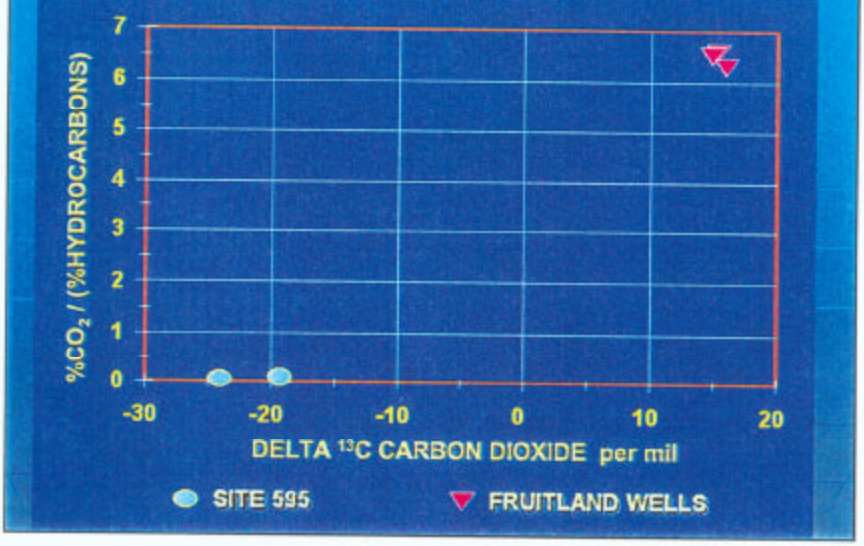
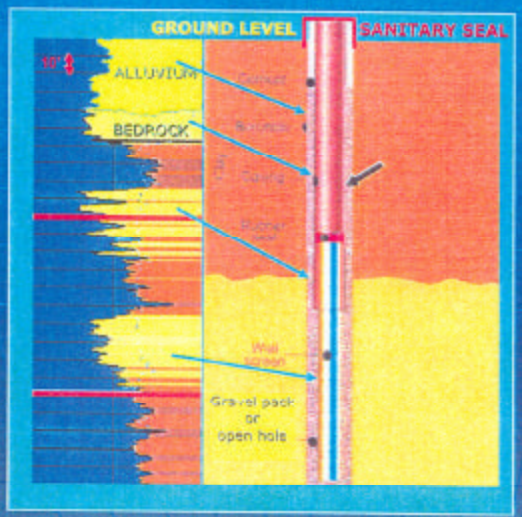
112-180

