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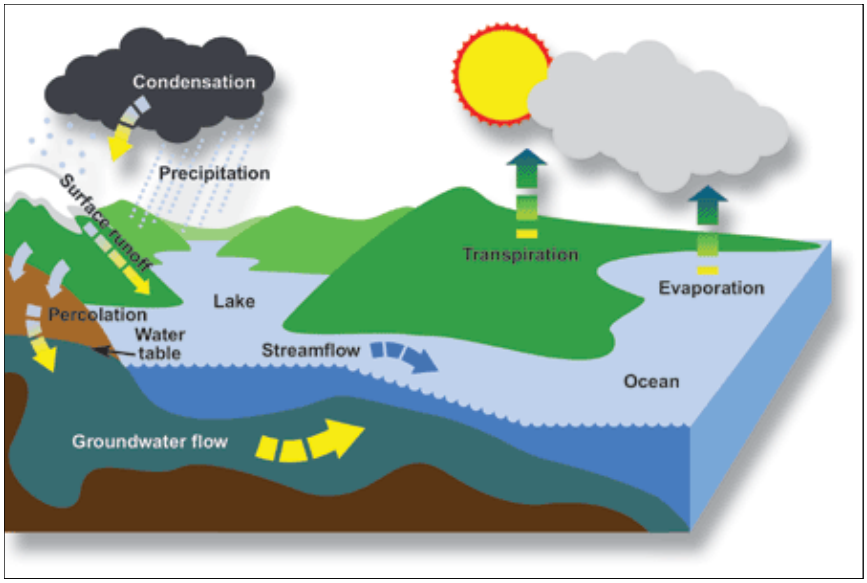
Essential materials for building a strong Ontario

GROUNDWATER IN THE AGGREGATE INDUSTRY

Groundwater is a renewable resource that is in constant motion as part of the hydrologic cycle. Above-water pits and quarries have little or no effect on water levels or the flow of groundwater.



What is Groundwater?

Just as the name implies, groundwater is water contained in the pores and fissures of the earth. Groundwater is a renewable resource. It is in constant motion, part of the hydrologic cycle (see Hydrologic Cycle on the cover page). Rainfall and snowmelt infiltrate into the earth to recharge groundwater, which then flows as baseflow into streams and lakes. Evaporation from open water, and transpiration from plants, returns water to the atmosphere to complete the cycle.

A common misconception is that groundwater flows in underground rivers and lakes like surface water. Instead, groundwater seeps very slowly through the pore spaces and small fissures in the soil and rock. Materials such as clay have a low permeability, and hence very slow groundwater flow, while sand and gravel, or highly fractured rock, have high permeability and permit groundwater to flow faster. These more permeable layers are called aquifers.

The water table is the depth at which the soils or rock become completely saturated with groundwater. If a hole were dug, and left to stand for a while for groundwater to seep in, the water level in the hole would represent the water table. The water table elevation is not static, though, and it can fluctuate in different seasons and from year-to-year, depending on the amount of recharge. Natural depressions can intersect the water table to form lakes, ponds and wetlands.

Water Wells

Groundwater is a critical resource in Ontario - nearly one quarter of us rely on wells for our water supply. Some of these are municipal wells serving urban communities, but the vast majority are private water wells, mainly in the rural parts of the province. Two common types of wells are shallow dug wells which draw water from the water table, and bored or drilled wells which draw water from deeper aquifers.

The *Ontario Water Resources Act* and the *Environmental Protection Act* both serve to protect the quality and quantity of groundwater. They are administered by the Ontario Ministry of the Environment, which will respond to public complaints regarding interference with water wells. The Ministry has several excellent publications available to homeowners on subjects including proper water well construction and maintenance, protecting water quality in wells and managing water shortages (1-800-565-4923 or www.ene.gov.on.ca).

Wells and their associated equipment require ongoing maintenance. Even with the best maintenance, though, they still tend to degrade naturally over a period of years, through mechanical wear and clogging of the well screen, pump and pipes, .

Fact Sheet
Groundwater at Pits and Quarries

- *Groundwater is a renewable resource.*
- *Water wells are protected under provincial legislation.*
- *Above-water pits and quarries can have a beneficial effect on groundwater and aquatic resources.*
- *Below-water pits and quarries can be operated without significant groundwater impacts if they are carefully designed and operated.*
- *Permits to Take Water ensure that aggregate wash plants do not harm water resources.*

Aggregate extraction and processing is a clean industry that does not provide groundwater contaminants.

Can Pits and Quarries Affect the Flow of Groundwater?

The answer depends on the type of pit or quarry.

Above-Water Pits and Quarries

Most of Ontario's sand and gravel pits, and a few of its rock quarries, are excavated entirely above the water table. This type of operation has little or no effect on water levels or the flow of groundwater because there is no direct, physical alteration of the water table or any aquifers. Monitoring programs at above-water pits and quarries across Ontario have confirmed that groundwater is unaffected.

In some ways, above-water pits and quarries can actually be beneficial to groundwater. They create a "bowl" that captures and infiltrates all rainfall and snowmelt rather than allowing some of it to run off across the ground surface. A study on the Oak Ridges Moraine documented a number of benefits related to this extra groundwater recharge (Hunter/Raven Beck,

1996). One of the important benefits is to reduce direct run-off to surface water streams and increase cold groundwater baseflow which is critical to fish habitat.

