

Water Quality Standards for  
Protection of Irrigated  
Agriculture in the Powder  
River Basin

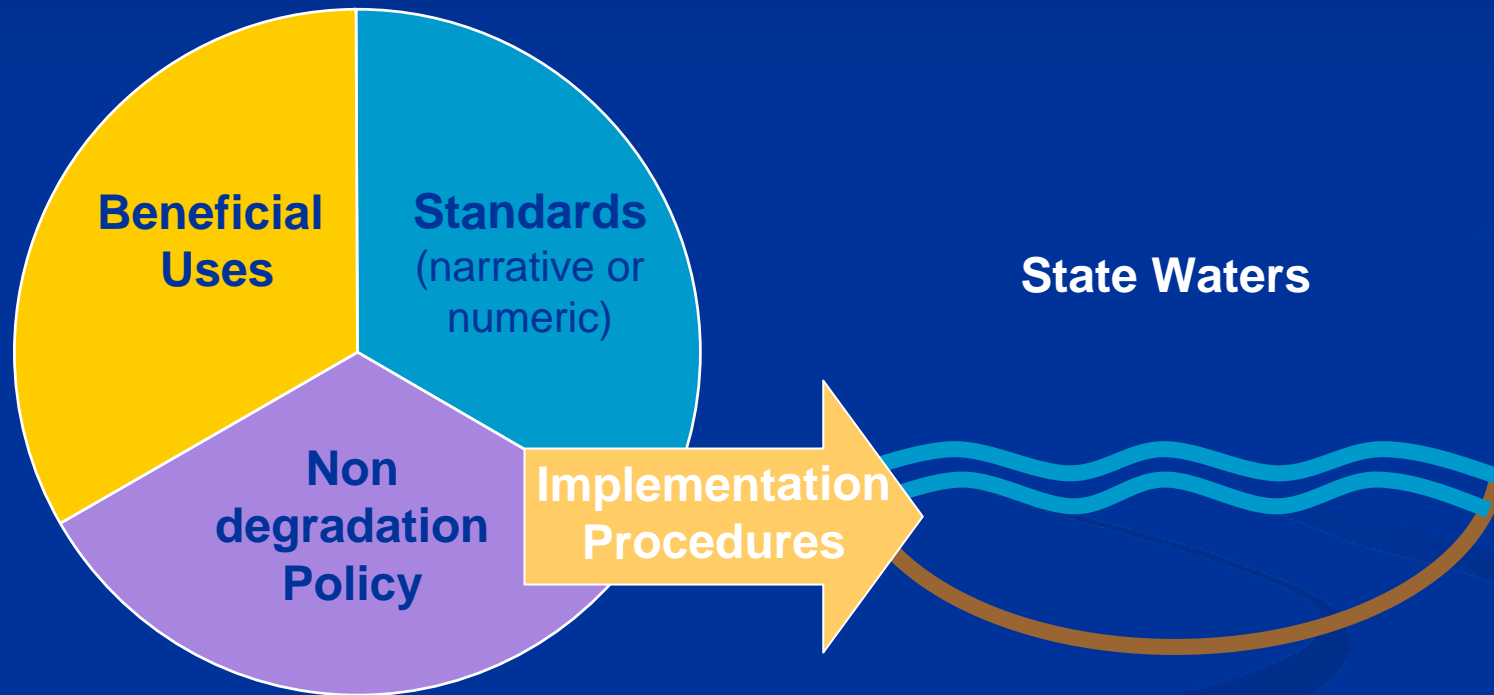
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# Overview

- Water Quality Standards & Nondegradation
- CBM & Need to protect irrigated agriculture
- Why Electrical Conductivity (EC) & Sodium Adsorption Ratio (SAR) standards
  - highlights of technical issues
- Brief history & current status

# Water Quality Standards



# Water Quality Standard Example

- Beneficial Use: human health
- Numeric standard: 100 ug/L Chromium
- Nondegradation Policy: “toxic”

