



# Biosolids Recycling at it's Finest

Land Application

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You've made biosolids, now what?



# Biosolids Land Application

- Science
- Economics
- Projects
- Logistics
- Considerations



# King County Wastewater Treatment Division

Population served: 1.6 million residents

- 5 treatment plants serve 425 square miles
- 4 CSO wet weather treatment facilities
- 186 million gallons of wastewater treated daily

Carnation



Vashon



## Our Service Area and Facilities



South Plant



West Point



Brightwater







# How we got started

## 1970's:

- Explored forestry application with UW

## 1980's:

- Forestry partnerships with
  - MTSG
  - Weyerhaeuser

## 1990's - Present:

- Ag partnership begins
- Composting partnership



# LAND APPLICATION

The Science



# BIOSOLIDS ARE GROUNDED IN RIGOROUS SCIENCE

- Repairing soils
- Better nutrient cycling
- Increase in soil microbiology
- Water retention
- Increased plant growth and soil structure







**Biosolids builds soil carbon**

# Common problem in agriculture: Soil compaction





Sand



Silt



Clay



Soil texture



Soil organic matter



Compaction and disturbance

What effects soil structure?

# Reductions in soil erosion





# Plant Essential Nutrients

Superior to conventional fertilizers, which only contain select macronutrients, Loop replenishes the soil by returning every nutrient plants need for healthy growth.

Macronutrient	Percentage	Micronutrient	Parts per million
Nitrogen	6.8	Iron	14,733
Phosphorus	2.0	Manganese	696
Potassium	0.1	Boron	20
Sulfur	1.3	Copper	405
Calcium	2.5	Zinc	797
Magnesium	0.5	Molybdenum	9

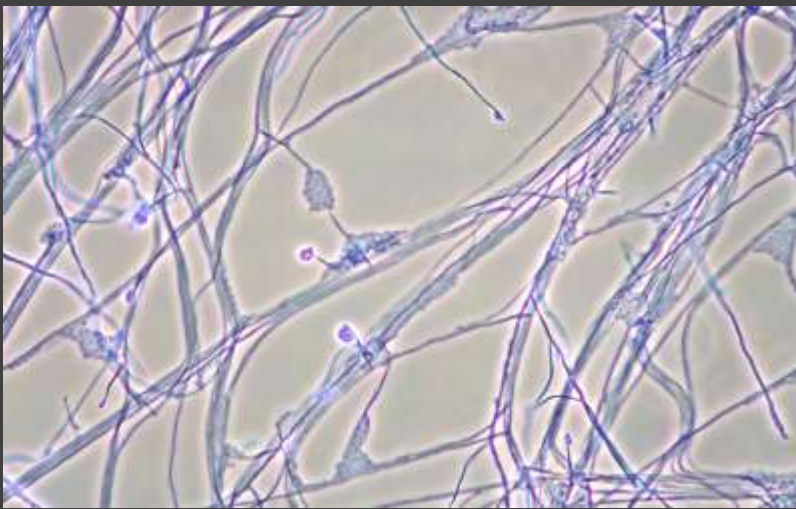
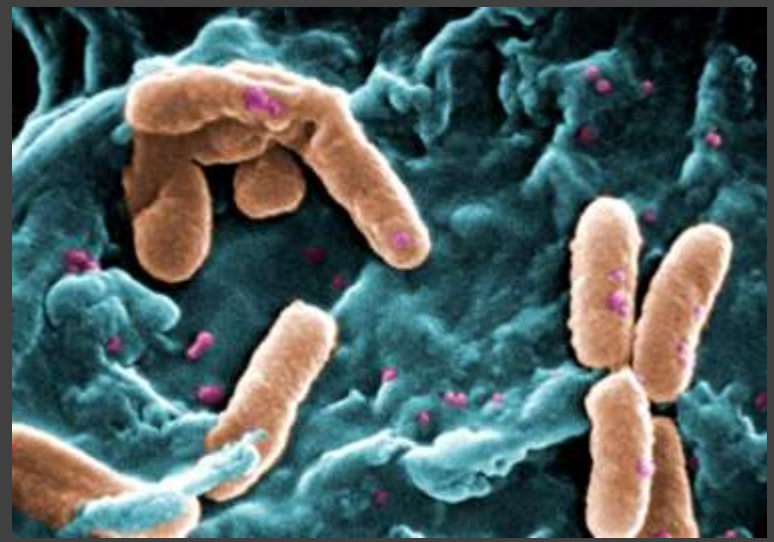


Wheat grown with Biosolids...



