



**Faro Mine Closure**  
Fermeture de la mine Faro

# Faro Mine Complex Monitor Mine Waste Rock Trial Covers: 2010 Data Summary

Prepared for:

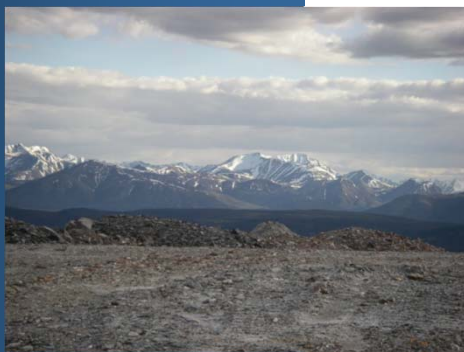


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**Faro Mining Complex**  
**Monitor Mine Waste Rock Trial Covers:**  
**2010 Data Summary**

**Government of Yukon**  
Assessment and Abandoned Mines  
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## Executive Summary

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### Objectives and Primary Findings:

This report summarizes the data collected during the 2010 monitoring season (June to October) from the waste rock cover trials at the Faro Mining Complex. The intent of this report is to document the field results and provide feedback on the quality of the data collected. Where problems with the collected data have been identified, this report provides recommendations for remedying the problem as well as mitigation strategies to prevent similar problems from reoccurring. The scope of this report is simply to confirm that the data collected is following reasonable trends, and that the instrumentation and data acquisition systems are performing as expected.

Detailed information regarding operation, calibration, suitability, and accuracy of the monitoring instrumentation used to collect the data presented in this report is provided in the as-built report (SRK 2006a, SRK 2008b), and therefore it is not repeated here.

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### Future Work Recommendations

The report provides a series of recommendations to ensure the continued high quality data collection as well as improved database management during subsequent monitoring years. These range from recommissioning the re-calibrated dataloggers to replacing the Sentek Diviner 2000 probe.

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- Appendix B: Additional Climatic Data Calculated and Stored by Davis Instruments Vantage Pro Data Logger
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# 1 Introduction and Scope of Report

## 1.1 General

In 1998, the mining activities undertaken by Anvil Range Mining Corporation (ARMC) ceased due to financial problems and Deloitte & Touche Inc. (D&T) was appointed Interim Receiver of the mine site. Included in the Interim Receiver's role were:

- management of the site's care and maintenance; and
- development of a site closure plan.

D&T was released of these obligations in April 2009. The Yukon Government (Energy, Mines and Resources Assessment and Abandoned Mines Branch) has assumed responsibility for the Faro Mine Complex, and on March 1, 2009, Denison Environmental Services (DES) was awarded a contract to provide care and maintenance services at this site on behalf of the Yukon Government.

The Faro Mine Complex Closure and Remediation Project is subject to assessment under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA). Under YESAA, the project is required to submit a "Project Proposal". Key elements of the Project Proposal include:

- Project purpose;
- Project description;
- Description of existing environmental and socio-economic conditions; and
- Identification of potential environmental and socio-economic effects and proposed mitigation measures.

The project also requires a variety of regulatory authorizations and land dispositions including a water licence for construction of diversions, construction/modification of impoundments, use of water, collection and treatment of contaminated water, and discharge of waste water.

SRK Consulting (Canada) Inc. (SRK) was retained by the Yukon Government to assist in the development of the Project Description for the Faro Mine Complex Final Closure and Remediation Plan. The monitoring data presented in this Report has been collected in support of this Plan.

This report summarizes data collected between November 2009 and October 2010. The 2010 Monitoring Report follows "Faro Mine Complex Monitor Mine Waste Rock Trail Covers: 2009 Data Summary" (SRK 2010), "Faro Mine Complex Monitor Mine Waste Rock Trial Covers: 2008 Data Summary" (SRK 2009), 2007/08 Task 18a, "Monitor Mine Waste Rock Trial Covers"(SRK 2008a), 2006/07 Task 17a, "Monitor Mine Waste Rock Trial Covers"(SRK 2007), 2005/06 Task 20a, "Waste Rock Dump Cover Trials" (SRK 2006b), and 2004/05 Task 14a. No report was issued for 2004/05 Task 14a because construction of the cover trials was only completed in September 2004, and there was no data to report.

## 1.2 Background of the Project

The Faro Mining Complex (FMC) has about 185 million cubic meters of waste rock covering about 542 ha of surface area. Detailed geochemical characterization has confirmed that much of this waste rock is acid generating and contains leachable metals. As part of the approved Plan, one of the methods is physical covering of the waste rock piles.

The specific functions that a cover would have to perform have been defined as follows:

- prevent direct exposure and contact of humans and terrestrial wildlife with the waste rock;
- reduce infiltration through the waste rock to specified targets;
- provide a medium that would allow establishment of successional vegetation.

There appears to be consensus within the Work Group responsible for the description and evaluation of the cover methods that significant oxidation of the waste rock has already occurred. This fact effectively negates the benefits offered by oxygen exclusion, thus constructing covers to act as oxygen barriers would not result in significant changes in leachate chemistry.

One of the single most challenging aspects of cover design for the site entails designing an infiltration reducing cover that will continue to perform effectively in the very long term, using the locally available till and glacio-fluvial soils. It is standard practice to make use of numerical models to assess the potential performance ranges of different cover configurations. However, the only reliable method to evaluate the physical aspects that determine long-term cover performance is to monitor site specific trial covers.

Subsequently, six trial covers (CT #1, CT #2A, CT #2B, CT #3A, CT #3B and CT #4) were constructed on the Vangorda waste rock pile in September 2004, as illustrated in Figures 1, 2 and 3. These trial covers have been designed to test a range of different physical performance criteria for the available materials, specifically focused towards evaluating performance as “infiltration reducing” covers. Detailed water balance instrumentation was installed in the trial covers in June 2005 (see Figures 4 through 8).

In 2007, following the recommendation of the Independent Peer Review Panel a set of two large lysimeters (25 meters by 25 meters) were constructed on the plateau of the Vangorda waste rock dump. As shown in Figure 3, the lysimeters were built immediately west of the existing cover trial plots, adjacent to CT #2A. The lysimeters were instrumented in June 2008, using the same suite of instrumentation installed for the existing cover trials (Figure 9). Details about the location and type of instrumentation can be found in the lysimeters as-built report (SRK 2008b).

## 1.3 Scope of Work

This report summarizes the data collected from the trial covers during the 2010 monitoring season (November 2009 to October 2010). The intent of this report is to document the basic field results

and provide feedback on the quality of data collected. Where data collection problems are identified, this report provides recommendations to remedy the problems as well as propose mitigation measures that can be implemented to prevent similar problems from occurring in the future. This report does not contain a technical analysis of the data. A preliminary performance review was completed (SRK 2008c), based on three years of data.

Instrumentation was re-commissioned by SRK between June 23 and June 25, 2010. DES personnel retrieved data from all automated data loggers every two weeks until October 14, 2010. Manual thermistor and soil moisture content (Diviner) data respectively were collected starting June 26 through August 18. The last download for the season was performed by Iozsef Miskolczi of SRK at the time of decommissioning of the instrumentation, on October 26, 2010.

The reasons for the late start of the monitoring season are non-technical and pertain to the contractual relationship between SRK and the Government of Yukon.

Detailed information regarding the monitoring instrumentation used to collect the data presented in this report, pertaining to their operation, calibration, suitability and accuracy, is provided in the respective as-built reports (SRK 2006a, SRK 2008b), and is therefore not repeated here.

## 1.4 Methods

Six trial covers (Figures 2 and 3) were constructed in September 2004, in accordance with SRK design requirements. Construction was carried out by a local contractor, Tim Moon Construction, supported by FMC staff and equipment. Construction supervision was carried out by two SRK engineers, Maritz Rykaart, P.Eng. and Peter Mikes, EIT. The instrumentation was installed and commissioned in June 2005 by Maritz Rykaart, with complete construction and instrumentation details provided in an as-built report (SRK 2006a). Two lysimeters were built in August 2007 by the same local contractor, Tim Moon Construction, with support from FMC staff. Supervision of the construction phase was provided by SRK engineer Iozsef Miskolczi, EIT. Instrumentation was installed and commissioned in June 2008 by Iozsef Miskolczi. Detailed construction and instrumentation notes can be found in the as-built report (SRK 2008b).

DES site staff was trained by SRK to carry out the field monitoring for the 2010 monitoring season (June to October). Most of the downloads were performed by Ben Bekk and Shelby Fulton.

A written monitoring protocol was provided to DES. Data was downloaded directly from the different data loggers onto a field laptop computer. In addition, a series of readings were collected manually and converted into electronic format. All field data collected by DES was sent to SRK via e-mail.

SRK used proprietary software linked to each of the data loggers to open and view the data to ensure that the loggers were operating satisfactorily. All data was collated into a series of databases at the end of the season. These databases convert raw field data into its final usable format by applying, where required, material specific calibration information and some format manipulation. As a final

step, all data is linked to a master database to simplify the visualization process. The figures illustrating the field data presented in this report (Figures 11 through 143) were created using this master database. Figures 11 through 143 do not show all the data collected to date. These figures only present the data collected subsequent to November 11, 2009 (which is the end date of the 2009 monitoring season). As a result of the fact that some dataloggers do not collect data through the winter season, some figures presenting data as a graph will have lines extending from the end of the 2009 data set to the start of the 2010 data set. The range of the x-axis has been set to obscure this artifact but it can still be observed on the left hand side of the graph. Complete details of how data is prepared for input into the database are included in Appendix A.

In addition to the data presented in this report, weather data is collected from two on-site Weather Stations, and annual snow surveys are conducted by staff from the Yukon Territorial Government (Janowicz *et al.* 2005, 2006, 2007, and 2008). This data is not presented here, but will be used to compare the validity of the trial cover data when detailed data analysis is carried out following future years of monitoring.

## 1.5 Post Processing

In an effort to simplify the post-processing protocol, following challenges identified during the 2008 monitoring season it was decided to make use of the Visual Basic and SQL programming capabilities of Microsoft Access. The 2008 and subsequent data was compiled using this new protocol. Older data (2007 and earlier) was also processed and stored in the database format to allow easy integration of all data at a later time. The new post-processing protocol does not change the data download protocols from the field instruments.

## 1.6 Report Structure

Section 2 contains information associated with the series of automated data loggers which collect field monitoring data for the trial covers. The remainder of the instrumentation data is collected manually, the details of which are presented in Section 3. The final section of the report provides a summary of the action items arising from this data summary report.

## 2 Automated Instrumentation Data

### 2.1 Davis Instruments Vantage Pro (Weather Stations and Satellite Stations)

Complete climatic data is collected at the Vangorda Waste Rock Pile trial cover location using two Davis Instruments Vantage Pro Weather stations. The first station is located on the sloped CT #1 trial cover and the second on the dividing berm between horizontal trial covers CT #2A and CT #2B. Figure 2 schematically illustrates these locations. Additional climatic data (air temperature and relative humidity), as well as shallow soil moisture and temperature data, are collected via two satellite Davis Instruments stations located approximately 25 meters from these two primary Weather Stations, as illustrated in Figure 4. Figures 6 and 7 illustrate the locations of the soil moisture and temperature sensors installed as part of the Satellite Stations.

At each setup, data from the weather station and the satellite station is collected by a Vantage Pro data logger housed in the weather-proof enclosure situated beneath the weather station. The data loggers collect and store primary climatic data, as listed in Table 1. This data is measured directly from the suite of climatic sensors. This data is also presented as time-series graphs in Figures 11 through 22, and spans from June 26, 2010 through October 26, 2010.

In addition to the sensor data listed in Table 1, the data logger uses this primary data to calculate a series of secondary climatic information. Since this report focuses on the integrity of the primary collected data, this calculated data was not reported. SRK did, however, review all this data to confirm that the data logger was operating satisfactorily, and that the data collected made sense. This data has also been imported into the central database for future use. Appendix B provides a brief summary of this data.

At time of recommissioning, it was noted that the Integrated Sensor Suite (ISS) of Station CT #2AB (ID=4) was damaged during storage. The plate holding the UV and solar radiation sensors was bent at about 30 degrees, and one of the plastic rings of the RH sensor's radiation shield was cracked. The damage was repaired by bending the metal plate back as much as possible. The sensors were subsequently adjusted to horizontal after installation of the ISS in field. The primary diagnostic of the system showed that all instruments were working properly.

Although recommended in the 2009 Data Summary Report (SRK 2010), maintenance or recalibration was not carried out on the weather or Satellite Stations in 2010. The wireless transmitters of the Satellite Stations were loaded with new batteries, and were found to be functioning well throughout the season. The rechargeable batteries installed in 2009 were charged using the AC charger and then installed. As a precautionary measure, a spare set of batteries were provided on site, but did not have to be used.

During the 2009 monitoring season it was noted that the suction sensor of Satellite Station #2 of the CT #2AB weather station was malfunctioning. Replacement of the sensor was recommended in the 2009 Data Summary Report (SRK 2010), but a more in-depth analysis showed that replacement could not be possible without major disturbance of the adjacent temperature sensor and of the cover in general. As a consequence it was decided that leaving the sensor unrepaired is higher value to the project than major disturbance of the cover.

The horizontal lines at maximum suction (200 kPa) recorded from both weather stations starting mid-October are due to the freeze-up of the sensors, which are not suitable to operate in sub-zero temperatures.

In the case of Station #1 it was observed that erroneous data was collected by the console between June 24 and June 25, and then no data was collected at all after June 25. The cause of the malfunction is unknown. The weather station console was reset on July 11, and good data was collected subsequently.

As shown in figure 16, Station CT #2AB stopped collecting wind speed and wind direction data starting October 5. The cause of the malfunction is not clear, and further troubleshooting is required.

**Table 1: Summary of Primary Data Collected by Davis Instruments Vantage Pro Weather and Satellite Stations**

Parameter	Location	Sample Frequency	Units	Figure	Comment
Rainfall	Both Weather Stations	Every 50-60 sec; output as hourly total	mm	Figure 11	Hourly total; Rain rate (mm/hr) is also recorded (not presented)
Ambient Outside Air Temperature	Both weather and Satellite Stations	Every 10-12 sec; output as mean hourly	°C	Figure 12	Max/Min hourly also recorded at Weather Stations (not presented)
Relative Humidity	Both weather and Satellite Stations	Every 50-60 sec; output as mean hourly	%	Figure 13	Range of 0% to 100%
Solar Radiation	Both Weather Stations	Every 50-60 sec; output as mean hourly	W/m <sup>2</sup>	Figure 14	"Hi solar radiation", i.e. peak hourly solar radiation also recorded (not presented)
Barometric Pressure	Both Weather Stations	Every 50-60 sec; output as mean hourly	kPa	Figure 15	
Wind Speed	Both Weather Stations	Every 2.5-3 sec; output as mean hourly	km/hr	Figure 16	Max/Min hourly also recorded at Weather Stations (not presented)
Wind Direction	Both Weather Stations	Every 2.5-3 sec; output as mean hourly	N/E/S/W	Figure 17	Max hourly also recorded at Weather Stations (not presented)
Ultraviolet (UV) Index	Both Weather Stations	Every 50-60 sec; output as mean hourly	Scale 1 – 16	Figure 18	"Hi UV Index", i.e. maximum hourly UV Index also recorded (not presented)
Soil Moisture <sup>1</sup>	Both Satellite Stations	Every 50-60 sec; output as mean hourly	kPa	Figure 19 (CT#1); Figure 21 (CT#2A)	Measured at two depths
Soil Temperature	Both Satellite Stations	Every 50-60 sec; output as mean hourly	°C	Figure 20 (CT#1); Figure 22 (CT#2A)	Measured at two depths

1. Soil moisture is measured in units of centibar (Cb) according to the supplier, which is not a true unit of soil moisture. The true parameter measured by this instrument is soil matric suction.

## 2.2 Campbell Scientific Data Loggers

### 2.2.1 General Notes

Two different models of Campbell Scientific dataloggers are installed on site: two CR10X and one CR1000. These data loggers are monitoring and collecting data from the following suite of instruments:

- soil matric suction and temperature data from CS229 thermal conductivity sensors
- soil volumetric moisture content data from Sentek EnviroScan sensors
- flow volumes from tipping bucket flow gauges

In addition, the data loggers monitor and record the minimum battery voltage each day, for diagnostic purposes. The CR10X are located adjacent to each other in the lower monitoring hut at the base of CT #3B while the CR1000 is located in the upper monitoring hut between CT #4 and CT #3A, as illustrated in Figures 4 and 5.

The first data logger (CR10X #1) collects volumetric moisture content data from CT #2A and 2B, as well as the entire suite of flow data from 9 tipping buckets. The second data logger (CR10X #2) records the soil temperature and suction from CT #1, CT #2A, CT #2B, CT #3A, CT #3B, and CT #4, as well as moisture content data from CT #1, CT #3A, CT #3B, and CT #4. The third datalogger (CR1000) is collecting soil temperature, suction, moisture content and flow data from Lysimeters L #1 and L #2. Details of the instrument locations are presented in Figures 4 through 9.

Data collected by model CR10X data loggers is stored in a series of summary tables. The soil matrix suction, temperature and volumetric moisture content are recorded every six hours (midnight, 6AM, noon, and 6PM). The interflow is continuously monitored by both CR1000 and CR10X #2 and cumulative flow is output every 30 minutes. Daily summary of the battery voltage is also recorded for diagnostic purposes.

The Campbell Scientific data loggers are not decommissioned during winter months and as a consequence data is continuously collected, as opposed to the Weather Stations which are decommissioned in the fall and recommissioned in the spring. Data collected by these dataloggers spans from the end of the previous monitoring season (November 11, 2009) to the end of this monitoring season (October 26, 2010). Although the instruments installed on site are not suitable to measure moisture content and suction in frozen soils all data is presented in this report as illustration of the performance of the data acquisition system. As previously stated, the purpose of this report is to assess the functionality of the installed instrumentation and data acquisition system.

The field computer used by DES personnel to download the instrumentation began malfunctioning subsequent to October 14 (last download by DES personnel). At time of the last download by SRK (October 26) the field computer was no longer functional, and downloads of the CR10X and CR1000 dataloggers was not possible. Data from the CR10X dataloggers was recovered subsequently in the SRK office (the dataloggers were decommissioned for recalibration and transported to SRK's office). As a consequence, the dataset recorded by the CR1000 datalogger ends on October 14, 2010, while the dataset for CR10X dataloggers ends on October 26, 2010. Subsequently recorded data will be recovered from the datalogger's internal memory at time of the first download in 2011.

The CR10X dataloggers were installed in 2005, totalling to date over 30,000 hours of operation. As recommended in last year's Data Summary Report (SRK 2010), the dataloggers were removed at the end of the monitoring season and shipped to the manufacturer for recalibration. At the time this report was written, the dataloggers were serviced, recalibrated, and shipped from the manufacturer to SRK. The dataloggers will be recommissioned at the beginning of the 2011 monitoring season.

A visual inspection of the instrumentation during the recommissioning of the weather stations revealed the fact that the data transfer cable of suction sensor #3 installed on L #2 was worn out and the insulation was compromised. Repair of the cable was carried out by cutting the cable, stripping the ends of the wires and connecting them using a connector block. The data collected subsequently showed that the repair was unsuccessful and the sensor remained off-line.

### 2.2.2 Battery Voltage

The Campbell Scientific data loggers and instruments controlled by them are powered by 12V batteries (one per data logger). These batteries are continuously recharged using solar panels (one solar panel per battery). The data logger has an internal protection circuit that will shut the logger down if the battery voltage drops below 8V, or exceeds 15V. For this reason, the data loggers have been programmed to record the battery voltage as part of the daily summary array. Figure 23 presents the graph of daily minimum battery voltages measured for each of the Campbell Scientific data loggers.

Although a second solar panel was installed in 2009 to recharge the battery of the CR1000 datalogger, the recorded battery voltage over the winter of 2009/2010 showed that the solar panels failed to keep the battery charged in the winter months. As the battery voltage dropped below 8 Volts, it caused the datalogger to shut down. As a consequence, no data was recorded between December 2, 2009 and April 6, 2010. One possible cause may be that drifting snow accumulated in the trench where the Upper Monitoring hut is located, covering the solar panels. Power recovered at the beginning of April, and the voltage remained optimal for the entire monitoring season.

As shown in Figure 23, the battery voltage of the CR10X datalogger was maintained above 12Volts over the entire period, while the battery voltage of the CR1000 dropped sharply and stayed low over the winter months.

The written monitoring protocol required a physical diagnostic check on the batteries and solar panels installed in the Lower Monitoring hut (housing the CR10X dataloggers and the connected instrumentation) every time that the data is downloaded, which confirmed that both systems were functioning properly. Observation sheets are included as Appendix C.

### 2.2.3 Soil Matric Suction

Soil matric suction is measured in each trial cover using a series of Campbell Scientific CS229 thermal conductivity sensors. There are three to six sensors in each trial cover and four sensors in each lysimeter, as illustrated in Figures 6 to 9. Soil matric suction is recorded as a voltage differential by the data logger. This voltage differential, through the application of material specific calibration curves, is converted to matric suction, expressed in kPa. This is done by SRK during the conversion of the data from its raw format. Figures 24 through 31 illustrate the converted soil matric suction values recorded during the 2010 season, starting with the end of the 2009 monitoring season. Due to the fact that range of suction values is very wide, the graphs presenting these values are shown on a log-normal scale.

The straight lines on Figures 30 and 31 are due to the fact that the lack of data for the given time period forces Access to interpolate between the last data point in 2009 and the first data point in 2010. The data gap spans between December 2, 2009 and April 30, 2010 and is due to the black-out of the datalogger caused by insufficient power.

In general the suction sensors performed as expected, except for one individual sensor. As discussed in the previous sections, sensor #3 (1.1 meter depth) on L #2, as shown in Figure 31, was disabled due to defective cables.

## 2.2.4 Soil Temperature

The soil temperature is measured using the same CS229 thermal conductivity sensors. This is possible because the first step in recording the soil matric suction entails taking an in-situ soil temperature reading. Just as with the matric suction data, the raw data is recorded as a voltage and, through application of the material specific calibration curves in the post-processing phase, the soil temperature profiles illustrated in Figures 32 to 39 are produced. As shown in Figures 38 and 39, the data gap due to the black-out of the CR1000 datalogger is same as for the suction data, and sensor #3 on L #2 became idle at the end of June.

## 2.2.5 Soil Volumetric Moisture Content

A profile of soil volumetric moisture content is measured in each trial cover using EnviroScan probes manufactured by Sentek Sensor Technologies. Each profile contains between seven and thirteen individual beads, as illustrated in Figures 6 to 9. The data recorded by the sensors is relative volumetric moisture content, expressed as a fraction, using a standard calibration curve. During the post-processing, these values are corrected to actual volumetric moisture contents by applying material specific calibration curves. This data is presented in Figures 40 through 47. In general, all probes performed as expected, except for one of the sensors on CT #3A, which reported erroneous values as shown in Figure 43. The sensor will have to be replaced in 2011. The data recorded from L #1 (Figure 46) and L #2 (Figure 47) shows the same gap between December 2, 2009 and April 7, 2010.

## 2.2.6 Tipping Bucket Flow Gauges (Runoff and Interflow)

The flow (interflow as well as surface flow) data is collected using two methods: tipping bucket flow gauges and SeaMetrics turbine flow meters. The tipping buckets located in the Lower Monitoring hut are continuously monitored by CR10X #1 through two SDM-SW8A pulse counter devices connected in series; cumulated total tips are recorded every 30 minutes. The tipping bucket flow gauges installed in the Upper Monitoring hut are recording the surface flow and two interflow values on each lysimeter through the CR1000 data logger, with 30 minute cumulative totals being recorded. The interflow of the lysimeters was separated in order to quantify the purely vertical infiltration from the infiltration affected by the fill-liner boundary.

The last of the tipping buckets was installed in the Upper Monitoring hut at time of recommissioning of the weather stations. This tipping bucket arrived to site broken in 2009 and was replaced by the supplier.

The recorded interflow data for CT #3A/B and CT #4 is presented in Figures 48 to 50, while surface runoff data for all cover trials is presented in Figures 51 through 56. Flow data from the Lysimeters is presented in Figures 57 to 62. All gauges performed as expected.

## **2.3 SeaMetrics DL75 Data Loggers (Surface Runoff and Interflow)**

Surface runoff is measured from each trial cover using individual SeaMetrics flow meters, each connected to an individual SeaMetrics DL75 data logger. Interflow from CT #3A, CT #3B and CT #4 is also measured with a similar setup (in addition to tipping buckets, as discussed in Section 2.2.6). Each of these nine flow meters is located in the Lower Monitoring hut, with the flow directed to them through a series of buried drainage pipes, as illustrated in Figure 5. In addition, a similar setup was installed for the lysimeters, with the SeaMetrics flow meters and the corresponding data loggers installed inside the Upper Monitoring hut.

The data loggers sample the flow rate once every 60 seconds. This data is used to calculate an incremental flow volume. In addition, each data logger calculates a total volume and flow rate over a user specified timeframe. During the post-processing of the data, the null values (no flow recorded) are removed from the database to save space, thus the graphs in this report show only the non-null values in chronological sequence. This data is presented in Figures 63 through 73. All flow meters were performing as expected. Maintenance of the flow meters and sediment traps was performed at the beginning of the 2010 monitoring season.

No surface flow data was recorded by the flow meters for CT #2A, CT #2B, and CT #3A, and no interflow data was recorded for CT #3B. The most likely cause is the fact that the low end of the calibrated flow range for these meters is 12L/min, while the actual flow (as measured by the tipping buckets) was more like a trickle.

## **2.4 Lakewood Systems UL16 Data Logger (Soil Temperature)**

Two thermistor strings, each with eight M-Squared thermistor beads, have been installed in the Grum Overburden Dump, as illustrated in Figure 10.

Based on borrow material requirements related to construction activities under the Progressive Reclamation Program of the Grum Waste Rock Dump the thermistor strings could have been disturbed, and decommissioning of the thermistor strings and the data logger was recommended by the project management team. However, during the recommissioning of the instrumentation it was decided by SRK to leave the strings in place and removed them only when disturbance becomes imminent. As construction plans changed, the area of the thermistor strings was not disturbed, and the monitoring went on as planned.

These two thermistor strings (String A and String B) are monitored by a Lakewood UL16 data logger which records a relative voltage every twelve hours and calculates the ground temperature based on the Steinhart-Hart linearization equation. The calculated ground temperature profiles are presented in Figures 72 and 73, and confirm that the strings were performing as expected.

## **3 Manually Collected Instrumentation Data**

### **3.1 M-Squared Thermistor Strings (Ground Temperature)**

Four thermistor strings each with eight thermistor beads have been installed adjacent to the two strings connected to the Lakewood Systems data logger, in the Grum Overburden Dump. Their installation details are presented in Figure 10.

These four thermistor strings are manually read at regular intervals by the site staff and the raw data is reported as resistances. These resistance values are converted to soil temperatures during the post-processing phase. The measured soil temperature profiles for the 2010 season from these four strings are shown in Figures 76 through 79. Although all thermistor strings performed as expected, some erroneous values were collected. The errors were most likely due to faulty connection between the readout and the switch box. To avoid such errors in the future, special attention should be paid to this item during the training/refresher provided to personnel performing the downloads. Measurements were taken on 7 occasions, between August 25 and October 14.

### **3.2 Sentek Sensor Technologies Diviner 2000 (Soil Volumetric Moisture Content)**

Each trial cover has six to eight vertical PVC access tubes, as illustrated in Figure 5, while the lysimeters have ten access tubes each. A Sentek Sensor Technologies Diviner 2000 probe is inserted manually into each of these tubes to record an instantaneous value of the soil volumetric moisture content profile at 10 cm intervals. Data was collected from each of the 60 access tubes between June 25 and August 20 for a total of 45 events. Data was recorded using a portable data logger, and the results are expressed in terms of relative volumetric moisture content. During the post-processing stage, material specific calibration curves are applied. Figures 80 through 139 present the final volumetric moisture content profiles for each access tube. Data collected from these tubes confirm that the instrument performed as expected.

As shown in Figures 80, 96, 110, and 128 the dataset is comprised of a reduced number of readings. The cause is water being present in the access tubes, rendering some of the readings invalid. As the water was removed a few readings were possible later in the season.

Some of the figures also show a sharp jump in the moisture content, limited to a one-time event. This erroneous value is an error of measurement caused by the failing connection between the probe and the portable datalogger. The faulty connection was patched by DES site personnel, but the probe should be replaced in 2011.

### **3.3 HOBO Water Level Loggers**

In an effort to mitigate the difficulty of measuring flow in the beginning and end of each season due to frozen drainage pipes, a series of culverts were installed on CT #2A, CT #2B, and both lysimeters.

The culverts consist of a rectangular wooden channel placed in a gap in the containment berm. Each culvert was instrumented with a HOBO water level logger that monitors and samples the pressure every 90 seconds. Changes in recorded pressure are an indication of water level fluctuations, i.e. flow through the culvert. Due to low sensitivity of the level logger ( $\pm 3$  mm), the instruments are not suitable to quantify the volume of flow, but rather to confirm the number and duration of flow events. Because of the closed pressure cell of the HOBO instrument, the recorded data has to be reduced by subtracting the atmospheric pressure recorded by the Weather Stations on site. Due to limited available memory of the HOBO device, the download protocol provided to the site personnel required download every 14 days.

Data presented in Figures 140 to 143 represents the uncorrected, absolute pressure values collected by the HOBO loggers. Although data is collected every 90 seconds, the data presented in this report was reduced to represent only one value for each hour of operation, as the complete files are too large to be presented in an Access graph.

The level loggers performed as expected, although, as shown by the straight lines in the figures some data gaps are present. These gaps are due to the time between downloads being longer than specified in the download plan, resulting in the dataloggers' memory filling up and shutting down the datalogger. Data download schedule should be followed more rigorously, to ensure the maximum time between downloads is not exceeded.

## 4 Conclusion

### 4.1 Summary

This report documents the 2010 season of data collected for the trial covers constructed on the Vangorda waste rock pile. The trial covers were constructed in September 2004 with the instrumentation installed in June 2005. Two lysimeters were added in August 2007 and the instrumentation installed in June 2008. For the 2010 season, instrumentation was commissioned on June 25 and shut down on October 26. Data collection and instrumentation performance was good, and partial loss of data experienced for some of the instruments will not significantly affect the overall quality of information.

Preventative maintenance and small repairs were performed to the instruments, as required, comprising of cleaning of the tipping bucket flow gauges, cleaning of the sediment traps, attempted repair of broken cable of suction sensor #3 on L #2, repair of the defective cable of the Diviner 200 probe, and repair and re-calibration of the ISS of weather station #2AB. The CR10X dataloggers proposed for re-calibration in the 2009 Data Summary Report were decommissioned and shipped to the manufacturer for maintenance.

### 4.2 Database Management

As proposed in the 2009 Data Summary Report (SRK 2010), the databases containing the entire data collected to date was migrated to a SQL Server set up by the SRK IT team. Some adjustments will be necessary to streamline the access to data and graphic output options. These adjustments are not critical to the regular data management, and should be performed at the end of the 2011 season, to include the new data collected.

### 4.3 Action Items

The monitoring of the instrumentation should continue for at least 3 more years to provide 5 years span of data from the Lysimeters, and the following is a list of recommendations that should be implemented to ensure that future monitoring is successful:

- All instrumentation should be re-commissioned in early May 2011.
- A new field computer running all the proprietary software is required. It could be provided by SRK, same as the previous one. Due to the fact that the software resident on the old field computer was lost, new licenses may be required. This is an opportunity to get up-to-date versions of the software (some of the old licenses were issued before 2005).
- The CR10X data loggers were re-calibrated and should be recommissioned at the beginning of the 2011 season.

- The batteries of all Campbell Scientific data loggers, as well as the Davis Vantage Pro weather stations should be replaced at time of recommissioning. The batteries powering the CR10X and CR1000 dataloggers should be replaced with large capacity (at least 75 Ahr) maintenance-free lead-acid batteries.
- Site staff should be retrained on the download protocols.
- The desiccant packs in the weatherproof enclosure of each data logger must be replaced every two weeks. The removed desiccant packs can be dried out in the laboratory oven as per the manufacturer's instructions.
- Desiccant packs should be replaced in each EnviroScan tube to eliminate condensation.
- Sand traps installed in the upper monitoring hut should be inspected and cleaned of any sediment at the beginning of the monitoring season, and on a monthly basis thereafter throughout the monitoring season.
- General maintenance of all tipping bucket flow gauges in both the lower and upper monitoring huts should be performed at time of recommissioning.
- Level of all tipping buckets should be checked at the beginning of the monitoring season, and monthly thereafter throughout the season. Horizontal position should be restored, as required.
- Positive drainage around each Diviner and EnviroScan tube should be created by mounding some soil around the pipes, to minimise the preferential drainage paths along the pipes.
- The defective EnviroScan sensor on CT #3A should be replaced.
- All Diviner and EnviroScan access tubes should be checked for condensed water, and where necessary water should be bailed out and the tube dried prior to commencing the 2011 monitoring season.
- The existing Diviner 2000 probe is in a state of advanced wear of the connector cable, and should be replaced with a new one.
- The connector cable of suction sensor #3 on L#2 should be spliced using adequate materials.
- Throughout the 2011 monitoring season daily data should be collected using the Diviner 2000 instrument, weather permitting.
- Another round of in-situ density and hydraulic conductivity testing should be carried out on the trial covers in July/August 2011. Density testing using the sand cone replacement method should be carried out on all test covers in parallel to the nuclear density testing, to allow for direct comparison between the two methods.

This report, “**Faro Mine Complex, Monitor Mine Waste Rock Trial Covers: 2010 Data Summary**”, has been prepared by SRK Consulting (Canada) Inc.

**Prepared by:**

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AND STAMPED

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Consultant

**Reviewed by:**

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Maritz Rykaart, Ph.D, PEng.  
Principal

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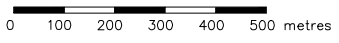
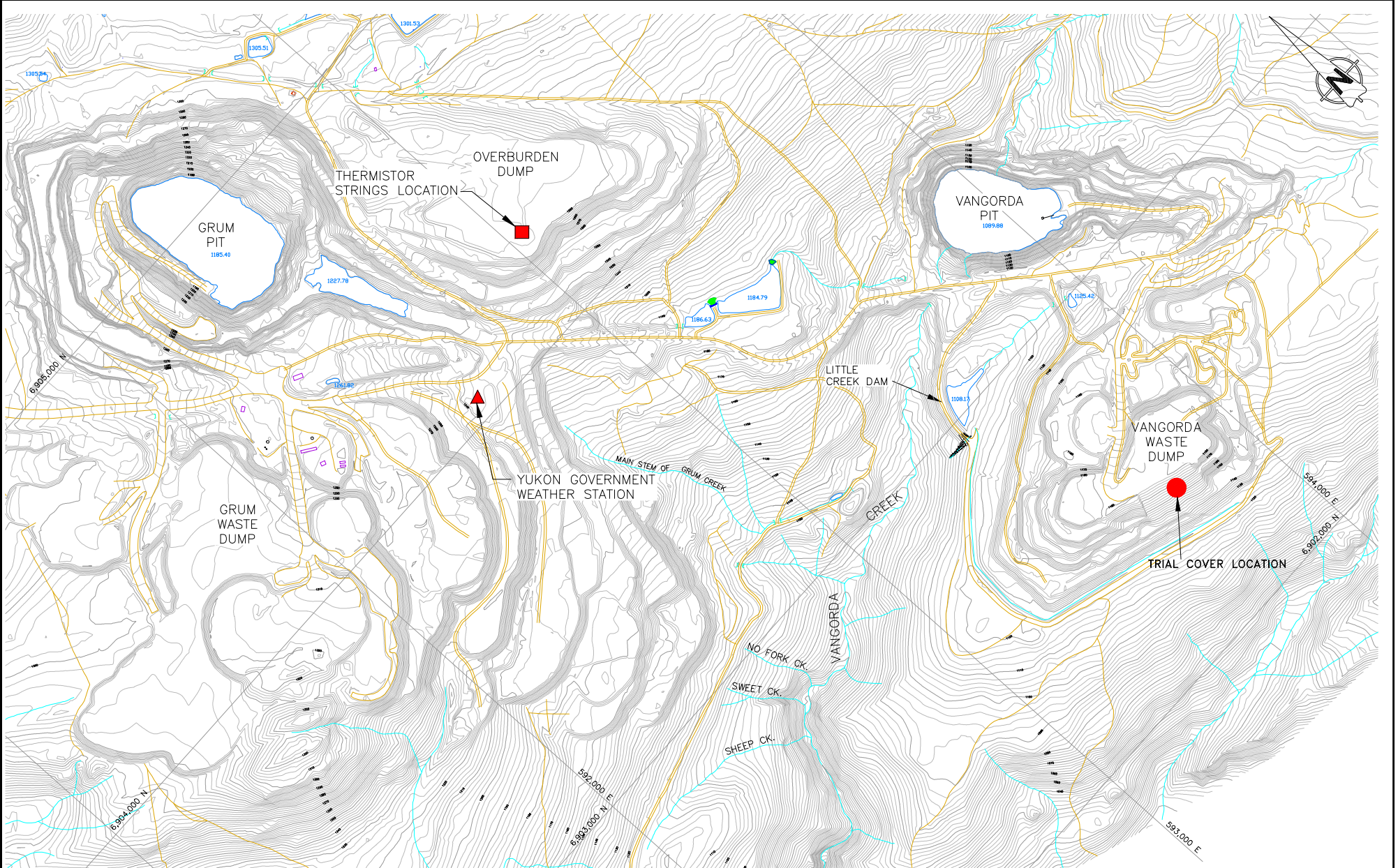
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**Figures**



Monitor Mine Area Waste Rock Trial Covers  
2010 Data Summary

**Location Plan for Trial Covers  
and Thermistor Strings**

SRK JOB NO.: 1CY001.045.800

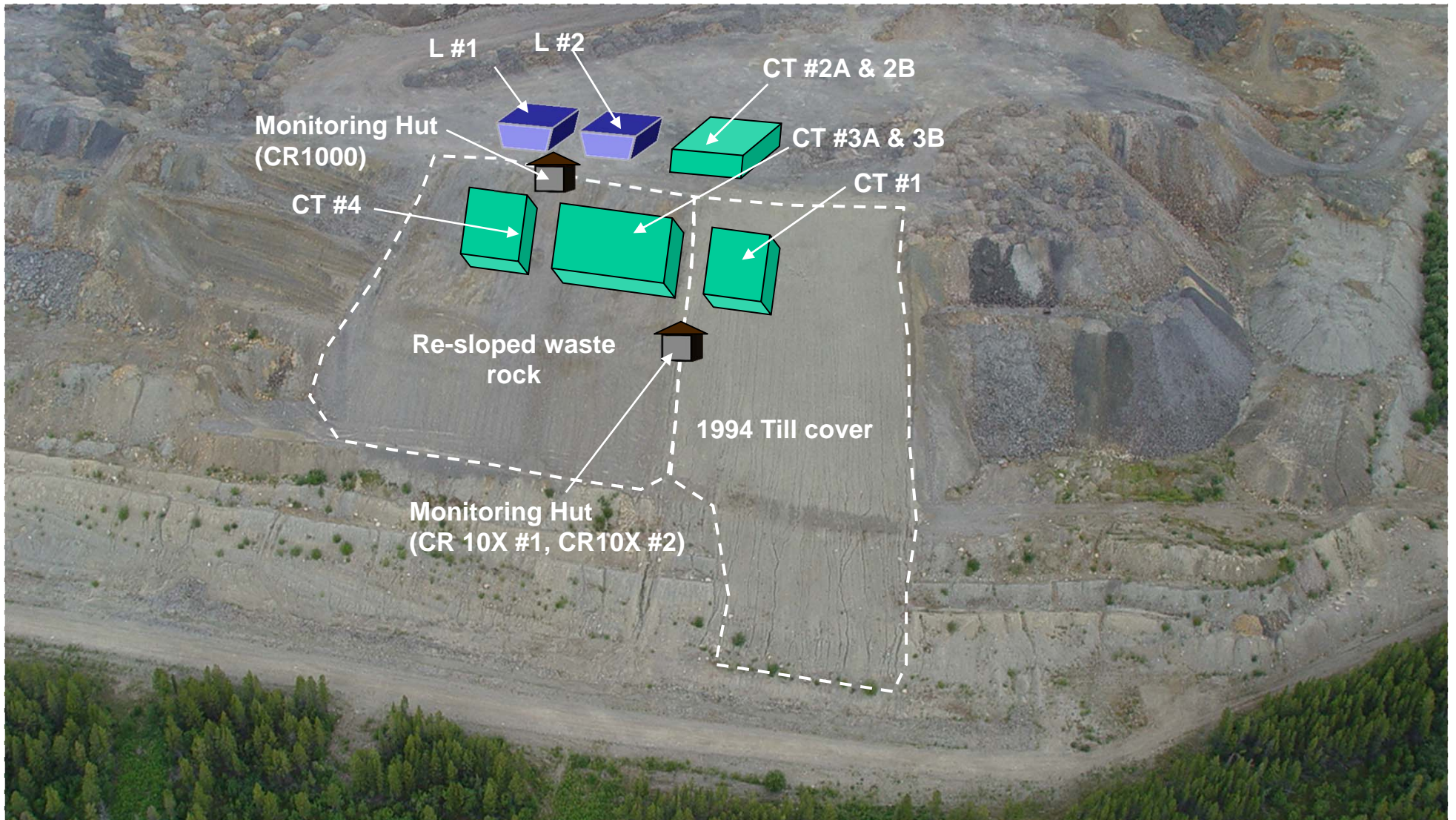
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Faro Mining Complex

DATE: Jan. 2011

APPROVED: IM

FIGURE: 1



Monitor Mine Area Waste Rock Trial Covers  
2010 Data Summary

Aerial View of Trial Cover Layout

Job No: 1CY001.045.800

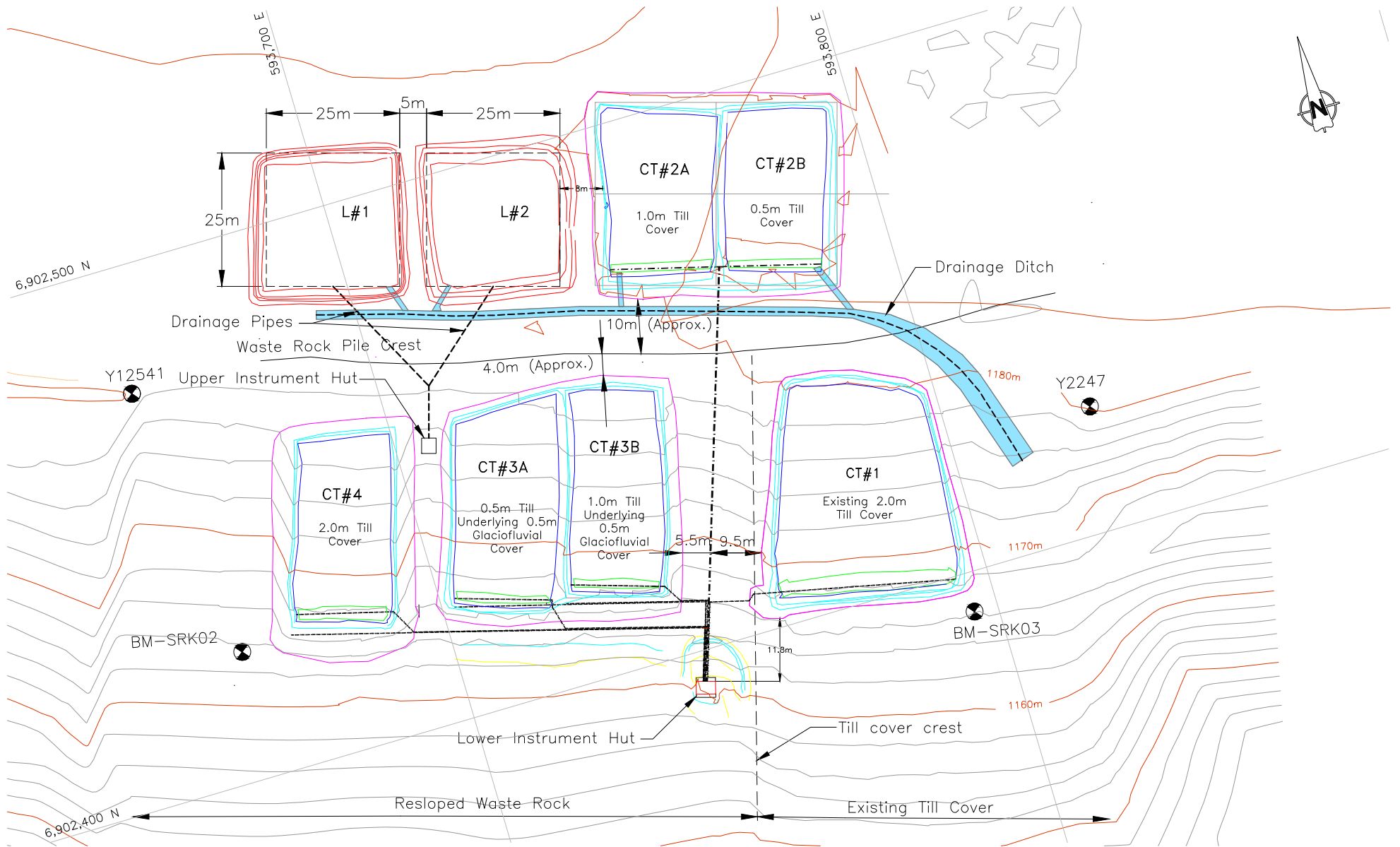
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Faro Mine Complex

Date:  
January 2011

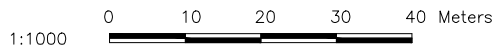
Approved:  
IM

Figure:  
**2**



**LEGEND**

Benchmark



1:1000



SRK JOB NO.: 1CY001.045.800  
FILE NAME: Test Covers Asbuilt with Ditch.dwg



Faro Mining Complex

Monitor Mine Area Waste Rock Trial Covers  
2010 Data Summary

**Trial Covers and  
Lysimeter Layout Plan**

DATE: Jan. 2011	APPROVED: IM	FIGURE: 3
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**Legend:**



Multiplexer



Campbell Scientific Datalogger



Satellite Station



Weather Station



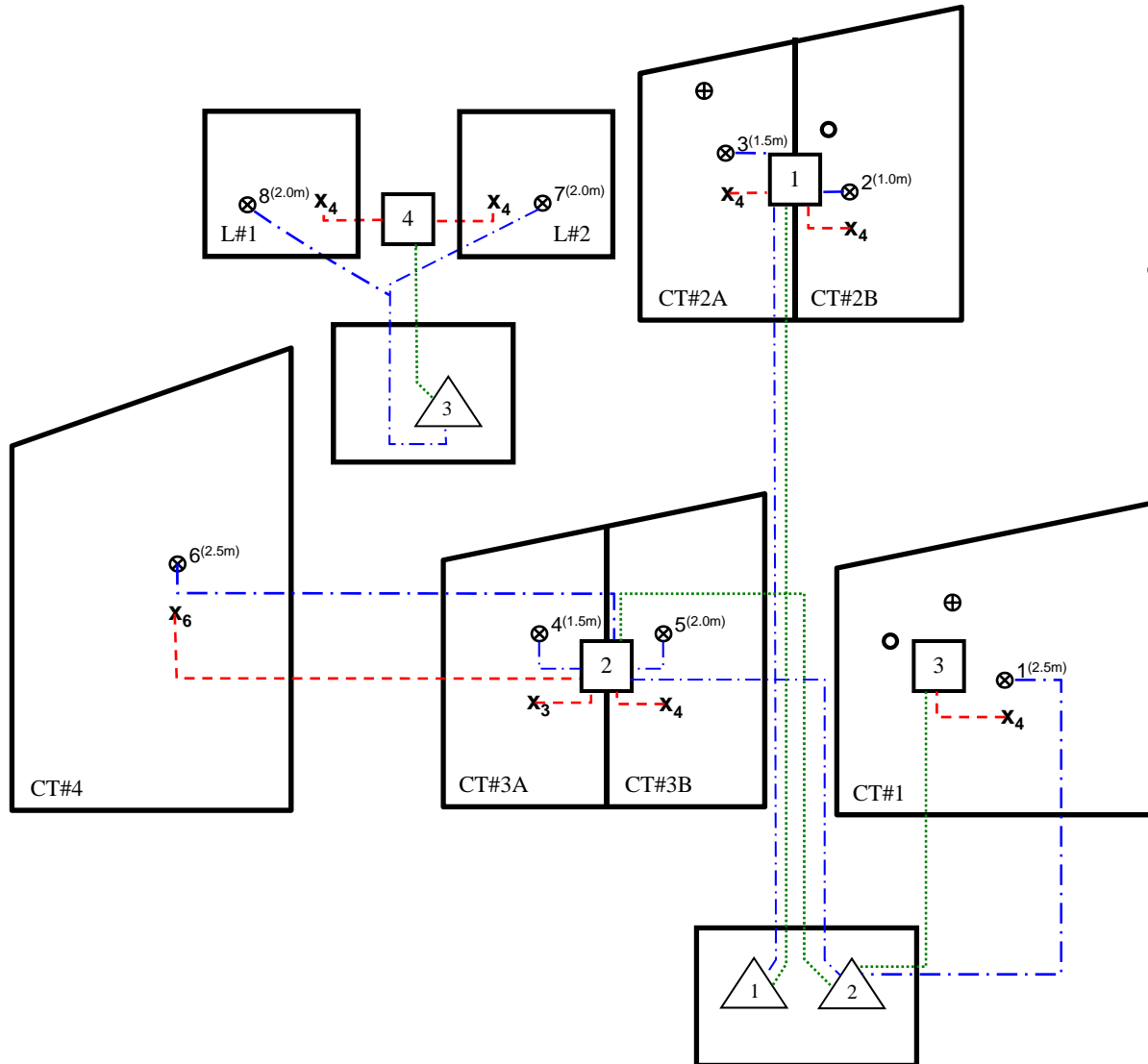
EnviroSCAN Probe #(#m rail) & Communication Wire



CS229 Thermal Conductivity Sensor (# sensors in profile) & Lead wires



Multiplexer Communication Wire



Job No: 1CY001.045.800  
 Filename: Fig2\_4-9\_Trial covers\_20110112.ppt



Faro Mine Complex

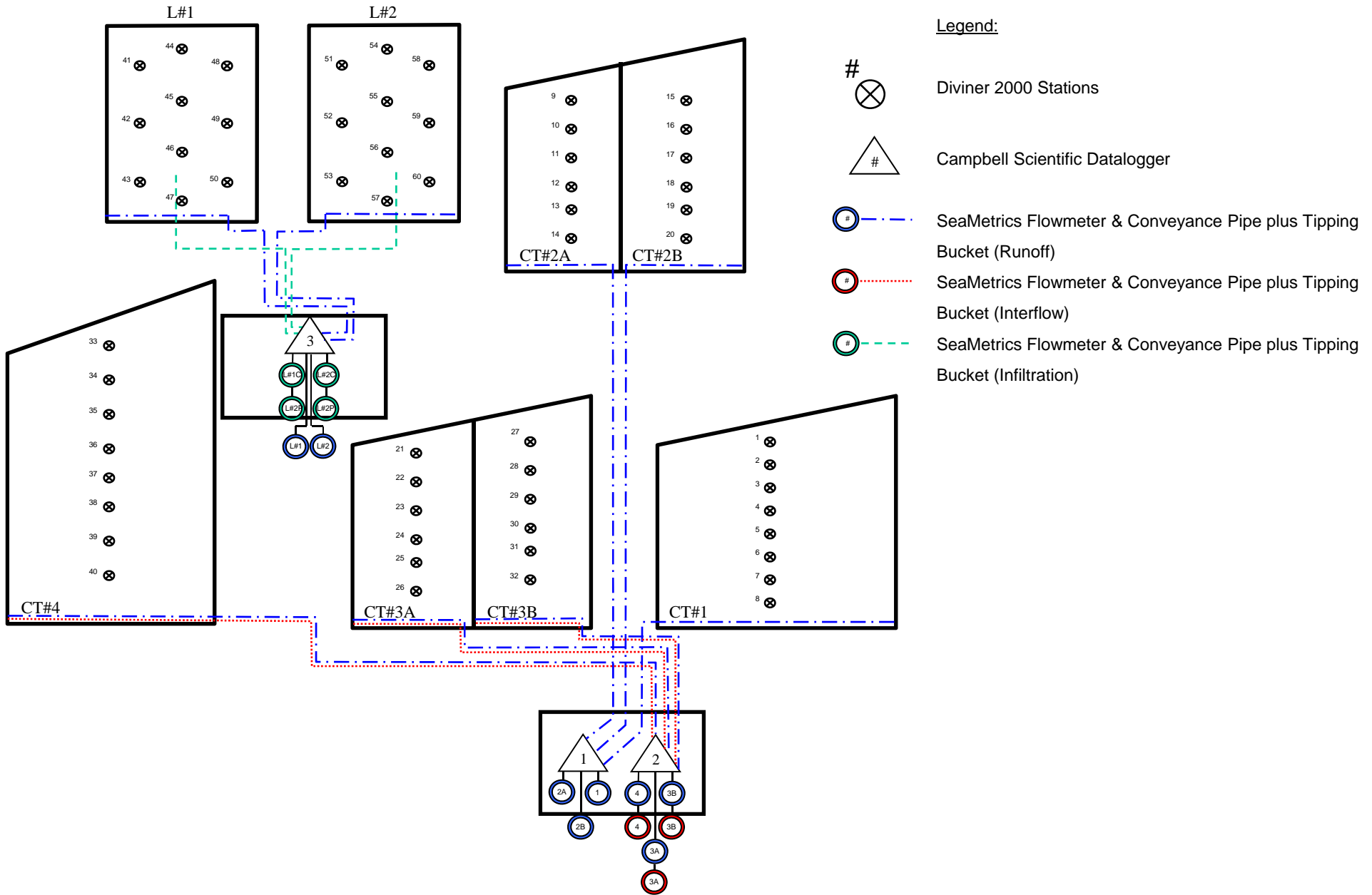
Monitor Mine Area Waste Rock Trial Covers  
 2010 Data Summary

