UPDATE for Northport Harbor Water
Quality Protection Commmittee
March 23, 2022

Background on Aqua Vectors:

Our Focus
Affordable, Effective NO_3 Removal

What Our System Does
Tertiary Process for Continuous Flow Systems

Our Goals
- **Make 80%+ rate of Nitrate removal cheap: reduce CapEx 50% and OpEx 75%+**
- **Make by-products benign and re-usable.**

Our Target Market
WWTPs: 42 (215M GPD) on Long Island
645 (2.8B GPD) in NYS
15,837 (32.3B GPD) in US
SPDES Permits: 2,182 on Long Island alone

How It Works

Multi-Disciplinary Methodology

Electrolytic, Wet & Surface Chemistry

Electrolysis widely used in industry

Drives non-spontaneous reactions

Accelerates natural processes

AV's Unique Electrolytic Cell (patented)

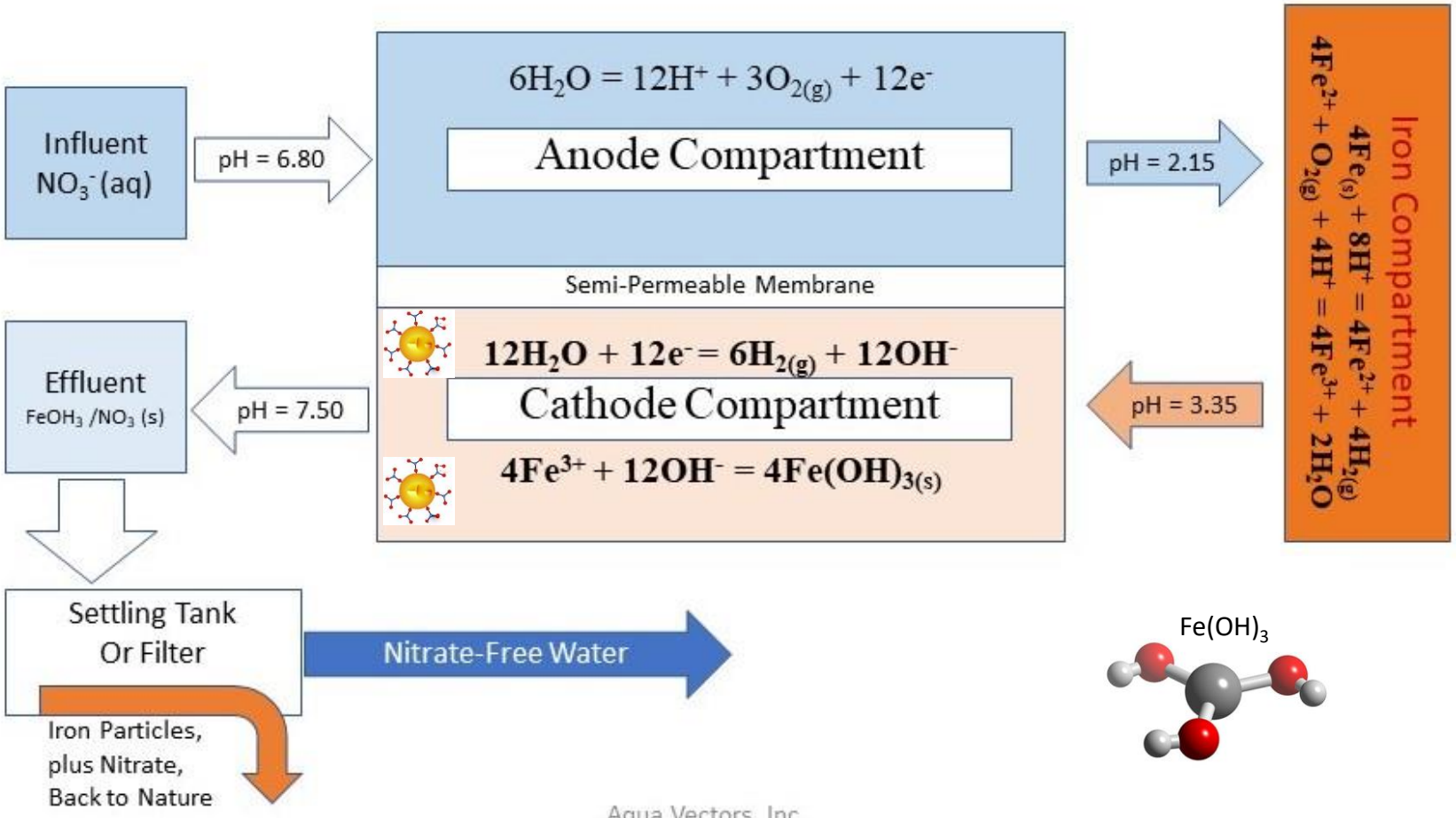
Dissolves solid iron into aqueous solution

