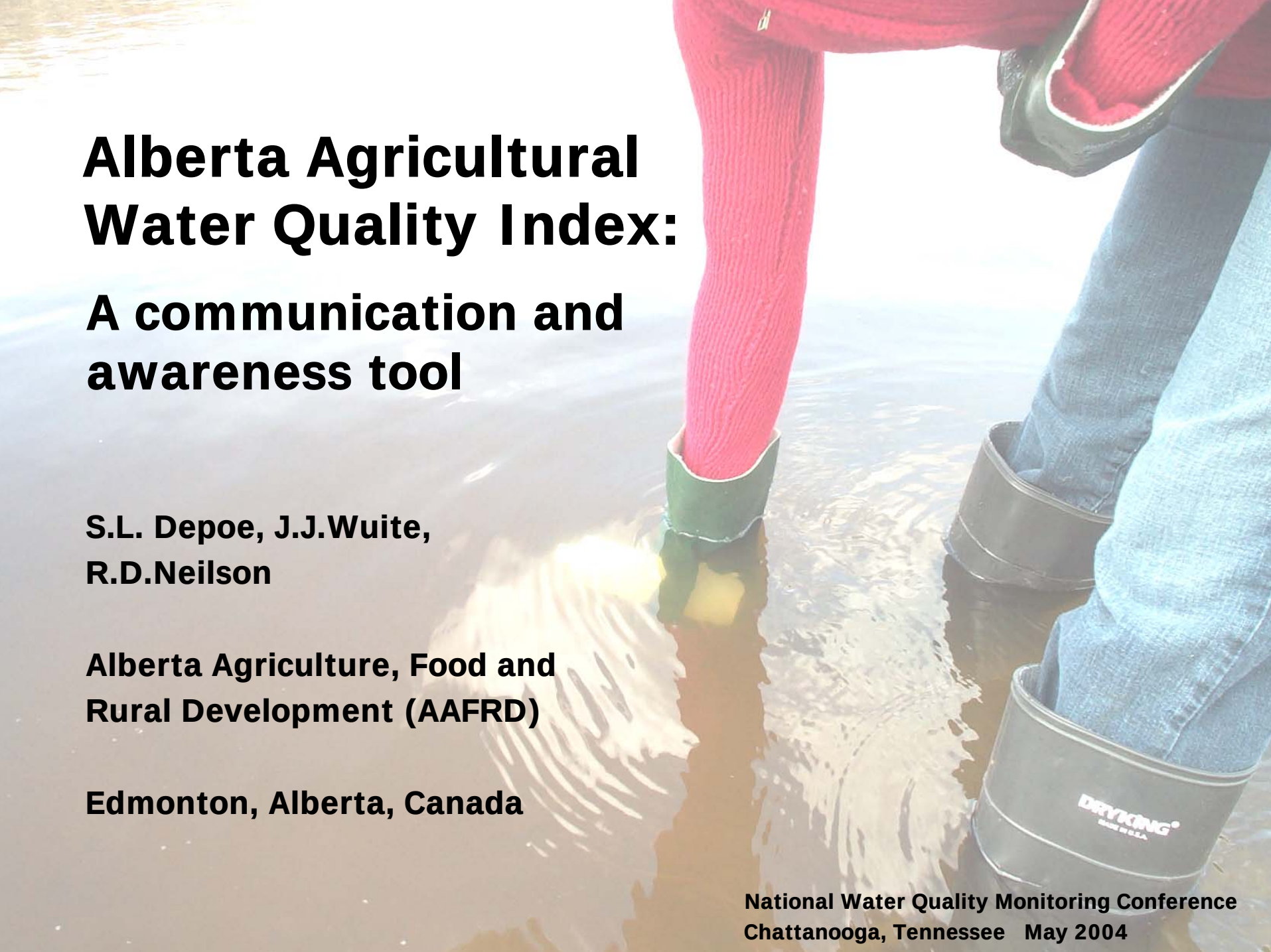
Alberta Agricultural Water Quality Index:

A communication and awareness tool

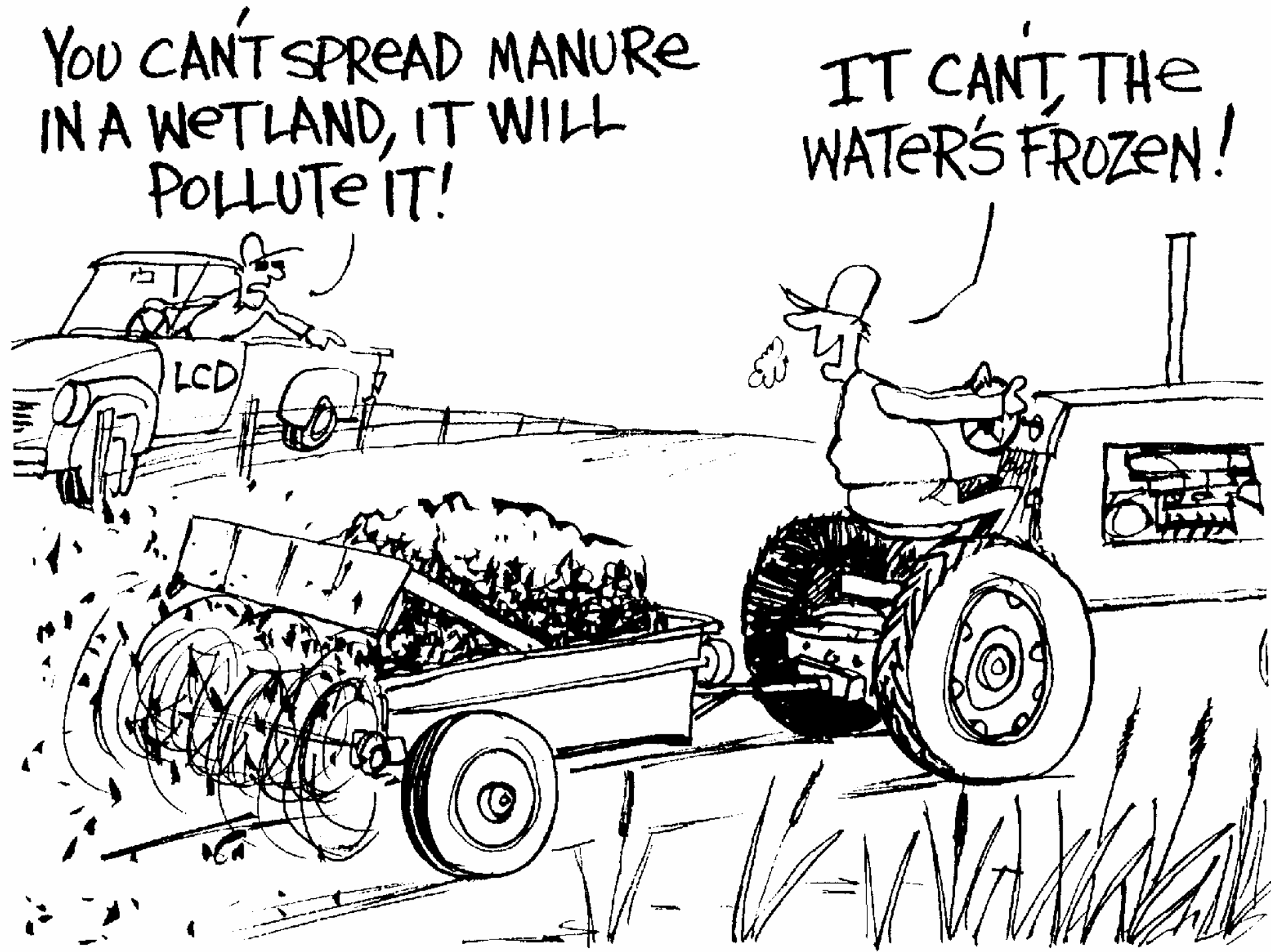
S.L. Depoe, J.J.Wuite, R.D.Neilson

Alberta Agriculture, Food and Rural Development (AAFRD)

