55,372	$ -
TOTAL	**$ 746,719**	**$ 112,008**	**$ 858,727**	**$ 747,516**	**$ 692,144**

Reverse Osmosis (RO)

For reverse osmosis, the lifetime of the mechanical equipment was 5 years and replacement percent was 100. The summary table for "RO" replacement costs is given in Table 4-48.

Table 4-48 Replacement costs - RO

Construction Items	Capital Cost ($)	Unknown (Capital Cost x 0.15)	Capital Cost ($)	YEAR 5	YEAR 10	YEAR 15
Construction	$ 56,497	$ 8,475	$ 64,972	$ -	$ -	$ -
Mechanical	$ 172,500	$ 25,875	$ 198,375	$ 198,375	$ 198,375	$ 198,375
Electrical	$ 5,175	$ 776	$ 5,951	$ -	$ 2,381	$ -
TOTAL	**$ 234,172**	**$ 35,126**	**$ 269,298**	**$ 198,375**	**$ 200,756**	**$ 198,375**
Construction Items	**Capital Cost ($)**	**Unknown (Capital Cost x 0.15)**	**Capital Cost ($)**	**YEAR 20**	**YEAR 25**	
Construction	$ 56,497	$ 8,475	$ 64,972	$ -	$ -	
Mechanical	$ 172,500	$ 25,875	$ 198,375	$ 198,375	$ 198,375	
Electrical	$ 5,175	$ 776	$ 5,951	$ 2,381	$ -	
TOTAL	**$ 234,172**	**$ 35,126**	**$ 269,298**	**$ 200,756**	**$ 198,375**	

4.3.2.2 Operational Costs

For tertiary/ advanced treatment units, operational cost covered only the maintenance cost and energy cost. Because selected tertiary/ advanced treatment units except CL, MDF and RO, do not need chemical to operate, chemical costs were not included. For the case of chlorination, because the dosage amount varied with site-specific conditions, the chlorine amount is not included in operational cost. In MDF and RO technologies, chemicals used for cleaning purposes, but the frequency and cost of the cleaning agents were low, chemical costs for MDF and RO were not included.

4.3.2.2.1 Maintenance Cost

For chlorination, UV disinfection, pressurized sand filter and rapid sand filter, the maintenance cost was selected as 3.0 % of the capital cost for civil, mechanical and electrical/sanitary costs. Summary tables are given in Table 4-49, Table 4-50, Table 4-51 and Table 4-52, respectively.

Table 4-49 Maintenance cost calculation – Chlorination

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 56,498	2.0-4.0	3	$ 1,695
Mechanical	$ 348,93	2.0-6.0	3	$ 10,446
Electrical-Sanitary	$ 10,445	2.0-6.0	3	$ 313
			TOTAL	**$ 6,486**

Table 4-50 Maintenance cost calculation – UV Disinfection

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 24,482	2.0-4.0	3	$ 734
Mechanical	$ 387,805	2.0-6.0	3	$ 11,634
Electrical-Sanitary	$ 11,634	2.0-6.0	3	$ 349
			TOTAL	**$ 12,717**

Table 4-51 Maintenance cost calculation - PSF

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 56,497	2.0-4.0	3	$ 1,695
Mechanical	$ 348,193	2.0-6.0	3	$ 10,446
Electrical-Sanitary	$ 10,446	2.0-6.0	3	$ 313
			TOTAL	**$ 12,454**

Table 4-52 Maintenance cost calculation - RSF

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 696,799	2.0-4.0	3	$ 20,904
Mechanical	$ 668,259	2.0-6.0	3	$ 20,048
Electrical-Sanitary	$ 20,048	2.0-6.0	3	$ 601
			TOTAL	**$ 42,154**

For MDF, the maintenance cost was selected as 3.0 % for civil, electrical/sanitary and piping works, whereas 5.0 % of the capital cost was assumed as mechanical costs. The summary table for “MDF” maintenance costs is given in Table 4-53.

Table 4-53 Maintenance cost calculation - MDF

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 24,482	2.0-4.0	3	$ 734
Mechanical	$ 601,864	2.0-6.0	5	$ 30,093
Electrical-Sanitary	$ 120,373	2.0-6.0	3	$ 3,611
			TOTAL	**$ 34,438**

The maintenance costs of RO were selected as 3.0 % for civil, electrical/sanitary and piping works, whereas 6.0 % of the capital cost was assumed as mechanical costs. The summary table for "RO" maintenance costs is given in Table 4-54.

Table 4-54 Maintenance cost calculation - RO

Construction Items	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 56,497	2.0-4.0	3	$ 1,695
Mechanical	$ 172,500	2.0-6.0	6	$ 10,350
Electrical-Sanitary	$ 5,175	2.0-6.0	3	$ 155
			TOTAL	**$ 12,200**

4.3.2.2.2 Energy Cost

Chlorination

In chlorine disinfection, it was assumed that the equipment used in the technology, whose power is 15 kW worked 8 hours in a day. Then, the 1st year electrical cost was calculated as $ 2,978.

Ultraviolet Disinfection (UV)

In UV disinfection, it was assumed that equipment used in the technology, whose power is 77 kW, worked 12 hours in a day. Then, the 1st year electrical cost was calculated as $ 15,289.

Pressure Sand Filter (PSF)

In PSF, it was assumed that equipment used in the technology, whose power is 100 kW, worked 8 hours in a day. Then, the 1st year electrical cost was calculated as $ 29,784.

Rapid Sand Filter (RSF)

In RSF, it was assumed that equipment used in the technology, whose power is 500 kW, worked 8 hours in a day. Then, the 1st year electrical cost was calculated as $ 99,280.

Micro Disc Filter (MDF)

In MDF, it was assumed that equipment used in the technology, whose power is 25 kW, worked 8 hours in a day. Then, the 1st year electrical cost was calculated as $ 4,964.00.

Reverse Osmosis (RO)

In RO, it was assumed that equipment used in the technology, whose power is 300 kW, worked 8 hours in a day. Then, the 1st year electrical cost was calculated as $ 59,568.

4.3.2.3 Present Value Calculation of Tertiary/ Advanced Treatment Level

In the present value calculation of the tertiary/ advanced treatment, capital costs and operational costs were included together in the analysis.

It was assumed that civil works and piping lasted for two years, whereas mechanical and electrical-sanitary works were completed at 2nd year. 1st and 2nd year capital costs of CL, UV, PSF, RSF, MDF and RO are calculated in Table 4-55, Table 4-56, Table 4-57, Table 4-58, Table 4-59 and Table 4-60.

Table 4-55 1st and 2nd-year capital costs – Chlorination

Construction Items	Capital Cost ($)	Years	
		1st Year	2nd Year
Construction	$ 94,162	$ 47,081	$ 47,081
Mechanical	$ 122,622	$ -	$ 122,622
Electrical	$ 3,679	$ -	$ 3,679
	$ 220,463	**$ 47,081**	**$ 173,382**

Table 4-56 1st and 2nd-year capital costs – UV Disinfection

Construction Items	Capital Cost ($)	Years	
		1st Year	2nd Year
Construction	$ 24,482	$ 12,241	$ 12,241
Mechanical	$ 387,805	$ -	$ 387,805
Electrical	$ 11,634	$ -	$ 11,634
	$ 423,921	**$ 12,241**	**$ 411,680**

Table 4-57 1st and 2nd-year capital costs - PSF

Construction Items	Capital Cost ($)	Years	
		1st Year	2nd Year
Construction	$ 56,497	$ 28,249	$ 28,249
Mechanical	$ 348,193	$ -	$ 348,193
Electrical	$ 10,446	$ -	$ 10,446
	$ 415,136	**$ 28,249**	**$ 386,888**

Table 4-58 1st and 2nd-year capital costs - RSF

Construction Items	Capital Cost ($)	Years	
		1st Year	2nd Year
Construction	$ 696,798	$ 348,399	$ 348,399
Mechanical	$ 668,259	$ -	$ 668,259
Electrical	$ 20,048	$ -	$ 20,048
	$ 1,405,153	**$ 358,423**	**$ 1,046,730**

Table 4-59 1st and 2nd-year capital costs - MDF

Construction Items	**Capital Cost ($)**	**Years**	
		1st Year	**2nd Year**
Construction	$ 24,482	$ 12,241	$ 12,241
Mechanical	$ 601,864	$ -	$ 601,864
Electrical	$ 120,373	$ -	$ 120,373
	$ 746,719	**$ 12,241**	**$ 734,478**

Table 4-60 1st and 2nd-year capital costs - RO

Construction Items	**Capital Cost ($)**	**Years**	
		1st Year	**2nd Year**
Construction	$ 56,497	$ 28,249	$ 28,249
Mechanical	$ 172,500	$ -	$ 172,500
Electrical	$ 5,175	$ -	$ 5,175
	$ 234,172	**$ 28,249**	**$ 205,924**

Operational costs were evaluated in two parts. Operational Costs 1 (OC1) includes energy, chemical and sludge costs, which increased with the population growth. Operational Costs 2 (OC2) includes salary and maintenance cost, where no increase by population growth was assumed. The summation of OC1 and OC2 was evaluated as total operational cost for selected technology.

Operational costs were calculated in Table 4-61, Table 4-62, Table 4-63, Table 4-64, Table 4-65 and Table 4-66 for tertiary/ advanced treatment level.

Table 4-61 Operational cost – Chlorination

YEAR	Population Growth Constant	Energy Cost ($/year)	1/(1+i)^n	Operational Cost 1 ($/year)
2019			1.000	
2020			0.980	
2021			0.960	
2022	1.0000	$2,978.40	0.940	$ 2,799.68
2023	1.0136	$3,019.00	0.921	$ 2,779.90
2024	1.0274	$3,101.85	0.902	$ 2,797.89
2025	1.0414	$3,230.43	0.884	$ 2,854.37
2026	1.0556	$3,410.18	0.866	$ 2,951.69
2027	1.0700	$3,649.01	0.848	$ 3,093.92
2028	1.0846	$3,957.78	0.831	$ 3,287.21
2029	1.0994	$4,351.19	0.814	$ 3,540.19
2030	1.1144	$4,848.90	0.797	$ 3,864.59
2031	1.1296	$5,477.20	0.781	$ 4,276.22
2032	1.1450	$6,271.24	0.765	$ 4,796.20
2033	1.1606	$7,278.25	0.749	$ 5,452.71
2034	1.1764	$8,562.11	0.734	$ 6,283.59
2035	1.1924	$10,209.71	0.719	$ 7,339.78
2036	1.2087	$12,340.30	0.704	$ 8,690.35
2037	1.2252	$15,118.81	0.690	$ 10,429.67
2038	1.2419	$18,775.39	0.676	$ 12,687.73
2039	1.2588	$23,634.14	0.662	$ 15,645.03
2040	1.2759	$30,155.74	0.648	$ 19,554.58
2041	1.2933	$39,001.35	0.635	$ 24,774.22
2042	1.3110	$51,129.17	0.622	$ 31,814.92
2043	1.3288	$67,941.84	0.610	$ 41,413.44
2044	1.3469	$91,513.53	0.597	$ 54,642.58
2045	1.3653	$124,943.25	0.585	$ 73,080.33
2046	1.3839	$172,909.85	0.573	$ 99,071.62
2047	1.4028	$242,552.71	0.561	$ 136,137.41
2048	1.4219	$344,883.15	0.550	$ 189,620.44
2049	1.4413	$497,069.69	0.539	$ 267,714.74
2050	1.4609	$726,176.25	0.528	$ 383,123.58
2051	1.4808	$1,075,341.12	0.517	$ 555,756.99
			TOTAL	**$ 1,980,275.57**

YEAR	Maintanance Cost ($/year)	1/(1+i)^n	Operational Cost 2 ($/year)
2019		1.000	
2020		0.980	
2021		0.960	
2022	$ 6,486.00	0.940	$ 6,096.81
2023	$ 6,486.00	0.921	$ 5,972.34
2024	$ 6,486.00	0.902	$ 5,850.41
2025	$ 6,486.00	0.884	$ 5,730.97
2026	$ 6,486.00	0.866	$ 5,613.97
2027	$ 6,486.00	0.848	$ 5,499.35
2028	$ 6,486.00	0.831	$ 5,387.08
2029	$ 6,486.00	0.814	$ 5,277.10
2030	$ 6,486.00	0.797	$ 5,169.36
2031	$ 6,486.00	0.781	$ 5,063.83
2032	$ 6,486.00	0.765	$ 4,960.45
2033	$ 6,486.00	0.749	$ 4,859.18
2034	$ 6,486.00	0.734	$ 4,759.97
2035	$ 6,486.00	0.719	$ 4,662.79
2036	$ 6,486.00	0.704	$ 4,567.60
2037	$ 6,486.00	0.690	$ 4,474.35
2038	$ 6,486.00	0.676	$ 4,383.00
2039	$ 6,486.00	0.662	$ 4,293.52
2040	$ 6,486.00	0.648	$ 4,205.87
2041	$ 6,486.00	0.635	$ 4,120.00
2042	$ 6,486.00	0.622	$ 4,035.89
2043	$ 6,486.00	0.610	$ 3,953.49
2044	$ 6,486.00	0.597	$ 3,872.78
2045	$ 6,486.00	0.585	$ 3,793.71
2046	$ 6,486.00	0.573	$ 3,716.26
2047	$ 6,486.00	0.561	$ 3,640.39
2048	$ 6,486.00	0.550	$ 3,566.07
2049	$ 6,486.00	0.539	$ 3,493.27
2050	$ 6,486.00	0.528	$ 3,421.95
2051	$ 6,486.00	0.517	$ 3,352.09
		TOTAL	**$ 137,793.85**

Table 4-62 Operational cost - UV Disinfection

YEAR	Population Growth Constant	Energy Cost ($/year)	1/(1+i)^n	Operational Cost 1 ($/year)
2019			1.000	
2020			0.980	
2021			0.960	
2022	1.0000	$15,289.12	0.940	$ 14,371.69
2023	1.0136	$15,497.51	0.921	$ 14,270.17
2024	1.0274	$15,922.85	0.902	$ 14,362.50
2025	1.0414	$16,582.85	0.884	$ 14,652.45
2026	1.0556	$17,505.60	0.866	$ 15,152.00
2027	1.0700	$18,731.58	0.848	$ 15,882.14
2028	1.0846	$20,316.60	0.831	$ 16,874.37
2029	1.0994	$22,336.10	0.814	$ 18,172.96
2030	1.1144	$24,891.03	0.797	$ 19,838.24
2031	1.1296	$28,116.29	0.781	$ 21,951.29
2032	1.1450	$32,192.34	0.765	$ 24,620.47
2033	1.1606	$37,361.69	0.749	$ 27,990.60
2034	1.1764	$43,952.14	0.734	$ 32,255.78
2035	1.1924	$52,409.86	0.719	$ 37,677.52
2036	1.2087	$63,346.90	0.704	$ 44,610.44
2037	1.2252	$77,609.91	0.690	$ 53,538.99
2038	1.2419	$96,380.34	0.676	$ 65,130.33
2039	1.2588	$121,321.90	0.662	$ 80,311.16
2040	1.2759	$154,799.45	0.648	$ 100,380.17
2041	1.2933	$200,206.91	0.635	$ 127,174.32
2042	1.3110	$262,463.06	0.622	$ 163,316.61
2043	1.3288	$348,768.10	0.610	$ 212,588.99
2044	1.3469	$469,769.46	0.597	$ 280,498.55
2045	1.3653	$641,375.35	0.585	$ 375,145.67
2046	1.3839	$887,603.90	0.573	$ 508,567.63
2047	1.4028	$1,245,103.90	0.561	$ 698,838.68
2048	1.4219	$1,770,400.17	0.550	$ 973,384.93
2049	1.4413	$2,551,624.40	0.539	$ 1,374,269.02
2050	1.4609	$3,727,704.74	0.528	$ 1,966,701.05
2051	1.4808	$5,520,084.44	0.517	$ 2,852,885.87
			TOTAL	**$ 10,165,414.59**

Maintanance Cost ($/year)	1/(1+i)^n	Operational Cost 2 ($/year)
	1.000	
	0.980	
	0.960	
$ 12,717.00	0.940	$ 11,953.92
$ 12,717.00	0.921	$ 11,709.87
$ 12,717.00	0.902	$ 11,470.80
$ 12,717.00	0.884	$ 11,236.62
$ 12,717.00	0.866	$ 11,007.22
$ 12,717.00	0.848	$ 10,782.50
$ 12,717.00	0.831	$ 10,562.37
$ 12,717.00	0.814	$ 10,346.73
$ 12,717.00	0.797	$ 10,135.49
$ 12,717.00	0.781	$ 9,928.57
$ 12,717.00	0.765	$ 9,725.87
$ 12,717.00	0.749	$ 9,527.31
$ 12,717.00	0.734	$ 9,332.80
$ 12,717.00	0.719	$ 9,142.27
$ 12,717.00	0.704	$ 8,955.62
$ 12,717.00	0.690	$ 8,772.79
$ 12,717.00	0.676	$ 8,593.69
$ 12,717.00	0.662	$ 8,418.24
$ 12,717.00	0.648	$ 8,246.38
$ 12,717.00	0.635	$ 8,078.02
$ 12,717.00	0.622	$ 7,913.10
$ 12,717.00	0.610	$ 7,751.55
$ 12,717.00	0.597	$ 7,593.30
$ 12,717.00	0.585	$ 7,438.28
$ 12,717.00	0.573	$ 7,286.42
$ 12,717.00	0.561	$ 7,137.66
$ 12,717.00	0.550	$ 6,991.94
$ 12,717.00	0.539	$ 6,849.20
$ 12,717.00	0.528	$ 6,709.37
$ 12,717.00	0.517	$ 6,572.39
	TOTAL	**$ 270,170.28**

Table 4-63 Operational cost - PSF

YEAR	Population Growth Constant	Energy Cost ($/year)	1/(1+i)^n	Operational Cost 1 ($/year)
2019			1.000	
2020			0.980	
2021			0.960	
2022	1.0000	$19,856.00	0.940	$ 18,664.54
2023	1.0136	$20,126.64	0.921	$ 18,532.69
2024	1.0274	$20,679.03	0.902	$ 18,652.60
2025	1.0414	$21,536.17	0.884	$ 19,029.15
2026	1.0556	$22,734.55	0.866	$ 19,677.92
2027	1.0700	$24,326.72	0.848	$ 20,626.15
2028	1.0846	$26,385.20	0.831	$ 21,914.77
2029	1.0994	$29,007.92	0.814	$ 23,601.24
2030	1.1144	$32,326.01	0.797	$ 25,763.94
2031	1.1296	$36,514.66	0.781	$ 28,508.17
2032	1.1450	$41,808.23	0.765	$ 31,974.64
2033	1.1606	$48,521.68	0.749	$ 36,351.43
2034	1.1764	$57,080.70	0.734	$ 41,890.62
2035	1.1924	$68,064.75	0.719	$ 48,931.84
2036	1.2087	$82,268.70	0.704	$ 57,935.64
2037	1.2252	$100,792.09	0.690	$ 69,531.16
2038	1.2419	$125,169.28	0.676	$ 84,584.85
2039	1.2588	$157,560.91	0.662	$ 104,300.20
2040	1.2759	$201,038.25	0.648	$ 130,363.86
2041	1.2933	$260,008.98	0.635	$ 165,161.45
2042	1.3110	$340,861.12	0.622	$ 212,099.50
2043	1.3288	$452,945.59	0.610	$ 276,089.60
2044	1.3469	$610,090.21	0.597	$ 364,283.83
2045	1.3653	$832,955.00	0.585	$ 487,202.17
2046	1.3839	$1,152,732.34	0.573	$ 660,477.44
2047	1.4028	$1,617,018.05	0.561	$ 907,582.70
2048	1.4219	$2,299,221.00	0.550	$ 1,264,136.27
2049	1.4413	$3,313,797.92	0.539	$ 1,784,764.96
2050	1.4609	$4,841,174.98	0.528	$ 2,554,157.21
2051	1.4808	$7,168,940.83	0.517	$ 3,705,046.59
			TOTAL	**$ 13,201,837.13**

Maintanance Cost ($/year)	1/(1+i)^n	Operational Cost 2 ($/year)
	1.000	
	0.980	
	0.960	
$ 12,454.00	0.940	$ 11,706.70
$ 12,454.00	0.921	$ 11,467.70
$ 12,454.00	0.902	$ 11,233.58
$ 12,454.00	0.884	$ 11,004.24
$ 12,454.00	0.866	$ 10,779.58
$ 12,454.00	0.848	$ 10,559.50
$ 12,454.00	0.831	$ 10,343.93
$ 12,454.00	0.814	$ 10,132.75
$ 12,454.00	0.797	$ 9,925.88
$ 12,454.00	0.781	$ 9,723.24
$ 12,454.00	0.765	$ 9,524.73
$ 12,454.00	0.749	$ 9,330.28
$ 12,454.00	0.734	$ 9,139.79
$ 12,454.00	0.719	$ 8,953.20
$ 12,454.00	0.704	$ 8,770.41
$ 12,454.00	0.690	$ 8,591.36
$ 12,454.00	0.676	$ 8,415.96
$ 12,454.00	0.662	$ 8,244.14
$ 12,454.00	0.648	$ 8,075.83
$ 12,454.00	0.635	$ 7,910.96
$ 12,454.00	0.622	$ 7,749.45
$ 12,454.00	0.610	$ 7,591.24
$ 12,454.00	0.597	$ 7,436.26
$ 12,454.00	0.585	$ 7,284.45
$ 12,454.00	0.573	$ 7,135.73
$ 12,454.00	0.561	$ 6,990.05
$ 12,454.00	0.550	$ 6,847.34
$ 12,454.00	0.539	$ 6,707.55
$ 12,454.00	0.528	$ 6,570.61
$ 12,454.00	0.517	$ 6,436.47
	TOTAL	**$ 264,582.89**

Table 4-64 Operational cost - RSF

YEAR	Population Growth Constant	Energy Cost ($/year)	1/(1+i)^n	Operational Cost 1 ($/year)
2019			1.000	
2020			0.980	
2021			0.960	
2022	1.0000	$99,280.00	0.940	$ 93,322.69
2023	1.0136	$100,633.19	0.921	$ 92,663.47
2024	1.0274	$103,395.14	0.902	$ 93,262.98
2025	1.0414	$107,680.86	0.884	$ 95,145.77
2026	1.0556	$113,672.74	0.866	$ 98,389.59
2027	1.0700	$121,633.61	0.848	$ 103,130.77
2028	1.0846	$131,925.98	0.831	$ 109,573.83
2029	1.0994	$145,039.58	0.814	$ 118,006.21
2030	1.1144	$161,630.07	0.797	$ 128,819.72
2031	1.1296	$182,573.30	0.781	$ 142,540.83
2032	1.1450	$209,041.17	0.765	$ 159,873.20
2033	1.1606	$242,608.41	0.749	$ 181,757.16
2034	1.1764	$285,403.51	0.734	$ 209,453.11
2035	1.1924	$340,323.73	0.719	$ 244,659.21
2036	1.2087	$411,343.48	0.704	$ 289,678.18
2037	1.2252	$503,960.45	0.690	$ 347,655.78
2038	1.2419	$625,846.38	0.676	$ 422,924.25
2039	1.2588	$787,804.56	0.662	$ 521,501.02
2040	1.2759	$1,005,191.24	0.648	$ 651,819.28
2041	1.2933	$1,300,044.90	0.635	$ 825,807.25
2042	1.3110	$1,704,305.58	0.622	$ 1,060,497.48
2043	1.3288	$2,264,727.93	0.610	$ 1,380,447.98
2044	1.3469	$3,050,451.06	0.597	$ 1,821,419.17
2045	1.3653	$4,164,774.99	0.585	$ 2,436,010.85
2046	1.3839	$5,763,661.68	0.573	$ 3,302,387.18
2047	1.4028	$8,085,090.26	0.561	$ 4,537,913.52
2048	1.4219	$11,496,104.98	0.550	$ 6,320,681.37
2049	1.4413	$16,568,989.59	0.539	$ 8,923,824.80
2050	1.4609	$24,205,874.91	0.528	$ 12,770,786.04
2051	1.4808	$35,844,704.14	0.517	$ 18,525,232.95
			TOTAL	**$ 66,009,185.66**

Maintanance Cost ($/year)	1/(1+i)^n	Operational Cost 2 ($/year)
	1.000	
	0.980	
	0.960	
$ 42,154.00	0.940	$ 39,624.55
$ 42,154.00	0.921	$ 38,815.58
$ 42,154.00	0.902	$ 38,023.14
$ 42,154.00	0.884	$ 37,246.87
$ 42,154.00	0.866	$ 36,486.45
$ 42,154.00	0.848	$ 35,741.56
$ 42,154.00	0.831	$ 35,011.87
$ 42,154.00	0.814	$ 34,297.08
$ 42,154.00	0.797	$ 33,596.88
$ 42,154.00	0.781	$ 32,910.98
$ 42,154.00	0.765	$ 32,239.08
$ 42,154.00	0.749	$ 31,580.90
$ 42,154.00	0.734	$ 30,936.15
$ 42,154.00	0.719	$ 30,304.57
$ 42,154.00	0.704	$ 29,685.88
$ 42,154.00	0.690	$ 29,079.83
$ 42,154.00	0.676	$ 28,486.14
$ 42,154.00	0.662	$ 27,904.58
$ 42,154.00	0.648	$ 27,334.89
$ 42,154.00	0.635	$ 26,776.83
$ 42,154.00	0.622	$ 26,230.16
$ 42,154.00	0.610	$ 25,694.66
$ 42,154.00	0.597	$ 25,170.08
$ 42,154.00	0.585	$ 24,656.22
$ 42,154.00	0.573	$ 24,152.85
$ 42,154.00	0.561	$ 23,659.75
$ 42,154.00	0.550	$ 23,176.72
$ 42,154.00	0.539	$ 22,703.55
$ 42,154.00	0.528	$ 22,240.04
$ 42,154.00	0.517	$ 21,786.00
	TOTAL	**$ 895,553.82**

Table 4-65 Operational cost - MDF

YEAR	Population Growth Constant	Energy Cost	1/(1+i)^n	Operational Cost 1
		($/year)		($/year)
2019			1.000	
2020			0.980	
2021			0.960	
2022	1.0000	$4,964.00	0.940	$ 4,666.13
2023	1.0136	$5,031.66	0.921	$ 4,633.17
2024	1.0274	$5,169.76	0.902	$ 4,663.15
2025	1.0414	$5,384.04	0.884	$ 4,757.29
2026	1.0556	$5,683.64	0.866	$ 4,919.48
2027	1.0700	$6,081.68	0.848	$ 5,156.54
2028	1.0846	$6,596.30	0.831	$ 5,478.69
2029	1.0994	$7,251.98	0.814	$ 5,900.31
2030	1.1144	$8,081.50	0.797	$ 6,440.99
2031	1.1296	$9,128.67	0.781	$ 7,127.04
2032	1.1450	$10,452.06	0.765	$ 7,993.66
2033	1.1606	$12,130.42	0.749	$ 9,087.86
2034	1.1764	$14,270.18	0.734	$ 10,472.66
2035	1.1924	$17,016.19	0.719	$ 12,232.96
2036	1.2087	$20,567.17	0.704	$ 14,483.91
2037	1.2252	$25,198.02	0.690	$ 17,382.79
2038	1.2419	$31,292.32	0.676	$ 21,146.21
2039	1.2588	$39,390.23	0.662	$ 26,075.05
2040	1.2759	$50,259.56	0.648	$ 32,590.96
2041	1.2933	$65,002.25	0.635	$ 41,290.36
2042	1.3110	$85,215.28	0.622	$ 53,024.87
2043	1.3288	$113,236.40	0.610	$ 69,022.40
2044	1.3469	$152,522.55	0.597	$ 91,070.96
2045	1.3653	$208,238.75	0.585	$ 121,800.54
2046	1.3839	$288,183.08	0.573	$ 165,119.36
2047	1.4028	$404,254.51	0.561	$ 226,895.68
2048	1.4219	$574,805.25	0.550	$ 316,034.07
2049	1.4413	$828,449.48	0.539	$ 446,191.24
2050	1.4609	$1,210,293.75	0.528	$ 638,539.30
2051	1.4808	$1,792,235.21	0.517	$ 926,261.65
			TOTAL	**$ 3,300,459.28**

Maintanance Cost	1/(1+i)^n	Operational Cost 2
($/year)		($/year)
	1.000	
	0.980	
	0.960	
$ 34,438.00	0.940	$ 32,371.54
$ 34,438.00	0.921	$ 31,710.66
$ 34,438.00	0.902	$ 31,063.26
$ 34,438.00	0.884	$ 30,429.09
$ 34,438.00	0.866	$ 29,807.86
$ 34,438.00	0.848	$ 29,199.31
$ 34,438.00	0.831	$ 28,603.19
$ 34,438.00	0.814	$ 28,019.23
$ 34,438.00	0.797	$ 27,447.20
$ 34,438.00	0.781	$ 26,886.85
$ 34,438.00	0.765	$ 26,337.94
$ 34,438.00	0.749	$ 25,800.23
$ 34,438.00	0.734	$ 25,273.50
$ 34,438.00	0.719	$ 24,757.53
$ 34,438.00	0.704	$ 24,252.09
$ 34,438.00	0.690	$ 23,756.96
$ 34,438.00	0.676	$ 23,271.95
$ 34,438.00	0.662	$ 22,796.84
$ 34,438.00	0.648	$ 22,331.42
$ 34,438.00	0.635	$ 21,875.51
$ 34,438.00	0.622	$ 21,428.91
$ 34,438.00	0.610	$ 20,991.43
$ 34,438.00	0.597	$ 20,562.87
$ 34,438.00	0.585	$ 20,143.07
$ 34,438.00	0.573	$ 19,731.83
$ 34,438.00	0.561	$ 19,328.99
$ 34,438.00	0.550	$ 18,934.38
$ 34,438.00	0.539	$ 18,547.82
$ 34,438.00	0.528	$ 18,169.16
$ 34,438.00	0.517	$ 17,798.22
	TOTAL	**$ 731,628.85**

Table 4-66 Operational cost - RO

YEAR	Population Growth Constant	Energy Cost	1/(1+i)^n	Operational Cost 1	Maintanance Cost	1/(1+i)^n	Operational Cost 2
		($/year)		($/year)	($/year)		($/year)
2019			1.000			1.000	
2020			0.980			0.980	
2021			0.960			0.960	
2022	1.0000	$59,568.00	0.940	$ 55,993.62	$ 12,200.00	0.940	$ 11,467.94
2023	1.0136	$60,379.91	0.921	$ 55,598.08	$ 12,200.00	0.921	$ 11,233.81
2024	1.0274	$62,037.09	0.902	$ 55,957.79	$ 12,200.00	0.902	$ 11,004.47
2025	1.0414	$64,608.51	0.884	$ 57,087.46	$ 12,200.00	0.884	$ 10,779.80
2026	1.0556	$68,203.64	0.866	$ 59,033.76	$ 12,200.00	0.866	$ 10,559.73
2027	1.0700	$72,980.17	0.848	$ 61,878.46	$ 12,200.00	0.848	$ 10,344.14
2028	1.0846	$79,155.59	0.831	$ 65,744.30	$ 12,200.00	0.831	$ 10,132.96
2029	1.0994	$87,023.75	0.814	$ 70,803.73	$ 12,200.00	0.814	$ 9,926.09
2030	1.1144	$96,978.04	0.797	$ 77,291.83	$ 12,200.00	0.797	$ 9,723.44
2031	1.1296	$109,543.98	0.781	$ 85,524.50	$ 12,200.00	0.781	$ 9,524.93
2032	1.1450	$125,424.70	0.765	$ 95,923.92	$ 12,200.00	0.765	$ 9,330.47
2033	1.1606	$145,565.04	0.749	$ 109,054.29	$ 12,200.00	0.749	$ 9,139.99
2034	1.1764	$171,242.11	0.734	$ 125,671.87	$ 12,200.00	0.734	$ 8,953.39
2035	1.1924	$204,194.24	0.719	$ 146,795.53	$ 12,200.00	0.719	$ 8,770.60
2036	1.2087	$246,806.09	0.704	$ 173,806.91	$ 12,200.00	0.704	$ 8,591.54
2037	1.2252	$302,376.27	0.690	$ 208,593.47	$ 12,200.00	0.690	$ 8,416.14
2038	1.2419	$375,507.83	0.676	$ 253,754.55	$ 12,200.00	0.676	$ 8,244.32
2039	1.2588	$472,682.74	0.662	$ 312,900.61	$ 12,200.00	0.662	$ 8,076.00
2040	1.2759	$603,114.74	0.648	$ 391,091.57	$ 12,200.00	0.648	$ 7,911.13
2041	1.2933	$780,026.94	0.635	$ 495,484.35	$ 12,200.00	0.635	$ 7,749.62
2042	1.3110	$1,022,583.35	0.622	$ 636,298.49	$ 12,200.00	0.622	$ 7,591.40
2043	1.3288	$1,358,836.76	0.610	$ 828,268.79	$ 12,200.00	0.610	$ 7,436.42
2044	1.3469	$1,830,270.64	0.597	$ 1,092,851.50	$ 12,200.00	0.597	$ 7,284.60
2045	1.3653	$2,498,865.00	0.585	$ 1,461,606.51	$ 12,200.00	0.585	$ 7,135.88
2046	1.3839	$3,458,197.01	0.573	$ 1,981,432.31	$ 12,200.00	0.573	$ 6,990.20
2047	1.4028	$4,851,054.16	0.561	$ 2,722,748.11	$ 12,200.00	0.561	$ 6,847.49
2048	1.4219	$6,897,662.99	0.550	$ 3,792,408.82	$ 12,200.00	0.550	$ 6,707.69
2049	1.4413	$9,941,393.75	0.539	$ 5,354,294.88	$ 12,200.00	0.539	$ 6,570.75
2050	1.4609	$14,523,524.95	0.528	$ 7,662,471.62	$ 12,200.00	0.528	$ 6,436.60
2051	1.4808	$21,506,822.49	0.517	$ 11,115,139.77	$ 12,200.00	0.517	$ 6,305.19
			TOTAL	**$ 39,605,511.40**		**TOTAL**	**$ 259,186.71**

The total cost was calculated by the addition of capital and replacement costs. Then, by multiplying with net present value factor, $(1/(1+i)^n)$, net present value ($) was found.

In cost analysis calculations , similar to secondary treatment level, capital costs (1st column) included civil, mechanical and electrical costs, whereas replacement costs (2nd column) showed up in specific years like year 5, year 10, year 15, year 20 and year 25 for replacement of equipment etc.

Present value calculation results for “Chlorination” can be seen in Table 4-67.

Table 4-67 Total flowrates and cost analysis – Chlorination

YEAR	Capital Cost ($)	Replacement Cost ($)	Total Cost ($)	1/(1+i)^n	Net Present Value ($)	Flowrate (m³/day)	Population Growth Constant	Total Flowrate (m³/year)
2019	$ -	$ -	$ -	1.000	$ -	0.00		0.00
2020	$ 47,080.98	$ -	$ 47,080.98	0.980	$ 46,119.79	0.00		0.00
2021	$ 169,087.85	$ -	$ 169,087.85	0.960	$ 162,254.24	0.00		0.00
2022	$ -	$ -	$ -	0.940	$ -	**5,000.00**	1.0000	1,825,000.00
2023	$ -	$ -	$ -	0.921	$ -	5,068	1.0136	1,849,820.00
2024	$ -	$ -	$ -	0.902	$ -	5,137	1.0274	1,875,005.00
2025	$ -	$ -	$ -	0.884	$ -	5,207	1.0414	1,900,555.00
2026	$ -	$ -	$ -	0.866	$ -	5,278	1.0556	1,926,470.00
2027	$ -	$ -	$ -	0.848	$ -	5,350	1.0700	1,952,750.00
2028	$ -	$ -	$ -	0.831	$ -	5,423	1.0846	1,979,395.00
2029	$ -	$ -	$ -	0.814	$ -	5,497	1.0994	2,006,405.00
2030	$ -	$ -	$ -	0.797	$ -	5,572	1.1144	2,033,780.00
2031	$ -	$ 83,367.41	$ 83,367.41	0.781	$ 65,087.61	5,648	1.1296	2,061,520.00
2032	$ -	$ -	$ -	0.765	$ -	5,725	1.1450	2,089,625.00
2033	$ -	$ -	$ -	0.749	$ -	5,803	1.1606	2,118,095.00
2034	$ -	$ -	$ -	0.734	$ -	5,882	1.1764	2,146,930.00
2035	$ -	$ -	$ -	0.719	$ -	5,962	1.1924	2,176,130.00
2036	$ -	$ -	$ -	0.704	$ -	6,043	1.2087	2,205,695.00
2037	$ -	$ -	$ -	0.690	$ -	6,126	1.2252	2,235,990.00
2038	$ -	$ -	$ -	0.676	$ -	6,209	1.2419	2,266,285.00
2039	$ -	$ -	$ -	0.662	$ -	6,294	1.2588	2,297,310.00
2040	$ -	$ -	$ -	0.648	$ -	6,380	1.2759	2,328,700.00
2041	$ -	$ 83,367.41	$ 83,367.41	0.635	$ 52,956.18	6,467	1.2933	2,360,455.00
2042	$ -	$ -	$ -	0.622	$ -	6,555	1.3110	2,392,575.00
2043	$ -	$ -	$ -	0.610	$ -	6,644	1.3288	2,425,060.00
2044	$ -	$ -	$ -	0.597	$ -	6,735	1.3469	2,458,275.00
2045	$ -	$ -	$ -	0.585	$ -	6,826	1.3653	2,491,490.00
2046	$ -	$ -	$ -	0.573	$ -	6,920	1.3839	2,525,800.00
2047	$ -	$ -	$ -	0.561	$ -	7,014	1.4028	2,560,110.00
2048	$ -	$ -	$ -	0.550	$ -	7,109	1.4219	2,594,785.00
2049	$ -	$ -	$ -	0.539	$ -	7,206	1.4413	2,630,190.00
2050	$ -	$ -	$ -	0.528	$ -	7,305	1.4609	2,666,325.00
2051	$ -	$ -	$ -	0.517	$ -	7,404	1.4808	2,702,460.00
				TOTAL	**$ 326,417.83**		**TOTAL**	**67,082,985**

For 30 year period, capital cost was \$ 326,418 and operational cost (OC 1 + OC 2) was \$ 2,118,068, with a total of \$ 2,444,487. The unit cost of chlorination was calculated as \$ 0.036 /m³, where the total flow rate was calculated as 67,082,985 m³ (Table 4-68).

Table 4-68 Cost analysis results – Chlorination

	Total Flowrate (m³)	67,082,985
	Cost ($)	**Unit Cost ($/m³)**
Capital Costs	$ 326,418	$ 0.005
Operational Costs	$ 2,118,069	$ 0.032
Total Costs	$ 2,444,487	$ 0.036

Present value calculation results for “UV Disinfection” can be seen in Table 4-69.

Table 4-69 Total flowrates and cost analysis - UV Disinfection

YEAR	Capital Cost ($)	Replacement Cost ($)	Total Cost ($)	1/(1+i)^n	Net Present Value ($)	Flowrate (m^3/day)	Population Growth Constant	Total Flowrate (m^3/year)
2019	$ -	$ -	$ -	1.000	$ -	0.00		0.00
2020	$ 12,241.05	$ -	$ 12,241.05	0.980	$ 11,991.15	0.00		0.00
2021	$ 411,680.29	$ -	$ 411,680.29	0.960	$ 395,042.43	0.00		0.00
2022	$ -	$ -	$ -	0.940	$ -	**30,000.00**	1.0000	10,950,000.00
2023	$ -	$ -	$ -	0.921	$ -	30,409	1.0136	11,099,285.00
2024	$ -	$ -	$ -	0.902	$ -	30,823	1.0274	11,250,395.00
2025	$ -	$ -	$ -	0.884	$ -	31,243	1.0414	11,403,695.00
2026	$ -	$ -	$ -	0.866	$ -	31,669	1.0556	11,559,185.00
2027	$ -	$ -	$ -	0.848	$ -	32,101	1.0700	11,716,865.00
2028	$ -	$ -	$ -	0.831	$ -	32,539	1.0846	11,876,735.00
2029	$ -	$ -	$ -	0.814	$ -	32,982	1.0994	12,038,430.00
2030	$ -	$ -	$ -	0.797	$ -	33,432	1.1144	12,202,680.00
2031	$ -	$ 451,327.56	$ 451,327.56	0.781	$ 352,365.89	33,887	1.1296	12,368,755.00
2032	$ -	$ -	$ -	0.765	$ -	34,349	1.1450	12,537,385.00
2033	$ -	$ -	$ -	0.749	$ -	34,817	1.1606	12,708,205.00
2034	$ -	$ -	$ -	0.734	$ -	35,292	1.1764	12,881,580.00
2035	$ -	$ -	$ -	0.719	$ -	35,773	1.1924	13,057,145.00
2036	$ -	$ -	$ -	0.704	$ -	36,260	1.2087	13,234,900.00
2037	$ -	$ -	$ -	0.690	$ -	36,755	1.2252	13,415,575.00
2038	$ -	$ -	$ -	0.676	$ -	37,256	1.2419	13,598,440.00
2039	$ -	$ -	$ -	0.662	$ -	37,763	1.2588	13,783,495.00
2040	$ -	$ -	$ -	0.648	$ -	38,278	1.2759	13,971,470.00
2041	$ -	$ 451,327.56	$ 451,327.56	0.635	$ 286,689.77	38,800	1.2933	14,162,000.00
2042	$ -	$ -	$ -	0.622	$ -	39,329	1.3110	14,355,085.00
2043	$ -	$ -	$ -	0.610	$ -	39,865	1.3288	14,550,725.00
2044	$ -	$ -	$ -	0.597	$ -	40,408	1.3469	14,748,920.00
2045	$ -	$ -	$ -	0.585	$ -	40,959	1.3653	14,950,035.00
2046	$ -	$ -	$ -	0.573	$ -	41,517	1.3839	15,153,705.00
2047	$ -	$ -	$ -	0.561	$ -	42,083	1.4028	15,360,295.00
2048	$ -	$ -	$ -	0.550	$ -	42,657	1.4219	15,569,805.00
2049	$ -	$ -	$ -	0.539	$ -	43,238	1.4413	15,781,870.00
2050	$ -	$ -	$ -	0.528	$ -	43,827	1.4609	15,996,855.00
2051	$ -	$ -	$ -	0.517	$ -	44,425	1.4808	16,215,125.00
				TOTAL	**$ 1,046,089.23**		**TOTAL**	**402,498,640**

For 30 year period, capital cost was $ 1,046,089 and operational cost (OC 1 + OC 2) was $ 10,435,585, with a total of $ 11,481,674. The unit cost of UV Disinfection was calculated as $ 0.029 /m³ where total flowrate was calculated as 402,498,640 m³ (Table 4-70).

Table 4-70 Cost analysis results – UV Disinfection

	Total Flowrate (m³)	402,498,640
	Cost ($)	**Unit Cost ($/m³)**
Capital Costs	$ 1,046,089	$ 0.003
Operational Costs	$ 10,435,585	$ 0.026
Total Costs	$ 11,481,674	$ 0.029

Present value calculation results for “Pressurized Sand Filter” can be seen in Table 4-71.

Table 4-71 Total flowrates and cost analysis - PSF

YEAR	Capital Cost ($)	Replacement Cost ($)	Total Cost ($)	1/(1+i)^n	Net Present Value ($)	Flowrate (m^3/day)	Population Growth Constant	Total Flowrate (m^3/year)
2019		$ -	$ -	1.000	$ -	0.00		0.00
2020	$ 28,248.59	$ -	$ 28,248.59	0.980	$ 27,671.87	0.00		0.00
2021	$ 386,887.63	$ -	$ 386,887.63	0.960	$ 371,251.75	0.00		0.00
2022	$ -	$ -	$ -	0.940	$ -	**12,000.00**	1.0000	4,380,000.00
2023	$ -	$ -	$ -	0.921	$ -	12,164	1.0136	4,439,860.00
2024	$ -	$ -	$ -	0.902	$ -	12,329	1.0274	4,500,085.00
2025	$ -	$ -	$ -	0.884	$ -	12,497	1.0414	4,561,405.00
2026	$ -	$ -	$ -	0.866	$ -	12,668	1.0556	4,623,820.00
2027	$ -	$ -	$ -	0.848	$ -	12,840	1.0700	4,686,600.00
2028	$ -	$ -	$ -	0.831	$ -	13,015	1.0846	4,750,475.00
2029	$ -	$ -	$ -	0.814	$ -	13,193	1.0994	4,815,445.00
2030	$ -	$ -	$ -	0.797	$ -	13,373	1.1144	4,881,145.00
2031	$ -	$ 4,805.07	$ 4,805.07	0.781	$ 3,751.47	13,555	1.1296	4,947,575.00
2032	$ -	$ -	$ -	0.765	$ -	13,740	1.1450	5,015,100.00
2033	$ -	$ -	$ -	0.749	$ -	13,927	1.1606	5,083,355.00
2034	$ -	$ -	$ -	0.734	$ -	14,117	1.1764	5,152,705.00
2035	$ -	$ -	$ -	0.719	$ -	14,309	1.1924	5,222,785.00
2036	$ -	$ -	$ -	0.704	$ -	14,504	1.2087	5,293,960.00
2037	$ -	$ -	$ -	0.690	$ -	14,702	1.2252	5,366,230.00
2038	$ -	$ -	$ -	0.676	$ -	14,902	1.2419	5,439,230.00
2039	$ -	$ -	$ -	0.662	$ -	15,105	1.2588	5,513,325.00
2040	$ -	$ -	$ -	0.648	$ -	15,311	1.2759	5,588,515.00
2041	$ -	$ 245,058.41	$ 245,058.41	0.635	$ 155,664.63	15,520	1.2933	5,664,800.00
2042	$ -	$ -	$ -	0.622	$ -	15,732	1.3110	5,742,180.00
2043	$ -	$ -	$ -	0.610	$ -	15,946	1.3288	5,820,290.00
2044	$ -	$ -	$ -	0.597	$ -	16,163	1.3469	5,899,495.00
2045	$ -	$ -	$ -	0.585	$ -	16,384	1.3653	5,980,160.00
2046	$ -	$ -	$ -	0.573	$ -	16,607	1.3839	6,061,555.00
2047	$ -	$ -	$ -	0.561	$ -	16,833	1.4028	6,144,045.00
2048	$ -	$ -	$ -	0.550	$ -	17,063	1.4219	6,227,995.00
2049	$ -	$ -	$ -	0.539	$ -	17,295	1.4413	6,312,675.00
2050	$ -	$ -	$ -	0.528	$ -	17,531	1.4609	6,398,815.00
2051	$ -	$ -	$ -	0.517	$ -	17,770	1.4808	6,486,050.00
				TOTAL	**$ 558,339.73**		**TOTAL**	**160,999,675**

For 30 year period, capital cost was $ 558,340 and operational cost (OC 1 + OC 2) was $ 13,466,420, with a total of $ 14,024,760. The unit cost of PSF was calculated as $ 0.087 /m³, where the total flow rate was calculated as 160,999,675 m³ (Table 4-72).

Table 4-72 Cost analysis results - PSF

	Total Flowrate (m^3)	160,999,675
	Cost ($)	**Unit Cost ($/m³)**
Capital Costs	$ 558,340	$ 0.003
Operational Costs	$ 13,466,420	$ 0.084
Total Costs	$ 14,024,760	$ 0.087

Present value calculation results for “Rapid Sand Filter” can be seen in Table 4-73.

Table 4-73 Total flowrates and cost analysis - RSF

YEAR	Capital Cost	Replacement Cost	Total Cost	1/(1+i)^n	Net Present Value	Flowrate	Population Growth Constant	Total Flowrate
	($)	($)	($)		($)	(m^3/day)		(m^3/year)
2019	$ -	$ -	$ -	1.000	$ -	0.00		0.00
2020	$ 358,423.13	$ -	$ 358,423.13	0.980	$ 351,105.69	0.00		0.00
2021	$1,046,729.93	$ -	$1,046,729.93	0.960	$ 1,004,426.84	0.00		0.00
2022	$ -	$ -	$ -	0.940	$ -	**69,600.00**	1.0000	25,404,000.00
2023	$ -	$ -	$ -	0.921	$ -	70,549	1.0136	25,750,385.00
2024	$ -	$ -	$ -	0.902	$ -	71,510	1.0274	26,101,150.00
2025	$ -	$ -	$ -	0.884	$ -	72,485	1.0414	26,457,025.00
2026	$ -	$ -	$ -	0.866	$ -	73,473	1.0556	26,817,645.00
2027	$ -	$ -	$ -	0.848	$ -	74,474	1.0700	27,183,010.00
2028	$ -	$ -	$ -	0.831	$ -	75,489	1.0846	27,553,485.00
2029	$ -	$ -	$ -	0.814	$ -	76,518	1.0994	27,929,070.00
2030	$ -	$ -	$ -	0.797	$ -	77,561	1.1144	28,309,765.00
2031	$ -	$ 9,221.97	$ 9,221.97	0.781	$ 7,199.89	78,618	1.1296	28,695,570.00
2032	$ -	$ -	$ -	0.765	$ -	79,690	1.1450	29,086,850.00
2033	$ -	$ -	$ -	0.749	$ -	80,776	1.1606	29,483,240.00
2034	$ -	$ -	$ -	0.734	$ -	81,877	1.1764	29,885,105.00
2035	$ -	$ -	$ -	0.719	$ -	82,993	1.1924	30,292,445.00
2036	$ -	$ -	$ -	0.704	$ -	84,124	1.2087	30,705,260.00
2037	$ -	$ -	$ -	0.690	$ -	85,271	1.2252	31,123,915.00
2038	$ -	$ -	$ -	0.676	$ -	86,433	1.2419	31,548,045.00
2039	$ -	$ -	$ -	0.662	$ -	87,611	1.2588	31,978,015.00
2040	$ -	$ -	$ -	0.648	$ -	88,805	1.2759	32,413,825.00
2041	$ -	$ 470,320.71	$ 470,320.71	0.635	$ 298,754.49	90,016	1.2933	32,855,840.00
2042	$ -	$ -	$ -	0.622	$ -	91,243	1.3110	33,303,695.00
2043	$ -	$ -	$ -	0.610	$ -	92,486	1.3288	33,757,390.00
2044	$ -	$ -	$ -	0.597	$ -	93,747	1.3469	34,217,655.00
2045	$ -	$ -	$ -	0.585	$ -	95,025	1.3653	34,684,125.00
2046	$ -	$ -	$ -	0.573	$ -	96,320	1.3839	35,156,800.00
2047	$ -	$ -	$ -	0.561	$ -	97,633	1.4028	35,636,045.00
2048	$ -	$ -	$ -	0.550	$ -	98,964	1.4219	36,121,860.00
2049	$ -	$ -	$ -	0.539	$ -	100,312	1.4413	36,613,880.00
2050	$ -	$ -	$ -	0.528	$ -	101,680	1.4609	37,113,200.00
2051	$ -	$ -	$ -	0.517	$ -	103,066	1.4808	37,619,090.00
				TOTAL	**$ 1,661,486.91**		**TOTAL**	**933,797,385**

For 30 year period, capital cost was $ 1,661,487 and operational cost (OC 1 + OC 2) was $ 66,904,740, with a total of $ 68,566,226. The unit cost of RSF was calculated as $ 0.074 /m³, where the total flow rate was calculated as 933,797,385 m³ (Table 4-74).

Table 4-74 Cost analysis results – RSF

	Total Flowrate (m^3)	933,797,385
	Cost ($)	**Unit Cost ($/$m^3$)**
Capital Costs	$ 1,661,487	$ 0.002
Operational Costs	$ 66,904,740	$ 0.072
Total Costs	$ 68,566,226	$ 0.074

Present value calculation results for “Micro disc Filter” can be seen in Table 4-75.

Table 4-75 Total flowrates and cost analysis - MDF

YEAR	Capital Cost	Replacement Cost	Total Cost	1/(1+i)^n	Net Present Value	Flowrate	Population Growth Constant	Total Flowrate
	($)	($)	($)		($)	(m^3/day)		(m^3/year)
2019	$ -	$ -	$ -	1.000	$ -	0.00		0.00
2020	$ 12,241.05	$ -	$ 12,241.05	0.980	$ 11,991.15	0.00		0.00
2021	$ 734,478.34	$ -	$ 734,478.34	0.960	$ 704,794.75	0.00		0.00
2022	$ -	$ -	$ -	0.940	$ -	**10,000.00**	1.0000	3,650,000.00
2023	$ -	$ -	$ -	0.921	$ -	10,136	1.0136	3,699,640.00
2024	$ -	$ -	$ -	0.902	$ -	10,274	1.0274	3,750,010.00
2025	$ -	$ -	$ -	0.884	$ -	10,414	1.0414	3,801,110.00
2026	$ -	$ 747,515.59	$ 747,515.59	0.866	$ 647,013.13	10,556	1.0556	3,852,940.00
2027	$ -	$ -	$ -	0.848	$ -	10,700	1.0700	3,905,500.00
2028	$ -	$ -	$ -	0.831	$ -	10,846	1.0846	3,958,790.00
2029	$ -	$ -	$ -	0.814	$ -	10,994	1.0994	4,012,810.00
2030	$ -	$ -	$ -	0.797	$ -	11,144	1.1144	4,067,560.00
2031	$ -	$ 692,144.07	$ 692,144.07	0.781	$ 540,379.05	11,296	1.1296	4,123,040.00
2032	$ -	$ -	$ -	0.765	$ -	11,450	1.1450	4,179,250.00
2033	$ -	$ -	$ -	0.749	$ -	11,606	1.1606	4,236,190.00
2034	$ -	$ -	$ -	0.734	$ -	11,764	1.1764	4,293,860.00
2035	$ -	$ -	$ -	0.719	$ -	11,924	1.1924	4,352,260.00
2036	$ -	$ 747,515.59	$ 747,515.59	0.704	$ 526,418.85	12,087	1.2087	4,411,755.00
2037	$ -	$ -	$ -	0.690	$ -	12,252	1.2252	4,471,980.00
2038	$ -	$ -	$ -	0.676	$ -	12,419	1.2419	4,532,935.00
2039	$ -	$ -	$ -	0.662	$ -	12,588	1.2588	4,594,620.00
2040	$ -	$ -	$ -	0.648	$ -	12,759	1.2759	4,657,035.00
2041	$ -	$ 692,144.07	$ 692,144.07	0.635	$ 439,659.88	12,933	1.2933	4,720,545.00
2042	$ -	$ -	$ -	0.622	$ -	13,110	1.3110	4,785,150.00
2043	$ -	$ -	$ -	0.610	$ -	13,288	1.3288	4,850,120.00
2044	$ -	$ -	$ -	0.597	$ -	13,469	1.3469	4,916,185.00
2045	$ -	$ -	$ -	0.585	$ -	13,653	1.3653	4,983,345.00
2046	$ -	$ 755,961.92	$ 755,961.92	0.573	$ 433,141.13	13,839	1.3839	5,051,235.00
2047	$ -	$ -	$ -	0.561	$ -	14,028	1.4028	5,120,220.00
2048	$ -	$ -	$ -	0.550	$ -	14,219	1.4219	5,189,935.00
2049	$ -	$ -	$ -	0.539	$ -	14,413	1.4413	5,260,745.00
2050	$ -	$ -	$ -	0.528	$ -	14,609	1.4609	5,332,285.00
2051	$ -	$ -	$ -	0.517	$ -	14,808	1.4808	5,404,920.00
				TOTAL	**$ 3,303,397.94**		**TOTAL**	**134,165,970**

For 30 year period, capital cost was $ 3,303,398 and operational cost (OC 1 + OC 2) was $ 4,032,088, with a total of $ 7,335,486. The unit cost of MDF was calculated as $ 0.055 /m^3, where the total flow rate was calculated as 134,165,970 m^3 (Table 4-76).

Table 4-76 Cost analysis results – MDF

	Total Flowrate (m^3)	134,165,970
	Cost ($)	**Unit Cost ($/$m^3$)**
Capital Costs	$ 3,303,398	$ 0.025
Operational Costs	$ 4,032,088	$ 0.030
Total Costs	$ 7,335,486	$ 0.055

Present value calculation results for “Reverse Osmosis” can be seen in Table 4-77.

Table 4-77 Total flowrates and cost analysis - RO

YEAR	Capital Cost	Replacement Cost	Total Cost	1/(1+i)^n	Net Present Value	Flowrate	Population Growth Constant	Total Flowrate
	($)	($)	($)		($)	(m^3/day)		(m^3/year)
2019	$ -	$ -	$ -	1.000	$ -	0.00		0.00
2020	$ 28,248.59	$ -	$ 28,248.59	0.980	$ 27,671.87	0.00		0.00
2021	$ 205,923.59	$ -	$ 205,923.59	0.960	$ 197,601.28	0.00		0.00
2022	$ -	$ -	$ -	0.940	$ -	**24,720.00**	1.0000	9,022,800.00
2023	$ -	$ -	$ -	0.921	$ -	25,057	1.0136	9,145,805.00
2024	$ -	$ -	$ -	0.902	$ -	25,398	1.0274	9,270,270.00
2025	$ -	$ -	$ -	0.884	$ -	25,745	1.0414	9,396,925.00
2026	$ -	$ 198,375.00	$ 198,375.00	0.866	$ 171,703.75	26,096	1.0556	9,525,040.00
2027	$ -	$ -	$ -	0.848	$ -	26,451	1.0700	9,654,615.00
2028	$ -	$ -	$ -	0.831	$ -	26,812	1.0846	9,786,380.00
2029	$ -	$ -	$ -	0.814	$ -	27,177	1.0994	9,919,605.00
2030	$ -	$ -	$ -	0.797	$ -	27,548	1.1144	10,055,020.00
2031	$ -	$ 200,755.50	$ 200,755.50	0.781	$ 156,736.25	27,923	1.1296	10,191,895.00
2032	$ -	$ -	$ -	0.765	$ -	28,304	1.1450	10,330,960.00
2033	$ -	$ -	$ -	0.749	$ -	28,689	1.1606	10,471,485.00
2034	$ -	$ -	$ -	0.734	$ -	29,081	1.1764	10,614,565.00
2035	$ -	$ -	$ -	0.719	$ -	29,477	1.1924	10,759,105.00
2036	$ -	$ 198,375.00	$ 198,375.00	0.704	$ 139,700.55	29,879	1.2087	10,905,835.00
2037	$ -	$ -	$ -	0.690	$ -	30,286	1.2252	11,054,390.00
2038	$ -	$ -	$ -	0.676	$ -	30,699	1.2419	11,205,135.00
2039	$ -	$ -	$ -	0.662	$ -	31,117	1.2588	11,357,705.00
2040	$ -	$ -	$ -	0.648	$ -	31,541	1.2759	11,512,465.00
2041	$ -	$ 200,755.50	$ 200,755.50	0.635	$ 127,522.79	31,971	1.2933	11,669,415.00
2042	$ -	$ -	$ -	0.622	$ -	32,407	1.3110	11,828,555.00
2043	$ -	$ -	$ -	0.610	$ -	32,849	1.3288	11,989,885.00
2044	$ -	$ -	$ -	0.597	$ -	33,296	1.3469	12,153,040.00
2045	$ -	$ -	$ -	0.585	$ -	33,750	1.3653	12,318,750.00
2046	$ -	$ 198,375.00	$ 198,375.00	0.573	$ 113,662.30	34,210	1.3839	12,486,650.00
2047	$ -	$ -	$ -	0.561	$ -	34,676	1.4028	12,656,740.00
2048	$ -	$ -	$ -	0.550	$ -	35,149	1.4219	12,829,385.00
2049	$ -	$ -	$ -	0.539	$ -	35,628	1.4413	13,004,220.00
2050	$ -	$ -	$ -	0.528	$ -	36,114	1.4609	13,181,610.00
2051	$ -	$ -	$ -	0.517	$ -	36,606	1.4808	13,361,190.00
				TOTAL	**$ 934,598.80**	TOTAL		**331,659,440**

For 30 year period, capital cost was $ 934,599 and operational cost (OC 1 + OC 2) was $ 39,864,698, with a total of $ 40,799,297. The unit cost of RO was calculated as $ 0.123 /m³, where the total flow rate was calculated as 331,659,440 m³ (Table 4-78).

Table 4-78 Cost analysis results – RO

	Total Flowrate (m³)	331,659,440
	Cost ($)	**Unit Cost ($/m³)**
Capital Costs	$ 934,599	$ 0.003
Operational Costs	$ 39,864,698	$ 0.120
Total Costs	$ 40,799,297	$ 0.123

To sum up, in the scope of the cost analyses performed for tertiary/ advanced treatment technologies, the following results shown in Table 4-79 and Table 4-80 were obtained. Table 4-79 indicated the total costs of each unit for the potential to use in tertiary/ advanced treatment level. In Table 4-80, the unit cost of each tertiary/ advanced treatment is shown.

Table 4-79 Total costs for tertiary/ advanced treatment ($)

	Capacity (m^3/day)	Capital Cost ($)	Operational Cost ($)	Total Cost ($)
CL	5000	$ 334,693	$ 2,120,789	$ 2,455,482
UV	30000	$ 1,046,089	$ 10,435,585	$ 11,481,674
PSF	10000	$ 54,779	$ 13,292,626	$ 13,347,405
RSF	69600	$ 1,661,486.911	$ 66,904,739.487	$ 68,566,226
MDF	24720	$ 3,303,398	$ 4,032,088	$ 7,335,486
RO	12000	$ 934,599	$ 39,864,698	$ 40,799,297

Table 4-80 Unit costs for tertiary/ advanced treatment ($/$m^3$)

	Capital Unit Cost ($/$m^3$)	Operational Unit Cost ($/$m^3$)	Total Unit Cost ($/$m^3$)
CL	$ 0.005 /m^3	$ 0.032 /m^3	$ 0.037 /m^3
UV	$ 0.003 /m^3	$ 0.026 /m^3	$ 0.029 /m^3
PSF	$ 0.003 /m^3	$ 0.084 /m^3	$ 0.087 /m^3
RSF	$ 0.002 /m^3	$ 0.072 /m^3	$ 0.074 /m^3
MDF	$ 0.025 /m^3	$ 0.030 /m^3	$ 0.055 /m^3
RO	$ 0.003 /m^3	$ 0.120 /m^3	$ 0.123 /m^3

It was observed In Table 4-80 that UV disinfection was cheaper than chlorination; with the rapid increase in technology and demand for UV technology were the main reasons for having lower unit cost. When filtration processes were examined, PSF had a higher unit cost compared to RSF, like the outcome of this study; lower capacity treatment plants/ units had larger costs than larger-scale projects. Lastly, for membrane technologies, RO had a higher unit cost than MDF. The complexity and its pore size the main parameters that affect the unit cost of the membrane technologies. Moreover, it was expected to observe higher costs in RO than MDF units.

4.3.3 Cost Analysis based on Full Treatment Scheme including Secondary and Tertiary/Advanced Treatment Levels

In this section, cost analysis based on full treatment costs was examined for TS_1 to TS_6. In previous sections, each of the secondary and tertiary/ advanced treatment processes costs was examined individually. With these estimated unit costs and total costs, the cost of the six full treatment schemes was found.

It should be noted that TS_1 to TS_6 wastewater treatment schemes are potential schemes where the treated water can be used for reuse applications (Section 3.3). In reclamation and reuse plants, it is not always necessary to use % 100 of the treated water, but partial use is possible (Melgarejo et al., 2016). In this thesis study, accordingly, 0 % to 100 % of the treated water was aimed to use in reuse applications. The reason for changing the reused water amount was to involve a low cost (low reused water amount) or high cost (high reused water amount) options for reuse alternatives. If it is 0 %, that is, if the treated wastewater would not be used, it is still disinfected by chlorine before discharge to the receiving bodies. Therefore, disinfection cost was still included for no reuse option.

In the filtration unit used in TS_1, TS_2 and TS_3, pressurized or rapid sand filter was used. Pressurized sand filters are applicable for a maximum flowrate of 6000 m^3/day, and there is no production of larger pressurized filter tanks. Pressurized sand filter suppliers recommended rapid sand filters for larger flow rates. In this study, for flowrates larger than 6000 m^3/day, rapid sand filters were used.

As an example calculation, 6KA2OLOW with TS_1, which is A2O + Filtration + Chlorination + UV, was selected, with the reuse flow portion of 30 % (Table 4-81). With this scheme, the rest of the effluent (70 %) was disinfected after secondary treatment. The total and unit costs of 30 % (reused part) and 70 % (not reused part) of the effluent were calculated separately. The weighted average of these costs was taken for total and unit costs calculations.

Total and unit treatment costs were calculated in previous sections (Section 4.3.1.3, Table 4-33). Total treatment cost for 30 % (1800 m^3/day) of 6KA2OLOW scenario is $ 3,102,033. For the tertiary/advanced treatment level part, in previous chapters (Section 4.3.2.3, Table 4-80) the unit treatment cost was found. The total treatment cost for the filtration, chlorination and UV units was calculated for the flow of 1800 m^3/day (30 % reused). The total costs of filtration (PSF) and disinfection units, namely Cl and UV, were calculated as $ 2,188,992, $ 880,017 and $ 688,900, respectively. The total and unit treatment costs for the 30% reused portion are calculated as $ 6,859,943 and $ 0.273/m^3, respectively. Moreover, 70 % no-reuse portion of 6KA2OLOW was discharged to surface water with disinfection after secondary treatment. The total treatment costs of 70 % no-reuse portion of 6KA2OLOW (4200 m^3/d) were found as $ 7,237,928 and cost of chlorination was $ 2,053,335. The unit cost of the no-reuse portion was calculated as $ 0.158/m^3. Thus, the total treatment cost for 4200 m^3/day was calculated as $ 9,291,299. The summation of 30 % and 70 % of treatment cost gave the total cost, which was $ 16,151,202. The weighted average of reused and not reused part unit costs was calculated as $ 0.193/m^3. The above example calculation table can be seen in Table 4-81. This calculation was done for ten percentage increments in water reuse amounts for TS_1 to TS_6. Calculation tables for all schemes can be seen in Appendix K.

Table 4-81 Example calculation for TS_1 – 6KA2OLOW scenario

TS1	% Reused	Flowrate (m^3/day)			Total Secondary Cost	Total Tertiary and Disinfection Cost			Total Cost		Unit Cost	Unit Cost (weighted average)
		PSF	CL	UV		PSF	CL	UV				
6KA2OLOW	0%	0	0	0	$ -	$ -	$ -	$ -	$ -	$ 13,273,541.256	$ -	$ 0.158
		0	6000	0	$ 10,340,141.221	$ -	$ 2,933,400.035	$ -	$ 13,273,541.256		$ 0.158	
	10%	600	600	600	$ 1,033,996.104	$ 729,653.300	$ 293,334.892	$ 229,630.281	$ 2,286,614.577	$ 14,232,767.014	$ 0.273	$ 0.170
		0	5400	0	$ 9,306,100.072	$ -	$ 2,640,052.364	$ -	$ 11,946,152.437		$ 0.158	
	20%	1200	1200	1200	$ 2,067,992.209	$1,459,306.600	$ 586,669.784	$ 459,260.562	$ 4,573,229.154	$ 15,192,050.594	$ 0.273	$ 0.181
		0	4800	0	$ 8,272,103.968	$ -	$ 2,346,717.472	$ -	$ 10,618,821.440		$ 0.158	
	30%	1800	1800	1800	$ 3,102,033.357	$2,188,991.686	$ 880,017.455	$ 688,900.846	$ 6,859,943.344	$ 16,151,202.495	$ 0.273	$ 0.193
		0	4200	0	$ 7,237,927.686	$ -	$ 2,053,331.466	$ -	$ 9,291,259.151		$ 0.158	
	40%	2400	2400	2400	$ 4,136,029.462	$2,918,644.985	$ 1,173,352.347	$ 918,531.127	$ 9,146,557.921	$ 17,110,717.369	$ 0.273	$ 0.204
		0	3600	0	$ 6,204,111.759	$ -	$ 1,760,047.688	$ -	$ 7,964,159.448		$ 0.158	
	50%	3000	3000	3000	$ 5,170,025.566	$3,648,298.285	$ 1,466,687.239	$ 1,148,161.408	$ 11,433,172.498	$ 18,069,885.303	$ 0.273	$ 0.216
		0	3000	0	$ 5,170,025.566	$ -	$ 1,466,687.239	$ -	$ 6,636,712.805		$ 0.158	
	60%	3600	3600	3600	$ 6,204,111.759	$4,378,015.157	$ 1,760,047.688	$ 1,377,811.696	$ 13,719,986.301	$ 19,029,368.110	$ 0.273	$ 0.227
		0	2400	0	$ 4,136,029.462	$ -	$ 1,173,352.347	$ -	$ 5,309,381.809		$ 0.158	
	70%	4200	4200	4200	$ 7,237,927.686	$5,107,541.312	$ 2,053,331.466	$ 1,607,401.963	$ 16,006,202.426	$ 19,988,253.239	$ 0.273	$ 0.239
		0	1800	0	$ 3,102,033.357	$ -	$ 880,017.455	$ -	$ 3,982,050.812		$ 0.158	
	80%	4800	4800	4800	$ 8,272,103.968	$5,837,321.757	$ 2,346,717.472	$ 1,837,072.258	$ 18,293,215.455	$ 20,947,877.448	$ 0.273	$ 0.250
		0	1200	0	$ 2,067,992.209	$ -	$ 586,669.784	$ -	$ 2,654,661.993		$ 0.158	
	90%	5400	5400	5400	$ 9,306,100.072	$6,566,975.057	$ 2,640,052.364	$ 2,066,702.539	$ 20,579,830.032	$ 21,907,161.028	$ 0.273	$ 0.261
		0	600	0	$ 1,033,996.104	$ -	$ 293,334.892	$ -	$ 1,327,330.996		$ 0.158	
	100%	6000	6000	6000	$ 10,340,141.221	$7,296,660.143	$ 2,933,400.035	$ 2,296,342.823	$ 22,866,544.222	$ 22,866,544.222	$ 0.273	$ 0.273
		0	0	0	$ -	$ -	$ -	$ -	$ -		$ -	

The above calculation was done with 10 % increments for every treatment scheme scenario (TS_1 to TS_6). Reclaimed water costs for 6KA2OLOW scenarios of TS_1 to TS_6 can be seen in Table 4-82. Results for other scenarios can be seen in Appendix L.

Table 4-82 Reclaimed water unit costs for TS_1 – TS_6, 6KA2OLOW scenarios

Reuse Flow Percent	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.158	$ 0.158	$ 0.186	$ 0.123	$ 0.158	$ 0.158
10%	$ 0.170	$ 0.200	$ 0.192	$ 0.123	$ 0.161	$ 0.179
20%	$ 0.181	$ 0.242	$ 0.198	$ 0.123	$ 0.164	$ 0.199
30%	$ 0.193	$ 0.283	$ 0.204	$ 0.123	$ 0.167	$ 0.219
40%	$ 0.204	$ 0.325	$ 0.210	$ 0.123	$ 0.169	$ 0.240
50%	$ 0.216	$ 0.366	$ 0.216	$ 0.123	$ 0.172	$ 0.260
60%	$ 0.227	$ 0.408	$ 0.222	$ 0.123	$ 0.175	$ 0.280
70%	$ 0.239	$ 0.449	$ 0.228	$ 0.123	$ 0.178	$ 0.300
80%	$ 0.250	$ 0.491	$ 0.234	$ 0.123	$ 0.180	$ 0.321
90%	$ 0.261	$ 0.532	$ 0.240	$ 0.123	$ 0.183	$ 0.341
100%	$ 0.273	$ 0.574	$ 0.246	$ 0.123	$ 0.186	$ 0.361

As shown in Table 4-82 and other scenarios, the highest cost was obtained from TS_2, where SAT treatment was applied, unit treatment cost of SAT was taken as $ 0.301/m^3 (Idelovitch, 2003; Sharma & Kennedy, 2017). Countries like Israel, Dan Region uses SAT for further treatment unless the cost or land availability was a concern (Dott et al., 2008). This treatment scheme could be used when enough area and funds are available. TS_6 was followed by TS_2, where advanced treatment units were applied in the former. Microfiltration and reverse osmosis processes were expensive processes not only with capital costs but also with operational costs. TS_3 had the third-highest cost among others, where the filtration unit existed for further suspended solids removal. TS_4 and TS_5 followed others where TS_4 was direct usage of secondary effluent and TS_5 only including disinfection of secondary effluent. Table 4-82 also reveals that, for all scenarios except TS_4, the unit cost of reclaimed water increases with the increase in reuse flow portion, as expected.