# Water Quality Standards

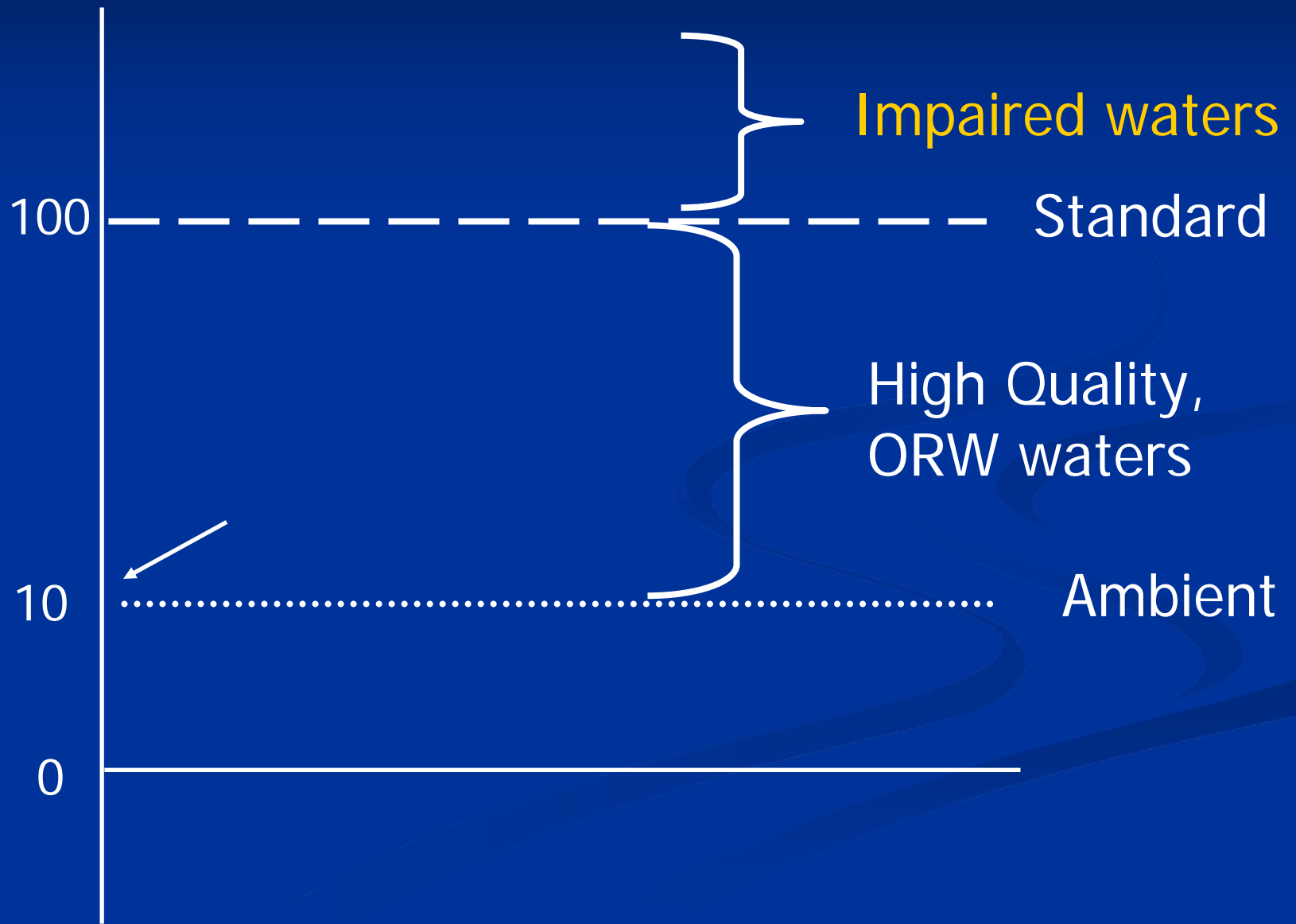
- Standards provide decision criteria for:
  - Permit discharge limits
  - Water quality impairment determinations (303(d) list)
  - TMDLs
- Nondegradation Policy:
  - Permits
    - applied to “new & increased sources”

