



In-Situ Groundwater Nitrification and Denitrification – Bench Scale Testing to Full Scale Remediation

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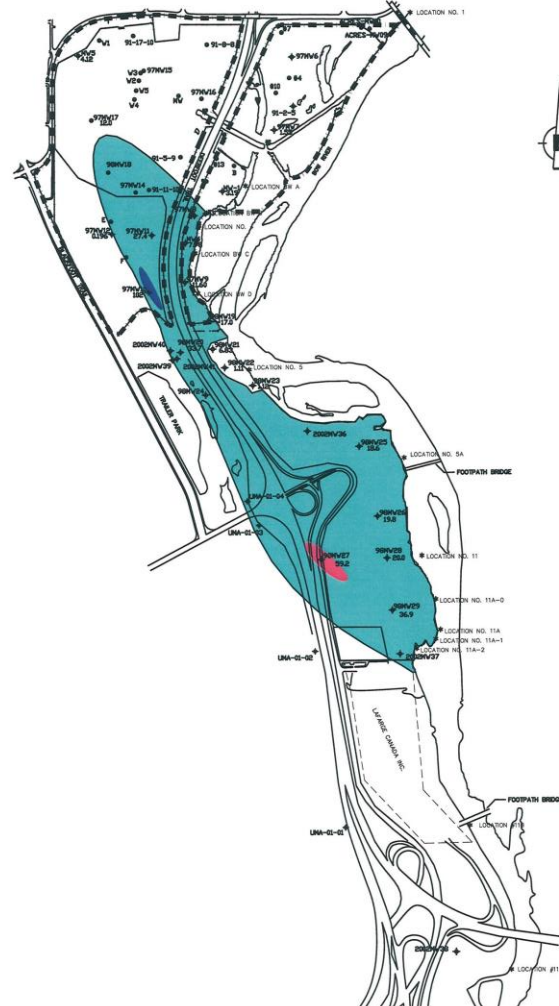


Background

1956 Air
Photo





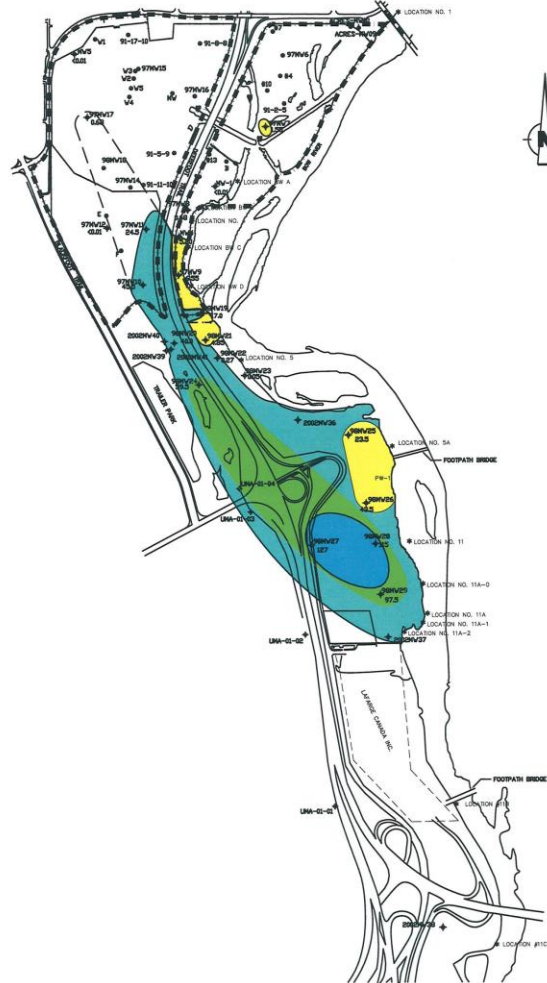


LEGEND

- GROUNDWATER MONITORING WELL (CHEMISTRY AND LEVEL)
- GROUNDWATER MONITORING WELL (LEVEL ONLY)
- SURFACE WATER QUALITY MONITORING STATION
- UMA-01-02

- >150 mg-N/L
- 100 - 150 mg-N/L
- 50 - 100 mg-N/L
- 10 - 50 mg-N/L

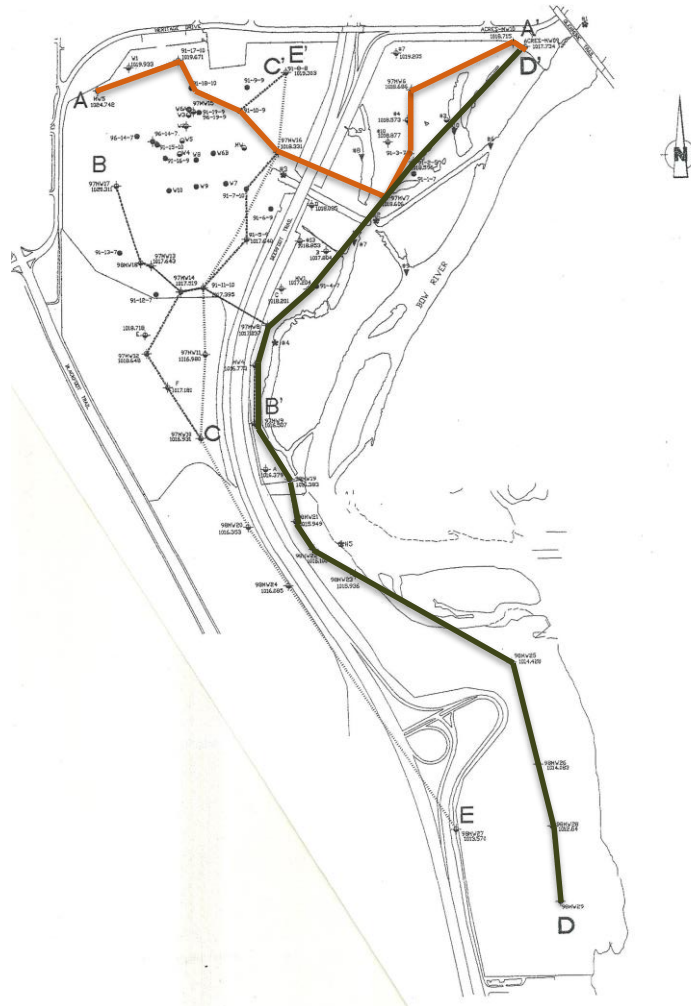
PLAN VIEW OF GROUNDWATER NITRATE-N CONCENTRATIONS
(December 13, 2002)



