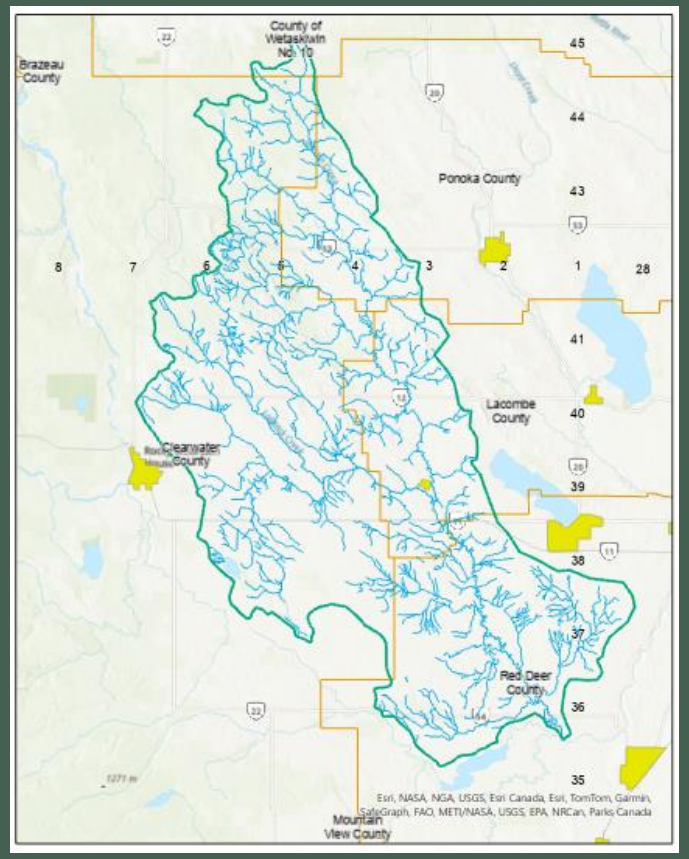
MEDICINE RIVER WATERSHED

Groundwater

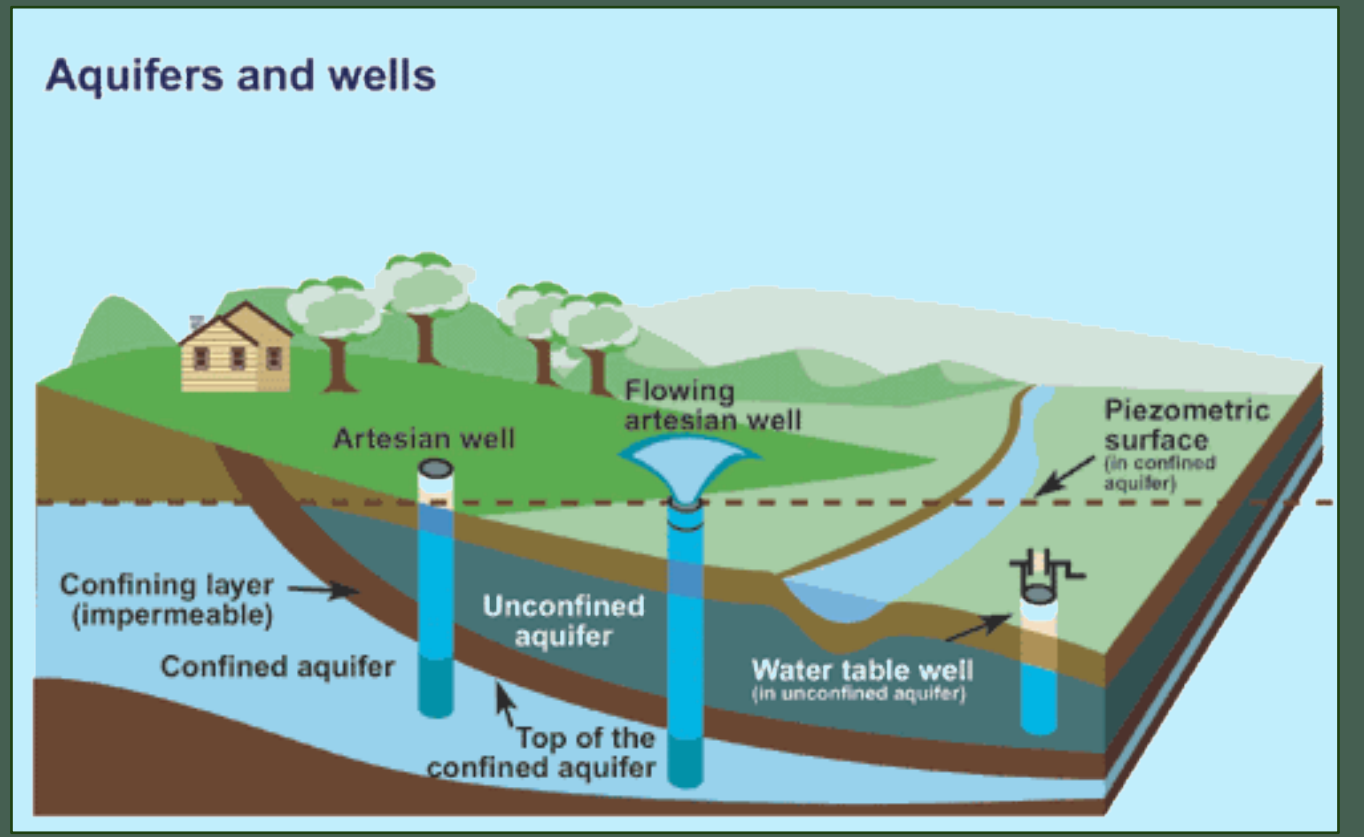
Medicine River Watershed

- The Medicine River sub-watershed is part of the Red Deer River watershed.
- It covers 2900 km^2 (1120 square miles) of land.
- It is divided between 5 counties; Wetaskiwin, Ponoka, Clearwater, Lacombe, and Red Deer.
- The Medicine River begins at Medicine Lake.
- Horseguard Creek and Dickson Creek are the main tributaries.
- Joins the Red Deer River south of Markerville.
- Water well Density in Medicine watershed is from 2-6 / km^2



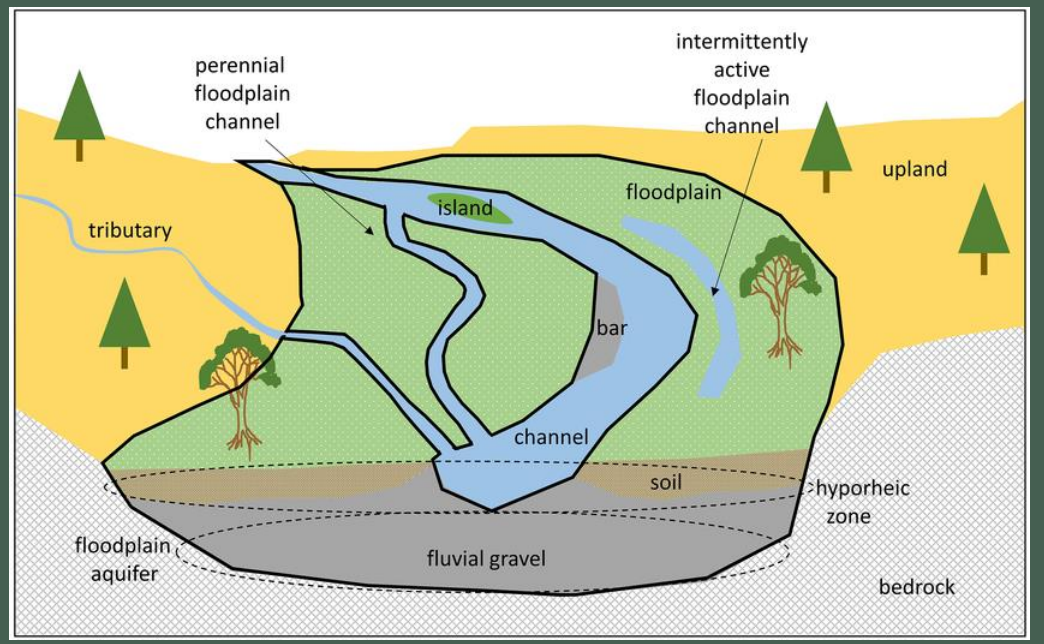
Aquifers

- Definition of an aquifer:
- A porous and permeable rock material capable of delivering sufficient water to a well to meet the needs of the owner.
- Aquifers can be confined or unconfined
- Sign up for Working Well seminars to learn more about wells.



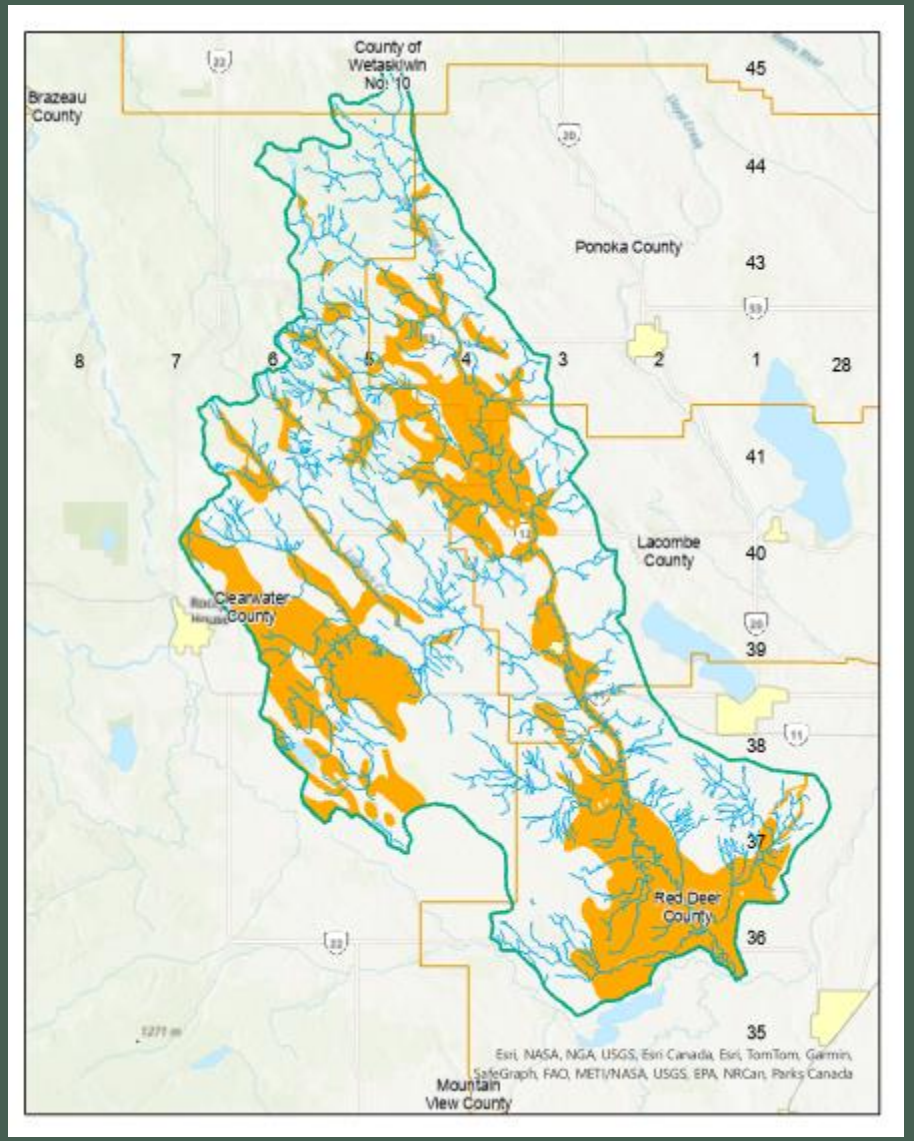
Groundwater Sources in the Medicine River Watershed :

- **Glacial Overburden.**
- is thin in this area.
- generally < 100 ft, often < 30 ft thick.
- Require sandy glacial deposits of sufficient thickness and saturation to supply a well.
- Glacial aquifers are scattered
- Potential for groundwater-surface water interaction



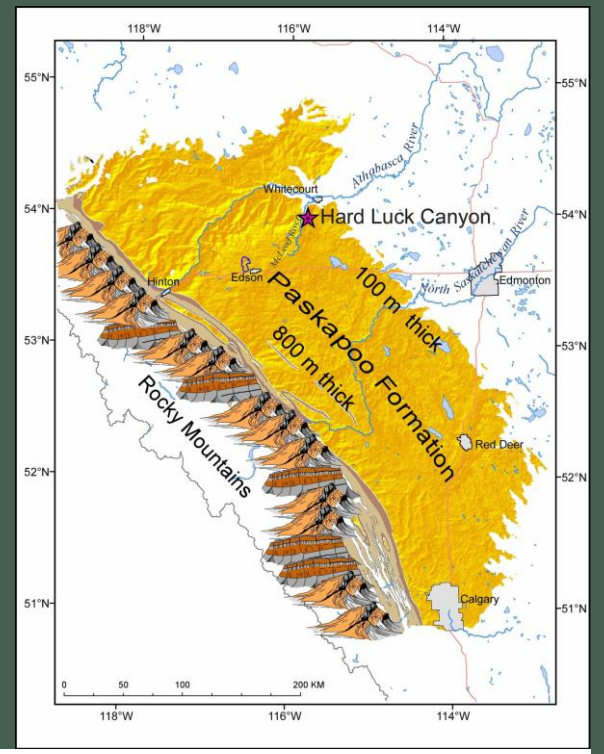
Sand and Gravel

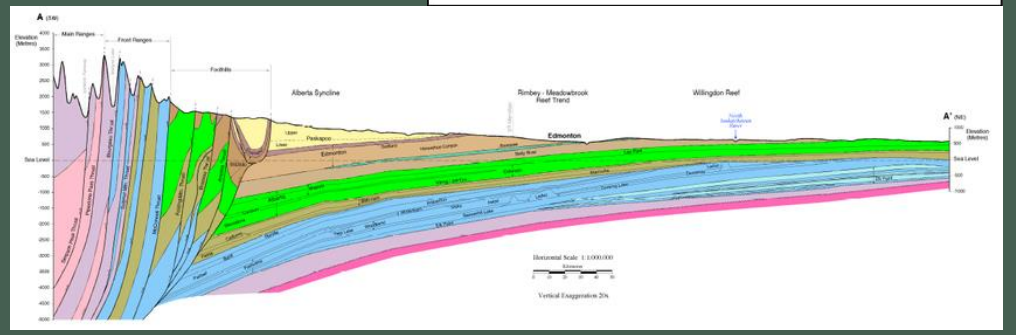
- **Glacial Overburden.**
- Origins: glacio-fluvial, glacio-lacustrine, eolian (wind-blown).
- A glacial meltwater channel follows the Medicine River.
- Sandy overburden found south of Markerville and in western parts of watershed.
- Aquifer potential depends on porosity, extent, and saturated thickness.



