Nursery Practices and Planting Stock: Aiming Towards Rapid Early Growth, Faster Establishment and Better Survivability

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IFA NURSERIES, INC.®

Regeneration success depends largely on seedling quality at the time of planting and matching stocktype to environment. If you don’t have a quality product your growth and survival will suffer.


Crash
Course
in seedling
quality

Seedling handling

- Water status of seedlings
  - Survival in the month immediately after planting depends on the 'base' water stress of the plant when it reaches the site, the conductance of existing roots and the rapid extension of new roots to link up with soil matrix
- Importance of moist roots in the bag and not allowing them to dry during storage and planting

Seedling handling (cont)

- Seedlings where their roots were exposed to air for <2 hours had reduced survival (reduced by 1/4) and shoot extension (reduced by 2/3) compared to the untreated control.
- Once roots have been desiccated there is a permanent reduction in permeability
- Root damage → direct impact on water uptake
- Negative feedback loop when insufficient root conductance causes reduced photosynthesis which in turn causes depletion of carbohydrate reserves in the plant, inhibiting new root growth

*Coutts, 1981

Seedling handling (cont)

- **Refrigeration 101**
  - **Cold damage during storage (particularly to exposed fine roots)**
  - **Carboyhdrate loss or ethylene buildup during storage, particularly if temperatures aren't kept low**
  - **Rapid pathogen buildup during storage at temps above $37^{o}F$**

Seedling handling: Cold storage and desiccation

Deans, Lundberg, Tabbush, Cannell, Sheppard and Murray. 1990

- **Desiccation and rough handling had impacts on growth and survival through year 3 in the field**
  - **Carefully handled, non-stored control survived at 90%**
  - **Carefully handled trees with desiccation dropped to 77% survival and lost 20% of growth vs. control**
  - **Roughly handled trees with desiccation dropped to 27% survival and lost 30% of growth vs control**
- **Cold stored trees were more tolerant of maltreatment than plants lifted directly from the nursery and planted, though they still showed significant detriment from rough handling and desiccation.**
  - **Cold storage with careful handling and no desiccation reduced RGP by 18%; adding desiccation reduced RGP by 67%; adding rough handling reduced RGP by 85%, decling markedly during the first month in storage.**

Seedling handling review: cold storage

- Carbohydrates deplete over time, accelerated by heat, lack of light, ethylene buildup
- Pathogen buildup and damage to roots and foliage
- Temps of 95-102^{o}F have been measured in bags after 1 hour of exposure to direct sunlight on warm days (Tabboush, 1987)
- Pathogen growth rates are controlled by temperature and some can develop very rapidly at 50^{o}F and above (phythium is one of the fastest).

Nursery practices

- How do nurseries improve quality and growth?
  - Culturing their roots
    - Undercutting
    - Improved farming practices
    - Wrenching
  - Carful handling
  - Knowing what your customer wants, their site characteristics
  - Understanding of various stocktypes and how they fit different sites and environments

How do you decide?

- Use the Target Seedling Concept
  - Seedling quality is determined by outplanting performance not the best looking tree
  - The idea that the best seedling is the one that is the best adapted for it's purpose (site conditions)

