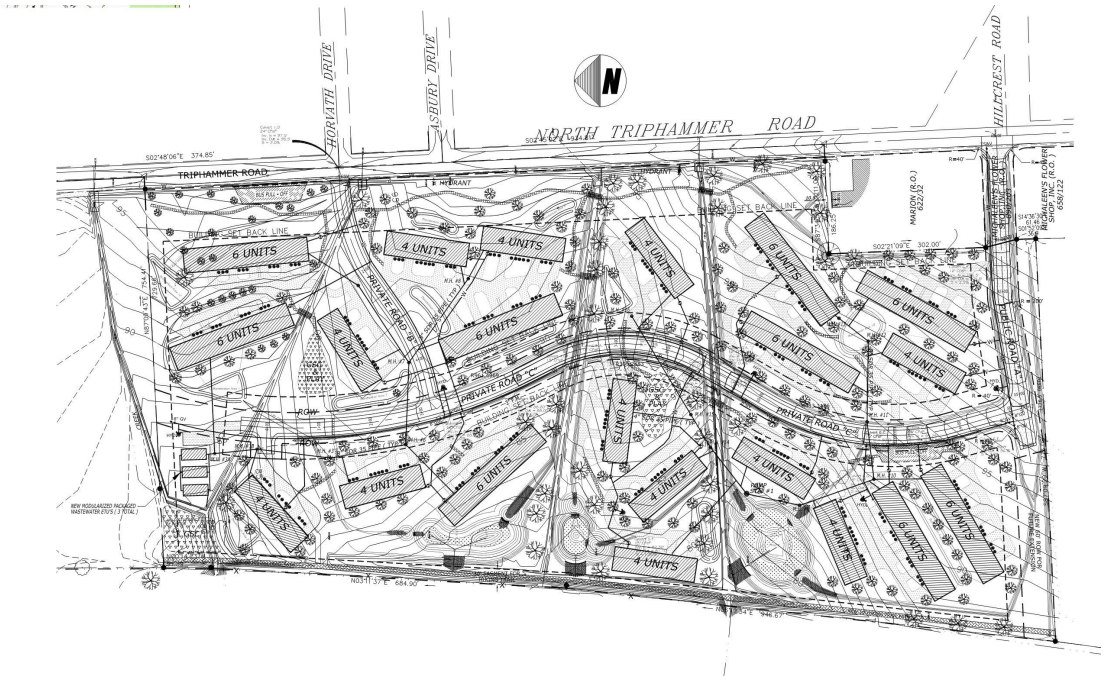
# Preliminary Design of an Orenco® Effluent Sewer System And AdvanTex® Treatment Facility




**Project Name**
Cayuga Farms Townhomes

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Orenco Systems® Inc.
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# SECTION 1: PRELMINARY DESIGN

This report presents the preliminary design of the Cayuga Farms Townhouse development. The proposed service area consists of 102 townhomes of either one, two, or three bedrooms. These homes will be clustered into 21 townhome buildings (4 to 6 a building), each with a STEP tank, discharging effluent to a forcemain that conveys it to an AdvanTex treatment plant before final disposal.

Projected hydraulic design parameters are provided in the following tables. Expected organic loads and permit requirements are further described in this report. Any changes in design or permit limits will require a review by Orenco Systems, Inc.

## Design Parameters

| Design Parameters | |
|---|---|
| Residential Housing Unit (1, 2, or 3 Bedroom) | 102 EDUs |
| Equivalent Dwelling Units Design Average Flow/EDU | 160 gal/day |
| Equivalent Dwelling Units Max Day Flow/EDU | 320 gal/day |

## Hydraulic Design Parameters

| Hydraulic Design Parameters | |
|---|---|
| Design Average Day Flow | 16,320 gal/day |
| Design Max Day Flow | 32,640 gal/day |
| Design Peak Hourly Flow | 66 gal/min |

## Waste Strength

| Recirculation Tank Influent Characteristics (Design Average) | Average | Maximum |
|---|---|---|
| $BOD_5$ | 150 mg/L | 250 mg/L |
| TSS | 40 mg/L | 75 mg/L |
| TKN | 65 mg/L | 75 mg/L |
| $NH_3$-N | 45 mg/L | 55 mg/L |
| pH | 8.0 SU | 8.0 SU |
| FOG | 20 mg/L | 25 mg/L |
| Alkalinity as $CaCO_3$ | 300 mg/L | 300 mg/L |