Schematic Trial Cover and Lysimeter Layout  
 Showing Automated Soil Suction, Moisture  
 Instrumentation, Datalogger as well as Weather  
 and Satellite Station Locations

Date:  
 January 2011

Approved:  
 IM

Figure:  
**4**



Legend:

- # ⊗ Diviner 2000 Stations
- △ # Campbell Scientific Datalogger
- ⊙ # SeaMetrics Flowmeter & Conveyance Pipe plus Tipping Bucket (Runoff)
- ⊙ # SeaMetrics Flowmeter & Conveyance Pipe plus Tipping Bucket (Interflow)
- ⊙ # SeaMetrics Flowmeter & Conveyance Pipe plus Tipping Bucket (Infiltration)



Monitor Mine Area Waste Rock Trial Covers  
2010 Data Summary

Schematic Trial Cover and Lysimeter Layout  
Showing Diviner 2000 Stations, Surface Runoff,  
and Interflow Measurement Locations

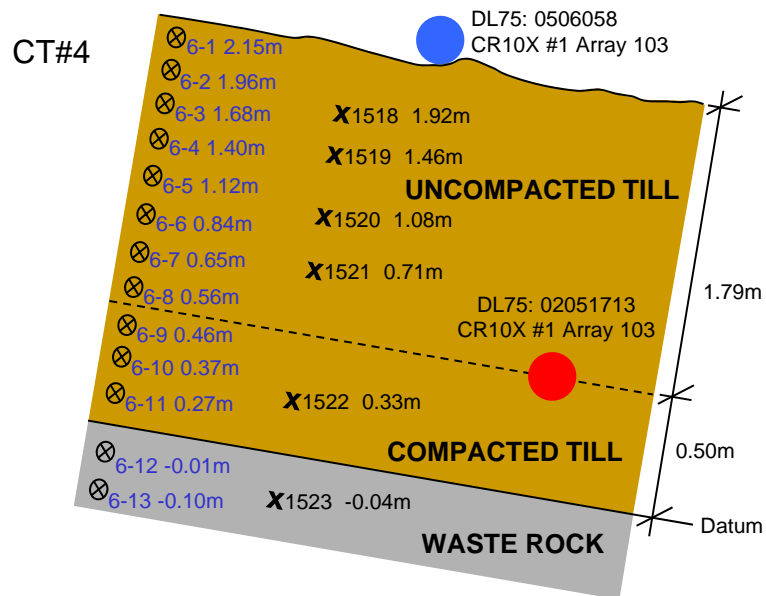
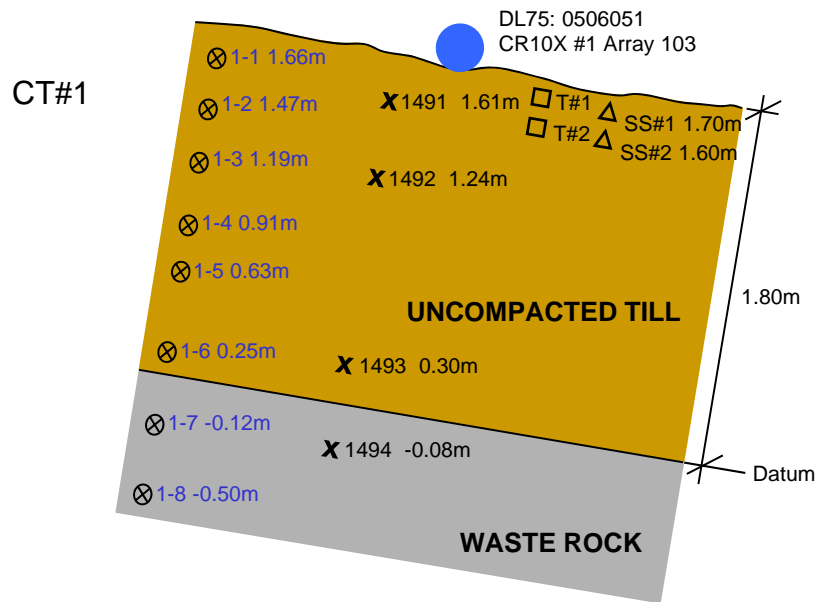
Job No: 1CY001.045.800  
Filename: Fig2\_4-9\_Trial covers\_20110112.ppt

Faro Mine Complex

Date:  
January 2011

Approved:  
IM

Figure: **5**



- Legend:
- #-# #.##m EnviroSCAN Probe, s/n and depth
  - # #.##m CS229 Thermal Conductivity Sensor, s/n and depth
  - T## #.##m Satellite Station Soil Temperature probe and depth
  - SS## #.##m Satellite Station Soil Moisture probe and depth
  - DL75: # CR10X #2 Array # Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
  - DL75: # Seametrics Datalogger with Flowmeter (Runoff)

Note:  
 Depths measured from Datum  
 - Positive = up  
 - Negative = down



Monitor Mine Area Waste Rock Trial Covers  
2010 Data Summary

Schematic Instrument Profiles for  
CT#1 and CT#4

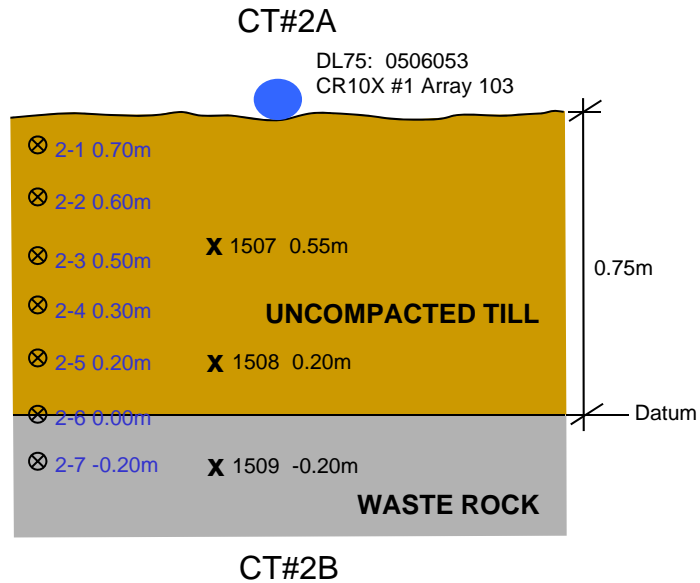
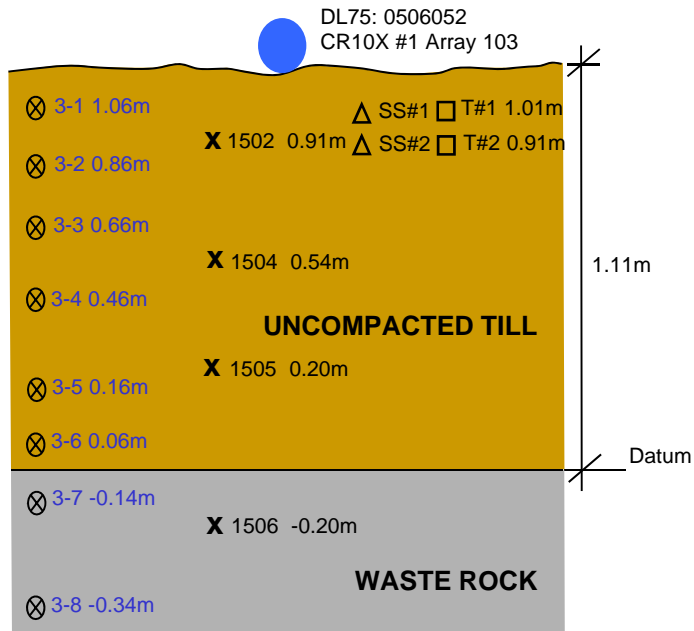
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Faro Mine Complex

Date:  
January 2011

Approved:  
IM

Figure: **6**



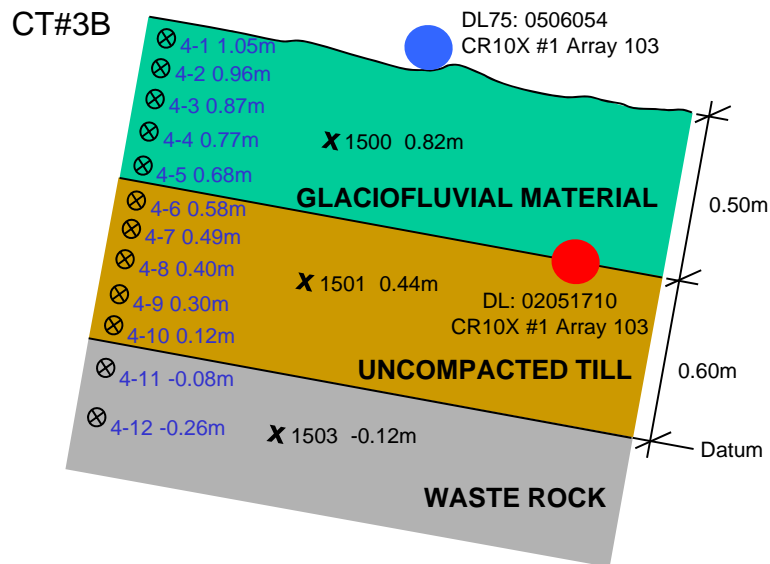
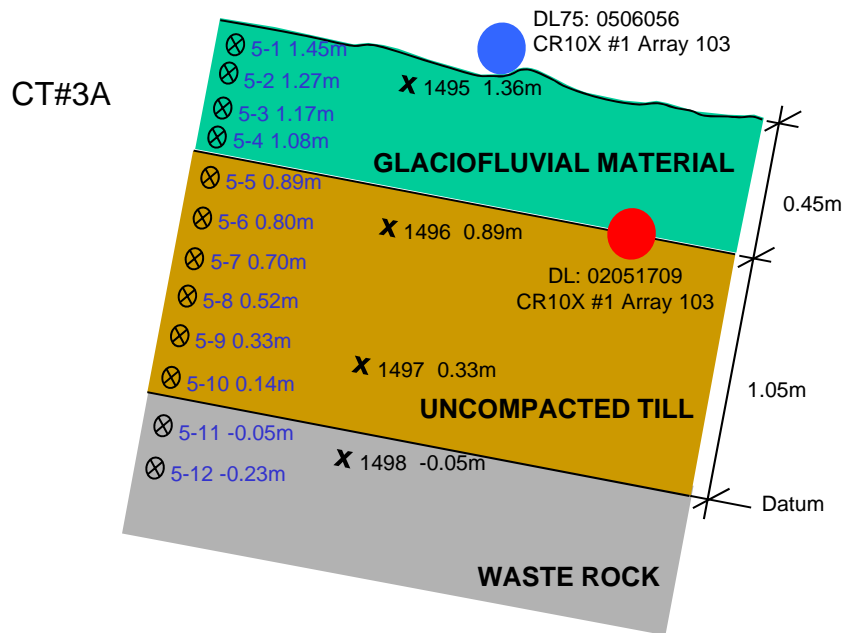
**Legend:**

- #-#-###m EnviroSCAN Probe with bead s/n and depth
- X** #-#-###m CS229 Thermal Conductivity Sensor bead s/n and depth
- T##-###m Satellite Station Temperature probe and depth
- SS##-###m Satellite Station Soil Moisture probe and depth
- DL75: # CR10X #2 Array # Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
- DL75: # Seametrics Datalogger with Flowmeter (Runoff)

**Note:**

- Depths measured from Datum
- Positive = up
- Negative = down

<p><b>SRK Consulting</b> Engineers and Scientists VANCOUVER</p>	<p><b>Faro Mine Closure</b> Fermeture de la mine Faro</p>	Monitor Mine Area Waste Rock Trial Covers 2010 Data Summary		
		Schematic Instrument Profiles for CT#2A and CT#2B		
Job No: 1CY001.045.800 Filename: Fig2_4-9_Trial covers_20110112.ppt	Faro Mine Complex	Date: January 2011	Approved: IM	Figure: <b>7</b>



Legend:

- ⊗ #-# #.##m EnviroSCAN Probe with bead s/n and depth
- X # #.##m CS229 Thermal Conductivity Sensor bead s/n and depth
- T## #.##m Satellite Station Temperature probe and depth
- △ SS## #.##m Satellite Station Soil Moisture probe and depth
- DL75: # CR10X #2 Array # Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
- DL75: # Seametrics Datalogger with Flowmeter (Runoff)

Note:

- Depths measured from Datum
- Positive = up
- Negative = down



Monitor Mine Area Waste Rock Trial Covers  
2010 Data Summary

Schematic Instrument Profiles for  
CT#3A and CT#3B

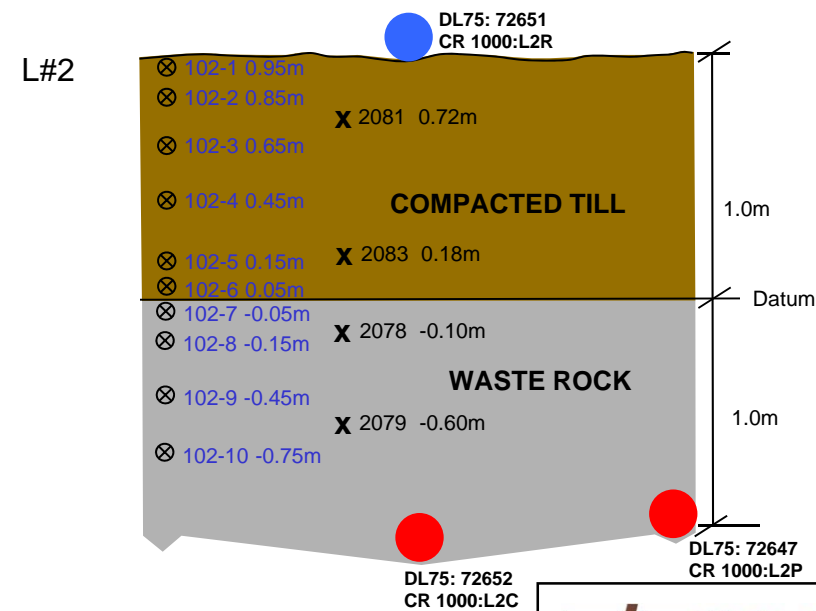
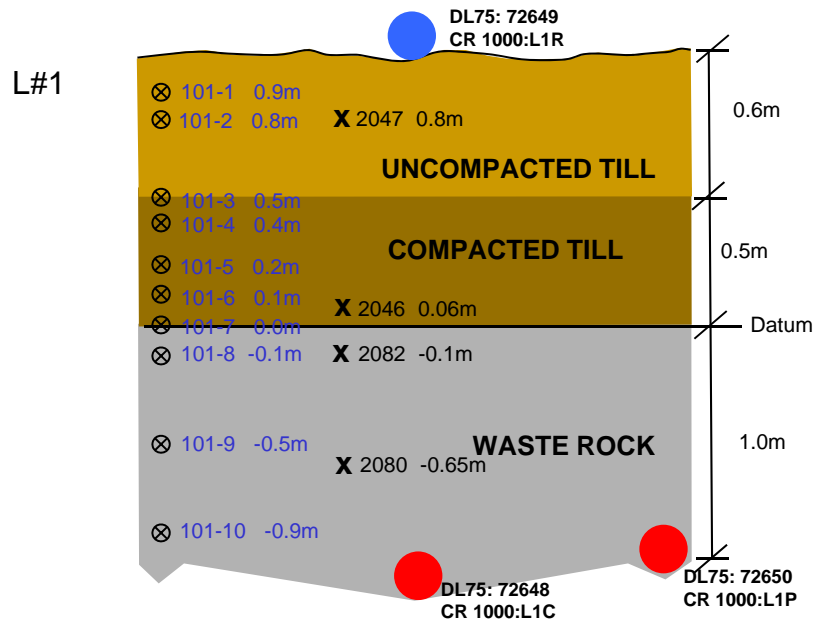
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Fig2\_4-9\_Trial covers\_20110112.ppt

Faro Mine Complex

Date:  
January 2011

Approved:  
IM

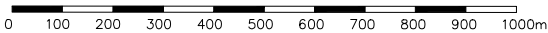
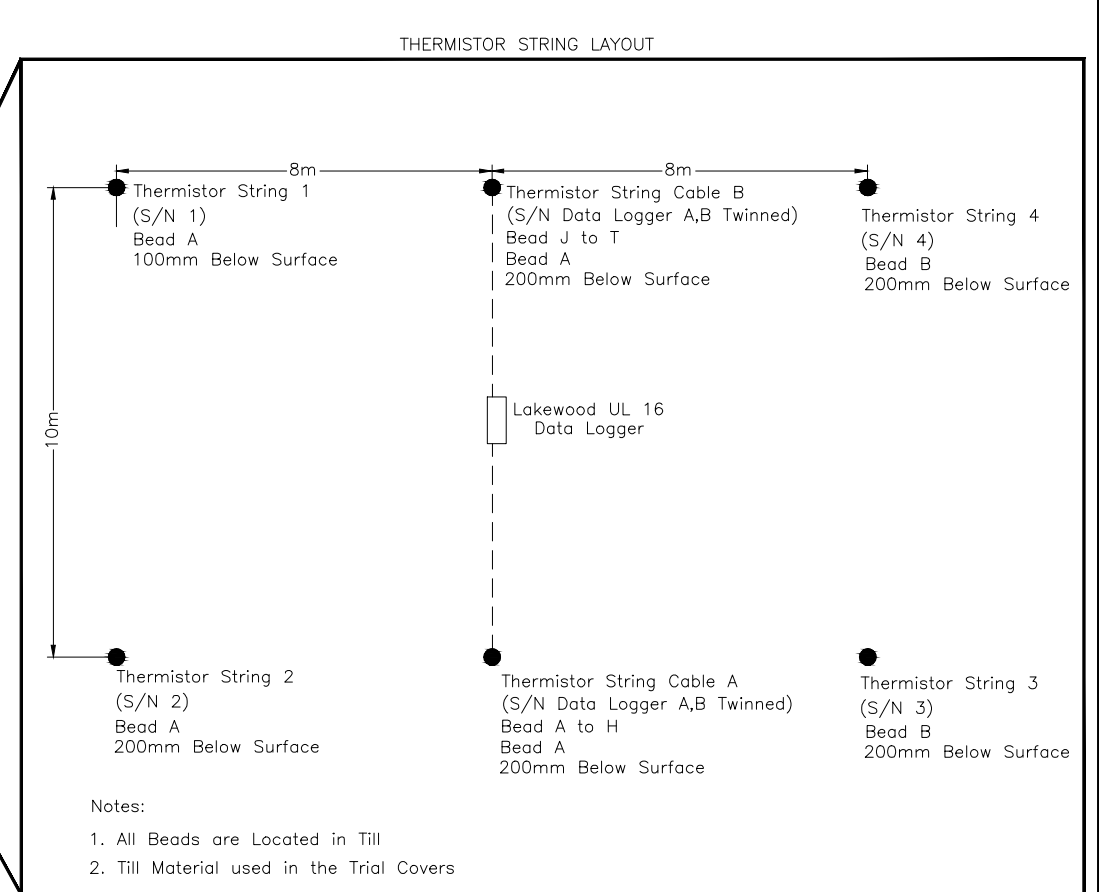
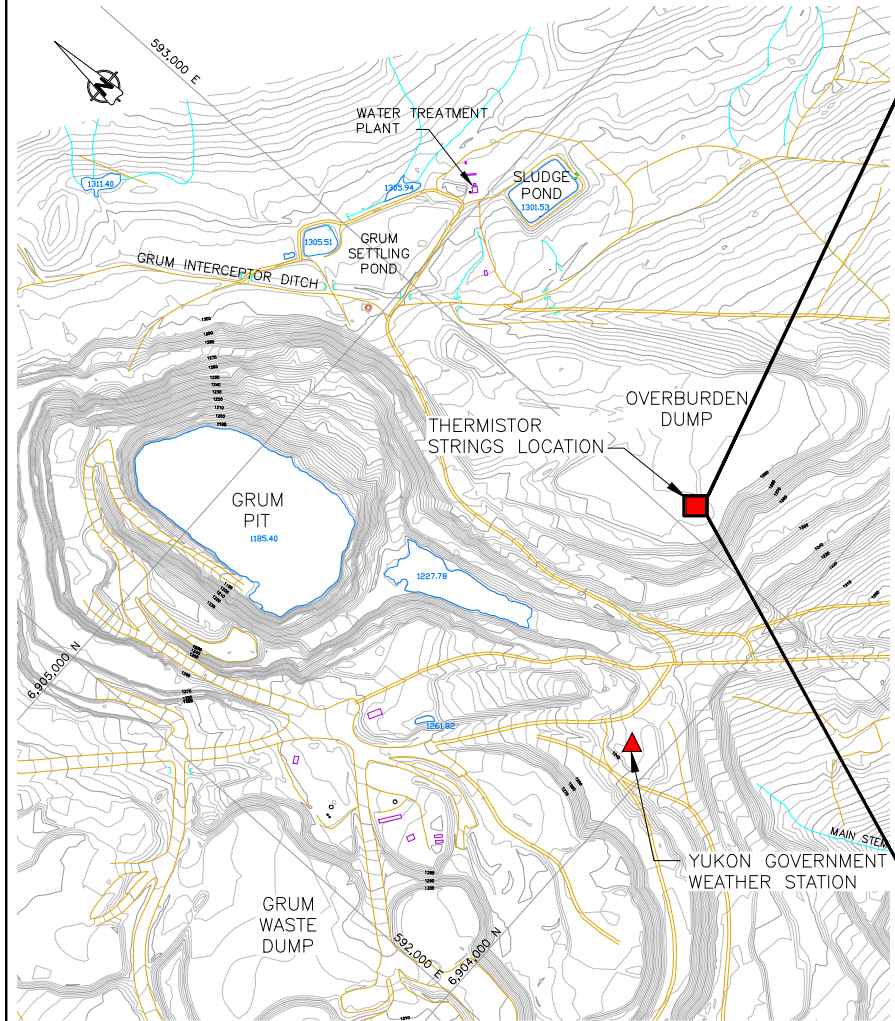
Figure: **8**



- Legend:**
- ⊗ #-#-###m: EnviroSCAN Probe with bead s/n and depth
  - X #-#-###m: CS229 Thermal Conductivity Sensor bead s/n and depth
  - T##-#-###m: Satellite Station Temperature probe and depth
  - △ SS##-#-###m: Satellite Station Soil Moisture probe and depth
  - DL75: 72650 CR 1000:L1P: Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
  - DL75: #: Seametrics Datalogger with Flowmeter (Runoff)

**Note:**  
 Depths measured from Datum  
 - Positive = up  
 - Negative = down

		Monitor Mine Area Waste Rock Trial Covers 2010 Data Summary		
		Schematic Instrument Profiles for L#1 and L#2		
Job No: 1CY001.045.800 Filename: Fig2_4-9_Trial covers_20110112.ppt	Faro Mine Complex	Date: January 2011	Approved: IM	Figure: <b>9</b>



THERMISTOR STRING PROFILES

Thermistor String 1 (S/N 1)		Thermistor String 2 (S/N 2)		Thermistor String 3 (S/N 3)		Thermistor String 4 (S/N 4)		Thermistor String Cable A (S/N Datalogger A,B Twinned)		Thermistor String Cable B (S/N Datalogger A,B Twinned)	
Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)
A	0.1	A	0.2	A	-0.65	A	0.2	A	0.2	J	0.2
B	0.6	B	0.7	B	-0.15	B	0.7	B	0.7	K	0.7
C	1.1	C	1.2	C	0.35	C	1.2	C	1.2	L	1.2
D	2.1	D	2.2	D	1.35	D	2.2	D	2.2	N	2.2
E	3.1	E	3.2	E	2.35	E	3.2	E	3.2	P	3.2
F	4.1	F	4.2	F	3.35	F	4.2	F	4.2	R	4.2
G	5.1	G	5.2	G	4.35	G	5.2	G	5.2	S	5.2
H	6.1	H	6.2	H	5.35	H	6.2	H	6.2	T	6.2



SRK JOB NO.: 1CY001.045.800  
 FILE NAME: site\_plan\_Thermistor.dwg



Faro Mining Complex

Monitor Mine Area Waste Rock Trial Covers  
 2010 Data Summary

Location Plan and Schematic  
 Thermistor Layout on  
 Grum Overburden Dump

DATE: Jan 2011    APPROVED: IM    FIGURE: 10

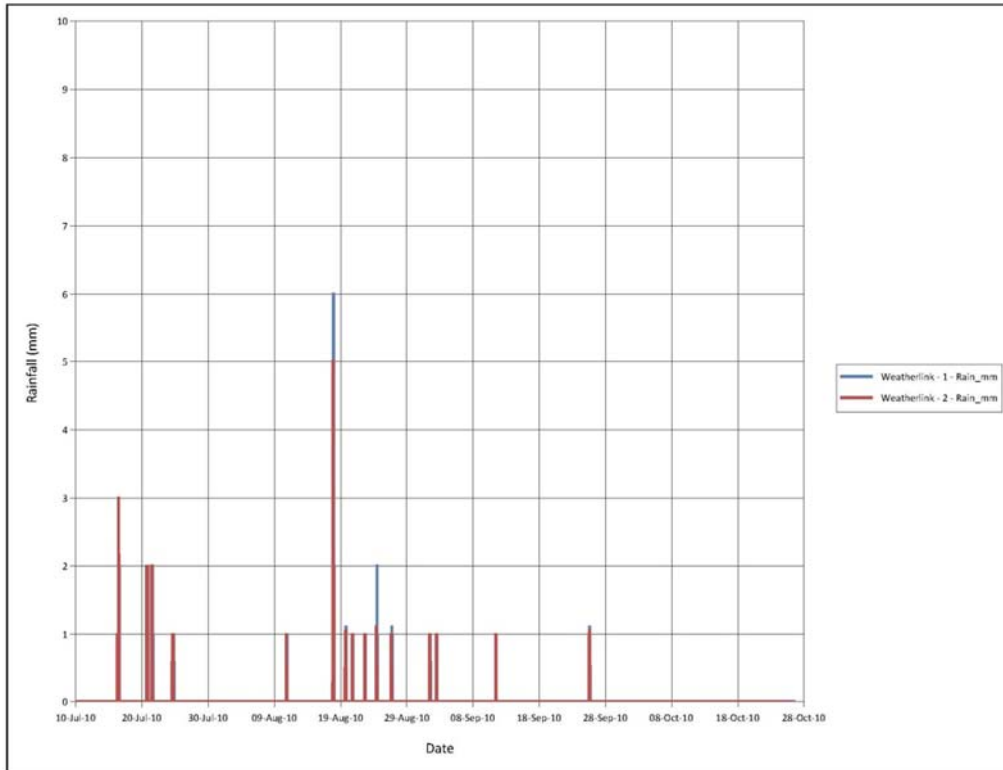


Figure 11: Total hourly rainfall on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

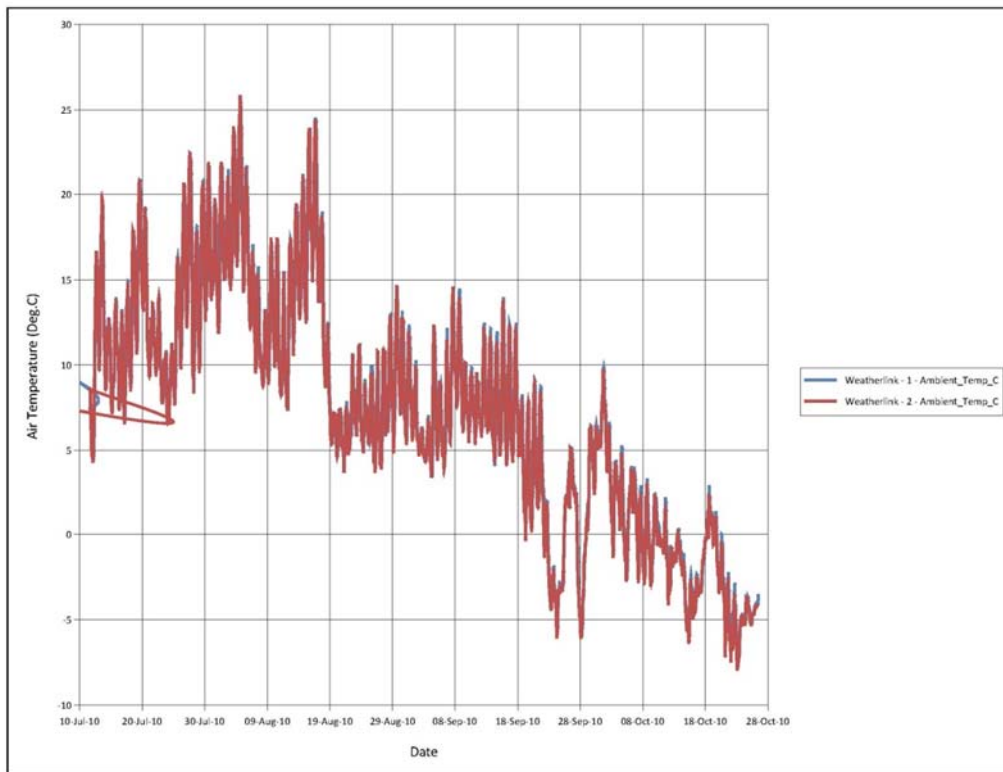


Figure 12: Mean hourly air temperature on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations and satellite stations.

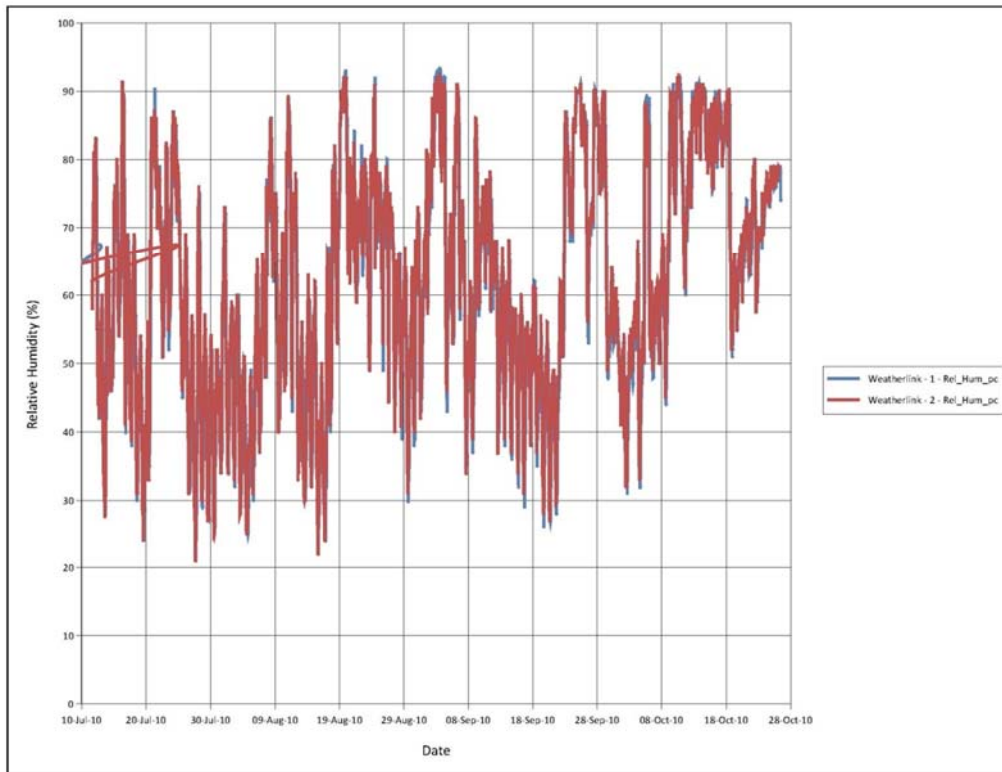


Figure 13: Mean hourly relative humidity on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations and satellite stations.

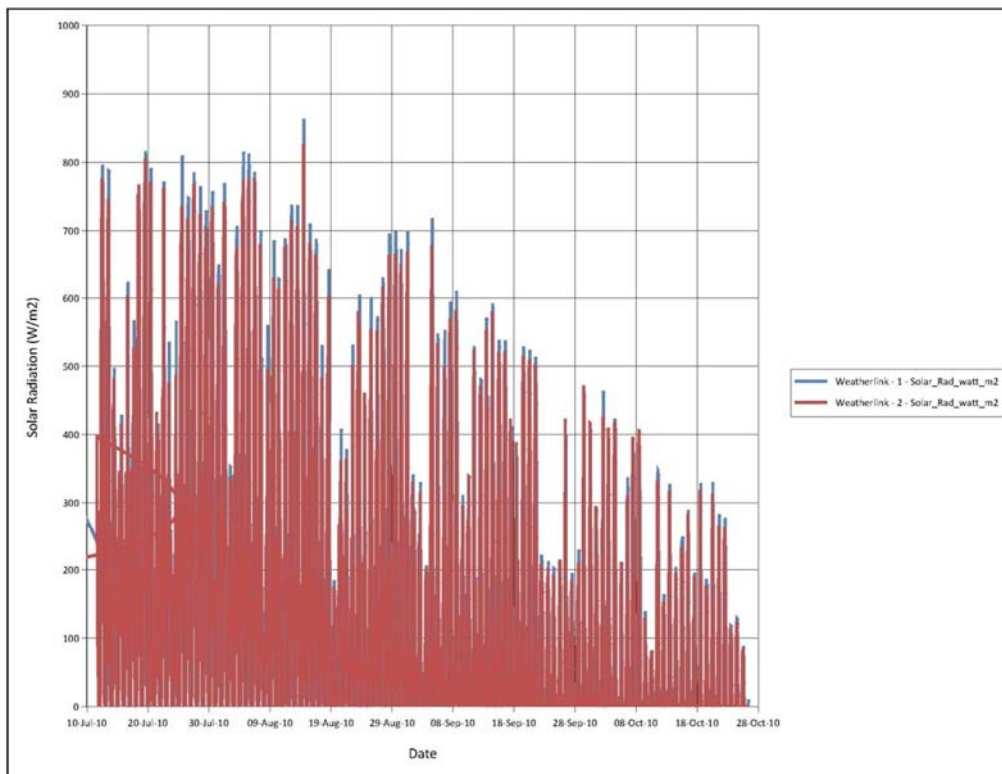


Figure 14: Mean hourly solar radiation on CT#1 & CT2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

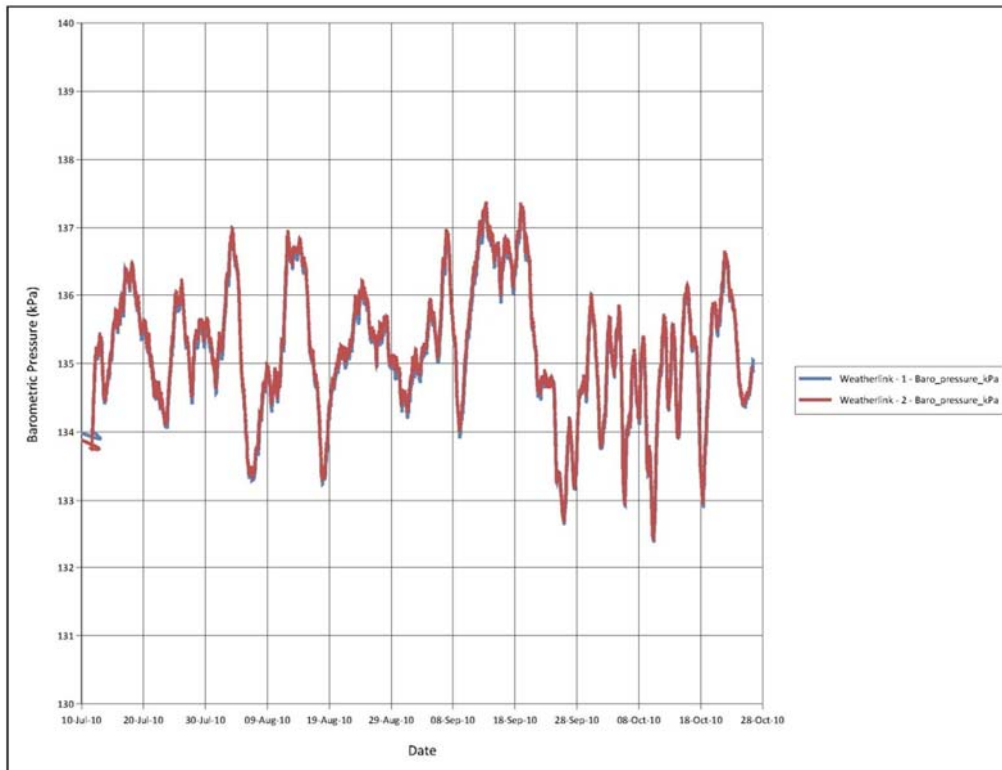


Figure 15: Mean hourly barometric pressure on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

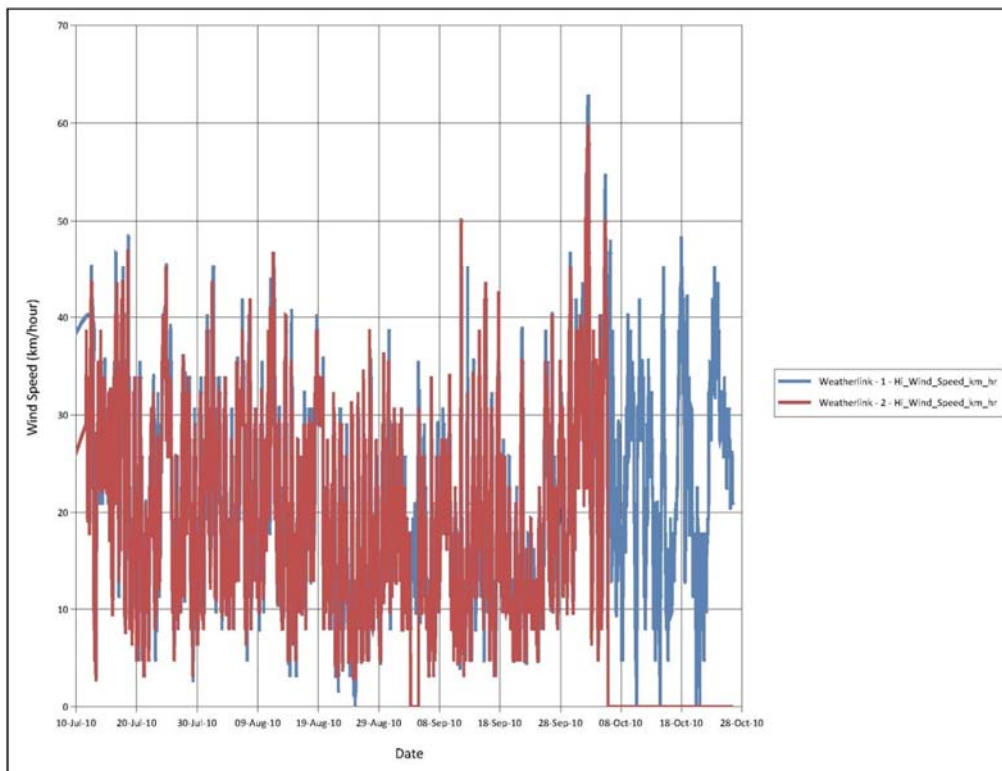


Figure 16: Mean hourly wind speed on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

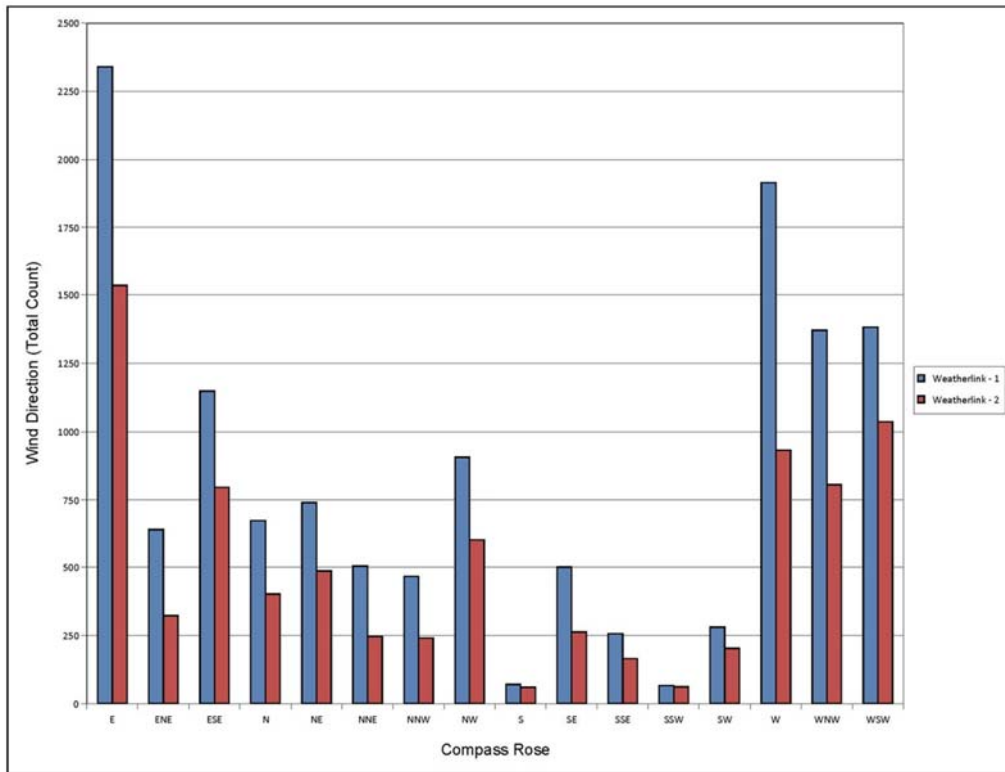


Figure 17: Wind direction totals (measured hourly) on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

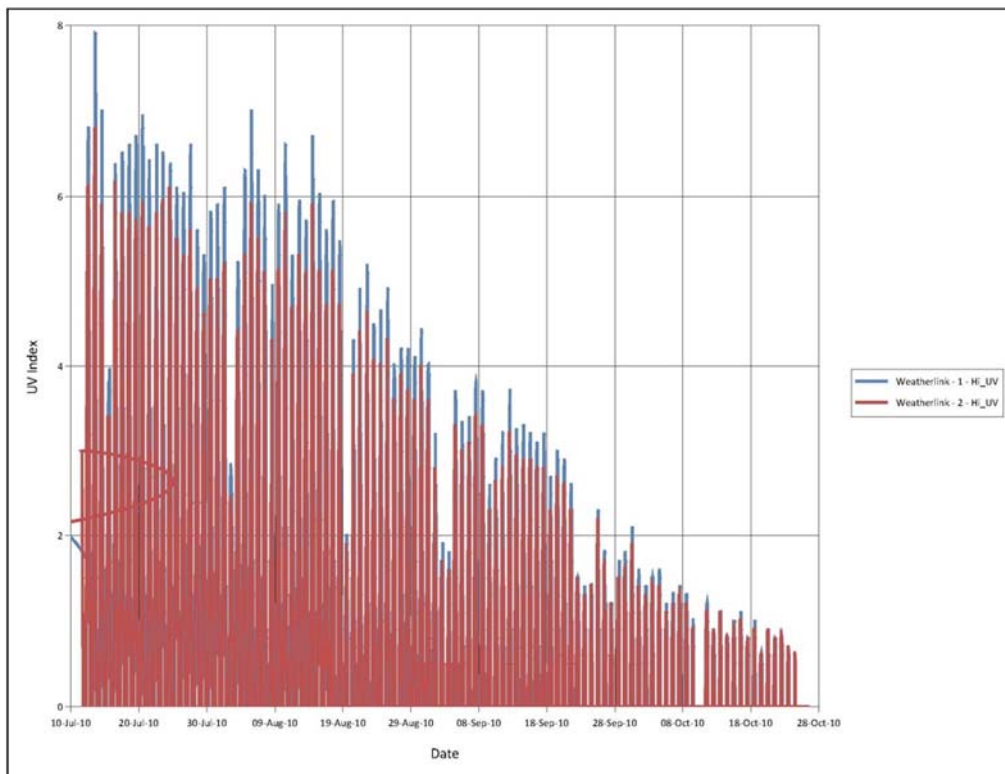


Figure 18: Mean hourly UV Index on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

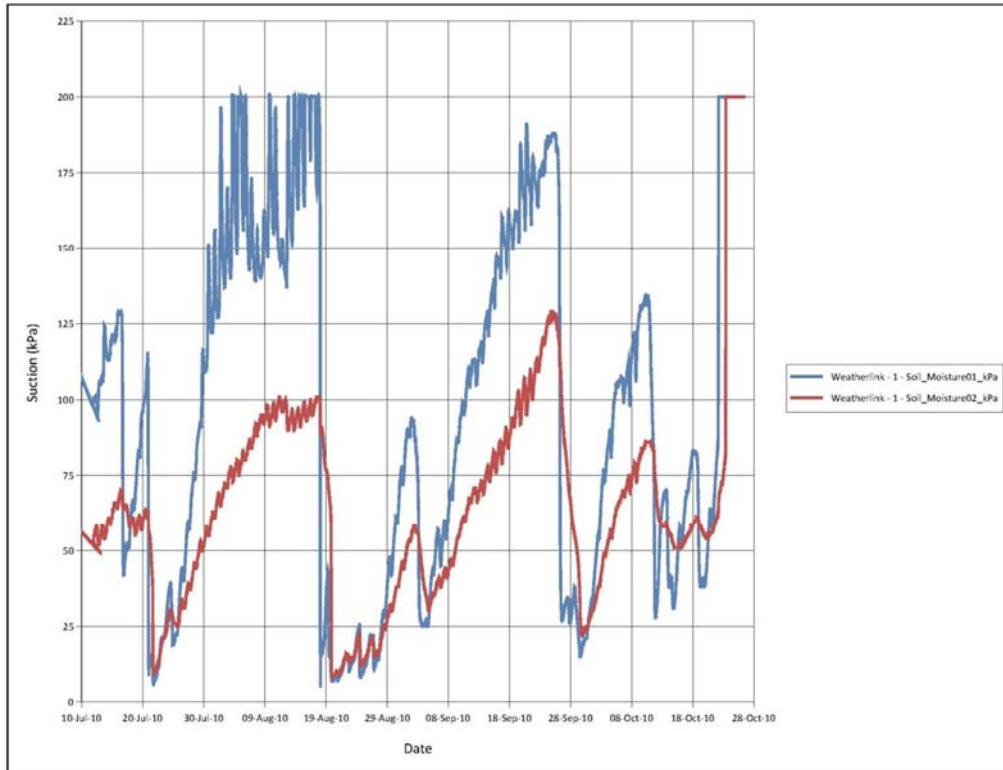


Figure 19: Mean hourly Matric Suction in CT#1 recorded by the Davis Instruments Vantage Pro satellite station.

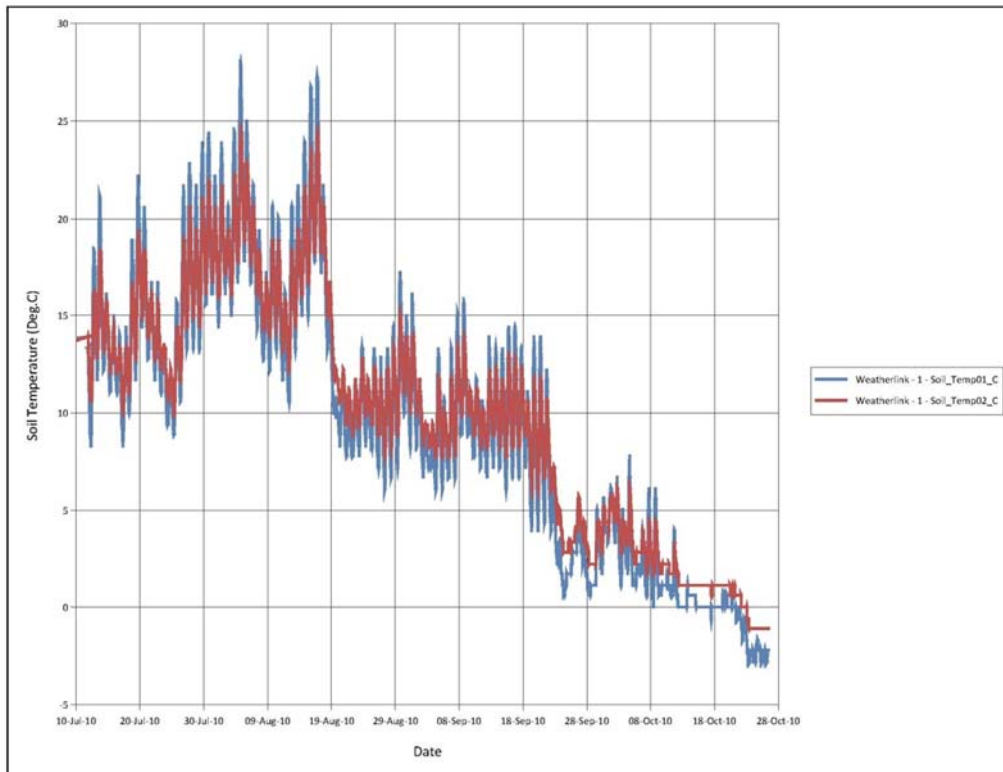


Figure 20: Mean hourly soil temperature in CT#1 recorded by the Davis Instruments Vantage Pro satellite station.

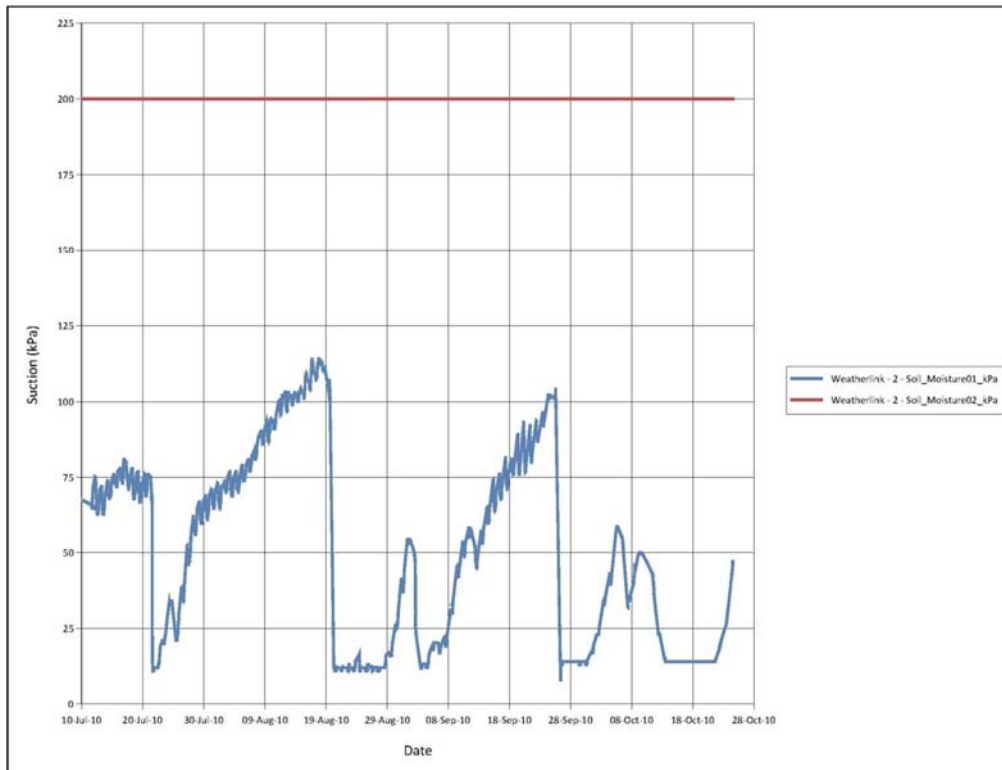


Figure 21: Mean hourly Matric Suction in CT#2A recorded by the Davis Instruments Vantage Pro satellite station.

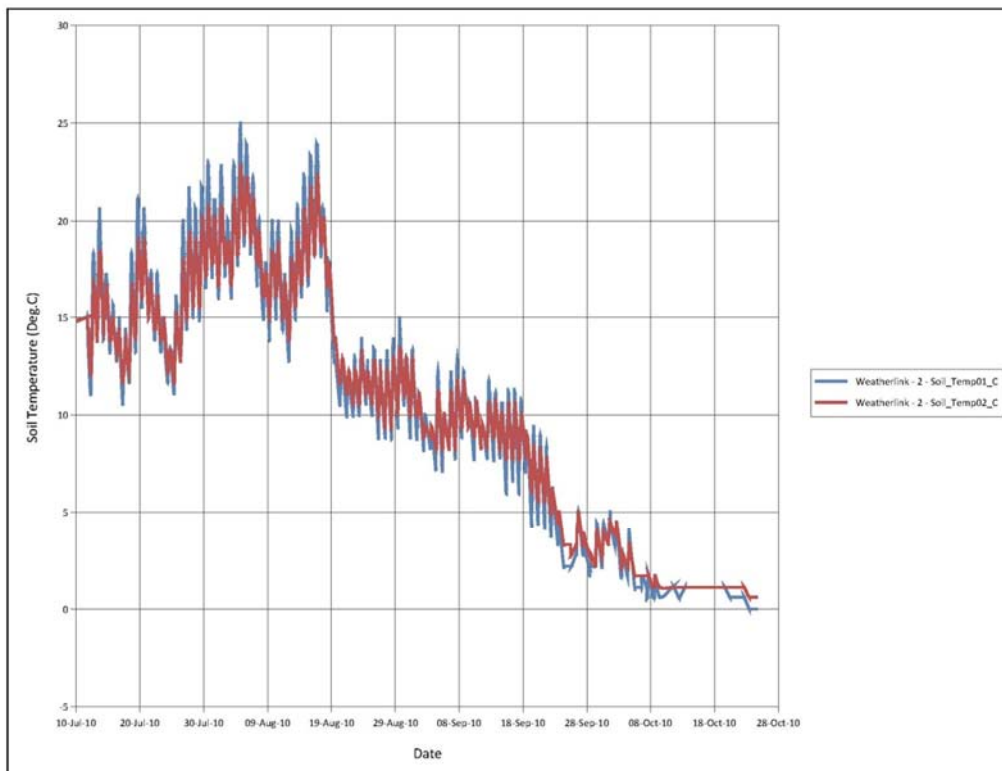


Figure 22: Mean hourly soil temperature in CT#2A recorded by the Davis Instruments Vantage Pro satellite station.

