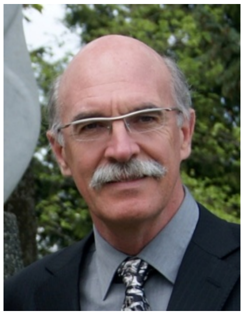
# 5. Look at Groundwater Differently

This section synthesizes the pioneer work of Dr. Gilles Wendling, and presents it in his own words. Because he looked at groundwater differently in the Englishman River, Gilles Wendling has advanced the science and he has developed a practical application of water balance thinking. His contributions to science-based understanding extend beyond the technical and into the communication and education realm. His work provides a bridge between rainfall (Section 3) and stream health (Section 4).



Dr. Wendling emphasizes that time is a critically important dimension in maintaining the water balance (refer to Figure 8). Also, that water is always moving. These are fundamental concepts, yet are not always well understood.

## Characterizing Aquifers

"Characterizing aquifers is a complex and costly exercise because you need wells in order to reach aquifers and to monitor the depth and fluctuation of the level of the water table," states Dr. Wendling.

"The cost of drilling a well is typically between $5,000 and $10,000, and several wells per aquifer are needed to get the required information to define the movement of groundwater in an aquifer. Then you need to install monitoring equipment, to collect the data, and to store and process it. The final cost is in the hundreds of thousands of dollars if you want to do a proper assessment over a watershed containing several aquifers."

"The approach that we took with the Mid Vancouver Island Habitat Enhancement Society (MVIHES) in the Englishman River Watershed was to involve the community."

***Involve the Community:*** Dr. Wendling explains that the benefits of community involvement were two-fold:

"First, we saved the large cost of having to install new wells. We used existing wells that owners volunteered for monitoring."

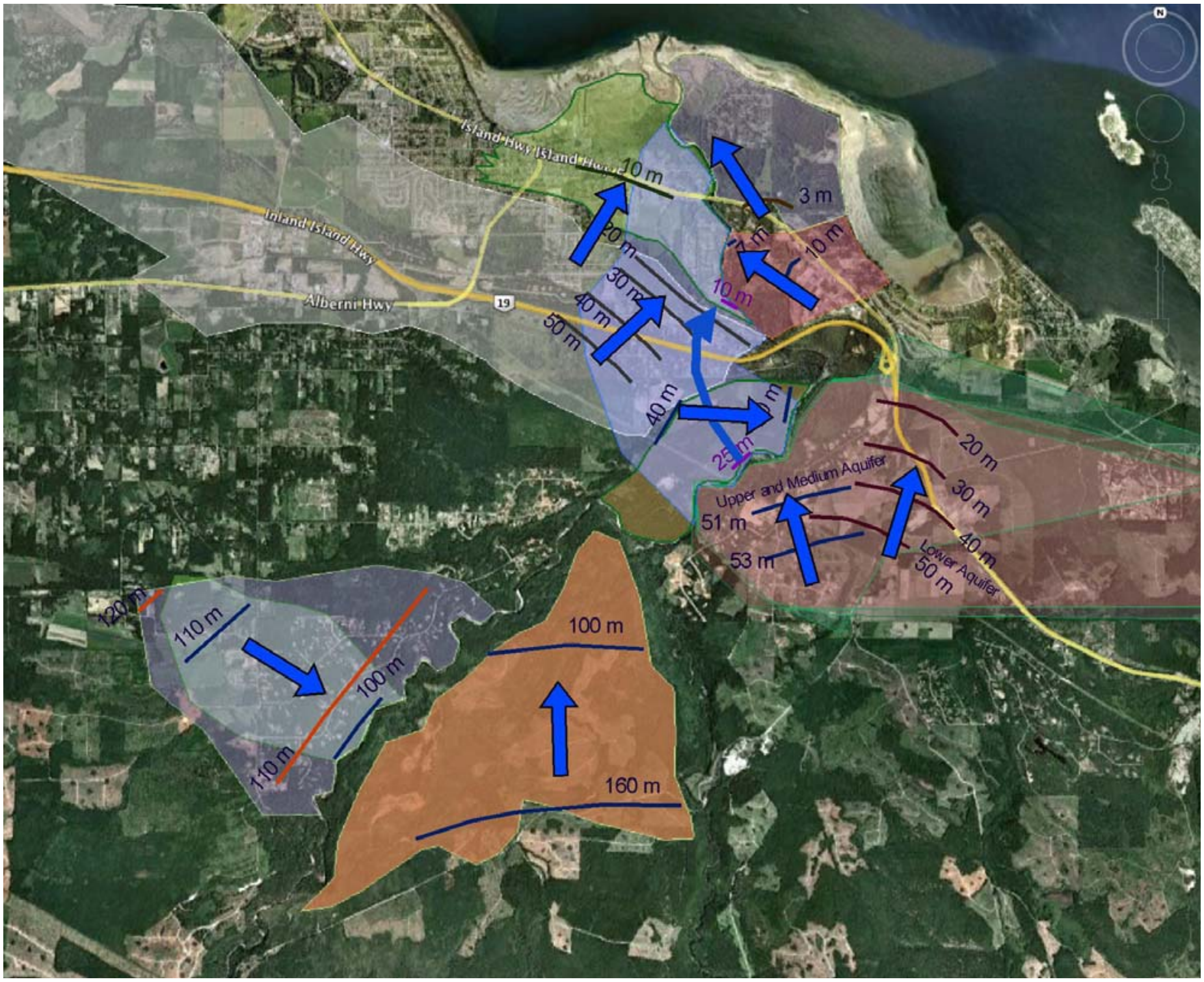
"Secondly, we believe that the long-term health of watersheds depends upon the stewardship of the people who live in the watersheds. By getting them involved in its study, the community connects to its watershed, its complexity and how it works."