## Discharge Limits

| Permit Limits | Average | Maximum |
|---|---|---|
| $cBOD_5$ | 5.0 mg/L | 0.0 mg/L |
| TSS | 10.0 mg/L | 0.0 mg/L |
| Ammonia $NH_3$-N - Summer | 1.5 mg/L | 0.0 mg/L |
| Ammonia $NH_3$-N - Winter | 2.2 mg/L | 0.0 mg/L |

| | | |
|---|---|---|
| pH | 6.5 SU | 8.5 SU |
| Dissolved Oxygen | 6.0 mg/L | 0.0 mg/L |

## STEP Tanks

| | |
|---|---|
| Interceptor Tanks | 21 Units |
| Interceptor Tank Access Equipment | 21 Units |
| Pumping Equipment (Duplex) | 21 Units |
| Control Panel | 21 Units |
| 1.25" Dia Service Lateral and Connection (Ball Valve & Check Valve) | 21 Units |

## Flow Equalization/Pre-Anoxic Tank Equipment

| | |
|---|---|
| Tank Volume | 17,000 gal |
| Pumping Package(s) | 1 Duplex Packages |

## Stage One Process Equipment

| | |
|---|---|
| AdvanTex Sqft (Recommended) | 900 sq.ft. |
| 42 ft AX-MAX | 3 AX-MAX |
| 14 ft T-MAX Pump Basin | 1 T-MAX |
| RNE pump | 1 Pump |
| Pumping Package(s) | 3 Duplex Packages |
| Ventilation Assemblies | 2 Fans |

## Stage Two Process Equipment

| | |
|---|---|
| AdvanTex Sqft (Recommended) | 250 sq.ft. |
| 35 ft AX-MAX | 1 AX-MAX |
| Pumping Package(s) | 1 Duplex Packages |
| Ventilation Assemblies | 1 Fans |