# Nondegradation categories of protection:

1. Protect existing uses (all waters)
2. Protect high quality water (unimpaired waters)
3. Outstanding Resource Waters
  - National Parks & Wilderness
  - Waters designated by BER



# Nondegradation



# CBM development & water quality:

- Large volumes of produced water
  - ~ 2 bbls/mcf gas
  - Variable in quality, but typically
    - High in salts, EC ~ 2,000
    - Very high SAR ~ 50
- Tongue River
  - EC ~ 700
  - SAR ~ 0.9



# Salt:

## 1. Salinity

- Typically measured as TDS or Electrical Conductivity (EC)
- Harmful to plants
  - Reduces availability of soil water

## 2. Sodicity

- Typically measured in terms of proportion of  $\text{Na}^+$  relative to  $\text{Ca}^{++}$  &  $\text{Mg}^{++}$
- $\text{SAR} = [\text{Na}] / (([\text{Ca}] + [\text{Mg}])/2)^{1/2}$
- Harmful to soils
  - Disperse clay complexes
  - Dissolves organic matter
  - Reduce availability of water & nutrients
  - Can ruin sensitive soils

# Setting EC Criterion for Crop

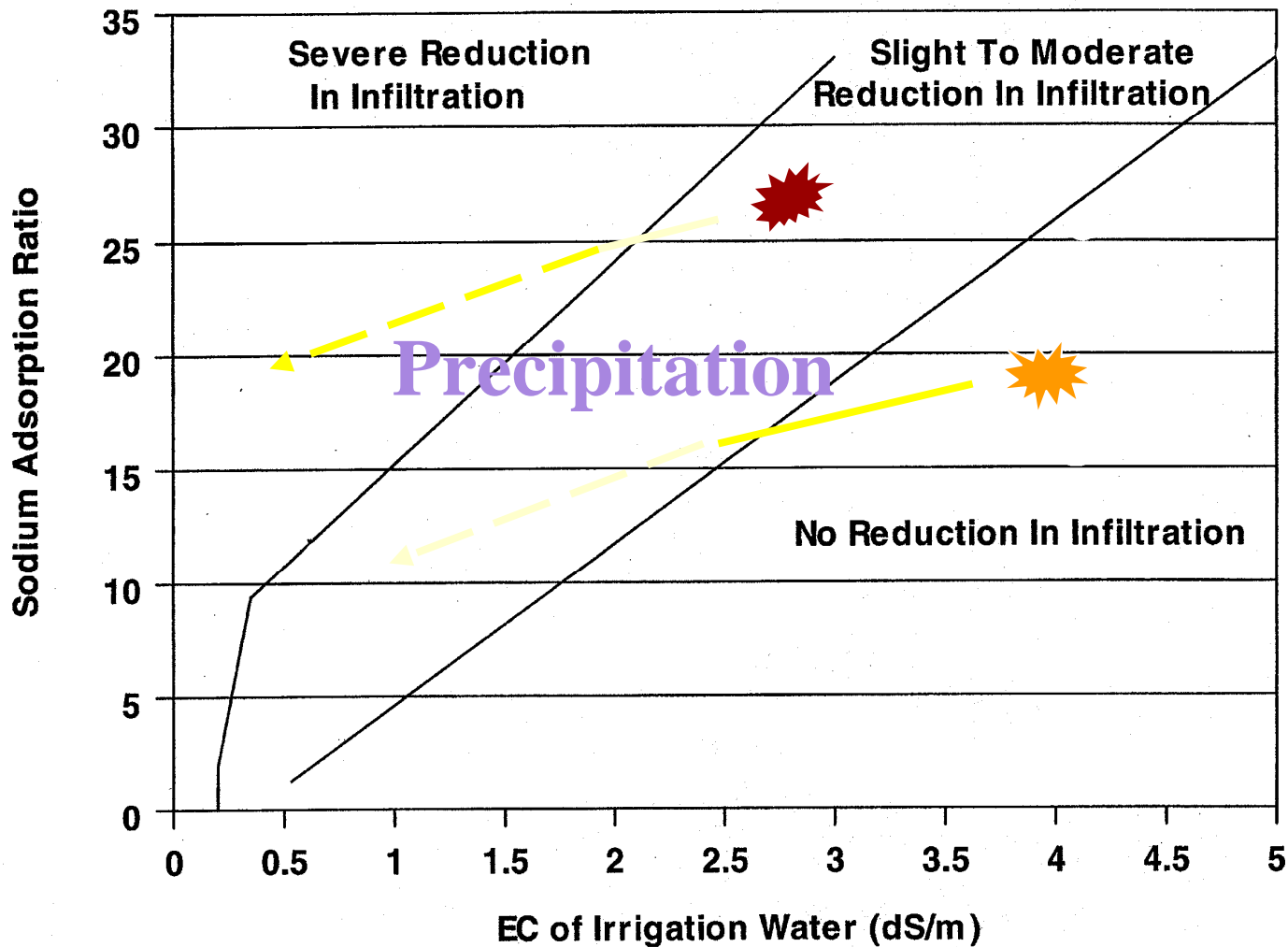
- Key considerations:
  - Most sensitive crop
  - Soil water EC threshold, above which crop production starts to decline
    - Typically more concentrated than irrigation water
  - Leaching fraction necessary to protect soil from excess salt buildup
  - Determine relative proportion of irrigation water & precipitation to meet crop needs

