# Appendix 1. Example of Cost Estimation using CapdetWorks 2.1

Additional detailed information that is related to Chapter 6 is contained in the present appendix.

## 1.1 Detailed Procedure for Application of CapdetWorks to a Scenario

A sample case of costing water disposal using CapdetWorks 2.1 for the Broward/North WWTP for 2005 flow with Alternative 1 and scenario A is presented here. The current design capacity of the plant is 84 MGD that is projected to expand to a capacity of 94 MGD in 2025. Water flow rates to the ocean outfall are at 51 MGD following secondary treatment and basic level chlorine disinfection. Water flow rates to the UIC wells are at 30 MGD, following secondary treatment. Water flow rates for traditional reuse are at 2.4 MGD following secondary treatment with filtration and high level chlorine disinfection.

Table 1-1 lists parameters that will be entered into CapdetWorks menus. In the sections that follow, a step by step procedure is provided as a guide to enter the parameters below into CapdetWorks. After entering these data, CapdetWorks may be used to estimate the project cost, land cost and total annual O&M cost.

**Appendix Table 1-1.** List of parameters for input to CapdetWorks

| Path to Menu / Treatment Object in Process Tool Bar | Parameter | Value to be entered | Comments |
|---|---|---|---|
| Cost data > Unit Costs | Land costs | 120,000 $/acre | |
| Cost data > Cost Indices | Marshall & Swift Index | 1250 | |
| | Engineering News Records Cost Index (ENR Cost | 7410 | (Although the ENR Cost Index value for 2005 is 7405, CapdetWorks rounds the value to 7410) |
| | Pipe Cost Index | 620 | |
| Influent Wastewater | Average Flow | 84.1 MGD(US) | |
| | Minimum Flow | 84.1 MGD(US) | Simulations carried out with CapdetWorks suggested that costing did not change when minimum flow was different from average flow |
| | Maximum Flow | 194 MGD (US) | A peaking factor of 2.3 was used to evaluate maximum flow. CapdetWorks rounds off the calculated value of 193.6 to 194 MGD |

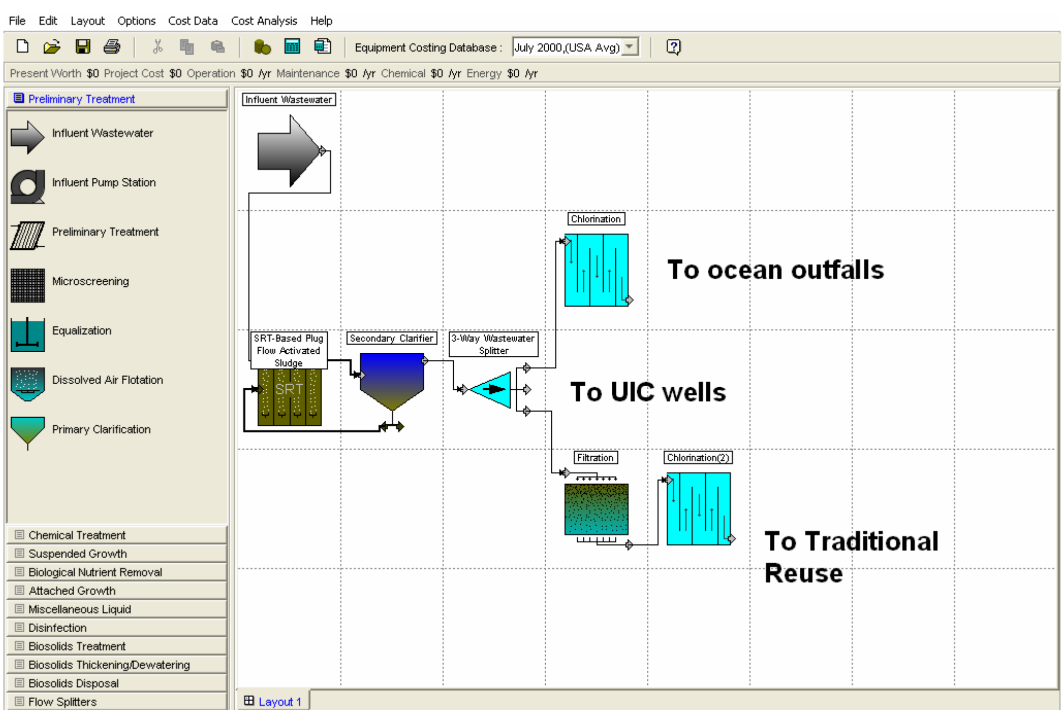
| Path to Menu / Treatment Object in Process Tool | Parameter | Value to be entered | Comments |
|---|---|---|---|
| Influent Wastewater | Suspended Solids | 248 mg/L | |
| | BOD | 142 mg/L | |
| | Soluble BOD | 0 mg/L | (Previous simulations indicate that soluble BOD values do not impact costing as long as it is below the BOD level) |
| | COD | 0 mg/L | (Previous simulations indicate that COD values are superseded by BOD values) |
| | Soluble COD | 0 mg/L | (Previous simulations indicate that soluble COD values do not impact costing as long as it is below the COD level) |
| | TKN | 25.8 mg/L | TKN levels were calculated from BOD levels using an empirical relationship obtained from Metcalf and Eddy (1991 ) |
| | Soluble TKN | 0 mg/L | (Previous simulations indicate that soluble TKN values do not impact costing as long as it is below the TKN level) |
| | Ammonia | 0 mg/L | |
| | Total Phosphorous | 5.2 mg/L | Total Phosphorous levels were calculated from BOD levels using an empirical relationship obtained from Metcalf and Eddy (1991 ) |
| SRT-Based Plug Flow Activated Sludge | Design SRT | 3.53 d | |
| | Mixed Liquor Suspended Solids | 2000 mg/L | |
| Wastewater Flow Splitter | Percent of Flow To First Split | 61.5 | Flow to Ocean Outfall = 59.07 MGD. |
| | Percent of Flow To Second Split | 35.7 | Flow to UIC Well = 35.7 MGD. The percent of flow to the third split is calculated automatically by CapdetWorks. |

| Path to Menu / Treatment Object in Process Tool Bar | Parameter | Value to be entered | Comments |
|---|---|---|---|
| Chlorination (leading to ocean outfalls) | Contact Time at Peak Flow | 15 min | |
| Chlorination (following filtration, leading to Traditional Reuse) | Contact Time at Peak Flow | 45 min | |
| | Chlorine Dose | 16 mg/L | |

CapdetWorks displays default values in black and non default values in blue. For the benefit of those reading this procedure from a black and white print out, we specify which values are different from the default.

### 1.1.1 Creation of Plant Layout

The first step is to create a layout that represents the plant. The layout is assembled in the Drawing Board of the CapdetWorks screen. The plant is assembled by connecting objects that are selected and dragged from treatment options listed in the Process Tool Bar (Fig. 1-1). For further details, the reader is referred to the CapdetWorks Users Guide manual that is available as a pdf file upon installation of the software.




**Appendix Figure 1-1.** Layout representing Broward/North WWTP 2005 Flow with Alternative I, scenario A

In the example presented, the object “Influent Treatment” may be selected from the Preliminary Treatment option listed in the Process Tool Bar. Similarly, the“SRT-Based Plug flow Activated Sludge” may be obtained from the Suspended Growth option listed in the Process Tool Bar. The “Secondary Clarifier” is a part of the “SRT-Based Plug Flow Activated Sludge” object and does not need to be selected separately.

The “3-Way Wastewater Splitter” object is selected from the Flow Splitters option listed in the Process Tool Bar. The “Chlorination (tank)” object is available in the Disinfection option and the “Filtration” object is available in the “Miscellaneous Liquid” option listed in the Process Tool Bar.

## 1.2 Procedure to Input Influent Parameters

This section describes the procedure to input the influent parameters listed in Table 1-1, into CapdetWorks. Each input into a CapdetWorks menu is accompanied by a figure that illustrates the values that is entered into respective menus.