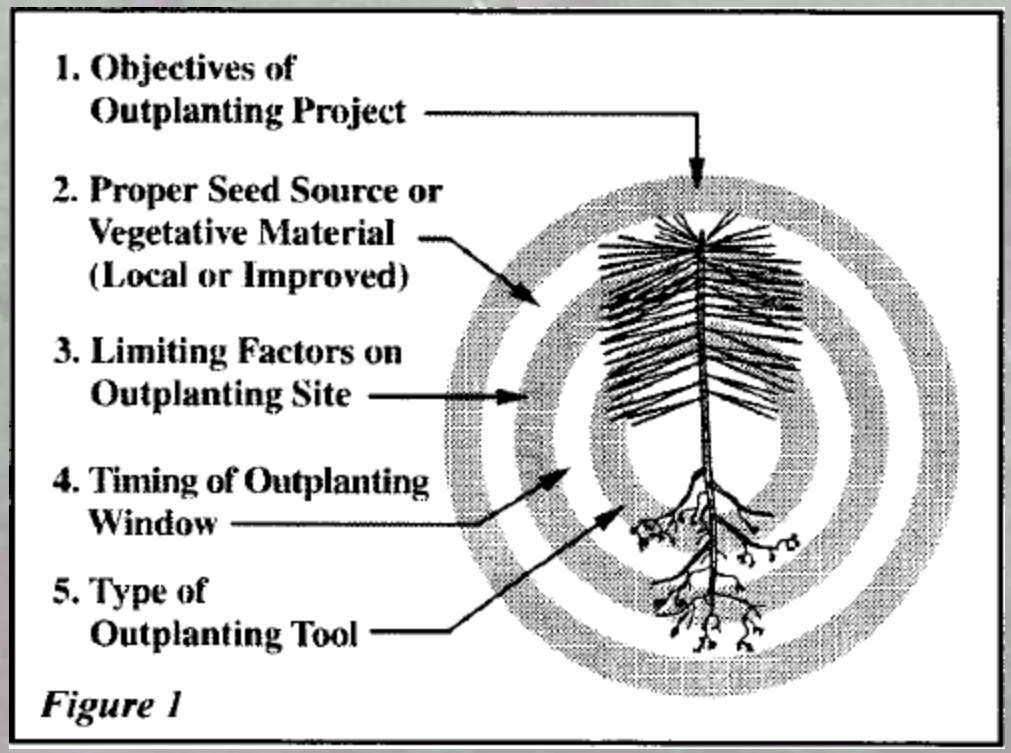
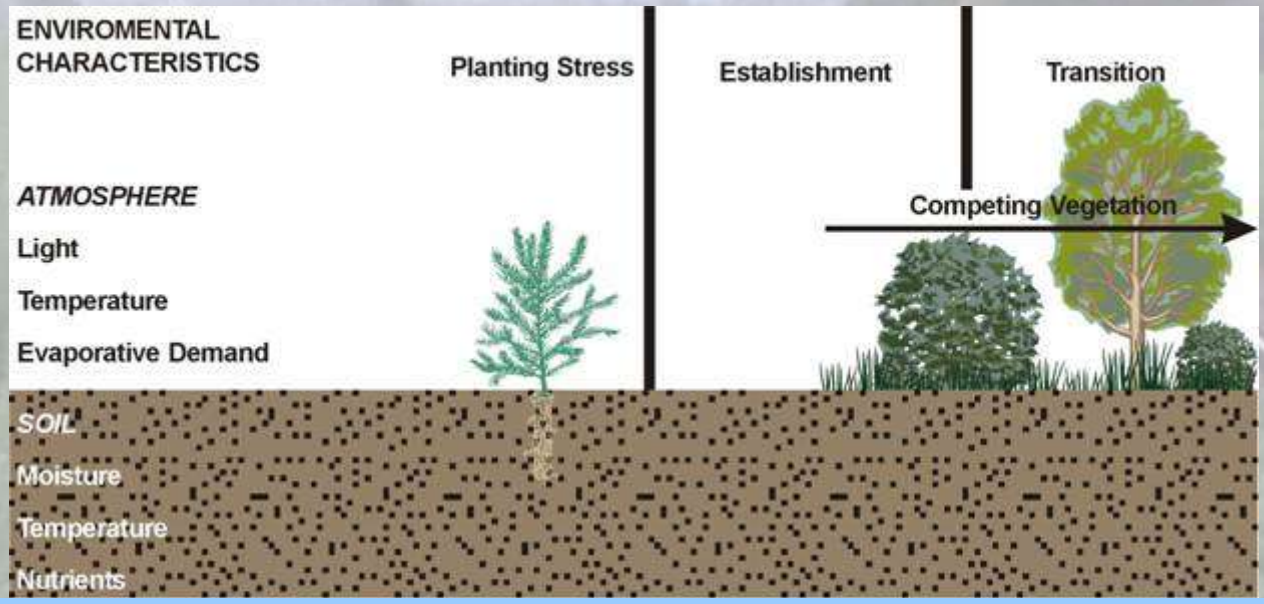


Figure 1

The Forest Regeneration Process



Avoiding post-planting stress requires coupling of seedlings to the site.

- *Shoot & root volume*
- *S/R ratio ~ balanced seedling*
- *Overall size*
  - *Ridges – smaller seedlings*
  - *Valleys – larger seedlings*
  - *Coastal vs. inland*
- *Soil & moisture conditions*
- *Browse, disease, competition considerations*

Microenvironments

Special Conditions

Site Preparation

Species Selection

65% survival 36%

STOCKTYPE SELECTION: DOES IT REALLY MATTER?

ABSOLUTELY!

- Success depends on matching stock types to:
  - Site conditions (soils, climate, animals, etc.)
  - Site preparation intensity
  - Potential future gain
  - Budget

- Make sure you are getting the best possible tree for the value.

Qplug + 1

415B

515A

NTC 2006 annual meeting

Bareroot stocktypes

- 2+0 = two years same location density
- 1+1 = One year in the seedbed, transplanted and grown for an additional year at lower density
- P+1 = Small plug grown in a greenhouse for 4-6 months, then transplanted either in fall or spring into a transplant bed for an additional 10-17 months.
- 1+0 – On year old seedling usually reserved for transplanting but in some cases can be outplant stock (i.e. red alder, other deciduous).

