

ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT

Addendum

Prepared for

Deloitte & Touche Inc.

On behalf of

Faro Mine Closure Planning Office

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KLOHN CRIPPEN



June 26, 2006

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Mr. Doug Sedgwick

Dear Mr. Sedgwick:

**Anvil Range Mining Complex, Yukon
Rose Creek Tailings Impoundment
Seismic Stability Assessment Addendum**

Enclosed is the Seismic Stability Assessment Addendum which adds to the first seismic stability report on the tailings retention dams which was issued on March 31, 2006. The first report is based on site investigations done in 2004 while this report is based on site investigations done in 2005. Together these two reports present the seismic stability of the Cross Valley, Intermediate and Secondary Dams.

Yours truly,

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EXECUTIVE SUMMARY

This is an addendum to the March 31, 2006 report entitled “Rose Creek Tailings Impoundment, Seismic Stability Assessment, Intermediate and Secondary Dams” The field work for that report was completed in 2004. That report recommended further work at the Intermediate Dam and the Secondary Dam – East Limb which this addendum completes. The seismic vulnerability of the Cross Valley Dam is also addressed in this addendum.

The Cross Valley Dam is downstream of the Intermediate Dam. The Cross Valley Dam is a conventional water retaining dam with a spillway on the right abutment. The dam has a central impervious core, filters, and an upstream blanket to reduce foundation seepage. The dam retains a polishing pond which inundates the toe of the Intermediate Dam at its maximum section on the left abutment. The Intermediate and Secondary Dams retain tailings which prevents dam breach by a failure of the upstream slope. Therefore, the cost of remediation has only considered the downstream slopes of these two dams. Because the Cross Valley Dam retains water, not tailings, both the upstream and downstream seismic stability has to be considered to prevent breach.

The former Rose Creek channel made an abrupt north turn near the alignment of the Cross Valley Dam which means most of the supporting foundation soils are Recent Rose Creek alluvial sediments. Three closed Becker Penetration Tests (BPT) and one mud rotary hole with Standard Penetration Tests (SPT) and Large Penetration Tests (LPT) were completed to obtain penetration data in the foundation soils. The energy transferred to the Becker casing was measured at all three BPTs by a qualified consultant. Problems with rig misfires in 2004 did not happen during the 2005 program.

The 2005 field investigation together with the test hole logs available from the foundation investigations for the original 1979/1980 investigations show Rose Creek alluvial sediments over denser alluvial sediments over glacial till on rock at the Cross Valley Dam. Only the Recent Rose Creek alluvial sediments are liquefiable. The uppermost soils at the toe are dense in some test holes which is likely due to construction activities.

The liquefiable zones of the foundation soils must be remediated to prevent failure of the Cross Valley Dam during the Maximum Credible Earthquake (MCE), the seismic design motions for this structure. The liquefiable sections of the foundation include zones of interlayered silts and sands. These silts are generally low to non-plastic. Recent work by Bray et al (2004) indicate that these silts are liquefiable but past criteria indicate the liquefaction potential to be marginal. Potentially liquefiable silts are difficult or expensive to improve. Because there is controversy in the literature about the liquefaction potential of silts and because remediation is expensive, cyclic simple shear

tests on undisturbed samples of silts should be conducted to assess liquefaction susceptibility directly.

For the purposes of this report, we assume the silts will liquefy. Similar silts were found within the terrace deposits of the Intermediate Dam in 2004. In that case, we judged that the silts were not liquefiable. The recent work by Bray may be contradictory but the limited extent of that terrace silt horizon means that any incipient failure surface must pass through non-liquefiable soils whose strength should be sufficient to prevent failure. In the case of the Cross Valley Dam, the silts are widespread and interlayered with liquefiable sands so the silts were assumed to be liquefiable.

There was no possibility of investigation of the foundation soils of the upstream slope of the Cross Valley Dam because of the polishing pond. We assumed that the foundation soils were largely similar to those beneath the downstream toe as appropriate for the 1979/1980 test holes in the upstream area.

We estimated the cost of remediation of the upstream and downstream toe area of the Cross Valley Dam at about \$7 M using a combination of compaction grouting in the silts and explosive compaction in the sands and gravels. This cost assumes that the polishing pond can be emptied to allow construction in the dry and includes repair of the upstream blanket after ground improvement. We also estimated the cost of vibroreplacement for both the upstream and downstream slopes at about \$9 M. This assumes that the change to the foundation seepage regime is acceptable and that the impervious blanket is excavated and replaced. Both the upstream and downstream foundation improvement options include a stabilizing toe berm.

In the 2004 investigations it was found that the Recent Rose Creek alluvial sediments beneath the maximum section of the Intermediate Dam were not liquefiable. Elsewhere the Recent Rose Creek alluvium was found to be liquefiable. To check this apparently contradictory result, two more BPTs and SPTs/LPTs were conducted at the Intermediate Dam with the same result. The Recent Rose Creek alluvial sediments at the Intermediate Dam are not liquefiable so remediation is not necessary for present conditions.

There is no change to our conclusions regarding the seismic stability of the Secondary Dam West Limb. If the tailings are left on the downstream toe, the dam will be stable during a major earthquake. If the tailings are removed, remediation will be required at the estimated costs given previously.

Two more BPTs were conducted on the East Limb which identified a more extensive zone of liquefaction. These soils are largely loose sands and loose sands and gravels. The soils and the configuration of the downstream slope of the dam are conducive to dynamic compaction which is estimated to cost \$900K.

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1. INTRODUCTION

This is an addendum to the seismic stability report issued by Klohn Crippen in March 2006 which was based on field work done in summer 2004. This addendum arose out of the recommendations of that tailings seismic stability report (which is referenced as 2004/2005 report in this report) and the subsequent need to evaluate the seismic vulnerability of the Cross Valley Dam which retains the polishing pond whose eastern shore inundates the toe of the Intermediate Dam. The Intermediate Dam together with the up valley Secondary Dam retains all of the tailings from the closed mill. These structures have been classified as high hazard on the basis of downstream environmental losses in the Pelly and Yukon Rivers should failure occur. For the purposes of this report, we will treat the Cross Valley Dam as a high hazard structure.

The seismic assessment work in the 2004/2005 report arose out of a seismic hazard assessment by Dr. Gail Atkinson which identified post-glacial movements along the nearby Tintina Fault which increased the seismic hazard beyond that used in most past designs. This led to the cone penetration tests by Golder Associates in the tailings themselves and the 2004 investigations in the foundation soils of the Intermediate Dam and the Secondary Dam, East and West Limbs. That work showed that the tailings were liquefiable under the design earthquake which was set at the MCE level. The foundation investigations and review of historic data showed that the uppermost foundation soils consisted of Recent Rose Creek sediments and a terrace deposit which existed primarily on the north side of the Rose Creek Valley. In general, the Rose Creek sediments with one exception were found in the 2004 investigation to be liquefiable while the terrace deposits were not.

Recent Rose Creek sediments occur beneath the Secondary Dam alignment at two locations. At the West Limb location, there are tailings on the downstream toe of the Secondary Dam which would prevent failure during the MCE design loads even if the

foundation soils liquefy. At the East Limb location, there are no tailings at the toe. Liquefaction of the foundation soils would lead to failure of the dam and loss of tailings unless the dam section is improved. One component of the 2005 field investigations was to determine the extent of the liquefiable zone at the East Limb to improve the cost estimates for remediation as given in the 2004/2005 report.

The Rose Creek sediments beneath the Intermediate Dam were found not to be liquefiable in the 2004 field investigations. This was contrary to the findings for the Secondary Dam so parts of the field investigations in 2005 were devoted to further investigations of the penetration resistance through the Rose Creek sediments on the south side of the dam.

At the Cross Valley Dam, the former Rose Creek channel abruptly turns north so that most of the alignment is over Recent Rose Creek sediments. Most of the drilling program was devoted to investigation of the liquefaction resistance of the Cross Valley foundation soils.

As with most historic mining sites in Canada, there are several elevation datums and drawings are in both Imperial and SI units. In this report we use SI units unless specifically noted and the mean sea level datum. The site UTM grid is used on all drawings in this report. In the tailings area there is the Down Valley Datum which is converted to mean sea level by subtracting 32 m or 106.0 ft. The surveyors reported borehole locations to mean sea level and the UTM grid. There is also a mine datum which is converted to mean sea level by subtracting 33.3 m or 109.2 ft.

The next section describes the 2005 field program. Section 3 describes the foundation stratigraphy beneath the Cross Valley Dam, the liquefaction potential of the foundation soils, the potential for failure of the existing structure during design seismic loading, and

the characteristics and cost of remedial measures to prevent a failure. Section 4 compares the 2005 penetration test results to those obtained in 2004 at the Rose Creek section of the Intermediate Dam alignment. Section 5 describes the 2005 penetration resistances obtained at the East Limb of the Secondary Dam and adjusts the remedial costs for this new data. Section 6 is a summary of remediation costs.

2. 2005 FIELD INVESTIGATIONS

Test holes drilled for the design and construction of the Cross Valley Dam are shown in plan on Figure 2.1. These test holes used conventional Standard Penetration Testing (SPT) to obtain foundation samples and penetration resistance. Most of the test holes were taken through the Rose Creek sediments into the underlying glacial till horizon. The SPT procedures were done using conventional practice for the time. The data is considered reliable.

The intent of the 2005 investigations was to provide penetration resistance values that could be used to calculate the liquefaction resistance of the foundation soils. As for the 2004 investigation program at the Intermediate and Secondary Dams, the Becker Penetration Test was chosen because it can penetrate coarser and denser soils than the more common SPT and Cone Penetration Tests (CPT). The Becker field procedures and data interpretation are described in the 2004/2005 report. In the 2004 field investigation, the Becker diesel hammer repeatedly misfired causing some data interpretation difficulties. In 2005, the Becker Hammer functioned properly. Also, many more direct energy measurements were made by Mr. Bert Miner, a qualified PDA subconsultant, than in 2004.

Foundex Exploration supplied an HAV-180 Becker Penetration rig for the 2005 program. This same Becker Penetration rig was used for the 2004 exploration program. The Becker penetration test involves driving a 6 5/8 inch diameter closed ended casing into the ground using a single acting diesel hammer. The resulting resistance to penetration which is expressed as blows per foot can be correlated to liquefaction resistance. The liquefaction procedure based on Becker blowcounts is described in our report.

The Becker Penetration program started in the field on Monday August 15, 2005 and ended on Wednesday August 31, 2005. The program started at the Intermediate Dam on

the downstream 1031 m berm at BPT05-01, a closed ended Becker Penetration Test. Energy measurements were made by Mr. Bert Miner with a PDA unit at this and the next closed ended Becker Penetration Test, BPT05-02 at the Intermediate Dam. The Becker closed ended pipe could not be driven through the compacted berm fill. To reach the foundation soils through the compacted fill, the Becker open ended casing was used to create a hole which was backfilled with pea gravel as the casing was pulled. The closed ended Becker was then driven through the gravel filled hole. The blowcounts were recorded but are meaningless.

At the end of the program, the Becker rig was moved back to the Intermediate Dam where an open Becker was used to penetrate to the foundation soils at BPT05-01 where four (4) SPTs were conducted in the upper part of the foundation soils. This open hole was labelled BKS05-08. Together BPT05-01 and BKS05-08 are shown on the same test hole log as BK05-01.

At the Cross Valley Dam, three closed ended Becker tests were completed; BPT05-03, BPT05-04, and BPT05-05. Open Beckers were completed at BPT05-03 and BPT05-04. At BPT05-05, a mud rotary hole was completed nearby, DH05-01, where SPTs were taken at 1.5 m intervals to 18.3 m, below which LPTs were taken at the same depth interval to the bottom of the hole at 27.8 m. Energy measurements were made by Mr. Bert Miner on all BPTs at the Cross Valley Dam as well as the SPTs. At DH05-01 energy measurements were made on all SPTs and LPTs.

Two closed Beckers, BPT05-06 and BPT05-07 were completed at the East Limb of the Secondary Dam. The first BPT at the East Limb had to be abandoned because the casing refused on a boulder. Open Beckers were done opposite both closed Beckers. Energy measurements were not done at these locations. Bounce chamber pressures were

measured and, as at all other closed Beckers, the pull up force on the casing was measured as the hole was advanced.

As stated above, in 2004 the Becker rig diesel hammer mis-fired routinely creating uncertainty about the actual penetration resistance. In 2005 the Becker rig did not misfire. Additionally, energy measurements were made at the first five closed Becker holes and energy measurements were made at the majority of SPT and LPTs. This additional effort has eliminated much of the uncertainty surrounding the energy corrections used in the 2004 work. In general, the 2005 penetration results confirmed those obtained in 2004.

3. CROSS VALLEY DAM

3.1 Dam Configuration

The Cross Valley Dam was constructed as part of the Down Valley Project in the early 1980s to expand the tailings disposal capacity in the Rose Creek Valley. The Cross Valley Dam was constructed to retain a tailings water polishing pond downstream of the Intermediate Dam. The embankment is a conventional water retaining dam with no retained tailings. Figure 3.1 shows the design section of the Cross Valley Dam.

The crest of the dam is at El. 1034 m and the downstream toe is at El. 1016 m (nominal). The height of the dam is about 18 m above existing grade. The polishing pond was at El. 1030.8 m during the 2004 investigations. The dam section is a central impervious core supported by upstream and downstream granular shells at slopes of 2H:1V. The core and downstream shell are separated by a chimney drain which connects to a blanket drain to the toe. There is also a chimney drain on the upstream side of the core.

The central impervious core connects to an impervious upstream blanket which extends beneath the upstream shell to 60 m upstream of the toe. The core was extended a few meters into existing ground below stripped grade. This nominal cutoff and upstream blanket were designed to reduce seepage through the foundation soils. There are no other cutoffs into the previous Rose Creek sediments.

The evidence is that the dam is well designed and well constructed with no obvious performance deficiencies. The dam fill was compacted so it will not liquefy during a major earthquake, irrespective of seismic intensity. We note that the 1031 m berm could not be penetrated by the closed ended Becker rig without pre-drilling. This seismic investigation concentrated on determining the strength characteristics of the foundation soils.

3.2 Foundation Conditions

Our interpretation of the foundation conditions above the glacial till and rock valley bottom is shown on Figure 3.2. This figure is based on the original longitudinal section along the dam alignment prepared for the Down Valley Project which included the Cross Valley Dam. In contrast to the alignment of the Intermediate Dam and the West Limb of the Secondary Dam where only a portion of the alignment rests on Recent Rose Creek sediments, virtually the entire foundation of the Cross Valley Dam is founded on Recent Rose Creek sediments. This is because Rose Creek bends to the north abruptly at the alignment of the Cross Valley Dam.

The section shown in Figure 3.2 is along the downstream toe of the dam where most of the historic and all recent ground information was obtained. Because the Cross Valley Dam is a water retaining dam, the upstream slope could also fail through the foundation during a major earthquake. There were no investigations in the upstream foundation because the polishing pond would have to have been drained or drilling done from a barge. Also the dam includes an impervious upstream blanket which would have to be penetrated and repaired.

In addition to the historic data and the recent Klohn Crippen Becker penetration and sampled mud rotary hole, several groundwater monitoring holes were installed at virtually the same time in August 2005. These holes were advanced using a Sonic rig and the cores were laid out on the ground for our inspection. Samples for laboratory testing were taken from the Sonic core and those results are given in Appendix II.

As described, most of the alignment of the dam is along the recent channel of Rose Creek. The uppermost soils are alluvial sands and gravels with silt layers which are abandoned in-filled meander channels. We expect these post-glacial soils to be loose and liquefiable. A loose granular surface layer to about 2 m followed by a denser, non-liquefiable layer to about 5 m was encountered in the BPTs along the downstream toe.

The original test holes in the late 1970s show muskeg and soft soils at the surface in most holes. These soils were not encountered in the 2005 test holes which mean they were stripped from beyond the toe of the dam during construction. We would expect that the base of the stripped excavation was proof rolled after stripping which may explain the denser soils to 5 m below current grade.

The original test hole logs show frozen soils in some holes. Thermistor strings were installed in two holes. Frozen soils were not encountered in the 2004 and 2005 test holes.

Below these uppermost, compacted soils are the loose alluvial sands and silts of the Rose Creek sediments. Many more silt layers were encountered along this dam alignment than along the Intermediate and Secondary Dams. At DH05-01, the silt was up to 6 m thick. In test hole DH05-01, seven silt samples between 8.78 and 14.02 m had water contents which ranged from 21.7% to 33.6%, averaging 29.1%. The liquid limit varied from 22 to 34% while the plastic limit varied from 19% to 22%. The soil is classified as a low plastic silt to clay. Generally the unit has increasing fines and plasticity with depth. At the base of the unit, the silt is 98% passing the No. 200 sieve with 17 % clay sizes.

The sand and gravel horizons are all well-graded with between 5 and 10 percent passing the No. 200 sieve in general. This percent is based on SPT samples where the larger sizes cannot be captured.

The silt deposits have oxbow lake shapes (in plan) and occur at different elevations. These silts will not be continuous as typically are lacustrine silts and clays. The parallel alignment of the dam and the former creek channel together with loose interlayered sands and gravels makes it convenient to map these as a single loose, or potentially, liquefiable unit on Figure 3.2.

Beneath the Recent Rose Creek sediments are denser, non-liquefiable sands and gravels. These typically rest on glacial till and rock. At BH79-21, there is a dense silt deposit at 7 to 15 m depth from original grade. This interbedded sand and silt layer has high blowcounts and is not liquefiable.

The stratigraphy shown on Figure 3.2 roughly follows the traditional geological facies distinction of Recent alluvial, Pleistocene alluvial and Pleistocene glacial till deposits. Within the Recent alluvial or Rose Creek sediments we have distinguished between the uppermost denser alluvial deposits and the underlying looser deposits. Almost certainly, the uppermost denser alluvial deposits have been densified by construction activities.

3.3 Seismic Ground Response

One dimensional total stress site response analyses were carried out at three locations (BPT05-03, BPT05-04 and BPT05-05) on the Cross-Valley Dam for conditions with the dam (i.e. through the dam crest) and without the dam (i.e. through the dam toe) using the computer program PROSHAKE (Edupro Cicil Systems, 2005), which is very similar to the computer program SHAKE (Idriss and Sun, 1992). The soil classification data and the equivalent SPT $(N_1)_{60}$ from the adjacent open-end Becker test holes and drill holes were used to estimate soil properties for site response analyses.

All six natural earthquake records recommended by Atkinson (2003) were used as input motions in the site response analyses. This same set of records was used in the analyses in the 2004/2005 report for the Intermediate Dam and the Secondary Dam.

Figure 3.3 shows the peak acceleration profiles through the dam crest from the PROSHAKE analyses at BPT05-03, BPT05-04 and BPT05-05. Each of these three profiles uses the ground conditions at the respective Becker holes but corrected for the weight of the dam fill. The peak accelerations within the dam fill at BPT04-03, where no silt was present in the foundation, are generally amplified. However, the presence of silt

within the foundation soils at BPT05-04 and BPT05-05 causes significant deamplification as can be seen from Figure 3.3.

Figure 3.4 shows the acceleration profiles at the toe of the dam from PROSHAKE at the same BPT locations. The acceleration at the surface at BPT05-03 is amplified but the amplification factors are higher than those for the response at the dam crest. At BPT05-04 and BPT05-05, the motions at the surface are deamplified and the deamplification factors are slightly smaller.

3.4 Initial Liquefaction Assessment

The liquefaction assessment of granular soils (sand and gravel) at the Cross Valley Dam was evaluated using the same approach used to evaluate the liquefaction potential of foundation soils at the Intermediate Dam and the Secondary Dam as described in the 2004/2005 report. In this approach, cyclic stress ratios (CSRs) induced by the design earthquake are compared with the cyclic resistance ratios (CRRs). The CSRs were computed from the results of one dimensional total stress site response analyses described above. The CRRs were evaluated based on the SPT (N1)60 values derived from the measured BPT, SPT or LPT data. The procedure outlined in Youd et al. (2001) was used to determine the CRRs using the SPT (N1)60. Appendix V describes the details of the interpretation of BPT, LPT and SPT data to determine the equivalent SPT (N1)60 blow counts. Appendix VI describes the site response analyses and liquefaction assessment.

Figures 3.5 shows the liquefaction evaluation in the foundation soils beneath the dam crest and Figure 3.6 shows the same at the dam toe. The earthquake induced CSRs are expressed in terms of the required (N1)60 to prevent liquefaction in Figures 3.5 and 3.6 for the six earthquake records. The required (N1)60 were determined from the results of the site response analyses as explained in Appendix VI. The (N1)60 converted following the method by Sy (1997) from measured Becker Blow Counts at BPT05-03, BPT05-04

and BPT05-05 are shown in Figures 3.5 and 3.6 together with the (N1)60 from the measured SPTs and LPTs at the drill hole DH05-05 and LPTs at the open Becker holes at BKS05-03 and BKS05-04. For comparison, the converted (N1)60 from the 2004 Becker test BPT05-14 which was located close to BPT05-05 are also shown. (N1)60 from the measured SPTs and LPTs generally agree with the (N1)60 converted following the method by Sy (1997) from measured Becker blow counts.

The potentially liquefiable zones during the design earthquake are shaded in yellow in Figures 3.5 and 3.6. Although the required (N1)60 to prevent liquefaction triggering is slightly higher at the dam toe than beneath the dam crest, the extent of the liquefaction is approximately the same at both locations. As evident from Figures 3.5 and 3.6, extensive liquefaction is expected to occur between El. 1011 and 1003 in BPT05-03, between El. 1008 m and El. 995 m in BPT05-04, and between El. 1008 m and El. 1001 m in BPT05-05. Moderate to marginal liquefaction was predicted between about El. 1001 and El. 995 in BPT05-03 and between about El. 996 m and El. 992 m in BPT05-05.

The liquefiable zones shaded in Figures 3.5 and 3.6 at BPT05-04 and BPT05-05 included layers of silty soil present at these holes below El. 1008 m. The liquefaction potential of these silty layers is discussed below.

The liquefaction potential of the silt layers was evaluated using the Chinese criteria (Seed and Idriss, 1982), Andrews and Martin (2000) criteria and Bray et al. (2004) criteria. SPT and LPT samples from the silt layer in DH05-01 and a sample from the open Becker in BKS05-04 were tested in the laboratory for grain size, Atterberg limits and moisture content (see Appendix III for laboratory test results). These data were used in the screening for liquefaction and Figure 3.7 shows the liquefaction assessment.

The Chinese and Andrews and Martin criteria for liquefaction suggest that this silt layer is not liquefiable due to its high clay content but recommend further testing for most

samples. However, the Bray et al. criteria suggested the silt layer is liquefiable. Note that Bray et al. (2004) argue that it is not the amount of clay-size particles in the soil, but rather the percent of clay minerals that best indicate the liquefaction susceptibility. Hence, they used the plasticity index and the ratio of water content to the liquid limit in their proposed criteria, and excluded the clay content. Sannin and Wijewickreme (2005) also noted, based on their cyclic simple shear testing on the Fraser river silt, that the empirical criteria that use plasticity parameters and water content (e.g. Bray et al. 2004) has a better ability to capture liquefaction susceptibility than the criteria that use grain size. Laboratory cyclic simple shear or cyclic triaxial tests on good quality silt samples are necessary to investigate the behaviour of this silt under the cyclic loading before ground improvement options are advanced. However, in the absence of such data, it was conservatively assumed that the silt layer is liquefiable.

3.5 Seismic Stability

Flow liquefaction stability analyses were carried out on representative sections of the Cross Valley Dam to determine the potential for flow sliding and the factor of safety (FOS). Both upstream and downstream slopes of the dam were analyzed. Details of the analyses are presented in Appendix VII. The computer program Geo Studio Office (Geo-Slope, 2005) and the Morgenstern-Price method were used in the analyses.

Figure 3.2 shows the interpretation of the foundation conditions above the glacial till and the rock valley bottom. The measured Becker below count (N_b) profiles from the Becker penetration holes and the SPT (N_1)₆₀ profiles from the test holes located near the downstream of the dam are also shown in Figure 3.2. As can be seen from Figure 3.2, the upper most layer within the dam foundation is generally dense sands and gravels. The second layer, which consists of interbedded silts and/or silty sands and gravels is generally loose and is potentially liquefiable under the design earthquake. The thickness and sequence of silt, sand and gravel in this interbedded layer vary significantly along the

dam axis. The third layer in Figure 3.2 is generally dense and consists mainly of sands and gravels. Thus, stability analyses of representative sections of the Cross Valley Dam were conducted to evaluate the effect of the liquefaction of the second layer. Due to the limited data, the foundation conditions and the liquefaction potential at the downstream toe where most new site investigation data were collected were assumed across the dam axis including the area near the upstream toe and the models for the stability analyses were generated accordingly. The variable nature of the layering, thickness and sequence of silts, sands and gravels within the potentially liquefiable layer were considered in the design of conceptual remedial measured by carrying out sensitivity analyses.

The loose sand, gravel and silt layers that would liquefy under the design earthquake motions beneath the dam were assigned post-liquefaction residual strengths. The residual strength of the sand and gravel layers were estimated based on the mean $(N_1)_{60}$ values using the correlation proposed by Idriss (2004). The residual strength of the sand and gravel layers was set to 10% of the initial effective overburden stress in the stability analyses (i.e. $S_{ur}/\sigma_{vo}'=0.1$).

As described in the previous section, the silt layers were assumed to liquefy under the design earthquake loading and their residual strength was estimated using the correlation proposed by Stark and Olson (2002) between the mean $(N_1)_{60}$ and the residual strengths. The residual strength of the silt layers was set to 8% of the initial effective overburden stress. (i.e. $S_{ur}/\sigma_{vo}'=0.08$) in the stability analyses. The more dense foundation sand and gravel layers with a mean $(N_1)_{60}$ greater than 22 that are expected to have marginal or no liquefaction were assigned an unreduced frictional strength of 35 degrees with no cohesion in the analyses

Table 3.1 summarizes the Factor of Safety against flow liquefaction for the Cross- Valley Dam. The stability sections are presented in Appendix VII.

Table 3.1 Post-Liquefaction Factors of Safety of Unremediated Cross Valley Dam with the Polishing Pond

Section	Liquefaction Potential	Condition	Post-Liquefaction Factor of Safety (Morgenstern-Price)
Near BPT05-04	Liquefaction of foundation silts, silty sands and gravels between El. 1008 m and El. 995 m.	Downstream Slope	0.60
		Upstream Slope	1.09
Near BPT05-03	Liquefaction of foundation silts, silty sands and gravels between El. 1011 m and El. 1003 m.	Downstream Slope	0.54
		Upstream Slope	0.94

The calculated Factors of Safety for the downstream stability at both sections are much less than 1.0, and therefore flow sliding and/or large displacements are expected to occur under the design earthquake. Remedial measures are required at the downstream slope to improve the stability and to achieve a minimum post-liquefaction FOS of 1.1. The post-liquefaction FOS for the upstream slope at both sections is much higher than that for the downstream slope. However, the Factor of Safety was less than 1.0 at the section near BPT05-03 and slightly less than 1.1 at the section near BPT05-04. Therefore, remedial measures will still be required at the upstream slope.

A remediation scheme consisting of a toe berm and in-situ densification of the potentially-liquefiable foundation soils was considered to improve both the downstream and upstream stability of the dam. Figure 3.8 shows the plan and elevation view of the proposed conceptual remediation scheme. To obtain the dimensions of the remediation schemes, seismic stability analyses were carried out with higher strengths in the improved zones. It was assumed that the densified soils would not trigger liquefaction. Friction angle of 35 degrees was assumed for the compacted berm and the densified foundation sand and gravel and 25 degrees was assumed for the foundation silt.

Table 3.2 summarizes the results of the post-liquefaction stability analyses with the proposed remediation schemes. More details of the analyses are presented in Appendix VII.

Table 3.2 Stability Analyses Results for Existing and Remediated Slopes - Cross Valley Dam

Section	Case	Proposed Remediation Scheme	Post-Liquefaction FOS (M-P)	
			Existing	Remediated Section
Near BPT05-04	Downstream Slope	30 m wide in situ densification and 25 m x 8 m toe berm	0.60	1.25
	Upstream Slope	10 m x 5 m toe berm	1.09	1.17
Near BPT05-03	Downstream Slope	30 m wide in situ densification and 25 m x 8 m toe berm	0.54	1.54 (1.13) ^a
	Upstream Slope	8 m wide in situ densification and 10 m x 5 m toe berm	0.94	1.40 (1.15) ^a

^a Based on sensitivity analyses where the potentially liquefiable layer was treated as silt layer instead of sand and gravel layer to account for the variability of soils and to ensure the robustness of the remediation scheme.

3.6 Remediation Cost

Figure 3.8 shows the plan and elevation view of the proposed conceptual remediation scheme for the Cross Valley Dam. The following two options were considered for the densification of foundation loose soils consisting of silts, silty sands and gravels.

Option 1: Vibroreplacement

Option 2: Explosive compaction and compaction grouting.

Tables 3.3 and 3.4 shows the cost estimate for the two options. Both options would require a toe berm at the upstream and downstream in addition to the foundation densification. For the vibroreplacement option, it was assumed that stone columns can improve the foundation loose soils either through densification or drainage and so that design strength parameters can be achieved. We note that vibroreplacement densification of silts is not possible. The top layer overlying the loose soils may require pre-augering to disturb or softens the soils so that the vibro-probe can reach the loose soils. The vibroreplacement cost includes pre-augering of top dense soils, backfill of stone columns, densification of both the top dense zone and the loose zone beneath the dense zone.

Table 3.3 Cost Estimate for Remedial Option 1 with Berm and Vibroreplacement for the Cross Valley Dam

Item No.	Description of Work	Unit	Qty.	Unit Cost	Total Cost (\$ CAD)
1	Mob and demob of equipment and crew	ls	1	150,000	150,000
2	Vibroreplacement-Downstream	m ³	180,000	25	4,500,000
3	Vibroreplacement -Upstream	m ³	34,000	25	850,000
4	Downstream Toe Berm	m ³	80,000	5	400,000
5	Upstream Toe Berm	m ³	24,000	5	120,000
6	Removal and Replacement of Upstream Blanket	ls	1	75,000	75,000
7	Verification BPT/SPT Testing	ls	1	50,000	50,000
8	Environmental Protection Measures	ls	1	50,000	50,000
				Subtotal	6,195,000
9	Design and Project/Construction Management @ 12%	ls	1	743,400	743,400
				Subtotal	6,938,400
10	Contingency (minimum 30% recommended)	allow	1	2,081,520	2,081,520
				Total	9,019,920

Say 9,000,000

Notes:

1. Unit cost for stone columns include cost for pre-augering and stones
2. Pond level has to be lowered to allow ground improvement to be done in the dry (U/S blanket removal and reconstruction). No cost is included for lowering the pond level
3. Drain layer may be needed beneath blanket if natural sand and gravel is not present
4. Mob and demob will be lower if crane for dynamic compaction at the Secondary Dam East Limb is mobilized

In the Option 2, explosive compaction was considered to densify the loose sands and gravels and compaction grouting for the foundation silts since the explosive compaction will not be effective in the silts. The available data at the downstream of the cross-valley dam are insufficient to clearly define the extent and the thickness of foundation silts. Thus, at the conceptual level, it was assumed that one-third of the densification has to be done by compaction grouting and the remaining two third can be done by explosive compaction. An estimated unit rate of \$15 and \$60 dollars per cubic meter were used for explosive compaction and compaction grouting, respectively. During the detail design stage, a comprehensive site investigation program will be required to define the extent of the loose silty zones. We have also included a contingency of 30 % and a project

monitoring fee of 12%. Note that all cost estimates section are based on information available to date and are only our opinion of probable cost for budgetary purposes. Actual cost depends on many factors which can change with time, including site and market conditions at the time of construction. The cost range for this design level could be $\pm 50\%$.

Table 3.4 Cost Estimate for Remedial Option 2 with Berm and Explosive Compaction and Compaction Grouting for the Cross Valley Dam

Item No.	Description of Work	Unit	Qty.	Unit Cost	Total Cost (\$ CAD)
1	Mob and demob of equipment and crew	ls	1	100,000	100,000
2	Densification Zone-Downstream	m ³	111,000	30	3,330,000
3	Densification Zone-Upstream	m ³	23,000	30	690,000
4	Downstream Toe Berm	m ³	80,000	5	400,000
5	Upstream Toe Berm	m ³	24,000	5	120,000
6	Removal and Replacement of Upstream Blanket	ls	1	75,000	75,000
7	Verification BPT/SPT Testing	ls	1	50,000	50,000
8	Environmental Protection Measures	ls	1	50,000	50,000
				Subtotal	4,815,000
9	Design and Project/Construction Management @ 12%	ls	1	577,800	577,800
				Subtotal	5,392,800
10	Contingency (minimum 30% recommended)	allow	1	1,617,840	1,617,840
				Total	7,010,640

Say 7,000,000

Notes:

1. About 1/3 of densification will be done using compaction grouting due to the presence of silt and the remaining 2/3 using explosive compaction
2. Pond Level is lowered to allow ground improvement to be done in the dry (U/S blanket removal and reconstruction)

4. INTERMEDIATE DAM

4.1 Background

The drilling program at the Intermediate Dam was designed to check the Becker penetration resistance values that were obtained in the 2004 investigation program. All test holes were located on the downstream side of the dam on the 1031 m berm at about El. 1030 m berm. Two closed Becker penetration tests were completed, BPT05-01 and BPT05-02. The locations of these test holes are shown on Figure 2.1. The energy delivered to the Becker casing was monitored for both tests by Mr. Bert Miner. BKS05-08 was drilled at the end of the program to obtain SPT/LPT data.

The stratigraphic interpretation did not change as a result of this further work. Figure 4.1 shows an updated section. The liquefaction assessment procedures follow that described in the 2004/2005 report.

4.2 Site Response Analyses and Initial Liquefaction Assessment Update

One dimensional total stress response analyses were carried out using the newly acquired information from the 2005 site investigation at BPT05-01 and BPT05-02, which were located south of the 2004 Becker holes BPT04-01 and BPT04-10 on the Intermediate Dam. The analyses were carried out for conditions with (i.e. through the dam crest) and without the dam (i.e. through the dam toe) using the computer program PROSHAKE (Edupro Civil Systems, 2005). As for the 2004/2005 report, analyses were carried out using the six natural earthquake records recommended by Atkinson (2003).

Figures 4.2 and 4.3 show the peak acceleration profiles for conditions through the dam crest and through the dam toe from PROSHAKE analyses at BPT05-01 and BPT05-02. For comparison, the results from the analyses at BPT04-10 are also shown. The response at BPT05-01 and BPT05-02 generally agrees with the response at BPT04-10. The

surface accelerations are generally amplified. However, the amplification factors for the column through the dam toe are much higher than those for the response at the dam crest (1.8 and 1.2 for columns through the toe and crest, respectively). Note that the PROSHAKE and SHAKE analyses use an equivalent linear total stress approach. The yielding in soils that may occur when the induced stresses exceed the soil strength and when development of excess pore water pressures leads to loss in the strength and stiffness of the soils are not modeled in SHAKE analyses. Thus, the predicted accelerations and shear stresses are generally high or conservative.

Figures 4.4 shows the liquefaction evaluation in the foundation soils beneath the dam crest and Figure 4.5 shows the same at the dam toe. The method of assessment is same as that was used for the Cross Valley Dam. The earthquake induced CSRs are expressed in terms of the required $(N_1)_{60}$ to prevent liquefaction in Figures 4.4 and 4.5 for the six earthquake records. The $(N_1)_{60}$ values converted following the method by Sy (1997) from the measured Becker Blow Counts at BPT05-01 and BPT05-02 are shown in Figures 4.4 and 4.5. For comparison, the converted $(N_1)_{60}$ from the 2004 Becker test BPT05-01 and BPT05-10 are also shown. $(N_1)_{60}$ from the measured SPTs at the open Becker hole BKS05-08, which was located close to BPT05-01, are also shown. They agree well with the equivalent $(N_1)_{60}$ values corresponding to Becker blow counts at BPT05-01.

Figures 4.4 and 4.5 show that the liquefaction will not be triggered during the design earthquake at BPT05-01 and BPT05-02. Thus, the additional information gathered from BPT05-01 and BPT05-02 confirm that the Rose Creek sediments at the Intermediate Dam are dense and are unlikely to liquefy during the design earthquake. Therefore, no remedial measures are required at the Intermediate Dam.

5. SECONDARY DAM – EAST LIMB

5.1 Background

Two Becker closed penetration tests were completed at the East Limb of the Secondary Dam east and west of the 2004 Becker hole BPT04-13 to investigate the extent of the liquefiable zone identified in BPT04-13. The revised stratigraphy is shown on Figure 5.1.

5.2 Initial Liquefaction and Seismic Stability Assessment Update

Total stress response analyses were carried out using the newly acquired information from the 2005 site investigation Becker holes at BPT05-06B and BPT05-07, which were located at the east limb of the Secondary Dam east and west of the 2004 Becker hole BPT04-13, respectively. The analyses were carried out for conditions with (i.e. through the dam crest) and without the dam (i.e. through the dam toe) using the computer program PROSHAKE (Edupro Civil Systems, 2005).

Figure 5.2 and 5.3 show the peak acceleration profiles for conditions through the dam crest and through the dam toe at BPT05-06B and BPT05-07. For comparison, the results from the analyses at BPT04-13 are also shown. The surface accelerations are generally amplified and the amplification at the toe of the dam is much higher than the same at the crest. Also, at BPT05-07, the amplification at the toe of the dam was relatively higher and exceeded 1 g. Thus, as explained, the estimated accelerations are likely high or conservative.

Figures 5.4 and 5.5 show the liquefaction evaluation in the foundation soils beneath the dam crest and the dam toe, respectively, based on the information from Becker holes BPT05-06B and BPT05-07. The method of assessment is same as that was used for the Cross Valley and the Intermediate Dams. For comparison, the liquefaction assessment

for BPT04-13 is also shown. SPT $(N_1)_{60}$ values from the measured SPTs at the open Becker hole BKS05-06 and BKS05-07 are also shown.

At BPT05-06B, liquefaction was predicted close to the natural ground between El. 1054 m and El. 1050 m as shown in Figures 5.4 and 5.5. At this location, a deep 3-4 m thick liquefiable loose layer was also identified at about El. 1046 m. At BPT05-07, only marginal liquefaction was predicted between El. 1052 m and El. 1049 m. The additional information gathered from BPT05-07 bounded the liquefiable Rose Creek sediments on the west side of the east limb of the Secondary Dam. However, the BPT05-07 showed that it can extend up to this Becker hole and any potential remediation scheme should go beyond this hole location. It is noted that the presence of loose Rose Creek liquefiable sediments in the foundation west of this hole may not give rise to flow slide type of failure since the dam height reduces significantly thereby reducing the driving shear stresses required for the flow slide.

A deep liquefiable layer about 3-4 m thick was identified at about El. 1046 m at BPT05-07. Post-earthquake stability analyses, which were conducted to check the effect of this liquefied layer, resulted in high factors of safety (>1.3) for the deep seated slip surfaces through this layer. Thus, the seismic stability of the dam will not be affected by the liquefaction of this deep layer.

5.3 Remediation Cost

Figure 6.6 shows the plan and elevation view of the proposed conceptual remediation scheme for the Secondary Dam – East limb. Based on the information from the additional holes, the aerial extent of the zone that will require improvement was redefined. Table 5.1 shows the estimated cost for densification using dynamic compaction technique. Vibroreplacement was considered as an alternative option. However, the cost for remediating the Secondary Dam – East Limb alone with

vibroreplacement is significantly higher than the cost for dynamic compaction. Thus, the dynamic compaction was selected as the preferred option. Note that, in the dynamic compaction technique, the width of the densification zone is also controlled by the maximum depth of zone to be densified and hence the width was increased to 15 m from the design value of 10 m.

Table 5.1 Cost Estimate for Dynamic Compaction for the Secondary Dam East Limb

Item No.	Description of Work	Unit	Qty.	Unit Cost	Total Cost (\$ CAD)
1	Mob and demob of equipment and crew	ls	1	150,000	150,000
2	Dynamic Compaction	m ²	5,900	50	295,000
3	Site Preparation	ls	1	50,000	50,000
4	Verification BPT/SPT Testing	ls	1	50,000	50,000
5	Environmental Protection Measures	ls	1	50,000	50,000
				Subtotal	595,000
6	Design and Project/Construction Management @ 12%	ls	1	71,400.00	71,400
				Subtotal	666,400
7	Contingency (minimum 30% recommended)	allow	1	199,920.00	199,920
				Total	866,320

Say 900,000

6. REMEDIATION COST SUMMARY

Table 6.1 summarizes our cost estimates for the remediation of the Cross Valley Dam, the Intermediate Dam, and the Secondary Dam East and West Limbs. The costs given in Table 6.1 include a contingency.

Table 6.1 Remediation Cost Summary for Cross Valley Dam, the Intermediate Dam, and the Secondary Dam East and West Limbs

Structure	Remediation Technique	Estimated Cost	Condition
Cross Valley Dam	Berm, Explosive Compaction, and Compaction Grouting in Silt	\$7M	Upstream and downstream slopes
	Berm and Vibroreplacement	\$9M	
Intermediate Dam	Not required	0	Not applicable
Secondary Dam – West Limb	Not required	0	With Tailings
	Berm and foundation drainage	\$6.4 M	Removal of D/S Tailings
	Vibroreplacement	\$11.4 M	
Secondary Dam – East Limb	Dynamic Compaction	\$900K	

These costs are opinions of probable cost only for construction in 2006. Construction costs are highly volatile in this current market place with escalation common. We also note that remediation trials would be required for the Cross Valley Dam in the silt sections because improvement of silts to resist liquefaction is more difficult than for loose sands. Each of these costs assumes that the remediation projects are done independently with no cost savings for common items such as mobilization and demobilization. The costs are given for the purposes of choosing long term tailings disposal options.

Dynamic compaction will not materially affect the hydraulic regime beneath the slope of the East Limb of the Secondary Dam. Vibroreplacement and drainage measures will affect the seepage regimes beneath dams and this needs to be further considered if any of these schemes proceed.

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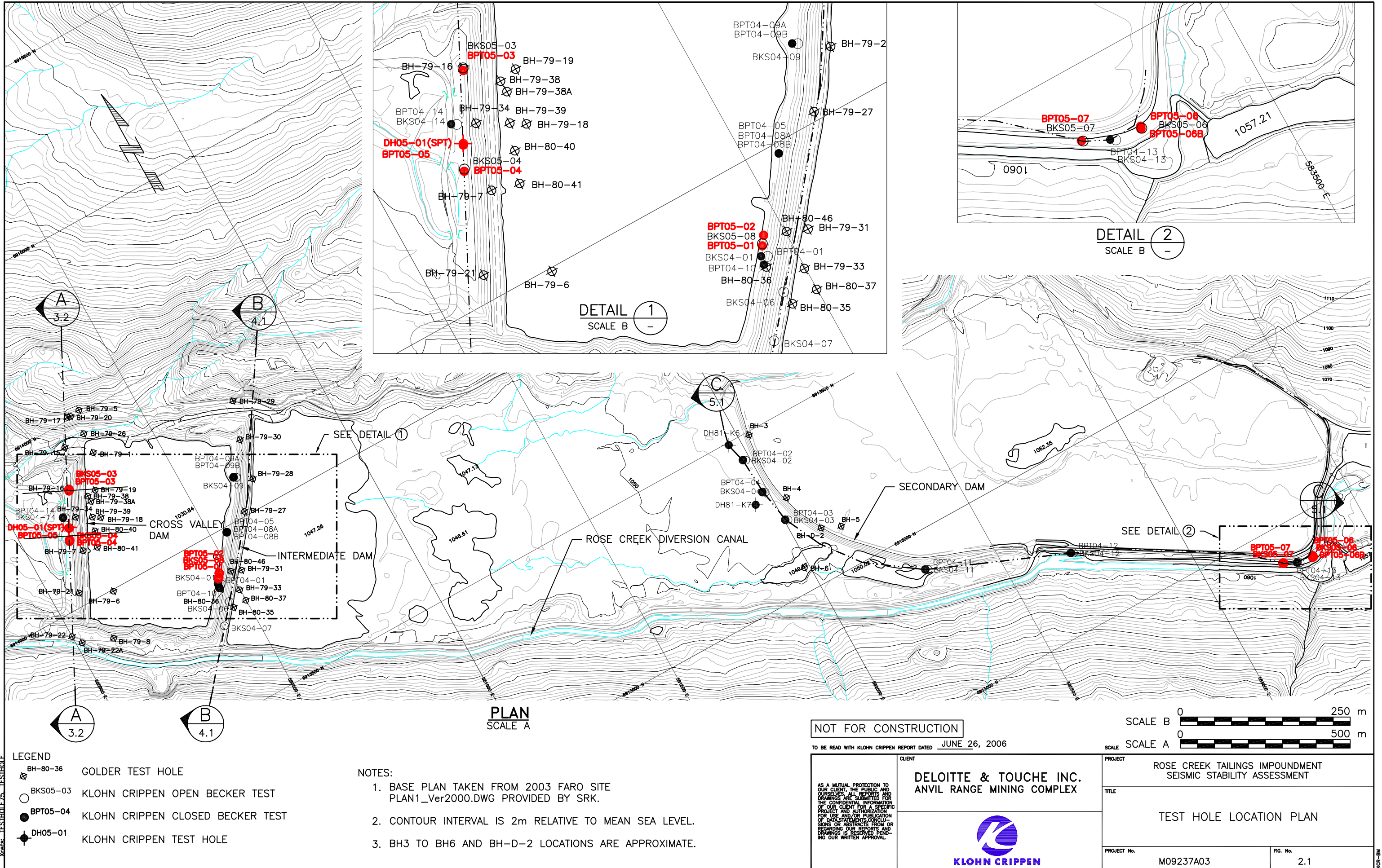
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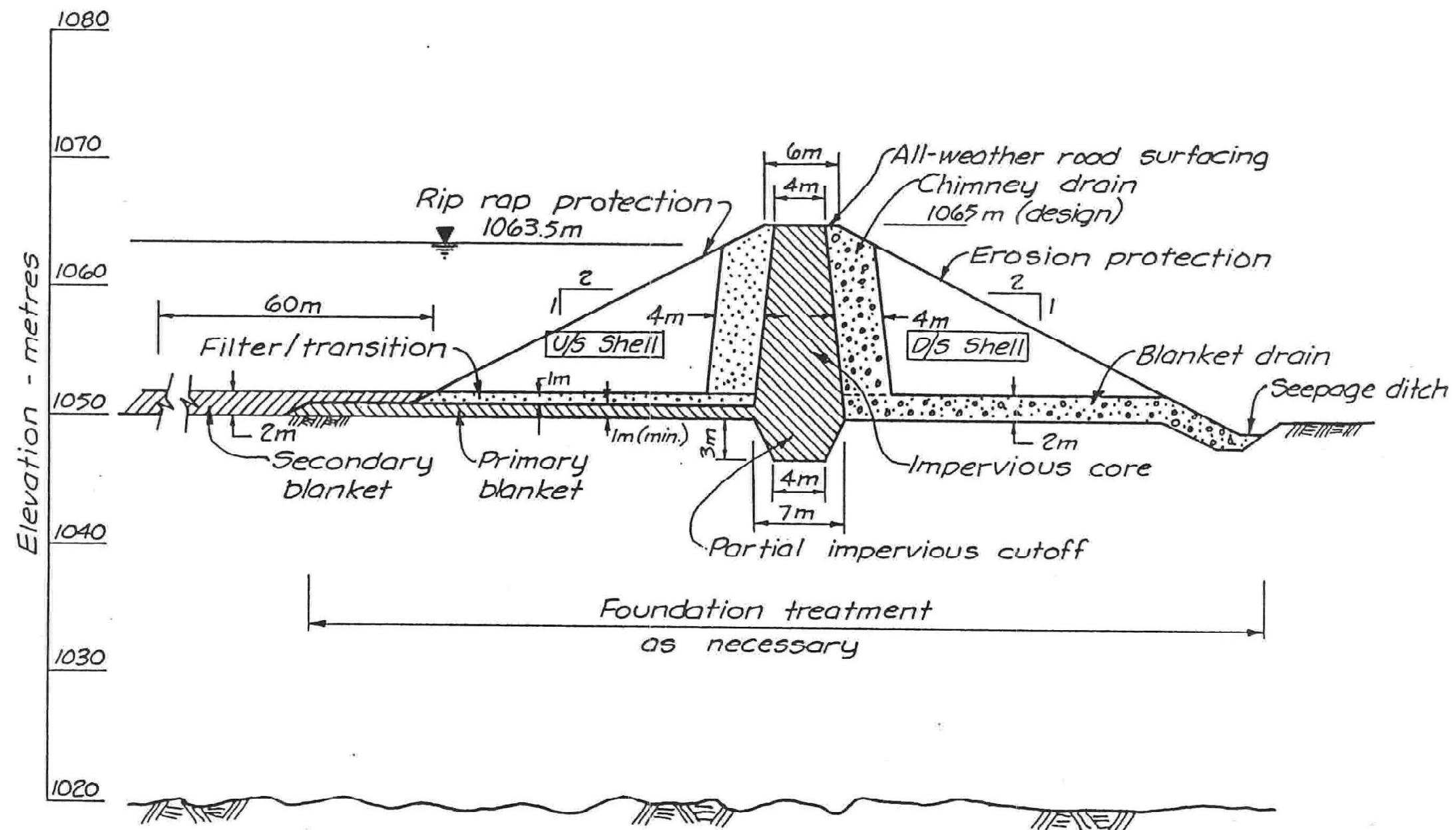
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FIGURES

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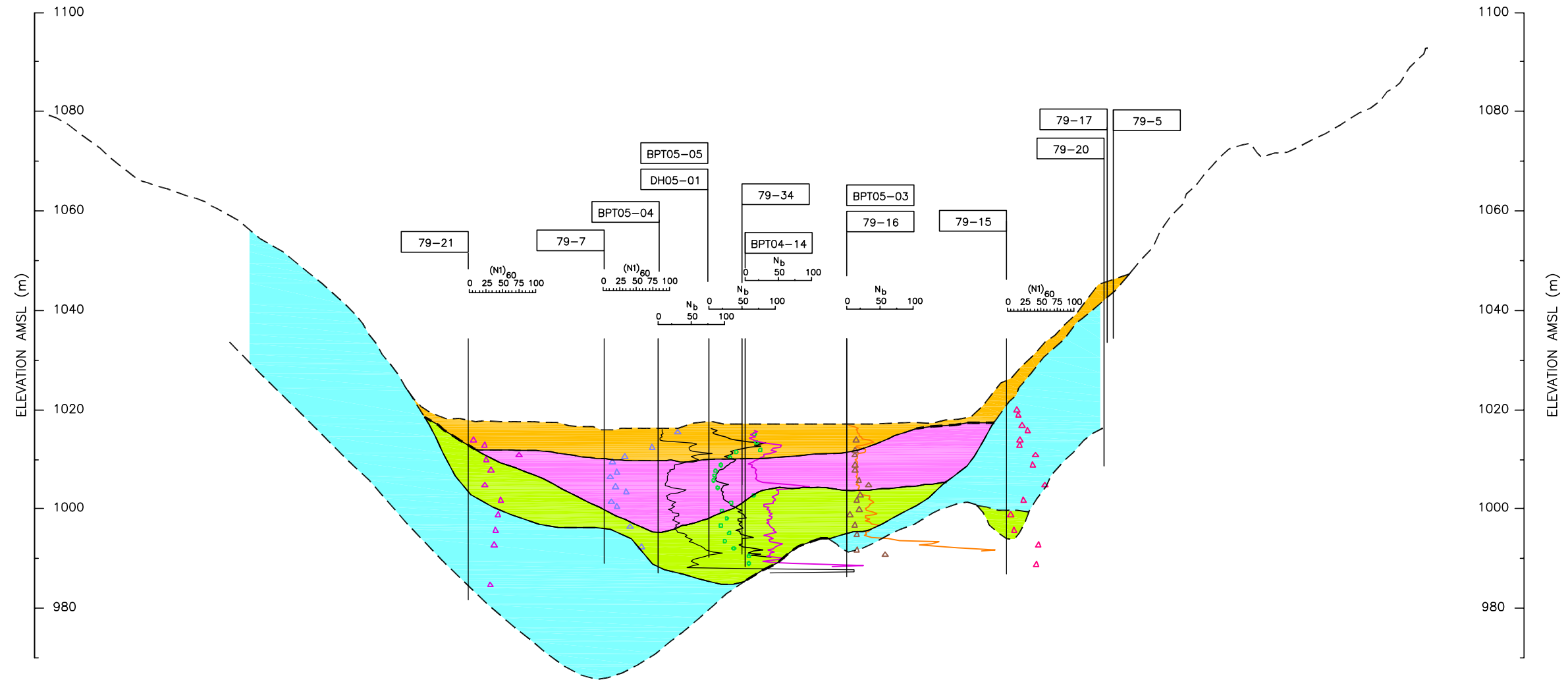


NOTES:
FIGURE SHOWING THE TYPICAL DESIGN SECTION OF THE
CROSS VALLEY DAM TAKEN FROM GOLDR ASSOCIATES
REPORT TO CYPRUS ANVIL MINING DATED JUNE 1980.

TO BE READ WITH KLOHN-CRIPPEN REPORT DATED JUNE 26, 2006

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	KLOHN CRIPPEN		TITLE CROSS VALLEY DAM TYPICAL DESIGN SECTION
	PROJECT NO. M 09237 A03 01	FIGURE NO. 3.1	

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SECTION A
2.1

LEGEND

- ROSE CREEK ALLUVIUM - DENSE
- ROSE CREEK ALLUVIUM - LOOSE
- PLEISTOCENE SANDS AND GRAVELS - DENSE
- PLEISTOCENE GLACIAL TILL

NOTE:

1. SECTION IS TAKEN FROM KLOHN LEONOFF (1981) DRAWING AND UPDATED WITH KC BECKER AND DRILL HOLE INFORMATION.
2. FOUNDATION CONDITIONS ARE KNOWN ONLY AT THE TEST HOLE LOCATIONS. THE SOIL STRATIGRAPHY SHOWN BETWEEN THE TEST HOLES IS AN INTERPRETATION ONLY.
3. THE ACCURACY OF THE 79/80 TEST HOLE LOCATIONS IS NOT KNOWN.
4. N_b - MEASURED BECKER BLOW COUNTS AND $(N_1)_{60}$ - CORRECTED SPT/LPT BLOW COUNTS.

VERTICAL SCALE



HORIZONTAL SCALE



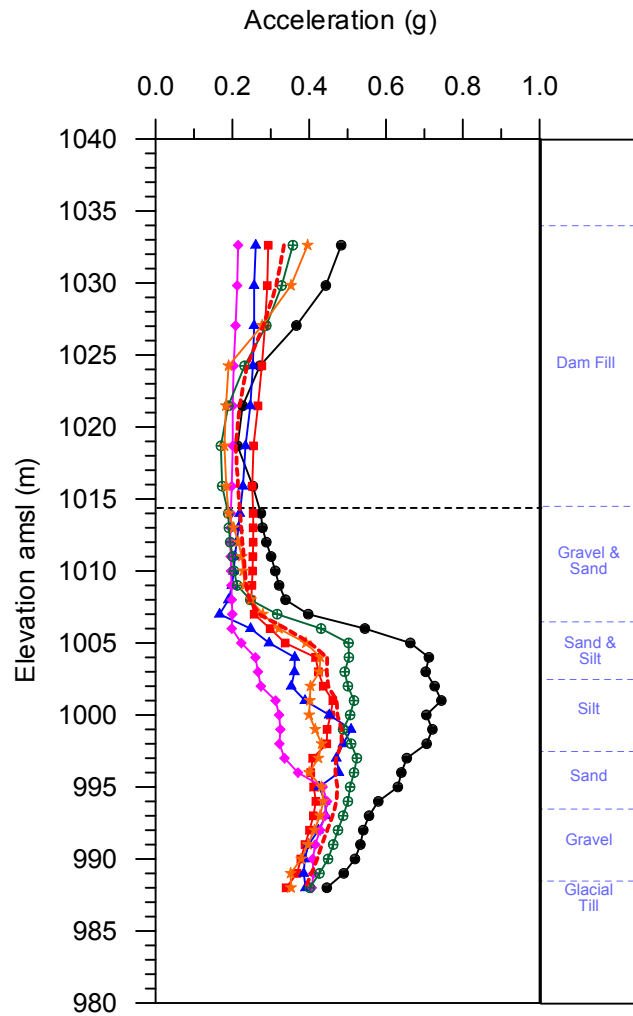
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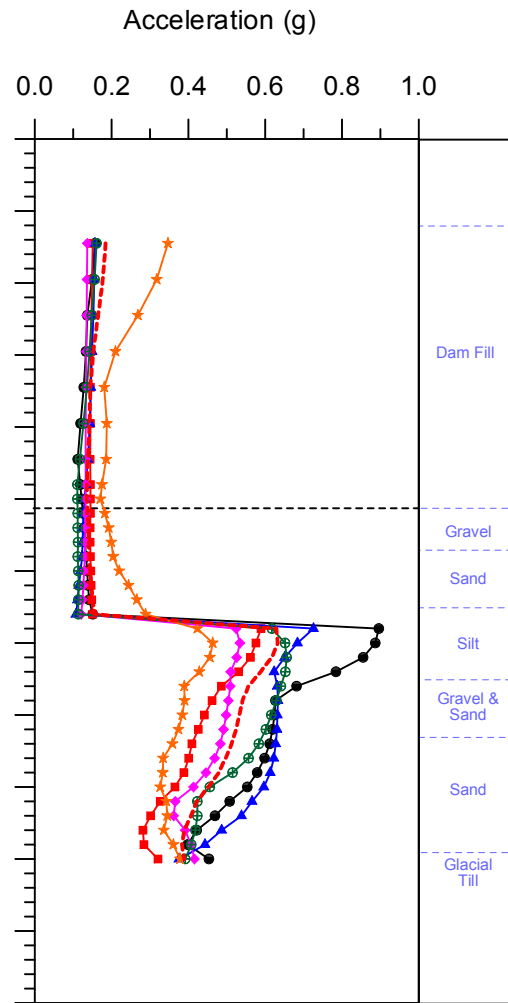
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	DELOITTE & TOUCHE INC. ANVIL RANGE MINING COMPLEX	TITLE	
	 KLOHN CRIPPEN	CROSS VALLEY DAM FOUNDATION STRATIGRAPHY	
PROJECT No.		M09237A03	FIG. No. 3.2

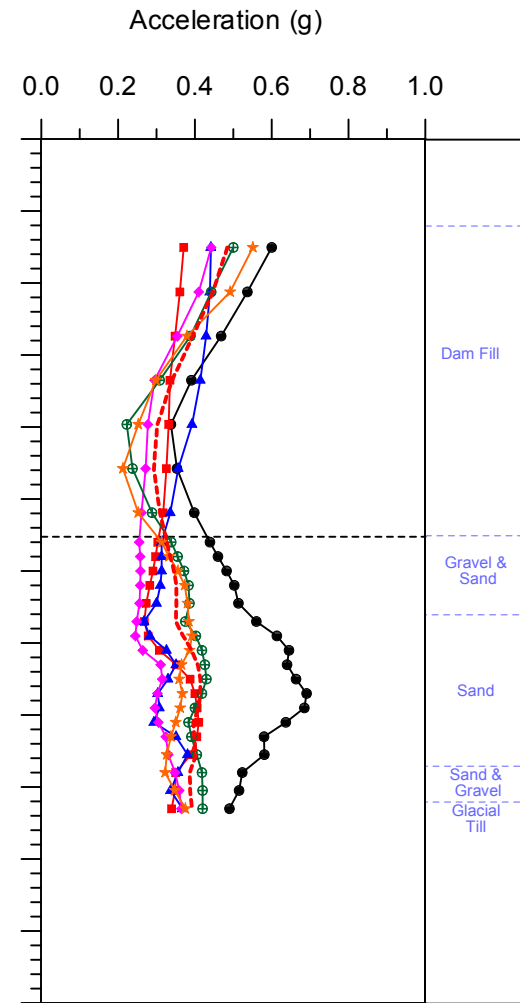
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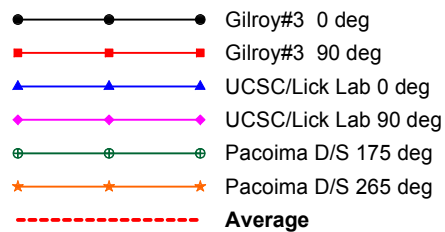
BPT05-04



BPT05-05



BPT05-03



Note:
1. Soil layering interpreted from open Becker tests and drill hole data.

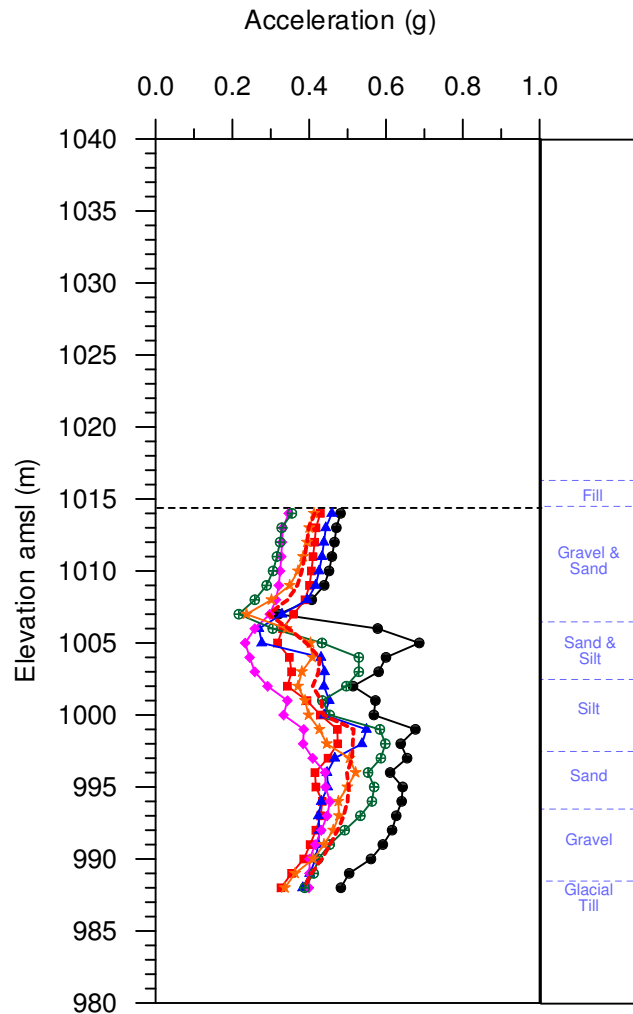
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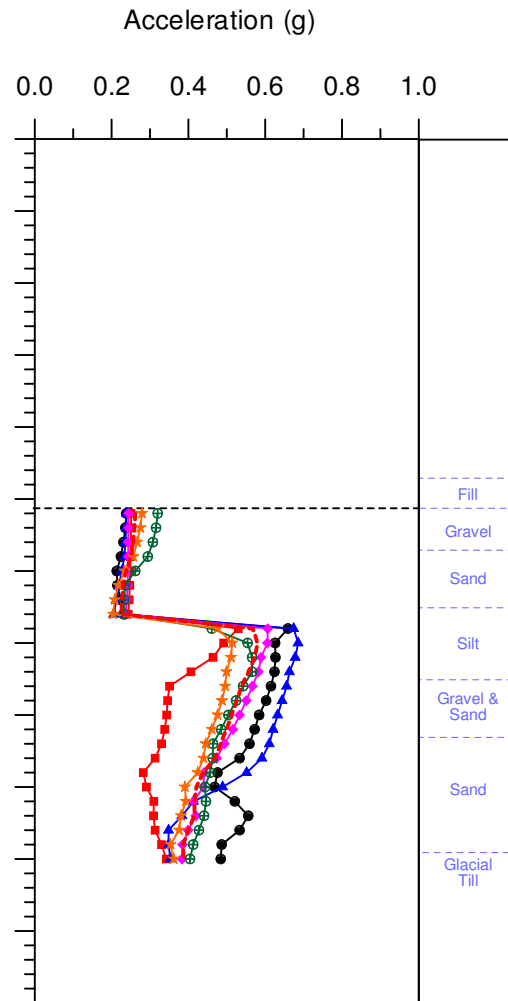


CLIENT:
DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX

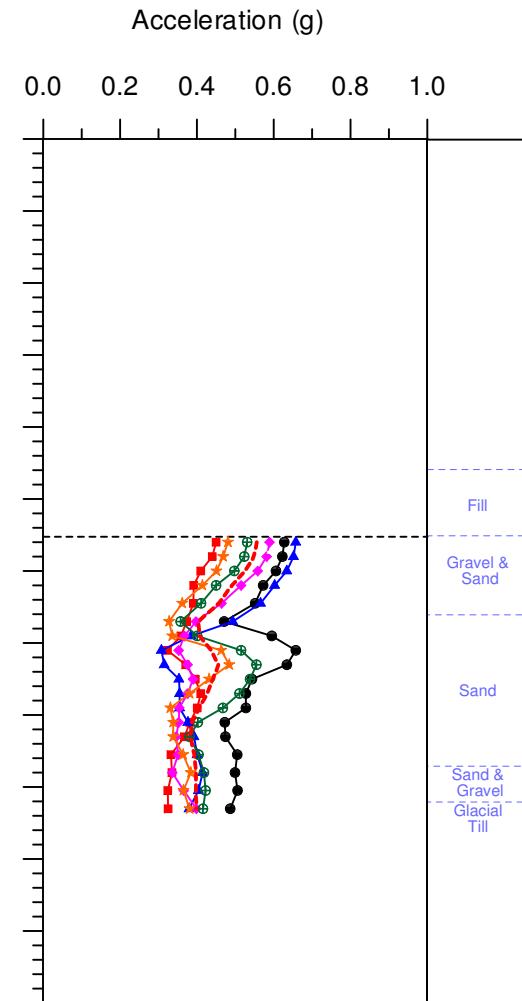
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TITLE PEAK ACCELERATION PROFILES THROUGH THE DAM CREST AT THE CROSS VALLEY DAM			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 3.3	REV
APPROVAL			



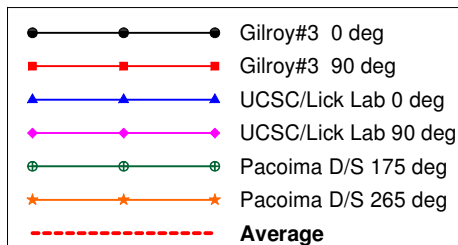
BPT05-04



BPT05-05



BPT05-03



Note:
1. Soil layering interpreted from open Becker tests and drill hole data.

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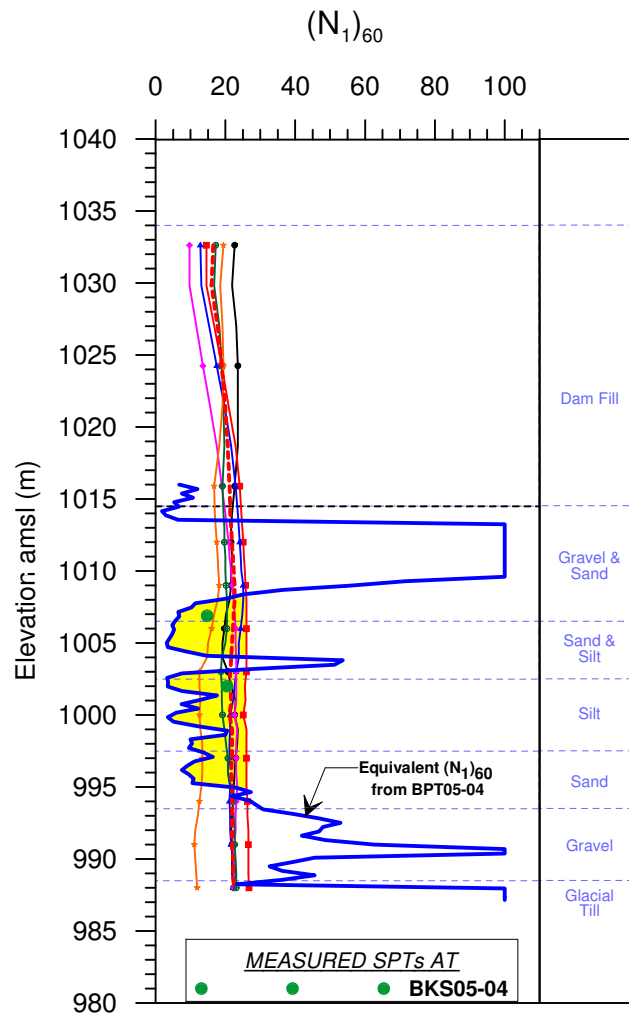
TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 26, 2006



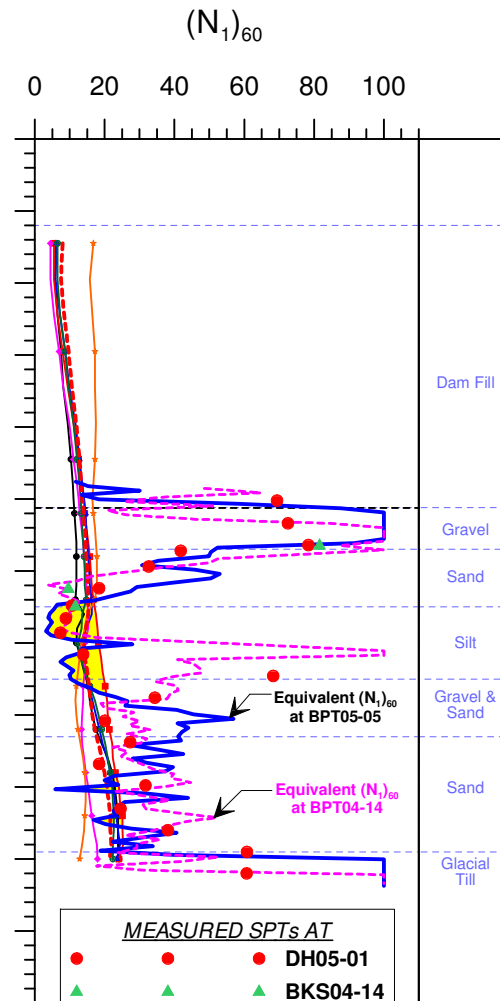
CLIENT:

DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX

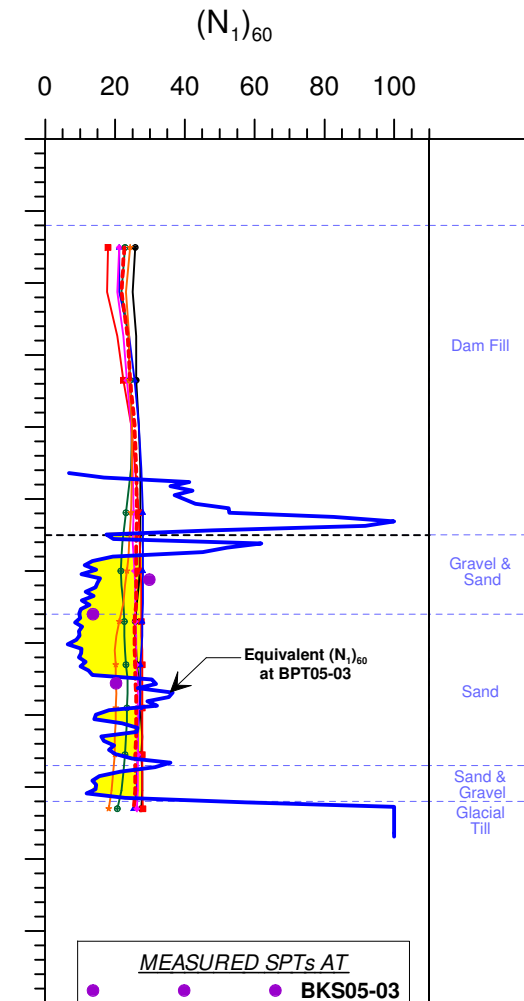
PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE PEAK ACCELERATION PROFILES THROUGH THE DAM TOE AT THE CROSS VALLEY DAM			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 3.4	REV
APPROVAL			



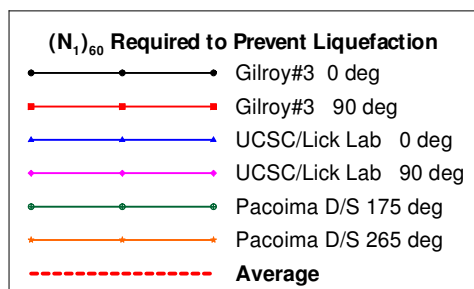
BPT05-04



BPT05-05



BPT05-03



Liquefied Zones

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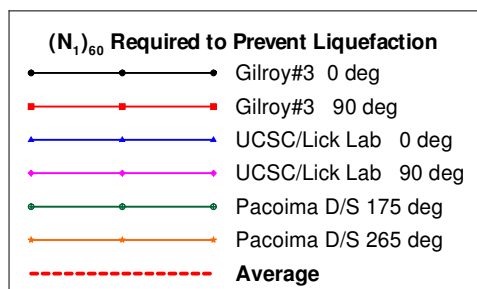
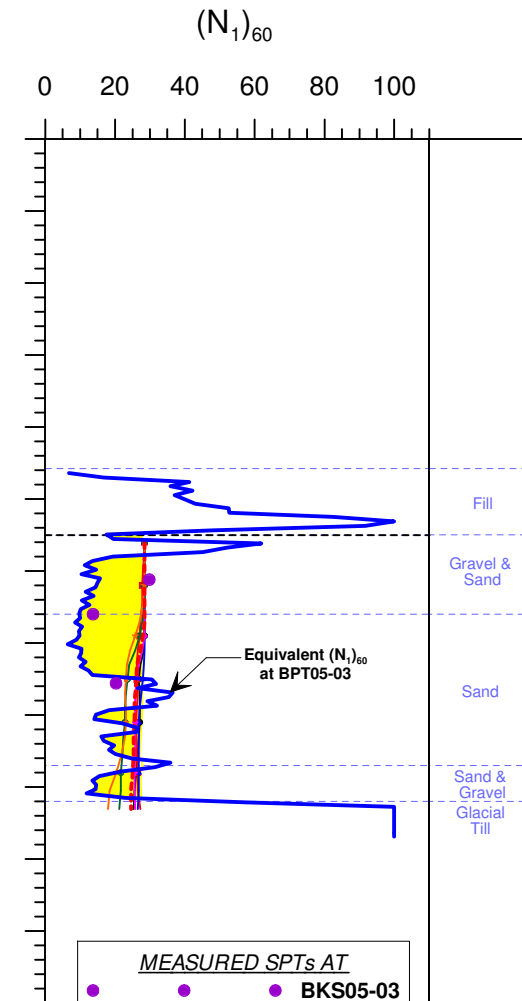
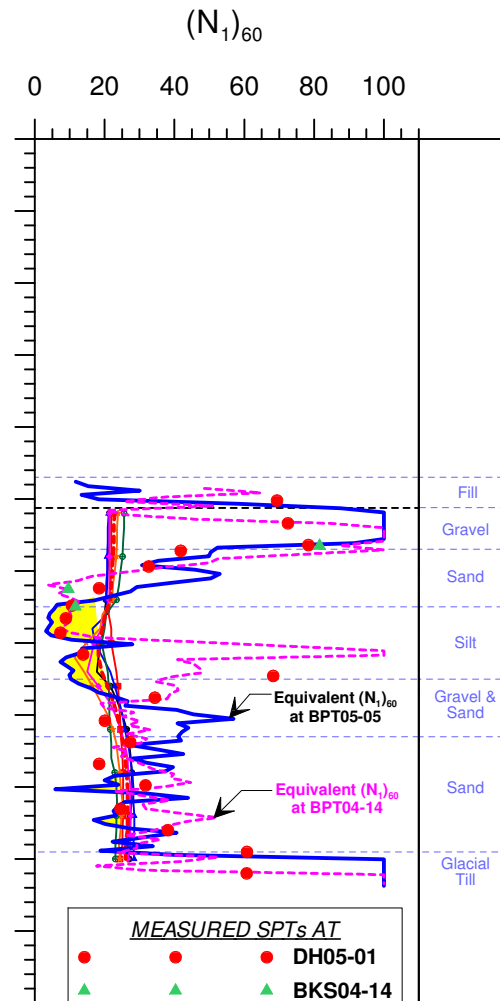
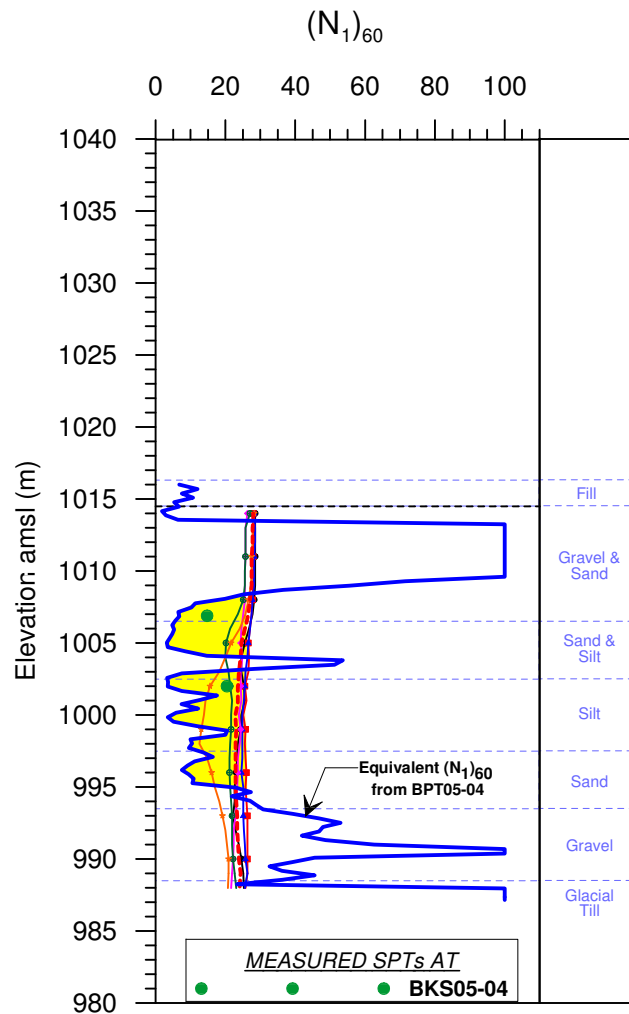
TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 26, 2006



DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX

PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT		TITLE LIQUEFACTION ASSESSMENT BELOW THE CROSS VALLEY DAM CENTERLINE	
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 3.5	REV
APPROVAL			

- Notes:
1. Measured BPT blow counts converted to equivalent N_{60} using the Sy (1993) method.
 2. Required $(N_1)_{60}$ computed from EQ induced CSR following Youd et al. (2001).
 3. Equivalent $(N_1)_{60}$ greater than 100 plotted as 100 for illustration only.
 4. Soil layering interpreted from open Becker tests and drill hole data.



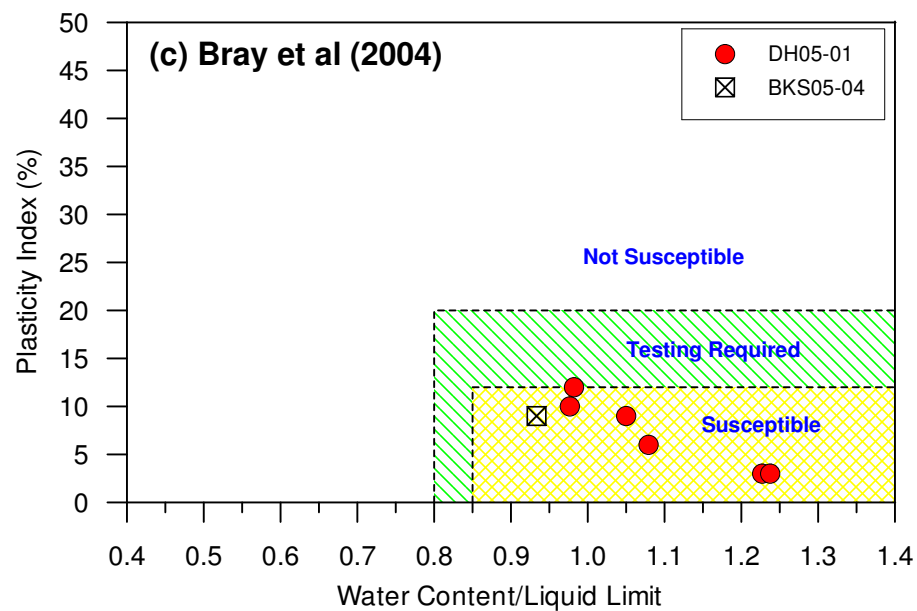
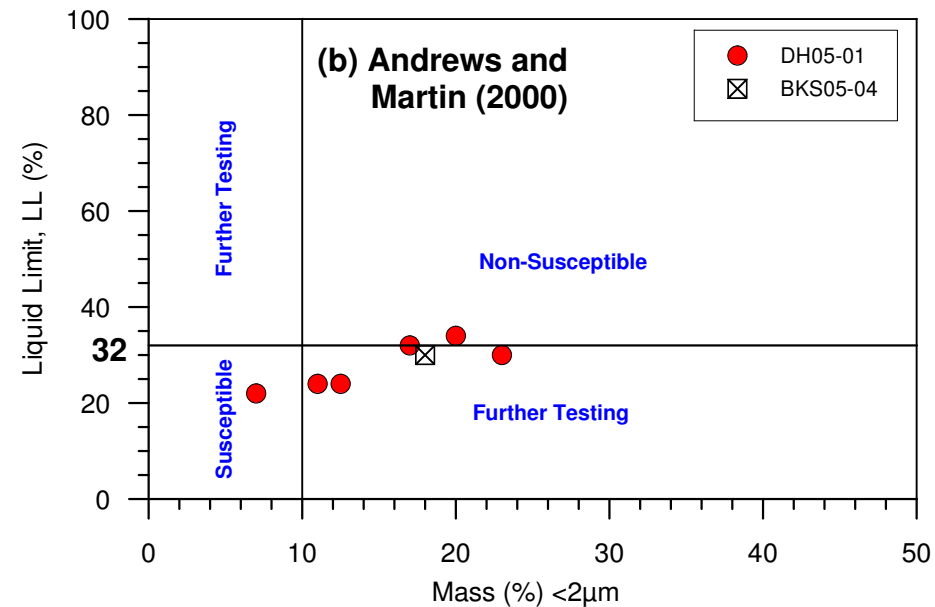
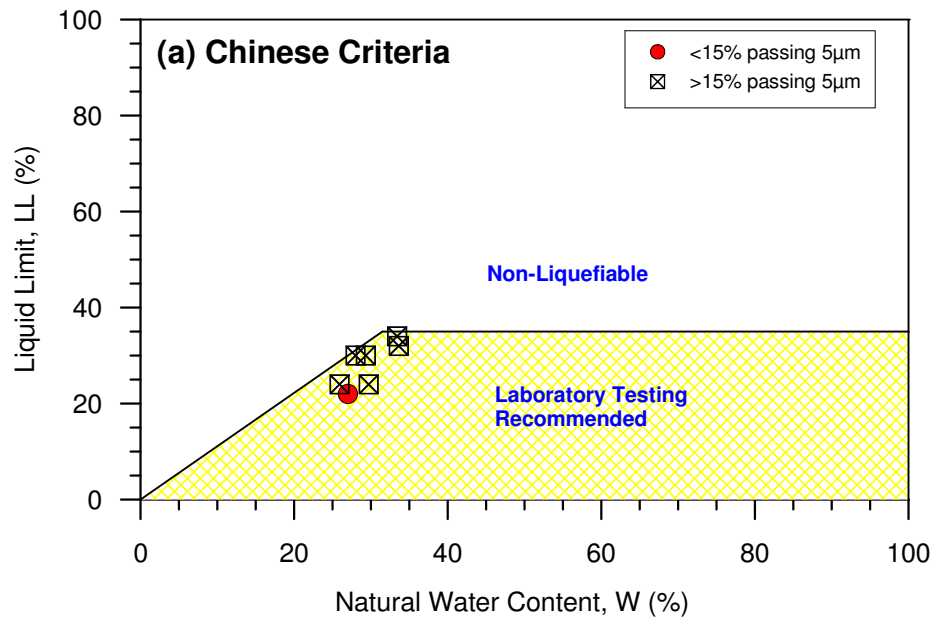
Liquefied Zones

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		PROJECT		ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT	
		TITLE		LIQUEFACTION ASSESSMENT AT THE CROSS VALLEY DAM TOE	
CLIENT:		DATE OF ISSUE:		PROJECT No.:	FIGURE No.:
DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX		JUNE 26, 2006		M09237A03 01	3.6
		APPROVAL:			

- Notes:
1. Measured BPT blow counts converted to equivalent N_{60} using the Sy (1993) method.
 2. Required $(N_1)_{60}$ computed from EQ induced CSR following Youd et al. (2001).
 3. Equivalent $(N_1)_{60}$ greater than 100 plotted as 100 for illustration only.
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SCALE



CLIENT: **DELOTTE & TOUCHE INC.**
ANVIL MINING RANGE COMPLEX

PROJECT: **ROSE CREEK TAILINGS IMPOUNDMENT
SEISMIC STABILITY ASSESSMENT**

TITLE: **LIQUEFACTION ASSESSMENT OF SILT
USING SCREENING CRITERION**

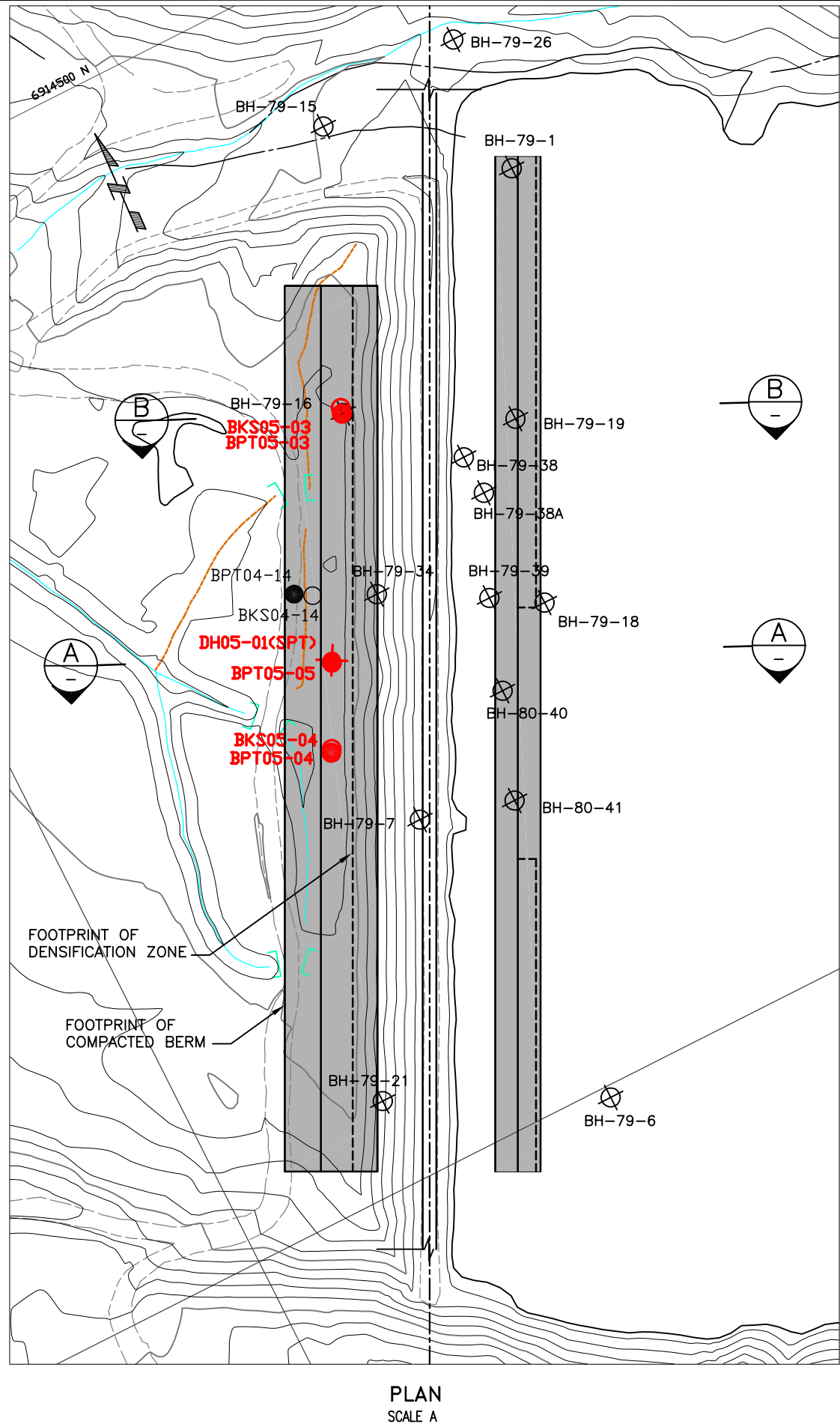
DATE OF ISSUE:
JUNE 26, 2006

PROJECT No.:
M09237A03 01

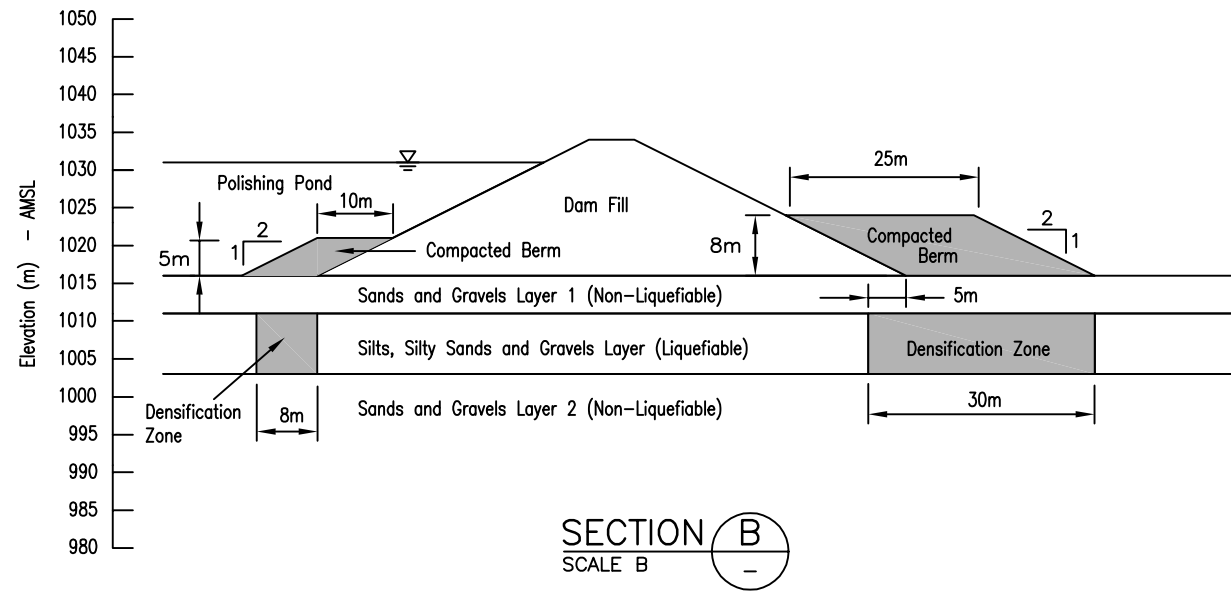
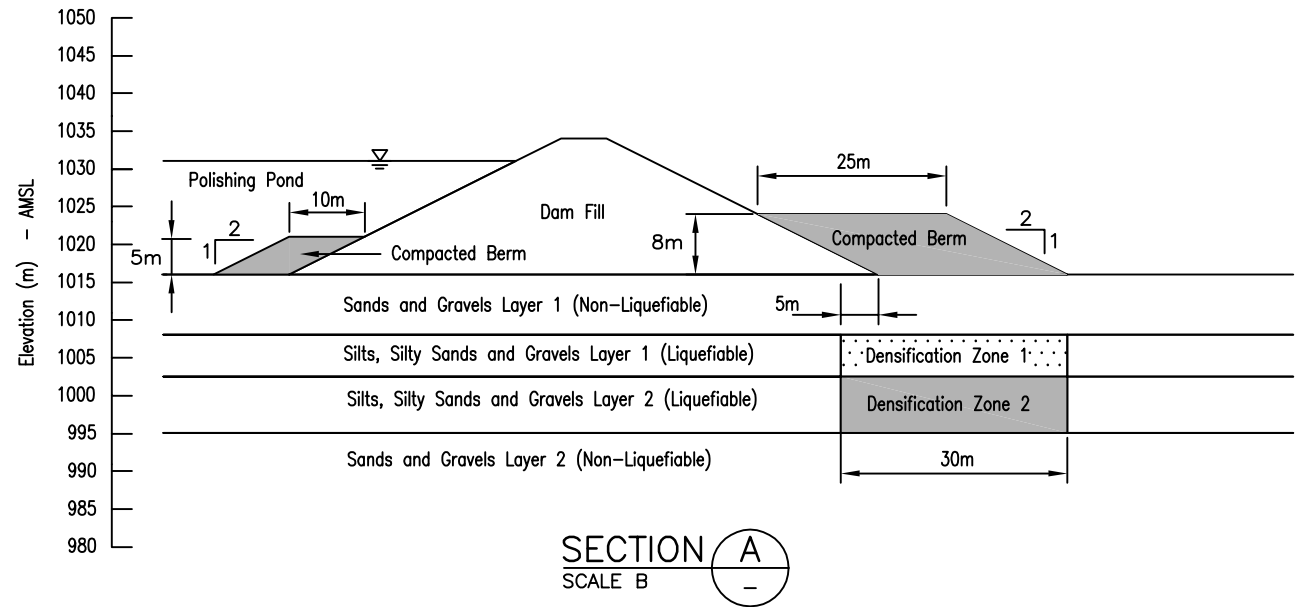
Fig. No.:
3.7

REV.

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PLAN
SCALE A



NOT FOR CONSTRUCTION

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CLIENT

DELOITTE & TOUCHE INC.
ANVIL RANGE MINING COMPLEX



PROJECT

ROSE CREEK TAILINGS IMPOUNDMENT
SEISMIC STABILITY ASSESSMENT

TITLE

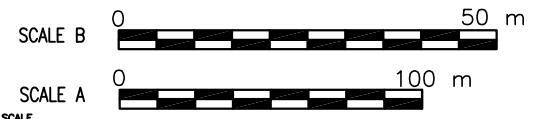
CONCEPTUAL REMEDIAL OPTION
CROSS VALLEY DAM

PROJECT No.

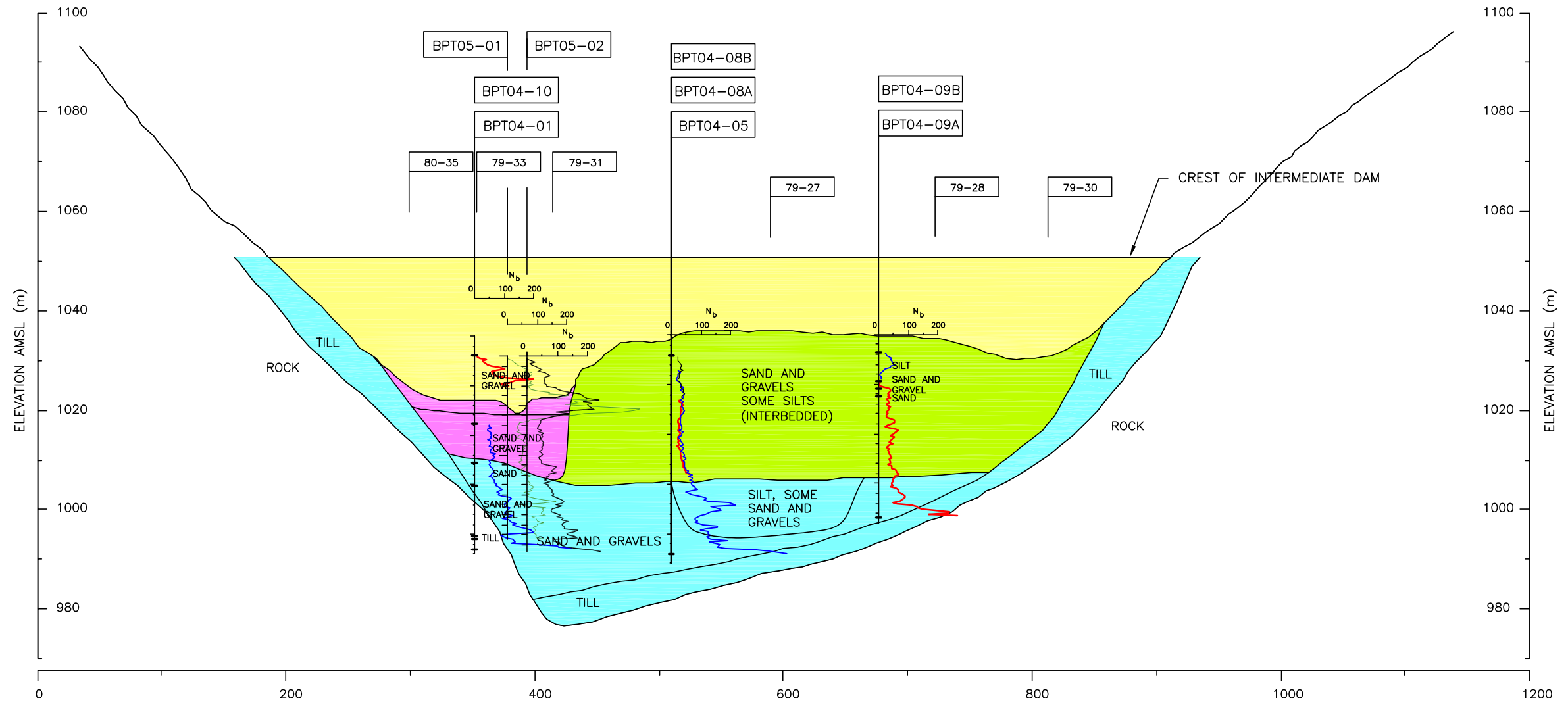
M09237A013

FIG. No.

3.8



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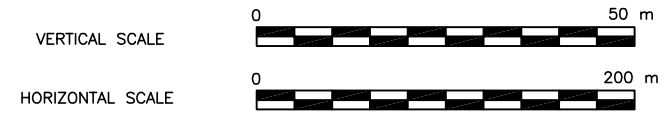
SECTION B
2.1

- LEGEND
- FILL
 - ROSE CREEK SEDIMENTS
 - GLACIO-FLUVIAL SEDIMENTS-TERRACE
 - PLEISTOCENE SEDIMENTS

NOTE:
1. SECTION IS TAKEN FROM KLOHN LEONOFF (1981) DRAWING FOR GROUND CONDITIONS BENEATH CENTERLINE OF INTERMEDIATE DAM. KC BECKER HOLE INFORMATION IS SUPERIMPOSED AND WAS OBTAINED ON DOWNSTREAM BERM.