Paskapoo Aquifer System

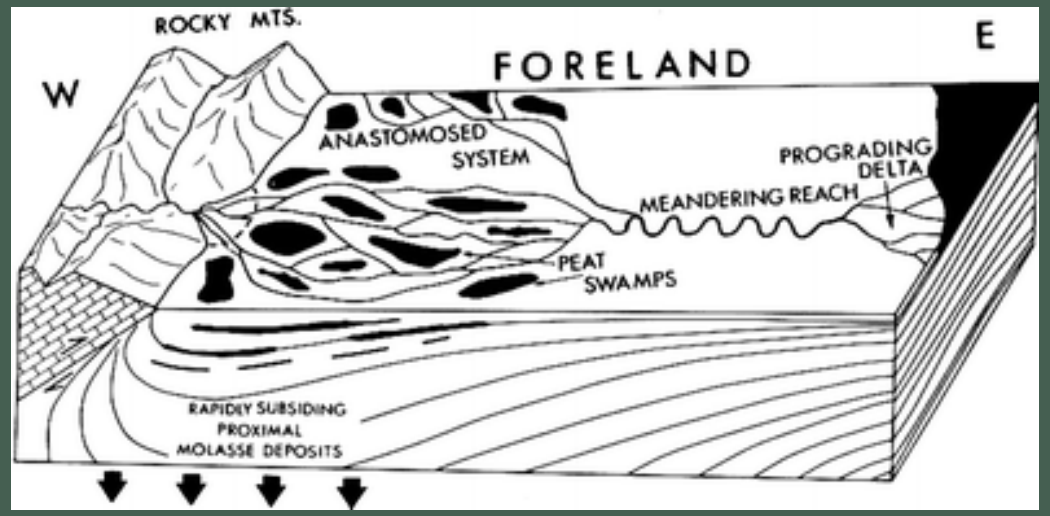
- Bedrock groundwater supply comes entirely from the upper Paskapoo rock formation.
- The Paskapoo covers much of western Alberta.
- Paskapoo made of shale, siltstone, sandstone and coal. Individual sandstone beds are aquifers.
- Paskapoo is described as an "aquifer system"
- = A rock formation that contains related individual aquifers distributed throughout the rock body.
- It supports more groundwater wells than any other aquifer feature on the Canadian Prairies.
- Has local development pressures. E.g. Sylvan Lake and other municipal users.

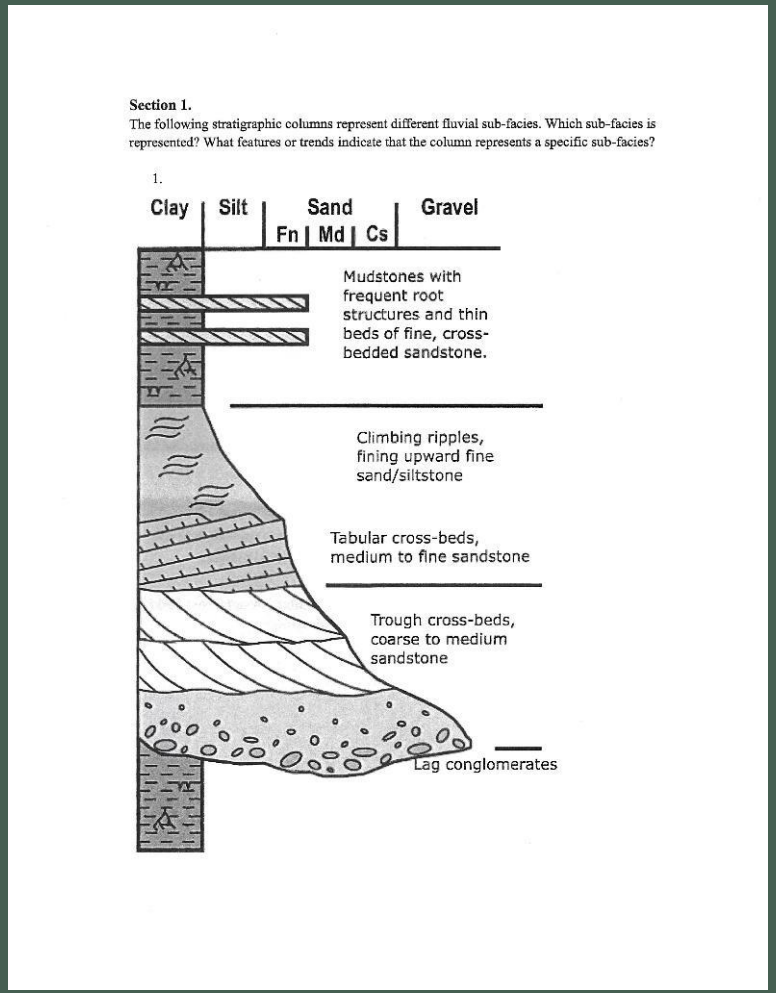




Paskapoo Geology

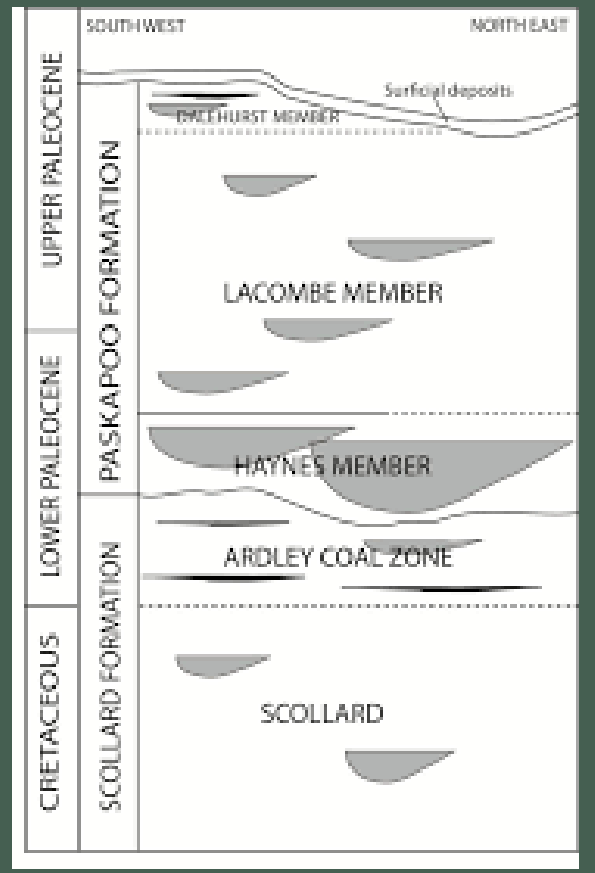
- Fluvial Geological Model
- Coarsening downward bed sequence in drill logs: goes from shale to siltstone to sandstone in repeating cycles.
- Highly variable productivity: may yield between 6.5 to 6500 m3/day (1 to 100 igpm, mostly on the low side.



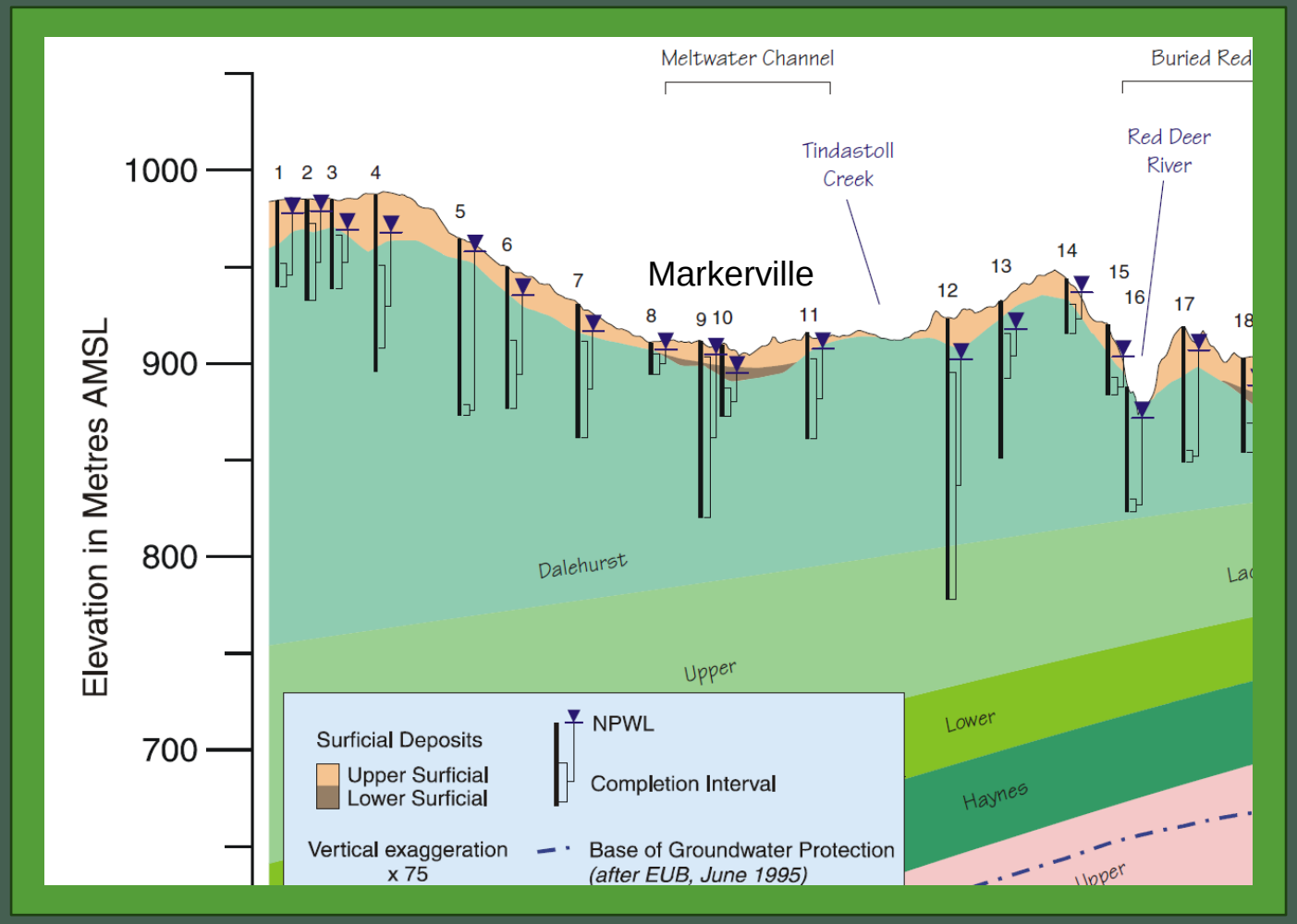


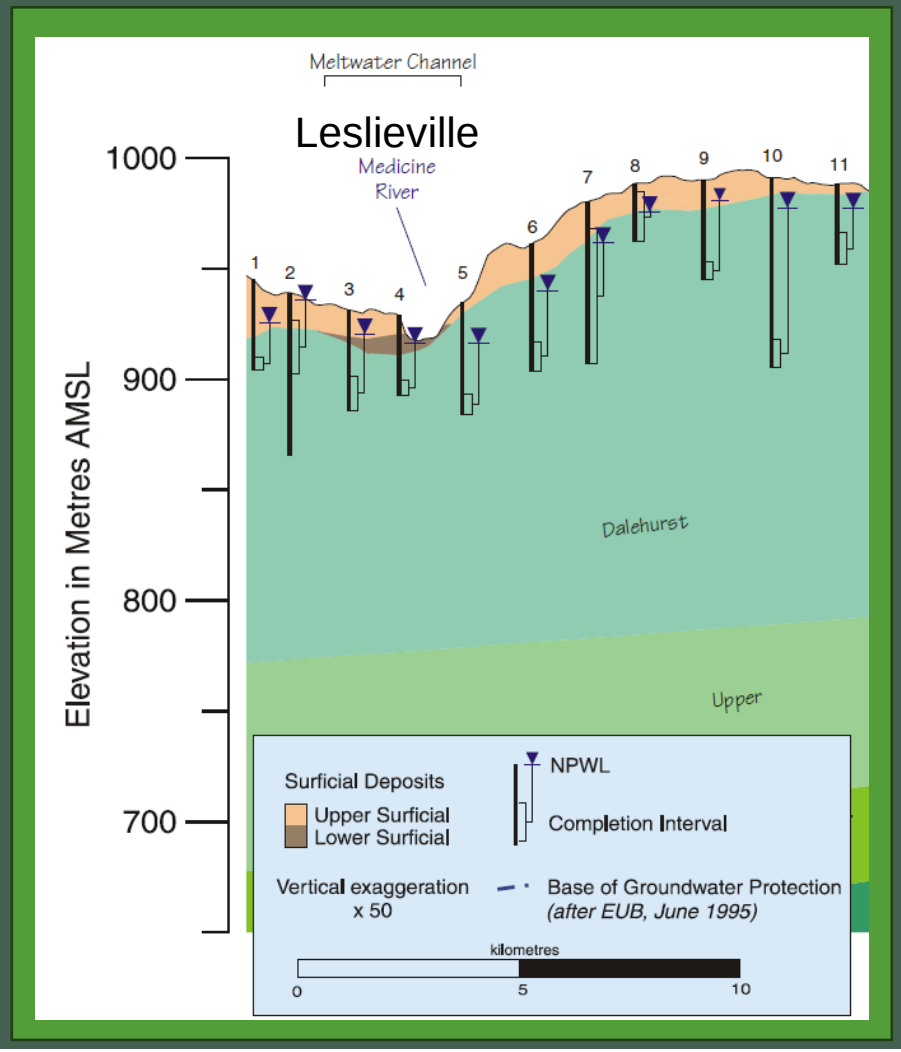
Paskapoo Physical Characteristics

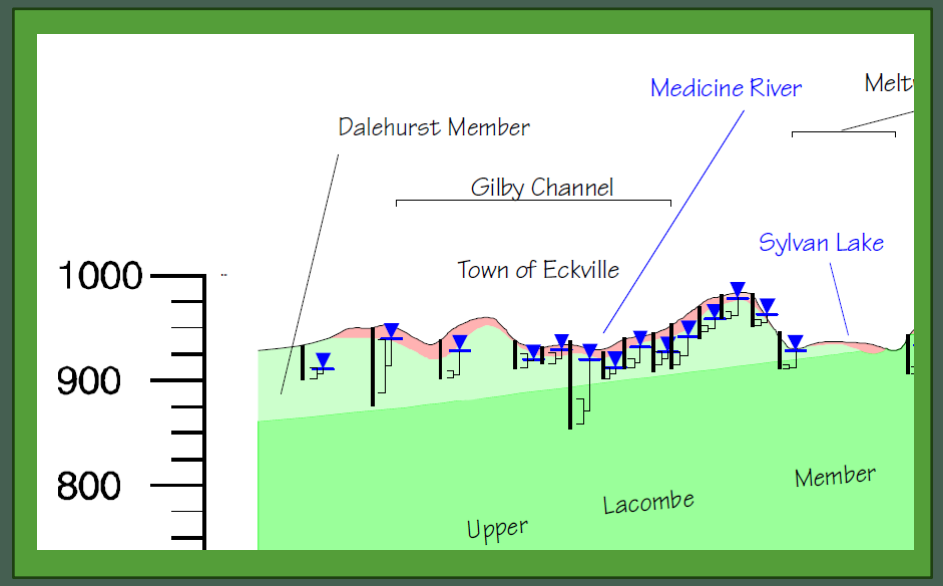
- Dalehurst member is shallowest and forms the local bedrock. Lacombe aquitard is deeper and is accessible in the north part of the basin.
- Good water supply for domestic users.
- Sandstone beds have limited extent.
- Thick, widespread sandstone beds make best aquifers.
- Thinner sandstone beds may require fracturing to be productive.
- Fractures are best developed near surface and in areas where there are linear features like river valleys.
- Dependence on fracturing and Lacombe aquitard means going deeper is not likely to give more water.
- Large scale water users may require multiple wells and are at risk of aquifer decline.