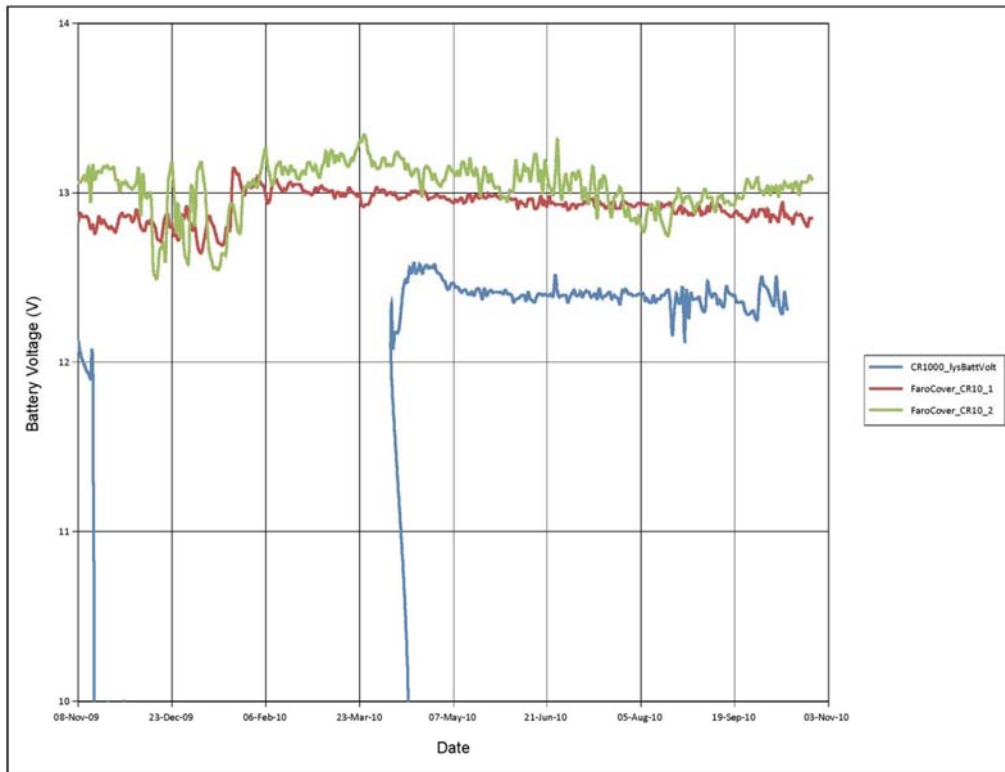


Figure 23: Daily battery voltage of the Campbell Scientific CR10X #1, CR10X#2, and CR1000 data loggers.

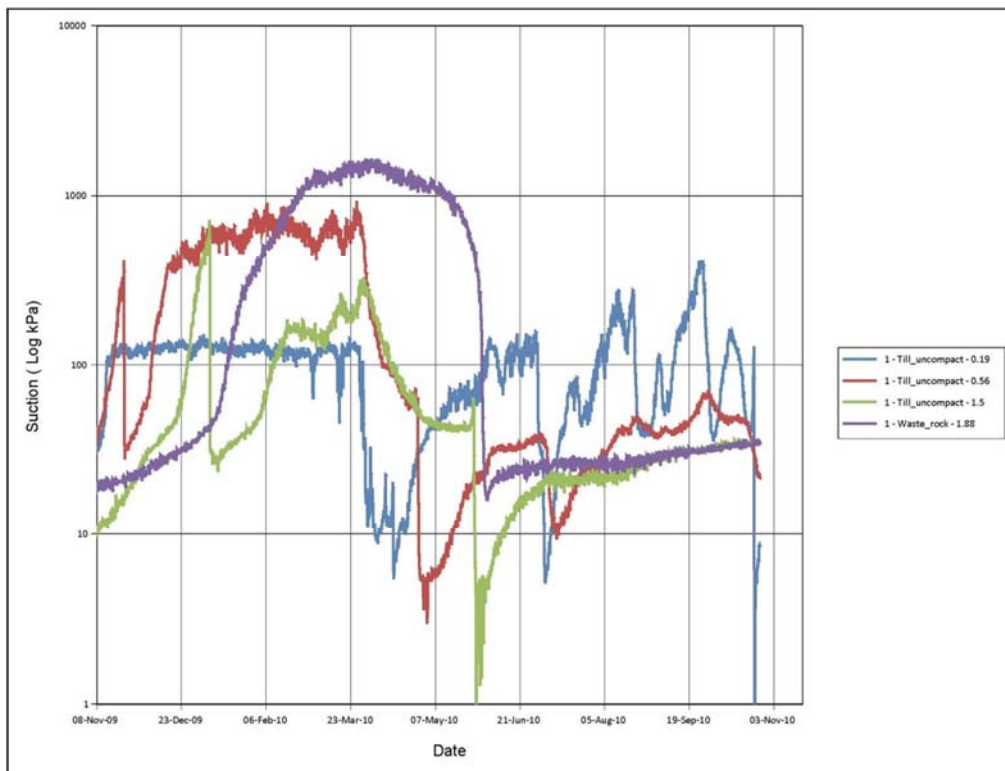


Figure 24: Soil matric suction measurements (taken every six hours) in CT#1 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

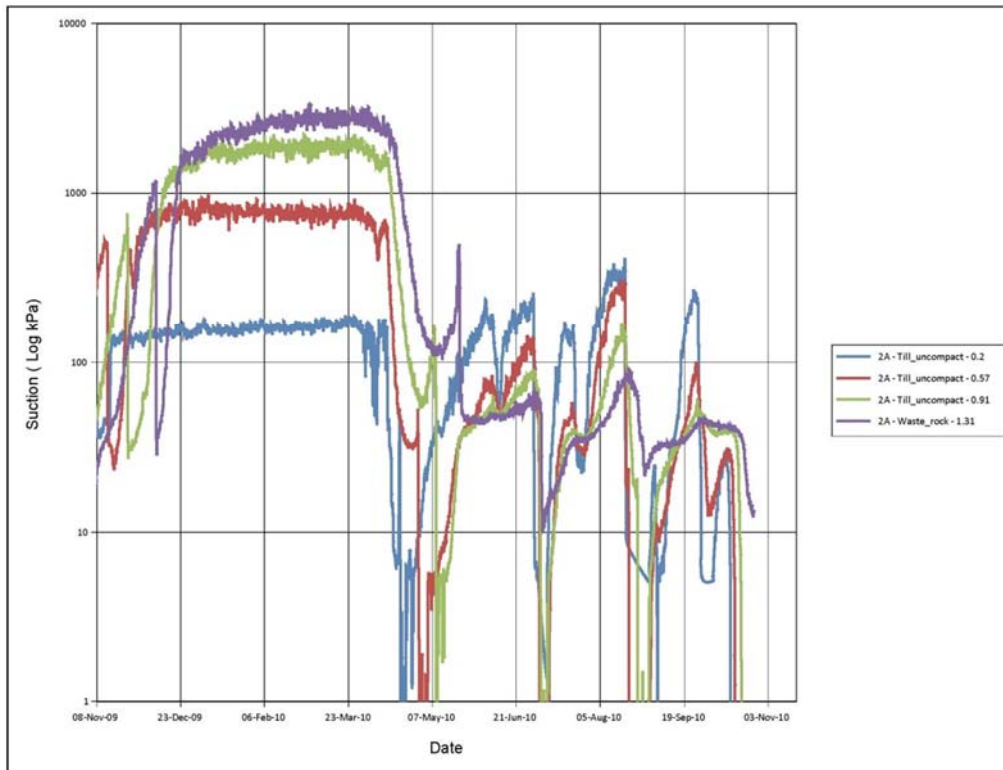


Figure 25: Soil matric suction measurements (taken every six hours) in CT#2A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

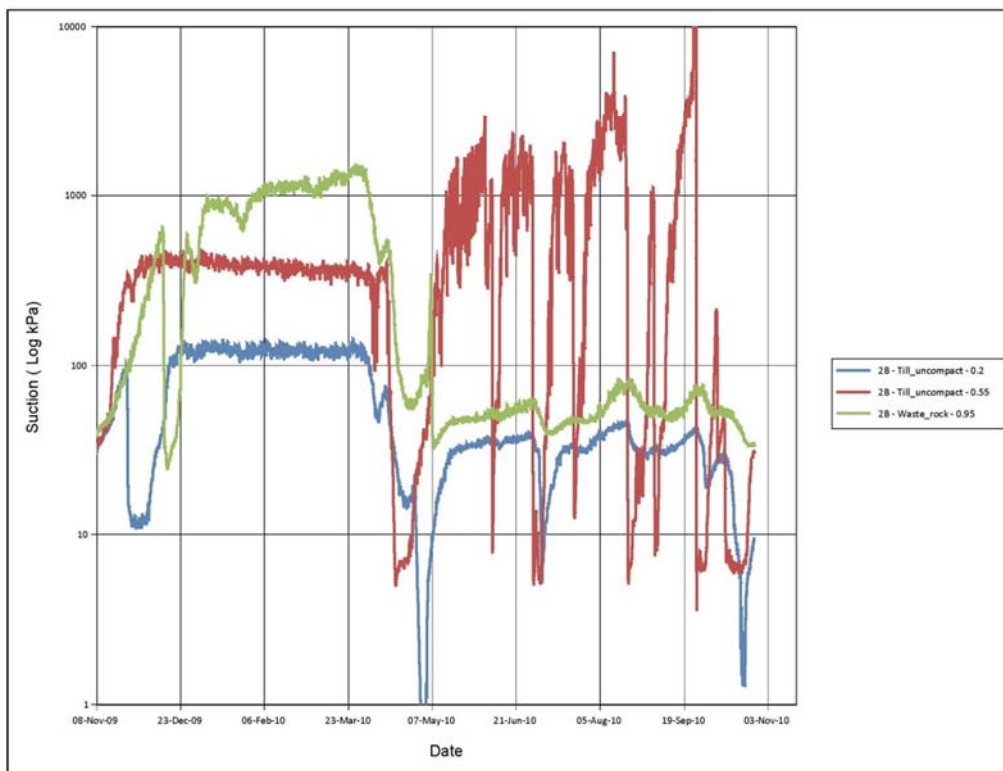


Figure 26: Soil matric suction measurements (taken daily) in CT#2B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

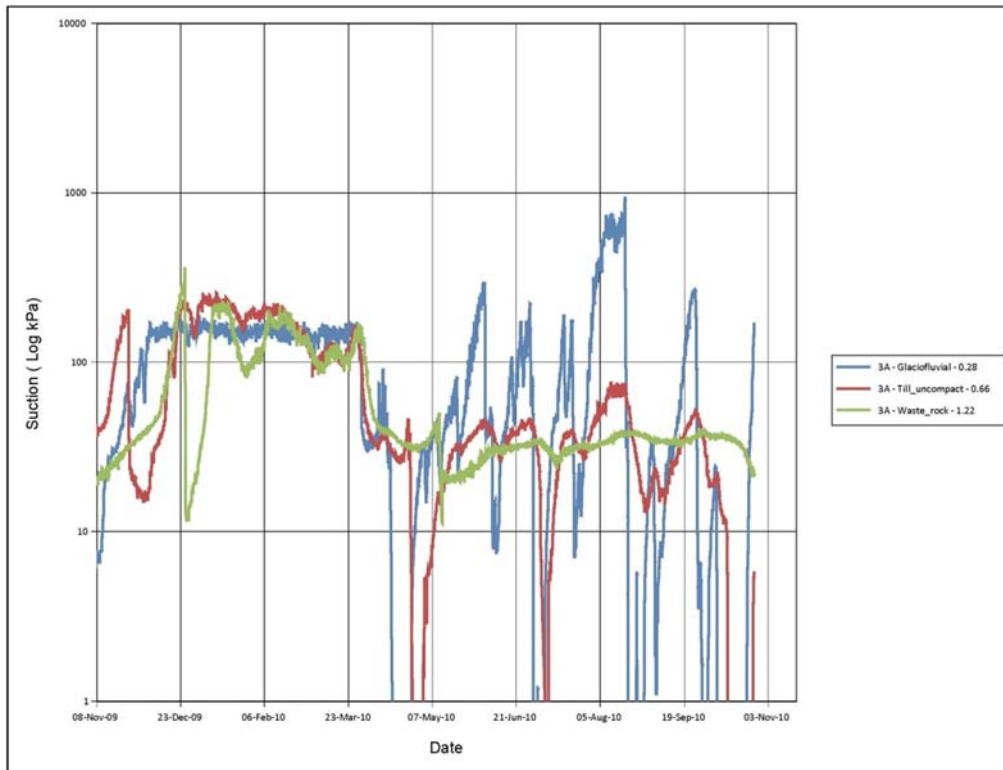


Figure 27: Soil matric suction measurements (taken every six hours) in CT#3A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

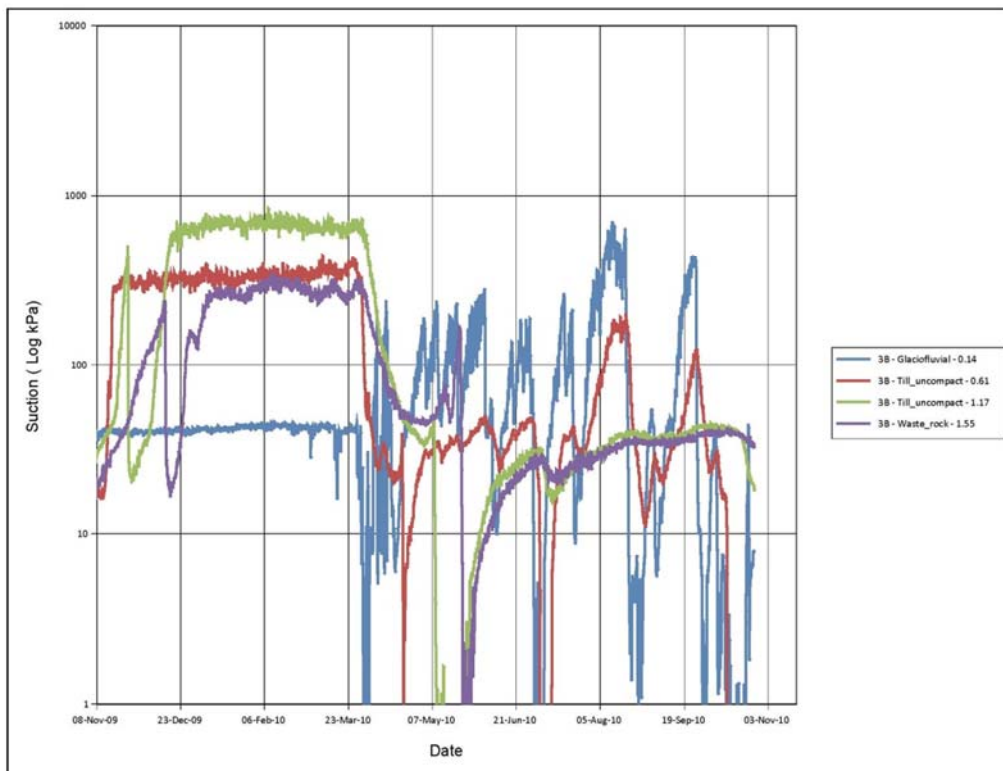


Figure 28: Soil matric suction measurements (taken every six hours) in CT#3B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

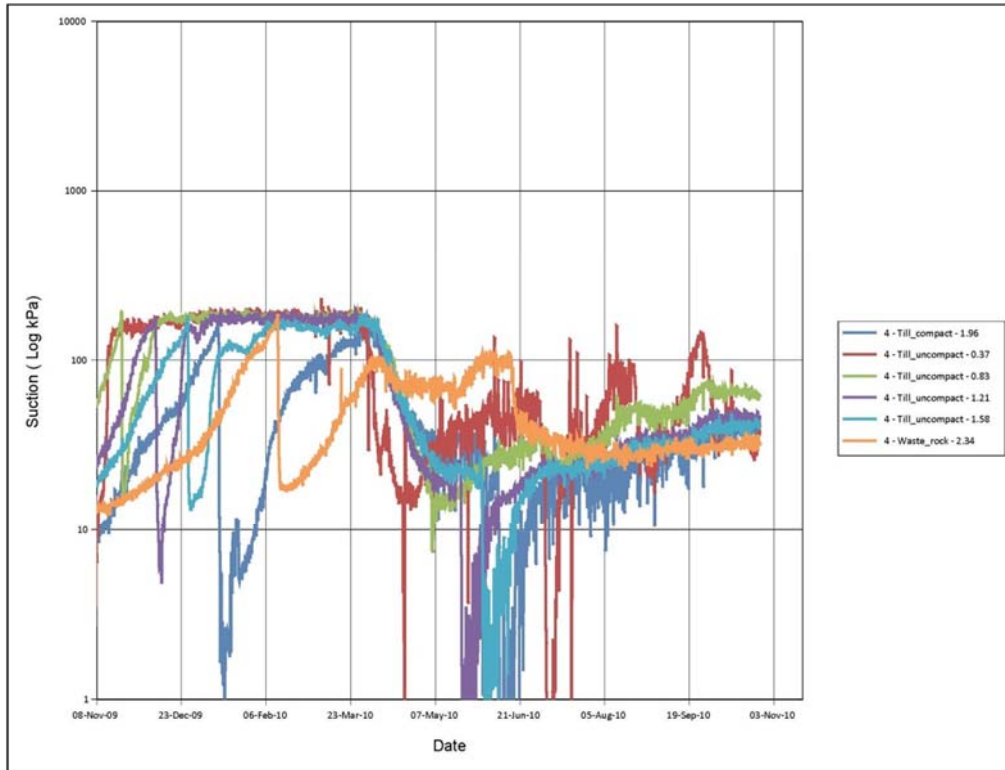


Figure 29: Soil matric suction measurements (taken every six hours) in CT#4 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

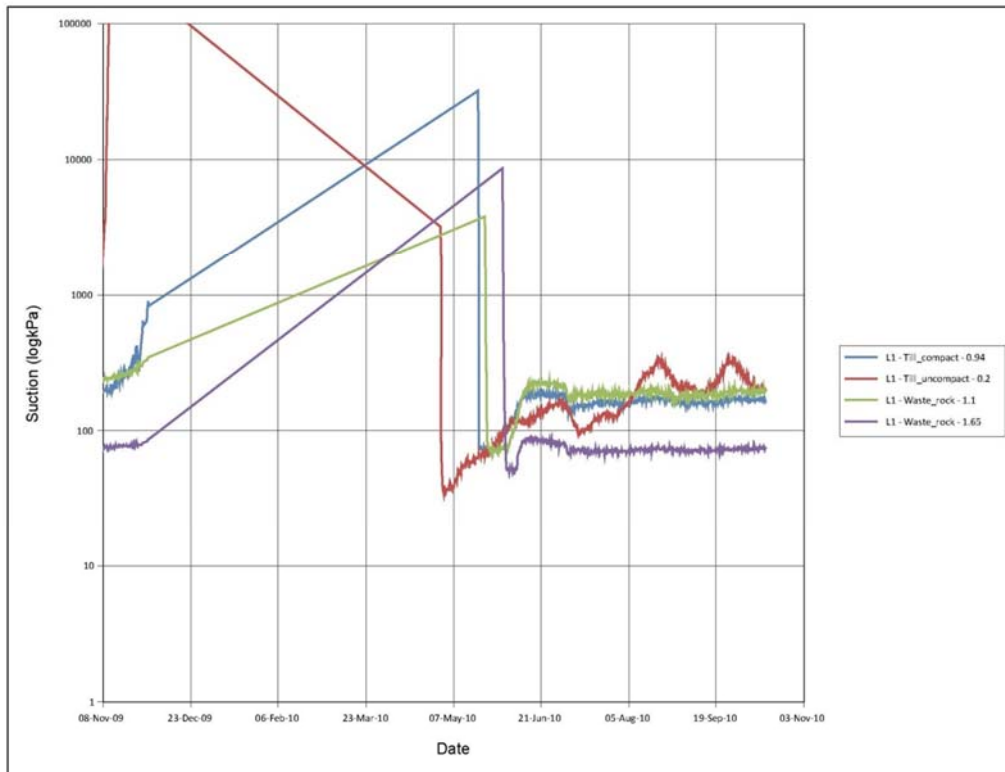


Figure 30: Soil matric suction measurements (taken every six hours) in L#1 recorded by CS229 sensors connected to Campbell Scientific CR1000 data logger.

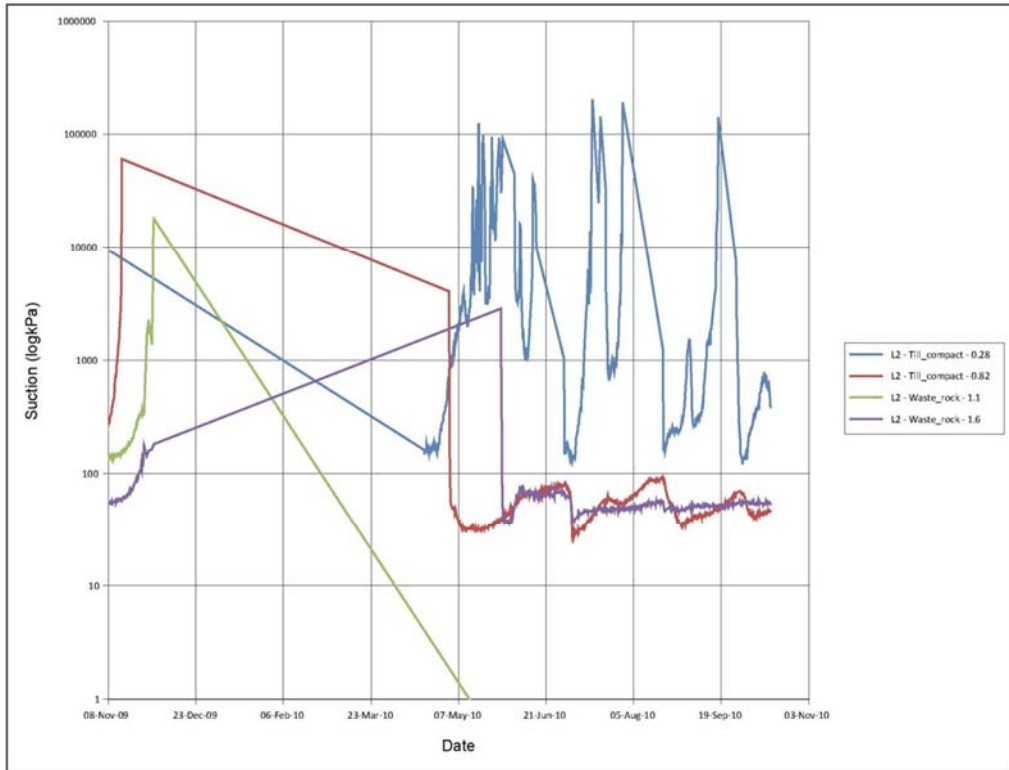


Figure 31: Soil matric suction measurements (taken every six hours) in L#2 recorded by CS229 sensors connected to Campbell Scientific CR1000 data logger.

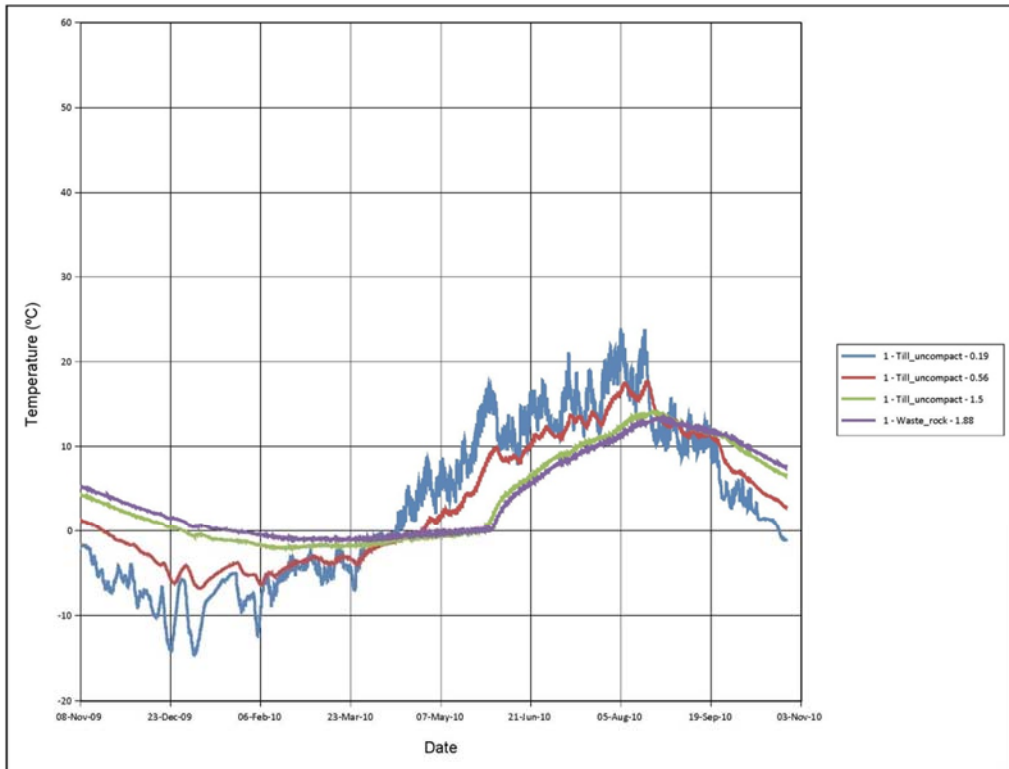


Figure 32: Soil temperature measurements (taken every six hours) in CT#1 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

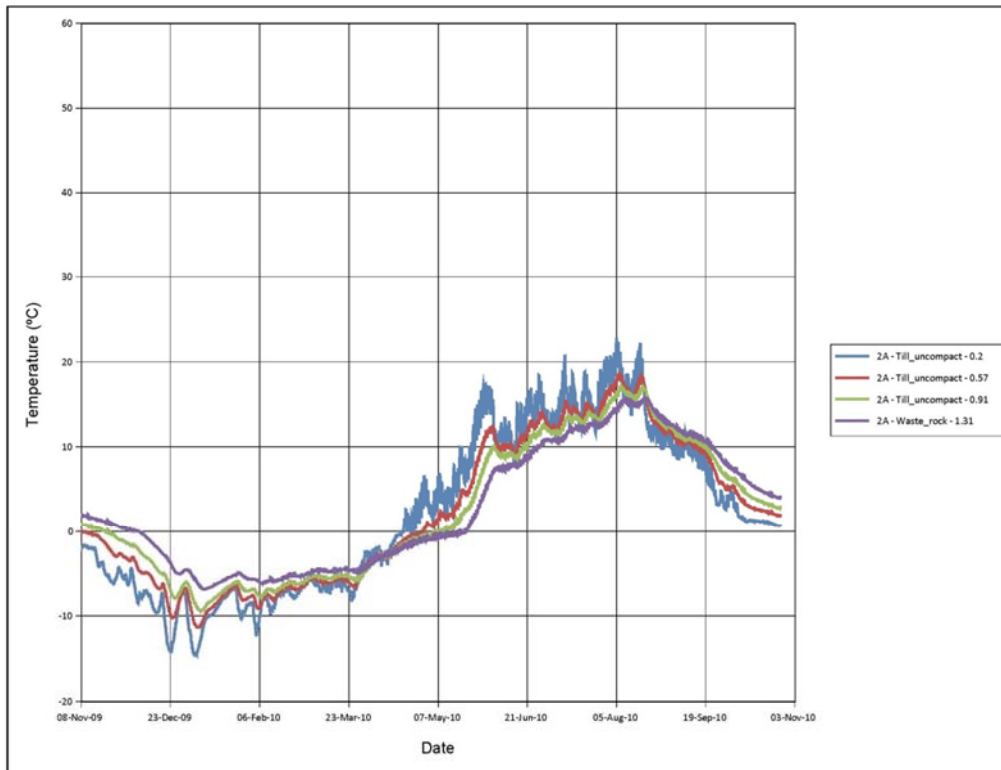


Figure 33: Soil temperature measurements (taken every six hours) in CT#2A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #1 (Array 168).

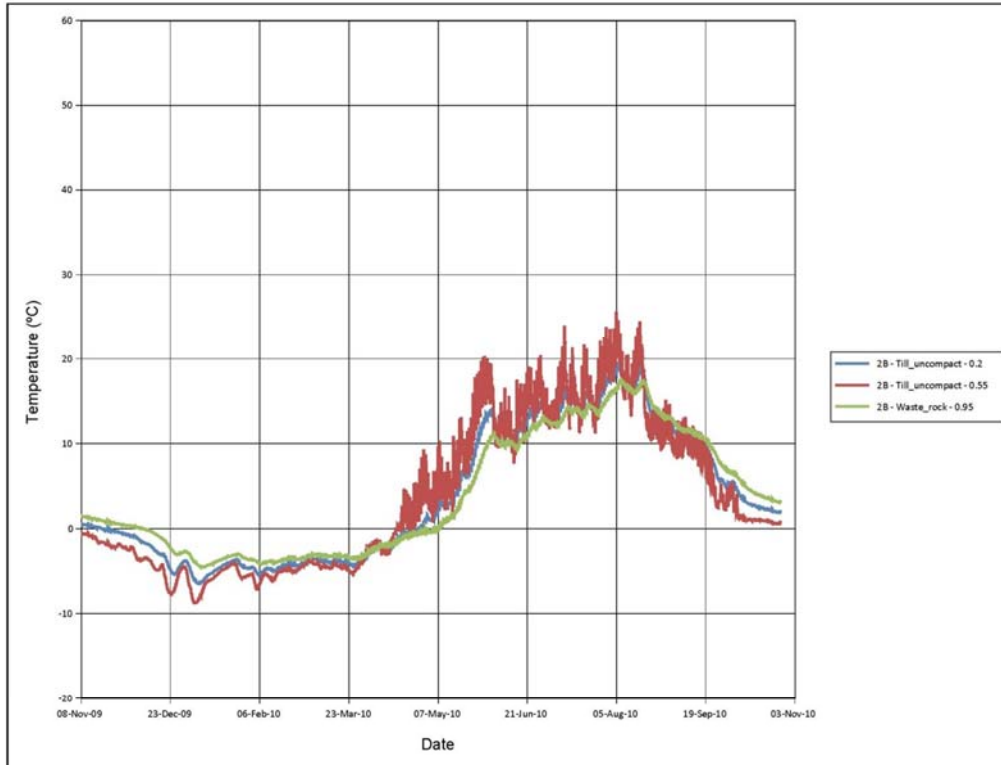


Figure 34: Soil temperature measurements (taken every six hours) in CT#2B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #1 (Array 168).

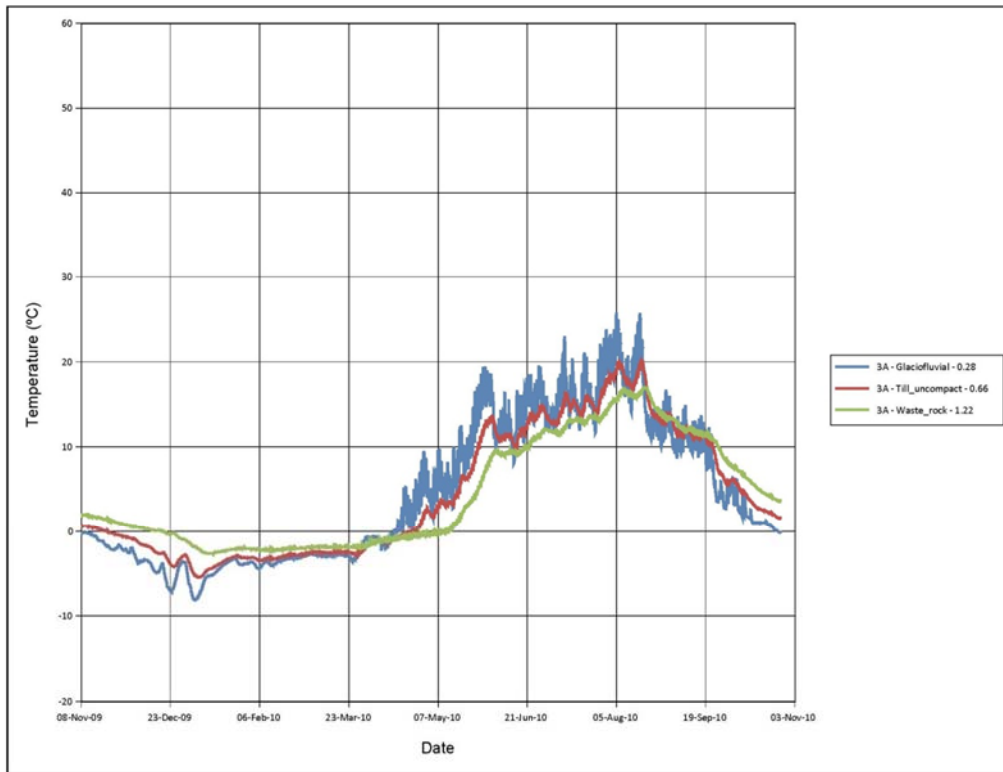


Figure 35: Soil temperature measurements (taken every six hours) in CT#3A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

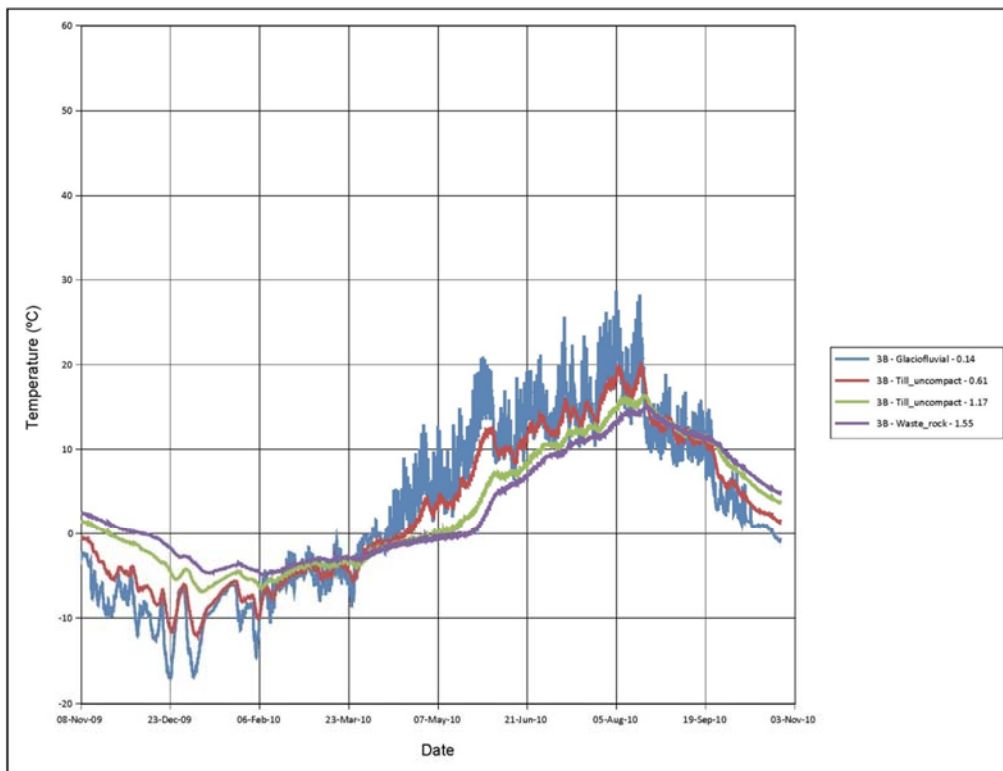


Figure 36: Soil temperature measurements (taken every six hours) in CT#3B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

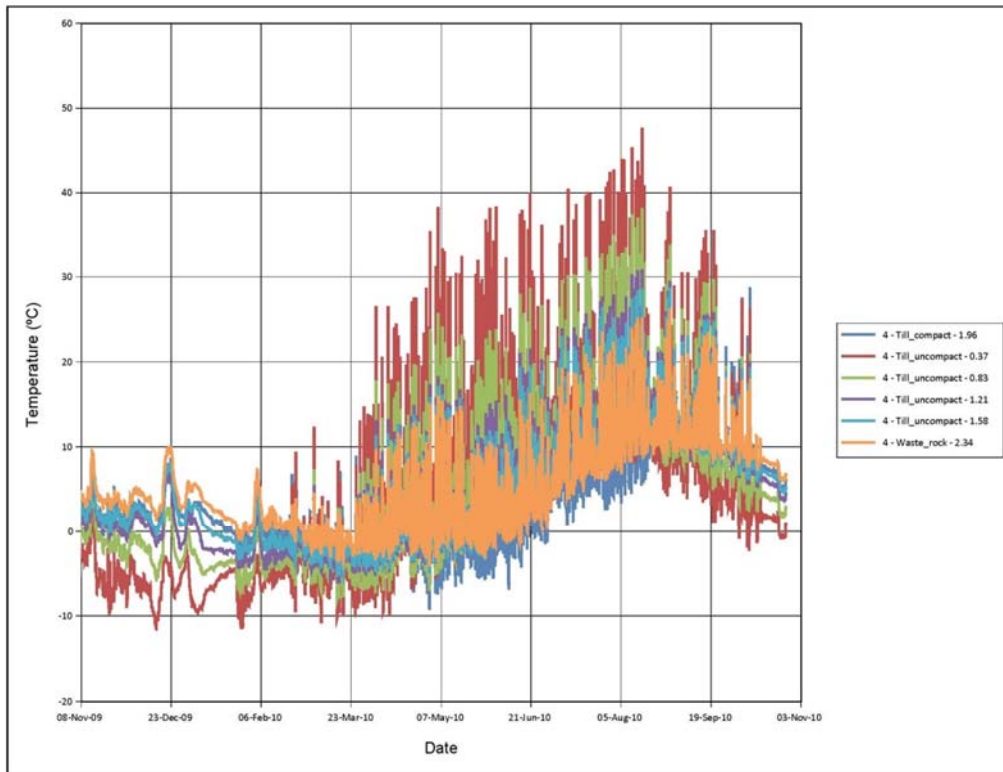


Figure 37: Soil temperature measurements (taken every six hours) in CT#4 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

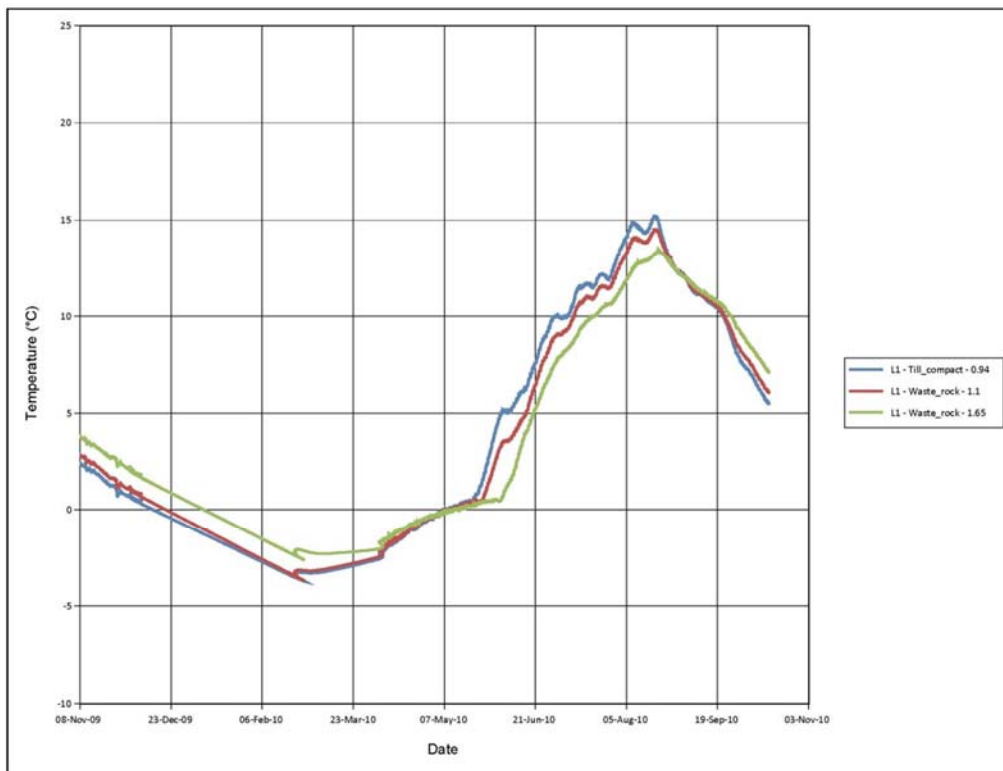


Figure 38: Soil temperature measurements (taken every six hours) in L#1 recorded by CS229 sensors connected to Campbell Scientific data logger CR1000.

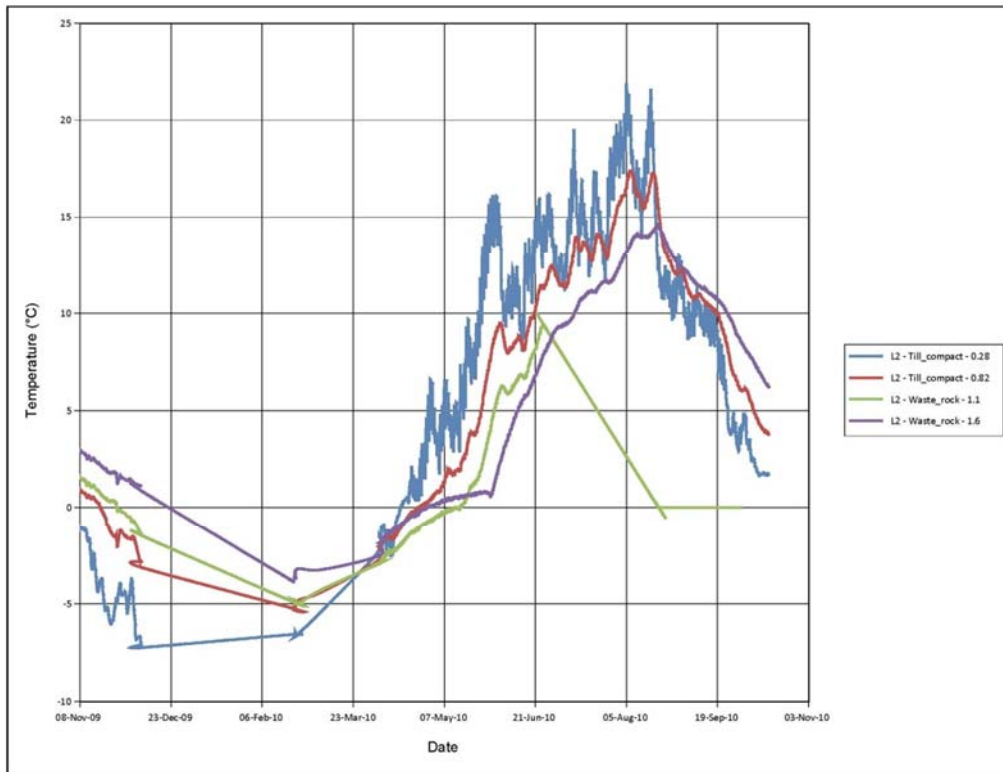


Figure 39: Soil temperature measurements (taken every six hours) in L#2 recorded by CS229 sensors connected to Campbell Scientific data logger CR1000.

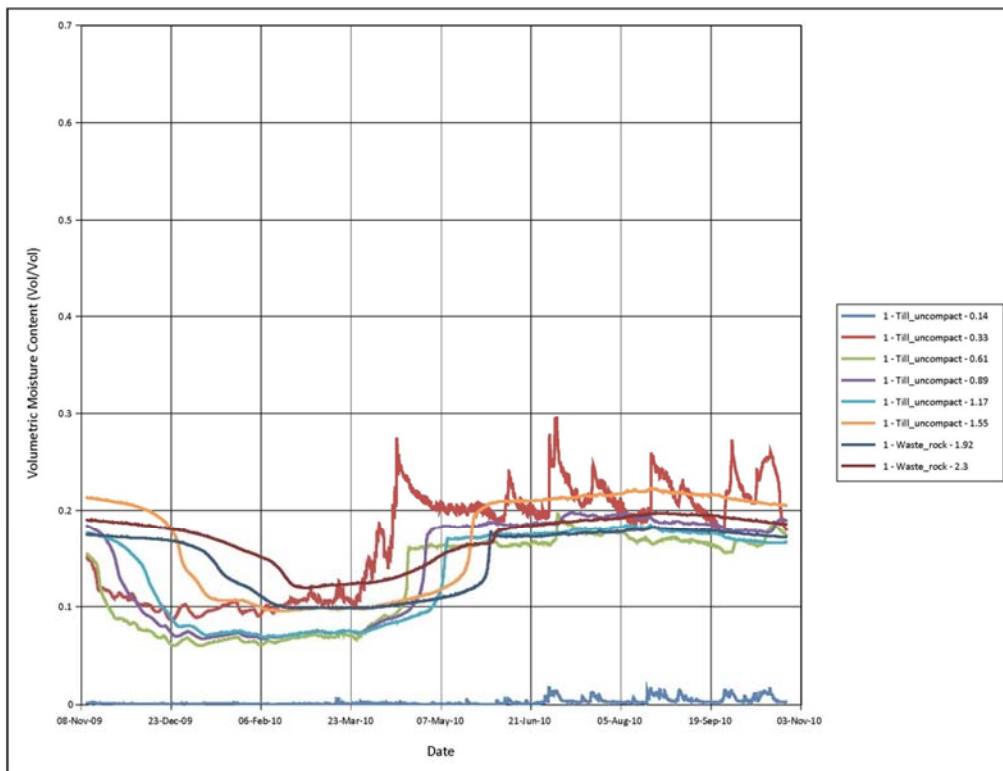


Figure 40: Volumetric moisture content measurements (taken every six hours) in CT#1 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

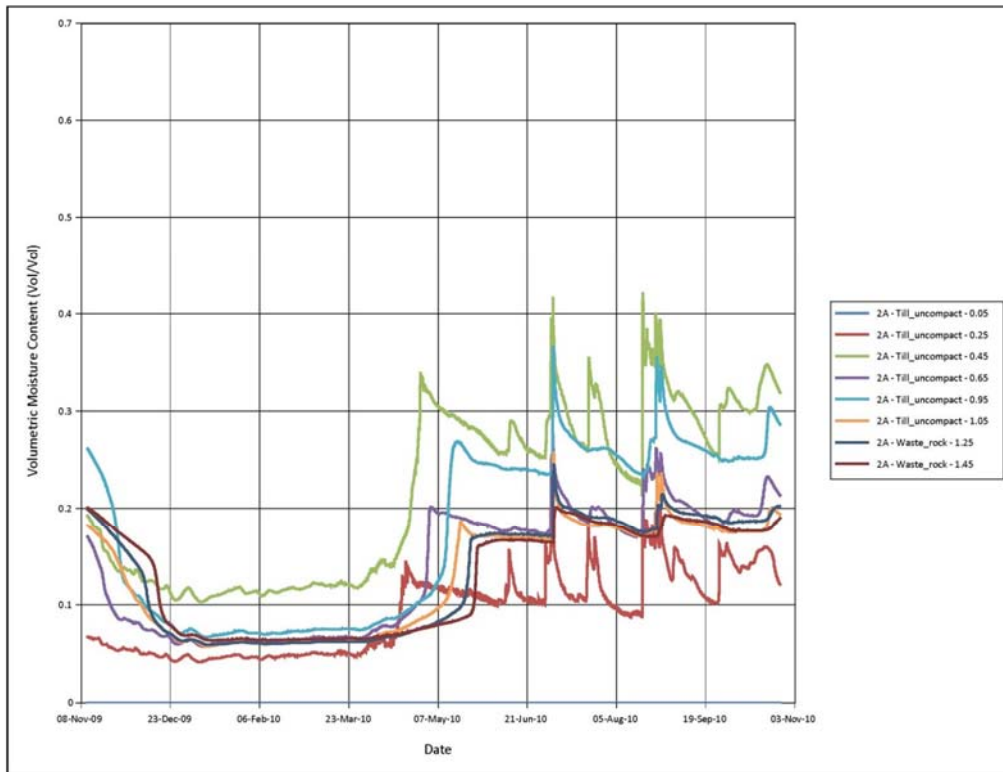


Figure 41: Volumetric moisture content measurements (taken every six hours) in CT#2A recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #1 (Array 130).

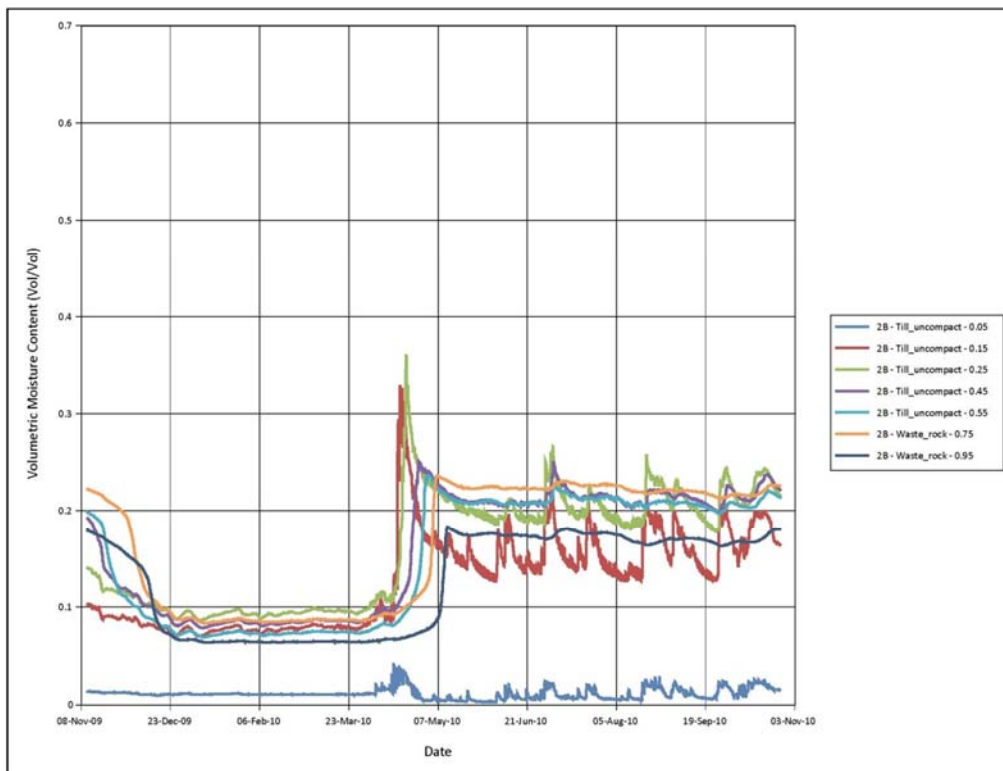


Figure 42: Volumetric moisture content measurements (taken every six hours) in CT#2B recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #1 (Array 130).

