

Attachment C
Soil Covers for Example Alternatives and Short-Listed Options

1 Preliminary Designs of Soil Covers

1.1 Introduction

Most of the example alternatives for closure of the Anvil Range Complex include some form of soil cover over waste rock piles, sulphide cells, low grade ore, oxide fines or tailings. The purpose of this report is to describe the reasoning used to select the cover designs and make estimates of cover performance for the assessment of example alternatives.

The designs and performance estimates presented herein are preliminary only. Investigations related to soil covers for the Anvil Range waste rock and tailings are expected to continue for several seasons before definitive cover designs are put forward. The ongoing investigations are presented in more detail in SRK (2006a), SRK (2006b) and SRK (2005).

The appendices to this report also present background information from earlier studies that have not been reported elsewhere:

- Appendix 1 reviews the cover studies that were completed at the site prior to the Interim Receivership;
- Appendix 2 presents results of laboratory and field tests, completed in 2003, to characterize the locally available soil materials that might be used for cover construction; and
- Appendix 3 presents results of preliminary modeling, completed in 2004, to estimate the range of infiltration rates that could be achieved by covers constructed from the locally available materials.

2 Overview of Cover Types and Functions

2.1 Cover Types

Table 1 lists and briefly describes the major types of soil covers. SRK (2004) and Rykaart et al. (2006) present a survey of soil covers constructed at minesites around the world, and show that there will be exceptions to any simple categorization. The reason is that soil cover design and construction is highly dependent on both the local climate and the locally available materials. The categorization in Table 1 captures the range of cover possibilities for the Anvil Range site.

The “no cover” option is included as a base case, and because it was under consideration for the most inert waste rock. “Rudimentary covers” are assumed to be the minimum thickness of soil needed for reclamation. They would also serve to minimize dust release and prevent direct contact of animals with the waste. The “low infiltration” and “very low infiltration” covers are designed to limit the amount of water that enters the underlying tailings or rock, and thereby reduce the amount of contaminated water that ultimately needs to be captured and treated. There are several types within each category. The distinction between “low infiltration” and “very low infiltration” is arbitrary, but is included to allow for the possibility that higher strength contaminant sources might warrant covers that allow much less infiltration.

The distinction between “barrier” covers and “store and release” covers is important. Barrier covers are what most people think of when they picture a low infiltration or very low infiltration cover. They incorporate a low permeability “barrier” layer that simply blocks the flow of water. In dry areas such as the Yukon, the permeability of the barrier layer must be very low, as can be illustrated by a simple calculation. If the mean annual precipitation of about 380 mm/year is assumed to fall uniformly throughout the year, the rate of precipitation would be about 1×10^{-6} cm/s. To be an effective barrier to infiltration under those conditions, a soil layer would need to have a permeability much lower than 1×10^{-6} cm/s. Such low permeabilities are achievable with the till soils available in the Anvil Range area, but require heavy compaction at carefully controlled moisture contents.

Store and release covers represent a very different system. They limit infiltration by acting as sponges that hold the water until it can be removed by evaporation and/or uptake by plant roots. The evaporated water is lost directly to the atmosphere. The water taken up by plant roots is either consumed in the plant or makes its way back to the atmosphere by a process known as evapotranspiration. In all cases, the water is no longer available to infiltrate to the underlying tailings or rock. Store and release covers are in common use in dry climates, and the science to test the store and release capacity of soil materials is well developed (largely from studies of agricultural irrigation). Testing of the till soils available in the Anvil Range area shows that they can retain up to 180 mm of water in each metre of soil. That means that roughly 2 m of such soil would be capable of storing an entire year’s worth of precipitation. However, in practice, store and release covers are designed only to store seasonal peak flows, meaning that thinner layers would be feasible.

The table does not attempt to list many requirements that are common to all types of soil covers. These include:

1. Identification and development of borrow sources;
2. Development of haul roads;
3. Re-grading of steeply sloping areas to allow machine access and effective compaction, and re-grading of flat or “bubble dump” surfaces to promote positive drainage;
4. Excavating, loading, hauling, dumping, spreading and compacting the soil materials, with intensive field quality assurance and control;
5. Reclamation of borrow sources and haul roads;
6. Re-vegetation of the cover surface by seeding or planting and fertilization, with maintenance applications of additional seed and fertilizer until a natural succession is established;
7. Construction of ditches and/or swales to promote the shedding of surface water, with heavy maintenance and suspended sediment controls in the first several years and likely some level of annual maintenance over the long term;
8. Repair of erosion-damaged areas annually for the first few years after construction, and after extreme climate or seismic events in the long term; and
9. Annual inspections until stable conditions are established.

A further requirement specific to the low infiltration and very low infiltration covers is the completion of field investigations. As discussed in the references cited in Section 1, field tests of covers have been initiated. However, several additional seasons of monitoring, followed by detailed analysis of the data, will be required before final designs are possible.

Table 1: Types of Soil Cover

Category	Description
No Cover	Un-covered rock or tailings surface allowed to weather and, if possible, re-vegetate naturally.
Rudimentary Covers	Cover rock or tailings with the minimum thickness of soil needed to allow plant growth.
Low Infiltration Covers	Cover rock or tailings with layers of soil to significantly reduce the amount of water entering the surface of the waste. Two major types: • “Barrier” covers incorporating a compacted, low permeability layer that acts to stop water flow. • “Store and release” covers incorporating a thick layer of soil that can hold water until it can be evaporated and/or taken up by plants.
Very Low Infiltration Covers	Cover rock or tailings with layers of soil and/or synthetic materials to minimize the amount of water entering the surface of the waste. The major types are: • Soil covers, including barrier covers as above but with a lower permeability layer, store and release covers as above but with thicker layers, and combination covers that have store and release layers above barrier layers. • Covers incorporating a plastic, clay-impregnated fabric, or bitumen-impregnated fabric liner as the very low permeability element, generally with layers of soil below and above.

2.2 Cover Functions

Table 2 presents a list of the functions that might be required of soil covers at the Anvil Range site, and assessments of the extent to which each cover type can achieve each function. The list of functions was compiled from previous discussions with the project team and reviewers. The assessments were based on a combination of experience elsewhere and consideration of the site climate and soil properties. Most of the assessments are straightforward, but some require explanation:

- **Revegetation of surface.** All of the covers would allow some form of re-vegetation, (and in fact require it per item 6 in Section 2), but the thicker covers would allow a greater diversity of vegetation types. Concerns about root penetration can also limit the types of vegetation that are allowed to colonize a cover. For example, thinner barrier type covers and covers incorporating geosynthetics have a requirement for annual or bi-annual removal of deeply rooting tree species.
- **Contamination of surface runoff.** All of the covers include swales and ditches (see item 7 above) to assist water to run over the surface without becoming contaminated by the underlying waste. The extent to which the runoff can be kept clean is mostly dependent on those surface swales and ditches, and the associated maintenance (see item 8). However, the thinner rudimentary covers are the most likely to be eroded and the most likely to experience an upward flux of contaminants, and are therefore the least likely to provide clean runoff.
- **Infiltration and contaminated seepage.** Even rudimentary covers will promote runoff and uptake of water by vegetation, and thereby will reduce the infiltration of water into the underlying waste. However, the low infiltration and very low infiltration covers are designed specifically to reduce infiltration and will therefore be much more effective in that regard.
- **Oxygen.** Rudimentary covers can partially limit the flow of air through waste rock, and thereby restrict the oxidation reactions that lead to the release of contaminants. Thicker store and release or barrier covers will be more effective in that regard. Barrier covers that include a water saturated layer also have the potential to slow the diffusion of oxygen into the underlying waste, further limiting oxidation and acid generation.
- **Material variability.** The thicker covers that rely on either store and release or synthetic low permeability elements are likely to retain their functionality even when the soil materials are variable. Rudimentary covers are likely to be very sensitive to material variability, because the thin construction will spread any poor quality material over large areas. Covers that incorporate low permeability soil layers are also very sensitive to material variability, because both variations in grain size and moisture content can strongly affect a soil layer's "as built" permeability.
- **Construction quality.** Concerns about construction quality go hand in hand with concerns about material variability. However, some cover types can be sensitive to changes in construction quality, even when the material is perfect. Store and release covers generally have limited compaction requirements, and are therefore more likely to function even when construction quality is poor (within reason). Rudimentary covers, on the other hand, are likely to be very

sensitive to failures to control layer thickness and/or compaction. Both construction of low permeability soil layers and installation of geosynthetic liners require a high level of quality control, so covers incorporating such layers are sensitive to poor construction quality.

- Erosion. The primary defenses against erosion are vegetation and surface water management, which would be required for all of the cover types (see items 6, 7 and 8 above). However, the thinner rudimentary covers have less soil to lose, and are therefore more likely to be compromised by erosion. Covers with thicker layers have the added benefit that they can eventually self-armour, meaning that wind and water will wash away the finest surficial materials and leave behind a sand and gravel mixture that makes the remaining surface more resistant to erosion.
- Frost action. The term “frost action” covers many different phenomena arising from seasonal freezing of the soil. Soil freezing is most strong near the surface, and therefore the thinner rudimentary covers will be the most likely to be damaged by any of these processes. Freezing and thawing of compacted soils is known to significantly decrease compaction and increase permeability, meaning that covers incorporating low permeability soil layers could also be compromised by frost action. Covers incorporating geosynthetic layers are likely to retain their low permeability even after frost action, but could be subject to frost-induced heaving and solifluction. The thicker store and release covers, which do not rely on heavy compaction and do not incorporate sharply different materials, are the most likely to retain their functionality under freeze-thaw conditions.
- Root penetration. Root penetration has two effects on covers. First the root holes provide a conduit for water to get through the cover. Second, when wind or rot causes some types of trees to fall, large root balls can be pulled out and leave wide holes in the cover. The thinner rudimentary covers are the most sensitive to both effects. Covers with low permeability soil layers are most susceptible to the former effect, but covers with low permeability geosynthetic layers are also susceptible to root penetration. Covers with store and release layers generally benefit from the presence of roots, which act to draw the stored water out of the cover, but they are also susceptible to damage from uprooting.

Table 2: Cover Functions

Cover Type		Prevents release of contaminated dust	Prevents direct contact by animals	Allows re-vegetation of surface	Reduces contamination of surface runoff	Reduces infiltration & contaminated seepage	Limits oxygen entry & slows acid generation	Retains functionality in event of:				
								Material variability	Poor construction quality	Erosion	Frost action	Root penetration
No Cover		No	No	No	No	No	No	n/a	n/a	No	n/a	n/a
Rudimentary Covers		Yes	Yes	Yes (+)	Yes (-)	Yes (-)	Yes (-)	No	No	No	No	No
Low Infiltration Covers	Barrier	Yes	Yes	Yes (+)	Yes (++)	Yes (++)	Yes (++)	No	No	Yes	No	No
	Store & Release	Yes	Yes	Yes (+++)	Yes (++)	Yes (++)	Yes (+)	Yes	Yes	Yes	Yes (++)	Yes (+)
Very Low Infiltration Covers	Soil only barrier	Yes	Yes	Yes (+++)	Yes (++)	Yes (+++)	Yes (++)	No	No	Yes	No	No
	Soil only store & release	Yes	Yes	Yes (+++)	Yes (++)	Yes (+++)	Yes (+)	Yes	Yes	Yes	Yes (++)	Yes (+)
	Soil only combination	Yes	Yes	Yes (+++)	Yes (++)	Yes (+++)	Yes (++)	No	No	Yes	Yes (+/-)	Yes (+/-)
	Soil and geosynthetic	Yes	Yes	Yes (+)	Yes (++)	Yes (+++)	Yes (++)	Yes	No	Yes	Yes (+/-)	Yes(+/-)

3 Selection of Cover Types for Example Alternatives

3.1 Covers for Mine Areas

The example alternatives for closure of the Faro Mine area and the Vangorda/Grum Mine area were intended to cover a wide range of possibilities. Not surprisingly therefore, rudimentary covers, low infiltration covers and very low infiltration covers are all included. Tables 3 and 4 show the selections for each example alternative.

Where low infiltration covers are required, store and release covers were chosen over barrier covers. The reasons are largely apparent in Table 2, which shows that the store and release covers will be more robust against material variability, poor construction quality, frost action and root penetration. The borrow material studies to date also indicate an abundance of material suitable for use in store and release covers, but less material suitable for low permeability barriers.

Where very low infiltration covers are required, the choice was for either combination soil covers or soil and geosynthetic covers. It was agreed that both forms of very low permeability cover could be constructed, but that both methods have associated questions. For combination soil covers, it is not clear how thick the upper layer would need to be to protect the low permeability layer from frost action. For soil and geosynthetic covers, it is uncertain whether the use of the synthetic material with a finite life span would be acceptable to stakeholders. The decision was made to include both types in the example alternatives, so that these questions could receive further discussion by a larger group.

Table 3: Cover Types for Faro Mine Example Alternatives

Component	Alternative 1 Flow-Through Pit	Alternative 2 Upgrade Faro Creek Diversion	Alternative 3 Minimize Construction	Alternative 4 Minimize Water Treatment
Oxide Fines/ Low-Grade Ore	Very low infiltration cover, soil + geosynthetic	Very low infiltration cover, soil + geosynthetic	Rudimentary cover	Relocated to pit
Sulphide Cells	Low infiltration cover, store & release	Low infiltration cover, store & release	Rudimentary cover	Very low infiltration cover, combination soil
Faro Valley Dump	Rudimentary cover	Rudimentary cover	Rudimentary cover	Relocated to sulphide cells
Other Waste Rock	Rudimentary cover	Rudimentary cover	Rudimentary cover	Low infiltration cover, store & release

Table 4: Cover types for Vangorda/Grum Example Alternatives

Component	Alternative 1 Backfill Vangorda Pit	Alternative 2 Stabilize in Place	Alternative 3 Minimize Construction	Alternative 4 Minimize Water Treatment
Vangorda Waste Rock	Relocated to pit, low infiltration cover, store & release	Low infiltration cover, store & release	Rudimentary cover	Relocated to pit, low infiltration cover, store & release
Grum Waste	Rudimentary cover	Rudimentary cover	Rudimentary cover	Low infiltration cover, store & release
Grum Sulphide Cell	Low infiltration cover, store & release	Low infiltration cover, store & release	Rudimentary cover	Very low infiltration cover, combination soil
Ore Transfer Pad	Rudimentary cover	Rudimentary cover	Rudimentary cover	Rudimentary cover

3.2 Tailings Covers

The primary distinction among the Tailings Area example alternatives is whether the tailings are relocated. As shown in Table 5, tailings that remain in place under Example Alternatives 2 and 3 would be covered with a low infiltration cover. Under Example Alternative 4, the tailings surface would be treated to reduce dust emissions but would otherwise be left uncovered.

Table 5: Cover Types for Tailings Example Alternatives

Component	Alternative 1 Complete Relocation	Alternative 2 Stabilize in Place	Alternative 3 Partial Relocation	Alternative 4 Minimize Construction
Intermediate Tailings	Relocated to Pit	Low infiltration cover, store & release	Relocated to Pit	No cover
Original and Secondary Tailings			Low infiltration cover, store & release	

4 Design and Performance Assumptions

Long term field studies are currently underway, and will provide the basis for definitive cover designs and performance estimates. In the interim, it is necessary to make judicious assumptions about the design and performance of each type of cover, specifically:

- The material to be used;
- The thickness of material needed; and
- The resulting effect on infiltration (which affects both water quality and water treatment costs).

The following paragraphs present the design and performance assumptions recommended for use in the comparison of example alternatives. All of the assumptions are based on the best current information, but they will be subject to review as results of the long-term studies become available.

The cover types share many common requirements, as listed in Section 2. Because they are common to all of the cover types, those requirements are not discussed further herein. However, they were taken into account in estimating the construction and maintenance costs associated with each example alternative.

4.1 Mine Areas

4.1.1 Rudimentary Covers

Material

The logical source of material for construction of rudimentary covers are the abundant till deposits on the Vangorda/Grum side of the property. Laboratory tests of the till grain size distribution, compaction, permeability and soil water characteristic curves, as well as field assessments of the (previously constructed) till cover on the Vangorda waste rock dump, are reported in Appendix 2:

- The till is somewhat variable and can be classified as either sandy-clay (CL) or clayey-sand (SC) with a plasticity index between 2 and 10. Some tested till samples have no plasticity and classify as a silty-sand (SM).
- The till is generally well-graded with the gravel content less than 20%. Occasional well-rounded cobbles and boulders are found within the till matrix.
- Laboratory compaction testing shows a saturated hydraulic conductivity of between 2.5×10^{-6} cm/sec and 1.1×10^{-7} cm/sec at 95% of Standard Proctor Density.
- Field permeability tests on the Vangorda cover indicate saturated hydraulic conductivities between 2.5×10^{-4} and 1.9×10^{-5} cm/sec, at densities between 80 and 82% of Standard Proctor Density. The measured densities are significantly lower than they were immediately after construction, indicating the strong effect of seasonal freeze-thaw and wet-dry cycles.
- The capacity of the till to store and release water, estimated as the difference between the volumetric moisture contents at 33 kPa suction (i.e. field capacity) and at 1500 kPa (the wilting

point of common plants), ranges from 0.15 to 0.18. In other words, the till can store from 150 to 180 mm of water in each meter of thickness.

The borrow source investigations discussed in SRK (2005) indicate that it would be necessary to haul the till a relatively long distance for use in the Faro Mine area, but no better local sources have been identified.

Design Thickness

To meet the objective of a rudimentary cover, the thickness of the till layer only needs to be sufficient to allow plant growth. Layers as thin as 0.2 m have been used for that purpose elsewhere. However, such thin layers are difficult to place uniformly over coarse surfaces. A thickness of 0.5 m was therefore assumed for the rudimentary cover in the example alternatives. The till would need to be lightly compacted to keep it in place during construction and to minimize erosion until vegetation is established.

Estimated Infiltration Rate

The rudimentary covers would be expected to reduce infiltration of water into the underlying waste in two ways. First, the cover material would act as a sponge to store water until it could be taken up and evapotranspired by plants (i.e. a store and release effect). The 0.5 m of lightly compacted till would be able to store about 75 mm of water, or about 20% of Mean Annual Precipitation (MAP). Second, the surface grading and water management ditches would promote runoff. Currently, there is very little runoff from the waste rock surfaces, so any increase would represent an improvement.

Studies of the surface water balance of the Faro, Grum and Vangorda waste rock piles during the 2004-05 water year concluded that approximately 55% of precipitation ended up infiltrating into the uncovered dumps. However, long-term meteorological records from the Faro airport indicate that the 2004-05 water year was exceptionally wet. Total precipitation at the airport was 420 mm, which is the highest in the 28-year record and is 32% above MAP. In a more normal year, one would expect lower infiltration rates. The long term water balance and contaminant loading predictions for the site therefore assume that a typical rate of infiltration into uncovered waste rock piles will be about 45% of MAP. (Janowicz et al 2006, SRK 2006c).

Starting with the estimated infiltration of 45% of MAP into uncovered dumps, and allowing for increased evapotranspiration and runoff, a reasonable estimate of infiltration through the rudimentary covers is from about 15% to about 25% of MAP. That range was adopted for sensitivity analysis of the example alternatives. The middle of the range, 20% of MAP, was adopted as the base case assumption.

4.1.2 Low Infiltration Covers

Material

The Vangorda/Grum till deposits are the logical source of material for the construction of low infiltration covers. The properties of the till are discussed in Appendix 2 and summarized in the preceding section.

Design Thickness

Section 2 above defines a low infiltration cover as one that “significantly reduces” infiltration. Section 3 concludes that store-and-release covers are best suited to achieve that objective in the Anvil Range area.

As noted above, the till is capable of storing and releasing from 150 to 180 mm of water in each metre of thickness. Total cover thicknesses in the range of 1-2 m would therefore be capable of storing and releasing roughly from 50% to 90% of MAP, which is the typical range of effective store and release covers.

A thickness of 2.0 m was assumed for the preliminary design. In addition to being in the range needed for effective store and release of water, the 2.0 m design would allow for:

- Construction in at least four layers, which in turn allows for good quality control and reduces any impact of material variability;
- Compaction of the lowest 0.5 m layer to provide a “barrier” function; and
- Some protection of the compacted layer from freeze-thaw effects.

Regarding the last point, it is recognized that the 2.0 m depth is not sufficient to offer complete protection from freeze-thaw effects. However, it should allow the barrier layer to remain reasonably compact during the first several years after construction. By the time significant degradation of the barrier occurs, vegetation will be well established and the store and release processes will be fully operative.

Estimated Infiltration Rate

As noted above, the estimated rate of infiltration into uncovered dumps is 45% of MAP. The 2.0 m thick till covers would increase surface runoff and provide strong store and release effects. Infiltration rates through the covers would be expected to be less than 10% of MAP.

The complexities of store and release processes mean that more precise estimates of cover performance need to be based on numerical modeling. The currently ongoing field tests are expected to provide the data necessary to calibrate such models, but only after several more seasons of monitoring.

Scoping level numerical modeling, based on the material properties measured in laboratory and field tests carried out in 2003, is reported in Appendix 3. The results indicate that till covers with a thickness of 2.0 m would allow infiltration rates of about 5% of MAP. Given the limitations of models that have not been calibrated with extensive field tests that estimate needs to be treated cautiously. However, a number of conservative assumptions were made in the scoping level modeling, for example the effects vegetation and frozen layers of soil were not included.

It therefore seems reasonable to use the 5% MAP estimate as a base case assumption, but to include a wider range in sensitivity analyses. The range selected for sensitivity analyses was 3% to 8% of MAP.

4.1.3 Very Low Infiltration Covers

Material

The simplest method to construct a very low infiltration cover is to employ a geosynthetic material such as a high density polyethylene (HDPE) liner. It is well proven that such materials, if placed and seamed with adequate quality control, can be essentially impervious.

However, there are many significant concerns about the use of geosynthetics, including:

- High cost;
- Quality control difficulties associated with placing large areas of geosynthetic liner under the conditions typical of the Anvil Range site;
- Instability on sloped surfaces;
- Finite longevity; and
- A preference expressed by local first nations on other mine closure projects to avoid heavy reliance on “plastic” materials.

Therefore, an alternative type of very low infiltration cover, consisting only of till, was also considered.

Design Thickness

The combination soil and geosynthetic cover was assumed to require geotextile protection layers above and below the HDPE, a thin 0.3 m layer of compacted till subgrade below the geosynthetics, and a 1.0 m layer of till above the geosynthetics to support vegetation. These dimensions are in the range of practice elsewhere.

The soil only very low infiltration cover was assumed to consist of a 1.0 m thick layer of compacted till, overlain by 1.5 m of lightly compacted till. These dimensions were chosen arbitrarily, with the intent being only that this cover would be significantly thicker than the low infiltration cover. The 1.0 m compacted layer is intended to be a more effective barrier than the corresponding 0.5 m layer in the low infiltration cover.

Estimated Infiltration Rates

Section 2 above defines a very low infiltration cover as one that “minimizes” infiltration. The combination of soil and geosynthetic can reasonably be expected to do that. An infiltration rate of 0.5% of MAP was assumed for the combination soil and geosynthetic covers. Studies elsewhere suggest that that estimate will be conservative, even for the case of geosynthetic liners placed with poor quality control.

An estimated infiltration rate of 2% of MAP was adopted for the very low infiltration soil cover. That estimate was arbitrarily selected to be significantly lower than the 5% MAP assumption adopted for the low infiltration covers, but still higher than the 0.5% MAP estimate for the soil and geosynthetic covers.

4.2 Tailings Area

4.2.1 No Cover

The rate of infiltration into the uncovered tailings were estimated by two methods:

- Examination of the tailings porewater chemistry, and specifically the depth to which oxidation products had penetrated, led to estimated infiltration rates of 9% of MAP in fine tailings and 19% of MAP in coarse tailings.
- The scoping level numerical modeling discussed in Section 4.1.2 also included modeling of uncovered tailings, and provided estimated infiltration rates of 7% and 24% in fine and coarse tailings, respectively.

The good correlation between these two sets of estimates, developed in very different ways, is encouraging. The former estimates, which are based on field evidence, were adopted.

4.2.2 Waste Rock and Till

The scoping level numerical modeling of tailings cover variants indicated that very low infiltration rates could theoretically be obtained by some combinations of till and waste rock covers. However, those results required high proportions of the water to run off the cover surface. In the real world, construction difficulties and long-term settlement will make it difficult to ensure surface water will run off the tailing covers. It is therefore more reasonable to consider both the infiltration and the infiltration plus runoff estimates from the scoping level modeling, which ranged from a low of 5% of MAP to a high of roughly 20% of MAP.

That range also coincidentally brackets the range of infiltration estimates for the uncovered tailings. It is reasonable to assume that one requirement for the final design of the tailings covers will be that they not significantly increase infiltration. In other words, the covers will not be allowed to significantly increase either the contamination of the underlying aquifer or the cost of groundwater collection and treatment.

The range 5% to 20% MAP was therefore adopted for the sensitivity analyses of the tailings covers, and 10% of MAP was adopted as the base case estimate.

5 Summary

Table 6 summarizes the design and performance assumptions recommended for use in the assessment of example alternatives. As noted in Section 1, these recommendations are preliminary only, and subject to revision as further results become available from the ongoing field testing.

Table 6: Summary of Preliminary Design and Performance Assumptions

Cover Type	Design Assumptions	Assumed Infiltration Rate (%MAP)	
		Base Case Assumption	Range for Sensitivity Analyses
Rudimentary Covers	0.5 m lightly compacted till	20%	15% - 25%
Low Infiltration Covers	0.5 m compacted till overlain by 1.5 m lightly compacted till	5%	3% - 8%
Very Low Infiltration Covers: Soil Only	1.0 m compacted till overlain by 1.5 m lightly compacted till	2%	n/a
Very Low Infiltration Covers: Soil and Geosynthetic	0.3 m till bedding layer, overlain by geotextile, HDPE geomembrane, geotextile and 1.0 m till cover layer	0.5%	n/a
Tailings Covers	0.5 m waste rock overlain by 1.5 m lightly compacted till	10%	5% - 20%

6 References

Janowicz et al 2006 – Waste dump water balance report.

Rykaart et al 2006 – ICARD paper on cover survey.

SRK 2004 – WISMUT report on cover survey.

SRK 2005 – Borrow Sources.

SRK 2006a – Tailings Cover Tests.

SRK 2006b – Waste Rock Cover Tests.

SRK 2006c – Update of waste rock water quality predictions.

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1 ARMC Tailings Test Covers

Curragh Resources Inc. initiated a program of seven test plots on the Original Rose Creek tailings impoundment in the summer of 1987 and monitored them for five years (SRK, 1986). The purpose of these test plots was to test the effects of various cover types on Faro tailings, specifically their ability to inhibit acid generation in the tailings.

The test facility, illustrated in Photo 1, consisted of six test plots (see Figure 2) and one designated site within the old tailings adjacent to the test plots. Five different cover types were investigated including: (1) shallow water cover, (2) till cover, (3) unsaturated composite cover, (4) saturated composite cover, and an (5) organic cover. The sixth test plot was a control plot of uncovered tailings, and the seventh site was uncovered old (in-situ) tailings. Details of the construction of the test facility, baseline chemical composition of the tailings and annual monitoring results are documented in a number of reports.



Photo 1: Tailings cover test facility on the Original impoundment of the Rose Creek tailings

The effectiveness of the test covers was measured by the covers effect on temperature and oxygen availability within the tailings mass. This in turn was used to estimate the effect of the cover on the rate of sulphide oxidation and acid generation within the tailings mass.

The experiment results confirmed that the different covers did affect the oxidation processes of the tailings mass. The tailings in each test plot were shown to be generating acid, however pore water chemistry confirmed that the test plots were oxidizing at different rates.

The cover test program was not entirely successful due to a number of instrumentation failures, and the fact that the test design caused a different thermal regime than in the actual tailings impoundment. Furthermore meteoric water infiltrating through the covers was not measured and this made interpretation of the pore water chemistry difficult. However, it could be deduced that the composite covers were useful in reducing acid generation and/or migration. A review of the oxidation products indicated that the composite covers showed the greatest limitation of oxidation. The second most effective cover appeared to be the organic cover; however this was only in based on

temperature control. Based on pore water chemistry the till cover appeared to be more effective than the organic cover. The till cover however had little effect on the temperature regime, therefore its affect on oxidation retardation is prescribed to oxygen control only.

Theoretically both low temperatures and low oxygen can limit oxidation. The composite covers were shown to significantly lower the underlying tailings temperature. The same was observed for the organic cover, although much more subdued than for the composite covers. The extent to which oxidation retardation was caused by temperature control as opposed to oxygen diffusion is not known.

Although it could be deduced that the composite covers were effective in reducing the oxidation rate in the underlying tailings, the long term effects could not be determined. After the five year test period, it was recommended that the cover monitoring be extended; however, this was never carried out.

Nicholson et al. (1996) documents the results of a numerical model which was used to estimate the release of zinc and other sulphide oxidation products from the Rose Creek tailings. The purpose of this modeling was to compare the relative differences in the water quality of the Rose Creek resulting from different decommissioning alternatives. However one result is pertinent to the test covers. The composite covers, identified in the test program as the most effective cover system, were estimated to have a diffusion coefficient of $1 \times 10^{-8} \text{ m}^2/\text{s}$ over the long term. Nicholson's modeling indicates that would provide only limited protection from rapid sulphide oxidation. The modeling suggests that a more effective cover would require a diffusion coefficient a factor of five lower than this.

2 Partial Vangorda Waste Rock Pile Cover

When the Vangorda waste rock pile was designed, it was anticipated that it would be closed, by re-sloping to 3H:1V and placing a 3 m thick low permeability till cover, which would act as an infiltration and oxygen barrier. In 1993 SRK was contracted to design an interim cover for the Vangorda waste rock pile. A requirement of the design was that the waste rock pile could be reactivated in the event that mining would continue, and as such the design was not considered the final closure design. The soil cover requirement of 3 m till was considered excessive and SRK ultimately designed a 2-layer, 2 m thick till cover. The bottom 1 m till was placed with a high degree of compaction, and the upper 1 m was only loosely compacted. Furthermore, the re-sloping was done to 2.5H:1V, more as a result of survey errors by the contractor, than the intended design.

SRK recommended a small test section first to evaluate constructability of the cover. This test section would then be used to determine quality control measures for the rest of the project. This test section involved a 100 m wide section of re-sloped waste rock, and 50 m wide of till cover placed over the entire side slope length. Unfortunately, cover construction was halted at that time, and no further work continued.

The original cover design called for the final surface to be vegetated as an erosion protection measure, however due to the construction being halted, this was never done. Furthermore, since construction was halted prematurely, the final surface was not cross-graded perpendicular to the slope, and therefore runoff could flow unimpeded down the entire slope length.

This full scale test cover section has been in place for almost 10 years now. Dr. Maritz Rykaart, P.Eng., conducted a visual inspection of the site in July 2003. There were numerous erosion gulleys on the cover; however the largest gulleys were less than 200 mm deep, with the majority being between 50 and 100 mm deep (with the exception of the lower section where a sharp slope break occurs). Photos 2 and 3 illustrate some of the gulleying on this cover. The till cover is a low plasticity material, which is prone to erosion, and the amount of washed out material in the toe collection drain is evidence of the amount of the erosion that has occurred to date (See Photo 4). The amount of rilling and erosion could possibly have been limited if vegetation had established, and if the final surface was cross-ripped perpendicular to the slope to break the length of the flow path.



Photo 2: Erosion gullies on the 10 year old till cover on the Vangorda waste rock pile, as seen from the crest of the pile



Photo 3: View of the 10 year old till cover on the Vangorda waste rock pile as seen from the base of the pile



Photo 4: View of the collection drain at the toe of the till cover. Note the accumulated fines that have been washed off the slope

There was no evidence of cracking of the cover, either due to freeze/thaw action or natural wetting and drying. Some minor vegetation spots have started to develop on the cover, mostly within the erosion gullies (Photo 5).

The original cover design called for the lower compacted till layer to be 98% Standard Proctor density, and the upper loose layer to be 95% Standard Proctor density. Actual construction quality control records show that both layers were in fact placed at densities between 95 and 100% Standard Proctor density. In-situ density tests by SRK in 2003 confirmed that the cover was in a state resembling 90% Standard Proctor density, which does suggest that natural weathering has taken place. This density state is however consistent with that observed on the Overburden dump, and is therefore likely the natural density state to which this material will revert irrespective of its initial compaction.

In-situ infiltration testing on the cover in September 2003, indicated permeabilities of 2.5×10^{-4} to 6.5×10^{-5} cm/s, both at surface and 1 m deep. Simple oxygen lances were installed through the cover by SRK in 2002, and the measured oxygen concentration results suggest that the cover is not acting as an effective oxygen barrier, however, that is most likely due to the cover not being saturated at the same time of testing, a fact confirmed by shallow test pitting in the cover in September 2003.



Photo 5: Sparse natural vegetation starting to establish in the erosion gullies on the 10 year old Vangorda waste rock pile till cover.

Paste pH and conductivity testing in the cover was carried out in 2003. The results did not suggest any uptake contamination from the underlying waste rock, which could imply that there is no upward flux through the cover.

3 Vangorda Waste Rock Pile Starter Berm

The Vangorda waste rock pile has a compacted till started dyke, with 2H:1V exposed side slopes. These till dykes have been constructed with similar till as that used for the Vangorda cover test section, and the remainder of till available on site for future cover construction. The performance of the starter dyke with respect to resistance to long-term weathering and erosion has been similar to that of the Vangorda cover trial. Much of the area has been re-graded, so long-term erosion is no

longer evident. The re-graded area had a very hard surface, due to either compaction or drying. The hard surface is not conducive to vegetation, indicating that it will be necessary to carefully control surface compaction, seeding and fertilization to prevent the development of an infertile surface.

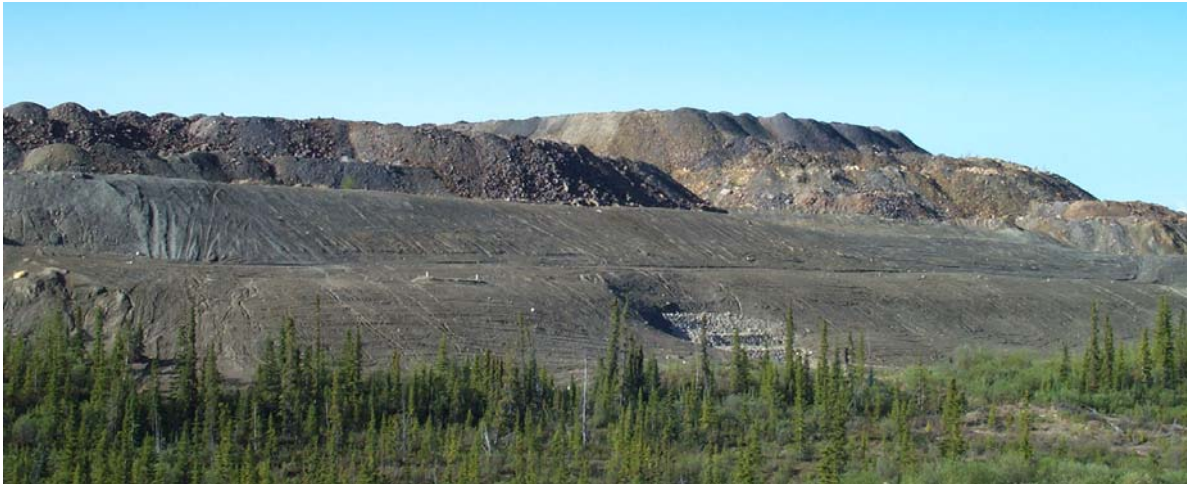


Photo 6: View of the Vangorda waste rock pile starter berm, which has been constructed from the same till that is available as a potential cover material

4 Overburden Dump

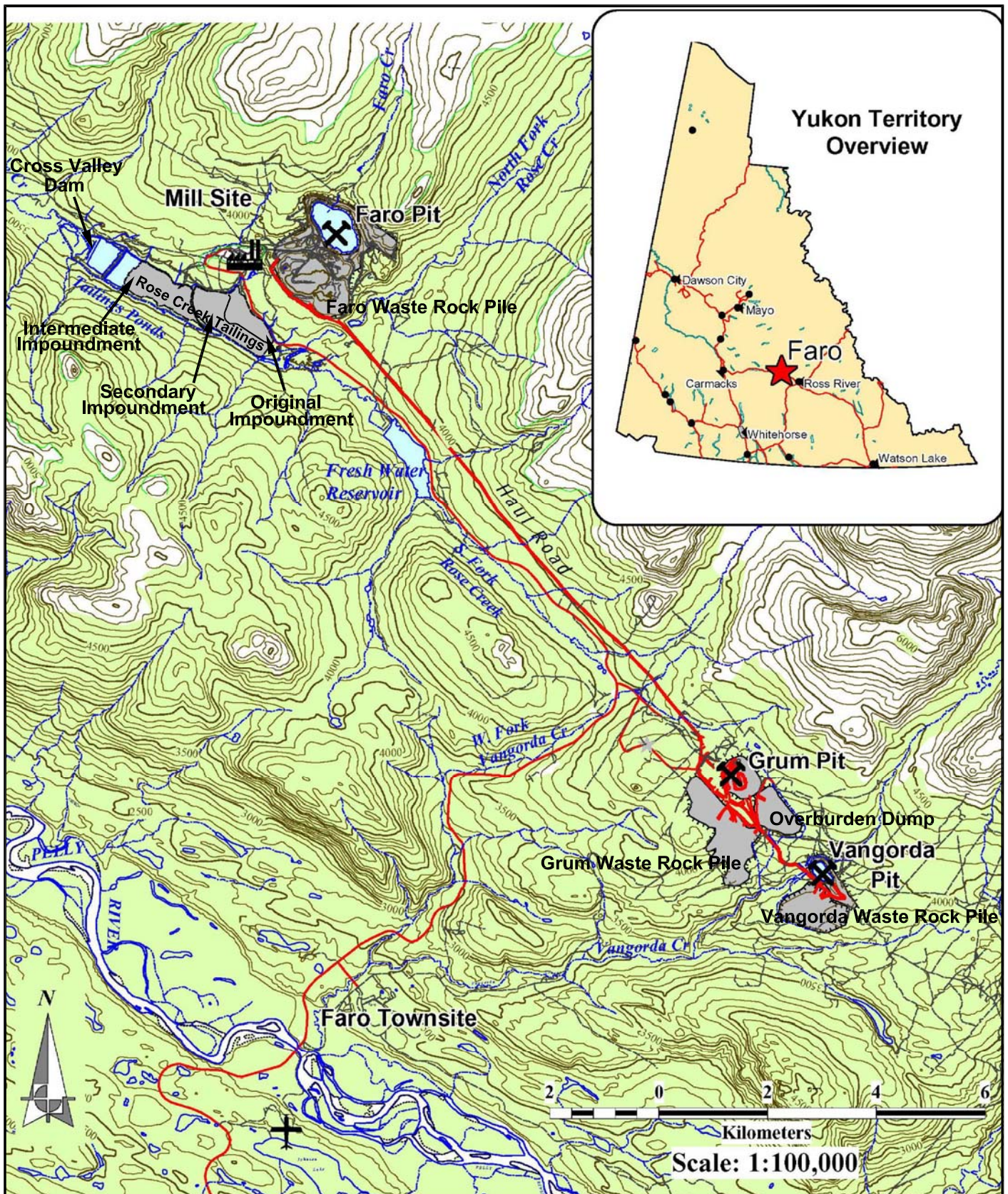
The Overburden dump consist primarily of till salvaged from the Grum pit development. This dump, which is at angle of repose, does not show excessive erosion problems, and there are signs of natural vegetation establishing, which suggest that with some assistance the material may carry vegetation. These slopes are illustrated on Photo 6.

Curragh Resources did some experimenting with re-vegetation of the Overburden dump till. They re-sloped a 200 m wide section of the dump to approximately 3H:1V and seeded the slope. No formal records exist of how and when this was done. However, vegetation continues to grow in the area, which is shown in Photo 7.

There are substantial erosion rills present on the slope, again reflecting the high erosion potential of the till material. However, the final grading on the slope was not perpendicular to the slope, thus creating preferential flow paths. Clearly the sequence and timing of revegetation is also an issue. Generally, one objective of revegetation is to quickly establish enough vegetation cover and root development to inhibit erosion. That does not appear to have been achieved in the Curragh Resources trials.



Photo 7: View of re-sloped and re-vegetated slope on the Overburden dump. Note the abrupt edge of the vegetation, confirming that without active seeding, natural re-vegetation potential is low.



Dwg Ref: Regional Loc Map.dwg

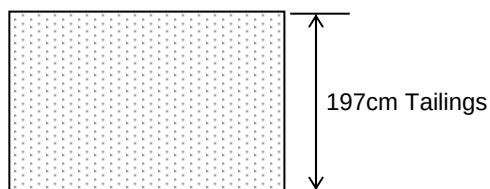


**Deloitte
& Touche**

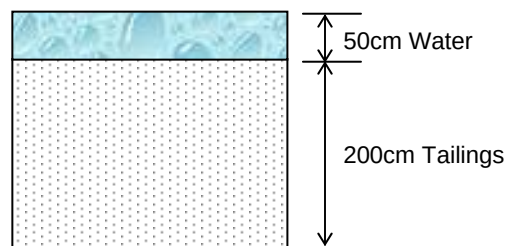
Anvil Range Mining Complex

Location Map

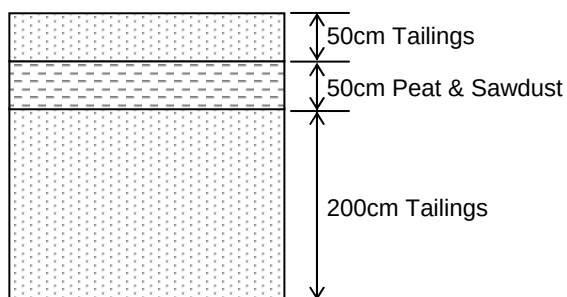
PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.26	Feb. 2004	J.H.P.	1



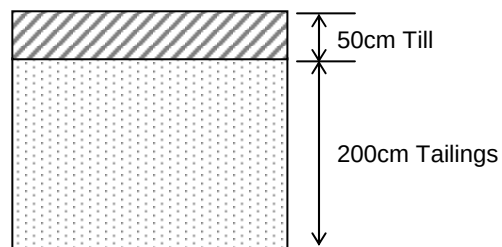
**Test Pit #3
(Control)**



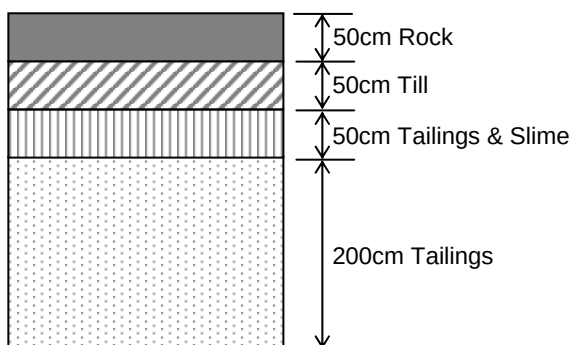
**Test Pit #6
(Water Cover)**



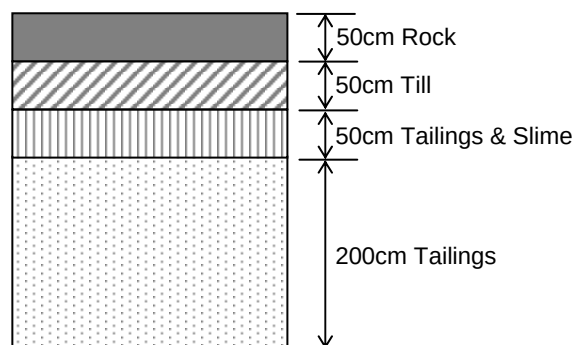
**Test Pit #2
(Organic Cover)**



**Test Pit #5
(Till Cover)**



**Test Pit #1
(Composite Cover)
saturated**



**Test Pit #4
(Composite cover)
unsaturated**

Attachment C2
Results of Laboratory and Field Testing of
Soil Cover Material Properties

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1 Laboratory Testing

1.1 Borrow Sources (Haul Distances)

SRK conducted a borrow source investigation in 2003 (SRK, 2003) to explore various potential borrow areas in the vicinity of the ARMC for use as cover materials and erosion protection. The investigation included a compilation of existing geological information for the site which was used to select locations for excavating 60 shallow test pits, which were profiled and selectively sampled for basic geotechnical testing (grain size and plasticity).

The borrow source investigation identified four primary sources of material; silts and medium plasticity clays (present in the form of till deposits), silty sands to sandy gravels (present in the glaciofluvial deposits), coarse-grained rock (for use as rip-rap), and organics. These borrow sites are scattered throughout the mine site, as illustrated on Figures 1 and 2, and the economical use of these borrow sources as potential cover materials would be dependant on the haul distances to the waste facilities.

For the purpose of this study, haul distances between the waste facilities and the borrow sources were calculated using the latest site mapping (2003 aerial photography). These haul distances are summarized in Table 1 and are based on the maximum distance between the most likely development area of each borrow site and the center of the waste facility as measured along the existing network of roads on the site.

Table 1: Summary of potential cover material volumes & haul distances

Material Type	Source (Location)	Estimated Volume (Million m ³)	Calculated Maximum Haul Distance (km)			
			Rose Creek Tailings	Faro Waste Rock Pile	Grum Waste Rock Pile	Vangorda Waste Rock Pile
Till	Grum overburden dump	8.00	18.9	18.1	3.8	4.9
	Vangorda overburden dump	0.40	19.6	18.8	4.5	2.9
	Haul road	0.72	5.6	4.7	12.3	14.8
	Rose Creek haul road	0.80	5.7	10.5	19.4	21.9
	Faro tailings	1.70	4.7	9.5	18.4	20.9
Galcio-fluvial	Haul road	0.15	5.6	4.7	12.3	14.8
	Moose pond	0.45	18.7	17.9	3.6	2.9
	Grum creek	0.20	18.7	17.9	3.6	2.8
	Vangorda/Grum back road	0.10	19.8	19.0	4.7	4.2
	Upper Vangorda creek	0.50	20.4	19.6	5.3	4.3
	Rose creek	1.40	6.7	11.4	20.4	22.8
Organics	East of Vangorda dump	0.075–0.15	20.4	19.6	5.3	4.3
	Faro west	0.05–0.075	6.0	10.8	19.7	22.2

The borrow source investigation estimated the volume of potential cover materials primarily based on the aerial extent of the deposits. The depth of the deposits was estimated based on local anecdotal knowledge of the area as opposed to actual deep drilling results. Based on these estimates, there is approximately 11.62 million cubic meters of till material, 2.8 million cubic meters of glaciofluvial material and between 0.125 to 0.225 million cubic meters of organics.

1.2 Laboratory Testing Program

1.2.1 Introduction

The evaluation of the effectiveness of a soil cover rests on a detailed assessment of the unsaturated geotechnical properties of the waste and potential cover material. Representative samples of the waste and potential cover materials were collected by SRK in June 2003, specifically for testing of these properties. This section presents the detailed results of this testing program.

1.2.2 Sample Collection, Shipping & Testing Requirements

Field samples were collected for laboratory testing by Dr. Maritz Rykaart, P.Eng. a Senior Geotechnical Engineer from SRK Vancouver, on June 10 and 11, 2003. Eight samples were collected with one sample each of the tailings (beach tailings from the Original impoundment) and waste rock (re-handled waste rock from the re-contoured slopes on the Vangorda waste rock pile), two samples containing glaciofluvial deposits, and the remaining four were till samples. The sample locations were identified in the field using a hand-held GPS, and Table 2 lists the complete information regarding each sample. The sample locations are marked on Figures 3 and 4, and Photos 1 through 8 illustrate what the sample location looked like.

Table 2: Details of waste and potential cover samples collected in June 2003

Sample No.	GPS Coordinate ¹		Sample Type (classified for general identification)
	Easting (m)	Northing (m)	
SRK-03-C01	593,781	6,902,291	Till
SRK-03-C02	593,017	6,904,626	Till
SRK-03-C03	584,776	6,912,652	Glaciofluvial
SRK-03-C04	581,020	6,914,323	Till
SRK-03-C05	579,171	6,915,071	Glaciofluvial
SRK-03-C06	580,257	6,914,564	Till
SRK-03-C07	583,228	6,912,905	Tailings
SRK-03-C08	593,749	6,902,441	Waste Rock

Coordinates based on hand-held GPS readings using UTM NAD 27 in zone 8V.



Photo 1: SRK-03-C01, till sample from the Vangorda waste rock pile cover. The sample excluded material that exceeded 50 mm (2'') in size



Photo 2: SRK-03-C02, till sample from the top of the Overburden dump. The sample excluded material that exceeded 50 mm (2'') in size



Photo 3: SRK-03-C03, glaciofluvial sample from north fork haul road borrow area. The sample excluded material that exceeded 50 mm (2") in size.



Photo 4: SRK-03-C04, till sample from Rose Creek haul road borrow area. The sample excluded material that exceeded 50 mm (2") in size.



Photo 5: SRK-03-05, glaciofluvial sample from Rose Creek west pit borrow area. The sample excluded material that exceeded 50 mm (2") in size.



Photo 6: SRK-03-C06, till sample from road cut opposite main Rose Creek tailings dam. The sample excluded material that exceeded 50 mm (2") in size.



Photo 7: SRK-03-C07, surface beach tailings from the Original impoundment at Rose Creek tailings.



Photo 8: SRK-03-C08, re-handled waste rock from Vangorda waste rock pile. The sample excluded material that exceeded 50 mm (2") in size.

Samples SRK-03-C01 through SRK-03-C06 was collected in four Ziploc bags (each weighing approximately 5 kg), and samples SRK-03-C07 and SRK-03-C08 was collected in two standard soil sample bags (each weighing approximately 10 kg). Each set of sample bags was then placed in individual plastic 5-gallon pails for shipping to the laboratory. All samples were from shallow hand-dug test pits, using a shovel, as shown in Photos 1 through 8.

The samples were transported by road from the ARMC to Whitehorse on June 11, 2003. From here they were road shipped by a commercial freight company to MDH Engineered Solutions Corp. (MDH) in Saskatoon. MDH confirmed arrival of the samples at their laboratory on June 18, 2003. At the time of testing, this was the only laboratory in Canada that could carry out the specialized unsaturated soils testing that was required.

SRK specified a list of tests that MDH was to carry out on the collected samples. This list is presented in Table 3 below. The complete laboratory results were presented to SRK on October 31, 2003 in the form of a Laboratory Testing Report (MDH, 2003) attached hereto as Data Sheet A. The results of the materials property testing is summarized in the following sections.

Table 3: List of laboratory testing carried out by MDH

Sample No.	Atterberg Limits	Specific Gravity ¹	Grain size	Standard Proctor	SWCC ²	Consolidation	Hydraulic Conductivity
SRK-03-C01	Yes	<#4 #4 – 3/8" 3/8" – 2"	Sieve & Hydrometer	4-inch mould	300 mm & 64 mm	No test	Falling head
SRK-03-C02	Yes	<#4 #4 – 3/8" 3/8" – 2"	Sieve & Hydrometer	4-inch mould	64 mm	No test	Falling head
SRK-03-C03	Yes	<#4 #4 – 3/8"	Sieve & Hydrometer	6-inch mould	300 mm & 64 mm	No test	Constant head
SRK-03-C04	Yes	<#4 #4 – 3/8"	Sieve & Hydrometer	4-inch mould	64 mm	No test	Falling head
SRK-03-C05	Yes	<#4 #4 – 3/8"	Sieve & Hydrometer	4-inch mould	64 mm	No test	Falling head & Constant head
SRK-03-C06	Yes	<#4 #4 – 3/8"	Sieve & Hydrometer	4-inch mould	64 mm	No test	Falling head
SRK-03-C07	Yes	<#4 #4 – 3/8"	Sieve & Hydrometer	No test	64 mm	Yes	Falling head
SRK-03-C08	Yes	<#4 #4 – 3/8"	Sieve & Hydrometer	No test	300 mm	No test	Constant head

1. Specific gravity testing was carried out using the different size fractions noted here.
2. Soil Water Characteristic Curves (SWCC).

1.2.3 Atterberg Limits

Atterberg limits tests were attempted on all eight samples. According to the Unified Soil Classification System (UCS), based on plasticity alone, three of the till samples were classified as inorganic clays of low to medium plasticity (CL). The remaining five samples, including one till sample, two glaciofluvial and one each tailings and waste rock samples was all classified as being non-plastic. The complete Atterberg limits results are presented in Table 4.

Table 4: Summary of Atterberg limits results

Sample No.	Material Type	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
SRK-03-C01	Till	23.0	14.5	8.5
SRK-03-C02	Till	23.8	13.9	9.9
SRK-03-C04	Till	19.4	16.8	2.6
SRK-03-C06	Till	Non-plastic		
SRK-03-C03	Glaciofluvial	Non-plastic		
SRK-03-C05	Glaciofluvial	Non-plastic		
SRK-03-C07	Tailings	Non-plastic		
SRK-03-C08	Waste Rock	Non-plastic		

1.2.4 Specific Gravity

Specific gravity tests were conducted on each sample using three size fractions. The till and glaciofluvial samples measured consistent values of between 2.68 and 2.73, with no significant variance between different size fractions. This value is typical of normal silica material. The waste rock measured a specific gravity of between 2.85 and 2.88, and again the difference between the size fractions was not significant. The slightly higher specific gravity is representative of the sulphides present in the waste rock. The finer fraction of the tailings had a measured value of 3.46, which is consistent with sulphide tailings. The complete results are summarized in Table 5.

Table 5: Summary of specific gravity results

Sample No.	Material Type	<#4 Sieve (4.75 mm)	#4 Sieve – 3/8"	3/8" – 2"
SRK-03-C01	Till	2.70	2.73	2.72
SRK-03-C02	Till	2.69	2.68	2.72
SRK-03-C04	Till	2.69	2.71	No test
SRK-03-C06	Till	2.68	2.70	No test
SRK-03-C03	Glaciofluvial	2.68	2.70	No test
SRK-03-C05	Glaciofluvial	2.68	2.70	No test
SRK-03-C07	Tailings	3.46	No test	No test
SRK-03-C08	Waste Rock	2.88	2.85	No test

1.2.5 Particle-Size Analysis

Particle-size analysis was carried out on all eight samples, and included both sieve and hydrometer testing, to measure the full envelope of the fines. Table 6 list the major size fractions of each sample, and the final UCS designation assigned to each sample (inclusive of the limits results). Figure 5 presents a summary of all these curves.

It should be noted that the sampling of till, glaciofluvial and waste rock was specifically biased to select materials smaller than 50 mm (2"). This bias when sampling the till material should not significantly affect the representativeness of the data, since the overriding majority of this material is

less than 4.75 mm in size. The glaciofluvial results may be less representative, since there are clearly significant amounts of cobbles and boulders in these deposits. These cobbles and boulders can however be easily screened, and it is likely that the materials represented by the testing would be a material that could practically be manufactured. Photos 9, 10 and 11 illustrates the heterogeneity of the till and glaciofluvial material.



Photo 9: A typical exposed till slope. Note the well-rounded cobbles and boulders contained in the soil matrix, which is not included in the laboratory sampling and testing.



Photo 10: The first of two typical exposed glaciofluvial deposits. In these deposits, there are horizontal boulder layers present, which can be easily screened out.



Photo 11: The second of two typical exposed glaciofluvial deposits. In these deposits, there are much less cobbles and boulders, and when present they are mixed throughout the matrix.

A visual inspection of the waste rock piles would lead one to conclude that the waste rock sample tested during this study would not be representative (Photo 12). Whilst this may be true, we specifically selected a sample on the re-sloped Vangorda waste rock pile for testing. If soil covers are to be used, it is a reasonable assumption that waste rock surfaces must be re-sloped. Re-sloping of these highly weathered waste rock piles, would result in the finer material being brought to surface. Furthermore, the amount of cobbles and boulders that are present after such grading and weathering, will remain in the matrix, but is less likely to dominate flow.



Photo 12: The waste rock can be anything from clay size particles to boulders.

Table 6: Summary of grain-size distribution results

Sample No.	Material Type	Gravel Content (>4.75 mm) (%)	Sand Content (0.075 mm - 4.75 mm) (%)	Fines Content (<0.075 mm) (%)	UCS
SRK-03-C01	Till	16	34	50	CL (sandy-clay)
SRK-03-C02	Till	16	37	47	SC (clayey-sand)
SRK-03-C04	Till	19	43	38	SC (clayey-sand)
SRK-03-C06	Till	0	71	29	SM (silty-sand)
SRK-03-C03	Glaciofluvial	40	60	0	GP (poorly graded gravel-sand mixture)
SRK-03-C05	Glaciofluvial	16	78	6	GP (poorly graded gravel-sand mixture)
SRK-03-C07	Tailings	0	70	30	SM (silty-sand)
SRK-03-C08	Waste Rock	49	39	12	GW (well graded gravel-sand mixture)

1.2.6 Standard Proctor Compaction Test

The potential cover materials were subjected to Standard Proctor compaction testing. The results of these tests are summarized in Table 7 below.

Table 7: Summary of Standard Proctor compaction test results

Sample No.	Material Type	Maximum Dry Density (kg/m ³)	Optimum Water Content (%)
SRK-03-C01	Till	2,072	9.9
SRK-03-C02	Till	2,045	10.0
SRK-03-C04	Till	2,120	7.4
SRK-03-C06	Till	2,087	8.4
SRK-03-C03	Glaciofluvial	2,195	6.9
SRK-03-C05	Glaciofluvial	2,065	8.5

1.2.7 Consolidation Test

A consolidation test was performed on the tailings sample (SRK-03-C07). The results of this test are summarized in Table 8. The sample was slurried into the consolidation ring and the initial moisture content was 19.2% for an initial dry density of 2,391 kg/m³, at a void ratio of 0.44.

Table 8: Summary of consolidation test results

Pressure (kPa)	Void Ratio	Coefficient of Consolidation, c_v (cm ² /s)
13.9	0.44	3.39×10^{-5}
29.3	0.44	1.34×10^{-4}
64.2	0.44	2.25×10^{-5}
131.9	0.43	3.21×10^{-5}
267.6	0.42	5.69×10^{-5}
607.8	0.40	1.11×10^{-4}
1204.7	0.38	7.07×10^{-5}
2426.5	0.36	8.59×10^{-5}
4866.6	0.32	4.35×10^{-5}

1.2.8 Saturated Hydraulic Conductivity Test

Falling head and constant head hydraulic conductivity tests was conducted on select samples. Sample SRK-03-05 was subjected to both a falling head and constant head test for quality assurance purposes. The complete hydraulic conductivity results are summarized in Table 9. All samples were prepared to 95% Standard Proctor density.

Table 9: Summary of laboratory hydraulic conductivity tests

Sample No.	Material Type	Test Type	Water content (%)	Dry Density (kg/m ³)	Hydraulic Conductivity (cm/s)
SRK-03-C01	Till	Falling Head	15.9	1,966	1.28×10^{-7}
SRK-03-C02	Till	Falling Head	14.8	1,932	1.09×10^{-7}
SRK-03-C04	Till	Falling Head	14.2	2,025	3.25×10^{-6}
SRK-03-C06	Till	Falling Head	14.8	1,967	2.48×10^{-6}
SRK-03-C03	Glaciofluvial	Constant Head	8.0	2,095	1.13×10^{-3}
SRK-03-C05	Glaciofluvial	Falling Head	-	2,011	3.81×10^{-5}
SRK-03-C05	Glaciofluvial	Constant Head	10.0	2,019	4.98×10^{-5}
SRK-03-C07	Tailings	Falling Head	15.4	2,676	1.16×10^{-5}
SRK-03-C08	Waste Rock	Constant Head	8.0	1,852	5.11×10^{-3}

1.2.9 Soil-Water Characteristic Curve Test

Soil water characteristic curve (SWCC) tests were carried out on all the samples using the pressure plate technique for the suction range below 1,500 kPa and the vapour extraction technique for suctions higher than this. Two samples; one till and one glaciofluvial sample were subjected to both the standard test method (63 mm sample diameter) which consists of screening out the size fraction less than 4.75 mm, and full size fraction using 300 mm diameter Tempe cells. The complete laboratory results are presented in Figure 6.

The numerical code RETC was used to fit curves to the laboratory data, using the van Genuchten formulation. The most representative curves for all samples are presented on Figures 7, 8 and 9, and the representative van Genuchten parameters for these curves are listed in Table 10.

Table 10: Summary of van Genuchten parameters for SWCC's

Sample No.	Material Type	θ_r (%) ¹	θ_s (%) ²	K_s (cm/sec) ³	a^4	n^4	p^4
SRK-03-C01	Till	20.8	27.8	1.46×10^{-7}	0.007	1.314	0.5
SRK-03-C01 – large test	Till	17.8	28.7	1.46×10^{-7}	11.782	1.137	0.5
SRK-03-C02	Till	10.8	27.0	1.52×10^{-7}	0.003	1.154	0.5
SRK-03-C04	Till	0.0	26.0	3.61×10^{-6}	0.071	1.073	0.5
SRK-03-C06	Till	0.0	26.2	2.67×10^{-6}	0.002	1.411	0.5
SRK-03-C03	Glaciofluvial	0.0	22.8	1.15×10^{-3}	0.011	1.350	0.5
SRK-03-C03 – large test	Glaciofluvial	0.0	23.1	1.15×10^{-3}	0.293	1.222	0.5
SRK-03-C05	Glaciofluvial	0.0	24.6	4.49×10^{-5}	0.008	1.406	0.5
SRK-03-C07	Tailings	8.0	38.0	1.31×10^{-5}	0.012	2.103	0.5
SRK-03-C08	Waste Rock	0.0	36.1	5.54×10^{-3}	0.327	1.225	0.5

1. Residual volumetric moisture content.
2. Saturated volumetric moisture content.
3. Saturated hydraulic conductivity.
4. Curve fit parameters.

RETC applies a best-fit SWCC curve to the laboratory data, however in some cases these curve fits were not representative of the sample characteristics. Figures 10 to 13 present the results of four SWCC tests where we manually adjusted the curve fit. In all these cases the base case RETC curve resulted in a steep SWCC with a higher Air Entry Value (AEV) than suggested by the data, and lower saturated volumetric moisture content. If we forced the curve fit to pass through the laboratory measured saturated volumetric moisture content, the AEV became less than suggested by the data points, and to steep in the medium suction range. In these cases we therefore opted to ignore the high suction range data points and used a best-fit through the low to medium range data points. This was deemed representative, since the availability of moisture and the primary infiltration characteristics of these materials will be governed by matric suction and hydraulic conductivity in the low suction ranges, as opposed to the high suction ranges.

Two samples were subjected to both the standard test method, and a large-scale SWCC test. The large scale test was designed to yield more representative results for samples with substantial amounts of particles larger than 4.75 mm. The large scale till sample (Figure 14) showed a very low AEV (less than 0.1 kPa); however the curve suggests that the sample has a dual porosity with another AEV at approximately 200 kPa. The small scale-sample showed a more distinct AEV at approximately 10 kPa, however, the high suction data points again suggested dual porosity with another AEV at approximately 1,000 kPa.

The difference between the large and small-scale test on the glaciofluvial sample (Figure 15) was similar with the large cell indicating a lower AEV than the small cell. These results can be explained in terms of the greater drainage characteristics of the larger particles present in the large cells.

The determination of the saturated volumetric water content (θ_s), for each SWCC was a direct outcome of the test, whilst the determination of the AEV, the residual matric suction (ψ_r) and the residual moisture content (θ_r) for each test was carried out using the construction technique proposed by Fredlund and Xing (1994), using the van Genuchten curves presented in Figures 7, 8 and 9. Table 11 list these properties for each of the tested samples.

Table 11: Summary of soil water characteristic curve results

Sample No.	Material Type	θ_s (%)	AEV (kPa)	θ_r (%)	ψ_r (kPa)
SRK-03-C01	Till	27.8	10.0	3,000	6.0
SRK-03-C01 – large test	Till	28.7	0.1	3,000	4.0
SRK-03-C02	Till	27.0	20.0	3,000	6.0
SRK-03-C04	Till	26.0	1.0	3,000	4.0
SRK-03-C06	Till	26.2	20.0	3,000	3.0
SRK-03-C03	Glaciofluvial	22.8	3.0	3,000	2.0
SRK-03-C03 – large test	Glaciofluvial	23.1	0.1	3,000	4.0
SRK-03-C05	Glaciofluvial	24.6	3.0	3,000	2.0
SRK-03-C07	Tailings	38.0	3.0	3,000	4.0
SRK-03-C08	Waste Rock	36.1	0.1	3,000	3.0

1.2.10 Unsaturated Hydraulic Conductivity

The unsaturated hydraulic conductivity curves for each of the samples were developed from the SWCC data using a number of empirical formulations. The saturated hydraulic conductivity value for each sample was taken initially from the laboratory data as presented in the previous section. Later adjustments were made to these curves based on in-situ saturated hydraulic conductivity measurements (see next section of this report). The corresponding unsaturated hydraulic conductivity curves are presented in Figures 16 to 19 for each of the material types tested.

1.3 Summary of Cover Materials

The borrow source investigation estimated the volume of potential cover materials primarily based on the aerial extent of the deposits. The depth of the deposits was estimated based on local anecdotal knowledge of the area as opposed to actual deep drilling results. Based on these estimates, there is approximately 11.62 million cubic meters of till material, 2.8 million cubic meters of glaciofluvial material and between 0.125 to 0.225 million cubic meters of organics.

The most abundant potential cover material is the till deposits. The till is predominantly silicacious, having a specific gravity of 2.7, and is predominantly well graded sandy-clay (CL) to clayey-sand

(SC) with a plasticity index between 2 and 10. This material generally has 20% gravel content with the sand fraction between 34 and 43%, and a fines content of 38 to 50%. One of the tested till samples were a non-plastic silty-sand (SM), consisting of zero gravel content, 71% sand and 29% fines.

Standard Proctor compaction suggests a maximum dry density of between 2,072 and 2,120 kg/m³ is achievable at moisture contents ranging between 7.4 and 10%. Falling head permeability results on samples compacted to 95% Proctor density showed results that ranged between 2.5×10^{-6} and 1.3×10^{-7} cm/sec.

The well-graded nature of the till, together with the fines content suggests that the material would be a good “barrier-type” cover material. The SWCC’s of the tested samples suggest AEV’s between 1 and 20 kPa, however, the data suggest that there may be a dual porosity in the material, with a secondary AEV value of approximately 1,000 kPa. This means that although the till does allow some rapid de-saturation, the fines have a large potential to retain moisture, and therefore act as a barrier to oxygen diffusion where sufficient moisture is available.

The glaciofluvial deposits are also silica based, sharing the same specific gravity value of 2.7 as the till. The material can however be classified as poorly graded gravel-sand mixtures with an abundance of sand and gravel and virtually no fines. Compaction results showed similar maximum dry densities and moisture contents as observed for the till material, however the 95% Proctor saturated permeabilities illustrates the effects of the fine sands, varying between 1.1×10^{-3} and 5×10^{-5} cm/sec.

The water retention properties of the glaciofluvial material is less complex than the till, showing a fairly steep curve, with AEV’s around 10 kPa for standard Tempe cells tests. The large Tempe cell test suggests that the AEV of the sample as a whole is closer to 1 kPa. Based on these results it is likely to expect that the glaciofluvial material would be less suitable to use as a barrier cover than the till material.

2 In-Situ Testing

2.1 Introduction

Laboratory testing is an important component in characterizing potential cover materials; however, natural soils exhibit a large degree of heterogeneity and therefore in-situ material property testing becomes invaluable when trying to predict cover performance.

In order to develop some understanding regarding the in-situ permeability and density of the materials under consideration at the ARMC, SRK excavated a number of shallow test pits in September 2003. These test pits and the area immediately surrounding the test pits were subjected to in-situ infiltration tests (using a single ring infiltrometer and/or Guelph permeameter), and density tests (sand-cone replacement tests).

In addition to these tests pits a number of shallow thermistors were installed into the various potential cover materials to allow us to measure the depth of the active zone.

2.2 Field Program

The field program was carried out by Dr. Maritz Rykaart, P.Eng., a Senior Geotechnical Engineer and Mr. Joe Pun, E.I.T, a Junior Engineer, both from SRK in Vancouver. The field program was carried out between September 8 and 19, 2003.

A total of 16 thermistors was installed and seven test pits was excavated, around which a total of 28 single ring infiltrometer tests was conducted, seven Guelph permeameter tests and 19 sand-cone replacement tests. The test locations are marked on Figures 3 and 4, and the details of each test pit location is also listed in Table 12.

Test pits were excavated using a CAT-235B excavator supplied by the ARMC, complete with skilled operators.

Table 12: Details of the test pit locations for conducting in-situ property testing

Location	Test Pit ID	GPS Coordinates ¹	
		<i>Easting (m)</i>	<i>Northing (m)</i>
Vangorda Overburden Dump	VA-OD-TP01	593,152	6,904,689
Vangorda Embankment Till	VA-ET-TP01	593,663	6,902,864
Vangorda Re-sloped Till Cover	VA-CT-TP01	593,774	6,902,416
Vangorda Re-sloped Waste Rock Piles	VA-WR-TP01	593,719	6,902,451
Vangorda Glaciofluvial Deposits ¹	VA-GF-TP01	584,816	6,912,522
Faro Slime Tailings	FA-TS-TP01	582,167	6,913,155
Faro Beach Tailings	FA-TB-TP01	583,409	6,912,613

1. Co-ordinates based on hand-held GPS readings using UTM NAD 27 in zone 8V.

2. This sample was incorrectly labelled as being on the Vangorda property – it is actually at Faro.

2.3 Thermistor String Installation

Shallow thermistor strings were installed into the ground, through potential cover materials and into the tailings, to start to gather a data base of information with respect to the depth of the active zone.

Thermistor strings were proposed to be installed at all test pit locations (three, 5-meter thermistor strings at each of the Vangorda test pits and four 6-meter strings at Faro tailings) excluding the re-sloped Vangorda till cover and waste rock pile area. The installation technique however prevented some installations from being completed, and field adjustments were made. Table 13 lists the final locations of all the thermistors.

All thermistors, except for those on Rose Creek tailings were installed by pushing down a 50 mm diameter steel pipe, 1 m shorter than the thermistor string, into the profile with the bucket of an excavator. A specially manufactured metal drive-point tip was first placed at the base of the pipe to ensure that the pipe does not fill with soil, and assist in penetration of the pipe. Once the pipe was completely pushed in, the thermistor string was placed into the pipe, before slowly pulling the pipe out again using the excavator. The drive-point tip and the thermistor string remained in the hole. The hole was then backfilled around the thermistor to ensure that it stayed in place. The Rose Creek tailings thermistors was installed using a 50 mm diameter hand auger

The thermistor strings were ordered from RST Instruments Ltd. with 12 strings in 5 meter lengths and four strings in 6 meter lengths. All thermistor strings were designed to have beads positioned at 1.5, 2.0, 2.5, 3.0, 4.0, and 5.0 meters below the nominal ground surface (with 1 m stick-up), while the 6 meter lengths thermistor strings have one extra bead positioned at 6.0 meter beneath normal ground surface. They were each constructed with open-ended wires at the above-ground end to allow hand-held devices for data collection in relation to each bead. Photo 13 illustrates completed thermistor installations in the till and on the Rose Creek tailings.

A hand-held digital thermometer (model 866C from Omega Technologies) was used to collect temperature data from the installed thermistor strings. Up to two sets of data were collected after the

thermistor strings were installed. Details of the collected data are presented in Data Sheet B-6, together with the complete thermistor calibration data sheets. The second set of readings confirmed that the strings are reaching equilibrium, and more data will be completed during the later winter and spring of 2004.

