

Forest Reclamation and Tree Salvage in the Foothills of Alberta

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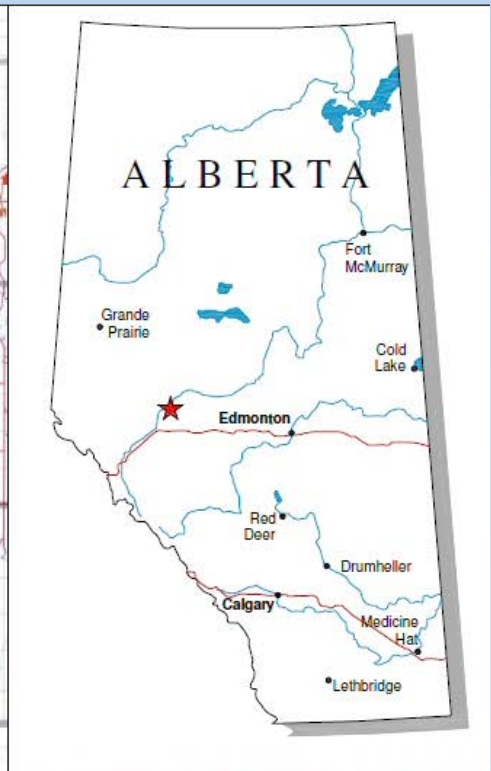
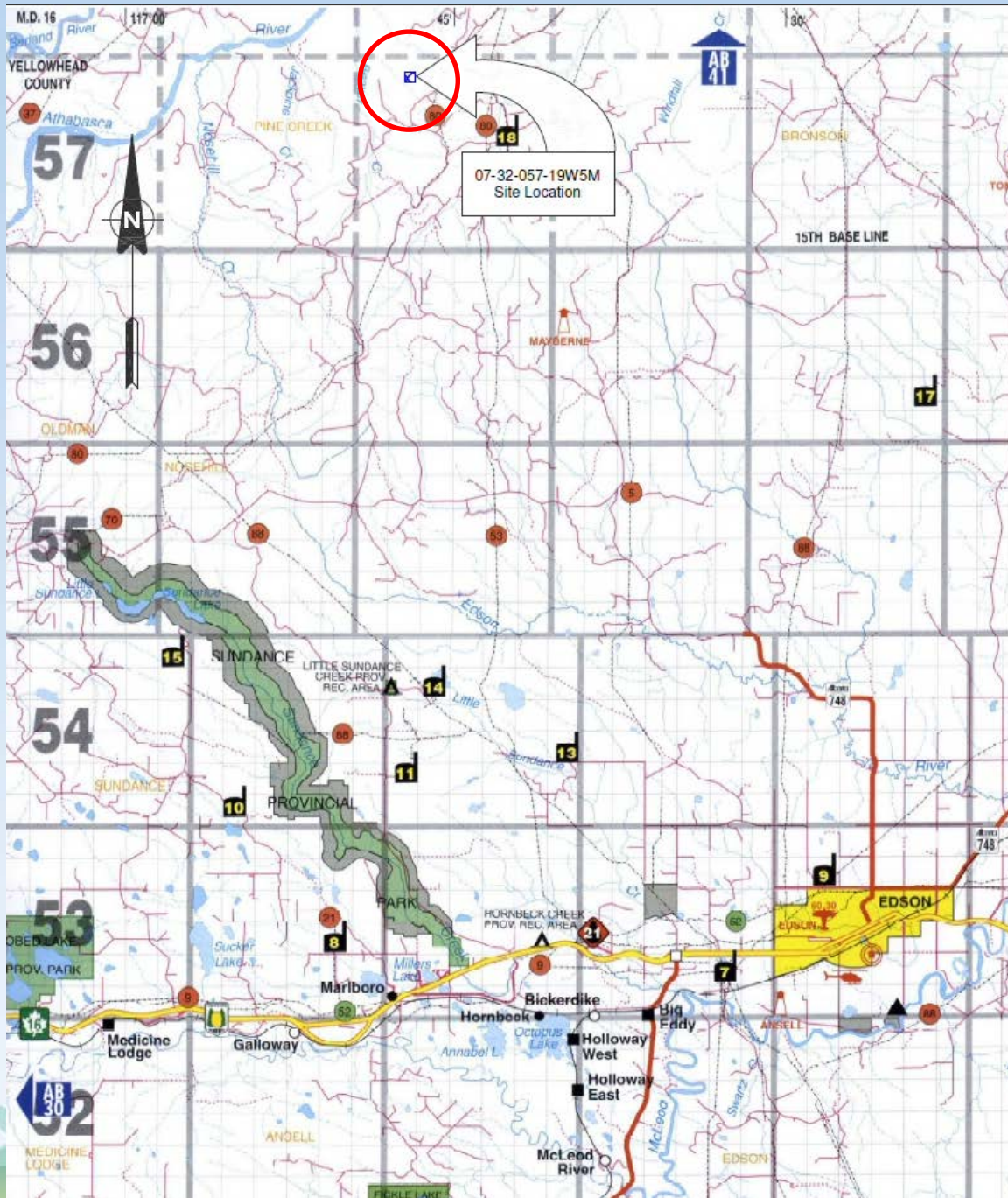
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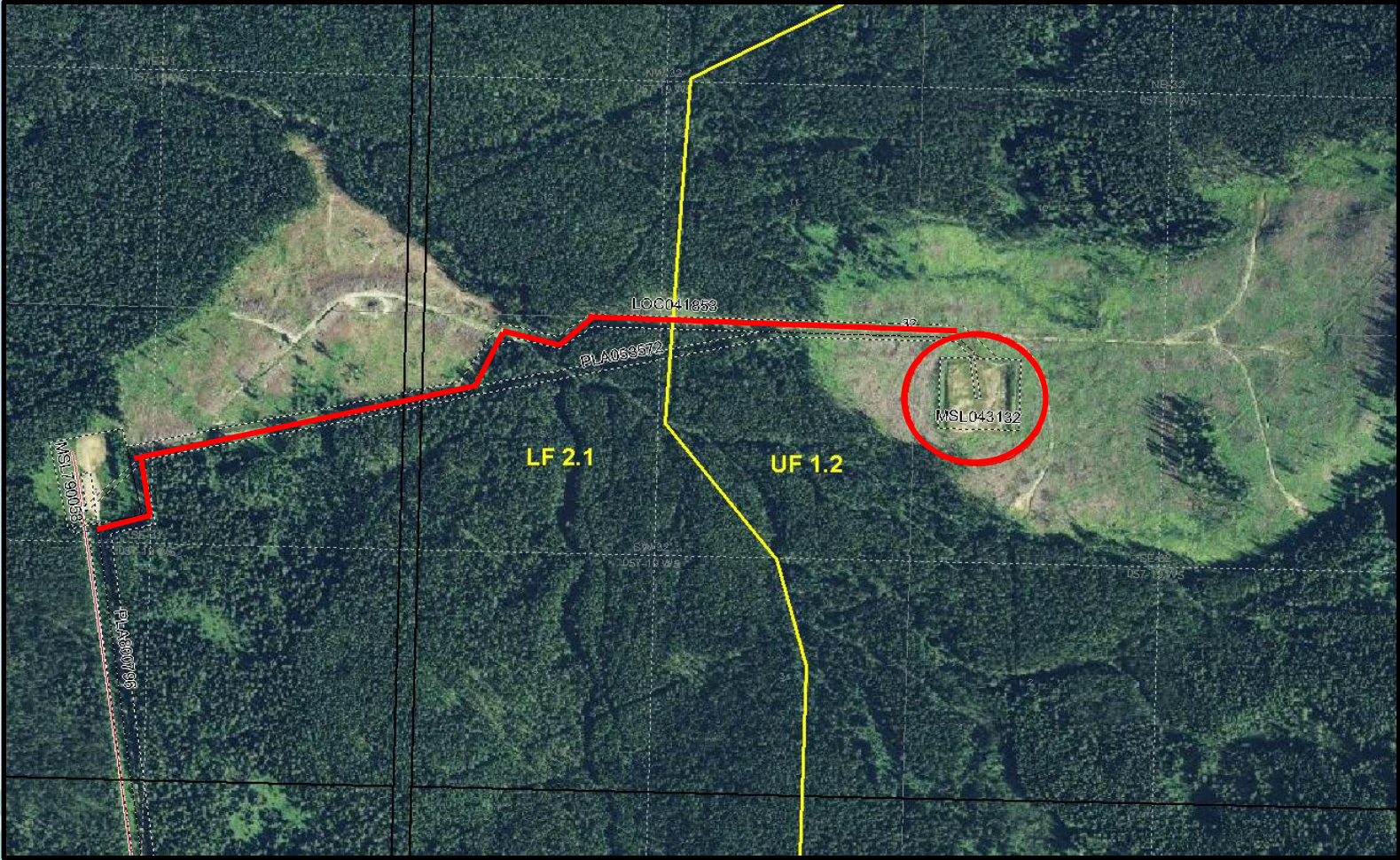
Outline

