



Sub-surface Flow Wetlands – Constructed Wastewater Treatment System

Village of Avoca - St. Clair County, Michigan

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Environmental Consulting & Technology, Inc.



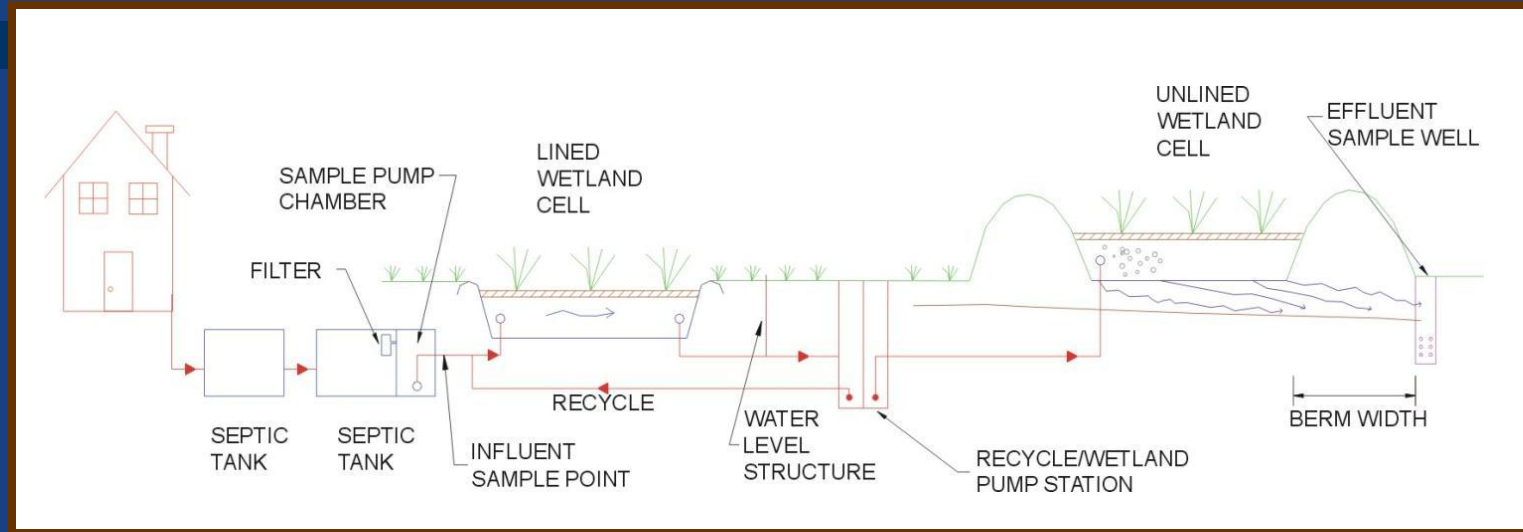
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NATURAL WATER SOLUTIONS
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The Project Problem

- The Village of Avoca had no sanitary system
 - ✓ Wastewater (raw or semi treated) discharges into drain system
 - ✓ Approximately 15,000 gpd
 - ✓ *E. coli* detected in County Drain
 - ✓ *E. coli* levels from >24,000 to > 240,000