Table 13: Details of Installed thermistors strings

Location	Therm. No. (Serial #)	Date Installed	GPS Coordinate ¹		Depth of Beads from Ground Surface (m)
			<i>Easting (m)</i>	<i>Northing (m)</i>	
Overburden Dump	TS-04 (23262-4)	10-Sep-03	593,174	6,904,639	0.05, 0.40, 0.90, 1.40, 2.40, 3.40
	TS-06 (23262-6)	10-Sep-03	593,158	6,904,668	0.05, 0.50, 1.00, 1.50, 2.50, 3.50
Vangorda Embankmen t Till	TS-08 ² (23262-8)	10-Sep-03	593,668	6,902,65	0.05, 0.55, 1.05, 1.55, 2.55, 3.55
	TS-09 (23262-9)	11-Sep-03	593,652	6,9028,54	0.10, 0.60, 1.10, 1.60, 2.60, 3.60
	TS-10 (23262-10)	10-Sep-03	593,688	6,9028,70	0.05, 0.20, 0.30, 0.80, 1.80, 2.80
	TS-11 (23262-11)	11-Sep-03	593,638	6,9028,44	0.05, 0.55, 1.05, 1.55, 2.55, 3.55
Vangorda Glaciofluvial Deposits	TS-01 (23262-1)	15-Sep-03	584,823	6,9124,38	0.05, 0.36, 0.86, 1.36, 2.36, 3.36
	TS-02 (23262-2)	15-Sep-03	584,908	6,9125,54	0.05, 0.10, 0.15, 0.20, 0.50, 1.50
	TS-03 (23262-3)	15-Sep-03	584,835	6,9124,57	0.05, 0.23, 0.73, 1.23, 2.23, 3.23
	TS-05 (23262-5)	15-Sep-03	584,774	6,9125,13	0.05, 0.10, 0.53, 1.03, 2.03, 3.03
Faro Tailings	TS-07 (23262-7)	12-Sep-03	583,173	6,9125,10	0.05, 0.45, 0.95, 1.45, 2.45, 3.45
	TS-12 (23262-12)	12-Sep-03	582,194	6,9131,97	0.50, 1.00, 1.50, 2.00, 3.00, 4.00
	TS-13 (23262-13)	12-Sep-03	583,105	6,9128,51	0.05, 0.15, 0.25, 0.75, 1.75, 2.75, 3.75
	TS-14 (23262-14)	12-Sep-03	583,206	6,9129,36	0.50, 1.00, 1.50, 2.00, 3.00, 4.00, 5.00
	TS-15 (23262-15)	12-Sep-03	582,235	6,9131,27	0.05, 0.15, 0.25, 0.55, 1.55, 2.55, 3.55
	TS-16 (23262-16)	12-Sep-03	582,894	6,9126,96	0.05, 0.25, 0.75, 1.25, 2.25, 3.25, 4.25

1. Co-ordinates based on hand-held GPS readings using UTM NAD 27 in zone 8V.
2. GPS Location not exact - estimated from neighboring installed thermistor locations.



Photo 13: Examples of the thermistor installations on (1) Rose Creek tailings and (2) Vangorda waste rock pile starter dyke till.

2.4 Single Ring Infiltrometer Tests

Single ring infiltrometer tests were used to obtain an in-situ measurement of the saturated hydraulic conductivity of the potential cover soils and the waste.

The infiltrometers measured approximately 60 cm in diameter and 30 cm in height, and was constructed from 44-gallon steel drums. The test is performed by placing the infiltrometer on a relatively level surface, then pushing/driving the ring into the ground for at least 5 to 10 cm. The ring is then filled with water to a predetermined height, and the rate of water loss is recoded over time to second lower predetermined level. The water level is topped-up, and the process is repeated until a constant rate of water loss is observed. If leakage was observed around the outer edge of the infiltrometer during the test, some fine soils was used as backfill against the edge, and if this could not contain the leakage, the test was abandoned. Photo 14 illustrates tests being conducted.

Many of the tests required at the ARMC were on the side slopes, which does not allow for testing using the ring infiltrometer. In these locations an area measuring approximately 100 cm x 100 cm was excavated by hand using geological picks and shovels to allow a flat platform to perform the test on. Similarly, where infiltrometer tests were conducted in the bottom of test pits, a flat platform was prepared for placing the test

The infiltration measured from the ring infiltrometers were analyzed to convert it to an equivalent saturated hydraulic conductivity, using the procedure developed by Bouwer et al. (1999). Summarized results of the ring-infiltrator tests are presented in Table 14 and the complete field data sheets are presented in Data Sheet B-1.

Table 14: Summarized results of the single ring infiltration tests

Test Site	Test Pit ID	Date Tested	Location	Test No.	In-Situ Saturated Hydraulic Conductivity, K_{fs} (cm/sec)
Vangorda Overburden Dump	VA-OD-TP1	9-Sep-03	Bottom of Test Pit	SR-01	2.31×10^{-4}
			Surface	SR-02	1.49×10^{-4}
Vangorda Re-sloped Embankment Till	VA-ET-TP1	10-Sep-03	Bottom of Test Pit	SR-01	2.25×10^{-4}
			Surface	SR-02	3.14×10^{-5}
				SR-03	3.16×10^{-5}
				SR-04	5.63×10^{-5}
Vangorda Re-sloped Till Cover	VA-CT-TP1	11-Sep-03	Bottom of Test Pit	SR-01	2.48×10^{-4}
			Surface	SR-02	1.94×10^{-5}
				SR-03	6.42×10^{-5}
				SR-04	5.73×10^{-5}
Vangorda Re-Sloped Waste Rock Dump	VA-WR-TP1	12-Sep-03	Bottom of Test Pit	SR-01	1.68×10^{-3}
			Surface	SR-02	1.23×10^{-5}
				SR-03	9.23×10^{-5}
				SR-04	4.85×10^{-4}
				SR-05	4.38×10^{-4}
Vangorda Glaciofluvial Deposits	VA-GF-TP1	13-Sep-03	Surface (loosened)	SR-01	2.84×10^{-3}
				SR-04	4.64×10^{-3}
			Surface (compacted)	SR-02	1.39×10^{-5}
				SR-03	9.92×10^{-5}
Faro Slime Tailings	FA-TS-TP1	14-Sep-03	Surface	SR-01	8.61×10^{-8}
				SR-02	4.08×10^{-6}
				SR-03	3.01×10^{-5}
				SR-04	9.15×10^{-8}
				SR-05	1.92×10^{-6}
Faro Beach Tailings	FA-TB-TP1	17-Sep-03	Surface	SR-01	1.58×10^{-3}
				SR-02	1.51×10^{-3}
				SR-03	1.58×10^{-3}
				SR-04	1.88×10^{-3}



Photo 14: Sloped test site showing 3 ring infiltrometers being used for testing.

2.5 Guelph Permeameter Tests

Additional in-situ infiltration tests were conducted using a Guelph permeameter. The Guelph permeameter differs from the ring infiltrometer in that it is essentially a constant head as opposed to a falling head permeability test, and its area of influence is substantially smaller than the ring infiltrometer. The Guelph permeameter is therefore more suited to finer grained, fairly homogeneous material, such as the tailings.

Although the till is a good candidate for using the Guelph permeameter in terms of its fines content, the large gravel fraction therein makes for quite random results, which may not necessarily be representative. For this reason, only a limited amount of Guelph permeameter testing was completed.

The complete field data sheets are included in Data Sheet B-2, and Table 15 summarizes the results of the Guelph permeameter tests. Photo 15 illustrates a Guelph permeameter test being conducted adjacent to a ring infiltrometer test.

Table 15: Summary of Guelph permeameter test results

Test Site	Date Tested	Test No.	Location	Depth of Well Hole	Effective Saturated Hydraulic Conductivity, K_{fs} (cm/sec)
Vangorda Overburden Dump	9-Sep-03	GP-01	Up-slope of SR-02	20cm	2.62×10^{-4}
Vangorda Embankment Till	10-Sep-03	GP-01	Nearby SR-02	20cm	4.85×10^{-4}
		GP-02	Nearby SR-01	20cm	4.35×10^{-3}
Faro Beach Tailings	18-Sep-03	GP-01-1	Nearby SR-03	20cm	3.86×10^{-3}
	19-Sep-03	GP-01-2		50cm	1.77×10^{-3}
		GP-02-1	Nearby SR-04	20cm	4.40×10^{-3}
		GP-02-2		50cm	1.93×10^{-3}



Photo 15: Test site showing a ring infiltrometer and Guelph permeameter.

2.6 In-Situ Density Tests

The sand cone test method (ASTM D1556 with 6-inch cone and Ottawa sand) was used to determine the in-situ density of the potential cover soils and waste at various locations.

The experiments were performed by first preparing a level surface (approximately 30 cm x 30 cm) at each designated location, for placing the base plate. The sand-cone replacement test was then conducted, and the in-situ sand weights were determined on site using the scale in the water laboratory at the Faro main gate.

The wet samples was preserved and shipped to EBA Engineering in Whitehorse for moisture content determination. Table 16 presents a summary of the test results, and the complete data sheets are presented in Data Sheet B-3.

Table 16: Summary of the in-situ density test results

Test Site	Date Tested	Test No.	Location	In-Situ Dry Density (g/cm ³)
Vangorda Re-sloped Till Cover	11-Sep-03	SC-01	Surface - sloped	1.91
		SC-02	Surface - sloped	2.05
	15-Sep-03	SC-03	Surface - sloped	1.75
		SC-04	Surface - sloped	1.63
Vangorda Embankment Till	16-Sep-03	SC-01	Surface - sloped	1.61
		SC-02	Surface - sloped	1.46
		SC-03	Surface - sloped	1.32
Vangorda Overburden Dump		SC-01	Surface - sloped	1.75
		SC-02	Surface - sloped	1.85
		SC-03	Surface - sloped	1.70
Vangorda Glaciofluvial Deposits		SC-01	Surface - flat	1.89
		SC-02	Surface - flat	2.06
		SC-03	Surface - flat	2.09
Faro Slime Tailings	14-Sep-03	SC-01	Surface - flat	1.66
		SC-02	Surface - flat	1.78
		SC-03	Surface - flat	1.91
Faro Beach Tailings	17-Sep-03	SC-01	Surface - flat	1.43
		SC-02	Surface - flat	1.34
		SC-03	Surface - flat	1.43

2.7 Conductivity and pH Sampling

Samples were collected at all test pits at various depths for conductivity and pH testing. The samples were mixed with distilled water in a 1:1 volume ratio to form a paste composition for testing using calibrated hand-held instruments. For low range conductivity samples (0 – 1,999 μ S), hand held instruments (model TDSTestr 40 from Oakton Instruments) and (model pHTestr 3 from Oakton Instruments) were used for conductivity and pH testing respectively. Conversely, for the higher range conductivity samples (>1,999 μ S), a different instrument (model pH/Cond 340i from WTW Wissenschaftlich-Technische Werkstätten GmbH & Co. KG) was used for both conductivity and pH testing.

Different sampling procedures were conducted at different test pit locations. For samples collected at the Rose Creek tailings impoundment, a hand auger was used to obtain samples at 50 cm intervals from the surface down to a maximum depth of 500 cm. Alternatively for all the actual test pits, samples were collected, at 1 m intervals, from the surface. Detailed results from the laboratory testing are presented in Data Sheet B-5.

2.8 In-Situ Moisture Content

Samples were collected at various depths of all test pits to determine the in-situ moisture content of the materials before and after the single ring infiltrometer tests. A hand auger was used to obtain a dry soil profile of samples (15 cm intervals from the surface down to a maximum depth of 60 cm) before the infiltration tests. Subsequently after each test, a wet surface sample was collected. A minimum of one set of dry and wet samples were obtained at each test pit where single ring infiltrometer tests were conducted. The samples were kept in air-tight containers and were sent to EBA Engineering in Whitehorse for moisture content determination. The results are provided in the laboratory report from EBA Engineering in Data Sheet B-4. A summary of the collected sample locations, date, quantities and depths is outlined in Table 17 below.

Table 17: Details of in-situ moisture content samples collected

Test Pit Site	Date Collected	Location (Single Ring Infiltration Test No.)	Quantity & Depths (cm below ground surface)
Vangorda Overburden Dump	9-Sep-03	SR-01	dry profile (0, 15, 30, 45, 60)
			wet profile (0, 15, 30, 45, 60)
		SR-02	dry profile (0, 15, 30, 45, 60)
			wet profile (0, 15, 30, 45, 60)
Vangorda Embankment Till	10-Sep-03	SR-01	dry profile (0, 15, 30, 45, 60)
			wet profile (0, 15, 30)
		SR-02	dry profile (0, 15, 30, 45, 60)
Vangorda Till Cover	11-Sep-03	SR-02	dry profile (0, 15)
			wet surface sample
Vangorda Waste Rock Dump	12-Sep-03	SR-01	wet surface sample
		SR-03	dry profile (0, 15)
			wet surface sample
		SR-04	wet surface sample
Vangorda Glaciofluvial	13-Sep-03	SR-01	dry profile (0, 15, 30, 45, 60)
			wet surface sample
Faro Slime Tailings	14-Sep-03	SR-01	dry profile (0, 15, 30, 45, 60)
			wet surface sample
Faro Beach Tailings	17-Sep-03	SR-03	dry profile (0, 15, 30, 45, 60)
			wet surface sample

2.9 Summary of In-Situ Testing Results

The in-situ permeability results confirmed that the field hydraulic conductivity of the till is between 1.5×10^{-4} and 6.4×10^{-5} cm/sec (473 to 202 mm/year), which is between 1 and 2 orders of magnitude more permeable than the laboratory results. Similarly, the in-situ permeability of the glaciofluvial material is approximately 9.9×10^{-5} cm/sec (312 mm/year) for the compacted traffic surfaces and

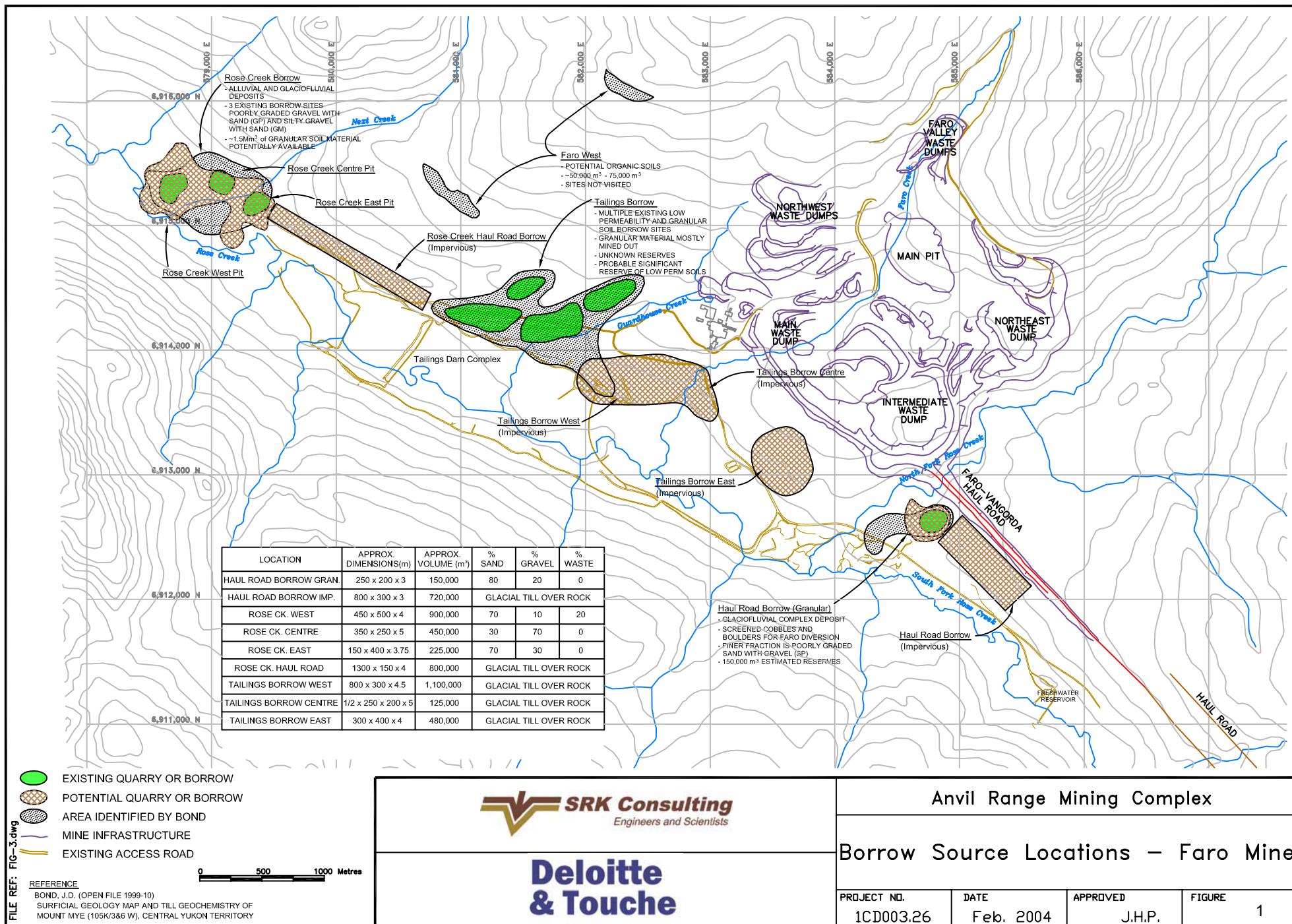
2.8×10^{-3} cm/sec (8,830 mm/year) for the looser unconsolidated sections. These results are quite consistent with the laboratory results.

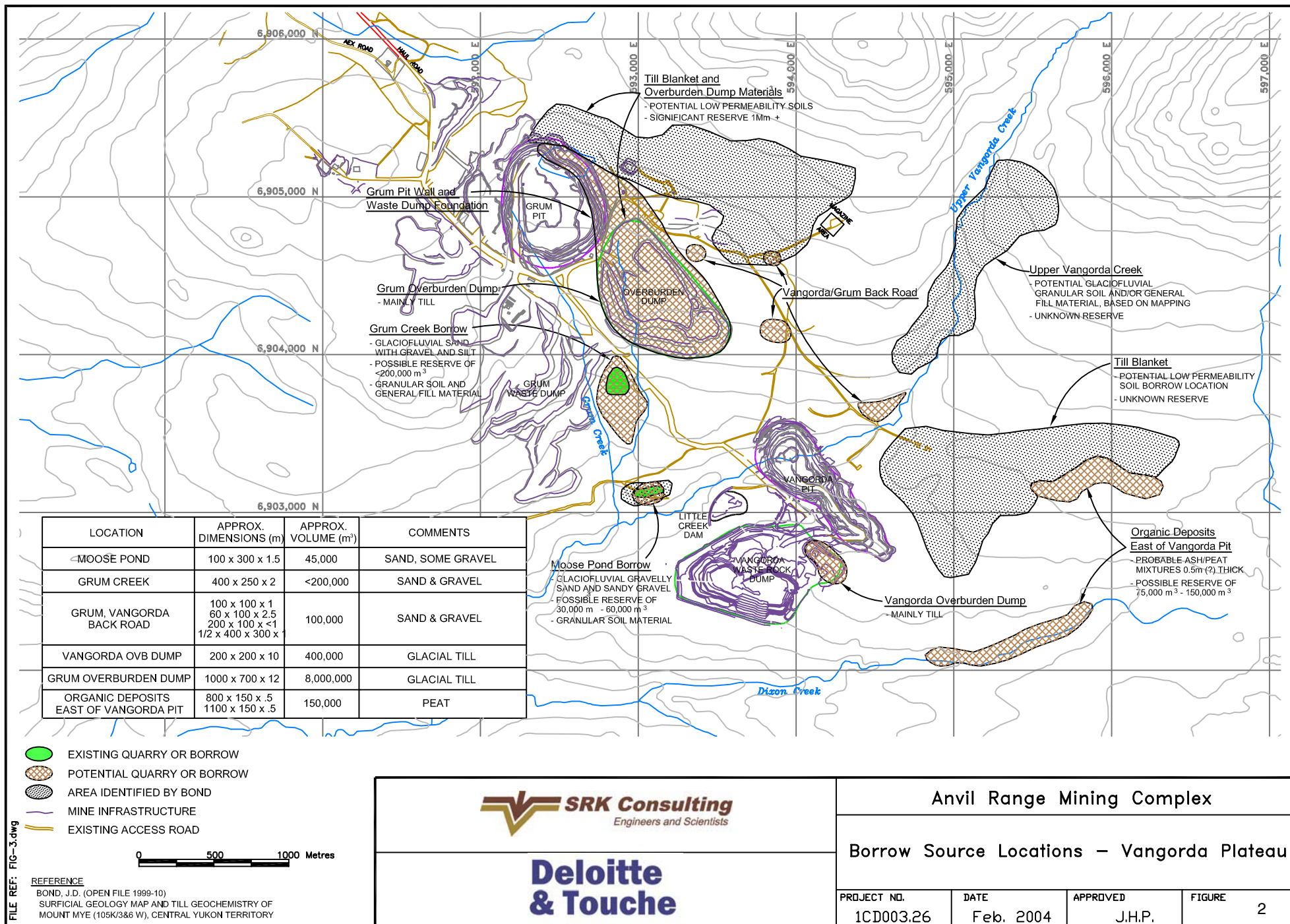
The in-situ density results for the till, suggest substantially lower densities than the 95% Proctor density tested in the laboratory, which may be part of the reason for the higher permeabilities measured in the field.

The tailings and waste rock samples measured conductivities in the milli-Siemens range, whilst all the potential cover materials measured conductivities in the micro-Siemens range. The most important conclusion with regard to these results is the fact that the Vangorda waste rock pile till cover, does not appear to be impacted by contaminants that are present in the underlying waste rock. There is no definitive gradient of increased conductivities close to the waste rock contact, suggesting that upward fluxes are negligible, if present at all. This is further confirmed by the past pH results which show the waste rock to have a consistent paste pH of 5.1 to 5.9, whilst the till cover has a consistent paste pH between 7.4 and 7.7.

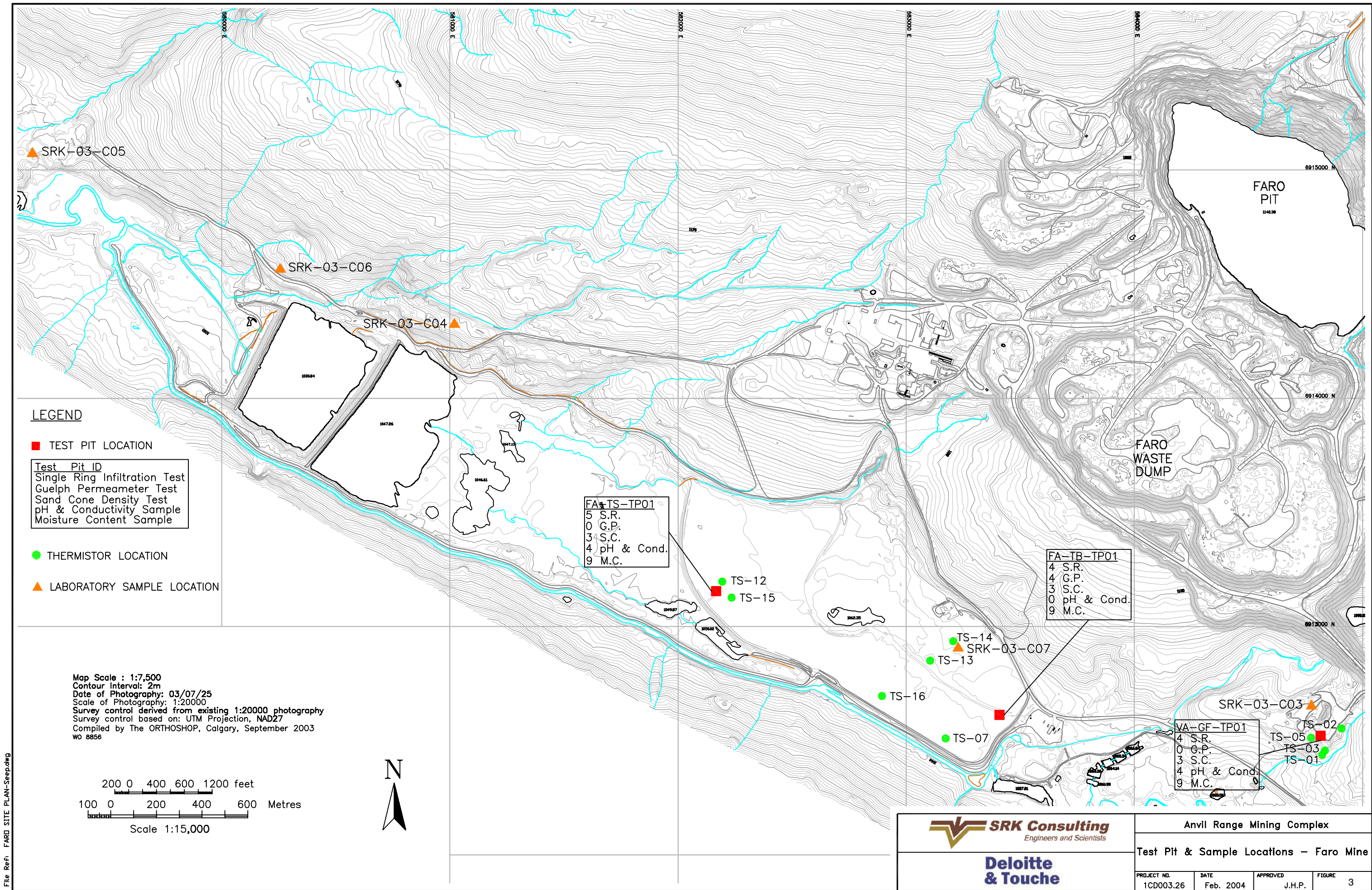
The embankment till did show the highest conductivities in natural materials, and these higher conductivities were associated with lower paste pH values ranging between 5.7 and 6.9. This result cannot be immediately explained.

The tailings conductivities were consistently high, and the paste pH varied between 1.6 and 5.2, with a near consistent pattern of increasing pH with depth.

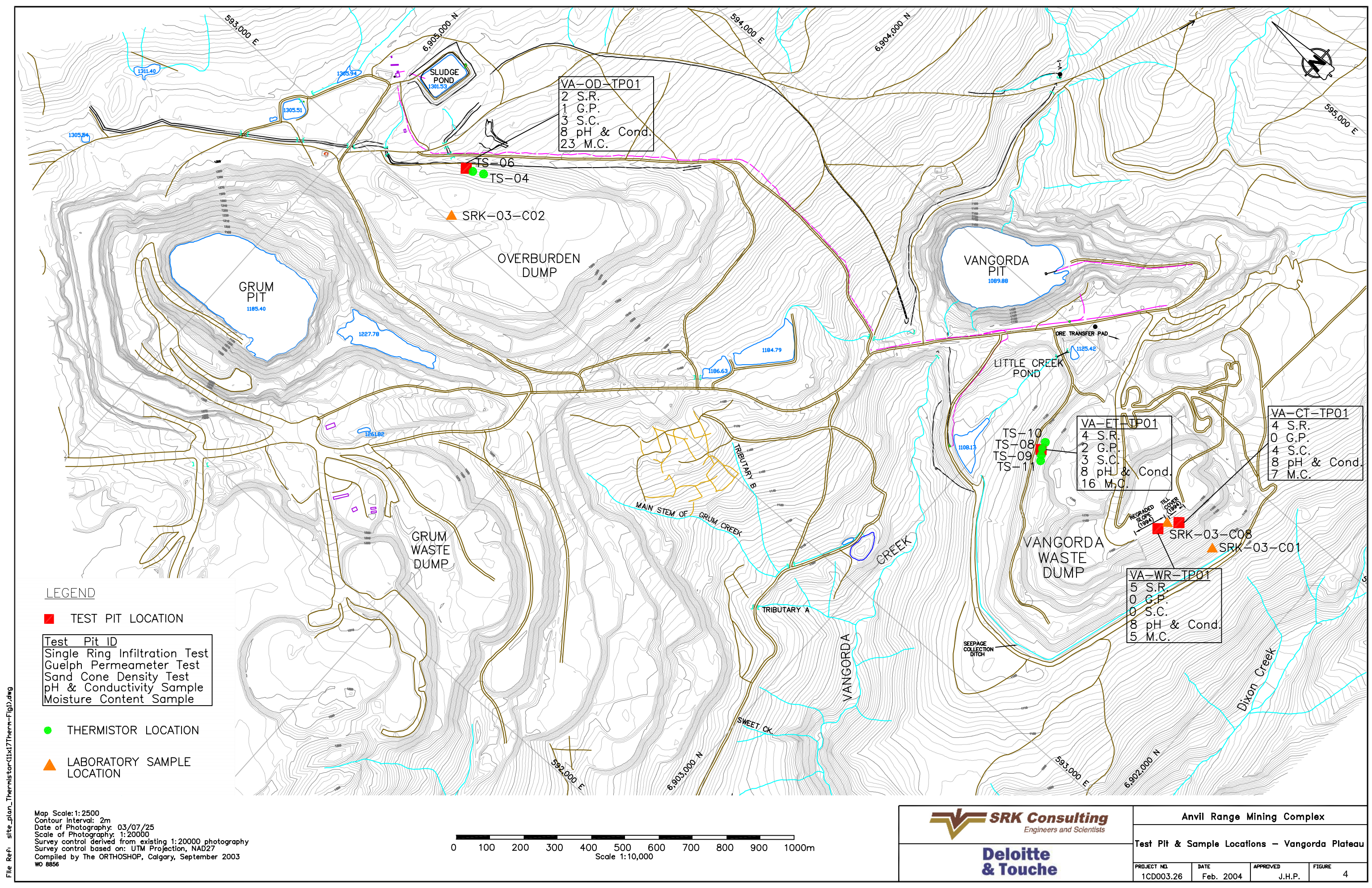




File Ref: FARO SITE PLAN-Seep.dwg



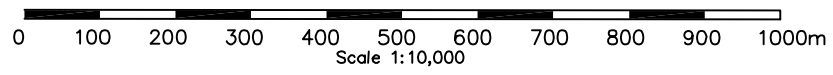
File Ref: site_plan_Thermistor(11x17Therm-Fig1).dwg



LEGEND

- TEST PIT LOCATION
- Thermistor Location
- LABORATORY SAMPLE LOCATION

Map Scale: 1:2500
Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856





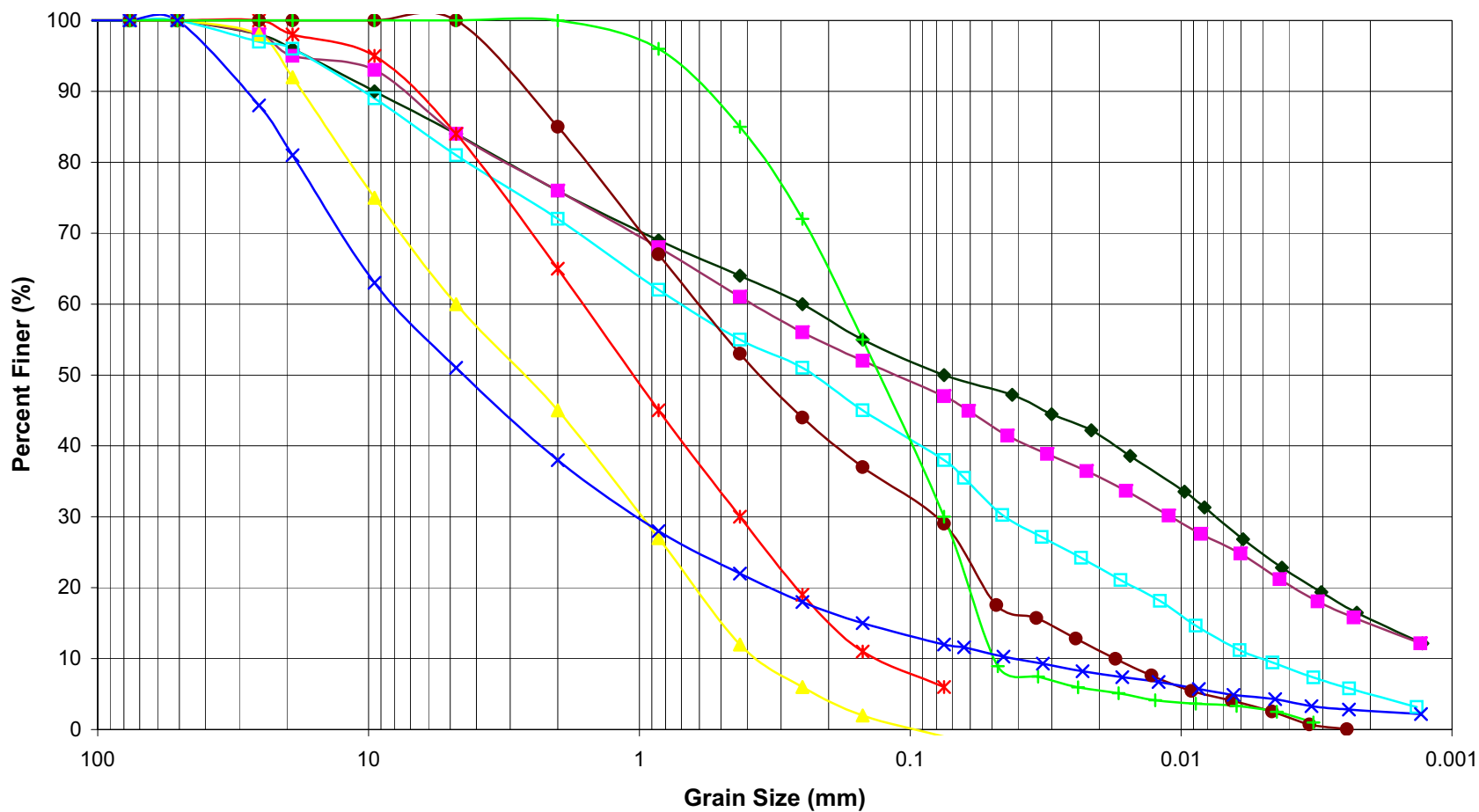
SRK Consulting
Engineers and Scientists

Anvil Range Mining Complex

Test Pit & Sample Locations – Vangorda Plateau

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◆ SRK-03-01 (Till) ◆ SRK-03-02 (Till) ▲ SRK-03-03 (Glaciofluvial) □ SRK-03-04 (Till)
 ✱ SRK-03-05 (Glaciofluvial) ● SRK-03-06 (Till) + SRK-03-07 (Tailings) ✕ SRK-03-08 (Waste Rock)



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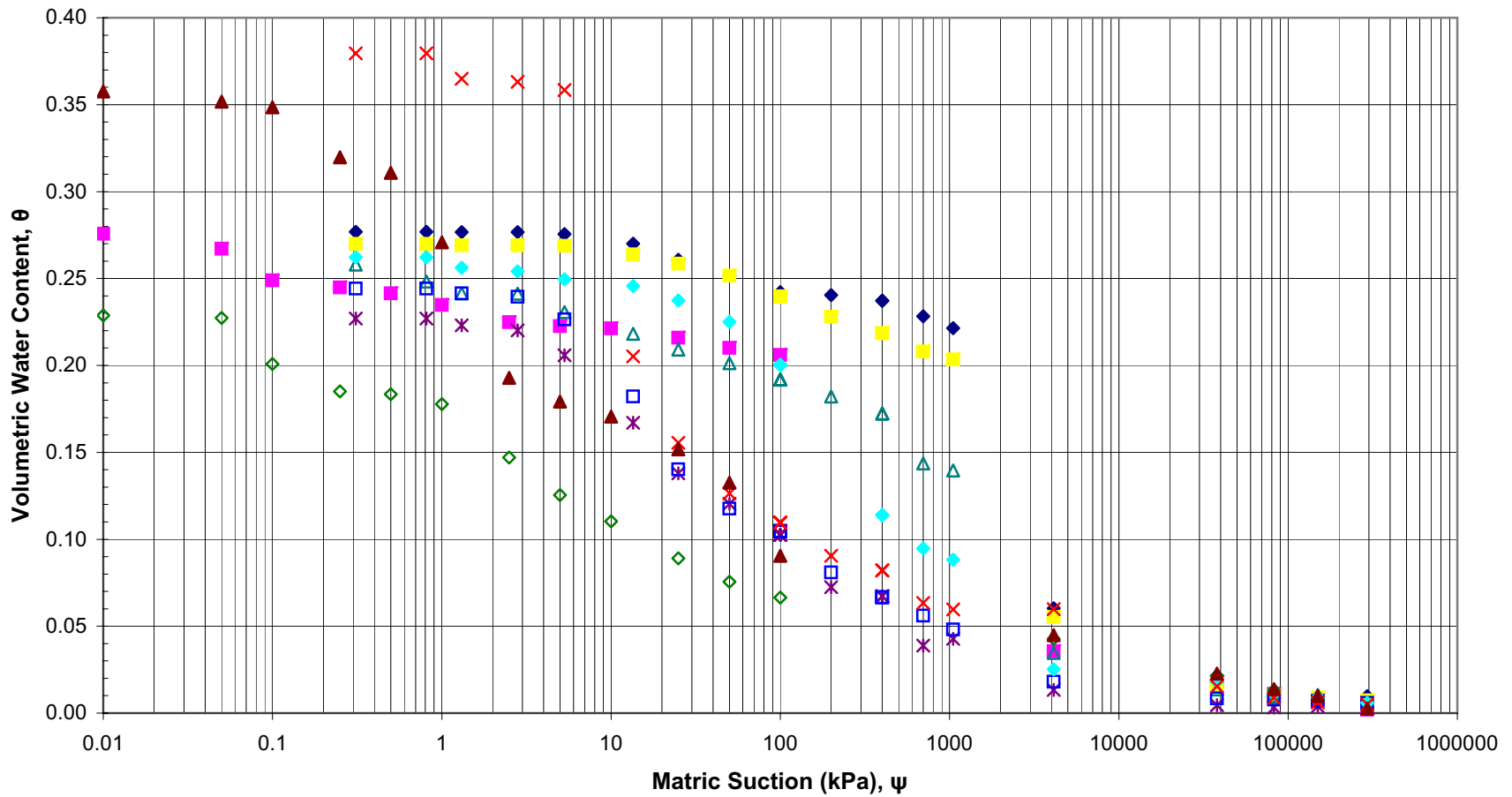
Particle Size Distribution Curves

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FIGURE
5



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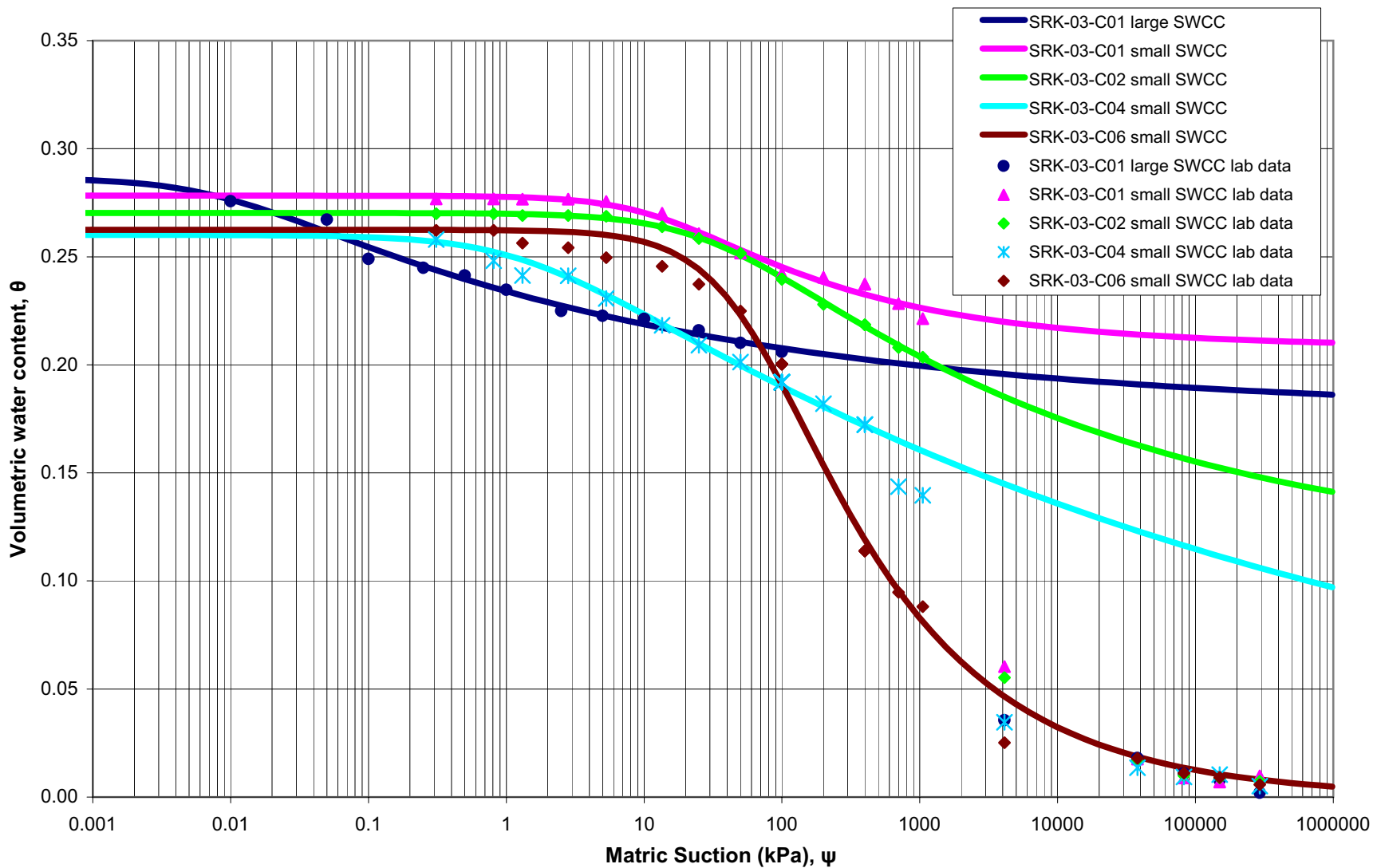
Soil Water Characteristic Curve Data

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FIGURE
6



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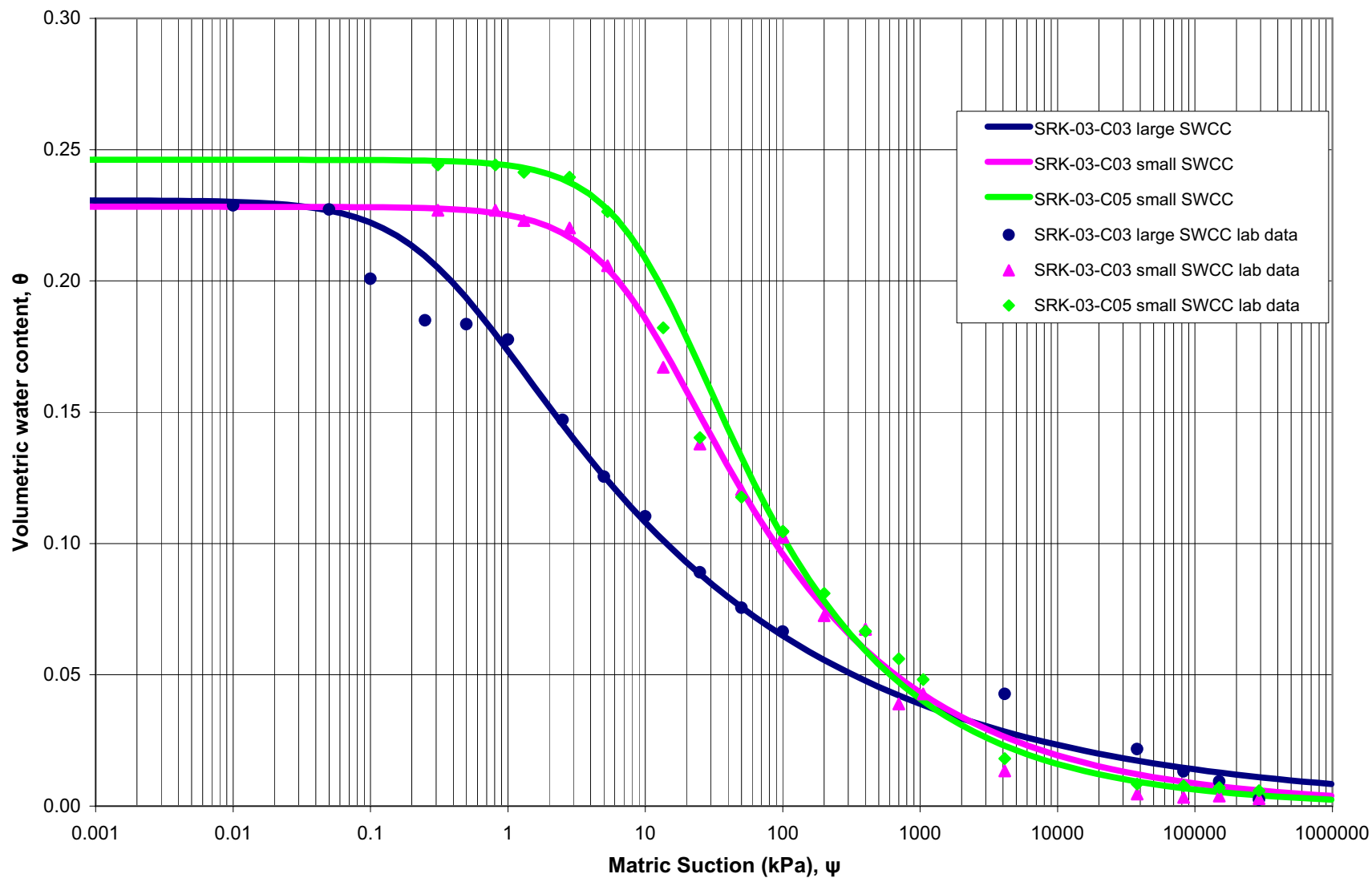
**Soil Water Characteristic Curves
(Till Material)**

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FIGURE
7



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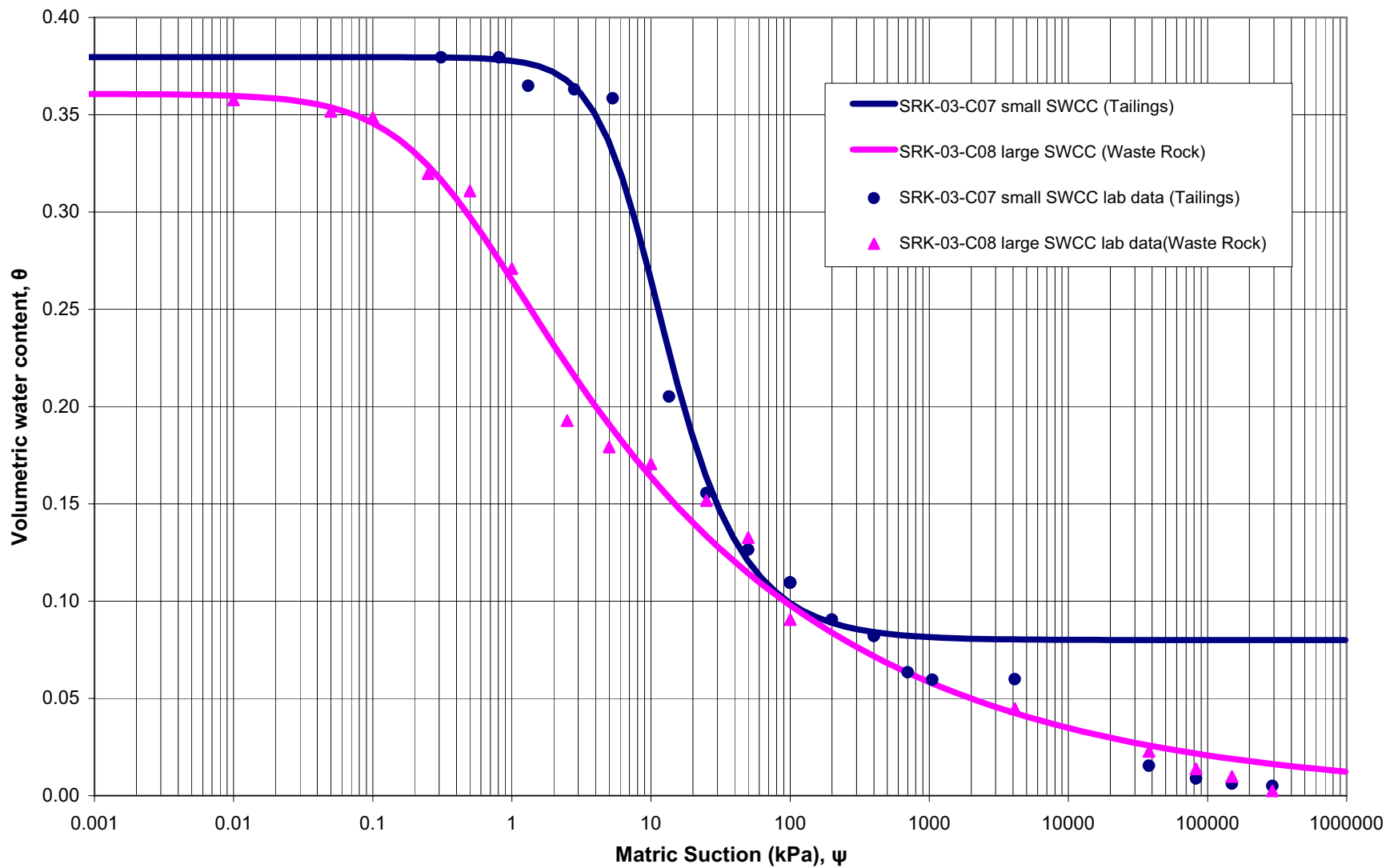
**Soil Water Characteristic Curves
(Glaciofluvial Material)**

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FIGURE
8



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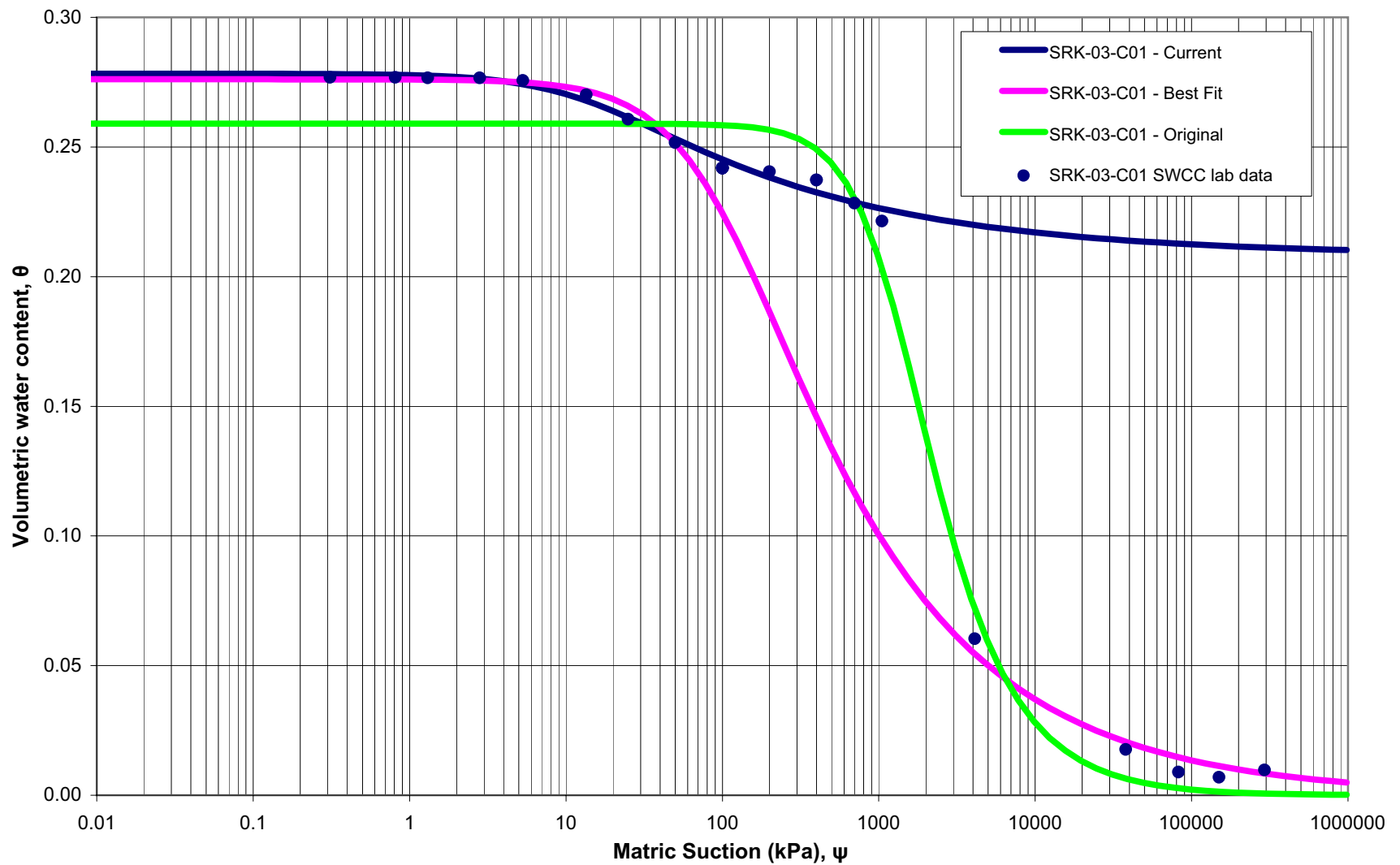
**Soil Water Characteristic Curves
(Waste Rock & Tailings)**

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FIGURE
9



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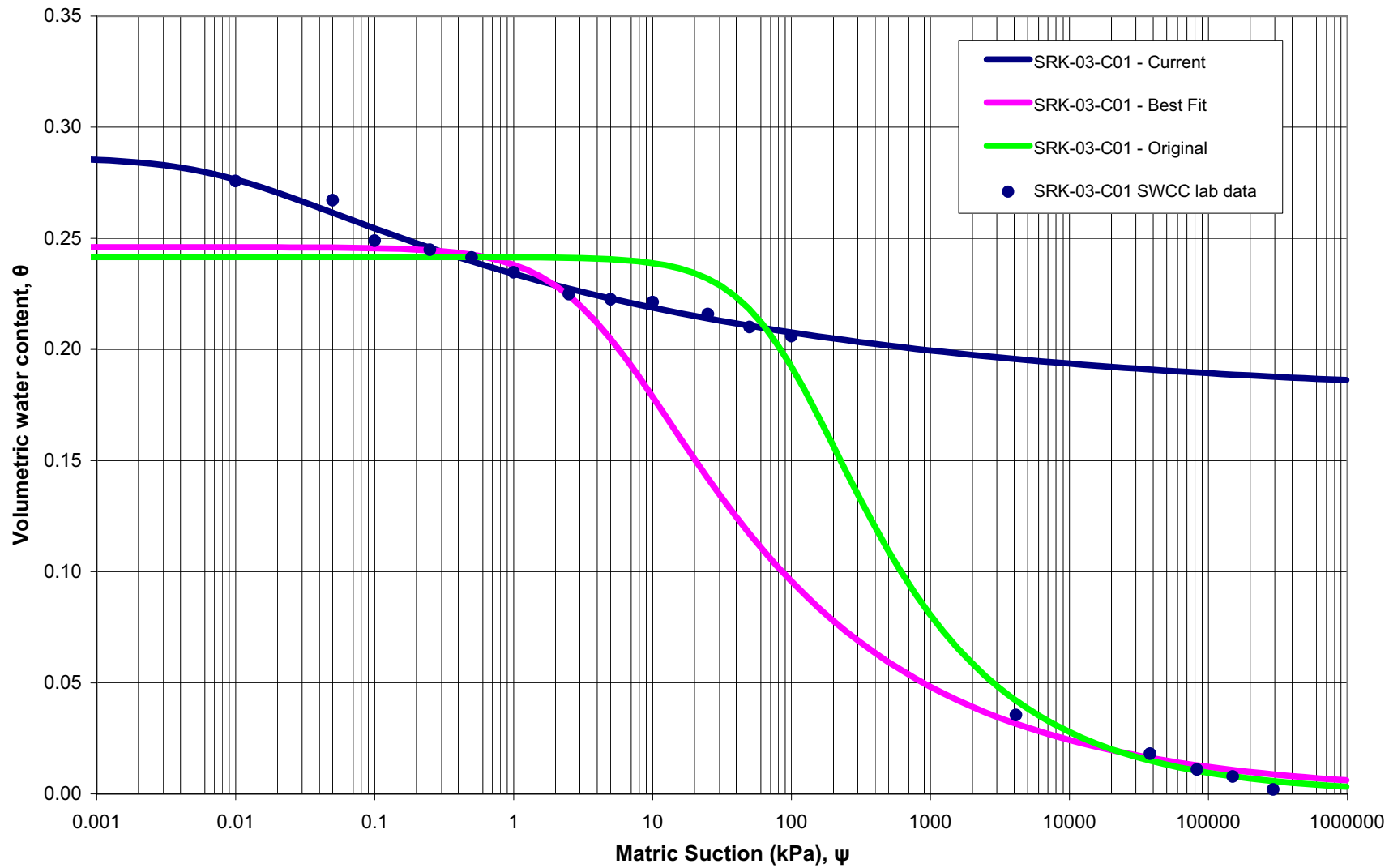
**Soil Water Characteristic Curves
(Till, SRK-03-C01, Standard Tempe Cell)**

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FIGURE
10



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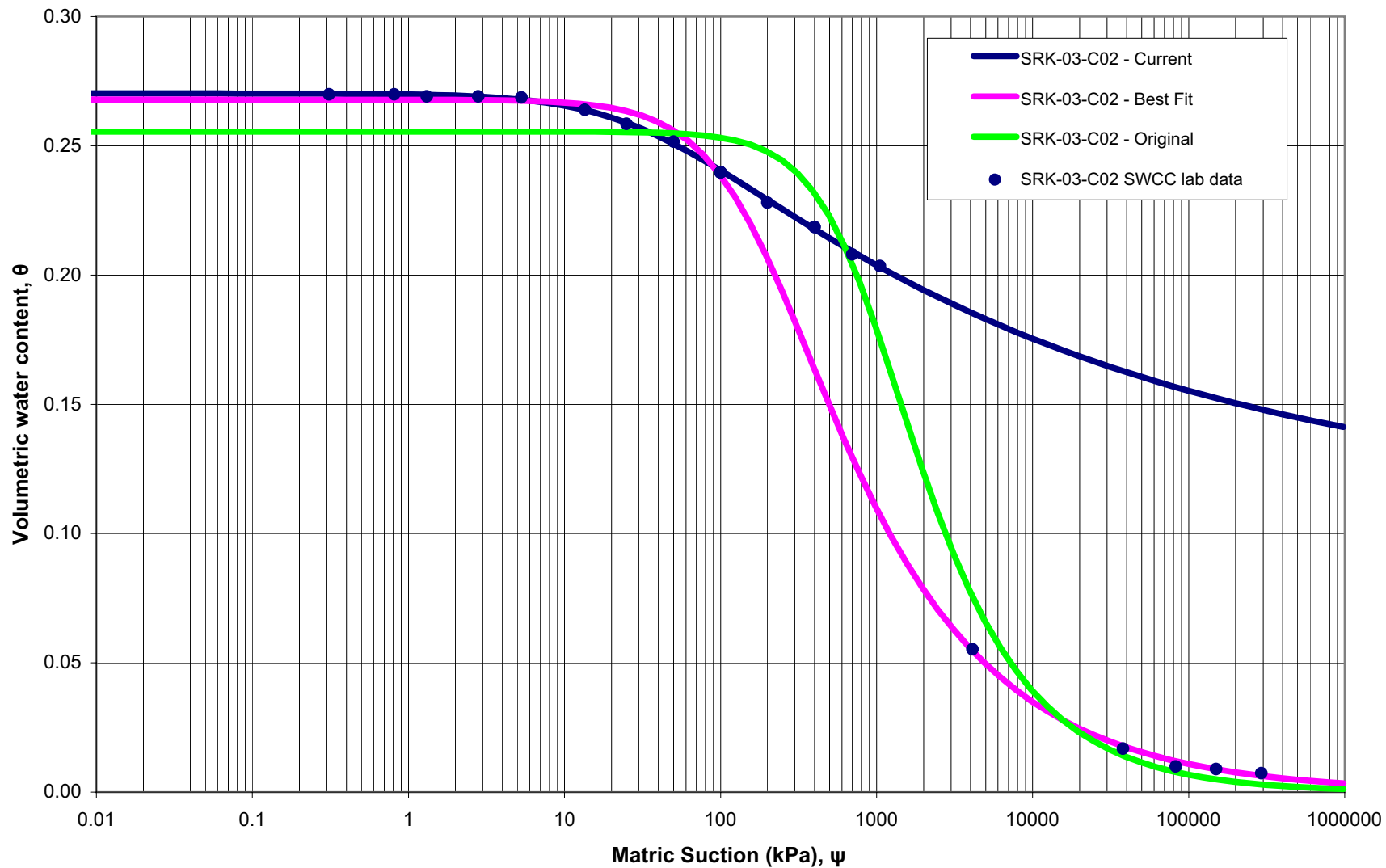
**Soil Water Characteristic Curves
(Till, SRK-03-C01, Large Tempe Cell)**

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FIGURE
11



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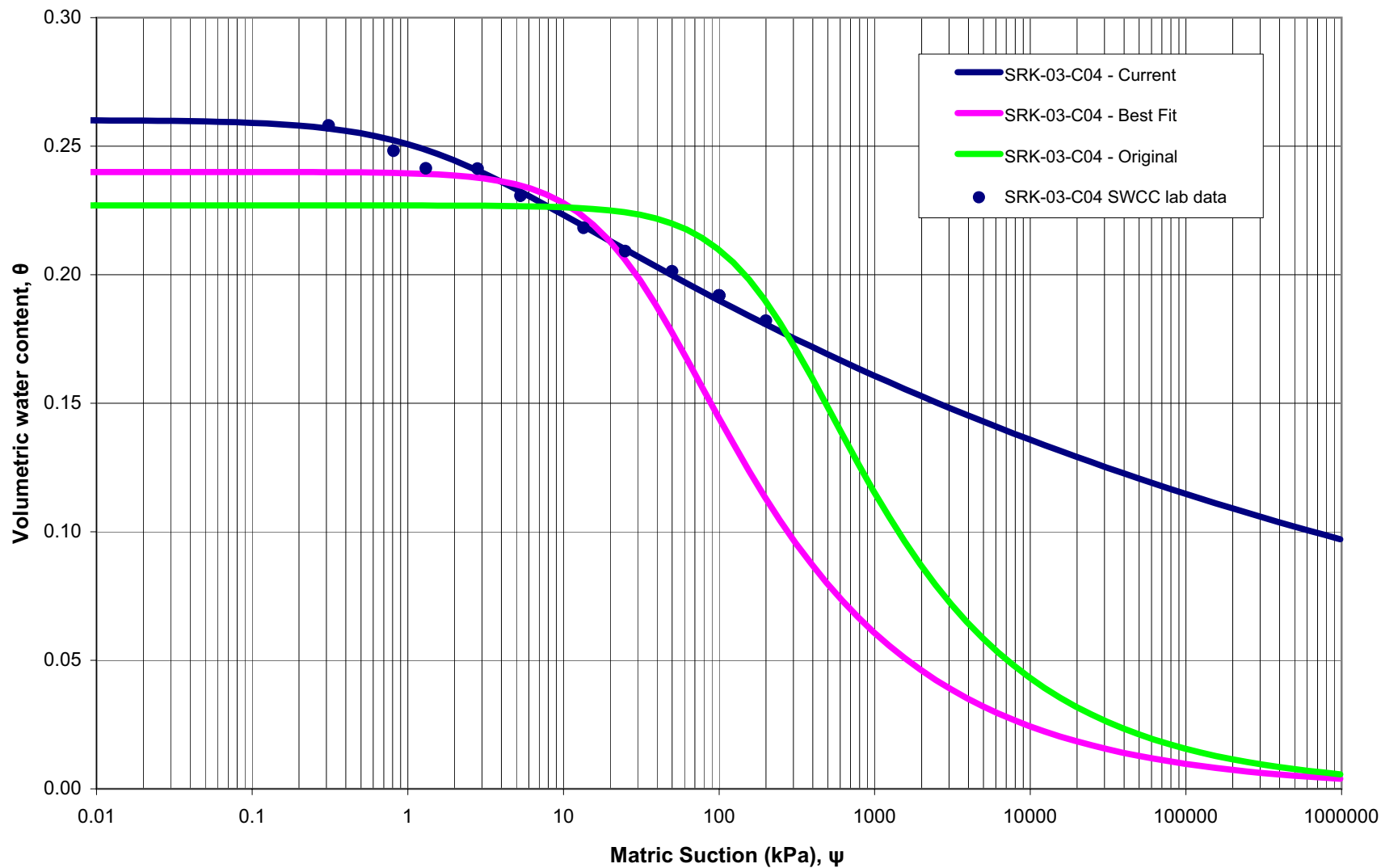
**Soil Water Characteristic Curves
(Till, SRK-03-C02, Standard Tempe Cell)**

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FIGURE
12



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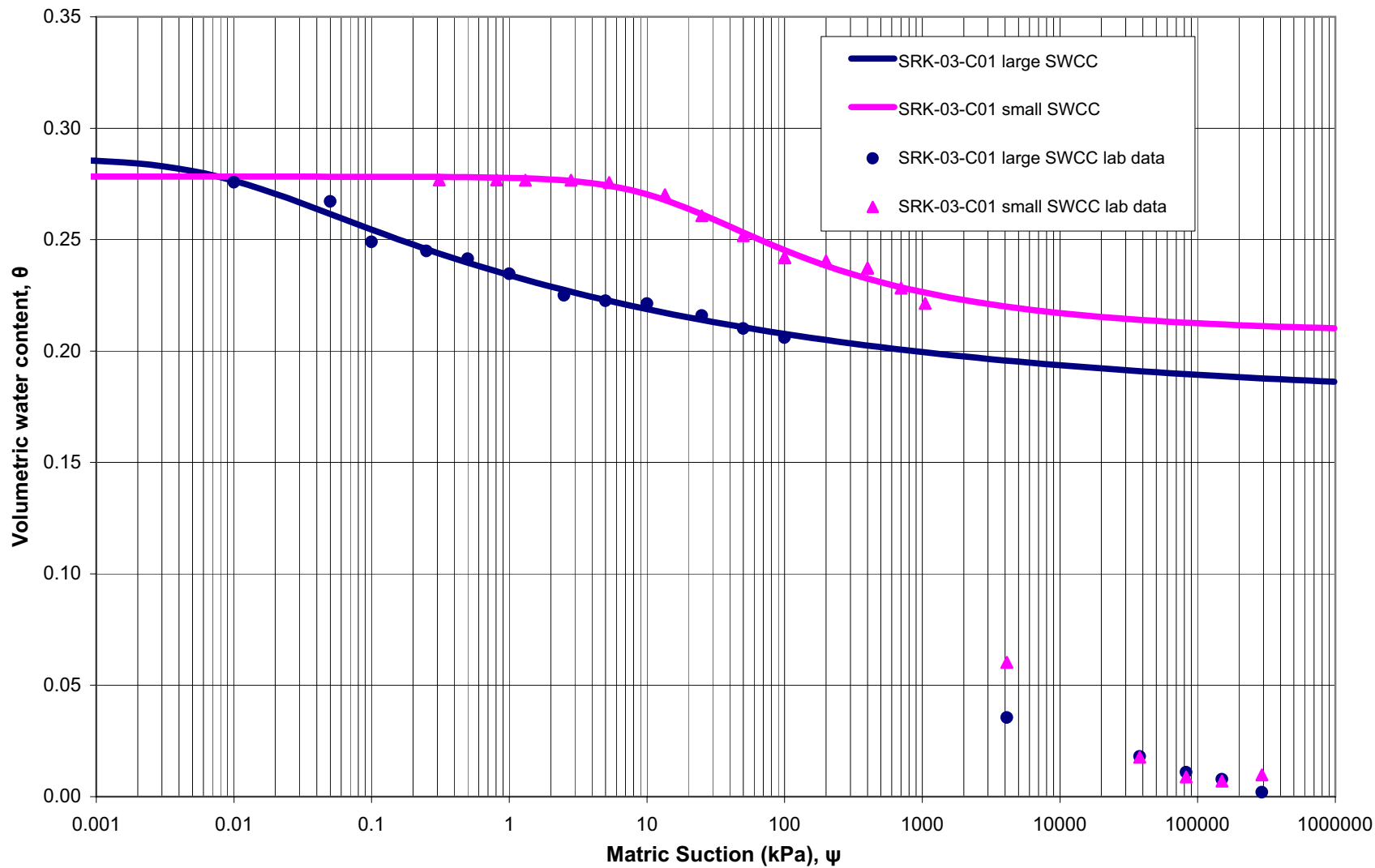
**Soil Water Characteristic Curves
(Till, SRK-03-C04, Standard Tempe Cell)**

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FIGURE
13



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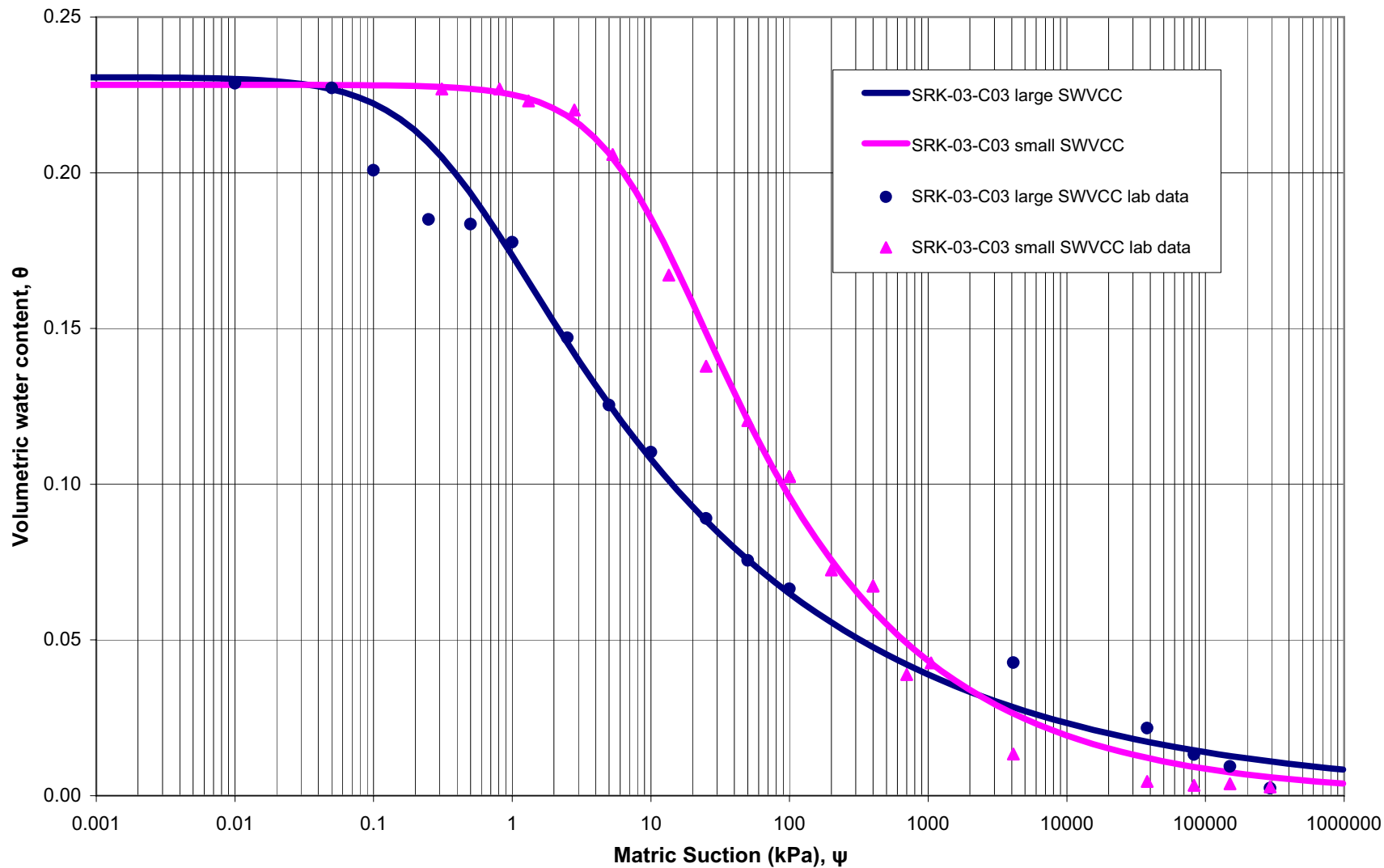
**Soil Water Characteristic Curves
(Till, SRK-03-C01)**