Container stocktypes (Cont'd)

- P-0 (1-year old)
  - Most often grown in Styroblocks with varying cell sizes
    - Metric
      - Diameter X Depth in cm (415A)
    - Capacity
      - Approx. Cubic Inches (e.g. 6A=5.8 C.I.)
  - May be large cells for outplants (S15, S20)
  - Or small cells for transplanting (S2-S6)
- P-P transplants (2-years old, sometimes 18 months)
  - Small cell transplanted into a larger cell
- Other container types
  - Q-Plugs with polymer media and transplanted - 12-18 mo. tree
  - Leach cells are individual containers placed into a holding block

www.stuewe.com

Best of Both

- Plug-1's
  - Spring or fall transplanting
    - Spring smaller - mitigate risk during 1+0 year
    - Fall large - has two root and caliper growth seasons for one height
  - Low density – increase spacing between plants allows for more lateral branching, more caliper growth
  - Uniformity
  - Reduced crop risk
  - More customization (2A, 3A, 4A, ST4, ST6)
  - Very hardy – shutdown early , no frost risk
  - Improved physiology

Every stocktype has varying characteristics

- Physiology
  - Nutrient composition
    - NPK balance
    - Minor elements
  - Hormone levels
    - Dormancy
    - Frost hardiness
    - Phenology
  - Transpiration
  - Photosynthesis =>Growth
- Morphology
  - Shoot/Root ratio
  - Height
  - Caliper
  - Root structure
  - Branching
  - Bud count
  - Needle size
  - Stem form
- Survival

Advantages

- CONTAINERS
  - One year crop
  - Controlled environment
    - No risk of frost damage
    - Fall or winter plant
  - Soilless media (w/ CRF)
  - Early dormancy (BO)
  - Easy/inexpensive planting (maybe)
  - Reduced transplant shock
- BARE ROOT
  - Instant forest
  - More animal fodder
    - larger
  - More tree for the money
  - Large caliper
  - Fibrous roots
  - Custom growing
  - Better branch architecture
    - More buds
  - Very hardy

Disadvantages

- CONTAINERS
  - More susceptible to severe animal damage
  - Slower “greenup”
  - Smaller caliper
  - Less lateral branching
  - Sanitation costs
  - Seed usage
  - Frost heaving
- BARE ROOT
  - More difficult to plant
  - 1-0 crop vulnerable to frost
  - Shipping & handling costs
  - Narrow planting window
  - Exposed root system
  - Transplant shock
  - Only winter plant

Cost & size considerations

- Bare root 1-1
  - $280-$300 per M — 14-28” X 6-12 mm
- Large plugs for outplant
  - $350-$380+ per M — 10-16” X 3-5 mm
- Plug-1
  - $320-$350 — 14-28” X 6-12 mm

Costs vary by plug size, transplant season & density

Price vs. size

	S-8	S-15	S-20	P+1	1+1	FP+1
% Height gain	0%	14%	20%	25%	22%	35%
% Price Increase	0%	38%	73%	21%	12%	26%
$/acre	195	269	338	236	306	246

Which stocktype do I need?

Probably several

Use all of your available tools

Match the right stocktype to the site

Consider costs and long range objectives

Things to consider when choosing stocktypes…

What season should I plant in?

Aug. 17 – Jan. 10

Coastal site

Winter/Spring Planting

- Advantages
  - Adequate soil moisture
  - Low risk of high temperature and low RH damage
  - Deepest dormancy and stress resistance

- Disadvantages
  - Need for cold storage; stored carbohydrates decline
  - Seedling flush may coincide with soil moisture deficits and high temperatures; especially at high elevation sites

Krumlik 1984, Scagel 1990

Fall Planting

- Advantages
  - Active roots and dormant shoots
  - Extended planting windows
  - Warm soils for root growth
  - Little or no storage necessary
- Disadvantages
  - Inadequate soil moisture
  - Potential for damage due to early frost
  - Potential for increased animal damage

Krumlik 1984, Scagel 1990

At high elevations maybe fall planting is the best choice

- Early spring planting is often not practical because access to sites may be restricted by late snowmelt or plowing may be necessary
- Rapid loss of soil moisture upon snow melt in early spring due to shallow volcanic soils

So what does all of this mean for the practitioner?

- There is no silver bullet
  - Do your homework – identify what your site characteristics are
  - Choose a stocktype that meets your short and long-term goals
  - Don’t be hung up on trying to make one stocktype work everywhere
  - Get creative, talk to your nursery, try new ideas
  - A

– If you do all that right…

THE END RESULT!!!