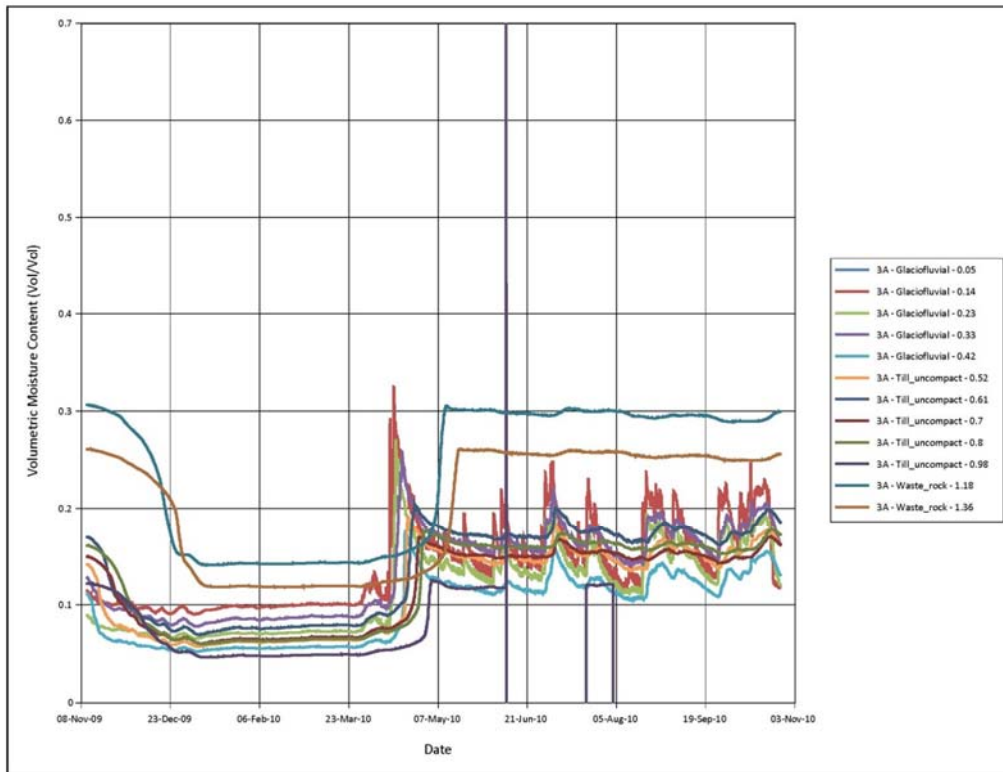


Figure 43: Volumetric moisture content measurements (taken every six hours) in CT#3A recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

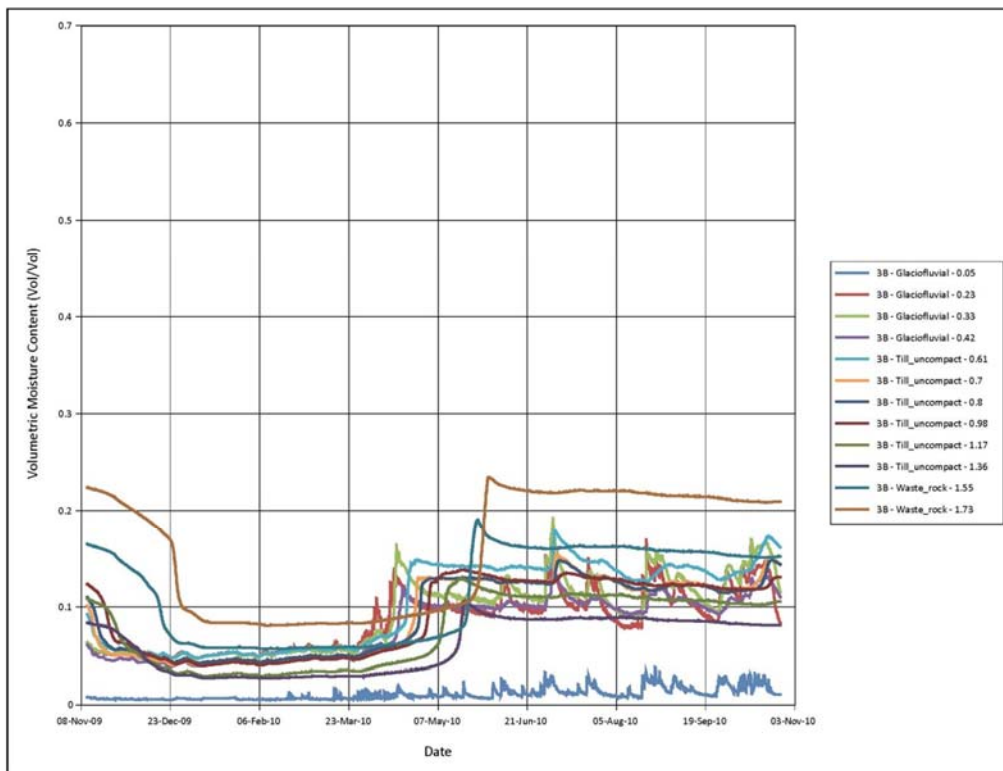


Figure 44: Volumetric moisture content measurements (taken every six hours) in CT#3B recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

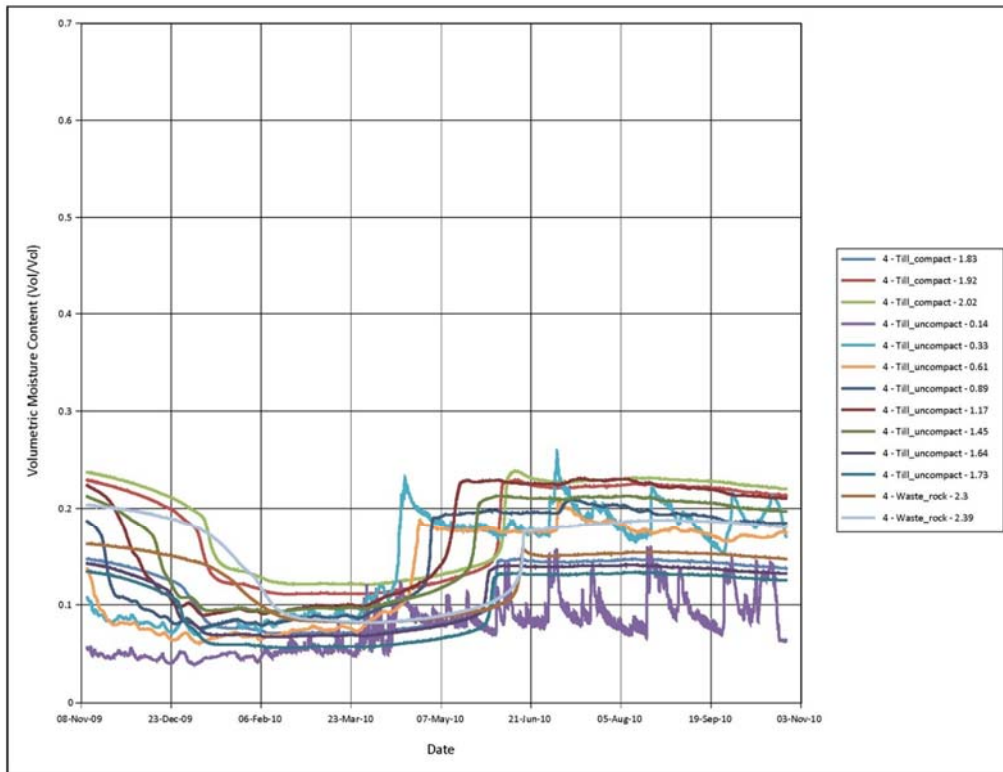


Figure 45: Volumetric moisture content measurements (taken every six hours) in CT#4 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

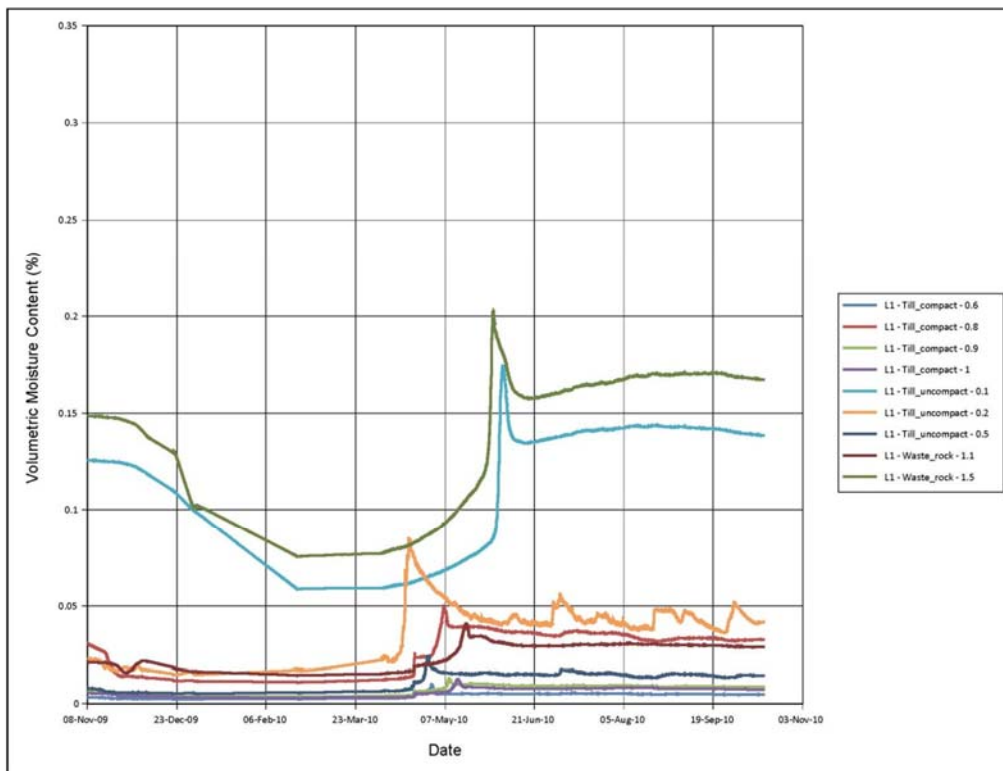


Figure 46: Volumetric moisture content measurements (taken every six hours) in L#1 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR1000.

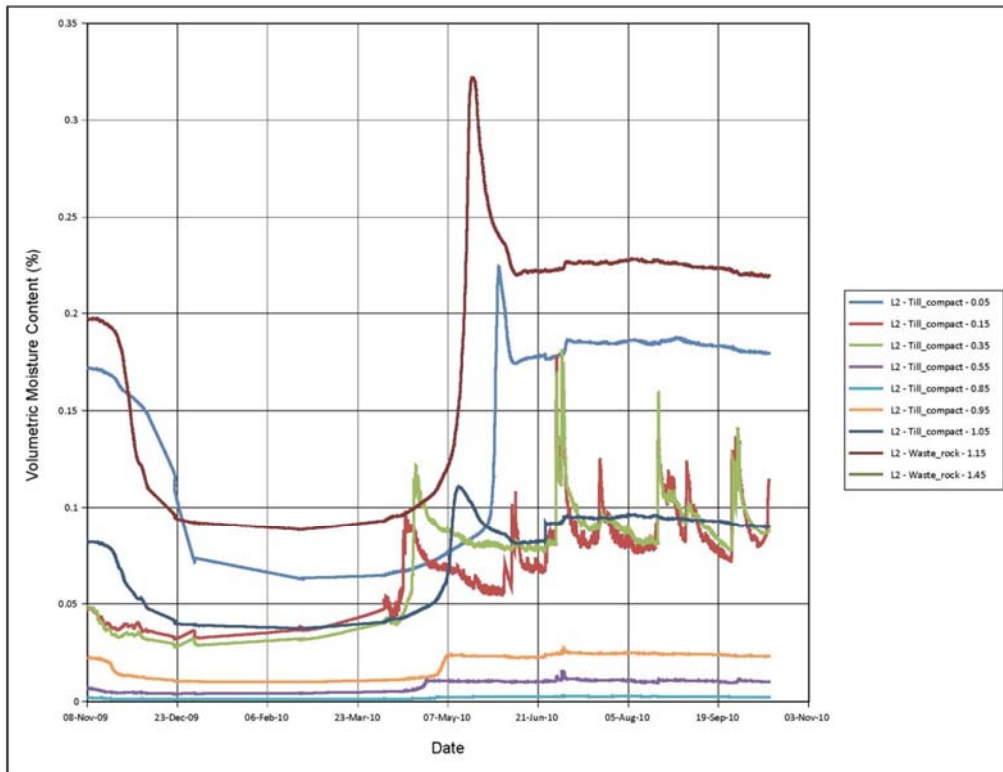


Figure 47: Volumetric moisture content measurements (taken every six hours) in L#2 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR1000.

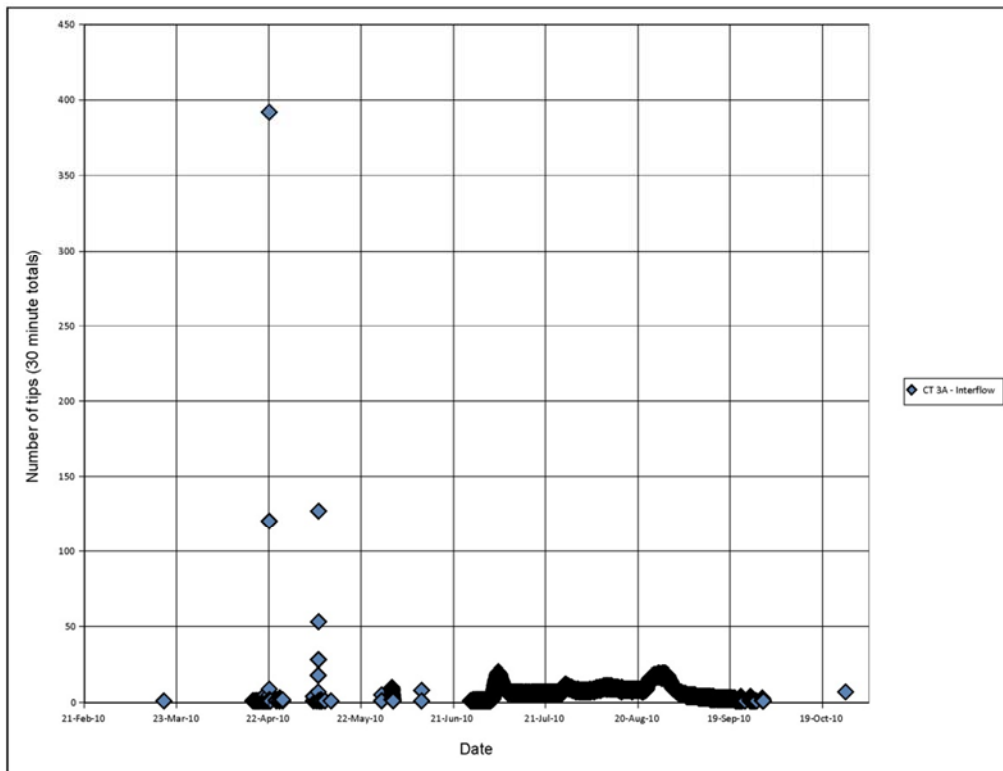


Figure 48: Interflow totals in CT#3A measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

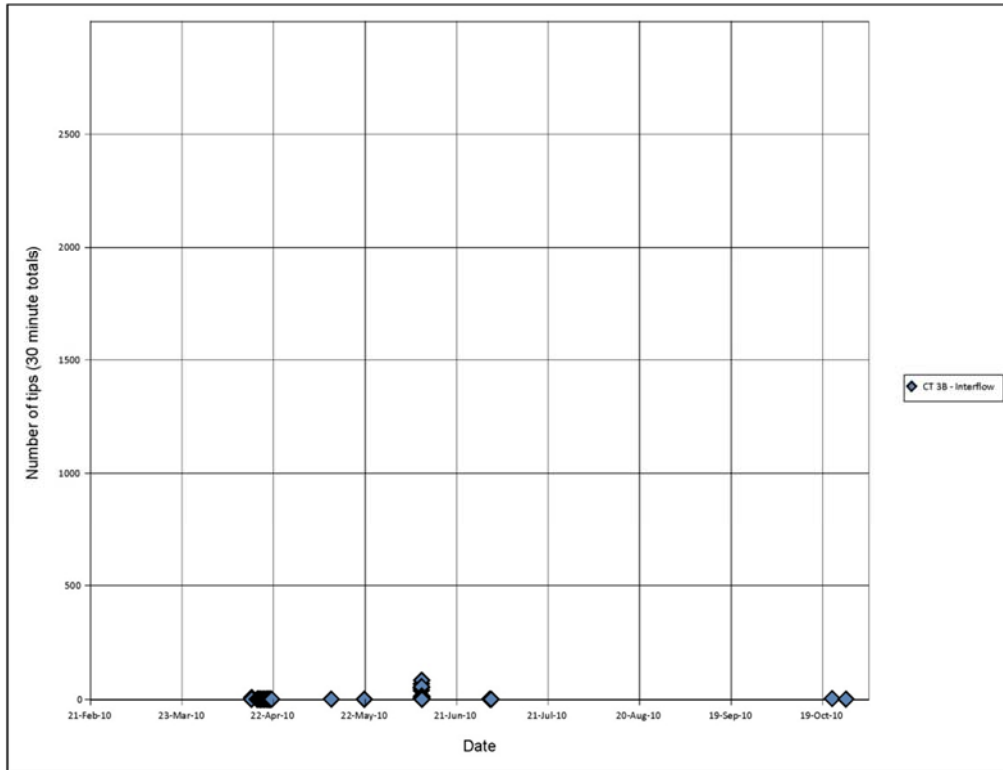


Figure 49: Interflow totals in CT#3B measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

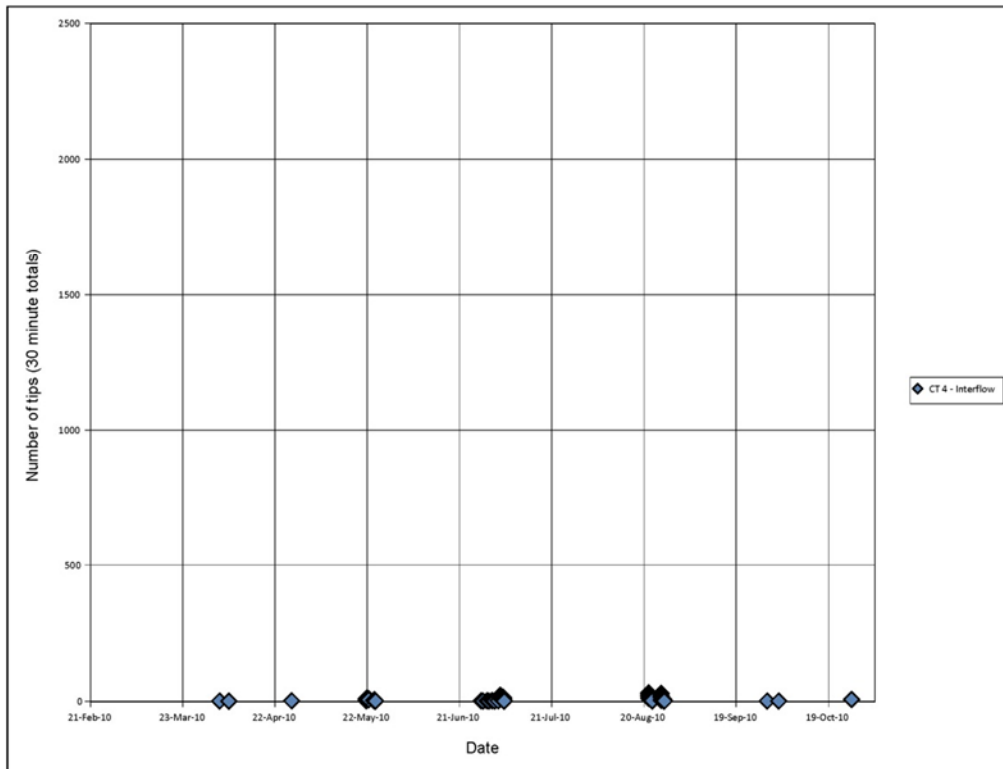


Figure 50: Interflow totals in CT#4 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

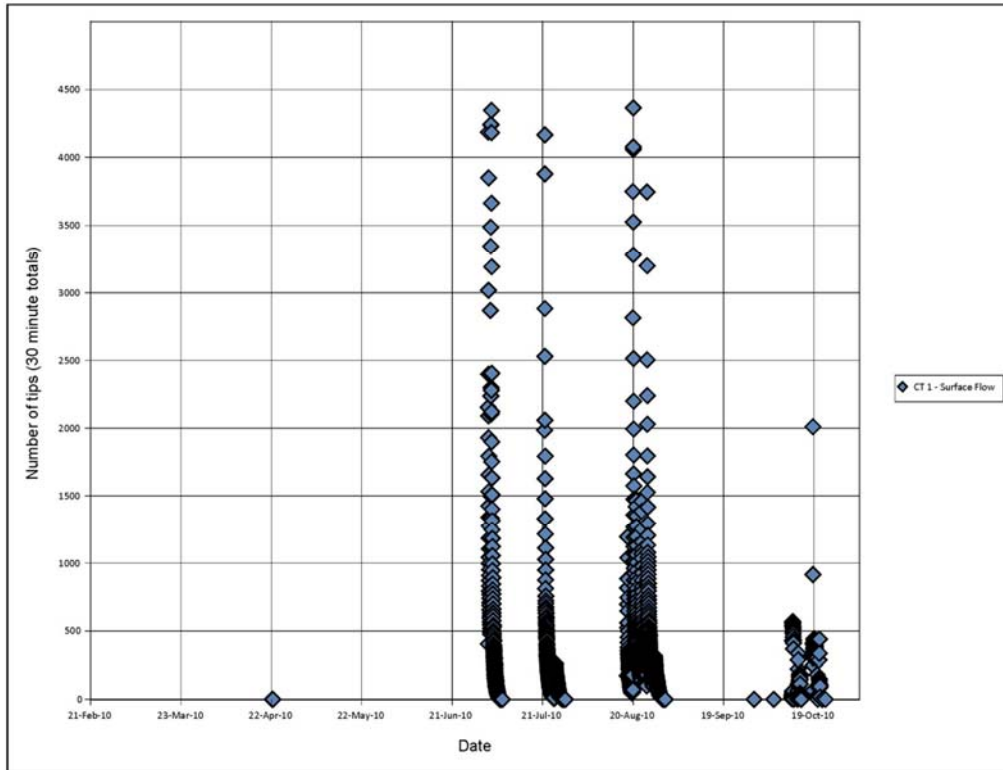


Figure 51: Surface flow totals in CT#1 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

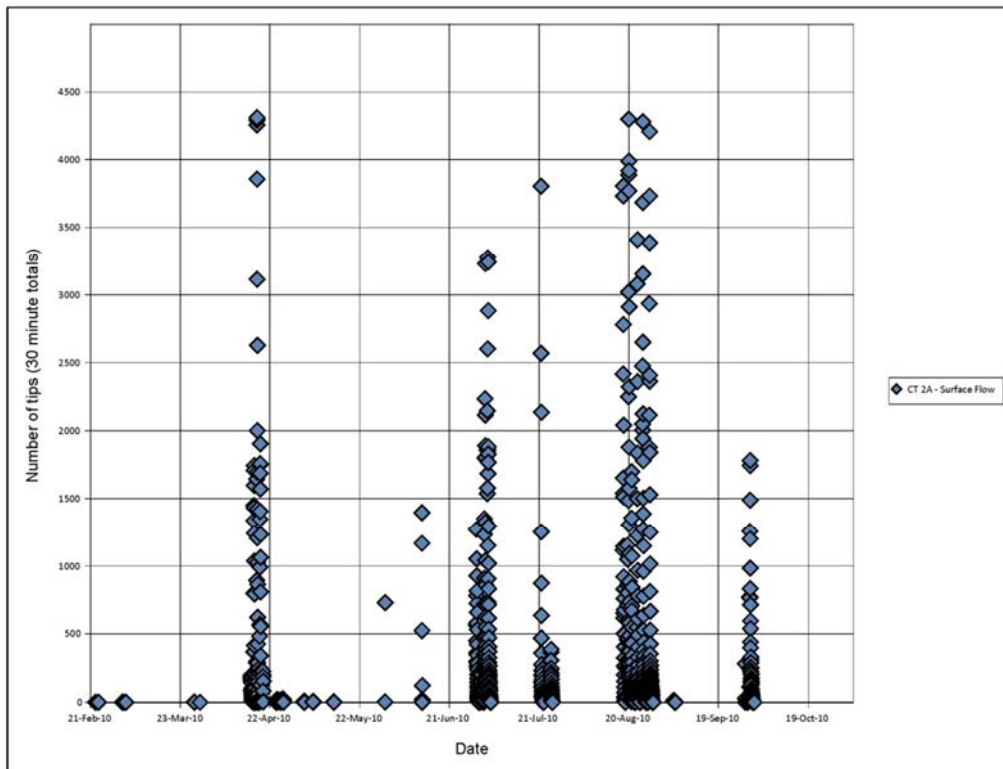


Figure 52: Surface flow totals in CT#2A measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

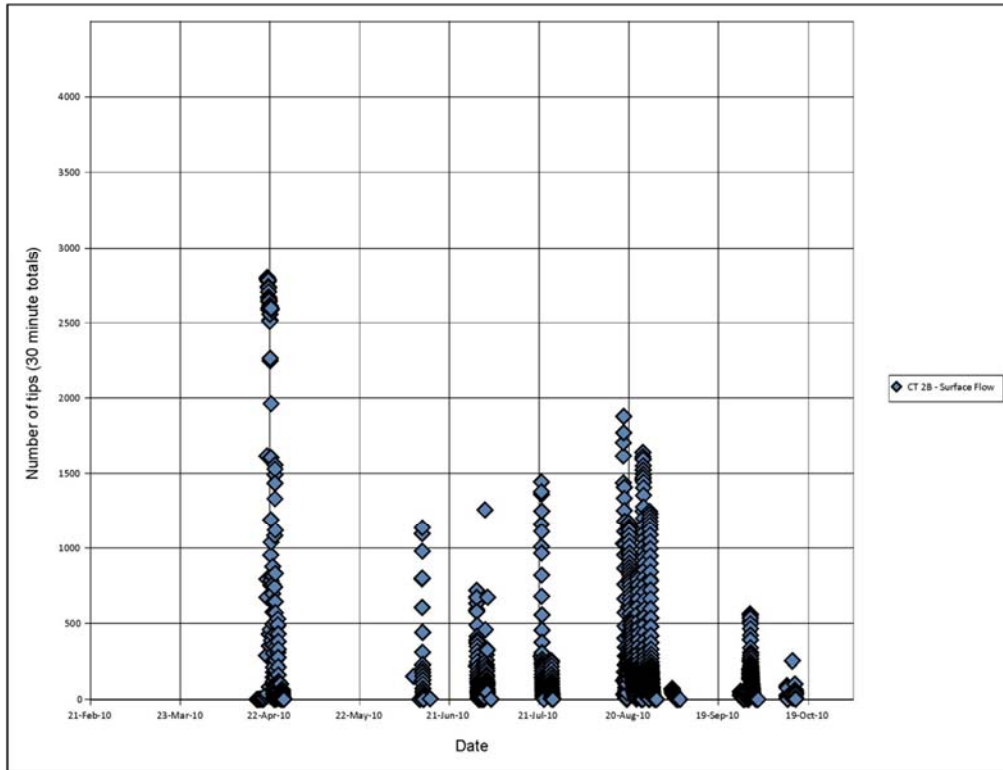


Figure 53: Surface flow totals in CT#2B measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

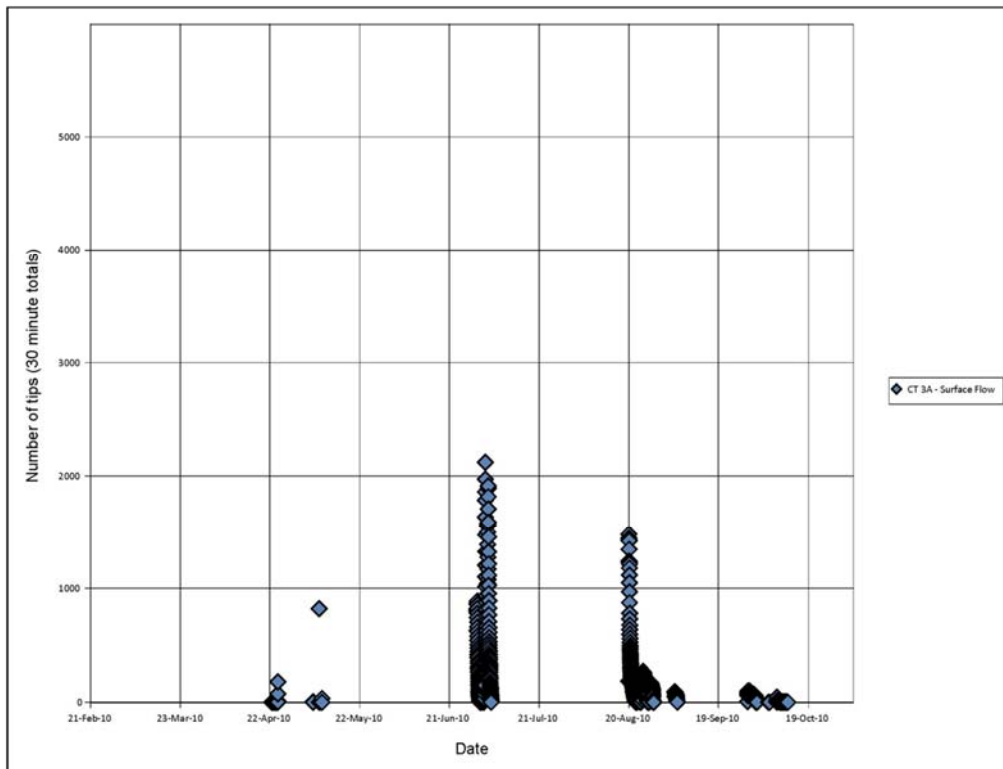


Figure 54: Surface flow totals in CT#3A measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

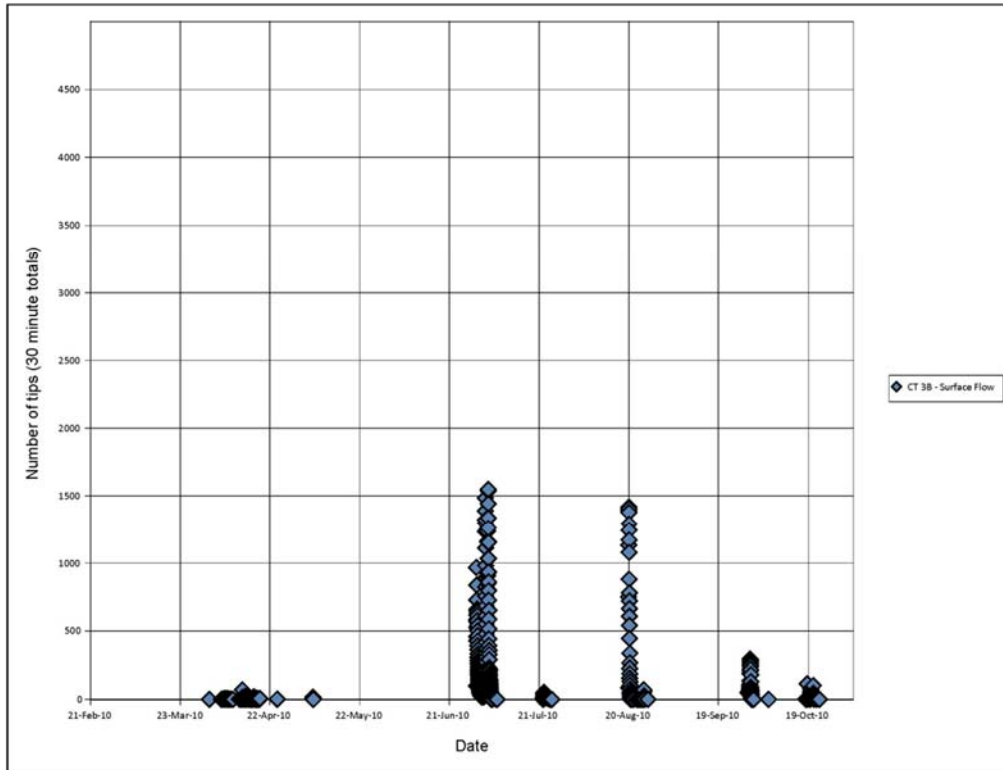


Figure 55: Surface flow totals in CT#3B measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

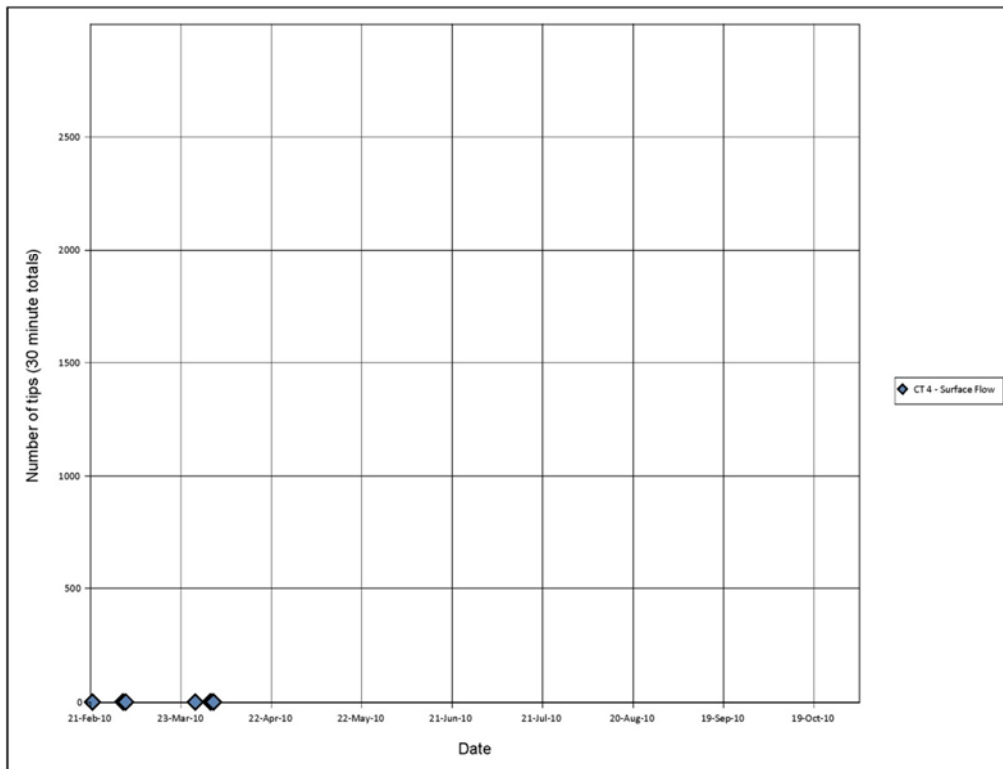


Figure 56: Surface flow totals in CT#4 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

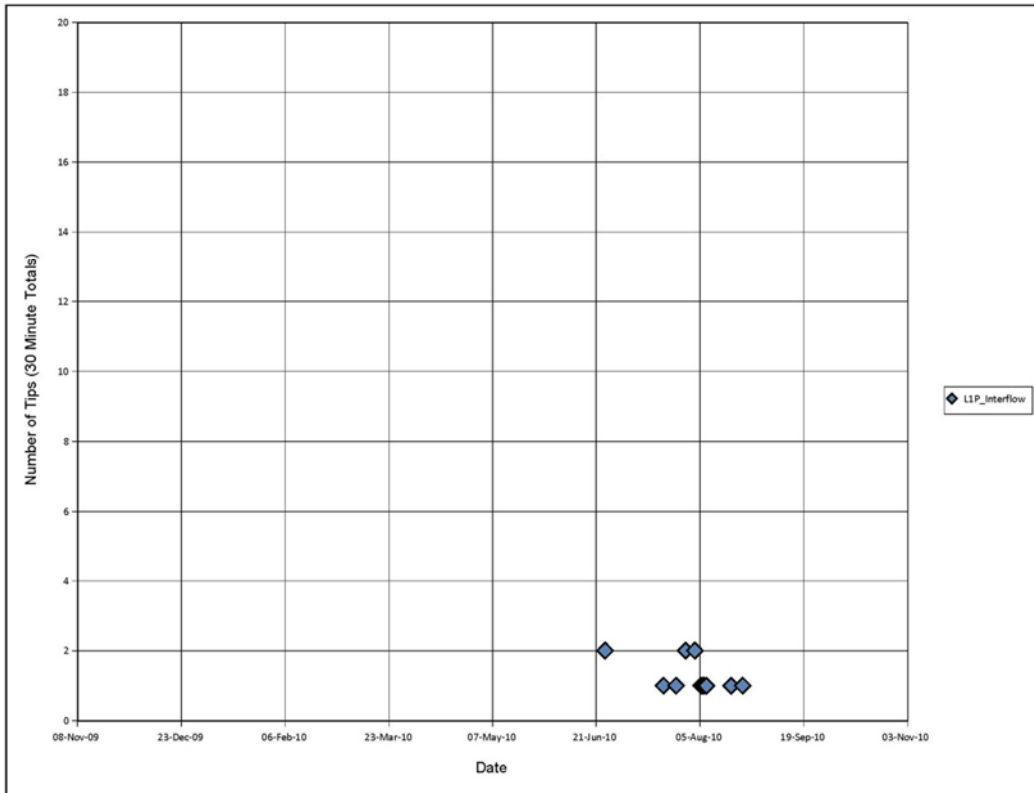


Figure 57: Peripheral interflow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

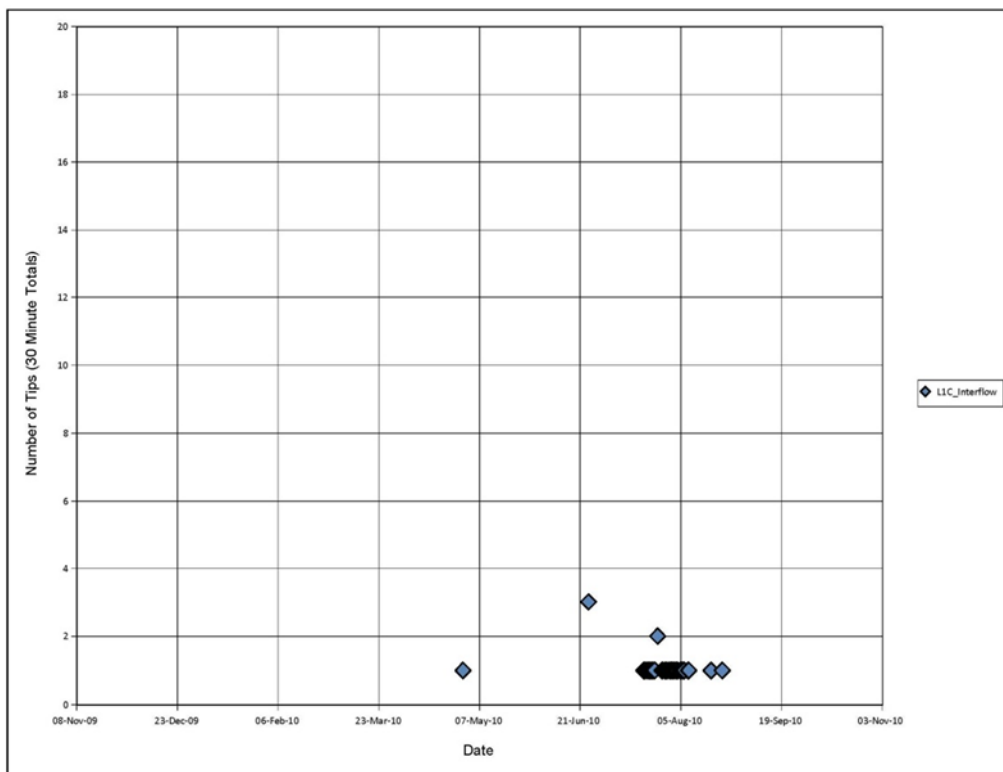


Figure 58: Central interflow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

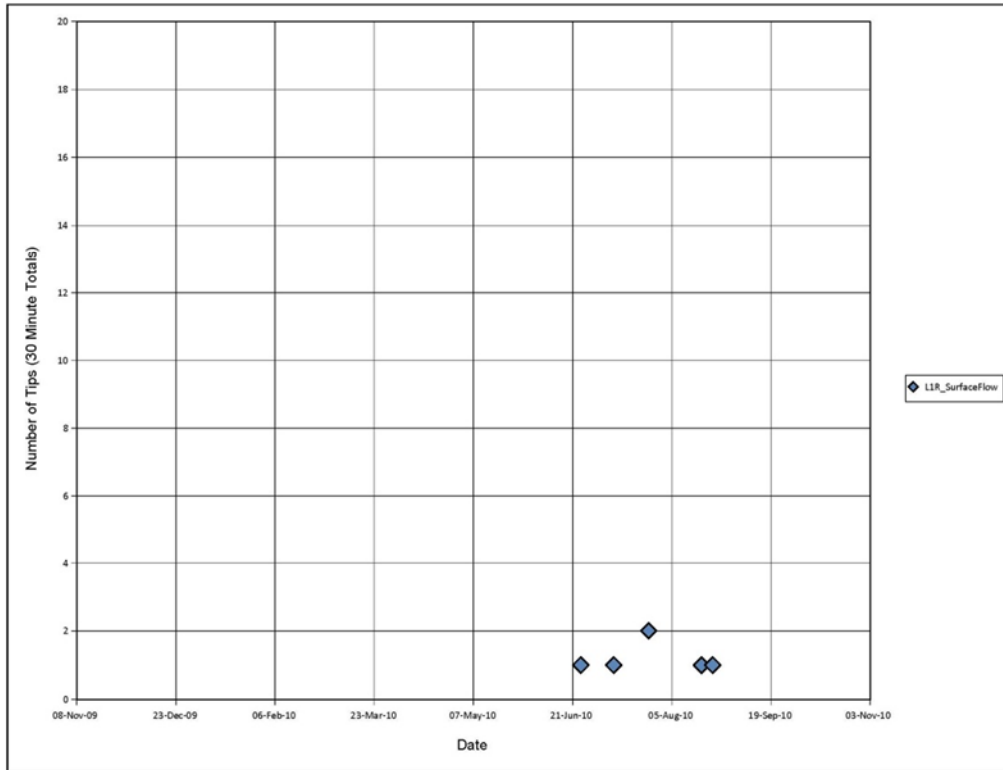


Figure 59: Surface flow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

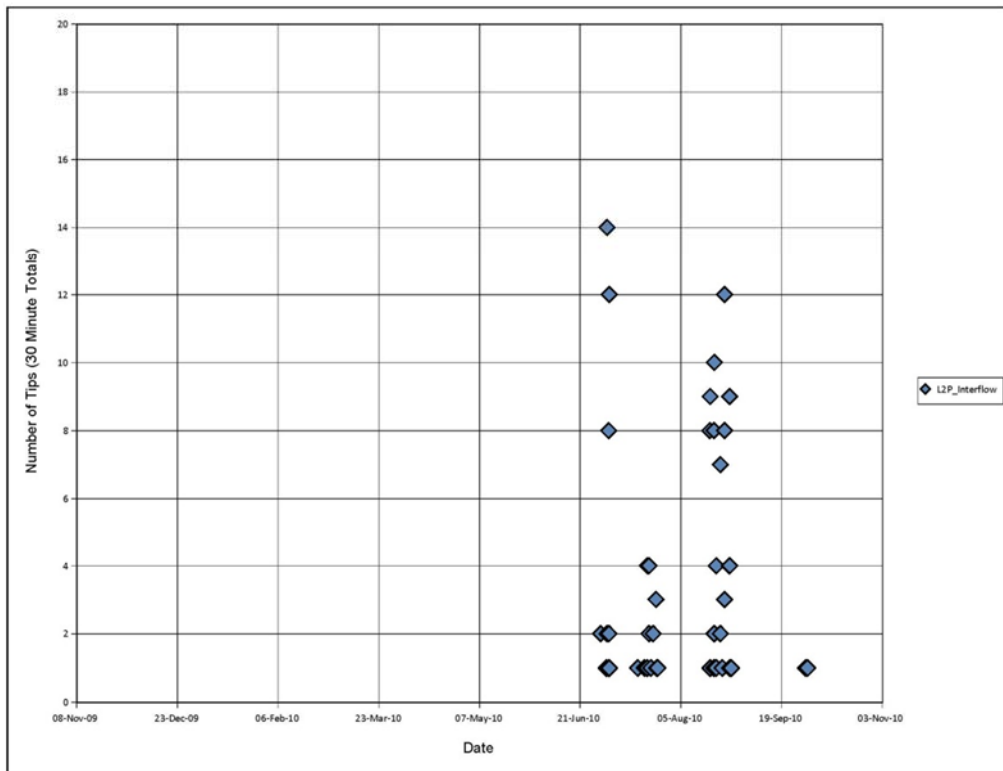


Figure 60: Peripheral interflow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

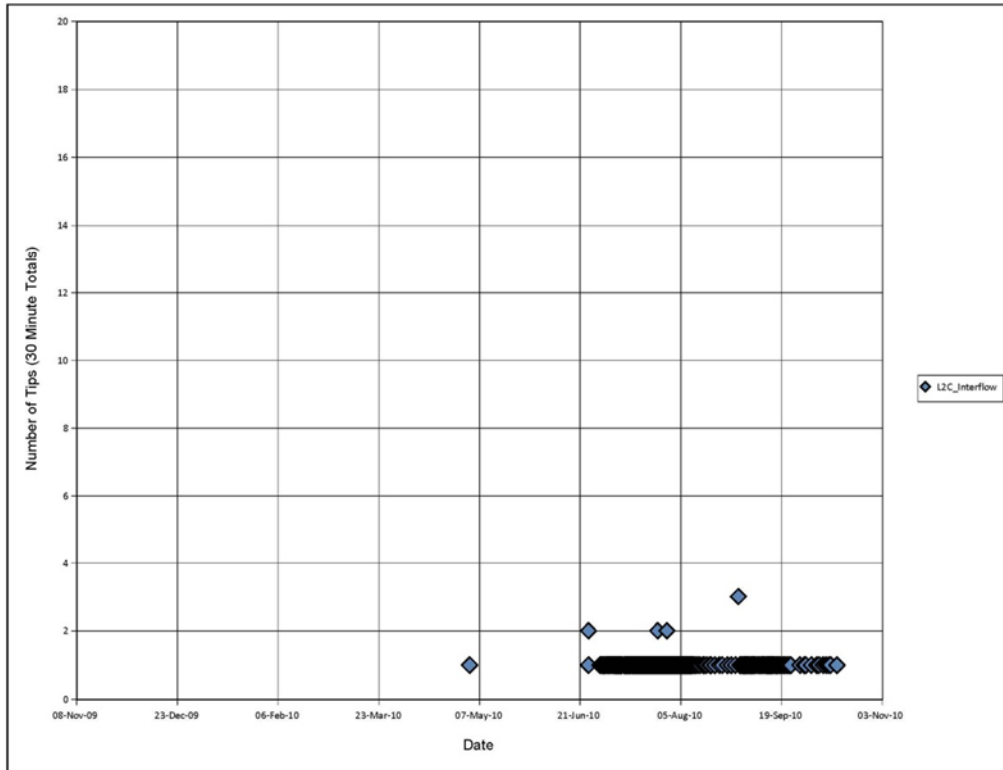


Figure 61: Central interflow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

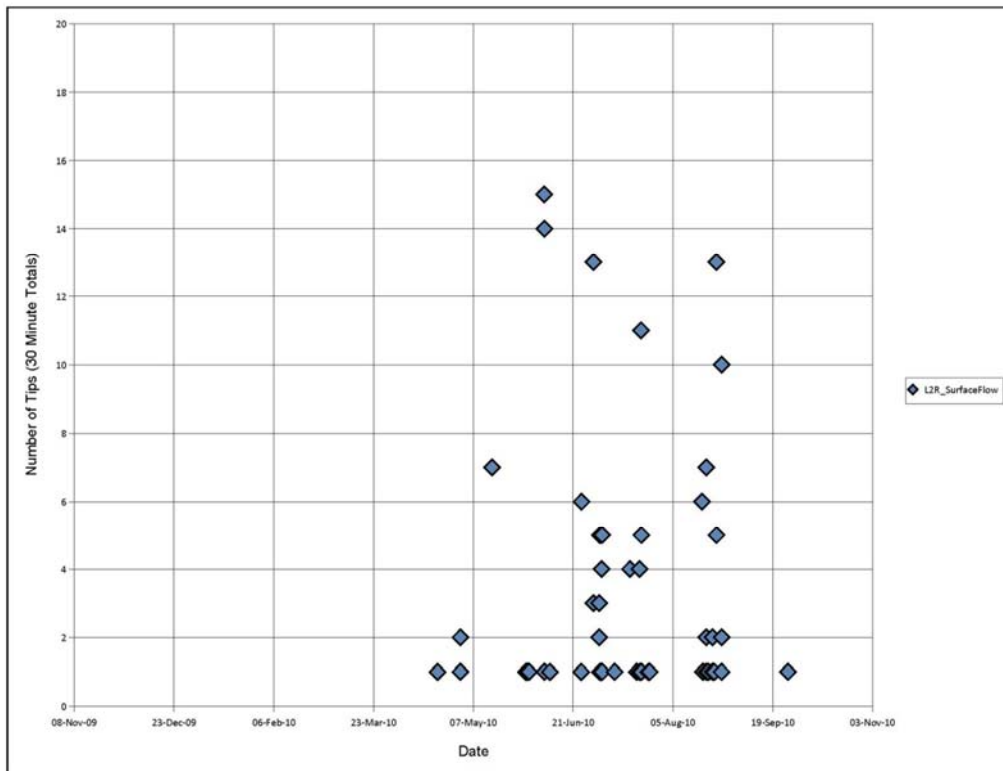


Figure 62: Surface flow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.



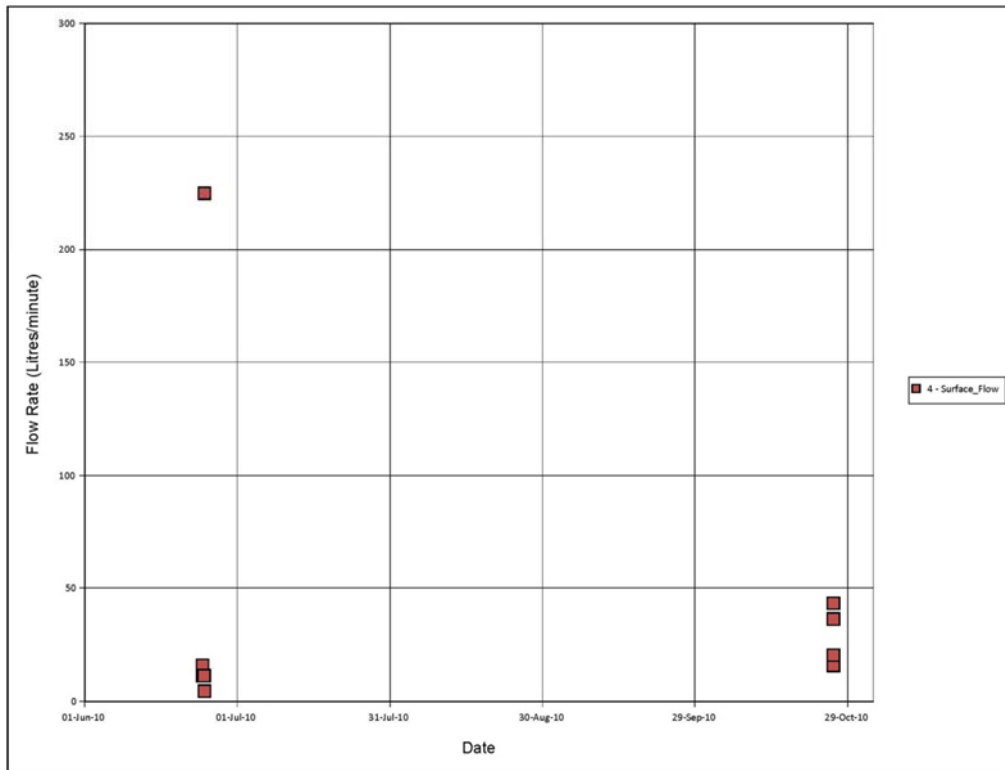


Figure 65: Surface runoff (measured every minute) on CT#4 by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 0506058).

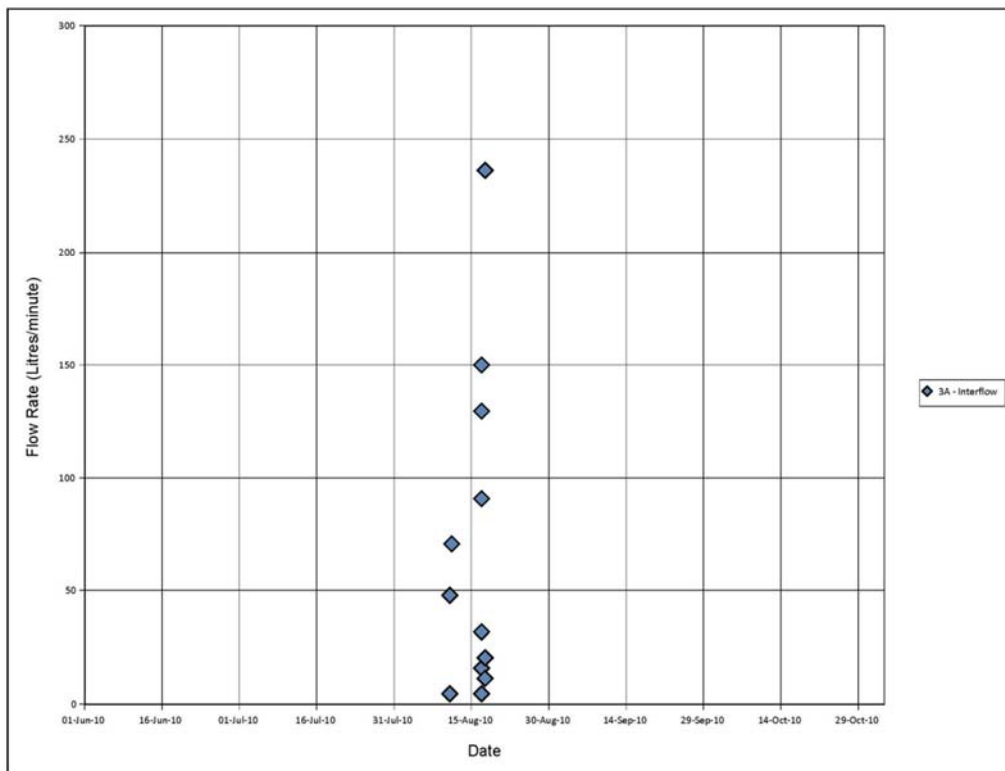


Figure 66: Interflow (measured every minute) on CT#3A by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 02051709).

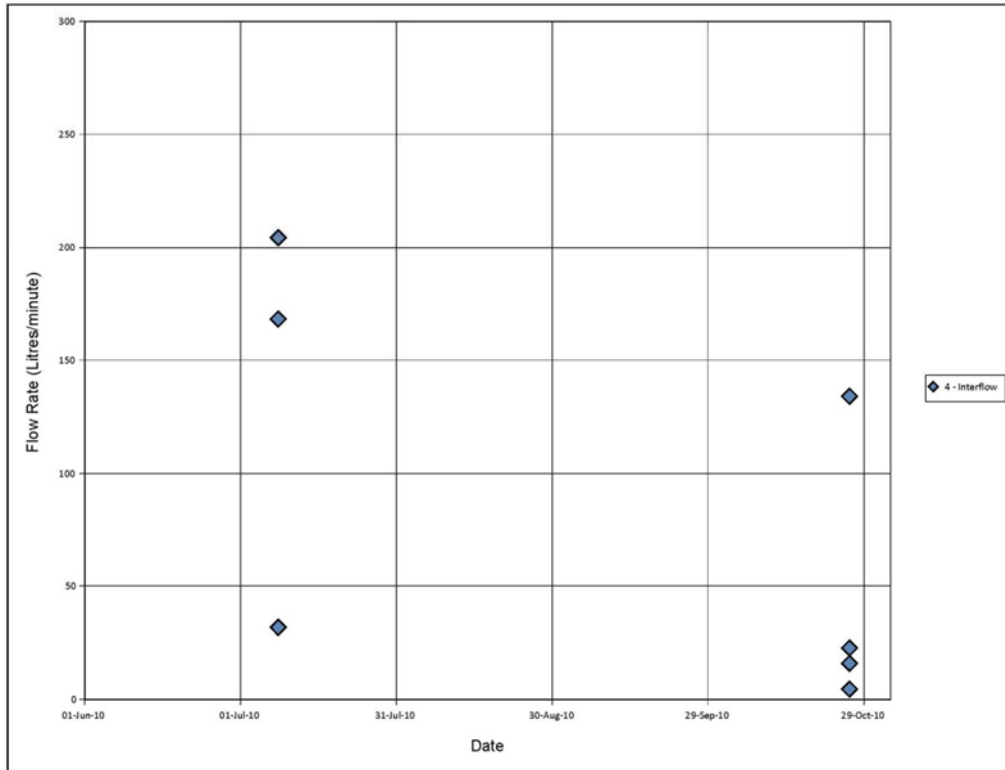


Figure 67: Interflow (measured every minute) on CT#4 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 0506054).

