Non-Growing Season Reuse Water Treatment

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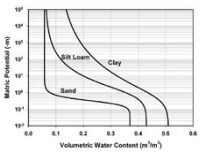
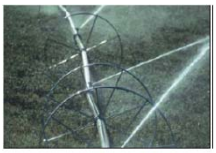
Purpose

- Describe non-growing season land application
- Define HLR_{ngs} and parameters
- Examples (Soil Science 101)
- Management Considerations





Why Non-Growing Season Land Application?

- Wastewater generated year round
- Storage limited or problematic
  - Space
  - Cost
  - Odors

History of NGS

- Past: high hydraulic loading NGS
  - No plant uptake
  - Exceed soil water holding capacity
  - Soil impacts
  - Groundwater impacts
- Current
  - Handbook addresses NGS application
    - Keep constituents in root zone (minimize leaching)
    - Limit hydraulic loading
    - Evaluate groundwater impacts (mixing zone)

How Does Idaho Regulate NGS Application

- Industrial Permits – many with NGS
- Municipal Permits GS only
- IDAPA 58.01.17 – Recycled Rules silent NGS
- Guidance for Reclamation and Reuse of Municipal and Industrial Wastewater 2007 (Handbook)
- WWRU System Modeling tool

$$HLR_{ngs} = AWC + E - PPT_{ngs}$$

HLR_{ngs} =non-growing season hydraulic loading rate (inches)

AWC = weighted composite available water holding capacity of the soil to 60 inches or root limiting layer, whichever is shallowest (inches)

E = estimate of ET during the non-growing season (inches)

PPT_{ngs} = average precipitation falling during the non-growing season (inches)

$HLR_{ngs} = AWC + E - PPT_{ngs}$

Example HLRngs Southern Idaho (November through March)

Parameter	Management Unit (inches)	Comment
AWC	10.8	NRCS
Average E	2.4	ET Idaho
Precipitation	5.8	Historic weather data (average)
Proposed NGS Limit	**7.4**	Calculated: AWC + E – PPTngs

7.4 acre-inches/acre. If we had 200 acres, result in 40 MG of wastewater applied over the NGS

Definitions

- Soil Moisture:
  - Θ: Volumetric water content, volume water/bulk volume soil (cm^3/cm^3)
  - Θg: Gravimetric water content, mass water/mass dry soil (g/g)
  - θ = (ρb/ρw) X θg (typical ρb 1.5 g/cm^3)
- Field capacity, wilting point, and saturation:

Definitions

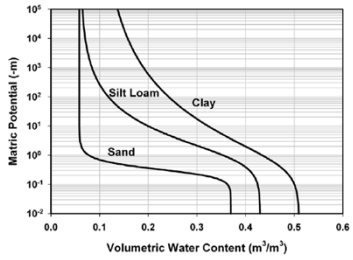
$HLR_{ngs} = AWC + E - PPT_{ngs}$

$AWC = \theta fc - \theta wp$

Soil Texture	Field Capacity	Permanent Wilting Point	Available Water Holding Capacity
	θ – volumetric water content		
Sand	0.10	0.05	0.05
Fine Sand	0.15	0.06	0.09
Sandy Loam	0.20	0.07	0.13
Fine Sandy Loam	0.25	0.08	0.17
Loam	0.29	0.09	0.20
Silt Loam	0.31	0.10	0.21
Clay Loam	0.39	0.18	0.21
Clay	0.40	0.23	0.17

Soil Water Characterization Curve

fs: 0.15 and 0.06
Sil: 0.31 and 0.10
C: 0.40 and 0.23

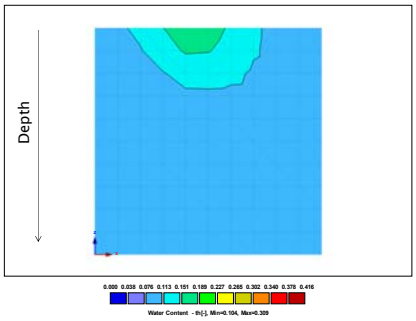


Water tension – matrix potential – capillarity and adsorption forces

Example 1

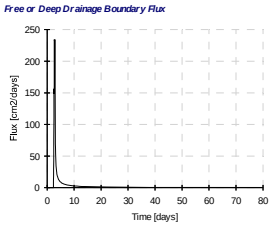
- 10" by 10" square box with silt loam soil
- AWC ~ 0.21 in. water/in. soil (or 2.1 inches AWC)
- Add 0.4 in. water
- 2.1" – 0.4" = 1.7" AWC remaining.
- 0.4" water X (1"soil/0.21"water) = about 2 inches depth.
- Use HYDRUS 2D/3D – numerical water and solute transport software

Silt loam:
θfc = 0.31
θwp = 0.10



Example 2

- Apply wastewater: Day 2 (2.5") and Day 3 (2.5")
- Run model for 80 days
- 5 inches of wastewater. Predict 3" deep drainage (AWC 2.1")
- HYDRUS estimated 3.5" drained water

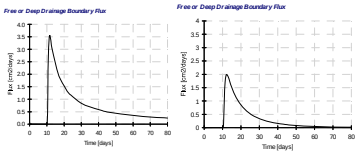


Evaporation (E)

- HLR_{ngs} = AWC + E – PPT_{ngs}
  - Handbook:
    - Lysimeter data Kimberly
    - ET X K (bare soil or reference crop X K)
  - ET Idaho (U of I, Kimberly Research Station)
    - Penman-Monteith Method
    - Bare Soil or Crop (Actual daily ET or Potential Daily ET)

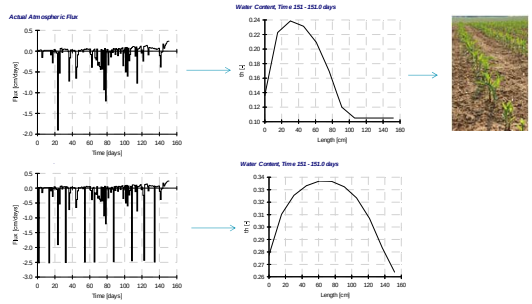
Example 3

- Wastewater: Day 3 (1.0"); Day 10 (1.5"), run 80 days
- Compare results with and without E .
- E = 0.02"/day (typical Dec and Jan) total 1.6"
- Without E: 2.5" – 2.1" = 0.4" deep drainage
- HYDRUS predicts 0.8" without E
- HYDRUS predict 0.03" with E



Example 4 – daily data

- Wilder Area for NGS (Nov 1 2007 through March 2008).
- Daily ppt and E (ET Idaho)
- Silt loam 60"; ppt = 7.05"; E= 3.75"
- HLR_{ngs} = AWC + E – PPT_{ngs}
- = 12.6" + 3.75" – 7.05" = 9.3"
- Run w/o ww irrigation
- Run with 9" of wastewater



Silt loam:
θfc = 0.31
θwp = 0.10

Deep Percolation 2.2 to 4.1"

NGS Management

- Going into NGS:
  - % AWC?
  - Opportunity to allow soils to dry?
- During NGS:
  - Timing of application versus precipitation events
- Crop type:
  - Deep rooted perennial crop
  - Winter wheat or Barley
  - Bare soil

NGS Management

- Percolation will occur!
  - Key:
    - keep nutrients near surface (ammonium versus nitrate)
    - Manage soil water
  - GW mixing analysis

Questions?