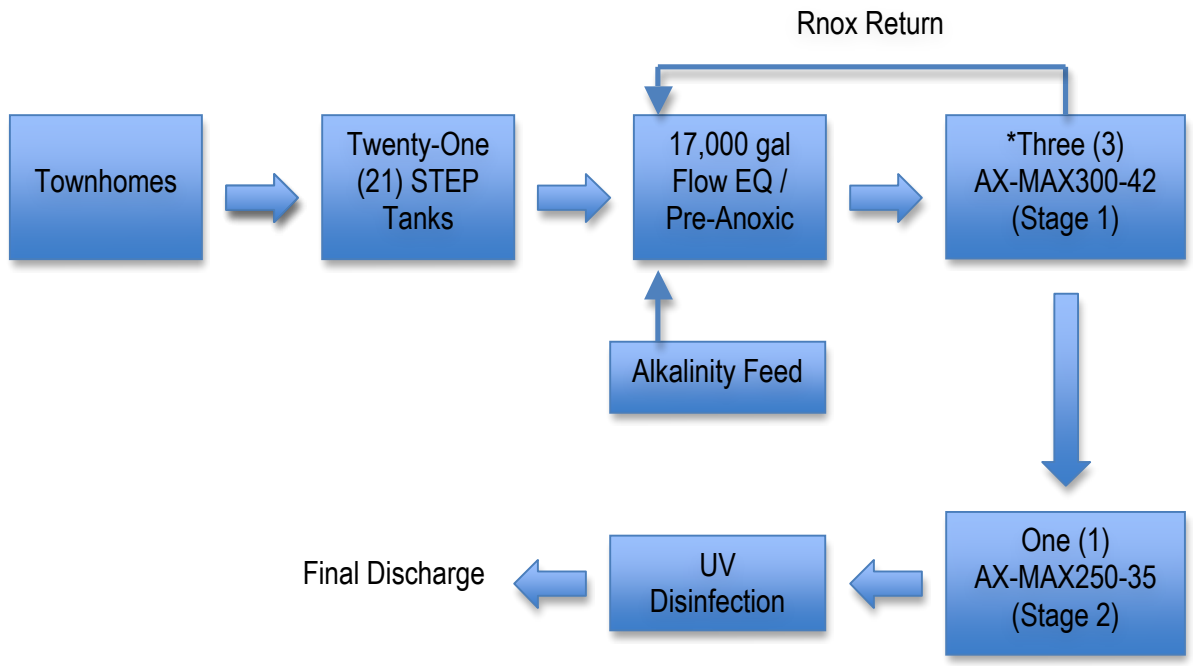
## Discharge Equipment

| | |
|---|---|
| Pumping Package(s) | 2 Duplex Packages |

## Ancillary Equipment

| | |
|---|---|
| Alkalinity Feed System | 1 Unit |
| Controls Building | 100 sq.ft. |
| Instrumentation / Flow Meter | 1 Unit |
| Disinfection (UV) | 1 Unit |

## Flow Schematic




**AdvanTex AX-MAX units are configured with integral recirculation-blend capacity and do not require and external recirculation-blend tank.*

## Process Descriptions

### *Overall Process*

For wastewater systems requiring ammonia removal due to restrictive ammonia nitrogen (NH3-N) or TKN discharge limits (>95% removal), a Second Stage AdvanTex system will be necessary following standard AdvanTex treatment. The configuration above is recommended for discharge limits associated with this level of treatment.

The nitrification occurring in the AdvanTex system is heavily influenced by the alkalinity required to buffer the process (7.14 mg/L alkalinity per 1 mg/L of ammonia-N). pH levels of 7.5 to 8.5 are ideal for complete nitrification and should be buffered to remain above a pH of 7 for all applications. Immediately preceding the AdvanTex treatment stage, a supplemental alkalinity feeder may be necessary to ensure sufficient alkalinity for nitrification to break down ammonia.

Using a pre-anoxic stage helps buffer pH, as denitrification in this stage will return as much as 50% of the alkalinity consumed during nitrification. In addition, readily available BOD is consumed in the pre-anoxic denitrification stage, reducing the BOD load to the secondary treatment unit. Most application types provide adequate carbon in the incoming stream to achieve denitrification and subsequent alkalinity return, but in the design it is best to ensure that there is enough alkalinity added without relying on this occurrence. As operational data becomes available for the specific treatment system – demonstrating the return of alkalinity through denitrification – alkalinity feed rates can be adjusted downward.

### *STEP Tanks*

Septic Tank Effluent Pumping (STEP) stage is designed to collect wastewater; segregate settleable and floatable solids (sludge and scum); accumulate, consolidate and store solids; digest organic matter; and discharge primary treated effluent. Passive, energy-free primary tankage provides the most cost-efficient method of primary treatment available for nonindustrial sewage; BOD removal of >50% and TSS removal of > 90% (when using a Biotube Pump Vault) are typically accomplished with passive primary treatment. Pretreated effluent is then pumped to the Flow Equalization/Pre-Anoxic treatment stage.

### *Flow Equalization/Pre-Anoxic Treatment Stage*

Flow equalization (EQ) / Pre-Anoxic provides stability by leveling out peaks in flow and allowing consistent loading of the treatment system while recirculating a portion of the recirc-blend (or filtrate) from the AdvanTex secondary treatment system to an anoxic zone within the tank. A pre-anoxic treatment stage tends to balance and lower concentrations by blending primary treated effluent with AX filtrate. It also provides an environment for denitrifying a portion of the nitrified filtrate.

The use of a pre-anoxic stage benefits all applications and is essential for those applications with high-strength waste (organic or nitrogen concentrations) and restrictive permit limits, as well as applications in which higher-quality effluent and enhanced overall removal performance are desired.

The Flow EQ/Pre-Anoxic stage consists of a tank or tanks fitted with a timed-dose-controlled pumping system. It follows the primary tanks (STEP) is typically located before the stage 1 treatment system.