- Site Introduction
- Assessment & Remediation
- Overview of Silviculture
- Tree Salvage
- Tree Planting
- Data Collection
- Analysis

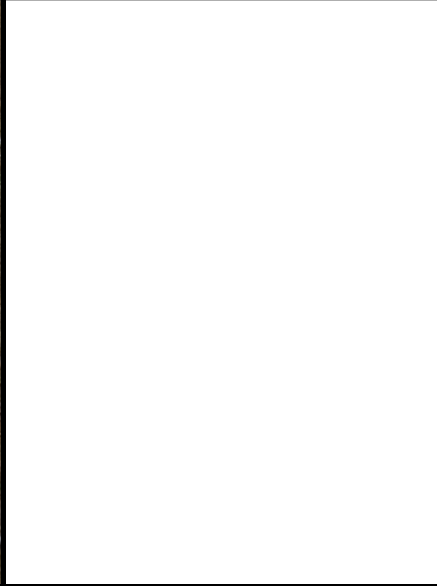




Location



MSL



LOC



Tree Species



- Lodgepole Pine
- White Spruce
- Black Spruce
- Balsam Fir
- Trembling Aspen
- Balsam Poplar
- Alder
- Willow
- Mountain Ash

Phase I

- Completed in Fall 2014
- D & A February 2005
- Gel-chem and Invert drilling mud
- Areas of Concern
 - Wellbore
 - East Stockpile
 - West Stockpile
- Cut and fill 30,000 m³



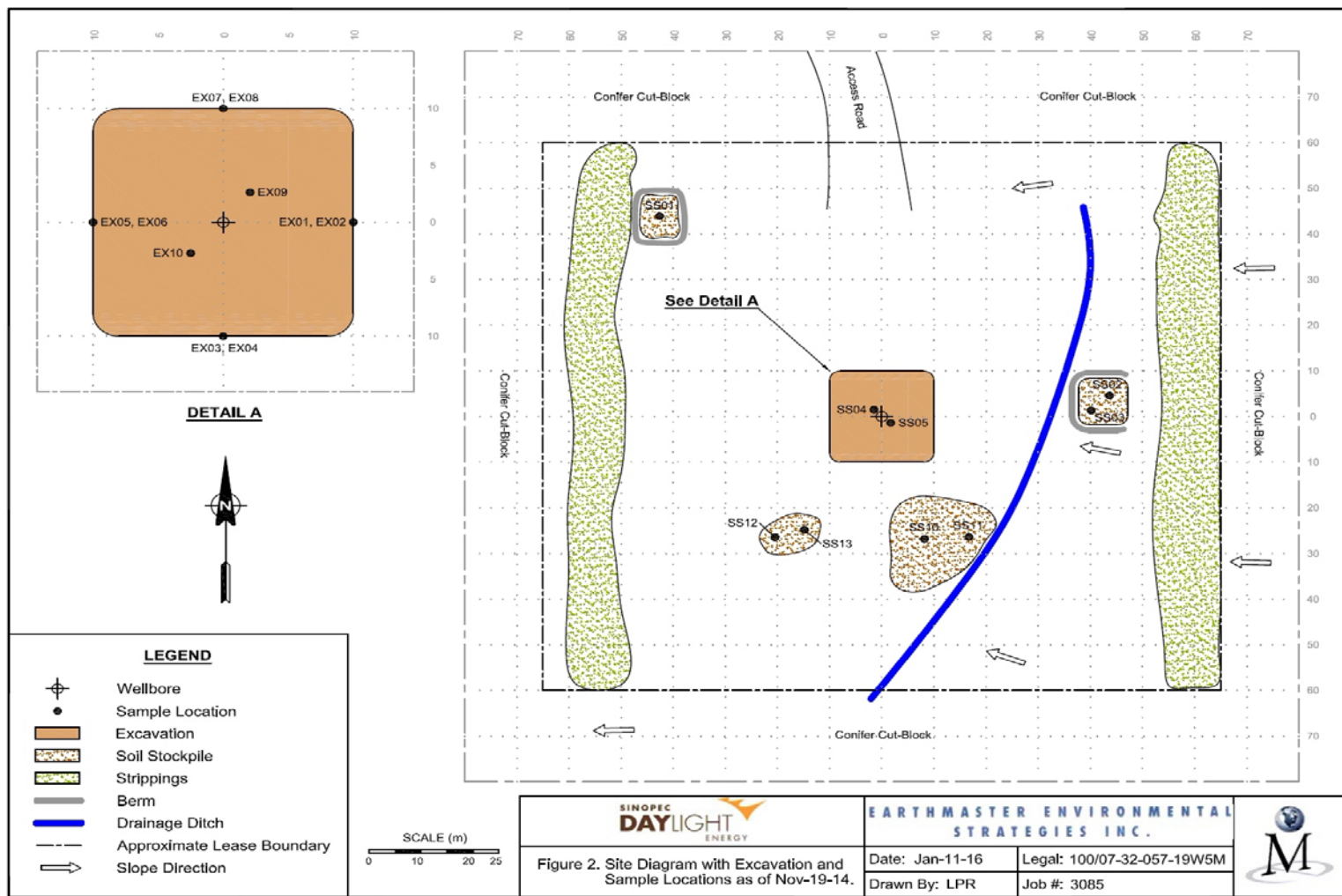
Assessment

| Sample Location | | Sampling Date | Sample Depth (m bgl) | Fraction 1 (C6-C10) | Fraction 2 (C11-C16) | Fraction 3 (C17-C34) | Fraction 4 (C35+) | Benzene | Toluene | Ethylbenzene | Xylenes |
|--|---------------------|--|----------------------|---------------------|----------------------|----------------------|-------------------|---------|---------|--------------|---------|
| | | | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) |
| Alberta Tier 1 Soil and Groundwater Remediation Guidelines | | Natural Land Use: Blended Fine/Coarse Surface Soil | | 210 | 150 | 300 | 2800 | 0.046 | 0.49 | 0.11 | 15 |
| | | Natural Land Use: Blended Fine/Coarse SubSoil | | 420 | 300 | 600 | 5600 | 0.046 | 0.49 | 0.11 | 15 |
| SS01 | NW Stockpile | Oct-10-14 | 0.5-0.65 | <10 | <10 | 34 | <10 | <0.005 | <0.05 | <0.01 | <0.05 |
| SS02 | E Stockpile | Oct-10-14 | 0.5-0.65 | 30 | 8280 | 18900 | 262 | 0.012 | 0.06 | 0.01 | 0.09 |
| SS03 | Base of E Stockpile | Oct-10-14 | 2.0-2.15 | <10 | 2520 | 5510 | 92 | 0.007 | <0.05 | 0.02 | 0.08 |
| SS04 | Cut & Cap Fill | Oct-10-14 | Grab | <10 | 569 | 1460 | 54 | <0.005 | <0.05 | <0.01 | <0.05 |
| SS05 | Base of Cut & Cap | Oct-10-14 | 2.0-2.15 | <10 | 89 | 220 | 16 | <0.005 | <0.05 | <0.01 | <0.05 |

Remediation



Site Diagram



Confirmatory Sampling

| Sample Location | | Sampling Date | Sample Depth (m bgl) | Fraction 1 (C6-C10) | Fraction 2 (C11-C16) | Fraction 3 (C17-C34) | Fraction 4 (C35+) | Gravimetric Hydrocarbons | Benzene | Toluene | Ethylbenzene | Xylenes |
|--|---------------------|--|----------------------|---------------------|----------------------|----------------------|-------------------|--------------------------|---------|---------|--------------|---------|
| | | | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) |
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| | | Natural Land Use: Blended Fine/Coarse SubSoil | | 420 | 300 | 600 | 5600 | 5600 | 0.046 | 0.49 | 0.11 | 15 |
| EX01 | East Wall 1.0-1.15 | Nov-06-14 | 1.0-1.15 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX02 | East Wall 2.0-2.15 | Nov-06-14 | 2.0-2.15 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX03 | South Wall 1.0-1.15 | Nov-06-14 | 1.0-1.15 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX04 | South Wall 1.0-1.15 | Nov-06-14 | 2.0-2.15 | <10 | <10 | 28 | 20 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX05 | West Wall 1.0-1.15 | Nov-06-14 | 1.0-1.15 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX06 | West Wall 1.0-1.15 | Nov-06-14 | 2.0-2.15 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX07 | North Wall 1.0-1.15 | Nov-06-14 | 1.0-1.15 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX08 | North Wall 2.0-2.15 | Nov-06-14 | 2.0-2.15 | <10 | <10 | 19 | 22 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX09 | Base 2.5-2.65 | Nov-06-14 | 2.5-2.65 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |
| EX10 | Base 2.2-2.65 | Nov-06-14 | 2.5-2.65 | <10 | <10 | <10 | <10 | - | <0.005 | <0.05 | <0.01 | <0.05 |

Reclamation

- The process of reconvertng disturbed land to its former, or other, productive uses.

