Sequencing Batch Reactors in Wastewater Treatment

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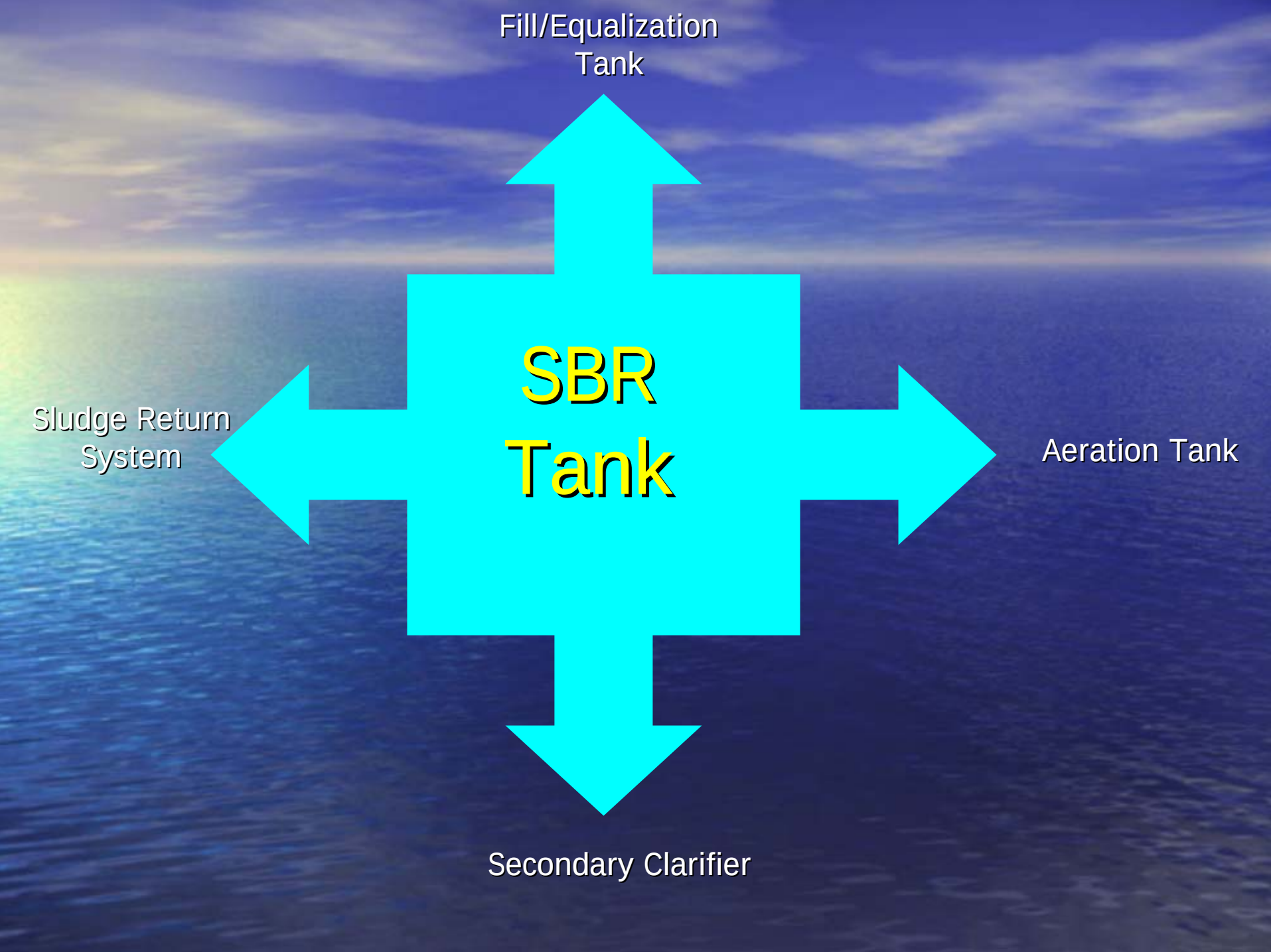
SBR History

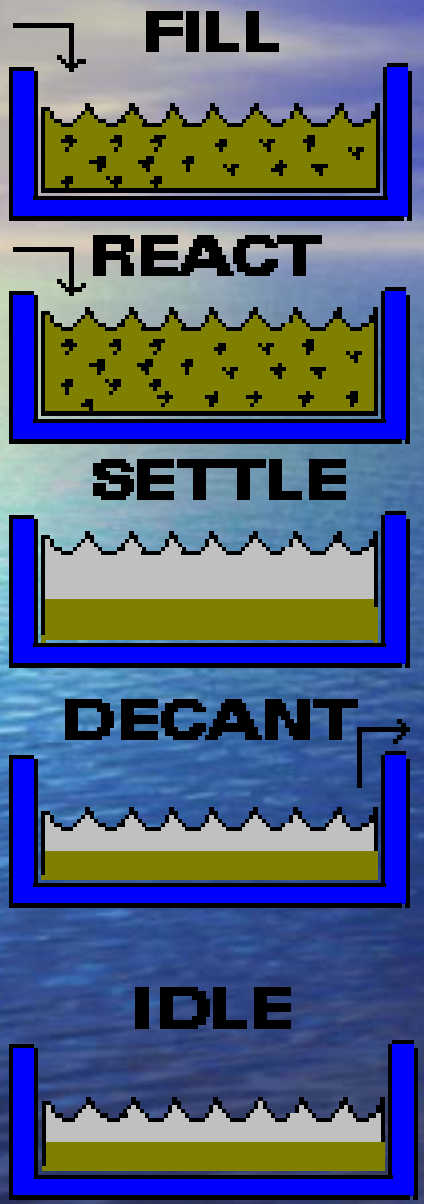
- During the early development of the activated sludge process in the United Kingdom by Ardern and Lockett around 1914, plants were operated using fill-and-draw or batch feed methods.
- Around 1956, development of oxidation ditch technology.
- By the late 1970s, the sequencing batch reactor (SBR) was well established and many small plants were in operation.
- Recent developments in technology made SBRs a more viable option for small to medium size facilities.