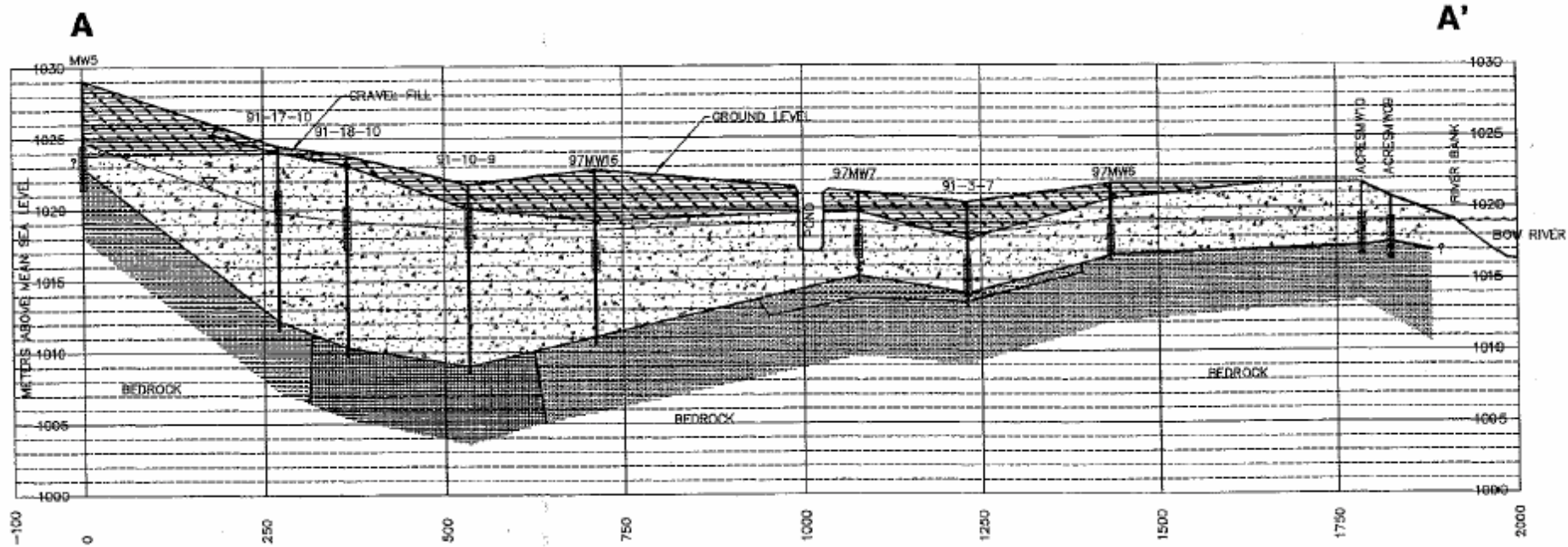
LEGEND

- 97WV25 GROUNDWATER MONITORING WELL (CHEMISTRY AND LEVEL)
- #3 GROUNDWATER MONITORING WELL (LEVEL ONLY)
- LOCATION #11C SURFACE WATER QUALITY MONITORING STATION
- UMA-01-02
- 2.608 – 16.93 mg-N/L (CHRONIC)
- 16.93 – 50.00 mg-N/L (ACUTE)
- 50 – 100 mg-N/L (ACUTE)
- > 100 mg-N/L (ACUTE)

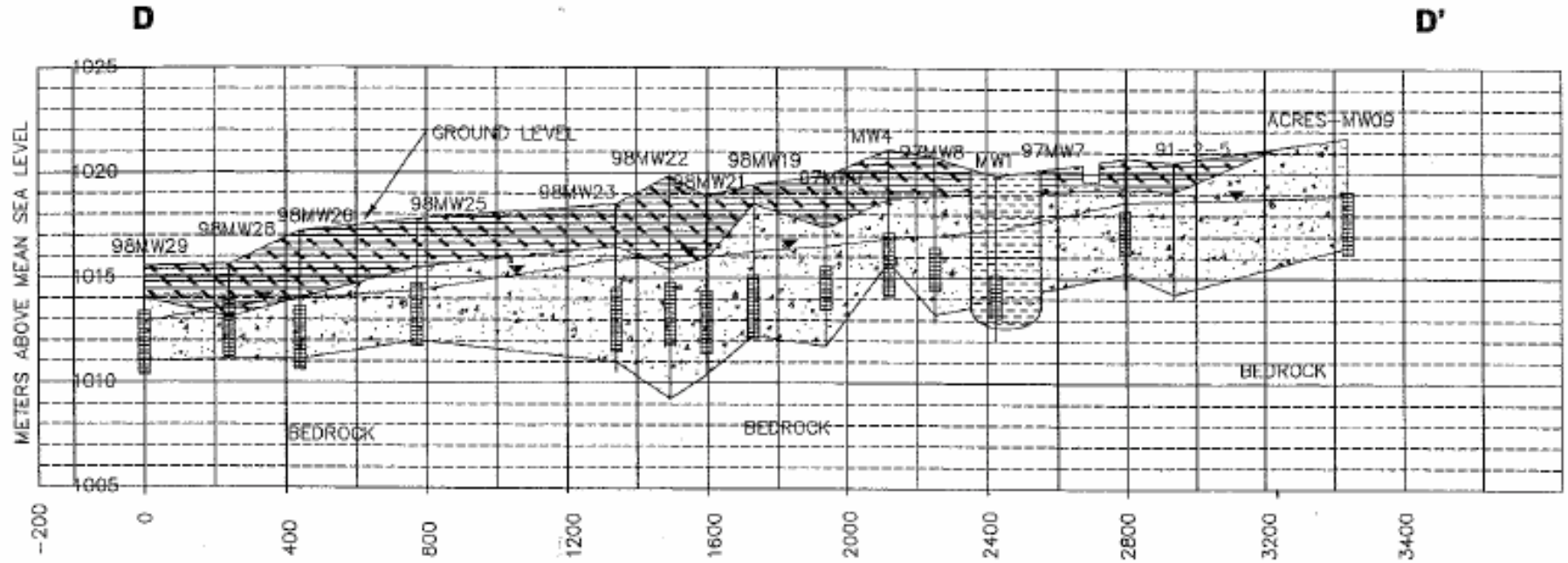
PLAN VIEW OF GROUNDWATER AMMONIA-N CONCENTRATIONS
(December 13, 2002)



Geology



Geology



Geology



1.5 – 3.0 m Silty Sand



3.7 – 4.5 m Sandy Gravel



Site Information

- Good to excellent drainage
- Hydraulic conductivity ~49 m/day
- Hydraulic gradient 0.0013 - 0.0026
- Groundwater velocity 0.3 - 0.5 m/day
- Groundwater flux 144 m³/day (22 igpm)
- Ammonia concentration ~50 - 100 mg-N/L
- Nitrate concentration ~75 - 100 mg-N/L

Remediation required to prevent discharge of ammonia and nitrate impacted groundwater to Bow River

Solution.

