Wetland Augmentation: An Emerging Technique for Wastewater Management in North Carolina

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The Basic Questions

- What is a Wetland?
- What is Wetland Augmentation?
- Do other states operate similar practices? If so, how do their regulations compare to the proposed North Carolina regulations?

What is a Wetland?

- Defined by US Army Corps of Engineers.
- Wetlands are characterized as having wetland vegetation, wetland soils and wetland hydrology.
- Standard for wetland hydrology.

Source: US Army Corps of Engineers, Wetland Delineation Manual. 1987.

Why Wetlands?

- Wetlands provide natural filters, floodwater abatement, groundwater recharge, and wildlife sanctuary*
- Highly efficient filtering mechanisms of wetlands have long been recognized, but their importance had been severely underestimated until the past 50 years*
- Summertime in the Southeast = low wetland water tables and high demand for wastewater treatment and dispersion

*Source: Gopal, B., et al. "Natural Wetlands." Encyclopedia of Ecology. Oxford: Academic Press, 2008. 2493-504.

Why Wetlands? (contd.)

- Wetlands are semi-aquatic systems that normally contain large amounts of water. These systems are also prone to flooding, which may be achieved through the addition of wastewater
- Wetlands contain partly oxic, partly anoxic soils that allow pathways for the chemical fixation of nitrogen and phosphorous
- Wetlands support highly prolific, stalwart, and resilient vegetation capable of absorbing large amounts of nutrients

Source: Verhoeven, J. T. A., and A. F. M. Meuleman. "Wetlands for Wastewater Treatment: Opportunities and Limitations." Ecological Engineering 12.1-2 (1999): 5-12.

What is Wetland Augmentation?

- Rules developed by the North Carolina Environmental Management Commission (NC EMC)
- Proposed rule changes at the September 2008 meeting regarding the state's wastewater dispersal regulations (15A NCAC 02T .0900) were approved to go to public hearing. Rule changes deal with the acceptable uses of reclaimed water.
- The new term for this wastewater dispersal process is "wetland augmentation" and would be approved in North Carolina if a "net environmental benefit" can be quantified.

Summary

- Wetland hydrology is critical in determining the functionality of a site proposed for wetland augmentation with reclaimed water. A net environmental benefit cannot be determined without understanding this parameter on any given site. Wetland hydrology changes in accordance with:
  - Geographic location of a wetland system
  - Seasonal or climactic variations
  - Intensity and duration of rainfall events
  - Site factors – hydrologic alteration (dams, ditches)

North Carolina Wetland Augmentation baseline stipulations

- Wetland augmentation must be limited to freshwater wetlands excluding riparian zones and pocosins
- Reclaimed water discharge to Salt-Water Wetlands or Unique Wetlands is not permitted
- Reclaimed water discharge to wetlands areas must be limited to times when the vertical separation distance to the groundwater table is greater than or equal to one foot

Source: North Carolina Department of Environment and Natural Resources. Administrative Code Title 15A, Chapter 2T, Section .0900. 2008.

Literature Review

- Louisiana and Florida regulations are reviewed
  - LA and FL environmental departments offer an abundance of literature regarding wetland wastewater treatment systems
  - LA and FL have mature wetland wastewater systems which have been in operation for up to 80 years

Literature Review - Louisiana

- Unique land features allow wastewater treatment (extensive wetland systems, Mississippi river delta, low topography)
- Louisiana Department of Environmental Quality (LDEQ) permits secondary and tertiary treated wastewaters into wetlands
- LDEQ is more concerned with improved discharge water quality over onsite degradation (maintain <20% reduction in productivity over 5 years)
- Wetland wastewater sites operational for more than 60 years
- No depth to water table restriction

Source: Louisiana Department of Environmental Quality. Administrative Code Title 33, Part Ix, Chapter 11 - Surface Water Quality Standards" 2007.

