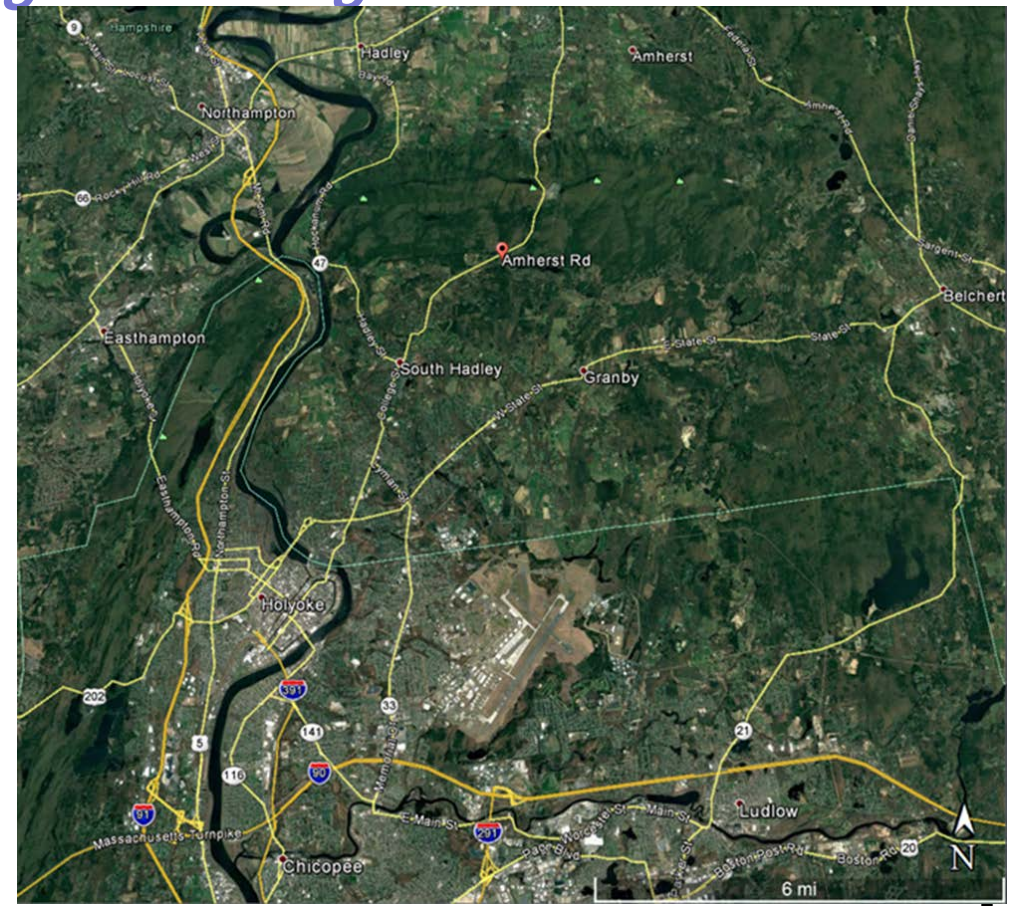
Cost-Effective On-Site Groundwater Discharge Wastewater MA Project Achieving Effluent Total Nitrogen < 2 mg/L