4.4 Feasibility of Wastewater Treatment Schemes and Water Reuse Applications

In this part, the feasibility of treatment schemes considering the costs and water reuse applications was examined. In previous parts, secondary and tertiary/advanced treatment unit costs were evaluated. Then according to treatment schemes determined with respect to the specific water reuse applications, total unit costs were calculated. Because the treatment of whole wastewater flow to a level of reclaimed water quality could be challenging and costly, a portion of the secondary treated water was further treated in tertiary/ advanced treatment units for reuse application. The portion of flow to be further treated and thus reused was increased by 10 % increments from no reuse (0%) option to full (100%) reuse option. This portion of the reuse range appeals to every situation constrained by cost. Figures were constructed for each treatment scheme changing with reuse percentages. It was aimed to compare the calculated unit costs of TS_1 to TS_6 (with 11 different reuse portions/ percentages) to the current potable water, reclaimed water and wastewater charges around the world.

One of the objectives was to examine if the usage of wastewater treatment plant effluents with required effluent quality was economically feasible or not. To do this, charges of potable water, reclaimed water and wastewater around the world were compared with the results of this study. The second objective was to evaluate whether the wastewater and reclaimed water prices were reasonable or not, or profit exists in this area or not. In the scope of these aims, the following, potable water, wastewater and reclaimed water charges were used for comparison in this study.

- Potable Water Charge in Orange County, USA = $ 1.37/m^3
  (Orange County - Utility Rates & Charges, 2019)
- Reclaimed Water Charge in Orange County, USA = $ 1.05/m^3
  (Orange County - Utility Rates & Charges, 2019)
- Potable Water Charge in Singapore = $ 2.74/m^3
  (Singapore's National Water Agency, 2019)
- Reclaimed Water Charge in Singapore = $ 2.33/m^3
  (Singapore's National Water Agency, 2019)
- Water Charge for Agricultural Purposes (Napa, Southern Cyprus) = $ 0.09/m^3 *(Hidalgo et al., 2005)*
- Potable Water Charge in Ankara, Turkey = TL 5.00/m^3 ($ 0.94/m^3)
  (Retrieved from bills on May 2019) (Taxes are included)
- Wastewater Charge in Ankara, Turkey = TL 1.67/m^3 ($ 0.31/m^3)
  (Retrieved from bills on May 2019)

Allocations of Orange County, USA and Singapore were selected on purpose for the feasibility analysis. Unlike most of the allocations, there is a water reclamation plant in these places and the effluent of water reclamation plants are sold to the public as reclaimed water. Additionally, their treatment schemes are similar to secondary treatment followed by microfiltration and reverse osmosis (TS_6).

4.4.1 Feasibility Analysis of TS_1

In TS_1, A2O with the addition of chlorination and UV were used. This tertiary treated effluent can be used in unrestricted area irrigation or agricultural reuse (EPA, 2012; Iglesias et al., 2010; Maryam & Büyükgüngör, 2017).

The comparison of the calculated reclaimed water cost of TS_1 scenarios with the above mentioned water/ wastewater charges is given in Figure 4-4. It could be said that the charge for reclaimed water in Singapore (\$ 2.33/m^3) and Orange County (\$ 1.05/m^3) is greater than the calculated reclaimed water cost (\$ 0.153/m^3 - \$ 0.201/m^3). In any case, TS_1 – A2O effluent quality may not be the same as reclaimed water in Singapore and Orange County, in comparison of the results this should be considered. If Napa, S. Cyprus cost for irrigation (\$ 0.09/m^3) is examined, TS_1 – A2O costs are found to be above in all scenarios. One of the reasons can be the quality of TS_1 – A2O effluent, potential to be better than the water quality in S. Cyprus. The second reason can be that the government may sell the irrigation water not for profit purposes but for the aim of public service.

TS_1 – A2O effluent costs for all scenarios with different water reuse percentages are below the charge of wastewater that is collected from public in Turkey (\$ 0.31/m^3). It was mentioned in Section 4.3.1.3 that commonly used wastewater treatment plant schemes in Turkey, i.e., CAS and EXT systems are slightly cheaper ones. Nevertheless, it is not expected to have lower wastewater charges in Turkey than those of TS_1 – A2O scenarios. There may be a profit gained from wastewater treatment, yet, it should not be for wastewater treatment being a public service.

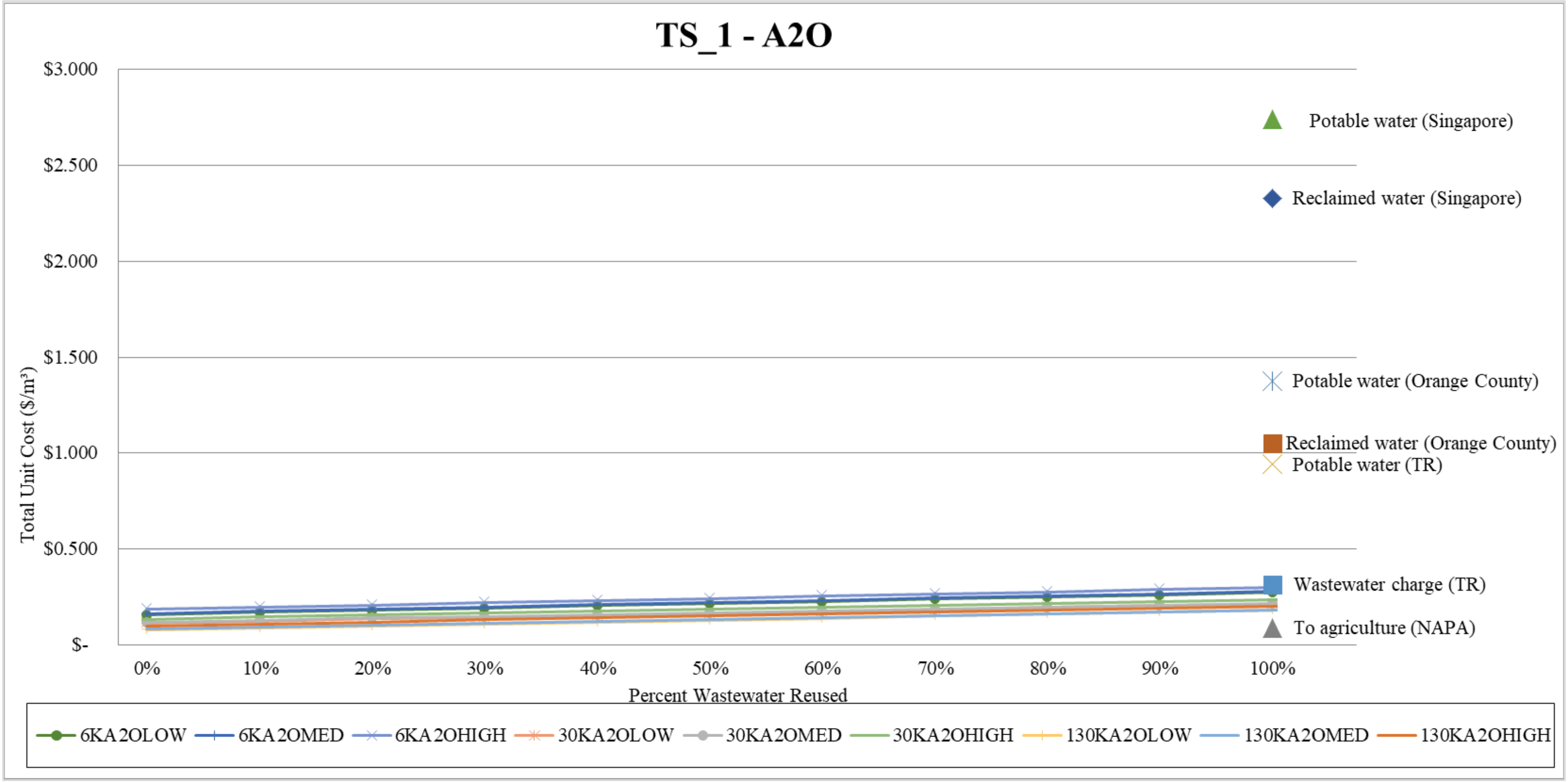

Figure 4-4 Cost comparison for TS_1 - A2O scenarios

4.4.2 Feasibility Analysis of TS_2

In TS_2, the effluent of secondary treatment units, namely CAS, EXT, A2O processes, was filtrated with pressurized sand filters or rapid sand filters. After that, it was disinfected with chlorination and UV. In the end, soil aquifer treatment (SAT) was applied. The effluent could be used in indirect potable usage like groundwater recharge by spreading into potable aquifers (Asano et al., 2007; EPA, 2012). TS_2 effluent quality was high because of the SAT process, which enables the removal of suspended and organic substances with physicochemical and biological reactions through the soil at the required retention time. The unit cost of the SAT process is approximated as \$ 0.301/m³, which is above from secondary treatment level costs (Idelovitch, 2003; Sharma & Kennedy, 2017).

TS_2 - CAS/EXT/A2O treatment scheme with 70 % reused portion (\$ 0.345/m³ - \$ 0.476/m³) is an expensive scheme when the Turkey wastewater charges (\$ 0.31/m³) are considered (Figure 4-5, Figure 4-6 and Figure 4-7). For the TS_2 – CAS/EXT/A2O scenario, if the reused water portion is greater than 30-60 %, 40-60 %, 30-60 %, respectively, the TS_2 – CAS/EXT/A2O scenarios costs exceed the wastewater charges in Turkey. Therefore, if the TS_2 scenario is intended to use in Turkey, charges which are collected from the public should be revised or some incentives should be applied. However, it should be noted that partial reuse of TS_2 effluents (i.e., partial treatment of secondary effluent in following units of TS_2 scheme) makes the scenarios less costly then Turkey wastewater charges are applicable (Figure 4-5).

TS_2 – CAS/EXT/A2O costs were not higher than the Turkey potable water charges (\$ 0.94/m³). This might be expected because the cost for reclamation in this scheme was for remediation purposes; in other words, it was not used as direct potable usage. Therefore it was not expected that the water quality reaches potable water quality.

Charge for reclaimed water in Singapore ($ 2.33/m^3) and Orange County ($ 1.05/m^3) is far greater than the costs of TS_2 – CAS/EXT/A2O scenarios. TS_2 - CAS/EXT/A2O costs were above from Napa, S. Cyprus cost for irrigation ($ 0.09/m^3) after 10 % reused water portion of the treatment plants.

TS_2 - CAS/EXT/A2O process was found as an expensive process. If the area, equipment and experts were provided, and if partial reuse is intended, the process could be applied.

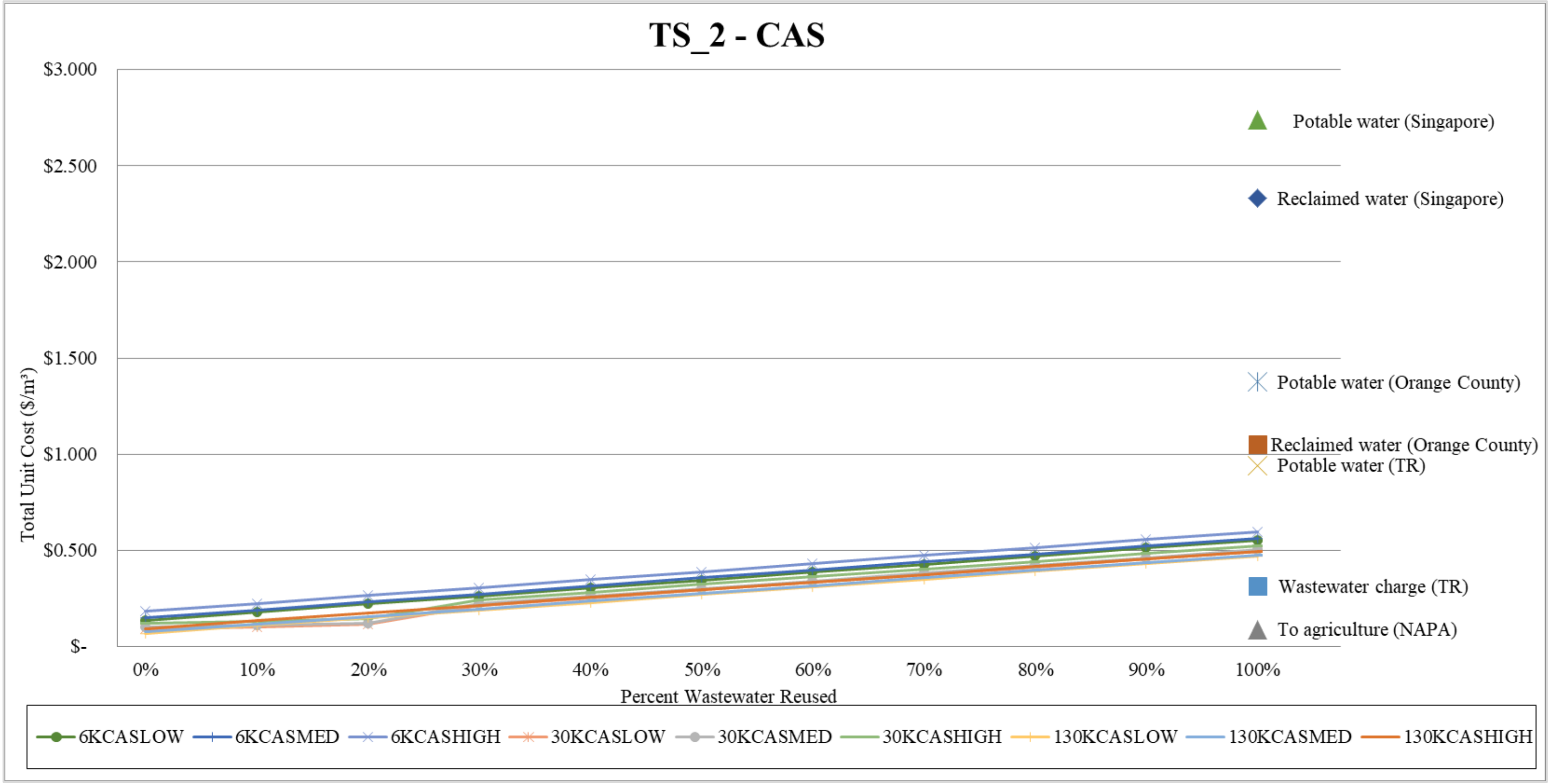

Figure 4-5 Cost comparison for TS_2 – CAS scenarios

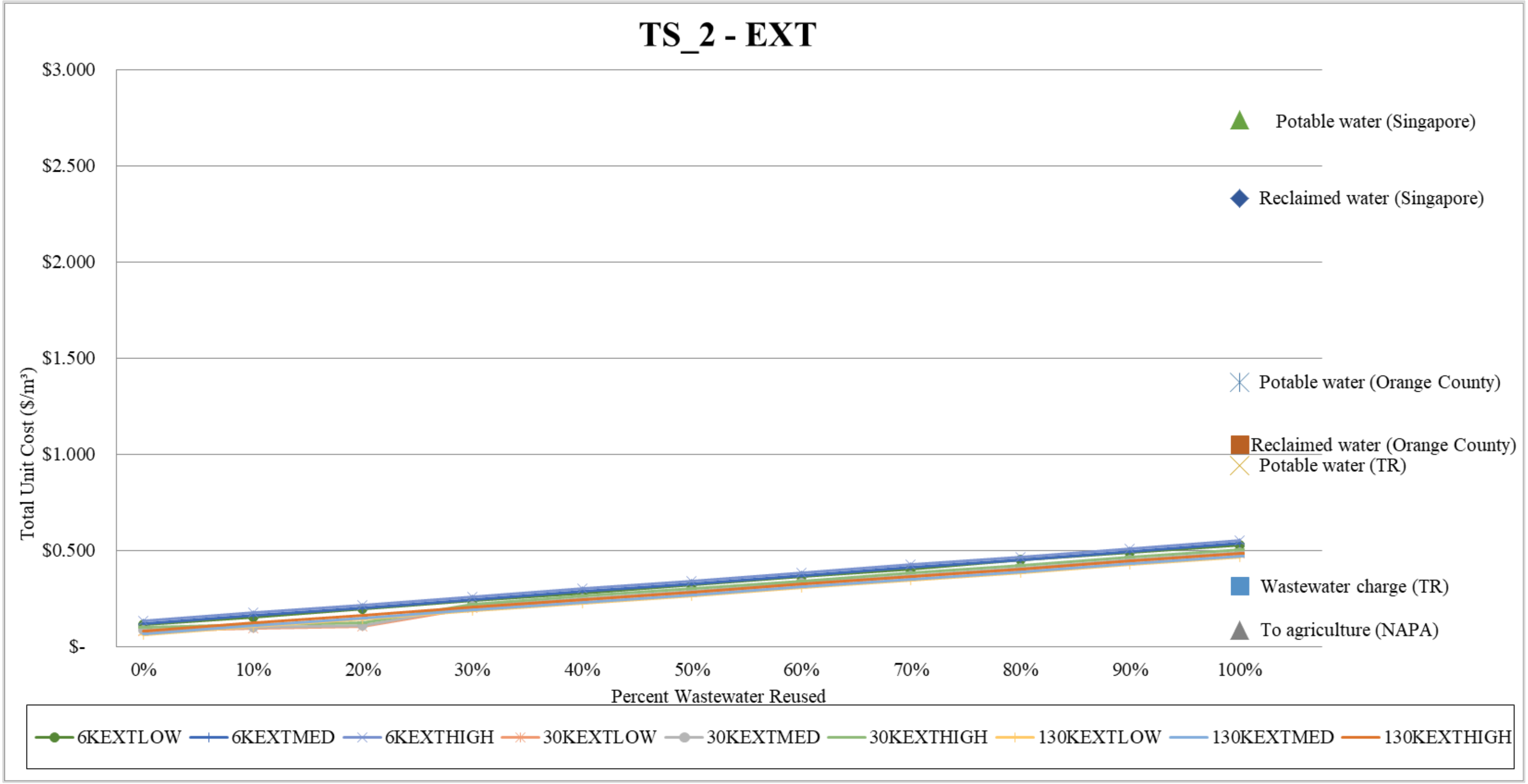

Figure 4-6 Cost comparison for TS_2 – EXT scenarios

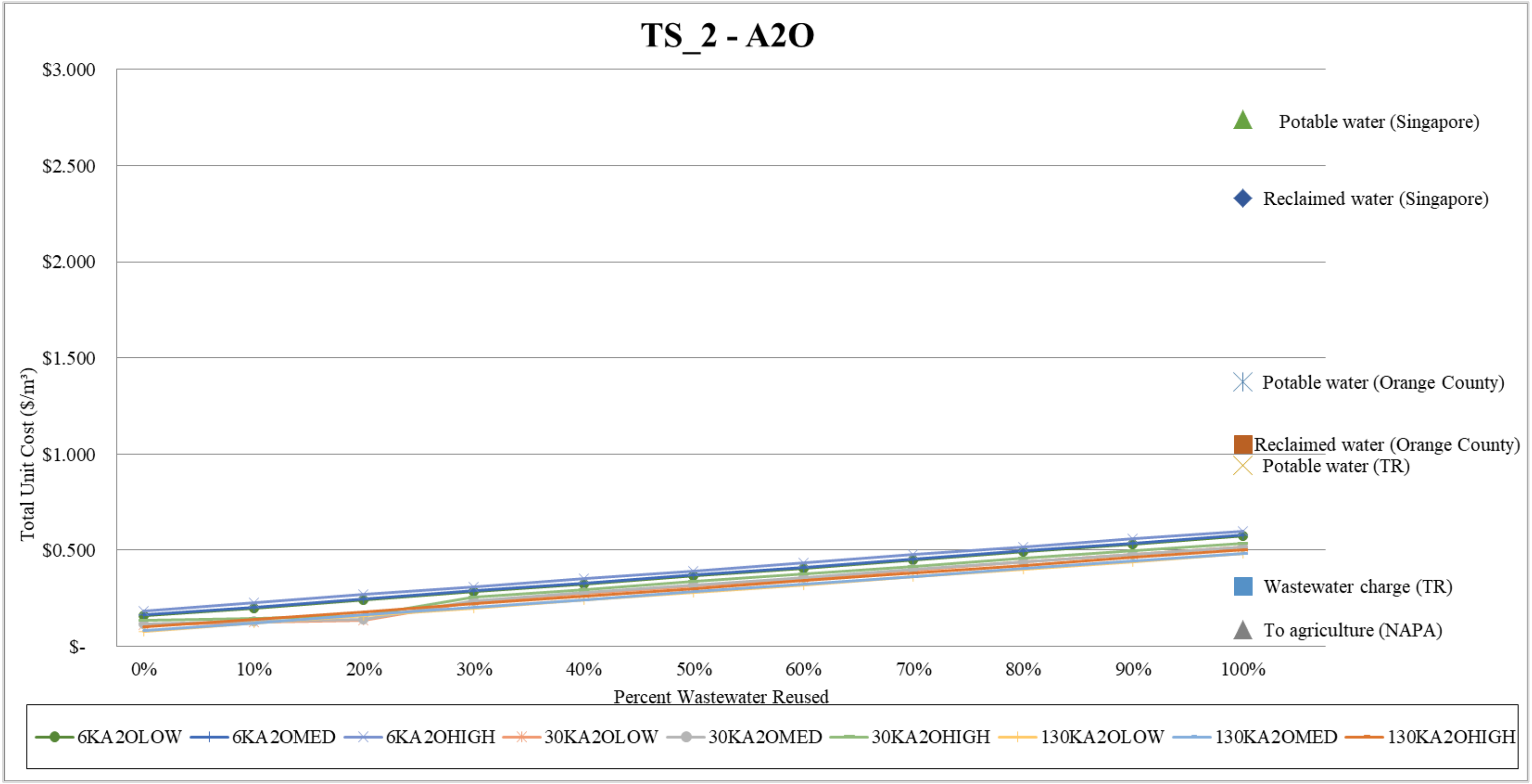

Figure 4-7 Cost comparison for TS_2 – A2O scenarios

4.4.3 Feasibility Analysis of TS_3

In TS_3, the effluent from secondary treatment units, namely CAS, EXT, A2O processes was filtrated at pressurized sand filters or rapid sand filters. After that, it was disinfected with chlorine and UV. The difference from TS_2 is that no SAT was applied in this scheme. With TS_3, reclaimed water could be used as urban reuse in restricted areas after disinfection (Asano et al., 2007; EPA, 2012; Maryam & Büyükgüngör, 2017).

All scenarios for TS_3 - CAS/EXT/A2O costs (\$ 0.138/m³ - \$ 0.300/m³) were lower than the charge of wastewater in Turkey (\$ 0.31/m³) (Figure 4-8, Figure 4-9 and Figure 4-10). So, TS_3 - CAS/EXT/A2O effluent water might be intended to sell for urban reuse in restricted areas, the government still has a profit with current Turkey wastewater charges.

Charge for reclaimed water in Singapore (\$ 2.33/m³) and Orange County (\$ 1.05/m³) is greater than the costs of TS_3 - CAS/EXT/A2O scenarios. If Napa, S. Cyprus cost for irrigation (\$ 0.09/m³) was examined, TS_3 - A2O costs were above after 10 % reused water portion and for TS_3 - CAS/EXT costs were above for all reuse portions.

Nevertheless, considering the Turkey charges, this treatment scheme seems to be a feasible approach to recover wastewater and its further reuse.

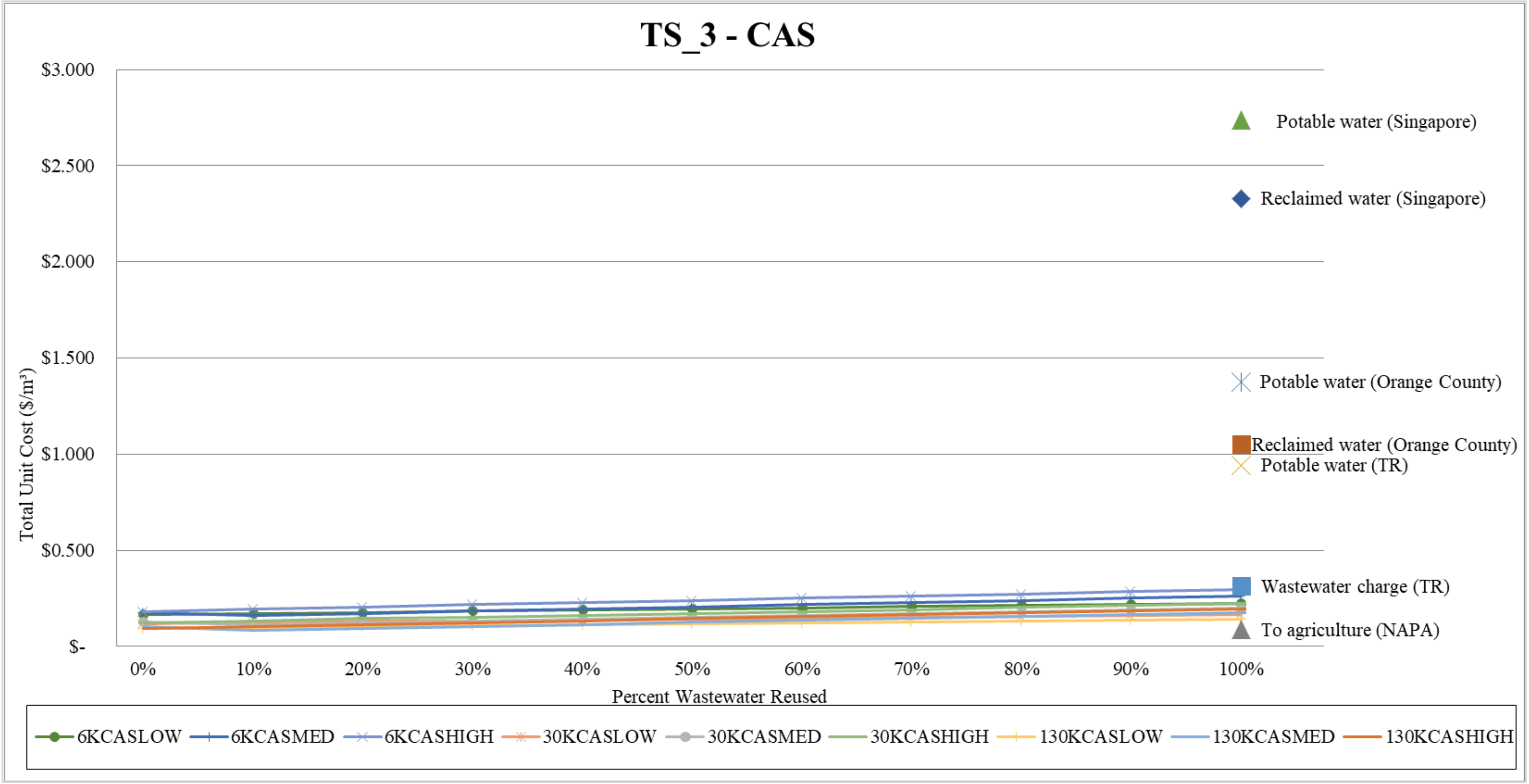

Figure 4-8 Cost comparison for TS_3 – CAS scenarios

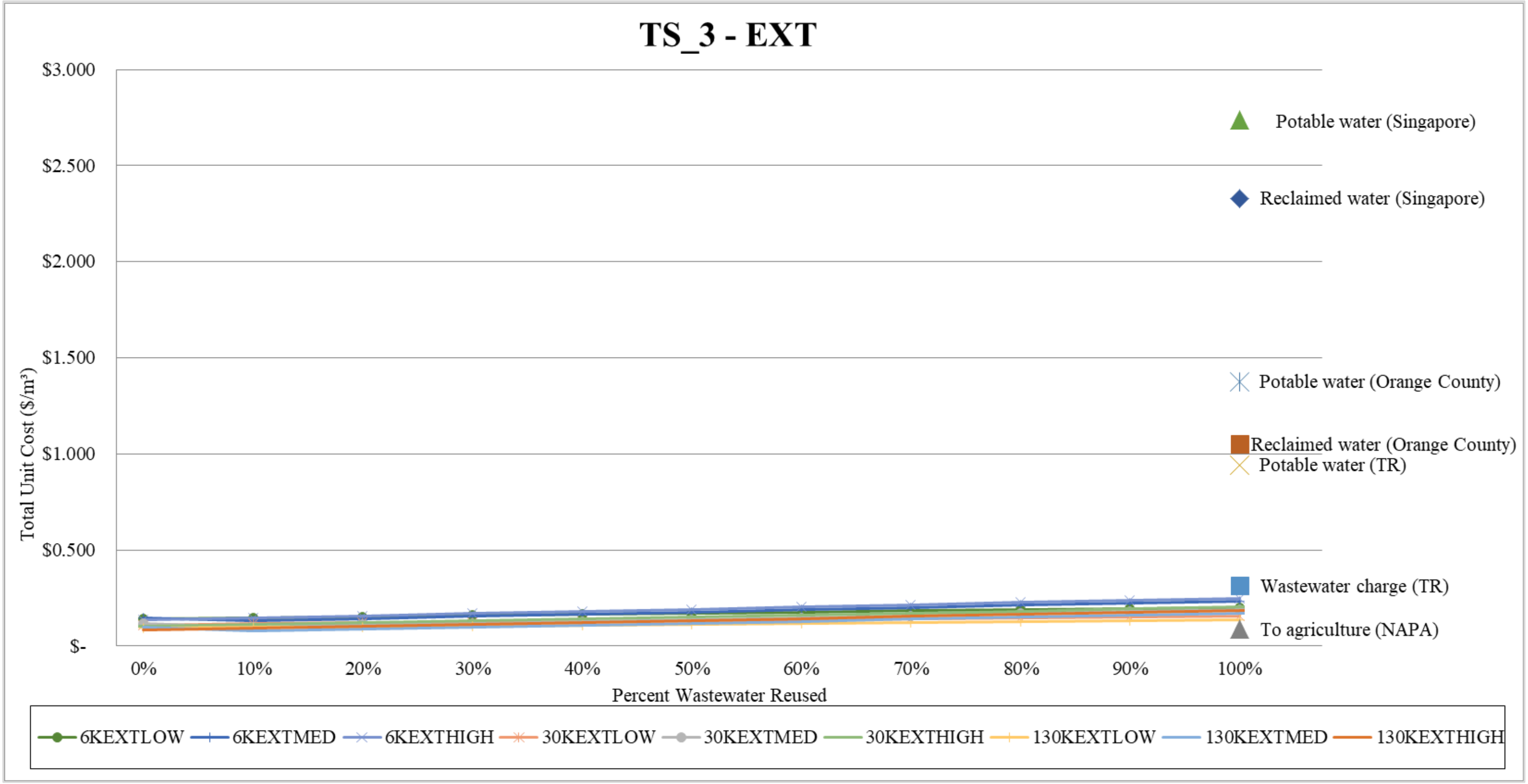

Figure 4-9 Cost comparison for TS_3 – EXT scenarios

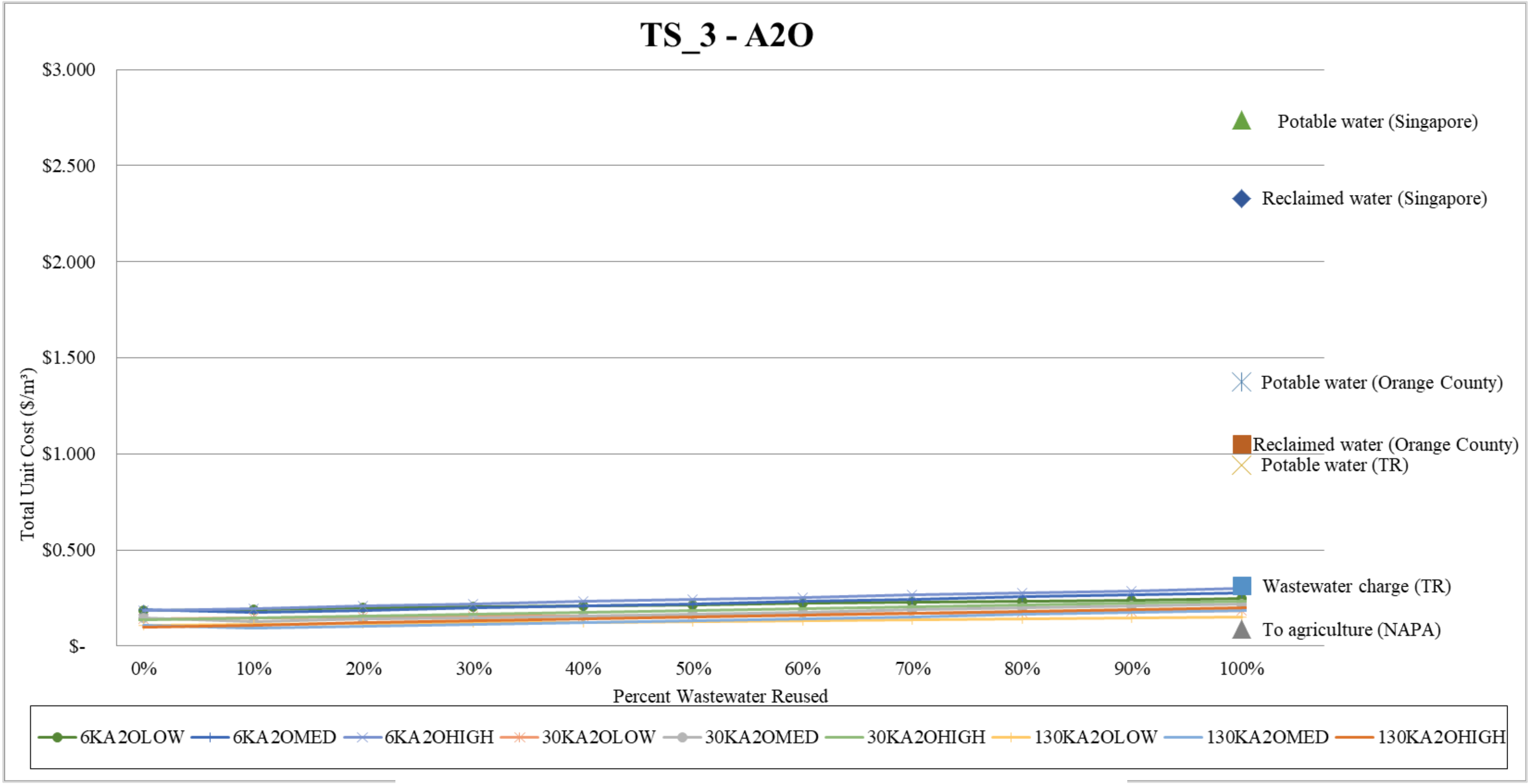

Figure 4-10 Cost comparison for TS_3 – A2O scenarios

4.4.4 Feasibility Analysis of TS_4

In TS_4, the direct effluent from secondary treatment units, namely CAS, EXT, A2O processes were used as reclaimed water. In other words, this is the no-action option; secondary treated water could be used for industrial reuse, once-through cooling (Asano et al., 2007; EPA, 2012). Moreover, groundwater recharge is applicable when the groundwater was used as non-potable purposes, where no human contact was expected (Asano et al., 2007).

TS_4 – CAS/EXT/A2O costs (\$ 0.029/m^3 - \$ 0.150/m^3) were below all the charges of reclaimed water in Singapore (\$ 2.33/m^3), Orange County (\$ 1.05/m^3), Turkey wastewater charges (\$ 0.31/m^3) and Turkey potable water charges (\$ 0.94/m^3) (Figure 4-11, Figure 4-12 and Figure 4-13).

The treatment costs of TS_4 scenarios mentioned below were greater than the Napa, S. Cyprus cost for irrigation (\$ 0.09/m^3).

- 6KCASLOW, 6CASMED, 6KCASHIGH
- 6KEXTLOW, 6KEXTMED, 6KEXTHIGH
- 6KA2OLOW, 6KA2OMED, 6KA2OHIGH, 30KA2OLOW, 30KA2OMED 30KA2OHIGH, 130KA2OLOW, 130KA2OMED, 130KA2OHIGH

TS_4 might be an option if no further treatment was aimed and if area (SAT area requirement is high) or budget (comparably expensive process with conventional ones) is not enough for site-specific conditions.

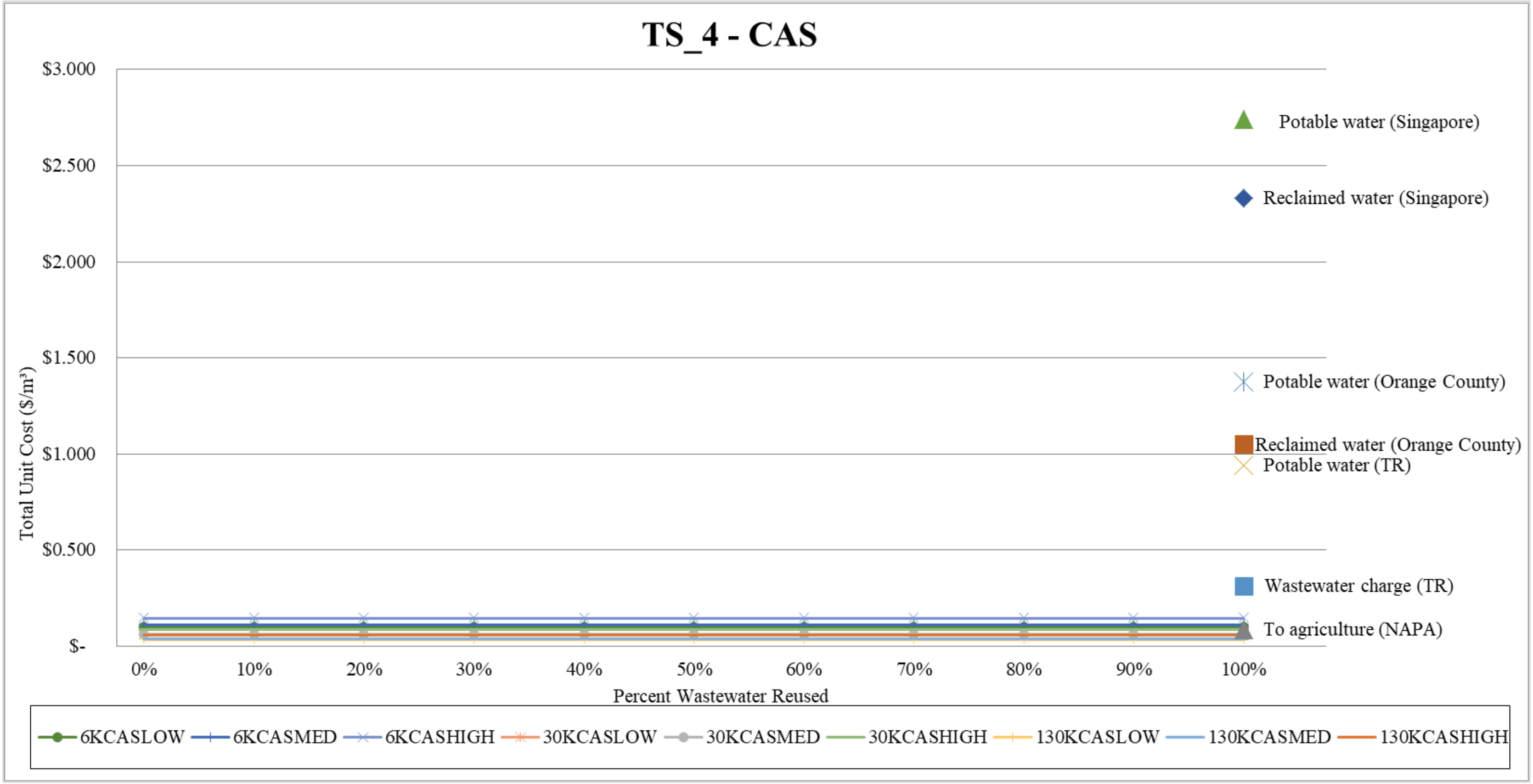

Figure 4-11 Cost comparison for TS_4 – CAS scenarios

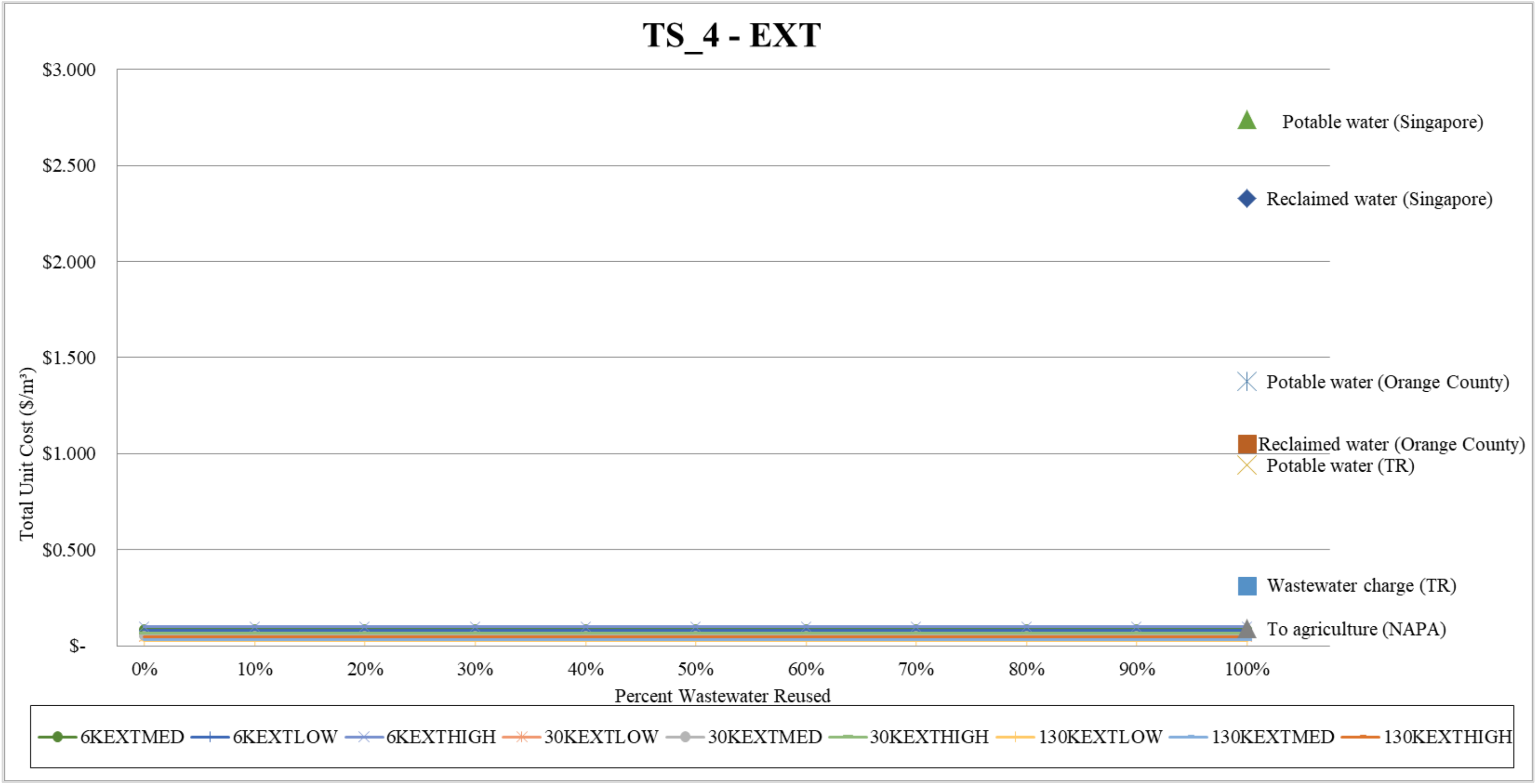

Figure 4-12 Cost comparison for TS_4 – EXT scenarios

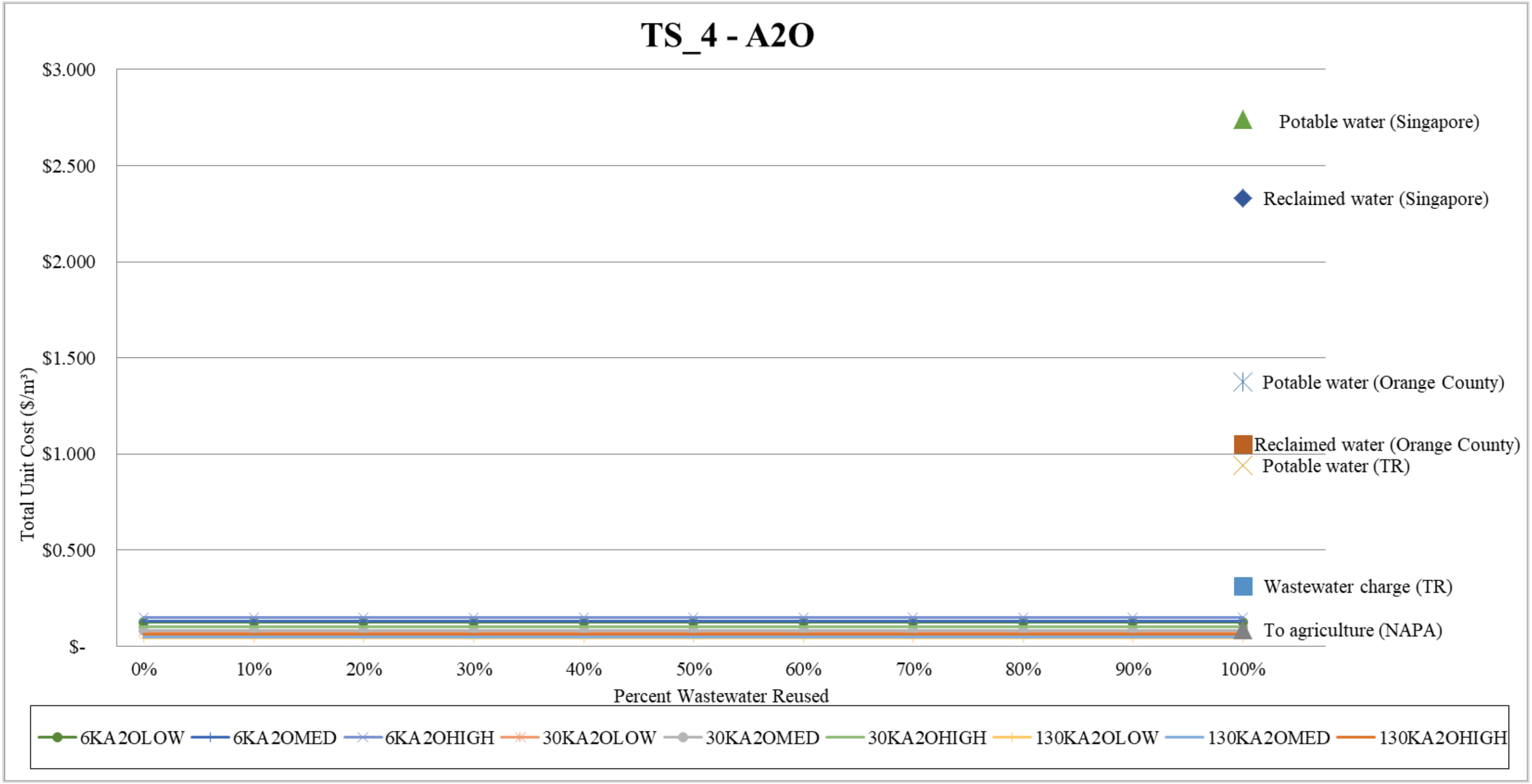

Figure 4-13 Cost comparison for TS_4 – A2O scenarios

4.4.5 Feasibility Analysis of TS_5

In TS_5, effluent from secondary treatment units, namely CAS, EXT, A2O processes, were used as reclaimed water after the disinfection processes with chlorine and UV disinfection. In other words, this is an alternative version of no action option; this process can be integrated into existing plants or newly constructed plants. Effluent reclaimed water could be used in the restricted areas, for agricultural irrigation where processed food crops or non-food crops are planted, in impoundments that have restricted usage and for environmental reuse applications (Asano et al., 2007; EPA, 2012; Maryam & Büyükgüngör, 2017).

TS_5 – CAS/EXT/A2O costs ($ 0.092/m^3 - $ 0.213/m^3) were below all the charges of reclaimed water in Singapore ($ 2.33/m^3), Orange County ($ 1.05/m^3), Turkey wastewater charges ($ 0.31/m^3), Turkey potable water charge ($ 0.94/m^3) and Napa, S. Cyprus cost for irrigation ($ 0.09/m^3) (Figure 4-14, Figure 4-15 and Figure 4-16). TS_5 may be used for all existing treatment plants when proper disinfection was applied.

TS_5 option was found as a cost-effective option where there is a few reuse applications respect to other treatment schemes.

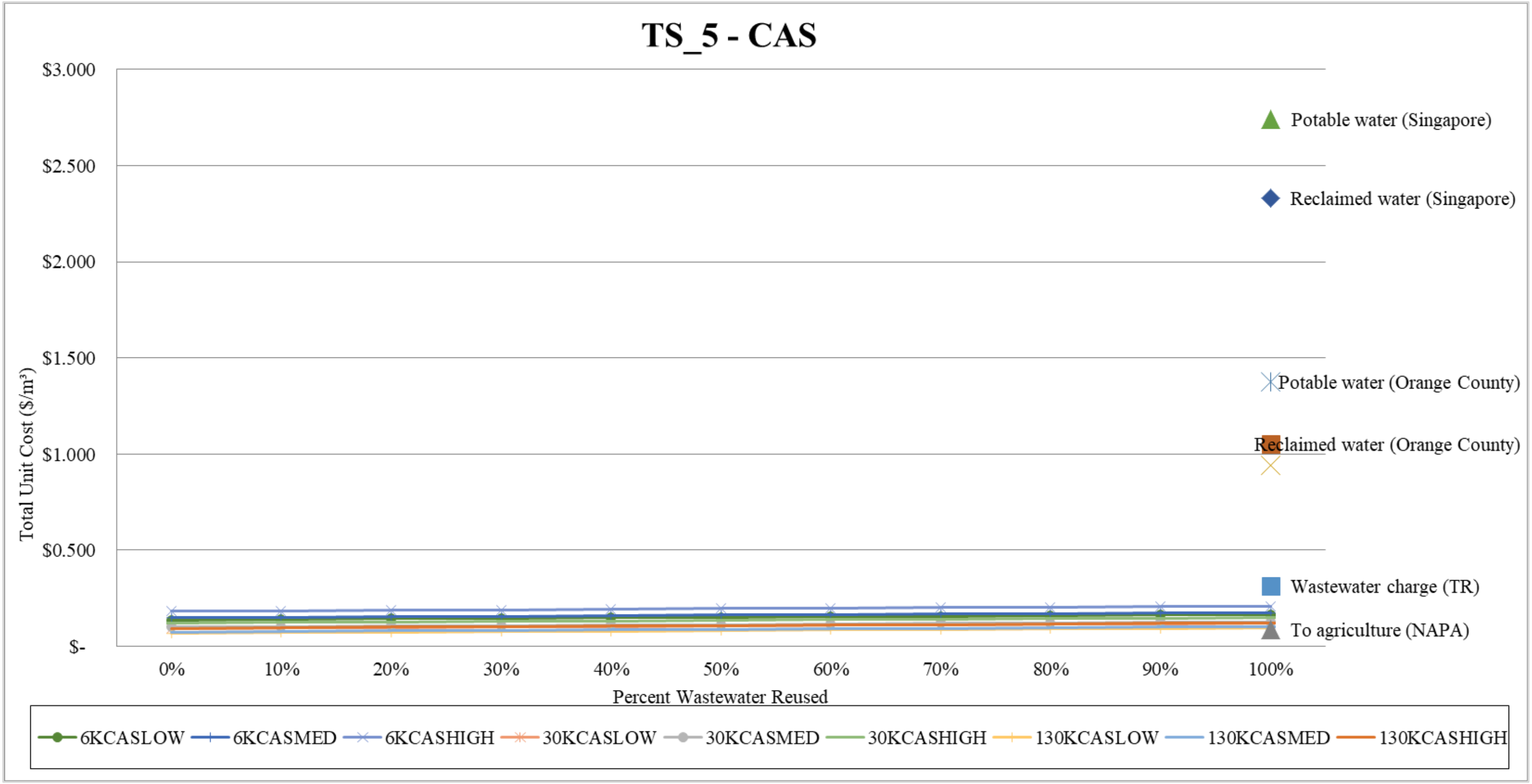

Figure 4-14 Cost comparison for TS_5 – CAS scenarios

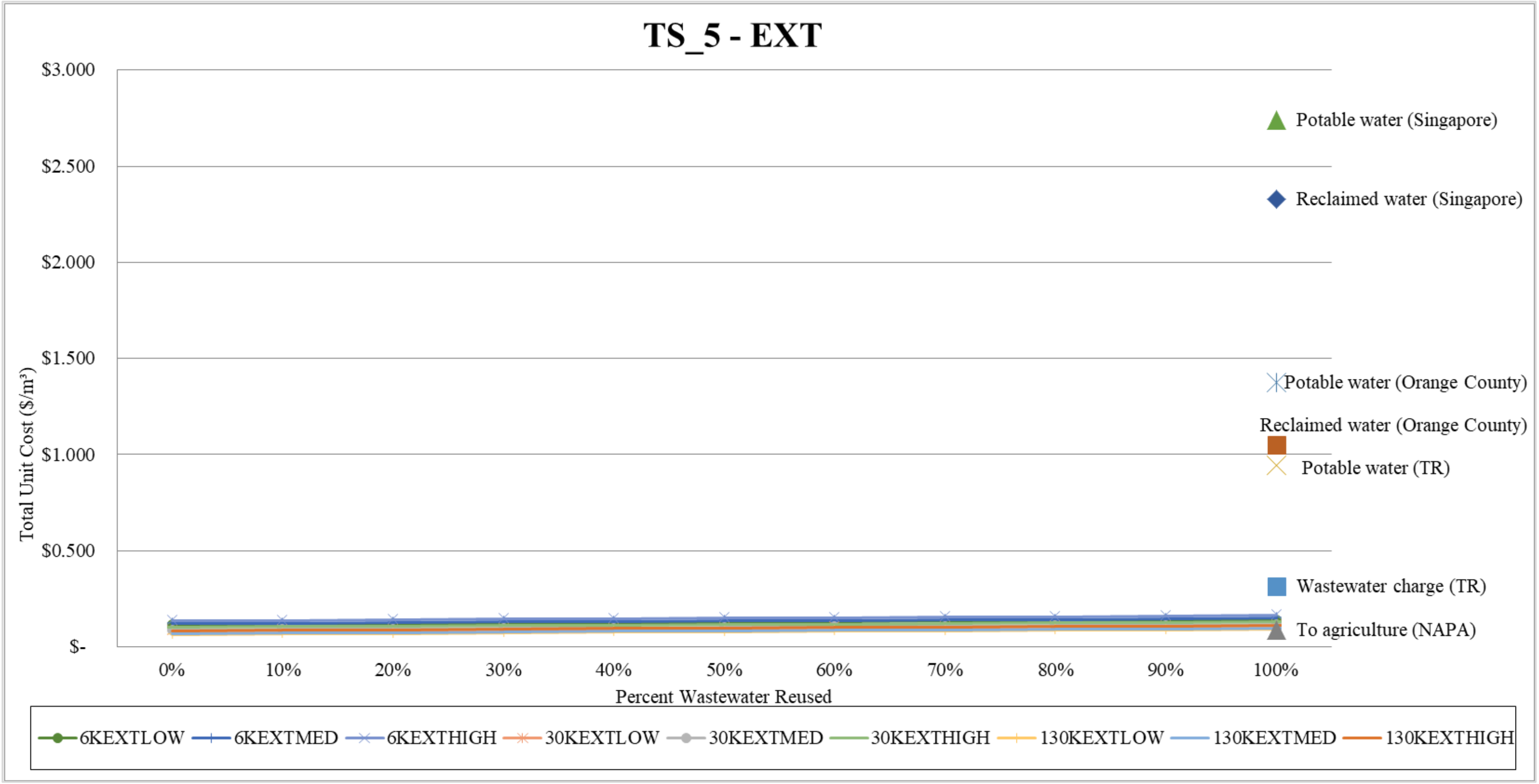

Figure 4-15 Cost comparison for TS_5 – EXT scenarios

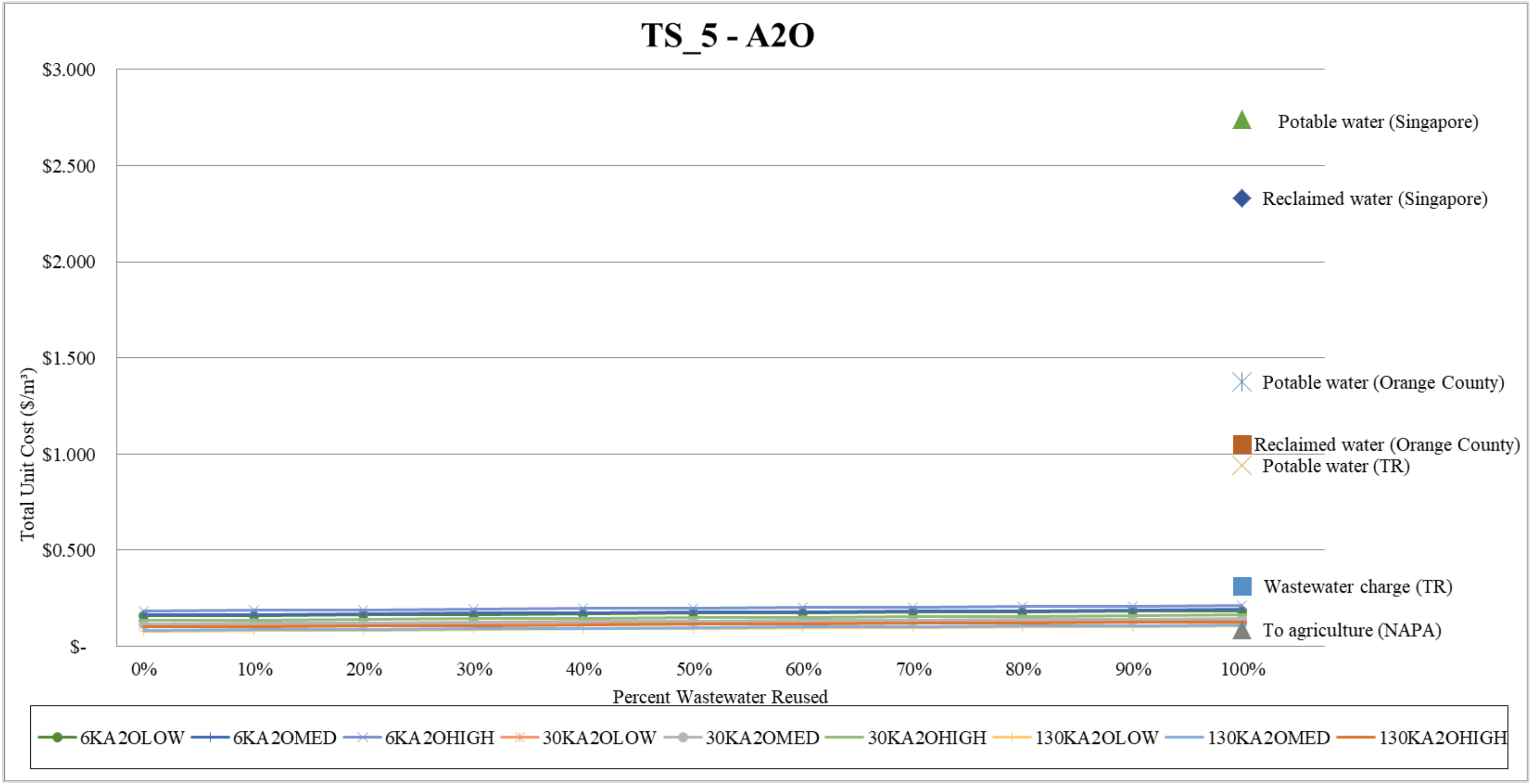

Figure 4-16 Cost comparison for TS_5 – A2O scenarios

4.4.6 Feasibility Analysis of TS_6

TS_6 was a sophisticated scheme and effluent quality was expected to be higher than the other treatment schemes. In TS_6, the secondary effluent of A2O process was further treated with Micro disc filters (MDF) and reverses osmosis (RO), and then disinfected with chlorine and UV. The effluent can be used for indirect potable reuse purposes and groundwater recharge by injection into potable aquifers and augmentation of surface water supply reservoirs (Asano et al., 2007; Iglesias et al., 2010; Maryam & Büyükgüngör, 2017; Roccaro, 2018).

The water quality obtained from this scheme was higher than the irrigation water quality, so Napa, S. Cyprus cost ($ 0.09/m³) with TS_6 – A2O costs ($ 0.220/m³ - $ 0.326/m³) were not compared.

TS_6 – A2O scenario costs are lower than Turkey wastewater charges ($ 0.31/m³), except for the cases mentioned below (Figure 4-17).

- TS_6 – 6KA2OLOW with the reused water portion above 70 %
- TS_6 – 6KA2OMED with the reused water portion above 70 %
- TS_6 – 6KA2OHIGH with the reused water portion above 60 %
- TS_6 – 30KA2OLOW with the reused water portion of 100 %
- TS_6 – 30KA2OMED with the reused water portion above 90 %
- TS_6 – 30KA2OHIGH with the reused water portion above 90 %
- TS_6 – 130KA2OHIGH with the reused water portion of 100 %

When potable and reclaimed water costs in Singapore ($ 2.74/m³and $ 2.33/m³) and Orange County ($ 1.37/m³ and $ 1.05/m³) were evaluated, they were far greater than calculated TS_6 – A2O costs ($ 0.282/m³ - $ 0.388/m³). Although Singapore and Orange County use similar treatment processes, the difference in operational and maintenance costs may differ in different countries. This may be the reason why potable and the reclaimed cost difference between Singapore and Orange County with this thesis results.

TS_6 – A2O scheme is an expensive process. Although treatment costs are high, TS_6 treatment costs are still lower than Turkey wastewater charges ($ 0.31/m^3) for all scenarios with exceptions. Therefore, TS_6 is applicable and economically feasible.

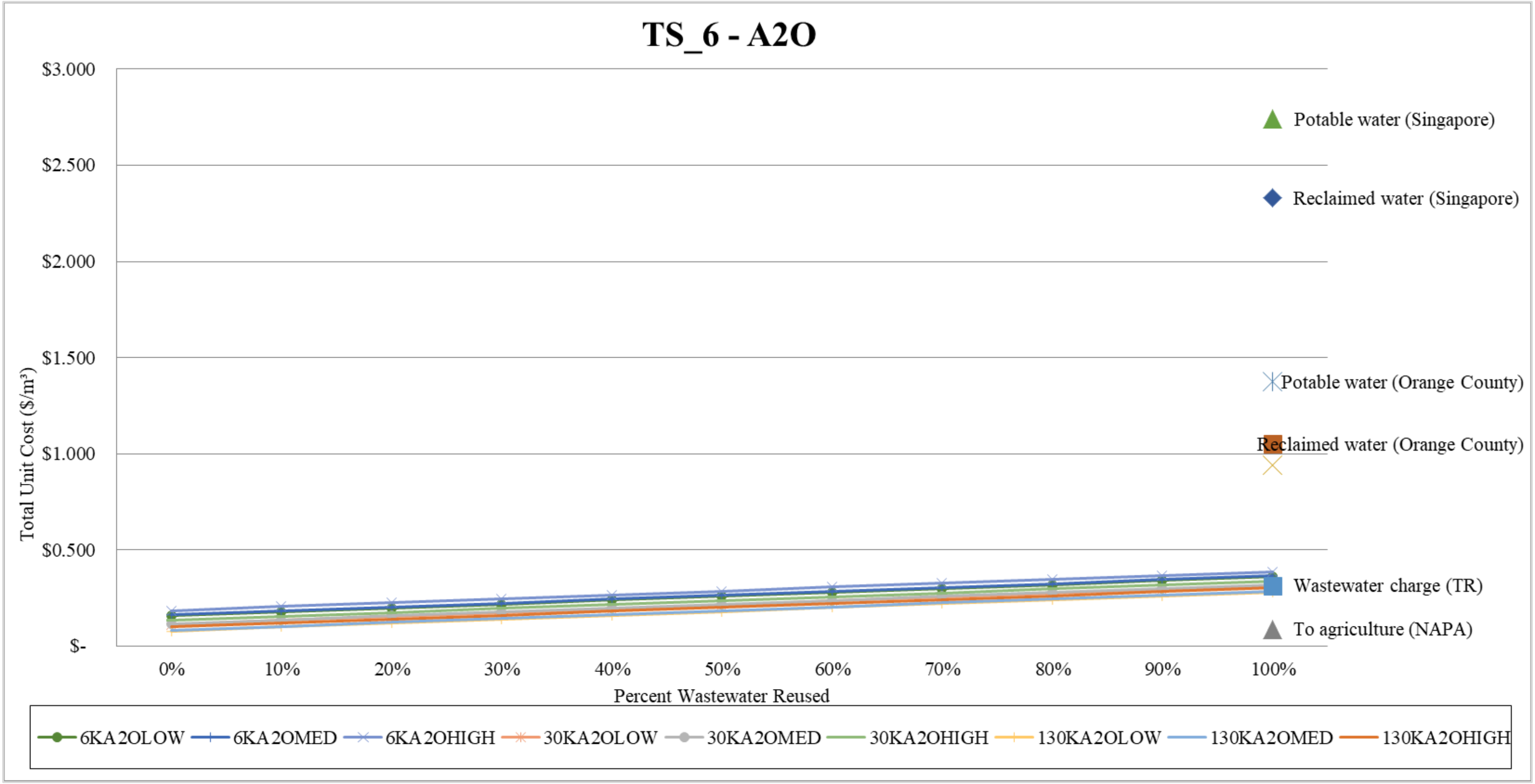

Figure 4-17 Cost comparison for TS_6 – A2O scenarios

Briefly, it can be concluded that depending on the application and water reuse percentage, reclaimed water costs will change. The decision-maker can select the wastewater treatment scheme after deciding on the application and how much reclaimed water is needed by considering Section 3.3, Table 3-9 and Section 3.3, Table 4-7. These results can be adapted to newly constructed or existing treatment plants as well.

In Spain, the cost of treatment of reclaimed water changes between \$ 0.070/m^3 to \$ 0.740/m^3, which was similar to this study where it ranges within \$ 0.044/m^3 to \$ 0.598/m^3 (Villar, 2018). The difference in water charges compromised from different treatment levels (Villar, 2018). Also, in the same study of Villar (2018), reclaimed water distribution costs were found between \$ 0.410/m^3 and \$ 0.920/m^3. As mentioned earlier, in this thesis, the collection of wastewater and distribution of reclaimed water costs were not included. By considering Villar's research, it is seen that the collection and distribution costs were large parts of the total reclaimed cost. Therefore, if this thesis is implemented in real-life cases, wastewater collection and reclaimed water distribution costs should be also considered.

4.5 Discussions of the Results Based on Turkey

In Turkey, wastewater reclamation is a relatively new topic. The importance and implementation are not fully understood. The marketing, engineering assessment and cost analysis of the water reuse alternatives are still in progress. Public acceptance can be another handicap for water reclamation in Turkey. Even if these issues are solved, future studies are required to spot the cost of reclaimed water.

As mentioned earlier, water reuse applications were site-specific. Depending on the need, reclaimed water can be used with cost-efficient approaches. Wastewater reclamation applications are not high in number, where the potential for water reuse in Turkey is enormous. Agricultural water use in Turkey has the most extensive section of water consumption (Maryam & Büyükgüngör, 2017). For arid cities such as Konya, Ankara and Kırklareli, water reclamation for irrigation could be further investigated. Within this scope of this thesis, unit and total treatment costs were already found. The user could decide on the related treatment scheme (TS_ 1 or TS_5 for Konya, Ankara and Kırklareli) that corresponds to the existing wastewater treatment plants in the investment step. Depending on the treatment scheme, the construction of new units/ technologies, if needed, may be on the table. For cities like Kocaeli and İzmir, where industrial activities exist in general, TS_4, the direct usage of secondary effluent, can be selected to use in these sectors with a cost-efficient approach.

Also it should be noted that water reuse for irrigation purposes is the most practical application for Turkey. Many of the cities whose own extensive agricultural lands own irrigation channels transmit the irrigation water to all agricultural lands. If the reuse application of agricultural use is selected, existing irrigational channels can transmit the reclaimed water. No further distribution costs will appear like pumping station costs or electricity costs for pumping the reclaimed water.

Not only in Turkey but also in other countries, wastewater characteristics may be different from design values. In this study, three strengths that were low, medium and high strength were considered from literature values (Tchobanoglus et al., 2014). But not all the time, these characteristics fit real-world wastewater characteristics when the WWTP operates. The change can be because of infiltration in the collection system or misunderstanding of wastewater parameters in the design step. Alteration in some outcomes of this thesis was observed when the influent characteristics varied. Tank volumes, effluent concentrations, sludge amounts depending on the TSS amount and following by sludge amounts, sludge costs and chemical costs were changed with influent characteristics. Sludge costs and chemical costs were evaluated under operational costs in cost analysis section for secondary treatment level. It was mentioned earlier that, rather than capital costs, operational costs specified the total treatment cost. Consequently, the user should be aware of that estimated costs in this thesis were calculated for wastewater strengths in literature values. For case-specific wastewater characteristics, a new set of calculations should be needed for case-specific realistic results.

CHAPTER 5

SUMMARY, CONCLUSIONS AND FUTURE RECOMMENDATIONS

The purpose of this study was to evaluate different wastewater treatment schemes for a range of water reuse applications through modeling and cost analysis. At the end of this study, the decision-maker is empowered to make a cost-benefit decision on which process to follow depending on the water reuse application in case-specific situations like different wastewater flowrates and characteristics on newly constructed or existing plants that will be retrofit.

5.1 Summary and Conclusions Based on Secondary Treatment Level

In the first part of the study, a cost analysis was done on secondary treatment. Schemes were selected considering the wastewater treatment plant pattern in Turkey to address real-life cases. Scenarios were selected by using TS_A (CAS), TS_B (EXT) and TS_C (A2O) treatment schemes with three flowrates (6000 m^3/day, 30000 m^3/day and 130000 m^3/day) and strengths (low, medium and high-strength wastewater). Models were constructed at BioWin with necessary data for cost analysis. At the end of secondary treatment level cost analysis, the following results were obtained.

- Higher capacity treatment plants had lower unit costs in the 30 year period for each of the secondary treatment level used (TS_A, TS_B, TS_C).
- Treatment schemes with high-strength wastewater resulted in the highest unit cost, while low-strength wastewater unit cost was the lowest for every scenario.
- Total costs of treatment schemes in descending order were TS_C, TS_A and TS_B for all flowrate and strength scenarios.
    - Capital costs in descending order were TS_A, TS_C and TS_B.

- Operation and maintenance costs in descending order were TS_C, TS_A and TS_B.

Within this scope of this thesis, change in inflation rate on total unit cost of treatment was also calculated. Total unit treatment costs for USA inflation rate (2.08 %) were higher than Turkey inflation rate (9.86 %). Then, it was observed that increasing inflation rate results in lower total unit treatment costs.

5.2 Summary and Conclusions Based on Tertiary and Advanced Treatment Level

In the second part of the study, cost analyses were done on tertiary and advanced treatment and disinfection processes. It should be noted that, different from modeling of secondary level treatment, removal efficiencies for selected technologies for tertiary and advanced treatment were assumed to be attained according to literature values. Similarly, the 30 year period cost analyses were performed. At the end of the tertiary and advanced treatment and disinfection cost analyses, the following results were obtained.