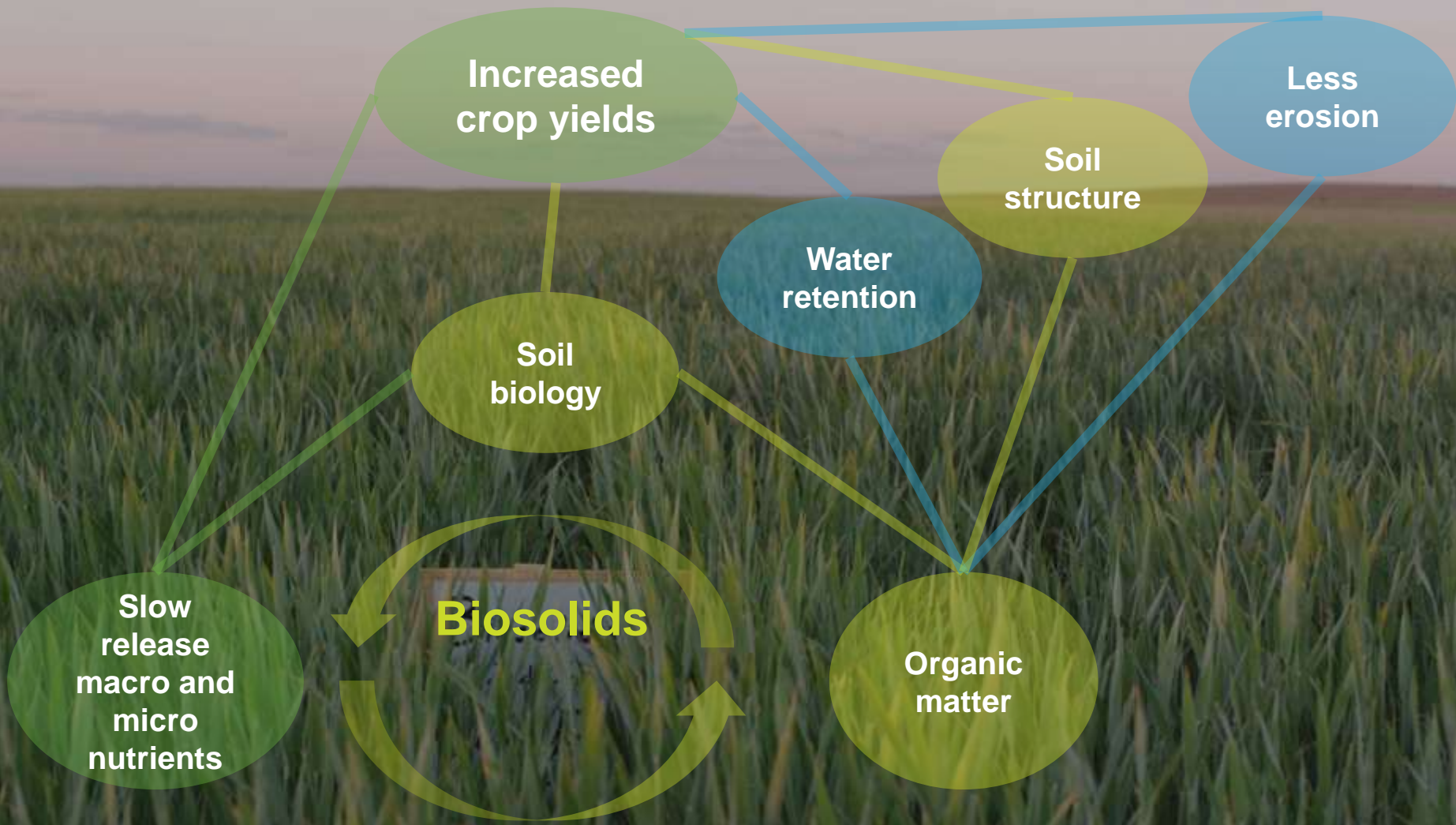
...and without Biosolids





# Soil Organisms





# ENVIRONMENTAL BENEFITS









# LAND APPLICATION

The Economics





# How do different uses of Loop stack up?

	Cost	Environmental benefit	Climate change solution	Social benefit
Farms, forests & land reclamation	\$			
Compost	\$			
Waste to energy incineration*	\$\$\$\$	Environmental cost		
Landfill*	\$\$\$	Environmental cost	Environmental cost	Social cost

\*Not considered beneficial use; not allowed for long term use under Washington State law.



**Generates Revenue**



**Supports Export Industries**



**Supports Local Jobs**



**Cost Sharing With Other Agencies**

# Economic Benefits



# Nutrient value:

Approximate first-year fertilizer replacement value for anaerobically-digested biosolids.