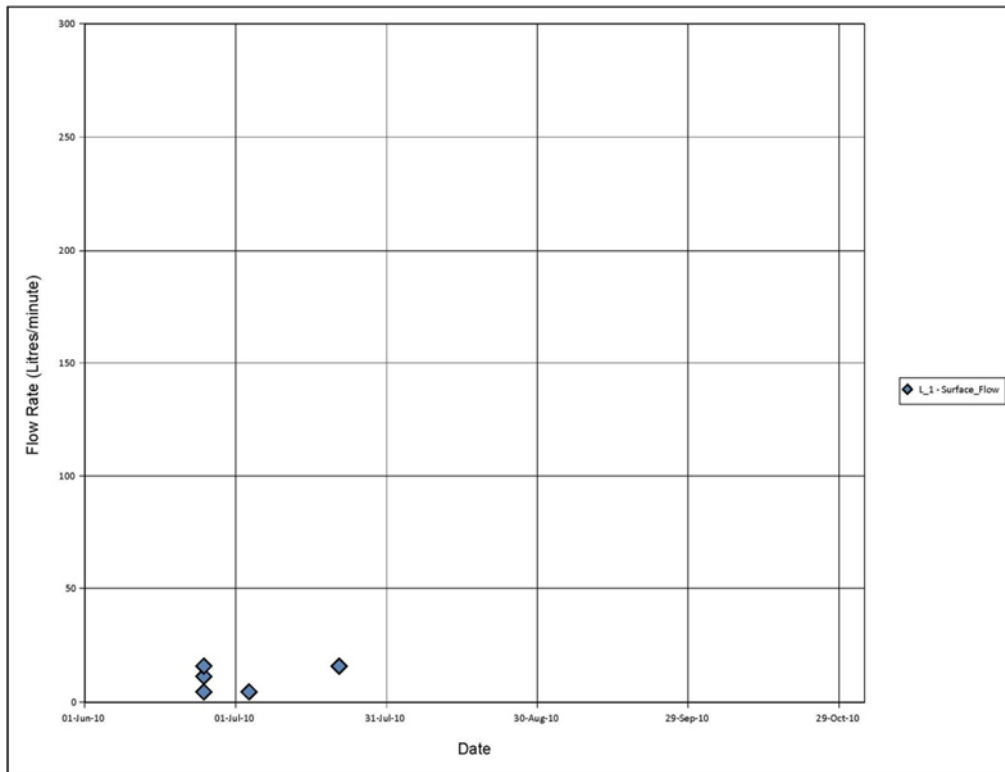


Figure 68 Surface runoff (measured every minute) on L#1 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 72649).



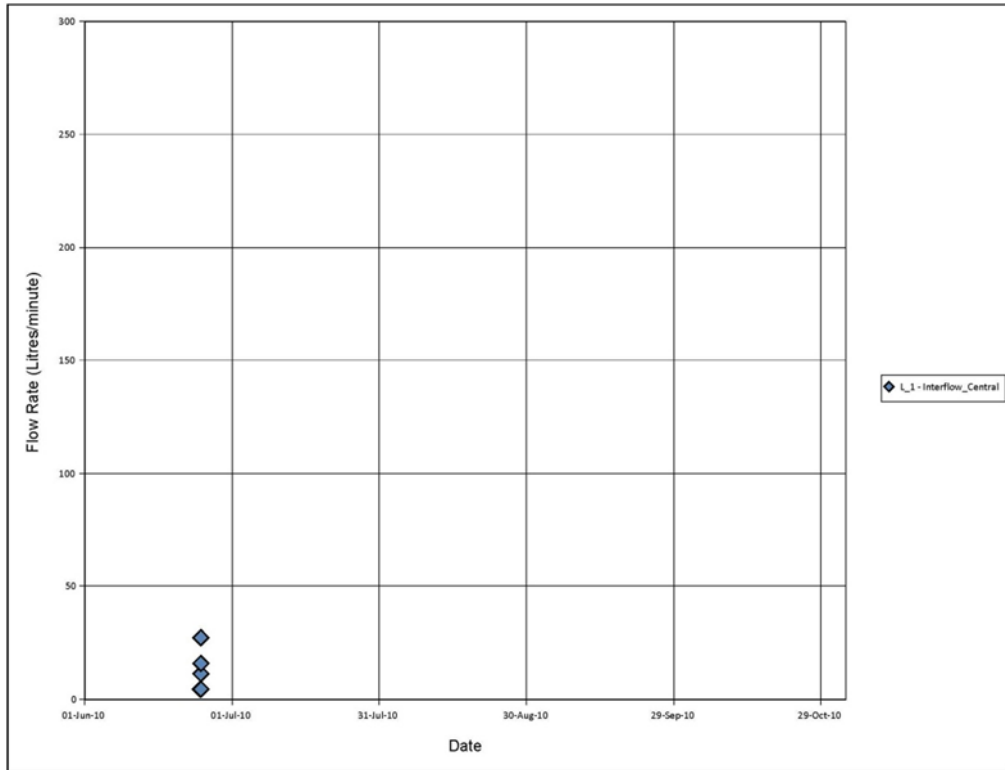


Figure 71: Central Interflow (measured every minute) on L#1 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 72648).

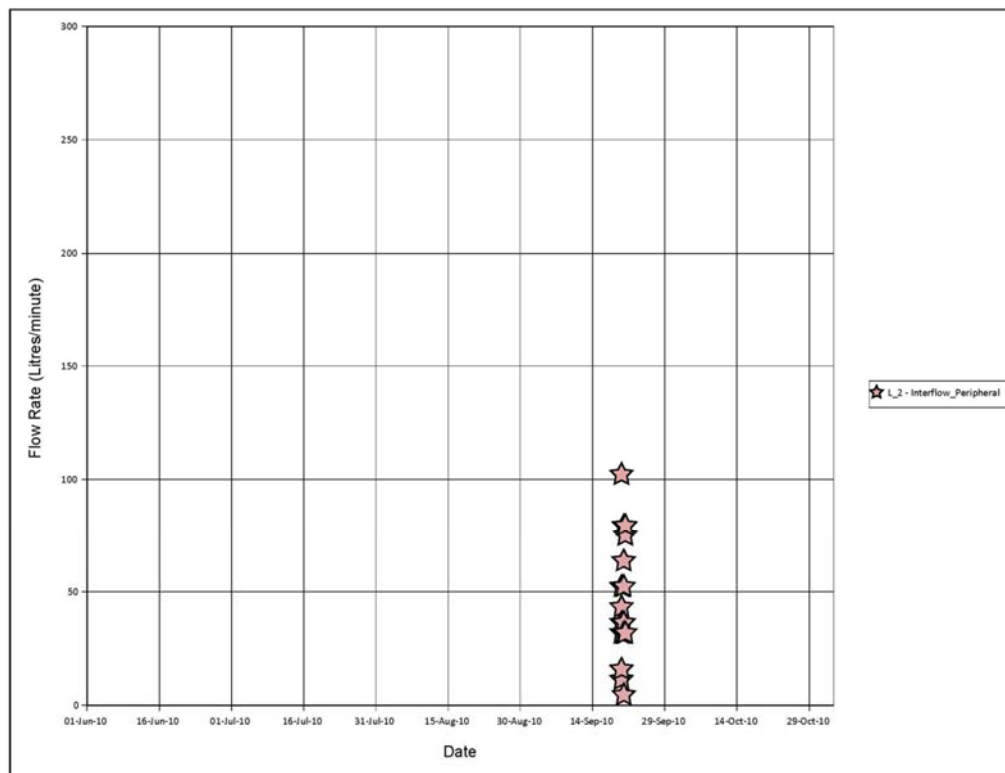


Figure 72: Peripheral Interflow (measured every minute) on L#2 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 72647).

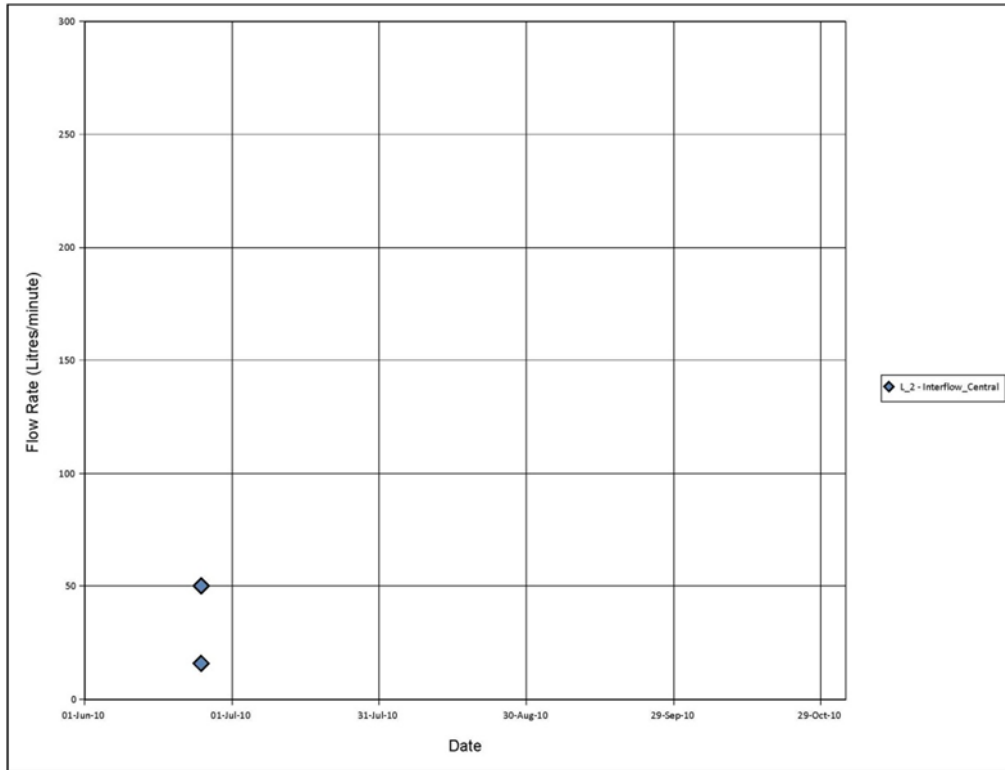


Figure 73: Central Interflow (measured every minute) on L#2 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 72652).

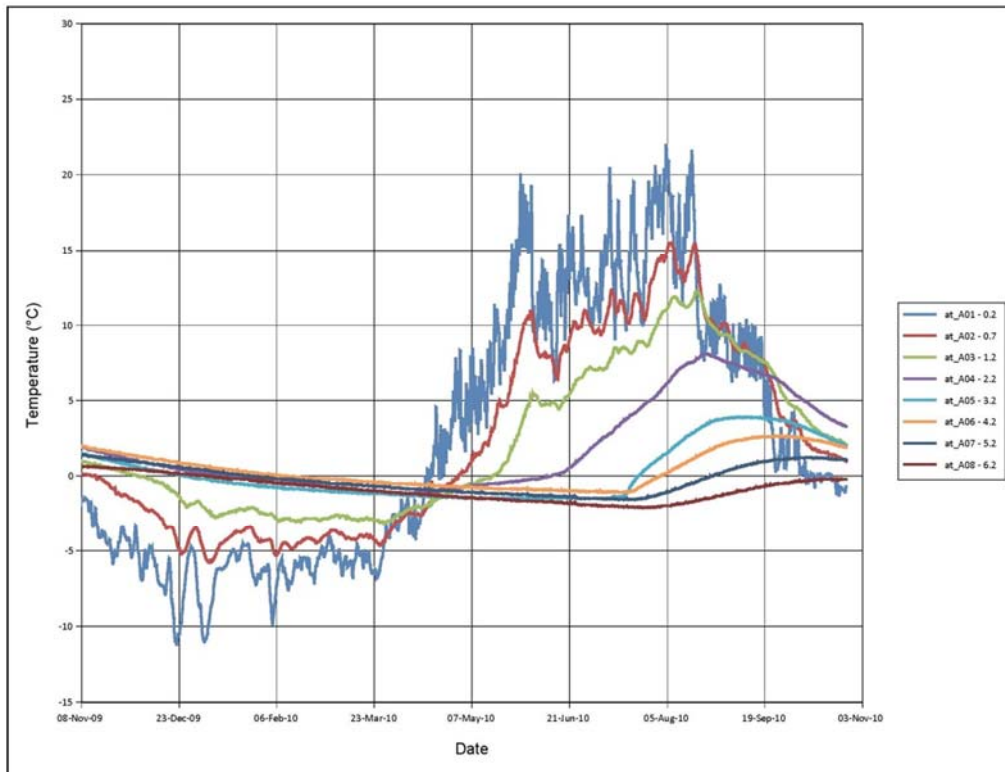


Figure 74: Ground temperature measured in Grum overburden dump by an M-squared thermistor string connected to a Lakewood UL16 data logger (String A).

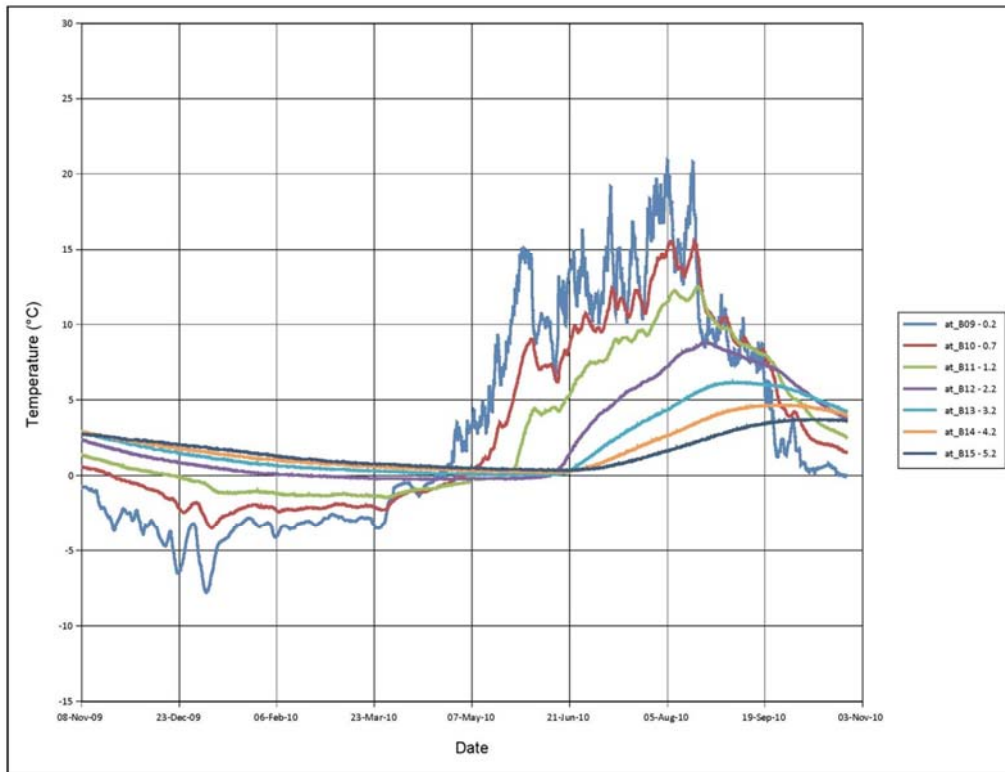


Figure 75: Ground temperature in Grum overburden dump by an M-squared thermistor string connected to a Lakewood UL16 data logger (String B).

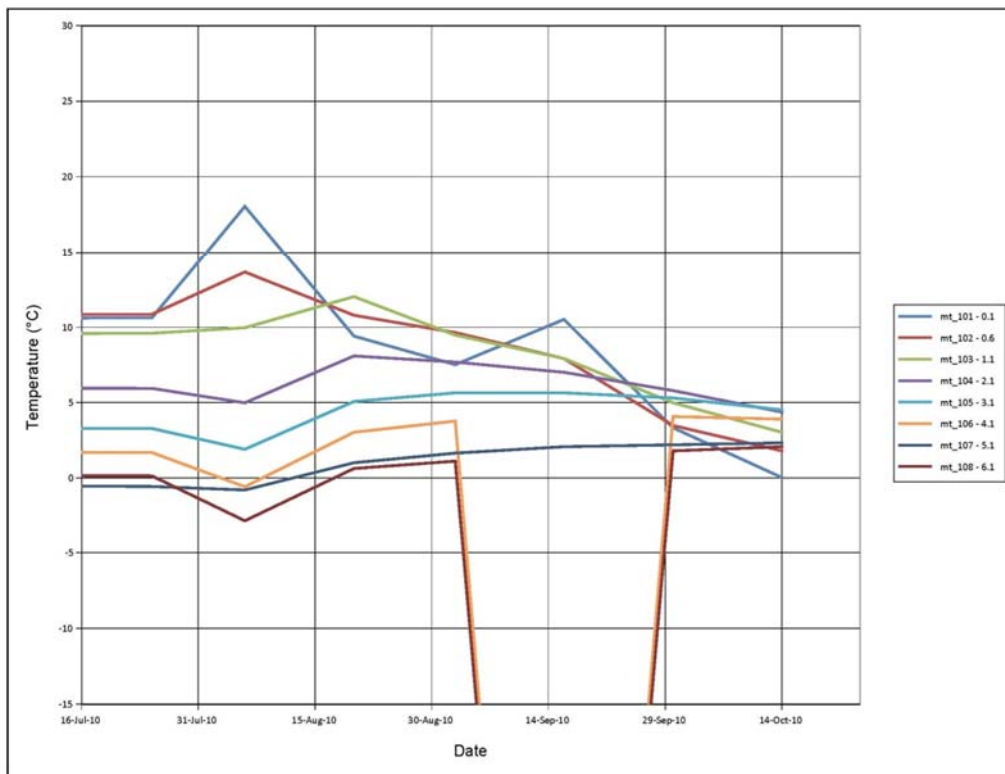


Figure 76: Monthly ground temperature measured in Grum overburden dump by an M-squared thermistor string collected manually (String 1).

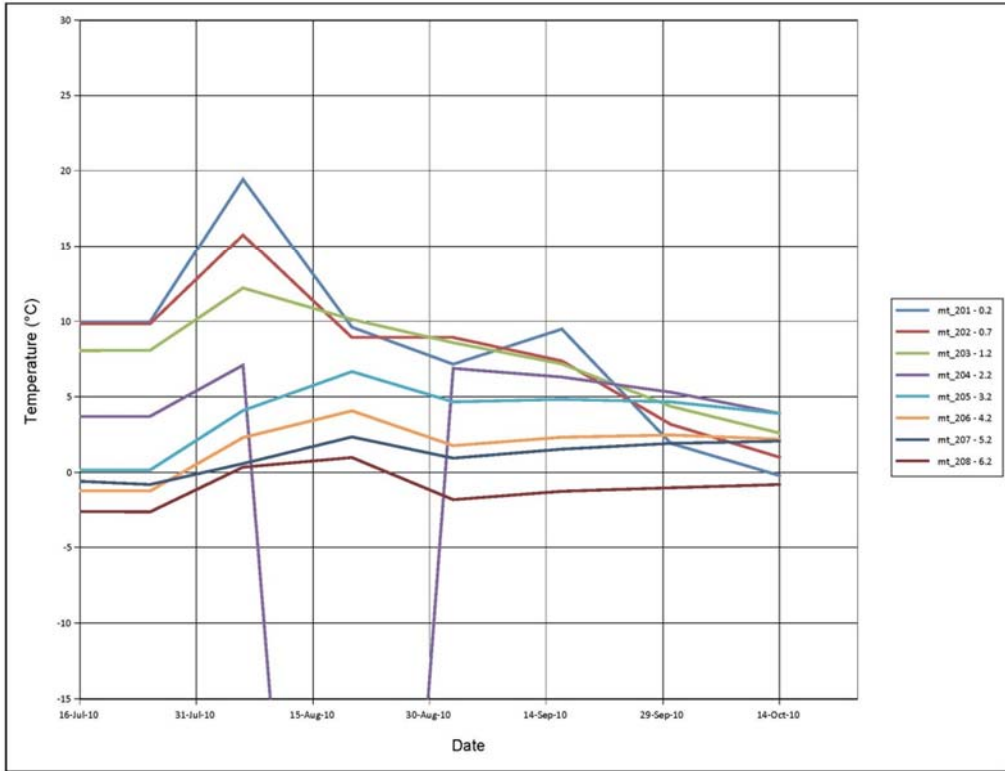


Figure 77: Monthly ground temperature measured in Grum overburden dump by an M-squared thermistor string collected manually (String 2).

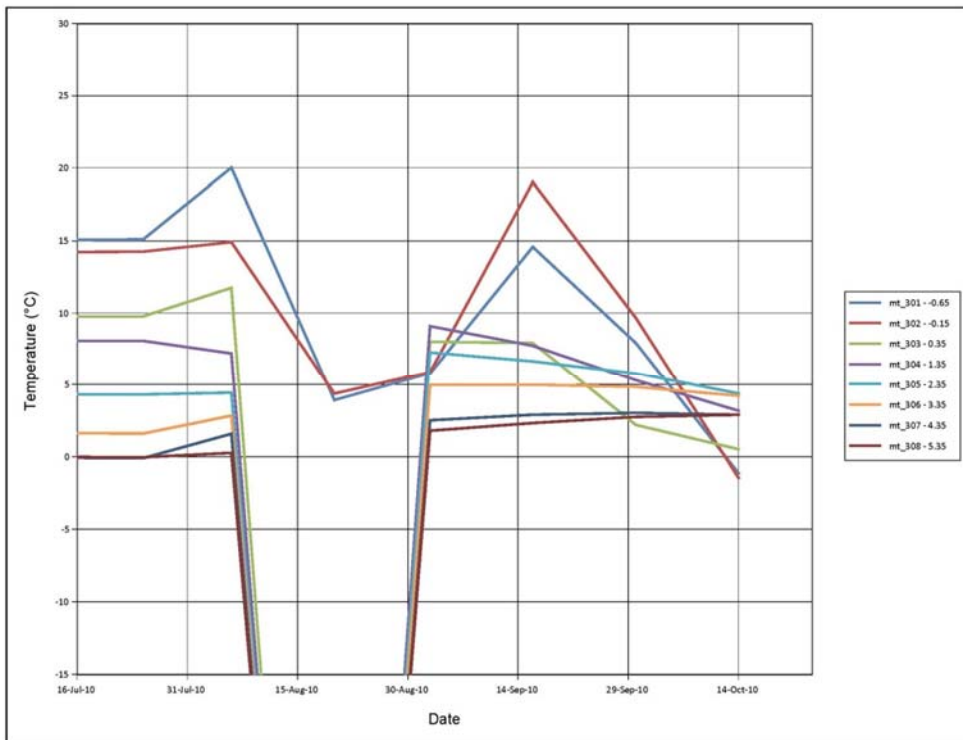


Figure 78: Monthly ground temperature measured in Grum overburden dump by an M-squared thermistor string collected manually (String 3).

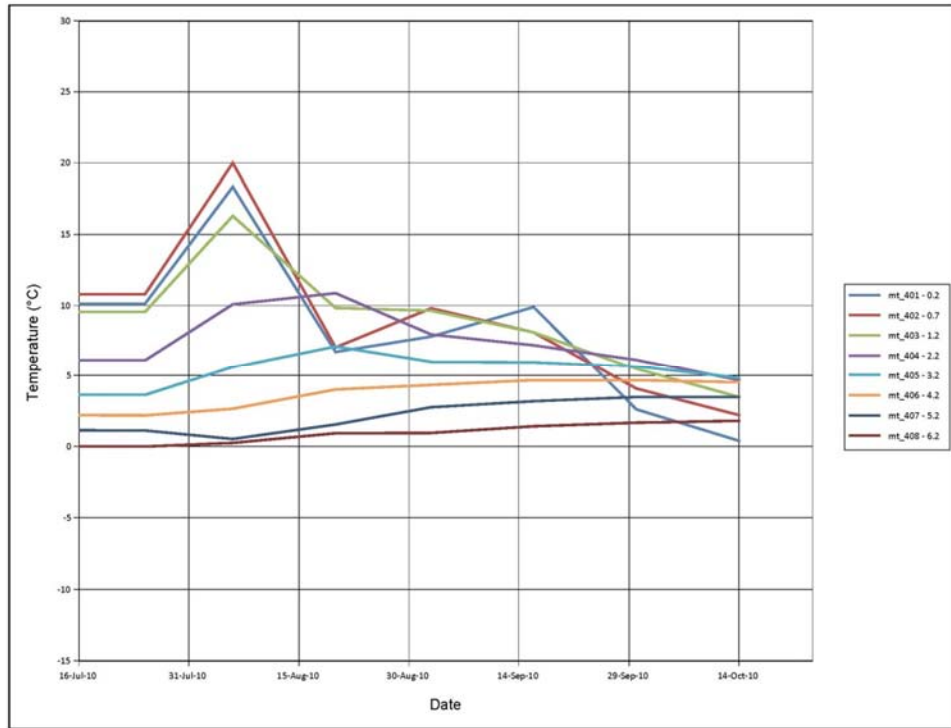


Figure 79: Monthly ground temperature measured in Grum overburden dump by an M-squared thermistor string collected manually (String 4).

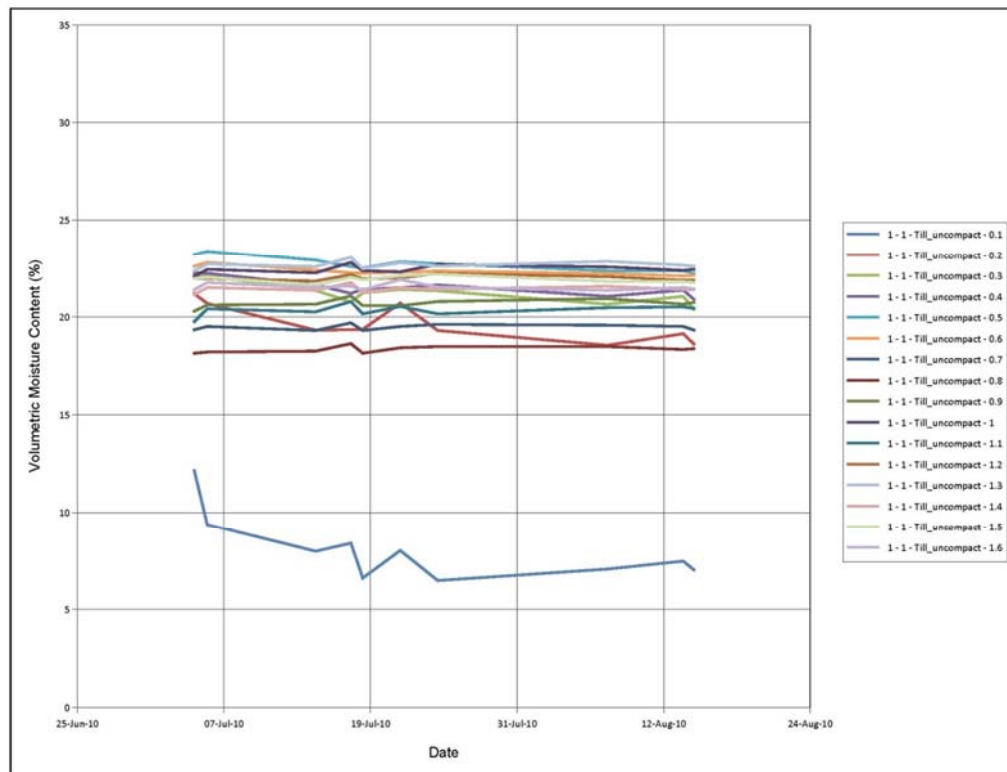


Figure 80: Daily volumetric moisture content in CT#1 (Station #1) measured manually by a Sentek Diviner 2000.

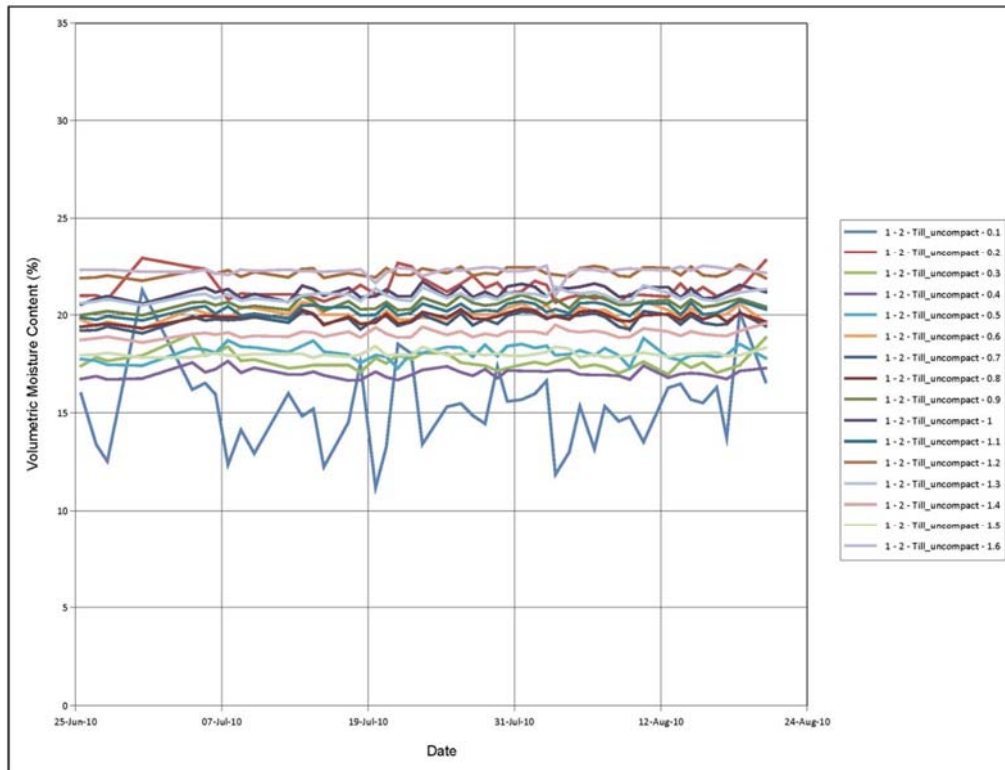


Figure 81: Daily volumetric moisture content in CT#1 (Station #2) measured manually by a Sentek Diviner 2000.

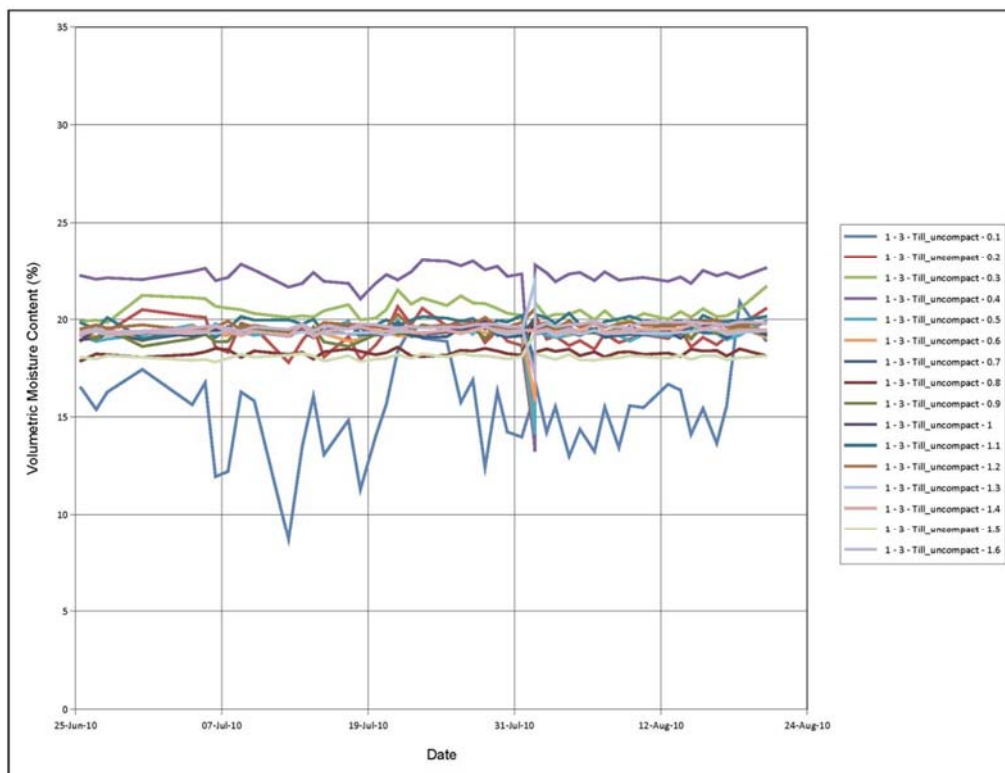


Figure 82: Daily volumetric moisture content in CT#1 (Station #3) measured manually by a Sentek Diviner 2000.

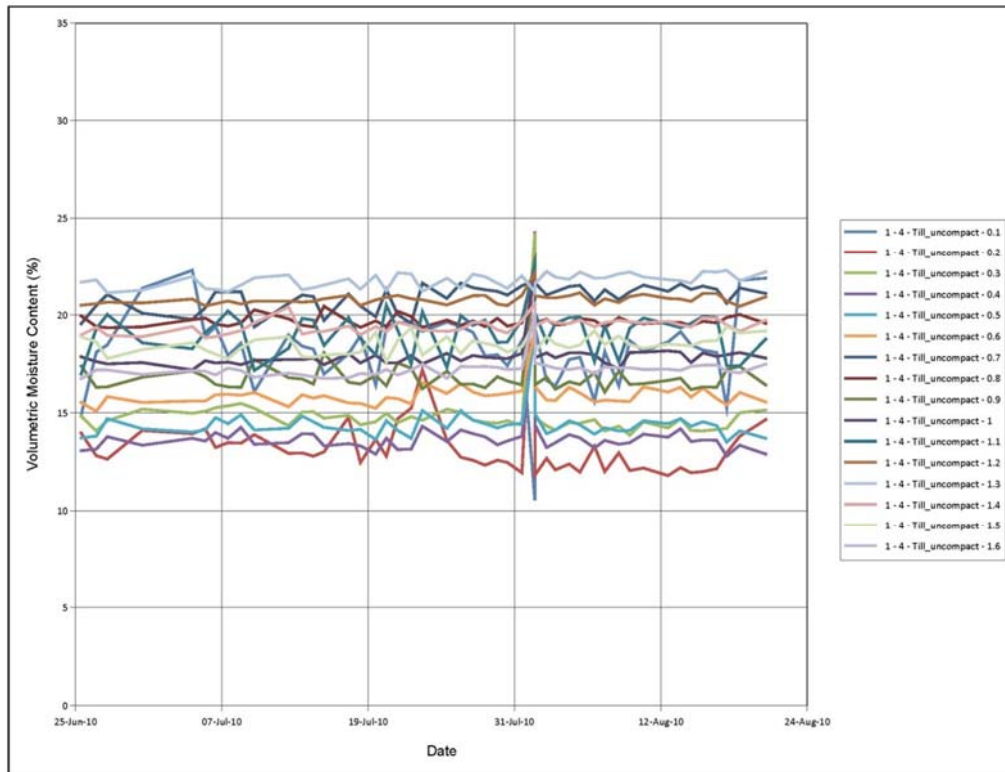


Figure 83: Daily volumetric moisture content in CT#1 (Station #4) measured manually by a Sentek Diviner 2000.

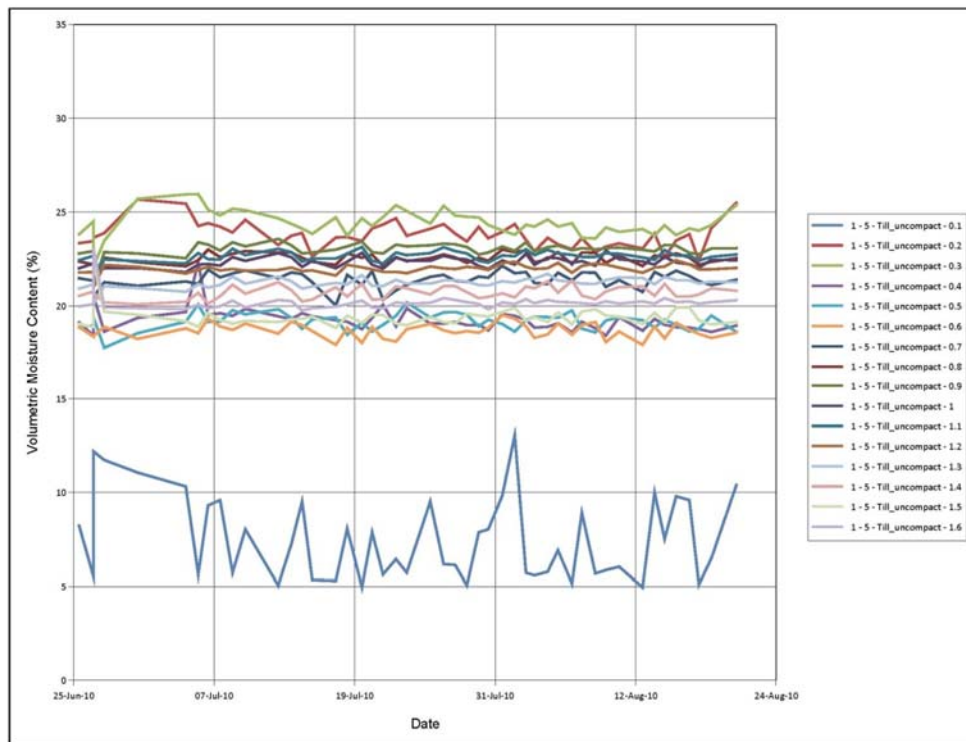


Figure 84: Daily volumetric moisture content in CT#1 (Station #5) measured manually by a Sentek Diviner 2000.

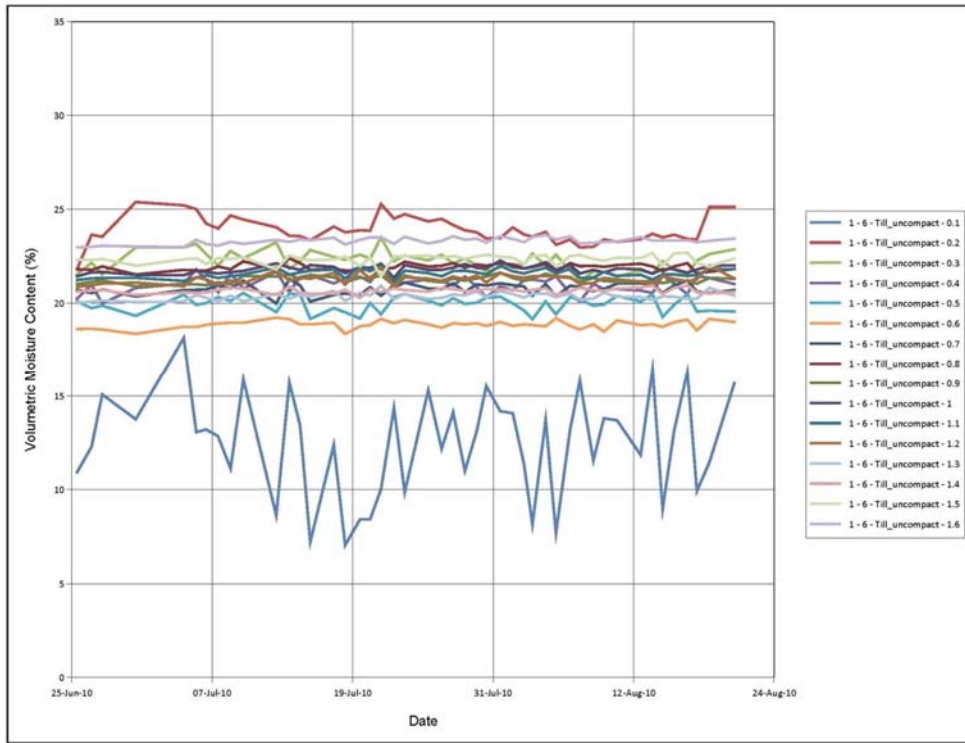


Figure 85: Daily volumetric moisture content in CT#1 (Station #6) measured manually by a Sentek Diviner 2000.

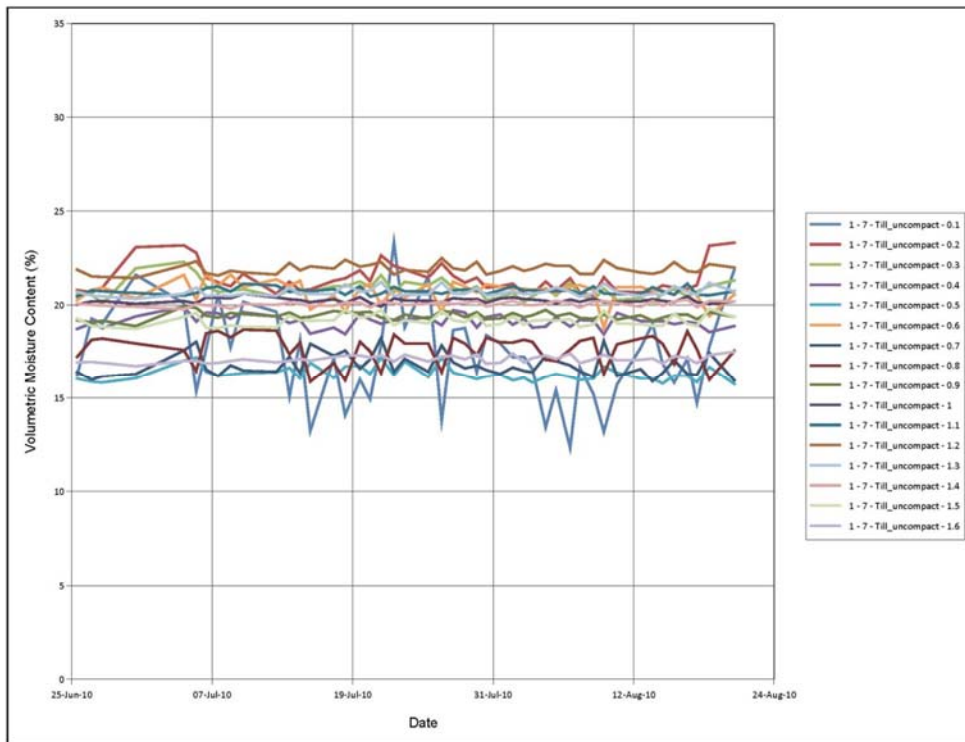


Figure 86: Daily volumetric moisture content in CT#1 (Station #7) measured manually by a Sentek Diviner 2000.

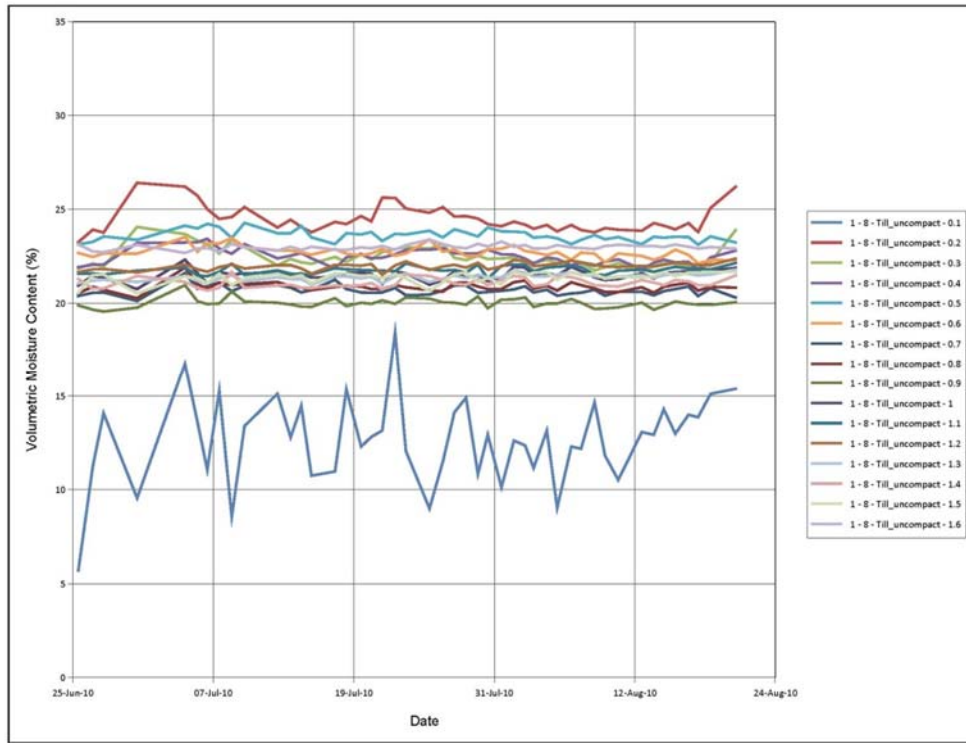


Figure 87: Daily volumetric moisture content in CT#1 (Station #8) measured manually by a Sentek Diviner 2000.

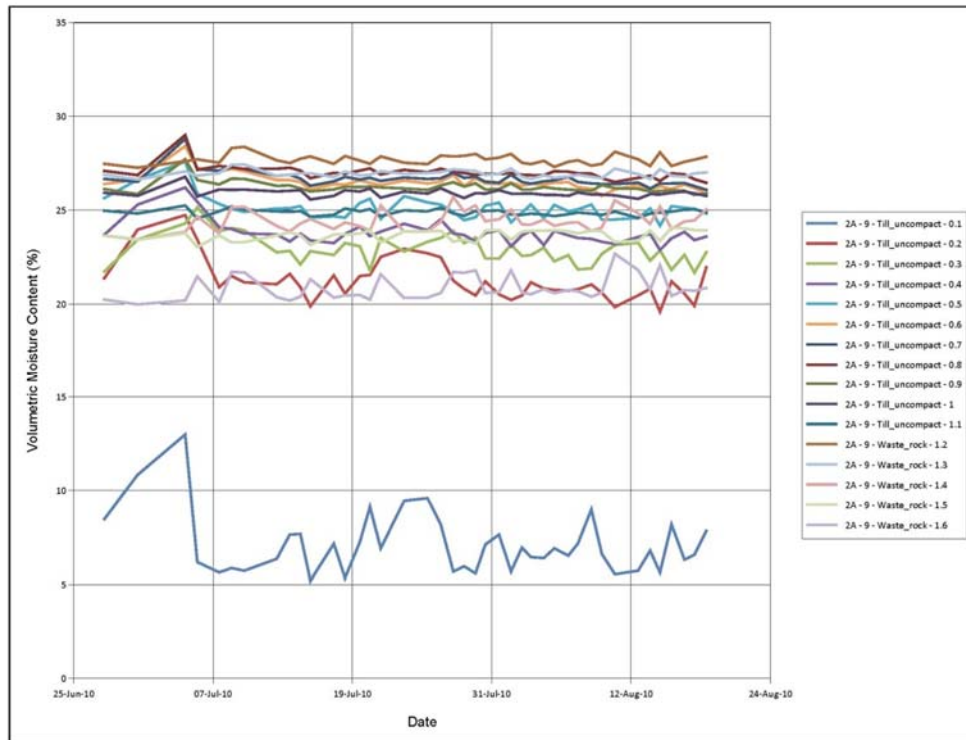


Figure 88: Daily volumetric moisture content in CT#2A (Station #9) measured manually by a Sentek Diviner 2000.

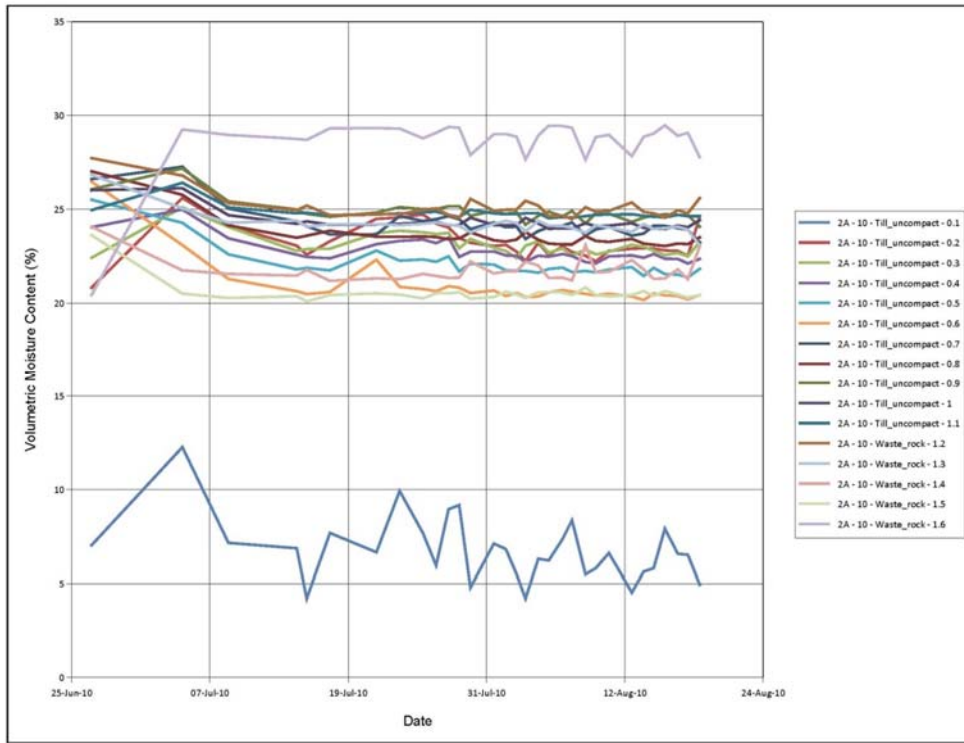


Figure 89: Daily volumetric moisture content in CT#2A (Station #10) measured manually by a Sentek Diviner 2000.

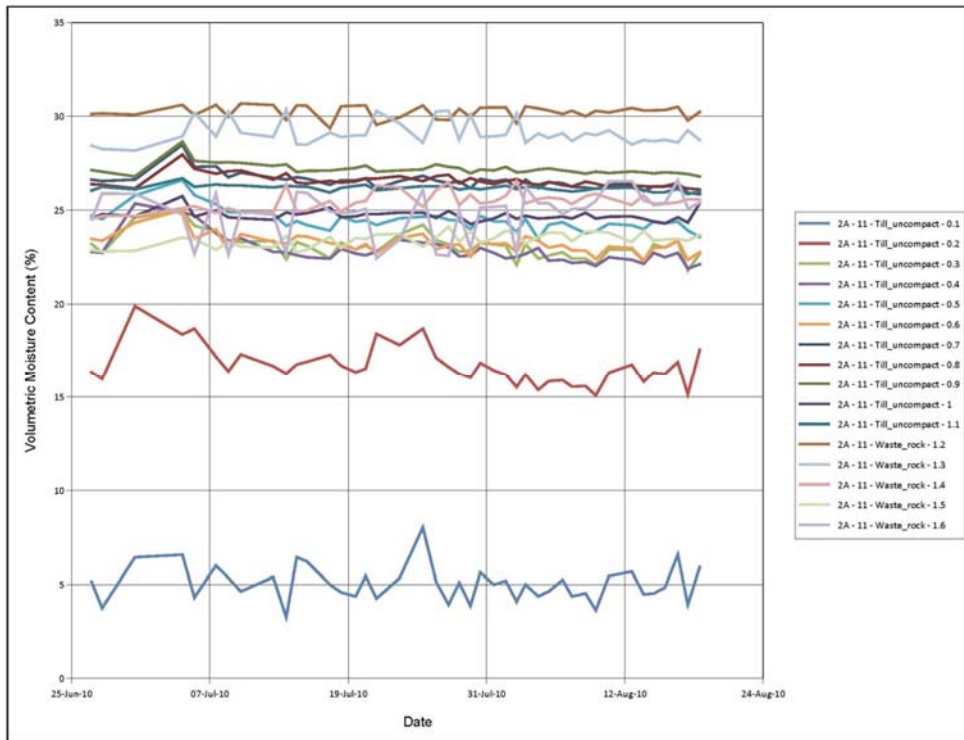


Figure 90: Daily volumetric moisture content in CT#2A (Station #11) measured manually by a Sentek Diviner 2000.

