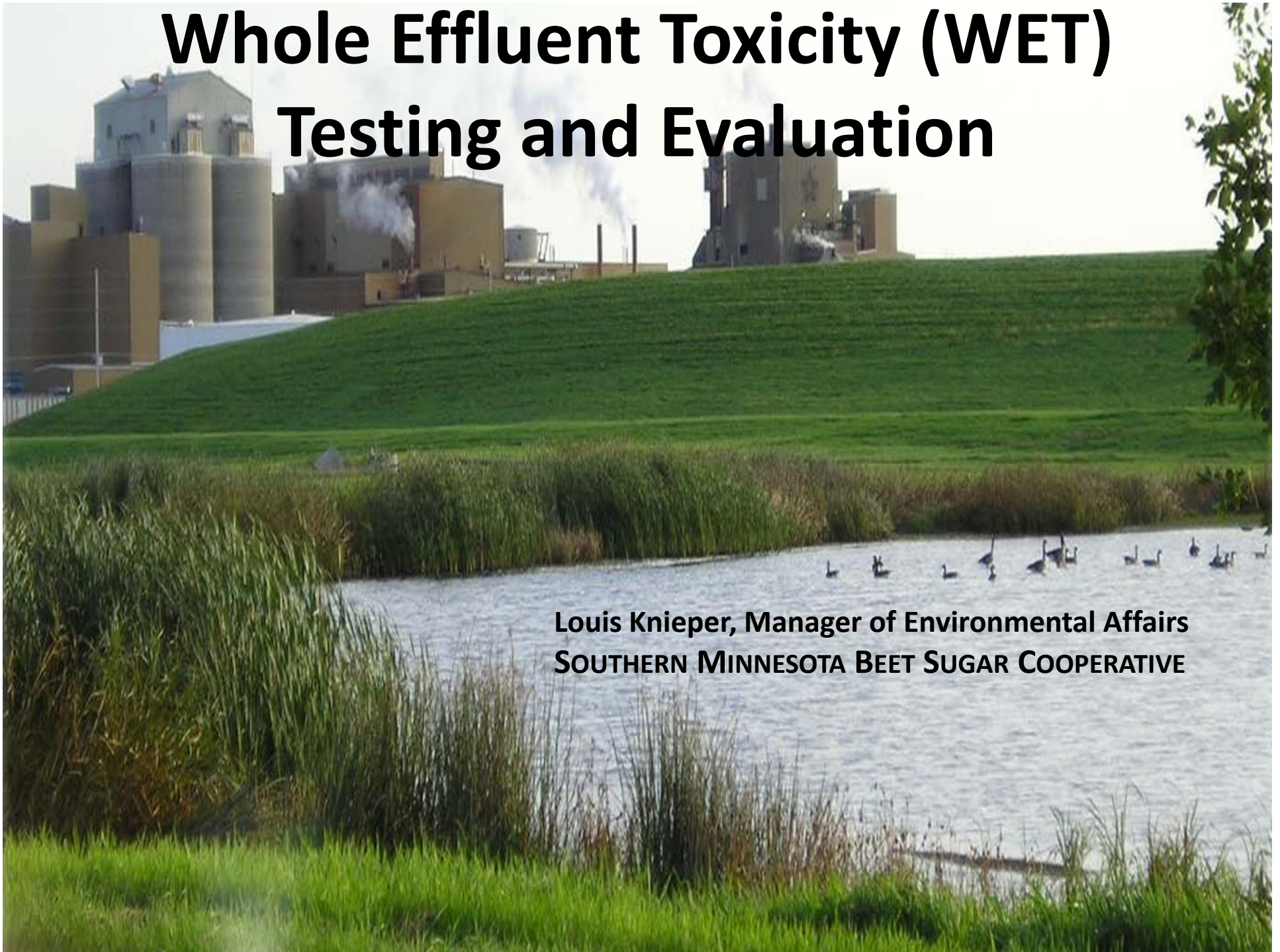


Whole Effluent Toxicity (WET) Testing and Evaluation

**Louis Knieper, Manager of Environmental Affairs
SOUTHERN MINNESOTA BEET SUGAR COOPERATIVE**



SMBSC WET Testing Experience

Wastewater treatment by anaerobic and aerobic processes with solids removal



SMBSC WET Testing Experience

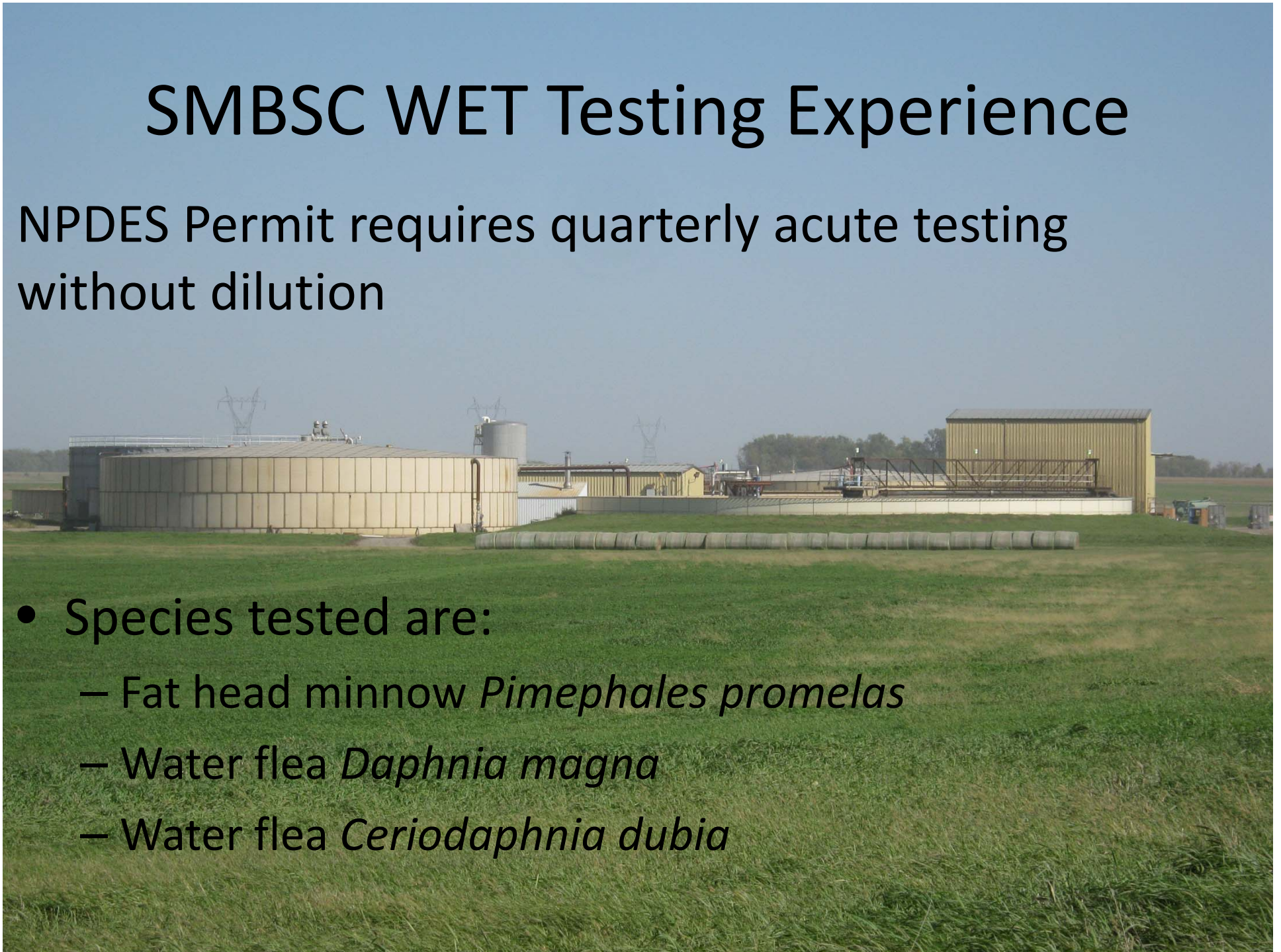
NPDES Permit requires quarterly acute testing without dilution