### 1.2.1 Input of Land Costs

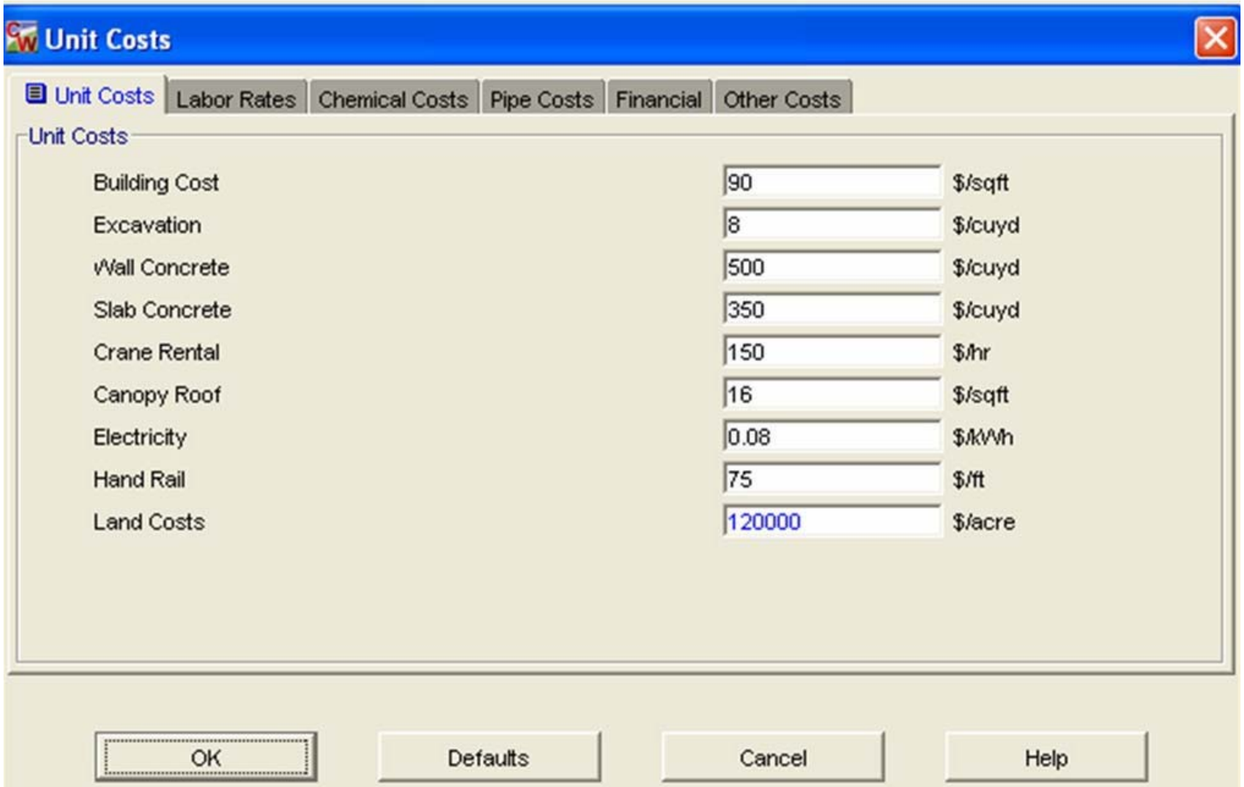
In the CapdetWorks Menu Bar, follow the path: Cost data > Unit Costs. Overwrite the default land cost of 10,000 $/acre with 120,000 $/acre (Figure 1-2).

### 1.2.2 Input of Cost Indices

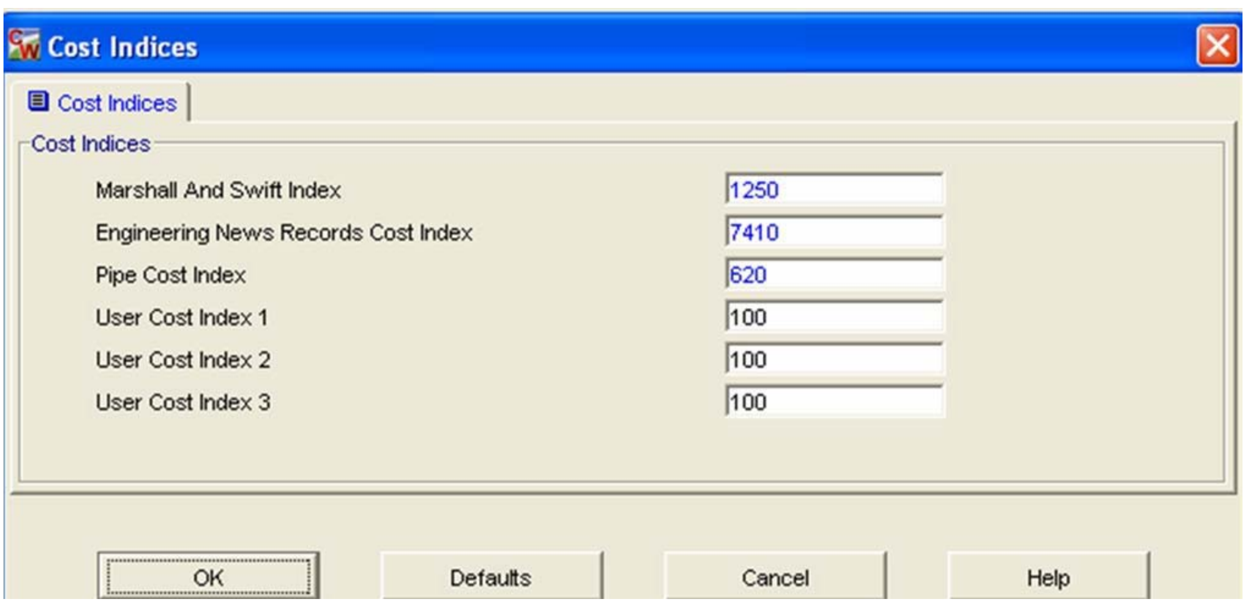
In the CapdetWorks Menu Bar, follow the path: Cost data > Cost Indices. Update the default index values with those that correspond to the year 2005 (Table 1-1) as shown in Figure 1-3.

### 1.2.3 Input of Influent Wastewater Composition

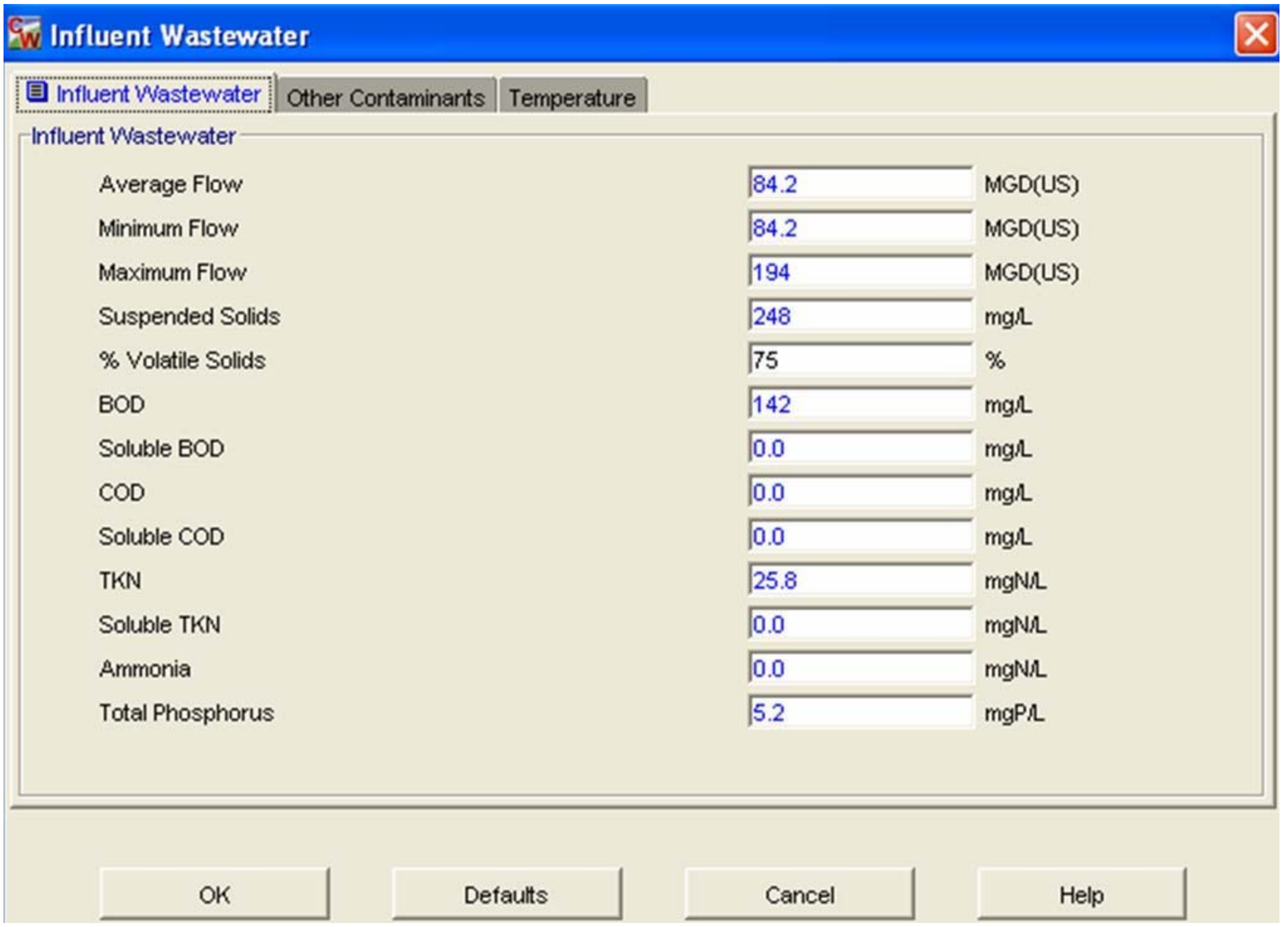
To enter the influent wastewater composition listed in Table 1-1, right click on the object “Influent Wastewater” located in the drawing board of the CapdetWorks screen and select the option “Edit Influent Wastewater Parameters.” The influent wastewater parameters entered is illustrated in Figure 1-3, and appear in blue color. For those with a black and white print out, all values have been altered except for “% Volatile Solids”, for which the default value is retained.