- Among disinfection processes, UV disinfection (\$ 0.029/m^3) had lower unit cost than chlorine disinfection (\$ 0.036/m^3).
- In filtration, pressurized sand filters (\$ 0.087/m^3) were more expensive than rapid sand filters (\$ 0.074/m^3). However, both were applied for different capacities of wastewater treatment plants.
- In membrane filtration, costs in descending order were reverse osmosis (\$ 0.123/m^3) and micro disk filter (\$ 0.055/m^3).

5.3 Summary and Conclusions of Feasibility of Wastewater Treatment Schemes and Water Reuse Applications

In the last part of the study, cost analyses were done with the calculated secondary, tertiary, advanced treatment and disinfection processes costs for the following six treatment scenarios (TS_1 to TS_6) determined for reuse purposes.

Treatment Scheme No.	Treatment Scheme Configurations	Reuse Applications
TS_1	A2O + Filtration + Disinfection (Cl and UV)	• Urban Reuse – Unrestricted • Agricultural Reuse – Food Crops • Impoundments – Unrestricted
TS_2	CAS/EXT/A2O + Filtration + Disinfection (Cl and UV) + SAT	• Indirect Potable Reuse – Groundwater Recharge by Spreading into Potable Aquifers
TS_3	CAS/EXT/A2O + Filtration + Disinfection (Cl and UV)	• Urban Reuse – Restricted
TS_4	A2O/CAS/EXT	• Industrial Reuse – Once-through Cooling • Groundwater Recharge – Non-potable Reuse
TS_5	CAS/EXT/A2O + Disinfection (Cl and UV)	• Urban Reuse – Restricted • Agricultural Reuse – Processed Food / Nonfood Crops • Impoundments – Restricted • Environmental Reuse
TS_6	A2O + MF + RO + Disinfection (Cl and UV)	• Indirect Potable Reuse – Groundwater Recharge by Injection into Potable Aquifers • Indirect Potable Reuse – Augmentation of Surface Water Supply Reservoirs

- In TS_1, the effluent is aimed to use in unrestricted area irrigation or agricultural reuse. With altered reuse percentage (0-100 % of effluent to be reused),
    - Unit cost for TS_1 – A2O scenarios changed between \$ 0.180/m^3 (TS_1 – 130KA2OLOW) and \$ 0.300/m^3 (TS_1 – 6KA2OHIGH).
- In TS_2, effluent can be used in indirect potable usage like groundwater recharge by spreading into potable aquifers. With altered reuse percentage (0-100 % of effluent to be reused),

- Unit cost for TS_2 – CAS scenarios changed between $ 0.470/m³ (TS_2 – 130KCASLOW) and $ 0.598/m³ (TS_2 – 6KCASHIGH).
- Unit cost for TS_2 – EXT scenarios changed between $ 0.446/m³ (TS_2 – 130KEXTLOW) and $ 0.550/m³ (TS_2 – 6KEXTHIGH).
- Unit cost for TS_2 – A2O scenarios changed between $ 0.481/m³ (TS_2 – 130KA2OLOW) and $ 0.601/m³ (TS_2 – 6KA2OHIGH).

- In TS_3, with this treatment process, reclaimed water can be used for urban reuse in restricted areas. With altered reuse percentage (0-100 % of effluent to be reused),
  - Unit cost for TS_3 – CAS scenarios changed between $ 0.142/m³ (TS_3 – 130KCASLOW) and $ 0.297/m³ (TS_3 – 6KCASHIGH).
  - Unit cost for TS_3 – EXT scenarios changed between $ 0.138/m³ (TS_3 – 130KEXTLOW) and $ 0.249/m³ (TS_3 – 6KEXTHIGH).
  - Unit cost for TS_3 – A2O scenarios changed between $ 0.153/m³ (TS_3 – 130KA2OLOW) and $ 0.300/m³ (TS_3 – 6KA2OHIGH).
- In TS_4, effluent from secondary treatment can be used for industrial reuse purposes and once-through cooling. With altered reuse percentage (0-100 % of effluent to be reused),
  - Unit cost for TS_4 – CAS scenarios changed between $ 0.034/m³ (TS_4 – 130KCASLOW) and $ 0.147/m³ (TS_4 – 6KCASHIGH).
  - Unit cost for TS_4 – EXT scenarios changed between $ 0.029/m³ (TS_4 – 130KEXTLOW) and $ 0.100/m³ (TS_4 – 6KEXTHIGH).
  - Unit cost for TS_4 – A2O scenarios changed between $ 0.044/m³ (TS_4 – 130KA2OLOW) and $ 0.150/m³ (TS_4 – 6KA2OHIGH).
- In TS_5, effluent reclaimed water can be used in the restricted areas, for agricultural irrigation where processed food crops or non-food crops are planted, in impoundments that have restricted usage and for environmental reuse applications. With altered reuse percentage (0-100 % of effluent to be reused),

  - Unit cost for TS_5 – CAS scenarios changed between \$ 0.107/m³ (TS_5 – 130KCASLOW) and \$ 0.213/m³ (TS_5 – 6KCASHIGH).
  - Unit cost for TS_5 – EXT scenarios changed between \$ 0.092/m³ (TS_5 – 130KEXTLOW) and \$ 0.162/m³ (TS_5 – 6KEXTHIGH).
  - Unit cost for TS_5 – A2O scenarios changed between \$ 0.096/m³ (TS_5 – 130KA2OLOW) and \$ 0.210/m³ (TS_5 – 6KA2OHIGH).
- In TS_6, the effluent is high-quality water, which can be used in indirect potable reuse and groundwater recharge by injection into potable aquifers and augmentation of surface water supply reservoirs. With altered reuse percentage (0-100 % of effluent to be reused),
  - Unit cost for TS_6 – A2O scenarios changed between \$ 0.282/m³ (TS_6 – 130KA2OLOW) and \$ 0.388/m³ (TS_6 – 6KA2OHIGH).

A feasibility analysis was done for six treatment schemes (TS_1 to TS_6). At the end of the feasibility analysis, the user can select the optimum wastewater treatment scheme with respect to the reuse application.

Cost analysis revealed that the unit cost of the reclaimed water changed with respect to the water reuse application. The origin of the difference in unit costs was related to the potential contact of the people with the reclaimed water during the applications. In other words, the possibility of contact with humans increased the unit cost of reclaimed water because precautions taken are much higher due to health concerns.

In TS_1, TS_3, TS_4 and TS_5, unit costs of reclaimed water which were around \$ 0.100/m³ to \$ 0.300/m³, were relatively lower than those of TS_2 and TS_6. These four schemes could be used in unrestricted area irrigation or agricultural reuse or urban reuse in the restricted area; the common point is that direct contact with human is not aimed. Subsequently, if the user has a lower budget for water reuse application, TS_1, TS_3, TS_4 and TS_5 are appropriate for site-specific use. Another point is that these four treatment schemes are readily available for retrofitting existing treatment plants without further costs.

In TS_2 and TS_6, reclaimed water could be used in potable usage where direct human contact is highly possible. In these treatment schemes, a higher level of water quality was needed. Then, higher costs are not unavoidable, which was changing between \$ 0.220/m^3 and \$ 0.601/m^3. In these two treatment schemes, the budget was the primary concern; also, land availability was another factor that cannot be ignored.

Another aspect is that treated water from the secondary level WWTP does not need to be further treated with different processes. Partial further treatment of secondary treated water is always possible. With this approach, the budget does not have to be enormous for large scale treatment plants. Part of the secondary treated water can be used for selected water reuse applications, after tertiary and/or advanced treatment if necessary, with a minor budget.

Wastewater reclamation and reuse are driven by not only water scarcity and economic reasons but also policy factors. As it can be found in this thesis, wastewater reclamation needs considerable first investment cost, followed by high operational costs. The price of the reclaimed water should be kept low to sell reclaimed water to the public. The production cost of reclaimed water should be even lower than the treatment cost. The government should not gain profit while selling reclaimed water (Lyu et al., 2016).

Another critical point is the effect of water reclamation on human health. Complete removal of emerging contaminants is not available with biological treatment. Longer SRT in activated sludge systems, nitrifying and heterotrophic bacteria may play a crucial role in the removal of emerging contaminants. Reverse osmosis, nanofiltration, activated carbon and advanced oxidation processes can achieve higher removal efficiencies after the activated sludge process (Diaz-Elsayed et al., 2019; EPA, 2009).

5.4 Future Recommendations

It is believed that the results of this thesis hopefully are significant for pointing out the appropriate and economical selection of wastewater treatment schemes for a specific water reuse application. For further studies, it is highly recommended to involve the costs for the collection of wastewater and the distribution of reclaimed water. It is also recommended to involve sludge disposal and usage for treatment schemes. Furthermore, it is recommended that the related ministries should involve in this concept and inspire the customers to use reclaimed water, where this study supports that the treatment scheme to achieve reclaimed water quality does not always need an enormous budget.

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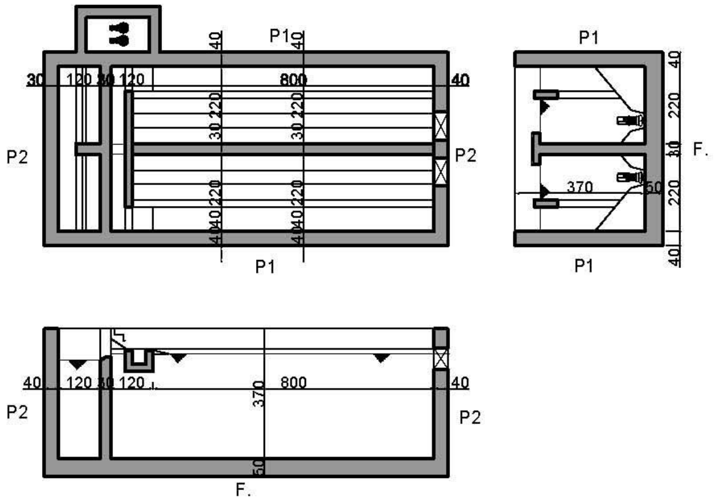
APPENDICES

A. WWTP Capacities, Population And Wastewater Generated in Metropolitan Cities in Turkey (TUIK, 2018a, 2018b)

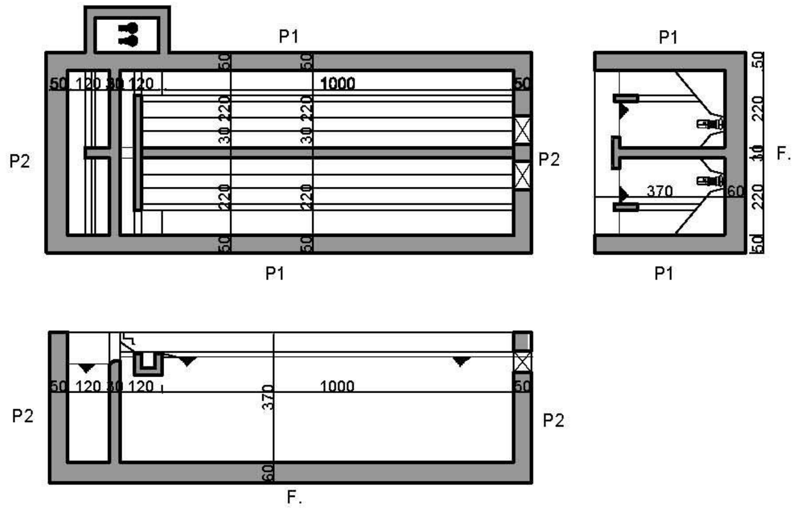
Metropolitan Cities	WWTP Name	Population 2017 (capita)	Capacity (m^3/day)	WW discharge to WWTPs L/day.capita (TUIK, 2018b)	WW discharge by WWTPs m^3/day
Adana	Seyhan WWTP (Batı)	800,387	227,000	163	130,463
	Yüreğir WWTP (Doğu)	424,999	128,000	163	69,275
Ankara	ASKİ Tatlar WWTP	4,872,064	765,000	162	789,274
Antalya	Hurma WWTP	752,834	210,000	277	208,535
	Lara WWTP	488,670	31,250	277	135,362
Aydın	Doğu WWTP	287,518	53,831	245	70,442
Balıkesir	Balıkesir WWTP	355,972	67,117	153	54,464
Bursa	Doğu WWTP	1,504,290	240,000	134	201,575
	Batı WWTP	424,909	87,500	134	56,938
	İnegöl WWTP	257,931	130,000	134	34,563
Denizli	Denizli Merkez WWTP	295,699	150000	181	53,522
Diyarbakır	Diyarbakır WWTP	1,047,286	175,000	81	84,830
Erzurum	Erzurum B. Bel. ESKİ WWTP	422,389	130,416	121	51,109
Eskişehir	ESKİ WWTP	752,630	105,000	159	119,668
Gaziantep	Gaziantep Merkez WWTP	760,849	200,000	187	142,279
Hatay	HATSU Antakya WWTP	517,288	28,800	193	99,837
İstanbul	Ambarlı WWTP	435,682	400,000	226	98,464
	Paşaköy WWTP	402,391	100,000	226	90,940
	Tuzla WWTP	252,923	150,000	226	57,161
	Ataköy WWTP	222,370	390,000	226	50,256

Metropolitan Cities	WWTP Name	Population 2017 (capita)	Capacity (m^3/day)	WW discharge to WWTPs L/day.capita (TUIK, 2018b)	WW discharge by WWTPs m^3/day
	Büyükçekmece WWTP	75,517	132,155	226	17,067
İzmir	İZSU Kuzey (Çiğli) Bölgesi WWTP	2,907,117	604,800	195	566,888
K.maraş	K.maraş Merkez WWTP	632,487	110,000	197	124,600
Kayseri	Kayseri WWTP	1,123,759	110,000	150	168,564
Kocaeli	Gebze WWTP	368,278	144,000	191	70,341
	Plajyolu WWTP	360,409	99,000	191	68,838
	Körfez WWTP	162,230	93,000	191	30,986
	Gölcük Yeniköy WWTP	161,117	81,000	191	30,773
	Kullar WWTP	93,988	93,000	191	17,952
Konya	KOSKİ WWTP	1,301,222	200,000	182	236,822
Malatya	MASKİ WWTP	618,831	135,000	221	136,762
Manisa	Merkez WWTP	400,686	160,000	153	61,305
Mardin	Güney (Kızıltepe) WWTP	365,395	64,749	67	24,481
Mersin	MESKİ Karaduvar WWTP	817,919	189,523	174	142,318
Muğla	Muğla WWTP	109,979	17,111	254	27,935
Ordu	Durugöl WWTP	213,582	213,000	166	35,455
Sakarya	Karaman WWTP	575,604	198,000	214	123,179
Samsun	SASKİ Samsun Doğu WWTP	676,845	110,000	158	106,942
Şanlıurfa	ŞUSKİ B.B. WWTP	1,024,215	144,833	210	215,085
Tekirdağ	Çorlu WWTP	321,318	60,000	98	31,489
	Çerkezköy WWTP	270,200	52,800	98	26,480
Van	TUŞBA WWTP	457,513	103680	191	87,385
	TOTAL	**28,317,292**	**6,884,565**	**-**	**4,950,601**

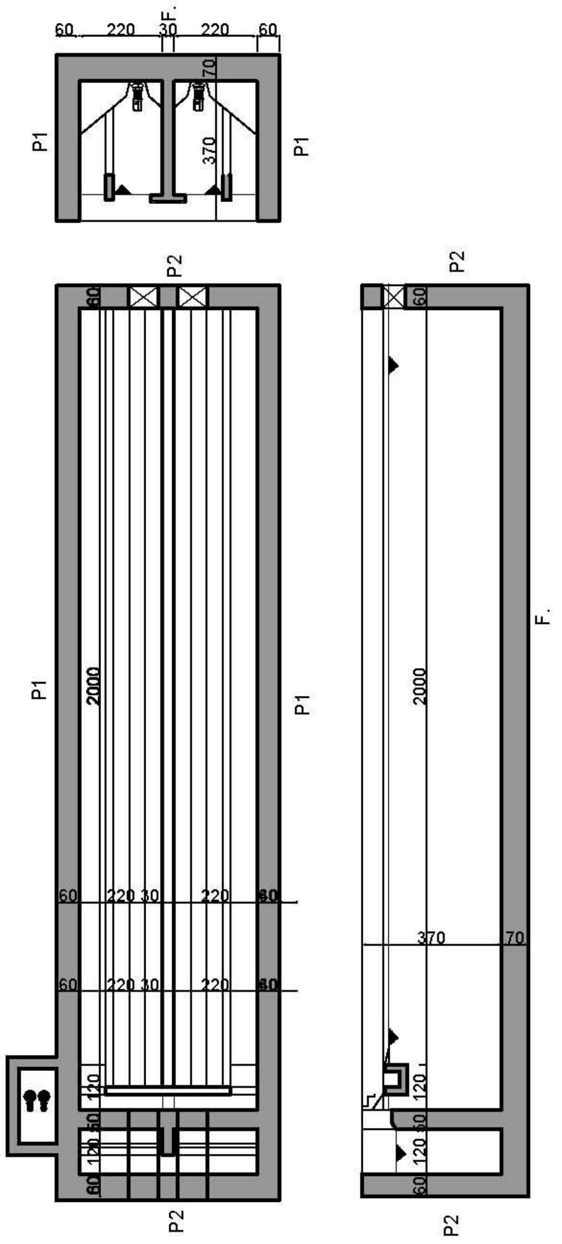
B. Drawings of Secondary Treatment Unit



FLOW	6K
TS	CAS , EXT, A2O
UNIT	GRIT CHAMBER
SCALE	1/500



FLOW	30K
TS	CAS , EXT, A2O
UNIT	GRIT CHAMBER
SCALE	1/500



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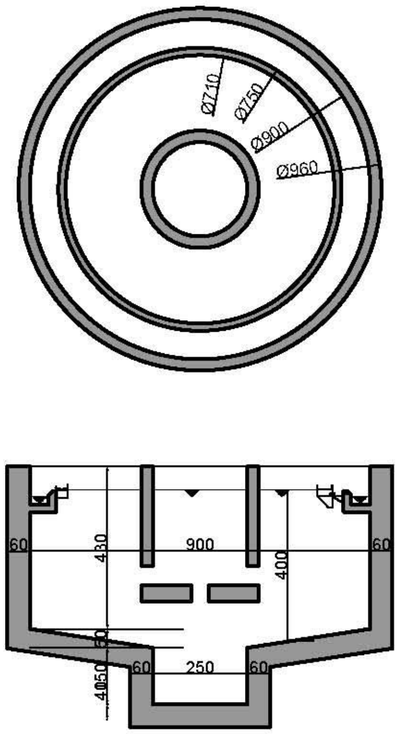
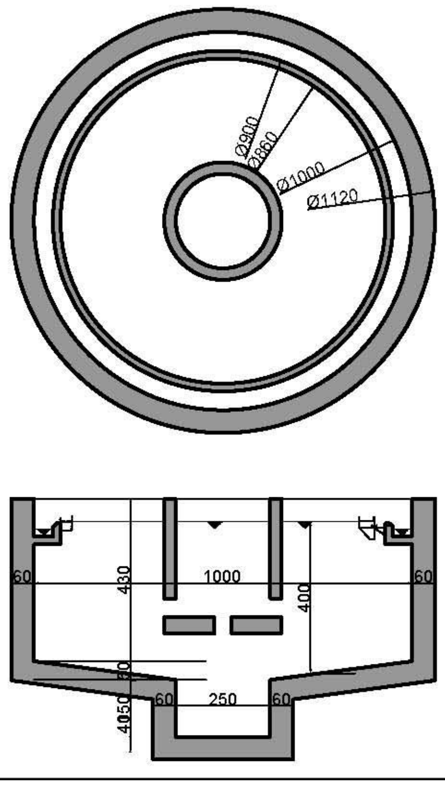
TS	CAS , EXT, A2O
UNIT	GRIT CHAMBER
SCALE	1/500



FLOW	6K
TS	CAS
UNIT	PRI. SEDIMEN. TANK
SCALE	1/500



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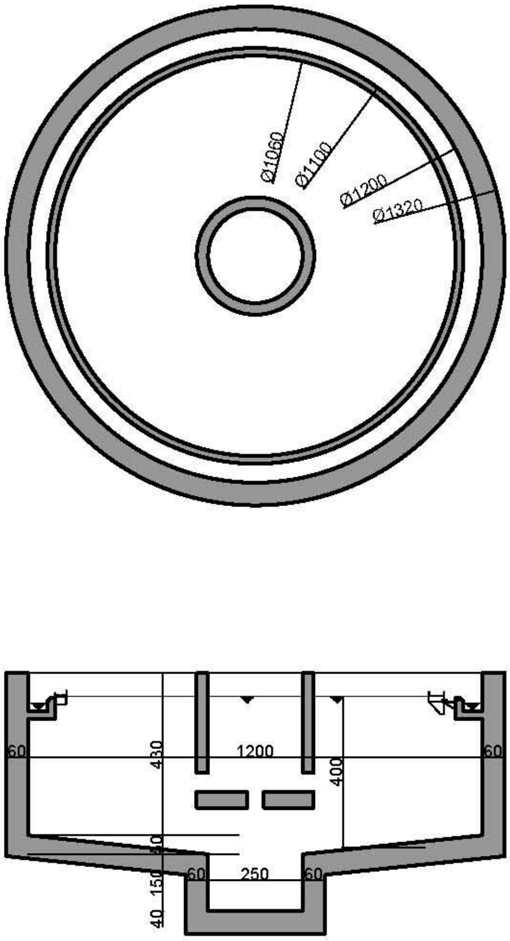
TS	CAS
UNIT	PRI. SEDIMEN. TANK
SCALE	1/500



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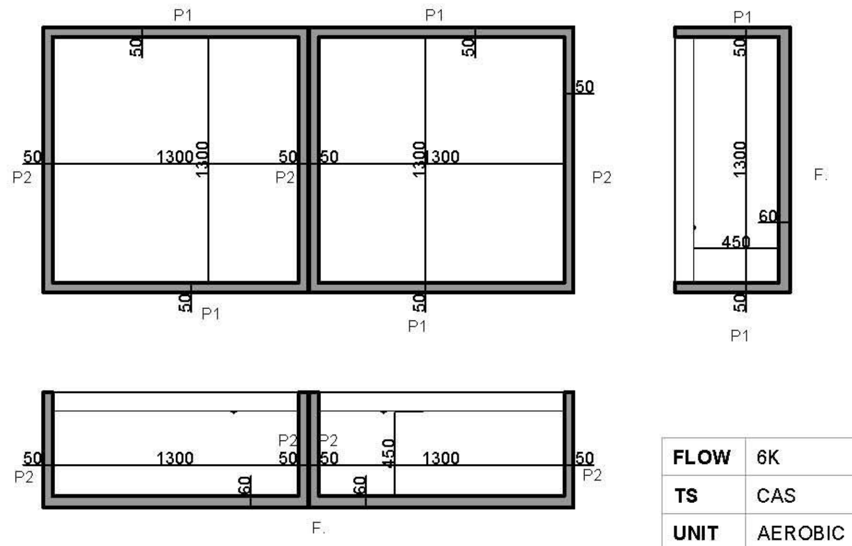
TS	CAS
UNIT	PRI. SEDIMEN. TANK
SCALE	1/500



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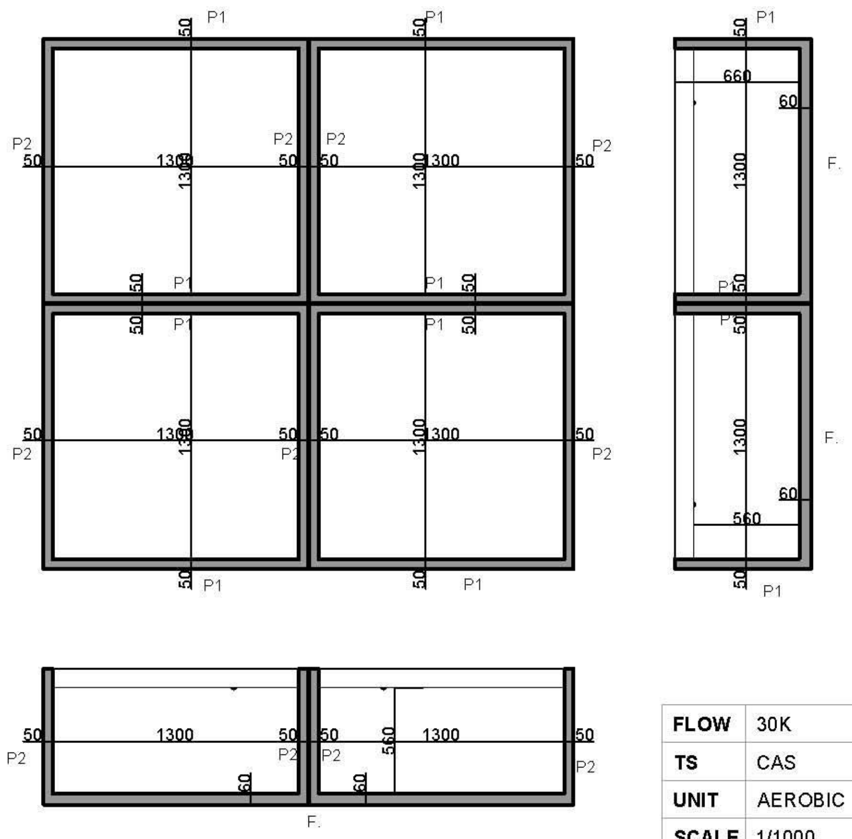
TS	CAS
UNIT	AEROBIC
SCALE	1/1000



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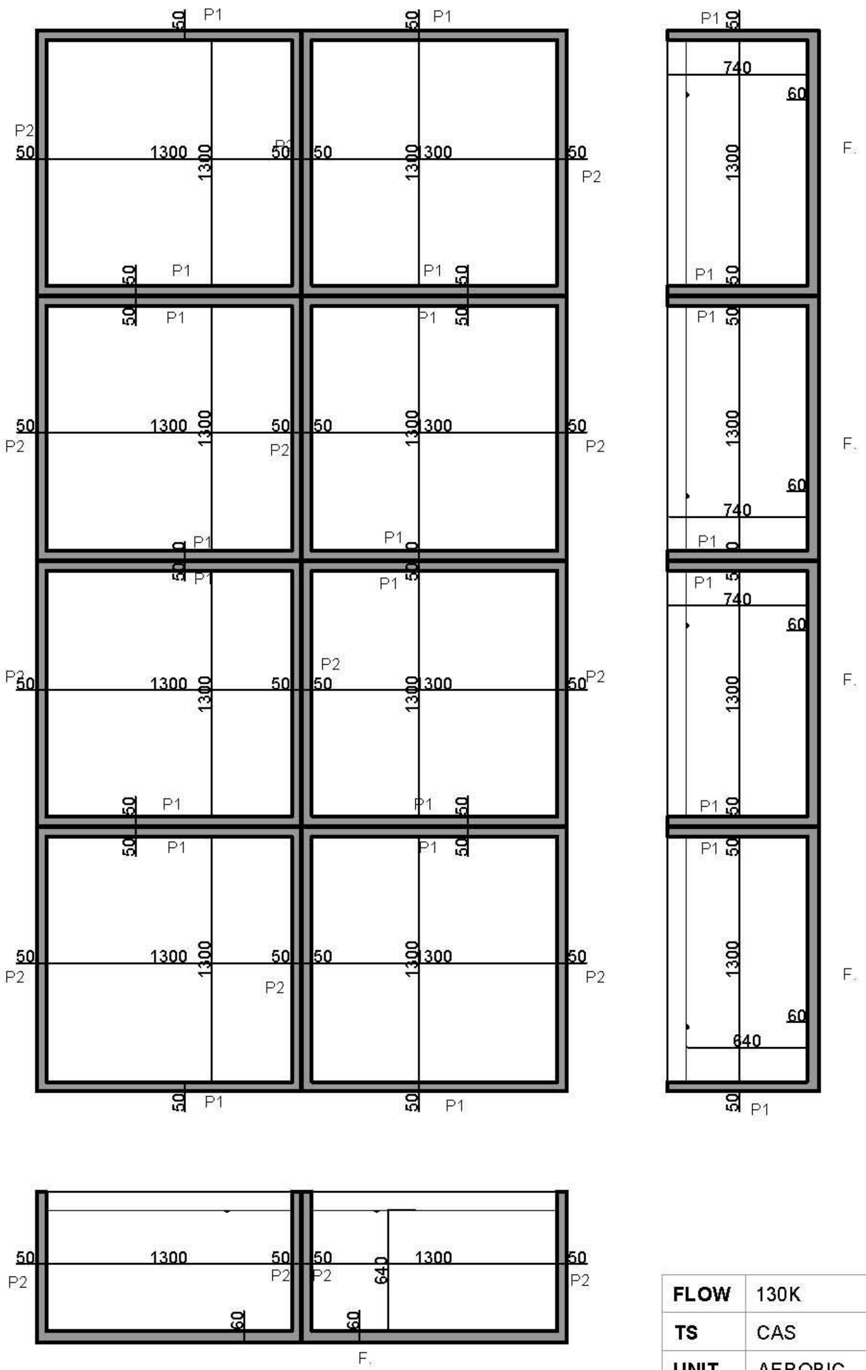
TS	CAS
UNIT	AEROBIC
SCALE	1/1000



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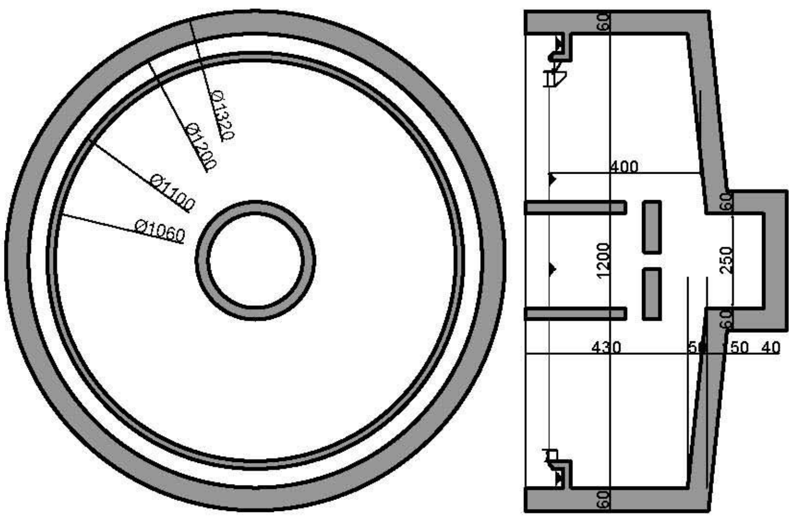
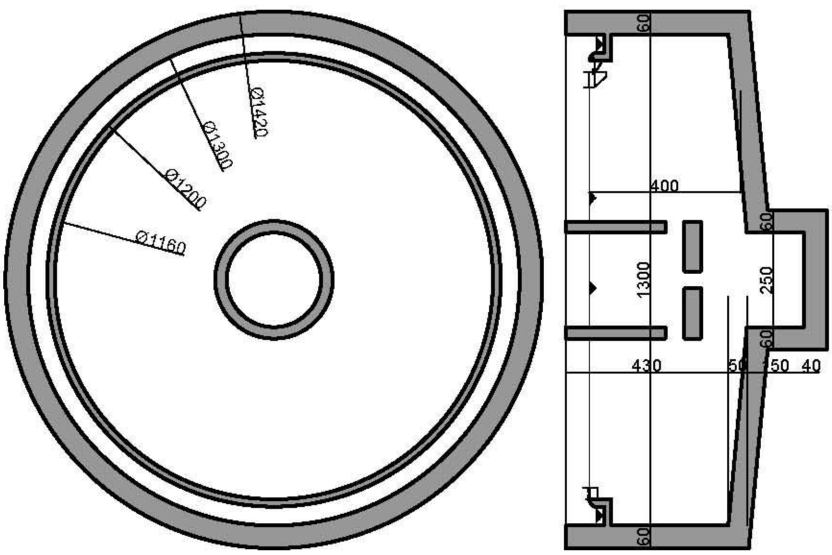
TS	CAS
UNIT	AEROBIC
SCALE	1/1000



FLOW	6K
TS	CAS
UNIT	SEC.SEDIMEN.TANK
SCALE	1/500



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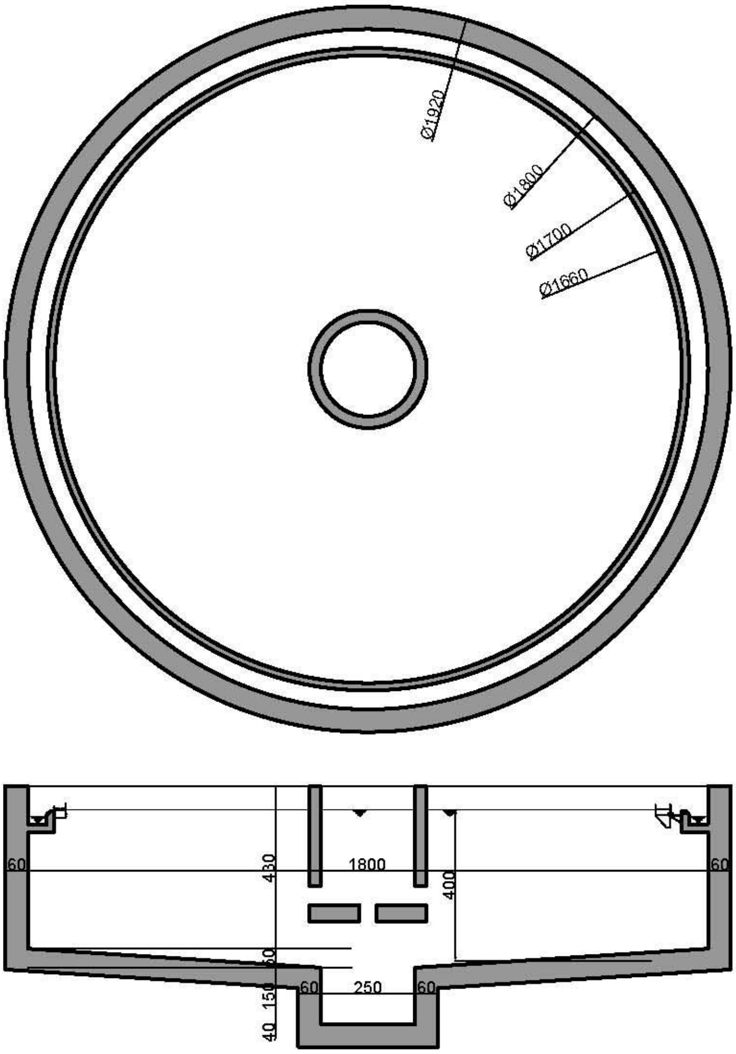
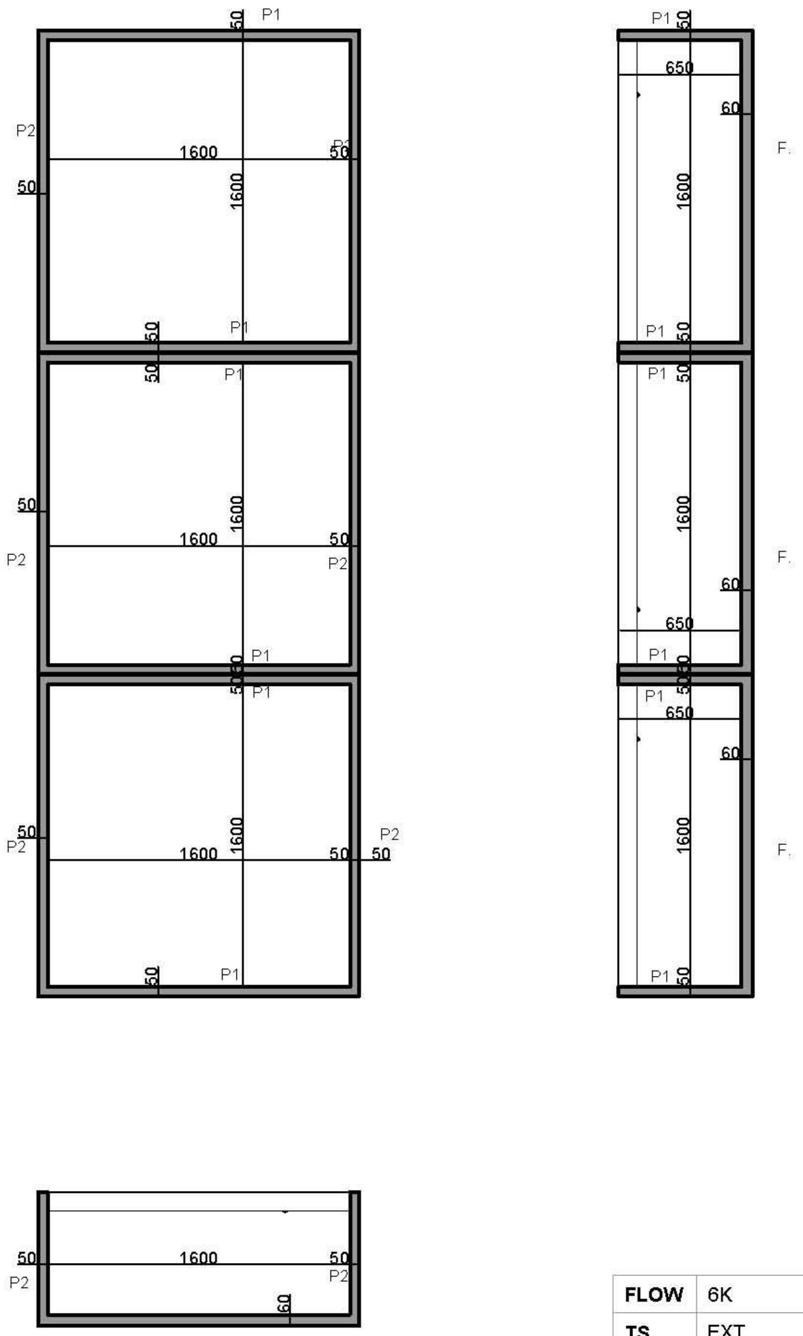
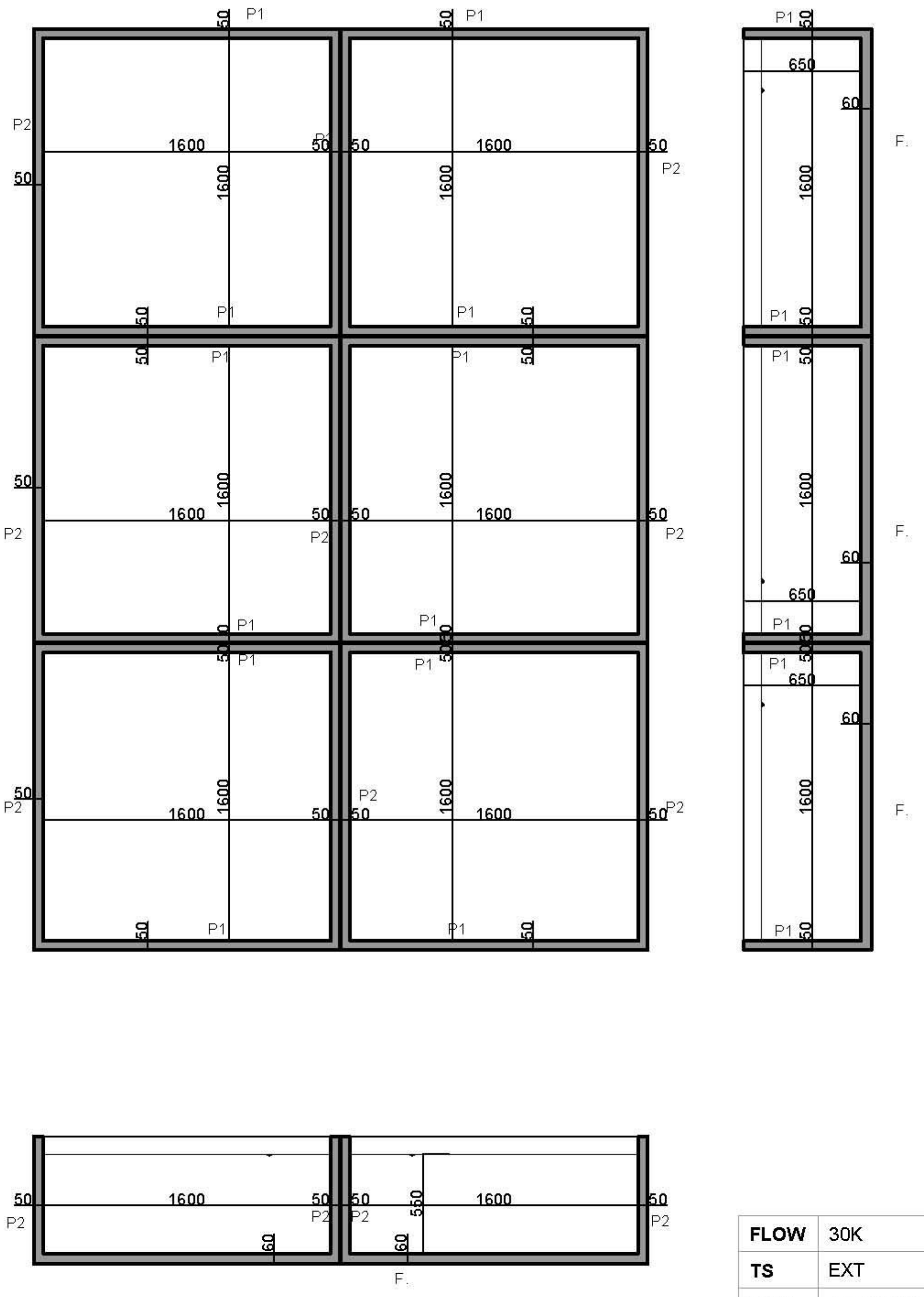
TS	CAS
UNIT	SEC.SEDIMEN.TANK
SCALE	1/500



FLOW	130K
TS	CAS
UNIT	SEC. SEDIMEN. TANK
SCALE	1/500



FLOW	6K
TS	EXT
UNIT	AEROBIC
SCALE	1/1000



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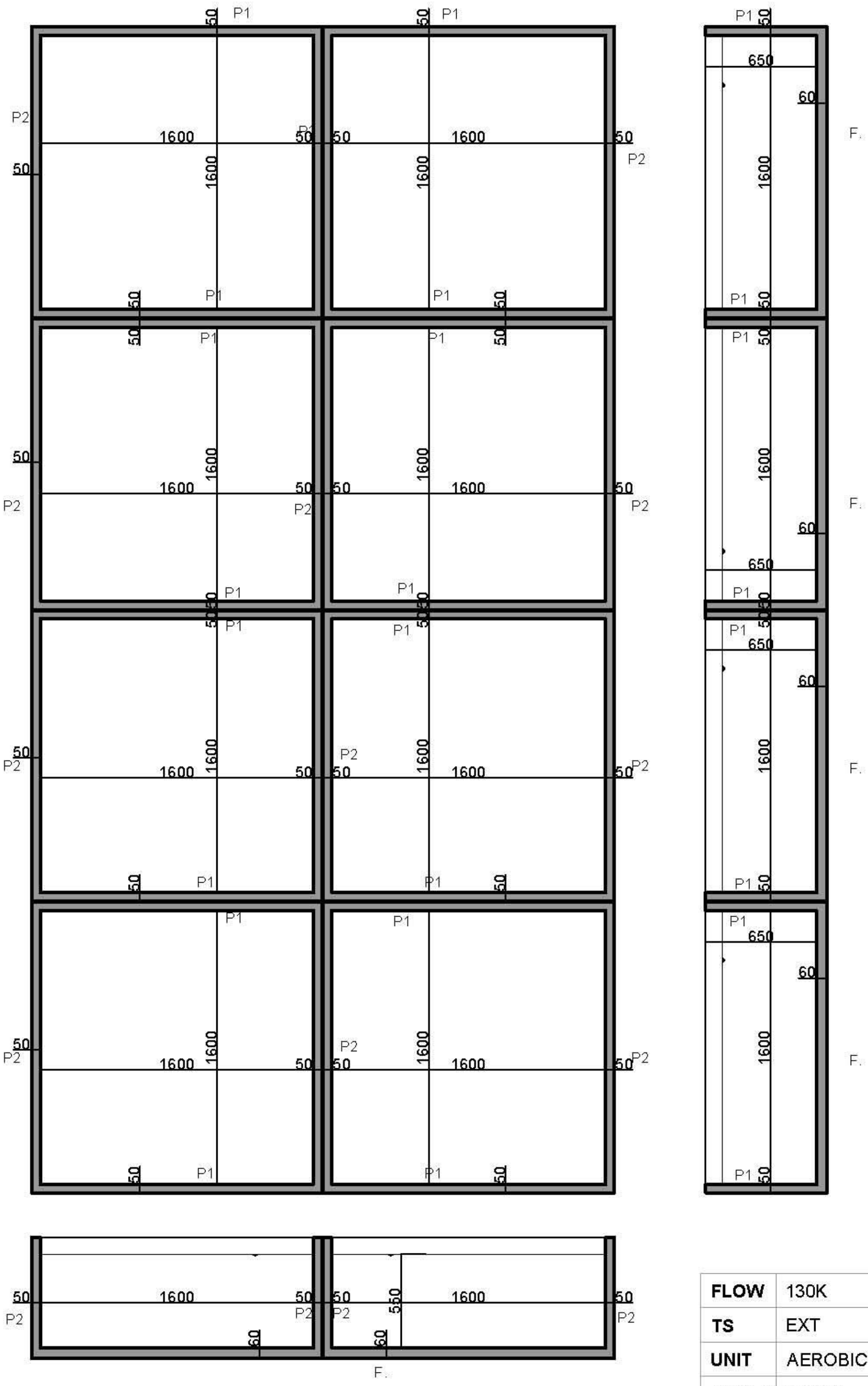
TS	EXT
UNIT	AEROBIC
SCALE	1/1000



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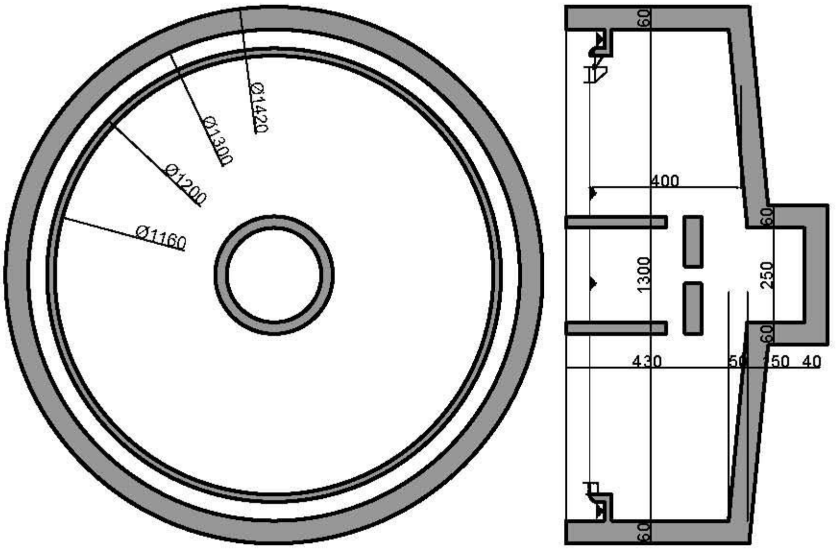
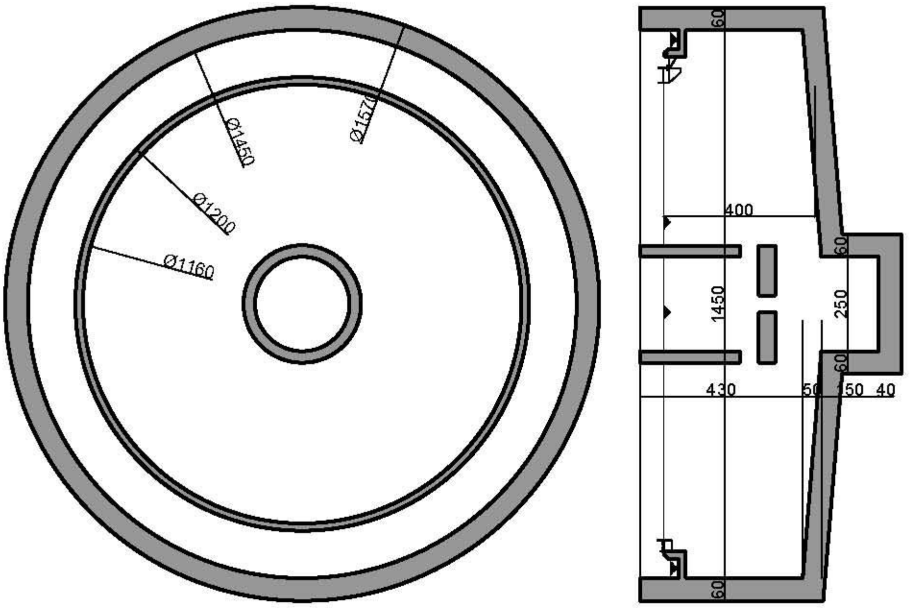
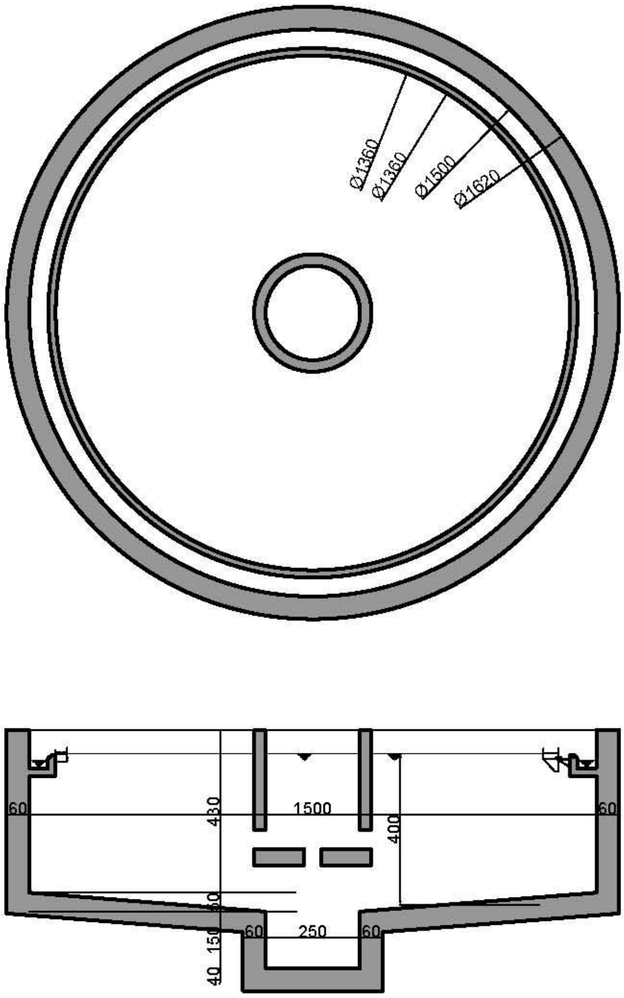
TS	EXT
UNIT	AEROBIC
SCALE	1/1000



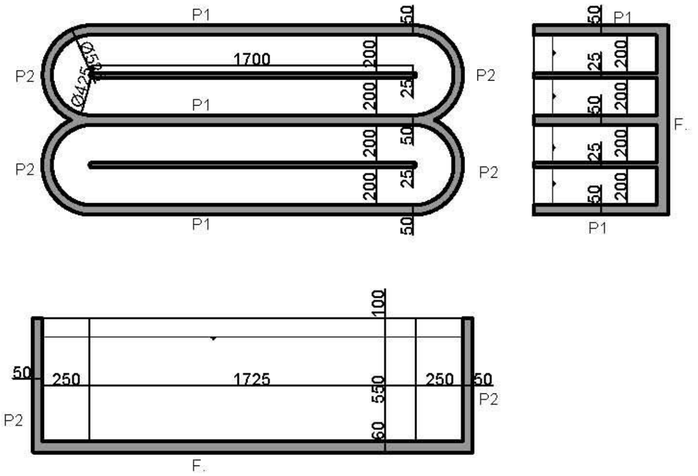
FLOW	6K
TS	EXT
UNIT	SEC. SEDIMEN. TANK
SCALE	1/500



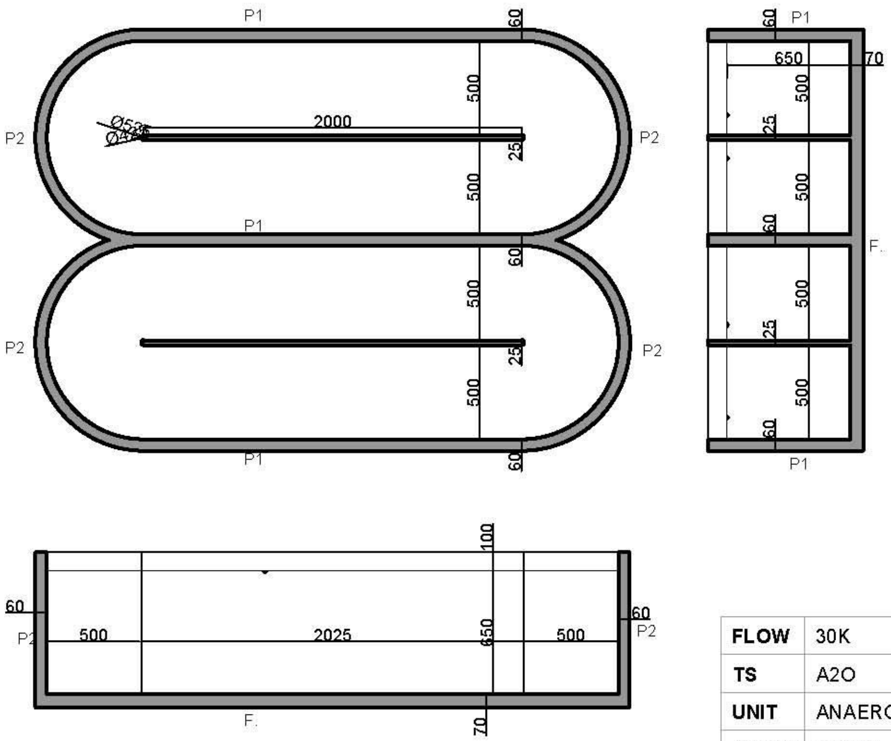
FLOW	30K
TS	EXT
UNIT	SEC. SEDIMEN. TANK
SCALE	1/500



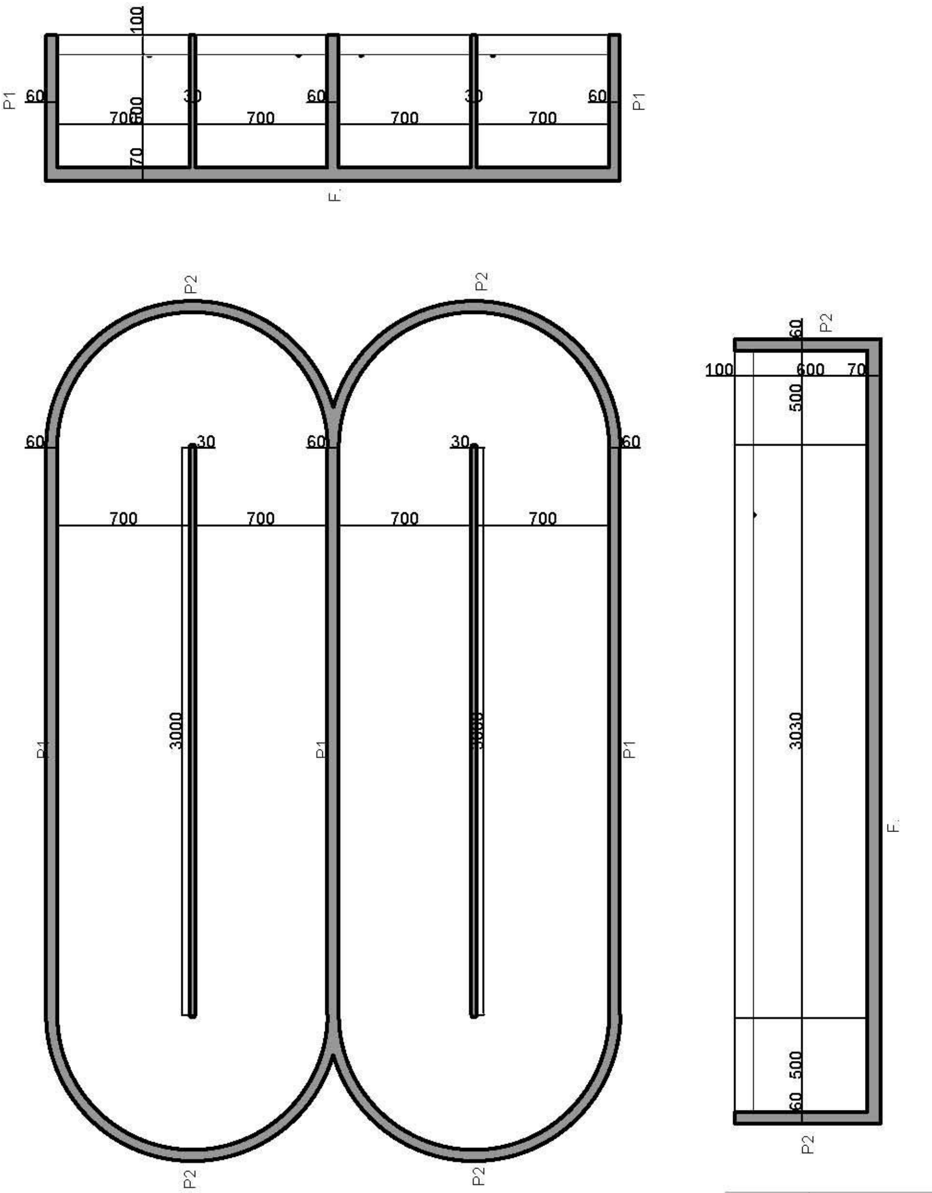
FLOW	130K
TS	EXT
UNIT	SEC.SEDIMEN.TANK
SCALE	1/500



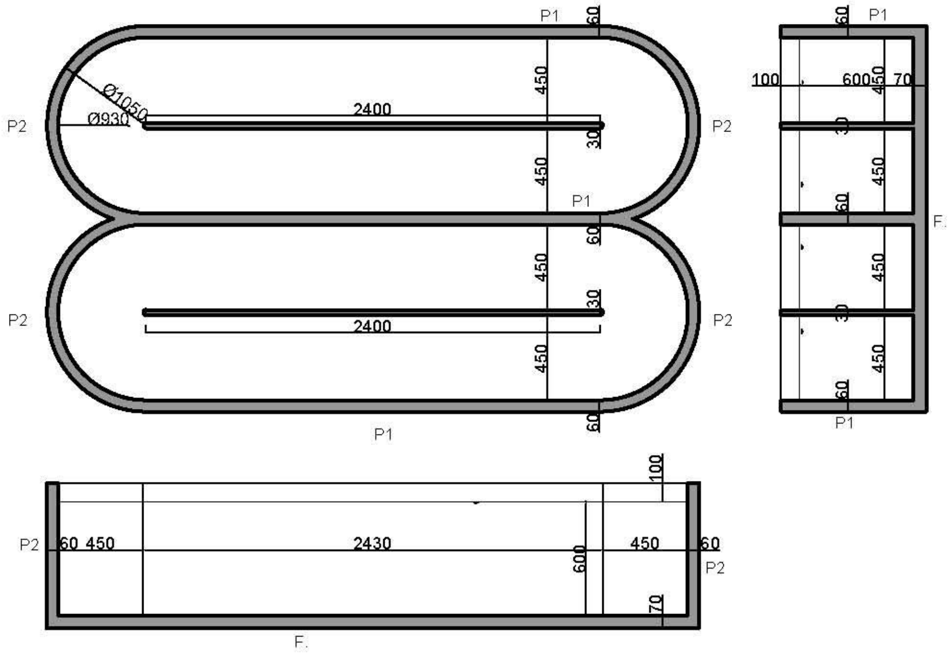
FLOW	6K
TS	A2O
UNIT	ANAEROBIC
SCALE	1/1000



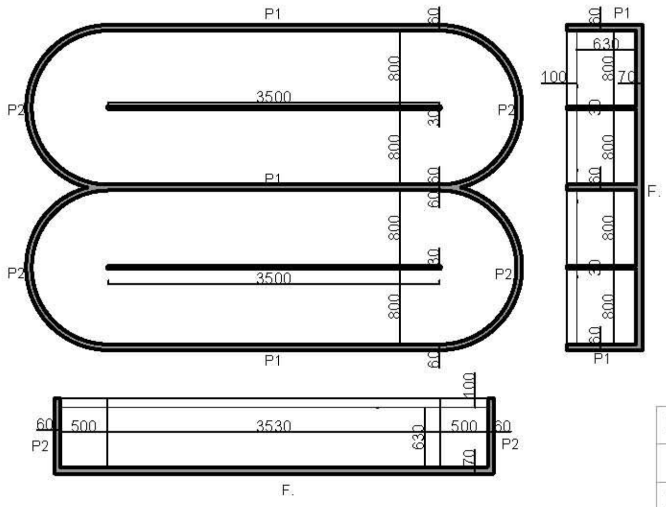
FLOW	30K
TS	A2O
UNIT	ANAEROBIC
SCALE	1/1000



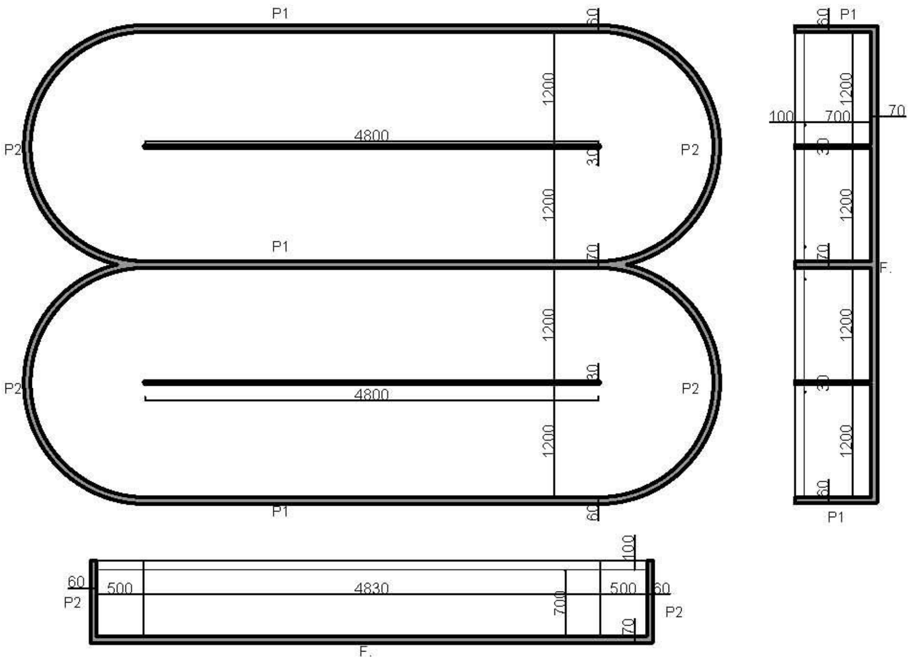
FLOW	130K
TS	A2O
UNIT	ANAEROBIC
SCALE	1/1000



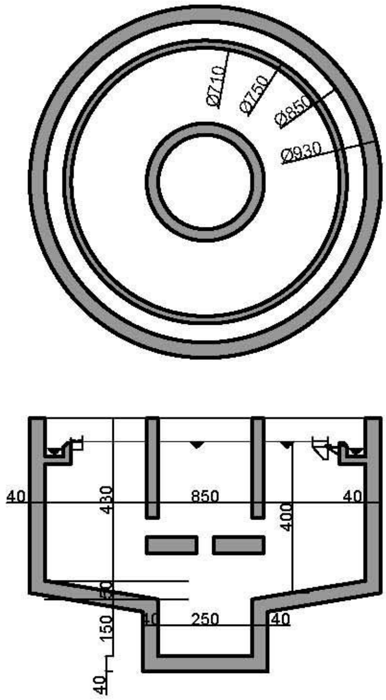
FLOW	6K
TS	A2O
UNIT	**ANOXIC&AEROBIC**
SCALE	1/1000



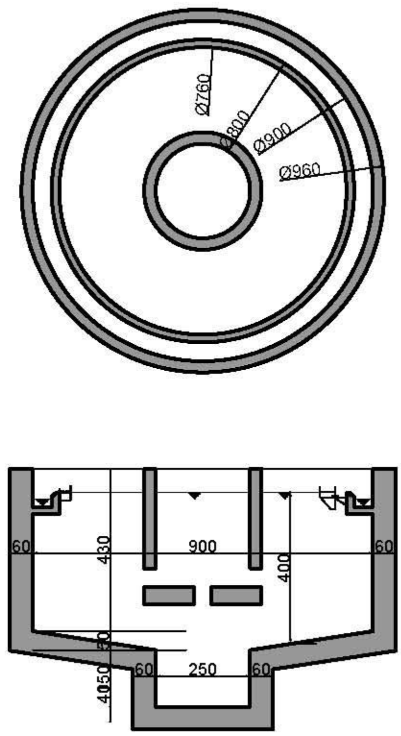
FLOW	30K
TS	A2O
UNIT	ANOXIC&AEROBIC
SCALE	1/2000



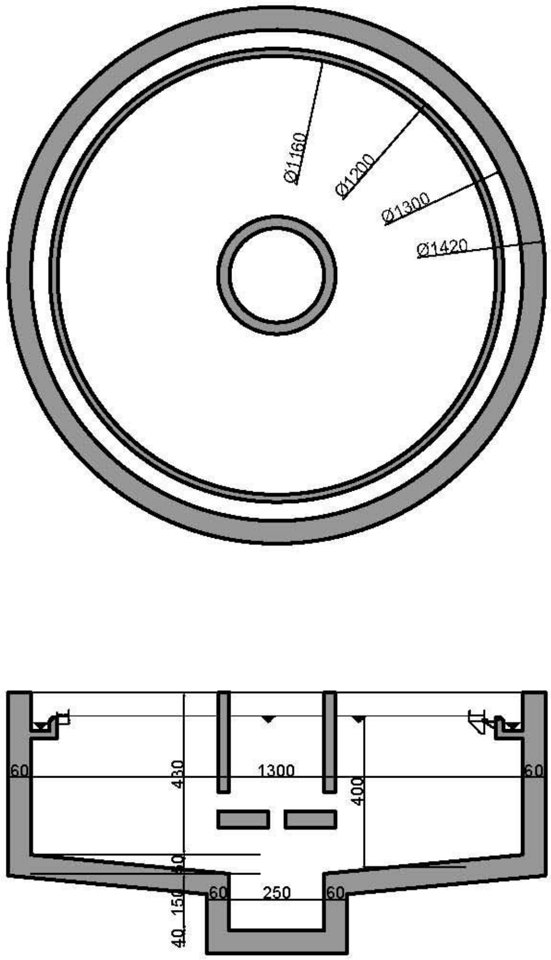
FLOW	30K
TS	A2O
UNIT	ANOXIC&AEROBIC
SCALE	1/2000



FLOW	6K
TS	A2O
UNIT	SEC. SEDIMEN. TANK
SCALE	1/500



FLOW	30K
TS	A2O
UNIT	SEC. SEDIMEN. TANK
SCALE	1/500



FLOW	130K
TS	A2O
UNIT	SEC.SEDIMEN.TANK
SCALE	1/500

C. Calculation of Civil Works

6000 m3/day - CAS

Grit Chamber

Foundatiton	0.5	m
Wall Thickness	0.4	m
Volume	**50**	**m3**
Height	3	m
Area	16.67	m2
Free board	0.7	m
Number of Double Tank	0.5	pcs.
Width	2.2	m
Length	8	m
Area	17.6	m2
Volume	52.8	m3
	TRUE	
P1		
Width	8	m
Length	3.7	m
Height	0.4	m
Pcs.	4	
Concrete Volume	23.68	m3
P2		
Area	2.2	m2
Length	3.7	m
Height	0.4	
Pcs.	4	
Concrete Volume	6.512	m3
Foundatation		
Area	66	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	39.6	m3
P1+P2+Foundatiton	69.792	m3
Tank Amount	1	pcs.
Unexpected	0.2	
Concrete Volume	41.88	m3
Amount of steel rebar	4.188	ton

Aerobic

Foundatiton	0.6	m
Wall Thickness	0.5	m
Volume	**1500**	**m3**
Height	4.5	m
Area	333.33	m2
Free board	1	m
Number of lines	1	pcs.
With between walls (W)	13	m
Tank Length (L)	13	m
Tank Surface Area Calculation		
Area of rectangular shape	13 x 13 = 169 m2	
Tank Surface Area	169 x 4.5 = 760.5 m3	
Tank Amount	2	pcs.
Total Volume	1521.0	m3
P1		
Width	13	m
Length	5.5	m
Wall Thickness	0.5	m
Pcs.	2	pcs.
Concrete Volume	71.5	m3
P2		
Width	13	m
Length	5.5	m
Wall Thickness	0.5	m
Pcs.	2	pcs.
Concrete Volume	71.5	m3
Foundatation		
Area	289	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	173.4	m3
P1+P2+Foundatiton	316.4	m3
Tank Amount	2	pcs.
Unexpected	0.2	
Concrete Volume	759.36	m3
Amount of steel rebar	75.936	ton

Secondary Sedimentation

Foundatiton	0.6	m
Wall Thickness	0.6	m
Height	**4**	**m**
Area	**400**	**m2**
Free board	0.3	m
Pcs.	2	pcs.
Diameter	11.28	m
Selected diameter	12	m
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m
P1 - CYNDRICAL PART		
Area	100.85	m2
Length	4.3	m
TRUE Height	0.6	m
Pcs.	1	
Concrete Volume	260.19	m3
P2 - CONIC PART		
Area	100.85	m2
Length	0.5	m
Height	0.6	m
Pcs.	1	
Concrete Volume	30.26	m3
P3 - SLUDGE COLLECTION PART		
Area	10.66	m2
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	39.98	m3
Foundatation		
Area	10.75	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	6.45	m3
P1+P2+P3+Foundatiton	336.88	m3
Tank Amount	2	pcs.
Unexpected	0.2	
Concrete Volume	808.51	m3
Amount of steel rebar	80.851	ton

Primary Sedimentation

Foundatiton	0.6	m
Wall Thickness	0.6	m
Height	**4**	**m**
Area	**210**	**m2**
Free board	0.3	m
Pcs.	2	pcs.
Diameter	8.18	m
TRUE Selected diameter	9	m
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m
P1 - CYNDRICAL PART		
Area	61.46	m2
Length	4.3	m
Height	0.6	m
Pcs.	1	
Concrete Volume	158.57	m3
P2 - CONIC PART		
Area	61.46	m2
Length	0.5	m
Height	0.6	m
Pcs.	1	
Concrete Volume	18.44	m3
P3 - SLUDGE COLLECTION PART		
Area	10.66	m2
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	39.98	m3
Foundatation		
Area	10.75	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	6.45	m3
P1+P2+P3+Foundatiton	223.44	m3
Tank Amount	2	pcs.
Unexpected	0.2	
Concrete Volume	536.26	m3
Amount of steel rebar	53.626	ton

30000 m3/day - CAS

Grit Chamber

Foundatiton	0.6	m
Wall Thickness	0.5	m
Volume	**250**	**m3**
Height	3	m
Area	83.33	m2
Free board	0.7	m
Number of Double Tank	2	pcs.
Width	2.2	m
Length	10	m
Area	88	m2
Volume	264	m3

TRUE

P1

Width	10	m
Length	3.7	m
Height	0.5	m
Pcs.	4	
Concrete Volume	148	m3

P2

Area	2.2	m2
Length	3.7	m
Height	0.5	
Pcs.	4	
Concrete Volume	8.14	m3

Foundatation

Area	81	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	48.6	m3
P1+P2+Foundatiton	204.74	m3
Tank Amount	2	pcs.
Unexpected	0.2	
Concrete Volume	491.38	m3
Amount of steel rebar	49.138	ton