Edmonton, Alberta, Canada

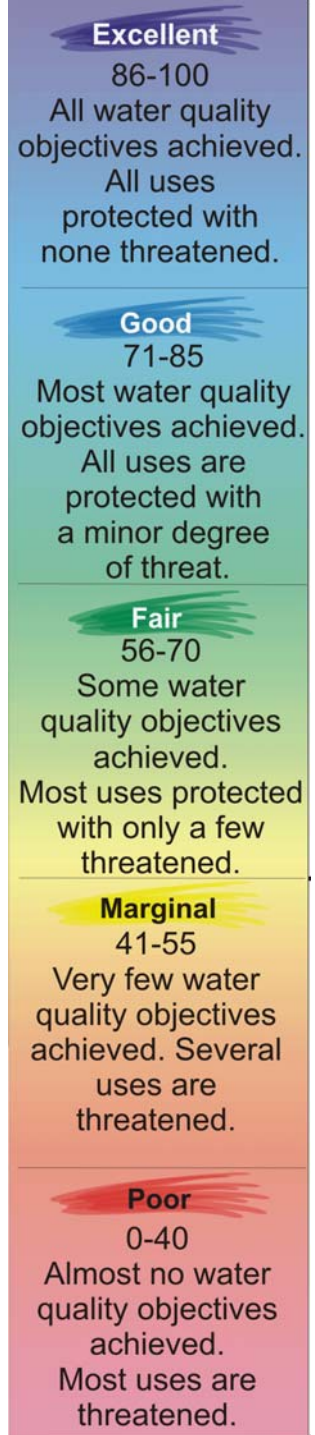


National Water Quality Monitoring Conference
Chattanooga, Tennessee May 2004


YOU CAN'T SPREAD MANURE IN A WETLAND, IT WILL POLLUTE IT!
IT CAN'T, THE WATER'S FROZEN!
LCD

Water Quality Index

- Used as a **tool** to communicate findings of ambient monitoring program
- Education and awareness builds capacity for land stewardship

