Taking Care of Our Water Supply

This flyer was prepared by the Sustainable Land Use Select Committee and approved by Highlands Council

What do we know and why does it matter? 90% of Highlanders depend on wells for their water; many of the remainder draw surface water from lakes and streams. Piped city water is not an option for most of us- it is prohibited by a CRD servicing agreement (urban containment boundary) and installing the pipes and pumps would have prohibitive cost even if the servicing boundary were extended northward and eastward to cover everyone. If we want to live in a rural Highlands, we will continue to depend on local water sources (ground and surface) for our houses and gardens, and to keep the surrounding natural environment healthy and beautiful.

Citizens and Highlands Council have long been concerned about threats to groundwater quality and availability. Recent steps toward assessing these risks were to identify potential sources of contamination, to estimate supply, usage and loss rates; and to develop a groundwater monitoring program and water balance budget. This work was started in 2006 by the citizen-led Groundwater Task Force, and led to a contracted 2007-2014 Groundwater Protection Study by Golder Associates Ltd, and a set of monitoring and modeling analyses and reports (available online at http://www.highlands.ca/177/Ground-Water-Protection-Study). Baseline monitoring and analysis will continue, and regulatory options are being studied by Council, Staff, and Advisory Committees. This brochure provides a short summary of what we currently know about:

- how our aquifer works over the course of a year,
- the main present and future threats to water amount and quality, and
- what individuals and our local government can do to protect our water supply.

A much more detailed web-based information source is being developed to go on the District of Highlands website.

Schematic diagram (from 2008 Highlands Community Green Map) showing:

The hydrologic cycle of a rural watershed sitting on a fractured bedrock aquifer (precipitation, evaporation, transpiration, surface runoff and wetlands, and movement of groundwater through soil and cracks in the bedrock). Narrow strips (called "lineaments") containing more abundant and larger cracks lie beneath and along valley bottoms

Plus

Examples of proven household water conservation practices (efficient indoor fixtures and appliances, drip irrigation, rainwater and graywater harvest and storage, drought-resistant

WHAT IS THE SOURCE OF OUR GROUNDWATER?

Our ultimate water source is the precipitation (rain + snow) that falls within or (in a few places) very near the Highlands boundaries. Because the headwaters of our main surface watersheds lie within our boundaries, there is negligible external stream-flow input. And (contrary to folklore) there is also NO evidence of underground and under-ocean supply from snow-covered distant locations like the Sooke Hills, the Olympic Mountains, or the mainland Coast Mountains.

Historically, we average up to about one meter per year of precipitation. Most falls in the winter wet season (more than 50% November through January, more than 80% October through March). Fortunately for us, some of it gets stored underground and in surface water features (lakes, ponds, wetlands) from which it can be withdrawn to supply human use and ecosystem function for the remainder of the year.

What happens to the water while it's in the ground?

Chemical, biological, and mechanical interactions during slow movement through the soil and bedrock help to filter and purify the groundwater. These also gradually change the amount and type of dissolved minerals and gases. The amounts of dissolved minerals increase, making the water harder. The amount of dissolved oxygen decreases with time in the ground, affecting which minerals are soluble. Water from most Highlands deep wells is somewhat oxygen-depleted and contains high levels of dissolved iron and manganese. These minerals stain plumbing, dishes and laundry, and can alter the taste of the water and at very high concentrations can be a health concern. In rare cases where oxygen gets completely depleted, specialized underground bacteria produce hydrogen sulphide, the water tastes bad and has a rotten egg smell, and there is a health hazard. Both situations can be fixed by in-line chemical filtration and treatment.

WHAT HAPPENS TO THAT PRECIPITATION: THE HYDROLOGIC (WATER) CYCLE

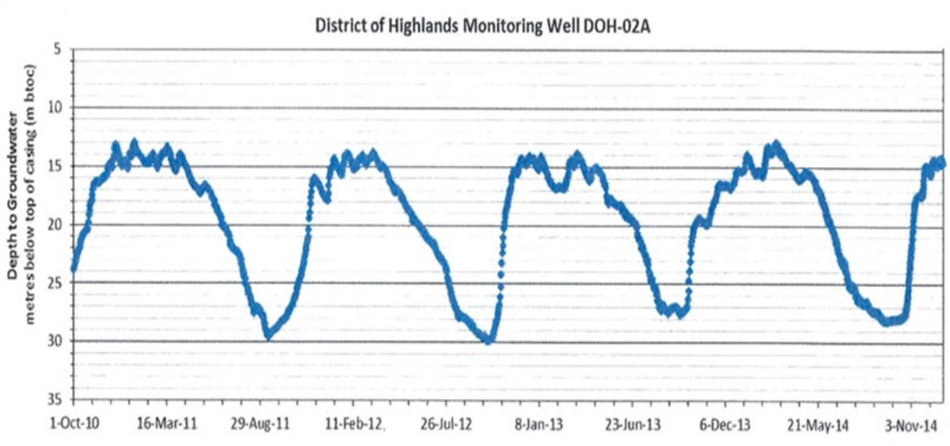
The exchanges of water between oceans, atmosphere, surface freshwater, groundwater and living organisms is called the hydrologic cycle. The main components are illustrated schematically in the drawing on the right.