Below-Water Pits

Below-water pits usually use large excavators or draglines to dredge sand and gravel from the *pit ponds* that form below the water table level. Generally, this type of extraction does not have major impacts because most of the groundwater remains in the pit, or drains back into the pit. This type of pit also captures surface water run-off and promotes more groundwater recharge, but these benefits are offset by the increased evaporation that will occur from the surface of a pit pond. Minor water losses also occur due to residual moisture contained in the aggregate products that are shipped from the site. Finally, the removal of solid sand and gravel particles from below the water table has the effect of temporarily lowering the water level in a pit pond (imagine removing a rock from a bucket of water).

The water surface in very large below-water pit ponds will stabilize at a uniform level, whereas the groundwater table before extraction may have been irregular or sloping. Therefore, the water table around the pit will have to "adjust" to the water level in the pit pond, possibly resulting in slightly different groundwater flow patterns. Fortunately, there is a simple solution where this may be a problem – digging several smaller pit ponds rather than one large pond (Ostrander *et al*, 1998).

When all of these factors are combined, the net effects of below-water extraction are normally minor and very localized. However, in certain circumstances they could still be significant if there are sensitive features such as wetlands or shallow wells in close proximity. As a result, a detailed and careful hydrogeological study is necessary when licencing this type of pit (Ministry of Natural Resources, 1997), and mitigation (solutions) to any negative impacts will be required. An ongoing groundwater monitoring program may be required.

Below-Water Quarries

Most quarries that extract from below the water table pump water out of the excavation so that the work of blasting and recovering the bedrock can be done on a dry floor. *Dewatering* usually does affect groundwater levels and flow patterns around the site, since it artificially lowers the water table to at least the base of the quarry. Hydrogeologists call the area around the quarry that is affected by the dewatering the *drawdown cone* or the *radius of influence*. Wells, streams, wetlands, or other sensitive features within this area must be carefully studied to predict the impacts and devise mitigation measures before the quarry can be licenced (Ministry of Natural Resources, 1997) and a groundwater monitoring program will normally be required.

There are many locations in Ontario where below-water quarries are successfully operated while sensitive water uses continue nearby – it depends very much on the specific hydrogeological setting. Recently, some innovative technologies have been introduced in Ontario to lessen the effects of quarry dewatering, such as pumping the water from the quarry back into the groundwater system around the quarry to artificially recharge the water table. This has so far proven to be quite successful (Gartner Lee Limited, 2001).

Other Water Takings

Pits and quarries have uses for water, similar to other businesses, such as supplying offices and shops with drinking water, watering lawns and gardens, etc., but these tend to be relatively minor. Most types of aggregate processing, such as crushing and screening, are dry operations and do not require water supply.

However, to minimize dust (which is a byproduct of excavation in a pit or quarry) spray water is used on internal haul roads, processing equipment, stockpiles and trucks.

One exception is aggregate washing plants, which are used at some sites, and do require relatively large quantities of water. Most plants recycle wash water through a "closed loop" series of holding ponds and settling ponds (i.e., the water is re-circulated, with no off-site discharge), so that the amount of water actually consumed in the process is usually less than about 10%. This *make-up water* normally comes from local groundwater or surface water sources. A common configuration would be to have a well that would be used occasionally during the production season to "top up" the ponds.

These water takings are regulated separately from the pit licence under the *Ontario Water Resources Act*, and controlled through Permits to Take Water. The applications and related hydrogeological studies are carefully reviewed by the Ministry of the Environment, other government agencies, and the interested public through the Environmental Bill of Rights process to ensure there will be no unacceptable impacts from these water takings, before the permit is issued.

GROUNDWATER IN THE AGGREGATE INDUSTRY

Can a Pit or Quarry Contaminate Groundwater?

It surprises some people to learn that aggregate extraction is a clean industry. Processing aggregates is a purely mechanical process of crushing, screening, blending, and sometimes washing (with water), without the need for chemicals. At most sites, fuels and lubricants for the equipment are the only potential sources of groundwater contamination, and these are closely regulated under the *Technical Standards and Safety Act*. A spills contingency plan is a standard condition of every new aggregate licence.

Bacteriological contamination of the type responsible for the Walkerton tragedy comes from human and animal wastes. Aggregate extraction and processing is not a source of this type of contamination.

As a result, water quality in and around pits and quarries is not normally an issue. This was confirmed through a study in 1989 as part of the Ontario government's MISA program, where monitoring at a selected number of pits and quarries found good water quality, with only sporadic traces of organic compounds at some sites that might indicate the use of petroleum products (SENES, 1989). In addition, there are many site specific monitoring programs in place at aggregate operations.

What About Water Temperature?

Water temperature concerns are occasionally raised in conjunction with below-water pits. A pit pond warmed through the summer months could result in a flow of warmer groundwater to nearby points of baseflow discharge and, in turn, affect cold water fisheries resources. An analysis conducted on behalf of the Credit Valley Conservation Authority in 1998 concluded that pit ponds have minimal impact on groundwater temperatures, and that these minor effects are completely dissipated within a few hundred metres from a pit (Ostrander *et al*, 1998). Field monitoring has also confirmed that groundwater returns to its normal background temperature within tens of metres of pit ponds (Harden Environmental, 1995).

As a result of the research to-date, thermal effects of pits and quarries is not considered to be a major issue in most cases. However, where there are cold water fisheries close to a pit pond, appropriate investigations and studies are required, and the setbacks and buffer zones will be adjusted accordingly.

For further information, please contact the OSSGA Environment and Resources Manager, at (905) 507-0711 or visit the OSSGA website at www.ossga.com.

Prepared by Gartner Lee Limited in consultation with OSSGA's Environment Committee.

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OSSGA
ONTARIO STONE, SAND & GRAVEL ASSOCIATION

365 Brunel Road, Unit 2
Mississauga, ON L4Z 1Z5
T: (905) 507-0711 F: (905) 507-0717
www.ossga.com
www.theholestory.ca