Nurseries have quarantine pre-shipment requirements before we can ship any product to customers

- QPS certifies our stock as free from pests like
  - Diseases
    - Fusarium
    - Pythium
    - Cylindrocarpon
    - Phytophthora
  - Weeds – state, national, international noxious weed lists
  - Nematodes and other undesirable pests

Pythium caused damping-off

Water management is critical to controlling Pythium borne disease. Fall rains and frost protection further exacerbates this issue.

Photo from OSU BOT 415 website

Seedling losses by Fusarium

Photo from OSU BOT 415 website

Phytophthora Root Disease – Bareroot Douglas-fir

Photo from OSU BOT 415 website

Cylindrocarpon on western hemlock

How do we control pests?

- **Fumigation**
  - **The use of fumigation is the primary way we control the spread of disease and weeds**

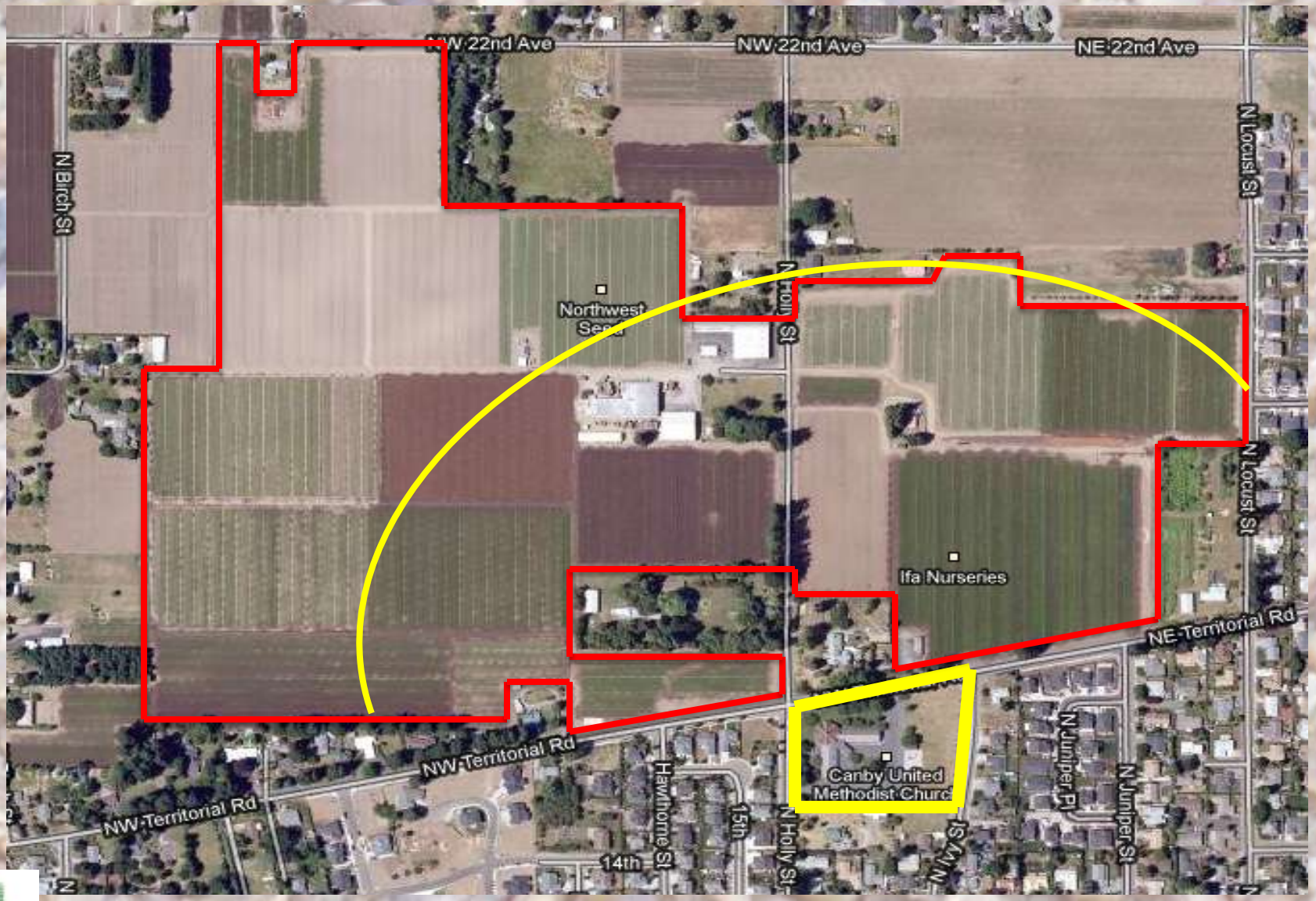
New EPA RED's

- Buffer zone's – increased cost due to loss of production ground
- Respiratory Protection for handlers – increased cost to have fitness testing and purchase equipment
- Posting requirements – posted signs around application fields notifying public
- Good Agricultural Practices – good farming practices and proper soil moisture
- Fumigation management plan – record keeping
- Community outreach – neighbor notification
- Many more…