Re-crystallizes under engineered conditions

Electrostatically binds anions (nitrate ions) to iron

Filters or settles out iron crystals

The Aqua Vectors Process

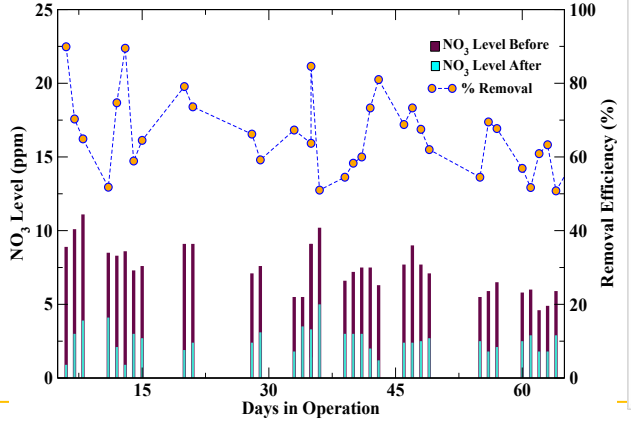


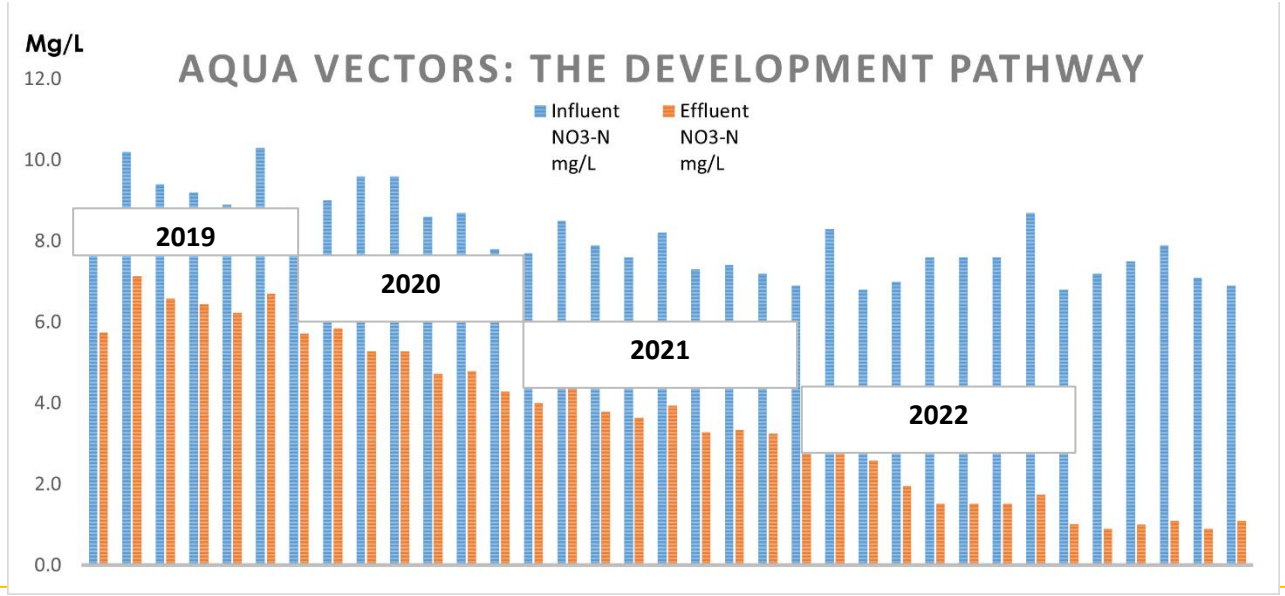
Aqua Vectors, Inc.

The Pathway: Where We Are

- ☑ Phase I: 2010-2014, Proof of Concept
- ☑ Phase II: 2014-2017, The Science: What Works, What Doesn't, and Why
- ☑ Phase III: 2017-2018, Limits and what causes them
- ☐ Phase IV: 2019-2022, Breaking Limits: Enhancing Adsorption Rates
- ☐ Phase V: 2023, Commercial Scale-Up

Original Data - 2012





How We Get There

20 years of Nutrient Removal Research to 2012

Materials science advances in 2012-2022

Development Funding: $1.7M to date

- Self-Funding 2010-2022 - $290K
- Grants (NSF, NYS) 2016-2020 - $254K
- Angels 2017-2022 - $345K
- Sweat Equity 2010-2022 - $790K

Final Development Phase (2022) – now raising $200,000

- Apply Cutting Edge Materials Science
  - Synchrotron/PDF analysis of molecular formation (Argonne/Brookhaven)
  - Big Data materials discovery: alternative structures and kinetics
  - Engineering of form and structure to improve coordination sites
- Results Expected: more Nitrates adsorbed on less Iron
  - Removal rates: 65%-75% → 85% range
  - Cost drivers (iron and electric power): much less required
- Multi-Disciplinary advances in molecular kinetics, adsorption mechanisms
  - Cutting edge materials science, applied
    - Karena Chapman at Stony Brook University
    - Joseph Bennett at Univ of Maryland, Baltimore County
    - Marc Michel (PhD-SBU) at Virginia Tech