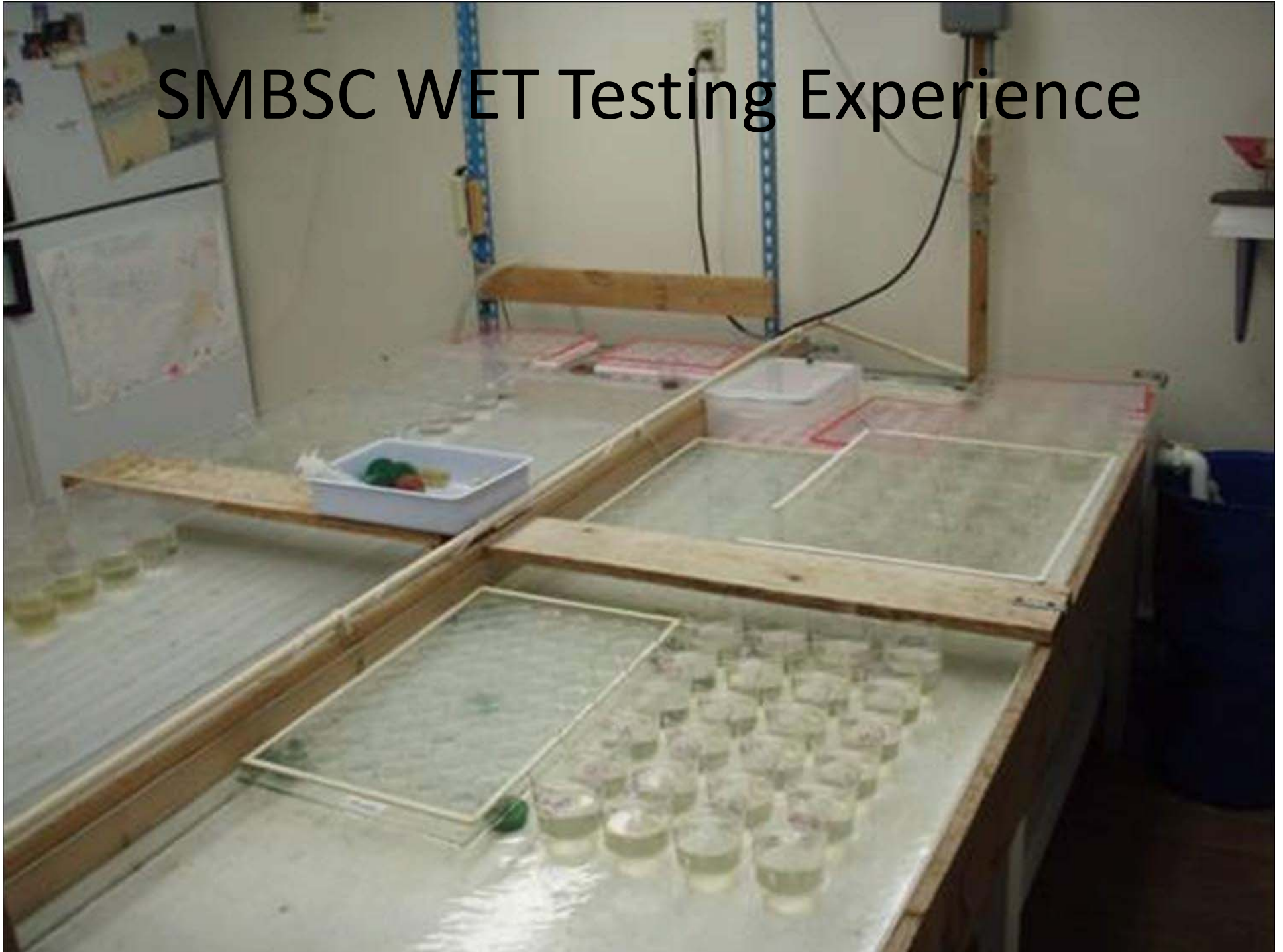
SMBSC WET Testing Experience

NPDES Permit requires quarterly acute testing without dilution

- Species tested are:
 - Fat head minnow *Pimephales promelas*
 - Water flea *Daphnia magna*
 - Water flea *Ceriodaphnia dubia*