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FIGURE
14



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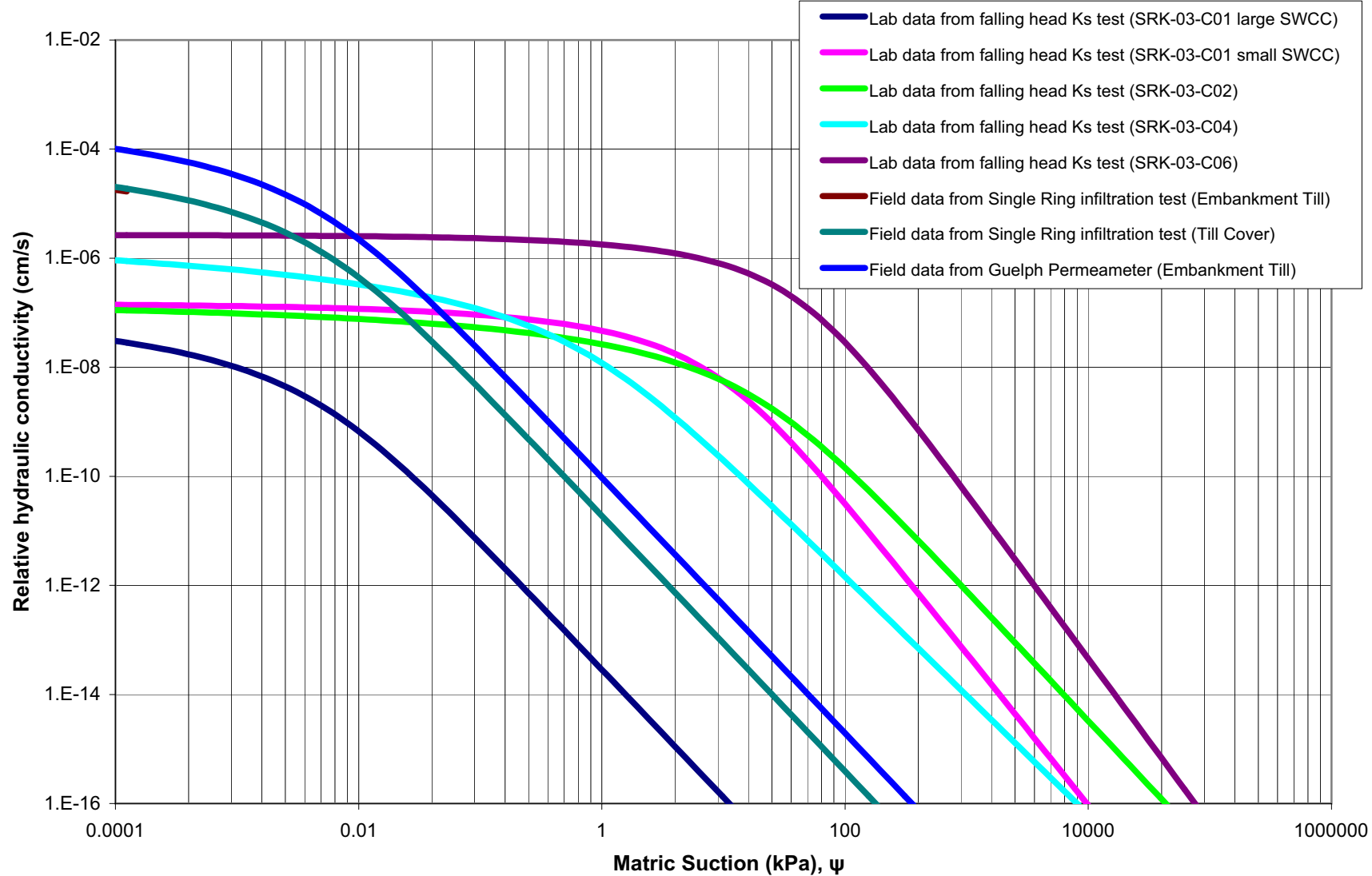
**Soil Water Characteristic Curves
(Glaciofluvial, SRK-03-C03)**

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FIGURE
15



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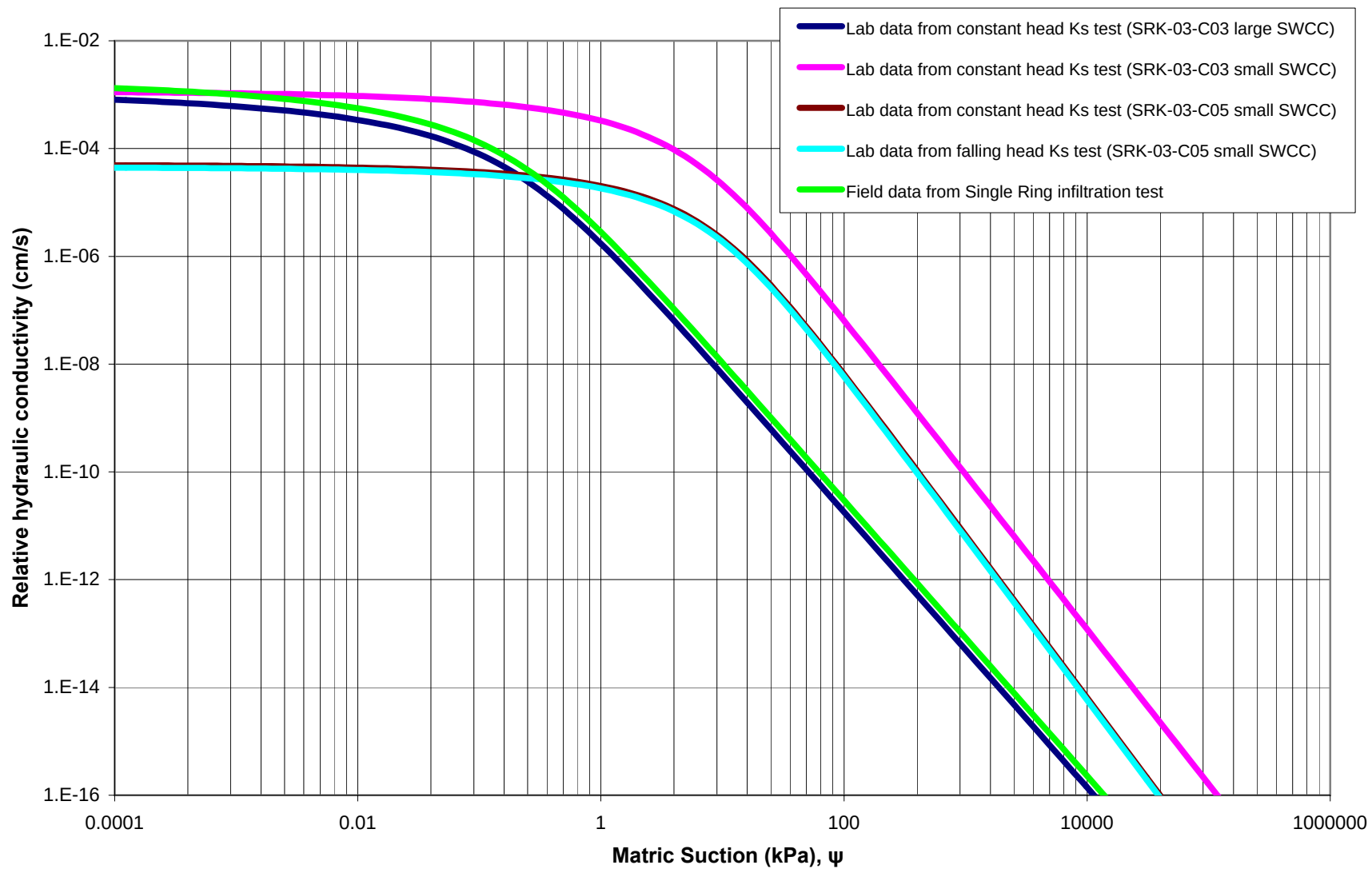
**Unsaturated Hydraulic Conductivity
Curves (Till Material)**

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FIGURE
16



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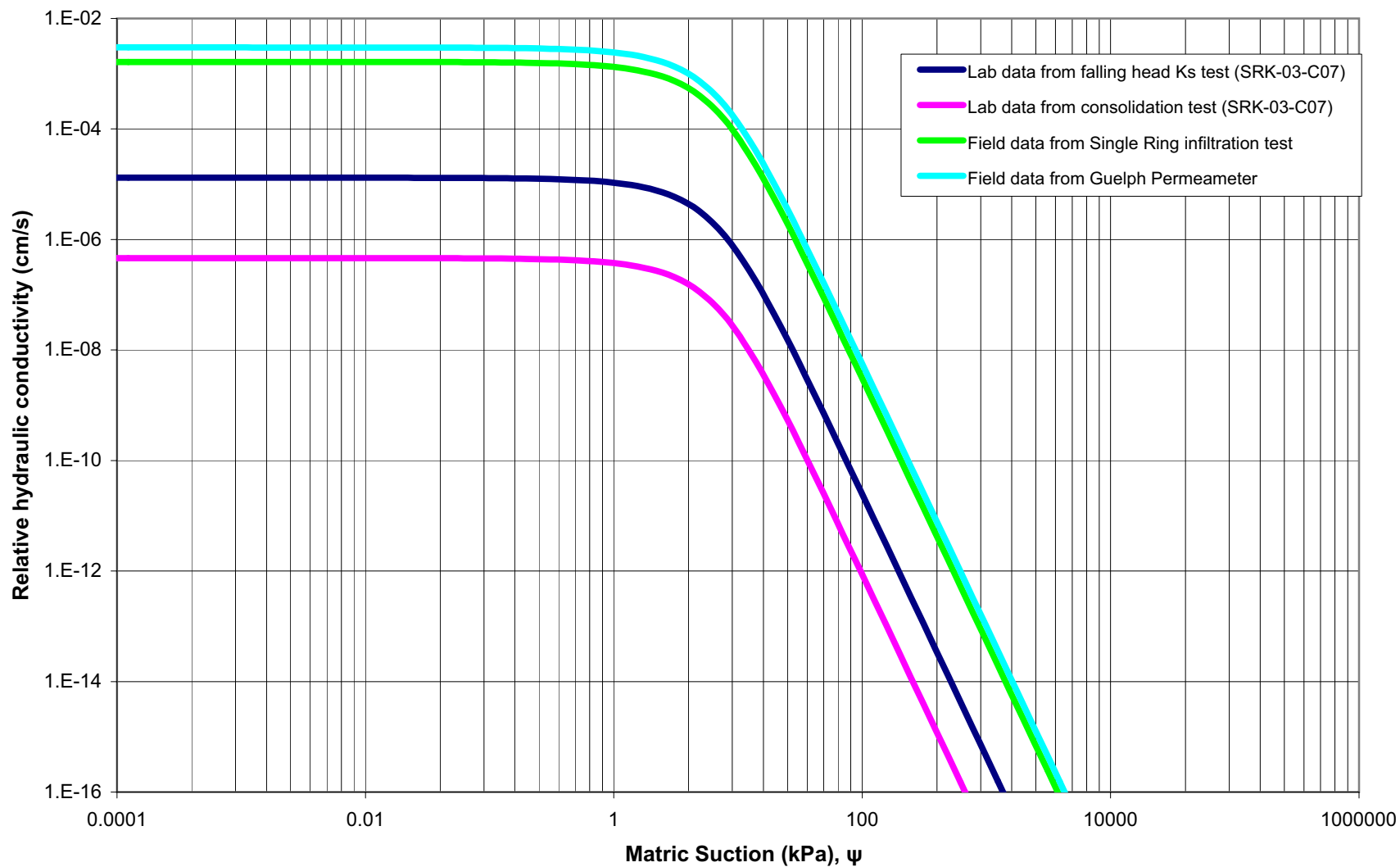
**Unsaturated Hydraulic Conductivity
Curves (Glaciofluvial Material)**

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FIGURE
17



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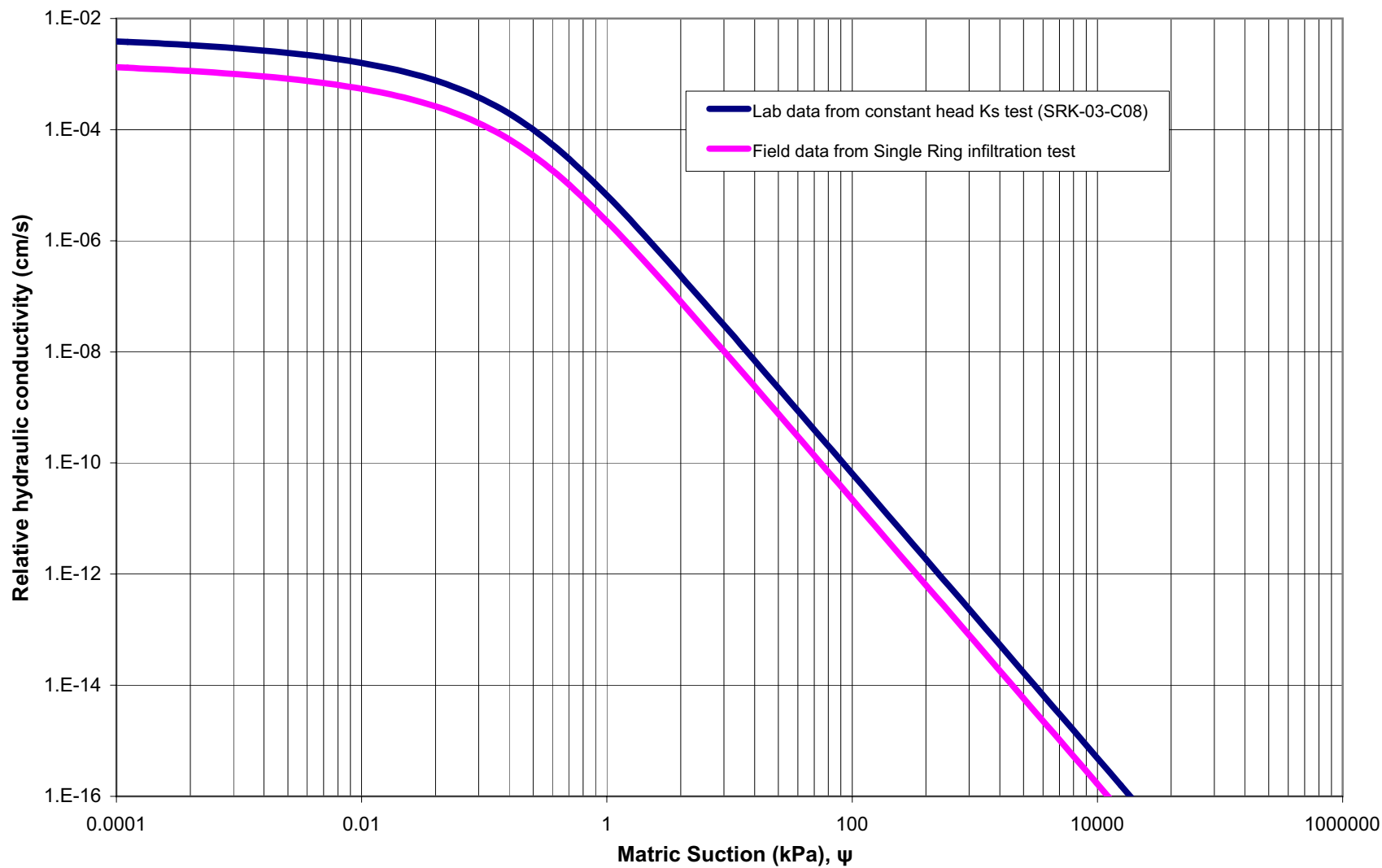
**Unsaturated Hydraulic Conductivity
Curves (Tailings)**

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FIGURE
18



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**Unsaturated Hydraulic Conductivity
Curves (Waste Rock)**

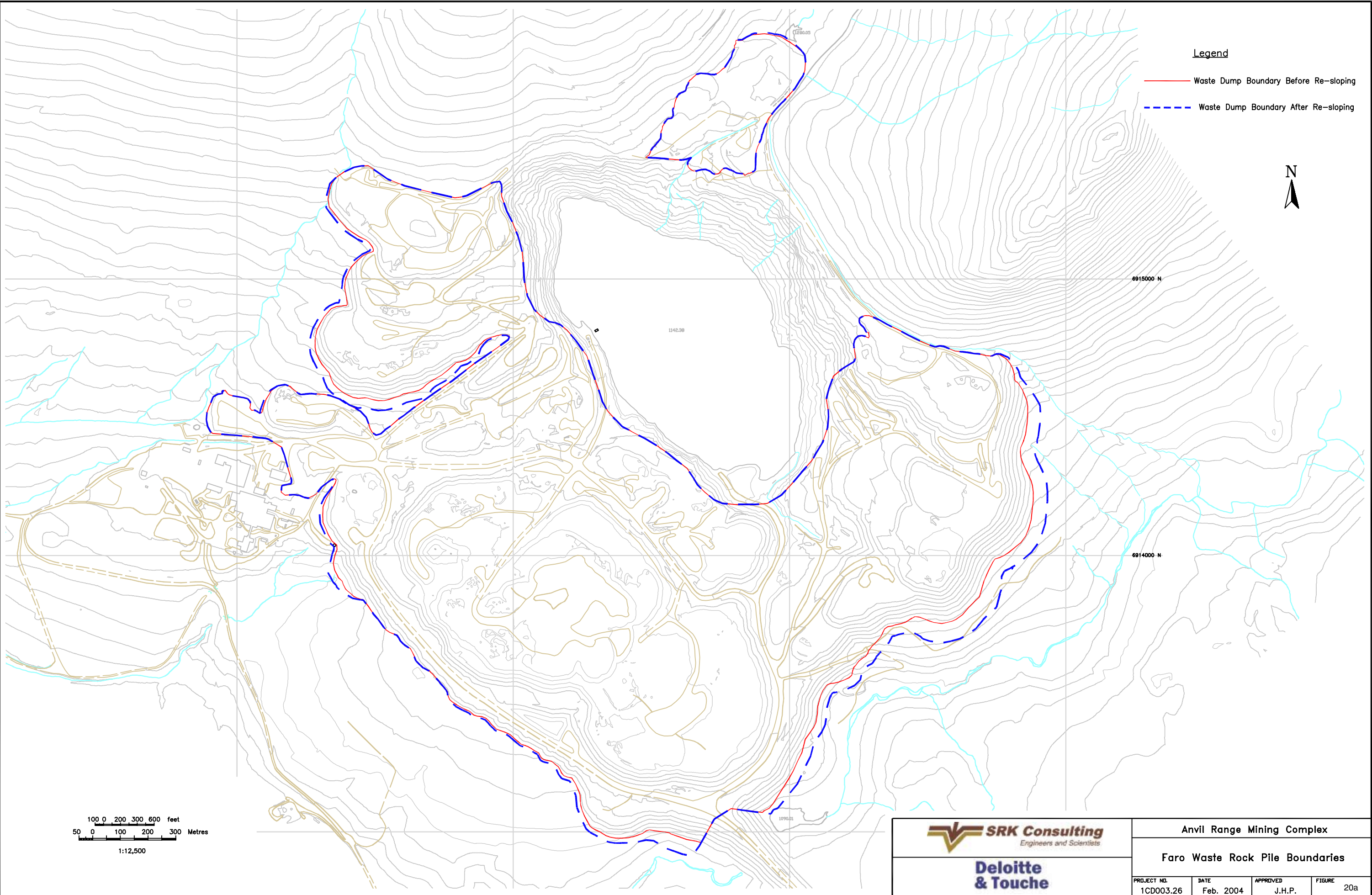
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DATE
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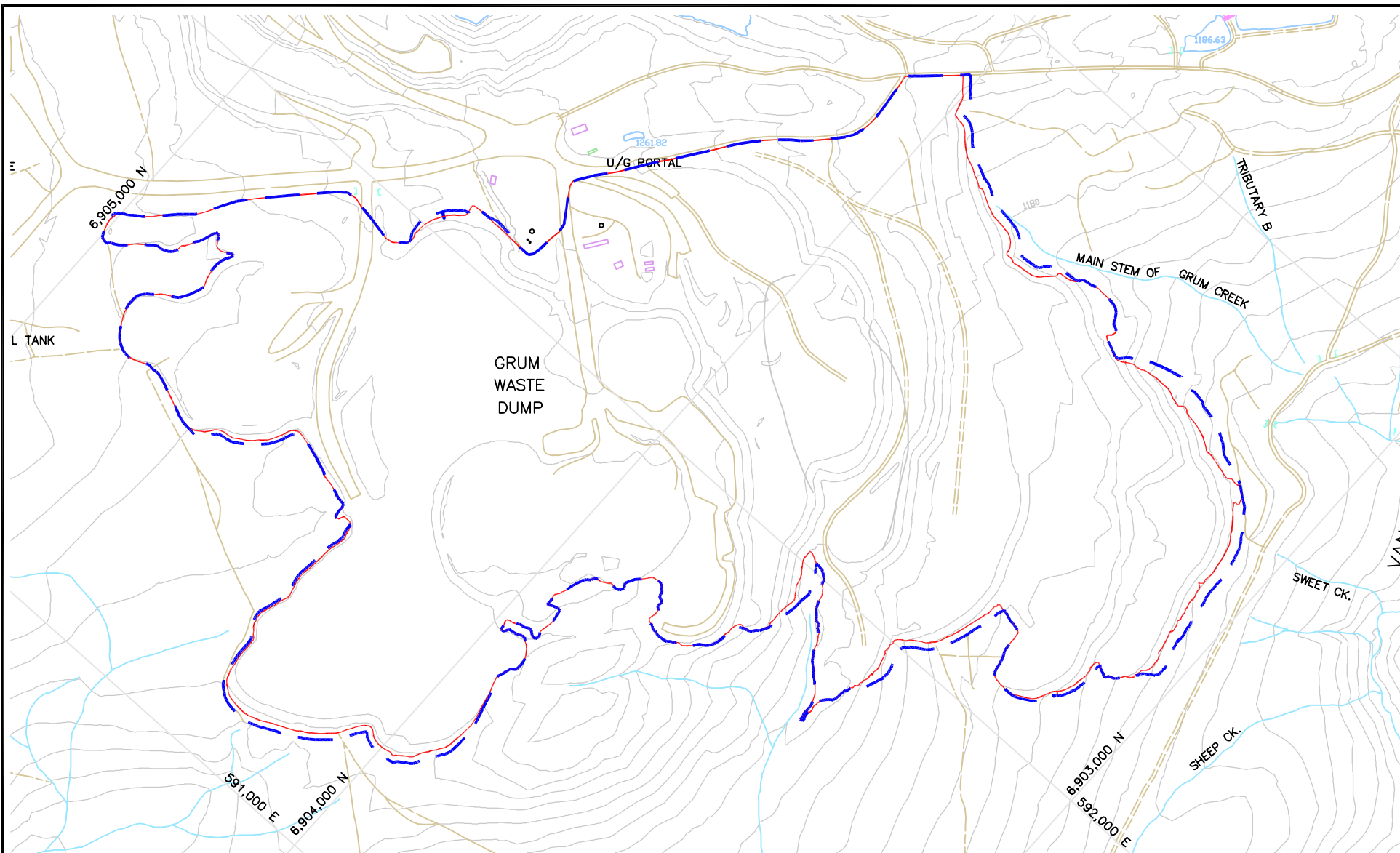
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FIGURE
19

File Ref: 2003 SITE PLAN-photodwg



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	Faro Waste Rock Pile Boundaries			
PROJECT NO. 1CD003.26	DATE Feb. 2004	APPROVED J.H.P.	FIGURE 20a	



Legend

- Waste Dump Boundary Before Re-sloping
- Waste Dump Boundary After Re-sloping

0 25 50 75 100 125 150 175 200 225 250m
Scale 1:10,000



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Anvil Range Mining Complex

Grum Waste Rock Pile Boundaries

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.26	Feb. 2004	J.H.P.	20b

October 31, 2003

Dr. Maritz Rykaart, P.Eng.
Senior Geoenvironmental Engineer
SRK Consulting
Suite 800, 1066 West Hastings Street
Vancouver, BC
Canada V6E 3X2

Dear Dr. Rykaart:

Re: Geotechnical Laboratory Testing for Faro Mine Project, White Horse

This letter presents the results of a laboratory testing program conducted on materials from the Faro Mine in White Horse. MDH Geotechnical Laboratories conducted this testing program for SRK Consulting in Vancouver.

On June 18, 2003, eight 5-gallon pails of materials were received at MDH Geotechnical laboratories. The pails were labeled:

1. SRK-03-C01 (consists of 4 Ziploc bags of sandy till)
2. SRK-03-C02 (consists of 4 Ziploc bags of sandy till with some gravels)
3. SRK-03-C03 (consists of 4 Ziploc bags of glaciofluvial sand)
4. SRK-03-C04 (consists of 4 Ziploc bags of till)
5. SRK-03-C05 (consists of 4 Ziploc bags of glaciofluvial sand)
6. SRK-03-C06 (consists of 4 Ziploc bags of till)
7. SRK-03-C07 (consists of 2 bags of tailings)
8. SRK-03-C08 (consists of 2 bags of weathered waste rocks).

Instructions were received from SRK consulting to combine the individual bags in each pail to form eight samples for the laboratory testing program.

Laboratory Testing Program

The testing program is presented in Table 1 below.

Materials	Atterberg Limits	Specific gravity	Grain size	Standard Proctor	SWCC	Consolidation	Hydraulic Conductivity
SRK-03-C01	Yes	<#4 #4– 3/8" 3/8"-2"	Mech & hydrometer	4-inch mold	300-mm 64-mm		Falling head
SRK-03-C02	Yes	<#4 #4– 3/8" 3/8"-2"	Mech & hydrometer	4-inch mold	64-mm		Falling head
SRK-03-C03	Yes	<#4 #4– 3/8"	Mech & hydrometer	6-inch mold	300-mm 64-mm		Constant head
SRK-03-C04	Yes	<#4 #4– 3/8"	Mech & hydrometer	4-inch mold	64-mm		Falling head
SRK-03-C05	Yes	<#4 #4– 3/8"	Mech & hydrometer	4-inch mold	64-mm		Falling head & Constant head
SRK-03-C06	Yes	<#4 #4– 3/8"	Mech & hydrometer	4-inch mold	64-mm		Falling head
SRK-03-C07	Yes	<#4 #4– 3/8"	Mech & hydrometer		64-mm	Max Press. 4866 kPa	Falling head
SRK-03-C08	Yes	<#4 #4– 3/8"	Mech & hydrometer		300-mm		Constant head

Atterberg Limits

The Atterberg limits tests were conducted as per ASTM D 4318.

The Atterberg limits tests determine the water contents at which the materials were in the plastic and liquid states. The plastic limit is determined by the water content at which the soil begins to exhibit plastic behaviour and the liquid limit is determined by the water content at which the soil is at the boundary between the semi-liquid and plastic states. The plasticity index is the water

content over which the soil behaves in a plastic manner. Numerically, plastic index is the difference between the liquid limit and the plastic limit.

Atterberg limits are conducted on fine-grained materials only. The Atterberg limits are used to characterize the fine-grained fraction of soils and are used to correlate with engineering behavior such as compressibility, permeability, compactibility, shrink-swell, water retention and shear strength.

Atterberg limits tests were attempted on all eight materials. Five out of the eight materials turned out to be non-plastic. These non-plastic materials are SRK-03-C03, SRK-03-C05, SRK-03-C06, SRK-03-C07 and SRK-03-C08. Results of the Atterberg limits tests are presented in Appendix I.

Specific Gravity

Specific gravity tests were conducted for fine-grained materials as well as for coarse aggregates. Specific gravity tests for the fine-grained materials were conducted on materials passing the #4 sieve (4.75-mm) as per ASTM D 854. Specific gravity tests for the coarse aggregates were conducted on materials larger than the #4 sieve as per ASTM C 127. For the specific gravity tests on the coarse aggregates, the materials were divided into two size groups, namely; #4 to 3/8" and 3/8" to 2'.

The specific gravity is required for calculating phase relationships.

Results of the specific gravity tests are presented in Appendix II.

Grain-size Distribution

Grain-size analyses were conducted as per ASTM D 422.

Wash sieve analyses were conducted on material larger than the #10 sieve (2.00-mm) and hydrometer analyses were conducted on material smaller than the #10 sieve. Results from the wash sieve analyses and hydrometer analyses were combined to provide the grain-size distribution curves. Results from the wash sieve analyses and hydrometer analyses are presented in Appendix III.

Standard Proctor Tests

Standard Proctor tests were conducted as per ASTM D 698.

The standard Proctor tests establish the relationship between water content and dry density of soils compacted in a 4 or 6-inch (101.6 or 152.4-mm) diameter mold using a 5.5-lbf (24.4-N) hammer dropped from a height of 12 inches (305 mm), producing a compactive effort of 12,400 ft-lb/ft³ (600 kN-m/m³).

Standard Proctor tests were conducted on six of the eight materials. These six materials were SRK-03-C01, SRK-03-C02, SRK-03-C03, SRK-03-C04, SRK-03-C05 and SRK-03-C06. Only one Standard Proctor test on material SRK 03-CO3 was conducted using a 6-inch mold due to the amount of oversize materials. The remainder of the materials were tested using a 4-inch mold.

Results of the standard proctor tests are presented in Appendix IV.

Soil-Water Characteristic Curve Tests

The pressure plate technique and the vapor extraction technique were used in the soil-water characteristic curve tests. The pressure plate technique was used for suction values up to the wilting point (i.e., 15-bar pressure). The vapor extraction technique was used for suction values greater than the wilting point.

Pressure Plate Apparatus

MDH Geotechnical Laboratories have three models of pressure plate apparatuses. These are 1.) 300mm diameter pressure plate cells suitable for testing waste rock materials with maximum particle size of 60mm (Figure 1), 2.) small pressure cells suitable for fine-grained and sand-size materials passing the #4 sieve (4.75mm) (Figure 2), and 3.) a large conventional pressure plate extractor from Soil Moisture commonly used by agricultural soil scientists. The large conventional pressure plate extractor from Soil Moisture is suitable only for testing fine-grained material and cannot be used for testing coarse-grained materials like waste rocks.

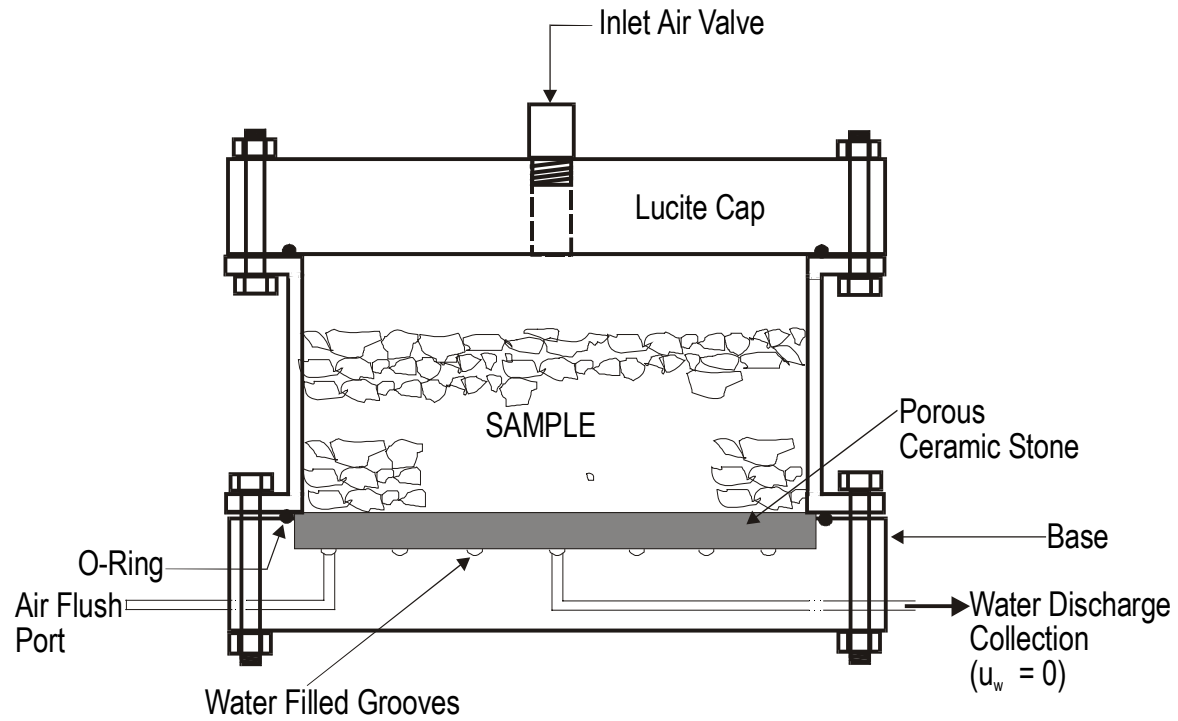


Figure 1 – Large pressure plate cell suitable for testing waste rocks with maximum particle size of 60mm.

Testing in this program were conducted using the small pressure plate cells for suction values up to 100 kPa and the conventional large pressure plate extraction for suction values from 200 kPa to 1500 kPa.

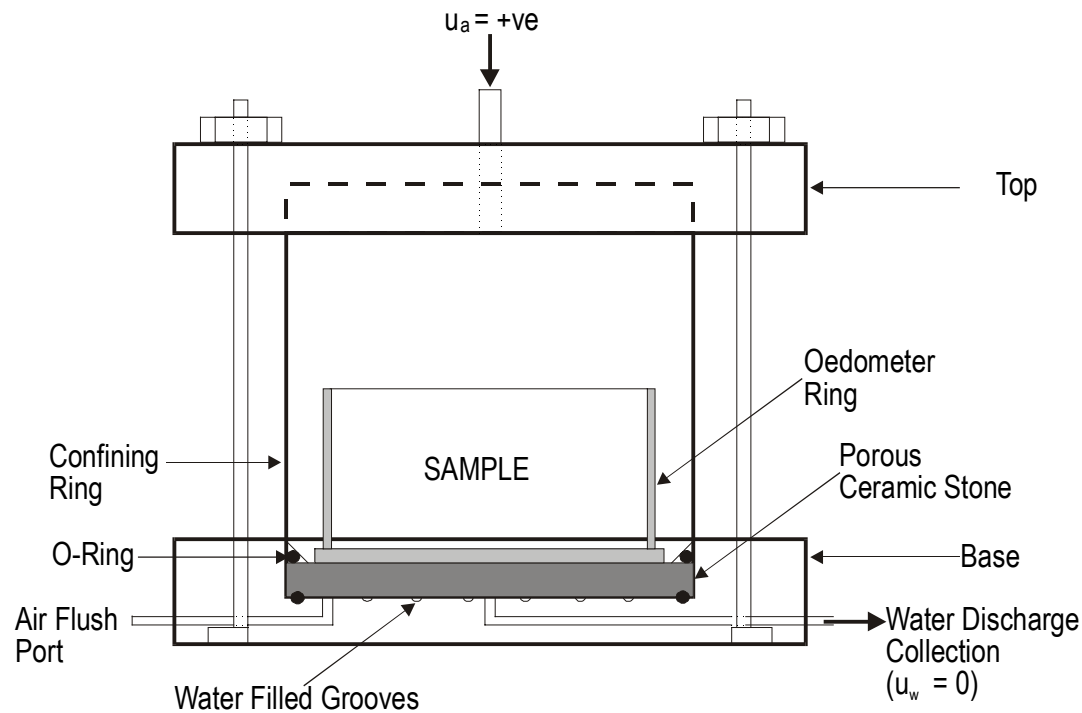


Figure 2 – Schematic diagram of small pressure plate cell.

Specimen Preparation

64-mm diameter specimens were used for the soil-water characteristic curve tests using the small pressure plate cells and the conventional large pressure plate extractor. The specimens were prepared using steel consolidometer rings with a diameter of 64mm and a height of 30mm.

The test specimens were prepared by tamping materials at its as-received water content condition into the steel consolidometer rings to 95% standard Proctor density.

Slurry test specimens were prepared in the following manner. Each slurry sample was first thoroughly mixed using an electric mixer for about 5 minutes. The thoroughly mixed slurry was allowed to settle overnight. Excess water was decanted and a test specimen was obtained by pressing the steel oedometer ring into the settled slurry.

The ringed-test specimens were then mounted into the small pressure plate cells (Figure 2) for soil-water characteristic curve tests. The high air-entry ceramic disks of the pressure plate cells were saturated prior to use.

Test Procedure

The soil-water characteristic curve tests conducted in this program were strictly desorption tests. Adsorption tests were not conducted. The test specimens were saturated prior to starting the desorption process.

Specimens prepared from consolidated slurries were assumed saturated. Compacted specimens were saturated in the pressure plate cells by applying a water head to the bottom of the specimen. This was accomplished using a water column attached to the base of the pressure plate cell. Wetting from the bottom allowed air to escape easily through the surface of the specimen. During the saturation process, the pressure plate cell was vented to the atmosphere.

Suction was initially applied to the soil specimens by means of a water column. A 1-m long flexible tubing was attached to the outlet port of the pressure plate cell. The flexible tubing was completely filled with water to ensure a continuous water phase to the soil specimen. A negative water head was applied to the water in the soil specimen by maintaining the water level in the flexible tubing at the required distance below the surface of the soil specimen. The flexible tubing was capped with a septum and vented using a hypodermic needle. Suction equilibrium was attained in the soil specimen when water ceased to drain from the soil. At each suction equilibrium stage, the entire pressure plate cell system was weighed. In this manner, water that was extracted from the soil specimen can be accurately tracked. The water column was used for extracting water from the specimen up to a suction value of 5 kPa (negative 50 cm head). The water head was measured with reference to the surface of the specimen. The height of the specimen was about 30mm and there would be a suction difference of about 0.3 kPa between the top and bottom of the specimen.

The tests were continued beyond 5kPa using an air pressure supply for controlling suction in the soil specimen. On achieving suction equilibrium at 100 kPa, the test specimens were transferred into the conventional large pressure plate extractor for continuation of testing up to 1500 kPa.

The pressure plate tests used the axis-translation technique. In the axis-translation technique, the air and water pressures within the soil specimens were both translated to ensure that the water within the soil measurement systems remained at a positive value. In this test program, the water pressures were maintained near atmospheric condition for the tests that were conducted using an air supply system. Using the axis-translation technique, it is then possible to apply suction greater than 100 kPa without the problem of cavitation of the water phase within the measurement system. The applied suction being equal to the difference between the air and water pressure.

At the completion of the pressure plate test, the volume-mass properties of each test specimen were determined. From the volume-mass data obtained at the end of the test, the volumetric and gravimetric water contents of the soil specimens corresponding to each suction equilibrium condition were computed by accounting for the amount of water that was lost from the soil at each stage.

Vapor Extraction Using Desiccators

For obtaining the soil-water characteristic curves at suctions greater than the wilting point, the vapor extraction technique was used. The vapor extraction tests were conducted using desiccators containing saturated salt solutions. The salt solutions and their corresponding suction values are presented in Table 2.

Table 2 – Saturated salt solutions and equivalent total suctions.

DESICCATOR	SALT	TEMPERATURE (°C)	RELATIVE HUMIDITY (%)	EQUIVALENT TOTAL SUCTION (kPa)
A	Lithium Chloride ($\text{LiCl}_2 \cdot \text{H}_2\text{O}$ + $\text{LiCl}_2 \cdot 2\text{H}_2\text{O}$)	20	11.5	2.93×10^5
B	Magnesium Chloride ($\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$)	20	33.0	1.50×10^5
C	Magnesium Nitrate ($\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$)	20	54.3	8.26×10^4
D	Sodium Chloride (NaCl)	20	75.5	3.80×10^4
E	Potassium Sulphate	20	97.0	4.12×10^3

Small samples from each of the ten material types were placed in each of the above five desiccators at the start of the testing program. The samples were kept in the desiccators until the pressure plate tests were nearing completion, a period of over six weeks in this case. Typically, a period of two to three weeks was required for the specimens in the desiccators to attain equilibrium. The equilibrium conditions were checked by weighing the specimens. Constant weight over two weighing period would confirm equilibrium condition. The water contents of each sample on attaining vapor equilibrium were then determined.

Results of the large diameter (300-mm) and small diameter (64-mm) soil-water characteristic curve tests are presented in Appendix V-a and V-b, respectively.

Consolidation Test

Consolidation test was conducted on tailings material SRK-03-CO7 as per ASTM D 2435. The test was conducted to a maximum pressure of 4866 kPa. Results of the consolidation tests performed on SRK-03-CO7 are presented in Appendix VI.

Hydraulic Conductivity Tests

Falling head hydraulic conductivity tests were conducted on materials SRK-03-C01, SRK-03-C02 SRK-03-C04, SRK-03-C05, SRK-03-C06 and SRK-03-C07.

Constant head tests were conducted on materials SRK-03-C03 and SRK-03-C08. Constant head test was also repeated for material SRK-03-C05, and the results checked out well with the falling head test results.

Details on the constant head and falling head tests can be found in "Liu & Evett, 1984, SOIL PROPERTIES: Testing, Measurement, and Evaluation, Prentice-Hall, New Jersey".

Results of the falling head and constant head tests are presented in Appendix VII-a and VII-b, respectively.

Closure

The tests conducted in this program were requested by Dr. Maritz Rykaart of SRK Consulting, Vancouver. This report was prepared exclusively for SRK Consulting, Vancouver.

We trust this report meets your present needs. Please contact the undersigned if you have any questions, or if we can be of further assistance.

Respectfully submitted

MDH Geotechnical Laboratories

Julian Gan, M.Sc., P.Eng.
Laboratories Manager

APPENDIX I

Atterberg Limits Tests Results



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

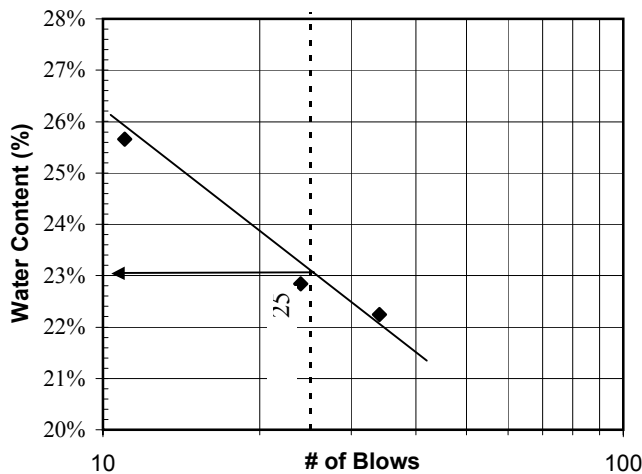
Sample: SRK-03-C01

Plastic Limit

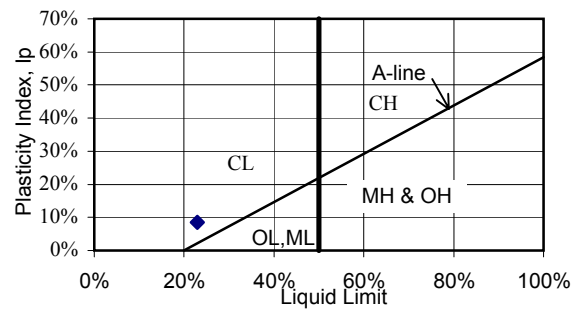
Tare #	A11	A2					
Tare Wt, g	13.41	13.16					
Wet + Tare, g	21.11	19.25					
Dry + Tare, g	20.13	18.48					
M%	14.6%	14.5%		Average:	14.5%		

Liquid Limit

# of Blows	11	24	34				
Tare #	A15	A6	A14				
Tare Wt, g	13.65	13.33	13.52				
Wet + tare, g	28.49	28.12	30.39				
Dry + tare, g	25.46	25.37	27.32				
M%	25.7%	22.8%	22.2%				



Plastic Limit: 14.5%
 Liquid Limit: 23.0%
 Plasticity Index: 8.5%
 Classification: CL



Comments: _____



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

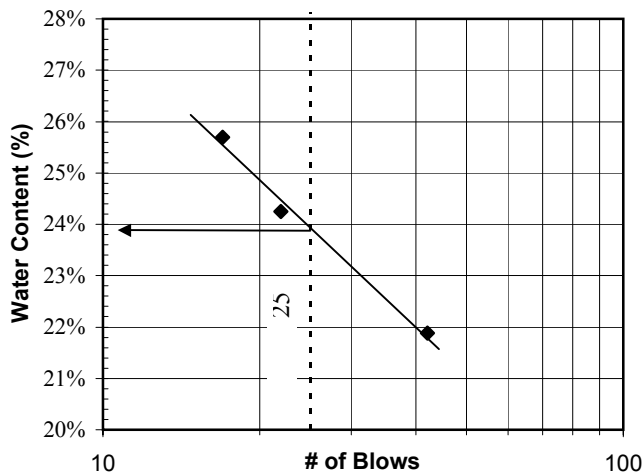
Sample: SRK-03-C02

Plastic Limit

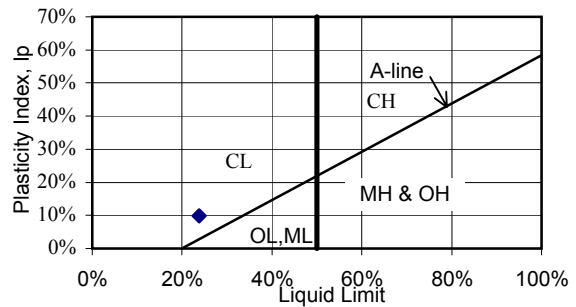
Tare #	A5	A4					
Tare Wt, g	13.45	13.50					
Wet + Tare, g	19.6	20.43					
Dry + Tare, g	18.85	19.58					
M%	13.9%	14.0%		Average:	13.9%		

Liquid Limit

# of Blows	42	22	17				
Tare #	A8	A3	A11				
Tare Wt, g	13.50	13.74	13.35				
Wet + tare, g	30.71	27.78	26.95				
Dry + tare, g	27.62	25.04	24.17				
M%	21.9%	24.2%	25.7%				



Plastic Limit: 13.9%
 Liquid Limit: 23.8%
 Plasticity Index: 9.9%
 Classification: CL



Comments: _____



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

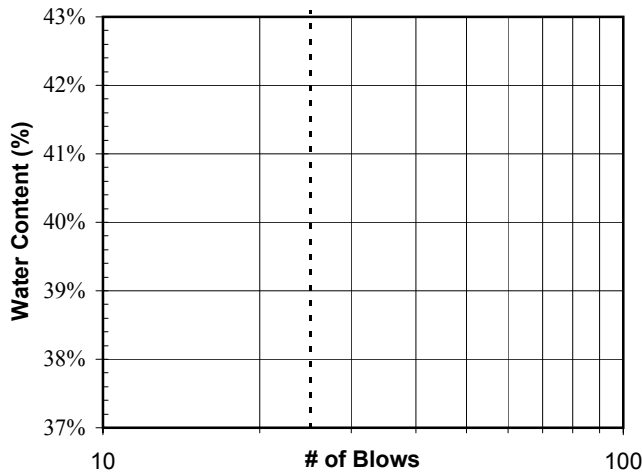
Sample: SRK-03-C03

Plastic Limit

Tare #							
Tare Wt, g							
Wet + Tare, g							
Dry + Tare, g							
M%	#DIV/0!	#DIV/0!		Average:	#DIV/0!		

Liquid Limit

# of Blows							
Tare #							
Tare Wt, g							
Wet + tare, g							
Dry + tare, g							
M%	#DIV/0!	#DIV/0!	#DIV/0!				

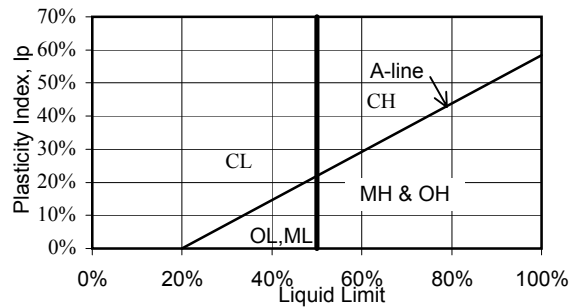


Plastic Limit: #DIV/0!

Liquid Limit:

Plasticity Index: #DIV/0!

Classification:



Comments: Material would not roll - all sand. Material classified as NONPLASTIC



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

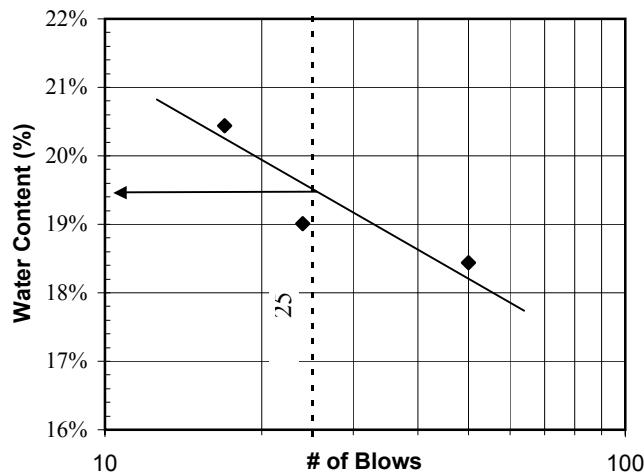
Sample: SRK-03-C04

Plastic Limit

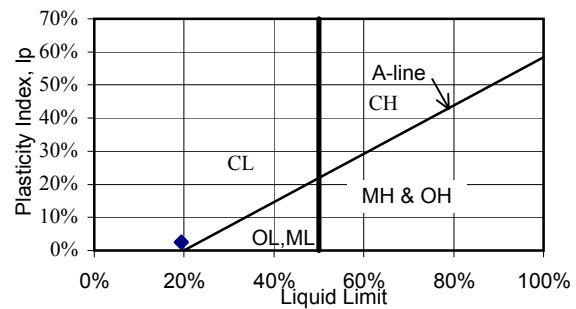
Tare #	A13	A9					
Tare Wt, g	13.37	13.42					
Wet + Tare, g	19.91	22.27					
Dry + Tare, g	18.97	20.99					
M%	16.8%	16.9%		Average:	16.8%		

Liquid Limit

# of Blows	17	24	50				
Tare #	A12	A7	A24				
Tare Wt, g	13.59	13.50	13.12				
Wet + tare, g	31.68	35.91	29.37				
Dry + tare, g	28.61	32.33	26.84				
M%	20.4%	19.0%	18.4%				



Plastic Limit: 16.8%
 Liquid Limit: 19.4%
 Plasticity Index: 2.6%
 Classification: CL



Comments: _____



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

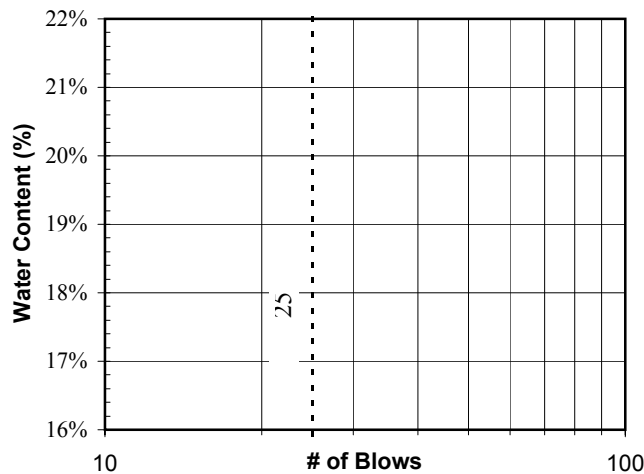
Sample: SRK-03-C05

Plastic Limit

Tare #							
Tare Wt, g							
Wet + Tare, g							
Dry + Tare, g							
M%	#DIV/0!	#DIV/0!		Average:	#DIV/0!		

Liquid Limit

# of Blows							
Tare #							
Tare Wt, g							
Wet + tare, g							
Dry + tare, g							
M%	#DIV/0!	#DIV/0!	#DIV/0!				

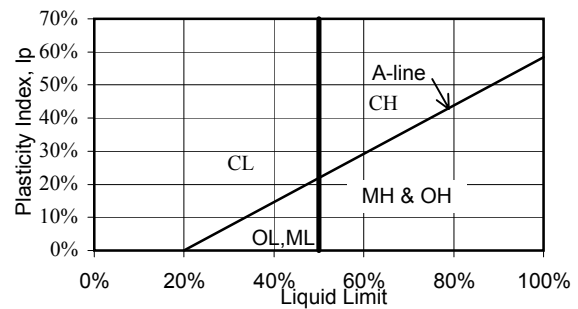


Plastic Limit: #DIV/0!

Liquid Limit:

Plasticity Index: #DIV/0!

Classification:



Comments: Material would not roll - too sandy - soil classified as NONPLASTIC



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

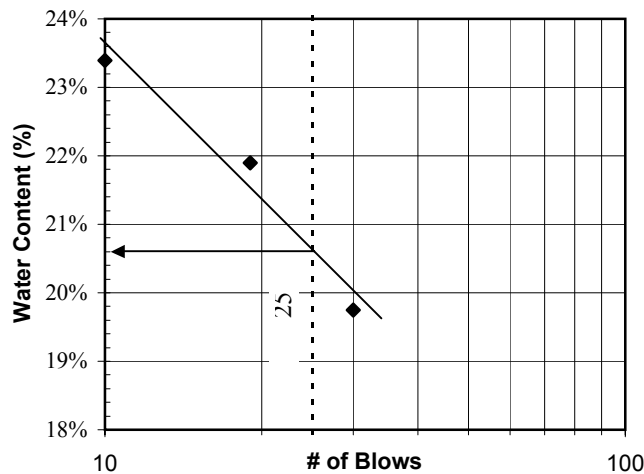
Sample: SRK-03-C06

Plastic Limit

Tare #	A31	A19					
Tare Wt, g	13.57	13.54					
Wet + Tare, g	20.08	19.36					
Dry + Tare, g	18.89	18.33					
M%	22.4%	21.5%		Average:	21.9%		

Liquid Limit

# of Blows	10	19	30				
Tare #	A30	A29	A25				
Tare Wt, g	13.17	13.38	13.60				
Wet + tare, g	31.00	31.08	32.52				
Dry + tare, g	27.62	27.90	29.40				
M%	23.4%	21.9%	19.7%				

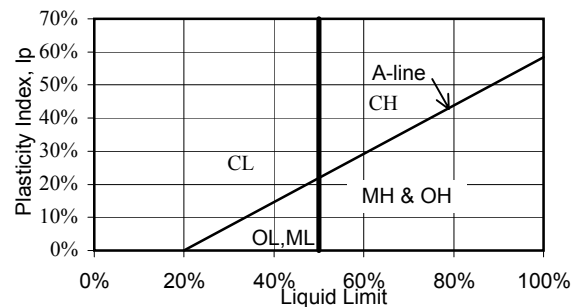


Plastic Limit: 21.9%

Liquid Limit: 20.6%

Plasticity Index: -1.3%

Classification:



Comments: Material barely rolled - too sandy - soil classified as NONPLASTIC



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

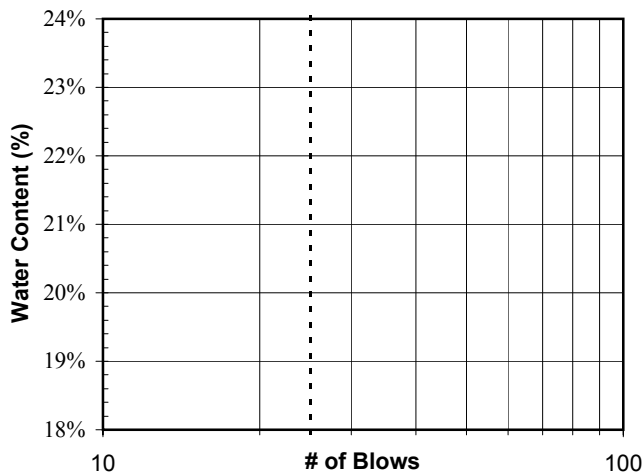
Sample: SRK-03-C07

Plastic Limit

Tare #							
Tare Wt, g							
Wet + Tare, g							
Dry + Tare, g							
M%	#DIV/0!	#DIV/0!		Average:	#DIV/0!		

Liquid Limit

# of Blows							
Tare #							
Tare Wt, g							
Wet + tare, g							
Dry + tare, g							
M%	#DIV/0!	#DIV/0!	#DIV/0!				

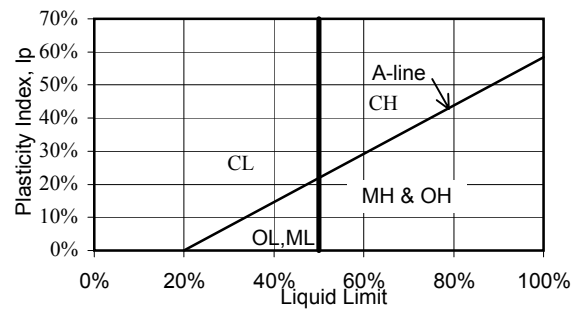


Plastic Limit: #DIV/0!

Liquid Limit:

Plasticity Index: #DIV/0!

Classification:



Comments: Material would not roll - too sandy - soil classified as NONPLASTIC



ATTERBERG LIMITS

Project: Faro Mine

Location: Whitehorse, Yukon

SRK Consulting

Technician: SO

Date: 22-Jul-03

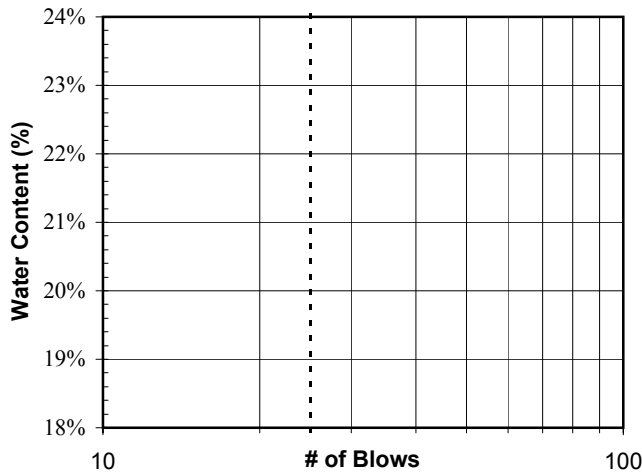
Sample: SRK-03-C08

Plastic Limit

Tare #							
Tare Wt, g							
Wet + Tare, g							
Dry + Tare, g							
M%	#DIV/0!	#DIV/0!		Average:	#DIV/0!		

Liquid Limit

# of Blows							
Tare #							
Tare Wt, g							
Wet + tare, g							
Dry + tare, g							
M%	#DIV/0!	#DIV/0!	#DIV/0!				

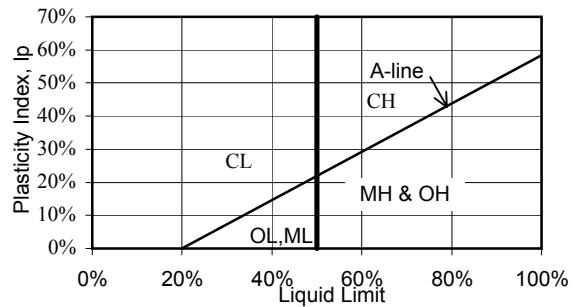


Plastic Limit: #DIV/0!

Liquid Limit:

Plasticity Index: #DIV/0!

Classification:



Comments: Material would not roll - too sandy - soil classified as NONPLASTIC

APPENDIX II

Specific Gravity Results



**SPECIFIC GRAVITY DETERMINATION FOR COARSE
AGGREGATE - ASTM C 127**

Project: SRK Consulting
 Location: Faro Mine, WhiteHorse
 Date: 14-Jul-03

Computation for Bulk Specific Gravity

Sample: SRK-03-C01

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)		263.86	92.22	
Weight of Saturated-Surface-Dry Sample in Air, B (g)		265.85	93.39	
Weight of Saturated Sample in Water, C (g)		166.85	58.42	
Bulk Specific Gravity, $G_s = B/(B-C)$		2.69	2.67	
Apparent Specific Gravity, $G_{as} = A/(A-C)$		2.72	2.73	2.70

Computation for Bulk Specific Gravity

Sample: SRK-03-C02

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)		263.86	107.12	
Weight of Saturated-Surface-Dry Sample in Air, B (g)		265.85	108.24	
Weight of Saturated Sample in Water, C (g)		166.85	67.08	
Bulk Specific Gravity, $G_s = B/(B-C)$		2.69	2.63	
Apparent Specific Gravity, $G_{as} = A/(A-C)$		2.72	2.68	2.69

Computation for Bulk Specific Gravity

Sample: SRK-03-C03

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)			215.25	
Weight of Saturated-Surface-Dry Sample in Air, B (g)			217.60	
Weight of Saturated Sample in Water, C (g)			135.61	
Bulk Specific Gravity, $G_s = B/(B-C)$			2.65	
Apparent Specific Gravity, $G_{as} = A/(A-C)$			2.70	2.68

Comments:



**SPECIFIC GRAVITY DETERMINATION FOR COARSE
AGGREGATE - ASTM C 127**

Project: SRK Consulting
 Location: Faro Mine, WhiteHorse
 Date: 14-Jul-03

Computation for Bulk Specific Gravity

Sample: SRK-03-C04

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)			108.16	
Weight of Saturated-Surface-Dry Sample in Air, B (g)			109.72	
Weight of Saturated Sample in Water, C (g)			68.18	
Bulk Specific Gravity, $G_s = B/(B-C)$			2.64	
Apparent Specific Gravity, $G_{as} = A/(A-C)$			2.71	2.69

Computation for Bulk Specific Gravity

Sample: SRK-03-C05

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)			148.02	
Weight of Saturated-Surface-Dry Sample in Air, B (g)			150.87	
Weight of Saturated Sample in Water, C (g)			93.15	
Bulk Specific Gravity, $G_s = B/(B-C)$			2.61	
Apparent Specific Gravity, $G_{as} = A/(A-C)$			2.70	2.68

Computation for Bulk Specific Gravity

Sample: SRK-03-C06

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)			155.73	
Weight of Saturated-Surface-Dry Sample in Air, B (g)			158.70	
Weight of Saturated Sample in Water, C (g)			98.07	
Bulk Specific Gravity, $G_s = B/(B-C)$			2.62	
Apparent Specific Gravity, $G_{as} = A/(A-C)$			2.70	2.68

Comments:



**SPECIFIC GRAVITY DETERMINATION FOR COARSE
AGGREGATE - ASTM C 127**

Project: SRK Consulting
 Location: Faro Mine, WhiteHorse
 Date: 14-Jul-03

Computation for Bulk Specific Gravity

Sample: SRK-03-C07

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)			108.16	
Weight of Saturated-Surface-Dry Sample in Air, B (g)			109.72	
Weight of Saturated Sample in Water, C (g)			68.18	
Bulk Specific Gravity, $G_s = B/(B-C)$			2.64	
Apparent Specific Gravity, $G_{as} = A/(A-C)$			2.71	3.46

Computation for Bulk Specific Gravity

Sample: SRK-03-C08

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)			167.43	
Weight of Saturated-Surface-Dry Sample in Air, B (g)			170.19	
Weight of Saturated Sample in Water, C (g)			108.71	
Bulk Specific Gravity, $G_s = B/(B-C)$			2.77	
Apparent Specific Gravity, $G_{as} = A/(A-C)$			2.85	2.88

Computation for Bulk Specific Gravity

Soil	> 2"	3/8" - 2"	#4 - 3/8"	<#4
Weight of Oven-Dry Sample in Air, A (g)				
Weight of Saturated-Surface-Dry Sample in Air, B (g)				
Weight of Saturated Sample in Water, C (g)				
Bulk Specific Gravity, $G_s = B/(B-C)$				
Apparent Specific Gravity, $G_{as} = A/(A-C)$				

Comments:

APPENDIX III

Grain Size Distribution Results

GRAIN SIZE DISTRIBUTION



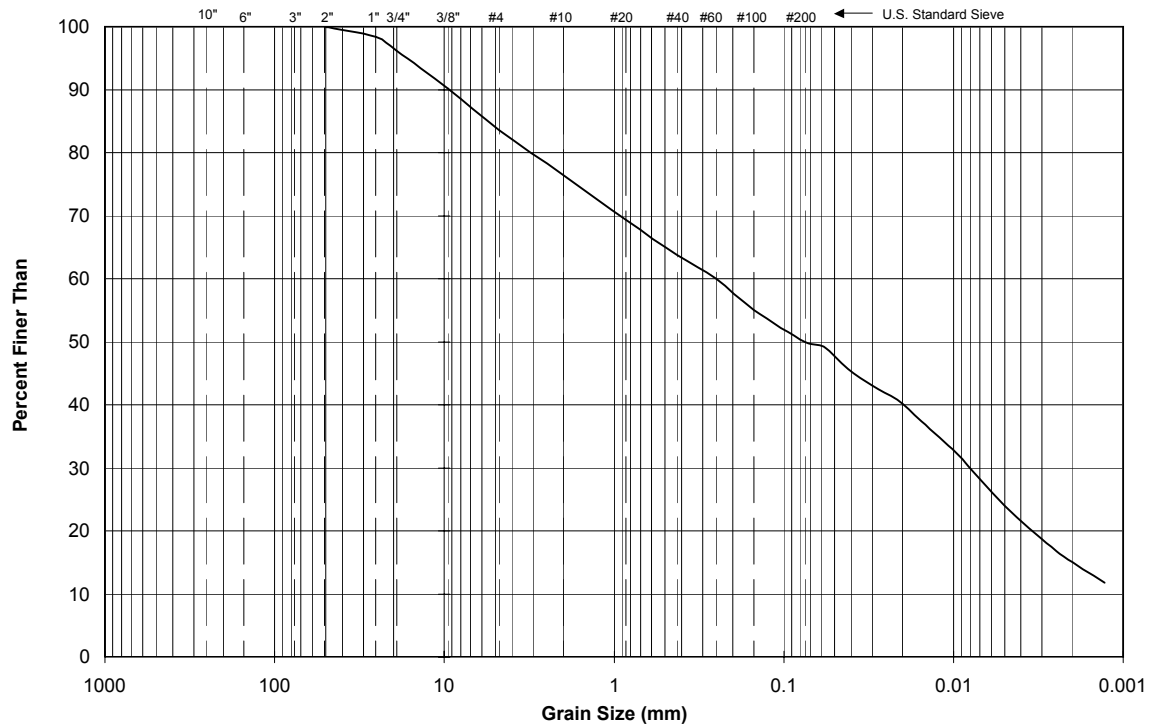
	Sieve	Diameter (mm)	% Finer
Mechanical:	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	98
	3/4"	19.1	96
	3/8"	9.5	90
	# 4	4.75	84
	# 10	2.00	76
	# 20	0.850	69
	# 40	0.425	64
	# 60	0.250	60
	# 100	0.150	55
	# 200	0.075	50

PROJECT: Faro Mine
LOCATION: Whitehorse, Yukon
SITE: SRK Consulting
SAMPLE: SRK-03-C01
DATE: 25-Jul-03

COMMENTS:

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS
 % COBBLES
 % GRAVEL 16
 % SAND 34
 % FINES (SILT, CLAY) 50



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System

GRAIN SIZE DISTRIBUTION



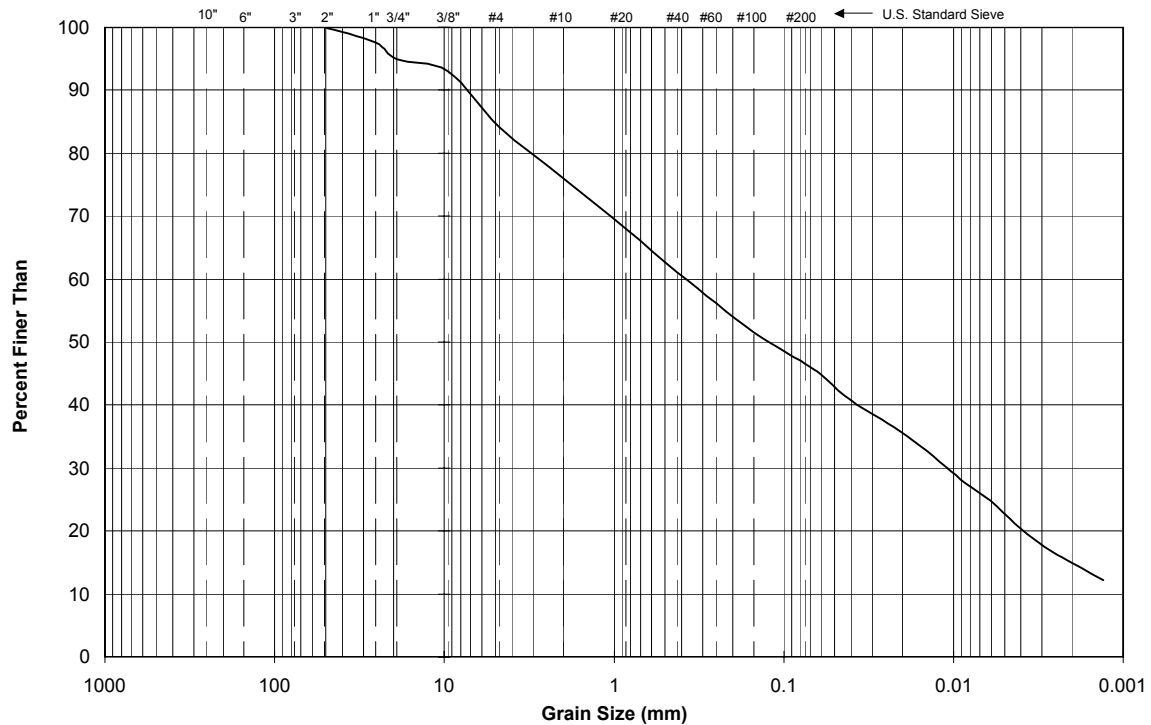
	Sieve	Diameter (mm)	% Finer
Mechanical:	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	98
	3/4"	19.1	95
	3/8"	9.5	93
	# 4	4.75	84
	# 10	2.00	76
	# 20	0.850	68
	# 40	0.425	61
	# 60	0.250	56
	# 100	0.150	52
	# 200	0.075	47

PROJECT: Faro Mine
LOCATION: Whitehorse, Yukon
SITE: SRK Consulting
SAMPLE: SRK-03-C02
DATE: 25-Jul-03

COMMENTS:

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS
 % COBBLES
 % GRAVEL 16
 % SAND 37
 % FINES (SILT, CLAY) 47



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System

GRAIN SIZE DISTRIBUTION

	Diameter		% Finer
	Sieve	(mm)	
Mechanical:	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	98
	3/4"	19.1	92
	3/8"	9.5	75
	# 4	4.75	60
	# 10	2.00	45
	# 20	0.850	27
	# 40	0.425	12
	# 60	0.250	6
	# 100	0.150	2
	# 200	0.075	-1

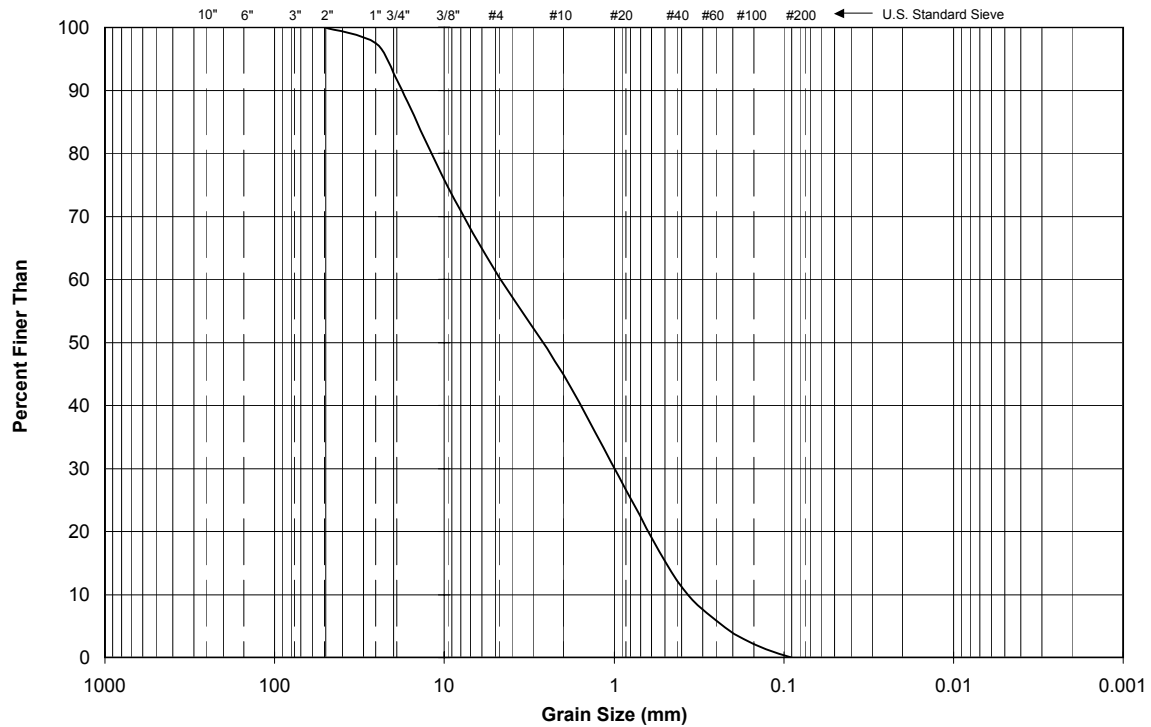


PROJECT: Faro Mine
LOCATION: Whitehorse, Yukon
SITE: SRK Consulting
SAMPLE: SRK-03-C03
DATE: Jul 3-03