Aerobic

Foundatiton	0.6	m
Wall Thickness	0.5	m
Volume	**7500**	**m3**
Height	5.6	m
Area	1339.29	m2
Free board	1	m
Number of lines	2	pcs.
With between walls (W)	13	m
Tank Length (L)	13	m

Tank Surface Area Calculation

Area of rectangular shape	13 x 13 = 169 m2	
Tank Surface Area	169 x 5.6 = 946.4 m3	
Tank Amount	4	pcs.
Total Volume	7571.2	m3

TRUE

P1

Width	13	m
Length	6.6	m
Wall Thickness	0.5	m
Pcs.	2	pcs.
Concrete Volume	85.8	m3

P2

Width	13	m
Length	6.6	m
Wall Thickness	0.5	m
Pcs.	2	pcs.
Concrete Volume	85.8	m3

Foundatation

Area	289	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	173.4	m3
P1+P2+Foundatiton	345	m3
Tank Amount	8	pcs.
Unexpected	0.2	
Concrete Volume	3312	m3
Amount of steel rebar	331.2	ton

Secondary Sedimentation

Foundatiton	0.6	m
Wall Thickness	0.6	m
Height	**4**	**m**
Area	**2000**	**m2**
Free board	0.3	m
Pcs.	4	pcs.
Diameter	12.62	m
Selected diameter	13	m
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m

TRUE

P1 - CYNDRICAL PART

Area	116.12	m2
Length	4.3	m
Height	0.6	m
Pcs.	1	
Concrete Volume	299.59	m3

P2 - CONIC PART

Area	116.12	m2
Length	0.5	m
Height	0.6	m
Pcs.	1	
Concrete Volume	34.84	m3

P3 - SLUDGE COLLECTION PART

Area	10.66	m2
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	39.98	m3

Foundatation

Area	10.75	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	6.45	m3
P1+P2+P3+Foundatiton	380.86	m3
Tank Amount	4	pcs.
Unexpected	0.2	
Concrete Volume	1828.13	m3
Amount of steel rebar	182.813	ton

Primary Sedimentation

Foundatiton	0.6	m
Wall Thickness	0.6	m
Height	**4**	**m**
Area	**1100**	**m2**
Free board	0.3	m
Pcs.	4	pcs.
Diameter	9.36	m
Selected diameter	10	m
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m

TRUE

P1 - CYNDRICAL PART

Area	73.52	m2
Length	4.3	m
Height	0.6	m
Pcs.	1	
Concrete Volume	189.68	m3

P2 - CONIC PART

Area	73.52	m2
Length	0.5	m
Height	0.6	m
Pcs.	1	
Concrete Volume	22.06	m3

P3 - SLUDGE COLLECTION PART

Area	10.66	m2
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	39.98	m3

Foundatation

Area	10.75	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	6.45	m3
P1+P2+P3+Foundatiton	258.17	m3
Tank Amount	4	pcs.
Unexpected	0.2	
Concrete Volume	1239.22	m3
Amount of steel rebar	123.922	ton

130000 m3/day -CAS

Grit Chamber

Foundatiton	:	0.6	m
Wall Thickness	:	0.5	m
Volume	**:**	**1000**	**m3**
Height	:	3.5	m
Area	:	285.71	m2
Free board	:	0.7	m
Number of Double Tank	:	4	pcs.
Width	:	2.2	m
Length	:	17	m
Area	:	299.2	m2
Volume	:	1047.2	m3

TRUE

P1

Width	:	17	m
Length	:	4.2	m
Height	:	0.5	m
Pcs.	:	4	
Concrete Volume	:	571.2	m3

P2

Area	:	2.2	m2
Length	:	4.2	m
Height	:	0.5	
Pcs.	:	4	
Concrete Volume	:	9.24	m3

Foundatation

Area	:	129	m2
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	77.4	m3
P1+P2+Foundatiton	:	657.84	m3
Tank Amount	:	4	pcs.
Unexpected	:	0.2	
Concrete Volume	:	3157.63	m3
Amount of steel rebar	:	315.763	ton

Aerobic

Foundatiton	:	0.7	m
Wall Thickness	:	0.6	m
Volume	**:**	**33000**	**m3**
Height	:	6.4	m
Area	:	5156.25	m2
Free board	:	1	m
Number of lines	:	4	pcs.
With between walls (W)	:	13	m
Tank Length (L)	:	13	m

Tank Surface Area Calculation

Area of rectangular shape	:	13 x 13 = 169 m2	
Tank Surface Area	:	169 x 6.4 = 1081.6 m3	
Tank Amount	:	8	pcs.
Total Volume	:	34611.2	m3

TRUE

P1

Width	:	13	m
Length	:	7.4	m
Wall Thickness	:	0.6	m
Pcs.	:	2	pcs.
Concrete Volume	:	115.44	m3

P2

Width	:	13	m
Length	:	7.4	m
Wall Thickness	:	0.6	m
Pcs.	:	2	pcs.
Concrete Volume	:	115.44	m3

Foundatation

Area	:	289	m2
Height	:	0.7	m
Pcs.	:	1	
Concrete Volume	:	202.3	m3
P1+P2+Foundatiton	:	433.18	m3
Tank Amount	:	32	pcs.
Unexpected	:	0.2	
Concrete Volume	:	16634.11	m3
Amount of steel rebar	:	1663.411	ton

Secondary Sedimentation

Foundatiton	:	0.6	m
Wall Thickness	:	0.6	m
Height	**:**	**4.5**	**m**
Area	**:**	**8700**	**m2**
Free board	:	0.3	m
Pcs.	:	6	pcs.
Diameter	:	17.54	m
Selected diameter	:	18	m
Sludge Collection Part Diameter	:	2.5	m
Sludge Collection Part Height	:	1.5	m

TRUE

P1 - CYNDRICAL PART

Area	:	208.53	m2
Length	:	4.8	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	600.57	m3

P2 - CONIC PART

Area	:	208.53	m2
Length	:	0.5	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	62.56	m3

P3 - SLUDGE COLLECTION PART

Area	:	10.66	m2
Length	:	2.5	m
Height	:	1.5	m
Pcs.	:	1	
Concrete Volume	:	39.98	m3

Foundatation

Area	:	10.75	m2
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	6.45	m3
P1+P2+P3+Foundatiton	:	709.56	m3
Tank Amount	:	6	pcs.
Unexpected	:	0.2	
Concrete Volume	:	5108.83	m3
Amount of steel rebar	:	510.883	ton

Primary Sedimentation

Foundatiton	:	0.6	m
Wall Thickness	:	0.6	m
Height	**:**	**4.5**	**m**
Area	**:**	**4000**	**m2**
Free board	:	0.3	m
Pcs.	:	6	pcs.
Diameter	:	11.89	m
Selected diameter	:	12	m
Sludge Collection Part Diameter	:	2.5	m
Sludge Collection Part Height	:	1.5	m

TRUE

P1 - CYNDRICAL PART

Area	:	100.85	m2
Length	:	4.8	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	290.45	m3

P2 - CONIC PART

Area	:	100.85	m2
Length	:	0.5	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	30.26	m3

P3 - SLUDGE COLLECTION PART

Area	:	10.66	m2
Length	:	2.5	m
Height	:	1.5	m
Pcs.	:	1	
Concrete Volume	:	39.98	m3

Foundatation

Area	:	10.75	m2
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	6.45	m3
P1+P2+P3+Foundatiton	:	367.14	m3
Tank Amount	:	6	pcs.
Unexpected	:	0.2	
Concrete Volume	:	2643.41	m3
Amount of steel rebar	:	264.341	ton

6000 m3/day - EXT

Grit Chamber

Foundatiton	0.5	m
Wall Thickness	0.4	m
Volume	**50**	**m3**
Height	3	m
Area	16.67	m2
Free board	0.7	m
Number of Double Tank	0.5	pcs.
Width	2.2	m
Length	8	m
Area	17.6	m2
Volume	52.8	m3	TRUE

P1

Width	8	m
Length	3.7	m
Height	0.4	m
Pcs.	4	
Concrete Volume	23.68	m3

P2

Area	2.2	m2
Length	3.7	m
Height	0.4	
Pcs.	4	
Concrete Volume	6.512	m3

Foundatation

Area	66	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	39.6	m3
P1+P2+Foundatiton	69.792	m3
Tank Amount	1	pcs.
Unexpected	0.2	
Concrete Volume	41.88	m3
Amount of steel rebar	4.188	ton

Aerobic

Foundatiton	0.6	m
Wall Thickness	0.5	m
Volume	**7500**	**m3**
Height	5	m
Area	1500	m2
Free board	1	m
Number of lines	2	pcs.
With between walls (W)	16	m
Tank Length (L)	16	m

Tank Surface Area Calculation

Area of rectangular shape	16 x 16 = 256 m2	
Tank Surface Area	256 x 5 = 1280 m3	
Tank Amount	3	pcs.
Total Volume	7680.0	m3	TRUE

P1

Width	16	m
Length	6	m
Wall Thickness	0.5	m
Pcs.	2	pcs.
Concrete Volume	96	m3

P2

Width	16	m
Length	6	m
Wall Thickness	0.5	m
Pcs.	2	pcs.
Concrete Volume	96	m3

Foundatation

Area	196	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	117.6	m3
P1+P2+Foundatiton	309.6	m3
Tank Amount	6	pcs.
Unexpected	0.2	
Concrete Volume	2229.12	m3
Amount of steel rebar	222.912	ton

Secondary Sedimentation

Foundatiton	0.6	m
Wall Thickness	0.6	m
Height	**4**	**m**
Area	**500**	**m2**
Free board	0.3	m
Pcs.	2	pcs.
Diameter	12.62	m
Selected diameter	13	m	TRUE
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m

P1 - CYNDRICAL PART

Area	116.12	m2
Length	4.3	m
Height	0.6	m
Pcs.	1	
Concrete Volume	299.59	m3

P2 - CONIC PART

Area	116.12	m2
Length	0.5	m
Height	0.6	m
Pcs.	1	
Concrete Volume	34.84	m3

P3 - SLUDGE COLLECTION PART

Area	10.66	m2
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	39.98	m3

Foundatation

Area	10.75	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	6.45	m3
P1+P2+P3+Foundatiton	380.86	m3
Tank Amount	2	pcs.
Unexpected	0.2	
Concrete Volume	914.06	m3
Amount of steel rebar	91.406	ton

30000 m3/day - LOW - EXT

Grit Chamber

Foundatiton	0.6	m
Wall Thickness	0.5	m
Volume	**250**	**m3**
Height	3	m
Area	83.33	m2
Free board	0.7	m
Number of Double Tank	2	pcs.
Width	2.2	m
Length	10	m
Area	88	m2
Volume	264	m3

TRUE

P1

Width	10	m
Length	3.7	m
Height	0.5	m
Pcs.	4	
Concrete Volume	148	m3

P2

Area	2.2	m2
Length	3.7	m
Height	0.5	
Pcs.	4	
Concrete Volume	8.14	m3

Foundatation

Area	81	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	48.6	m3
P1+P2+Foundatiton	204.74	m3
Tank Amount	2	pcs.
Unexpected	0.2	
Concrete Volume	491.38	m3
Amount of steel rebar	49.138	ton

Aerobic

Foundatiton	0.7	m
Wall Thickness	0.6	m
Volume	**37500**	**m3**
Height	6.2	m
Area	6048.39	m2
Free board	1	m
Number of lines	4	pcs.
With between walls (W)	16	m
Tank Length (L)	16	m

Tank Surface Area Calculation

Area of rectangular shape	16 x 16 = 256 m2	
Tank Surface Area	256 x 6.2 = 1587.2 m3	
Tank Amount	6	pcs.
Total Volume	38092.8	m3

TRUE

P1

Width	16	m
Length	7.2	m
Wall Thickness	0.6	m
Pcs.	2	pcs.
Concrete Volume	138.24	m3

P2

Width	16	m
Length	7.2	m
Wall Thickness	0.6	m
Pcs.	2	pcs.
Concrete Volume	138.24	m3

Foundatation

Area	196	m2
Height	0.7	m
Pcs.	1	
Concrete Volume	137.2	m3
P1+P2+Foundatiton	413.68	m3
Tank Amount	24	pcs.
Unexpected	0.2	
Concrete Volume	11913.98	m3
Amount of steel rebar	1191.398	ton

Secondary Sedimentation

Foundatiton	0.6	m
Wall Thickness	0.6	m
Height	**4**	**m**
Area	**2500**	**m2**
Free board	0.3	m
Pcs.	4	pcs.
Diameter	14.1	m
Selected diameter	14.5	m
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m

TRUE

P1 - CYNDRICAL PART

Area	141.03	m2
Length	4.3	m
Height	0.6	m
Pcs.	1	
Concrete Volume	363.86	m3

P2 - CONIC PART

Area	141.03	m2
Length	0.5	m
Height	0.6	m
Pcs.	1	
Concrete Volume	42.31	m3

P3 - SLUDGE COLLECTION PART

Area	10.66	m2
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	39.98	m3

Foundatation

Area	10.75	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	6.45	m3
P1+P2+P3+Foundatiton	452.6	m3
Tank Amount	4	pcs.
Unexpected	0.2	
Concrete Volume	2172.48	m3
Amount of steel rebar	217.248	ton

130000 m3/day - EXT

Grit Chamber

Foundatiton	:	0.6	m
Wall Thickness	:	0.5	m
Volume	:	**1000**	**m3**
Height	:	3.5	m
Area	:	285.71	m2
Free board	:	0.7	m
Number of Double Tank	:	4	pcs.
Width	:	2.2	m
Length	:	17	m
Area	:	299.2	m2
Volume	:	1047.2	m3

TRUE

P1

Width	:	17	m
Length	:	4.2	m
Height	:	0.5	m
Pcs.	:	4	
Concrete Volume	:	571.2	m3

P2

Area	:	2.2	m2
Length	:	4.2	m
Height	:	0.5	
Pcs.	:	4	
Concrete Volume	:	9.24	m3

Foundatation

Area	:	129	m2
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	77.4	m3
P1+P2+Foundatiton	:	657.84	m3
Tank Amount	:	4	pcs.
Unexpected	:	0.2	
Concrete Volume	:	3157.63	m3
Amount of steel rebar	:	315.763	ton

Aerobic

Foundatiton	:	0.7	m
Wall Thickness	:	0.6	m
Volume	:	**163000**	**m3**
Height	:	6.7	m
Area	:	24328.36	m2
Free board	:	1	m
Number of lines	:	8	pcs.
With between walls (W)	:	16	m
Tank Length (L)	:	16	m

Tank Surface Area Calculation

Area of rectangular shape	:	16 x 16 = 256 m2	
Tank Surface Area	:	256 x 6.7 = 1715.2 m3	
Tank Amount	:	12	pcs.
Total Volume	:	164659.2	m3

TRUE

P1

Width	:	16	m
Length	:	7.7	m
Wall Thickness	:	0.6	m
Pcs.	:	2	pcs.
Concrete Volume	:	147.84	m3

P2

Width	:	16	m
Length	:	7.7	m
Wall Thickness	:	0.6	m
Pcs.	:	2	pcs.
Concrete Volume	:	147.84	m3

Foundatation

Area	:	196	m2
Height	:	0.7	m
Pcs.	:	1	
Concrete Volume	:	137.2	m3
P1+P2+Foundatiton	:	432.88	m3
Tank Amount	:	96	pcs.
Unexpected	:	0.2	
Concrete Volume	:	49867.78	m3
Amount of steel rebar	:	4986.778	ton

Secondary Sedimentation

Foundatiton	:	0.6	m
Wall Thickness	:	0.6	m
Height	:	**4.5**	**m**
Area	:	**11000**	**m2**
Free board	:	0.3	m
Pcs.	:	8	pcs.
Diameter	:	14.79	m
Selected diameter	:	15	m
Sludge Collection Part Diameter	:	2.5	m
Sludge Collection Part Height	:	1.5	m

TRUE

P1 - CYNDRICAL PART

Area	:	149.87	m2
Length	:	4.8	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	431.63	m3

P2 - CONIC PART

Area	:	149.87	m2
Length	:	0.5	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	44.96	m3

P3 - SLUDGE COLLECTION PART

Area	:	10.66	m2
Length	:	2.5	m
Height	:	1.5	m
Pcs.	:	1	
Concrete Volume	:	39.98	m3

Foundatation

Area	:	10.75	m2
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	6.45	m3
P1+P2+P3+Foundatiton	:	523.02	m3
Tank Amount	:	8	pcs.
Unexpected	:	0.2	
Concrete Volume	:	5020.99	m3
Amount of steel rebar	:	502.099	ton

6000 m3/day - A2O

Grit Chamber

Foundatiton	0.5	m
Wall Thickness	0.4	m
Volume	**50**	**m3**
Height	3	m
Area	16.67	m2
Free board	0.7	m
Number of Double Tank	0.5	Pcs.
Width	2.2	m
Length	8	m
Area	17.6	m2
Volume	52.8	m3	TRUE

P1

Width	8	m
Length	3.7	m
Height	0.4	m
Pcs.	4	
Concrete Volume	23.68	m3

P2

Area	2.2	m2
Length	3.7	m
Height	0.4	
Pcs.	4	
Concrete Volume	6.512	m3

Foundatiton

Area	66	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	39.6	m3
P1+P2+Foundatiton	69.792	m3
Tank Amount	1	Pcs.
Unexpected	0.2	
Concrete Volume	41.88	m3
Amount of steel rebar	4.188	ton

Anaerobic Tank

Foundatiton	0.6	m
Wall Thickness	0.5	m
Volume	**480**	**m3**
Height	5.5	m
Area	87.27	m2
Free board	1	m
With between walls (W)	2	m
Middle Wall Width	0.25	m
Tank Length (L)	17	m
R1	4.25	m
hwater	5.5	m

Tank Surface Area Calculation

Area of rectangular shape	2x2 x 17 = 34 m2
Area of circular shape	(3.14 x 4.25^2)/4 =14.19 m2
Middle Wall Area	2x17 x 0.25 = 4.25 m2
Tank Surface Area	34 + 14.19 - 4.25 = 43.94 m2
	43.94 x 2 = 87.88 m2
Tank Amount	2 pcs.
1 Tank Volume	43.94 x 5.5 = 241.67 m3
Twin Tank Volume	241.67 x 2 = 483.34 m3
Twin Tank Amount	1 Pcs.
Total Volume	483.3 m3 TRUE

P1

Width	17	m
Length	6.5	m
Height	0.5	m
Pcs.	3	
Concrete Volume	165.75	m3

P2

Area	7.46	m2
Height	0.5	m
Pcs.	4	
Concrete Volume	14.92	m3

Foundatiton

Area	212	m2
Height	0.6	m
Pcs.	1	
Concrete Volume	127.2	m3
P1+P2+Foundatiton	307.87	m3
Tank Amount	1	Pcs.
Unexpected	0.2	
Concrete Volume	369.44	m3
Amount of steel rebar	36.944	ton

Anoxic - Aerobic Tank

Foundatiton	0.7	m
Wall Thickness	0.6	m
Volume	**3400**	**m3**
Height	6	m
Area	566.67	m2
Free board	1	m
With between walls (W)	4.5	m
Middle Wall Width	0.3	m
Tank Length (L)	24	m
R1	9.3	m
hwater	6	m

Tank Surface Area Calculation

Area of rectangular shape	2 x4.5 x 24 = 108 m2
Area of circular shape	(3.14 x 9.3^2)/4 =67.93 m2
Middle Wall Area	2 x24 x 0.3 = 7.2 m2
Tank Surface Area	108 + 67.93 - 7.2 = 168.73 m2
	168.73 x 2 = 337.46 m2
Tank Amount	2 pcs.
1 Tank Volume	168.73 x 6 = 1012.38 m3
Twin Tank Volume	1012.38 x 2 = 2024.76 m3
Twin Tank Amount	2 Pcs.
Total Volume	4049.5 m3 TRUE

P1

Width	24	m
Length	7	m
Height	0.6	m
Pcs.	3	
Concrete Volume	302.4	m3

P2

Area	18.66	m2
Height	0.6	m
Pcs.	4	
Concrete Volume	44.78	m3

Foundatiton

Area	661	m2
Height	0.7	m
Pcs.	2	
Concrete Volume	925.4	m3
P1+P2+Foundatiton	1272.58	m3
Tank Amount	2	Pcs.
Unexpected	0.2	
Concrete Volume	3054.19	m3
Amount of steel rebar	305.419	ton

Secondary Sedimentation

Foundatiton	0.4	m
Wall Thickness	0.4	m
Height	**1.5**	**m**
Area	**210**	**m2**
Free board	0.3	m
Pcs.	2	Pcs.
Diameter	8.18	m
Selected diameter	8.5	m	TRUE
Sludge Collection Part Diameter	2.5	m
Sludge Collection Part Height	1.5	m

P1 - CYLINDRICAL PART

Area	49.87	m2
Length	1.8	m
Height	0.4	m
Pcs.	1	
Concrete Volume	35.91	m3

P2 - CONIC PART

Area	49.87	m2
Length	0.5	m
Height	0.4	m
Pcs.	1	
Concrete Volume	9.97	m3

P3 - SLUDGE COLLECTION PART

Area	8.51	m2
Length	2.5	m
Height	1.5	m
Pcs.	1	
Concrete Volume	31.91	m3

Foundatiton

Area	8.55	m2
Height	0.4	m
Pcs.	1	
Concrete Volume	3.42	m3
P1+P2+P3+Foundatiton	81.21	m3
Tank Amount	2	Pcs.
Unexpected	0.2	
Concrete Volume	194.9	m3
Amount of steel rebar	19.49	ton

30000 m3/day - A2O

Grit Chamber

Foundatiton	0.6	m	
Wall Thickness	0.5	m	
Volume	**250**	**m3**	
Height	3	m	
Area	83.33	m2	
Free board	0.7	m	
Number of Double Tank	2	pcs.	
Width	2.2	m	
Length	10	m	
Area	88	m2	
Volume	264	m3	TRUE
P1			
Width	10	m	
Length	3.7	m	
Height	0.5	m	
Pcs.	4		
Concrete Volume	148	m3	
P2			
Area	2.2	m2	
Length	3.7	m	
Height	0.5		
Pcs.	4		
Concrete Volume	8.14	m3	
Foundatiton			
Area	81	m2	
Height	0.6	m	
Pcs.	1		
Concrete Volume	48.6	m3	
P1+P2+Foundatiton	204.74	m3	
Tank Amount	2	pcs.	
Unexpected	0.2		
Concrete Volume	491.38	m3	
Amount of steel rebar	49.138	ton	

Anaerobic Tank

Foundatiton	0.7	m	
Wall Thickness	0.6	m	
Volume	**2300**	**m3**	
Height	6.5	m	
Area	353.85	m2	
Free board	1	m	
With between walls (W)	5	m	
Middle Wall Width	0.25	m	
Tank Length (L)	20	m	
R1	10.25	m	
hwater	6.5	m	
Tank Surface Area Calculation			
Area of rectangular shape	2x5 x 20 = 100 m2		
Area of circular shape	(3.14 x 10.25^2)/4 =82.52 m2		
Middle Wall Area	2 x20 x 0.25 = 5 m2		
Tank Surface Area	100 + 82.52 - 5 = 177.52 m2		
	177.52 x 2 = 355.04 m2		
Tank Amount	2	pcs.	
1 Tank Volume	177.52 x 6.5 = 1153.88 m3		
Twin Tank Volume	1153.88 x 2 = 2307.76 m3		
Twin Tank Amount	1	pcs.	
Total Volume	2307.8	m3	TRUE
P1			
Width	20	m	
Length	7.5	m	
Height	0.6	m	
Pcs.	3		
Concrete Volume	270	m3	
P2			
Area	20.45	m2	
Height	0.6	m	
Pcs.	4		
Concrete Volume	49.08	m3	
Foundatiton			
Area	650	m2	
Height	0.7	m	
Pcs.	1		
Concrete Volume	455	m3	
P1+P2+Foundatiton	774.08	m3	
Tank Amount	1	pcs.	
Unexpected	0.2		
Concrete Volume	928.9	m3	
Amount of steel rebar	92.89	ton	

Anoxic - Aerobic Tank

Foundatiton	0.7	m	
Wall Thickness	0.6	m	
Volume	**19900**	**m3**	
Height	6.5	m	
Area	3061.54	m2	
Free board	1	m	
With between walls (W)	7	m	
Middle Wall Width	0.3	m	
Tank Length (L)	35	m	
R1	14.3	m	
hwater	6.3	m	
Tank Surface Area Calculation			
Area of rectangular shape	2 x7 x 35 = 245 m2		
Area of circular shape	(3.14 x 14.3^2)/4 =160.61 m2		
Middle Wall Area	2 x35 x 0.3 = 10.5 m2		
Tank Surface Area	245 + 160.61 - 10.5 = 395.11 m2		
	395.11 x 2 = 790.22 m2		
Tank Amount	2	pcs.	
1 Tank Volume	395.11 x 6.3 = 2489.193 m3		
Twin Tank Volume	2489.193 x 2 = 4978.386 m3		
Twin Tank Amount	4	pcs.	
Total Volume	19913.5	m3	TRUE
P1			
Width	35	m	
Length	7.5	m	
Height	0.6	m	
Pcs.	3		
Concrete Volume	472.5	m3	
P2			
Area	28.09	m2	
Height	0.6	m	
Pcs.	4		
Concrete Volume	67.42	m3	
Foundatiton			
Area	1683	m2	
Height	0.7	m	
Pcs.	4		
Concrete Volume	4712.4	m3	
P1+P2+Foundatiton	5252.32	m3	
Tank Amount	4	pcs.	
Unexpected	0.2		
Concrete Volume	25211.14	m3	
Amount of steel rebar	2521.114	ton	

Secondary Sedimentation

Foundatiton	0.5	m	
Wall Thickness	0.5	m	
Height	**4**	**m**	
Area	**1000**	**m2**	
Free board	0.3	m	
Pcs.	4	Pcs.	
Diameter	8.92	m	
Selected diameter	9	m	TRUE
Sludge Collection Part Diameter	2.5	m	
Sludge Collection Part Height	1.5	m	
P1 - CYNDRICAL PART			
Area	58.29	m2	
Length	4.3	m	
Height	0.5	m	
Pcs.	1		
Concrete Volume	125.32	m3	
P2 - CONIC PART			
Area	58.29	m2	
Length	0.5	m	
Height	0.5	m	
Pcs.	1		
Concrete Volume	14.57	m3	
P3 - SLUDGE COLLECTION PART			
Area	9.56	m2	
Length	2.5	m	
Height	1.5	m	
Pcs.	1		
Concrete Volume	35.85	m3	
Foundatiton			
Area	9.62	m2	
Height	0.5	m	
Pcs.	1		
Concrete Volume	4.81	m3	
P1+P2+P3+Foundatiton	180.55	m3	
Tank Amount	4	Pcs.	
Unexpected	0.2		
Concrete Volume	866.64	m3	
Amount of steel rebar	86.664	ton	

130000 m3/day - A2O

Grit Chamber

Foundatiton	:	0.6	m
Wall Thickness	:	0.5	m
Volume	:	**1000**	**m3**
Height	:	3.5	m
Area	:	285.71	m2
Free board	:	0.7	m
Number of Double Tanl	:	4	pcs.
Width	:	2.2	m
Length	:	17	m
Area	:	299.2	m2
Volume	:	1047.2	m3 TRUE
P1			
Width	:	17	m
Length	:	4.2	m
Height	:	0.5	m
Pcs.	:	4	
Concrete Volume	:	571.2	m3
P2			
Area	:	2.2	m2
Length	:	4.2	m
Height	:	0.5	
Pcs.	:	4	
Concrete Volume	:	9.24	m3
Foundatiton			
Area	:	129	m2
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	77.4	m3
P1+P2+Foundatiton	:	657.84	m3
Tank Amount	:	4	pcs.
Unexpected	:	0.2	
Concrete Volume	:	3157.63	m3
Amount of steel rebar	:	315.763	ton

Anaerobic Tank

Foundatiton	:	0.7	m
Wall Thickness	:	0.6	m
Volume	:	**10000**	**m3**
Height	:	7	m
Area	:	1428.57	m2
Free board	:	1	m
With between walls (W)	:	7	m
Middle Wall Width	:	0.25	m
Tank Length (L)	:	30	m
R1	:	14.25	m
hwater	:	7	m
Tank Surface Area Calculation			
Area of rectangular shape	:	2 x 7 x 30 = 210 m2	
Area of circular shape	:	(3.14 x 14.25^2)/4 = 159.48 m2	
Middle Wall Area	:	2 x 30 x 0.25 = 7.5 m2	
Tank Surface Area	:	210 + 159.48 - 7.5 = 361.98 m2	
		361.98 x 2 = 723.96 m2	
Tank Amount	:	2	pcs.
1 Tank Volume	:	361.98 x 7 = 2533.86 m3	
Twin Tank Volume	:	2533.86 x 2 = 5067.72 m3	
Twin Tank Amount	:	2	pcs.
Total Volume	:	10135.4	m3 TRUE
P1			
Width	:	30	m
Length	:	8	m
Height	:	0.6	m
Pcs.	:	3	
Concrete Volume	:	432	m3
P2			
Area	:	27.99	m2
Height	:	0.6	m
Pcs.	:	4	
Concrete Volume	:	67.176	m3
Foundatiton			
Area	:	1290	m2
Height	:	0.7	m
Pcs.	:	2	
Concrete Volume	:	1806	m3
P1+P2+Foundatiton	:	2305.176	m3
Tank Amount	:	2	pcs.
Unexpected	:	0.2	
Concrete Volume	:	5532.42	m3
Amount of steel rebar	:	553.242	ton

Anoxic - Aerobic Tank

Foundatiton	:	0.7	m
Wall Thickness	:	0.6	m
Volume	:	**86000**	**m3**
Height	:	7	m
Area	:	12285.71	m2
Free board	:	1	m
With between walls (W)	:	12	m
Middle Wall Width	:	0.3	m
Tank Length (L)	:	48	m
R1	:	24.3	m
hwater	:	7	m
Tank Surface Area Calculation			
Area of rectangular shape	:	2 x 12 x 48 = 576 m2	
Area of circular shape	:	(3.14 x 24.3^2)/4 = 463.77 m2	
Middle Wall Area	:	2 x 48 x 0.3 = 14.4 m2	
Tank Surface Area	:	576 + 463.77 - 14.4 = 1025.37 m2	
		1025.37 x 2 = 2050.74 m2	
Tank Amount	:	2	pcs.
1 Tank Volume	:	1025.37 x 7 = 7177.59 m3	
Twin Tank Volume	:	7177.59 x 2 = 14355.18 m3	
Twin Tank Amount	:	6	pcs.
Total Volume	:	86131.1	m3 TRUE
P1			
Width	:	48	m
Length	:	8	m
Height	:	0.6	m
Pcs.	:	3	
Concrete Volume	:	691.2	m3
P2			
Area	:	46.94	m2
Height	:	0.6	m
Pcs.	:	4	
Concrete Volume	:	112.66	m3
Foundatiton			
Area	:	3470	m2
Height	:	0.7	m
Pcs.	:	6	
Concrete Volume	:	14574	m3
P1+P2+Foundatiton	:	15377.86	m3
Tank Amount	:	6	pcs.
Unexpected	:	0.2	
Concrete Volume	:	110720.59	m3
Amount of steel rebar	:	11072.059	ton

Secondary Sedimentation

Foundatiton	:	0.6	m
Wall Thickness	:	0.6	m
Height	:	**4.5**	**m**
Area	:	**4500**	**m2**
Free board	:	0.3	m
Pcs.	:	6	Pcs.
Diameter	:	12.62	m
Selected diameter	:	13	m TRUE
Sludge Collection Part Diameter	:	2.5	m
Sludge Collection Part Height	:	1.5	m
P1 - CYNDRICAL PART			
Area	:	116.12	m2
Length	:	4.8	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	334.43	m3
P2 - CONIC PART			
Area	:	116.12	m2
Length	:	0.5	m
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	34.84	m3
P3 - SLUDGE COLLECTION PART			
Area	:	10.66	m2
Length	:	2.5	m
Height	:	1.5	m
Pcs.	:	1	
Concrete Volume	:	39.98	m3
Foundatiton			
Area	:	10.75	m2
Height	:	0.6	m
Pcs.	:	1	
Concrete Volume	:	6.45	m3
P1+P2+P3+Foundatiton	:	415.7	m3
Tank Amount	:	6	Pcs.
Unexpected	:	0.2	
Concrete Volume	:	2993.04	m3
Amount of steel rebar	:	299.304	ton

D. Mechanical Equipment List (Equipment Power and Cost)

Treatment Scheme	6KCAS								
Equipment used in each unit	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption	Cost per Pcs.	Total Cost
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	0.55	4	0	2.20	90%	1	1.98	$ 7,651.06	$ 30,604.24
Coarse Screen	1.50	2	1	4.50	90%	24	64.80	$ 14,755.61	$ 44,266.84
Fine Screen	1.50	2	1	4.50	90%	24	64.80	$ 17,331.99	$ 51,995.97
Conveyor	1.50	2	0	3.00	90%	24	64.80	$ 11,710.81	$ 23,421.61
Inlet Pumps	15.00	2	1	45.00	90%	24	648.00	$ 10,032.26	$ 30,096.77
Crane	5.50	1	0	5.50	90%	1	4.95	$ 2,190.42	$ 2,190.42
Others	0	1	0	0.00	0%	0	0.00	$ 3,534.36	$ 3,534.36
Grit Chamber									
Scrapper	0.55	2	0	1.10	90%	24	23.76	$ 25,997.99	$ 51,995.97
Grit Pumps	1.1	2	1	3.30	90%	12	23.76	$ 1,943.99	$ 5,831.98
Grit Separator	0.55	1	0	0.55	90%	12	5.94	$ 10,539.72	$ 10,539.72
Lift Gate	0.55	2	0	1.10	90%	1	0.99	$ 6,714.19	$ 13,428.39
Blower	7.5	1	1	15.00	90%	24	162.00	$ 3,906.72	$ 7,813.45
Others	0	1	0	0.00	0%	0	0.00	$ 21,669.33	$ 21,669.33
Flowmeters	0	2	0	0.00	0%	0	0.00	$ 743.68	$ 1,487.36
Primary Sedimentation Tanks									
Scum Pumps	1.1	2	2	4.40	90%	0	0.00	$ 5,371.36	$ 21,485.42
Scrapper	1.1	2	0	2.20	90%	0	0.00	$ 59,022.46	$ 118,044.92
Aerobic Tanks									
Lift Gate	1.5	2	0	3.00	90%	1	2.70	$ 10,617.80	$ 21,235.59
Jib Crane	2.2	2	0	4.40	90%	1	3.96	$ 2,190.42	$ 4,380.84
Mixer	2.2	4	0	8.80	90%	18	142.56	$ 16,129.68	$ 64,518.73
Others	0	1	0	0.00	0%	0	0.00	$ 18,013.21	$ 18,013.21
Secondary Sedimentation Tanks									
Scum Pumps	1.1	2	2	4.40	90%	6	11.88	$ 1,943.99	$ 7,775.97
Scrapper	1.5	2	0	3.00	90%	24	64.80	$ 59,022.46	$ 118,044.92
Others	0	1	0	0.00	0%	0	0.00	$ 4,667.69	$ 4,667.69
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	11	3	1	44.00	90%	24	712.80	$ 9,477.94	$ 37,911.78
Excess Sludge Pumps	1.1	3	1	4.40	90%	24	71.28	$ 1,943.99	$ 7,775.97
Others	0	1	0	0.00	0%	0	0.00	$ 4,416.15	$ 4,416.15
			TOTAL	**168.45**	**-**	**-**	**2,120.04**		**$ 727,147.61**

Treatment Scheme	30KCAS								
Equipment used in each unit	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption	Cost per Pcs.	Total Cost
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	1.50	8	0	12.00	90%	1	10.80	$ 10,629.84	$ 85,038.73
Coarse Screen	1.50	2	1	4.50	90%	24	64.80	$ 17,223.21	$ 51,669.63
Fine Screen	1.50	2	1	4.50	90%	24	64.80	$ 22,329.08	$ 66,987.24
Conveyor	2.20	2	0	4.40	90%	24	95.04	$ 22,407.57	$ 44,815.15
Inlet Pumps	55.00	3	1	220.00	90%	24	3,564.00	$ 17,278.72	$ 69,114.88
Crane	5.50	1	0	5.50	90%	1	4.95	$ 2,190.42	$ 2,190.42
Others	0	1	0	0.00	0%	1	0.00	$ 17,422.22	$ 17,422.22
Grit Chamber									
Scrapper	0.55	4	0	2.20	90%	24	47.52	$ 25,750.21	$ 103,000.85
Grit Pumps	1.5	4	1	7.50	90%	12	64.80	$ 1,543.93	$ 7,719.67
Grit Separator	0.55	2	0	1.10	90%	12	11.88	$ 12,231.74	$ 24,463.47
Lift Gate	1.5	4	0	6.00	90%	1	5.40	$ 10,235.74	$ 40,942.97
Blower	7.5	2	1	22.50	90%	24	324.00	$ 9,109.59	$ 27,328.76
Others	0	1	0	0.00	0%	0	0.00	$ 16,474.35	$ 16,474.35
Flowmeters	0	1	0	0.00	0%	0	0.00	$ 9,270.02	$ 9,270.02
Primary Sedimentation Tanks									
Scum Pumps	1.1	4	2	6.60	90%	6	23.76	$ 6,267.99	$ 37,607.93
Scrapper	1.5	4	0	6.00	90%	24	129.60	$ 66,930.43	$ 267,721.70
Aerobic Tanks									
Lift Gate	1.5	4	0	6.00	90%	1	5.40	$ 15,372.62	$ 61,490.47
Jib Crane	2.2	8	0	17.60	90%	1	15.84	$ 6,600.64	$ 52,805.08
Mixer	2.2	8	0	17.60	90%	18	285.12	$ 20,364.50	$ 162,915.99
Others	0	1	0	0.00	0%	0	0.00	$ 6,267.99	$ 6,267.99
Secondary Sedimentation Tanks									
Scum Pumps	1.1	4	2	6.60	90%	6	23.76	$ 2,160.23	$ 12,961.38
Scrapper	1.5	4	0	6.00	90%	24	129.60	$ 66,930.43	$ 267,721.70
Others	0	1	0	0.00	0%	0	0.00	$ 319,701.92	$ 319,701.92
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	45	3	1	180.00	90%	24	2,916.00	$ 26,639.60	$ 106,558.39
Excess Sludge Pumps	7.5	3	1	30.00	90%	24	486.00	$ 4,960.18	$ 19,840.71
Others	0	1	0	0.00	90%	0	0.00	$ 25,727.45	$ 25,727.45
			TOTAL	**604.05**	-	-	**8,584.16**		**$ 2,175,480.76**

Treatment Scheme	130KCAS								
Equipment used in each unit	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption	Cost per Pcs.	Total Cost
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	2.20	16	0	35.20	90%	1	31.68	$ 4,791.88	$ 76,670.00
Coarse Screen	1.50	8	2	15.00	90%	24	259.20	$ 21,667.25	$ 216,672.50
Fine Screen	1.50	8	2	15.00	90%	24	259.20	$ 17,501.00	$ 175,010.00
Conveyor	2.20	4	0	8.80	90%	24	190.08	$ 10,000.38	$ 40,001.50
Inlet Pumps	132.00	4	2	792.00	90%	24	11,404.80	$ 74,791.68	$ 448,750.09
Crane	5.50	1	0	5.50	90%	1	4.95	$ 14,947.11	$ 14,947.11
Others	0	1	0	0.00	90%	1	0.00	$ 26,434.44	$ 26,434.44
Grit Chamber									
Scrapper	0.55	1	0	0.55	90%	24	11.88	$ 30,001.13	$ 30,001.13
Grit Pumps	1.5	1	1	3.00	90%	12	16.20	$ 1,709.78	$ 3,419.56
Grit Separator	1.1	1	0	1.10	90%	12	11.88	$ 12,500.13	$ 12,500.13
Lift Gate	2.2	4	0	8.80	90%	1	7.92	$ 4,791.88	$ 19,167.50
Blower	15	2	1	45.00	90%	24	648.00	$ 8,740.94	$ 26,222.83
Others	0	1	0	0.00	0%	0	0.00	$ 20,557.85	$ 20,557.85
Flowmeters	0	3	0	0.00	0%	0	0.00	$ 6,503.50	$ 19,510.51
Primary Sedimentation Tanks									
Scum Pumps	5.5	6	0	33.00	90%	6	178.20	$ 12,500.13	$ 75,000.75
Scrapper	5.5	6	0	33.00	90%	24	712.80	$ 58,334.24	$ 350,005.43
Aerobic Tanks									
Lift Gate	1.5	16	0	24.00	90%	1	21.60	$ 8,333.88	$ 133,342.00
Jib Crane	2.2	32	0	70.40	90%	1	63.36	$ 2,190.42	$ 70,093.44
Mixer	2.2	32	0	70.40	90%	18	1,140.48	$ 21,052.44	$ 673,677.96
Others	0	1	0	0.00	0%	0	0.00	$ 375,215.57	$ 375,215.57
Secondary Sedimentation Tanks									
Scum Pumps	1.1	6	2	8.80	90%	6	35.64	$ 1,609.06	$ 12,872.52
Scrapper	1.5	6	0	9.00	90%	24	194.40	$ 58,334.24	$ 350,005.43
Others	0	1	0	0.00	0%	0	0.00	$ 141,031.79	$ 141,031.79
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	90	3	1	360.00	90%	24	5,832.00	$ 42,116.82	$ 168,467.27
Excess Sludge Pumps	7.5	3	1	30.00	90%	24	486.00	$ 6,359.36	$ 25,437.43
Others	0	1	0	0.00	0%	0	0.00	$ 4,416.15	$ 4,416.15
			TOTAL	**1,604.90**	**-**	**-**	**21,821.36**		**$ 3,515,934.35**

Treatment Scheme	6KEXT								
Equipment used in each unit	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption	Cost per Pcs.	Total Cost
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	0.55	4	0	2.20	90%	1	1.98	$ 7,651.06	$ 30,604.24
Coarse Screen	1.50	2	1	4.50	90%	24	64.80	$ 14,755.61	$ 44,266.84
Fine Screen	1.50	2	1	4.50	90%	24	64.80	$ 17,331.99	$ 51,995.97
Conveyor	1.50	2	0	3.00	90%	24	64.80	$ 11,710.81	$ 23,421.61
Inlet Pumps	15.00	2	1	45.00	90%	24	648.00	$ 10,032.26	$ 30,096.77
Crane	5.50	1	0	5.50	90%	1	4.95	$ 2,190.42	$ 2,190.42
Others	0	1	0	0.00	90%	1	0.00	$ 3,534.36	$ 3,534.36
Grit Chamber									
Scrapper	0.55	2	0	1.10	90%	24	23.76	$ 25,997.99	$ 51,995.97
Grit Pumps	1.1	2	1	3.30	90%	12	23.76	$ 1,943.99	$ 5,831.98
Grit Separator	0.55	1	0	0.55	90%	12	5.94	$ 10,539.72	$ 10,539.72
Lift Gate	0.55	2	0	1.10	90%	1	0.99	$ 6,714.19	$ 13,428.39
Blower	7.5	1	1	15.00	90%	24	162.00	$ 3,906.72	$ 7,813.45
Others	0	1	0	0.00	0%	0	0.00	$ 21,669.33	$ 21,669.33
Flowmeters	0	2	0	0.00	0%	0	0.00	$ 743.68	$ 1,487.36
Aerobic Tanks									
Lift Gate	1.5	2	0	3.00	90%	1	2.70	$ 10,617.80	$ 21,235.59
Jib Crane	1.5	3	0	4.50	90%	1	4.05	$ 2,190.42	$ 6,571.26
Mixer	2.2	3	0	6.60	90%	12	71.28	$ 16,129.68	$ 48,389.05
Others	0	1	0	0.00	0%	0	0.00	$ 16,011.74	$ 16,011.74
Secondary Sedimentation Tanks									
Scum Pumps	1.1	2	1	3.30	90%	6	11.88	$ 1,943.99	$ 5,831.98
Scrapper	1.5	2	0	3.00	90%	24	64.80	$ 84,317.80	$ 168,635.59
Others	0	1	0	0.00	90%	0	0.00	$ 4,618.28	$ 4,618.28
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	11	2	1	33.00	90%	24	475.20	$ 9,477.94	$ 28,433.83
Excess Sludge Pumps	1.1	2	1	3.30	90%	24	47.52	$ 1,943.99	$ 5,831.98
Others	0	1	0	0.00	0%	0	0.00	$ 3,925.46	$ 3,925.46
				TOTAL	**39.60**	**356.00**	-		**$ 608,361.20**

Treatment Scheme	30KEXT								
Equipment used in each unit	**Equipment properties**			**Installed Power**	**Efficiency**	**Working time interval**	**Daily Power Consumption**	**Cost per Pcs.**	**Total Cost**
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	1.50	8	0	12.00	90%	1	10.80	$ 10,629.84	$ 85,038.73
Coarse Screen	1.50	2	1	4.50	90%	24	64.80	$ 17,223.21	$ 51,669.63
Fine Screen	1.50	2	1	4.50	90%	24	64.80	$ 22,329.08	$ 66,987.24
Conveyor	2.20	2	0	4.40	90%	24	95.04	$ 22,407.57	$ 44,815.15
Inlet Pumps	55.00	3	1	220.00	90%	24	3,564.00	$ 17,278.72	$ 69,114.88
Crane	5.50	1	0	5.50	90%	1	4.95	$ 2,190.42	$ 2,190.42
Others	0	1	0	0.00	0%	1	0.00	$ 17,422.22	$ 17,422.22
Grit Chamber									
Scrapper	0.55	4	0	2.20	90%	24	47.52	$ 25,750.21	$ 103,000.85
Grit Pumps	1.5	4	1	7.50	90%	12	64.80	$ 1,543.93	$ 7,719.67
Grit Separator	0.55	2	0	1.10	90%	12	11.88	$ 12,231.74	$ 24,463.47
Lift Gate	1.5	4	0	6.00	90%	1	5.40	$ 10,235.74	$ 40,942.97
Blower	7.5	2	1	22.50	90%	24	324.00	$ 9,109.59	$ 27,328.76
Others	0	1	0	0.00	0%	0	0.00	$ 16,474.35	$ 16,474.35
Flowmeters	0	4	0	0.00	0%	0	0.00	$ 9,270.02	$ 37,080.08
Aerobic Tanks									
Lift Gate	1.5	4	0	6.00	90%	1	5.40	$ 15,372.62	$ 61,490.47
Jib Crane	1.5	6	0	9.00	90%	1	8.10	$ 6,600.64	$ 39,603.81
Mixer	2.2	6	0	13.20	90%	12	142.56	$ 20,364.50	$ 122,186.99
Others	0	1	0	0.00	0%	0	0.00	$ 5,571.55	$ 5,571.55
Secondary Sedimentation Tanks									
Scum Pumps	1.1	3	1	4.40	90%	6	17.82	$ 2,160.23	$ 8,640.92
Scrapper	1.5	3	0	4.50	90%	24	97.20	$ 95,614.89	$ 286,844.68
Others	0	1	0	0.00	0%	0	0.00	$ 333,262.86	$ 333,262.86
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	45	2	1	135.00	90%	24	1,944.00	$ 26,639.60	$ 79,918.79
Excess Sludge Pumps	7.5	2	1	22.50	90%	24	324.00	$ 4,960.18	$ 14,880.53
Others	0	1	0	0.00	90%	0	0.00	$ 22,868.84	$ 22,868.84
			TOTAL	**526.65**	**-**	**-**	**7,131.92**		**$ 1,569,517.85**

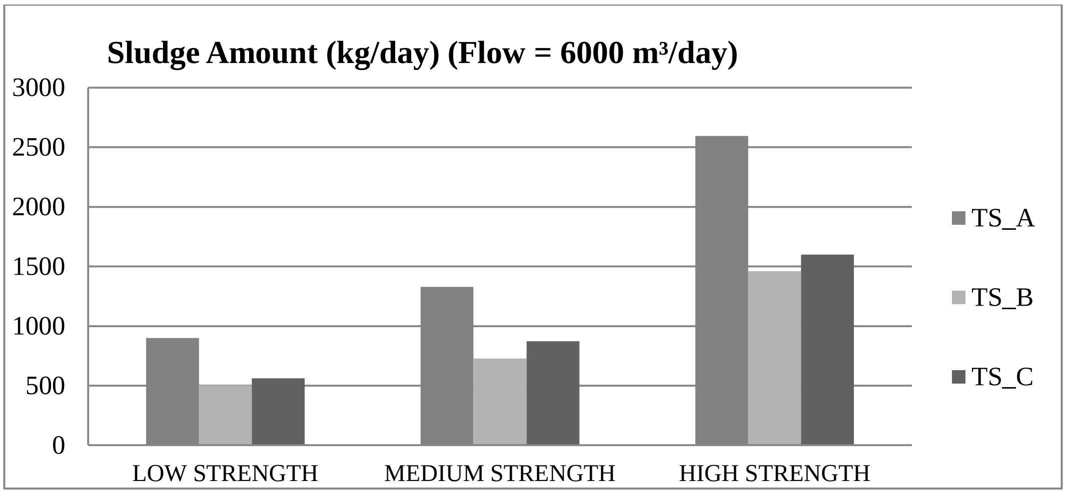
Treatment Scheme	130KEXT								
Equipment used in each unit	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption	Cost per Pcs.	Total Cost
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	2.20	16	0	35.20	90%	1	31.68	$ 4,791.88	$ 76,670.00
Coarse Screen	1.50	8	2	15.00	90%	24	259.20	$ 21,667.25	$ 216,672.50
Fine Screen	1.50	8	2	15.00	90%	24	259.20	$ 17,501.00	$ 175,010.00
Conveyor	2.20	4	0	8.80	90%	24	190.08	$ 10,000.38	$ 40,001.50
Inlet Pumps	132.00	4	2	792.00	90%	24	11,404.80	$ 74,791.68	$ 448,750.09
Crane	5.50	1	0	5.50	90%	1	4.95	$ 14,947.11	$ 14,947.11
Others	0	1	0	0.00	0%	0	0.00	$ 26,434.44	$ 26,434.44
Grit Chamber									
Scrapper	0.55	1	0	0.55	90%	24	11.88	$ 30,001.13	$ 30,001.13
Grit Pumps	1.5	1	1	3.00	90%	12	16.20	$ 1,709.78	$ 3,419.56
Grit Separator	1.1	1	0	1.10	90%	12	11.88	$ 12,500.13	$ 12,500.13
Lift Gate	2.2	4	0	8.80	90%	1	7.92	$ 4,791.88	$ 19,167.50
Blower	15	2	1	45.00	90%	24	648.00	$ 8,740.94	$ 26,222.83
Others	0	1	0	0.00	0%	0	0.00	$ 13,705.23	$ 13,705.23
Flowmeters	0	8	0	0.00	0%	0	0.00	$ 6,503.50	$ 52,028.01
Aerobic Tanks									
Lift Gate	1.5	8	0	12.00	90%	1	10.80	$ 8,333.88	$ 66,671.00
Jib Crane	1.5	16	0	24.00	90%	1	21.60	$ 2,190.42	$ 35,046.72
Mixer	2.2	16	0	35.20	90%	12	380.16	$ 21,052.44	$ 336,838.98
Others	0	1	0	0.00	0%	0	0.00	$ 333,524.95	$ 333,524.95
Secondary Sedimentation Tanks									
Scum Pumps	1.1	8	2	11.00	90%	6	47.52	$ 1,609.06	$ 16,090.65
Scrapper	1.5	8	0	12.00	90%	24	259.20	$ 83,334.63	$ 666,677.00
Others	0	1	0	0.00	0%	0	0.00	$ 125,361.59	$ 125,361.59
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	90	1	1	180.00	90%	24	1,944.00	$ 42,116.82	$ 84,233.63
Excess Sludge Pumps	7.5	1	1	15.00	90%	24	162.00	$ 6,359.36	$ 12,718.72
Others	0	1	0	0.00	90%	0	0.00	$ 3,925.46	$ 3,925.46
			TOTAL	**1,259.90**	**-**	**-**	**16,005.92**		**$ 2,843,122.22**

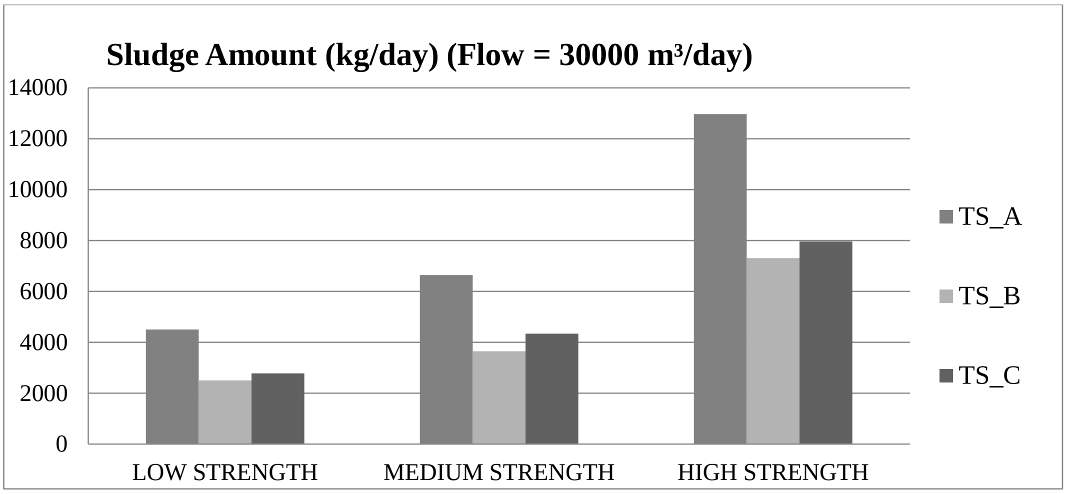
Treatment Scheme	6KA2O								
Equipment used in each unit	**Equipment properties**			**Installed Power**	**Efficiency**	**Working time interval**	**Daily Power Consumption**	**Cost per Pcs.**	**Total Cost**
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	0.55	4	0	2.20	90%	1	1.98	$ 7,651.06	$ 30,604.24
Coarse Screen	1.50	2	1	4.50	90%	24	64.80	$ 14,755.61	$ 44,266.84
Fine Screen	1.50	2	1	4.50	90%	24	64.80	$ 17,331.99	$ 51,995.97
Conveyor	1.50	2	0	3.00	90%	24	64.80	$ 11,710.81	$ 23,421.61
Inlet Pumps	15.00	2	1	45.00	90%	24	648.00	$ 10,032.26	$ 30,096.77
Crane	5.50	1	0	5.50	90%	1	4.95	$ 2,190.42	$ 2,190.42
Others	0	1	0	0.00	0%	0	0.00	$ 3,534.36	$ 3,534.36
Grit Chamber									
Scrapper	0.55	2	0	1.10	90%	24	23.76	$ 25,997.99	$ 51,995.97
Grit Pumps	1.1	2	1	3.30	90%	12	23.76	$ 1,943.99	$ 5,831.98
Grit Separator	0.55	1	0	0.55	90%	12	5.94	$ 10,539.72	$ 10,539.72
Lift Gate	0.55	2	0	1.10	90%	1	0.99	$ 6,714.19	$ 13,428.39
Blower	7.5	1	1	15.00	90%	24	162.00	$ 3,906.72	$ 7,813.45
Others	0	1	0	0.00	0%	0	0.00	$ 21,669.33	$ 21,669.33
Flowmeters	0	2	0	0.00	0%	0	0.00	$ 743.68	$ 1,487.36
Anaerobic Tanks									
Lift Gate 1	0.55	4	0	2.20	90%	1	1.98	$ 12,803.81	$ 51,215.25
Lift Gate 2	0.55	4	0	2.20	90%	1	1.98	$ 7,651.06	$ 30,604.24
Jib Crane	1.5	4	0	6.00	90%	1	5.40	$ 2,186.02	$ 8,744.07
Mixer	3	4	0	12.00	90%	24	259.20	$ 5,129.33	$ 20,517.33
Aerobic Tanks									
Lift Gate 1	0.55	4	0	2.20	90%	1	1.98	$ 10,617.80	$ 42,471.19
Lift Gate 2	0.55	2	0	1.10	90%	1	0.99	$ 6,245.76	$ 12,491.53
Jib Crane	1.5	4	0	6.00	90%	1	5.40	$ 2,190.42	$ 8,761.68
Mixer	3	8	0	24.00	90%	24	518.40	$ 16,129.68	$ 129,037.46
Others	0	1	0	0.00	0%	0	0.00	$ 20,014.68	$ 20,014.68
Secondary Sedimentation Tanks									
Scum Pumps	1.1	2	1	3.30	90%	6	11.88	$ 1,943.99	$ 5,831.98
Scrapper	0.55	2	0	1.10	90%	24	23.76	$ 84,317.80	$ 168,635.59
Others	0	1	0	0.00	0%	0	0.00	$ 4,717.10	$ 4,717.10
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	11	3	1	44.00	90%	24	712.80	$ 9,477.94	$ 37,911.78
Excess Sludge Pumps	1.1	3	1	4.40	90%	24	71.28	$ 1,943.99	$ 7,775.97
Others	0	1	0	0.00	0%	0	0.00	$ 4,906.83	$ 4,906.83
			TOTAL	**198.35**	**-**	**-**	**2,725.11**		**$ 847,606.27**

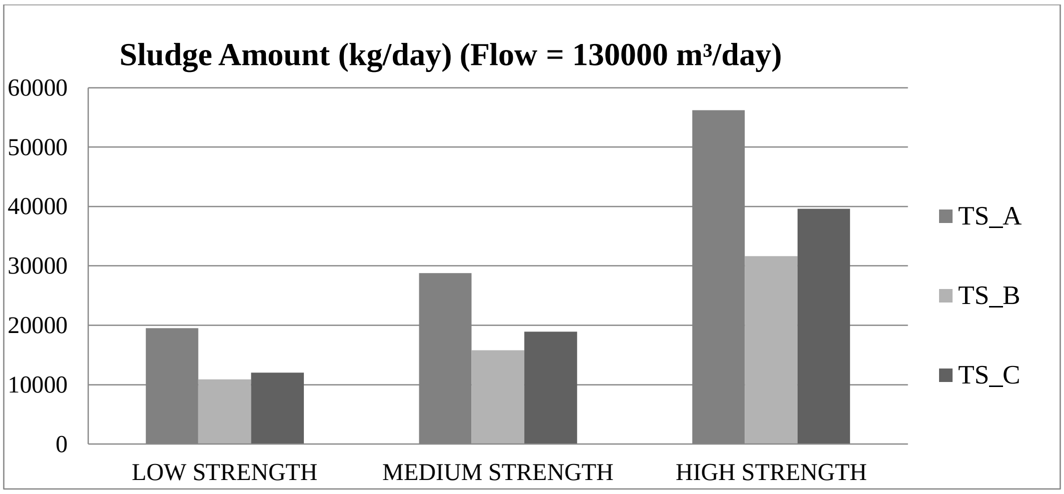
Treatment Scheme	30KA2O									
	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption		Cost per Pcs.	Total Cost
	kW	prime	backup	kw	%	hr	kWhr.day		$	$
Screens and Inlet Pumping Station										
Lift Gate	1.50	8	0	12.00	90%	1	10.80		$ 10,629.84	$ 85,038.73
Coarse Screen	1.50	2	1	4.50	90%	24	64.80		$ 17,223.21	$ 51,669.63
Fine Screen	1.50	2	1	4.50	90%	24	64.80		$ 22,329.08	$ 66,987.24
Conveyor	2.20	2	0	4.40	90%	24	95.04		$ 22,407.57	$ 44,815.15
Inlet Pumps	55.00	3	1	220.00	90%	24	3,564.00		$ 17,278.72	$ 69,114.88
Crane	5.50	1	0	5.50	90%	1	4.95		$ 2,190.42	$ 2,190.42
Others	0	1	0	0.00	90%	0	0.00		$ 17,422.22	$ 17,422.22
Grit Chamber										
Scrapper	0.55	4	0	2.20	90%	24	47.52		$ 25,750.21	$ 103,000.85
Grit Pumps	1.5	4	1	7.50	90%	12	64.80		$ 1,543.93	$ 7,719.67
Grit Separator	0.55	2	0	1.10	90%	12	11.88		$ 12,231.74	$ 24,463.47
Lift Gate	1.5	4	0	6.00	90%	1	5.40		$ 10,235.74	$ 40,942.97
Blower	7.5	2	1	22.50	90%	24	324.00		$ 9,109.59	$ 27,328.76
Others	0	1	0	0.00	0%	0	0.00		$ 16,474.35	$ 16,474.35
Flowmeters	0	3	0	0.00	0%	0	0.00		$ 9,270.02	$ 27,810.06
Anaerobic Tanks										
Lift Gate 1	2	2	0	4.00	90%	1	3.60		$ 14,951.37	$ 29,902.73
Lift Gate 2	2	2	0	4.00	90%	1	3.60		$ 13,679.44	$ 27,358.88
Jib Crane	5.5	2	0	11.00	90%	1	9.90		$ 1,315.65	$ 2,631.29
Mixer	3	2	0	6.00	90%	24	129.60		$ 3,237.86	$ 6,475.72
Aerobic Tanks										
Lift Gate 1	1.5	8	0	12.00	90%	4	43.20		$ 15,372.62	$ 122,980.93
Lift Gate 2	1.5	4	0	6.00	90%	4	21.60		$ 18,673.74	$ 74,694.96
Jib Crane	5.5	8	0	44.00	90%	1	39.60		$ 6,600.64	$ 52,805.08
Mixer	5.5	16	0	88.00	90%	24	1,900.80		$ 20,364.50	$ 325,831.98
Others	0	1	0	0.00	0%	0	0.00		$ 6,964.43	$ 6,964.43
Secondary Sedimentation Tanks										
Scum Pumps	2.2	3	1	8.80	90%	6	35.64		$ 2,160.23	$ 8,640.92
Scrapper	1.5	4	0	6.00	90%	24	129.60		$ 95,614.89	$ 382,459.58
Others	0	1	0	0.00	0%	0	0.00		$ 306,140.99	$ 306,140.99
Return and Excess Sludge Pumping Station										
Return Sludge Pumps	45	4	2	270.00	90%	24	3,888.00		$ 26,639.60	$ 159,837.58
Excess Sludge Pumps	7.5	4	2	45.00	90%	24	648.00		$ 4,960.18	$ 29,761.06
Others	0	1	0	0.00	0%	0	0.00		$ 28,586.05	$ 28,586.05
			TOTAL	**836.85**	-	-	**11,445.98**			**$ 2,150,050.57**

Treatment Scheme	130KA2O								
	Equipment properties			Installed Power	Efficiency	Working time interval	Daily Power Consumption	Cost per Pcs.	Total Cost
	kW	prime	backup	kw	%	hr	kWhr.day	$	$
Screens and Inlet Pumping Station									
Lift Gate	2.20	16	0	35.20	90%	1	31.68	$ 4,791.88	$ 76,670.00
Coarse Screen	1.50	8	2	15.00	90%	24	259.20	$ 21,667.25	$ 216,672.50
Fine Screen	1.50	8	2	15.00	90%	24	259.20	$ 17,501.00	$ 175,010.00
Conveyor	2.20	4	0	8.80	90%	24	190.08	$ 10,000.38	$ 40,001.50
Inlet Pumps	132.00	4	2	792.00	90%	24	11,404.80	$ 74,791.68	$ 448,750.09
Crane	5.50	1	0	5.50	90%	1	4.95	$ 14,947.11	$ 14,947.11
Others	0	1	0	0.00	0%	0	0.00	$ 26,434.44	$ 26,434.44
Grit Chamber									
Scrapper	0.55	1	0	0.55	90%	12	5.94	$ 30,001.13	$ 30,001.13
Grit Pumps	1.5	1	1	3.00	90%	12	16.20	$ 1,709.78	$ 3,419.56
Grit Separator	1.1	1	0	1.10	90%	12	11.88	$ 12,500.13	$ 12,500.13
Lift Gate	2.2	4	0	8.80	90%	1	7.92	$ 4,791.88	$ 19,167.50
Blower	15	2	1	45.00	90%	24	648.00	$ 8,740.94	$ 26,222.83
Others	0	1	0	0.00	0%	1	0.00	$ 20,557.85	$ 20,557.85
Flowmeters	0	4	0	0.00	0%	0	0.00	$ 6,503.50	$ 26,014.01
Anaerobic Tanks									
Lift Gate 1	2.2	4	0	8.80	90%	1	7.92	$ 10,833.63	$ 43,334.50
Lift Gate 2	2.2	4	0	8.80	90%	1	7.92	$ 6,875.00	$ 27,500.00
Jib Crane	1.5	6	0	9.00	90%	1	8.10	$ 2,190.42	$ 13,142.52
Mixer	1.5	6	0	9.00	90%	1	8.10	$ 13,730.06	$ 82,380.36
Aerobic Tanks									
Lift Gate 1	2.2	12	0	26.40	90%	1	23.76	$ 8,333.88	$ 100,006.50
Lift Gate 2	2.2	6	0	13.20	90%	1	11.88	$ 10,000.38	$ 60,002.25
Jib Crane	1.5	12	0	18.00	90%	1	16.20	$ 2,190.42	$ 26,285.04
Mixer	5.5	24	0	132.00	90%	1	118.80	$ 21,052.44	$ 505,258.47
Others	0	1	0	0.00	0%	0	0.00	$ 416,906.18	$ 416,906.18
Secondary Sedimentation Tanks									
Scum Pumps	1.1	6	2	8.80	90%	6	35.64	$ 1,609.06	$ 12,872.52
Scrapper	5.5	6	0	33.00	90%	24	712.80	$ 83,334.63	$ 500,007.75
Others	0	1	0	0.00	0%	1	0.00	$ 156,701.99	$ 156,701.99
Return and Excess Sludge Pumping Station									
Return Sludge Pumps	90	3	1	360.00	90%	24	5,832.00	$ 42,116.82	$ 168,467.27
Excess Sludge Pumps	7.5	3	1	30.00	90%	12	243.00	$ 6,359.36	$ 25,437.43
Others	0	1	0	0.00	90%	0	0.00	$ 4,906.83	$ 4,906.83
			TOTAL	**1,627.70**	**-**	**-**	**20,200.82**		**$ 3,279,578.24**

E. BioWin Results- Sludge Amounts (kg/day)







F. Replacement Cost Calculation

Construction Items	6KCASMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 574,720.60
Piping	$ 76,629.41	$ 76,629.41
TOTAL	$ 76,629.41	$ 651,350.01

Construction Items	6KCASMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 675,206.43
Piping	$ 90,027.52	$ 90,027.52
TOTAL	$ 90,027.52	$ 765,233.95

Construction Items	6KCASHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,042,348.80
Piping	$ 138,979.84	$ 138,979.84
TOTAL	$ 138,979.84	$ 1,181,328.64

Construction Items	30KCASLOW	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,668,708.84
Piping	$ 222,494.51	$ 222,494.51
TOTAL	$ 222,494.51	$ 1,891,203.36

Construction Items	30KCASMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,780,785.12
Piping	$ 237,438.02	$ 237,438.02
TOTAL	$ 237,438.02	$ 2,018,223.13

Construction Items	30KCASHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 2,198,293.59
Piping	$ 293,105.81	$ 293,105.81
TOTAL	$ 293,105.81	$ 2,491,399.40

Construction Items	130KCASLOW	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 2,687,181.14
Piping	$ 358,290.82	$ 358,290.82
TOTAL	$ 358,290.82	$ 3,045,471.96

Construction Items	130KCASMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 2,799,257.41
Piping	$ 373,234.32	$ 373,234.32
TOTAL	$ 373,234.32	$ 3,172,491.74

Construction Items	130KCASHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 3,216,765.89
Piping	$ 428,902.12	$ 428,902.12
TOTAL	$ 428,902.12	$ 3,645,668.01

Construction Items	6KEXTLOW	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 500,554.58
Piping	$ 66,740.61	$ 66,740.61
TOTAL	$ 66,740.61	$ 567,295.19

Construction Items	6KEXTMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 533,150.65
Piping	$ 71,086.75	$ 71,086.75
TOTAL	$ 71,086.75	$ 604,237.40

Construction Items	6KEXTHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 533,150.65
Piping	$ 71,086.75	$ 71,086.75
TOTAL	$ 71,086.75	$ 604,237.40

Construction Items	30KEXTLOW	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,350,001.21
Piping	$ 180,000.16	$ 180,000.16
TOTAL	$ 180,000.16	$ 1,530,001.37

Construction Items	30KEXTMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,393,857.14
Piping	$ 185,847.62	$ 185,847.62
TOTAL	$ 185,847.62	$ 1,579,704.76

Construction Items	30KEXTHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,393,857.14
Piping	$ 185,847.62	$ 185,847.62
TOTAL	$ 185,847.62	$ 1,579,704.76

Construction Items	130KEXTLOW	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 2,542,601.79
Piping	$ 339,013.57	$ 339,013.57
TOTAL	$ 339,013.57	$ 2,881,615.36

Construction Items	130KEXTMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 2,625,440.77
Piping	$ 350,058.77	$ 350,058.77
TOTAL	$ 350,058.77	$ 2,975,499.54

Construction Items	130KEXTHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 2,877,271.28
Piping	$ 383,636.17	$ 383,636.17
TOTAL	$ 383,636.17	$ 3,260,907.45

Construction Items	6KA2OLOW	
	YEAR 10	YEAR 20
Civil	-	-
Mechanical	-	$ 667,530.24
Electrical-Sanitary	$ 89,004.03	$ 89,004.03
Piping	-	-
TOTAL	$ 89,004.03	$ 756,534.27

Construction Items	6KA2OMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 676,932.95
Piping	$ 90,257.73	$ 90,257.73
TOTAL	$ 90,257.73	$ 767,190.68

Construction Items	6KA2OHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 853,962.00
Piping	$ 113,861.60	$ 113,861.60
TOTAL	$ 113,861.60	$ 967,823.60

Construction Items	30KA2OLOW	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,813,906.50
Piping	$ 241,854.20	$ 241,854.20
TOTAL	$ 241,854.20	$ 2,055,760.70

Construction Items	30KA2OMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 1,843,143.79
Piping	$ 245,752.51	$ 245,752.51
TOTAL	$ 245,752.51	$ 2,088,896.30

Construction Items	30KA2OHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 2,375,272.18
Piping	$ 316,702.96	$ 316,702.96
TOTAL	$ 316,702.96	$ 2,691,975.14

Construction Items	130KA2OLOW	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 3,583,459.83
Piping	$ 477,794.64	$ 477,794.64
TOTAL	$ 477,794.64	$ 4,061,254.48

Construction Items	130KA2OMED	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 3,629,576.78
Piping	$ 483,943.57	$ 483,943.57
TOTAL	$ 483,943.57	$ 4,113,520.36

Construction Items	130KA2OHIGH	
	YEAR 10	YEAR 20
Civil	$ -	$ -
Mechanical	$ -	$ -
Electrical-Sanitary	$ -	$ 4,596,629.33
Piping	$ 612,883.91	$ 612,883.91
TOTAL	$ 612,883.91	$ 5,209,513.24

G. Maintenance Cost Calculation

Construction Items	6KCASLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 220,022.20	2.0-4.0	3.0	$ 6,601.00
Mechanical	$ 832,928.40	2.0-6.0	3.0	$ 24,988.00
Electrical-Sanitary	$ 166,585.68	2.0-6.0	3.0	$ 4,998.00
Piping	$ 133,268.54	2.0-6.0	3.0	$ 3,998.00
TOTAL			**TOTAL**	$ 40,585.00

Construction Items	6KCASMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 220,022.20	2.0-4.0	3.0	$ 6,601.00
Mechanical	$ 978,560.04	2.0-6.0	3.0	$ 29,357.00
Electrical-Sanitary	$ 195,712.01	2.0-6.0	3.0	$ 5,871.00
Piping	$ 156,569.61	2.0-6.0	3.0	$ 4,697.00
TOTAL			**TOTAL**	$ 46,526.00