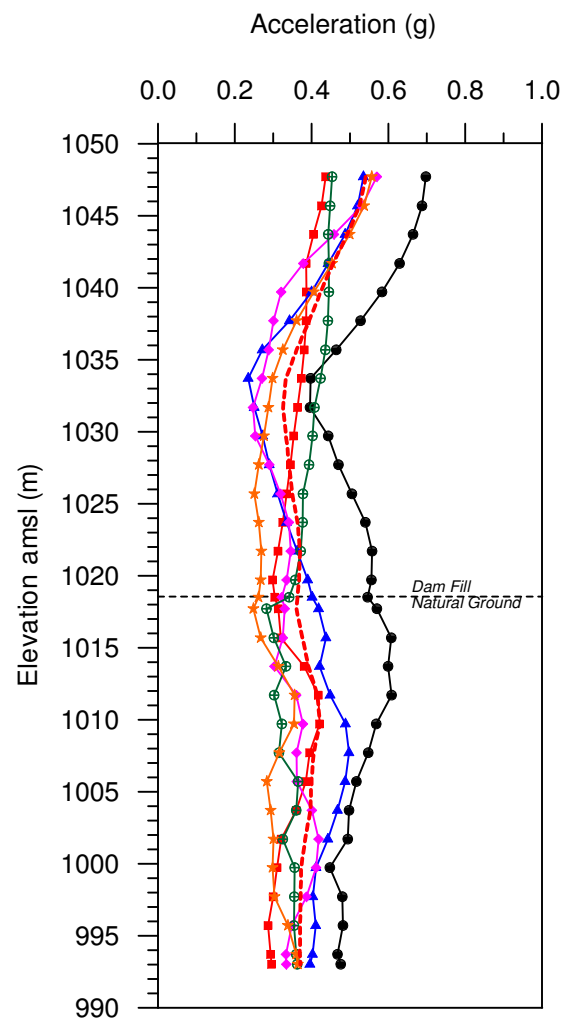
NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 26, 2006

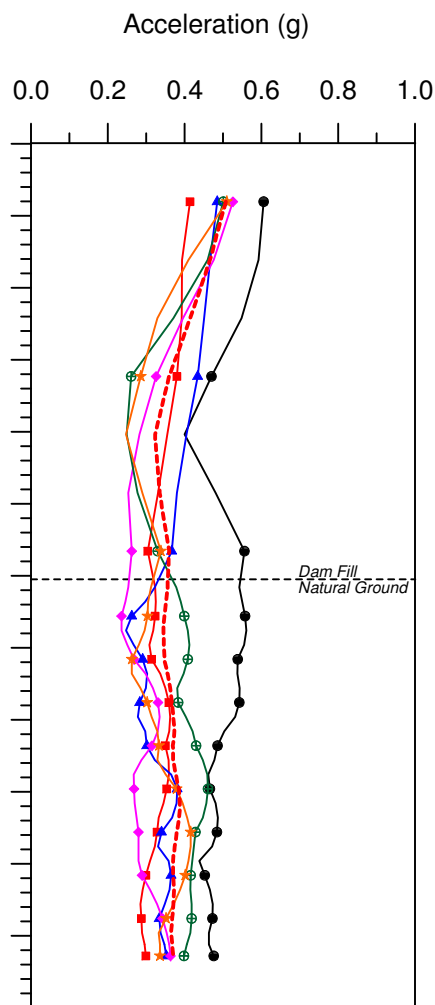


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	DELOITTE & TOUCHE INC. ANVIL RANGE MINING COMPLEX	ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT	
		TITLE INTERMEDIATE DAM FOUNDATION STRATIGRAPHY	
		PROJECT No.	FIG. No.
		M09237A01	4.1

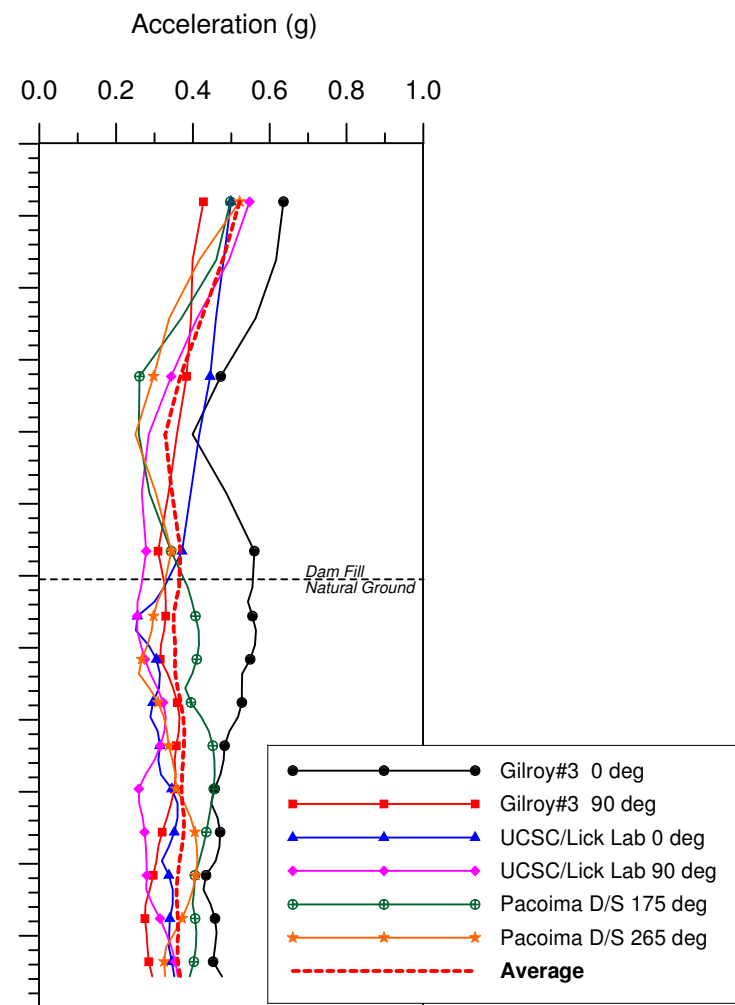
KCP-20



BPT04-10



BPT05-01



BPT05-02

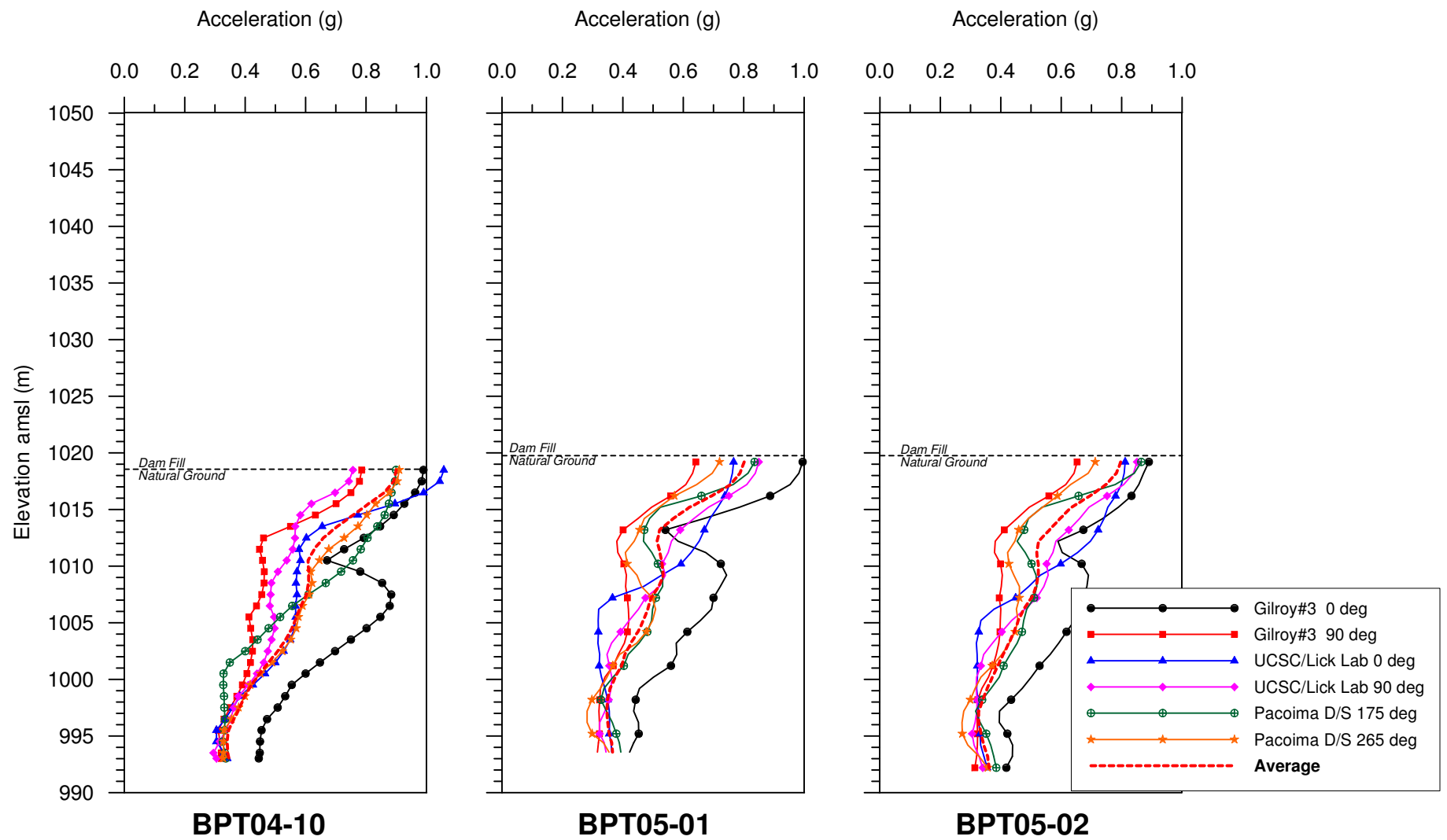
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CLIENT: **DELOTTE & TOUCHE INC.**
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PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE PEAK ACCELERATION PROFILES THROUGH THE DAM CREST AT THE INTERMEDIATE DAM			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 4.2	REV
APPROVAL			



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TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 26, 2006

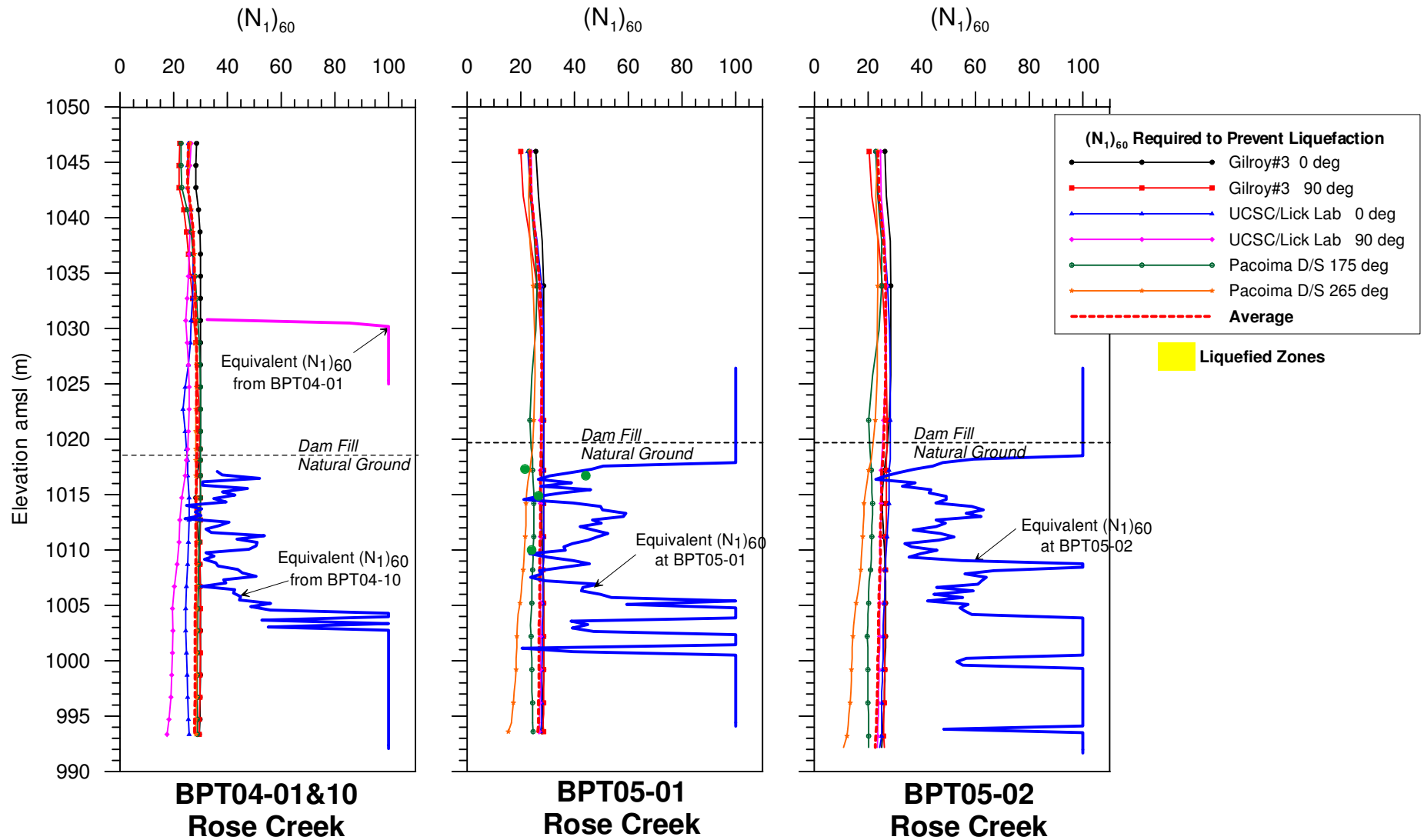


KLOHN CRIPPEN

CLIENT:

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PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE PEAK ACCELERATION PROFILES THROUGH THE DAM TOE AT THE INTERMEDIATE DAM			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 4.3	REV
APPROVAL			



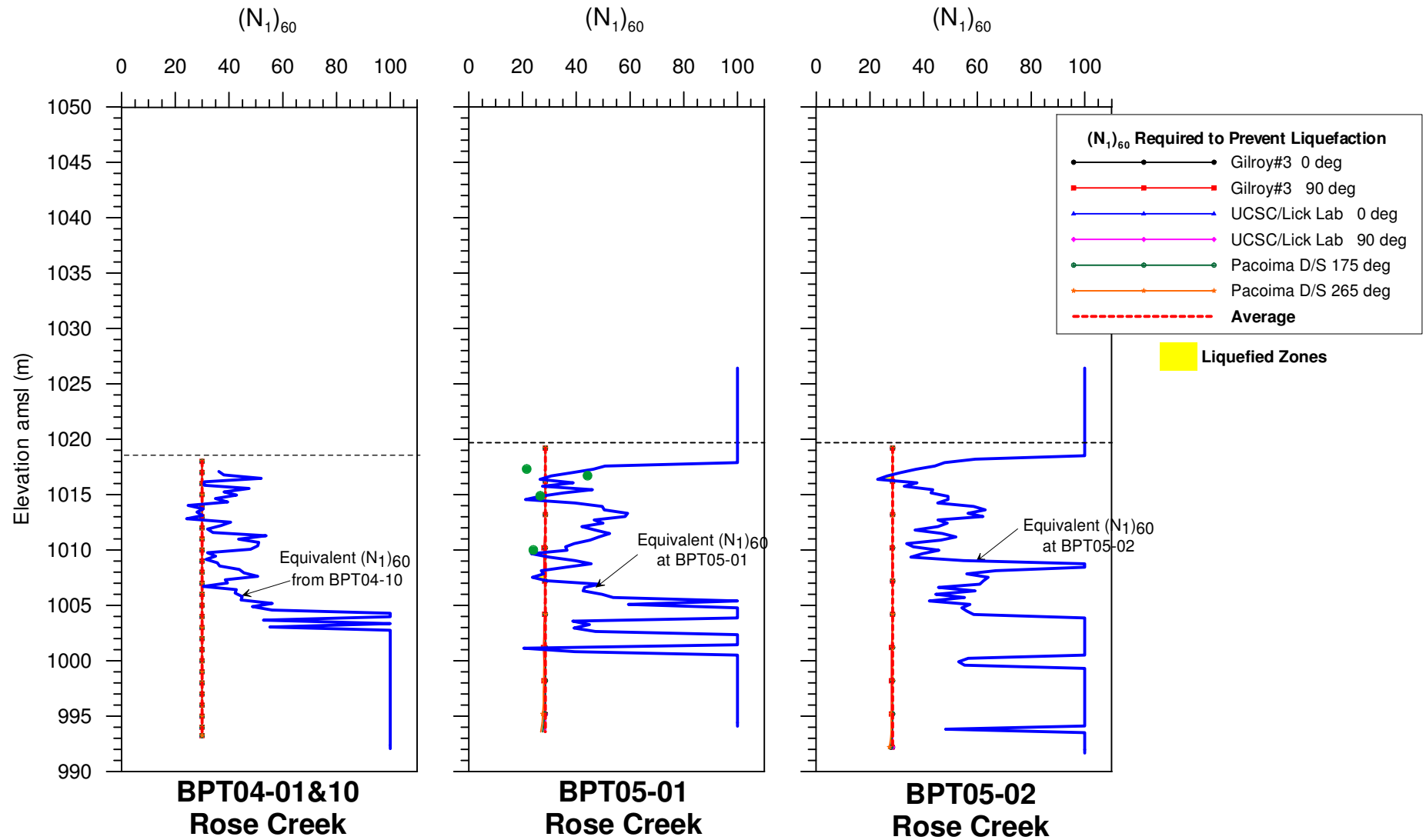
AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORT AND DRAWINGS.

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ANVIL MINING RANGE COMPLEX

PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE LIQUEFACTION ASSESSMENT BELOW THE INTERMEDIATE DAM CENTERLINE			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 4.4	REV
APPROVAL			



MEASURED SPTs AT

● ● ● BKS05-08

- Notes:
1. Measured BPT blow counts converted to equivalent N_{60} using the Sy (1993) method.
 2. Required $(N_1)_{60}$ computed from EQ induced CSR following Youd et al. (2001).
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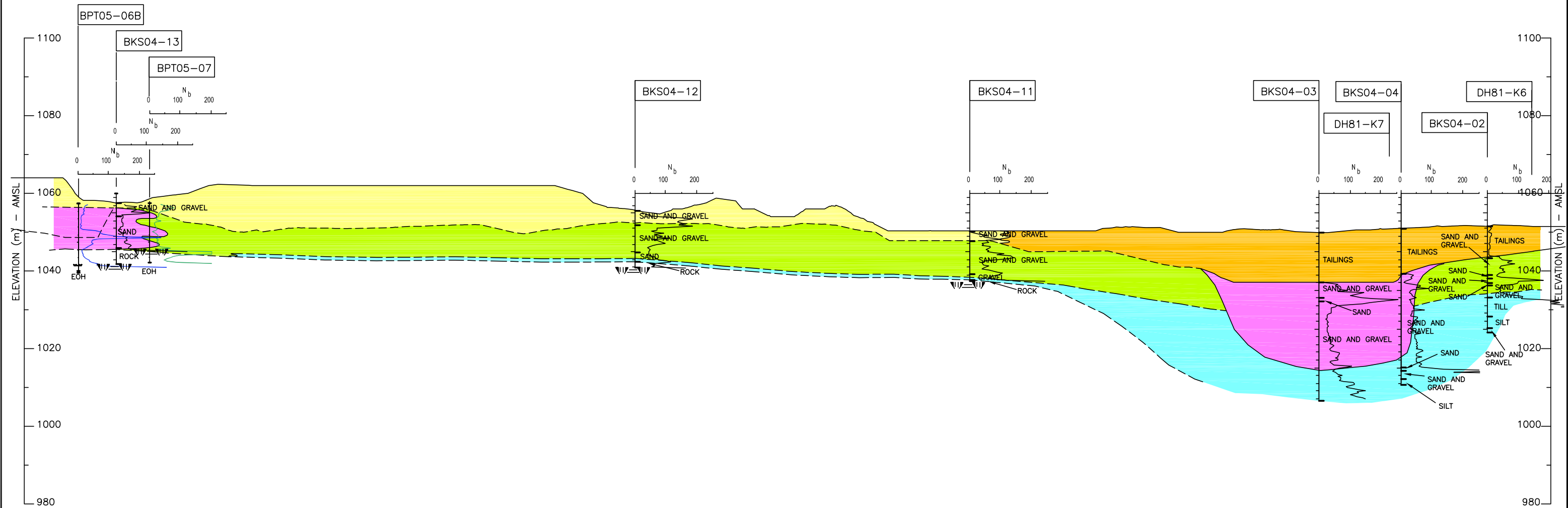
TO BE READ WITH KLOHN CRIPPEN REPORT DATED **JUNE 26, 2006**



DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX

PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE LIQUEFACTION ASSESSMENT AT THE INTERMEDIATE DAM TOE			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 4.5	REV
APPROVAL			

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 Xrefs: TESTHOLE



- LEGEND
- FILL
 - TAILINGS
 - ROSE CREEK SEDIMENTS
 - GLACIO-FLUVIAL SEDIMENTS-TERRACE
 - PLEISTOCENE SEDIMENTS

SECTION C
2.1

NOT FOR CONSTRUCTION

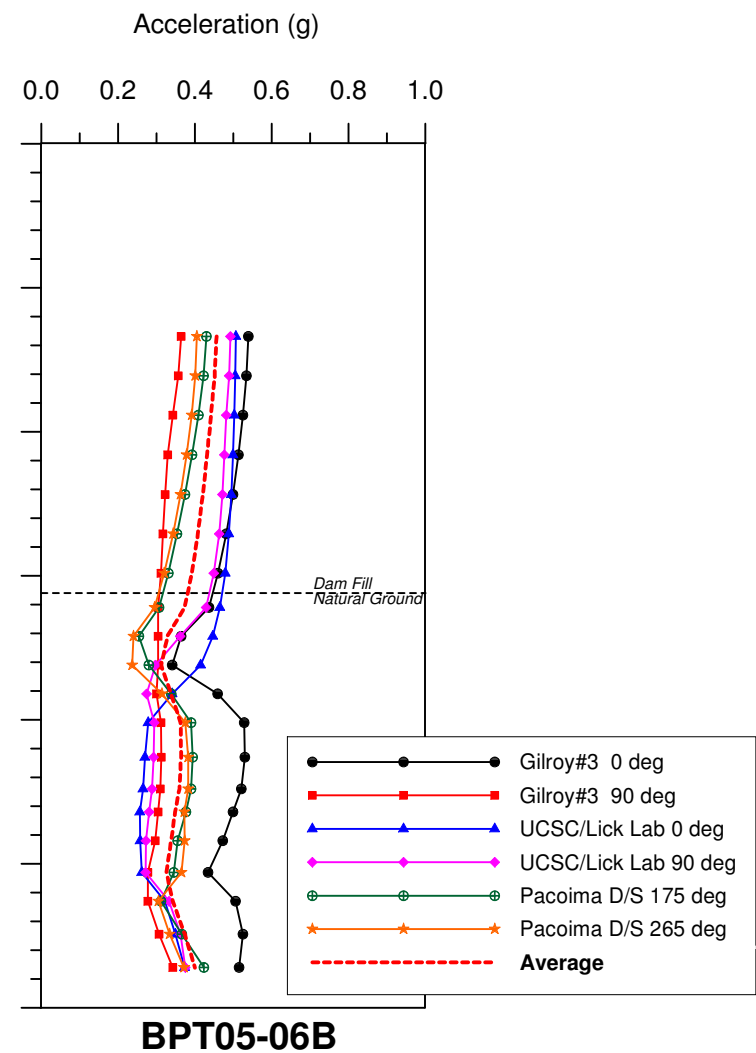
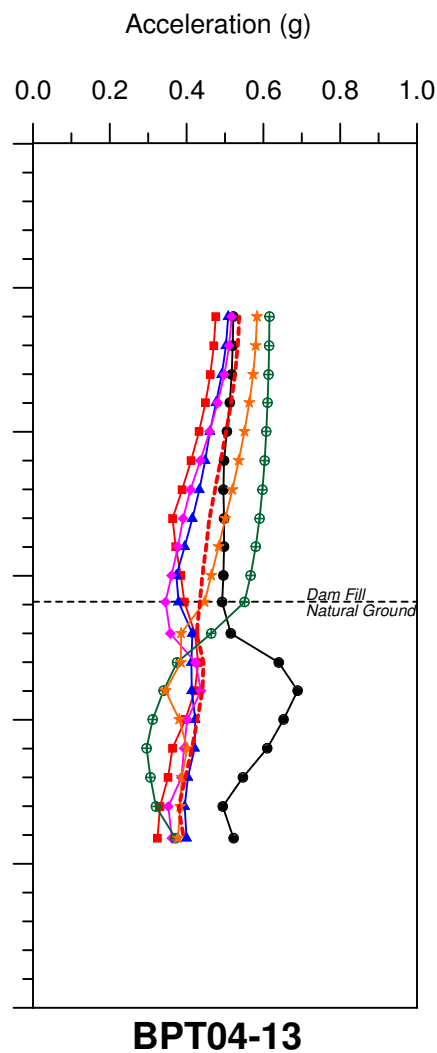
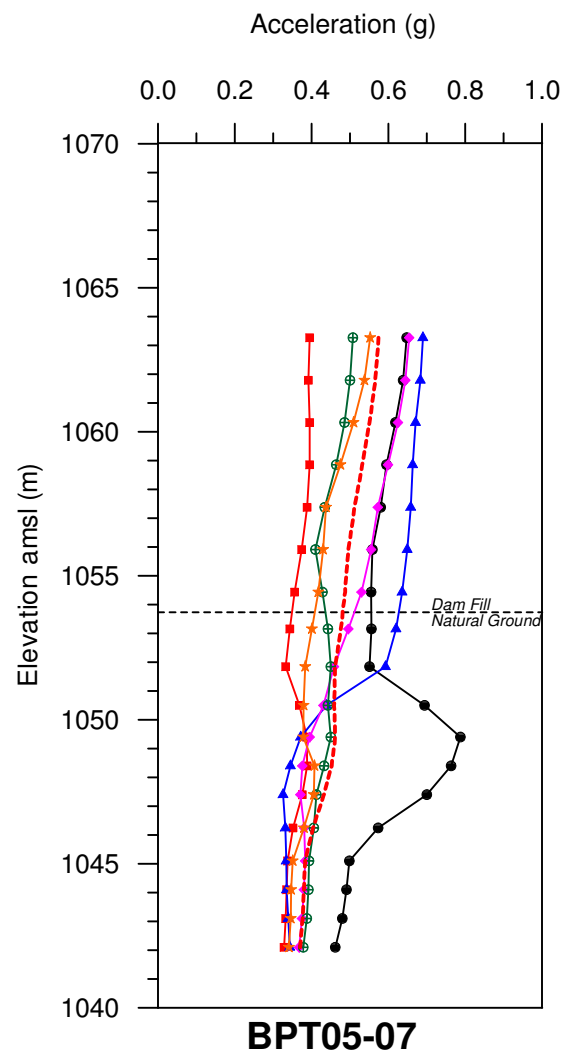
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	 KLOHN CRIPPEN			TITLE	SECONDARY DAM FOUNDATION STRATIGRAPHY	
				PROJECT No.	M09237A01	FIG. No.

VERTICAL SCALE
HORIZONTAL SCALE



KCB-BM



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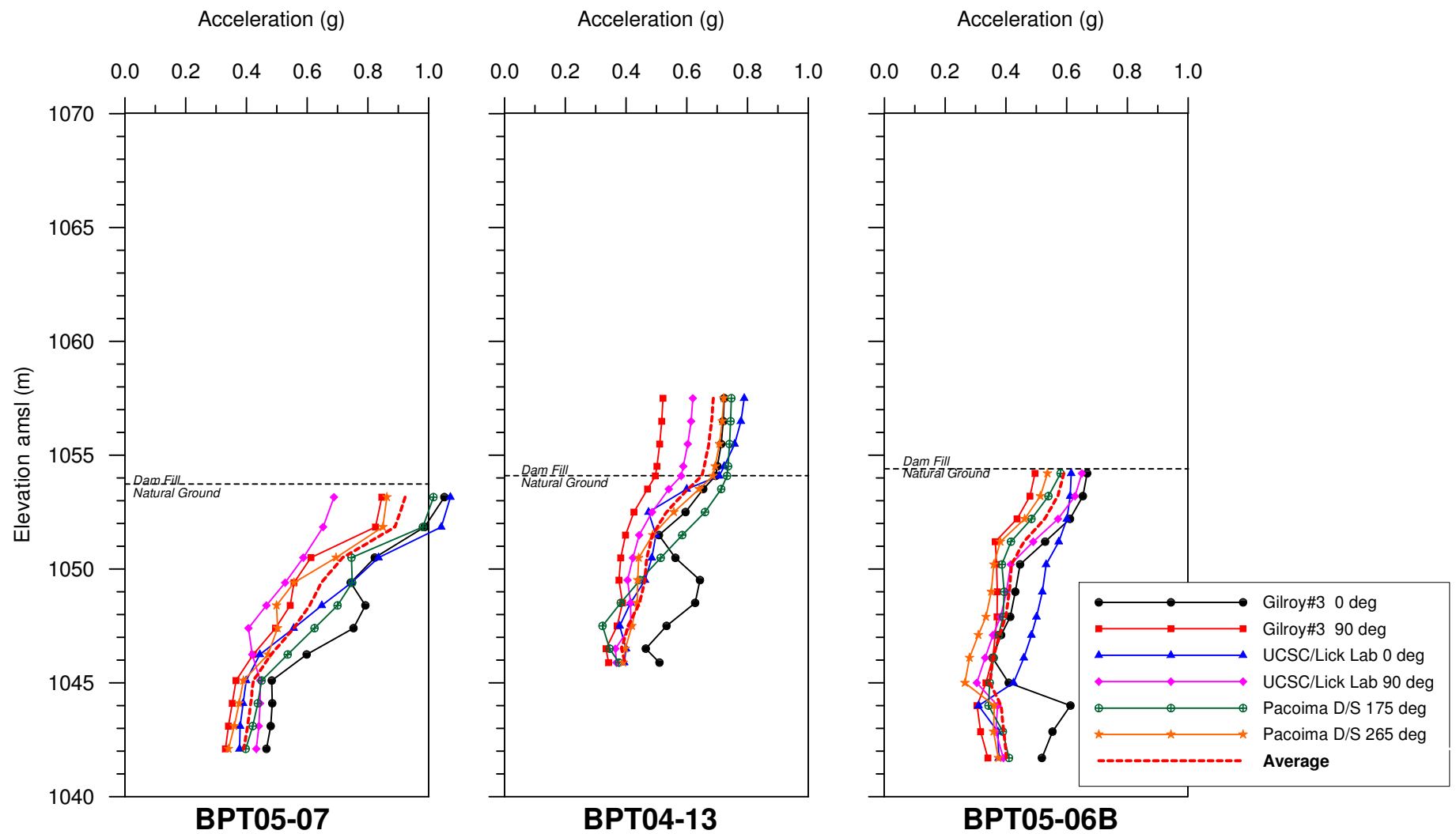
TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 26, 2006



CLIENT:

DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX

PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE PEAK ACCELERATION PROFILES THROUGH THE DAM CREST AT THE SECONDARY DAM (EAST LIMB)			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 5.2	REV
APPROVAL			



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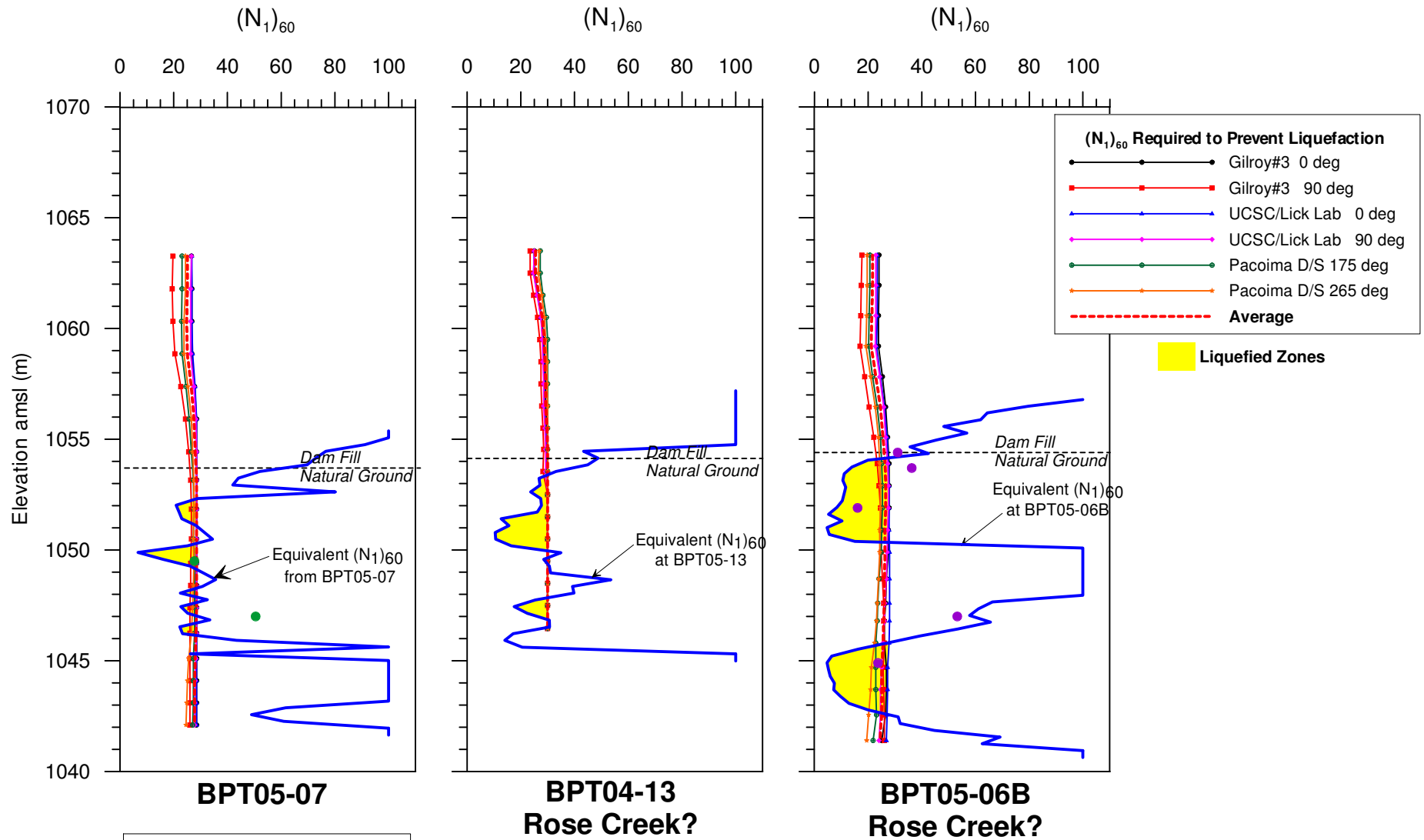
TO BE READ WITH KLOHN CRIPPEN REPORT DATED JUNE 26, 2006



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PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE PEAK ACCELERATION PROFILES FROM ANALYSES WITHOUT THE DAM AT THE SECONDARY DAM (EAST LIMB)			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 5.3	REV
APPROVAL			



MEASURED SPTs AT

● ● ● BKS05-07

MEASURED SPTs AT

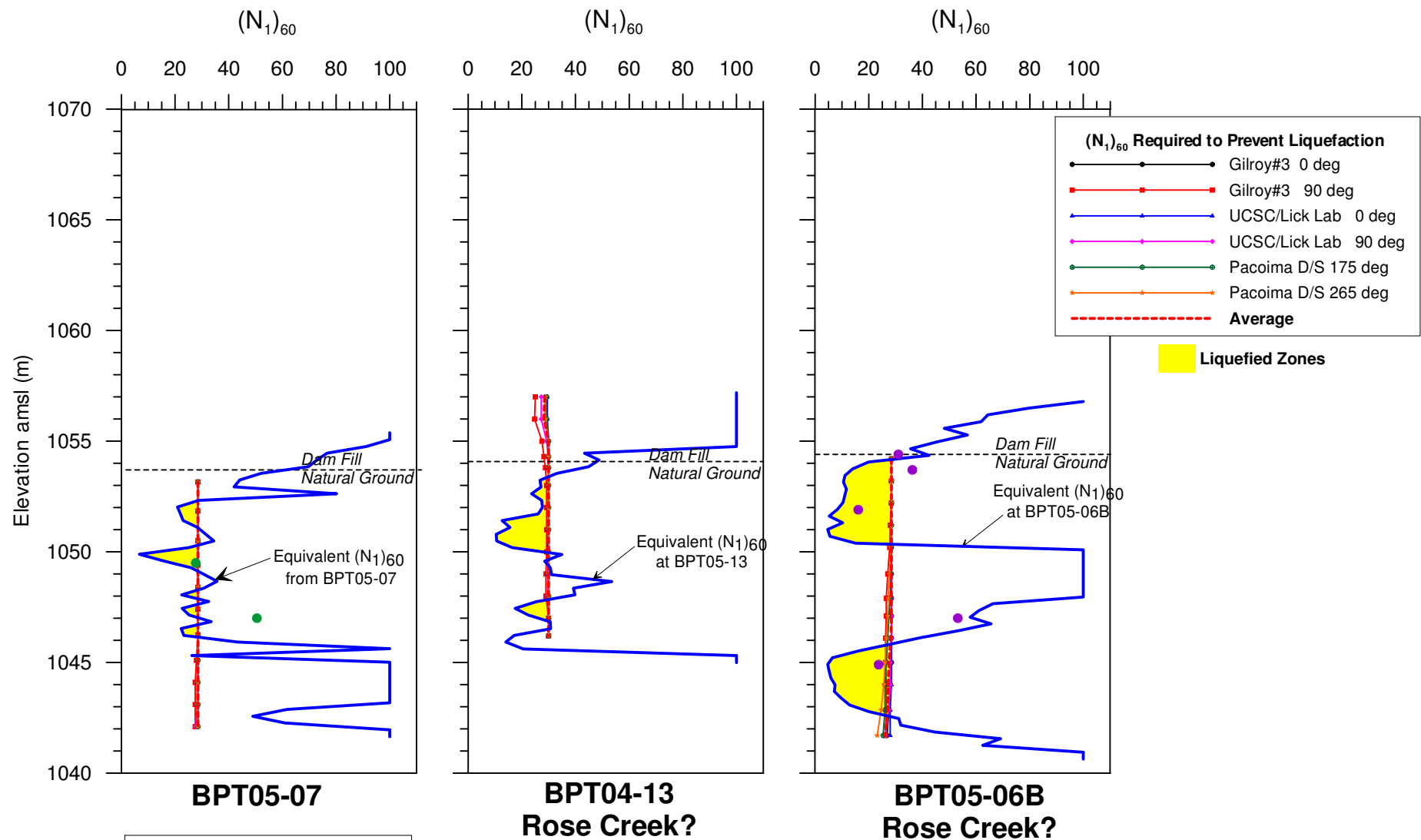
● ● ● BKS05-06

- Notes:
1. Measured BPT blow counts converted to equivalent N_{60} using the Sy (1993) method.
 2. Required $(N_1)_{60}$ computed from EQ induced CSR following Youd et al. (2001).
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		PROJECT		ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT	
		TITLE		LIQUEFACTION ASSESSMENT BELOW THE SECONDARY DAM (EAST LIMB) CENTERLINE	
CLIENT:		DATE OF ISSUE	PROJECT No.	FIGURE No.	REV
DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX		JUNE 26, 2006	M09237A03 01	5.4	
		APPROVAL			



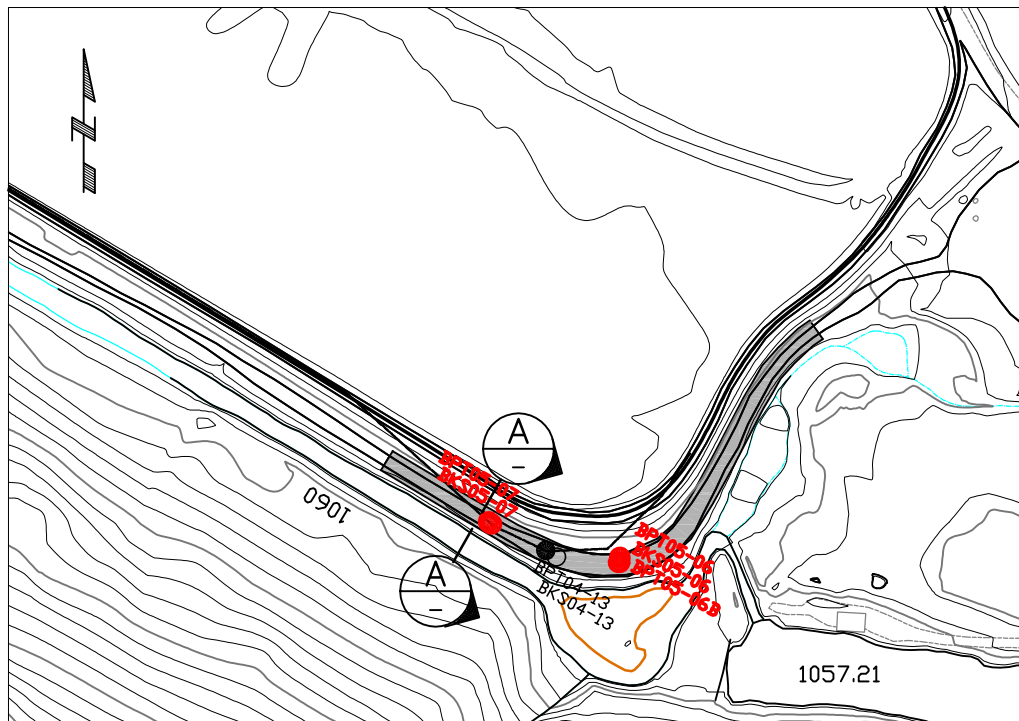
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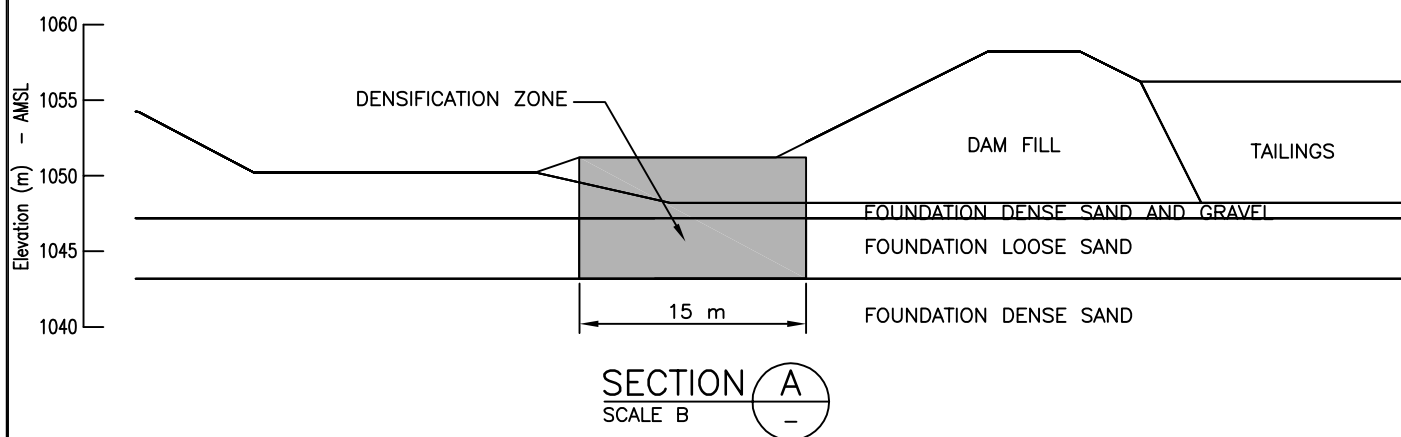


DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX

PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT			
TITLE LIQUEFACTION ASSESSMENT AT THE SECONDARY DAM (EAST LIMB) TOE			
DATE OF ISSUE JUNE 26, 2006	PROJECT No. M09237A03 01	FIGURE No. 5.5	REV
APPROVAL			



PLAN 1
SCALE A

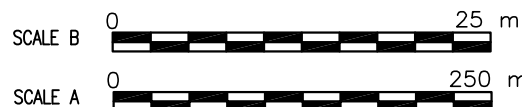


SECTION A
SCALE B

NOT FOR CONSTRUCTION

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CLIENT DELOITTE & TOUCHE INC. ANVIL RANGE MINING COMPLEX	PROJECT ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT		
	TITLE CONCEPTUAL REMEDIAL OPTION FOR SECONDARY DAM (EAST LIMB) <tr> <td> PROJECT No. M09237A03 </td><td> FIG. No. 5.6 </td></tr>	PROJECT No. M09237A03	FIG. No. 5.6
PROJECT No. M09237A03	FIG. No. 5.6		

Time: 8:43:4
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CANCEL PRINTS BEARING PREVIOUS

KCRA-M

APPENDIX I

Test Hole Logs

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P%

X

W%

O

W_L%

X

DEPTH (m)

SPT BLOWS
PER 0.15m

SAMPLE TYPE

SAMPLE No.

SYMBOL

STARTED: 18-Aug-2005 FINISHED: 19-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1031.0

COORDINATES (m): N 6913877.6 E 580460.3

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

SAND (FILL) gravelly, light brown, dry

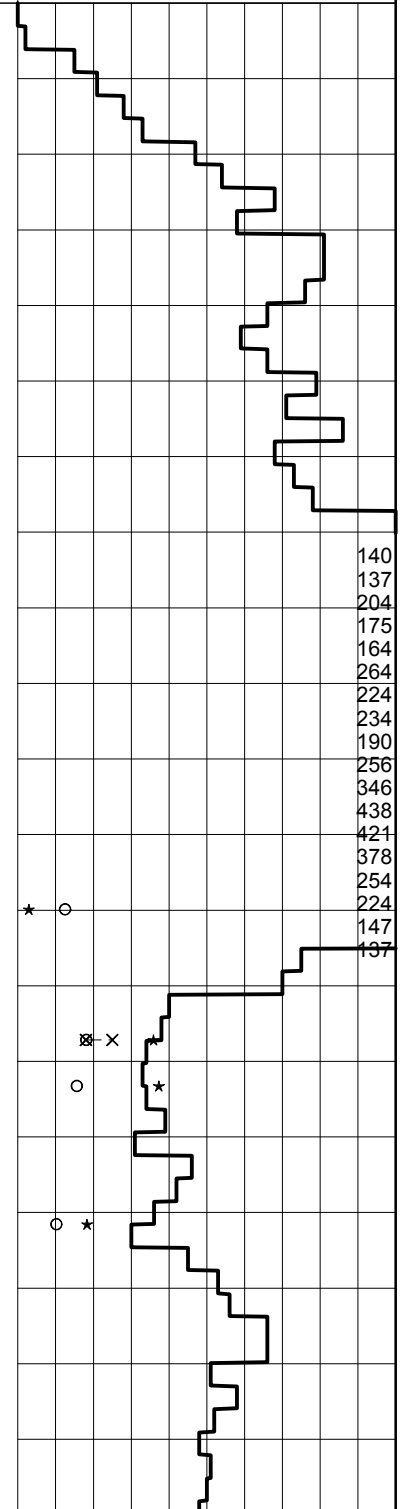
GRAVEL (FILL) sandy, trace silt, rounded gravel,
angular sand, moist

GRAVEL & SAND (GM-SP) coarse to fine sand, silty to
some silt, trace cobbles and boulders, poorly graded,
subrounded to subangular gravel, light grey to light
brown
- trace silt, trace cobbles, angular gravel, moist

SAND (SM) coarse to fine, silty, gravelly to trace gravel,
well-graded, angular to subangular gravel,
yellowish-brown

- rounded to subrounded gravel
- gravelly

- subangular to subrounded gravel



Continued Next Page



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 1 OF 2

HOLE NO.: BK05-01

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P%

X

W%

O

W_L%

X

20

40

60

80

STARTED: 19-Aug-2005 FINISHED: 20-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1031.0

COORDINATES (m): N 6913890.4 E 580469.6

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

101
117
142
174
184
189
200
240
186
216
200
205
211
220
154
138
140

Continued Next Page



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 1 OF 2

HOLE NO.: BPT05-02

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P%

X

W%

O

W_L%

X

20

40

60

80

DEPTH (m)

SPT BLOWS
PER 0.15m

SAMPLE TYPE

SAMPLE No.

SYMBOL

STARTED:19-Aug-2005 FINISHED: 20-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1031.0

COORDINATES (m): N 6913890.4 E 580469.6

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

105

116

122

118

114

110

101

120

115

135

121

116

118

125

123

170

157

132

136

158

105

108

109

116

129

168

218

244

39.3
991.7

End of BPT at 39.3 m



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 2 OF 2

HOLE NO.: BPT05-02

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P% W% W_L%
X O X
20 40 60 80

STARTED 20-Aug-2005 FINISHED: 28-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1017.1

COORDINATES (m): N 6914316.9 E 580200.5

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

SAND & GRAVEL (FILL) medium to coarse sand, trace silt, trace organics, trace cobbles, angular gravel and cobbles, organics dark brown

- geotextile at 1.5 m
- water table at 1.8 m (perched?)
GRAVEL (FILL), fine to coarse, sandy, some silt, angular sand, subrounded gravel, yellowish-brown (drainage blanket?)

4.6
1012.5 GRAVEL & SAND (GM-SM) coarse to medium sand, silty, angular sand, subrounded to subangular gravel, dark brown, lumps of silt
- sand poorly graded, subangular to angular gravel, yellowish-brown

- coarse to fine sand, trace silt, poorly-graded, yellowish-brown

- gravelly

10.1
1007.0 SAND (SW) medium to fine, some silt to silty, trace gravel, compact to dense, olive grey, (blow count could be low due to heave and flush)

- coarse to fine, angular sand and gravel

14.3
1002.8 SAND (SP) coarse to fine, some gravel to gravelly, some silt to silty, angular sand, rounded to subrounded gravel, yellowish-orange
- interbedded sands and gravels to 20.1 m

- fine to medium sand, silty, some gravel, yellowish-brown

Continued Next Page

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 1 OF 2

HOLE NO.: BK05-03



KLOHN CRIPPEN

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P% W% W_L%
X O X
20 40 60 80

STARTED 20-Aug-2005 FINISHED: 28-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1017.1

COORDINATES (m): N 6914316.9 E 580200.5

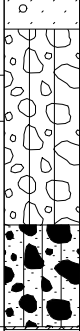
DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

21

GRAB

9



20.4
996.7 SAND & GRAVEL (SM-GM) coarse to fine gravel,
coarse to fine sand, silty, angular sand, subangular
to subrounded gravel, olive grey

- possible weathered till
- large heave

22

23



23.0
994.1 SAND & GRAVEL, bouldery, silty, very dense, angular
gravel, olive gray (GLACIAL TILL)

24

GRAB

10



24.4
992.4 BEDROCK (250 blows for 5 cm)
992.7

25

25.5
991.6 End of BPT at 25.5 m

26

27

- BPT05-03: N6914317.0, E580200.5, El. 1017.1 m
- BKS05-03: N6914320.4, E580202.2, El. 1017.149 m

28

- LPT: I.D. = 47.63 mm, O.D. = 63.5 mm

29

- Energy measured by PDA on BPT

30

- Hole was grout backfilled

31

32

33

34

35

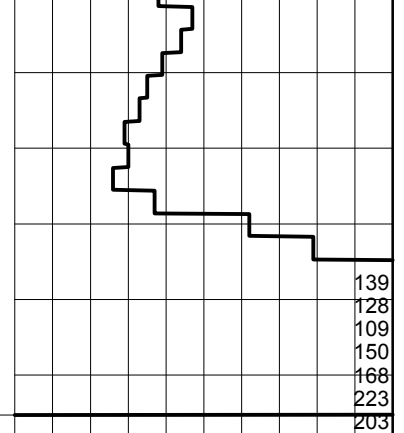
36

37

38

39

40



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 2 OF 2

HOLE NO.: BK05-03

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P%

X

W%

○

W_L%

X

20

40

60

80

STARTED 21-Aug-2005 FINISHED: 26-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1016.3

COORDINATES (m): N 6914186.3 E 580129.8

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

SAND & GRAVEL (FILL) silty, brown, moist

- geotextile

1.8
1014.5 SAND (SM) gravelly, silty, angular, yellowish-orange, wet

2.7
1013.6 GRAVEL (GP) some sand, trace to some silt, coarse to medium sand, angular sand, angular to subrounded gravel, olive grey

4.6
1011.7 GRAVEL & SAND (GP-SP) sand coarse to medium, trace silt, angular to subrounded gravel, subrounded to subangular sand, yellowish-orange

6.4
1009.9 SAND (SP) coarse to fine, gravelly to some gravel, trace silt, angular sand, angular to subrounded gravel, yellowish-orange

- silty, well graded, subrounded to subangular gravel

9.7
1006.6 SAND (SM) fine, silty, some gravel, yellowish-orange

11.9
1004.4 - at 11.9 m, 0.4 m heave; lost circulation; soils unknown

12.8
1003.5 SAND (SM) medium to fine, silty, trace gravel

13.7
1002.6 SILT (ML) clayey, trace sand, low plasticity, olive grey

- SPT sampler advanced 0.15 m under self-weight

- some sand, coarse to fine, angular

- trace fine sand

- medium to fine sand

- some to trace fine sand

19.2
997.1 SAND (SM) coarse to fine, silty, trace gravel, angular to subangular sand, subrounded to subangular gravel

Continued Next Page



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 1 OF 2

HOLE NO.: BK05-04

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P% W% W_L%
X O X
20 40 60 80

INSTRUMENT
DETAILS

STARTED 21-Aug-2005 FINISHED: 26-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1016.3

COORDINATES (m): N 6914186.3 E 580129.8

DESCRIPTION OF MATERIALS

21

22

23

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37

38

39

40

GRAB

14

GRAB

15

GRAB

16

yellowish-orange

- trace wood
- olive grey silt, some sand, fine to medium sand

- yellowish-brown

23.5

992.8

GRAVEL (GW) sandy, trace to some silt, trace cobbles, coarse to fine sand, subangular to subrounded gravel, angular sand, yellowish-brown to yellowish-orange

- gravel and sand, silty, coarse to medium sand, angular gravel, yellowish-orange

27.1

989.2

SAND (SM) silty, trace gravel, trace cobbles, subangular gravel, subrounded cobbles, yellowish-orange, wet

- gravelly, coarse to fine sand, angular sand and gravel

29.6

986.7

GRAVEL (GP) sandy, trace silt, gravel angular to rounded (Glacial Till)

30.2

986.1

- hard layer, refusal

30.6

985.7

End of BPT at 30.6 m

- BPT 28.95m-29.10m - 169 blows for 0.15 m

- BPT05-04: N6914186.3, E580129.8, El. 1016.3 m
- BKS05-04: N6914189.2, E580131.7, El. 1016.3 m

- Energy measured by PDA on BPT

- Hole was grout backfilled

142

295

295

169



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 2 OF 2

HOLE NO.: BK05-04

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P% W% W_L%
X O X
20 40 60 80

DEPTH (m)

SPT BLOWS
PER 0.15m

SAMPLE TYPE

SAMPLE No.

SYMBOL

STARTED 20-Aug-2005 FINISHED: 21-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1016.5

COORDINATES (m): N 6914220.9 E 580147.5

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

1
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16
17
18
19
20

Continued Next Page



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 1 OF 2

HOLE NO.: BPT05-05

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_P%

X

W%

O

W_L%

X

20

40

60

80

DEPTH (m)

SPT BLOWS
PER 0.15m

SAMPLE TYPE

SAMPLE No.

SYMBOL

STARTED 20-Aug-2005 FINISHED: 21-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1016.5

COORDINATES (m): N 6914220.9 E 580147.5

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

28.4
988.2

End of BPT at 28.4 m

- Energy measured by PDA on BPT

132
135
122
132
168
152
334



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 2 OF 2

HOLE NO.: BPT05-05

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_p% W% W_L%
X O X
20 40 60 80

STARTED 29-Aug-2005 FINISHED: 30-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1057.1

COORDINATES (m): N 6912371.1 E 583308.6

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

1
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13
14
15
16
17
18
19
20

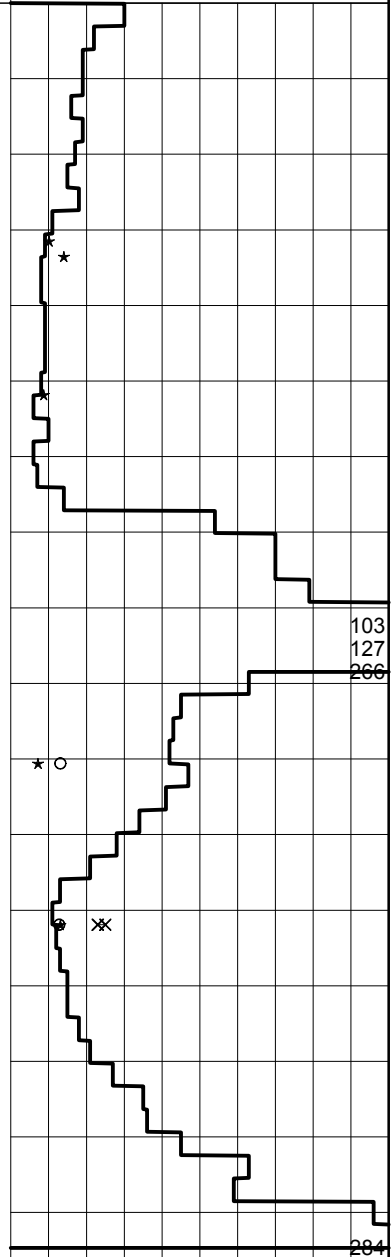
25/9/6
20/12/8
5/5/5
10/19/29
29/12/9

GRAB
SPT
SPT
GRAB
SPT
GRAB
GRAB
GRAB
SPT
GRAB
SPT
GRAB

1
2
3
4
5
6
7
8
9
10
11
12

GRAVEL (FILL) silty, some sand, rounded to subrounded, yellowish-brown
- sandy, silty, coarse to medium sand, moist
2.7
1054.4
SAND and GRAVEL (SW-GW) coarse to medium sand, trace to some silt, subrounded to subangular gravel, angular sand, yellowish-brown, wet
- rock in top of sampler
- max. 5 cm dia.
6.7
1050.4
- weathered boulder or cobble; schist/ chlorite/quartz
GRAVEL & SAND (GW-SW) coarse to fine sand, silty, subangular to subrounded gravel, angular sand, very dense, beige-brown
- medium to fine sand, angular to rounded gravel
9.0
1048.1
SAND (SW) coarse to fine, gravelly, trace silt, subrounded to subangular gravel, yellowish-brown
- 5 cm dia. rock in tip of sampler
10.8
1046.3
GRAVEL (GW) sandy, silty, coarse to medium sand, subrounded to rounded gravel, subangular sand, yellowish-brown
11.8
1045.3
SAND (SW) medium to fine, gravelly, some silt, gravel subangular, yellowish-brown
15.7
1041.4
Weathered bedrock
17.4
1039.7
End of BPT at 17.4 m

- BPT05-06: N6912374.4, E583310.3, El. 1057.2 m
- BKS05-06: N6912371.2, E583310.2, El. 1057.1 m
- BPT05-06B: N6912371.1, E583308.6, El. 1057.1 m



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 1 OF 1

HOLE NO.: BK05-06

BECKER TEST HOLE LOG

BECKER PENETRATION TEST

Casing O.D.:
6 5/8 inch

CLOSE ENDED
(blows/0.3m)

Hammer Energy:
11 kJ max. rated

OPEN ENDED
(blows/0.3m)

● SPT N

★ FINES CONTENT
(%)

W_p% W% W_L%
X O X
20 40 60 80

STARTED 30-Aug-2005 FINISHED: 30-Aug-2005

DRILL RIG MODEL: Becker HAV-180

GROUND ELEV. (m): 1057.1

COORDINATES (m): N 6912397.9 E 583223.4

DESCRIPTION OF MATERIALS

INSTRUMENT
DETAILS

GRAVEL & SAND (FILL) fine to medium sand, silty,
subrounded to angular gravel, yellowish-brown

-moist
-boulder; SPT sampler refused

GRAVEL & SAND (GM-SP) medium to fine sand, silty

SAND (SM) coarse to fine, silty, some gravel,
subrounded gravel, yellowish-brown
- attempt SPT; refused

- max. 5 cm dia., angular to subrounded gravel,
orange-brown

SAND AND GRAVEL (SP-GP) coarse sand, trace silt,
subrounded gravel (depleted in fines, possibly due to
water flush)

-SAND (SM) silty, some gravel, coarse to fine sand,
subangular to angular gravel, cobbles scattered

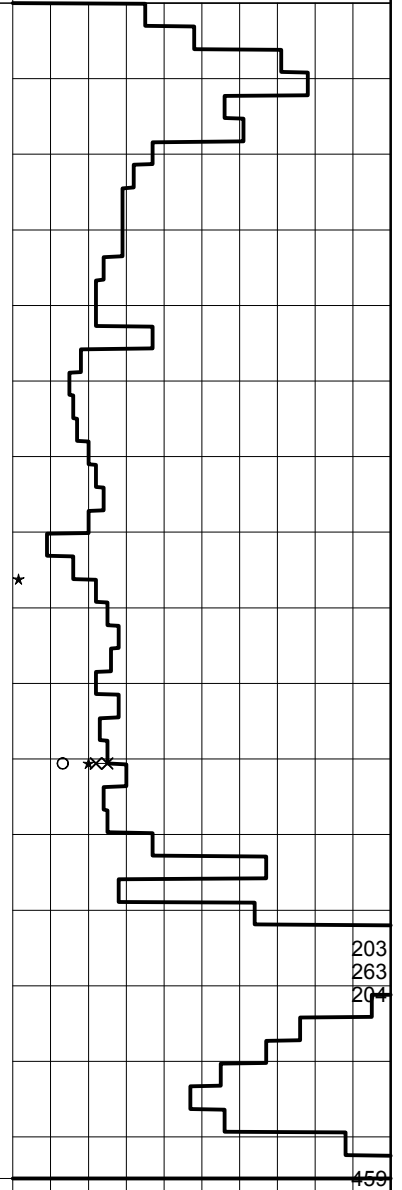
- gravelly, some silt to silty, subrounded gravel, trace
oxides and schist fragments, rock in top of sampler

BEDROCK (schist), weathered, silty, trace rounded
gravel

- no rounded gravel

End of BPT at 15.6 m

- BKS05-07: N6912396.4, E583225.4, El. 1057.1 m
- BPT05-07: N6912397.9, E583223.4, El. 1057.1 m



203
263
204

459



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 1 OF 1

HOLE NO.: BK05-07

TEST HOLE LOG							Su - kPa				
DEPTH (m)	SPT BLOWS PER 0.15m	SAMPLE TYPE	SAMPLE No.	SYMBOL	STARTED: 22-Aug-2005 FINISHED: 25-Aug-2005	INSTRUMENT DETAILS	20 60 100 140 180				
					DRILL METHOD: Open Becker & Mud Rotary		VANE PEAK REMOLD	FIELD	LAB	UC/2	
					GROUND ELEV. (m): 1016.50		★ % FINES	● SPT N	△ P.PEN/2		
					COORDINATES (m): N 6914222.7 E 580148.5		W _P %	W%	W _L %		
					DESCRIPTION OF MATERIALS		x	o	x		
							20	40	60	80	
1					GRAVEL (GP) fine to medium sand, fine to coarse gravel, sandy, trace silt, poorly graded, flat and elongated, angular sand, subangular gravel, grey, no odour, wet (Fill)						
2	16/15/16	SPT	1		2.10 1014.40		★	○	●		
3	17/19/17	SPT	2		GRAVEL (GP) coarse to fine, sandy, coarse to medium sand, trace silt, flat and elongated, subangular gravel, grey, no odour, moist, no cementation		★	○	●		
4											
5	31/27/18	SPT	3		5.03 1011.47		★	○	●		
6	8/10/16	SPT	4		SAND (SW) coarse to fine, some silt, trace gravel, trace organics, flat and elongated, subangular, brown, no odour, moist, weak cementation		★	○	●		
7	8/8/13	SPT	5		- gravelly, subangular sand and gravel, no cementation		★	○	●		
8	7/6/7	SPT	6		7.64 1008.86		★	○	●	×	★
9	2/3/5	SPT	7		8.78 1007.72		★	○	●	×	★
10	2/2/5	SPT	8		SILT (ML) some sand, trace clay, trace organics, low plasticity, olive grey, low dry strength - sandy, dark grey from 9.04 m - 9.19 m - trace to some clay, trace fine sand		★	○	●	×	★
Continued Next Page											
 KLOHN CRIPPEN							PROJECT NO.: M09237A03 Cross Valley Dam				
							PROJECT: Rose Creek Seismic Stability Assessment				
							LOCATION: Anvil Range Mine, Yukon				
							LOGGED BY: IL CHECKED BY: BDW				
SHEET 1 OF 3							HOLE NO.: DH05-01				

TEST HOLE LOG

TEST HOLE LOG								Su - kPa						
DEPTH (m)	SPT BLOWS PER 0.15m	SAMPLE TYPE	SAMPLE No.	SYMBOL	STARTED: 22-Aug-2005 FINISHED: 25-Aug-2005		INSTRUMENT DETAILS	20	60	100	140	180		
					DRILL METHOD:Open Becker & Mud Rotary			VANE PEAK	FIELD	LAB	▲ UC/2			
					GROUND ELEV. (m): 1016.50			REMO	◇	□	△ P.PEN/2			
					COORDINATES (m): N 6914222.7 E 580148.5			★ % FINES		● SPT N				
					DESCRIPTION OF MATERIALS			W _p %	W%	W _L %				
								</						

Continued Next Page



KLOHN CRIPPEN

PROJECT NO.: M09237A03 Cross Valley Dam

PROJECT: Rose Creek Seismic Stability Assessment

LOCATION: Anvil Range Mine, Yukon

LOGGED BY: IL

CHECKED BY: BDW

SHEET 2 OF 3

HOLE NO.: DH05-01

TEST HOLE LOG							Su - kPa											
DEPTH (m)	SPT BLOWS PER 0.15m	SAMPLE TYPE	SAMPLE No.	SYMBOL	STARTED: 22-Aug-2005 FINISHED: 25-Aug-2005		INSTRUMENT DETAILS	VANE PEAK REMOLD					FIELD		LAB		UC/2 P.PEN/2	
					DRILL METHOD: Open Becker & Mud Rotary			★ % FINES					SPT N		W _p %		W _L %	
					GROUND ELEV. (m): 1016.50			x - - - - - o - - - - - x					20 40 60 80		20 40 60 80		20 40 60 80	
					COORDINATES (m): N 6914222.7 E 580148.5													
					DESCRIPTION OF MATERIALS													
21	13/12/15	LPT	15		- cobble													
22	20/29/18	LPT	16															
23	10/19/18	LPT	17															
24	16/60	LPT	18		- refusal at 24.61m; 50 blows for 0.075 m													
25																		
26	30/48/50	LPT	19		25.91 990.59 GRAVEL & SAND (GP-SP) coarse to fine sand, trace to some silt, angular sand and gravel, olive grey, moist (GLACIAL TILL) - refusal at 26.06 m; 50 blows for 0.125 m													
27																		
28	38/48/50	LPT	20		27.84 988.66 End of Hole at 27.84 m													
29																		
30					- LPT: I.D. = 44.45 mm, O.D. = 63.5 mm - Open Becker down to 5.0 m; then switch to mud rotary. - Energy measured by PDA on all LPTS and selected SPTs - Hole was grout backfilled													
KLOHN CRIPPEN							PROJECT NO.: M09237A03 Cross Valley Dam											
							PROJECT: Rose Creek Seismic Stability Assessment											
							LOCATION: Anvil Range Mine, Yukon											
							LOGGED BY: IL						CHECKED BY: BDW					
							SHEET 3 OF 3						HOLE NO.: DH05-01					



KLOHN CRIPPEN

APPENDIX II

Site Investigation Photographs



Photo II-1 BPT at the Intermediate Dam Downstream Berm Using HAV180 Drill Rig and Instrumented Casing



Photo II-2 PDA Data Acquisition System and Monitoring Equipments at the Intermediate Dam



Photo II-3 SPT Data Set up with Automatic Trip Hammer and Instrumented Rod for Energy Measurements During Becker Open Hole Test at the Cross Valley Dam

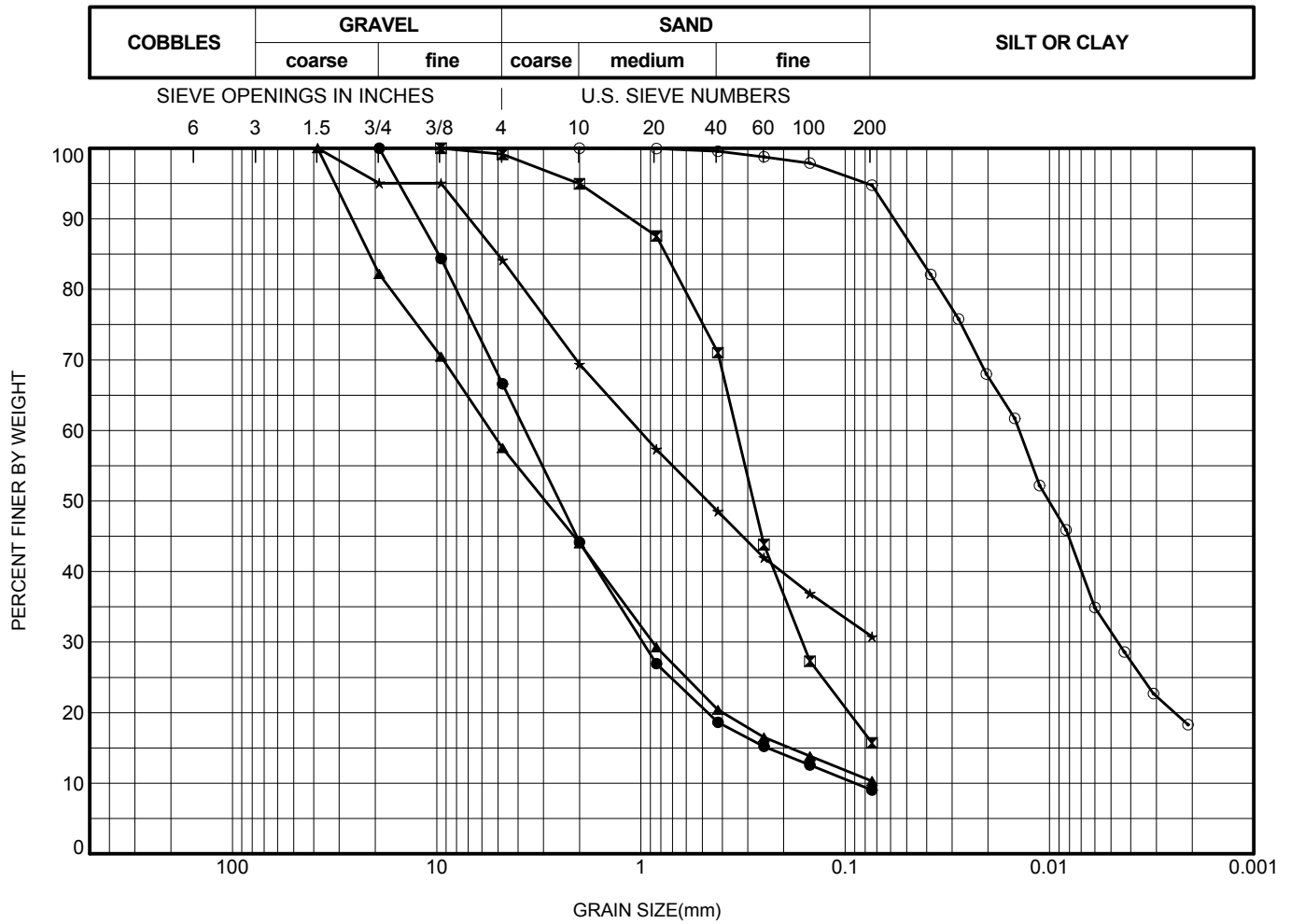


Photo II-4 Photo II-5 SPT Data Set up with Automatic Trip Hammer and Instrumented Rod for Energy Measurements During Mud Rotary Drilling at the Cross Valley Dam

APPENDIX III

Laboratory Test Results

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	BKS05-03	7.60	9.791	3.688	2.506	0.240	0.090	41.146	33.4	57.5	9.1
⊠	BKS05-03	10.10	0.754	0.340	0.281				0.9	83.2	15.9
▲	BKS05-03	14.90	21.308	5.438	2.937	0.187	0.070	77.986	42.5	47.1	10.4
★	BKS05-04	9.40	5.032	1.018	0.471				15.9	53.2	30.9
⊙	BKS05-04	14.30							0.0	5.2	94.8

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	BKS05-03	LPT 1	7.60					25 ft
⊠	BKS05-03	LPT 2	10.10					33 ft
▲	BKS05-03	LPT 3	14.90					49 ft
★	BKS05-04	SPT 1	9.40					31 ft
⊙	BKS05-04	SPT 2	14.30		30	21	9	47 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

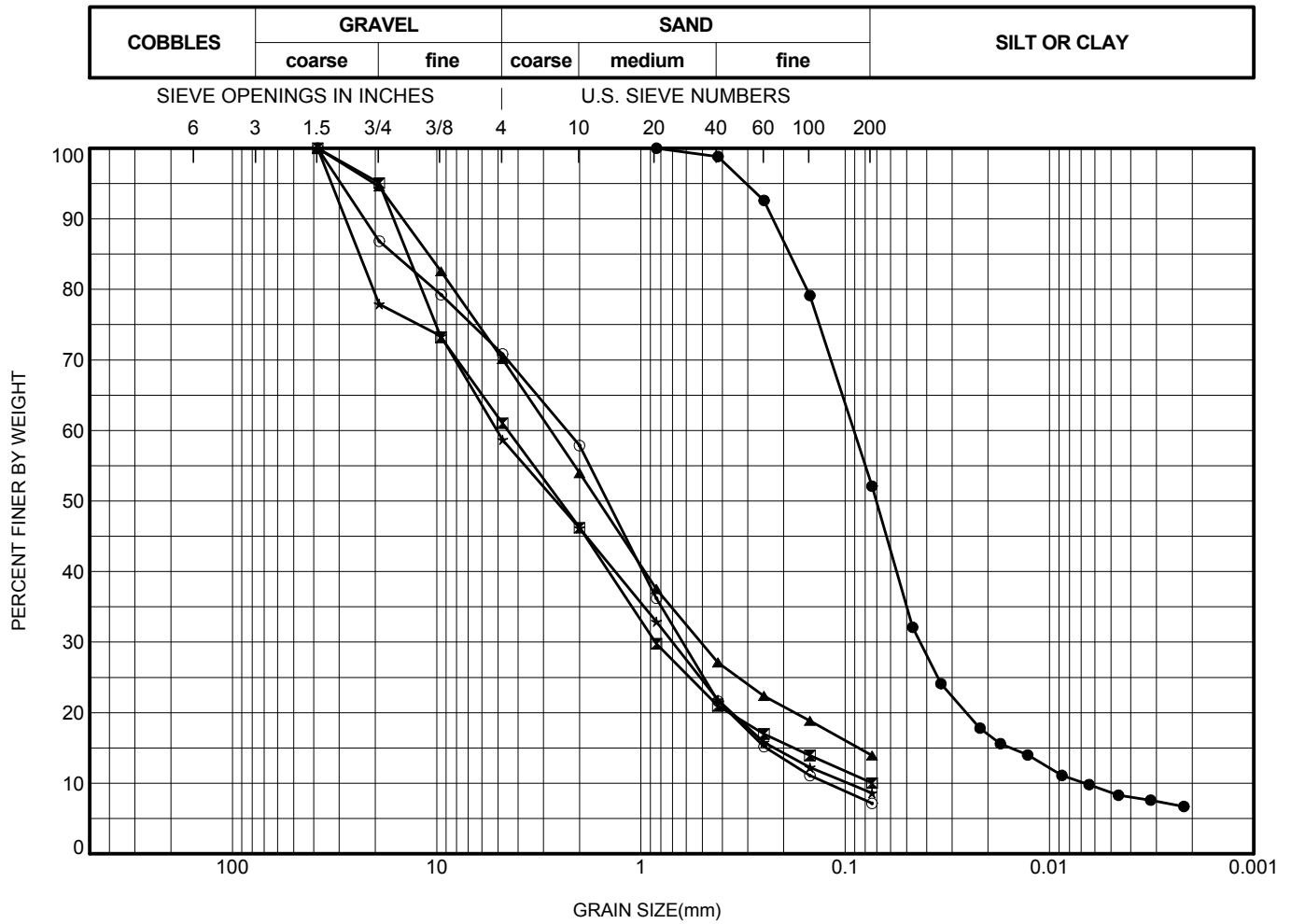
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	BKS05-04	16.80	0.187	0.091					0.0	47.4	52.6
⊠	BKS05-06	3.20	13.861	4.482	2.495	0.179	0.074	60.804	39.0	50.9	10.1
▲	BKS05-06	3.40	10.966	2.766	1.623	0.086			29.9	56.0	14.0
★	BKS05-06	5.20	23.854	5.063	2.608	0.223	0.097	52.355	41.3	50.0	8.7
⊙	BKS05-06	10.10	16.152	2.306	1.459	0.244	0.123	18.767	29.2	63.6	7.2

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	BKS05-04		16.80		NP	15	NP	55 ft
⊠	BKS05-06	SPT 1	3.20					10.4 ft
▲	BKS05-06	SPT 2	3.40					11 ft
★	BKS05-06	SPT 3	5.20					17 ft
⊙	BKS05-06	SPT 4	10.10					33 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

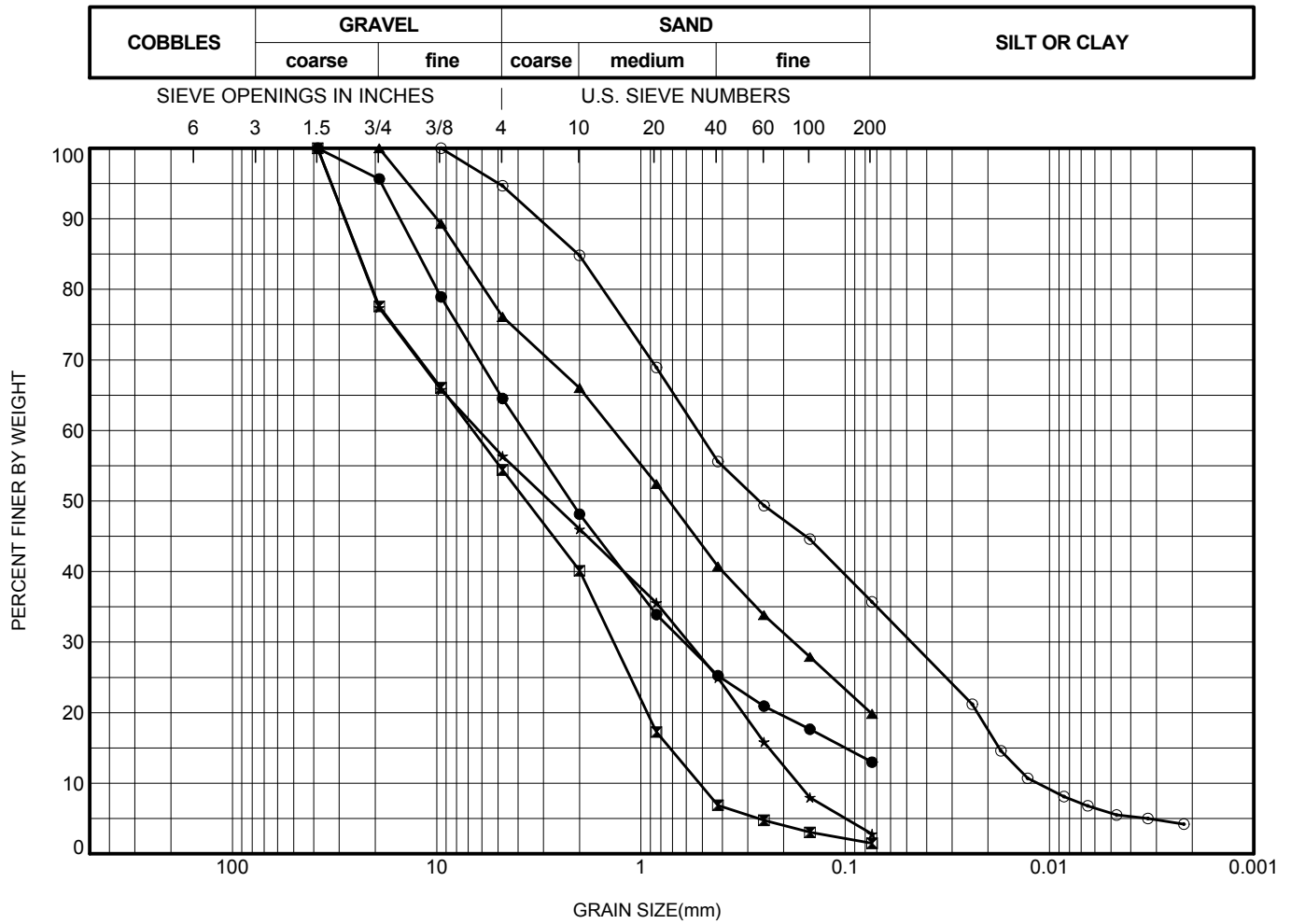
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	BKS05-06	12.20	12.261	3.746	2.207	0.100			35.5	51.4	13.1
⊠	BKS05-07	7.60	24.019	6.641	3.644	0.722	0.517	12.840	45.6	52.9	1.5
▲	BKS05-07	10.10	7.594	1.363	0.728				23.9	56.1	20.0
★	BKS05-08	12.00	24.120	6.217	2.795	0.237	0.170	36.490	43.7	53.4	2.9
⊙	BKS05-08	13.70	2.033	0.528	0.264				5.3	58.8	35.9

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	BKS05-06	SPT 5	12.20		25	23	2	40 ft
⊠	BKS05-07	SPT 1	7.60					25 ft
▲	BKS05-07	SPT 2	10.10		25	22	3	33 ft
★	BKS05-08	SPT 1	12.00					39.3 ft
⊙	BKS05-08	SPT 2	13.70		25	18	6	45 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

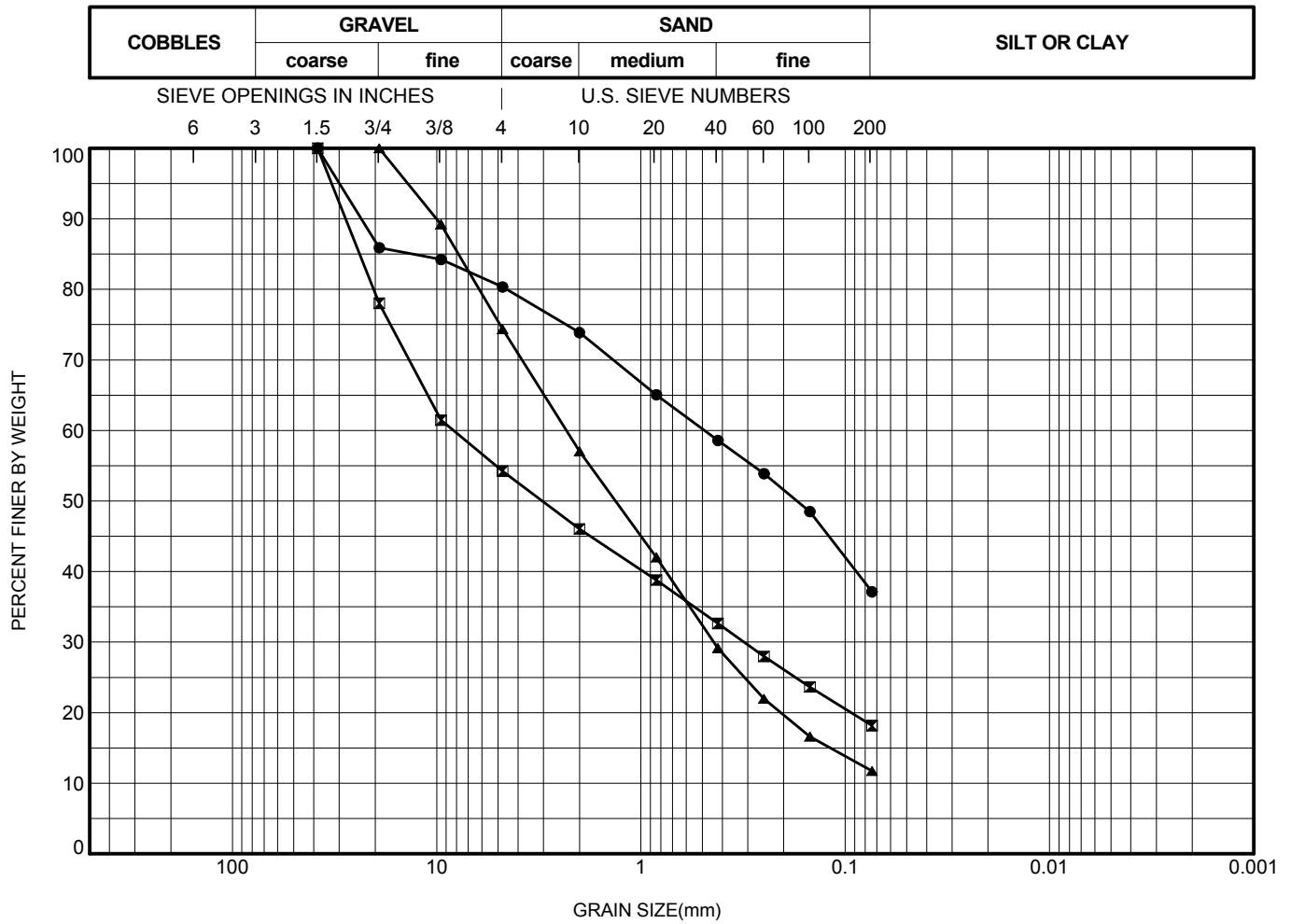
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	BKS05-08	14.30	13.130	0.489	0.172				19.7	43.0	37.3
⊠	BKS05-08	16.20	23.804	8.274	3.040				45.8	35.9	18.3
▲	BKS05-08	21.00	7.821	2.320	1.332	0.118	0.058	40.234	25.7	62.5	11.8

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	BKS05-08	SPT 3	14.30					47 ft
⊠	BKS05-08	SPT 4	16.20					53 ft
▲	BKS05-08	SPT 5	21.00		25	19	6	69 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

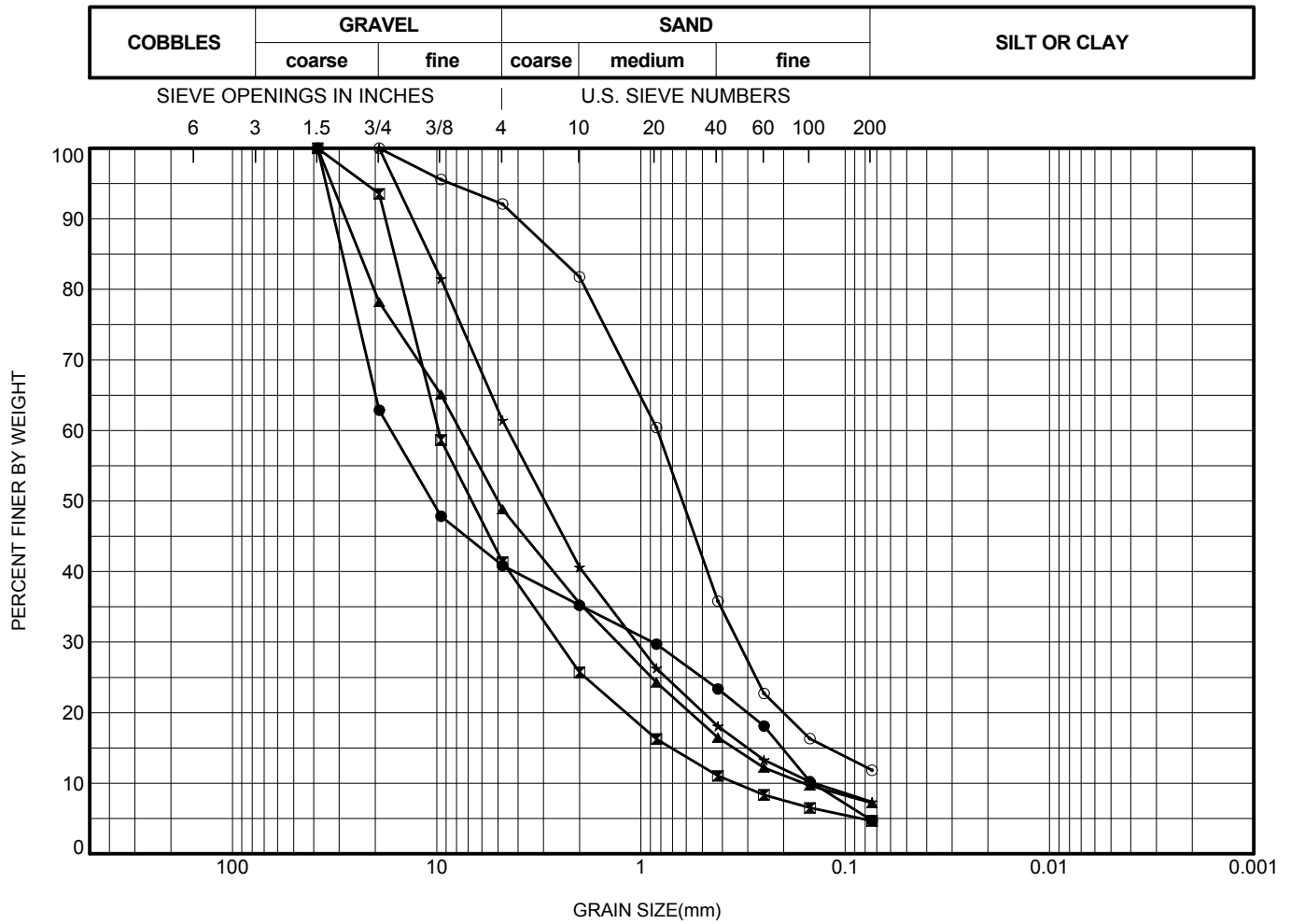
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	DH05-01	1.50	28.870	16.722	10.522	0.204	0.145	115.595	59.2	36.0	4.8
⊠	DH05-01	3.00	16.107	9.782	6.733	0.710	0.344	28.441	58.7	36.6	4.7
▲	DH05-01	4.60	23.710	7.665	5.005	0.352	0.159	48.083	51.2	41.6	7.2
★	DH05-01	4.90	10.855	4.486	2.958	0.300	0.141	31.756	38.6	54.0	7.4
⊙	DH05-01	5.00	2.623	0.830	0.626	0.121	0.056	14.956	7.9	80.1	11.9

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	DH05-01	SPT 1	1.50					5 ft
⊠	DH05-01	SPT 2	3.00					10 ft
▲	DH05-01	SPT 3	4.60					15 ft
★	DH05-01	SPT 4	4.90					16 ft
⊙	DH05-01	SPT 4	5.00					16.5 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

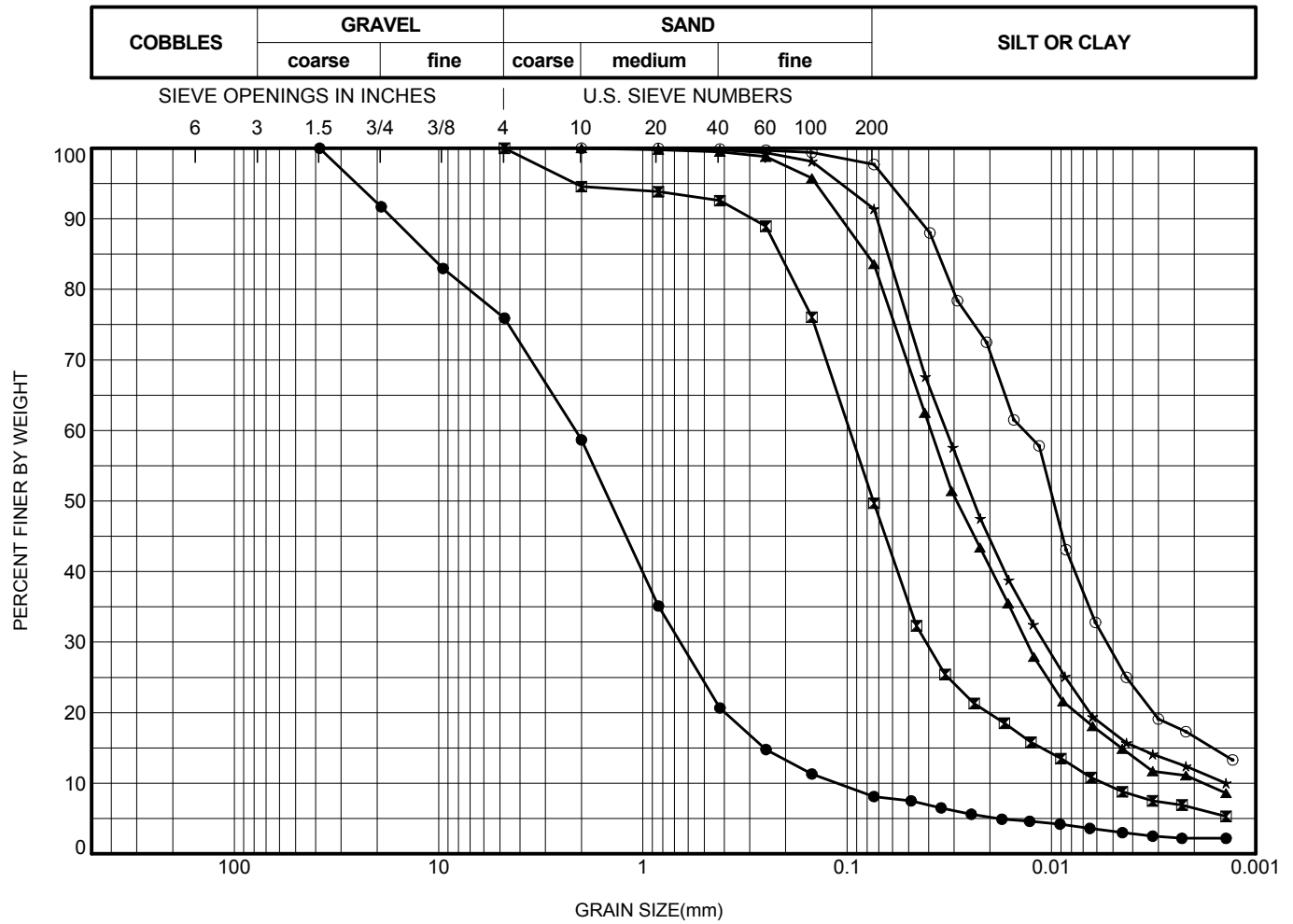
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	DH05-01	6.10	11.193	2.138	1.453	0.255	0.112	19.095	24.1	67.7	8.2
⊠	DH05-01	7.60	0.213	0.097	0.075				0.0	49.8	50.2
▲	DH05-01	8.80	0.080						0.0	16.2	83.8
★	DH05-01	9.70							0.0	8.4	91.6
⊙	DH05-01	10.70							0.0	2.3	97.7

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	DH05-01	SPT 5	6.10					20 ft
⊠	DH05-01	SPT 6	7.60		22	19	3	25 ft
▲	DH05-01	SPT 7	8.80		24	20	3	28.8 ft
★	DH05-01	SPT 8	9.70		24	19	6	31.8 ft
⊙	DH05-01	SPT 9	10.70		32	22	9	35 ft. Top layer

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

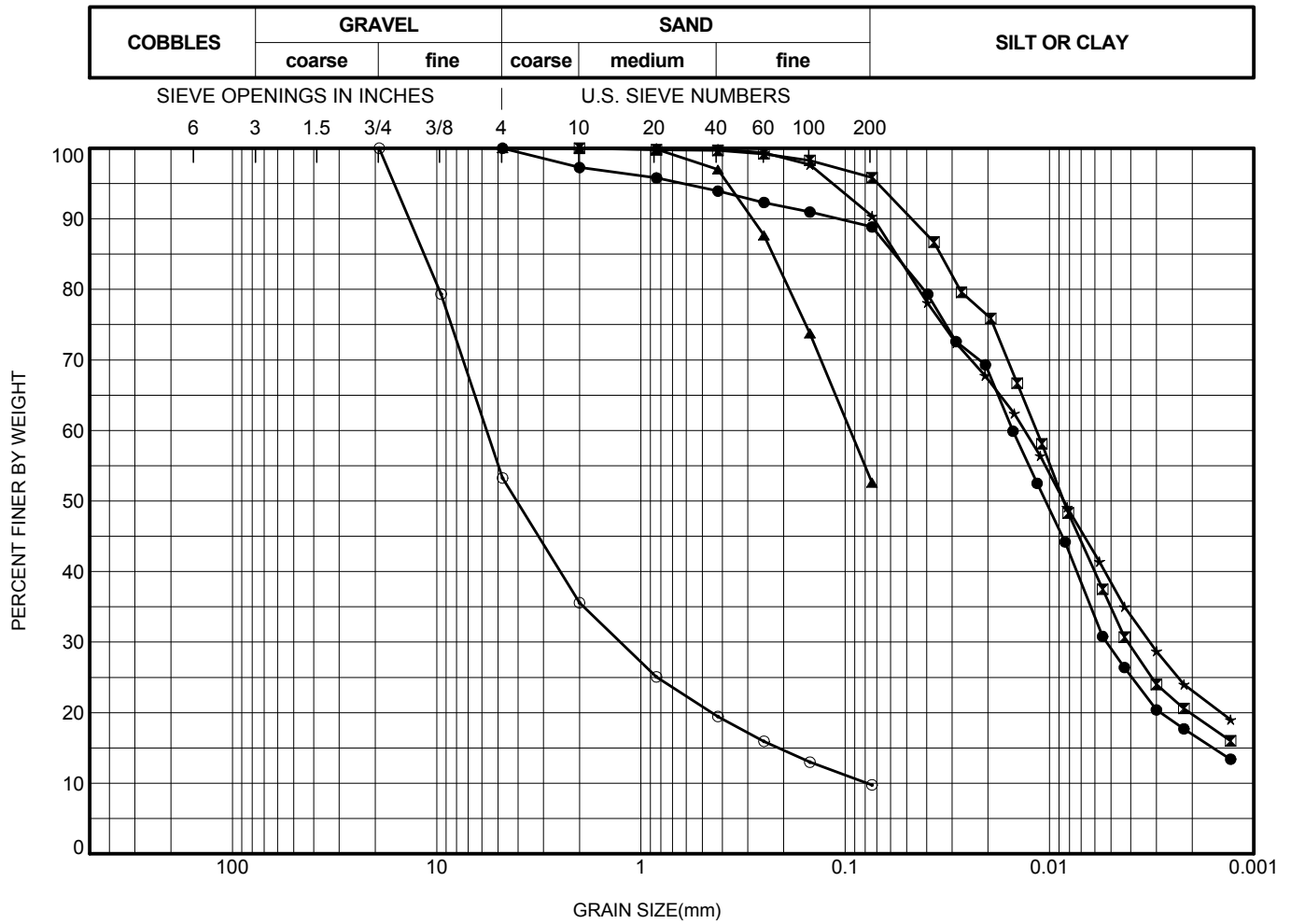
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	DH05-01	11.00							0.0	11.1	88.9
⊠	DH05-01	12.20							0.0	4.1	95.9
▲	DH05-01	12.50	0.226	0.095					0.0	47.0	53.0
★	DH05-01	13.70							0.0	9.5	90.5
⊙	DH05-01	14.00	11.522	5.694	4.056	0.212	0.078	72.986	46.8	43.4	9.8

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	DH05-01	SPT 9	11.00					36 ft. Bottom layer
⊠	DH05-01	SPT 10	12.20		34	21	12	40 ft
▲	DH05-01	SPT 10	12.50					41 ft
★	DH05-01	SPT 11	13.70		30	19	10	45 ft
⊙	DH05-01	SPT 11	14.00					46 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

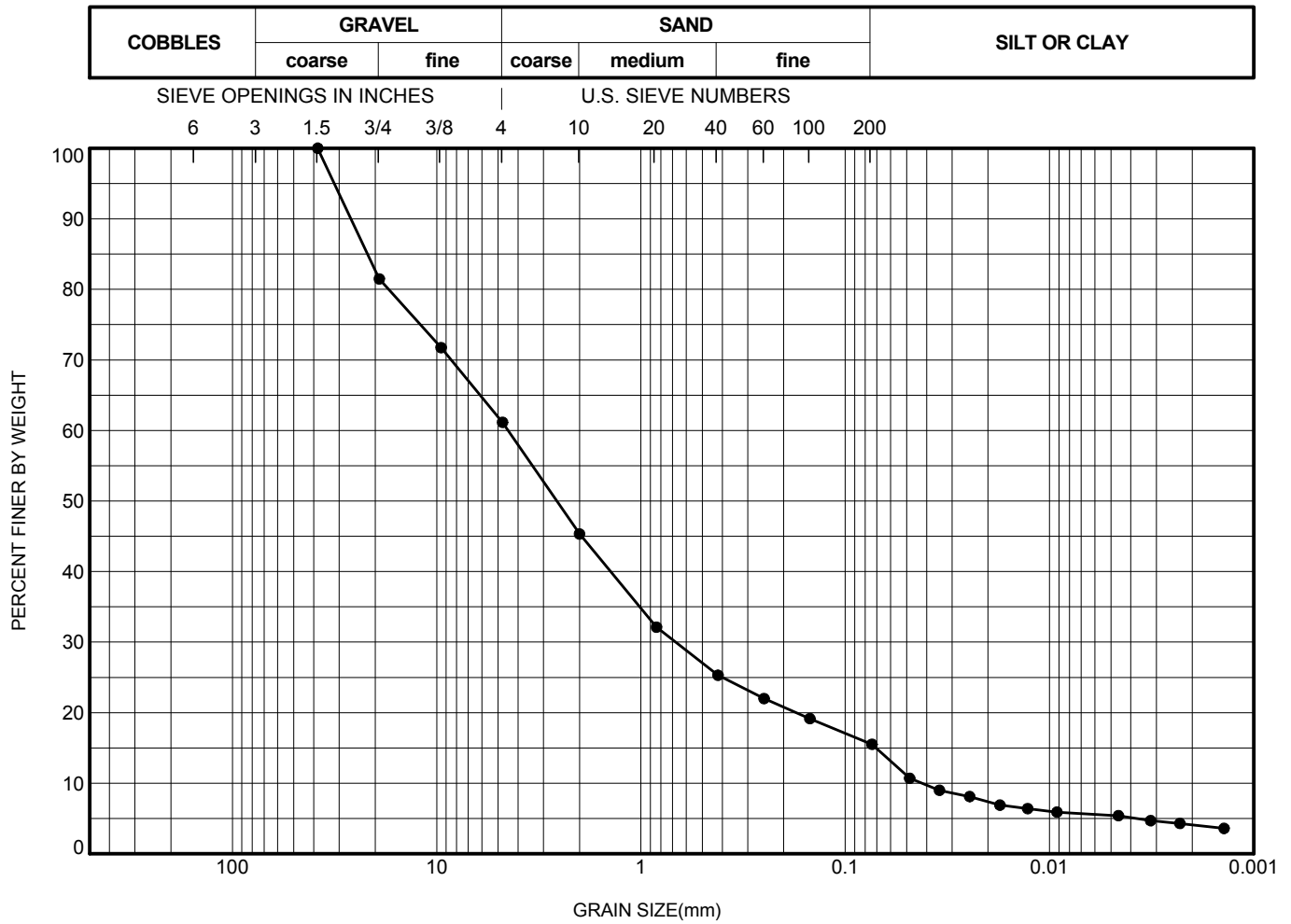
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	DH05-01	15.20	21.789	4.468	2.583				38.9	45.5	15.6

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	DH05-01	SPT 12	15.20					50 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