COMMENTS:

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS
 % COBBLES
 % GRAVEL 40
 % SAND 60
 % FINES (SILT, CLAY)



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System

GRAIN SIZE DISTRIBUTION

	Sieve	Diameter (mm)	% Finer
Mechanical:	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	97
	3/4"	19.1	96
	3/8"	9.5	89
	# 4	4.75	81
	# 10	2.00	72
	# 20	0.850	62
	# 40	0.425	55
	# 60	0.250	51
	# 100	0.150	45
	# 200	0.075	38

0.0634	35.5
0.0457	30.3
0.0327	27.1
0.0234	24.2
0.0167	21.1
0.0120	18.1
0.0088	14.7
0.0061	11.2
0.0046	9.5
0.0032	7.3
0.0024	5.8
0.0013	3.2

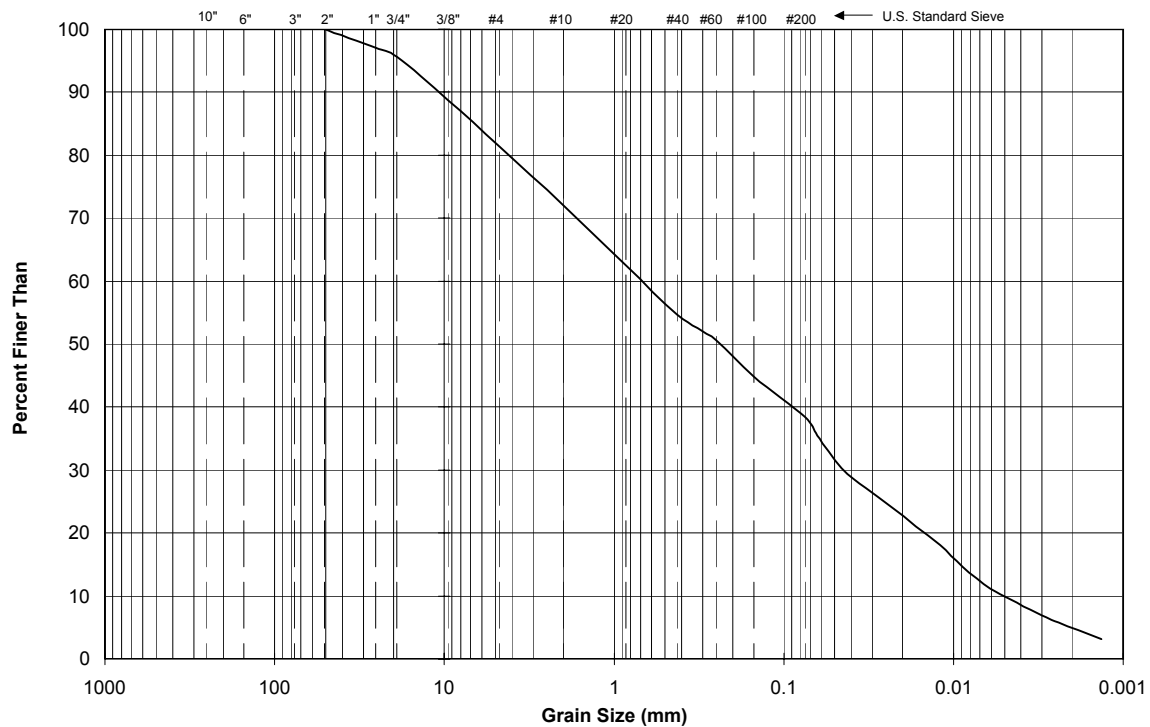


PROJECT: Faro Mine
LOCATION: Whitehorse
SITE: SRK Consulting
SAMPLE: SRK-03-C04
DATE: 25-Jul-03

COMMENTS:

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS
 % COBBLES
 % GRAVEL 19
 % SAND 43
 % FINES (SILT, CLAY) 38



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System

GRAIN SIZE DISTRIBUTION

	Sieve	Diameter (mm)	% Finer
Mechanical:	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	100
	3/4"	19.1	98
	3/8"	9.5	95
	# 4	4.75	84
	# 10	2.00	65
	# 20	0.850	45
	# 40	0.425	30
	# 60	0.250	19
	# 100	0.150	11
	# 200	0.075	6



PROJECT: SRK Consultants

LOCATION:

SITE: Faro Mine, Whitehorse

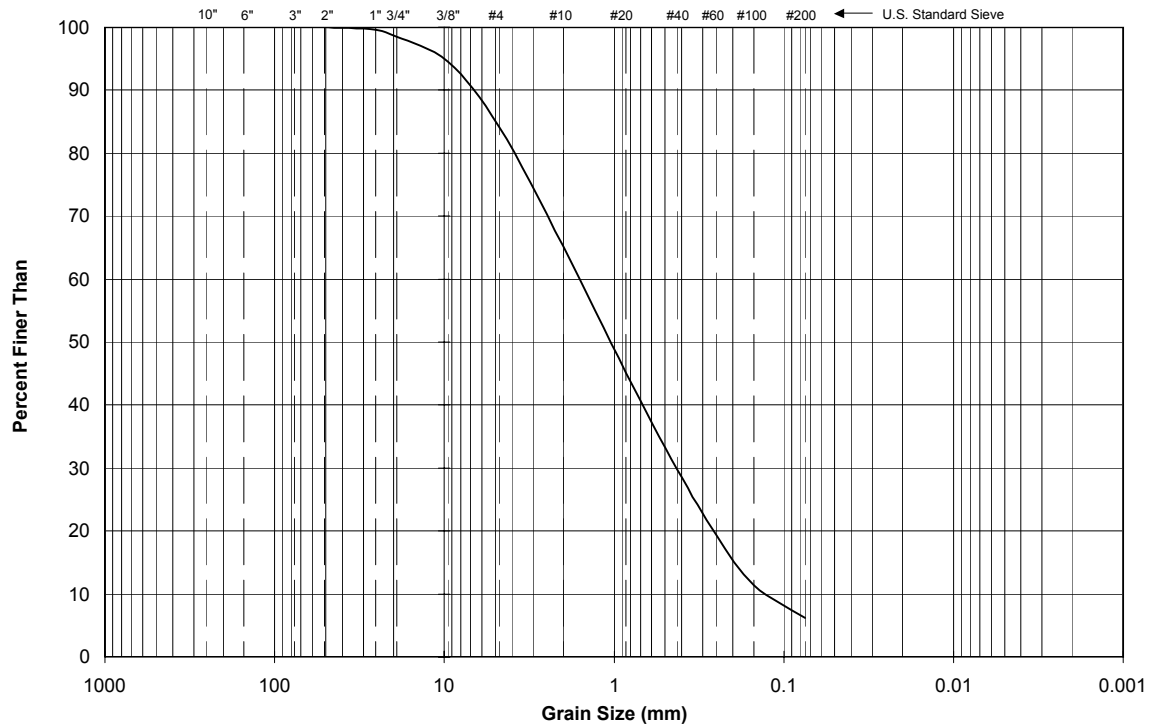
SAMPLE: SRK-030-C05

DATE: Jul-3-03

COMMENTS:

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS
 % COBBLES
 % GRAVEL 16
 % SAND 78
 % FINES (SILT, CLAY) 6



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System

GRAIN SIZE DISTRIBUTION



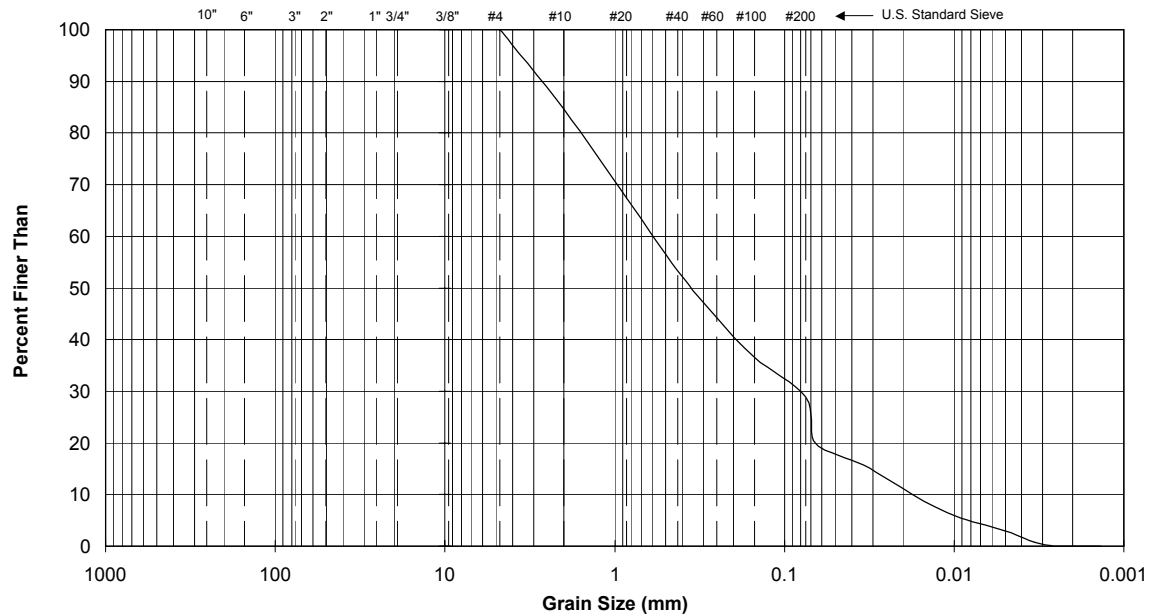
PROJECT: Faro Mine
Whitehorse, Yukon
SRK Consulting
SAMPLE: SRK-03-C06
DATE: 22-Jul-03

COMMENTS:

	Sieve	Diameter (mm)	% Finer
Mechanical:	15"	381.0	100
	14"	355.6	100
	13"	330.2	100
	12"	304.8	100
	11"	279.4	100
	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	100
	3/4"	19.1	100
	3/8"	9.5	100
	# 4	4.75	100
	# 10	2.00	85
	# 20	0.850	67
Hydrometer:	# 40	0.425	53
	# 60	0.250	44
	# 100	0.150	37
	# 200	0.075	29
		0.0673	20.4
		0.0481	17.6
		0.0342	15.7
		0.0245	12.8
		0.0175	10.0
		0.0129	7.6
		0.0091	5.4
		0.0065	4.1
		0.0046	2.6
		0.0034	0.7
		0.0024	0.0
		0.0014	

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS
% COBBLES
% GRAVEL
% SAND 71
% FINES (SILT, CLAY) 29



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Course	Fine	Course	Medium	Fine	

Unified Soil Classification System

GRAIN SIZE DISTRIBUTION

	Sieve	Diameter (mm)	% Finer
Mechanical:	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	100
	3/4"	19.1	100
	3/8"	9.5	100
	# 4	4.75	100
	# 10	2.00	100
	# 20	0.850	96
	# 40	0.425	85
	# 60	0.250	72
	# 100	0.150	55
	# 200	0.075	30

0.0666	11.4
0.0475	8.9
0.0338	7.5
0.0240	6.0
0.0170	5.1
0.0125	4.1
0.0088	3.7
0.0062	3.3
0.0044	2.5
0.0033	1.0
0.0024	
0.0013	



PROJECT: Faro Mine

LOCATION: Whitehorse

SITE:

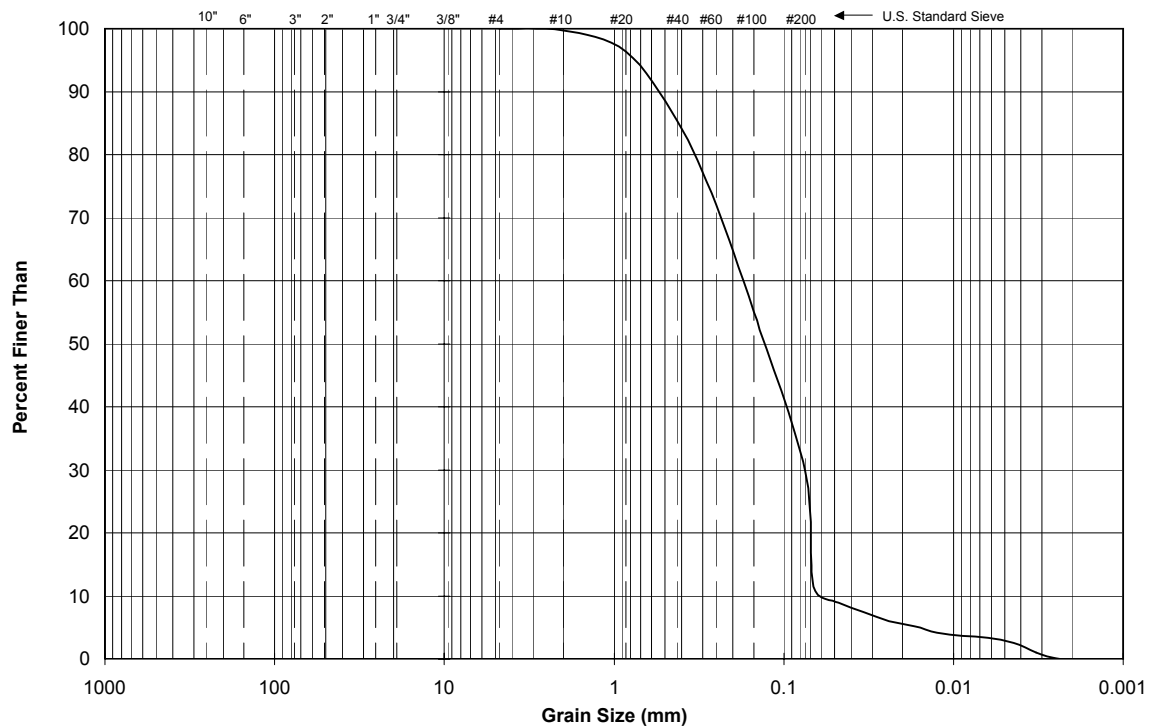
SAMPLE: SRK-03-C07

DATE: 25-Jul-03

COMMENTS:

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS
 % COBBLES
 % GRAVEL
 % SAND 70
 % FINES (SILT, CLAY) 30



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System

GRAIN SIZE DISTRIBUTION

	Sieve	Diameter (mm)	% Finer
Mechanical:	10"	254.0	100
	9"	228.6	100
	8"	203.2	100
	7"	177.8	100
	6"	152.4	100
	5"	127.0	100
	4"	101.6	100
	3"	76.2	100
	2"	50.8	100
	1"	25.4	88
	3/4"	19.1	81
	3/8"	9.5	63
	# 4	4.75	51
	# 10	2.00	38
	# 20	0.850	28
	# 40	0.425	22
	# 60	0.250	18
	# 100	0.150	15
	# 200	0.075	12

0.0633	11.6
0.0453	10.3
0.0324	9.3
0.0231	8.2
0.0165	7.4
0.0121	6.7
0.0086	5.7
0.0064	4.9
0.0045	4.3
0.0033	3.3
0.0024	2.8
0.0013	2.2



PROJECT: Faro Mine

LOCATION: Whitehorse

SITE:

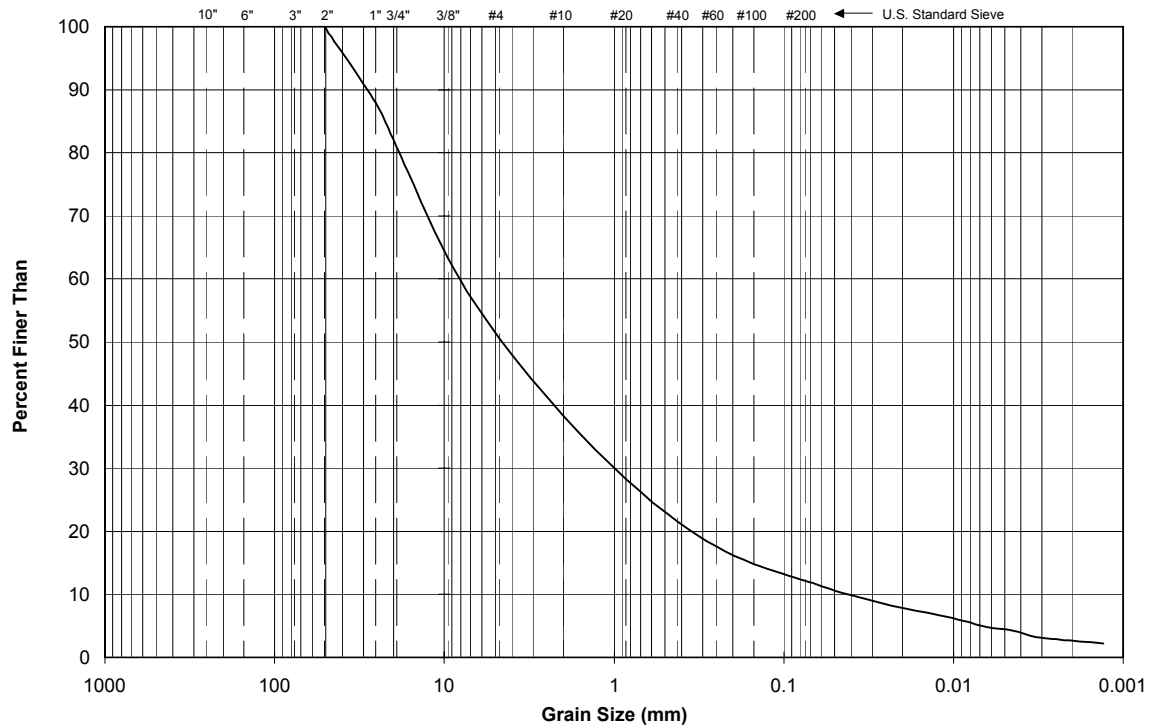
SAMPLE: SRK-03-C08

DATE: 10-Jul-03

COMMENTS:

PARTICLE SIZE DISTRIBUTION SUMMARY

% BOULDERS	
% COBBLES	
% GRAVEL	49
% SAND	39
% FINES (SILT, CLAY)	12



BOULDERS	COBBLES	GRAVEL		SAND			FINES (SILT, CLAY)
		Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System

APPENDIX IV

Standard Proctor Tests Results



COMPACTION TEST

PROJECT: M453
Faro Mine
Whitehorse, Yukon

SAMPLE: SRK 03-C01

DATE: 10-Jul-03

Test Results:

Water Content: (%)	Dry Density (kg/m ³)
6.8	1987
8.7	2057
10.3	2070
11.4	2011
13.0	1958

Maximum dry density: 2072 kg/m³
Optimum water content: 9.9 %

Results corrected for oversized material?
yes

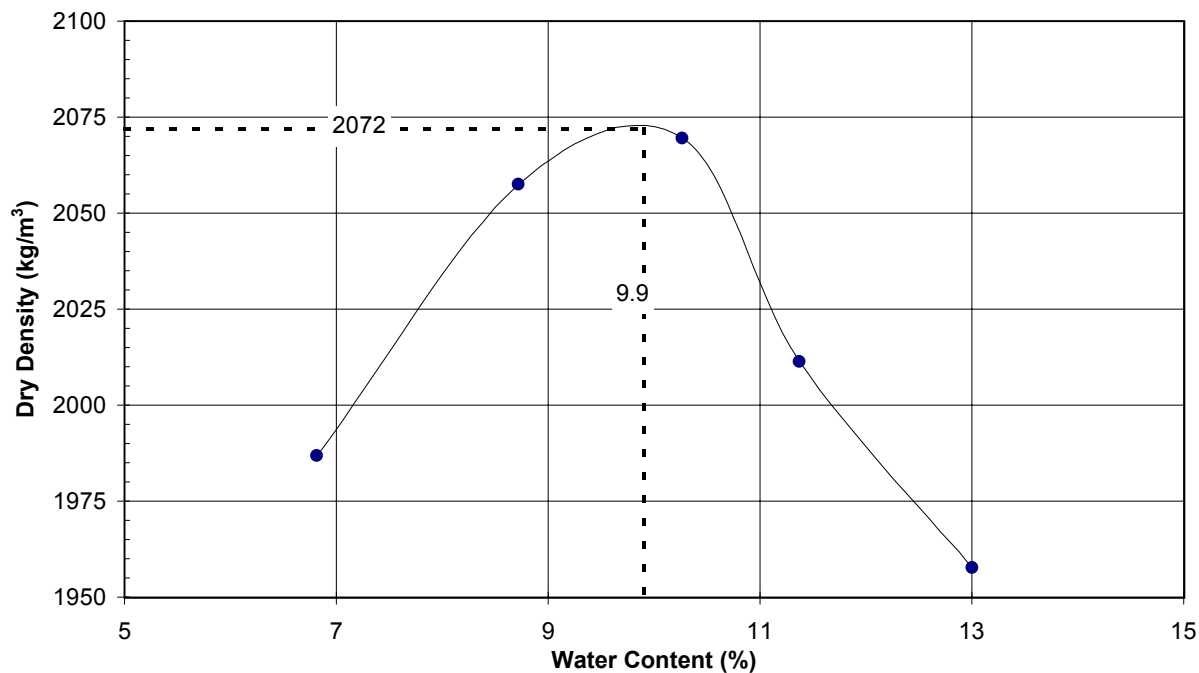
Test Details:

Effort: Standard
Procedure used: A
Diameter of mold: 101 mm
Compacted material less than: 4.75 mm in diameter
Method of preparation: dry

Overflow Correction Data (if applicable):

Percentage overflow fraction: 21.0 %
Specific gravity: 2.50 (assumed)

Comments:





COMPACTION TEST

PROJECT: Faro Mine
Whitehorse

SAMPLE: SRC 03 C02
DATE: 3-Jul-03

Test Results:

Water Content: (%)	Dry Density (kg/m ³)
6.6	1870
8.2	1978
9.8	2048
11.4	1999
13.1	1934

Maximum dry density: 2045 kg/m³
Optimum water content: 10.0 %

Results corrected for oversized material?
yes

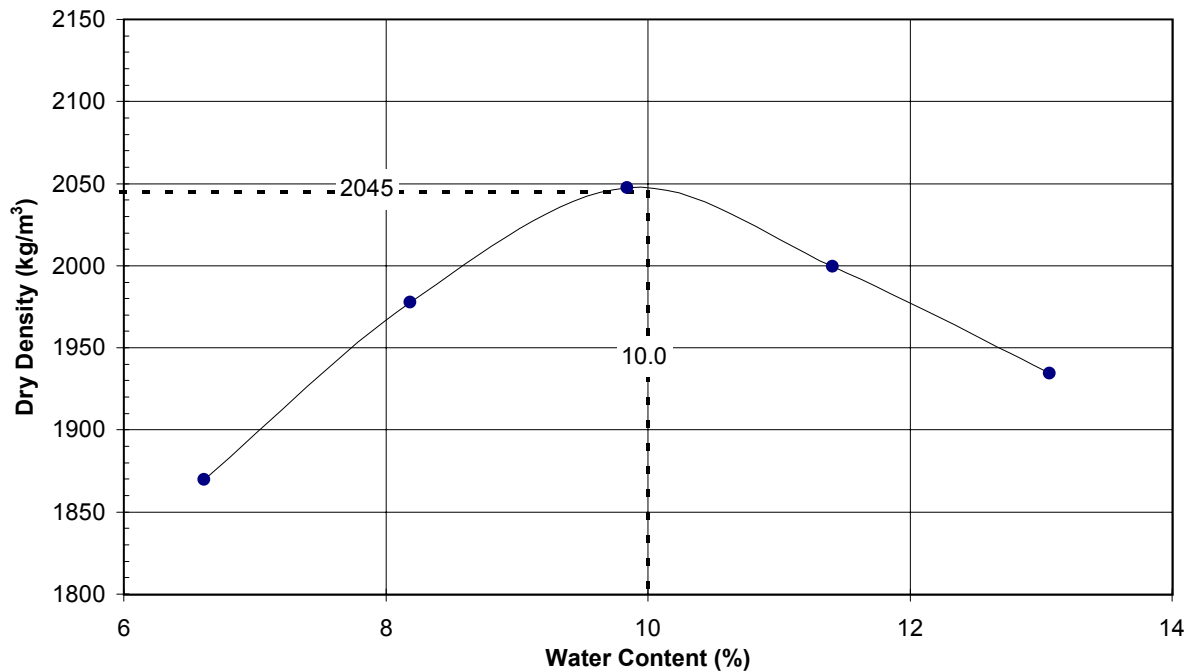
Test Details:

Effort: Standard
Procedure used: A
Diameter of mold: 101 mm
Compacted material less than: 4.75 mm in diameter
Method of preparation: dry

Overflow Correction Data (if applicable):

Percentage overflow fraction: 17.3 %
Specific gravity: 2.50 (assumed)

Comments:





COMPACTION TEST

PROJECT: M453

Faro Mine

Whitehorse, Yukon

SAMPLE: SRK 03-C03

DATE: 11-Jul-03

Test Results:

Water Content: (%)	Dry Density (kg/m ³)
1.9	2129
3.5	2157
5.5	2183
7.2	2193
8.4	2144

Maximum dry density: 2195 kg/m³

Optimum water content: 6.9 %

Results corrected for oversized material?
yes

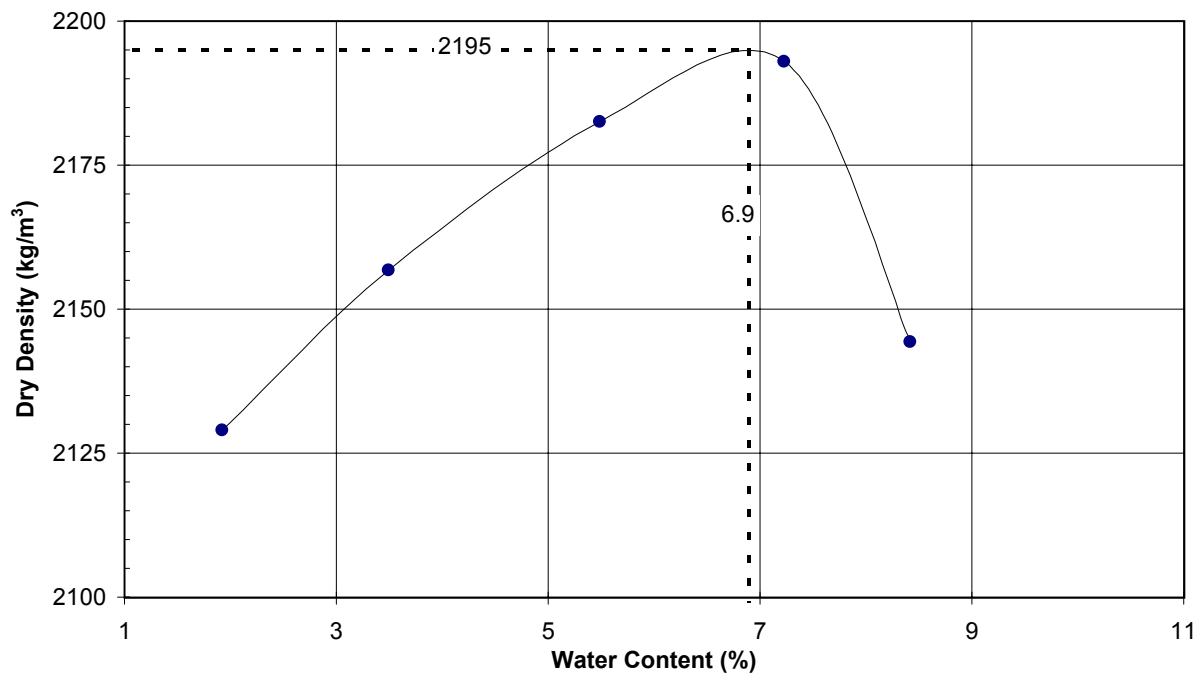
Test Details:

Effort: Standard
Procedure used: C
Diameter of mold: 152 mm
Compacted material less than: 19.1 mm in diameter
Method of preparation: dry

Overflow Correction Data (if applicable):

Percentage overflow fraction: 6.0 %
Specific gravity: 2.50 (assumed)

Comments:





COMPACTION TEST

PROJECT: Faro Mine
Whitehorse

SAMPLE: SRK-03-C04
DATE: 10-Jul-03

Test Results:

Water Content: (%)	Dry Density (kg/m ³)
4.8	2033
6.3	2102
7.6	2117
9.4	2057
11.0	1992

Maximum dry density: 2120 kg/m³
Optimum water content: 7.4 %

Results corrected for oversized material?
N/A

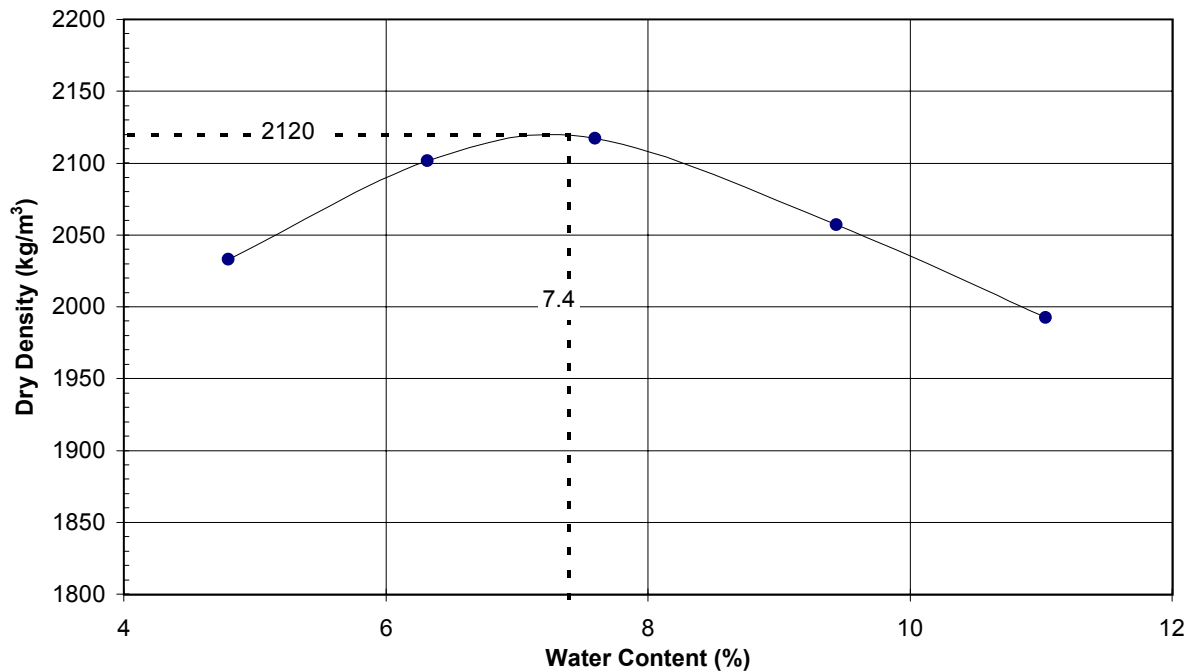
Test Details:

Effort: Standard
Procedure used: A
Diameter of mold: 101 mm
Compacted material less than: 4.75 mm in diameter
Method of preparation: dry

Override Correction Data (if applicable):

Percentage override fraction: 20.0 %
Specific gravity: 2.50 (assumed)

Comments:





COMPACTION TEST

PROJECT: M453
Faro Mine
Whitehorse, Yukon

SAMPLE: SRK 03-C05

DATE: 8-Jul-03

Test Results:

Water Content: (%)	Dry Density (kg/m ³)
5.3	2024
6.9	2040
8.3	2065
10.0	2040
12.3	1931

Maximum dry density: 2065 kg/m³
Optimum water content: 8.5 %

Results corrected for oversized material?
yes

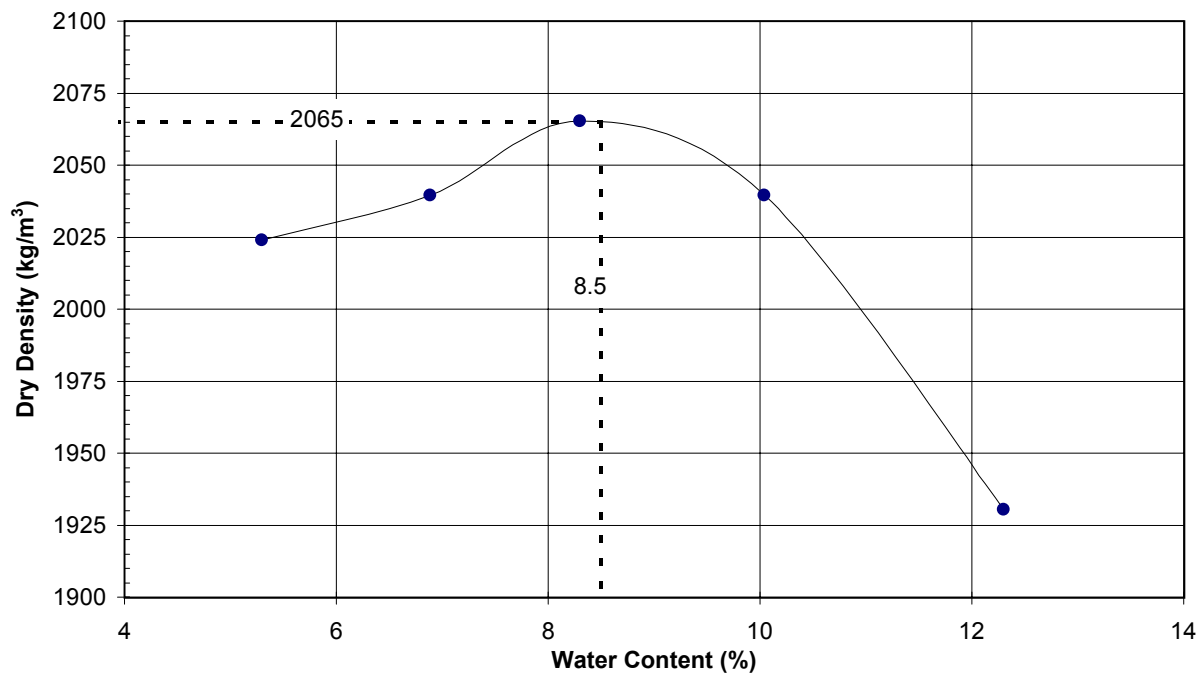
Test Details:

Effort: Standard
Procedure used: A
Diameter of mold: 101 mm
Compacted material less than: 4.75 mm in diameter
Method of preparation: dry

Override Correction Data (if applicable):

Percentage override fraction: 13.0 %
Specific gravity: 2.50 (assumed)

Comments:





COMPACTION TEST

PROJECT: M453
Faro Mine
Whitehorse, Yukon

SAMPLE: SRK 03-C06

DATE: 10-Jul-03

Test Results:

Water Content: (%)	Dry Density (kg/m ³)
5.1	2051
6.6	2069
8.4	2087
9.6	2061
11.2	2011

Maximum dry density: 2087 kg/m³
Optimum water content: 8.4 %

Results corrected for oversized material?
yes

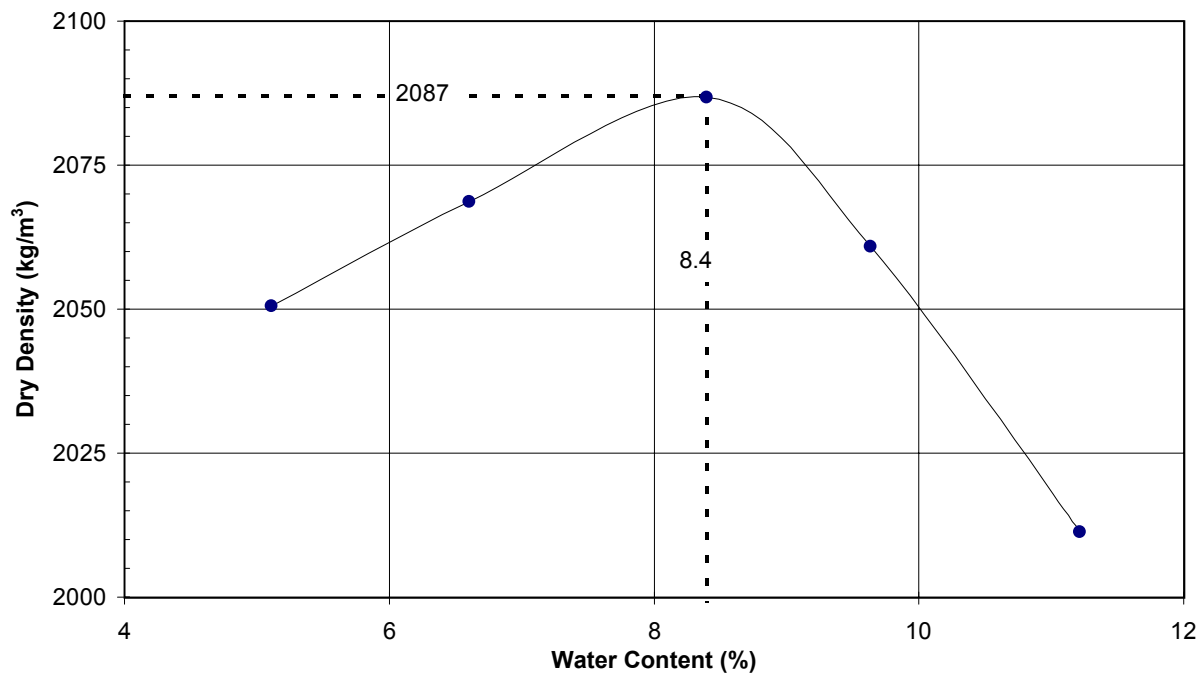
Test Details:

Effort: Standard
Procedure used: A
Diameter of mold: 101 mm
Compacted material less than: 4.75 mm in diameter
Method of preparation: dry

Override Correction Data (if applicable):

Percentage override fraction: 21.0 %
Specific gravity: 2.50 (assumed)

Comments:



APPENDIX V-a

Large Diameter (300-mm) SWCC Tests Results

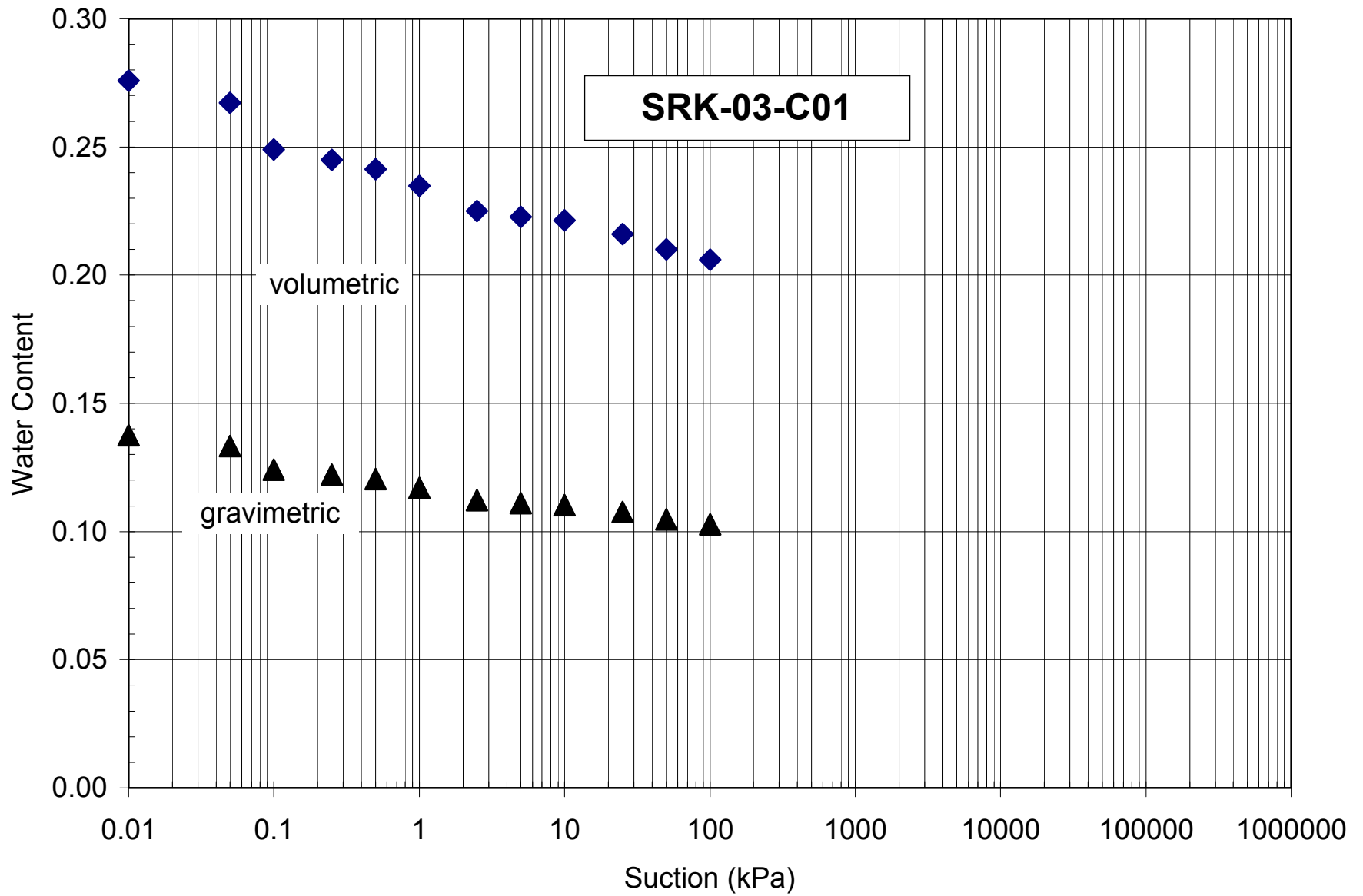
				SOIL-WATER CHARACTERISTIC CURVE							
Project: SRK Consultants, Vancouver Location: Faro Mine, Whitehorse Date: 23-Jul-03											
Sample: SRK-03-C01 @1.968 Mg/m ³ @ 10.5%											
	Elevation of water column below top of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content		Notes
Large Pressure Plate cell	0	0	0.01	67801		0	1894.0	0.138	0.276		
	0.5	0	0.05	67742		59	1835.0	0.133	0.267		
	1	0	0.1	67617		184	1710.0	0.124	0.249		
	2.5	0	0.25	67589		212	1682.0	0.122	0.245		
	5	0	0.5	67565		236	1658.0	0.120	0.241		
	10	0	1	67519		282	1612.0	0.117	0.235		
	25	0	2.5	67452		349	1545.0	0.112	0.225		
	50	0	5	67436		365	1529.0	0.111	0.223		
	0	10	10	67427		374	1520.0	0.110	0.221		
	0	25	25	67390		411	1483.0	0.108	0.216		
	0	50	50	67350		451	1443.0	0.105	0.210		
	0	100	100	67322		479	1415.0	0.103	0.206		
Dessicator Tests											
Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)	Suction (kPa)					Gravimetric water content	Volumetric water content		
4.282	4.189	0.627	4120					0.026	0.03552		
4.086	4.042	0.722	38000					0.013	0.01803		
3.123	3.103	0.622	82600					0.008	0.01097		
4.066	4.048	0.918	150000					0.006	0.00782		
4.288	4.283	0.917	293000					0.001	0.00202		

Final water content determination

	Tare #1	Tare #2	Total
Weight of tare (g)	965	644	1609
Tare + soil wet (g)	11040	5756	16796
Tare + soil dry (g)	10076	5305	15381
Weight of dry soil (g)	9111	4661	13772
Weight of water in soil (g)	964	451	1415
Water content			10.3%

Dimensions of specimen

	Initial
Diameter of specimen (mm)	305.00
Height of specimen (mm)	94.00
Volume of specimen (cc)	6868.7
Dry density of specimen (kg/m ³)	2005.04



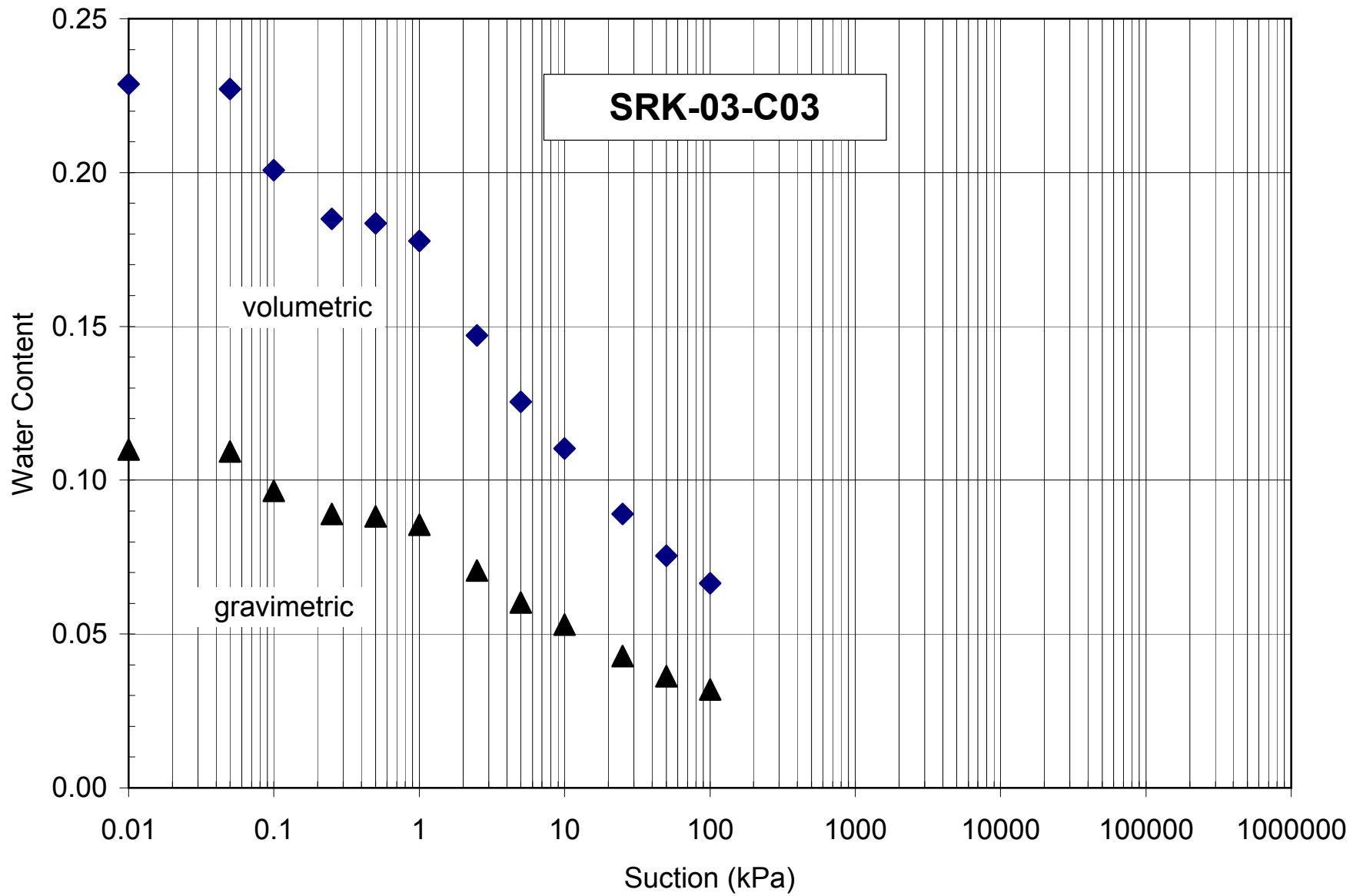
				SOIL-WATER CHARACTERISTIC CURVE							
Project: SRK Consultants, Vancouver Location: Faro Mine, Whitehorse Date: 23-Jul-03											
Sample: SRK-03-C03 @2.085 Mg/m ³ @ 7.5%											
	Elevation of water column below top of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content		Notes
Large Pressure Plate cell	0	0	0.01	67598		0	1663.0	0.110	0.229		
	0.5	0	0.05	67587		11	1652.0	0.109	0.227		
	1	0	0.1	67395		203	1460.0	0.097	0.201		
	2.5	0	0.25	67280		318	1345.0	0.089	0.185		
	5	0	0.5	67269		329	1334.0	0.088	0.183		
	10	0	1	67227		371	1292.0	0.085	0.178		
	25	0	2.5	67004		594	1069.0	0.071	0.147		
	50	0	5	66847		751	912.0	0.060	0.125		
	0	10	10	66737		861	802.0	0.053	0.110		
	0	25	25	66582		1016	647.0	0.043	0.089		
	0	50	50	66484		1114	549.0	0.036	0.076		
	0	100	100	66418		1180	483.0	0.032	0.066		
Dessicator Tests											
Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)	Suction (kPa)					Gravimetric water content	Volumetric water content		
4.282	4.189	0.627	4120					0.026	0.04269		
4.086	4.042	0.722	38000					0.013	0.02167		
3.123	3.103	0.622	82600					0.008	0.01318		
4.066	4.048	0.918	150000					0.006	0.0094		
4.288	4.283	0.917	293000					0.001	0.00243		

Final water content determination

	Tare #3	Tare #4	Total
Weight of tare (g)	960	624	1584
Tare + soil wet (g)	10886	6296	17182
Tare + soil dry (g)	10581	6118	16699
Weight of dry soil (g)	9621	5494	15115
Weight of water in soil (g)	305	178	483
Water content			3%

Dimensions of specimen

	Initial
Diameter of specimen (mm)	305.00
Height of specimen (mm)	99.50
Volume of specimen (cc)	7270.6
Dry density of specimen (kg/m ³)	2078.93



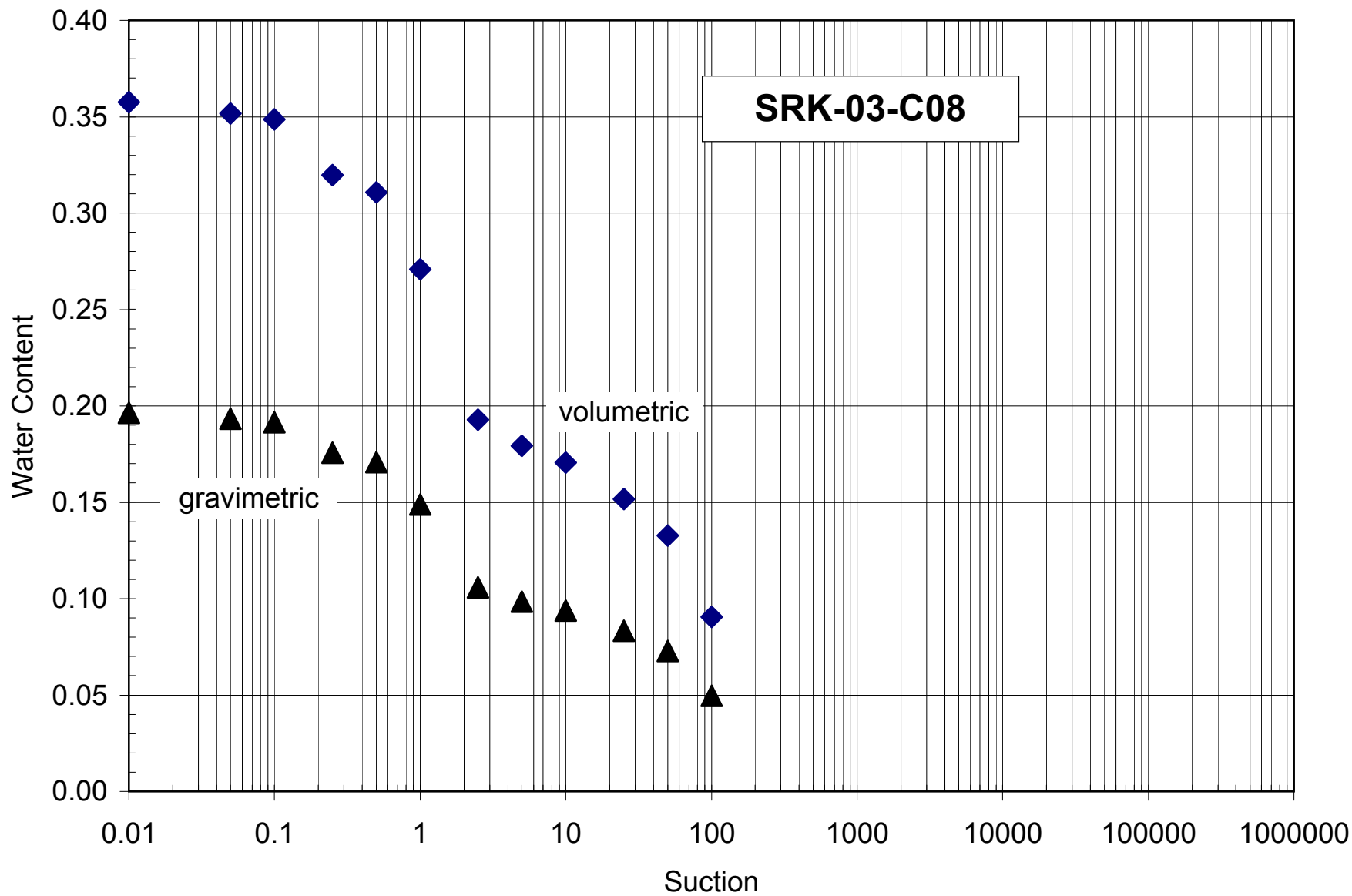
				SOIL-WATER CHARACTERISTIC CURVE							
Project: SRK Consultants, Vancouver				Location: Faro Mine, Whitehorse							
Date: 23-Jul-03											
Sample: SRK-03-C08											
	Elevation of water column below top of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content		Notes
Large Pressure Plate cell	0	0	0.01	54434		0	2639.0	0.197	0.358		
	0.5	0	0.05	54391		43	2596.0	0.193	0.352		
	1	0	0.1	54367		67	2572.0	0.192	0.349		
	2.5	0	0.25	54155		279	2360.0	0.176	0.320		
	5	0	0.5	54089		345	2294.0	0.171	0.311		
	10	0	1	53794		640	1999.0	0.149	0.271		
	25	0	2.5	53218		1216	1423.0	0.106	0.193		
	50	0	5	53118		1316	1323.0	0.099	0.179		
	0	10	10	53054		1380	1259.0	0.094	0.171		
	0	25	25	52915		1519	1120.0	0.083	0.152		
	0	50	50	52774		1660	979.0	0.073	0.133		
	0	100	100	52463		1971	668.0	0.050	0.091		
Dessicator Tests											
Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)	Suction (kPa)					Gravimetric water content	Volumetric water content		
4.282	4.189	0.627	4120					0.026	0.04476		
4.086	4.042	0.722	38000					0.013	0.02272		
3.123	3.103	0.622	82600					0.008	0.01382		
4.066	4.048	0.918	150000					0.006	0.00986		
4.288	4.283	0.917	293000					0.001	0.00255		

Final water content determination

	Tare #5	Tare #6	Total
Weight of tare (g)	623	622	1245
Tare + soil wet (g)	7345	7997	15342
Tare + soil dry (g)	7030	7644	14674
Weight of dry soil (g)	6407	7022	13429
Weight of water in soil (g)	315	353	668
Water content			5%

Dimensions of specimen

	Initial
Diameter of specimen (mm)	305.00
Height of specimen (mm)	101.00
Volume of specimen (cc)	7380.2
Dry density of specimen (kg/m ³)	1819.6



APPENDIX V-b

Small Diameter (64-mm) SWCC Tests Results

SOIL-WATER CHARACTERISTIC CURVE

Project: SRK Consultants
 Location: Faro Mine, Whitehorse
 Date: 10-Aug-03

Sample: SRK-03-CO1

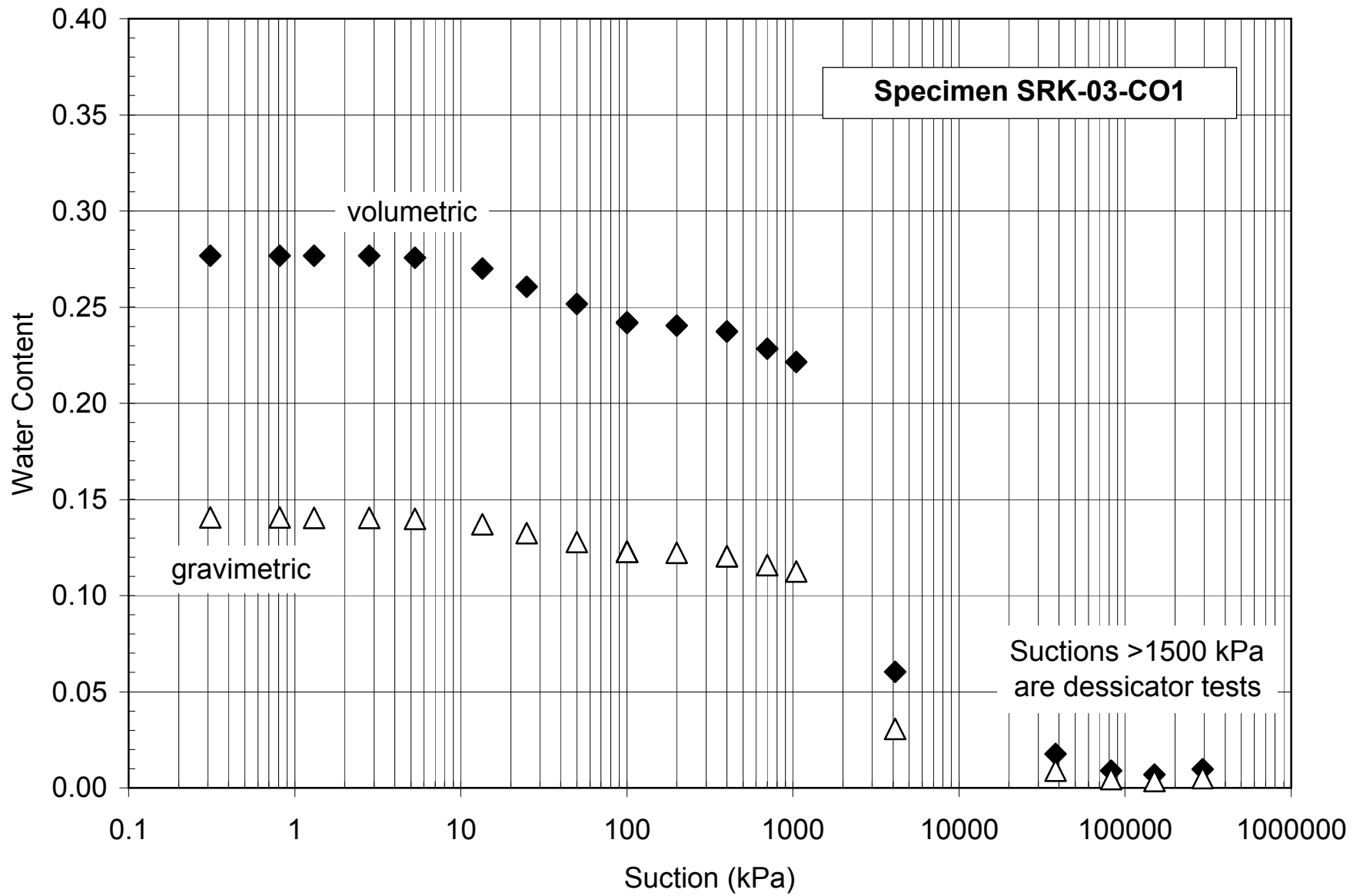
	Elevation of water column below base of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content (assuming volume constant during test)	Degree of saturation (computed based on Gs)		
1-Bar Stone	0	0	0.31	393.364	85.637	0.000	27.608	0.141	0.277	1.022		
	5	0	0.81	393.364	85.637	0.000	27.608	0.141	0.277	1.022		
	10	0	1.31	393.350	85.637	0.014	27.594	0.141	0.277	1.022		
	25	0	2.81	393.350	85.637	0.014	27.594	0.141	0.277	1.022		
	50	0	5.31	393.244	85.637	0.120	27.488	0.140	0.276	1.018		
	0	13.5	13.5	392.696	85.637	0.668	26.940	0.137	0.270	0.997		
	0	25	25	391.760	85.637	1.604	26.004	0.132	0.261	0.963		
	0	50	50	390.864	85.637	2.500	25.108	0.128	0.252	0.930		
	0	100	100	389.879	85.637	3.485	24.123	0.123	0.242	0.893		
	0	100	100	389.879	85.637	3.485	24.123	0.123	0.242	0.893		
	0	100	100	389.879	85.637	3.485	24.123	0.123	0.242	0.893		
	0	100	100	389.879	85.637	3.485	24.123	0.123	0.242	0.893		
5-Bar Stone	0	100	100	440.146	136.110	3.485	24.123	0.123	0.242	0.893		
	0	200	200	440.011	136.110	3.620	23.988	0.122	0.241	0.888		
	0	400	400	439.687	136.110	3.944	23.664	0.121	0.237	0.876		
15-Bar Stone	0	400	400	303.473	0.000	3.944	23.664	0.121	0.237	0.876		
	0	700	700	302.578	0.000	4.839	22.769	0.116	0.228	0.843		
	0	1050	1050	301.891	0.000	5.526	22.082	0.112	0.221	0.818		
		Desiccator tests	Suction (kPa)	Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)		Gravimetric water content	Volumetric water content			
			4120	3.909	3.811	0.631		0.031	0.06031			
			38000	4.714	4.680	0.910		0.009	0.01765			
			82600	3.626	3.613	0.746		0.005	0.00887			
			150000	3.302	3.293	0.762		0.004	0.0070			
			293000	3.914	3.899	0.893		0.005	0.00977			

Final water content determination

Weight of ring (g)	83.42
Weight of tare (g)	115.246
Tare + ring + soil wet (g)	417.118
Tare + ring + soil dry (g)	395.036
Weight of dry soil (g)	196.370
Weight of water in soil (g)	22.082
Specific gravity, G _s	2.70

Dimensions of specimen

Diameter of specimen (mm)	64.00
Height of specimen (mm)	31.00
Volume of specimen (cc)	99.74
Dry density of specimen (kg/m ³)	1968.8
Volume of solids (cc)	72.73
Porosity	0.271



SOIL-WATER CHARACTERISTIC CURVE

Project: SRK Consultants
Location: Faro Mine, Whitehorse
Date: 10-Aug-03

Sample: SRK-03-CO2

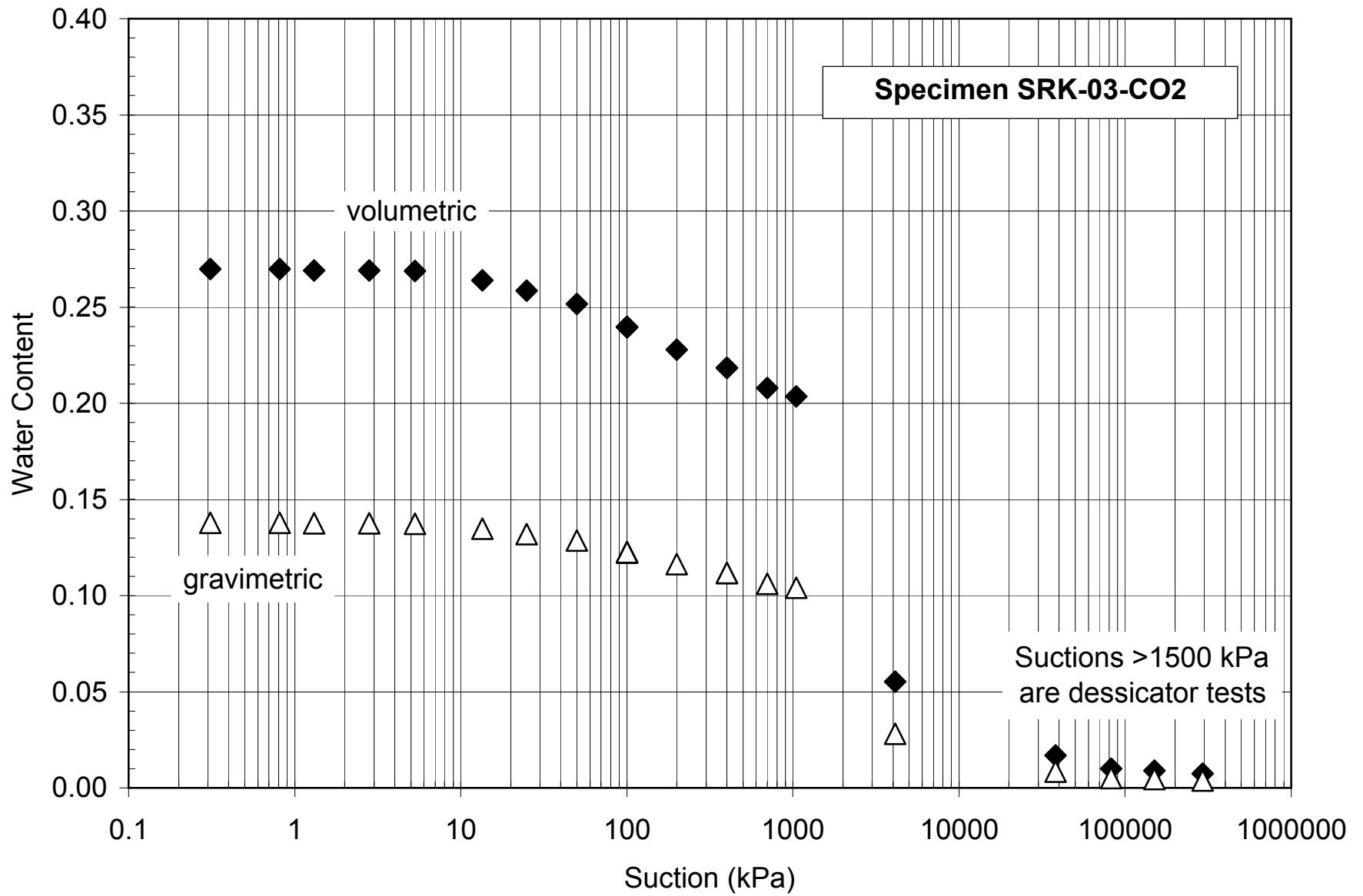
		Elevation of water column below base of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content (assuming volume constant during test)	Degree of saturation (computed based on Gs)		
1-Bar Stone	0	0	0.31	440.546	135.253	0.000	26.902	0.138	0.270	0.991			
	5	0	0.81	440.546	135.253	0.000	26.902	0.138	0.270	0.991			
	10	0	1.31	440.468	135.253	0.078	26.824	0.137	0.269	0.988			
	25	0	2.81	440.466	135.253	0.080	26.822	0.137	0.269	0.988			
	50	0	5.31	440.431	135.253	0.115	26.787	0.137	0.269	0.986			
	0	13.5	13.5	439.950	135.253	0.596	26.306	0.135	0.264	0.969			
	0	25	25	439.411	135.253	1.135	25.767	0.132	0.258	0.949			
	0	50	50	438.728	135.253	1.818	25.084	0.129	0.252	0.924			
	0	100	100	437.534	135.253	3.012	23.890	0.122	0.240	0.880			
	0	100	100	437.534	135.253	3.012	23.890	0.122	0.240	0.880			
	0	100	100	437.534	135.253	3.012	23.890	0.122	0.240	0.880			
	0	100	100	437.534	135.253	3.012	23.890	0.122	0.240	0.880			
5-Bar Stone	0	100	100	442.500	140.295	3.012	23.890	0.122	0.240	0.880			
	0	200	200	441.333	140.295	4.179	22.723	0.116	0.228	0.837			
	0	400	400	440.396	140.295	5.116	21.786	0.112	0.219	0.802			
15-Bar Stone	0	400	400	300.059	0.000	5.116	21.786	0.112	0.219	0.802			
	0	700	700	299.006	0.000	6.169	20.733	0.106	0.208	0.763			
	0	1050	1050	298.559	0.000	6.616	20.286	0.104	0.203	0.747			
		Desiccator tests	Suction (kPa)	Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)		Gravimetric water content	Volumetric water content				
			4120	4.985	4.871	0.823		0.028	0.05526				
			38000	4.207	4.179	0.909		0.009	0.0168				
			82600	3.803	3.787	0.621		0.005	0.00992				
			150000	5.197	5.177	0.752		0.005	0.00887				
			293000	4.694	4.680	0.920		0.004	0.00731				

Final water content determination

Weight of ring (g)	83.154
Weight of tare (g)	115.409
Tare + ring + soil wet (g)	413.961
Tare + ring + soil dry (g)	393.675
Weight of dry soil (g)	195.112
Weight of water in soil (g)	20.286
Specific gravity, G _s	2.69

Dimensions of specimen

Diameter of specimen (mm)	63.85
Height of specimen (mm)	31.13
Volume of specimen (cc)	99.69
Dry density of specimen (kg/m ³)	1957.2
Volume of solids (cc)	72.53
Porosity	0.272



SOIL-WATER CHARACTERISTIC CURVE

Project: SRK Consultants
Location: Faro Mine, Whitehorse
Date: 10-Aug-03

Sample: SRK-03-CO3

	Elevation of water column below base of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content (assuming volume constant during test)	Degree of saturation (computed based on Gs)		
1-Bar Stone	0	0	0.31	389.072	85.066	0.000	22.280	0.110	0.227	0.973		
	5	0	0.81	389.072	85.066	0.000	22.280	0.110	0.227	0.973		
	10	0	1.31	388.691	85.066	0.381	21.899	0.109	0.223	0.957		
	25	0	2.81	388.408	85.066	0.664	21.616	0.107	0.220	0.944		
	50	0	5.31	387.003	85.066	2.069	20.211	0.100	0.206	0.883		
	0	13.5	13.5	383.199	85.066	5.873	16.407	0.081	0.167	0.717		
	0	25	25	380.333	85.066	8.739	13.541	0.067	0.138	0.591		
	0	50	50	378.619	85.066	10.453	11.827	0.059	0.120	0.517		
	0	100	100	376.855	85.066	12.217	10.063	0.050	0.102	0.440		
	0	100	100	376.855	85.066	12.217	10.063	0.050	0.102	0.440		
	0	100	100	376.855	85.066	12.217	10.063	0.050	0.102	0.440		
	0	100	100	376.855	85.066	12.217	10.063	0.050	0.102	0.440		
5-Bar Stone	0	100	100	430.337	138.926	12.217	10.063	0.050	0.102	0.440		
	0	200	200	427.394	138.926	15.160	7.120	0.035	0.073	0.311		
	0	400	400	426.881	138.926	15.673	6.607	0.033	0.067	0.289		
15-Bar Stone	0	400	400	287.888	0.000	15.673	6.607	0.033	0.067	0.289		
	0	700	700	285.101	0.000	18.460	3.820	0.019	0.039	0.167		
	0	1050	1050	285.471	0.000	18.090	4.190	0.021	0.043	0.183		
		Desiccator tests	Suction (kPa)	Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)		Gravimetric water content	Volumetric water content			
			4120	4.359	4.337	0.932		0.006	0.01336			
			38000	3.898	3.891	0.748		0.002	0.00461			
			82600	4.542	4.536	0.785		0.002	0.00331			
			150000	3.939	3.933	0.718		0.002	0.00386			
			293000	3.676	3.672	0.771		0.001	0.00285			