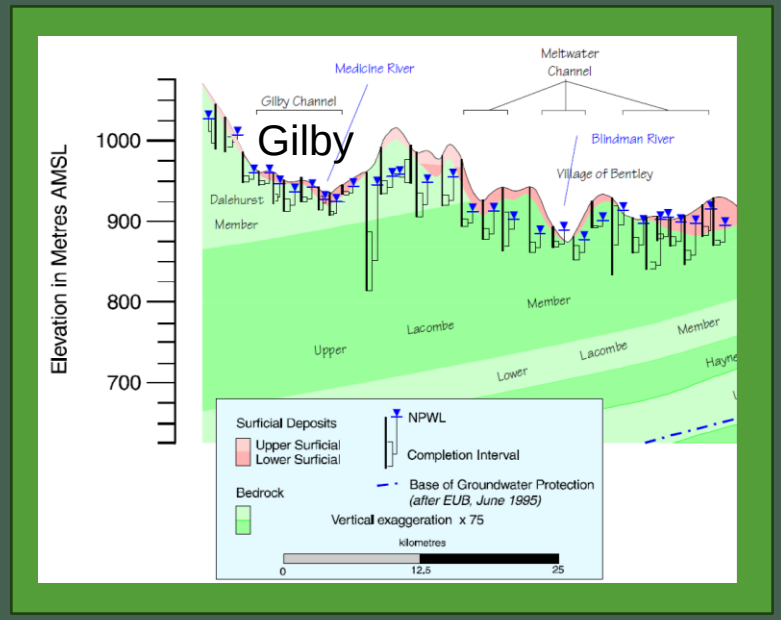


West-East Geological Cross Sections









Cross Sections

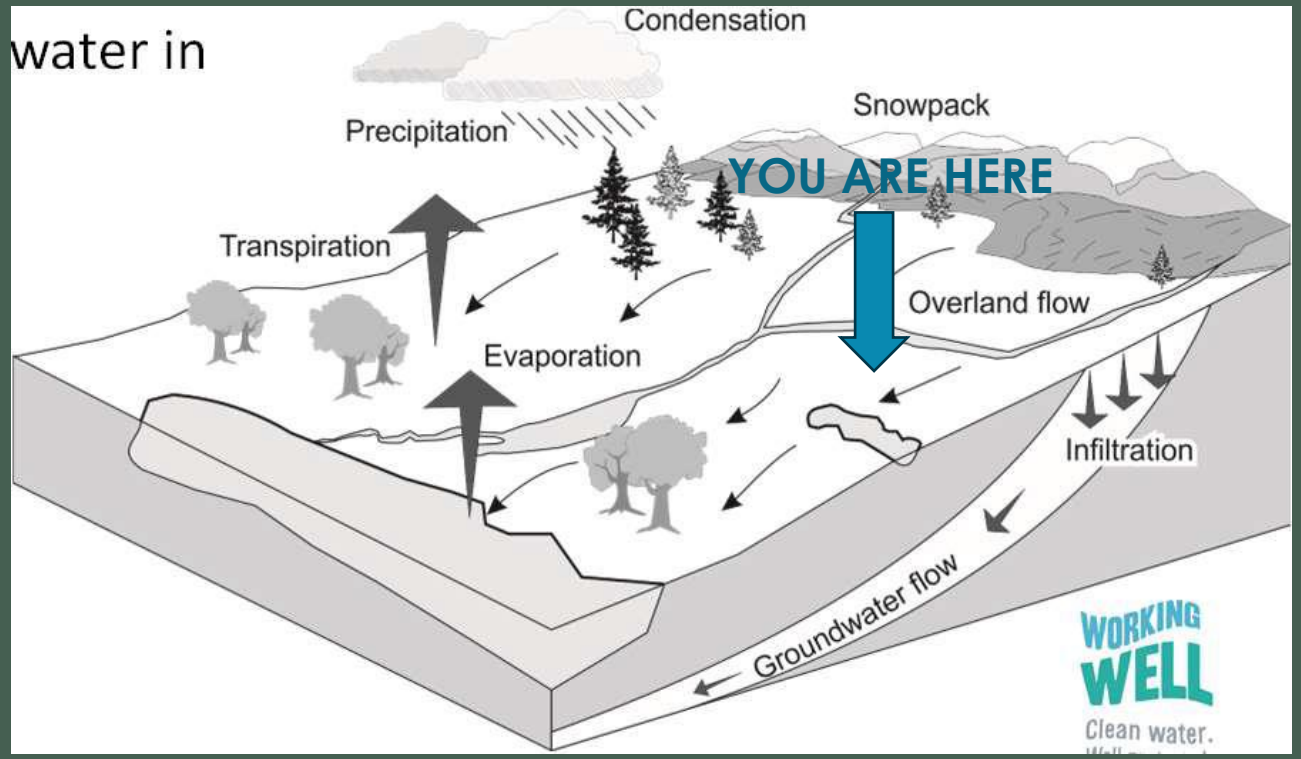
- Source: Red Deer County Groundwater Report 2005; Lacombe County Groundwater Report
- Deepest wells used to make the cross sections.
- Maximum well depth about 300 ft.
- Deeper wells often have very long screened intervals - kept drilling due to not finding shallower water.

Locating New Water Sources

- Consult with geological maps with the area
- Compare results with neighbouring wells
- Seek out thick beds, lineaments and fracture zones
- Deeper Lacombe aquitard has poor prospects.
- Water Storage may be required in areas where aquifer prospects are poor – cisterns, dugouts
- Improve well construction practices to improve well efficiency – used machine slotted liners instead of saw or drill cut linters.

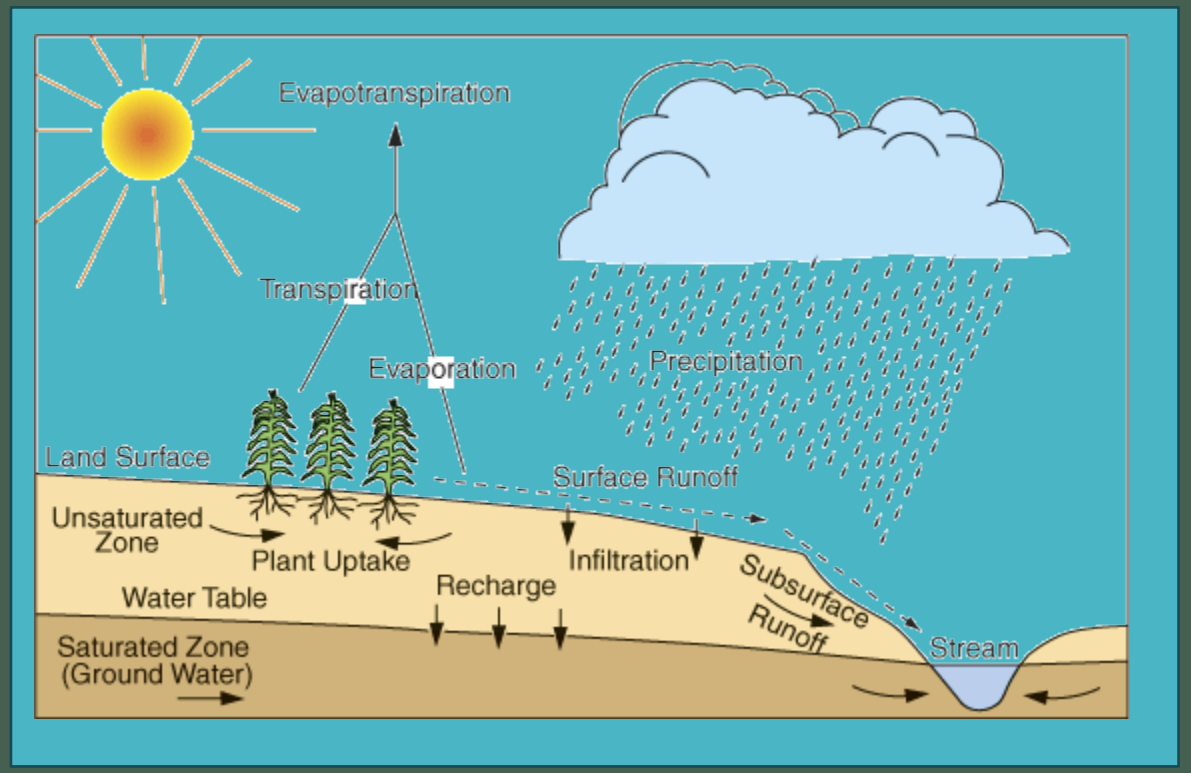
Medicine River in the Water Cycle

- Your position in the water cycle matters
- Groundwater and surface water in the Medicine River Watershed are entirely from rain and snowfall within the watershed.
- Groundwater is recharged locally and is being lost to other basins via flow into deeper Paskapoo.



Groundwater Recharge

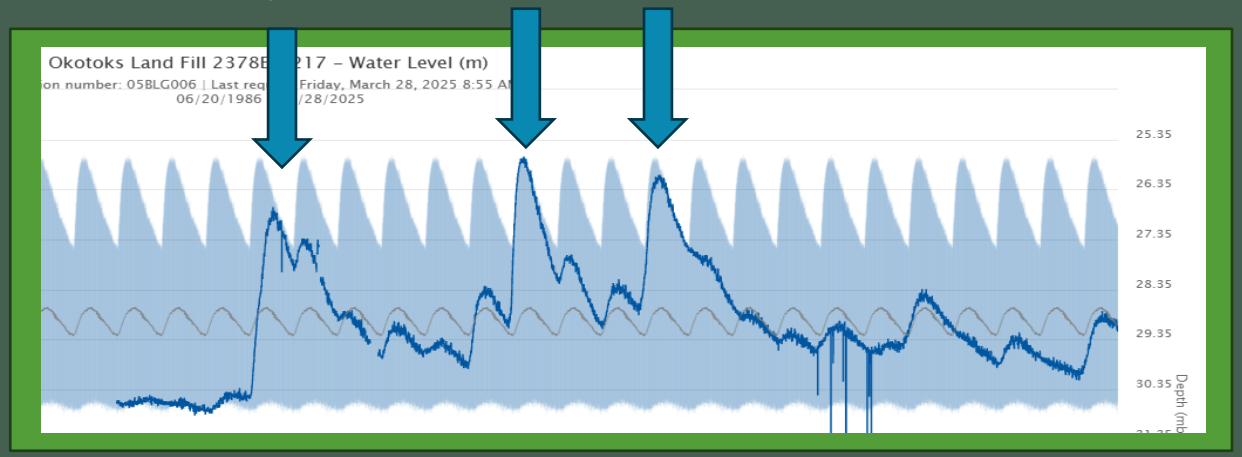
- To reach the water table, rainfall and snowmelt must pass obstacles.
- The unsaturated zone (soil moisture) is like a sponge. It will absorb water. If there is a moisture deficit, that deficit will need to be made up.
- Thirsty plants will consume water from light rains during the growing season and it will not reach the water table.
- Water passes easily through sand but is absorbed by clay.
- Snow melt and big summer storms bring a pulse of water that will reach the water table

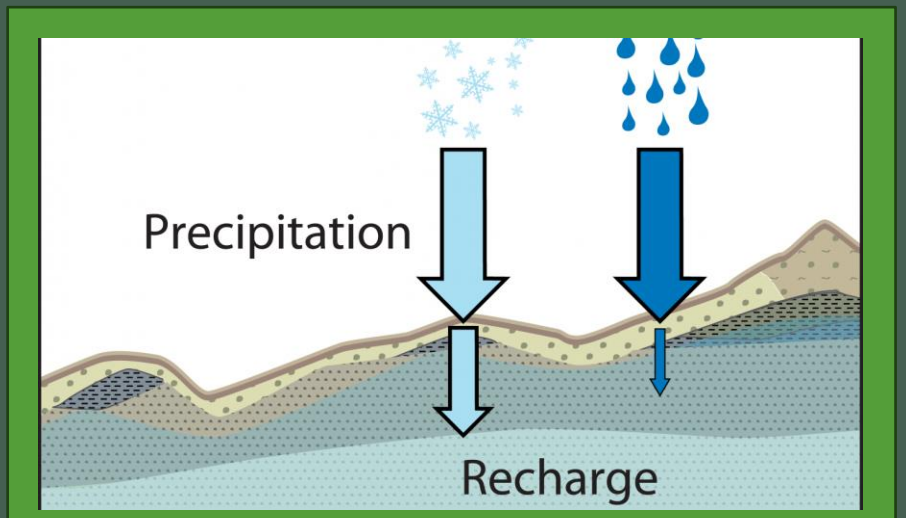


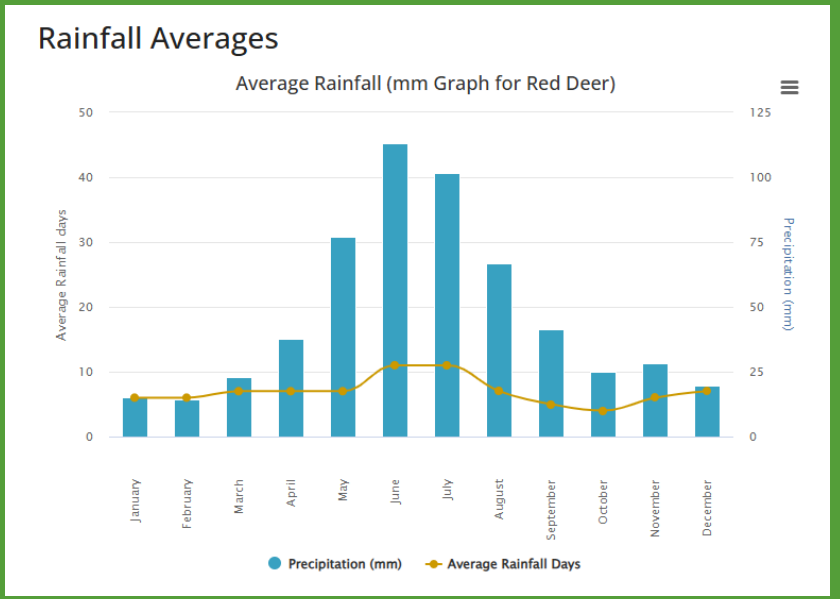
Groundwater Recharge Alberta

- Rainiest months are June and July.
- A greater percentage of snow makes it to groundwater than rain. (no plant consumption)
- Major storm events (e.g Red Deer floods of 2005, 2011) can be significant contributors to groundwater recharge.