(1) stable, non-hazardous, non-erodible, favorably drained soil conditions, and

(2) equivalent land capability.

Silviculture

- The art and science of controlling the establishment, growth, composition, and quality of forest vegetation for the full range of forest resource objectives.
- Applies not only to timber production but also includes wildlife, water, recreation, aesthetics, or any combination of these or other forest uses.

Traditional Silviculture Methods

- Planting
- Seed Tree
- Suckering
- Drag Scarification
- Disc Trenching
- Mound and Plant



Forest Harvesting Wellsite Reclamation

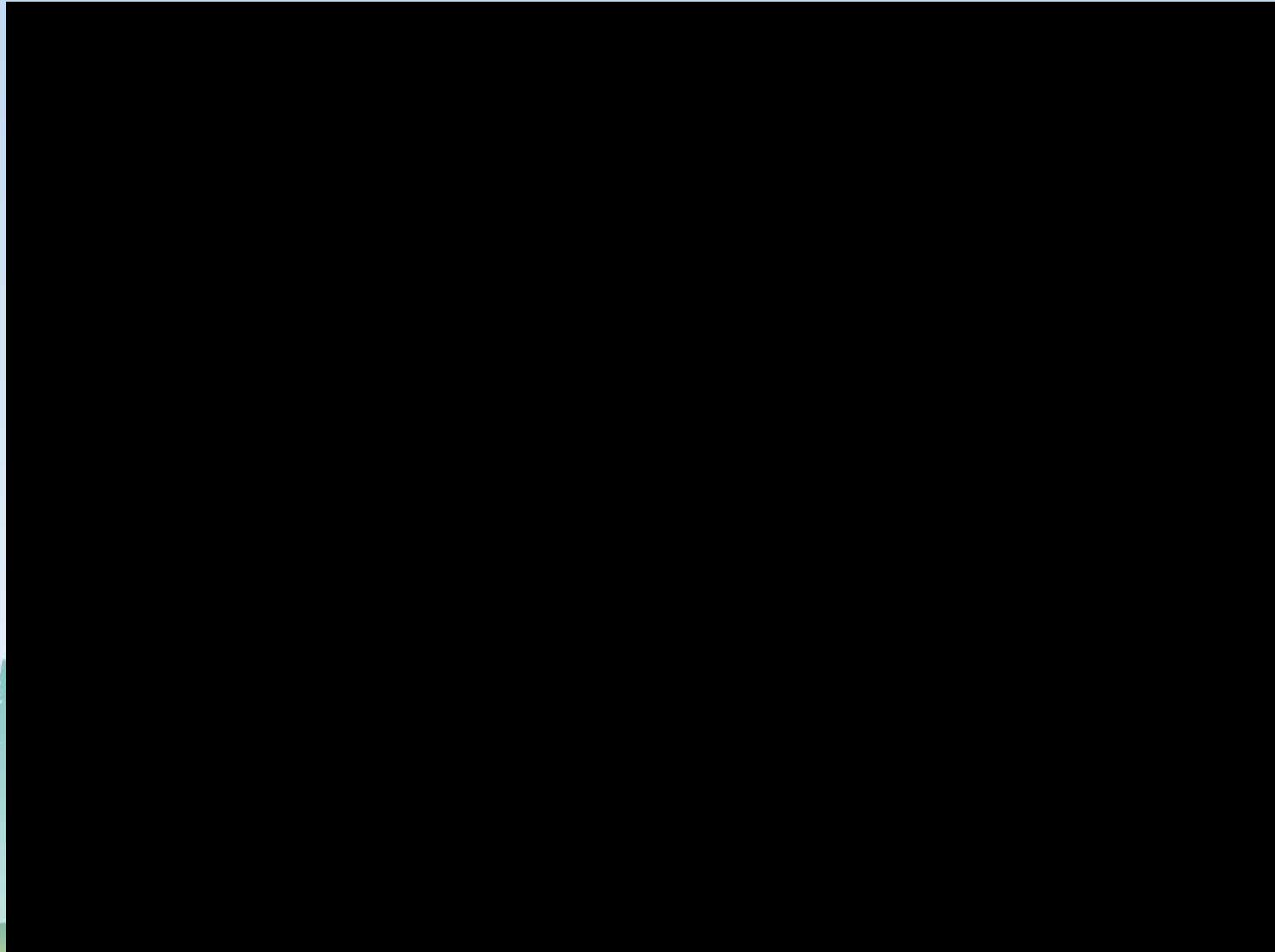
Reclamation Objective

- Meet 2010 Forest Reclamation Criteria
- Satisfy landscape, soil and vegetation requirements
- Established a desirable plant community based on the surrounding ecosite
- Woody stem count > 2000 stems/ha
- Reclamation certificate