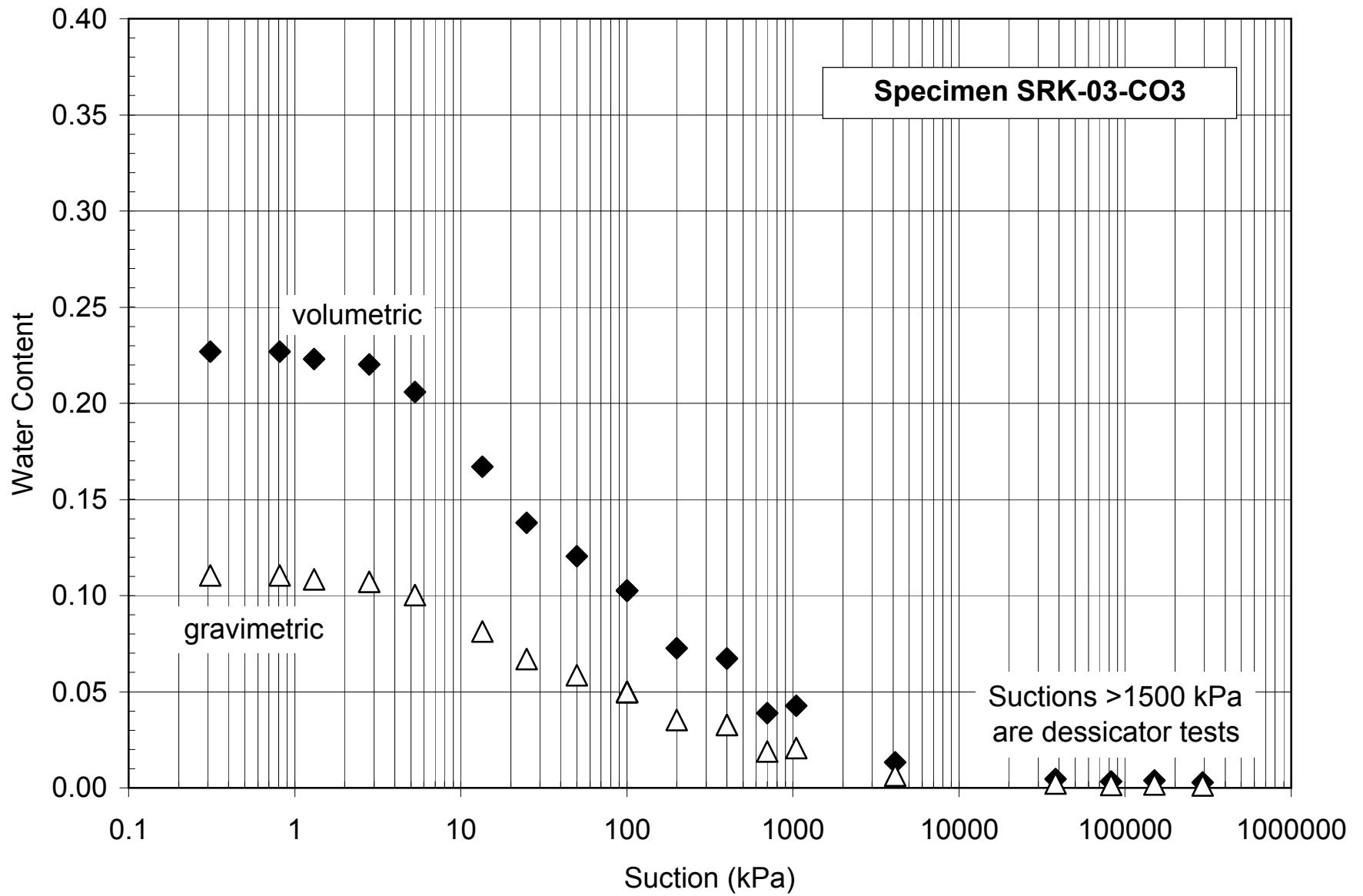
Final water content determination

Weight of ring (g)	79.493
Weight of tare (g)	268.843
Tare + ring + soil wet (g)	554.310
Tare + ring + soil dry (g)	550.120
Weight of dry soil (g)	201.784
Weight of water in soil (g)	4.19
Specific gravity, G _s	2.68

Dimensions of specimen

Diameter of specimen (mm)	63.50
Height of specimen (mm)	31.00
Volume of specimen (cc)	98.19
Dry density of specimen (kg/m ³)	2055.1
Volume of solids (cc)	75.29
Porosity	0.233

Initial



SOIL-WATER CHARACTERISTIC CURVE

Project: SRK Consultants
 Location: Faro Mine, Whitehorse
 Date: 10-Aug-03

Sample: SRK-03-CO4

	Elevation of water column below base of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content (assuming volume constant during test)	Degree of saturation (computed based on Gs)		
1-Bar Stone	0	0	0.31	449.907	139.899	0.000	25.977	0.129	0.258	1.004		
	5	0	0.81	448.923	139.899	0.984	24.993	0.124	0.248	0.966		
	10	0	1.31	448.231	139.899	1.676	24.301	0.121	0.241	0.939		
	25	0	2.81	448.220	139.899	1.687	24.290	0.121	0.241	0.939		
	50	0	5.31	447.161	139.899	2.746	23.231	0.115	0.231	0.898		
	0	13.5	13.5	445.905	139.899	4.002	21.975	0.109	0.218	0.849		
	0	25	25	444.984	139.899	4.923	21.054	0.105	0.209	0.814		
	0	50	50	444.196	139.899	5.711	20.266	0.101	0.201	0.783		
	0	100	100	443.251	139.899	6.656	19.321	0.096	0.192	0.747		
	0	100	100	443.251	139.899	6.656	19.321	0.096	0.192	0.747		
	0	100	100	443.251	139.899	6.656	19.321	0.096	0.192	0.747		
	0	100	100	443.251	139.899	6.656	19.321	0.096	0.192	0.747		
5-Bar Stone	0	100	100	434.891	131.595	6.656	19.321	0.096	0.192	0.747		
	0	200	200	433.902	131.595	7.645	18.332	0.091	0.182	0.709		
	0	400	400	432.922	131.595	8.625	17.352	0.086	0.172	0.671		
15-Bar Stone	0	400	400	301.274	0.000	8.625	17.352	0.086	0.172	0.671		
	0	700	700	298.381	0.000	11.518	14.459	0.072	0.144	0.559		
	0	1050	1050	297.979	0.000	11.920	14.057	0.070	0.140	0.543		
		Desiccator tests	Suction (kPa)	Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)		Gravimetric water content	Volumetric water content			
			4120	4.496	4.435	0.913		0.017	0.03458			
			38000	3.987	3.966	0.880		0.007	0.01359			
			82600	4.406	4.389	0.747		0.005	0.00932			
			150000	4.974	4.953	0.926		0.005	0.01041			
			293000	5.624	5.612	0.869		0.003	0.00505			

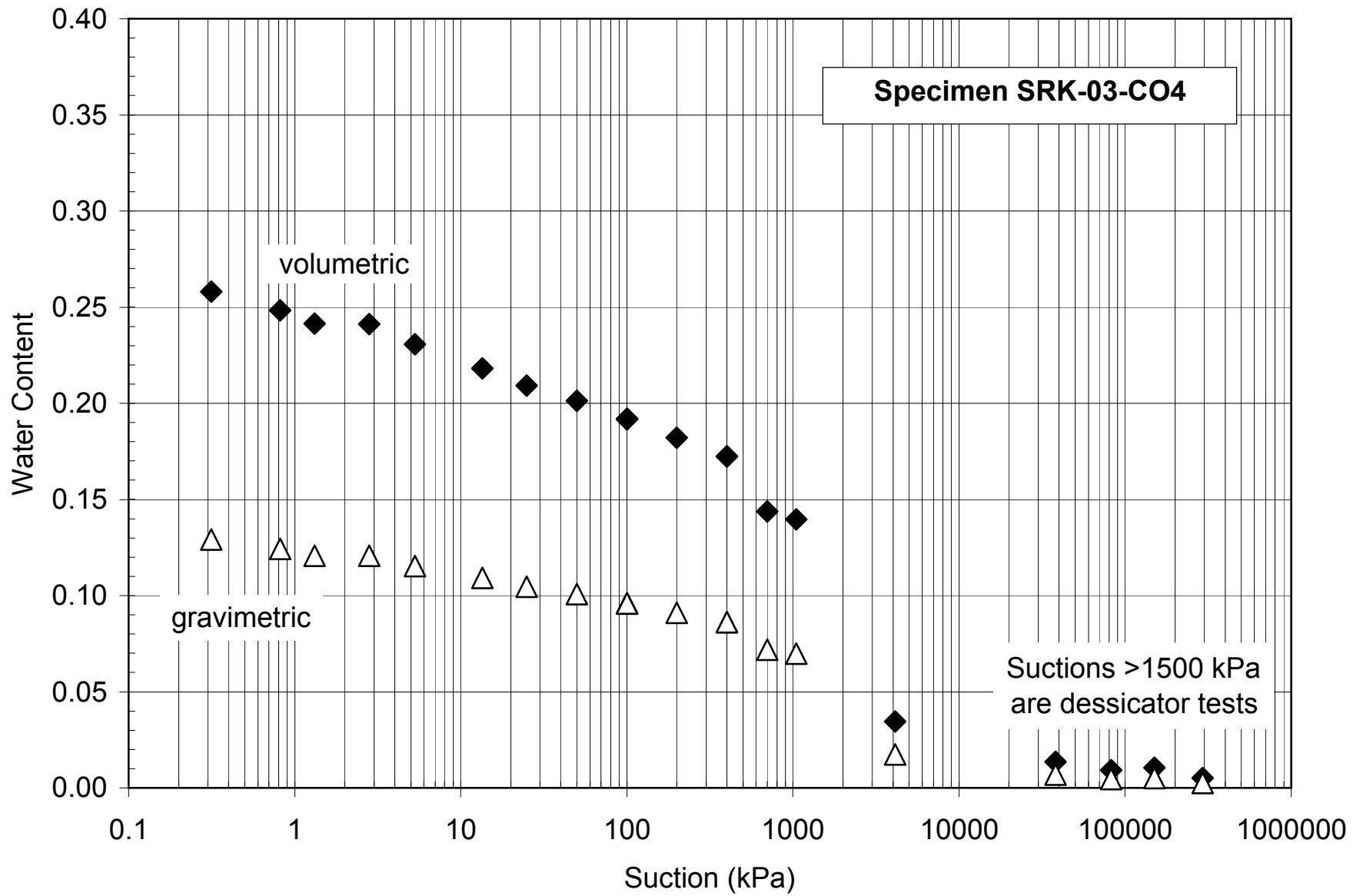
Final water content determination

Weight of ring (g)	82.668
Weight of tare (g)	31.076
Tare + ring + soil wet (g)	329.055
Tare + ring + soil dry (g)	314.998
Weight of dry soil (g)	201.254
Weight of water in soil (g)	14.057
Specific gravity, G _s	2.69

Dimensions of specimen

Diameter of specimen (mm)	63.80
Height of specimen (mm)	31.49
Volume of specimen (cc)	100.68
Dry density of specimen (kg/m ³)	1998.9
Volume of solids (cc)	74.82
Porosity	0.257

Initial



SOIL-WATER CHARACTERISTIC CURVE

Project: SRK Consultants
Location: Faro Mine, Whitehorse
Date: 10-Aug-03

Sample: SRK-03-CO5

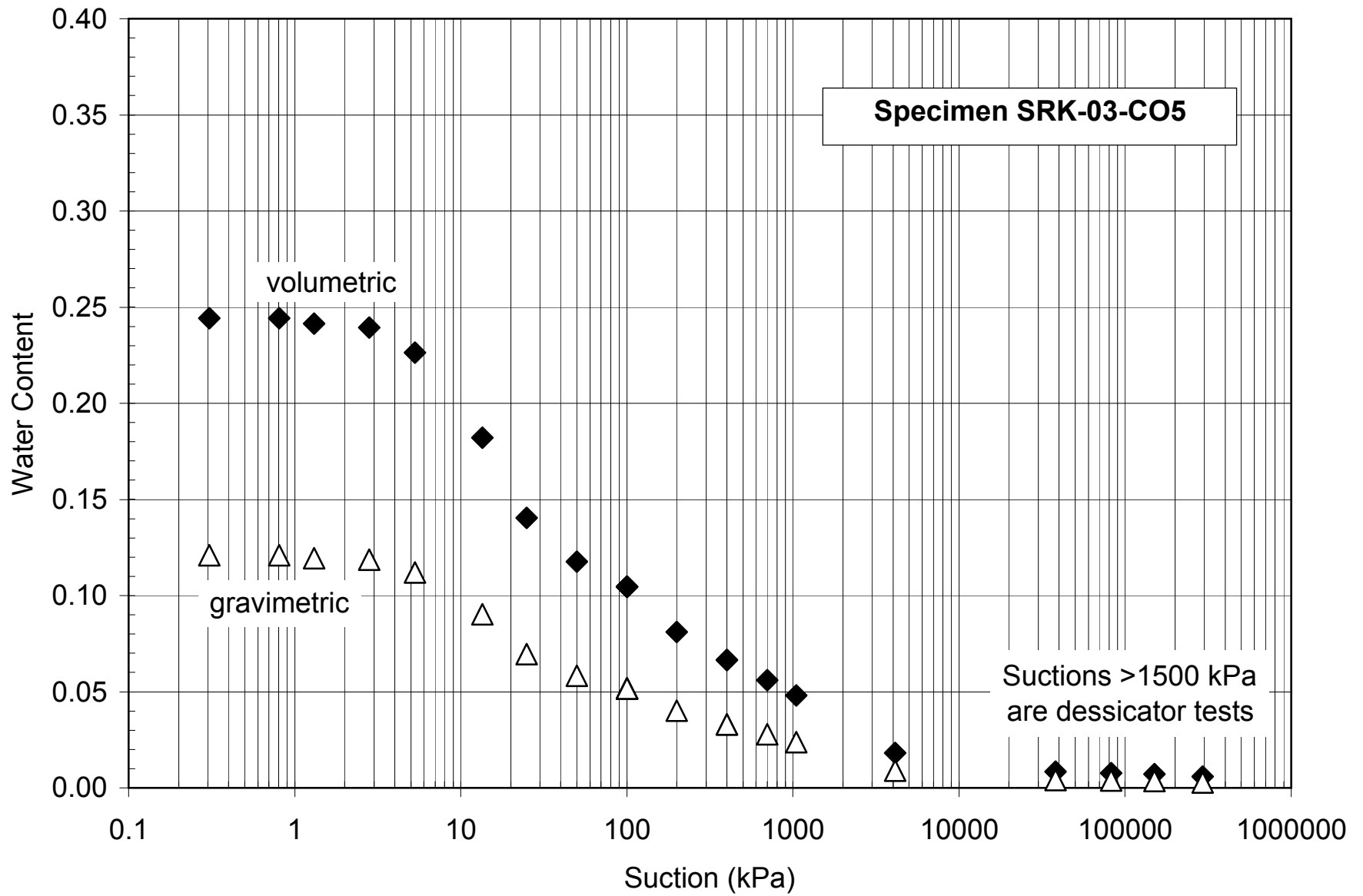
	Elevation of water column below base of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content (assuming volume constant during test)	Degree of saturation (computed based on Gs)		
1-Bar Stone	0	0	0.31	432.112	137.616	0.000	23.884	0.121	0.244	0.992		
	5	0	0.81	432.112	137.616	0.000	23.884	0.121	0.244	0.992		
	10	0	1.31	431.839	137.616	0.273	23.611	0.119	0.241	0.980		
	25	0	2.81	431.656	137.616	0.456	23.428	0.119	0.240	0.973		
	50	0	5.31	430.376	137.616	1.736	22.148	0.112	0.226	0.919		
	0	13.5	13.5	426.046	137.616	6.066	17.818	0.090	0.182	0.740		
	0	25	25	421.950	137.616	10.162	13.722	0.069	0.140	0.570		
	0	50	50	419.741	137.616	12.371	11.513	0.058	0.118	0.478		
	0	100	100	418.457	137.616	13.655	10.229	0.052	0.105	0.425		
	0	100	100	418.457	137.616	13.655	10.229	0.052	0.105	0.425		
	0	100	100	418.457	137.616	13.655	10.229	0.052	0.105	0.425		
	0	100	100	418.457	137.616	13.655	10.229	0.052	0.105	0.425		
5-Bar Stone	0	100	100	412.050	131.218	13.655	10.229	0.052	0.105	0.425		
	0	200	200	409.742	131.218	15.963	7.921	0.040	0.081	0.329		
	0	400	400	408.333	131.218	17.372	6.512	0.033	0.067	0.270		
15-Bar Stone	0	400	400	277.059	0.000	17.372	6.512	0.033	0.067	0.270		
	0	700	700	276.034	0.000	18.397	5.487	0.028	0.056	0.228		
	0	1050	1050	275.258	0.000	19.173	4.711	0.024	0.048	0.196		
		Desiccator tests	Suction (kPa)	Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)		Gravimetric water content	Volumetric water content			
			4120	6.288	6.239	0.742		0.009	0.01804			
			38000	3.749	3.737	0.861		0.004	0.00845			
			82600	4.282	4.269	0.880		0.004	0.00776			
			150000	4.096	4.085	0.927		0.003	0.00705			
			293000	5.396	5.383	0.909		0.003	0.00588			

Final water content determination

Weight of ring (g)	72.865
Weight of tare (g)	30.905
Tare + ring + soil wet (g)	306.072
Tare + ring + soil dry (g)	301.361
Weight of dry soil (g)	197.591
Weight of water in soil (g)	4.711
Specific gravity, G _s	2.68

Dimensions of specimen

Diameter of specimen (mm)	63.73
Height of specimen (mm)	30.66
Volume of specimen (cc)	97.82
Dry density of specimen (kg/m ³)	2020.0
Volume of solids (cc)	73.73
Porosity	0.246



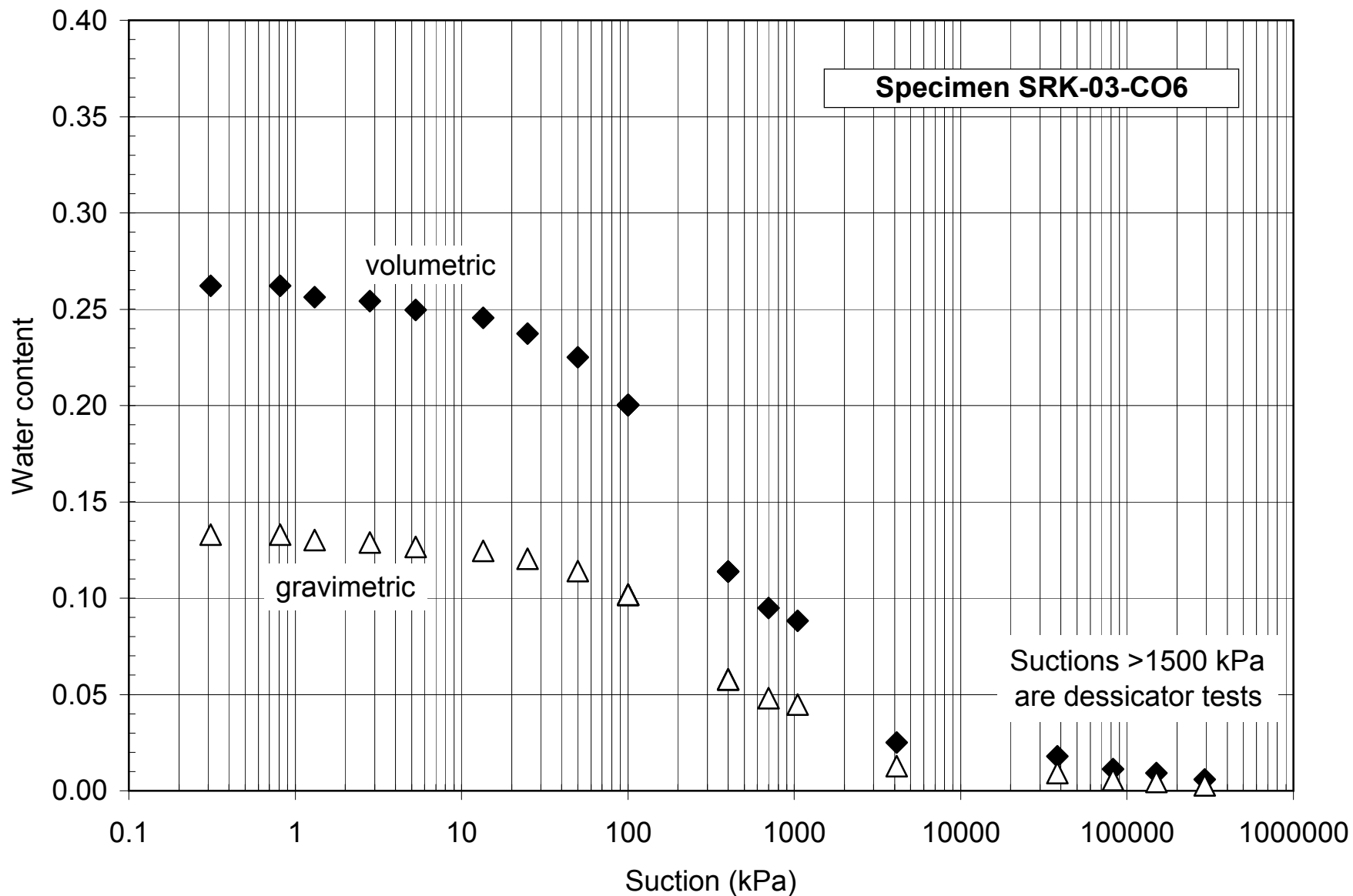
				SOIL-WATER CHARACTERISTIC CURVE								
Project:				SRK Consultants								
Location:				Faro Mine, Whitehorse								
Date:				10-Aug-03								
Sample:				SRK-03-CO6								
	Elevation of water column below base of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content (assuming volume constant during test)	Degree of saturation (computed based on G _s)		
1-Bar Stone	0	0	0.31	438.787	139.022	0.000	25.972	0.133	0.262	0.990		
	5	0	0.81	438.787	139.022	0.000	25.972	0.133	0.262	0.990		
	10	0	1.31	438.200	139.022	0.587	25.385	0.130	0.256	0.968		
	25	0	2.81	437.992	139.022	0.795	25.177	0.129	0.254	0.960		
	50	0	5.31	437.542	139.022	1.245	24.727	0.127	0.250	0.943		
	0	13.5	13.5	437.146	139.022	1.641	24.331	0.125	0.246	0.928		
	0	25	25	436.320	139.022	2.467	23.505	0.120	0.237	0.896		
	0	50	50	435.096	139.022	3.691	22.281	0.114	0.225	0.849		
	0	100	100	432.659	139.022	6.128	19.844	0.102	0.200	0.756		
	0	100	100	432.659	139.022	6.128	19.844	0.102	0.200	0.756		
	0	100	100	432.659	139.022	6.128	19.844	0.102	0.200	0.756		
	0	100	100	432.659	139.022	6.128	19.844	0.102	0.200	0.756		
5-Bar Stone	0	100	100	371.970	78.493	6.128	19.844	0.102	0.200	0.756		
	0	400	400	363.401	78.493	14.697	11.275	0.058	0.114	0.430		
	0	400	400	363.401	78.493	14.697	11.275	0.058	0.114	0.430		
15-Bar Stone	0	400	400	284.796	0.000	14.697	11.275	0.058	0.114	0.430		
	0	700	700	282.907	0.000	16.586	9.386	0.048	0.095	0.358		
	0	1050	1050	282.254	0.000	17.239	8.733	0.045	0.088	0.333		
Desiccator tests		Suction (kPa)	Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)			Gravimetric water content	Volumetric water content			
		4120	3.120	3.090	0.731			0.013	0.02512			
		38000	5.005	4.968	0.900			0.009	0.01797			
		82600	3.319	3.305	0.824			0.006	0.01115			
		150000	3.541	3.529	0.920			0.005	0.00909			
		293000	3.311	3.304	0.909			0.003	0.00577			

Final water content determination

Weight of ring (g)	78.271
Weight of tare (g)	32.052
Tare + ring + soil wet (g)	314.215
Tare + ring + soil dry (g)	305.482
Weight of dry soil (g)	195.159
Weight of water in soil (g)	8.733
Specific gravity, G _s	2.68

Dimensions of specimen

Diameter of specimen (mm)	63.80
Height of specimen (mm)	30.98
Volume of specimen (cc)	99.05
Dry density of specimen (kg/m ³)	1970.2
Volume of solids (cc)	72.82
Porosity	0.265



SOIL-WATER CHARACTERISTIC CURVE

Project: SRK Consultants
 Location: Faro Mine, Whitehorse
 Date: 10-Aug-03

Sample: SRK-03-CO7

	Elevation of water column below base of sample (cm)	Applied air pressure (kPa)	Suction at surface of sample (kPa)	Weight of system (g)	Weight of saturated stone/lucite plate/etc (g)	Cumulative weight of water loss (g)	Weight of water in soil (g)	Gravimetric water content	Vol. water content (assuming volume constant during test)	Degree of saturation (computed based on Gs)		
1-Bar Stone	0	0	0.31	412.549	89.164	0.000	37.293	0.180	0.380	0.970		
	5	0	0.81	412.549	89.164	0.000	37.293	0.180	0.380	0.970		
	10	0	1.31	411.106	89.164	1.443	35.850	0.173	0.365	0.932		
	25	0	2.81	410.934	89.164	1.615	35.678	0.172	0.363	0.928		
	50	0	5.31	410.475	89.164	2.074	35.219	0.170	0.358	0.916		
	0	13.5	13.5	395.419	89.164	17.130	20.163	0.097	0.205	0.524		
	0	25	25	390.536	89.164	22.013	15.280	0.074	0.156	0.397		
	0	50	50	387.676	89.164	24.873	12.420	0.060	0.126	0.323		
	0	100	100	386.013	89.164	26.536	10.757	0.052	0.109	0.280		
	0	100	100	386.013	89.164	26.536	10.757	0.052	0.109	0.280		
	0	100	100	386.013	89.164	26.536	10.757	0.052	0.109	0.280		
	0	100	100	386.013	89.164	26.536	10.757	0.052	0.109	0.280		
5-Bar Stone	0	100	100	374.315	78.176	26.536	10.757	0.052	0.109	0.280		
	0	200	200	372.455	78.176	28.396	8.897	0.043	0.091	0.231		
	0	400	400	371.624	78.176	29.227	8.066	0.039	0.082	0.210		
15-Bar Stone	0	400	400	293.370	0.000	29.227	8.066	0.039	0.082	0.210		
	0	700	700	291.533	0.000	31.064	6.229	0.030	0.063	0.162		
	0	1050	1050	291.165	0.000	31.432	5.861	0.028	0.060	0.152		
		Desiccator tests	Suction (kPa)	Soil wet + tare (g)	Soil dry + tare (g)	Weight of tare (g)		Gravimetric water content	Volumetric water content			
			4120	4.089	4.001	0.866		0.028	0.05982			
			38000	3.132	3.114	0.623		0.007	0.0154			
			82600	4.131	4.118	0.968		0.004	0.0088			
			150000	2.268	2.264	0.889		0.003	0.0062			
			293000	3.924	3.917	0.958		0.002	0.00504			

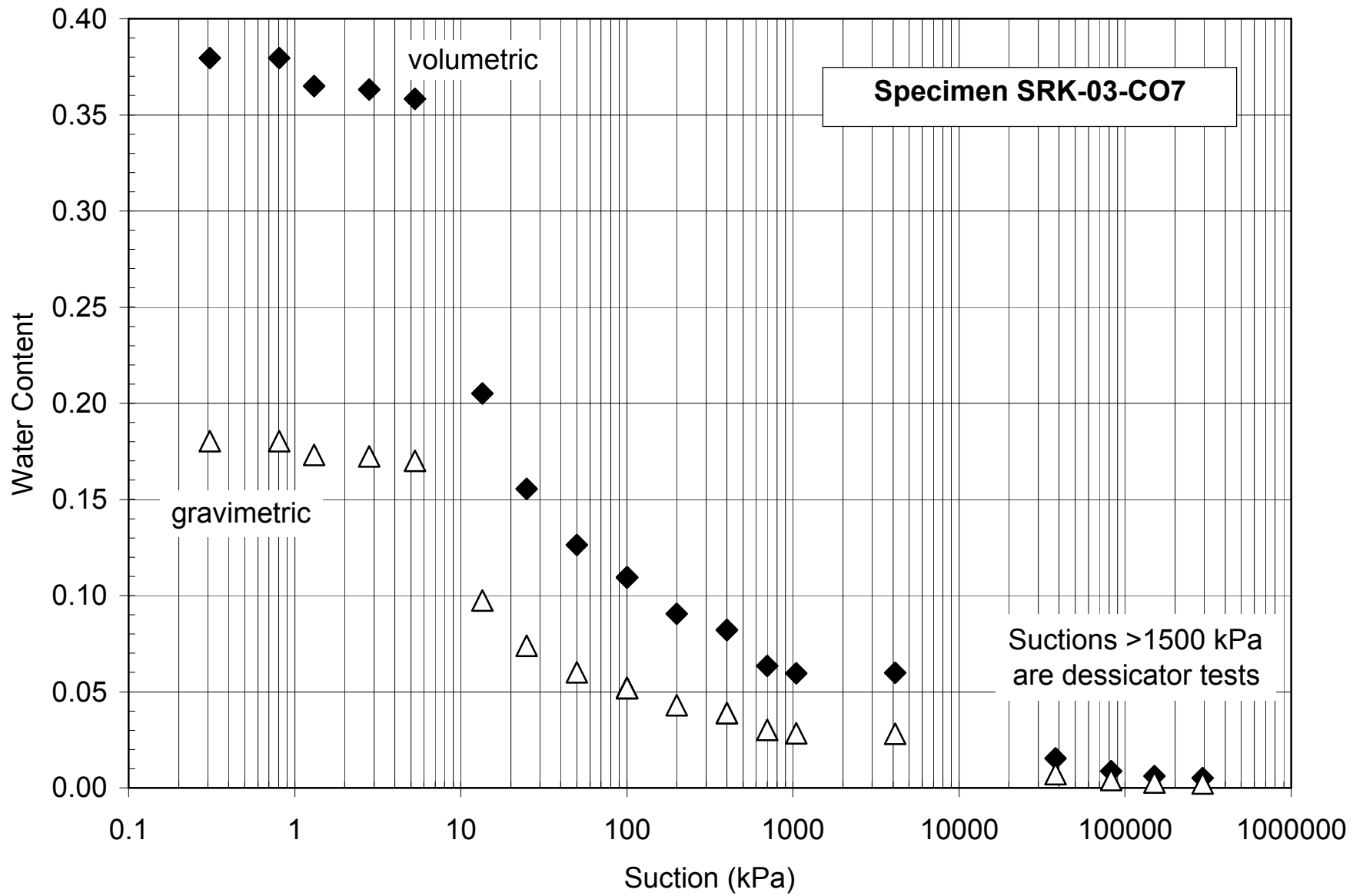
Final water content determination

Weight of ring (g)	78.343
Weight of tare (g)	122.835
Tare + ring + soil wet (g)	414.004
Tare + ring + soil dry (g)	408.143
Weight of dry soil (g)	206.965
Weight of water in soil (g)	5.861
Specific gravity, G _s	3.46

Dimensions of specimen

Diameter of specimen (mm)	63.73
Height of specimen (mm)	30.80
Volume of specimen (cc)	98.26
Dry density of specimen (kg/m ³)	2106.3
Volume of solids (cc)	59.82
Porosity	0.391

Initial



APPENDIX VI

Consolidation Tests Results

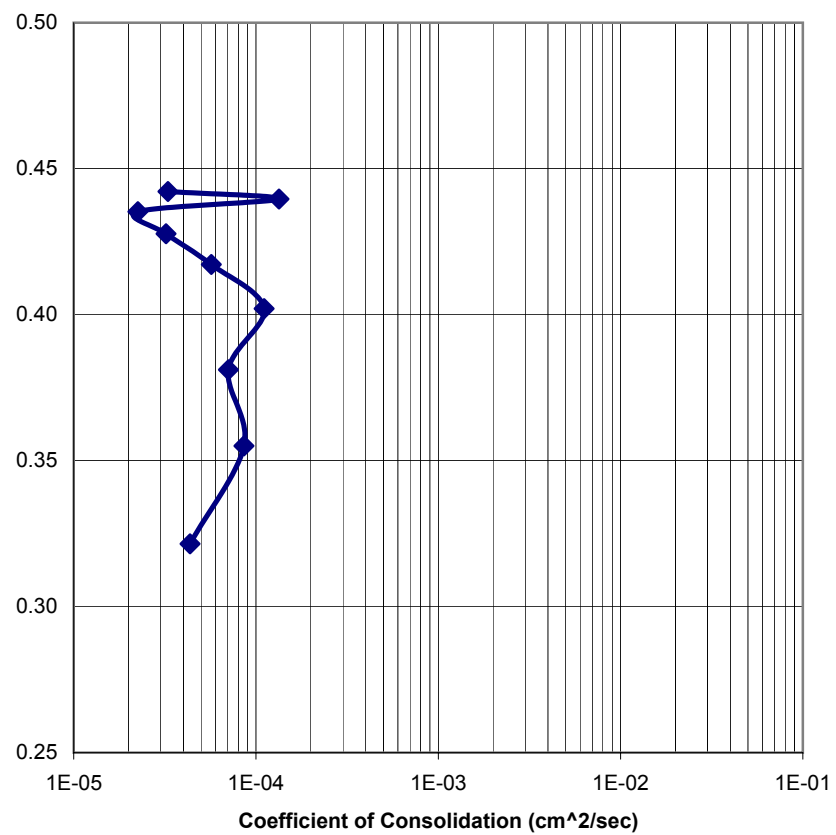
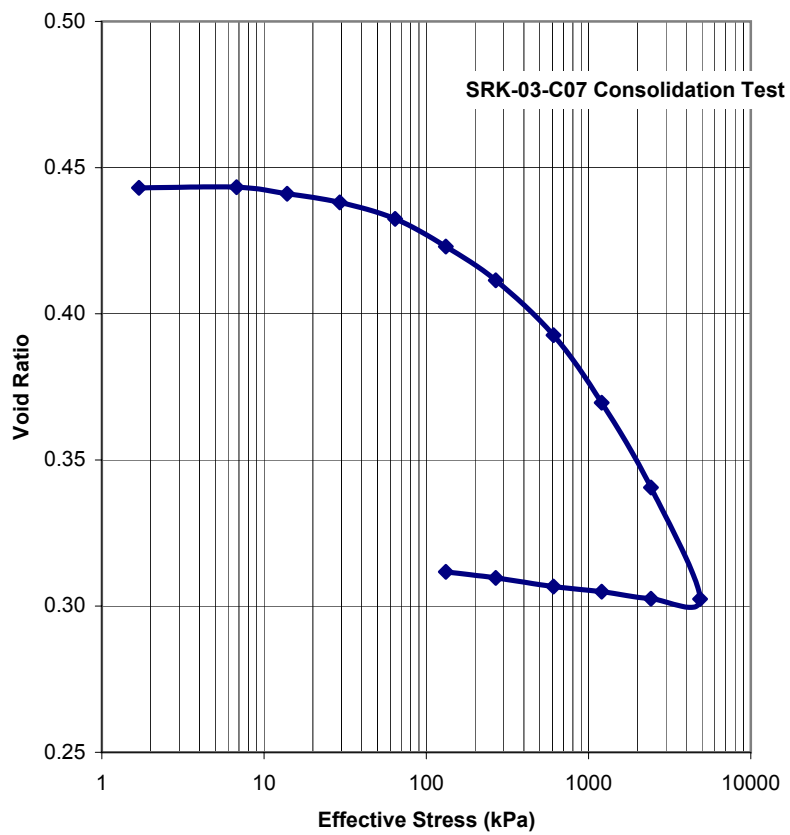
Input:

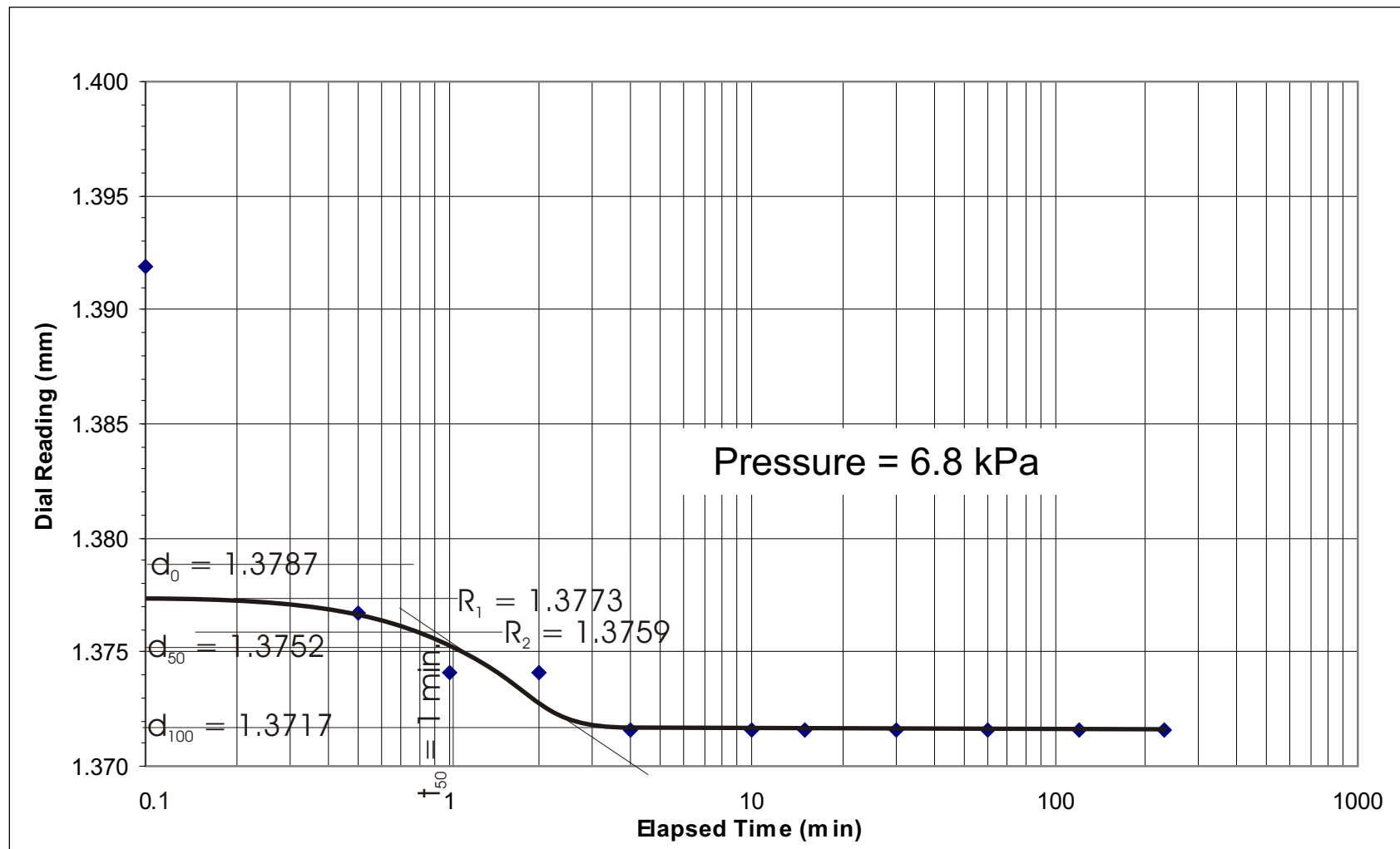
Diameter of ring: 63.84 mm
 Initial height of sample: 18.99 mm
 Specific gravity: 3.45
 Initial wet sample mass: 173.22 g
 Initial water content: 19.2 %
 Initial dial reading: 0.0548 inches
 Final dry mass of sample: 145.32 g
 Mechanical Advantage: 11.04

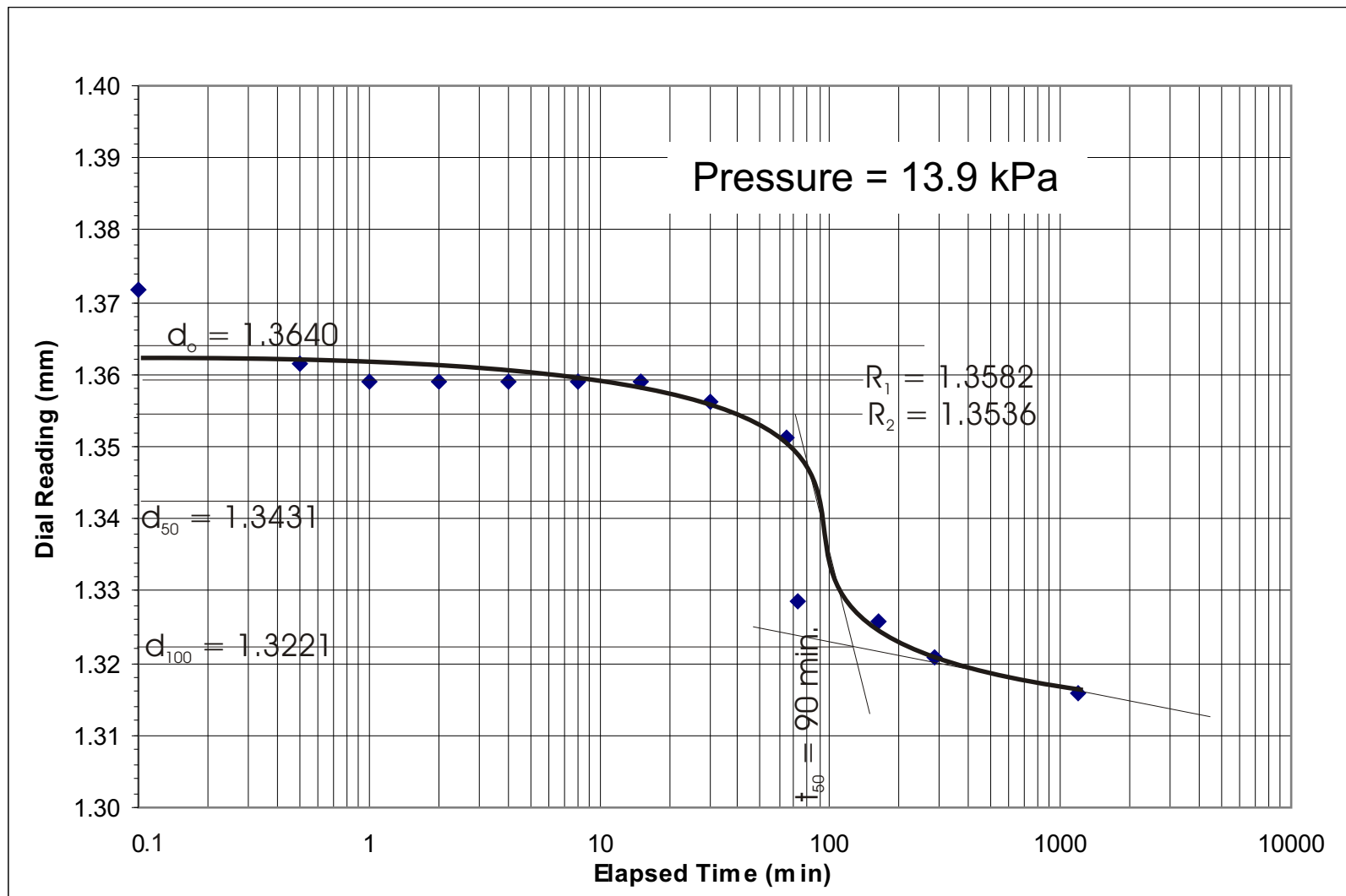
Calculations:

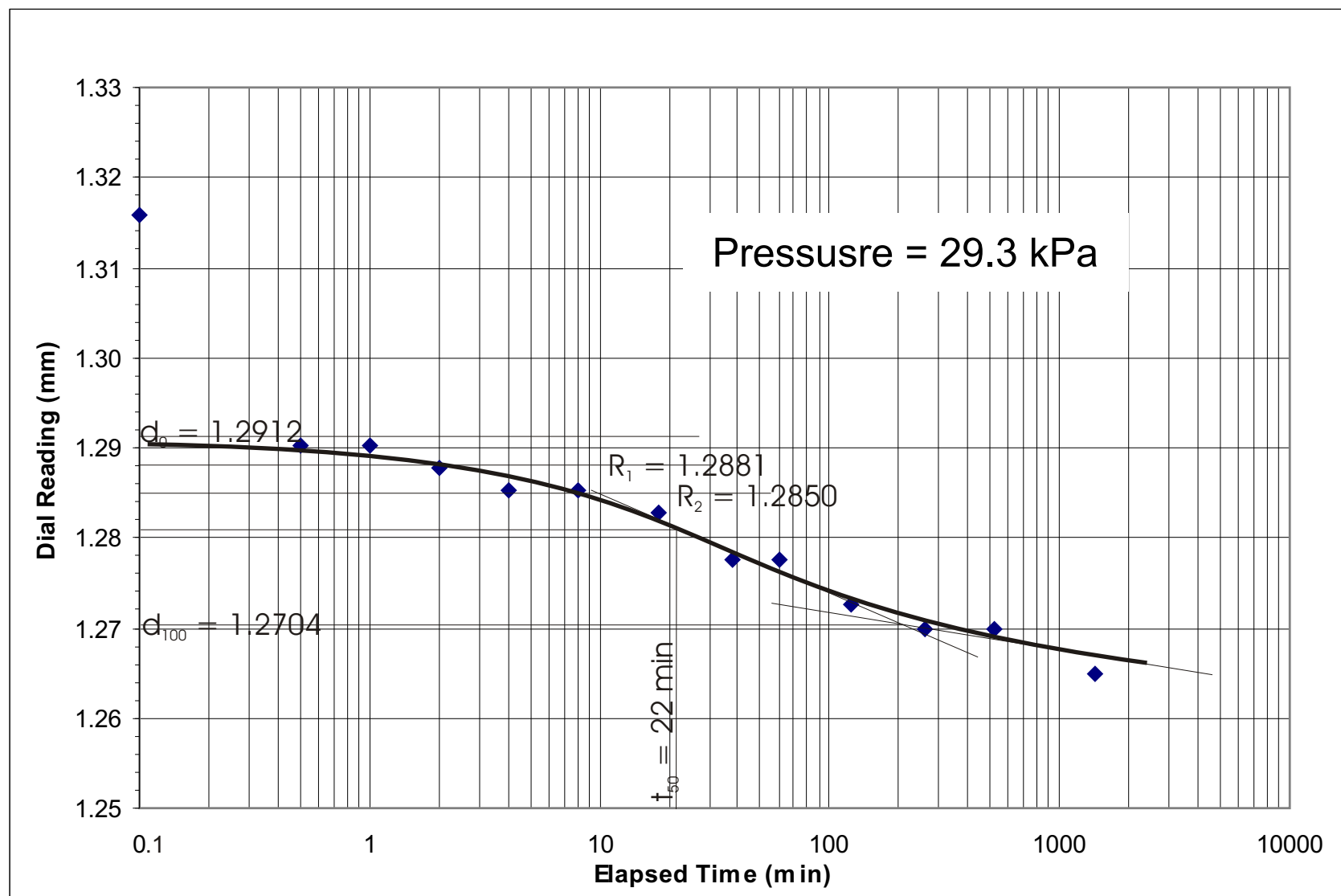
Cross-sectional area: 32.01 cc 3.2E-03 m³
 Volume of solids: 42.12 cc 4.2E-05 m³
 Total volume: 60.79 cc (prior to loading)
 Volume of voids: 18.66 cc (prior to loading)
 Initial void ratio: 0.44 (prior to loading)
 Dry mass of solids: 145.32 g
 Initial wet density: 2850 kg/m³ (prior to loading)
 Initial dry density: 2391 kg/m³ (prior to loading)
 Initial dial reading: 1.39 mm

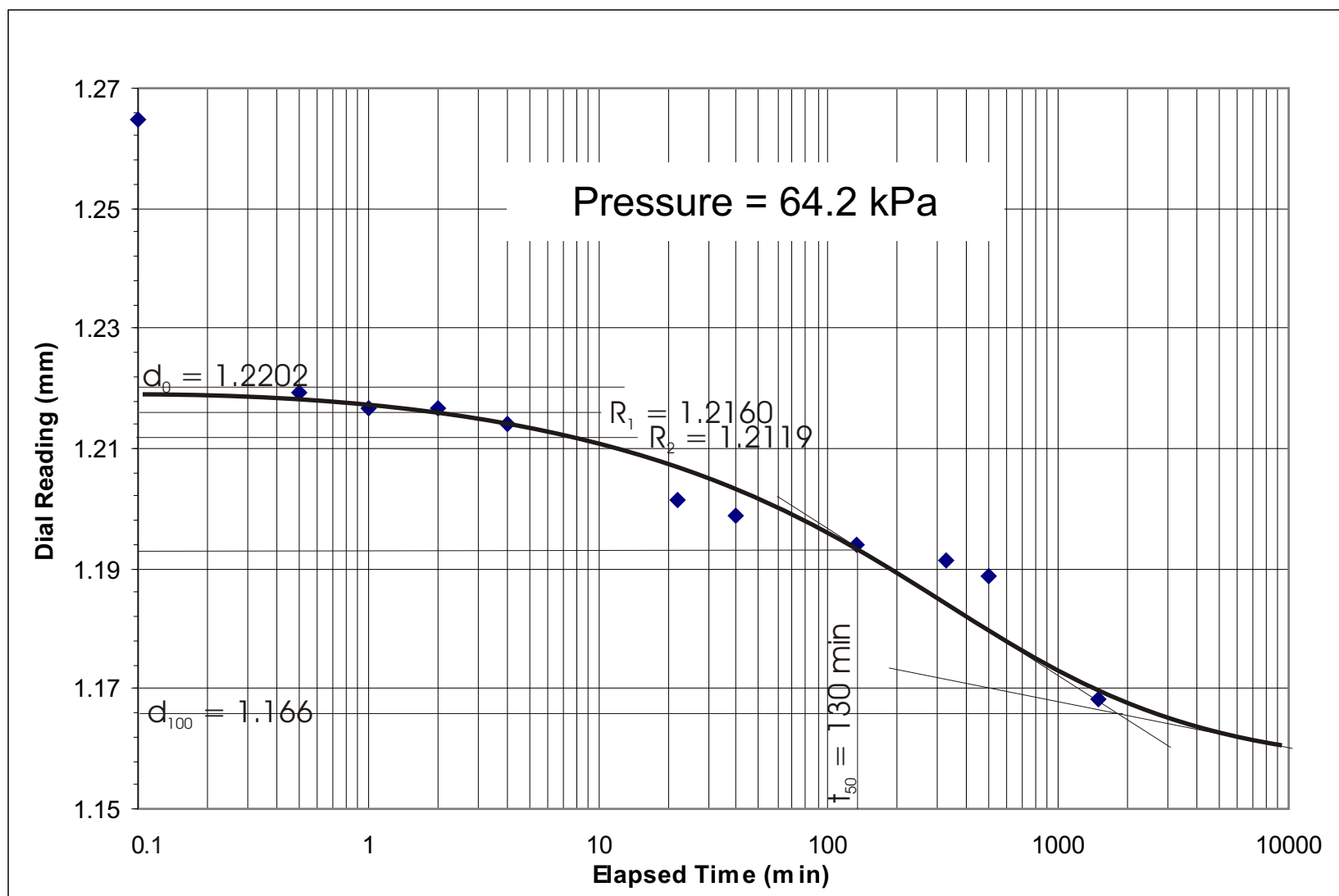
Loading Increment	Pressure (kPa)	At End of Primary Consolidation							Coefficient of Consolidation					
		R ₁₀₀ (mm)	Uncorrected Sample Height (mm)	Equipment Compressibility (mm)	Corrected Sample Height (mm)	Volume of Sample (cc)	Volume of Voids (cc)	Void Ratio	Average Void Ratio	R ₅₀ (mm)	Corrected Sample Height at R ₅₀ (mm)	H _{D50} (mm)	time50 (sec)	Coefficient of Consolidation c _v (cm ² /s)
swelling	1.7							0.44						
1	6.8	1.37	18.97	0.023	18.99	60.79	18.67	0.44						
2	13.9	1.32	18.92	0.043	18.96	60.70	18.58	0.44	0.44	1.34	18.98	9.49	5400	3.29E-05
3	29.3	1.27	18.87	0.056	18.92	60.58	18.45	0.44	0.44	1.28	18.93	9.47	1320	1.34E-04
4	64.2	1.17	18.76	0.086	18.85	60.34	18.22	0.43	0.44	1.19	18.88	9.44	7800	2.25E-05
5	131.9	1.01	18.61	0.119	18.73	59.94	17.82	0.42	0.43	1.05	18.76	9.38	5400	3.21E-05
6	267.6	0.82	18.42	0.152	18.57	59.45	17.33	0.41	0.42	0.86	18.61	9.31	3000	5.69E-05
7	607.8	0.52	18.11	0.213	18.33	58.66	16.54	0.39	0.40	0.56	18.37	9.19	1500	1.11E-04
8	1204.7	0.15	17.75	0.274	18.02	57.69	15.57	0.37	0.38	0.22	18.09	9.04	2280	7.07E-05
9	2426.5	-0.32	17.28	0.358	17.64	56.47	14.35	0.34	0.36	-0.24	17.72	8.86	1800	8.59E-05
10	4866.6	-0.93	16.66	0.475	17.14	54.86	12.74	0.30	0.32	-0.24	17.83	8.92	3600	4.35E-05
11	2426.5	-0.86	16.73	0.406	17.14	54.86	12.74	0.30	0.30					
12	1204.7	-0.79	16.81	0.366	17.17	54.97	12.84	0.30	0.30					
13	607.8	-0.74	16.86	0.333	17.20	55.04	12.92	0.31	0.31					
14	267.6	-0.67	16.93	0.305	17.23	55.17	13.04	0.31	0.31					
15	131.9	-0.62	16.98	0.279	17.26	55.25	13.13	0.31	0.31					