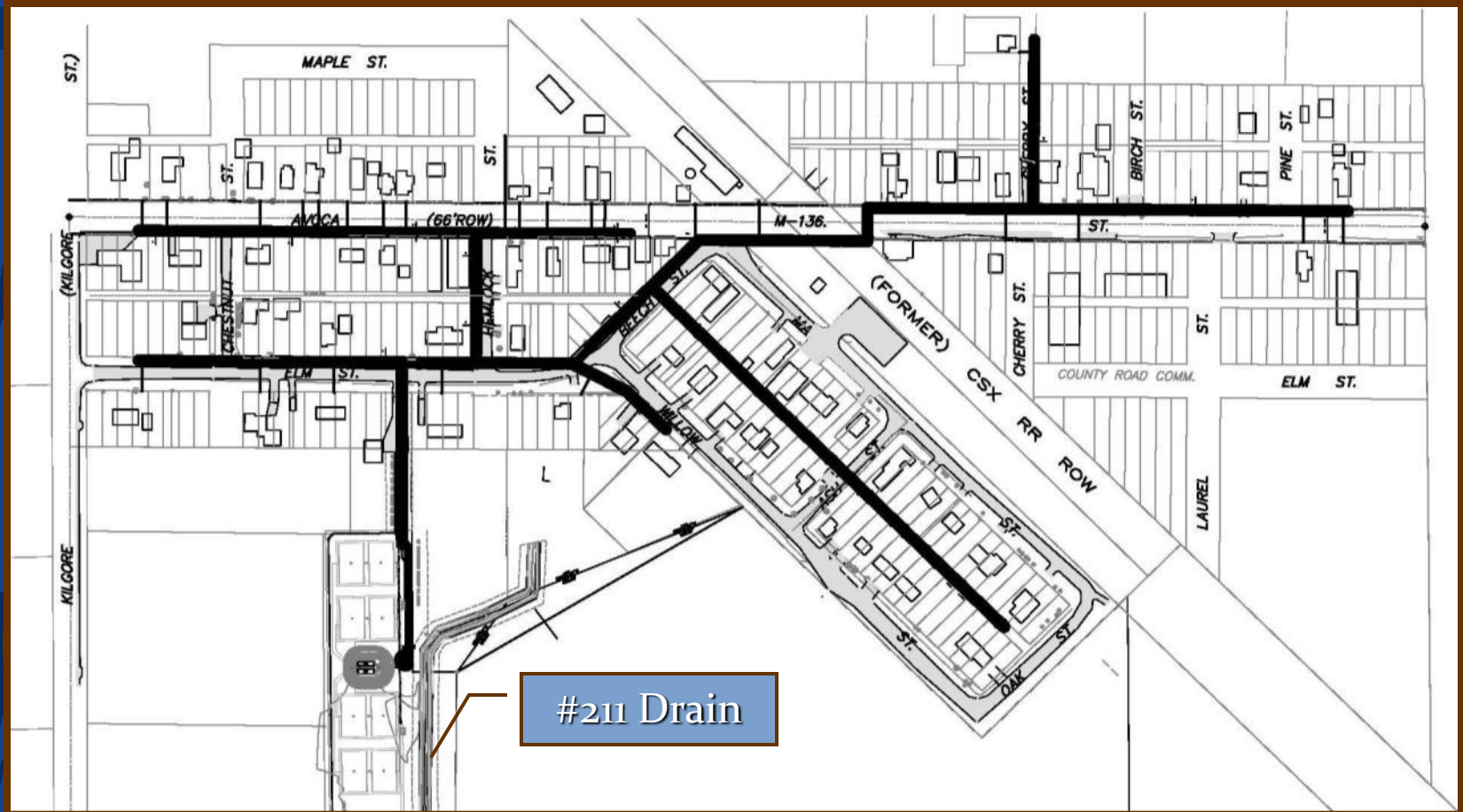
The Project Solution



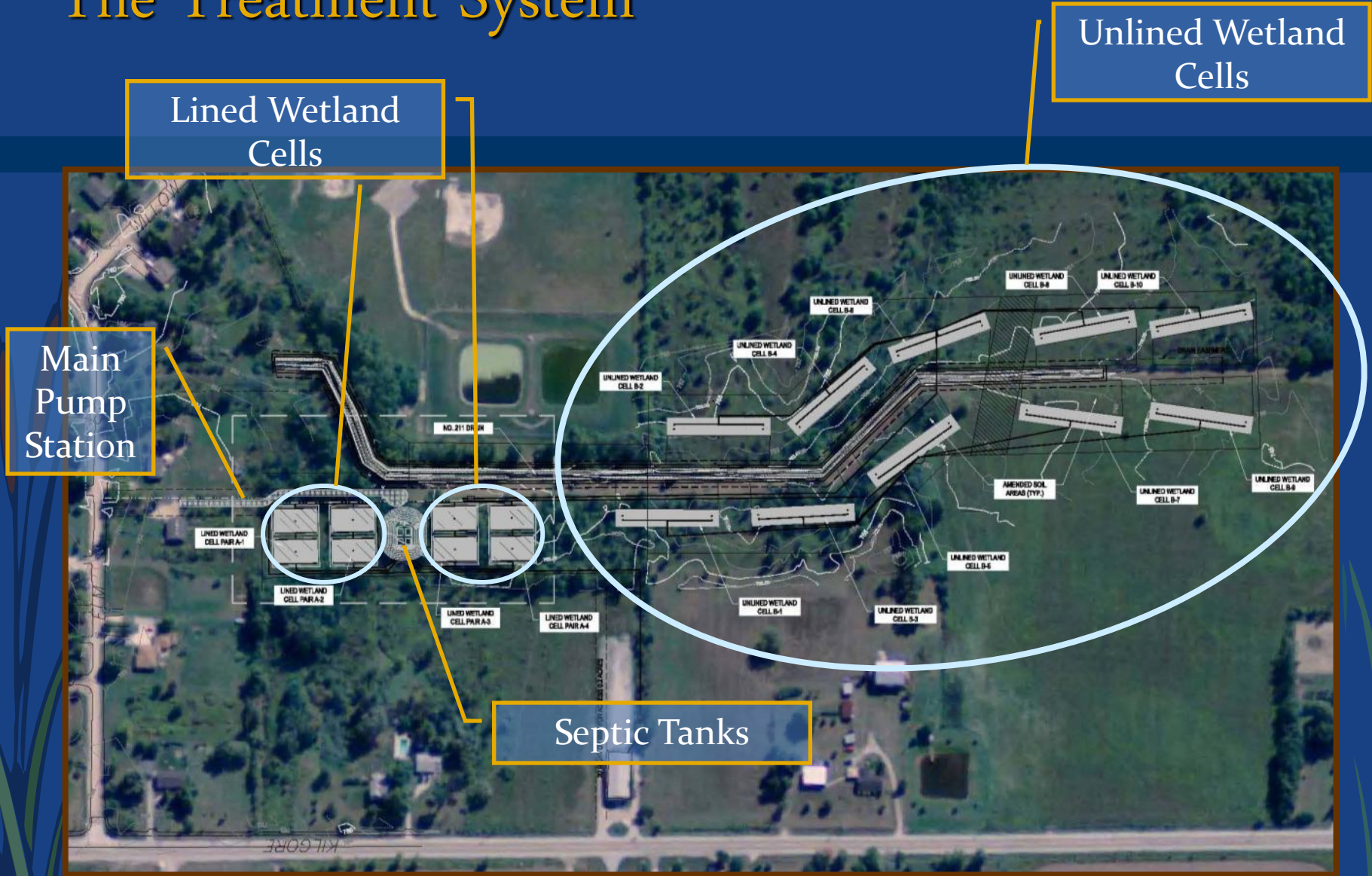
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- Standard Collection with Subsurface Wetland Wastewater Treatment System with a capacity of 20,000 gallons per day
 - ✓ Funding Secured through a Clean Michigan Initiative (CMI) grant, United States Department of Agriculture (USDA) grant, and USDA low interest loans
 - ✓ September 2009- Construction Began
 - ✓ July 2010- System Start Up