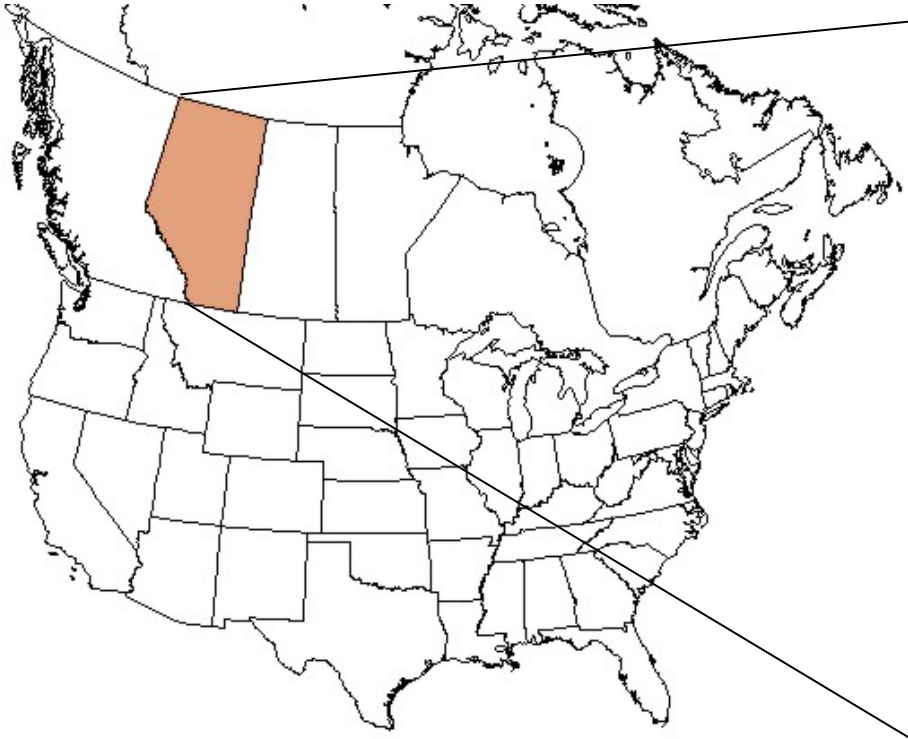


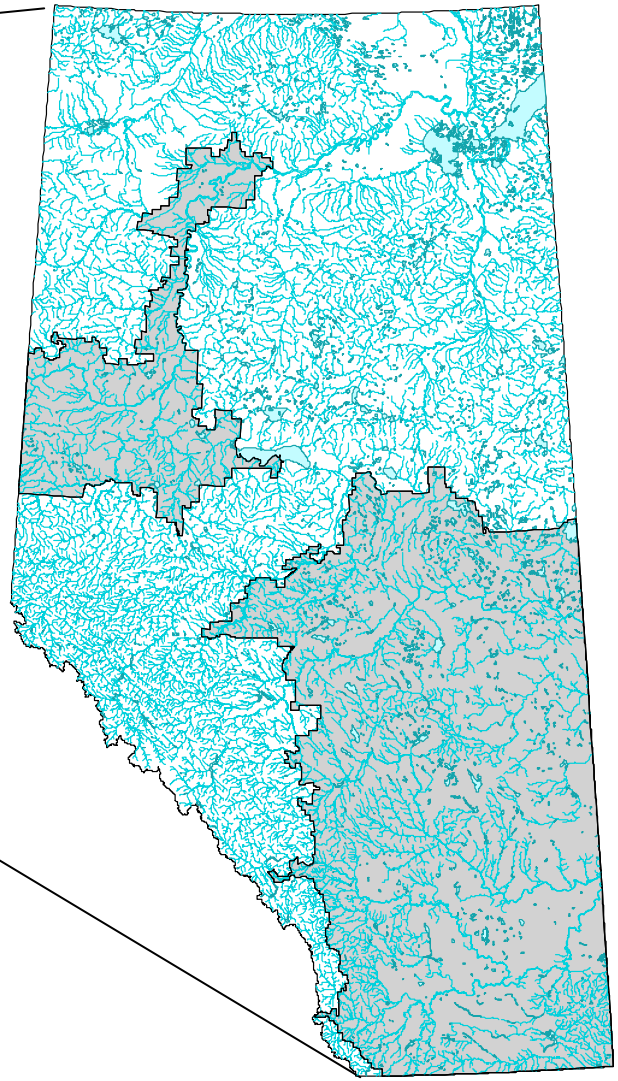
- **Long-term stream monitoring program:**

AESA Stream Survey

AESA
Alberta Environmentally Sustainable Agriculture Program

Alberta
AGRICULTURE, FOOD AND RURAL DEVELOPMENT
ENVIRONMENT
HEALTH AND WELLNESS



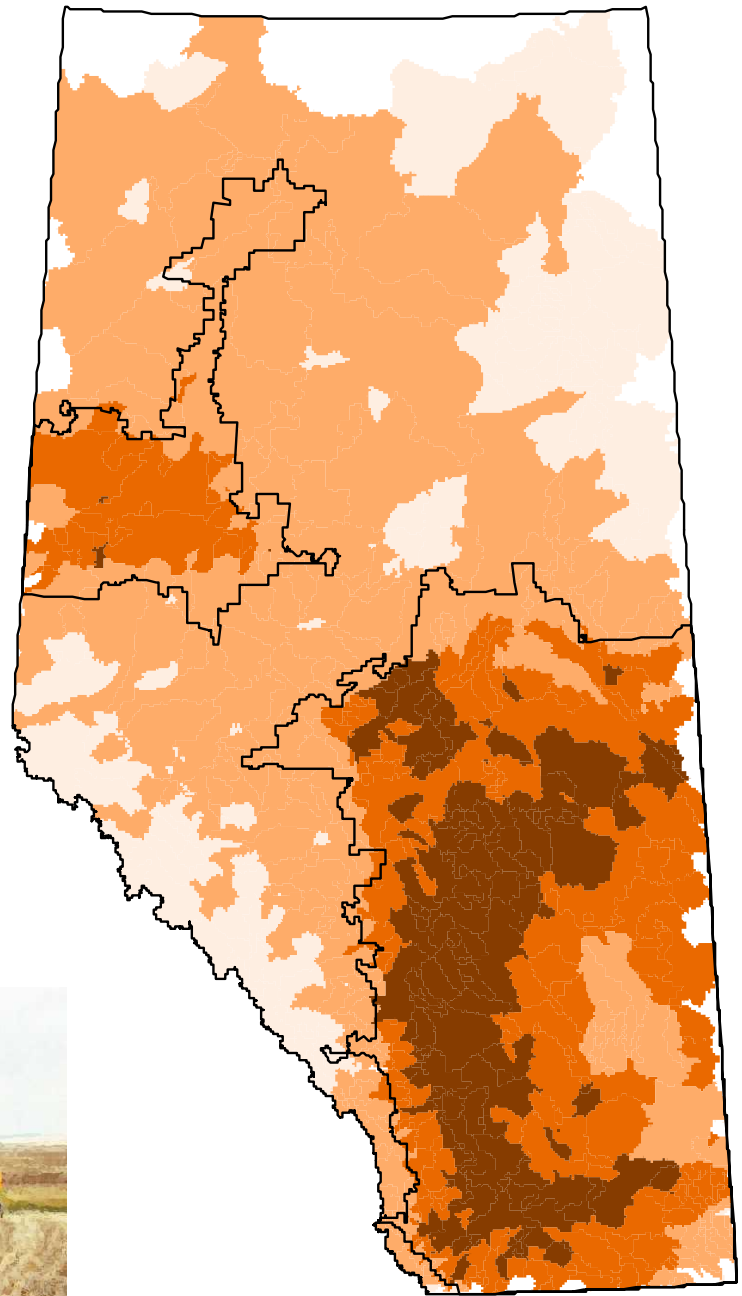


Agricultural Area of Alberta

Background:
Agriculture and Water Quality in Alberta

- Negative correlation between stream water quality and watershed agricultural intensity