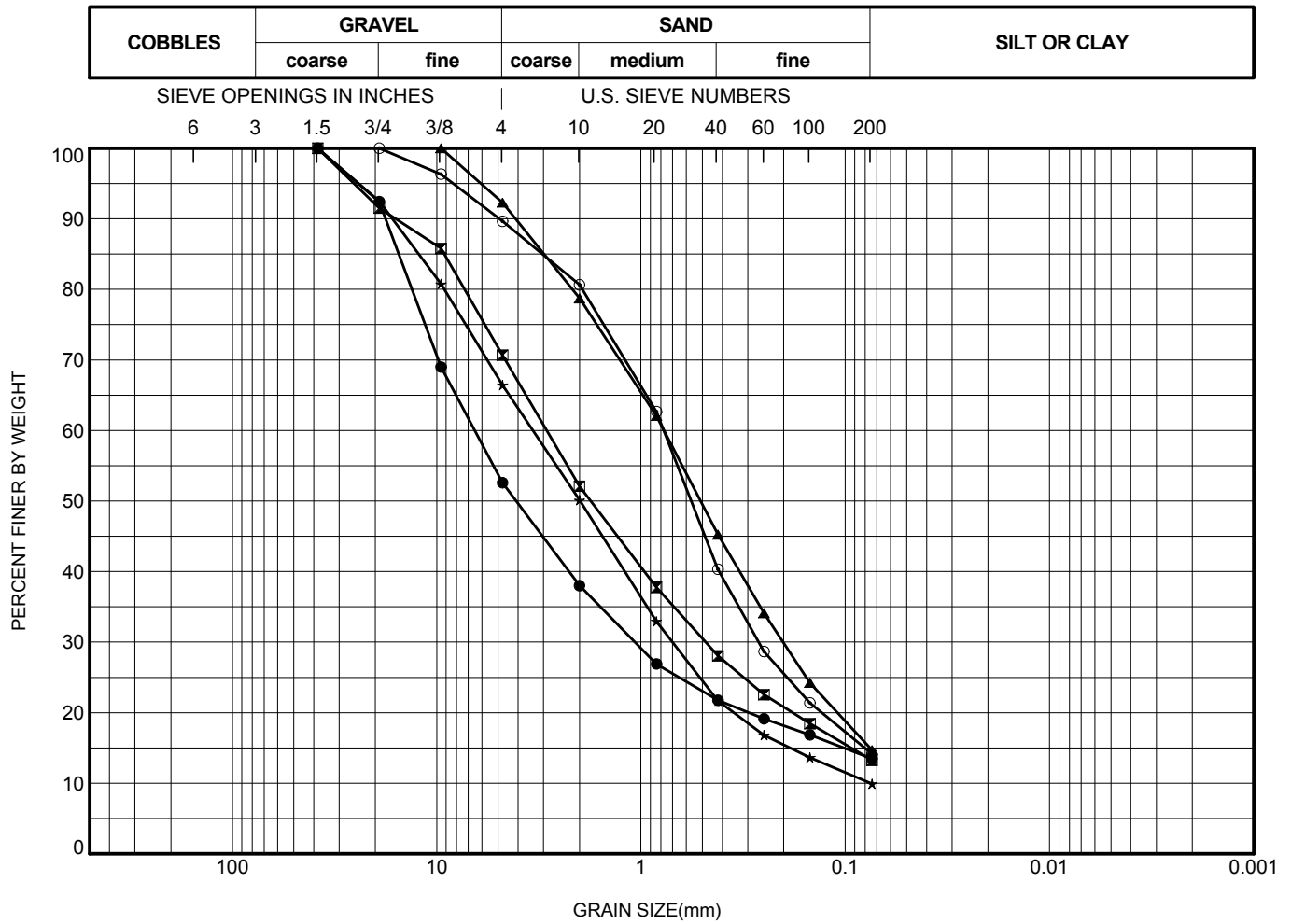
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	DH05-01	16.80	15.315	6.510	4.081	0.101			47.4	39.0	13.5
⊠	DH05-01	18.30	9.176	2.893	1.762	0.094			29.4	57.3	13.4
▲	DH05-01	19.80	2.986	0.771	0.511	0.076			7.7	77.4	14.9
★	DH05-01	21.30	12.245	3.383	1.988	0.186	0.075	45.033	33.6	56.4	10.0
⊙	DH05-01	22.90	3.041	0.773	0.567	0.080			10.4	75.3	14.3

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	DH05-01	SPT 13	16.80					55 ft
⊠	DH05-01	LPT 14	18.30					60 ft
▲	DH05-01	LPT 15	19.80					65 ft
★	DH05-01	LPT 16	21.30					70 ft
⊙	DH05-01	LPT 17	22.90					75 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

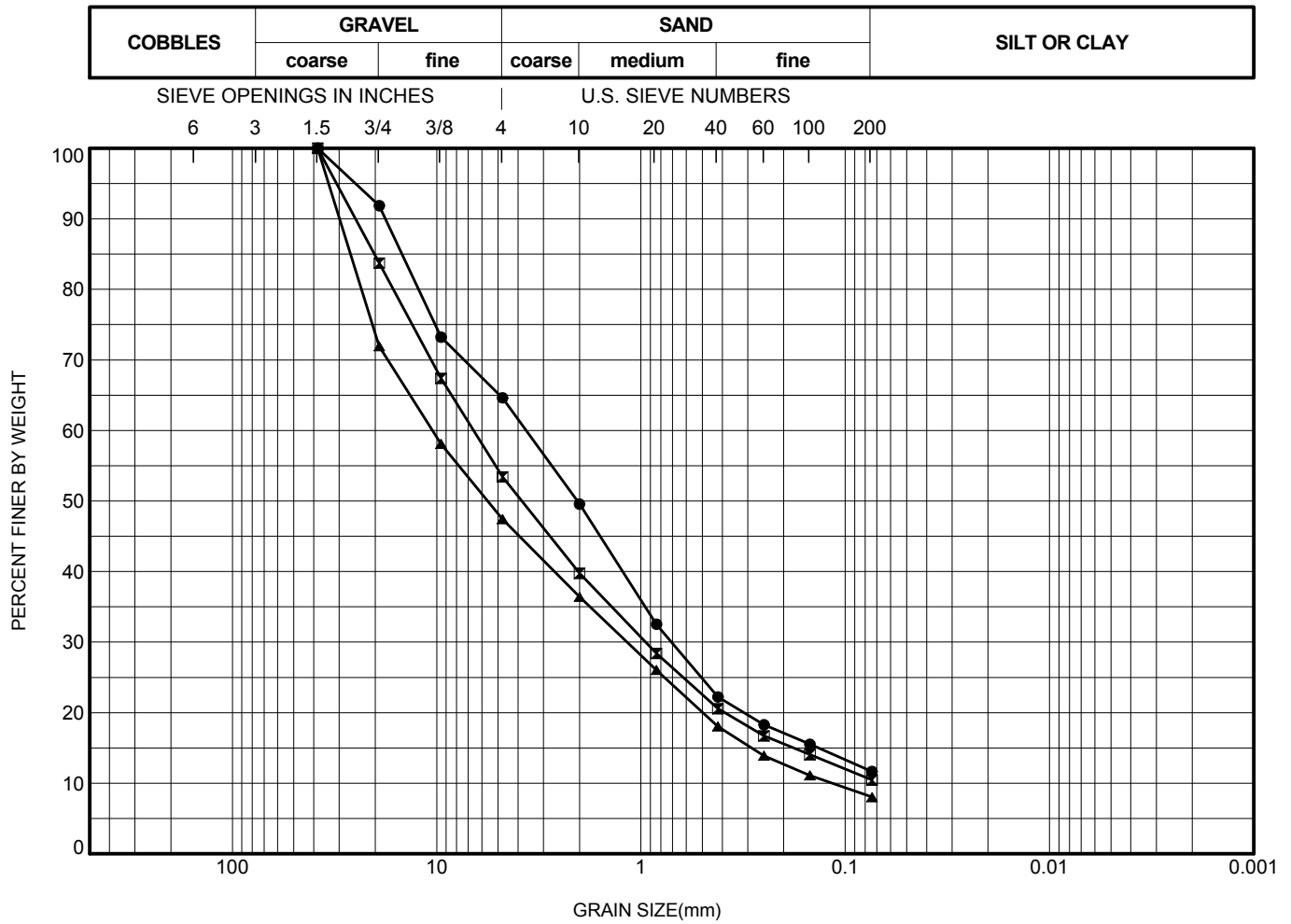
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	DH05-01	24.40	14.780	3.648	2.050	0.135	0.055	66.497	35.4	52.9	11.7
⊠	DH05-01	25.90	20.163	6.599	3.832	0.179	0.068	97.555	46.6	42.9	10.5
▲	DH05-01	27.40	26.372	10.473	5.623	0.287	0.116	90.465	52.6	39.3	8.1

	HOLE	SAMPLE	DEPTH (m)	W%	W _L	W _P	PI	REMARKS / SAMPLE DESCRIPTION
●	DH05-01	LPT 18	24.40		23	21	3	80 ft
⊠	DH05-01	LPT 19	25.90					85 ft
▲	DH05-01	LPT 20	27.40					90 ft

CU = COEFFICIENT OF UNIFORMITY = D60/D10

PARTICLE SIZES, e.g. D85, in mm

Tested by Wet Sieving Method (ASTM D1140 & D422)



KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

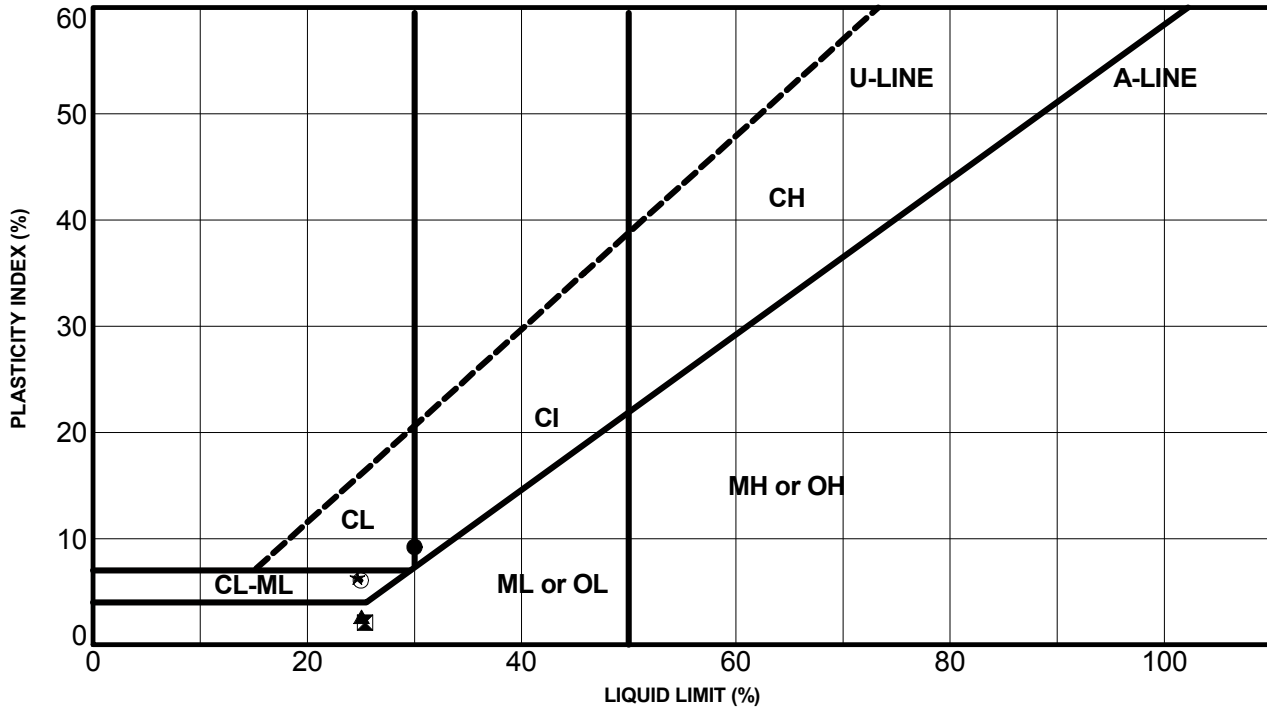
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

PLASTICITY CHART

[illegible]

KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

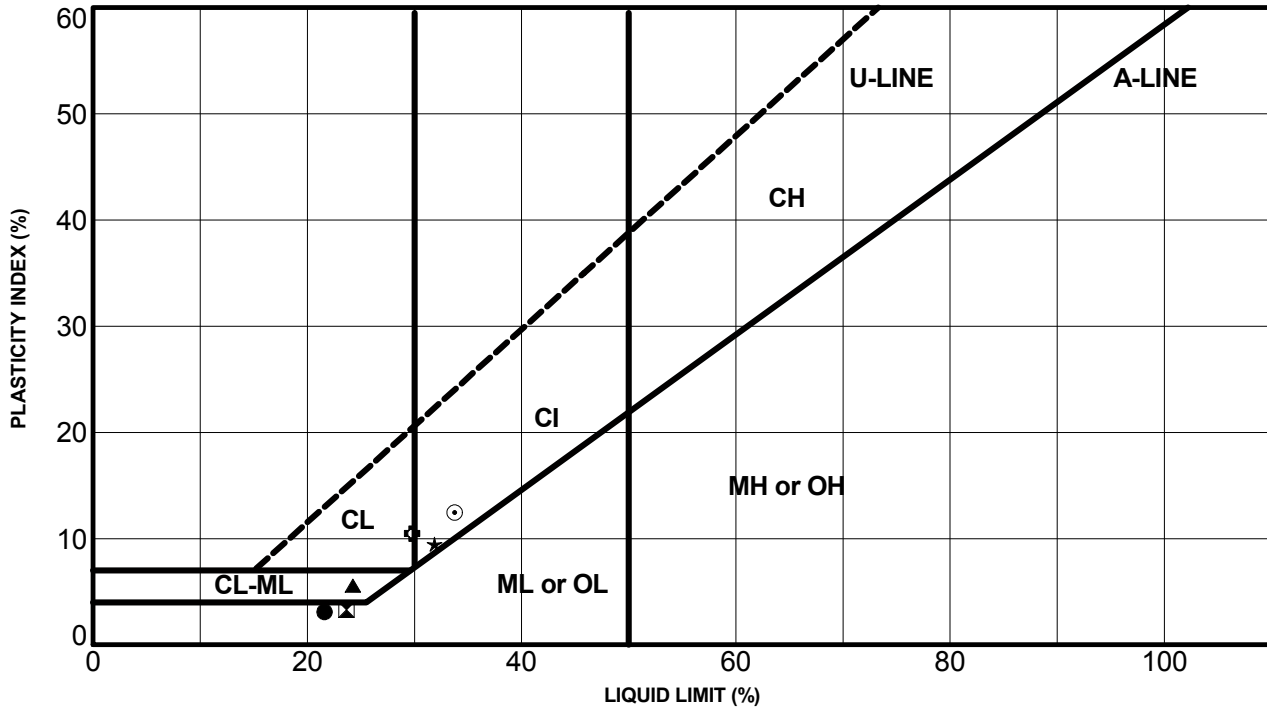
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

PLASTICITY CHART

[illegible]

KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

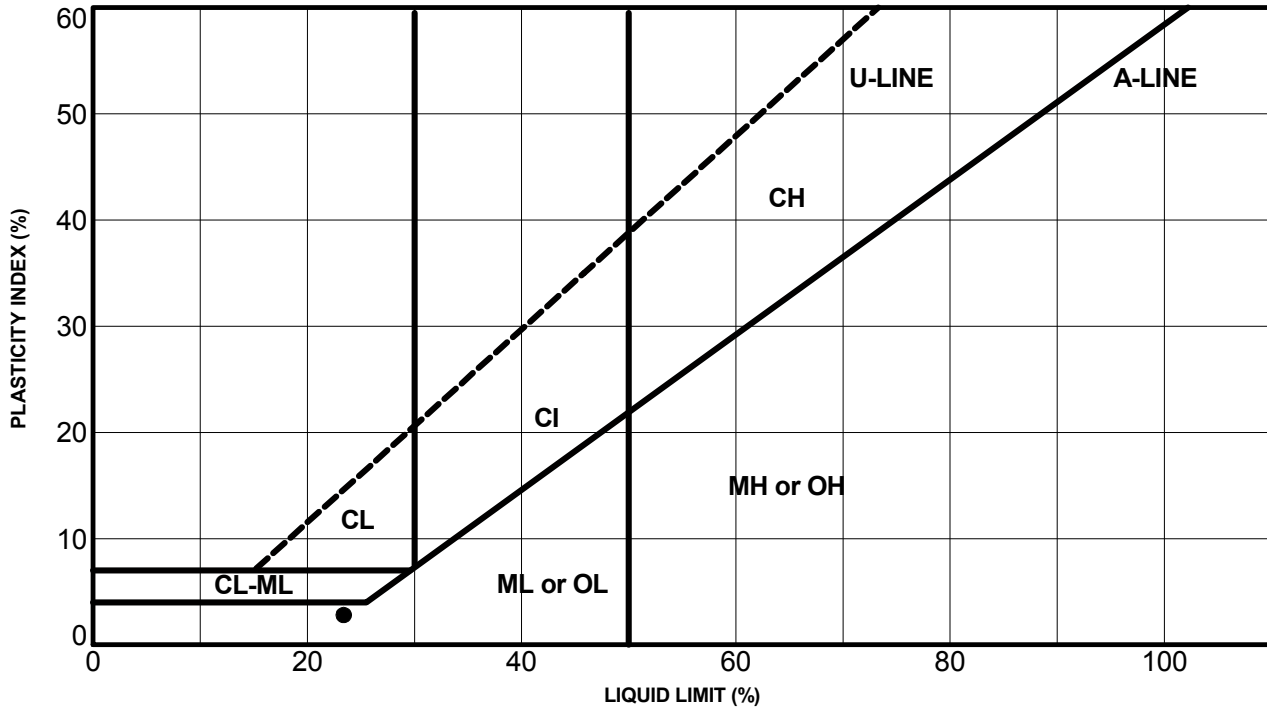
LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

PLASTICITY CHART

[illegible]

KLOHN CRIPPEN

PROJECT NO.: M09237A03

PROJECT: Rose Creek Tailings Impoundment

LOCATION: Faro, Yukon

FIGURE:

DRAWN BY: JS

CHECKED BY: JAG

WATER CONTENT OF SOIL (ASTM D2216)

Hole No.	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01
Depth m (ft)	1.5 (5)	3.0 (10)	4.6 (15)	4.9 (16)	5.0 (16.5)	6.1 (20)	7.6 (25)
Sample No.	SPT 1	SPT 2	SPT 3	SPT 4	SPT 4	SPT 5	SPT 6
Wet Weight + Tare (g)	320.64	332.85	328.08	298.34	242.86	239.06	158.92
Dry Weight + Tare (g)	302.36	314.60	305.26	271.52	215.54	221.39	141.90
Tare (g)	73.49	76.35	78.57	82.17	73.02	81.58	78.78
Water Weight (g)	18.28	18.25	22.82	26.82	27.32	17.67	17.02
Total Dry Weight (g)	228.87	238.25	226.69	189.35	142.52	139.81	63.12
Water Content (%)	8.0	7.7	10.1	14.2	19.2	12.6	27.0

Hole No.	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01
Depth m (ft)	8.8 (28.8)	9.7 (31.8)	10.7 (35)	11.0 (36)	12.2 (40)	12.5 (41)	13.7 (45)
Sample No.	SPT 7	SPT 8	SPT 9	SPT 9	SPT 10	SPT 10	SPT 11
Wet Weight + Tare (g)	134.30	161.05	147.62	124.48	150.56	167.47	116.40
Dry Weight + Tare (g)	122.12	147.91	139.59	122.15	141.70	155.78	112.03
Tare (g)	81.15	97.12	115.66	114.37	115.15	101.97	97.11
Water Weight (g)	12.18	13.14	8.03	2.33	8.86	11.69	4.37
Total Dry Weight (g)	40.97	50.79	23.93	7.78	26.55	53.81	14.92
Water Content (%)	29.7	25.9	33.6	29.9	33.4	21.7	29.3

Hole No.	DH 05-01	DH 05-01					
Depth m (ft)	14.0 (46)	15.2 (50)					
Sample No.	SPT 11	SPT 12					
Wet Weight + Tare (g)	287.06	232.05					
Dry Weight + Tare (g)	270.93	219.22					
Tare (g)	79.67	99.72					
Water Weight (g)	16.13	12.83					
Total Dry Weight (g)	191.26	119.50					
Water Content (%)	8.4	10.7					

Hole No.							
Depth (ft)							
Sample No.							
Wet Weight + Tare (g)							
Dry Weight + Tare (g)							
Tare (g)							
Water Weight (g)							
Total Dry Weight (g)							
Water Content (%)							



JOB NO.:	M09237 A03 01 02
PROJECT:	Rose Creek Tailings Impoundment
LOCATION:	Faro, Yukon
DATE:	August 29, 2005
TESTED BY:	Juan
CHECKED BY:	JAG

WATER CONTENT OF SOIL (ASTM D2216)

Hole No.	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01	DH 05-01	
Depth m (ft)	19.8 (65)	21.3 (70)	22.9 (75)	24.4 (80)	25.9 (85)	27.4 (90)	
Sample No.	LPT 15	LPT 16	LPT 17	LPT 18	LPT 19	LPT 20	
Wet Weight + Tare (g)	245.86	562.60	266.82	335.32	512.37	519.09	
Dry Weight + Tare (g)	228.09	518.17	246.35	311.70	479.51	491.58	
Tare (g)	104.45	113.43	112.15	109.33	107.09	115.82	
Water Weight (g)	17.77	44.43	20.47	23.62	32.86	27.51	
Total Dry Weight (g)	123.64	404.74	134.20	202.37	372.42	375.76	
Water Content (%)	14.4	11.0	15.3	11.7	8.8	7.3	

Hole No.	BKS 05-03	BKS 05-03	BKS 05-04	BKS 05-04	BKS 05-06	BKS 05-06	BKS 05-07
Depth m (ft)	10.1 (33)	14.9 (49)	9.4 (31)	14.3 (47)	10.1 (33)	12.2 (40)	10.1 (33)
Sample No.	LPT 2	LPT 3	SPT 1	SPT 2	SPT 4	SPT 5	SPT 2
Wet Weight + Tare (g)	346.33	374.51	259.09	182.60	408.31	343.45	224.91
Dry Weight + Tare (g)	311.32	352.07	236.75	164.22	373.48	316.95	212.87
Tare (g)	105.92	101.49	101.77	98.63	107.29	110.43	121.78
Water Weight (g)	35.01	22.44	22.34	18.38	34.83	26.50	12.04
Total Dry Weight (g)	205.40	250.58	134.98	65.59	266.19	206.52	91.09
Water Content (%)	17.0	9.0	16.6	28.0	13.1	12.8	13.2

Hole No.	BKS 05-08	BKS 05-08	BKS 05-08	BKS 05-08	BKS 05-08		
Depth m (ft)	12.0 (39.3)	13.7 (45)	14.3 (47)	16.2 (53)	21.0 (69)		
Sample No.	SPT 1	SPT 2	SPT 3	SPT 4	SPT 5		
Wet Weight + Tare (g)	558.40	277.33	289.34	360.09	335.21		
Dry Weight + Tare (g)	514.97	259.05	271.15	340.70	311.99		
Tare (g)	167.06	158.29	154.42	149.77	160.17		
Water Weight (g)	43.43	18.28	18.19	19.39	23.22		
Total Dry Weight (g)	347.91	100.76	116.73	190.93	151.82		
Water Content (%)	12.5	18.1	15.6	10.2	15.3		

Hole No.							
Depth m (ft)							
Sample No.							
Wet Weight + Tare (g)							
Dry Weight + Tare (g)							
Tare (g)							
Water Weight (g)							
Total Dry Weight (g)							
Water Content (%)							



JOB NO.:	M09237 03
PROJECT:	Rose Creek Tailings Impoundment
LOCATION:	Faro, Yukon
DATE:	September 11, 2005
TESTED BY:	Juan
CHECKED BY:	JAG

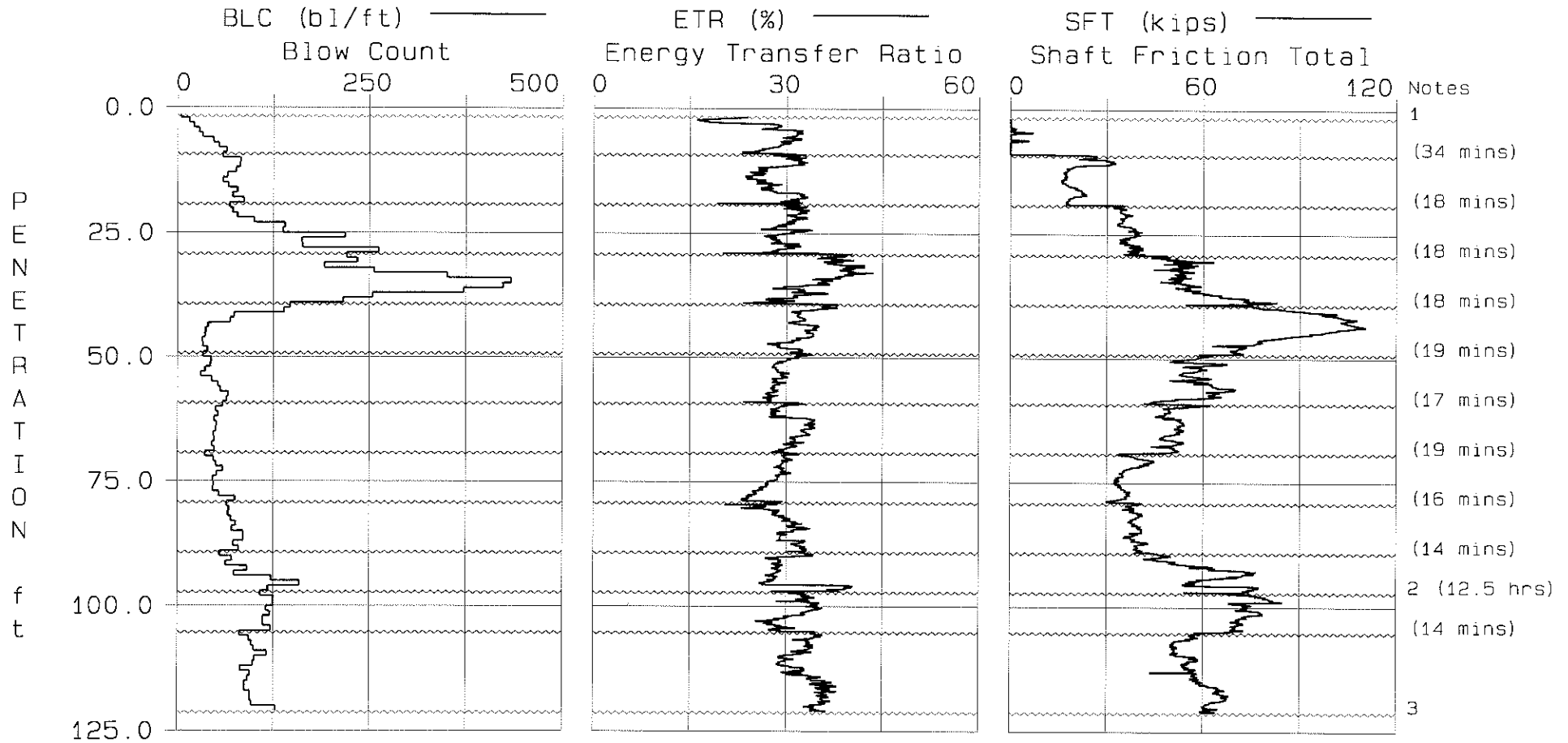
APPENDIX IV

BPT PDA Measurements

R Miner Dynamic Test

2005-Aug-20

ROSE CREEK INTERMED. DAM, BPT 05-01, HAV 180, 6-5/8" CLOSED

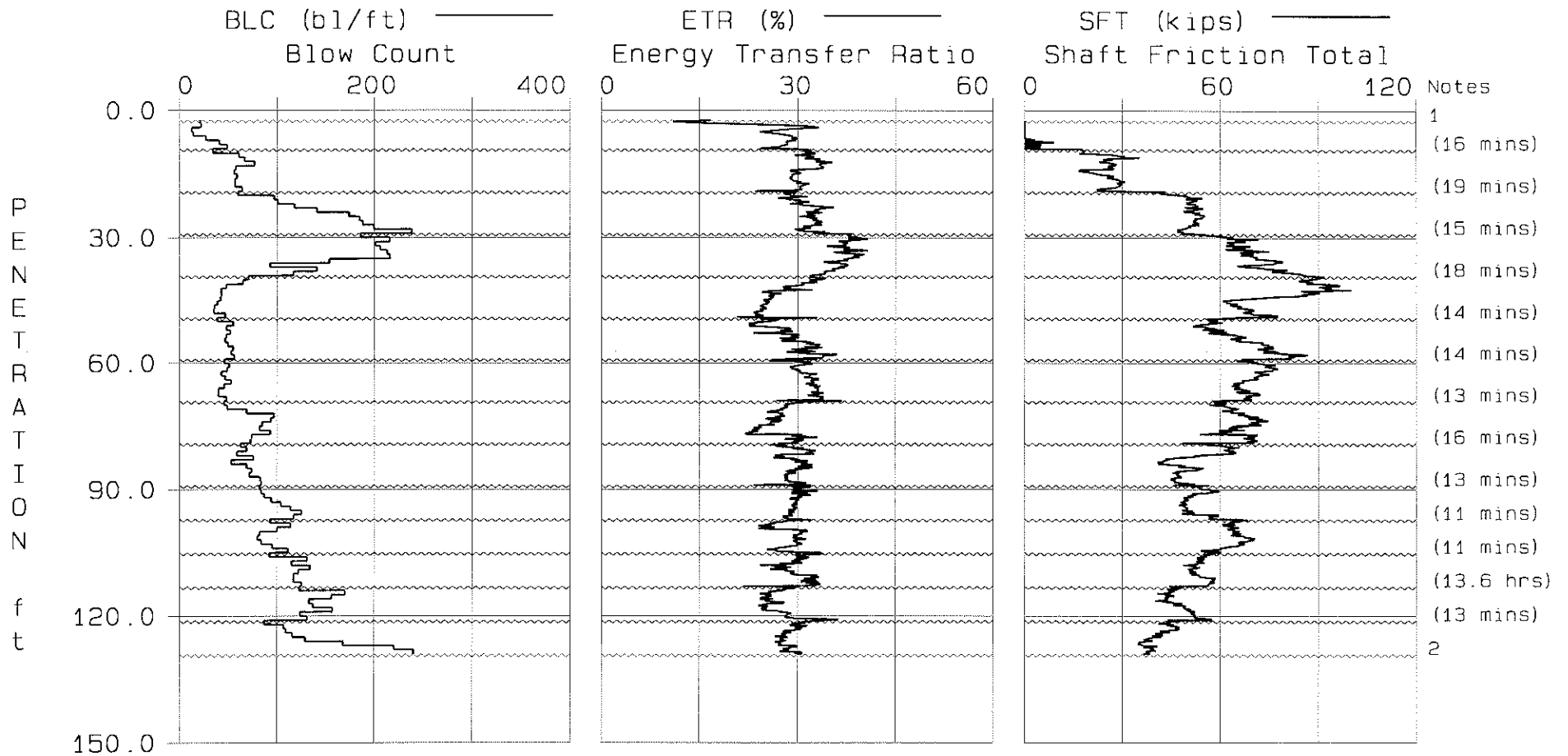


- Notes
1. BPT 05-01, DRILLED OPEN TO 38 FT, PEA-GRAVEL BACKFILLED.
 2. HALT AT 97 FT 19:39 18AUG05, CONTINUE FROM 97 FT 08:11 19AUG05.
 3. TERMINATE BPT0501, 121 FT, 09:06 19AUG05.

R Miner Dynamic Test

2005-Aug-19

ROSE CREEK, X'VALLEY DAM, BPT 05-02, HAV 180, 6-5/8" CLOSED

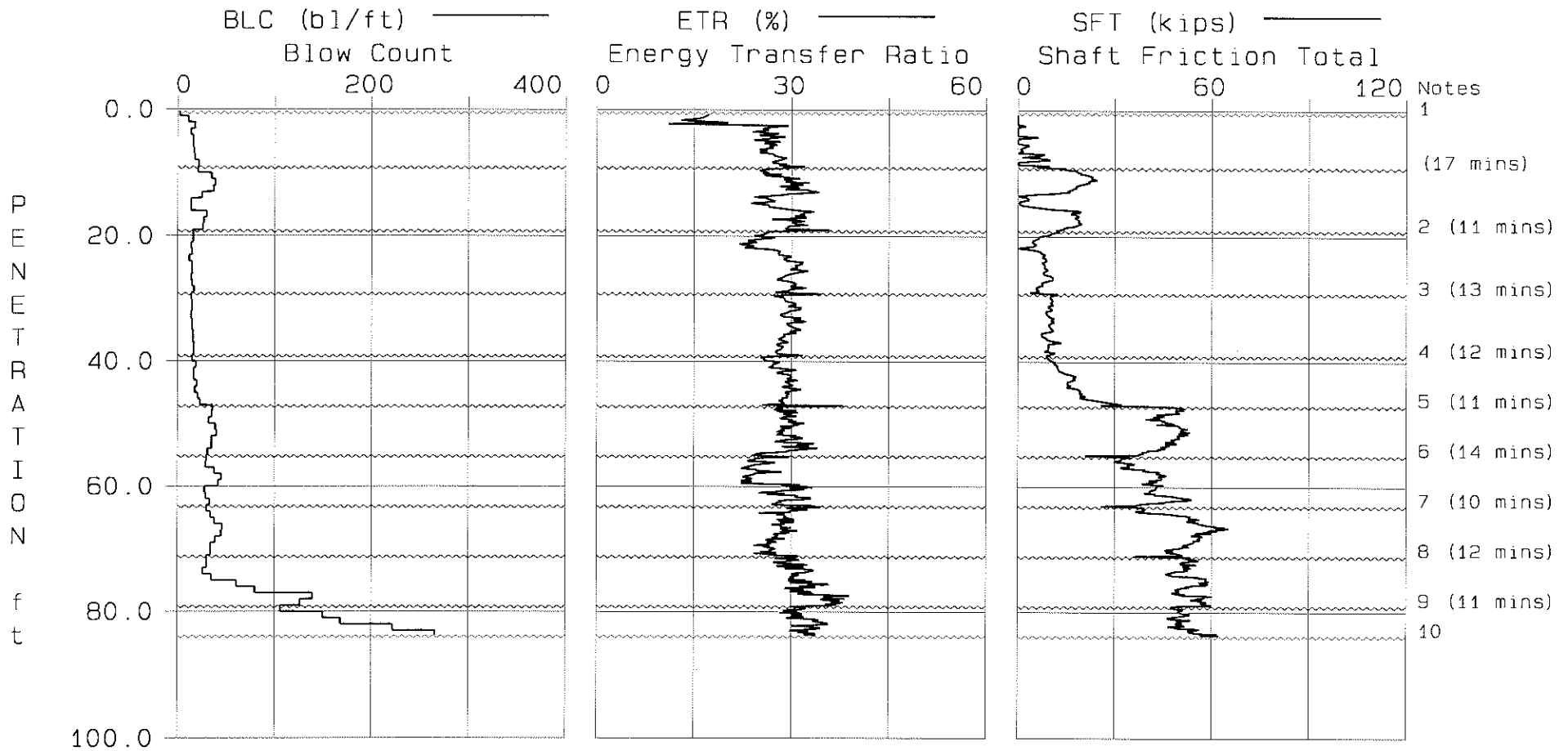


Notes 1. BEGIN BPT 05-01 AT 2.2 FT AFTER OPEN-BECKER TO 37.5 FT WITH BACKFILL.
2. TERMINATE BPT 05-02, 129 FT, 08:53 20AUG05.

R Miner Dynamic Test

2005-Aug-20

ROSE CREEK, X'VALLEY DAM, BPT 05-03, HAV180, 6-5/8" CLOSED



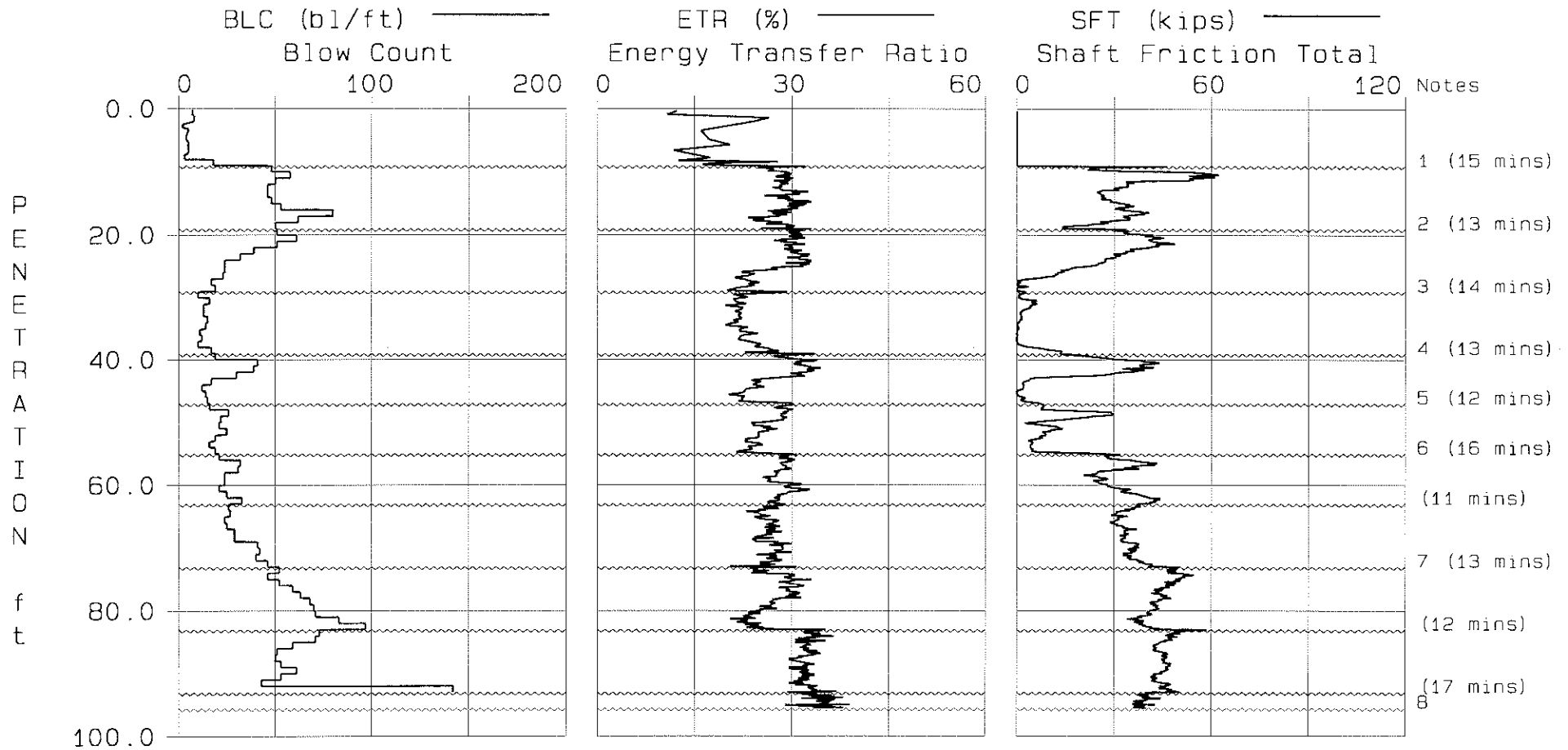
Notes 1. BEGIN BPT 05-03, 13:33 20AUG05.
 2. STOP AT 19 FT, PULL TEST, ADD 10 FT.
 3. STOP AT 29 FT, PULL TEST, ADD 10 FT.
 4. STOP AT 39 FT, PULL TEST, ADD 8 FT.
 5. STOP AT 47 FT, PULL TEST, ADD 8 FT.

Notes 6. STOP AT 55 FT, PULL TEST, ADD 8 FT.
 7. STOP AT 63 FT, PULL TEST, ADD 8 FT.
 8. STOP AT 71 FT, PULL TEST, ADD 8 FT.
 9. STOP AT 79 FT, PULL TEST, ADD 8 FT.
 10. HALT BPT 05-03, 83.75 FT, 16:03, 20AUG05.

R Miner Dynamic Test

2005-Aug-21

ROSE CREEK, X'VALLEY DAM, BPT 05-04, HAV 180, 6-5/8" CLOSED



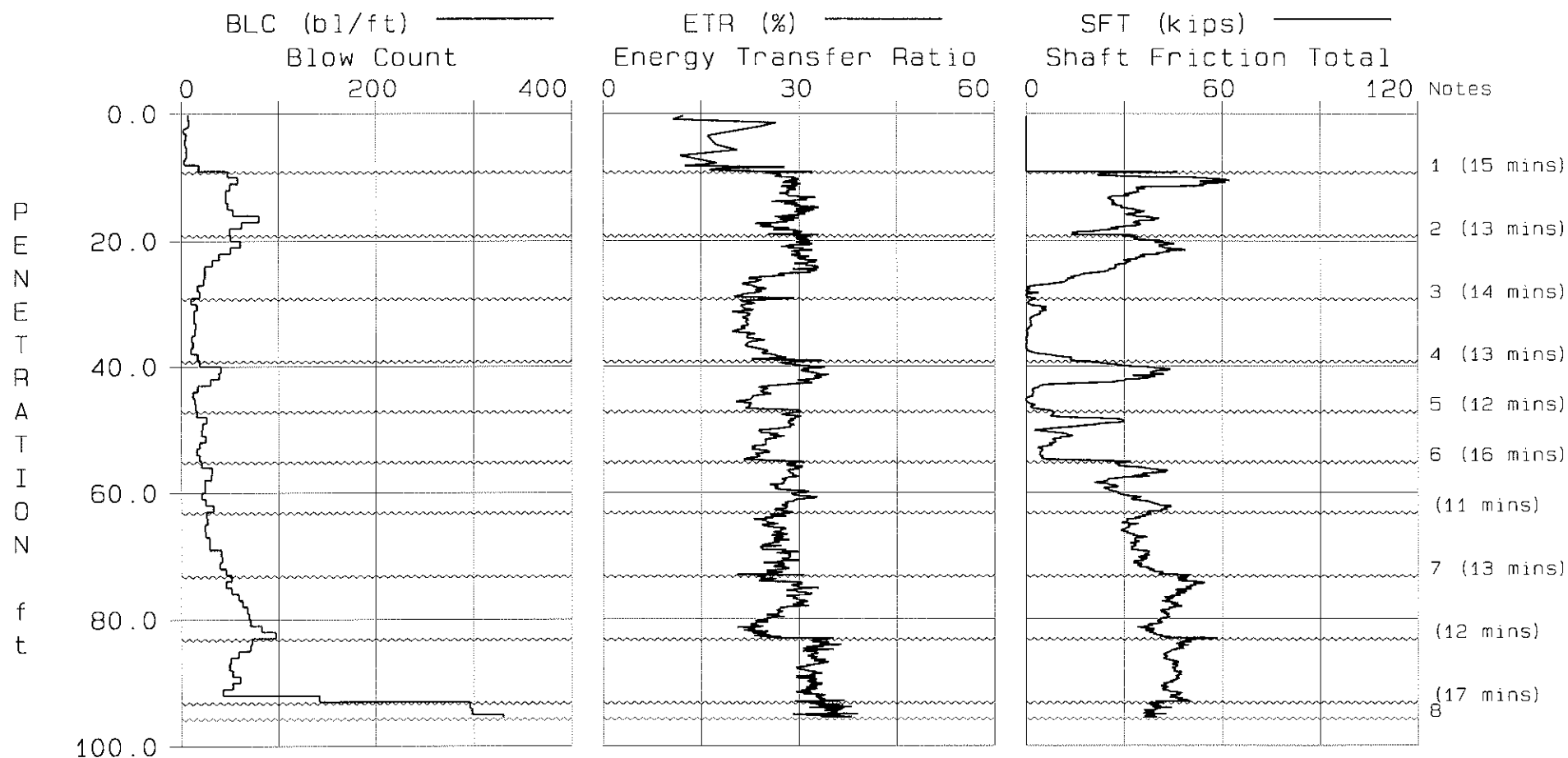
Notes 1. STOP AT 9 FT, PULL TEST, ADD 10 FT.
 2. STOP AT 19 FT, PULL TEST, ADD 10 FT.
 3. STOP AT 29 FT, PULL TEST, ADD 10 FT.
 4. STOP AT 39 FT, PULL TEST, ADD 8 FT.
 5. STOP AT 47 FT, PULL TEST, ADD 8 FT.

Notes 6. STOP AT 55 FT, PULL TEST, ADD 8 FT.
 7. STOP AT 73 FT, PULL TEST, ADD 10 FT.
 8. HALT BPT 05-04, 95.5 FT, 11:27 21AUG05.

R Miner Dynamic Test

2005-Aug-21

ROSE CREEK, X'VALLEY DAM, BPT 05-04, HAV 180, 6-5/8" CLOSED



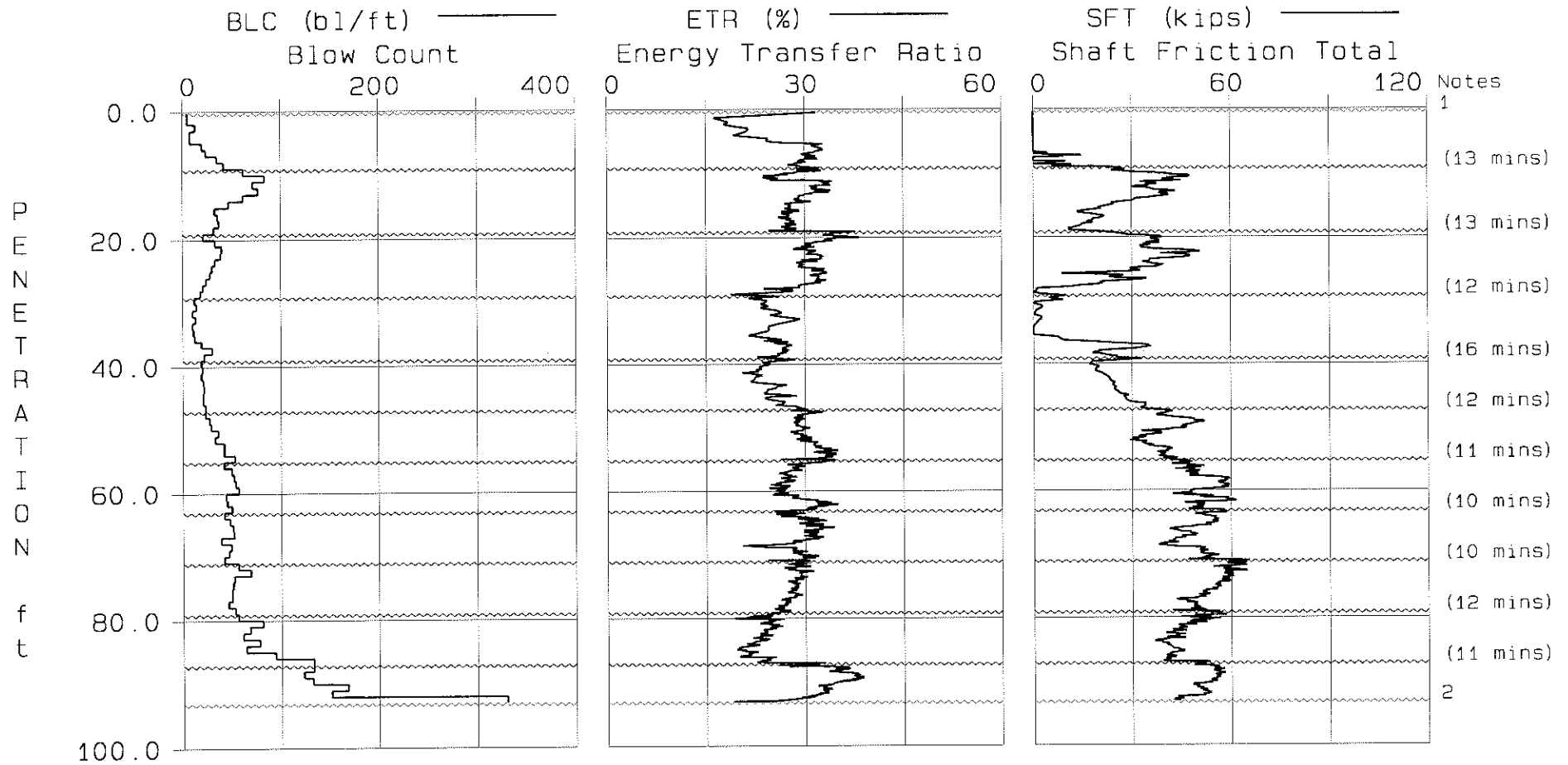
Notes 1. STOP AT 9 FT, PULL TEST, ADD 10 FT.
 2. STOP AT 19 FT, PULL TEST, ADD 10 FT.
 3. STOP AT 29 FT, PULL TEST, ADD 10 FT.
 4. STOP AT 39 FT, PULL TEST, ADD 8 FT.
 5. STOP AT 47 FT, PULL TEST, ADD 8 FT.

Notes 6. STOP AT 55 FT, PULL TEST, ADD 8 FT.
 7. STOP AT 73 FT, PULL TEST, ADD 10 FT.
 8. HALT BPT 05-04, 95.5 FT, 11: 27 21AUG05.

R Miner Dynamic Test

2005-Aug-22

ROSE CREEK, X'VALLEY DAM, BPT 05-05, HAV 180, 6-5/8" CLOSED

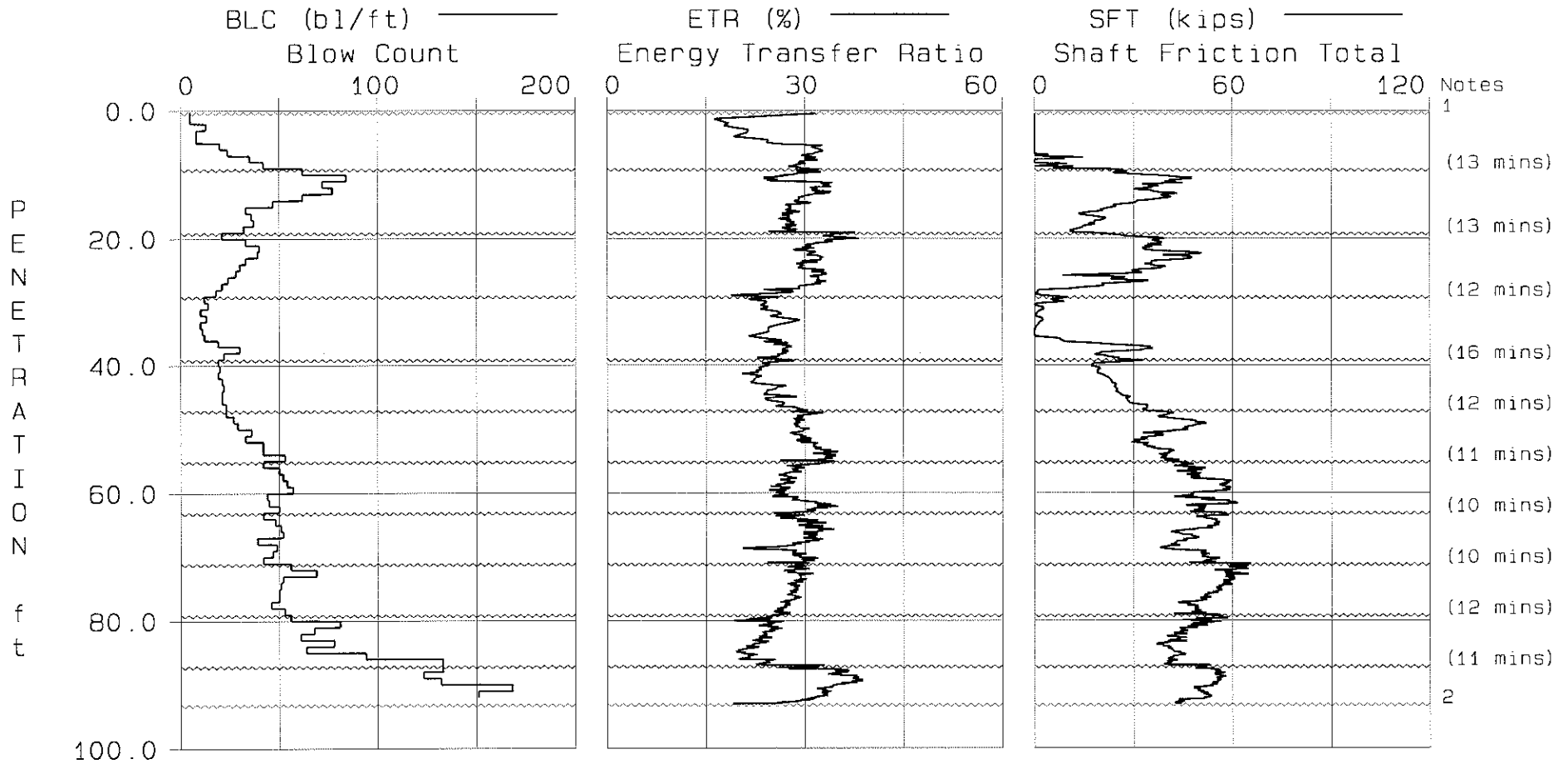


- Notes
1. BEGIN BPT 05-05, 14: 13 21AUG05.
 2. TERMINATE BPT 05-05, 93 FT, 17: 06 21AUG05.

R Miner Dynamic Test

2005-Aug-22

ROSE CREEK, X'VALLEY DAM, BPT 05-05, HAV 180, 6-5/8" CLOSED



- Notes
1. BEGIN BPT 05-05, 14:13 21AUG05.
 2. TERMINATE BPT 05-05, 93 FT, 17:06 21AUG05.

File: BPT 05-01
 Info: HAV 180, 6-5/8" CLOSED
 AR: 12.1 in²
 LE: 12.0 ft

Proj: ROSE CREEK, INTERMED. DAM Pg1
 SP: 0.493 k/ft³
 WS: 16800 ft/s
 EM: 30004 KSI

CSX: Max Measured C-Stress
 EFV: Max Transferred Energy
 ETR: Energy Transfer Ratio
 SFT: Shaft Friction Total
 VMX: Max Measured Velocity

BPM: Blows Per Minute
 FMX: Max Measured Force
 RA2: Capacity - RA2
 DMX: Max Meas'd Displacement

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX
end bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
3	1	2.00 AV	3.22	2.27	28	0	7.9	30.7	39	7	2.16
18	15	3.00 AV	4.69	1.41	17	0	4.6	84.8	57	30	0.63
39	21	4.00 AV	9.67	2.36	29	1	6.8	94.6	117	46	0.64
67	28	5.00 AV	11.93	2.51	30	2	7.7	92.7	145	51	0.56
100	33	6.00 AV	13.31	2.54	31	0	7.9	91.8	161	70	0.49
147	47	7.00 AV	15.04	2.55	31	2	8.3	90.9	182	77	0.41
201	54	8.00 AV	14.89	2.37	29	0	8.2	91.0	180	81	0.36
265	64	9.00 AV	14.35	2.09	25	0	7.7	91.1	174	98	0.32
324	59	10.00 AV	15.59	2.53	31	23	8.4	86.2	189	95	0.44
406	82	11.00 AV	16.49	2.61	32	31	8.8	90.6	200	113	0.37
487	81	12.00 AV	14.82	2.43	30	21	8.1	90.9	180	108	0.35
563	76	13.00 AV	13.08	2.14	26	17	7.1	91.5	159	105	0.34
628	65	14.00 AV	11.99	2.05	25	17	6.4	92.0	145	94	0.35
687	59	15.00 AV	12.76	2.12	26	17	6.9	92.0	155	94	0.35
753	66	16.00 AV	13.98	2.24	27	19	7.6	91.5	169	102	0.34
831	78	17.00 AV	14.74	2.28	28	22	7.9	91.2	179	101	0.32
903	72	18.00 AV	15.84	2.64	33	20	8.6	90.6	192	118	0.36
990	87	19.00 AV	15.27	2.49	30	18	8.3	90.6	185	126	0.35
1058	68	20.00 AV	14.76	2.50	30	33	8.1	87.3	179	90	0.38
1130	72	21.00 AV	15.50	2.63	32	35	8.4	91.3	188	91	0.38
1208	78	22.00 AV	15.75	2.59	32	36	8.4	91.2	191	101	0.37
1308	100	23.00 AV	15.93	2.55	31	34	8.7	90.8	193	119	0.40
1448	140	24.00 AV	15.87	2.39	29	37	8.6	90.8	192	124	0.46
1585	137	25.00 AV	16.64	2.52	31	39	8.9	90.6	202	129	0.45
1803	218	26.00 AV	15.99	2.30	28	37	8.5	90.8	194	131	0.39
1965	162	27.00 AV	16.47	2.34	28	35	8.8	90.8	200	137	0.43
2128	163	28.00 AV	17.41	2.53	31	39	9.3	90.6	211	144	0.43
2390	262	29.00 AV	17.39	2.38	29	39	9.2	90.6	211	160	0.36
2610	220	30.00 AV	18.00	3.00	37	47	9.7	88.4	218	161	0.45
2844	234	31.00 AV	18.56	3.09	38	54	10.1	90.3	225	158	0.50
3035	191	32.00 AV	18.85	3.24	40	53	10.3	90.3	228	171	0.50
3291	256	33.00 AV	19.53	3.28	40	53	10.7	90.3	236	184	0.57
3642	351	34.00 AV	19.55	3.20	39	53	10.6	90.3	237	198	0.53
4075	433	35.00 AV	18.57	2.92	36	52	10.1	90.5	225	179	0.44
4498	423	36.00 AV	18.00	2.66	32	56	9.8	90.6	218	185	0.43
4870	372	37.00 AV	17.84	2.62	32	58	9.7	90.7	216	173	0.45
5124	254	38.00 AV	17.47	2.65	32	69	9.6	90.9	212	152	0.42
5340	216	39.00 AV	16.09	2.30	28	76	8.6	91.7	195	140	0.37
5487	147	40.00 AV	17.14	2.90	35	74	8.9	85.3	208	134	0.57
5626	139	41.00 AV	16.86	2.71	33	94	8.8	91.4	204	122	0.38
5700	74	42.00 AV	16.46	2.62	32	103	8.5	91.7	199	98	0.42
5769	69	43.00 AV	16.69	2.61	32	105	8.7	91.8	202	102	0.36
5809	40	44.00 AV	16.83	2.80	34	107	8.7	91.8	204	88	0.55
5846	37	45.00 AV	16.42	2.75	34	98	8.5	91.9	199	86	0.53
5882	36	46.00 AV	16.13	2.77	34	87	8.4	92.2	195	64	0.53

File: BPT 05-01
Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, INTERMED. DAM Pg2

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX	
end bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch	
5914	32	47.00	AV	15.23	2.57	31	78	7.9	92.9	185	66	0.48
5947	33	48.00	AV	14.55	2.33	28	71	7.4	93.7	176	54	0.54
5986	39	49.00	AV	15.72	2.57	31	70	8.0	92.4	190	63	0.44
6019	33	50.00	AV	15.56	2.64	32	60	8.1	89.7	189	55	0.56
6063	44	51.00	AV	14.86	2.46	30	56	7.7	92.5	180	56	0.54
6106	43	52.00	AV	14.58	2.31	28	59	7.6	92.7	177	59	0.58
6142	36	53.00	AV	14.26	2.34	28	57	7.4	93.0	173	50	0.56
6172	30	54.00	AV	14.27	2.46	30	57	7.5	93.1	173	49	0.68
6217	45	55.00	AV	14.58	2.35	29	57	7.6	92.4	177	63	0.46
6270	53	56.00	AV	14.81	2.33	29	63	7.7	92.2	179	67	0.46
6326	56	57.00	AV	15.01	2.30	28	66	7.7	92.0	182	71	0.41
6392	66	58.00	AV	14.68	2.25	27	63	7.6	91.9	178	74	0.37
6456	64	59.00	AV	12.82	2.19	27	48	6.7	91.9	155	81	0.37
6515	59	60.00	AV	15.37	2.49	30	54	7.9	89.4	186	66	0.52
6565	50	61.00	AV	15.05	2.32	28	49	7.7	92.6	182	69	0.48
6618	53	62.00	AV	14.75	2.30	28	48	7.5	92.8	179	68	0.43
6666	48	63.00	AV	16.19	2.72	33	52	8.3	91.8	196	70	0.52
6717	51	64.00	AV	16.39	2.76	34	53	8.5	91.7	198	70	0.48
6767	50	65.00	AV	16.14	2.71	33	53	8.5	91.9	196	72	0.49
6814	47	66.00	AV	15.34	2.67	33	49	7.8	91.7	186	67	0.47
6862	48	67.00	AV	14.95	2.56	31	51	7.4	91.8	181	64	0.45
6907	45	68.00	AV	14.74	2.55	31	50	7.3	91.9	179	68	0.43
6955	48	69.00	AV	13.11	2.39	29	51	7.1	91.8	159	72	0.43
6991	36	70.00	AV	14.74	2.51	31	36	8.2	87.3	179	50	0.54
7038	47	71.00	AV	15.21	2.47	30	43	8.3	91.8	184	55	0.49
7088	50	72.00	AV	15.13	2.41	29	41	8.2	91.7	183	59	0.45
7147	59	73.00	AV	15.03	2.41	29	36	8.0	91.7	182	57	0.45
7198	51	74.00	AV	14.88	2.42	29	34	7.9	91.9	180	55	0.48
7244	46	75.00	AV	14.69	2.31	28	33	7.7	92.2	178	50	0.50
7291	47	76.00	AV	14.42	2.20	27	34	7.6	92.4	175	48	0.50
7337	46	77.00	AV	14.11	2.12	26	36	7.4	92.6	171	47	0.44
7391	54	78.00	AV	14.11	2.05	25	36	7.5	92.4	171	55	0.42
7466	75	79.00	AV	14.11	2.01	24	33	7.6	92.3	171	61	0.41
7530	64	80.00	AV	14.07	2.21	27	39	7.3	88.6	171	70	0.46
7597	67	81.00	AV	14.16	2.20	27	38	7.4	93.0	172	69	0.45
7663	66	82.00	AV	15.02	2.34	29	40	7.9	92.3	182	77	0.43
7733	70	83.00	AV	15.62	2.46	30	38	8.3	91.9	189	79	0.45
7809	76	84.00	AV	15.90	2.57	31	39	8.4	91.5	193	82	0.47
7880	71	85.00	AV	16.01	2.61	32	40	8.5	91.4	194	92	0.42
7966	86	86.00	AV	15.29	2.40	29	38	8.1	91.8	185	93	0.41
8052	86	87.00	AV	15.37	2.44	30	39	8.2	91.7	186	95	0.37
8125	73	88.00	AV	15.87	2.62	32	40	8.5	91.4	192	97	0.39
8205	80	89.00	AV	15.88	2.66	33	40	8.5	91.3	192	96	0.44
8260	55	90.00	AV	15.34	2.71	33	47	9.0	88.5	186	67	0.46
8331	71	91.00	AV	13.55	2.34	28	46	8.0	92.2	164	69	0.37
8394	63	92.00	AV	14.07	2.37	29	55	8.2	91.9	170	69	0.40
8485	91	93.00	AV	14.32	2.35	29	68	8.2	91.9	173	79	0.40
8559	74	94.00	AV	13.77	2.28	28	72	7.8	92.0	167	87	0.38
8681	122	95.00	AV	13.91	2.30	28	60	7.8	92.0	168	94	0.37
8840	159	96.00	AV	14.77	2.46	30	61	8.4	92.0	179	94	0.39
8958	118	97.00	AV	17.09	3.16	39	74	9.9	90.9	207	85	0.47
9066	108	98.00	AV	14.13	2.55	31	71	8.1	87.6	171	79	0.48
9317	125	100.00	AV	14.87	2.74	33	76	8.7	89.5	180	86	0.48

File: BPT 05-01
 Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, INTERMED. DAM Pg3

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX	
end bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch	
9433	116	101.00	AV	15.26	2.82	34	73	9.0	90.3	185	86	0.51
9554	121	102.00	AV	14.46	2.58	31	74	8.4	90.6	175	83	0.49
9666	112	103.00	AV	13.73	2.37	29	71	7.9	90.6	166	80	0.43
9778	112	104.00	AV	13.52	2.28	28	71	7.8	90.7	164	78	0.42
9900	122	105.00	AV	14.08	2.36	29	69	8.2	90.9	171	79	0.43
9981	81	106.00	AV	15.61	2.84	35	57	9.0	89.4	189	68	0.56
10075	94	107.00	AV	15.37	2.73	33	54	8.9	90.8	186	79	0.48
10172	97	108.00	AV	15.73	2.74	34	51	9.1	90.6	191	88	0.50
10272	100	109.00	AV	15.68	2.71	33	51	9.1	90.6	190	90	0.43
10389	117	110.00	AV	15.06	2.58	31	53	8.7	90.7	182	90	0.44
10490	101	111.00	AV	14.41	2.45	30	57	8.2	90.7	175	84	0.42
10589	99	112.00	AV	14.47	2.40	29	55	8.3	90.7	175	82	0.44
10671	82	113.00	AV	15.53	2.62	32	56	9.1	90.6	188	83	0.45
10766	95	114.00	AV	15.04	2.59	31	56	8.6	89.4	182	74	0.47
10858	92	115.00	AV	15.70	2.84	35	58	9.0	91.0	190	83	0.49
10946	88	116.00	AV	16.13	2.92	36	61	9.3	90.8	195	86	0.46
11034	88	117.00	AV	16.51	2.96	36	65	9.5	90.6	200	90	0.48
11129	95	118.00	AV	16.40	2.93	36	66	9.5	90.7	199	88	0.51
11224	95	119.00	AV	16.68	2.95	36	66	9.7	90.5	202	89	0.42
11321	97	120.00	AV	16.52	2.88	35	61	9.5	90.6	200	86	0.46
11449	128	121.00	AV	16.20	2.82	35	61	9.2	90.5	196	88	0.43

BL# COMMENTS

1 BPT 05-01, DRILLED OPEN TO 38 FT, PEA-GRAVEL BACKFILLED.
 524 JC = 0.20
 536 JC = 0.10
 8958 HALT AT 97 FT 19:39 18AUG05, CONTINUE FROM 97 FT 08:11 19AUG05.
 11449 TERMINATE BPT0501, 121 FT, 09:06 19AUG05.

File: BPT 05-01
Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, INTERMED. DAM Pg4

```
-----
DRIVE TIME SUMMARY (2005-Aug-18 : BPT0501.MDF)
-----
BN      1 ->   267, START 15:02:02 -> 15:05:25 STOP,   3.38
BN    268 ->   990, START 15:39:42 -> 15:47:39 STOP,   7.95
BN   991 ->  2390, START 16:05:55 -> 16:21:22 STOP,  15.45
BN  2391 ->  2409, START 16:40:02 -> 16:40:15 STOP,   0.22
BN  2412 ->  2511, START 16:40:20 -> 16:41:26 STOP,   1.10
BN  2512 ->  2515, START 16:41:30 -> 16:41:32 STOP,   0.03
BN  2516 ->  5340, START 16:41:34 -> 17:13:26 STOP,  31.87
BN  5341 ->  5986, START 17:31:35 -> 17:38:37 STOP,   7.03
BN  5987 ->  6456, START 17:58:24 -> 18:03:30 STOP,   5.10
BN  6457 ->  6955, START 18:21:20 -> 18:26:46 STOP,   5.43
BN  6956 ->  7466, START 18:46:45 -> 18:52:18 STOP,   5.55
BN  7467 ->  8205, START 19:08:44 -> 19:16:47 STOP,   8.05
BN  8206 ->  8958, START 19:30:49 -> 19:39:01 STOP,   8.20
BN  8959 ->  9900, START   8:11:38 ->   8:24:51 STOP,  13.22
BN  9901 -> 10671, START   8:39:28 ->   8:47:57 STOP,   8.48
BN 10672 -> 10688, START   8:57:50 ->   8:58:01 STOP,   0.18
BN 10692 -> 11449, START   8:58:05 ->   9:06:27 STOP,   8.37
-----
Total Elapsed time 1084.40 minutes      Total Time 129.62 minutes 954.78
-----
```

File: BPT 05-02
 Info: HAV 180, 6-5/8" CLOSED
 AR: 12.1 in²
 LE: 12.0 ft

Proj: ROSE CREEK, X'VALLEY DAM Pg1
 SP: 0.493 k/ft³
 WS: 16800 ft/s
 EM: 30004 KSI

CSX: Max Measured C-Stress
 EFV: Max Transferred Energy
 ETR: Energy Transfer Ratio
 SFT: Shaft Friction Total
 VMX: Max Measured Velocity

BPM: Blows Per Minute
 FMX: Max Measured Force
 RA2: Capacity - RA2
 DMX: Max Meas'd Displacement

BL#		depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX
end	bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
18	21	3.00	AV	4.40	1.21	14	0	4.1	102.5	53	30	0.57
40	22	4.00	AV	9.95	2.25	28	0	6.0	95.5	121	49	0.56
52	12	5.00	AV	5.35	2.18	27	0	5.8	98.0	65	28	0.99
66	14	6.00	AV	6.91	2.31	28	0	6.1	95.1	84	42	0.79
93	27	7.00	AV	11.37	2.40	29	1	7.3	92.5	138	58	0.52
134	41	8.00	AV	13.38	2.35	29	2	8.1	91.8	162	76	0.54
183	49	9.00	AV	13.77	2.19	27	3	7.9	89.4	167	75	0.51
217	34	10.00	AV	13.02	2.57	31	18	6.7	92.1	158	75	0.54
278	61	11.00	AV	14.48	2.60	32	26	7.5	91.2	175	99	0.46
345	67	12.00	AV	15.71	2.66	33	27	8.2	90.8	190	113	0.44
422	77	13.00	AV	16.49	2.78	34	26	8.7	90.7	200	118	0.44
480	58	14.00	AV	15.84	2.67	33	25	8.5	91.0	192	106	0.51
536	56	15.00	AV	15.12	2.44	30	19	8.2	91.2	183	100	0.44
595	59	16.00	AV	14.92	2.40	29	26	8.0	91.2	181	97	0.42
652	57	17.00	AV	15.49	2.43	29	29	8.3	91.2	188	96	0.37
709	57	18.00	AV	15.91	2.55	31	29	8.5	91.1	193	96	0.42
773	64	19.00	AV	15.50	2.37	29	24	8.1	87.3	188	103	0.53
833	60	20.00	AV	15.14	2.36	28	43	7.9	92.0	183	97	0.36
930	97	21.00	AV	15.34	2.39	29	51	7.9	91.5	186	108	0.38
1031	101	22.00	AV	15.90	2.50	30	51	8.3	91.0	193	119	0.35
1149	118	23.00	AV	16.88	2.66	32	52	8.9	90.9	205	130	0.44
1290	141	24.00	AV	17.22	2.67	33	51	9.0	90.7	209	144	0.37
1464	174	25.00	AV	17.22	2.63	32	54	8.9	90.6	209	153	0.40
1649	185	26.00	AV	17.48	2.66	32	53	9.0	90.6	212	158	0.39
1837	188	27.00	AV	17.80	2.70	33	52	9.2	90.5	216	159	0.37
2037	200	28.00	AV	17.61	2.59	32	50	9.1	90.4	213	161	0.41
2274	238	29.00	AV	17.68	2.61	32	48	9.2	90.4	214	168	0.36
2461	186	30.00	AV	18.01	3.06	37	57	9.5	87.7	218	166	0.46
2677	216	31.00	AV	19.02	3.16	38	66	10.0	90.4	230	170	0.56
2878	201	32.00	AV	18.75	3.01	37	64	9.7	90.4	227	163	0.46
3084	206	33.00	AV	19.25	3.05	37	66	9.9	90.4	233	172	0.41
3297	213	34.00	AV	19.41	3.12	38	70	10.0	90.5	235	177	0.45
3513	216	35.00	AV	19.67	3.19	39	70	10.2	90.6	238	178	0.46
3667	154	36.00	AV	18.66	2.95	36	76	9.5	90.7	226	151	0.41
3760	93	37.00	AV	18.39	3.05	37	70	9.5	90.7	223	136	0.50
3901	141	38.00	AV	18.82	2.92	36	76	9.8	90.7	228	150	0.40
4018	117	39.00	AV	17.84	2.77	34	83	9.3	91.0	216	123	0.42
4089	71	40.00	AV	16.51	2.71	33	90	8.7	91.4	200	105	0.41
4154	65	41.00	AV	15.81	2.61	32	88	8.2	91.7	191	86	0.45
4202	48	42.00	AV	14.79	2.40	29	93	8.1	92.3	179	78	0.50
4245	43	43.00	AV	14.80	2.25	27	91	7.6	93.0	179	73	0.45
4288	43	44.00	AV	14.87	2.16	26	86	7.6	92.5	180	74	0.56
4330	42	45.00	AV	13.92	2.12	26	69	7.1	92.7	169	65	0.51
4369	39	46.00	AV	13.64	2.10	25	63	7.0	92.8	165	64	0.49
4405	36	47.00	AV	13.44	2.06	25	66	6.9	93.1	163	60	0.46

File: BPT 05-02
 Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg2

BL#		depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX
end	bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
4440	35	48.00	AV	13.27	2.01	24	69	6.8	93.2	161	56	0.49
4487	47	49.00	AV	13.54	1.96	24	73	7.0	89.4	164	57	0.42
4526	39	50.00	AV	13.44	2.23	27	59	7.3	92.9	163	61	0.52
4581	55	51.00	AV	12.76	1.93	23	56	6.9	93.7	155	69	0.41
4629	48	52.00	AV	13.76	2.23	27	57	7.5	92.7	167	73	0.43
4681	52	53.00	AV	13.94	2.25	27	59	7.5	92.6	169	77	0.44
4729	48	54.00	AV	14.57	2.42	29	65	7.9	92.1	177	76	0.44
4776	47	55.00	AV	14.66	2.40	29	67	7.9	92.2	178	76	0.45
4826	50	56.00	AV	16.03	2.65	33	74	8.6	91.5	194	84	0.47
4881	55	57.00	AV	15.99	2.60	32	74	8.6	91.6	194	86	0.46
4934	53	58.00	AV	16.09	2.57	31	78	8.7	91.7	195	85	0.44
4990	56	59.00	AV	16.57	2.73	33	80	8.8	88.1	201	89	0.43
5036	46	60.00	AV	15.07	2.43	30	69	7.9	91.9	183	63	0.55
5087	51	61.00	AV	15.69	2.51	30	74	8.2	91.5	190	66	0.57
5136	49	62.00	AV	15.67	2.45	30	76	8.2	91.6	190	68	0.57
5179	43	63.00	AV	16.12	2.58	31	73	8.5	91.4	195	63	0.59
5226	47	64.00	AV	16.33	2.64	32	71	8.6	91.3	198	71	0.53
5279	53	65.00	AV	16.10	2.63	32	66	8.5	91.4	195	70	0.46
5325	46	66.00	AV	15.89	2.67	33	65	8.4	91.5	192	67	0.63
5365	40	67.00	AV	15.89	2.69	33	67	8.4	91.5	192	66	0.64
5405	40	68.00	AV	16.24	2.68	33	70	8.6	91.4	197	63	0.54
5453	48	69.00	AV	16.12	2.67	33	67	8.5	87.6	195	68	0.50
5499	46	70.00	AV	15.89	2.52	31	60	8.3	89.4	192	63	0.60
5548	49	71.00	AV	15.08	2.29	28	63	7.9	91.6	183	70	0.45
5617	69	72.00	AV	15.13	2.20	27	64	7.9	91.6	183	81	0.39
5714	97	73.00	AV	15.60	2.24	27	68	8.2	91.5	189	91	0.35
5808	94	74.00	AV	15.51	2.17	26	72	8.2	91.6	188	91	0.37
5893	85	75.00	AV	15.24	2.12	26	70	8.0	91.8	185	83	0.37
5975	82	76.00	AV	14.85	1.97	24	64	7.8	92.1	180	77	0.34
6068	93	77.00	AV	14.51	1.91	23	61	7.6	92.3	176	76	0.36
6142	74	78.00	AV	16.18	2.50	30	70	8.4	91.4	196	79	0.48
6215	73	79.00	AV	15.99	2.43	29	68	8.5	88.8	194	73	0.40
6278	63	80.00	AV	14.60	2.30	28	59	7.9	91.8	177	66	0.40
6347	69	81.00	AV	15.07	2.53	31	63	8.3	91.3	183	70	0.44
6406	59	82.00	AV	15.05	2.50	30	61	8.3	91.2	182	68	0.47
6482	76	83.00	AV	14.82	2.30	28	48	8.2	91.6	180	63	0.43
6535	53	84.00	AV	15.48	2.52	31	42	8.6	91.1	188	68	0.46
6604	69	85.00	AV	15.91	2.57	31	49	8.9	91.1	193	67	0.46
6678	74	86.00	AV	15.72	2.43	30	50	8.6	91.1	190	69	0.40
6750	72	87.00	AV	15.52	2.36	29	47	8.6	91.2	188	68	0.45
6833	83	88.00	AV	15.13	2.31	28	46	8.4	91.3	183	69	0.37
6917	84	89.00	AV	14.99	2.40	29	49	8.4	88.1	182	67	0.41
6999	82	90.00	AV	15.04	2.51	30	54	8.6	91.7	182	79	0.43
7083	84	91.00	AV	15.66	2.54	31	57	8.9	91.3	190	69	0.39
7170	87	92.00	AV	15.22	2.50	30	51	8.8	91.3	184	69	0.37
7264	94	93.00	AV	14.81	2.45	29	49	8.6	91.4	179	72	0.39
7368	104	94.00	AV	14.85	2.44	29	49	8.6	91.4	180	81	0.38
7482	114	95.00	AV	15.10	2.43	29	49	8.7	91.4	183	86	0.38
7607	125	96.00	AV	15.15	2.39	29	51	8.8	91.4	184	77	0.40
7724	117	97.00	AV	15.40	2.33	28	58	8.8	90.0	187	71	0.37
7817	93	98.00	AV	14.93	2.34	28	65	8.9	90.7	181	77	0.38
7931	114	99.00	AV	14.35	2.11	26	63	8.4	92.0	174	75	0.37
8031	100	100.00	AV	15.01	2.28	27	64	8.8	91.7	182	77	0.42

File: BPT 05-02
 Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg3

BL#	end	bl/ft	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX
			ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
8113	82		101.00	AV	16.01	2.51	30	65	9.2	91.3	194	75	0.42
8193	80		102.00	AV	16.30	2.47	30	69	9.2	91.3	197	73	0.38
8277	84		103.00	AV	16.40	2.46	30	68	9.3	91.3	199	75	0.37
8372	95		104.00	AV	16.51	2.38	29	63	9.3	91.3	200	74	0.33
8483	111		105.00	AV	15.54	2.23	27	58	8.9	88.3	188	73	0.35
8575	92		106.00	AV	16.35	2.60	32	56	9.2	91.2	198	76	0.41
8706	131		107.00	AV	16.00	2.51	30	54	9.0	91.3	194	79	0.40
8821	115		108.00	AV	15.12	2.35	29	53	8.5	91.9	183	81	0.38
8955	134		109.00	AV	14.84	2.23	27	52	8.3	92.0	180	80	0.34
9077	122		110.00	AV	15.51	2.36	29	51	8.7	91.5	188	79	0.37
9194	117		111.00	AV	16.58	2.57	32	54	9.3	91.1	201	82	0.37
9311	117		112.00	AV	17.10	2.62	32	58	9.3	91.0	207	86	0.42
9436	125		113.00	AV	16.81	2.57	31	55	9.2	88.3	204	85	0.37
9559	123		114.00	AV	15.30	2.34	28	46	8.5	90.5	185	84	0.35
9729	170		115.00	AV	14.88	2.14	26	44	8.2	90.4	180	80	0.36
9885	156		116.00	AV	15.14	2.12	25	44	8.4	90.4	183	73	0.38
10018	133		117.00	AV	15.30	2.15	26	44	8.5	90.5	185	71	0.44
10155	137		118.00	AV	14.94	2.09	25	48	8.4	90.7	181	72	0.35
10312	157		119.00	AV	14.77	2.09	25	50	8.3	90.7	179	71	0.33
10436	124		120.00	AV	15.59	2.31	28	52	8.7	90.7	189	76	0.47
10567	131		121.00	AV	16.63	2.59	31	53	9.4	87.9	201	73	0.49
10654	87		122.00	AV	16.41	2.57	31	44	9.3	90.4	199	65	0.52
10761	107		123.00	AV	16.31	2.47	30	45	9.2	90.6	198	67	0.45
10870	109		124.00	AV	16.49	2.39	29	44	9.2	90.6	200	68	0.32
10986	116		125.00	AV	16.25	2.25	28	41	9.0	90.6	197	65	0.36
11115	129		126.00	AV	16.21	2.28	28	39	9.1	90.6	196	64	0.38
11283	168		127.00	AV	15.94	2.22	27	36	9.1	90.6	193	68	0.39
11503	220		128.00	AV	16.46	2.37	29	39	9.4	90.4	199	79	0.40
11743	240		129.00	AV	16.98	2.41	29	38	9.6	90.5	206	80	0.40

BL# COMMENTS

1 BEGIN BPT 05-01 AT 2.2 FT AFTER OPEN-BECKER TO 37.5 FT WITH BACKFILL.
 7723 DATA MERGE: 02097FT.Q00
 7723 RMDT--B. Miner
 11743 TERMINATE BPT 05-02, 129 FT, 08:53 20AUG05.

File: BPT 05-02
Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg4

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DRIVE TIME SUMMARY (2005-Aug-19 : BPT0502.MDF)      DRIVE      WAIT  
----- minutes -----  
BN      1 ->    182, START 14:08:09 -> 14:10:05 STOP,    1.93  
BN    183 ->    772, START 14:26:54 -> 14:33:22 STOP,    6.47  
BN    773 ->   2274, START 14:52:36 -> 15:09:11 STOP,   16.58  
BN   2275 ->   4017, START 15:25:08 -> 15:44:25 STOP,   19.28  
BN   4018 ->   4486, START 16:02:30 -> 16:08:16 STOP,    5.77  
BN   4487 ->   4989, START 16:22:25 -> 16:27:52 STOP,    5.45  
BN   4990 ->   5452, START 16:42:20 -> 16:47:25 STOP,    5.08  
BN   5453 ->   6214, START 17:00:56 -> 17:09:15 STOP,    8.32  
BN   6215 ->   6916, START 17:25:19 -> 17:33:01 STOP,    7.70  
BN   6917 ->   7723, START 17:46:07 -> 17:54:56 STOP,    8.82  
BN   7724 ->   8482, START 18:06:46 -> 18:15:04 STOP,    8.30  
BN   8483 ->   9435, START 18:26:04 -> 18:36:29 STOP,   10.42  
BN   9436 ->  10566, START  8:14:36 ->  8:27:05 STOP,   12.48  
BN 10567 ->  11743, START  8:40:43 ->  8:53:43 STOP,   13.00  
-----  
Total Elapsed time 1125.55 minutes      Total Time 129.60 minutes 995.95
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File: BPT 05-03
 Info: HAV180, 6-5/8" CLOSED
 AR: 12.1 in²
 LE: 13.0 ft

Proj: ROSE CREEK, X'VALLEY DAM Pg1
 SP: 0.493 k/ft³
 WS: 16800 ft/s
 EM: 30004 KSI

CSX: Max Measured C-Stress
 EFV: Max Transferred Energy
 ETR: Energy Transfer Ratio
 SFT: Shaft Friction Total
 VMX: Max Measured Velocity

BPM: Blows Per Minute
 FMX: Max Measured Force
 RA2: Capacity - RA2
 DMX: Max Meas'd Displacement

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX	
end	bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
1	2	0.30	AV	3.96	1.39	17	0	7.8	0.0	48	4	2.54
3	2	1.00	AV	3.13	1.65	20	0	7.8	99.2	38	5	2.14
14	11	2.00	AV	3.91	1.23	15	0	4.4	93.1	47	22	0.85
32	18	3.00	AV	6.07	1.95	23	1	5.3	97.7	74	31	0.80
46	14	4.00	AV	6.35	2.18	26	0	5.8	96.0	77	28	0.91
62	16	5.00	AV	6.90	2.20	27	2	5.9	95.6	84	31	0.89
78	16	6.00	AV	7.21	2.24	27	2	6.0	95.8	87	32	0.82
95	17	7.00	AV	7.43	2.11	25	2	6.1	95.6	90	31	0.75
113	18	8.00	AV	9.13	2.32	28	7	6.1	94.6	111	33	0.71
135	22	9.00	AV	8.60	2.26	28	3	5.8	89.8	104	43	0.70
156	21	10.00	AV	10.04	2.29	28	17	5.9	95.3	122	41	0.64
191	35	11.00	AV	11.81	2.33	28	22	6.1	93.6	143	63	0.54
230	39	12.00	AV	13.04	2.52	30	21	6.8	92.0	158	82	0.49
267	37	13.00	AV	12.11	2.56	31	17	6.3	92.5	147	62	0.55
292	25	14.00	AV	7.56	2.32	28	5	5.3	95.3	92	42	0.68
306	14	15.00	AV	5.49	2.14	26	1	5.2	98.5	66	26	0.90
320	14	16.00	AV	8.07	2.37	29	10	5.8	96.5	98	30	0.79
350	30	17.00	AV	11.86	2.63	32	18	6.3	93.0	144	55	0.57
377	27	18.00	AV	11.49	2.49	30	19	6.1	93.5	139	51	0.60
403	26	19.00	AV	10.16	2.49	30	15	6.0	90.7	123	43	0.66
419	16	20.00	AV	8.79	2.27	27	11	6.2	96.5	106	27	0.78
435	16	21.00	AV	6.71	2.07	25	5	5.5	98.2	81	24	0.82
449	14	22.00	AV	5.38	1.92	23	4	4.8	98.8	65	24	0.77
464	15	23.00	AV	6.44	2.32	28	7	5.4	97.1	78	25	0.88
476	12	24.00	AV	6.89	2.43	29	8	5.5	96.6	84	27	0.88
491	15	25.00	AV	8.05	2.58	31	8	5.8	95.6	97	30	0.88
506	15	26.00	AV	8.94	2.54	31	9	5.9	95.2	108	29	0.83
520	14	27.00	AV	9.03	2.39	29	10	5.9	94.8	109	26	0.80
535	15	28.00	AV	9.26	2.51	30	7	6.0	95.3	112	27	0.82
552	17	29.00	AV	8.52	2.47	30	6	6.0	89.4	103	26	0.88
566	14	30.00	AV	9.95	2.50	30	11	6.5	95.8	121	20	0.90
581	15	31.00	AV	10.18	2.46	30	10	6.1	95.3	123	27	0.82
596	15	32.00	AV	10.03	2.51	31	10	6.1	95.0	121	28	0.84
610	14	33.00	AV	9.36	2.42	29	10	5.7	95.1	113	23	0.83
625	15	34.00	AV	9.94	2.52	30	11	5.9	95.1	120	24	0.87
640	15	35.00	AV	9.85	2.52	30	10	5.9	95.0	119	25	0.84
656	16	36.00	AV	9.61	2.45	30	8	5.9	95.1	116	26	0.80
672	16	37.00	AV	9.80	2.37	29	11	5.7	95.1	119	25	0.74
689	17	38.00	AV	9.77	2.34	28	9	5.6	95.0	118	24	0.74
706	17	39.00	AV	9.27	2.26	27	10	5.6	89.2	112	22	0.75
721	15	40.00	AV	8.81	2.28	28	10	5.5	96.3	107	17	0.81
740	19	41.00	AV	8.37	2.25	27	12	5.0	96.0	101	24	0.71
757	17	42.00	AV	8.97	2.39	29	13	5.1	94.7	109	27	0.71
774	17	43.00	AV	9.73	2.49	30	17	5.4	94.3	118	26	0.71
794	20	44.00	AV	9.90	2.45	30	16	5.6	94.2	120	25	0.71

File: BPT 05-03
Info: HAV180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg2

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX	
end bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch	
812	18	45.00	AV	10.43	2.48	30	19	5.9	94.0	126	27	0.74
833	21	46.00	AV	10.86	2.43	29	20	6.3	93.7	132	31	0.71
856	23	47.00	AV	11.15	2.32	28	28	6.4	89.2	135	37	0.55
892	36	48.00	AV	12.58	2.43	29	49	7.4	92.4	152	64	0.51
927	35	49.00	AV	11.77	2.44	30	45	6.9	92.7	142	61	0.53
959	32	50.00	AV	11.35	2.47	30	45	6.6	92.7	137	63	0.54
998	39	51.00	AV	12.05	2.45	30	50	7.1	92.3	146	69	0.49
1038	40	52.00	AV	12.03	2.36	29	51	7.0	92.5	146	67	0.47
1073	35	53.00	AV	11.72	2.46	30	48	6.9	92.3	142	66	0.49
1108	35	54.00	AV	12.61	2.62	32	46	7.4	91.8	153	62	0.52
1139	31	55.00	AV	11.25	2.26	27	38	6.6	89.7	136	53	0.51
1169	30	56.00	AV	11.02	2.13	26	31	6.6	93.1	133	42	0.60
1198	29	57.00	AV	10.99	2.06	25	34	6.6	93.1	133	47	0.55
1236	38	58.00	AV	11.57	2.09	25	41	6.8	92.7	140	59	0.48
1281	45	59.00	AV	11.47	1.94	23	44	6.7	92.7	139	66	0.41
1323	42	60.00	AV	11.37	2.15	26	42	6.8	92.8	138	63	0.47
1351	28	61.00	AV	11.68	2.45	30	42	7.0	93.1	141	57	0.56
1380	29	62.00	AV	12.12	2.49	30	48	7.3	92.8	147	59	0.54
1413	33	63.00	AV	11.45	2.31	28	43	6.9	93.4	139	57	0.52
1443	30	64.00	AV	12.39	2.66	32	37	7.4	89.4	150	41	0.70
1477	34	65.00	AV	11.83	2.35	28	49	7.1	92.7	143	62	0.52
1515	38	66.00	AV	12.49	2.43	29	55	7.5	92.3	151	65	0.49
1561	46	67.00	AV	12.70	2.36	29	62	7.6	92.2	154	72	0.47
1606	45	68.00	AV	12.22	2.35	29	57	7.4	92.3	148	67	0.48
1645	39	69.00	AV	11.87	2.23	27	55	7.3	92.6	144	58	0.49
1679	34	70.00	AV	11.21	2.17	26	51	6.9	92.8	136	56	0.51
1713	34	71.00	AV	10.97	2.15	26	48	6.6	93.2	133	56	0.51
1743	30	72.00	AV	12.60	2.53	31	51	7.3	90.2	153	44	0.57
1773	30	73.00	AV	12.14	2.44	30	52	6.8	93.7	147	50	0.56
1799	26	74.00	AV	12.20	2.59	32	49	6.9	93.5	148	48	0.59
1834	35	75.00	AV	12.88	2.53	31	55	7.3	89.9	156	62	0.52
1895	61	76.00	AV	13.93	2.68	33	56	8.0	91.7	169	93	0.48
1975	80	77.00	AV	13.55	2.59	32	50	7.8	91.9	164	103	0.46
2114	139	78.00	AV	15.08	2.86	35	55	8.8	91.1	183	126	0.47
2240	126	79.00	AV	15.26	2.97	36	57	9.1	90.9	185	120	0.49
2346	106	80.00	AV	13.47	2.57	31	49	8.3	91.5	163	109	0.46
2496	150	81.00	AV	13.41	2.51	30	50	8.4	91.3	162	113	0.45
2664	168	82.00	AV	14.77	2.80	34	50	9.0	90.8	179	122	0.49
2886	222	83.00	AV	14.70	2.68	33	52	8.9	90.8	178	126	0.47
3086	266	83.75	AV	14.81	2.66	32	57	9.1	90.7	179	139	0.51

BL# COMMENTS
1 BEGIN BPT 05-03, 13:33 20AUG05.
1 JC = 0.10
402 STOP AT 19 FT, PULL TEST, ADD 10 FT.
551 STOP AT 29 FT, PULL TEST, ADD 10 FT.
705 STOP AT 39 FT, PULL TEST, ADD 8 FT.
855 STOP AT 47 FT, PULL TEST, ADD 8 FT.
1138 STOP AT 55 FT, PULL TEST, ADD 8 FT.
1413 STOP AT 63 FT, PULL TEST, ADD 8 FT.
1713 STOP AT 71 FT, PULL TEST, ADD 8 FT.
2239 STOP AT 79 FT, PULL TEST, ADD 8 FT.
3086 HALT BPT 05-03, 83.75 FT, 16:03, 20AUG05.