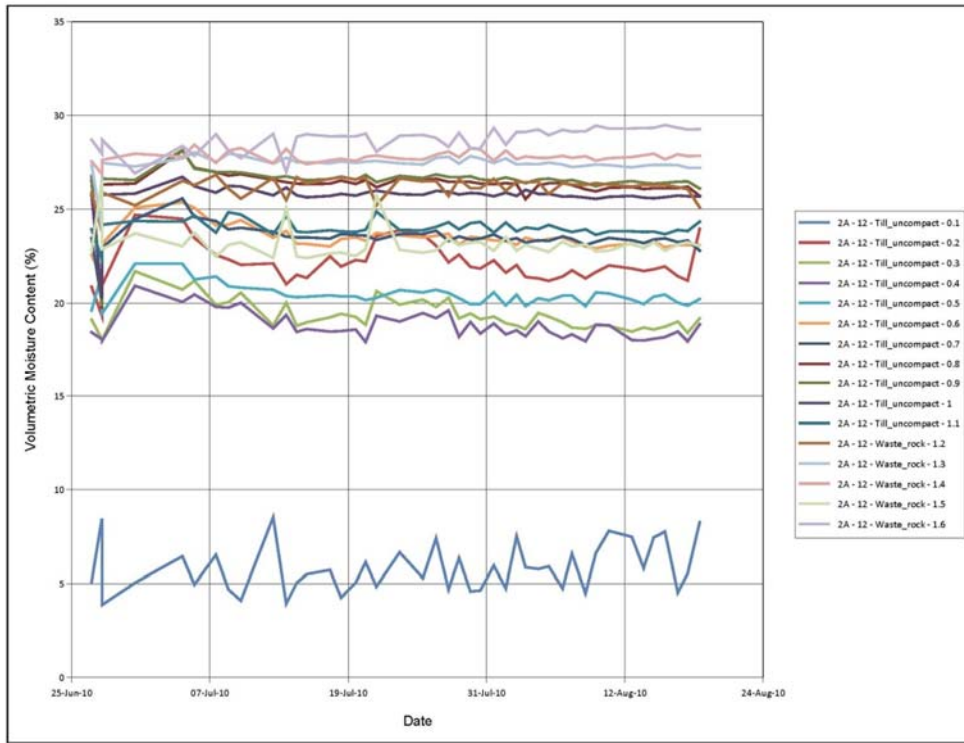


Figure 91: Daily volumetric moisture content in CT#2A (Station #12) measured manually by a Sentek Diviner 2000.

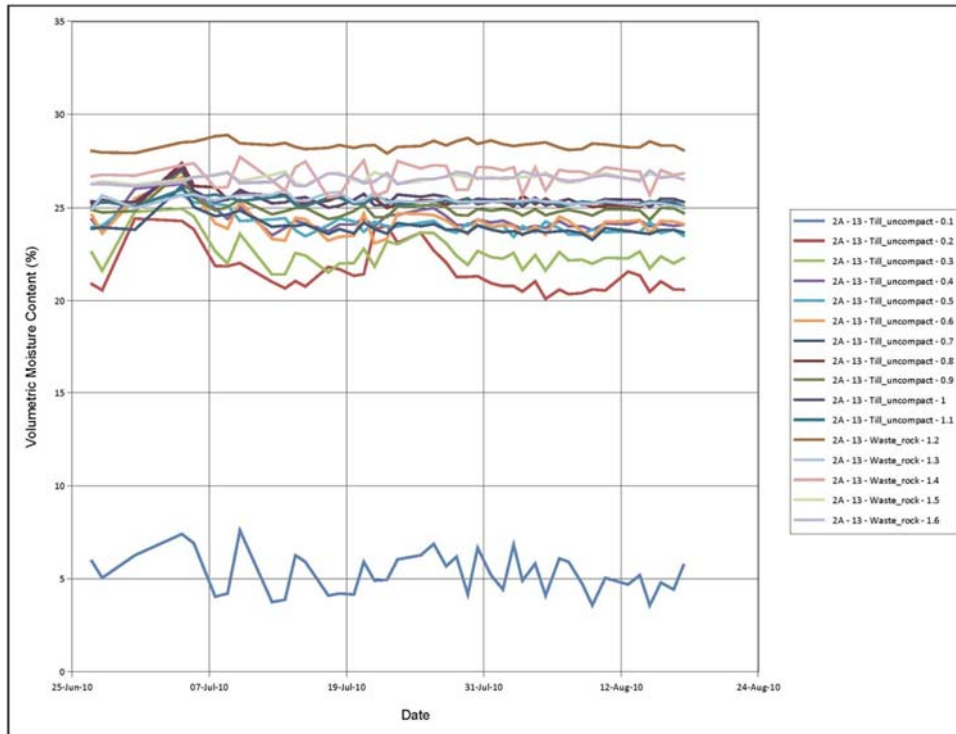


Figure 92: Daily volumetric moisture content in CT#2A (Station #13) measured manually by a Sentek Diviner 2000.

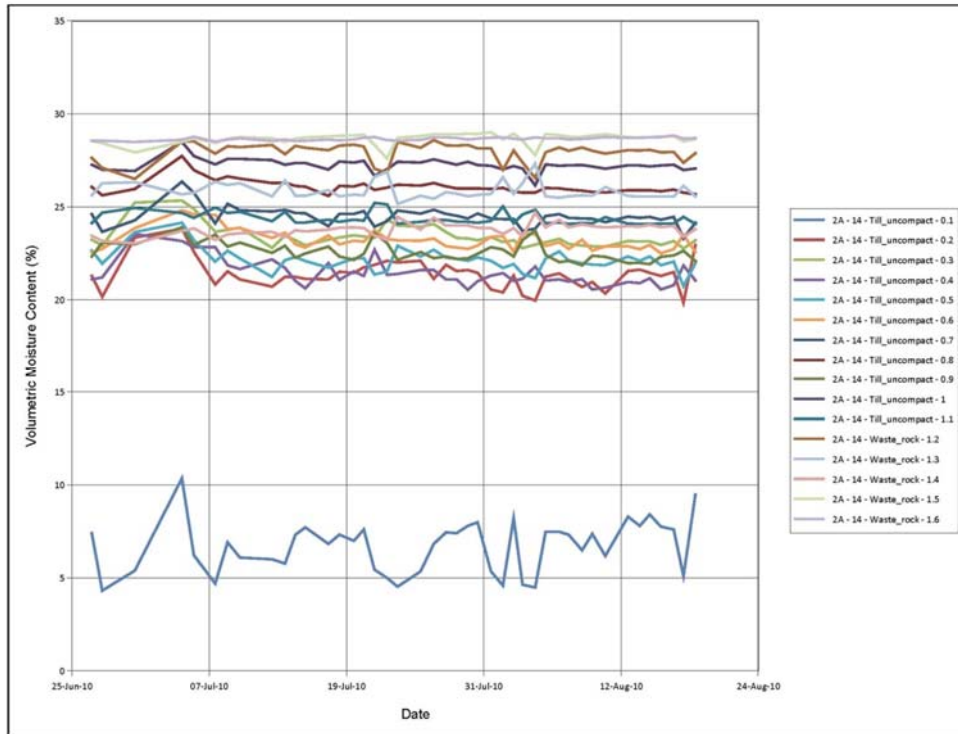


Figure 93: Daily volumetric moisture content in CT#2A (Station #14) measured manually by a Sentek Diviner 2000.

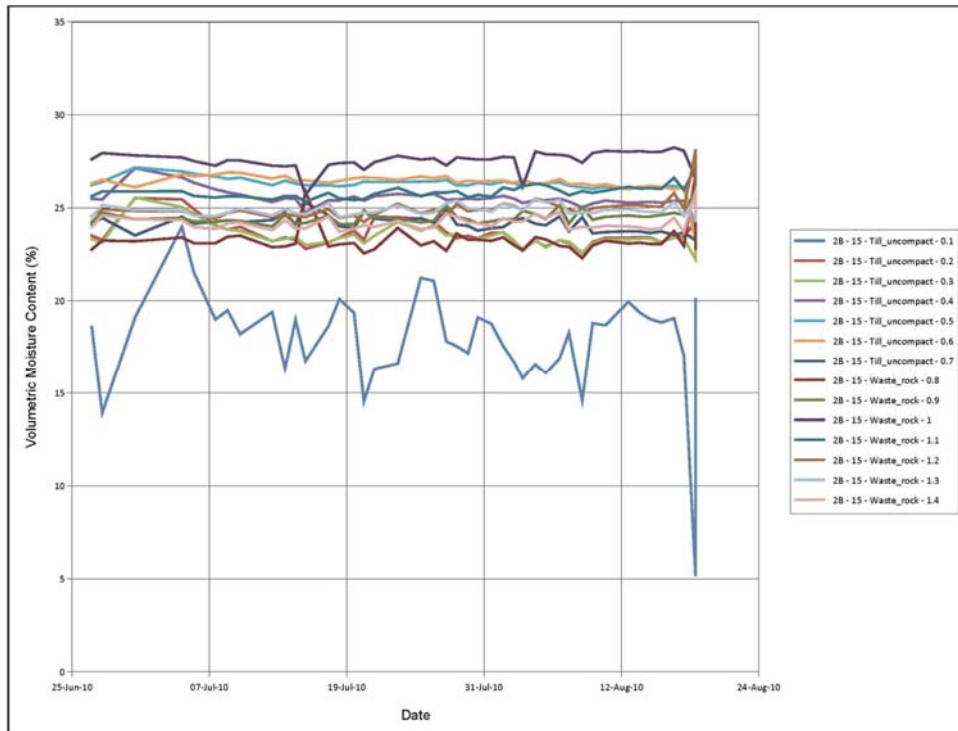


Figure 94: Daily volumetric moisture content in CT#2B (Station #15) measured manually by a Sentek Diviner 2000.

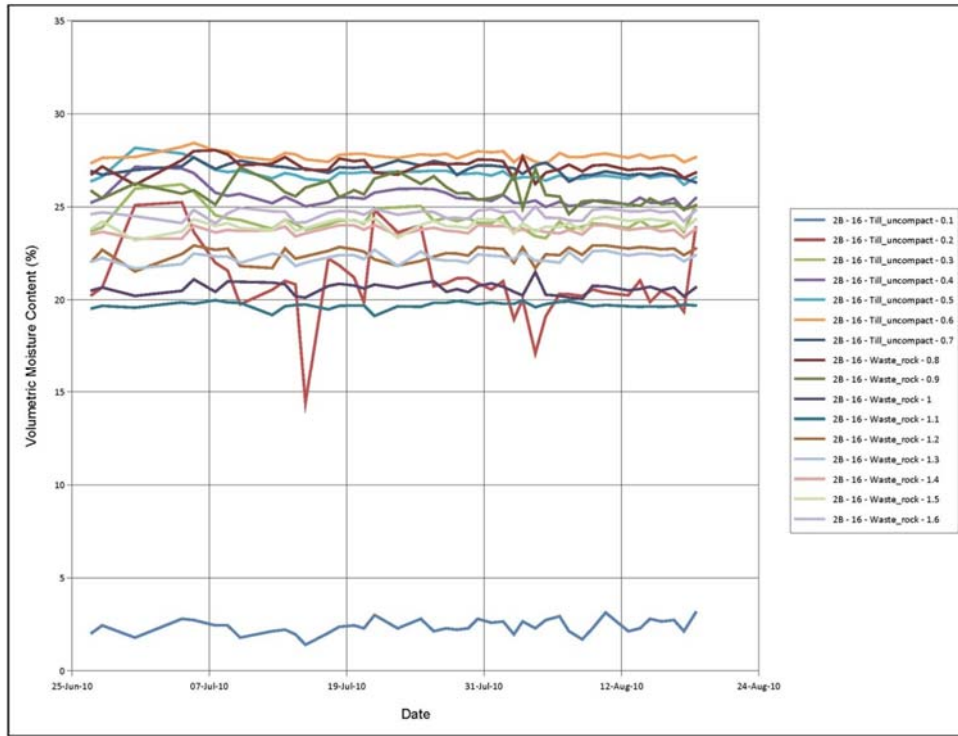


Figure 95: Daily volumetric moisture content in CT#2B (Station #16) measured manually by a Sentek Diviner 2000.

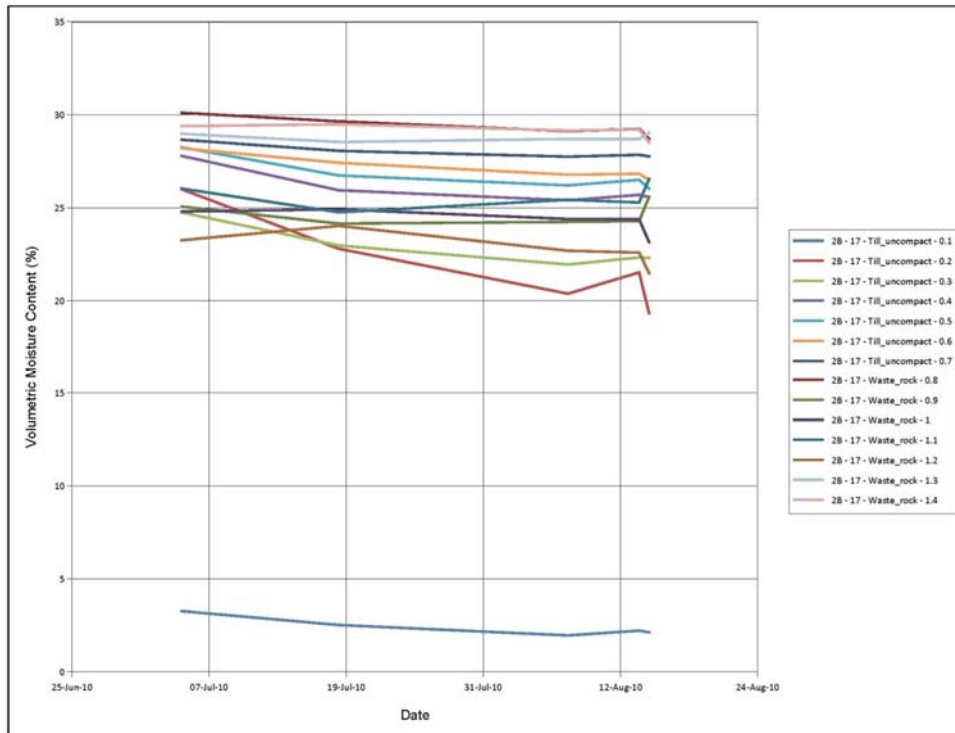


Figure 96: Daily volumetric moisture content in CT#2B (Station #17) measured manually by a Sentek Diviner 2000.

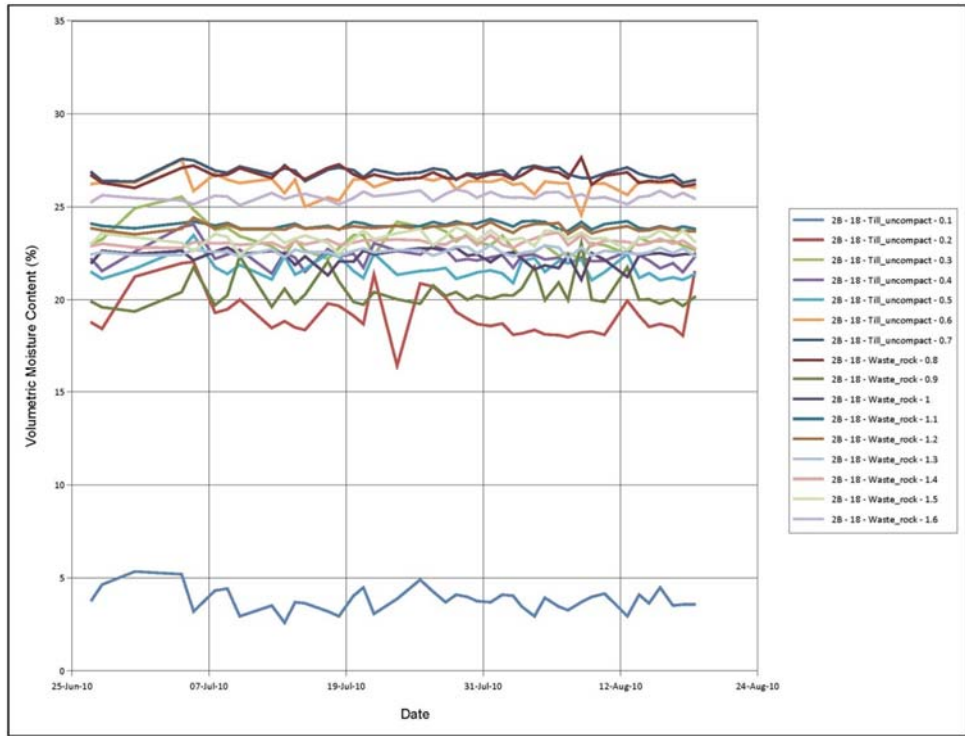


Figure 97: Daily volumetric moisture content in CT#2B (Station #18) measured manually by a Sentek Diviner 2000.

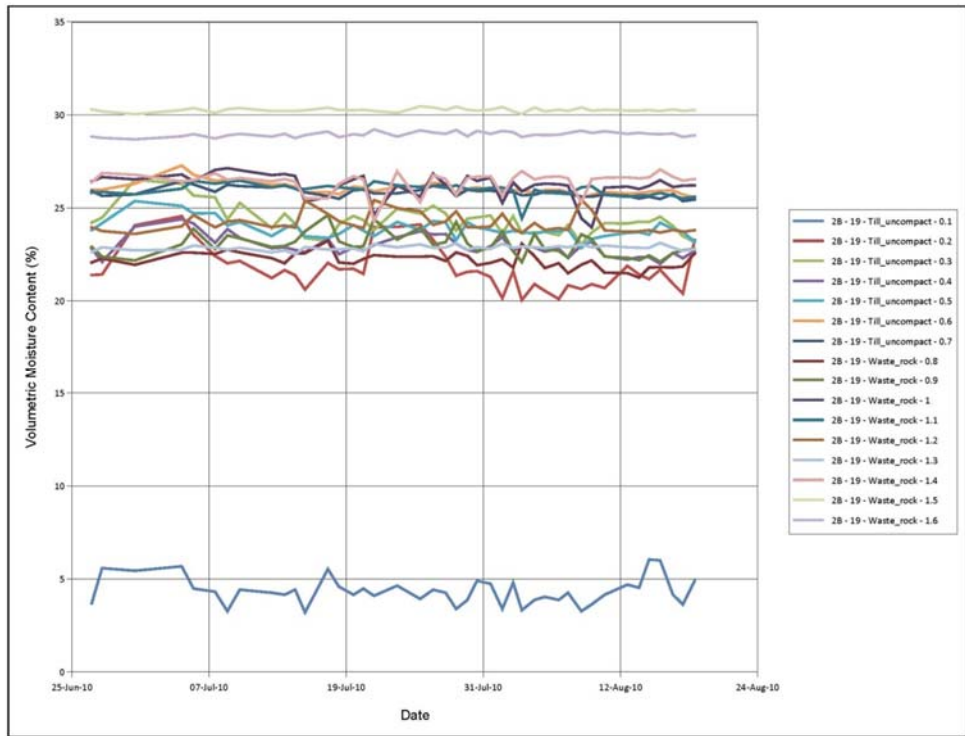


Figure 98: Daily volumetric moisture content in CT#2B (Station #19) measured manually by a Sentek Diviner 2000.

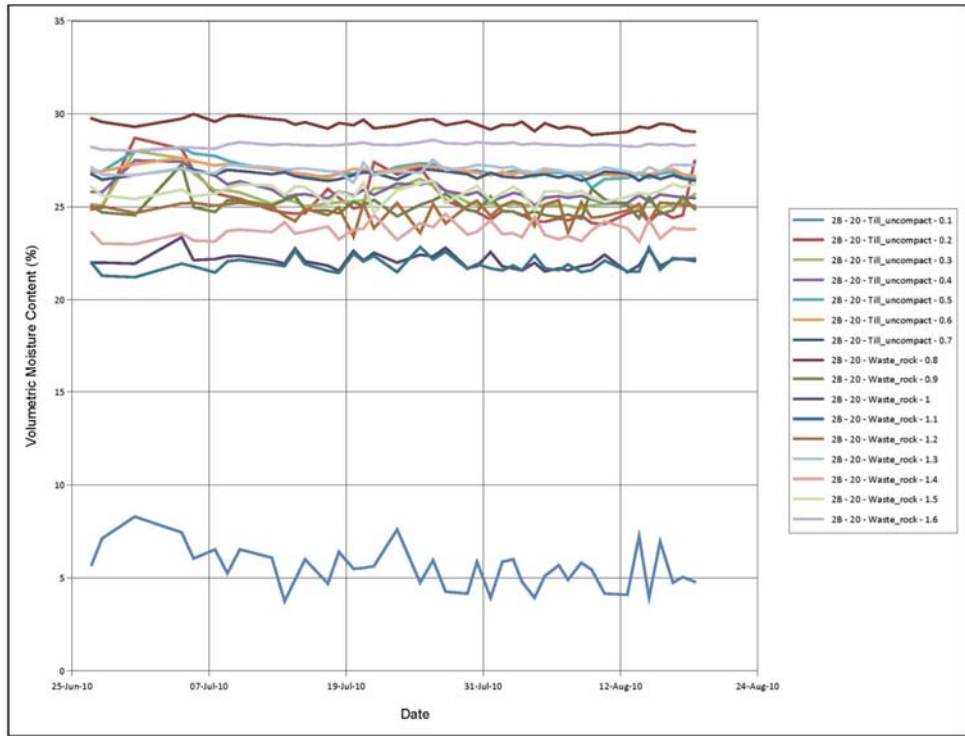


Figure 99: Daily volumetric moisture content in CT#2B (Station #20) measured manually by a Sentek Diviner 2000.

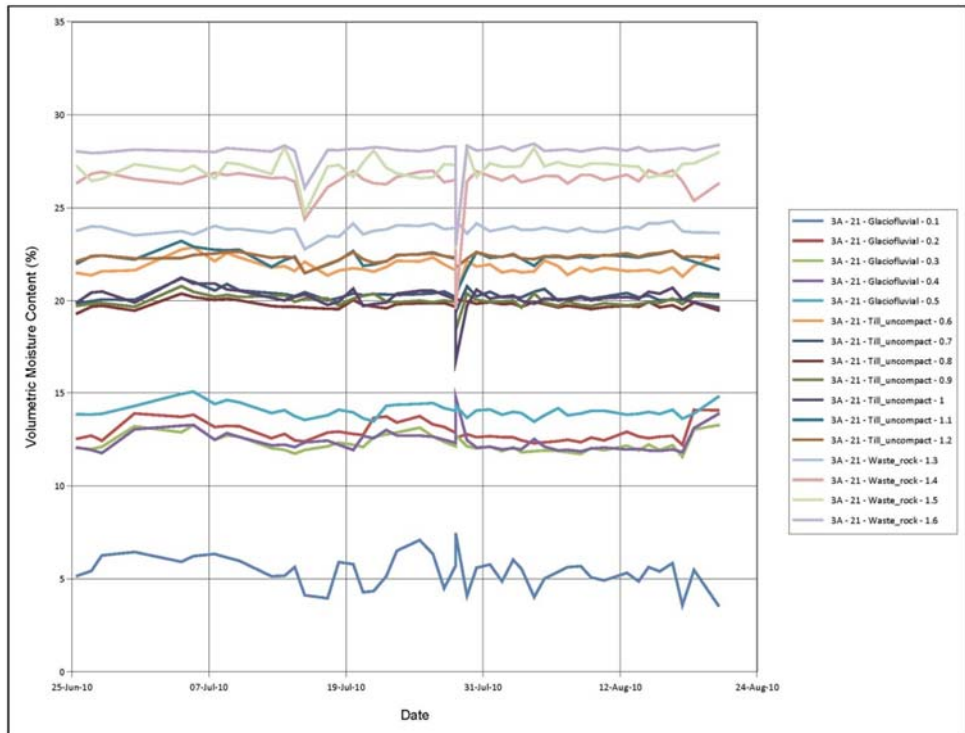


Figure 100: Daily volumetric moisture content in CT#3A (Station #21) measured manually by a Sentek Diviner 2000.

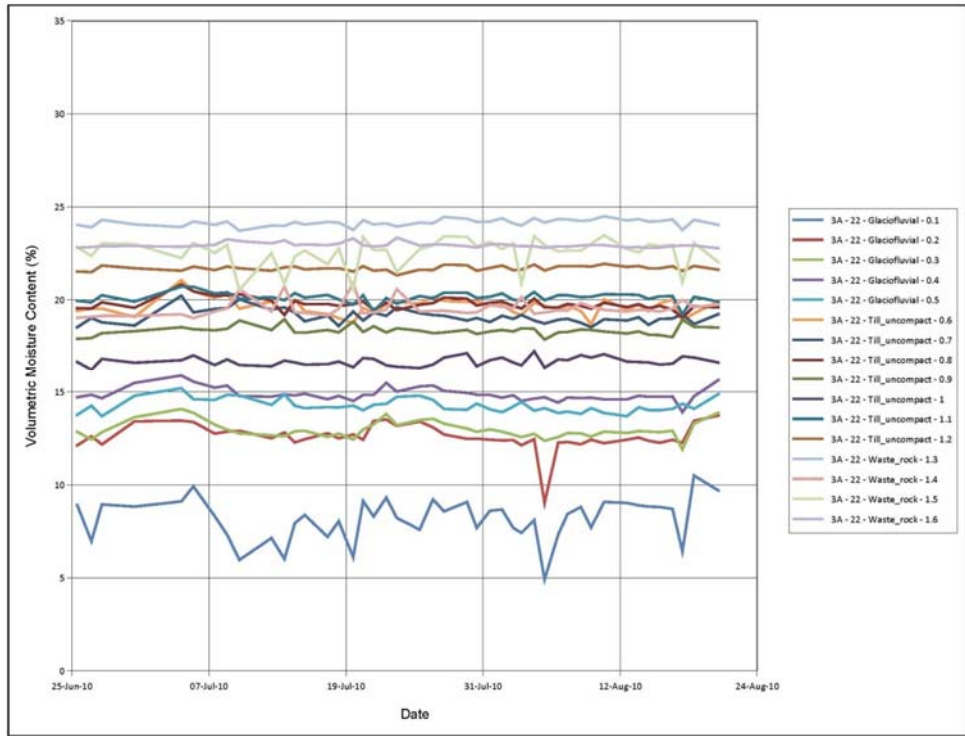


Figure 101: Daily volumetric moisture content in CT#3A (Station #22) measured manually by a Sentek Diviner 2000.

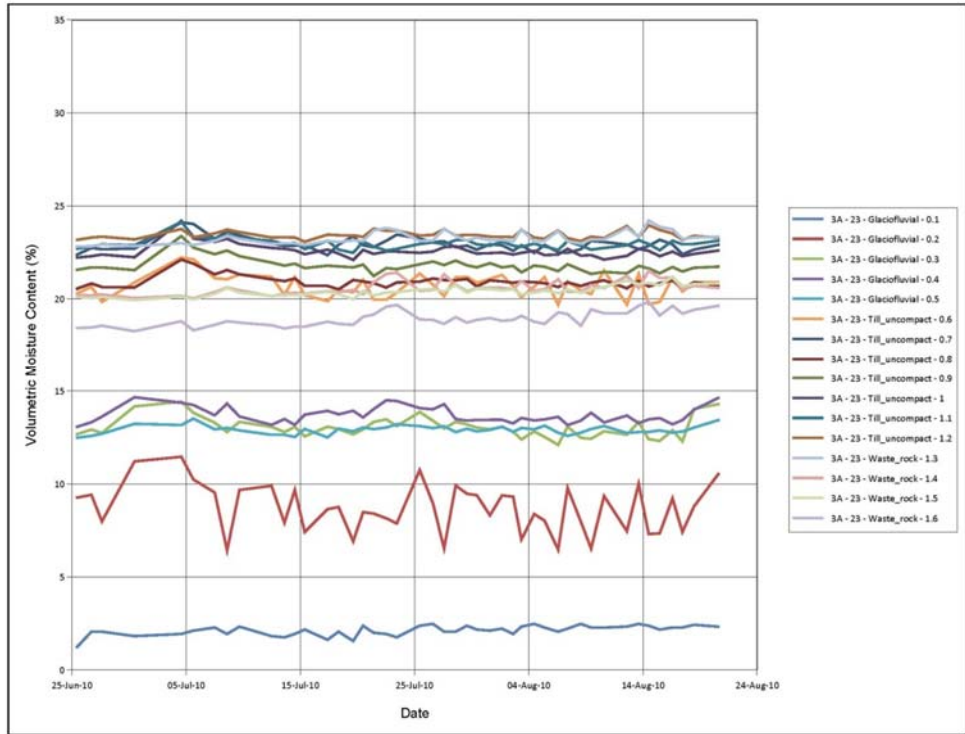


Figure 102: Daily volumetric moisture content in CT#3A (Station #23) measured manually by a Sentek Diviner 2000.

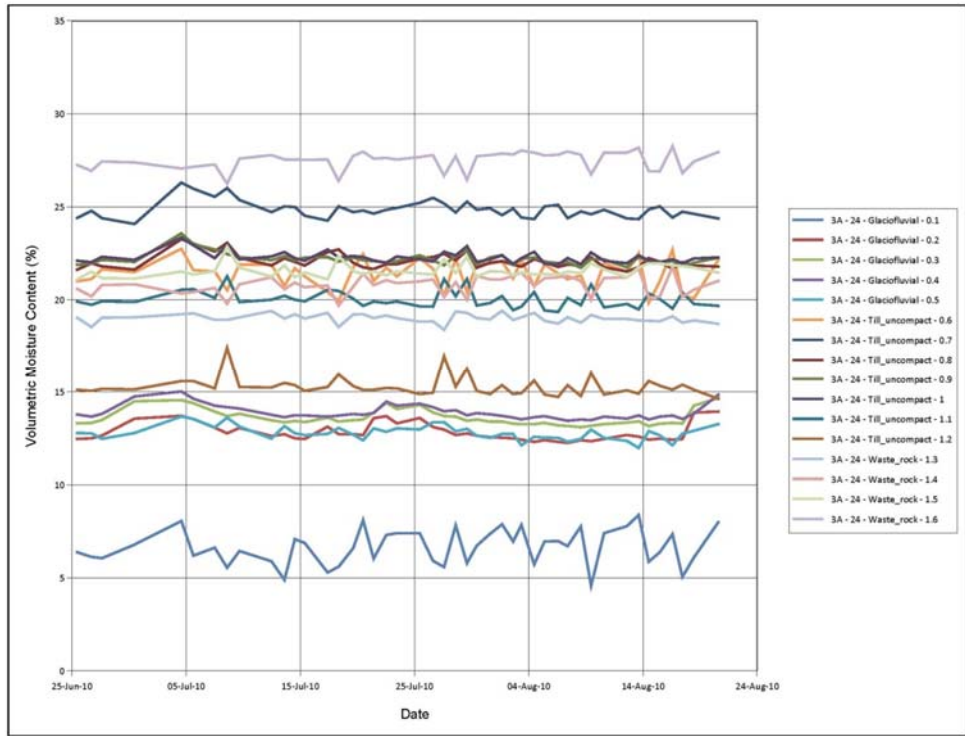


Figure 103: Daily volumetric moisture content in CT#3A (Station #24) measured manually by a Sentek Diviner 2000.

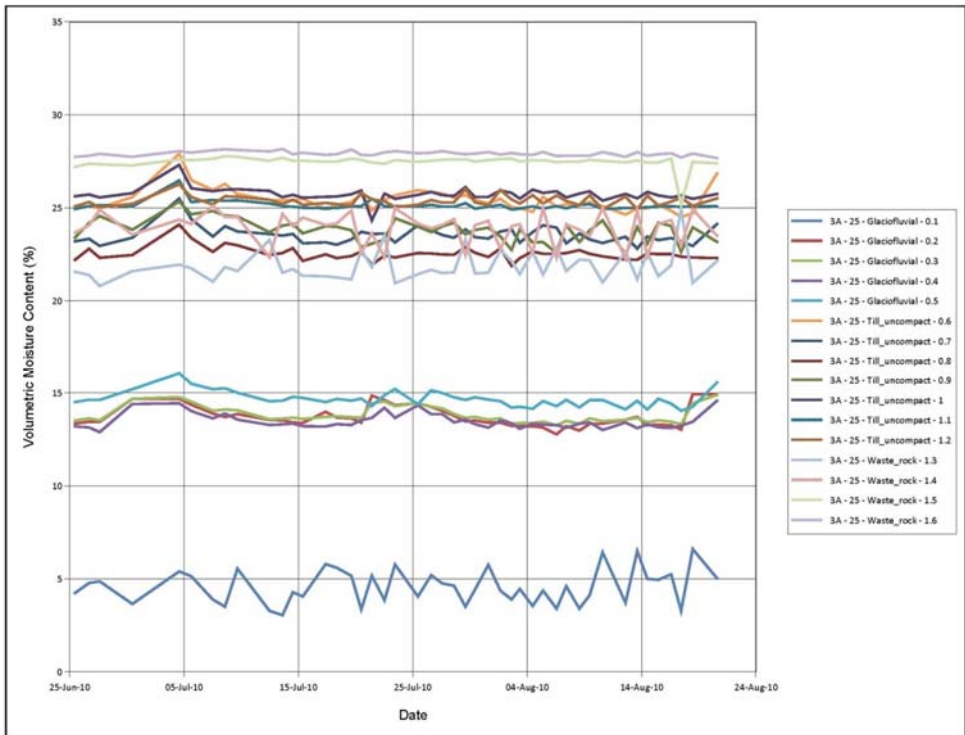


Figure 104: Daily volumetric moisture content in CT#3A (Station #25) measured manually by a Sentek Diviner 2000.

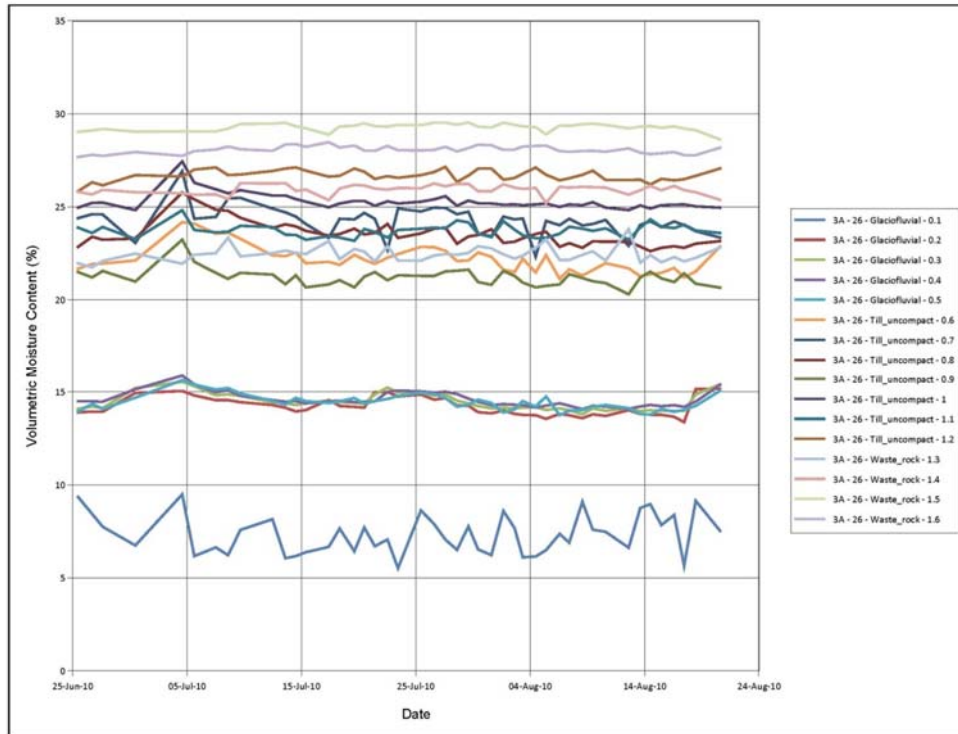


Figure 105: Daily volumetric moisture content in CT#3A (Station #26) measured manually by a Sentek Diviner 2000.

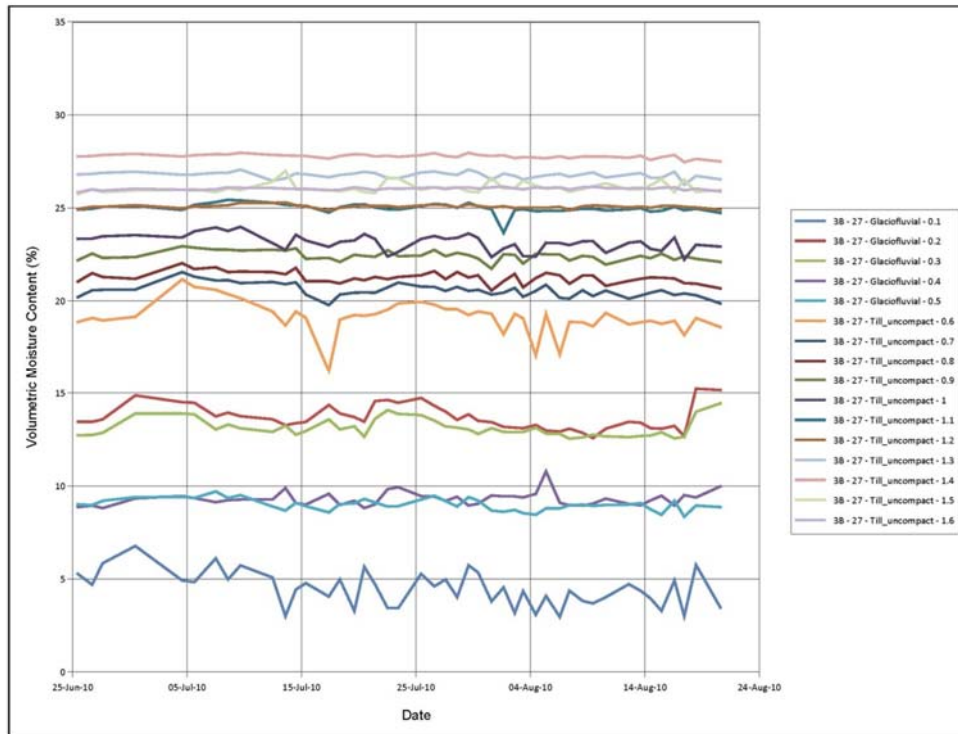


Figure 106: Daily volumetric moisture content in CT#3B (Station #27) measured manually by a Sentek Diviner 2000.

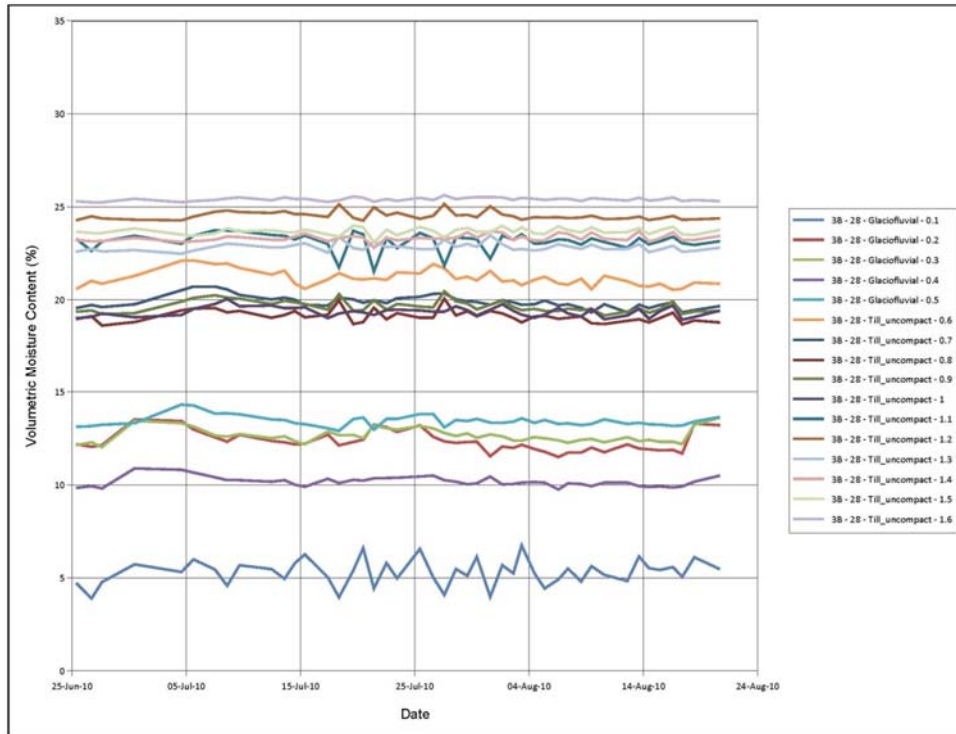


Figure 107: Daily volumetric moisture content in CT#3B (Station #28) measured manually by a Sentek Diviner 2000.

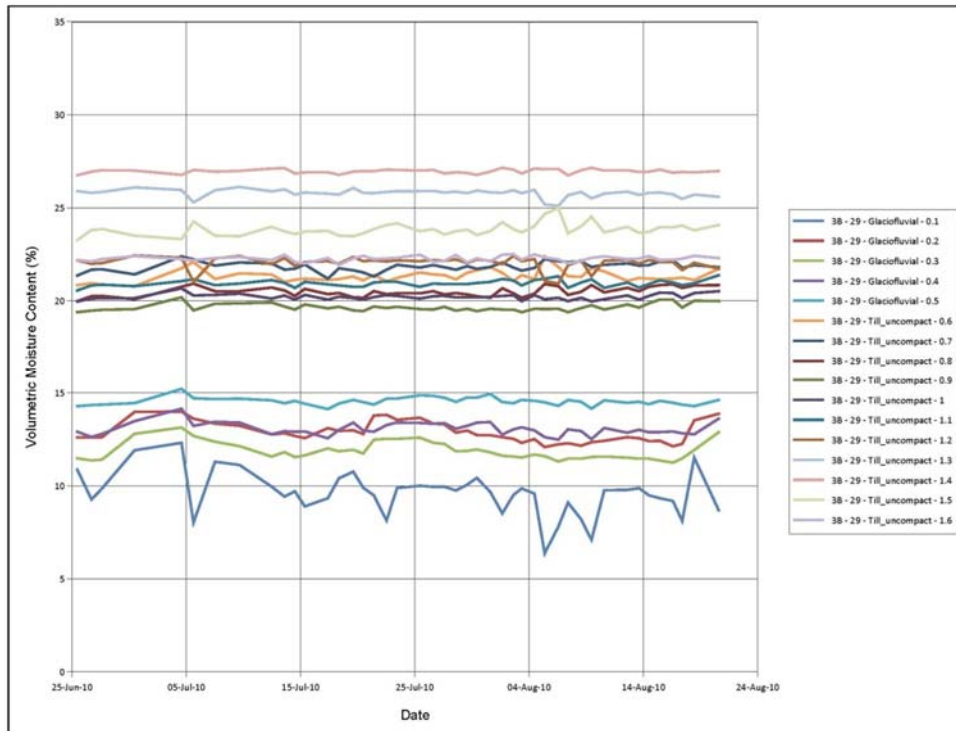


Figure 108: Daily volumetric moisture content in CT#3B (Station #29) measured manually by a Sentek Diviner 2000.

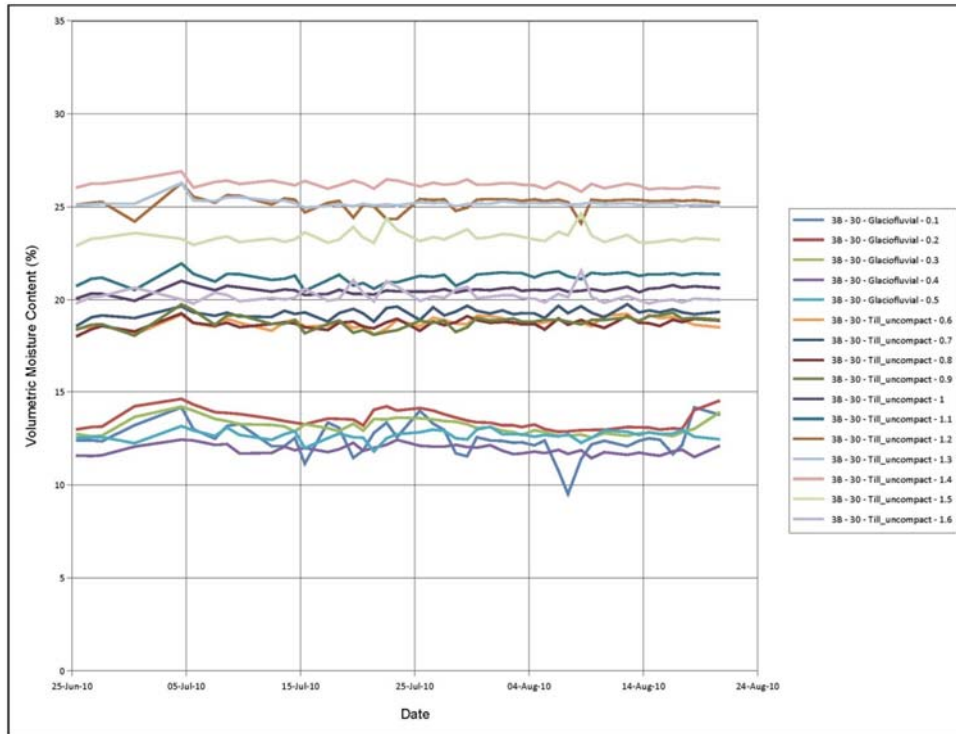


Figure 109: Daily volumetric moisture content in CT#3B (Station #30) measured manually by a Sentek Diviner 2000.

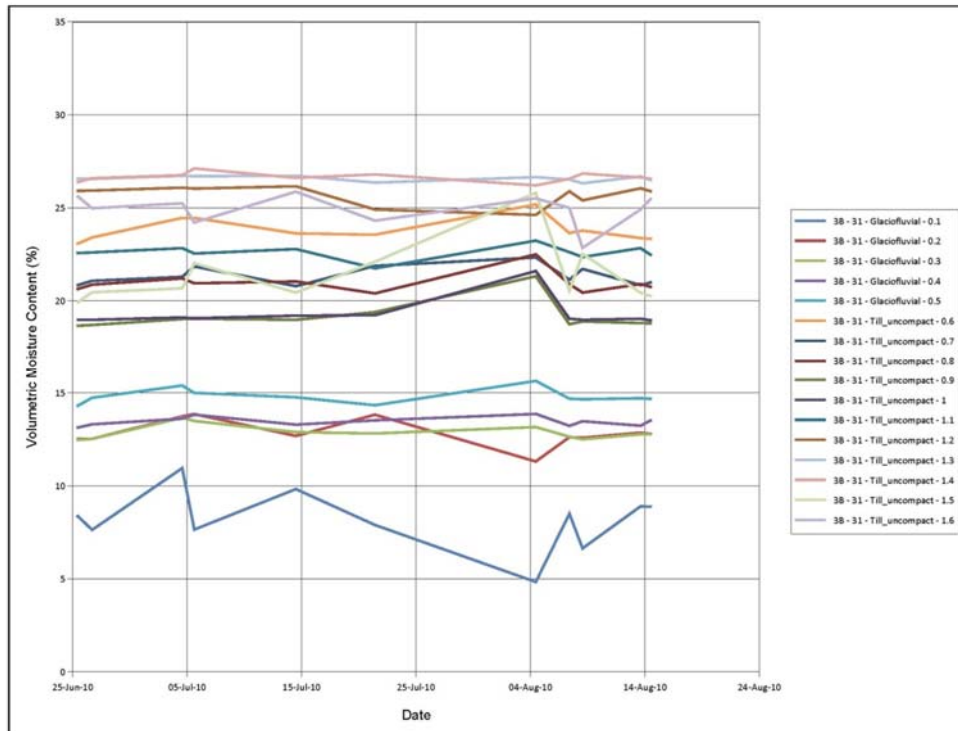


Figure 110: Daily volumetric moisture content in CT#3B (Station #31) measured manually by a Sentek Diviner 2000.

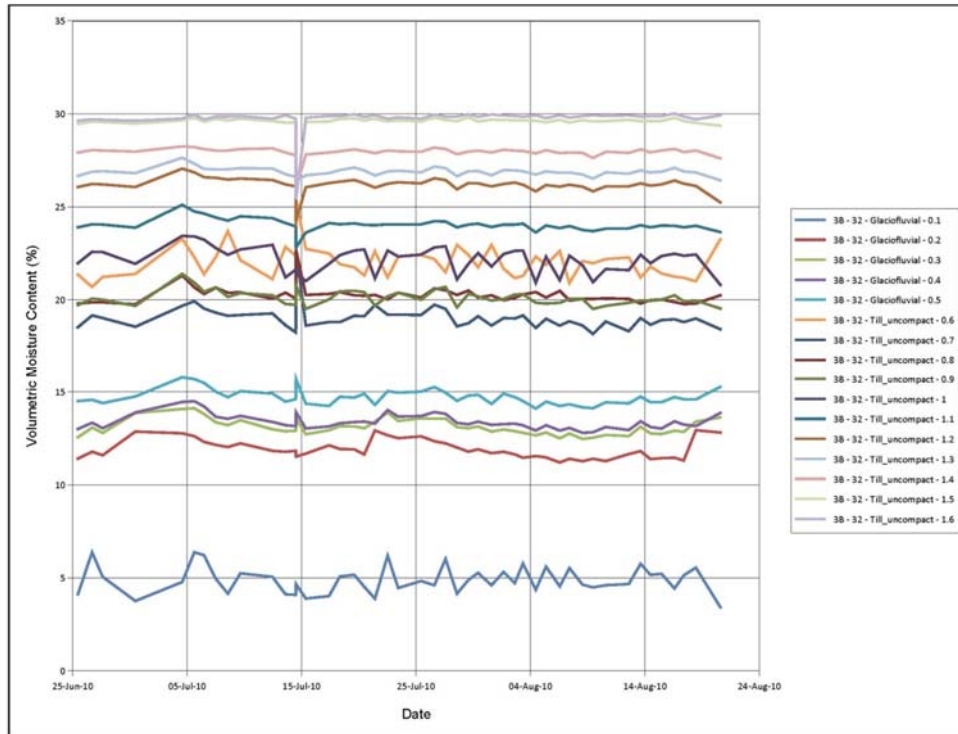


Figure 111: Daily volumetric moisture content in CT#3B (Station #32) measured manually by a Sentek Diviner 2000.

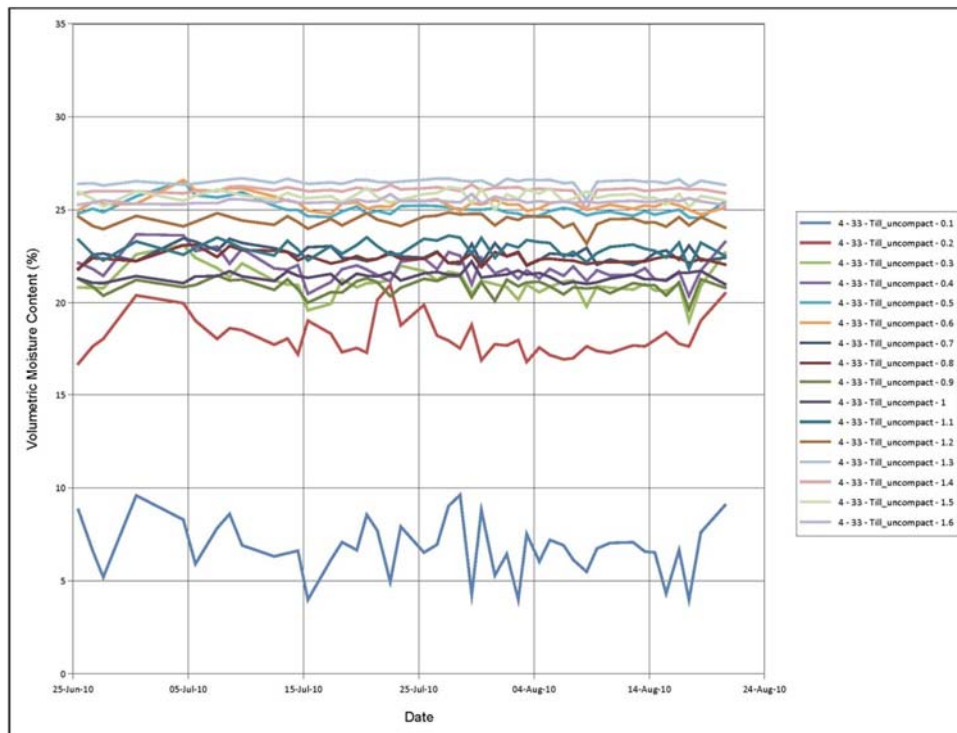


Figure 112: Daily volumetric moisture content in CT#4 (Station #33) measured manually by a Sentek Diviner 2000.

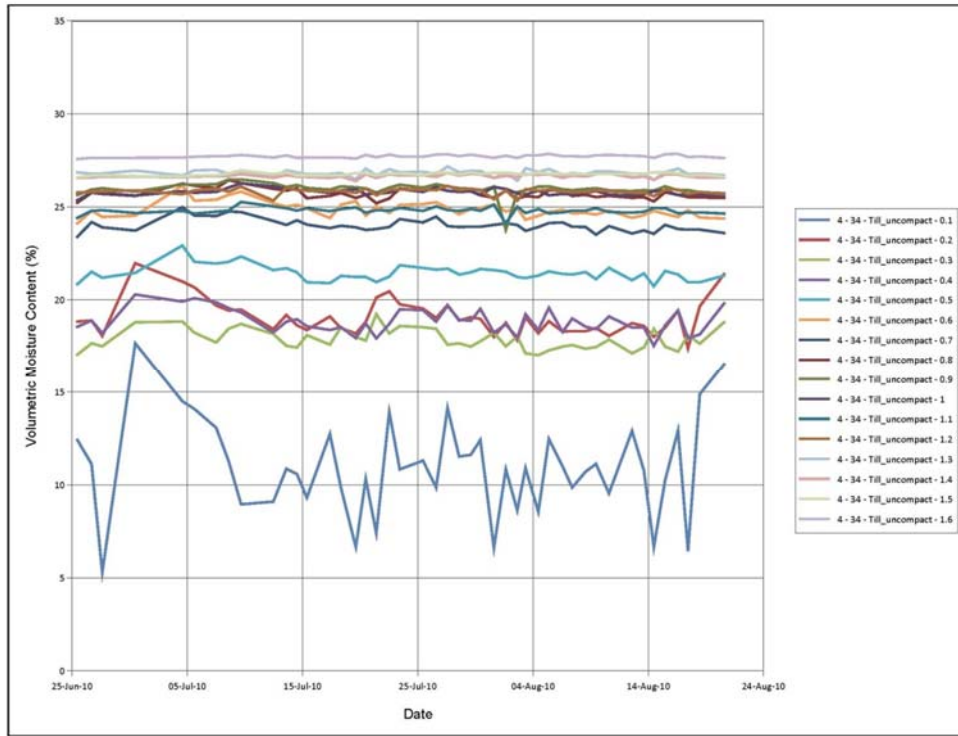


Figure 113: Daily volumetric moisture content in CT#4 (Station #34) measured manually by a Sentek Diviner 2000.

