How Water Moves and Why it Matters

Water moves in a continuous cycle. It evaporates from the Earth’s surface or transpires from plants as water vapor—then it settles back as condensation and precipitation, such as dew or rain or snow.

Surface water collects on the ground or as water bodies like streams, rivers or lakes.

Water also collects and travels below the earth’s surface. Though hidden, this groundwater is a critical part of the water cycle, as it is by far the largest source of available fresh water on earth. Groundwater does not move like a stream, but travels much more slowly, within gravel, sand, and fractures in limestone or bedrock.

Hydrology is the scientific study of water and its movement, especially in relation to land. Understanding how water moves through an area is important to predicting how that area may be affected by development. Knowing how water moves both above and below ground helps to develop a picture of existing conditions and to forecast changes that may occur.

There is a give-and-take relationship between surface water and groundwater. Groundwater may be replenished (recharged) by rain, snow and other precipitation, or seepage from streams. In turn, groundwater may well up (discharge) to the surface to feed springs, streams, or smaller pools of water, called seeps—at which point it is considered surface water. Groundwater discharged in one area can travel as surface water in some areas and then be recharged into the ground miles away from its starting point.

The rate and amount of water flow from surface to underground and back again is influenced by many factors, including geology and seasonal changes in precipitation.

Because this interplay is so complex, and because groundwater is such an important resource, developers must have an in-depth understanding of regional hydrology to avoid groundwater depletion or contamination.
Using Data: Groundwater Studies

Pebble project developers have funded extensive groundwater studies in the proposed mine area. The Pebble Limited Partnership “Report Series D: Groundwater Hydrology,” which covers data collection between 2004 and 2007, reports that these studies are important in order to minimize groundwater impact, include measures to mitigate residual effects, and identify optimal locations for mine facilities.

During the study, monitoring wells were used to collect groundwater samples and monitor groundwater levels. Piezometers, which are similar to monitoring wells, were also installed to measure groundwater levels. Data was collected from 259 wells located at 196 sites throughout the watershed areas of Upper Talarik Creek and the north and south forks of the Koktuli River. Data was recorded as frequently as hourly in some wells.

Rocks matter

Developers have been studying, or “characterizing,” the surface and subsurface geology in the Pebble project area as well. They are measuring hydraulic conductivity (how fast water flows through soil and rock), as this is a major indicator of how closely groundwater and surface water are connected. Hydraulic conductivity is determined by the permeability and porosity of a material. For example, clays allow very little water transport, while coarse-grained material such as gravel allows water to fill in between the rocks and move through it faster.

Pebble Partnership’s “Report Series C” delves further into the surficial geology of the Pebble deposit area, noting that the complex land formations were caused by four separate glacial episodes. These glaciers left behind sand, soil and rock in a number of moraines, meltwater deposits and outwash aprons.

How this data may be used

Pump test data helps determine how quickly groundwater recharges in an area after being pumped out. In addition, data from subsurface geologic tests can help assess hydraulic conductivity of different rock units, which impacts recharge rates. Ultimately, this data will be used to develop a groundwater model to evaluate potential changes in local and regional water tables, as well as groundwater interaction with local streams, wetlands and lakes.

Learn more...

For an overview of the studies, and to access more detailed documents, including locations of wells and drill holes, and data on pumping results and seep inventories, you can reference “Report Series C” and “Report Series D” online. Links to all the published data can be found under “Resources & Links” at www.pebblewatch.com.
Groundwater and surface water interactions

Why they matter

Historically, groundwater and surface water were evaluated as separate systems, but today they are considered one related resource. Alaska is one of the few western states that has adopted a conjunctive water rights management system, treating both groundwater and surface water the same from a regulatory standpoint.

Since groundwater can’t be readily seen, there are significant challenges to understanding all the ways it interconnects with surface water, especially since these interactions can take place in a widespread area. As one example, Pebble project developers noted in the 2004 Baseline Studies Progress Report that some of the groundwater originating in the South Fork Koktuli River in the Nushagak watershed actually makes its way into Upper Talarik Creek, which is in the Kvichak watershed.