Literature Review - Florida

- Florida Department of Environmental Protection (FDEP) permits secondary and tertiary treated wastewaters into wetlands
- Concerned with dominant vegetation* (cattail) and maximum loading rates over onsite conditions (maintain <25% reduction in productivity)
- Defined loading rates (no more than 2" per week in natural wetlands & 6" per week in Hydrologically altered wetlands)
- Wetland wastewater sites operational for more than 80 years
- No depth to water table restriction

Source: Florida Department of Environmental Protection. Water Rules by Program Area, Chapter 62-611, Title "Wetlands Application." 1996.

Literature Review - Comparisons

Similarities

- High chemical, physical, and biological treatment standard of water quality discharge (BOD reduction, N & P removal, TSS removal, etc.)
- Protection of unique and riparian wetlands

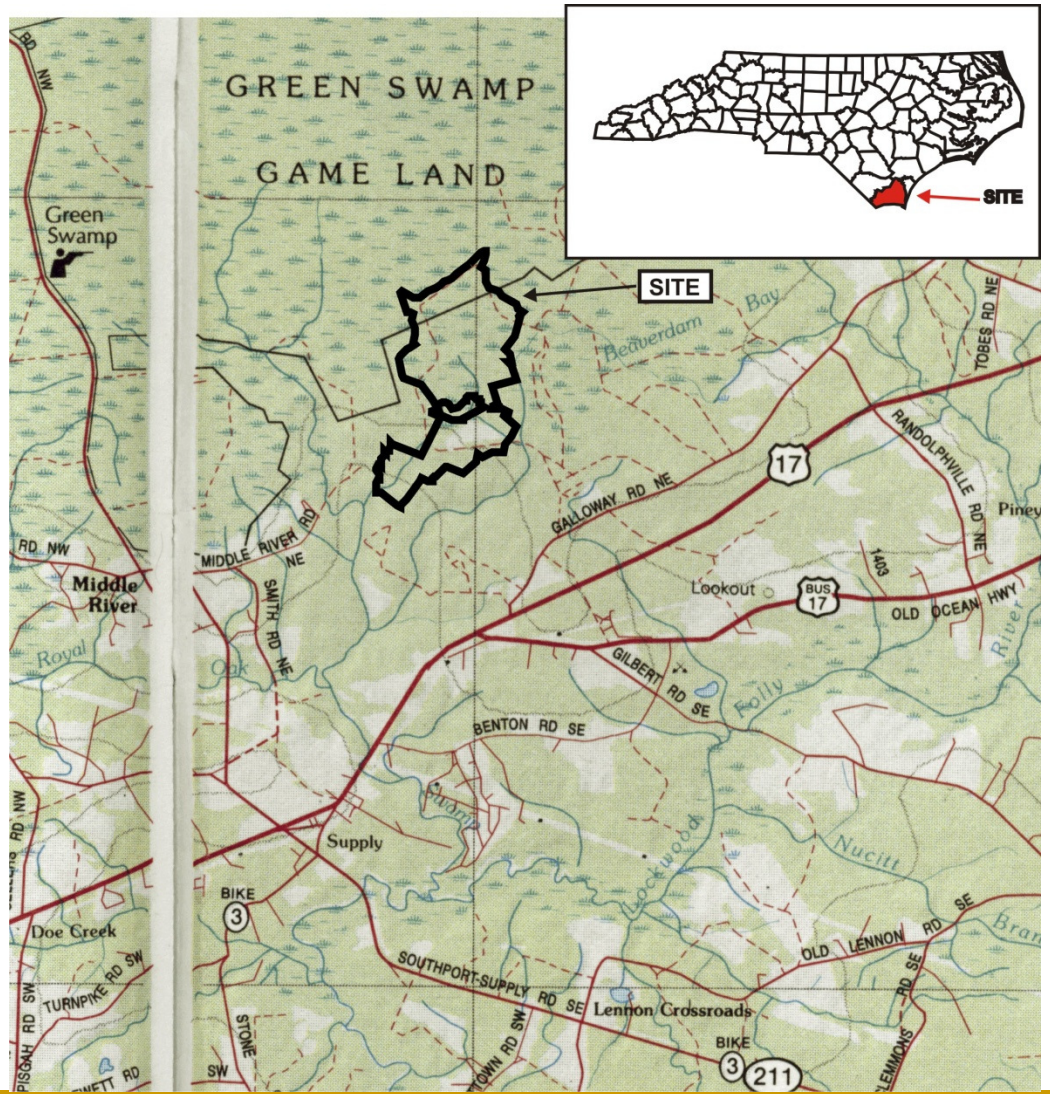
Differences

- No -12” depth to water table restriction in LA and FL
- Slight reduction in productivity allowed in LA and FL, Net Environmental benefit required in NC
- Secondary treated allowed in LA and FL, only tertiary treated in NC

Disclaimer*

- Previous literature review and following site analysis only examines hydrology
- Prior to making permitting decisions, NCDENR will be assessing all other elements of the net environmental benefit of a wetland augmentation system including:
  - Loading recommendation
  - Hydro-geologic description
  - Wetland Classification
  - Local and surrounding topography
  - Wildlife prevalence
  - Nutrient and heavy metals toxicology
  - …all investigative results must support that detrimental changes to primary productivity will not occur and net environmental benefits are gained*