In-situ Groundwater Nitrification¹

- Extracting groundwater
- Adding oxygen and nutrients
- Injection of amended groundwater

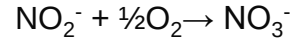
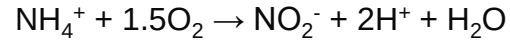
In-situ Groundwater Denitrification¹

- Extracting groundwater
- Adding carbon and nutrients
- Injection of amended groundwater

¹US and Canadian Patents: Innovate Calgary
Dr. Angus Chu, U of C. (Phone: 403.220.8987)
Steve Mailath, Trace Associates. (Phone: 403.971.4189)

Reactions

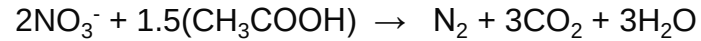
Nitrification - conversion of ammonia to nitrate through reactions:



As a result, the following overall reaction occurs:



Denitrification - conversion of nitrate to nitrogen gas through reaction:



(Acetic acid or other carbon source)

Bench Scale Testing



Nitrification Reactor Conditions

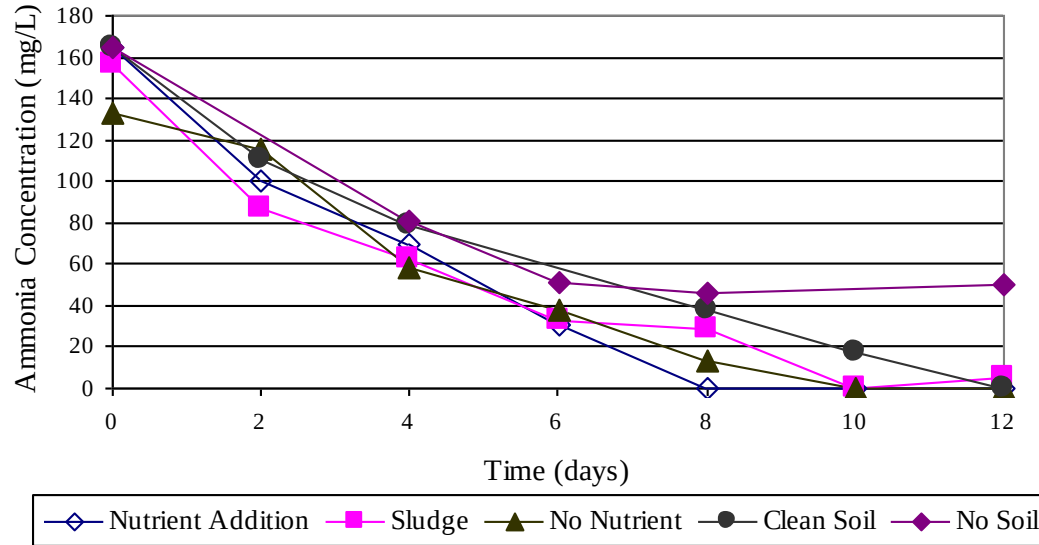
- Sodium azide killed control (Abiotic effects)
- No nutrient control
- Clean soil amended experiment
- Nitrified soil amended experiment
- No soil control
- Activated sludge amended

Denitrification Reactor Conditions

- Abiotic effects
- Biomass present in soil from the site.
- Bonnybrook wastewater treatment plant activated sludge
- Biomass present in the groundwater
- Biodegradable substrate (sodium acetate) with and without the addition of nitrified soil