Some precipitation turns back into water vapor before it can soak into the ground ("Evaporation"). Some soaks temporarily into the upper layers of soil, but is taken up by plant roots before it can soak deeper into the ground, and then evaporated out of plant foliage ("Transpiration") to help the plants stay green and grow. When we irrigate lawns, gardens and golf courses, we are choosing to let transpiration and plant growth occur faster and for more of the year.

Much of the precipitation leaves the Highlands as surface streamflow ("Runoff") and makes its way pretty quickly to the ocean. In addition, any coastal snowfall usually melts quickly during the wet season (unlike in higher and colder parts of BC, where a considerable fraction is stored for several months as snowpack, and then released to groundwater and surface streamflow by melting during the dry season).

Only a relatively small fraction of annual precipitation (3-10%) soaks downward through the soil and fills the fractures of the underlying bedrock. The amount of pore space within the bedrock available to store the groundwater is also limited - less than 1% of the bedrock volume. This means that only a small fraction of precipitation can be stored in the ground. The level below which pores in the soil or fractures in the bedrock are filled with water is called the "Water Table". This level follows the surface topography, but is normally deeper below the surface beneath hills, and is closer to the surface beneath valleys and stream beds. It also moves up and down a lot seasonally, rising during the rainy season when groundwater recharge exceeds removals, and falling (often by up to ten or more meters, depending on location) during the dry season.

Within the bedrock, the groundwater continues to flow downhill, although at a much reduced rate. A fractured bedrock aquifer similar to that shown in the drawing underlays virtually all of the Highlands and much of the CRD. Because the pattern of surface streams often follows the pattern of bedrock fractures and groundwater flow, there is little or no exchange of groundwater between adjoining watersheds. Where and when the water table intersects the soil-bedrock interface, some groundwater returns to the surface via seeps and springs. Although this return flow is a loss in terms of summer availability to wells, it plays an important ecological role in damping summer changes in soil moisture, soil and water temperature, and in maintaining some summer streamflow. This in turn helps keep the Highlands green. Much of the groundwater pumped up by wells is lost to evaporation, transpiration and surface runoff. A small fraction of the pumped water can percolate down into the aquifer (but mostly only during winter).



Four-year history of water level in one of the Highlands Groundwater Project's monitoring wells (this well is unused, so its water levels match the surrounding water table). Note the annual winter fill-up followed by annual 12-15 meter drop to an end-of-dry-season minimum. An active well at this location would have deeper levels in all seasons, and probably also a larger annual range.

What could go wrong for our groundwater supply? Threats to groundwater quality

Groundwater contamination typically results from poor land use practices, either by individuals or by commercial and institutional facilities. In rural areas, common sources of groundwater contamination include malfunctioning septic systems; livestock waste (manure); overuse of fertilizer, pesticides and herbicides; leaky above-ground storage of gasoline, oil, solvents, or paints; and inadequate containment of wastes dumped on or under the soil surface. The larger scale public and private dump sites located in and near the Highlands tend to be more closely regulated, but have been or could become contaminant sources if their containment systems prove inadequate. In both individual and large-scale cases, flooding during extreme rainfall events can overcome containment systems, and cause surface contamination. Poorly installed or maintained wells can provide a shortcut path for contaminated surface water to enter the bedrock aquifer.

Effects of local population growth and land development

What is removed by one well affects the supply available to neighboring wells. Intensified residential and commercial land use will increase the demand for well water pumped out of the aquifer. Each active well produces a conical depression in the local water table. The depth and volume of this depression increases with the rate of water withdrawal, the diameter depends on the number, orientation and size of cracks in the local bedrock. But at some point, the water table depressions extend far enough to overlap and reduce availability to neighboring wells and wetlands.

Threats to groundwater availability

Groundwater availability depends on the year-round balance of supply (from the amount of precipitation reaching the soil surface and the efficiency of subsequent downward soaking into the soil and the underlying bedrock aquifer) versus removals (losses to the atmosphere via evaporation and transpiration, losses to the ocean via surface runoff, and withdrawals from the aquifer via wells).