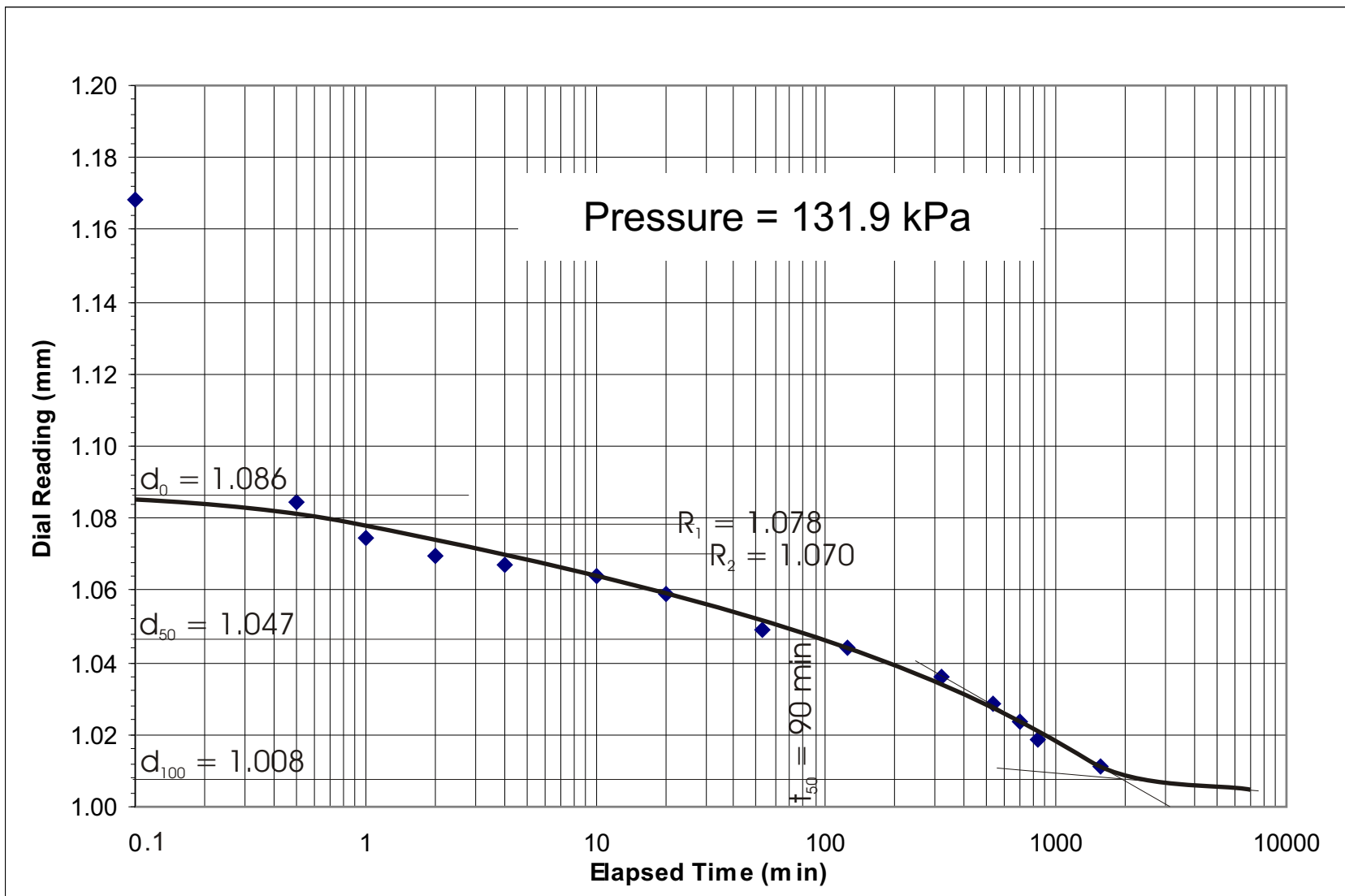


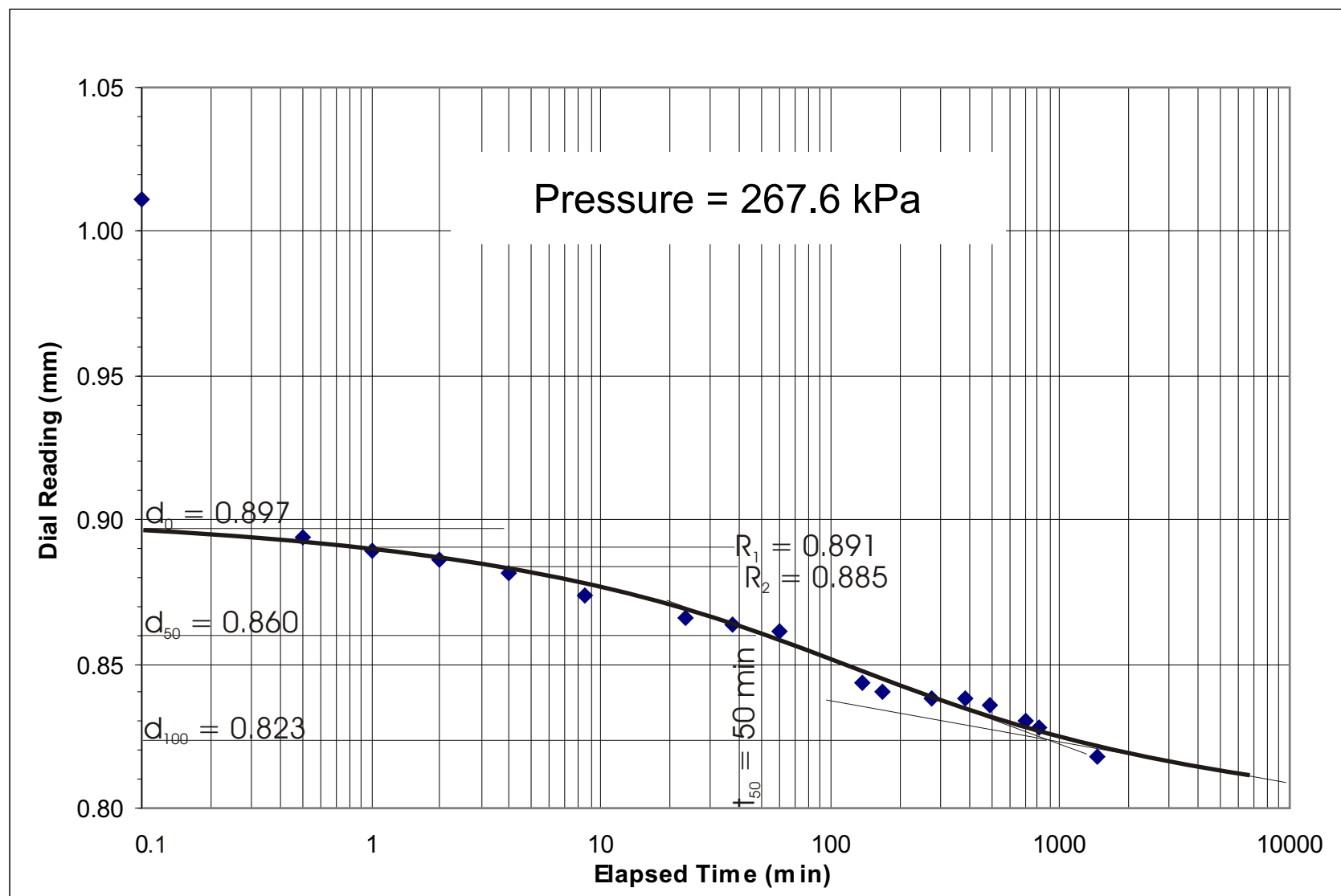


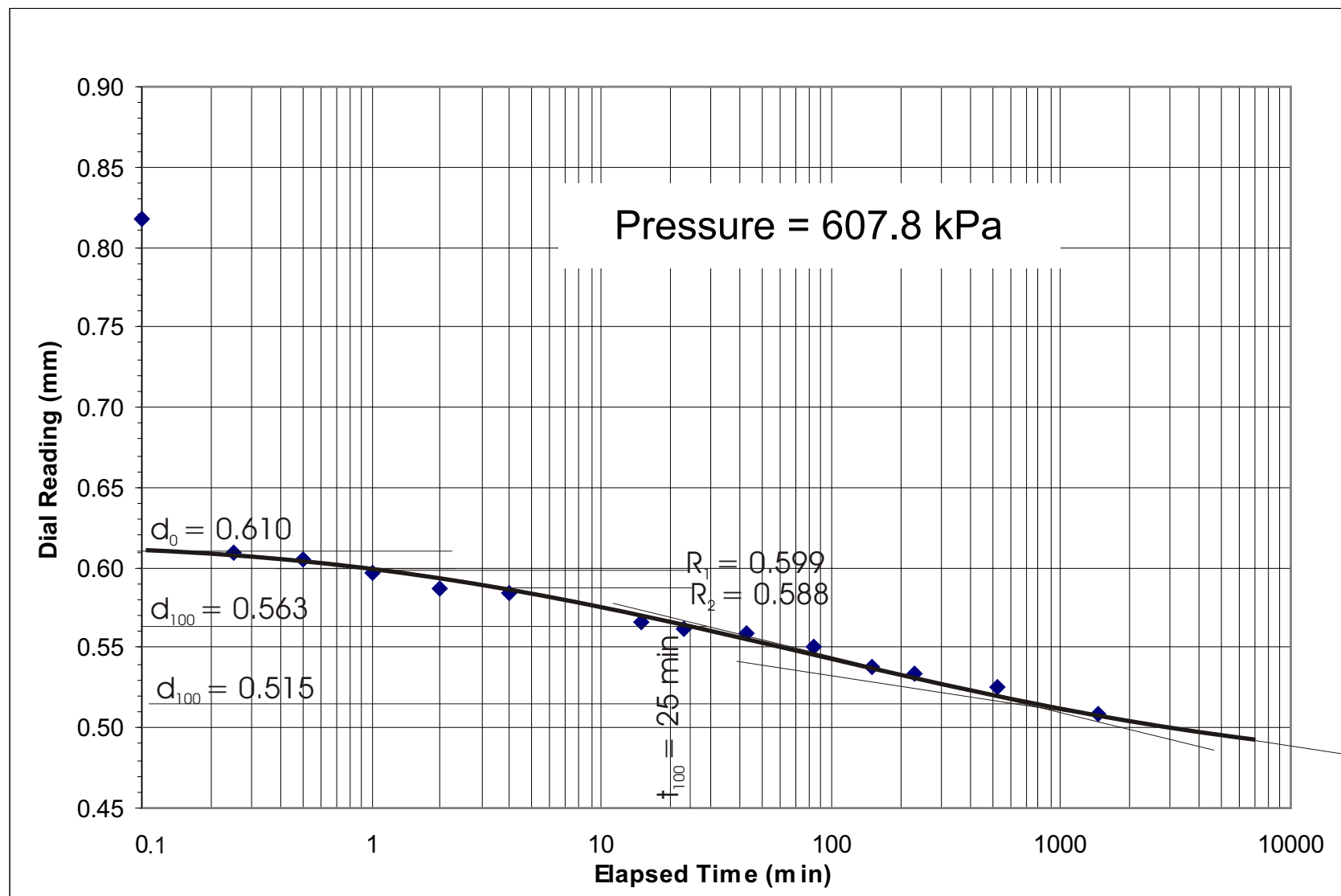


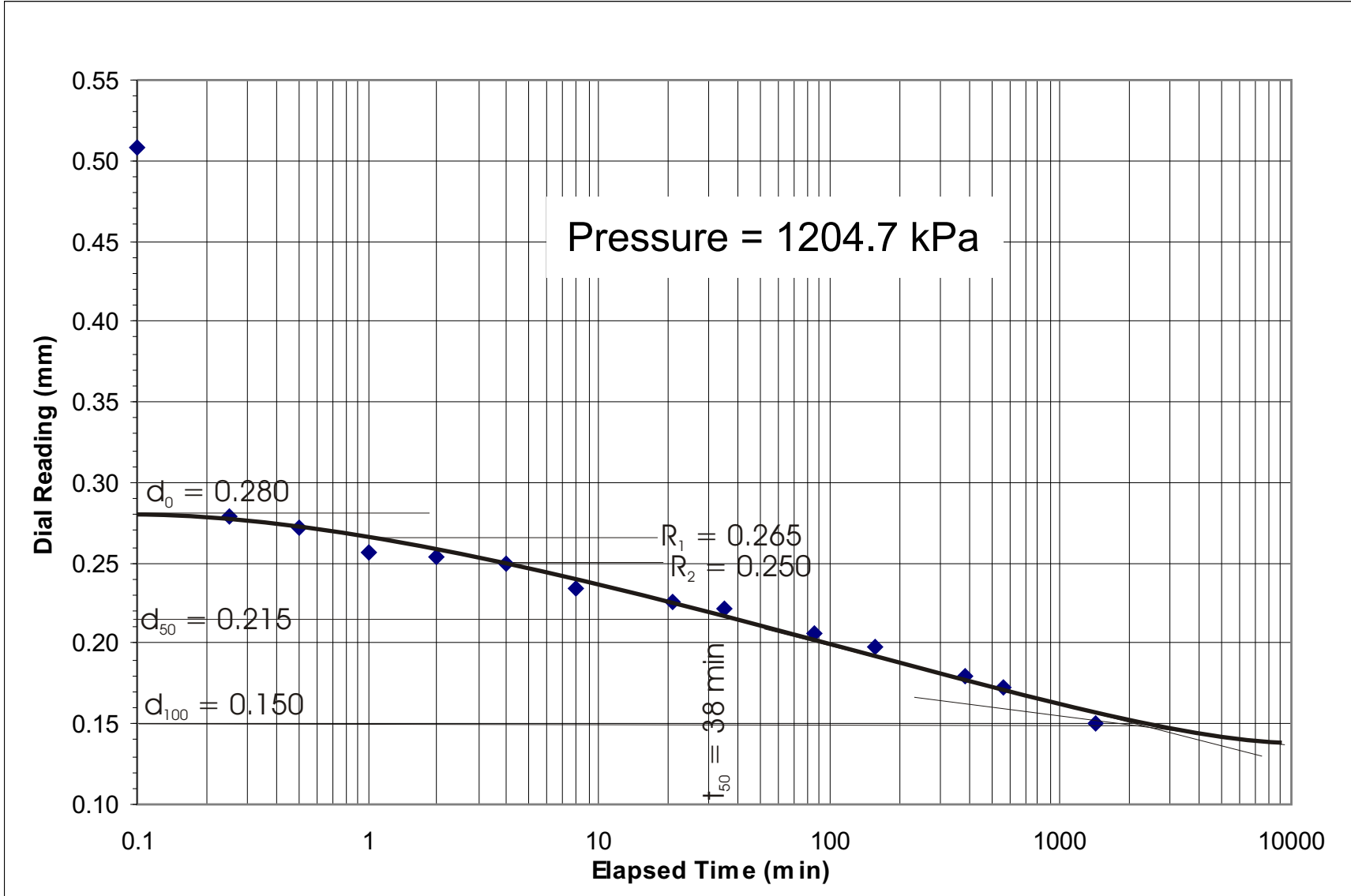


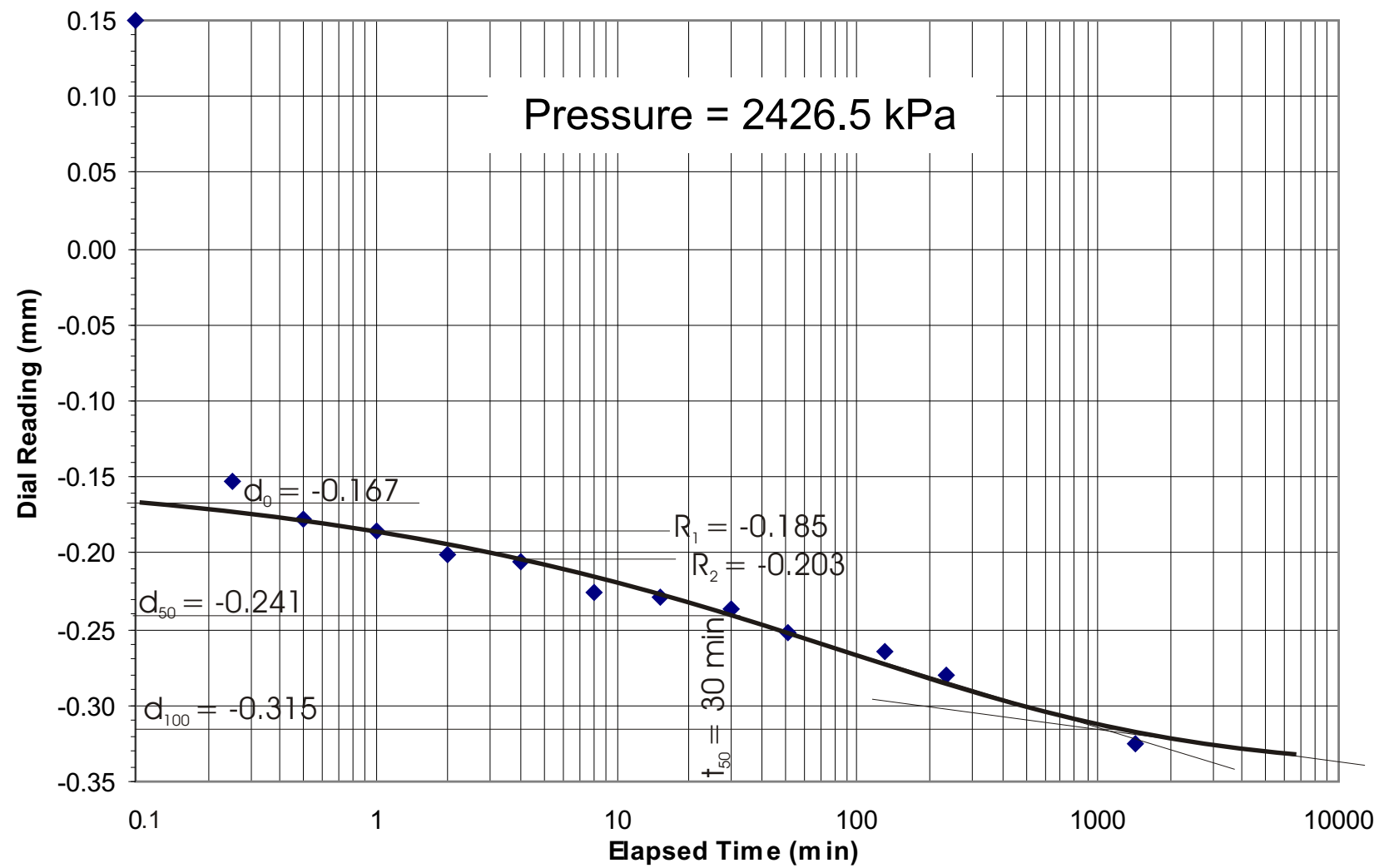


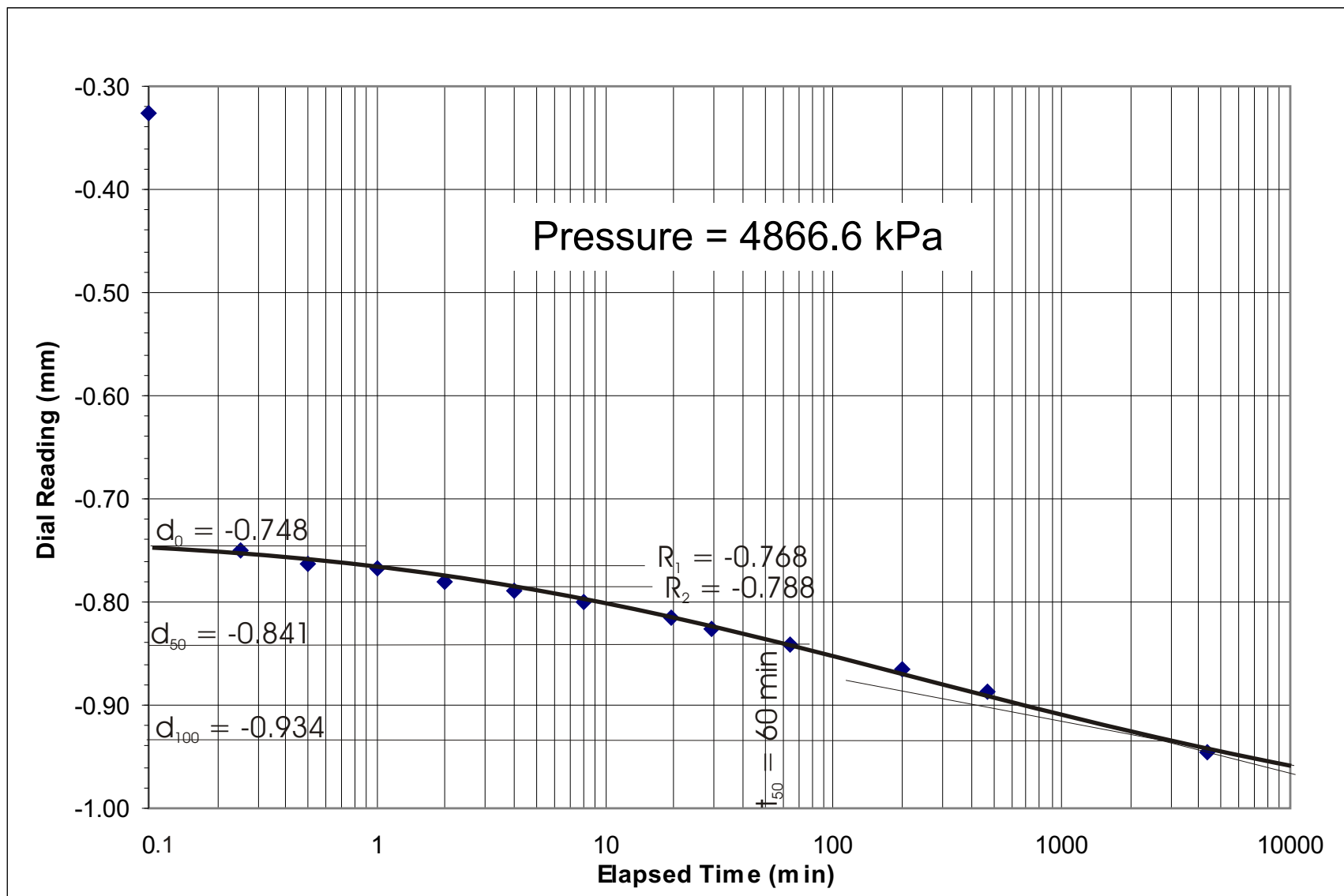


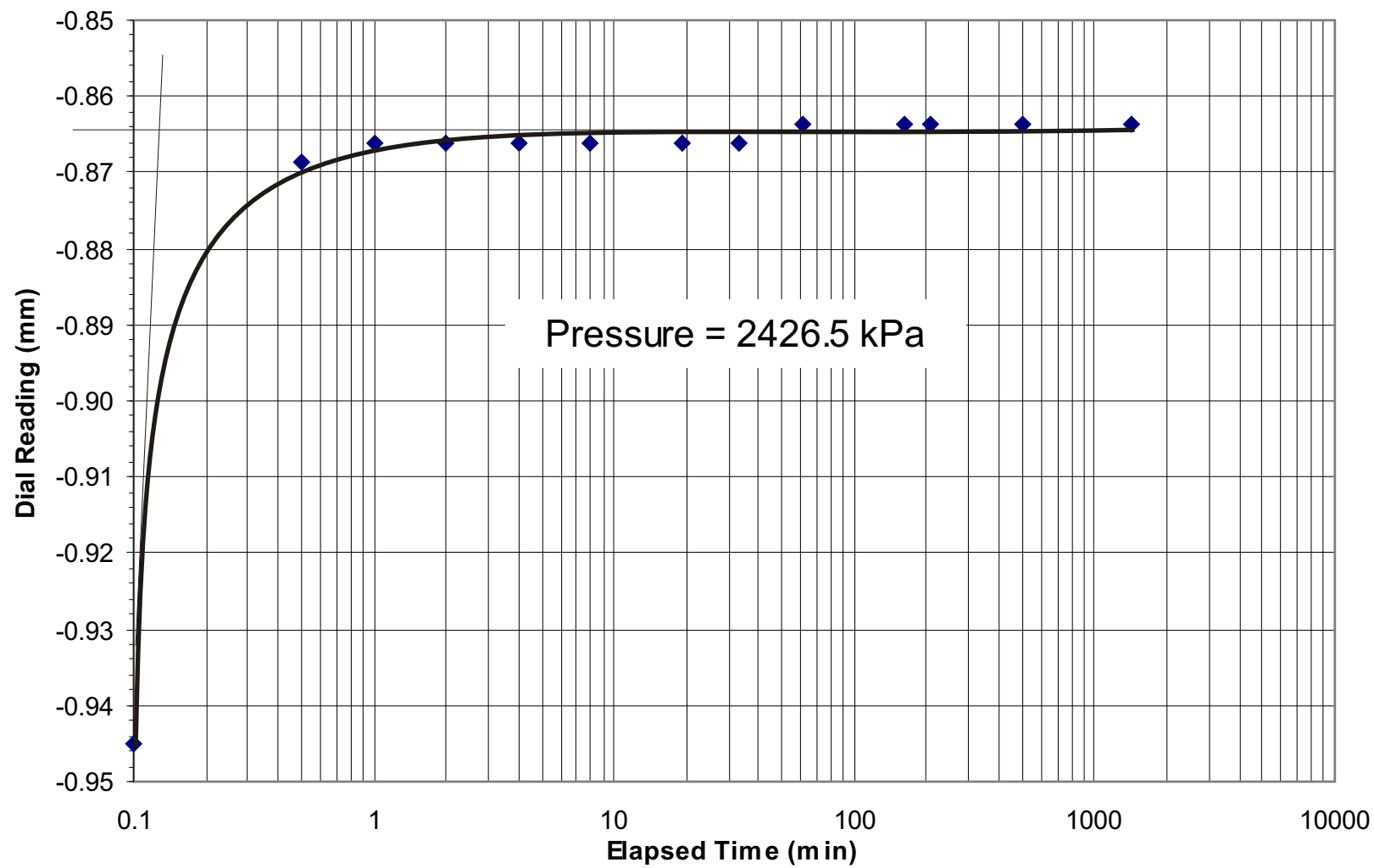


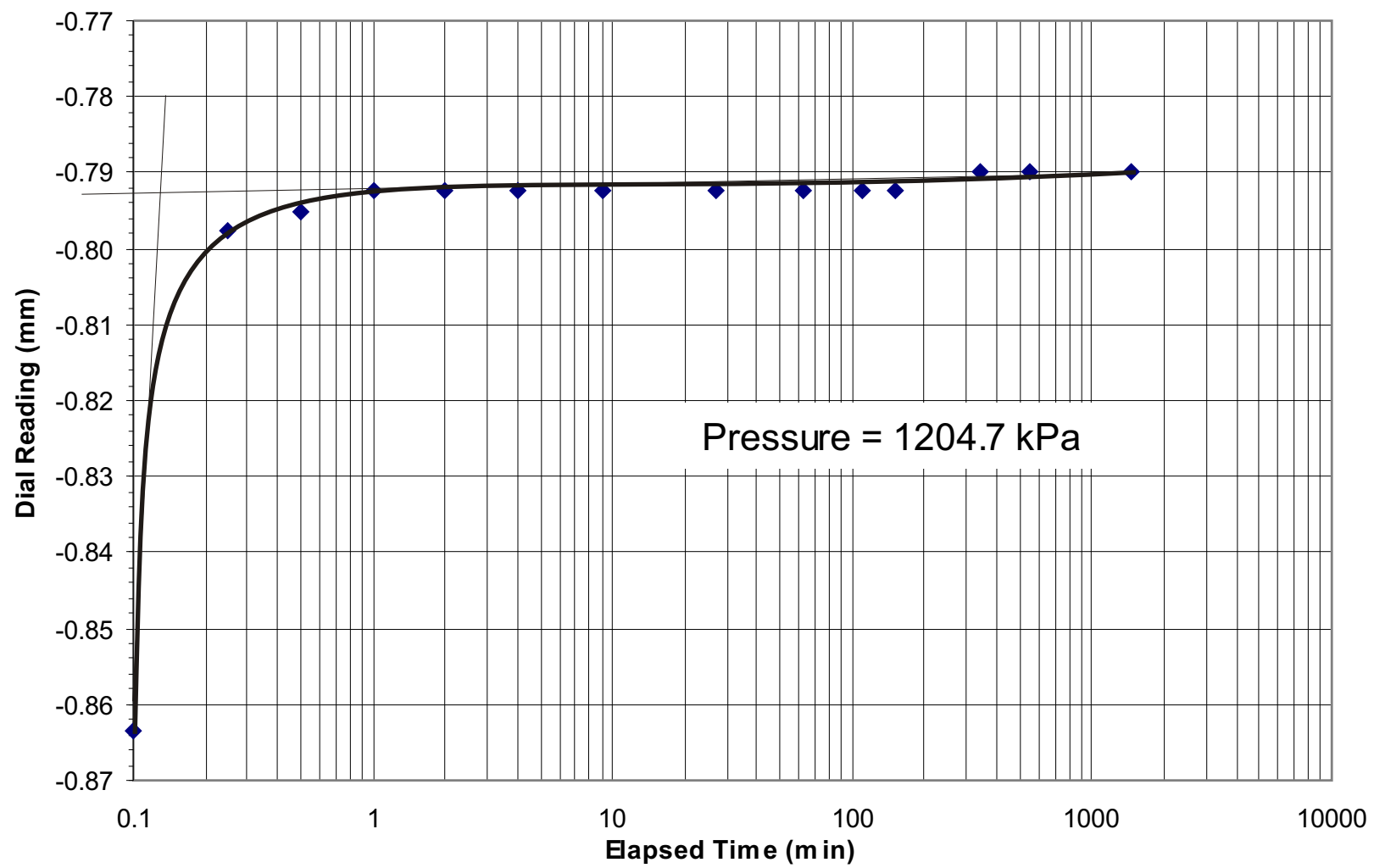


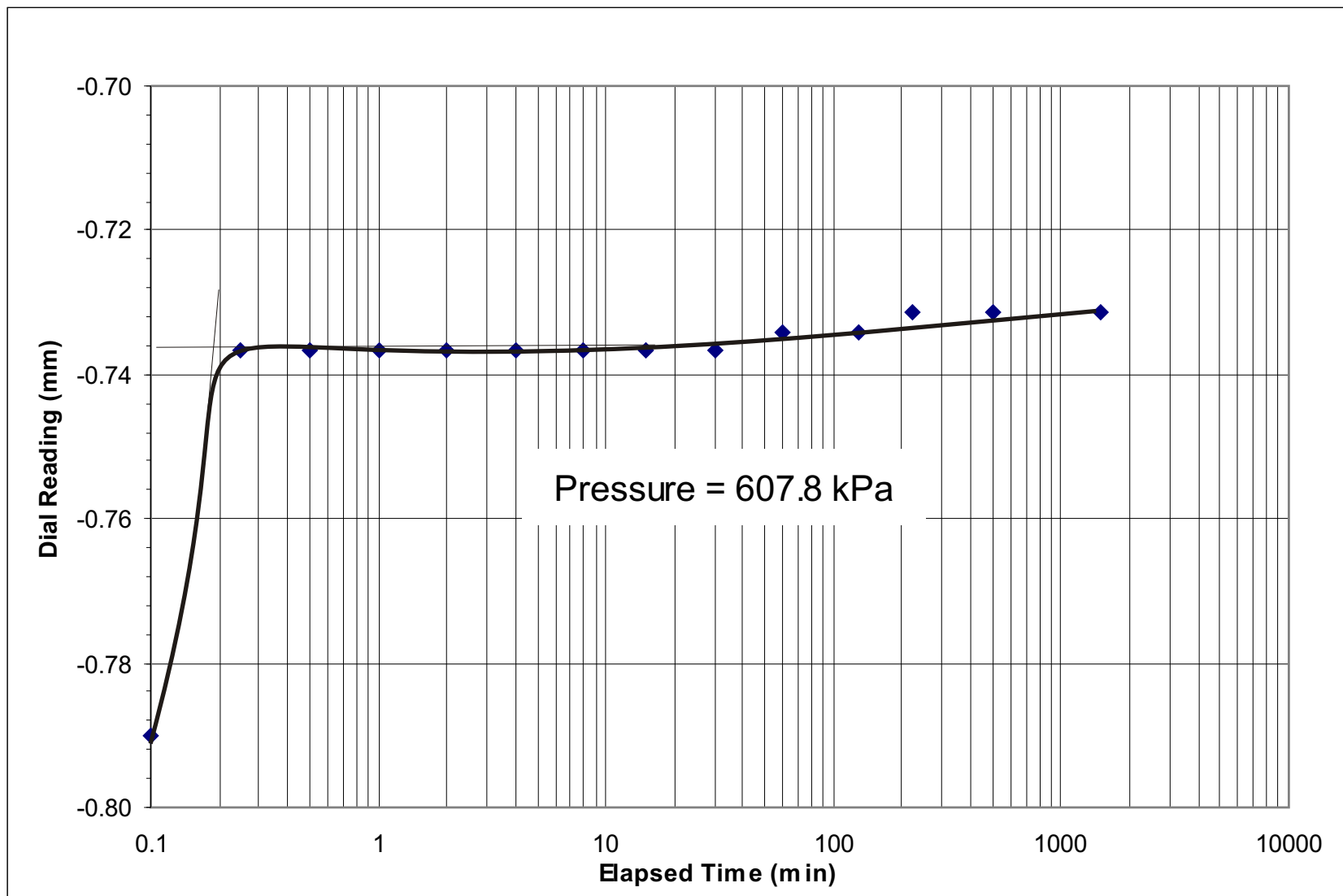


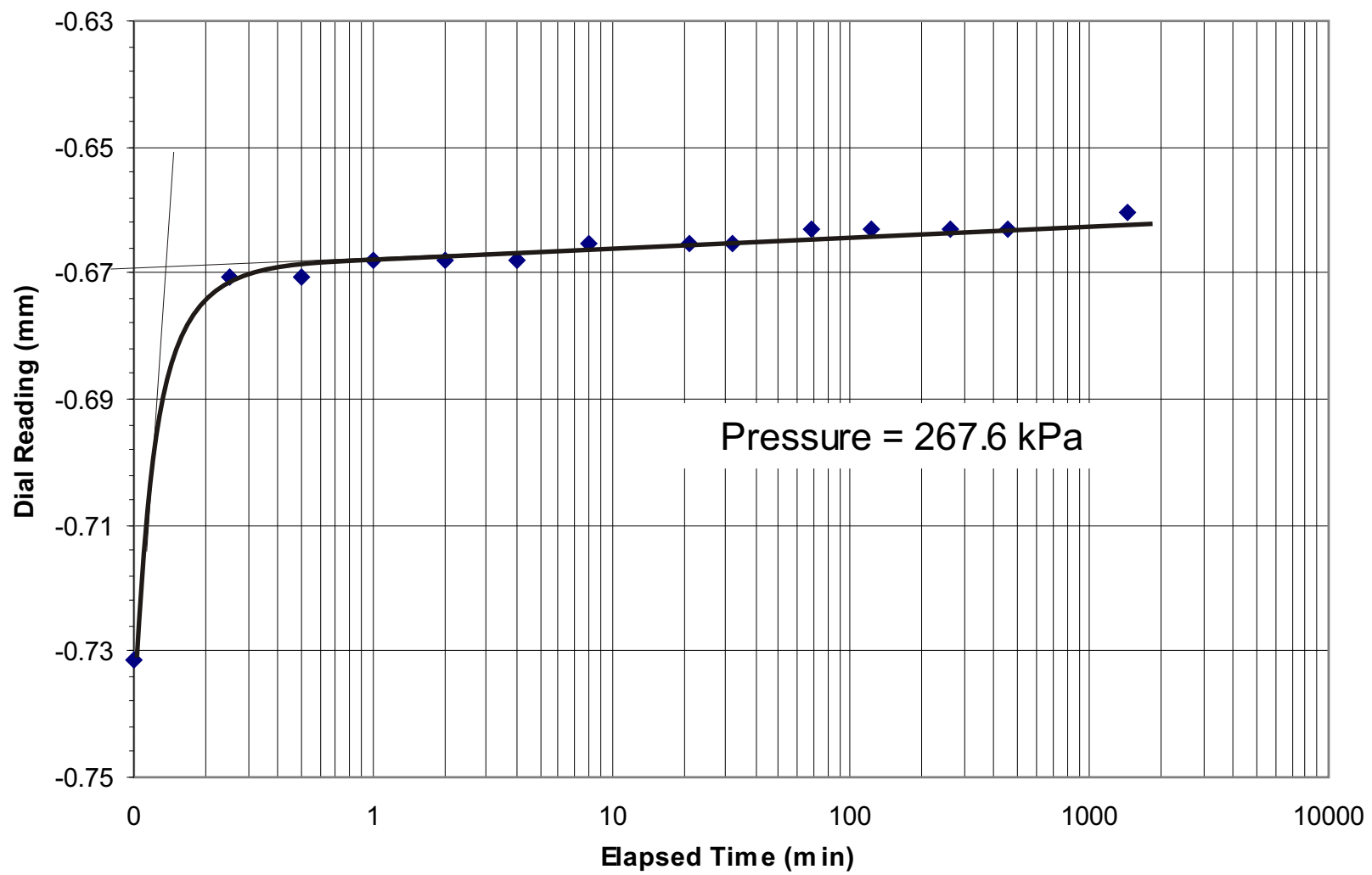


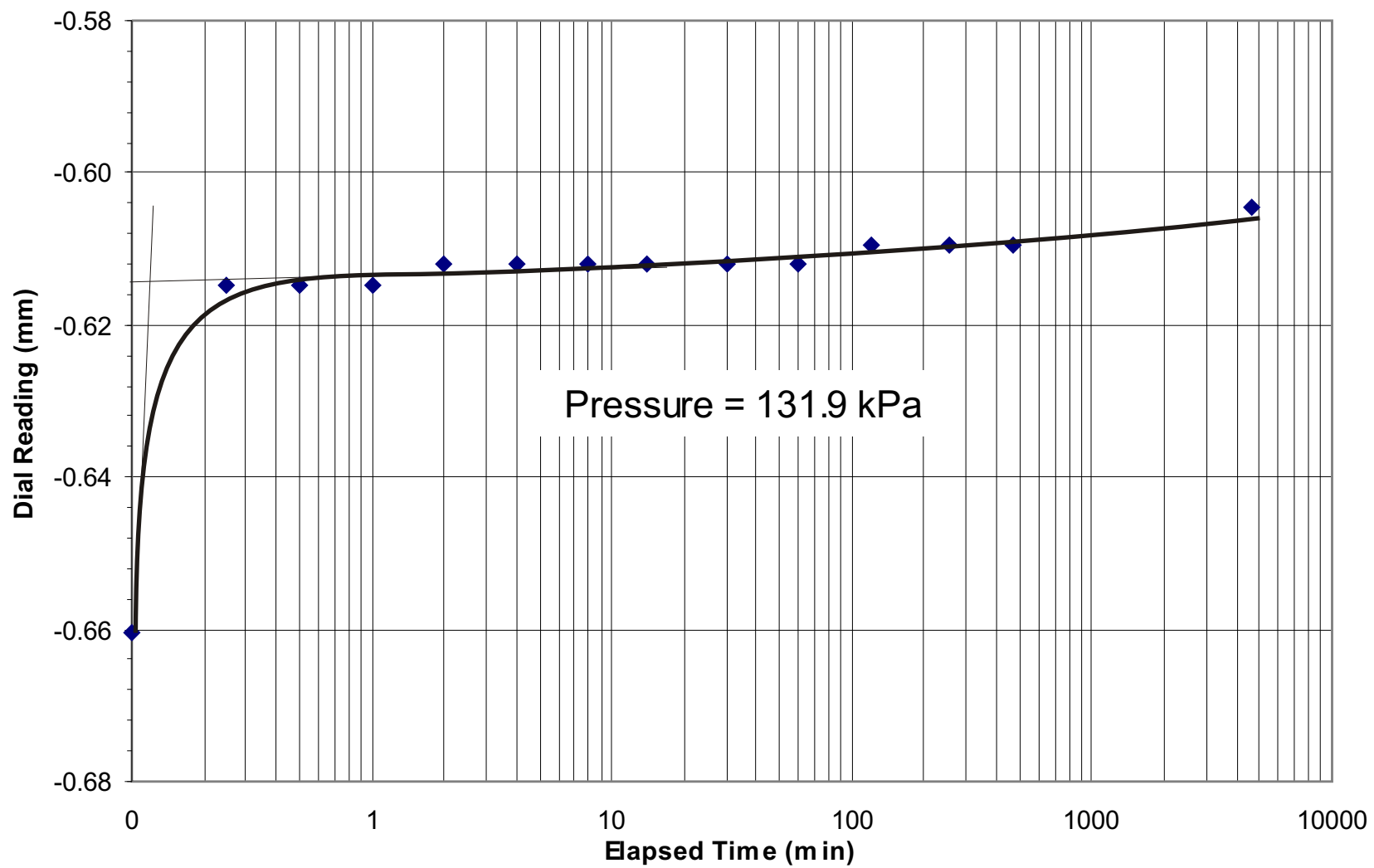












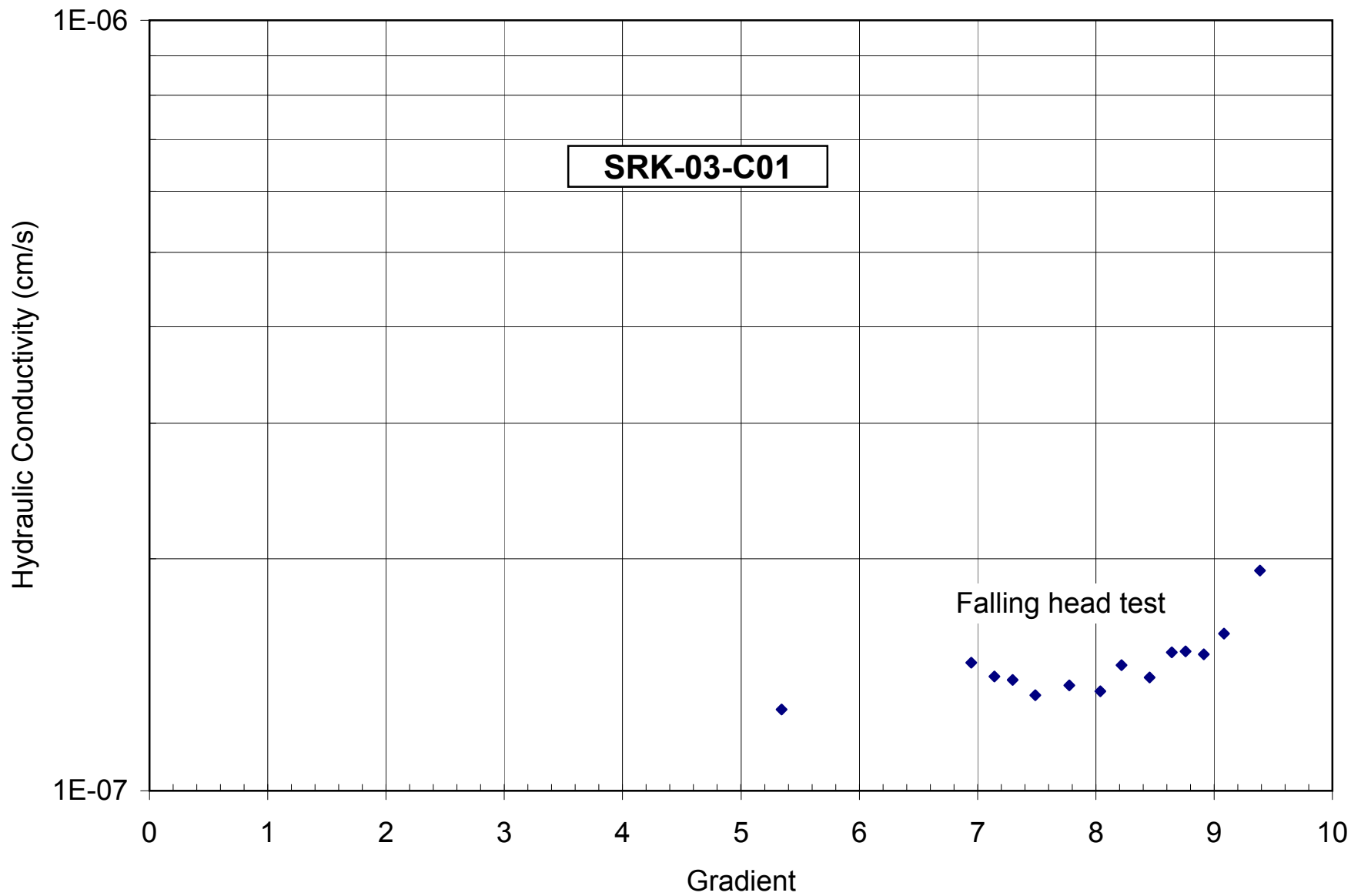
APPENDIX VII-a

Falling Head Hydraulic Conductivity Tests Results

FALLING-HEAD K-TEST

Sample: SRK-03-C01

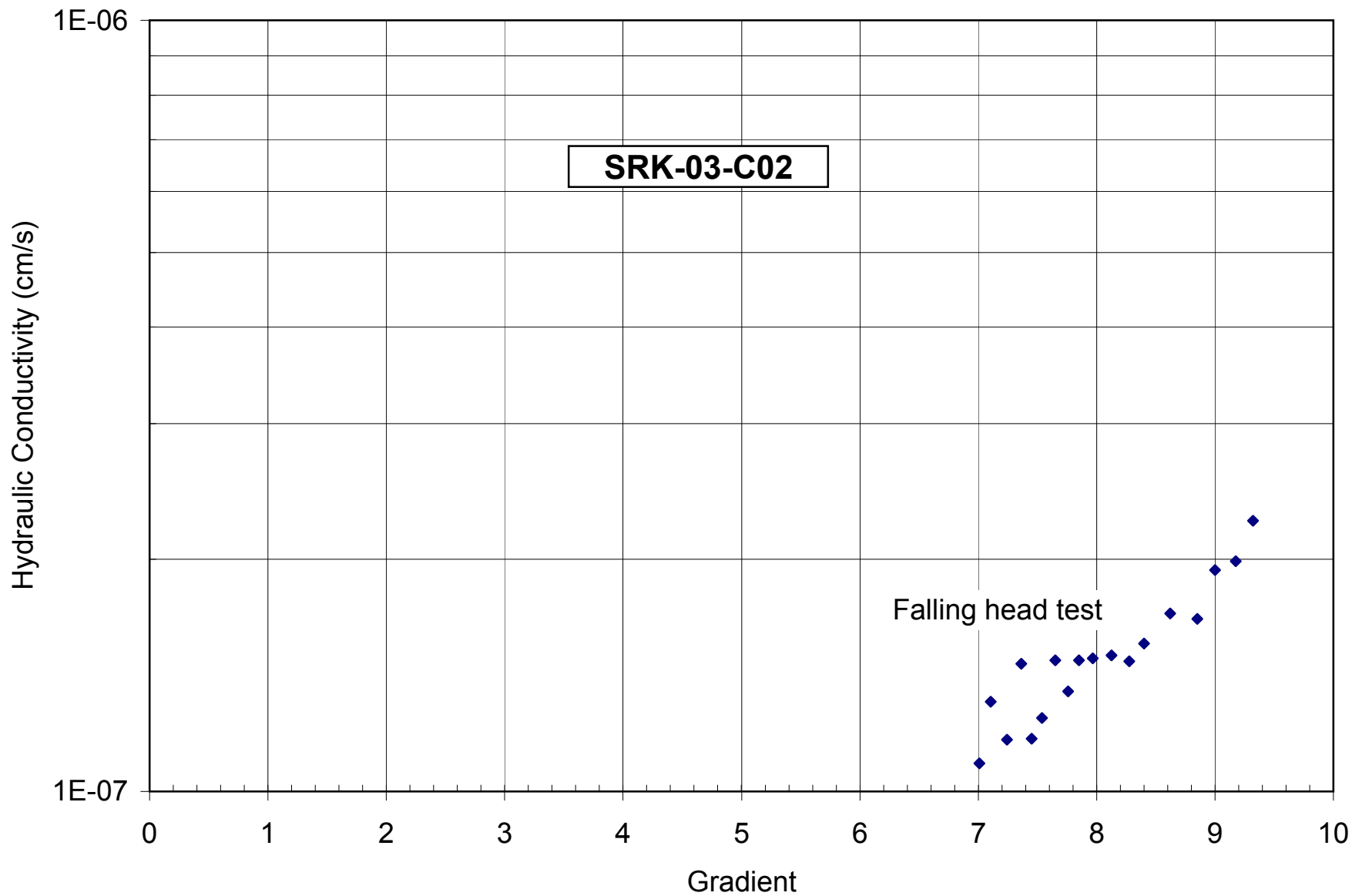
Time T1	Time T2	delta t min	Buret reading at T1	H1 cm	Buret reading at T2	H2 cm	k cm/s	Average gradient	Test using material <#4 sieve Maximum dry density = 1980 Mg/m3 Optimum water content = 12.5%
9:26:00	10:16:00	50	98.30	113.300	93.10	108.100	1.93E-07	9.39	Buret, a = 0.183 cm2
10:16:00	10:40:00	24	93.10	108.100	91.10	106.100	1.60E-07	9.08	
10:40:00	11:06:00	26	91.10	106.100	89.10	104.100	1.50E-07	8.91	Specimen dimensions
11:06:00	11:27:00	21	89.10	104.100	87.50	102.500	1.52E-07	8.76	Height, L = 5.4 cm
11:27:00	11:43:00	16	87.50	102.500	86.30	101.300	1.51E-07	8.64	Diameter, D= 10.1 cm
11:43:00	12:30:00	47	86.30	101.300	83.10	98.100	1.40E-07	8.45	X-sectional area, A = 80.13 cm2
12:30:00	13:05:00	35	83.10	98.100	80.70	95.700	1.45E-07	8.22	
13:05:00	13:34:00	29	80.70	95.700	78.90	93.900	1.35E-07	8.04	Post-test information
13:34:00	14:46:00	72	78.90	93.900	74.50	89.500	1.37E-07	7.78	Water content
14:46:00	15:28:00	42	74.50	89.500	72.10	87.100	1.33E-07	7.49	Tare mass = 18.47 g
15:28:00	16:04:00	36	72.10	87.100	70.00	85.000	1.39E-07	7.30	Wet sample + tare = 1004.32 g
16:04:00	16:30:00	26	70.00	85.000	68.50	83.500	1.41E-07	7.14	Dry sample + tare 869.05 g
16:30:00	17:23:00	53	68.50	83.500	65.40	80.400	1.47E-07	6.95	Water content = 15.9%
17:23:00	8:37:00	914	65.40	80.400	30.60	45.600	1.28E-07	5.34	Dry density = 1.966 Mg/m3



FALLING-HEAD K-TEST

Sample: SRK-03-C02

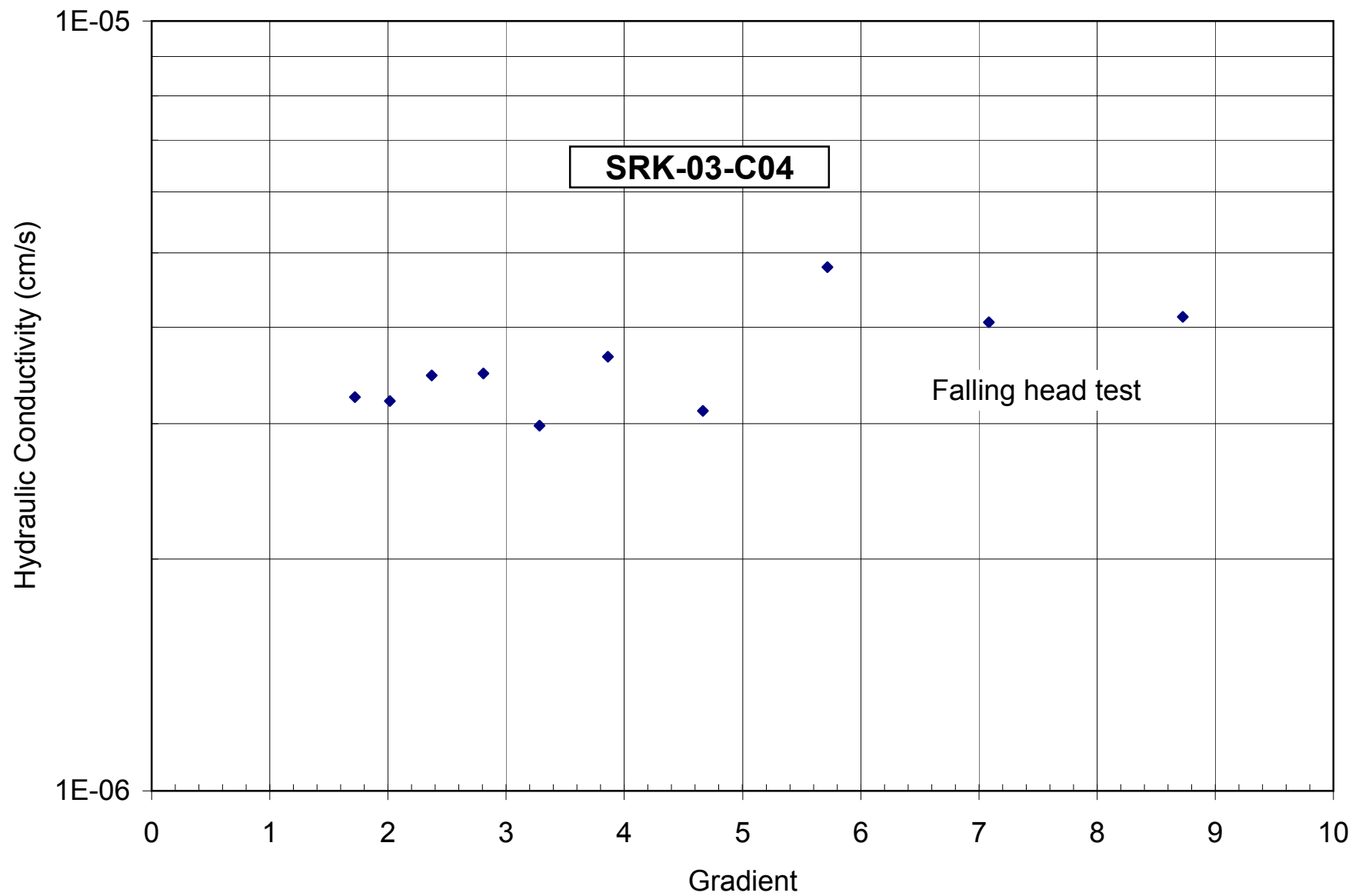
Time T1	Time T2	delta t min	Buret reading at T1	H1 cm	Buret reading at T2	H2 cm	k cm/s	Average gradient	Test using material <#4 sieve Maximum dry density = 1975 Mg/m ³ Optimum water content = 12.0 % Buret, a = 0.183 cm ² Specimen dimensions Height, L = 5.4 cm Diameter, D= 10.1 cm X-sectional area, A = 80.13 cm ² Post-test information Water content Tare mass = 312 g Wet sample + tare = 1272 g Dry sample + tare 1148.16 g Water content = 14.8% Dry density = 1.932 Mg/m ³
9:17:00	9:27:00	10	95.50	110.500	94.30	109.300	2.24E-07	9.32	
9:27:00	9:48:00	21	94.30	109.300	92.10	107.100	1.99E-07	9.17	
9:48:00	10:07:00	19	92.10	107.100	90.20	105.200	1.94E-07	9.00	
10:07:00	10:27:00	20	90.20	105.200	88.50	103.500	1.67E-07	8.85	
10:27:00	11:11:00	44	88.50	103.500	84.80	99.800	1.70E-07	8.62	
11:11:00	11:31:00	20	84.80	99.800	83.30	98.300	1.56E-07	8.40	
11:31:00	11:51:00	20	83.30	98.300	81.90	96.900	1.47E-07	8.28	
11:51:00	12:21:00	30	81.90	96.900	79.80	94.800	1.50E-07	8.13	
12:21:00	12:46:00	25	79.80	94.800	78.10	93.100	1.49E-07	7.97	
12:46:00	13:01:00	15	78.10	93.100	77.10	92.100	1.48E-07	7.85	
13:01:00	13:21:00	20	77.10	92.100	75.90	90.900	1.35E-07	7.76	
13:21:00	13:41:00	20	75.90	90.900	74.60	89.600	1.48E-07	7.65	
13:41:00	14:07:00	26	74.60	89.600	73.20	88.200	1.24E-07	7.54	
14:07:00	14:21:00	14	73.20	88.200	72.50	87.500	1.17E-07	7.45	
14:21:00	14:42:00	21	72.50	87.500	71.20	86.200	1.47E-07	7.36	
14:42:00	15:15:00	33	71.20	86.200	69.60	84.600	1.17E-07	7.24	
15:15:00	15:45:00	30	69.60	84.600	68.00	83.000	1.31E-07	7.11	
15:45:00	16:01:00	16	68.00	83.000	67.30	82.300	1.09E-07	7.01	



FALLING-HEAD K-TEST

Sample: SRK-03-C04

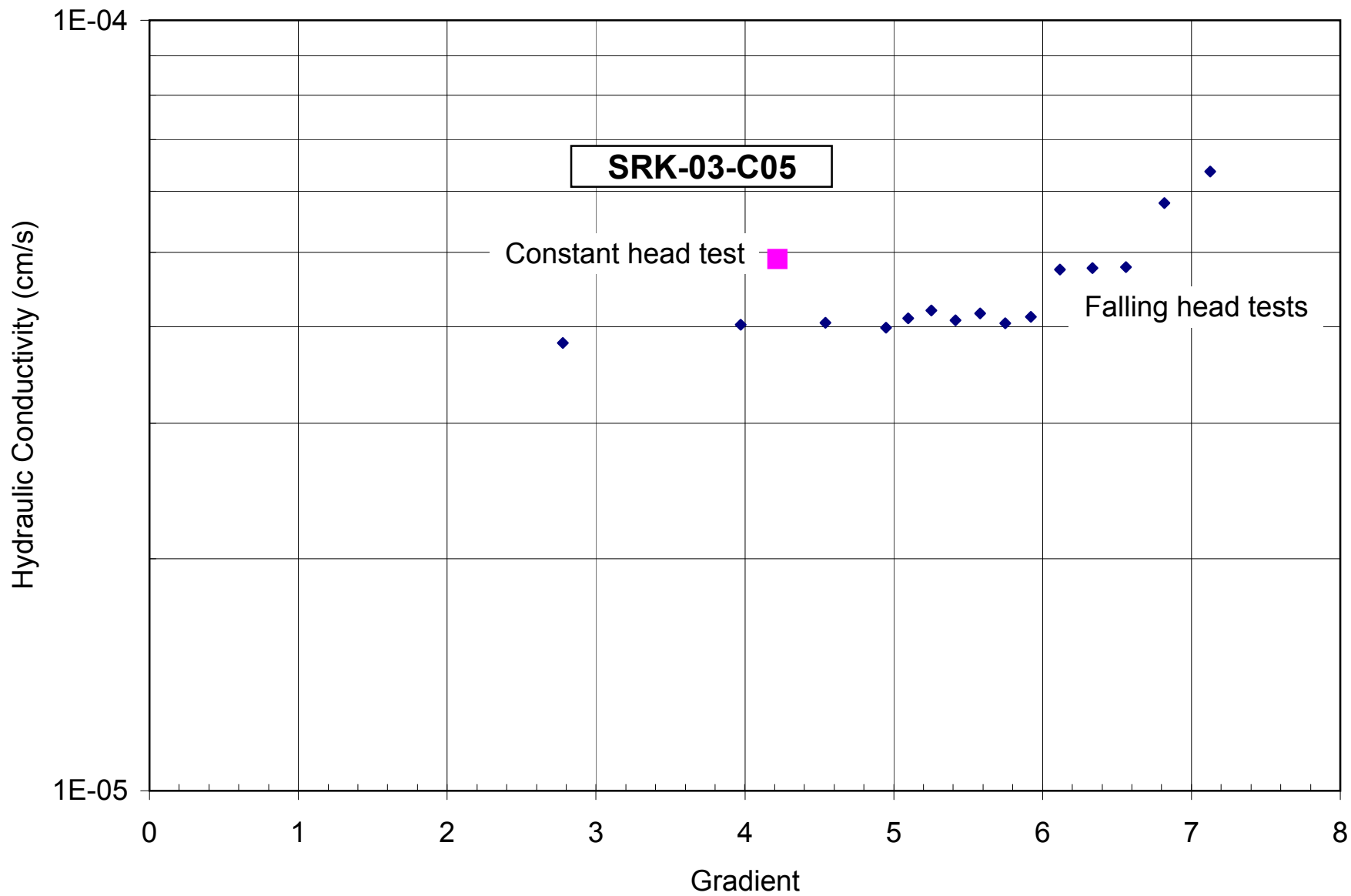
Time T1	Time T2	delta t min	Buret reading at T1	H1 cm	Buret reading at T2	H2 cm	k cm/s	Average gradient	
									Test using material <#4 sieve Maximum dry density = 2045 Mg/m ³ Optimum water content = 9.0 %
10:58:00	11:08:00	10	98.20	113.200	77.60	92.600	4.13E-06	8.73	Buret, a = 0.183 cm ²
11:08:00	11:19:00	11	77.60	92.600	59.50	74.500	4.06E-06	7.08	
11:19:00	11:28:00	9	59.50	74.500	45.40	60.400	4.79E-06	5.72	Specimen dimensions
11:28:00	11:41:00	13	45.40	60.400	34.60	49.600	3.11E-06	4.66	Height, L = 5.4 cm
11:41:00	11:51:00	10	34.60	49.600	26.50	41.500	3.66E-06	3.86	Diameter, D= 10.1 cm
11:51:00	12:01:00	10	26.50	41.500	20.90	35.900	2.98E-06	3.28	X-sectional area, A = 80.13 cm ²
12:01:00	12:11:00	10	20.90	35.900	15.30	30.300	3.49E-06	2.81	
12:11:00	12:21:00	10	15.30	30.300	10.60	25.600	3.46E-06	2.37	Post-test information
12:21:00	12:31:00	10	10.60	25.600	6.90	21.900	3.21E-06	2.01	Water content
12:31:00	12:41:00	10	6.90	21.900	3.70	18.700	3.25E-06	1.72	Tare mass = 308.42 g
									Wet sample + tare = 1309.66 g
									Dry sample + tare 1184.82 g
									Water content = 14.2%
									Dry density = 2.025 Mg/m ³



FALLING-HEAD K-TEST

Sample: SRK-03-C05

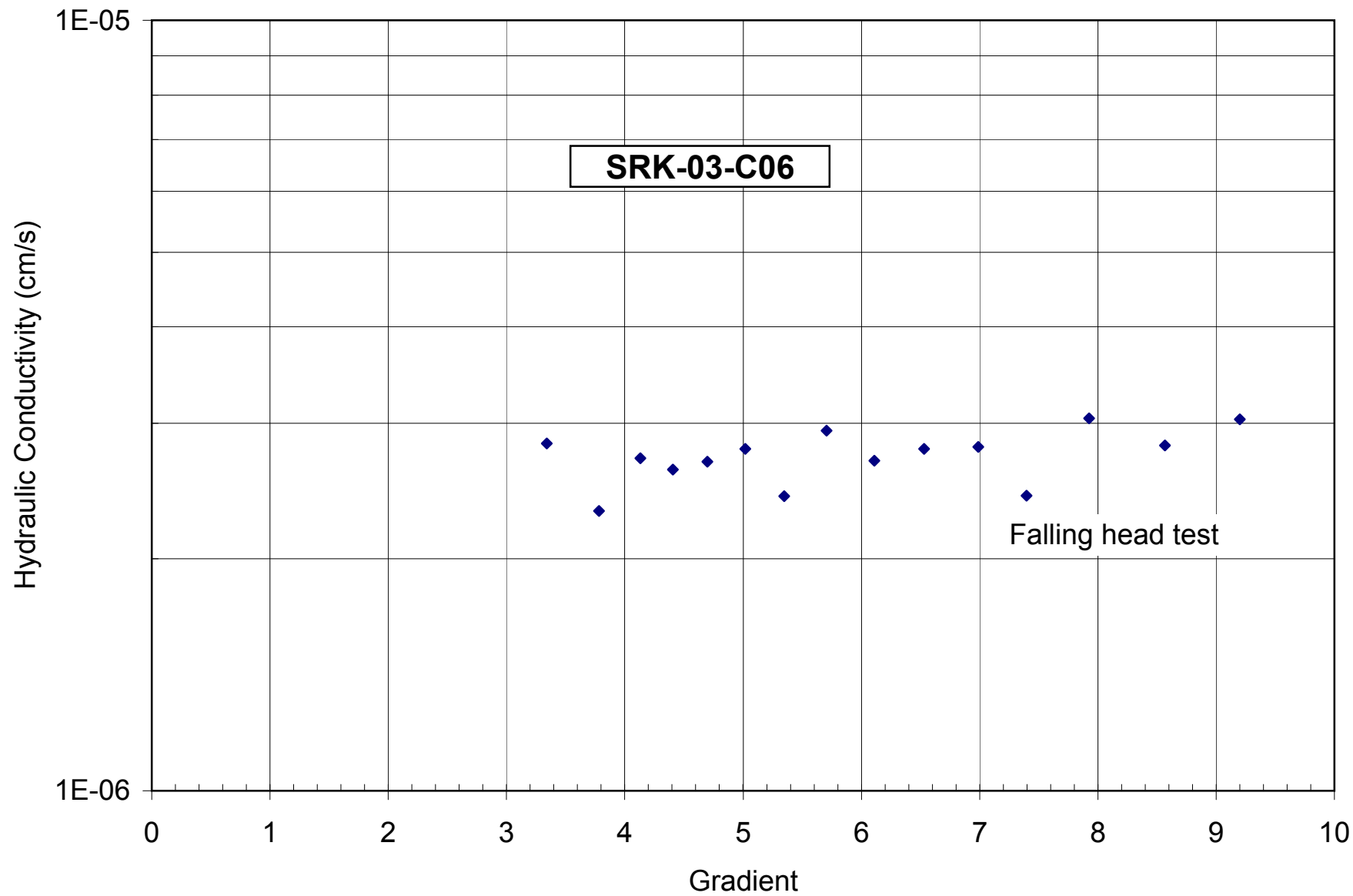
Time T1	Time T2	delta t min	Buret reading at T1	H1 cm	Buret reading at T2	H2 cm	k cm/s	Average gradient	Test using material <#4 sieve Maximum dry density = 2020 Mg/m ³ Optimum water content = 10.5 % Buret, a = 0.183 cm ² Specimen dimensions Height, L = 18.0 cm Diameter, D= 10.1 cm X-sectional area, A = 80.13 cm ² Initial dry density = 2.011 Mg/m ³
16:46:30	16:47:00	0.5	84.30	86.000	80.40	82.100	6.36E-05	7.13	
16:47:00	16:47:30	0.5	80.40	82.100	77.00	78.700	5.80E-05	6.82	
16:47:30	16:48:00	0.5	77.00	78.700	74.30	76.000	4.78E-05	6.56	
16:48:00	16:48:30	0.5	74.30	76.000	71.70	73.400	4.77E-05	6.33	
16:48:30	16:49:00	0.5	71.70	73.400	69.20	70.900	4.75E-05	6.12	
16:49:00	16:49:30	0.5	69.20	70.900	67.10	68.800	4.12E-05	5.92	
16:49:30	16:50:00	0.5	67.10	68.800	65.10	66.800	4.04E-05	5.75	
16:50:00	16:50:30	0.5	65.10	66.800	63.10	64.800	4.17E-05	5.58	
16:50:30	16:51:00	0.5	63.10	64.800	61.20	62.900	4.08E-05	5.41	
16:51:00	16:51:30	0.5	61.20	62.900	59.30	61.000	4.20E-05	5.25	
16:51:30	16:52:00	0.5	59.30	61.000	57.50	59.200	4.10E-05	5.10	
16:52:00	16:52:30	0.5	57.50	59.200	55.80	57.500	3.99E-05	4.95	
16:52:30	16:55:00	2.5	55.80	57.500	47.90	49.600	4.05E-05	4.54	
16:55:00	16:57:00	2	47.90	49.600	42.40	44.100	4.03E-05	3.97	
16:57:00	17:10:00	13	42.40	44.100	19.70	21.400	3.81E-05	2.78	
Constant head test							4.90E-05	4.22	



FALLING-HEAD K-TEST

Sample: SRK-03-C06

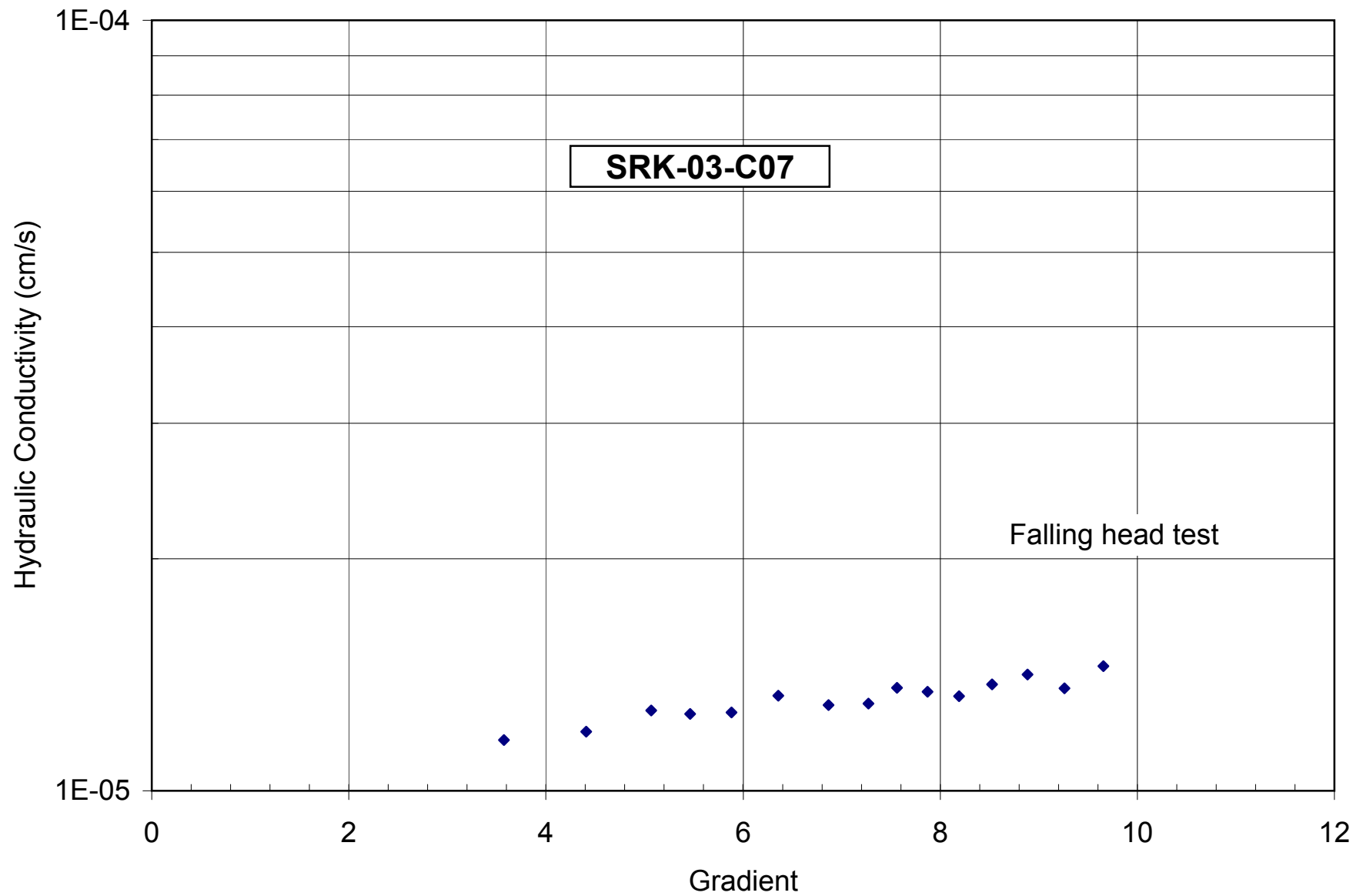
Time T1	Time T2	delta t min	Buret reading at T1	H1 cm	Buret reading at T2	H2 cm	k cm/s	Average gradient	Test using material <#4 sieve Maximum dry density = 2000 Mg/m ³ Optimum water content = 10.5 % Buret, a = 0.183 cm ² Specimen dimensions Height, L = 5.4 cm Diameter, D= 10.1 cm X-sectional area, A = 80.13 cm ² Post-test information Water content Tare mass = 13.26 g Wet sample + tare = 990.2 g Dry sample + tare 864.57 g Water content = 14.8% Dry density = 1.967 Mg/m ³
13:37:00	13:42:00	5	97.50	112.500	89.50	104.500	3.03E-06	9.20	
13:42:00	13:47:00	5	89.50	104.500	82.60	97.600	2.81E-06	8.57	
13:47:00	13:53:00	6	82.60	97.600	74.30	89.300	3.04E-06	7.92	
13:53:00	13:57:00	4	74.30	89.300	70.20	85.200	2.42E-06	7.40	
13:57:00	14:02:00	5	70.20	85.200	64.60	79.600	2.79E-06	6.99	
14:02:00	14:07:00	5	64.60	79.600	59.40	74.400	2.78E-06	6.53	
14:07:00	14:12:00	5	59.40	74.400	54.70	69.700	2.68E-06	6.11	
14:12:00	14:17:00	5	54.70	69.700	49.90	64.900	2.93E-06	5.71	
14:17:00	14:22:00	5	49.90	64.900	46.20	61.200	2.41E-06	5.35	
14:22:00	14:27:00	5	46.20	61.200	42.20	57.200	2.78E-06	5.02	
14:27:00	14:32:00	5	42.20	57.200	38.60	53.600	2.67E-06	4.70	
14:32:00	14:37:00	5	38.60	53.600	35.30	50.300	2.61E-06	4.41	
14:37:00	14:42:00	5	35.30	50.300	32.10	47.100	2.70E-06	4.13	
14:42:00	14:52:00	10	32.10	47.100	27.10	42.100	2.31E-06	3.78	
14:52:00	15:02:00	10	27.10	42.100	21.70	36.700	2.82E-06	3.34	
15:02:00	15:12:00	10	21.70	36.700	17.30	32.300	2.62E-06	2.93	
15:12:00	15:22:00	10	17.30	32.300	13.40	28.400	2.64E-06	2.57	
15:22:00	15:32:00	10	13.40	28.400	10.40	25.400	2.29E-06	2.28	
15:32:00	15:47:00	15	10.40	25.400	6.20	21.200	2.48E-06	1.98	



FALLING-HEAD K-TEST

Sample: SRK-03-C07

Time T1	Time T2	delta t min	Buret reading at T1	H1 cm	Buret reading at T2	H2 cm	k cm/s	Average gradient	Test using material <#4 sieve
14:27:00	14:27:30	0.5	95.60	116.300	90.70	111.400	1.45E-05	9.65	Buret, a = 0.183 cm ²
14:27:30	14:28:00	0.5	90.70	111.400	86.30	107.000	1.36E-05	9.26	
14:28:00	14:28:30	0.5	86.30	107.000	81.90	102.600	1.42E-05	8.89	Specimen dimensions
14:28:30	14:29:00	0.5	81.90	102.600	77.80	98.500	1.38E-05	8.53	Height, L = 5.7 cm
14:29:00	14:29:30	0.5	77.80	98.500	74.00	94.700	1.33E-05	8.19	Diameter, D= 11.457 cm
14:29:30	14:30:00	0.5	74.00	94.700	70.30	91.000	1.34E-05	7.87	X-sectional area, A = 103.11 cm ²
14:30:00	14:30:30	0.5	70.30	91.000	66.70	87.400	1.36E-05	7.56	
14:30:30	14:31:00	0.5	66.70	87.400	63.40	84.100	1.30E-05	7.27	Post-test information
14:31:00	14:32:00	1	63.40	84.100	57.20	77.900	1.29E-05	6.87	Water content
14:32:00	14:33:00	1	57.20	77.900	51.30	72.000	1.33E-05	6.36	Tare mass = 308.23 g
14:33:00	14:34:00	1	51.30	72.000	46.10	66.800	1.26E-05	5.88	Wet sample + tare = 2123.2 g
14:34:00	14:35:00	1	46.10	66.800	41.30	62.000	1.26E-05	5.46	Dry sample + tare 1880.96 g
14:35:00	14:36:00	1	41.30	62.000	36.80	57.500	1.27E-05	5.07	Water content = 15.4%
14:36:00	14:39:00	3	36.80	57.500	25.80	46.500	1.19E-05	4.41	Dry density = 2.676 Mg/m ³
14:39:00	14:42:00	3	25.80	46.500	17.10	37.800	1.16E-05	3.57	



APPENDIX VII-b

Constant Head Hydraulic Conductivity Tests Results



Date: 11-Aug-03

Diameter of specimen, D, cm =	10.1
Height of specimen, L, cm =	18
Cross-sectional Area, A, cm ² =	80.12886

Dry density of test specimen, $\text{kg/m}^3 = \underline{\hspace{2cm} 2019 \hspace{2cm}}$

[illegible]



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Project: SRK Consultants, Vancouver

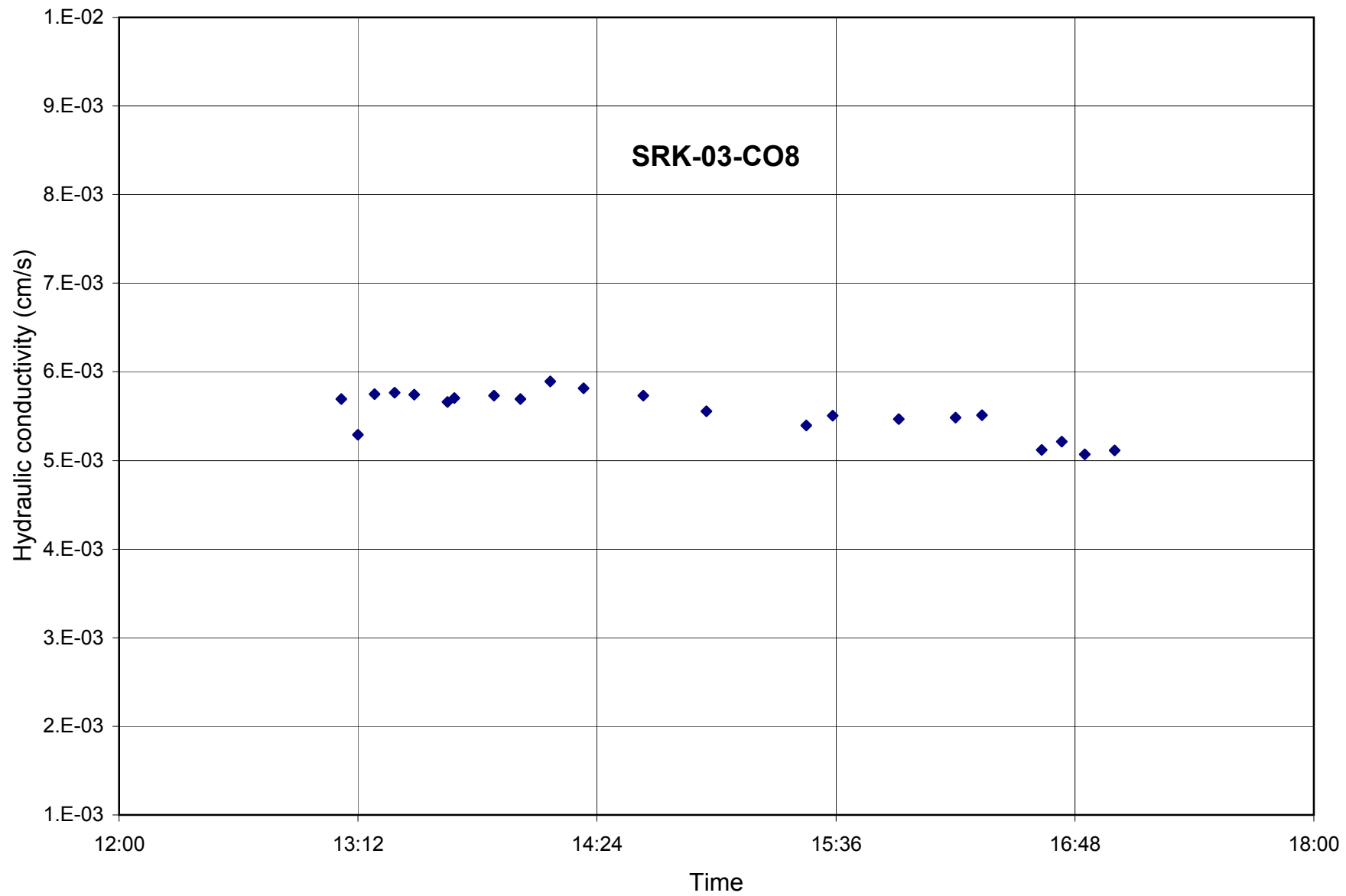
Location: Faro Mine, Whitehorse

Date: 18-Aug-03

Sample:SRK-03-C08

				Initial condition of test specimen	
Diameter of specimen, D, cm =	19.95	Weight of wet soil, g =	9914		
Height of specimen, L, cm =	15.84	Water content of wet soil, % =	8%		
Cross-sectional Area, A, cm ² =	312.631	Weight of dry soil, g =	9171		
		Volume of test specimen, cm ³ =	4952		
		Dry density of test specimen, kg/m ³ =	1852		

Time		Water level		Head, h cm	Q cm3	t sec	Q/At	i = h/L	k cm/s
Start	End	H ₁	H ₂						
13:07	13:08	26.5	13.4	13.1	88.3	60	4.71E-03	0.827	5.69E-03
13:12	13:13	26.5	13.4	13.1	82.1	60	4.38E-03	0.827	5.29E-03
13:17	13:18	26.5	13.4	13.1	89.2	60	4.76E-03	0.827	5.75E-03
13:23	13:24	26.5	13.4	13.1	89.4	60	4.77E-03	0.827	5.76E-03
13:29	13:30	26.5	13.4	13.1	89.1	60	4.75E-03	0.827	5.74E-03
13:39	13:40	26.5	13.4	13.1	87.8	60	4.68E-03	0.827	5.66E-03
13:41	13:42	26.5	13.4	13.1	88.5	60	4.72E-03	0.827	5.70E-03
13:53	13:54	26.5	13.4	13.1	88.9	60	4.74E-03	0.827	5.73E-03
14:01	14:02	26.5	13.4	13.1	88.3	60	4.71E-03	0.827	5.69E-03
14:10	14:11	26.5	13.4	13.1	91.4	60	4.87E-03	0.827	5.89E-03
14:20	14:21	26.5	13.4	13.1	90.2	60	4.81E-03	0.827	5.81E-03
14:38	14:39	26.5	13.4	13.1	88.9	60	4.74E-03	0.827	5.73E-03
14:57	14:58	26.5	13.4	13.1	86.2	60	4.60E-03	0.827	5.56E-03
15:27	15:28	26.5	13.4	13.1	83.7	60	4.46E-03	0.827	5.40E-03
15:35	15:36	26.5	13.4	13.1	85.4	60	4.55E-03	0.827	5.51E-03
15:55	15:56	26.5	13.4	13.1	84.8	60	4.52E-03	0.827	5.47E-03
16:12	16:13	26.5	13.4	13.1	85.1	60	4.54E-03	0.827	5.49E-03
16:20	16:21	26.5	13.4	13.1	85.5	60	4.56E-03	0.827	5.51E-03
16:38	16:39	26.5	13.4	13.1	79.4	60	4.23E-03	0.827	5.12E-03
16:44	16:45	26.5	13.4	13.1	80.9	60	4.31E-03	0.827	5.21E-03
16:51	16:52	26.5	13.4	13.1	78.6	60	4.19E-03	0.827	5.07E-03
17:00	17:01	26.5	13.4	13.1	79.3	60	4.23E-03	0.827	5.11E-03





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Project: SRK Consultants, Vancouver

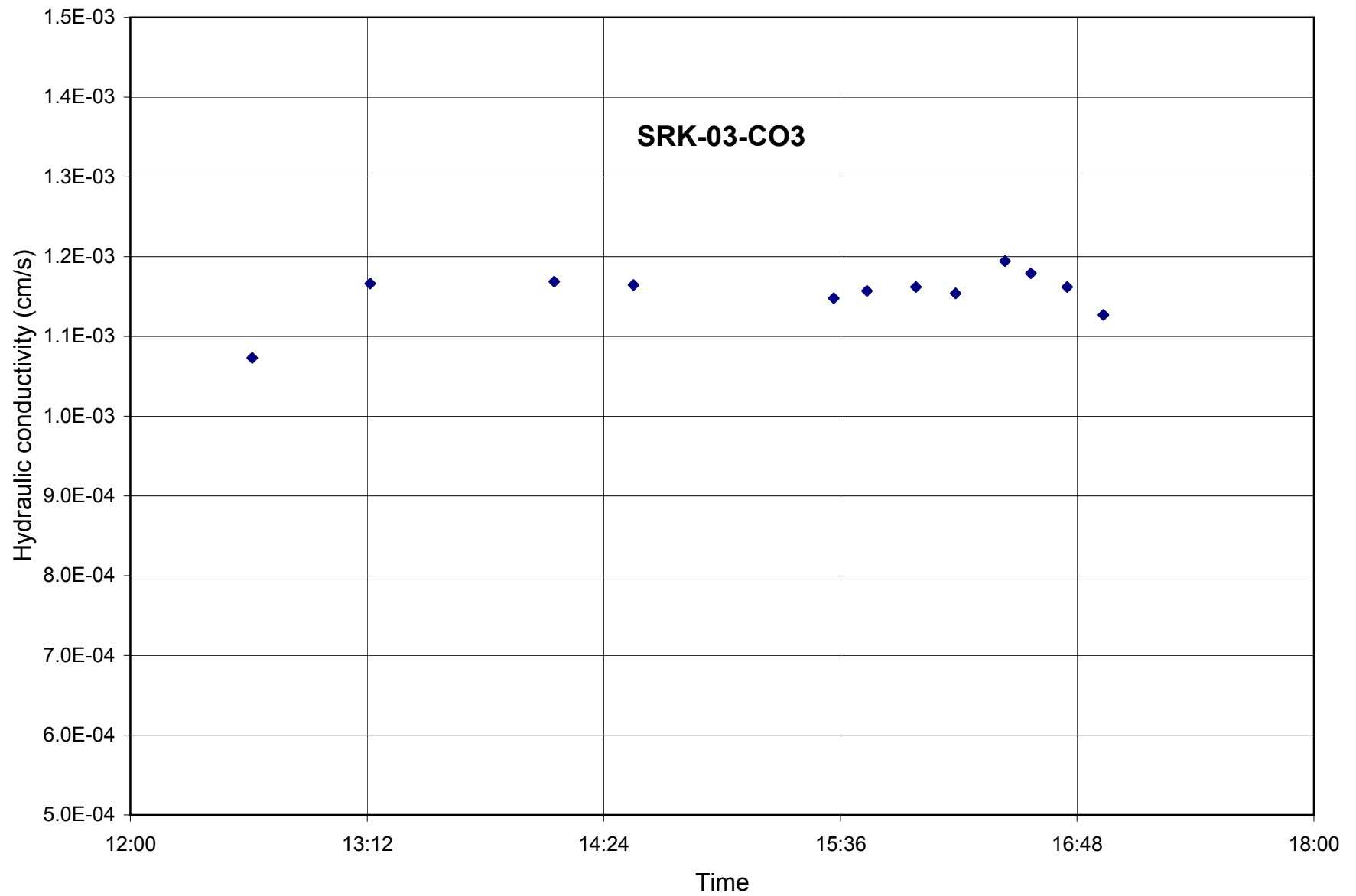
Location: Faro Mine, Whitehorse

Date: 18-Aug-03

Sample:SRK-03-C03

				Initial condition of test specimen	
Diameter of specimen, D, cm =	19.95	Weight of wet soil, g =	11353		
Height of specimen, L, cm =	16.06	Water content of wet soil, % =	8%		
Cross-sectional Area, A, cm ² =	312.631	Weight of dry soil, g =	10520		
		Volume of test specimen, cm ³ =	5021		
		Dry density of test specimen, kg/m ³ =	2095		

Time		Water level		Head, h cm	Q cm3	t sec	Q/At	i = h/L	k cm/s
Start	End	H ₁	H ₂						
9:36	9:41	26.5	13.4	13.1	88.3	300	9.41E-04	0.816	1.15E-03
12:37	12:42	26.5	13.4	13.1	82.1	300	8.75E-04	0.816	1.07E-03
13:13	13:18	26.5	13.4	13.1	89.2	300	9.51E-04	0.816	1.17E-03
14:09	14:14	26.5	13.4	13.1	89.4	300	9.53E-04	0.816	1.17E-03
14:33	14:38	26.5	13.4	13.1	89.1	300	9.50E-04	0.816	1.16E-03
15:34	15:39	26.5	13.4	13.1	87.8	300	9.36E-04	0.816	1.15E-03
15:44	15:49	26.5	13.4	13.1	88.5	300	9.44E-04	0.816	1.16E-03
15:59	16:04	26.5	13.4	13.1	88.9	300	9.48E-04	0.816	1.16E-03
16:11	16:16	26.5	13.4	13.1	88.3	300	9.41E-04	0.816	1.15E-03
16:26	16:31	26.5	13.4	13.1	91.4	300	9.75E-04	0.816	1.19E-03
16:34	16:39	26.5	13.4	13.1	90.2	300	9.62E-04	0.816	1.18E-03
16:45	16:50	26.5	13.4	13.1	88.9	300	9.48E-04	0.816	1.16E-03
16:56	17:01	26.5	13.4	13.1	86.2	300	9.19E-04	0.816	1.13E-03



Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Till Cover
Date: 11-Sep-03
Test Pit No.: VA-CT-TP01
Ring No.: SR-01
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 6.5 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:35	9:38	3.0	5.0	4.0	1.0	2551.8	20.0
2	9:38	9:42	4.0	5.0	4.0	1.0	2551.8	15.0
3	9:42	15:29	347.0	5.5	5.0	0.5	1275.9	0.1
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Average Depth of Water in the Ring: 5.2 cm

