PDA USER DAYS 1992

PILE PROFILE CALCULATIONS USING PITWAP

Frank Rausche

PITWAP signal matching is laborious and sometimes frustrating, particularly for long piles with high energy losses. Then the soil resistance effects often have little influence near the toe and the calculated profile becomes unstable (huge or zero). A simpler method is the pile profile calculation whose premise is that a stepwise change in impedance causes pulse-like velocity wave effect at the pile top. In other words, the effect of an impedance change has the appearance of the derivative of the impedance change. Inversely, the profile is the integral of the wave effects at the pile top. In the absence of soil resistance effects, the profile therefore has the appearance of the pile top displacement.

Under this simple sounding prescription, calculations can be very rapid. However, our difficulties have not yet ended since we do not want to include the soil resistance effects in the calculation or our piles would all be big (soil resistance looks like an impedance increase). The prescription therefore requires that we first identify soil resistance effects, and then integrate the difference between the measured pile top velocity and the velocity due to soil resistance effects.

For an understanding of the concept, let us first examine a pile with no soil resistance and only end bearing. The integral would produce a zero profile at time 2L/c and a full profile between top and bottom. The soil effect is evaluated with zero resistance on an infinitely long pile (or a finite pile with critical toe damper, J_{toe} = 1, but no other resistance) produces in this case a straight line. The difference between the record and this straight line soil effect is the actual pile impedance change.

For a pile which actually has resistance effects, PITWAP's damping and static resistance models can be used to generate the proper reference. A few words of caution. The soil effect analysis is most crucial to the success of this method. Often however, often the pile top velocity does not change much when RI, JS and JT values are varied. In particular, large velocity offsets must be reduced by one or more of the following DA options.

HPfl

This is the high-pass filter option. A high-pass filter removes low frequency components. Low frequency components are, for example, a slow drift away from the zero line or an offset in a record. High-pass filtering in PITWAP is calculated by taking an average over a certain number of samples and then subtracting this average from its midpoint. The process is repeated for all data points as a midpoint with the exception of data points in the impact area. HP0 uses 20 impact pulses as the average length, HPn uses n samples.

HP effectively reduces long time offsets. However, if n is used too small, then most characteristics of a record might be removed. This filter also produces a few uncomfortable side effects such as a lowering of a positive pulse with a leading and a trailing negative pulse which would indicate a bulb before a defect. HP therefore should be used with extreme caution.

TRns

This quantity allows you to specify how the transition is made from impact zone to a fully hi-pass filtered record. TR can be specified with a parameter n which specifies how many percent high-pass filtering should be included over one pulse length following the impact pulse. TR0 is the default which means that the velocity is practically not adjusted within the first pulse length after impact.

ACas

The acceleration shift starts at impact and lasts till the end of the record. It therefore pivots the velocity curve around the time of impact. Small adjustments in ACas can be very effective and helpful.

TA1, TA2, A12

Acceleration shift between time TA1 and TA2 may effectively be used to achieve a momentary velocity shift by making the TA2 time only slightly longer than TA1 and then using a relatively high A12. Use ACas to bring the end of the record to a desirable low velocity value. TA1 may, for example, be set to impact time TVpk and TA2 1/2 ms later to produce a velocity shift which is hidden in the impact signal and has its effect immediately following impact.

TA3, TA4, A34

As for TA1, TA2, A12.

MAgn

Of course, this is the exponential amplification also used in PIT. It can be very helpful in making a pile toe reflection such that the profile closes. Note that large amplifications can sometimes produce undesirable zero line shifts which may require HP or AC corrections.

MDep

The depth at which magnification starts. Of course, this should correspond to the depth below shaft or pile top.

MOpt

An option which will allow amplification to be applied to the measured velocity only (MO0) or to both computed and measured velocity (MO1). The latter usually does not produce satisfactory results.