Process – Activated Sludge

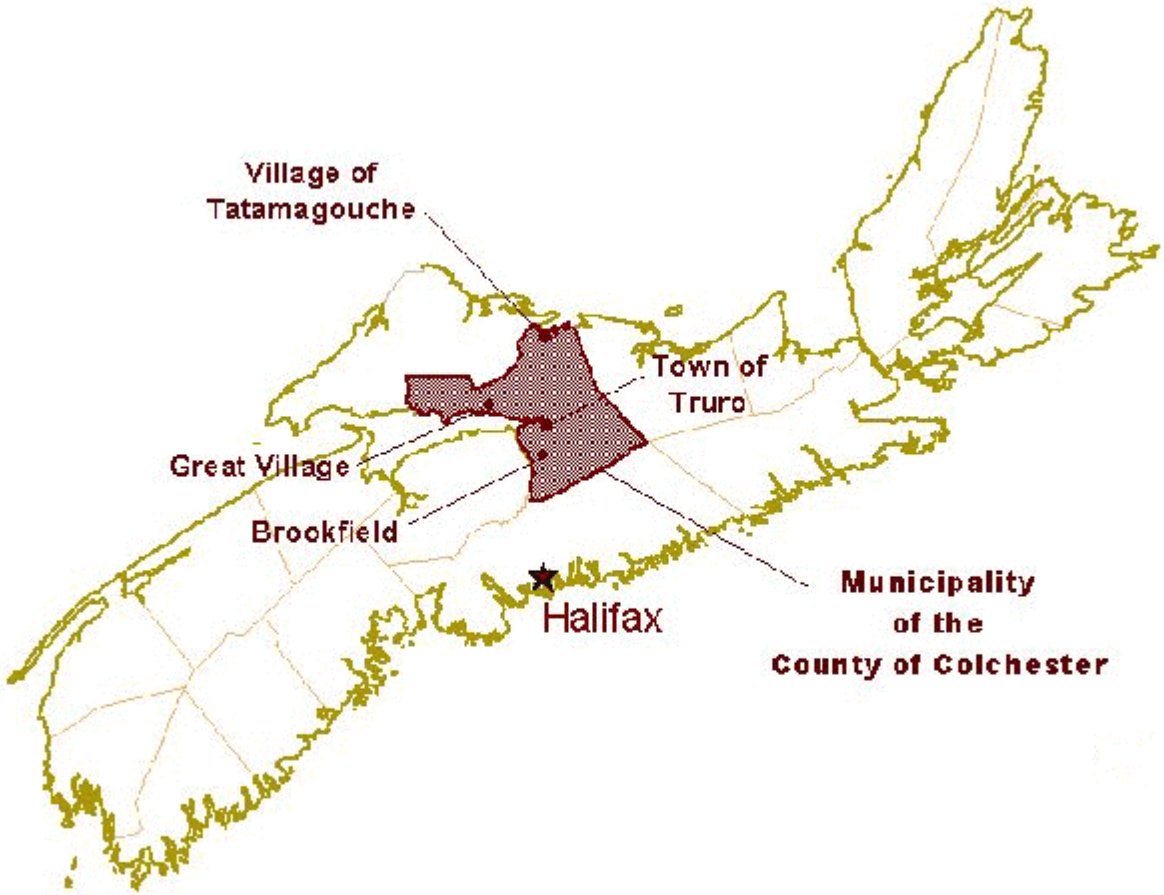
- **Activated Sludge** systems use suspended natural biological and bacterial growth to remove contaminants. The wastewater is mixed with a bacterial floc in an aeration tank where the contaminants are removed by sorption and subsequent breakdown
- **Sequencing Batch Reactors (SBR)** are a special form of activated sludge treatment in which all of the treatment process takes place in the reactor tank and clarifiers are not required. This process treats the wastewater in batch mode and each batch is sequenced through a series of treatment stages.


Fill/Equalization Tank
Sludge Return System
SBR Tank
Aeration Tank
Secondary Clarifier

