Managed Aquifer Recharge
– the Right Tool in the Right Place –

Columbia River Policy Advisory Group

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Managed Aquifer Recharge
– the Right Tool in the Right Place –

- A water resource management tool.
- Used around the world.
- Proponents are lining up.
- But obstacles remain in WA:

Clarity needed on:

- **Recoverable quantity** (water right)
- **Water quality** (groundwater protection)

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Recoverable Quantity

How much of the recharged water can be recovered?

(WAC 173-157)

Recoverable quantity = Residual increased storage.

- It's a water balance question.
- Computer models can help.
- Water level data are empirical.
  - Multi-cycle/year monitoring during permit period.

- Water quality is not a valid metric for recoverable quantity for water rights.
- Water quality is a valid metric for end use considerations (e.g., storage in brackish aquifers)

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Recoverable Quantity

Examples

- Well-contained areas = high recoverable quantity:
  - Natural flowing artesian conditions (low seepage out).
  - Mined groundwater areas (low recharge in; storage created)
  - Geologic structural controls (e.g., basins, block-faulted basalt)

- Walla Walla, TVWD **(basalt)**: >90% (@1 yr) (modeled, validated)
- Yakima **(Sandstone)**: 95% (@1 yr) – 65% (@10 yrs) (modeled)
- Walla Walla **(sand & gravel)**: 33% (@1 year; seepage augments streamflow)

- Oregon routinely permits 95% recovery without involved analysis.

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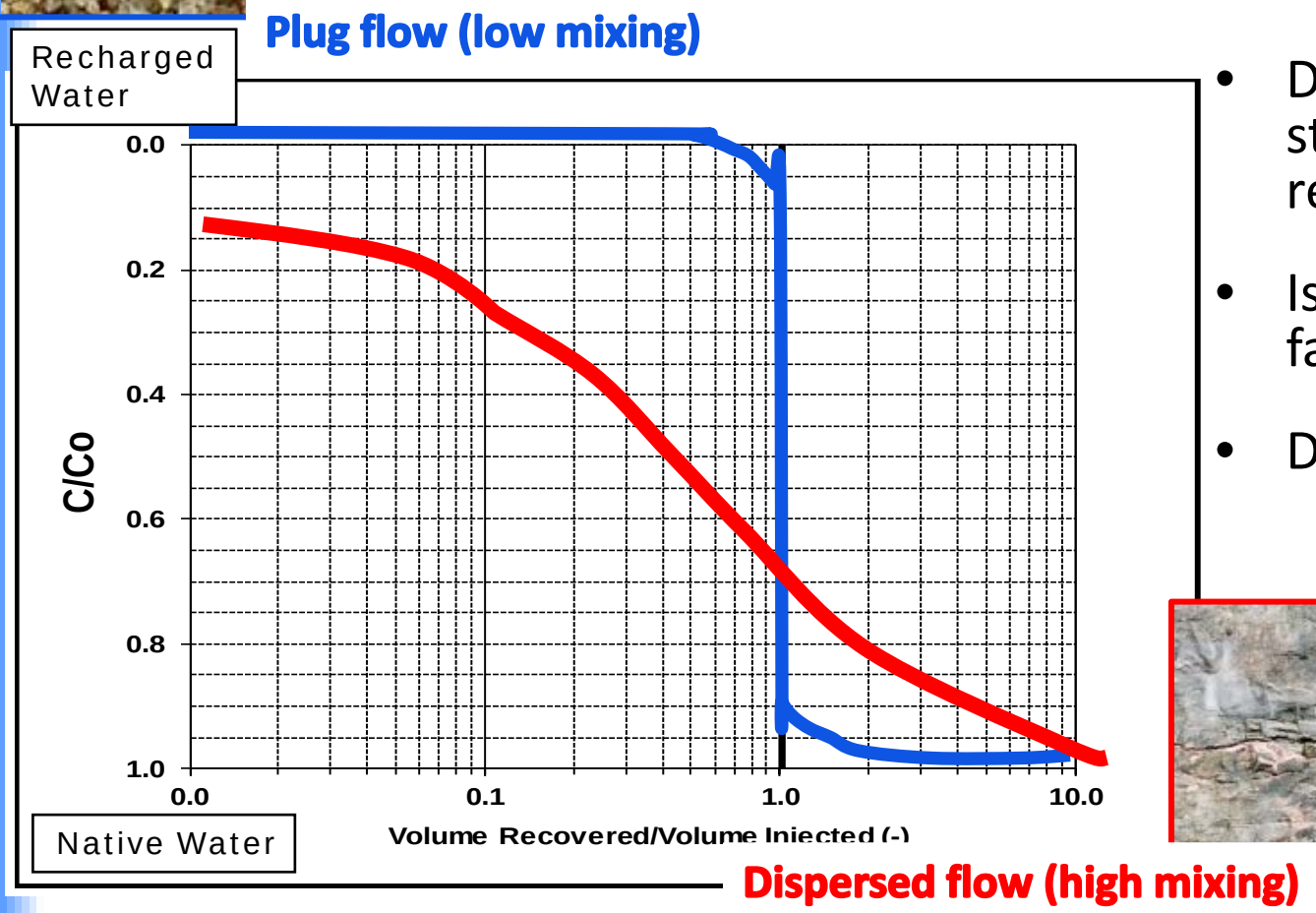
Water Quality in Recovery

