

Ken Baxter, M.Sc., P.Geol. Dan R. Brown, M.Sc., P.Geol.



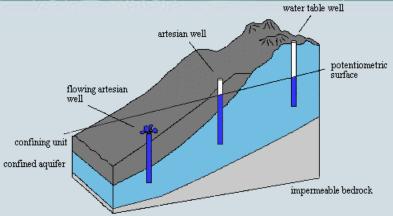
The Role of Groundwater in Alberta's Tight Water Supply Environment

Outline

- Importance of groundwater in Alberta
- Groundwater is not a mystery!
- Sustainable groundwater yield
- Groundwater use in petroleum industry
- Water Conservation & Allocation Policy
- Water shortage in SSRB
- When is groundwater surface water?
- The Paskapoo Formation aquifer
- Hidden treasure Buried Valley Aquifers









GROUNDWATER HAS ALWAYS PLAYED A MAJOR ROLE IN ALBERTA







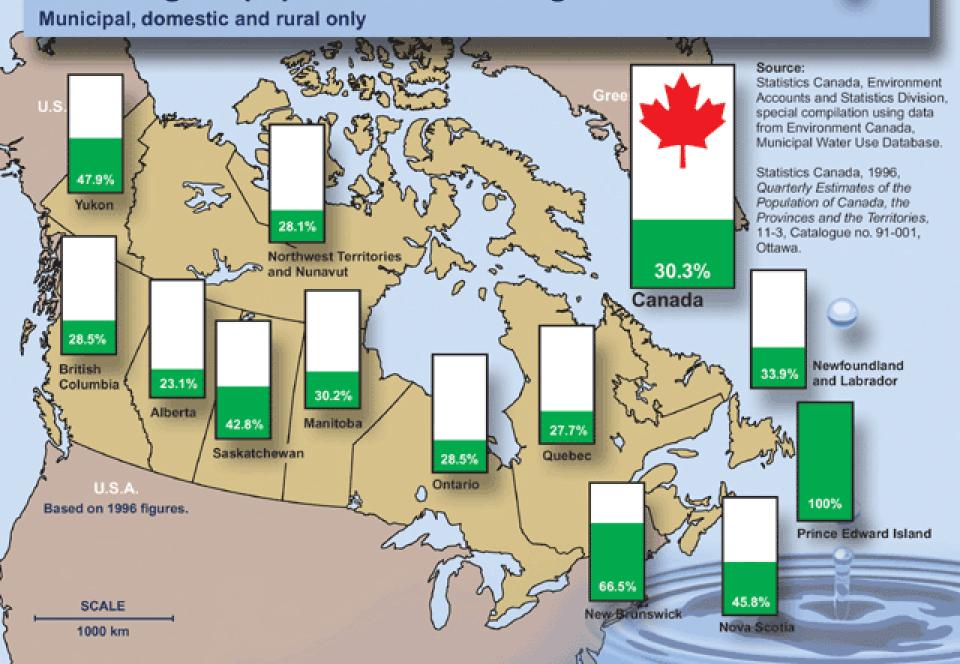


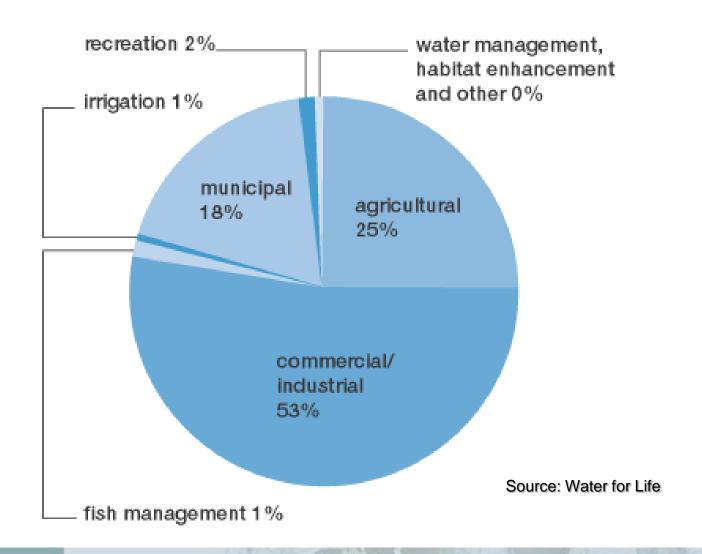
Importance of Groundwater in Alberta:

- > 500,000 water wells
- > 180 municipal water supplies
- 600,000 Albertans depend on groundwater for drinking water
- Currently supplies only ~3% of overall provincial water supply



Percentage of population reliant on groundwater





GROUNDWATER USE IN ALBERTA

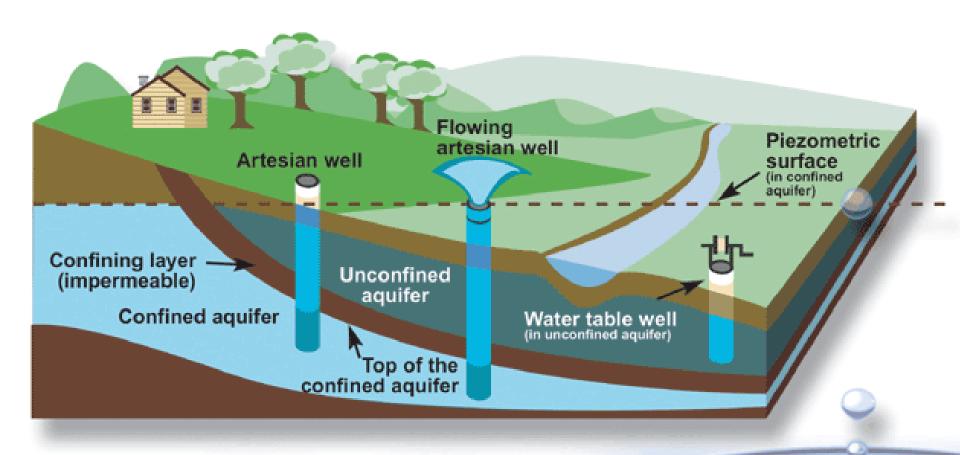




GROUNDWATER IS NOT A MYSTERY!

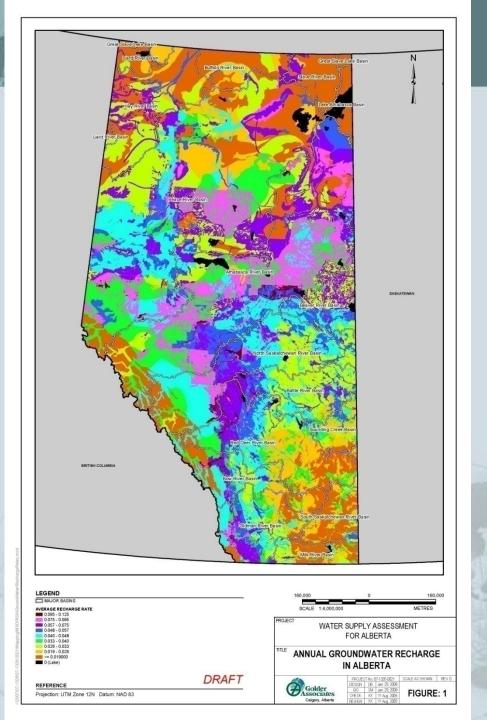
Scientists have studied it for hundreds of years

Aquifers and wells



Source: Environment Canada

Annual Groundwater Recharge in Alberta





Local recharge rates vary from <2 to 15 cm/year Estimated Total Groundwater Recharge in Alberta:

Water for Life
14 billion m3

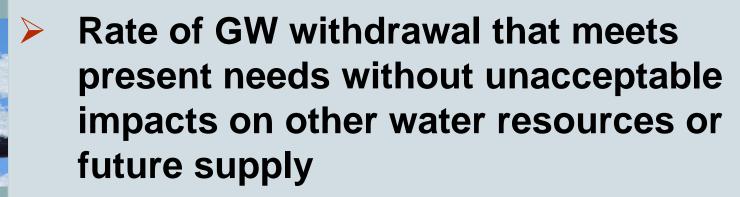
Hydrograph Separation
32 billion m3

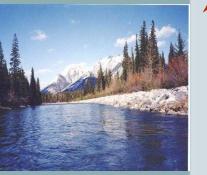
Recharge Est. 27 billion m3

Groundwater contribution is more significant than once thought



Sustainable Groundwater Yield





Must be interpreted in light of the interconnection between GW and SW, and the on-going concern in Alberta for In-stream Flow Needs (IFN)



Sustainable Groundwater Yield for a River Basin

One Approach:

- 1. Estimate the 20th percentile of all monthly mean flows recorded at a river gauging station and equate to groundwater recharge upstream
- 2. Assume that winter flows are essentially "ecological base flows" and cannot be withdrawn due to IFN
- 3. The <u>sustainable groundwater yield</u> is 15% of (openwater baseflow 20th percentile of monthly mean flows)