<b>Biosolids Nutrient</b>	<b>Expressed As</b>	<b>Biosolids Total Nutrient</b>	<b>Biosolids Available Nutrient</b>	<b>Nutrient Value</b>	<b>Fertilizer Replacement Value of Biosolids</b>
		% dry wt.	% of total nutrient	\$ per lb	\$/dry ton
Nitrogen	N	5.0	35	0.57	\$19.95
Phosphorus	P	2.5	40	1.09	\$21.80
Potassium	K	0.3	100	0.69	\$4.14
Sulfur	S	1.0	35	0.38	\$2.66
Total					<b>\$48.55</b>

At approximately \$8.00/dry ton (\$2.00/wet ton), biosolids help to keep farming viable in areas where land is marginal, irrigation may not exist, and profits are slim.

# LAND APPLICATION

The Projects





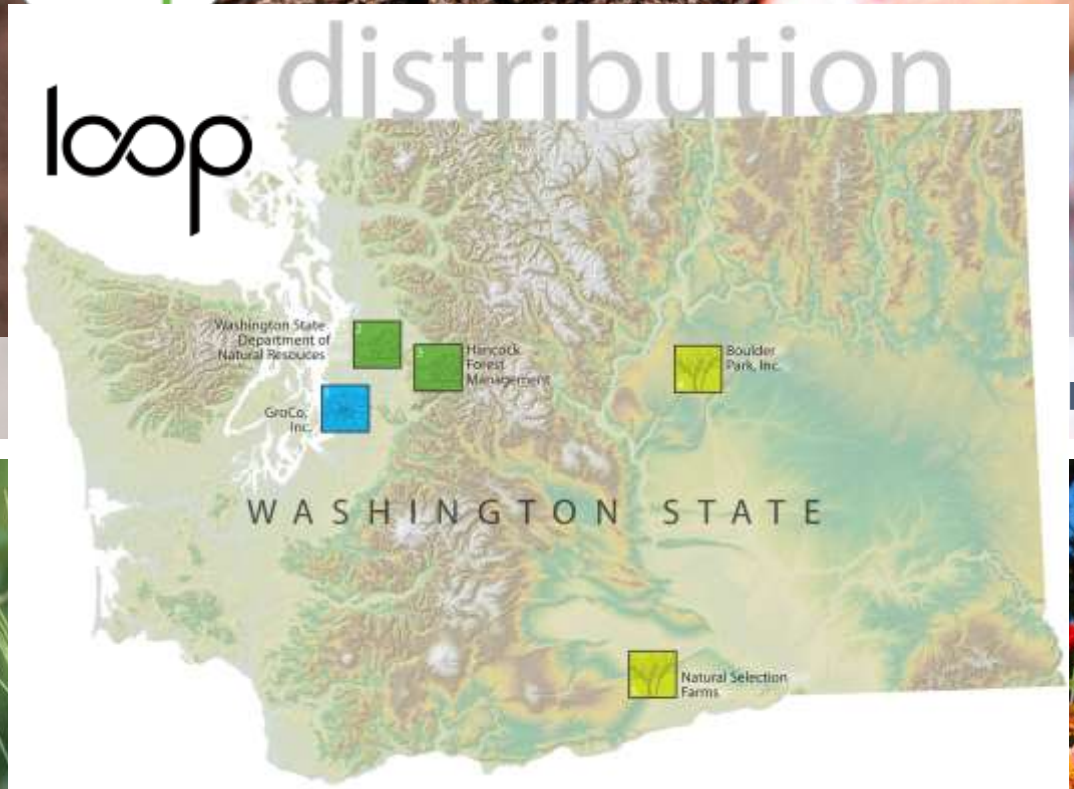
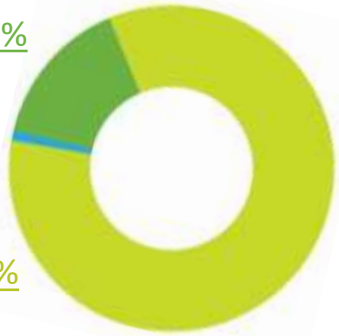