File: BPT 05-03
Info: HAV180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg3

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-----  
DRIVE TIME SUMMARY (2005-Aug-20 : BPT0503.MDF)      DRIVE      WAIT  
----- minutes -----  
BN      1 ->   134, START 13:33:42 -> 13:35:06 STOP,   1.40  
                                           17.95  
BN    135 ->   402, START 13:53:03 -> 13:55:53 STOP,   2.83  
                                           11.22  
BN    403 ->   551, START 14:07:06 -> 14:08:39 STOP,   1.55  
                                           13.68  
BN    552 ->   705, START 14:22:20 -> 14:23:57 STOP,   1.62  
                                           12.88  
BN    706 ->   855, START 14:36:50 -> 14:38:25 STOP,   1.58  
                                           11.53  
BN    856 ->  1138, START 14:49:57 -> 14:53:00 STOP,   3.05  
                                           14.10  
BN   1139 ->  1413, START 15:07:06 -> 15:10:03 STOP,   2.95  
                                           10.97  
BN   1414 ->  1713, START 15:21:01 -> 15:24:15 STOP,   3.23  
                                           12.73  
BN   1714 ->  2239, START 15:36:59 -> 15:42:57 STOP,   5.97  
                                           11.03  
BN   2240 ->  3086, START 15:53:59 -> 16:03:18 STOP,   9.32  
-----  
Total Elapsed time 149.60 minutes      Total Time 33.50 minutes 116.10
```

File: BPT 05-04
 Info: HAV 180, 6-5/8" CLOSED
 AR: 12.1 in²
 LE: 12.0 ft

Proj: ROSE CREEK, X'VALLEY DAM Pg1
 SP: 0.493 k/ft³
 WS: 16800 ft/s
 EM: 30004 KSI

CSX: Max Measured C-Stress
 EFV: Max Transferred Energy
 ETR: Energy Transfer Ratio
 SFT: Shaft Friction Total
 VMX: Max Measured Velocity

BPM: Blows Per Minute
 FMX: Max Measured Force
 RA2: Capacity - RA2
 DMX: Max Meas'd Displacement

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX
end bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
7	7	1.00 AV	1.35	1.00	12	0	3.8	0.0	16	6	1.28
15	8	2.00 AV	4.17	2.00	24	0	7.8	43.0	51	5	2.02
17	2	3.00 AV	2.39	1.15	14	0	3.8	79.3	29	9	0.93
19	5	3.40 AV	3.10	1.39	16	0	6.3	48.3	38	5	2.00
26	4	5.00 AV	2.85	1.49	18	0	5.3	87.7	35	3	1.70
31	5	6.00 AV	3.00	1.71	20	0	6.8	94.5	36	5	1.77
36	5	7.00 AV	2.64	1.03	12	0	5.8	102.0	32	4	1.86
39	3	8.00 AV	1.49	1.47	17	0	5.2	0.0	18	3	1.96
57	18	9.00 AV	4.41	1.50	18	0	4.0	70.9	53	37	0.65
105	48	10.00 AV	10.95	2.25	27	28	6.2	90.3	133	78	0.44
163	58	11.00 AV	12.49	2.39	29	58	8.3	91.1	151	87	0.50
213	50	12.00 AV	13.02	2.38	29	42	7.2	91.4	158	80	0.55
259	46	13.00 AV	13.33	2.33	28	32	6.9	91.5	161	82	0.48
305	46	14.00 AV	13.65	2.46	30	26	7.0	91.6	165	88	0.45
353	48	15.00 AV	14.05	2.50	30	29	7.1	91.7	170	91	0.44
406	53	16.00 AV	14.06	2.52	31	33	6.9	91.5	170	95	0.43
486	80	17.00 AV	14.11	2.31	28	37	6.9	91.2	171	107	0.36
548	62	18.00 AV	12.55	2.13	26	31	6.2	91.8	152	95	0.36
598	50	19.00 AV	12.11	2.38	29	20	6.3	90.2	147	83	0.43
649	51	20.00 AV	14.50	2.54	31	34	7.6	90.8	175	90	0.50
710	61	21.00 AV	14.66	2.48	30	42	7.6	91.8	177	94	0.43
761	51	22.00 AV	14.66	2.48	30	44	7.4	91.8	177	89	0.51
800	39	23.00 AV	13.65	2.49	30	35	6.9	92.3	165	77	0.54
832	32	24.00 AV	13.04	2.57	31	29	6.8	92.4	158	65	0.63
856	24	25.00 AV	12.46	2.63	32	26	6.5	92.8	151	50	0.68
880	24	26.00 AV	9.33	2.15	26	16	5.6	94.8	113	41	0.60
903	23	27.00 AV	7.19	1.88	23	10	4.7	95.7	87	37	0.58
920	17	28.00 AV	5.33	1.95	24	0	4.3	95.5	65	29	0.70
939	19	29.00 AV	4.94	1.85	22	1	4.2	91.4	60	27	0.75
949	10	30.00 AV	7.71	1.98	24	2	5.6	91.2	93	17	0.96
965	16	31.00 AV	6.80	1.81	22	4	5.1	99.3	82	16	0.81
978	13	32.00 AV	6.33	1.79	22	4	4.9	99.8	77	18	0.84
991	13	33.00 AV	5.25	1.81	22	1	4.3	98.7	64	20	0.83
1006	15	34.00 AV	5.15	1.79	22	1	4.1	97.8	62	20	0.80
1020	14	35.00 AV	5.13	1.79	21	0	4.3	98.5	62	17	0.86
1031	11	36.00 AV	5.96	1.92	23	0	5.0	99.2	72	16	0.93
1043	12	37.00 AV	5.26	1.82	22	0	4.8	99.8	64	14	0.94
1053	10	38.00 AV	5.92	2.06	24	1	5.1	98.4	72	15	0.99
1070	17	39.00 AV	8.43	2.14	26	11	5.3	96.2	102	24	0.78
1089	19	40.00 AV	10.98	2.49	30	23	6.5	86.3	133	38	0.72
1130	41	41.00 AV	13.57	2.61	32	40	7.7	92.5	164	71	0.52
1169	39	42.00 AV	13.58	2.70	33	38	7.8	92.2	164	72	0.55
1199	30	43.00 AV	11.25	2.50	30	22	6.5	93.6	136	51	0.60
1216	17	44.00 AV	6.25	2.07	25	3	4.5	96.8	76	25	0.77
1228	12	45.00 AV	5.23	1.99	24	2	4.3	97.5	63	14	0.94

File: BPT 05-04
Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg2

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX	
end	bl/ft	ft	ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch	
1242	14	46.00	AV	4.68	1.82	22	0	4.0	98.0	57	12	0.88
1257	15	47.00	AV	5.39	1.83	22	2	4.2	90.5	65	13	0.82
1273	16	48.00	AV	9.86	2.52	30	9	5.9	95.3	119	16	0.86
1299	26	49.00	AV	11.26	2.40	29	25	6.5	93.7	136	40	0.62
1321	22	50.00	AV	10.02	2.31	28	15	5.8	94.5	121	30	0.68
1342	21	51.00	AV	8.77	2.09	25	8	5.1	95.3	106	28	0.65
1367	25	52.00	AV	8.98	2.14	26	10	5.2	94.4	109	32	0.64
1386	19	53.00	AV	7.31	2.01	24	7	4.4	95.2	88	23	0.69
1402	16	54.00	AV	6.72	2.00	24	5	4.5	95.6	81	18	0.73
1421	19	55.00	AV	6.29	1.82	22	6	4.1	90.6	76	17	0.68
1442	21	56.00	AV	11.97	2.52	31	30	6.8	93.9	145	27	0.71
1474	32	57.00	AV	11.92	2.40	29	39	6.9	93.3	144	48	0.61
1505	31	58.00	AV	11.52	2.37	29	32	6.7	93.3	139	40	0.57
1529	24	59.00	AV	10.21	2.23	27	24	5.9	94.0	124	28	0.62
1553	24	60.00	AV	10.74	2.32	28	26	6.1	93.8	130	29	0.61
1574	21	61.00	AV	11.87	2.51	31	31	6.8	93.2	144	28	0.67
1599	25	62.00	AV	12.32	2.36	29	37	6.9	92.9	149	42	0.58
1632	33	63.00	AV	11.38	2.22	27	42	6.2	90.0	138	47	0.58
1658	26	64.00	AV	12.62	2.29	28	37	7.0	93.2	153	42	0.58
1685	27	65.00	AV	11.61	2.08	25	32	6.4	94.0	141	41	0.56
1709	24	66.00	AV	11.50	2.16	26	31	6.3	94.0	139	41	0.57
1734	25	67.00	AV	11.80	2.24	27	32	6.4	93.7	143	42	0.60
1763	29	68.00	AV	11.71	2.23	27	34	6.4	93.5	142	43	0.55
1792	29	69.00	AV	11.28	2.07	25	33	6.2	93.8	137	46	0.50
1833	41	70.00	AV	12.57	2.31	28	36	7.0	92.8	152	60	0.50
1875	42	71.00	AV	12.44	2.32	28	35	7.0	93.1	151	64	0.55
1915	40	72.00	AV	11.64	2.22	27	35	6.6	93.1	141	61	0.51
1961	46	73.00	AV	11.85	2.15	26	40	6.6	93.2	143	57	0.47
2013	52	74.00	AV	13.56	2.08	25	48	7.4	90.7	164	57	0.41
2059	46	75.00	AV	14.14	2.41	29	52	7.7	92.0	171	64	0.45
2111	52	76.00	AV	14.47	2.49	30	48	7.7	91.7	175	74	0.47
2170	59	77.00	AV	14.56	2.47	30	45	7.8	91.7	176	77	0.46
2233	63	78.00	AV	14.78	2.53	31	44	7.9	91.4	179	82	0.45
2301	68	79.00	AV	13.40	2.25	27	44	7.3	92.0	162	78	0.39
2371	70	80.00	AV	12.58	2.15	26	43	6.8	92.1	152	77	0.39
2442	71	81.00	AV	11.48	1.98	24	40	6.2	92.8	139	74	0.38
2525	83	82.00	AV	11.43	1.90	23	37	6.2	92.8	138	75	0.37
2622	97	83.00	AV	12.10	2.02	24	41	6.6	91.0	146	76	0.38
2695	73	84.00	AV	15.37	2.75	34	50	8.0	91.9	186	84	0.45
2766	71	85.00	AV	14.98	2.72	33	47	7.7	92.0	181	77	0.42
2825	59	86.00	AV	14.82	2.63	32	43	7.6	91.9	179	68	0.46
2876	51	87.00	AV	15.03	2.73	33	45	7.7	91.8	182	64	0.44
2926	50	88.00	AV	14.38	2.56	31	45	7.4	92.1	174	64	0.41
2979	53	89.00	AV	14.85	2.63	32	46	7.6	92.0	180	68	0.43
3040	61	90.00	AV	14.72	2.60	32	46	7.6	92.1	178	71	0.41
3093	53	91.00	AV	14.61	2.66	32	43	7.6	92.0	177	64	0.45
3136	43	92.00	AV	14.33	2.59	31	45	7.4	92.0	173	54	0.43
3278	142	93.00	AV	15.46	2.74	33	46	8.0	90.6	187	109	0.40
3574	296	94.00	AV	14.96	2.75	33	40	8.3	91.2	181	110	0.46
3872	298	95.00	AV	15.68	2.94	36	39	8.6	91.1	190	110	0.50
4037	330	95.50	AV	15.07	2.80	34	38	8.2	90.9	182	110	0.49

File: BPT 05-04
Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg3

BL# COMMENTS
1 RMDT--B. Miner
56 STOP AT 9 FT, PULL TEST, ADD 10 FT.
597 STOP AT 19 FT, PULL TEST, ADD 10 FT.
938 STOP AT 29 FT, PULL TEST, ADD 10 FT.
1070 STOP AT 39 FT, PULL TEST, ADD 8 FT.
1256 STOP AT 47 FT, PULL TEST, ADD 8 FT.
1420 STOP AT 55 FT, PULL TEST, ADD 8 FT.
1961 STOP AT 73 FT, PULL TEST, ADD 10 FT.
4037 HALT BPT 05-04, 95.5 FT, 11:27 21AUG05.

DRIVE TIME SUMMARY (2005-Aug-21 : BPT0504.MDF)				DRIVE	WAIT
-----				minutes	----
BN	1 ->	56, START	8:15:02 -> 8:21:18 STOP,	6.27	
					15.00
BN	57 ->	597, START	8:36:18 -> 8:42:14 STOP,	5.93	
					13.17
BN	598 ->	938, START	8:55:24 -> 8:59:04 STOP,	3.67	
					14.58
BN	939 ->	1070, START	9:13:39 -> 9:15:00 STOP,	1.35	
					13.22
BN	1071 ->	1256, START	9:28:13 -> 9:30:12 STOP,	1.98	
					12.02
BN	1257 ->	1420, START	9:42:13 -> 9:43:56 STOP,	1.72	
					16.67
BN	1421 ->	1631, START	10:00:36 -> 10:02:52 STOP,	2.27	
					11.90
BN	1632 ->	1961, START	10:14:46 -> 10:18:18 STOP,	3.53	
					13.73
BN	1962 ->	2621, START	10:32:02 -> 10:39:11 STOP,	7.15	
					12.40
BN	2622 ->	3277, START	10:51:35 -> 10:58:43 STOP,	7.13	
					17.95
BN	3278 ->	3872, START	11:16:40 -> 11:24:23 STOP,	7.72	
					1.37
BN	3873 ->	4037, START	11:25:45 -> 11:27:33 STOP,	1.80	

Total Elapsed time 192.52 minutes				Total Time 50.52 minutes	142.00

File: BPT 05-05
 Info: HAV 180, 6-5/8" CLOSED
 AR: 12.1 in²
 LE: 12.0 ft

Proj: ROSE CREEK, X'VALLEY DAM Pg1
 SP: 0.493 k/ft³
 WS: 16800 ft/s
 EM: 30004 KSI

CSX: Max Measured C-Stress
 EFV: Max Transferred Energy
 ETR: Energy Transfer Ratio
 SFT: Shaft Friction Total
 VMX: Max Measured Velocity

BPM: Blows Per Minute
 FMX: Max Measured Force
 RA2: Capacity - RA2
 DMX: Max Meas'd Displacement

BL#	depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX
end bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
5	5	1.00 AV	7.60	2.47	30	0	10.6	43.6	92	8	2.34
10	5	2.00 AV	2.89	1.38	16	0	5.3	82.6	35	9	1.42
23	13	3.00 AV	4.11	1.59	19	0	5.1	103.7	50	17	0.86
31	8	4.00 AV	3.95	1.70	20	0	6.7	103.7	48	8	1.46
39	8	5.00 AV	4.13	1.88	23	0	6.0	102.8	50	16	1.23
59	20	6.00 AV	10.30	2.49	30	0	6.3	95.6	125	47	0.68
83	24	7.00 AV	12.76	2.61	32	1	7.3	93.3	154	52	0.63
118	35	8.00 AV	13.81	2.53	31	4	7.5	92.4	167	74	0.54
160	42	9.00 AV	13.74	2.37	29	5	7.5	90.2	166	74	0.53
222	62	10.00 AV	15.78	2.48	30	27	8.3	91.5	191	103	0.47
306	84	11.00 AV	15.45	2.10	25	43	7.8	91.6	187	98	0.34
378	72	12.00 AV	16.40	2.65	32	38	8.5	90.9	199	111	0.43
455	77	13.00 AV	16.58	2.65	32	36	8.7	90.7	201	112	0.40
517	62	14.00 AV	13.98	2.46	30	38	7.5	91.0	169	96	0.42
564	47	15.00 AV	11.68	2.35	29	27	6.1	91.6	141	77	0.44
597	33	16.00 AV	11.05	2.32	28	19	5.5	92.4	134	58	0.54
633	36	17.00 AV	11.61	2.26	27	18	5.9	92.2	141	61	0.51
670	37	18.00 AV	11.55	2.30	28	18	5.8	92.2	140	62	0.51
702	32	19.00 AV	9.98	2.27	28	12	5.4	90.1	121	56	0.58
723	21	20.00 AV	13.12	2.91	35	29	6.9	90.6	159	54	0.66
756	33	21.00 AV	12.80	2.70	33	37	6.4	92.9	155	66	0.60
796	40	22.00 AV	12.30	2.48	30	34	6.2	92.6	149	74	0.49
835	39	23.00 AV	12.83	2.59	32	46	6.6	92.2	155	77	0.56
868	33	24.00 AV	12.44	2.55	31	39	6.4	92.7	151	65	0.62
898	30	25.00 AV	10.99	2.50	30	35	5.8	93.4	133	57	0.61
926	28	26.00 AV	10.34	2.65	32	24	5.8	93.4	125	46	0.66
950	24	27.00 AV	10.61	2.64	32	28	5.8	93.4	128	44	0.74
971	21	28.00 AV	9.05	2.42	29	15	5.5	94.7	110	33	0.70
989	18	29.00 AV	5.91	2.05	25	1	5.0	91.4	72	24	0.84
1001	12	30.00 AV	8.49	1.98	24	8	5.9	92.0	103	12	0.97
1015	14	31.00 AV	7.91	1.97	24	1	5.7	98.9	96	14	0.94
1025	10	32.00 AV	8.52	2.12	26	1	5.7	98.8	103	13	1.02
1038	13	33.00 AV	8.12	2.23	27	2	5.5	98.3	98	17	0.98
1048	10	34.00 AV	7.34	2.15	26	1	5.4	98.2	89	14	1.03
1059	11	35.00 AV	6.61	2.02	24	0	5.3	98.7	80	13	1.07
1071	12	36.00 AV	6.51	1.94	23	4	5.1	98.2	79	15	0.95
1090	19	37.00 AV	8.81	2.17	26	19	5.2	94.9	107	29	0.70
1120	30	38.00 AV	11.02	2.23	27	31	5.6	93.4	133	45	0.57
1142	22	39.00 AV	8.60	2.09	25	21	5.1	90.7	104	27	0.69
1161	19	40.00 AV	9.59	2.16	26	24	5.4	91.6	116	25	0.72
1181	20	41.00 AV	7.94	1.95	23	19	4.9	95.8	96	16	0.72
1200	19	42.00 AV	8.68	1.87	22	21	4.7	95.6	105	22	0.64
1221	21	43.00 AV	8.42	1.86	22	23	4.5	95.5	102	26	0.59
1243	22	44.00 AV	9.51	2.11	26	25	5.2	94.7	115	28	0.61
1264	21	45.00 AV	9.18	2.11	25	26	4.9	94.8	111	29	0.62

Pile: BPT 05-05
 Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg2

BL#		depth	TY	CSX	EFV	ETR	SFT	VMX	BPM	FMX	RA2	DMX
end	bl/ft	ft		ksi	K-ft	%	kips	ft/sec	bl/min	kips	kips	inch
1285	21	46.00	AV	8.89	2.09	25	28	4.7	94.8	108	29	0.60
1308	23	47.00	AV	9.87	2.21	27	33	5.1	90.1	119	32	0.59
1331	23	48.00	AV	10.70	2.58	31	39	6.2	93.3	130	32	0.67
1358	27	49.00	AV	10.03	2.40	29	44	5.8	93.6	121	38	0.66
1387	29	50.00	AV	10.15	2.39	29	48	6.1	92.9	123	53	0.54
1423	36	51.00	AV	10.08	2.42	29	40	6.2	92.8	122	57	0.53
1456	33	52.00	AV	10.02	2.48	30	33	6.3	92.5	121	55	0.53
1498	42	53.00	AV	10.14	2.58	31	34	6.7	91.8	123	68	0.53
1540	42	54.00	AV	10.69	2.69	33	40	7.2	91.5	129	76	0.52
1593	53	55.00	AV	10.69	2.69	33	40	7.4	89.6	129	79	0.50
1635	42	56.00	AV	13.85	2.57	31	45	7.9	90.5	168	68	0.52
1685	50	57.00	AV	12.91	2.36	29	48	7.3	92.1	156	65	0.48
1737	52	58.00	AV	12.29	2.24	27	50	6.7	92.2	149	70	0.44
1791	54	59.00	AV	12.52	2.23	27	58	6.8	92.2	152	73	0.46
1848	57	60.00	AV	12.06	2.17	26	56	6.4	92.3	146	74	0.42
1892	44	61.00	AV	11.97	2.25	27	47	6.4	92.3	145	63	0.48
1937	45	62.00	AV	13.18	2.56	31	56	7.4	91.7	160	73	0.48
1987	50	63.00	AV	12.83	2.61	32	50	7.7	89.8	155	73	0.52
2029	42	64.00	AV	13.06	2.32	28	55	7.6	90.8	158	59	0.48
2077	48	65.00	AV	13.36	2.50	30	55	7.8	92.5	162	64	0.50
2128	51	66.00	AV	14.04	2.61	32	51	8.2	91.8	170	75	0.49
2180	52	67.00	AV	13.86	2.57	31	45	8.1	92.0	168	69	0.49
2219	39	68.00	AV	13.81	2.52	31	45	8.2	92.0	167	58	0.54
2268	49	69.00	AV	12.19	2.12	26	41	7.1	93.1	148	53	0.49
2315	47	70.00	AV	13.54	2.36	29	51	7.9	92.1	164	64	0.50
2356	47	70.87	AV	14.41	2.50	30	53	8.4	89.3	174	75	0.56
2357	7	71.00	AV	5.95	1.35	16	37	3.2	0.0	72	34	0.35
2413	56	72.00	AV	14.24	2.40	29	62	8.7	91.7	172	75	0.44
2482	69	73.00	AV	14.14	2.37	29	59	8.6	91.5	171	79	0.44
2534	52	74.00	AV	14.10	2.44	29	59	8.7	91.5	171	72	0.47
2585	51	75.00	AV	13.81	2.36	28	57	8.6	91.6	167	68	0.47
2635	50	76.00	AV	13.67	2.32	28	55	8.5	91.7	165	66	0.47
2685	50	77.00	AV	13.57	2.35	28	52	8.4	91.7	164	62	0.49
2731	46	78.00	AV	13.26	2.22	27	47	8.2	92.0	161	57	0.50
2784	53	79.00	AV	13.26	2.16	26	49	8.3	90.2	160	61	0.47
2840	56	80.00	AV	12.21	2.05	25	54	7.7	88.6	148	68	0.43
2921	81	81.00	AV	12.38	2.00	24	51	7.8	92.5	150	73	0.40
2989	68	82.00	AV	12.66	2.09	25	45	8.0	92.2	153	67	0.41
3050	61	83.00	AV	12.33	1.99	24	43	7.9	92.4	149	61	0.40
3128	78	84.00	AV	12.10	1.91	23	40	7.7	92.3	146	65	0.42
3192	64	85.00	AV	11.31	1.75	21	41	7.2	92.8	137	58	0.41
3286	94	86.00	AV	11.86	1.77	21	43	7.4	92.6	144	71	0.37
3419	133	87.00	AV	12.29	1.94	23	41	7.7	90.8	149	85	0.36
3552	133	88.00	AV	14.50	2.65	32	53	8.7	91.2	176	101	0.41
3675	123	89.00	AV	15.25	2.95	36	56	9.2	90.9	185	103	0.50
3807	132	90.00	AV	15.09	3.05	37	56	9.1	90.8	183	114	0.47
3975	168	91.00	AV	14.18	2.76	34	51	8.5	91.0	172	112	0.41
4126	151	92.00	AV	14.36	2.69	33	52	8.6	91.1	174	109	0.39
4456	330	93.00	AV	12.29	2.38	29	46	7.1	91.3	149	116	0.39

File: BPT 05-05
Info: HAV 180, 6-5/8" CLOSED

Proj: ROSE CREEK, X'VALLEY DAM Pg3

BL# COMMENTS
1 BEGIN BPT 05-05, 14:13 21AUG05.
2356 DATA MERGE: 05BOT.MDF
4456 TERMINATE BPT 05-05, 93 FT, 17:06 21AUG05.

DRIVE TIME SUMMARY (2005-Aug-21 : BPT0505.MDF)		DRIVE	WAIT
-----		minutes	----
BN	1 -> 159, START 14:13:03 -> 14:15:03 STOP,	2.00	
BN	160 -> 701, START 14:28:49 -> 14:34:44 STOP,	5.92	13.77
BN	702 -> 988, START 14:47:57 -> 14:51:02 STOP,	3.08	13.22
BN	989 -> 1141, START 15:03:57 -> 15:05:33 STOP,	1.60	12.92
BN	1142 -> 1307, START 15:21:58 -> 15:23:43 STOP,	1.75	16.42
BN	1308 -> 1592, START 15:35:48 -> 15:38:53 STOP,	3.08	12.08
BN	1593 -> 1986, START 15:50:05 -> 15:54:23 STOP,	4.30	11.20
BN	1987 -> 2315, START 16:04:41 -> 16:08:17 STOP,	3.60	10.30
BN	2316 -> 2356, START 16:08:21 -> 16:08:47 STOP,	0.43	0.07
BN	2357 -> 2783, START 16:19:46 -> 16:24:25 STOP,	4.65	10.98
BN	2784 -> 3418, START 16:36:50 -> 16:43:56 STOP,	7.10	12.42
BN	3419 -> 4456, START 16:55:22 -> 17:06:46 STOP,	11.40	11.43
Total Elapsed time 173.72 minutes		Total Time	48.92 minutes 124.80

R Miner Dynamic Test

ROSE CREEK, BPT05-01

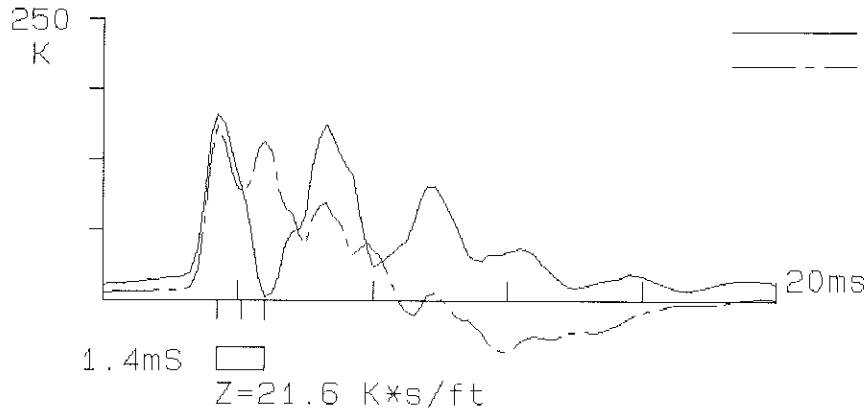
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

01000FT 2005-08-18

HAV 180, 6-5/8" CLOSED

BN 60/261



CSX 13.63 Ksi

EFV 1.990 Kip-ft

ETR 24 %

BPM 91.4 BPM

VMX 7.1 ft/s

SFT 0 Kips

FMX 165 Kips

RA2 102 Kips

DMX 0.30 inch

LP 8.00 ft

LE 12.00 ft

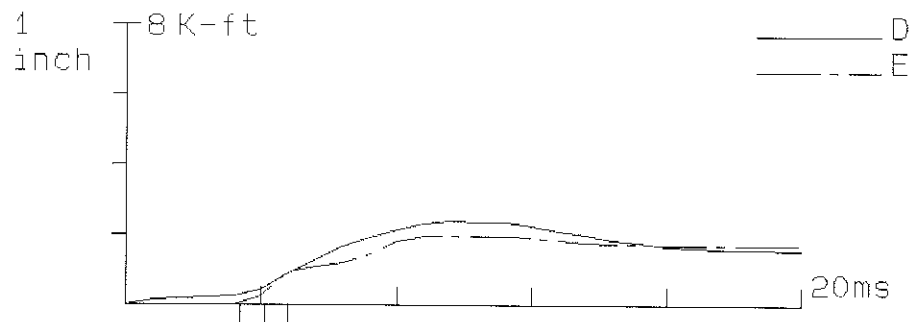
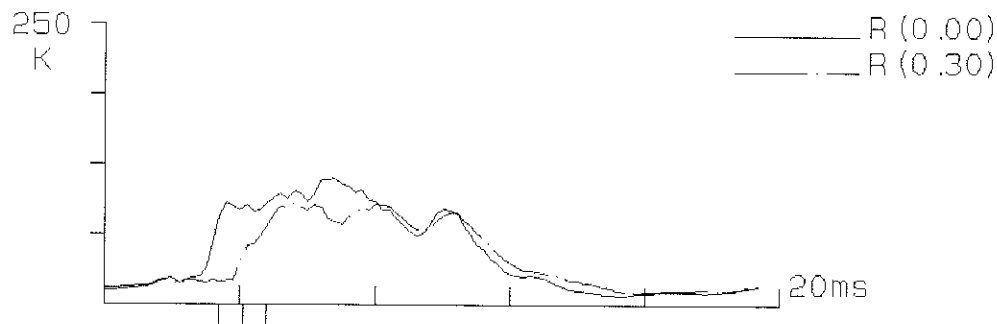
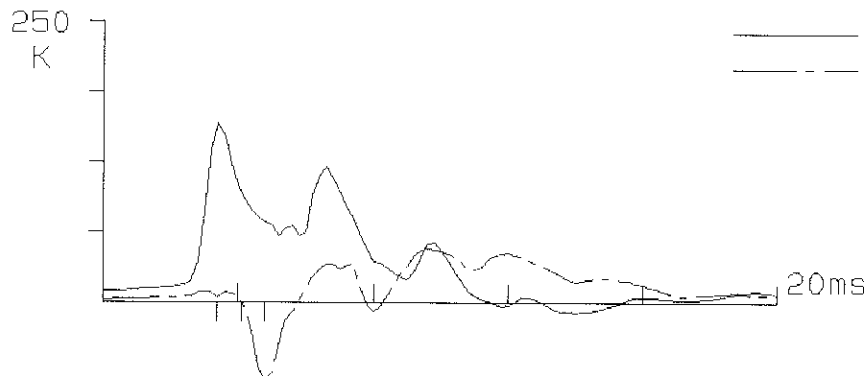
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-01

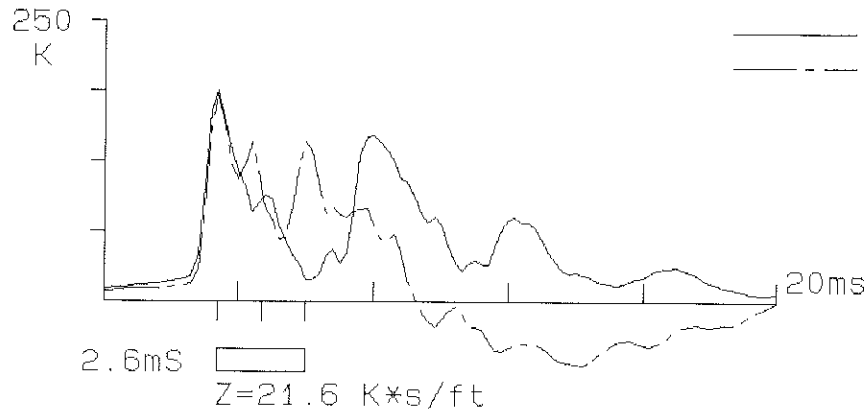
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

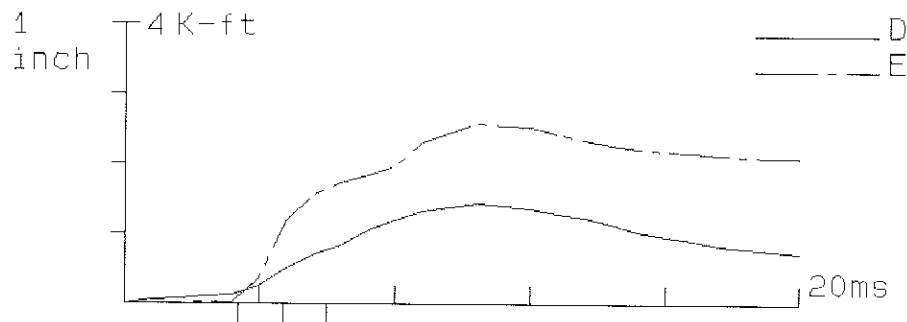
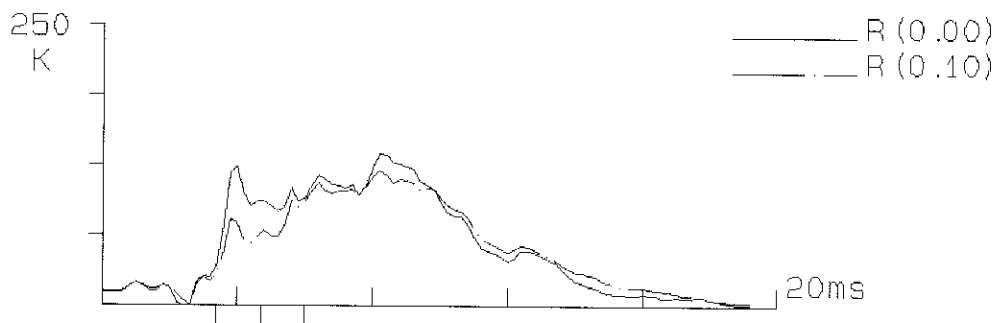
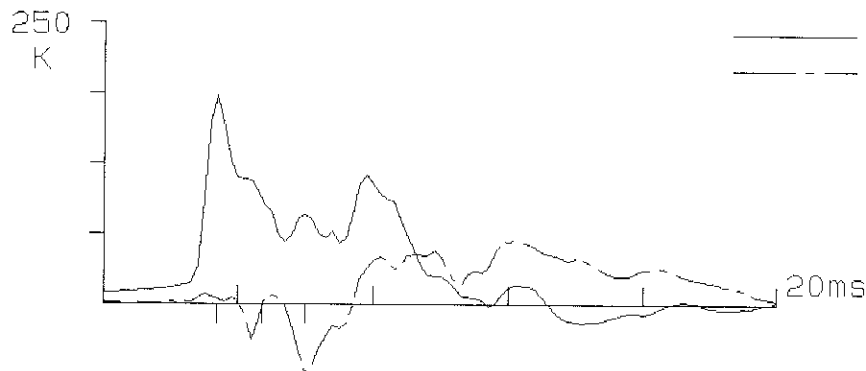
01009FT 2005-08-18

HAV 180, 6-5/8" CLOSED

BN 84/720



CSX 15.53 Ksi
EFV 2.600 Kip-ft
ETR 32 %
BPM 90.6 BPM
VMX 8.5 ft/s
SFT 18 Kips
FMX 188 Kips
RA2 127 Kips
DMX 0.36 inch
LP 18.00 ft
LE 22.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

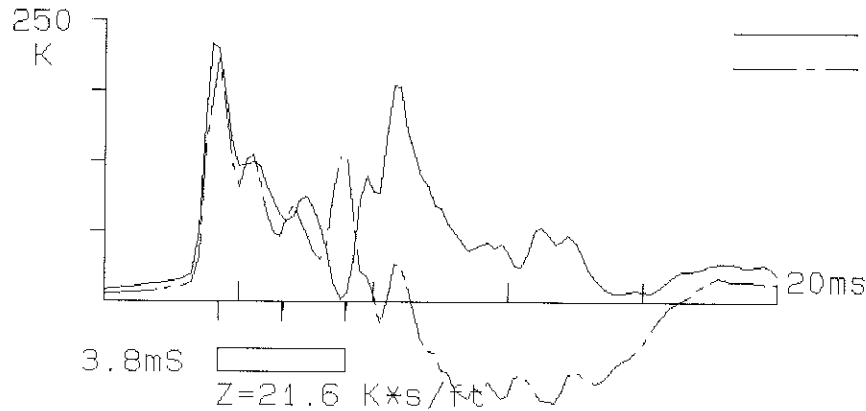
ROSE CREEK, BPT05-01

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

01019FT 2005-08-18

HAV 180, 6-5/8" CLOSED



BN 240/1378

CSX 18.92 Ksi

EFV 2.820 Kip-ft

ETR 34 %

BPM 90.2 BPM

VMX 10.0 ft/s

SFT 42 Kips

FMX 229 Kips

RA2 172 Kips

DMX 0.31 inch

LP 28.00 ft

LE 32.00 ft

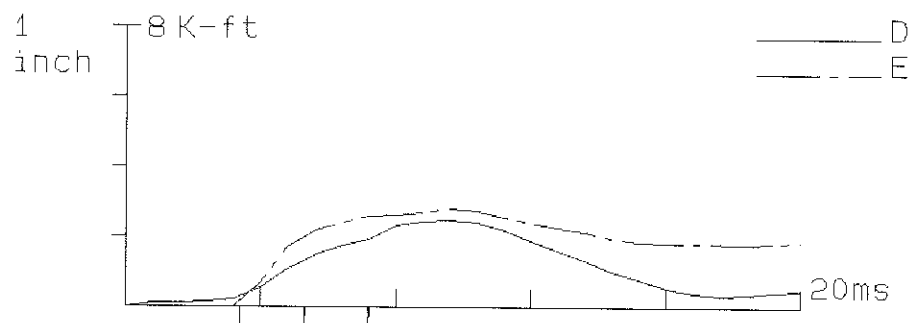
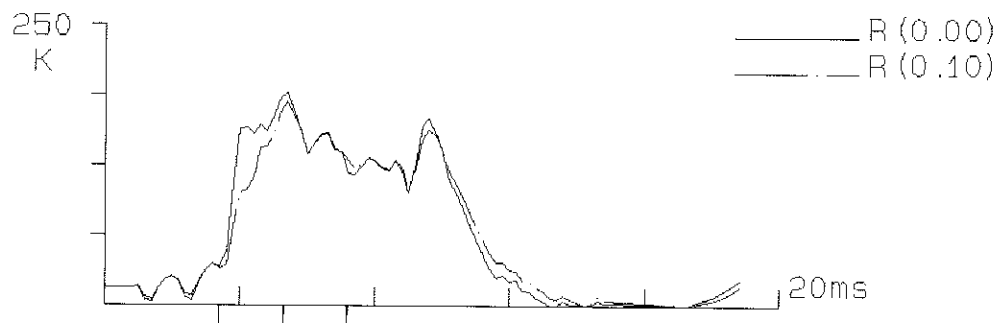
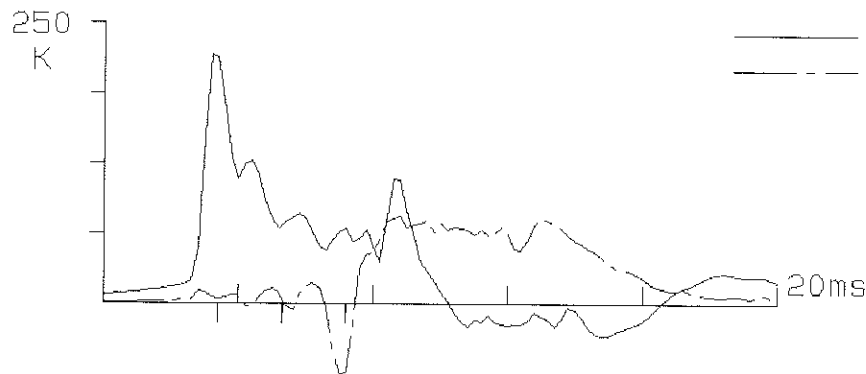
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-01

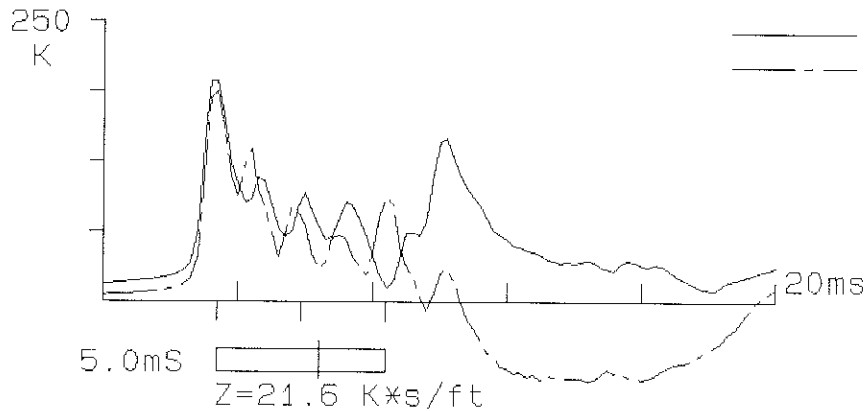
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

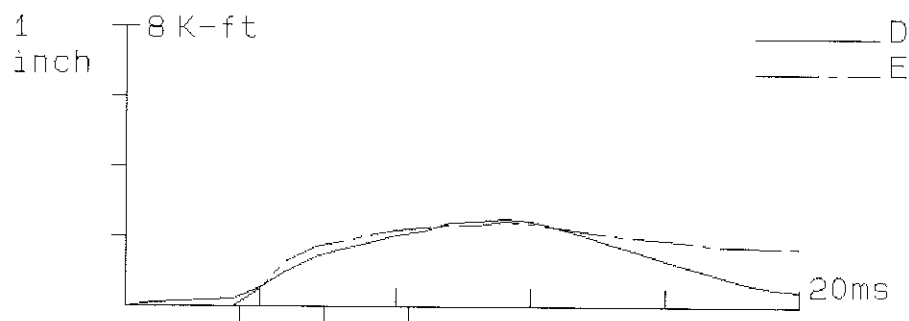
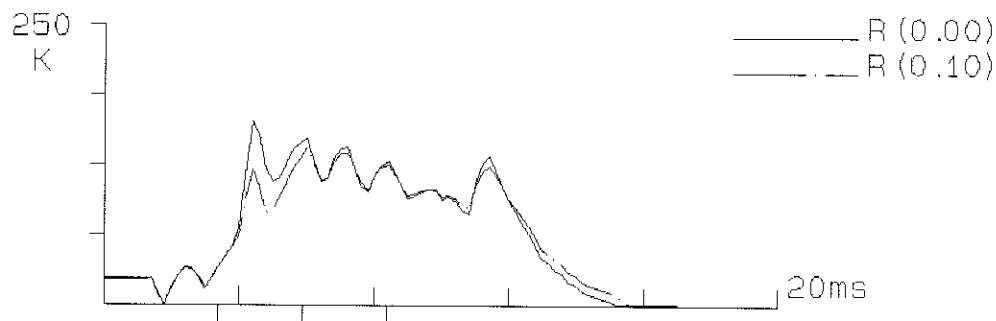
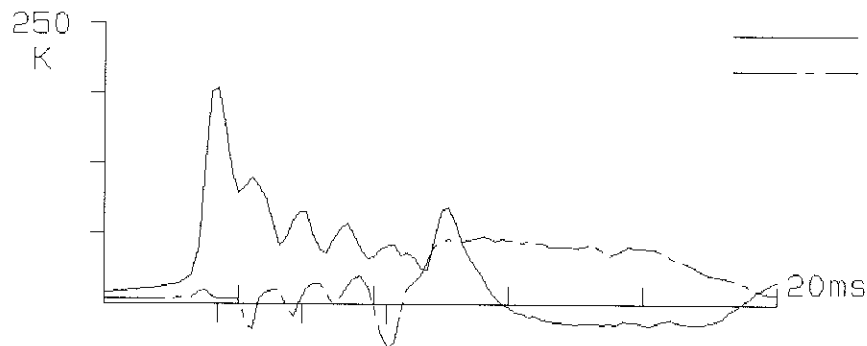
01029FT 2005-08-18

HAV 180, 6-5/8" CLOSED

BN 192/2927



CSX 16.28 Ksi
EFV 2.460 Kip-ft
ETR 30 %
BPM 91.4 BPM
VMX 8.7 ft/s
SFT 81 Kips
FMX 197 Kips
RA2 131 Kips
DMX 0.32 inch
LP 38.00 ft
LE 42.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-01

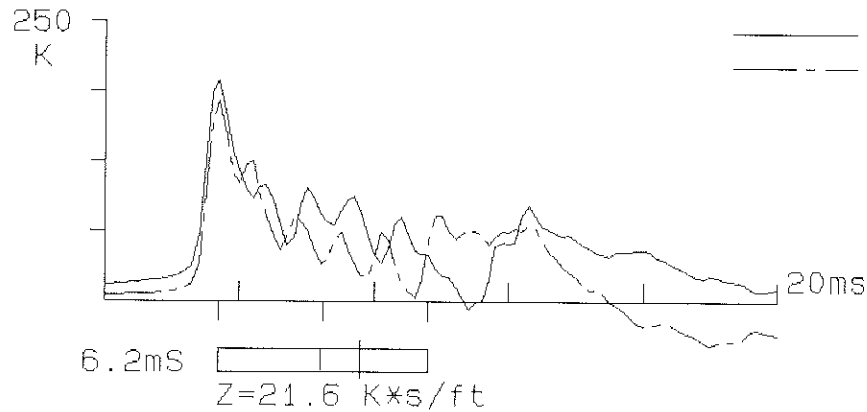
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

01039FT 2005-08-18

HAV 180, 6-5/8" CLOSED

BN 35/643



CSX 16.28 Ksi

EFV 2.730 Kip-ft

ETR 33 %

BPM 91.7 BPM

VMX 8.2 ft/s

SFT 75 Kips

FMX 197 Kips

RA2 77 Kips

DMX 0.43 inch

LP 48.00 ft

LE 52.00 ft

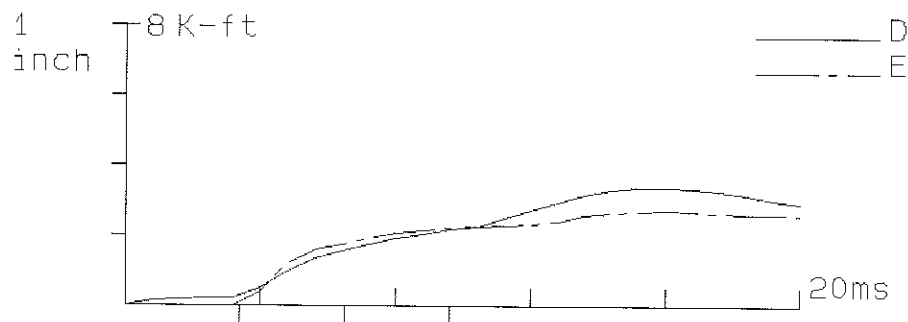
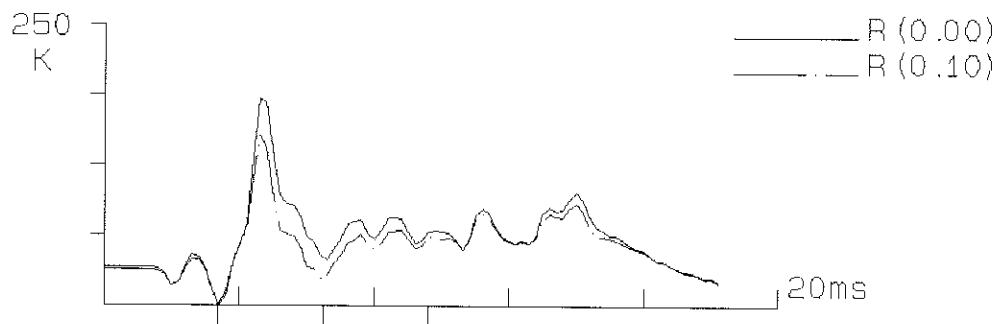
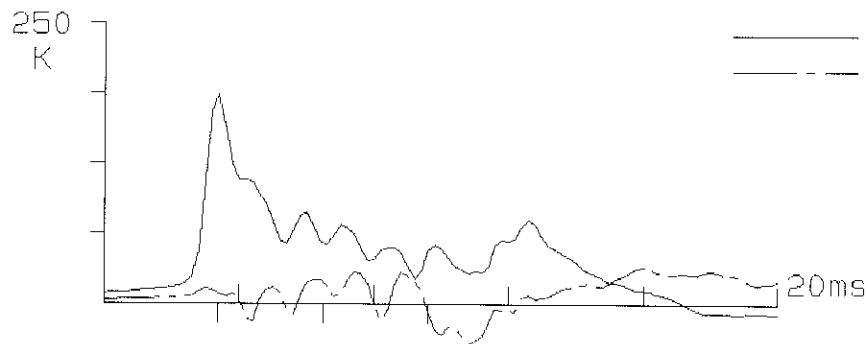
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

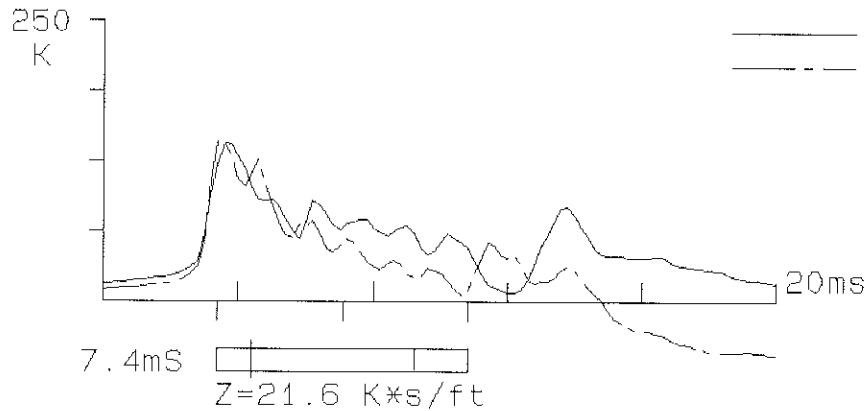
ROSE CREEK, BPT05-01

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

01049FT 2005-08-18

HAV 180, 6-5/8" CLOSED



BN 56/462

CSX 11.65 Ksi

EFV 2.210 Kip-ft

ETR 27 %

BPM 92.0 BPM

VMX 6.6 ft/s

SFT 45 Kips

FMX 141 Kips

RA2 83 Kips

DMX 0.37 inch

LP 59.00 ft

LE 62.00 ft

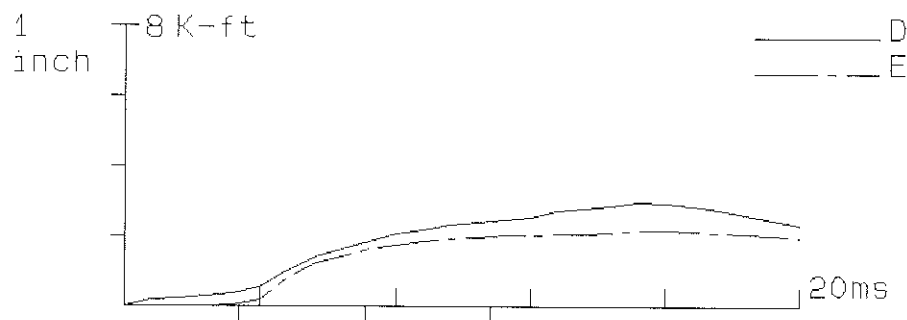
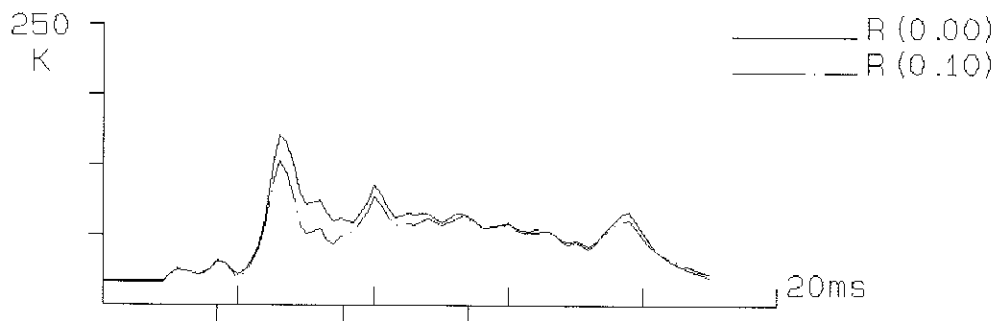
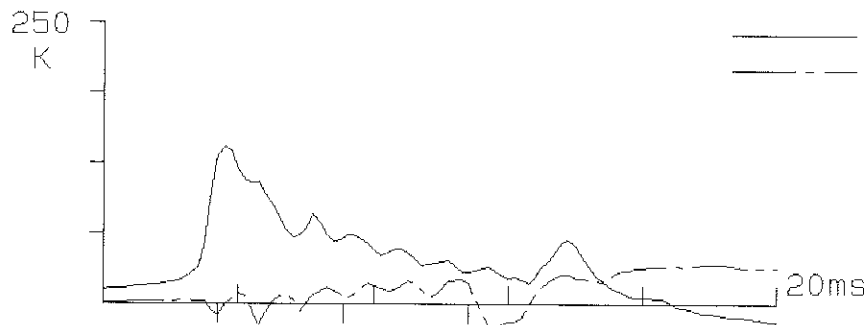
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-01

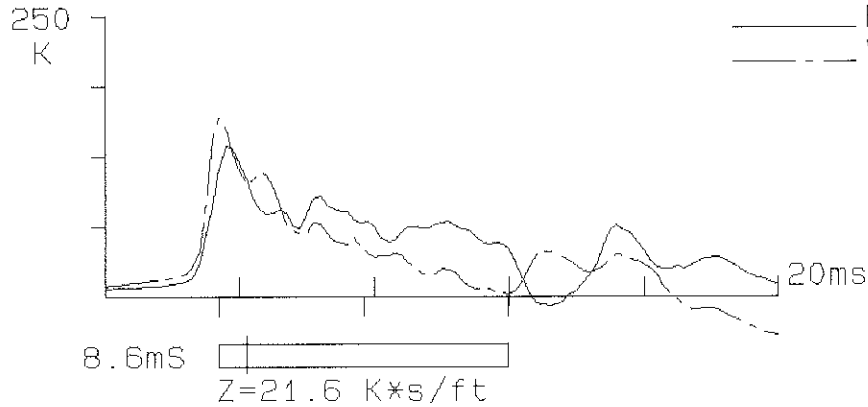
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

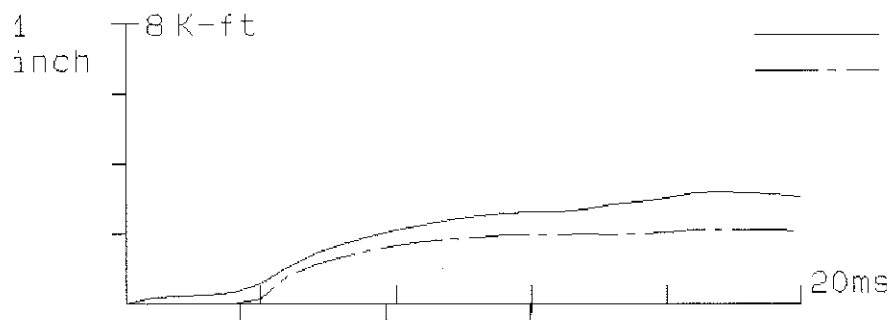
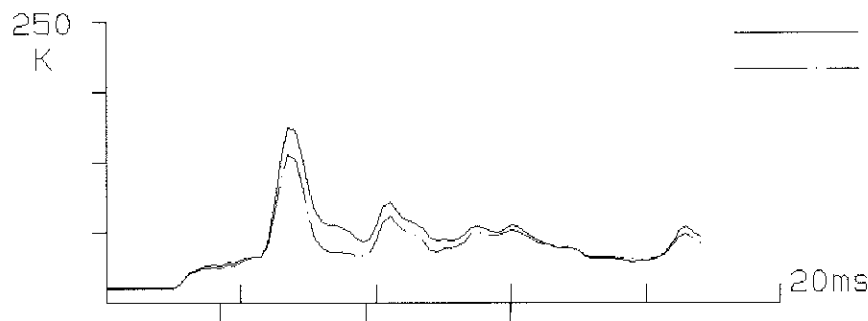
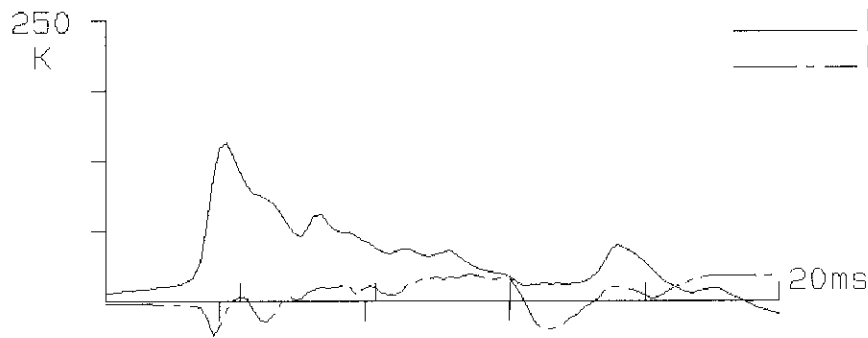
01059FT 2005-08-18

HAV 180, 6-5/8" CLOSED

BN 45/496



CSX 11.07 Ksi
EFV 2.300 Kip-ft
ETR 28 %
BPM 91.8 BPM
VMX 7.3 ft/s
SFT 50 Kips
FMX 134 Kips
RA2 68 Kips
DMX 0.40 inch
LP 68.00 ft
LE 72.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

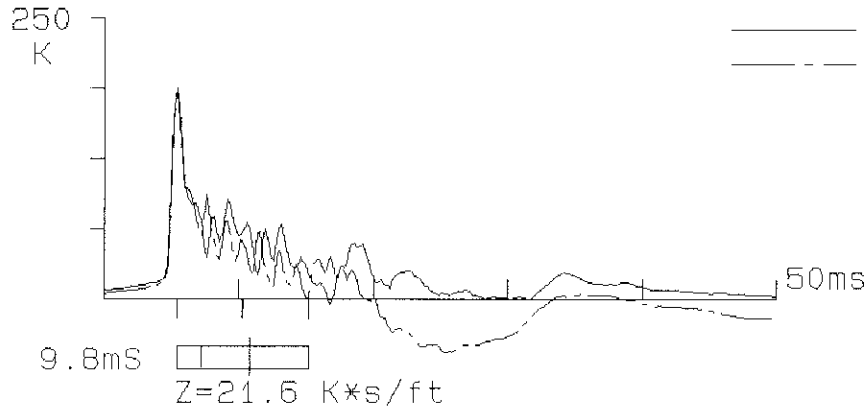
ROSE CREEK, BPT05-01

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

01069FT 2005-08-18

HAV 180, 6-5/8" CLOSED



BN 72/508

CSX 15.53 Ksi

EFV 2.430 Kip-ft

ETR 29 %

BPM 91.4 BPM

VMX 8.5 ft/s

SFT 34 Kips

FMX 188 Kips

RA2 61 Kips

DMX 0.40 inch

LP 78.00 ft

LE 82.00 ft

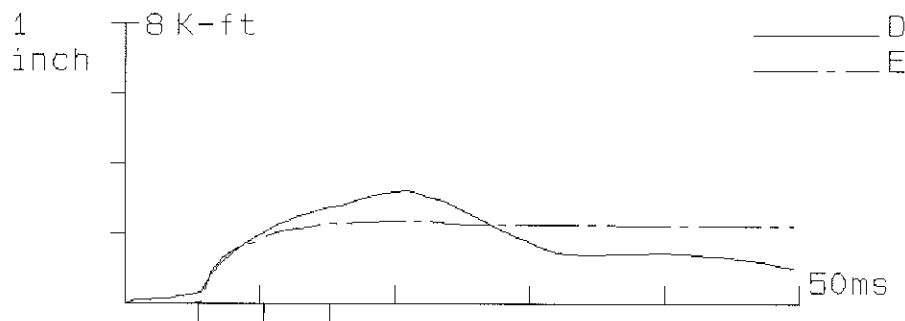
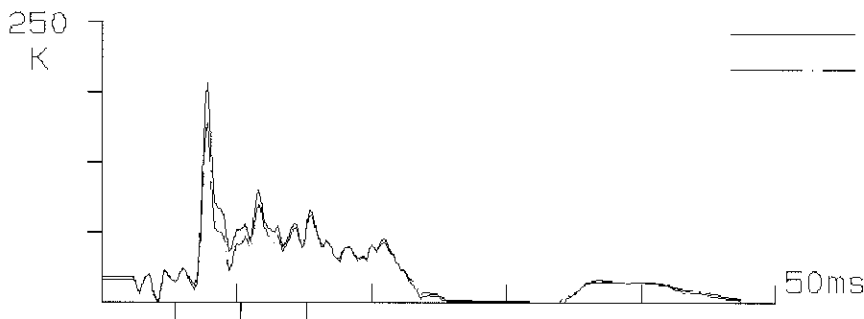
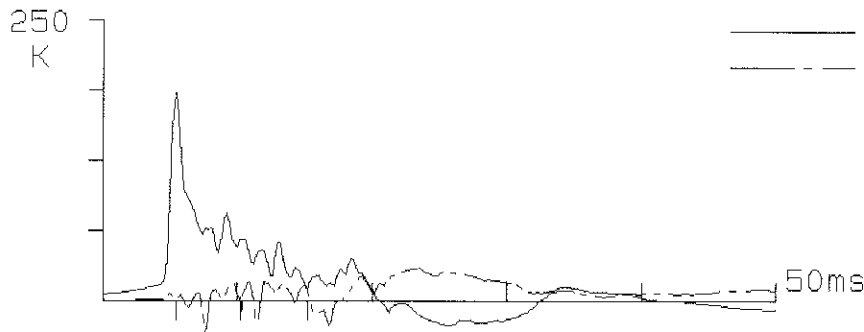
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-01

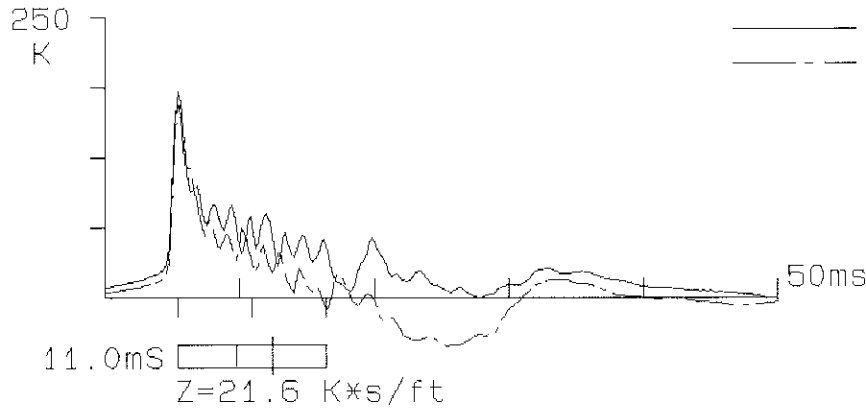
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PDI PILE DRIVING ANALYZER® v5.02

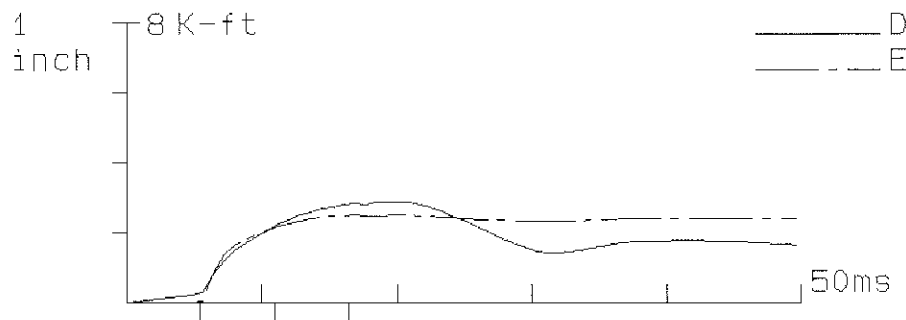
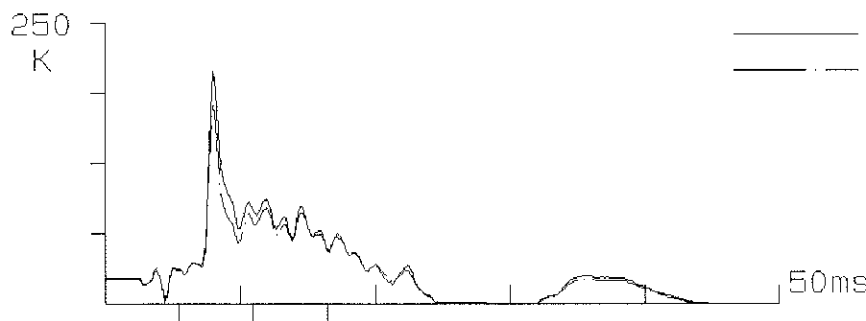
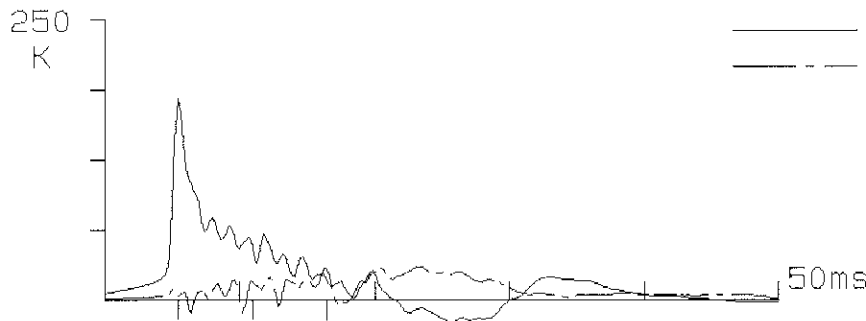
01079FT 2005-08-18

HAV 180, 6-5/8" CLOSED

BN 79/738



CSX 15.20 Ksi