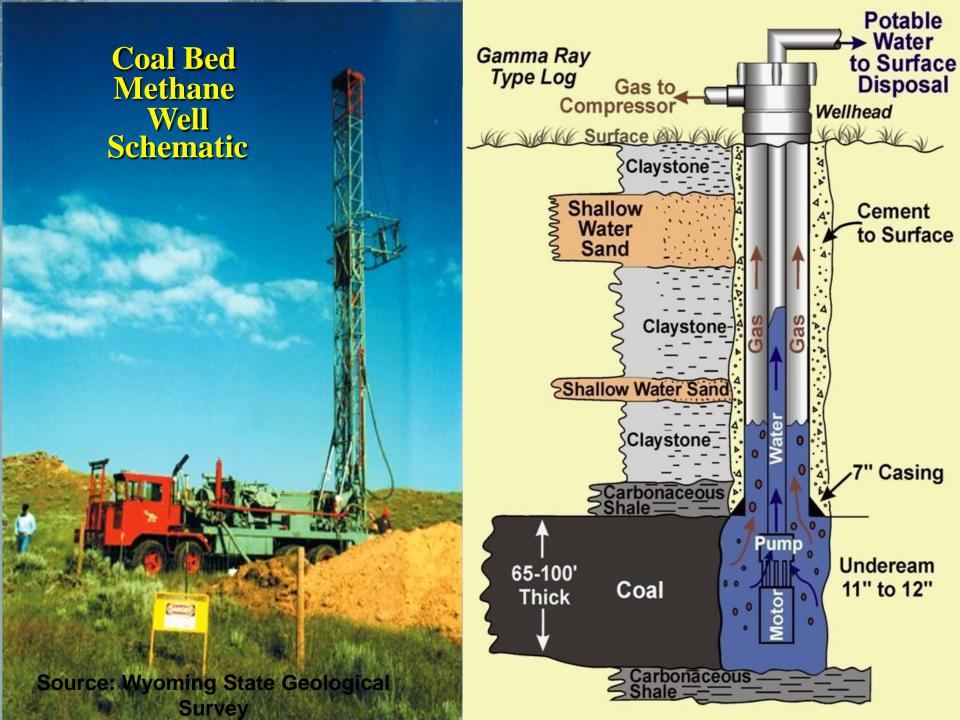


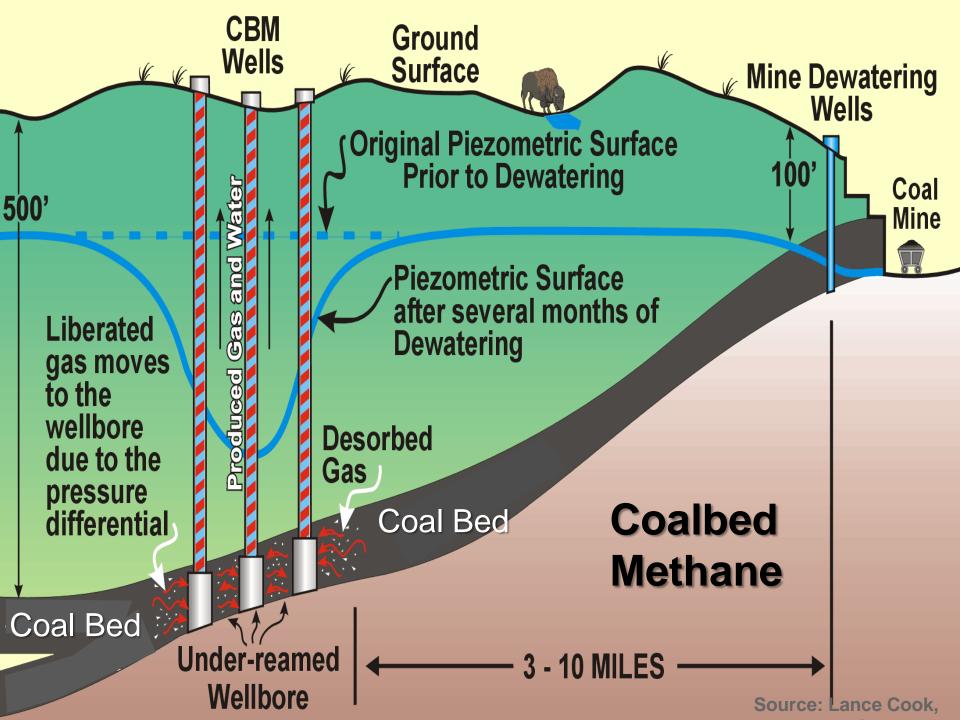


Groundwater Diversion & Use in Alberta's Petroleum industry

- Conventional oil and gas
 - Water for drilling fluids
 - ➤ As WCSB development matures, secondary recovery is necessary
 - More water for "water flood"
- Coalbed methane
 - Dewatering of coals to release gas
- Shale gas
 - Water for drilling fluids and hydrofracing







Oil Sands

Groundwater Diversion & Use in Alberta's Petroleum industry

- Oil sands open pit mines
 - Extensive overburden dewatering
 - > Pit depressurization
 - ➤ Water for operations & upgraders

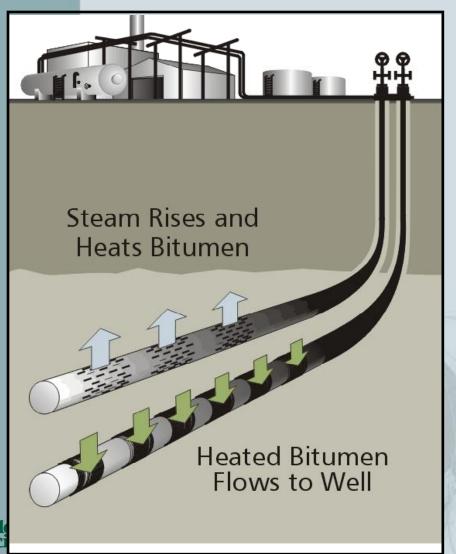
Syncrude Aurora Mine Ft. McMurray





SAGD Projects

Groundwater is main source of water for steam



Oil Sands Thermal Operations

- Water for steam
- Water for processing







- ➤ Ultimate Goal: to reduce or eliminate allocation of non-saline (fresh) water for oilfield injection, while respecting the rights of current licence holders.
- Applies to EOR and SAGD projects
- Replaces the "Groundwater Allocation Policy for Oilfield Injection Purposes" (March 1990),



Applies to water management for industry working in naturally water-short areas and areas with development pressures to maximize water conservation

"Water-short areas" are primarily in the southern part of Alberta



- Applies to new projects in watershort areas that propose to use non-saline water
- Must demonstrate that
 - every feasible alternative has been evaluated
 - non-saline water resource use will prevent stranding oil resources (economics)
- Rules require use of less of available fresh water supply (50% vs 70%)