June 10, 2021

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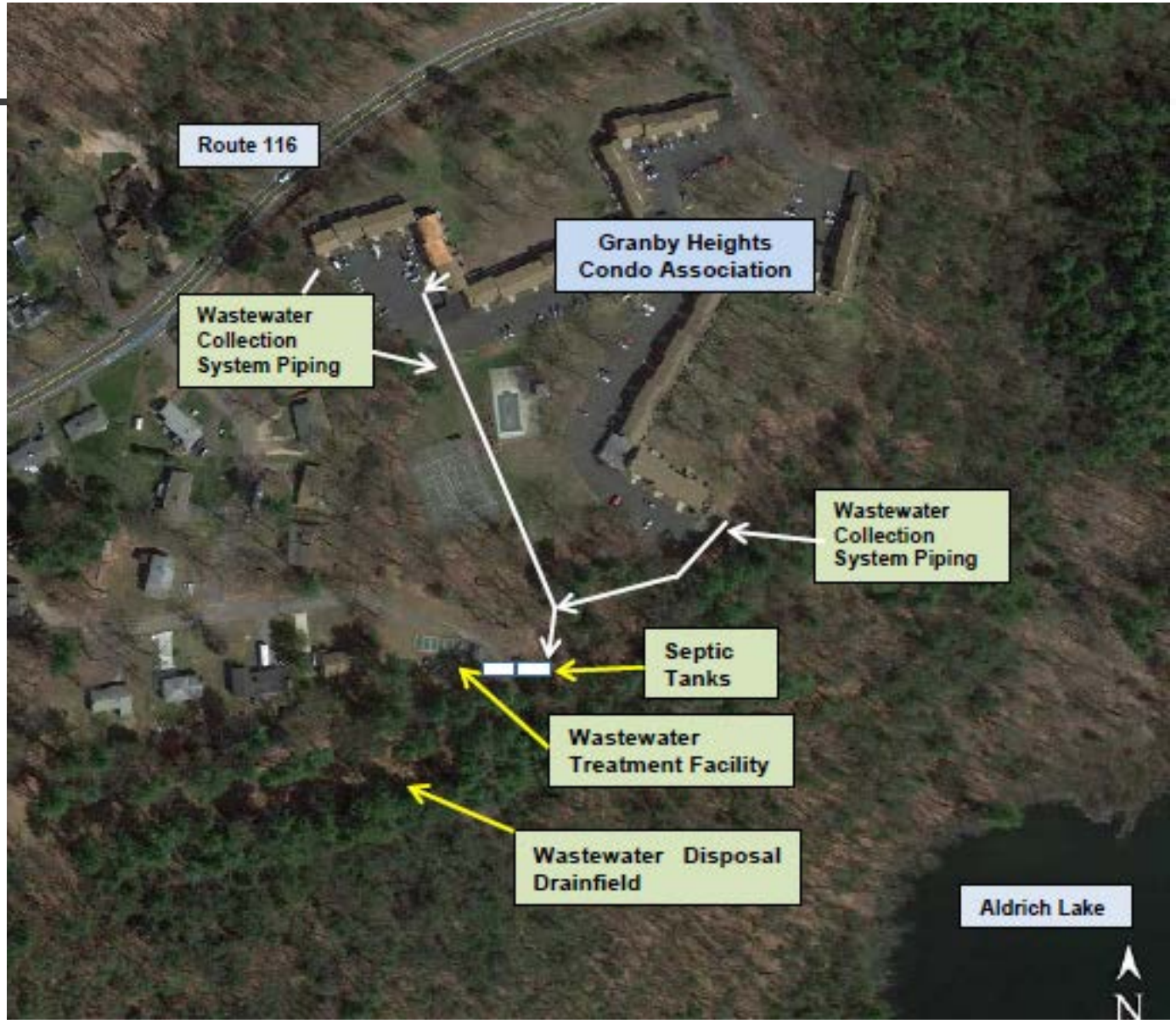
Project Site – History Granby Heights Association, Inc. (GHA)

- 76-unit condominium in central MA Town of Granby, near Amherst
- Required in early 2000s by MassDEP to upgrade 17,000 gallons per day septic system to achieve effluent Total Nitrogen (TN) of < 10 mg/L
- Wastewater system designed, installed and operational by 2010 – using recirculating media filters and chemical (Micro C) addition
- Treatment system effluent TN 15+ mg/L

Project Site – History Granby Heights Association, Inc. (GHA)