IFA Nursery, Canby OR

Nursery main site property line

Pre school/church: ¼ mile no BZ credits available:
loss of 40 Acres



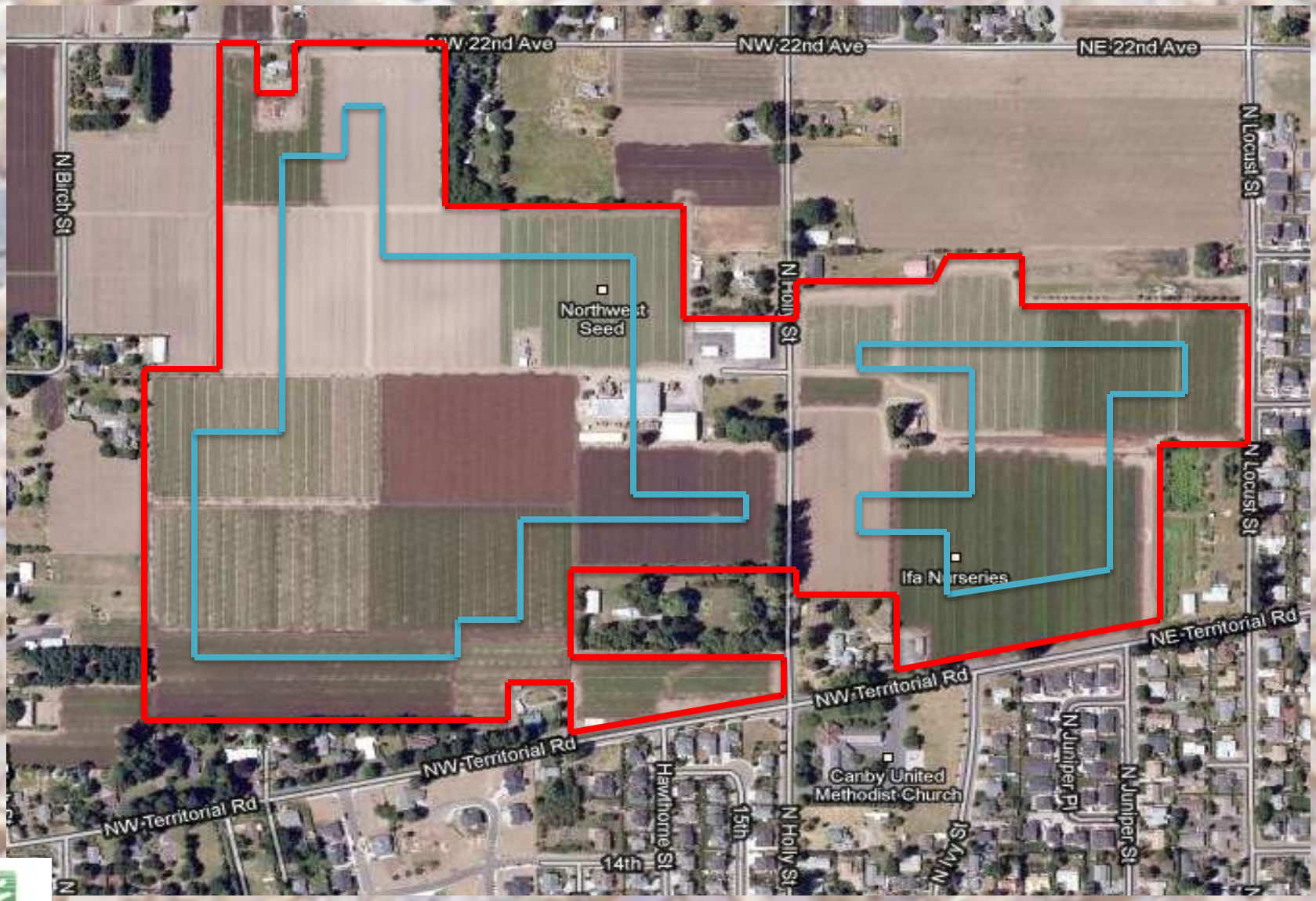
Difficult to evacuate sites; have a 36 hour re-entry period after application

