WILLOW CREEK WATERSHED AQUIFER MAPPING AND GROUNDWATER MANAGEMENT PLANNING STUDY

David van Everdingen and Darren David
Waterline Resources Inc.

April 11, 2013
Water Technologies Symposium 2013

OLDMAN WATERSHED COUNCIL
watershed management – watershed health

Waterline Resources Inc.

Presentation Outline

- Conceptual Hydrogeological Model
  - Hydrology
  - Surficial and Bedrock Geology
  - Aquifers and Conceptual Model
  - Water Diversion and Use
  - Groundwater Budget
  - Water Quality Assessment
- Knowledge and Data Gaps

Waterline Resources Inc

Water well records
in watershed = 2,164

ESRD Water Well Information Database Records

Waterline Resources Inc

District	1996	2006	%Δ
Clareshol m	3,42 7	3,700	+8
Granum	337	415	+23
MD 26	5,106	5,337	+5
MD 66	108	86	-20

Type	Population
Urban	8,737
Rural	5,665

How many live in the watershed?

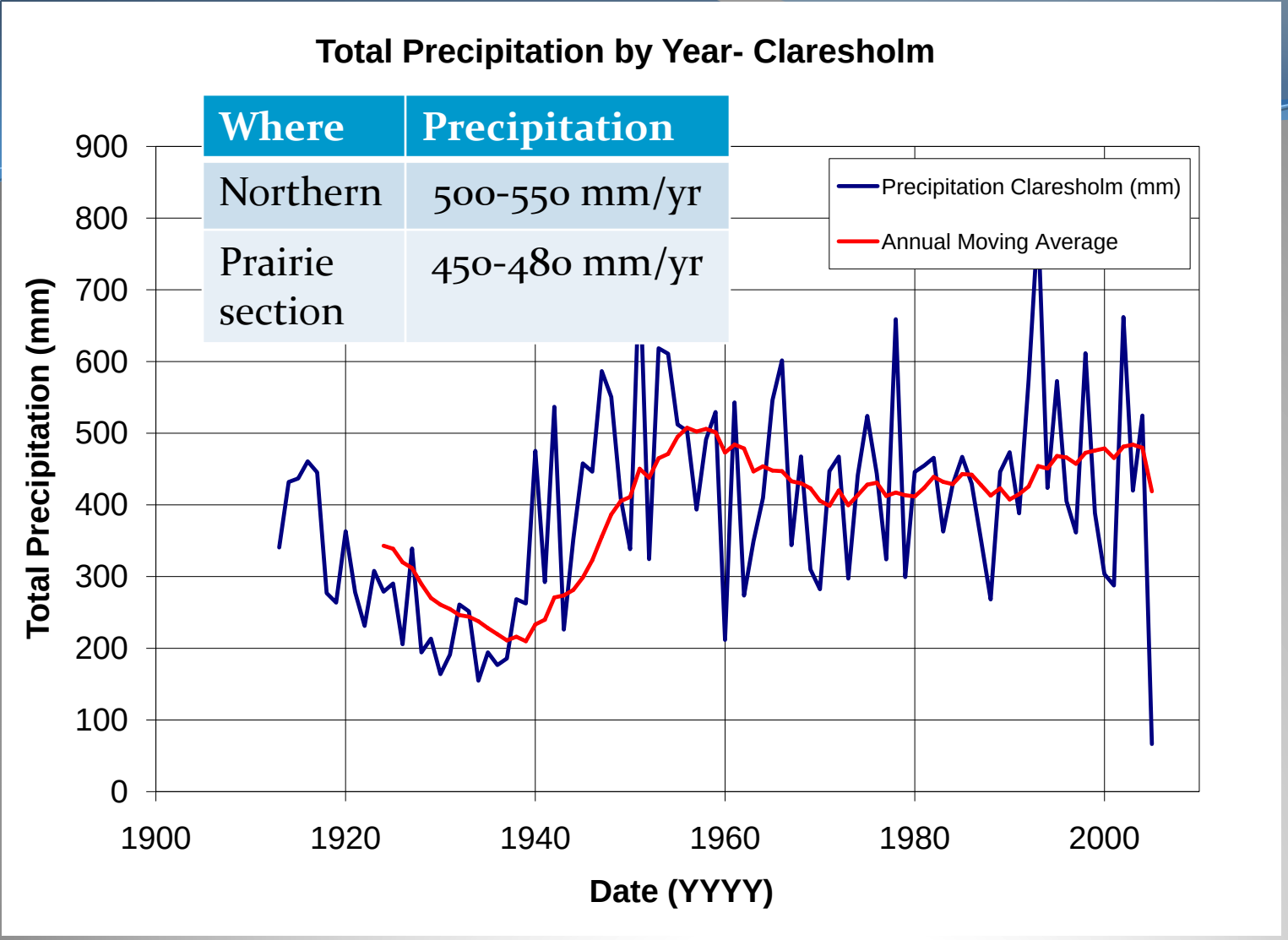
Waterline Resources Inc

Land Cover (in 2000)