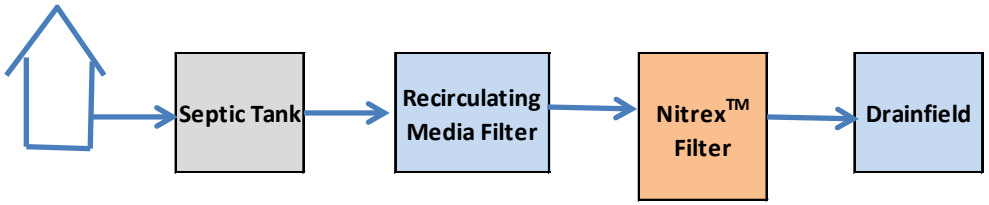
- MassDEP issues consent order
- GHA recovers damages from original design engineer
- Lombardo Associates, Inc. (LAI) retained to upgrade WWTP under design + equipment supply agreement. Owner retains local, trusted contractor on a time & materials agreement.
- LAI guarantees groundwater discharge permit compliance
- MassDEP approves use of Nitrex System
- Design starts October 2017 + Nitrex system operational in December 2018


Route 116
Granby Heights Condo Association
Wastewater Collection System Piping
Wastewater Collection System Piping
Septic Tanks
Wastewater Treatment Facility
Wastewater Disposal Drainfield
Aldrich Lake
N

Nitrex™ for Nitrogen Removal

MassDEP Permitted Nitrex System

Simplified process Flow Diagram



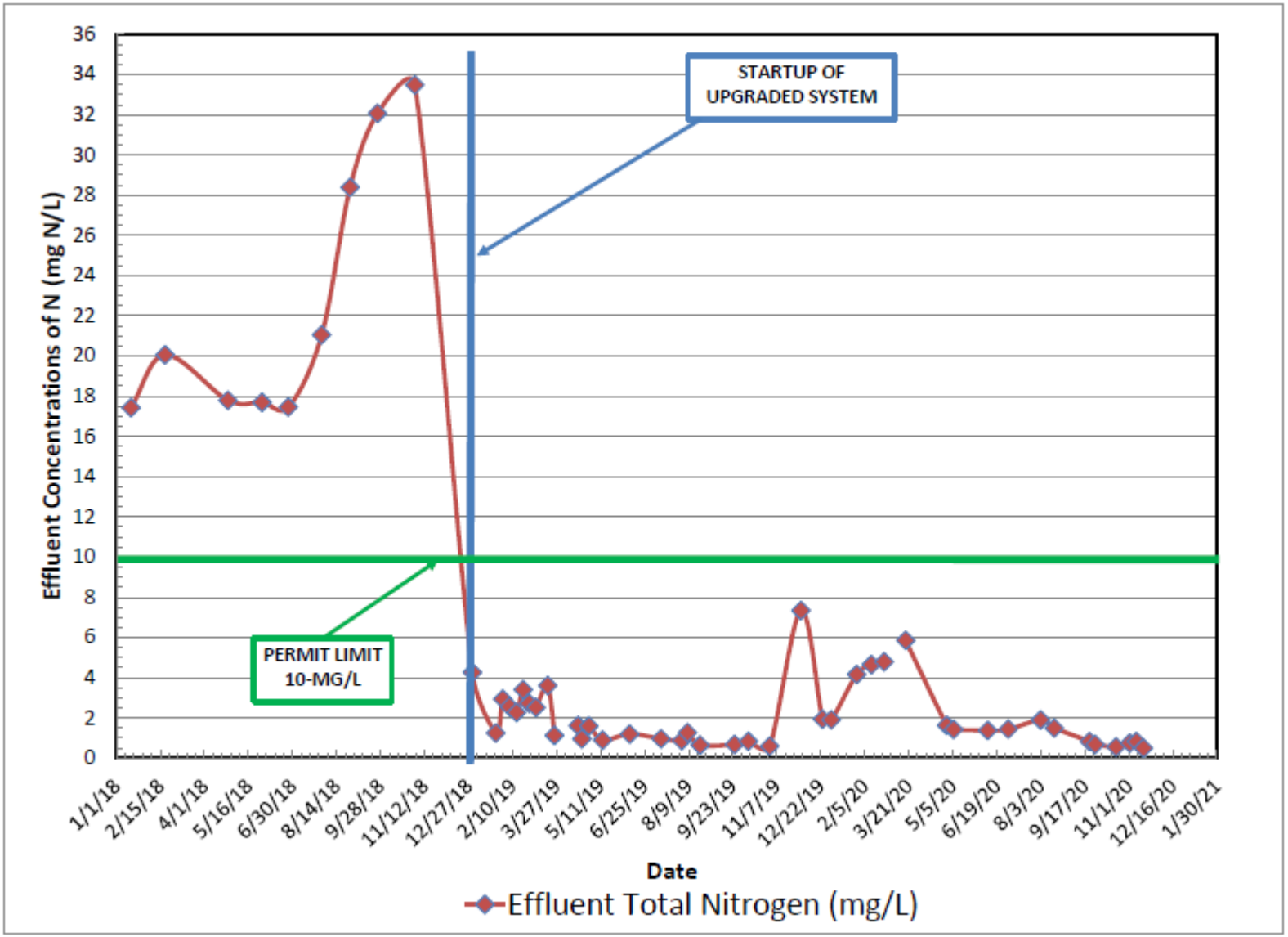
- **Passive, no chemical addition**
- **No sludge, other than septic tank septage**
- **No aeration**
- **Electricity mainly for pumps typically < 1 HP**
  - **Annual power use 17,500 kwhr**
- **Achieves TN < 10 mg/L, averaging < 2 mg/L**