(Anderson et al. 1998)

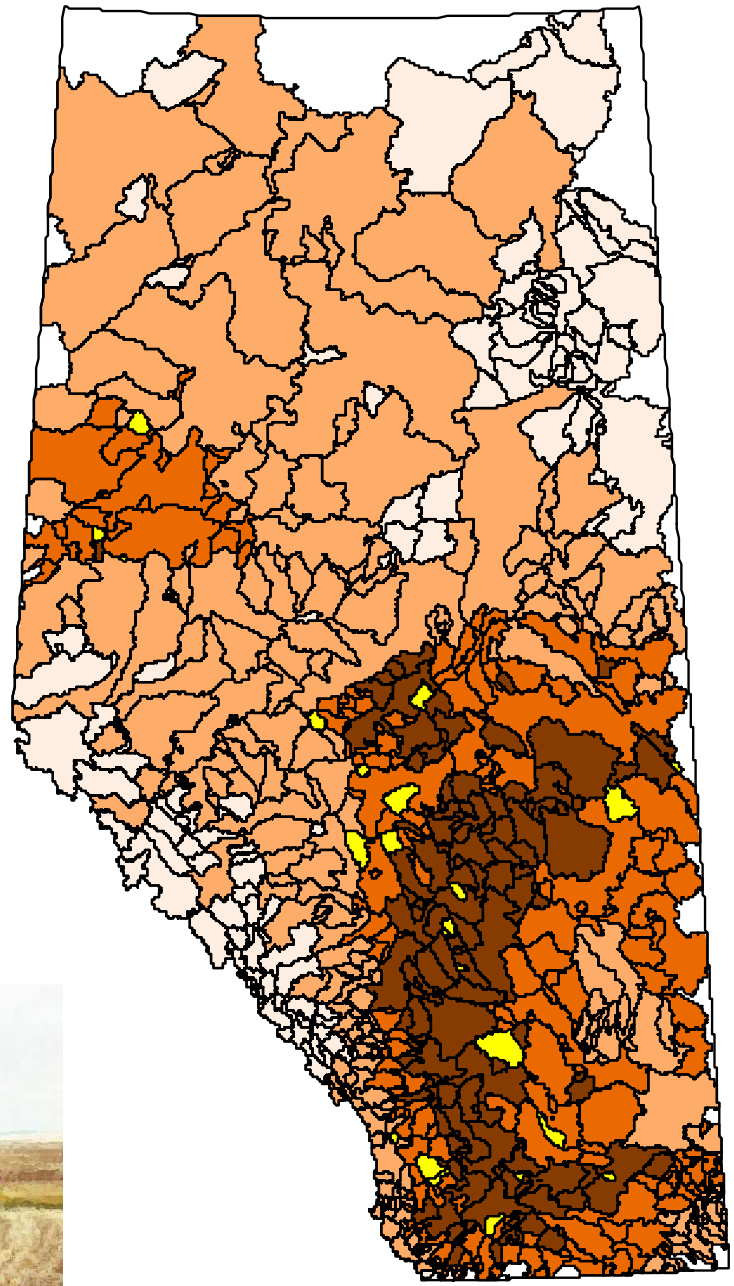


Monitoring Goals

- Assess water quality impacts associated with agriculture in Alberta
- **Improve comprehension water quality issues**
- **Target management efforts**
- Assess trends in stream quality over time

Background:
Agriculture and Water Quality in Alberta

- Watershed selection:
  - Agricultural intensity indicators
  - Climate
  - Soil and landform runoff characteristics
- 23 Study Watersheds