"Community members will then be able to more willingly modify their behaviour and management of the land, after they appreciate the direct connection between what happens at surface and what happens in the subsurface, on their property, the property of their neighbours and their local environment," concludes Dr. Wendling.

***So where are the aquifers and in which direction is the groundwater moving:*** "Through the review of numerous well logs, the drafting of cross sections, field observations, water level monitoring in water wells, and inspection of the riverbanks, a map was produced showing the estimated footprint of the aquifers in contact with the Englishman River (refer to Figure 21)," continues Dr. Wendling.

"In addition, the depth to water measured in the wells has given us the information to estimate the slope of the water table. So we can now estimate the direction of the water (*shown with the blue arrows on Figure 21*), and the slope of the water table." The latter is indicated by the water table elevation lines on Figure 21.

"It was important for us to characterize the flux under both high and low water table conditions, particularly to assess if there were sections of the Englishman River where there was a reversal of the flux between the river and the aquifers due to the seasonal fluctuation of the water table. And generally it does not happen. **The aquifers keep providing groundwater to the river, all year long**," concludes Dr. Wendling.




## General Groundwater Directions in Overburden Aquifers in Englishman River Lower Watershed

Figure 21

## How Much Groundwater is Discharging to the Englishman River?

"In order to visualize the flux between the aquifers and the Englishman River under low summer flow conditions, we created a series of images," states Dr. Wendling.

"In the accompanying image (refer to Figure 22), you are traveling down the Englishman River, between 10 km and 5 km up from its estuary. On your left you see the face of the left bank, and on your right the right bank. The picture of the land, on both sides allows you to position yourself in the watershed."

"The blue line represents the elevation of the river. The coloured shapes represent the sections where the aquifers intersect both banks. And the arrows express the flux of groundwater discharging into the river."

"The estimate of the flux is summarized in the boxes, in litres per second (l/s) and cubic metres per day (m3/day). The ratio between the flux from the aquifers and the summer river lowest flow rate is expressed as a percentage, to show how much the aquifers participate in providing water to the Englishman River during its period of low flows."

***Flux Defined:*** Flux is a core technical concept, and one that Dr. Wendling stresses when making presentations.

"The groundwater flux is the quantity of water traveling through and aquifer (in the voids between the grains of salt or the pieces of gravel) per section area (typically per $m^2$ of the section of the aquifer it is traveling through) and per unit of time (e.g., per second, minute, day, year)," explains Dr. Wendling.

"In my experience, it is important to both remind and emphasize that an aquifer is NOT an underground lake. This fact is not necessarily understood by everyone. So we need to be clear that an aquifer simply consists of saturated layers of sand and gravel in the subsurface. The water is always moving."

## Groundwater and Surface Water: Same water

The ability of Dr. Wendling to make groundwater concepts real to an audience is illustrated by the story that he tells about a puddle on farmland in the Englishman River watershed.

Figure 23 is a collage of four pictures that illustrate the "story of the puddle". It is a big puddle, approximately 1 metre in diameter.