Average Infiltration Rate: 11.7 cm/hr

Infiltration Rate (account for lateral divergence): 8.46 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 4.29E-04 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Till Cover
Date: 11-Sep-03
Test Pit No.: VA-CT-TP01
Ring No.: SR-02
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 9 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:16	10:02	46.0	5.0	4.0	1.0	2551.8	1.3
2	10:02	12:26	144.0	5.0	4.0	1.0	2551.8	0.4
3	12:26	15:07	161.0	5.0	4.1	0.9	2296.6	0.3
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Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.7 cm/hr

Infiltration Rate (account for lateral divergence): 0.50 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 3.26E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Till Cover
Date: 11-Sep-03
Test Pit No.: VA-CT-TP01
Ring No.: SR-03
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 30 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	10:00	10:22	22.0	5.0	4.0	1.0	2551.8	2.7
2	10:22	10:58	36.0	5.0	4.0	1.0	2551.8	1.7
3	10:58	11:35	37.0	5.0	4.0	1.0	2551.8	1.6
4	11:35	12:20	45.0	5.0	4.0	1.0	2551.8	1.3
5	12:20	13:05	45.0	5.0	4.0	1.0	2551.8	1.3
6	13:05	13:50	45.0	5.0	4.0	1.0	2551.8	1.3
7	13:50	14:40	50.0	5.0	4.0	1.0	2551.8	1.2
8	14:40	16:28	108.0	5.0	4.0	1.0	2551.8	0.6
9	16:28	17:18	50.0	5.0	4.2	0.8	2041.4	1.0
10								
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14								
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Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.9 cm/hr

Infiltration Rate (account for lateral divergence): 0.66 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 9.25E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Till Cover
Date: 11-Sep-03
Test Pit No.: VA-CT-TP01
Ring No.: SR-04
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 20 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	10:13	11:14	61.0	5.0	3.7	1.3	3317.3	1.3
2	11:14	12:25	71.0	5.0	4.0	1.0	2551.8	0.8
3	12:25	14:18	113.0	5.0	4.0	1.0	2551.8	0.5
4	14:18	15:40	82.0	5.0	4.0	1.0	2551.8	0.7
5	15:40	16:59	79.0	5.0	4.0	1.0	2551.8	0.8
6	16:59	17:20	21.0	5.0	4.4	0.6	1531.1	1.7
7								
8								
9								
10								
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12								
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30								

Average Depth of Water in the Ring: 5.0
 cm

Average Infiltration Rate: 1.1
 cm/hr

Infiltration Rate (account for lateral divergence): 0.77 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 8.77E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Overburden Dump
Date: 9-Sep-03
Test Pit No.: VA-OD-TP01
Ring No.: SR-01
Tested By: Maritz Rykaart

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 20 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	14:07	14:11	4.0	5.0	4.0	1.0	2551.8	15.0
2	14:11	14:37	26.0	5.0	3.5	1.5	3827.6	3.5
3	14:38	15:13	35.0	5.0	4.0	1.0	2551.8	1.7
4	15:13	15:45	32.0	5.5	4.0	1.5	3827.6	2.8
5	15:46	16:20	34.0	5.0	4.0	1.0	2551.8	1.8
6	16:20	16:45	25.0	5.0	4.0	1.0	2551.8	2.4
7	16:45	17:01	16.0	5.0	4.5	0.5	1275.9	1.9
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Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 2.0 cm/hr

Infiltration Rate (account for lateral divergence): 1.46 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.65E-04 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Overburden Dump
Date: 9-Sep-03
Test Pit No.: VA-OD-TP01
Ring No.: SR-02
Tested By: Maritz Rykaart

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 20 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	14:21	14:48	27.0	5.0	4.0	1.0	2551.8	2.2
2	14:49	15:56	67.0	5.0	4.0	1.0	2551.8	0.9
3	15:56	17:07	71.0	5.0	4.1	0.9	2296.6	0.8
4								
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Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 1.3 cm/hr

Infiltration Rate (account for lateral divergence): 0.94 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.06E-04 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Glaciofluvial
Date: 13-Sep-03
Test Pit No.: VA-GF-TP01
Ring No.: SR-01
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 50 cm
Water Entry Value: -8.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:12	9:14	2.0	5.0	4.0	1.0	2551.8	30.0
2	9:14	9:17	3.0	5.0	4.0	1.0	2551.8	20.0
3	9:17	9:20	3.0	5.0	4.0	1.0	2551.8	20.0
4	9:20	9:23	3.0	5.0	4.0	1.0	2551.8	20.0
5	9:23	9:26	3.0	5.0	4.0	1.0	2551.8	20.0
6	9:26	9:30	4.0	5.0	4.0	1.0	2551.8	15.0
7	9:30	9:33	3.0	5.0	4.0	1.0	2551.8	20.0
8	9:33	9:36	3.0	5.0	4.0	1.0	2551.8	20.0
9	9:36	9:39	3.0	5.0	4.0	1.0	2551.8	20.0
10	9:39	9:42	3.0	5.0	4.0	1.0	2551.8	20.0
11	9:42	9:45	3.0	5.0	4.0	1.0	2551.8	20.0
12	9:45	9:49	4.0	5.0	4.0	1.0	2551.8	15.0
13	9:49	9:52	3.0	5.0	4.0	1.0	2551.8	20.0
14	9:52	9:55	3.0	5.0	4.0	1.0	2551.8	20.0
15	9:55	9:58	3.0	5.0	4.0	1.0	2551.8	20.0
16	9:58	10:01	3.0	5.0	4.0	1.0	2551.8	20.0
17	10:01	10:04	3.0	5.0	4.0	1.0	2551.8	20.0
18	10:04	10:07	3.0	5.0	4.0	1.0	2551.8	20.0
19	10:07	10:10	3.0	5.0	4.0	1.0	2551.8	20.0
20	10:10	10:14	4.0	5.0	4.0	1.0	2551.8	15.0
21	10:14	10:17	3.0	5.0	4.0	1.0	2551.8	20.0
22	10:17	10:20	3.0	5.0	4.0	1.0	2551.8	20.0
23	10:20	10:23	3.0	5.0	4.0	1.0	2551.8	20.0
24	10:23	10:27	4.0	5.0	4.0	1.0	2551.8	15.0
25	10:27	10:30	3.0	5.0	4.0	1.0	2551.8	20.0
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 18.3 cm/hr

Infiltration Rate (account for lateral divergence): 13.27 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 2.90E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Glaciofluvial
Date: 13-Sep-03
Test Pit No.: VA-GF-TP01
Ring No.: SR-02
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 10 cm
Water Entry Value: -8.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	12:32	17:10	278.0	5.0	4.2	0.8	2041.4	0.2
2								
3								
4								
5								
6								
7								
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Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.2 cm/hr

Infiltration Rate (account for lateral divergence): 0.12 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.48E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Glaciofluvial
Date: 13-Sep-03
Test Pit No.: VA-GF-TP01
Ring No.: SR-03
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 20 cm
Water Entry Value: -8.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	13:08	13:30	22.0	5.0	4.0	1.0	2551.8	2.7
2	13:30	14:13	43.0	5.0	4.0	1.0	2551.8	1.4
3	14:13	15:12	59.0	5.0	4.0	1.0	2551.8	1.0
4	15:12	16:19	67.0	5.0	4.0	1.0	2551.8	0.9
5	16:19	17:12	53.0	5.0	4.4	0.6	1531.1	0.7
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Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.9 cm/hr

Infiltration Rate (account for lateral divergence): 0.63 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.04E-04 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Glaciofluvial
Date: 13-Sep-03
Test Pit No.: VA-GF-TP01
Ring No.: SR-04
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 50 cm
Water Entry Value: -8.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	15:39	15:40	1.0	5.0	4.0	1.0	2551.8	60.0
2	15:40	15:42	2.0	5.0	4.0	1.0	2551.8	30.0
3	15:42	15:44	2.0	5.0	4.0	1.0	2551.8	30.0
4	15:44	15:46	2.0	5.0	4.0	1.0	2551.8	30.0
5	15:46	15:48	2.0	5.0	4.0	1.0	2551.8	30.0
6	15:48	15:50	2.0	5.0	4.0	1.0	2551.8	30.0
7	15:50	15:52	2.0	5.0	4.0	1.0	2551.8	30.0
8	15:52	15:54	2.0	5.0	4.0	1.0	2551.8	30.0
9	15:54	15:56	2.0	5.0	4.0	1.0	2551.8	30.0
10	15:56	15:58	2.0	5.0	4.0	1.0	2551.8	30.0
11	15:58	16:00	2.0	5.0	4.0	1.0	2551.8	30.0
12	16:00	16:02	2.0	5.0	4.0	1.0	2551.8	30.0
13	16:02	16:04	2.0	5.0	4.0	1.0	2551.8	30.0
14	16:04	16:06	2.0	5.0	4.0	1.0	2551.8	30.0
15	16:06	16:08	2.0	5.0	4.0	1.0	2551.8	30.0
16	16:08	16:10	2.0	5.0	4.0	1.0	2551.8	30.0
17	16:10	16:12	2.0	5.0	4.0	1.0	2551.8	30.0
18	16:12	16:14	2.0	5.0	4.0	1.0	2551.8	30.0
19	16:14	16:16	2.0	5.0	4.0	1.0	2551.8	30.0
20	16:16	16:18	2.0	5.0	4.0	1.0	2551.8	30.0
21	16:18	16:20	2.0	5.0	4.0	1.0	2551.8	30.0
22	16:20	16:22	2.0	5.0	4.0	1.0	2551.8	30.0
23	16:22	16:24	2.0	5.0	4.0	1.0	2551.8	30.0
24	16:24	16:26	2.0	5.0	4.0	1.0	2551.8	30.0
25	16:26	16:28	2.0	5.0	4.0	1.0	2551.8	30.0
26	16:28	16:30	2.0	5.0	4.0	1.0	2551.8	30.0
27	16:30	16:32	2.0	5.0	4.0	1.0	2551.8	30.0
28	16:32	16:35	3.0	5.0	4.0	1.0	2551.8	20.0
29	16:35	16:37	2.0	5.0	4.0	1.0	2551.8	30.0
30	16:37	16:39	2.0	5.0	4.0	1.0	2551.8	30.0
31	16:39	16:41	2.0	5.0	4.0	1.0	2551.8	30.0
32	16:41	16:44	3.0	5.0	4.0	1.0	2551.8	20.0
33	16:44	16:46	2.5	5.0	4.0	1.0	2551.8	24.0
34	16:46:30	16:49	2.5	5.0	4.0	1.0	2551.8	24.0
35	16:49	16:51	2.5	5.0	4.0	1.0	2551.8	24.0
36	16:51:30	16:54	2.5	5.0	4.0	1.0	2551.8	24.0
37	16:54	16:56	2.0	5.0	4.0	1.0	2551.8	30.0
38	16:56	16:58	2.0	5.0	4.0	1.0	2551.8	30.0
39	16:58	17:00	2.0	5.0	4.0	1.0	2551.8	30.0
40								

Average Depth of Water in the Ring: 5.0
 cm

Average Infiltration Rate: 30.0
 cm/hr

Infiltration Rate (account for lateral divergence): 21.71 cm/hr

Effective Saturated Hydraulic Conductivity K_s : 4.75E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Embankment Till
Date: 10-Sep-03
Test Pit No.: VA-ET-TP01
Ring No.: SR-01
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 70 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:12	9:14	2.0	5.0	4.0	1.0	2551.8	30.0
2	9:14	9:19	5.0	5.0	4.0	1.0	2551.8	12.0
3	9:19	9:30	11.0	5.0	4.0	1.0	2551.8	5.5
4	9:30	9:50	20.0	5.5	4.0	1.5	3827.6	4.5
5	9:50	10:12	22.0	5.0	4.0	1.0	2551.8	2.7
6	10:12	10:31	19.0	5.0	4.0	1.0	2551.8	3.2
7	10:31	10:48	17.0	5.0	4.0	1.0	2551.8	3.5
8	10:48	10:59	11.0	5.0	4.0	1.0	2551.8	5.5
9	10:59	11:13	14.0	5.0	4.0	1.0	2551.8	4.3
10	11:13	11:35	22.0	5.0	4.0	1.0	2551.8	2.7
11	11:35	12:02	27.0	5.0	4.0	1.0	2551.8	2.2
12	12:02	12:32	30.0	5.0	4.0	1.0	2551.8	2.0
13	12:32	13:02	30.0	5.0	4.0	1.0	2551.8	2.0
14	13:02	13:32	30.0	5.0	4.0	1.0	2551.8	2.0
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 2.0 cm/hr

Infiltration Rate (account for lateral divergence): 1.45 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 2.84E-04 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Embankment Till
Date: 10-Sep-03
Test Pit No.: VA-ET-TP01
Ring No.: SR-02
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 20 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:25	10:23	58.0	5.0	4.0	1.0	2551.8	1.0
2	10:23	11:35	72.0	5.0	4.2	0.8	2041.4	0.7
3	11:35	14:02	147.0	5.1	4.3	0.8	2041.4	0.3
4	14:02	15:20	78.0	5.5	4.5	1.0	2551.8	0.8
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
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22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.2 cm

Average Infiltration Rate: 0.6 cm/hr

Infiltration Rate (account for lateral divergence): 0.43 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 4.80E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Embankment Till
Date: 10-Sep-03
Test Pit No.: VA-ET-TP01
Ring No.: SR-03
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 16 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	13:34	14:28	54.0	5.0	4.0	1.0	2551.8	1.1
2	14:28	17:16	168.0	5.0	4.2	0.8	2041.4	0.3
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.7 cm/hr

Infiltration Rate (account for lateral divergence): 0.51 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 4.99E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Embankment Till
Date: 10-Sep-03
Test Pit No.: VA-ET-TP01
Ring No.: SR-04
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 30 cm
Water Entry Value: -24 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	12:55	13:28	33.0	5.0	4.0	1.0	2551.8	1.8
2	13:28	14:18	50.0	5.0	4.0	1.0	2551.8	1.2
3	14:18	16:00	102.0	5.0	4.0	1.0	2551.8	0.6
4	16:00	17:01	61.0	5.0	4.4	0.6	1531.1	0.6
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.8 cm/hr

Infiltration Rate (account for lateral divergence): 0.57 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 8.10E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Slime Tailings
Date: 14-Sep-03
Test Pit No.: FA-TS-TP01
Ring No.: SR-01
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 3 cm
Depth of Wetting Front: 1.5 cm
Water Entry Value: -60 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	10:54	17:06	372.0	5.0	4.9	0.1	255.2	0.02
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.02 cm/hr

Infiltration Rate (account for lateral divergence): 0.01 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 8.27E-08 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Slime Tailings
Date: 14-Sep-03
Test Pit No.: FA-TS-TP01
Ring No.: SR-02
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 3 cm
Depth of Wetting Front: 5 cm
Water Entry Value: -60 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	11:09	14:14	185.0	5.0	4.0	1.0	2551.8	0.3
2	14:14	17:18	184.0	5.0	4.5	0.5	1275.9	0.2
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.2 cm/hr

Infiltration Rate (account for lateral divergence): 0.20 cm/hr

Effective Saturated Hydraulic Conductivity K_{fs} : 3.96E-06 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Slime Tailings
Date: 14-Sep-03
Test Pit No.: FA-TS-TP01
Ring No.: SR-03
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 3 cm
Depth of Wetting Front: 16 cm
Water Entry Value: -60 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	11:24	11:43	19.0	5.0	4.0	1.0	2551.8	3.2
2	11:43	12:35	52.0	5.0	4.0	1.0	2551.8	1.2
3	12:35	13:44	69.0	5.0	4.0	1.0	2551.8	0.9
4	13:44	15:23	99.0	5.0	4.0	1.0	2551.8	0.6
5	15:23	17:19	116.0	5.0	4.0	1.0	2551.8	0.5
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.7 cm/hr

Infiltration Rate (account for lateral divergence): 0.54 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 2.98E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Slime Tailings
Date: 14-Sep-03
Test Pit No.: FA-TS-TP01
Ring No.: SR-04
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 3 cm
Depth of Wetting Front: 1.5 cm
Water Entry Value: -60 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	11:49	17:39	350.0	5.0	4.9	0.1	255.2	0.02
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 0.02 cm/hr

Infiltration Rate (account for lateral divergence): 0.01 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 8.79E-08 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Slime Tailings
Date: 14-Sep-03
Test Pit No.: FA-TS-TP01
Ring No.: SR-05
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 3 cm
Depth of Wetting Front: 4.5 cm
Water Entry Value: -60 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	12:09	17:42	333.0	5.0	4.3	0.7	1786.2	0.13
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0
 cm

Average Infiltration Rate: 0.13
 cm/hr

Infiltration Rate (account for lateral divergence): 0.10 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.86E-06 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Beach Tailings
Date: 17-Sep-03
Test Pit No.: FA-TB-TP01
Ring No.: SR-01
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 70 cm
Water Entry Value: -42 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:36	9:40	4.0	5.0	4.0	1.0	2551.8	15.0
2	9:40	9:45	5.0	5.0	4.0	1.0	2551.8	12.0
3	9:45	9:50	5.0	5.0	4.0	1.0	2551.8	12.0
4	9:50	9:55	5.0	5.0	4.0	1.0	2551.8	12.0
5	9:55	10:00	5.0	5.0	4.0	1.0	2551.8	12.0
6	10:00	10:05	5.0	5.0	4.0	1.0	2551.8	12.0
7	10:05	10:10	5.0	5.0	4.0	1.0	2551.8	12.0
8	10:10	10:15	5.0	5.0	4.0	1.0	2551.8	12.0
9	10:15	10:20	5.0	5.0	4.0	1.0	2551.8	12.0
10	10:20	10:25	5.0	5.0	4.0	1.0	2551.8	12.0
11	10:25	10:30	5.0	5.0	4.0	1.0	2551.8	12.0
12	10:30	10:35	5.0	5.0	4.0	1.0	2551.8	12.0
13	10:35	10:40	5.0	5.0	4.0	1.0	2551.8	12.0
14	10:40	10:45	5.0	5.0	4.0	1.0	2551.8	12.0
15	10:45	10:50	5.0	5.0	4.0	1.0	2551.8	12.0
16	10:50	10:55	5.0	5.0	4.0	1.0	2551.8	12.0
17	10:55	11:00	5.0	5.0	4.0	1.0	2551.8	12.0
18	11:00	11:04	4.0	5.0	4.0	1.0	2551.8	15.0
19	11:04	11:09	5.0	5.0	4.0	1.0	2551.8	12.0
20	11:09	11:13	4.0	5.0	4.0	1.0	2551.8	15.0
21	11:13	11:19	6.0	5.0	3.5	1.5	3827.6	15.0
22	11:19	11:24	5.0	5.0	4.0	1.0	2551.8	12.0
23	11:24	11:28	4.0	5.0	4.0	1.0	2551.8	15.0
24	11:28	11:33	5.0	5.0	4.0	1.0	2551.8	12.0
25	11:33	11:37	4.0	5.0	4.0	1.0	2551.8	15.0
26	11:37	11:41	4.0	5.0	4.0	1.0	2551.8	15.0
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 14.0 cm/hr

Infiltration Rate (account for lateral divergence): 10.13 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.68E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Beach Tailings
Date: 17-Sep-03
Test Pit No.: FA-TB-TP01
Ring No.: SR-02
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 55 cm
Water Entry Value: -42 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	10:17	10:21	4.0	5.0	4.0	1.0	2551.8	15.0
2	10:21	10:28	7.0	5.0	4.0	1.0	2551.8	8.6
3	10:28	10:34	6.0	5.0	4.0	1.0	2551.8	10.0
4	10:34	10:40	6.0	5.0	4.0	1.0	2551.8	10.0
5	10:40	10:47	7.0	5.0	4.0	1.0	2551.8	8.6
6	10:47	10:54	7.0	5.0	4.0	1.0	2551.8	8.6
7	10:54	11:00	6.0	5.0	4.0	1.0	2551.8	10.0
8	11:00	11:05	5.0	5.0	4.0	1.0	2551.8	12.0
9	11:05	11:10	5.0	5.0	4.0	1.0	2551.8	12.0
10	11:10	11:14	4.0	5.0	4.0	1.0	2551.8	15.0
11	11:14	11:19	5.0	5.0	4.0	1.0	2551.8	12.0
12	11:19	11:23	4.0	5.0	4.0	1.0	2551.8	15.0
13	11:23	11:27	4.0	5.0	4.0	1.0	2551.8	15.0
14	11:27	11:32	5.0	5.0	4.0	1.0	2551.8	12.0
15	11:32	11:36	4.0	5.0	4.0	1.0	2551.8	15.0
16	11:36	11:40	4.0	5.0	4.0	1.0	2551.8	15.0
17	11:40	11:44	4.0	5.0	4.0	1.0	2551.8	15.0
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0
 cm

Average Infiltration Rate: 15.0
 cm/hr

Infiltration Rate (account for lateral divergence): 10.86 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.63E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Beach Tailings
Date: 17-Sep-03
Test Pit No.: FA-TB-TP01
Ring No.: SR-03
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 70 cm
Water Entry Value: -42 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	14:05	14:07	2.0	5.0	4.0	1.0	2551.8	30.0
2	14:07	14:10	3.0	5.0	4.0	1.0	2551.8	20.0
3	14:10	14:14	4.0	5.0	4.0	1.0	2551.8	15.0
4	14:14	14:18	4.0	5.0	4.0	1.0	2551.8	15.0
5	14:18	14:22	4.0	5.0	4.0	1.0	2551.8	15.0
6	14:22	14:27	5.0	5.0	4.0	1.0	2551.8	12.0
7	14:27	14:31	4.0	5.0	4.0	1.0	2551.8	15.0
8	14:31	14:35	4.0	5.0	4.0	1.0	2551.8	15.0
9	14:35	14:40	5.0	5.0	4.0	1.0	2551.8	12.0
10	14:40	14:44	4.0	5.0	4.0	1.0	2551.8	15.0
11	14:44	14:48	4.0	5.0	4.0	1.0	2551.8	15.0
12	14:48	14:52	4.0	5.0	4.0	1.0	2551.8	15.0
13	14:52	14:57	5.0	5.0	4.0	1.0	2551.8	12.0
14	14:57	15:01	4.0	5.0	4.0	1.0	2551.8	15.0
15	15:01	15:05	4.0	5.0	4.0	1.0	2551.8	15.0
16	15:05	15:09	4.0	5.0	4.0	1.0	2551.8	15.0
17	15:09	15:13	4.0	5.0	4.0	1.0	2551.8	15.0
18	15:13	15:17	4.0	5.0	4.0	1.0	2551.8	15.0
19	15:17	15:22	5.0	5.0	4.0	1.0	2551.8	12.0
20	15:22	15:26	4.0	5.0	4.0	1.0	2551.8	15.0
21	15:26	15:31	5.0	5.0	4.0	1.0	2551.8	12.0
22	15:31	15:35	4.0	5.0	4.0	1.0	2551.8	15.0
23	15:35	15:39	4.0	5.0	4.0	1.0	2551.8	15.0
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 14.0 cm/hr

Infiltration Rate (account for lateral divergence): 10.13 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.68E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Faro Beach Tailings
Date: 17-Sep-03
Test Pit No.: FA-TB-TP01
Ring No.: SR-04
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 70 cm
Water Entry Value: -42 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	14:32	14:35	3.0	5.0	4.0	1.0	2551.8	20.0
2	14:35	14:38	3.0	5.0	4.0	1.0	2551.8	20.0
3	14:38	14:41	3.0	5.0	4.0	1.0	2551.8	20.0
4	14:41	14:44	3.0	5.0	4.0	1.0	2551.8	20.0
5	14:44	14:48	4.0	5.0	4.0	1.0	2551.8	15.0
6	14:48	14:51	3.0	5.0	4.0	1.0	2551.8	20.0
7	14:51	14:54	3.0	5.0	4.0	1.0	2551.8	20.0
8	14:54	14:57	3.0	5.0	4.0	1.0	2551.8	20.0
9	14:57	15:01	4.0	5.0	4.0	1.0	2551.8	15.0
10	15:01	15:04	3.0	5.0	4.0	1.0	2551.8	20.0
11	15:04	15:08	4.0	5.0	4.0	1.0	2551.8	15.0
12	15:08	15:11	3.0	5.0	4.0	1.0	2551.8	20.0
13	15:11	15:14	3.0	5.0	4.0	1.0	2551.8	20.0
14	15:14	15:17	3.0	5.0	4.0	1.0	2551.8	20.0
15	15:17	15:21	4.0	5.0	4.0	1.0	2551.8	15.0
16	15:21	15:24	3.0	5.0	4.0	1.0	2551.8	20.0
17	15:24	15:27	3.0	5.0	4.0	1.0	2551.8	20.0
18	15:27	15:30	3.0	5.0	4.0	1.0	2551.8	20.0
19	15:30	15:33	3.0	5.0	4.0	1.0	2551.8	20.0
20	15:33	15:36	3.0	5.0	4.0	1.0	2551.8	20.0
21	15:36	15:39	3.0	5.0	4.0	1.0	2551.8	20.0
22	15:39	15:43	4.0	5.0	4.0	1.0	2551.8	15.0
23	15:43	15:47	4.0	5.0	4.0	1.0	2551.8	15.0
24	15:47	15:52	5.0	5.0	4.0	1.0	2551.8	12.0
25	15:52	15:55	3.0	5.0	4.0	1.0	2551.8	20.0
26	15:55	15:59	4.0	5.0	4.0	1.0	2551.8	15.0
27	15:59	16:02	3.0	5.0	4.0	1.0	2551.8	20.0
28	16:02	16:06	4.0	5.0	4.0	1.0	2551.8	15.0
29	16:06	16:10	4.0	5.0	4.0	1.0	2551.8	15.0
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 16.7 cm/hr

Infiltration Rate (account for lateral divergence): 12.06 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 2.00E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Wasterock Dump
Date: 12-Sep-03
Test Pit No.: VA-WR-TP01
Ring No.: SR-01
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 55 cm
Water Entry Value: -1.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:18	9:19	1.0	5.0	4.0	1.0	2551.8	60.0
2	9:19	9:20	1.0	5.0	4.0	1.0	2551.8	60.0
3	9:20	9:22	2.0	5.0	4.0	1.0	2551.8	30.0
4	9:22	9:24	2.0	5.0	4.0	1.0	2551.8	30.0
5	9:24	9:27	3.0	5.0	4.0	1.0	2551.8	20.0
6	9:27	9:30	3.0	5.0	4.0	1.0	2551.8	20.0
7	9:30	9:33	3.0	5.0	4.0	1.0	2551.8	20.0
8	9:33	9:36	3.0	5.0	4.0	1.0	2551.8	20.0
9	9:36	9:39	3.0	5.0	4.0	1.0	2551.8	20.0
10	9:39	9:42	3.0	5.0	4.0	1.0	2551.8	20.0
11	9:42	9:45	3.0	5.0	4.0	1.0	2551.8	20.0
12	9:45	9:50	5.0	5.0	4.0	1.0	2551.8	12.0
13	9:50	9:54	4.0	5.0	4.0	1.0	2551.8	15.0
14	9:54	9:57	3.0	5.0	4.0	1.0	2551.8	20.0
15	9:57	10:01	4.0	5.0	4.0	1.0	2551.8	15.0
16	10:01	10:05	4.0	5.0	4.0	1.0	2551.8	15.0
17	10:05	10:09	4.0	5.0	4.0	1.0	2551.8	15.0
18	10:09	10:13	4.0	5.0	4.0	1.0	2551.8	15.0
19	10:13	10:16	3.0	5.0	4.0	1.0	2551.8	20.0
20	10:16	10:20	4.0	5.0	4.0	1.0	2551.8	15.0
21	10:20	10:24	4.0	5.0	4.0	1.0	2551.8	15.0
22	10:24	10:28	4.0	5.0	4.0	1.0	2551.8	15.0
23	10:28	10:32	4.0	5.0	4.0	1.0	2551.8	15.0
24	10:32	10:36	4.0	5.0	4.0	1.0	2551.8	15.0
25	10:36	10:40	4.0	5.0	4.0	1.0	2551.8	15.0
26	10:40	10:44	4.0	5.0	4.0	1.0	2551.8	15.0
27	10:44	10:48	4.0	5.0	4.0	1.0	2551.8	15.0
28	10:48	10:51	3.0	5.0	4.0	1.0	2551.8	20.0
29								
30								

Average Depth of Water in the Ring: 5.0
 cm

Average Infiltration Rate: 16.7
 cm/hr

Infiltration Rate (account for lateral divergence): 12.06 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 3.00E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Wasterock Dump
Date: 12-Sep-03
Test Pit No.: VA-WR-TP01
Ring No.: SR-02
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 8 cm
Water Entry Value: -1.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:09	10:30	81.0	5.0	4.0	1.0	2551.8	0.7
2	10:30	12:20	110.0	5.0	4.0	1.0	2551.8	0.5
3	12:20	14:18	118.0	5.0	4.0	1.0	2551.8	0.5
4	14:18	17:05	167.0	5.2	4.1	1.1	2806.9	0.4
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
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30								

Average Depth of Water in the Ring: 5.1 cm

Average Infiltration Rate: 0.5 cm/hr

Infiltration Rate (account for lateral divergence): 0.35 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 5.33E-05 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Wasterock Dump
Date: 12-Sep-03
Test Pit No.: VA-WR-TP01
Ring No.: SR-03
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 13 cm
Water Entry Value: -1.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	9:57	10:07	10.0	5.0	4.0	1.0	2551.8	6.0
2	10:07	10:29	22.0	5.0	3.7	1.3	3317.3	3.5
3	10:29	10:52	23.0	5.0	4.0	1.0	2551.8	2.6
4	10:52	11:13	21.0	5.0	4.0	1.0	2551.8	2.9
5	11:13	11:41	28.0	5.0	4.0	1.0	2551.8	2.1
6	11:41	12:05	24.0	5.0	4.0	1.0	2551.8	2.5
7	12:05	12:27	22.0	5.0	4.0	1.0	2551.8	2.7
8	12:27	12:51	24.0	5.0	4.0	1.0	2551.8	2.5
9	12:51	13:17	26.0	5.0	4.0	1.0	2551.8	2.3
10	13:17	13:42	25.0	5.0	4.0	1.0	2551.8	2.4
11	13:42	14:09	27.0	5.0	4.8	0.2	510.4	0.4
12								
13								
14								
15								
16								
17								
18								
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30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 2.4 cm/hr

Infiltration Rate (account for lateral divergence): 1.74 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 3.22E-04 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Wasterock Dump
Date: 12-Sep-03
Test Pit No.: VA-WR-TP01
Ring No.: SR-04
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 20 cm
Water Entry Value: -1.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	10:02	10:04	2.0	5.0	4.0	1.0	2551.8	30.0
2				Paused (drained out)				
3				Continued				
4	11:33	11:40	7.0	5.0	4.0	1.0	2551.8	8.6
5	11:40	11:49	9.0	5.0	4.0	1.0	2551.8	6.7
6	11:49	11:58	9.0	5.0	3.7	1.3	3317.3	8.7
7	11:58	12:08	10.0	5.2	4.0	1.2	3062.1	7.2
8	12:08	12:16	8.0	5.0	4.0	1.0	2551.8	7.5
9	12:16	12:22	6.0	5.0	4.0	1.0	2551.8	10.0
10	12:22	12:28	6.0	5.0	4.0	1.0	2551.8	10.0
11	12:28	12:35	7.0	5.0	4.0	1.0	2551.8	8.6
12	12:35	12:42	7.0	5.0	4.0	1.0	2551.8	8.6
13	12:42	12:49	7.0	5.0	4.0	1.0	2551.8	8.6
14	12:49	12:56	7.0	5.0	4.0	1.0	2551.8	8.6
15	12:56	13:03	7.0	5.0	4.0	1.0	2551.8	8.6
16	13:03	13:10	7.0	5.0	4.0	1.0	2551.8	8.6
17	13:10	13:16	6.0	5.0	4.0	1.0	2551.8	10.0
18	13:16	13:24	8.0	5.0	4.0	1.0	2551.8	7.5
19	13:24	13:31	7.0	5.0	4.0	1.0	2551.8	8.6
20	13:31	13:38	7.0	5.0	4.0	1.0	2551.8	8.6
21	13:38	13:44	6.0	5.0	4.0	1.0	2551.8	10.0
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0
 cm

Average Infiltration Rate: 9.0
 cm/hr

Infiltration Rate (account for lateral divergence): 6.55 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 1.37E-03 cm/sec

Single Ring Infiltrometer Calculation Sheet

Location: Vangorda Wasterock Dump
Date: 12-Sep-03
Test Pit No.: VA-WR-TP05
Ring No.: SR-03
Tested By: Joe Pun

Inner Diameter of Ring: 57.0 cm
Inner Area of Ring: 2551.8 cm²
Lateral Divergence: 5 cm
Depth of Wetting Front: 40 cm
Water Entry Value: -1.5 cm

No.	Start Time (hh:mm)	End Time (hh:mm)	Time Elapsed (min)	Initial Water Level (cm)	Ending Water Level (cm)	Change in Water Level (cm)	Incremental Ring Volume (cm ³)	Infiltration Rate (cm/hr)
1	14:51	14:57	6.0	5.0	4.0	1.0	2551.8	10.0
2	14:57	15:05	8.0	5.0	4.0	1.0	2551.8	7.5
3	15:05	15:14	9.0	5.0	4.0	1.0	2551.8	6.7
4	15:14	15:24	10.0	5.0	4.0	1.0	2551.8	6.0
5	15:24	15:35	11.0	5.0	4.0	1.0	2551.8	5.5
6	15:35	15:46	11.0	5.0	4.0	1.0	2551.8	5.5
7	15:46	15:57	11.0	5.0	4.0	1.0	2551.8	5.5
8	15:57	16:09	12.0	5.0	4.0	1.0	2551.8	5.0
9	16:09	16:22	13.0	5.0	4.0	1.0	2551.8	4.6
10	16:22	16:33	11.0	5.0	4.0	1.0	2551.8	5.5
11	16:33	16:44	11.0	5.0	4.0	1.0	2551.8	5.5
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

Average Depth of Water in the Ring: 5.0 cm

Average Infiltration Rate: 5.2 cm/hr

Infiltration Rate (account for lateral divergence): 3.75 cm/hr
Effective Saturated Hydraulic Conductivity K_{fs} : 8.95E-04 cm/sec

GUELPH INFILTRMETER CALCULATION SHEET

Date: September 9, 2003
 Investigator: Maritz Rykaart
 Location: Vangorda Overburden Dump
 Site: VA-OD-TP01-GP01
 Dominant Soil Type: Clay/Gravel & Boulders
 Depth of Well Hole: 20 cm

Volumetric Moisture Content
 Initial Moisture Content, θ_i : 0.110
 Final Moisture Content, θ_{fs} : 0.139
Moisture Content Difference, $\Delta\theta$: 0.029

Reservoir X Constant: 35.22 cm²
 Reservoir Y Constant: 2.15 cm²

Both Reservoirs Used: Yes
 Only Inner Reservoir Used:

Reading Set #1 - H1 = 5 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	15:53	0.00	0.0	0.0	0.000
2	15:53:30	0.50	1.6	1.6	0.053
3	15:55	1.50	2.0	0.4	0.004
4	16:02	7.00	3.2	1.2	0.003
5	16:05	3.00	3.9	0.7	0.004
6	16:10	5.00	4.8	0.9	0.003
7	16:15	5.00	6.5	1.7	0.006
8	16:20	5.00	8.1	1.6	0.005
9	16:25	5.00	10.0	1.9	0.006
10	16:30	5.00	11.4	1.4	0.005
11	16:35	5.00	12.8	1.4	0.005
12	16:40	5.00	14.2	1.4	0.005
13					
14					
15					
16					
17					
18					
19					
20					

Reading Set #1 - H1 = 10 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	16:41	0.00	14.5	0.0	0.000
2	16:42	1.00	14.7	0.2	0.003
3	16:45	3.00	15.7	1.0	0.006
4	16:50	5.00	17.1	1.4	0.005
5	16:55	5.00	18.5	1.4	0.005
6	17:00	5.00	19.8	1.3	0.004
7	17:05	5.00	21.1	1.3	0.004
8	17:10	5.00	22.4	1.3	0.004
9	17:15	5.00	23.7	1.3	0.004
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

R1_{avg}: 0.005 cm/sec

R2_{avg}: 0.004 cm/sec

When Using Both Reservoirs

Field Saturated Hyd. Cond., K_{fs} : -2.62E-04 cm/sec
 Matric Flux Potential, ϕ_m : 5.78E-03 cm²/sec
 Sorptivity, S : 0.0183 cm/sec^{-1/2}
 Alpha Parameter, α : -0.0453 1/cm

When Using Only Inner Reservoir

Field Saturated Hyd. Cond., K_{fs} : -1.60E-05 cm/sec
 Matric Flux Potential, ϕ_m : 3.53E-04 cm²/sec
 Sorptivity, S : 0.0045 cm/sec^{-1/2}
 Alpha Parameter, α : -0.0453 1/cm

Field Measured Moisture Contents

	Before	After
Tare (g)		
Tare + Wet Sample (g)		
Tare + Dry Sample (g)		
Weight Water (g)	0	0
Weight Dry Sample (g)	0	0
Gravimetric Moisture Content	-	-
Water Density (g/cm ³)	1.000	
Tailings Dry Density (g/cm ³)	1.400	
Water Volume (cm ³)	0.00	0.00
Total Volume (cm ³)	0.00	0.00
Volumetric Moisture Content	11.0%	13.9%

Special Note: A negative result indicates soil heterogeneities - further testing required

GUELPH INFILTRMETER CALCULATION SHEET

Date: September 10, 2003
 Investigator: Maritz Rykaart/Joe Pun
 Location: Vangorda Embankment Till
 Site: VA-ET-TP01-GP01
 Dominant Soil Type: Sand/Silt
 Depth of Well Hole: 20 cm

Volumetric Moisture Content
 Initial Moisture Content, θ_i : 0.115
 Final Moisture Content, θ_{fs} : 0.185
Moisture Content Difference, $\Delta\theta$: 0.070

Reservoir X Constant: 35.22 cm²
 Reservoir Y Constant: 2.15 cm²

Both Reservoirs Used: Yes
 Only Inner Reservoir Used:

Reading Set #1 - H1 = 5 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	10:00	0.00	0.0	0.0	0.000
2	10:01	1.00	2.4	2.4	0.040
3	10:05	4.00	3.1	0.7	0.003
4	10:15	10.00	4.2	1.1	0.002
5	10:25	10.00	5.4	1.2	0.002
6	10:35	10.00	6.3	0.9	0.001
7	10:45	10.00	7.2	0.9	0.002
8	10:55	10.00	8.1	0.9	0.002
9	11:05	10.00	9.0	0.9	0.001
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Reading Set #1 - H1 = 10 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	11:17	0.00	13.5	0.0	0.000
2	11:18	1.00	13.7	0.2	0.003
3	11:20	2.00	14.0	0.3	0.003
4	11:25	5.00	15.0	1.0	0.003
5	11:30	5.00	15.8	0.8	0.003
6	11:40	10.00	17.5	1.7	0.003
7	11:50	10.00	19.1	1.6	0.003
8	12:00	10.00	21.0	1.9	0.003
9	12:10	10.00	23.0	2.0	0.003
10	12:20	10.00	24.6	1.6	0.003
11	12:30	10.00	26.8	2.2	0.004
12	12:40	10.00	28.0	1.2	0.002
13	12:50	10.00	31.4	3.4	0.006
14	13:00	10.00	35.7	4.3	0.007
15	13:10	10.00	36.2	0.5	0.001
16	13:20	10.00	39.2	3.0	0.005
17	13:30	10.00	42.2	3.0	0.005
18	13:40	10.00	45.5	3.3	0.006
19	13:50	10.00	48.8	3.3	0.005
20					

R1_{avg}: 0.002 cm/sec

R2_{avg}: 0.005 cm/sec

When Using Both Reservoirs

Field Saturated Hyd. Cond., K_{fs} : 4.85E-04 cm/sec
 Matric Flux Potential, ϕ_m : -1.43E-03 cm²/sec
 Sorptivity, S : #NUM! cm/sec^{-1/2}
 Alpha Parameter, α : -0.3391 1/cm

When Using Only Inner Reservoir

Field Saturated Hyd. Cond., K_{fs} : 2.96E-05 cm/sec
 Matric Flux Potential, ϕ_m : -8.73E-05 cm²/sec
 Sorptivity, S : #NUM! cm/sec^{-1/2}
 Alpha Parameter, α : -0.3391 1/cm

Field Measured Moisture Contents

	Before	After
Tare (g)		
Tare + Wet Sample (g)		
Tare + Dry Sample (g)		
Weight Water (g)	0	0
Weight Dry Sample (g)	0	0
Gravimetric Moisture Content	-	-
Water Density (g/cm ³)	1.000	
Tailings Dry Density (g/cm ³)	1.400	
Water Volume (cm ³)	0.00	0.00
Total Volume (cm ³)	0.00	0.00
Volumetric Moisture Content	11.5%	18.5%

Special Note: A negative result indicates soil heterogeneities - further testing required

GUELPH INFILTRMETER CALCULATION SHEET

Date: September 10, 2003
 Investigator: Joe Pun
 Location: Vangorda Embankment Till
 Site: VA-ET-TP01-GP02
 Dominant Soil Type: Sand/Silt
 Depth of Well Hole: 20 cm

Volumetric Moisture Content
 Initial Moisture Content, θ_i : 0.114
 Final Moisture Content, θ_{fs} : 0.185
Moisture Content Difference, $\Delta\theta$: 0.071

Reservoir X Constant: 35.22 cm²
 Reservoir Y Constant: 2.15 cm²

Both Reservoirs Used: Yes
 Only Inner Reservoir Used:

Reading Set #1 - H1 = 5 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	14:43	0.00	0.0	0.0	0.000
2	14:44	1.00	1.8	1.8	0.030
3	14:45	1.00	4.0	2.2	0.037
4	14:46	1.00	6.3	2.3	0.038
5	14:47	1.00	8.4	2.1	0.035
6	14:48	1.00	10.4	2.0	0.033
7	14:49	1.00	12.4	2.0	0.033
8	14:50	1.00	14.0	1.6	0.027
9	14:51	1.00	16.1	2.1	0.035
10	14:52	1.00	18.0	1.9	0.032
11	14:53	1.00	19.8	1.8	0.030
12	14:54	1.00	21.8	2.0	0.033
13	14:55	1.00	23.6	1.8	0.030
14	14:56	1.00	25.5	1.9	0.032
15	14:57	1.00	27.3	1.8	0.030
16	14:58	1.00	29.1	1.8	0.030
17	14:59	1.00	30.8	1.7	0.028
18	15:00	1.00	32.4	1.6	0.027
19	15:01	1.00	34.0	1.6	0.027
20	15:02	1.00	35.6	1.6	0.027

Reading Set #1 - H1 = 10 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	15:13	0.00	0.0	0.0	0.000
2	15:41	28.00	2.4	2.4	0.001
3	15:51	10.00	4.4	2.0	0.003
4	15:56	5.00	5.9	1.5	0.005
5	16:02	6.00	7.2	1.3	0.004
6	16:07	5.00	9.4	2.2	0.007
7	16:12	5.00	11.6	2.2	0.007
8	16:17	5.00	13.9	2.3	0.008
9	16:22	5.00	15.7	1.8	0.006
10	16:29	7.00	18.1	2.4	0.006
11	16:34	5.00	20.3	2.2	0.007
12	16:39	5.00	22.5	2.2	0.007
13	16:44	5.00	24.0	1.5	0.005
14	16:49	5.00	25.6	1.6	0.005
15	16:54	5.00	27.2	1.6	0.005
16	16:59	5.00	28.7	1.5	0.005
17	17:04	5.00	30.2	1.5	0.005
18	17:09	5.00	31.7	1.5	0.005
19					
20					

R1_{avg}: 0.027 cm/sec

R2_{avg}: 0.005 cm/sec

When Using Both Reservoirs

Field Saturated Hyd. Cond., K_{fs} : -4.35E-03 cm/sec
 Matric Flux Potential, ϕ_m : 4.95E-02 cm²/sec
 Sorptivity, S : 0.0839 cm/sec^{-1/2}
 Alpha Pappmeter, a : -0.0878 1/cm

When Using Only Inner Reservoir

Field Saturated Hyd. Cond., K_{fs} : -2.66E-04 cm/sec
 Matric Flux Potential, ϕ_m : 3.02E-03 cm²/sec
 Sorptivity, S : 0.0207 cm/sec^{-1/2}
 Alpha Pappmeter, a : -0.0878 1/cm

Field Measured Moisture Contents

	Before	After
Tare (g)		
Tare + Wet Spmple (g)		
Tare + Dry Spmple (g)		
Weight Water (g)	0	0
Weight Dry Spmple (g)	0	0
Gravimetric Moisture Content	-	-
Water Density (g/cm ³)	1.000	
Tailings Dry Density (g/cm ³)	1.400	
Water Volume (cm ³)	0.00	0.00
Total Volume (cm ³)	0.00	0.00
Volumetric Moisture Content	11.4%	18.5%

Special Note: A negative result indicates soil heterogeneities - further testing required

GUELPH INFILTRMETER CALCULATION SHEET

Date: September 18, 2003
 Investigator: Joe Pun
 Location: Faro Beach Tailings
 Site: FA-TB-TP01-GP01
 Dominant Soil Type: Beach Tailings
 Depth of Well Hole: 20 cm

Volumetric Moisture Content
 Initial Moisture Content, θ_i : 0.067
 Final Moisture Content, θ_{fs} : 0.235
Moisture Content Difference, $\Delta\theta$: 0.168

Reservoir X Constant: 35.22 cm²
 Reservoir Y Constant: 2.15 cm²

Both Reservoirs Used: Yes
 Only Inner Reservoir Used:

Reading Set #1 - H1 = 5 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	16:11	0.00	0.0	0.0	0.000
2	16:12	1.00	4.7	4.7	0.078
3	16:13	1.00	6.5	1.8	0.030
4	16:14	1.00	8.9	2.4	0.040
5	16:15	1.00	10.0	1.1	0.018
6	16:16	1.00	11.6	1.6	0.027
7	16:17	1.00	13.4	1.8	0.030
8	16:18	1.00	15.1	1.7	0.028
9	16:19	1.00	16.8	1.7	0.028
10	16:20	1.00	18.4	1.6	0.027
11	16:21	1.00	20.1	1.7	0.028
12					
13					
14					
15					
16					
17					
18					
19					
20					

Reading Set #1 - H1 = 10 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	16:22	0.00	26.9	0.0	0.000
2	16:23	1.00	31.1	4.2	0.070
3	16:24	1.00	35.0	3.9	0.065
4	16:25	1.00	38.7	3.7	0.062
5	16:26	1.00	42.4	3.7	0.062
6	16:27	1.00	46.2	3.8	0.063
7	16:28	1.00	49.7	3.5	0.058
8	16:29	1.00	53.3	3.6	0.060
9	16:30	1.00	57.2	3.9	0.065
10	16:31	1.00	61.5	4.3	0.072
11	16:32	1.00	65.3	3.8	0.063
12	16:33	1.00	69.1	3.8	0.063
13	16:34	1.00	72.9	3.8	0.063
14					
15					
16					
17					
18					
19					
20					

R1_{avg}: 0.028 cm/sec

R2_{avg}: 0.063 cm/sec

When Using Both Reservoirs

Field Saturated Hyd. Cond., K_{fs} : 3.86E-03 cm/sec
 Matric Flux Potential, ϕ_m : 3.10E-03 cm²/sec
 Sorptivity, S : 0.0323 cm/sec^{-1/2}
 Alpha Parpmer, a : 1.2478 1/cm

When Using Only Inner Reservoir

Field Saturated Hyd. Cond., K_{fs} : 2.36E-04 cm/sec
 Matric Flux Potential, ϕ_m : 1.89E-04 cm²/sec
 Sorptivity, S : 0.0080 cm/sec^{-1/2}
 Alpha Parpmer, a : 1.2478 1/cm

Field Measured Moisture Contents

	Before	After
Tare (g)		
Tare + Wet Spmple (g)		
Tare + Dry Spmple (g)		
Weight Water (g)	0	0
Weight Dry Spmple (g)	0	0
Gravimetric Moisture Content	-	-
Water Density (g/cm ³)	1.000	
Tailings Dry Density (g/cm ³)	1.400	
Water Volume (cm ³)	0.00	0.00
Total Volume (cm ³)	0.00	0.00
Volumetric Moisture Content	6.7%	23.5%

Special Note: A negative result indicates soil heterogeneities - further testing required

GUELPH INFILTRMETER CALCULATION SHEET

Date: September 19, 2003
 Investigator: Joe Pun
 Location: Faro Beach Tailings
 Site: FA-TB-TP01-GP01
 Dominant Soil Type: Beach Tailings
 Depth of Well Hole: 50 cm

Volumetric Moisture Content
 Initial Moisture Content, θ_i : 0.067
 Final Moisture Content, θ_{fs} : 0.235
Moisture Content Difference, $\Delta\theta$: 0.168

Reservoir X Constant: 35.22 cm²
 Reservoir Y Constant: 2.15 cm²

Both Reservoirs Used: Yes
 Only Inner Reservoir Used:

Reading Set #1 - H1 = 5 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	10:39	0.00	0	0.0	0.000
2	10:40	1.00	4.9	4.9	0.082
3	10:41	1.00	8.2	3.3	0.055
4	10:42	1.00	11.2	3.0	0.050
5	10:43	1.00	14.0	2.8	0.047
6	10:44	1.00	16.9	2.9	0.048
7	10:45	1.00	19.6	2.7	0.045
8	10:46	1.00	22.2	2.6	0.043
9	10:47	1.00	25.0	2.8	0.047
10	10:48	1.00	27.8	2.8	0.047
11	10:49	1.00	30.6	2.8	0.047
12	10:50	1.00	33.5	2.9	0.048
13					
14					
15					
16					
17					
18					
19					
20					

Reading Set #1 - H1 = 10 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	10:51	0.00	36.2	0.0	0.000
2	10:52	1.00	45.1	8.9	0.148
3	10:53	1.00	50.0	4.9	0.082
4	10:54	1.00	54.5	4.5	0.075
5	10:55	1.00	59.3	4.8	0.080
6	10:56	1.00	63.7	4.4	0.073
7	10:57	1.00	68.2	4.5	0.075
8	10:58	1.00	72.7	4.5	0.075
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

R1_{avg}: 0.047
cm/sec

R2_{avg}: 0.074
cm/sec

When Using Both Reservoirs

Field Saturated Hyd. Cond., K_{fs} : 1.77E-03 cm/sec
 Matric Flux Potential, ϕ_m : 3.30E-02 cm²/sec
 Sorptivity, S : 0.1053 cm/sec^{-1/2}
 Alpha Parpmer, a : 0.0536 1/cm

When Using Only Inner Reservoir

Field Saturated Hyd. Cond., K_{fs} : 1.08E-04 cm/sec
 Matric Flux Potential, ϕ_m : 2.01E-03 cm²/sec
 Sorptivity, S : 0.0260 cm/sec^{-1/2}
 Alpha Parpmer, a : 0.0536 1/cm

Field Measured Moisture Contents

	Before	After
Tare (g)		
Tare + Wet Spmple (g)		
Tare + Dry Spmple (g)		
Weight Water (g)	0	0
Weight Dry Spmple (g)	0	0
Gravimetric Moisture Content	-	-
Water Density (g/cm ³)	1.000	
Tailings Dry Density (g/cm ³)	1.400	
Water Volume (cm ³)	0.00	0.00
Total Volume (cm ³)	0.00	0.00
Volumetric Moisture Content	6.7%	23.5%

Special Note: A negative result indicates soil heterogeneities - further testing required

GUELPH INFILTRMETER CALCULATION SHEET

Date: September 19, 2003
 Investigator: Joe Pun
 Location: Faro Beach Tailings
 Site: FA-TB-TP01-GP02
 Dominant Soil Type: Beach Tailings
 Depth of Well Hole: 20 cm

Volumetric Moisture Content
 Initial Moisture Content, θ_i : 0.067
 Final Moisture Content, θ_{fs} : 0.235
Moisture Content Difference, $\Delta\theta$: 0.168

Reservoir X Constant: 35.22 cm²
 Reservoir Y Constant: 2.15 cm²

Both Reservoirs Used: Yes
 Only Inner Reservoir Used:

Reading Set #1 - H1 = 5 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	11:44	0.00	0	0.0	0.000
2	11:45	1.00	4.4	4.4	0.073
3	11:46	1.00	6.5	2.1	0.035
4	11:47	1.00	8.3	1.8	0.030
5	11:48	1.00	10.2	1.9	0.032
6	11:49	1.00	12.0	1.8	0.030
7	11:50	1.00	13.7	1.7	0.028
8	11:51	1.00	15.5	1.8	0.030
9	11:52	1.00	17.3	1.8	0.030
10	11:53	1.00	19.1	1.8	0.030
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Reading Set #1 - H1 = 10 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	11:54	0.00	20.9	0.0	0.000
2	11:55	1.00	29.3	8.4	0.140
3	11:56	1.00	34.3	5.0	0.083
4	11:57	1.00	38.8	4.5	0.075
5	11:58	1.00	43.4	4.6	0.077
6	11:59	1.00	48.0	4.6	0.077
7	12:00	1.00	52.0	4.0	0.067
8	12:01	1.00	56.5	4.5	0.075
9	12:02	1.00	61.1	4.6	0.077
10	12:03	1.00	65.3	4.2	0.070
11	12:04	1.00	69.5	4.2	0.070
12	12:05	1.00	73.7	4.2	0.070
13					
14					
15					
16					
17					
18					
19					
20					

R1_{avg}: 0.030
cm/sec

R2_{avg}: 0.070
cm/sec

When Using Both Reservoirs

Field Saturated Hyd. Cond., K_{fs} : 4.40E-03 cm/sec
 Matric Flux Potential, ϕ_m : 2.01E-03 cm²/sec
 Sorptivity, S : 0.0260 cm/sec^{-1/2}
 Alpha Parpmer, a : 2.1930 1/cm

When Using Only Inner Reservoir

Field Saturated Hyd. Cond., K_{fs} : 2.69E-04 cm/sec
 Matric Flux Potential, ϕ_m : 1.23E-04 cm²/sec
 Sorptivity, S : 0.0064 cm/sec^{-1/2}
 Alpha Parpmer, a : 2.1930 1/cm

Field Measured Moisture Contents

	Before	After
Tare (g)		
Tare + Wet Spmple (g)		
Tare + Dry Spmple (g)		
Weight Water (g)	0	0
Weight Dry Spmple (g)	0	0
Gravimetric Moisture Content	-	-
Water Density (g/cm ³)	1.000	
Tailings Dry Density (g/cm ³)	1.400	
Water Volume (cm ³)	0.00	0.00
Total Volume (cm ³)	0.00	0.00
Volumetric Moisture Content	6.7%	23.5%

Special Note: A negative result indicates soil heterogeneities - further testing required

GUELPH INFILTRMETER CALCULATION SHEET

Date: September 19, 2003
 Investigator: Joe Pun
 Location: Faro Beach Tailings
 Site: FA-TB-TP01-GP02
 Dominant Soil Type: Beach Tailings
 Depth of Well Hole: 50 cm

Volumetric Moisture Content
 Initial Moisture Content, θ_i : 0.067
 Final Moisture Content, θ_{fs} : 0.235
Moisture Content Difference, $\Delta\theta$: 0.168

Reservoir X Constant: 35.22 cm²
 Reservoir Y Constant: 2.15 cm²

Both Reservoirs Used: Yes
 Only Inner Reservoir Used:

Reading Set #1 - H1 = 5 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	12:26	0.00	0	0.0	0.000
2	12:27	1.00	5.0	5.0	0.083
3	12:28	1.00	8.1	3.1	0.052
4	12:29	1.00	10.8	2.7	0.045
5	12:30	1.00	13.5	2.7	0.045
6	12:31	1.00	16.2	2.7	0.045
7	12:32	1.00	19.0	2.8	0.047
8	12:33	1.00	21.7	2.7	0.045
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Reading Set #1 - H1 = 10 cm:					
No.	Time	Time Int.	Water Level	Level Change	Rate of Change, R1
	[hh:mm]	[min]	[cm]	[cm]	[cm/sec]
1	12:37	0.00	0	0.0	0.000
2	12:38	1.00	7.0	7.0	0.117
3	12:39	1.00	12.8	5.8	0.097
4	12:40	1.00	15.7	2.9	0.048
5	12:41	1.00	20.0	4.3	0.072
6	12:42	1.00	24.2	4.2	0.070
7	12:43	1.00	28.2	4.0	0.067
8	12:44	1.00	32.7	4.5	0.075
9	12:45	1.00	36.8	4.1	0.068
10	12:46	1.00	41.2	4.4	0.073
11	12:47	1.00	45.6	4.4	0.073
12	12:48	1.00	50.0	4.4	0.073
13	12:49	1.00	54.4	4.4	0.073
14					
15					
16					
17					
18					
19					
20					

R1_{avg}: 0.046
cm/sec

R2_{avg}: 0.073
cm/sec

When Using Both Reservoirs

Field Saturated Hyd. Cond., K_{fs} : 1.93E-03 cm/sec
 Matric Flux Potential, ϕ_m : 3.06E-02 cm²/sec
 Sorptivity, S : 0.1013 cm/sec^{-1/2}
 Alpha Parpmer, a : 0.0630 1/cm

When Using Only Inner Reservoir

Field Saturated Hyd. Cond., K_{fs} : 1.18E-04 cm/sec
 Matric Flux Potential, ϕ_m : 1.87E-03 cm²/sec
 Sorptivity, S : 0.0250 cm/sec^{-1/2}
 Alpha Parpmer, a : 0.0630 1/cm

Field Measured Moisture Contents

	Before	After
Tare (g)		
Tare + Wet Spmple (g)		
Tare + Dry Spmple (g)		
Weight Water (g)	0	0
Weight Dry Spmple (g)	0	0
Gravimetric Moisture Content	-	-
Water Density (g/cm ³)	1.000	
Tailings Dry Density (g/cm ³)	1.400	
Water Volume (cm ³)	0.00	0.00
Total Volume (cm ³)	0.00	0.00
Volumetric Moisture Content	6.7%	23.5%

Special Note: A negative result indicates soil heterogeneities - further testing required

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Embankment Till	
Soil Description : Well-grained silt, clay	Test Pit # : VA-ET-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-01
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1650.1
Mass of Wet Sample Removed From Hole (g)	1609.7
Water Content (%)	10.6
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3261.4
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3134.4
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	905.0
Mass of Dry Soil Removed From Test Hole (g)	1455.4
In-Situ Wet Density (g/cm ³)	1.8
In-Situ Dry Density (g/cm ³)	1.6

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Embankment Till	
Soil Description : Well-grained silt, clay	Test Pit # : VA-ET-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-02
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1427.4
Mass of Wet Sample Removed From Hole (g)	1387.0
Water Content (%)	10.1
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3323.6
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3072.2
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	861.4
Mass of Dry Soil Removed From Test Hole (g)	1259.8
In-Situ Wet Density (g/cm ³)	1.6
In-Situ Dry Density (g/cm ³)	1.5

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Embankment Till	
Soil Description : Well-grained silt, clay	Test Pit # : VA-ET-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-03
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1981.6
Mass of Wet Sample Removed From Hole (g)	1941.2
Water Content (%)	10.5
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	2650.4
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3745.4
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	1333.9
Mass of Dry Soil Removed From Test Hole (g)	1756.7
In-Situ Wet Density (g/cm ³)	1.5
In-Situ Dry Density (g/cm ³)	1.3

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Till Cover	
Soil Description : Sand, silt, cobbles	Test Pit # : VA-CT-TP01
Sand Type: Ottawa Sand	Test Date: 11-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-01
Sand Bulk Density (g/cm ³): 1.42	Tested By: Maritz Rykaart

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	2149.2
Mass of Wet Sample Removed From Hole (g)	2108.8
Water Content (%)	7.9
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3089.2
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3306.6
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	1025.9
Mass of Dry Soil Removed From Test Hole (g)	1954.4
In-Situ Wet Density (g/cm ³)	2.1
In-Situ Dry Density (g/cm ³)	1.9

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Till Cover	
Soil Description : Sand, silt, cobbles	Test Pit # : VA-CT-TP01
Sand Type: Ottawa Sand	Test Date: 11-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-02
Sand Bulk Density (g/cm ³): 1.42	Tested By: Maritz Rykaart

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1841.5
Mass of Wet Sample Removed From Hole (g)	1801.1
Water Content (%)	8.0
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3390.5
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3005.3
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	814.4
Mass of Dry Soil Removed From Test Hole (g)	1667.7
In-Situ Wet Density (g/cm ³)	2.2
In-Situ Dry Density (g/cm ³)	2.0

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Till Cover	
Soil Description : Sand, silt, cobbles	Test Pit # : VA-CT-TP01
Sand Type: Ottawa Sand	Test Date: 15-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-03
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1743.9
Mass of Wet Sample Removed From Hole (g)	1703.5
Water Content (%)	11.3
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3307.2
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3088.6
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	872.9
Mass of Dry Soil Removed From Test Hole (g)	1530.5
In-Situ Wet Density (g/cm ³)	2.0
In-Situ Dry Density (g/cm ³)	1.8

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Till Cover	
Soil Description : Sand, silt, cobbles	Test Pit # : VA-CT-TP01
Sand Type: Ottawa Sand	Test Date: 15-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-04
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1540.1
Mass of Wet Sample Removed From Hole (g)	1499.7
Water Content (%)	10.1
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3358.9
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3036.9
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	836.6
Mass of Dry Soil Removed From Test Hole (g)	1362.1
In-Situ Wet Density (g/cm ³)	1.8
In-Situ Dry Density (g/cm ³)	1.6

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Overburden Dump	
Soil Description : Clay, sand, cobbles	Test Pit # : VA-OD-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-01
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1517.1
Mass of Wet Sample Removed From Hole (g)	1476.7
Water Content (%)	11.6
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3474.7
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	2921.1
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	755.3
Mass of Dry Soil Removed From Test Hole (g)	1323.2
In-Situ Wet Density (g/cm ³)	2.0
In-Situ Dry Density (g/cm ³)	1.8

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Overburden Dump	
Soil Description : Clay, sand, cobbles	Test Pit # : VA-OD-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-02
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1634.4
Mass of Wet Sample Removed From Hole (g)	1594.0
Water Content (%)	12.6
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3463.0
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	2932.8
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	763.5
Mass of Dry Soil Removed From Test Hole (g)	1415.6
In-Situ Wet Density (g/cm ³)	2.1
In-Situ Dry Density (g/cm ³)	1.9

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Overburden Dump	
Soil Description : Clay, sand, cobbles	Test Pit # : VA-OD-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-03
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1821.2
Mass of Wet Sample Removed From Hole (g)	1780.8
Water Content (%)	8.7
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3180.5
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3215.3
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	961.8
Mass of Dry Soil Removed From Test Hole (g)	1638.3
In-Situ Wet Density (g/cm ³)	1.9
In-Situ Dry Density (g/cm ³)	1.7

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Glaciofluvial Deposit	
Soil Description : Sand & Silt	Test Pit # : VA-GF-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-01
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1816.0
Mass of Wet Sample Removed From Hole (g)	1775.6
Water Content (%)	4.1
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3264.7
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3131.1
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	902.7
Mass of Dry Soil Removed From Test Hole (g)	1705.7
In-Situ Wet Density (g/cm ³)	2.0
In-Situ Dry Density (g/cm ³)	1.9

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Glaciofluvial Deposit	
Soil Description : Sand & Silt	Test Pit # : VA-GF-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-02
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	2071.4
Mass of Wet Sample Removed From Hole (g)	2031.0
Water Content (%)	4.2
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3203.2
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3192.6
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	945.9
Mass of Dry Soil Removed From Test Hole (g)	1949.1
In-Situ Wet Density (g/cm ³)	2.1
In-Situ Dry Density (g/cm ³)	2.1

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Vangorda Glaciofluvial Deposit	
Soil Description : Sand & Silt	Test Pit # : VA-GF-TP01
Sand Type: Ottawa Sand	Test Date: 16-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-03
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1925.5
Mass of Wet Sample Removed From Hole (g)	1885.1
Water Content (%)	4.6
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3319.7
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3076.1
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	864.1
Mass of Dry Soil Removed From Test Hole (g)	1802.2
In-Situ Wet Density (g/cm ³)	2.2
In-Situ Dry Density (g/cm ³)	2.1

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Faro Slime Tailings	
Soil Description : Slime Tailings	Test Pit # : FA-TS-TP01
Sand Type: Ottawa Sand	Test Date: 14-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-01
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	2428.0
Mass of Wet Sample Removed From Hole (g)	2387.6
Water Content (%)	20.6
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	2848.4
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3547.4
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	1194.9
Mass of Dry Soil Removed From Test Hole (g)	1979.8
In-Situ Wet Density (g/cm ³)	2.0
In-Situ Dry Density (g/cm ³)	1.7

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Faro Slime Tailings	
Soil Description : Slime Tailings	Test Pit # : FA-TS-TP01
Sand Type: Ottawa Sand	Test Date: 14-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-02
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	2364.1
Mass of Wet Sample Removed From Hole (g)	2323.7
Water Content (%)	22.6
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3034.8
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3361.0
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	1064.1
Mass of Dry Soil Removed From Test Hole (g)	1895.4
In-Situ Wet Density (g/cm ³)	2.2
In-Situ Dry Density (g/cm ³)	1.8

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Faro Slime Tailings	
Soil Description : Slime Tailings	Test Pit # : FA-TS-TP01
Sand Type: Ottawa Sand	Test Date: 14-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-03
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	2270.5
Mass of Wet Sample Removed From Hole (g)	2230.1
Water Content (%)	23.2
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	3202.7
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3193.1
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	946.2
Mass of Dry Soil Removed From Test Hole (g)	1810.1
In-Situ Wet Density (g/cm ³)	2.4
In-Situ Dry Density (g/cm ³)	1.9

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Faro Beach Tailings	
Soil Description : Beach Tailings	Test Pit # : FA-TB-TP01
Sand Type: Ottawa Sand	Test Date: 17-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-01
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	1983.9
Mass of Wet Sample Removed From Hole (g)	1943.5
Water Content (%)	11.0
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	2806.0
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3589.8
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	1224.7
Mass of Dry Soil Removed From Test Hole (g)	1750.9
In-Situ Wet Density (g/cm ³)	1.6
In-Situ Dry Density (g/cm ³)	1.4

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Faro Beach Tailings	
Soil Description : Beach Tailings	Test Pit # : FA-TB-TP01
Sand Type: Ottawa Sand	Test Date: 17-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-02
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	2087.9
Mass of Wet Sample Removed From Hole (g)	2047.5
Water Content (%)	11.7
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	2600.4
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	3795.4
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	1369.0
Mass of Dry Soil Removed From Test Hole (g)	1833.0
In-Situ Wet Density (g/cm ³)	1.5
In-Situ Dry Density (g/cm ³)	1.3

IN-SITU DENSITY (Sand-Cone Method)

Site Location: Faro Beach Tailings	
Soil Description : Beach Tailings	Test Pit # : FA-TB-TP01
Sand Type: Ottawa Sand	Test Date: 17-Sep-03
Specific Gravity of Sand: 2.65	Test No: SC-03
Sand Bulk Density (g/cm ³): 1.42	Tested By: Joe Pun

Maximum Particle Size	Minimum Test Hole Volume
1/2" (12.7 mm)	1415 cm ³ (0.05 ft ³)
1" (25.4 mm)	2125 cm ³ (0.075 ft ³)
1.5" (38 mm)	2830 cm ³ (0.1 ft ³)

Approximate Hole Size	6" Φ, 9cm depth
Mass of Empty Moisture Tight Container (g)	40.4
Mass of Moisture Tight Container with Wet Sample (g)	2895.5
Mass of Wet Sample Removed From Hole (g)	2855.1
Water Content (%)	6.6
Mass of Apparatus Filled With Sand Prior to Test (g)	6550.0
Mass of Empty Apparatus (g)	194.6
Mass of Remaining Sand in Sample Container (g)	1884.3
Mass of Sand Used to Fill Test Hole, Funnel & Base Plate (g)	4511.5
Mass of Sand Used to Fill Funnel & Base Plate (g)	1845.0
Calculated Volume of Test Hole (cm ³)	1871.6
Mass of Dry Soil Removed From Test Hole (g)	2678.3
In-Situ Wet Density (g/cm ³)	1.5
In-Situ Dry Density (g/cm ³)	1.4

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

October 14, 2003

SRK Consulting
Suite 800, 1066 West Hastings
Vancouver, B.C.
V6E 3X2

EBA File: 1200034.026

Attention: Mr. Joe Pun
Project Engineer

**Subject: Summary Letter – Moisture Content Testing
Faro, Yukon**

As requested, this letter summarizes the moisture content testing program completed on the samples which were collected by SRK forces in Faro, Yukon and delivered to EBA's Whitehorse laboratory for natural moisture content testing. Testing was completed on "whole samples" (delivered in bags and jars) in accordance to test method designation ASTM D2216. Results are presented below:

Test Pit Location	Sample No.	Moisture Content	Test Pit Location	Sample No.	Moisture Content	Test Pit Location	Sample No.	Moisture Content
VA-OD-TP1	SR01-B0	11.9	VA-ET-TP1	SR01-B0	11.4	VA-GF-TP1	SR01-B0	2.7
	SR01-B15	12.0		SR01-B15	11.2		SR01-B15	2.8
	SR01-B30	8.9		SR01-B30	12.9		SR01-B30	2.9
	SR01-B45	10.7		SR01-B45	11.9		SR01-B45	3.1
	SR01-B60	10.9		SR01-B60	12.3		SR01-B60	3.4
	SR01-Af0	16.6		SR01-Af0	18.5		SR01-Af0	11.6
	SR01-Af15	19.7		SR01-Af15	18.5		SC-01	4.1
	SR01-Af30	15.7		SR01-Af30	18.9		SC-02	4.2
	SR01-Af45	16.9		SR02-B0	11.5		SC-03	4.6
	SR01-Af60	12.9		SR02-B15	11.9	FA-TS-TP1	SR01-B0	24.2
	SR02-B0	11.0		SR02-B30	10.2		SR01-B15	32.4
	SR02-B15	12.5		SR02-B45	9.4		SR01-B30	29.7
	SR02-B30	12.8		SR02-B60	9.6		SR01-B45	25.3
	SR02-B45	13.6		SC-01	10.6		SR01-B60	22.9
	SR02-B60	12.0		SC-02	10.1		SR01-Af0	22.3
	SR02-Af0	13.9		SC-03	10.5		SC-01	20.6
	SR02-Af15	11.3	VA-CT-TP1	SR02-B0	5.4		SC-02	22.6
	SR02-Af30	12.8		SR02-B15	5.7		SC-03	23.2
	SR02-Af45	13.7		SR02-Af0	17.9	FA-TB-TP1	SR03-B0	6.7
	SR02-Af60	12.2		SC-01	7.9		SR03-B15	6.2
	SC-01	11.6		SC-02	8.0		SR03-B30	6.1
	SC-02	12.6		SC-03	11.3		SR03-B45	6.8
	SC-03	8.7		SC-04	10.1		SR03-B60	6.1
			VA-WR-TP1	SR03-B0	3.8		SR03-Af0	23.5
				SR03-B15	3.8		SC-01	11.0
				SR01-Af0	13.6		SC-02	11.7
				SR03-Af0	14.2		SC-03	6.6
				SR04-Af0	13.2			

We trust this summary meets your present requirements; however, if you have any questions or concerns please contact the undersigned.

Yours truly,
EBA Engineering Consultants Ltd.

A handwritten signature in black ink, appearing to read "M. Plaunt", with a stylized flourish at the end.