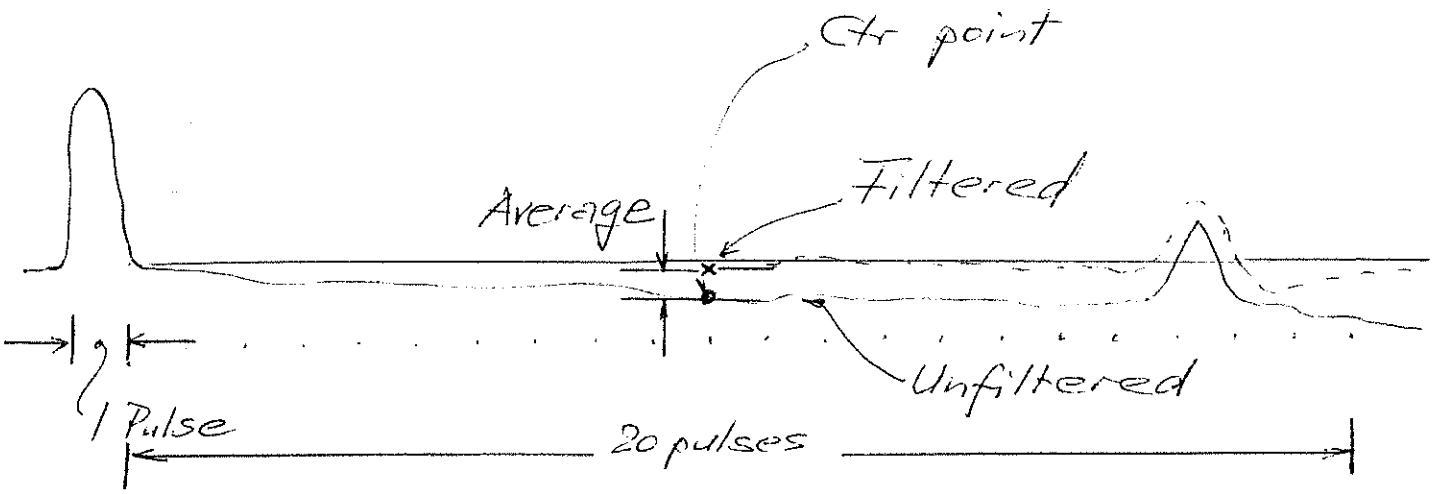
Adjustment and Analysis Procedure

After any one of the DA options is used, display with FVpl in order to calculate the new velocity curve and to check the effect of your actions. Then assign soil resistance, if necessary, and then analyze. After the analysis you can run your new profile using PP.