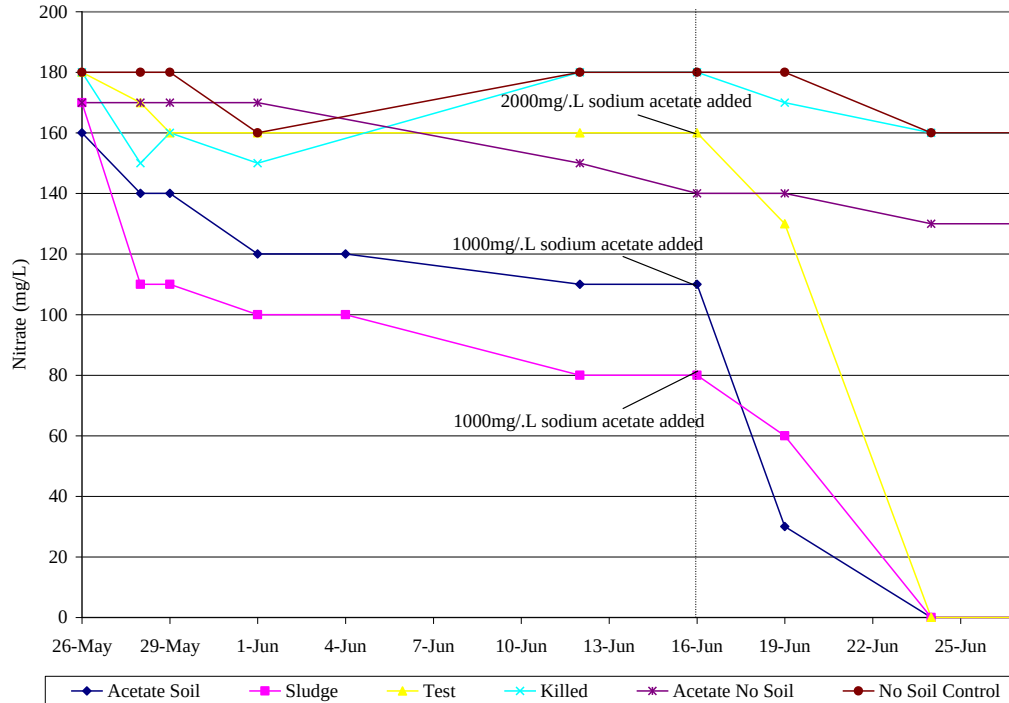
Bench Test Results

Nitrification: Ammonia Degradation Kinetics

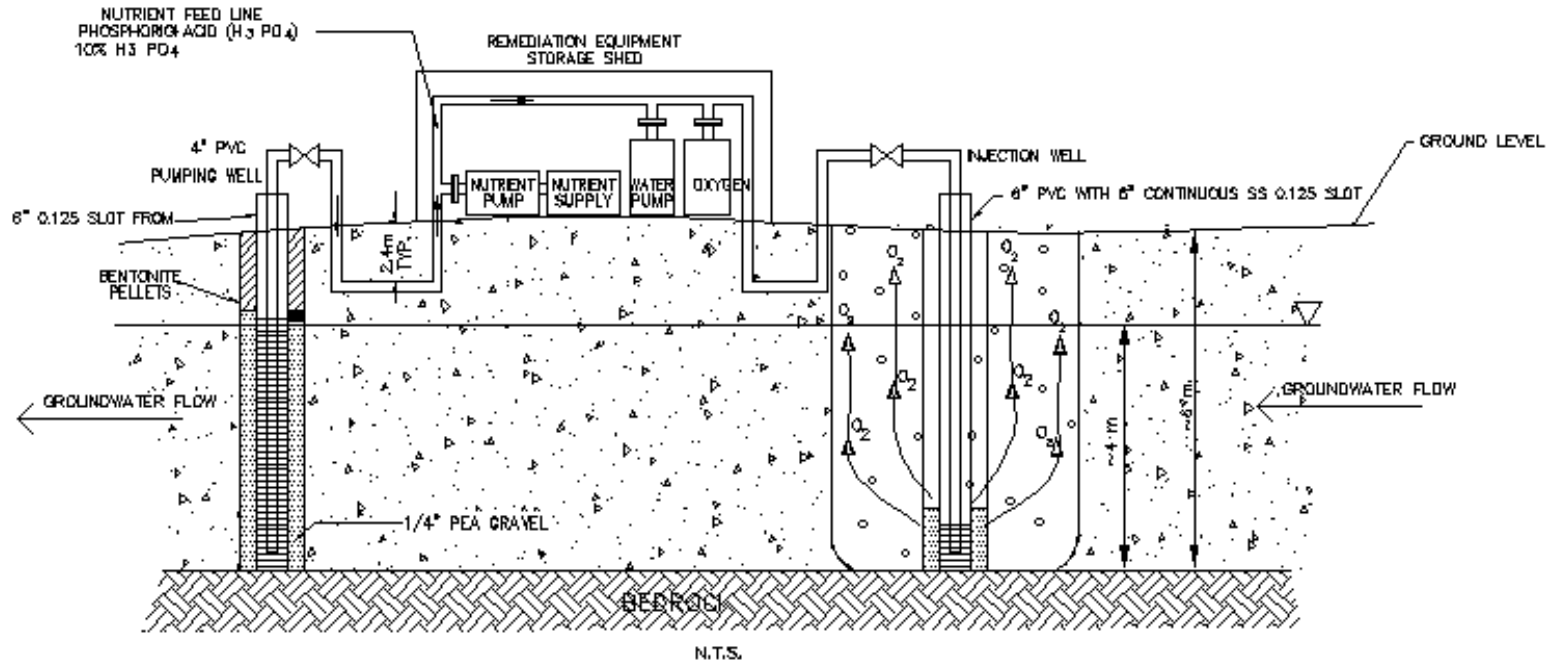


Bench Test Results

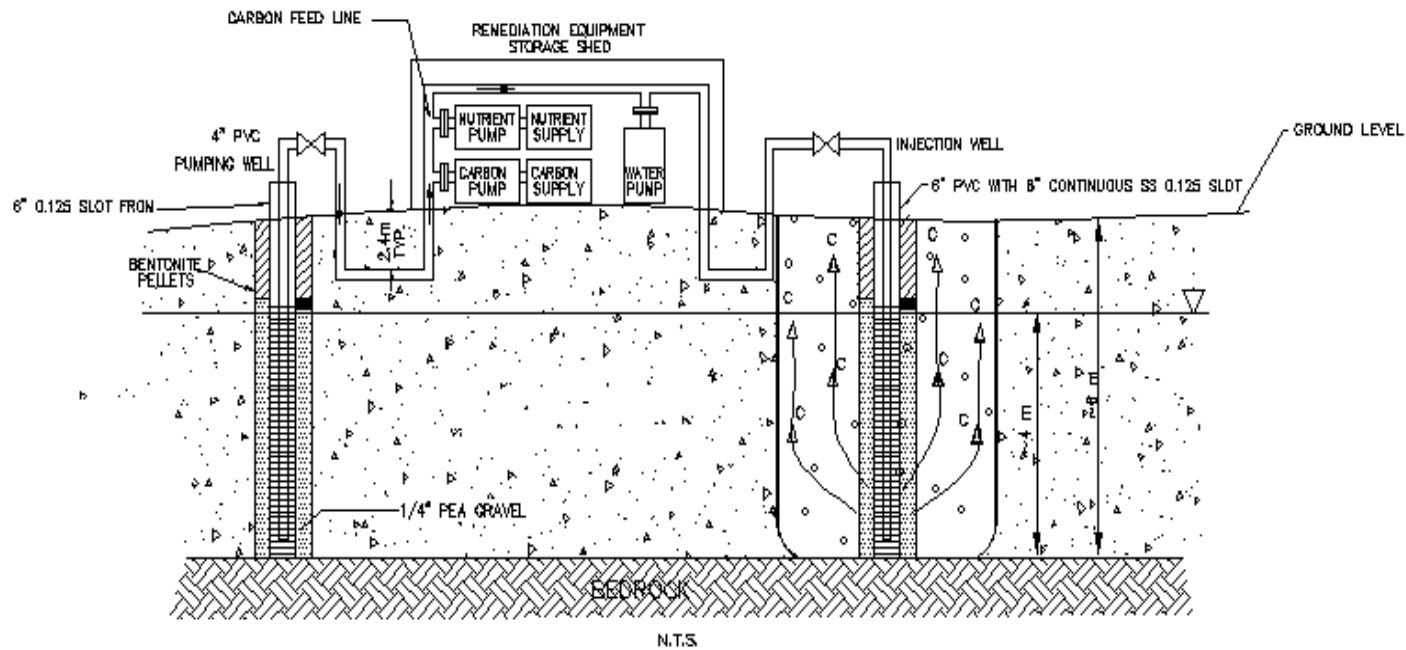
Denitrification: Nitrate Degradation Kinetics



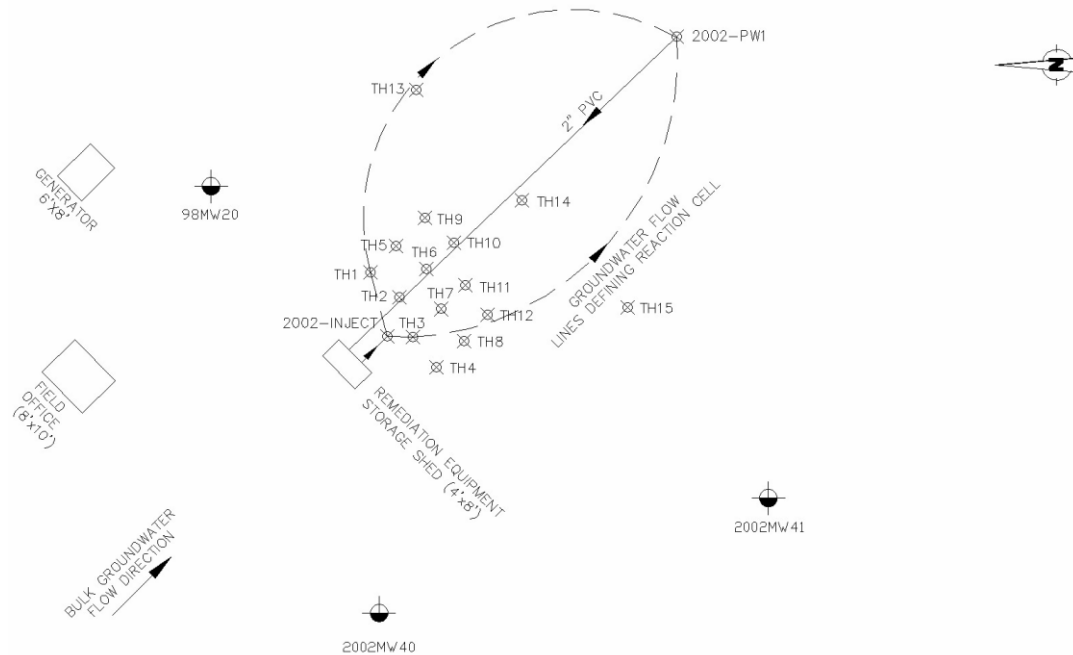
In-Situ Nitrification Pilot Scale Testing