Treatment System Performance

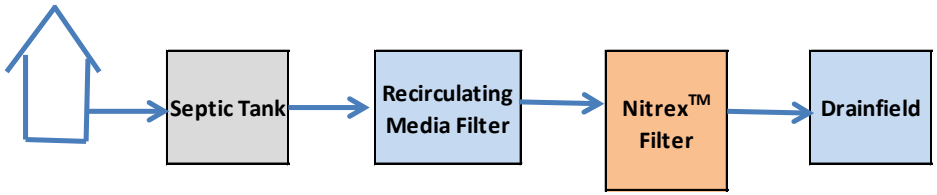
Date	Influent	Effluent
	Inf. TN	Eff. TN
12/31/18	57	4.26
1/24/19		1.25
1/31/19	59.9	2.94
2/7/19		2.57
2/14/19		2.27
2/21/19		3.40
2/27/19	60.3	2.73
3/6/19		2.53
3/18/19		3.61
3/25/19	55.4	1.13
4/18/19		1.62
4/22/19		0.96
4/29/19	63.9	1.59
5/13/19	54.2	0.89
6/10/19	56	1.20
7/12/19	49	0.96
8/2/19		0.87
8/8/19	53.5	1.27
8/21/19	78.7	0.65
9/25/19	60.3	0.68
10/9/19	59.1	0.84
10/31/19		0.59
12/2/19	60.2	7.35
12/24/19	64.5	1.95

Date	Influent	Effluent
	Inf. TN	Eff. TN
1/2/20	61.4	1.91
1/28/20		4.16
2/12/20		4.66
2/25/20	62.1	4.79
3/18/20	69.8	5.85
4/29/20	63.7	1.64
5/6/20	65.2	1.44
6/10/20	65.7	1.38
7/1/20	62.3	1.44
8/3/20	67	1.90
8/17/20	68.67	1.50
9/22/20	65	0.83
9/28/20	68	0.68
10/19/20	68	0.56
11/2/20	68	0.74
11/9/20	68	0.83
11/16/20	71.3	0.51
Average	**63.34**	**2.02**
Geomean	**63.02**	**1.57**

Treatment System Performance



Nitrex™ for Nitrogen Removal



- **Odor – foul gases collected via vent system piping and treated by activated carbon prior to discharge.**
- **Treatment system managed by a Programmable Logic Controller (PLC) with internet connection to Engineer + Operator**
- **Daily reports electronically issued on system wastewater flows and process unit status.**
- **Alarm conditions are instantaneously sent to the facility operator and engineer with identification of alarm cause**

GRANBY WWTP

Environmental Engineers/Consultants
LOMBARDO ASSOCIATES, INC.