Construction Items	6KCASHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 220,022.20	2.0-4.0	3.0	$ 6,601.00
Mechanical	$ 1,510,650.44	2.0-6.0	3.0	$ 45,320.00
Electrical-Sanitary	$ 302,130.09	2.0-6.0	3.0	$ 9,064.00
Piping	$ 156,569.61	2.0-6.0	3.0	$ 4,697.00
TOTAL			**TOTAL**	$ 65,682.00

Construction Items	30KCASLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 704,429.68	2.0-4.0	3.0	$ 21,133.00
Mechanical	$ 2,418,418.62	2.0-6.0	3.0	$ 72,553.00
Electrical-Sanitary	$ 483,683.72	2.0-6.0	3.0	$ 14,511.00
Piping	$ 386,946.98	2.0-6.0	3.0	$ 11,608.00
TOTAL			**TOTAL**	$ 119,805.00

Construction Items	30KCASMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 704,429.68	2.0-4.0	3.0	$ 21,133.00
Mechanical	$ 2,580,847.99	2.0-6.0	3.0	$ 77,425.00
Electrical-Sanitary	$ 516,169.60	2.0-6.0	3.0	$ 15,485.00
Piping	$ 412,935.68	2.0-6.0	3.0	$ 12,388.00
TOTAL			**TOTAL**	$ 126,431.00

Construction Items	30KCASHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 704,429.68	2.0-4.0	3.0	$ 21,133.00
Mechanical	$ 3,185,932.74	2.0-6.0	3.0	$ 95,578.00
Electrical-Sanitary	$ 637,186.55	2.0-6.0	3.0	$ 19,116.00
Piping	$ 509,749.24	2.0-6.0	3.0	$ 15,292.00
TOTAL			**TOTAL**	$ 151,119.00

Construction Items	130KCASLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 2,823,978.97	2.0-4.0	3.0	$ 84,719.00
Mechanical	$ 3,894,465.42	2.0-6.0	3.0	$ 116,834.00
Electrical-Sanitary	$ 778,893.08	2.0-6.0	3.0	$ 23,367.00
Piping	$ 623,114.47	2.0-6.0	3.0	$ 18,693.00
TOTAL			**TOTAL**	$ 243,613.00

Construction Items	130KCASMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 2,823,978.97	2.0-4.0	3.0	$ 84,719.00
Mechanical	$ 4,056,894.80	2.0-6.0	3.0	$ 121,707.00
Electrical-Sanitary	$ 811,378.96	2.0-6.0	3.0	$ 24,341.00
Piping	$ 649,103.17	2.0-6.0	3.0	$ 19,473.00
TOTAL			**TOTAL**	$ 250,240.00

Construction Items	130KCASHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 2,823,978.97	2.0-4.0	3.0	$ 84,719.00
Mechanical	$ 4,661,979.55	2.0-6.0	3.0	$ 139,859.00
Electrical-Sanitary	$ 932,395.91	2.0-6.0	3.0	$ 27,972.00
Piping	$ 745,916.73	2.0-6.0	3.0	$ 22,378.00
TOTAL			**TOTAL**	$ 274,928.00

Construction Items	6KEXTLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 326,552.03	2.0-4.0	2.0	$ 6,531.00
Mechanical	$ 725,441.42	2.0-6.0	2.0	$ 14,509.00
Electrical-Sanitary	$ 145,088.28	2.0-6.0	2.0	$ 2,902.00
Piping	$ 116,070.63	2.0-6.0	2.0	$ 2,321.00
TOTAL			**TOTAL**	$ 26,263.00

Construction Items	6KEXTMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 326,552.03	2.0-4.0	2.0	$ 6,531.00
Mechanical	$ 772,682.10	2.0-6.0	2.0	$ 15,454.00
Electrical-Sanitary	$ 154,536.42	2.0-6.0	2.0	$ 3,091.00
Piping	$ 123,629.14	2.0-6.0	2.0	$ 2,473.00
TOTAL			**TOTAL**	$ 27,549.00

Construction Items	6KEXTHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 326,552.03	2.0-4.0	2.0	$ 6,531.00
Mechanical	$ 772,682.10	2.0-6.0	2.0	$ 15,454.00
Electrical-Sanitary	$ 154,536.42	2.0-6.0	2.0	$ 3,091.00
Piping	$ 123,629.14	2.0-6.0	2.0	$ 2,473.00
TOTAL			**TOTAL**	$ 27,549.00

Construction Items	30KEXTLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 1,494,610.20	2.0-4.0	2.0	$ 29,892.00
Mechanical	$ 1,956,523.50	2.0-6.0	2.0	$ 39,130.00
Electrical-Sanitary	$ 391,304.70	2.0-6.0	2.0	$ 7,826.00
Piping	$ 313,043.76	2.0-6.0	2.0	$ 6,261.00
TOTAL			**TOTAL**	$ 83,109.00

Construction Items	30KEXTMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 1,494,610.20	2.0-4.0	2.0	$ 29,892.00
Mechanical	$ 2,020,082.82	2.0-6.0	2.0	$ 40,402.00
Electrical-Sanitary	$ 404,016.56	2.0-6.0	2.0	$ 8,080.00
Piping	$ 323,213.25	2.0-6.0	2.0	$ 6,464.00
TOTAL			**TOTAL**	$ 84,838.00

Construction Items	30KEXTHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 1,494,610.20	2.0-4.0	2.0	$ 29,892.00
Mechanical	$ 2,020,082.82	2.0-6.0	2.0	$ 40,402.00
Electrical-Sanitary	$ 404,016.56	2.0-6.0	2.0	$ 8,080.00
Piping	$ 323,213.25	2.0-6.0	2.0	$ 6,464.00
TOTAL			**TOTAL**	$ 84,838.00

Construction Items	130KEXTLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 5,951,275.48	2.0-4.0	2.0	$ 119,026.00
Mechanical	$ 3,684,930.13	2.0-6.0	2.0	$ 73,699.00
Electrical-Sanitary	$ 736,986.03	2.0-6.0	2.0	$ 14,740.00
Piping	$ 589,588.82	2.0-6.0	2.0	$ 11,792.00
TOTAL			**TOTAL**	$ 219,257.00

Construction Items	130KEXTMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 5,951,275.48	2.0-4.0	2.0	$ 119,026.00
Mechanical	$ 3,804,986.63	2.0-6.0	2.0	$ 76,100.00
Electrical-Sanitary	$ 760,997.33	2.0-6.0	2.0	$ 15,220.00
Piping	$ 608,797.86	2.0-6.0	2.0	$ 12,176.00
TOTAL			**TOTAL**	$ 222,522.00

Construction Items	130KEXTHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 5,951,275.48	2.0-4.0	2.0	$ 119,026.00
Mechanical	$ 4,169,958.38	2.0-6.0	2.0	$ 83,399.00
Electrical-Sanitary	$ 833,991.68	2.0-6.0	2.0	$ 16,680.00
Piping	$ 667,193.34	2.0-6.0	2.0	$ 13,344.00
TOTAL			**TOTAL**	$ 232,449.00

Construction Items	6KA2OLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 375,287.84	2.0-4.0	4.0	$ 15,012.00
Mechanical	$ 967,435.13	2.0-6.0	4.0	$ 38,697.00
Electrical-Sanitary	$ 193,487.03	2.0-6.0	4.0	$ 7,739.00
Piping	$ 154,789.62	2.0-6.0	4.0	$ 6,192.00
TOTAL			**TOTAL**	$ 67,640.00

Construction Items	6KA2OMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 375,287.84	2.0-4.0	4.0	$ 15,012.00
Mechanical	$ 981,062.25	2.0-6.0	4.0	$ 39,242.00
Electrical-Sanitary	$ 196,212.45	2.0-6.0	4.0	$ 7,848.00
Piping	$ 156,969.96	2.0-6.0	4.0	$ 6,279.00
TOTAL			**TOTAL**	$ 68,381.00

Construction Items	6KA2OHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 375,287.84	2.0-4.0	4.0	$ 15,012.00
Mechanical	$ 1,237,626.09	2.0-6.0	4.0	$ 49,505.00
Electrical-Sanitary	$ 247,525.22	2.0-6.0	4.0	$ 9,901.00
Piping	$ 198,020.17	2.0-6.0	4.0	$ 7,921.00
TOTAL			**TOTAL**	$ 82,339.00

Construction Items	30KA2OLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 2,819,270.97	2.0-4.0	4.0	$ 112,771.00
Mechanical	$ 2,628,850.00	2.0-6.0	4.0	$ 105,154.00
Electrical-Sanitary	$ 525,770.00	2.0-6.0	4.0	$ 21,031.00
Piping	$ 420,616.00	2.0-6.0	4.0	$ 16,825.00
TOTAL			**TOTAL**	$ 255,781.00

Construction Items	30KA2OMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 2,819,270.97	2.0-4.0	4.0	$ 112,771.00
Mechanical	$ 2,671,222.89	2.0-6.0	4.0	$ 106,849.00
Electrical-Sanitary	$ 534,244.58	2.0-6.0	4.0	$ 21,370.00
Piping	$ 427,395.66	2.0-6.0	4.0	$ 17,096.00
TOTAL			**TOTAL**	$ 258,086.00

Construction Items	30KA2OHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 2,819,270.97	2.0-4.0	4.0	$ 112,771.00
Mechanical	$ 3,442,423.45	2.0-6.0	4.0	$ 137,697.00
Electrical-Sanitary	$ 688,484.69	2.0-6.0	4.0	$ 27,539.00
Piping	$ 550,787.75	2.0-6.0	4.0	$ 22,032.00
TOTAL			**TOTAL**	$ 300,039.00

Construction Items	130KA2OLOW			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 12,549,581.36	2.0-4.0	4.0	$ 501,983.00
Mechanical	$ 5,193,420.05	2.0-6.0	4.0	$ 207,737.00
Electrical-Sanitary	$ 1,038,684.01	2.0-6.0	4.0	$ 41,547.00
Piping	$ 830,947.21	2.0-6.0	4.0	$ 33,238.00
TOTAL			**TOTAL**	$ 784,505.00

Construction Items	130KA2OMED			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 12,549,581.36	2.0-4.0	4.0	$ 501,983.00
Mechanical	$ 5,260,256.21	2.0-6.0	4.0	$ 210,410.00
Electrical-Sanitary	$ 1,052,051.24	2.0-6.0	4.0	$ 42,082.00
Piping	$ 841,640.99	2.0-6.0	4.0	$ 33,666.00
TOTAL			**TOTAL**	$ 788,141.00

Construction Items	130KA2OHIGH			
	Capital Cost ($)	Range (%)	Selected Value (%)	Maintenance Cost ($/year)
Civil	$ 12,549,581.36	2.0-4.0	4.0	$ 501,983.00
Mechanical	$ 6,661,781.63	2.0-6.0	4.0	$ 266,471.00
Electrical-Sanitary	$ 1,332,356.33	2.0-6.0	4.0	$ 53,294.00
Piping	$ 1,065,885.06	2.0-6.0	4.0	$ 42,635.00
TOTAL			**TOTAL**	$ 864,383.00

H. Salary Calculation

6KCASLOW/MED/HIGH				
	Number of people	Salary per month	Total Salary per month	Total Salary per year
Worker	1	$ 1,500.00	$ 1,500.00	$ 18,000.00
Safeguard	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Engineer	1	$ 2,500.00	$ 2,500.00	$ 30,000.00
Technician	2	$ 1,500.00	$ 3,000.00	$ 6,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	7	$ 10,500.00	$ 13,500.00	$ 62,000.00

30KCASLOW/MED/HIGH				
	Number of people	Salary per month	Total Salary per month	Total Salary per year
Worker	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Safeguard	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Engineer	2	$ 2,500.00	$ 5,000.00	$ 60,000.00
Technician	4	$ 1,500.00	$ 6,000.00	$ 72,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	11	$ 10,500.00	$ 0,500.00	$ 246000.00

130KCASLOW/MED/HIGH				
	Number of people	Salary per month	Total Salary per month	Total Salary per year
Worker	4	$ 1,500.00	$ 6,000.00	$ 2,000.00
Safeguard	3	$ 1,500.00	$ 4,500.00	$ 54,000.00
Engineer	3	$ 2,500.00	$ 7,500.00	$ 90,000.00
Technician	6	$ 1,500.00	$ 9,000.00	$ 08,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	17	$ 10,500.00	$ 30,500.00	$ 366,000.00

6KEXTLOW/MED/HIGH				
	Number of people	Salary per month	Total Salary per month	Total Salary per year
Worker	0	$ 1,500.00	$ -	$ -
Safeguard	1	$ 1,500.00	$ 1,500.00	$ 18,000.00
Engineer	1	$ 2,500.00	$ 2,500.00	$ 30,000.00
Technician	1	$ 1,500.00	$ 1,500.00	$ 18,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	4	$ 10,500.00	$ 9,000.00	$ 108,000.00

30KEXTLOW/MED/HIGH				
	Number of people	**Salary per month**	**Total Salary per month**	**Total Salary per year**
Worker	1	$ 1,500.00	$ 1,500.00	$ 18,000.00
Safeguard	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Engineer	2	$ 2,500.00	$ 5,000.00	$ 60,000.00
Technician	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	8	$ 10,500.00	$ 16,000.00	$ 192,000.00

130KEXTLOW/MED/HIGH				
	Number of people	**Salary per month**	**Total Salary per month**	**Total Salary per year**
Worker	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Safeguard	3	$ 1,500.00	$ 4,500.00	$ 54,000.00
Engineer	3	$ 2,500.00	$ 7,500.00	$ 90,000.00
Technician	3	$ 1,500.00	$ 4,500.00	$ 54,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	12	$ 10,500.00	$ 23,000.00	$ 276,000.00

6KA2OLOW/MED/HIGH				
	Number of people	**Salary per month**	**Total Salary per month**	**Total Salary per year**
Worker	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Safeguard	2	$ 1,500.00	$ 3,000.00	$ 36,000.00
Engineer	1	$ 2,500.00	$ 2,500.00	$ 30,000.00
Technician	3	$ 1,500.00	$ 4,500.00	$ 54,000.00
Manager	1	$ 3,500.00	$ 3,500.00	$ 42,000.00
TOTAL	9	$ 10,500.00	$ 16,500.00	$ 198,000.00

30KA2OLOW/MED/HIGH				
	Number of people	**Salary per month**	**Total Salary per month**	**Total Salary per year**
Worker	4	$ 1,500.00	$ 6,000.00	$ 72,000.00
Safeguard	4	$ 1,500.00	$ 6,000.00	$ 72,000.00
Engineer	2	$ 2,500.00	$ 5,000.00	$ 60,000.00
Technician	6	$ 1,500.00	$ 9,000.00	$ 108,000.00
Manager	2	$ 3,500.00	$ 7,000.00	$ 84,000.00
TOTAL	18	$ 10,500.00	$ 33,000.00	$ 396,000.00

130KA2OLOW/MED/HIGH				
	Number of people	**Salary per month**	**Total Salary per month**	**Total Salary per year**
Worker	8	$ 1,500.00	$ 12,000.00	$ 144,000.00
Safeguard	8	$ 1,500.00	$ 12,000.00	$ 144,000.00
Engineer	4	$ 2,500.00	$ 10,000.00	$ 120,000.00
Technician	6	$ 1,500.00	$ 9,000.00	$ 108,000.00
Manager	2	$ 3,500.00	$ 7,000.00	$ 84,000.00
TOTAL	28	$ 10,500.00	$ 50,000.00	$ 600,000.00

I. Cost Analysis Based on Secondary Treatment

6KCASLOW

YEAR	Population Growth	Energy Req'd	Energy Req'd	Energy for treatment	Chemical Cost	Sludge Cost	1/(1+i)^n	Operational Cost 1
		(kWh/day)	(kWh/year)	($/year)	($/year)	($/year)		($/year)
2019							1.00	
2020							0.98	
2021							0.96	
2022	1.0000	2,962.44	1081291	$73,527.76	$ 8,820.00	$16,592.90	0.94	$ 93,003.72
2023	1.0136	3,002.82	1096029	$74,529.94	$ 8,940.22	$16,819.06	0.92	$ 92,346.75
2024	1.0274	3,043.75	1110967	$75,545.79	$ 9,062.07	$17,048.31	0.90	$ 91,694.42
2025	1.0414	3,085.23	1126110	$76,575.48	$ 9,185.59	$17,280.67	0.88	$ 91,046.69
2026	1.0556	3,127.28	1141459	$77,619.20	$ 9,310.79	$17,516.21	0.87	$ 90,403.55
2027	1.0700	3,169.91	1157017	$78,677.15	$ 9,437.69	$17,754.95	0.85	$ 89,764.94
2028	1.0846	3,213.12	1172787	$79,749.52	$ 9,566.33	$17,996.95	0.83	$ 89,130.85
2029	1.0994	3,256.91	1188772	$80,836.51	$ 9,696.72	$18,242.25	0.81	$ 88,501.24
2030	1.1144	3,301.30	1204975	$81,938.31	$ 9,828.88	$18,490.90	0.80	$ 87,876.07
2031	1.1296	3,346.30	1221399	$83,055.13	$ 9,962.85	$18,742.93	0.78	$ 87,255.32
2032	1.1450	3,391.91	1238047	$84,187.17	$10,098.65	$18,998.39	0.76	$ 86,638.95
2033	1.1606	3,438.14	1254921	$85,334.64	$10,236.29	$19,257.34	0.75	$ 86,026.94
2034	1.1764	3,485.00	1272026	$86,497.75	$10,375.81	$19,519.82	0.73	$ 85,419.26
2035	1.1924	3,532.50	1289363	$87,676.71	$10,517.23	$19,785.87	0.72	$ 84,815.86
2036	1.2087	3,580.65	1306937	$88,871.75	$10,660.58	$20,055.55	0.70	$ 84,216.73
2037	1.2252	3,629.45	1324751	$90,083.07	$10,805.89	$20,328.91	0.69	$ 83,621.83
2038	1.2419	3,678.92	1342807	$91,310.90	$10,953.17	$20,605.99	0.68	$ 83,031.13
2039	1.2588	3,729.07	1361110	$92,555.47	$11,102.46	$20,886.85	0.66	$ 82,444.60
2040	1.2759	3,779.90	1379662	$93,817.00	$11,253.79	$21,171.54	0.65	$ 81,862.22
2041	1.2933	3,831.42	1398467	$95,095.73	$11,407.18	$21,460.11	0.64	$ 81,283.95
2042	1.3110	3,883.64	1417528	$96,391.88	$11,562.66	$21,752.61	0.62	$ 80,709.77
2043	1.3288	3,936.57	1436849	$97,705.70	$11,720.26	$22,049.10	0.61	$ 80,139.64
2044	1.3469	3,990.23	1456433	$99,037.43	$11,880.00	$22,349.63	0.60	$ 79,573.54
2045	1.3653	4,044.61	1476284	$100,387.31	$12,041.93	$22,654.25	0.58	$ 79,011.44
2046	1.3839	4,099.74	1496406	$101,755.59	$12,206.06	$22,963.03	0.57	$ 78,453.31
2047	1.4028	4,155.62	1516802	$103,142.52	$12,372.43	$23,276.02	0.56	$ 77,899.12
2048	1.4219	4,212.26	1537476	$104,548.35	$12,541.07	$23,593.27	0.55	$ 77,348.84
2049	1.4413	4,269.68	1558432	$105,973.35	$12,712.00	$23,914.85	0.54	$ 76,802.46
2050	1.4609	4,327.87	1579673	$107,417.76	$12,885.26	$24,240.81	0.53	$ 76,259.93
2051	1.4808	4,386.86	1601204	$108,881.87	$13,060.89	$24,571.21	0.52	$ 75,721.24
							TOTAL	**$ 2,522,304.28**

Salary	Maintanance Cost	1/(1+i)^n	Operational Cost 2
($/year)	($/year)		($/year)
		1.00	
		0.98	
		0.96	
$162,000.00	$ 40,585.00	0.94	$ 190,428.87
$162,000.00	$ 40,585.00	0.92	$ 186,541.14
$162,000.00	$ 40,585.00	0.90	$ 182,732.78
$162,000.00	$ 40,585.00	0.88	$ 179,002.17
$162,000.00	$ 40,585.00	0.87	$ 175,347.72
$162,000.00	$ 40,585.00	0.85	$ 171,767.88
$162,000.00	$ 40,585.00	0.83	$ 168,261.13
$162,000.00	$ 40,585.00	0.81	$ 164,825.96
$162,000.00	$ 40,585.00	0.80	$ 161,460.93
$162,000.00	$ 40,585.00	0.78	$ 158,164.60
$162,000.00	$ 40,585.00	0.76	$ 154,935.57
$162,000.00	$ 40,585.00	0.75	$ 151,772.45
$162,000.00	$ 40,585.00	0.73	$ 148,673.92
$162,000.00	$ 40,585.00	0.72	$ 145,638.64
$162,000.00	$ 40,585.00	0.70	$ 142,665.33
$162,000.00	$ 40,585.00	0.69	$ 139,752.73
$162,000.00	$ 40,585.00	0.68	$ 136,899.58
$162,000.00	$ 40,585.00	0.66	$ 134,104.69
$162,000.00	$ 40,585.00	0.65	$ 131,366.85
$162,000.00	$ 40,585.00	0.64	$ 128,684.91
$162,000.00	$ 40,585.00	0.62	$ 126,057.72
$162,000.00	$ 40,585.00	0.61	$ 123,484.17
$162,000.00	$ 40,585.00	0.60	$ 120,963.16
$162,000.00	$ 40,585.00	0.58	$ 118,493.62
$162,000.00	$ 40,585.00	0.57	$ 116,074.49
$162,000.00	$ 40,585.00	0.56	$ 113,704.76
$162,000.00	$ 40,585.00	0.55	$ 111,383.40
$162,000.00	$ 40,585.00	0.54	$ 109,109.43
$162,000.00	$ 40,585.00	0.53	$ 106,881.89
$162,000.00	$ 40,585.00	0.52	$ 104,699.83
		TOTAL	**$ 4,303,880.32**

6KCASLOW

YEAR	Investment Cost	Replacement Cost	Total Cost	1/(1+i)^n	Net Present Value	Flowrate	Population Growth	Total Flowrate
	($)	($)	($)		($)	(m3/day)		(m3/year)
2019	$ -	$ -	$ -	1.00000	$ -	0.00	0.000	0.00
2020	$ 176,645.37	$ -	$ 176,645.37	0.97958	$ 173,039.04	0.00	0.000	0.00
2021	$ 1,176,159.46	$ -	$ 1,176,159.46	0.95959	$ 1,128,625.54	0.00	0.000	0.00
2022	$ -	$ -	$ -	0.93999	$ -	**6,000.00**	1.000	2,190,000.00
2023	$ -	$ -	$ -	0.92080	$ -	6,082	1.014	2,219,930.00
2024	$ -	$ -	$ -	0.90201	$ -	6,165	1.027	2,250,225.00
2025	$ -	$ -	$ -	0.88359	$ -	6,249	1.041	2,280,885.00
2026	$ -	$ -	$ -	0.86555	$ -	6,334	1.056	2,311,910.00
2027	$ -	$ -	$ -	0.84788	$ -	6,420	1.070	2,343,300.00
2028	$ -	$ -	$ -	0.83057	$ -	6,508	1.085	2,375,420.00
2029	$ -	$ -	$ -	0.81361	$ -	6,596	1.099	2,407,540.00
2030	$ -	$ -	$ -	0.79700	$ -	6,686	1.114	2,440,390.00
2031	$ -	$ 76,629.41	$ 76,629.41	0.78073	$ 59,827.04	6,777	1.130	2,473,605.00
2032	$ -	$ -	$ -	0.76479	$ -	6,870	1.145	2,507,550.00
2033	$ -	$ -	$ -	0.74918	$ -	6,963	1.161	2,541,495.00
2034	$ -	$ -	$ -	0.73388	$ -	7,058	1.176	2,576,170.00
2035	$ -	$ -	$ -	0.71890	$ -	7,155	1.192	2,611,575.00
2036	$ -	$ -	$ -	0.70422	$ -	7,252	1.209	2,646,980.00
2037	$ -	$ -	$ -	0.68985	$ -	7,351	1.225	2,683,115.00
2038	$ -	$ -	$ -	0.67576	$ -	7,451	1.242	2,719,615.00
2039	$ -	$ -	$ -	0.66197	$ -	7,553	1.259	2,756,845.00
2040	$ -	$ -	$ -	0.64845	$ -	7,656	1.276	2,794,440.00
2041	$ -	$ 651,350.01	$ 651,350.01	0.63521	$ 413,746.91	7,760	1.293	2,832,400.00
2042	$ -	$ -	$ -	0.62225	$ -	7,866	1.311	2,871,090.00
2043	$ -	$ -	$ -	0.60954	$ -	7,973	1.329	2,910,145.00
2044	$ -	$ -	$ -	0.59710	$ -	8,082	1.347	2,949,930.00
2045	$ -	$ -	$ -	0.58491	$ -	8,192	1.365	2,990,080.00
2046	$ -	$ -	$ -	0.57297	$ -	8,303	1.384	3,030,595.00
2047	$ -	$ -	$ -	0.56127	$ -	8,417	1.403	3,072,205.00
2048	$ -	$ -	$ -	0.54981	$ -	8,531	1.422	3,113,815.00
2049	$ -	$ -	$ -	0.53859	$ -	8,648	1.441	3,156,520.00
2050	$ -	$ -	$ -	0.52759	$ -	8,765	1.461	3,199,225.00
2051	$ -	$ -	$ -	0.51682	$ -	8,885	1.481	3,243,025.00
				TOTAL	**$ 1,775,238.53**		**TOTAL**	**80,500,020**

30EXTMED

Population Growth	Energy Req'd	Energy Req'd	Energy for treatment	Chemical Cost	Sludge Cost	1/(1+i)^n	Operational Cost 1
	(kWh/day)	(kWh/year)	($/year)	($/year)	($/year)		($/year)
						1.00	
						0.98	
						0.96	
1.0000	13,352.72	4873741	$331,414.39	$35,732.00	$67,280.45	0.94	$ 408,359.01
1.0136	13,534.71	4940170	$335,931.56	$36,219.03	$68,197.48	0.92	$ 405,474.40
1.0274	13,719.19	5007505	$340,510.31	$36,712.69	$69,127.01	0.90	$ 402,610.16
1.0414	13,906.18	5075757	$345,151.47	$37,213.09	$70,069.22	0.88	$ 399,766.15
1.0556	14,095.72	5144939	$349,855.88	$37,720.30	$71,024.26	0.87	$ 396,942.23
1.0700	14,287.85	5215065	$354,624.42	$38,234.43	$71,992.32	0.85	$ 394,138.26
1.0846	14,482.59	5286146	$359,457.95	$38,755.56	$72,973.57	0.83	$ 391,354.10
1.0994	14,679.99	5358196	$364,357.36	$39,283.80	$73,968.20	0.81	$ 388,589.60
1.1144	14,880.08	5431229	$369,323.55	$39,819.24	$74,976.39	0.80	$ 385,844.63
1.1296	15,082.89	5505256	$374,357.43	$40,361.98	$75,998.32	0.78	$ 383,119.05
1.1450	15,288.47	5580293	$379,459.92	$40,912.11	$77,034.18	0.76	$ 380,412.73
1.1606	15,496.86	5656352	$384,631.96	$41,469.74	$78,084.15	0.75	$ 377,725.52
1.1764	15,708.08	5733448	$389,874.49	$42,034.98	$79,148.44	0.73	$ 375,057.30
1.1924	15,922.18	5811595	$395,188.48	$42,607.91	$80,227.23	0.72	$ 372,407.92
1.2087	16,139.20	5890807	$400,574.90	$43,188.66	$81,320.73	0.70	$ 369,777.26
1.2252	16,359.18	5971099	$406,034.74	$43,777.32	$82,429.13	0.69	$ 367,165.18
1.2419	16,582.15	6052485	$411,568.99	$44,374.00	$83,552.64	0.68	$ 364,571.55
1.2588	16,808.17	6134981	$417,178.68	$44,978.82	$84,691.46	0.66	$ 361,996.25
1.2759	17,037.26	6218600	$422,864.82	$45,591.88	$85,845.81	0.65	$ 359,439.13
1.2933	17,269.48	6303360	$428,628.47	$46,213.30	$87,015.89	0.64	$ 356,900.08
1.3110	17,504.86	6389275	$434,470.68	$46,843.19	$88,201.91	0.62	$ 354,378.96
1.3288	17,743.45	6476360	$440,392.51	$47,481.66	$89,404.10	0.61	$ 351,875.66
1.3469	17,985.30	6564633	$446,395.06	$48,128.84	$90,622.68	0.60	$ 349,390.03
1.3653	18,230.44	6654109	$452,479.43	$48,784.83	$91,857.87	0.58	$ 346,921.97
1.3839	18,478.92	6744805	$458,646.72	$49,449.77	$93,109.89	0.57	$ 344,471.34
1.4028	18,730.78	6836736	$464,898.08	$50,123.77	$94,378.98	0.56	$ 342,038.02
1.4219	18,986.09	6929921	$471,234.64	$50,806.96	$95,665.37	0.55	$ 339,621.89
1.4413	19,244.87	7024376	$477,657.57	$51,499.45	$96,969.28	0.54	$ 337,222.82
1.4609	19,507.17	7120118	$484,168.04	$52,201.39	$98,290.98	0.53	$ 334,840.71
1.4808	19,773.06	7217165	$490,767.25	$52,912.90	$99,630.68	0.52	$ 332,475.42
						TOTAL	**$ 11,074,887.30**

Salary	Maintanance Cost	1/(1+i)^n	Operational Cost 2
($/year)	($/year)		($/year)
		1.00	
		0.98	
		0.96	
$192,000.00	$ 84,838.00	0.94	$ 260,226.31
$192,000.00	$ 84,838.00	0.92	$ 254,913.62
$192,000.00	$ 84,838.00	0.90	$ 249,709.39
$192,000.00	$ 84,838.00	0.88	$ 244,611.41
$192,000.00	$ 84,838.00	0.87	$ 239,617.50
$192,000.00	$ 84,838.00	0.85	$ 234,725.55
$192,000.00	$ 84,838.00	0.83	$ 229,933.48
$192,000.00	$ 84,838.00	0.81	$ 225,239.23
$192,000.00	$ 84,838.00	0.80	$ 220,640.83
$192,000.00	$ 84,838.00	0.78	$ 216,136.30
$192,000.00	$ 84,838.00	0.76	$ 211,723.73
$192,000.00	$ 84,838.00	0.75	$ 207,401.25
$192,000.00	$ 84,838.00	0.73	$ 203,167.02
$192,000.00	$ 84,838.00	0.72	$ 199,019.23
$192,000.00	$ 84,838.00	0.70	$ 194,956.12
$192,000.00	$ 84,838.00	0.69	$ 190,975.96
$192,000.00	$ 84,838.00	0.68	$ 187,077.06
$192,000.00	$ 84,838.00	0.66	$ 183,257.76
$192,000.00	$ 84,838.00	0.65	$ 179,516.43
$192,000.00	$ 84,838.00	0.64	$ 175,851.49
$192,000.00	$ 84,838.00	0.62	$ 172,261.36
$192,000.00	$ 84,838.00	0.61	$ 168,744.53
$192,000.00	$ 84,838.00	0.60	$ 165,299.50
$192,000.00	$ 84,838.00	0.58	$ 161,924.80
$192,000.00	$ 84,838.00	0.57	$ 158,619.00
$192,000.00	$ 84,838.00	0.56	$ 155,380.69
$192,000.00	$ 84,838.00	0.55	$ 152,208.49
$192,000.00	$ 84,838.00	0.54	$ 149,101.05
$192,000.00	$ 84,838.00	0.53	$ 146,057.06
$192,000.00	$ 84,838.00	0.52	$ 143,075.21
		TOTAL	**$ 5,881,371.38**

30EXTMED

YEAR	Investment Cost	Replacement Cost	Total Cost	1/(1+i)^n	Net Present Value	Flowrate	Population Growth	Total Flowrate
	($)	($)	($)		($)	(m3/day)		(m3/year)
2019	$ -	$ -	$ -	1.00000	$ -	0.00	0.000	0.00
2020	$ 908,911.73	$ -	$ 908,911.73	0.97958	$ 890,355.69	0.00	0.000	0.00
2021	$ 3,333,011.11	$ -	$ 3,333,011.11	0.95959	$ 3,198,309.06	0.00	0.000	0.00
2022	$ -	$ -	$ -	0.93999	$ -	**30,000.00**	1.000	10,950,000.00
2023	$ -	$ -	$ -	0.92080	$ -	30,409	1.014	11,099,285.00
2024	$ -	$ -	$ -	0.90201	$ -	30,823	1.027	11,250,395.00
2025	$ -	$ -	$ -	0.88359	$ -	31,243	1.041	11,403,695.00
2026	$ -	$ -	$ -	0.86555	$ -	31,669	1.056	11,559,185.00
2027	$ -	$ -	$ -	0.84788	$ -	32,101	1.070	11,716,865.00
2028	$ -	$ -	$ -	0.83057	$ -	32,539	1.085	11,876,735.00
2029	$ -	$ -	$ -	0.81361	$ -	32,982	1.099	12,038,430.00
2030	$ -	$ -	$ -	0.79700	$ -	33,432	1.114	12,202,680.00
2031	$ -	$ 185,847.62	$ 185,847.62	0.78073	$ 145,097.19	33,887	1.130	12,368,755.00
2032	$ -	$ -	$ -	0.76479	$ -	34,349	1.145	12,537,385.00
2033	$ -	$ -	$ -	0.74918	$ -	34,817	1.161	12,708,205.00
2034	$ -	$ -	$ -	0.73388	$ -	35,292	1.176	12,881,580.00
2035	$ -	$ -	$ -	0.71890	$ -	35,773	1.192	13,057,145.00
2036	$ -	$ -	$ -	0.70422	$ -	36,260	1.209	13,234,900.00
2037	$ -	$ -	$ -	0.68985	$ -	36,755	1.225	13,415,575.00
2038	$ -	$ -	$ -	0.67576	$ -	37,256	1.242	13,598,440.00
2039	$ -	$ -	$ -	0.66197	$ -	37,763	1.259	13,783,495.00
2040	$ -	$ -	$ -	0.64845	$ -	38,278	1.276	13,971,470.00
2041	$ -	$ 1,579,704.76	$ 1,579,704.76	0.63521	$ 1,003,451.23	38,800	1.293	14,162,000.00
2042	$ -	$ -	$ -	0.62225	$ -	39,329	1.311	14,355,085.00
2043	$ -	$ -	$ -	0.60954	$ -	39,865	1.329	14,550,725.00
2044	$ -	$ -	$ -	0.59710	$ -	40,408	1.347	14,748,920.00
2045	$ -	$ -	$ -	0.58491	$ -	40,959	1.365	14,950,035.00
2046	$ -	$ -	$ -	0.57297	$ -	41,517	1.384	15,153,705.00
2047	$ -	$ -	$ -	0.56127	$ -	42,083	1.403	15,360,295.00
2048	$ -	$ -	$ -	0.54981	$ -	42,657	1.422	15,569,805.00
2049	$ -	$ -	$ -	0.53859	$ -	43,238	1.441	15,781,870.00
2050	$ -	$ -	$ -	0.52759	$ -	43,827	1.461	15,996,855.00
2051	$ -	$ -	$ -	0.51682	$ -	44,425	1.481	16,215,125.00
				TOTAL	**$ 5,237,213.18**		**TOTAL**	**402,498,640**

130A2OHIGH

YEAR	Population Growth	Energy Req'd	Energy Req'd	Energy Cost	Chemical Cost	Sludge Cost	1/(1+i)^n	Operational Cost 1
		(kWh/day)	(kWh/year)	($/year)	($/year)	($/year)		($/year)
2019							1.00	
2020							0.98	
2021							0.96	
2022	1.0000	53,353.22	19473923	$1,324,226.80	$387,972.00	$ 730,730.00	0.94	$ 2,296,340.63
2023	1.0136	54,080.42	19739353	$1,342,276.01	$393,260.06	$ 740,689.85	0.92	$ 2,280,119.45
2024	1.0274	54,817.54	20008400	$1,360,571.23	$398,620.19	$ 750,785.45	0.90	$ 2,264,012.86
2025	1.0414	55,564.70	20281115	$1,379,115.82	$404,053.39	$ 761,018.66	0.88	$ 2,248,020.04
2026	1.0556	56,322.05	20557547	$1,397,913.16	$409,560.63	$ 771,391.34	0.87	$ 2,232,140.19
2027	1.0700	57,089.71	20837746	$1,416,966.72	$415,142.95	$ 781,905.41	0.85	$ 2,216,372.52
2028	1.0846	57,867.85	21121764	$1,436,279.98	$420,801.34	$ 792,562.78	0.83	$ 2,200,716.23
2029	1.0994	58,656.59	21409654	$1,455,856.47	$426,536.87	$ 803,365.41	0.81	$ 2,185,170.53
2030	1.1144	59,456.08	21701468	$1,475,699.80	$432,350.56	$ 814,315.28	0.80	$ 2,169,734.65
2031	1.1296	60,266.46	21997259	$1,495,813.58	$438,243.50	$ 825,414.40	0.78	$ 2,154,407.81
2032	1.1450	61,087.89	22297081	$1,516,201.52	$444,216.76	$ 836,664.79	0.76	$ 2,139,189.23
2033	1.1606	61,920.52	22600990	$1,536,867.35	$450,271.43	$ 848,068.54	0.75	$ 2,124,078.16
2034	1.1764	62,764.50	22909042	$1,557,814.85	$456,408.63	$ 859,627.71	0.73	$ 2,109,073.83
2035	1.1924	63,619.98	23221292	$1,579,047.87	$462,629.48	$ 871,344.43	0.72	$ 2,094,175.49
2036	1.2087	64,487.12	23537798	$1,600,570.29	$468,935.12	$ 883,220.86	0.70	$ 2,079,382.39
2037	1.2252	65,366.08	23858619	$1,622,386.06	$475,326.71	$ 895,259.16	0.69	$ 2,064,693.79
2038	1.2419	66,257.02	24183812	$1,644,499.19	$481,805.41	$ 907,461.54	0.68	$ 2,050,108.94
2039	1.2588	67,160.10	24513437	$1,666,913.71	$488,372.42	$ 919,830.24	0.66	$ 2,035,627.13
2040	1.2759	68,075.49	24847555	$1,689,633.74	$495,028.94	$ 932,367.53	0.65	$ 2,021,247.61
2041	1.2933	69,003.36	25186227	$1,712,663.45	$501,776.18	$ 945,075.70	0.64	$ 2,006,969.66
2042	1.3110	69,943.88	25529516	$1,736,007.06	$508,615.39	$ 957,957.08	0.62	$ 1,992,792.58
2043	1.3288	70,897.21	25877483	$1,759,668.83	$515,547.82	$ 971,014.04	0.61	$ 1,978,715.64
2044	1.3469	71,863.54	26230193	$1,783,653.12	$522,574.74	$ 984,248.96	0.60	$ 1,964,738.14
2045	1.3653	72,843.04	26587710	$1,807,964.31	$529,697.43	$ 997,664.27	0.58	$ 1,950,859.38
2046	1.3839	73,835.89	26950101	$1,832,606.86	$536,917.20	$1,011,262.43	0.57	$ 1,937,078.65
2047	1.4028	74,842.28	27317431	$1,857,585.29	$544,235.39	$1,025,045.94	0.56	$ 1,923,395.27
2048	1.4219	75,862.38	27689767	$1,882,904.18	$551,653.31	$1,039,017.32	0.55	$ 1,909,808.55
2049	1.4413	76,896.38	28067179	$1,908,568.17	$559,172.35	$1,053,179.12	0.54	$ 1,896,317.81
2050	1.4609	77,944.48	28449735	$1,934,581.95	$566,793.87	$1,067,533.95	0.53	$ 1,882,922.36
2051	1.4808	79,006.86	28837504	$1,960,950.30	$574,519.27	$1,082,084.44	0.52	$ 1,869,621.54
							TOTAL	**$ 62,277,831.05**

Salary	Maintanance Cost	1/(1+i)^n	Operational Cost 2
($/year)	($/year)		($/year)
		1.00	
		0.98	
		0.96	
$600,000.00	$ 864,383.00	0.94	$ 1,376,512.56
$600,000.00	$ 864,383.00	0.92	$ 1,348,410.15
$600,000.00	$ 864,383.00	0.90	$ 1,320,881.47
$600,000.00	$ 864,383.00	0.88	$ 1,293,914.80
$600,000.00	$ 864,383.00	0.87	$ 1,267,498.68
$600,000.00	$ 864,383.00	0.85	$ 1,241,621.85
$600,000.00	$ 864,383.00	0.83	$ 1,216,273.32
$600,000.00	$ 864,383.00	0.81	$ 1,191,442.30
$600,000.00	$ 864,383.00	0.80	$ 1,167,118.22
$600,000.00	$ 864,383.00	0.78	$ 1,143,290.73
$600,000.00	$ 864,383.00	0.76	$ 1,119,949.70
$600,000.00	$ 864,383.00	0.75	$ 1,097,085.18
$600,000.00	$ 864,383.00	0.73	$ 1,074,687.47
$600,000.00	$ 864,383.00	0.72	$ 1,052,747.01
$600,000.00	$ 864,383.00	0.70	$ 1,031,254.49
$600,000.00	$ 864,383.00	0.69	$ 1,010,200.75
$600,000.00	$ 864,383.00	0.68	$ 989,576.83
$600,000.00	$ 864,383.00	0.66	$ 969,373.97
$600,000.00	$ 864,383.00	0.65	$ 949,583.56
$600,000.00	$ 864,383.00	0.64	$ 930,197.18
$600,000.00	$ 864,383.00	0.62	$ 911,206.59
$600,000.00	$ 864,383.00	0.61	$ 892,603.71
$600,000.00	$ 864,383.00	0.60	$ 874,380.61
$600,000.00	$ 864,383.00	0.58	$ 856,529.56
$600,000.00	$ 864,383.00	0.57	$ 839,042.94
$600,000.00	$ 864,383.00	0.56	$ 821,913.33
$600,000.00	$ 864,383.00	0.55	$ 805,133.42
$600,000.00	$ 864,383.00	0.54	$ 788,696.09
$600,000.00	$ 864,383.00	0.53	$ 772,594.34
$600,000.00	$ 864,383.00	0.52	$ 756,821.32
		TOTAL	**$ 31,110,542.12**

J. Unit Costs for Secondary Treatment Level for Different Assumptions on Piping and Electrical/ Sanitary Costs

CASE 1
Piping , 16 % of mechanical cost
Electrical and Sanitary, 20 % of mechanical cost

Scenarios	Capital Cost ($)	Operational Cost ($)	Total Cost ($)
6KCASLOW	$ 1,775,239	$ 6,826,185	$ 8,601,423
6KCASMED	$ 2,048,327	$ 7,456,968	$ 9,505,295
6KCASHIGH	$ 2,963,559	$ 9,372,455	$ 12,336,014
30KCASLOW	$ 5,218,026	$ 18,821,463	$ 24,039,489
30KCASMED	$ 5,522,614	$ 21,629,136	$ 27,151,749
30KCASHIGH	$ 6,657,269	$ 29,556,392	$ 36,213,661
130KCASLOW	$ 10,040,994	$ 51,039,199	$ 61,080,193
130KCASMED	$ 10,345,581	$ 61,968,495	$ 72,314,076
130KCASHIGH	$ 11,480,237	$ 95,395,954	$ 106,876,191
6KEXTLOW	$ 1,676,969	$ 4,923,662	$ 6,600,631
6KEXTMED	$ 1,765,554	$ 5,369,876	$ 7,135,431
6KEXTHIGH	$ 1,765,554	$ 6,582,777	$ 8,348,331
30KEXTLOW	$ 5,118,027	$ 14,974,065	$ 20,092,092
30KEXTMED	$ 5,237,213	$ 16,956,259	$ 22,193,472
30KEXTHIGH	$ 5,237,213	$ 22,776,402	$ 28,013,616
130KEXTLOW	$ 12,680,252	$ 40,244,831	$ 52,925,083
130KEXTMED	$ 12,905,382	$ 48,792,878	$ 61,698,260
130KEXTHIGH	$ 13,589,778	$ 74,237,087	$ 87,826,865
6KA2OLOW	$ 2,178,009	$ 8,162,132	$ 10,340,141
6KA2OMED	$ 2,203,563	$ 8,562,764	$ 10,766,326
6KA2OHIGH	$ 2,684,671	$ 9,898,668	$ 12,583,340
30KA2OLOW	$ 7,663,145	$ 24,866,753	$ 32,529,898
30KA2OMED	$ 7,742,603	$ 26,702,484	$ 34,445,087
30KA2OHIGH	$ 9,188,759	$ 32,644,118	$ 41,832,877
130KA2OLOW	$ 21,906,592	$ 58,182,600	$ 80,089,193

Scenarios	Capital Unit Cost ($/m³)	Operational Unit Cost ($/m³)
6KCASLOW	$ 0.022	$ 0.085
6KCASMED	$ 0.025	$ 0.093
6KCASHIGH	$ 0.037	$ 0.116
30KCASLOW	$ 0.013	$ 0.047
30KCASMED	$ 0.014	$ 0.054
30KCASHIGH	$ 0.017	$ 0.073
130KCASLOW	$ 0.006	$ 0.029
130KCASMED	$ 0.006	$ 0.036
130KCASHIGH	$ 0.007	$ 0.055
6KEXTLOW	$ 0.021	$ 0.061
6KEXTMED	$ 0.022	$ 0.067
6KEXTHIGH	$ 0.022	$ 0.082
30KEXTLOW	$ 0.013	$ 0.037
30KEXTMED	$ 0.013	$ 0.042
30KEXTHIGH	$ 0.013	$ 0.057
130KEXTLOW	$ 0.007	$ 0.023
130KEXTMED	$ 0.007	$ 0.028
130KEXTHIGH	$ 0.008	$ 0.043
6KA2OLOW	$ 0.027	$ 0.101
6KA2OMED	$ 0.027	$ 0.106
6KA2OHIGH	$ 0.033	$ 0.123
30KA2OLOW	$ 0.019	$ 0.062
30KA2OMED	$ 0.019	$ 0.066
30KA2OHIGH	$ 0.023	$ 0.081
130KA2OLOW	$ 0.013	$ 0.033

CASE 2
Piping , 11 % of mechanical cost
Electrical and Sanitary, 15 % of mechanical cost

Scenarios	Capital Cost ($)	Operational Cost ($)	Total Cost ($)
6KCASLOW	$ 1,667,770	$ 6,773,094	$ 8,440,864
6KCASMED	$ 1,922,068	$ 7,394,615	$ 9,316,683
6KCASHIGH	$ 2,794,442	$ 9,293,127	$ 12,087,569
30KCASLOW	$ 4,905,989	$ 18,667,332	$ 23,573,320
30KCASMED	$ 5,189,619	$ 21,464,659	$ 26,654,277
30KCASHIGH	$ 6,246,203	$ 29,353,356	$ 35,599,559
130KCASLOW	$ 9,538,509	$ 50,790,996	$ 60,329,505
130KCASMED	$ 9,822,139	$ 61,709,945	$ 71,532,085
130KCASHIGH	$ 10,878,724	$ 95,098,824	$ 105,977,548
6KEXTLOW	$ 1,583,368	$ 4,892,836	$ 6,476,204
6KEXTMED	$ 1,665,859	$ 5,337,032	$ 7,002,891
6KEXTHIGH	$ 1,665,859	$ 6,549,932	$ 8,215,791
30KEXTLOW	$ 4,865,586	$ 14,890,934	$ 19,756,520
30KEXTMED	$ 4,976,571	$ 16,870,430	$ 21,847,001
30KEXTHIGH	$ 4,976,571	$ 22,690,573	$ 27,667,145
130KEXTLOW	$ 12,204,803	$ 40,088,257	$ 52,293,060
130KEXTMED	$ 12,414,443	$ 48,631,205	$ 61,045,648
130KEXTHIGH	$ 13,051,748	$ 74,059,905	$ 87,111,653
6KA2OLOW	$ 2,053,185	$ 8,079,936	$ 10,133,121
6KA2OMED	$ 2,076,981	$ 8,479,399	$ 10,556,380
6KA2OHIGH	$ 2,524,986	$ 9,793,507	$ 12,318,493
30KA2OLOW	$ 7,323,957	$ 24,643,342	$ 31,967,299
30KA2OMED	$ 7,742,603	$ 26,475,462	$ 34,218,065
30KA2OHIGH	$ 8,744,599	$ 32,351,598	$ 41,096,197
130KA2OLOW	$ 21,236,510	$ 57,741,282	$ 78,977,792

Scenarios	Capital Unit Cost ($/m³)	Operational Unit Cost ($/m³)
6KCASLOW	$ 0.021	$ 0.084
6KCASMED	$ 0.024	$ 0.092
6KCASHIGH	$ 0.035	$ 0.115
30KCASLOW	$ 0.012	$ 0.046
30KCASMED	$ 0.013	$ 0.053
30KCASHIGH	$ 0.016	$ 0.073
130KCASLOW	$ 0.005	$ 0.029
130KCASMED	$ 0.006	$ 0.035
130KCASHIGH	$ 0.006	$ 0.055
6KEXTLOW	$ 0.020	$ 0.061
6KEXTMED	$ 0.021	$ 0.066
6KEXTHIGH	$ 0.021	$ 0.081
30KEXTLOW	$ 0.012	$ 0.037
30KEXTMED	$ 0.012	$ 0.042
30KEXTHIGH	$ 0.012	$ 0.056
130KEXTLOW	$ 0.007	$ 0.023
130KEXTMED	$ 0.007	$ 0.028
130KEXTHIGH	$ 0.007	$ 0.042
6KA2OLOW	$ 0.026	$ 0.100
6KA2OMED	$ 0.026	$ 0.105
6KA2OHIGH	$ 0.031	$ 0.122
30KA2OLOW	$ 0.018	$ 0.061
30KA2OMED	$ 0.019	$ 0.066
30KA2OHIGH	$ 0.022	$ 0.080
130KA2OLOW	$ 0.012	$ 0.033

CASE 3
Piping , 21 % of mechanical cost
Electrical and Sanitary, 25 % of mechanical cost

Scenarios	Capital Cost ($)	Operational Cost ($)	Total Cost ($)
6KCASLOW	$ 1,882,707	$ 6,879,254	$ 8,761,961
6KCASMED	$ 2,174,586	$ 7,519,343	$ 9,693,929
6KCASHIGH	$ 3,132,675	$ 9,451,783	$ 12,584,459
30KCASLOW	$ 5,530,063	$ 18,975,594	$ 24,505,657
30KCASMED	$ 5,855,608	$ 21,793,613	$ 27,649,221
30KCASHIGH	$ 7,068,335	$ 29,759,429	$ 36,827,764
130KCASLOW	$ 10,543,478	$ 51,287,402	$ 61,830,880
130KCASMED	$ 10,869,023	$ 62,227,065	$ 73,096,089
130KCASHIGH	$ 12,081,750	$ 95,693,063	$ 107,774,813
6KEXTLOW	$ 1,770,569	$ 4,954,489	$ 6,725,057
6KEXTMED	$ 1,865,250	$ 5,402,678	$ 7,267,928
6KEXTHIGH	$ 1,865,250	$ 6,615,579	$ 8,480,829
30KEXTLOW	$ 5,370,468	$ 15,057,196	$ 20,427,664
30KEXTMED	$ 5,497,855	$ 17,042,088	$ 22,539,943
30KEXTHIGH	$ 5,497,855	$ 22,862,231	$ 28,360,086
130KEXTLOW	$ 13,155,701	$ 40,401,405	$ 53,557,107
130KEXTMED	$ 13,396,322	$ 48,954,551	$ 62,350,873
130KEXTHIGH	$ 14,127,808	$ 74,414,269	$ 88,542,076
6KA2OLOW	$ 2,302,833	$ 8,244,328	$ 10,547,161
6KA2OMED	$ 2,330,144	$ 8,646,149	$ 10,976,294
6KA2OHIGH	$ 2,844,356	$ 10,003,830	$ 12,848,187
30KA2OLOW	$ 8,002,333	$ 25,090,142	$ 33,092,475
30KA2OMED	$ 7,742,603	$ 26,929,464	$ 34,672,067
30KA2OHIGH	$ 9,632,919	$ 32,936,638	$ 42,569,556
130KA2OLOW	$ 22,576,675	$ 58,623,940	$ 81,200,615

Scenarios	Capital Unit Cost ($/m³)	Operational Unit Cost ($/m³)
6KCASLOW	$ 0.023	$ 0.085
6KCASMED	$ 0.027	$ 0.093
6KCASHIGH	$ 0.039	$ 0.117
30KCASLOW	$ 0.014	$ 0.047
30KCASMED	$ 0.015	$ 0.054
30KCASHIGH	$ 0.018	$ 0.074
130KCASLOW	$ 0.006	$ 0.029
130KCASMED	$ 0.006	$ 0.036
130KCASHIGH	$ 0.007	$ 0.055
6KEXTLOW	$ 0.022	$ 0.062
6KEXTMED	$ 0.023	$ 0.067
6KEXTHIGH	$ 0.023	$ 0.082
30KEXTLOW	$ 0.013	$ 0.037
30KEXTMED	$ 0.014	$ 0.042
30KEXTHIGH	$ 0.014	$ 0.057
130KEXTLOW	$ 0.008	$ 0.023
130KEXTMED	$ 0.008	$ 0.028
130KEXTHIGH	$ 0.008	$ 0.043
6KA2OLOW	$ 0.029	$ 0.102
6KA2OMED	$ 0.029	$ 0.107
6KA2OHIGH	$ 0.035	$ 0.124
30KA2OLOW	$ 0.020	$ 0.062
30KA2OMED	$ 0.019	$ 0.066
30KA2OHIGH	$ 0.024	$ 0.082
130KA2OLOW	$ 0.013	$ 0.034

K. Cost Analysis Based on Full Treatment

TS1	% Reused	Total Secondary Cost	Total Tertiary and Disinfection Cost			Total Cost
			PSF	CL	UV	
6KA2OLOW	0%	$ -	$ -	$ -	$ -	$ 13,273,541.256
		$ 10,340,141.221	$ -	$ 2,933,400.035	$ -	
	10%	$ 1,033,996.104	$ 729,653.300	$ 293,334.892	$ 229,630.281	$ 14,232,767.014
		$ 9,306,100.072	$ -	$ 2,640,052.364	$ -	
	20%	$ 2,067,992.209	$1,459,306.600	$ 586,669.784	$ 459,260.562	$ 15,192,050.594
		$ 8,272,103.968	$ -	$ 2,346,717.472	$ -	
	30%	$ 3,102,033.357	$2,188,991.686	$ 880,017.455	$ 688,900.846	$ 16,151,202.495
		$ 7,237,927.686	$ -	$ 2,053,331.466	$ -	
	40%	$ 4,136,029.462	$2,918,644.985	$ 1,173,352.347	$ 918,531.127	$ 17,110,717.369
		$ 6,204,111.759	$ -	$ 1,760,047.688	$ -	
	50%	$ 5,170,025.566	$3,648,298.285	$ 1,466,687.239	$ 1,148,161.408	$ 18,069,885.303
		$ 5,170,025.566	$ -	$ 1,466,687.239	$ -	
	60%	$ 6,204,111.759	$4,378,015.157	$ 1,760,047.688	$ 1,377,811.696	$ 19,029,368.110
		$ 4,136,029.462	$ -	$ 1,173,352.347	$ -	
	70%	$ 7,237,927.686	$5,107,541.312	$ 2,053,331.466	$ 1,607,401.963	$ 19,988,253.239
		$ 3,102,033.357	$ -	$ 880,017.455	$ -	
	80%	$ 8,272,103.968	$5,837,321.757	$ 2,346,717.472	$ 1,837,072.258	$ 20,947,877.448
		$ 2,067,992.209	$ -	$ 586,669.784	$ -	
	90%	$ 9,306,100.072	$6,566,975.057	$ 2,640,052.364	$ 2,066,702.539	$ 21,907,161.028
		$ 1,033,996.104	$ -	$ 293,334.892	$ -	
	100%	$ 10,340,141.221	$7,296,660.143	$ 2,933,400.035	$ 2,296,342.823	$ 22,866,544.222
		$ -	$ -	$ -	$ -	
6KA2OMED	0%	$ -	$ -	$ -	$ -	$ 13,699,726.128
		$ 10,766,326.093	$ -	$ 2,933,400.035	$ -	
	10%	$ 1,076,613.849	$ 729,653.300	$ 293,334.892	$ 229,630.281	$ 14,658,950.029
		$ 9,689,665.343	$ -	$ 2,640,052.364	$ -	
	20%	$ 2,153,227.698	$1,459,306.600	$ 586,669.784	$ 459,260.562	$ 15,618,233.609
		$ 8,613,051.494	$ -	$ 2,346,717.472	$ -	
	30%	$ 3,229,888.448	$2,188,991.686	$ 880,017.455	$ 688,900.846	$ 16,577,379.941
		$ 7,536,250.041	$ -	$ 2,053,331.466	$ -	
	40%	$ 4,306,502.296	$2,918,644.985	$ 1,173,352.347	$ 918,531.127	$ 17,536,902.240
		$ 6,459,823.796	$ -	$ 1,760,047.688	$ -	
	50%	$ 5,383,116.145	$3,648,298.285	$ 1,466,687.239	$ 1,148,161.408	$ 18,496,066.461
		$ 5,383,116.145	$ -	$ 1,466,687.239	$ -	
	60%	$ 6,459,823.796	$4,378,015.157	$ 1,760,047.688	$ 1,377,811.696	$ 19,455,552.981
		$ 4,306,502.296	$ -	$ 1,173,352.347	$ -	
	70%	$ 7,536,250.041	$5,107,541.312	$ 2,053,331.466	$ 1,607,401.963	$ 20,414,430.684
		$ 3,229,888.448	$ -	$ 880,017.455	$ -	
	80%	$ 8,613,051.494	$5,837,321.757	$ 2,346,717.472	$ 1,837,072.258	$ 21,374,060.463
		$ 2,153,227.698	$ -	$ 586,669.784	$ -	
	90%	$ 9,689,665.343	$6,566,975.057	$ 2,640,052.364	$ 2,066,702.539	$ 22,333,344.043
		$ 1,076,613.849	$ -	$ 293,334.892	$ -	
	100%	$ 10,766,326.093	$7,296,660.143	$ 2,933,400.035	$ 2,296,342.823	$ 23,292,729.094
		$ -	$ -	$ -	$ -	
6KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ 15,516,739.783
		$ 12,583,339.748	$ -	$ 2,933,400.035	$ -	
	10%	$ 1,258,312.048	$ 729,653.300	$ 293,334.892	$ 229,630.281	$ 16,475,955.769
		$ 11,324,972.883	$ -	$ 2,640,052.364	$ -	
	20%	$ 2,516,624.096	$1,459,306.600	$ 586,669.784	$ 459,260.562	$ 17,435,239.349
		$ 10,066,660.835	$ -	$ 2,346,717.472	$ -	
	30%	$ 3,774,990.961	$2,188,991.686	$ 880,017.455	$ 688,900.846	$ 18,394,361.934
		$ 8,808,129.521	$ -	$ 2,053,331.466	$ -	
	40%	$ 5,033,303.009	$2,918,644.985	$ 1,173,352.347	$ 918,531.127	$ 19,353,915.896
		$ 7,550,036.739	$ -	$ 1,760,047.688	$ -	
	50%	$ 6,291,615.058	$3,648,298.285	$ 1,466,687.239	$ 1,148,161.408	$ 20,313,064.286
		$ 6,291,615.058	$ -	$ 1,466,687.239	$ -	
	60%	$ 7,550,036.739	$4,378,015.157	$ 1,760,047.688	$ 1,377,811.696	$ 21,272,566.636
		$ 5,033,303.009	$ -	$ 1,173,352.347	$ -	

TS1	% Reused	Total Secondary Cost	Total Tertiary and Disinfection Cost			Total Cost
			PSF	CL	UV	
	70%	$ 8,808,129.521	$5,107,541.312	$ 2,053,331.466	$ 1,607,401.963	$ 22,231,412.678
		$ 3,774,990.961	$ -	$ 880,017.455	$ -	
	80%	$ 10,066,660.835	$5,837,321.757	$ 2,346,717.472	$ 1,837,072.258	$ 23,191,066.203
		$ 2,516,624.096	$ -	$ 586,669.784	$ -	
	90%	$ 11,324,972.883	$6,566,975.057	$ 2,640,052.364	$ 2,066,702.539	$ 24,150,349.783
		$ 1,258,312.048	$ -	$ 293,334.892	$ -	
	100%	$ 12,583,339.748	$7,296,660.143	$ 2,933,400.035	$ 2,296,342.823	$ 25,109,742.749
		$ -	$ -	$ -	$ -	
30KA2OLOW	0%	$ -	$ -	$ -	$ -	$ 47,196,847.009
		$ 32,529,897.948	$ -	$ 14,666,949.061	$ -	
	10%	$ 3,252,972.790	$3,648,298.285	$ 1,466,687.239	$ 1,148,161.408	$ 51,993,265.581
		$ 29,276,896.817	$ -	$ 13,200,249.043	$ -	
	20%	$ 6,506,002.263	$7,296,660.143	$ 2,933,400.035	$ 2,296,342.823	$ 56,789,932.216
		$ 26,023,952.369	$ -	$ 11,733,574.583	$ -	
	30%	$ 9,758,946.711	$ -	$ 4,400,074.495	$ 3,444,494.228	$ 59,869,537.525
		$ 22,770,845.246	$ -	$ 10,266,826.777	$ -	
	40%	$ 13,002,891.239	$ -	$ 5,862,691.108	$ 4,589,469.042	$ 64,069,014.232
		$ 19,517,893.422	$ -	$ 8,800,148.990	$ -	
	50%	$ 16,264,948.974	$ -	$ 7,333,474.530	$ 5,740,837.051	$ 68,318,303.242
		$ 16,264,948.974	$ -	$ 7,333,474.530	$ -	
	60%	$ 19,517,893.422	$ -	$ 8,800,148.990	$ 6,888,988.455	$ 72,529,313.351
		$ 13,002,891.239	$ -	$ 5,862,691.108	$ -	
	70%	$ 22,770,845.246	$ -	$ 10,266,826.777	$ 8,037,142.463	$ 76,766,623.760
		$ 9,758,946.711	$ -	$ 4,400,074.495	$ -	
	80%	$ 26,023,952.369	$ -	$ 11,733,574.583	$ 9,185,351.285	$ 83,287,646.211
		$ 6,506,002.263	$ -	$ 2,933,400.035	$ 2,296,342.823	
	90%	$ 29,276,896.817	$ -	$ 13,200,249.043	$ 10,333,502.690	$ 86,363,573.793
		$ 3,252,972.790	$ -	$ 1,466,687.239	$ 1,148,161.408	
	100%	$ 32,529,897.948	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 89,439,759.474
		$ -	$ -	$ -	$ -	
30KA2OMED	0%	$ -	$ -	$ -	$ -	$ 49,112,035.985
		$ 34,445,086.925	$ -	$ 14,666,949.061	$ -	
	10%	$ 3,444,490.686	$3,648,298.285	$ 1,466,687.239	$ 1,148,161.408	$ 53,908,452.889
		$ 31,000,566.228	$ -	$ 13,200,249.043	$ -	
	20%	$ 6,889,041.393	$7,296,660.143	$ 2,933,400.035	$ 2,296,342.823	$ 58,705,124.530
		$ 27,556,105.552	$ -	$ 11,733,574.583	$ -	
	30%	$ 10,333,502.069	$ -	$ 4,400,074.495	$ 3,444,494.228	$ 61,784,720.261
		$ 24,111,472.625	$ -	$ 10,266,826.777	$ -	
	40%	$ 13,768,432.957	$ -	$ 5,862,691.108	$ 4,589,469.042	$ 65,983,666.666
		$ 20,667,004.138	$ -	$ 8,800,148.990	$ -	
	50%	$ 17,222,543.462	$ -	$ 7,333,474.530	$ 5,740,837.051	$ 70,233,492.218
		$ 17,222,543.462	$ -	$ 7,333,474.530	$ -	
	60%	$ 20,667,004.138	$ -	$ 8,800,148.990	$ 6,888,988.455	$ 74,443,965.785
		$ 13,768,432.957	$ -	$ 5,862,691.108	$ -	
	70%	$ 24,111,472.625	$ -	$ 10,266,826.777	$ 8,037,142.463	$ 78,681,806.496
		$ 10,333,502.069	$ -	$ 4,400,074.495	$ -	
	80%	$ 27,556,105.552	$ -	$ 11,733,574.583	$ 9,185,351.285	$ 82,906,495.702
		$ 6,889,041.393	$ -	$ 2,933,400.035	$ -	
	90%	$ 31,000,566.228	$ -	$ 13,200,249.043	$ 10,333,502.690	$ 87,130,599.693
		$ 3,444,490.686	$ -	$ 1,466,687.239	$ -	
	100%	$ 34,445,086.925	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 91,354,948.451
		$ -	$ -	$ -	$ -	
30KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ 56,499,825.932
		$ 41,832,876.871	$ -	$ 14,666,949.061	$ -	
	10%	$ 4,183,265.819	$3,648,298.285	$ 1,466,687.239	$ 1,148,161.408	$ 61,296,236.399
		$ 37,649,574.605	$ -	$ 13,200,249.043	$ -	
	20%	$ 8,366,604.532	$7,296,660.143	$ 2,933,400.035	$ 2,296,342.823	$ 66,092,927.349
		$ 33,466,345.233	$ -	$ 11,733,574.583	$ -	
	30%	$ 12,549,833.904	$ -	$ 4,400,074.495	$ 3,444,494.228	$ 69,172,486.136
		$ 29,282,906.665	$ -	$ 10,266,826.777	$ -	
	40%	$ 16,721,489.536	$ -	$ 5,862,691.108	$ 4,589,469.042	$ 73,369,386.915
		$ 25,099,667.807	$ -	$ 8,800,148.990	$ -	

TS1	% Reused	Total Secondary Cost	Total Tertiary and Disinfection Cost			Total Cost
			PSF	CL	UV	
	50%	$ 20,916,438.435	$ -	$ 7,333,474.530	$ 5,740,837.051	$ 77,621,282.164
		$ 20,916,438.435	$ -	$ 7,333,474.530	$ -	
	60%	$ 25,099,667.807	$ -	$ 8,800,148.990	$ 6,888,988.455	$ 81,829,686.034
		$ 16,721,489.536	$ -	$ 5,862,691.108	$ -	
	70%	$ 29,282,906.665	$ -	$ 10,266,826.777	$ 8,037,142.463	$ 86,069,572.371
		$ 12,549,833.904	$ -	$ 4,400,074.495	$ -	
	80%	$ 33,466,345.233	$ -	$ 11,733,574.583	$ 9,185,351.285	$ 90,294,298.521
		$ 8,366,604.532	$ -	$ 2,933,400.035	$ -	
	90%	$ 37,649,574.605	$ -	$ 13,200,249.043	$ 10,333,502.690	$ 94,518,383.203
		$ 4,183,265.819	$ -	$ 1,466,687.239	$ -	
	100%	$ 41,832,876.871	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 98,742,738.397
		$ -	$ -	$ -	$ -	
130KA2OLOW	0%	$ -	$ -	$ -	$ -	$ 143,646,039.959
		$ 80,089,192.544	$ -	$ 63,556,847.415	$ -	
	10%	$ 8,008,922.475	$ -	$ 6,355,687.297	$ 4,975,399.446	$ 161,951,386.780
		$ 72,080,302.274	$ -	$ 57,201,185.676	$ -	
	20%	$ 16,017,828.847	$ -	$ 12,711,361.816	$ 9,950,788.889	$ 180,256,581.272
		$ 64,071,363.697	$ -	$ 50,845,485.600	$ -	
	30%	$ 24,026,783.527	$ -	$ 19,067,074.671	$ 14,926,208.343	$ 198,562,001.702
		$ 56,062,441.222	$ -	$ 44,489,798.302	$ -	
	40%	$ 32,035,738.208	$ -	$ 25,422,787.525	$ 19,901,627.796	$ 216,867,422.132
		$ 48,053,518.747	$ -	$ 38,134,111.005	$ -	
	50%	$ 40,044,612.375	$ -	$ 31,778,436.486	$ 24,876,997.232	$ 235,172,543.014
		$ 40,044,612.375	$ -	$ 31,778,436.486	$ -	
	60%	$ 48,053,518.747	$ -	$ 38,134,111.005	$ 29,852,386.675	$ 253,477,853.030
		$ 32,035,738.208	$ -	$ 25,422,787.525	$ -	
	70%	$ 56,062,441.222	$ -	$ 44,489,798.302	$ 34,827,786.121	$ 271,783,084.326
		$ 24,026,783.527	$ -	$ 19,067,074.671	$ -	
	80%	$ 64,071,363.697	$ -	$ 50,845,485.600	$ 39,803,185.568	$ 290,088,315.622
		$ 16,017,828.847	$ -	$ 12,711,361.816	$ -	
	90%	$ 72,080,302.274	$ -	$ 57,201,185.676	$ 44,778,595.018	$ 313,369,098.694
		$ 8,008,922.475	$ -	$ 6,355,687.297	$ 4,975,399.446	
	100%	$ 80,089,192.544	$ -	$ 63,556,847.415	$ 49,753,974.457	$ 326,698,856.934
		$ -	$ -	$ -	$ -	
130KA2OMED	0%	$ -	$ -	$ -	$ -	$ 150,643,334.444
		$ 87,086,487.029	$ -	$ 63,556,847.415	$ -	
	10%	$ 8,708,652.205	$ -	$ 6,355,687.297	$ 4,975,399.446	$ 168,948,684.079
		$ 78,377,869.843	$ -	$ 57,201,185.676	$ -	
	20%	$ 17,417,286.900	$ -	$ 12,711,361.816	$ 9,950,788.889	$ 187,253,875.757
		$ 69,669,200.129	$ -	$ 50,845,485.600	$ -	
	30%	$ 26,125,974.124	$ -	$ 19,067,074.671	$ 14,926,208.343	$ 205,559,299.000
		$ 60,960,547.924	$ -	$ 44,489,798.302	$ -	
	40%	$ 34,834,661.348	$ -	$ 25,422,787.525	$ 19,901,627.796	$ 223,864,722.244
		$ 52,251,895.719	$ -	$ 38,134,111.005	$ -	
	50%	$ 43,543,261.024	$ -	$ 31,778,436.486	$ 24,876,997.232	$ 242,169,840.313
		$ 43,543,261.024	$ -	$ 31,778,436.486	$ -	
	60%	$ 52,251,895.719	$ -	$ 38,134,111.005	$ 29,852,386.675	$ 260,475,153.143
		$ 34,834,661.348	$ -	$ 25,422,787.525	$ -	
	70%	$ 60,960,547.924	$ -	$ 44,489,798.302	$ 34,827,786.121	$ 278,780,381.625
		$ 26,125,974.124	$ -	$ 19,067,074.671	$ -	
	80%	$ 69,669,200.129	$ -	$ 50,845,485.600	$ 39,803,185.568	$ 297,085,610.107
		$ 17,417,286.900	$ -	$ 12,711,361.816	$ -	
	90%	$ 78,377,869.843	$ -	$ 57,201,185.676	$ 44,778,595.018	$ 315,390,996.546
		$ 8,708,652.205	$ -	$ 6,355,687.297	$ -	
	100%	$ 87,086,487.029	$ -	$ 63,556,847.415	$ 49,753,974.457	$ 333,696,151.419
		$ -	$ -	$ -	$ -	
130KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ 181,605,286.048
		$118,048,438.633	$ -	$ 63,556,847.415	$ -	
	10%	$ 11,804,848.610	$ -	$ 6,355,687.297	$ 4,975,399.446	$ 199,910,648.134
		$106,243,637.492	$ -	$ 57,201,185.676	$ -	
	20%	$ 23,609,673.486	$ -	$ 12,711,361.816	$ 9,950,788.889	$ 218,215,827.361
		$ 94,438,765.147	$ -	$ 50,845,485.600	$ -	