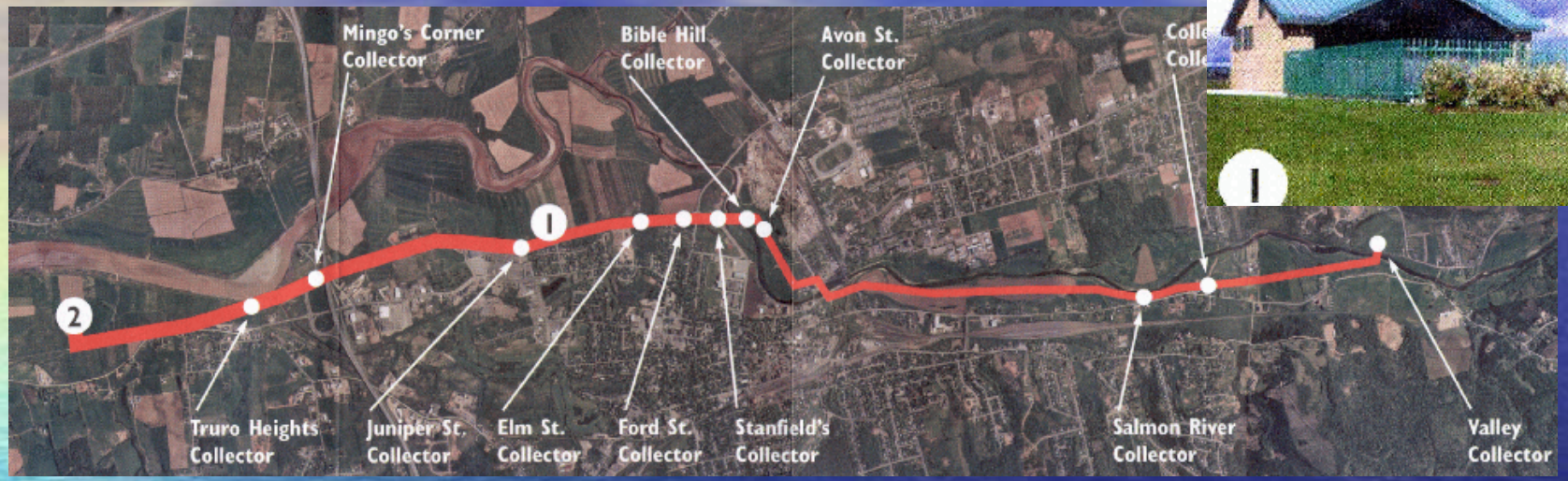
Typical SBR Process



- Wastewater fills the tank, mixing with biomass that settles during the previous cycle
- Air is added to the tank to aid biologial growth and facilitate subsequent waste reduction.
- Mixing and aeration stop during this stage to allow solids to settle to the bottom of the tank
- Clarified effluent is discharged.
- If necessary, sludge removal occurs during this stage.


Village of
Tatamagouche
Town of
Truro
Great Village
Brookfield
Halifax
Municipality
of the
County of Colchester

Central Colchester : Wastewater Collection & Treatment



- Serves a population of 25,000 people
- 11 Km. Trunk Sewer 4 feet in diameter
- Archimedes Screw Sewage Lift Station
- Sewage Treatment Plant : SBR;
  Ave. Capacity 5 MGD

Plant Performance

- Consistently meets/exceeds the permit requirements; BOD/SS:30/30
- Overflows happen after 8 MIGD
- Operating Cost $900,000 per year
  includes Biosolids handling, disposal and leachate treatment from Colchester & Cumberland landfills.
- Staff – 4.5 persons
- Power Cost - $300,000

Sewage Treatment Projects Background

- Call for Proposals – 1995
- Consultant completed an Interim Report in Sept. 1996 recommending replacement of all three treatment plants
- Final Report completed in March 1997
- Three applications made to Infrastructure Program
- Detailed Design and drawings completed by Jan. 1998

Rural Waterwater Collection and Treatment

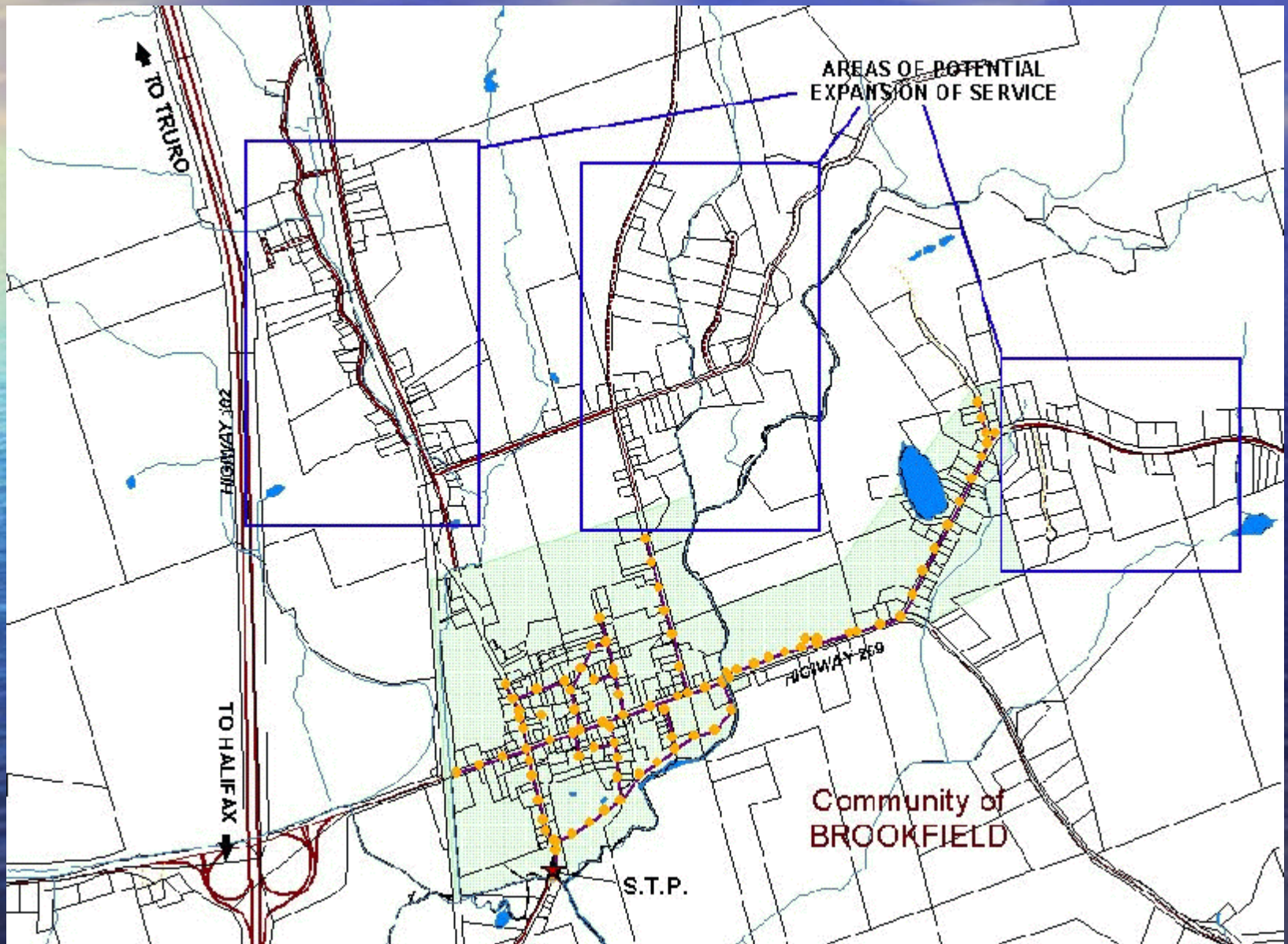
Three Systems :

1. Brookfield : Population 760
2. Great Village: Population 200
3. Tatamagouche: Population 720

Future Systems : designed with 22% growth over next 20 years.