**Appendix Figure 1-2.** Menu to be used to enter land costs




**Appendix Figure 1-3.** Menu of cost indices




**Appendix Figure 1-4.** Menu to enter influent wastewater parameters

### 1.2.4 Input of Parameters for SRT-Based Plug Flow Activated Sludge and Secondary Clarifier

Right click on the "SRT-Based Plug Flow Activated Sludge" object in the drawing board of the CapdetWorks screen and select the option "edit SRT based plug flow activated sludge reactor parameters." In the menu that appears, overwrite the design SRT with the value shown in the first window that constitutes Figure 1-5. This value was calculated based on the specified reactor volume, specified MLSS and influent flow rate. Next, select the "Mixed Liquor" option of the menu that appears and enter the MLSS value as shown in the second window of Figure 1-5. None of the parameters of the Secondary Clarifier were altered.

### 1.2.5 Input Parameters for 3-way Wastewater Flow Splitter

The percentage of influent water flow that branch to the ocean outfalls, UIC wells and traditional reuse is entered into the 3-way wastewater flow splitter. Right click on the graphical module to enter the parameters as shown in Figure 1-6.

### 1.2.6 Input Parameters for the Chlorination Tank that leads to the Ocean Outfalls Stream

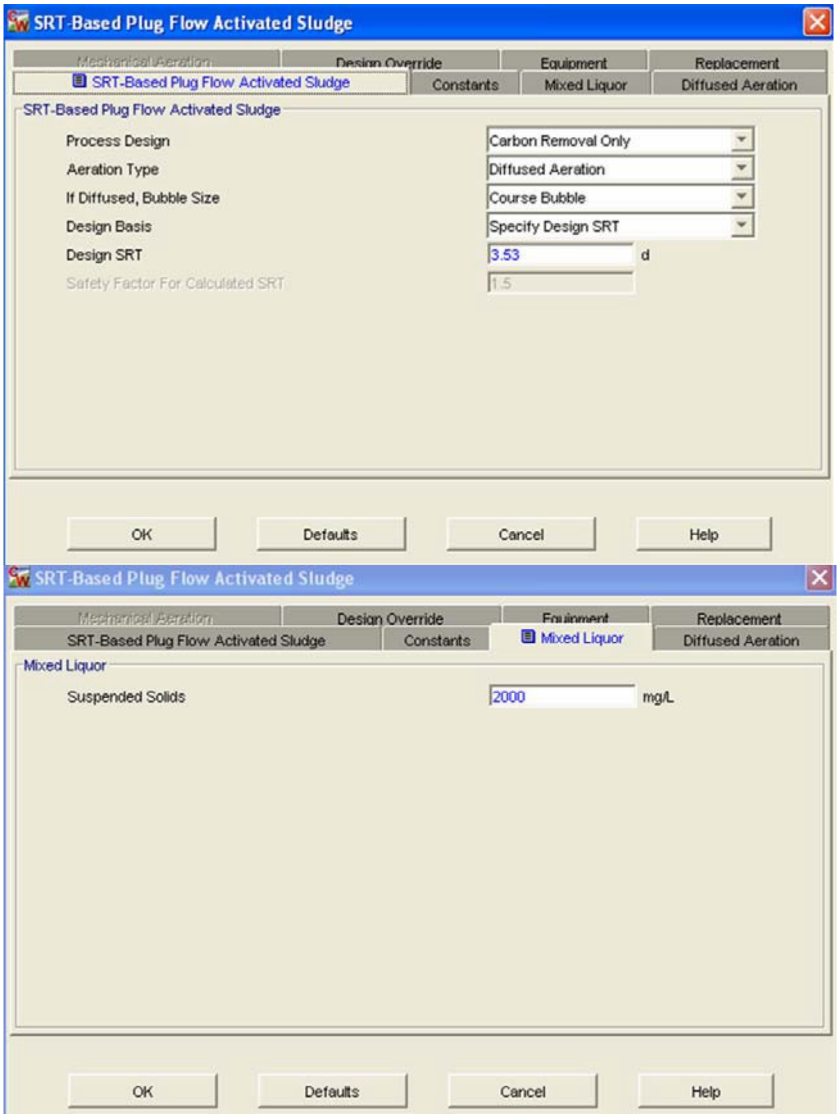
The input parameters for the water stream that discharges into the ocean outfalls post basic level chlorine disinfection water is represented by Figure 1-7. This chlorination tank is located north of the “3 way wastewater splitter” as depicted by Figure 1-1.

Right click on the Chlorination object and select “Edit Chlorination Parameters.” In the menu that appears, replace the default value of “contact time at peak flow” with the value as listed in Figure 1-7.

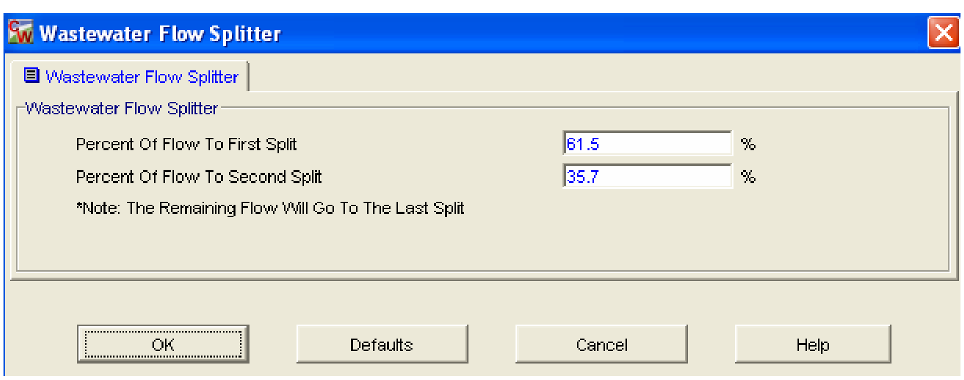
### 1.2.7 Input Parameters for the Chlorination Tank that leads to Traditional Reuse

The input parameters for the water stream that leads to Traditional Reuse post filtration and high level chlorine disinfection water is depicted by Figure 1-8.

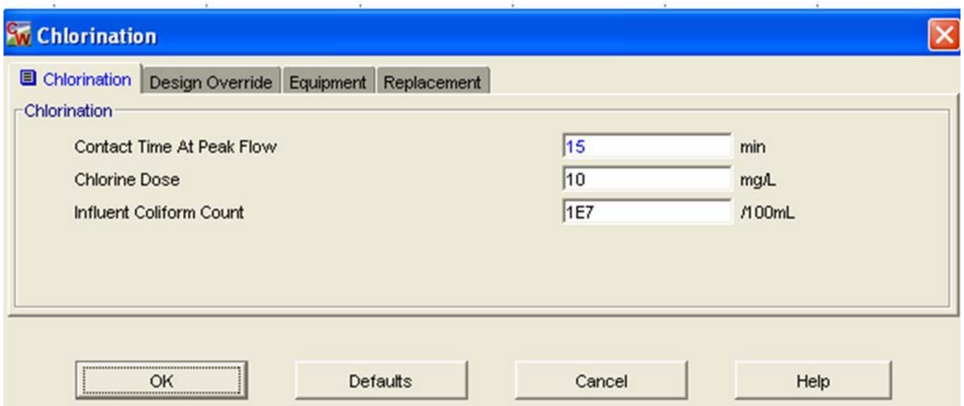
No default parameters of the filtration unit were changed. By a similar procedure as followed in section 1.2.6, parameters of the chlorination object is altered to values as shown in Figure 1-8 that correspond to high level chlorine disinfection.



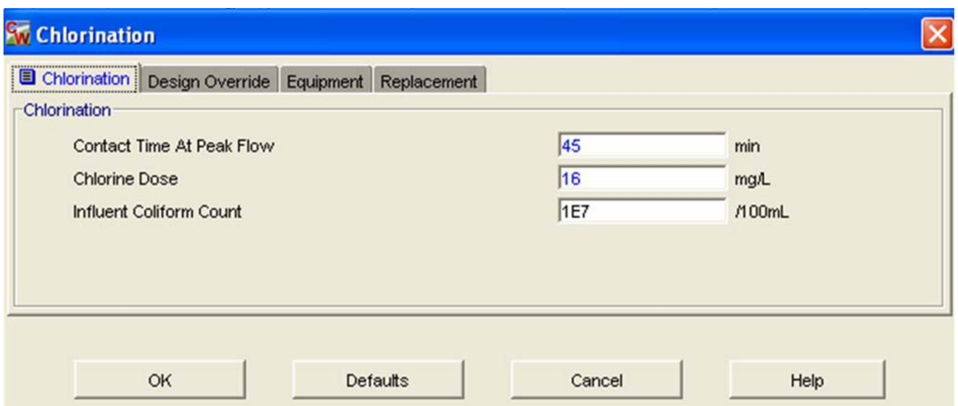

**Appendix Figure 1-5.** Input parameters for SRT based plug flow activated sludge




**Appendix Figure 1-6.** Input parameters for 3-way wastewater flow splitter




**Appendix Figure 1-7.** Parameters entered for the chlorination tank where water discharging in the ocean outfalls is treated for basic level chorine disinfection




**Appendix Figure 1-8.** Parameters entered for the chlorination tank where water leading to traditional reuse is treated by filtration and high level chorine disinfection