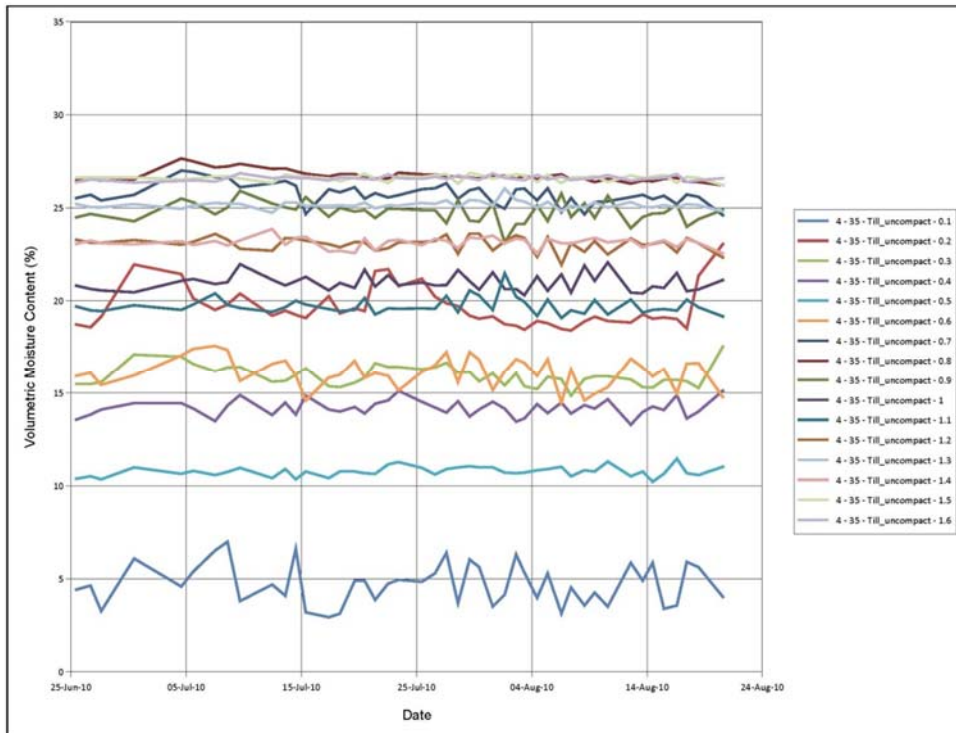


Figure 114: Daily volumetric moisture content in CT#4 (Station #35) measured manually by a Sentek Diviner 2000.

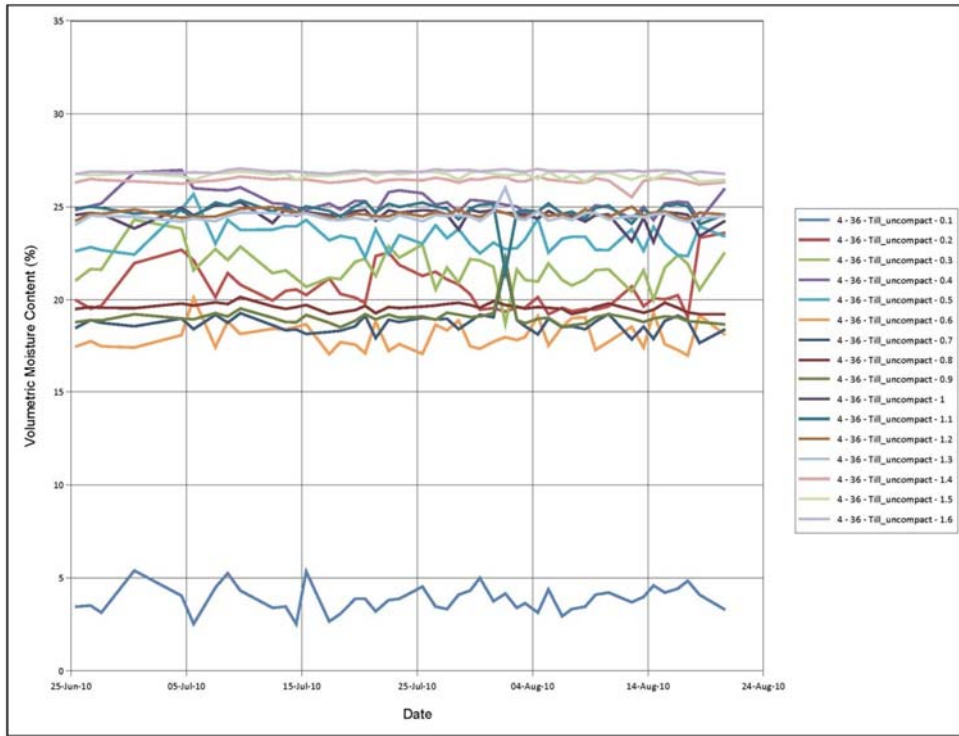


Figure 115: Daily volumetric moisture content in CT#4 (Station #36) measured manually by a Sentek Diviner 2000.

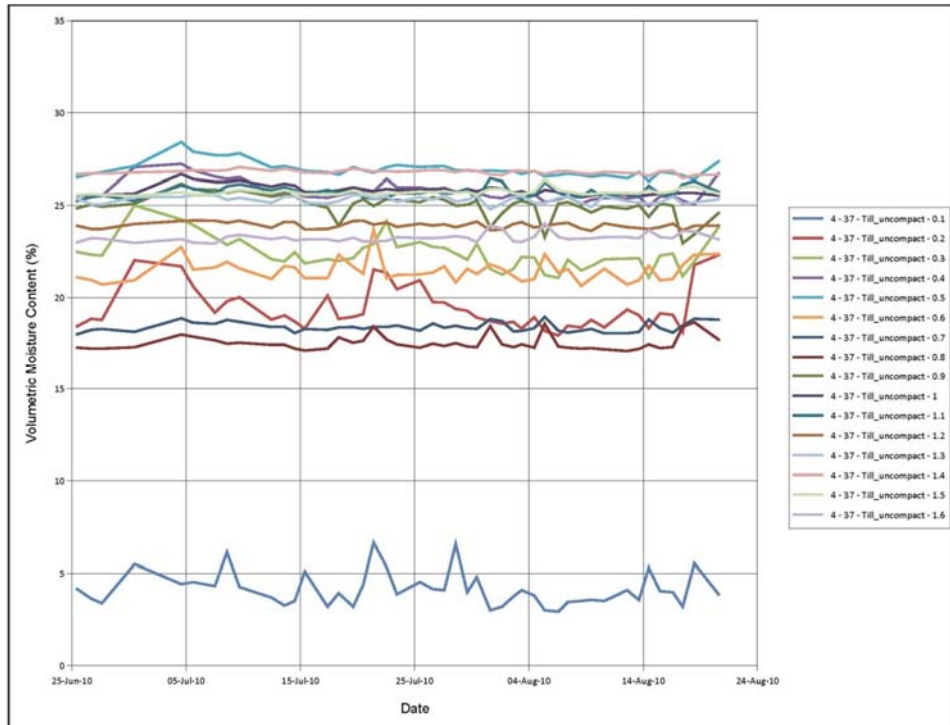


Figure 116: Daily volumetric moisture content in CT#4 (Station #37) measured manually by a Sentek Diviner 2000.

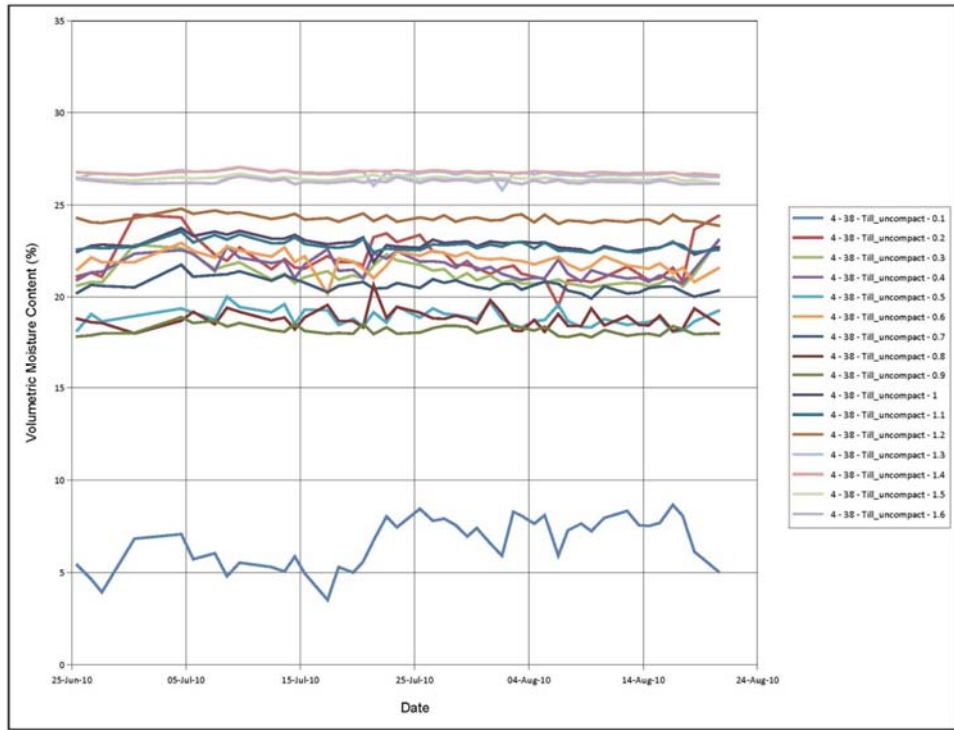


Figure 117: Daily volumetric moisture content in CT#4 (Station #38) measured manually by a Sentek Diviner 2000.

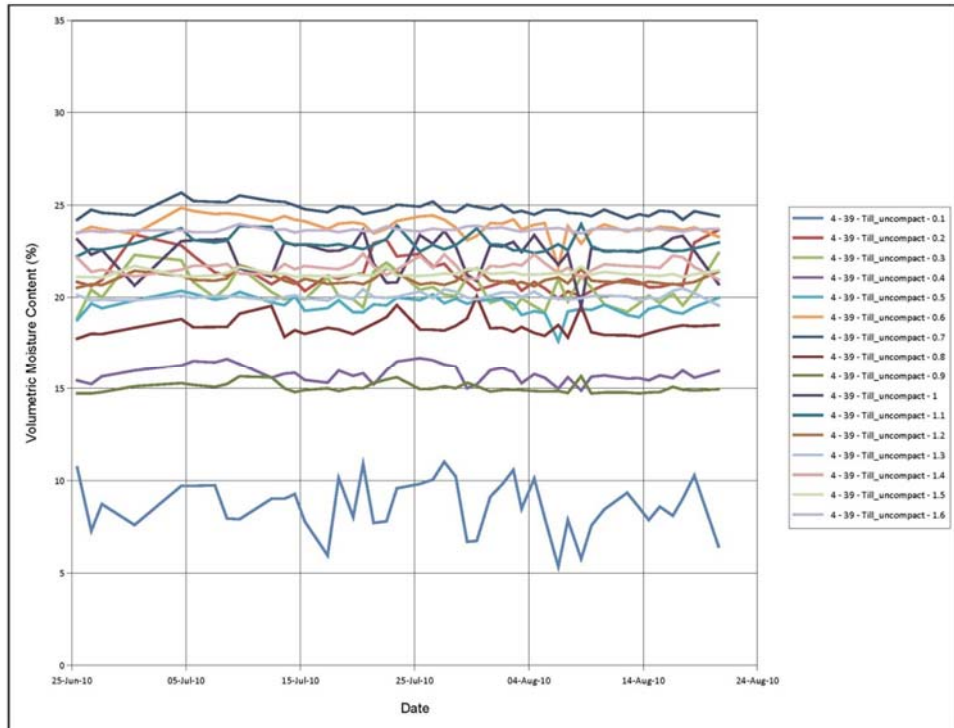


Figure 118: Daily volumetric moisture content in CT#4 (Station #39) measured manually by a Sentek Diviner 2000.

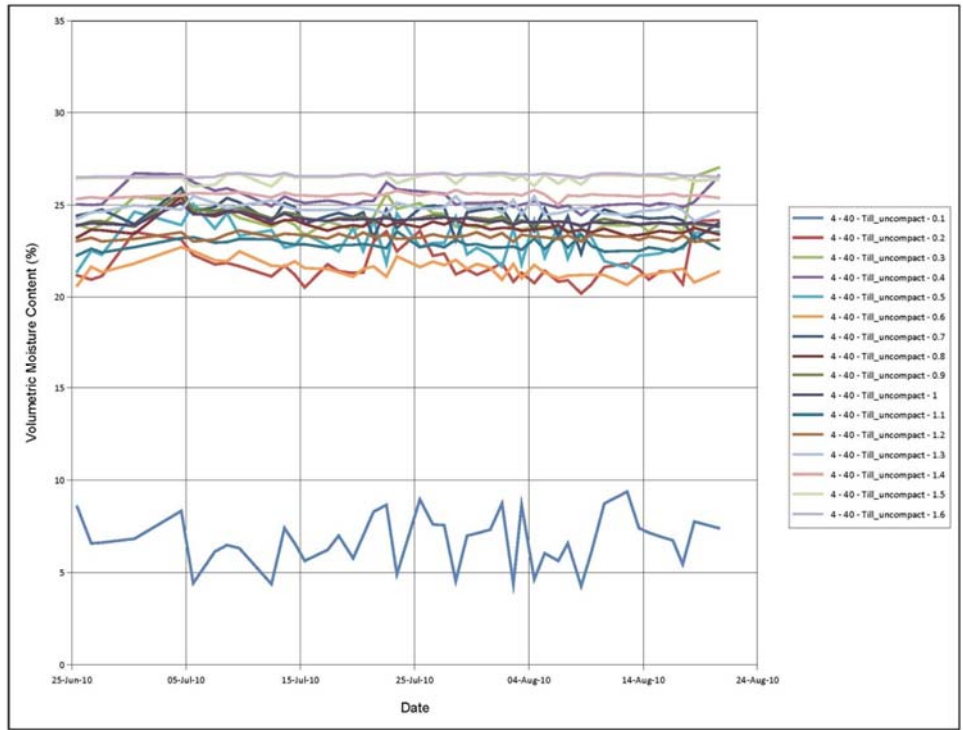


Figure 119: Daily volumetric moisture content in CT#4 (Station #40) measured manually by a Sentek Diviner 2000.

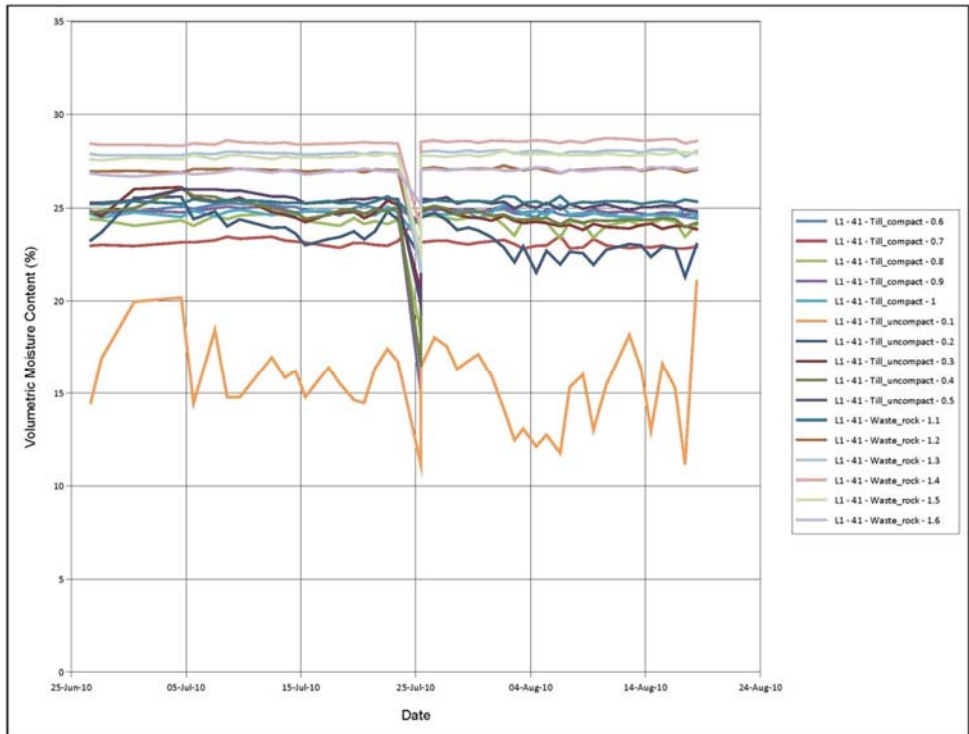


Figure 120: Daily volumetric moisture content in L#1 (Station #41) measured manually by a Sentek Diviner 2000.

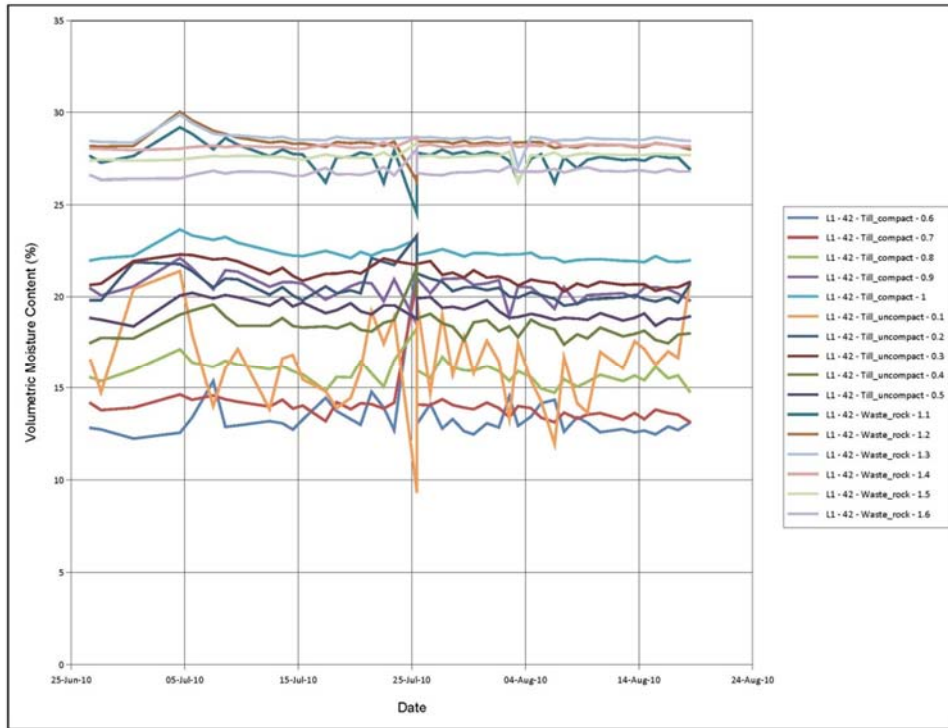


Figure 121: Daily volumetric moisture content in L#1 (Station #42) measured manually by a Sentek Diviner 2000.

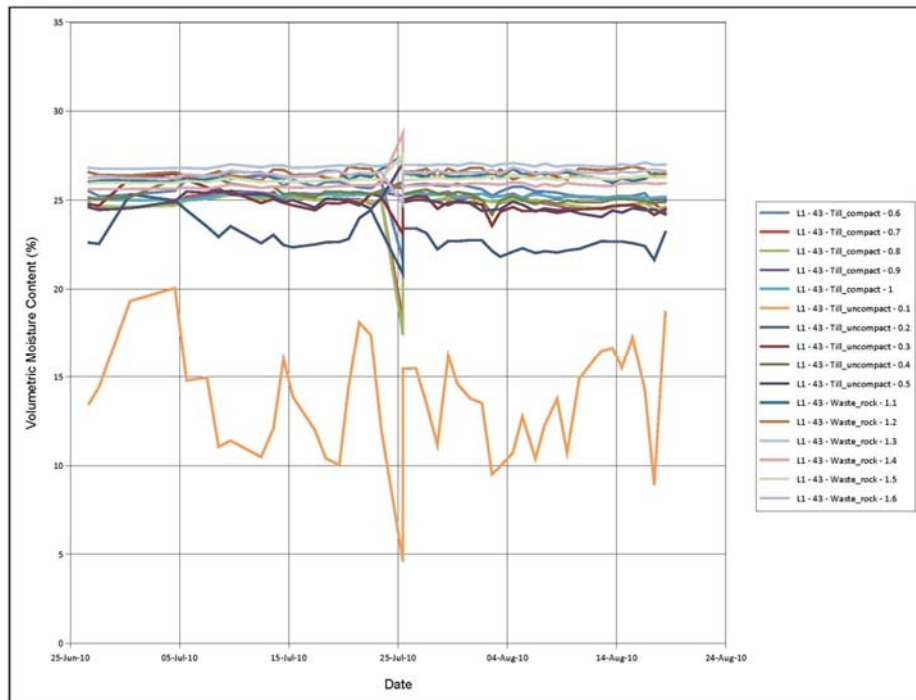


Figure 122: Daily volumetric moisture content in L#1 (Station #43) measured manually by a Sentek Diviner 2000.

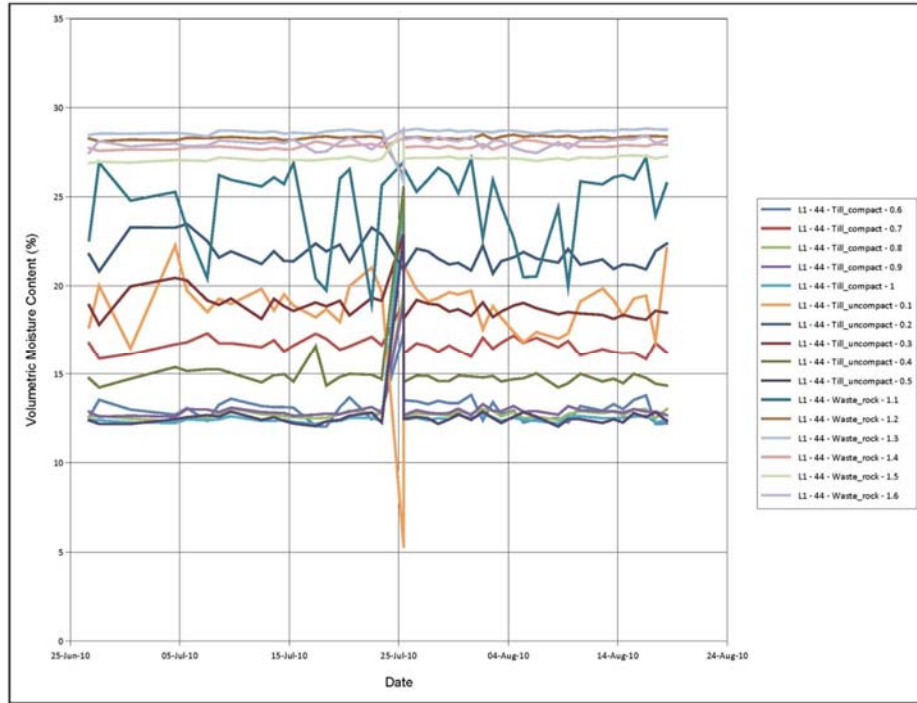


Figure 123: Daily volumetric moisture content in L#1 (Station #44) measured manually by a Sentek Diviner 2000.

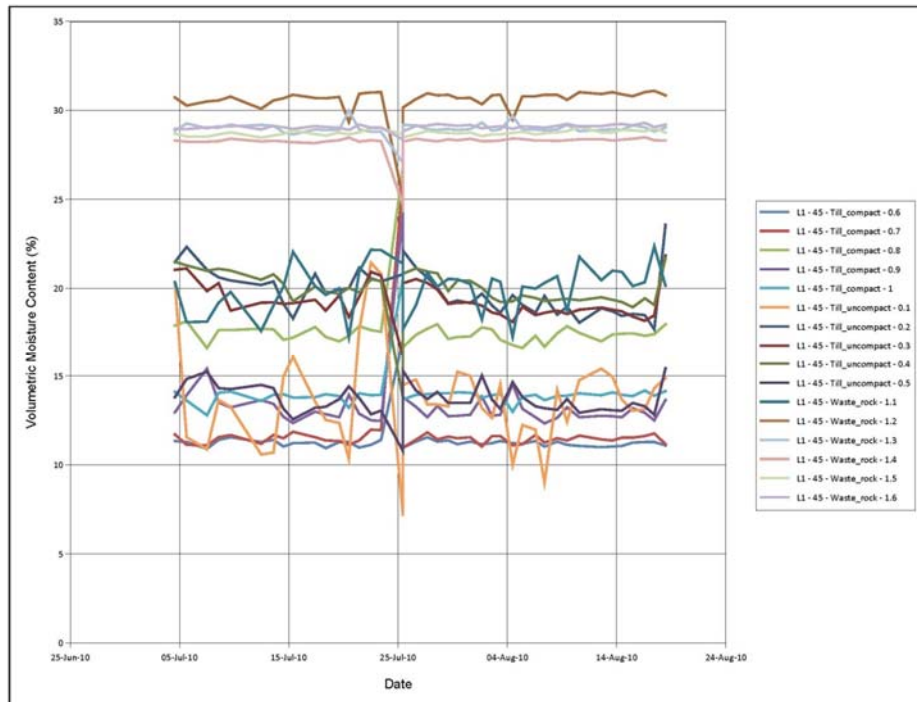


Figure 124: Daily volumetric moisture content in L#1 (Station #45) measured manually by a Sentek Diviner 2000.

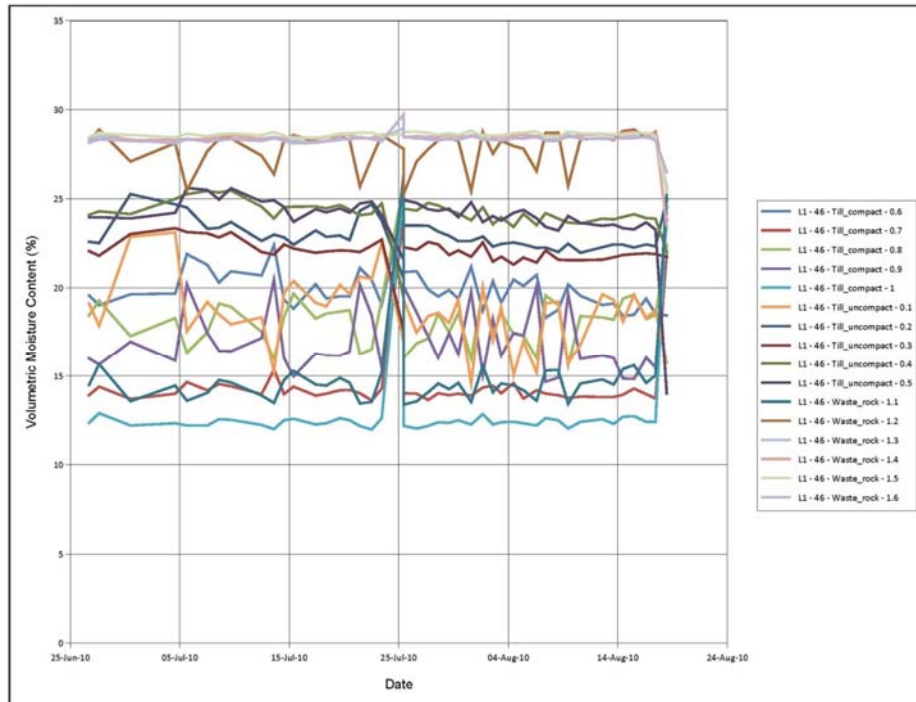


Figure 125: Daily volumetric moisture content in L#1 (Station #46) measured manually by a Sentek Diviner 2000.

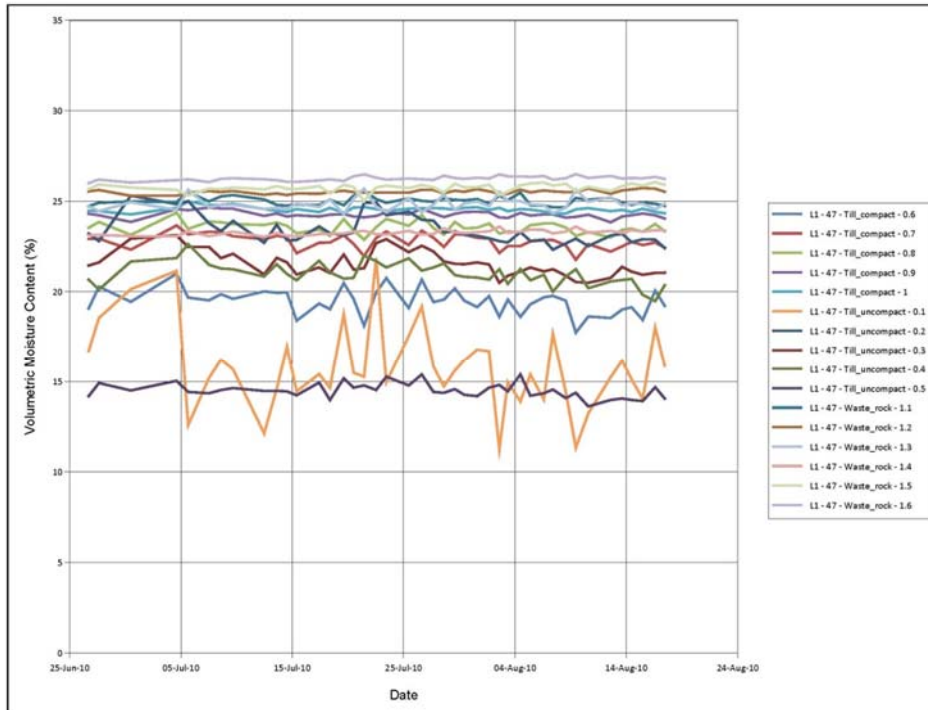


Figure 126: Daily volumetric moisture content in L#1 (Station #47) measured manually by a Sentek Diviner 2000.

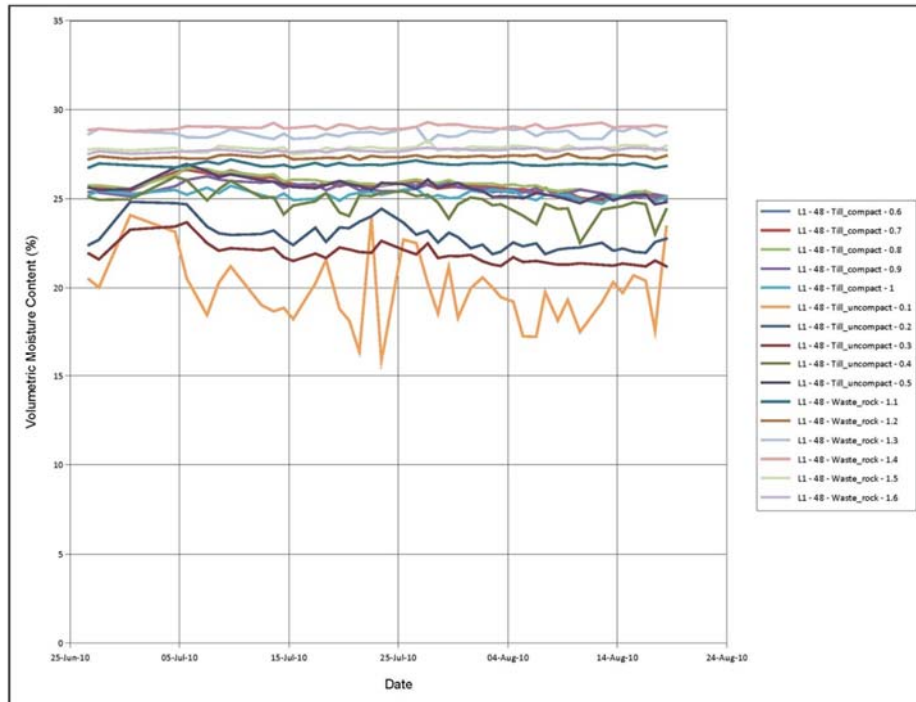


Figure 127: Daily volumetric moisture content in L#1 (Station #48) measured manually by a Sentek Diviner 2000.

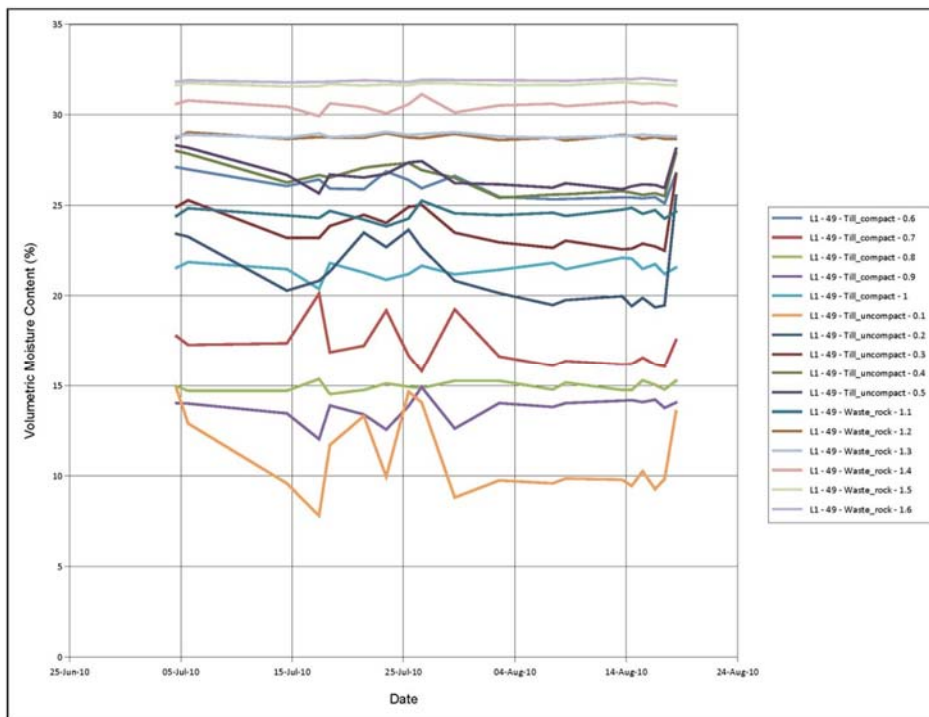


Figure 128: Daily volumetric moisture content in L#2 (Station #49) measured manually by a Sentek Diviner 2000.

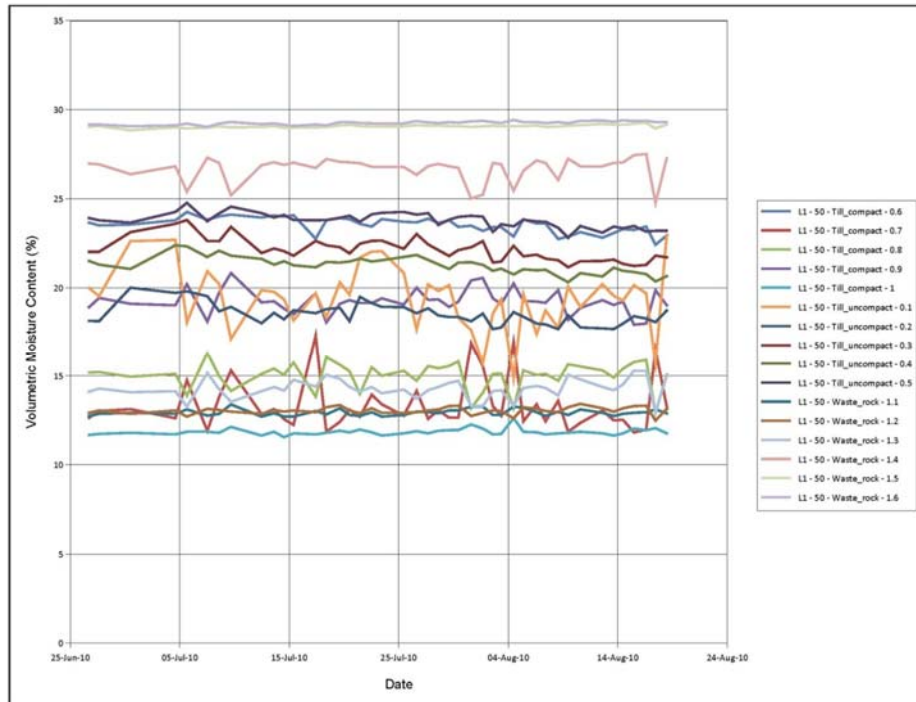


Figure 129: Daily volumetric moisture content in L#2 (Station #50) measured manually by a Sentek Diviner 2000.

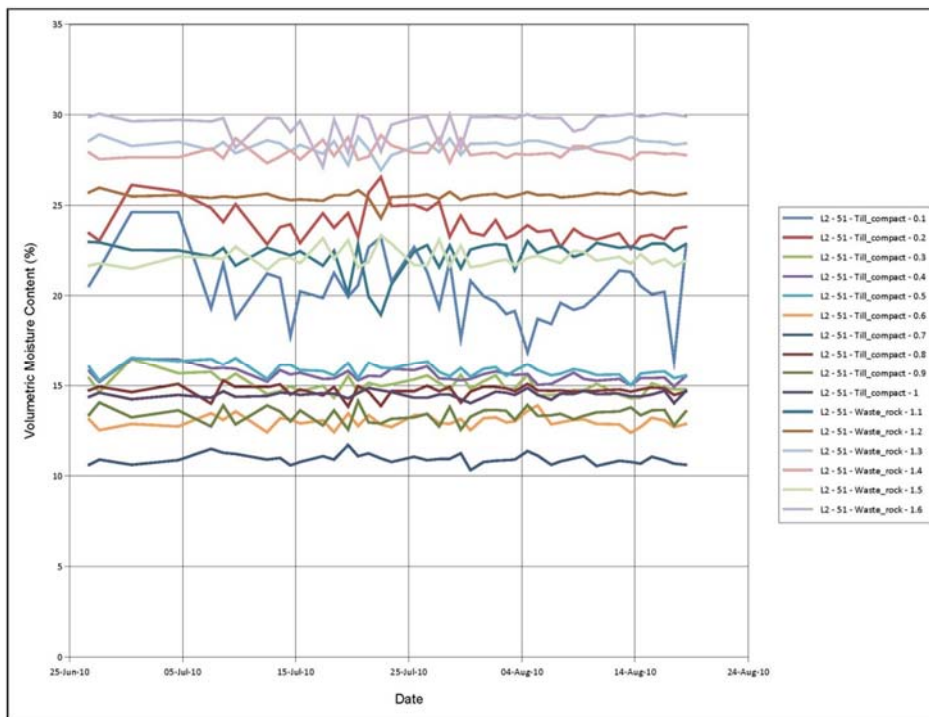


Figure 130: Daily volumetric moisture content in L#2 (Station #51) measured manually by a Sentek Diviner 2000.

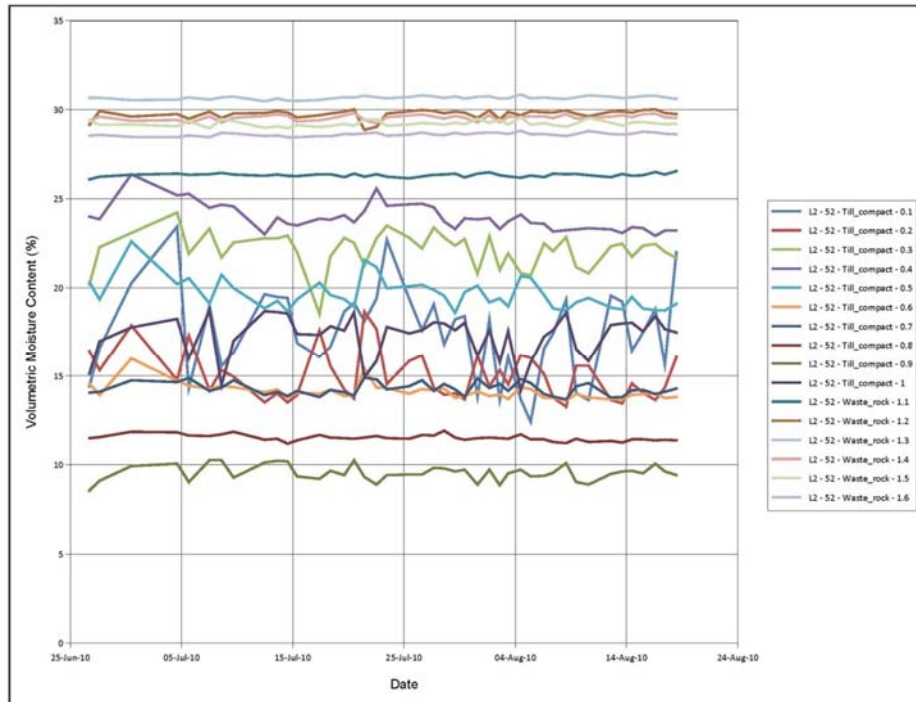


Figure 131: Daily volumetric moisture content in L#2 (Station #52) measured manually by a Sentek Diviner 2000.

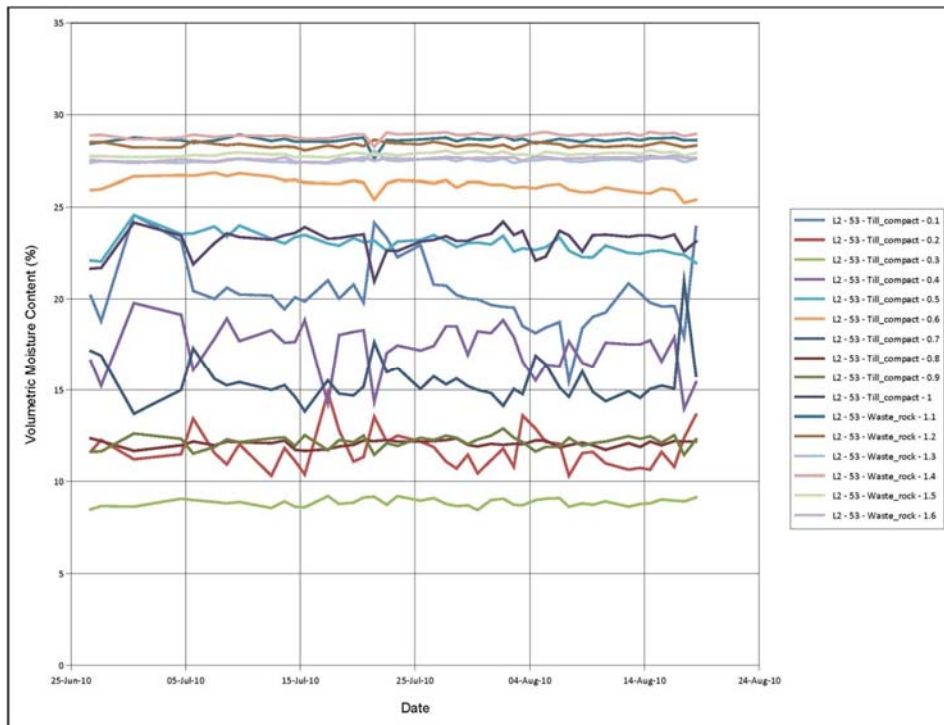


Figure 132: Daily volumetric moisture content in L#2 (Station #53) measured manually by a Sentek Diviner 2000.

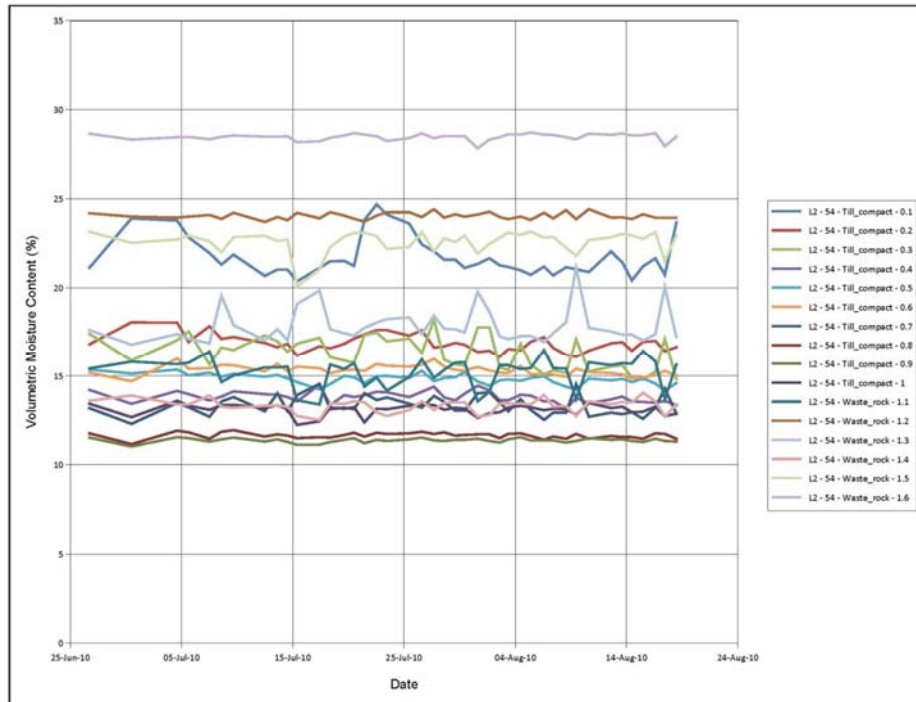


Figure 133: Daily volumetric moisture content in L#2 (Station #54) measured manually by a Sentek Diviner 2000.

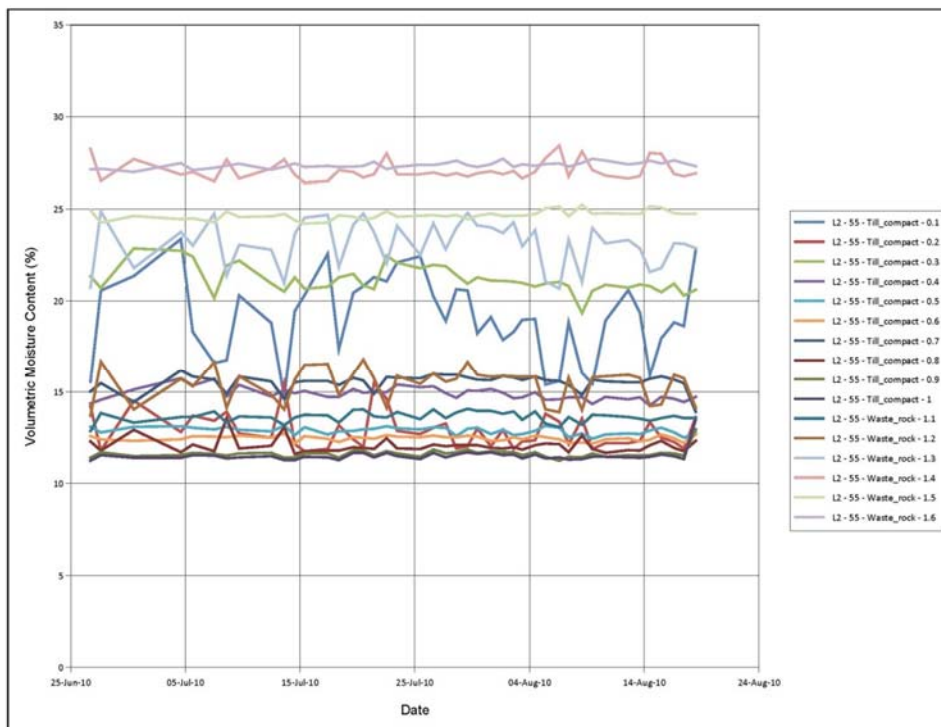


Figure 134: Daily volumetric moisture content in L#2 (Station #55) measured manually by a Sentek Diviner 2000.

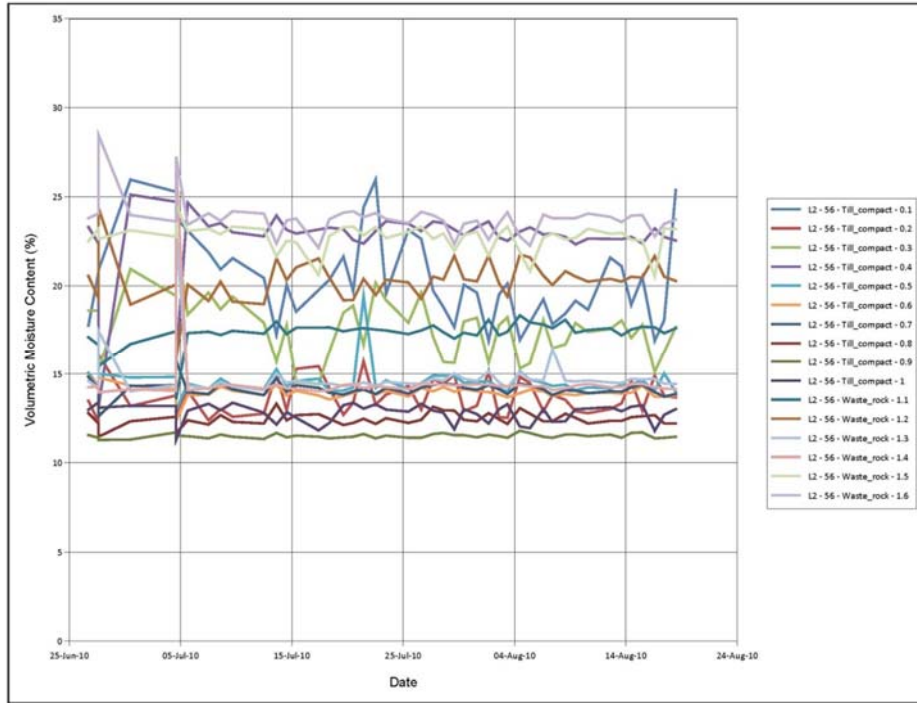


Figure 135: Daily volumetric moisture content in L#2 (Station #56) measured manually by a Sentek Diviner 2000.

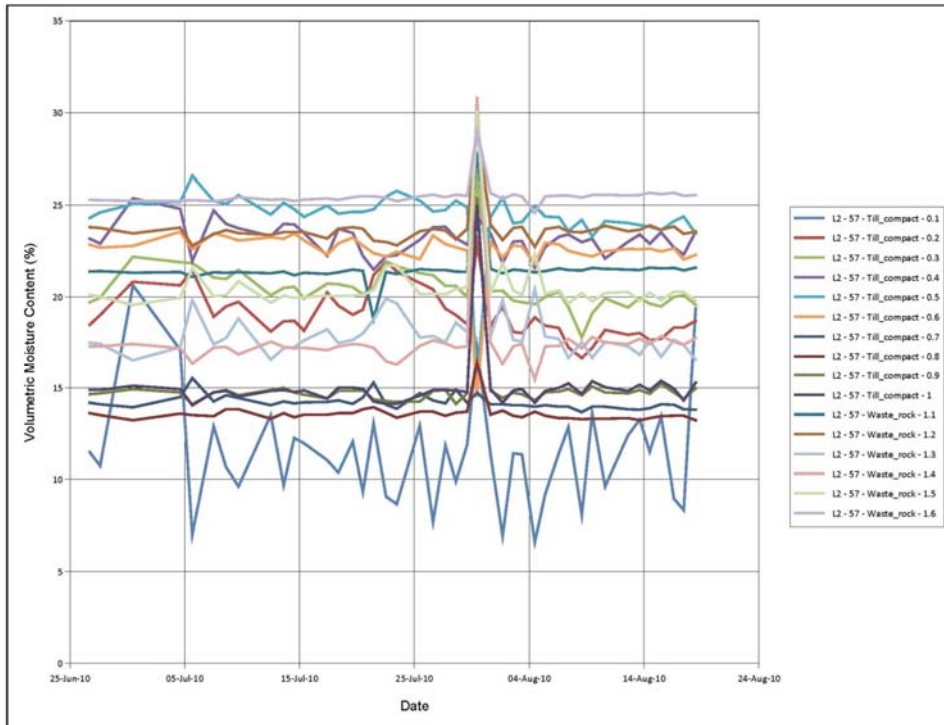


Figure 136: Daily volumetric moisture content in L#2 (Station #57) measured manually by a Sentek Diviner 2000.

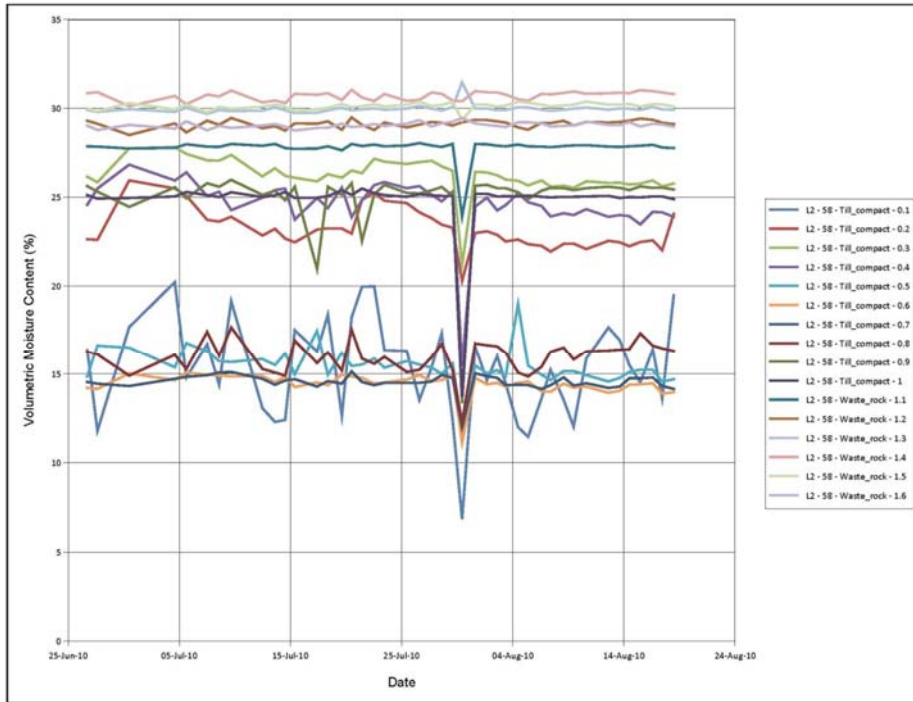


Figure 137: Daily volumetric moisture content in L2 (Station #58) measured manually by a Sentek Diviner 2000.