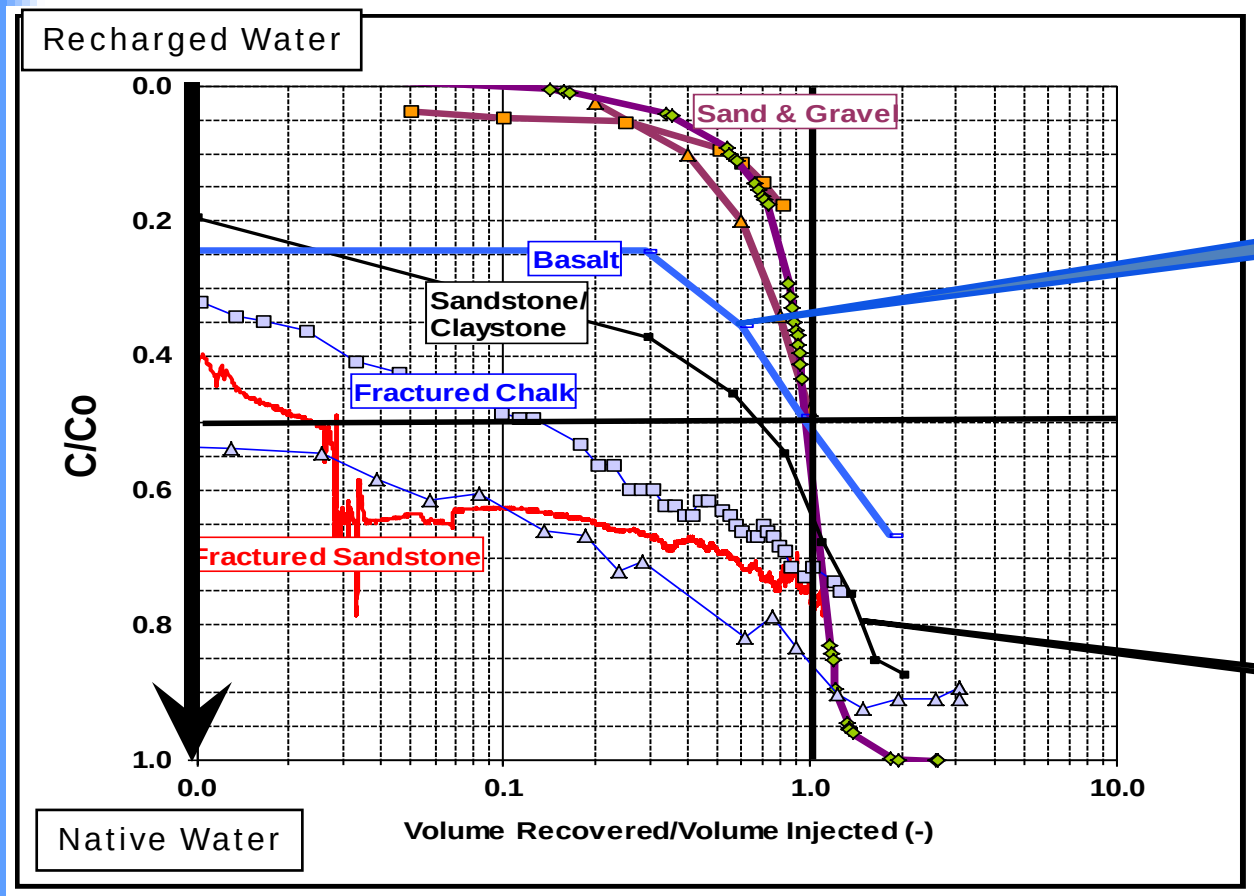
Theory

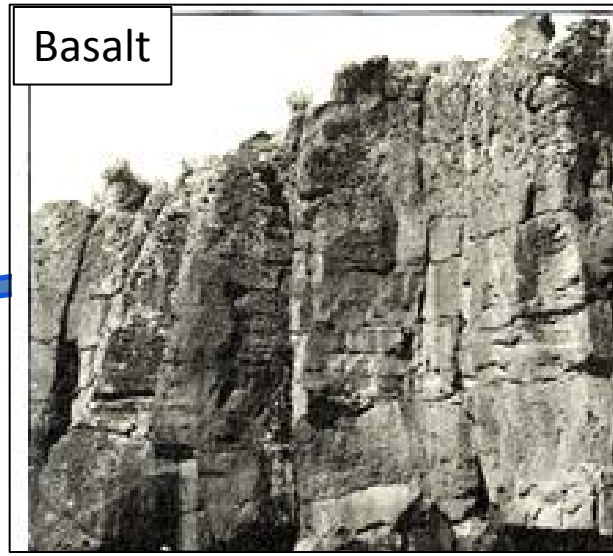


- Dispersivity (mixing) has strong influence on recovered water quality.
- Is intrinsic to the aquifer fabric
- Doesn't affect storability

Water Quality in Recovery

Mixing Examples





Data sets are from different projects and are affected by: duration of storage; number of recharge/recovery cycles; and, other variables. Examples illustrate the range of water quality distributions as a function of different aquifer fabrics.

Criteria for Recovery

- 3 simple end member illustrative cases.

Case 1	Case 2	Case 3
Contained Aquifer	**Un-Contained Aquifer**	**Contained Aquifer**
No Mixing	**No Mixing**	**Mixing**

- Illustrations are simplification of real conditions.
- Real conditions are more complex.