Agricultural Intensity

Parameters

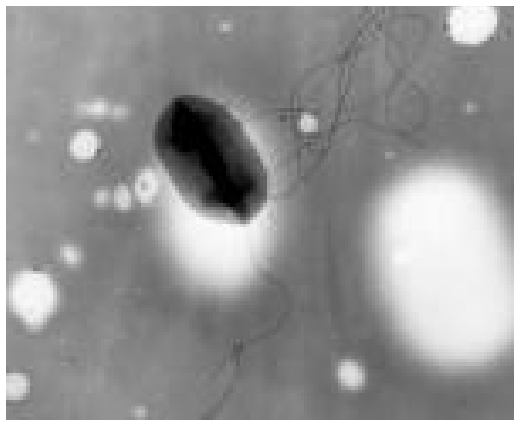
Nutrients

Nitrogen and

Phosphorus

Bacteria

FeCaL COLIFORMS
AND E.COLI



Pesticides

Over 40 compounds

Alberta Agricultural Water Quality Index

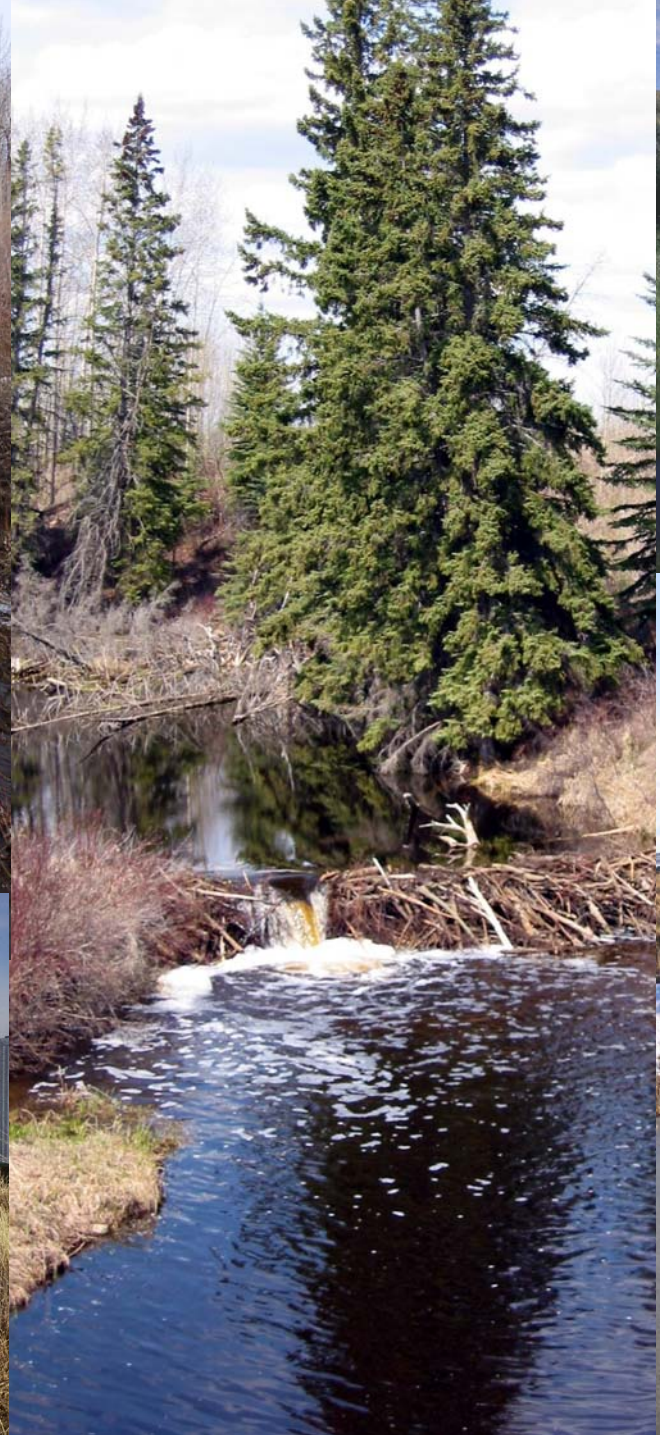
- A simple metric of agricultural WQ stressors
- 30 physico-chemical variables
- Overall Index Score =

  Average of 3 equally-weighted sub-indices

  1. Nutrients
  2. Fecal bacteria
  3. Pesticides
- Ranges from 0 – 100, Poor to Excellent
- Reported annually

Water Quality Objectives

- Baseline conditions – Median concentrations in 27 small agricultural streams sampled from 1995 to 1998
- In most cases, objectives are more stringent than provincial and federal surface water quality guidelines (aquatic life)


AAQWI

average of 3 sub-indices

$$\text{Overall AAWQI} = \frac{\text{Nutrients} + \text{Fecal Bacteria} + \text{Pesticides}}{3}$$

Nutrients	Fecal Bacteria	Pesticides
TP TDP TKN TN NO_2+NO_3-N NH_4-N	fecal coliforms *E. coli*	2,4-D dicamba picloram clopyralid MCPA etc..