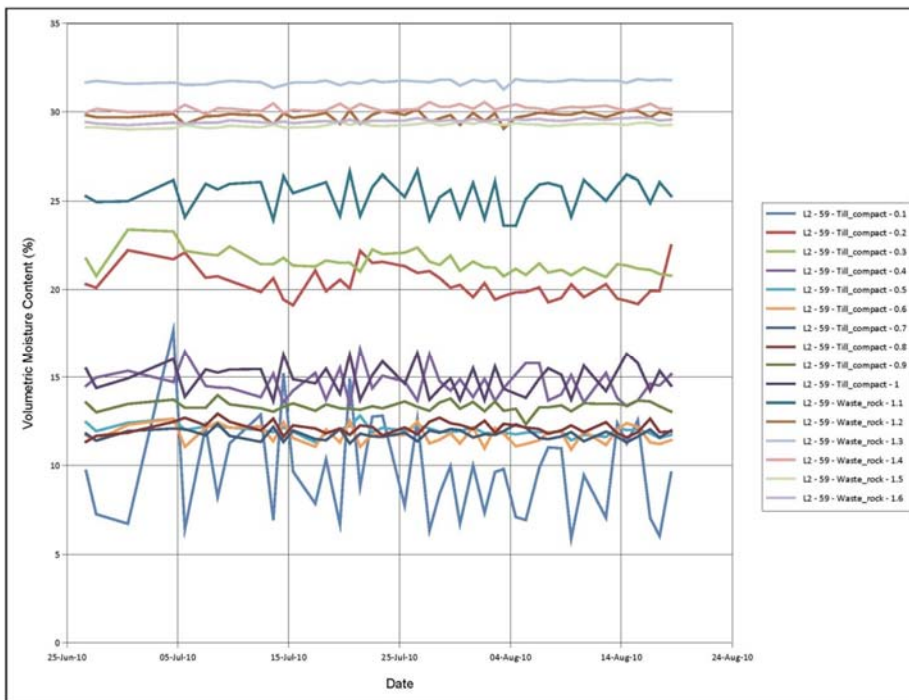


Figure 138: Daily volumetric moisture content in L#2 (Station #59) measured manually by a Sentek Diviner 2000.

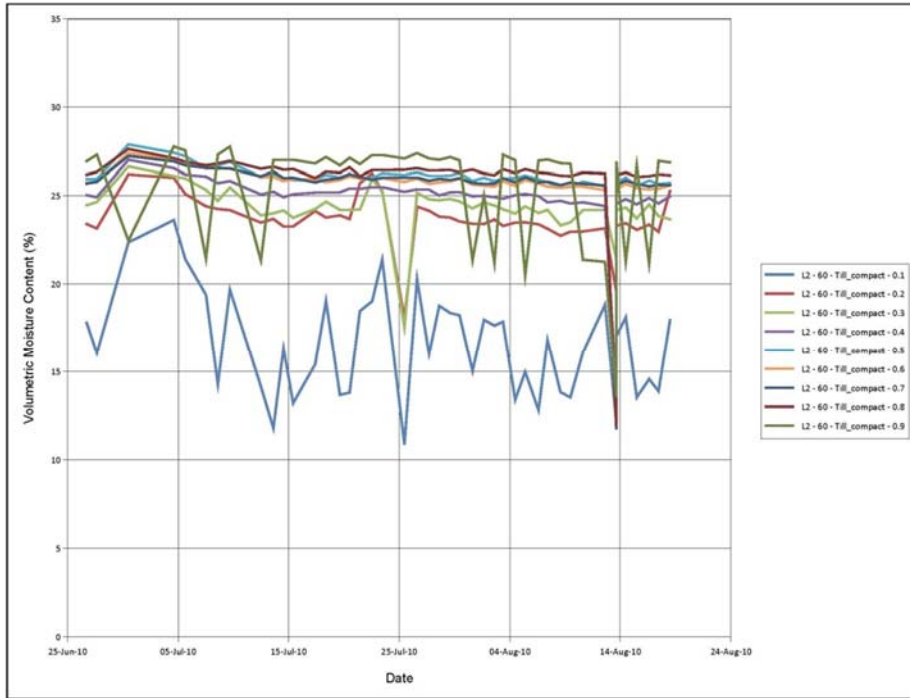


Figure 139: Daily volumetric moisture content in L2 (Station #60) measured manually by a Sentek Diviner 2000.

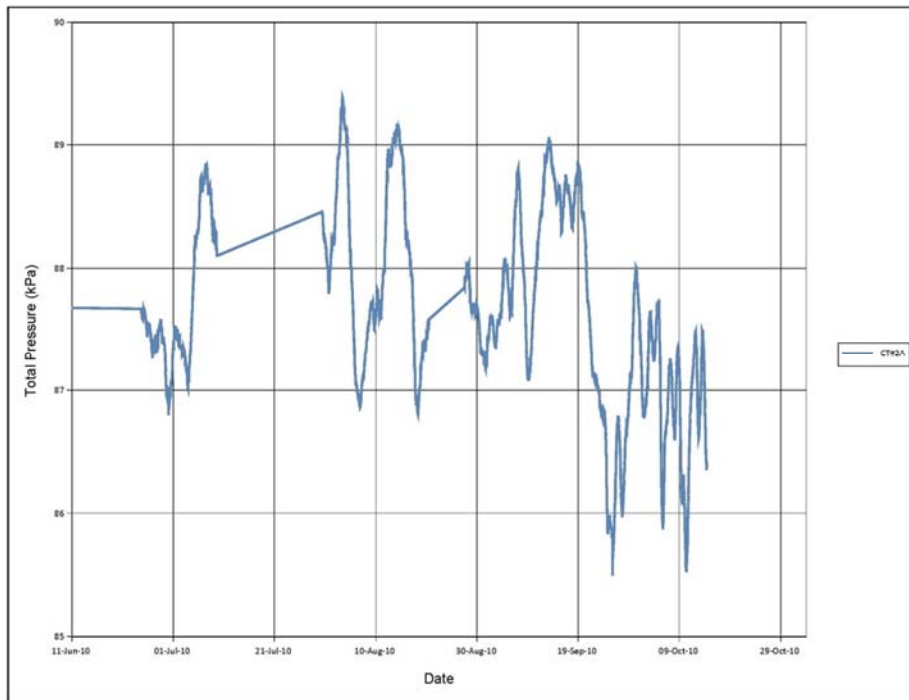


Figure 140: Hydrostatic pressure measured using the HOBO water level logger installed on CT#2A. Only significant values are displayed

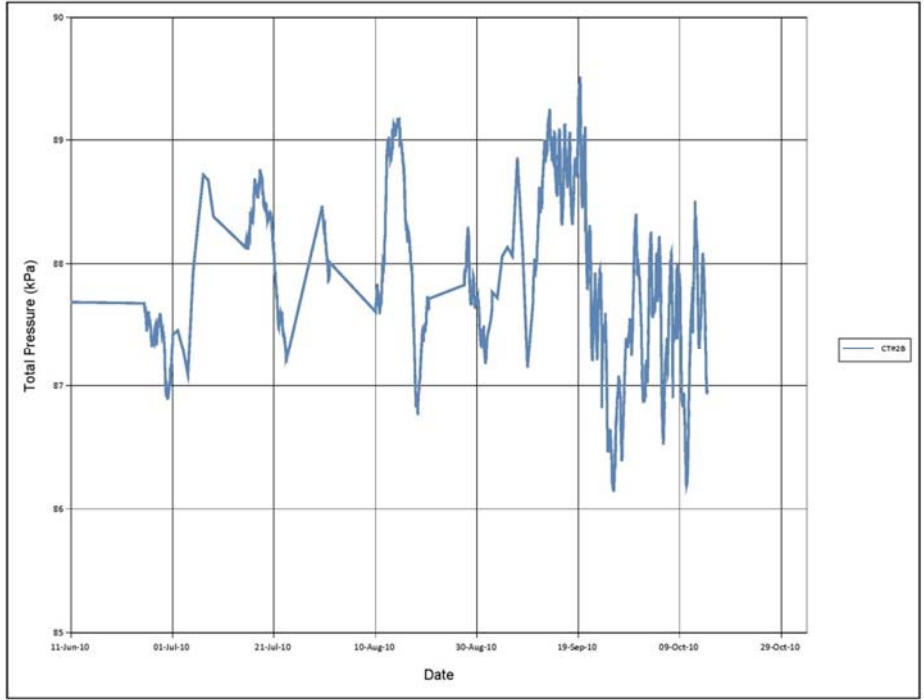


Figure 141: Hydrostatic pressure measured using the HOBO water level logger installed on CT#2B. Only significant values are displayed

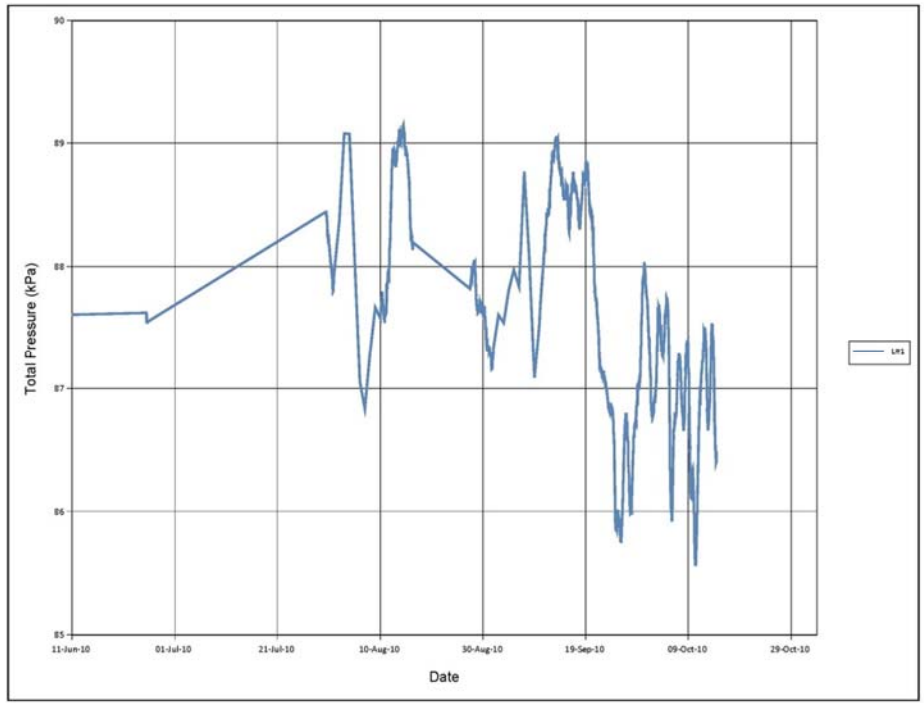


Figure 142: Hydrostatic pressure measured using the HOBO water level logger installed on L#1. Only significant values are displayed

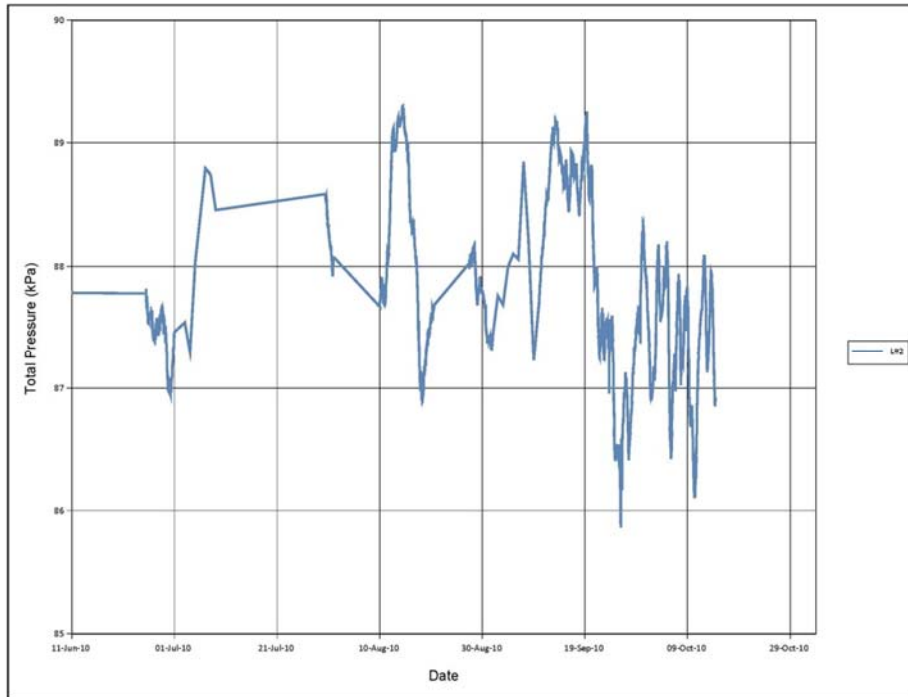


Figure 143: Hydrostatic pressure measured using the HOBO water level logger installed on L#2. Only significant values are displayed

**Appendices**

**Appendix A**  
**Technical Instructions for Data Processing and Visualisation in**  
**Microsoft Access – Technical Memorandum**

## Memo

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**To:** File **Date:** January 25, 2011  
**cc:** Maritz Rykaart, SRK **From:** Iozsef Miskolczi  
**Subject:** Processing and visualizing field data **Project #:** 1CY001.045  
 from Faro – Vangorda Test Covers in  
 Access databases

---

The data downloaded by field personnel is transmitted to SRK by email. The data files are grouped in a compressed folder for ease of transmission. A full download suite should contain a total of 30 files and 2 additional subfolders (named CT1 and CT2a2b respectively). Most of the various types of data files are easily identifiable by the file extension, as presented in Table 1 below.

**Table 1: Summary of Datalogger Types and File Formats**

Datalogger Type	Monitored Parameter	File Extension	Dedicated Software	# of files in a complete download
SeaMetric DL75	Flow	*.dlf	Flow Inspector	15
Campbell Scientific CR10X	Suction, Soil Temperature, Soil Moisture Content, Flow (Tipping Buckets), Battery Voltage	*.dat	--	2
Campbell Scientific CR1000	Suction, Soil Temperature, Soil Moisture Content, Flow (Tipping Buckets), Battery Voltage	*.dat	--	4
Lakewood UL16	Soil Temperature	*.raw	Lakewood Prolog	1
Sentek Diviner 2000	Soil Moisture Content	*.dbk	Diviner 2000 Utilities	1
Davis Vantage Pro	Climate Parameters	*.wtk	Weatherlink	Two subfolders (CT1 and CT2a2b respectively) each containing same number of files, increasing by one each month
HOBO Water Level Logger	Presence/Absence of flow	*.hobo	HoboWare Pro	4

The sections below provide a brief description of the procedure to follow for uploading the field data into an Access database and subsequent data processing and visualisation.

## 1 Flow Inspector

### 1.1 Convert raw field data into text files

The raw data downloaded from each individual SeaMetric DL 75 datalogger is stored in files with extension \*.dlf, with the numerals in the file name representing the dataloggers' serial number (used as unique identifier in this project). The dataloggers installed in the lower monitoring hut in 2005, 9 in total, have incremental serial numbers starting with 0506061 and ending 0506059 while the 6 dataloggers installed in 2008 in the upper monitoring hut have serial numbers from 72647 to 72652.

The following procedure will convert the raw data files into text files:

- Install the FlowInspector proprietary software on your computer
- Copy the downloaded data files to the C:\FIWORK directory
- Run the software and under File, Open and select a .dlf file
- The raw data for the recording period is exported by clicking File from the top drop down menu and selecting Export. From the popup dialogue box select .txt file type. When naming the exported file keep the original file name but add the year / month / day of the download to the file name as in the following example: 050605nyyyymmdd.txt, Where n = datalogger ID; and yyyymmdd = year / month / day of the download file
- Repeat steps 3 and 4 until all 15 files were exported as text files
- Copy the text files into the Flow Inspector folder under the Exported Data directory

### 1.2 Import text files into Access

- Open “transp\_Flow\_Thermistor\_Diviner\_dataAllKey03\_Final1.accdb” database on the server
- Import text files one by one using the “External Data\Import\Text File” tool
  - Create a new table for each imported file
  - In step 4 select “no primary key”
  - Name each new data table according to the naming convention detailed in Table2 below.

**Table 2: File naming convention for imported Flow Inspector text files.**

Datalogger number	Access Table Name
0506051	FaroCover_FlowInsp_1
0506052	FaroCover_FlowInsp_2
0506053	FaroCover_FlowInsp_3
0506054	FaroCover_FlowInsp_4
0506055	FaroCover_FlowInsp_5
0506056	FaroCover_FlowInsp_6
0506057	FaroCover_FlowInsp_7
0506058	FaroCover_FlowInsp_8
0506059	FaroCover_FlowInsp_9
(090521)72647	FaroCover_FlowInsp_10
(090521)72648	FaroCover_FlowInsp_11
(090521)72649	FaroCover_FlowInsp_12
(090521)72650	FaroCover_FlowInsp_13
(090521)72651	FaroCover_FlowInsp_14
(090521)72652	FaroCover_FlowInsp_15

### 1.3 Data processing and calibration

- Run “sFlowInsp\_rawToDataAll” query to collect the raw data from the separate files into on file
- Run “flowInsp\_calc” query to reconstitute the date and perform the volume and flow rate unit conversions

- Run “FlowInspectorDataAll\_Calc” query to add the identifiers and location of each flow meter. This will create a new table, “FlowInspectorDataAll\_Calc” which contains only the latest data uploaded. Paste-append the new data to “FlowInspectorDataAll” table.

#### **1.4 Visualize data in Access**

- Open “Data\_Presentation” database
- Update link to “FlowInspectorDataAll” table
- Run “Fig\_FlowMeters” to create the data graphs

## 2 Soil temperature measured by thermistors

### 2.1 Automated thermistors (Lakewood Prolog)

#### 2.1.1 Convert raw files into text files

- Install the Lakewood Prolog proprietary software on your computer
- Open \*.raw file in Lakewood Prolog software
- Switch to the “Sensor” tab on the left side of the window and select TP-10KC as measurement unit, in order to convert the raw data into temperature values (in °C)
- Export file as excel spreadsheet by clicking on the Excel logo
- Open file in Excel and delete first 9 rows, then save as Lakewood\_yyyymmdd.txt file

#### 2.1.2 Import text files into Access

- Open “transp\_Flow\_Thermistor\_Diviner\_dataAllKey03\_Final1.accdb” database on the server
- Import text files one by one using the “External Data\Import\Text File” tool
  - Import data in a new table
  - In step 3 change data type for Field1 and Field2 to Text
  - In step 4 select “no primary key”
  - Name the table as Lakewood\_yyyymmdd

#### 2.1.3 Data processing and calibration

- Transpose table using the “TransposeTable” form
  - Source file = Lakewood\_yyyymmdd
  - fixed columns = 2
  - first column to transpose=3
  - target file: “Lakewood\_dataTransp”
  - datalogger ID:”GrumThermistor\_Auto”
- Paste-Append data from “Lakewood\_dataTransp” to “lakewood\_rawTRANS”
- Run “sLakewoodCalc01”

#### 2.1.4 Visualize data in Access

- At this point you cannot visualise the dataset, as data graphs are created for both the Manual and the Automated (Lakewood) data together. See section 2.2.3 and 2.2.4 for details.

### 2.2 Manual Thermistors

#### 2.2.1 Convert raw files into text files

- Compile the manual readings into a single spreadsheet
- Save the spreadsheet as txt file with the following headings: “dataloggerID”, “SensorID”, “String\_No”, “Port\_No”, “Date”, “Resistance\_kOhm”, and “Temperature\_C”. Make sure the date is in SI format: yyyy/mm/dd. Leave the “dataloggerID”, “SensorID”, and “Temperature\_C” columns blank.

#### 2.2.2 Import text files into Access

- Open “transp\_Flow\_Thermistor\_Diviner\_dataAllKey03\_Final1.accdb” database on the server
- Import text file using the “External Data\Import\Text File” tool
  - In step 3 change data type for Field1 and Field2 to Text
  - In step 4 select “no primary key”

#### 2.2.3 Data processing and calibration

- Run “Step2\_ManualThermistor2009\_CalcTemp”
- Run “Step4\_sTemperatureData\_combined”
- Run” Step5\_ThermistorDataAll” to create table “SoilTempAllData\_Thermistors” containing all thermistor data combined (manual and Lakewood)

#### 2.2.4 Visualize data in Access

- Data graphs are created for both the Manual and the Automated (Lakewood) data together
- Open “Data\_Presentation” database
- Update link to “SoilTempAllData\_Thermistors” table
- Run “Fig\_ThermistorsAll” to create the data graphs

### 3 Weatherlink

#### 3.1 Convert raw files into text files

To convert the application specific format into text format, follow the procedure outlined in the “Data Post Processing Procedure” memo (SRK 2005).

The procedure is reproduced below:

- Install “Weatherlink” proprietary software on your computer.
- Place all **.wlk** files in the subdirectory directory and run WeatherLink program.
- Under **File** in the top pull down menu select **Open Station** and a popup dialogue box will open.
- Select the station that corresponds to the project location and Weatherlink will open all **.wlk** files in the directory.
- Click the **Browse** button (the yellow pad of paper and pencil) and all the data will be displayed.
- To export the data, click **Browse** from the top pull down menu and select **Export Records**.
- A pop up window will allow you can choose to export **Days / Months / Years**. Selecting **Years** will select all available data.
- Click **OK** and name the **.txt** file. The **.txt** file will contain the column headings and columns of data.
- When naming the exported **.txt** file use the following naming convention

**ctnyyyymmdd.txt**

**Where ct = cover trial; n = 1 or 2, which identifies the datalogger; and yyyymmdd = year / month / day of the download data file**

- Delete the data files from the Project directory and the VantageP directories before working on another data set or else the existing data will be incorporated into the new data.

#### 3.2 Import text files into Access

- Open each text file in Microsoft Excel and perform the following changes:
  - Delete first two rows from file
  - Change the date format to YYYY-MM-DD
  - Save files as: CT\_1\_raw.txt or CT\_2AB\_raw.txt respectively
- Open “transp\_Weatherlink\_dataAllKey03\_Final1.accdb” database on the server
- Import the text file using the “external Data\Import\text file” tool
  - In step 4 select “no primary key”

#### 3.3 Data processing and calibration

- Run “AddField43\_CT1” and “AddField43\_CT2AB” respectively to add the Barometric Pressure in kPa field. This will create or overwrite the tables “CT\_1\_calc” and “CT\_2AB\_calc”.
- Transpose table “CT\_1\_calc” using the “Transpose Table” form:
  - source file = CT\_1\_calc
  - target file: CT\_1\_Transp
  - fixed columns = 2
  - first column to transpose=3
  - dataloggerID: Weatherlink
- Transpose table “CT\_2AB\_calc” using the “Transpose Table” form:
  - source file = CT\_2AB\_calc
  - target file: CT\_2AB\_Transp
  - fixed columns = 2
  - first column to transpose=3
  - dataloggerID: Weatherlink

- Run “ArrayNo\_CT2A2B” for CT2AB data. This will create or overwrite the table “Weatherlink2009Data\_CT2AB”.
- Run “ArrayNo\_CT1” for CT1 data. This will create or overwrite table “Weatherlink2009Data\_CT1”
- Open “All\_data.accdb” and link tables “WeatherlinkData\_CT1” and “Weatherlink2009Data\_CT2AB” to this database
- Run query “u\_Weatherlink2009Data\_All” to compile all data collected after 2009 by the 2 weather station
- Run MakeTable query “m\_Weatherlink2009DataAll” to create table “Weatherlink2009DataAll” which contains all the data collected after 2009 and the additional processed data fields

### 3.4 Visualize data in Access

- Open “Data\_Presentation” database and refresh the link to “Weatherlink2009DataAll” table
- Run queries “q\_WL\_Wind\_Direction” and “q\_WL\_AllParameters” to prepare the data for graphing
- Open form “Fig\_WL\_Wind\_Direction” to create the graph for wind direction and form “q\_WL\_AllParameters” to create the graphs for all the other parameters. You will have to change the Y-axis scale and caption to the appropriate values for each parameter.

## 4 Sentek Diviner

### 4.1 Convert raw files into text files

- Install Sentek Diviner Utilities proprietary software on your computer.
- From the Start / Programs / Sentek highlight Diviner 2000 Utilities. This runs the program.
- Click the **Settings** tab and under the **Current Backup Path** click **Browse** (this opens a second popup window) to set the path where the **.dbk** files are stored.
- Click the **Restore / Export** tab and highlight the **.dbk** files to be exported and click the **Export** button.
  - A second popup window will open with the title **Export to CSV**
  - Highlight the rows of data to be exported (all except 99) and select the radio button for **Calibrated Moisture Readings** under the **Format** heading at the bottom of the window
  - At the top of the **Export to CSV** window, under **Export As** click the **Browse** button to set the path where the exported files will be written to:
    - A third popup window, with the title **Save as** opens and under **Save in:** set the path and file to save the exported files
    - Under **File name:** enter the name of the exported **.csv** files
    - When naming the exported **.csv** files use the following naming convention

**yyyymmdd**

**Where yyyymmdd is the year / month / day of the download data file**

- Click **Save**. This will close the **Save as** window
- Click **OK** at the bottom of the **Export to CSV** window. This will open a new window titled **Newly Created Profile Files** displaying a list of the selected files to be exported
- Click **OK** at the bottom of this window
- A series of exported files will be created in the selected directory with the following naming convention

**yyyymmdd (Pro##).csv**

**Where yyyymmdd is the year / month / day of the download data file; Pro = profile file; and ## = the file number corresponding to the station ID**

- Export the data to csv format by selecting the “Restore/Export” tab and selecting the appropriate backup file; in the subsequent window select the “Scaled Frequency” option, then highlight the profiles to be exported (all except profile No. 99)

### 4.2 Import text files into Access

- Open “Diviner\_mn01.mdb”
- Run form “importText”; the path to the input files should be generic (i.e. not the mapped drive on your machine); the target file should be named “DivinerAllData”. This operation compiles all 60 profiles into one file located under the same path as the input files
- Import the “DivinerAllData” using the “External Data\Import\Text file” tool

### 4.3 Data processing and calibration

- Transpose “DivinerAllData” using the “transposeTable” form
  - Source file = DivinerAllData
  - fixed columns = 2
  - first column to transpose=3
  - target file = DivinerAllData\_Transp
  - datalogger ID = Sentek\_Diviner

- Run "DivinerDataAll\_Calc" (= make table query) to create "DivinerAllData\_Calc" table which contains calibrated scaled frequency values

#### 4.4 Visualize data in Access

- Open "Data\_presentation.accdb" and update the link to "DivinerAllData\_Calc"
- Run "DivinerAllData\_2009" query to prepare data for graphing
- Open "DivinerAllData\_2009" form to visualise the data in a graph

## 5 CR1000

### 5.1 Convert raw files into text files

The CR1000 datalogger outputs the data in separate tables for each of the instrument monitored. These individual tables do not require processing other than deleting the first rows which contain the description of the data and are not required in Access. No proprietary software is required for data pre-processing. The following is the procedure broken down for each data type.

#### 5.1.1 Battery Voltage

- Open “CR1000\_lysimeters\_BattVolt.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

#### 5.1.2 Tipping Buckets

- Open “CR1000\_lysimeters\_TB.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

#### 5.1.3 Suction

- Open “CR1000\_lysimeters\_Suction.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

#### 5.1.4 Moisture Content

- Open “CR1000\_lysimeters\_Sentek\_ES.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

### 5.2 Import text files into Access

#### 5.2.1 Battery Voltage

- Open “transp\_CR1000\_dataAllKey03\_Final1.accdb”
- Import text files using the “External Data\Import\Text File” tool:
  - step 3 change field1 to Date/Time format
  - step 4 = no primary key
  - overwrite old file “CR1000\_lysimeters\_BattVolt”

#### 5.2.2 Tipping Buckets

- Open “transp\_CR1000\_dataAllKey03\_Final1.accdb”
- Import text file under same name:
  - step 3 change field1 to Date/Time format
  - step 4 = no primary key

#### 5.2.3 Suction and soil temperature

- Open “transp\_CR1000\_dataAllKey03\_Final1.accdb”
- Import text file under same name:
  - step 3 change field1 to Date/Time format
  - step 4 = no primary key

#### 5.2.4 Moisture Content

- Open “transp\_CR1000\_dataAllKey03\_Final1.accdb”
- Import text file under same name:
  - step 3 change field1 to Date/Time format
  - step 4 = no primary key

### 5.3 Data Processing and Calibration

#### 5.3.1 Battery Voltage

- Transpose using the “Transpose” form:
  - No of fixed columns = 1
  - First column to transpose = 3
  - Target file: “CR1000\_lysimeters\_BattVolt\_Transp”
- Run “Append\_lysimBattVolt\_ToCR1000\_DataAll” to append data to the “CR1000\_DataAll” table

#### 5.3.2 Tipping Buckets

- Transpose using the “Transpose” form
  - No of fixed columns = 1
  - First column to transpose = 3
  - Target file: “CR1000\_lysimeters\_TB\_Transp”
- Run “Append\_lysimTB\_ToCR1000\_DataAll” to append data to the “CR1000\_DataAll” table
- Run “q\_TBtotals” to create “CR1000\_lysimeters\_TB”

#### 5.3.3 Suction and soil temperature

- Transpose using the “Transpose” form
  - No of fixed columns = 1
  - First column to transpose = 3
  - Target file: “CR1000\_lysimeters\_Suction\_Transp”
- Run “Append\_lysimSuction\_ToCR1000\_DataAll” to append data to the “CR1000\_DataAll” table
- Run “CR1000\_RawSuctionData\_cs229” to create “zData” table
- Run “CR1000\_CalculatedSuction\_cs229” to create “CR1000\_SuctionOnly\_cs229”

#### 5.3.4 Moisture Content

- Transpose using the “Transpose” form
  - No of fixed columns = 1
  - First column to transpose = 3
  - Target file: “CR1000\_lysimeters\_Sentek\_ES\_Transp”
- Run “Append\_lysimSentekES\_ToCR1000\_DataAll” to append data to the “CR1000\_DataAll” table
- Run “createTable\_CR1000\_SentekES\_Calc” to create “CR1000\_SentekES\_Only” table

### 5.4 Visualize data in Access

#### 5.4.1 Battery Voltage

- Open “Data\_presentation.accdb” and update the link to “CR1000\_DataAllTranspKey”
- Run “u\_CR1000\_CR10X\_BattVolt\_all” to prepare data for visualisation
- Run “Fig\_CR1000\_CR10X\_BattVolt\_all” to visualise data as a graph

#### 5.4.2 Tipping Buckets

- Open “Data\_presentation.accdb” and update the link to “CR1000\_DataAllTranspKey”
- Run “q\_CR1000\_Flow\_TB” to prepare the data for graphing
- Run “Fig\_CR1000\_Flow\_TB” form to visualise data as a graph

#### 5.4.3 Suction

- Open “Data\_presentation.accdb” and update the link to “CR1000\_SuctionOnly\_cs229” table
- Run “q\_CR1000\_Suction” to prepare data for graphing
- Run “Fig\_CR1000\_Suction” form to visualise data as a graph

#### 5.4.4 Soil Temperature

- Open “Data\_presentation.accdb” and update the link to “CR1000\_DataAllTranspKey”
- Run “q\_CR1000\_SoilTemp\_cs229” to prepare data for graphing
- Open “Fig\_CR1000\_SoilTemp\_cs229” form to visualise data as a graph

#### 5.4.5 Moisture Content

- Open “Data\_presentation.accdb” and update the link to “CR1000\_SentekES\_Only” table
- Run “q\_CR1000\_SentekES” to prepare data for visualisation
- Open “Fig\_CR1000\_SentekES” form to visualise data as a graph

## 6 CR10X Data

The CR10X dataloggers output the data in one generic data table (one for each datalogger) with the extension “dat”. The data tables do not require any pre-processing.

### 6.1 Convert raw files into text files

- Change the name of the files from the current (received from field download) CR10X\_#1\_SA#1 to CR10X\_1 and CR10X\_#2\_SA#1 to CR10X\_2 respectively
- Change the extension of the data files from “\*.dat” to “\*.txt”

### 6.2 Import text files into Access

- Open “transp\_CR10X\_dataAllKey09\_Final1.accdb”
- Import text files one-by-one using the “External Data\Import\Text File” tool
  - step 4 = no primary key
  - overwrite old file “CR10X\_1” and “CR10X\_2” respectively

### 6.3 Data processing and calibration

- Open “transp\_CR10X\_dataAllKey09\_Final1.accdb”
- Run “m\_createCR10x\_1\_TB” to create table “CR10x\_1\_TB” which contains only the TB data
- Run “update\_CR10x\_1” to eliminate the TB data from the table
- Transpose the data files using the “Transpose file” form
  - CR10X\_1:
    - Source file = CR10x\_1
    - Fixed columns = 4
    - First column to transpose=5
    - Target file: CR10x\_1\_dataTransp
  - CR10X\_2:
    - Source file = CR10x\_2
    - Fixed columns = 4
    - First column to transpose=5
    - Target file: CR10x\_2\_dataTransp
  - CR10X\_1\_TB:
    - Source file = CR10x\_1\_TB
    - Fixed columns = 3
    - First column to transpose=4
    - Target file: CR10x\_1\_TB\_dataTransp
- Run “appendCR10x\_1\_Transp” to append the new CR10X\_1 data to “cr10x\_dataAllTranspKey” table
- Run “appendCR10x\_1TB\_Transp” to append the new CR10X\_1TB data to “cr10x\_dataAllTranspKey” table
- Run “appendCR10x\_2\_Transp” to append the new CR10X\_2 data to “cr10x\_dataAllTranspKey” table
- Run “updateCR10x\_withDateTime” to calculate the date/time and update the new data in “cr10x\_dataAllTranspKey”

#### 6.3.1 Suction

- Open “transp\_CR10X\_dataAllKey09\_calc\_Final2.accdb”
- Update all links to tables from “transp\_CR10X\_dataAllKey09\_Final1.accdb”
- Run “CR10x\_CalculatedSuction\_cs229” to create “CR10x\_SuctionOnly\_cs229” table

### 6.3.2 Moisture Content

- Open “transp\_CR10X\_dataAllKey09\_calc\_Final2.accdb”
- Update all links to tables from “transp\_CR10X\_dataAllKey09\_Final1.accdb”
- Run “createTable\_CR10x\_SentekES\_calc” to create “CR10x\_ES\_dataOnly” table

## 6.4 Visualize data in Access

### 6.4.1 Battery Voltage

- Open “Data\_presentation.accdb” and update the link to “cr10x\_dataAllTranspKey”
- Run “u\_CR1000\_CR10X\_BattVolt\_all” to prepare data for visualisation
- Run “Fig\_CR1000\_CR10X\_BattVolt\_all” form to visualise data as a graph

### 6.4.2 Tipping Buckets

- Open “Data\_presentation.accdb” and update the link to “cr10x\_dataAllTranspKey”
- Run “q\_CR10X\_Flow\_TB” to prepare the data for graphing
- Run “Fig\_CR10X\_Flow\_TB” form to visualise data as a graph

### 6.4.3 Suction

- Open “Data\_presentation.accdb” and update the link to “CR10x\_SuctionOnly\_cs229” table
- Run “q\_CR10X\_Suction” to prepare data for graphing
- Run “Fig\_CR10X\_Suction” form to visualise data as a graph

### 6.4.4 Soil Temperature

- Open “Data\_presentation.accdb” and update the link to “cr10x\_dataAllTranspKey”
- Run “q\_CR10X\_SoilTemp\_cs229” to prepare data for graphing
- Open “Fig\_CR10X\_SoilTemp\_cs229” form to visualise data as a graph
- 

### 6.4.5 Moisture Content

- Open “Data\_presentation.accdb” and update the link to “CR10x\_ES\_dataOnly” table
- Run “q\_CR10X\_SentekES” to prepare data for visualisation
- Open “Fig\_CR10X\_SentekES” form to visualise data as a graph

## 7 HOBO Water Level Logger Data

### 7.1 Convert raw files into text files

To convert the application specific format into text format, open the files in “HOBOWarePro” proprietary software. After visualizing the data in the right format (KPa and °C) click on the “Export Table Data” from the File menu to export the data to csv format.

### 7.2 Import text files into Access

- Open the csv files in Excel and perform the following changes:
  - Delete first two rows from file
  - Clear all cells from columns E through I
  - Save files as: [CoverName].txt, where CoverName could be CT#2A, CT#2B, L#1, or L#2 respectively
- Open “HOBO.accdb” database on the server
- Import the text file using the “external Data\Import\text file” tool
  - In step 4 select “no primary key”

### 7.3 Data processing and calibration

- Run the queries in the database one by one, to reconstitute the date and create the HOBO\_[CoverName]\_Calc files

### 7.4 Visualize data in Access

- Open “Data\_Presentation” database and refresh the link to all 4 “HOBO\_[CoverName]\_Calc ” tables
- Run query “HOBO\_AllData2009\_Mod” to prepare the data for graphing. This will collect the data from all 4 data tables into one table, as well as filter the data such that only values at full hour values (i.e. minute:second=00:00) are shown
- Open form “HOBO\_AllData2009I\_Mod” to create the graph

## 8 References

SRK Consulting (Canada) Inc. (2007) Downloading, Pre&Post Processing of Datalogger Data through Proprietary Software. Technical Memorandum . Project No. 1CD003.051. January.

**Appendix B**  
**Additional Climatic Data Calculated and Stored by**  
**Davis Instruments Vantage Pro Data Logger**

Parameter	Description	Verification
Dew Point	Dew-point is the temperature to which air must be cooled for saturation (100% relative humidity) to occur, providing there is no change in water content. The dew-point is an important measurement used to predict the formation of dew, frost, and fog. Dew-point is also a good indicator of the air's actual water vapor content, unlike relative humidity, which takes the air's temperature into account. High dew-point indicates high vapor content; low dew-point indicates low vapor content. In addition a high dew-point indicates a better chance of rain and severe thunder storms.	Checked
Wind Run	Wind run is measurement of the "amount" of wind passing the station during a given period of time, expressed in either "miles of wind" or "kilometres of wind". WeatherLink calculates wind run by multiplying the average wind speed for each archive record by the archive interval.	Checked
Wind Chill	Wind chill takes into account how the speed of the wind affects our perception of air temperature. Your body warms the surrounding air molecules by transferring heat from your skin. If there's no air movement, this insulating layer of warm air molecules stays next to your body and offers some protection from cooler air molecules. Wind disperses this layer of warm air, causing the air temperature to "feel" colder. The faster the wind blows, the quicker the layer of warm air is dispersed, and the colder you feel. Above 76.7°F (24.8°C), wind movement has no effect on the apparent temperature. WeatherLink versions 5.1 and later use the Osczevski (1995) equation to calculate wind chill. This is the method adopted by the US National Weather Service in September of 2001.	Checked
Heat Index	The Heat Index uses the temperature and the relative humidity to determine how hot the air actually "feels." When humidity is low, the apparent temperature will be lower than the air temperature, since perspiration evaporates rapidly to cool the body. However, when humidity is high (i.e., the air is saturated with water vapor) the apparent temperature "feels" higher than the actual air temperature, because perspiration evaporates more slowly. WeatherLink uses the Steadman (1979 & 1998) formula to calculate Heat Index, which is more accurate than the method used by the Vantage Pro console and is calculated for all temperatures.	Checked
THW Index	The THW Index uses humidity, temperature and wind to calculate an apparent temperature that incorporates the cooling effects of wind on our perception of temperature.	Checked
THSW Index	The THSW Index uses humidity, temperature, the cooling effects of wind and the heating effects of direct solar radiation to calculate an apparent temperature.	Checked
Solar Energy	The amount of accumulated solar radiation energy over a period of time is measured in Langleys.	Checked
UV Dose	Measured in MED which stands for Minimum Erythral Dose, defined as the amount of sunlight exposure necessary to induce a barely perceptible redness of the skin within 24 hours after sun exposure. In other words, exposure to 1 MED will result in a reddening of the skin. Because different skin types burn at different rates, 1 MED for persons with very dark skin is different from 1 MED for persons with very light skin.	Checked
Heating DD	One heating degree-day is the amount of heat required to keep a structure at 65°F when the outside temperature remains one degree below the 65°F threshold for 24 hours. One heating degree-day is also the amount of heat required to keep that structure at 65°F when the temperature remains 24°F below that 65° threshold for 1 hour.	Checked
Cooling DD	One cooling degree-day is the amount of cooling required to keep a structure at 65°F when the outside temperature remains one degree above the 65°F threshold for 24 hours. One cooling degree-day is also the amount of cooling required to keep that structure at 65°F when the temperature remains 24°F above that 65° threshold for 1 hour.	Checked
Inside Temp	The temperature measured inside the console	Checked
Inside Humidity	The relative humidity measured inside the console	Rising toward the end of the season.
ET	Evapotranspiration is the measure of the quantity of moisture transpiring from the leaves of a crop and evaporating from the ground. ET values are calculated from measured data on wind run, air temperature, relative humidity, and solar radiation. The ET value is calculated once each hour using the data averaged over the prior hour	Checked

**Appendix C**  
**Field Diagnostic Data Sheets**

**SRK Consulting**  
**ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet**

for Jozsef Miskolczi

Date and Time:   
 Downloaded by:

**Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)**

<b>CT#1</b>		<b>CT#2A/2B</b>	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text"/>	Console battery voltage:	<input type="text"/>
Special Comments:	<input type="text"/>		

**Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)**

	<b>CR10X-1</b>	<b>CR10X-2</b>	<b>CR1000</b>
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.05 V"/>	<input type="text" value="13.22V"/>	<input type="text" value="13.00V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

**Seametrics Data Loggers (Flowmeters in Monitoring Hut)**

	<b>Download</b>	<b>Battery OK</b>		<b>Download</b>	<b>Battery O.K.</b>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL32):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

**Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)**

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text"/>	String #3:	<input type="text"/>
String #2:	<input type="text"/>	String #4:	<input type="text"/>

Special Comments:

**Diviner 2000 Data Logger (Manual Moisture Content Probe)**

Data successfully downloaded:

Special Comments:

**HOBO Water Level Loggers**

	<b>CT#2A</b>	<b>CT#2B</b>	<b>L#1</b>	<b>L#2</b>
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

**SRK Consulting**  
**ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet**

for Jozsef Miskolczi

Date and Time:   
 Downloaded by:

**Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)**

<b>CT#1</b>		<b>CT#2A/2B</b>	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text"/>	Diagnostic test run:	<input type="text"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="6.87 V"/>	Console battery voltage:	<input type="text" value="6.81 V"/>
Special Comments:	<input type="text" value="Both stations displayed a low battery warning"/>		

**Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)**

	<b>CR10X-1</b>	<b>CR10X-2</b>	<b>CR1000</b>
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text"/>	<input type="text"/>	<input type="text"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.65 V"/>	<input type="text" value="13.72 V"/>	<input type="text" value="13.07 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

**Seametrics Data Loggers (Flowmeters in Monitoring Hut)**

	<b>Download</b>	<b>Battery OK</b>		<b>Download</b>	<b>Battery O.K.</b>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#2):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

**Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)**

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text"/>	String #3:	<input type="text"/>
String #2:	<input type="text"/>	String #4:	<input type="text"/>

Special Comments:

**Diviner 2000 Data Logger (Manual Moisture Content Probe)**

Data successfully downloaded:

Special Comments:

**HOBO Water Level Loggers**

	<b>CT#2A</b>	<b>CT#2B</b>	<b>L#1</b>	<b>L#2</b>
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

**SRK Consulting**  
**ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet**

for Jozsef Miskolczi

Date and Time:   
 Downloaded by:

**Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)**

<u>CT#1</u>	<u>CT#2A/2B</u>
Data successfully downloaded: <input type="text" value="n"/>	Data successfully downloaded: <input type="text" value="n"/>
Diagnostic test run: <input type="text" value="n"/>	Diagnostic test run: <input type="text" value="n"/>
Diagnostic test results: <input type="text"/>	Diagnostic test results: <input type="text"/>
Console battery voltage: <input type="text"/>	Console battery voltage: <input type="text"/>
Special Comments: <input type="text" value="was unable to download due to error in program"/>	

**Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)**

	<u>CR10X-1</u>	<u>CR10X-2</u>	<u>CR1000</u>
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.59 V"/>	<input type="text" value="14.83 V"/>	<input type="text" value="13.25 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

**Seametrics Data Loggers (Flowmeters in Monitoring Hut)**

	<u>Download</u>	<u>Battery OK</u>		<u>Download</u>	<u>Battery O.K.</u>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL32):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

**Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)**

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

**Diviner 2000 Data Logger (Manual Moisture Content Probe)**

Data successfully downloaded:

Special Comments:

**HOBO Water Level Loggers**

	<u>CT#2A</u>	<u>CT#2B</u>	<u>L#1</u>	<u>L#2</u>
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

**SRK Consulting**  
**ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet**

for Jozsef Miskolczi

Date and Time:   
 Downloaded by:

**Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)**

<u>CT#1</u>	<u>CT#2A/2B</u>
Data successfully downloaded: <input type="text" value="n"/>	Data successfully downloaded: <input type="text" value="n"/>
Diagnostic test run: <input type="text" value="n"/>	Diagnostic test run: <input type="text" value="n"/>
Diagnostic test results: <input type="text"/>	Diagnostic test results: <input type="text"/>
Console battery voltage: <input type="text"/>	Console battery voltage: <input type="text"/>
Special Comments: <input type="text" value="Not downloaded due to not being set up"/>	

**Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)**

	<u>CR10X-1</u>	<u>CR10X-2</u>	<u>CR1000</u>
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.36 V"/>	<input type="text" value="13.82"/>	<input type="text" value="12.75"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text" value="Changed desi paks"/>		

**Seametrics Data Loggers (Flowmeters in Monitoring Hut)**

	<u>Download</u>	<u>Battery OK</u>		<u>Download</u>	<u>Battery O.K.</u>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#2):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text" value="Water leaking from pipe right after CT#2B flow meter"/>				

**Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)**

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

**Diviner 2000 Data Logger (Manual Moisture Content Probe)**

Data successfully downloaded:

Special Comments:

**HOBO Water Level Loggers**

	<u>CT#2A</u>	<u>CT#2B</u>	<u>L#1</u>	<u>L#2</u>
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text" value="not sure if L#1 was properly relaunched after prior download."/>			

**SRK Consulting**  
**ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet**

for Jozsef Miskolczi

Date and Time:   
 Downloaded by:

**Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)**

<u>CT#1</u>	<u>CT#2A/2B</u>
Data successfully downloaded: <input type="text" value="n"/>	Data successfully downloaded: <input type="text" value="n"/>
Diagnostic test run: <input type="text" value="n"/>	Diagnostic test run: <input type="text" value="n"/>
Diagnostic test results: Console battery voltage: <input type="text"/>	Diagnostic test results: Console battery voltage: <input type="text"/>
Special Comments: <input type="text"/>	

**Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)**

	<u>CR10X-1</u>	<u>CR10X-2</u>	<u>CR1000</u>
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results: Battery Voltage:	<input type="text"/>	<input type="text"/>	<input type="text"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	No Battery voltage taken		

**Seametrics Data Loggers (Flowmeters in Monitoring Hut)**

	<u>Download</u>	<u>Battery OK</u>		<u>Download</u>	<u>Battery O.K.</u>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL32):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

**Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)**

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

**Diviner 2000 Data Logger (Manual Moisture Content Probe)**

Data successfully downloaded:

Special Comments:

**HOBO Water Level Loggers**

	<u>CT#2A</u>	<u>CT#2B</u>	<u>L#1</u>	<u>L#2</u>
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

**SRK Consulting**  
**ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet**

for Jozsef Miskolczi

Date and Time:   
 Downloaded by:

**Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)**

<u>CT#1</u>		<u>CT#2A/2B</u>	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text"/>	Console battery voltage:	<input type="text" value="3.06 v"/>
Special Comments:	<input type="text" value="Could not measure battery voltage on CT#1 b/c case zip-tied shut."/>		

**Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)**

	<u>CR10X-1</u>	<u>CR10X-2</u>	<u>CR1000</u>
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.14 V"/>	<input type="text" value="13.31 V"/>	<input type="text" value="13.19 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

**Seametrics Data Loggers (Flowmeters in Monitoring Hut)**

	<u>Download</u>	<u>Battery OK</u>		<u>Download</u>	<u>Battery O.K.</u>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#2):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="?"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input "replace="" active"="" battery"="" or="" type="text" value="No lights flashing on L#1_2 for "/>				

**Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)**

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

**Diviner 2000 Data Logger (Manual Moisture Content Probe)**

Data successfully downloaded:

Special Comments:

**HOBO Water Level Loggers**

	<u>CT#2A</u>	<u>CT#2B</u>	<u>L#1</u>	<u>L#2</u>
Data Successfully Downloaded	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Datalogger launched	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>			

**SRK Consulting**  
**ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet**

for Jozsef Miskolczi

Date and Time:   
 Downloaded by:

**Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)**

<b>CT#1</b>		<b>CT#2A/2B</b>	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="6.66 V"/>	Console battery voltage:	<input type="text" value="6.62 V"/>
Special Comments:	<input type="text"/>		

**Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)**

	<b>CR10X-1</b>	<b>CR10X-2</b>	<b>CR1000</b>
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.62 V"/>	<input type="text" value="13.78 V"/>	<input type="text" value="12.90 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

**Seametrics Data Loggers (Flowmeters in Monitoring Hut)**

	<b>Download</b>	<b>Battery OK</b>		<b>Download</b>	<b>Battery O.K.</b>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#2):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

**Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)**

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

**Diviner 2000 Data Logger (Manual Moisture Content Probe)**

Data successfully downloaded:

Special Comments:

**HOBO Water Level Loggers**

	<b>CT#2A</b>	<b>CT#2B</b>	<b>L#1</b>	<b>L#2</b>
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

**Appendix D**  
**Instrumentation Recommissioning – Activity Summary Memo**

## Memo

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<b>To:</b>	File	<b>Date:</b>	June 28, 2010
<b>cc:</b>	Maritz Rykaart	<b>From:</b>	Iozsef Miskolczi
<b>Subject:</b>	Faro Waste Rock Cover Trials Task 300 Instrumentation Recommissioning Activity Report	<b>Project #:</b>	1CY001.045

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Between June 23 and June 25 a site visit to the Faro Mine Waste Rock Trial Covers was performed by Iozsef Miskolczi. The scope of the visit was recommissioning of instrumentation, check the status of the continuously operating instrumentation, and provide training/refresher to site personnel tasked with the data downloads for the 2010 monitoring season.

On discussions with Jay Cherian, DES Environmental Coordinator, a verbal commitment was made by DES to make site personnel available to download the data during the 2010 monitoring season.

### 1 Instrumentation Recommissioning

The instruments decommissioned and removed from the monitoring huts in the previous fall were re-installed and recommissioned. The following instruments were recommissioned:

#### 1.1 Weather stations

The weather stations, consisting of the Integrated Sensor Suite (ISS) and the station console were found in the storage area at the main gate building, cleaned, transported to Vangorda and installed in their respective locations on CT#2AB and CT#1. Batteries were changed in the consoles, and the correct date and location parameters were initialised on start-up. The ID of each ISS was changed in the console setup to the correct one (ID=1 for CT#1 and ID=4 for CT#2A/B). A test download was performed successfully.

#### 1.2 Flow meters

All flow meters were re-installed, either the entire T connector or just the turbine, as required. A test download was performed successfully on one of the DL75 dataloggers. All batteries were checked and found to be working properly.

#### 1.3 Thermistor Strings

As part of the progressive reclamation campaign, some of the overburden from the Grum Dump will be hauled away. The thermistors installed on the dump fall within the area planned to be disturbed and it is our understanding that YG and DES agreed on considering the thermistors lost. Upon inspection, it was determined that the thermistors are close to the boundary of the disturbed area, and it may not have to be decommissioned until much later on (most likely September). It was decided to leave the thermistors in place for now and monitor as in previous years. The instruments will be removed only when the disturbance zone will encroach on their location.

## **2 Visual Inspection of Covers**

Some small erosion gullies were noted on the lower berm of CT#1 and CT#3A. No other signs of erosion requiring major earth works were noted. The wires between the satellite station on CT#1 and the soil moisture sensors were exposed. The wires were covered with till, and rocks were placed on top as erosion protection.

## **3 Download Procedure Refresher for DES Site Personnel**

Refresher on the download procedures of the CR1000/10X, DL75, weather stations, and the Diviner 2000 was provided to DES site personnel. The persons present were: Jay Cherian, Ben Bekk, and Shelby Fulton.

## **4 Instrumentation Maintenance and Repairs**

### **4.1 Weather Station ISS**

It was noted that the ISS with ID 4 (CT#2AB) was damaged during storage. The plate holding the UV and solar radiation sensors was bent at about 30 degrees, and one of the plastic rings of the radiation shield was cracked. Emergency repairs were performed, as required. The metal plate was bent back into its original shape, as much as possible, and the sensors were adjusted to horizontal after installation of the ISS in field.

### **4.2 Suction Sensor Cable**

The cable of one of the TC sensors on Lysimeter #2 was broken. The wires were cleaned and connected using a connector box. The plumber's magic tape was used to seal the connection and make it watertight.

### **4.3 Tipping Bucket Flow Gauge**

The last tipping bucket (last year arrived to site broken) was installed in the upper monitoring hut, and connected to the CR1000 datalogger. All the other TB's were cleaned and adjusted to horizontal position, as required. The TB's in the lower monitoring hut were inspected and were found to be working properly. The precipitates were cleaned from the plastic TB's inside the lower monitoring hut.