### *Stage 1 AdvanTex Treatment*

After flow eq/pre-anoxic treatment, effluent is transported to the first of a series of three (3) AX-MAX treatment units, where it is blended with AdvanTex filtrate. The blended wastewater is distributed over the AdvanTex textile media and percolates down through the media, where it is filtered, cleaned, and nitrified by the naturally occurring microorganisms populating the media. After treatment, a portion of the filtrate is returned to the recirculation-blend chamber while a portion is transported to stage 2 treatment. Note that a portion of the recirc-blend (or filtrate) is often returned directly to the pre-anoxic treatment stage (Rnox) for denitrification.

In the first stage process, AdvanTex units filter and clean effluent from the primary treatment system. When loaded at or below the applicable loading rate, they typically achieve treatment levels of < 10 mg/L BOD5/cBOD5 and TSS (30-day average or 30-day arithmetic mean), with total nitrogen (TN) reduction typically > 60% and nitrification averages of 95% (range 90-99%).

### *Stage 2 AdvanTex treatment*

A second stage of AdvanTex treatment is used cost-effectively for enhanced nitrification:

- Nitrifying the waste stream for systems with very low ammonia (NH3-N) or TKN discharge requirements – typically > 95% removal (nitrification)
- Removing any excess BOD5 that is not consumed in the denitrification process following the post-anoxic stage on projects with restrictive BOD5/cBOD5 permit limits, typically 20 mg/L or less (polishing)
- Removing BOD5 for systems with NOT TO EXCEED permit limits of < 10 mg/L BOD5/cBOD5 or 30-day average permit limits of ″ 5 mg/L BOD5/cBOD5 (polishing)

### *Disinfection*

Secondary-treated effluent is usually clear and odorless, but it still contains pathogens at levels that can cause illness if ingested or released to the environment. Disinfection is required in many surface discharge or reuse systems. Disinfection can be achieved by any method that destroys pathogens; ultraviolet (UV) rays, chlorine (tablet or gas), and ozonation are the most common methods.

Due to the low turbidity of AdvanTex effluent and the fact that UV disinfection requires no chemicals and leaves no toxic residue, UV disinfection is the most common method used following AdvanTex systems.

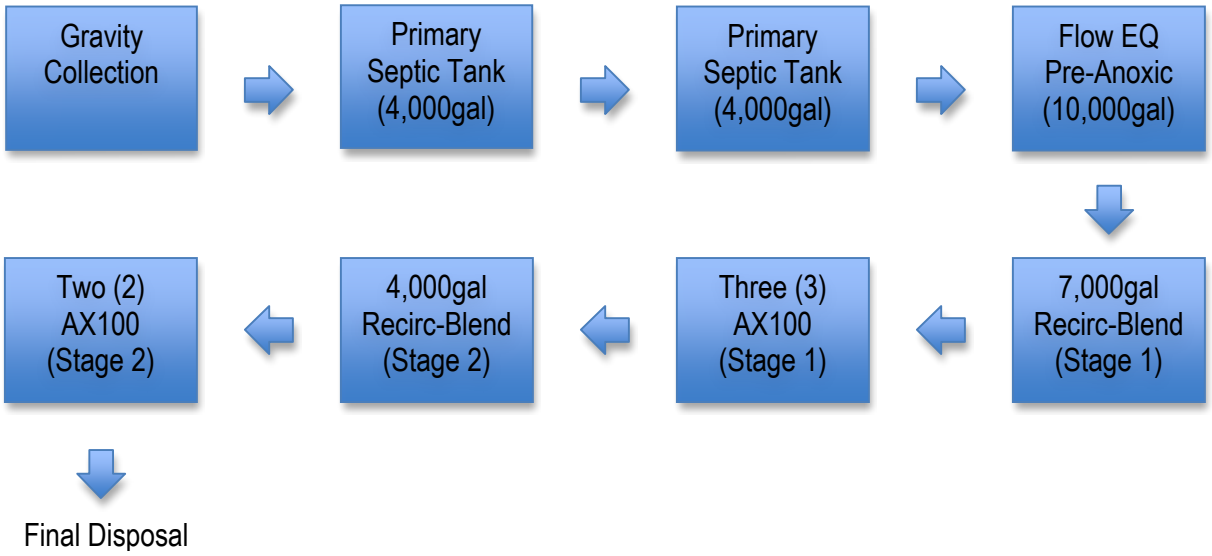
Chlorination is also a common disinfection method that is utilized; however, handling issues and concerns about chemical residue make it less desirable than UV. Ozonation, another common method, is extremely effective and popular for re-use applications within facilities (e.g. toilet flushing), due to its ability to remove any residual color in the effluent stream. Ozonation is typically the least economical of the three methods in the lower flow applications common with decentralized systems.