2005, 2011 and 2014 - Okotoks Well







AEP Groundwater Observation Wells

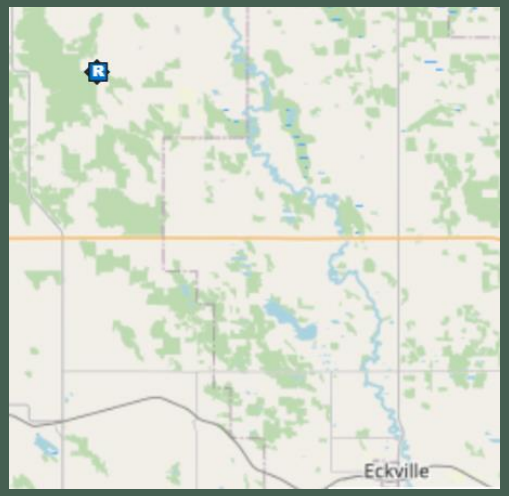
Active Wells

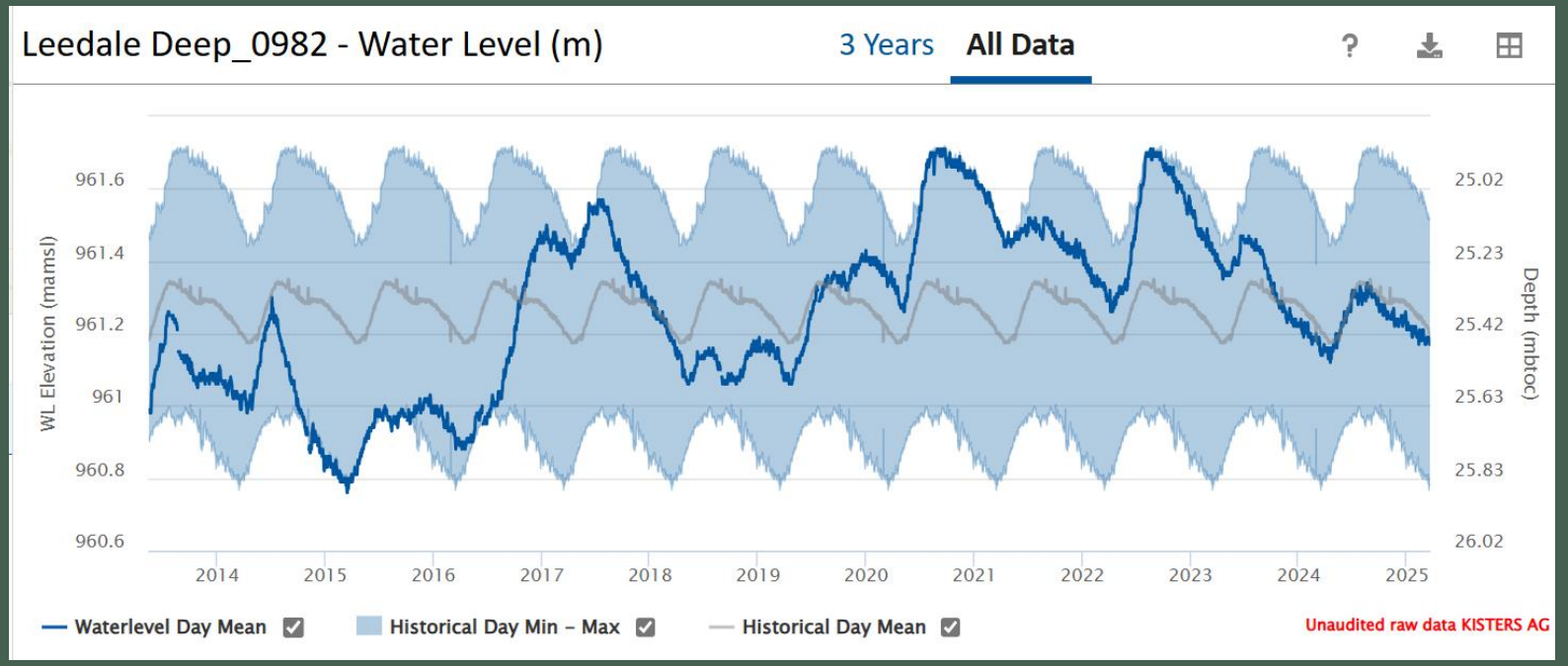
- Leedale Deep Well _0982
- 59.44 m (195 ft) deep in Paskapoo sandstone
- Continuously live-monitored since 2013
- Main purpose was to monitor fracking
- 9 km SW of Leedale.
- 23 km NW of Eckville

2016 major Summer storms

2020 10+ year rainfall and July 16 storm

2024 Drought

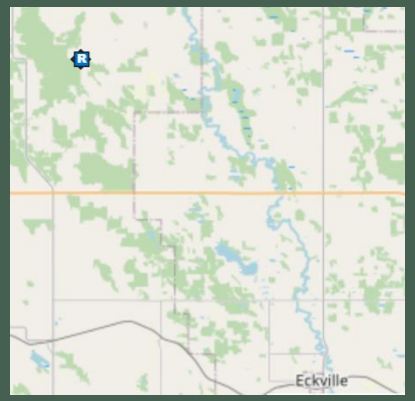




AEP Groundwater Observation Wells

Active Wells

- Leedale Shallow 3022
- Continuous monitoring since 2013
- 9 km SW of Leedale.
- 23 km NW of Eckville
- In gravel and clay
- 10.06 m (33 ft) deep

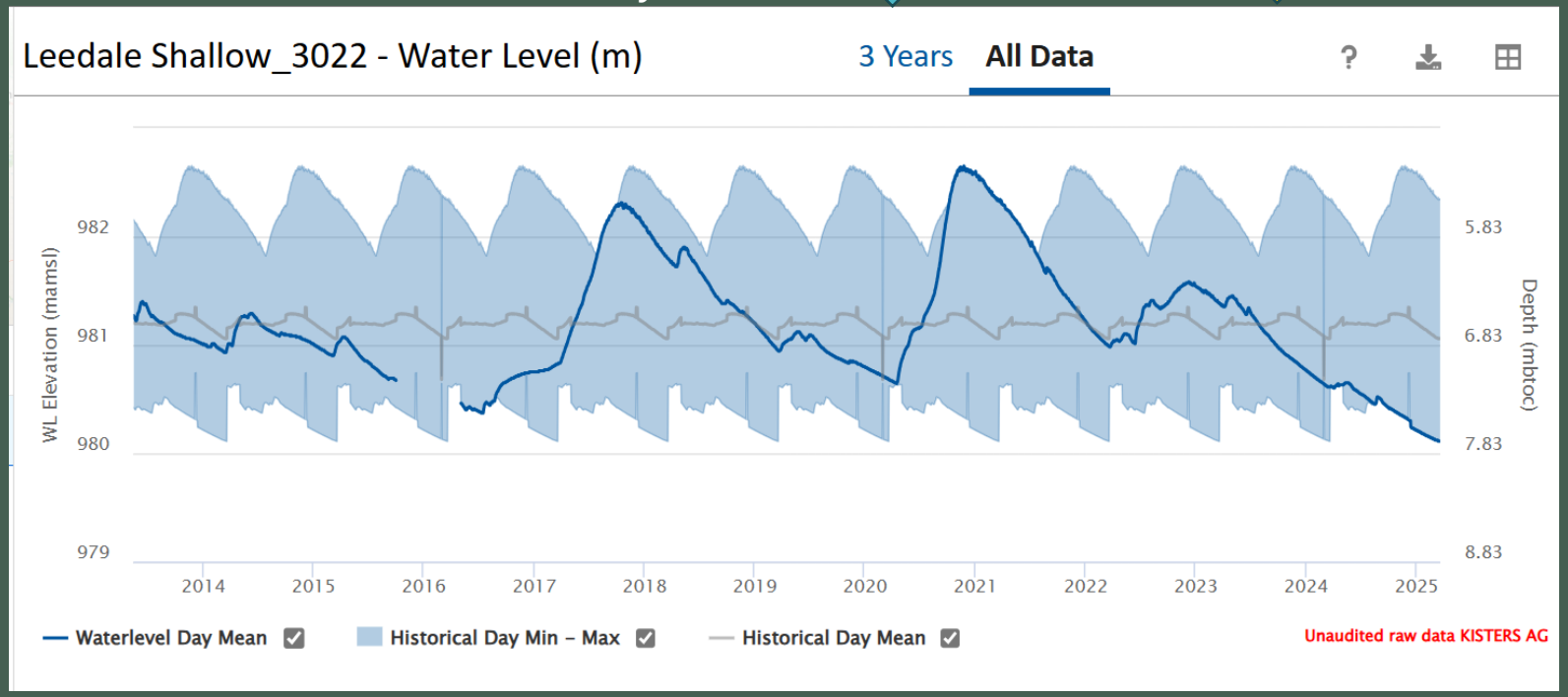


2016 Drought + Summer Storms

June 2017 Storm Sylvan Lk.

2020 10+ year rainfall and July 16 storm

2024 Drought



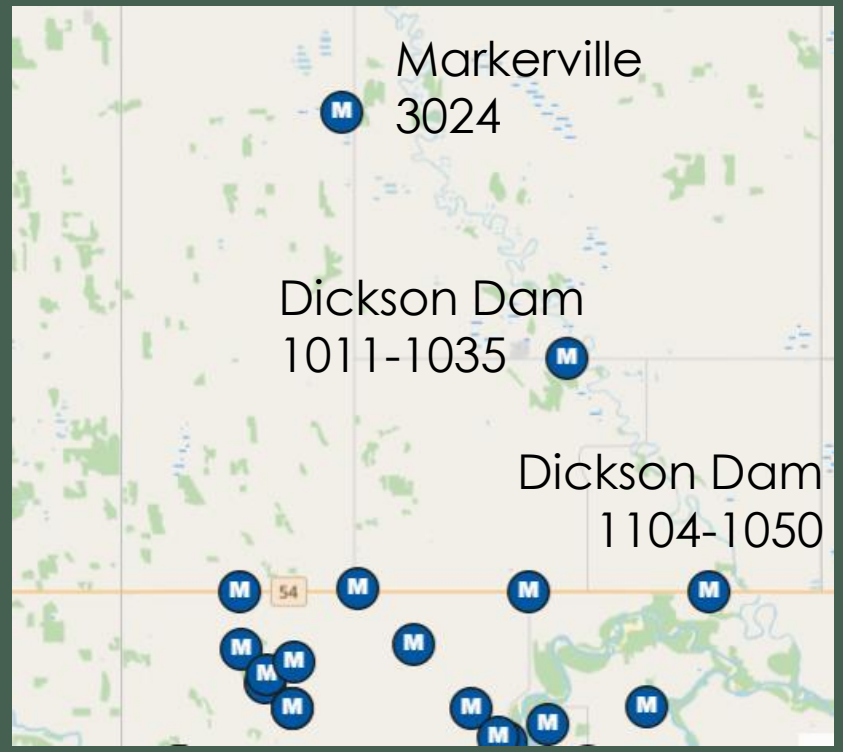
AEP Groundwater Observation Wells
Inactive Wells

Inactive Wells are not currently monitored or maintained
Current physical well status may be unknown.

- **Markerville 3024**
- 12 km NW of Markerville
- 5.49 m deep
- Sand and Clay aquifer
- Water quality sampling

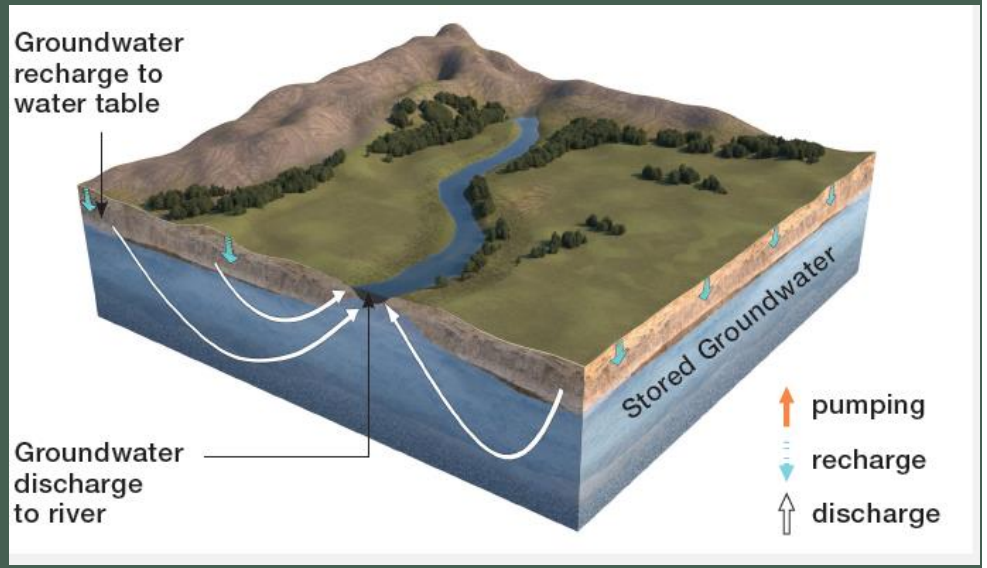
- **Dickson Dam 1011-1035**
- 3 km NW of Markerville
- 54.86 m deep
- Siltstone
- Paskapoo
- 1977 –
- Spot readings

- **Dickson Dam 1004-1050**
- Hwy 54 near confluence of Medicine River and Red Deer River.
- 8.53 m deep
- Dickson Buried Channel
- Gravel
- 1977-
- Spot readings

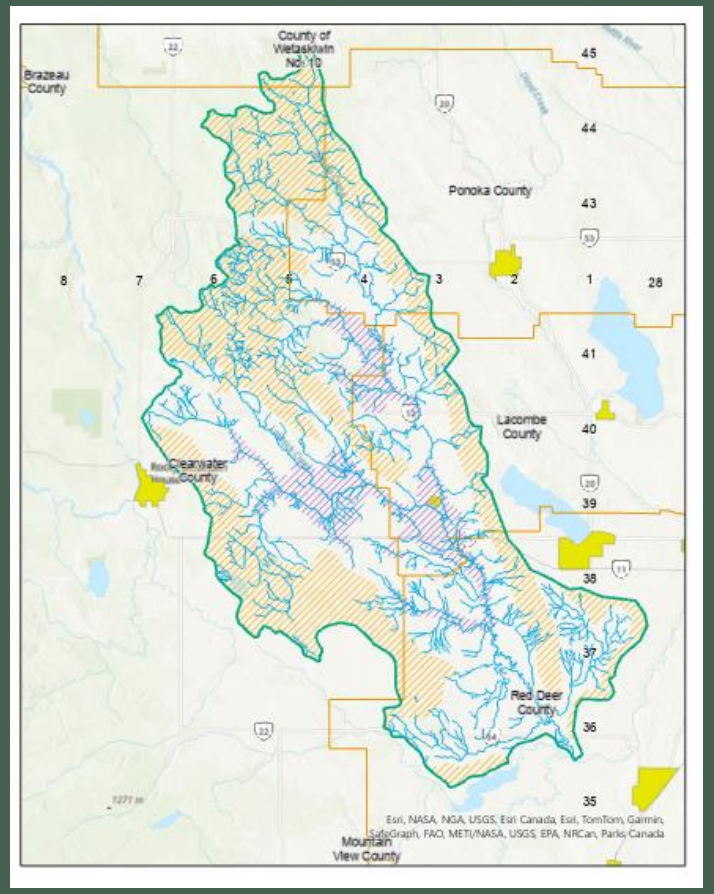


Recharge and Discharge areas

- Paskapoo is the top rock layer
- Basin-scale flow driven by Medicine River basin boundary topography.
- Sub-basin flow driven by local topography.
- Larger scale flow system = deep circulation.
- Smaller scale flow system = shallow circulation
- Vertical flow is weak except at basin boundary.
- The water table is deep at the basin margins and shallow at basin centre along streams.

