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## Moving Water is Our Business



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VALUE IN MULTIPURPOSE SUBSURFACE EXPLORATIONS

Traditionally, it has been common practice for a project to employ independent services for geotechnical and environmental investigations. Over the last few years, we have seen a more competitive marketplace for both the drilling and consulting industries; as such, it is starting to become common practice for some sites to combine their geotechnical and environmental field programmes. While the subsurface information required by geotechnical and environmental investigations may differ, there can be engineering value and project cost savings when the subsurface exploration programmes are combined for a project.

Typically, a project includes a preliminary geotechnical investigation and a separate preliminary environmental investigation followed by further subsurface investigations derived from the preliminary findings. Environmental investigations are commonly performed with soil bores conducted by direct push tooling, with continuous sampling, using 1.5m plastic liners.

Groundwater monitoring wells can be installed for groundwater sampling and site hydraulic profiling. Geotechnical investigations are commonly performed utilising test bores conducted by solid auger; rotary wash with driven casing; or by hollow stem augers. Sampling is performed using split-spoon samplers with SPT N-values obtained for geotechnical correlations. Split-spoon sampling is performed at continuous intervals for critical layers and at 1.5m intervals for greater efficiency with standard drill tool lengths.

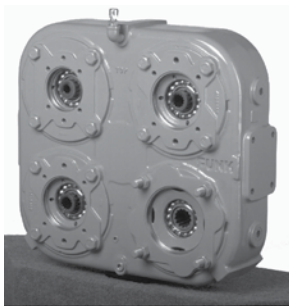
An alternative exploration method to the test boring is cone penetration testing (CPT). CPT is performed by a cone on the end of a series of rods pushed into the ground at a constant rate to obtain continuous measurements of friction and resistance to penetration of the cone. Results of the CPT penetration tests are interpreted to obtain soil type, water table, and soil parameters for engineering design. Seismic CPT can be performed at discrete intervals to obtain shear wave velocity data. Additional sensors useful to environmental explorations include; electrical resistivity,



gamma detection, fuel fluorescence detection, pH sensors, and visual recording.

In the past, drilling rigs were designed to perform specific exploration methods such as drill rigs for geotechnical test borings, direct push rigs for environmental test borings, and heavy push rigs for CPT. Over the last 5-10 years we have seen the introduction of site investigation rigs that are capable of performing both geotechnical and environmental sampling along with CPT and other direct image technology. These rigs, while limited to a certain degree, offer the consulting companies an opportunity to reduce their mobilisation costs and utilise one machine for a wide range of services.

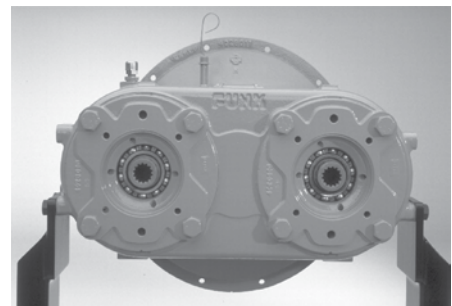
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As an example of this diversity, US company Summit Geoengineering Services undertook an exploration programme using a multipurpose site investigation rig. The project consisted of a development site for a retail building within a former petrol station in central Maine. The subsurface conditions consist of fill (mixture of gravel-sand) overlying marine deposits (silt-clay). Groundwater was present at a depth range of 2-4 metres below the existing ground surface. Bedrock was present at a depth range of 8-13 metres below the existing ground surface.

The boreholes were drilled using 3.5-inch (9cm) direct push tooling with SPT sampling. Continuous samples were taken in plastic liners within the fill layers and upper portions of clay subgrade for environmental samples and testing. SPT split-spoon samplers using an auto-drop hammer were used for geotechnical testing and sampling. CPT was also performed to a depth of refusal for

continuous subgrade profiling. Fifty millimetre groundwater monitoring wells were installed within select test borings for environmental sampling and hydraulic analysis.

The ability to perform this range of drilling, testing and installation of groundwater wells, utilising a multipurpose rig, offers the following advantages to this example project:

- Cost savings due to the reduced number of total preliminary boreholes which were combined utilising a joint geotechnical and environmental subsurface investigation program;
- Improved geotechnical design information provided by the use of continuous soil sampling that was required by the environmental investigation;
- Improved groundwater hydraulic information provided to the geotechnical consultant by the use of groundwater monitoring wells that was required for the environmental investigation;
- Improved overall understanding of the subsurface conditions and site geology for the environmental consultant provided by deeper bore holes and use of CPT which was required by the geotechnical consultant; and
- Improved interaction among design team members due to collaboration of preliminary subsurface investigation and shared results of findings.

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