## Bethlehem, New York

### *Site Information*

| | |
|---|---|
| **Design Average Day Flow:** | 4,250 gpd |
| **Design Max Day Flow:** | 8,500 gpd |
| **Application Type:** | Municipality/Residential |
| **Collection Type:** | Gravity |
| **Primary Treatment:** | Onsite Primary Septic Tanks |
| **Treatment Type:** | AX100 Two-Stage AdvanTex Treatment |
| **Number of pods:** | Five (3 for first stage, 2 for second stage) |
| **Treatment Area:** | Stage 1: 300 sqft. Stage 2: 200 sqft |
| **Disposal:** | Surface |
| **Start Up:** | 8/20/2010 |

### *Flow Schematic*




### *Quarterly Samples (2014)*

**Primary Effluent**

| Quarter | Temp | Dissolved Oxygen | TSS | $BOD_5$ | $NH_3$ | $NO_3^-$ | TKN | pH | Alkalinity |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.8 | | 58 | 187 | 18.5 | | | 7.43 | 222 |
| 2 | 15 | | 25 | 92 | 21.7 | | | 7.38 | 0 |
| 3 | 15 | | 27 | 101 | 25.1 | | | 7.24 | 0 |
| 4 | 18 | | 28 | 127 | 46.2 | | | 7.23 | 0 |

### AdvanTex Stage 1 Filtrate

| Quarter | Temp | Dissolved Oxygen | TSS | $BOD_5$ | $NH_3$ | $NO_3^-$ | TKN | pH | Alkalinity |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.6 | 7.9 | 8 | 9 | 6.2 | | | 7.11 | 152 |
| 2 | 16 | 10 | 10 | 16 | 5.3 | | | 7.66 | 210 |
| 3 | 15 | 10 | 4 | 12 | 1.96 | | | 7.45 | 224 |
| 4 | 16 | 8 | 2 | <5 | 1.13 | | | 7.28 | 116 |

### AdvanTex Stage 2 Filtrate

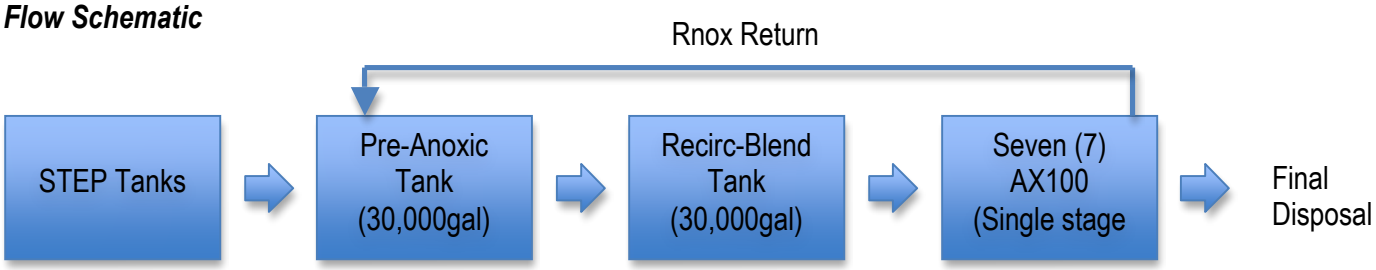
| Quarter | Temp | Dissolved Oxygen | TSS | $BOD_5$ | $NH_3$ | $NO_3^-$ | TKN | pH | Alkalinity |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.2 | 11.3 | <5 | 0 | 0.3 | | | 7.6 | 104 |
| 2 | 16 | 10 | 1 | <6 | <0.1 | | | 7.71 | 172 |
| 3 | 15 | 10 | <1 | 0 | <0.100 | | | 8.09 | 228 |
| 4 | 11 | 10.6 | <1 | <2 | <0.100 | | | 8.21 | 110 |