At least under present climate and land/water use patterns, the annual precipitation (mostly in winter) exceeds annual losses to evaporation, transpiration, and well-withdrawals (occurring year-round but more intense in summer). Available pore space in the bedrock is therefore able to fill up sometime during the winter. Any additional precipitation leaves as surface runoff (very low in summer through early fall, intense in winter and early spring). The main threat to availability occurs toward the end of the dry season, when cumulative removals might lower the water table below the depth of existing wells.

Effects of climate change

Climate science predictions broadly agree that:

- Our local summer dry seasons will become longer and hotter, even under the most optimistic scenarios for reduction of green-house gas emissions. Recent heat and drought records may well become the new "normal", and future extreme years will be even hotter and drier than 2015.
- Our winter wet seasons will be shorter, and less of the total precipitation will fall as snow.
- Although total annual precipitation may increase or decrease slightly, more of it will be delivered by intense storm events. Because high rainfall rates greatly exceed maximum soak-in rates, this change could also reduce the fraction of rainfall that reaches the bedrock aquifer.
- Summer evaporation and transpiration rates will increase. Existing "natural" vegetation (mostly forest at present) will be more stressed by summer drought. Cultivated vegetation will want more irrigation. Changes in amount and type of vegetation cover (for example, from shady moist forest toward arid grass and brush, or to paved areas) could further increase evaporation

Interactions of climate change and additional development

Both will contribute to amplification of seasonal differences in water availability and a lowering of the water table late in the dry season. The Golder groundwater model predicts additional lowering of the water table by 1-3 meters during the wet season and in valley bottoms, but by 5-20 meters at higher elevations in the dry season. Some wells that are marginal now could fail in the future, requiring re-drilling or seasonal top-up with trucked water.

What can we do to protect our water supply?

Steps to protect groundwater quality

The BC Provincial Government claims primary regulatory jurisdiction over water quality, but there are many things that individuals can do to make sure their property does not become a contaminant source, and to keep their wells safe from surface contamination. Here are some key suggestions:

- Empty your septic tank at least every 2-3 years, and have your septic field tested to ensure its integrity.
- Reduce/eliminate application of pesticides and fertilizers.
- Dispose of chemicals and solvents at recycling centers – DON'T dump them down the drain or on the ground.
- Remove/relocate any sources of contamination (storage tanks, hazardous products, garbage, compost, livestock) that are closer than 30 meters (100 feet) to a well.
- Protect active wells by casing their upper ends, and making sure that their wellheads are sealed, covered, locked, and raised above potential flood levels. Cap and seal in accordance with the requirements of the *BC Ground Water Protection Regulation.*
- Periodically test your water system for both bacteria and contaminants (costs about $40-200 depending on what is measured). A water softener removes minerals, not bacteria. It will NOT disinfect your water.

Don't store unsealed containers of gasoline, oil, paints, or other chemical substances in uncovered locations.

Steps to protect groundwater quantity

1. Conserve by reducing demands:

- Perform a household audit of water use. Reduce waste by repairing leaks, and replacing older fixtures and appliances with more efficient options such as low-flow shower heads and
  toilets, and water efficient appliances.
- Reduce outdoor demand by replacing irrigated lawn areas with drought resistant plants (xeriscaping) and/or allowing lawns to dry out in summer ("brown can be beautiful").
- If you do irrigate, use irrigation systems that put more of the water in the ground, and lose less to evaporation. Replace spray heads with ground-level soakers. Irrigate at night or early morning rather than in the heat of the day.

2. Re-use waste water to reduce demand on groundwater

- Capture and store clean roof runoff (suitable for many non-potable uses).
- Consider altering plumbing to allow recycling of household "grey water" for appropriate non-potable uses (but this must be done carefully, it is not a good DIY project).

3. Maintain or increase the fraction of precipitation that enters the aquifer - "Slow it down, spread it out, soak it in"

- In built areas, avoid or reduce the use of impermeable surfaces like pavement.
- If feasible, redirect the runoff from remaining hard surfaces onto nearby level and porous catchment areas.
- If feasible and safe, expand surface storage of winter runoff from natural areas (most Highlands lakes are artificial reservoirs created by putting small dams in seasonal or year-round streams). But surface water storage also must be done very carefully to be simultaneously useful, safe, and legal–any new ponds need to be deep enough to support more than breeding mosquitos, spillways engineered to prevent oxygen depletion of the deeper water, and any new dams engineered to resist erosion, washout, and downstream flooding by extreme precipitation events.

4. Encourage governments (especially the Province) to improve groundwater management.

Under the new *Water Sustainability Act,* which came into effect on February 29, 2016, groundwater for non-domestic use will be licensed.