EFV 2.510 Kip-ft
ETR 30 %
BPM 91.6 BPM
VMX 8.1 ft/s
SFT 37 Kips
FMX 184 Kips
RA2 85 Kips
DMX 0.69 inch
LP 88.00 ft
LE 92.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

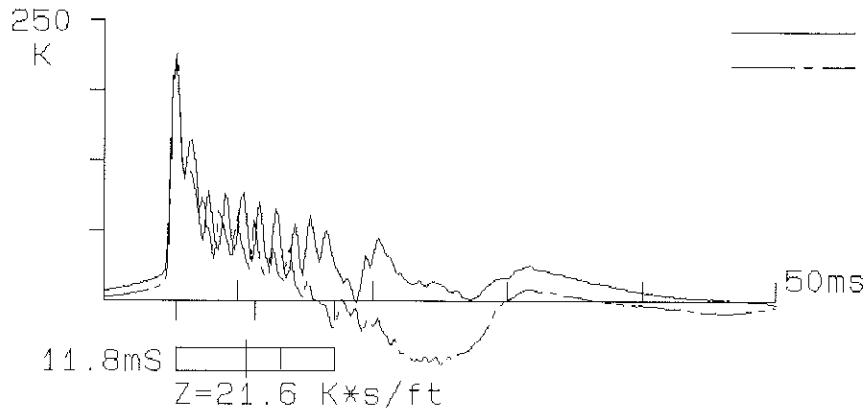
ROSE CREEK, BPT05-01

PDA OP: RMDT: -B. Miner

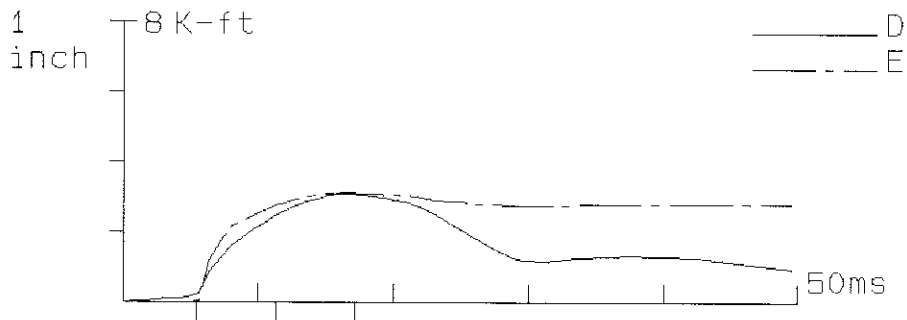
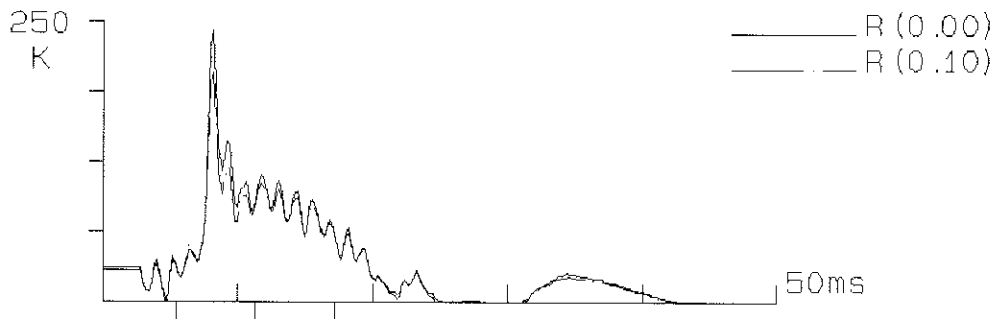
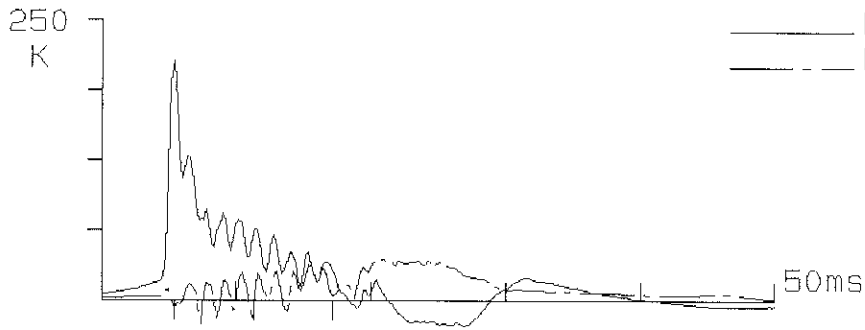
PDI PILE DRIVING ANALYZER® v5.02

01089FT 2005-08-18

HAV 180, 6-5/8" CLOSED



BN 116/751
 CSX 17.27 Ksi
 EFV 3.130 Kip-ft
 ETR 38 %
 BPM 90.9 BPM
 VMX 10.1 ft/s
 SFT 71 Kips
 FMX 209 Kips
 RA2 81 Kips
 DMX 0.39 inch
 LP 96.00 ft
 LE 99.00 ft
 AR 12.10 in2
 EM 30004 Ksi
 SP 0.493 K/ft3
 WS 16800 ft/s
 F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-01

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

01097FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 120/940

CSX 13.47 Ksi

EFV 2.260 Kip-ft

ETR 28 %

BPM 91.6 BPM

VMX 7.7 ft/s

SFT 71 Kips

FMX 163 Kips

RA2 75 Kips

DMX 0.36 inch

LP 104.00 ft

LE 107.00 ft

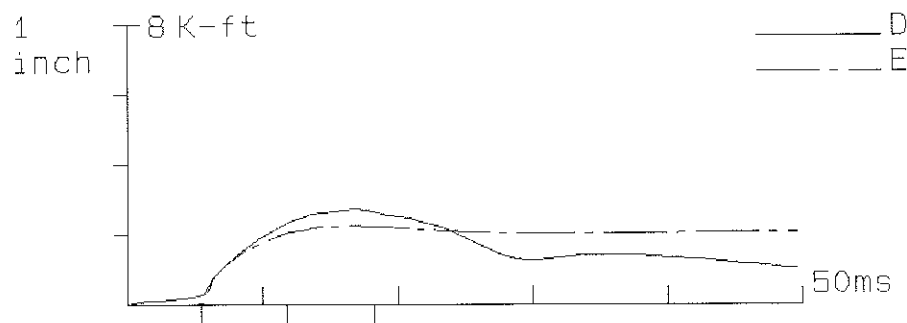
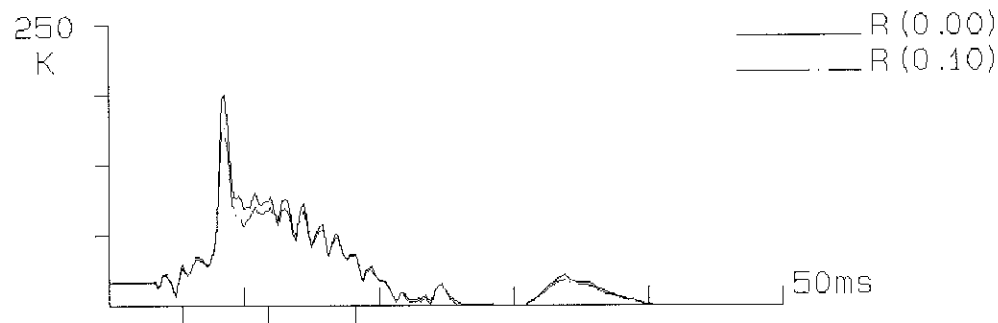
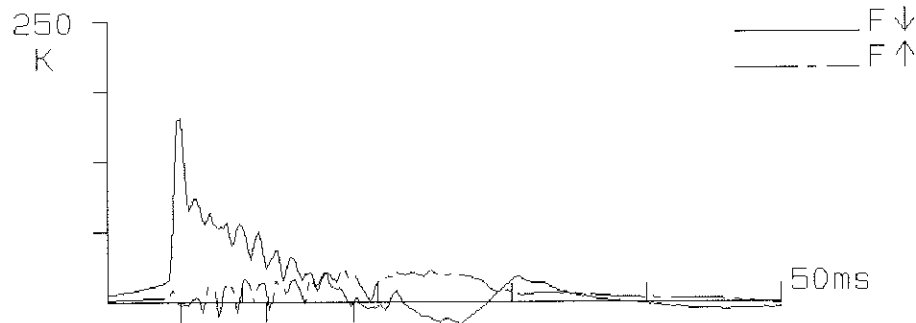
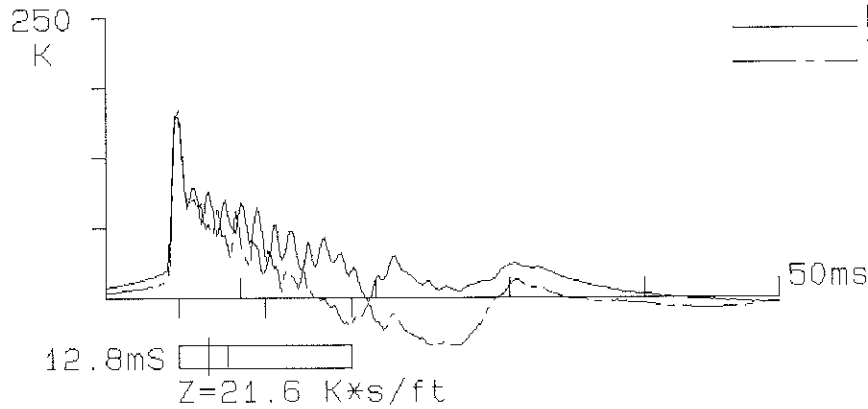
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-01

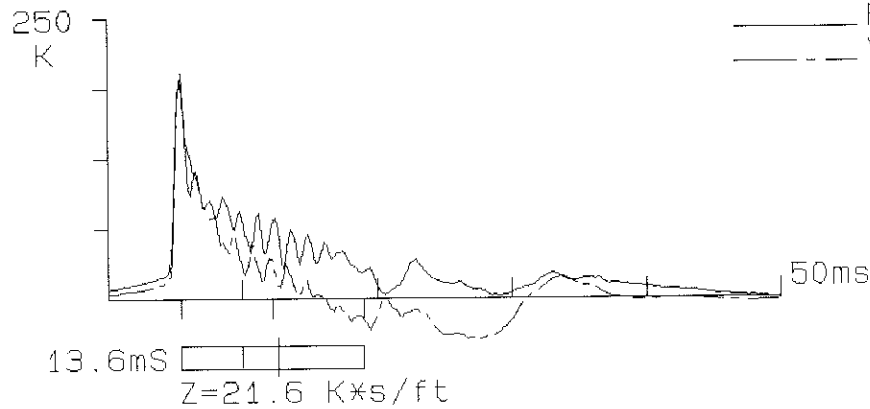
PDA OP: RMDT: -B. Miner

POI PILE DRIVING ANALYZER® V5.02

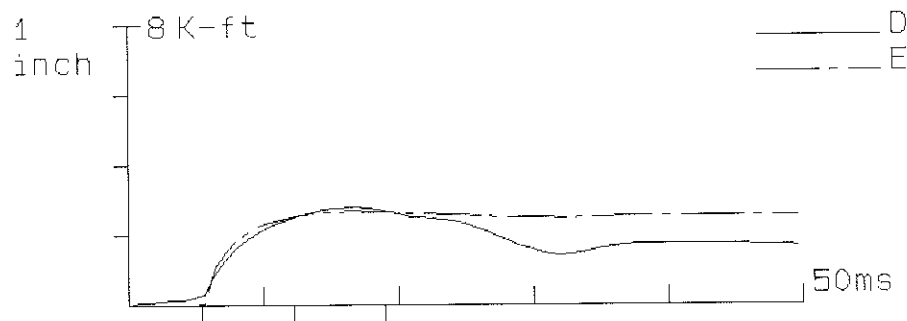
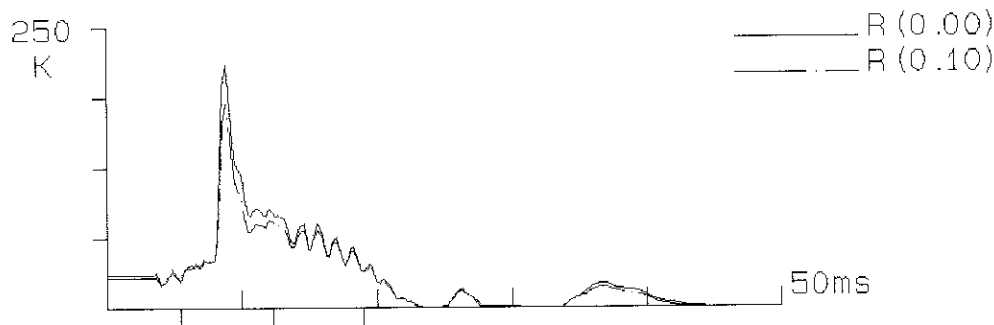
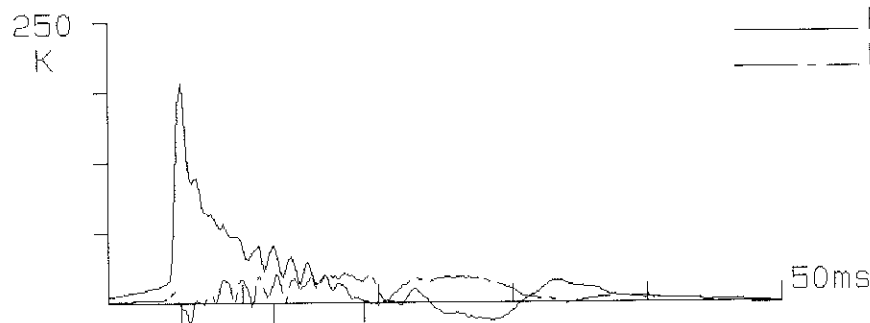
01105FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 78/767



CSX 15.86 Ksi
EFV 2.700 Kip-ft
ETR 33 %
BPM 90.6 BPM
VMX 9.3 ft/s
SFT 54 Kips
FMX 192 Kips
RA2 78 Kips
DMX 0.69 inch
LP 112.00 ft
LE 115.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

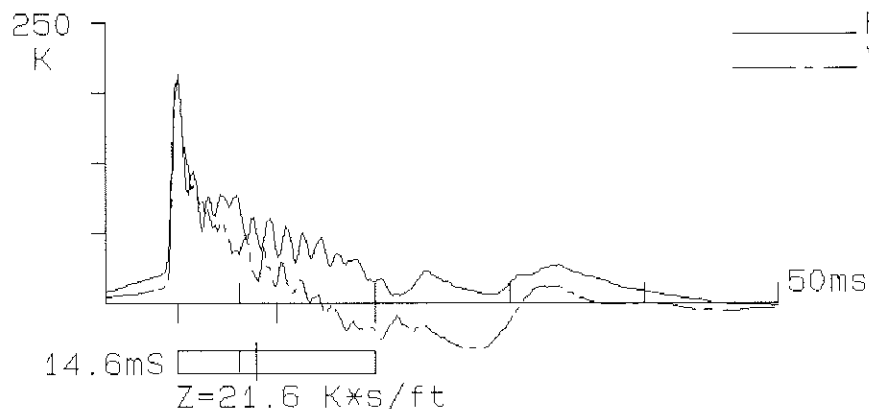
ROSE CREEK, BPT05-01

PDA OP: AMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

01103FT 2005-08-19

HAV 180, 6-5/8" CLOSED



BN 125/776

CSX 16.61 Ksi

EFV 3.090 Kip-ft

ETR 38 %

BPM 90.3 BPM

VMX 9.4 ft/s

SFT 62 Kips

FMX 201 Kips

RA2 93 Kips

DMX 0.65 inch

LP 120.00 ft

LE 123.00 ft

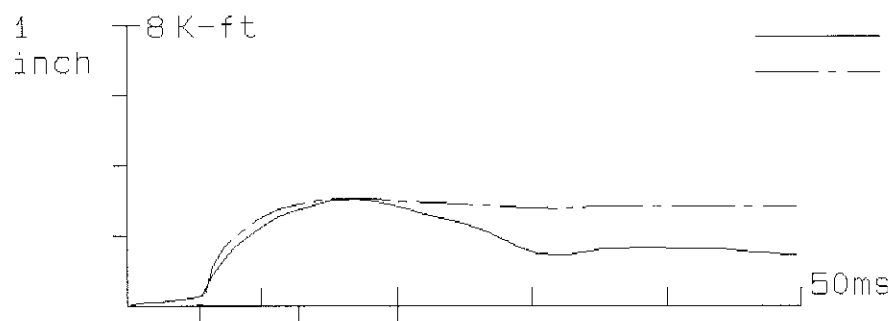
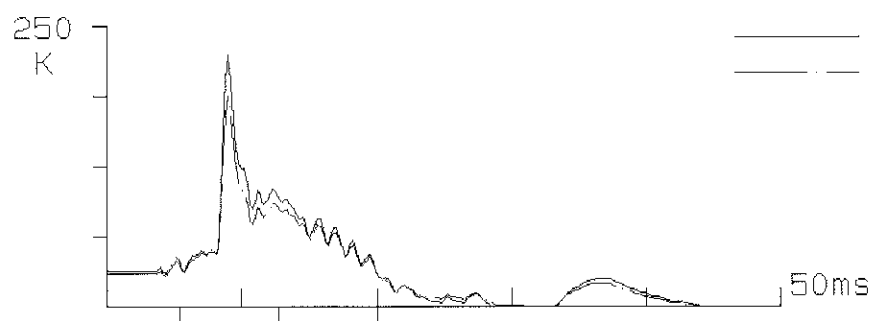
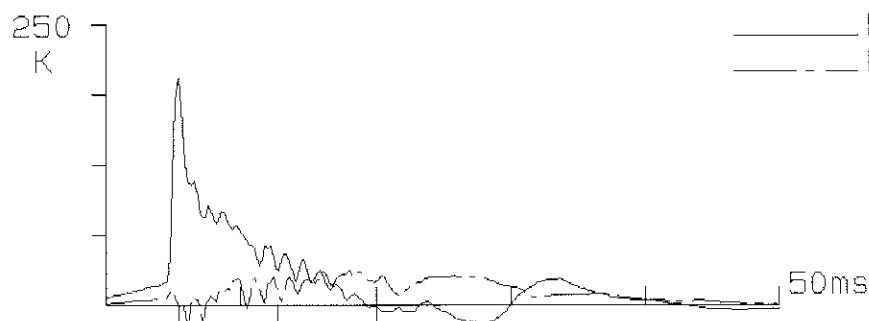
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-02

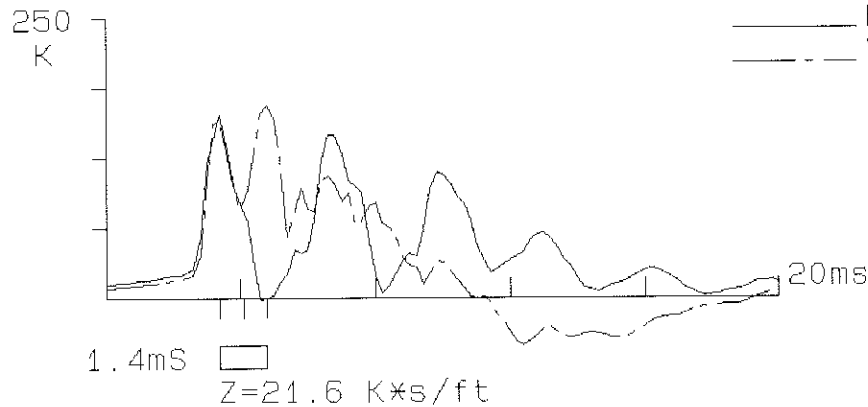
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

02000FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 44/178



CSX 13.55 Ksi

EFV 2.190 Kip-ft

ETR 27 %

BPM 91.7 BPM

VMX 7.9 ft/s

SFT 0 Kips

FMX 164 Kips

RA2 71 Kips

DMX 0.45 inch

LP 8.00 ft

LE 12.00 ft

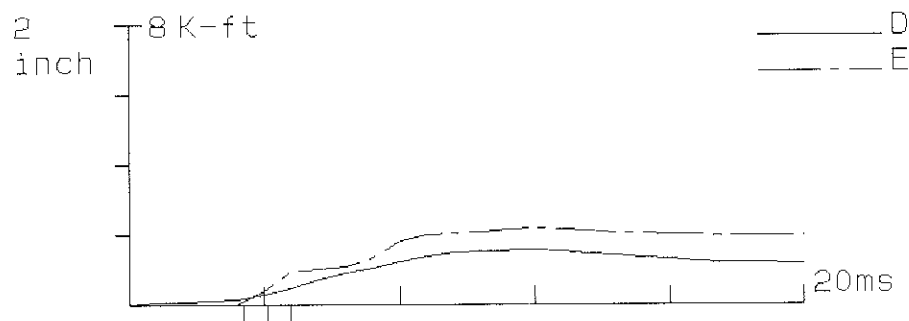
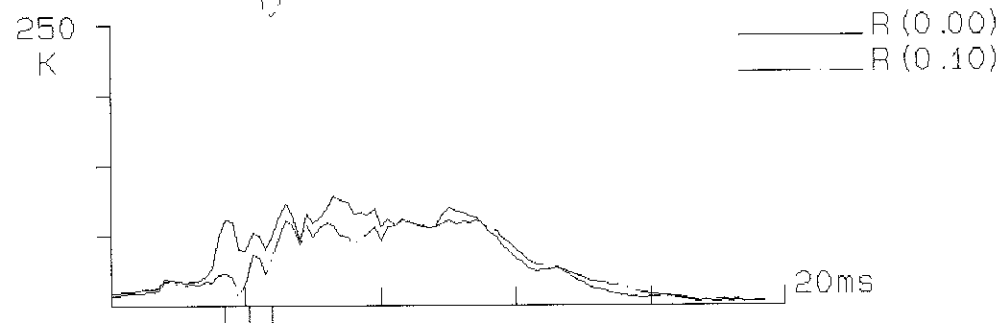
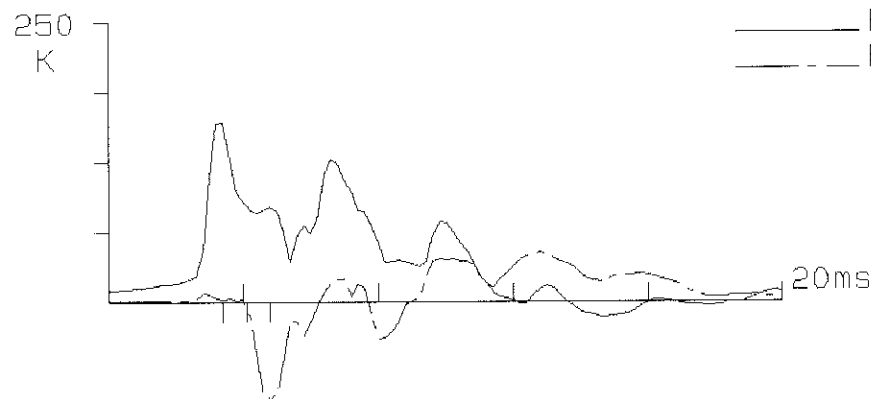
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

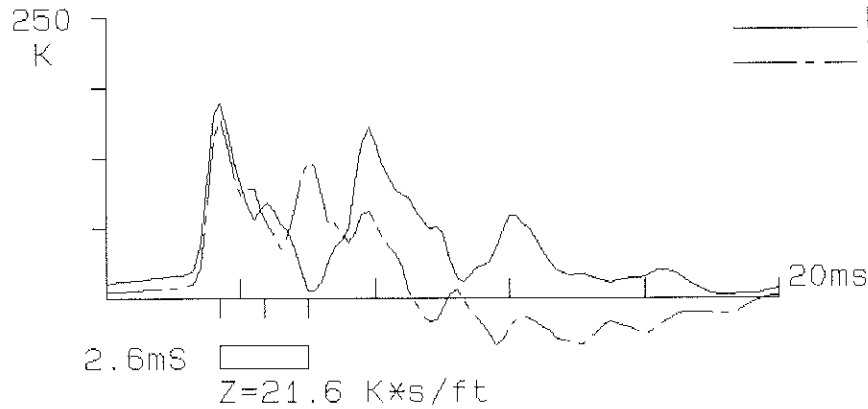
ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

POI PILE DRIVING ANALYZER® v5.02

02009FT 2005-08-19

HAV 180, 6-5/8" CLOSED



BN 56/583

CSX 14.29 Ksi

EFV 2.040 Kip-ft

ETR 24 %

BPM 91.4 BPM

VMX 7.4 ft/s

SFT 22 Kips

FMX 173 Kips

RA2 93 Kips

DMX 0.30 inch

LP 18.00 ft

LE 22.00 ft

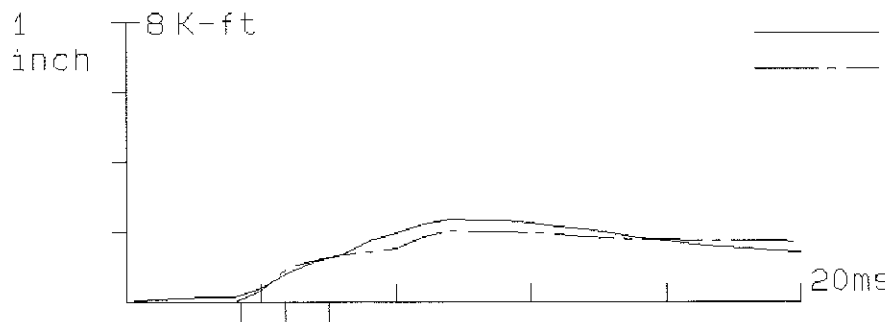
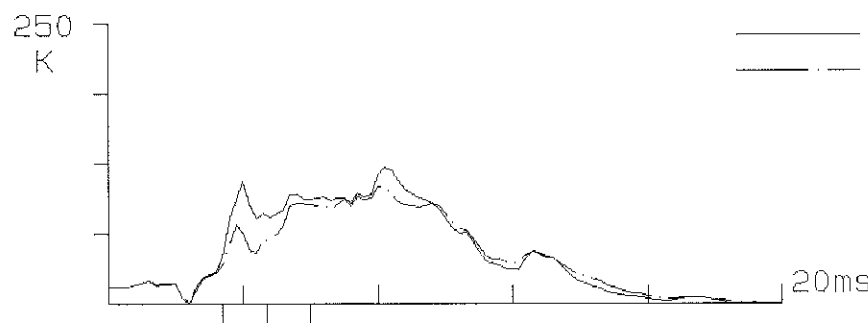
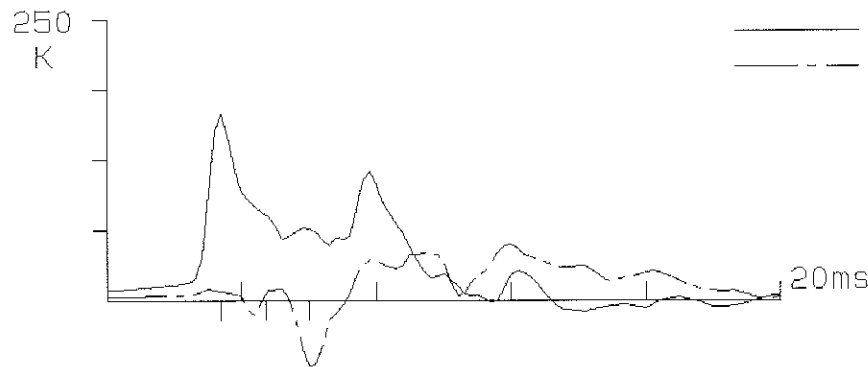
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-02

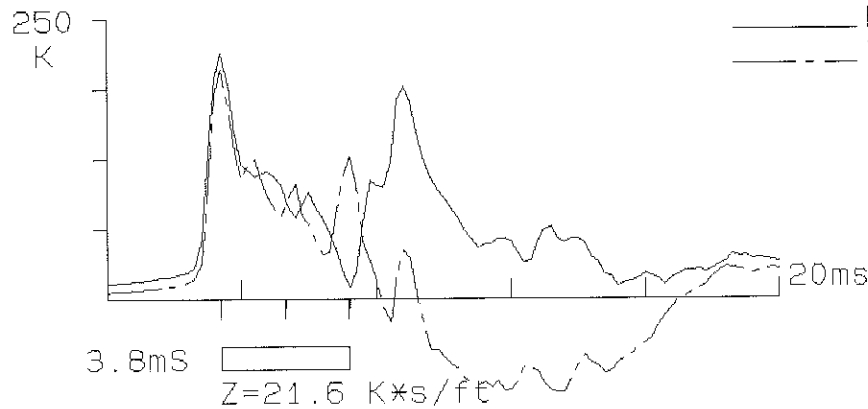
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

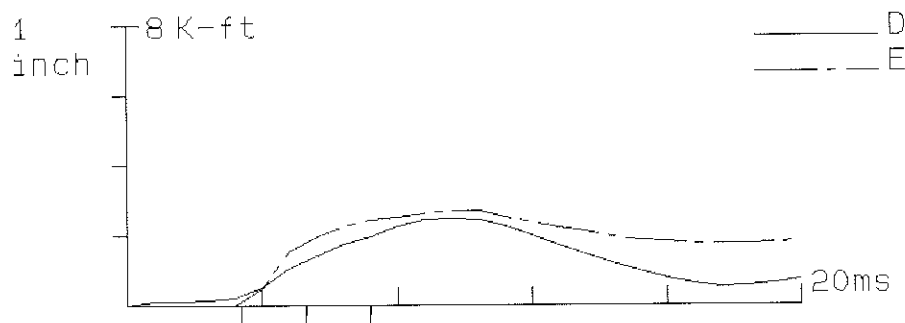
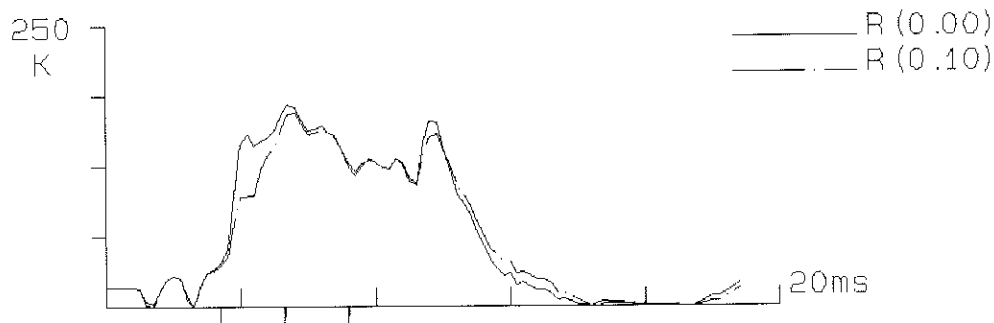
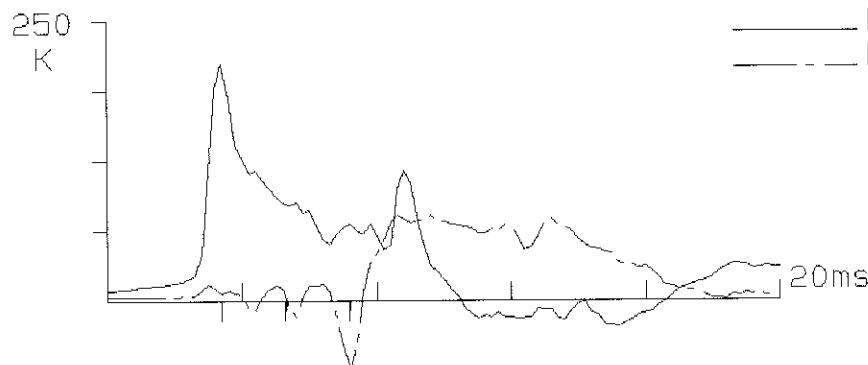
02019FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 233/1498



CSX 18.18 Ksi
EFV 2.780 Kip-ft
ETR 34 %
BPM 90.4 BPM
VMX 9.5 ft/s
SFT 50 Kips
FMX 220 Kips
RA2 167 Kips
DMX 0.32 inch
LP 28.00 ft
LE 32.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

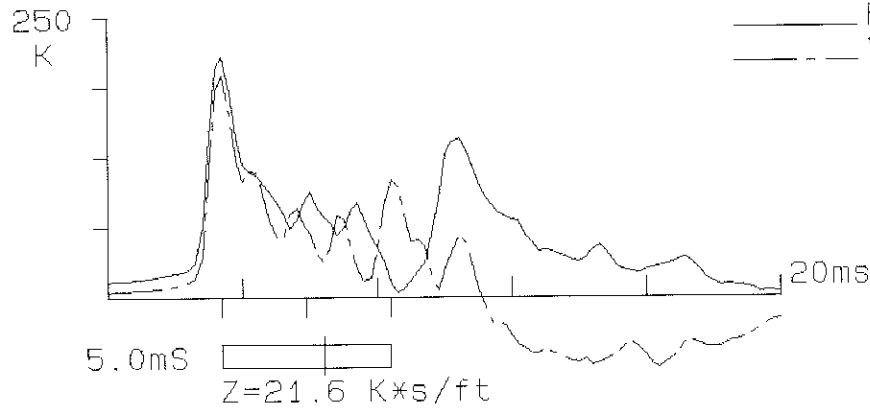
ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

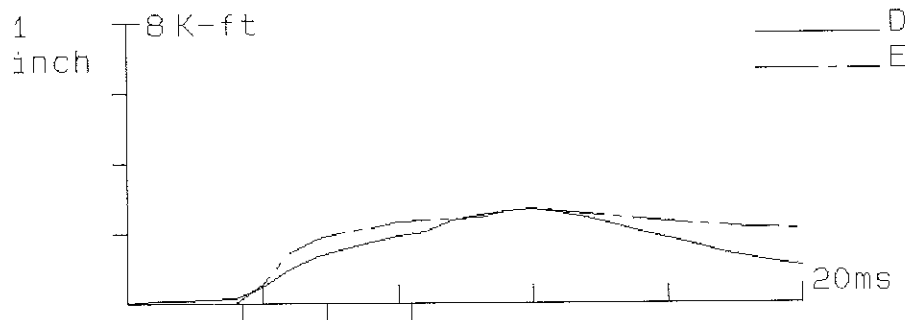
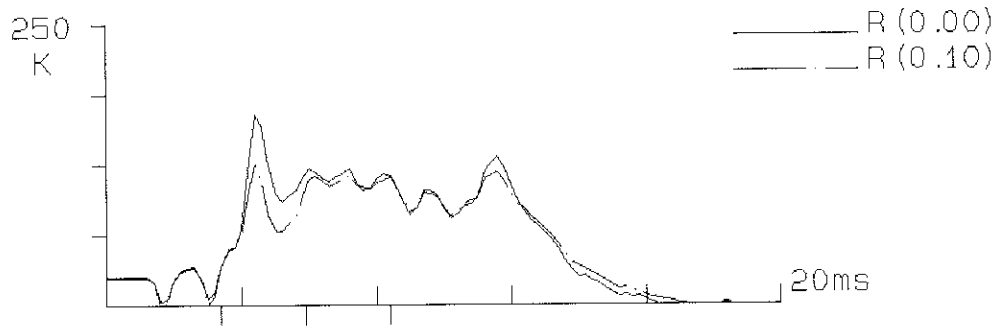
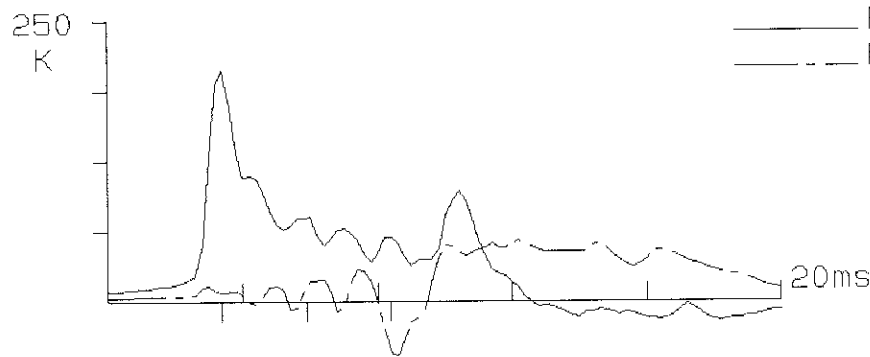
PDI PILE DRIVING ANALYZER®v5.02

02029FT 2005-08-19

HAV 180, 6-5/8" CLOSED



BN 112/1739
 CSX 17.76 Ksi
 EFV 2.720 Kip-ft
 ETR 33 %
 BPM 90.9 BPM
 VMX 9.1 ft/s
 SFT 83 Kips
 FMX 215 Kips
 RA2 119 Kips
 DMX 0.34 inch
 LP 38.00 ft
 LE 42.00 ft
 AR 12.10 in2
 EM 30004 Ksi
 SP 0.493 K/ft3
 WS 16800 ft/s
 F 34 A 34



R Miner Dynamic Test

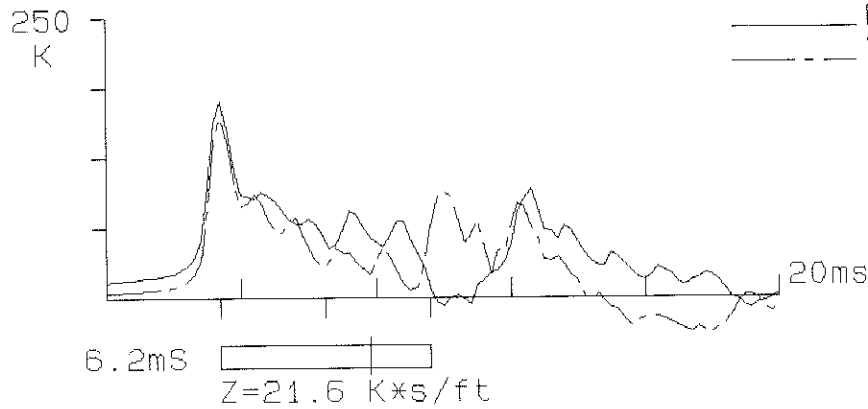
ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

POI PILE DRIVING ANALYZER®v5.02

02039FT 2005-08-19

HAV 180, 6-5/8" CLOSED



BN 42/469

CSX 14.46 Ksi

EFV 2.090 Kip-ft

ETR 25 %

BPM 92.7 BPM

VMX 7.5 ft/s

SFT 76 Kips

FMX 175 Kips

RA2 58 Kips

DMX 0.48 inch

LP 48.00 ft

LE 52.00 ft

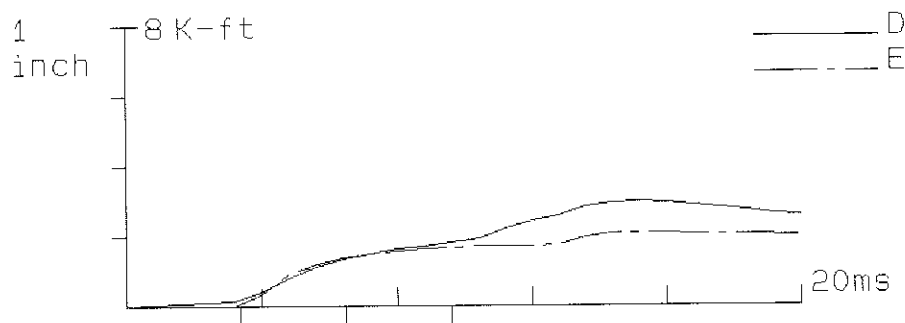
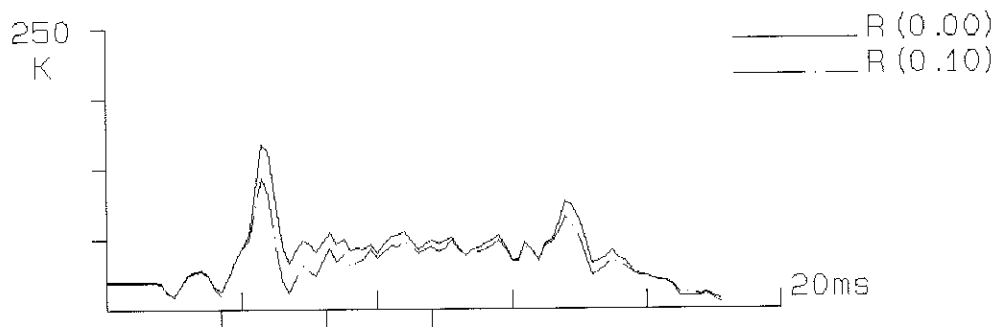
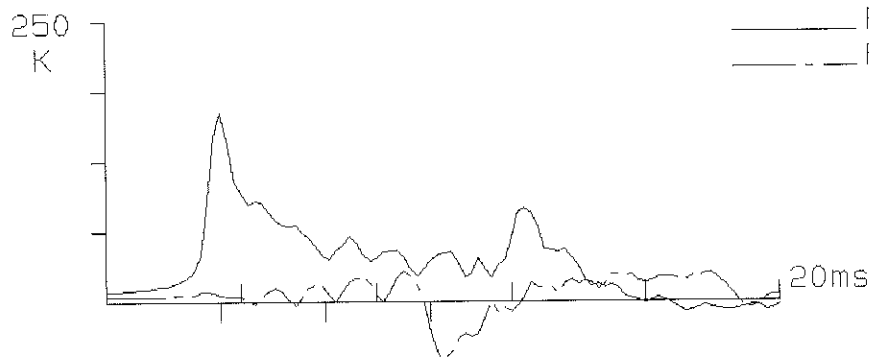
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-02

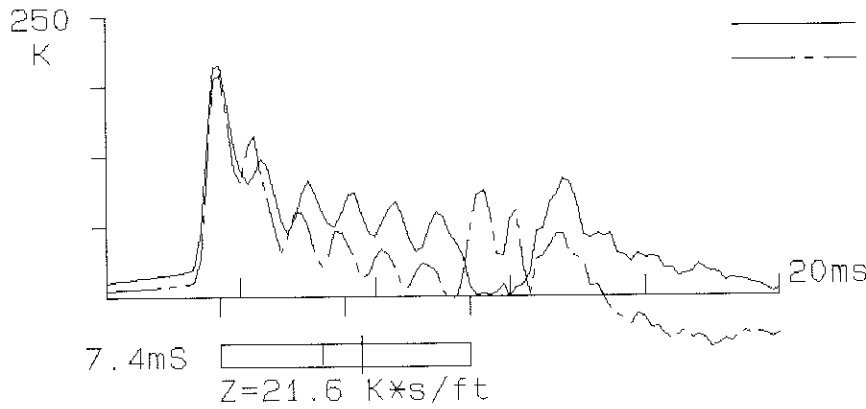
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PDI PILE DRIVING ANALYZER® v5.02

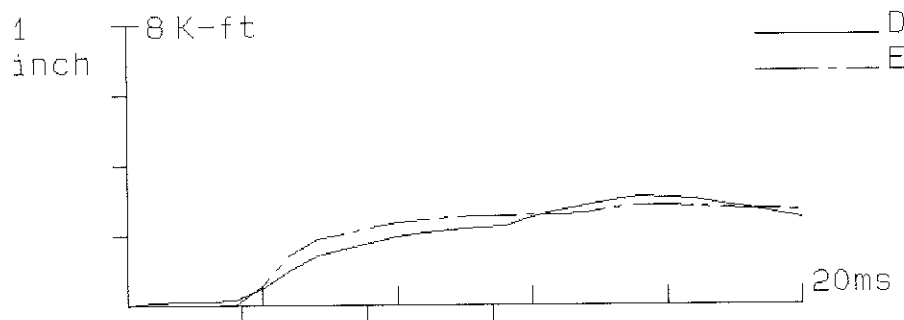
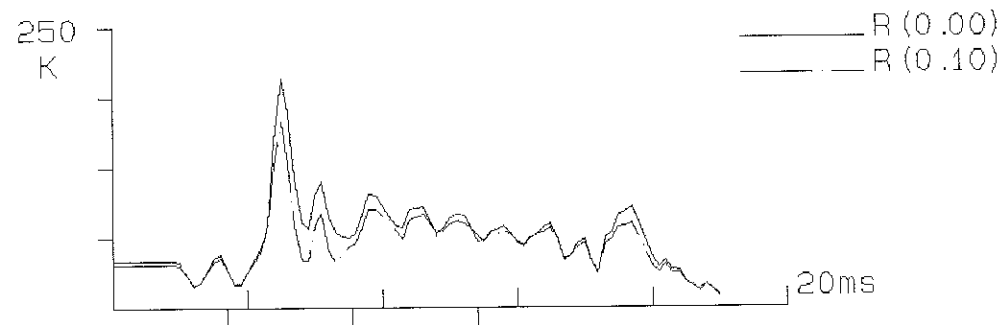
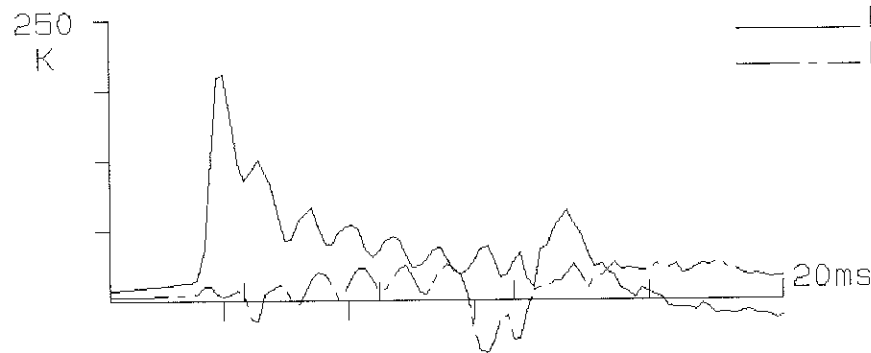
02049FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 50/498



CSX 17.02 Ksi
EFV 2.860 Kip-ft
ETR 35 %
BPM 91.1 BPM
VMX 9.1 ft/s
SFT 85 Kips
FMX 206 Kips
RA2 91 Kips
DMX 0.67 inch
LP 58.00 ft
LE 62.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-02

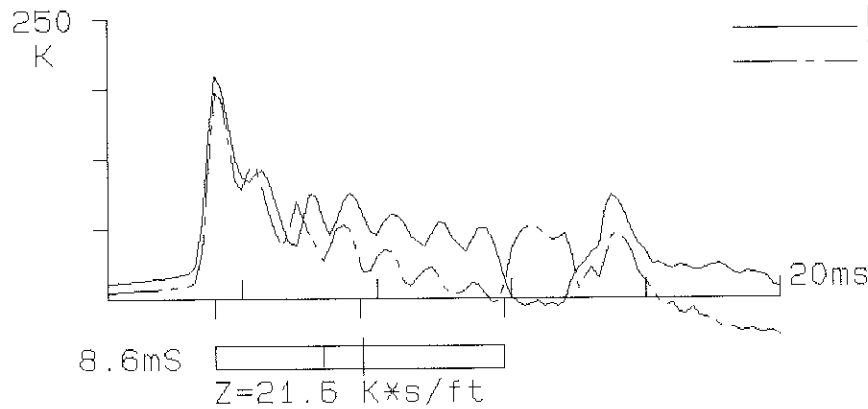
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PDI PILE DRIVING ANALYZER® v5.02

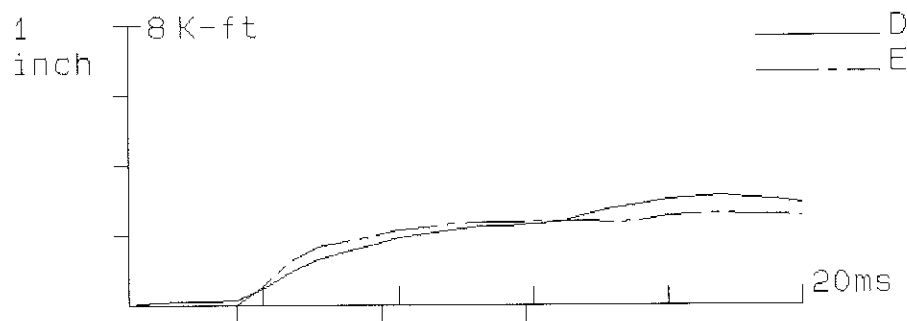
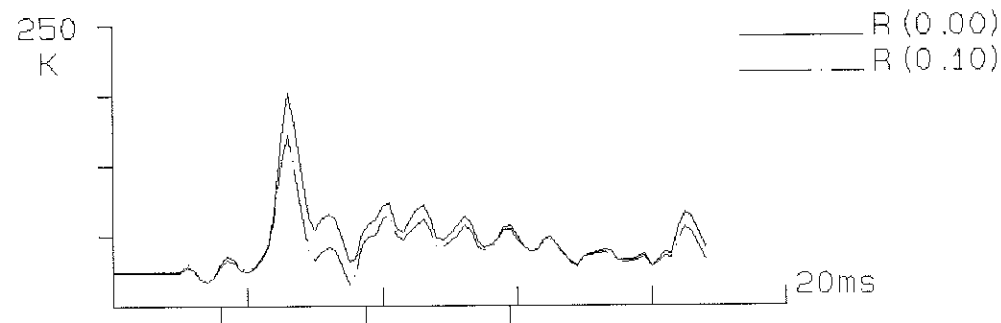
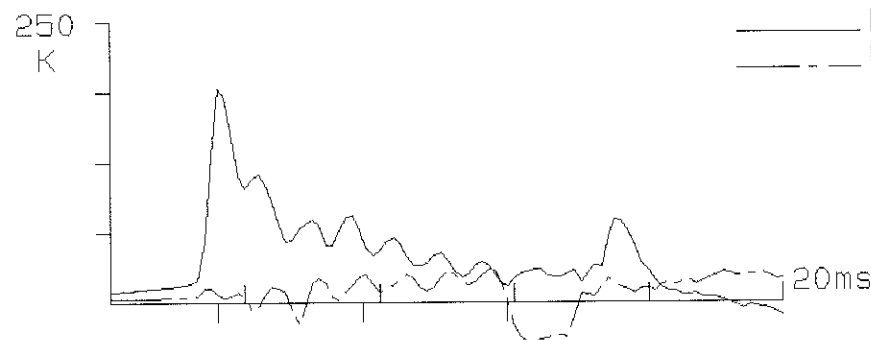
02059FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 43/459



CSX 16.44 Ksi
EFV 2.620 Kip-ft
ETR 32 %
BPM 91.6 BPM
VMX 8.5 ft/s
SFT 69 Kips
FMX 199 Kips
RA2 70 Kips
DMX 0.39 inch
LP 68.00 ft
LE 72.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

02069FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 70/760

CSX 16.03 Ksi

EFV 2.370 Kip-ft

ETR 29 %

BPM 91.1 BPM

VMX 8.7 ft/s

SFT 66 Kips

FMX 194 Kips

RA2 71 Kips

DMX 0.33 inch

LP 78.00 ft

LE 82.00 ft

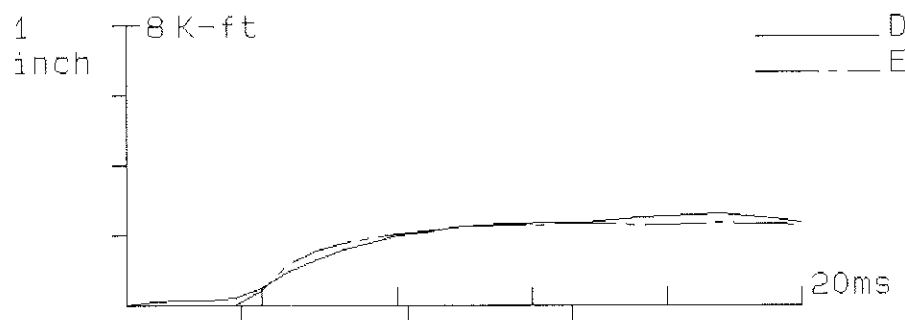
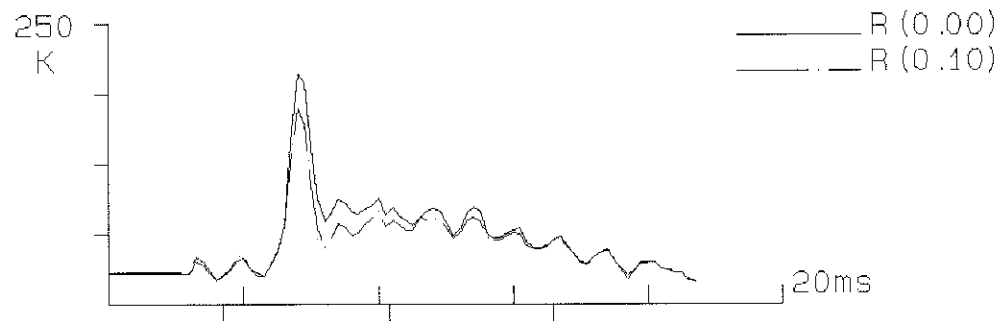
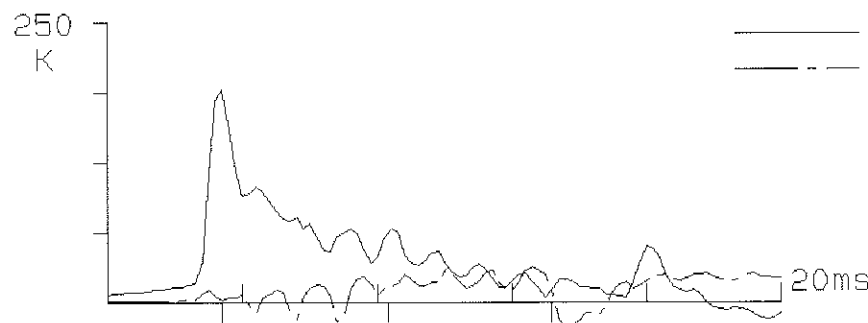
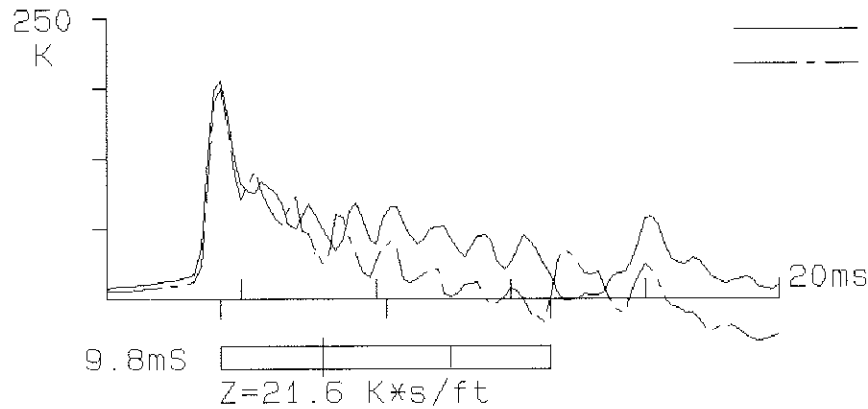
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-02

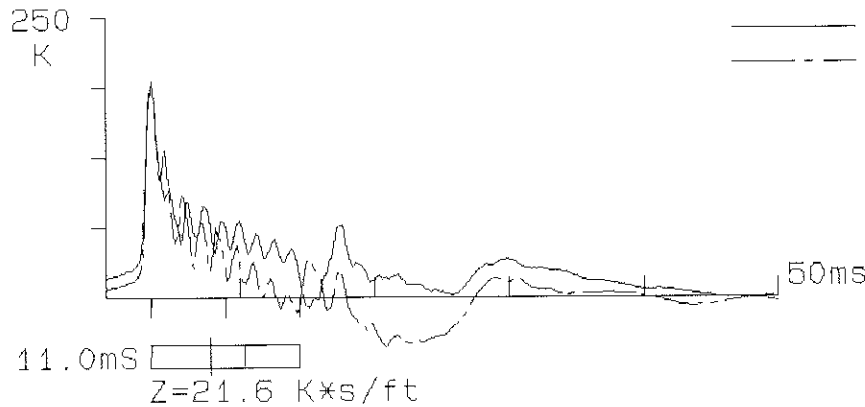
PDA OP: AMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

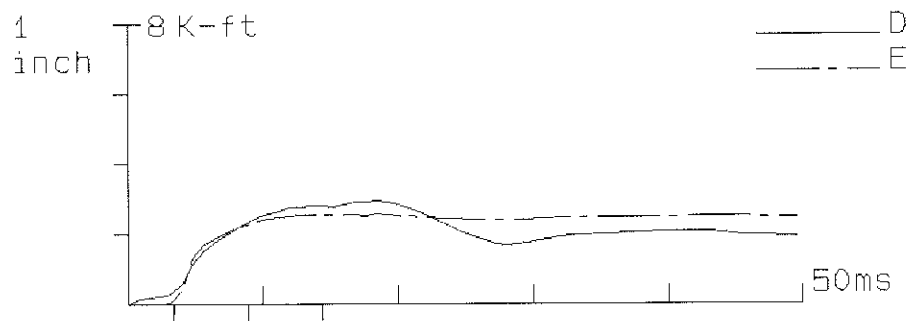
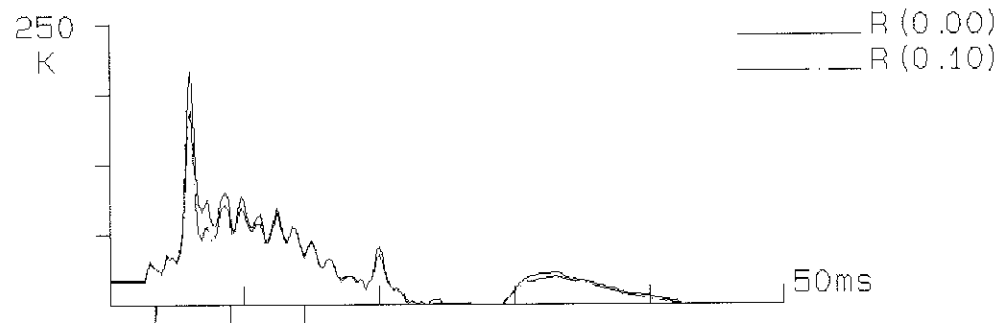
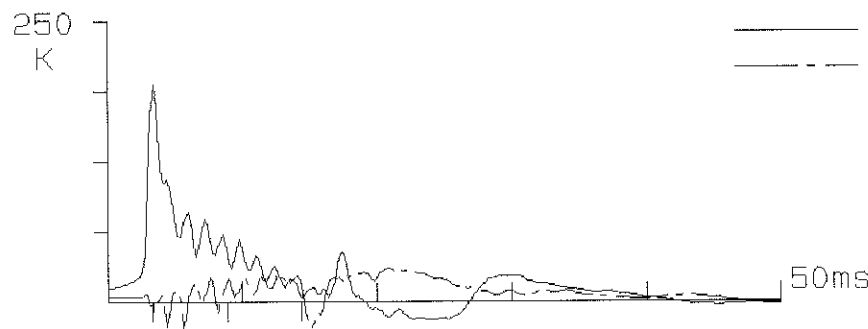
02079FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 74/693



CSX 15.95 Ksi
EFV 2.580 Kip-ft
ETR 32 %
BPM 90.9 BPM
VMX 9.0 ft/s
SFT 50 Kips
FMX 193 Kips
RA2 65 Kips
DMX 0.75 inch
LP 88.00 ft
LE 92.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

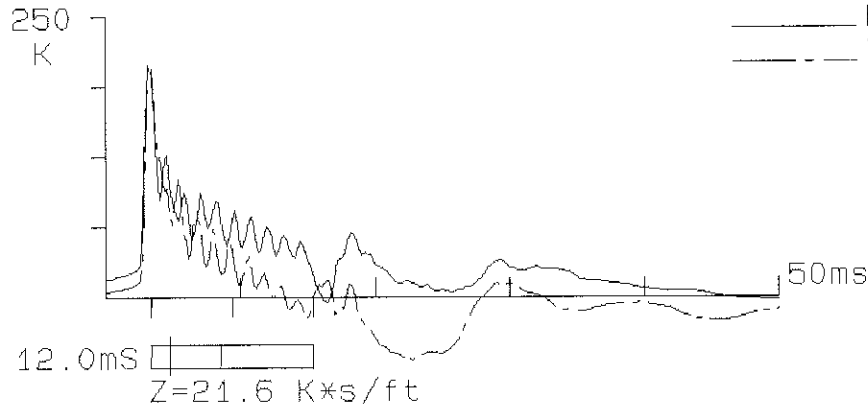
ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER®v5.02

02089FT 2005-08-19

HAV 180, 6-5/8" CLOSED



BN 111/802

CSX 17.10 Ksi

EFV 2.810 Kip-ft

ETR 34 %

BPM 90.9 BPM

VMX 9.5 ft/s

SFT 66 Kips

FMX 207 Kips

RA2 76 Kips

DMX 0.34 inch

LP 96.00 ft

LE 100.00 ft

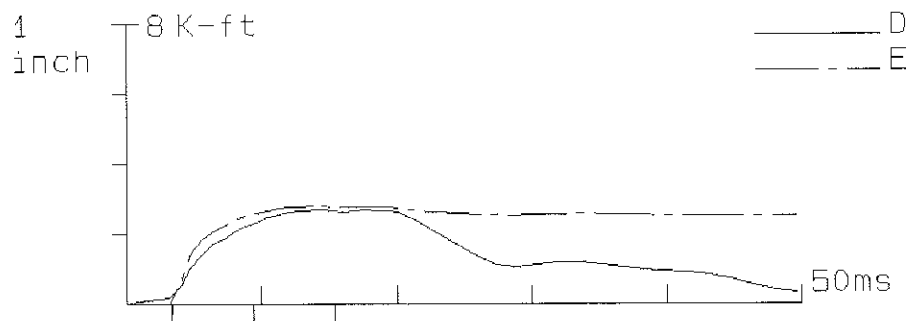
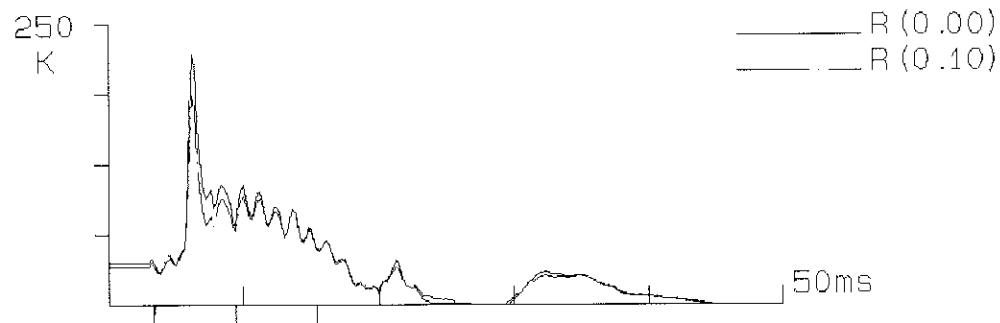
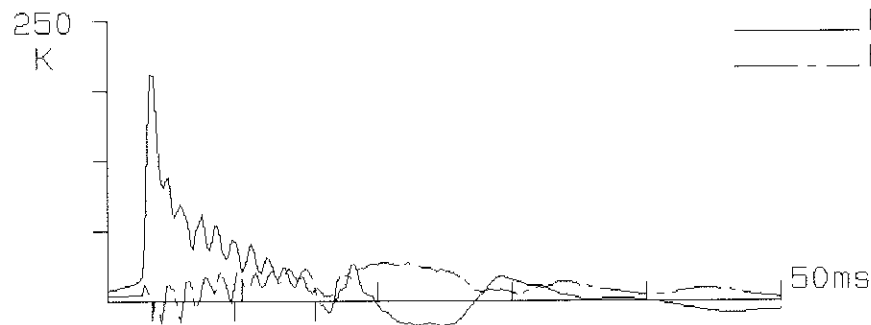
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-02

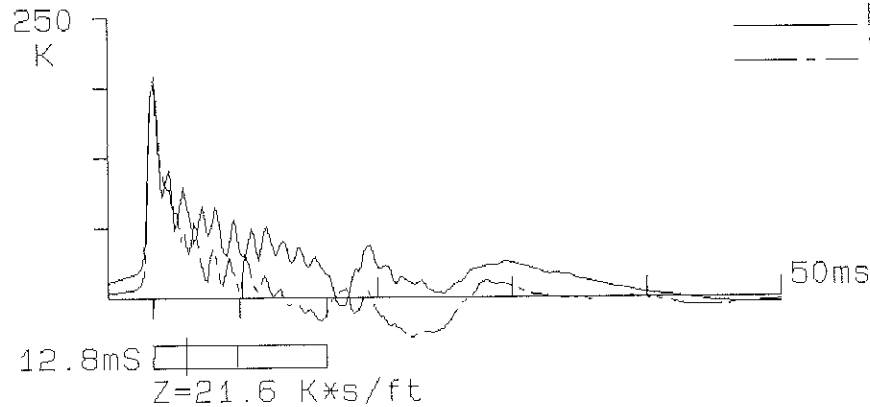
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PDI PILE DRIVING ANALYZER® v5.02

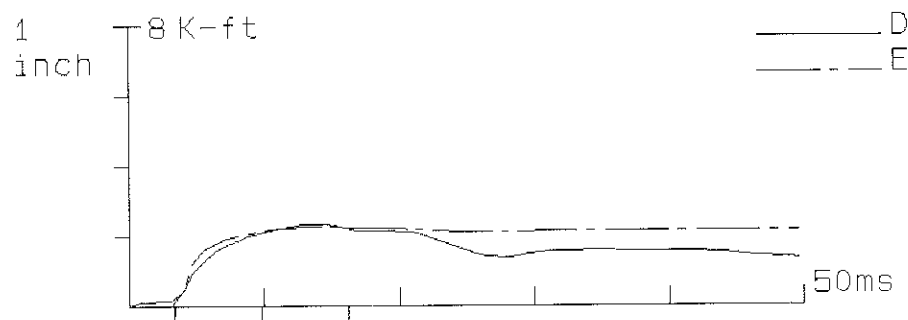
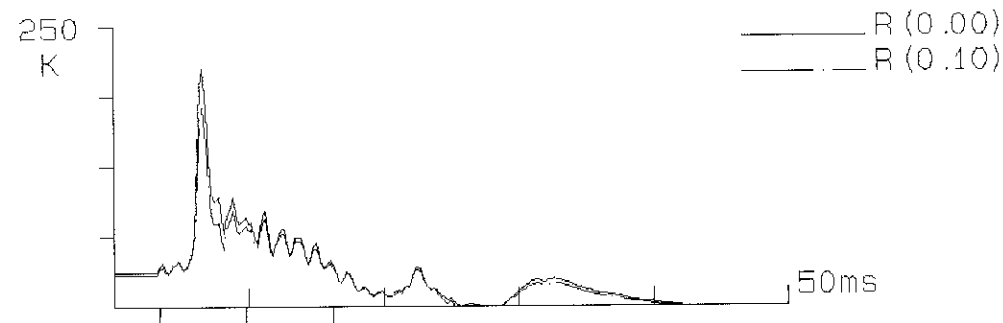
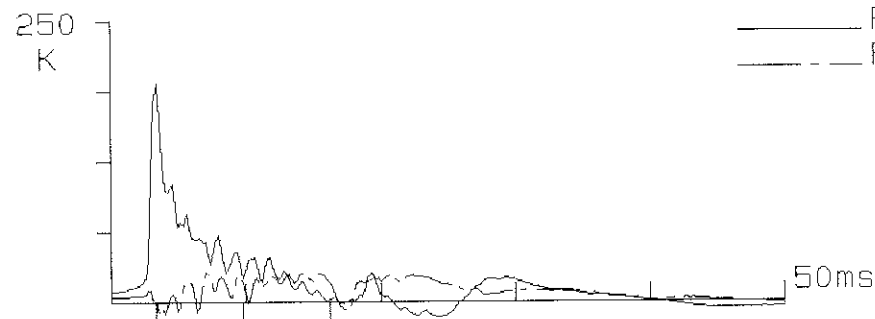
02097FT 2005-08-19

HAV 180, 6-5/8" CLOSED

BN 80/729



CSX 15.78 Ksi
EFV 2.290 Kip-ft
ETR 28 %
BPM 91.3 BPM
VMX 9.1 ft/s
SFT 56 Kips
FMX 191 Kips
RA2 75 Kips
DMX 0.54 inch
LP 104.00 ft
LE 108.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

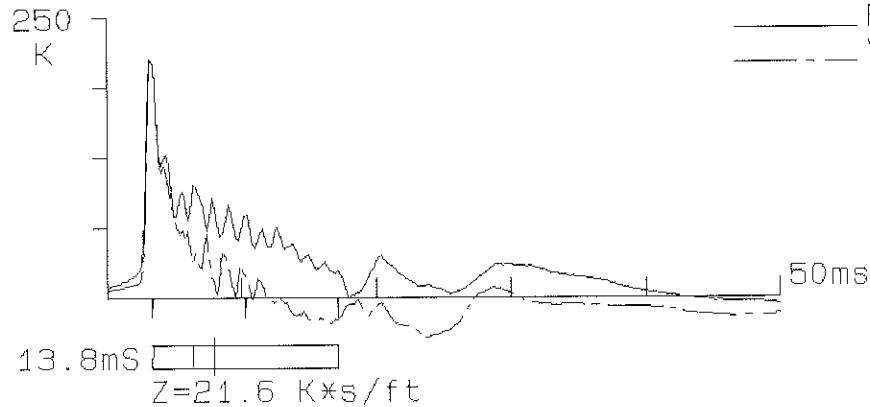
ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

02105FT 2005-08-19

HAV 180, 6-5/8" CLOSED



BN 100/929

CSX 17.60 Ksi

EFV 2.710 Kip-ft

ETR 33 %

BPM 90.7 BPM

VMX 9.6 ft/s

SFT 58 Kips

FMX 213 Kips

RA2 88 Kips

DMX 0.30 inch

LP 112.00 ft

LE 116.00 ft

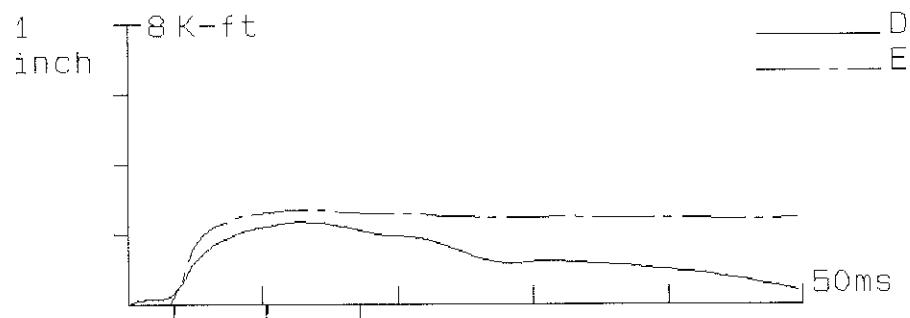
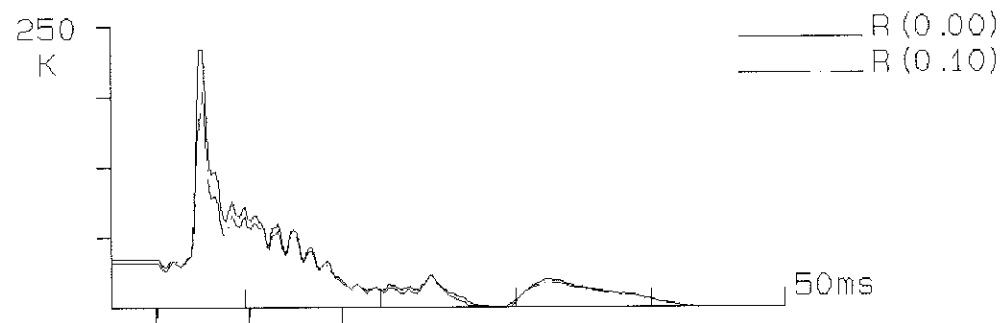
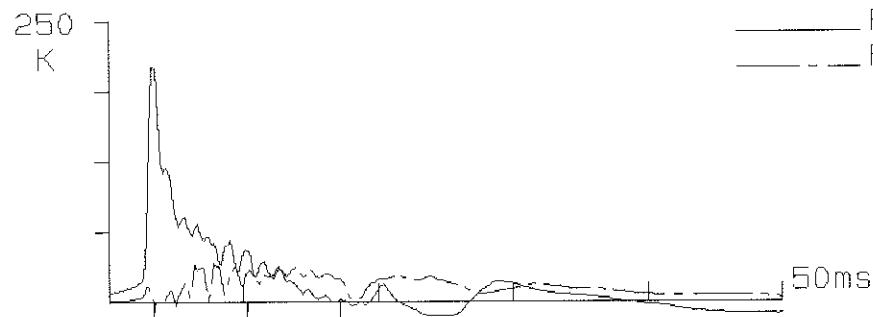
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

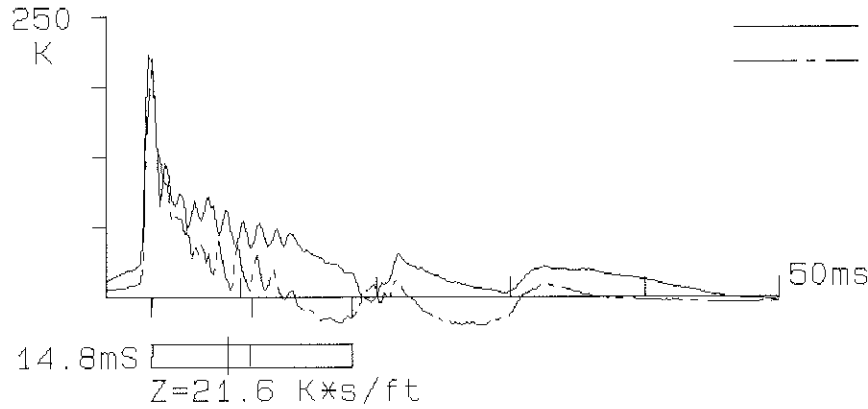
ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

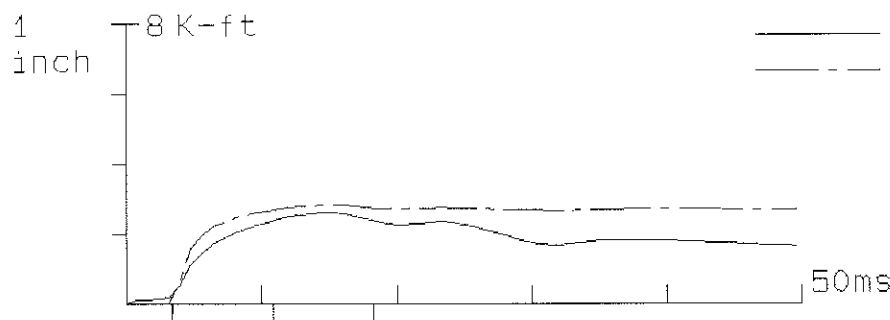
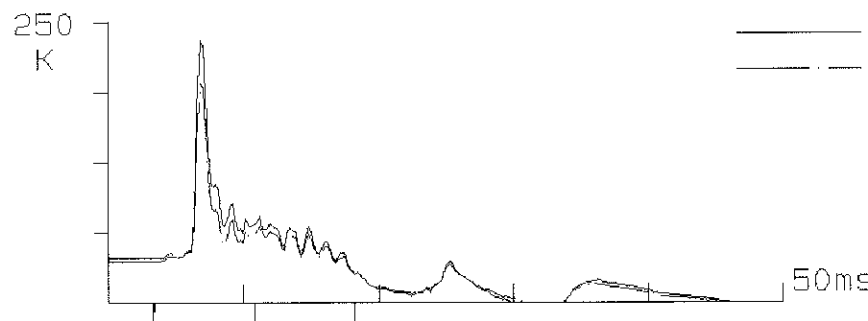
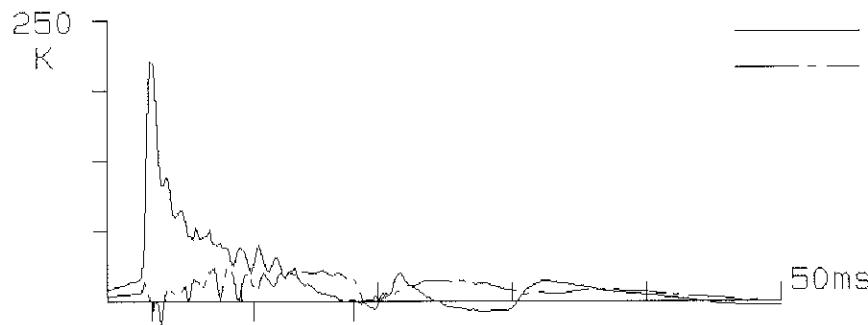
PDI PILE DRIVING ANALYZER® v5.02

02113FT 2005-08-20

HAV 180, 6-5/8" CLOSED



BN 251/1128
 CSX 17.85 Ksi
 EFV 2.850 Kip-ft
 ETR 34 %
 BPM 90.2 BPM
 VMX 9.8 ft/s
 SFT 56 Kips
 FMX 216 Kips
 RA2 73 Kips
 DMX 0.33 inch
 LP 119.00 ft
 LE 124.00 ft
 AR 12.10 in2
 EM 30004 Ksi
 SP 0.493 K/ft3
 WS 16800 ft/s
 F 34 A 34



R Miner Dynamic Test

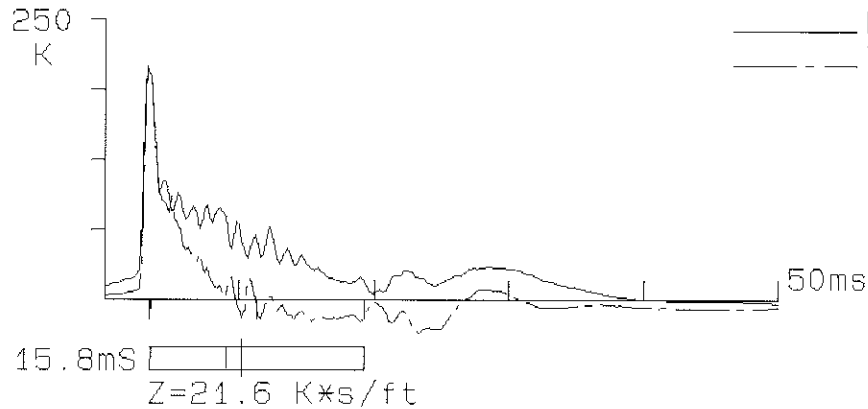
ROSE CREEK, BPT05-02

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

02121FT 2005-08-20

HAV 180, 6-5/8" CLOSED



BN 240/1177

CSX 17.10 Ksi

EFV 2.410 Kip-ft

ETR 29 %

BPM 90.6 BPM

VMX 9.4 ft/s

SFT 37 Kips

FMX 207 Kips

RA2 78 Kips

DMX 0.27 inch

LP 128.00 ft

LE 132.00 ft

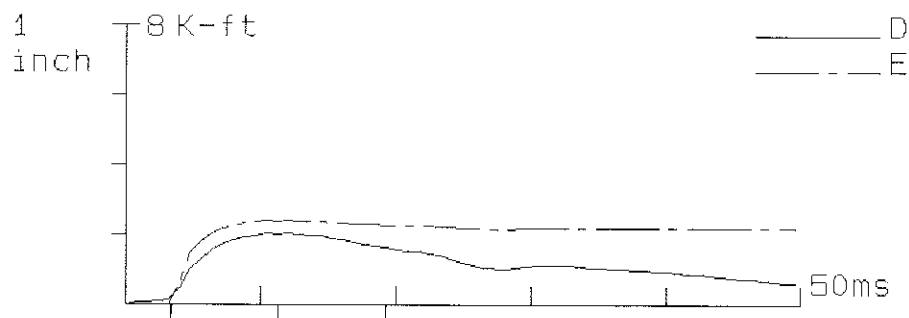
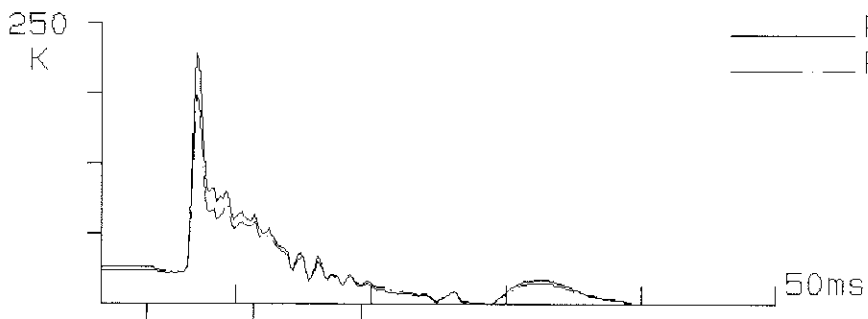
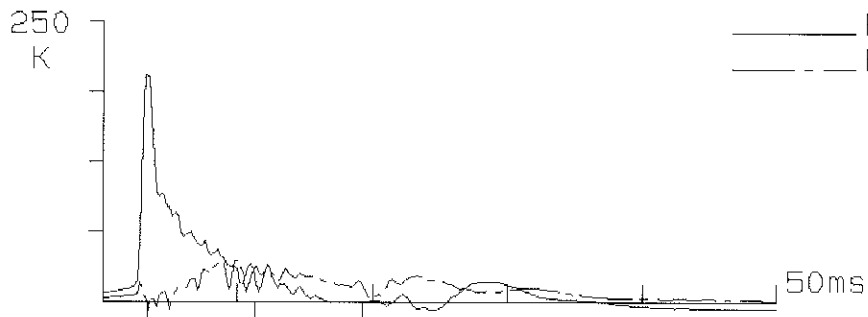
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-03

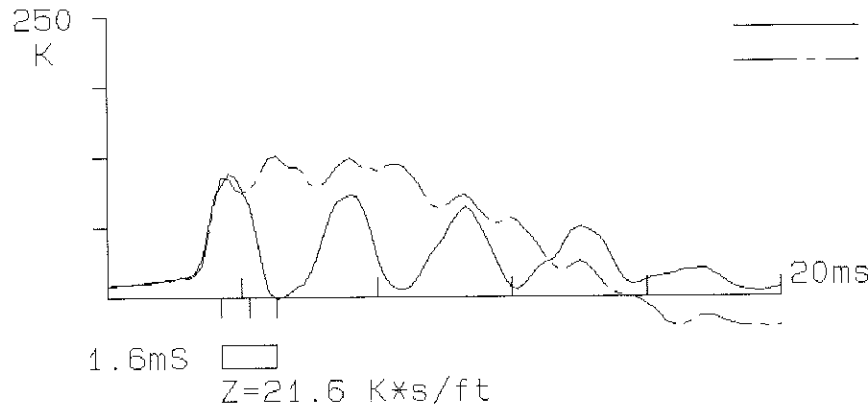
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

03000FT 2005-08-20

HAV180, 6-5/8" CLOSED

BN 18/131



CSX 9.17 Ksi

EFV 2.290 Kip-ft

ETR 28 %

BPM 93.4 BPM

VMX 5.8 ft/s

SFT 10 Kips

FMX 111 Kips

RA2 52 Kips

DMX 0.61 inch

LP 8.00 ft

LE 13.00 ft

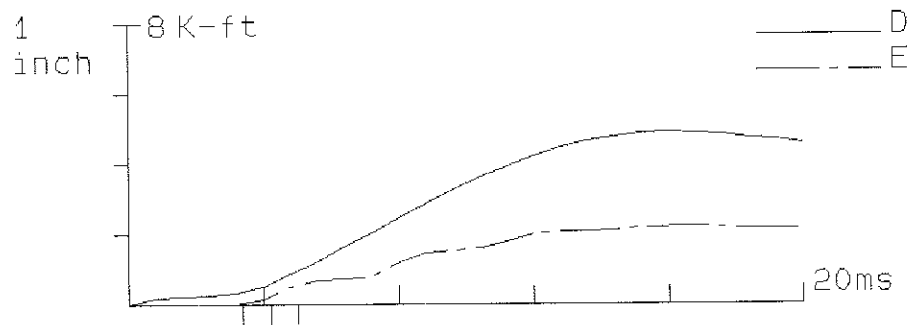
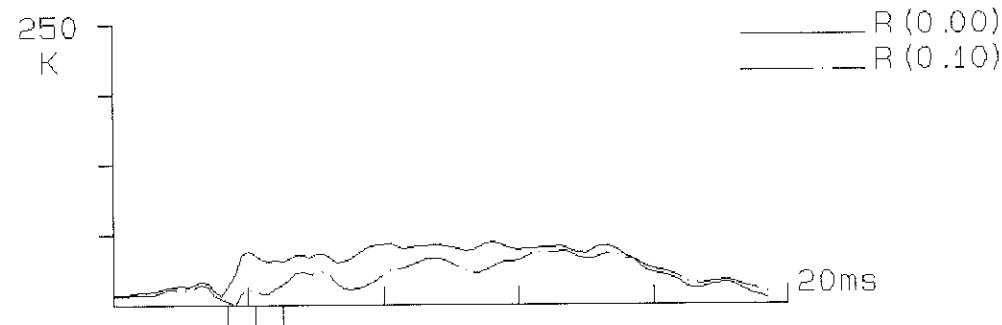
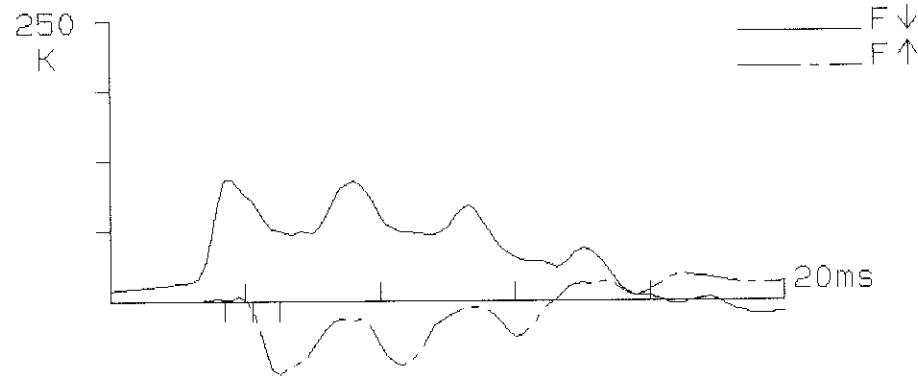
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-03

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

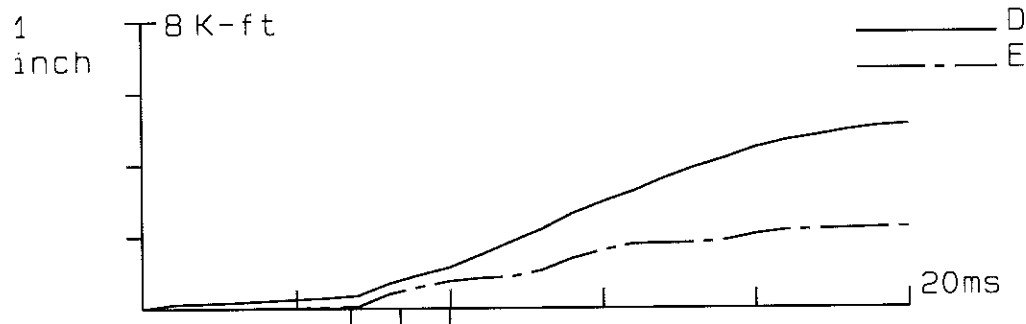
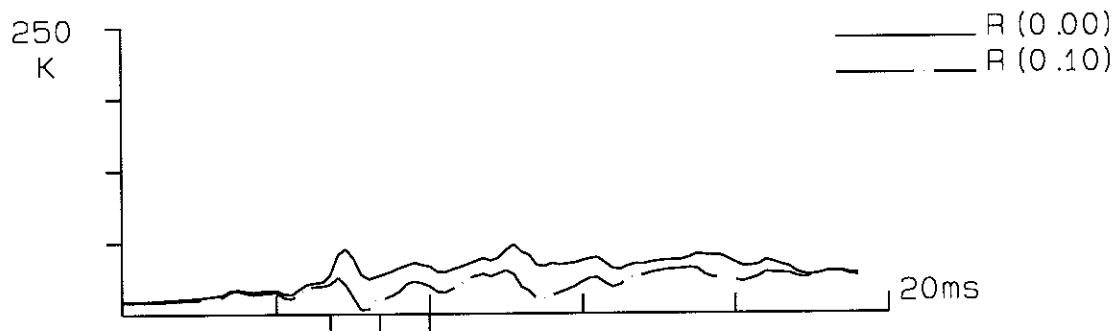
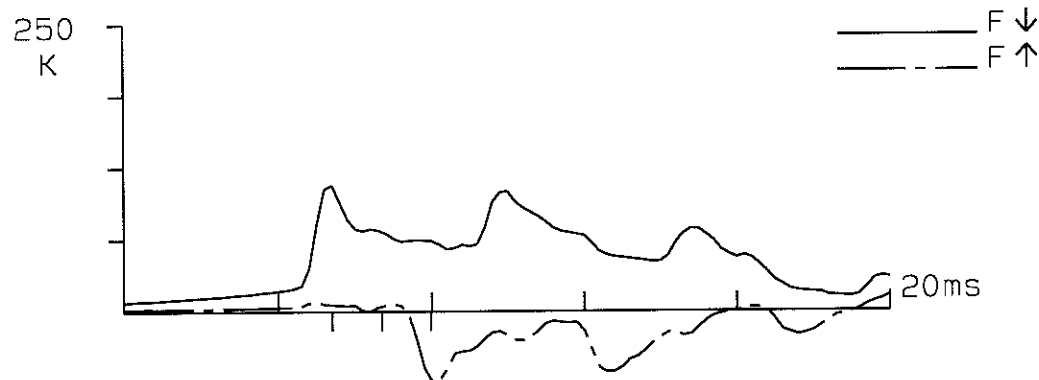
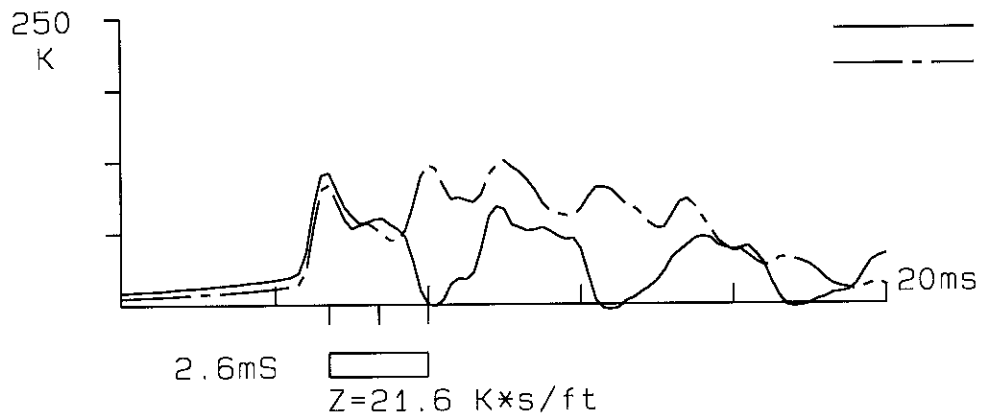
03009FT

2005-08-20

HAV180, 6-5/8" CLOSED

BN 23/266

CSX 9.50 Ksi
EFV 2.390 Kip-ft
ETR 29 %
BPM 95.2 BPM
VMX 5.8 ft/s
SFT 14 Kips
FMX 115 Kips
RA2 32 Kips
DMX 0.65 inch
LP 18.00 ft
LE 22.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

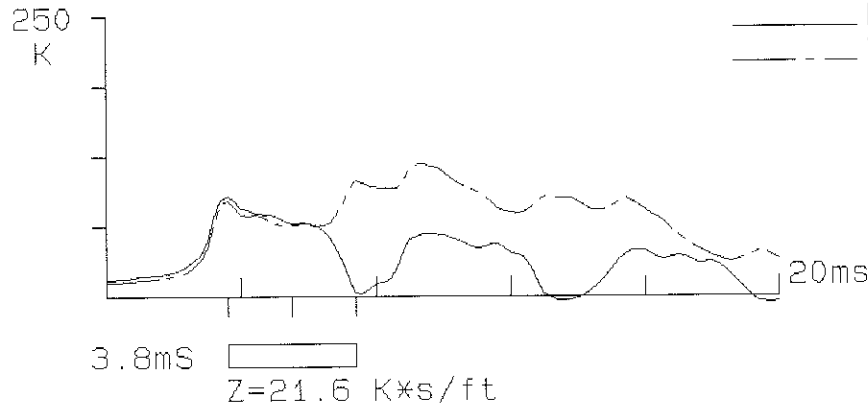
ROSE CREEK, BPT05-03

PDA OP: RMDT: -B. Miner

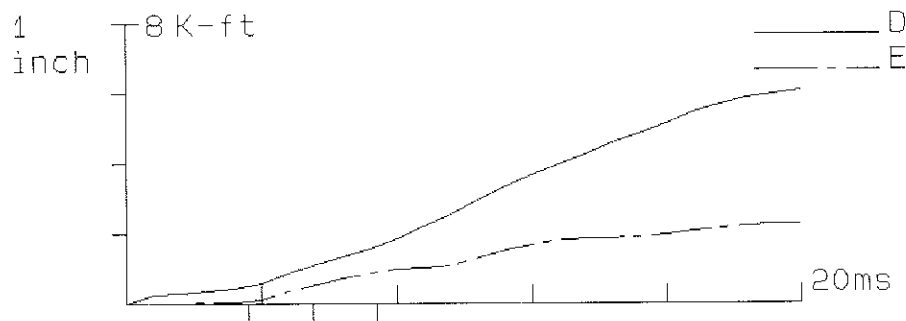
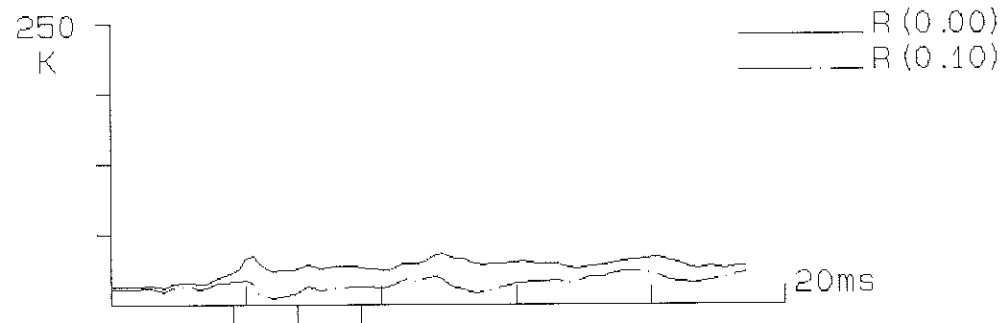
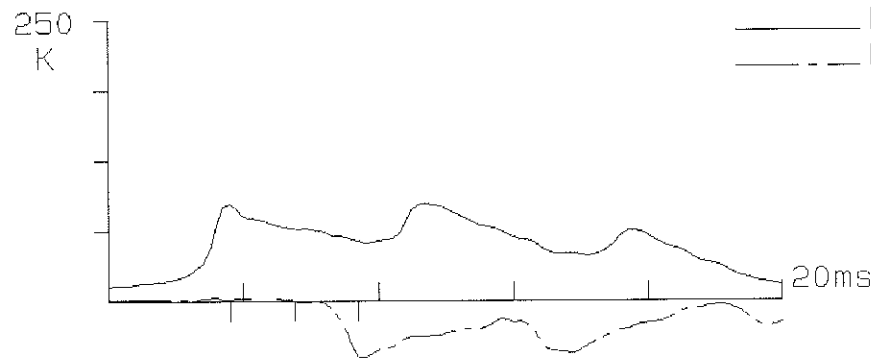
POI PILE DRIVING ANALYZER® v5.02

03019FT 2005-08-20

HAV180, 6-5/8" CLOSED



BN 13/146
 CSX 7.35 Ksi
 EFV 2.360 Kip-ft
 ETR 29 %
 BPM 95.0 BPM
 VMX 5.5 ft/s
 SFT 6 Kips
 FMX 89 Kips
 RA2 30 Kips
 DMX 0.82 inch
 LP 28.00 ft
 LE 32.00 ft
 AR 12.10 in2
 EM 30004 Ksi
 SP 0.493 K/ft3
 WS 16800 ft/s
 F 34 A 34



R Miner Dynamic Test

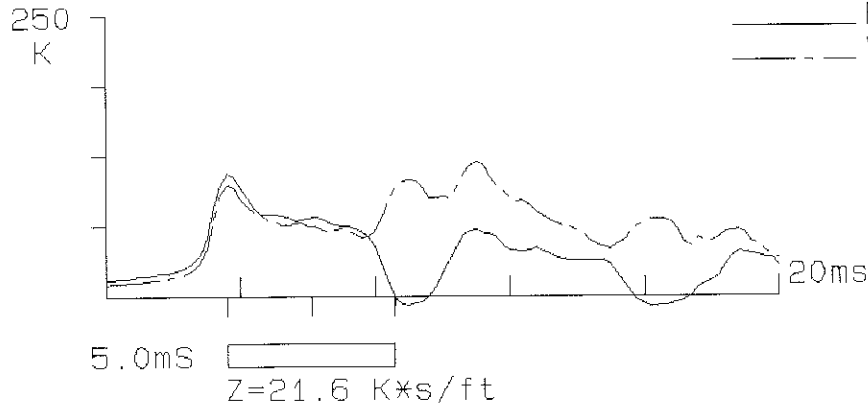
ROSE CREEK, BPT05-03

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

03029FT 2005-08-20

HAV180, 6-5/8" CLOSED



BN 13/151

CSX 9.00 Ksi

EFV 2.320 Kip-ft

ETR 28 %

BPM 94.7 BPM

VMX 5.5 ft/s

SFT 10 Kips

FMX 109 Kips

RA2 24 Kips

DMX 0.74 inch

LP 38.00 ft

LE 42.00 ft

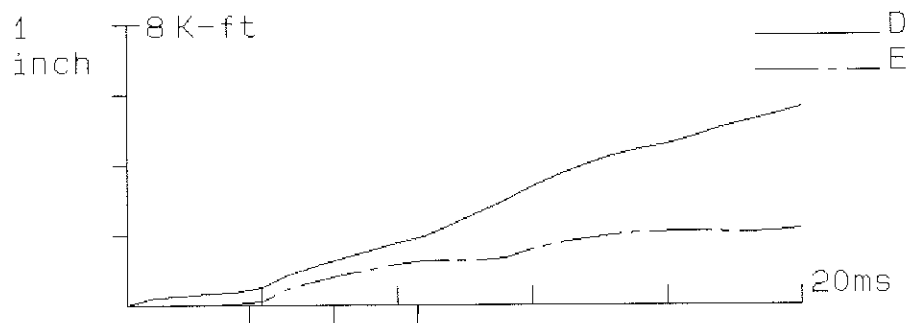
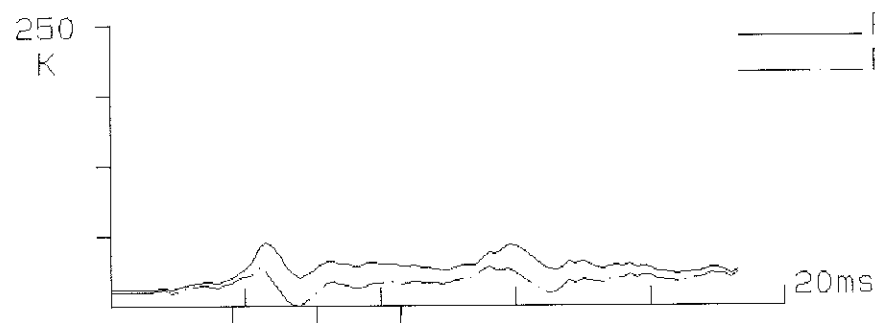
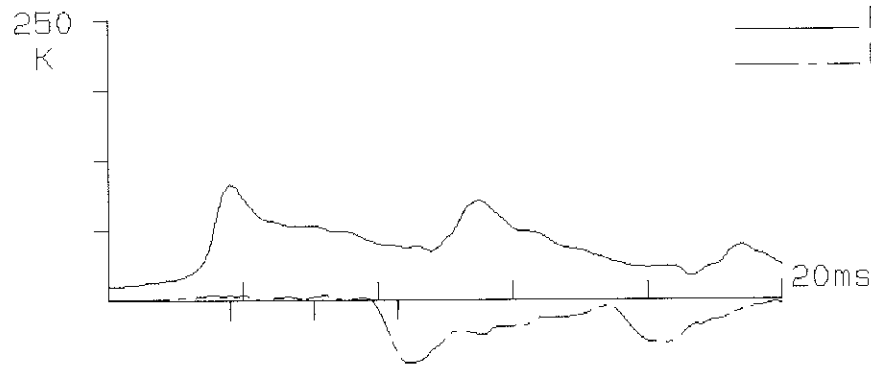
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-03

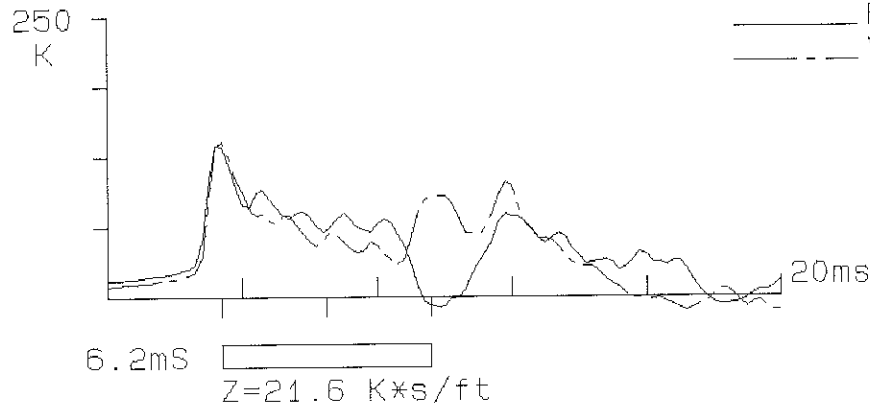
PDA OP: RMDT: -B. Miner

POI PILE DRIVING ANALYZER® v5.02

03039FT 2005-08-20

HAV180, 6-5/8" CLOSED

BN 20/148



CSX 11.15 Ksi

EFV 2.270 Kip-ft

ETR 28 %

BPM 93.0 BPM

VMX 6.4 ft/s

SFT 33 Kips

FMX 135 Kips

RA2 47 Kips

DMX 0.47 inch

LP 46.00 ft

LE 52.00 ft

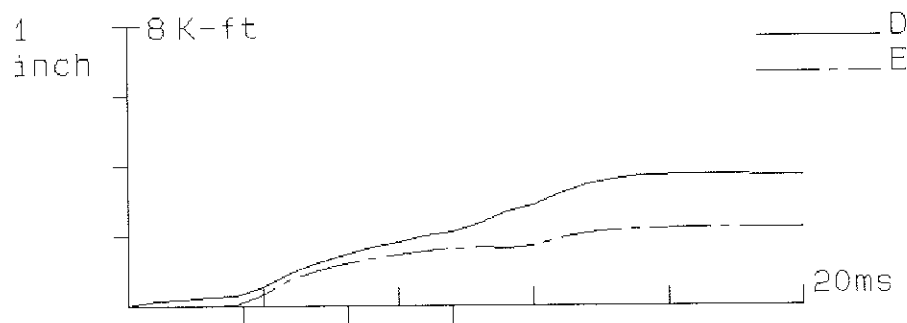
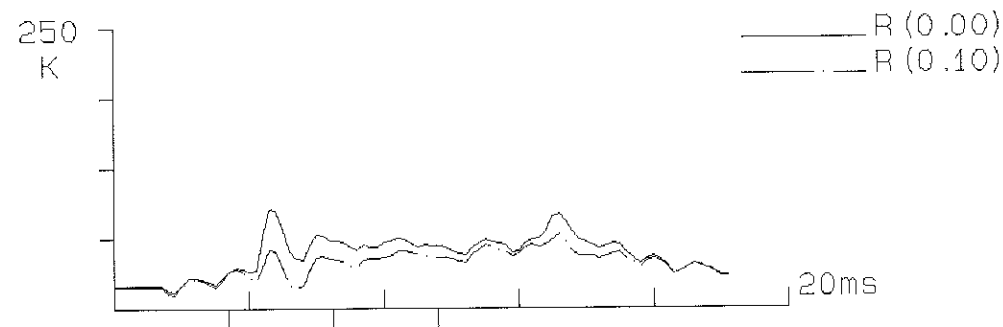
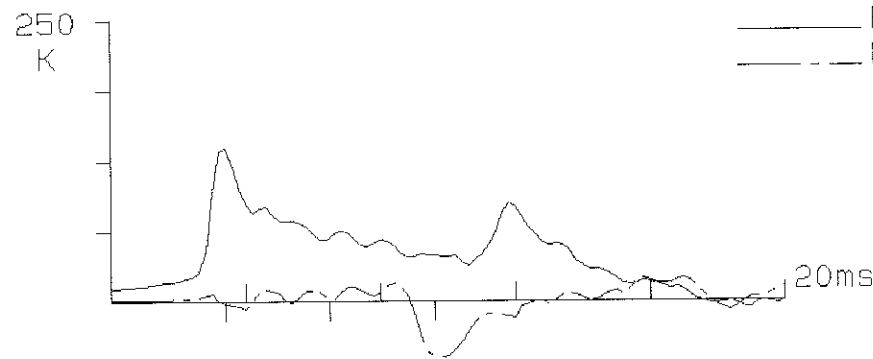
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-03

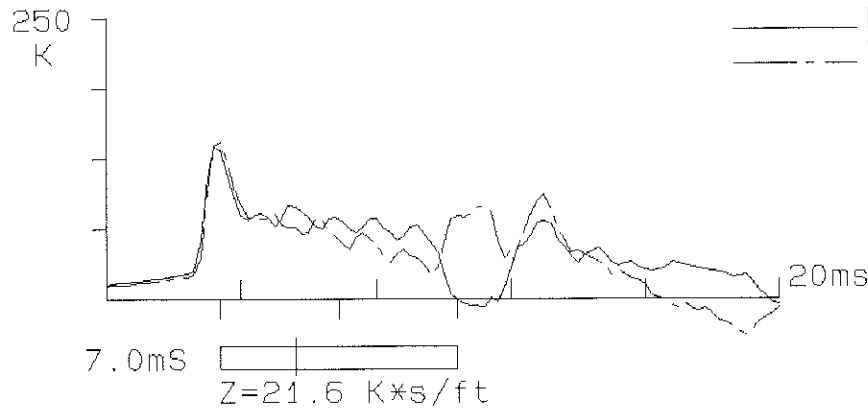
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PDI PILE DRIVING ANALYZER®v5.02

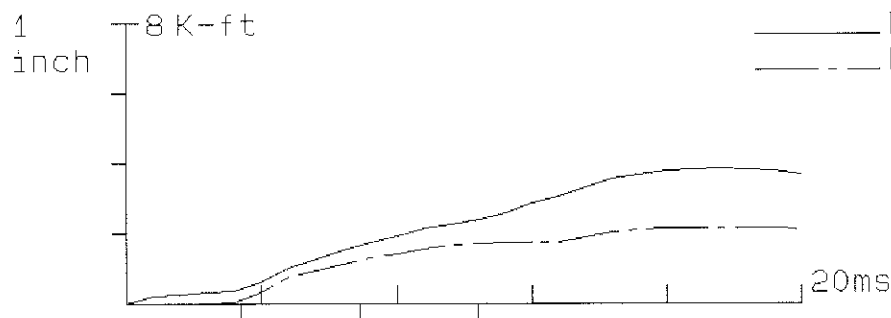
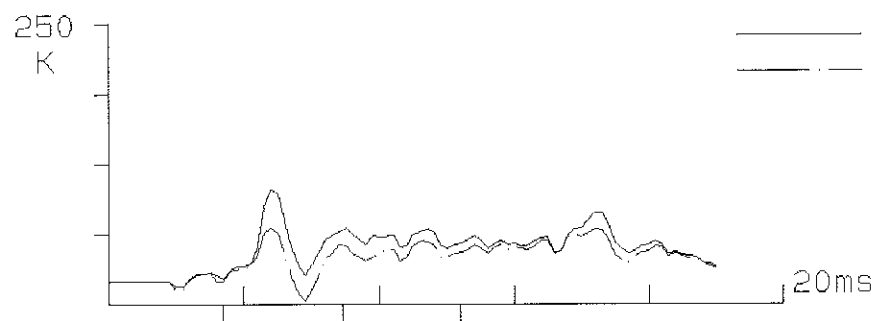
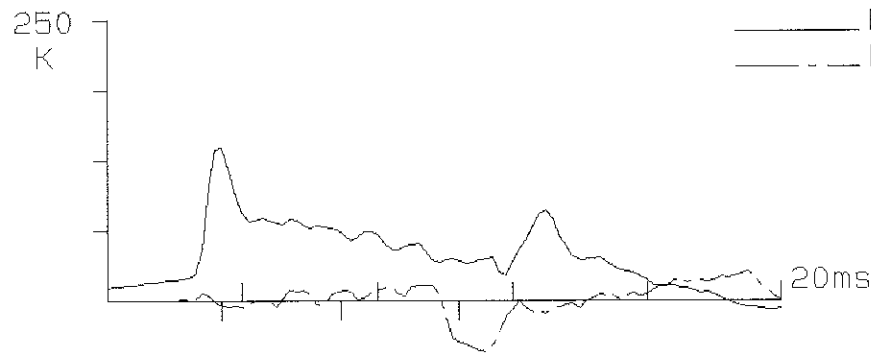
03047FT 2005-08-20

HAV180, 6-5/8" CLOSED

BN 27/280



CSX 11.15 Ksi
EFV 2.180 Kip-ft
ETR 27 %
BPM 92.8 BPM
VMX 6.5 ft/s
SFT 38 Kips
FMX 135 Kips
RA2 50 Kips
DMX 0.48 inch
LP 54.00 ft
LE 58.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-03

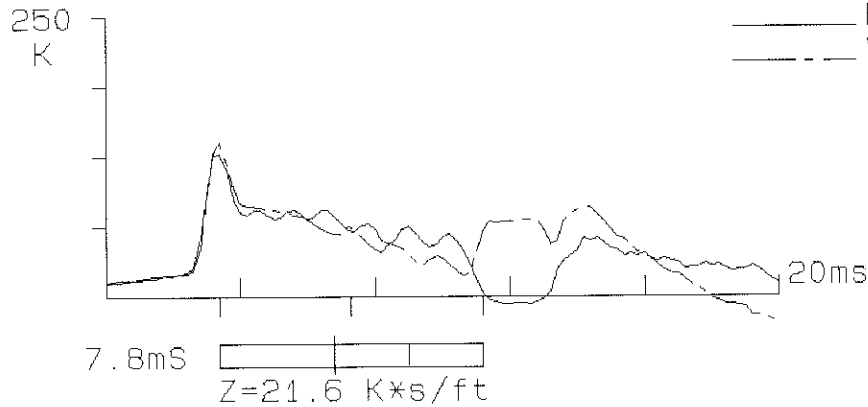
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

03055FT 2005-08-20

HAV180, 6-5/8" CLOSED

BN 30/272



CSX 10.49 Ksi

EFV 2.160 Kip-ft

ETR 27 %

BPM 94.0 BPM

VMX 6.4 ft/s

SFT 36 Kips

FMX 127 Kips

RA2 57 Kips

DMX 0.53 inch

LP 62.00 ft

LE 66.00 ft

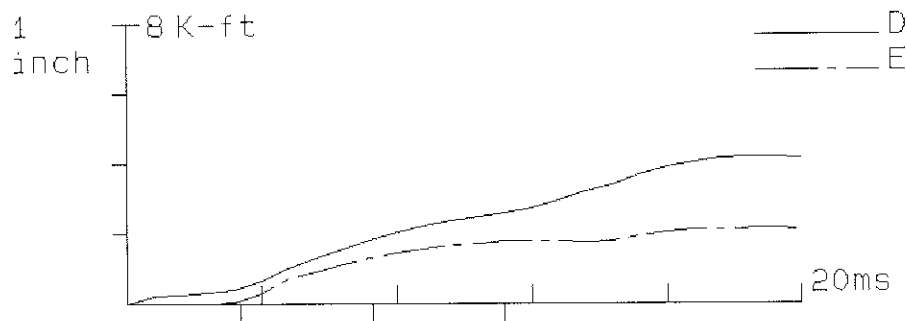
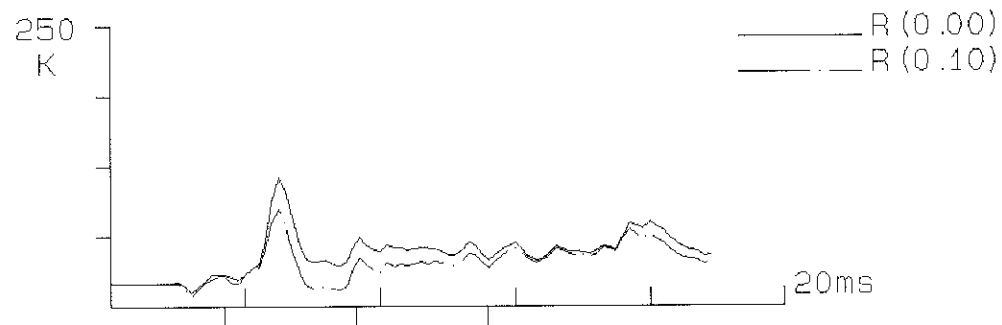
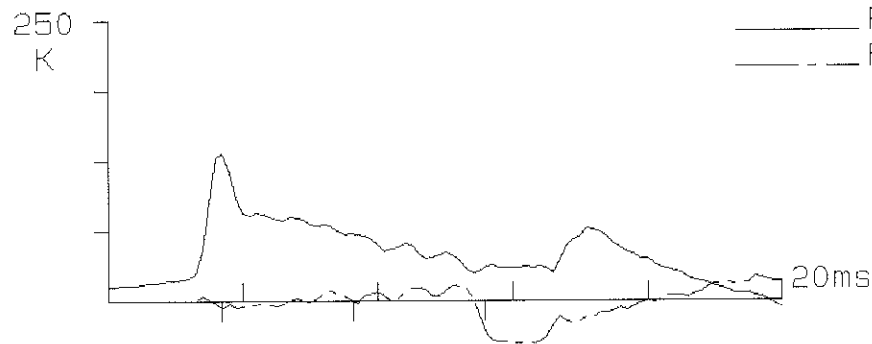
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-03

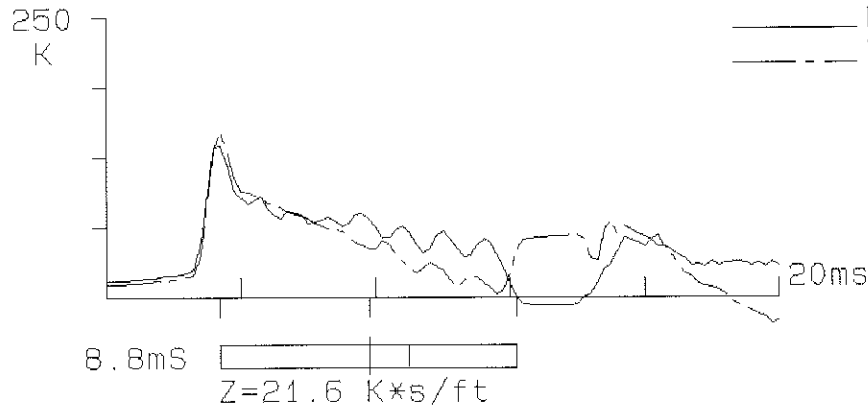
PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

03063FT 2005-08-20

HAV180, 6-5/8" CLOSED

BN 30/296



CSX 11.15 Ksi

EFV 2.190 Kip-ft

ETR 27 %

BPM 93.1 BPM

VMX 6.8 ft/s

SFT 52 Kips

FMX 135 Kips

RA2 46 Kips

DMX 0.49 inch

LP 70.00 ft

LE 74.00 ft

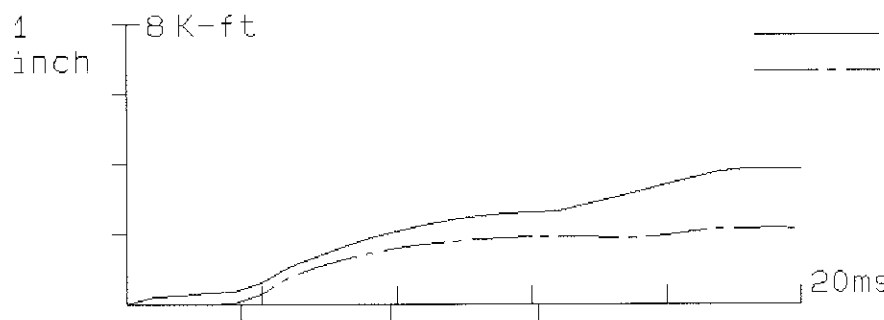
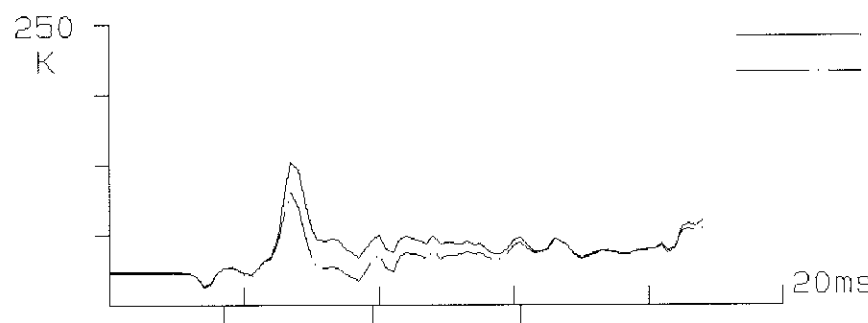
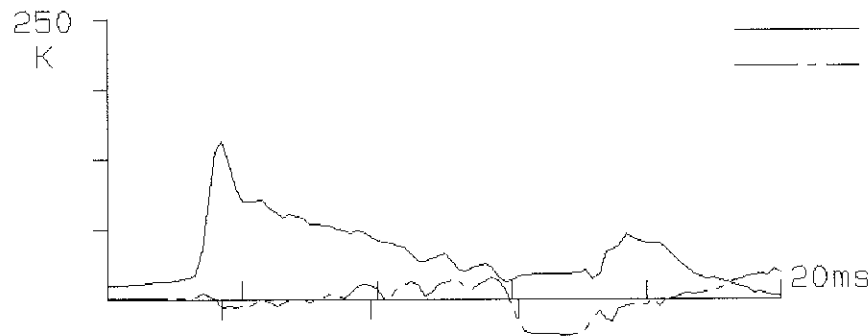
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-03

PDA OP: RMDT: -B. Miner

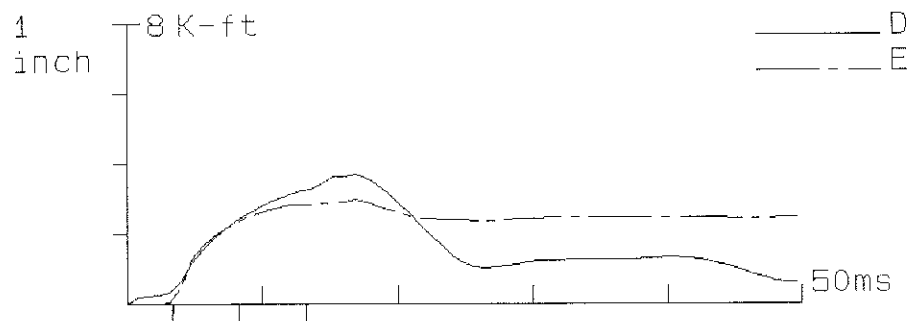
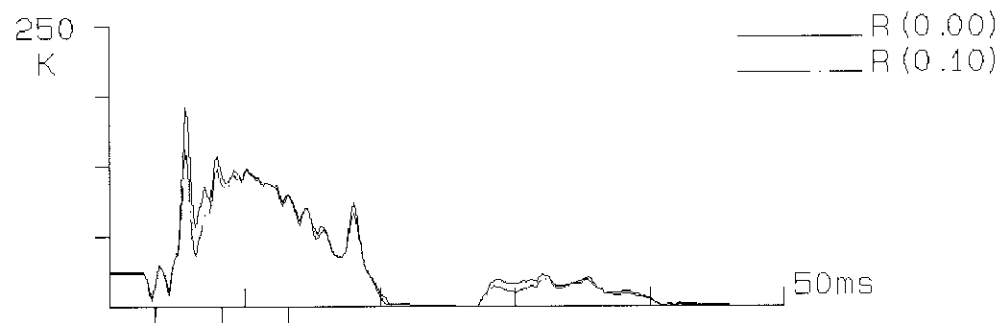
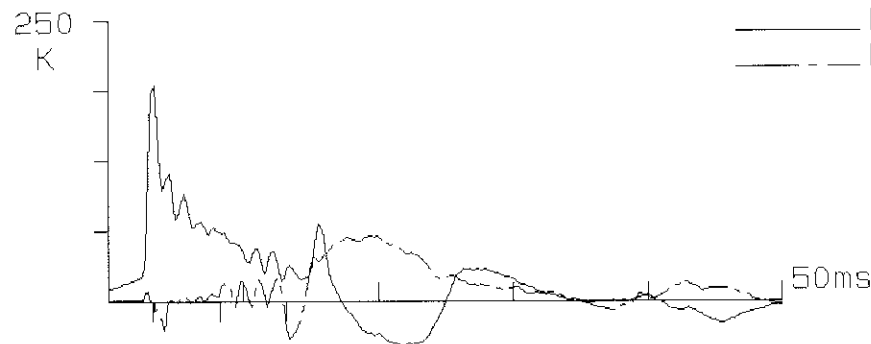
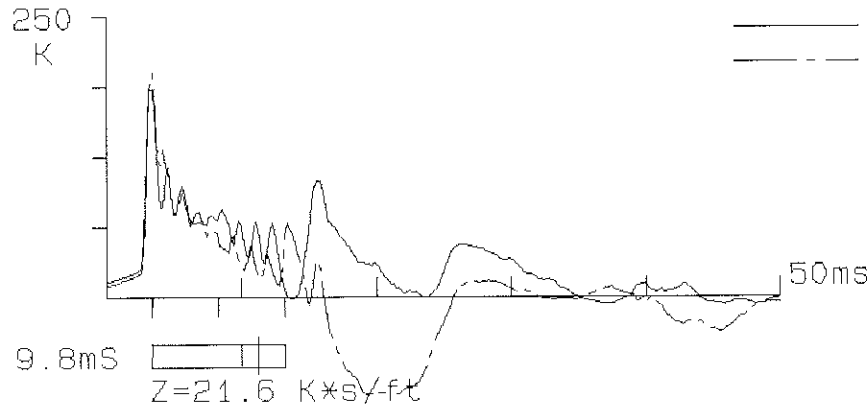
PDI PILE DRIVING ANALYZER® v5.02

03071FT 2005-08-20

HAV180, 6-5/8" CLOSED

BN 79/480

_____ F	CSX 15.28 Ksi
----- V*Z	EFV 2.990 Kip-ft
	ETR 37 %
	BPM 90.9 BPM
	VMX 9.2 ft/s
	SFT 58 Kips
	FMX 185 Kips
	RA2 113 Kips
	DMX 0.46 inch
	LP 78.00 ft
	LE 82.00 ft
	AR 12.10 in2
	EM 30004 Ksi
	SP 0.493 K/ft3
	WS 16800 ft/s
	F 34 A 34



R Miner Dynamic Test

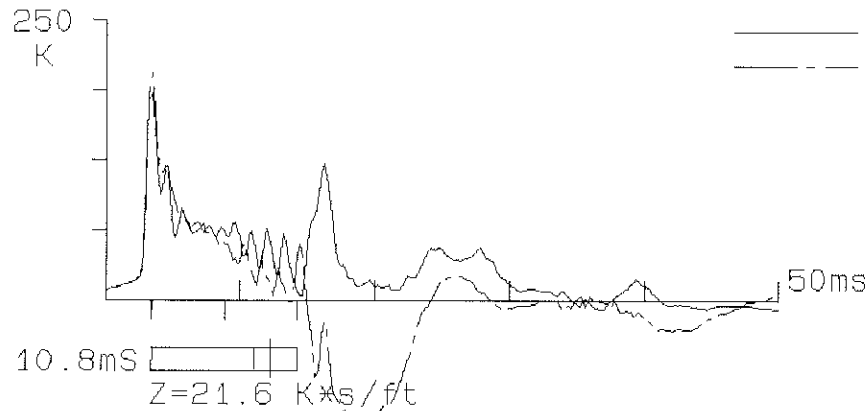
ROSE CREEK, BPT05-03

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

03079FT 2005-08-20

HAV180, 6-5/8" CLOSED



BN 1507800

CSX 15.28 Ksi

EFV 2.820 Kip-ft

ETR 34 %

BPM 90.7 BPM

VMX 9.3 ft/s

SFT 61 Kips

FMX 185 Kips

RA2 144 Kips

DMX 0.56 inch

LP 83.00 ft

LE 90.00 ft

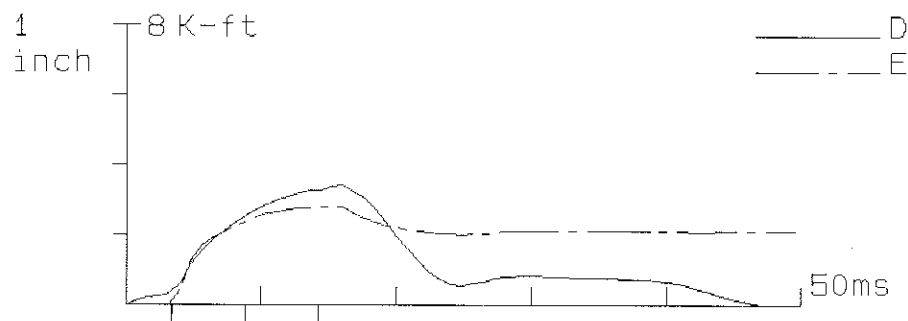
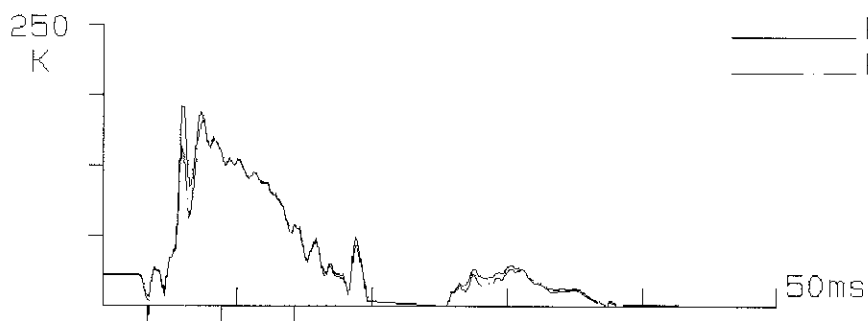
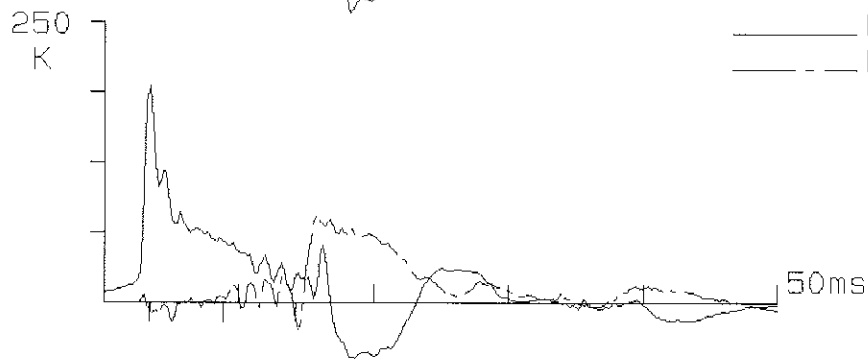
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

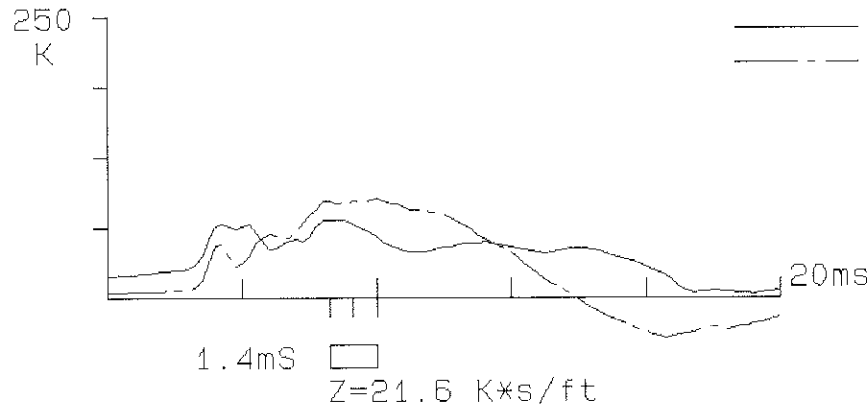
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

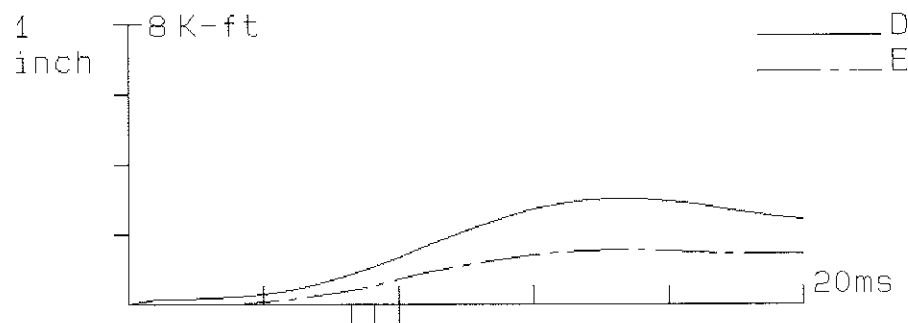
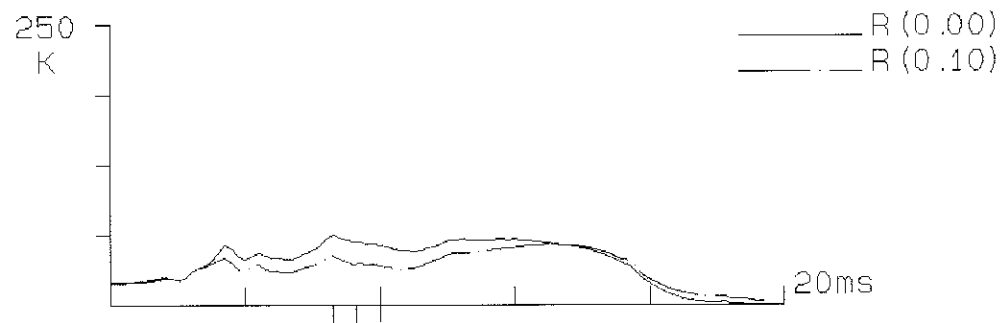
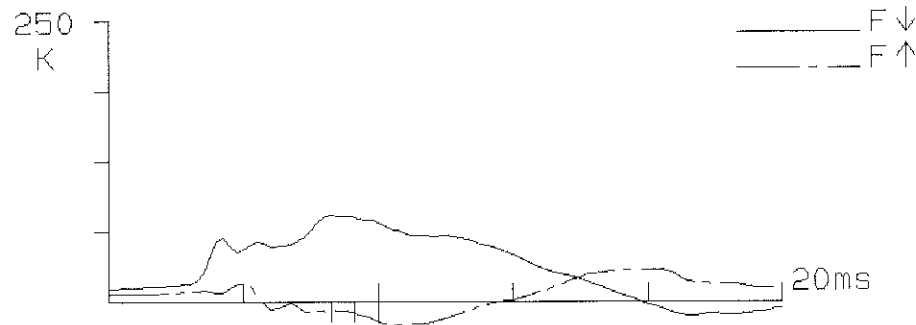
PDI PILE DRIVING ANALYZER® v5.02

04000FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 15/54
 CSX 5.78 Ksi
 EFV 1.580 Kip-ft
 ETR 19 %
 BPM 96.3 BPM
 VMX 4.1 ft/s
 SFT 0 Kips
 FMX 70 Kips
 RA2 56 Kips
 DMX 0.38 inch
 LP 8.00 ft
 LE 12.00 ft
 AR 12.10 in2
 EM 30004 Ksi
 SP 0.493 K/ft3
 WS 16800 ft/s
 F 34 A 34



R Miner Dynamic Test

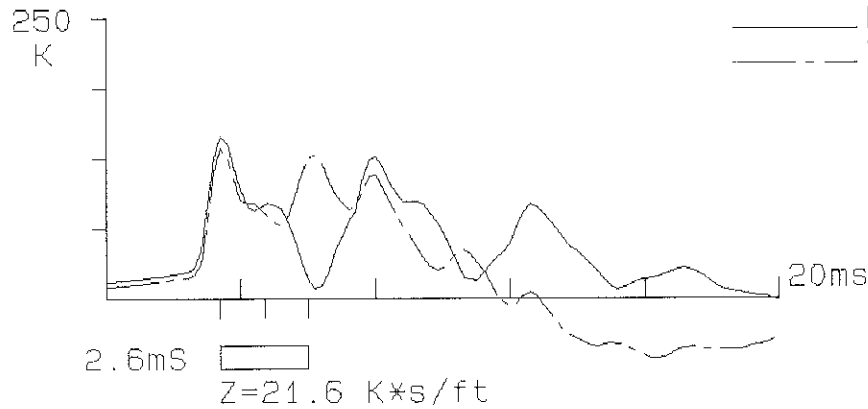
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

04009FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 46/538

CSX 11.98 Ksi

EFV 2.370 Kip-ft

ETR 29 %

BPM 92.3 BPM

VMX 6.2 ft/s

SFT 16 Kips

FMX 145 Kips

RA2 88 Kips

DMX 0.41 inch

LP 18.00 ft

LE 22.00 ft

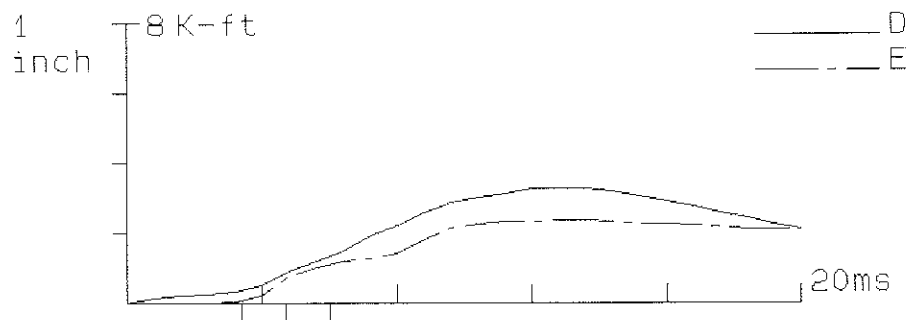
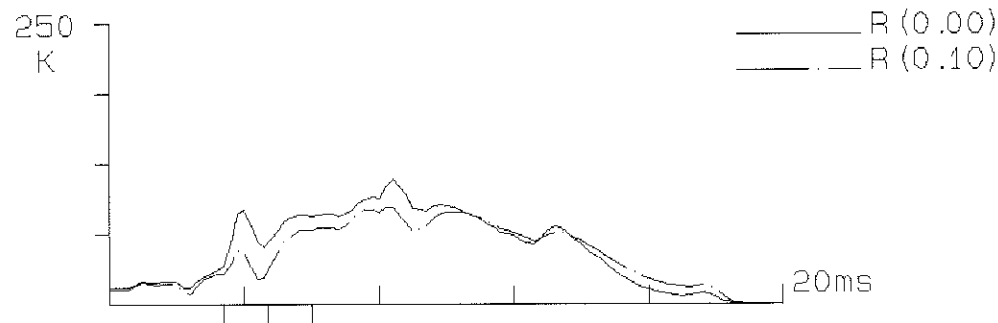
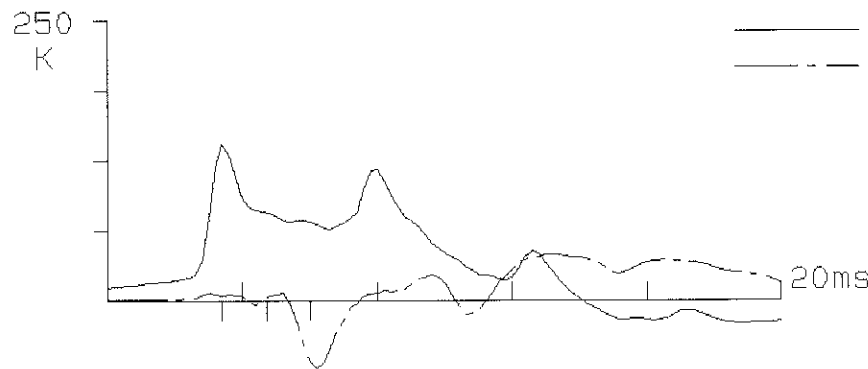
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

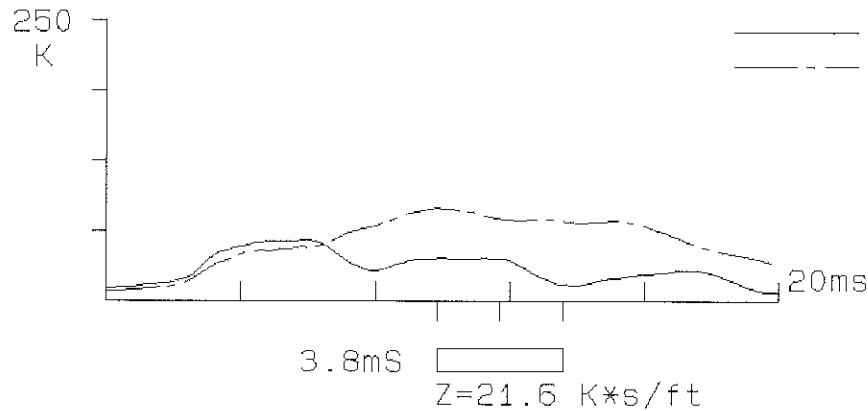
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

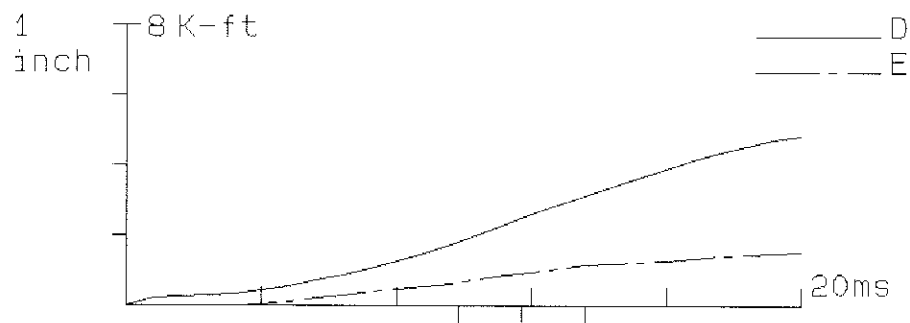
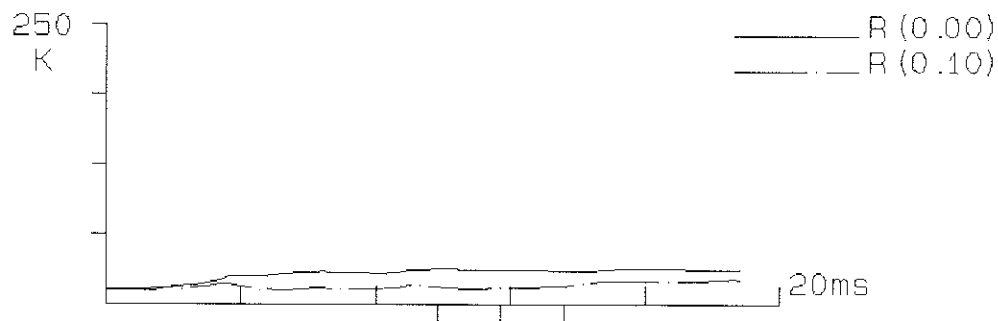
PDI PILE DRIVING ANALYZER® v5.02

04019FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 15/338
 CSX 4.46 Ksi
 EFV 1.710 Kip-ft
 ETR 20 %
 BPM 96.9 BPM
 VMX 3.8 ft/s
 SFT 0 Kips
 FMX 54 Kips
 RA2 27 Kips
 DMX 0.67 inch
 LP 28.00 ft
 LE 32.00 ft
 AR 12.10 in2
 EM 30004 Ksi
 SP 0.493 K/ft3
 WS 16800 ft/s
 F 34 A 34



R Miner Dynamic Test

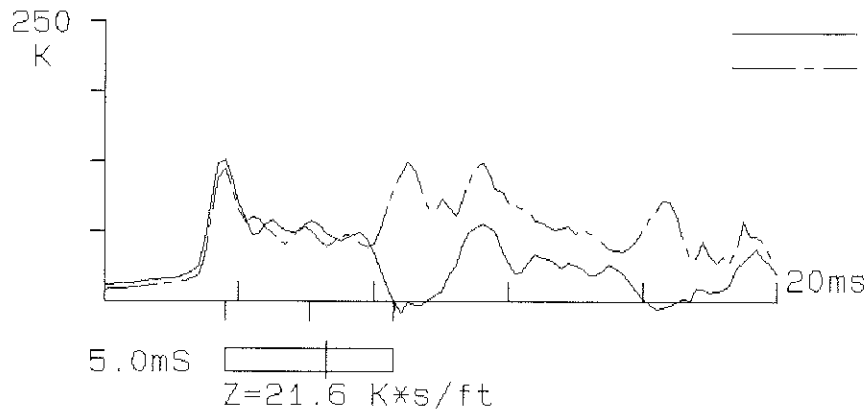
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI FILE DRIVING ANALYZER® v5.02

04029FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 14/129

CSX 10.41 Ksi

EFV 2.270 Kip-ft

ETR 28 %

BPM 95.2 BPM

VMX 5.7 ft/s

SFT 14 Kips

FMX 126 Kips

RA2 28 Kips

DMX 0.75 inch

LP 38.00 ft

LE 42.00 ft

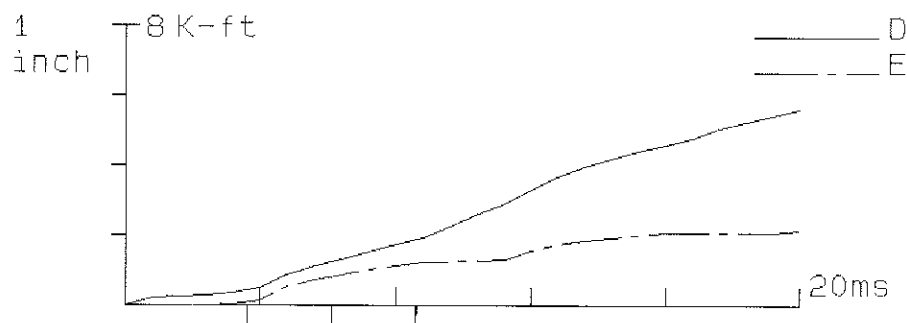
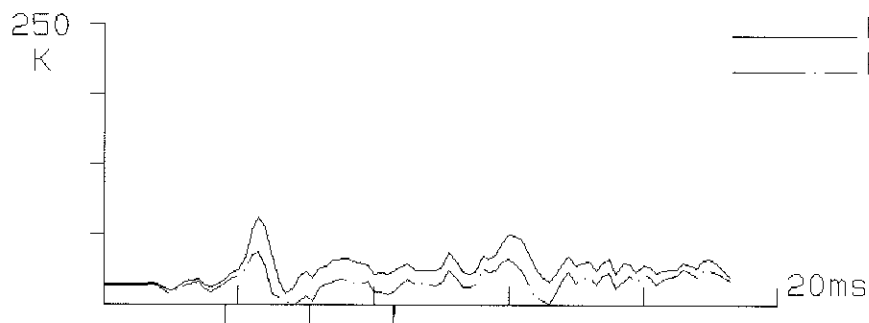
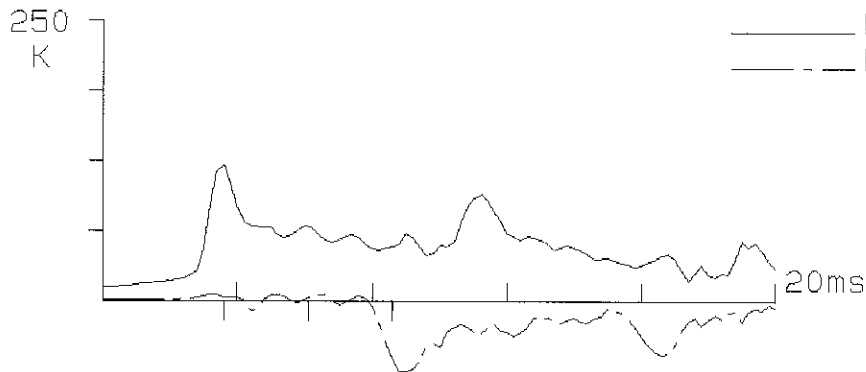
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

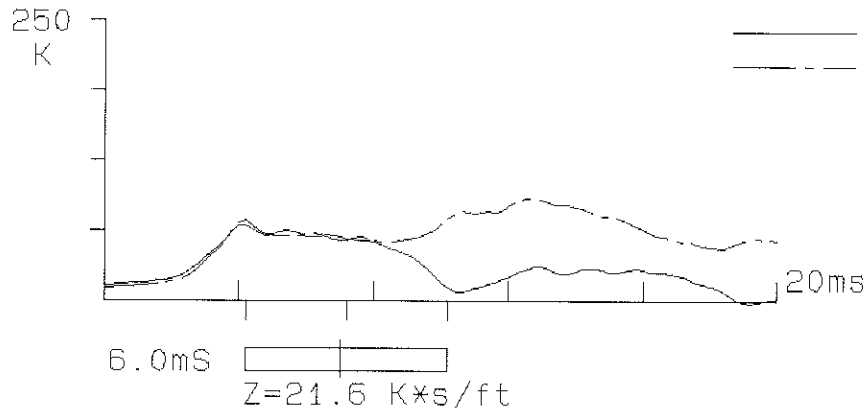
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

04039FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 12/184

CSX 5.53 Ksi

EFV 1.810 Kip-ft

ETR 22 %

BPM 97.0 BPM

VMX 4.3 ft/s

SFT 3 Kips

FMX 67 Kips

RA2 15 Kips

DMX 0.81 inch

LP 46.00 ft

LE 50.00 ft

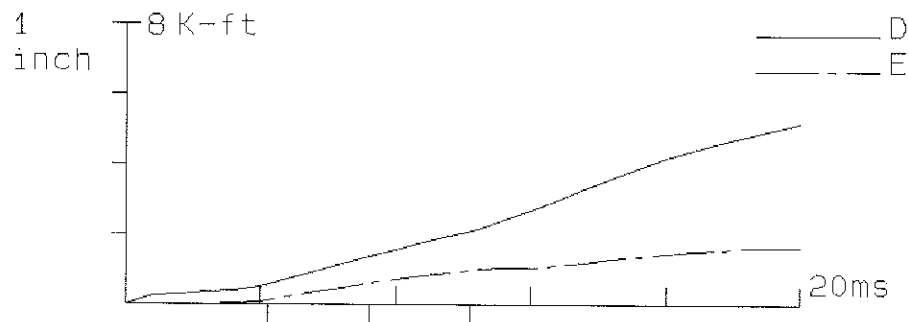
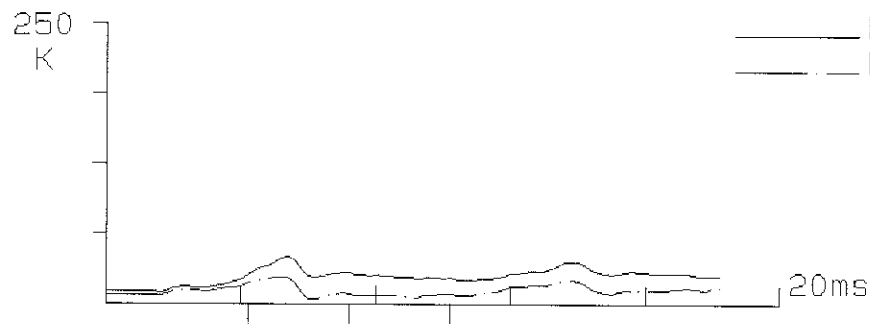
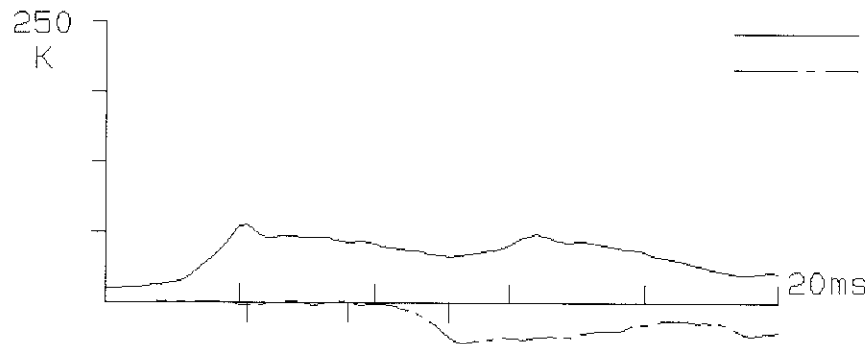
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

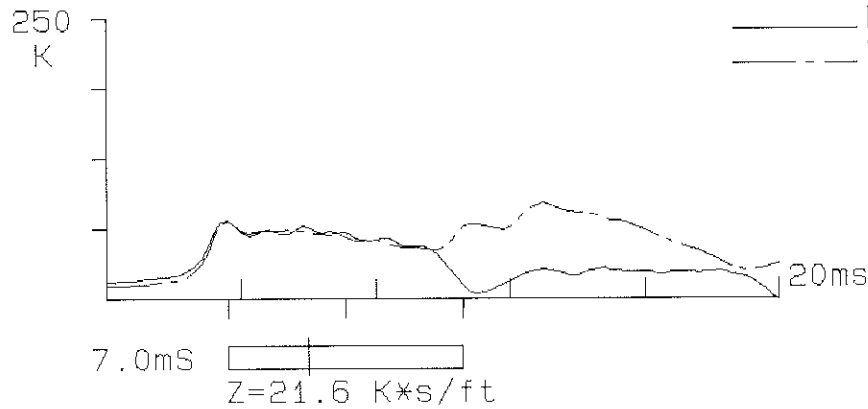
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

04047FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 12/158

CSX 5.70 Ksi

EFV 1.720 Kip-ft

ETR 20 %

BPM 96.1 BPM

VMX 3.9 ft/s

SFT 5 Kips

FMX 69 Kips

RA2 17 Kips

DMX 0.68 inch

LP 54.00 ft

LE 58.00 ft

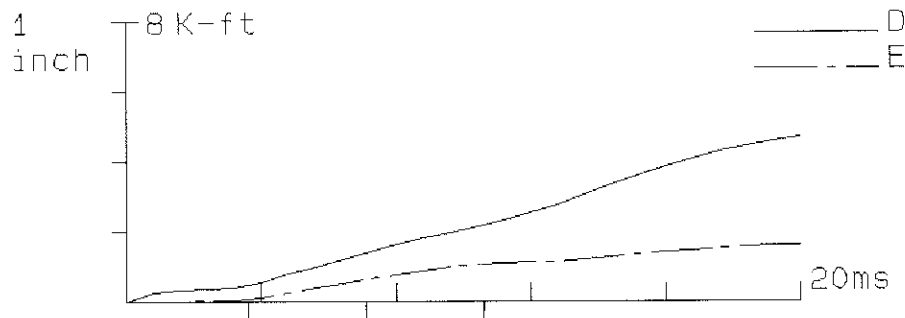
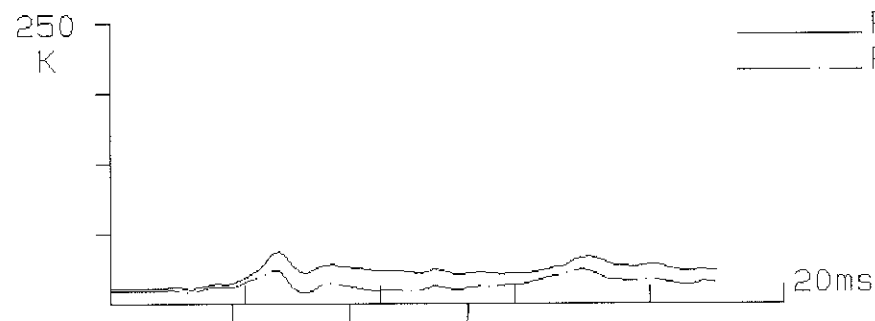
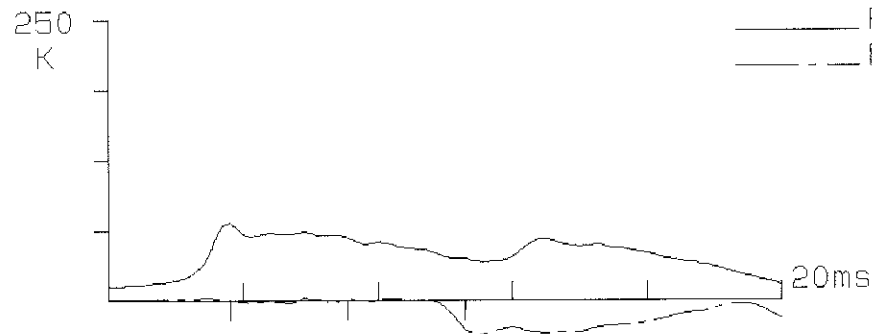
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

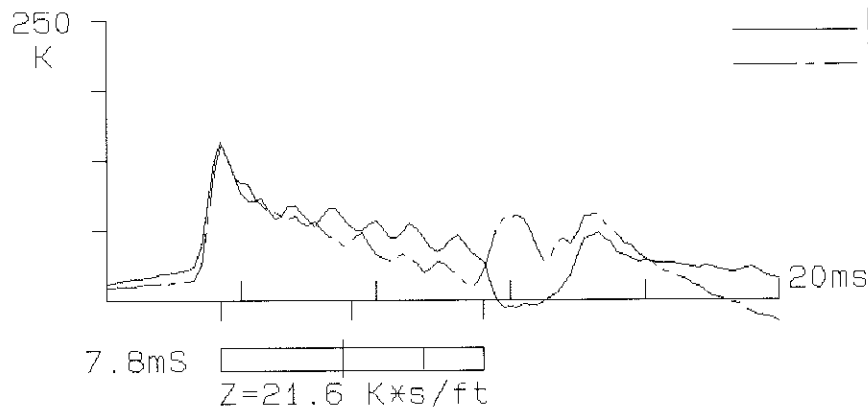
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

04055FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 20/199

CSX 11.57 Ksi

EFV 2.350 Kip-ft

ETR 28 %

BPM 92.7 BPM

VMX 6.3 ft/s

SFT 42 Kips

FMX 140 Kips

RA2 52 Kips

DMX 0.84 inch

LP 62.00 ft

LE 66.00 ft

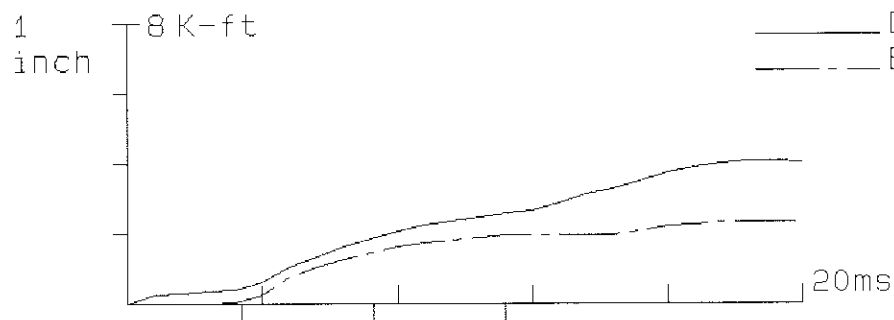
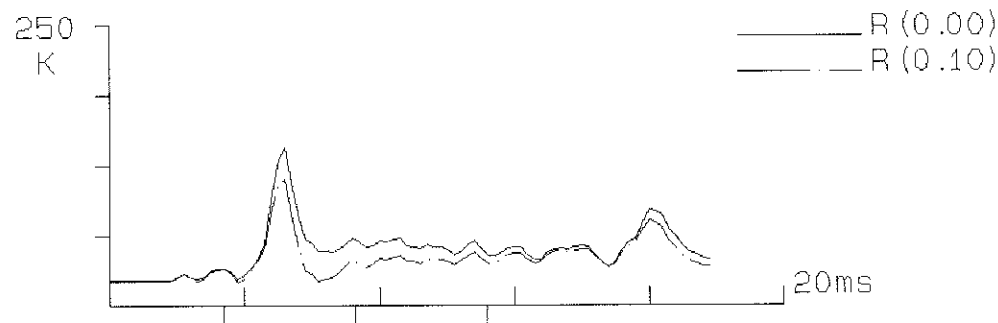
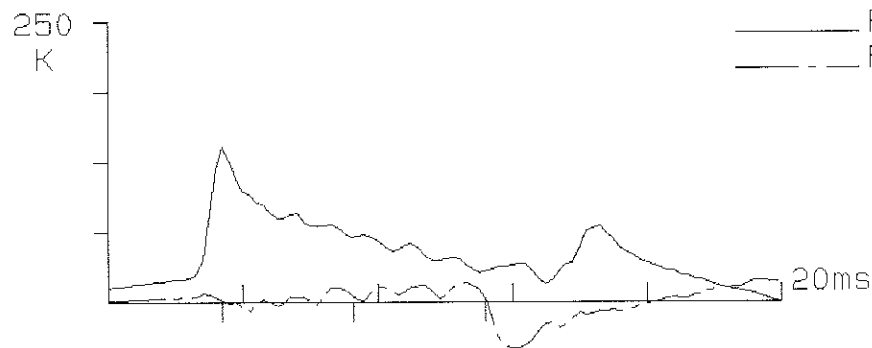
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

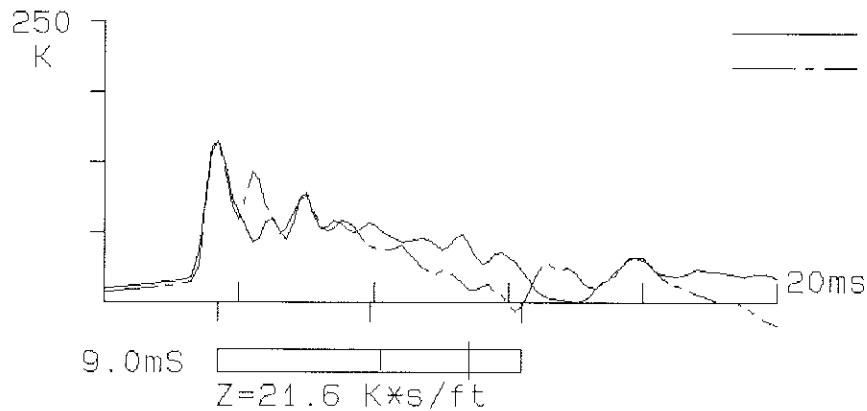
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

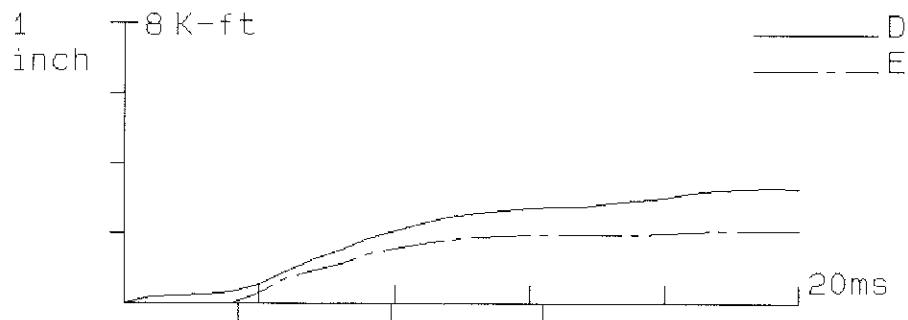
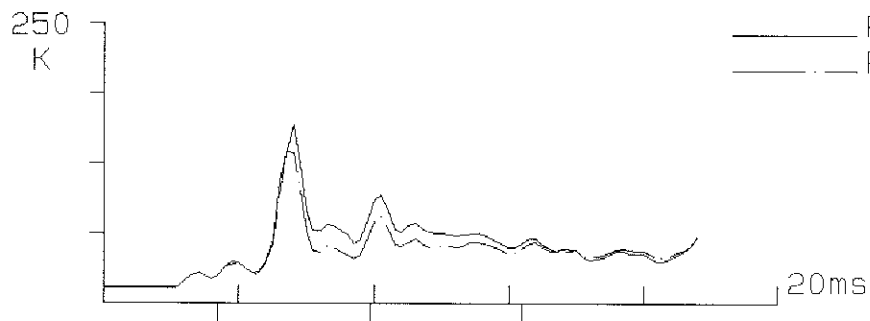
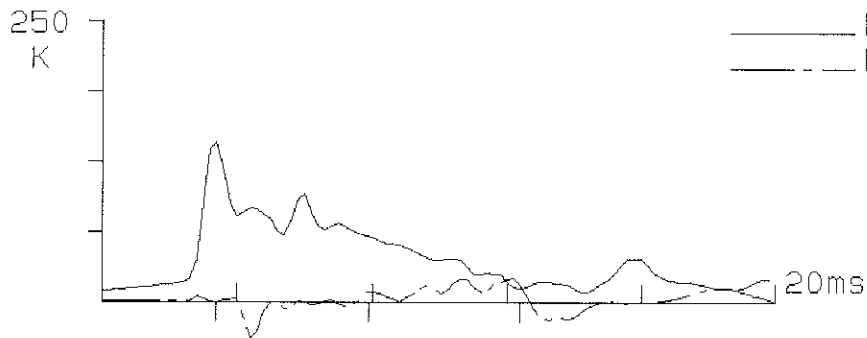
04063FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 42/326

CSX	11.81	Ksi
EFV	2.210	Kip-ft
ETR	27	%
BPM	93.3	BPM
VMX	6.6	ft/s
SFT	43	Kips
FMX	143	Kips
RA2	53	Kips
DMX	0.41	inch
LP	72.00	ft
LE	76.00	ft
AR	12.10	in2
EM	30004	Ksi
SP	0.493	K/ft3
WS	16800	ft/s
F	34	A 34



R Miner Dynamic Test

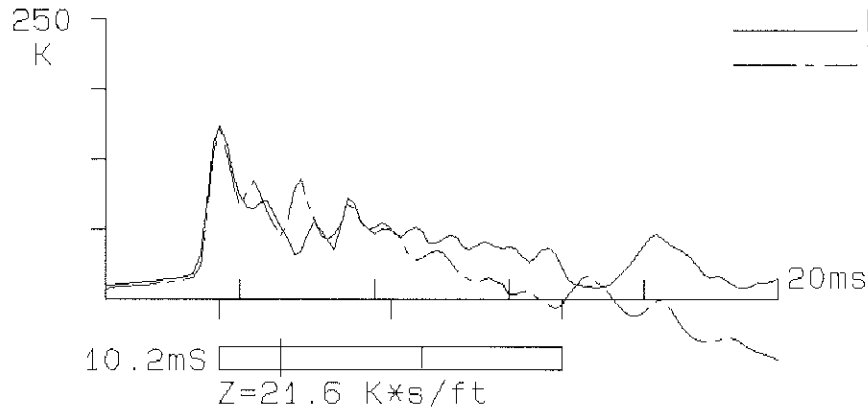
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

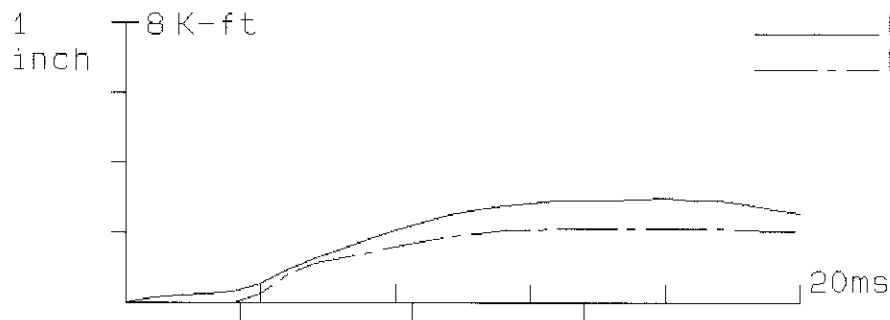
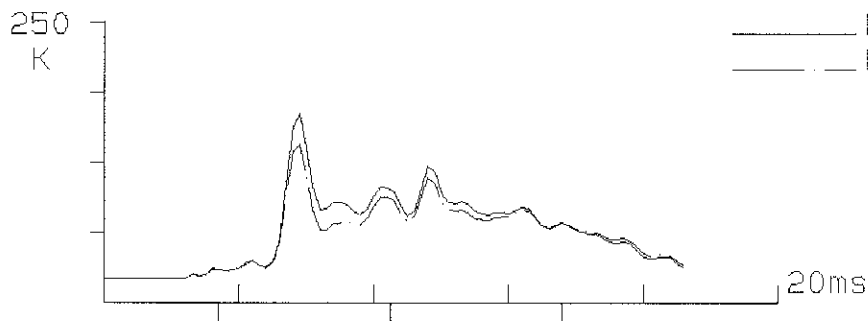
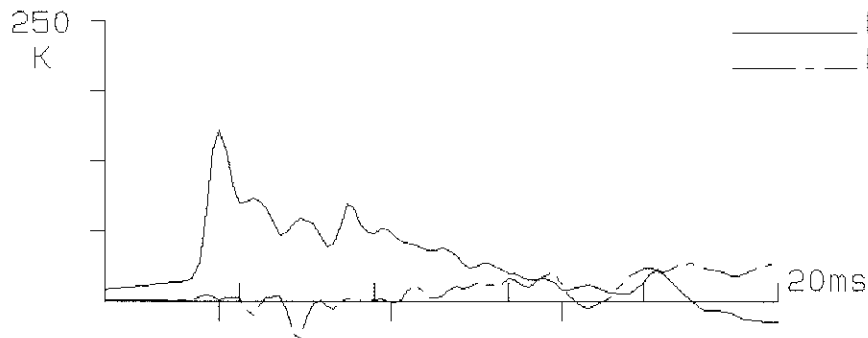
04073FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 90/654

CSX	12.80	Ksi
EFV	2.140	Kip-ft
ETR	25	%
BPM	92.0	BPM
VMX	7.0	ft/s
SFT	41	Kips
FMX	155	Kips
RA2	81	Kips
DMX	0.37	inch
LP	82.00	ft
LE	86.00	ft
AR	12.10	in2
EM	30004	Ksi
SP	0.493	K/ft3
WS	16800	ft/s
F	34	A 34



R Miner Dynamic Test

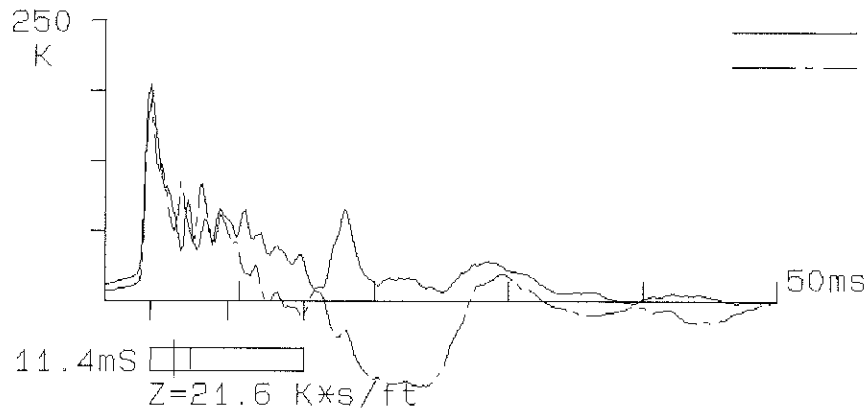
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

04083FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 135/651

CSX 15.95 Ksi

EFV 2.900 Kip-ft

ETR 35 %

BPM 91.0 BPM

VMX 8.3 ft/s

SFT 48 Kips

FMX 193 Kips

RA2 120 Kips

DMX 0.40 inch

LP 92.00 ft

LE 96.00 ft

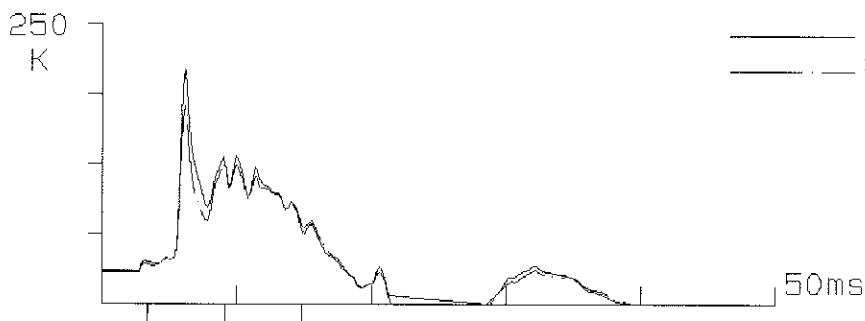
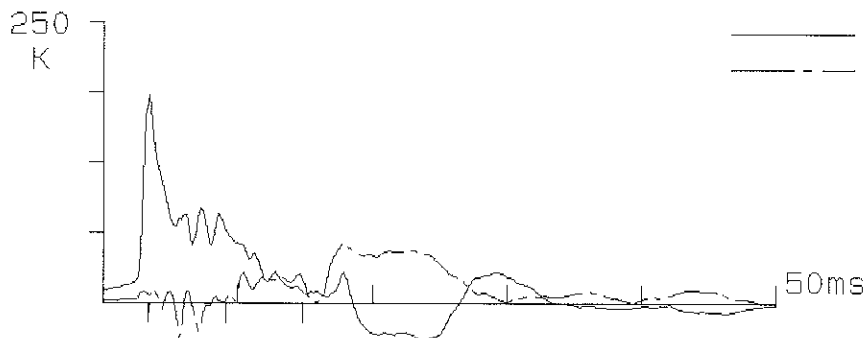
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

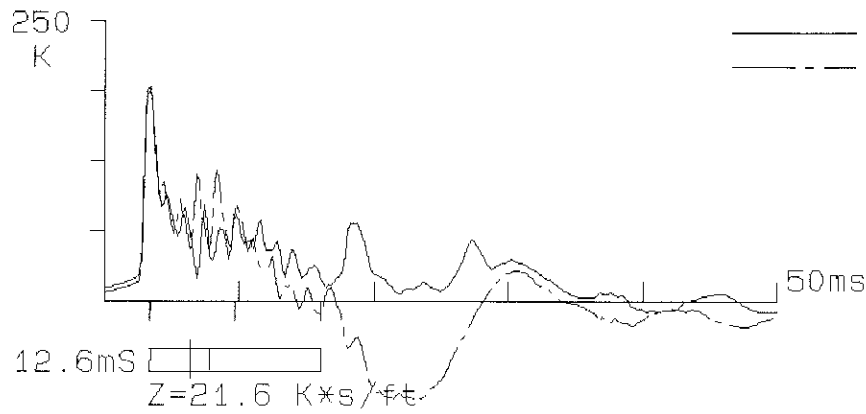
ROSE CREEK, BPT05-04

PDA OP: RMDT: -B. Miner

PDI PILE DRIVING ANALYZER® v5.02

04093FT 2005-08-21

HAV180, 6-5/8" CLOSED



BN 391/688

CSX 15.78 Ksi

EFV 2.970 Kip-ft

ETR 37 %

BPM 91.0 BPM

VMX 8.7 ft/s

SFT 37 Kips

FMX 191 Kips

RA2 113 Kips

DMX 0.46 inch

LP 94.00 ft