Site Testing Location



Map Source: North Carolina Atlas & Gazetteer. Pg 87. 2003

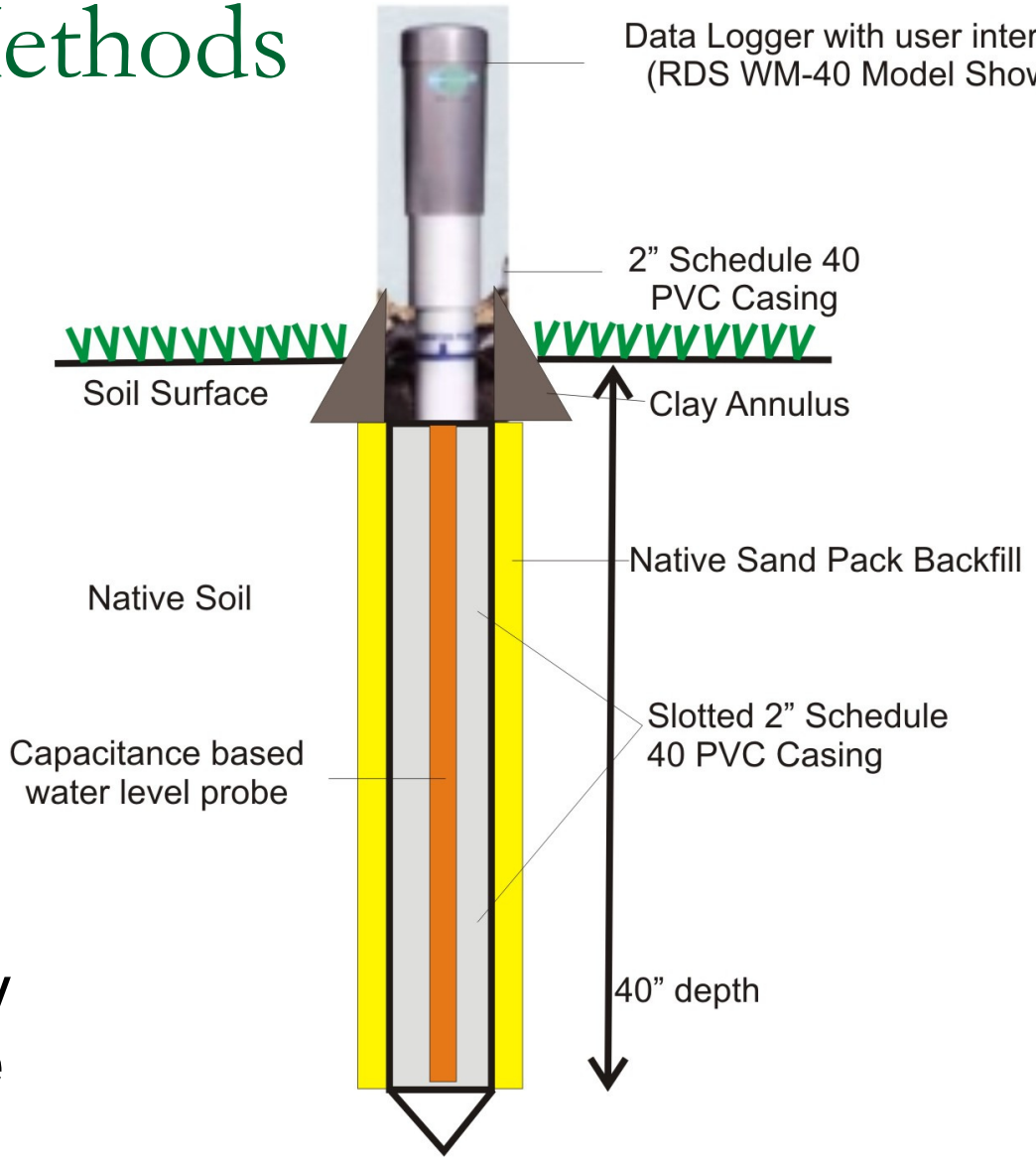
Introduction – Supply Spray Site

- The Brunswick County - Supply site is currently utilized as an active land application field for tertiary treated wastewater (Since February 2008).
- The site is comprised of 1,036 acres of which approximately 590 acres receive reclaimed water.
- The site is permitted for dispersal of 1.72 MGD and the wastewater generated ranges from 1.2 MGD in a typical winter month to 3.0 MGD in a peak summer month.
- The non-wetted acreage is primarily jurisdictional 404 Wetlands.

Source: Worthington, Ron. "Supply Spray Field." Personal Communication ed. Supply Township, North Carolina 2010.