Waterline Resources Inc

Topography

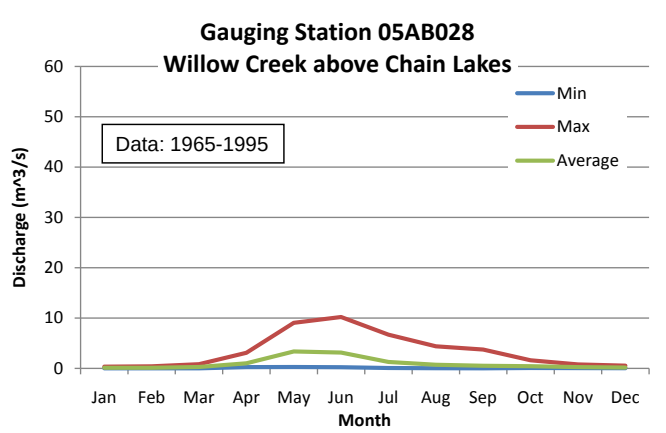
Waterline Resources Inc

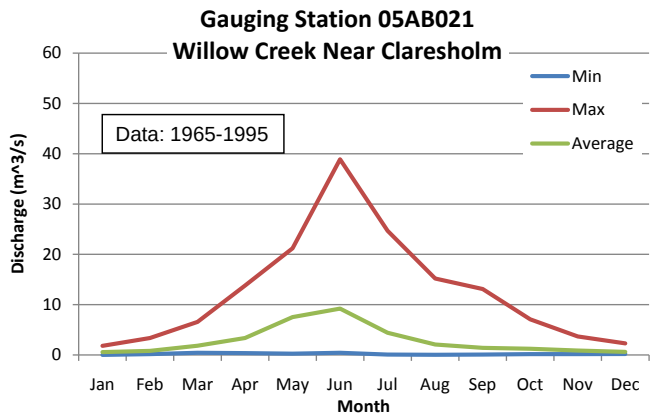


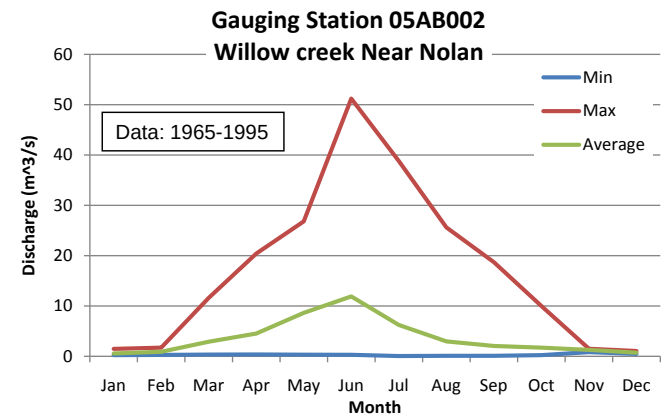
Where	Precipitation
Northern	500-550 mm/yr
Prairie section	450-480 mm/yr

Precipitation

Waterline Resources Inc



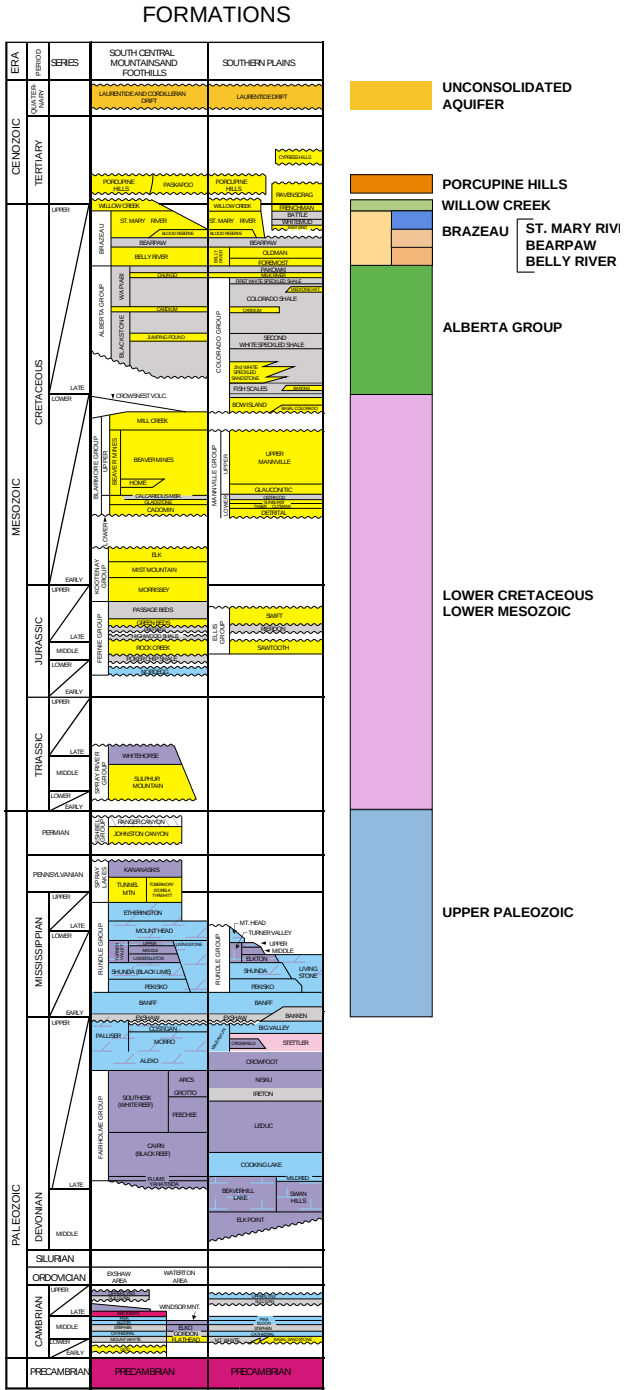


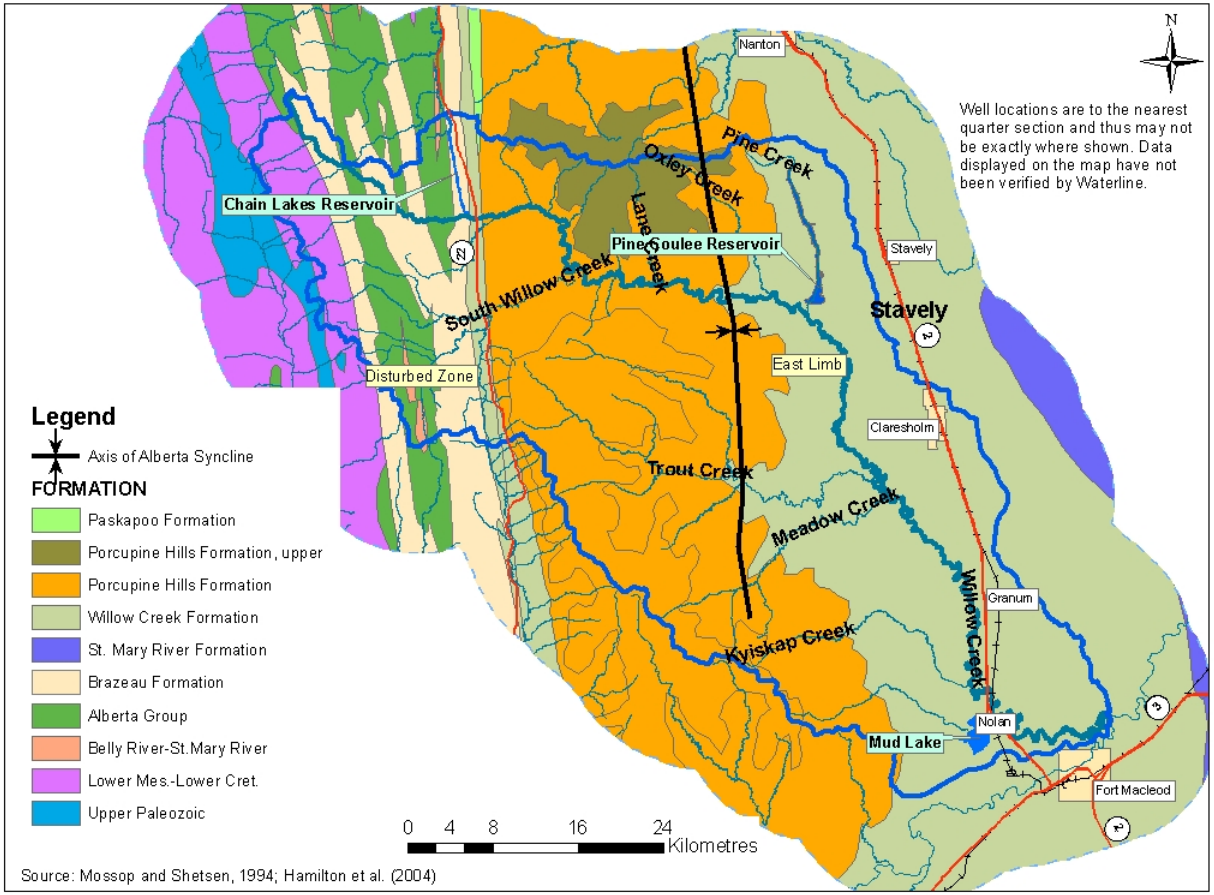


Willow Creek monitoring

Source: AMEC, 2010

Waterline Resources Inc





Bedrock Geology

Waterline Resources Inc.