Where no feasible alternative exists, consideration must be given to delaying projects until new technology or alternative water sources are available

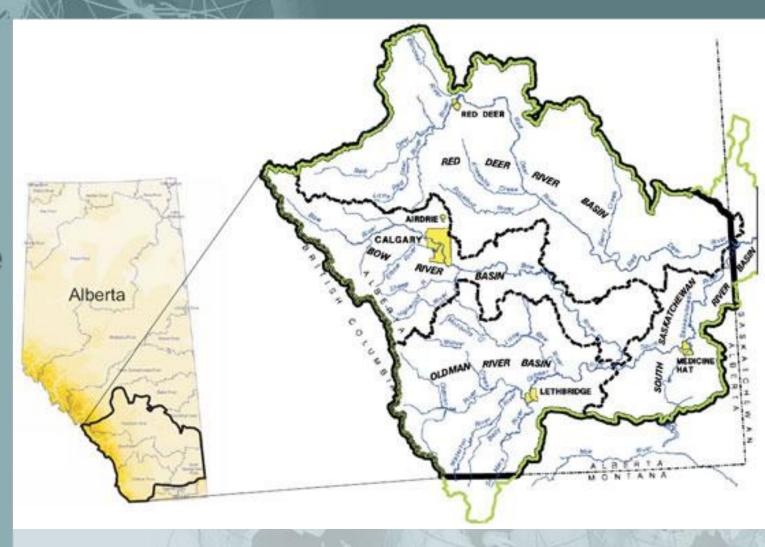


Effect of Policy? Trends?

- ➤ Operators are on side
- In 1990, 90% of oil field injection was done using non-saline water
- In 2007, only 60% of injected water was non-saline, 40% was saline, despite increased costs



Water Shortage







Alberta Regulation 171/2007 under the Water Act

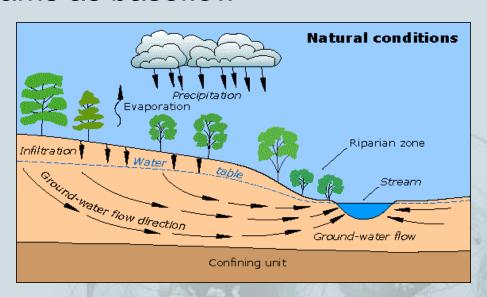
"All the water in the Bow River Basin, Oldman River Basin and South Saskatchewan River Basin that is not...allocated under a licence or registration or specified in a preliminary certificate is reserved".

- Resulted in a ban on new water diversions
- Applies to both surface water and groundwater connected to surface water
- For groundwater, there must be no evidence of hydraulic connection with river



When is a groundwater diversion, effectively, a surface water diversion?

Most shallow groundwater discharges to streams as baseflow



➤ However, deeper aquifers are part of regional, long-term flow systems and are generally not considered directly connected

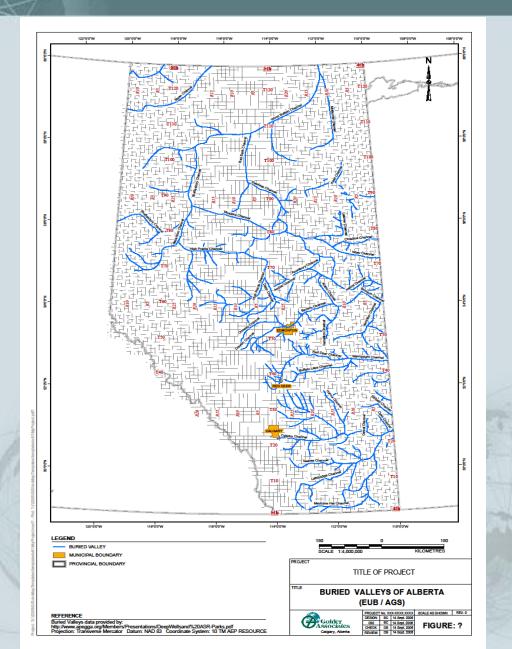


Paskapoo Formation Aquifer

- Covers 10,000 km2
- 10% of Alberta by area
- Supplies ~100,000 water wells
- 20+% of all wells in Alberta
- 5-10m thick channel sandstones
- Most heavily used aquifer in Prairies
- Typically good supplies for domestic, farm and commercial use, but yields not sufficient for municipal supply