Municipality's Goal:
Replace these STPs by 2004

Brookfield Sewer System



Existing Brookfield STP

New Brookfield STP

Brookfield STP

- Council authorized design-build in August 2001.
- Approval for funding received in March 2002
- Construction started in August 2002
- Plant commissioned in March 2003
- Warranty period ends March 2005

CLR

Brookfield Plant Performance

Parameter	Plant Effluent 2004 Av. Value	NSDEL Permit	NSDEL Frequency
BOD (mg/L)	3	20	5/month
pH	7.3	6.5 – 9.0	Grab
Fecal Coliform (Count/ml)	3.5	200	5/month
Suspended Solids (mg/L)	4.2	20	5/month

Municipality of Colchester

Brookfield

$$$

Item	Cost
Tendering	$1,293.91
Supplies & Equipment	$46,165.51
Contractor Payments	$1,647,707.95
Engineering & Testing	$15,261.31
Miscellaneous	$5,346.23
Total	$1,715,775.91

Original Estimate for the new plant - $2.0 million (1998 estimate)

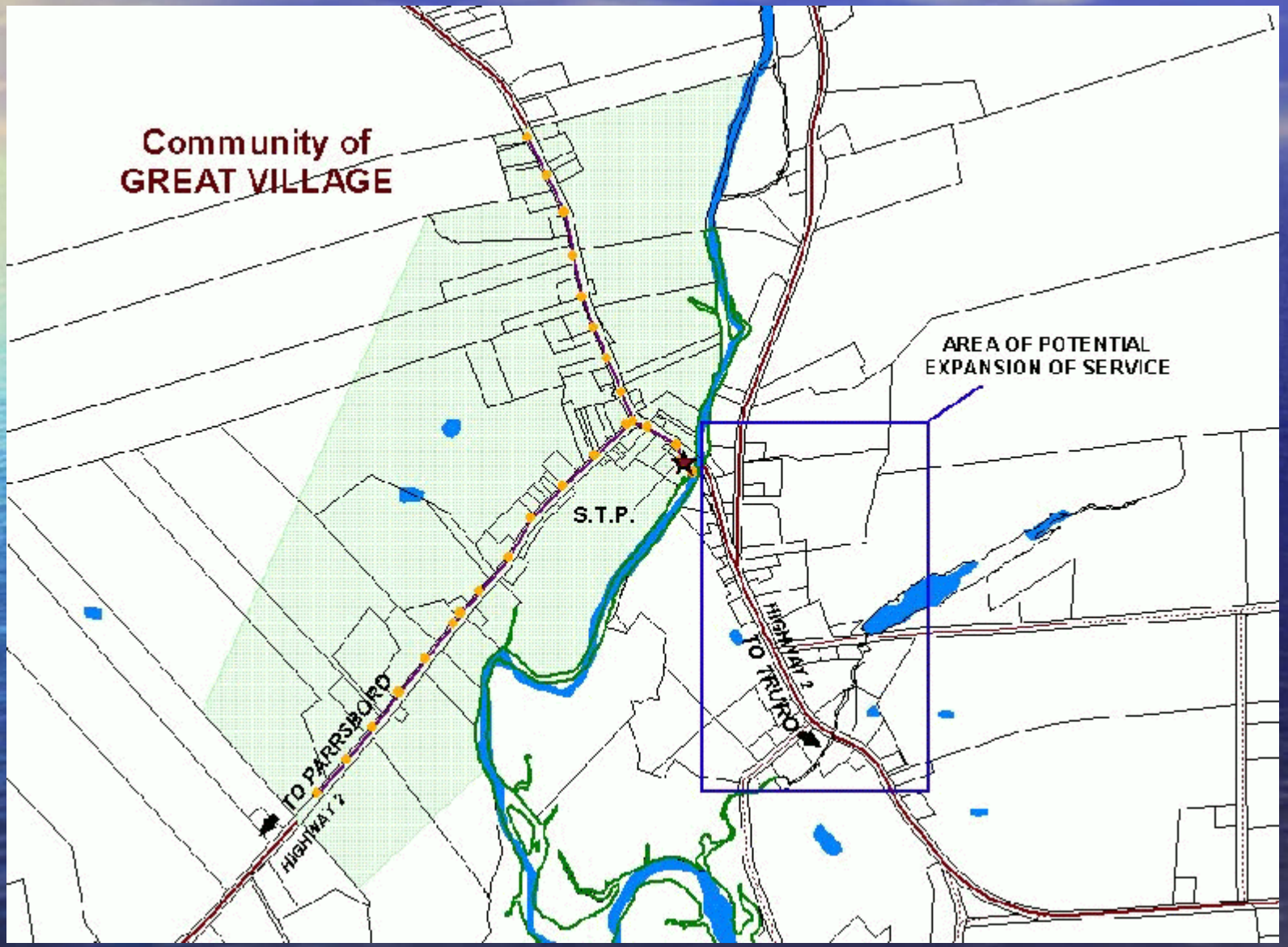
Infrastructure Funding Approved - $1,799,113

Brookfield Operations

- Design wet weather flow 250,000 IGPD.
- Effluent quality consistently below the permit discharge limitations of BOD/SS:20/20; tertiary quality effluent without filters
- Operating cost - $60,000; includes part-time operator, sludge transport &handling.
- Power Cost - $20,000
- Operator Time – 4 Hours/week