## Hillsdale, New York

### *Site Information*

| | |
|---|---|
| **Design Average Day Flow:** | 15,000 gpd |
| **Design Max Day Flow:** | 35,000 gpd |
| **Application Type:** | Municipality/Residential (120 EDUs) |
| **Collection Type:** | Effluent Sewer |
| **Primary Treatment:** | Septic Tank Effluent Pumping (STEP) |
| **Treatment Type:** | AX100 Single Stage AdvanTex Treatment |
| **Number of Pods:** | Seven |
| **Treatment Area:** | 700 sqft |
| **Disposal:** | Subsurface |
| **Start Up:** | 2/25/09 |

### *Flow Schematic*




### *Sample Data*

**Primary Effluent**

| Date | Temp | Dissolved Oxygen | TSS | $cBOD_5$ | $NH_3$ | $NO_3^-$ | TKN | pH | Alkalinity |
|---|---|---|---|---|---|---|---|---|---|
| 4/30/12 | | | 96 | 210 | 64.8 | | 75.9 | | |
| 8/16/12 | | | 390 | 120 | | | | | |

**AdvanTex Filtrate (Single Stage)**

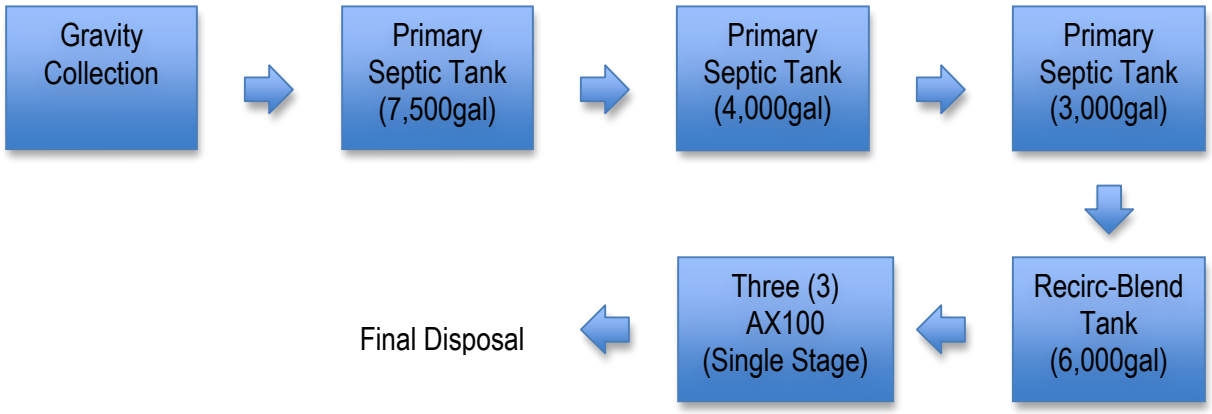
| Date | Temp | Dissolved Oxygen | TSS | $cBOD_5$ | $NH_3$ | $NO_3^-$ | TKN | pH | Alkalinity |
|---|---|---|---|---|---|---|---|---|---|
| 4/30/12 | | | <5 | 10 | 9.02 | 11.7 | 12 | | |
| 8/16/12 | | | 5.5 | 4.2 | 9.08 | | 12 | | |
| 3/31/13 | | | | | | 4.45 | | 6.5 | |
| 6/30/13 | | | | | | 6.63 | | | |

## East Schodack, New York

### *Site Information*

| | |
|---|---|
| **Design Average Day Flow:** | 3,750 gpd |
| **Design Max Day Flow:** | 7,500 gpd |
| **Application Type:** | Municipality/Residential |
| **Collection Type:** | Gravity |
| **Primary Treatment:** | Onsite Primary Septic Tanks |
| **Treatment Type:** | AX100 Single Stage AdvanTex Treatment |
| **Number of Pods:** | Three |
| **Treatment Area:** | 300 sqft |
| **Disposal:** | Surface |
| **Start Up:** | 8/11/09 |