01621647

SITE 595 DELTA ^{13}C VALUES OF CO_2 DO NOT CORRESPOND WITH FRUITLAND CO_2

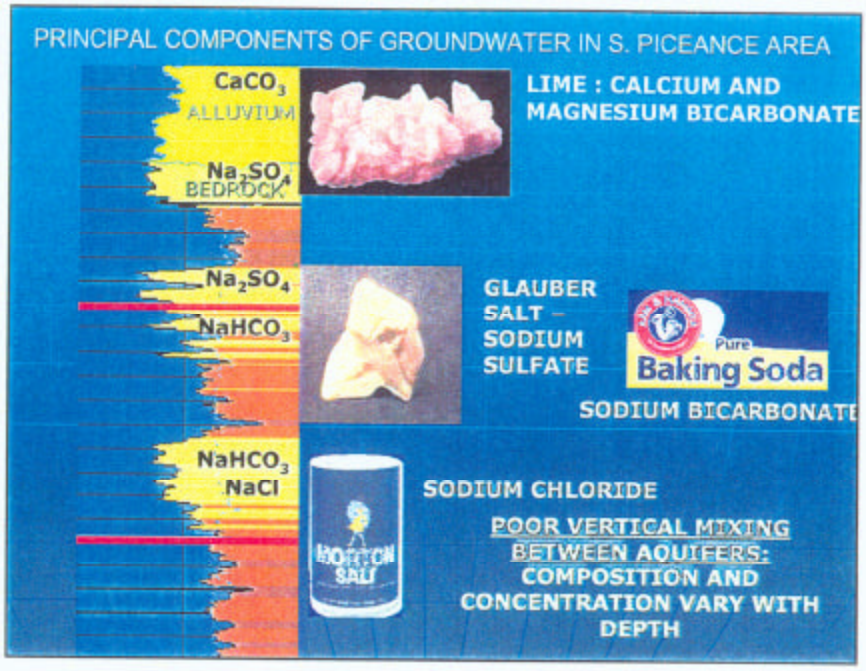


TYPICAL WELL BORE CONSTRUCTION FOR THIS AREA OF GARFIELD COUNTY



DEPENDING ON CONSTRUCTION, WATER CAN ORIGINATE FROM MULTIPLE SOURCES

http://www.ngwa.org/pdf/wellsystemmaterials.pdf

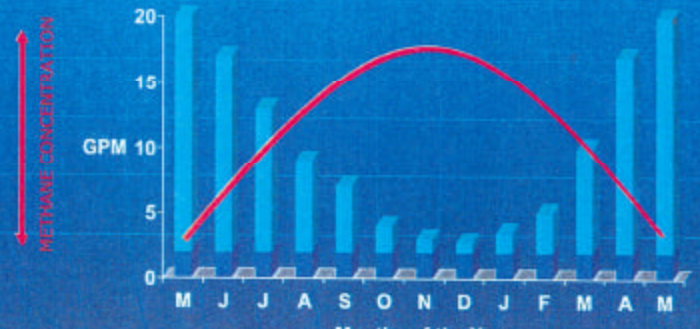

PRINCIPAL COMPONENTS OF GROUNDWATER IN S. PICEANCE AREA
$CaCO_3$
ALLUVIUM
Na_2SO_4
BEDROCK
LIME : CALCIUM AND MAGNESIUM BICARBONATE
Na_2SO_4
$NaHCO_3$
GLAUBER SALT – SODIUM SULFATE
Pure
Baking Soda
SODIUM BICARBONATE
$NaHCO_3$
NaCl
SODIUM CHLORIDE
POOR VERTICAL MIXING BETWEEN AQUIFERS: COMPOSITION AND CONCENTRATION VARY WITH DEPTH


DISSOLVED SALT AND METHANE CONCENTRATIONS IN WELL WATER CHANGE PRINCIPALLY AS A RESULT OF CHANGING MIXING RATES
Pure
Baking Soda
DILUTE
CONCENTRATED

