# Filling In: Geocells for Shoreline Stabilization

When Stantec Consulting Ltd. of Regina, SK, Canada, won the contract to design a new sewage lagoon for the City of Regina, the site's history provided a good indication that serious erosion control measures were called for.

Constructed in the early 1960s, the Regina Wastewater Treatment Plan uses a series of lagoons to contain secondary effluent from its sewage treatment operation. With the use of native clay soi1 as a containment medium and built with no shoreline protection system, the original lagoons soon began to erode from wind-induced wave action. A few years after their construction, their interior slopes were shored up with reclaimed sections of concrete from sidewalks and roads placed along the lagoons' top 3 m. Poured concrete was added to protect the slopes' lower portions. This hard-armor solution was only partially effective. The areas of concrete rubble at the tops of the slopes permitted extensive vegetation growth and were difficult for treatment plant operations crews to access. The poured concrete sections cracked and because they were not restrained tended to slide downslope.

**Crews install nonwoven geotextile on the slope before placing geocell panels.**

## Geosynthetic Technology

Entirely new technologies have emerged since the '60s, however, and for the new Lagoon 2A, Stantec chose a stabilization system that didn't exist when the original treatment plant was built. The Geoweb Cellular Confinement System, manufactured by Presto Geosystems of Appleton, WI, was selected for its performance history and ease of construction.

Geosynthetic materials, which have been developed over the last 35 years and used for soil stabilization since the early 1970s, offered a sophisticated solution when it came time to build Lagoon 2A in 1996. Geosynthetics are produced from a range of base polymers, such as polyester, polyethylene, and polypropylene, which are characterized by their high flexibility and strength, light weight, and durability. Geosynthetics have been adapted for specific functions, including filtration, drainage, separation, confinement, and retention and reinforcement of soil. Today, geosynthetic products include woven and nonwoven geotextiles, geogrids, geomembranes, geonets, and - germane to the Lagoon 2A - geocells.

Resulting from a cooperative development effort between Presto Products Company and the US Army Corps of Engineers, geocells were originally developed to provide load support to military vehicles traveling over soils of low shear strength, such as sand. Geocells are high-density polyethylene strips ultrasonically welded at specific intervals to form a panel of three-dimensional honeycomb cells. Available with different cell dimensions and depths, geocells are used today for soil retention in gravity- and geogrid-reinforced retaining walls, for erosion protection in channel linings, and for slope protection. Once installed the panels are infilled with concrete, vegetated topsoil, or structural fill.

## Preparing the Slope

Wappel Construction Company Ltd. of Regina completed the initial task of excavating the 450- x 170-m Lagoon 2A in six weeks. Berms were constructed from the excavated material, and the lagoon's 3:l internal slopes were compacted to 98% standard Proctor dry density using sheepsfoot compaction equipment. Before the geocell panels were put in place, a 200-g/m² nonwoven, needlepunched geotextile was installed on the prepared slope surface to prevent the loss of subgrade soil.

Stantec Consulting, working with Armtec Construction Products, Presto's Canadian representative, planned the geocell system to cover only the wave-vulnerable area of the interior slope - a 2.44-m slope length with an angle of 18.4° on all sides of the lagoon. The geocell panels were 2.44 x 6 m. The area to be covered by the panels was excavated to the cell depth of 100 mm, allowing the geocell system to be recessed and to sit flush with the rest of the slope. Based on the weight of the planned concrete infill, Stantec and Armtec calculated stake anchor requirements to provide a design factor of safety of 1.5 against downslope sliding.

PVC-coated-polyester tensile tendons incorporated into the system helped distribute the downslope driving forces to the stable subgrade. Cut to about one and a half times the length of the 6-m geocell panels, the tendons were inserted through factory-drilled holes in the collapsed panels and tied off at strategic points along the length of the panels to create a composite unit.

## Filling the Gaps

Wappel installed the geocell panels in their compacted shape and expanded them on the slope. J-shaped rebar anchor pins driven through the tendons held the panels in place. Stapling the edges of adjacent panels together helped maintain dimensional control of the edge cells until the addition of the concrete infill.

The geocells were filled from the top of the slope down, allowing easy raking of the concrete into the lower cells. Top-down filling also helps reduce the forces that attempt to drive the entire system down lope. A coarse broom gave the concrete its final surface texture so that the rough surface finish would provide good traction for maintenance workers on the slope.

Installing the Geoweb system was more expensive than simply dumping concrete rubble, as had been done decades earlier to combat erosion at the original lagoons, and was comparable in cost to poured in-place concrete, which had also been used less than successfully the site. Slope maintenance - specially vegetation control - has been greatly reduced. Because the Geoweb system is inherently flexible, cracking of the infill concrete has not occurred.

**Infilling geocells with concrete.**