LE 106.00 ft

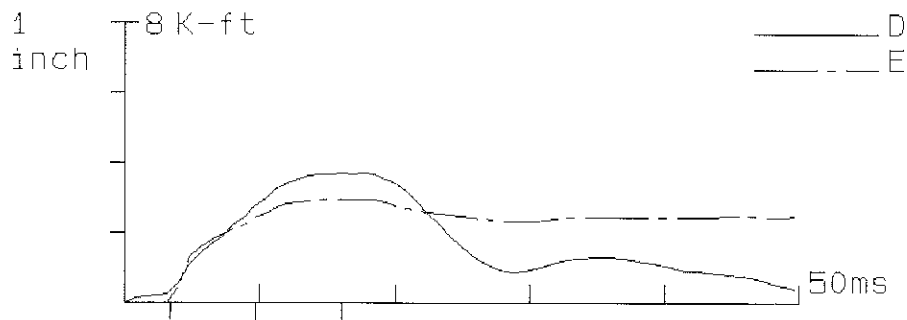
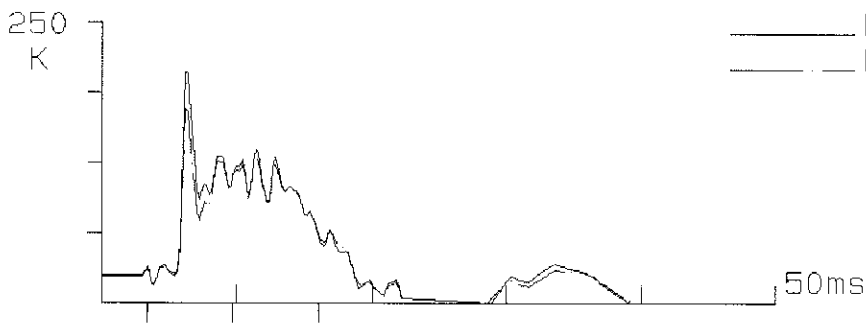
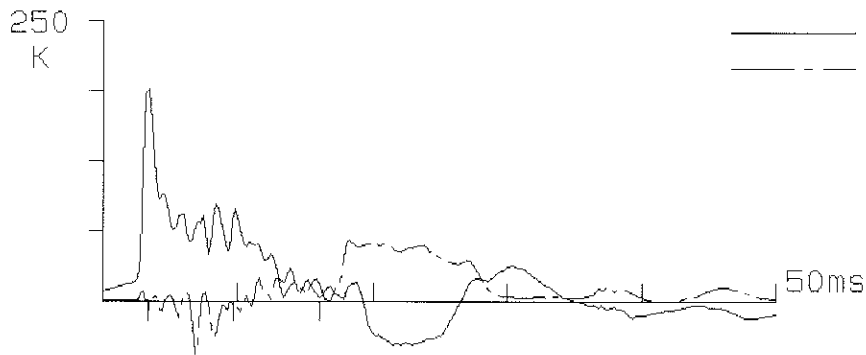
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

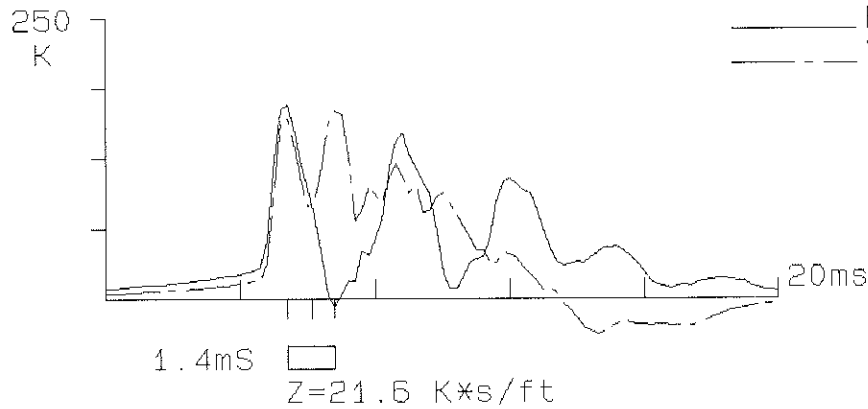
ROSE CREEK, BPT05-05

PDA OP: AMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

05000FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 39/157

CSX 14.29 Ksi

EFV 2.470 Kip-ft

ETR 30 %

BPM 92.1 BPM

VMX 7.7 ft/s

SFT 0 Kips

FMX 173 Kips

RA2 75 Kips

DMX 0.43 inch

LP 8.00 ft

LE 12.00 ft

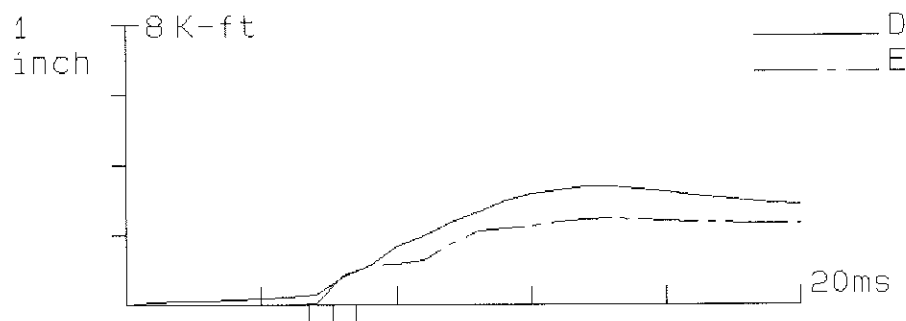
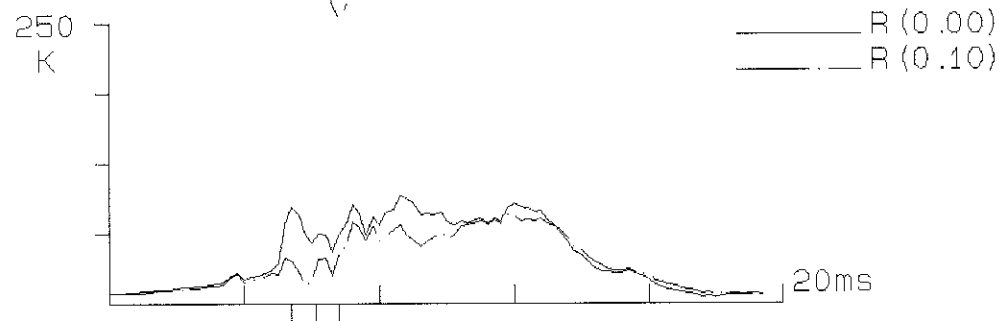
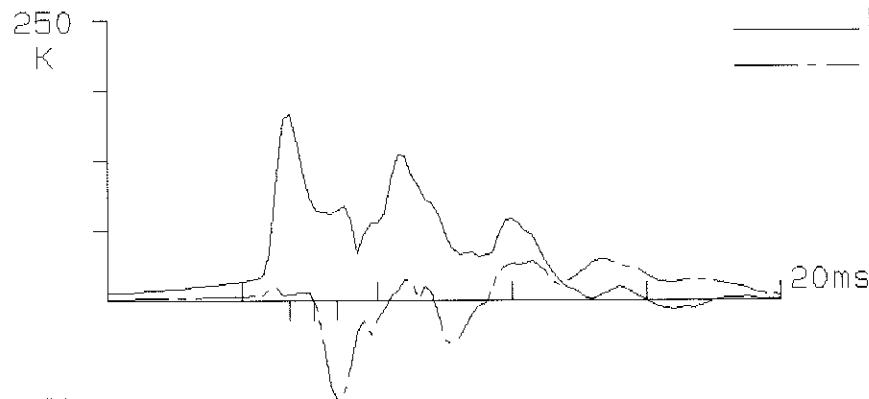
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-05

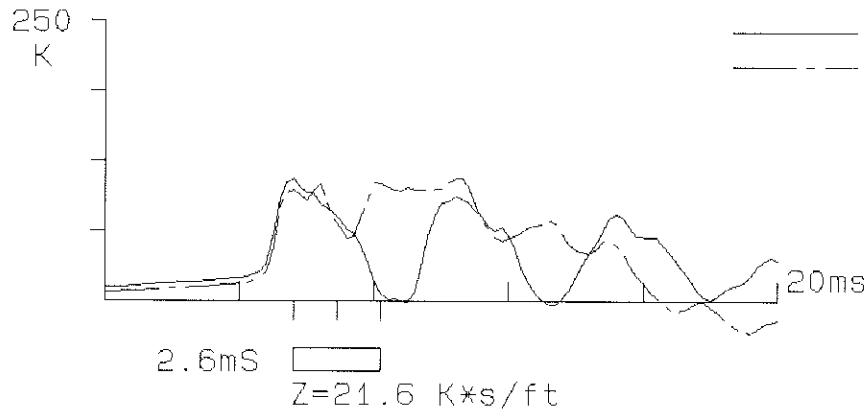
PDA OP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® V5.03

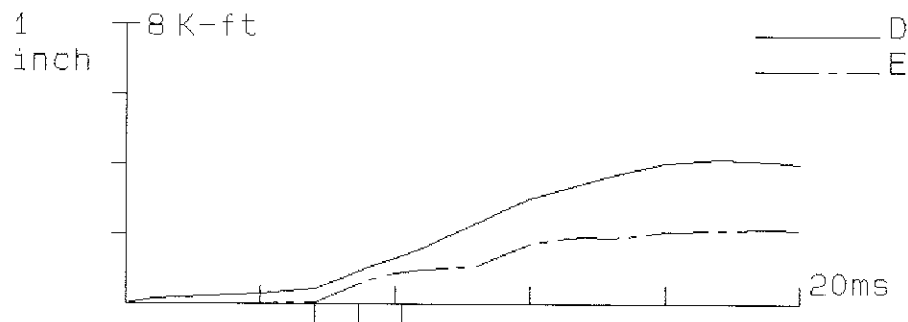
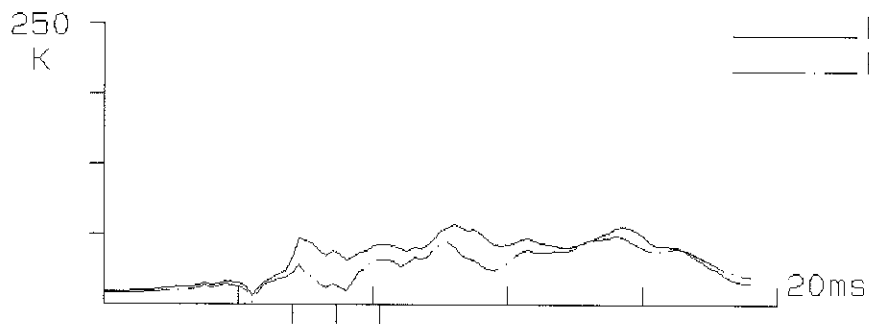
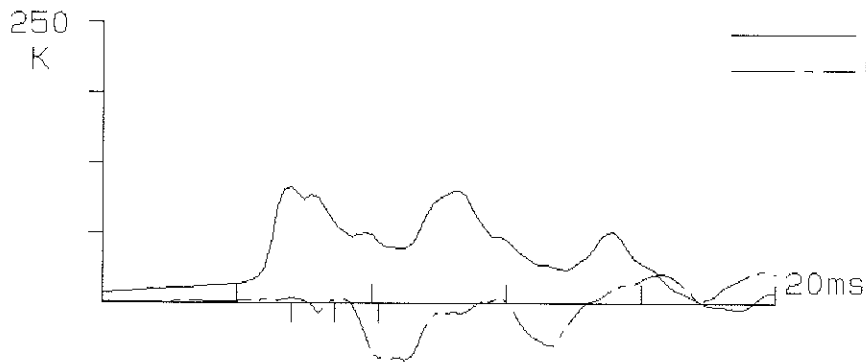
05009FT 2005-08-21

HAV 180, 6-5/8" CLOSED

BN 29/540



CSX 9.09 Ksi
EFV 2.160 Kip-ft
ETR 27 %
BPM 93.3 BPM
VMX 5.0 ft/s
SFT 10 Kips
FMX 110 Kips
RA2 53 Kips
DMX 0.71 inch
LP 18.00 ft
LE 22.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-05

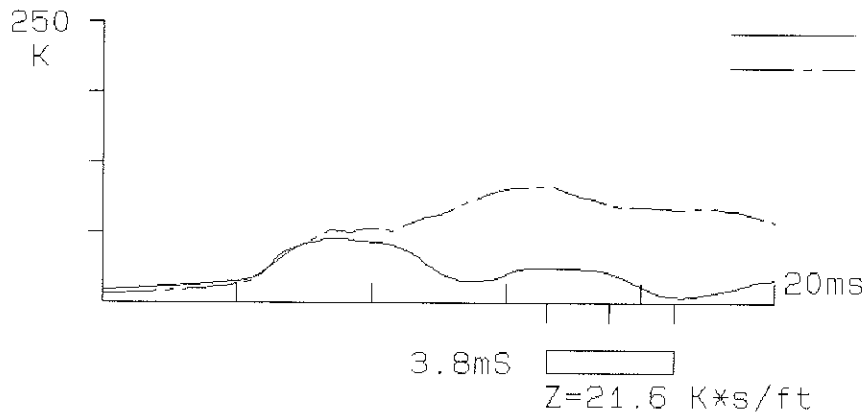
PDA OP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

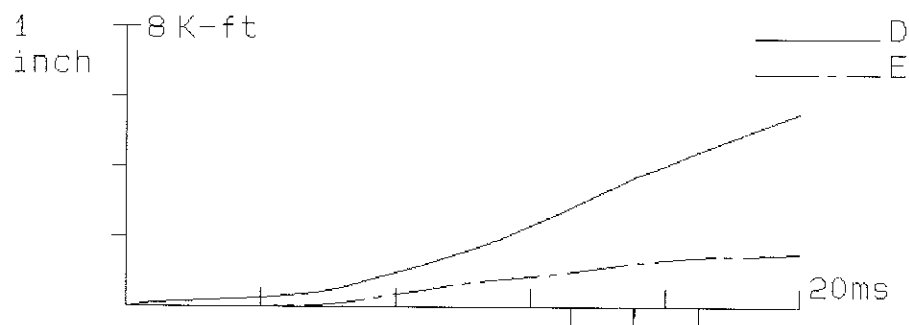
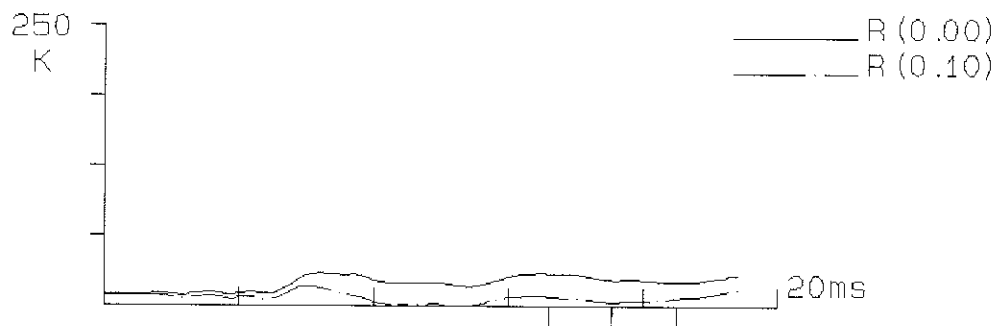
05019FT 2005-08-21

HAV 180, 6-5/8" CLOSED

BN 13/283



CSX 4.71 Ksi
EFV 1.890 Kip-ft
ETR 23 %
BPM 97.4 BPM
VMX 4.8 ft/s
SFT 0 Kips
FMX 57 Kips
RA2 20 Kips
DMX 0.89 inch
LP 28.00 ft
LE 32.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

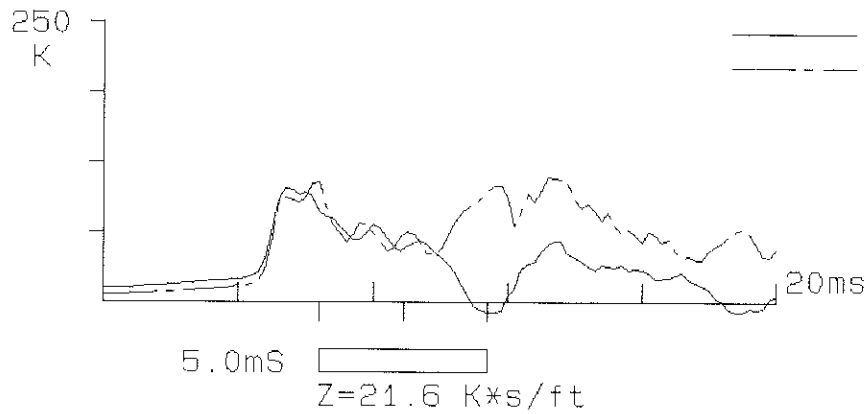
ROSE CREEK, BPT05-05

PDA OP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

05029FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 18/150

CSX 8.34 Ksi

EFV 2.070 Kip-ft

ETR 25 %

BPM 94.9 BPM

VMX 5.2 ft/s

SFT 28 Kips

FMX 101 Kips

RA2 30 Kips

DMX 0.71 inch

LP 38.00 ft

LE 42.00 ft

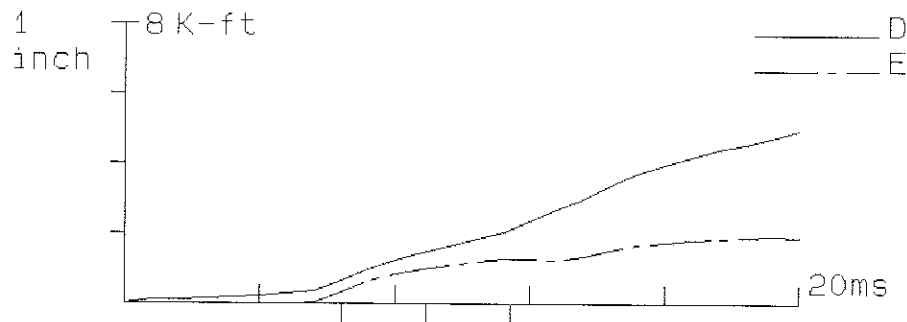
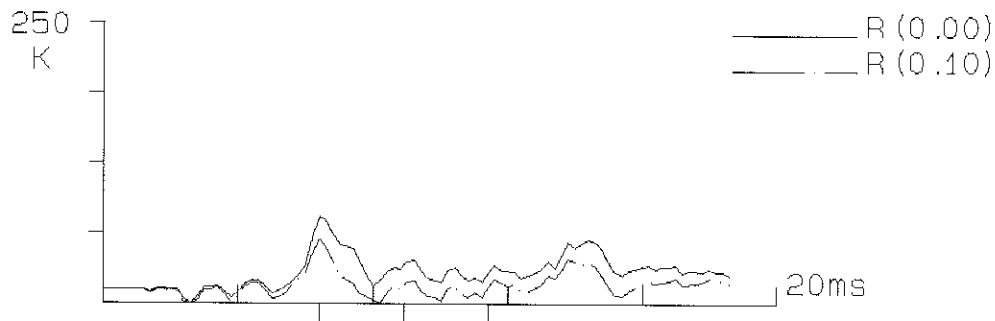
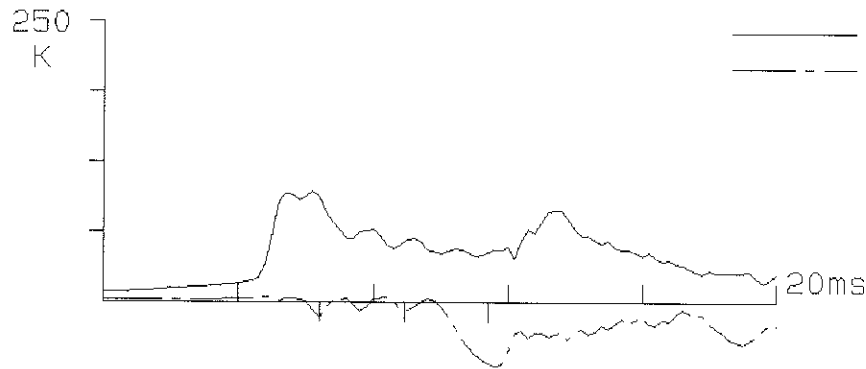
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



R Miner Dynamic Test

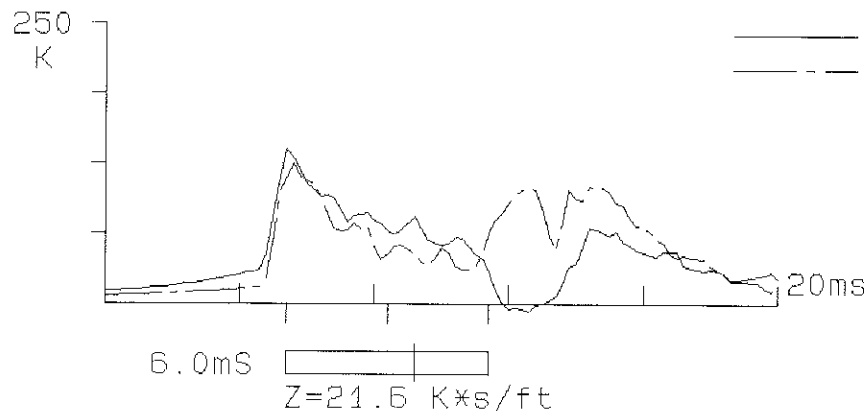
ROSE CREEK, BPT05-05

PDA QP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

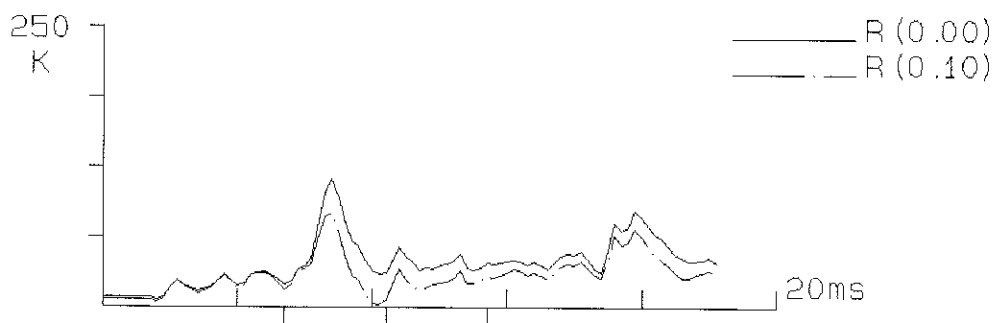
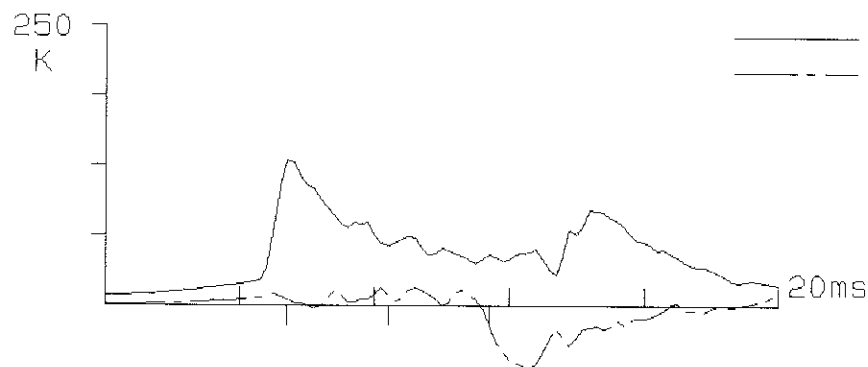
05039FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 19/163

CSX	11.32	Ksi
EFV	2.550	Kip-ft
ETR	30	%
BPM	93.7	BPM
VMX	5.8	ft/s
SFT	34	Kips
FMX	137	Kips
RA2	33	Kips
DMX	0.64	inch
LP	46.00	ft
LE	50.00	ft
AR	12.10	in2
EM	30004	Ksi
SP	0.493	K/ft3
WS	16800	ft/s
F	34	A 34



R Miner Dynamic Test

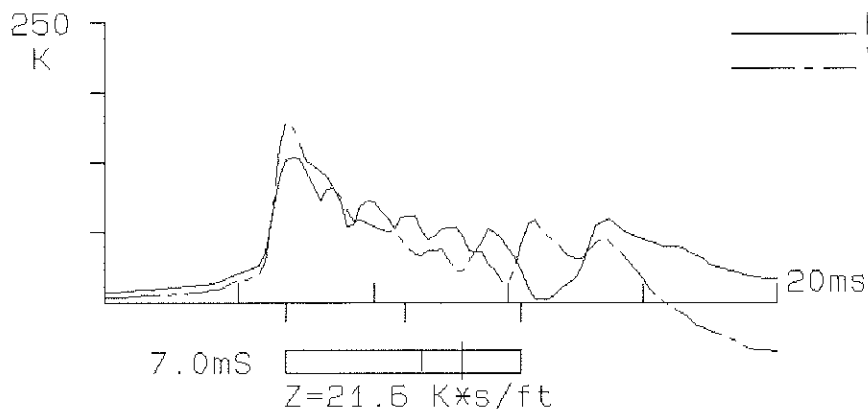
ROSE CREEK, BPT05-05

PDA OP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

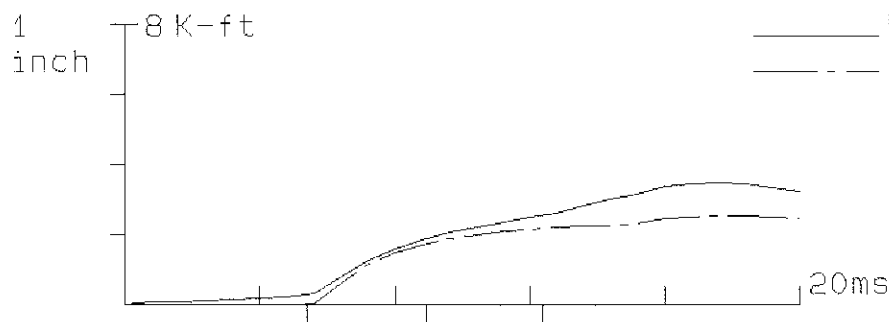
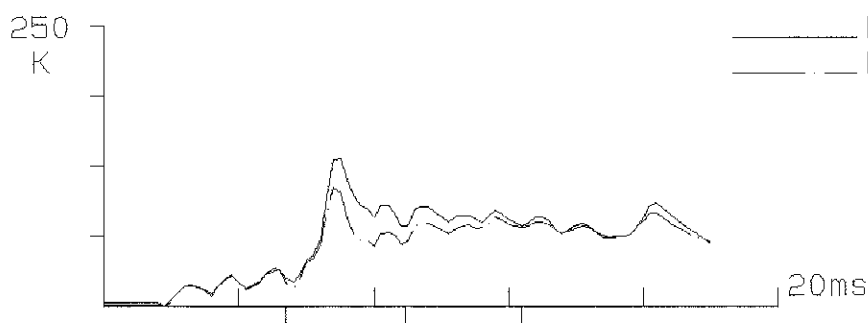
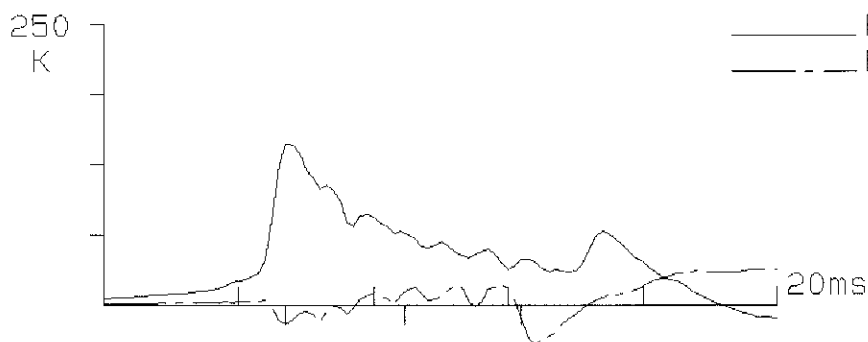
05047FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 49/282

CSX	10.74	Ksi
EFV	2.570	Kip-ft
ETR	32	%
BPM	91.4	BPM
VMX	7.4	ft/s
SFT	42	Kips
FMX	130	Kips
RA2	83	Kips
DMX	0.44	inch
LP	54.00	ft
LE	58.00	ft
AR	12.10	in2
EM	30004	Ksi
SP	0.493	K/ft3
WS	16800	ft/s
F	34	A 34



R Miner Dynamic Test

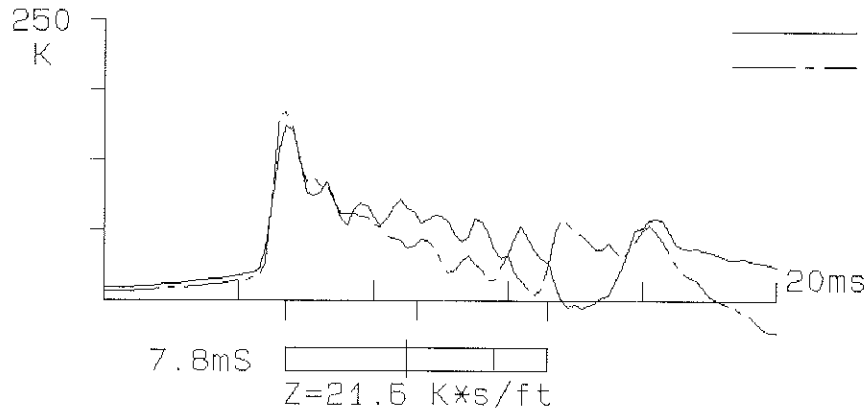
ROSE CREEK, BPT05-05

PDA OP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

05055FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 46/391

CSX 12.89 Ksi

EFV 2.600 Kip-ft

ETR 32 %

BPM 91.8 BPM

VMX 7.7 ft/s

SFT 54 Kips

FMX 156 Kips

RA2 71 Kips

DMX 0.46 inch

LP 62.00 ft

LE 66.00 ft

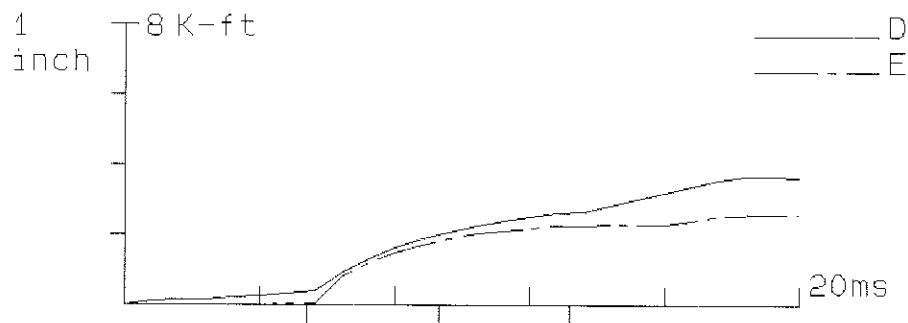
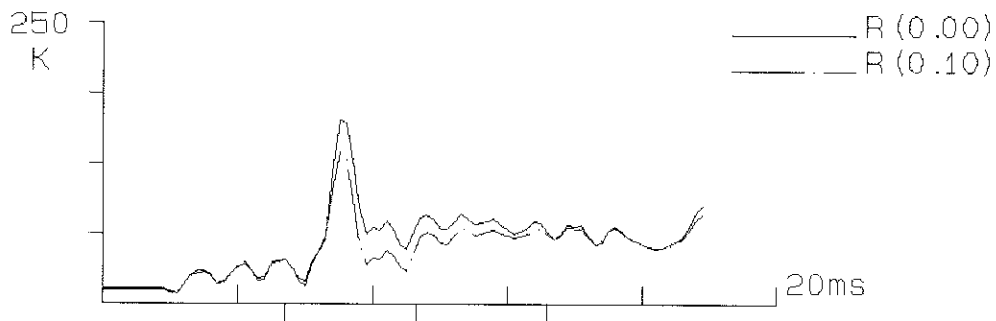
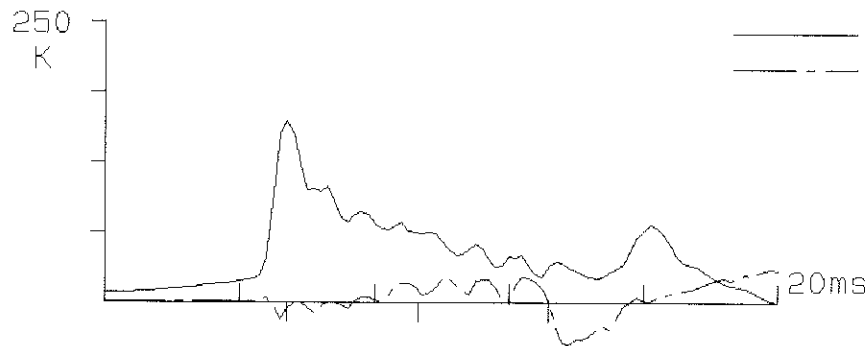
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



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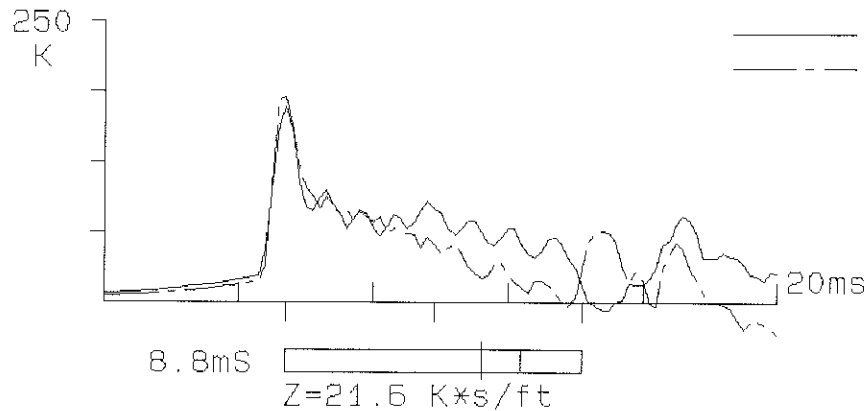
ROSE CREEK, BPT05-05

PDA OP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

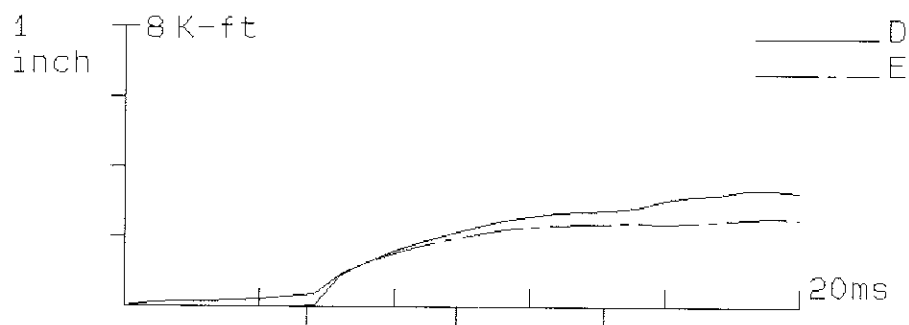
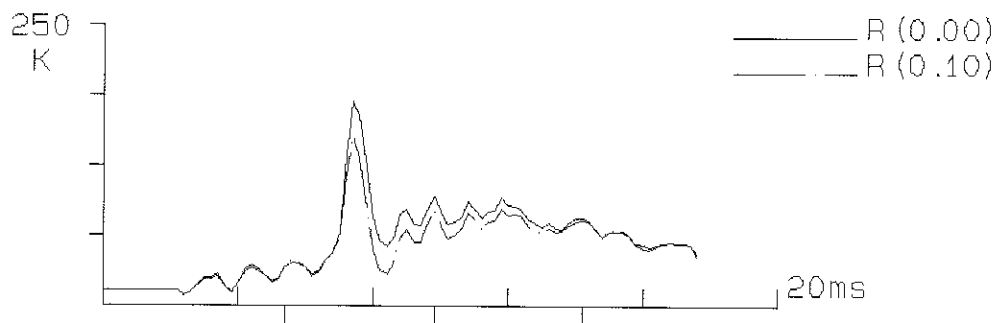
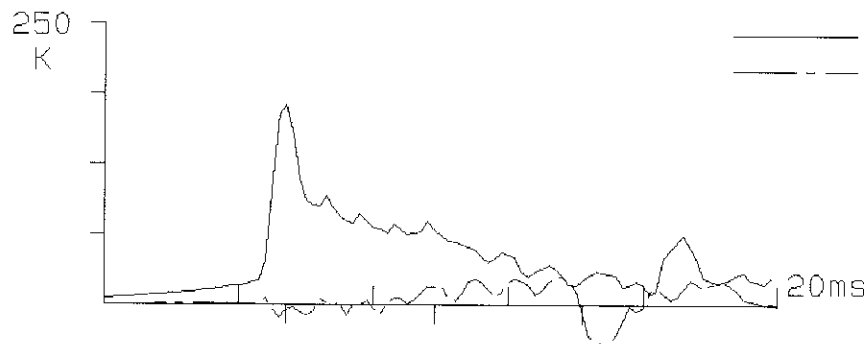
05063FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 38/367

CSX	14.38	Ksi
EFV	2.550	Kip-ft
ETR	30	%
BPM	91.4	BPM
VMX	8.5	ft/s
SFT	57	Kips
FMX	174	Kips
RA2	89	Kips
DMX	0.42	inch
LP	70.00	ft
LE	74.00	ft
AR	12.10	in2
EM	30004	Ksi
SP	0.493	K/ft3
WS	16800	ft/s
F	34	A 34



R Miner Dynamic Test

ROSE CREEK, BPT05-05

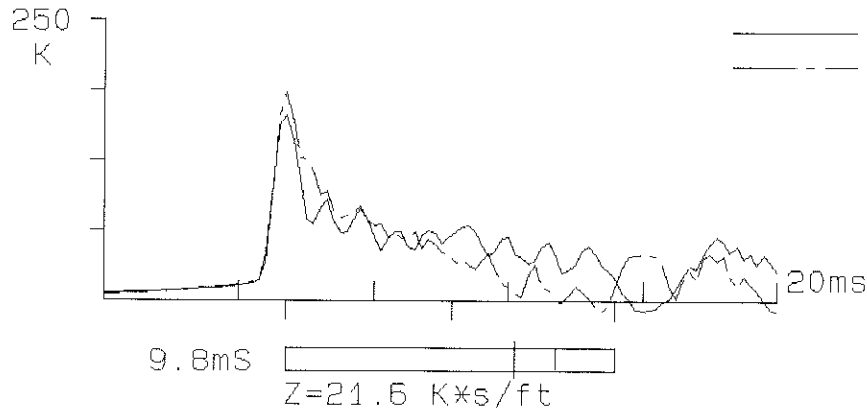
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PDI PILE DRIVING ANALYZER®v5.03

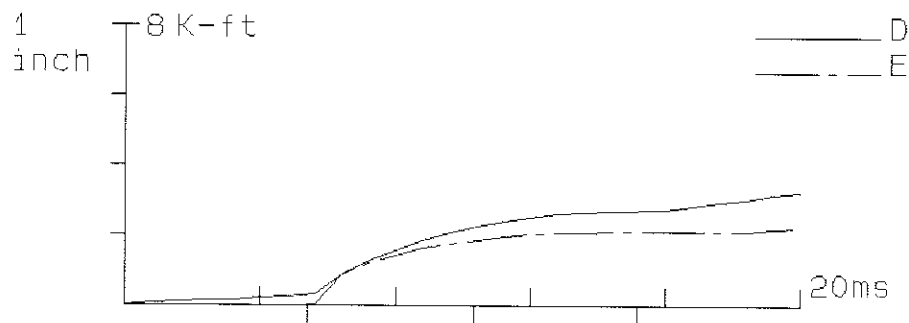
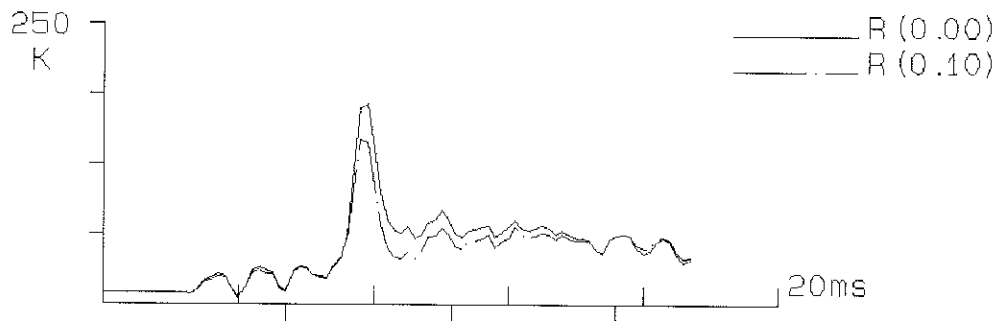
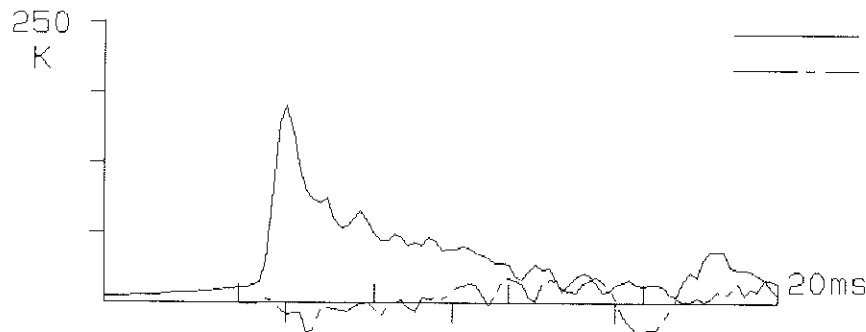
05071FT 2005-08-21

HAV 180, 6-5/8" CLOSED

BN 48/423



CSX 13.63 Ksi
EFV 2.230 Kip-ft
ETR 27 %
BPM 91.7 BPM
VMX 8.6 ft/s
SFT 51 Kips
FMX 165 Kips
RA2 69 Kips
DMX 0.40 inch
LP 78.00 ft
LE 82.00 ft
AR 12.10 in2
EM 30004 Ksi
SP 0.493 K/ft3
WS 16800 ft/s
F 34 A 34



R Miner Dynamic Test

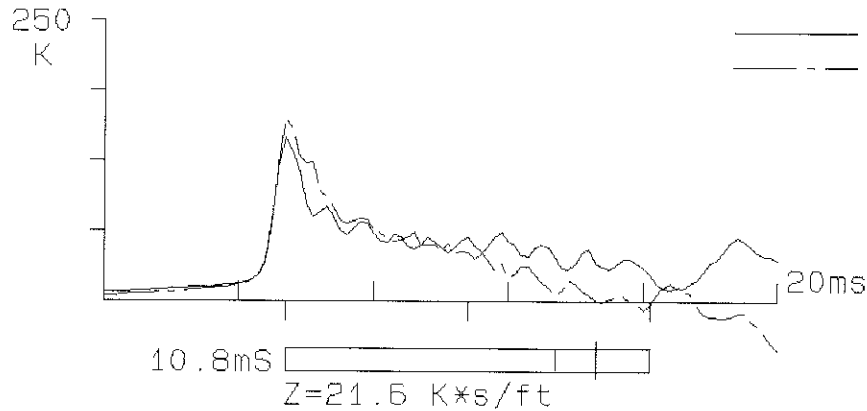
ROSE CREEK, BPT05-05

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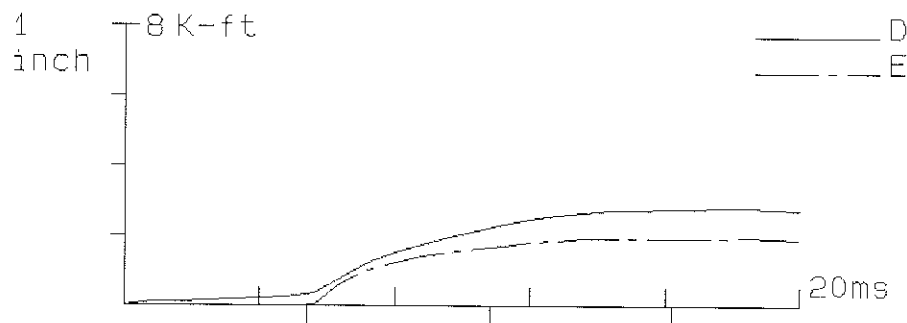
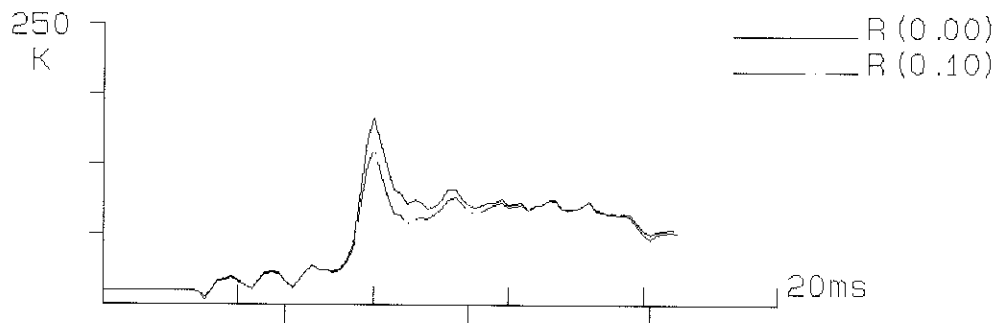
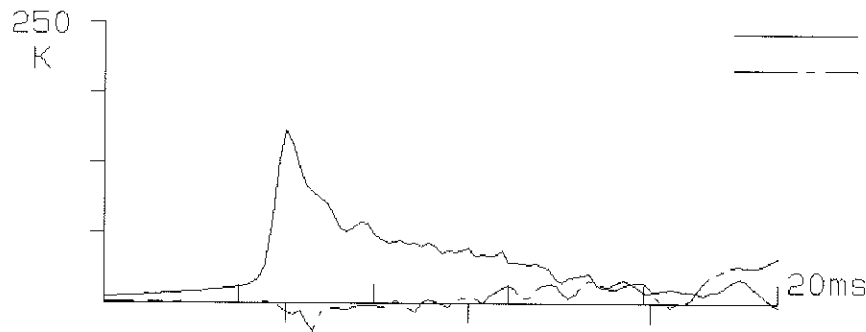
PDI FILE DRIVING ANALYZER®v5.03

05079FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 130/633
 CSX 12.06 Ksi
 EFV 1.960 Kip-ft
 ETR 24 %
 BPM 92.0 BPM
 VMX 7.5 ft/s
 SFT 41 Kips
 FMX 146 Kips
 RA2 89 Kips
 DMX 0.35 inch
 LP 86.00 ft
 LE 90.00 ft
 AR 12.10 in2
 EM 30004 Ksi
 SP 0.493 K/ft3
 WS 16800 ft/s
 F 34 A 34



R Miner Dynamic Test

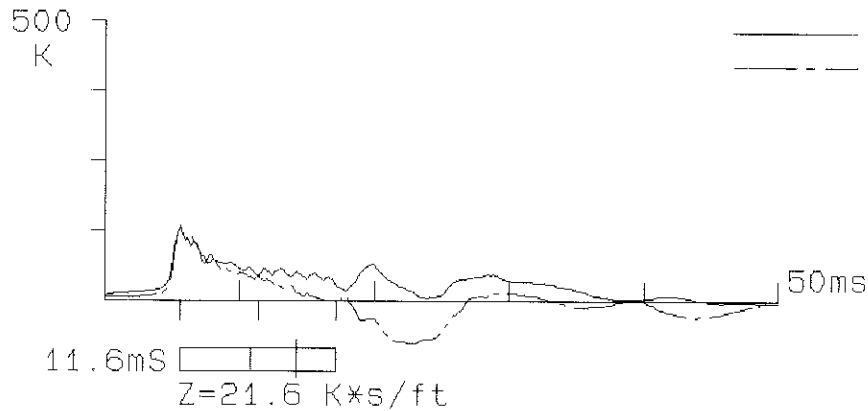
ROSE CREEK, BPT05-05

PDA OP: RMDT--B. Miner

PDI PILE DRIVING ANALYZER® v5.03

05087FT 2005-08-21

HAV 180, 6-5/8" CLOSED



BN 328/1036

CSX 10.82 Ksi

EFV 2.160 Kip-ft

ETR 27 %

BPM 91.7 BPM

VMX 6.2 ft/s

SFT 42 Kips

FMX 131 Kips

RA2 111 Kips

DMX 0.45 inch

LP 92.00 ft

LE 98.00 ft

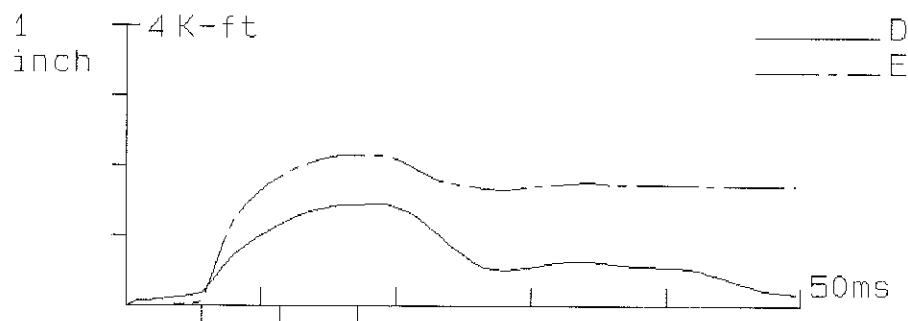
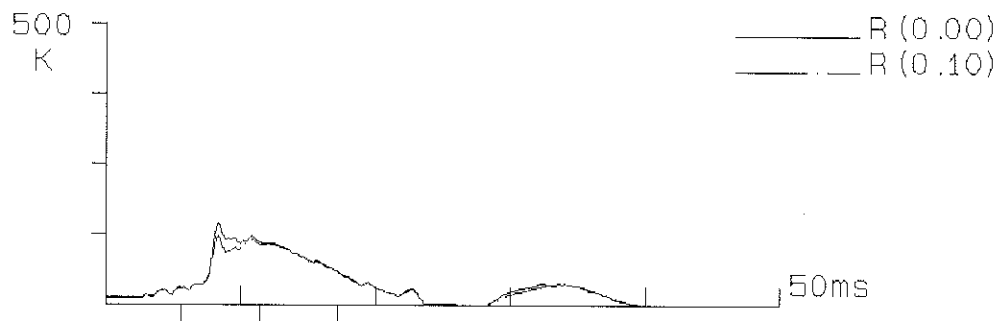
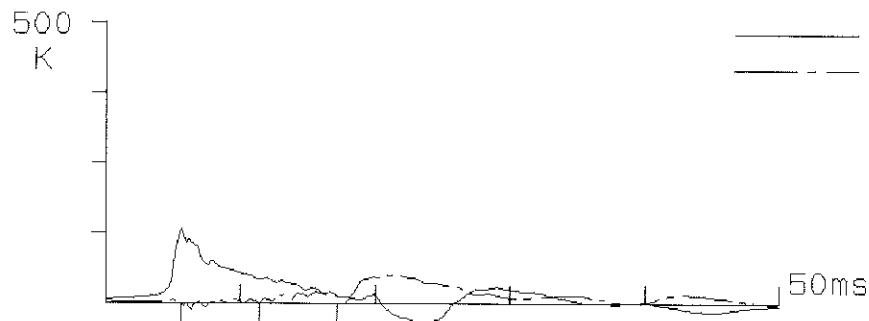
AR 12.10 in2

EM 30004 Ksi

SP 0.493 K/ft3

WS 16800 ft/s

F 34 A 34



APPENDIX V

BPT Data Interpretation

APPENDIX V

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APPENDIX V

BPT DATA INTERPRETATION

V-1. INTRODUCTION

The field observations of the performance of sites during earthquakes have formed the basis for the widely used Seed's simplified method of liquefaction potential assessment for level ground (Youd et al. 2001). Seed's procedure uses Standard penetration test (SPT) N_{60} values as the soil density index, and is applicable to sand and silty sand sites for which the performance database was compiled. For assessing soil liquefaction at gravelly sites, the current practice is to use the Becker penetration test (BPT) to determine the equivalent SPT N_{60} values for the gravelly soils, and then evaluate the liquefaction potential using the Seed SPT-based procedure for sand and silty sand sites. Two procedures were used to convert the Becker blowcounts to equivalent SPT N_{60} values in this study: an empirical approach proposed by Harder (1988), and the wave-equation based approach proposed by Sy (1993).

V-2. HARDER APPROACH

Harder (1988) proposed an empirical BPT-SPT correlation procedure based on standardizing the BPT blowcounts to a constant combustion condition by measuring peak pressures in the bounce chamber of the double-acting diesel hammer used in the BPT. The Harder procedure involves two steps. First, the field measured BPT blowcount (N_b) is corrected to a reference full combustion condition using the correction chart as shown on Figure V-1a, and second, the bounce chamber corrected BPT blowcount (N_{bc}) is used to estimate equivalent SPT N_{60} value using the correlation curve shown on Figure V-1b. In practice, the Harder procedure has several limitations:

- The reference combustion line A-A (Figure V-1a), although developed for a turbo-charged AP-1000 drill rig, is specific to the drill rig-hammer system used and the ground conditions that were encountered in the Harder (1988) correlation study, and is, therefore, unique. Sy and

Campanella (1993) and Sy (1997) illustrated that different reference combustion lines could be derived from the same drill rig at different sites, or from using different casing sizes at the same site, or from using different drill rigs.

- The BPT-SPT correlation shown on Figure V-1b was based on test data from three sand and silty sand sites to 15 m depth. Since the Harder approach does not explicitly consider casing friction, it may not be directly applicable to depths greater than 15 m or to gravelly soil sites.

Despite the above limitations, the Harder procedure has been used, mainly in the United States, for the liquefaction assessment of gravelly soils.

V-3. SY APPROACH

A more fundamental approach to BPT-SPT correlation, based on experimental and numerical studies of the SPT and BPT was proposed by Sy (1993). In this approach, the energy-corrected BPT blow count, N_{b30} , and the measured casing friction or shaft resistance, R_s , are used to estimate the equivalent SPT N_{60} value from theoretical BPT-SPT correlation (Figure V-2).

A Pile Driving Analyzer (PDA) is used during the BPT to determine the energy transferred into the top of the casing, similar to dynamic monitoring of pile driving (ASTM D4945-89). The PDA records force and velocity time histories for each hammer blow, and then calculates the transferred energy for each blow in real time. The transferred energy is used to normalize the field BPT blow count to a reference energy of 30% of the manufacturer's rated energy for the ICE 180 hammer in the Becker system:

$$N_{b30} = N_b \frac{ENTHRU}{30} \quad [1]$$

where N_{b30} is the normalized BPT blow count, N_b is the measured field BPT blowcount, and ENTHRU is the calculated transferred energy expressed as a percentage of the 11.0 kJ rated hammer energy for an ICE 180 hammer.

The soil friction and its distribution along the casing can be measured during the BPT by casing pull-up tests, or estimated from the PDA stress wave measurement using CAPWAP, a signal-matching wave equation analysis program. The casing pull-up test consists of measuring the pull-up force, R_s , during each rod change or casing add-on with a tension load cell connected to the top of the Becker casing. Sy (1997) found that the pull-up tension force, although fundamentally different from the compressive soil friction acting on the casing during driving, is comparable to the CAPWAP-estimated casing friction.

V-4. BPT-SPT INTERPRETATION RESULTS

Harder Method

For the Harder method, the measured peak bounce chamber pressures (BCP) were used in the BPT data conversion. Figure V-3 shows the variation of BPT blow counts with the bounce chamber pressure and the transferred energy for BPT05-01 through BPT05-05. The measured transferred energy varied between about 12% to 40%. The variation of BPT blow counts with the bounce chamber pressure only for BPT05-06, BPT05-06B or BPT05-07 are shown on Figure V-3 as well; no PDA (energy) measurements were taken for these BPT. The data show an expected positive correlation between penetration resistance (N_b) and BCP (Sy and Campanella, 1993).

Sy Method

For the Sy method, the measured transferred energies from the PDA and estimates of the casing friction from CAPWAP and from Sy (1997) were used in the BPT data interpretation. PDA measurements were performed in BPT05-01 through BPT05-05.

Where no PDA data were available, the transferred energy required to interpret the other BPTs was assumed to be 30% of the theoretical maximum.

Figure V-4 shows the measured casing friction profiles from pull-up tests at all of the BPT holes, together with sand and gravel type curves from Sy (1997) and the 2005 CAPWAP. The measured friction values from the pull-up tests are generally lower than the computed friction from the 2005 CAPWAP analyses and the average friction for both sand and gravel sites as compiled in Sy (1997). Consequently, an estimated friction curve from the 2005 CAPWAP was used to interpret BPT05-05, and the gravel type curve from Sy (1997) was used to interpret all of the other BPT.

BPT-SPT Interpretation

Both the Harder and Sy methods were applied to each BPT. The BPT interpretation results are presented in Figures V-5 to V-12 for the eight BPT, together with the available SPT and LPT data for these drill holes. The figures show the recorded BPT blow counts (N_b); the measured bounce chamber pressures (BCP); the measured or assumed transferred energies (ENTHRU); the bounce chamber pressure corrected blow counts (N_{bc}); the transferred energy normalized blow counts (N_{b30}); the casing friction values from pull-up tests, CAPWAP analyses and the gravel type curves from Sy (1997); and, the calculated equivalent SPT (N_1)₆₀ for the Sy and Harder methods.

Summary data for the SPT and LPT are given in Table V-1. The SPTs and LPTs were carried out using an automatic trip hammer and energy was monitored during the majority of SPTs and LPTs listed in Table V-1 using an SPT analyzer. The measured energy ranged between 71% and 84 %. The measured LPTs were converted to equivalent SPT N_{60} using the method proposed by Daniel et al. (2003). Energy correction for measured SPT N and the overburden stress correction for SPT N_{60} were applied following the recommendation in Youd et al. (2001).

As shown in Figure V-9, the equivalent $(N_1)_{60}$ values in DH05-01 are generally closer to the equivalent $(N_1)_{60}$ values estimated by Sy method than those by Harder method for BPT05-05. The SPT and LPT data for the other drill holes (Figures V-5 to V-8 and V-10 to V-12) generally show a similar pattern.

Table V-1 Summary of SPT and LPT Data

DRILL HOLE	MUDDIED HOLE (Y/N)	SAMPLE TYPE	ENERGY MEASUREMENT (Y/N)	DEPTH (m)	MEASURED BLOW COUNTS, (N)	EQUIVALENT SPT $(N_1)_{60}$
DH05-01	Y	SPT	N	1.5	31	69
DH05-01	Y	SPT	N	3.1	36	73
DH05-01	Y	SPT	N	4.6	45	78
DH05-01	Y	SPT	Y	5.0	26	42
DH05-01	Y	SPT	N	6.1	21	33
DH05-01	Y	SPT	N	7.6	13	18
DH05-01	Y	SPT	N	8.8	8	11
DH05-01	Y	SPT	N	9.7	7	9
DH05-01	Y	SPT	Y	10.7	6	7
DH05-01	Y	SPT	N	12.2	12	14
DH05-01	Y	SPT	Y	13.7	59	68
DH05-01	Y	SPT	Y	15.2	33	34
DH05-01	Y	SPT	Y	16.8	20	20
DH05-01	Y	LPT	Y	18.3	37	27
DH05-01	Y	LPT	Y	19.8	27	18
DH05-01	Y	LPT	Y	21.3	47	32
DH05-01	Y	LPT	Y	22.9	37	25
DH05-01	Y	LPT	Y	24.4	60	38
DH05-01	Y	LPT	Y	25.9	98	61
DH05-01	Y	LPT	Y	27.4	98	61
BKS05-03	N	LPT	N	7.7	28	30
BKS05-03	N	LPT	Y	10.1	15	14
BKS05-03	N	LPT	Y	14.9	25	20
BKS05-04	N	LPT	Y	9.4	15	15
BKS05-04	N	LPT	Y	14.3	25	20
BKS05-06	N	SPT	Y	2.7	15	31
BKS05-06	N	SPT	Y	3.4	20	36
BKS05-06	N	SPT	N	5.2	10	16
BKS05-06	N	SPT	Y	10.1	48	53
BKS05-06	N	SPT	Y	12.2	21	24
BKS05-07	N	SPT	Y	7.6	20	28
BKS05-07	N	SPT	Y	10.1	43	51
BKS05-08	N	SPT	Y	11.8	124	139
BKS05-08	N	SPT	Y	13.7	22	22
BKS05-08	N	SPT	Y	14.3	44	44
BKS05-08	N	SPT	Y	16.1	28	27
BKS05-08	N	SPT	Y	21.0	27	24

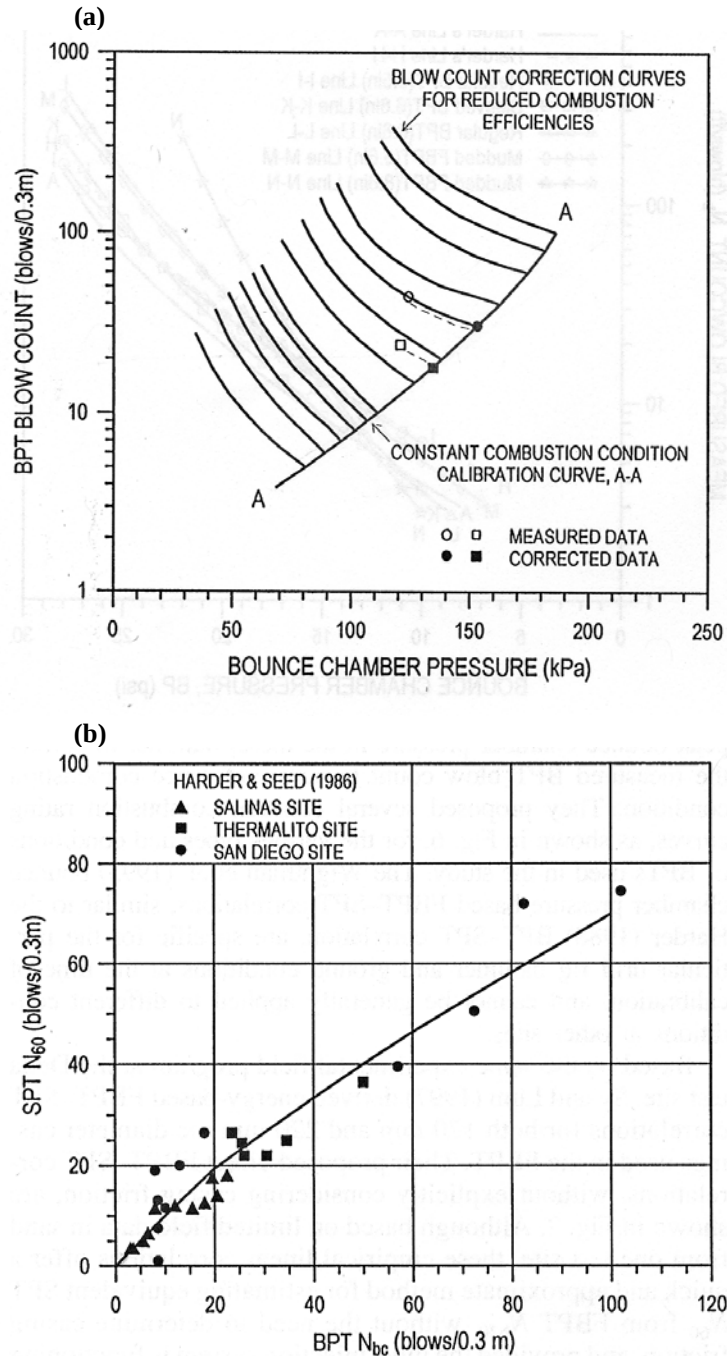


Figure V-1 Harder's BPT Interpretation Procedure (after Harder 1988)

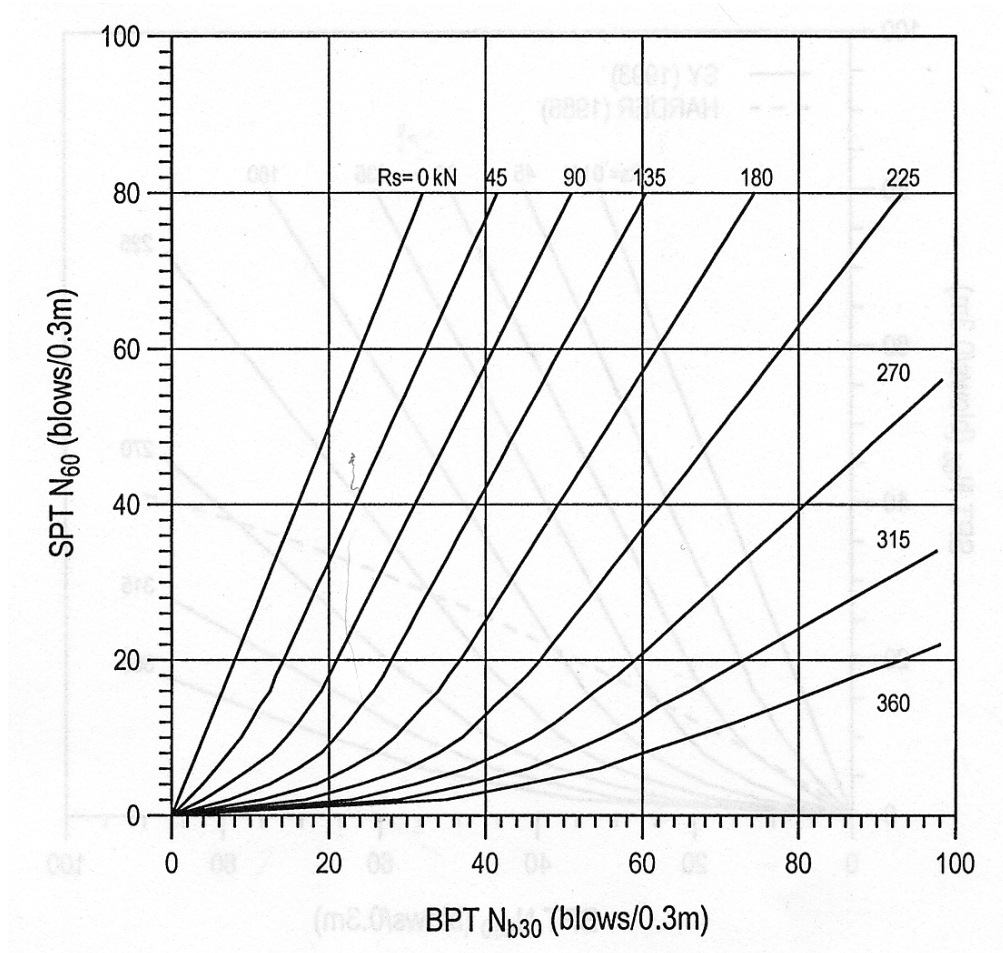


Figure V-2 Sy's BPT-SPT Correlation (after Sy, 1993)

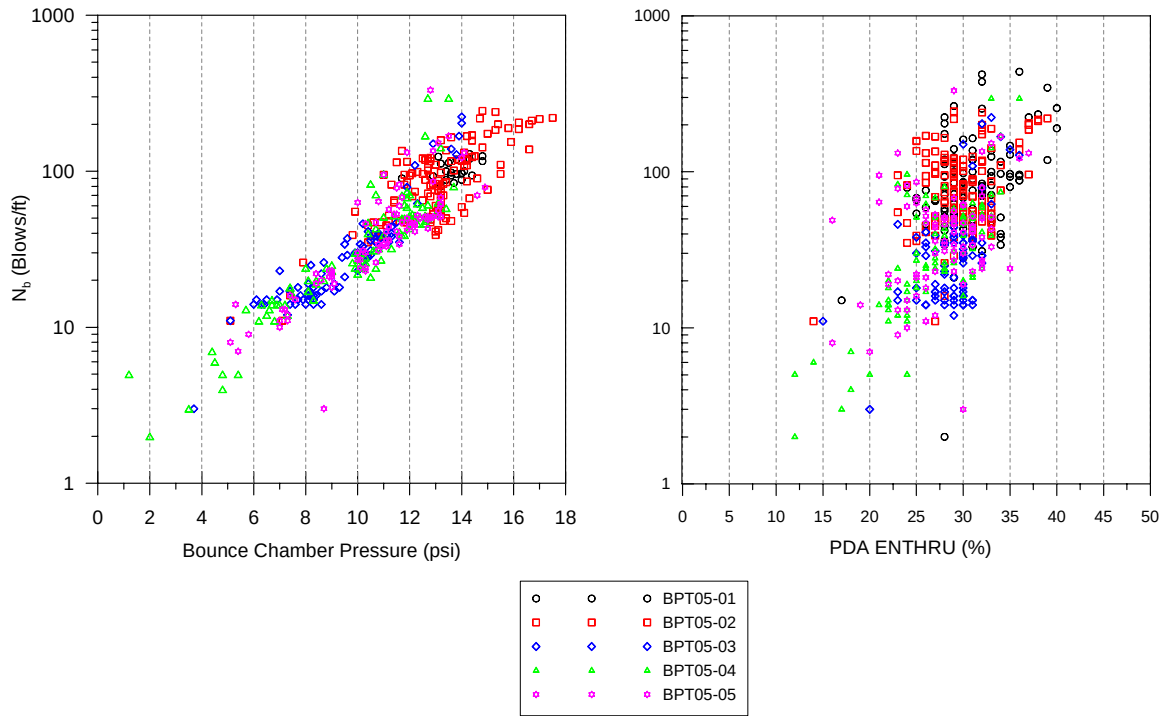
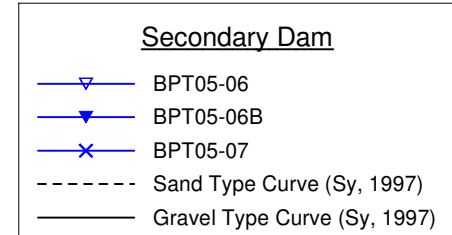
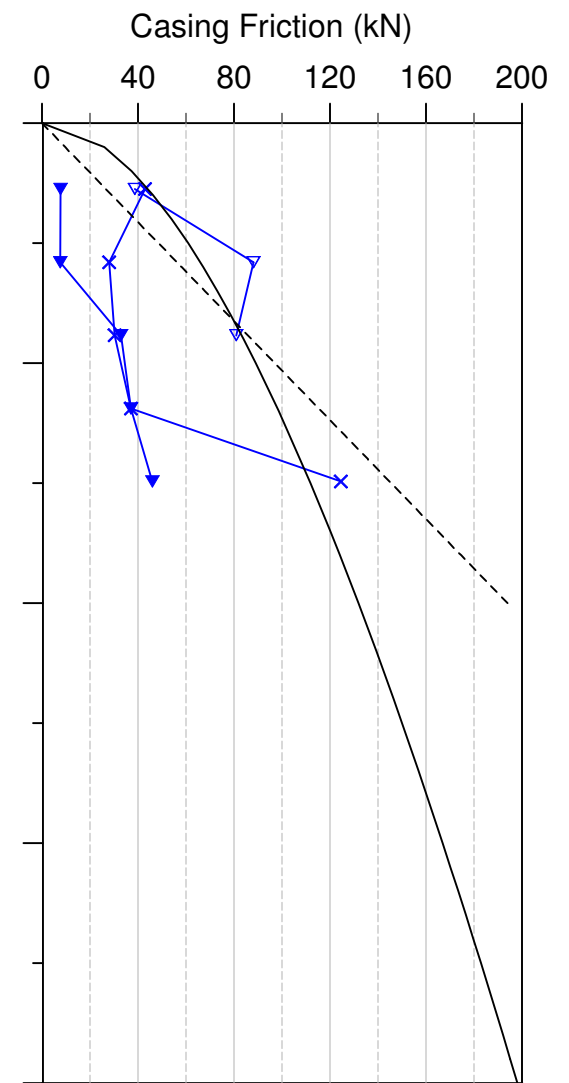
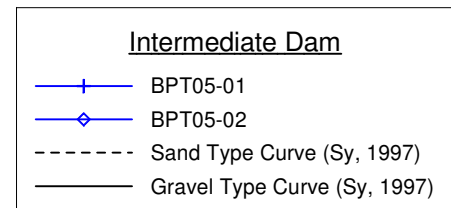
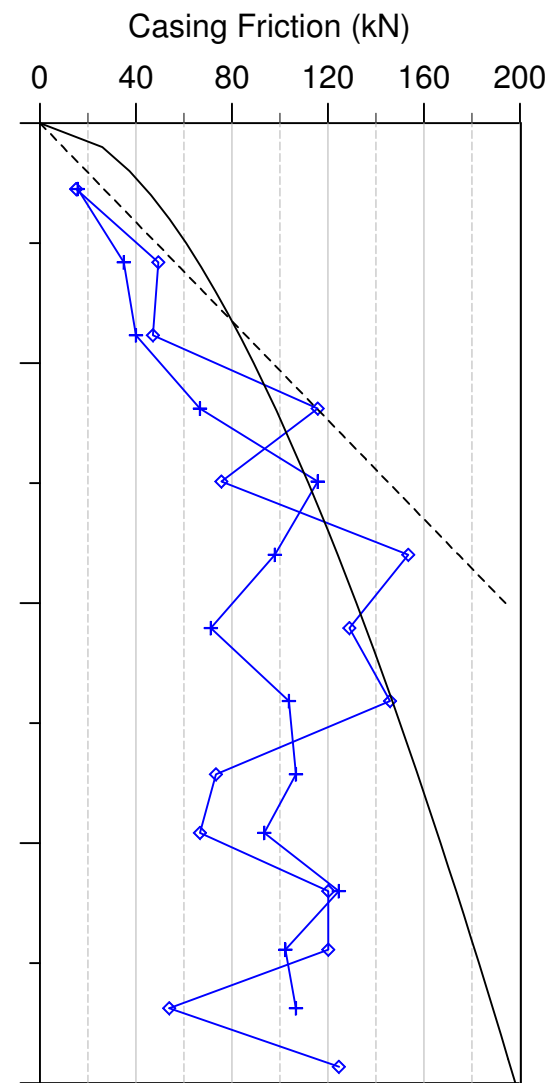
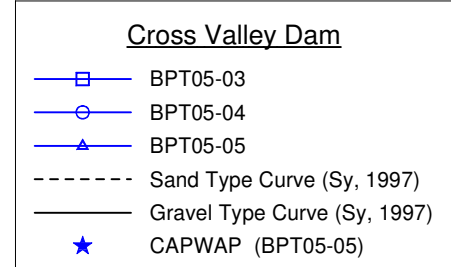
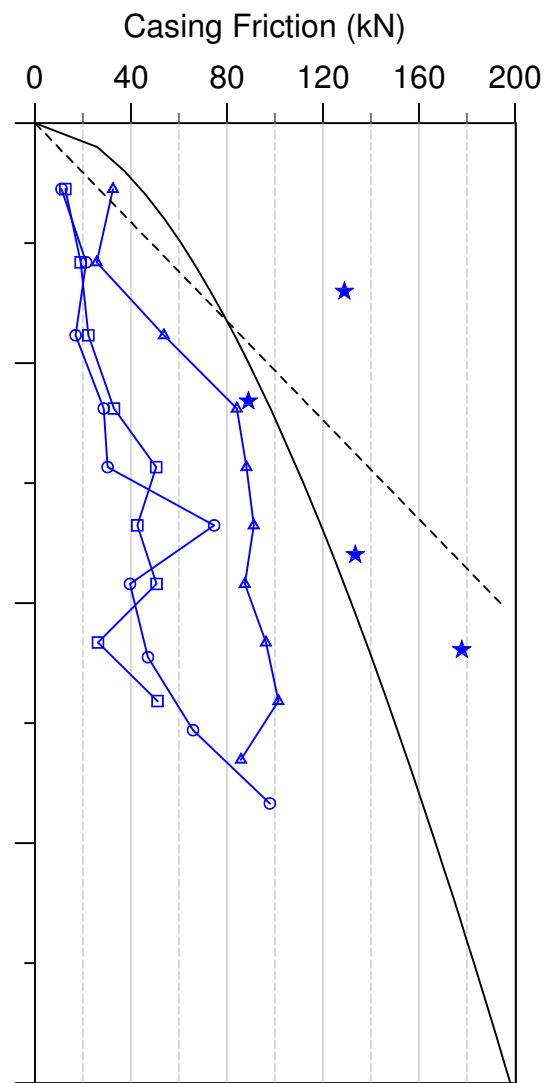
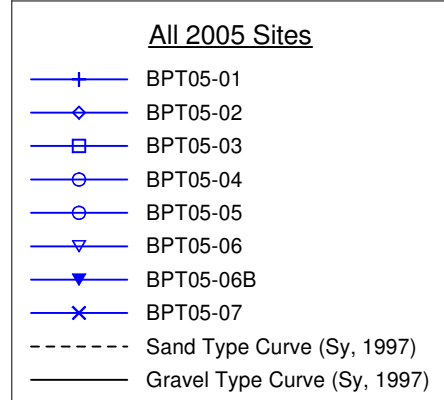
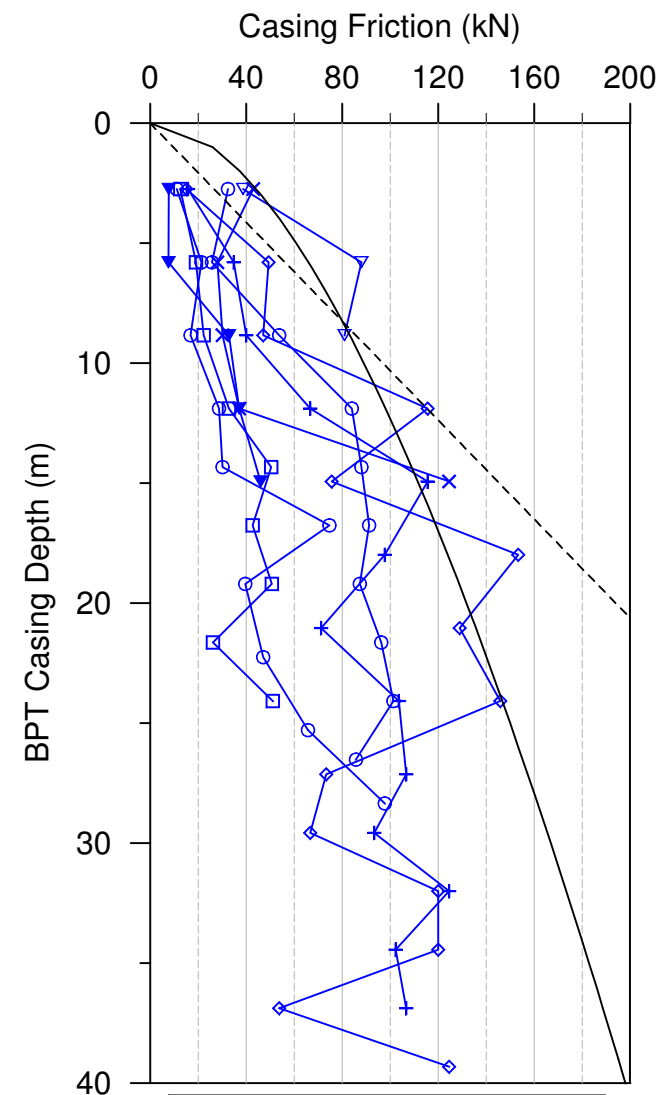


Figure V-3 Variation of BPT Blow Count with Bounce Chamber Pressure and ENTHRU Measurements



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CLIENT
DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX

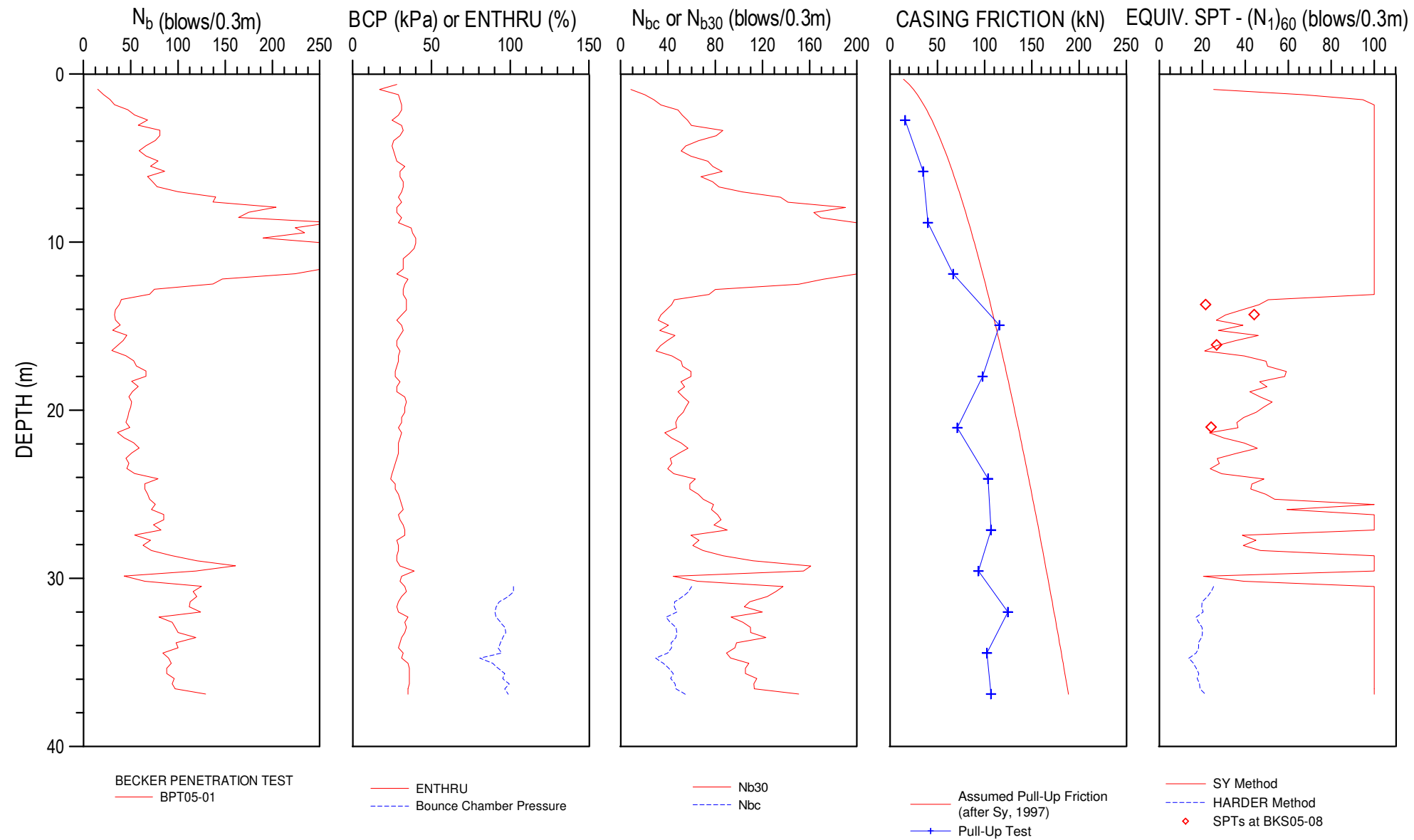


PROJECT
ROSE CREEK TAILINGS IMPOUNDMENT
SEISMIC STABILITY ASSESSMENT

TITLE
SUMMARY OF BPT PULL-UP TESTS
(AT 0.5 INCHES PULL-UP)

PROJECT NO. M09237 A03

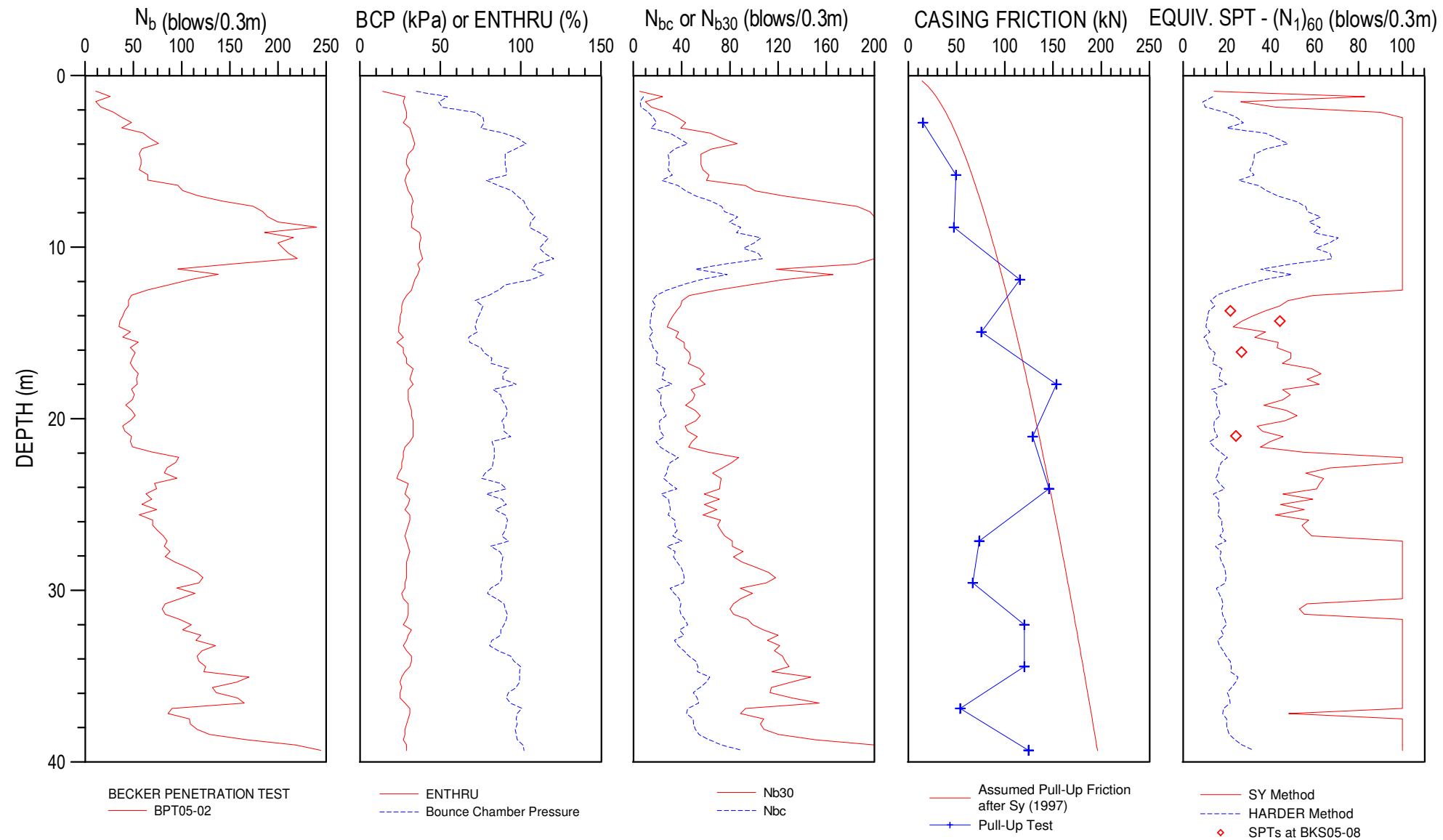
FIGURE NO. V-4



LEGEND	
N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

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	DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX	ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT	
		TITLE	
		DATA INTERPRETATION FOR BPT05-01	
		PROJECT NO.	FIGURE NO.
		M09237 A03	V-5

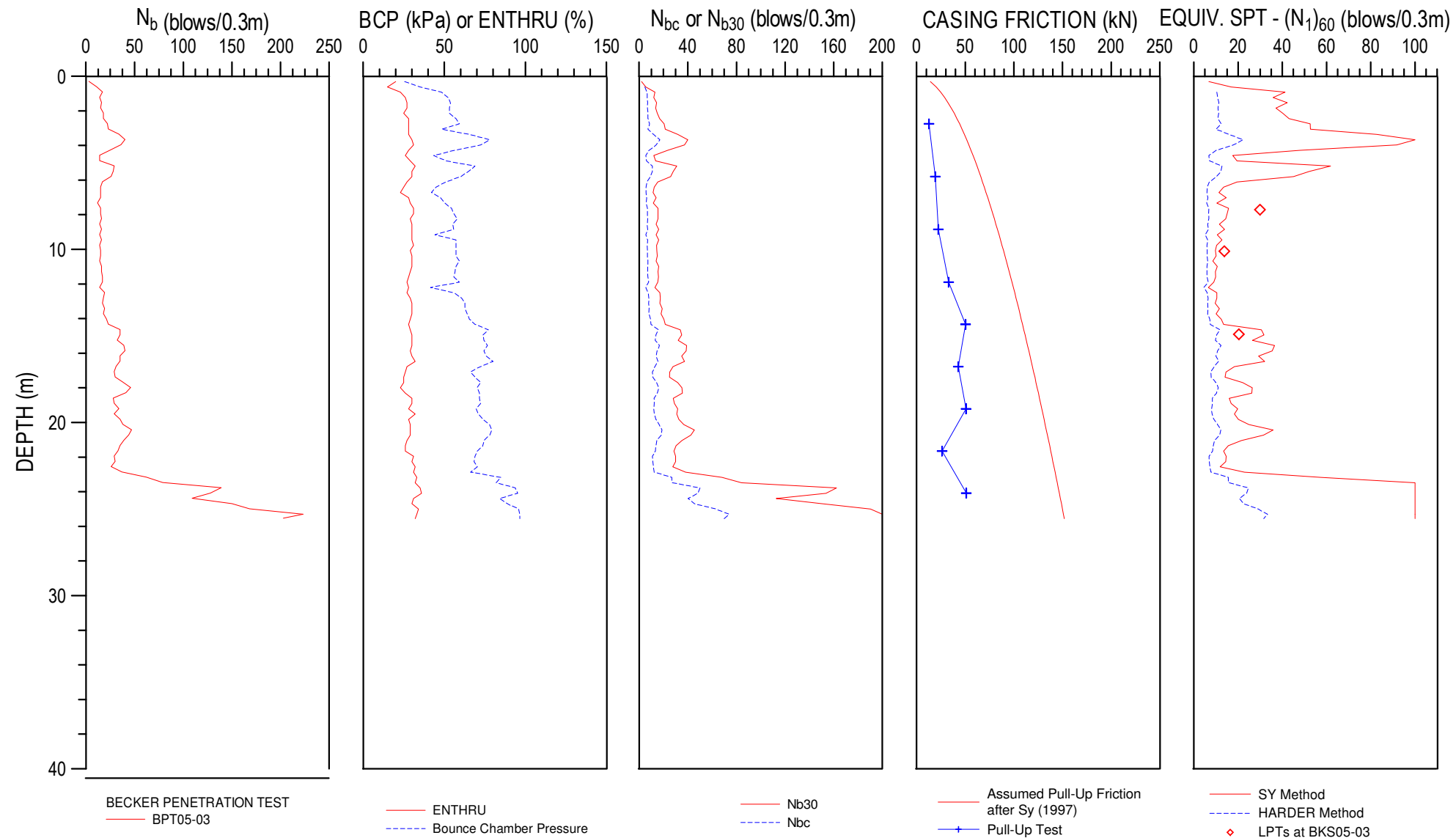


LEGEND

N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

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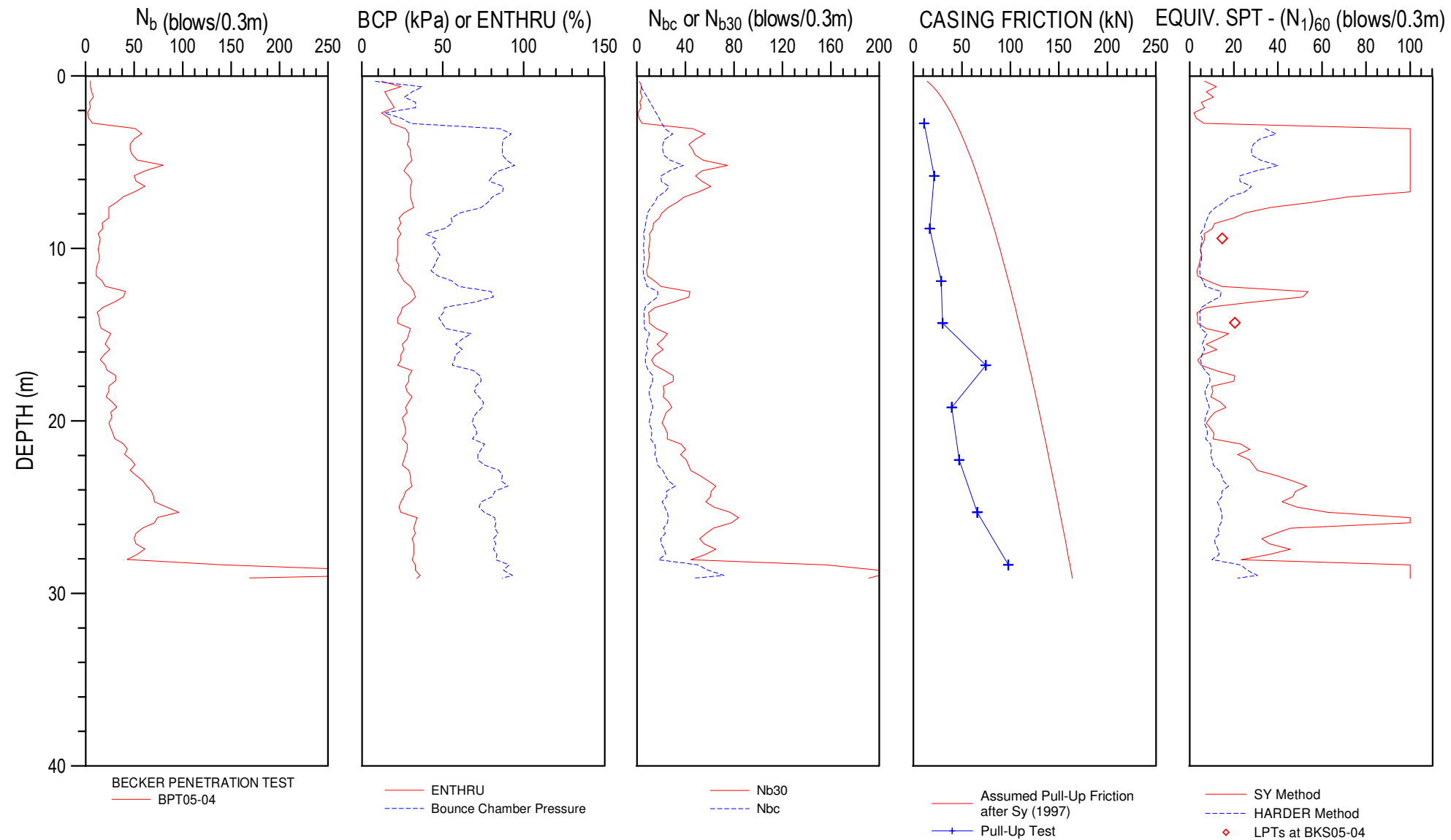
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KLOHN CRIPPEN		TITLE	
		DATA INTERPRETATION FOR BPT05-02	
		PROJECT NO.	FIGURE NO.
		M09237 A03	V-6



LEGEND	
N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

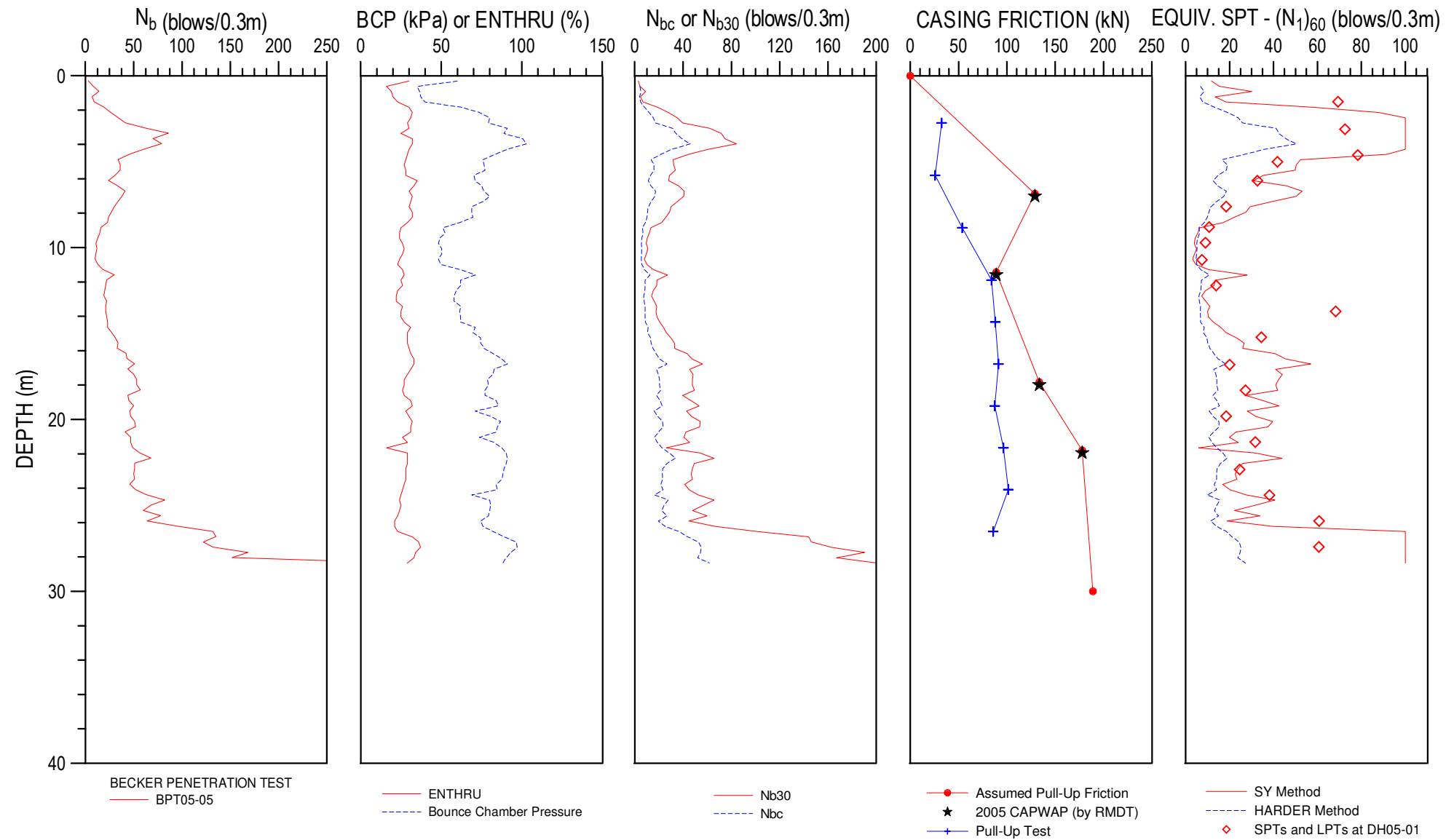
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		TITLE	
		DATA INTERPRETATION FOR BPT05-03	
		PROJECT NO.	FIGURE NO.
		M09237 A03	V-7



LEGEND	
N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

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				TITLE DATA INTERPRETATION FOR BPT05-04	
KLOHN CRIPPEN		PROJECT NO. M09237 A03		FIGURE NO. V-8	

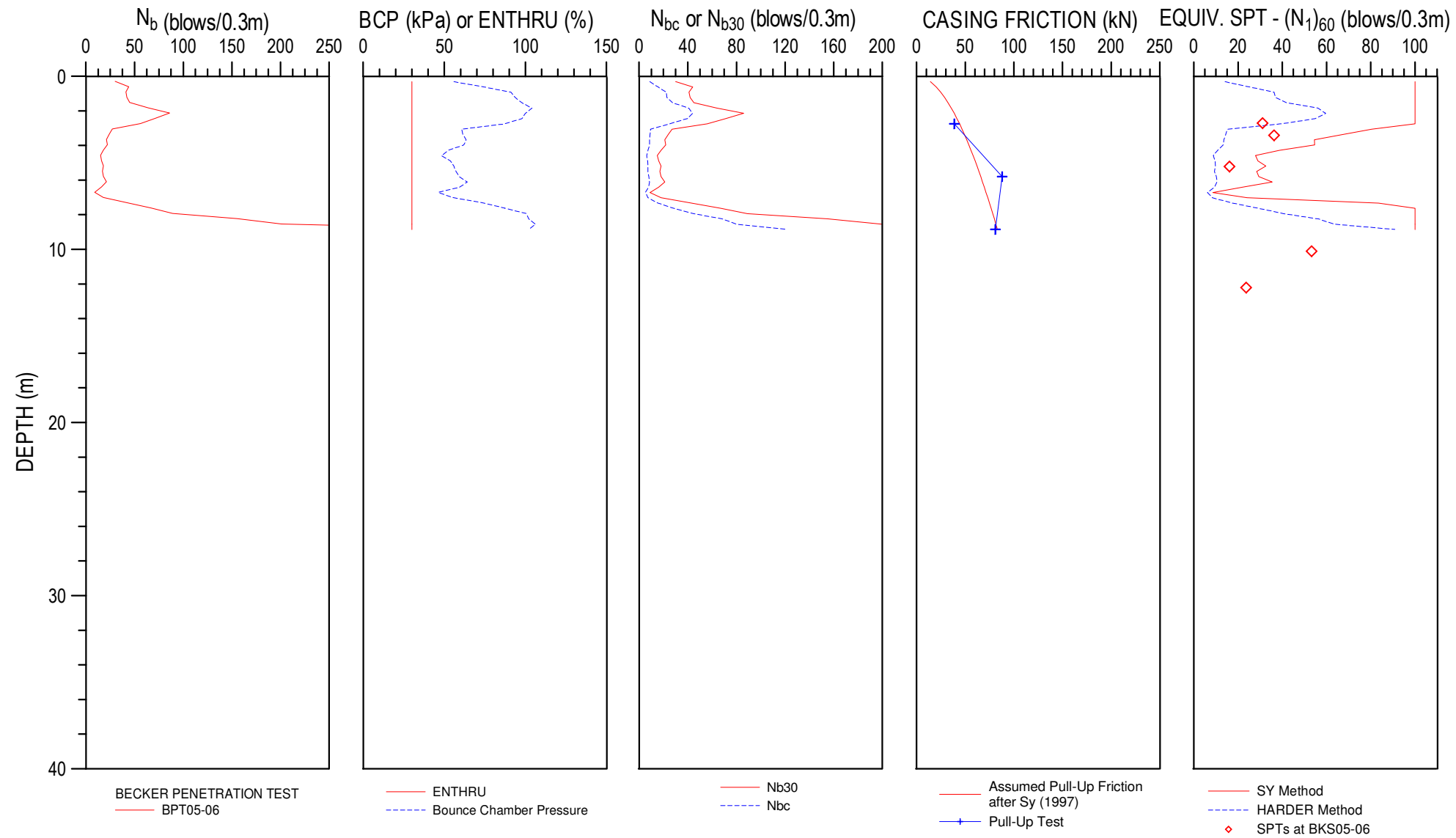


LEGEND

N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

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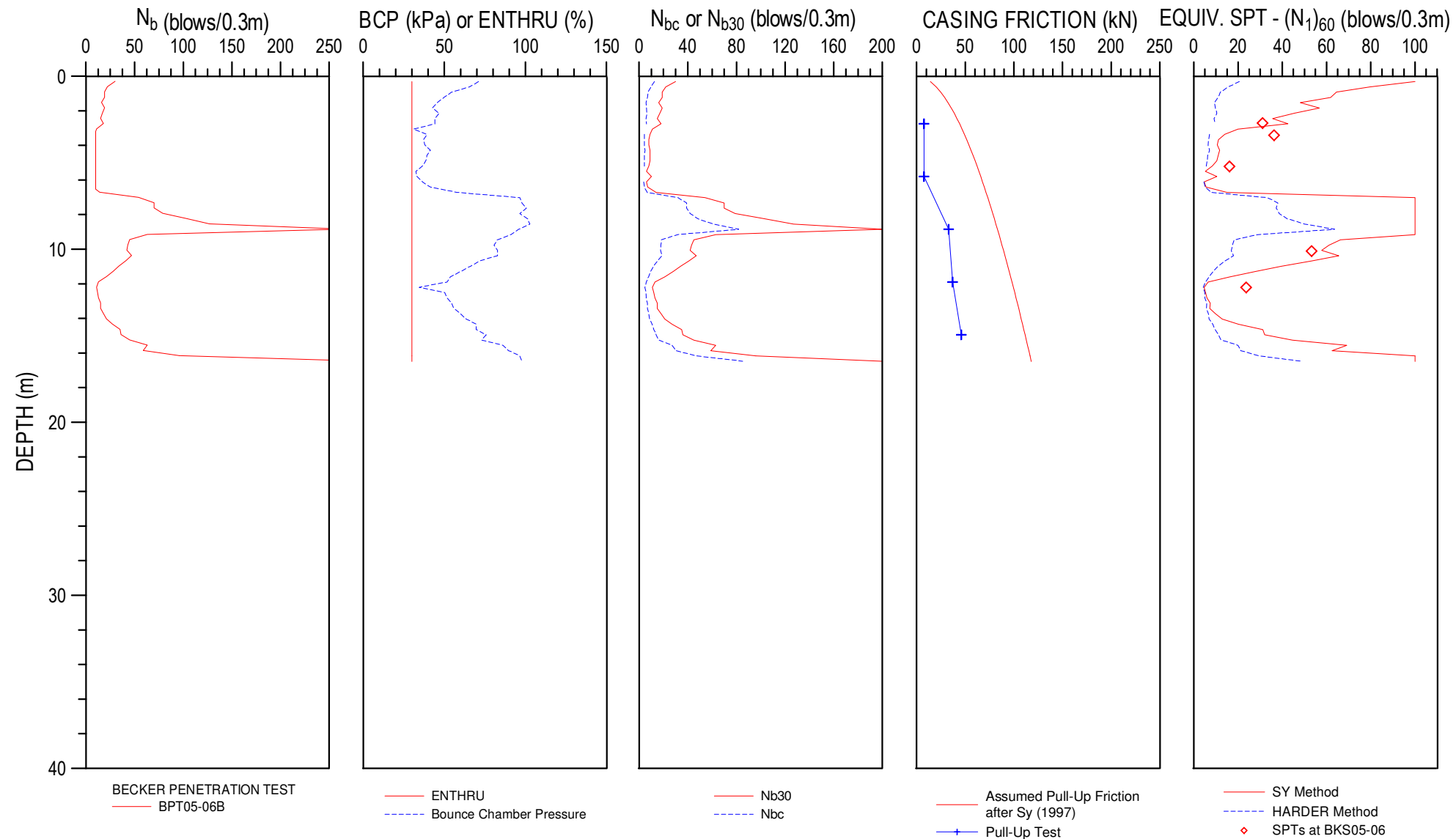
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	DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX	TITLE	DATA INTERPRETATION FOR BPT05-05	
	KLOHN CRIPPEN	PROJECT NO.	M09237 A03	FIGURE NO. V-9



LEGEND	
N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

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	DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX	ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT	
		TITLE	
		DATA INTERPRETATION FOR BPT05-06	
		PROJECT NO.	FIGURE NO.
		M09237 A03	V-10

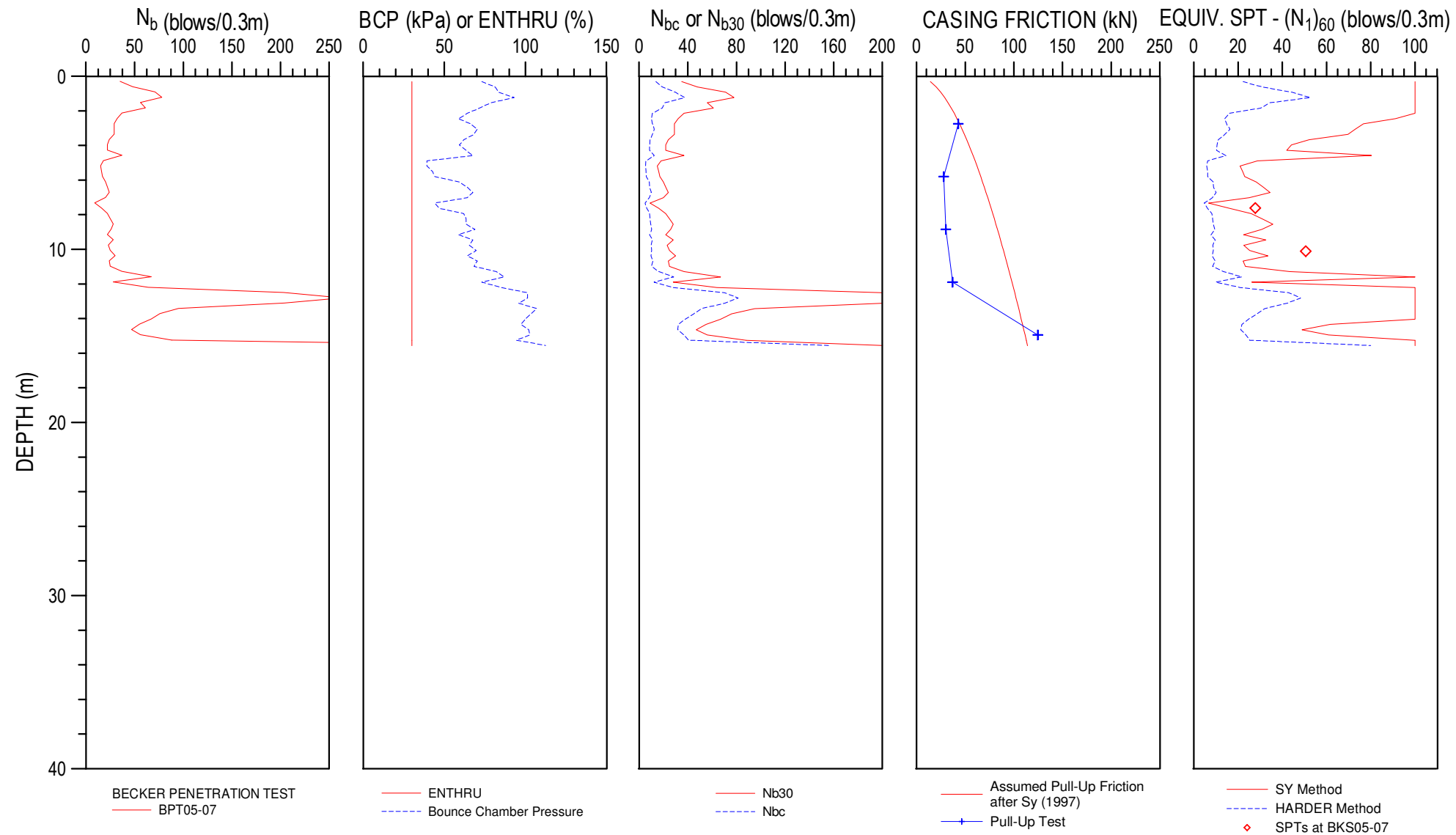


LEGEND

N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

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	DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX	TITLE DATA INTERPRETATION FOR BKS05-06B	
KLOHN CRIPPEN		PROJECT NO. M09237 A03	FIGURE NO. V-11



LEGEND

N_b	Measured BPT blow counts per 0.3 m
ENTHRU	Measured transferred energy as % of hammer rated energy
BCP	Measured bounce chamber pressure
N_{bc}	Corrected BPT blow counts to a constant combustion condition using Harder rating curve (1986)
N_{b30}	Corrected BPT blow counts to 30% reference energy of the rated energy for the ICE 180 hammer
HARDER method	Seed and Harder (1986) method for standardizing measured BPT blow counts to a constant combustion condition using measured bounce chamber pressures and correlation of the corrected blow count, N_{bc} , to the equivalent SPT N_{60}
SY Method	SY (1993) method for correcting measured BPT blow counts to the 30% reference energy level and estimation of the equivalent SPT N_{60} using the corrected blow count, N_{b30} , and measured or computed shaft resistance to account for soil friction effect

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	DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX	ROSE CREEK TAILINGS IMPOUNDMENT SEISMIC STABILITY ASSESSMENT	
KLOHN CRIPPEN		TITLE	
		DATA INTERPRETATION FOR BPT05-07	
		PROJECT NO.	FIGURE NO.
		M09237 A03	V-12

APPENDIX VI

Site Response and Liquefaction Analyses

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APPENDIX VI

SITE RESPONSE AND LIQUEFACTION ANALYSES

VI-1. INTRODUCTION

One dimensional total-stress site response analyses were carried out at each of the 2005 BPT locations on the Cross Valley Dam, the Intermediate Dam and the east limb of the Secondary Dam. The objective of the site response analyses was to determine peak horizontal acceleration and cyclic shear stress at various depths beneath the dams to carry out a liquefaction assessment. Table VI-1 lists the locations and conditions for which the analyses were carried out.