Lithology at Screen	#
Unconsolidated	161
Unconsol./Bedrock	40
Bedrock	679
No lithology	1,284

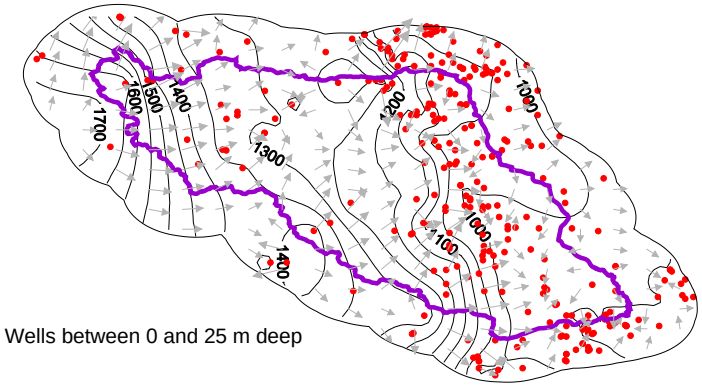
Unconsolidated and Bedrock Water Well Records

Waterline Resources Inc

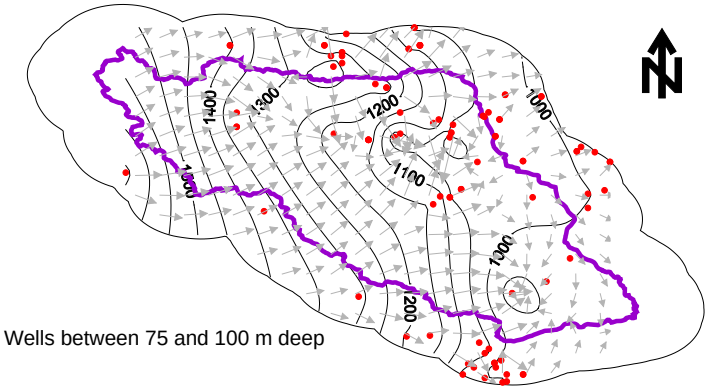
Well Test Yield and Aquifer Yield

Formation	Apparent Transmissivity	# Values
Unconsolidated	84.6	56
Porcupine Hills	14.3	115
Willow Creek	5.3	409
St. Mary River	3.6	11

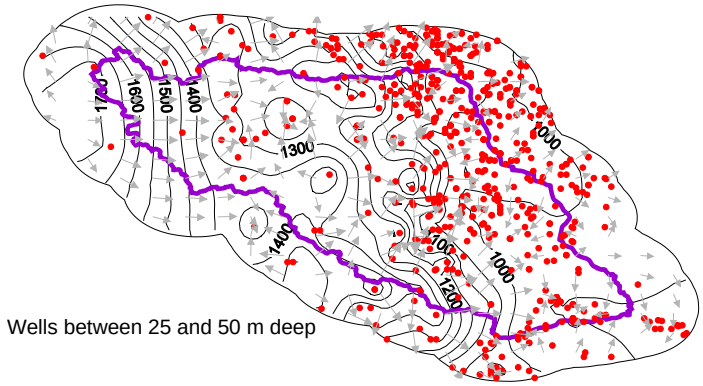
Waterline Resources Inc



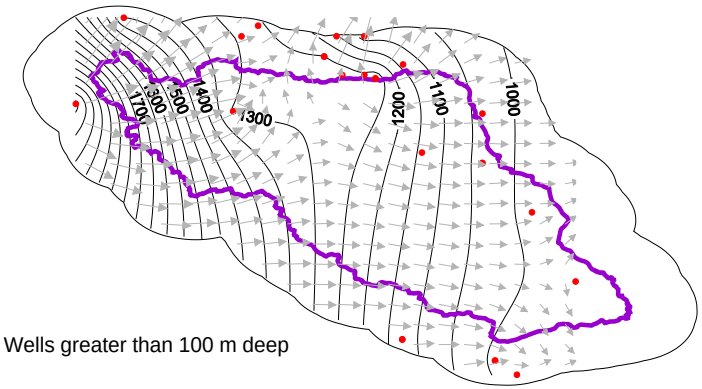
Wells between 0 and 25 m deep



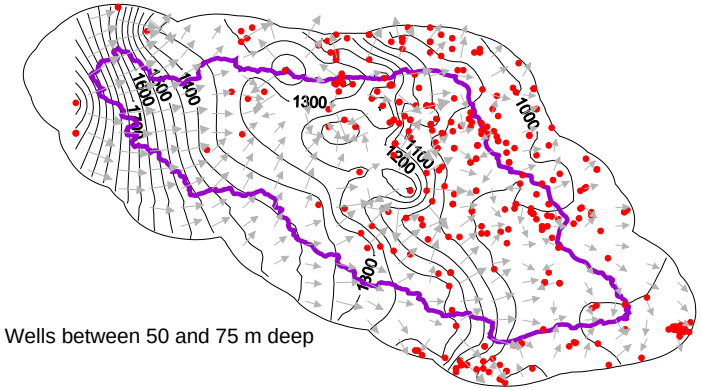
Wells between 75 and 100 m deep



Wells between 25 and 50 m deep



Wells greater than 100 m deep



Wells between 50 and 75 m deep

0 10 20 30 40 50km

Water level elevation in m above sea level
Contour interval = 50 metres
Grey Arrows = groundwater gradient direction
Red circles show well record locations
Purple line is watershed boundary
Bounding line is 10 km buffer outside watershed boundary

Horizontal Hydraulic Gradients

Waterline Resources Inc

Springs in the Watershed

Waterline Resources Inc

Depth to Bedrock (mBG)