***The Story of a Puddle:*** "This puddle is not just a puddle. When I walked by it, on July 21, 2010 at 2:31 pm (Figure 23B), on a sunny day, I observed fry; a dozen of them. They were all concentrated at a specific spot. Why there? Because it is where groundwater was discharging to this little puddle," reports Dr. Wendling.

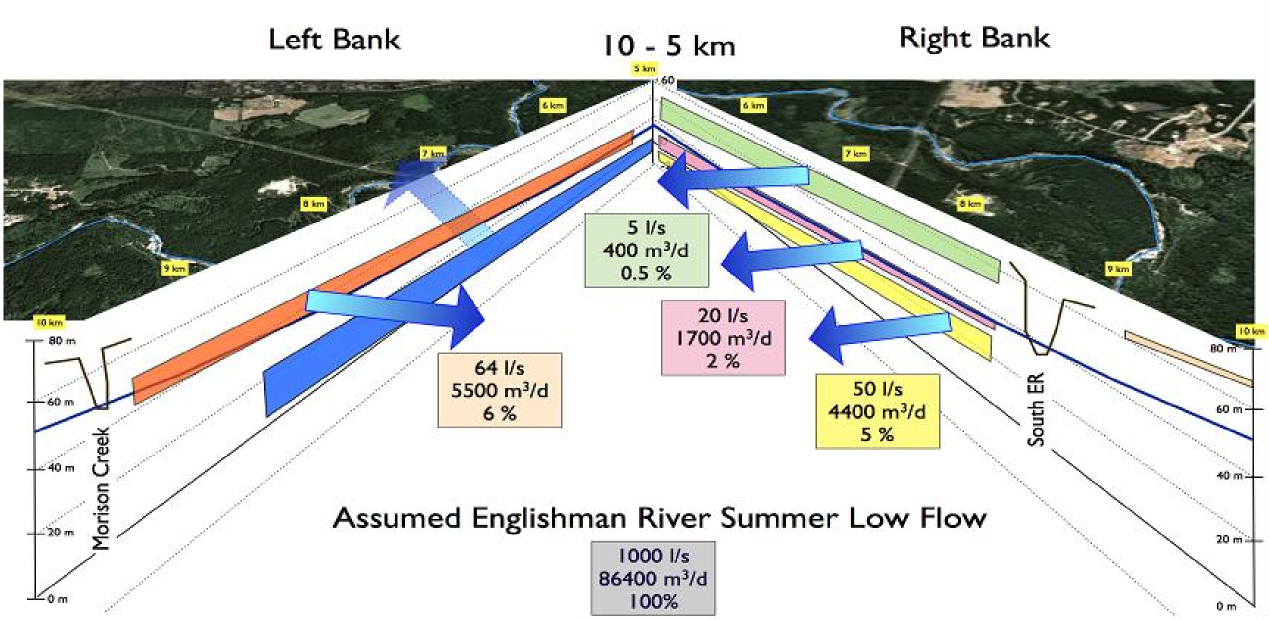
"They were looking for cooler and fresher water, possibly containing more oxygen than the warm, silty and algae rich water of the puddle."

"Where was that puddle? At the end of a drainage ditch, upland at the corner of a field (refer to Figure 23C and note the yellow circle). These fry had swum almost 2 km from the Englishman River up small tributaries to the local headwaters."

"Our study has shown that in this area, which is an important spawning and rearing ground for salmon, there is an important flux of groundwater towards the Englishman river, both under high and low water table conditions."

"When I walked by the puddle 2 hours later (Figure 23D), I was very saddened by what I saw. All the fry had died because the water conditions had passed the tipping point that allowed them to survive."

"This simple observation really confirmed to me that surface water and groundwater are closely connected. They are one, as shown by image (refer to Figure 24) that illustrates how the groundwater from aquifers feeds both the wetlands and the streams. We have to be very careful with what we do with the land and how it affects water tables," concludes Dr. Wendling.