### *Flow Schematic*




### *Sample Data*

**Primary Effluent**

| Date | Temp | Dissolved Oxygen | TSS | $cBOD_5$ | $NH_3$ | $NO_3^-$ | TKN | pH | Settleable Solids |
|---|---|---|---|---|---|---|---|---|---|
| 2/28/11 | | | 39 | 116 | | | | | |
| 1/31/12 | | | 30 | 158 | | | | | |
| 3/31/12 | | | 91 | 136 | | | | | |
| 1/31/13 | | | 48 | 152 | | | | | |

**AdvanTex Filtrate (Single Stage)**

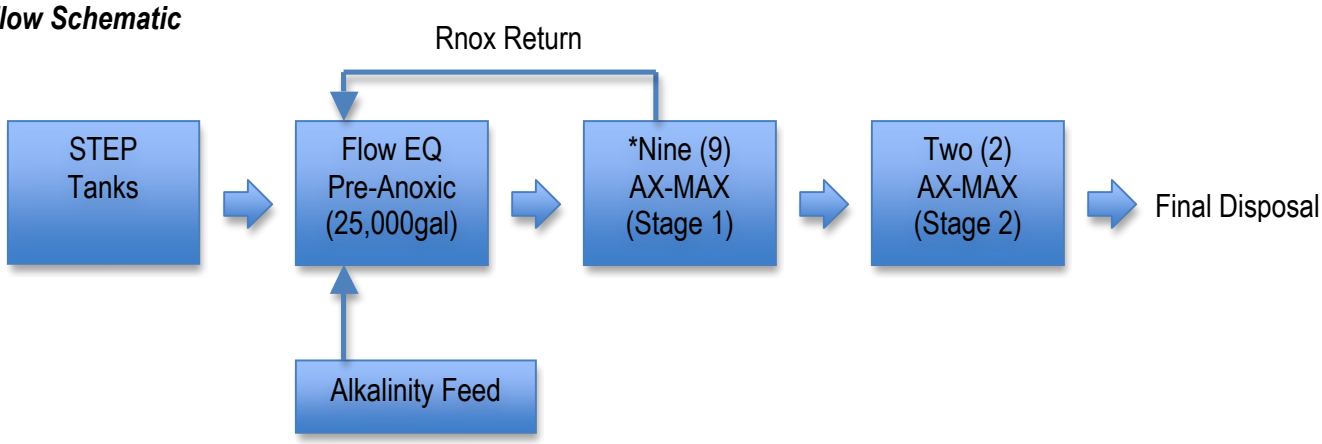
| Date | Temp | Dissolved Oxygen | TSS | $BOD_5$ | $NH_3$ | $NO_3^-$ | TKN | pH | Settleable Solids |
|---|---|---|---|---|---|---|---|---|---|
| 2/28/11 | | 9.6 | 10 | 10 | 1.8 | | | 7.75 | 0.05 |
| 1/31/12 | | 10.3 | 3 | 7 | 2.01 | | | 7.7 | 0.05 |
| 3/31/12 | | 9.6 | 2 | 4 | 1.73 | | | 7.7 | 0.05 |
| 1/31/13 | | 11.8 | 1 | 3 | 1.28 | | | 7.4 | 0.05 |

## Kensington Woods, New York

### *Site Information*

| | |
|---|---|
| **Design Average Day Flow:** | 35,500 gpd |
| **Design Max Day Flow:** | 50,700 gpd |
| **Application Type:** | Municipality/Residential (169 EDUs) |
| **Collection Type:** | Effluent Sewer |
| **Primary Treatment:** | STEP |
| **Treatment Type:** | Two-stage AX-MAX AdvanTex Treatment |
| **Number of Pods:** | Nine (7 for first stage, 2 for second stage) |
| **Treatment Area:** | Stage 1 – 700 sqft, Stage 2 – 200 sqft |
| **Disposal:** | Surface |
| **Start Up:** | Fall of 2015 |

### *Flow Schematic*




**AdvanTex AX-MAX units are configured with integral recirculation-blend capacity and do not require and external recirculation-blend tank.*

### *Permit Limits*

| $UOD_5$ | TSS | Settleable Solids | $NH_3$ Summer | $NH_3$ Winter | pH | Dissolved Oxygen |
|---|---|---|---|---|---|---|
| 25 | 10 | 0.1 | 1.5 | 2.2 | 6.5 – 8.5 | 0.05 |