Table VI-1 Summary of ProShake Analyses

DAM	DRILL HOLE	CONDITION
Cross Valley Dam	BPT05-03	With the dam (through the crest); and, without the dam (at the dam toe)
	BPT05-04	
	BPT05-05	
Intermediate Dam	BPT05-01	With the dam (through the crest); and, without the dam (at the dam toe)
	BPT05-02	
Secondary Dam East Limb	BPT05-06B	With the dam (through the crest); and, without the dam (at the dam toe)
	BPT05-07	

The computer program ProShake (Edupro Civil Systems, 2005) was used to analyze the soil column response to a synthetic horizontal earthquake acceleration applied to the column base. ProShake computes the response of a horizontally-layered soil deposit overlying a uniform half-space subjected to vertically propagating shear waves. The analysis is performed in the frequency domain. To account for the non-linear soil response to shear loading, the program uses an iterative equivalent-linear algorithm to compute a shear modulus and damping ratio in each soil layer that is compatible with the induced shear strain.

VI-2. EARTHQUAKE INPUT MOTIONS

The earthquake records used in the analyses are those recommended by Atkinson (2003), and consist of four records from the 1989 Loma Prieta earthquake and two records from the 1994 Northridge earthquake. Figure VI-1 shows the acceleration time histories of these six records. Atkinson (2003) recommended these records, without any scaling, as they generally match the design spectra for Faro with 10,000 year return period in the median (50th percentile) to mean range.

Figure VI-2 presents a comparison of acceleration spectra of the six records with the 10,000 year return period spectra corresponding to mean, median, 16th and 84th percentile recommended by Atkinson (2003). The peak acceleration of the selected six records varied between 0.37 g and 0.54 g. Note that the range of peak accelerations of the selected records is within the median (0.3 g) and mean (0.5 g) peak ground accelerations (PGAs) for the 10,000 year return period earthquake. Table VI-2 presents a summary of the parameters for the earthquake records used in the analyses.

Table VI-2 Earthquake Records Used in the Site Response Analyses

Record Number	Earthquake and Station	Magnitude	Component	PGA (g)
1	1989 Loma Prieta Earthquake, Gilroy No. 3	M _L 7	0 deg	0.55
2	1989 Loma Prieta Earthquake, Gilroy No. 3	M _L 7	90 deg	0.37
3	1989 Loma Prieta Earthquake, UCSC/Lick Lab (Santa Cruz)	M _L 7	0 deg	0.44
4	1989 Loma Prieta Earthquake, UCSC/Lick Lab (Santa Cruz)	M _L 7	90 deg	0.41
5	1994 Northridge Earthquake, Pacoima Dam Downstream	M _L 6.6	175 deg	0.42
6	1994 Northridge Earthquake, Pacoima Dam Downstream	M _L 6.6	265 deg	0.43

VI-3. GROUND RESPONSE ANALYSES

VI-3.1 Soil Models

Each soil column was divided into layers based primarily on stratigraphy derived from the open-ended Becker test hole data. The original ground elevations estimated from the open-ended Becker test hole data were checked, where possible, against the elevations estimated from the pre-mining contours shown in Figure 2.1. The bedrock or dense till layer at the bottom of each hole was treated as a half-space and the input acceleration time histories were applied at the top of the half-space. For the analyses that include the dams, the dam fill was treated as one soil unit. A total unit weight of 21 kN/m^3 was used for the sand and gravel foundation strata and for the dam fill. A total unit weight of 20 kN/m^3 was used for the silt foundation stratum.

VI-3.2 Low Strain Shear Modulus, $G_{\max}$

Foundation Materials

The low strain shear modulus, $G_{\max}$, is normally estimated from shear wave velocity using the relationship:

$$G_{\max} = \rho \times V_s^2 \quad [1]$$

where ρ is the density and V_s is the shear wave velocity. However, no directly measured shear wave velocities are available for the foundation materials beneath the dams. Thus, the low strain shear modulus, $G_{\max}$ was estimated from empirical correlations between $G_{\max}$ and SPT $(N_1)_{60}$. Various correlations for gravelly soils are available from Seed et al. (1986), Rollins et al. (1986), Lum and Yan (1994), Ohta and Goto (1976) and Yoshida et al. (1988). Seed et al. (1986) suggested the following correlation for gravels:

$$G_{\max} = 434 \times (N_1)_{60}^{0.33} \times (\sigma'_m \times P_a)^{0.5} \times F \quad [2]$$

where P_a is the atmospheric pressure, σ'_m is the mean effective normal stress, and F is a factor that can range between 1.35 to 2.5 for gravels; for sand, $F=1$.

For these analyses, the Seed et al. (1986) correlation with $F=1.5$ was used to estimate the shear wave velocity of gravelly soils. For sand, the same correlation with $F=1$ was used. For the silt encountered in BPT05-03, BPT05-04 and BPT05-05, because neither shear wave velocity or undrained shear strength data are available, the same correlation with $F=1$ was used.

Dam Fill

As measured shear wave velocities or small strain moduli were not available for the dam materials, the following relationship was used to estimate the low strain modulus:

$$G_{\max} = 3255 (\sigma'_m \times P_a)^{0.5} \quad [3]$$

Limited readings taken in the dam fill in BPT04-01 (Klohn Crippen, 2005) confirmed that the dam fill is dense.

VI-3.3 Shear Wave Velocity Profiles

Shear wave velocities were calculated from the estimated low strain modulus, $G_{\max}$. Figures VI-3, VI-4 and VI-5 show the computed shear wave velocity profiles for the Cross Valley Dam, Intermediate Dam and Secondary Dam (East Limb) respectively. The shear wave velocities were estimated from the computed $(N_1)_{60}$ at BPT05-01 through BPT05-05, BPT05-06B and BPT05-07. BPT04-10 and BPT04-13 were included on Figures VI-4 and VI-5 because they are close to the respective 2005 BPT holes shown on these figures. The profiles reflect local variations in the soil stratigraphy, and separate profiles were computed for subsurface conditions both with and without the dam fill. The profiles were averaged over discrete intervals for use in the ProShake analyses

(shown as solid lines with symbols on each respective figure). Bedrock or dense basal till layers at the base of the soil column were taken as the half-space in the ProShake analyses and were assigned a shear wave velocity of 1500 m/s.

VI-3.4 Modulus Reduction and Damping Curves

Modulus reduction and damping curves as a function of shear strain are required inputs for the equivalent linear analysis in ProShake. The modulus reduction and damping curves, generally considered characteristics of soil type, were obtained from the curves suggested by Rollins et al. (1998), Vucetic and Dobry (1991) and Seed et al. (1986). The modulus reduction and damping curves for sand and gravel, sand and silt used in the ProShake analyses are shown in Figure VI-6.

VI-3.5 ProShake Analyses

The results of the ProShake analyses for the six earthquake record input accelerations are shown in Figures VI-8 to VI-21 for subsurface conditions both with the dam (through the crest) and without the dam (at the dam toe). Each figure shows an elevation profile of the computed peak acceleration and the cyclic stress ratio (CSR) for each earthquake input. The CSR is the earthquake induced shear stress divided by the initial effective overburden stress. A profile of the average result of the six earthquake inputs is shown as well.

VI-4. LIQUEFACTION EVALUATION OF GRANULAR SOILS

VI-4.1 Methodology for Liquefaction Evaluation Using BPT

The liquefaction assessment of granular soils was carried out in general accordance with the Seed simplified approach as described in Youd et al. (2001), which summarizes the final recommendations from the 1996 NCEER and 1998 NCEER/NSF workshops on evaluation of liquefaction resistance of soils. In this approach, the cyclic stress ratios

(CSR) induced by the design earthquake are compared with the cyclic resistance ratios (CRR) derived from field observations of soils with known standard penetration test (SPT) resistances, at sites that have or have not liquefied during earthquakes. For this project, the induced CSR at each site was computed from the ProShake ground response analyses. The CRR evaluation is based on the equivalent $(N_1)_{60}$ values derived from the Becker penetration test (BPT) blow counts using the Sy (1997) method (Appendix V).

The procedure used for assessment of the liquefaction potential is as follows:

- The cyclic stress ratio (CSR) induced by the design earthquake is computed directly using results from the SHAKE analyses, where CSR is 65% of the maximum earthquake-induced cyclic shear stress divided by the initial effective overburden pressure at the depth of interest.
- The required cyclic resistance ratio (CRR) is computed from the above computed CSR and a factor of safety (FOS) of 1.0:

$$CRR = FOS \times CSR \quad [4]$$

- Because Seed's liquefaction chart is for a M7.5 earthquake at an overburden stress of 100 kPa (1 tsf), the CRR calculated from [4] is corrected as follows:

$$CRR_{M7.5} = \frac{CRR}{K_m K_\sigma} \quad [5]$$

where K_m is a correction factor for design earthquake magnitude not equal to M7.5, and K_σ is a correction factor for initial static confining stress greater than 100 kPa (1 tsf).

- The required SPT $(N_1)_{60}$ value corresponding to $CRR_{M7.5}$ is determined from the liquefaction resistance chart originally developed by Seed et al. (1985), and recently modified by Youd et al. (2001). The liquefaction curve for fines content of 10% was used.
- The $(N_1)_{60}$ values required for a factor of safety of 1.0 are then compared with the equivalent $(N_1)_{60}$ values estimated from BPTs to identify the liquefiable zones. At depths where the required $(N_1)_{60}$ values (demand)

are greater than the equivalent $(N_1)_{60}$ values (resistance), the factor of safety is less than 1.0 and liquefaction is expected to occur during the design earthquake.

M7.1 was used as design earthquake as suggested in Atkinson (2003) to determine the correction factor K_m . The correction factor, K_σ was conservatively estimated using the correlation recommended in Youd et al. (2001) for soils with relative density of 80%.

The fines content (percentage by mass passing the No. 200 mesh sieve) of foundation soil (fill excluded) from SPT and LPT in DH05-01 (19 samples), BKS05-03 (3 samples), BKS05-04 (3 samples), BKS05-06 (5 samples), BKS05-07 (2 samples) and BKS05-08 (5 samples) for a total of 37 samples was determined in the laboratory (see Appendix III for lab test results). The test results are summarized in Table VI-3.

Table VI-3 Summary of Laboratory Fines Content Determinations

LOCATION	AVERAGE FINES CONTENT % (NO. OF TESTS)			
	SILT	SILTY SAND	SAND	SANDY- GRAVEL
Cross Valley Dam	91.9 (7)	48.0 (4)	12.1 (10)	9.4 (8)
Intermediate Dam		36.6 (2)	15.1 (2)	8.6 (4)
Secondary Dam – East Limb			13.4 (3)	2.9 (1)
AVERAGE – all locations	91.9 (7)	44.2 (6)	12.8 (15)	8.7 (13)

The test results show that the average fines content for cohesionless soil (sand and sandy-gravel) varied from 8.7% to 12.8%, with only 3 of the 13 samples having less than 5% fines. The average fines content for all of the sand and sandy-gravel was 10.9%. The silty sands were typically encountered as relatively thin transitional strata adjacent to the silt-rich layers. On the basis of these data, the liquefaction curve corresponding to $FC < 10\%$ curve was considered appropriate for the analysis.

VI-5. RESULTS OF LIQUEFACTION ANALYSES

The liquefaction potential at Cross Valley Dam, Intermediate Dam and the east limb of Secondary Dam was assessed by comparing the required $(N_1)_{60}$ values for a factor of safety against liquefaction of 1.0 (demand curves) with the equivalent $(N_1)_{60}$ profiles from the BPT (resistance curves) following the method of Sy (1997). These curves are plotted on Figures VI-8 to VI-21. Liquefaction is deemed to occur under a design earthquake if the equivalent $(N_1)_{60}$ values for the resistance curve are less than those of the demand curve.

VI-5.1 Cross Valley Dam

Figures VI-8, VI-9 and VI-10 show the liquefaction evaluation for subsurface conditions beneath the dam crest. Extensive liquefaction is expected to occur between El. 1011 m and 1003 m in BPT05-03, between El. 1008 m and El. 995 m in BPT05-04, and between El. 1008 m and El. 1001 m in BPT05-05. Moderate to marginal liquefaction was predicted between about El. 1001 and El. 995 in BPT05-03 and between about El. 996 m and El. 992 m in BPT05-05. Relatively low equivalent $(N_1)_{60}$ below El. 1008 m in BPT05-04 and BPT05-05 coincide with layers of silty soil. The liquefaction potential of the silty soil is evaluated in Section VI-6.

Figures VI-11, VI-12 and VI-13 show the liquefaction evaluation for subsurface conditions at the downstream toe. The intervals of potentially liquefiable soil are similar to those that occur beneath the dam crest. Note that the required $(N_1)_{60}$ values (demand curves) for all of the records are greater than those for subsurface conditions beneath the dam, likely because of higher amplification at the toe of the dam.

VI-5.2 Intermediate Dam

Figures VI-14 and VI-15 show the liquefaction evaluation for subsurface conditions beneath the dam crest. Extensive liquefaction is not expected to occur in BPT05-01 or

BPT05-02. Intervals of marginal liquefaction potential between El. 1016 m to El 1014 m and between El. 1010 m to El 1007 m in BPT05-01 have equivalent $(N_1)_{60}$ (resistance) greater than 20 and are not expected to result in extensive zones of liquefaction.

Figures VI-16 and VI-17 show the liquefaction evaluation for subsurface conditions at the downstream toe. The intervals of potentially liquefiable soil are similar to those that occur beneath the dam crest. Note that the required $(N_1)_{60}$ values (demand curves) for all of the records are greater than for subsurface conditions beneath the dam, likely because of higher amplification at the toe of the dam.

VI-5.3 Secondary Dam – East Limb

Figures VI-18 and VI-19 show the liquefaction evaluation for subsurface conditions beneath the dam crest. Extensive liquefaction is expected to occur between El. 1054 m to El. 1050 m and between El. 1045 m to El. 1042 m in BPT05-06B. An interval of marginal liquefaction potential between El. 1052 m to El. 1046 m in BPT05-07 has an average equivalent $(N_1)_{60}$ (resistance) of 26, however, equivalent $(N_1)_{60}$ as low as 7 in this interval suggest that liquefaction will be triggered in some portions of this interval.

Figures VI-20 and VI-21 show the liquefaction evaluation for subsurface conditions at the downstream toe. The intervals of potentially liquefiable soil are similar to those that occur beneath the dam crest. Note that the required $(N_1)_{60}$ values (demand curves) for all of the records are greater than those for subsurface conditions beneath the dam, likely because of higher amplification at the toe of the dam.

VI-6. LIQUEFACTION EVALUATION OF FINE GRAINED SOILS

Silt layers were encountered in BPT05-04 between about El. 1002.6 m and El. 997.1 m, and in BPT05-05 between about El. 1007.7 m and El. 1002.5 m. The liquefaction susceptibility of fine-grained soils is typically assessed using the Chinese criteria (Seed

and Idriss, 1982) as a screening tool. Recent criteria developed by Andrews and Martin (2000) and by Bray et al. (2004) can also be used to assess the liquefaction susceptibility of fine-grained soils. The Chinese criteria are outlined below:

- Percent of Particles Finer than $5\mu\text{m} < 15\%$;
- Liquid Limit (LL) $< 35\%$; and
- Water Content (W) $> 0.9 \times \text{LL}$.

All three criteria must be satisfied for the soil to be considered potentially liquefiable and recommended for further laboratory testing. The criteria proposed by Andrews and Martin (2000) for fine grained soils are as follows:

- Percentage of Particles Finer than $2\mu\text{m} < 10\%$; and
- Liquid Limit $< 32\%$.

Both criteria need to be satisfied for the soil to be considered potentially liquefiable. If only one of the two criteria are satisfied, further testing is recommended.

Bray et al. (2004) proposed a new criterion to evaluate the liquefaction susceptibility of fine-grained soils, noting that it is not the amount of clay-size particles in the soil, but rather the amount of clay minerals that best indicate the liquefaction susceptibility. Hence, they used the plasticity index and the ratio of water content to the liquid limit in their proposed criteria, as follows:

- Water Content (W) $\geq 0.85 \times \text{LL}$.
- Plasticity Index (PI) $\leq 12\%$.

SPT and LPT samples from the silt layer in DH05-01 and a single disturbed sample collected during the open-ended Becker drilling in BKS05-04 were tested in the laboratory for grain size, Atterberg limits and moisture content (see Appendix III for laboratory test results). The test data were used to assess the liquefaction potential of the

silt using the assessment methods described above, and are presented in Figure VI-7.

These results are summarized as follows:

- According to the Chinese criteria, only one of the seven samples satisfied all of the liquefaction criteria; the other six had more than 15% fines by mass finer than 5 μm .
- According to the Andrews and Martin criteria, only one of the seven samples satisfied both of the liquefaction criteria; the other six had more than 10% fines by mass finer than 2 μm .
- According to the Bray et al. criteria, all of the seven samples tested satisfied both of the liquefaction criteria.

The liquefaction assessment based on the Chinese criteria and Andrews and Martin criteria are equivocal, and generally indicate that further laboratory testing is required. However, the assessment based on the Bray et al. criteria unequivocally indicates that the silt is liquefiable. A conservative appraisal of these results suggests that the silt layer(s) are potentially liquefiable.

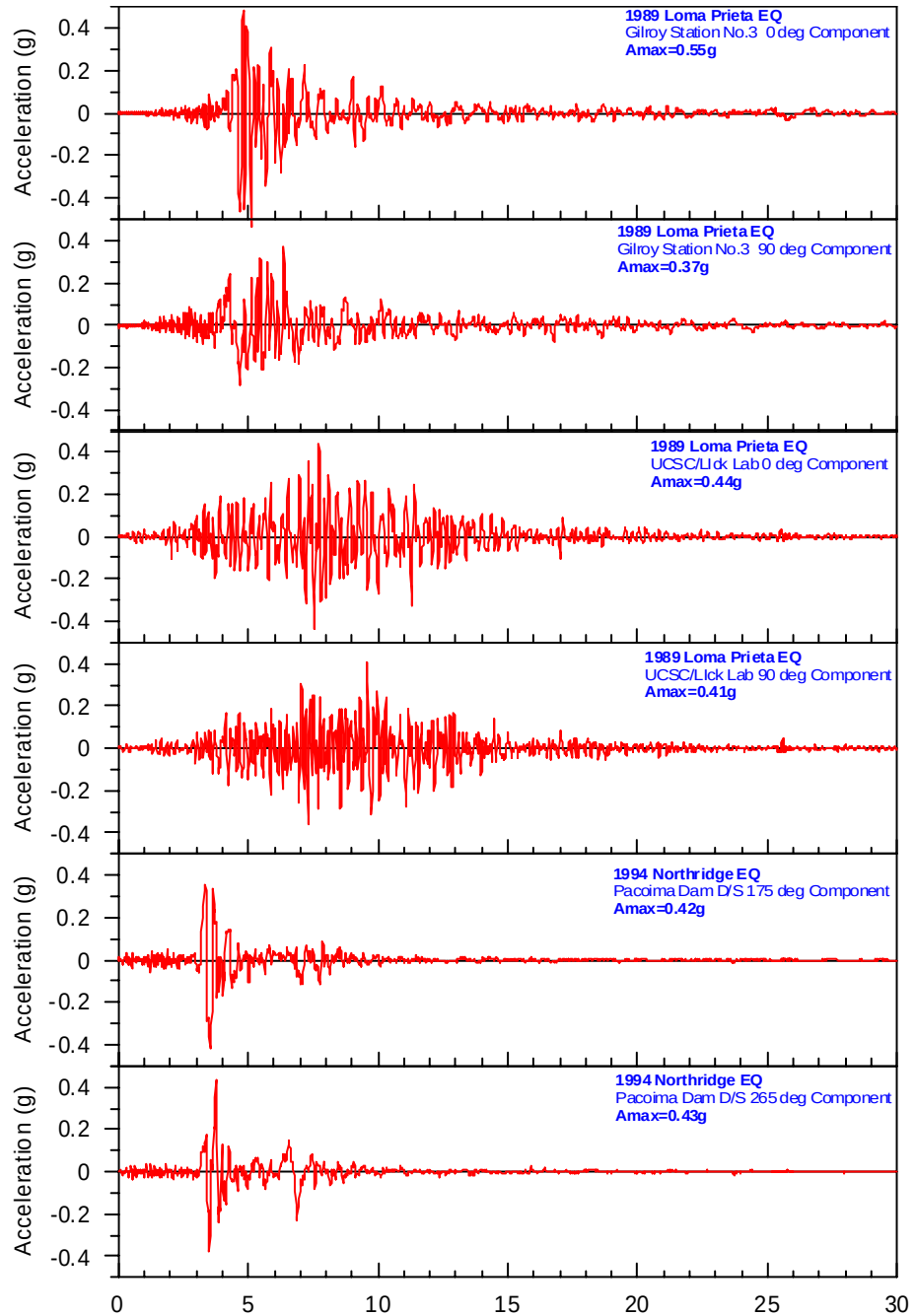


Figure VI-1 Six Input Acceleration Time Histories Used in the Site Response Analyses

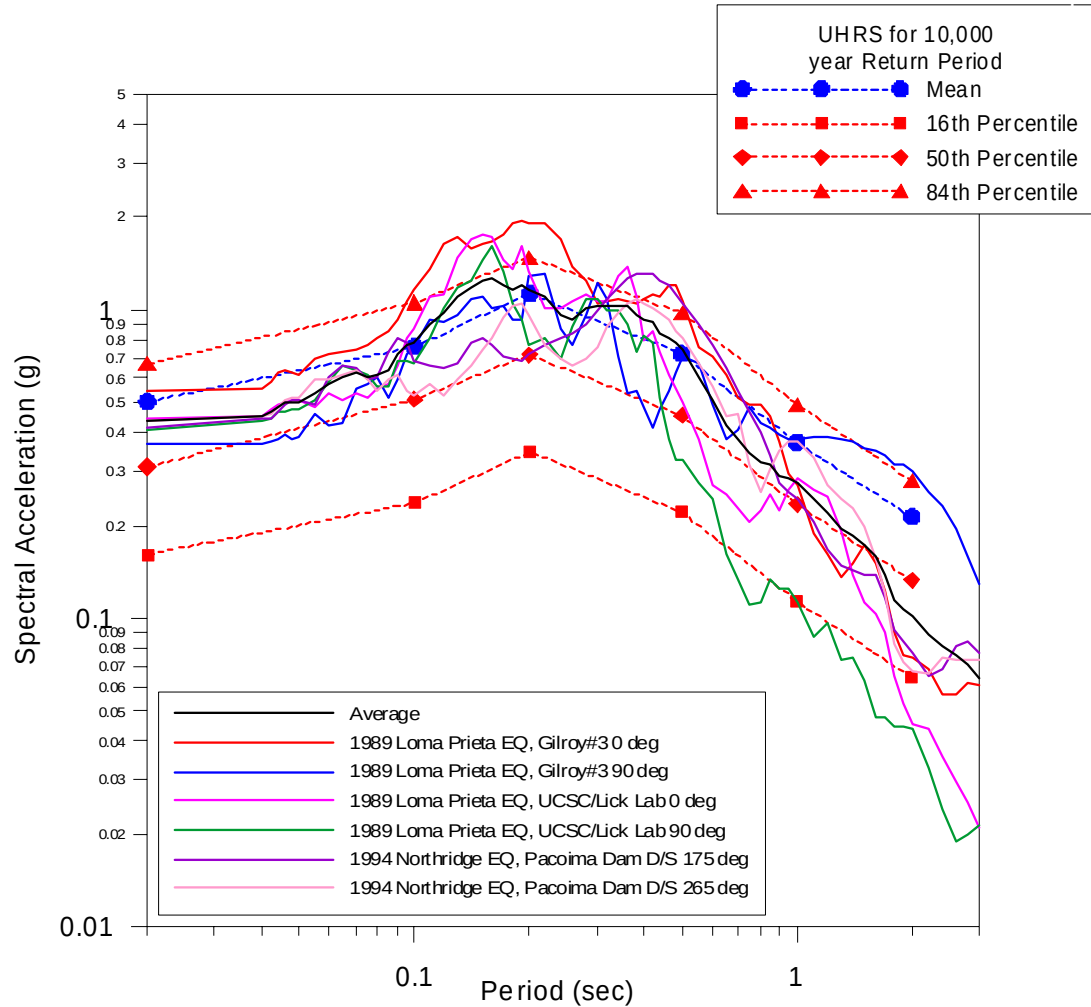


Figure VI-2 Comparison of Acceleration Response Spectra of Six Input Time Histories with the Target Spectra Provided by Atkinson (2003)

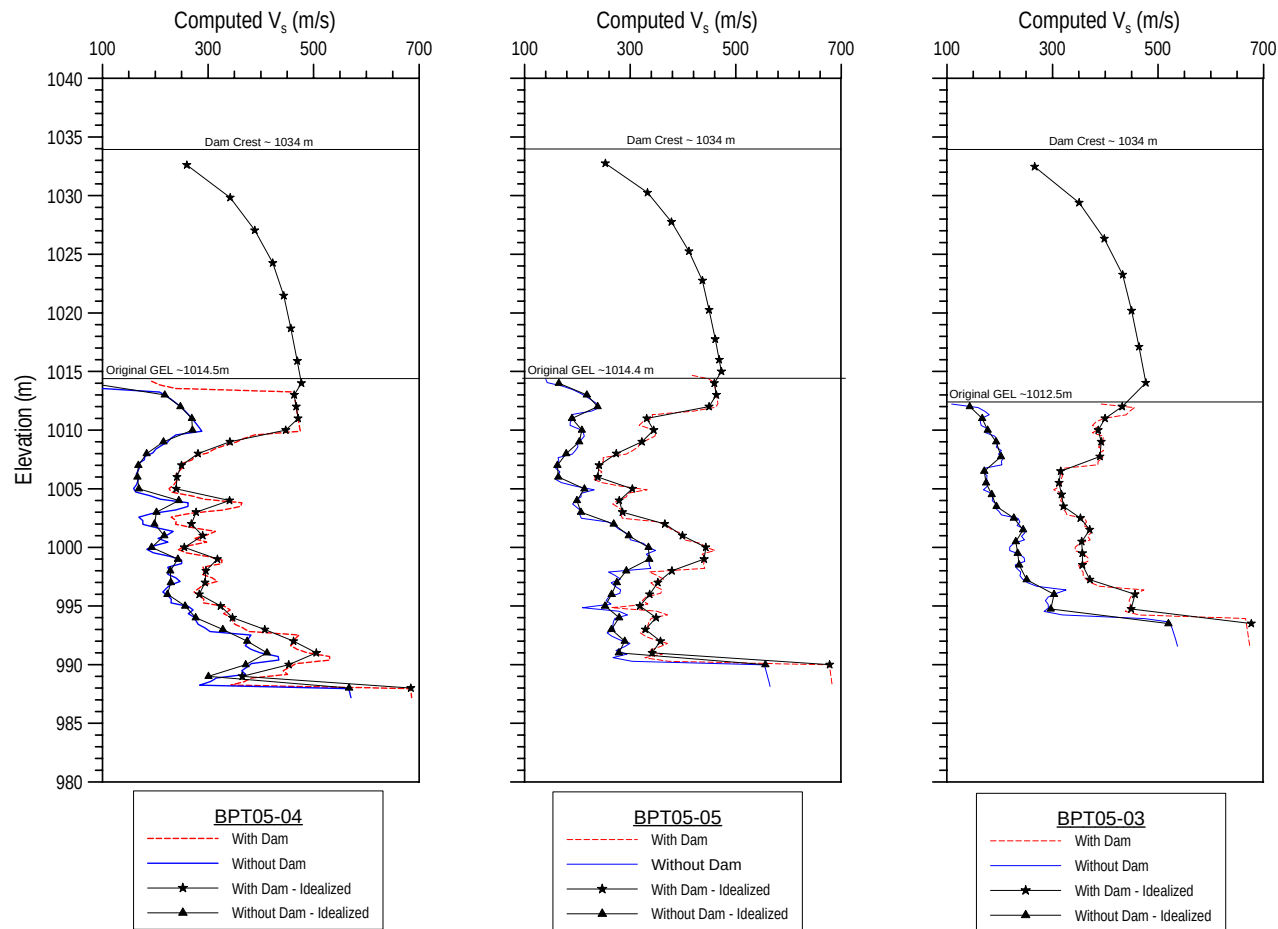


Figure VI-3 Computed and Idealized Shear Wave Velocity Profiles at Cross Valley Dam Used in the Site Response Analyses

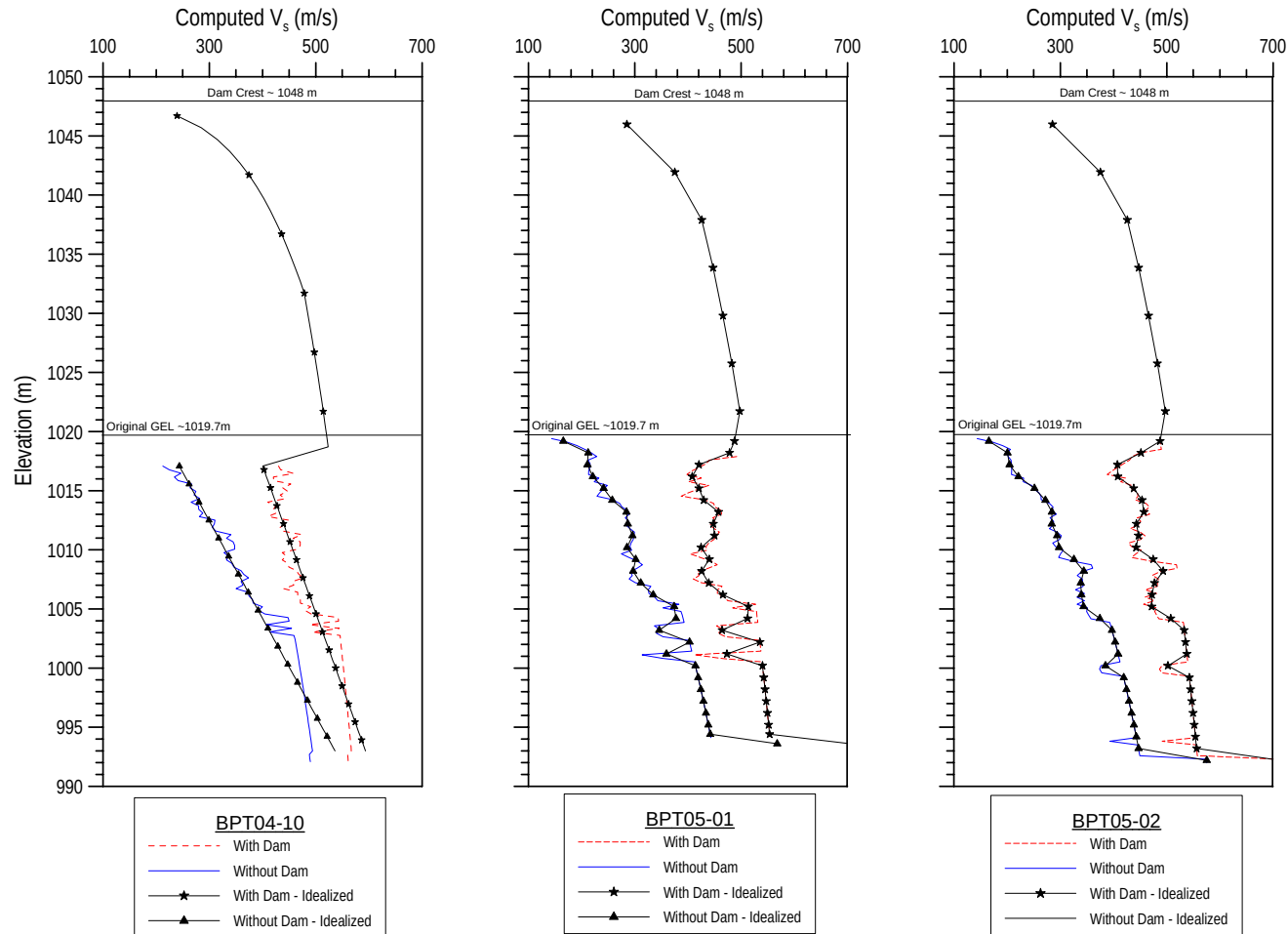


Figure VI-4 Computed and Idealized Shear Wave Velocity Profiles at Intermediate Dam Used in the Site Response Analyses

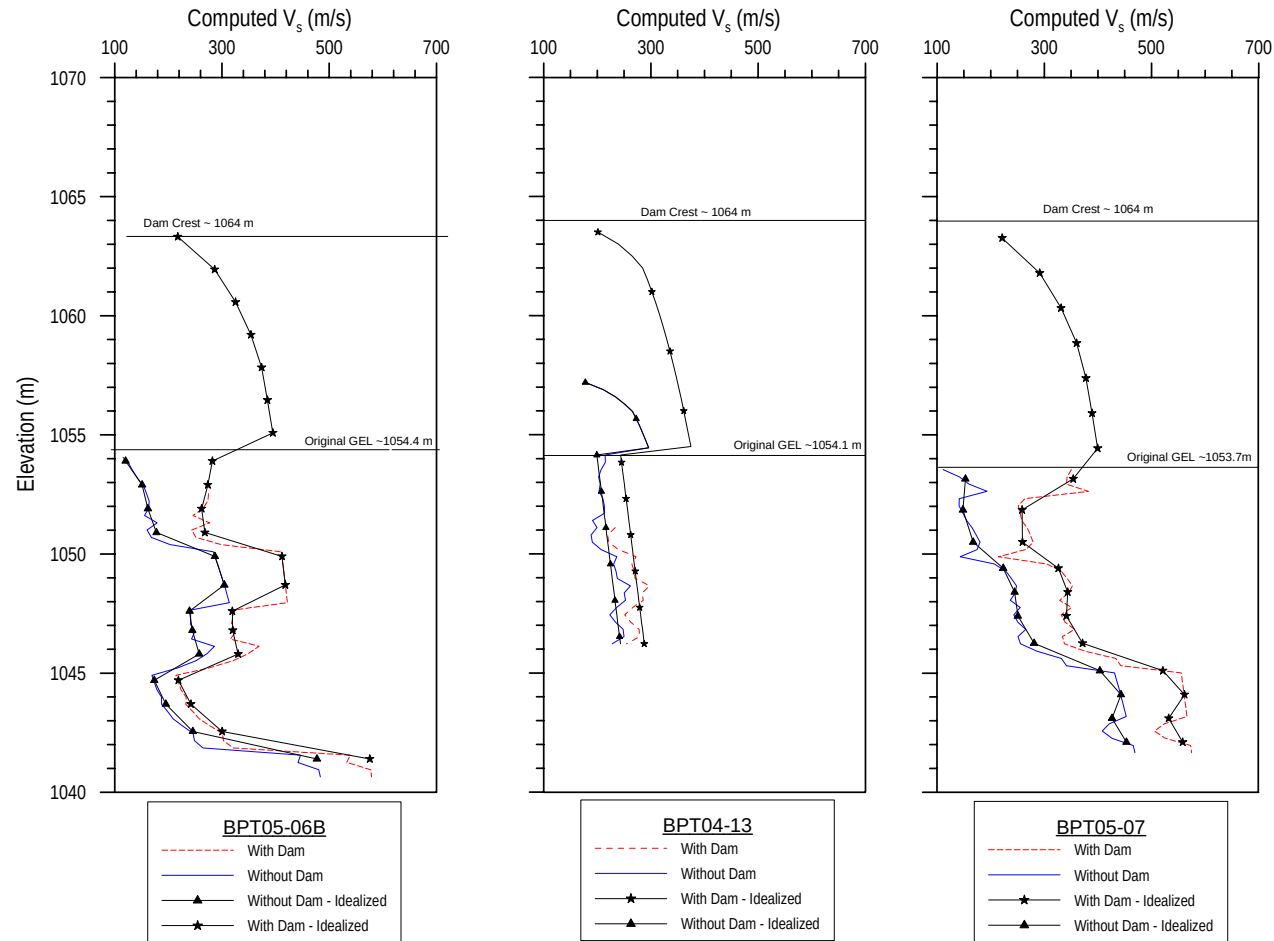


Figure VI-5 Computed and Idealized Shear Wave Velocity Profiles at Secondary Dam (East Limb) Used in the Site Response Analyses

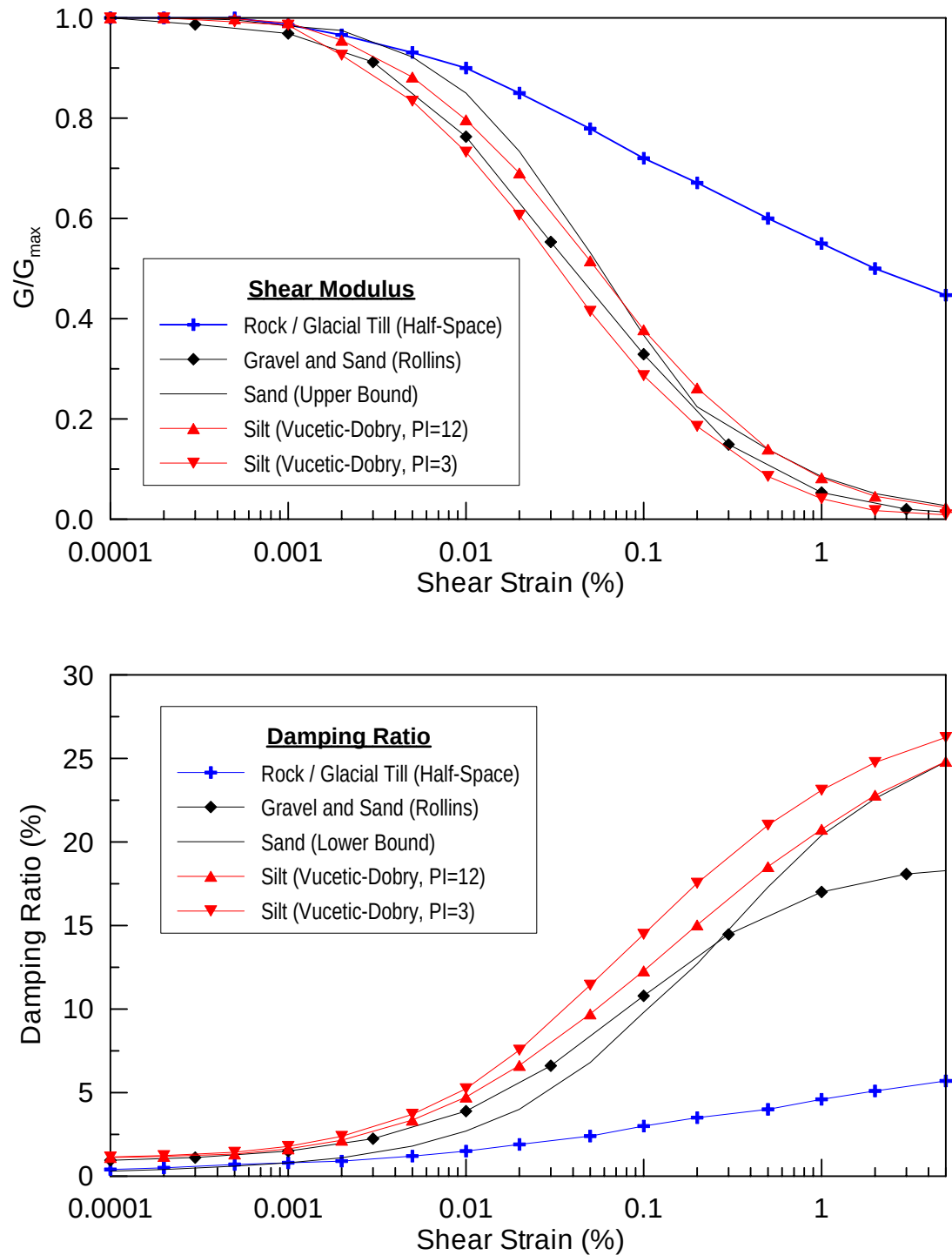
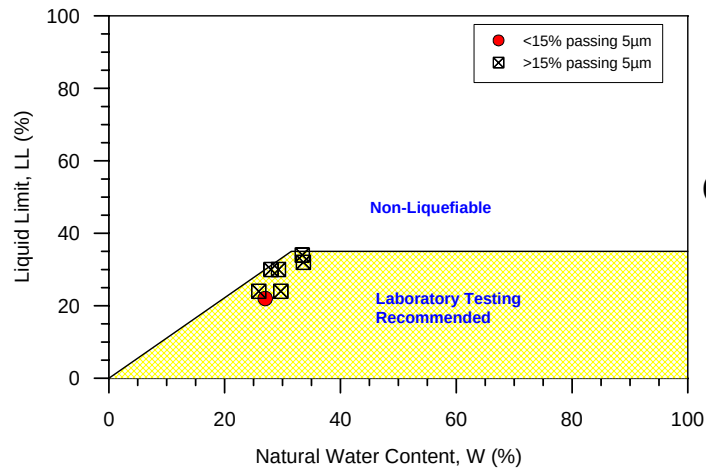
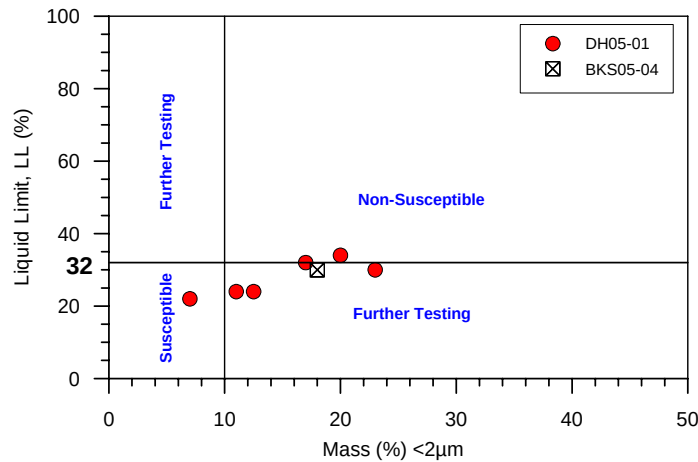


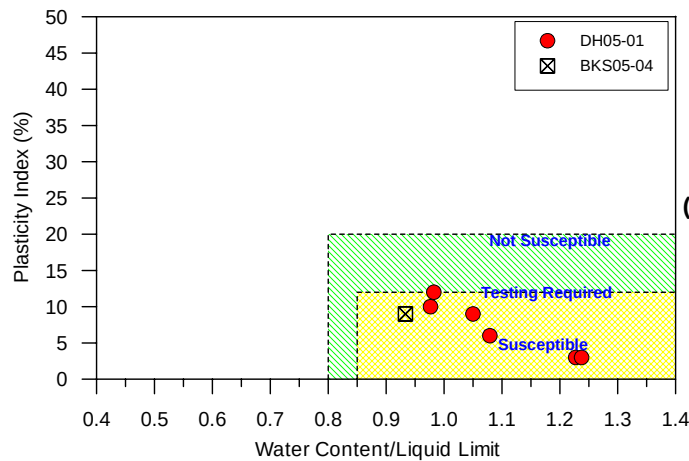
Figure VI-6 Modulus Reduction and Damping Curves Used in the ProShake Analyses



(a) Chinese Criteria

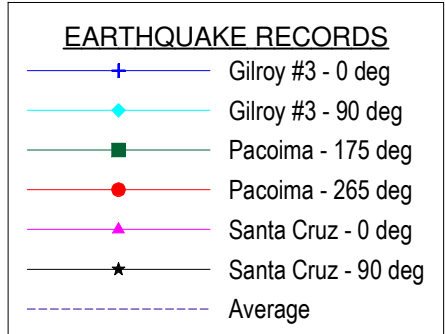
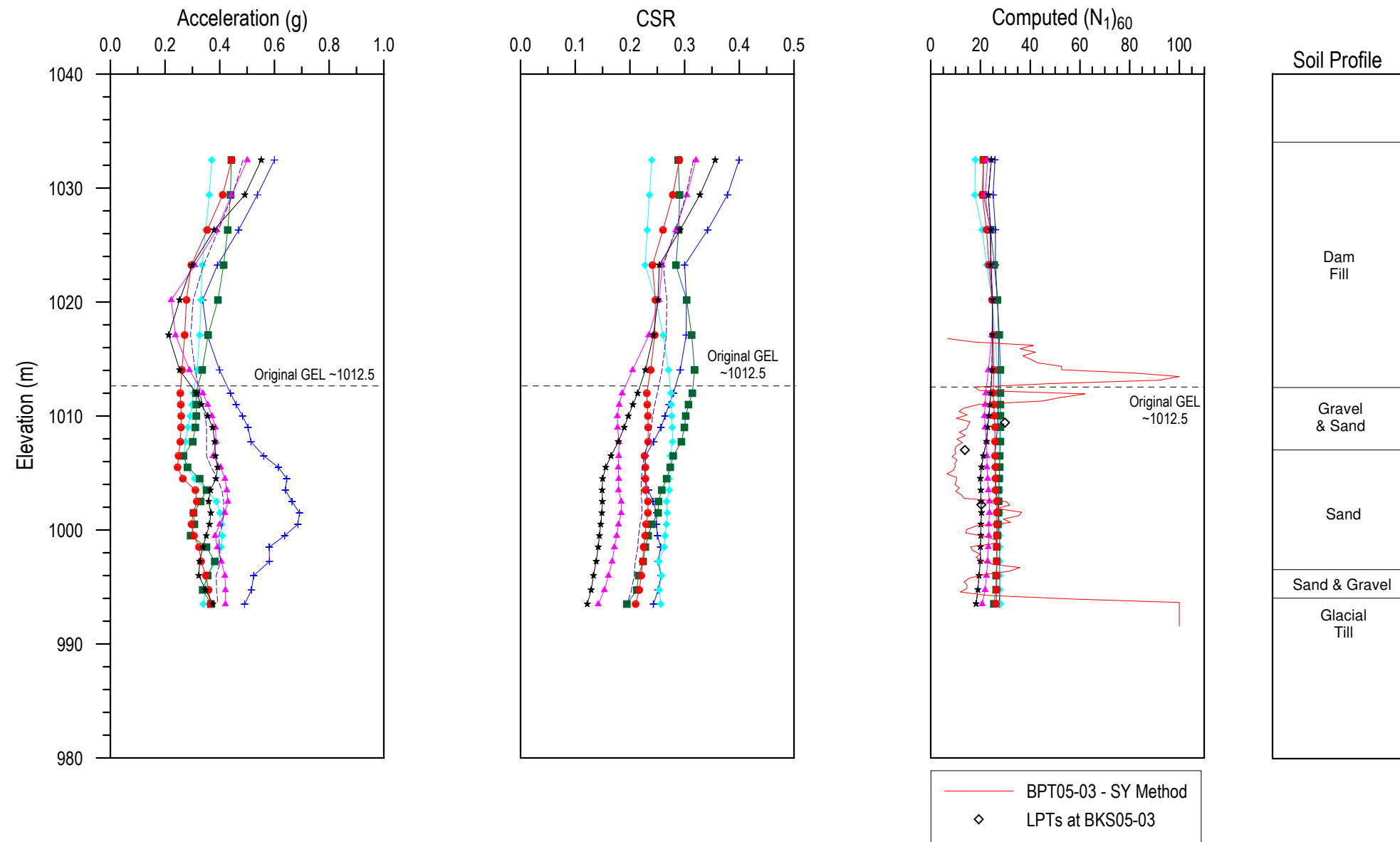


(b) Andrews and Martin (2000)

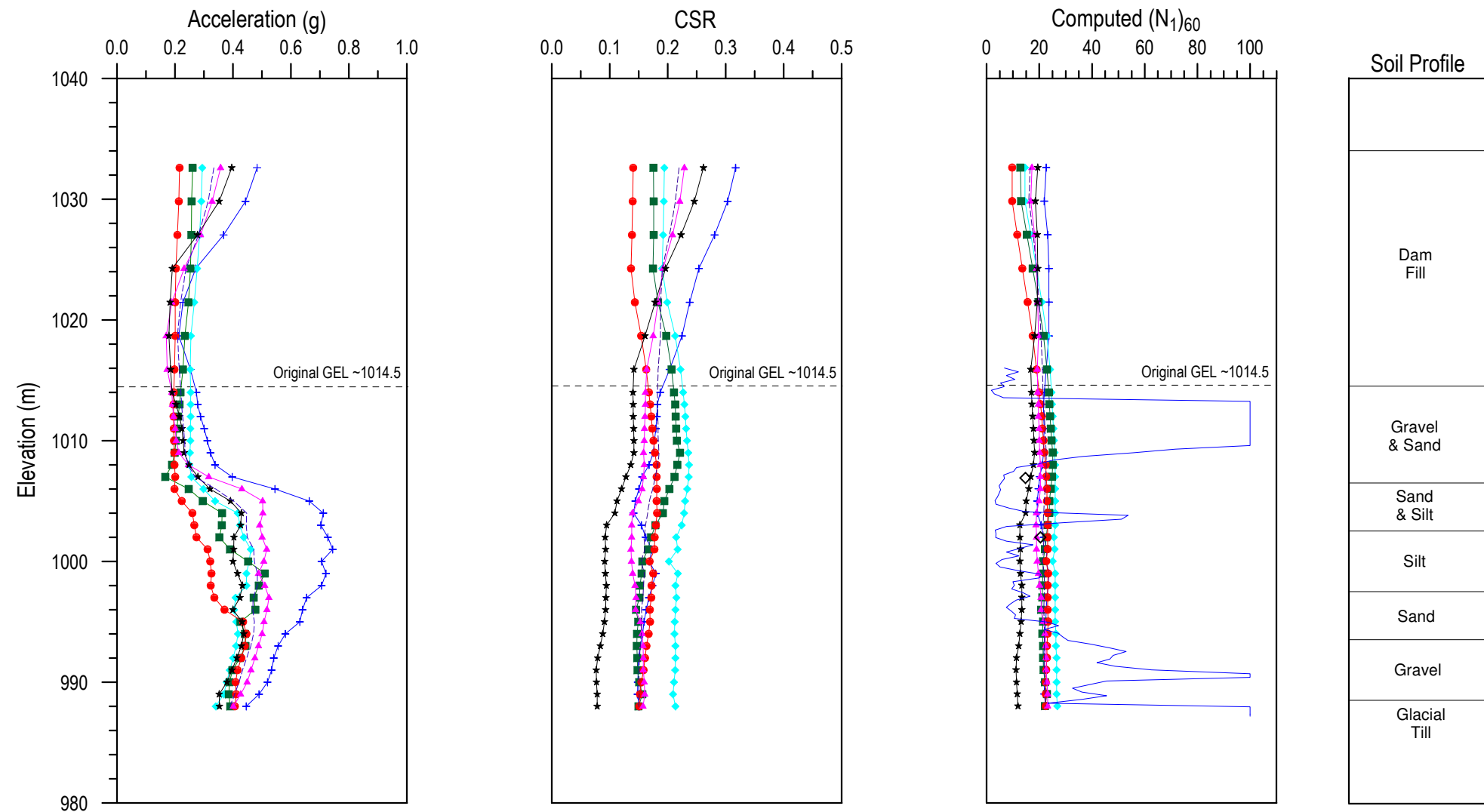


(c) Bray et al (2004)

Figure VI-7 Liquefaction Assessment of Silt Samples from DH05-01 and BKS05-04 Using the Fine Grained Soils Criteria

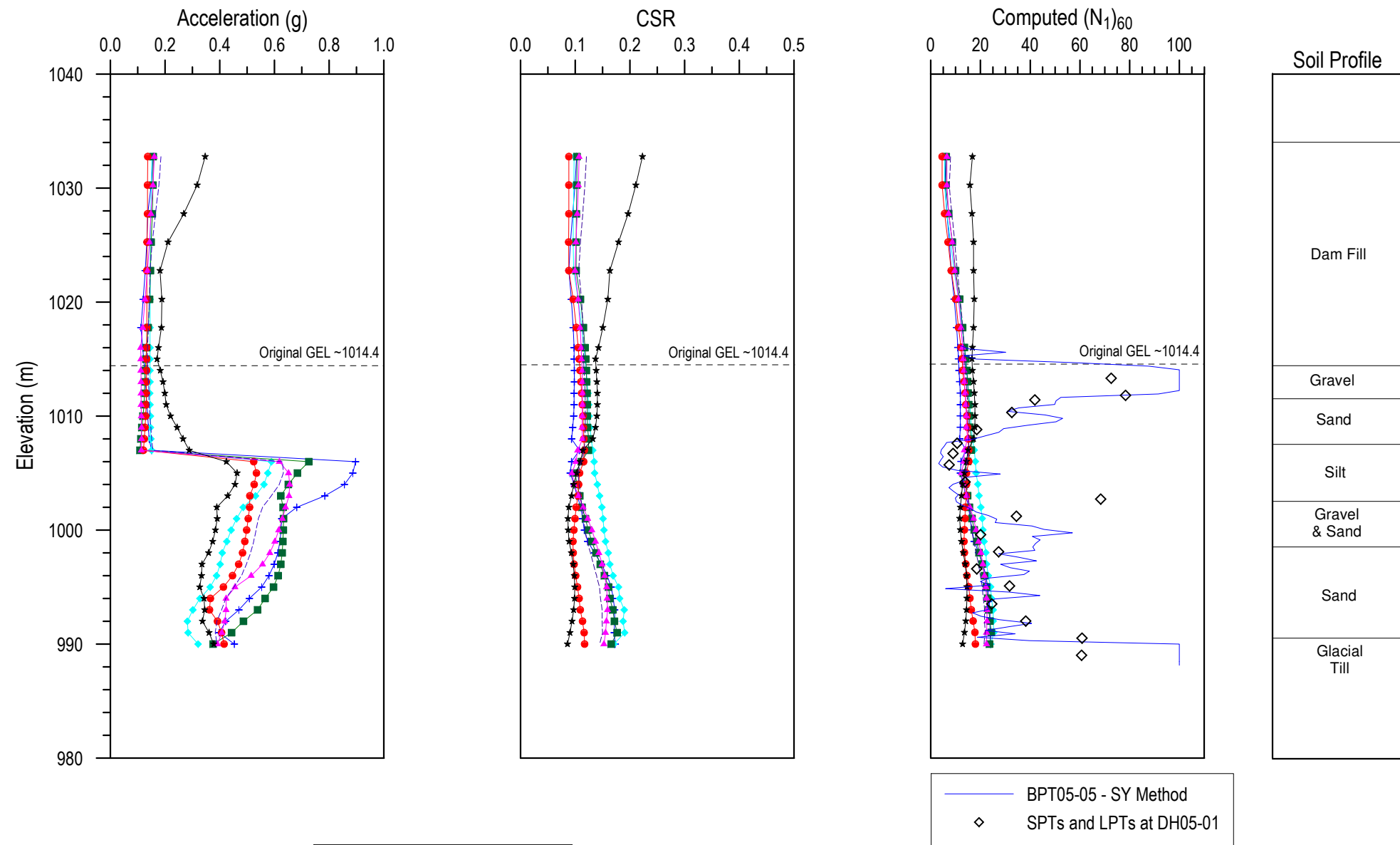


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		PROJECT NO.		M09237 A03	FIGURE NO.
					VI-8



TO BE READ WITH KLOHN-CRIPPEN REPORT DATED JUNE 26, 2006