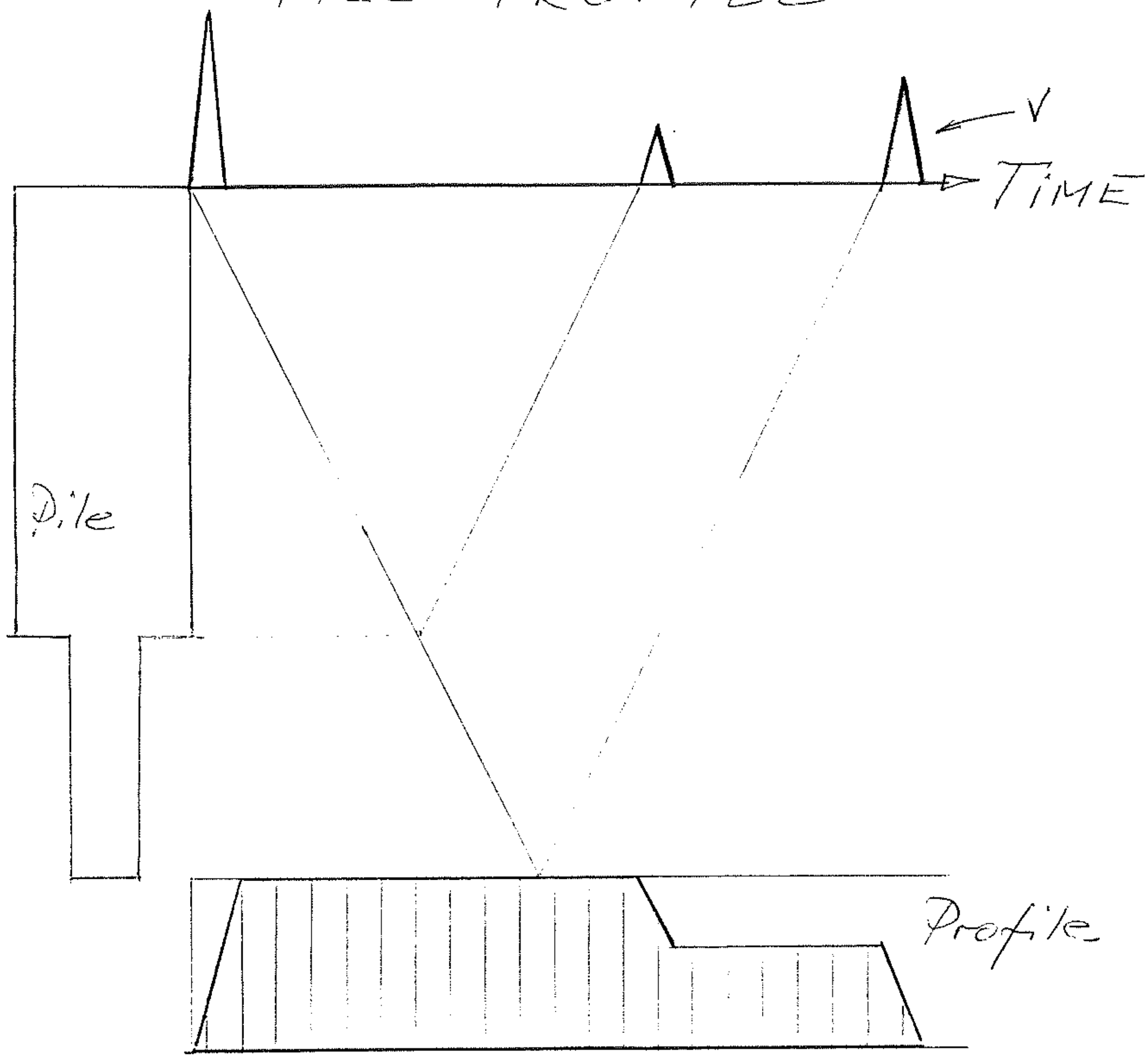
Example

A series of figures shows the development of a pile profile.

PIT HIGH PASS FILTER



PILE PROFILE



da
Data Adjustments: Relative Match Difference at Peak: -.068

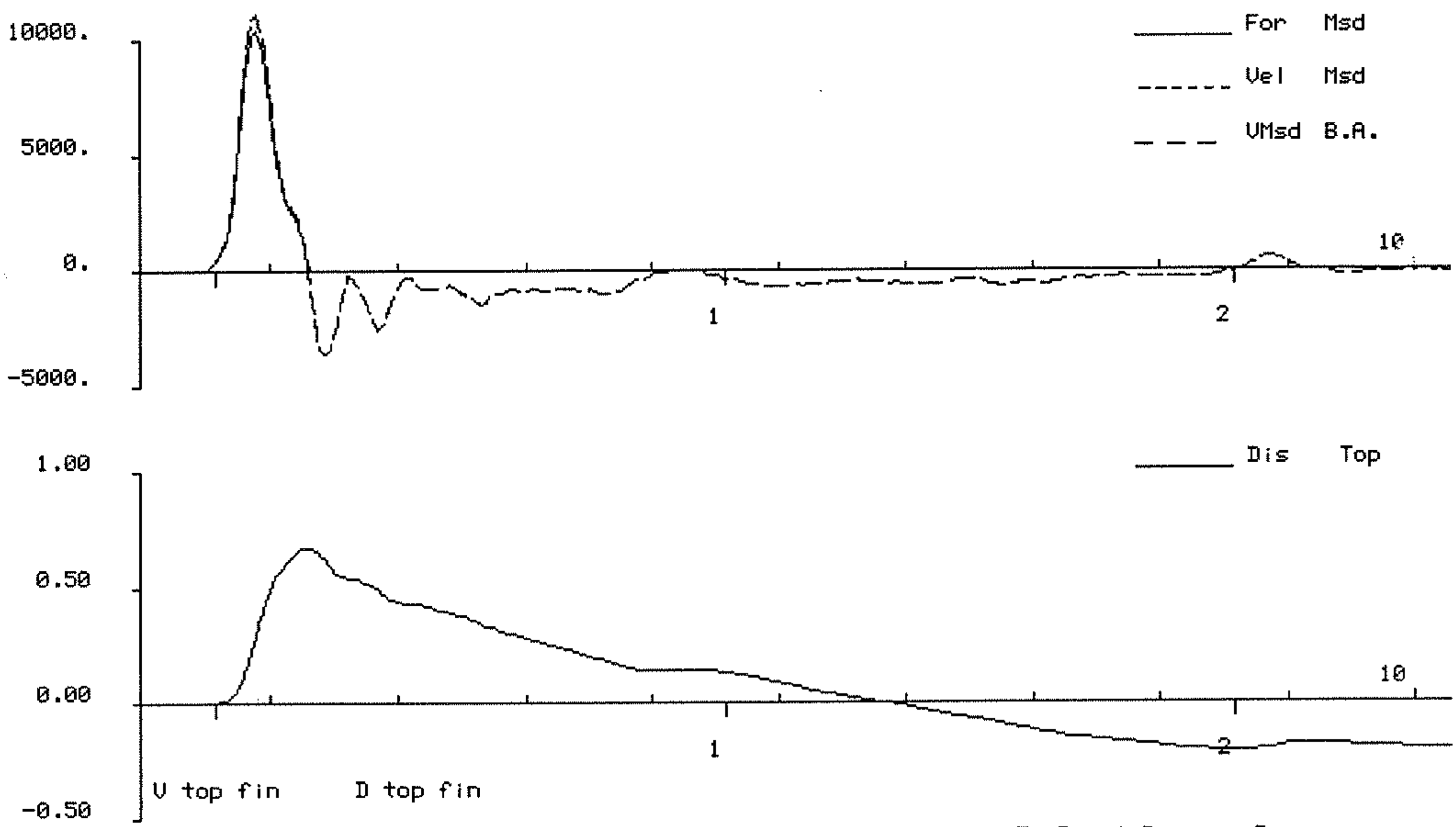
ACas	.00	TVpk	1.06	T1ad	.00	T2ad	1.08	A12	.00
TBeg	.19	TEnd	10.69	T3ad	1.08	T4ad	28.44	A34	.00
VAsh	.0	VCal	3.10	VPcl	1.00	VTsh	0	VFil	0
FAsh	.0	FCal	3.10	FPcl	1.00	FTsh	0	FFil	0
TIsc	.50	FOsc	2500.00			MAgn	1.00	MDep	3.60
FWpl		FVpl		MOpt	0.	HPfl	-1	TRns	0