Replaced Great Village STP

Great Village Sewer System



Cost Comparison - Great Village STP Options

ITEM	CLR	Design/Build	Brookfield Relocate
Replace Pump. Sta.	$35,000	$20,000	$15,000
Grinder/Screening	$20,000	$25,000	n/a
Site Preparation	$34,000	$20,000	n/a
Reactor Basin/Tankage	$60,000	$220,000	$20,000
Equipment	$160,000	$155,000	$53,000
Clarifer	$104,000	n/a	n/a
Sludge Storage	$15,000	n/a	n/a
Disinfection System	$50,000	$50,000	$30,000
Electrical/Controls/Generator	$64,000	$60,000	$59,000
Controls/Lab/Office Building	$48,000	$55,000	$68,000
Relocate Outfall	$10,000	$10,000	$10,000
Siteworks	$100,000	$50,000	$30,000
Miscellaneous	$20,000	$20,000	$20,000
Repairs/Sandblasting	n/a	n/a	$20,000
Design Flow Increase	$80,000	n/a	n/a
Subtotal	$800,000	$685,000	$325,000
Plus Contingency (10%)	$880,000	$753,500	$357,500
Plus Engineering (14%)	$1,003,200	n/a	$407,550

Great Village STP

- April 2002; Council withdrew application for funding from CNISP.
- Previously authorized the use of Brookfield STP tanks for this facility.
- Construction began in late August 2003.
- Plant Commissioned in Feb. 2004.

Great Village Plant Performance

Parameter	Plant Effluent 2004 Av. Value	NSDEL Permit	NSDEL Frequency
BOD (mg/L)	3.3	20	5/month
pH	6.8	6.5 – 9.0	Grab
Fecal Coliform (Count/ml)	4.66	1000	5/month
Suspended Solids (mg/L)	8.8	20	5/month

Great Village

$$$

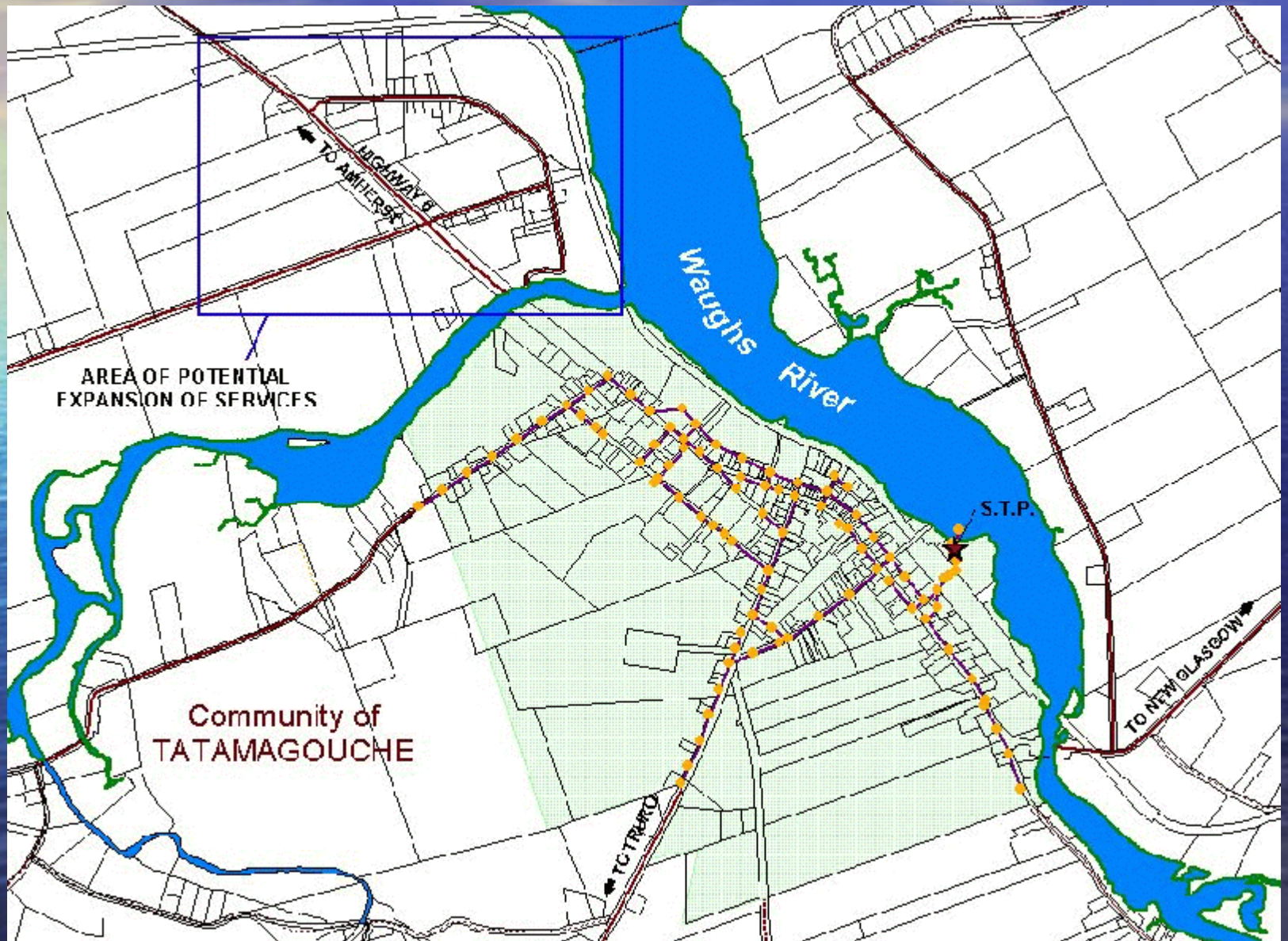
Item	Cost
Tendering	$728.15
Supplies & Equipment	$143,166.65
Contractor Payments	$360,763.03
Engineering & Testing	$24,343.65
Miscellaneous	$1414.23
Total	$530,415.71