## 2017 Loop distribution

Forestry 15%

Gardening 1%

Agriculture 84%



# Recycling Loop



Agriculture



Forestry



Land Reclamation



Urban Gardening



# Agriculture Projects

Boulder Park Inc – Year round  
Natural Selection Farms – winter backup



# BPI

Public private partnership  
Unique dual biosolids permit

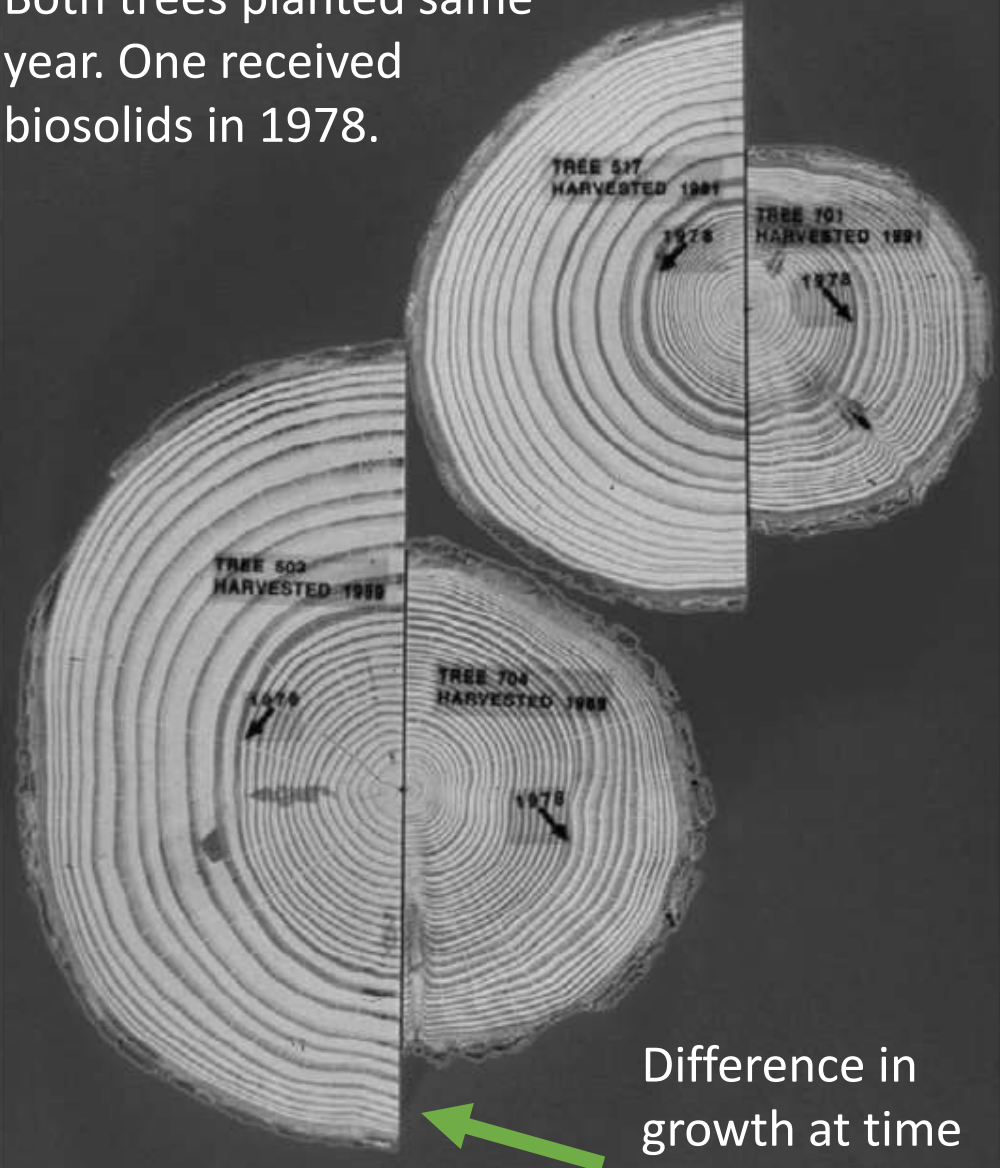
- Over 100 farmers
- 90,000 acres
- 30 utility contracts
- County owned equipment