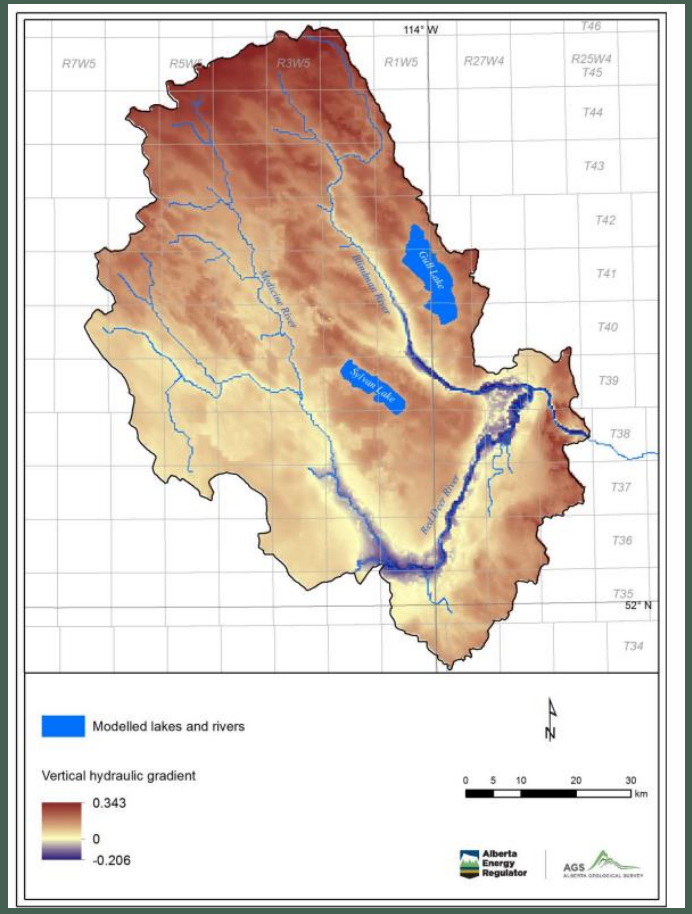


Recharge & Discharge



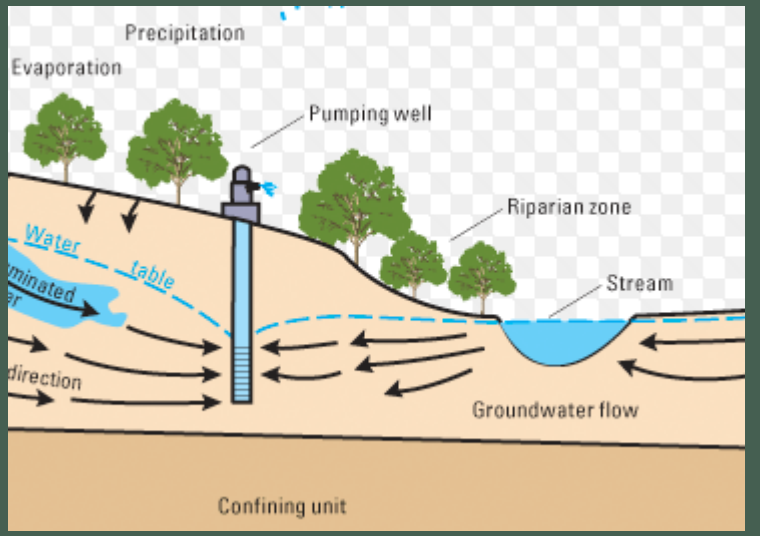
- Shallower Groundwater Flow (AGS mapping)
- Local Scale Flow Systems
- Recharge at edges
- Discharge along stream systems
- One the basin scale groundwater may take a few years to make it from recharge to discharge.

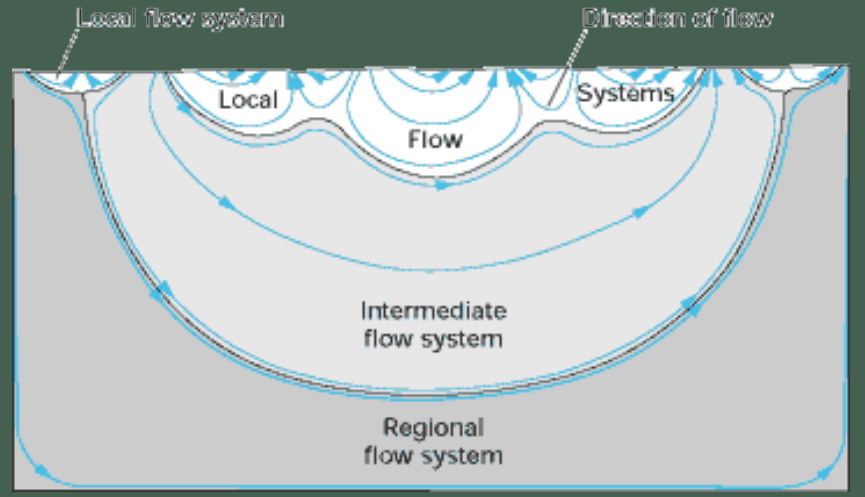
- Deeper Groundwater Flow
- (AGS Model)
- Regional Scale Flow Systems
- Discharge to lower Medicine River and Red Deer River
- Longer time frames



Local Flow

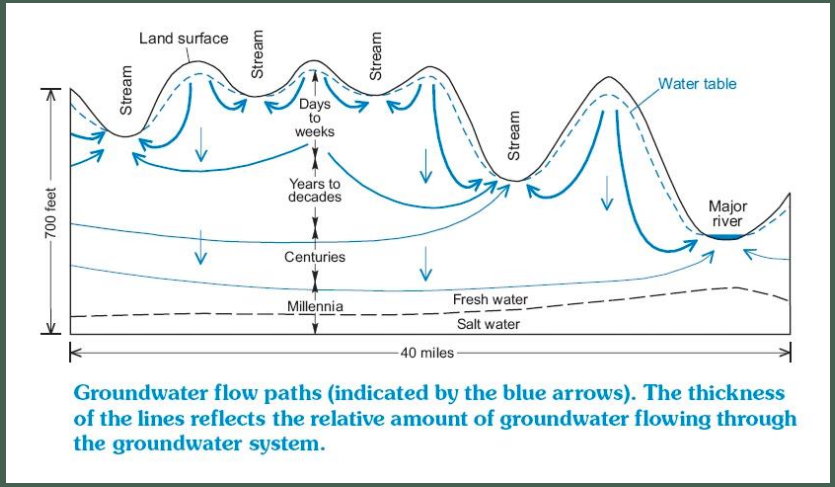
- Position at the top of the water cycle means no inflow of water from other bedrock aquifers.
- Water is sourced within the watershed making it drought sensitive.
- Local recharge-discharge systems are found near-surface, feeding streams and lakes.
- Bank Storage provides seasonal storage of base flow
- AGS estimates average annual minimum groundwater recharge to be 100 - 175 mm/year (4-7”)
- The Paskapoo is the top-most rock formation. Unlike other bedrock aquifers, there are no places with overlying rock formations.



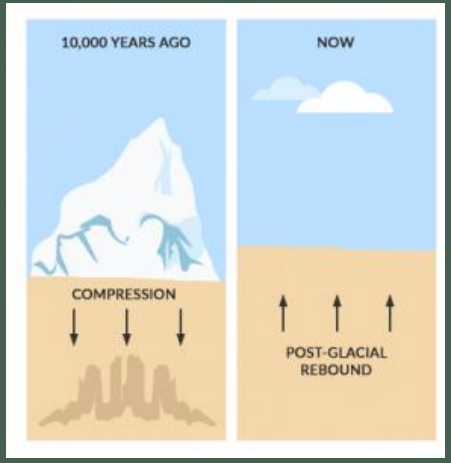


Deep flow

- On a regional scale, groundwater flows down into deeper aquifers due to elevated regional topography and glacial rebound.
- Rock expansion at depth caused by glacial erosion and unloading of ice has created low static water levels at depth which draws water deeper into the aquifer.
- Static water level gets deeper with deeper well depth.
- Effect on Wells: Low static water levels at depth require more lift and have reduced available head.



Groundwater flow paths (indicated by the blue arrows). The thickness of the lines reflects the relative amount of groundwater flowing through the groundwater system.



Water Budgets

- Basin water budget
- Change in Storage =
- + Precipitation + stream Inflow + groundwater inflow
- – evaporation – stream outflow – groundwater outflow
- Groundwater portion is remainder of other estimates.

Medicine River Basin inputs depend on local rain and snowfall.

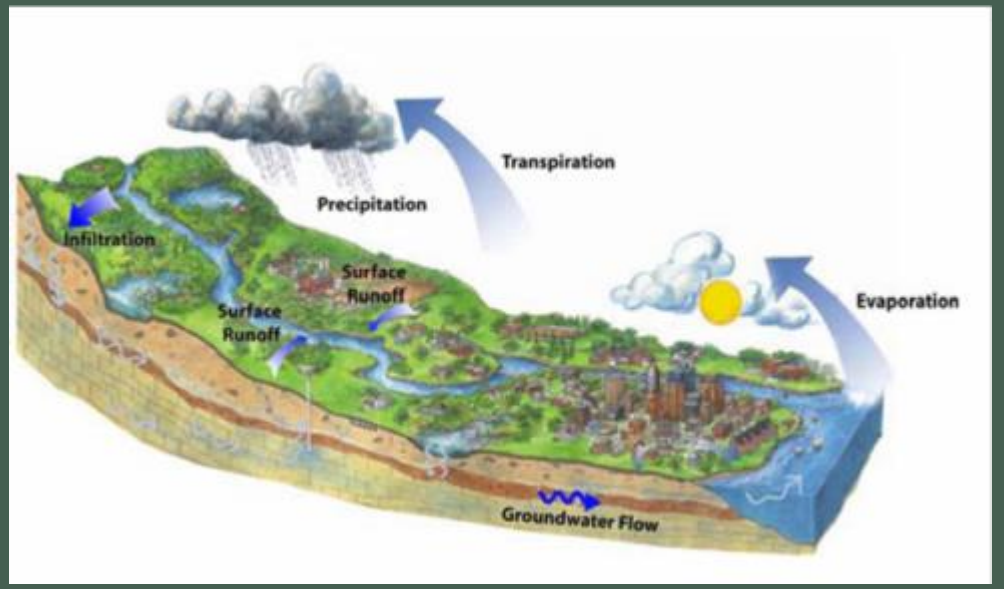
Stream inflow = 0

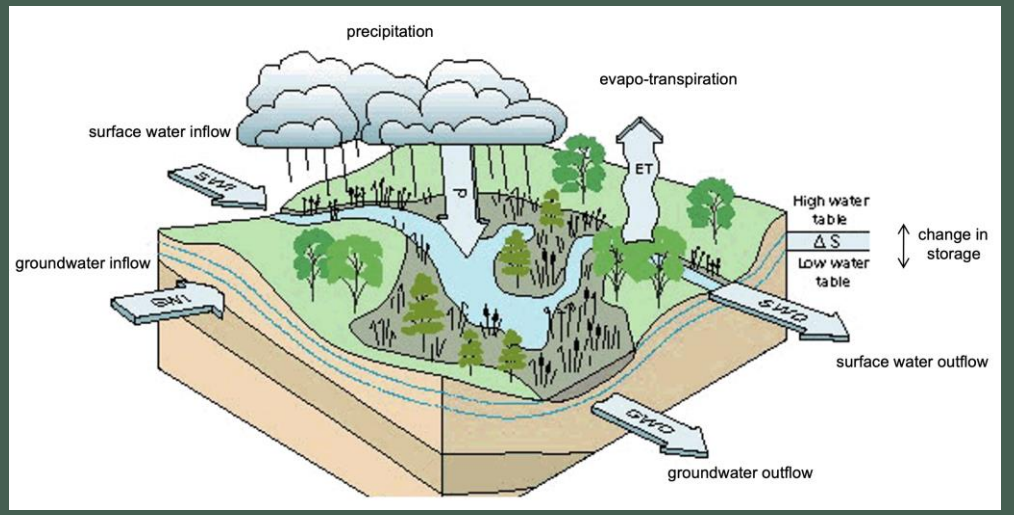
Groundwater inflow = 0

Outflow = losses to streams, evaporation, evapotranspiration, deep groundwater.

Water balance is not static. Less inflow during drought will reduce storage and outflow.