Technology Readiness Level

Where we have come:

Concept proven: NSF project

Technology Development

- 90% milestone achieved

Documented effectiveness: up to 90%

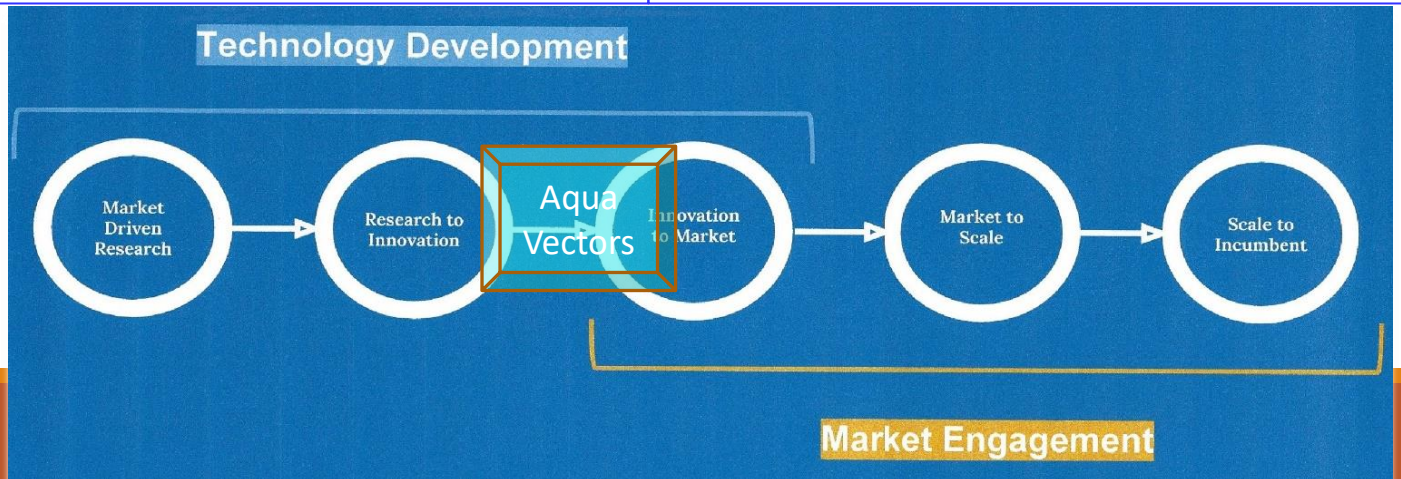
- wastewater and nonpotable fresh water
- reliable and predictable removal rates
- economics comparable to current methods

Northport WWTP has hosted continuously

Forward Strategy:

Enhance Adsorption Performance

- Secure $200K Development Funding
- Double (or more) Adsorption Rates
  - Iron-to-Nitrate Ratio: 10:1 → 4:1
  - Engineer Molecular Kinetics of Iron Formation
  - World Experts: Dr. Chapman (SBU), Dr. Michel (Va Tech), Dr. Bennett (UMBC)
- Key Performance Indicators:
  - Iron(III) Production: 75%+
  - Iron Formation: $Fe(OH)_3$ predominant
  - Adsorption Rate: molecular ratio 4:1 (Fe:NO3)



Our Criteria for Commercial Readiness

Objective	Status	Threshold	Goal
Effectiveness (mg/L NO_3 Removals)	65%-75%	70%-80%	85%+
Efficiency (mM Iron to mM NO_3 Removed)	12-14	6-8	3-4
Simplicity of Op'n and M't'ce	85%	85%	95%
Modularity of Apparatus	Yes	Yes	Yes
Small Footprint of Apparatus	Yes	Yes	Yes
Scalability of Apparatus	Yes	Yes	Yes
Energy Consumption	2.6 kWh/Kgal	2.4 kWh/Kgal	1.9 kWh/Kgal
Energy Consumption (as % of Other Methods)	130% BNR, 120% IEX, 65% RO	120% BNR, 105% IEX, 65% RO	100% BNR, 90% IEX, 50% RO
Operating Cost $/Kgal	$0.80	$0.52	$0.28
Operating Cost (vs. Other Methods)	50% BNR, 20% IEX, 16% RO	45% BNR, 18% IEX, 16% RO	40% BNR, 16% IEX, 15% RO
Capital Expense ($/Kgal over life of system)	$2.05	$1.12	$0.46
Capital Expense (vs. Other Methods)	100% BNR, 80% IEX, 80% RO	60% BNR, 70% IEX, 50% RO	40% BNR, 60% IEX, 40% RO

Thank you!

With unlimited thanks to the Village of Northport for hosting us