NAxxxx to change NAme to xxxx, "H" for Help
fv

Goble Rausche Likins & Associates, Inc.

DELFT SW5 VEL ONLY06/16/92

Blow 3 08/26/92



V top fin D top fin
-1.889 -0.868

To Print Depress P

Velocity and Displacement
No High Pass Filter

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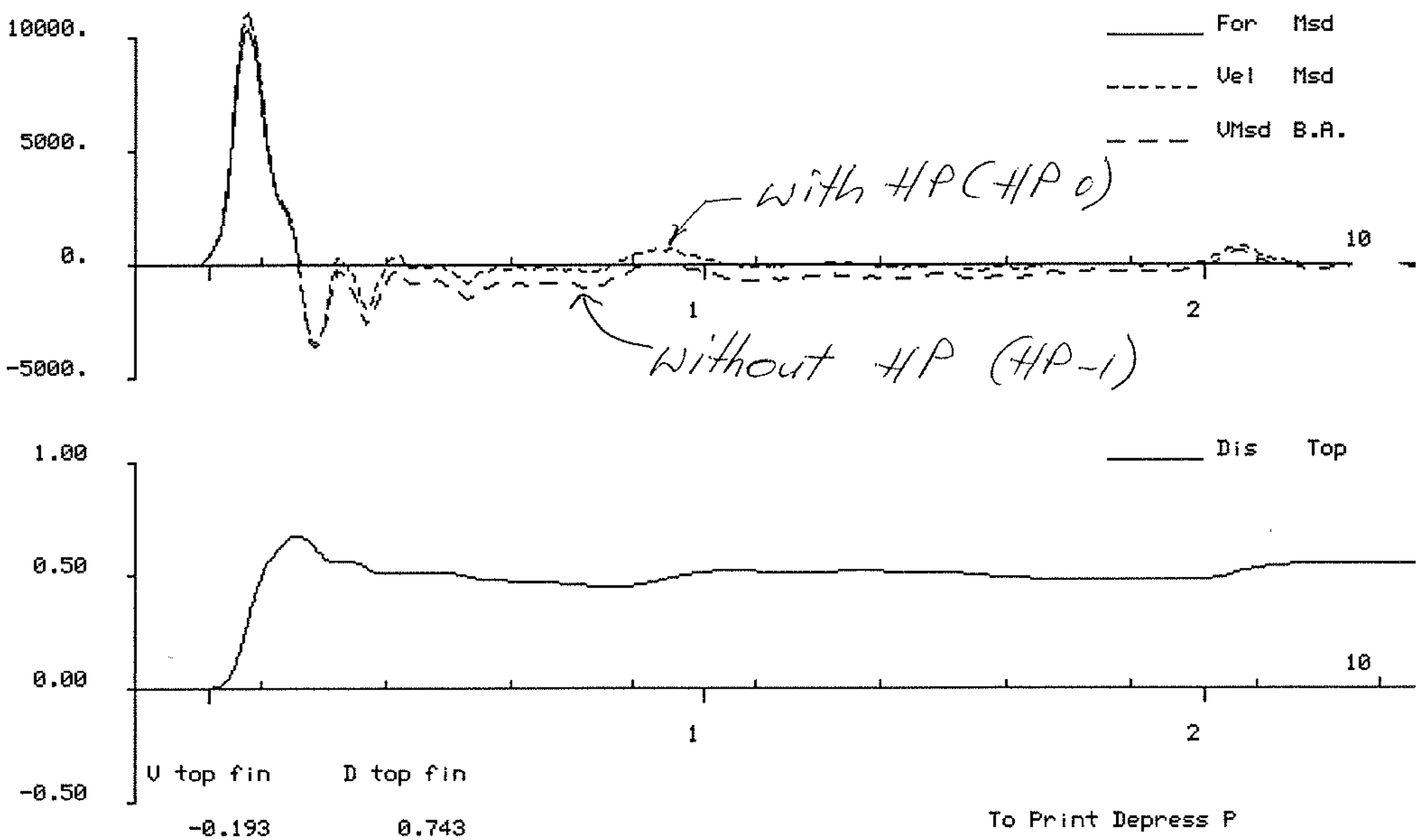
DELFT SW5 VEL ONLY06/16/92