Rates and buffer zones

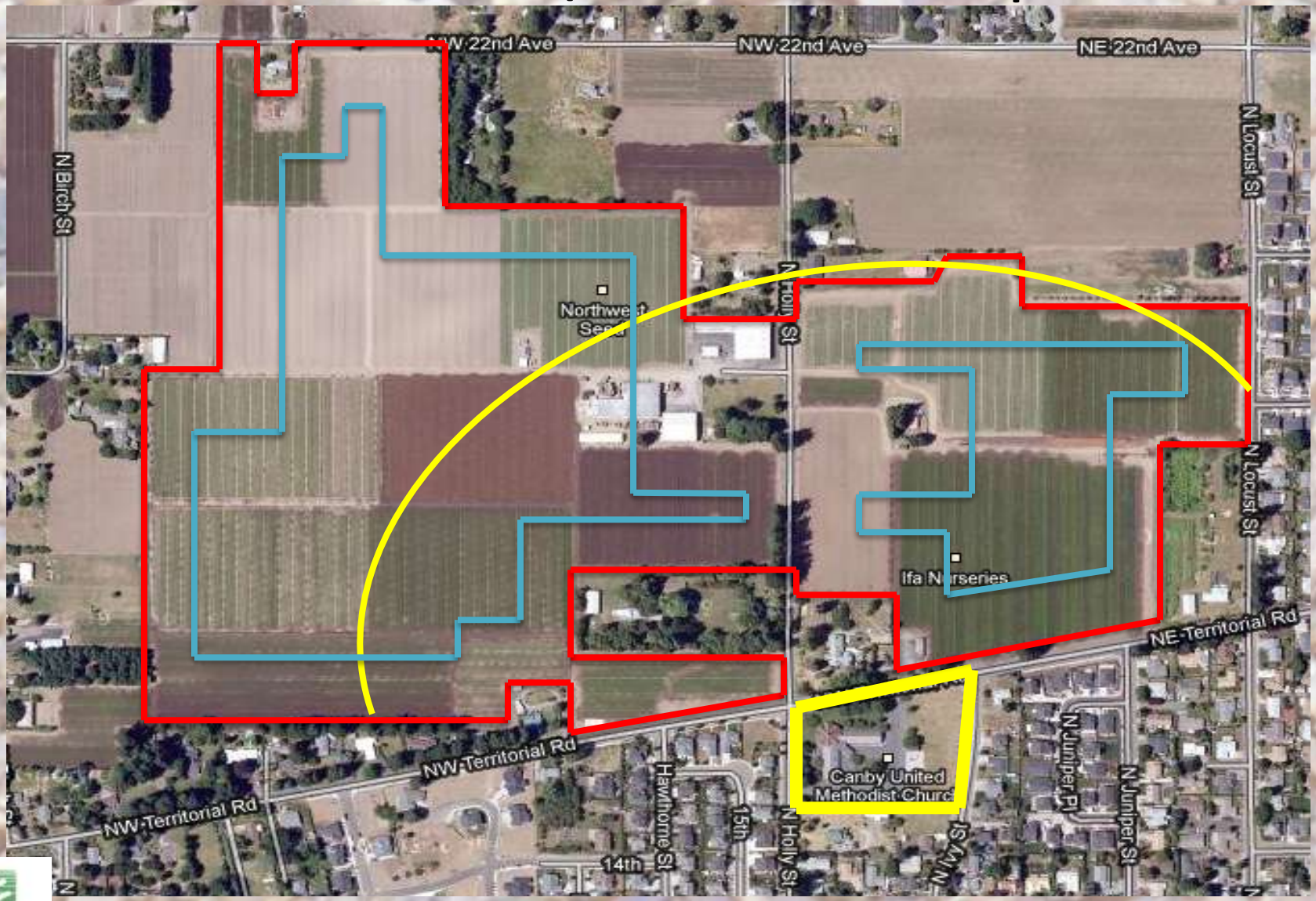
	ACRES	20	10	10	5
	LB/A	300	350	300	240
LB/A	MB	150	235	150	120
	CP	150	116	150	120
BUFFER ZONE	MB	145	300	95	25
	CP	**450**	**100**	**250**	**100**
CREDITS	VIF	40%	40%	40%	40%
NET BZ	**with VIF**	**270**	**180**	**150**	**60**

No fumigant applications will be permitted within ¼ mile of a difficult-to-evacuate site (school, daycare, church, etc) unless the site is not occupied during the application and the 36-hour period following the application.