# SAR Criterion

- Threshold of harm depends on salinity in the soil water
  - higher the salinity the higher the SAR can be without adverse dispersive effect on the soil
  - however, salinity limited by crop tolerance
- Relationship published (CA 3375)
- Rainfall effect needs to be considered since precipitation decreases EC, but has little effect on SAR in soil water

# Relationship between EC and SAR

(considering precipitation effects)



# Tongue River irrigation season example

- Beneficial Use: Irrigated Agriculture
- Numeric standard:
  - EC monthly average of 1000
  - SAR monthly average of 3
- Nondegradation Policy: initially “narrative” (2003), then “harmful” (2006)

## Administrative and Legal Proceedings

DEQ began investigating need for standards in late 1990's

BER initiates rulemaking for EC & SAR standards in 2002

MT used a narrative standard at the time

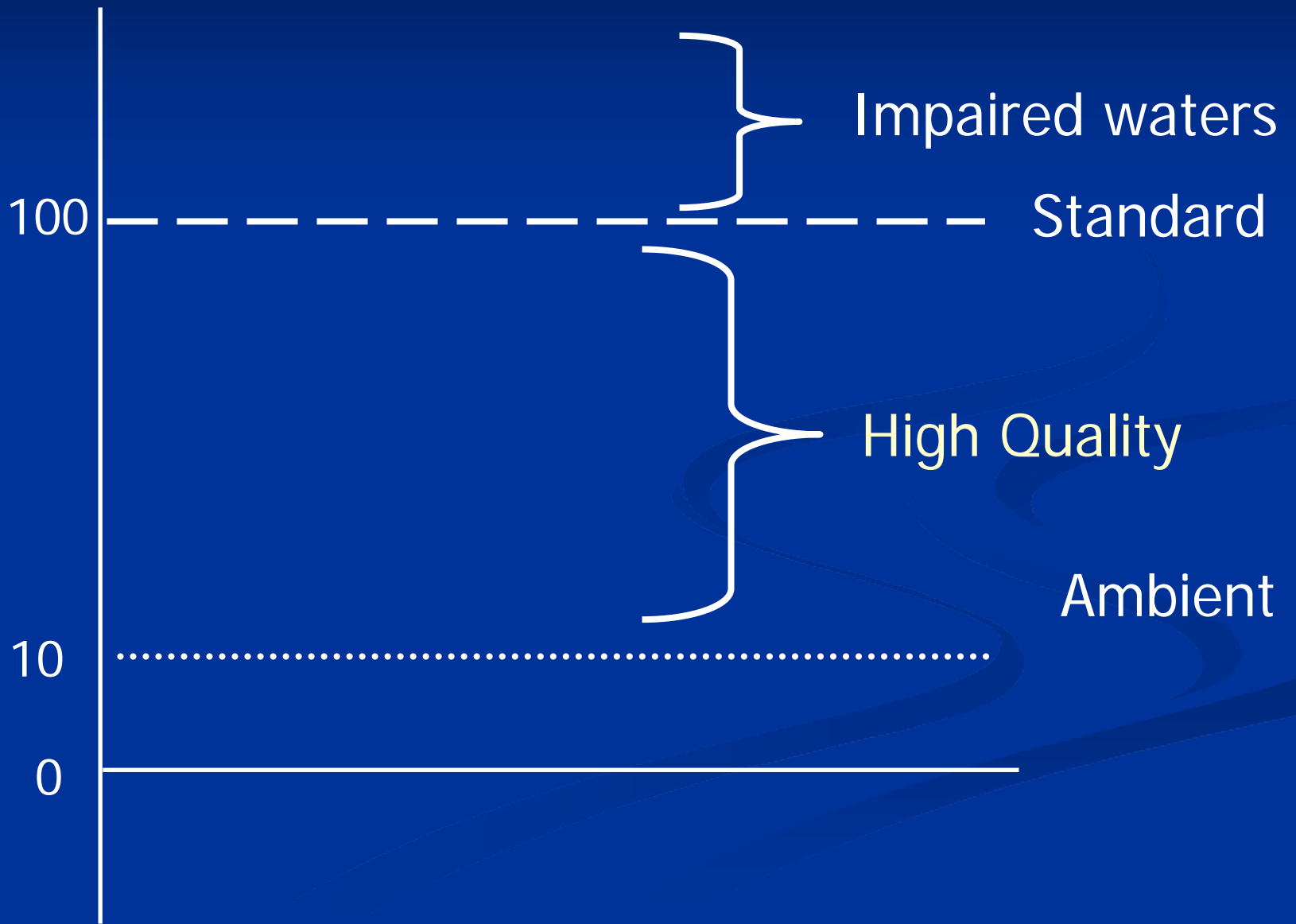
DEQ completed an exhaustive review and administrative record, including many public meetings, a collaborative group, and hired a technical expert