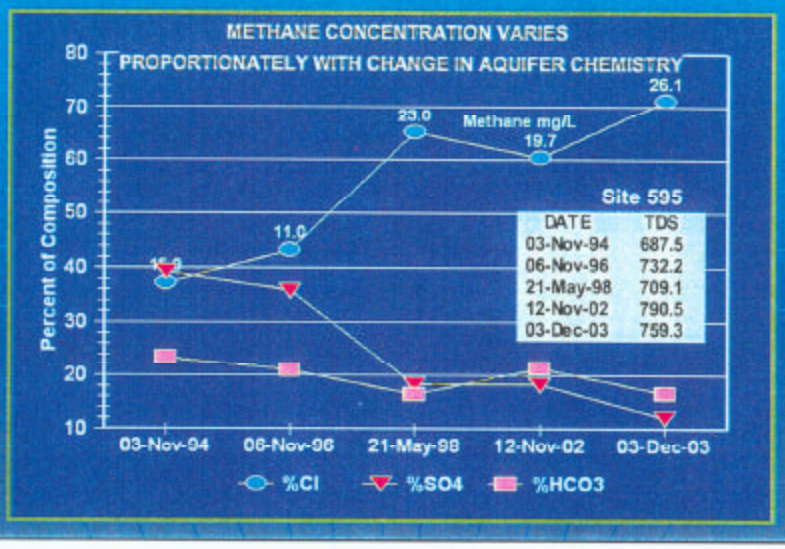
REDUCTION IN YIELD RATES FROM ANY SINGLE AQUIFER WILL CHANGE WATER COMPOSITION

A SINGLE SAMPLE ANALYSIS IS MERELY A "SNAPSHOT" OF EXISTING WELLBORE CONDITIONS

CHANGING RELATIVE AMOUNTS OF WATER FROM EACH SOURCE WILL CHANGE METHANE CONCENTRATION