Waterline Resources Inc

Wells in Pre-Glacial Valley	#
Unconsolidated	56
Bedrock	94
No lithology	187

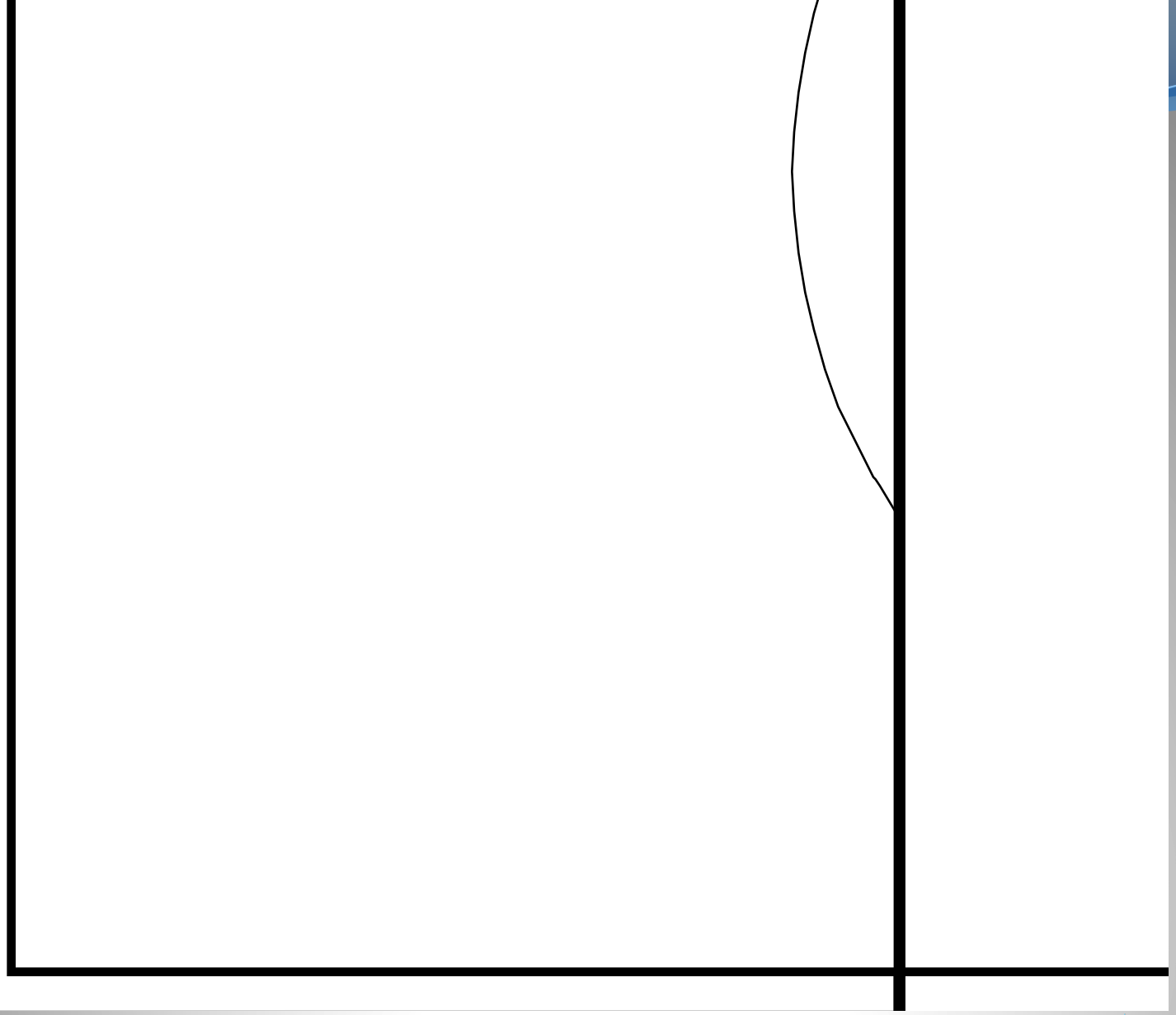
Water Well Records in the Buried Pre-Glacial Valleys

Waterline Resources Inc

Wells in Alluvial Aquifer	#
Unconsolidated	65
Bedrock	63
No lithology	180

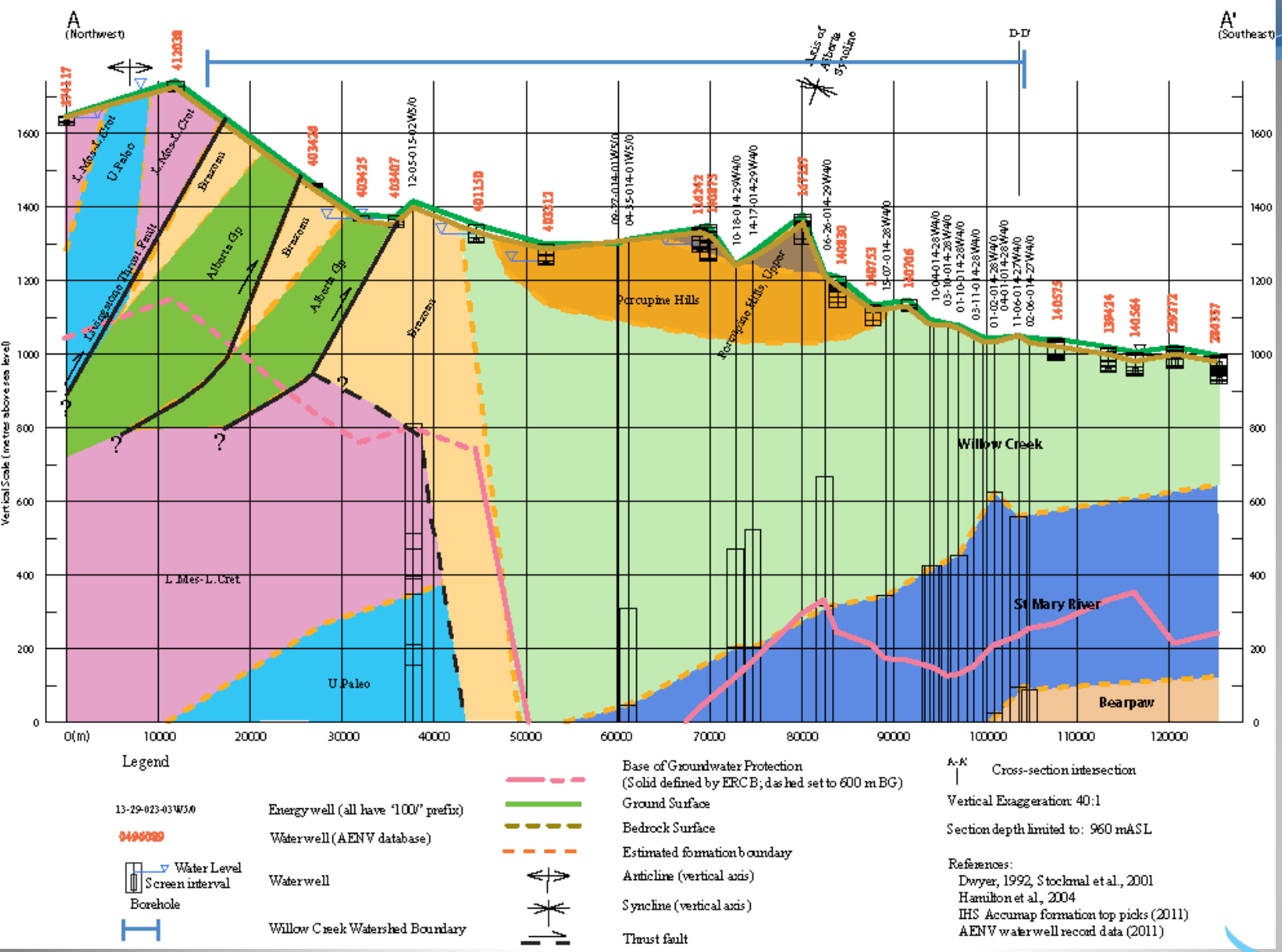
Water Well Records in Willow Creek Alluvial Aquifer