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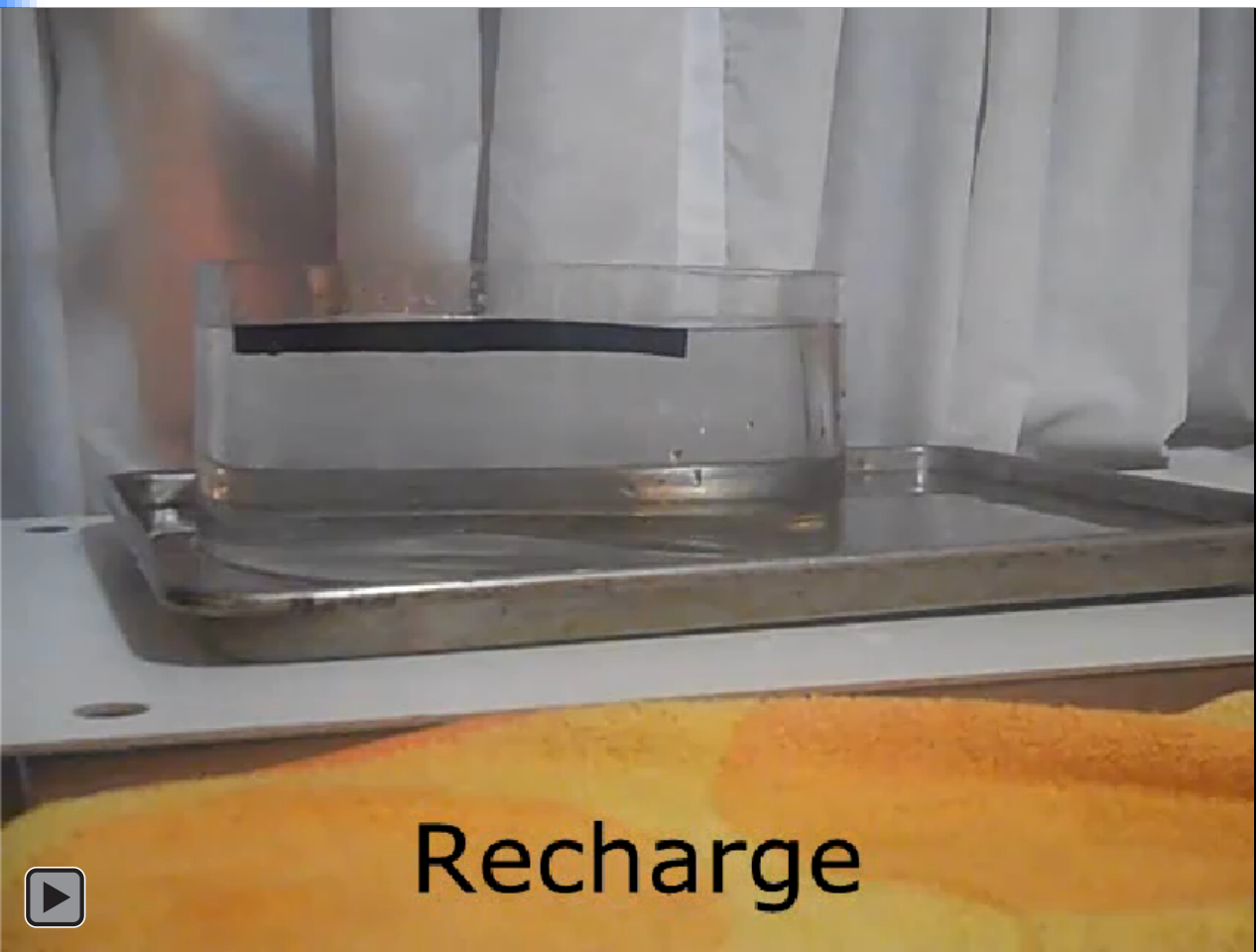
Criteria for Recovery