In-Situ Denitrification Pilot Scale Testing



Pilot Test Site



Pilot Test Site



Pilot Test Site



Pilot Test Site



Pilot Test Site



Pilot Test Site



Pilot Test Site

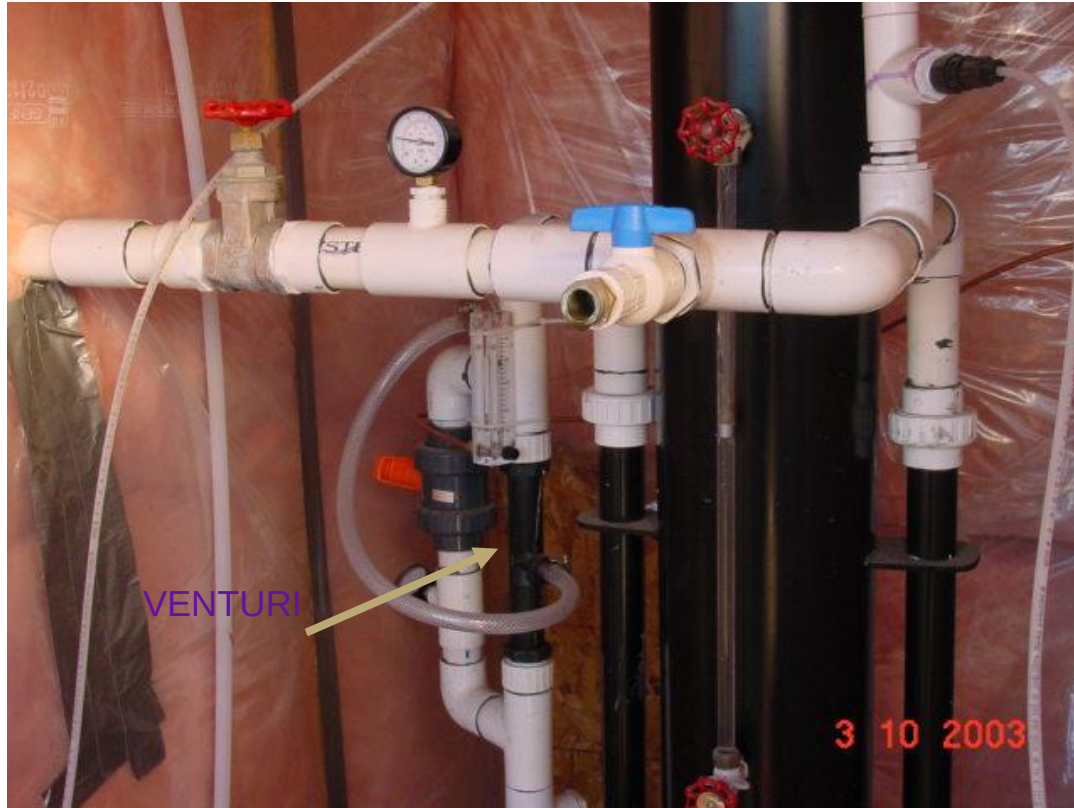
GAS LIQUID REACTOR

OXYGEN DELIVERY