Tree Salvage



Salvage



MSL Recontour



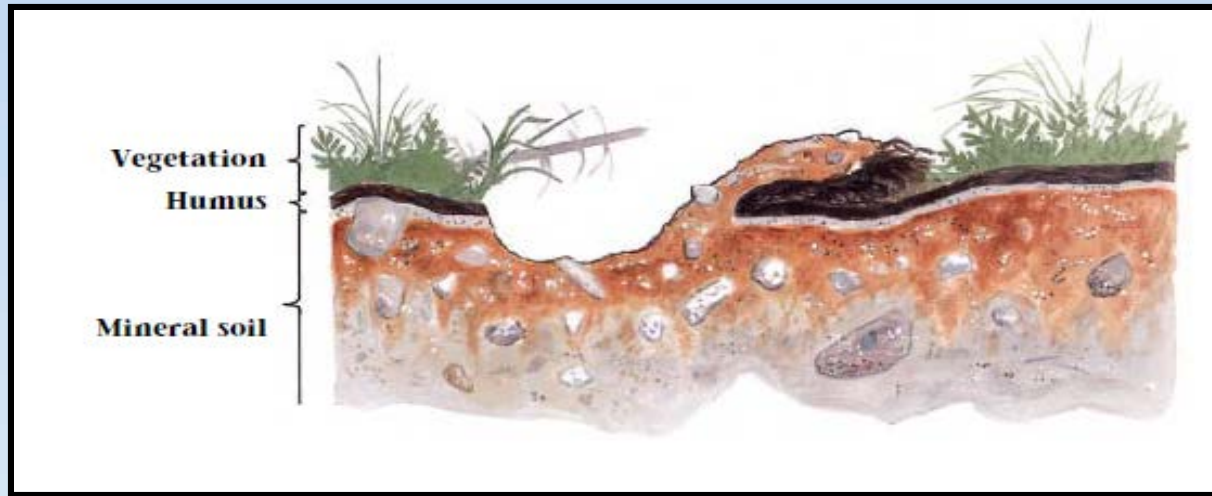
LOC Recontour



CWD Distribution



Site Preparation: Mounding

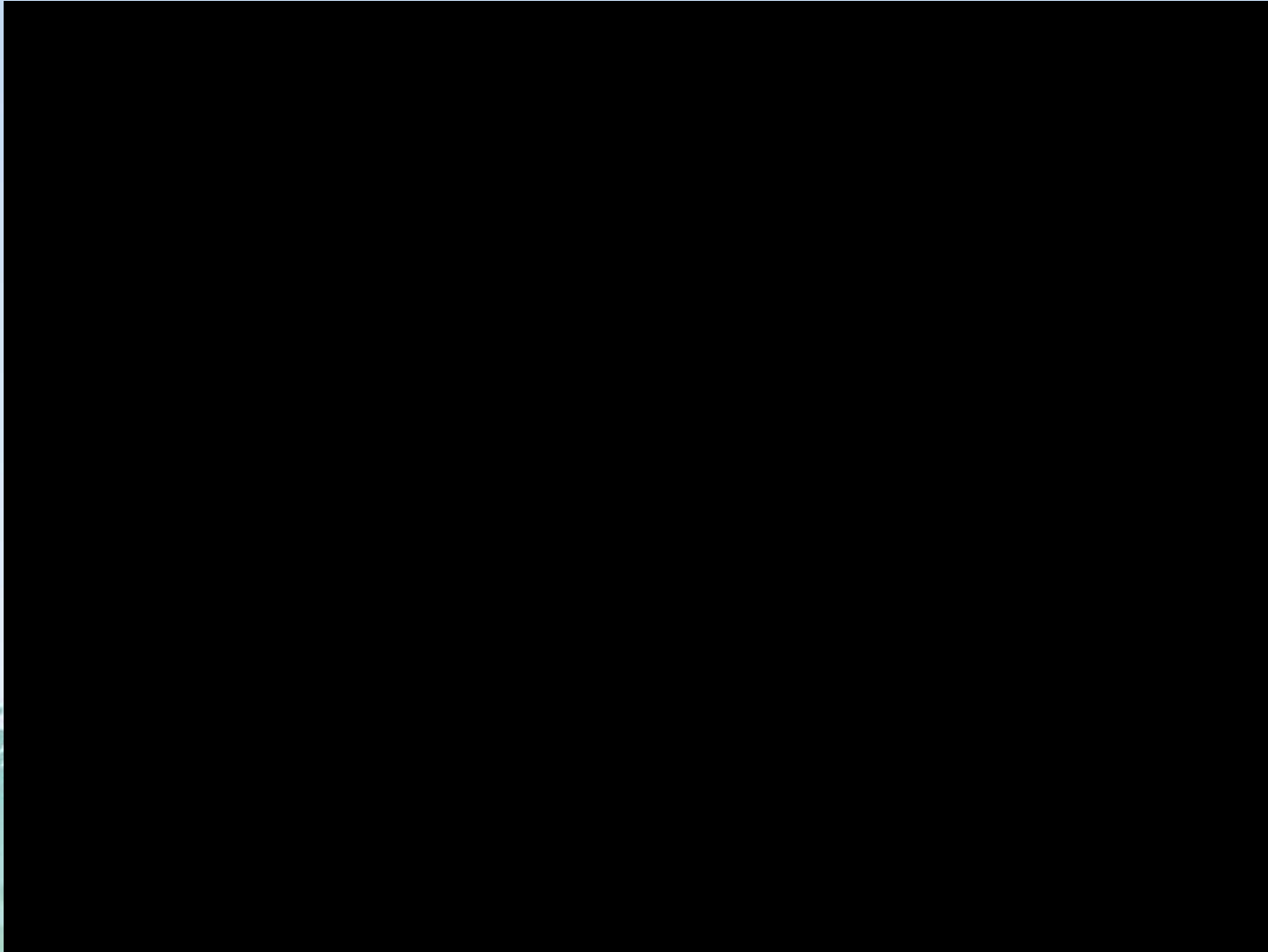


- Microsite creation
- Seed beds
- Availability of nutrients
- Increased soil temperatures
- Less competition
- Decrease bulk density
- Decrease frost damage
- Decrease water logging