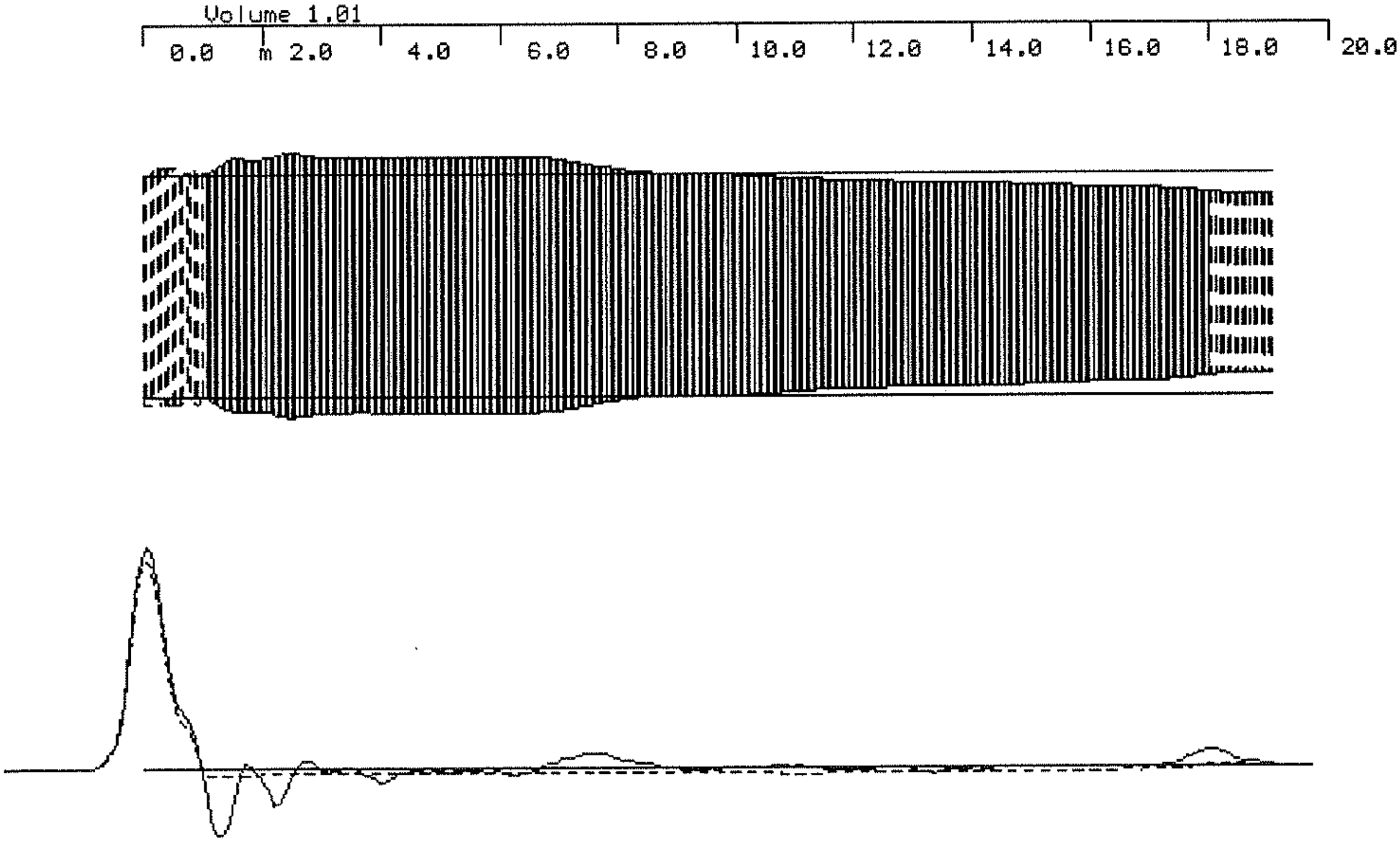
Blow 3 08/26/92



To Print Depress P

DELFT SW5 VEL ONLY06/16/92

Volume 1.01

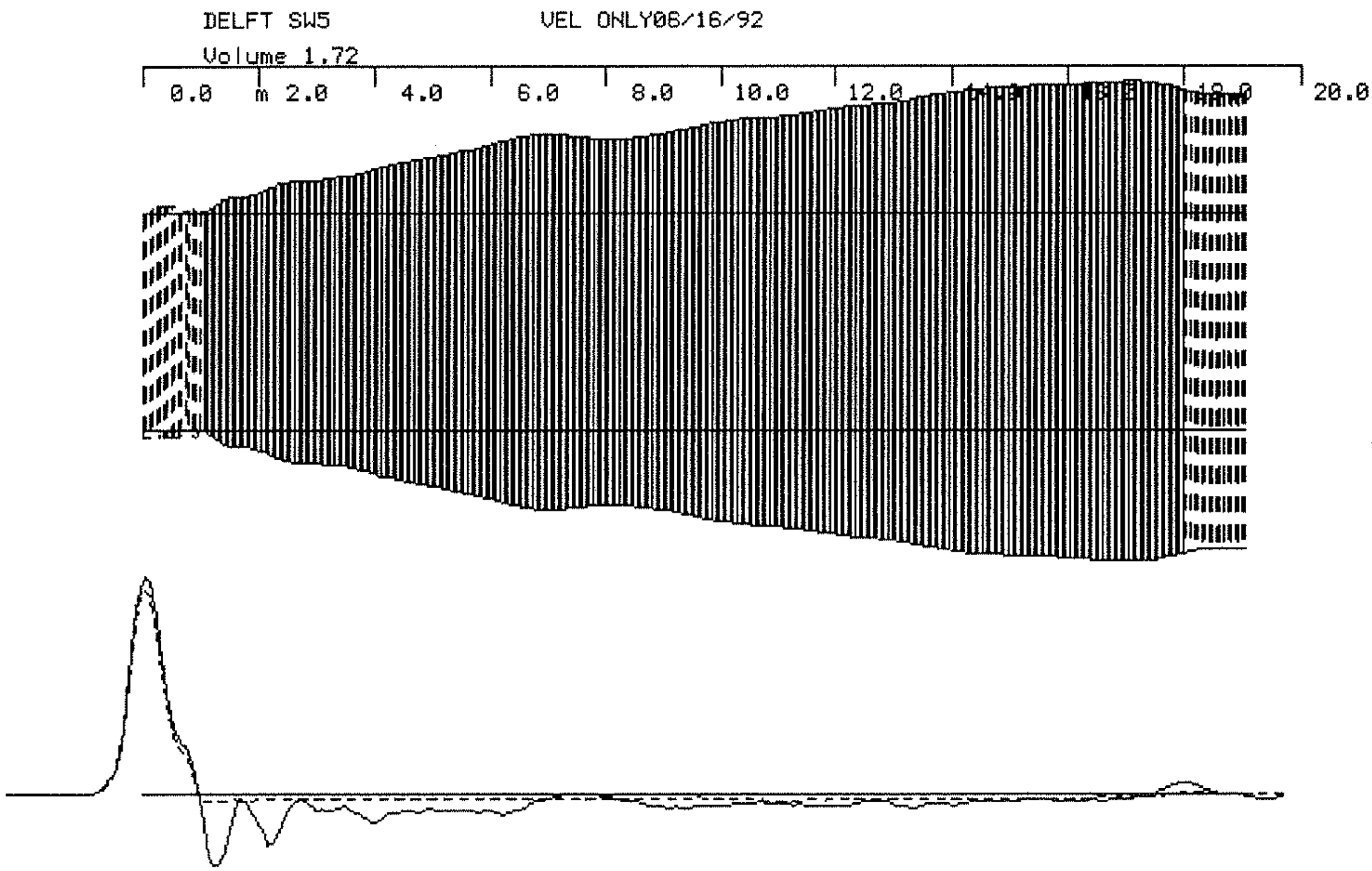


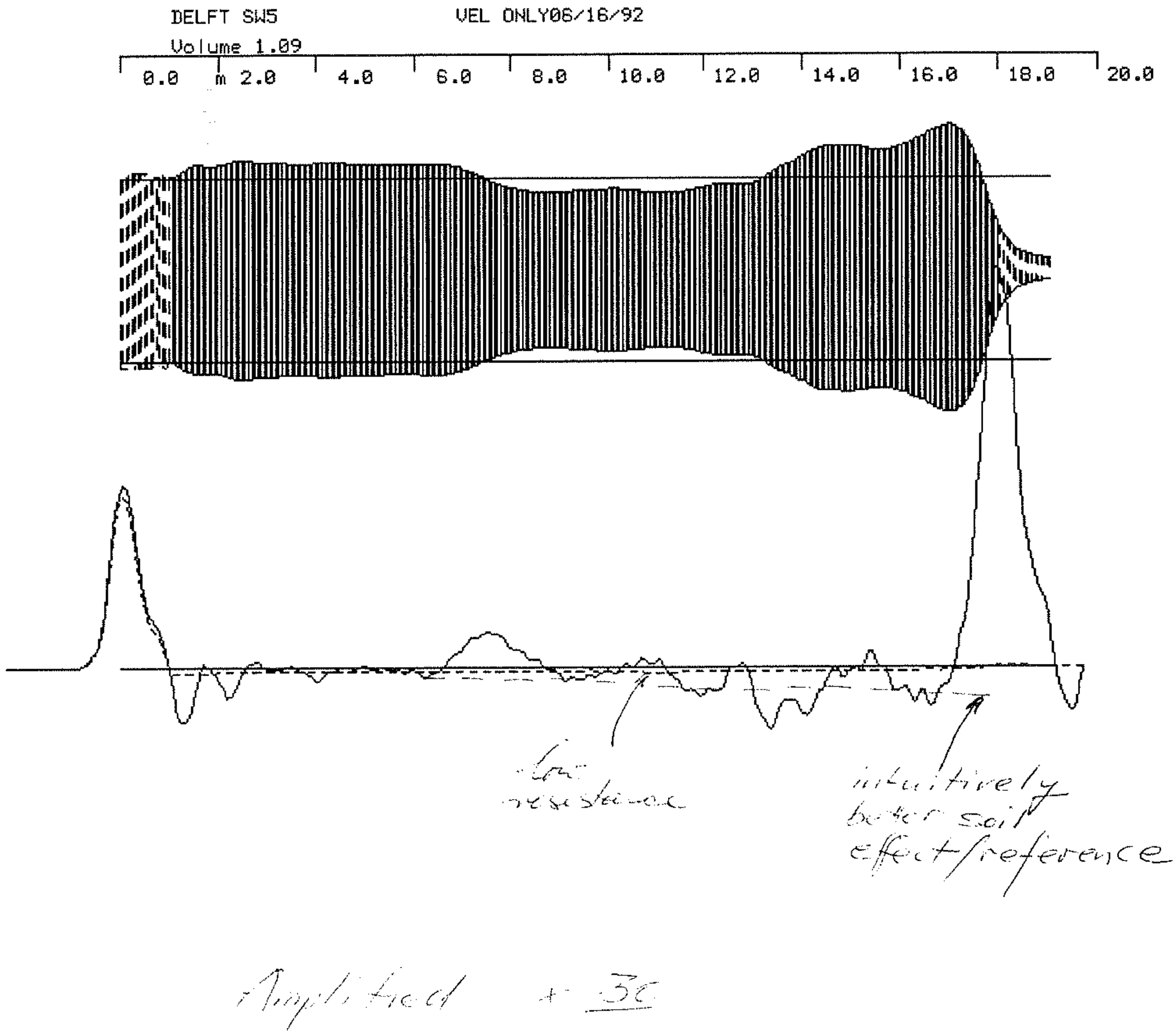
Hi pass filter
No amplification

Data Adjustments: Relative Match Difference at Peak: -.068

ACas	.00	TVpk	1.06	T1ad	.00	T2ad	1.08	A12	.00
TBeg	.19	TEnd	10.69	T3ad	1.08	T4ad	28.44	A34	.00
VAsh	.0	VCal	3.10	VPcl	1.00	VTsh	0	VFil	0
FAsh	.0	FCal	3.10	FPcl	1.00	FTsh	0	FFil	0
TIsc	.50	FOsc	2500.00			MAgn	1.00	MDep	3.60
FWpl		FVpl		MOpt	0.	HPfl	-1	TRns	0