Waterline Resources Inc



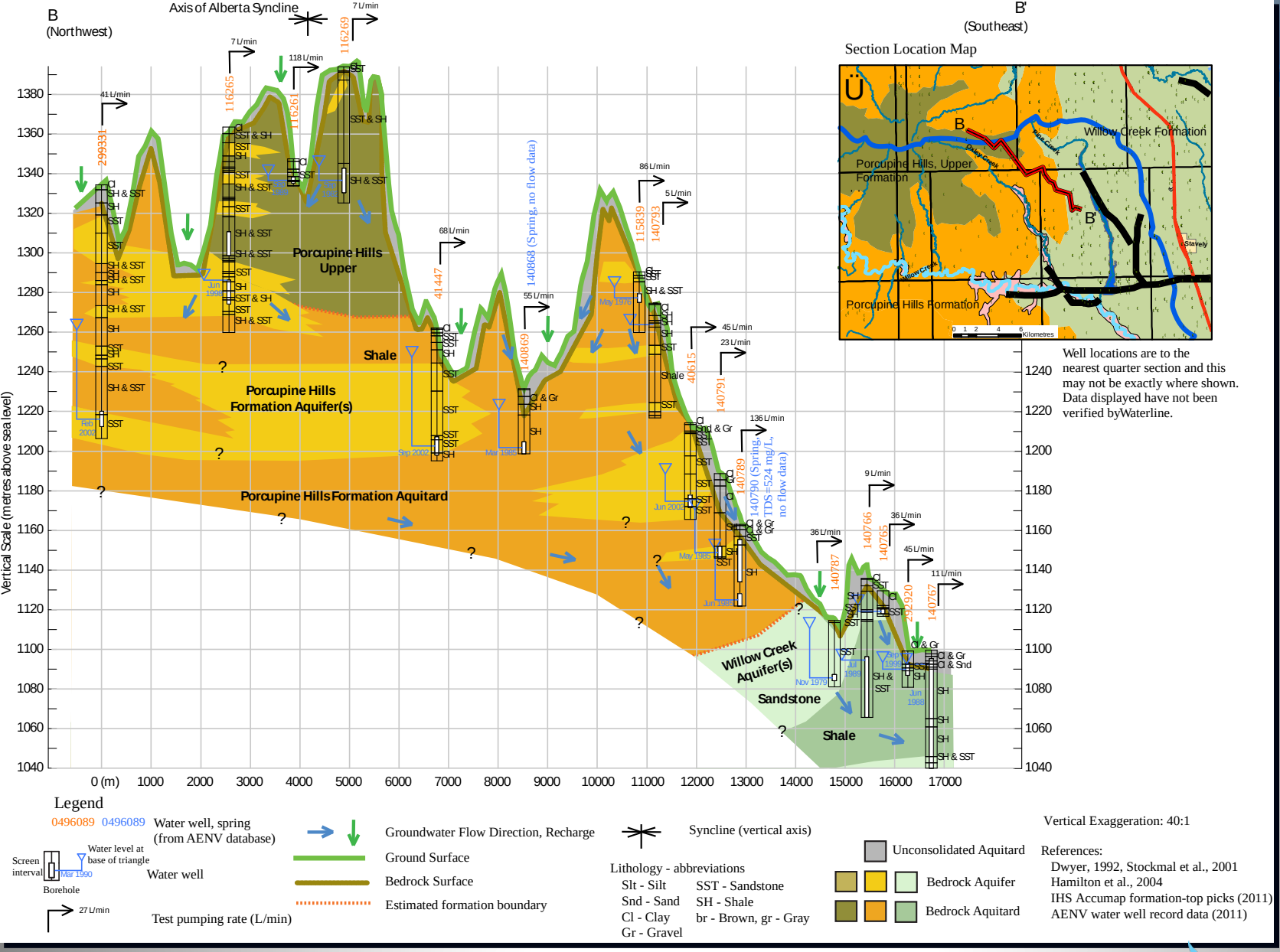
Cross-Section Locations

Waterline Resources Inc



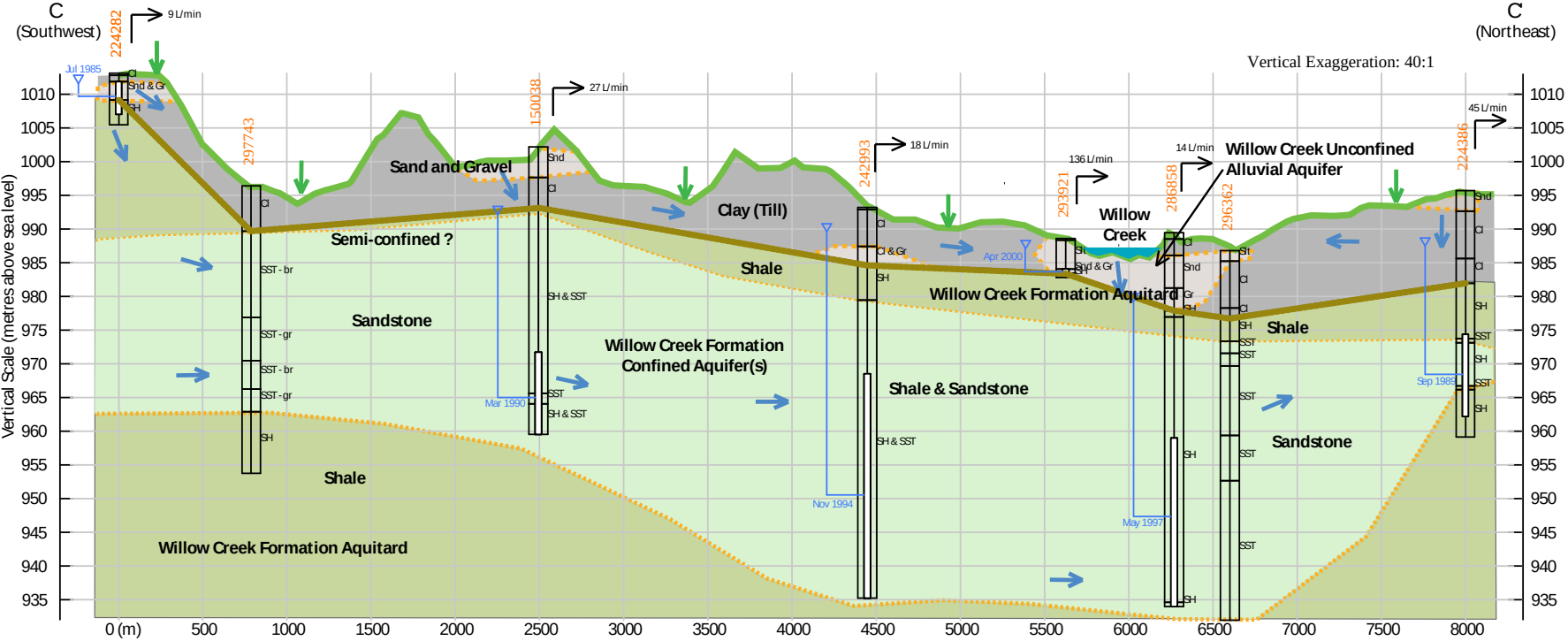
Cross-Section A-A'