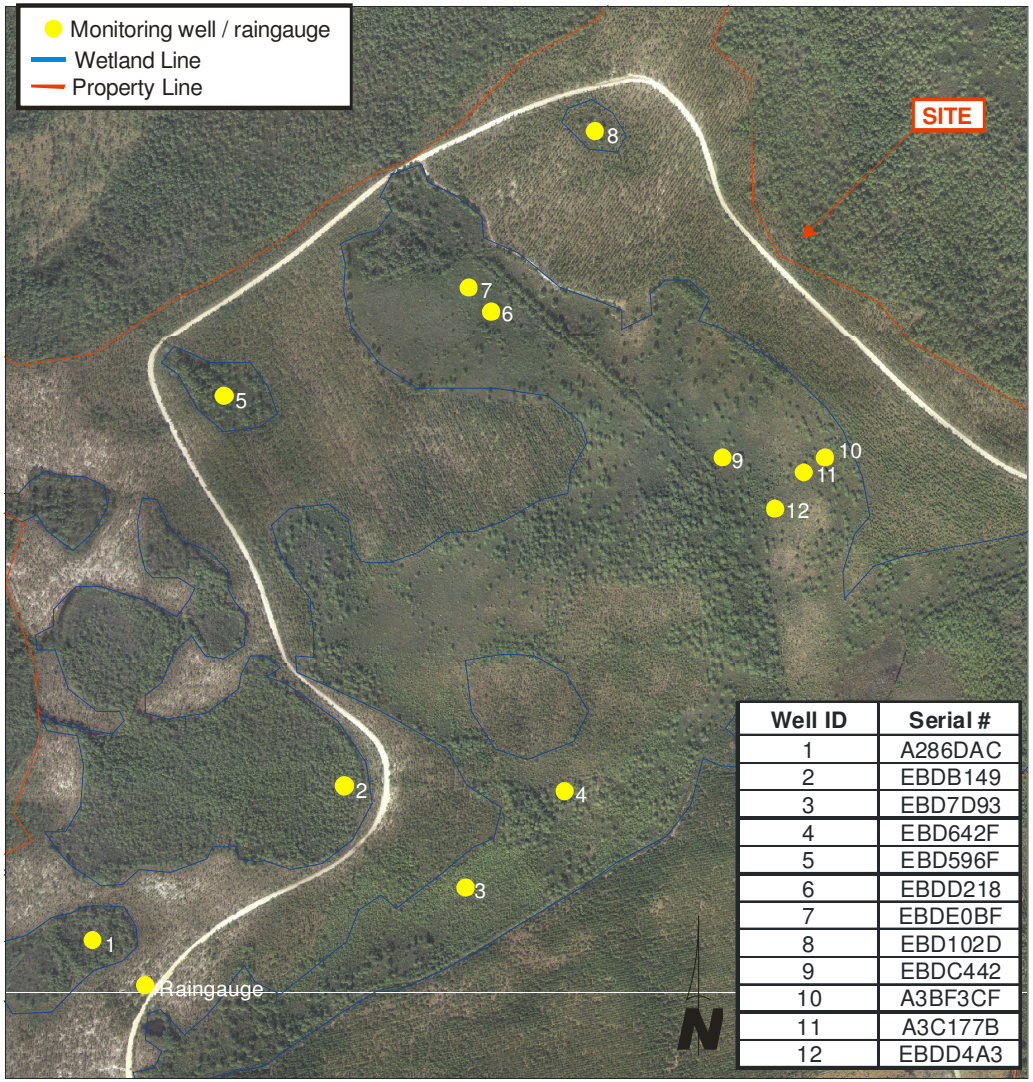
Monitoring Methods

- 12 monitoring devices / 1 rain gauge
- Descriptive time-series design from February to December 2009
- Sampling locations based on non-probability purposive sample



Data Logger Image Source: page 3 <http://www.rdsys.com/RDS_Catalog.pdf>

Site Map with wetland line and well overlay



Well ID	Serial #
1	A286DAC
2	EBDB149
3	EBD7D93
4	EBD642F
5	EBD596F
6	EBDD218
7	EBDE0BF
8	EBD102D
9	EBDC442
10	A3BF3CF
11	A3C177B
12	EBDD4A3