### 1.2.8 Cost Estimation

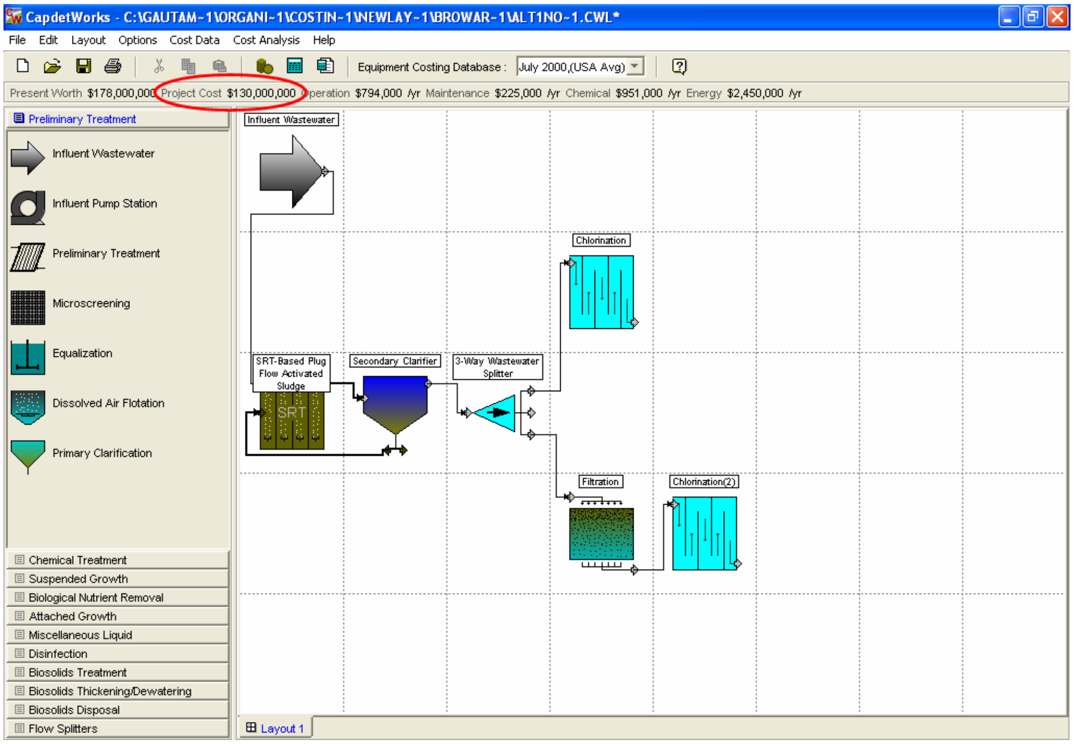
Estimate the cost by selecting: Cost Analysis > Estimate Cost of Current Layout. Figure 1-9 illustrates the Project Cost estimated by CapdetWorks.

Further, to obtain detailed costing data, select: Cost Analysis > Details of Cost Estimate.

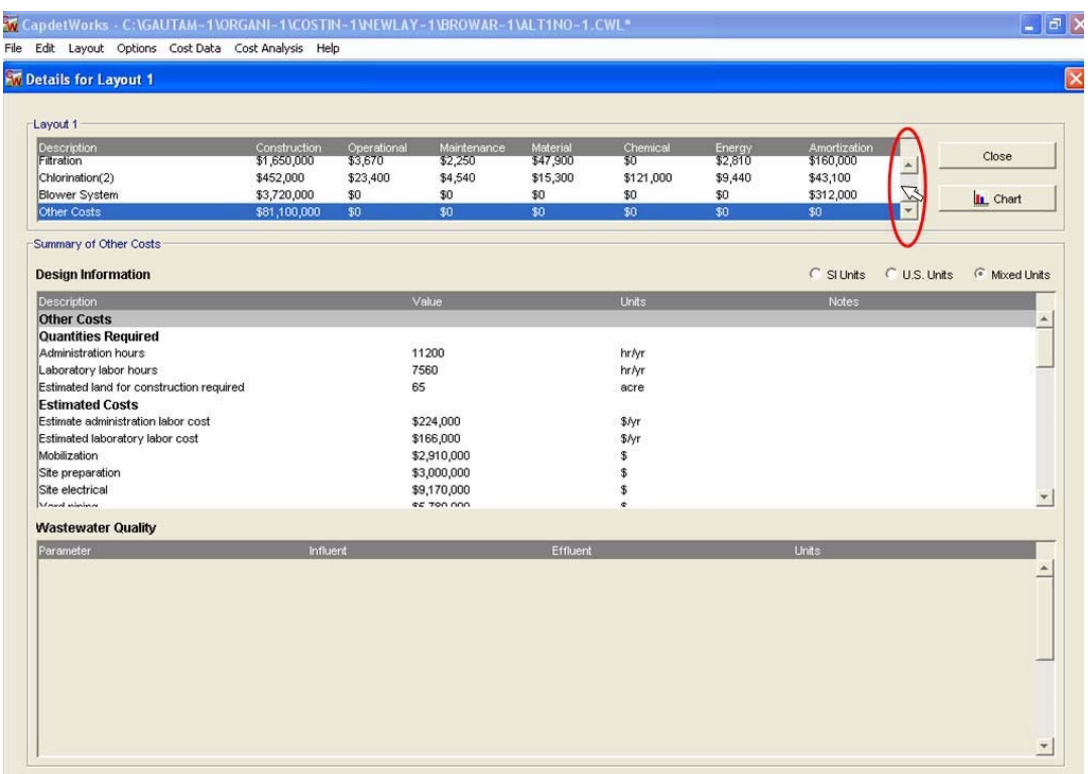
The screen that appears has a scroll bar in the window titled "Layout 1." Scroll down to the very end of the Layout 1 to the region titled "Other costs" (Fig. 1-10).

To obtain detailed costing data, select: Cost Analysis > Details of cost estimate.

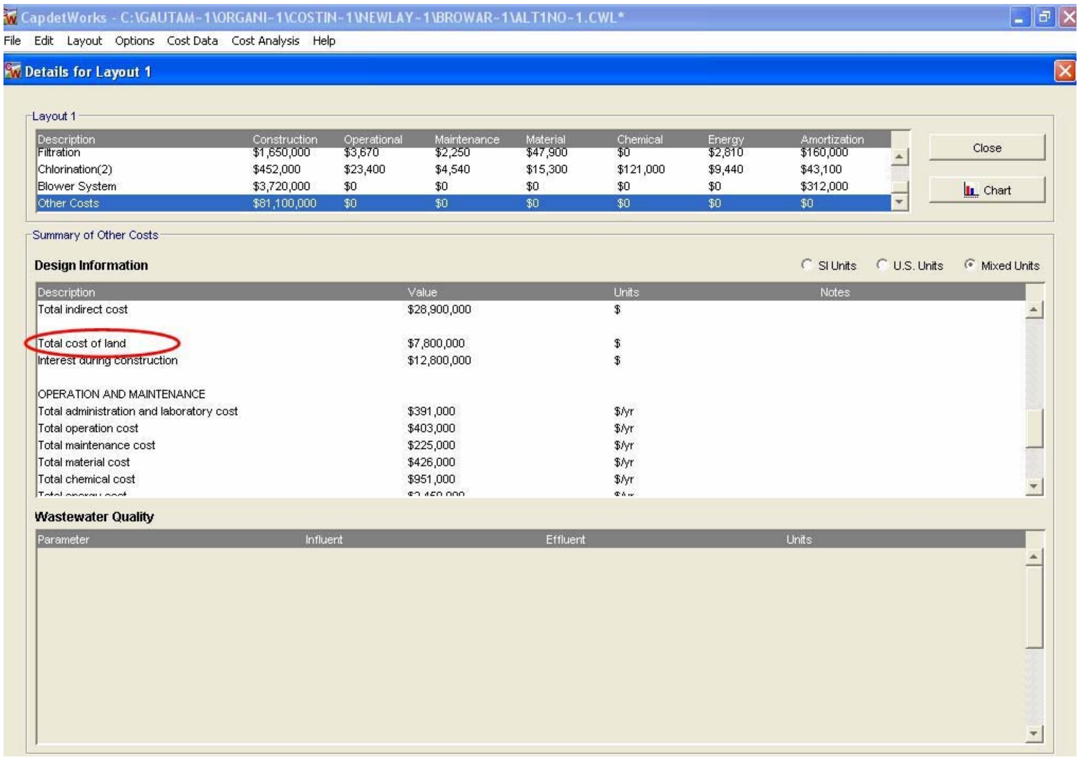
In the middle window of the screen, scroll down and note the values of Land cost (Fig. 1-11), Total annual O&M cost and Total Project Cost (Fig. 1-12).