Myles C. Plaunt, C.E.T.
Senior Technologist
(Direct Line: (867) 668-2071, ext. 27)
(email: mplaunt@eba.ca)

Faro Field SampleS Log

Test Pit	Date Collected	Sample No.	Location		pH	Conductivity (Initial)	Corrections	Conductivity (Final)
		<i>L: left side of test pit R: right side of test pit</i>	Inclined Depth from Ground Surface (m)	Vertical Depth from Ground Surface (m)				
Vangorda Overburden Dump	9-Sep-03	L1-0	0	0.00	7.60	280 µS	-	280 µS
		L1-1	1	0.71	7.00	546 µS	-	546 µS
		L1-2	2	1.41	6.88	787 µS	-	787 µS
		L1-3	3	2.12	6.82	626 µS	-	626 µS
		R1-0	0	0.00	7.20	162.2 µS	-	162.2 µS
		R1-1	1	0.71	6.85	611 µS	-	611 µS
		R1-2	2	1.41	6.78	816 µS	-	816 µS
		R1-3	3	2.12	6.77	638 µS	-	638 µS
Vangorda Embankment Till	10-Sep-03	L1-0	0	0.00	6.98	1188 µS	-	1188 µS
		L1-1	1	0.71	6.90	976 µS	-	976 µS
		L1-2	2	1.41	5.79	1223 µS	-	1223 µS
		L1-3	3	2.12	5.76	1220 µS	-	1220 µS
		R1-0	0	0.00	5.75	1149 µS	-	1149 µS
		R1-1	1	0.71	5.71	947 µS	-	947 µS
		R1-2	2	1.41	5.71	1038 µS	-	1038 µS
		R1-3	3	2.12	5.62	1210 µS	-	1210 µS
Vangorda Till Cover	11-Sep-03	L1-0	0	0.00	7.67	636 µS	-	636 µS
		L1-1	1	0.71	7.64	456 µS	-	456 µS
		L1-2	2	1.41	7.46	803 µS	-	803 µS
		L1-3	3	2.12	7.44	298 µS	-	298 µS
		R1-0	0	0.00	7.56	560 µS	-	560 µS
		R1-1	1	0.71	7.58	381 µS	-	381 µS
		R1-2	2	1.41	7.74	447 µS	-	447 µS
		R1-3	3	2.12	7.52	742 µS	-	742 µS
Vangorda Waste Rock	12-Sep-03	L1-0	0	0.00	5.12	6.35 mS	-40 µS	6.31 mS
		L1-1	1	0.71	5.74	3.5 mS	-40 µS	3.46 mS
		L1-2	2	1.41	5.68	5.56 mS	-40 µS	5.52 mS
		L1-3	3	2.12	5.48	4.41 mS	-40 µS	4.37 mS
		R1-0	0	0.00	5.90	4.33 mS	-40 µS	4.29 mS
		R1-1	1	0.71	5.75	2.48 mS	-40 µS	2.44 mS
		R1-2	2	1.41	5.66	5.23 mS	-40 µS	5.19 mS
		R1-3	3	2.12	5.90	3.7 mS	-40 µS	3.66 mS

Appendix B-5

Test Pit	Date Collected	Sample No.	Location		pH	Conductivity (Initial)	Corrections	Conductivity (Final)
		<i>L: left side of test pit R: right side of test pit</i>	Inclined Depth from Ground Surface (m)	Vertical Depth from Ground Surface (m)				
Vangorda Glaciofluvial Deposits	13-Sep-03	Sample 1	N/A	N/A	7.32	50 µS	-	50 µS
		Sample 2	N/A	N/A	7.47	49 µS	-	49 µS
		Sample 3	N/A	N/A	7.63	64 µS	-	64 µS
		Sample 4	N/A	N/A	6.45	54 µS	-	54 µS
Faro Tailings	11-Sep-03	T1-0	N/A	0	2.06	8.65 mS	-27 µS	8.62 mS
		T1-50	N/A	50	2.28	7.99 mS	-27 µS	7.96 mS
		T1-100	N/A	100	2.26	10.41 mS	-27 µS	10.38 mS
		T1-150	N/A	150	2.82	7.21 mS	-27 µS	7.18 mS
		T1-200	N/A	200	4.41	3.13 mS	-27 µS	3.10 mS
		T1-250	N/A	250	5.05	4.9 mS	-27 µS	4.87 mS
		T1-300	N/A	300	4.20	8.27 mS	-27 µS	8.24 mS
		T1-350	N/A	350	4.69	19.75 mS	-27 µS	19.72 mS
		T1-400	N/A	400	4.48	9.39 mS	-27 µS	9.36 mS
		T1-450	N/A	450	4.09	4.59 mS	-27 µS	4.56 mS
		T1-500	N/A	500	4.26	5.99 mS	-27 µS	5.96 mS
		T2-0	N/A	0	1.65	15.57 mS	-22 µS	15.55 mS
		T2-50	N/A	50	2.26	11.55 mS	-22 µS	11.53 mS
		T2-100	N/A	100	3.81	6.9 mS	-22 µS	6.88 mS
		T2-150	N/A	150	4.31	10.35 mS	-22 µS	10.33 mS
		T2-200	N/A	200	4.16	6.24 mS	-22 µS	6.22 mS
		T2-250	N/A	250	4.14	10.32 mS	-22 µS	10.30 mS
		T2-300	N/A	300	4.48	19.18 mS	-22 µS	19.16 mS
		T2-350	N/A	350	3.24	14.04 mS	-22 µS	14.02 mS
		T2-400	N/A	400	3.36	14.11 mS	-22 µS	14.09 mS
		T3-0	N/A	0	1.87	8.67 mS	-34 µS	8.64 mS
		T3-50	N/A	50	2.46	34.1 mS	-34 µS	34.07 mS
		T3-100	N/A	100	2.93	5.09 mS	-34 µS	5.06 mS
		T3-150	N/A	150	4.25	2.99 mS	-34 µS	2.96 mS
		T3-200	N/A	200	3.97	7.78 mS	-34 µS	7.75 mS
		T3-250	N/A	250	3.77	5.48 mS	-34 µS	5.45 mS
		T3-300	N/A	300	4.07	10.37 mS	-34 µS	10.34 mS
		T3-350	N/A	350	4.71	13.74 mS	-34 µS	13.71 mS
		T3-400	N/A	400	4.42	9.96 mS	-34 µS	9.93 mS
		T3-450	N/A	450	5.16	13.45 mS	-34 µS	13.42 mS
		T3-500	N/A	500	5.11	15.8 mS	-34 µS	15.77 mS
		T4-0	N/A	0	1.57	19.13 mS	-31 µS	19.10 mS
		T4-50	N/A	50	2.61	20.5 mS	-31 µS	20.47 mS
		T4-100	N/A	100	4.08	10.92 mS	-31 µS	10.89 mS
		T4-150	N/A	150	4.69	10.13 mS	-31 µS	10.10 mS
		T4-200	N/A	200	4.84	5.51 mS	-31 µS	5.48 mS
		T4-250	N/A	250	4.67	2.53 mS	-31 µS	2.50 mS
		T4-300	N/A	300	4.63	4.95 mS	-31 µS	4.92 mS
		T4-350	N/A	350	4.03	6.09 mS	-31 µS	6.06 mS
		T4-400	N/A	400	4.93	10.41 mS	-31 µS	10.38 mS
		T4-450	N/A	450	5.12	9.85 mS	-31 µS	9.82 mS

THERMISTOR DATA			
TS-01	Read By		Joe Pun
	Date		09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)
Bead 1	1.5	0.05	5.2
Bead 2	2.0	0.36	7.0
Bead 3	2.5	0.86	7.8
Bead 4	3.0	1.36	6.7
Bead 5	4.0	2.36	3.6
Bead 6	5.0	3.36	0.4
String Serial No. = 23262-1			
Total string length = 5.0 m			

THERMISTOR DATA			
TS-02	Read By		Joe Pun
	Date		09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)
Bead 1	1.5	0.05	6.1
Bead 2	2.0	0.10	3.0
Bead 3	2.5	0.15	0.0
Bead 4	3.0	0.20	-0.1
Bead 5	4.0	0.50	-0.1
Bead 6	5.0	1.50	-0.1
String Serial No. = 23262-2			
Total string length = 5.0 m			

THERMISTOR DATA			
TS-03	Read By		Joe Pun
	Date		09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)
Bead 1	1.5	0.05	5.7
Bead 2	2.0	0.23	7.2
Bead 3	2.5	0.73	7.1
Bead 4	3.0	1.23	5.4
Bead 5	4.0	2.23	1.8
Bead 6	5.0	3.23	0.4
String Serial No. = 23262-3			
Total string length = 5.0 m			

THERMISTOR DATA				
TS-04	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	6.6	6.2
Bead 2	2.0	0.40	7.2	7.0
Bead 3	2.5	0.90	7.8	6.6
Bead 4	3.0	1.40	7.9	5.2
Bead 5	4.0	2.40	7.6	2.4
Bead 6	5.0	3.40	4.5	-0.6
String Serial No. = 23262-4				
Total string length = 5.0 m				

THERMISTOR DATA			
TS-05	Read By		Joe Pun
	Date		09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)
Bead 1	1.5	0.05	6.6
Bead 2	2.0	0.10	7.6
Bead 3	2.5	0.53	6.5
Bead 4	3.0	1.03	3.8
Bead 5	4.0	2.03	0.0
Bead 6	5.0	3.03	0.0
String Serial No. = 23262-5			
Total string length = 5.0 m			

THERMISTOR DATA				
TS-06	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	6.8	6.4
Bead 2	2.0	0.50	7.1	7.3
Bead 3	2.5	1.00	8.2	7.4
Bead 4	3.0	1.50	8.2	6.3
Bead 5	4.0	2.50	8.3	3.8
Bead 6	5.0	3.50	5.0	-0.2
String Serial No. = 23262-6				
Total string length = 5.0 m				

THERMISTOR DATA				
TS-07	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	5.3	5.3
Bead 2	2.0	0.45	6.6	6.5
Bead 3	2.5	0.95	8.2	7.5
Bead 4	3.0	1.45	8.6	7.1
Bead 5	4.0	2.45	8.7	4.5
Bead 6	5.0	3.45	5.9	2.4
String Serial No. = 23262-7				
Total string length = 5.0 m				

THERMISTOR DATA				
TS-08	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	6.7	6.6
Bead 2	2.0	0.55	7.2	6.9
Bead 3	2.5	1.05	7.4	6.5
Bead 4	3.0	1.55	7.1	5.3
Bead 5	4.0	2.55	7.8	2.8
Bead 6	5.0	3.55	5.3	-1.4
String Serial No. = 23262-8				
Total string length = 5.0 m				

THERMISTOR DATA				
TS-09	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.10	8.8	6.6
Bead 2	2.0	0.60	8.9	7.0
Bead 3	2.5	1.10	8.3	6.9
Bead 4	3.0	1.60	6.8	5.9
Bead 5	4.0	2.60	8.2	3.6
Bead 6	5.0	3.60	9.2	-0.1
String Serial No. = 23262-9				
Total string length = 5.0 m				

THERMISTOR DATA				
TS-10	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	9.1	6.8
Bead 2	2.0	0.20	6.7	6.9
Bead 3	2.5	0.30	8.0	4.5
Bead 4	3.0	0.80	7.0	1.5
Bead 5	4.0	1.80	5.7	0.4
Bead 6	5.0	2.80	4.9	-1.0
String Serial No. = 23262-10				
Total string length = 5.0 m				

THERMISTOR DATA				
TS-11	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	7.6	6.0
Bead 2	2.0	0.55	16.6	6.5
Bead 3	2.5	1.05	9.8	6.4
Bead 4	3.0	1.55	10.1	5.6
Bead 5	4.0	2.55	10.1	3.3
Bead 6	5.0	3.55	6.9	-0.7
String Serial No. = 23262-11				
Total string length = 5.0 m				

THERMISTOR DATA				
TS-12	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.50	5.8	5.9
Bead 2	2.0	1.00	7.7	7.6
Bead 3	2.5	1.50	8.9	8.9
Bead 4	3.0	2.00	9.8	9.2
Bead 5	4.0	3.00	10.1	8.8
Bead 6	5.0	4.00	10.4	6.6
String Serial No. = 23262-12				
Total string length = 5.0 m				

THERMISTOR DATA				
TS-13	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	5.4	5.5
Bead 2	2.0	0.15	7.0	6.9
Bead 3	2.5	0.25	8.6	8.2
Bead 4	3.0	0.75	9.9	7.7
Bead 5	4.0	1.75	8.9	2.7
Bead 6	5.0	2.75	7.9	2.2
Bead 7	6.0	3.75	6.9	3.6
String Serial No. = 23262-13				
Total string length = 6.0 m				

THERMISTOR DATA				
TS-14	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.50	5.6	5.4
Bead 2	2.0	1.00	6.7	6.7
Bead 3	2.5	1.50	8.7	8.4
Bead 4	3.0	2.00	10.2	9.7
Bead 5	4.0	3.00	11.4	10.1
Bead 6	5.0	4.00	11.2	9.5
Bead 7	6.0	5.00	13.1	6.3
String Serial No. = 23262-14 Total string length = 6.0 m				

THERMISTOR DATA				
TS-15	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	8.9	6.4
Bead 2	2.0	0.15	8.0	7.8
Bead 3	2.5	0.25	9.3	8.8
Bead 4	3.0	0.55	10.2	6.6
Bead 5	4.0	1.55	9.1	2.6
Bead 6	5.0	2.55	7.9	1.7
Bead 7	6.0	3.55	6.7	2.3
String Serial No. = 23262-15				
Total string length = 6.0 m				

THERMISTOR DATA				
TS-16	Read By		Maritz Rykaart	Joe Pun
	Date		09/13/2003	09/18/2003
Bead No.	Bead Location from Top (m)	Bead Depth (m)	Temperature (Celsius)	
Bead 1	1.5	0.05	4.7	4.8
Bead 2	2.0	0.25	6.2	6.1
Bead 3	2.5	0.75	8.3	8.0
Bead 4	3.0	1.25	9.8	8.7
Bead 5	4.0	2.25	9.9	7.8
Bead 6	5.0	3.25	8.2	1.8
Bead 7	6.0	4.25	6.0	2.6
String Serial No. = 23262-16				
Total string length = 6.0 m				



2252 ohm THERMISTOR STRING CALIBRATION

Customer: SRK
 Date: 4-Sep-03
 Calibration Reference HP 34401A Digital Multimeter S/N US36053118
 Last referenced to National Standards 11-April-03
 Reference Thermistor Number RST0036
 Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-1	5m	Pt. 1	5739	4.9	2879	19.5
		Pt. 2	5749	4.9	2885	19.5
		Pt. 3	5741	4.9	2887	19.5
		Pt. 4	5741	4.9	2876	19.5
		Pt. 5	5755	4.9	2891	19.4
		Pt. 6	5737	5.0	2876	19.5

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

CHECKED BY



**2252 ohm
THERMISTOR STRING CALIBRATION**

Customer: SRK
Date: 4-Sep-03
Calibration Reference HP 34401A Digital Multimeter S/N US36053118
Last referenced to National Standards 11-April-03
Reference Thermistor Number RST0036
Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference	5m		5738	4.9	2879	19.5
23262-2		Pt. 1	5748	4.9	2879	19.5
		Pt. 2	5727	5.0	2863	19.6
		Pt. 3	5709	5.0	2856	19.7
		Pt. 4	5758	4.9	2881	19.5
		Pt. 5	5743	4.9	2874	19.5
		Pt. 6	5740	4.9	2866	19.6

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

CHECKED BY



**2252 ohm
THERMISTOR STRING CALIBRATION**

Customer: SRK
Date: 4-Sep-03
Calibration Reference HP 34401A Digital Multimeter S/N US36053118
Last referenced to National Standards 11-April-03
Reference Thermistor Number RST0036
Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-3	5m	Pt. 1	5781	4.8	2895	19.4
		Pt. 2	5761	4.9	2887	19.5
		Pt. 3	5759	4.9	2881	19.5
		Pt. 4	5767	4.8	2889	19.4
		Pt. 5	5764	4.9	2879	19.5
		Pt. 6	5753	4.9	2885	19.5

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

CHECKED BY



**2252 ohm
THERMISTOR STRING CALIBRATION**

Customer: SRK
Date: 4-Sep-03
Calibration Reference HP 34401A Digital Multimeter S/N US36053118
Last referenced to National Standards 11-April-03
Reference Thermistor Number RST0036
Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-4	5m	Pt. 1	5759	4.9	2888	19.4
		Pt. 2	5773	4.8	2884	19.5
		Pt. 3	5755	4.9	2873	19.6
		Pt. 4	5795	4.7	2898	19.4
		Pt. 5	5759	4.9	2874	19.5
		Pt. 6	5787	4.8	2894	19.4

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

$C_0 = 0.0014733$

$C_1 = 0.0002372$

$C_3 = 0.0000001074$

$\ln R =$ Natural Log of Resistance

$T_c =$ Temperature in °C

CHECKED BY

**2252 ohm
THERMISTOR STRING CALIBRATION**

Customer: SRK
Date: 4-Sep-03
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Last referenced to National Standards 11-April-03
Reference Thermistor Number RST0036
Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-5	5m	Pt. 1	5709	5.0	2860	19.7
		Pt. 2	5731	5.0	2876	19.5
		Pt. 3	5742	4.9	2881	19.5
		Pt. 4	5706	5.1	2860	19.7
		Pt. 5	5742	4.9	2880	19.5
		Pt. 6	5705	5.1	2869	19.6

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

CHECKED BY

**2252 ohm
THERMISTOR STRING CALIBRATION**

Customer: SRK
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Last referenced to National Standards 11-April-03
Reference Thermistor Number RST0036
Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-6	5m	Pt. 1	5701	5.1	2858	19.7
		Pt. 2	5742	4.9	2877	19.5
		Pt. 3	5738	4.9	2868	19.6
		Pt. 4	5739	4.9	2876	19.5
		Pt. 5	5717	5.0	2860	19.7
		Pt. 6	5732	5.0	2875	19.5

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

CHECKED BY

**2252 ohm
THERMISTOR STRING CALIBRATION**

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Last referenced to National Standards 11-April-03
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Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-7	5m	Pt. 1	5736	5.0	2867	19.6
		Pt. 2	5751	4.9	2874	19.5
		Pt. 3	5742	4.9	2871	19.6
		Pt. 4	5744	4.9	2885	19.5
		Pt. 5	5746	4.9	2874	19.5
		Pt. 6	5753	4.9	2890	19.4

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

CHECKED BY

**2252 ohm
THERMISTOR STRING CALIBRATION**

Customer: SRK
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Calibration Reference HP 34401A Digital Multimeter S/N US36053118
Last referenced to National Standards 11-April-03
Reference Thermistor Number RST0036
Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-8	5m	Pt. 1	5688	5.1	2849	19.7
		Pt. 2	5730	5.0	2864	19.6
		Pt. 3	5754	4.9	2878	19.5
		Pt. 4	5732	5.0	2876	19.5
		Pt. 5	5759	4.9	2885	19.5
		Pt. 6	5726	5.0	2868	19.6

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

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THERMISTOR STRING CALIBRATION**

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THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-9	5m	Pt. 1	5752	4.9	2880	19.5
		Pt. 2	5748	4.9	2878	19.5
		Pt. 3	5757	4.9	2888	19.4
		Pt. 4	5751	4.9	2873	19.6
		Pt. 5	5780	4.8	2897	19.4
		Pt. 6	5743	4.9	2869	19.6

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

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THERMISTOR STRING CALIBRATION**

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THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-10	5m	Pt. 1	5744	4.9	2888	19.4
		Pt. 2	5758	4.9	2884	19.5
		Pt. 3	5753	4.9	2875	19.5
		Pt. 4	5759	4.9	2882	19.5
		Pt. 5	5726	5.0	2861	19.6
		Pt. 6	5741	4.9	2878	19.5

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

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THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-11	5m	Pt. 1	5767	4.8	2890	19.4
		Pt. 2	5750	4.9	2877	19.5
		Pt. 3	5732	5.0	2874	19.5
		Pt. 4	5737	5.0	2868	19.6
		Pt. 5	5724	5.0	2882	19.5
		Pt. 6	5731	5.0	2870	19.6

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

C₁= 0.0002372

C₃= 0.0000001074

lnR= Natural Log of Resistance

T_c= Temperature in °C

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**2252 ohm
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THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-12	5m	Pt. 1	5681	5.1	2854	19.7
		Pt. 2	5726	5.0	2869	19.6
		Pt. 3	5731	5.0	2868	19.6
		Pt. 4	5761	4.9	2888	19.4
		Pt. 5	5739	4.9	2873	19.6
		Pt. 6	5761	4.9	2880	19.5

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

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THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-13	6m	Pt. 1	5750	4.9	2888	19.4
		Pt. 2	5765	4.9	2890	19.4
		Pt. 3	5779	4.8	2890	19.4
		Pt. 4	5759	4.9	2878	19.5
		Pt. 5	5749	4.9	2885	19.5
		Pt. 6	5756	4.9	2878	19.5
		Pt. 7	5780	4.8	2891	19.4

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

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Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-14	6m	Pt. 1	5746	4.9	2893	19.4
		Pt. 2	5755	4.9	2888	19.4
		Pt. 3	5777	4.8	2893	19.4
		Pt. 4	5741	4.9	2878	19.5
		Pt. 5	5748	4.9	2886	19.5
		Pt. 6	5729	5.0	2873	19.6
		Pt. 7	5768	4.8	2897	19.4

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

$C_0 = 0.0014733$

$C_1 = 0.0002372$

$C_3 = 0.0000001074$

$\ln R =$ Natural Log of Resistance

$T_c =$ Temperature in °C

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THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-15	6m	Pt. 1	5701	5.1	2857	19.7
		Pt. 2	5710	5.0	2857	19.7
		Pt. 3	5745	4.9	2873	19.6
		Pt. 4	5751	4.9	2880	19.5
		Pt. 5	5718	5.0	2858	19.7
		Pt. 6	5742	4.9	2874	19.5
		Pt. 7	5751	4.9	2878	19.5

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

C₀= 0.0014733

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C₃= 0.0000001074

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T_c= Temperature in °C

CHECKED BY 





2252 ohm THERMISTOR STRING CALIBRATION

Customer: SRK
 Date: 4-Sep-03
 Calibration Reference HP 34401A Digital Multimeter S/N US36053118
 Last referenced to National Standards 11-April-03
 Reference Thermistor Number RST0036
 Referenced Annually to National Standards

THERMISTOR #	Cable Length	Position	Low Temperature		High Temperature	
			Measured Resistance ohms	Calculated Temperature °C	Measured Resistance ohms	Calculated Temperature °C
Reference			5738	4.9	2879	19.5
23262-16	6m	Pt. 1	5772	4.8	2887	19.5
		Pt. 2	5773	4.8	2882	19.5
		Pt. 3	5748	4.9	2870	19.6
		Pt. 4	5761	4.9	2879	19.5
		Pt. 5	5751	4.9	2874	19.5
		Pt. 6	5769	4.8	2891	19.4
		Pt. 7	5748	4.9	2873	19.6

Temperature calculated using:

Steinhart-Hart Linearization

$$T_c = \frac{1}{C_0 + C_1(\ln R) + C_3(\ln R)^3} - 273.15$$

2252 Ohm @ 25C NTC Thermistor

$C_0 = 0.0014733$

$C_1 = 0.0002372$

$C_3 = 0.0000001074$

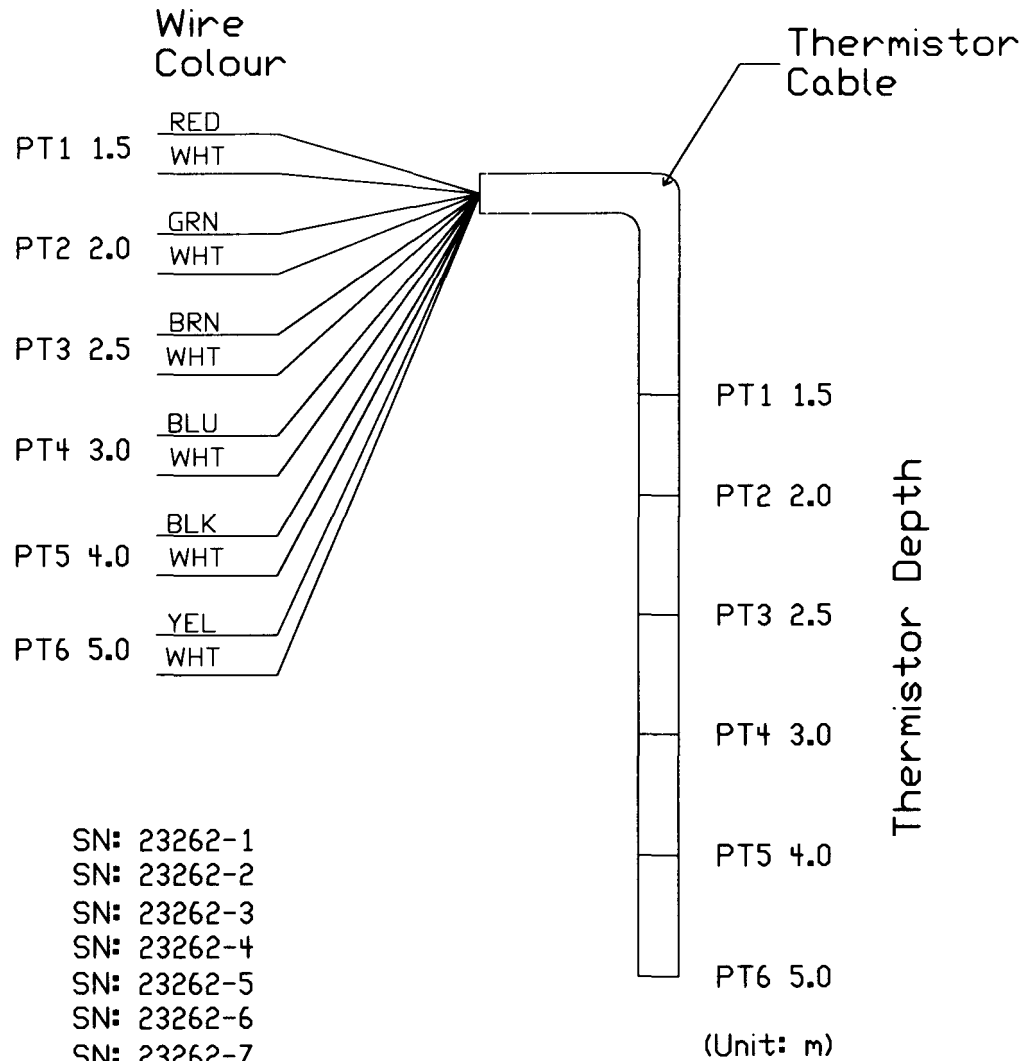
$\ln R =$ Natural Log of Resistance

$T_c =$ Temperature in °C

CHECKED BY

Resistance versus Temperature Relationship 2252 NTC Thermistors

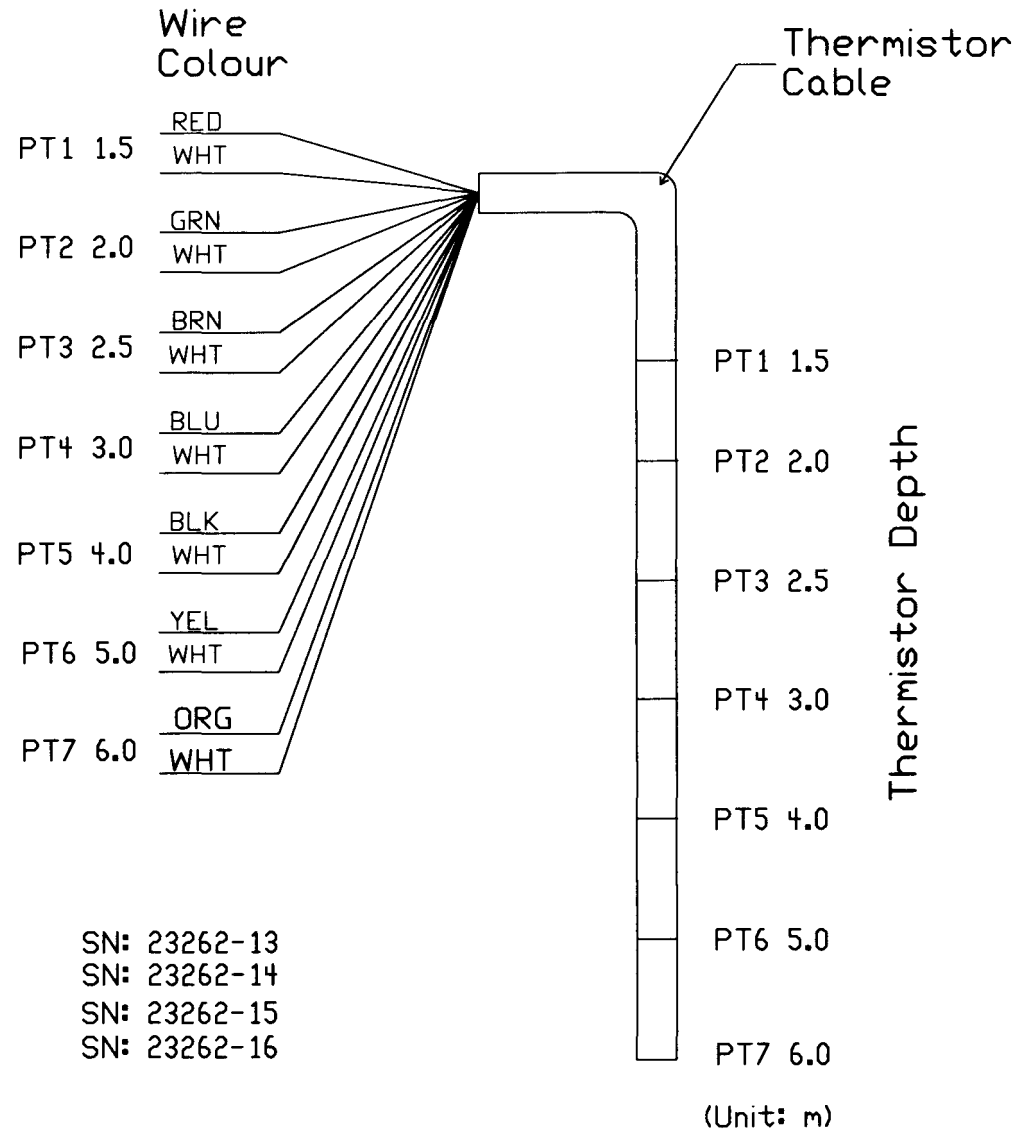
R ohms	T deg C	R ohms	T deg C	R ohms	T deg C	R ohms	T deg C
76000	-40.04	21500	-19.71	7300	0.15	2800	20.11
75000	-39.84	21000	-19.30	7200	0.42	2750	20.51
74000	-39.64	20500	-18.89	7100	0.69	2700	20.92
73000	-39.43	20000	-18.46	7000	0.97	2650	21.33
72000	-39.23	19500	-18.02	6900	1.26	2600	21.76
71000	-39.01	19000	-17.56	6800	1.54	2550	22.19
70000	-38.80	18500	-17.10	6700	1.84	2500	22.64
69000	-38.58	18000	-16.61	6600	2.14	2450	23.09
68000	-38.36	17500	-16.12	6500	2.44	2400	23.56
67000	-38.13	17000	-15.61	6400	2.75	2350	24.04
66000	-37.90	16500	-15.08	6300	3.06	2300	24.52
65000	-37.67	16000	-14.53	6200	3.38	2250	25.02
64000	-37.43	15800	-14.30	6100	3.71	2200	25.54
63000	-37.19	15600	-14.07	6000	4.04	2150	26.06
62000	-36.95	15400	-13.84	5900	4.38	2100	26.60
61000	-36.70	15200	-13.61	5800	4.72	2050	27.16
60000	-36.44	15000	-13.37	5700	5.07	2000	27.73
59000	-36.18	14800	-13.13	5600	5.43	1950	28.32
58000	-35.92	14600	-12.88	5500	5.79	1900	28.92
57000	-35.65	14400	-12.64	5400	6.17	1880	29.17
56000	-35.37	13900	-12.00	5300	6.55	1860	29.42
55000	-35.09	13400	-11.33	5200	6.94	1840	29.67
54000	-34.81	12900	-10.64	5100	7.33	1820	29.93
53000	-34.52	12400	-9.91	5000	7.74	1800	30.19
52000	-34.22	12200	-9.61	4900	8.16	1780	30.45
51000	-33.92	12000	-9.31	4800	8.58	1760	30.72
50000	-33.60	11800	-9.00	4700	9.02	1740	30.99
49000	-33.29	11600	-8.68	4600	9.46	1720	31.26
48000	-32.96	11400	-8.36	4500	9.92	1700	31.54
47000	-32.63	11200	-8.03	4400	10.39	1680	31.82
46000	-32.29	11000	-7.69	4300	10.87	1660	32.10
45000	-31.94	10800	-7.35	4200	11.36	1640	32.39
44000	-31.58	10600	-7.00	4100	11.87	1620	32.69
43000	-31.22	10400	-6.64	4000	12.39	1600	32.98
42000	-30.84	10200	-6.28	3900	12.93	1580	33.28
41000	-30.45	10000	-5.90	3850	13.20	1560	33.59
40000	-30.06	9800	-5.52	3800	13.48	1540	33.90
39000	-29.65	9600	-5.13	3750	13.76	1520	34.21
38000	-29.23	9400	-4.73	3700	14.05	1500	34.53
37000	-28.80	9200	-4.32	3650	14.34	1480	34.85
36000	-28.35	9000	-3.90	3600	14.63	1460	35.18
35000	-27.89	8800	-3.47	3550	14.93	1440	35.52
34000	-27.42	8700	-3.25	3500	15.24	1420	35.86
33000	-26.93	8600	-3.03	3450	15.55	1400	36.20
32000	-26.42	8500	-2.81	3400	15.86	1380	36.55
31000	-25.89	8400	-2.58	3350	16.18	1360	36.91
30000	-25.35	8300	-2.35	3300	16.51	1340	37.27
29000	-24.79	8200	-2.12	3250	16.84	1320	37.64
28000	-24.20	8100	-1.88	3200	17.18	1300	38.02
27000	-23.59	8000	-1.64	3150	17.52	1280	38.40
26000	-22.95	7900	-1.39	3100	17.87	1260	38.79
25000	-22.29	7800	-1.15	3050	18.23	1240	39.18
24000	-21.60	7700	-0.90	3000	18.59	1220	39.58
23000	-20.87	7600	-0.64	2950	18.96	1200	40.00
22500	-20.49	7500	-0.38	2900	19.33	1180	40.41
22000	-20.11	7400	-0.12	2850	19.72	1160	40.84



SN: 23262-1
 SN: 23262-2
 SN: 23262-3
 SN: 23262-4
 SN: 23262-5
 SN: 23262-6
 SN: 23262-7
 SN: 23262-8
 SN: 23262-9
 SN: 23262-10
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Attachment C3
Scoping Level Numerical Modeling of
Anvil Range Soil Covers

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1 Introduction

Scoping level numerical modeling was carried out to give a preliminary indication of the range of infiltration that can be achieved by placing soil covers over the Rose Creek tailings impoundment and the ARMC waste rock piles. The scoping level numerical modeling was based solely on laboratory and field measurements of soil properties. Long-term field tests are widely seen as a much better basis for definitive modeling. Therefore the results herein should be considered as preliminary only.

The SoilCover model was used. SoilCover is a mechanistic one-dimensional, transient, finite element coupled heat and water transfer (liquid and vapour) model that implements the physically based method described by Wilson et al. (1994) for predicting the exchange of moisture between the atmosphere and a soil surface. The coupling of the soil profile to the atmosphere is accomplished using a modified Penman formulation developed by Wilson (1990) and Wilson et al. (1994) that allows for the calculation of evaporation from a saturated or an unsaturated surface. These formulations represent the state of the art in numerical modeling. However, they do not account for many effects that are known to influence cover performance in the field, which is another reason why definitive predictions must await the completion of long-term field tests.

2 Model Setup

2.1 Mesh Generation

Two different mesh sizes were created for simulations for the waste rock and tailings covers. Waste rock cover profiles had a depth of 10 meters, while the tailings cover profiles had a depth of 7 m. These profiles were based on sensitivity analysis runs, and were selected to minimize boundary effects.

The base temperature was kept constant at 4°C in all simulations, while the initial surface temperature was set equal to 0°C. The top temperature was chosen to coincide with the beginning of the spring thaw, while the base temperature was chosen to be 6°C warmer than the mean annual temperature. The algorithms in SoilCover were used to calculate the daily ground temperatures. Initial moisture conditions for each profile were set by means of matric suction for the tailings simulations and by water content for waste rock simulations.

2.2 Material Properties

The material properties used in SoilCover is presented in this section, and has been based on actual laboratory and field test results. General properties for each material used in the simulations are summarized in the Table 1, and the remainder of the properties are discussed in subsequent sections. Appendix 2 provides the full range of laboratory and field measurements.

Table 1: Summary of material properties used in SoilCover modeling

Material	Porosity	Specific Gravity	Saturated Permeability (cm/s)
Waste Rock	0.361	2.86	1.7×10^{-3}
Till	0.262	2.70	2.7×10^{-6}
Glaciofluvial	0.246	2.70	1.0×10^{-4}
Coarse Tailings	0.380	2.93 ^a	2.0×10^{-3}
Fine Tailings	0.419	2.93 ^a	1.0×10^{-6}
Slimes	0.419	2.93 ^a	1.0×10^{-8}

a. This value should be 3.14; it does not impact the results significantly.

Soil Water Characteristic Curves

Points from the fitted van Genuchten SWCC's presented in Section 3 of this report were entered into the SoilCover model for each material. SoilCover uses the Fredlund and Xing (1996) method to develop a SWCC for use in calculations. The corresponding SWCC's that were used in the modeling is presented in Figure 1.

Unsaturated Hydraulic Conductivity Functions

Suction and relative permeability data is generated using the method developed by Fredlund et al. (1994). Modelled data is presented in Figure 2.

Thermal Conductivity & Specific Heat Functions

SoilCover generates a thermal conductivity function by specifying an overall weighted quartz percentage in the soil using the Johansen (1975) method. The function describes the amount of heat which flows through a unit area of soil, in a unit time, under a unit gradient (SoilCover, 1997). The values were entered using the typical values listed in the SoilCover manual and are listed in Table 2.

SoilCover also generates a volumetric specific heat function, by specifying a mass specific heat for each soil, using the de Vries method (1953). The function describes the amount of stored heat required to change the temperature of a unit volume (1m^3) by one degree Celsius (SoilCover, 1997). The values were entered using the typical values listed in the SoilCover manual and are listed in Table 2.

Table 2: Summary of thermal conductivity and volumetric specific heat constants

Material	% Quartz (dec.)	Solids Specific Heat (J/Kg-°C)
Waste Rock	0.9	850
Till	0.8	800
Glaciofluvial	0.8	800
Coarse Tailings	0.9	850
Fine Tailings	0.9	850
Slimes	0.9	850

2.3 General Boundary Conditions

Site data criteria used in SoilCover were kept constant for all simulations. Temperature and humidity lags were set to zero. The site latitude is 62.25°N. Simulations were carried out without making use of the soil freezing and vegetation modules of the model.

Initial conditions for the waste rock and tailings simulations were different. For the waste rock, profiles were created that varied linearly, with saturated water content at the surface to a volumetric water content of 16% at the bottom of the ten meter profile. For tailings, profiles were created that varied linearly from a suction of 50 kPa at the surface, to a suction of 0 kPa (saturation) at the bottom of the 7 m profile. Sensitivity analysis confirmed that for these simulations the depth to the water table had little effect on the modelled results.

The water content and suction profiles at the end of year 1 simulations were subsequently used as the initial condition for the start of year 2 simulations, which was used to evaluate final results.

2.4 Climate Data

Available climate data included daily air temperatures, rainfall, snowfall and precipitation data from the Faro airport weather station for the years from 1978 to 2000. The start and end date for the simulations were chosen as March 18th and October 25th of any particular year, which corresponds to the dates where the average maximum daily temperatures were above zero. For the remaining portion of the year, the ground is assumed to be frozen and no infiltration would occur.

Precipitation

A representative year for precipitation data was chosen to be 1995 as both the yearly rainfall (220 mm) and total precipitation (301 mm) was close to the annual rainfall average (215 mm) and total precipitation average (314 mm). For wet year precipitation data, the average of the three wettest years on record for the Faro airport from 1978 to 2000 were used (1991, 1993 and 2000). Figure 3 presents the daily rainfall used in the simulations for an average year.

Precipitation data was modified to account for the elevation difference between the airport and the mine site. Correlating the data between the Faro airport (717 m) and the ARMC weather station (1160 m) found that the precipitation increased by 18 mm per 100 m gained in elevation. Using an average top of dump elevation of 1200 m, gave an average precipitation total of 387 mm per year.

In order to simulate the spring snow melt, eighty percent of the total precipitation from Oct. 26th to March 17th was assumed to be present as snow on day one of the simulations. 3 mm of this total was then assumed to melt each day over the daylight hours of 10:00 to 16:00 until gone, which for an average year corresponded to 22 days. The remaining daily precipitation would occur over a 24 hr period on any given day.

Air Temperature

Daily maximum and minimum temperatures entered in all average year SoilCover simulations were from average daily data at the Faro Airport from 1978 to 2000. For wet year temperature data, the average temperatures of the wettest three years were used. Daily air temperatures used are shown in Figure 4.

Relative Humidity

Relative humidity data for the Faro area was scarce. The humidity data used was based on June and December average relative humidity data for Mayo, Yukon, found on the Government of Yukon website (<http://www.gov.yk.ca/depts/eco/stats/annual/enviro.pdf>). Monthly averages were derived by varying the data linearly from a maximum and minimum of 84% and 82% in December to the maximum and minimum of 75% and 44% in June. The monthly relative humidity values used are presented on Figure 5.

Evaporation

Lake Evaporation at Faro was determined to be 490 mm by Gartner Lee in the 2004 to 2008 Water License Renewal Report. A monthly breakdown of the Lake Evaporation was found in the SRK Report 60635 “Down Valley Tailings Impoundment Decommissioning Plan”, April 1991. The monthly Lake Evaporation data used was for Whitehorse, Yukon, and the actual numbers used in the SoilCover modeling is presented in Figure 6.

3 Modeling Results

3.1 Tailings Covers

The base case against which the numerical modeling results were evaluated, were the existing uncovered tailings. Tailings properties vary greatly in the tailings impoundment, from coarse beach tailings to fine tailings (slimes). Furthermore the phreatic level within the tailings impoundment varies greatly, from being right at the surface at the ponds, to being as far down as 10 m in some areas. Rykaart (2002) illustrated that site specific spatial surface flux boundary functions can be developed for tailings profiles such as these, which would allow for rigorous calculation of surface fluxes anywhere on the tailings surface. This was not attempted for this project; however, the same modeling principal was adopted, which calls for modeling generalized tailings profiles; in the case of Rose Creek tailings, a coarse and a fine tailings profile, and using varying depths to the water table. The model simulations confirmed that the most representative base case results for the uncovered tailings could be presented with two simulations of coarse (beach) and fine tailings using a phreatic level of 7 m below surface.

Appropriate cover configurations were selected based on available materials and the minimum cover layer thickness was arbitrarily set at 50 cm. Both single and multilayer covers were considered (see Figures 7a through d). Table 3 presents a list of the final modelling results.

Tailings settlement and trafficability is considered to be a significant risk associated with the successful application of any infiltration reducing cover at this site. It may thus be necessary to construct a traffic layer first, and after settlement has taken place, to construct a low-permeability cover. Since there is a shortage of suitable cover materials on site, we have assumed that waste rock could be used as a cover material, specifically to fill this bulk requirement. It is important to note that the modeled waste rock properties are well graded material containing significant fines. This material will not be representative of large run-of-mine material, and therefore the results should be considered in the appropriate context.

Table 3: Summary of tailings cover simulations

Cover Profile	Full Simulation Period (Precipitation = 387 mm)				
	Runoff (mm)	Evaporation (mm)	Infiltration (mm)	Flux at Top of Tailings ¹ (mm)	Flux at Top of Tailings ¹ (%)
Uncovered Tailings					
Uncovered Fine tailings	60	277	28	---	7%
Uncovered Coarse tailings	0	280	92	---	24%
Single Layer Covers					
1m Till on Fine Tailings	40	293	38	-33	-9%
1m Till on Coarse Tailings	26	280	64	-64	-17%
Two-Layer Covers					
0.5m Till, 1m Waste Rock on Fine Tailings	57	293	21	0	0%
0.5m Till, 1m Waste Rock on Coarse Tailings	56	294	21	0	0%
1m Till, 1m Waste Rock, 5m Fine Tailings	49	297	25	0	0%
1m Till, 1m Waste Rock, 5m Coarse Tailings	48	299	24	0	0%

1. For uncovered tailings a positive flux, implies a flux into the tailings, but for covered tailings, a negative flux implies flux through the cover into the underlying waste.

The uncovered fine tailings allows approximately 7% overall infiltration with 34% of the snowmelt reporting as infiltration. Surface runoff constitutes 16% of the water balance. In contrast the coarse uncovered tailings allows 24% overall infiltration, with 75% of the snowmelt infiltration, whilst there is no reported runoff. Currently, although local runoff can occur on the Rose Creek tailings, all this runoff is collected and contained on the impoundment, however, to allow more representative modeling we need to consider what occur on a more micro-scale.

One meter thick single layer till covers till are estimated to result in only a marginal reduction in infiltration. The close similarity of the water retention characteristics of the tailings and till is the likely explanation for these results.

The multilayer covers are estimated to perform better, with the model predicting no overall infiltration through the cover. This is evidence of a “capillary break” effect. However, it should be noted that capillary break effects are typically very pronounced in model simulations, but less strong in the field, where material variability blurs the contrast in properties that creates the effect.

3.2 Waste Rock Piles

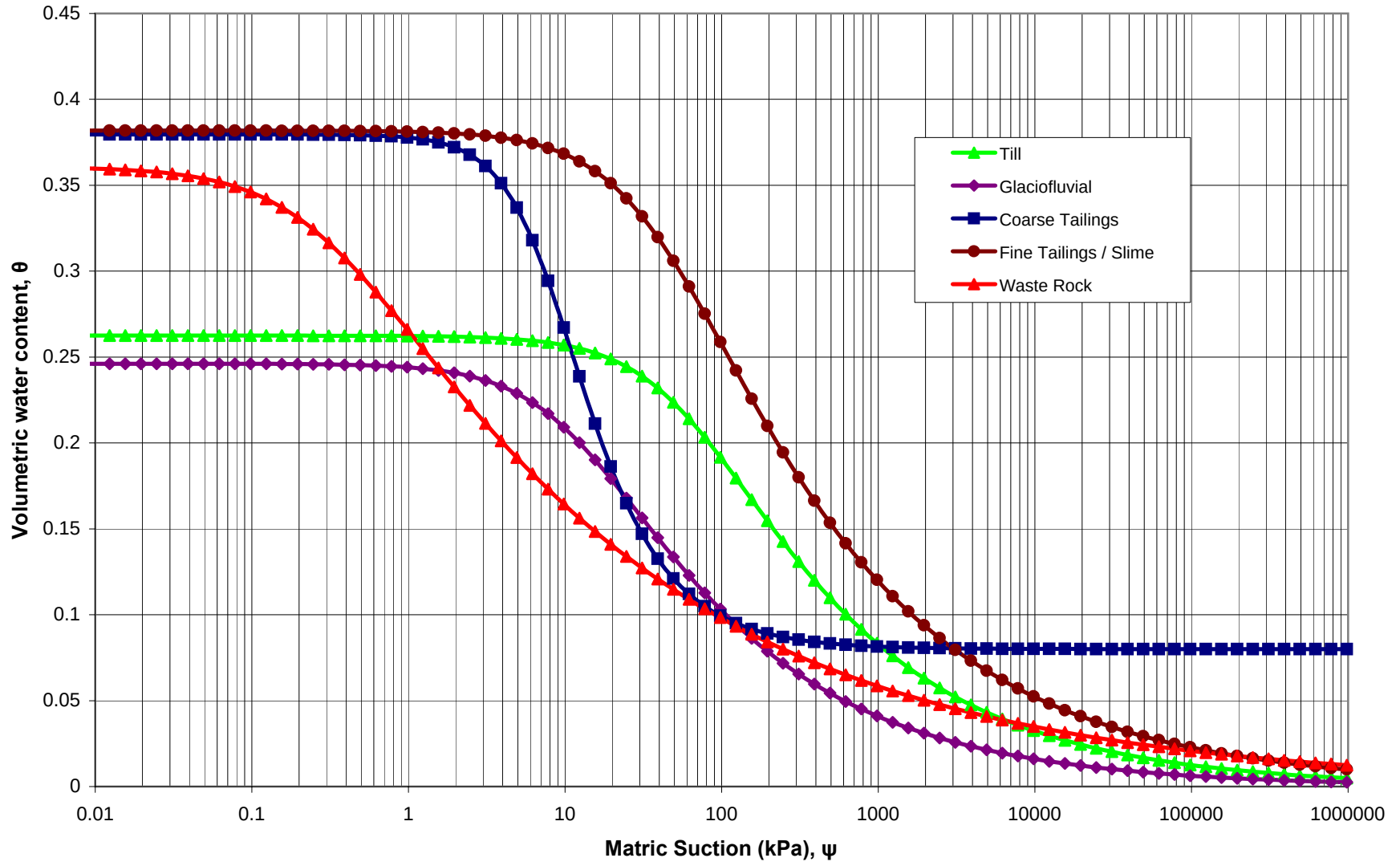
The base case against which modeling results were evaluated for covers over the waste rock piles, were the uncovered waste rock. It was however assumed that the waste rock piles would have to be re-contoured extensively to allow placement of the cover, as had occurred at the cover test section on the Vangorda waste rock pile. For this reason, the uncovered waste rock profile model simulations were based on those material properties. It should be noted that the ARMC waste rock appears to be highly susceptible to environmental weathering, and re-handling of this weathered waste results in a well graded mixture of gravel-sand-silt mixture, as opposed to the poorly graded segregated boulders that is commonly observed on the side slopes. Modeling results of the final runs are presented in Table 4 and on Figure 8.

Table 4: Summary of waste rock pile cover simulations

Cover Profile	Full Simulation Period (Precipitation = 387 mm)				
	Runoff (mm)	Evaporation (mm)	Infiltration (mm)	Flux at Top of Waste Rock ¹ (mm)	Flux at Top of Waste Rock ¹ (%)
Uncovered Waste Rock					
10m Waste Rock	80	199	92	----	24%
10m Waste Rock (K_{sat} 10^1 less permeable)	165	163	44	----	11%
10m Waste Rock (K_{sat} 10^1 more permeable)	6	234	131	----	34%
Covered Waste Rock					
0.5m Till, 9.5m Waste Rock	62	296	14	-17	-4%
0.5m Till (K_{sat} 10^1 more Permeable); 9.5m Waste Rock	0	347	2.5	3.3	1%
0.5m Till (K_{sat} 10^1 Less Permeable); 9.5m Waste Rock	131	222	17	2	1%
1.0m Till, 9m Waste Rock	48	299	24	-20	-5%
1.5m Till, 8.5m Waste Rock	47	298	26	-24	-6%
2.0m Till, 8.0m Waste Rock	45	296	30	-28	-7%

1. For uncovered waste rock a positive flux, implies a flux into the waste rock, but for covered waste rock, a negative flux implies flux through the cover into the underlying waste.

Figures



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& Touche**

Anvil Range Mining Complex

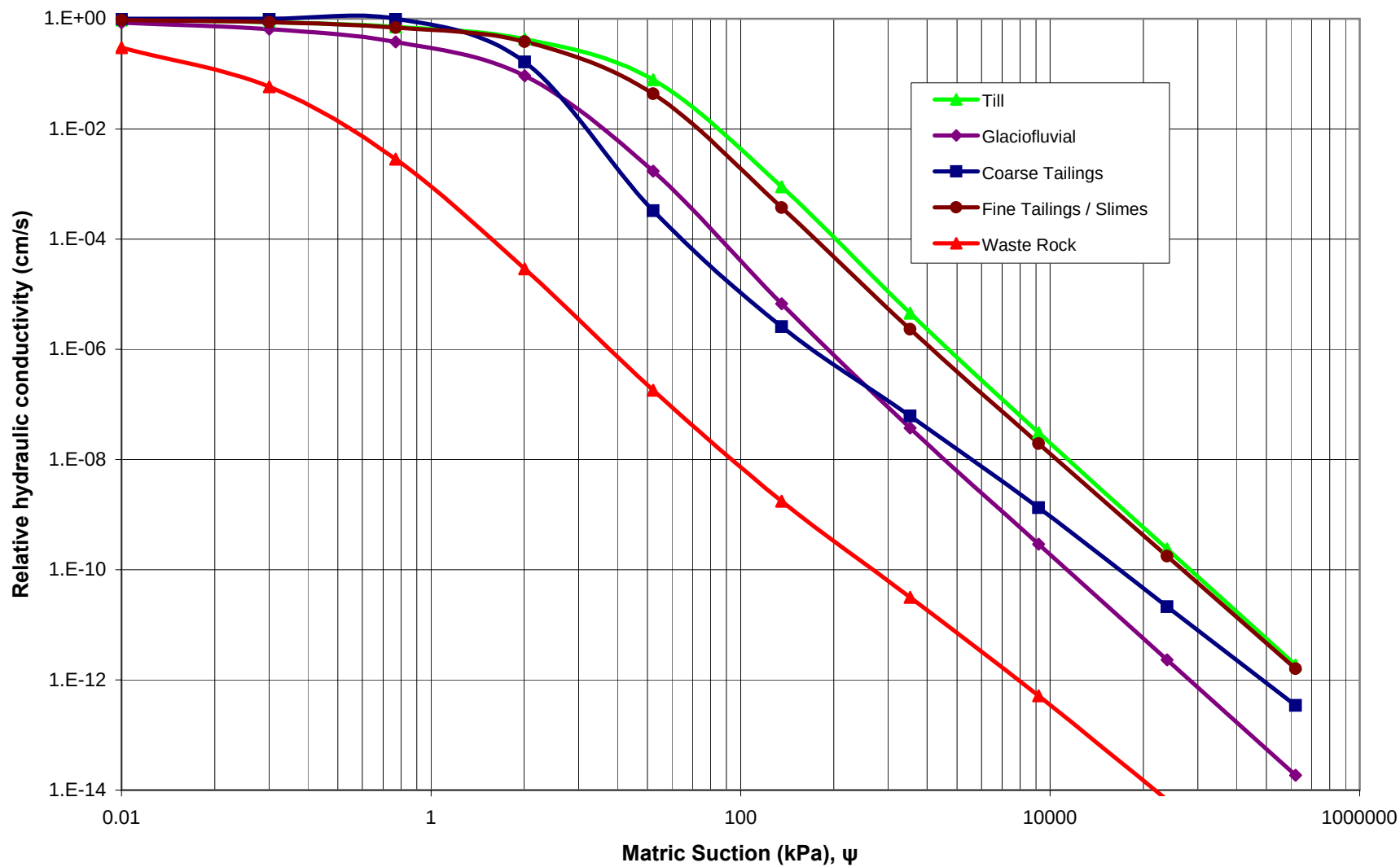
**Soil Water Characteristic Curves
Used in SoilCover Modeling**

PROJECT
1CD003.26

DATE
Feb. 2004

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E.M.R.

FIGURE
1



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Anvil Range Mining Complex

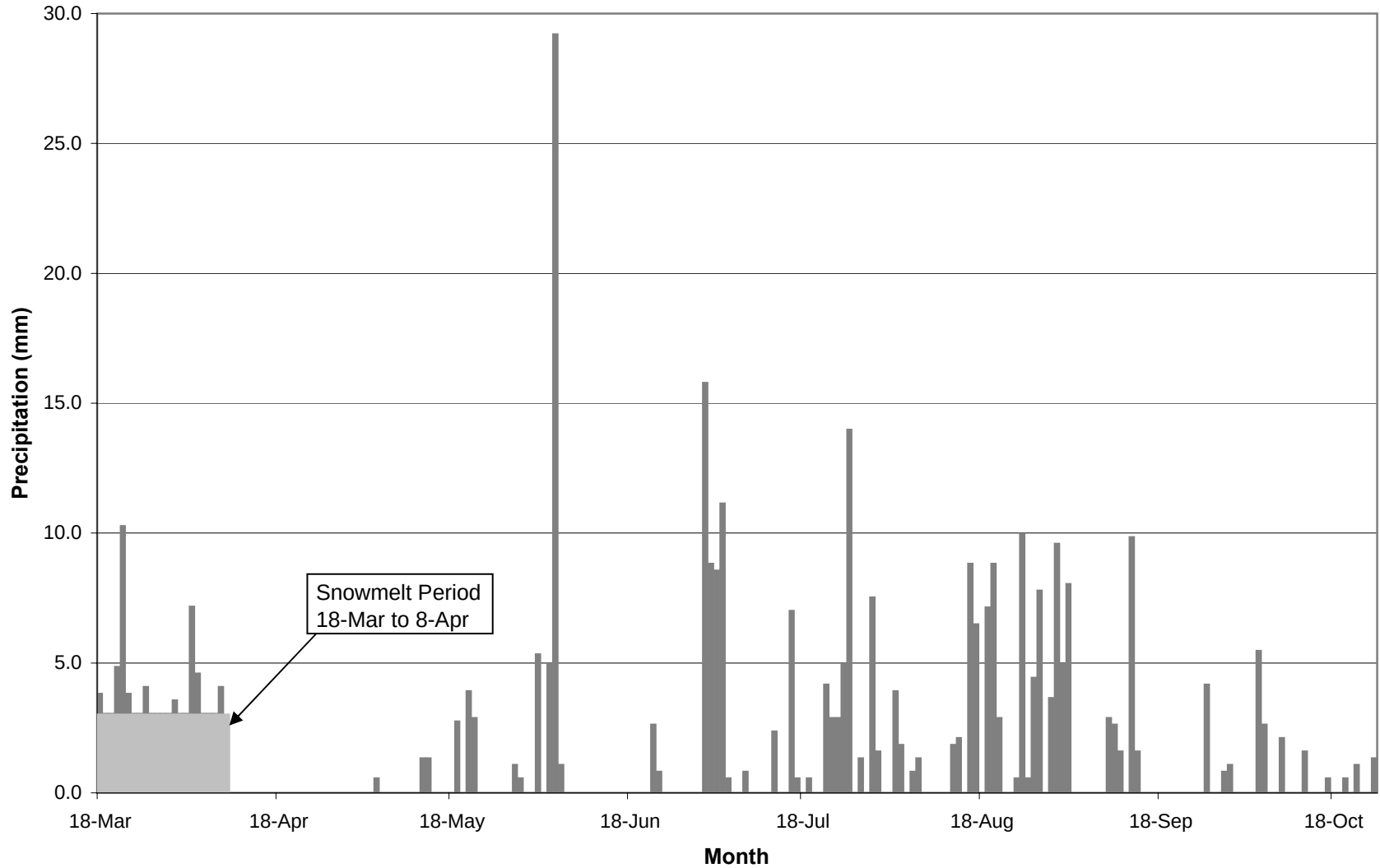
**Relative Unsaturated Hydraulic Conductivity
Curves Used in SoilCover Modeling**

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FIGURE
2



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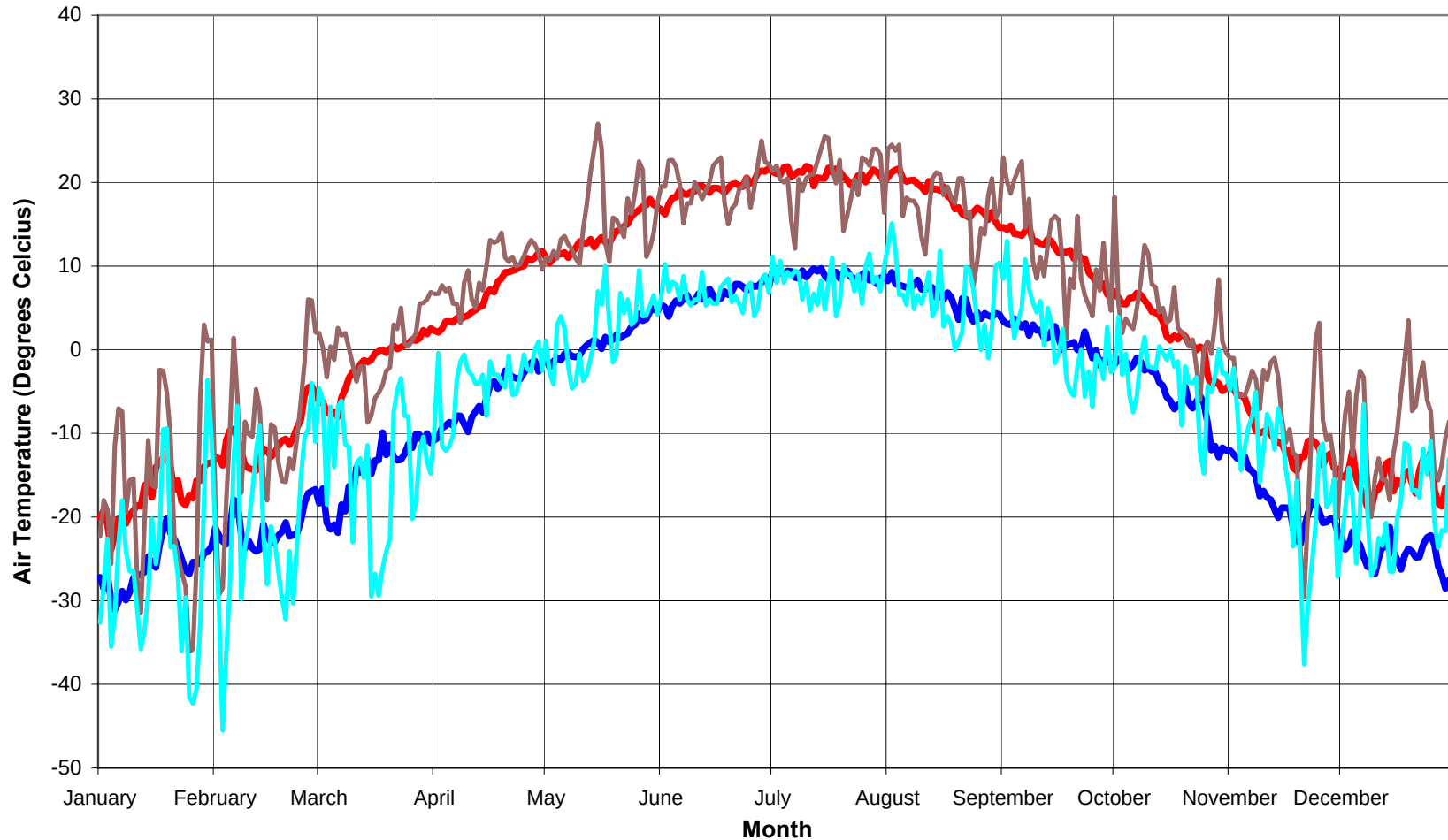
**Average Yearly Precipitation Used in
SoilCover Modeling**

PROJECT
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E.M.R.

FIGURE
3



— Average Year Max Temperature
 — Wet Year Max Temperature

— Average Year Min Temperature
 — Wet Year Min Temperature



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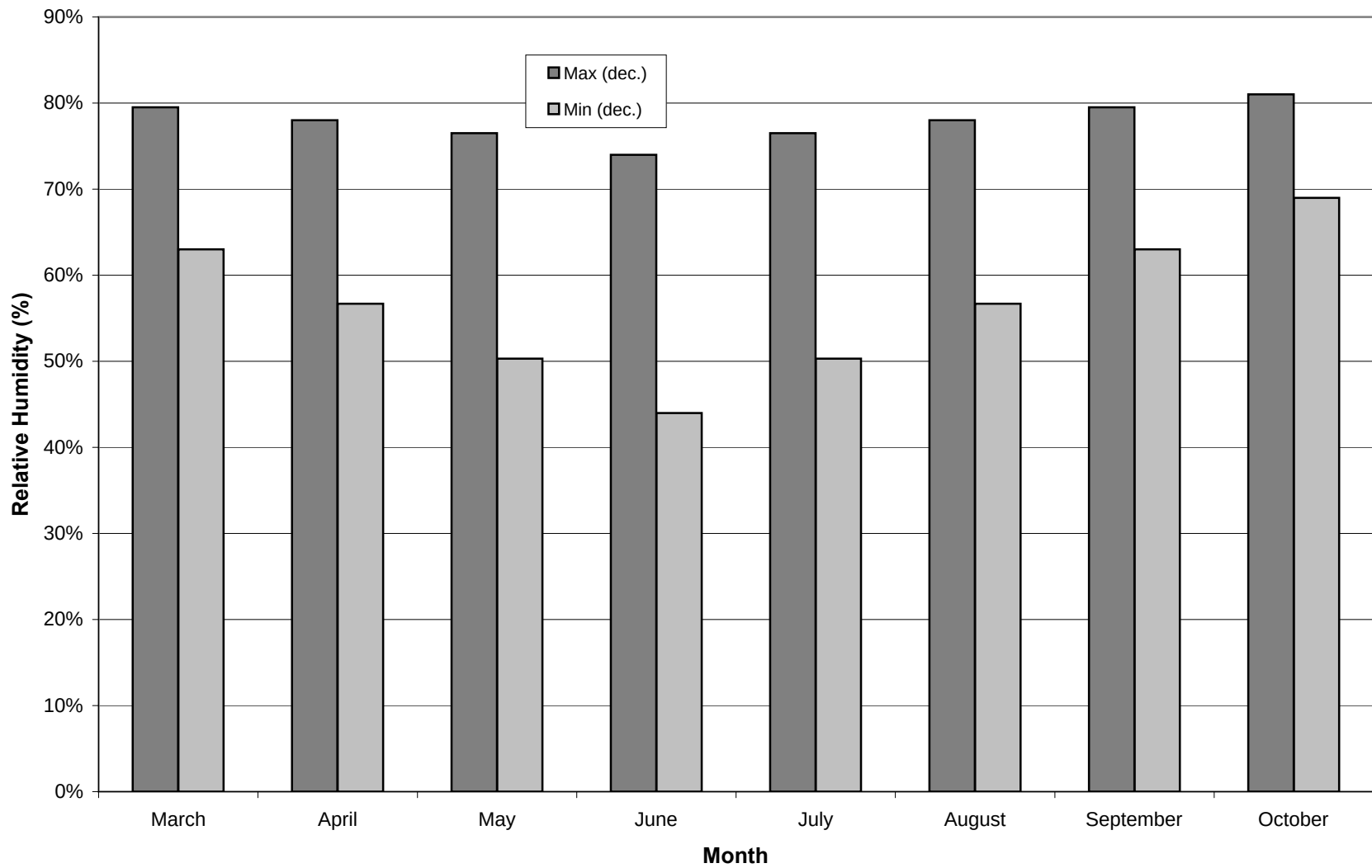
**Annual Air Temperatures Used in
 SoilCover Modeling**

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 1CD003.26

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FIGURE



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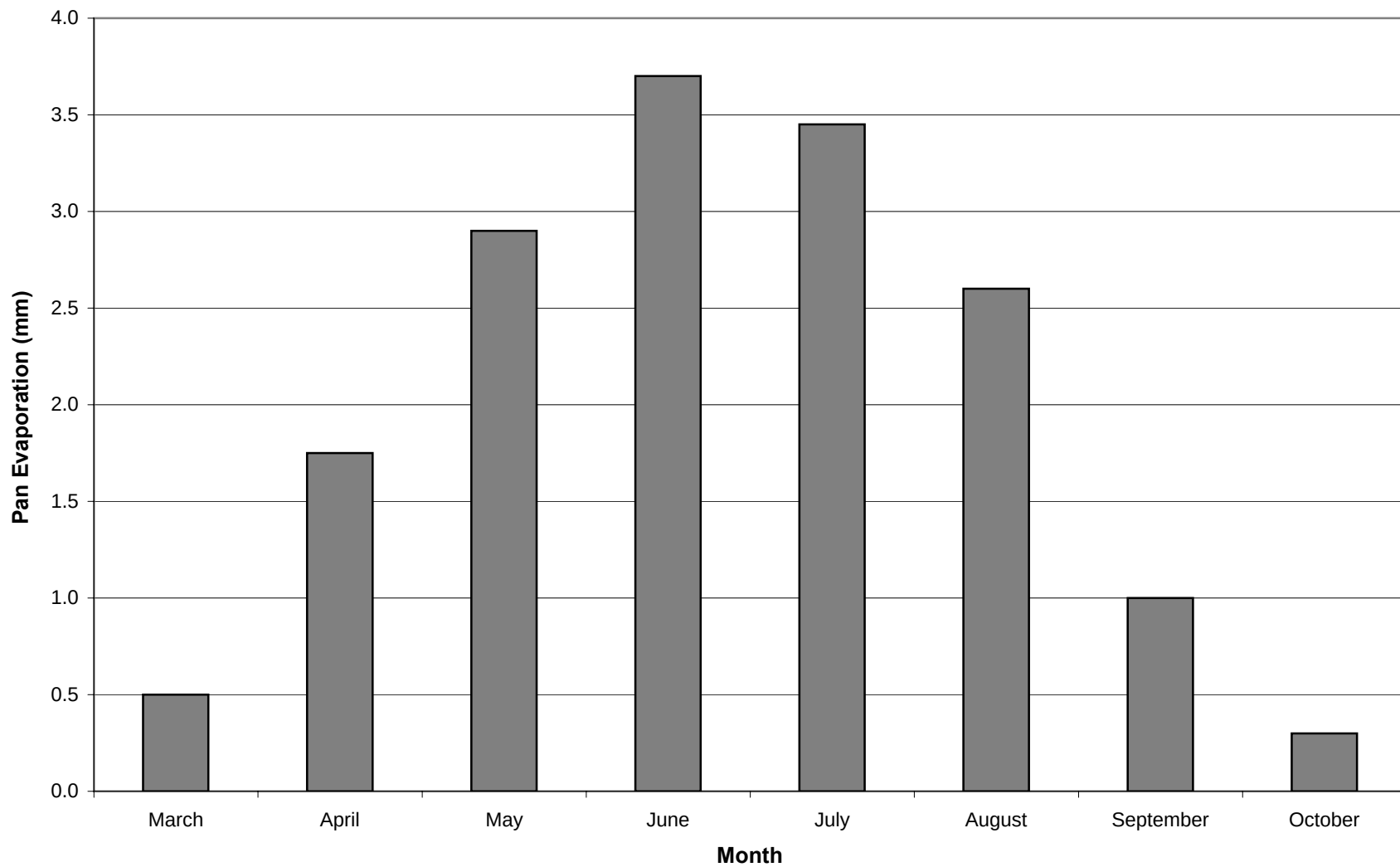
**Average Relative Humidity
Used in SoilCover Modeling**

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FIGURE
5



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Anvil Range Mining Complex

**Average Evaporation Used
in SoilCover Modeling**

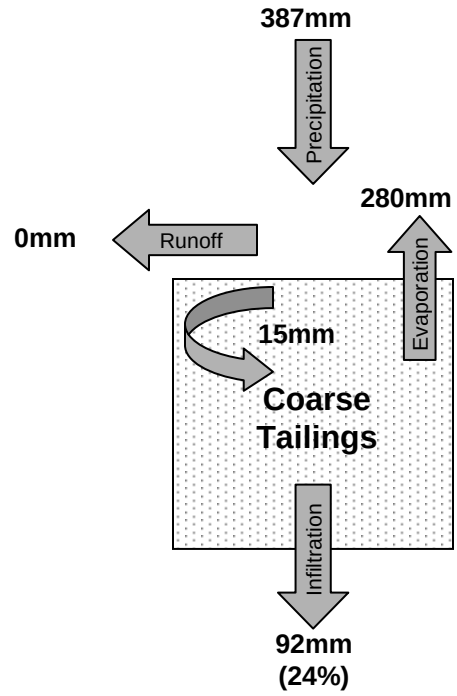
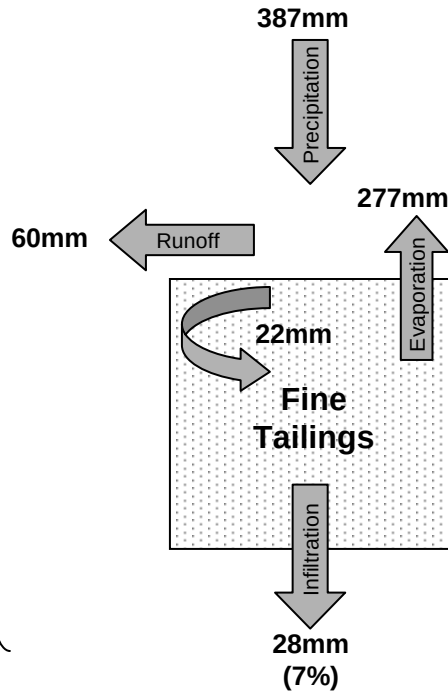
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FIGURE

**Full
Year**



**Freshet
Period**