150’ buffer MB/CP 50/50 with VIF credit = 42 ac loss of production space
50% loss acres/trees = 100% loss of profit – nursery will close



150’ buffer and ¼ mile buffer = ~61 ac loss of production space
70% loss of acres/trees – 100% loss of profit



EPA comments

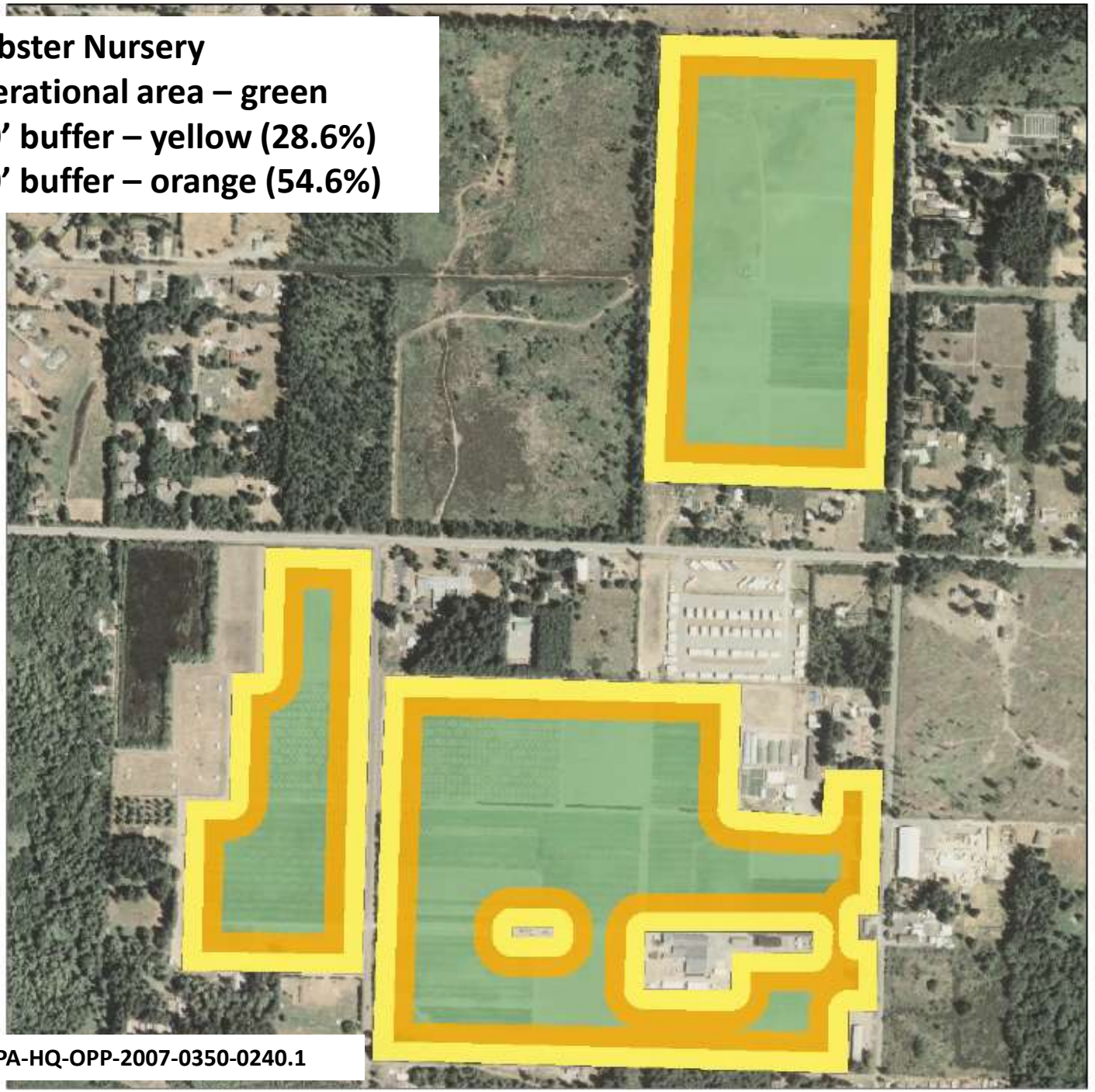
	Acres Impacted (%)		
	100' buffer	300' buffer	500' buffer
Aurora Loss	12%	45%	65%
Mima Loss	4%	18%	31%
Wt Average:	8%	30%	46%

	100' Buffer	200' Buffer	300' Buffer
Loss of acres/tree volume	8%	30%	46%
Loss of facility profit	9%	48%	95%