Boulder Park Inc.

- Maintains Equipment
- Manages sites
- Does application



Both trees planted same year. One received biosolids in 1978.



Department of  
Natural Resources –  
300 acres per year

Snoqualmie Forest –  
1000 acres per year

Forestry Project

Difference in growth at time of harvest, 1989.



# Forestry Projects

Oldest project in WA State

- Partnerships with:
  - MTSGT
  - Private Timber Co
  - Public Timber Lands
- Multiple Forest Sites
- Contract the land application
- County owns equipment



# Composting partnership

## GroCo Compost

- Class A compost
- 1% King County biosolids production
- Provides 100 yds each year for public outreach and education







Used in community and home gardens across King County



# LAND APPLICATION

The Logistics





# Biosolids Management Guidelines

- Land application plans
  - Site design and layout
  - Maps, recordkeeping
  - Monitoring plans
- Protections for ground & surface
  - Application rates based on nitrogen
  - Buffers from water bodies, wells





**Soil Nitrogen**



**Biosolids Nitrogen**



**Crop Nitrogen Requirement: Winter Wheat**



**Crop Nitrogen Requirement: Canola**

**Agronomic Rates are based on Nitrogen Requirements**



**BIOSOLIDS APPLICATION RATE WORKSHEET**  
 Prepared by Andy Bary, Washington State University  
 For the Boulder Park Project BUF