Waterline Resources Inc



Cross-Section B-B'

Waterline Resources Inc



Legend

0496089 0496089 Water well (AENV database)

Screen interval — Water Level (base of triangle) — Mar 1990 — Borehole — Water well

Ground Surface

Bedrock Surface

Estimated formation boundary

27 L/min — Test pumping rate (L/min)

Groundwater Flow Direction, Recharge

Lithology - abbreviations

Slt - Silt	SST - Sandstone
Snd - Sand	SH - Shale
Cl - Clay	br - Brown, gr - Gray
Gr - Gravel	

Well locations are to the nearest quarter section and this may not be exactly where shown. Data displayed have not been verified by Waterline.

Alluvial Aquifer

Unconsolidated Aquitard

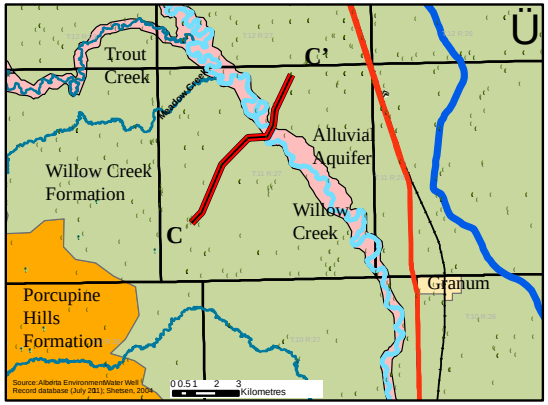
Bedrock Aquifer

Bedrock Aquitard

References:

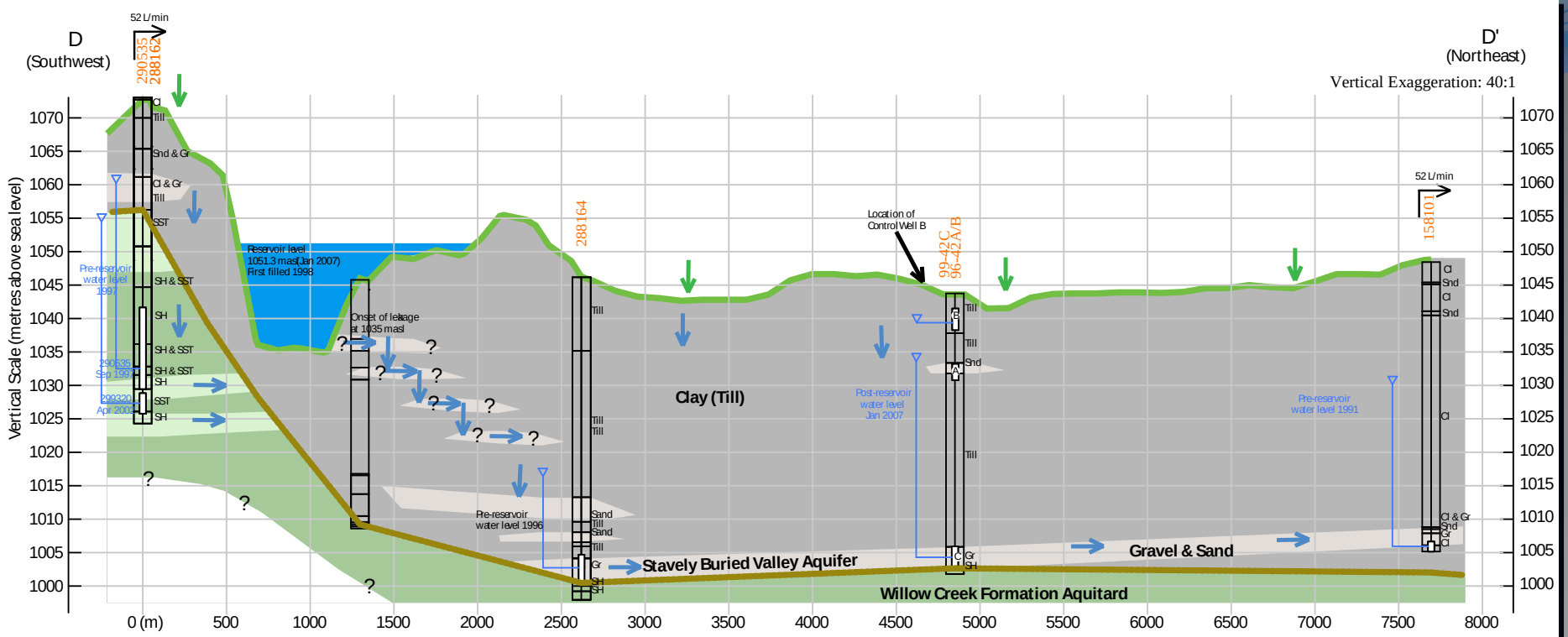
Dwyer, 1992, Stockmal et al., 2001
Hamilton et al., 2004
IHS Accumap formation-top picks (2011)
AENV water well record data (2011)

Section Location Map



Cross-Section C-C'

Waterline Resources Inc



Legend

0496089 96-42A/B Water well (AENV database, Omni-McCann well)

Screen interval — Water Level (base of triangle) — Mar 1990 — Water well — Borehole

Ground Surface

Bedrock Surface

Estimated formation boundary

References:

Dwyer, 1992, Stockmal et al., 2001
Hamilton et al., 2004
IHS Accumap formation-top picks (2011)
AENV water well record data (2011)

27 L/min — Test pumping rate (L/min)

Groundwater Flow Direction, Recharge

Lithology - abbreviations

Slt - Silt	SST - Sandstone
Snd - Sand	SH - Shale
Cl - Clay	br - Brown, gr - Gray
Gr - Gravel	

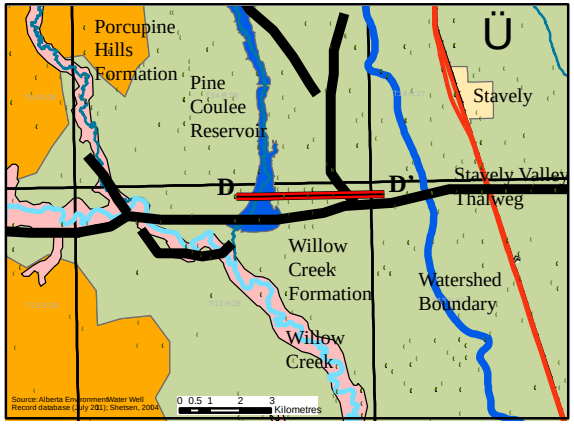
Well locations are to the nearest quarter section and this may not be exactly where shown. Data displayed have not been verified by Waterline.

Alluvial Aquifer

Unconsolidated Aquitard

Bedrock Aquifer

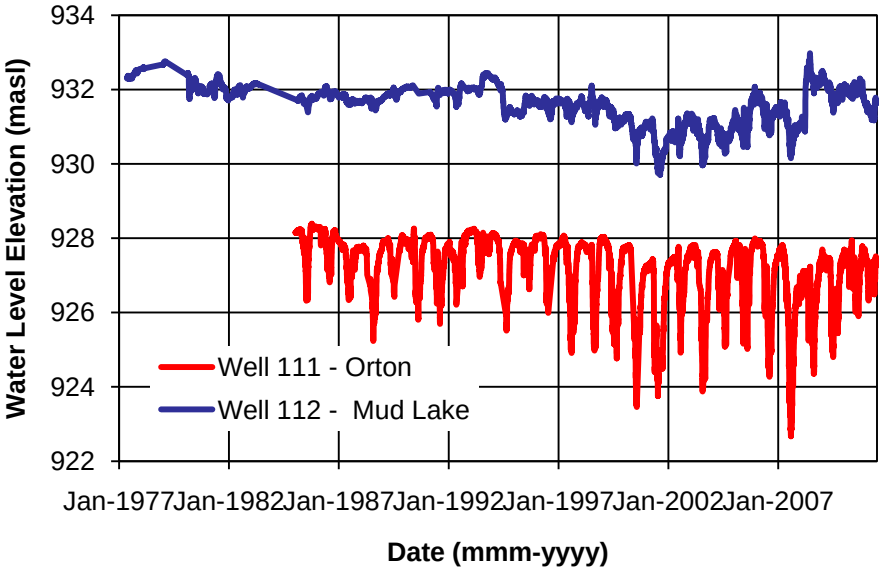
Bedrock Aquitard

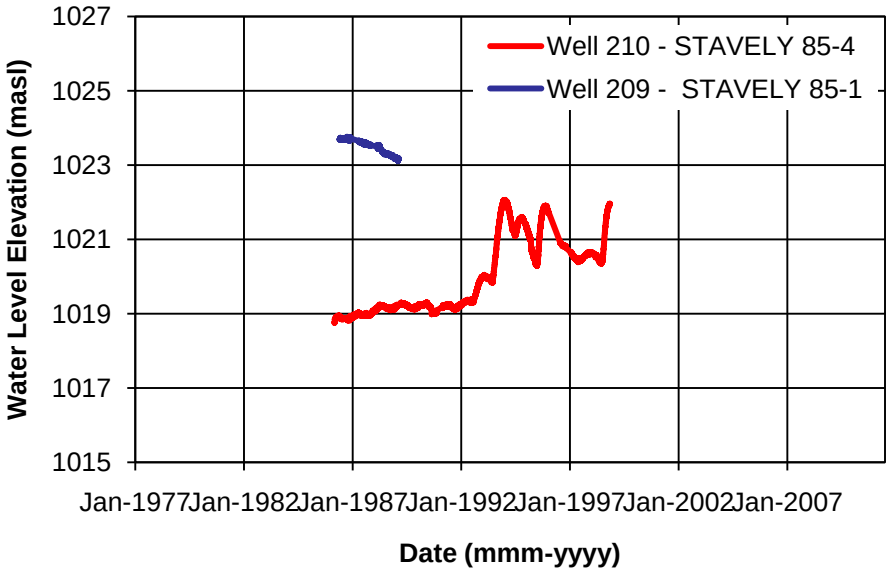


Section Location Map

Cross-Section D-D'