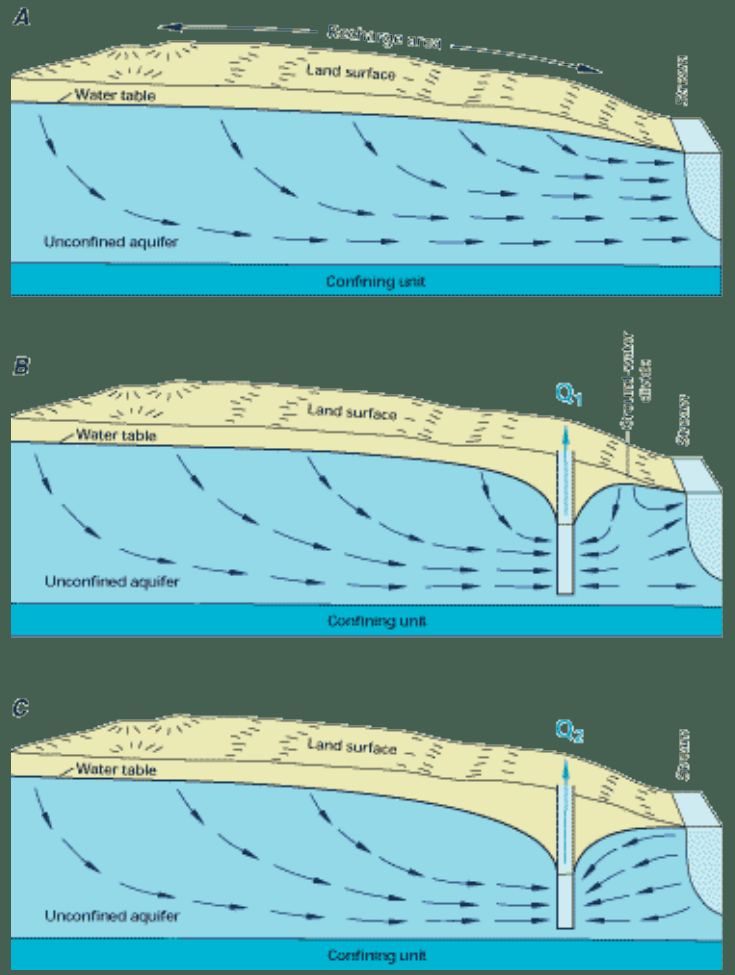
Water stored as groundwater will mitigate drought impacts.





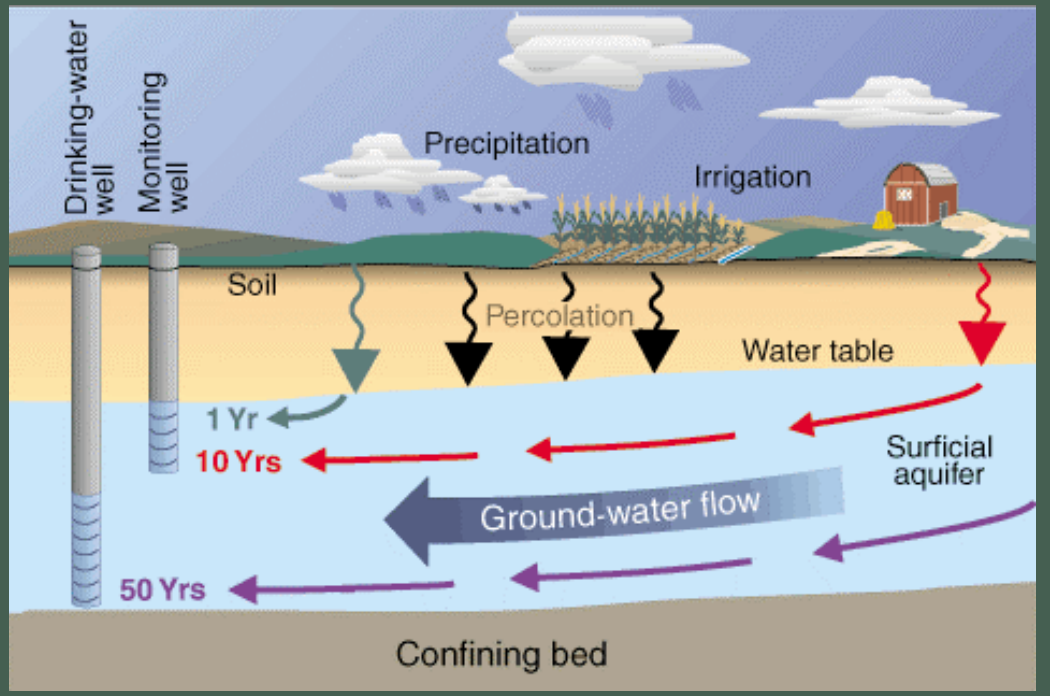
GUDI – Well – Stream Interference

- Wells will modify the groundwater flow directions away from natural systems to flow towards the well.
- Where is well is shallow and near a water body, ongoing pumping may eventually draw water from surface water.
- May affect stream flow.
- May affect drinking water quality if water is not sufficiently filtered to remove bacteria, viruses and parasites.



Groundwater Chemistry

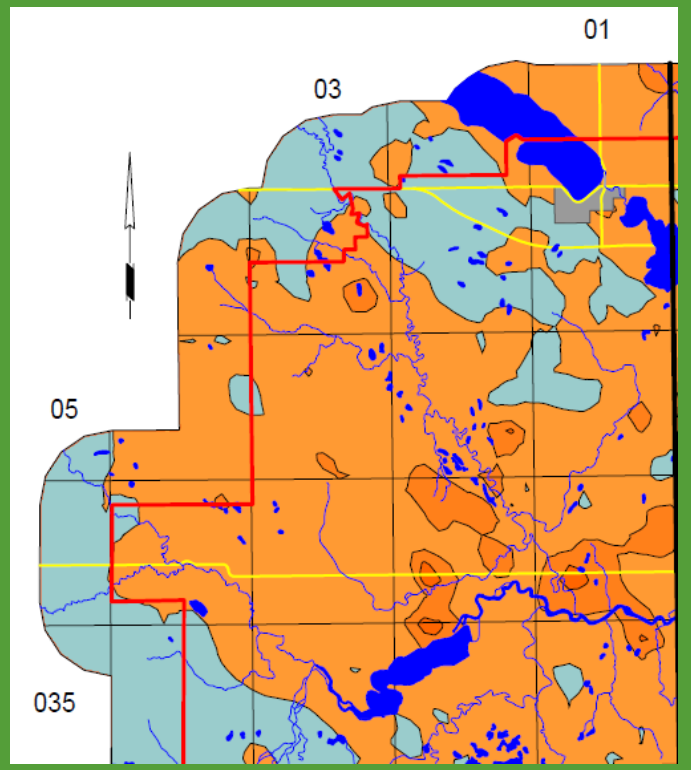
- Paskapoo Formation groundwater quality is determined by overlying geology.
- Because the groundwater is recharged locally, it has a short period of time to pick up minerals and salts.
- Low level of development limits contaminant sources.
- = Good Quality
- TDS <1000 mg/L – normal for groundwater
- Locally high fluoride (natural)



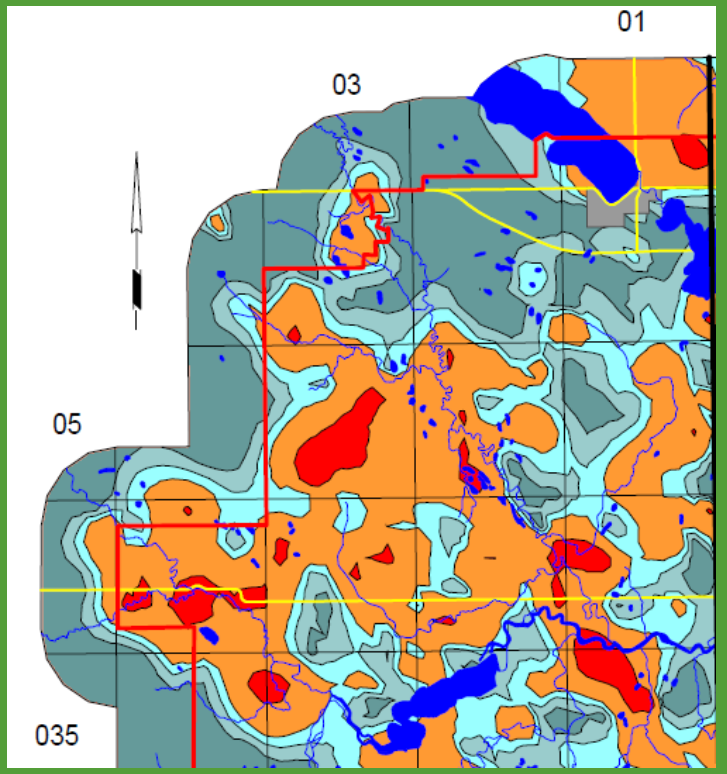
Well Water Chemistry (bedrock)

- **TDS mg/L**
- Grey <500 mg/L
- Orange = 500-1000
- Dark orange >1000
- **Fluoride mg/L**
- Grey <1.0
- blue= 1.0-1.5
- Orange = 1.5 - 3.0
- Red = 3.0 - 5.2
- Fluoridated city water is set at 0.7 mg/L
- Natural fluoride comes from volcanic minerals. Found worldwide along front ranges of mountains.
- High calcium intake reduces F absorption by the body
- >8 mg/L needed to develop fluorosis
- Tea has up to 4 (Tetley, Lipton) 2.5 for Twinings and Yorkshire teas. Green tea 1.0
- Coffee has 1.2 mg/L

TDS

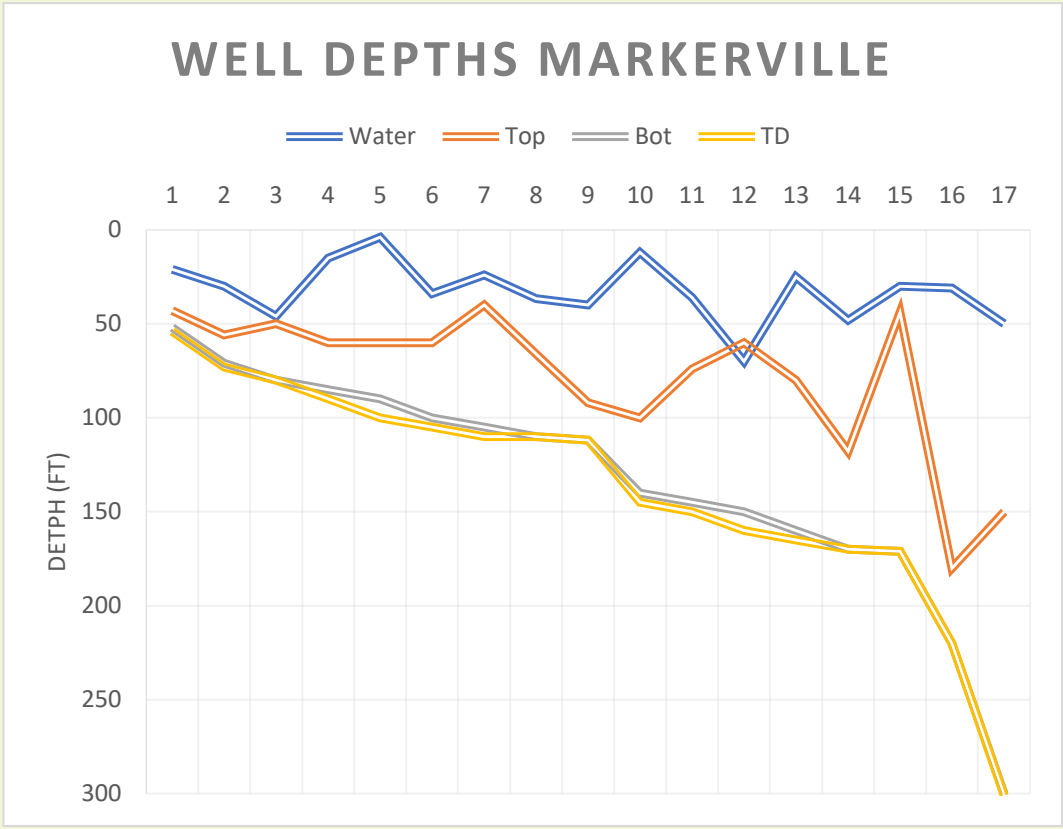


Fluoride



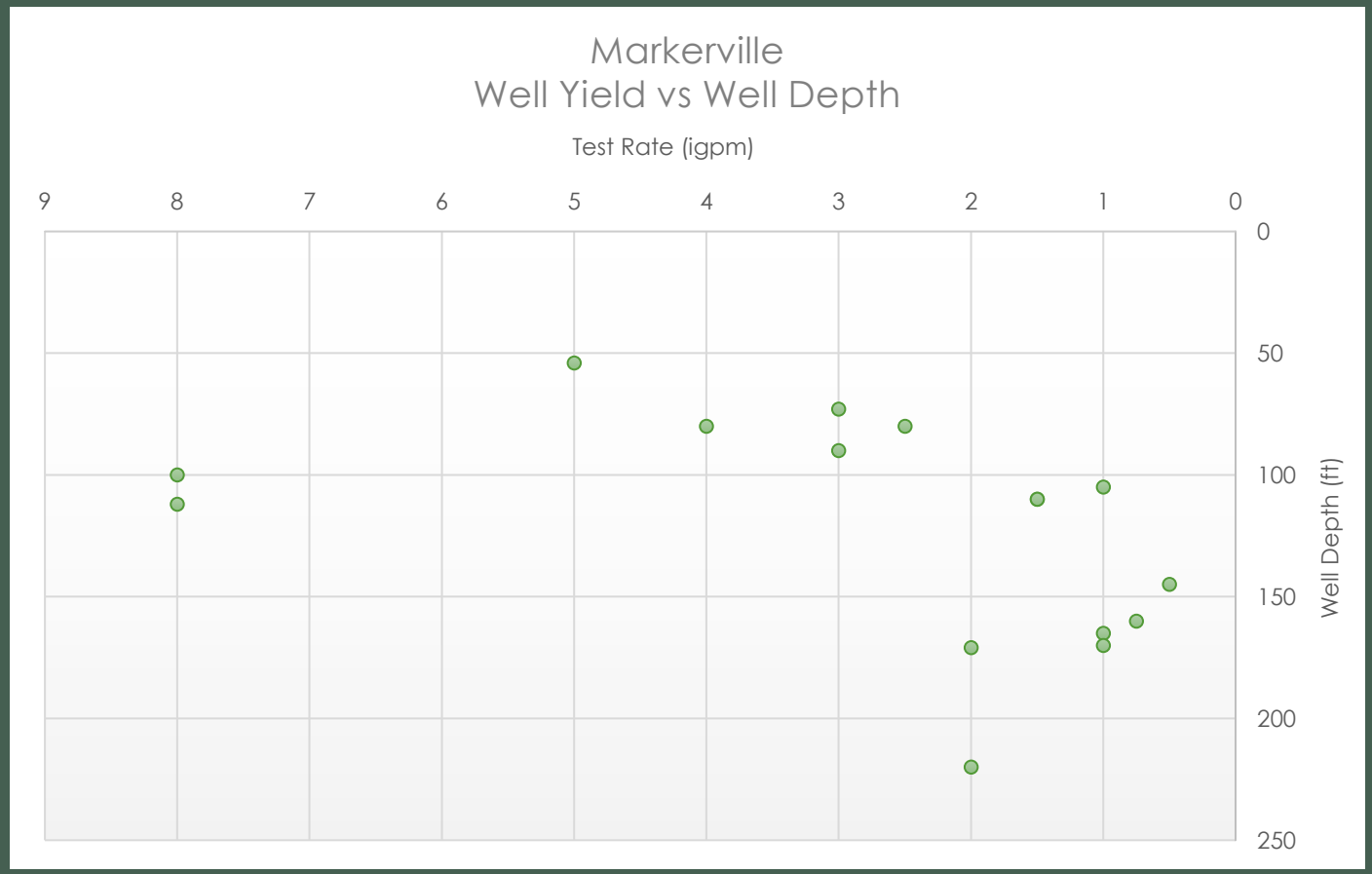
Markerville Wells

- Graph show individual wells in Markerville:
- Water Level
- Top Perforations
- Bottom Perforations
- Total Depth
- About half the wells are < 120 ft deep
- Drought Sensitive



Markerville Well Depth vs Well Yield

- Yield drops with increasing well depth
- Decrease in yield below 100 ft
- Deepest well was 300 ft. Produced 0.25 igpm.



