Irrigation of Hybrid Trees as an Effluent Discharge Alternative
Warrens Wastewater Treatment Facility
Warrens WWTF Site

2010

2017

Image USDA Farm Service Agency
Wastewater Treatment at Warrens, Wis.

OVERVIEW

- Population of 455 (year-round)
- Average flow: 78,000 gpd +/-
  Design Flow: 211,000 gpd
- Original WWTF: stabilization pond w/ seepage cell - 1975
- Current WWTF: activated sludge (oxidation ditch) w/ treated effluent discharge to Apple Creek - 2006

CHALLENGES

- New WPDES permit with extremely low effluent limits: phosphorus, copper, zinc
- Seasonal variations in flow; nearly double in summer due to large campground and many seasonal homes
- Financial difficulties as a result of “housing bust”
Addressing Treatment And Financial Challenges

1. Pay off Clean Water Fund loan with proceeds from USDA-Rural Development loan
   • Capital improvement project required as a condition of debt issuance

2. Evaluation and Preliminary Engineering Report identified groundwater discharge via irrigated hybrid trees to replace surface water discharge

3. Project funding: USDA-RD grant: $626k
   • USDA-RD loan: $664k
   • DNR CWF “principal forgiveness” (grant): $356k
   • Total Project Cost: $1.65M
Why Hybrid Trees

1. Hybrid poplars are phreatophytes (water loving)
   - Available water is usually a limiting factor to growth

2. Rapid growth: 2-5’ in first year; 3-5+’ annually for the next five years

3. High nutrient immobilization potential including: plant uptake; soil organic matter build up; and, denitrification
   - Warrens WPDES permit allows up to 300 lbs N/acre/year after establishment
   - Higher than allowed for soybeans, corn, or alfalfa: fewer acres

4. Longer growing season with greater evapotranspiration (ET) potential than annual crops
   - April through October: smaller storage pond required for non-irrigation season
Nitrogen Concerns

1. Highly permeable soils
2. Relatively shallow groundwater
3. Mitigated by:
   • Nitrogen applied at less than 3 lbs N/acre/cycle; “spoon feeding” trees and soil microbes
   • Denitrifying microbes use decomposing roots from previously removed trees and annual root sloughing of hybrid trees as carbon source
Trees

HYBRID COTTONWOODS

- A variety of Eastern Cottonwoods (*Populus deltoides*)
- All male clones, no cotton
- Planted as rooted stock
- Growth to 60+ feet tall with 36”+ dia. trunk
- Live 50+ years

HYBRID POPLARS

- True hybrids
- Crosses of eastern cottonwoods and black poplar (*P. nigra*)
- Planted as 12” cuttings
- Growth to 45 feet tall with 14” dia. trunk
- Lifespan 20 – 30 years
ALTERNATE COTTONWOOD & POPLAR ROWS: 15’ BETWEEN ROWS
TREE SPACING WITHIN ROW: POPLARS 10’ COTTONWOODS 15’
HYBRID POPLAR TREE CUTTINGS AND A SINGLE PLANTED CUTTING: 4300 ea.
ROOTED HYBRID COTTONWOODS: 2800 ea.
UW-STEVEN POINT FORESTRY DEPARTMENT
PLANTING CREW VOLUNTEERS – April 23 & 24, 2016
Irrigation System

1. Site is split up into three, 9+ acre irrigation zones
2. PLC controls irrigation, monitors application rate, duration, and volume by zone, and precipitation
   • Zones are irrigated sequentially, one at a time
   • Irrigation pump: approx. 600 gpm at 140 feet TDH
   • Operator pre-sets desired application rate and duration (volume) per zone, and hours between applications
   • Precipitation events of >0.75 inch shutdown the irrigation system for pre-set duration, after which irrigation of the zone is completed
3. Screen w/ automated flush removes particles that could clog sprayers
4. Irrigation sprayers each 1.6 gpm; on 30’ x 30’ spacing
Design Parameters

- Volume Irrigated = 26.1 MG/year
- Irrigation area = 26.9 acres
- Annual hydraulic application rate = 0.972 MG/acre/year
- Nitrogen concentration = 37 mg/L
- Annual nitrogen application rate = 300 lbs N/acre/year
- Application intensity = 0.16 in/hr
- Application duration = 4.1 hours
- Application rate each cycle = 0.65 inches = 5,750 gal/acre
- Rest between applications = 40 hours
- Irrigation days per year = 55
- No. of days required = 100 (60% of irrigation season)
- No. of days available for precipitation events = 70
- Precipitation event lockout = 40 hours if >0.75 inches within previous 36 hours
- Storage volume for non-irrigation season = 9.7 MG
Irrigation Zone Layout

8”, 6”, 4”, HDPE headers
2” and 1.5” HDPE laterals

Three zones, each with an automated control valve
PUMP BUILDING
EFFLUENT SCREEN
IRRIGATION APPLICATION IN ZONE 3
April 23, 2016 – immediately after planting
IRRIGATION APPLICATION IN ZONE 1
Summer 2017
Challenges

• Late frost (planting too early)
  ◦ Third week of May 2016, overnight temperature 21°F
  ◦ 75% poplar mortality; < 3% cottonwood mortality

• Weed control
  ◦ Competition, especially for replants

• Voles
  ◦ Approximately 5% of trees impacted during winter of 2016-17
TYPICAL HYBRID POPLAR CONDITION – Spring 2016
BOBCAT WITH MOWER ATTACHMENT
(not required in winter!)
VOLE AND WHAT THEY CAN DO TO YOUNG TREES
VOLES CONTROLLED BY TRAPS, AGGRESSIVE MOWING AND...
NATURAL PREDATORS
COYOTE, FOX & RAPTORS
Things Brian Would Change (*or already has):

1. Floating intake*
2. Upsize pump in order to be able to irrigate entire site (27+ acres) at one time (eliminate zones & control valves)
3. Use a standard pump rather than self priming for better efficiency
4. Deer fence around the entire planting*
Lessons Learned

1. Land clearing is more costly than purchasing agricultural land
2. Wait until 3rd week of May to plant in Northern Wisconsin or Cranberry Country
3. Have suitable equipment for mowing immediately
4. Vole control: Keep site well mowed first three years. Water traps, predator entrance points in fencing and hawk poles....
Summary

• Warrens, WI is making a successful transition from surface water to groundwater discharge via irrigation of hybrid trees
• Hybrid trees offer advantages over annual crops in terms of land and storage requirements
• Upper Wisconsin River TMDL could make irrigation a more viable option, depending on monthly allocation of annual load, by reducing land and storage requirements
• The Multi-Discharger Variance won’t last forever