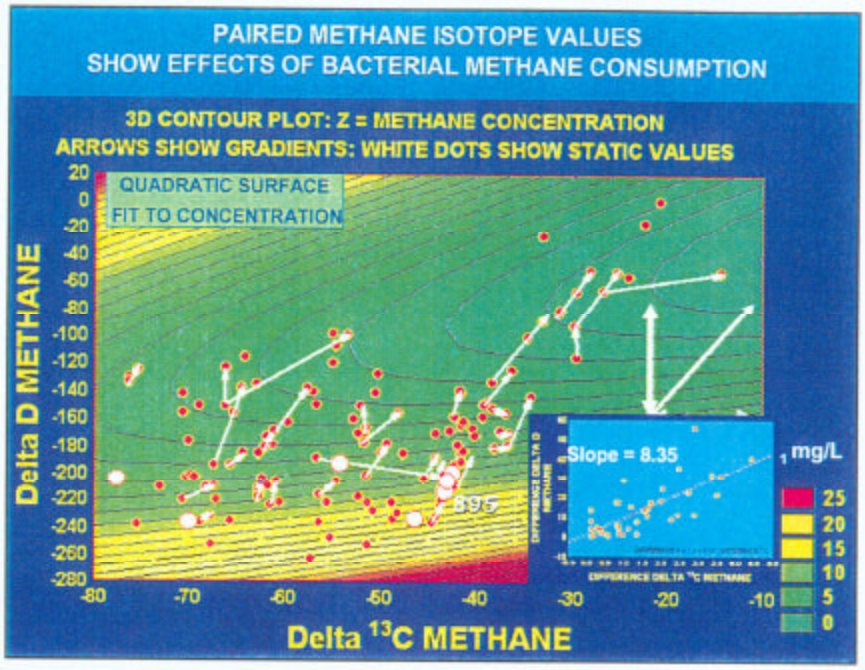


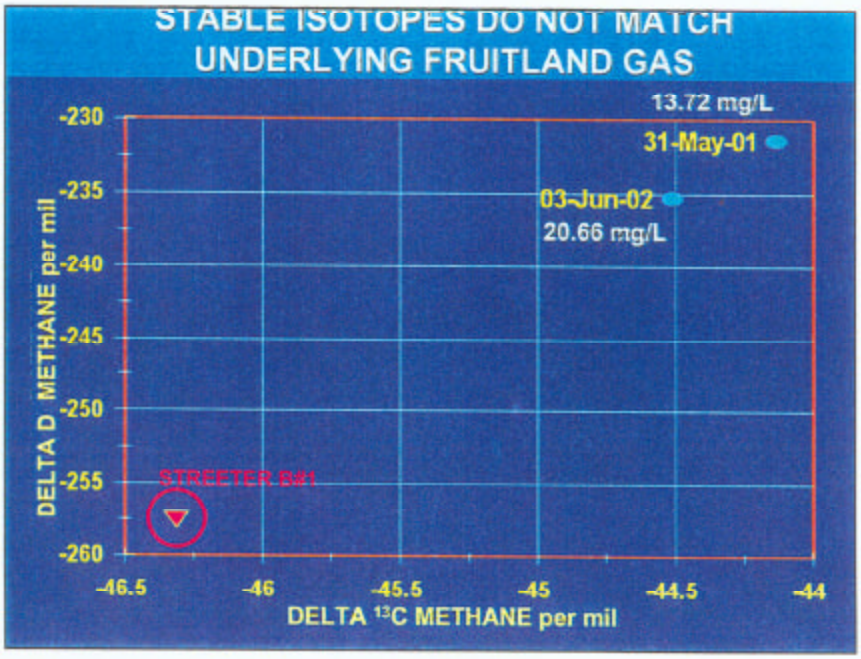
THE EFFECTS OF WELLBORE MIXING AND DILUTION ON DISSOLVED METHANE CONCENTRATION

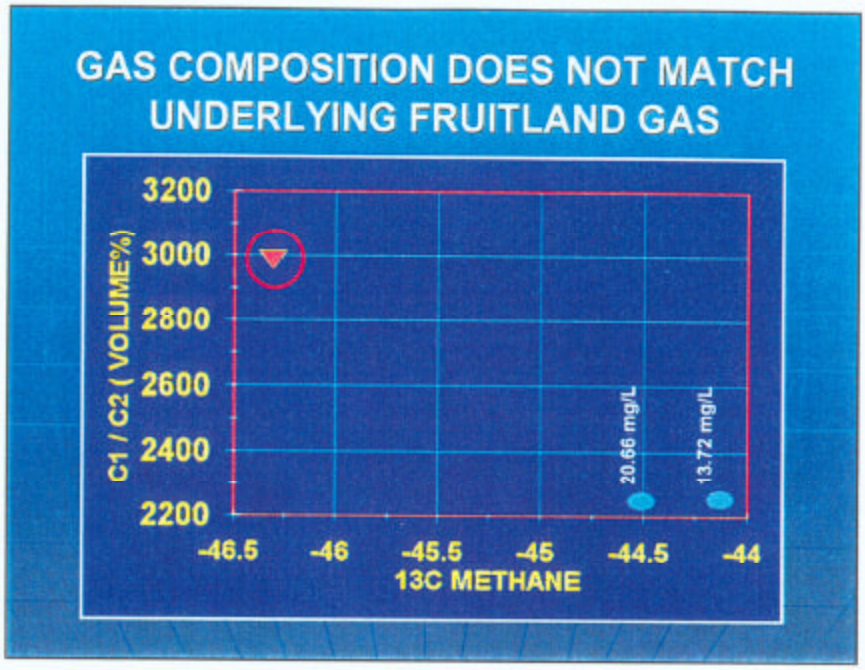


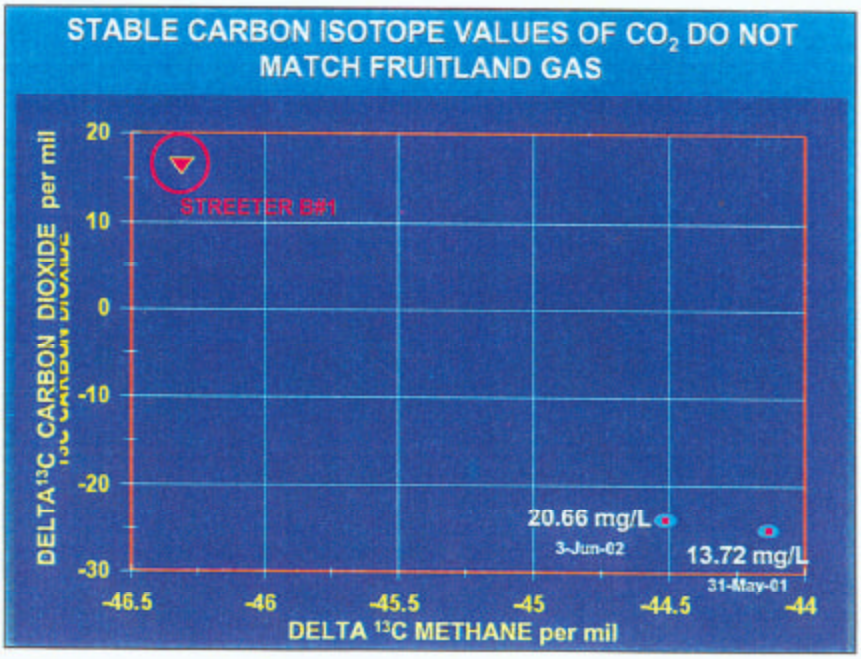
METHANE LOSS DUE TO BACTERIAL CONSUMPTION (METHANE OXIDATION)