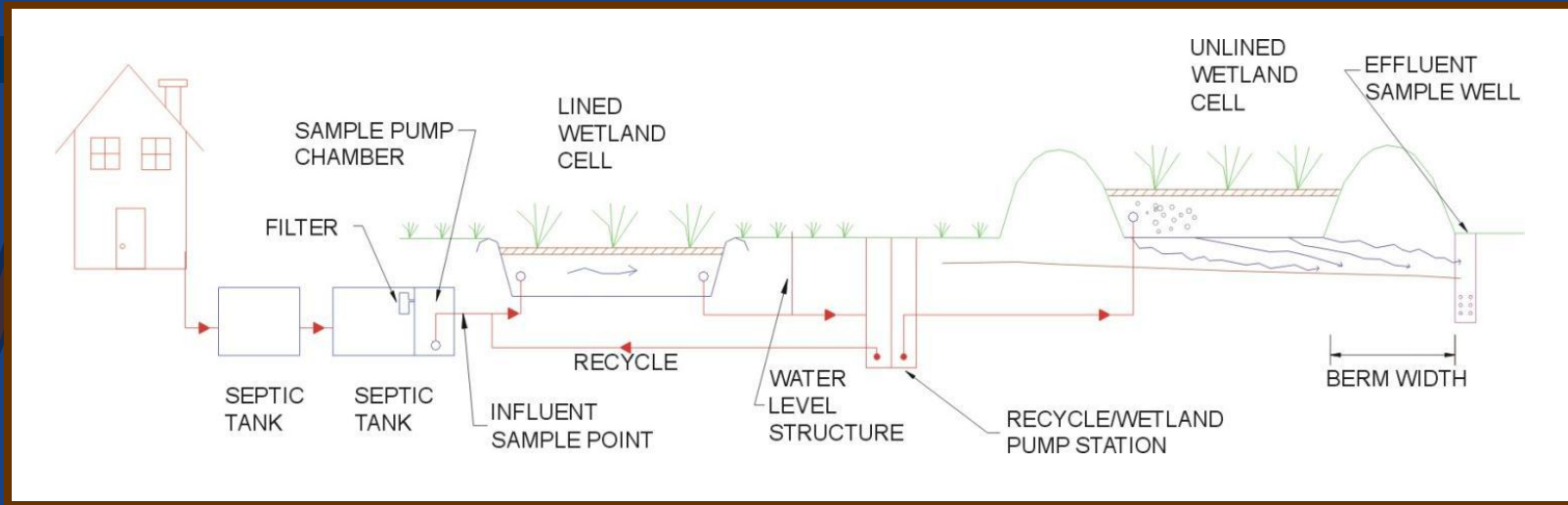
The Collection System



The Treatment System



Why the Treatment Works



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Septic Tanks
Provides
Pre-Treatment
(Settling of Solids &
Removal of fats,
oils and greases)

Lined Wetland
Cells Provide
Nitrogen, BOD₅
(organic matter),
and
TSS Reduction

Unlined Wetland
Cells
Provides added
Polishing, then
Dispersal

Dispersal into the
Soil Horizon
Provides
Phosphorus
Reduction

(cont.) Why it Works

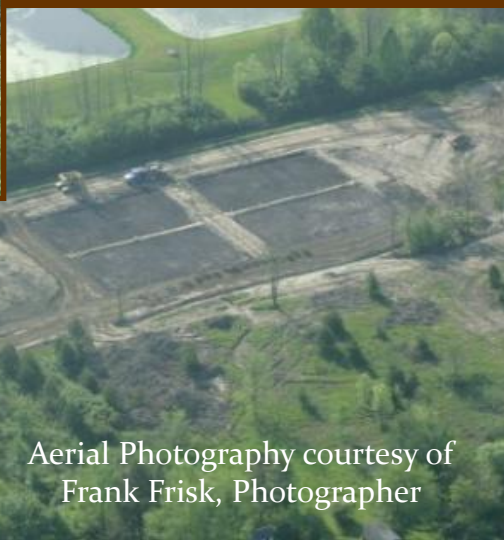
➤ Lined Wetland Cell

- ✓ BOD₅ Reduction
- ✓ Ammonia conv.- NO₂
- ✓ NO₂ conv. – NO₃
- ✓ NO₃ denitrification to N gas
 - Recycled Effluent -
 - Carbon addition from Septic Tank Discharge and Benthos!

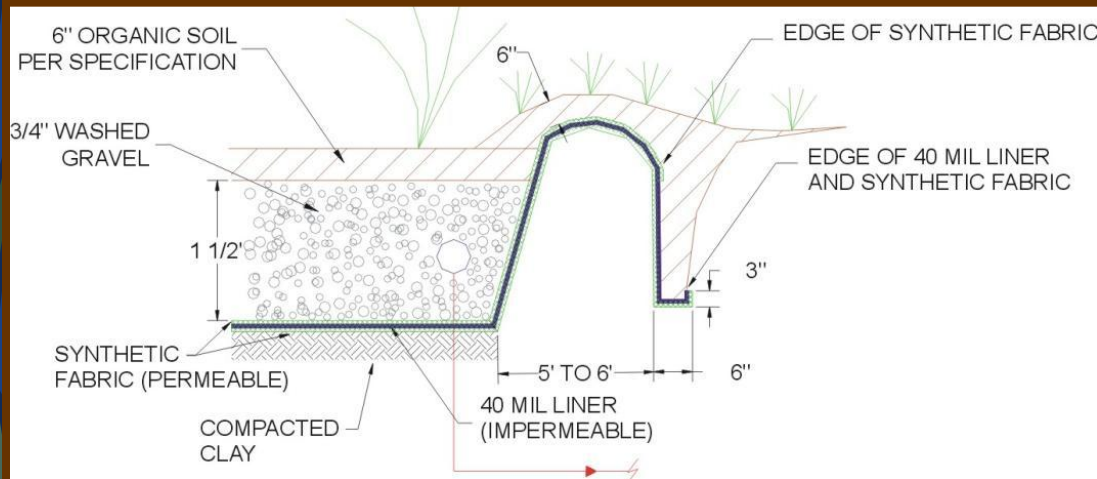
➤ Unlined Wetland Cell

- ✓ Cont. BOD₅ reduction
- ✓ Excellent TSS reduction from physical filtration in sand
- ✓ Continued polishing and nutrient reduction through soil horizon
- ✓ Phosphorous adsorption- soil horizon