Mounding



Mounding



Mechanical Site Preparation



Disc Trenching

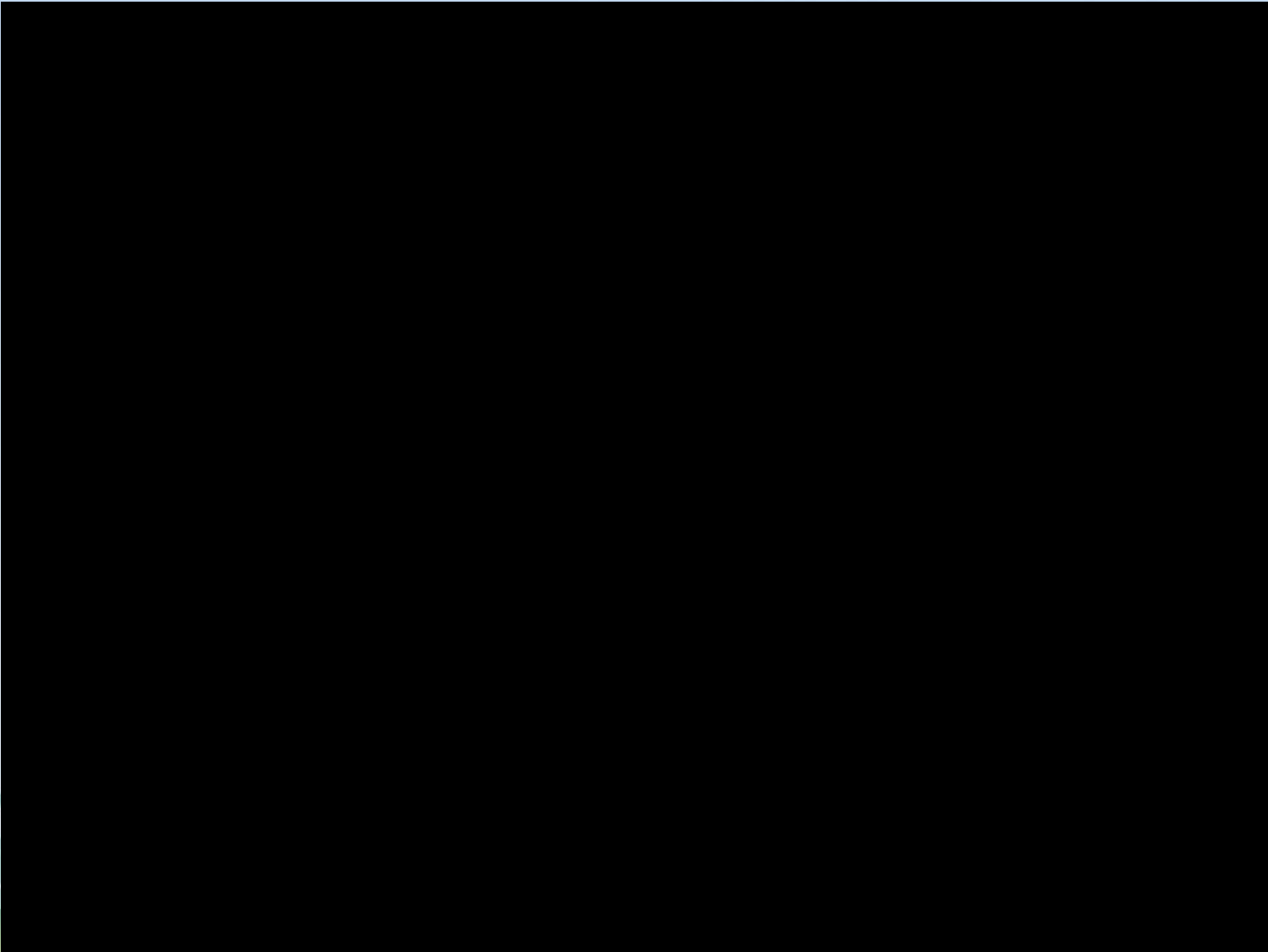


**Terra Tech
Mounding**

Salvage Tree Planting



Salvage Tree Planting



Snags



Bridge Removal



Seedling Tree Planting



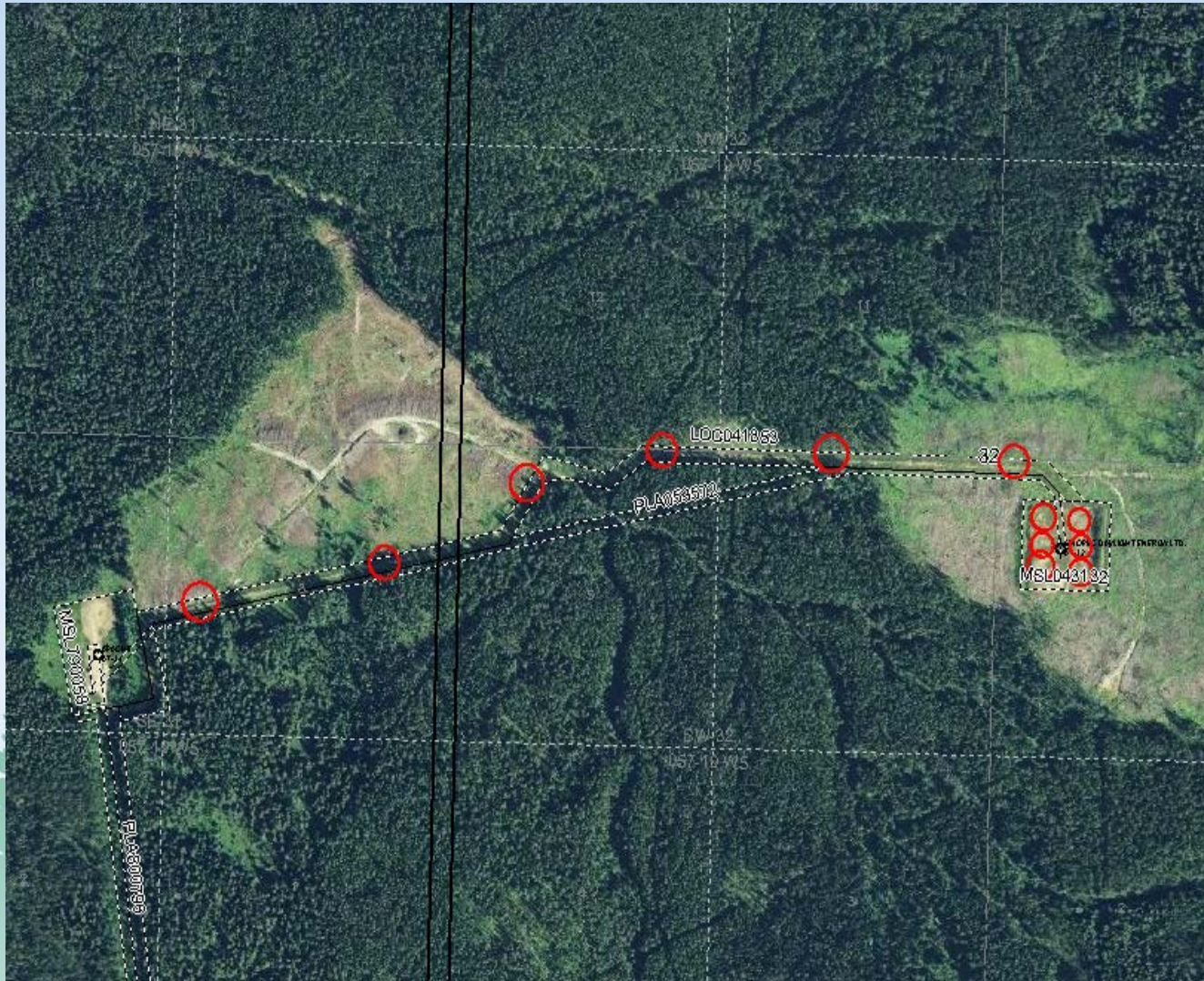
MSL Aerial



LOC Aerial

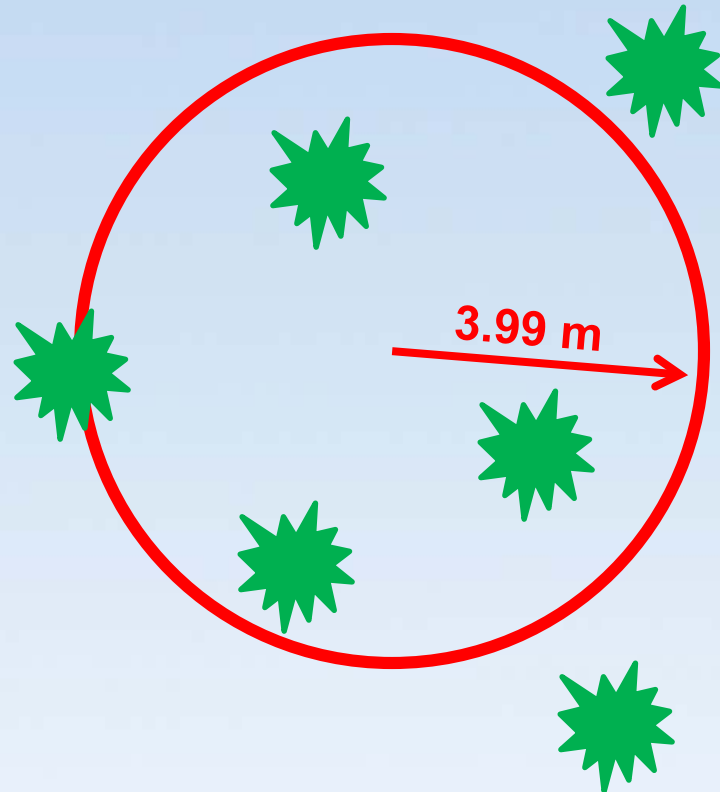


Silviculture Survey



Silviculture Survey

- Circular Plot
- $R = 3.99 \text{ m}$
- $1/200 \text{ ha}$
- 50 m^2
- 6 plots/disposition
- Tree count = 167



Silviculture Survey

Measured Parameters Included:

- Disposition
- Slope (%)
- Aspect
- Plot position on slope
- Topsoil depth
- Soil texture
- Tree species
- Tree condition
- Tree height
- Root collar diameter
- Dieback
- Leader length
- Course woody debris
- Snags
- Cover (%)
- Cover species