Formulation

$$\text{Index Score} = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}\right)$$

- F1: Scope – How many parameters exceeded objectives?
- F2: Frequency – How frequently?
- F3: Amplitude – By how much?

Microsoft Excel - 2003 AESA Stream Survey index calculations -- overall.xls

File Edit View Insert Format Tools Data New Menu S-PLUS Window Help Acrobat

C9 = E. coli

Objectives

400 Objectives maximum

Type "test" in Field "A" for the objective to be included in the Canadian Water Quality Index calculation

A		Water Quality Parameter	Non-compliance if:	Value1	Value 2	Unit	Hardness >=	Hardness <
	1	Chloride Dissolved	>	100		mg/L		
test	2	Coliforms Fecal	>	60		mg/L		
test	3	E. coli	>	60		mg/L		
	4	Copper Total	>	0.01		mg/L		
	5	Iron Dissolved	>	1		mg/L		
	6	Lead Total	>	0.02		mg/L		
	7	Manganese Dissolved	>	0.05		mg/L		
test	8	Nitrogen Dissolved NO3 & NO2	>	0.031		mg/L		
test	9	Nitrogen Total Kjeldahl	>	1.22		mg/L		
	10	Oxygen	<	6		mg/L		

Click Here to **Calculate the CWQI 1.0**

Legal Operators for the

">" If the conditions for non-compliance

"<" If the conditions for non-compliance

"<>" If the conditions for non-compliance fields (order does not matter).

"compute" If you wish to use objectives for NH_3 the **Non-compliance if:** field. The in temperature. The program will searc there are multiple variable names with **"Tested Data"** will display in green h program fails to find pH and Temp fi either missing or character entries eg.

Note: The NH_3 objectives are calculated fo respectively. If data values fall outsid for max or min pH and temperature t values are greater than 35°C, the pro

"hardness" Use this operator for those variables guidelines for each variable are suppo

Data / Instructions / Tested Data / **Objectives** / Output / Excursions

Example:
Nutrient sub-index

Microsoft Excel - 2003 AESA Stream Survey index calculations.xls

File Edit View Insert Format Tools Data New Menu S-PLUS Window Help

F2 =

	Station Name	Sample Date	Index Period	Nitrogen Dissolved NO3 & NO2	Nitrogen Total Kjeldahl	Phosphorous Total Dissolved	Phosphorus Total	Nitrogen Ammonia	Nitrogen Nitrite	Nitrogen Total
4	BATTERSEA DRAIN	#######	2003	1.77	5.11	0.526	0.662	1.57	0.081	6.88
5	BATTERSEA DRAIN	#######	2003	10.2	5.66	2.88	3.28	1.96	0.748	15.86
6	BATTERSEA DRAIN	#######	2003	5.46	10.5	1.51	1.74	1.65	0.49	15.96
7	BATTERSEA DRAIN	#######	2003	0.935	2.1	0.111	0.225	0.872	0.089	3.035
8	BATTERSEA DRAIN	#######	2003	2.19	1.79	0.016	0.086	0.15	0.074	3.98
9	BATTERSEA DRAIN	#######	2003	1.68	1.72	0.011	0.052	0.18	0.068	3.4
10	BATTERSEA DRAIN	#######	2003	3.79	2.33	0.059	0.259	0.326	0.134	6.12
11	BATTERSEA DRAIN	#######	2003	2.43	1.8	0.087	0.142	0.083	0.035	4.23
12	BATTERSEA DRAIN	#######	2003	3.13	2.39	0.049	0.104	0.247	0.076	5.52
13	BATTERSEA DRAIN	#######	2003	2.14	2.01	0.034	0.101	0.089	0.063	4.15
14	BATTERSEA DRAIN	#######	2003	0.068	1.03	0.014	0.074	0.013	L0.01	1.098
15	BATTERSEA DRAIN	#######	2003	0.093	0.61	0.034	0.06	0.009	0.007	0.703
16	BATTERSEA DRAIN	#######	2003	0.063	0.58	0.031	0.092	0.014	0.006	0.643
17	BATTERSEA DRAIN	#######	2003	L0.006	0.4	0.028	0.059	0.011	L0.002	0.4
18	BATTERSEA DRAIN	#######	2003	L0.006	0.36	0.028	0.053	0.016	L0.002	0.36
19	BATTERSEA DRAIN	#######	2003	0.041	0.4	0.04	0.067	0.024	0.007	0.441
20	BATTERSEA DRAIN	#######	2003	L0.006	0.46	0.019	0.041	0.033	L0.002	0.46
21	BATTERSEA DRAIN	#######	2003	0.008	0.44	0.013	0.05	0.021	L0.002	0.448
22	BATTERSEA DRAIN	#######	2003	0.072	0.47	0.009	0.056	0.019	0.004	0.542
23	BATTERSEA DRAIN	#######	2003	2.75	1.07	0.016	0.012	0.549	0.097	3.82