BER adopted numeric standards in 2003

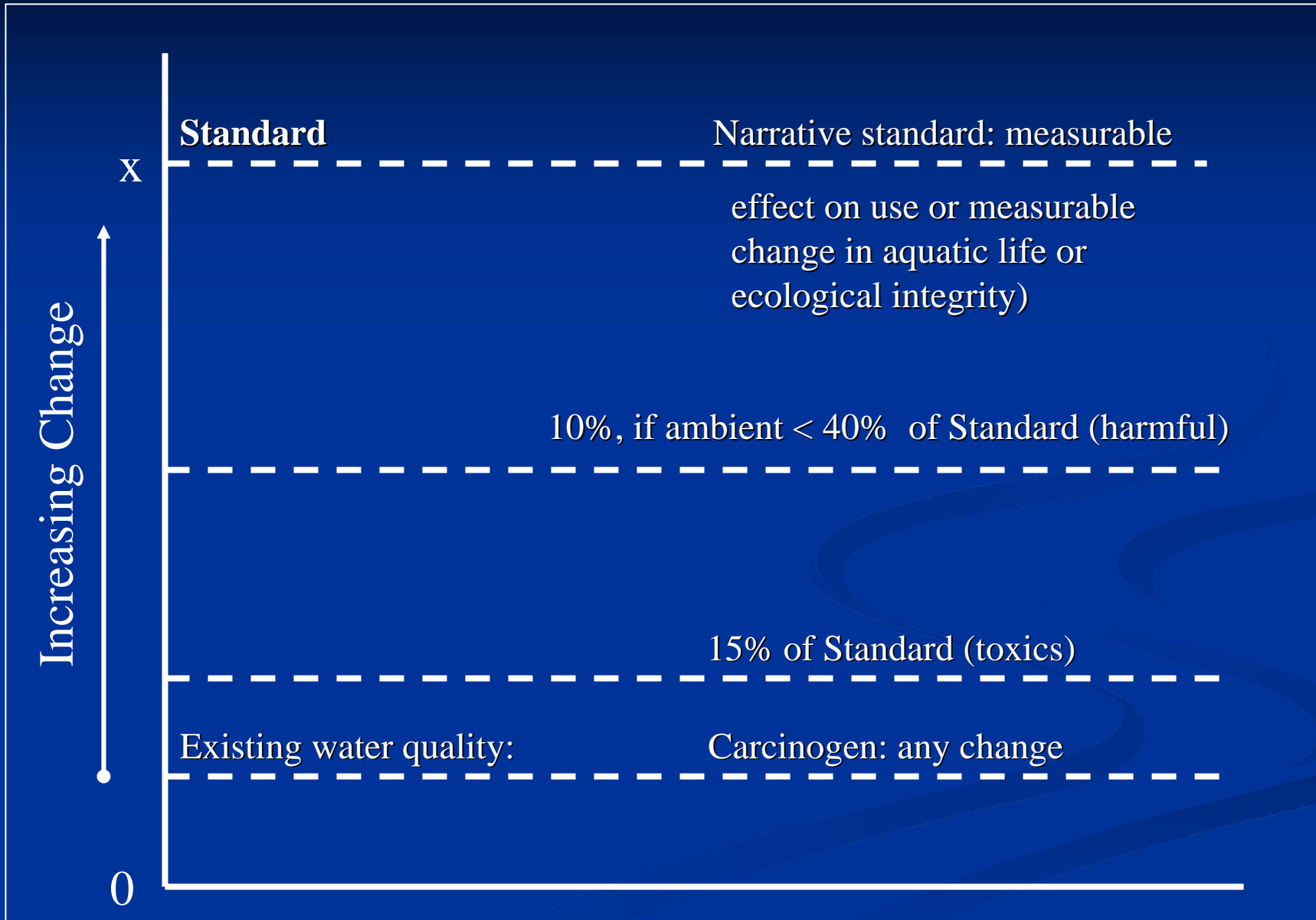
BER left the narrative standard in place for antidegradation significance threshold



# Nondegradation



# Significance Thresholds





**BER petitioned in 2005 to establish numeric antidegradation threshold, require reinjection of produced water, and other administrative adjustments**

**In 2006, following thorough review and development of another administrative record, BER adopted numeric antidegradation criteria, but did not adopt the requirement for reinjection**

**WY producers filed suit:**

- **state district court in MT challenging BER & DEQ on use of adequate science for EC & SAR standards and nondegradation**
- **federal district court in WY against EPA for not disapproving the MT standards and antidegradation thresholds, alleging that EPA:**
  - **failed to consider the entire administrative record from the state rulemaking**
  - **Failed to articulate a thorough analysis for its decision**
  - **Failed to determine whether the MT standards are based on appropriate technical and scientific data**