Chuck Masters for Weyerhaeuser – EPA-HQ-OPP-2005-012300404.1

http://www.regulations.gov/search/Regs/home.html#home

Webster Nursery
Operational area – green
100’ buffer – yellow (28.6%)
200’ buffer – orange (54.6%)



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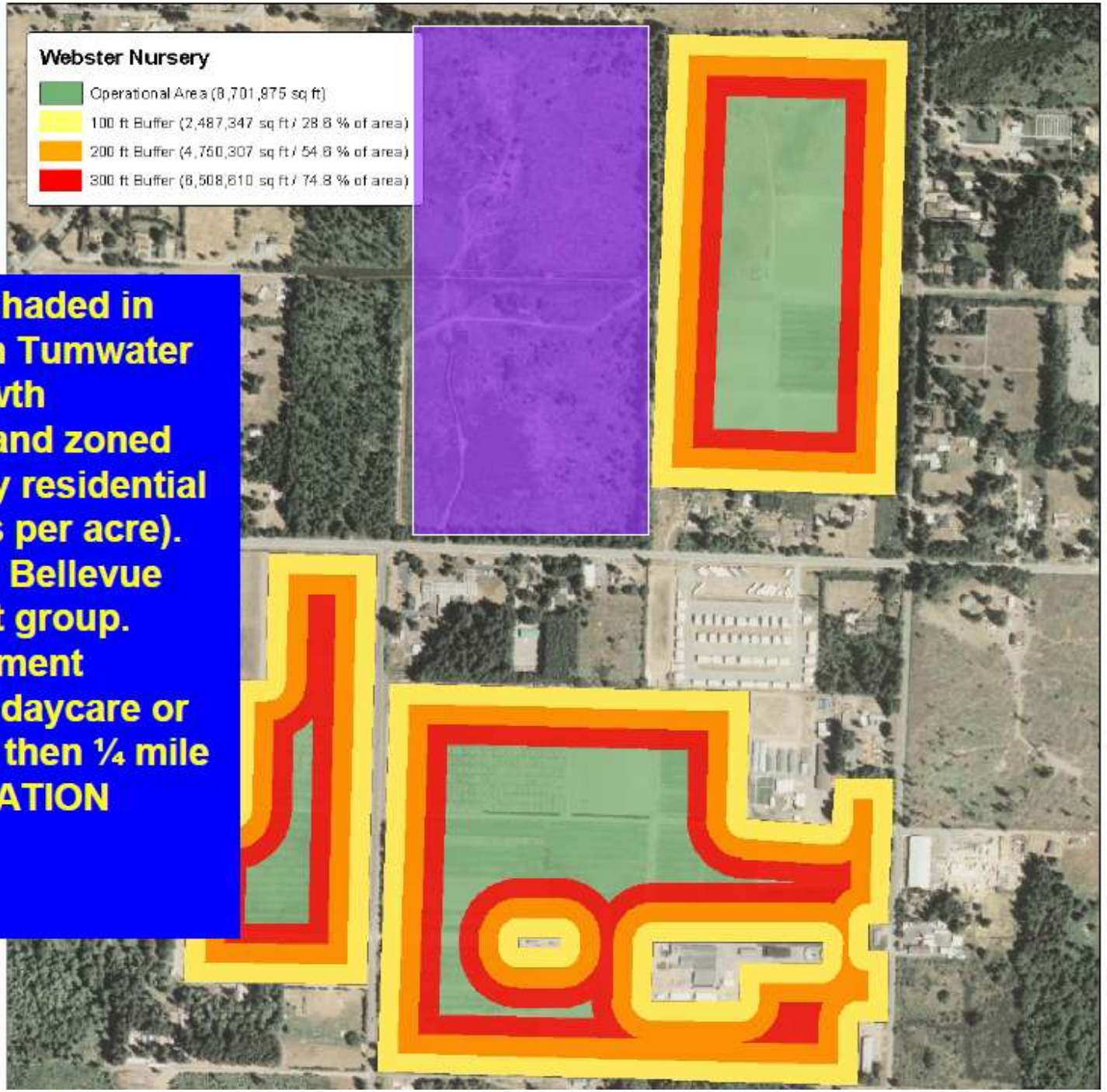

- 80 acres shaded in purple is in Tumwater urban growth boundary and zoned low density residential (5-7 homes per acre).
- Owned by Bellevue investment group.
- If development includes a daycare or elder care, then ¼ mile NO FUMIGATION buffer.

What's the bottom line for seedling quality?

- Seedling quality will maintain high but so will the cost of seedlings if production facilities are limited on crop size and available ground
- Some nurseries will not be able to maintain under current structure and will have to change location or go out of business
- Higher cost for seedlings will in turn decrease the future return on your investments


What will be the
stocktypes of the future?