Lined Wetland Cell



Aerial Photography courtesy of Frank Frisk, Photographer

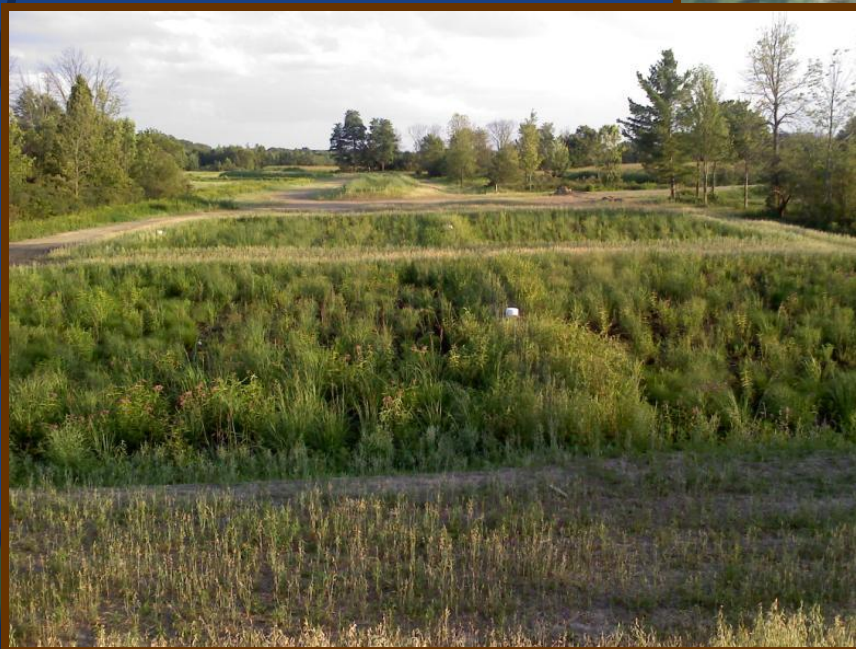


- PVC liner sandwiched between engineered fabric
- 18" of gravel and 6" of topsoil
- Leveling Structure to regulate water levels
- Entrance and exit plumbing
- Regional Native Wetland Plants