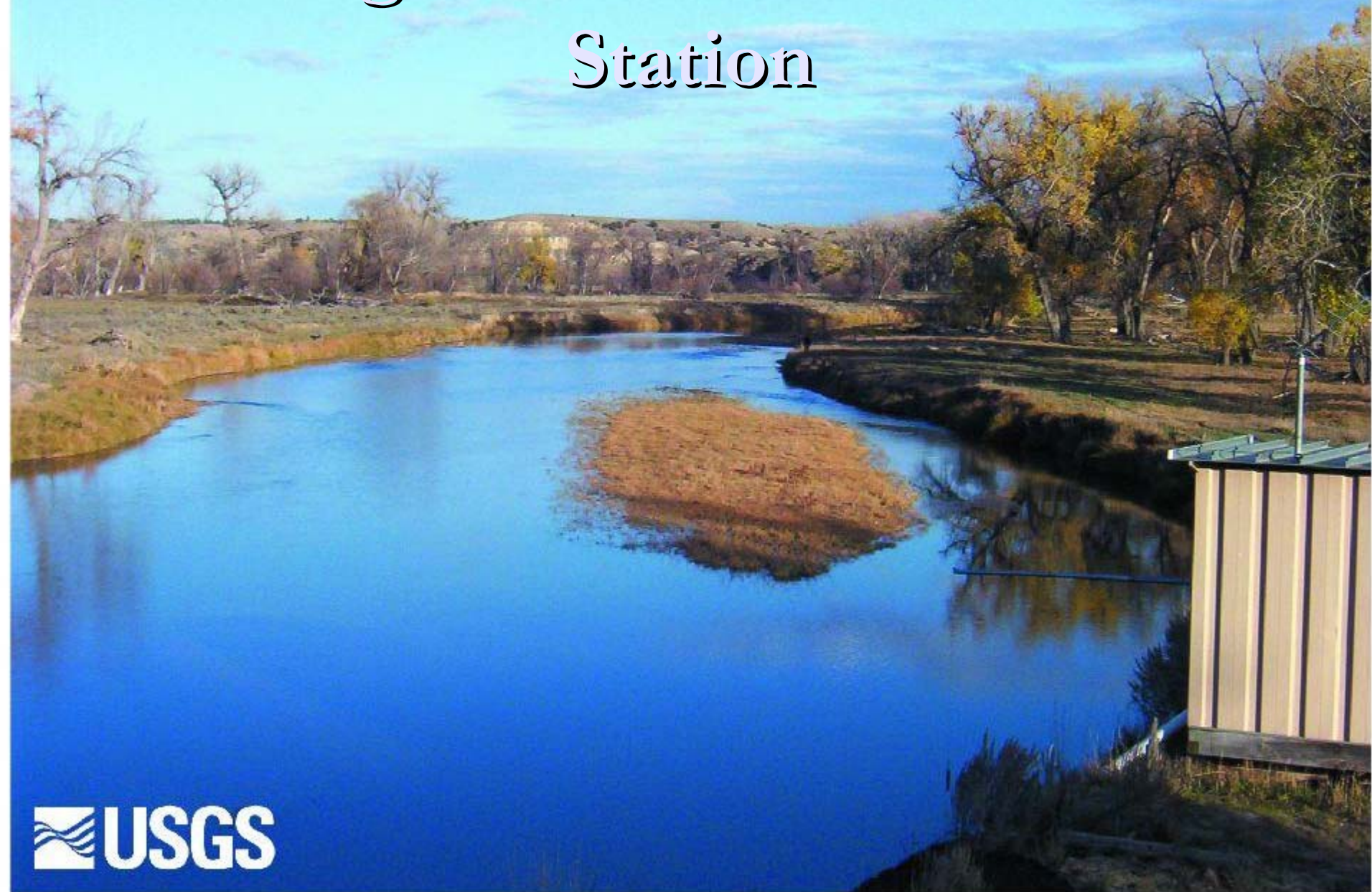
- State of WY intervened on behalf of WY producers; State of MT intervened on behalf of EPA
- MT won in state district court, as well as MT Supreme Court
- Federal district court in WY vacated EPA's approval of both the 2003 & 2006 standards submissions under the Clean Water Act
  - Remanded back to EPA based on court's finding of procedural errors, and that EPA is to:
    1. Consider the entire record
    2. "make plain it's course of analysis and reasoning"
    3. Determine whether the standards are based on appropriate science
- US EPA & DOJ filed notice of appeal 15 December

## ■ Development Update

- In WY, about 20,000 wells drilled, about 15,000 producing
  - Small % treated
- In MT, about 1200 wells drilled, about 900 producing
  - About half discharged water is treated
- Development very slow in 2009 due to economy & low gas prices