May 31, 2021

PS-FE1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-1	105.03	36.0	84	3780.97	1.25
P-2	105.00	36.0	84	3779.84	1.25
TOTALS	210.02		168	7560.85	

PS-AX1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-5	360.43	56.0	99	20184.11	3.64
P-6	359.33	56.0	98	20122.38	3.67
TOTALS	719.76		197	40306.50	

PS-NF1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-7	272.30	28.0	21	7624.27	12.97
P-8	278.25	28.0	20	7790.89	13.91
TOTALS	550.54		41	15415.16	

PS-AX2

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-3	205.99	62.0	103	12771.67	2.00
P-4	205.26	62.0	102	12725.88	2.01
TOTALS	411.25		205	25497.70	

PS-NF2

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-9	289.24	28.0	23	8098.81	12.58
P-10	244.26	28.0	22	6839.33	11.10
TOTALS	533.51		45	14938.14	

PS-DF1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-11	62.31	66.0	6	4112.47	10.39
P-12	66.44	66.0	6	4384.73	11.07
TOTALS	128.75		7	8497.20	

NITREX STAGE 1 DAILY FLOW

SV #	FLOW (GPD)	SV OPEN (MIN)	SV RATE (SEC)	# OF CYCLES	CALC OPEN TIME
SV-NX1	7431.2	191.30	0.0	304	0.00
SV-NX2	7630.7	192.03	0.0	305	0.00
SV-NX3	7607.1	179.63	0.0	307	0.00
SV-NX4	0.0	0.00	0.0	0	0.00
SV-NX5	0.0	0.00	0.0	0	0.00
TOTALS	22668.9	562.96		916	0.00

NITREX STAGE 2 DAILY FLOW

SV#	FLOW (GPD)	SV OPEN (MIN)	SV RATE (SEC)	# OF CYCLES	CALC OPEN TIME
SV-NX6	26.8	273.99	0.0	423	0.00
SV-NX7	26.7	273.44	0.0	417	0.00
TOTALS	53.5	547.43		840	0.00

ADVANTEX STAGE 1 TOTALS

SV#	FLOW (GPD)	SV OPEN (MIN)	SV RATE (SEC)	# OF CYCLES	CALC OPEN TIME
SV-AX1	24035.6	362.57	0.0	196	0.00
SV-AX2	23840.2	363.71	0.0	197	0.00
TOTALS	47875.9	726.27		393	0.00

ADVANTEX 2 AND EFFLUENT

FM-AX2 TOTAL GPD	112732.5 GAL		EFFLUENT TOTAL GPD	7699.2 GAL

12:00:14 AM 05/31/21

MAIN | PS-FE1 | PS-AX1 | PS-NF1 | PS-AX2 | PS-NF2 | PS-DF1 | TIMERS | ALARM

Run Mode

Unit Process Monitoring and Alarm Systems – Supervisory Control And Data Acquisition (SCADA)