**Appendix Figure 1-9.** Project Cost of treatment process for Broward/North WWTP 2005 Flow with Alternative 1, scenario A, as evaluated by CapdetWorks

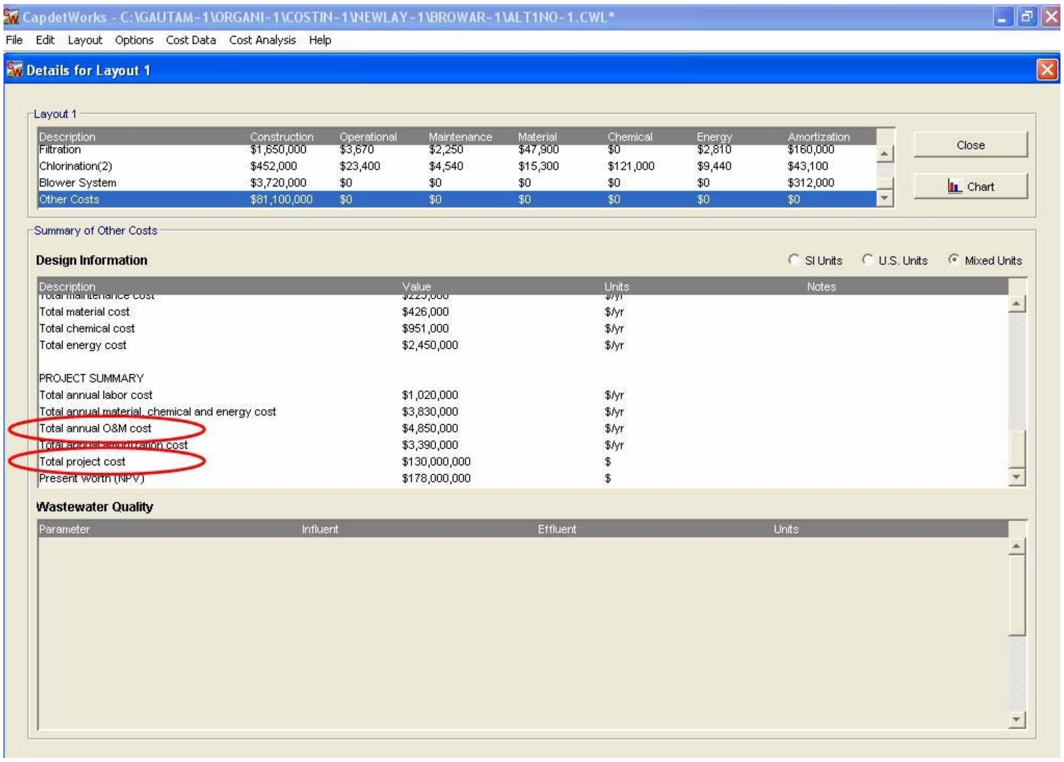



**Appendix Figure 1-10.** Location of “Other Costs” in CapdetWorks




**Appendix Figure 1-11.** Values of Land Cost obtained from the "Summary of Other Costs" in CapdetWorks

For the specified set of parameters, CapdetWorks evaluates the total Project Cost of the Broward/North plant at $130,000,000. Total annual O&M cost was evaluated at $4,850,000 per year and Land Cost was evaluated at $7,800,000.The unit cost per 1000 gallons ($/1000 gal) of wastewater treated is evaluated by the following procedure, as summarized in Table 1-2.




**Appendix Figure 1-12.** Values of Total annual O&M cost and Total Project Cost obtained from the "Summary of Other Costs" in CapdetWorks

**Appendix Table 1-2.** Procedure to estimate the annual cost of project and unit cost/1000 gal of wastewater treated using cost data obtained from CapdetWorks

| **Procedure** | **Formula Used** | **Result** |
|---|---|---|
| Deduct Land Cost from Total Project Cost | Total Project Cost – Land Cost | $130,000,000 – $7,800,000 = $ 122,200,000 (a) |
| Annualizing Project Cost that excludes Land Cost | Capital Recovery Factor* × (a) | $ 122,200,000 × 0.094 = $ 16,882,800 per year (b) |
| Annualizing Land Cost | Discount Rate* × Land Cost | 0.07 × $7,800,000 = $ 546,000 per year (c) |
| Total Annualized Project Cost | (b) + (c) + Operations and Maintenance Cost** | = $/yr (16,882,800 + 546,000 + 4,850,000) = $/yr 16,882,800 (d) |
| Cost/ 1000 gal | (d)/(Daily Influent) | = 16,882,800/(365×1000×84.2) = 0.549 $/1000 gal |

*Capital Recovery Factor evaluated at a discount rate of 7% for 20 years = 0.094

**The cost that we obtained through the procedure described in Table 1-2 is not the total cost. It represents only the total cost obtained from CapdetWorks. However, there are other costs contributing to the annualized project costs that are computed separately, annualized using the capital recovery factor and accounted in the total annualized project cost. These are described in the paragraph that follows.

If a plant has preliminary treatment step, the associated cost is evaluated separately as the "Preliminary Treatment" object, available in the Process Tool Bar of CapdetWorks, was found to behave unpredictably. Further, the costs treatment of biosolids and distribution of traditional reuse water are also evaluated separately using empirical cost functions. If ground water recharge is practiced in a plant, membrane filtration, reverse osmosis, filtration and advanced oxidation costs are evaluated separately using empirical cost functions. In addition, cost to transport permeates to the site of injection and costs associated with ground water injection wells are evaluated separately. Costs associated with the transport of concentrate to a site of injection, costs associated with deep wells and pumping costs associated with injecting concentrates to a non-potable aquifer are evaluated separately. These costs are added to the total annualized project cost following which the unit cost of wastewater treatment per 1000 gallons of influent is calculated.

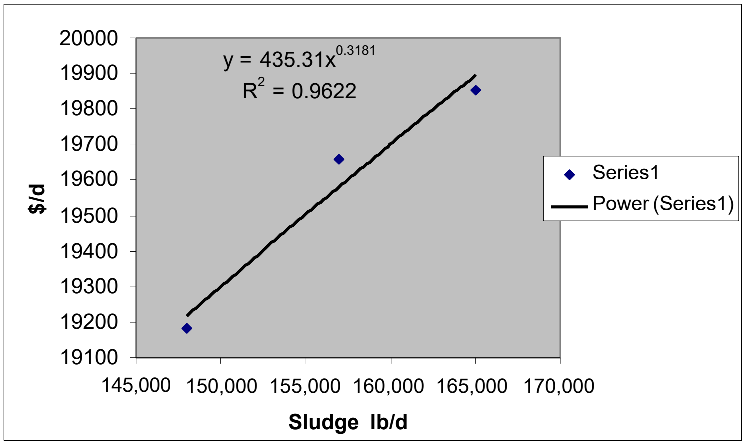
### 1.3 Procedure to Estimate the Cost to Treat Sludge

We present the procedure adopted to estimate the cost required to treat sludge/biosolids generated through three different scenarios A, C and E of the Broward/North plant for 2005 flows. For Alternative 1 and scenario A, water flowing to the ocean outfall undergoes secondary treatment followed by basic level chlorine disinfection. Water discharging to the UIC wells undergoes secondary treatment. The water stream leading to traditional reuse undergoes secondary treatment with filtration and high level chlorine disinfection.

For scenarios C and E, the only change in treatment is the extent of nutrient removal of the water stream discharging into the ocean outfalls. In scenario C, the water stream discharging into the ocean outfalls undergoes intermediate nutrient removal through a 3-stage biological treatment process while in scenario E, ocean outfall discharges undergoes high level nutrient removal through a 5-stage biological treatment process. Another notable difference is that flow rates of wastewater discharging into ocean outfalls, UIC wells and traditional reuse change with each alternative and year. The sludge generated is treated using dissolved air flotation thickeners, anaerobic digesters, and dewatering. Upon sludge digestion, it is disposed by land filling and land spreading.

Given the fact that all sludge generated within a plant go through a common sludge treatment process, a convenient way to circumvent numerous CapdetWorks simulations was to generate a relationship between the cost to treat sludge on a daily basis ($/day) with the quantity of sludge produced per day (lb/day).

CapdetWorks was used to estimate the total project cost of a treatment train consisting of an influent treatment station, SRT-based activated sludge and a biosolids treatment process consisting of air flotation thickeners, anaerobic digesters and a belt press filter for sludge dewatering. The project cost was evaluated across flow rates that encompass the current and projected plant capacities of 82 – 92 MGD. For each flow rate, the quantity of sludge produced was found from CapdetWorks. Project costs corresponding to the flow rates in the previous case were evaluated for a treatment train consisting only of the Influent Treatment Station and an SRT-Based Activated Sludge. The difference between the project costs gave the cost of sludge treatment. A plot of the cost of sludge treatment ($/day) vs. the quantity of sludge produced (lb/day) generated the relationship (Eq. 1-1) as shown Figure 1-13.




**Appendix Figure 1-13.** Relationship between cost of sludge treatment ($/day) vs. the quantity of sludge produced (lb/day) of the North Regional – Broward North Plant, for flow rates ranging between 82-92 MGD

Cost of sludge treatment ($/day) = 435.31×(Sludge produced (lb/d))$^{0.3181}$ (1-1)

Sludge generated is a function of flow rate as well as the treatment process. The quantity of sludge generated increases with flow rates and by the extent of nutrient removal from a treatment process. Hence, sludge generated decreases as we go from SRT-based Activated Sludge to 3-stage biological treatment to 5-stage biological treatment as the extent of nutrient removal along each treatment stage increases.