Original Estimate for the new plant - $1.0 million (1998 estimate)

Great Village Operations

- Design wet weather flow 70,000 IGPD.
- Effluent quality consistently below the permit discharge limitations of BOD/SS:20/20; tertiary quality effluent without filters
- Operating cost - $30,000; includes part-time operator, sludge transport &handling.
- Power Cost - $7,000
- Operator Time – 4 hours a week

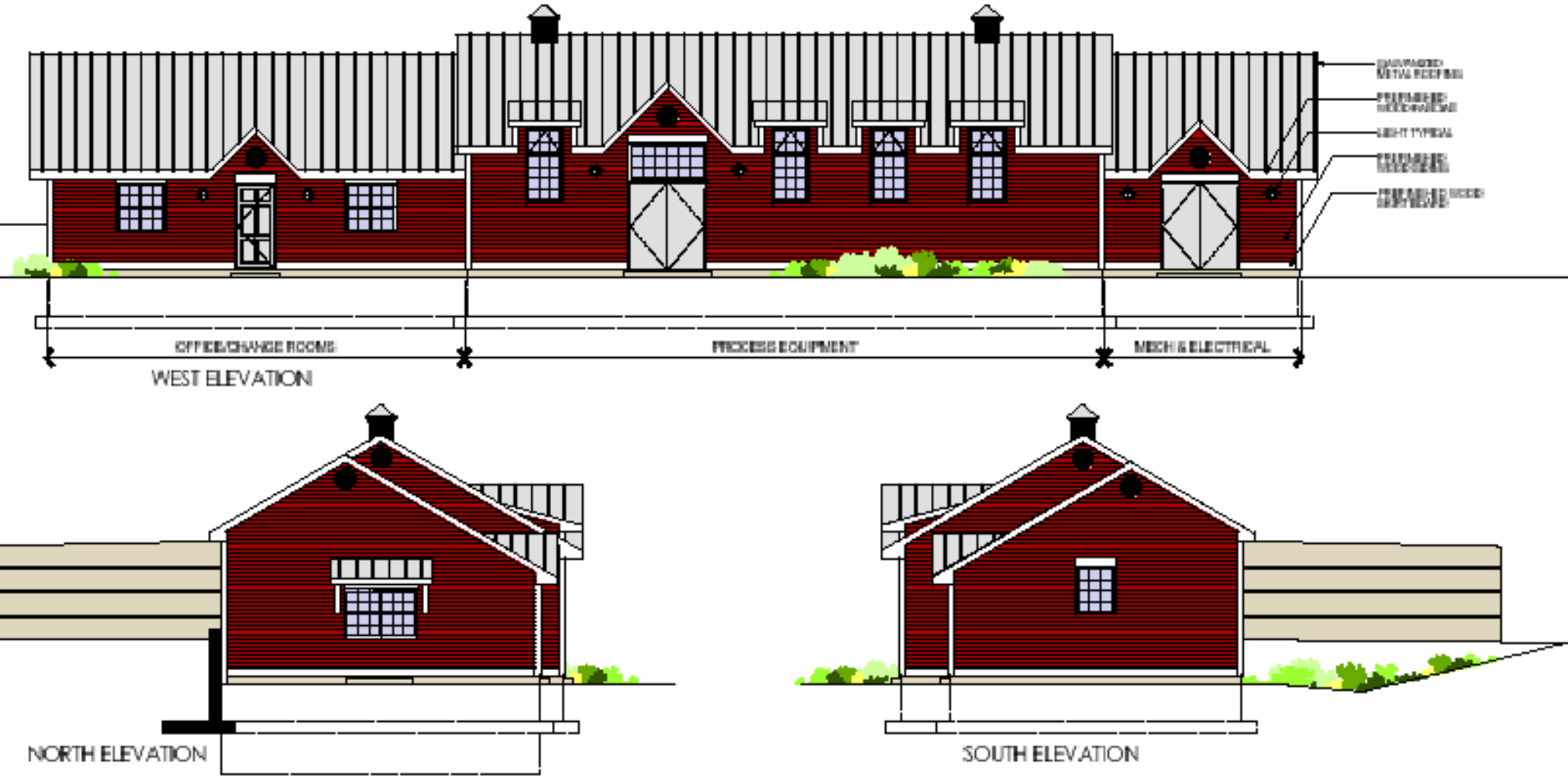
Tatamagouche Sewer System



Tatamagouche STP

- Feb. 2004; Funding approved from CNSIP
- June 2004; Consultant hired to design the new plant.
- Construction began in late Sept. 2004.
- Scheduled Plant Commissioning April 2005.

Tatamagouche STP - Proposed



Tatamagouche

$$$

Item	Cost
Contractor	$1,704,135
Engineering	$157,204
Electrical Panel	$45,000
Total	$1,906,339 plus Tax