Map Source: 2009 NAPP Aerial Photography

Results

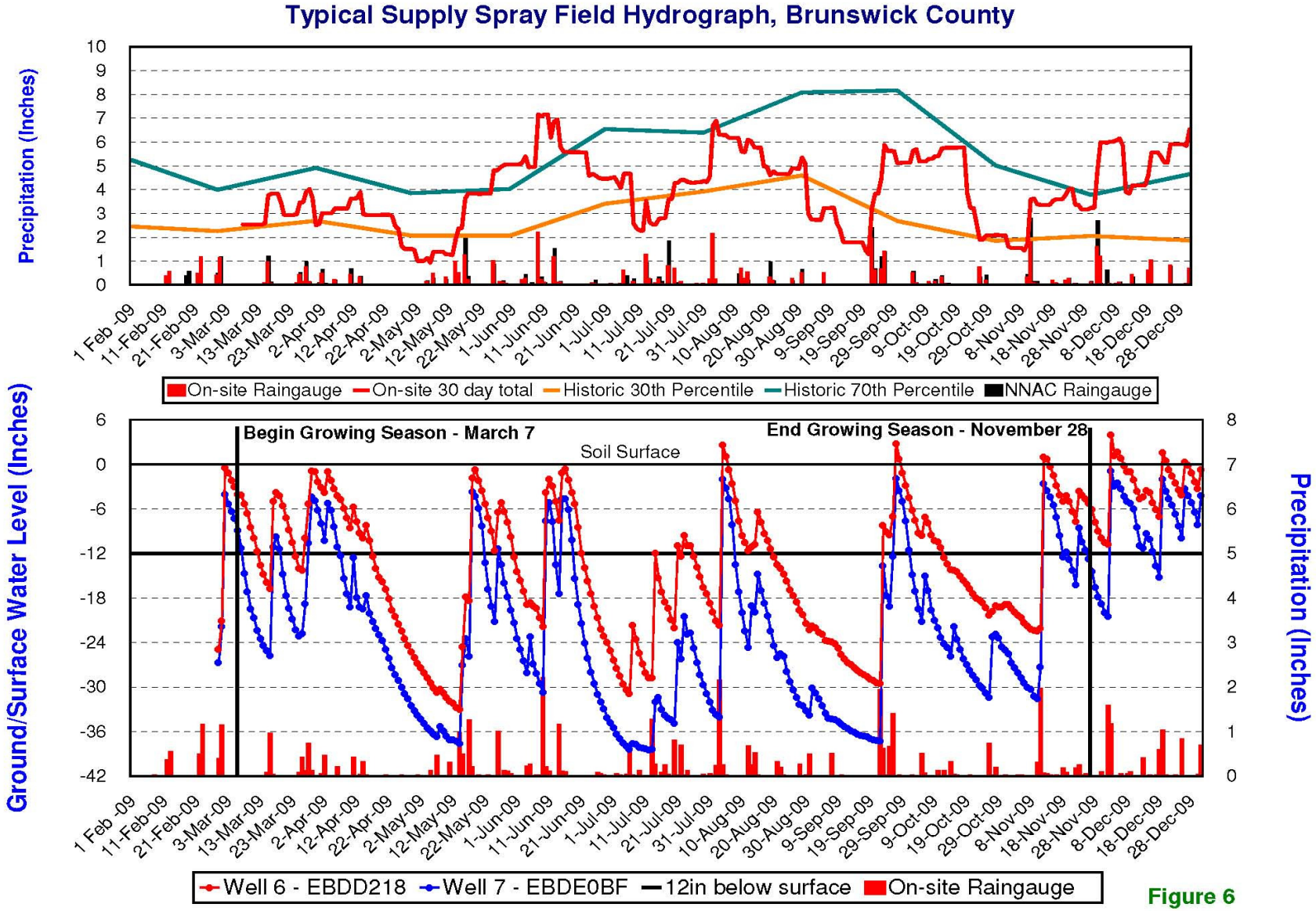


Figure 6

Results -12” threshold

Table 1. Examination of water table at or below -12" during the growing season

Well ID (location)	# of days water table is at or below -12 inches	average depth to water table during days that water table is at or below -12 inches
1	0	0.0
2	59	-15.0
3	22	-17.0
4	143	-24.9
5	0	0.0
6	153	-21.1
7	224	-26.5
8	8	-19.9
9	166	-22.4
10	93	-18.0
11	69	-13.7
12	93	-19.0

Results -6” threshold

Table 2. Examination of water table at or below -6" during the growing season

Well ID (location)	# of days water table is at or below -6 inches	average depth to water table during days that water table is at or below -6 inches
1	0	0
2	236	-9.9
3	52	-12.2
4	192	-20.9
5	26	-7.7
6	208	-17.9
7	246	-24.9
8	38	-9.9
9	186	-21.0
10	138	-15.0
11	108	-12.1
12	131	-16.1

Discussion

- Limits are placed on wetland augmentation capacities when a -12” restriction is enacted
- The restriction will present difficulties for municipalities to utilize wetland augmentation due to extensive seasonal variations, storage requirements, and fluctuating demand
- Based on physical parameters, wetlands are an acceptable repository for the dispersion of tertiary treated wastewater

Conclusions

- Wetlands are viable repositories for reclaimed water.
- NC currently utilizes upland drip irrigation systems to dispose of wastewaters, wetland augmentation offers an increased capacity for WWTPs
- Comparison states focus on a high level of discharged water quality
- Proposed NC EMC wetland augmentation regulations require the demonstration of a net environmental benefit but restrict the achievement of wetland hydrology, a critical factor in promoting wetland enhancement and environmental benefits

Future Study Recommendations

- Critically review the -12 inch depth to water threshold
- Conduct cost-benefit analyses regarding wetland augmentation in NC (Supply Site)
- Examine the potential of NC wetlands to treat secondary waste effluent
- Apply studies to military installations in North Carolina

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