SMBSC WET Testing Experience



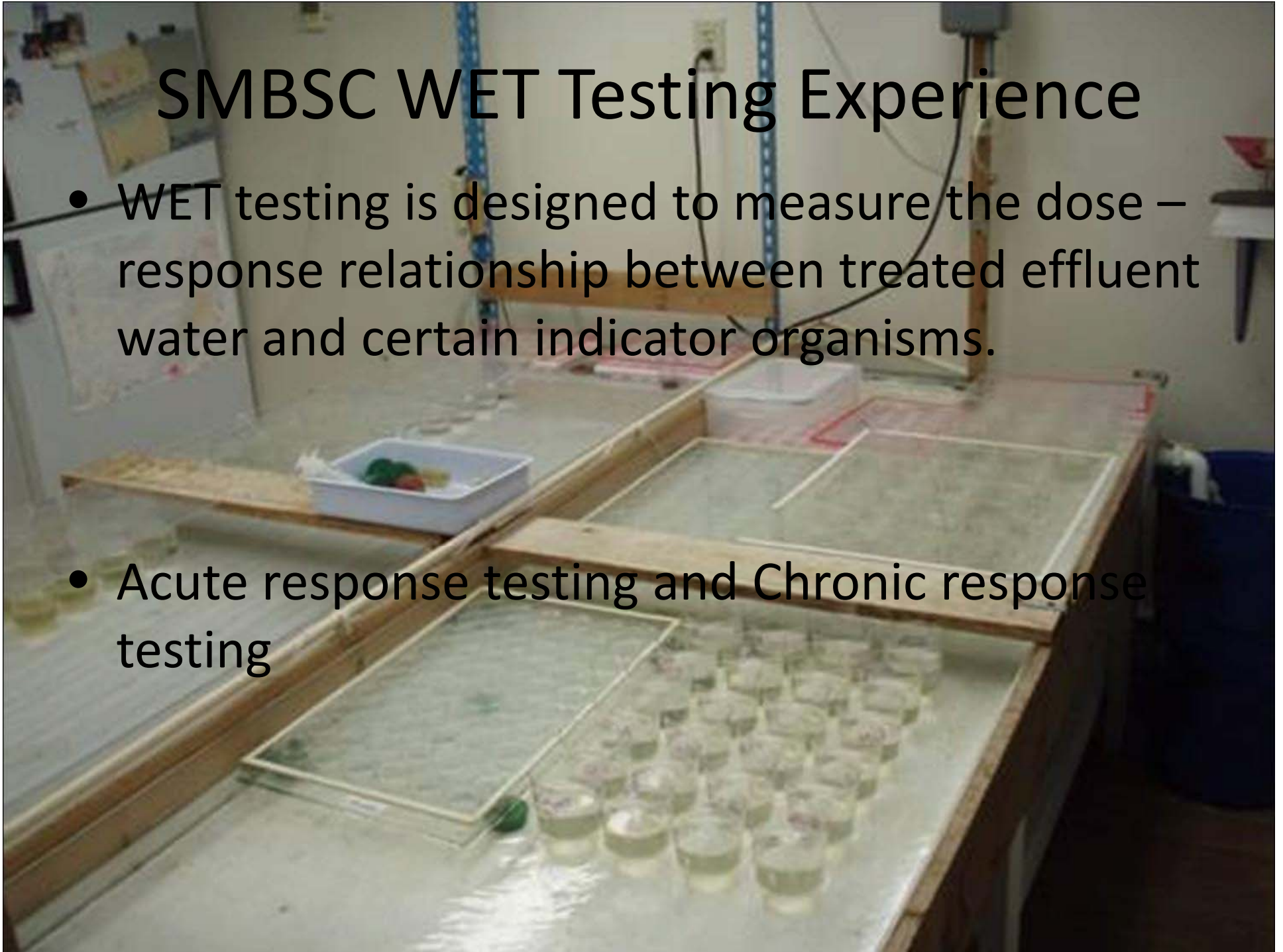
SMBSC WET Testing Experience

- WET testing is designed to measure the dose – response relationship between treated effluent water and certain indicator organisms.