NUTRIENT DELIVERY

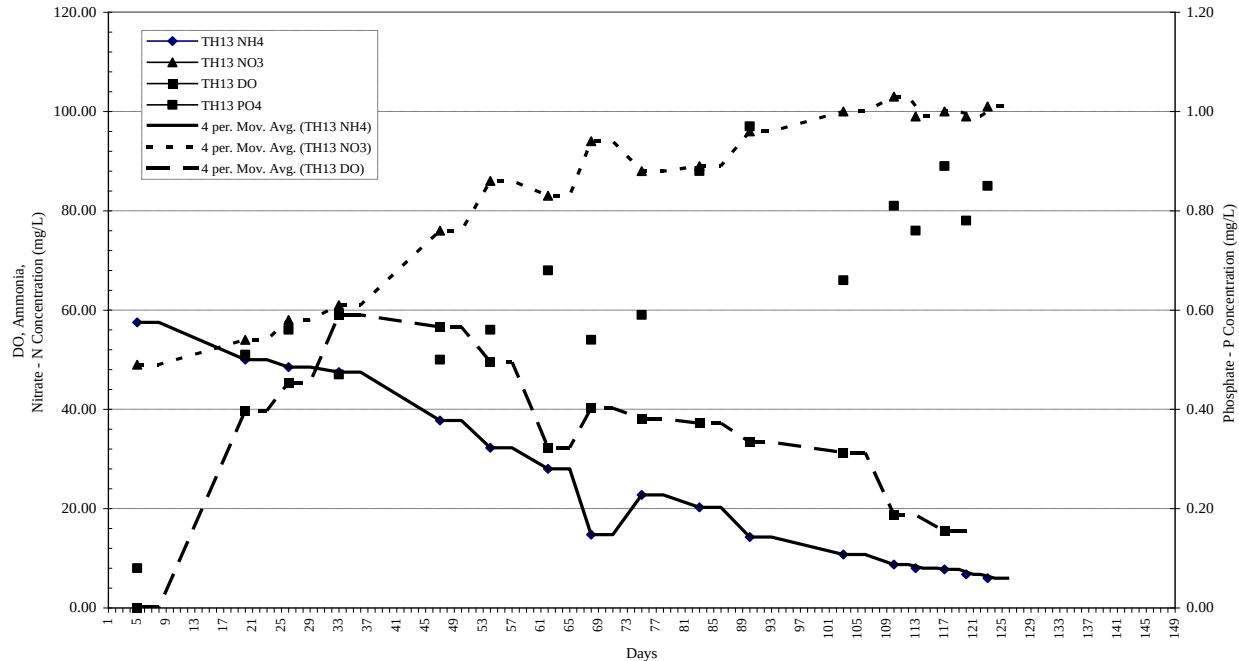


Pilot Test Site



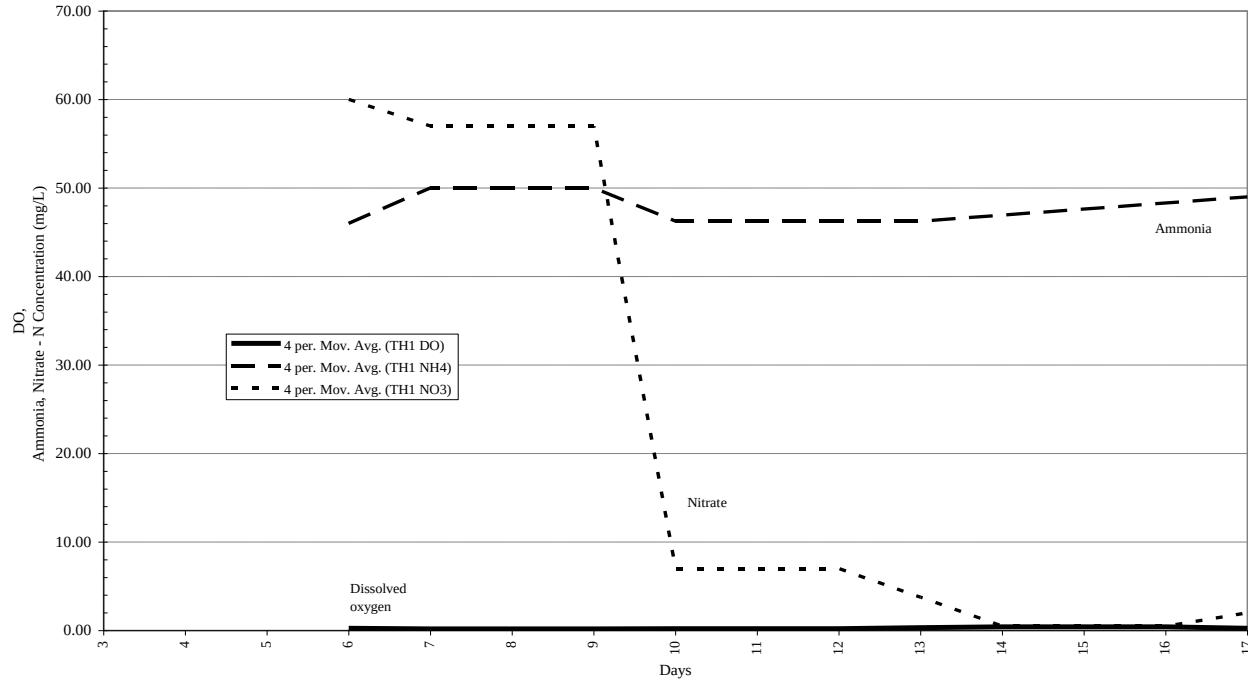
Pilot Test Site

Nitrification Results: 66 – 89 % Ammonia Reduction

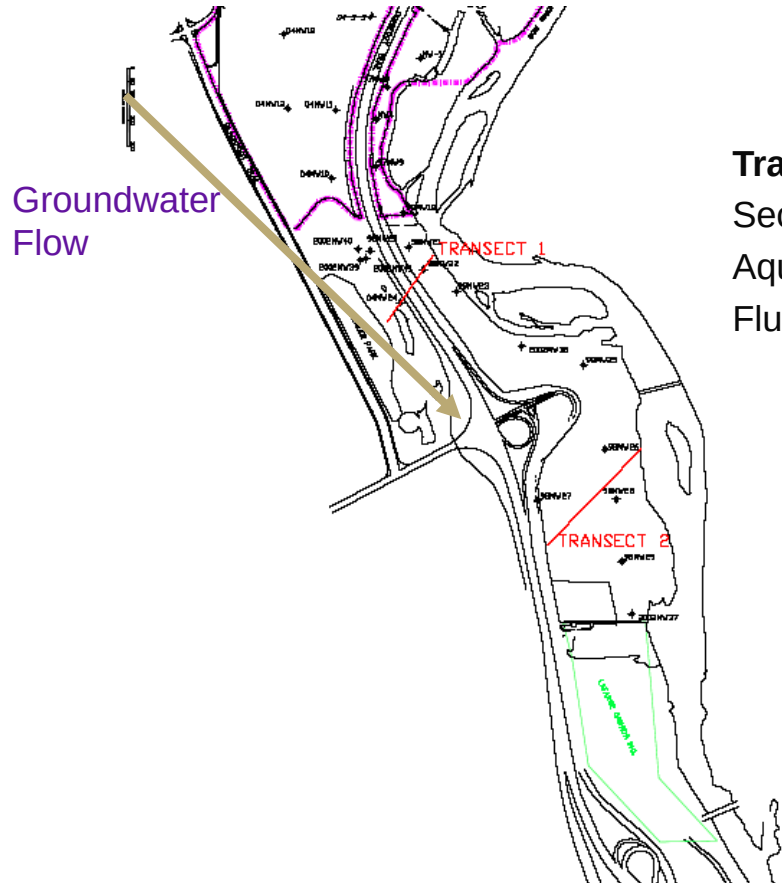


Pilot Test Site