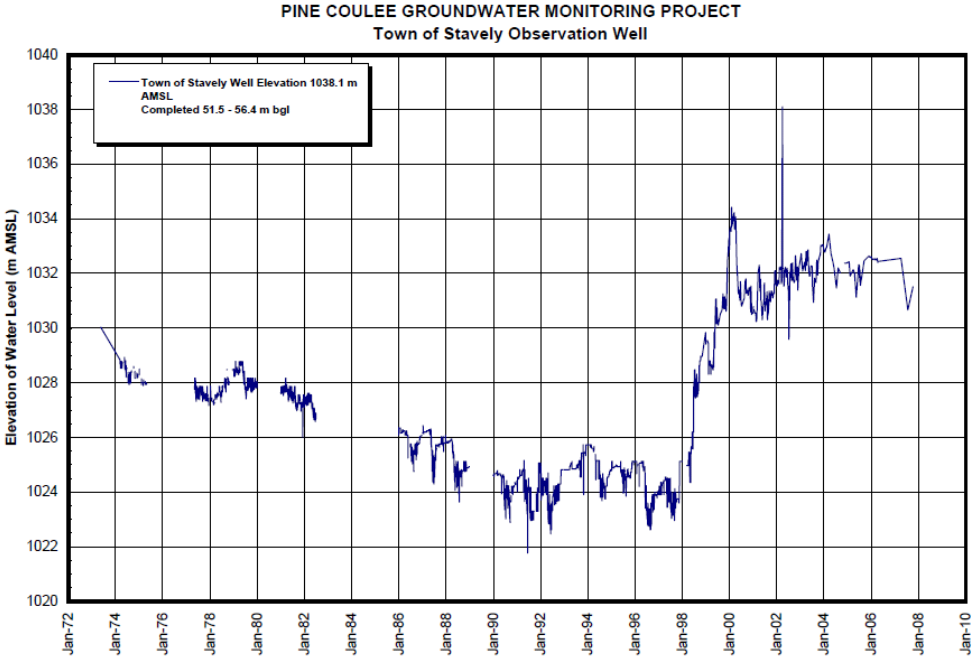
Waterline Resources Inc

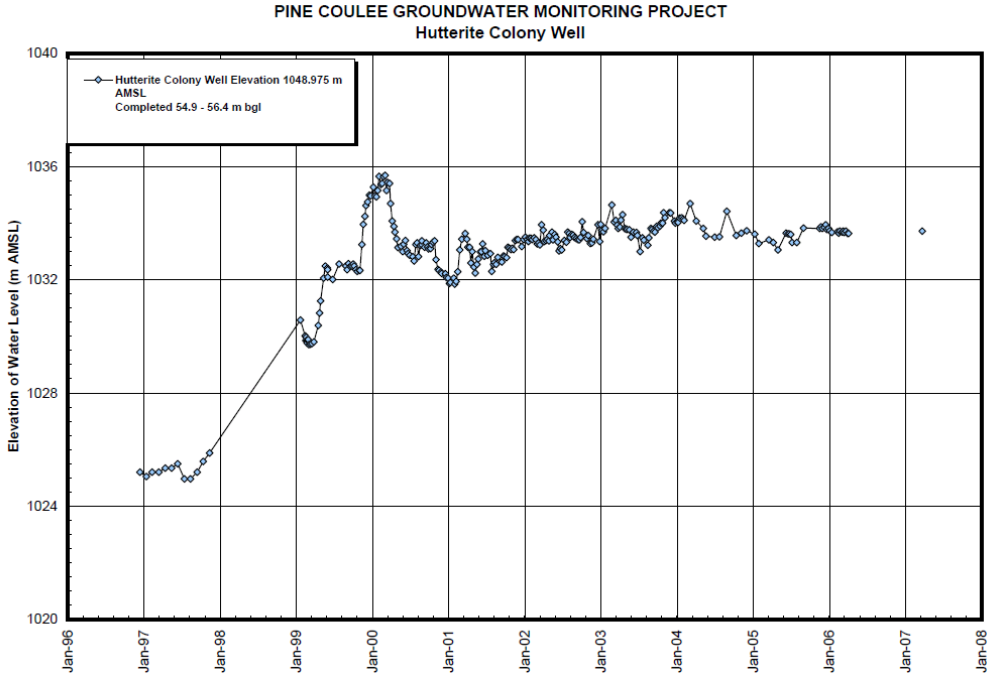




GOWN Wells

Waterline Resources Inc





Source: Omni McCann, 2008

Stavely Town Well

Hutterite Colony Well

Waterline Resources Inc

Water Diversion

- Surface Water
  - Most common use = irrigation
  - Most in eastern portion of watershed – agriculture
  - Total allocated = 550,187,486 m^3/yr
- Groundwater
  - Most common use = agriculture then municipal
  - Most likely from Alluvial aquifer and Willow Creek formation
  - Total allocated = 2,227,908 m^3/yr

Waterline Resources Inc

Crude Groundwater Budget

- Input – precipitation assumed recharge (5-15%) 54 to 150×10^6 m^3/yr
- Licensed water use 2.2×10^6 m^3/yr
- Domestic use 2.7×10^6 m^3/yr
- 3-9% of recharge is used

High-Level Water Balance Analysis

- **Crude Groundwater Budget:** precipitation assumed recharge (5-15%) and water use indicates 3-9% of recharge is used;
- **Surface water balance model** is needed for the entire watershed in order to further assess aquifer recharge and use;
- **Insufficient data to integrate groundwater and surface water** (except alluvial aquifer). Surface water suspected to play major role in aquifer recharge in mid to upper reaches of the watershed. Extreme western part of the watershed groundwater appears to flow to the west;
- **Buried valley aquifers, and bedrock aquifers disconnected from surface** (except Stavely Aquifer); and
- **Confined aquifers may be managed separately** if individual water balances are being tracked over one year periods.

Waterline Resources Inc

Groundwater Geochemistry

- **Springs**
  - TDS range 250-1,078 mg/L
    - low TDS = local
    - high TDS = regional source or Laurentide glacial till
  - Porcupine Hills Fm – Ca+Mg/HCO_3
  - Willow Creek Fm – Na/HCO_3
- **Groundwater**
  - Transforms from Ca+Mg/HCO_3 in Foothills/Mountains (Brazeau Fm and Alberta Group aquifer(s))
  - To Na/SO_4 or Na/SO_4 & HCO_3 mixed in plains

Waterline Resources Inc

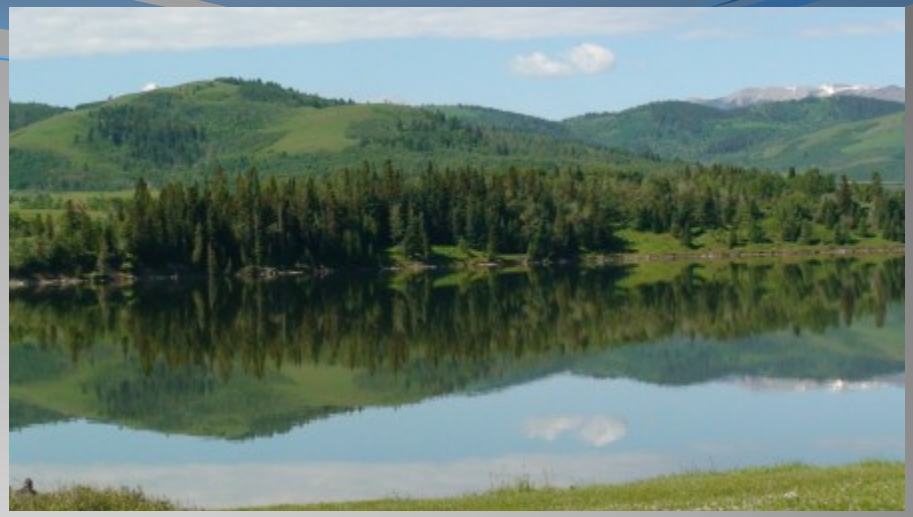
Total Dissolved Solids

Waterline Resources Inc

Data & Knowledge Gaps

- Water Well ID's, GPS Locations and Tagging;
- Reconciliation of Approvals and Water Wells;
- Capturing Landowner Water Level and Quality Data;
- Chemical Analyses by Local Health Units (helps to further refine hydrochemistry and assess possible contamination sources);
- Need for Groundwater Monitoring – increase accuracy of conceptual model as it relates to recharge and GW-SW interaction;
- Refine the elements of the Water budget and surface water balance (including groundwater-surface water interactions); and
- Promoting Groundwater Stewardship

Waterline Resources Inc



Willow Creek Watershed

Waterline Resources Inc