Trees



Salvage

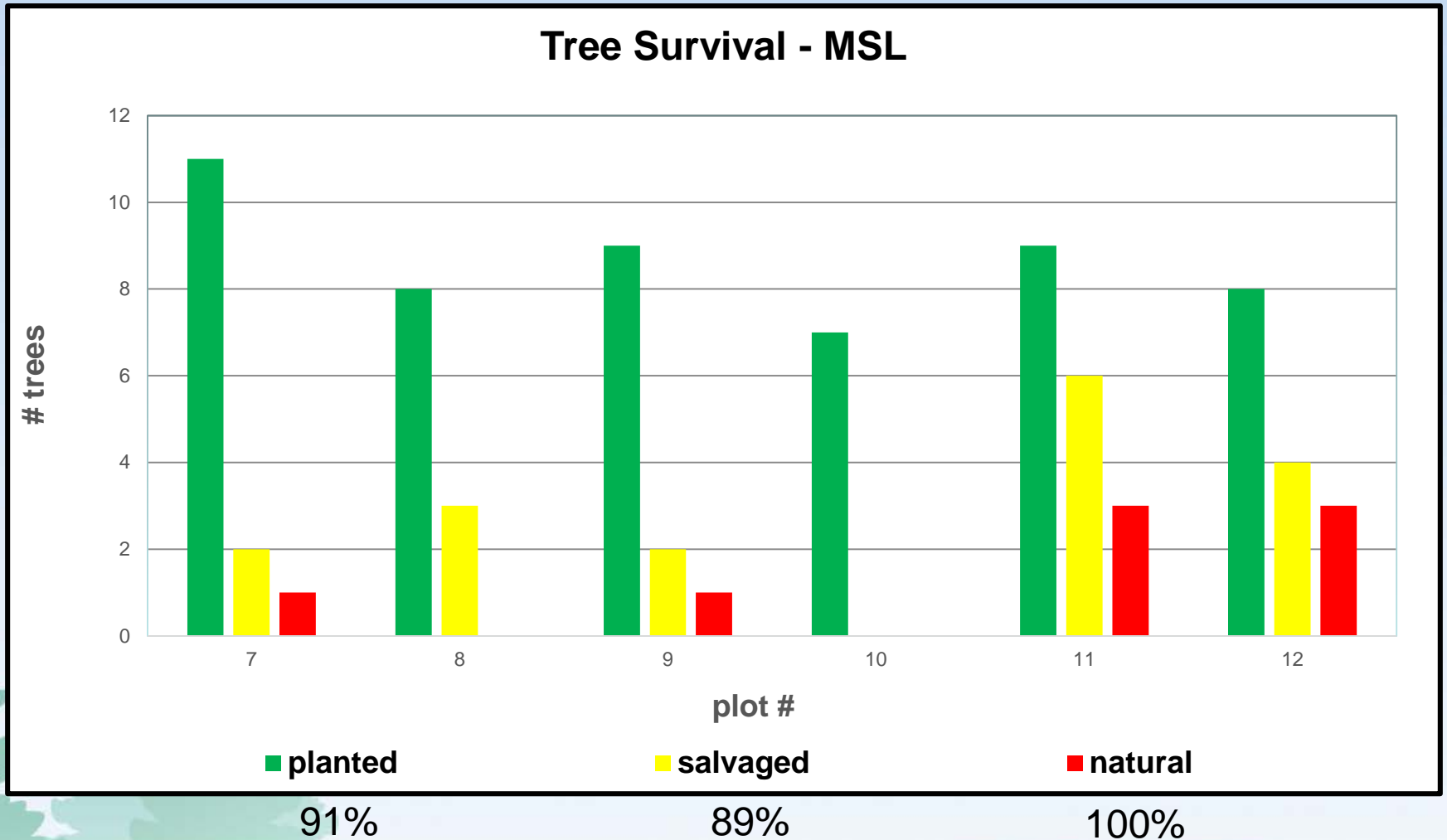


Planted

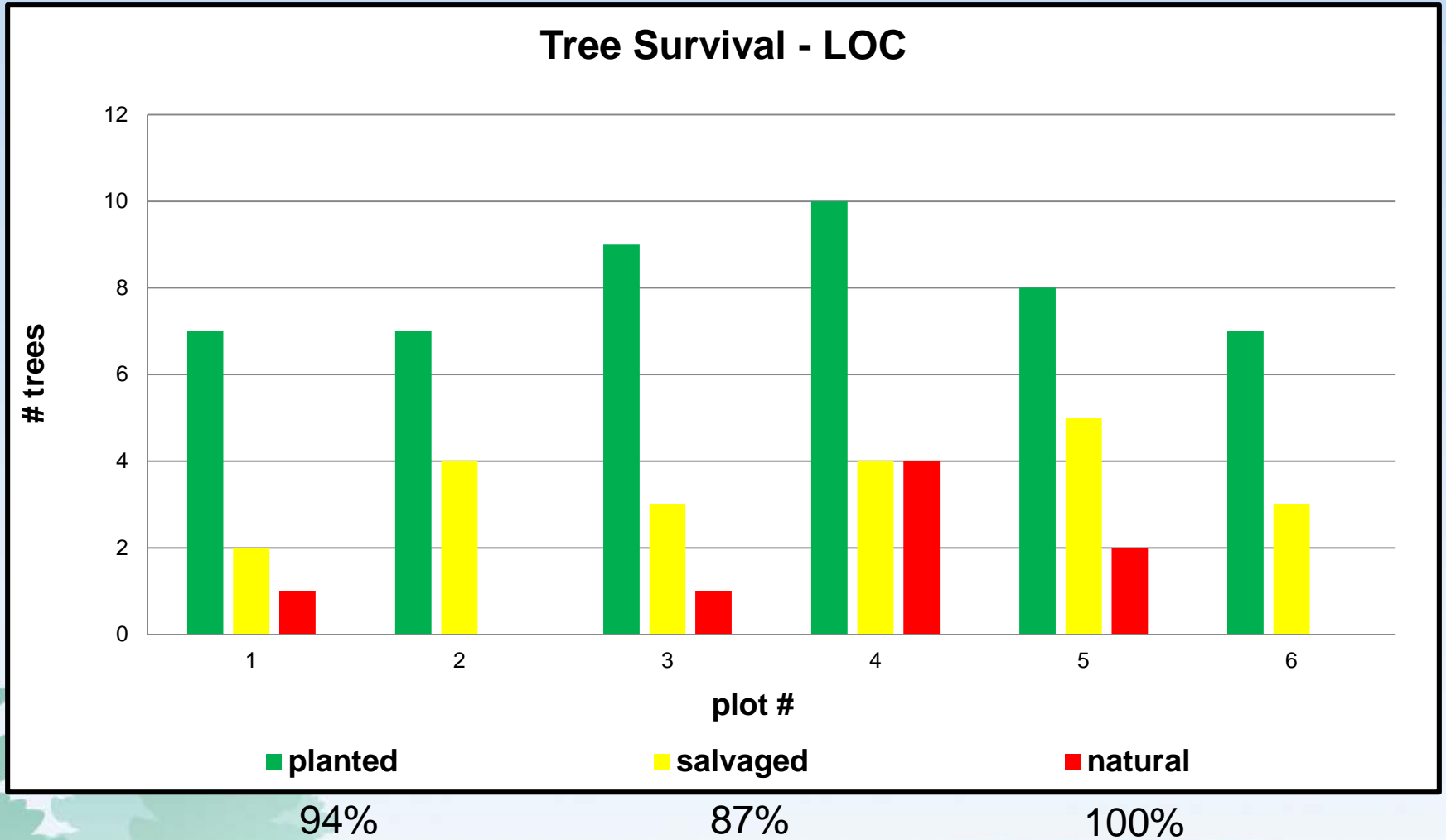


Natural

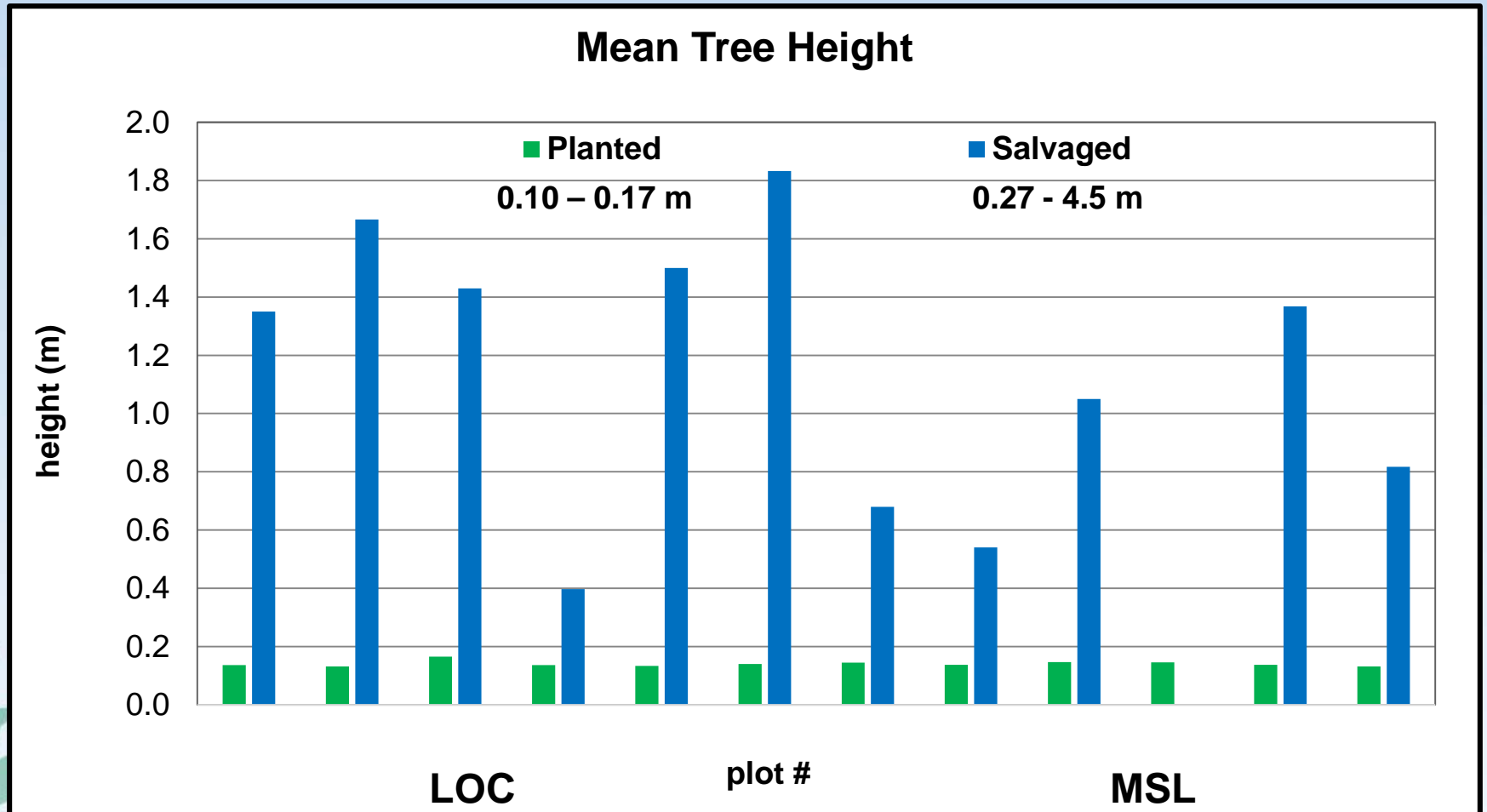
Tree Survival



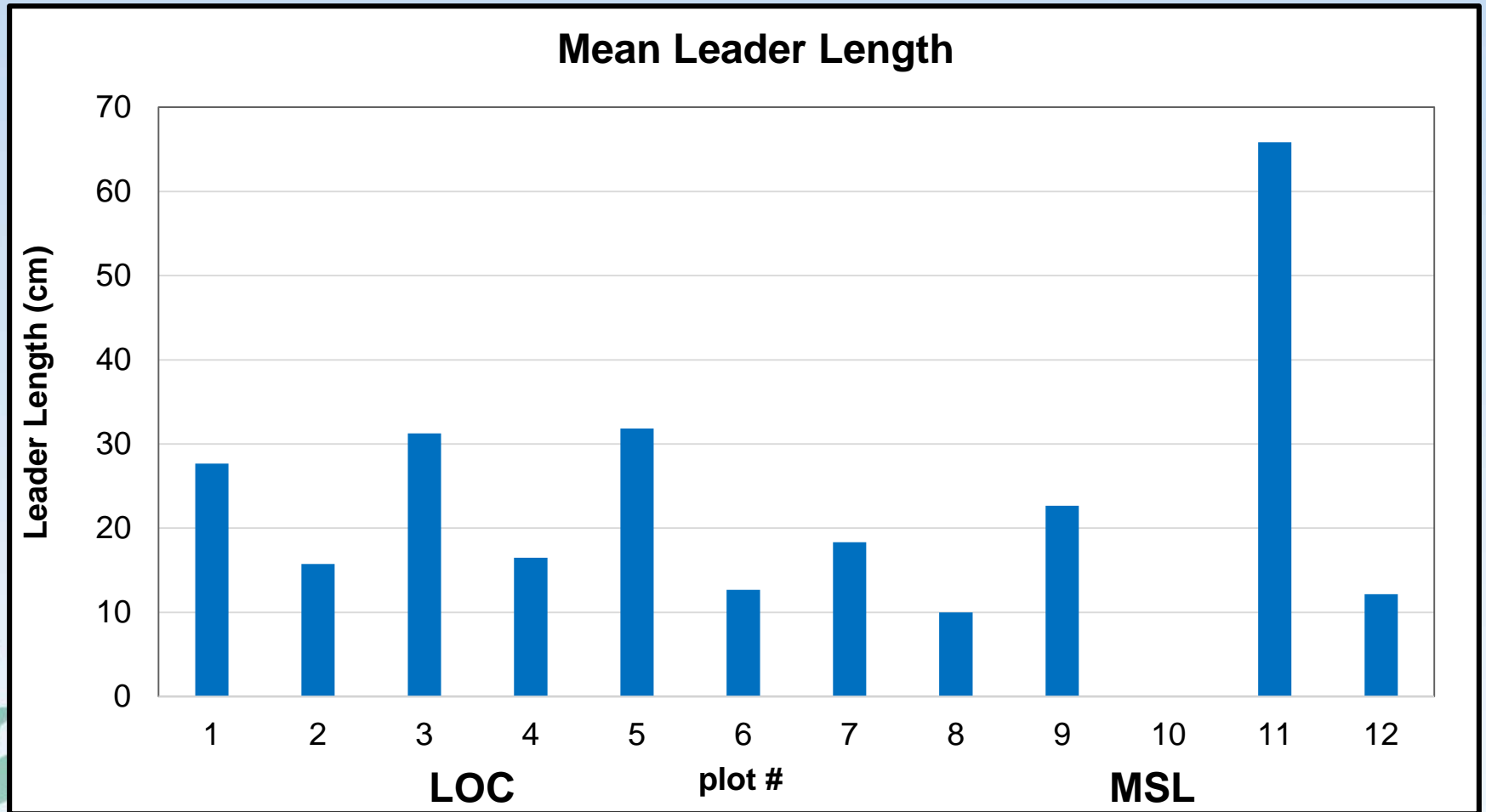
Tree Survival



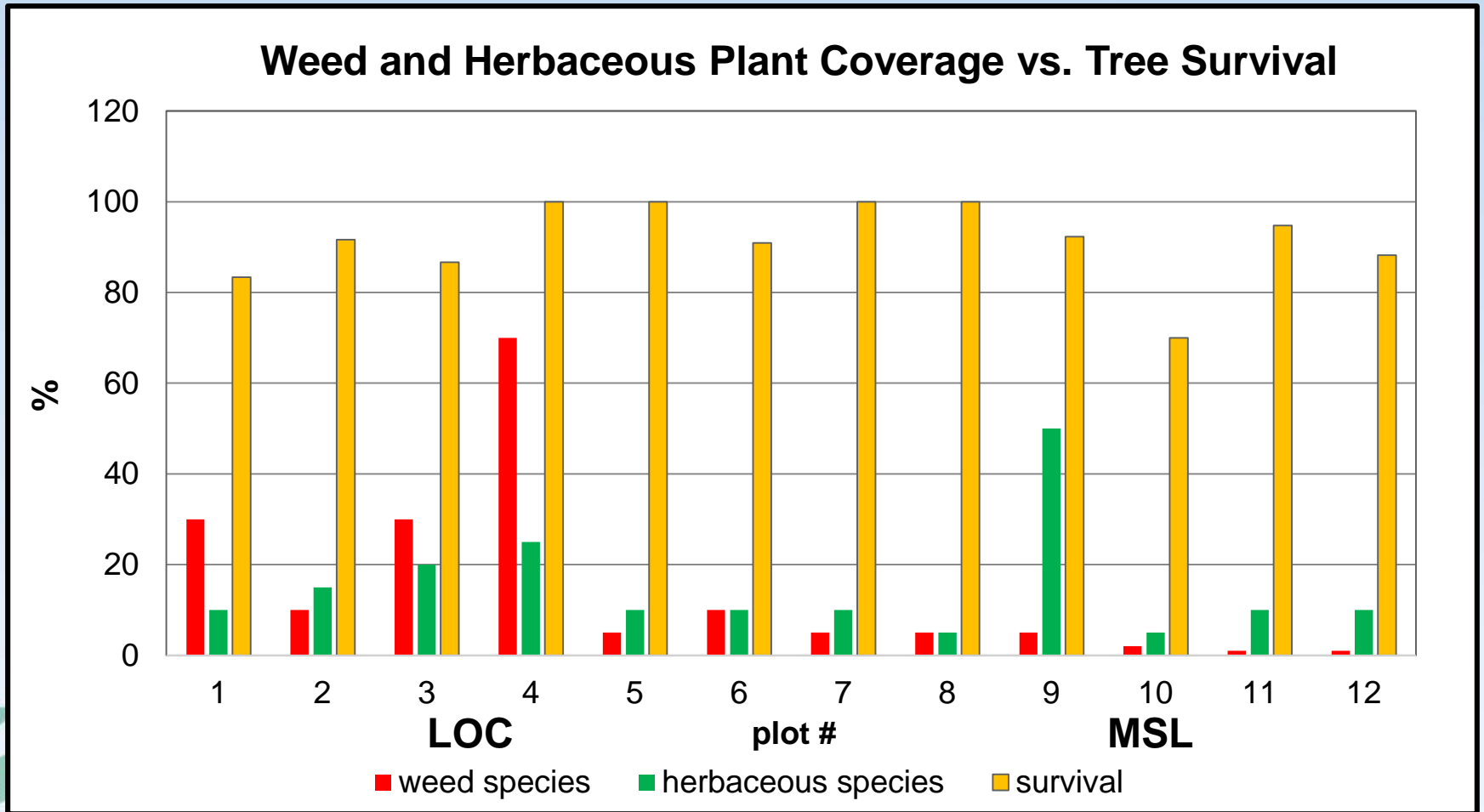
Tree Height



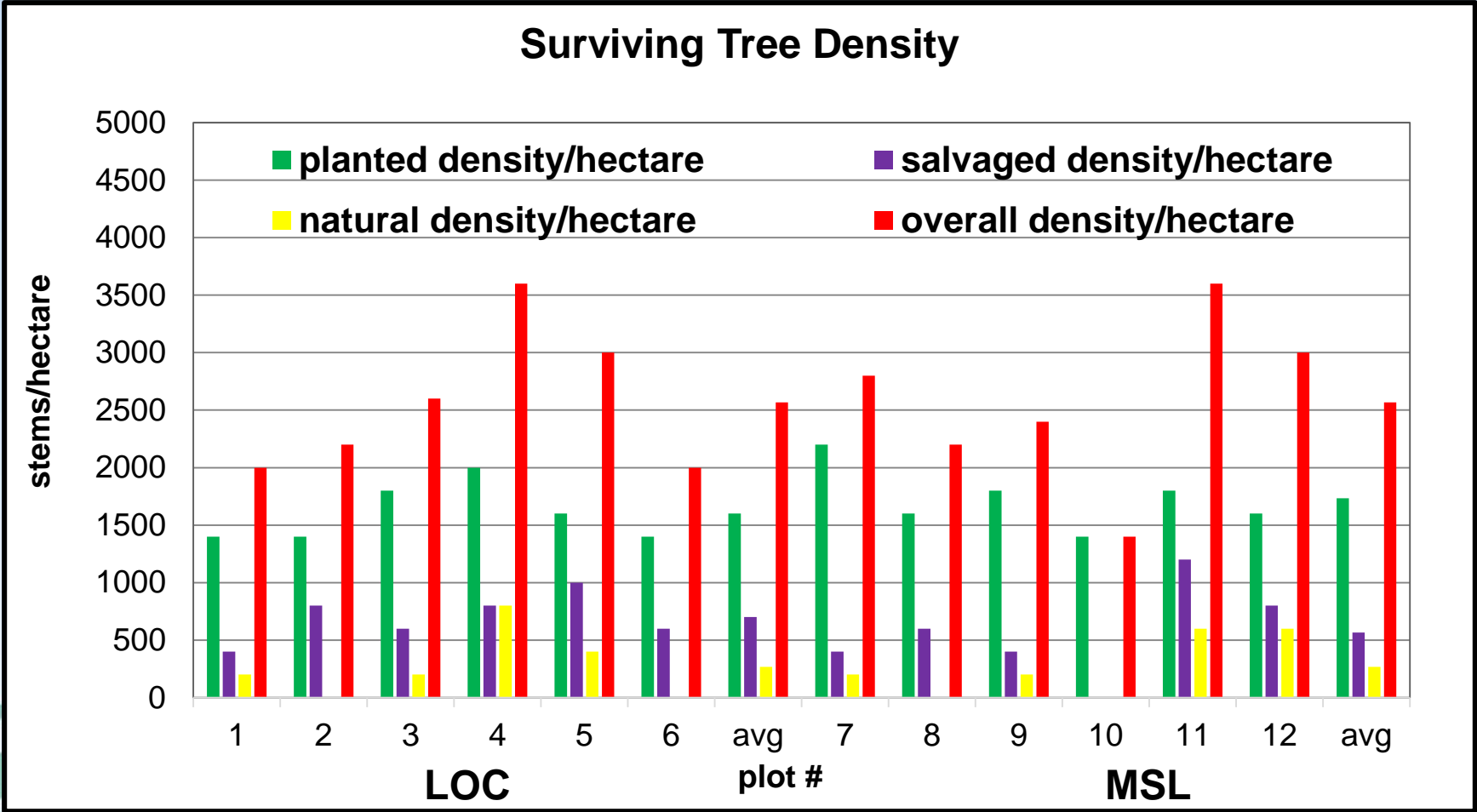
Leader Length



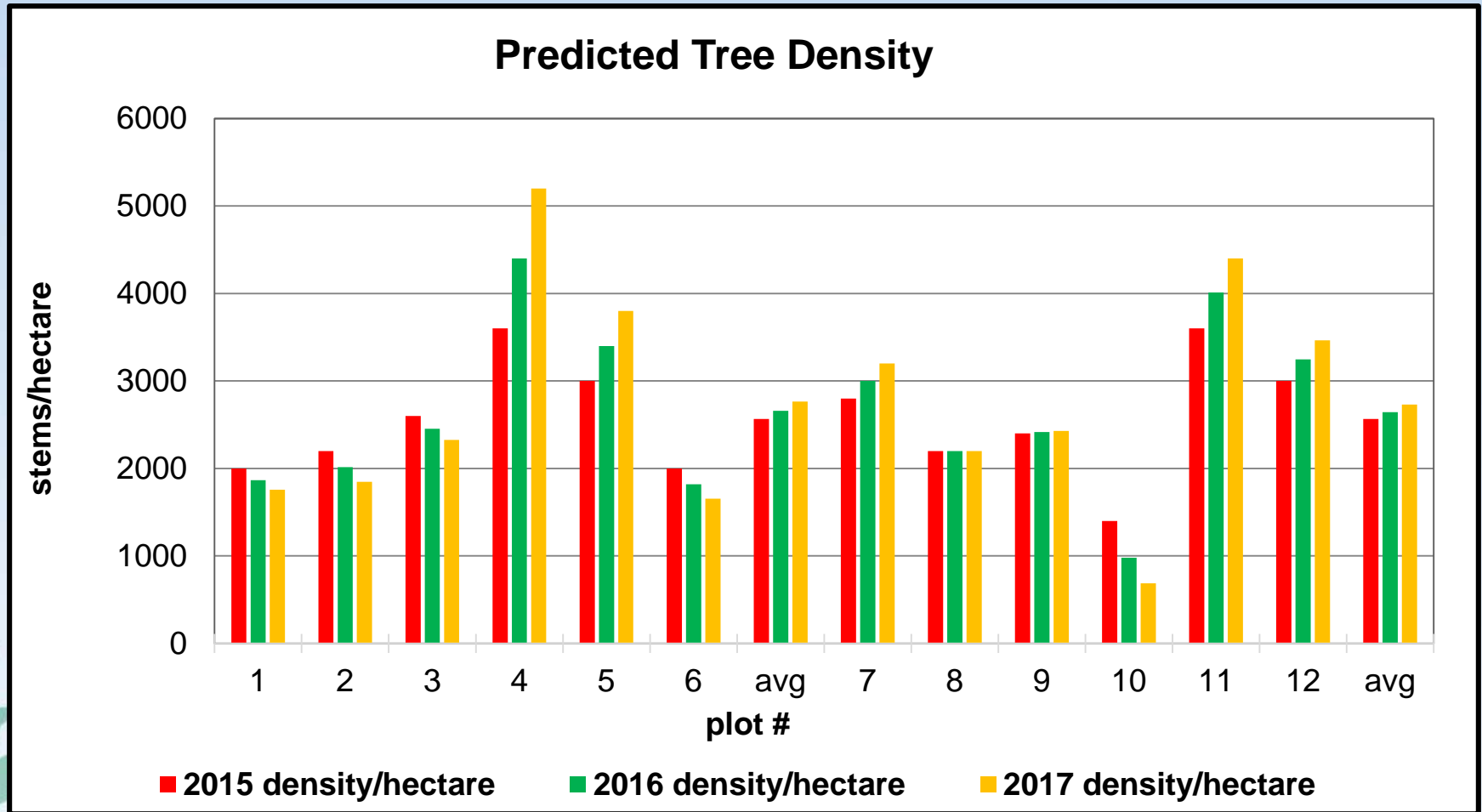