Case 1. Contained Aquifer, No Mixing



Water Quality

Recovered = recharged ✓

Water level

Final = Start ✓

Water quality criteria is consistent with recoverable quantity ✓

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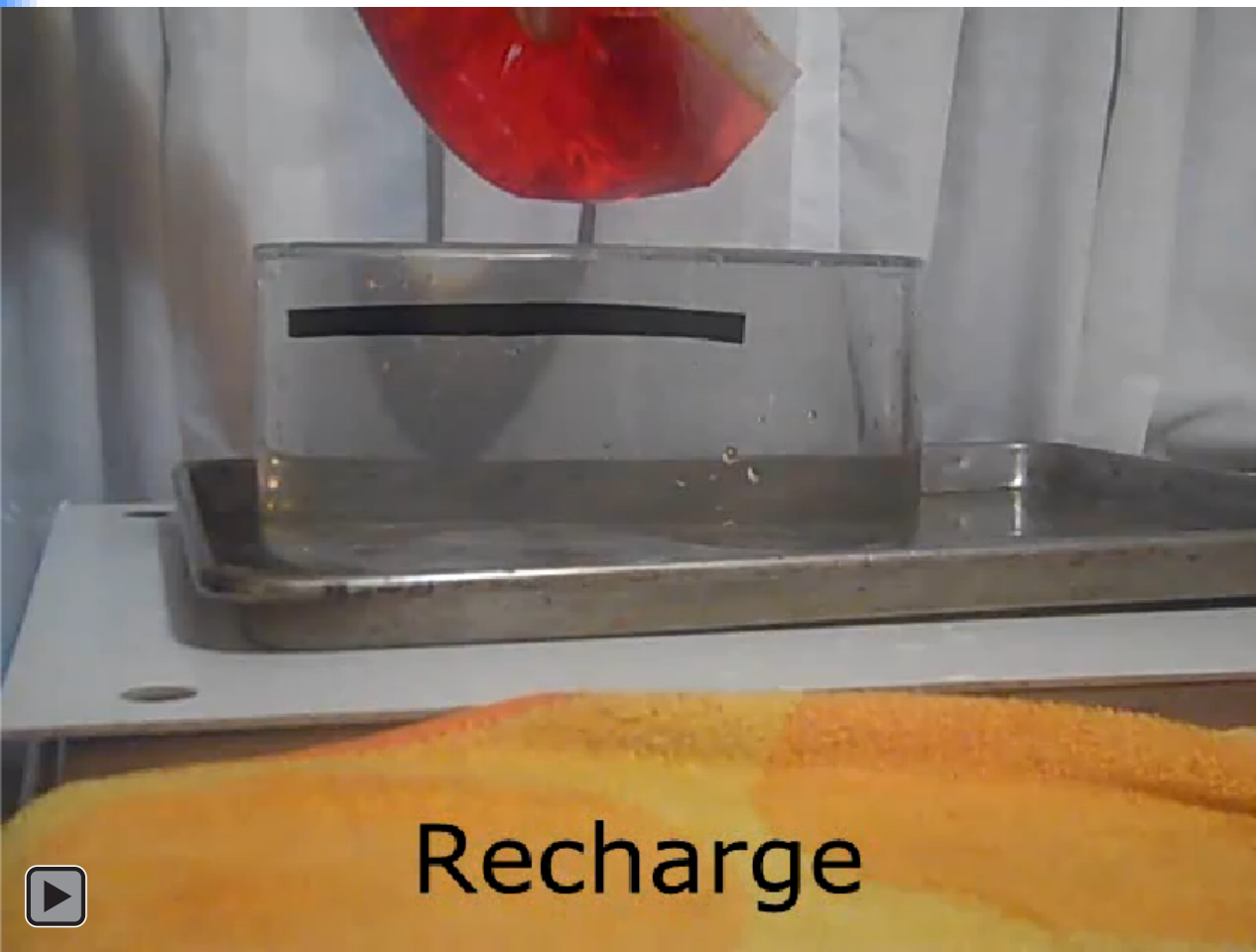
Criteria for Recovery

Case 2. Un-Contained Aquifer, No Mixing

(e.g., loss to surface water)



Water Quality

Recovered = recharged ✓

Water level

Final < Start ✗

Water quality criteria is **NOT CONSISTENT** with recoverable quantity ✗

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Criteria for Recovery
Case 3. Contained Aquifer, Mixed

Water Quality
Recovered ≠ recharged ✗

Water level
Final = Start ✓

Water quality criteria is
NOT CONSISTENT
with recoverable quantity ✗

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Criteria for Recovery
Reliability of Criteria

- Three simple end member illustrative cases.

	Case 1	Case 2	Case 3	
Conditions	Contained Aquifer – No Mixing	Un-Contained Aquifer – No Mixing	Contained Aquifer – Mixing	
Criteria	**Potential Recovery Indicated** (reliability = good ✓ or poor ✗)			**Reliability of Criteria as an Indicator**
Water Balance	High ✓	Lo ✓	High ✓	GOOD ✓
Water Quality	High ✓	High ✗	Lo ✗	POOR ✗

- Illustrations are simplification of real conditions.
- Real conditions are more complex.

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Protection of Groundwater Quality

- Status Quo (Antidegradation Rule, WAC 173-200)
  - Passed in early days of environmental regulation development (~1980s)
  - Stricter than drinking water standards
- Approaches to allow groundwater recharge :
  - 5-year variance (project uncertainty)
  - **O**verriding **P**ublic **I**nterest (OPI)
  - Groundwater Management Area (GWMA)

  Burden on regulatory staffing resources.
  - **Legislative fix** → **Recommended**

Oregon

- Allows 50% of drinking water standards by default
  - more allowed, as appropriate.