Denitrification Results: 78 – 99 % Nitrate Reduction



Full Scale Remediation



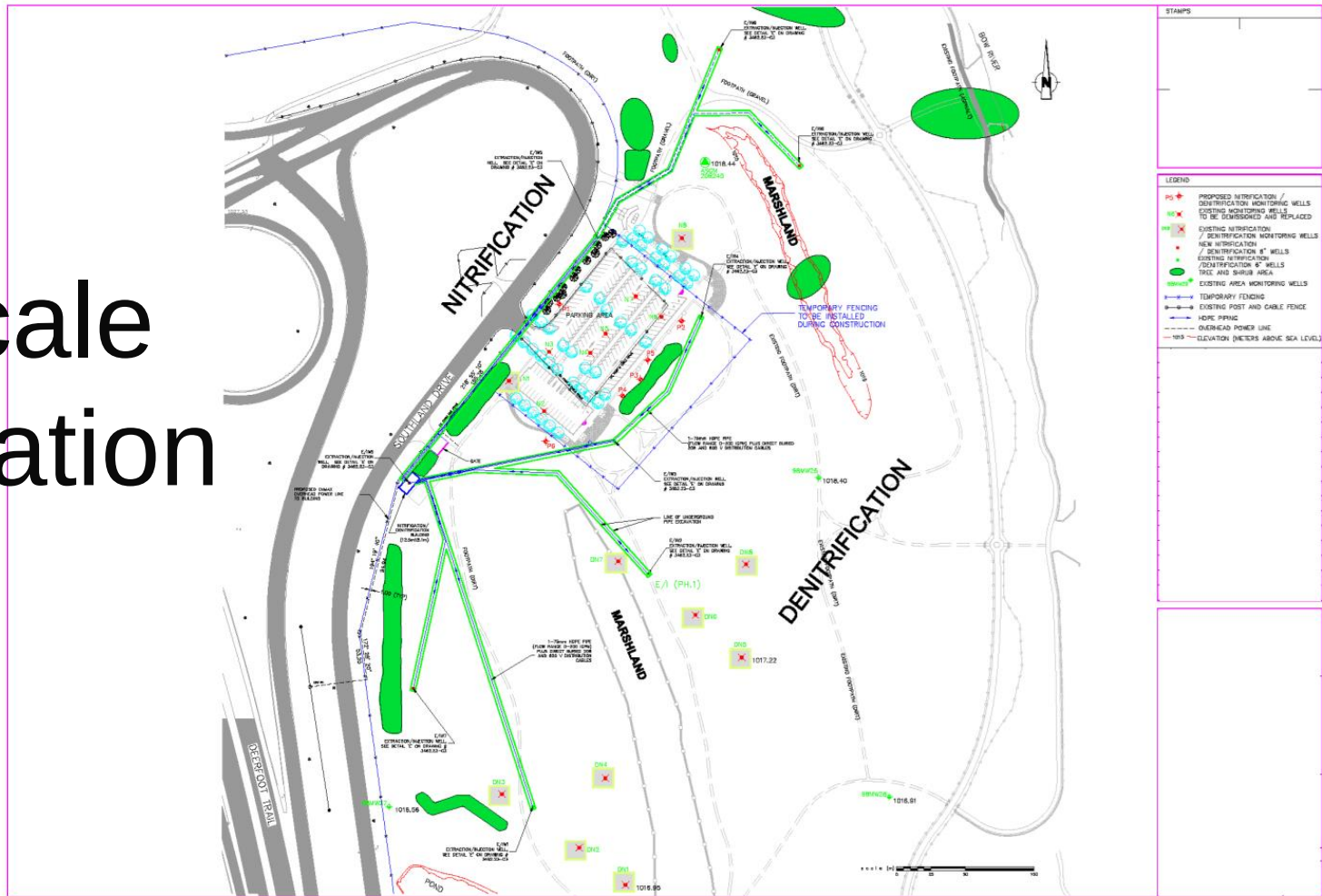
Transect 2

Section length - 425 m.

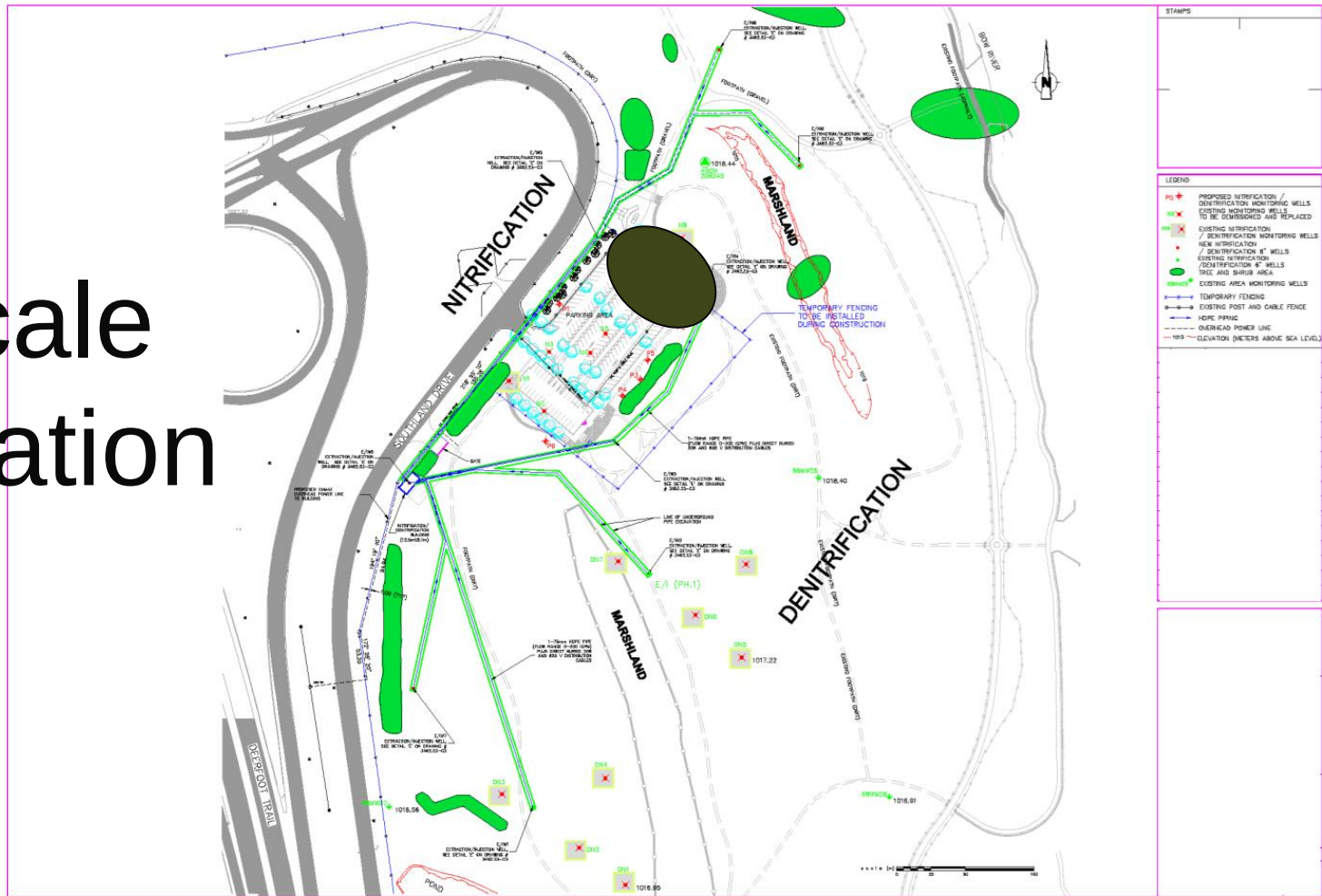
Aquifer thickness – 3 m

Flux - 144 m³/day (22 igpm)

