## OWNER
City of Somersworth
New Hampshire

## ENGINEER
Underwood Engineers, Inc.
Portsmouth
New Hampshire

## CONTRACTORS
**WWTF Improvements**
Penta Corporation
Moultonboro
New Hampshire

**Sludge Handling Improvements**
H.E. Sargent
Stillwater
Maine

## FUNDING
NHDES SRF Loan
NHDES SAG (Grant)
Federal STAG (Grant)
Local Funding

## Construction Period
Sludge Handling
Jan 2003 to Dec 2003
WWTF
Jan 2004 to Jan 2006

## Total Cost
Sludge Handling $2 M
WWTF $6.9 M

# Somersworth, New Hampshire Wastewater Treatment Facility

***The City of Somersworth New Hampshire elected to upgrade the existing Wastewater Treatment Facility (WWTF) to improve operational efficiency and to meet new NPDES Permit requirements.***

***New 1/8 Inch Fine Screens Installed in Headworks Building***

Underwood Engineers Inc. (UEI) of Portsmouth New Hampshire was selected to assist the City of Somersworth with evaluation, design and construction of improvements to the existing Somersworth WWTF to meet a total phosphorus limit of 0.5 mg/L, $BOD_5$ and TSS limit of 10 mg/L and $NH_3$-N limit of 7 mg/L.

Upgrade design options included evaluation of improved solids handling, dewatering and disposal, and secondary wastewater treatment to meet nutrient removal and effluent water quality criteria established in the NPDES Discharge Permit.

After careful evaluation of treatment alternatives, UEI recommended implementation of a Biological Nutrient Removal (BNR) process to meet the NPDES Permit requirements. The BNR process selected, the Modified University of Capetown (MUCT) Biological Nutrient Removal system, was implemented by retrofitting the existing aeration tanks to transform the existing facility to anaerobic, anoxic, and aeration tanks required for the BNR process.

Major improvements include a new Headworks Building, Modified UCT Process, secondary clarifier equipment replacement, effluent filtration, CCT improvements, post aeration and sludge handling upgrades.

A key component to the successful implementation of the BNR secondary treatment process was upgrading Preliminary Treatment. The new Headworks Building includes 1/8" fine screens and grit removal with grit washing to remove organics. In addition to the new Headworks Building, septage delivered to the WWTF is processed through a septage acceptance facility to separate the liquid and solid components with discharge to the septage storage and pumping systems.

The heart of the process is the activated sludge Modified UCT process. A detailed description is provided on the next page. Included with the process are submersible mixers and pumps for anaerobic and anoxic zones and fine bubble diffuser aeration for improved oxygen transfer efficiency in the aeration zones.

***Fine Bubble Diffused Aeration***

***Secondary Clarifiers***

The existing secondary clarifiers have been upgraded to center feed, peripheral discharge units for improved settling performance and sludge removal. Subsequent to clarification, the wastewater is treated to remove particulate solids to less than 10 mg/L using cloth media filters before disinfection. The final step in the upgraded process includes post aeration tanks using fine bubble diffusers to increase dissolved oxygen above 6.5 mg/L to meet the NPDES discharge limits.

# Biological Nutrient Removal (BNR) Treatment Process

## Modified UCT Process – General Description

The Modified UCT Process provides a single-activated sludge system that optimizes phosphorus removal while still providing a high degree of nitrogen removal.

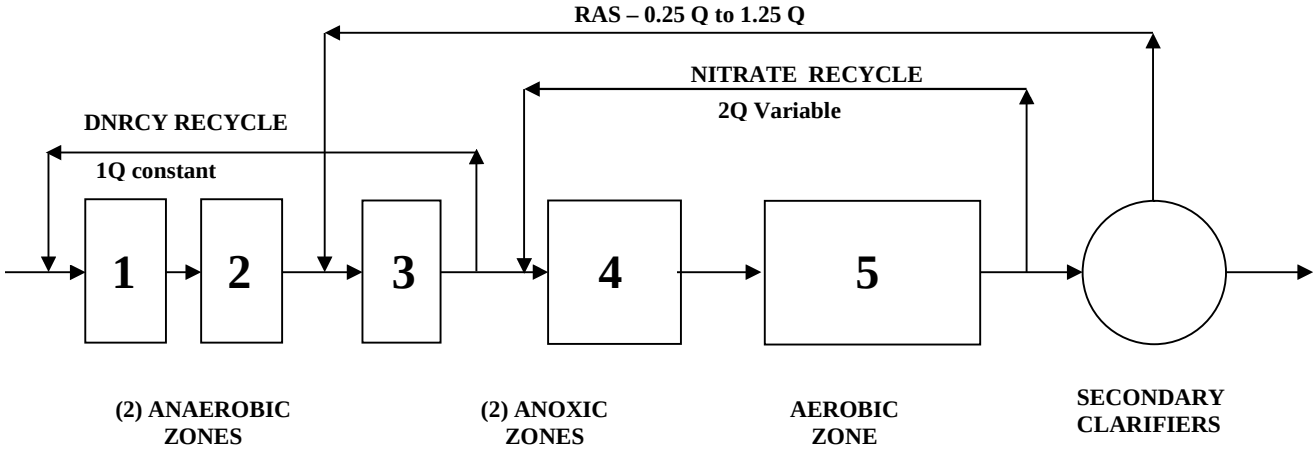
Influent flow enters the first tank (1) and is mixed with denitrified mixed liquor flow from the first anoxic cell (3). The flow from the DNRCY pump is a constant rate of 1.2 MGD (1Q). This blended wastewater should contain a high food source in the form of influent soluble $BOD_5$ or COD along with mixed liquor that has previously been sent through an anoxic zone to remove any nitrates contained in the RAS. Conditions in the first reactor should be anaerobic. The readily available food along with no nitrates or oxygen, force the bacteria to store energy in their cells in the form of orthophosphates in order to grow and reproduce in the aeration zones. Phosphorus is released and food is taken up by the bacteria in the anaerobic zones. The ratio of $BOD_5$ or COD to Phosphorus is a key factor in the degree of phosphorus released. A 20 to 1 $BOD_5$ to P or 40 to 1 COD to P ratio or greater generally indicates that conditions should be favorable for the bacteria.