In and around the Pebble deposit, there is evidence of significant interaction between groundwater and surface water, including upwelling of groundwater into streambeds and land surface area as seeps. Published data show more than 4,500 documented seeps in an area about 193 square miles in size.

Cold groundwater upwelling through clean gravelbeds are important spawning sites for Bristol Bay salmon, making it necessary to understand how changes to groundwater might affect water flow, temperature and quality in those areas.

Flow – Mining activities such as dewatering will impact the existing hydrologic system and potentially change the location, quantity and timing of groundwater upwelling and recharge. Dewatering can reduce flow to surface water and lower groundwater levels to a depth below what vegetation/wildlife habitat needs to survive.

Temperature – The flow of groundwater into a stream moderates stream temperature, which has an impact on fish health and populations.

Quality – Movement of water between surface and ground water can also transport mine-related contaminants between the two, increasing the likelihood of uncontrolled releases. For a more in-depth discussion of water quality issues, see the Feb./March issue of the Pebble Watch newsletter at www.pebblewatch.com.

Studying and predicting

Understanding the complex movement and interaction of groundwater and surface water requires a variety of data. This can include the study of rock and soil to see how quickly water moves through it (hydraulic conductivity), and water monitoring to measure water level and how fast water is replenished. Visual observations and aerial photography are also sources of information (to inventory locations of seeps, for example).

Data are used to chart typical conditions and seasonal changes, but it isn’t possible to measure everything. That’s why groundwater modeling is used to simulate how water moves in an existing system—and to predict changes that might occur if any known aspect of that system were to change. Modeling might be thought of as an equation where known information about an area is input—its geology, its surface water, groundwater and water flow—to understand what is not known. For example, such a model could be used to show how various locations for a mine tailings pond might affect ground and surface waters.

Such models provide a numerical 3-D overview of a water system. The type of program used and the data the model is built upon are critical for an accurate understanding of an area’s hydrologic conditions.

Although a certain amount of site-specific assumptions are made during modeling, regulatory agencies have accepted this method for predicting how activities such as mining can affect hydrology in a specific area. Models also must be standard enough that they can be subject to independent testing and review by regulators.

In addition, current research highlights the need for models to take into account the uncertainty inherent in model predictions, and the impact of long-term climate changes on hydrology, instead of basing predictions on fixed parameters.
The Permitting Process

Large development projects require multiple permits in order to move forward. The permitting process for the Pebble Mine project is complex, and requires over 60 permits, nine of which are directly related to hydrology.

The process will begin when the Pebble Limited Partnership (PLP) releases its final project description, its Environmental Baseline Document (EBD), and files a Section 404 Permit application with the US Army Corps of Engineers®. PLP CEO John Shively has said the partnership expects to begin permitting in late 2012, and anticipates that this process will take a minimum of three years.

The Pebble Watch science team developed a permitting matrix that provides details on permits for Pebble Mine, including links to relevant agencies and information on public comment periods (if any) for each permit. Permits are arranged by topic, so readers can easily pinpoint the main permits related to hydrology. Find the matrix under “Resources & Links” at www.pebblewatch.com.

Watershed Assessment

The U.S. Environmental Protection Agency (EPA) is conducting a year-long assessment of the Bristol Bay watershed, and it has posted an outline of the assessment plan on its web site. The assessment includes two rounds of public meetings, to begin in October 2011. Oral and written comments will be accepted. For more details, find the link to the assessment under “Resources & Links” at www.pebblewatch.com.

Coming up

Mining information sessions and community visits:

- June 1 – EPA Bristol Bay Update Meeting, Newhalen Teen Center
- June 2 – Mining information session, Newhalen Teen Center
- June 2 - EPA Nushagak River Community Visits
- June 3 – Mining information session, Dillingham BBNA Head Start Building
- June 3 - EPA Bristol Bay Update Meeting, Dillingham Elementary School

For details, click on the calendar at www.pebblewatch.com.

Keep up to date on current events affecting the proposed project area: www.pebblewatch.com