Infrastructure Funding Approved – $1,639,007

Tatamagouche Operations

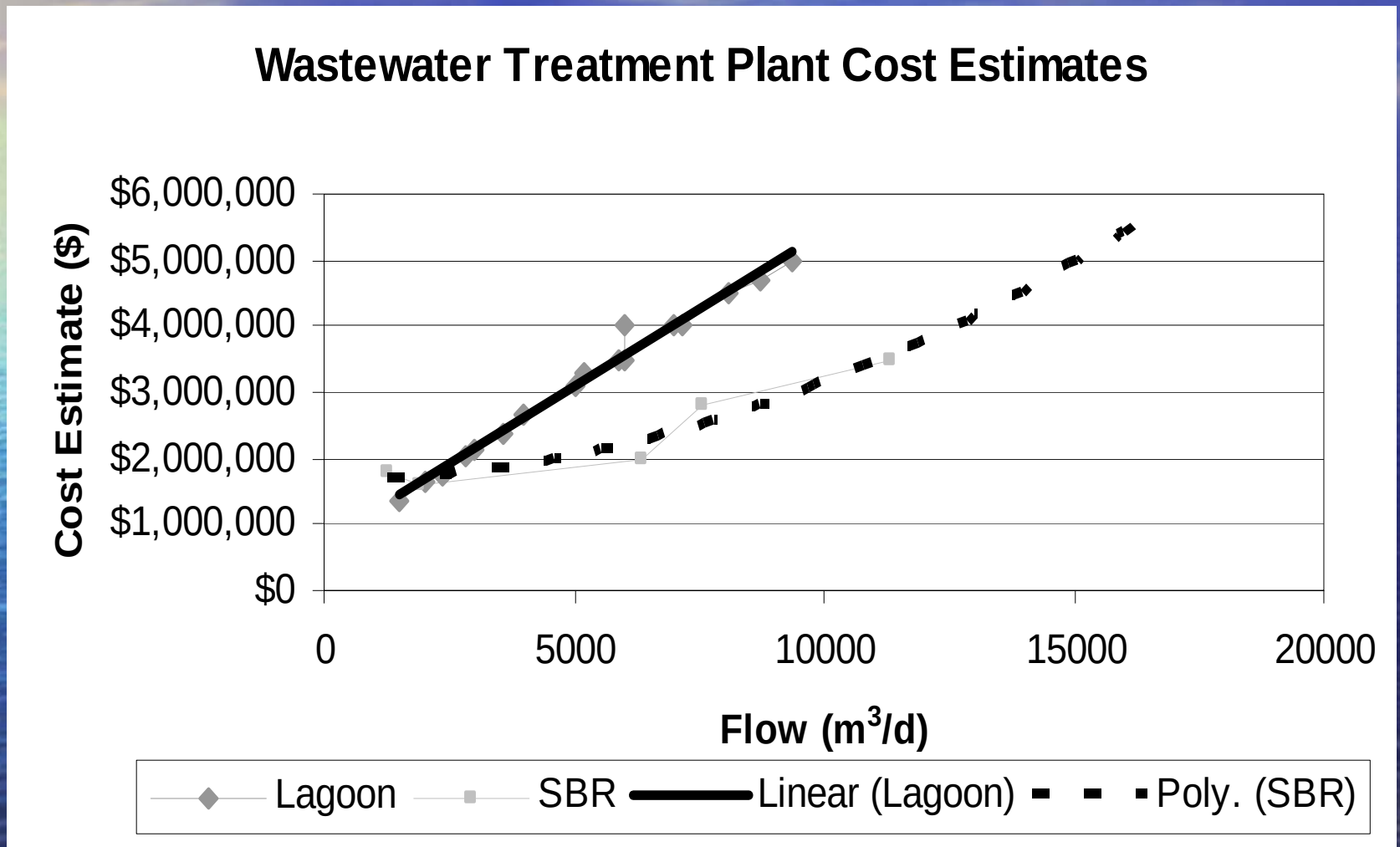
- Design wet weather flow 300,000 IGPD.
- *Expected* Effluent quality *to be* below the permit discharge limitations of BOD/SS:20/20; tertiary quality effluent without filters
- Budget Operating cost - $80,000; includes part-time operator, sludge transport &handling.
- Estimated Power Cost - $25,000

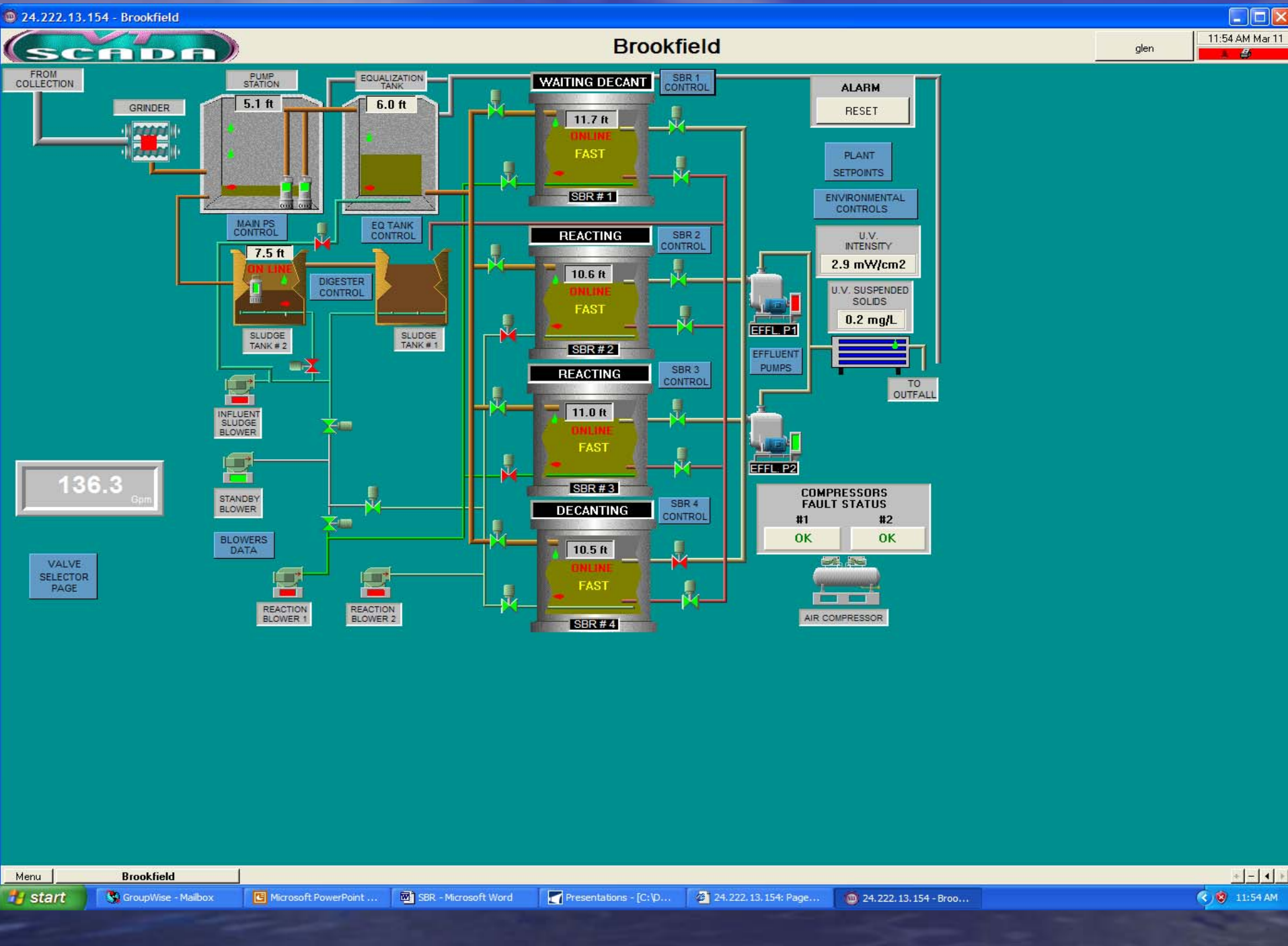
Baddeck STP (1.7 MGD, $2.2M)