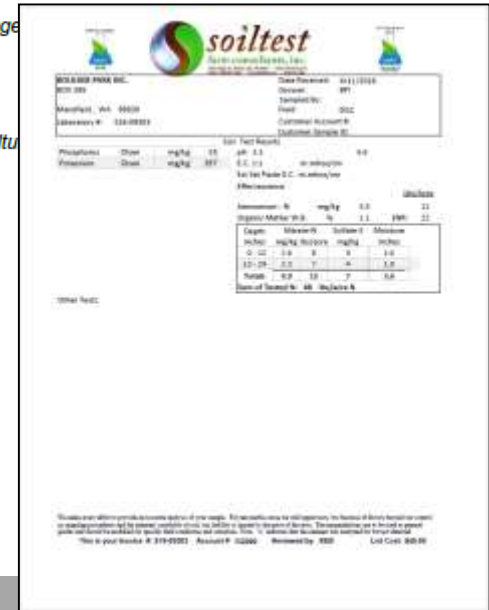


**MT14**

**2016**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Field (1)	Biosolids Source	Yield Goal bu/a	Crop N Requirement lb./a (2)	Soil Depth inches	SOIL NO <sub>3</sub> -N + NH <sub>4</sub> -N (Inorganic-N) mg/kg (3)	Soil NO <sub>3</sub> -N + NH <sub>4</sub> -N (Inorganic-N) lb./a (4)	Soil Profile NO <sub>3</sub> -N + NH <sub>4</sub> -N (Inorganic-N) lb./a (5)	Soil Organic Matter 0-12 inch	Soil TKN Est. of (Org-N) Release lb./a (6)	Previous BS Applications lb. N/a (7)	Estimated N from Crop and Soil lb./a	Crop Fertilizer N Req. lbs/a (8)	Biosolids Avail N lbs N/DT (9)	Biosolids App. Rate DT/a (10)	Biosolids App. Rate WT/a (11)	Total Solids (12)
MT14 2016	Brightwater	55	149	0-12	3.9	13.7	20.0	1.6	32.0	0.0	52.0	96.6	46.0	2.1	10.7	0.197
		70	189	12-24	1.8	6.3	20.0	1.6	32.0	0.0	52.0	137.1	46.0	3.0	15.1	0.197
MT14 2016	South Plant	55	149	0-12	3.9	13.7	20.0	1.6	32.0	0.0	52.0	96.6	39.7	2.4	10.0	0.242
		70	189	12-24	1.8	6.3	20.0	1.6	32.0	0.0	52.0	137.1	39.7	3.5	14.3	0.242
MT14 2016	KC West Point	55	149	0-12	3.9	13.7	20.0	1.6	32.0	0.0	52.0	96.6	38.4	2.5	8.5	0.296
		70	189	12-24	1.8	6.3	20.0	1.6	32.0	0.0	52.0	137.1	38.4	3.6	12.1	0.296

- Field and Year of biosolids generation
- Crop N Requirement = Column 3 X 2.7 +/- 0.2 lb. N/Bu from *Extension Bulletin EB1987, Dryland Winter Wheat, Eastern Washington Nutrient Management*
- Raw soil test values in mg/kg/1ft
- Lbs N/a = mg/kg \* 3.5 from *EB1987*
- Profile total N lb/a
- Assumes 20 lbs Org-N release rate x % organic matter in a 12 inch soil depth.
- N availability from previous biosolids applications per *Extension Bulletin PNW0511e, Worksheet for Calculating Biosolids Application Rates in Agriculture*
- Column 4 (crop N requirement) minus column 12 (estimated N from crop and soil) equals crop fertilizer requirement.
- For example: 38.6 lbs N/dry ton (WP) using 30% mineralization rate and 60% volatilization rate per *Extension Bulletin PNW0511e*
- Application rate dry ton/acre = column 13 / column 14
- For example: application rate wet ton/acre = column 8 divided by 28.4% Total Solids West Point.  
 (Soil analyses performed by Soiltest of Moses Lake. Please contact King County for copies of raw data, if needed.)
- Biosolids solids content for calculating wet/acre
- Application History: MT14 is a new application site never applied with biosolids. Field added to permit coverage in 2015.  
 Note1: Crop is soft white wheat unless otherwise specified.  
 Note2: King County biosolids available N data based on 2015 average approved by Ecology on 4/12/2016.



Agronomic rates account for available N release



Biosolids agronomic application on a dryland wheat field.





A typical agricultural application rate

# Transporting Biosolids

The Most Visible Part  
of Your Operation



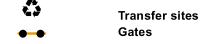




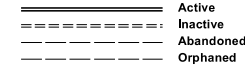
## Biosolids Application Unit 26-09-18B

Acres: 45.6  
Trails: 8,310

### Legend



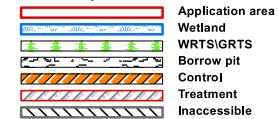
### Roads



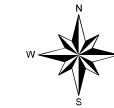
### Trails



### Unit Compartments



**6** Compartment Number  
**6.7** Compartment Acreage  
**657** IFP Shutdown zone



Scale  
1 : 4,200  
1" = 350'



Monday, January 30, 2012

Buffers: Stream, wetland and wells  
trail locations are flagged



- Tankers
- Utility trailers
- End dumps
- Side dumps
- Belt trailers
- Dump trucks

Equipment can be unique to your facility





Custom-Built Dump Truck and Trailer



Public perception is important



# LAND APPLICATION

Considerations



- Utility owns equipment and hauls
- Utility owns equipment – contracts hauling
- Combined trucking and land application contract (trucking subcontracted)



Customize your project



- Cradle-to-grave
- Periodic site visits
- Routine contact with land applicator and haul contractors(s)
- Ensure contractors follow regulatory requirements

Generator  
responsibilities





I-90 Off-ramp, Thorp, WA

It can happen. How will you respond?



# Questions?

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