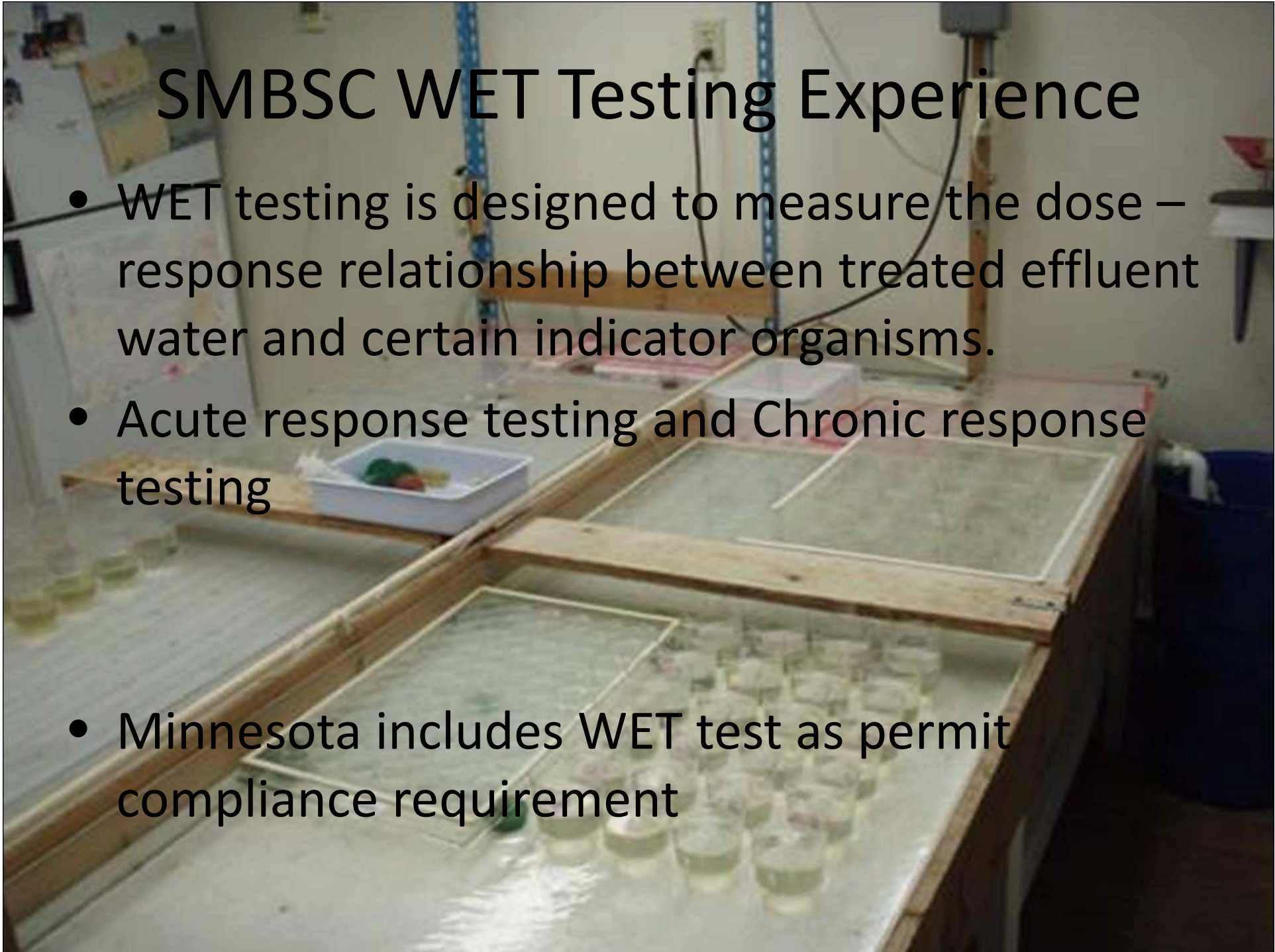
SMBSC WET Testing Experience

- WET testing is designed to measure the dose – response relationship between treated effluent water and certain indicator organisms.
- Acute response testing and Chronic response testing



SMBSC WET Testing Experience

- WET testing is designed to measure the dose – response relationship between treated effluent water and certain indicator organisms.
- Acute response testing and Chronic response testing
- Minnesota includes WET test as permit compliance requirement