TS1	% Reused	Total Secondary Cost	Total Tertiary and Disinfection Cost			Total Cost
			PSF	CL	UV	
	30%	$ 35,414,569.565	$ -	$ 19,067,074.671	$ 14,926,208.343	$ 236,521,263.055
		$ 82,633,916.537	$ -	$ 44,489,798.302	$ -	
	40%	$ 47,219,465.645	$ -	$ 25,422,787.525	$ 19,901,627.796	$ 254,826,698.749
		$ 70,829,067.927	$ -	$ 38,134,111.005	$ -	
	50%	$ 59,024,243.051	$ -	$ 31,778,436.486	$ 24,876,997.232	$ 273,131,804.367
		$ 59,024,243.051	$ -	$ 31,778,436.486	$ -	
	60%	$ 70,829,067.927	$ -	$ 38,134,111.005	$ 29,852,386.675	$ 291,437,129.648
		$ 47,219,465.645		$ 25,422,787.525	$ -	
	70%	$ 82,633,916.537	$ -	$ 44,489,798.302	$ 34,827,786.121	$ 309,742,345.679
		$ 35,414,569.565	$ -	$ 19,067,074.671	$ -	
	80%	$ 94,438,765.147	$ -	$ 50,845,485.600	$ 39,803,185.568	$ 328,047,561.711
		$ 23,609,673.486	$ -	$ 12,711,361.816	$ -	
	90%	$106,243,637.492	$ -	$ 57,201,185.676	$ 44,778,595.018	$ 346,352,960.601
		$ 11,804,848.610	$ -	$ 6,355,687.297	$ -	
	100%	$118,048,438.633	$ -	$ 63,556,847.415	$ 49,753,974.457	$ 364,658,103.023
		$ -	$ -	$ -	$ -	

TS2	% Reused	Total Secondary Cost	Total Tertiary, Advanced and Disinfection Cost					Total Cost
			PSF	RSF	CL	UV	SAT	
6KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,273,541.256
		$ 10,340,141.221	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 1,033,996.104	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 16,753,977.612
		$ 9,306,100.072	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 2,067,992.209	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 20,234,471.790
		$ 8,272,103.968	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 3,102,033.357	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 23,714,944.121
		$ 7,237,927.686	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 4,136,029.462	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 27,195,669.592
		$ 6,204,111.759	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 5,170,025.566	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 30,676,048.125
		$ 5,170,025.566	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 6,204,111.759	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 34,156,961.194
		$ 4,136,029.462	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 7,237,927.686	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 37,636,617.590
		$ 3,102,033.357	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 8,272,103.968	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 41,117,891.728
		$ 2,067,992.209	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 9,306,100.072	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 44,598,385.906
		$ 1,033,996.104	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 10,340,141.221	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 48,079,089.530
		$ -	$ -	$ -	$ -	$ -	$ -	
6KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,699,726.128
		$ 10,766,326.093	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 1,076,613.849	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 17,180,160.627
		$ 9,689,665.343	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 2,153,227.698	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 20,660,654.805
		$ 8,613,051.494	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 3,229,888.448	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 24,141,121.567
		$ 7,536,250.041	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 4,306,502.296	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 27,621,854.464
		$ 6,459,823.796	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 5,383,116.145	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 31,102,229.283
		$ 5,383,116.145	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 6,459,823.796	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 34,583,146.066
		$ 4,306,502.296	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 7,536,250.041	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 38,062,795.035
		$ 3,229,888.448	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 8,613,051.494	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 41,544,074.743
		$ 2,153,227.698	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 9,689,665.343	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 45,024,568.921
		$ 1,076,613.849	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 10,766,326.093	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 48,505,274.402
		$ -	$ -	$ -	$ -	$ -	$ -	
6KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,516,739.783
		$ 12,583,339.748	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 1,258,312.048	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 18,997,166.366
		$ 11,324,972.883	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 2,516,624.096	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 22,477,660.545
		$ 10,066,660.835	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 3,774,990.961	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 25,958,103.560
		$ 8,808,129.521	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 5,033,303.009	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 29,438,868.119
		$ 7,550,036.739	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 6,291,615.058	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 32,919,227.107
		$ 6,291,615.058	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 7,550,036.739	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 36,400,159.721
		$ 5,033,303.009	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 8,808,129.521	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 39,879,777.029
		$ 3,774,990.961	$ -	$ -	$ 880,017.455	$ -	$ -	

TS2	% Reused	Total Secondary Cost	Total Tertiary, Advanced and Disinfection Cost					Total Cost
			PSF	RSF	CL	UV	SAT	
	80%	$ 10,066,660.835	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 43,361,080.483
		$ 2,516,624.096	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 11,324,972.883	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 46,841,574.661
		$ 1,258,312.048	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 12,583,339.748	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 50,322,288.057
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 47,196,847.009
		$ 32,529,897.948	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 3,252,972.790	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 51,993,265.581
		$ 29,276,896.817	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 6,506,002.263	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 56,789,932.216
		$ 26,023,952.369	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 9,758,946.711	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 97,688,135.822
		$ 22,770,845.246	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 13,002,891.239	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 114,458,788.356
		$ 19,517,893.422	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 16,264,948.974	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 131,349,446.847
		$ 16,264,948.974	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 19,517,893.422	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 148,166,509.945
		$ 13,002,891.239	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 22,770,845.246	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 165,009,901.929
		$ 9,758,946.711	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 26,023,952.369	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 184,137,607.779
		$ 6,506,002.263	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	
	90%	$ 29,276,896.817	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 199,819,588.350
		$ 3,252,972.790	$ -	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	
	100%	$ 32,529,897.948	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 215,502,046.685
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 49,112,035.985
		$ 34,445,086.925	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 3,444,490.686	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 53,908,452.889
		$ 31,000,566.228	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 6,889,041.393	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 58,705,124.530
		$ 27,556,105.552	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 10,333,502.069	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 99,603,318.558
		$ 24,111,472.625	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 13,768,432.957	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 116,373,440.790
		$ 20,667,004.138	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 17,222,543.462	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 133,264,635.823
		$ 17,222,543.462	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 20,667,004.138	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 150,081,162.379
		$ 13,768,432.957	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 24,111,472.625	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 166,925,084.665
		$ 10,333,502.069	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 27,556,105.552	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 183,756,457.269
		$ 6,889,041.393	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 31,000,566.228	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 200,586,614.250
		$ 3,444,490.686	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 34,445,086.925	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 217,417,235.662
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 56,499,825.932
		$ 41,832,876.871	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 4,183,265.819	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 61,296,236.399
		$ 37,649,574.605	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 8,366,604.532	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 66,092,927.349
		$ 33,466,345.233	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 12,549,833.904	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 106,991,084.433
		$ 29,282,906.665	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 16,721,489.536	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 123,759,161.039
		$ 25,099,667.807	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 20,916,438.435	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 140,652,425.770
		$ 20,916,438.435	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 25,099,667.807	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 157,466,882.628
		$ 16,721,489.536	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 29,282,906.665	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 174,312,850.540
		$ 12,549,833.904	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 33,466,345.233	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 191,144,260.089
		$ 8,366,604.532	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 37,649,574.605	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 207,974,397.759
		$ 4,183,265.819	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 41,832,876.871	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 224,805,025.608
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 143,646,039.959
		$ 80,089,192.544	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 8,008,922.475	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 216,578,458.449
		$ 72,080,302.274	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 16,017,828.847	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 289,510,614.776
		$ 64,071,363.697	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 24,026,783.527	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 362,443,326.540
		$ 56,062,441.222	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 32,035,738.208	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 435,376,038.304
		$ 48,053,518.747	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 40,044,612.375	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 508,307,901.357
		$ 40,044,612.375	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 48,053,518.747	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 581,240,173.210
		$ 32,035,738.208	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 56,062,441.222	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 654,172,476.174
		$ 24,026,783.527	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 64,071,363.697	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 727,104,779.138
		$ 16,017,828.847	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 72,080,302.274	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 800,037,344.265
		$ 8,008,922.475	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$ 80,089,192.544	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 872,969,353.955
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2O MED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 150,643,334.444
		$ 87,086,487.029	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 8,708,652.205	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 223,575,755.748
		$ 78,377,869.843	$ -	$ -	$ 57,201,185.676	$ -	$ -	

TS2	% Reused	Total Secondary Cost	Total Tertiary, Advanced and Disinfection Cost					Total Cost
			PSF	RSF	CL	UV	SAT	
	20%	$ 17,417,286.900	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 296,507,909.261
		$ 69,669,200.129	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 26,125,974.124	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 369,440,623.839
		$ 60,960,547.924	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 34,834,661.348	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 442,373,338.417
		$ 52,251,895.719	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 43,543,261.024	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 515,305,198.656
		$ 43,543,261.024	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 52,251,895.719	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 588,237,473.322
		$ 34,834,661.348	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 60,960,547.924	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 661,169,773.473
		$ 26,125,974.124	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 69,669,200.129	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 734,102,073.623
		$ 17,417,286.900	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 78,377,869.843	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 807,034,641.564
		$ 8,708,652.205	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$ 87,086,487.029	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 879,966,648.440
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 181,605,286.048
		$118,048,438.633	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 11,804,848.610	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 254,537,719.802
		$106,243,637.492	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 23,609,673.486	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 327,469,860.865
		$ 94,438,765.147	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 35,414,569.565	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 400,402,587.894
		$ 82,633,916.537	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 47,219,465.645	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 473,335,314.922
		$ 70,829,067.927	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 59,024,243.051	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 546,267,162.710
		$ 59,024,243.051	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 70,829,067.927	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 619,199,449.827
		$ 47,219,465.645	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 82,633,916.537	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 692,131,737.527
		$ 35,414,569.565	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 94,438,765.147	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 765,064,025.227
		$ 23,609,673.486	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$106,243,637.492	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 837,996,605.618
		$ 11,804,848.610	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$118,048,438.633	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 910,928,600.044
		$ -	$ -	$ -	$ -	$ -	$ -	
6KEXTLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,534,030.917
		$ 6,600,630.882	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 660,051.587	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 13,014,483.563
		$ 5,940,550.541	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 1,320,103.173	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 16,494,977.741
		$ 5,280,498.955	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 1,980,183.514	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 19,975,498.943
		$ 4,620,332.352	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 2,640,235.100	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 23,456,159.253
		$ 3,960,395.782	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 3,300,286.687	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 26,936,570.366
		$ 3,300,286.687	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 3,960,395.782	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 30,417,450.855
		$ 2,640,235.100	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 4,620,332.352	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 33,897,172.412
		$ 1,980,183.514	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 5,280,498.955	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 37,837,658.241
		$ 1,320,103.173	$ -	$ -	$ 586,669.784	$ 459,260.562	$ -	
	90%	$ 5,940,550.541	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 41,088,522.138
		$ 660,051.587	$ -	$ -	$ 293,334.892	$ 229,630.281	$ -	
	100%	$ 6,600,630.882	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 44,339,579.191
		$ -	$ -	$ -	$ -	$ -	$ -	
6KEXTMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,068,830.574
		$ 7,135,430.539	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 713,530.620	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 13,549,280.890
		$ 6,421,868.835	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 1,427,061.241	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 17,029,775.069
		$ 5,708,338.215	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 2,140,622.945	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 20,510,289.282
		$ 4,994,683.259	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 2,854,153.565	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 23,990,958.910
		$ 4,281,276.974	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 3,567,684.186	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 27,471,365.364
		$ 3,567,684.186	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 4,281,276.974	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 30,952,250.512
		$ 2,854,153.565	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 4,994,683.259	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 34,431,962.750
		$ 2,140,622.945	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 5,708,338.215	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 37,913,195.007
		$ 1,427,061.241	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 6,421,868.835	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 41,393,689.185
		$ 713,530.620	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 7,135,430.539	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 44,874,378.848
		$ -	$ -	$ -	$ -	$ -	$ -	
6KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,281,731.197
		$ 8,348,331.162	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 834,818.569	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 14,762,176.229
		$ 7,513,476.225	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 1,669,637.138	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 18,242,670.408
		$ 6,678,657.656	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 2,504,492.075	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 21,723,168.770
		$ 5,843,693.617	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 3,339,310.644	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 25,203,859.533
		$ 5,009,020.518	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 4,174,129.214	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 28,684,255.419
		$ 4,174,129.214	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 5,009,020.518	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 32,165,151.135
		$ 3,339,310.644	$ -	$ -	$ 1,173,352.347	$ -	$ -	

TS2	% Reused	Total Secondary Cost	PSF	RSF	CL	UV	SAT	Total Cost
			Total Tertiary, Advanced and Disinfection Cost					
	70%	$ 5,843,693.617	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 35,644,842.239
		$ 2,504,492.075	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 6,678,657.656	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 39,126,090.346
		$ 1,669,637.138	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 7,513,476.225	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 42,606,584.524
		$ 834,818.569	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 8,348,331.162	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 46,087,279.471
		$ -	$ -	$ -	$ -	$ -	$ -	
30KEXTLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 34,759,040.972
		$ 20,092,091.912	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 2,009,198.688	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 39,555,470.381
		$ 18,082,875.718	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 4,018,432.387	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 44,352,104.506
		$ 16,073,694.536	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 6,027,613.569	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 85,250,370.311
		$ 14,064,412.877	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 8,031,235.951	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 102,024,466.785
		$ 12,055,227.138	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 10,046,045.956	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 118,911,640.810
		$ 10,046,045.956	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 12,055,227.138	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 135,732,188.374
		$ 8,031,235.951	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 14,064,412.877	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 152,572,136.418
		$ 6,027,613.569	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 16,073,694.536	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 169,403,437.246
		$ 4,018,432.387	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 18,082,875.718	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 186,233,631.742
		$ 2,009,198.688	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 20,092,091.912	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 203,064,240.649
		$ -	$ -	$ -	$ -	$ -	$ -	
30KEXTMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 36,860,420.919
		$ 22,193,471.859	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 2,219,335.584	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 41,656,848.497
		$ 19,974,116.938	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 4,438,709.841	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 46,453,488.115
		$ 17,754,800.690	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 6,658,026.089	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 87,351,743.411
		$ 15,535,373.458	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 8,871,202.155	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 104,125,258.028
		$ 13,316,052.177	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 11,096,735.929	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 121,013,020.757
		$ 11,096,735.929	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 13,316,052.177	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 137,832,979.617
		$ 8,871,202.155	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 15,535,373.458	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 154,673,509.518
		$ 6,658,026.089	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 17,754,800.690	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 171,504,820.855
		$ 4,438,709.841	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 19,974,116.938	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 188,335,009.858
		$ 2,219,335.584	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 22,193,471.859	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 205,165,620.595
		$ -	$ -	$ -	$ -	$ -	$ -	
30KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 42,680,564.654
		$ 28,013,615.594	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 2,801,346.915	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 47,476,987.162
		$ 25,212,244.271	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 5,602,742.644	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 52,273,641.991
		$ 22,410,921.763	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 8,404,065.152	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 93,171,868.183
		$ 19,609,459.165	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 11,197,637.243	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 109,943,771.243
		$ 16,808,130.305	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 14,006,807.797	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 126,833,164.492
		$ 14,006,807.797	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 16,808,130.305	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 143,651,492.832
		$ 11,197,637.243	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 19,609,459.165	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 160,493,634.290
		$ 8,404,065.152	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 22,410,921.763	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 177,324,974.731
		$ 5,602,742.644	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 25,212,244.271	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 194,155,148.522
		$ 2,801,346.915	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 28,013,615.594	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 210,985,764.330
		$ -	$ -	$ -	$ -	$ -	$ -	
130KEXTLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 116,481,930.523
		$ 52,925,083.107	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 5,292,510.439	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 189,414,338.089
		$ 47,632,593.950	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 10,585,010.237	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 262,346,505.339
		$ 42,340,072.870	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 15,877,541.958	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 335,279,206.180
		$ 37,047,562.431	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 21,170,073.679	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 408,211,907.021
		$ 31,755,051.992	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 26,462,552.195	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 481,143,780.997
		$ 26,462,552.195	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 31,755,051.992	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 554,076,041.926
		$ 21,170,073.679	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 37,047,562.431	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 627,008,355.814
		$ 15,877,541.958	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 42,340,072.870	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 699,940,669.701
		$ 10,585,010.237	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 47,632,593.950	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 772,873,223.905
		$ 5,292,510.439	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$ 52,925,083.107	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 845,805,244.518
		$ -	$ -	$ -	$ -	$ -	$ -	
130K EXT MED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 125,255,107.435
		$ 61,698,260.019	$ -	$ -	$ 63,556,847.415	$ -	$ -	

TS2	% Reused	Total Secondary Cost	Total Tertiary, Advanced and Disinfection Cost					Total Cost
			PSF	RSF	CL	UV	SAT	
	10%	$ 6,169,828.483	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 198,187,518.529
		$ 55,528,456.346	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 12,339,644.561	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 271,119,682.251
		$ 49,358,615.458	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 18,509,497.854	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 344,052,386.620
		$ 43,188,786.975	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 24,679,351.147	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 416,985,090.989
		$ 37,018,958.493	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 30,849,142.415	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 489,916,961.437
		$ 30,849,142.415	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 37,018,958.493	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 562,849,225.894
		$ 24,679,351.147	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 43,188,786.975	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 635,781,536.254
		$ 18,509,497.854	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 49,358,615.458	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 708,713,846.613
		$ 12,339,644.561	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 55,528,456.346	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 781,646,404.345
		$ 6,169,828.483	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$ 61,698,260.019	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 854,578,421.430
		$ -	$ -	$ -	$ -	$ -	$ -	
130KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 151,383,712.018
		$ 87,826,864.602	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 8,782,689.992	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 224,316,133.619
		$ 79,044,209.927	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 17,565,362.325	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 297,248,286.835
		$ 70,261,502.277	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 26,348,087.634	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 370,181,001.710
		$ 61,478,812.285	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 35,130,812.943	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 443,113,716.586
		$ 52,696,122.293	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 43,913,449.960	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 516,045,576.527
		$ 43,913,449.960	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 52,696,122.293	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 588,977,851.491
		$ 35,130,812.943	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 61,478,812.285	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 661,910,151.344
		$ 26,348,087.634	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 70,261,502.277	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 734,842,451.197
		$ 17,565,362.325	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 79,044,209.927	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 807,775,019.435
		$ 8,782,689.992	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$ 87,826,864.602	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 880,707,026.013
		$ -	$ -	$ -	$ -	$ -	$ -	
6KCASLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,534,823.163
		$ 8,601,423.128	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 860,127.325	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 15,015,267.093
		$ 7,741,258.333	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 1,720,254.649	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 18,495,761.271
		$ 6,881,131.008	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 2,580,419.444	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 21,976,256.325
		$ 6,020,853.803	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 3,440,546.769	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 25,456,951.499
		$ 5,160,876.359	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 4,300,674.094	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 28,937,345.180
		$ 4,300,674.094	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 5,160,876.359	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 32,418,243.101
		$ 3,440,546.769	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 6,020,853.803	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 35,897,929.794
		$ 2,580,419.444	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 6,881,131.008	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 39,379,181.209
		$ 1,720,254.649	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 7,741,258.333	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 42,859,675.387
		$ 860,127.325	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 8,601,423.128	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 46,340,371.437
		$ -	$ -	$ -	$ -	$ -	$ -	
6KCASMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,438,695.493
		$ 9,505,295.458	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 950,512.983	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 15,919,135.485
		$ 8,554,741.067	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 1,901,025.965	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 19,399,629.663
		$ 7,604,228.085	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 2,851,580.356	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 22,880,112.905
		$ 6,653,549.471	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 3,802,093.339	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 26,360,823.829
		$ 5,703,202.119	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 4,752,606.321	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 29,841,209.635
		$ 4,752,606.321	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	60%	$ 5,703,202.119	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 33,322,115.431
		$ 3,802,093.339	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 6,653,549.471	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 36,801,786.374
		$ 2,851,580.356	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 7,604,228.085	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 40,283,049.601
		$ 1,901,025.965	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 8,554,741.067	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 43,763,543.780
		$ 950,512.983	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 9,505,295.458	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 47,244,243.767
		$ -	$ -	$ -	$ -	$ -	$ -	
6KCASHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,269,413.687
		$ 12,336,013.652	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	10%	$ 1,233,579.870	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,521,210.598	$ 18,749,841.347
		$ 11,102,380.043	$ -	$ -	$ 2,640,052.364	$ -	$ -	
	20%	$ 2,467,159.739	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,042,421.195	$ 22,230,335.526
		$ 9,868,800.174	$ -	$ -	$ 2,346,717.472	$ -	$ -	
	30%	$ 3,700,793.348	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,563,741.626	$ 25,710,781.774
		$ 8,635,005.348	$ -	$ -	$ 2,053,331.466	$ -	$ -	
	40%	$ 4,934,373.217	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,084,952.224	$ 29,191,542.023
		$ 7,401,640.434	$ -	$ -	$ 1,760,047.688	$ -	$ -	
	50%	$ 6,167,953.087	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,606,162.821	$ 32,671,903.166
		$ 6,167,953.087	$ -	$ -	$ 1,466,687.239	$ -	$ -	

TS2	% Reused	Total Secondary Cost	Total Tertiary, Advanced and Disinfection Cost					Total Cost
			PSF	RSF	CL	UV	SAT	
	60%	$ 7,401,640.434	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,127,593.085	$ 36,152,833.625
		$ 4,934,373.217	$ -	$ -	$ 1,173,352.347	$ -	$ -	
	70%	$ 8,635,005.348	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,648,364.351	$ 39,632,455.242
		$ 3,700,793.348	$ -	$ -	$ 880,017.455	$ -	$ -	
	80%	$ 9,868,800.174	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,170,014.280	$ 43,113,755.464
		$ 2,467,159.739	$ -	$ -	$ 586,669.784	$ -	$ -	
	90%	$ 11,102,380.043	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,691,224.878	$ 46,594,249.642
		$ 1,233,579.870	$ -	$ -	$ 293,334.892	$ -	$ -	
	100%	$ 12,336,013.652	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,212,545.308	$ 50,074,961.961
		$ -	$ -	$ -	$ -	$ -	$ -	
30KCASLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 38,706,437.705
		$ 24,039,488.644	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 2,403,936.298	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 43,502,863.675
		$ 21,635,531.402	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 4,807,914.485	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 48,299,508.117
		$ 19,231,616.049	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 7,211,829.838	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 89,197,754.182
		$ 16,827,580.480	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 9,609,094.279	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 105,970,757.650
		$ 14,423,659.675	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 12,019,744.322	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 122,859,037.543
		$ 12,019,744.322	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 14,423,659.675	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 139,678,479.239
		$ 9,609,094.279	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 16,827,580.480	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 156,519,520.289
		$ 7,211,829.838	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 19,231,616.049	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 173,350,840.857
		$ 4,807,914.485	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 21,635,531.402	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 190,181,025.035
		$ 2,403,936.298	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 24,039,488.644	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 207,011,637.381
		$ -	$ -	$ -	$ -	$ -	$ -	
30KCASMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 41,818,698.495
		$ 27,151,749.435	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 2,715,160.750	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 46,615,121.754
		$ 24,436,565.029	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 5,430,368.812	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 51,411,774.331
		$ 21,721,427.935	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 8,145,505.906	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 92,310,004.832
		$ 19,006,155.062	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 10,853,131.030	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 109,082,146.537
		$ 16,291,011.811	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 13,575,874.717	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 125,971,298.334
		$ 13,575,874.717	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 16,291,011.811	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 142,789,868.126
		$ 10,853,131.030	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 19,006,155.062	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 159,631,770.939
		$ 8,145,505.906	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 21,721,427.935	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 176,463,107.071
		$ 5,430,368.812	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 24,436,565.029	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 193,293,283.114
		$ 2,715,160.750	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 27,151,749.435	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 210,123,898.172
		$ -	$ -	$ -	$ -	$ -	$ -	
30KCASHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,880,610.533
		$ 36,213,661.473	$ -	$ -	$ 14,666,949.061	$ -	$ -	
	10%	$ 3,621,347.216	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ -	$ 55,677,025.896
		$ 32,592,282.705	$ -	$ -	$ 13,200,249.043	$ -	$ -	
	20%	$ 7,242,757.536	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ -	$ 60,473,702.159
		$ 28,970,967.040	$ -	$ -	$ 11,733,574.583	$ -	$ -	
	30%	$ 10,864,073.201	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 37,818,598.297	$ 101,371,887.344
		$ 25,349,470.278	$ -	$ -	$ 10,266,826.777	$ -	$ -	
	40%	$ 14,475,369.773	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 50,389,774.124	$ 118,141,519.870
		$ 21,728,146.401	$ -	$ -	$ 8,800,148.990	$ -	$ -	
	50%	$ 18,106,830.736	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 63,031,143.605	$ 135,033,210.372
		$ 18,106,830.736	$ -	$ -	$ 7,333,474.530	$ -	$ -	
	60%	$ 21,728,146.401	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 75,637,196.594	$ 151,849,241.459
		$ 14,475,369.773	$ -	$ -	$ 5,862,691.108	$ -	$ -	
	70%	$ 25,349,470.278	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 88,243,278.169	$ 168,693,653.451
		$ 10,864,073.201	$ -	$ -	$ 4,400,074.495	$ -	$ -	
	80%	$ 28,970,967.040	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 100,849,961.568	$ 185,525,034.899
		$ 7,242,757.536	$ -	$ -	$ 2,933,400.035	$ -	$ -	
	90%	$ 32,592,282.705	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 113,456,014.557	$ 202,355,187.257
		$ 3,621,347.216	$ -	$ -	$ 1,466,687.239	$ -	$ -	
	100%	$ 36,213,661.473	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 126,062,287.211	$ 219,185,810.210
		$ -	$ -	$ -	$ -	$ -	$ -	
130KCASLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 124,637,040.034
		$ 61,080,192.619	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 6,108,021.718	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 197,569,450.880
		$ 54,972,195.462	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 12,216,031.155	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 270,501,614.851
		$ 48,864,161.464	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 18,324,077.435	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 343,434,318.971
		$ 42,756,139.746	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 24,432,123.714	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 416,367,023.092
		$ 36,648,118.027	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 30,540,108.590	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 489,298,893.788
		$ 30,540,108.590	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 36,648,118.027	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 562,231,157.997
		$ 24,432,123.714	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 42,756,139.746	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 635,163,468.605
		$ 18,324,077.435	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 48,864,161.464	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 708,095,779.213
		$ 12,216,031.155	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 54,972,195.462	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 781,028,336.696
		$ 6,108,021.718	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$ 61,080,192.619	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 853,960,354.030
		$ -	$ -	$ -	$ -	$ -	$ -	

TS2	% Reused	Total Secondary Cost	Total Tertiary, Advanced and Disinfection Cost					Total Cost
			PSF	RSF	CL	UV	SAT	
130KCASMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 135,870,923.532
		$ 72,314,076.116	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 7,231,410.520	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 208,803,338.895
		$ 65,082,694.676	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 14,462,806.500	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 281,735,498.349
		$ 57,851,269.617	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 21,694,246.098	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 354,668,206.986
		$ 50,619,859.097	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 28,925,685.696	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 427,600,915.624
		$ 43,388,448.578	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 36,157,052.598	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 500,532,781.803
		$ 36,157,052.598	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 43,388,448.578	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 573,465,050.529
		$ 28,925,685.696	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 50,619,859.097	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 646,397,356.620
		$ 21,694,246.098	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 57,851,269.617	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 719,329,662.711
		$ 14,462,806.500	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 65,082,694.676	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 792,262,224.711
		$ 7,231,410.520	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$ 72,314,076.116	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 865,194,237.527
		$ -	$ -	$ -	$ -	$ -	$ -	
130KCASHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 170,433,038.696
		$106,876,191.281	$ -	$ -	$ 63,556,847.415	$ -	$ -	
	10%	$ 10,687,623.426	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 54,627,071.669	$ 243,365,467.957
		$ 96,188,610.832	$ -	$ -	$ 57,201,185.676	$ -	$ -	
	20%	$ 21,375,225.363	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 109,254,033.505	$ 316,297,613.513
		$ 85,500,965.918	$ -	$ -	$ 50,845,485.600	$ -	$ -	
	30%	$ 32,062,891.766	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 163,881,324.839	$ 389,230,336.049
		$ 74,813,342.492	$ -	$ -	$ 44,489,798.302	$ -	$ -	
	40%	$ 42,750,558.168	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$ 218,508,616.173	$ 462,163,058.584
		$ 64,125,719.066	$ -	$ -	$ 38,134,111.005	$ -	$ -	
	50%	$ 53,438,117.129	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$ 273,135,358.343	$ 535,094,910.865
		$ 53,438,117.129	$ -	$ -	$ 31,778,436.486	$ -	$ -	
	60%	$ 64,125,719.066	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$ 327,762,320.179	$ 608,027,193.490
		$ 42,750,558.168	$ -	$ -	$ 25,422,787.525	$ -	$ -	
	70%	$ 74,813,342.492	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$ 382,389,391.848	$ 680,959,485.682
		$ 32,062,891.766	$ -	$ -	$ 19,067,074.671	$ -	$ -	
	80%	$ 85,500,965.918	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$ 437,016,463.516	$ 753,891,777.875
		$ 21,375,225.363	$ -	$ -	$ 12,711,361.816	$ -	$ -	
	90%	$ 96,188,610.832	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$ 491,643,645.018	$ 826,824,353.773
		$ 10,687,623.426	$ -	$ -	$ 6,355,687.297	$ -	$ -	
	100%	$106,876,191.281	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$ 546,270,497.021	$ 899,756,352.692
		$ -	$ -	$ -	$ -	$ -	$ -	

TS3	% Reused	Total Secondary Cost	Total Tertiary and Disinfection Cost				Total Cost	
			PSF	RSF	CL	UV		
6KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,569,884.079
		$ 10,340,141.221	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 15,569,884.079	
	10%	$ 1,033,996.104	$ 729,653.300	$ -	$ 293,334.892	$ -	$ 2,056,984.296	$ 16,069,839.272
		$ 9,306,100.072	$ -	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 14,012,854.975	
	20%	$ 2,067,992.209	$1,459,306.600	$ -	$ 586,669.784	$ -	$ 4,113,968.592	$ 16,569,862.290
		$ 8,272,103.968	$ -	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 12,455,893.698	
	30%	$ 3,102,033.357	$2,188,991.686	$ -	$ 880,017.455	$ -	$ 6,171,042.498	$ 17,069,703.612
		$ 7,237,927.686	$ -	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 10,898,661.114	
	40%	$ 4,136,029.462	$2,918,644.985	$ -	$ 1,173,352.347	$ -	$ 8,228,026.794	$ 17,569,997.938
		$ 6,204,111.759	$ -	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 9,341,971.144	
	50%	$ 5,170,025.566	$3,648,298.285	$ -	$ 1,466,687.239	$ -	$ 10,285,011.090	$ 18,069,885.303
		$ 5,170,025.566	$ -	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 7,784,874.213	
	60%	$ 6,204,111.759	$4,378,015.157	$ -	$ 1,760,047.688	$ -	$ 12,342,174.605	$ 18,570,087.541
		$ 4,136,029.462	$ -	$ -	$ 1,173,352.347	$ 918,531.127	$ 6,227,912.936	
	70%	$ 7,237,927.686	$5,107,541.312	$ -	$ 2,053,331.466	$ -	$ 14,398,800.464	$ 19,069,752.122
		$ 3,102,033.357	$ -	$ -	$ 880,017.455	$ 688,900.846	$ 4,670,951.658	
	80%	$ 8,272,103.968	$5,837,321.757	$ -	$ 2,346,717.472	$ -	$ 16,456,143.197	$ 19,570,065.752
		$ 2,067,992.209	$ -	$ -	$ 586,669.784	$ 459,260.562	$ 3,113,922.555	
	90%	$ 9,306,100.072	$6,566,975.057	$ -	$ 2,640,052.364	$ -	$ 18,513,127.493	$ 20,070,088.771
		$ 1,033,996.104	$ -	$ -	$ 293,334.892	$ 229,630.281	$ 1,556,961.277	
	100%	$ 10,340,141.221	$7,296,660.143	$ -	$ 2,933,400.035	$ -	$ 20,570,201.399	$ 20,570,201.399
		$ -	$ -	$ -	$ -	$ -	$ -	
6KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,996,068.951
		$ 10,766,326.093	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 15,996,068.951	
	10%	$ 1,076,613.849	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,329,232.322	$ 14,658,950.029
		$ 9,689,665.343	$ -	$ -	$ 2,640,052.364	$ -	$ 12,329,717.707	
	20%	$ 2,153,227.698	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 4,658,464.643	$ 15,618,233.609
		$ 8,613,051.494	$ -	$ -	$ 2,346,717.472	$ -	$ 10,959,768.966	
	30%	$ 3,229,888.448	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 6,987,798.434	$ 16,577,379.941
		$ 7,536,250.041	$ -	$ -	$ 2,053,331.466	$ -	$ 9,589,581.506	
	40%	$ 4,306,502.296	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 9,317,030.756	$ 17,536,902.240
		$ 6,459,823.796	$ -	$ -	$ 1,760,047.688	$ -	$ 8,219,871.485	
	50%	$ 5,383,116.145	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 11,646,263.077	$ 18,496,066.461
		$ 5,383,116.145	$ -	$ -	$ 1,466,687.239	$ -	$ 6,849,803.384	
	60%	$ 6,459,823.796	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 13,975,698.338	$ 19,455,552.981
		$ 4,306,502.296	$ -	$ -	$ 1,173,352.347	$ -	$ 5,479,854.643	
	70%	$ 7,536,250.041	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 16,304,524.781	$ 20,414,430.684
		$ 3,229,888.448	$ -	$ -	$ 880,017.455	$ -	$ 4,109,905.902	
	80%	$ 8,613,051.494	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 18,634,162.981	$ 21,374,060.463
		$ 2,153,227.698	$ -	$ -	$ 586,669.784	$ -	$ 2,739,897.482	
	90%	$ 9,689,665.343	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 20,963,395.303	$ 22,333,344.043
		$ 1,076,613.849	$ -	$ -	$ 293,334.892	$ -	$ 1,369,948.741	
	100%	$ 10,766,326.093	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 23,292,729.094	$ 23,292,729.094

		$ -	$ -	$ -	$ -	$ -	$ -	
6KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,516,739.783
		$ 12,583,339.748	$ -	$ -	$ 2,933,400.035	$ -	$ 15,516,739.783	
	10%	$ 1,258,312.048	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,510,930.521	$ 16,475,955.769
		$ 11,324,972.883	$ -	$ -	$ 2,640,052.364	$ -	$ 13,965,025.248	
	20%	$ 2,516,624.096	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 5,021,861.042	$ 17,435,239.349
		$ 10,066,660.835	$ -	$ -	$ 2,346,717.472	$ -	$ 12,413,378.308	
	30%	$ 3,774,990.961	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,532,900.948	$ 18,394,361.934
		$ 8,808,129.521	$ -	$ -	$ 2,053,331.466	$ -	$ 10,861,460.987	
	40%	$ 5,033,303.009	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 10,043,831.469	$ 19,353,915.896
		$ 7,550,036.739	$ -	$ -	$ 1,760,047.688	$ -	$ 9,310,084.427	
	50%	$ 6,291,615.058	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,554,761.990	$ 20,313,064.286
		$ 6,291,615.058	$ -	$ -	$ 1,466,687.239	$ -	$ 7,758,302.296	
	60%	$ 7,550,036.739	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 15,065,911.280	$ 21,272,566.636
		$ 5,033,303.009	$ -	$ -	$ 1,173,352.347	$ -	$ 6,206,655.356	
	70%	$ 8,808,129.521	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,576,404.262	$ 22,231,412.678
		$ 3,774,990.961	$ -	$ -	$ 880,017.455	$ -	$ 4,655,008.416	
	80%	$ 10,066,660.835	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 20,087,772.322	$ 23,191,066.203
		$ 2,516,624.096	$ -	$ -	$ 586,669.784	$ -	$ 3,103,293.881	
	90%	$ 11,324,972.883	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,598,702.843	$ 24,150,349.783
		$ 1,258,312.048	$ -	$ -	$ 293,334.892	$ -	$ 1,551,646.940	
	100%	$ 12,583,339.748	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 25,109,742.749	$ 25,109,742.749
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 58,678,521.110
		$ 32,529,897.948	$ -	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 58,678,521.110	
	10%	$ 3,252,972.790	$3,648,298.285	$ -	$ 1,466,687.239	$ -	$ 8,367,958.314	$ 61,178,606.863
		$ 29,276,896.817	$ -	$ -	$ 13,200,249.043	$ 10,333,502.690	$ 52,810,648.549	
	20%	$ 6,506,002.263	$7,296,660.143	$ -	$ 2,933,400.035	$ -	$ 16,736,062.441	$ 63,678,940.678
		$ 26,023,952.369	$ -	$ -	$ 11,733,574.583	$ 9,185,351.285	$ 46,942,878.237	
	30%	$ 9,758,946.711	$ -	$ 9,228,350.069	$ 4,400,074.495	$ -	$ 23,387,371.275	$ 64,462,185.761
		$ 22,770,845.246	$ -	$ -	$ 10,266,826.777	$ 8,037,142.463	$ 41,074,814.486	
	40%	$ 13,002,891.239	$ -	$ 12,295,920.432	$ 5,862,691.108	$ -	$ 31,161,502.778	$ 66,368,533.645
		$ 19,517,893.422	$ -	$ -	$ 8,800,148.990	$ 6,888,988.455	$ 35,207,030.867	
	50%	$ 16,264,948.974	$ -	$ 15,380,619.182	$ 7,333,474.530	$ -	$ 38,979,042.687	$ 68,318,303.242
		$ 16,264,948.974	$ -	$ -	$ 7,333,474.530	$ 5,740,837.051	$ 29,339,260.555	
	60%	$ 19,517,893.422	$ -	$ 18,456,700.137	$ 8,800,148.990	$ -	$ 46,774,742.549	$ 70,229,793.938
		$ 13,002,891.239	$ -	$ -	$ 5,862,691.108	$ 4,589,469.042	$ 23,455,051.388	
	70%	$ 22,770,845.246	$ -	$ 21,532,788.068	$ 10,266,826.777	$ -	$ 54,570,460.090	$ 72,173,975.524
		$ 9,758,946.711	$ -	$ -	$ 4,400,074.495	$ 3,444,494.228	$ 17,603,515.434	
	80%	$ 26,023,952.369	$ -	$ 24,609,022.853	$ 11,733,574.583	$ -	$ 62,366,549.804	$ 74,102,294.926
		$ 6,506,002.263	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 11,735,745.121	
	90%	$ 29,276,896.817	$ -	$ 27,685,103.808	$ 13,200,249.043	$ -	$ 70,162,249.667	$ 76,030,071.104
		$ 3,252,972.790	$ -	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 5,867,821.437	
	100%	$ 32,529,897.948	$ -	$ 30,761,238.364	$ 14,666,949.061	$ -	$ 77,958,085.373	$ 77,958,085.373
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 60,593,710.086
		$ 34,445,086.925	$ -	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 60,593,710.086	
	10%	$ 3,444,490.686	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 9,707,637.618	$ 53,908,452.889
		$ 31,000,566.228	$ -	$ -	$ 13,200,249.043	$ -	$ 44,200,815.271	
	20%	$ 6,889,041.393	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 19,415,444.394	$ 58,705,124.530
		$ 27,556,105.552	$ -	$ -	$ 11,733,574.583	$ -	$ 39,289,680.135	
	30%	$ 10,333,502.069	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 27,406,420.860	$ 61,784,720.261
		$ 24,111,472.625	$ -	$ -	$ 10,266,826.777	$ -	$ 34,378,299.401	
	40%	$ 13,768,432.957	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 36,516,513.538	$ 65,983,666.666
		$ 20,667,004.138	$ -	$ -	$ 8,800,148.990	$ -	$ 29,467,153.128	
	50%	$ 17,222,543.462	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 45,677,474.225	$ 70,233,492.218
		$ 17,222,543.462	$ -	$ -	$ 7,333,474.530	$ -	$ 24,556,017.993	
	60%	$ 20,667,004.138	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 54,812,841.721	$ 74,443,965.785
		$ 13,768,432.957	$ -	$ -	$ 5,862,691.108	$ -	$ 19,631,124.064	
	70%	$ 24,111,472.625	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 63,948,229.932	$ 78,681,806.496
		$ 10,333,502.069	$ -	$ -	$ 4,400,074.495	$ -	$ 14,733,576.564	
	80%	$ 27,556,105.552	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 73,084,054.273	$ 82,906,495.702
		$ 6,889,041.393	$ -	$ -	$ 2,933,400.035	$ -	$ 9,822,441.428	
	90%	$ 31,000,566.228	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 82,219,421.768	$ 87,130,599.693
		$ 3,444,490.686	$ -	$ -	$ 1,466,687.239	$ -	$ 4,911,177.925	
	100%	$ 34,445,086.925	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 91,354,948.451	$ 91,354,948.451
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 56,499,825.932
		$ 41,832,876.871	$ -	$ -	$ 14,666,949.061	$ -	$ 56,499,825.932	
	10%	$ 4,183,265.819	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 10,446,412.751	$ 61,296,236.399
		$ 37,649,574.605	$ -	$ -	$ 13,200,249.043	$ -	$ 50,849,823.648	
	20%	$ 8,366,604.532	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 20,893,007.533	$ 66,092,927.349
		$ 33,466,345.233	$ -	$ -	$ 11,733,574.583	$ -	$ 45,199,919.816	
	30%	$ 12,549,833.904	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 29,622,752.695	$ 69,172,486.136
		$ 29,282,906.665	$ -	$ -	$ 10,266,826.777	$ -	$ 39,549,733.441	
	40%	$ 16,721,489.536	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 39,469,570.117	$ 73,369,386.915
		$ 25,099,667.807	$ -	$ -	$ 8,800,148.990	$ -	$ 33,899,816.797	
	50%	$ 20,916,438.435	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 49,371,369.199	$ 77,621,282.164
		$ 20,916,438.435	$ -	$ -	$ 7,333,474.530	$ -	$ 28,249,912.966	
	60%	$ 25,099,667.807	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 59,245,505.390	$ 81,829,686.034
		$ 16,721,489.536	$ -	$ -	$ 5,862,691.108	$ -	$ 22,584,180.644	
	70%	$ 29,282,906.665	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 69,119,663.972	$ 86,069,572.371
		$ 12,549,833.904	$ -	$ -	$ 4,400,074.495	$ -	$ 16,949,908.399	
	80%	$ 33,466,345.233	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 78,994,293.954	$ 90,294,298.521
		$ 8,366,604.532	$ -	$ -	$ 2,933,400.035	$ -	$ 11,300,004.567	
	90%	$ 37,649,574.605	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 88,868,430.145	$ 94,518,383.203
		$ 4,183,265.819	$ -	$ -	$ 1,466,687.239	$ -	$ 5,649,953.058	
	100%	$ 41,832,876.871	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 98,742,738.397	$ 98,742,738.397
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 193,400,014.416
		$ 80,089,192.544	$ -	$ -	$ 63,556,847.415	$ 49,753,974.457	$193,400,014.416	
	10%	$ 8,008,922.475	$ -	$ 13,329,889.612	$ 6,355,687.297	$ -	$ 27,694,499.384	$ 201,754,582.352

		$ 72,080,302.274	$ -	$ -	$ 57,201,185.676	$ 44,778,595.018	$174,060,082.967	
	20%	$ 16,017,828.847	$ -	$ 26,659,752.423	$ 12,711,361.816	$ -	$ 55,388,943.086	$ 210,108,977.950
		$ 64,071,363.697	$ -	$ -	$ 50,845,485.600	$ 39,803,185.568	$154,720,034.864	
	30%	$ 24,026,783.527	$ -	$ 39,989,695.637	$ 19,067,074.671	$ -	$ 83,083,553.835	$ 218,463,579.480
		$ 56,062,441.222	$ -	$ -	$ 44,489,798.302	$ 34,827,786.121	$135,380,025.645	
	40%	$ 32,035,738.208	$ -	$ 53,319,638.851	$ 25,422,787.525	$ -	$110,778,164.584	$ 226,818,181.010
		$ 48,053,518.747	$ -	$ -	$ 38,134,111.005	$ 29,852,386.675	$116,040,016.427	
	50%	$ 40,044,612.375	$ -	$ 66,649,448.060	$ 31,778,436.486	$ -	$138,472,496.921	$ 235,172,543.014
		$ 40,044,612.375	$ -	$ -	$ 31,778,436.486	$ 24,876,997.232	$ 96,700,046.093	
	60%	$ 48,053,518.747	$ -	$ 79,979,310.871	$ 38,134,111.005	$ -	$166,166,940.623	$ 243,527,094.152
		$ 32,035,738.208	$ -	$ -	$ 25,422,787.525	$ 19,901,627.796	$ 77,360,153.529	
	70%	$ 56,062,441.222	$ -	$ 93,309,200.483	$ 44,489,798.302	$ -	$193,861,440.007	$ 251,881,506.547
		$ 24,026,783.527	$ -	$ -	$ 19,067,074.671	$ 14,926,208.343	$ 58,020,066.541	
	80%	$ 64,071,363.697	$ -	$106,639,090.095	$ 50,845,485.600	$ -	$221,555,939.391	$ 260,235,918.943
		$ 16,017,828.847	$ -	$ -	$ 12,711,361.816	$ 9,950,788.889	$ 38,679,979.552	
	90%	$ 72,080,302.274	$ -	$119,969,006.508	$ 57,201,185.676	$ -	$249,250,494.457	$ 268,590,503.676
		$ 8,008,922.475	$ -	$ -	$ 6,355,687.297	$ 4,975,399.446	$ 19,340,009.219	
	100%	$ 80,089,192.544	$ -	$133,298,842.518	$ 63,556,847.415	$ -	$276,944,882.477	$ 276,944,882.477
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 200,397,308.901
		$ 87,086,487.029	$ -	$ -	$ 63,556,847.415	$ 49,753,974.457	$200,397,308.901	
	10%	$ 8,708,652.205	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 33,369,628.560	$ 168,948,684.079
		$ 78,377,869.843	$ -	$ -	$ 57,201,185.676	$ -	$135,579,055.519	
	20%	$ 17,417,286.900	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 66,739,190.028	$ 187,253,875.757
		$ 69,669,200.129	$ -	$ -	$ 50,845,485.600	$ -	$120,514,685.728	
	30%	$ 26,125,974.124	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$100,108,952.774	$ 205,559,299.000
		$ 60,960,547.924	$ -	$ -	$ 44,489,798.302	$ -	$105,450,346.226	
	40%	$ 34,834,661.348	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$133,478,715.520	$ 223,864,722.244
		$ 52,251,895.719	$ -	$ -	$ 38,134,111.005	$ -	$ 90,386,006.724	
	50%	$ 43,543,261.024	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$166,848,142.802	$ 242,169,840.313
		$ 43,543,261.024	$ -	$ -	$ 31,778,436.486	$ -	$ 75,321,697.510	
	60%	$ 52,251,895.719	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$200,217,704.270	$ 260,475,153.143
		$ 34,834,661.348	$ -	$ -	$ 25,422,787.525	$ -	$ 60,257,448.873	
	70%	$ 60,960,547.924	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$233,587,332.830	$ 278,780,381.625
		$ 26,125,974.124	$ -	$ -	$ 19,067,074.671	$ -	$ 45,193,048.794	
	80%	$ 69,669,200.129	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$266,956,961.391	$ 297,085,610.107
		$ 17,417,286.900	$ -	$ -	$ 12,711,361.816	$ -	$ 30,128,648.716	
	90%	$ 78,377,869.843	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$300,326,657.044	$ 315,390,996.546
		$ 8,708,652.205	$ -	$ -	$ 6,355,687.297	$ -	$ 15,064,339.502	
	100%	$ 87,086,487.029	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$333,696,151.419	$ 333,696,151.419
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 181,605,286.048
		$118,048,438.633	$ -	$ -	$ 63,556,847.415	$ -	$181,605,286.048	
	10%	$ 11,804,848.610	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 36,465,824.966	$ 199,910,648.134
		$106,243,637.492	$ -	$ -	$ 57,201,185.676	$ -	$163,444,823.168	
	20%	$ 23,609,673.486	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 72,931,576.614	$ 218,215,827.361
		$ 94,438,765.147	$ -	$ -	$ 50,845,485.600	$ -	$145,284,250.747	
	30%	$ 35,414,569.565	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$109,397,548.216	$ 236,521,263.055
		$ 82,633,916.537	$ -	$ -	$ 44,489,798.302	$ -	$127,123,714.839	
	40%	$ 47,219,465.645	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$145,863,519.817	$ 254,826,698.749
		$ 70,829,067.927	$ -	$ -	$ 38,134,111.005	$ -	$108,963,178.932	
	50%	$ 59,024,243.051	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$182,329,124.829	$ 273,131,804.367
		$ 59,024,243.051	$ -	$ -	$ 31,778,436.486	$ -	$ 90,802,679.538	
	60%	$ 70,829,067.927	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$218,794,876.477	$ 291,437,129.648
		$ 47,219,465.645	$ -	$ -	$ 25,422,787.525	$ -	$ 72,642,253.170	
	70%	$ 82,633,916.537	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$255,260,701.443	$ 309,742,345.679
		$ 35,414,569.565	$ -	$ -	$ 19,067,074.671	$ -	$ 54,481,644.236	
	80%	$ 94,438,765.147	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$291,726,526.409	$ 328,047,561.711
		$ 23,609,673.486	$ -	$ -	$ 12,711,361.816	$ -	$ 36,321,035.302	
	90%	$106,243,637.492	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$328,192,424.693	$ 346,352,960.601
		$ 11,804,848.610	$ -	$ -	$ 6,355,687.297	$ -	$ 18,160,535.908	
	100%	$118,048,438.633	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$364,658,103.023	$ 364,658,103.023
		$ -	$ -	$ -	$ -	$ -	$ -	
6KEXTLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,830,373.740
		$ 6,600,630.882	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 11,830,373.740	
	10%	$ 660,051.587	$ 729,653.300	$ -	$ 293,334.892	$ -	$ 1,683,039.778	$ 12,330,345.223
		$ 5,940,550.541	$ -	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 10,647,305.444	
	20%	$ 1,320,103.173	$1,459,306.600	$ -	$ 586,669.784	$ -	$ 3,366,079.557	$ 12,830,368.242
		$ 5,280,498.955	$ -	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 9,464,288.685	
	30%	$ 1,980,183.514	$2,188,991.686	$ -	$ 880,017.455	$ -	$ 5,049,192.654	$ 13,330,258.434
		$ 4,620,332.352	$ -	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 8,281,065.780	
	40%	$ 2,640,235.100	$2,918,644.985	$ -	$ 1,173,352.347	$ -	$ 6,732,232.432	$ 13,830,487.598
		$ 3,960,395.782	$ -	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 7,098,255.166	
	50%	$ 3,300,286.687	$3,648,298.285	$ -	$ 1,466,687.239	$ -	$ 8,415,272.211	$ 14,330,407.545
		$ 3,300,286.687	$ -	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 5,915,135.334	
	60%	$ 3,960,395.782	$4,378,015.157	$ -	$ 1,760,047.688	$ -	$ 10,098,458.627	$ 14,830,577.202
		$ 2,640,235.100	$ -	$ -	$ 1,173,352.347	$ 918,531.127	$ 4,732,118.574	
	70%	$ 4,620,332.352	$5,107,541.312	$ -	$ 2,053,331.466	$ -	$ 11,781,205.129	$ 15,330,306.944
		$ 1,980,183.514	$ -	$ -	$ 880,017.455	$ 688,900.846	$ 3,549,101.815	
	80%	$ 5,280,498.955	$5,837,321.757	$ -	$ 2,346,717.472	$ -	$ 13,464,538.184	$ 15,830,571.703
		$ 1,320,103.173	$ -	$ -	$ 586,669.784	$ 459,260.562	$ 2,366,033.519	
	90%	$ 5,940,550.541	$6,566,975.057	$ -	$ 2,640,052.364	$ -	$ 15,147,577.962	$ 16,330,594.722
		$ 660,051.587	$ -	$ -	$ 293,334.892	$ 229,630.281	$ 1,183,016.759	
	100%	$ 6,600,630.882	$7,296,660.143	$ -	$ 2,933,400.035	$ -	$ 16,830,691.060	$ 16,830,691.060
		$ -	$ -	$ -	$ -	$ -	$ -	
6KEXTMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,365,173.397
		$ 7,135,430.539	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 12,365,173.397	
	10%	$ 713,530.620	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 1,966,149.093	$ 11,028,070.292
		$ 6,421,868.835	$ -	$ -	$ 2,640,052.364	$ -	$ 9,061,921.199	
	20%	$ 1,427,061.241	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 3,932,298.186	$ 11,987,353.873
		$ 5,708,338.215	$ -	$ -	$ 2,346,717.472	$ -	$ 8,055,055.687	
	30%	$ 2,140,622.945	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 5,898,532.932	$ 12,946,547.656

		$ 4,994,683.259	$ -	$ -	$ 2,053,331.466	$ -	$ 7,048,014.724	
	40%	$ 2,854,153.565	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 7,864,682.025	$ 13,906,006.687
		$ 4,281,276.974	$ -	$ -	$ 1,760,047.688	$ -	$ 6,041,324.662	
	50%	$ 3,567,684.186	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 9,830,831.118	$ 14,865,202.542
		$ 3,567,684.186	$ -	$ -	$ 1,466,687.239	$ -	$ 5,034,371.425	
	60%	$ 4,281,276.974	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 11,797,151.515	$ 15,824,657.428
		$ 2,854,153.565	$ -	$ -	$ 1,173,352.347	$ -	$ 4,027,505.912	
	70%	$ 4,994,683.259	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 13,762,957.999	$ 16,783,598.399
		$ 2,140,622.945	$ -	$ -	$ 880,017.455	$ -	$ 3,020,640.400	
	80%	$ 5,708,338.215	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 15,729,449.702	$ 17,743,180.726
		$ 1,427,061.241	$ -	$ -	$ 586,669.784	$ -	$ 2,013,731.025	
	90%	$ 6,421,868.835	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 17,695,598.795	$ 18,702,464.307
		$ 713,530.620	$ -	$ -	$ 293,334.892	$ -	$ 1,006,865.512	
	100%	$ 7,135,430.539	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 19,661,833.540	$ 19,661,833.540
		$ -	$ -	$ -	$ -	$ -	$ -	
6KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,281,731.197
		$ 8,348,331.162	$ -	$ -	$ 2,933,400.035	$ -	$ 11,281,731.197	
	10%	$ 834,818.569	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,087,437.042	$ 12,240,965.632
		$ 7,513,476.225	$ -	$ -	$ 2,640,052.364	$ -	$ 10,153,528.590	
	20%	$ 1,669,637.138	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 4,174,874.084	$ 13,200,249.212
		$ 6,678,657.656	$ -	$ -	$ 2,346,717.472	$ -	$ 9,025,375.129	
	30%	$ 2,504,492.075	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 6,262,402.062	$ 14,159,427.144
		$ 5,843,693.617	$ -	$ -	$ 2,053,331.466	$ -	$ 7,897,025.082	
	40%	$ 3,339,310.644	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 8,349,839.104	$ 15,118,907.310
		$ 5,009,020.518	$ -	$ -	$ 1,760,047.688	$ -	$ 6,769,068.206	
	50%	$ 4,174,129.214	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 10,437,276.145	$ 16,078,092.598
		$ 4,174,129.214	$ -	$ -	$ 1,466,687.239	$ -	$ 5,640,816.452	
	60%	$ 5,009,020.518	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 12,524,895.059	$ 17,037,558.051
		$ 3,339,310.644	$ -	$ -	$ 1,173,352.347	$ -	$ 4,512,662.991	
	70%	$ 5,843,693.617	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 14,611,968.357	$ 17,996,477.887
		$ 2,504,492.075	$ -	$ -	$ 880,017.455	$ -	$ 3,384,509.530	
	80%	$ 6,678,657.656	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 16,699,769.143	$ 18,956,076.066
		$ 1,669,637.138	$ -	$ -	$ 586,669.784	$ -	$ 2,256,306.922	
	90%	$ 7,513,476.225	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 18,787,206.185	$ 19,915,359.646
		$ 834,818.569	$ -	$ -	$ 293,334.892	$ -	$ 1,128,153.461	
	100%	$ 8,348,331.162	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 20,874,734.163	$ 20,874,734.163
		$ -	$ -	$ -	$ -	$ -	$ -	
30KEXTLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 46,240,715.073
		$ 20,092,091.912	$ -	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 46,240,715.073	
	10%	$ 2,009,198.688	$3,648,298.285	$ -	$ 1,466,687.239	$ -	$ 7,124,184.212	$ 48,740,811.663
		$ 18,082,875.718	$ -	$ -	$ 13,200,249.043	$ 10,333,502.690	$ 41,616,627.451	
	20%	$ 4,018,432.387	$7,296,660.143	$ -	$ 2,933,400.035	$ -	$ 14,248,492.564	$ 51,241,112.968
		$ 16,073,694.536	$ -	$ -	$ 11,733,574.583	$ 9,185,351.285	$ 36,992,620.404	
	30%	$ 6,027,613.569	$ -	$ 9,228,350.069	$ 4,400,074.495	$ -	$ 19,656,038.133	$ 52,024,420.250
		$ 14,064,412.877	$ -	$ -	$ 10,266,826.777	$ 8,037,142.463	$ 32,368,382.117	
	40%	$ 8,031,235.951	$ -	$ 12,295,920.432	$ 5,862,691.108	$ -	$ 26,189,847.490	$ 53,934,212.074
		$ 12,055,227.138	$ -	$ -	$ 8,800,148.990	$ 6,888,988.455	$ 27,744,364.584	
	50%	$ 10,046,045.956	$ -	$ 15,380,619.182	$ 7,333,474.530	$ -	$ 32,760,139.668	$ 55,880,497.205
		$ 10,046,045.956	$ -	$ -	$ 7,333,474.530	$ 5,740,837.051	$ 23,120,357.537	
	60%	$ 12,055,227.138	$ -	$ 18,456,700.137	$ 8,800,148.990	$ -	$ 39,312,076.266	$ 57,795,472.367
		$ 8,031,235.951	$ -	$ -	$ 5,862,691.108	$ 4,589,469.042	$ 18,483,396.101	
	70%	$ 14,064,412.877	$ -	$ 21,532,788.068	$ 10,266,826.777	$ -	$ 45,864,027.721	$ 59,736,210.013
		$ 6,027,613.569	$ -	$ -	$ 4,400,074.495	$ 3,444,494.228	$ 13,872,182.292	
	80%	$ 16,073,694.536	$ -	$ 24,609,022.853	$ 11,733,574.583	$ -	$ 52,416,291.971	$ 61,664,467.216
		$ 4,018,432.387	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 9,248,175.245	
	90%	$ 18,082,875.718	$ -	$ 27,685,103.808	$ 13,200,249.043	$ -	$ 58,968,228.569	$ 63,592,275.904
		$ 2,009,198.688	$ -	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 4,624,047.335	
	100%	$ 20,092,091.912	$ -	$ 30,761,238.364	$ 14,666,949.061	$ -	$ 65,520,279.337	$ 65,520,279.337
		$ -	$ -	$ -	$ -	$ -	$ -	
30KEXTMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 48,342,095.020
		$ 22,193,471.859	$ -	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 48,342,095.020	
	10%	$ 2,219,335.584	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 8,482,482.516	$ 41,656,848.497
		$ 19,974,116.938	$ -	$ -	$ 13,200,249.043	$ -	$ 33,174,365.981	
	20%	$ 4,438,709.841	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 16,965,112.842	$ 46,453,488.115
		$ 17,754,800.690	$ -	$ -	$ 11,733,574.583	$ -	$ 29,488,375.273	
	30%	$ 6,658,026.089	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 23,730,944.880	$ 49,533,145.114
		$ 15,535,373.458	$ -	$ -	$ 10,266,826.777	$ -	$ 25,802,200.234	
	40%	$ 8,871,202.155	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 31,619,282.736	$ 53,735,483.904
		$ 13,316,052.177	$ -	$ -	$ 8,800,148.990	$ -	$ 22,116,201.168	
	50%	$ 11,096,735.929	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 39,551,666.692	$ 57,981,877.152
		$ 11,096,735.929	$ -	$ -	$ 7,333,474.530	$ -	$ 18,430,210.460	
	60%	$ 13,316,052.177	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 47,461,889.760	$ 62,195,783.023
		$ 8,871,202.155	$ -	$ -	$ 5,862,691.108	$ -	$ 14,733,893.263	
	70%	$ 15,535,373.458	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 55,372,130.765	$ 66,430,231.349
		$ 6,658,026.089	$ -	$ -	$ 4,400,074.495	$ -	$ 11,058,100.584	
	80%	$ 17,754,800.690	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 63,282,749.411	$ 70,654,859.287
		$ 4,438,709.841	$ -	$ -	$ 2,933,400.035	$ -	$ 7,372,109.876	
	90%	$ 19,974,116.938	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 71,192,972.479	$ 74,878,995.301
		$ 2,219,335.584	$ -	$ -	$ 1,466,687.239	$ -	$ 3,686,022.823	
	100%	$ 22,193,471.859	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 79,103,333.385	$ 79,103,333.385
		$ -	$ -	$ -	$ -	$ -	$ -	
30KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 42,680,564.654
		$ 28,013,615.594	$ -	$ -	$ 14,666,949.061	$ -	$ 42,680,564.654	
	10%	$ 2,801,346.915	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 9,064,493.847	$ 47,476,987.162
		$ 25,212,244.271	$ -	$ -	$ 13,200,249.043	$ -	$ 38,412,493.314	
	20%	$ 5,602,742.644	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 18,129,145.645	$ 52,273,641.991
		$ 22,410,921.763	$ -	$ -	$ 11,733,574.583	$ -	$ 34,144,496.346	
	30%	$ 8,404,065.152	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 25,476,983.944	$ 55,353,269.886
		$ 19,609,459.165	$ -	$ -	$ 10,266,826.777	$ -	$ 29,876,285.942	
	40%	$ 11,197,637.243	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 33,945,717.824	$ 59,553,997.119
		$ 16,808,130.305	$ -	$ -	$ 8,800,148.990	$ -	$ 25,608,279.295	
	50%	$ 14,006,807.797	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 42,461,738.560	$ 63,802,020.887

		$ 14,006,807.797	$ -	$ -	$ 7,333,474.530	$ -	$ 21,340,282.327	
	60%	$ 16,808,130.305	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 50,953,967.887	$ 68,014,296.238
		$ 11,197,637.243	$ -	$ -	$ 5,862,691.108	$ -	$ 17,060,328.350	
	70%	$ 19,609,459.165	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 59,446,216.473	$ 72,250,356.120
		$ 8,404,065.152	$ -	$ -	$ 4,400,074.495	$ -	$ 12,804,139.648	
	80%	$ 22,410,921.763	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 67,938,870.484	$ 76,475,013.164
		$ 5,602,742.644	$ -	$ -	$ 2,933,400.035	$ -	$ 8,536,142.679	
	90%	$ 25,212,244.271	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 76,431,099.812	$ 80,699,133.966
		$ 2,801,346.915	$ -	$ -	$ 1,466,687.239	$ -	$ 4,268,034.154	
	100%	$ 28,013,615.594	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 84,923,477.120	$ 84,923,477.120
		$ -	$ -	$ -	$ -	$ -	$ -	
130KEXTLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 166,235,904.979
		$ 52,925,083.107	$ -	$ -	$ 63,556,847.415	$ 49,753,974.457	$166,235,904.979	
	10%	$ 5,292,510.439	$ -	$ 13,329,889.612	$ 6,355,687.297	$ -	$ 24,978,087.348	$ 174,590,461.992
		$ 47,632,593.950	$ -	$ -	$ 57,201,185.676	$ 44,778,595.018	$149,612,374.643	
	20%	$ 10,585,010.237	$ -	$ 26,659,752.423	$ 12,711,361.816	$ -	$ 49,956,124.476	$ 182,944,868.513
		$ 42,340,072.870	$ -	$ -	$ 50,845,485.600	$ 39,803,185.568	$132,988,744.038	
	30%	$ 15,877,541.958	$ -	$ 39,989,695.637	$ 19,067,074.671	$ -	$ 74,934,312.265	$ 191,299,459.120
		$ 37,047,562.431	$ -	$ -	$ 44,489,798.302	$ 34,827,786.121	$116,365,146.855	
	40%	$ 21,170,073.679	$ -	$ 53,319,638.851	$ 25,422,787.525	$ -	$ 99,912,500.055	$ 199,654,049.727
		$ 31,755,051.992	$ -	$ -	$ 38,134,111.005	$ 29,852,386.675	$ 99,741,549.672	
	50%	$ 26,462,552.195	$ -	$ 66,649,448.060	$ 31,778,436.486	$ -	$124,890,436.741	$ 208,008,422.654
		$ 26,462,552.195	$ -	$ -	$ 31,778,436.486	$ 24,876,997.232	$ 83,117,985.913	
	60%	$ 31,755,051.992	$ -	$ 79,979,310.871	$ 38,134,111.005	$ -	$149,868,473.868	$ 216,362,962.868
		$ 21,170,073.679	$ -	$ -	$ 25,422,787.525	$ 19,901,627.796	$ 66,494,489.000	
	70%	$ 37,047,562.431	$ -	$ 93,309,200.483	$ 44,489,798.302	$ -	$174,846,561.216	$ 224,717,386.187
		$ 15,877,541.958	$ -	$ -	$ 19,067,074.671	$ 14,926,208.343	$ 49,870,824.971	
	80%	$ 42,340,072.870	$ -	$106,639,090.095	$ 50,845,485.600	$ -	$199,824,648.565	$ 233,071,809.507
		$ 10,585,010.237	$ -	$ -	$ 12,711,361.816	$ 9,950,788.889	$ 33,247,160.942	
	90%	$ 47,632,593.950	$ -	$119,969,006.508	$ 57,201,185.676	$ -	$224,802,786.133	$ 241,426,383.316
		$ 5,292,510.439	$ -	$ -	$ 6,355,687.297	$ 4,975,399.446	$ 16,623,597.183	
	100%	$ 52,925,083.107	$ -	$133,298,842.518	$ 63,556,847.415	$ -	$249,780,773.040	$ 249,780,773.040
		$ -	$ -	$ -	$ -	$ -	$ -	
130KEXTMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 175,009,081.892
		$ 61,698,260.019	$ -	$ -	$ 63,556,847.415	$ 49,753,974.457	$175,009,081.892	
	10%	$ 6,169,828.483	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 30,830,804.839	$ 143,560,446.860
		$ 55,528,456.346	$ -	$ -	$ 57,201,185.676	$ -	$112,729,642.022	
	20%	$ 12,339,644.561	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 61,661,547.689	$ 161,865,648.747
		$ 49,358,615.458	$ -	$ -	$ 50,845,485.600	$ -	$100,204,101.058	
	30%	$ 18,509,497.854	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 92,492,476.504	$ 180,171,061.782
		$ 43,188,786.975	$ -	$ -	$ 44,489,798.302	$ -	$ 87,678,585.278	
	40%	$ 24,679,351.147	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$123,323,405.319	$ 198,476,474.816
		$ 37,018,958.493	$ -	$ -	$ 38,134,111.005	$ -	$ 75,153,069.498	
	50%	$ 30,849,142.415	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$154,154,024.193	$ 216,781,603.094
		$ 30,849,142.415	$ -	$ -	$ 31,778,436.486	$ -	$ 62,627,578.901	
	60%	$ 37,018,958.493	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$184,984,767.043	$ 235,086,905.715
		$ 24,679,351.147	$ -	$ -	$ 25,422,787.525	$ -	$ 50,102,138.672	
	70%	$ 43,188,786.975	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$215,815,571.882	$ 253,392,144.406
		$ 18,509,497.854	$ -	$ -	$ 19,067,074.671	$ -	$ 37,576,572.524	
	80%	$ 49,358,615.458	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$246,646,376.720	$ 271,697,383.097
		$ 12,339,644.561	$ -	$ -	$ 12,711,361.816	$ -	$ 25,051,006.377	
	90%	$ 55,528,456.346	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$277,477,243.547	$ 290,002,759.327
		$ 6,169,828.483	$ -	$ -	$ 6,355,687.297	$ -	$ 12,525,515.780	
	100%	$ 61,698,260.019	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$308,307,924.409	$ 308,307,924.409
		$ -	$ -	$ -	$ -	$ -	$ -	
130KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 151,383,712.018
		$ 87,826,864.602	$ -	$ -	$ 63,556,847.415	$ -	$151,383,712.018	
	10%	$ 8,782,689.992	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 33,443,666.348	$ 169,689,061.950
		$ 79,044,209.927	$ -	$ -	$ 57,201,185.676	$ -	$136,245,395.603	
	20%	$ 17,565,362.325	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 66,887,265.454	$ 187,994,253.330
		$ 70,261,502.277	$ -	$ -	$ 50,845,485.600	$ -	$121,106,987.876	
	30%	$ 26,348,087.634	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$100,331,066.284	$ 206,299,676.871
		$ 61,478,812.285	$ -	$ -	$ 44,489,798.302	$ -	$105,968,610.587	
	40%	$ 35,130,812.943	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$133,774,867.115	$ 224,605,100.413
		$ 52,696,122.293	$ -	$ -	$ 38,134,111.005	$ -	$ 90,830,233.298	
	50%	$ 43,913,449.960	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$167,218,331.738	$ 242,910,218.184
		$ 43,913,449.960	$ -	$ -	$ 31,778,436.486	$ -	$ 75,691,886.446	
	60%	$ 52,696,122.293	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$200,661,930.844	$ 261,215,531.312
		$ 35,130,812.943	$ -	$ -	$ 25,422,787.525	$ -	$ 60,553,600.468	
	70%	$ 61,478,812.285	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$234,105,597.191	$ 279,520,759.496
		$ 26,348,087.634	$ -	$ -	$ 19,067,074.671	$ -	$ 45,415,162.305	
	80%	$ 70,261,502.277	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$267,549,263.539	$ 297,825,987.680
		$ 17,565,362.325	$ -	$ -	$ 12,711,361.816	$ -	$ 30,276,724.141	
	90%	$ 79,044,209.927	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$300,992,997.128	$ 316,131,374.417
		$ 8,782,689.992	$ -	$ -	$ 6,355,687.297	$ -	$ 15,138,377.289	
	100%	$ 87,826,864.602	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$334,436,528.992	$ 334,436,528.992
		$ -	$ -	$ -	$ -	$ -	$ -	
6KCASLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,831,165.986
		$ 8,601,423.128	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 13,831,165.986	
	10%	$ 860,127.325	$ 729,653.300	$ -	$ 293,334.892	$ -	$ 1,883,115.517	$ 14,331,128.753
		$ 7,741,258.333	$ -	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 12,448,013.236	
	20%	$ 1,720,254.649	$1,459,306.600	$ -	$ 586,669.784	$ -	$ 3,766,231.033	$ 14,831,151.772
		$ 6,881,131.008	$ -	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 11,064,920.738	
	30%	$ 2,580,419.444	$2,188,991.686	$ -	$ 880,017.455	$ -	$ 5,649,428.585	$ 15,331,015.816
		$ 6,020,853.803	$ -	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 9,681,587.231	
	40%	$ 3,440,546.769	$2,918,644.985	$ -	$ 1,173,352.347	$ -	$ 7,532,544.101	$ 15,831,279.844
		$ 5,160,876.359	$ -	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 8,298,735.743	
	50%	$ 4,300,674.094	$3,648,298.285	$ -	$ 1,466,687.239	$ -	$ 9,415,659.618	$ 16,331,182.359
		$ 4,300,674.094	$ -	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 6,915,522.741	
	60%	$ 5,160,876.359	$4,378,015.157	$ -	$ 1,760,047.688	$ -	$ 11,298,939.205	$ 16,831,369.448
		$ 3,440,546.769	$ -	$ -	$ 1,173,352.347	$ 918,531.127	$ 5,532,430.243	
	70%	$ 6,020,853.803	$5,107,541.312	$ -	$ 2,053,331.466	$ -	$ 13,181,726.581	$ 17,331,064.326