- **DECREASING METHANE CONCENTRATION**
- **ENRICHMENT OF ^{13}C ISOTOPES IN METHANE (less negative values)**
- **DEPLETION OF ^{13}C ISOTOPES OF CO_2 (more negative values)**


PAIRED METHANE ISOTOPE VALUES
SHOW EFFECTS OF BACTERIAL METHANE CONSUMPTION
3D CONTOUR PLOT: Z = METHANE CONCENTRATION
ARROWS SHOW GRADIENTS: WHITE DOTS SHOW STATIC VALUES
QUADRATIC SURFACE
FIT TO CONCENTRATION
Delta D METHANE
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-80
-70
-60
-50
-40
-30
-20
-10
Delta 13C METHANE
Slope = 8.35
mg/L
25
20
15
10
5
0


STABLE ISOTOPES DO NOT MATCH
UNDERLYING FRUITLAND GAS
13.72 mg/L
31-May-01
03-Jun-02
20.66 mg/L
STREETER #1
DELTA D METHANE per mil
-230
-235
-240
-245
-250
-255
-260
-46.5
-46
-45.5
-45
-44.5
-44
DELTA 13C METHANE per mil


GAS COMPOSITION DOES NOT MATCH UNDERLYING FRUITLAND GAS
C1 / C2 (VOLUME%)
3200
3000
2800
2600
2400
2200
-46.5
-46
-45.5
-45
-44.5
-44
13C METHANE
20.66 mg/L
13.72 mg/L

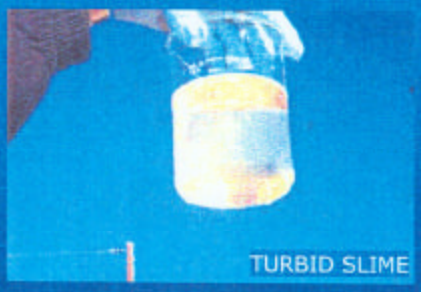

STABLE CARBON ISOTOPE VALUES OF CO_2 DO NOT MATCH FRUITLAND GAS
DELTA 13C CARBON DIOXIDE per mil
20
10
0
-10
-20
-30
STREETER B#1
20.66 mg/L
3-Jun-02
13.72 mg/L
31-May-01
-46.5
-46
-45.5
-45
-44.5
-44
DELTA 13C METHANE per mil

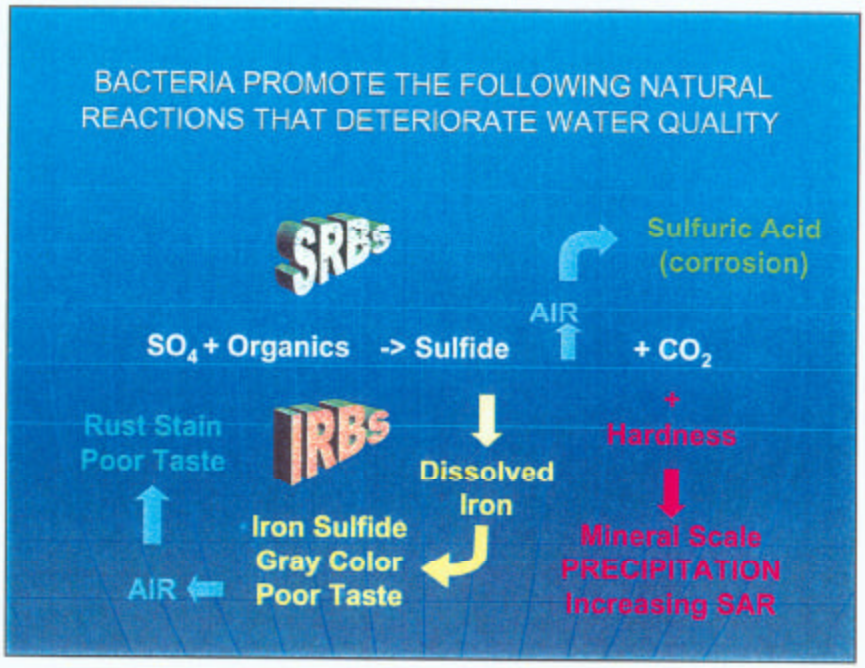
OPTIONAL ADDITIONAL DRILLING OF FRUITLAND GAS WELLS HAS NOT HAD ANY DISCERNIBLE IMPACT ON DISSOLVED METHANE CONCENTRATIONS IN GROUNDWATER