Trace
ASSOCIATES



Trace
ASSOCIATES



Full Scale Remediation

Components

Flow Meter

In Line Mixer





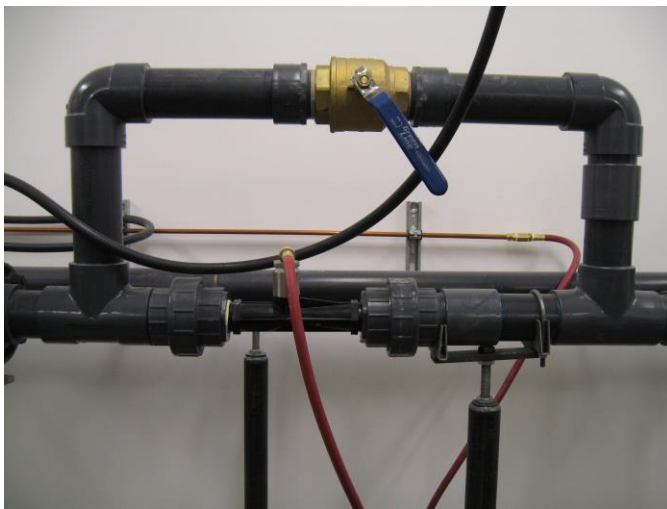
Oxygen Source



Oxygen Generator

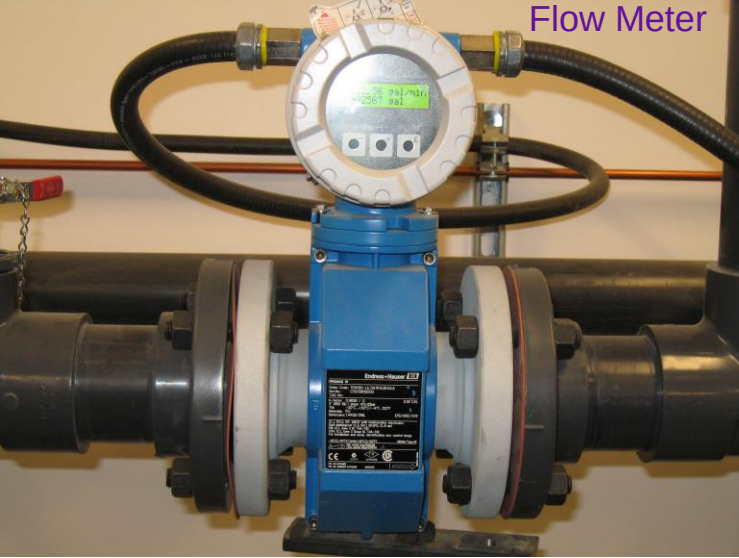
Components

Venturi



Air Flow Meter





Flow Meter



Air Release Valve

Components

In Line Mixer



In Line Mixer





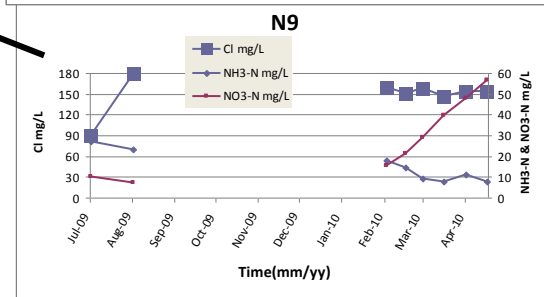
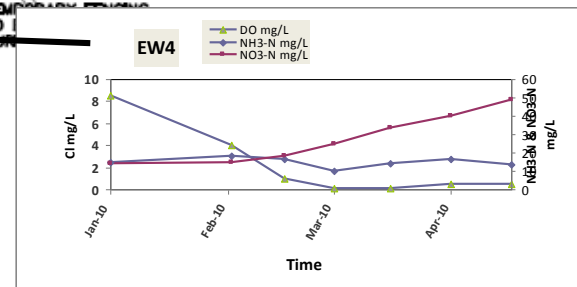
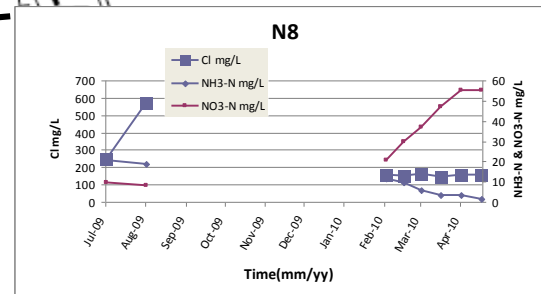
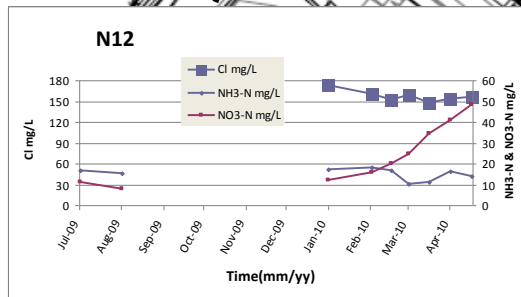
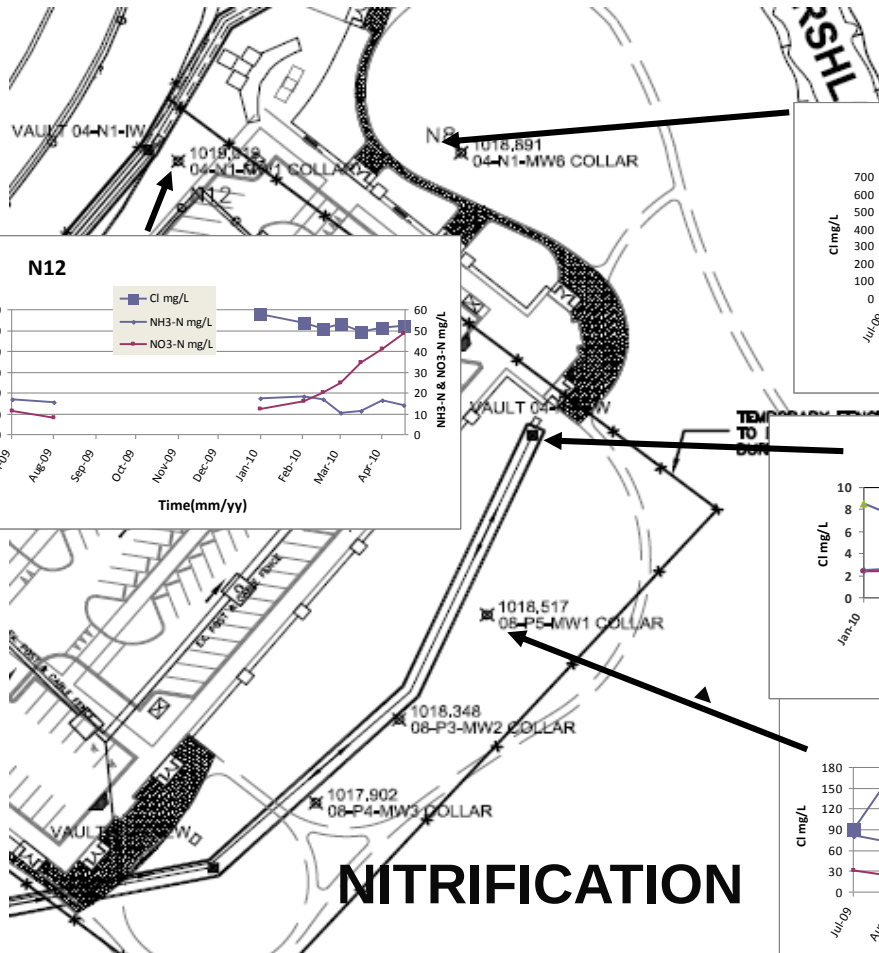
Carbon Tanks

Sample Description : PEPSI WASTE (01/09/04)
 Sample Date & Time : 2004/01/09
 Sampled By :
 Sample Type :
 Sample Received Date : 2004/02/02
 Sample Station Code :

Maxam Sample Number : 553502
 Maxam Job Number : CA401982
 Sample Access :
 Sample Matrix : Water
 Report Date : 2004/02/11

PARAMETER DESCRIPTION	RESULTS	Units	INST.	QA/QC Batch	MDL	RDL
Calculated Parameters						
Hardness (CaCO ₃)	71	mg/L	CALC	449306	0.5	1
Ion Balance	0.64	N/A	CALC	449309	0.01	0.02
Demand Parameters						
Biochemical Oxygen Demand	305000	mg/L	OELE	449943	0.1	0.2
Misc. Inorganics						

Carbon Source – Pepsi Waste



NITRIFICATION



In-situ Nitrification and Denitrification Can Be Achieved



Bench Testing

- Confirmed feasibility



Pilot Scale

- Confirmed in-situ capability



Remediation

- Full scale remediation reduces contaminant discharge to Bow River



Questions

Contact

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