		$ 2,580,419.444	$ -	$ -	$ 880,017.455	$ 688,900.846	$ 4,149,337.745	
	80%	$ 6,881,131.008	$5,837,321.757	$ -	$ 2,346,717.472	$ -	$ 15,065,170.238	$ 17,831,355.233
		$ 1,720,254.649	$ -	$ -	$ 586,669.784	$ 459,260.562	$ 2,766,184.995	
	90%	$ 7,741,258.333	$6,566,975.057	$ -	$ 2,640,052.364	$ -	$ 16,948,285.754	$ 18,331,378.252
		$ 860,127.325	$ -	$ -	$ 293,334.892	$ 229,630.281	$ 1,383,092.498	
	100%	$ 8,601,423.128	$7,296,660.143	$ -	$ 2,933,400.035	$ -	$ 18,831,483.306	$ 18,831,483.306
		$ -	$ -	$ -	$ -	$ -	$ -	
6KCASMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,735,038.316
		$ 9,505,295.458	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 14,735,038.316	
	10%	$ 950,512.983	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,203,131.455	$ 13,397,924.887
		$ 8,554,741.067	$ -	$ -	$ 2,640,052.364	$ -	$ 11,194,793.432	
	20%	$ 1,901,025.965	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 4,406,262.911	$ 14,357,208.468
		$ 7,604,228.085	$ -	$ -	$ 2,346,717.472	$ -	$ 9,950,945.557	
	30%	$ 2,851,580.356	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 6,609,490.342	$ 15,316,371.279
		$ 6,653,549.471	$ -	$ -	$ 2,053,331.466	$ -	$ 8,706,880.937	
	40%	$ 3,802,093.339	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 8,812,621.798	$ 16,275,871.605
		$ 5,703,202.119	$ -	$ -	$ 1,760,047.688	$ -	$ 7,463,249.808	
	50%	$ 4,752,606.321	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 11,015,753.253	$ 17,235,046.813
		$ 4,752,606.321	$ -	$ -	$ 1,466,687.239	$ -	$ 6,219,293.560	
	60%	$ 5,703,202.119	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 13,219,076.661	$ 18,194,522.346
		$ 3,802,093.339	$ -	$ -	$ 1,173,352.347	$ -	$ 4,975,445.685	
	70%	$ 6,653,549.471	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 15,421,824.212	$ 19,153,422.023
		$ 2,851,580.356	$ -	$ -	$ 880,017.455	$ -	$ 3,731,597.811	
	80%	$ 7,604,228.085	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 17,625,339.572	$ 20,113,035.321
		$ 1,901,025.965	$ -	$ -	$ 586,669.784	$ -	$ 2,487,695.750	
	90%	$ 8,554,741.067	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 19,828,471.027	$ 21,072,318.902
		$ 950,512.983	$ -	$ -	$ 293,334.892	$ -	$ 1,243,847.875	
	100%	$ 9,505,295.458	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 22,031,698.459	$ 22,031,698.459
		$ -	$ -	$ -	$ -	$ -	$ -	
6KCASHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,269,413.687
		$ 12,336,013.652	$ -	$ -	$ 2,933,400.035	$ -	$ 15,269,413.687	
	10%	$ 1,233,579.870	$ 729,653.300	$ -	$ 293,334.892	$ 229,630.281	$ 2,486,198.342	$ 16,228,630.750
		$ 11,102,380.043	$ -	$ -	$ 2,640,052.364	$ -	$ 13,742,432.407	
	20%	$ 2,467,159.739	$1,459,306.600	$ -	$ 586,669.784	$ 459,260.562	$ 4,972,396.685	$ 17,187,914.330
		$ 9,868,800.174	$ -	$ -	$ 2,346,717.472	$ -	$ 12,215,517.646	
	30%	$ 3,700,793.348	$2,188,991.686	$ -	$ 880,017.455	$ 688,900.846	$ 7,458,703.334	$ 18,147,040.148
		$ 8,635,005.348	$ -	$ -	$ 2,053,331.466	$ -	$ 10,688,336.813	
	40%	$ 4,934,373.217	$2,918,644.985	$ -	$ 1,173,352.347	$ 918,531.127	$ 9,944,901.677	$ 19,106,589.799
		$ 7,401,640.434	$ -	$ -	$ 1,760,047.688	$ -	$ 9,161,688.123	
	50%	$ 6,167,953.087	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 12,431,100.019	$ 20,065,740.344
		$ 6,167,953.087	$ -	$ -	$ 1,466,687.239	$ -	$ 7,634,640.326	
	60%	$ 7,401,640.434	$4,378,015.157	$ -	$ 1,760,047.688	$ 1,377,811.696	$ 14,917,514.976	$ 21,025,240.540
		$ 4,934,373.217	$ -	$ -	$ 1,173,352.347	$ -	$ 6,107,725.564	
	70%	$ 8,635,005.348	$5,107,541.312	$ -	$ 2,053,331.466	$ 1,607,401.963	$ 17,403,280.088	$ 21,984,090.891
		$ 3,700,793.348	$ -	$ -	$ 880,017.455	$ -	$ 4,580,810.802	
	80%	$ 9,868,800.174	$5,837,321.757	$ -	$ 2,346,717.472	$ 1,837,072.258	$ 19,889,911.661	$ 22,943,741.184
		$ 2,467,159.739	$ -	$ -	$ 586,669.784	$ -	$ 3,053,829.523	
	90%	$ 11,102,380.043	$6,566,975.057	$ -	$ 2,640,052.364	$ 2,066,702.539	$ 22,376,110.003	$ 23,903,024.764
		$ 1,233,579.870	$ -	$ -	$ 293,334.892	$ -	$ 1,526,914.762	
	100%	$ 12,336,013.652	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 24,862,416.653	$ 24,862,416.653
		$ -	$ -	$ -	$ -	$ -	$ -	
30KCASLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,188,111.806
		$ 24,039,488.644	$ -	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 50,188,111.806	
	10%	$ 2,403,936.298	$3,648,298.285	$ -	$ 1,466,687.239	$ -	$ 7,518,921.822	$ 52,688,204.956
		$ 21,635,531.402	$ -	$ -	$ 13,200,249.043	$ 10,333,502.690	$ 45,169,283.135	
	20%	$ 4,807,914.485	$7,296,660.143	$ -	$ 2,933,400.035	$ -	$ 15,037,974.662	$ 55,188,516.579
		$ 19,231,616.049	$ -	$ -	$ 11,733,574.583	$ 9,185,351.285	$ 40,150,541.917	
	30%	$ 7,211,829.838	$ -	$ 9,228,350.069	$ 4,400,074.495	$ -	$ 20,840,254.401	$ 55,971,804.121
		$ 16,827,580.480	$ -	$ -	$ 10,266,826.777	$ 8,037,142.463	$ 35,131,549.719	
	40%	$ 9,609,094.279	$ -	$ 12,295,920.432	$ 5,862,691.108	$ -	$ 27,767,705.818	$ 57,880,502.939
		$ 14,423,659.675	$ -	$ -	$ 8,800,148.990	$ 6,888,988.455	$ 30,112,797.121	
	50%	$ 12,019,744.322	$ -	$ 15,380,619.182	$ 7,333,474.530	$ -	$ 34,733,838.035	$ 59,827,893.938
		$ 12,019,744.322	$ -	$ -	$ 7,333,474.530	$ 5,740,837.051	$ 25,094,055.903	
	60%	$ 14,423,659.675	$ -	$ 18,456,700.137	$ 8,800,148.990	$ -	$ 41,680,508.803	$ 61,741,763.232
		$ 9,609,094.279	$ -	$ -	$ 5,862,691.108	$ 4,589,469.042	$ 20,061,254.429	
	70%	$ 16,827,580.480	$ -	$ 21,532,788.068	$ 10,266,826.777	$ -	$ 48,627,195.324	$ 63,683,593.884
		$ 7,211,829.838	$ -	$ -	$ 4,400,074.495	$ 3,444,494.228	$ 15,056,398.560	
	80%	$ 19,231,616.049	$ -	$ 24,609,022.853	$ 11,733,574.583	$ -	$ 55,574,213.484	$ 65,611,870.827
		$ 4,807,914.485	$ -	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 10,037,657.343	
	90%	$ 21,635,531.402	$ -	$ 27,685,103.808	$ 13,200,249.043	$ -	$ 62,520,884.253	$ 67,539,669.197
		$ 2,403,936.298	$ -	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 5,018,784.945	
	100%	$ 24,039,488.644	$ -	$ 30,761,238.364	$ 14,666,949.061	$ -	$ 69,467,676.069	$ 69,467,676.069
		$ -	$ -	$ -	$ -	$ -	$ -	
30KCASMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 53,300,372.597
		$ 27,151,749.435	$ -	$ -	$ 14,666,949.061	$ 11,481,674.101	$ 53,300,372.597	
	10%	$ 2,715,160.750	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 8,978,307.682	$ 46,615,121.754
		$ 24,436,565.029	$ -	$ -	$ 13,200,249.043	$ -	$ 37,636,814.072	
	20%	$ 5,430,368.812	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 17,956,771.813	$ 51,411,774.331
		$ 21,721,427.935	$ -	$ -	$ 11,733,574.583	$ -	$ 33,455,002.518	
	30%	$ 8,145,505.906	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 25,218,424.697	$ 54,491,406.535
		$ 19,006,155.062	$ -	$ -	$ 10,266,826.777	$ -	$ 29,272,981.838	
	40%	$ 10,853,131.030	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 33,601,211.612	$ 58,692,372.413
		$ 16,291,011.811	$ -	$ -	$ 8,800,148.990	$ -	$ 25,091,160.801	
	50%	$ 13,575,874.717	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 42,030,805.480	$ 62,940,154.728
		$ 13,575,874.717	$ -	$ -	$ 7,333,474.530	$ -	$ 20,909,349.248	
	60%	$ 16,291,011.811	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 50,436,849.394	$ 67,152,671.532
		$ 10,853,131.030	$ -	$ -	$ 5,862,691.108	$ -	$ 16,715,822.138	
	70%	$ 19,006,155.062	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 58,842,912.369	$ 71,388,492.770
		$ 8,145,505.906	$ -	$ -	$ 4,400,074.495	$ -	$ 12,545,580.401	
	80%	$ 21,721,427.935	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 67,249,376.656	$ 75,613,145.503
		$ 5,430,368.812	$ -	$ -	$ 2,933,400.035	$ -	$ 8,363,768.847	
	90%	$ 24,436,565.029	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 75,655,420.569	$ 79,837,268.558

		$ 2,715,160.750	$ -	$ -	$ 1,466,687.239	$ -	$ 4,181,847.989	
	100%	$ 27,151,749.435	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 84,061,610.961	$ 84,061,610.961
		$ -	$ -	$ -	$ -	$ -	$ -	
30KCASHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,880,610.533
		$ 36,213,661.473	$ -	$ -	$ 14,666,949.061	$ -	$ 50,880,610.533	
	10%	$ 3,621,347.216	$3,648,298.285	$ -	$ 1,466,687.239	$ 1,148,161.408	$ 9,884,494.148	$ 55,677,025.896
		$ 32,592,282.705	$ -	$ -	$ 13,200,249.043	$ -	$ 45,792,531.748	
	20%	$ 7,242,757.536	$7,296,660.143	$ -	$ 2,933,400.035	$ 2,296,342.823	$ 19,769,160.537	$ 60,473,702.159
		$ 28,970,967.040	$ -	$ -	$ 11,733,574.583	$ -	$ 40,704,541.623	
	30%	$ 10,864,073.201	$ -	$ 9,228,350.069	$ 4,400,074.495	$ 3,444,494.228	$ 27,936,991.992	$ 63,553,289.047
		$ 25,349,470.278	$ -	$ -	$ 10,266,826.777	$ -	$ 35,616,297.055	
	40%	$ 14,475,369.773	$ -	$ 12,295,920.432	$ 5,862,691.108	$ 4,589,469.042	$ 37,223,450.354	$ 67,751,745.746
		$ 21,728,146.401	$ -	$ -	$ 8,800,148.990	$ -	$ 30,528,295.392	
	50%	$ 18,106,830.736	$ -	$ 15,380,619.182	$ 7,333,474.530	$ 5,740,837.051	$ 46,561,761.500	$ 72,002,066.766
		$ 18,106,830.736	$ -	$ -	$ 7,333,474.530	$ -	$ 25,440,305.267	
	60%	$ 21,728,146.401	$ -	$ 18,456,700.137	$ 8,800,148.990	$ 6,888,988.455	$ 55,873,983.984	$ 76,212,044.865
		$ 14,475,369.773	$ -	$ -	$ 5,862,691.108	$ -	$ 20,338,060.881	
	70%	$ 25,349,470.278	$ -	$ 21,532,788.068	$ 10,266,826.777	$ 8,037,142.463	$ 65,186,227.586	$ 80,450,375.282
		$ 10,864,073.201	$ -	$ -	$ 4,400,074.495	$ -	$ 15,264,147.696	
	80%	$ 28,970,967.040	$ -	$ 24,609,022.853	$ 11,733,574.583	$ 9,185,351.285	$ 74,498,915.761	$ 84,675,073.332
		$ 7,242,757.536	$ -	$ -	$ 2,933,400.035	$ -	$ 10,176,157.571	
	90%	$ 32,592,282.705	$ -	$ 27,685,103.808	$ 13,200,249.043	$ 10,333,502.690	$ 83,811,138.245	$ 88,899,172.701
		$ 3,621,347.216	$ -	$ -	$ 1,466,687.239	$ -	$ 5,088,034.455	
	100%	$ 36,213,661.473	$ -	$ 30,761,238.364	$ 14,666,949.061	$ 11,481,674.101	$ 93,123,522.999	$ 93,123,522.999
		$ -	$ -	$ -	$ -	$ -	$ -	
130KCASLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 174,391,014.491
		$ 61,080,192.619	$ -	$ -	$ 63,556,847.415	$ 49,753,974.457	$174,391,014.491	
	10%	$ 6,108,021.718	$ -	$ 13,329,889.612	$ 6,355,687.297	$ -	$ 25,793,598.627	$ 182,745,574.783
		$ 54,972,195.462	$ -	$ -	$ 57,201,185.676	$ 44,778,595.018	$156,951,976.155	
	20%	$ 12,216,031.155	$ -	$ 26,659,752.423	$ 12,711,361.816	$ -	$ 51,587,145.394	$ 191,099,978.025
		$ 48,864,161.464	$ -	$ -	$ 50,845,485.600	$ 39,803,185.568	$139,512,832.631	
	30%	$ 18,324,077.435	$ -	$ 39,989,695.637	$ 19,067,074.671	$ -	$ 77,380,847.742	$ 199,454,571.911
		$ 42,756,139.746	$ -	$ -	$ 44,489,798.302	$ 34,827,786.121	$122,073,724.169	
	40%	$ 24,432,123.714	$ -	$ 53,319,638.851	$ 25,422,787.525	$ -	$103,174,550.090	$ 207,809,165.798
		$ 36,648,118.027	$ -	$ -	$ 38,134,111.005	$ 29,852,386.675	$104,634,615.707	
	50%	$ 30,540,108.590	$ -	$ 66,649,448.060	$ 31,778,436.486	$ -	$128,967,993.136	$ 216,163,535.445
		$ 30,540,108.590	$ -	$ -	$ 31,778,436.486	$ 24,876,997.232	$ 87,195,542.309	
	60%	$ 36,648,118.027	$ -	$ 79,979,310.871	$ 38,134,111.005	$ -	$154,761,539.903	$ 224,518,078.939
		$ 24,432,123.714	$ -	$ -	$ 25,422,787.525	$ 19,901,627.796	$ 69,756,539.036	
	70%	$ 42,756,139.746	$ -	$ 93,309,200.483	$ 44,489,798.302	$ -	$180,555,138.531	$ 232,872,498.979
		$ 18,324,077.435	$ -	$ -	$ 19,067,074.671	$ 14,926,208.343	$ 52,317,360.448	
	80%	$ 48,864,161.464	$ -	$106,639,090.095	$ 50,845,485.600	$ -	$206,348,737.158	$ 241,226,919.018
		$ 12,216,031.155	$ -	$ -	$ 12,711,361.816	$ 9,950,788.889	$ 34,878,181.860	
	90%	$ 54,972,195.462	$ -	$119,969,006.508	$ 57,201,185.676	$ -	$232,142,387.646	$ 249,581,496.107
		$ 6,108,021.718	$ -	$ -	$ 6,355,687.297	$ 4,975,399.446	$ 17,439,108.462	
	100%	$ 61,080,192.619	$ -	$133,298,842.518	$ 63,556,847.415	$ -	$257,935,882.552	$ 257,935,882.552
		$ -	$ -	$ -	$ -	$ -	$ -	
130KCASMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 185,624,897.989
		$ 72,314,076.116	$ -	$ -	$ 63,556,847.415	$ 49,753,974.457	$185,624,897.989	
	10%	$ 7,231,410.520	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 31,892,386.875	$ 154,176,267.226
		$ 65,082,694.676	$ -	$ -	$ 57,201,185.676	$ -	$122,283,880.351	
	20%	$ 14,462,806.500	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 63,784,709.628	$ 172,481,464.844
		$ 57,851,269.617	$ -	$ -	$ 50,845,485.600	$ -	$108,696,755.216	
	30%	$ 21,694,246.098	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$ 95,677,224.748	$ 190,786,882.148
		$ 50,619,859.097	$ -	$ -	$ 44,489,798.302	$ -	$ 95,109,657.399	
	40%	$ 28,925,685.696	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$127,569,739.868	$ 209,092,299.451
		$ 43,388,448.578	$ -	$ -	$ 38,134,111.005	$ -	$ 81,522,559.583	
	50%	$ 36,157,052.598	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$159,461,934.376	$ 227,397,423.460
		$ 36,157,052.598	$ -	$ -	$ 31,778,436.486	$ -	$ 67,935,489.084	
	60%	$ 43,388,448.578	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$191,354,257.128	$ 245,702,730.350
		$ 28,925,685.696	$ -	$ -	$ 25,422,787.525	$ -	$ 54,348,473.222	
	70%	$ 50,619,859.097	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$223,246,644.004	$ 264,007,964.772
		$ 21,694,246.098	$ -	$ -	$ 19,067,074.671	$ -	$ 40,761,320.769	
	80%	$ 57,851,269.617	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$255,139,030.879	$ 282,313,199.194
		$ 14,462,806.500	$ -	$ -	$ 12,711,361.816	$ -	$ 27,174,168.315	
	90%	$ 65,082,694.676	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$287,031,481.876	$ 300,618,579.693
		$ 7,231,410.520	$ -	$ -	$ 6,355,687.297	$ -	$ 13,587,097.817	
	100%	$ 72,314,076.116	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$318,923,740.506	$ 318,923,740.506
		$ -	$ -	$ -	$ -	$ -	$ -	
130KCASHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 170,433,038.696
		$106,876,191.281	$ -	$ -	$ 63,556,847.415	$ -	$170,433,038.696	
	10%	$ 10,687,623.426	$ -	$ 13,329,889.612	$ 6,355,687.297	$ 4,975,399.446	$ 35,348,599.781	$ 188,738,396.289
		$ 96,188,610.832	$ -	$ -	$ 57,201,185.676	$ -	$153,389,796.507	
	20%	$ 21,375,225.363	$ -	$ 26,659,752.423	$ 12,711,361.816	$ 9,950,788.889	$ 70,697,128.491	$ 207,043,580.008
		$ 85,500,965.918	$ -	$ -	$ 50,845,485.600	$ -	$136,346,451.517	
	30%	$ 32,062,891.766	$ -	$ 39,989,695.637	$ 19,067,074.671	$ 14,926,208.343	$106,045,870.416	$ 225,349,011.210
		$ 74,813,342.492	$ -	$ -	$ 44,489,798.302	$ -	$119,303,140.794	
	40%	$ 42,750,558.168	$ -	$ 53,319,638.851	$ 25,422,787.525	$ 19,901,627.796	$141,394,612.340	$ 243,654,442.412
		$ 64,125,719.066	$ -	$ -	$ 38,134,111.005	$ -	$102,259,830.071	
	50%	$ 53,438,117.129	$ -	$ 66,649,448.060	$ 31,778,436.486	$ 24,876,997.232	$176,742,998.907	$ 261,959,552.522
		$ 53,438,117.129	$ -	$ -	$ 31,778,436.486	$ -	$ 85,216,553.615	
	60%	$ 64,125,719.066	$ -	$ 79,979,310.871	$ 38,134,111.005	$ 29,852,386.675	$212,091,527.617	$ 280,264,873.310
		$ 42,750,558.168	$ -	$ -	$ 25,422,787.525	$ -	$ 68,173,345.694	
	70%	$ 74,813,342.492	$ -	$ 93,309,200.483	$ 44,489,798.302	$ 34,827,786.121	$247,440,127.398	$ 298,570,093.835
		$ 32,062,891.766	$ -	$ -	$ 19,067,074.671	$ -	$ 51,129,966.436	
	80%	$ 85,500,965.918	$ -	$106,639,090.095	$ 50,845,485.600	$ 39,803,185.568	$282,788,727.180	$ 316,875,314.359
		$ 21,375,225.363	$ -	$ -	$ 12,711,361.816	$ -	$ 34,086,587.179	
	90%	$ 96,188,610.832	$ -	$119,969,006.508	$ 57,201,185.676	$ 44,778,595.018	$318,137,398.033	$ 335,180,708.756
		$ 10,687,623.426	$ -	$ -	$ 6,355,687.297	$ -	$ 17,043,310.723	
	100%	$106,876,191.281	$ -	$133,298,842.518	$ 63,556,847.415	$ 49,753,974.457	$353,485,855.671	$ 353,485,855.671
		$ -	$ -	$ -	$ -	$ -	$ -	

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost		Total Cost	
			CL	UV		
6KA2OLOW	0%	$ -	$ -	$ -	$ -	$ 13,273,541.256
		$ 10,340,141.221	$ 2,933,400.035	$ -	$ 13,273,541.256	
	10%	$ 1,033,996.104	$ 293,334.892	$ 229,630.281	$ 1,556,961.277	$ 13,503,113.714
		$ 9,306,100.072	$ 2,640,052.364	$ -	$ 11,946,152.437	
	20%	$ 2,067,992.209	$ 586,669.784	$ 459,260.562	$ 3,113,922.555	$ 13,732,743.995
		$ 8,272,103.968	$ 2,346,717.472	$ -	$ 10,618,821.440	
	30%	$ 3,102,033.357	$ 880,017.455	$ 688,900.846	$ 4,670,951.658	$ 13,962,210.810
		$ 7,237,927.686	$ 2,053,331.466	$ -	$ 9,291,259.151	
	40%	$ 4,136,029.462	$ 1,173,352.347	$ 918,531.127	$ 6,227,912.936	$ 14,192,072.383
		$ 6,204,111.759	$ 1,760,047.688	$ -	$ 7,964,159.448	
	50%	$ 5,170,025.566	$ 1,466,687.239	$ 1,148,161.408	$ 7,784,874.213	$ 14,421,587.018
		$ 5,170,025.566	$ 1,466,687.239	$ -	$ 6,636,712.805	
	60%	$ 6,204,111.759	$ 1,760,047.688	$ 1,377,811.696	$ 9,341,971.144	$ 14,651,352.952
		$ 4,136,029.462	$ 1,173,352.347	$ -	$ 5,309,381.809	
	70%	$ 7,237,927.686	$ 2,053,331.466	$ 1,607,401.963	$ 10,898,661.114	$ 14,880,711.926
		$ 3,102,033.357	$ 880,017.455	$ -	$ 3,982,050.812	
	80%	$ 8,272,103.968	$ 2,346,717.472	$ 1,837,072.258	$ 12,455,893.698	$ 15,110,555.691
		$ 2,067,992.209	$ 586,669.784	$ -	$ 2,654,661.993	
	90%	$ 9,306,100.072	$ 2,640,052.364	$ 2,066,702.539	$ 14,012,854.975	$ 15,340,185.972
		$ 1,033,996.104	$ 293,334.892	$ -	$ 1,327,330.996	
	100%	$ 10,340,141.221	$ 2,933,400.035	$ 2,296,342.823	$ 15,569,884.079	$ 15,569,884.079
		$ -	$ -	$ -	$ -	
6KA2OMED	0%	$ -	$ -	$ -	$ -	$ 13,699,726.128
		$ 10,766,326.093	$ 2,933,400.035	$ -	$ 13,699,726.128	
	10%	$ 1,076,613.849	$ 293,334.892	$ 229,630.281	$ 1,599,579.022	$ 13,929,296.729
		$ 9,689,665.343	$ 2,640,052.364	$ -	$ 12,329,717.707	
	20%	$ 2,153,227.698	$ 586,669.784	$ 459,260.562	$ 3,199,158.044	$ 14,158,927.010
		$ 8,613,051.494	$ 2,346,717.472	$ -	$ 10,959,768.966	
	30%	$ 3,229,888.448	$ 880,017.455	$ 688,900.846	$ 4,798,806.749	$ 14,388,388.255
		$ 7,536,250.041	$ 2,053,331.466	$ -	$ 9,589,581.506	
	40%	$ 4,306,502.296	$ 1,173,352.347	$ 918,531.127	$ 6,398,385.770	$ 14,618,257.255
		$ 6,459,823.796	$ 1,760,047.688	$ -	$ 8,219,871.485	
	50%	$ 5,383,116.145	$ 1,466,687.239	$ 1,148,161.408	$ 7,997,964.792	$ 14,847,768.176
		$ 5,383,116.145	$ 1,466,687.239	$ -	$ 6,849,803.384	
	60%	$ 6,459,823.796	$ 1,760,047.688	$ 1,377,811.696	$ 9,597,683.180	$ 15,077,537.824
		$ 4,306,502.296	$ 1,173,352.347	$ -	$ 5,479,854.643	
	70%	$ 7,536,250.041	$ 2,053,331.466	$ 1,607,401.963	$ 11,196,983.469	$ 15,306,889.372
		$ 3,229,888.448	$ 880,017.455	$ -	$ 4,109,905.902	
	80%	$ 8,613,051.494	$ 2,346,717.472	$ 1,837,072.258	$ 12,796,841.224	$ 15,536,738.706
		$ 2,153,227.698	$ 586,669.784	$ -	$ 2,739,897.482	
	90%	$ 9,689,665.343	$ 2,640,052.364	$ 2,066,702.539	$ 14,396,420.246	$ 15,766,368.987
		$ 1,076,613.849	$ 293,334.892	$ -	$ 1,369,948.741	
	100%	$ 10,766,326.093	$ 2,933,400.035	$ 2,296,342.823	$ 15,996,068.951	$ 15,996,068.951
		$ -	$ -	$ -	$ -	
6KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ 15,516,739.783
		$ 12,583,339.748	$ 2,933,400.035	$ -	$ 15,516,739.783	
	10%	$ 1,258,312.048	$ 293,334.892	$ 229,630.281	$ 1,781,277.221	$ 15,746,302.469
		$ 11,324,972.883	$ 2,640,052.364	$ -	$ 13,965,025.248	
	20%	$ 2,516,624.096	$ 586,669.784	$ 459,260.562	$ 3,562,554.442	$ 15,975,932.750
		$ 10,066,660.835	$ 2,346,717.472	$ -	$ 12,413,378.308	
	30%	$ 3,774,990.961	$ 880,017.455	$ 688,900.846	$ 5,343,909.262	$ 16,205,370.249
		$ 8,808,129.521	$ 2,053,331.466	$ -	$ 10,861,460.987	
	40%	$ 5,033,303.009	$ 1,173,352.347	$ 918,531.127	$ 7,125,186.483	$ 16,435,270.910
		$ 7,550,036.739	$ 1,760,047.688	$ -	$ 9,310,084.427	
	50%	$ 6,291,615.058	$ 1,466,687.239	$ 1,148,161.408	$ 8,906,463.704	$ 16,664,766.001
		$ 6,291,615.058	$ 1,466,687.239	$ -	$ 7,758,302.296	
	60%	$ 7,550,036.739	$ 1,760,047.688	$ 1,377,811.696	$ 10,687,896.123	$ 16,894,551.479
		$ 5,033,303.009	$ 1,173,352.347	$ -	$ 6,206,655.356	
	70%	$ 8,808,129.521	$ 2,053,331.466	$ 1,607,401.963	$ 12,468,862.949	$ 17,123,871.365
		$ 3,774,990.961	$ 880,017.455	$ -	$ 4,655,008.416	
	80%	$ 10,066,660.835	$ 2,346,717.472	$ 1,837,072.258	$ 14,250,450.565	$ 17,353,744.446
		$ 2,516,624.096	$ 586,669.784	$ -	$ 3,103,293.881	
	90%	$ 11,324,972.883	$ 2,640,052.364	$ 2,066,702.539	$ 16,031,727.786	$ 17,583,374.727
		$ 1,258,312.048	$ 293,334.892	$ -	$ 1,551,646.940	
	100%	$ 12,583,339.748	$ 2,933,400.035	$ 2,296,342.823	$ 17,813,082.606	$ 17,813,082.606
		$ -	$ -	$ -	$ -	
A2O LO	0%	$ -	$ -	$ -	$ -	$ 47,196,847.009
		$ 32,529,897.948	$ 14,666,949.061	$ -	$ 47,196,847.009	

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost CL	Total Disinfection Cost UV	Total Cost	
	10%	$ 3,252,972.790	$ 1,466,687.239	$ 1,148,161.408	$ 5,867,821.437	$ 48,344,967.296
		$ 29,276,896.817	$ 13,200,249.043	$ -	$ 42,477,145.860	
	20%	$ 6,506,002.263	$ 2,933,400.035	$ 2,296,342.823	$ 11,735,745.121	$ 49,493,272.073
		$ 26,023,952.369	$ 11,733,574.583	$ -	$ 37,757,526.952	
	30%	$ 9,758,946.711	$ 4,400,074.495	$ 3,444,494.228	$ 17,603,515.434	$ 50,641,187.456
		$ 22,770,845.246	$ 10,266,826.777	$ -	$ 33,037,672.023	
	40%	$ 13,002,891.239	$ 5,862,691.108	$ 4,589,469.042	$ 23,455,051.388	$ 51,773,093.801
		$ 19,517,893.422	$ 8,800,148.990	$ -	$ 28,318,042.412	
	50%	$ 16,264,948.974	$ 7,333,474.530	$ 5,740,837.051	$ 29,339,260.555	$ 52,937,684.059
		$ 16,264,948.974	$ 7,333,474.530	$ -	$ 23,598,423.504	
	60%	$ 19,517,893.422	$ 8,800,148.990	$ 6,888,988.455	$ 35,207,030.867	$ 54,072,613.214
		$ 13,002,891.239	$ 5,862,691.108	$ -	$ 18,865,582.346	
	70%	$ 22,770,845.246	$ 10,266,826.777	$ 8,037,142.463	$ 41,074,814.486	$ 55,233,835.692
		$ 9,758,946.711	$ 4,400,074.495	$ -	$ 14,159,021.206	
	80%	$ 26,023,952.369	$ 11,733,574.583	$ 9,185,351.285	$ 46,942,878.237	$ 56,382,280.535
		$ 6,506,002.263	$ 2,933,400.035	$ -	$ 9,439,402.298	
	90%	$ 29,276,896.817	$ 13,200,249.043	$ 10,333,502.690	$ 52,810,648.549	$ 57,530,308.578
		$ 3,252,972.790	$ 1,466,687.239	$ -	$ 4,719,660.029	
	100%	$ 32,529,897.948	$ 14,666,949.061	$ 11,481,674.101	$ 58,678,521.110	$ 58,678,521.110
		$ -	$ -	$ -	$ -	
30KA2OMED	0%	$ -	$ -	$ -	$ -	$ 49,112,035.985
		$ 34,445,086.925	$ 14,666,949.061	$ -	$ 49,112,035.985	
	10%	$ 3,444,490.686	$ 1,466,687.239	$ 1,148,161.408	$ 6,059,339.333	$ 50,260,154.604
		$ 31,000,566.228	$ 13,200,249.043	$ -	$ 44,200,815.271	
	20%	$ 6,889,041.393	$ 2,933,400.035	$ 2,296,342.823	$ 12,118,784.251	$ 51,408,464.387
		$ 27,556,105.552	$ 11,733,574.583	$ -	$ 39,289,680.135	
	30%	$ 10,333,502.069	$ 4,400,074.495	$ 3,444,494.228	$ 18,178,070.792	$ 52,556,370.193
		$ 24,111,472.625	$ 10,266,826.777	$ -	$ 34,378,299.401	
	40%	$ 13,768,432.957	$ 5,862,691.108	$ 4,589,469.042	$ 24,220,593.106	$ 53,687,746.235
		$ 20,667,004.138	$ 8,800,148.990	$ -	$ 29,467,153.128	
	50%	$ 17,222,543.462	$ 7,333,474.530	$ 5,740,837.051	$ 30,296,855.043	$ 54,852,873.036
		$ 17,222,543.462	$ 7,333,474.530	$ -	$ 24,556,017.993	
	60%	$ 20,667,004.138	$ 8,800,148.990	$ 6,888,988.455	$ 36,356,141.583	$ 55,987,265.648
		$ 13,768,432.957	$ 5,862,691.108	$ -	$ 19,631,124.064	
	70%	$ 24,111,472.625	$ 10,266,826.777	$ 8,037,142.463	$ 42,415,441.864	$ 57,149,018.428
		$ 10,333,502.069	$ 4,400,074.495	$ -	$ 14,733,576.564	
	80%	$ 27,556,105.552	$ 11,733,574.583	$ 9,185,351.285	$ 48,475,031.420	$ 58,297,472.849
		$ 6,889,041.393	$ 2,933,400.035	$ -	$ 9,822,441.428	
	90%	$ 31,000,566.228	$ 13,200,249.043	$ 10,333,502.690	$ 54,534,317.961	$ 59,445,495.886
		$ 3,444,490.686	$ 1,466,687.239	$ -	$ 4,911,177.925	
	100%	$ 34,445,086.925	$ 14,666,949.061	$ 11,481,674.101	$ 60,593,710.086	$ 60,593,710.086
		$ -	$ -	$ -	$ -	
30KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ 56,499,825.932
		$ 41,832,876.871	$ 14,666,949.061	$ -	$ 56,499,825.932	
	10%	$ 4,183,265.819	$ 1,466,687.239	$ 1,148,161.408	$ 6,798,114.466	$ 57,647,938.114
		$ 37,649,574.605	$ 13,200,249.043	$ -	$ 50,849,823.648	
	20%	$ 8,366,604.532	$ 2,933,400.035	$ 2,296,342.823	$ 13,596,347.390	$ 58,796,267.206
		$ 33,466,345.233	$ 11,733,574.583	$ -	$ 45,199,919.816	
	30%	$ 12,549,833.904	$ 4,400,074.495	$ 3,444,494.228	$ 20,394,402.626	$ 59,944,136.068
		$ 29,282,906.665	$ 10,266,826.777	$ -	$ 39,549,733.441	
	40%	$ 16,721,489.536	$ 5,862,691.108	$ 4,589,469.042	$ 27,173,649.686	$ 61,073,466.483
		$ 25,099,667.807	$ 8,800,148.990	$ -	$ 33,899,816.797	
	50%	$ 20,916,438.435	$ 7,333,474.530	$ 5,740,837.051	$ 33,990,750.016	$ 62,240,662.982
		$ 20,916,438.435	$ 7,333,474.530	$ -	$ 28,249,912.966	
	60%	$ 25,099,667.807	$ 8,800,148.990	$ 6,888,988.455	$ 40,788,805.253	$ 63,372,985.896
		$ 16,721,489.536	$ 5,862,691.108	$ -	$ 22,584,180.644	
	70%	$ 29,282,906.665	$ 10,266,826.777	$ 8,037,142.463	$ 47,586,875.905	$ 64,536,784.303
		$ 12,549,833.904	$ 4,400,074.495	$ -	$ 16,949,908.399	
	80%	$ 33,466,345.233	$ 11,733,574.583	$ 9,185,351.285	$ 54,385,271.101	$ 65,685,275.668
		$ 8,366,604.532	$ 2,933,400.035	$ -	$ 11,300,004.567	
	90%	$ 37,649,574.605	$ 13,200,249.043	$ 10,333,502.690	$ 61,183,326.338	$ 66,833,279.395
		$ 4,183,265.819	$ 1,466,687.239	$ -	$ 5,649,953.058	
	100%	$ 41,832,876.871	$ 14,666,949.061	$ 11,481,674.101	$ 67,981,500.033	$ 67,981,500.033
		$ -	$ -	$ -	$ -	
130KA2OLOW	0%	$ -	$ -	$ -	$ -	$ 143,646,039.959
		$ 80,089,192.544	$ 63,556,847.415	$ -	$ 143,646,039.959	
	10%	$ 8,008,922.475	$ 6,355,687.297	$ 4,975,399.446	$ 19,340,009.219	$ 148,621,497.168
		$ 72,080,302.274	$ 57,201,185.676	$ -	$ 129,281,487.950	
	20%	$ 16,017,828.847	$ 12,711,361.816	$ 9,950,788.889	$ 38,679,979.552	$ 153,596,828.849
		$ 64,071,363.697	$ 50,845,485.600	$ -	$ 114,916,849.296	
	30%	$ 24,026,783.527	$ 19,067,074.671	$ 14,926,208.343	$ 58,020,066.541	$ 158,572,306.065

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost CL	UV	Total Cost	
		$ 56,062,441.222	$ 44,489,798.302	$ -	$ 100,552,239.524	
	40%	$ 32,035,738.208	$ 25,422,787.525	$ 19,901,627.796	$ 77,360,153.529	$ 163,547,783.281
		$ 48,053,518.747	$ 38,134,111.005	$ -	$ 86,187,629.752	
	50%	$ 40,044,612.375	$ 31,778,436.486	$ 24,876,997.232	$ 96,700,046.093	$ 168,523,094.954
		$ 40,044,612.375	$ 31,778,436.486	$ -	$ 71,823,048.861	
	60%	$ 48,053,518.747	$ 38,134,111.005	$ 29,852,386.675	$ 116,040,016.427	$ 173,498,542.160
		$ 32,035,738.208	$ 25,422,787.525	$ -	$ 57,458,525.733	
	70%	$ 56,062,441.222	$ 44,489,798.302	$ 34,827,786.121	$ 135,380,025.645	$ 178,473,883.843
		$ 24,026,783.527	$ 19,067,074.671	$ -	$ 43,093,858.198	
	80%	$ 64,071,363.697	$ 50,845,485.600	$ 39,803,185.568	$ 154,720,034.864	$ 183,449,225.527
		$ 16,017,828.847	$ 12,711,361.816	$ -	$ 28,729,190.663	
	90%	$ 72,080,302.274	$ 57,201,185.676	$ 44,778,595.018	$ 174,060,082.967	$ 188,424,692.740
		$ 8,008,922.475	$ 6,355,687.297	$ -	$ 14,364,609.772	
	100%	$ 80,089,192.544	$ 63,556,847.415	$ 49,753,974.457	$ 193,400,014.416	$ 193,400,014.416
		$ -	$ -	$ -	$ -	
130KA2OMED	0%	$ -	$ -	$ -	$ -	$ 150,643,334.444
		$ 87,086,487.029	$ 63,556,847.415	$ -	$ 150,643,334.444	
	10%	$ 8,708,652.205	$ 6,355,687.297	$ 4,975,399.446	$ 20,039,738.948	$ 155,618,794.467
		$ 78,377,869.843	$ 57,201,185.676	$ -	$ 135,579,055.519	
	20%	$ 17,417,286.900	$ 12,711,361.816	$ 9,950,788.889	$ 40,079,437.605	$ 160,594,123.334
		$ 69,669,200.129	$ 50,845,485.600	$ -	$ 120,514,685.728	
	30%	$ 26,125,974.124	$ 19,067,074.671	$ 14,926,208.343	$ 60,119,257.137	$ 165,569,603.363
		$ 60,960,547.924	$ 44,489,798.302	$ -	$ 105,450,346.226	
	40%	$ 34,834,661.348	$ 25,422,787.525	$ 19,901,627.796	$ 80,159,076.669	$ 170,545,083.393
		$ 52,251,895.719	$ 38,134,111.005	$ -	$ 90,386,006.724	
	50%	$ 43,543,261.024	$ 31,778,436.486	$ 24,876,997.232	$ 100,198,694.742	$ 175,520,392.253
		$ 43,543,261.024	$ 31,778,436.486	$ -	$ 75,321,697.510	
	60%	$ 52,251,895.719	$ 38,134,111.005	$ 29,852,386.675	$ 120,238,393.399	$ 180,495,842.272
		$ 34,834,661.348	$ 25,422,787.525	$ -	$ 60,257,448.873	
	70%	$ 60,960,547.924	$ 44,489,798.302	$ 34,827,786.121	$ 140,278,132.348	$ 185,471,181.142
		$ 26,125,974.124	$ 19,067,074.671	$ -	$ 45,193,048.794	
	80%	$ 69,669,200.129	$ 50,845,485.600	$ 39,803,185.568	$ 160,317,871.296	$ 190,446,520.012
		$ 17,417,286.900	$ 12,711,361.816	$ -	$ 30,128,648.716	
	90%	$ 78,377,869.843	$ 57,201,185.676	$ 44,778,595.018	$ 180,357,650.536	$ 195,421,990.038
		$ 8,708,652.205	$ 6,355,687.297	$ -	$ 15,064,339.502	
	100%	$ 87,086,487.029	$ 63,556,847.415	$ 49,753,974.457	$ 200,397,308.901	$ 200,397,308.901
		$ -	$ -	$ -	$ -	
130KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ 181,605,286.048
		$118,048,438.633	$ 63,556,847.415	$ -	$ 181,605,286.048	
	10%	$ 11,804,848.610	$ 6,355,687.297	$ 4,975,399.446	$ 23,135,935.354	$ 186,580,758.522
		$106,243,637.492	$ 57,201,185.676	$ -	$ 163,444,823.168	
	20%	$ 23,609,673.486	$ 12,711,361.816	$ 9,950,788.889	$ 46,271,824.191	$ 191,556,074.938
		$ 94,438,765.147	$ 50,845,485.600	$ -	$ 145,284,250.747	
	30%	$ 35,414,569.565	$ 19,067,074.671	$ 14,926,208.343	$ 69,407,852.579	$ 196,531,567.418
		$ 82,633,916.537	$ 44,489,798.302	$ -	$ 127,123,714.839	
	40%	$ 47,219,465.645	$ 25,422,787.525	$ 19,901,627.796	$ 92,543,880.966	$ 201,507,059.898
		$ 70,829,067.927	$ 38,134,111.005	$ -	$ 108,963,178.932	
	50%	$ 59,024,243.051	$ 31,778,436.486	$ 24,876,997.232	$ 115,679,676.770	$ 206,482,356.307
		$ 59,024,243.051	$ 31,778,436.486	$ -	$ 90,802,679.538	
	60%	$ 70,829,067.927	$ 38,134,111.005	$ 29,852,386.675	$ 138,815,565.607	$ 211,457,818.777
		$ 47,219,465.645	$ 25,422,787.525	$ -	$ 72,642,253.170	
	70%	$ 82,633,916.537	$ 44,489,798.302	$ 34,827,786.121	$ 161,951,500.961	$ 216,433,145.197
		$ 35,414,569.565	$ 19,067,074.671	$ -	$ 54,481,644.236	
	80%	$ 94,438,765.147	$ 50,845,485.600	$ 39,803,185.568	$ 185,087,436.315	$ 221,408,471.616
		$ 23,609,673.486	$ 12,711,361.816	$ -	$ 36,321,035.302	
	90%	$106,243,637.492	$ 57,201,185.676	$ 44,778,595.018	$ 208,223,418.185	$ 226,383,954.093
		$ 11,804,848.610	$ 6,355,687.297	$ -	$ 18,160,535.908	
	100%	$118,048,438.633	$ 63,556,847.415	$ 49,753,974.457	$ 231,359,260.505	$ 231,359,260.505
		$ -	$ -	$ -	$ -	
6KEXTLOW	0%	$ -	$ -	$ -	$ -	$ 9,534,030.917
		$ 6,600,630.882	$ 2,933,400.035	$ -	$ 9,534,030.917	
	10%	$ 660,051.587	$ 293,334.892	$ 229,630.281	$ 1,183,016.759	$ 9,763,619.665
		$ 5,940,550.541	$ 2,640,052.364	$ -	$ 8,580,602.906	
	20%	$ 1,320,103.173	$ 586,669.784	$ 459,260.562	$ 2,366,033.519	$ 9,993,249.946
		$ 5,280,498.955	$ 2,346,717.472	$ -	$ 7,627,216.427	
	30%	$ 1,980,183.514	$ 880,017.455	$ 688,900.846	$ 3,549,101.815	$ 10,222,765.632
		$ 4,620,332.352	$ 2,053,331.466	$ -	$ 6,673,663.817	
	40%	$ 2,640,235.100	$ 1,173,352.347	$ 918,531.127	$ 4,732,118.574	$ 10,452,562.044
		$ 3,960,395.782	$ 1,760,047.688	$ -	$ 5,720,443.470	
	50%	$ 3,300,286.687	$ 1,466,687.239	$ 1,148,161.408	$ 5,915,135.334	$ 10,682,109.259
		$ 3,300,286.687	$ 1,466,687.239	$ -	$ 4,766,973.926	

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost		Total Cost	
			CL	UV		
	60%	$ 3,960,395.782	$ 1,760,047.688	$ 1,377,811.696	$ 7,098,255.166	$ 10,911,842.613
		$ 2,640,235.100	$ 1,173,352.347	$ -	$ 3,813,587.447	
	70%	$ 4,620,332.352	$ 2,053,331.466	$ 1,607,401.963	$ 8,281,065.780	$ 11,141,266.749
		$ 1,980,183.514	$ 880,017.455	$ -	$ 2,860,200.969	
	80%	$ 5,280,498.955	$ 2,346,717.472	$ 1,837,072.258	$ 9,464,288.685	$ 11,371,061.642
		$ 1,320,103.173	$ 586,669.784	$ -	$ 1,906,772.957	
	90%	$ 5,940,550.541	$ 2,640,052.364	$ 2,066,702.539	$ 10,647,305.444	$ 11,600,691.923
		$ 660,051.587	$ 293,334.892	$ -	$ 953,386.479	
	100%	$ 6,600,630.882	$ 2,933,400.035	$ 2,296,342.823	$ 11,830,373.740	$ 11,830,373.740
		$ -	$ -	$ -	$ -	
6KEXTMED	0%	$ -	$ -	$ -	$ -	$ 10,068,830.574
		$ 7,135,430.539	$ 2,933,400.035	$ -	$ 10,068,830.574	
	10%	$ 713,530.620	$ 293,334.892	$ 229,630.281	$ 1,236,495.793	$ 10,298,416.993
		$ 6,421,868.835	$ 2,640,052.364	$ -	$ 9,061,921.199	
	20%	$ 1,427,061.241	$ 586,669.784	$ 459,260.562	$ 2,472,991.587	$ 10,528,047.274
		$ 5,708,338.215	$ 2,346,717.472	$ -	$ 8,055,055.687	
	30%	$ 2,140,622.945	$ 880,017.455	$ 688,900.846	$ 3,709,541.246	$ 10,757,555.970
		$ 4,994,683.259	$ 2,053,331.466	$ -	$ 7,048,014.724	
	40%	$ 2,854,153.565	$ 1,173,352.347	$ 918,531.127	$ 4,946,037.039	$ 10,987,361.701
		$ 4,281,276.974	$ 1,760,047.688	$ -	$ 6,041,324.662	
	50%	$ 3,567,684.186	$ 1,466,687.239	$ 1,148,161.408	$ 6,182,532.833	$ 11,216,904.257
		$ 3,567,684.186	$ 1,466,687.239	$ -	$ 5,034,371.425	
	60%	$ 4,281,276.974	$ 1,760,047.688	$ 1,377,811.696	$ 7,419,136.358	$ 11,446,642.270
		$ 2,854,153.565	$ 1,173,352.347	$ -	$ 4,027,505.912	
	70%	$ 4,994,683.259	$ 2,053,331.466	$ 1,607,401.963	$ 8,655,416.687	$ 11,676,057.087
		$ 2,140,622.945	$ 880,017.455	$ -	$ 3,020,640.400	
	80%	$ 5,708,338.215	$ 2,346,717.472	$ 1,837,072.258	$ 9,892,127.945	$ 11,905,858.969
		$ 1,427,061.241	$ 586,669.784	$ -	$ 2,013,731.025	
	90%	$ 6,421,868.835	$ 2,640,052.364	$ 2,066,702.539	$ 11,128,623.738	$ 12,135,489.250
		$ 713,530.620	$ 293,334.892	$ -	$ 1,006,865.512	
	100%	$ 7,135,430.539	$ 2,933,400.035	$ 2,296,342.823	$ 12,365,173.397	$ 12,365,173.397
		$ -	$ -	$ -	$ -	
6KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ 11,281,731.197
		$ 8,348,331.162	$ 2,933,400.035	$ -	$ 11,281,731.197	
	10%	$ 834,818.569	$ 293,334.892	$ 229,630.281	$ 1,357,783.742	$ 11,511,312.332
		$ 7,513,476.225	$ 2,640,052.364	$ -	$ 10,153,528.590	
	20%	$ 1,669,637.138	$ 586,669.784	$ 459,260.562	$ 2,715,567.484	$ 11,740,942.613
		$ 6,678,657.656	$ 2,346,717.472	$ -	$ 9,025,375.129	
	30%	$ 2,504,492.075	$ 880,017.455	$ 688,900.846	$ 4,073,410.376	$ 11,970,435.458
		$ 5,843,693.617	$ 2,053,331.466	$ -	$ 7,897,025.082	
	40%	$ 3,339,310.644	$ 1,173,352.347	$ 918,531.127	$ 5,431,194.118	$ 12,200,262.324
		$ 5,009,020.518	$ 1,760,047.688	$ -	$ 6,769,068.206	
	50%	$ 4,174,129.214	$ 1,466,687.239	$ 1,148,161.408	$ 6,788,977.860	$ 12,429,794.313
		$ 4,174,129.214	$ 1,466,687.239	$ -	$ 5,640,816.452	
	60%	$ 5,009,020.518	$ 1,760,047.688	$ 1,377,811.696	$ 8,146,879.902	$ 12,659,542.893
		$ 3,339,310.644	$ 1,173,352.347	$ -	$ 4,512,662.991	
	70%	$ 5,843,693.617	$ 2,053,331.466	$ 1,607,401.963	$ 9,504,427.045	$ 12,888,936.575
		$ 2,504,492.075	$ 880,017.455	$ -	$ 3,384,509.530	
	80%	$ 6,678,657.656	$ 2,346,717.472	$ 1,837,072.258	$ 10,862,447.386	$ 13,118,754.309
		$ 1,669,637.138	$ 586,669.784	$ -	$ 2,256,306.922	
	90%	$ 7,513,476.225	$ 2,640,052.364	$ 2,066,702.539	$ 12,220,231.128	$ 13,348,384.590
		$ 834,818.569	$ 293,334.892	$ -	$ 1,128,153.461	
	100%	$ 8,348,331.162	$ 2,933,400.035	$ 2,296,342.823	$ 13,578,074.020	$ 13,578,074.020
		$ -	$ -	$ -	$ -	
30KEXTLOW	0%	$ -	$ -	$ -	$ -	$ 34,759,040.972
		$ 20,092,091.912	$ 14,666,949.061	$ -	$ 34,759,040.972	
	10%	$ 2,009,198.688	$ 1,466,687.239	$ 1,148,161.408	$ 4,624,047.335	$ 35,907,172.096
		$ 18,082,875.718	$ 13,200,249.043	$ -	$ 31,283,124.761	
	20%	$ 4,018,432.387	$ 2,933,400.035	$ 2,296,342.823	$ 9,248,175.245	$ 37,055,444.364
		$ 16,073,694.536	$ 11,733,574.583	$ -	$ 27,807,269.119	
	30%	$ 6,027,613.569	$ 4,400,074.495	$ 3,444,494.228	$ 13,872,182.292	$ 38,203,421.946
		$ 14,064,412.877	$ 10,266,826.777	$ -	$ 24,331,239.654	
	40%	$ 8,031,235.951	$ 5,862,691.108	$ 4,589,469.042	$ 18,483,396.101	$ 39,338,772.230
		$ 12,055,227.138	$ 8,800,148.990	$ -	$ 20,855,376.129	
	50%	$ 10,046,045.956	$ 7,333,474.530	$ 5,740,837.051	$ 23,120,357.537	$ 40,499,878.023
		$ 10,046,045.956	$ 7,333,474.530	$ -	$ 17,379,520.486	
	60%	$ 12,055,227.138	$ 8,800,148.990	$ 6,888,988.455	$ 27,744,364.584	$ 41,638,291.643
		$ 8,031,235.951	$ 5,862,691.108	$ -	$ 13,893,927.059	
	70%	$ 14,064,412.877	$ 10,266,826.777	$ 8,037,142.463	$ 32,368,382.117	$ 42,796,070.181
		$ 6,027,613.569	$ 4,400,074.495	$ -	$ 10,427,688.064	
	80%	$ 16,073,694.536	$ 11,733,574.583	$ 9,185,351.285	$ 36,992,620.404	$ 43,944,452.826

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost		Total Cost	
			CL	UV		
		$ 4,018,432.387	$ 2,933,400.035	$ -	$ 6,951,832.422	
	90%	$ 18,082,875.718	$ 13,200,249.043	$ 10,333,502.690	$ 41,616,627.451	$ 45,092,513.378
		$ 2,009,198.688	$ 1,466,687.239	$ -	$ 3,475,885.927	
	100%	$ 20,092,091.912	$ 14,666,949.061	$ 11,481,674.101	$ 46,240,715.073	$ 46,240,715.073
		$ -	$ -	$ -	$ -	
30KEXTMED	0%	$ -	$ -	$ -	$ -	$ 36,860,420.919
		$ 22,193,471.859	$ 14,666,949.061	$ -	$ 36,860,420.919	
	10%	$ 2,219,335.584	$ 1,466,687.239	$ 1,148,161.408	$ 4,834,184.231	$ 38,008,550.212
		$ 19,974,116.938	$ 13,200,249.043	$ -	$ 33,174,365.981	
	20%	$ 4,438,709.841	$ 2,933,400.035	$ 2,296,342.823	$ 9,668,452.699	$ 39,156,827.972
		$ 17,754,800.690	$ 11,733,574.583	$ -	$ 29,488,375.273	
	30%	$ 6,658,026.089	$ 4,400,074.495	$ 3,444,494.228	$ 14,502,594.811	$ 40,304,795.046
		$ 15,535,373.458	$ 10,266,826.777	$ -	$ 25,802,200.234	
	40%	$ 8,871,202.155	$ 5,862,691.108	$ 4,589,469.042	$ 19,323,362.305	$ 41,439,563.473
		$ 13,316,052.177	$ 8,800,148.990	$ -	$ 22,116,201.168	
	50%	$ 11,096,735.929	$ 7,333,474.530	$ 5,740,837.051	$ 24,171,047.510	$ 42,601,257.970
		$ 11,096,735.929	$ 7,333,474.530	$ -	$ 18,430,210.460	
	60%	$ 13,316,052.177	$ 8,800,148.990	$ 6,888,988.455	$ 29,005,189.623	$ 43,739,082.886
		$ 8,871,202.155	$ 5,862,691.108	$ -	$ 14,733,893.263	
	70%	$ 15,535,373.458	$ 10,266,826.777	$ 8,037,142.463	$ 33,839,342.698	$ 44,897,443.281
		$ 6,658,026.089	$ 4,400,074.495	$ -	$ 11,058,100.584	
	80%	$ 17,754,800.690	$ 11,733,574.583	$ 9,185,351.285	$ 38,673,726.558	$ 46,045,836.434
		$ 4,438,709.841	$ 2,933,400.035	$ -	$ 7,372,109.876	
	90%	$ 19,974,116.938	$ 13,200,249.043	$ 10,333,502.690	$ 43,507,868.671	$ 47,193,891.494
		$ 2,219,335.584	$ 1,466,687.239	$ -	$ 3,686,022.823	
	100%	$ 22,193,471.859	$ 14,666,949.061	$ 11,481,674.101	$ 48,342,095.020	$ 48,342,095.020
		$ -	$ -	$ -	$ -	
30KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ 42,680,564.654
		$ 28,013,615.594	$ 14,666,949.061	$ -	$ 42,680,564.654	
	10%	$ 2,801,346.915	$ 1,466,687.239	$ 1,148,161.408	$ 5,416,195.562	$ 43,828,688.876
		$ 25,212,244.271	$ 13,200,249.043	$ -	$ 38,412,493.314	
	20%	$ 5,602,742.644	$ 2,933,400.035	$ 2,296,342.823	$ 10,832,485.502	$ 44,976,981.849
		$ 22,410,921.763	$ 11,733,574.583	$ -	$ 34,144,496.346	
	30%	$ 8,404,065.152	$ 4,400,074.495	$ 3,444,494.228	$ 16,248,633.875	$ 46,124,919.817
		$ 19,609,459.165	$ 10,266,826.777	$ -	$ 29,876,285.942	
	40%	$ 11,197,637.243	$ 5,862,691.108	$ 4,589,469.042	$ 21,649,797.392	$ 47,258,076.688
		$ 16,808,130.305	$ 8,800,148.990	$ -	$ 25,608,279.295	
	50%	$ 14,006,807.797	$ 7,333,474.530	$ 5,740,837.051	$ 27,081,119.378	$ 48,421,401.705
		$ 14,006,807.797	$ 7,333,474.530	$ -	$ 21,340,282.327	
	60%	$ 16,808,130.305	$ 8,800,148.990	$ 6,888,988.455	$ 32,497,267.750	$ 49,557,596.101
		$ 11,197,637.243	$ 5,862,691.108	$ -	$ 17,060,328.350	
	70%	$ 19,609,459.165	$ 10,266,826.777	$ 8,037,142.463	$ 37,913,428.405	$ 50,717,568.053
		$ 8,404,065.152	$ 4,400,074.495	$ -	$ 12,804,139.648	
	80%	$ 22,410,921.763	$ 11,733,574.583	$ 9,185,351.285	$ 43,329,847.631	$ 51,865,990.311
		$ 5,602,742.644	$ 2,933,400.035	$ -	$ 8,536,142.679	
	90%	$ 25,212,244.271	$ 13,200,249.043	$ 10,333,502.690	$ 48,745,996.004	$ 53,014,030.158
		$ 2,801,346.915	$ 1,466,687.239	$ -	$ 4,268,034.154	
	100%	$ 28,013,615.594	$ 14,666,949.061	$ 11,481,674.101	$ 54,162,238.755	$ 54,162,238.755
		$ -	$ -	$ -	$ -	
130KEXTLOW	0%	$ -	$ -	$ -	$ -	$ 116,481,930.523
		$ 52,925,083.107	$ 63,556,847.415	$ -	$ 116,481,930.523	
	10%	$ 5,292,510.439	$ 6,355,687.297	$ 4,975,399.446	$ 16,623,597.183	$ 121,457,376.808
		$ 47,632,593.950	$ 57,201,185.676	$ -	$ 104,833,779.626	
	20%	$ 10,585,010.237	$ 12,711,361.816	$ 9,950,788.889	$ 33,247,160.942	$ 126,432,719.412
		$ 42,340,072.870	$ 50,845,485.600	$ -	$ 93,185,558.470	
	30%	$ 15,877,541.958	$ 19,067,074.671	$ 14,926,208.343	$ 49,870,824.971	$ 131,408,185.705
		$ 37,047,562.431	$ 44,489,798.302	$ -	$ 81,537,360.734	
	40%	$ 21,170,073.679	$ 25,422,787.525	$ 19,901,627.796	$ 66,494,489.000	$ 136,383,651.998
		$ 31,755,051.992	$ 38,134,111.005	$ -	$ 69,889,162.997	
	50%	$ 26,462,552.195	$ 31,778,436.486	$ 24,876,997.232	$ 83,117,985.913	$ 141,358,974.594
		$ 26,462,552.195	$ 31,778,436.486	$ -	$ 58,240,988.681	
	60%	$ 31,755,051.992	$ 38,134,111.005	$ 29,852,386.675	$ 99,741,549.672	$ 146,334,410.876
		$ 21,170,073.679	$ 25,422,787.525	$ -	$ 46,592,861.204	
	70%	$ 37,047,562.431	$ 44,489,798.302	$ 34,827,786.121	$ 116,365,146.855	$ 151,309,763.483
		$ 15,877,541.958	$ 19,067,074.671	$ -	$ 34,944,616.628	
	80%	$ 42,340,072.870	$ 50,845,485.600	$ 39,803,185.568	$ 132,988,744.038	$ 156,285,116.090
		$ 10,585,010.237	$ 12,711,361.816	$ -	$ 23,296,372.053	
	90%	$ 47,632,593.950	$ 57,201,185.676	$ 44,778,595.018	$ 149,612,374.643	$ 161,260,572.380
		$ 5,292,510.439	$ 6,355,687.297	$ -	$ 11,648,197.736	
	100%	$ 52,925,083.107	$ 63,556,847.415	$ 49,753,974.457	$ 166,235,904.979	$ 166,235,904.979
		$ -	$ -	$ -	$ -	

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost		Total Cost	
			CL	UV		
130KEXTMED	0%	$ -	$ -	$ -	$ -	$ 125,255,107.435
		$ 61,698,260.019	$ 63,556,847.415	$ -	$ 125,255,107.435	
	10%	$ 6,169,828.483	$ 6,355,687.297	$ 4,975,399.446	$ 17,500,915.227	$ 130,230,557.248
		$ 55,528,456.346	$ 57,201,185.676	$ -	$ 112,729,642.022	
	20%	$ 12,339,644.561	$ 12,711,361.816	$ 9,950,788.889	$ 35,001,795.266	$ 135,205,896.324
		$ 49,358,615.458	$ 50,845,485.600	$ -	$ 100,204,101.058	
	30%	$ 18,509,497.854	$ 19,067,074.671	$ 14,926,208.343	$ 52,502,780.867	$ 140,181,366.145
		$ 43,188,786.975	$ 44,489,798.302	$ -	$ 87,678,585.278	
	40%	$ 24,679,351.147	$ 25,422,787.525	$ 19,901,627.796	$ 70,003,766.468	$ 145,156,835.966
		$ 37,018,958.493	$ 38,134,111.005	$ -	$ 75,153,069.498	
	50%	$ 30,849,142.415	$ 31,778,436.486	$ 24,876,997.232	$ 87,504,576.133	$ 150,132,155.034
		$ 30,849,142.415	$ 31,778,436.486	$ -	$ 62,627,578.901	
	60%	$ 37,018,958.493	$ 38,134,111.005	$ 29,852,386.675	$ 105,005,456.172	$ 155,107,594.844
		$ 24,679,351.147	$ 25,422,787.525	$ -	$ 50,102,138.672	
	70%	$ 43,188,786.975	$ 44,489,798.302	$ 34,827,786.121	$ 122,506,371.399	$ 160,082,943.923
		$ 18,509,497.854	$ 19,067,074.671	$ -	$ 37,576,572.524	
	80%	$ 49,358,615.458	$ 50,845,485.600	$ 39,803,185.568	$ 140,007,286.626	$ 165,058,293.002
		$ 12,339,644.561	$ 12,711,361.816	$ -	$ 25,051,006.377	
	90%	$ 55,528,456.346	$ 57,201,185.676	$ 44,778,595.018	$ 157,508,237.039	$ 170,033,752.820
		$ 6,169,828.483	$ 6,355,687.297	$ -	$ 12,525,515.780	
	100%	$ 61,698,260.019	$ 63,556,847.415	$ 49,753,974.457	$ 175,009,081.892	$ 175,009,081.892
		$ -	$ -	$ -	$ -	
130KEXTHIGH	0%	$ -	$ -	$ -	$ -	$ 151,383,712.018
		$ 87,826,864.602	$ 63,556,847.415	$ -	$ 151,383,712.018	
	10%	$ 8,782,689.992	$ 6,355,687.297	$ 4,975,399.446	$ 20,113,776.736	$ 156,359,172.338
		$ 79,044,209.927	$ 57,201,185.676	$ -	$ 136,245,395.603	
	20%	$ 17,565,362.325	$ 12,711,361.816	$ 9,950,788.889	$ 40,227,513.031	$ 161,334,500.907
		$ 70,261,502.277	$ 50,845,485.600	$ -	$ 121,106,987.876	
	30%	$ 26,348,087.634	$ 19,067,074.671	$ 14,926,208.343	$ 60,341,370.647	$ 166,309,981.235
		$ 61,478,812.285	$ 44,489,798.302	$ -	$ 105,968,610.587	
	40%	$ 35,130,812.943	$ 25,422,787.525	$ 19,901,627.796	$ 80,455,228.264	$ 171,285,461.562
		$ 52,696,122.293	$ 38,134,111.005	$ -	$ 90,830,233.298	
	50%	$ 43,913,449.960	$ 31,778,436.486	$ 24,876,997.232	$ 100,568,883.678	$ 176,260,770.124
		$ 43,913,449.960	$ 31,778,436.486	$ -	$ 75,691,886.446	
	60%	$ 52,696,122.293	$ 38,134,111.005	$ 29,852,386.675	$ 120,682,619.973	$ 181,236,220.441
		$ 35,130,812.943	$ 25,422,787.525	$ -	$ 60,553,600.468	
	70%	$ 61,478,812.285	$ 44,489,798.302	$ 34,827,786.121	$ 140,796,396.709	$ 186,211,559.013
		$ 26,348,087.634	$ 19,067,074.671	$ -	$ 45,415,162.305	
	80%	$ 70,261,502.277	$ 50,845,485.600	$ 39,803,185.568	$ 160,910,173.444	$ 191,186,897.585
		$ 17,565,362.325	$ 12,711,361.816	$ -	$ 30,276,724.141	
	90%	$ 79,044,209.927	$ 57,201,185.676	$ 44,778,595.018	$ 181,023,990.620	$ 196,162,367.910
		$ 8,782,689.992	$ 6,355,687.297	$ -	$ 15,138,377.289	
	100%	$ 87,826,864.602	$ 63,556,847.415	$ 49,753,974.457	$ 201,137,686.475	$ 201,137,686.475
		$ -	$ -	$ -	$ -	
6KCASLOW	0%	$ -	$ -	$ -	$ -	$ 11,534,823.163
		$ 8,601,423.128	$ 2,933,400.035	$ -	$ 11,534,823.163	
	10%	$ 860,127.325	$ 293,334.892	$ 229,630.281	$ 1,383,092.498	$ 11,764,403.195
		$ 7,741,258.333	$ 2,640,052.364	$ -	$ 10,381,310.697	
	20%	$ 1,720,254.649	$ 586,669.784	$ 459,260.562	$ 2,766,184.995	$ 11,994,033.476
		$ 6,881,131.008	$ 2,346,717.472	$ -	$ 9,227,848.481	
	30%	$ 2,580,419.444	$ 880,017.455	$ 688,900.846	$ 4,149,337.745	$ 12,223,523.014
		$ 6,020,853.803	$ 2,053,331.466	$ -	$ 8,074,185.269	
	40%	$ 3,440,546.769	$ 1,173,352.347	$ 918,531.127	$ 5,532,430.243	$ 12,453,354.290
		$ 5,160,876.359	$ 1,760,047.688	$ -	$ 6,920,924.047	
	50%	$ 4,300,674.094	$ 1,466,687.239	$ 1,148,161.408	$ 6,915,522.741	$ 12,682,884.073
		$ 4,300,674.094	$ 1,466,687.239	$ -	$ 5,767,361.333	
	60%	$ 5,160,876.359	$ 1,760,047.688	$ 1,377,811.696	$ 8,298,735.743	$ 12,912,634.859
		$ 3,440,546.769	$ 1,173,352.347	$ -	$ 4,613,899.116	
	70%	$ 6,020,853.803	$ 2,053,331.466	$ 1,607,401.963	$ 9,681,587.231	$ 13,142,024.131
		$ 2,580,419.444	$ 880,017.455	$ -	$ 3,460,436.899	
	80%	$ 6,881,131.008	$ 2,346,717.472	$ 1,837,072.258	$ 11,064,920.738	$ 13,371,845.172
		$ 1,720,254.649	$ 586,669.784	$ -	$ 2,306,924.434	
	90%	$ 7,741,258.333	$ 2,640,052.364	$ 2,066,702.539	$ 12,448,013.236	$ 13,601,475.453
		$ 860,127.325	$ 293,334.892	$ -	$ 1,153,462.217	
	100%	$ 8,601,423.128	$ 2,933,400.035	$ 2,296,342.823	$ 13,831,165.986	$ 13,831,165.986
		$ -	$ -	$ -	$ -	
6KCASMED	0%	$ -	$ -	$ -	$ -	$ 12,438,695.493
		$ 9,505,295.458	$ 2,933,400.035	$ -	$ 12,438,695.493	
	10%	$ 950,512.983	$ 293,334.892	$ 229,630.281	$ 1,473,478.156	$ 12,668,271.587
		$ 8,554,741.067	$ 2,640,052.364	$ -	$ 11,194,793.432	
	20%	$ 1,901,025.965	$ 586,669.784	$ 459,260.562	$ 2,946,956.311	$ 12,897,901.868