Sundance Wells

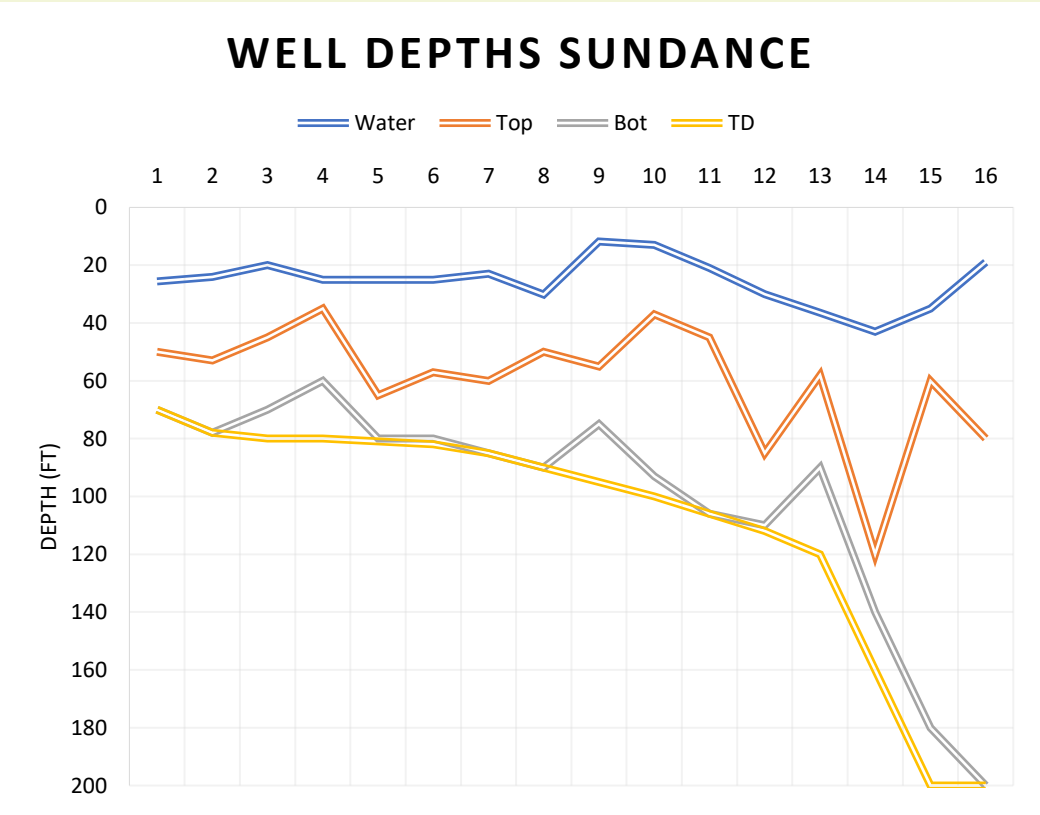
- 17 records
- 1 test hole (water bearing)
- 16 wells
- 30 feet to bedrock approx.
- All in sandstone-shale Paskapoo Bedrock
- Best producer: McGonigal Homes (20 igpm)
- Deeper wells had lower production and lower water levels
- Pump tests for 15 wells. **Seven drew down into screen during test.**
- **All bedrock wells used drill or saw-cut liners.**

All (Bedrock) Wells

	Well Depth ft	Test Rate igpm	Prod Top ft	Prod Bot ft	SWL ft	Year
Minimum	70	1	35	60	12	1965
Maximum	200	20	120	200	43	2022
Average	112	7	60	88	25	2012
Median	95	5.5	56	100	25	2013
Ave (n=12)	**< 113**	8	53	83	23	2010
Med (n=12)	**< 113**	7	52	80	25	2012
Ave (n=5)	**> 115**	2.5	80	153	33	2015
Med (n=5)	**> 115**	3	70	160	36	2013

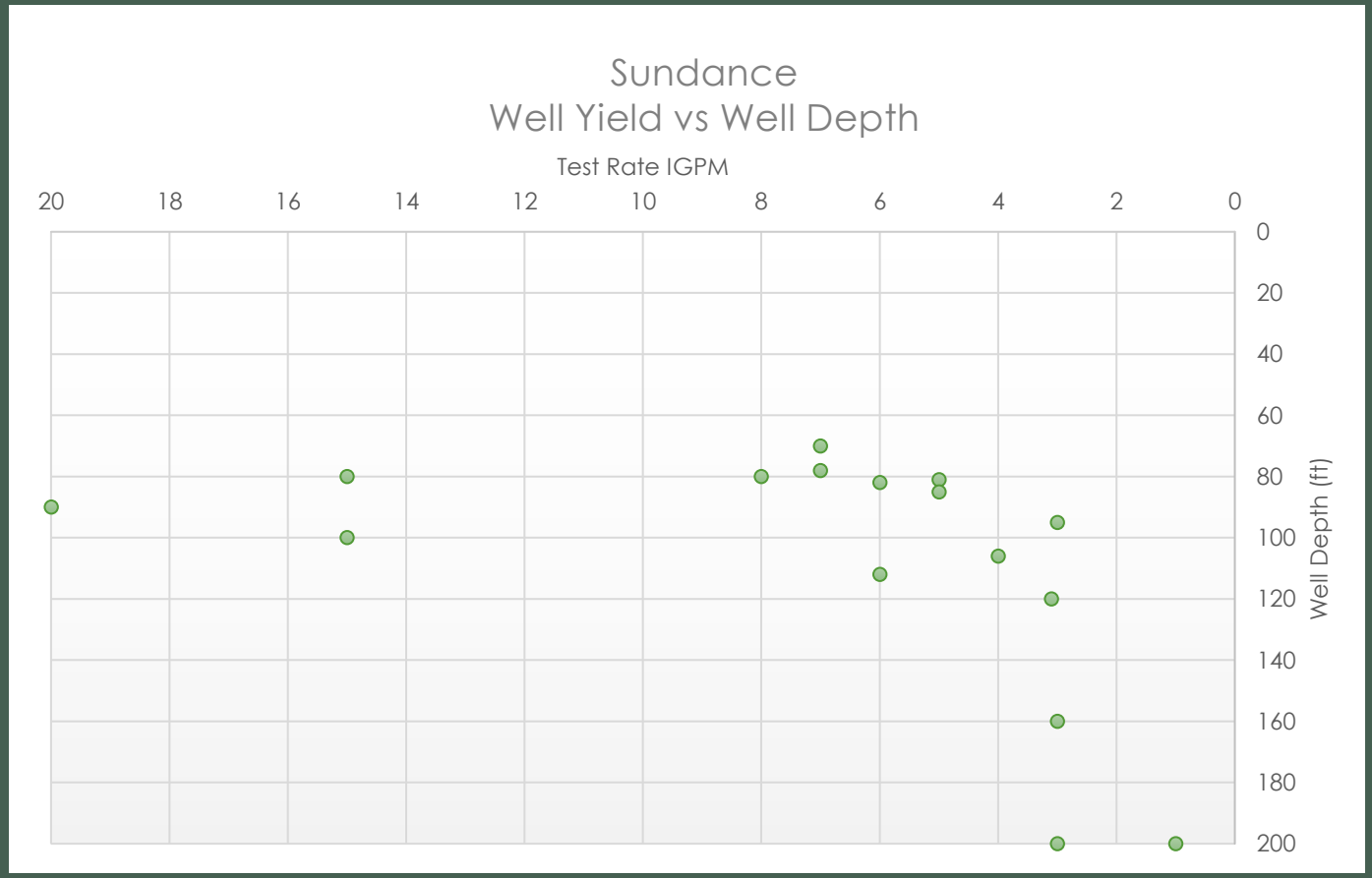
Sundance Wells

- Graph show individual wells in Sundance:
- Water Level
- Top Perforations
- Bottom Perforations
- Total Depth
- 3/4 of wells are < 120 ft deep



Sundance Well Depth vs Test Rate

- Yield drops with increasing well depth
- Decrease in yield below 100 ft.
- Deepest well is 200ft.

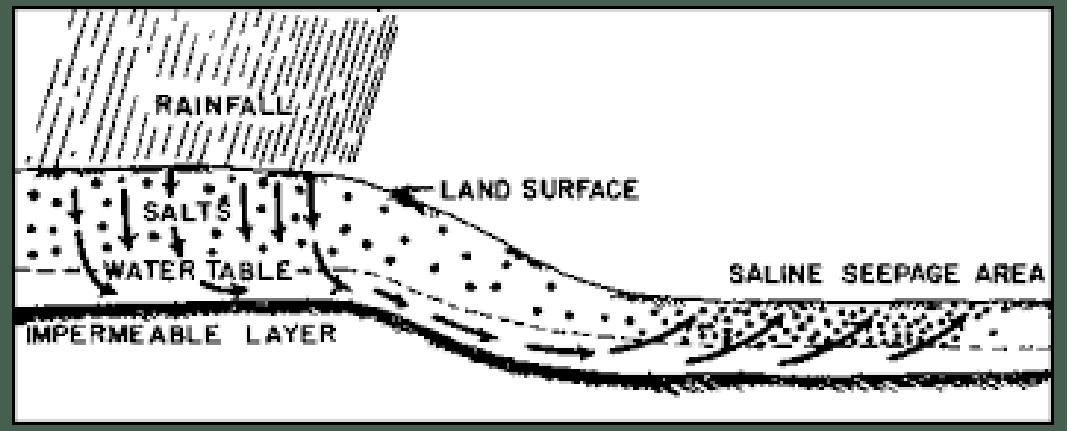


Groundwater as an Environmental Resource

- Groundwater is an environmental modifier
- Provides baseflow to streams.
- Drains elevated areas causing local water stresses.
- Discharges to low lying areas causing high water table.
- Leaches minerals, salts, iron and nutrients, transports and releases to discharge areas.
- Lubricates clay, silt and sand, which may induce landslides and erosion.
- Causes frost boils, soap holes and quicksand.
- Thermal moderation & increased humidity create micro-climates and ecosystems around springs.

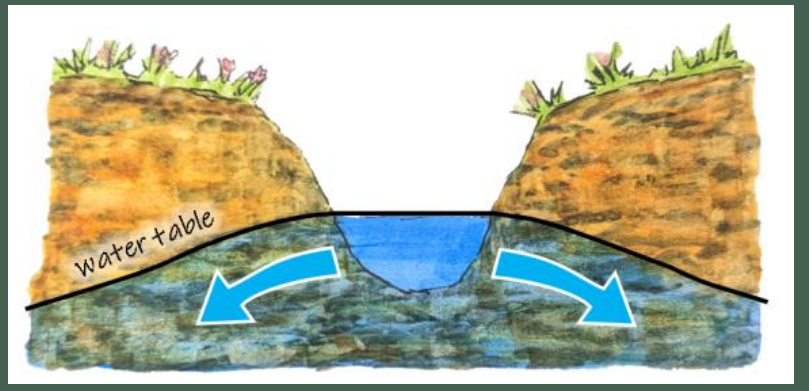
Groundwater in the landscape

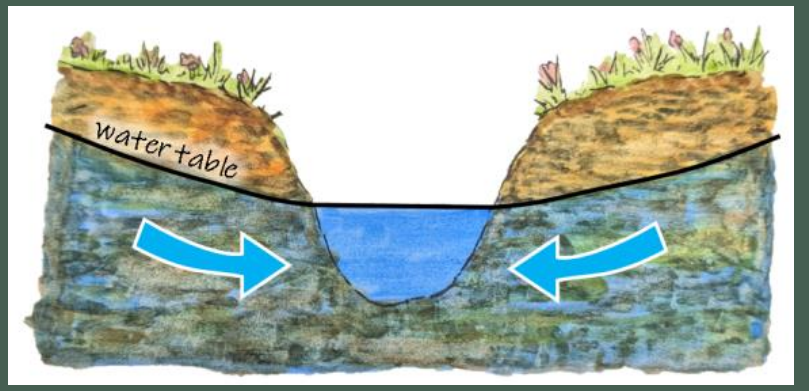
- Springs
- Soap Holes and quicksand
- Landslides
- Soil Salinization

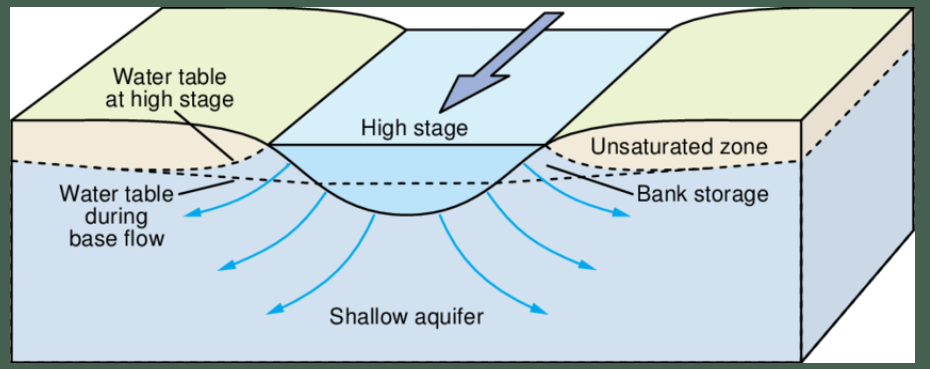


Groundwater-Stream Interaction

- Losing Stream: in groundwater recharge area. Stream is losing flow to groundwater. Ephemeral. Typical of upper reaches of streams.
- Gaining stream: in groundwater discharge area. Stream is maintained by groundwater discharge (baseflow).
- Bank storage: Groundwater seasonally stored in the river flood plain during spring floods and released back to the stream in the following months.