SMBSC WET Testing Experience

- 2005 – 2007 Irregular and unpredictable toxicity to Daphnids
- 2007 – 2009 Conducted Toxicity Identification Evaluation (TIE)
- 2008 – 2010 Conducted Toxicity Reduction Evaluation (TRE)
- 2010 – 2011 Confirm Results

SMBSC WET Testing Results

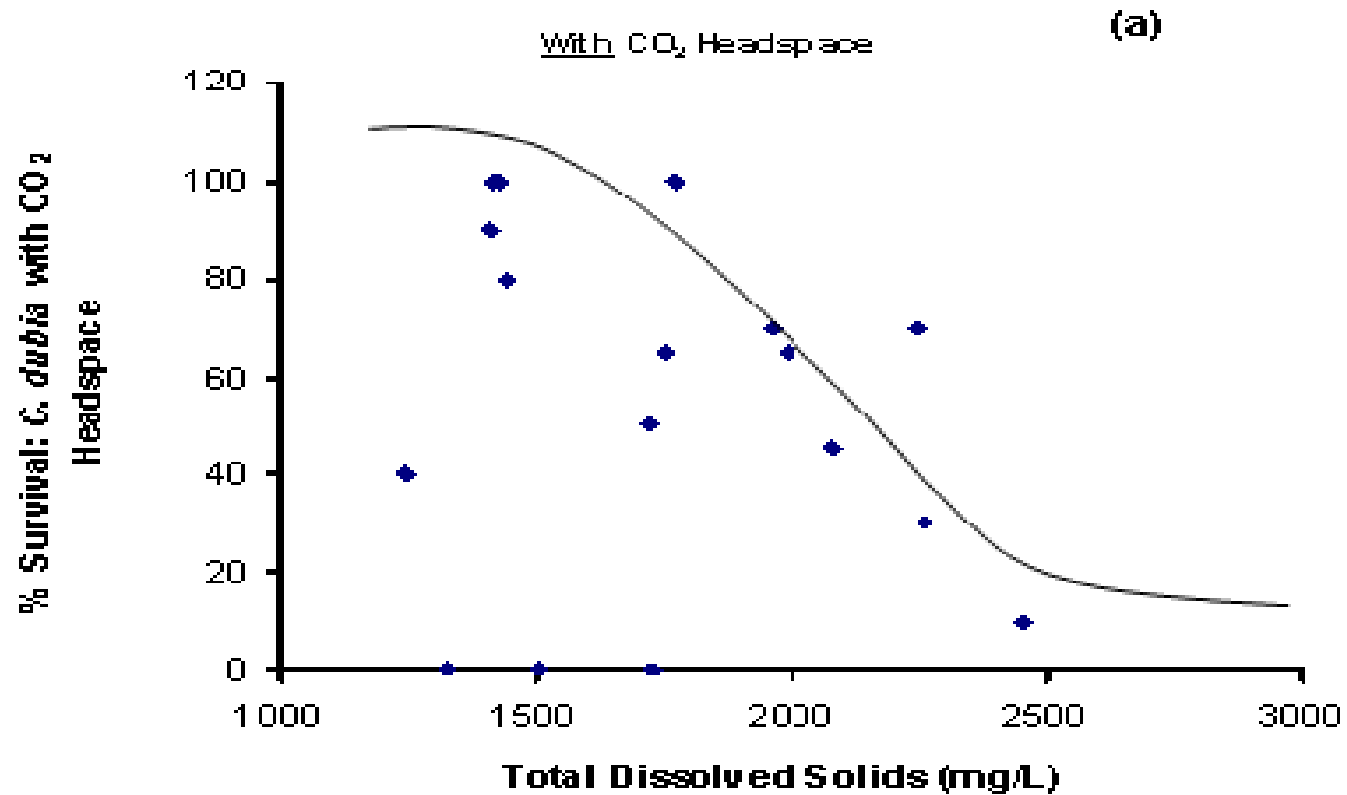
- TIE proved futile – no smoking gun found
 - No Biocides
 - No VOC's
 - No SVOC's
 - No PAH's
 - No Dioxins or Dibenzofurans
 - No Metals (Aluminum was suspect)
 - No Salts (Potassium was suspect)
 - No Saponins