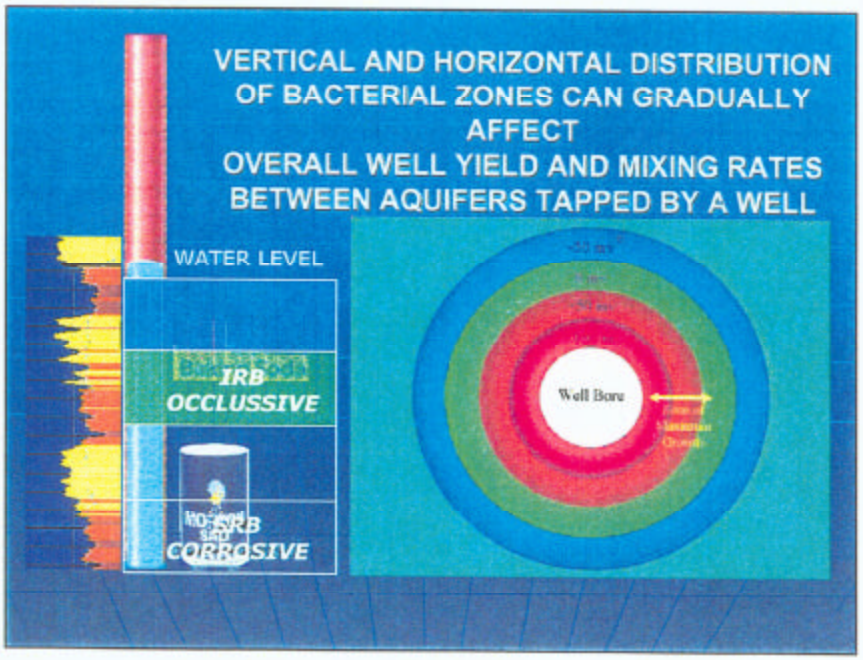
- **VARIABILITY IN METHANE CONCENTRATION IS DUE TO:**
  - SAMPLING AND ENVIRONMENTAL FACTORS
  - MIXING OF WATER FROM DIFFERENT AQUIFERS WITHIN A WATER WELL
  - METHANE OXIDATION BY METHANOTROPHIC BACTERIA
- **SAMPLING AND ANALYSIS METHODOLOGY IS EFFECTIVE AND USEFUL**

BACTERIA CAN SEVERLY IMPACT WELL WATER QUALITY AND QUANTITY

WELL CLOGGING MEDIATED BY BACTERIA




BACTERIA PROMOTE THE FOLLOWING NATURAL REACTIONS THAT DETERIORATE WATER QUALITY
SRBs
Sulfuric Acid (corrosion)
AIR
SO_4 + Organics -> Sulfide
+ CO_2
+
Hardness
Rust Stain
Poor Taste
IRBs
Dissolved Iron
Iron Sulfide
Gray Color
Poor Taste
AIR
Mineral Scale
PRECIPITATION
Increasing SAR


VERTICAL AND HORIZONTAL DISTRIBUTION OF BACTERIAL ZONES CAN GRADUALLY AFFECT
OVERALL WELL YIELD AND MIXING RATES BETWEEN AQUIFERS TAPPED BY A WELL
WATER LEVEL
IRB
OCCLUSSIVE
CORROSIVE
Well Bore