Separate simulations were run using CapdetWorks to estimate the quantity of sludge generated corresponding to the flow rates and nutrient removal processes that feature in a scenario. The total sludge produced was calculated by adding the sludge generated by each of the nutrient removal process. The cost of sludge processed ($/day) was evaluated from the empirical equation 1-1. The cost of sludge processed was converted from $/day to $/1000 gal of wastewater treated. Thus, the total cost of wastewater treatment ($/1000 gal) that includes cost of processing sludge was obtained by adding the cost of treating wastewater, illustrated in previous sections 1-1 and 1-2 with the cost to treat total sludge.

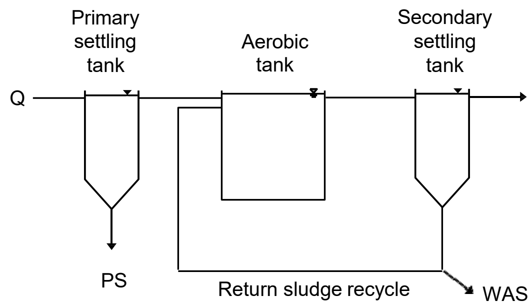
This exercise was repeated for scenarios C and E. The unit cost of treating water, the cost of sludge processed and the total cost of treating water and sludge processing, all in $/1000 gal of wastewater, are summarized in Table 1-3 for scenarios A, C and E.

**Appendix Table 1-3.** Cost of sludge processing and total cost of wastewater treatment and sludge processing for Broward/North Alternative 1, scenarios A, C and E, 2005 flows.

| **Scenarios and source(s) of sludge** | **Unit cost of wastewater treated ($/1000 gal)** | **Cost of sludge processed ($/1000 gal)** | **Total cost of wastewater treated and sludge processed ($/1000 gal)** |
|---|---|---|---|
| Scenario A: Source of sludge – SRT Based Activated Sludge Process | 0.549 | 0.228 | 0.778 |
| Scenario C: Source of sludge – SRT Based Activated Sludge and 3-Stage Biological Treatment Process | 0.693 | 0.226 | 0.919 |
| Scenario E: Source of sludge – SRT Based Activated Sludge and 5-Stage Biological Treatment Process | 0.864 | 0.224 | 1.088 |

The trends that emerge from Table 1-3 clearly indicate an appreciable cost added to a wastewater treatment train when the cost of sludge processing is included. However, it is also evident that the cost of sludge processing does not change dramatically with different treatment processes. Hence, there will be a minimal change in predictions made for costing upgrades of a treatment process, even when the cost of sludge processing is not included due to the near constant nature of processing the sludge across different treatment trains.

# Appendix 2. Process Trains



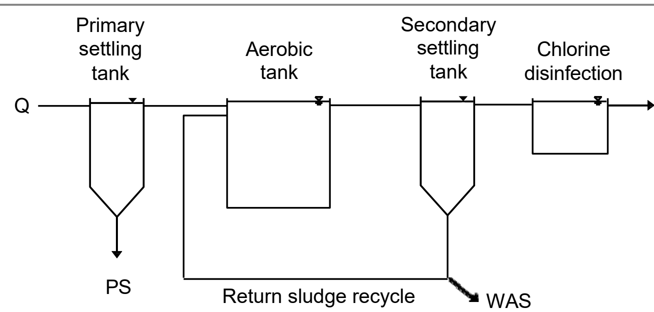

Applications

• Disposal through Class I injection wells under current standards

Process selection rationale

• Achieve secondary treatment ($CBOD_5$ and TSS ≤ 20 mg/L or removal ≥ 90%, whichever is more stringent) utilizing activated sludge technology similar to that in place at plants with ocean outfalls.

**Appendix Figure 2-1.** Process train T1 for activated sludge secondary treatment without disinfection. Note: primary settling is included only at facilities where this unit process is already used.




Applications

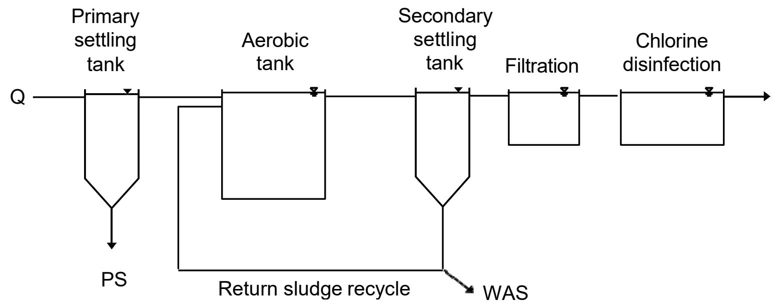
• Disposal through ocean outfalls under current standards

Process selection rationale

• Achieve secondary treatment ($CBOD_5$ and TSS ≤ 30 mg/L or removal ≥ 85%, whichever is most stringent) utilizing activated sludge technology similar to that in place at plants with ocean outfalls.

• Achieve basic-level disinfection (fecal coliforms ≤ 200/100 mL) utilizing chlorine dosing with short contact time, which is currently applied technology.

**Appendix Figure 2-2.** Process train T2 for activated sludge secondary treatment with basic-level chlorine disinfection. Note: primary settling is included only at facilities where this unit process is already used.



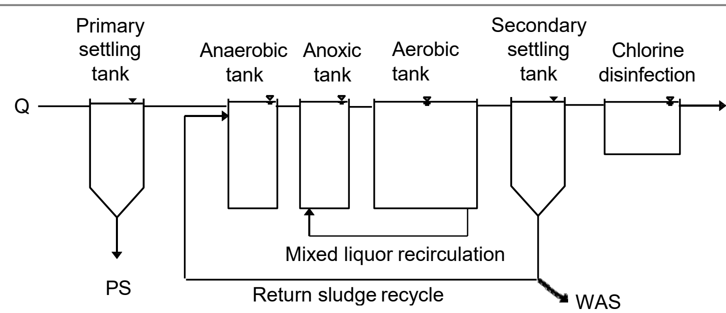

Applications

- Disposal through Class I injection wells under proposed EPA standards
- Public access water reuse

Process selection rationale

- Achieve secondary treatment in terms of $CBOD_5$ (≤ 20 mg/L or removal ≥ 90%, whichever is more stringent) utilizing activated sludge technology similar to that in place at plants with ocean outfalls.
- Achieve TSS ≤ 5.0 mg/L (single sample maximum) through secondary treatment and filtration
- Achieve high-level disinfection (fecal coliforms undetectable in 75% of samples; no sample with fecal coliforms > 25/100 mL) using high chlorine dose and long chlorine contact time, a technology currently applied for water reclamation at some of the plants.

**Appendix Figure 2-3.** Process train T3 for activated sludge treatment secondary treatment with filtration and high-level chlorine disinfection. Note: primary settling is included only at facilities where this unit process is already used.



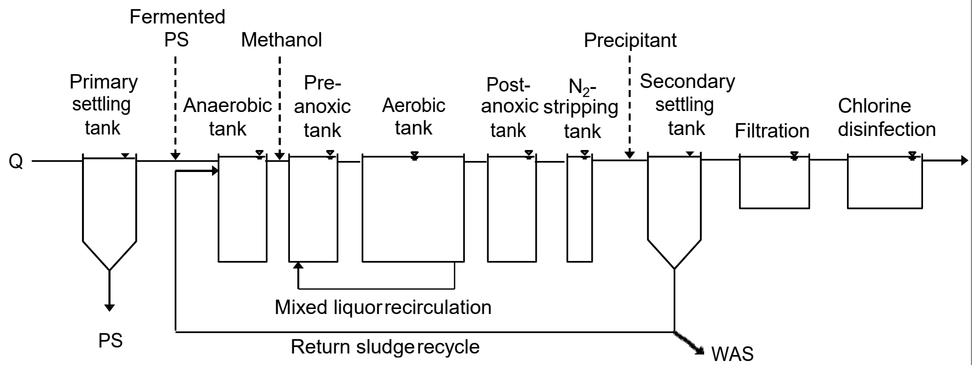

Applications

- Disposal through ocean outfalls under the scenario requiring intermediate nutrient removal

Process selection rationale

- Achieve intermediate nutrient removal ($CBOD_5$ ≤ 10 mg/L; TSS ≤ 10 mg/L; TN ≤ 10 mg/L; TP ≤ 3 mg/L) utilizing the $A^2/O$ process, which is a variation of the activated sludge process. This process is capable of achieving the nitrogen and phosphorus limits without chemical addition.
- Achieve basic-level disinfection (fecal coliforms ≤ 200/100 mL) utilizing low chlorine dose and short contact time, as currently practiced.

**Appendix Figure 2-4.** Process train T4 for intermediate nutrient removal with basic-level chlorine disinfection. Note: primary settling is included only at facilities where this unit process is already used.