Competition



Tree Density



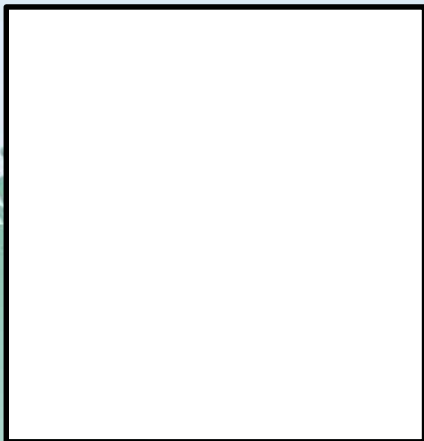
Tree Density Model



Cost Comparison

Salvage Trees

- 3,800 trees
- 633 stems/ha
- Various species
- 87-89% survival
 - \$6.32/tree



Nursery Trees

- 12,000 trees
- 2,000 stems/ha
- Lodgepole pine
- 91-94% survival
 - \$4.10/tree



Implications to Industry

- Species diversity
- Two cohorts of trees
- Salvaged trees are locally adapted
- Decreased plant competition both natural and weeds
- Faster vegetation establishment

Future Plans

- Measurement of second year growth and mortality
- Monitoring ingress of weeds/competition
- Progress herbaceous ingress
- Estimating the role of natural tree ingress
- Application to other dispositions and ecosites

Questions