BACTERIAL SLIME COATINGS FOUL WELL SCREENS BLOCKING ACCESS TO RECHARGING WATER

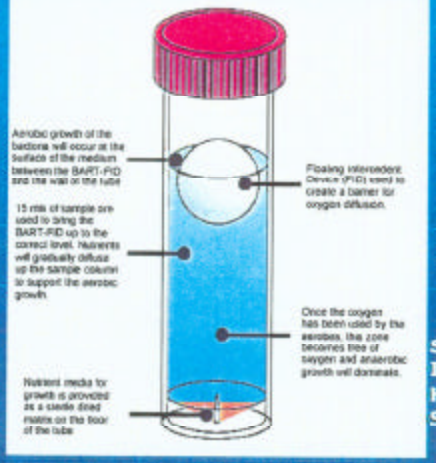
http://www.variperm.com/waterwell.htm

EXAMPLE OF SLIME COATINGS IN WELLS 20 FEET APART

DEEP WELL

SHALLOW WELL

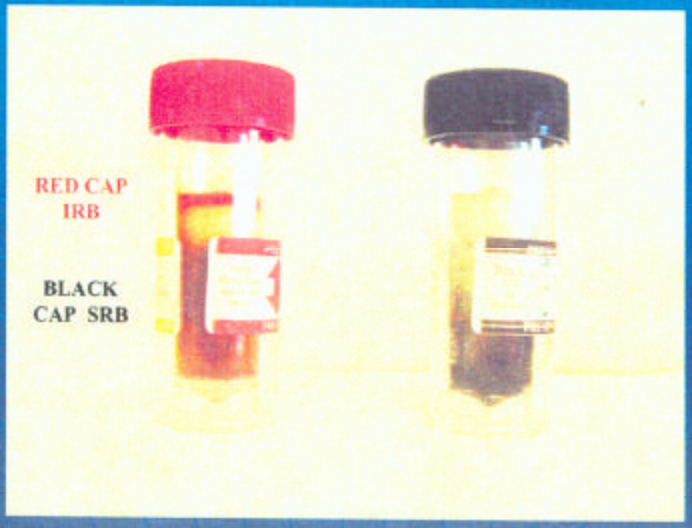
BIOLOGIC ACTIVITY REACTION TESTS (BART™) TO CHECK FOR PRESENCE OF BACTERIA



SRB – SULFATE REDUCING BACTERIA
IRB – IRON RELATED BACTERIA
HAB –HETEROTROPHIC AEROBIC
SLYM –SLIME FORMING BACTERIA

From: Biological Activity Reaction Test BART™User Manual
©2003 Edition, Droycon Bioconcepts Inc.Regina, Saskatchewan, Canada

REACTING BART SAMPLES



RELATIONSHIP BETWEEN TIME LAG (IN DAYS TO FIRST REACTION) AND BACTERIAL COLONY-FORMING UNITS (CFU)

TIME LAG (days)	IRB CFU	SRB CFU	HAB CFU	SLYM CFU	RANKING
0.5	3,981,072	3,981,072	6,309,573	6,309,573	EXTREMELY AGGRESSIVE
1.0	1,000,000	1,000,000	3,981,072	3,981,072	VERY AGGRESSIVE
1.5	630,957	630,957	630,957	630,957	AGGRESSIVE
2.0	100,000	100,000	398,107	398,107	
3.0	10,000	39,811	1,000	39,811	
4.0	3,981	10,000	100	1,000	POTENTIALLY AGGRESSIVE
5.0	1,000	3,981	10	398	
6.0	100	1,000	10	100	LOW AGGRESSIVITY
7.0	100	100	10	10	
8.0	100	100	10	10	

SUMMARY

- MOST WELLS SHOW EVIDENCE OF SIGNIFICANT BACTERIAL INFECTION
- WATER WELLS WITH LOW YIELDS ARE SUSCEPTIBLE TO BACTERIALLY-MEDIATED DAMAGE
  - INABILITY TO RECHARGE WELL
  - POOR WATER QUALITY, COLOR, ODOR, TASTE
- WATER WELLS SHOULD BE REGULARLY TREATED AND MAINTAINED