$$\frac{\text{Nutrients} + \text{Fecal Bacteria} + \text{Pesticides}}{3} = \text{Overall AAWQI}$$

37 → Poor

55 → Marginal

85 → Good

59 → Fair

AESA Stream Survey

Watershed Report

Provincial Overview of Watersheds in 2002

Snapshot of the Watersheds

AESA *Stream Survey* currently monitors water quality in 23 small agricultural watersheds across the province. These watersheds were selected to cover the range of agricultural intensities and runoff characteristics in Alberta (Figure 1).

Watersheds are grouped into dryland and irrigation categories, and dryland watersheds are further classified on the basis of farming intensity (e.g. low, moderate or high intensity). These watersheds are distributed throughout the province to cover the various ecoregions, and reflect the diverse climate, geology and physical characteristics in Alberta.

For more details on how the watersheds were selected, see the AESA Stream Survey factsheet *Watershed Selection Process*.

Monitoring Water Quality

All watersheds are sampled near Water Survey of Canada gauging stations. These gauging stations provide important information on the duration and volume of stream flow.

Samples are collected every year throughout the spring, summer and fall, and are analyzed for nutrients, bacteria, pesticides, and other physical and chemical characteristics. The sampling is designed to monitor non-point source pollution (i.e. runoff pollution).

For more details on sampling methods, see the following factsheets in the AESA Stream Survey series:

- *Nutrient Monitoring*
- *Pesticide Monitoring*
- *Fecal Bacteria Monitoring*

Interpreting the Data

Comparison to Guidelines: Stream data are compared to water quality guidelines as one way of evaluating stream water quality. A water quality guideline is the recommended concentration of a substance in water, or a narrative statement that describes the required water quality for a particular use. Guidelines define water quality according to the use of the water, such as for drinking water, livestock watering, recreation, or the protection of aquatic life.

Water quality guidelines are developed by federal and provincial agencies, and are a work in progress. As a result, some substances presently have either no guidelines or guidelines for only a few uses.

Index Scores: The water quality of each stream is also evaluated each year against established water quality objectives. The objectives represent baseline concentrations typically found in small agricultural streams. Baseline concentrations were determined based on five years of data from province-wide studies on agricultural watersheds.

A mathematical formula compares the data to the objectives, and converts the complex data into simple index scores of excellent, good, fair, marginal and poor. The index scores represent how much and how often stream water quality deviated from the objectives.

Trend Analysis: Every five years beginning in 2001, the data will be examined for trends to see if water quality is improving, deteriorating, or staying the same in each watershed. This information will help the industry keep track of progress as producers change practices to protect water quality.

Excellent
86-100
All water quality objectives achieved. All uses protected with none threatened.

Good
71-85
Most water quality objectives achieved. All uses are protected with a minor degree of threat.

Fair
56-70
Some water quality objectives achieved. Most uses protected with only a few threatened.

Marginal
41-55
Very few water quality objectives achieved. Several uses are threatened.

Poor
0-40
Almost no water quality objectives achieved. Most uses are threatened.

Successes

- Simple and concise
- Measures against own baseline
- Sub-indices address issue of index dilution
- Flags areas of concern for further investigation, and helps target management efforts

  e.g. Nutrient Score = Poor

Limitations / Improvements

- Annual index score affected by flow regime due to flow-proportionate design
- Number of pesticide included in index exceeds the number detected in streams (diluting the index)
- Covarying parameters – necessary to include all?

Water Quality Indices....

- Provide a meaningful summary of overall water quality in a single number and/or narrative statement

- Are not a stand-alone tool for managing water bodies

Alberta
AGRICULTURE, FOOD AND RURAL DEVELOPMENT

AESA

Sarah Depoe
Water Quality Specialist
sarah.depoe@gov.ab.ca
Edmonton, Alberta
(780) 432-5975