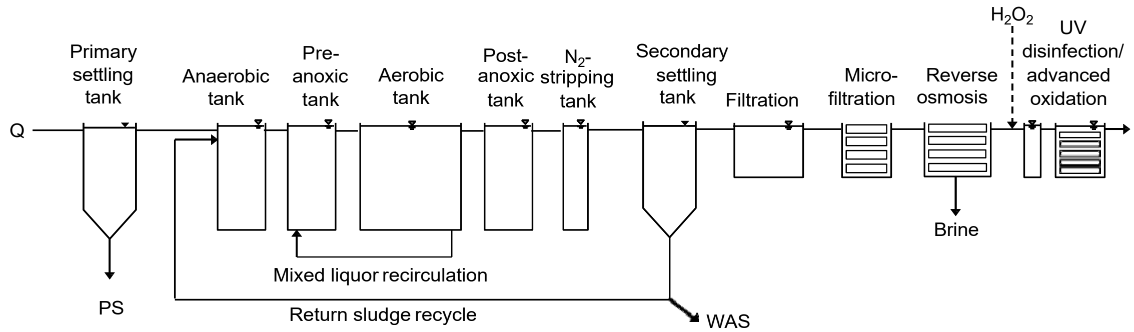

Applications

- Disposal through ocean outfalls under scenario requiring full nutrient removal

Process selection rationale

- Achieve full nutrient removal ($CBOD_5 \leq 5$ mg/L; TSS ≤ 5 mg/L; TN ≤ 3 mg/L; TP ≤ 1 mg/L) utilizing the 5-stage Bardenpho process, which is a variation of the activated sludge process. Depending on wastewater characteristics, this process may require addition of fermented primary sludge or chemical precipitants (alum; $FeCl_3$) to meet the phosphorus limit and addition of methanol to meet the nitrogen limit.
- Achieve basic-level disinfection (fecal coliforms ≤ 200/100 mL) utilizing low chlorine dose and short contact time

**Appendix Figure 2-5.** Process train T5 for full nutrient removal with filtration and basic-level chlorine disinfection. Note: primary settling is included only at facilities where this unit process is already used.




Applications

- Groundwater recharge to high-quality (TDS ≤ 1000 mg/L) aquifer

Process selection rationale

- Provide $CBOD_5$ and nutrient removal ($CBOD_5$ ≈ 5 mg/L; TN ≈ 3 mg/L; TP ≈ 1 mg/L) utilizing the 5-stage Bardenpho process with filtration to meet reuse rules ($CBOD_5$ ≤ 20 mg/L or removal ≥ 90%, whichever is more stringent; single sample maximum TSS = 5 mg/L; total nitrogen ≤ 10 mg/L) and decrease the fouling potential of the effluent.
- Achieve TSS ≤ 0.1 mg/L through microfiltration to further decrease fouling potential
- Achieve TDS ≤ 500 mg/L through reverse osmosis
- Achieve full disinfection (total coliforms undetectable), TOC ≤ 3 mg/L and TOX ≤ 0.2 mg/L by UV/advanced oxidation treatment

**Appendix Figure 2-6.** Process train T6 for full treatment and disinfection. Because of its multiple treatment processes culminating with reverse osmosis and advanced oxidation and UV disinfection, this process train represents an excellent means for producing a very high-quality drinking water and an excellent means for effectively controlling micropollutants. Note: primary settling is included only at facilities where this unit process is already used.

# Appendix 3. Glossary

***Activated sludge*** – A biological secondary treatment process commonly used to treat domestic wastewater. A large population of microorganisms (activated sludge) is maintained in suspension in the water being treated and is used to oxidize organic materials in the water. Air is provided to meet the needs of the microorganisms. A clarifier follows the aeration basin to separate the microorganisms from the liquid and some of the activated sludge is returned to the aeration basin.

***Advanced wastewater treatment (AWT)*** – A term generally used to describe any level of wastewater treatment that provides treatment beyond secondary treatment. Florida Statutes define one specific level of advanced wastewater treatment applicable in well-defined geographic areas, which involves treatment to meet 5 mg/L $CBOD_5$, 5 mg/L TSS, 3 mg/L total nitrogen, and 1 mg/L total phosphorus.

***Aquifer –*** A geological formation, group of formations, or part of a formation (stratum) that is capable of yielding potentially usable quantities of water from wells or springs.

***Aquifer storage and recovery (ASR)*** – The use of an underground formation to store water. Water is injected to the subsurface formation during periods when excess water is available; remains in storage; and is subsequently withdrawn to meet increased demands for water.

***Backflow prevention device*** – A device designed to prevent water from flowing backwards from a user's property into the drinking water distribution system.

***Basic level disinfection*** – A common level of disinfection used in Florida. Generally, this involves meeting an annual average limit of 200 fecal coliforms per 100 mL. This level of disinfection is typically used for surface water discharges and for some types of reuse projects (many RIBs and slow-rate systems featuring restricted public access).

***Biological nutrient removal (BNR)*** – Biological treatment systems designed to remove nitrogen and phosphorus in addition to organic materials. Some of these BNR systems are capable of meeting the advanced wastewater treatment limits (see "advanced wastewater treatment" above) specified in some portions of the Florida Statutes.

***Biosolids*** – A term commonly used in the United States to describe residuals or sludges produced during treatment of domestic wastewater. Florida uses the term "residuals" to refer to these materials.

***Capacity*** – Capacity represents the maximum amount of wastewater that could potentially be treated by a domestic wastewater treatment facility (the plant capacity) or the maximum amount of reclaimed water that could be distributed and used in a reuse system (reuse capacity). The capacity represents physical constraints imposed by mechanical equipment (like pumps) or by pipes and tanks. Capacity is commonly expressed in terms of millions of gallons per day (MGD).

***Carbonaceous biochemical oxygen demand ($CBOD_5$) –*** The quantity of oxygen utilized in the carbonaceous biochemical oxidation of organic matter present in a water or wastewater, reported as a five-day value determined using approved methods.

***Chlorination –*** The addition of chlorine to water, reclaimed water, or effluent to provide disinfection of that water.

***Clarifier*** – A unit process used in wastewater treatment to separate solids from the liquid stream. Typically, the clarifier is a large basin that allows solids to settle to the bottom by gravity and scum to be collected at the water's surface.

***Conservation rate*** – A fee structure in which the user pays for water based on the volume used.

***Consumptive use*** – Use of any water that reduces the supply from which it is withdrawn or diverted.

***Consumptive use permit (CUP)*** – A permit issued by a water management district that grants permission to make a consumptive use of water. Some water management districts refer to these as "water use permits."

***Cross-connection*** – Any physical arrangement whereby a public water supply is connected, directly or indirectly, with any other water supply system, sewer, drain, conduit, pool, storage reservoir, plumbing fixture, or other device which contains or may contain contaminated water, sewage or other waste, or liquid of unknown or unsafe quality which may be capable of imparting contamination to the public water supply as the result of backflow. Cross-connections are specifically prohibited in both Chapters 62-555 and 62-610, F.A.C.

***Dechlorination*** – The practice of removing the total combined chlorine residual that exists after chlorination to reduce the toxic effects of chlorinated effluents discharged to receiving waters or to be used for reuse applications.

***Deep well injection*** – A term that refers to effluent disposal using Class I injection wells. These wells are designed to inject effluent into isolated subsurface formations that contain G-IV ground water having TDS greater than 10,000 mg/L.

***Disinfection –*** The selective destruction of pathogens in reclaimed water, wastewater effluents, and residuals.

***Disposal*** – Effluent disposal involves the wasteful practice of releasing treated effluent back to the environment using ocean outfalls, surface water discharges, and deep injection wells.

***Domestic wastewater –*** Wastewater derived principally from dwellings, business buildings, institutions, and the like; sanitary wastewater; sewage.

***Drinking water standards*** – These are standards, which are contained in Chapter 62-550, F.A.C., define safe drinking water. The standards include both primary standards that are designed to protect human health and secondary standards that are designed to ensure that drinking water is aesthetically pleasing and palatable.

***Effluent*** – Water that is not reused after flowing out of any plant or other works used for the purpose of treating, stabilizing, or holding wastes. Effluent is "disposed" of.

***Equalization*** **–** Damping of flow variations so that a constant or nearly constant flow is achieved to overcome the operational problems caused by flow variations, to improve the performance of the downstream processes, and to reduce the size and cost of downstream treatment facilities.

***Eutrophication*** **–** A water quality concern with surface waters that includes a natural aging process in which the water becomes organically enriched, leading to increasing domination by aquatic weeds, transformation to marsh land, and eventually to dry land. Eutrophication can be accelerated by human input of nutrients.

***Fecal coliforms*** **–** A class of bacteria commonly used as an indicator of fecal matter in water; members of the coliform group capable of producing gas from lactose at 44.5 degrees C, as determined using approved methods.

***Filter*** – A unit process using a granular media or other material that is designed to remove solids from water. Florida's high-level disinfection requirements mandate the use of a filter before the disinfection process as a means for ensuring effective pathogen control, particularly for viruses and the protozoan pathogens (Giardia and Cryptosporidium).

***Filtration*** – A process for the removal of solids from water. Granular media, fabric, and a wide range of membranes may be used to provide filtration.

***Flow*** – The actual volume of water per unit time treated by a wastewater treatment plant or distributed through a reuse system. Flow is commonly expressed in terms of millions of gallons per day (MGD).

***Groundwater*** **–** Water below the land surface in the zone of saturation where water is at or above atmospheric pressure.

***Groundwater recharge*** **–** Reclaimed water directly injected into ground water aquifers or applied to surface spreading basins to augment ground water supplies.

***High-level disinfection*** – A level of disinfection required for many types of reuse activities, particularly for use of reclaimed water to irrigate residential lawns, public access areas, and edible crops. High-level disinfection couples filtration with the disinfection process to ensure effective control of pathogens. The filter must reduce TSS below 5.0 mg/L before the application of the disinfectant. The disinfected reclaimed water must have concentrations of fecal coliforms less than detection in at least 75 percent of all observations with no observation exceeding 25 per 100 mL.