Two anaerobic zones are used to optimize the phosphorus release conditions in the system. A measurement of the $PO_4$-P along the tank length should demonstrate an increase in phosphorus for the entire length. The bacteria that release the phosphorus will take up more phosphorus, in greater quantities than necessary (luxury uptake), in the aerobic zone in order to survive, which provides the phosphorus removal mechanism to meet the NPDES permit.

Once the flow leaves the second anaerobic tank, it enters the first anoxic tank and blends with the flow from the RAS. Since nitrates are available, they will be consumed in order for the bacteria to grow. This type of process is called denitrification. The RAS flow rate can be set at 0.2 to 1.25 Q. Generally higher RAS rates provide for increased denitrification. The removal of nitrates conditions the mixed liquor to be used in the first anaerobic zone. As the nitrates are consumed, an oxygen credit of 2.86 lb of oxygen per pound of nitrate-N is provided and an alkalinity credit of 3.57 lb of alkalinity per pound of nitrate-N is produced.

The second anoxic zone receives flow from the first anoxic zone along with recycled flow from the end of the aeration tanks. This larger anoxic tank provides the bulk of the denitrification for the process. The recycle of the aeration tank mixed liquor provides the nitrate source, with a flow of 2.4 MGD (2Q) that is adjustable.

From the second anoxic tank the flow enters the aeration tank. This tank has conditions favorable to remove the $BOD_5$ to a very low concentration and nitrify the wastewater. Nitrification is a two step process that occurs simultaneously in the aeration tank. Conditions that are favorable to the nitrification process include a neutral pH, favorable alkalinity and oxygen. During nitrification, 4.57 lb of oxygen are utilized per pound of ammonia-N nitrified and 7.14 lb of alkalinity are consumed per pound of ammonia-N nitrified.



## City of Somersworth
## New Hampshire

## Wastewater Treatment Facility

# WWTF Design Data Summary


***New Cloth Media Filters***

**Underwood Engineers, Inc.**

*Civil, and Environmental Engineering*
*Portsmouth and Concord, NH*

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Unit 1
Portsmouth
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## Flow

| | |
|---|---|
| Average Daily Flow | 2.4MGD |
| Maximum Daily Flow | 3.57 MGD |
| Peak Flow | 5.94 MGD |

| Loadings | Sewer Users | Septage | Total |
|---|---|---|---|
| $BOD_5$ | 4,518 LB/D | 625 LB/D | 5,143 LB/D |
| TSS | 3,058 LB/D | 1,829 LB/D | 4,887 LB/D |
| TKN | 624 LB/D | 128 LB/D | 752 LB/D |
| TP | 128 LB/D | 46 LB/D | 174 LB/D |

## Treatment Process Upgrade

***Preliminary Treatment***

Septage Receiving - (2) 10,000 gallon Tanks - 1 Septage Acceptance unit
Mechanical 1/8" Fine Screens - (2)
Detritor Grit Tanks -(2)
Grit Washer - (1)

***Advanced Secondary Treatment System (Modified UCT BNR)***

Two (2) Tanks with five (5) zones each
Anaerobic Volume AN1&2 (per tank) - 77,000 gallons
Anoxic Volume AX1 (per tank) - 39,000 gallons
Anoxic Volume AX2 (per tank) - 98,000 gallons
Aerobic Volume (per tank) - 619,000 gallons
Positive Displacement Blowers - (4) 50HP, Fine Bubble Membranes
Circular Center Feed Retrofit Clarifiers - (2) 80 ft diameter w/ 10.5 ft SWD
RAS Pumps (3) 0.25 – 1.25 Q
Ferric Chloride Addition with Chemical Induction Mixers

***Effluent Filtration***

Cloth Media Disc Filters - (2) pile cloth media, 8 discs per filter

***Disinfection System***

Sodium Hypo-Chlorite Chambers - (2)
Length: 120ft (CCT1) 124 (CCT2)
Width: 5ft
Side Water Depth: 9.44ft

***Dechlorination Chambers***

Sodium Bisulfite - (2)
Side Water Depth: 9.44ft
Area: 27.5 $ft^2$

***Post Aeration System***

Positive Displacement Blowers - (3), Fine Bubble Membranes

***Sludge Handling System***

Centrifuge - (1) 7 hours a day, 5 days a week (1,300 dry lbs/hr)
Sludge Dryer - (1) Class A sludge production - 630 DT/YR
Sludge Storage (3) 34,000 gallons, each