SMBSC WET Testing Results

TRE was interesting

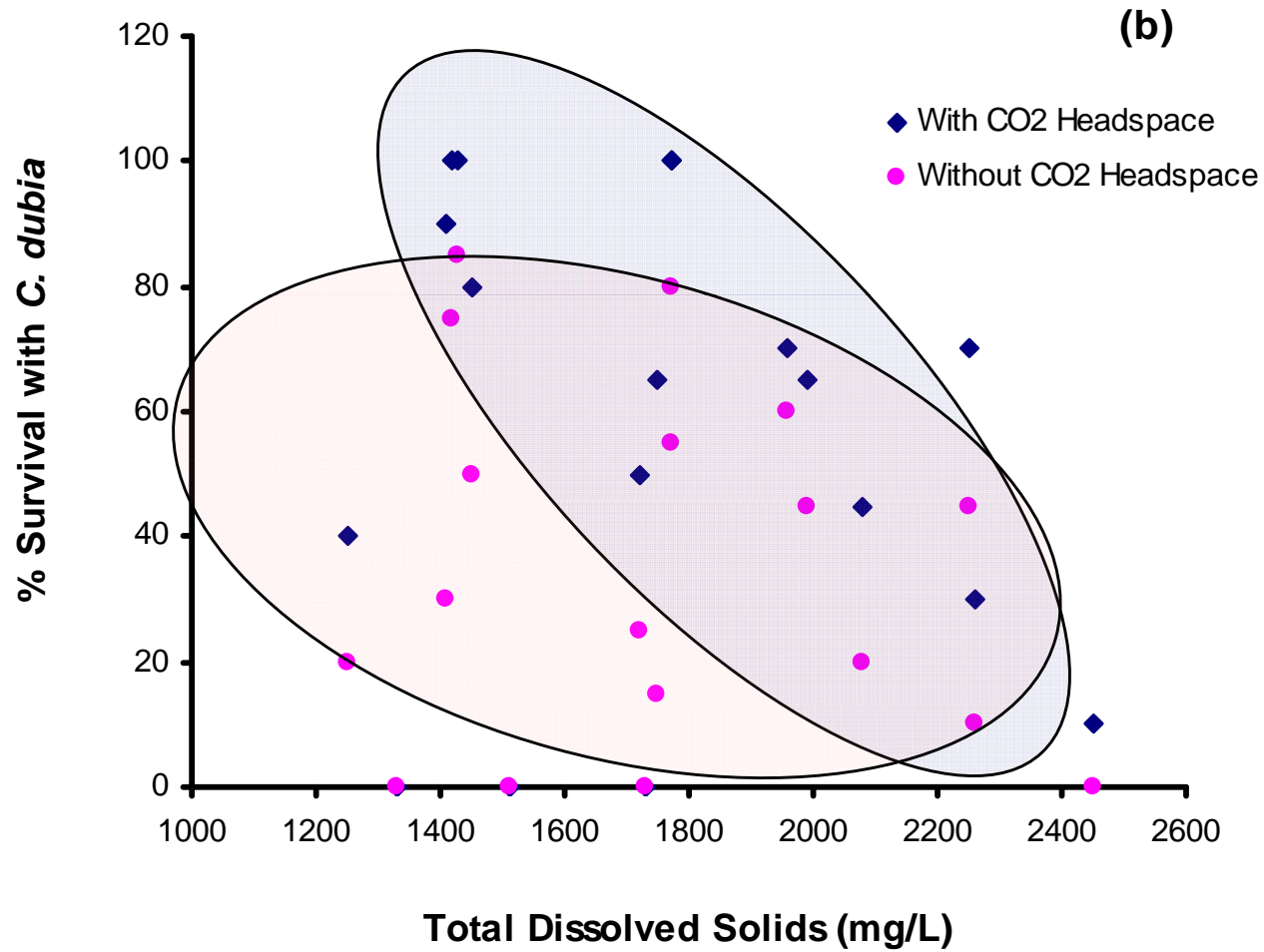
- Aging 2 – 6 days - **inconsistent performance**
- Modifying treatment - **no improvement**
- Aeration - **inconsistent performance**
- UV Light treatment - **no improvement**
- Heating effluent - **inconsistent performance**
- Additional filtration - **no improvement**
- Lime softening - **general improvement**
- Gypsum addition - **inconsistent performance**
- Anion exchange resin (Amberlite) - **100% perfect**