Ecohydrology

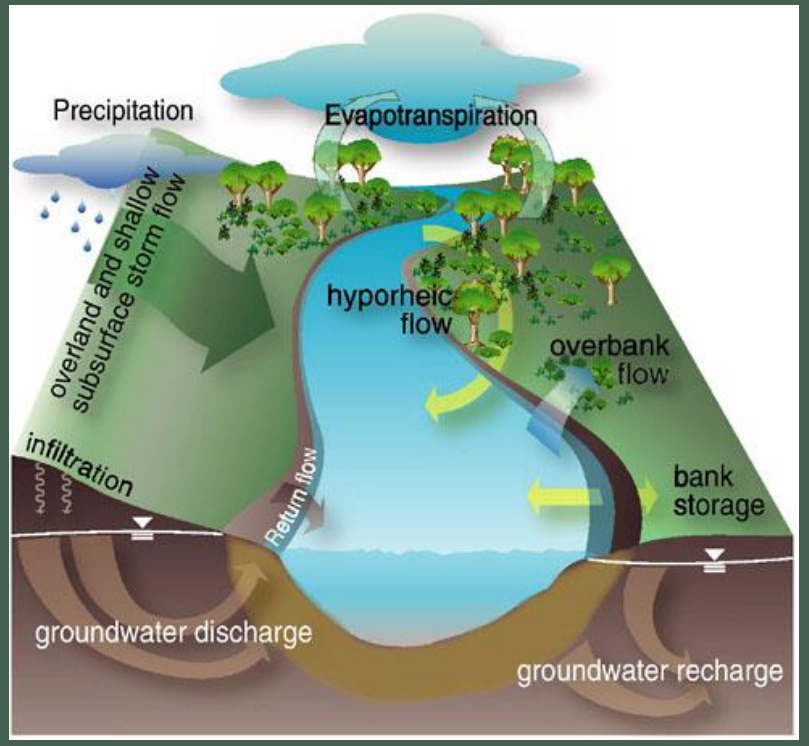
- Study of how water interacts with the biosphere.
- Groundwater plays a vital role in development of ecosystems and subsequent land use.
- Affects distribution of plants and wildlife
- Wildlife receive, habitat, cover and food sources. E.g. Moose and wetlands

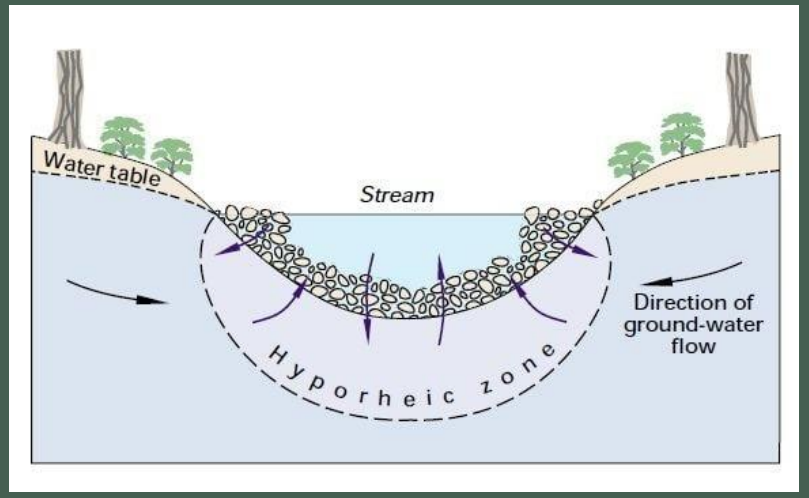
Wetlands

- River floodplain wetlands
- Marshes
- Swamps
- Peat lands – bogs and fens

Riparian Flood Plain

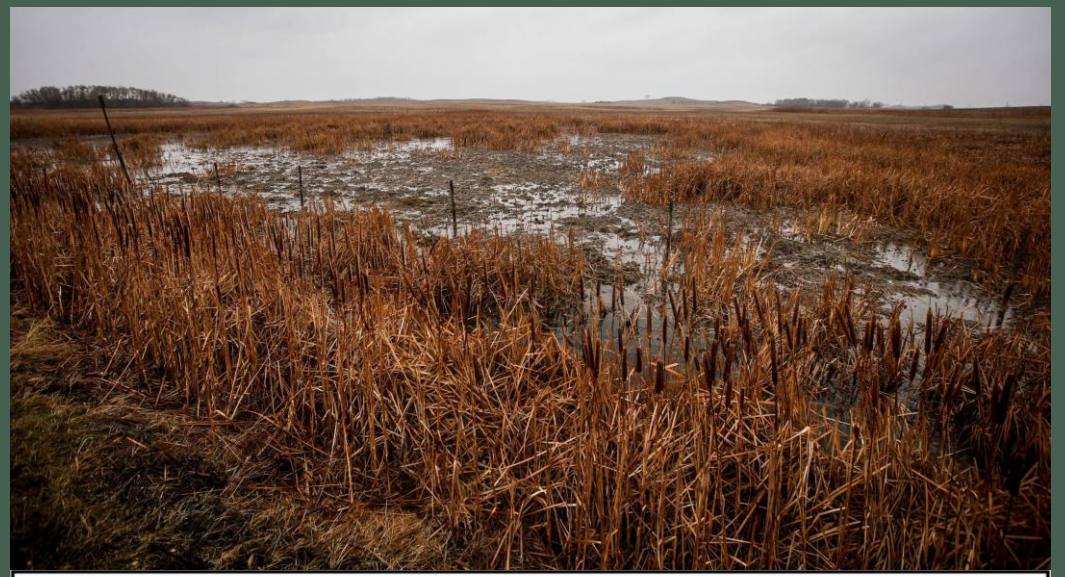
- Highest groundwater seepage is along the shoreline
- Seasonal bank storage of groundwater.
- Hyporheic Zone = zone of enhanced biological activity at surface water-groundwater mixing in stream bed.
- Mineral and Nutrient transfers.
- Chemical reactions.
- Contaminant filtering.
- Thermal refuges (fish, plants and animals).
- Natural Fish spawning & Fish Hatcheries (Raven).
- Medicine River occupies a local sandy aquifer in its valley which connects to Paskapoo bedrock.

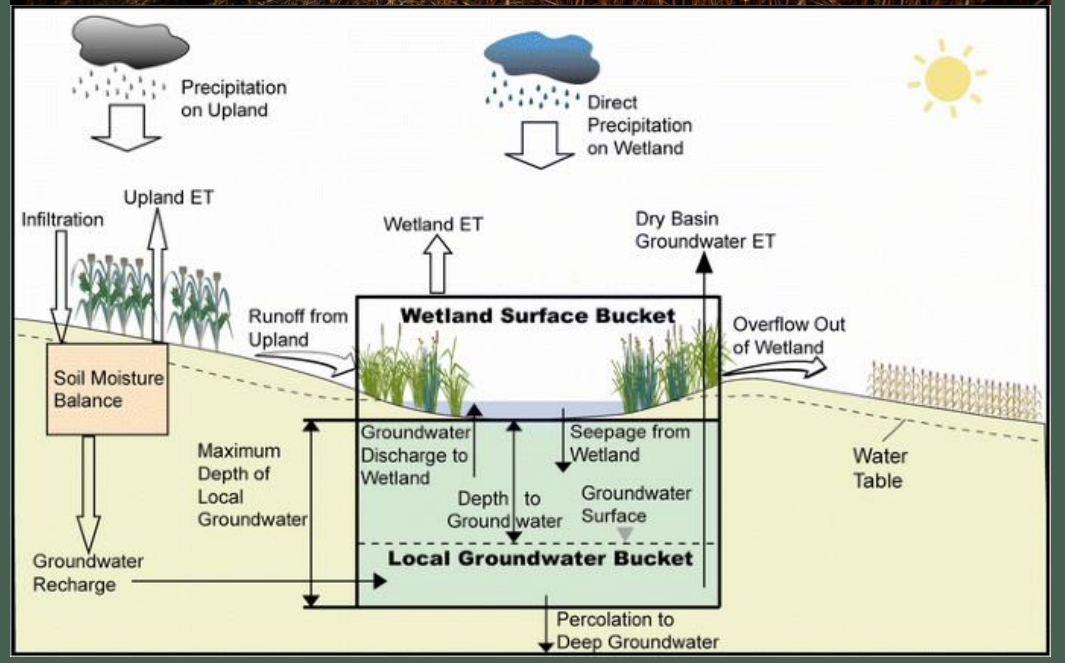




Marsh

- Prairie wetland
- Important features for water retention in the prairie landscape and buffering from drought.
- Open water ringed by cat tails and willows.
- Capture and retain spring runoff.
- Groundwater interaction is slow moving.
- Recharge marshes – elevated areas (scale of a few miles). Lose water to groundwater. Will dry up over summer.
- Discharge marshes - Low-lying areas. Receive groundwater. Will tend to remain filled year-round.



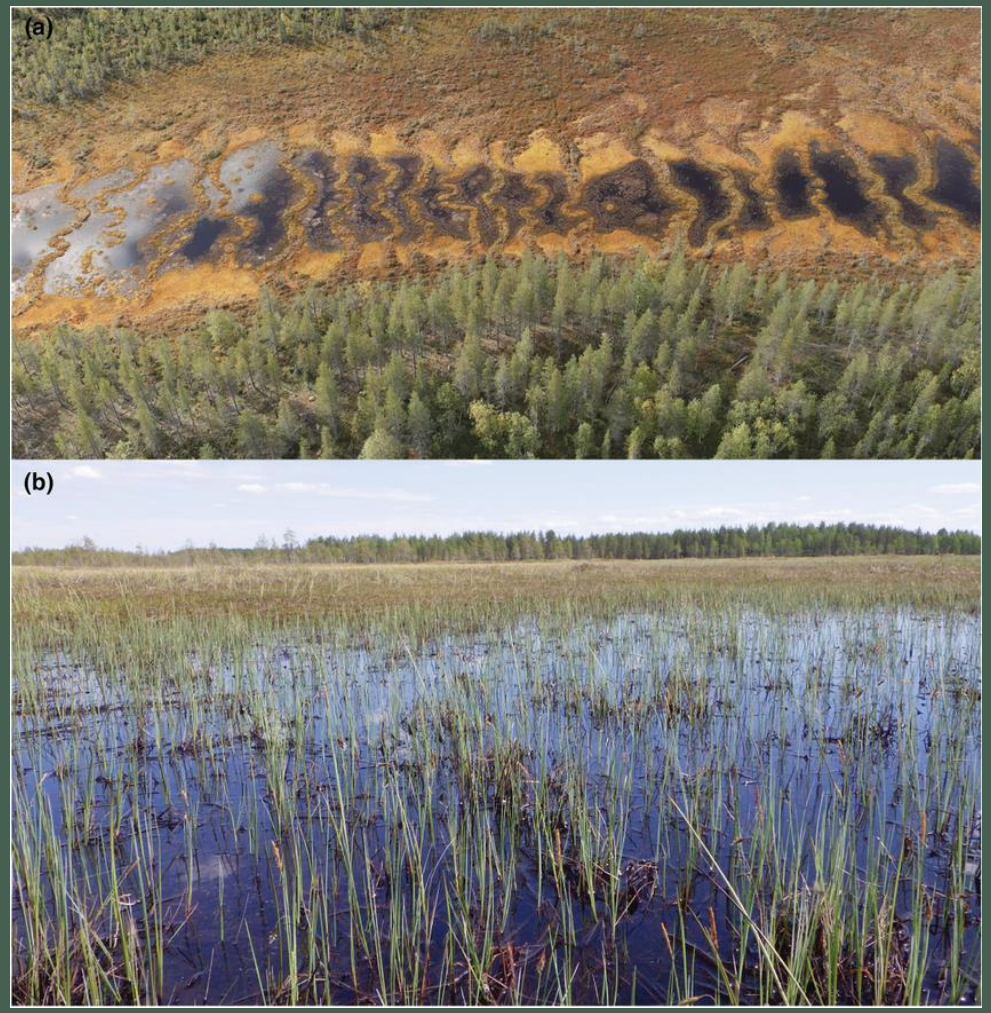


Willow Swamp

- Boreal equivalent to prairie marshes, generally lacking open water.
- Combination of surface runoff and groundwater.
- Fluctuating water levels.
- Lack defined drainage channels
- Treed: Willow, tamarack
- Grasses and sedges rather than mosses.
- Most common wetland in Medicine River Basin.

Fen and Bog

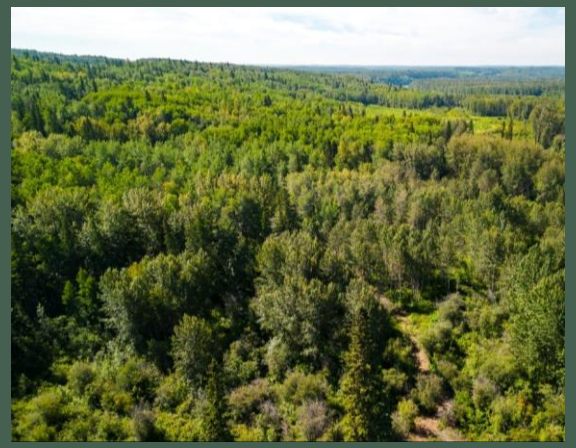
- Peat forming wetland with water table in Peat
- **Bogs**
- Found in elevated areas with poor drainage. Water is from rain and snow. pH is acidic. Biodiversity is limited to plants tolerant of water-logging and low nutrients.
- **Fens**
- Land is sloping and groundwater flows through coarse materials (surface aquifer).
- Often found near gravel pits.
- Flowing groundwater dissolves and transports minerals and nutrients. Groundwater provides thermal moderation. pH is neutral to alkaline. Biodiversity is high. Marl springs are a feature of some fens.
- Fens may support rare and unusual flora and fauna including carnivorous plants and orchids.
- A series of string fens or swamps are located between Stauffer and Alhambra.



Vegetation as groundwater indicators

Drought tolerance in plants depends on efficiency of drawing out soil moisture and minimizing evapotranspiration.

- **Xerophytes –**
- low water requirements –
- pine, juniper, grasses
- **Mesophytes –**
- like even moisture -
- aspen, white spruce
- **Phreatophytes –**
- roots will pull water directly from water table
- – willow, poplar, tamarack
- **Halophytes** – salt tolerant –
- foxtail, red samphire



Beaver Ponds

- Beavers will seek out areas of groundwater discharge / springs to build their dams.
- Groundwater discharge ensures that their pond will not dry up.
- Groundwater has thermal moderating ability
- Groundwater upwellings will keep patches of open water in the ponds over winter.

Summary

- Groundwater is an important source of domestic and farm water supply.
- Paskapoo is the main aquifer for the Medicine River Basin
- Groundwater provides water storage, mitigating drought.
- Groundwater sustains ecosystems and is an integral part of a healthy environment.