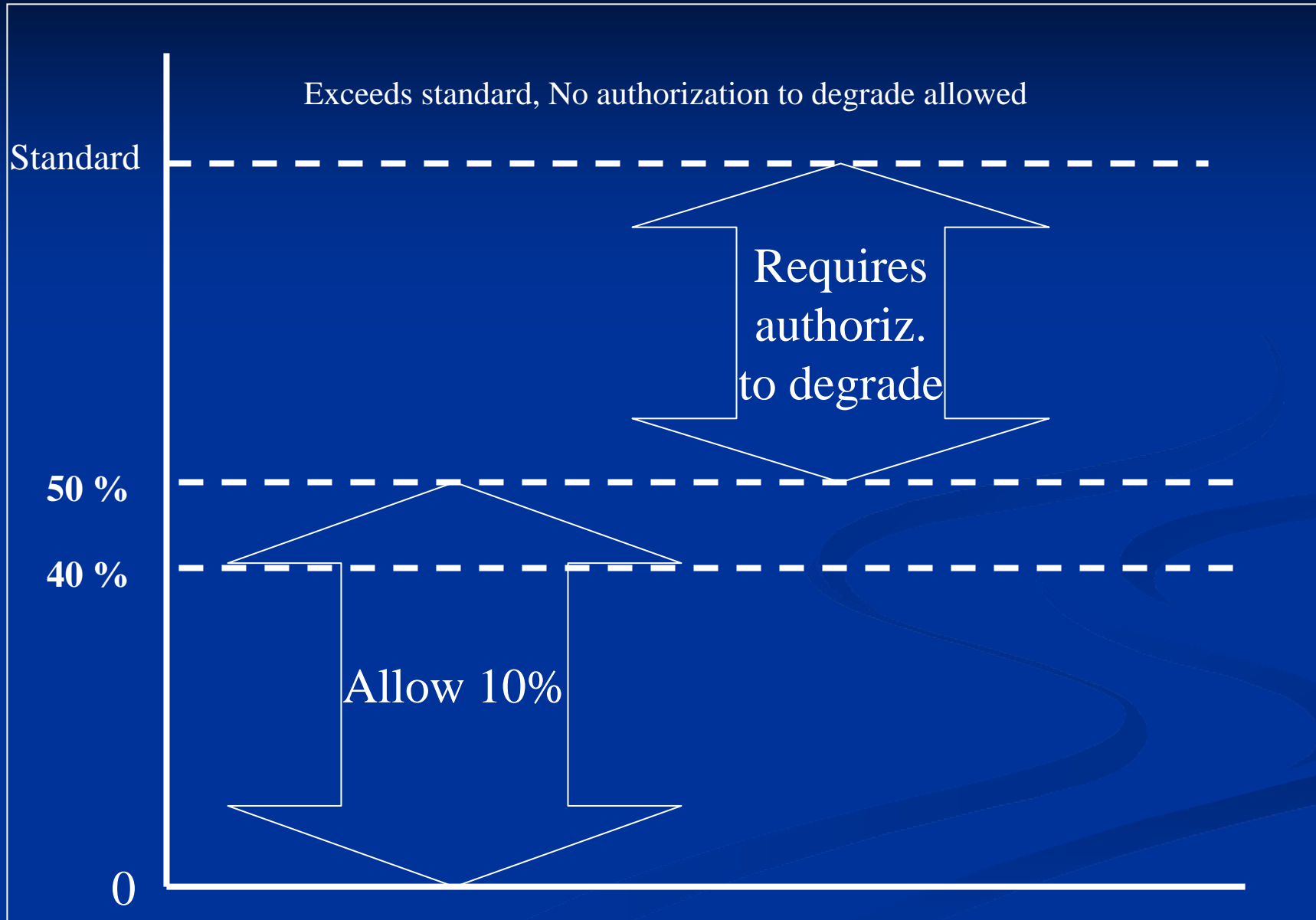
Questions?

# Tongue River at State Line Station



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# Harmful Nondegradation Approach



# Soil Water EC vs Irrigation Water EC with lines for different leaching fractions (Univ. Calif. Water Management pub. 3375)