Dissolved Salts and Toxicity



Southern Minnesota Beet Sugar Cooperative

Dissolved Salts and Toxicity



Southern Minnesota Beet Sugar
Cooperative

Observed versus predicted *C. dubia* survival using the logistic regression relationship provided in the figure

Day 2 Survival % = 100 * (1 / (1 + EXP(-(5.0 - 3.7 * Al - 0.01 * K - 0.9 * pH Rise)))
Aluminum and potassium in units mg/L, pH in s.u.

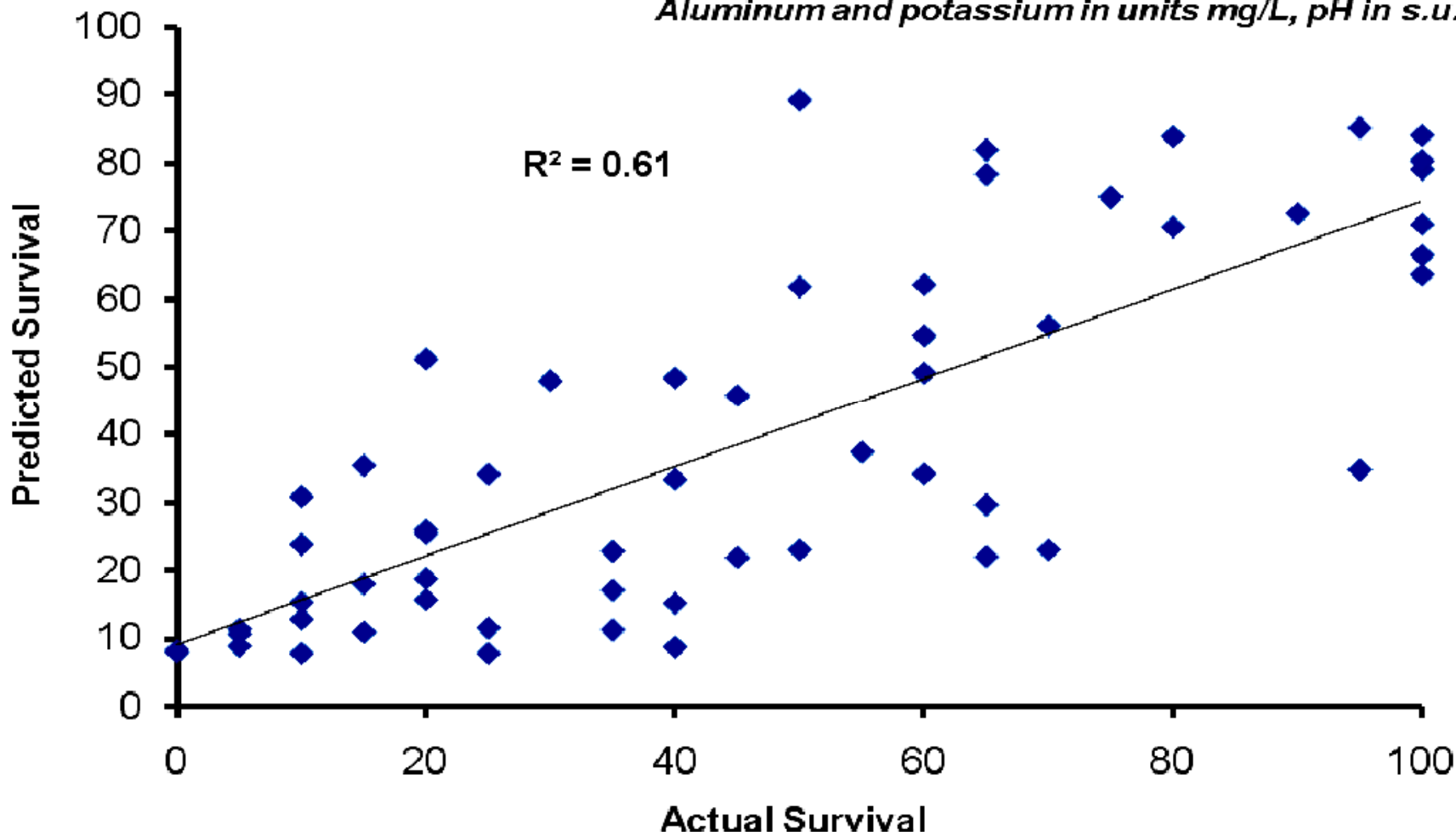
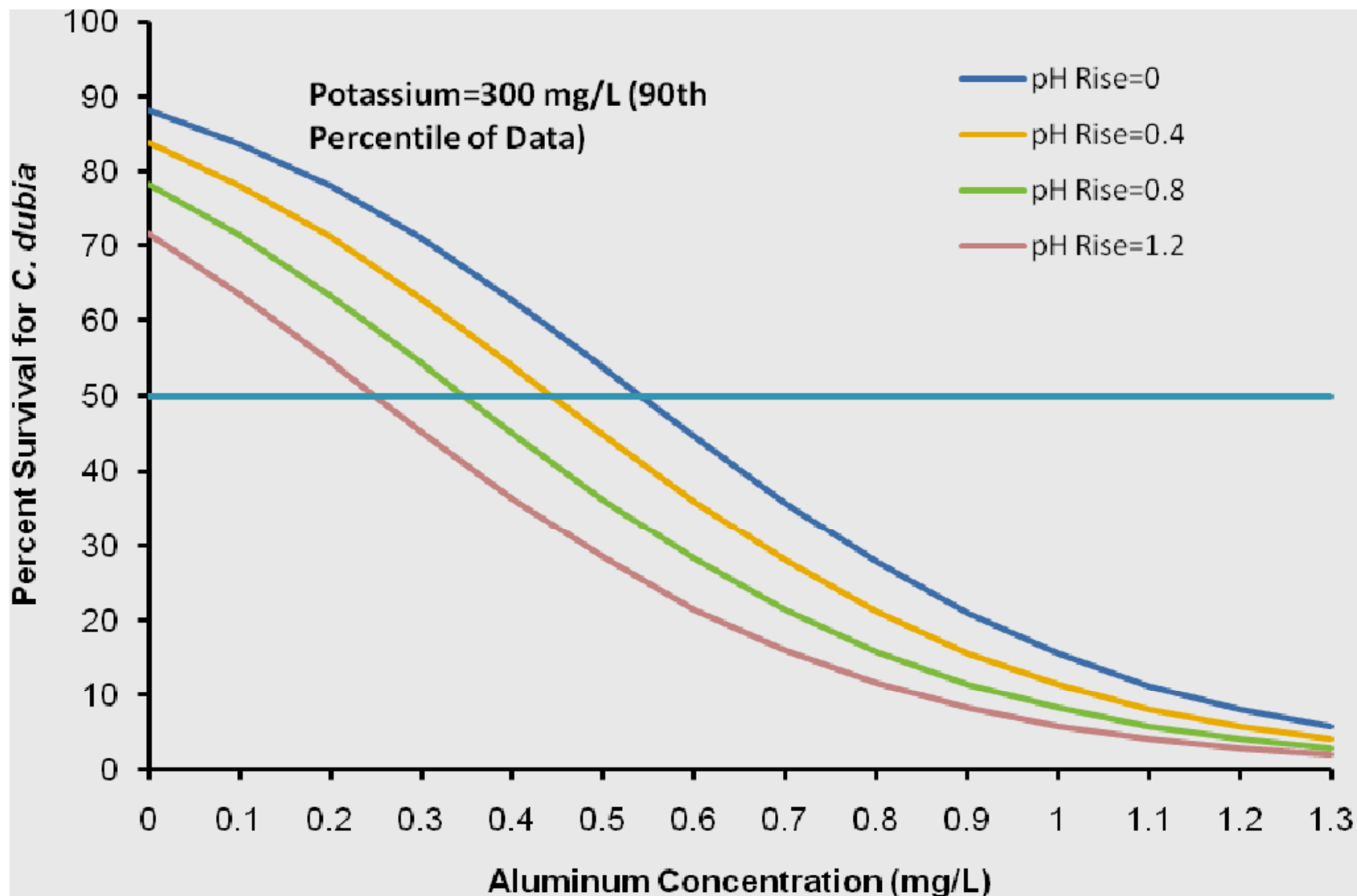


Figure 9. Logistic regression model showing the effect of SMBSC effluent aluminum and potassium levels and pH rise during testing on *C. dubia* survival.



SMBSC WET Testing Findings

- Toxicity limited to *Ceriodaphnia dubia*
- pH rise during testing caused toxicity
 - No sympathy from Regulators
- Conductivity (TDS) directly proportional to toxicity
- Conductivity (TDS) increases sensitivity in organisms
- Aluminum increased toxicity of effluent
- Potassium increased toxicity of effluent
- Ammonia is toxic above 8-9 mg/L in effluent

SMBSC WET Testing Applications

- Increased effluent pH to minimize effect from pH drift during testing.
- Switched Phosphorous removal treatment from Aluminum sulfate to Ferric chloride
- Increased heating capacity at WWTP to assure ammonia control
- Expanded Dissolved Mineral Reduction Program to lower overall TDS

WANTED



Alive!