Estimated Groundwater Flux to Englishman River
from Overburden Aquifers

Figure 22

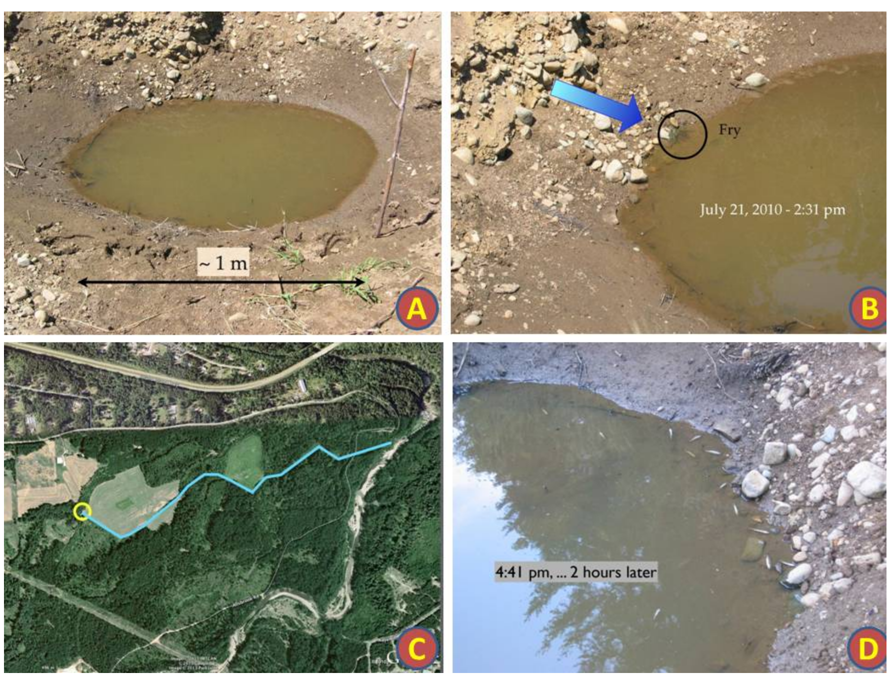



Figure 23

Groundwater and Surface Water: Same Water

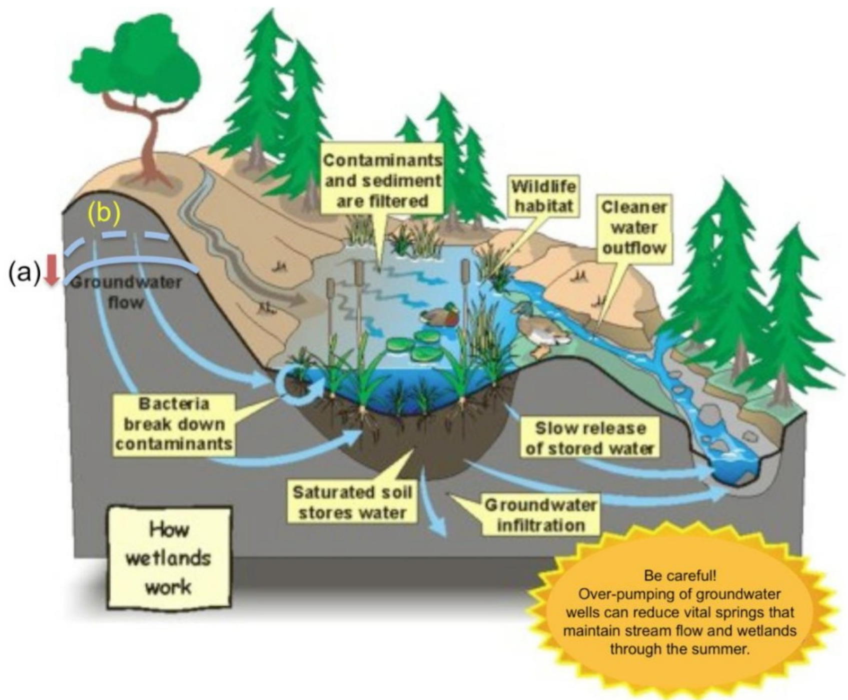



Figure 24

nrcan - geoscape Gulf Islands

### Groundwater and Land: They ARE Connected!

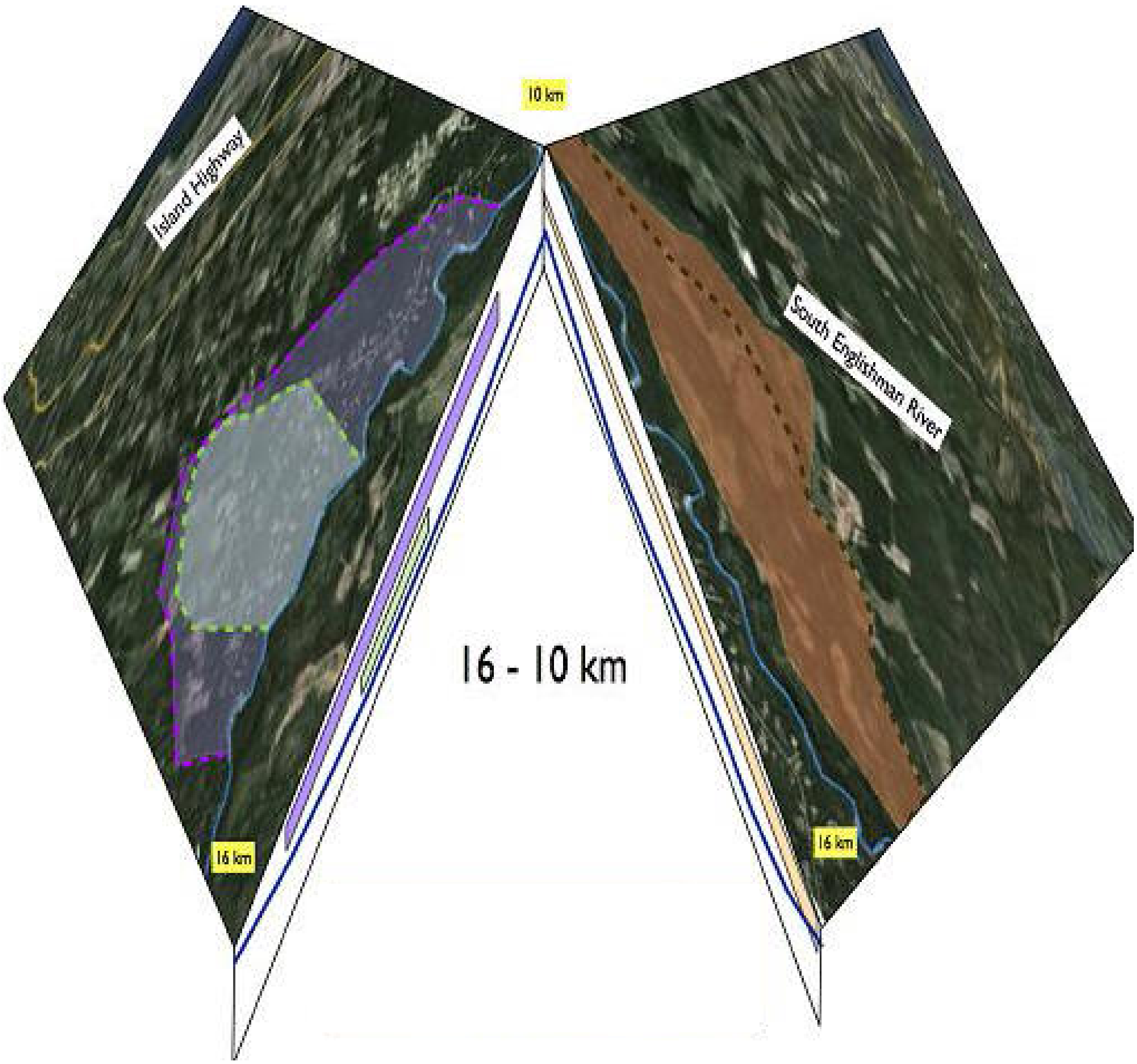
"One of the objectives of our project was to delineate the land where aquifers connect to the Englishman River and are being recharged. We have created 'butterfly' views for this purpose," explains Dr. Wendling.

***Butterfly Views:*** "We have used the views of both the right bank and the left bank of the river showing where the aquifers are in contact with the river (refer to Figure22) and have added the footprint of these aquifers, using color coding."

"For example (and with reference to Figure 25), we have a shallow aquifer in purple on the left bank. The purple shaded area shows its footprint. The thick dash line delineates the boundary of the estimated recharge area. This is the area where precipitation will generate infiltration that will reach the aquifer and will continue its travel as groundwater discharging into the river."

"On the right bank, the boundary of the recharge area does not correspond to the footprint of the aquifer, because there is a groundwater divide. Water droplets falling left of the divide (dashed line) will end up in the Englishman River. The ones falling on the right side will end up discharging into the South Englishman River.

***Need for an Integrated Approach:*** "Decisions made about land development therefore have to take into account how both runoff and infiltration are going to be modified due to the change in land topography, cover, permeability, etc.," concludes Dr. Wendling.




Estimated Recharge Zones of
Overburden Aquifers contributing to Englishman River

Figure 25