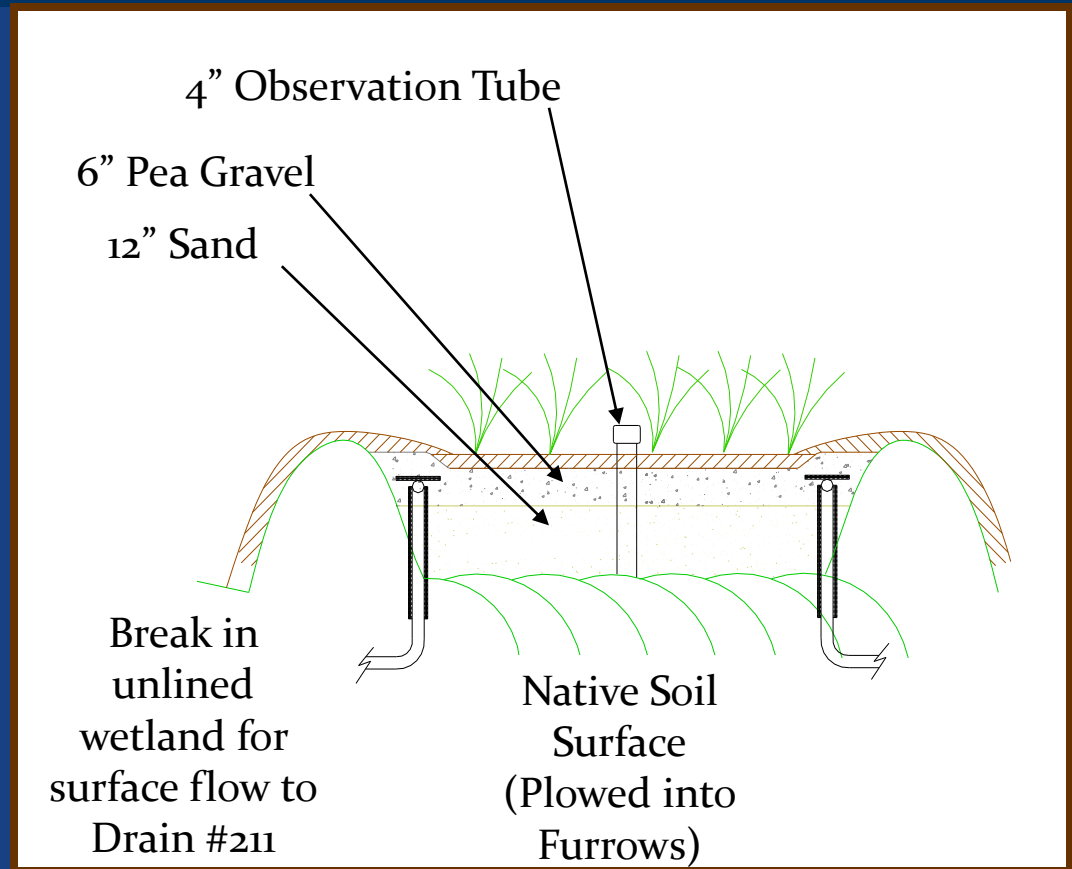
Lined Wetland



Aerial Photography courtesy of Frank Frisk, Photographer



Unlined Wetland Cell



Unlined Wetland Construction



Recycle Pump Stations



Other Unique Features



Leveling Structures



Patented

Distribution Valves



Natural System Treatment



Effective Results

**Avoca, Michigan
St. Clair County
Subsurface Flow Wetland**

Design Capacity 20,000 gal./day

Connections (laterals) = 77 units

Parameter	Raw Influent	Final Effluent Permitted Monitoring Well
	Measured at Wet Well	Measured at MW Wells
BOD5 (mg/L)	210.98	3.40
TIN-N (mg/L)	25.62	0.65
NH3-N (mg/L)	24.66	0.14
NO2-N (mg/L)	0.08	0.02
NO3-N (mg/L)	0.88	0.50
Total-P (mg/L)	5.02	0.56
DO (mg/L)	2.83	4.91
Fecal Coli (CFU/100 mL)	10,000,000*	4.43
Chloride (mg/L)	416.70	157.48
pH	7.52	6.74
Sodium (mg/L)	290.00	38.89
Sulfate (mg/L)	92.50	Not Measured

* From Water Environment Literature

Full Data Summary

**Avoca, Michigan
St. Clair County
Subsurface Flow Wetland**

Design Capacity 20,000 gal./day
Connections (laterals) = 77 units

Parameter	Raw Influent	Lined Cell Outlet 1/2 way through System	Unlined Cell Outlet	Final Effluent Permitted Monitoring Well
	Measured at Wet Well	Measured at Pump Tanks	Measured at Berm Toe	Measured at MW Wells Near Ditch
BOD5 (mg/L)	210.98	10.68	3.29	3.40
TIN-N (mg/L)	25.62	14.11	1.61	0.65
NH3-N (mg/L)	24.66	13.60	0.82	0.14
NO2-N (mg/L)	0.08	0.05	0.03	0.02
NO3-N (mg/L)	0.88	0.47	0.76	0.50
Total-P (mg/L)	5.02	1.63	0.14	0.56
DO (mg/L)	2.83	2.93	5.95	4.91
Fecal Coli (CFU/100 mL)	10,000,000*	Not Measured	Not Measured	4.43
Chloride (mg/L)	416.70	400.19	336.58	157.48
pH	7.52	6.97	6.86	6.74
Sodium (mg/L)	290.00	237.86	151.42	38.89
Sulfate (mg/L)	92.50	10.85	Not Measured	Not Measured

* From Water Environment Literature

Other Systems

Town of Oakfield, Wisconsin
Sanitary District - 6,500 gpd



- Kettle Moraine Lutheran High School – 4,100 gpd