Hidden Treasure! Alberta's Network of Buried Channel Aquifers





Examples of Alberta's Buried Valley Aquifers



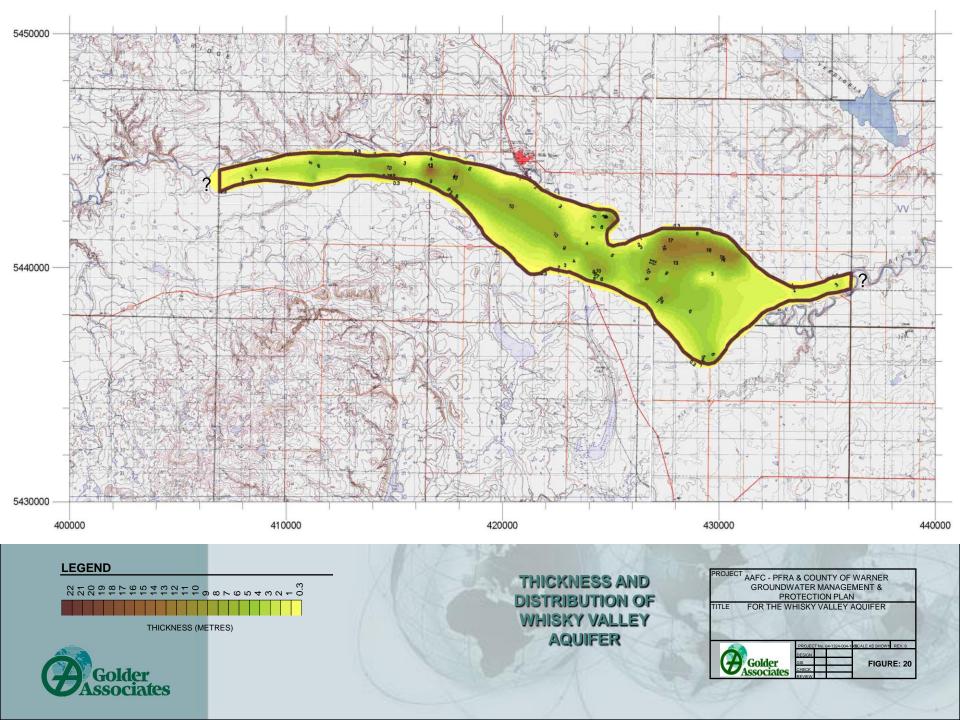
- Calgary Buried Valley Aquifer Exshaw Well
 - underlies the Bow River at 180 metres
 - Not hydraulically connected to river
 - 3000+ m3/d municipal supply from 1 well
- Beverly Channel Aquifer Heartland Region
 - reportedly connected to North Sask. River
 - Major supply for domestic, agric and industry
- Whisky Valley Aquifer County of Warner
 - high capacity communal wells supply local ranches
 - some connection shown to Milk River
- ➤ Gregoire Channel Aquifer Ft. McMurray
 - Oil sands SAGD area; being protected by AENV