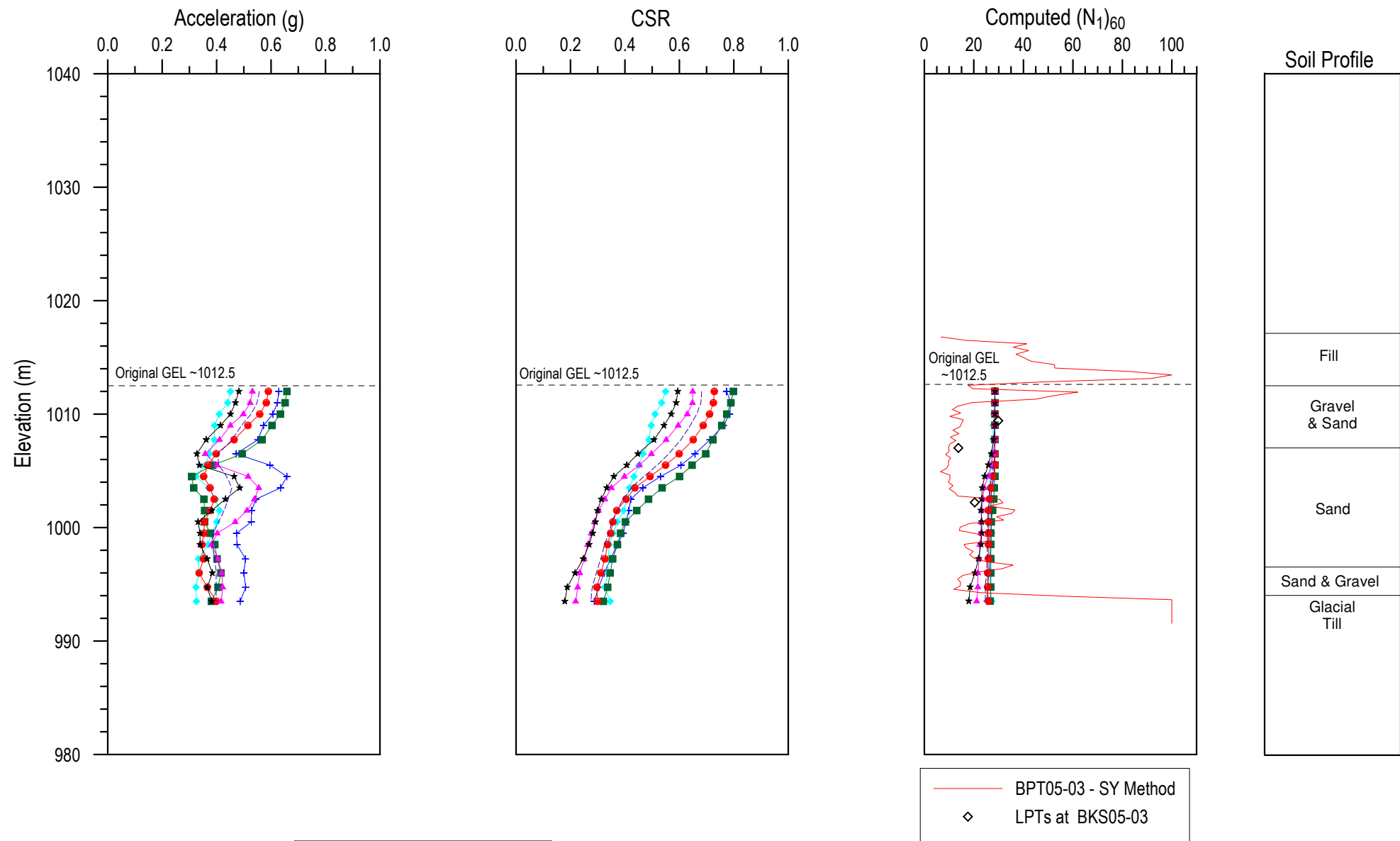
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	 KLOHN CRIPPEN		TITLE	
			LIQUEFACTION ASSESSMENT OF BPT05-04 UNDER CREST OF CROSS VALLEY DAM	
	PROJECT NO.	M09237 A03	FIGURE NO.	VI-9



EARTHQUAKE RECORDS	
—+—	Gilroy #3 - 0 deg
—◆—	Gilroy #3 - 90 deg
—■—	Pacoima - 175 deg
—●—	Pacoima - 265 deg
—▲—	Santa Cruz - 0 deg
—★—	Santa Cruz - 90 deg
---	Average

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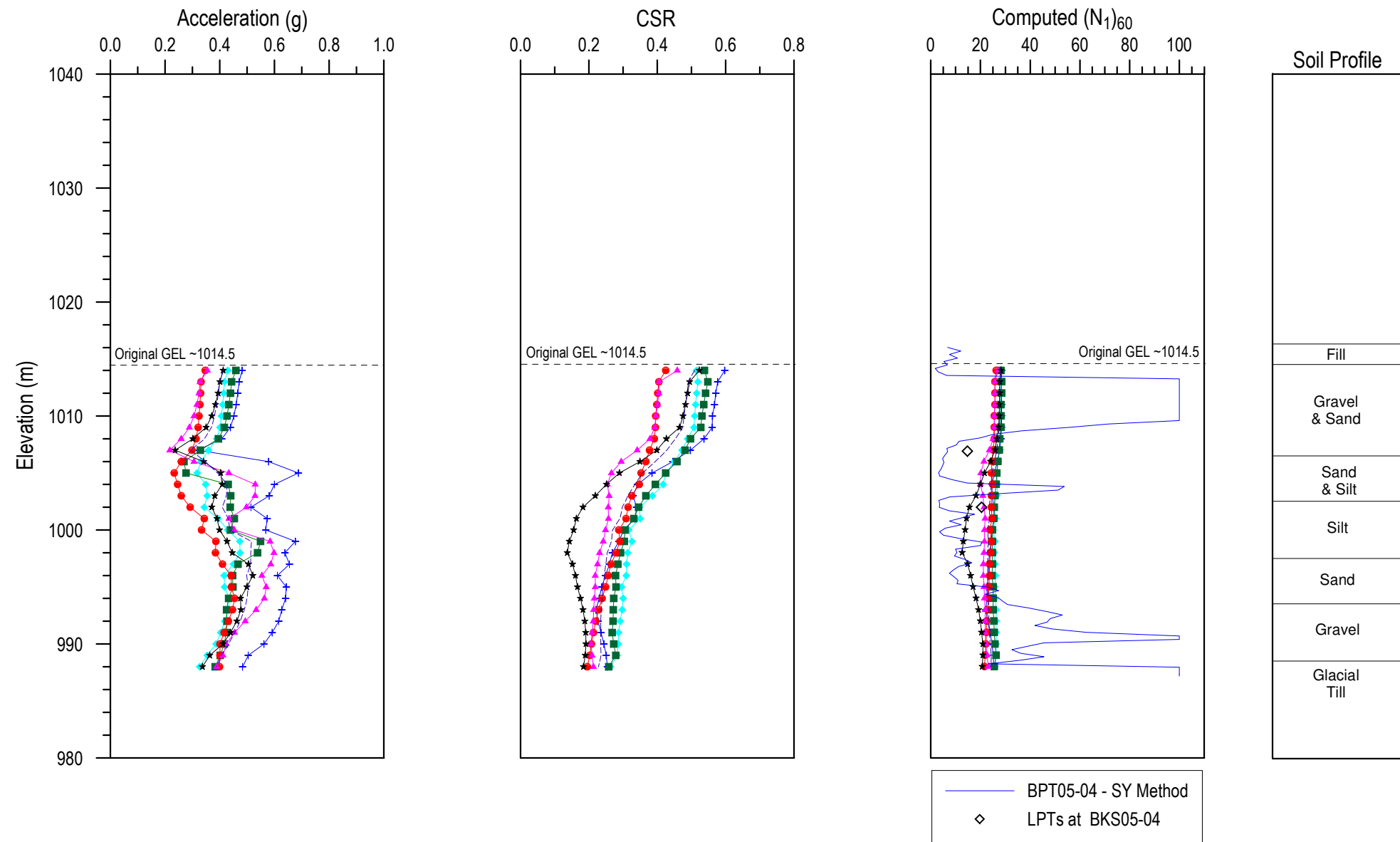
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		TITLE			
		LIQUEFACTION ASSESSMENT OF BPT05-05 UNDER CREST OF CROSS VALLEY DAM			
		PROJECT NO.	M09237 A03	FIGURE NO.	VI-10



EARTHQUAKE RECORDS	
— + —	Gilroy #3 - 0 deg
— ◆ —	Gilroy #3 - 90 deg
— ■ —	Pacoima - 175 deg
— ● —	Pacoima - 265 deg
— ▲ —	Santa Cruz - 0 deg
— ★ —	Santa Cruz - 90 deg
— - - —	Average

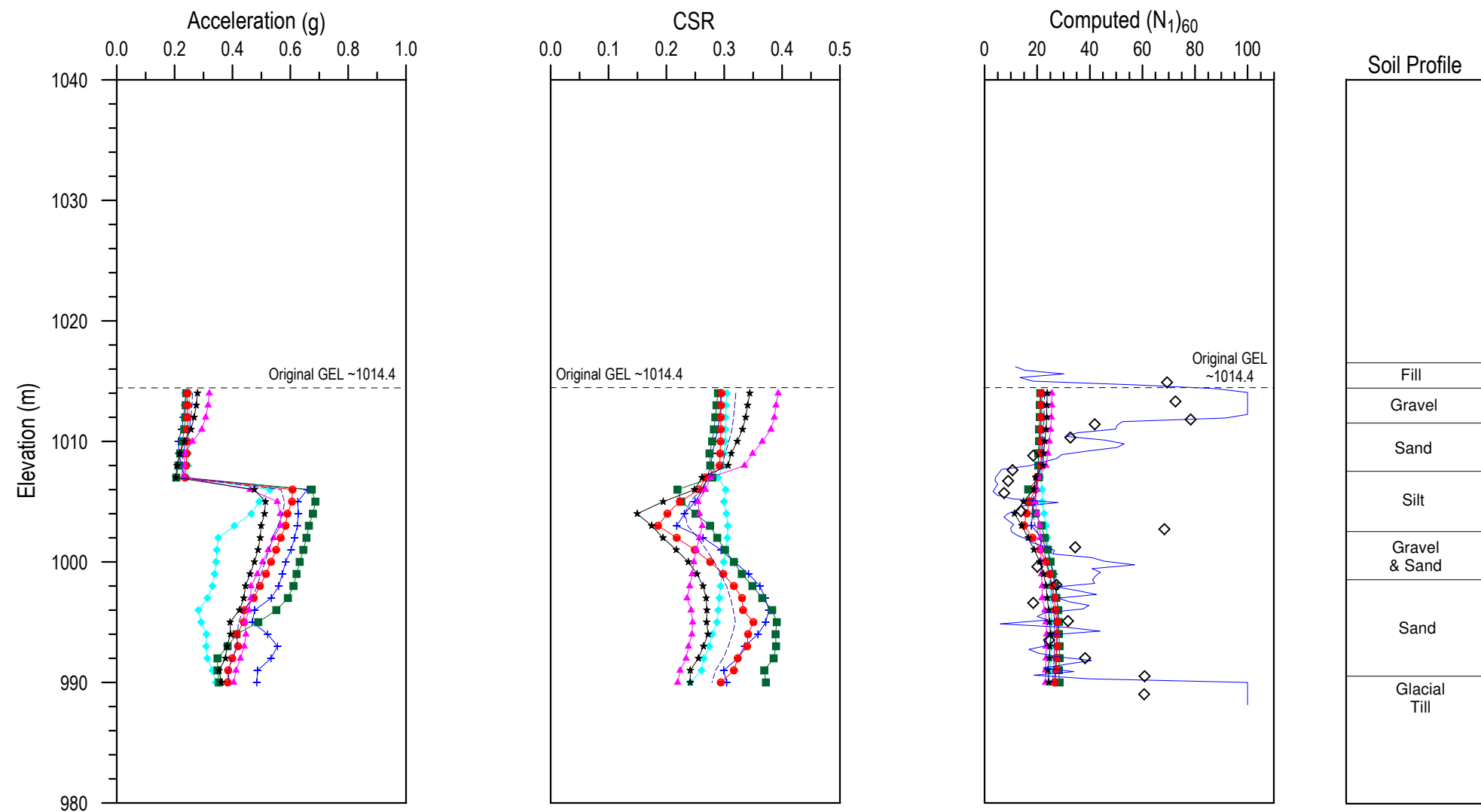
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		TITLE LIQUEFACTION ASSESSMENT OF BPT05-03 AT TOE OF CROSS VALLEY DAM	
		PROJECT NO.	M09237 A03
		FIGURE NO.	VI-11



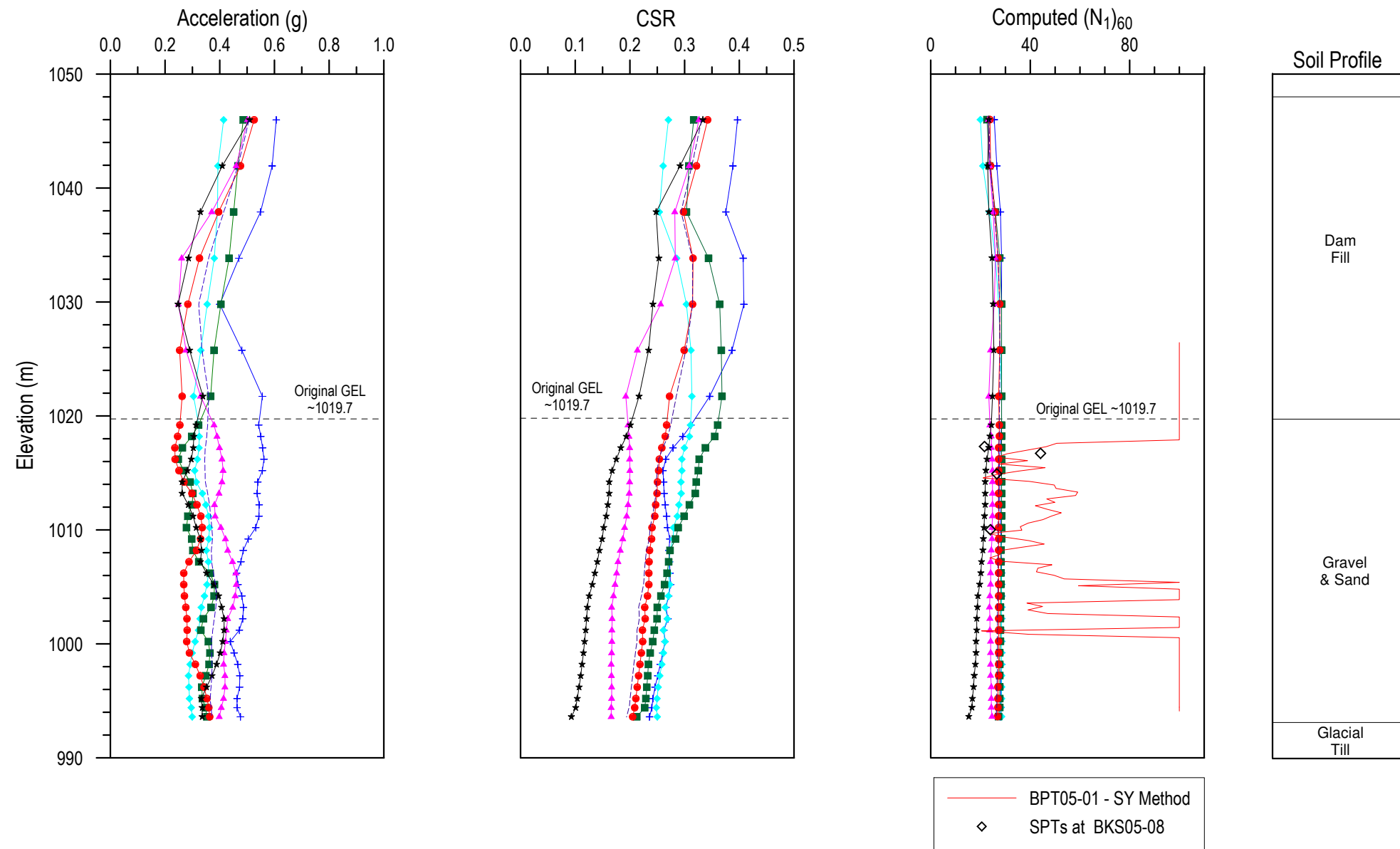
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	 KLOHN CRIPPEN	TITLE			
		LIQUEFACTION ASSESSMENT OF BPT05-04 AT TOE OF CROSS VALLEY DAM			
		PROJECT NO.	M09237 A03	FIGURE NO.	VI-12



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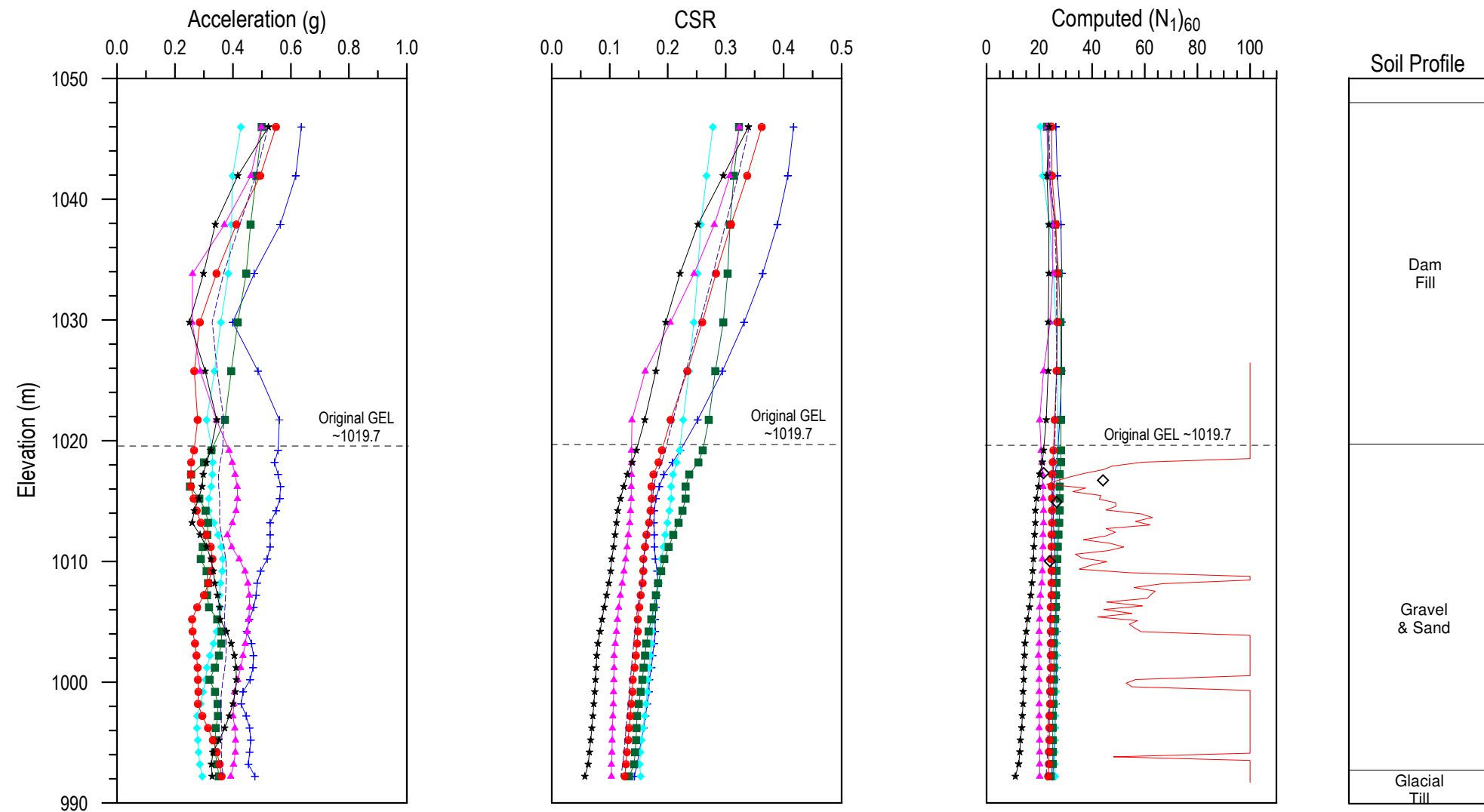
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			TITLE			
			LIQUEFACTION ASSESSMENT OF BPT05-05 AT TOE OF CROSS VALLEY DAM			
			PROJECT NO.	M09237 A03	FIGURE NO.	VI-13



EARTHQUAKE RECORDS	
—+—	Gilroy #3 - 0 deg
—◆—	Gilroy #3 - 90 deg
—■—	Pacoima - 175 deg
—●—	Pacoima - 265 deg
—▲—	Santa Cruz - 0 deg
—★—	Santa Cruz - 90 deg
---	Average

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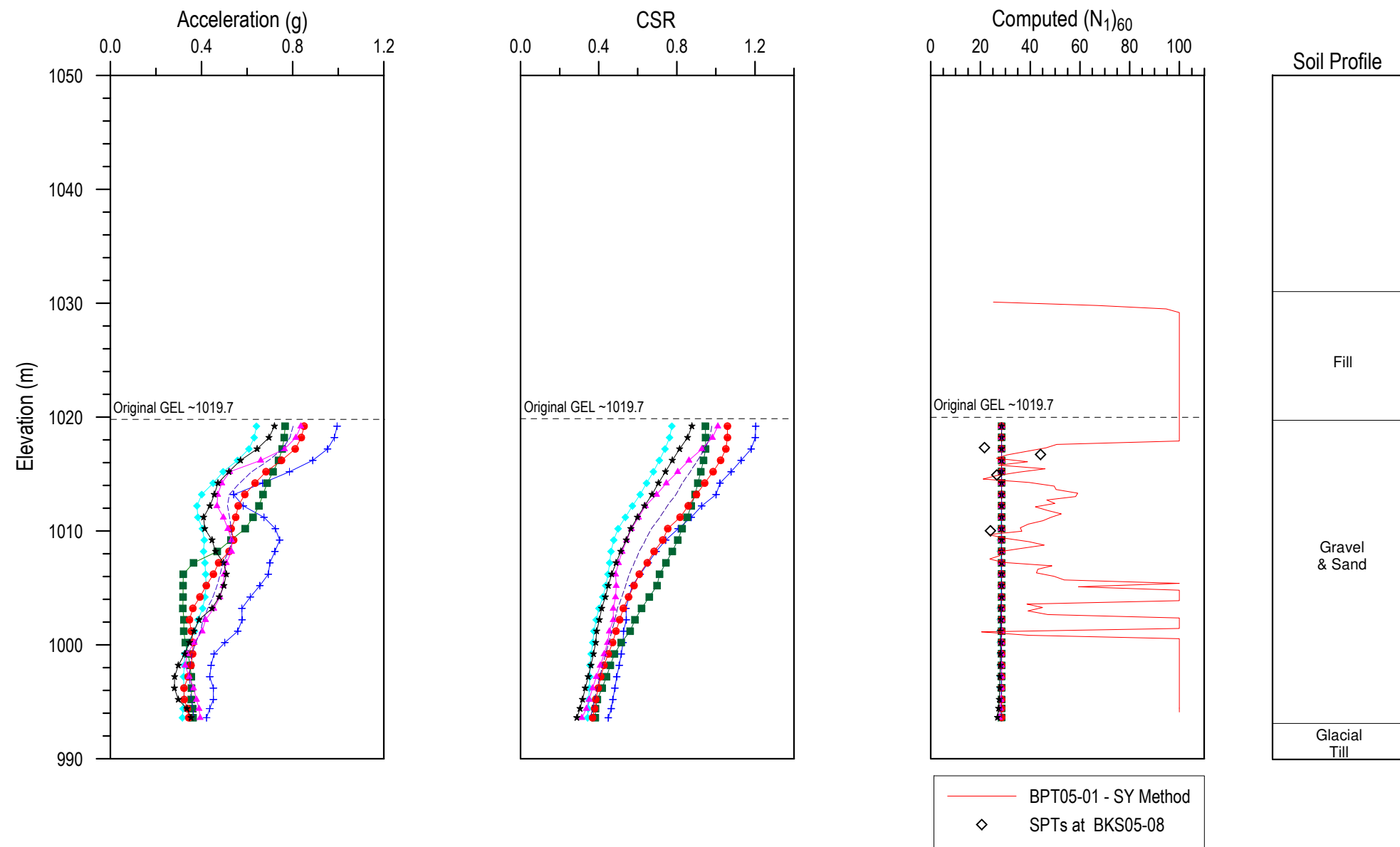
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		TITLE LIQUEFACTION ASSESSMENT OF BPT05-01 UNDER CREST OF INTERMEDIATE DAM	
		PROJECT NO.	M09237 A03
		FIGURE NO.	VI-14



- EARTHQUAKE RECORDS**
- + Gilroy #3 - 0 deg
 - ◆ Gilroy #3 - 90 deg
 - Pacoima - 175 deg
 - Pacoima - 265 deg
 - ▲ Santa Cruz - 0 deg
 - ★ Santa Cruz - 90 deg
 - - - Average

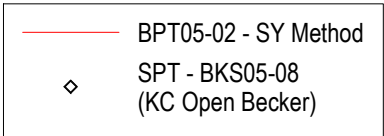
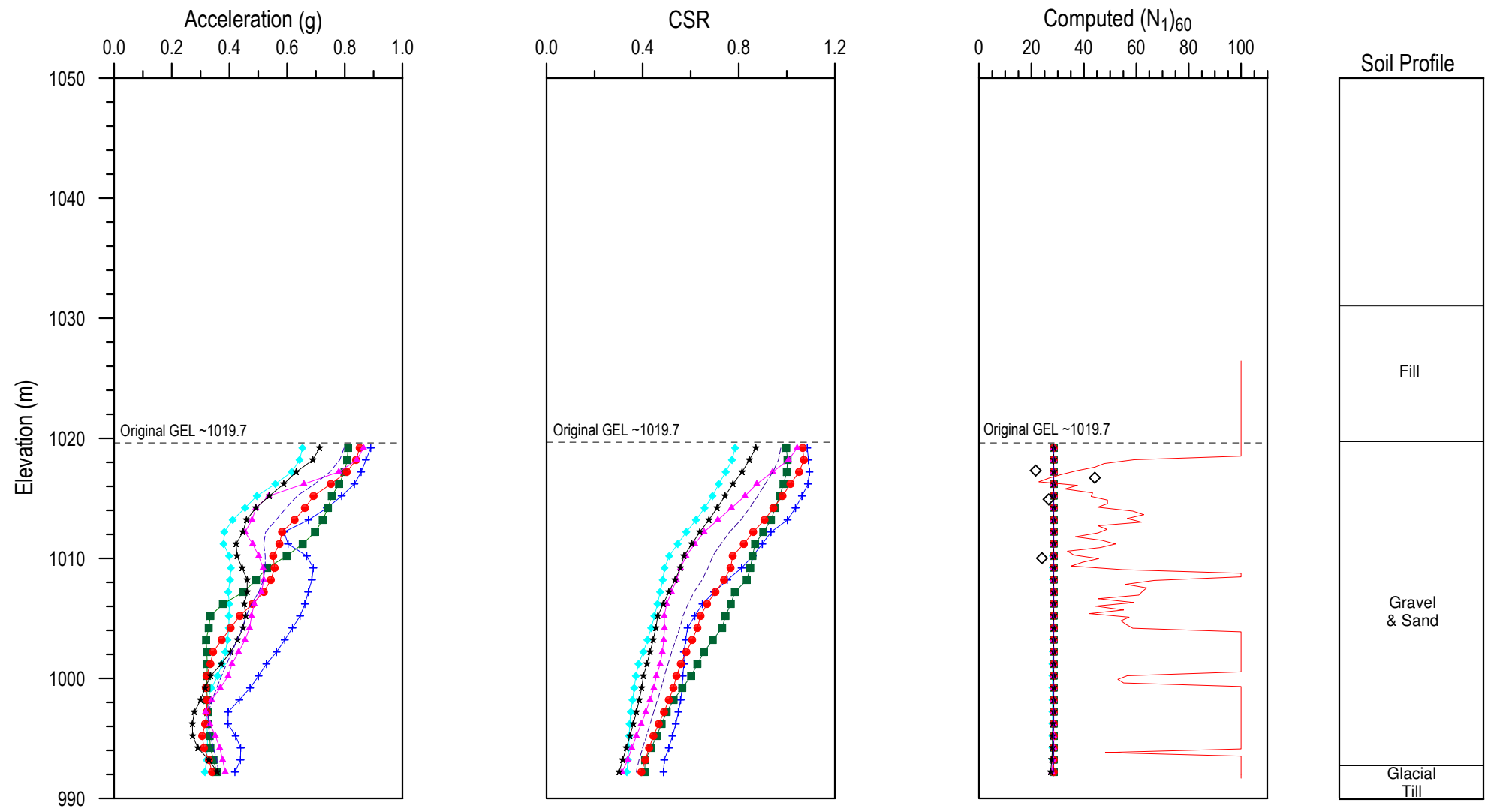
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	 KLOHN CRIPPEN		TITLE		
			LIQUEFACTION ASSESSMENT OF BPT05-02 UNDER CREST OF INTERMEDIATE DAM		
	PROJECT NO.		M09237 A03	FIGURE NO.	VI-15



- EARTHQUAKE RECORDS**
- + Gilroy #3 - 0 deg
 - ◆ Gilroy #3 - 90 deg
 - Pacoima - 175 deg
 - Pacoima - 265 deg
 - ▲ Santa Cruz - 0 deg
 - ★ Santa Cruz - 90 deg
 - - - Average

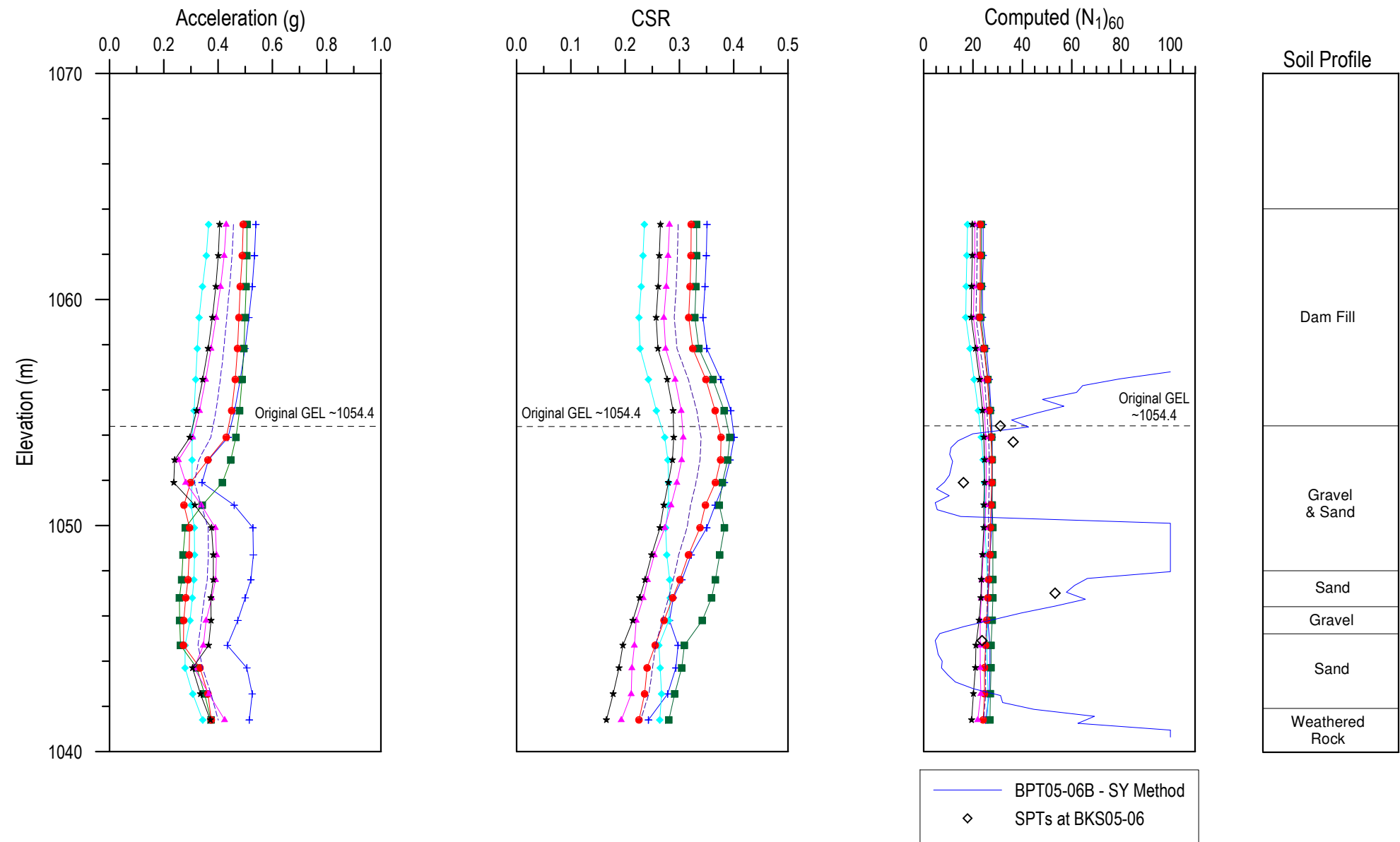
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		PROJECT NO.		M09237 A03	FIGURE NO. VI-16



EARTHQUAKE RECORDS

- Gilroy #3 - 0 deg
- Gilroy #3 - 90 deg
- Pacoima - 175 deg
- Pacoima - 265 deg
- Santa Cruz - 0 deg
- Santa Cruz - 90 deg
- Average

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		PROJECT NO.		M09237 A03	FIGURE NO. VI-17

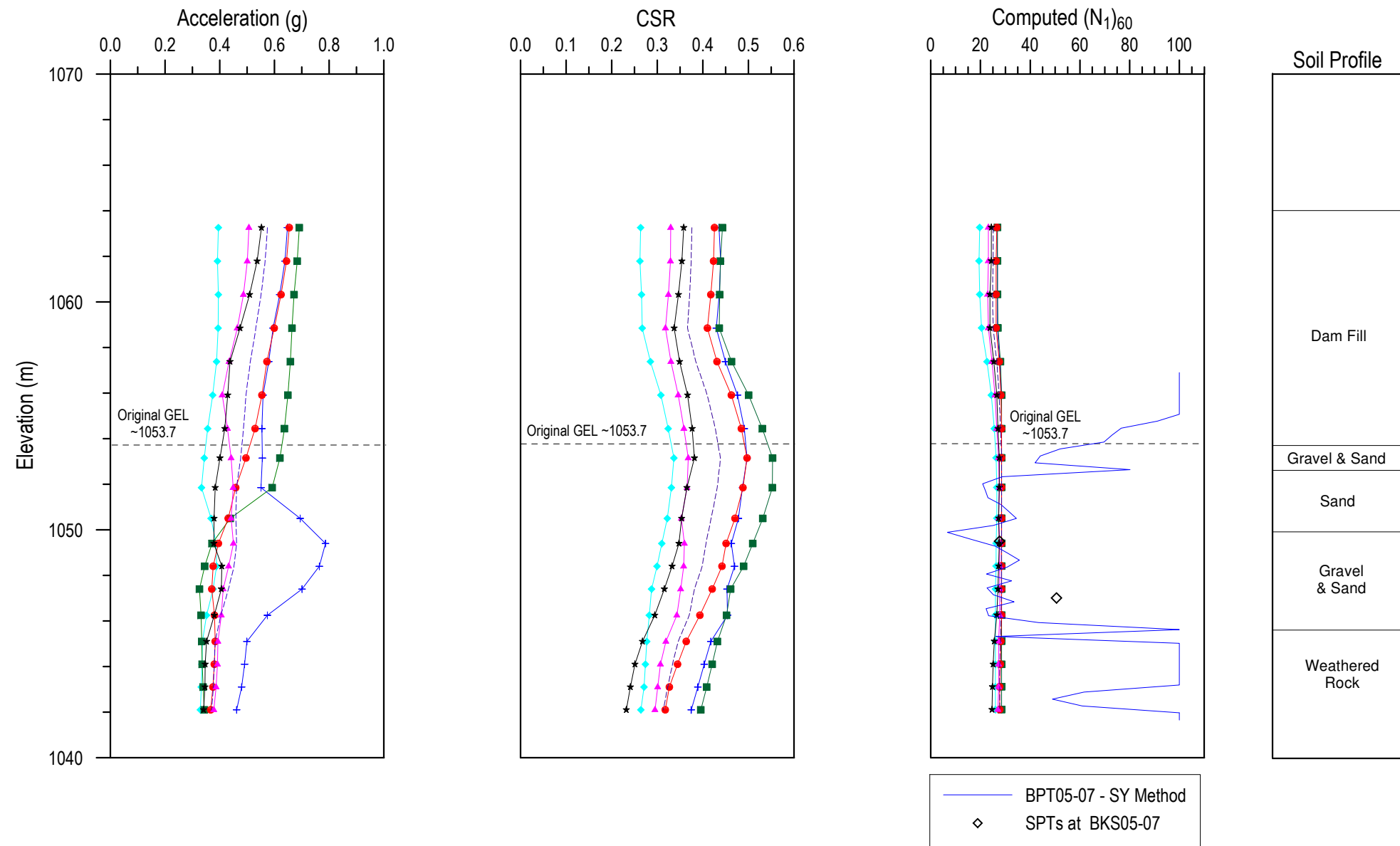


EARTHQUAKE RECORDS

- Gilroy #3 - 0 deg
- Gilroy #3 - 90 deg
- Pacoima - 175 deg
- Pacoima - 265 deg
- Santa Cruz - 0 deg
- Santa Cruz - 90 deg
- Average

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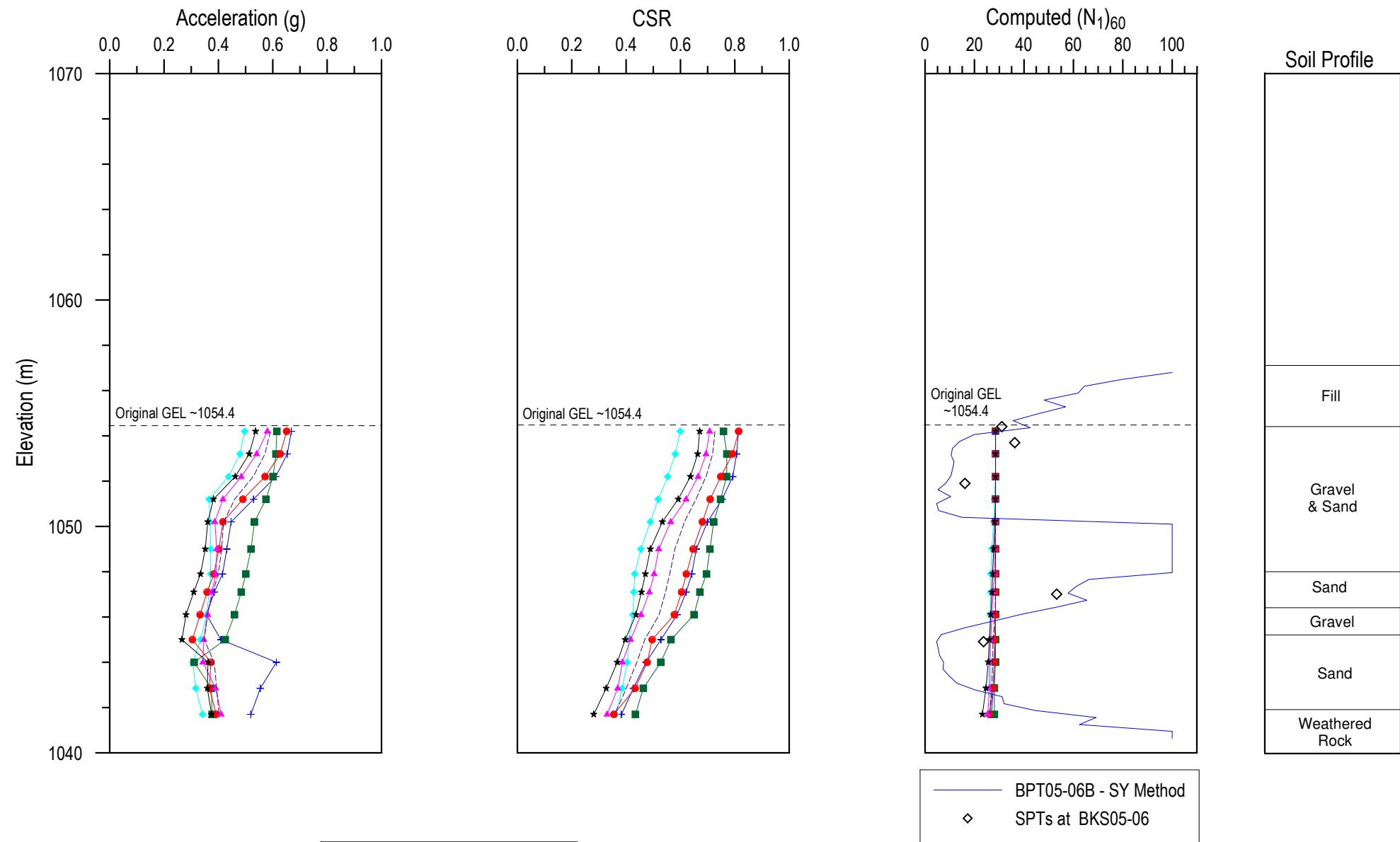
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			TITLE		
			LIQUEFACTION ASSESSMENT OF BPT05-06B UNDER CREST OF SECONDARY DAM - EAST LIMB		
	PROJECT NO.		M09237 A03	FIGURE NO.	VI-18



EARTHQUAKE RECORDS	
+	Gilroy #3 - 0 deg
◆	Gilroy #3 - 90 deg
■	Pacoima - 175 deg
●	Pacoima - 265 deg
▲	Santa Cruz - 0 deg
★	Santa Cruz - 90 deg
---	Average

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	 KLOHN CRIPPEN	TITLE	
		LIQUEFACTION ASSESSMENT OF BPT05-07 UNDER CREST OF SECONDARY DAM - EAST LIMB	
	PROJECT NO.	M09237 A03	FIGURE NO. VI-19



EARTHQUAKE RECORDS

- + Gilroy #3 - 0 deg
- ◆ Gilroy #3 - 90 deg
- Pacoima - 175 deg
- Pacoima - 265 deg
- ▲ Santa Cruz - 0 deg
- ★ Santa Cruz - 90 deg
- Average

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CLIENT

DELOTTE & TOUCHE INC.
ANVIL MINING RANGE COMPLEX



PROJECT

ROSE CREEK TAILINGS IMPOUNDMENT
SEISMIC STABILITY ASSESSMENT

TITLE

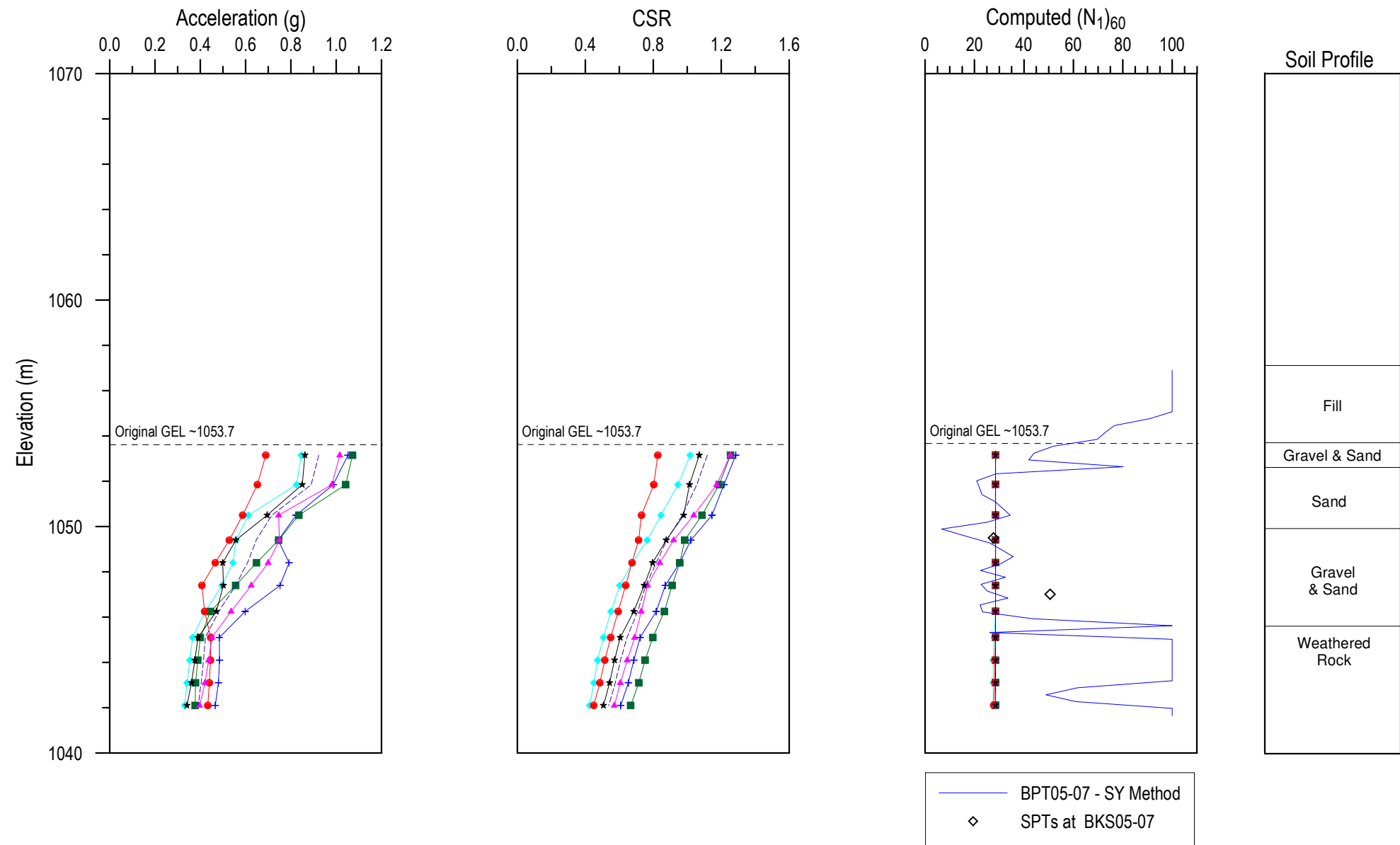
LIQUEFACTION ASSESSMENT OF BPT05-06B
AT TOE OF SECONDARY DAM - EAST LIMB

PROJECT NO.

M09237 A03

FIGURE NO.

VI-20



EARTHQUAKE RECORDS	
—+—	Gilroy #3 - 0 deg
—◆—	Gilroy #3 - 90 deg
—■—	Pacoima - 175 deg
—●—	Pacoima - 265 deg
—▲—	Santa Cruz - 0 deg
—★—	Santa Cruz - 90 deg
----	Average

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		TITLE	
CLIENT		LIQUEFACTION ASSESSMENT OF BPT05-07 AT TOE OF SECONDARY DAM - EAST LIMB	
DELOTTE & TOUCHE INC. ANVIL MINING RANGE COMPLEX		PROJECT NO.	M09237 A03
KLOHN CRIPPEN		FIGURE NO.	VI-21

APPENDIX VII

Stability Analyses

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APPENDIX VII

STABILITY ANALYSES

VII-1. INTRODUCTION

The site response analyses and liquefaction assessment described in Appendix VI identified zones of foundation soil under Cross Valley Dam and Secondary Dam (East Limb) that are susceptible to liquefaction in the design earthquake.

Klohn Crippen (2005) carried out limit-equilibrium stability analyses of critical cross sections through Intermediate Dam and Secondary Dam (East and West Limbs) to evaluate the Factor of Safety and flow-sliding potential, and to assess the level of remediation that would be required achieve a minimum post-earthquake Factor of Safety of 1.1. The site investigations, site response analysis and liquefaction assessment presented in this report do not alter the conclusions presented in Klohn Crippen (2005). Therefore, no additional stability analyses were carried out in this study for these two dams.

The focus of this study is a limit-equilibrium stability analyses to assess the following:

- Calculate the Factor of Safety and the flow sliding potential of a representative section through Cross Valley Dam under post-liquefaction conditions; and,
- Estimate the level of remediation that would be required to achieve a minimum calculated Factor of Safety of 1.1.

The computer program GeoStudio Office (Geo-Slope, 2005) using the Morgenstern-Price algorithm was used to perform the analyses.

Figure 3.2 shows the geological cross-section of the Cross Valley Dam interpreted from a limited number of Becker and drill hole data from the 2004 and 2005 site investigation and the Golder Associates (1980) test holes. Figure 3.2 also shows the measured Becker blow count (N_b) profiles from the BPT tests at BPT04-14, BPT05-03, BPT05-04 and BPT05-05 and the $(N_1)_{60}$ profiles from the measured SPT and LPT blow counts at drill holes DH05-01, BH79-7, BH79-21, BH79-16 and BH79-15. The second layer beneath the dam foundation shown in Figure 3.2 mainly consists of silts, silty sands and gravels. The thickness and sequence of silt, sand and gravel in this layer vary significantly along the dam. The N_b and $(N_1)_{60}$ blow counts are generally low in this layer. Based on the liquefaction assessment presented in detail in Appendix VI and summarized in Figures 3.5 and 3.6, this layer was found to be potentially liquefiable under the design earthquake. Thus, post-earthquake stability analyses were carried out to evaluate stability of the dam due to the liquefaction of this layer. Two representative sections near Becker test holes BPT05-04 and BPT05-03 were analyzed and sensitivity analyses were conducted to account for the variability of the soil profile along the dam. The results of the sensitivity analyses were taken into account in the design of remedial measures at this conceptual level.

VII-2. STABILITY ANALYSES OF UNREMEDiated SECTIONS

Analyses on the Cross Valley Dam included the upstream polishing pond with the nominal pond level at El. 1031 m. Table VII-1 summarizes the analyses that were carried out on unremediated sections of Cross Valley Dam. Figures VII-1 and to VII-2 show the simplified models of the dam used in the stability analyses on cross-sections XVS1 and XVS2, respectively.

Table VII-1 Summary of Stability Analyses of Unremediated Section

Location	Section	Liquefaction Potential	Condition
Cross Valley Dam	XVS1 (Near BPT05-04)	Liquefiable foundation soils between El. 1008 m and El. 995 m	With Polishing Pond; Downstream Analysis
			With Polishing Pond; Upstream Analysis
Cross Valley Dam	XVS2 (Near BPT05-03)	Liquefiable foundation soils between El. 1011 m and El. 1003 m	With Polishing Pond; Downstream Analysis
			With Polishing Pond; Upstream Analysis

VII-2.1 Soil Properties

Post-liquefaction residual strengths were assigned to the potentially liquefiable loose foundation soils in the stability analyses. An S_{ur}/σ'_{vo} ratio (undrained residual strength over the initial effective overburden stress) of 0.1 was used to estimate S_{ur} for the sand and gravel layers, following the relationship between S_{ur}/σ'_{vo} and $(N_1)_{60-cs}$ (clean sand equivalent SPT) proposed by Idriss (2004):

$$S_{ur}/\sigma'_{vo} = 0.02 + 0.025 \times [(N_1)_{60-cs}]^{1/2} \quad [1]$$

An S_{ur}/σ'_{vo} ratio of 0.08 was used to estimate S_{ur} for the silt layers, following the relation between S_{ur}/σ'_{vo} and $(N_1)_{60}$ proposed by Stark and Olson (2002):

$$S_{ur}/\sigma'_{vo} = 0.03 + 0.0075 \times (N_1)_{60} \quad [2]$$

The more dense foundation sand and gravel layers with a mean $(N_1)_{60}$ greater than 22 that are expected to have marginal or no liquefaction were assigned an unreduced frictional strength of 35 degrees for the analyses. The dam fill was assigned a frictional strength of 35 degrees as well. Bedrock and basal glacial till were assigned a very high strength relative to the other strata for the analyses.

The soil properties used in the post-liquefaction stability analyses are summarized in Table VII-2 and Table VII-3. In Section XVS1, the potentially liquefiable silts, silty sands and gravels layer was divided into two sub layers, layer 1 and layer 2 as shown in Figure VII-1. The top layer 1 was treated as sands and gravels and the layer 2 was treated as silt in line with the nearby Becker test hole information at BPT05-04. In Section XVS2, the silts, silty sands and gravels layer was treated as sands and gravels based on the Becker test hole information at BPT05-03. Note that the soil types of these potentially liquefiable layers were changed in sensitivity analyses to account for the soil variability and to check the robustness remediation schemes that are proposed later.

Table VII-2 Post-Liquefaction Soil Properties Used in the Cross Valley Dam Stability Analyses, Section XVS1

Soil Unit in Model	Unit Weight (kN/m ³)	Friction Angle (deg)	Cohesion (kPa)	Post-Liquefaction Residual Strength Ratio, S_{ur}/σ'_{vo}
Dam Core and Fill	21	35	0	n/a
Foundation Sands and Gravel Layer 1 [(N ₁) _{60-mean} >30] Layer 2 [(N ₁) _{60-mean} >30]	21	35	0	n/a
Foundation Silts, Silty Sands and Gravels Layer 1 ^(a) [(N ₁) _{60-mean} ~ 13]	21	n/a	0	0.1
Foundation Silts, Silty Sands and Gravels Layer 2 ^(b) [(N ₁) _{60-mean} ~ 11]	20	n/a	0	0.08

Notes: ^(a) treated as sands and gravels in the analyses

^(b) treated as silt

n/a - not applicable

Table VII-3 Post-Liquefaction Soil Properties Used in the Cross Valley Dam Stability Analyses, Section XVS2

Soil Unit	Unit Weight (kN/m ³)	Friction Angle (deg)	Cohesion (kPa)	Post-Liquefaction Residual Strength Ratio, S_{ur}/σ'_{vo}
Dam Core and Fill	21	35	0	n/a
Foundation Sand and Gravel Layer 1 [(N ₁) _{60-mean} > 30] Layer 2 [(N ₁) _{60-mean} > 22]	21	35	0	n/a
Foundation Silts, Silty Sands and Gravels Layer 1 ^(a) [(N ₁) _{60-mean} ~ 12]	21	n/a	0	0.1

Notes: ^(a) treated as sands and gravels in the analyses
n/a - not applicable

VII-2.2 Results of Post-Liquefaction Stability Analyses

Figures VII-3 to VII-6 show the calculated slip surfaces for the existing dam sections and Table VII-3 list the calculated Factors of Safety (FOS).

Table VII-4 Post-Liquefaction Factors of Safety of Unremediated Cross Valley Dam with Polishing Pond

Section	Case	Post-Liquefaction FOS (M-P)	Reference Figure
XVS1 (Near BPT05-04)	Downstream Analysis	0.60	VII-3
	Upstream Analysis	1.09	VII-4
XVS2 (Near BPT05-03)	Downstream Analysis	0.54	VII-5
	Upstream Analysis	0.94	VII-6

The calculated FOS for the downstream slip surfaces are much less than 1.0 for both sections, and therefore flow sliding and/or large displacements are expected to occur. Remedial measures are required at the downstream portion of the dam to achieve a minimum post-liquefaction FOS of 1.1. Post-liquefaction FOS of 1.09 and 0.94 were

obtained for the upstream stability at sections XVS1 and XVS2, respectively. Remediation schemes are required to achieve a minimum FOS of 1.1 at section XVS2 and to improve the stability at sections XVS1.

VII-3. STABILITY ANALYSES OF REMEDIATED SECTIONS

A remedial option consisting of a toe berm and in-situ densification of the potentially-liquefiable foundation soils was considered to improve the downstream stability of the dam at both sections XVS1 and XVS2. Figures VII-7 and VII-8 show the sections XVS1 and XVS2 with the proposed conceptual remediation schemes. The proposed downstream remediation comprises a 30 m wide densified zone with 5 m beneath the toe in the potentially liquefiable foundation soils and a 25 m wide by 8 m high compacted toe berm over the densified soil zone.

A toe berm was considered to improve the upstream stability of the section at XVS1 and in-situ densification and a toe berm was considered for the upstream improvement at section XVS2. The proposed conceptual remediation schemes are shown in Figures VII-9 and VII-10. The proposed upstream remediation comprises 8 m wide densified zone in the potentially liquefiable foundation soils and/or a 10 m wide by 5 m high compacted toe berm over the densified soil zone.

In the stability analyses of the remediated Sections XVS1 and XVS2, the same properties listed in Table VII-2 were used for the unimproved soil units. Table VII-5 lists the properties that were used for the improved foundation soils and compacted toe berm.

Table VII-5 Soil Properties of Improved Soils and Compacted Berm

Soil Unit	Unit Weight (kN/m ³)	Friction Angle (deg)	Cohesion (kPa)
Compacted Toe Berm Fill	20	35	0
Densified Foundation Sands and Gravels	21	35	0
Densified Foundation Silt	20	25	0

VII-3.1 Results of Post-Liquefaction Stability Analyses of Remediated Sections

Figures VII-11 through VII-14 show the slip surfaces for Sections XVS1 and XVS2 of Cross Valley Dam with the proposed remediation schemes. The analyses are summarized in Table VII-6.

Table VII-6 Liquefaction FOS of Cross Valley Dam with Polishing Pond with the Proposed Remediation Schemes

Section	Case	Post-Liquefaction FOS (M-P)	Reference Figure
XVS1 (Near BPT05-04)	Downstream Analysis	1.25	VII-11
	Upstream Analysis	1.17	VII-12
XVS2 (Near BPT05-03)	Downstream Analysis	1.54	VII-13
	Upstream Analysis	1.40	VII-14

Sensitivity analyses were conducted for section XVS2 in which the potentially liquefiable layer was treated as silt instead of sand and gravel to account for the variability of the soil and to check the robustness of the proposed remediation scheme. Figures VII-15 and VII-16 show the results for the downstream and upstream stability, respectively. The post-liquefaction FOS for the downstream stability reduced to 1.13 from 1.54 and the FOS for the upstream stability reduced to 1.15 from 1.40.

Similar check was carried out for section XVS1, in which the sequence of the type of soils in the potentially liquefiable layers was changed. The layer 1 (top layer) was treated as silt and the layer 2 (bottom layer) was treated as sand in the sensitivity analyses. The change of sequence in the sensitivity analyses resulted in increase in the FOS. The FOS for the downstream stability increased to 1.32 from 1.25 and the FOS for the upstream stability increased to 1.26 from 1.17. Therefore, the proposed remediation schemes are adequate to provide a post-liquefaction FOS of 1.1.

At Section XVS1, the proposed remediation scheme gave a minimum post-liquefaction FOS of 1.25, which is slightly higher than the target FOS of 1.1. A 25 wide densified zone with a 20m wide berm would give a post-liquefaction FOS of 1.13 (as shown in Figure VII-17) instead of the proposed scheme, which consists of a 25 m wide densification zone with a 25 wide berm. In account of the variability of the soil profile, to be conservative and to be in line with the remediation scheme at Section XVS2, the proposed remediation scheme was chosen at this conceptual level.

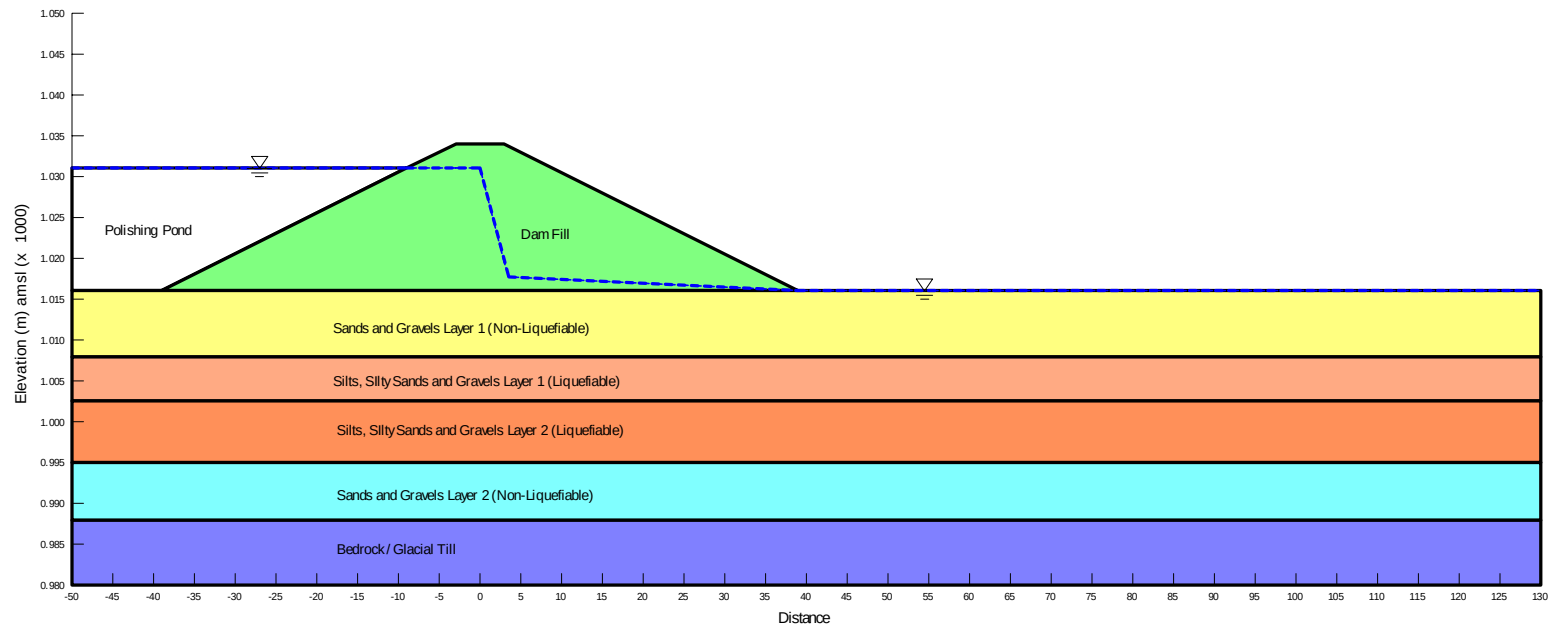


Figure VII-1 Simplified Model of Cross Valley Dam with Polishing Pond, Post-Liquefaction Stability Analyses, Section XVS1

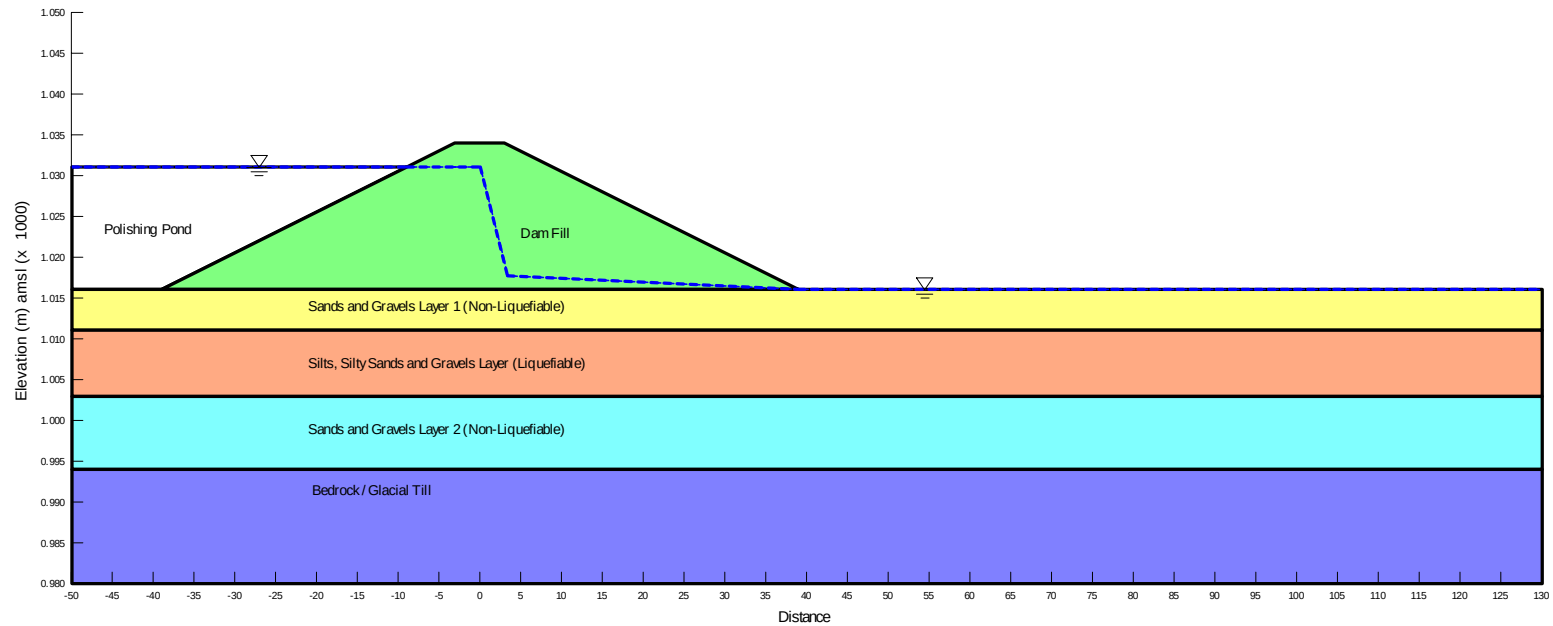


Figure VII-2 Simplified Model of Cross Valley Dam with Polishing Pond, Post-Liquefaction Stability Analyses, Section XVS2

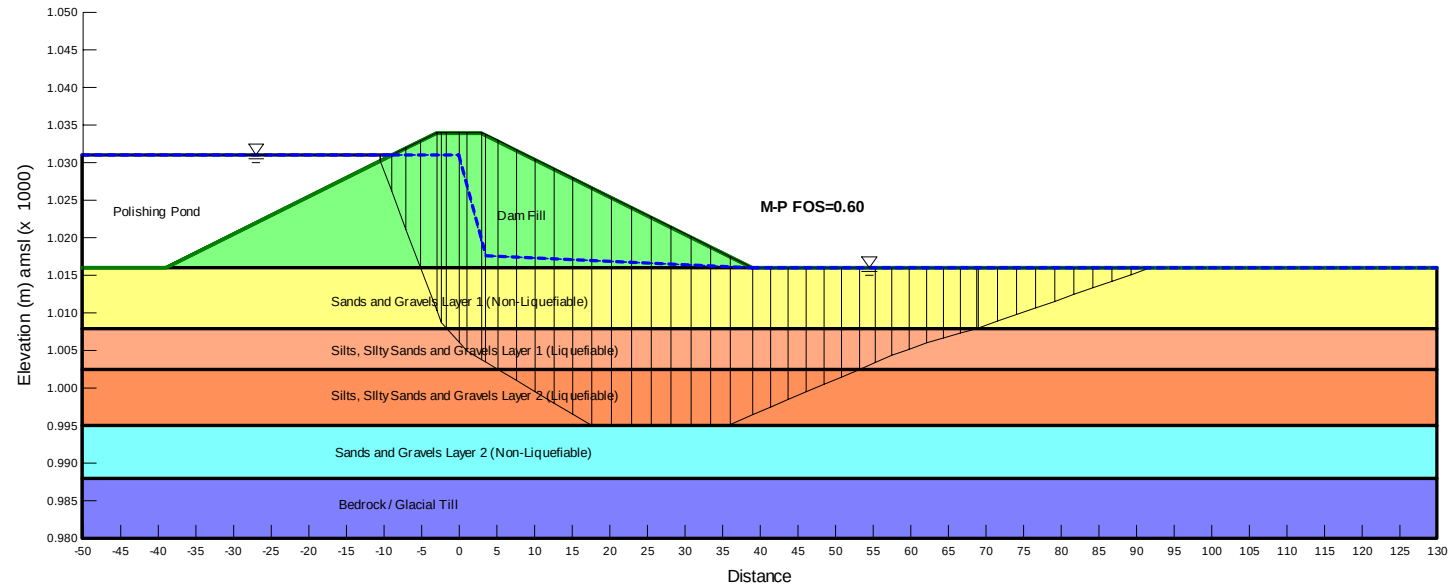


**Figure VII-3 Downstream Stability Analysis Results for Cross Valley Dam, Section XVS1
(Calculated Factor of Safety = 0.60)**

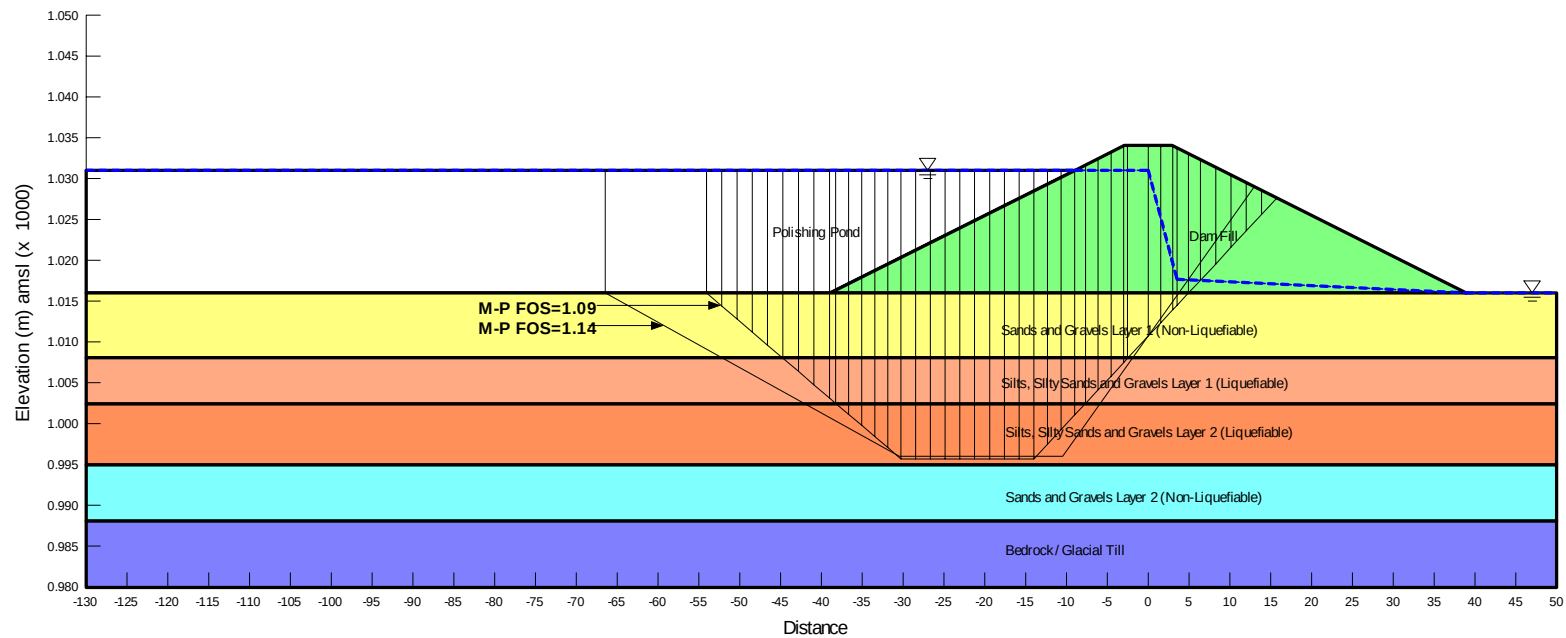


**Figure VII-4 Upstream Stability Analysis Results for Cross Valley Dam, Section XVS1
(Calculated Factor of Safety = 1.09)**

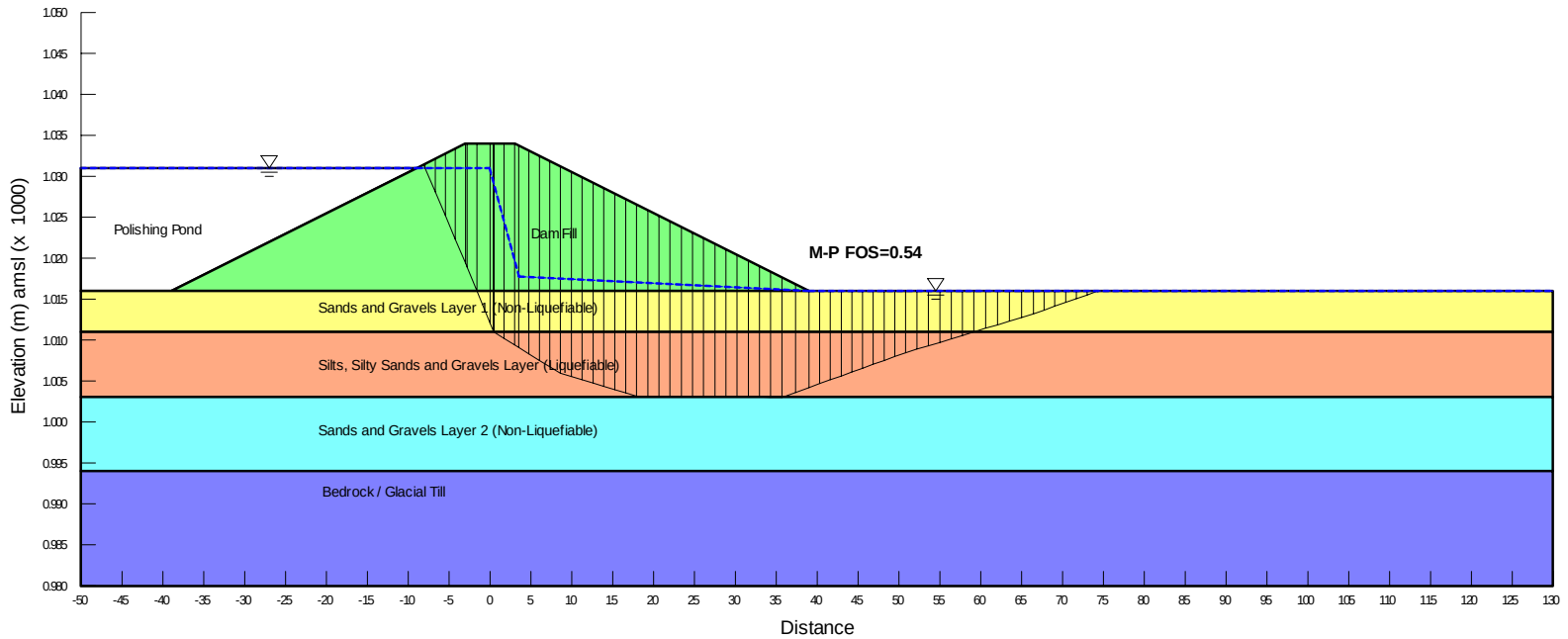


**Figure VII-5 Downstream Stability Analysis Results for Cross Valley Dam, Section XVS2
(Calculated Factor of Safety = 0.54)**

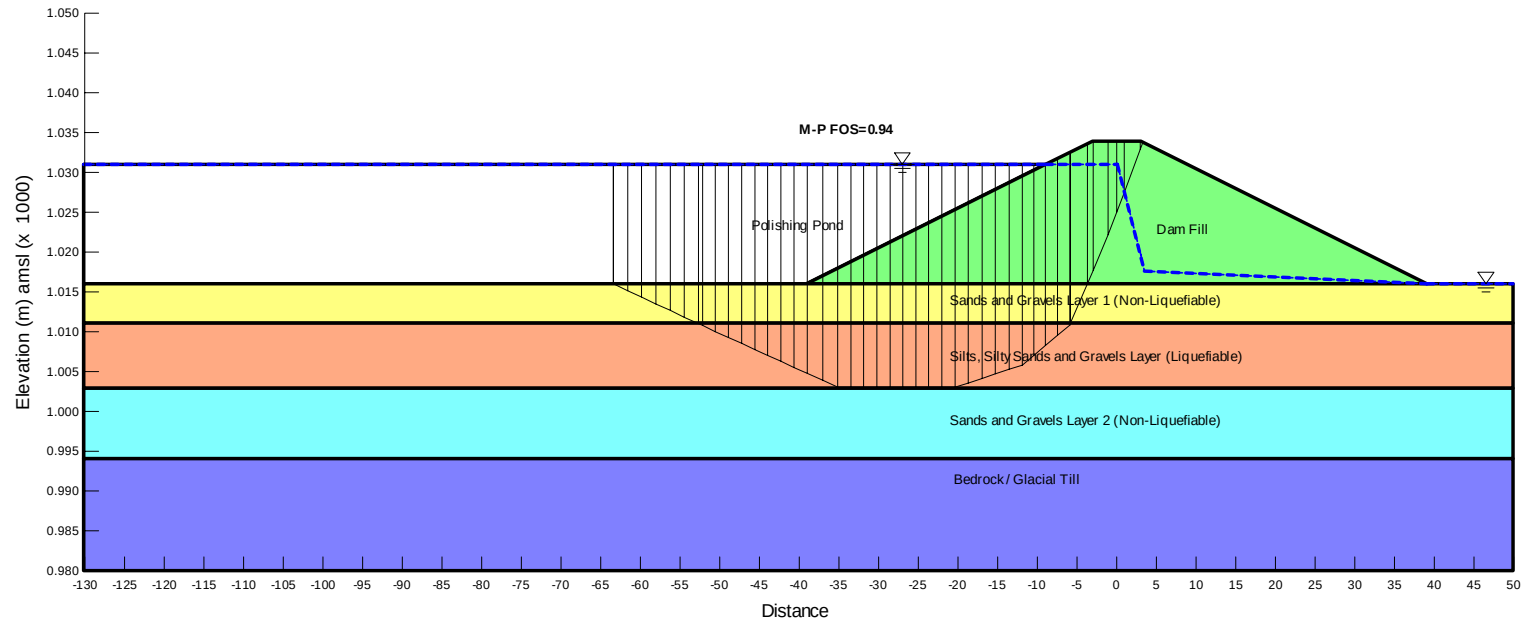


**Figure VII-6 Upstream Stability Analysis Results for Cross Valley Dam, Section XVS2
(Calculated Factor of Safety = 0.94)**

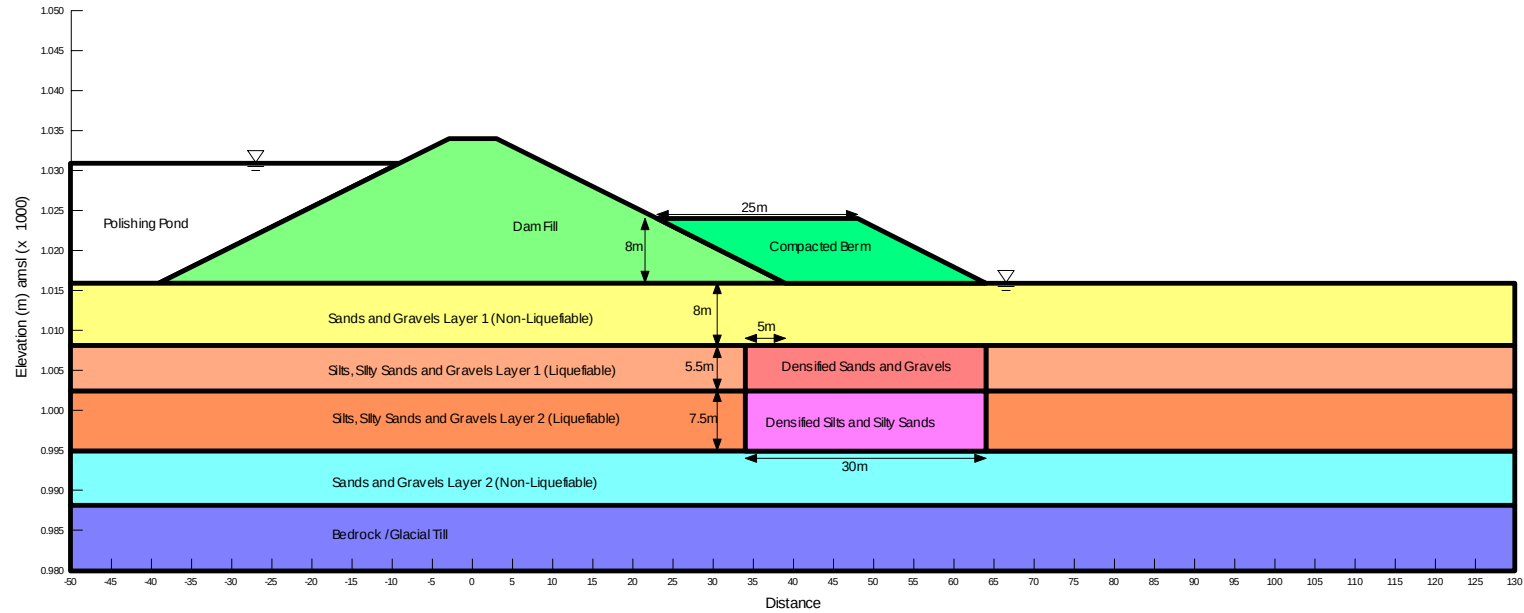


Figure VII-7 Proposed Remediation Scheme for Downstream at Section XVS1 with In situ Densification and Toe Berm

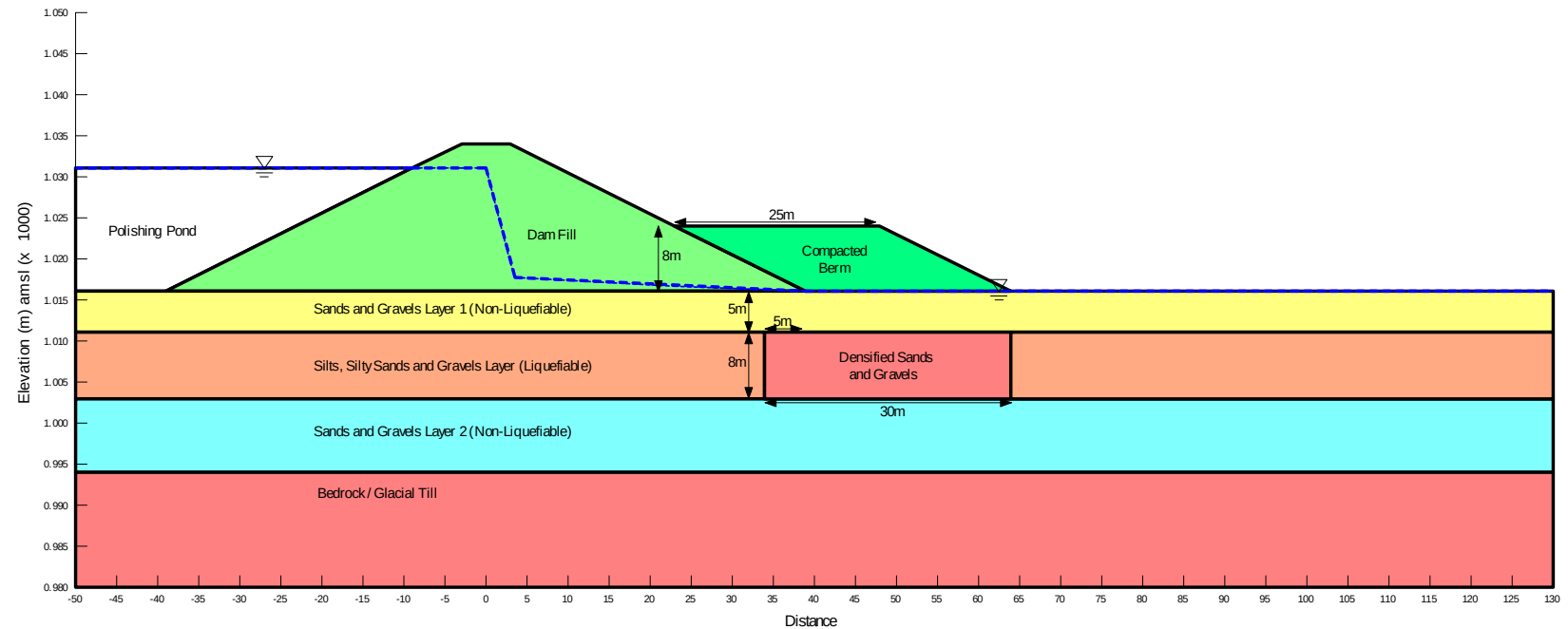


Figure VII-8 Proposed Remediation Scheme for Downstream at Section XVS2 with In situ Densification and Toe Berm

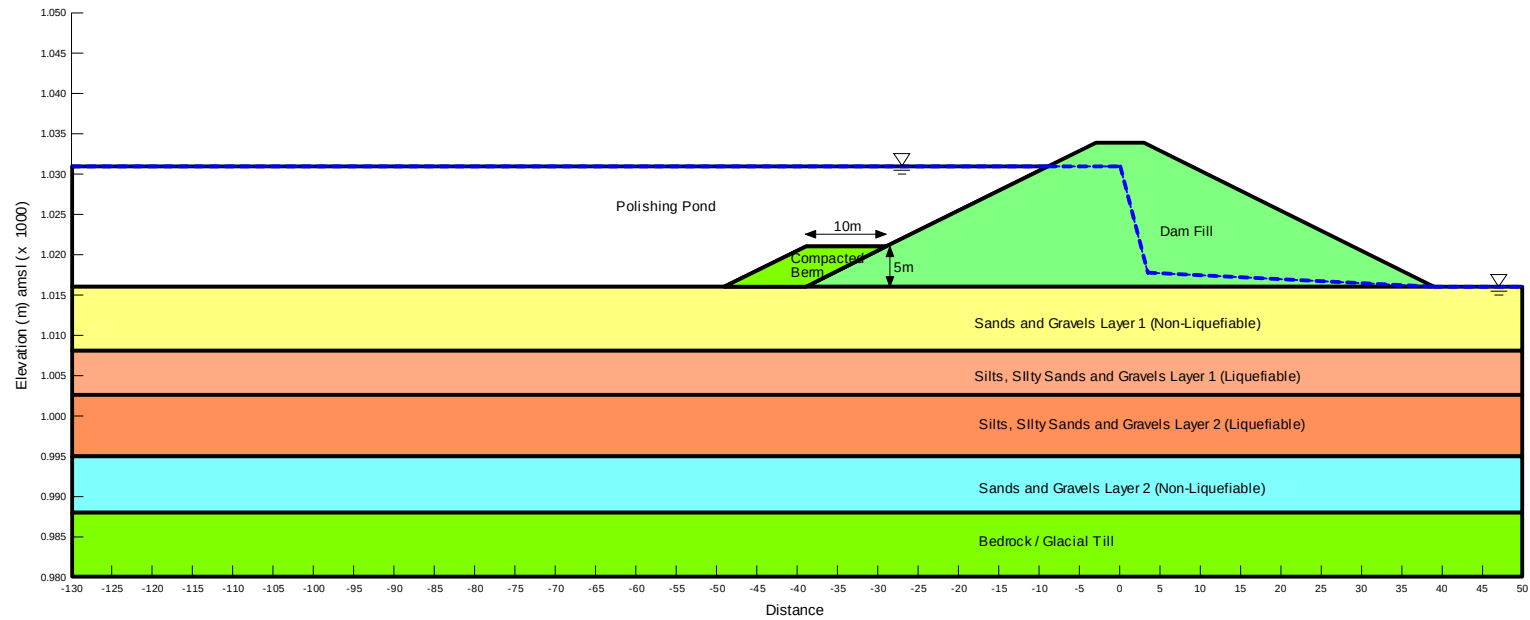


Figure VII-9 Proposed Remediation Scheme for Upstream at Section XVS1 with Toe Berm

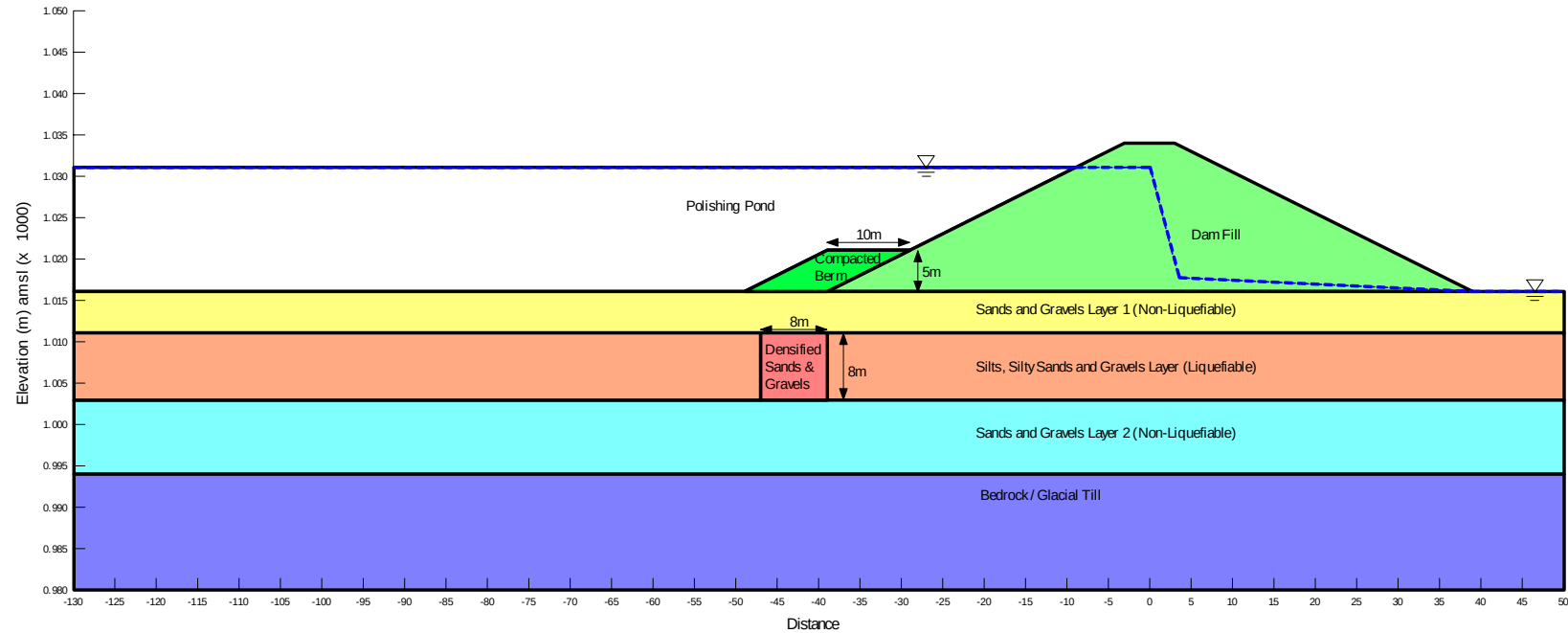


Figure VII-10 Proposed Remediation Scheme for Upstream at Section XVS2 with Insitu Densification and Toe Berm

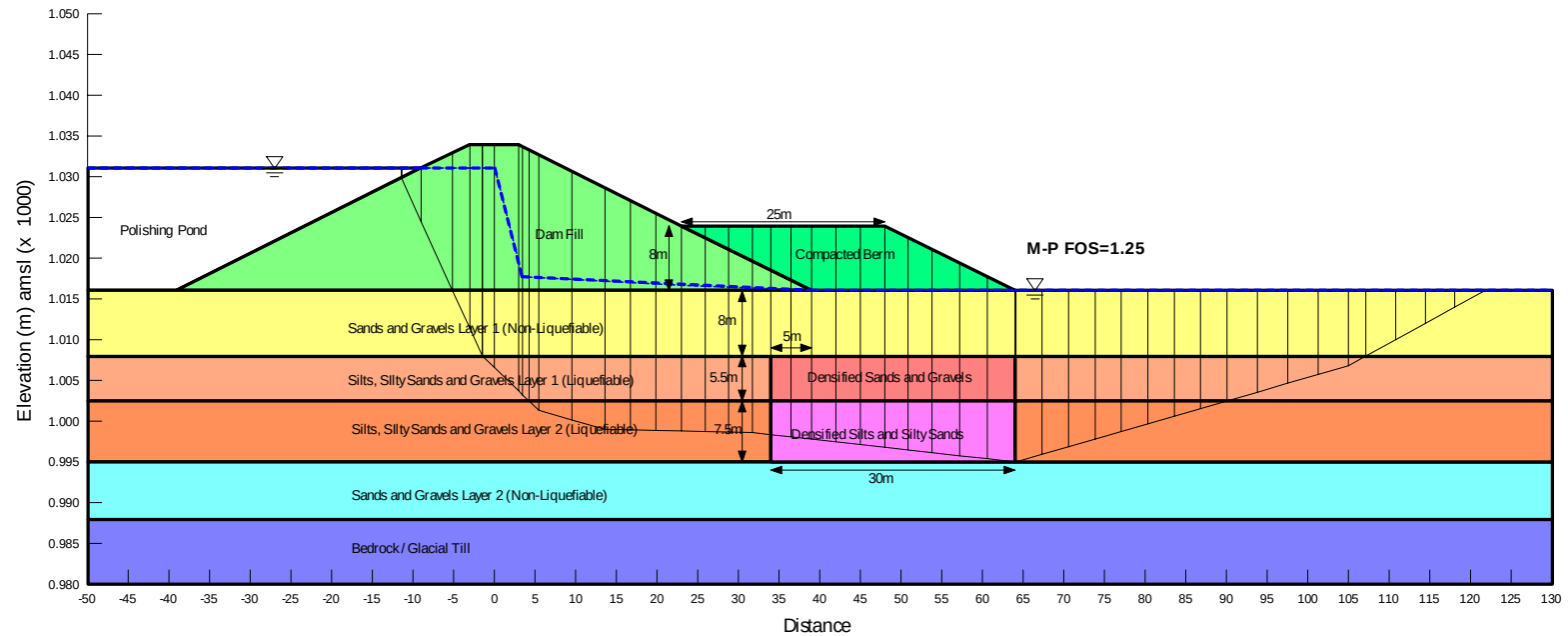


Figure VII-11 Downstream Stability Analysis Results for Cross Valley Dam with the Proposed Remediation Scheme at Section XVS1 (Calculated Factor of Safety = 1.25)

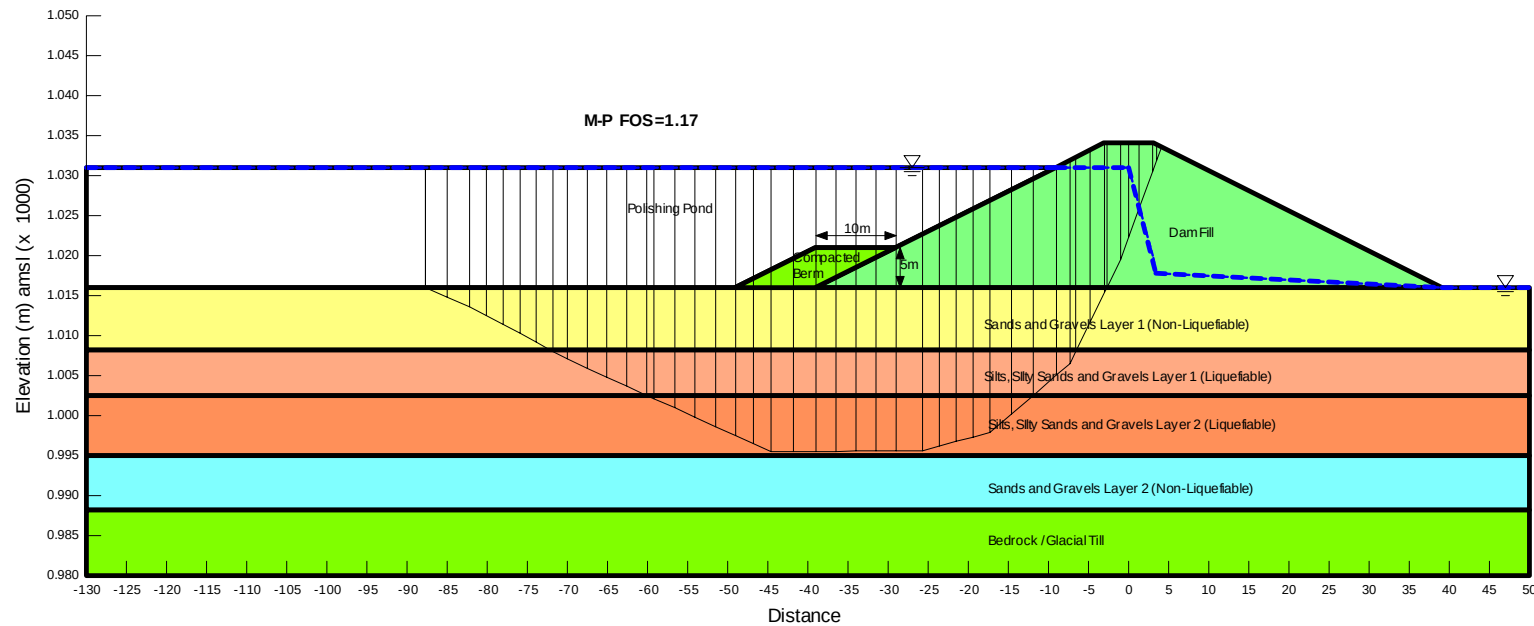


Figure VII-12 Upstream Stability Analysis Results for Cross Valley Dam with the Proposed Remediation Scheme at Section XVS1 (Calculated Factor of Safety = 1.17)

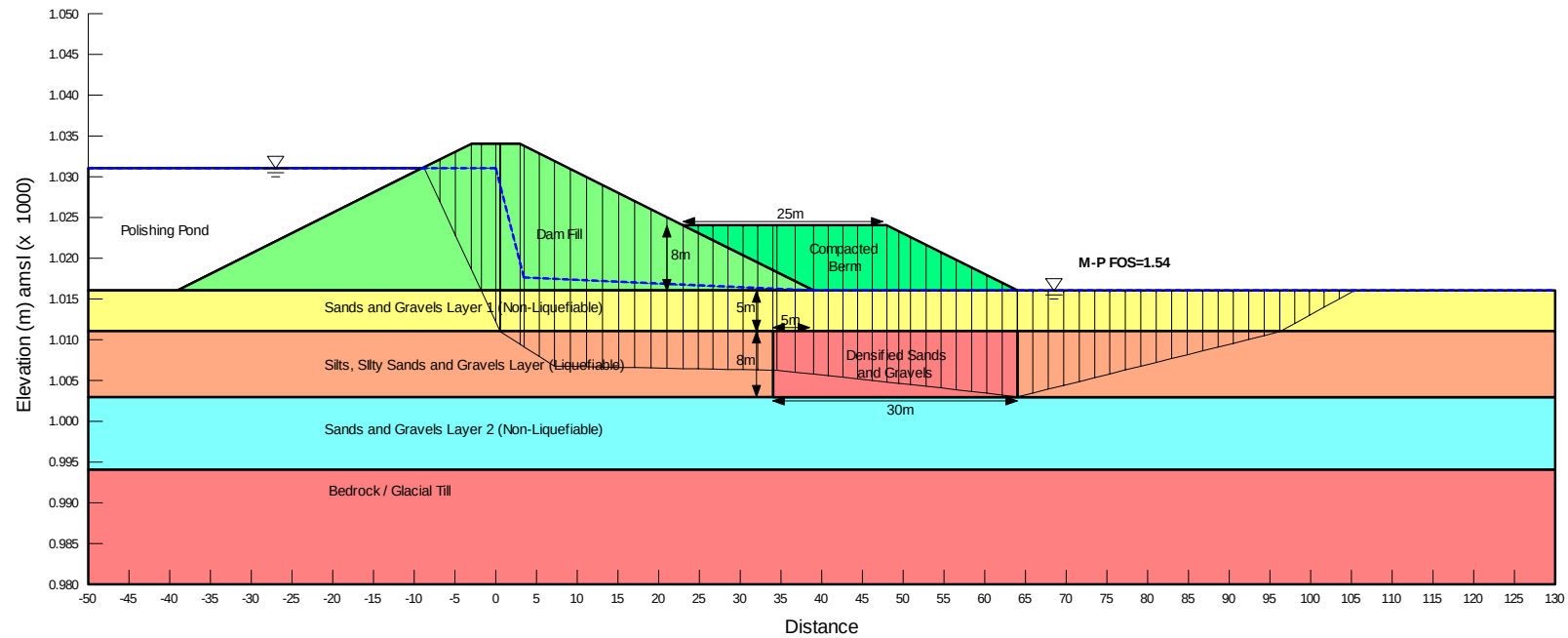


Figure VII-13 Downstream Stability Analysis Results for Cross Valley Dam with the Proposed Remediation Scheme at Section XVS2 (Calculated Factor of Safety = 1.54)

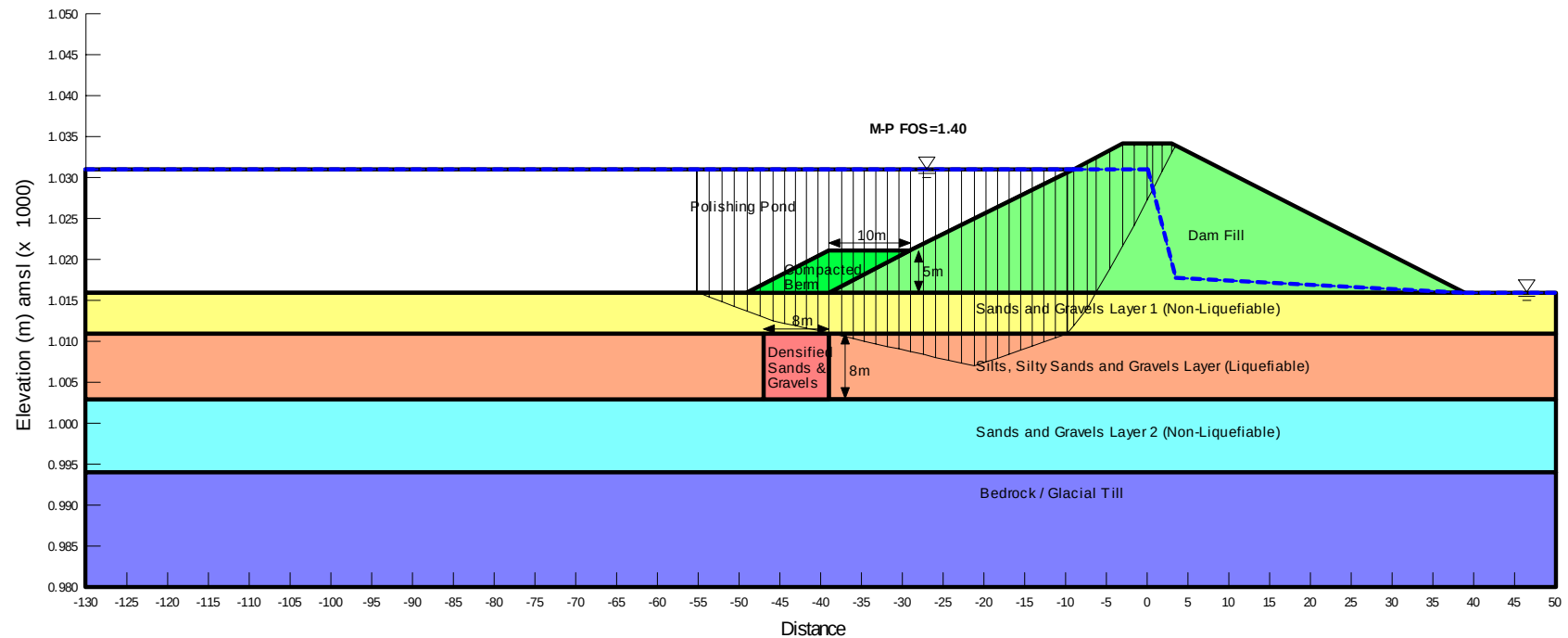


Figure VII-14 Upstream Stability Analysis Results for Cross Valley Dam with the Proposed Remediation Scheme at Section XVS2 (Calculated Factor of Safety = 1.40)

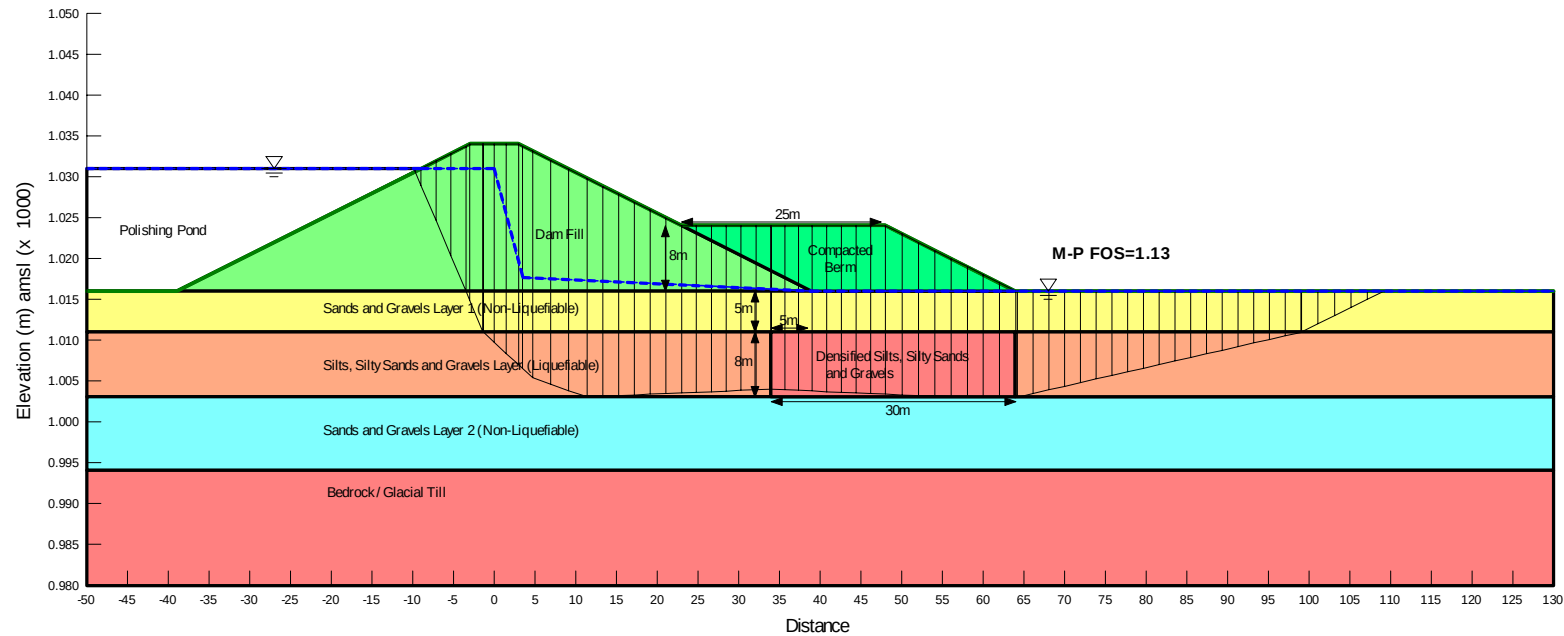


Figure VII-15 Sensitivity Downstream Stability Analysis Results for Cross Valley Dam with the Proposed Remediation Scheme at Section XVS2 (Calculated Factor of Safety = 1.13)

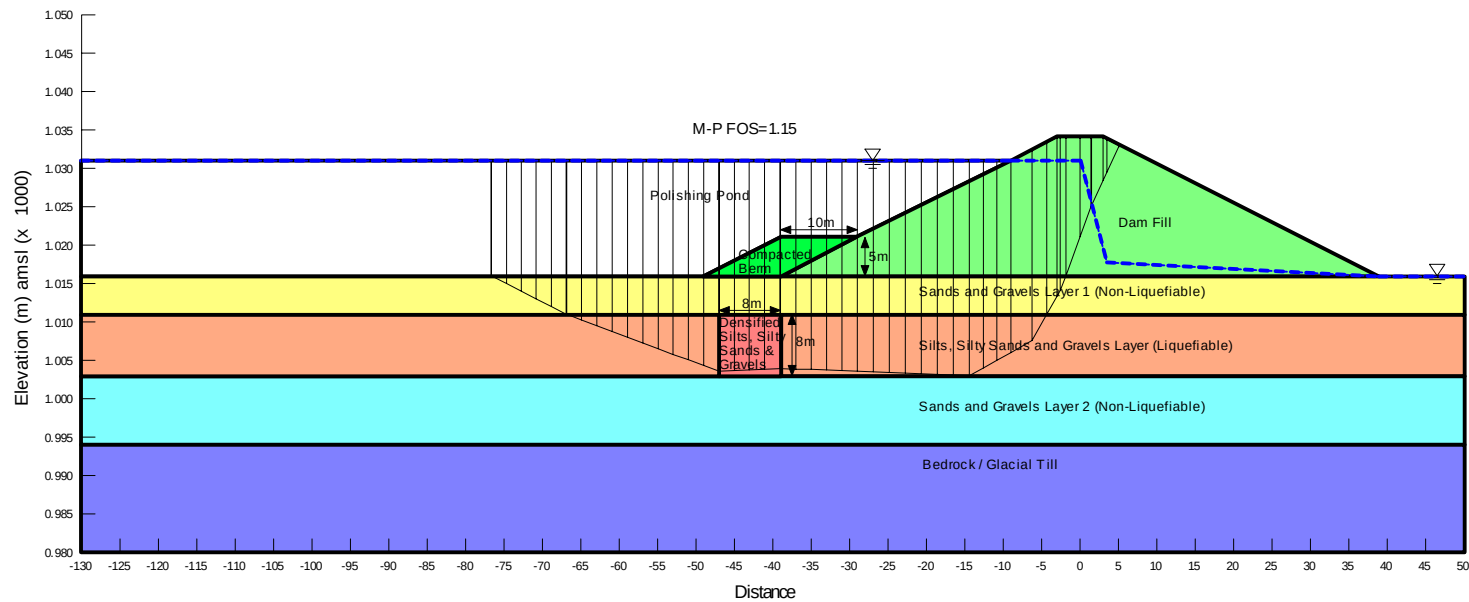


Figure VII-16 Sensitivity Upstream Stability Analysis Results for Cross Valley Dam with the Proposed Remediation Scheme at Section XVS2 (Calculated Factor of Safety = 1.15)

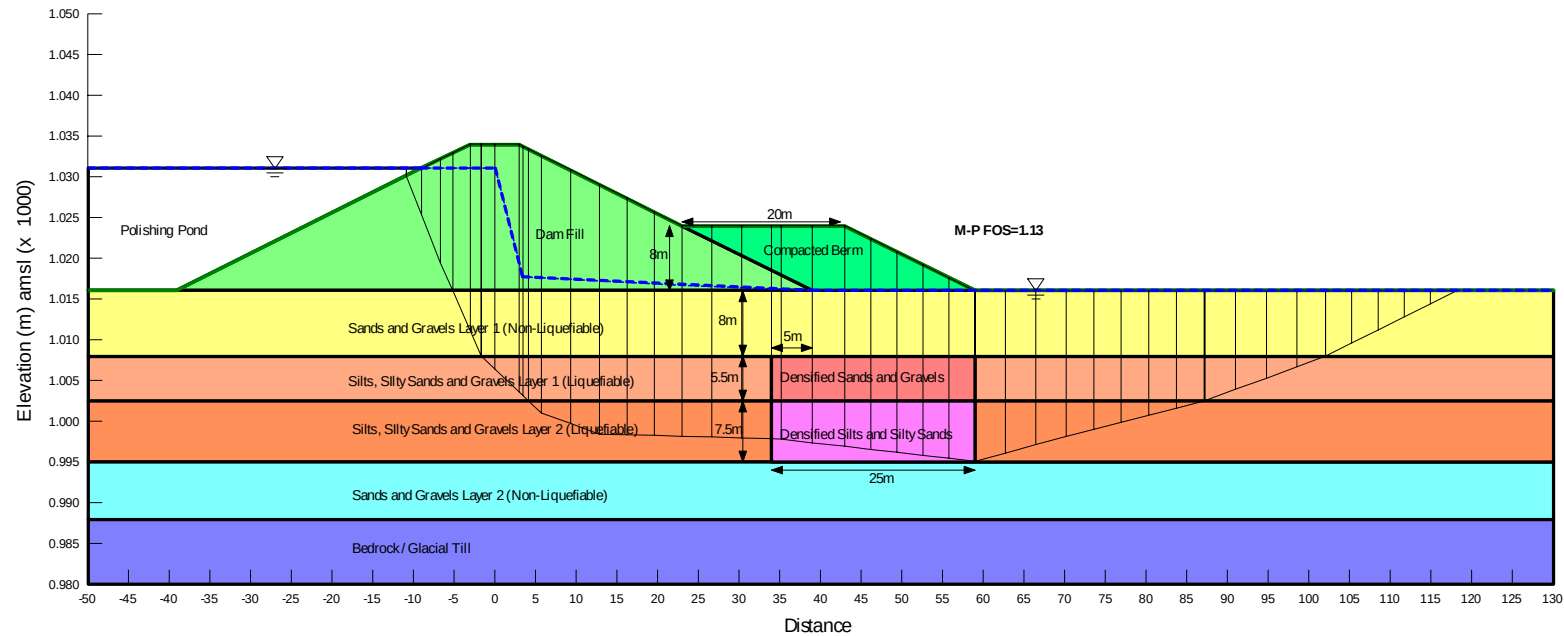


Figure VII-17 Downstream Stability Analysis Results for Cross Valley Dam with an Alternative Remediation Scheme at Section XVS1 (Calculated Factor of Safety = 1.13)