***Indirect potable reuse –*** The planned discharge of reclaimed water to a Class I surface waters to augment the supply of water available for drinking water and other uses. Indirect potable reuse is contrasted with "direct potable reuse" which involves the discharge of reclaimed water directly into a drinking water treatment facility or into a drinking water distribution system.

***Infiltration –*** Water entering a sewer system, including sewer service connections, from the ground through such means as defective pipes, pipe joints, connections, or manhole walls.

***Irrigation –*** The application of water to the soil with the intent of meeting the water needs of crops, turf, or other vegetation.

***Land application –*** The reuse of reclaimed water or the disposal of effluent on, above, or into the surface of the ground through spray irrigation, other irrigation techniques, rapid-rate systems, absorption fields, overland flow systems, or other methods.

***Lime softening*** – Water treatment through lime precipitation to produce softened water.

***Membrane bioreactor (MBR)*** – A process that couples membranes (typically microfiltration units) for solids separation with a biological secondary treatment process. Some MBRs will immerse the membranes directly in the aeration basin.

***Membranes*** – A film-like material that can be used to separate solids from a liquid stream. Reverse osmosis can remove a portion of the dissolved solids from the water being treated.

***Membrane softening*** – Use of membranes to reduce hardness and remove organics, color, bacteria and impurities from raw water.

***Metropolitan distance*** – Distance measured in the directions of the street grid

***Microfiltration*** – A membrane process that relies on the very small size of pores in the film to remove solids and some pathogens.

***Milligrams per liter (mg/L) –*** The quantity of material present in water or wastewater expressed on the basis of the weight (milligrams) per unit volume of solution (liter).

***Monitoring well –*** A strategically located well from which ground water levels are measured and samples are withdrawn for water quality analysis.

***New water demand –*** A term that refers to the water demand in excess of the existing or planned water supply (design capacity) of the water treatment facility.

***Ocean outfall –*** A term that refers to effluent disposal carried by a pipe laid in the ocean discharging to an offshore point.

***Part III activities***– Refers to a reuse project permitted under Part III of Chapter 62-610, F.A.C., and includes the use of reclaimed water for irrigation of residential lawns, public access areas, and edible crops along with a wide range of urban activities.

***Pathogen*** – A disease causing organism. Some bacteria, viruses, helminthes (worms), and protozoa are human pathogens.

***Pathogenic protozoan*** – A single-celled eucaryotic microorganism without cell walls which is also pathogenic such as *Giardia* and *Cryptosporidium*.

***Percolation –*** The generally vertical movement of water through soil or other unconsolidated medium to the water table and to lower aquifers where occurring.

***pH –*** A measure of the degree to which a substance is acidic or basic. The pH is the negative common logarithm of the hydrogen-ion activity in moles per liter.

***Potable quality water –*** Water that could be consumed as drinking water by humans. This includes treated drinking water provided by public water supply utilities and untreated Class F-I, G-I, and G-II ground water.

***Potable quality water offset –*** The amount of potable quality water (Class F-I, G-I, or G-II ground water or water meeting drinking water standards) saved through the use of reclaimed water expressed as a percentage of the total reclaimed water used. The ***potable quality water offset*** is calculated by dividing the amount of potable water saved by the amount of reclaimed water used and multiplying the quotient by 100.

***Preliminary treatment*** – Wastewater treatment processes located at or near the headworks that are designed to remove grit (sand), rags, large solids, and other debris that may damage other equipment in a domestic wastewater treatment facility. Preliminary treatment may include bar screens, other screens, comminutors, and grit chambers.

***Public access area –*** An area that is intended to be accessible to the general public; such as golf courses, cemeteries, parks, landscape areas, hotels, motels, and highway medians. Public access areas include private property that is not open to the public at large, but is intended for frequent use by many persons. Public access areas also include residential dwellings. Presence of authorized farm personnel or other authorized treatment plant, utilities system, or reuse system personnel does not constitute public access. Irrigation of exercise areas and other landscape areas accessible to prisoners at penal institutions shall be considered as irrigation of public access areas.

***Rapid infiltration basin (RIB) –*** A rapid-rate land application system permitted under Part IV of Chapter 62-610, F.A.C.; normally consisting of two or more percolation ponds.

***Recharge fraction*** **–** The portion of reclaimed water used in a reuse system that recharges an underlying potable quality ground water (Class F-I, G-I, and G-II ground water) that is used for potable supply, or augments a Class I surface water, expressed as a percentage of the total reclaimed water used.

***Reclaimed water*** **–** Water that has received at least secondary treatment and basic disinfection and is reused after flowing out of a domestic wastewater treatment facility.

***Reclaimed water distribution system*** **–** A network of pipes, pumping facilities, storage facilities, and appurtenances designed to convey and distribute reclaimed water from one or more domestic wastewater treatment facilities to one or more users of reclaimed water.

***Reuse*** **–** The deliberate application of reclaimed water for a beneficial purpose. Criteria used to classify projects as "reuse" or "effluent disposal" are contained in Rule 62-610.810, F.A.C.

***Reverse Osmosis (RO)*** – A membrane treatment process capable of removing a portion of dissolved solids from water. Reverse osmosis features excellent removal of pathogens and will removes a portion of the so-called EPOC.

***Secondary treatment*** **–** Wastewater treatment to a level that will achieve the effluent limitations specified in Rule 62-600.420(1)(a), F.A.C. This generally involves a biological treatment process such as activated sludge for the removal of organic materials. Secondary treatment facilities generally are designed to achieve 90-percent reductions in $CBOD_5$ and TSS and are operated to meet an annual average limit of 20 mg/L of $CBOD_5$ and TSS.

***Satellite reclamation facilities*** – The removal of untreated wastewater from sewers (sewer mining); treatment and disinfection of the wastewater at the point of removal to produce reclaimed water; and use of the reclaimed water for beneficial purposes in the vicinity of withdrawal and treatment; with the return of any excess reclaimed water and residuals (sludges) to the sewer. This type of a treatment facility also may be referred to as a "skimming facility," "scalping facility," or "satellite facility."

***Sludge*** – A somewhat dated term used to describe residuals or biosolids produced during treatment of domestic wastewater. Florida uses the term "residuals" to refer to these materials.

***Stormwater*** – Water that results from a rainfall event.

***Surface water*** **–** Water upon the surface of the earth, whether contained in bounds created naturally or artificially or diffused. Water from natural springs is classified as surface water when it exits from the spring onto the earth's surface.

***Traditional reuse*** – Reclaimed water used for public access areas and for on-site irrigation at the wastewater treatment plant site.

***Total dissolved solids (TDS)*** – Means the amount of dissolved constituents present in water or wastewater, usually expressed in milligrams per liter and analyzed as filterable residue, as determined using approved methods.

***Total organic carbon (TOC)*** – A measure of the total amount of organic carbon found in a water, usually expressed in milligrams per liter.

***Total organic halogens (TOX)*** – A measure of the total amount of organic materials having one or more halogen (chlorine, bromine, etc.) included in its molecular structure, usually expressed in milligrams per liter.

***Total suspended solids (TSS) –*** Solids that either float on the surface of, or are suspended in, water or wastewater; the quantity of material removed from a sample in a laboratory test referred to as nonfiltrable residue, as determined using approved methods.

***Treatment –*** Any method, technique, or process which changes the physical, chemical, or biological character or composition of wastewater and thereby reduces its potential for polluting waters of the state.

***Treatment plant –*** Any plant or other works used for the purpose of treating, stabilizing, or holding wastes.

***Turbidity –*** A condition in water or wastewater caused by the presence of suspended matter, resulting in the scattering and absorption of light rays, as determined using approved methods.

***Total maximum daily loads (TMDL) –*** The sum of the individual wasteload allocations for point sources and the load allocations for nonpoint sources and natural background. Prior to determining individual wasteload allocations and load allocations, the maximum amount of a pollutant that a water body or water segment can assimilate from all sources without exceeding water quality standards must first be calculated.

***Underground injection –*** Effluent disposal by well injection into underground geologic formations.

***Wastewater –*** The combination of liquid and water-carried pollutants from residences, commercial buildings, industrial plants, and institutions together with any ground water, surface runoff or leachate that may be present.

***Wastewater facilities –*** Any or all of the following: the collection/transmission system, the treatment plant, and the reuse or disposal system.

***Water conservation*** – Preventing and reducing wasteful, uneconomical, impractical, or unreasonable use of water resources.

***Water Conservation Initiative (WCI)*** – A program initiated in 2001 by the DEP, the water management districts, and other state agencies to develop strategies for conserving water in Florida. The WCI features significant consideration of water reuse as a means for conserving and augmenting available water supplies.

***Water quality standards –*** Standards comprised of designated most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water use or classification, the Florida Antidegradation Policy, and the moderating provisions contained in Chapters 62-302 and 62-4, F.A.C.

***Water reclamation facility*** – A domestic wastewater treatment facility that produces reclaimed water for reuse.

***Water supply planning –*** Process by which the water management districts develop 20-year water supply plans for defined regions.