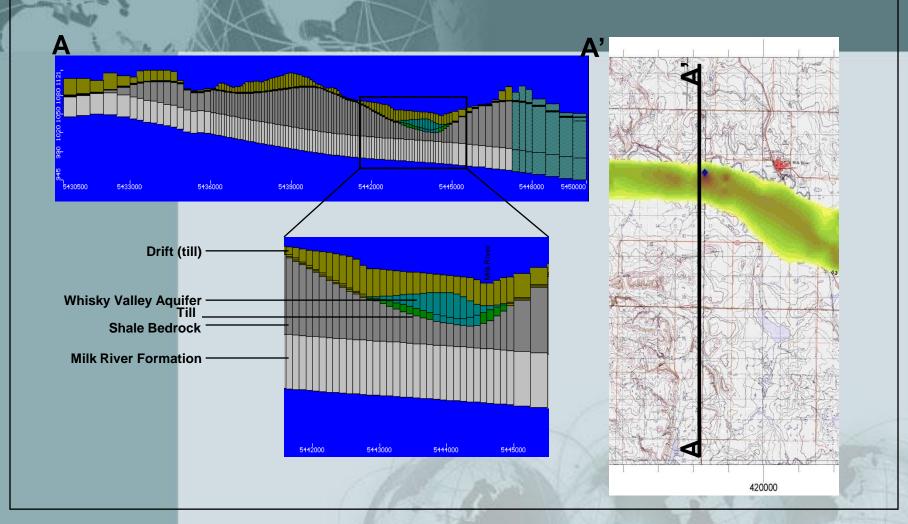












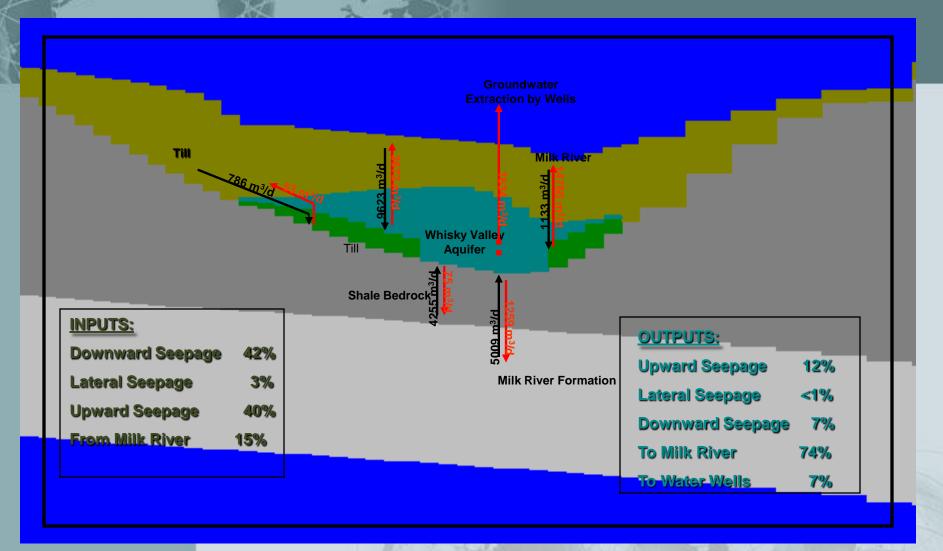
LEGEND

♦ MILK RIVER WEST/WARNER WEST PRODUCTION WELLS

CROSS-SECTION
THROUGH WHISKY
VALLEY AQUIFER
GROUNDWATER MODEL

MILK RIVER W	EST WATER USERS CO-OP
TITLE	
Golder	PROJECT No. 04-1324-004-1 SECALE AS SHOWN REV. 1 DESIGN GIS FIGURE: 28 BEVIEW





LEGEND

→ GROUNDWATER INPUTS TO WHISKY VALLEY AQUIFER

→ GROUNDWATER OUTPUTS FROM WHISKY VALLEY AQUIFER

AQUIFER WATER
BALANCE
SIMULATED BY
GROUNDWATER
MODEL

PROJECT	SAME OF STREET	19 102
MILK RIVER W	EST WATER	USERS CO-OP
TITLE	1	and the second
	PROJECT No. 04-1324	004-1 MSCALE AS SHOWN REV. 1
Golder		004-103CALE AS SHOWN REV. 1

WATER BALANCE ESTIMATES PROVIDED FOR CURRENT PUMPING CONDITIONS
Golder
Associates



SUMMARY

- Alberta's surface water supply is under pressure and is locally fully allocated, e.g., in the South Saskatchewan River Basin
- Many of Alberta's aquifers have limited capabilities, but some hold promise of high yields
- Buried channel aquifers hold the greatest untapped potential





Thank You - Questions?