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost CL	UV	Total Cost	
		$ 7,604,228.085	$ 2,346,717.472	$ -	$ 9,950,945.557	
	30%	$ 2,851,580.356	$ 880,017.455	$ 688,900.846	$ 4,420,498.657	$ 13,127,379.594
		$ 6,653,549.471	$ 2,053,331.466	$ -	$ 8,706,880.937	
	40%	$ 3,802,093.339	$ 1,173,352.347	$ 918,531.127	$ 5,893,976.812	$ 13,357,226.620
		$ 5,703,202.119	$ 1,760,047.688	$ -	$ 7,463,249.808	
	50%	$ 4,752,606.321	$ 1,466,687.239	$ 1,148,161.408	$ 7,367,454.968	$ 13,586,748.528
		$ 4,752,606.321	$ 1,466,687.239	$ -	$ 6,219,293.560	
	60%	$ 5,703,202.119	$ 1,760,047.688	$ 1,377,811.696	$ 8,841,061.504	$ 13,816,507.189
		$ 3,802,093.339	$ 1,173,352.347	$ -	$ 4,975,445.685	
	70%	$ 6,653,549.471	$ 2,053,331.466	$ 1,607,401.963	$ 10,314,282.900	$ 14,045,880.710
		$ 2,851,580.356	$ 880,017.455	$ -	$ 3,731,597.811	
	80%	$ 7,604,228.085	$ 2,346,717.472	$ 1,837,072.258	$ 11,788,017.815	$ 14,275,713.564
		$ 1,901,025.965	$ 586,669.784	$ -	$ 2,487,695.750	
	90%	$ 8,554,741.067	$ 2,640,052.364	$ 2,066,702.539	$ 13,261,495.970	$ 14,505,343.845
		$ 950,512.983	$ 293,334.892	$ -	$ 1,243,847.875	
	100%	$ 9,505,295.458	$ 2,933,400.035	$ 2,296,342.823	$ 14,735,038.316	$ 14,735,038.316
		$ -	$ -	$ -	$ -	
6KCASHIGH	0%	$ -	$ -	$ -	$ -	$ 15,269,413.687
		$ 12,336,013.652	$ 2,933,400.035	$ -	$ 15,269,413.687	
	10%	$ 1,233,579.870	$ 293,334.892	$ 229,630.281	$ 1,756,545.042	$ 15,498,977.450
		$ 11,102,380.043	$ 2,640,052.364	$ -	$ 13,742,432.407	
	20%	$ 2,467,159.739	$ 586,669.784	$ 459,260.562	$ 3,513,090.085	$ 15,728,607.731
		$ 9,868,800.174	$ 2,346,717.472	$ -	$ 12,215,517.646	
	30%	$ 3,700,793.348	$ 880,017.455	$ 688,900.846	$ 5,269,711.649	$ 15,958,048.462
		$ 8,635,005.348	$ 2,053,331.466	$ -	$ 10,688,336.813	
	40%	$ 4,934,373.217	$ 1,173,352.347	$ 918,531.127	$ 7,026,256.691	$ 16,187,944.814
		$ 7,401,640.434	$ 1,760,047.688	$ -	$ 9,161,688.123	
	50%	$ 6,167,953.087	$ 1,466,687.239	$ 1,148,161.408	$ 8,782,801.734	$ 16,417,442.059
		$ 6,167,953.087	$ 1,466,687.239	$ -	$ 7,634,640.326	
	60%	$ 7,401,640.434	$ 1,760,047.688	$ 1,377,811.696	$ 10,539,499.819	$ 16,647,225.383
		$ 4,934,373.217	$ 1,173,352.347	$ -	$ 6,107,725.564	
	70%	$ 8,635,005.348	$ 2,053,331.466	$ 1,607,401.963	$ 12,295,738.776	$ 16,876,549.579
		$ 3,700,793.348	$ 880,017.455	$ -	$ 4,580,810.802	
	80%	$ 9,868,800.174	$ 2,346,717.472	$ 1,837,072.258	$ 14,052,589.904	$ 17,106,419.427
		$ 2,467,159.739	$ 586,669.784	$ -	$ 3,053,829.523	
	90%	$ 11,102,380.043	$ 2,640,052.364	$ 2,066,702.539	$ 15,809,134.946	$ 17,336,049.708
		$ 1,233,579.870	$ 293,334.892	$ -	$ 1,526,914.762	
	100%	$ 12,336,013.652	$ 2,933,400.035	$ 2,296,342.823	$ 17,565,756.510	$ 17,565,756.510
		$ -	$ -	$ -	$ -	
30KCASLOW	0%	$ -	$ -	$ -	$ -	$ 38,706,437.705
		$ 24,039,488.644	$ 14,666,949.061	$ -	$ 38,706,437.705	
	10%	$ 2,403,936.298	$ 1,466,687.239	$ 1,148,161.408	$ 5,018,784.945	$ 39,854,565.390
		$ 21,635,531.402	$ 13,200,249.043	$ -	$ 34,835,780.445	
	20%	$ 4,807,914.485	$ 2,933,400.035	$ 2,296,342.823	$ 10,037,657.343	$ 41,002,847.974
		$ 19,231,616.049	$ 11,733,574.583	$ -	$ 30,965,190.632	
	30%	$ 7,211,829.838	$ 4,400,074.495	$ 3,444,494.228	$ 15,056,398.560	$ 42,150,805.817
		$ 16,827,580.480	$ 10,266,826.777	$ -	$ 27,094,407.256	
	40%	$ 9,609,094.279	$ 5,862,691.108	$ 4,589,469.042	$ 20,061,254.429	$ 43,285,063.094
		$ 14,423,659.675	$ 8,800,148.990	$ -	$ 23,223,808.666	
	50%	$ 12,019,744.322	$ 7,333,474.530	$ 5,740,837.051	$ 25,094,055.903	$ 44,447,274.755
		$ 12,019,744.322	$ 7,333,474.530	$ -	$ 19,353,218.852	
	60%	$ 14,423,659.675	$ 8,800,148.990	$ 6,888,988.455	$ 30,112,797.121	$ 45,584,582.508
		$ 9,609,094.279	$ 5,862,691.108	$ -	$ 15,471,785.387	
	70%	$ 16,827,580.480	$ 10,266,826.777	$ 8,037,142.463	$ 35,131,549.719	$ 46,743,454.052
		$ 7,211,829.838	$ 4,400,074.495	$ -	$ 11,611,904.333	
	80%	$ 19,231,616.049	$ 11,733,574.583	$ 9,185,351.285	$ 40,150,541.917	$ 47,891,856.436
		$ 4,807,914.485	$ 2,933,400.035	$ -	$ 7,741,314.520	
	90%	$ 21,635,531.402	$ 13,200,249.043	$ 10,333,502.690	$ 45,169,283.135	$ 49,039,906.671
		$ 2,403,936.298	$ 1,466,687.239	$ -	$ 3,870,623.537	
	100%	$ 24,039,488.644	$ 14,666,949.061	$ 11,481,674.101	$ 50,188,111.806	$ 50,188,111.806
		$ -	$ -	$ -	$ -	
30KCASMED	0%	$ -	$ -	$ -	$ -	$ 41,818,698.495
		$ 27,151,749.435	$ 14,666,949.061	$ -	$ 41,818,698.495	
	10%	$ 2,715,160.750	$ 1,466,687.239	$ 1,148,161.408	$ 5,330,009.397	$ 42,966,823.469
		$ 24,436,565.029	$ 13,200,249.043	$ -	$ 37,636,814.072	
	20%	$ 5,430,368.812	$ 2,933,400.035	$ 2,296,342.823	$ 10,660,111.670	$ 44,115,114.188
		$ 21,721,427.935	$ 11,733,574.583	$ -	$ 33,455,002.518	
	30%	$ 8,145,505.906	$ 4,400,074.495	$ 3,444,494.228	$ 15,990,074.628	$ 45,263,056.467
		$ 19,006,155.062	$ 10,266,826.777	$ -	$ 29,272,981.838	
	40%	$ 10,853,131.030	$ 5,862,691.108	$ 4,589,469.042	$ 21,305,291.180	$ 46,396,451.982
		$ 16,291,011.811	$ 8,800,148.990	$ -	$ 25,091,160.801	

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost		Total Cost	
			CL	UV		
	50%	$ 13,575,874.717	$ 7,333,474.530	$ 5,740,837.051	$ 26,650,186.298	$ 47,559,535.546
		$ 13,575,874.717	$ 7,333,474.530	$ -	$ 20,909,349.248	
	60%	$ 16,291,011.811	$ 8,800,148.990	$ 6,888,988.455	$ 31,980,149.257	$ 48,695,971.395
		$ 10,853,131.030	$ 5,862,691.108	$ -	$ 16,715,822.138	
	70%	$ 19,006,155.062	$ 10,266,826.777	$ 8,037,142.463	$ 37,310,124.302	$ 49,855,704.702
		$ 8,145,505.906	$ 4,400,074.495	$ -	$ 12,545,580.401	
	80%	$ 21,721,427.935	$ 11,733,574.583	$ 9,185,351.285	$ 42,640,353.803	$ 51,004,122.650
		$ 5,430,368.812	$ 2,933,400.035	$ -	$ 8,363,768.847	
	90%	$ 24,436,565.029	$ 13,200,249.043	$ 10,333,502.690	$ 47,970,316.762	$ 52,152,164.750
		$ 2,715,160.750	$ 1,466,687.239	$ -	$ 4,181,847.989	
	100%	$ 27,151,749.435	$ 14,666,949.061	$ 11,481,674.101	$ 53,300,372.597	$ 53,300,372.597
		$ -	$ -	$ -	$ -	
30KCASHIGH	0%	$ -	$ -	$ -	$ -	$ 50,880,610.533
		$ 36,213,661.473	$ 14,666,949.061	$ -	$ 50,880,610.533	
	10%	$ 3,621,347.216	$ 1,466,687.239	$ 1,148,161.408	$ 6,236,195.863	$ 52,028,727.611
		$ 32,592,282.705	$ 13,200,249.043	$ -	$ 45,792,531.748	
	20%	$ 7,242,757.536	$ 2,933,400.035	$ 2,296,342.823	$ 12,472,500.394	$ 53,177,042.017
		$ 28,970,967.040	$ 11,733,574.583	$ -	$ 40,704,541.623	
	30%	$ 10,864,073.201	$ 4,400,074.495	$ 3,444,494.228	$ 18,708,641.923	$ 54,324,938.978
		$ 25,349,470.278	$ 10,266,826.777	$ -	$ 35,616,297.055	
	40%	$ 14,475,369.773	$ 5,862,691.108	$ 4,589,469.042	$ 24,927,529.923	$ 55,455,825.315
		$ 21,728,146.401	$ 8,800,148.990	$ -	$ 30,528,295.392	
	50%	$ 18,106,830.736	$ 7,333,474.530	$ 5,740,837.051	$ 31,181,142.317	$ 56,621,447.584
		$ 18,106,830.736	$ 7,333,474.530	$ -	$ 25,440,305.267	
	60%	$ 21,728,146.401	$ 8,800,148.990	$ 6,888,988.455	$ 37,417,283.847	$ 57,755,344.728
		$ 14,475,369.773	$ 5,862,691.108	$ -	$ 20,338,060.881	
	70%	$ 25,349,470.278	$ 10,266,826.777	$ 8,037,142.463	$ 43,653,439.518	$ 58,917,587.214
		$ 10,864,073.201	$ 4,400,074.495	$ -	$ 15,264,147.696	
	80%	$ 28,970,967.040	$ 11,733,574.583	$ 9,185,351.285	$ 49,889,892.908	$ 60,066,050.479
		$ 7,242,757.536	$ 2,933,400.035	$ -	$ 10,176,157.571	
	90%	$ 32,592,282.705	$ 13,200,249.043	$ 10,333,502.690	$ 56,126,034.438	$ 61,214,068.893
		$ 3,621,347.216	$ 1,466,687.239	$ -	$ 5,088,034.455	
	100%	$ 36,213,661.473	$ 14,666,949.061	$ 11,481,674.101	$ 62,362,284.635	$ 62,362,284.635
		$ -	$ -	$ -	$ -	
130KCASLOW	0%	$ -	$ -	$ -	$ -	$ 124,637,040.034
		$ 61,080,192.619	$ 63,556,847.415	$ -	$ 124,637,040.034	
	10%	$ 6,108,021.718	$ 6,355,687.297	$ 4,975,399.446	$ 17,439,108.462	$ 129,612,489.600
		$ 54,972,195.462	$ 57,201,185.676	$ -	$ 112,173,381.138	
	20%	$ 12,216,031.155	$ 12,711,361.816	$ 9,950,788.889	$ 34,878,181.860	$ 134,587,828.924
		$ 48,864,161.464	$ 50,845,485.600	$ -	$ 99,709,647.063	
	30%	$ 18,324,077.435	$ 19,067,074.671	$ 14,926,208.343	$ 52,317,360.448	$ 139,563,298.496
		$ 42,756,139.746	$ 44,489,798.302	$ -	$ 87,245,938.048	
	40%	$ 24,432,123.714	$ 25,422,787.525	$ 19,901,627.796	$ 69,756,539.036	$ 144,538,768.068
		$ 36,648,118.027	$ 38,134,111.005	$ -	$ 74,782,229.032	
	50%	$ 30,540,108.590	$ 31,778,436.486	$ 24,876,997.232	$ 87,195,542.309	$ 149,514,087.385
		$ 30,540,108.590	$ 31,778,436.486	$ -	$ 62,318,545.077	
	60%	$ 36,648,118.027	$ 38,134,111.005	$ 29,852,386.675	$ 104,634,615.707	$ 154,489,526.947
		$ 24,432,123.714	$ 25,422,787.525	$ -	$ 49,854,911.240	
	70%	$ 42,756,139.746	$ 44,489,798.302	$ 34,827,786.121	$ 122,073,724.169	$ 159,464,876.274
		$ 18,324,077.435	$ 19,067,074.671	$ -	$ 37,391,152.105	
	80%	$ 48,864,161.464	$ 50,845,485.600	$ 39,803,185.568	$ 139,512,832.631	$ 164,440,225.602
		$ 12,216,031.155	$ 12,711,361.816	$ -	$ 24,927,392.971	
	90%	$ 54,972,195.462	$ 57,201,185.676	$ 44,778,595.018	$ 156,951,976.155	$ 169,415,685.171
		$ 6,108,021.718	$ 6,355,687.297	$ -	$ 12,463,709.015	
	100%	$ 61,080,192.619	$ 63,556,847.415	$ 49,753,974.457	$ 174,391,014.491	$ 174,391,014.491
		$ -	$ -	$ -	$ -	
130KCASMED	0%	$ -	$ -	$ -	$ -	$ 135,870,923.532
		$ 72,314,076.116	$ 63,556,847.415	$ -	$ 135,870,923.532	
	10%	$ 7,231,410.520	$ 6,355,687.297	$ 4,975,399.446	$ 18,562,497.263	$ 140,846,377.614
		$ 65,082,694.676	$ 57,201,185.676	$ -	$ 122,283,880.351	
	20%	$ 14,462,806.500	$ 12,711,361.816	$ 9,950,788.889	$ 37,124,957.205	$ 145,821,712.421
		$ 57,851,269.617	$ 50,845,485.600	$ -	$ 108,696,755.216	
	30%	$ 21,694,246.098	$ 19,067,074.671	$ 14,926,208.343	$ 55,687,529.111	$ 150,797,186.511
		$ 50,619,859.097	$ 44,489,798.302	$ -	$ 95,109,657.399	
	40%	$ 28,925,685.696	$ 25,422,787.525	$ 19,901,627.796	$ 74,250,101.018	$ 155,772,660.600
		$ 43,388,448.578	$ 38,134,111.005	$ -	$ 81,522,559.583	
	50%	$ 36,157,052.598	$ 31,778,436.486	$ 24,876,997.232	$ 92,812,486.316	$ 160,747,975.400
		$ 36,157,052.598	$ 31,778,436.486	$ -	$ 67,935,489.084	
	60%	$ 43,388,448.578	$ 38,134,111.005	$ 29,852,386.675	$ 111,374,946.258	$ 165,723,419.479
		$ 28,925,685.696	$ 25,422,787.525	$ -	$ 54,348,473.222	
	70%	$ 50,619,859.097	$ 44,489,798.302	$ 34,827,786.121	$ 129,937,443.521	$ 170,698,764.289

TS5	% Reused	Total Secondary Cost	Total Disinfection Cost		Total Cost	
			CL	UV		
		$ 21,694,246.098	$ 19,067,074.671	$ -	$ 40,761,320.769	
	80%	$ 57,851,269.617	$ 50,845,485.600	$ 39,803,185.568	$ 148,499,940.784	$ 175,674,109.099
		$ 14,462,806.500	$ 12,711,361.816	$ -	$ 27,174,168.315	
	90%	$ 65,082,694.676	$ 57,201,185.676	$ 44,778,595.018	$ 167,062,475.369	$ 180,649,573.186
		$ 7,231,410.520	$ 6,355,687.297	$ -	$ 13,587,097.817	
	100%	$ 72,314,076.116	$ 63,556,847.415	$ 49,753,974.457	$ 185,624,897.989	$ 185,624,897.989
		$ -	$ -	$ -	$ -	
130KCASHIGH	0%	$ -	$ -	$ -	$ -	$ 170,433,038.696
		$106,876,191.281	$ 63,556,847.415	$ -	$ 170,433,038.696	
	10%	$ 10,687,623.426	$ 6,355,687.297	$ 4,975,399.446	$ 22,018,710.169	$ 175,408,506.677
		$ 96,188,610.832	$ 57,201,185.676	$ -	$ 153,389,796.507	
	20%	$ 21,375,225.363	$ 12,711,361.816	$ 9,950,788.889	$ 44,037,376.068	$ 180,383,827.586
		$ 85,500,965.918	$ 50,845,485.600	$ -	$ 136,346,451.517	
	30%	$ 32,062,891.766	$ 19,067,074.671	$ 14,926,208.343	$ 66,056,174.779	$ 185,359,315.573
		$ 74,813,342.492	$ 44,489,798.302	$ -	$ 119,303,140.794	
	40%	$ 42,750,558.168	$ 25,422,787.525	$ 19,901,627.796	$ 88,074,973.490	$ 190,334,803.561
		$ 64,125,719.066	$ 38,134,111.005	$ -	$ 102,259,830.071	
	50%	$ 53,438,117.129	$ 31,778,436.486	$ 24,876,997.232	$ 110,093,550.847	$ 195,310,104.462
		$ 53,438,117.129	$ 31,778,436.486	$ -	$ 85,216,553.615	
	60%	$ 64,125,719.066	$ 38,134,111.005	$ 29,852,386.675	$ 132,112,216.746	$ 200,285,562.440
		$ 42,750,558.168	$ 25,422,787.525	$ -	$ 68,173,345.694	
	70%	$ 74,813,342.492	$ 44,489,798.302	$ 34,827,786.121	$ 154,130,926.915	$ 205,260,893.352
		$ 32,062,891.766	$ 19,067,074.671	$ -	$ 51,129,966.436	
	80%	$ 85,500,965.918	$ 50,845,485.600	$ 39,803,185.568	$ 176,149,637.085	$ 210,236,224.264
		$ 21,375,225.363	$ 12,711,361.816	$ -	$ 34,086,587.179	
	90%	$ 96,188,610.832	$ 57,201,185.676	$ 44,778,595.018	$ 198,168,391.525	$ 215,211,702.248
		$ 10,687,623.426	$ 6,355,687.297	$ -	$ 17,043,310.723	
	100%	$106,876,191.281	$ 63,556,847.415	$ 49,753,974.457	$ 220,187,013.153	$ 220,187,013.153
		$ -	$ -	$ -	$ -	

TS6	% Reused	Total Secondary Cost	Total Tertiary, Advanced and Disinfection Cost				Total Cost	
			MDF	RO	CL	UV		
6KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,273,541.256
		$ 10,340,141.221	$ -	$ -	$ 2,933,400.035	$ -	$ 13,273,541.256	
	10%	$ 1,033,996.104	$ 440,123.796	$ 1,030,695.731	$ 293,334.892	$ 229,630.281	$ 3,027,780.805	$ 14,973,933.241
		$ 9,306,100.072	$ -	$ -	$ 2,640,052.364	$ -	$ 11,946,152.437	
	20%	$ 2,067,992.209	$ 880,247.592	$ 2,061,391.463	$ 586,669.784	$ 459,260.562	$ 6,055,561.609	$ 16,674,383.050
		$ 8,272,103.968	$ -	$ -	$ 2,346,717.472	$ -	$ 10,618,821.440	
	30%	$ 3,102,033.357	$ 1,320,390.561	$ 3,092,132.095	$ 880,017.455	$ 688,900.846	$ 9,083,474.315	$ 18,374,733.466
		$ 7,237,927.686	$ -	$ -	$ 2,053,331.466	$ -	$ 9,291,259.151	
	40%	$ 4,136,029.462	$ 1,760,514.357	$ 4,122,827.826	$ 1,173,352.347	$ 918,531.127	$ 12,111,255.119	$ 20,075,414.567
		$ 6,204,111.759	$ -	$ -	$ 1,760,047.688	$ -	$ 7,964,159.448	
	50%	$ 5,170,025.566	$ 2,200,638.153	$ 5,153,523.558	$ 1,466,687.239	$ 1,148,161.408	$ 15,139,035.924	$ 21,775,748.729
		$ 5,170,025.566	$ -	$ -	$ 1,466,687.239	$ -	$ 6,636,712.805	
	60%	$ 6,204,111.759	$ 2,640,800.296	$ 6,184,309.090	$ 1,760,047.688	$ 1,377,811.696	$ 18,167,080.530	$ 23,476,462.338
		$ 4,136,029.462	$ -	$ -	$ 1,173,352.347	$ -	$ 5,309,381.809	
	70%	$ 7,237,927.686	$ 3,080,847.399	$ 7,214,825.219	$ 2,053,331.466	$ 1,607,401.963	$ 21,194,333.732	$ 25,176,384.544
		$ 3,102,033.357	$ -	$ -	$ 880,017.455	$ -	$ 3,982,050.812	
	80%	$ 8,272,103.968	$ 3,521,047.888	$ 8,245,700.553	$ 2,346,717.472	$ 1,837,072.258	$ 24,222,642.139	$ 26,877,304.132
		$ 2,067,992.209	$ -	$ -	$ 586,669.784	$ -	$ 2,654,661.993	
	90%	$ 9,306,100.072	$ 3,961,171.684	$ 9,276,396.284	$ 2,640,052.364	$ 2,066,702.539	$ 27,250,422.944	$ 28,577,753.940
		$ 1,033,996.104	$ -	$ -	$ 293,334.892	$ -	$ 1,327,330.996	
	100%	$ 10,340,141.221	$ 4,401,314.653	$ 10,307,136.916	$ 2,933,400.035	$ 2,296,342.823	$ 30,278,335.649	$ 30,278,335.649
		$ -	$ -	$ -	$ -	$ -	$ -	
6KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,699,726.128
		$ 10,766,326.093	$ -	$ -	$ 2,933,400.035	$ -	$ 13,699,726.128	
	10%	$ 1,076,613.849	$ 440,123.796	$ 1,030,695.731	$ 293,334.892	$ 229,630.281	$ 3,070,398.549	$ 15,400,116.256
		$ 9,689,665.343	$ -	$ -	$ 2,640,052.364	$ -	$ 12,329,717.707	
	20%	$ 2,153,227.698	$ 880,247.592	$ 2,061,391.463	$ 586,669.784	$ 459,260.562	$ 6,140,797.098	$ 17,100,566.065
		$ 8,613,051.494	$ -	$ -	$ 2,346,717.472	$ -	$ 10,959,768.966	
	30%	$ 3,229,888.448	$ 1,320,390.561	$ 3,092,132.095	$ 880,017.455	$ 688,900.846	$ 9,211,329.405	$ 18,800,910.911
		$ 7,536,250.041	$ -	$ -	$ 2,053,331.466	$ -	$ 9,589,581.506	
	40%	$ 4,306,502.296	$ 1,760,514.357	$ 4,122,827.826	$ 1,173,352.347	$ 918,531.127	$ 12,281,727.954	$ 20,501,599.438
		$ 6,459,823.796	$ -	$ -	$ 1,760,047.688	$ -	$ 8,219,871.485	
	50%	$ 5,383,116.145	$ 2,200,638.153	$ 5,153,523.558	$ 1,466,687.239	$ 1,148,161.408	$ 15,352,126.503	$ 22,201,929.887
		$ 5,383,116.145	$ -	$ -	$ 1,466,687.239	$ -	$ 6,849,803.384	
	60%	$ 6,459,823.796	$ 2,640,800.296	$ 6,184,309.090	$ 1,760,047.688	$ 1,377,811.696	$ 18,422,792.567	$ 23,902,647.210
		$ 4,306,502.296	$ -	$ -	$ 1,173,352.347	$ -	$ 5,479,854.643	
	70%	$ 7,536,250.041	$ 3,080,847.399	$ 7,214,825.219	$ 2,053,331.466	$ 1,607,401.963	$ 21,492,656.087	$ 25,602,561.989
		$ 3,229,888.448	$ -	$ -	$ 880,017.455	$ -	$ 4,109,905.902	
	80%	$ 8,613,051.494	$ 3,521,047.888	$ 8,245,700.553	$ 2,346,717.472	$ 1,837,072.258	$ 24,563,589.665	$ 27,303,487.147
		$ 2,153,227.698	$ -	$ -	$ 586,669.784	$ -	$ 2,739,897.482	
	90%	$ 9,689,665.343	$ 3,961,171.684	$ 9,276,396.284	$ 2,640,052.364	$ 2,066,702.539	$ 27,633,988.214	$ 29,003,936.955
		$ 1,076,613.849	$ -	$ -	$ 293,334.892	$ -	$ 1,369,948.741	
	100%	$ 10,766,326.093	$ 4,401,314.653	$ 10,307,136.916	$ 2,933,400.035	$ 2,296,342.823	$ 30,704,520.520	$ 30,704,520.520
		$ -	$ -	$ -	$ -	$ -	$ -	
6KA2O HIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,516,739.783
		$ 12,583,339.748	$ -	$ -	$ 2,933,400.035	$ -	$ 15,516,739.783	
	10%	$ 1,258,312.048	$ 440,123.796	$ 1,030,695.731	$ 293,334.892	$ 229,630.281	$ 3,252,096.749	$ 17,217,121.996

		$ 11,324,972.883	$ -	$ -	$ 2,640,052.364	$ -	$ 13,965,025.248	
	20%	$ 2,516,624.096	$ 880,247.592	$ 2,061,391.463	$ 586,669.784	$ 459,260.562	$ 6,504,193.497	$ 18,917,571.805
		$ 10,066,660.835	$ -	$ -	$ 2,346,717.472	$ -	$ 12,413,378.308	
	30%	$ 3,774,990.961	$ 1,320,390.561	$ 3,092,132.095	$ 880,017.455	$ 688,900.846	$ 9,756,431.918	$ 20,617,892.905
		$ 8,808,129.521	$ -	$ -	$ 2,053,331.466	$ -	$ 10,861,460.987	
	40%	$ 5,033,303.009	$ 1,760,514.357	$ 4,122,827.826	$ 1,173,352.347	$ 918,531.127	$ 13,008,528.667	$ 22,318,613.094
		$ 7,550,036.739	$ -	$ -	$ 1,760,047.688	$ -	$ 9,310,084.427	
	50%	$ 6,291,615.058	$ 2,200,638.153	$ 5,153,523.558	$ 1,466,687.239	$ 1,148,161.408	$ 16,260,625.415	$ 24,018,927.712
		$ 6,291,615.058	$ -	$ -	$ 1,466,687.239	$ -	$ 7,758,302.296	
	60%	$ 7,550,036.739	$ 2,640,800.296	$ 6,184,309.090	$ 1,760,047.688	$ 1,377,811.696	$ 19,513,005.509	$ 25,719,660.865
		$ 5,033,303.009	$ -	$ -	$ 1,173,352.347	$ -	$ 6,206,655.356	
	70%	$ 8,808,129.521	$ 3,080,847.399	$ 7,214,825.219	$ 2,053,331.466	$ 1,607,401.963	$ 22,764,535.567	$ 27,419,543.983
		$ 3,774,990.961	$ -	$ -	$ 880,017.455	$ -	$ 4,655,008.416	
	80%	$ 10,066,660.835	$ 3,521,047.888	$ 8,245,700.553	$ 2,346,717.472	$ 1,837,072.258	$ 26,017,199.006	$ 29,120,492.887
		$ 2,516,624.096	$ -	$ -	$ 586,669.784	$ -	$ 3,103,293.881	
	90%	$ 11,324,972.883	$ 3,961,171.684	$ 9,276,396.284	$ 2,640,052.364	$ 2,066,702.539	$ 29,269,295.755	$ 30,820,942.695
		$ 1,258,312.048	$ -	$ -	$ 293,334.892	$ -	$ 1,551,646.940	
	100%	$ 12,583,339.748	$ 4,401,314.653	$ 10,307,136.916	$ 2,933,400.035	$ 2,296,342.823	$ 32,521,534.176	$ 32,521,534.176
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 47,196,847.009
		$ 32,529,897.948	$ -	$ -	$ 14,666,949.061	$ -	$ 47,196,847.009	
	10%	$ 3,252,972.790	$ 2,200,638.153	$ 5,153,523.558	$ 1,466,687.239	$ 1,148,161.408	$ 13,221,983.147	$ 55,699,129.007
		$ 29,276,896.817	$ -	$ -	$ 13,200,249.043	$ -	$ 42,477,145.860	
	20%	$ 6,506,002.263	$ 4,401,314.653	$ 10,307,136.916	$ 2,933,400.035	$ 2,296,342.823	$ 26,444,196.691	$ 64,201,723.643
		$ 26,023,952.369	$ -	$ -	$ 11,733,574.583	$ -	$ 37,757,526.952	
	30%	$ 9,758,946.711	$ 6,601,933.633	$ 15,460,615.573	$ 4,400,074.495	$ 3,444,494.228	$ 39,666,064.640	$ 72,703,736.663
		$ 22,770,845.246	$ -	$ -	$ 10,266,826.777	$ -	$ 33,037,672.023	
	40%	$ 13,002,891.239	$ 8,796,464.161	$ 20,599,836.103	$ 5,862,691.108	$ 4,589,469.042	$ 52,851,351.653	$ 81,169,394.065
		$ 19,517,893.422	$ -	$ -	$ 8,800,148.990	$ -	$ 28,318,042.412	
	50%	$ 16,264,948.974	$11,003,248.286	$ 25,767,752.490	$ 7,333,474.530	$ 5,740,837.051	$ 66,110,261.331	$ 89,708,684.835
		$ 16,264,948.974	$ -	$ -	$ 7,333,474.530	$ -	$ 23,598,423.504	
	60%	$ 19,517,893.422	$13,203,867.266	$ 30,921,231.147	$ 8,800,148.990	$ 6,888,988.455	$ 79,332,129.280	$ 98,197,711.626
		$ 13,002,891.239	$ -	$ -	$ 5,862,691.108	$ -	$ 18,865,582.346	
	70%	$ 22,770,845.246	$15,404,491.236	$ 36,074,721.490	$ 10,266,826.777	$ 8,037,142.463	$ 92,554,027.212	$106,713,048.418
		$ 9,758,946.711	$ -	$ -	$ 4,400,074.495	$ -	$ 14,159,021.206	
	80%	$ 26,023,952.369	$17,605,220.266	$ 41,228,457.864	$ 11,733,574.583	$ 9,185,351.285	$105,776,556.367	$115,215,958.665
		$ 6,506,002.263	$ -	$ -	$ 2,933,400.035	$ -	$ 9,439,402.298	
	90%	$ 29,276,896.817	$19,805,839.246	$ 46,381,936.521	$ 13,200,249.043	$ 10,333,502.690	$118,998,424.316	$123,718,084.345
		$ 3,252,972.790	$ -	$ -	$ 1,466,687.239	$ -	$ 4,719,660.029	
	100%	$ 32,529,897.948	$22,006,496.572	$ 51,535,504.980	$ 14,666,949.061	$ 11,481,674.101	$132,220,522.662	$132,220,522.662
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 49,112,035.985
		$ 34,445,086.925	$ -	$ -	$ 14,666,949.061	$ -	$ 49,112,035.985	
	10%	$ 3,444,490.686	$ 2,200,638.153	$ 5,153,523.558	$ 1,466,687.239	$ 1,148,161.408	$ 13,413,501.044	$ 57,614,316.315
		$ 31,000,566.228	$ -	$ -	$ 13,200,249.043	$ -	$ 44,200,815.271	
	20%	$ 6,889,041.393	$ 4,401,314.653	$ 10,307,136.916	$ 2,933,400.035	$ 2,296,342.823	$ 26,827,235.821	$ 66,116,915.956
		$ 27,556,105.552	$ -	$ -	$ 11,733,574.583	$ -	$ 39,289,680.135	
	30%	$ 10,333,502.069	$ 6,601,933.633	$ 15,460,615.573	$ 4,400,074.495	$ 3,444,494.228	$ 40,240,619.998	$ 74,618,919.399
		$ 24,111,472.625	$ -	$ -	$ 10,266,826.777	$ -	$ 34,378,299.401	
	40%	$ 13,768,432.957	$ 8,796,464.161	$ 20,599,836.103	$ 5,862,691.108	$ 4,589,469.042	$ 53,616,893.371	$ 83,084,046.499
		$ 20,667,004.138	$ -	$ -	$ 8,800,148.990	$ -	$ 29,467,153.128	
	50%	$ 17,222,543.462	$11,003,248.286	$ 25,767,752.490	$ 7,333,474.530	$ 5,740,837.051	$ 67,067,855.819	$ 91,623,873.812
		$ 17,222,543.462	$ -	$ -	$ 7,333,474.530	$ -	$ 24,556,017.993	
	60%	$ 20,667,004.138	$13,203,867.266	$ 30,921,231.147	$ 8,800,148.990	$ 6,888,988.455	$ 80,481,239.996	$100,112,364.061
		$ 13,768,432.957	$ -	$ -	$ 5,862,691.108	$ -	$ 19,631,124.064	
	70%	$ 24,111,472.625	$15,404,491.236	$ 36,074,721.490	$ 10,266,826.777	$ 8,037,142.463	$ 93,894,654.591	$108,628,231.155
		$ 10,333,502.069	$ -	$ -	$ 4,400,074.495	$ -	$ 14,733,576.564	
	80%	$ 27,556,105.552	$17,605,220.266	$ 41,228,457.864	$ 11,733,574.583	$ 9,185,351.285	$107,308,709.551	$117,131,150.979
		$ 6,889,041.393	$ -	$ -	$ 2,933,400.035	$ -	$ 9,822,441.428	
	90%	$ 31,000,566.228	$19,805,839.246	$ 46,381,936.521	$ 13,200,249.043	$ 10,333,502.690	$120,722,093.728	$125,633,271.653
		$ 3,444,490.686	$ -	$ -	$ 1,466,687.239	$ -	$ 4,911,177.925	
	100%	$ 34,445,086.925	$22,006,496.572	$ 51,535,504.980	$ 14,666,949.061	$ 11,481,674.101	$134,135,711.638	$134,135,711.638
		$ -	$ -	$ -	$ -	$ -	$ -	
30KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$ 56,499,825.932
		$ 41,832,876.871	$ -	$ -	$ 14,666,949.061	$ -	$ 56,499,825.932	
	10%	$ 4,183,265.819	$ 2,200,638.153	$ 5,153,523.558	$ 1,466,687.239	$ 1,148,161.408	$ 14,152,276.176	$ 65,002,099.824
		$ 37,649,574.605	$ -	$ -	$ 13,200,249.043	$ -	$ 50,849,823.648	
	20%	$ 8,366,604.532	$ 4,401,314.653	$ 10,307,136.916	$ 2,933,400.035	$ 2,296,342.823	$ 28,304,798.960	$ 73,504,718.776
		$ 33,466,345.233	$ -	$ -	$ 11,733,574.583	$ -	$ 45,199,919.816	
	30%	$ 12,549,833.904	$ 6,601,933.633	$ 15,460,615.573	$ 4,400,074.495	$ 3,444,494.228	$ 42,456,951.833	$ 82,006,685.274
		$ 29,282,906.665	$ -	$ -	$ 10,266,826.777	$ -	$ 39,549,733.441	
	40%	$ 16,721,489.536	$ 8,796,464.161	$ 20,599,836.103	$ 5,862,691.108	$ 4,589,469.042	$ 56,569,949.950	$ 90,469,766.748
		$ 25,099,667.807	$ -	$ -	$ 8,800,148.990	$ -	$ 33,899,816.797	
	50%	$ 20,916,438.435	$11,003,248.286	$ 25,767,752.490	$ 7,333,474.530	$ 5,740,837.051	$ 70,761,750.792	$ 99,011,663.758
		$ 20,916,438.435	$ -	$ -	$ 7,333,474.530	$ -	$ 28,249,912.966	
	60%	$ 25,099,667.807	$13,203,867.266	$ 30,921,231.147	$ 8,800,148.990	$ 6,888,988.455	$ 84,913,903.665	$107,498,084.309
		$ 16,721,489.536	$ -	$ -	$ 5,862,691.108	$ -	$ 22,584,180.644	
	70%	$ 29,282,906.665	$15,404,491.236	$ 36,074,721.490	$ 10,266,826.777	$ 8,037,142.463	$ 99,066,088.631	$116,015,997.030
		$ 12,549,833.904	$ -	$ -	$ 4,400,074.495	$ -	$ 16,949,908.399	
	80%	$ 33,466,345.233	$17,605,220.266	$ 41,228,457.864	$ 11,733,574.583	$ 9,185,351.285	$113,218,949.232	$124,518,953.799
		$ 8,366,604.532	$ -	$ -	$ 2,933,400.035	$ -	$ 11,300,004.567	
	90%	$ 37,649,574.605	$19,805,839.246	$ 46,381,936.521	$ 13,200,249.043	$ 10,333,502.690	$127,371,102.105	$133,021,055.162
		$ 4,183,265.819	$ -	$ -	$ 1,466,687.239	$ -	$ 5,649,953.058	
	100%	$ 41,832,876.871	$22,006,496.572	$ 51,535,504.980	$ 14,666,949.061	$ 11,481,674.101	$141,523,501.585	$141,523,501.585
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OLOW	0%	$ -	$ -	$ -	$ -	$ -	$ -	$143,646,039.959
		$ 80,089,192.544	$ -	$ -	$ 63,556,847.415	$ -	$143,646,039.959	
	10%	$ 8,008,922.475	$ 9,536,162.575	$ 22,332,085.085	$ 6,355,687.297	$ 4,975,399.446	$ 51,208,256.879	$180,489,744.829
		$ 72,080,302.274	$ -	$ -	$ 57,201,185.676	$ -	$129,281,487.950	
	20%	$ 16,017,828.847	$19,072,305.977	$ 44,664,125.269	$ 12,711,361.816	$ 9,950,788.889	$102,416,410.799	$217,333,260.095
		$ 64,071,363.697	$ -	$ -	$ 50,845,485.600	$ -	$114,916,849.296	
	30%	$ 24,026,783.527	$28,608,506.899	$ 66,996,300.156	$ 19,067,074.671	$ 14,926,208.343	$153,624,873.595	$254,177,113.119

		$ 56,062,441.222	$ -	$ -	$ 44,489,798.302	$ -	$100,552,239.524	
	40%	$ 32,035,738.208	$38,144,707.821	$ 89,328,475.042	$ 25,422,787.525	$ 19,901,627.796	$204,833,336.392	$291,020,966.143
		$ 48,053,518.747	$ -	$ -	$ 38,134,111.005	$ -	$ 86,187,629.752	
	50%	$ 40,044,612.375	$47,680,812.876	$111,660,425.425	$ 31,778,436.486	$ 24,876,997.232	$256,041,284.394	$327,864,333.255
		$ 40,044,612.375	$ -	$ -	$ 31,778,436.486	$ -	$ 71,823,048.861	
	60%	$ 48,053,518.747	$57,216,956.277	$133,992,465.609	$ 38,134,111.005	$ 29,852,386.675	$307,249,438.313	$364,707,964.046
		$ 32,035,738.208	$ -	$ -	$ 25,422,787.525	$ -	$ 57,458,525.733	
	70%	$ 56,062,441.222	$66,753,118.853	$156,324,550.694	$ 44,489,798.302	$ 34,827,786.121	$358,457,695.192	$401,551,553.390
		$ 24,026,783.527	$ -	$ -	$ 19,067,074.671	$ -	$ 43,093,858.198	
	80%	$ 64,071,363.697	$76,289,281.428	$178,656,635.779	$ 50,845,485.600	$ 39,803,185.568	$409,665,952.071	$438,395,142.734
		$ 16,017,828.847	$ -	$ -	$ 12,711,361.816	$ -	$ 28,729,190.663	
	90%	$ 72,080,302.274	$85,825,463.176	$200,988,765.765	$ 57,201,185.676	$ 44,778,595.018	$460,874,311.908	$475,238,921.681
		$ 8,008,922.475	$ -	$ -	$ 6,355,687.297	$ -	$ 14,364,609.772	
	100%	$ 80,089,192.544	$95,361,587.405	$223,320,761.048	$ 63,556,847.415	$ 49,753,974.457	$512,082,362.869	$512,082,362.869
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OMED	0%	$ -	$ -	$ -	$ -	$ -	$ -	$150,643,334.444
		$ 87,086,487.029	$ -	$ -	$ 63,556,847.415	$ -	$150,643,334.444	
	10%	$ 8,708,652.205	$ 9,536,162.575	$ 22,332,085.085	$ 6,355,687.297	$ 4,975,399.446	$ 51,907,986.609	$187,487,042.127
		$ 78,377,869.843	$ -	$ -	$ 57,201,185.676	$ -	$135,579,055.519	
	20%	$ 17,417,286.900	$19,072,305.977	$ 44,664,125.269	$ 12,711,361.816	$ 9,950,788.889	$103,815,868.851	$224,330,554.580
		$ 69,669,200.129	$ -	$ -	$ 50,845,485.600	$ -	$120,514,685.728	
	30%	$ 26,125,974.124	$28,608,506.899	$ 66,996,300.156	$ 19,067,074.671	$ 14,926,208.343	$155,724,064.192	$261,174,410.418
		$ 60,960,547.924	$ -	$ -	$ 44,489,798.302	$ -	$105,450,346.226	
	40%	$ 34,834,661.348	$38,144,707.821	$ 89,328,475.042	$ 25,422,787.525	$ 19,901,627.796	$207,632,259.532	$298,018,266.256
		$ 52,251,895.719	$ -	$ -	$ 38,134,111.005	$ -	$ 90,386,006.724	
	50%	$ 43,543,261.024	$47,680,812.876	$111,660,425.425	$ 31,778,436.486	$ 24,876,997.232	$259,539,933.043	$334,861,630.553
		$ 43,543,261.024	$ -	$ -	$ 31,778,436.486	$ -	$ 75,321,697.510	
	60%	$ 52,251,895.719	$57,216,956.277	$133,992,465.609	$ 38,134,111.005	$ 29,852,386.675	$311,447,815.286	$371,705,264.159
		$ 34,834,661.348	$ -	$ -	$ 25,422,787.525	$ -	$ 60,257,448.873	
	70%	$ 60,960,547.924	$66,753,118.853	$156,324,550.694	$ 44,489,798.302	$ 34,827,786.121	$363,355,801.894	$408,548,850.689
		$ 26,125,974.124	$ -	$ -	$ 19,067,074.671	$ -	$ 45,193,048.794	
	80%	$ 69,669,200.129	$76,289,281.428	$178,656,635.779	$ 50,845,485.600	$ 39,803,185.568	$415,263,788.503	$445,392,437.219
		$ 17,417,286.900	$ -	$ -	$ 12,711,361.816	$ -	$ 30,128,648.716	
	90%	$ 78,377,869.843	$85,825,463.176	$200,988,765.765	$ 57,201,185.676	$ 44,778,595.018	$467,171,879.477	$482,236,218.979
		$ 8,708,652.205	$ -	$ -	$ 6,355,687.297	$ -	$ 15,064,339.502	
	100%	$ 87,086,487.029	$95,361,587.405	$223,320,761.048	$ 63,556,847.415	$ 49,753,974.457	$519,079,657.354	$519,079,657.354
		$ -	$ -	$ -	$ -	$ -	$ -	
130KA2OHIGH	0%	$ -	$ -	$ -	$ -	$ -	$ -	$181,605,286.048
		$118,048,438.633	$ -	$ -	$ 63,556,847.415	$ -	$181,605,286.048	
	10%	$ 11,804,848.610	$ 9,536,162.575	$ 22,332,085.085	$ 6,355,687.297	$ 4,975,399.446	$ 55,004,183.014	$218,449,006.182
		$106,243,637.492	$ -	$ -	$ 57,201,185.676	$ -	$163,444,823.168	
	20%	$ 23,609,673.486	$19,072,305.977	$ 44,664,125.269	$ 12,711,361.816	$ 9,950,788.889	$110,008,255.437	$255,292,506.184
		$ 94,438,765.147	$ -	$ -	$ 50,845,485.600	$ -	$145,284,250.747	
	30%	$ 35,414,569.565	$28,608,506.899	$ 66,996,300.156	$ 19,067,074.671	$ 14,926,208.343	$165,012,659.633	$292,136,374.472
		$ 82,633,916.537	$ -	$ -	$ 44,489,798.302	$ -	$127,123,714.839	
	40%	$ 47,219,465.645	$38,144,707.821	$ 89,328,475.042	$ 25,422,787.525	$ 19,901,627.796	$220,017,063.829	$328,980,242.761
		$ 70,829,067.927	$ -	$ -	$ 38,134,111.005	$ -	$108,963,178.932	
	50%	$ 59,024,243.051	$47,680,812.876	$111,660,425.425	$ 31,778,436.486	$ 24,876,997.232	$275,020,915.070	$365,823,594.608
		$ 59,024,243.051	$ -	$ -	$ 31,778,436.486	$ -	$ 90,802,679.538	
	60%	$ 70,829,067.927	$57,216,956.277	$133,992,465.609	$ 38,134,111.005	$ 29,852,386.675	$330,024,987.493	$402,667,240.664
		$ 47,219,465.645	$ -	$ -	$ 25,422,787.525	$ -	$ 72,642,253.170	
	70%	$ 82,633,916.537	$66,753,118.853	$156,324,550.694	$ 44,489,798.302	$ 34,827,786.121	$385,029,170.507	$439,510,814.743
		$ 35,414,569.565	$ -	$ -	$ 19,067,074.671	$ -	$ 54,481,644.236	
	80%	$ 94,438,765.147	$76,289,281.428	$178,656,635.779	$ 50,845,485.600	$ 39,803,185.568	$440,033,353.521	$476,354,388.823
		$ 23,609,673.486	$ -	$ -	$ 12,711,361.816	$ -	$ 36,321,035.302	
	90%	$106,243,637.492	$85,825,463.176	$200,988,765.765	$ 57,201,185.676	$ 44,778,595.018	$495,037,647.126	$513,198,183.034
		$ 11,804,848.610	$ -	$ -	$ 6,355,687.297	$ -	$ 18,160,535.908	
	100%	$118,048,438.633	$95,361,587.405	$223,320,761.048	$ 63,556,847.415	$ 49,753,974.457	$550,041,608.958	$550,041,608.958
		$ -	$ -	$ -	$ -	$ -	$ -	

L. Unit Costs Based on Full Treatment

6KCASLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.138	$ 0.165	$ 0.103	$ 0.138	-
10%	-	$ 0.179	$ 0.171	$ 0.103	$ 0.140	-
20%	-	$ 0.221	$ 0.177	$ 0.103	$ 0.143	-
30%	-	$ 0.262	$ 0.183	$ 0.103	$ 0.146	-
40%	-	$ 0.304	$ 0.189	$ 0.103	$ 0.149	-
50%	-	$ 0.345	$ 0.195	$ 0.103	$ 0.151	-
60%	-	$ 0.387	$ 0.201	$ 0.103	$ 0.154	-
70%	-	$ 0.428	$ 0.207	$ 0.103	$ 0.157	-
80%	-	$ 0.470	$ 0.213	$ 0.103	$ 0.160	-
90%	-	$ 0.512	$ 0.219	$ 0.103	$ 0.162	-
100%	-	$ 0.553	$ 0.225	$ 0.103	$ 0.165	-

6KCASMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.148	$ 0.176	$ 0.113	$ 0.148	-
10%	-	$ 0.190	$ 0.160	$ 0.113	$ 0.151	-
20%	-	$ 0.232	$ 0.171	$ 0.113	$ 0.154	-
30%	-	$ 0.273	$ 0.183	$ 0.113	$ 0.157	-
40%	-	$ 0.315	$ 0.194	$ 0.113	$ 0.159	-
50%	-	$ 0.356	$ 0.206	$ 0.113	$ 0.162	-
60%	-	$ 0.398	$ 0.217	$ 0.113	$ 0.165	-
70%	-	$ 0.439	$ 0.229	$ 0.113	$ 0.168	-
80%	-	$ 0.481	$ 0.240	$ 0.113	$ 0.170	-
90%	-	$ 0.522	$ 0.251	$ 0.113	$ 0.173	-
100%	-	$ 0.564	$ 0.263	$ 0.113	$ 0.176	-

6KCASHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.182	$ 0.182	$ 0.147	$ 0.182	-
10%	-	$ 0.224	$ 0.194	$ 0.147	$ 0.185	-
20%	-	$ 0.265	$ 0.205	$ 0.147	$ 0.188	-
30%	-	$ 0.307	$ 0.217	$ 0.147	$ 0.190	-
40%	-	$ 0.348	$ 0.228	$ 0.147	$ 0.193	-
50%	-	$ 0.390	$ 0.239	$ 0.147	$ 0.196	-
60%	-	$ 0.431	$ 0.251	$ 0.147	$ 0.199	-
70%	-	$ 0.473	$ 0.262	$ 0.147	$ 0.201	-
80%	-	$ 0.515	$ 0.274	$ 0.147	$ 0.204	-
90%	-	$ 0.556	$ 0.285	$ 0.147	$ 0.207	-
100%	-	$ 0.598	$ 0.297	$ 0.147	$ 0.210	-

30KCASLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.092	$ 0.120	$ 0.057	$ 0.092	-
10%	-	$ 0.104	$ 0.126	$ 0.057	$ 0.095	-
20%	-	$ 0.115	$ 0.132	$ 0.057	$ 0.098	-
30%	-	$ 0.213	$ 0.134	$ 0.057	$ 0.101	-
40%	-	$ 0.253	$ 0.138	$ 0.057	$ 0.103	-
50%	-	$ 0.293	$ 0.143	$ 0.057	$ 0.106	-
60%	-	$ 0.333	$ 0.147	$ 0.057	$ 0.109	-
70%	-	$ 0.374	$ 0.152	$ 0.057	$ 0.112	-
80%	-	$ 0.414	$ 0.157	$ 0.057	$ 0.114	-
90%	-	$ 0.454	$ 0.161	$ 0.057	$ 0.117	-
100%	-	$ 0.494	$ 0.166	$ 0.057	$ 0.120	-

30KCASMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.100	$ 0.127	$ 0.065	$ 0.100	-
10%	-	$ 0.111	$ 0.111	$ 0.065	$ 0.103	-
20%	-	$ 0.123	$ 0.123	$ 0.065	$ 0.105	-
30%	-	$ 0.220	$ 0.130	$ 0.065	$ 0.108	-
40%	-	$ 0.261	$ 0.140	$ 0.065	$ 0.111	-
50%	-	$ 0.301	$ 0.150	$ 0.065	$ 0.114	-
60%	-	$ 0.341	$ 0.160	$ 0.065	$ 0.116	-
70%	-	$ 0.381	$ 0.170	$ 0.065	$ 0.119	-
80%	-	$ 0.421	$ 0.180	$ 0.065	$ 0.122	-
90%	-	$ 0.461	$ 0.191	$ 0.065	$ 0.124	-
100%	-	$ 0.502	$ 0.201	$ 0.065	$ 0.127	-

30KCASHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.121	$ 0.121	$ 0.086	$ 0.121	-
10%	-	$ 0.133	$ 0.133	$ 0.086	$ 0.124	-
20%	-	$ 0.144	$ 0.144	$ 0.086	$ 0.127	-
30%	-	$ 0.242	$ 0.152	$ 0.086	$ 0.130	-
40%	-	$ 0.282	$ 0.162	$ 0.086	$ 0.132	-
50%	-	$ 0.322	$ 0.172	$ 0.086	$ 0.135	-
60%	-	$ 0.362	$ 0.182	$ 0.086	$ 0.138	-
70%	-	$ 0.403	$ 0.192	$ 0.086	$ 0.141	-
80%	-	$ 0.443	$ 0.202	$ 0.086	$ 0.143	-
90%	-	$ 0.483	$ 0.212	$ 0.086	$ 0.146	-
100%	-	$ 0.523	$ 0.222	$ 0.086	$ 0.149	-

130KCASLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.069	$ 0.096	$ 0.034	$ 0.069	-
10%	-	$ 0.109	$ 0.101	$ 0.034	$ 0.071	-
20%	-	$ 0.149	$ 0.105	$ 0.034	$ 0.074	-
30%	-	$ 0.189	$ 0.110	$ 0.034	$ 0.077	-
40%	-	$ 0.229	$ 0.114	$ 0.034	$ 0.080	-
50%	-	$ 0.270	$ 0.119	$ 0.034	$ 0.082	-
60%	-	$ 0.310	$ 0.124	$ 0.034	$ 0.085	-
70%	-	$ 0.350	$ 0.128	$ 0.034	$ 0.088	-
80%	-	$ 0.390	$ 0.133	$ 0.034	$ 0.091	-
90%	-	$ 0.430	$ 0.137	$ 0.034	$ 0.093	-
100%	-	$ 0.470	$ 0.142	$ 0.034	$ 0.096	-

130KCASMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.075	$ 0.102	$ 0.040	$ 0.075	-
10%	-	$ 0.115	$ 0.085	$ 0.040	$ 0.078	-
20%	-	$ 0.155	$ 0.095	$ 0.040	$ 0.080	-
30%	-	$ 0.195	$ 0.105	$ 0.040	$ 0.083	-
40%	-	$ 0.236	$ 0.115	$ 0.040	$ 0.086	-
50%	-	$ 0.276	$ 0.125	$ 0.040	$ 0.089	-
60%	-	$ 0.316	$ 0.135	$ 0.040	$ 0.091	-
70%	-	$ 0.356	$ 0.145	$ 0.040	$ 0.094	-
80%	-	$ 0.396	$ 0.156	$ 0.040	$ 0.097	-
90%	-	$ 0.436	$ 0.166	$ 0.040	$ 0.100	-
100%	-	$ 0.477	$ 0.176	$ 0.040	$ 0.102	-

130KCASHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.094	$ 0.094	$ 0.059	$ 0.094	-
10%	-	$ 0.134	$ 0.104	$ 0.059	$ 0.097	-
20%	-	$ 0.174	$ 0.114	$ 0.059	$ 0.099	-
30%	-	$ 0.214	$ 0.124	$ 0.059	$ 0.102	-
40%	-	$ 0.255	$ 0.134	$ 0.059	$ 0.105	-
50%	-	$ 0.295	$ 0.144	$ 0.059	$ 0.108	-
60%	-	$ 0.335	$ 0.154	$ 0.059	$ 0.110	-
70%	-	$ 0.375	$ 0.164	$ 0.059	$ 0.113	-
80%	-	$ 0.415	$ 0.175	$ 0.059	$ 0.116	-
90%	-	$ 0.455	$ 0.185	$ 0.059	$ 0.119	-
100%	-	$ 0.496	$ 0.195	$ 0.059	$ 0.121	-

6KEXTLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.114	$ 0.141	$ 0.079	$ 0.114	-
10%	-	$ 0.155	$ 0.147	$ 0.079	$ 0.117	-
20%	-	$ 0.197	$ 0.153	$ 0.079	$ 0.119	-
30%	-	$ 0.238	$ 0.159	$ 0.079	$ 0.122	-
40%	-	$ 0.280	$ 0.165	$ 0.079	$ 0.125	-
50%	-	$ 0.321	$ 0.171	$ 0.079	$ 0.127	-
60%	-	$ 0.363	$ 0.177	$ 0.079	$ 0.130	-
70%	-	$ 0.405	$ 0.183	$ 0.079	$ 0.133	-
80%	-	$ 0.452	$ 0.189	$ 0.079	$ 0.136	-
90%	-	$ 0.490	$ 0.195	$ 0.079	$ 0.138	-
100%	-	$ 0.529	$ 0.201	$ 0.079	$ 0.141	-

6KEXTMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.120	$ 0.148	$ 0.085	$ 0.120	-
10%	-	$ 0.162	$ 0.132	$ 0.085	$ 0.123	-
20%	-	$ 0.203	$ 0.143	$ 0.085	$ 0.126	-
30%	-	$ 0.245	$ 0.155	$ 0.085	$ 0.128	-
40%	-	$ 0.286	$ 0.166	$ 0.085	$ 0.131	-
50%	-	$ 0.328	$ 0.177	$ 0.085	$ 0.134	-
60%	-	$ 0.369	$ 0.189	$ 0.085	$ 0.137	-
70%	-	$ 0.411	$ 0.200	$ 0.085	$ 0.139	-
80%	-	$ 0.452	$ 0.212	$ 0.085	$ 0.142	-
90%	-	$ 0.494	$ 0.223	$ 0.085	$ 0.145	-
100%	-	$ 0.536	$ 0.235	$ 0.085	$ 0.148	-

6KEXTHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.135	$ 0.135	$ 0.100	$ 0.135	-
10%	-	$ 0.176	$ 0.146	$ 0.100	$ 0.137	-
20%	-	$ 0.218	$ 0.158	$ 0.100	$ 0.140	-
30%	-	$ 0.259	$ 0.169	$ 0.100	$ 0.143	-
40%	-	$ 0.301	$ 0.180	$ 0.100	$ 0.146	-
50%	-	$ 0.342	$ 0.192	$ 0.100	$ 0.148	-
60%	-	$ 0.384	$ 0.203	$ 0.100	$ 0.151	-
70%	-	$ 0.425	$ 0.215	$ 0.100	$ 0.154	-
80%	-	$ 0.467	$ 0.226	$ 0.100	$ 0.157	-
90%	-	$ 0.509	$ 0.238	$ 0.100	$ 0.159	-
100%	-	$ 0.550	$ 0.249	$ 0.100	$ 0.162	-

30KEXTLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.083	$ 0.110	$ 0.048	$ 0.083	-
10%	-	$ 0.094	$ 0.116	$ 0.048	$ 0.086	-
20%	-	$ 0.106	$ 0.122	$ 0.048	$ 0.088	-
30%	-	$ 0.203	$ 0.124	$ 0.048	$ 0.091	-
40%	-	$ 0.244	$ 0.129	$ 0.048	$ 0.094	-
50%	-	$ 0.284	$ 0.133	$ 0.048	$ 0.097	-
60%	-	$ 0.324	$ 0.138	$ 0.048	$ 0.099	-
70%	-	$ 0.364	$ 0.143	$ 0.048	$ 0.102	-
80%	-	$ 0.404	$ 0.147	$ 0.048	$ 0.105	-
90%	-	$ 0.445	$ 0.152	$ 0.048	$ 0.108	-
100%	-	$ 0.485	$ 0.156	$ 0.048	$ 0.110	-

30KEXTMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.088	$ 0.115	$ 0.053	$ 0.088	-
10%	-	$ 0.099	$ 0.099	$ 0.053	$ 0.091	-
20%	-	$ 0.111	$ 0.111	$ 0.053	$ 0.093	-
30%	-	$ 0.209	$ 0.118	$ 0.053	$ 0.096	-
40%	-	$ 0.249	$ 0.128	$ 0.053	$ 0.099	-
50%	-	$ 0.289	$ 0.138	$ 0.053	$ 0.102	-
60%	-	$ 0.329	$ 0.148	$ 0.053	$ 0.104	-
70%	-	$ 0.369	$ 0.159	$ 0.053	$ 0.107	-
80%	-	$ 0.409	$ 0.169	$ 0.053	$ 0.110	-
90%	-	$ 0.450	$ 0.179	$ 0.053	$ 0.113	-
100%	-	$ 0.490	$ 0.189	$ 0.053	$ 0.115	-

30KEXTHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.102	$ 0.102	$ 0.067	$ 0.102	-
10%	-	$ 0.113	$ 0.113	$ 0.067	$ 0.105	-
20%	-	$ 0.125	$ 0.125	$ 0.067	$ 0.107	-
30%	-	$ 0.222	$ 0.132	$ 0.067	$ 0.110	-
40%	-	$ 0.263	$ 0.142	$ 0.067	$ 0.113	-
50%	-	$ 0.303	$ 0.152	$ 0.067	$ 0.116	-
60%	-	$ 0.343	$ 0.162	$ 0.067	$ 0.118	-
70%	-	$ 0.383	$ 0.172	$ 0.067	$ 0.121	-
80%	-	$ 0.423	$ 0.183	$ 0.067	$ 0.124	-
90%	-	$ 0.463	$ 0.193	$ 0.067	$ 0.127	-
100%	-	$ 0.504	$ 0.203	$ 0.067	$ 0.129	-

130KEXTLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.064	$ 0.092	$ 0.029	$ 0.064	-
10%	-	$ 0.104	$ 0.096	$ 0.029	$ 0.067	-
20%	-	$ 0.145	$ 0.101	$ 0.029	$ 0.070	-
30%	-	$ 0.185	$ 0.105	$ 0.029	$ 0.072	-
40%	-	$ 0.225	$ 0.110	$ 0.029	$ 0.075	-
50%	-	$ 0.265	$ 0.115	$ 0.029	$ 0.078	-
60%	-	$ 0.305	$ 0.119	$ 0.029	$ 0.081	-
70%	-	$ 0.345	$ 0.124	$ 0.029	$ 0.083	-
80%	-	$ 0.386	$ 0.128	$ 0.029	$ 0.086	-
90%	-	$ 0.426	$ 0.133	$ 0.029	$ 0.089	-
100%	-	$ 0.466	$ 0.138	$ 0.029	$ 0.092	-

130KEXTMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.069	$ 0.096	$ 0.034	$ 0.069	-
10%	-	$ 0.109	$ 0.079	$ 0.034	$ 0.072	-
20%	-	$ 0.149	$ 0.089	$ 0.034	$ 0.074	-
30%	-	$ 0.190	$ 0.099	$ 0.034	$ 0.077	-
40%	-	$ 0.230	$ 0.109	$ 0.034	$ 0.080	-
50%	-	$ 0.270	$ 0.119	$ 0.034	$ 0.083	-
60%	-	$ 0.310	$ 0.129	$ 0.034	$ 0.085	-
70%	-	$ 0.350	$ 0.140	$ 0.034	$ 0.088	-
80%	-	$ 0.390	$ 0.150	$ 0.034	$ 0.091	-
90%	-	$ 0.431	$ 0.160	$ 0.034	$ 0.094	-
100%	-	$ 0.471	$ 0.170	$ 0.034	$ 0.096	-

130KEXTHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	-	$ 0.083	$ 0.083	$ 0.048	$ 0.083	-
10%	-	$ 0.124	$ 0.093	$ 0.048	$ 0.086	-
20%	-	$ 0.164	$ 0.104	$ 0.048	$ 0.089	-
30%	-	$ 0.204	$ 0.114	$ 0.048	$ 0.092	-
40%	-	$ 0.244	$ 0.124	$ 0.048	$ 0.094	-
50%	-	$ 0.284	$ 0.134	$ 0.048	$ 0.097	-
60%	-	$ 0.324	$ 0.144	$ 0.048	$ 0.100	-
70%	-	$ 0.365	$ 0.154	$ 0.048	$ 0.103	-
80%	-	$ 0.405	$ 0.164	$ 0.048	$ 0.105	-
90%	-	$ 0.445	$ 0.174	$ 0.048	$ 0.108	-
100%	-	$ 0.485	$ 0.184	$ 0.048	$ 0.111	-

6KA2OLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.158	$ 0.158	$ 0.186	$ 0.123	$ 0.158	$ 0.158
10%	$ 0.170	$ 0.200	$ 0.192	$ 0.123	$ 0.161	$ 0.179
20%	$ 0.181	$ 0.242	$ 0.198	$ 0.123	$ 0.164	$ 0.199
30%	$ 0.193	$ 0.283	$ 0.204	$ 0.123	$ 0.167	$ 0.219
40%	$ 0.204	$ 0.325	$ 0.210	$ 0.123	$ 0.169	$ 0.240
50%	$ 0.216	$ 0.366	$ 0.216	$ 0.123	$ 0.172	$ 0.260
60%	$ 0.227	$ 0.408	$ 0.222	$ 0.123	$ 0.175	$ 0.280
70%	$ 0.239	$ 0.449	$ 0.228	$ 0.123	$ 0.178	$ 0.300
80%	$ 0.250	$ 0.491	$ 0.234	$ 0.123	$ 0.180	$ 0.321
90%	$ 0.261	$ 0.532	$ 0.240	$ 0.123	$ 0.183	$ 0.341
100%	$ 0.273	$ 0.574	$ 0.246	$ 0.123	$ 0.186	$ 0.361

6KA2OMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.164	$ 0.164	$ 0.191	$ 0.128	$ 0.164	$ 0.164
10%	$ 0.175	$ 0.205	$ 0.175	$ 0.128	$ 0.166	$ 0.184
20%	$ 0.186	$ 0.247	$ 0.186	$ 0.128	$ 0.169	$ 0.204
30%	$ 0.198	$ 0.288	$ 0.198	$ 0.128	$ 0.172	$ 0.224
40%	$ 0.209	$ 0.330	$ 0.209	$ 0.128	$ 0.174	$ 0.245
50%	$ 0.221	$ 0.371	$ 0.221	$ 0.128	$ 0.177	$ 0.265
60%	$ 0.232	$ 0.413	$ 0.232	$ 0.128	$ 0.180	$ 0.285
70%	$ 0.244	$ 0.454	$ 0.244	$ 0.128	$ 0.183	$ 0.306
80%	$ 0.255	$ 0.496	$ 0.255	$ 0.128	$ 0.185	$ 0.326
90%	$ 0.267	$ 0.537	$ 0.267	$ 0.128	$ 0.188	$ 0.346
100%	$ 0.278	$ 0.579	$ 0.278	$ 0.128	$ 0.191	$ 0.366

6KA2OHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.185	$ 0.185	$ 0.185	$ 0.150	$ 0.185	$ 0.185
10%	$ 0.197	$ 0.227	$ 0.197	$ 0.150	$ 0.188	$ 0.205
20%	$ 0.208	$ 0.268	$ 0.208	$ 0.150	$ 0.191	$ 0.226
30%	$ 0.220	$ 0.310	$ 0.220	$ 0.150	$ 0.193	$ 0.246
40%	$ 0.231	$ 0.351	$ 0.231	$ 0.150	$ 0.196	$ 0.266
50%	$ 0.242	$ 0.393	$ 0.242	$ 0.150	$ 0.199	$ 0.287
60%	$ 0.254	$ 0.434	$ 0.254	$ 0.150	$ 0.202	$ 0.307
70%	$ 0.265	$ 0.476	$ 0.265	$ 0.150	$ 0.204	$ 0.327
80%	$ 0.277	$ 0.518	$ 0.277	$ 0.150	$ 0.207	$ 0.348
90%	$ 0.288	$ 0.559	$ 0.288	$ 0.150	$ 0.210	$ 0.368
100%	$ 0.300	$ 0.601	$ 0.300	$ 0.150	$ 0.213	$ 0.388

30KA2OLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.113	$ 0.113	$ 0.140	$ 0.078	$ 0.113	$ 0.113
10%	$ 0.124	$ 0.124	$ 0.146	$ 0.078	$ 0.115	$ 0.133
20%	$ 0.136	$ 0.136	$ 0.152	$ 0.078	$ 0.118	$ 0.153
30%	$ 0.143	$ 0.233	$ 0.154	$ 0.078	$ 0.121	$ 0.174
40%	$ 0.153	$ 0.273	$ 0.158	$ 0.078	$ 0.124	$ 0.194
50%	$ 0.163	$ 0.314	$ 0.163	$ 0.078	$ 0.126	$ 0.214
60%	$ 0.173	$ 0.354	$ 0.168	$ 0.078	$ 0.129	$ 0.234
70%	$ 0.183	$ 0.394	$ 0.172	$ 0.078	$ 0.132	$ 0.255
80%	$ 0.199	$ 0.440	$ 0.177	$ 0.078	$ 0.135	$ 0.275
90%	$ 0.206	$ 0.477	$ 0.181	$ 0.078	$ 0.137	$ 0.295
100%	$ 0.213	$ 0.514	$ 0.186	$ 0.078	$ 0.140	$ 0.316

30KA2OMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.117	$ 0.117	$ 0.145	$ 0.082	$ 0.117	$ 0.117
10%	$ 0.129	$ 0.129	$ 0.129	$ 0.082	$ 0.120	$ 0.138
20%	$ 0.140	$ 0.140	$ 0.140	$ 0.082	$ 0.123	$ 0.158
30%	$ 0.147	$ 0.238	$ 0.147	$ 0.082	$ 0.125	$ 0.178
40%	$ 0.158	$ 0.278	$ 0.158	$ 0.082	$ 0.128	$ 0.198
50%	$ 0.168	$ 0.318	$ 0.168	$ 0.082	$ 0.131	$ 0.219
60%	$ 0.178	$ 0.358	$ 0.178	$ 0.082	$ 0.134	$ 0.239
70%	$ 0.188	$ 0.398	$ 0.188	$ 0.082	$ 0.136	$ 0.259
80%	$ 0.198	$ 0.439	$ 0.198	$ 0.082	$ 0.139	$ 0.280
90%	$ 0.208	$ 0.479	$ 0.208	$ 0.082	$ 0.142	$ 0.300
100%	$ 0.218	$ 0.519	$ 0.218	$ 0.082	$ 0.145	$ 0.320

30KA2OHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.135	$ 0.135	$ 0.135	$ 0.100	$ 0.135	$ 0.135
10%	$ 0.146	$ 0.146	$ 0.146	$ 0.100	$ 0.138	$ 0.155
20%	$ 0.158	$ 0.158	$ 0.158	$ 0.100	$ 0.140	$ 0.175
30%	$ 0.165	$ 0.255	$ 0.165	$ 0.100	$ 0.143	$ 0.196
40%	$ 0.175	$ 0.296	$ 0.175	$ 0.100	$ 0.146	$ 0.216
50%	$ 0.185	$ 0.336	$ 0.185	$ 0.100	$ 0.149	$ 0.236
60%	$ 0.195	$ 0.376	$ 0.195	$ 0.100	$ 0.151	$ 0.257
70%	$ 0.205	$ 0.416	$ 0.205	$ 0.100	$ 0.154	$ 0.277
80%	$ 0.216	$ 0.456	$ 0.216	$ 0.100	$ 0.157	$ 0.297
90%	$ 0.226	$ 0.496	$ 0.226	$ 0.100	$ 0.160	$ 0.318
100%	$ 0.236	$ 0.537	$ 0.236	$ 0.100	$ 0.162	$ 0.338

130KA2OLOW	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.079	$ 0.079	$ 0.107	$ 0.044	$ 0.079	$ 0.079
10%	$ 0.089	$ 0.119	$ 0.111	$ 0.044	$ 0.082	$ 0.099
20%	$ 0.099	$ 0.159	$ 0.116	$ 0.044	$ 0.085	$ 0.120
30%	$ 0.109	$ 0.200	$ 0.120	$ 0.044	$ 0.087	$ 0.140
40%	$ 0.119	$ 0.240	$ 0.125	$ 0.044	$ 0.090	$ 0.160
50%	$ 0.130	$ 0.280	$ 0.130	$ 0.044	$ 0.093	$ 0.181
60%	$ 0.140	$ 0.320	$ 0.134	$ 0.044	$ 0.096	$ 0.201
70%	$ 0.150	$ 0.360	$ 0.139	$ 0.044	$ 0.098	$ 0.221
80%	$ 0.160	$ 0.401	$ 0.143	$ 0.044	$ 0.101	$ 0.241
90%	$ 0.173	$ 0.441	$ 0.148	$ 0.044	$ 0.104	$ 0.262
100%	$ 0.180	$ 0.481	$ 0.153	$ 0.044	$ 0.107	$ 0.282

130KA2OMED	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.083	$ 0.083	$ 0.110	$ 0.048	$ 0.083	$ 0.083
10%	$ 0.093	$ 0.123	$ 0.093	$ 0.048	$ 0.086	$ 0.103
20%	$ 0.103	$ 0.163	$ 0.103	$ 0.048	$ 0.088	$ 0.124
30%	$ 0.113	$ 0.204	$ 0.113	$ 0.048	$ 0.091	$ 0.144
40%	$ 0.123	$ 0.244	$ 0.123	$ 0.048	$ 0.094	$ 0.164
50%	$ 0.133	$ 0.284	$ 0.133	$ 0.048	$ 0.097	$ 0.184
60%	$ 0.143	$ 0.324	$ 0.143	$ 0.048	$ 0.099	$ 0.205
70%	$ 0.154	$ 0.364	$ 0.154	$ 0.048	$ 0.102	$ 0.225
80%	$ 0.164	$ 0.404	$ 0.164	$ 0.048	$ 0.105	$ 0.245
90%	$ 0.174	$ 0.445	$ 0.174	$ 0.048	$ 0.108	$ 0.266
100%	$ 0.184	$ 0.485	$ 0.184	$ 0.048	$ 0.110	$ 0.286

130KA2OHIGH	TS_1	TS_2	TS_3	TS_4	TS_5	TS_6
0%	$ 0.100	$ 0.100	$ 0.100	$ 0.065	$ 0.100	$ 0.100
10%	$ 0.110	$ 0.140	$ 0.110	$ 0.065	$ 0.103	$ 0.120
20%	$ 0.120	$ 0.180	$ 0.120	$ 0.065	$ 0.106	$ 0.141
30%	$ 0.130	$ 0.221	$ 0.130	$ 0.065	$ 0.108	$ 0.161
40%	$ 0.140	$ 0.261	$ 0.140	$ 0.065	$ 0.111	$ 0.181
50%	$ 0.150	$ 0.301	$ 0.150	$ 0.065	$ 0.114	$ 0.202
60%	$ 0.161	$ 0.341	$ 0.161	$ 0.065	$ 0.116	$ 0.222
70%	$ 0.171	$ 0.381	$ 0.171	$ 0.065	$ 0.119	$ 0.242
80%	$ 0.181	$ 0.421	$ 0.181	$ 0.065	$ 0.122	$ 0.262
90%	$ 0.191	$ 0.462	$ 0.191	$ 0.065	$ 0.125	$ 0.283
100%	$ 0.201	$ 0.502	$ 0.201	$ 0.065	$ 0.127	$ 0.303