Unit Process	Potential Mode(s) of Failure	Monitoring Equipment / Data	Monitoring System / Operator Response
Septic Tank / Flow EQ Tank	Pump Failure / Clogged filter	Alarm Float HLA-1, Flow Meter FM-1, Current Sensor	Adjust timer settings for PS-FE1 if high levels. Check pump / filter if flow rate is low.
Recirculation Tank #1	Pump Failure / Clogged filter	Alarm Float HLA-2, Pump Current Sensors, Flow Meter FM-AX1	Adjust timer settings if override / alarm float consistently is activated. Inspect pump filter and solenoid valves if flow is low. Inspect pumps if current draw is out of normal operating range.
Pump Station AX-1			
1st Stage Advantex Feed Solenoid Valves	Valve Failure / Clogging / Leakage		
Recirculation Tank #2	Pump Failure / Clogged filter	Alarm Float HLA-2, Pump Current Sensors, Flow Meter FM-AX1	Adjust timer settings if override / alarm float consistently is activated. Inspect pump filter if flow is low. Inspect pumps if current draw is out of normal operating range.
Pump Station AX-2			
Recirculating Splitter Valves - 1st and 2nd Stage	Clogged Inlet / Float Ball Failure	Pump run times	Inspect splitter valve / float ball assembly if pump run times vary significantly than what is expected for current timer settings
1st Stage Advantex Units	Spray Nozzles / Distribution System	Flow Meter FM-AX1 / Real-time NH4 / NO3 Data	Check nozzles for clogging / poor spray patters. Replace / clean as needed. Adjust timer settings to increse recirc. ratio if NH4 levels are high.
2nd Stage Advantex Units	Spray Nozzles / Distribution System	Flow Meter FM-AX2	Check nozzles for clogging / poor spray patters. Replace / clean as needed. Adjust timer settings to increse recirc. ratio if NH4 levels are high.
Vent Fan / Heater	Power loss / equip. Failure	Air Temp. / Velocity Meter	Check operation if temperature and/or velocity fall below normal operating range
1st Stage Nitrex Pump Station	Pump Failure / Clogged filter	Alarm Float HLA-3, Current sensor	Check pumps, filter if high levels occur or current is out of range
1st Stage Nitrex Solenoid Valves	Valve Failure / Clogging / Leakage	Flow Meter FM-NX1	Check solenoid valves if flows are unusually high or low
1st Stage Nitrex Filters	Clogged Collection Pipe	Alarm Floats HLA-7 through HLA-9	Check effluent pipe if high level alarm is activated
2nd Stage Nitrex Pump Station	Pump Failure / Clogged filter	Alarm Float HLA-3, Current sensor	Check pumps, filter if high levels occur or current is out of range
2nd Stage Nitrex Solenoid Valves	Valve Failure / Clogging / Leakage	Flow Meter FM-NX2	Check solenoid valves if flows are unusually high or low
2nd Stage Nitrex Filters	Clogged Collection Pipe	Alarm Floats HLA-10 & HLA-11	Check effluent pipe if high level alarm is activated
Final Discharge Tank & Pump Station	Pump Failure / Clogged filter	Alarm Float HLA-6, Current sensor	Check pumps, filter if high levels occur or current is out of range
Drainfield Distribution Valve	Valve Failure / Uneven Distribution	Flow Switches DF-FS1 through DF-FS4	Check Distribution Valve if daily flow of any zone is significantly more/less than 1/4 the total effluent flow.

O&M Requirements & Costs

- ✓ **Operator visits 2 – 3 times per month**
  - **Typically half days**
  - **Benchtop samples / analysis**
  - **Cleaning spray nozzles**
  - **Cleaning filters**
  - **Operator labor fees very low**

- ✓ **Costs**
  - **Capital costs < $25,000 / unit**
  - **25% of capital costs are placed in total equipment replacement fund (required in MA)**
  - **Annual Base O&M = $400 / unit**
  - **Annual Repair & replacement funding = $190 / unit**

GHA manager Steve Nally stated,

“Granby Heights now has a system that not only has exceeded our expectations to achieve permit requirements but also has significantly reduced our annual operational costs.”

Installation demonstrates that decentralized treatment systems can achieve effluent TN levels comparable to most sophisticated centralized facilities with minimal operator attention

Thank you for your interest !

Pio Lombardo, P.E.

Environmental Engineers/ Consultants

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