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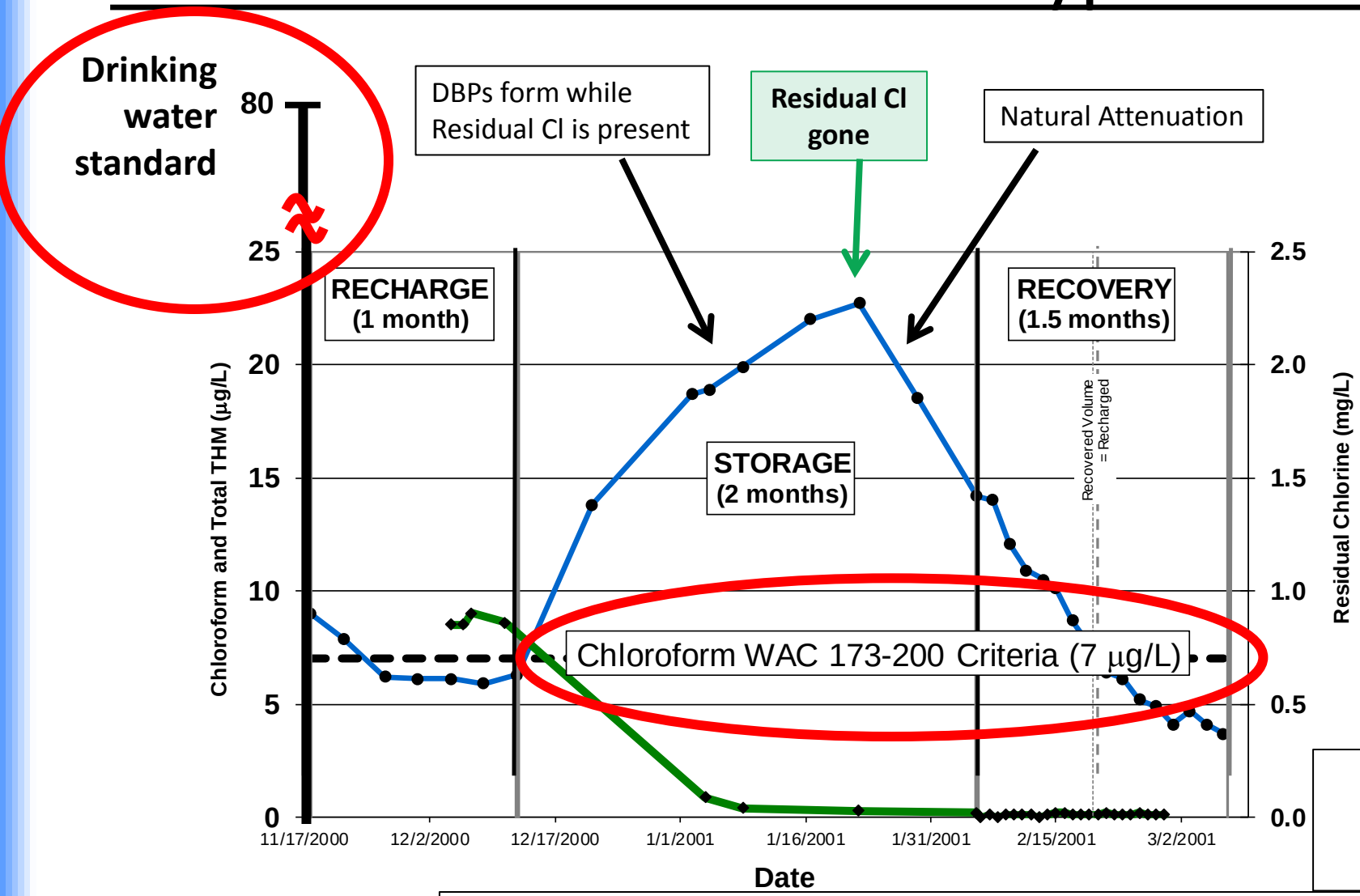
Chlorination Disinfection Byproducts (DBPs)



Yakima ASR Test

DBPs remain within safe drinking limits and naturally attenuate during storage

SUMMARY

Determining recoverable quantity in water right context:

- Water balance approach should be used.
- Water quality is not a valid metric.
- Oregon routinely permits 95% recovery in contained aquifers without involved analysis.

Protection of groundwater quality:

- Water quality is important for end use and operations
- Legislative fix recommended for WAC 173-200 consistency.
- Oregon default is up to 50% of drinking water standard (higher if appropriate with supporting analysis).

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Thank you!

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