Pugwash STP (0.5 MGD, $1.6M)

Pamquet STP


POMQUET SBR
SEWAGE TREATMENT FACILITY
MUNICIPALITY OF THE COUNTY OF ANTIGONISH
AUTHORIZED PERSONNEL ONLY


Wastewater Treatment Plant Cost Estimates
Cost Estimate ($)
$6,000,000
$5,000,000
$4,000,000
$3,000,000
$2,000,000
$1,000,000
$0
0
5000
10000
15000
20000
Flow (m3/d)
Lagoon
SBR
Linear (Lagoon)
Poly. (SBR)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SCADA
Brookfield
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FROM COLLECTION
GRINDER
PUMP STATION
5.1 ft
EQUALIZATION TANK
6.0 ft
MAIN PS CONTROL
EQ TANK CONTROL
7.5 ft
ON LINE
DIGESTER CONTROL
SLUDGE TANK # 2
SLUDGE TANK # 1
INFLUENT SLUDGE BLOWER
STANDBY BLOWER
BLOWERS DATA
REACTION BLOWER 1
REACTION BLOWER 2
136.3
Gpm
VALVE SELECTOR PAGE
WAITING DECANT
SBR 1 CONTROL
11.7 ft
ONLINE
FAST
SBR # 1
REACTING
SBR 2 CONTROL
10.6 ft
ONLINE
FAST
SBR # 2
REACTING
SBR 3 CONTROL
11.0 ft
ONLINE
FAST
SBR # 3
DECANTING
SBR 4 CONTROL
10.5 ft
ONLINE
FAST
SBR # 4
ALARM
RESET
PLANT SETPOINTS
ENVIRONMENTAL CONTROLS
U.V. INTENSITY
2.9 mW/cm2
U.V. SUSPENDED SOLIDS
0.2 mg/L
EFFL. P1
EFFL. P2
EFFLUENT PUMPS
TO OUTFALL
COMPRESSORS FAULT STATUS
#1
#2
OK
OK
AIR COMPRESSOR
Menu
Brookfield
start
GroupWise - Mailbox
Microsoft PowerPoint ...
SBR - Microsoft Word
Presentations - [C:\D...
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Planning for an SBR

- ✓ Get accurate flow monitoring data
- ✓ Inflow/Infiltration considerations
- ✓ Wastewater Characteristics
- ✓ Community Growth Patterns
- ✓ Site Adaptation/Selection
- ✓ Access to skilled operators

SBR Selection

- ✓Different configurations of the SBR
  - Equalization/non Equalization
  - Two Cell/Four Cell Design
  - Fill cycle variations
  - Different Aeration systems
  - Decanter designs
  - Sludge wasting mechanisms
  - Controls and Automation
  - Configuration to site

SBR Selection Contd.

- ✓Different vendors have their own designs
- ✓Wastewater Characteristics
- ✓Community Growth Patterns
- ✓Site Adaptation/Selection
- ✓Access to skilled operators

Pugwash STP (0.5 MGD, $1.6M)

Advantages of SBR

- Small footprint
- Maximum day flow sizing, not peak hourly.
- Can handle large fluctuations in flow and influent quality
- No hydraulic connection between incoming sewage and the outfall
- Flexibility and control
- Deeper tanks, better AOTR
- Modular, adaptable to retrofits & upgrades
- Full back up systems

Disadvantages

- Requires highly skilled team to design and construct the facilities
- Highly skilled operators
- Can be higher in operating cost, you do not control the cost of electricity.
- Bigger disinfection system, batch discharge
- More mechanical equipment

Main Points to Consider

- No matter what type of plant you decide, remember these facilities often times become the boundary of a community
- Do not oversize, go modular and have back up systems
- Select readily available equipment
- Choose open architecture and non-proprietary control systems
- Trained operators is a must for SBRs
- Consider high level of automation
- Hire an operator in the planning stage
- Optimize plant to start with (InfraGuide Best Practices); one additional hp costs $1,000 more per year to run.
- Set up an equipment reserve as a maintenance cost.
- UV Disinfection
- Biosolids handling and disposal

Acknowlegdements

Halifax Regional Water Commission

Municipality of the County of Colchester

&

You all

Questions?????