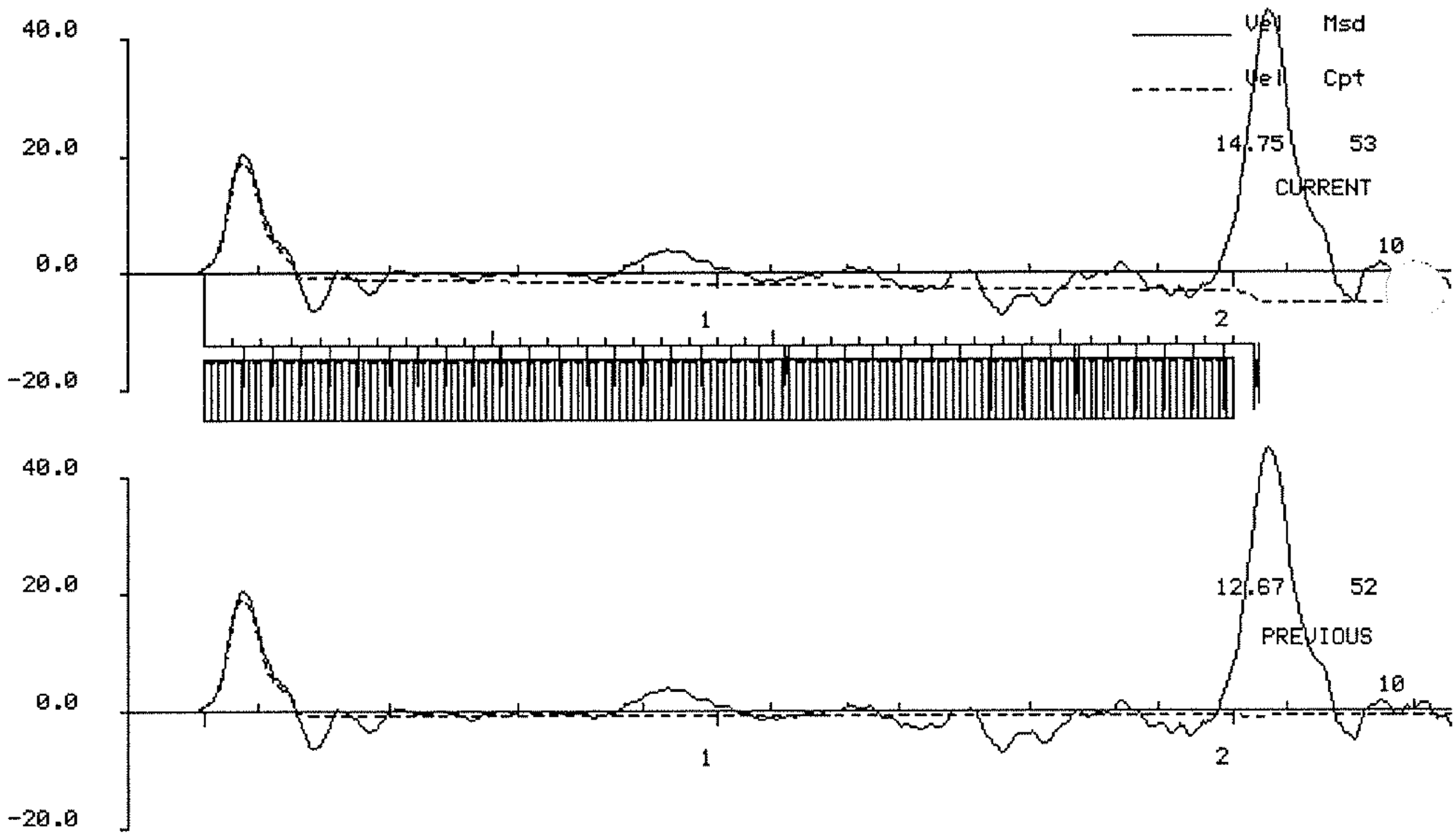
NAxxxx to change NAme to xxxx, "H" for Help



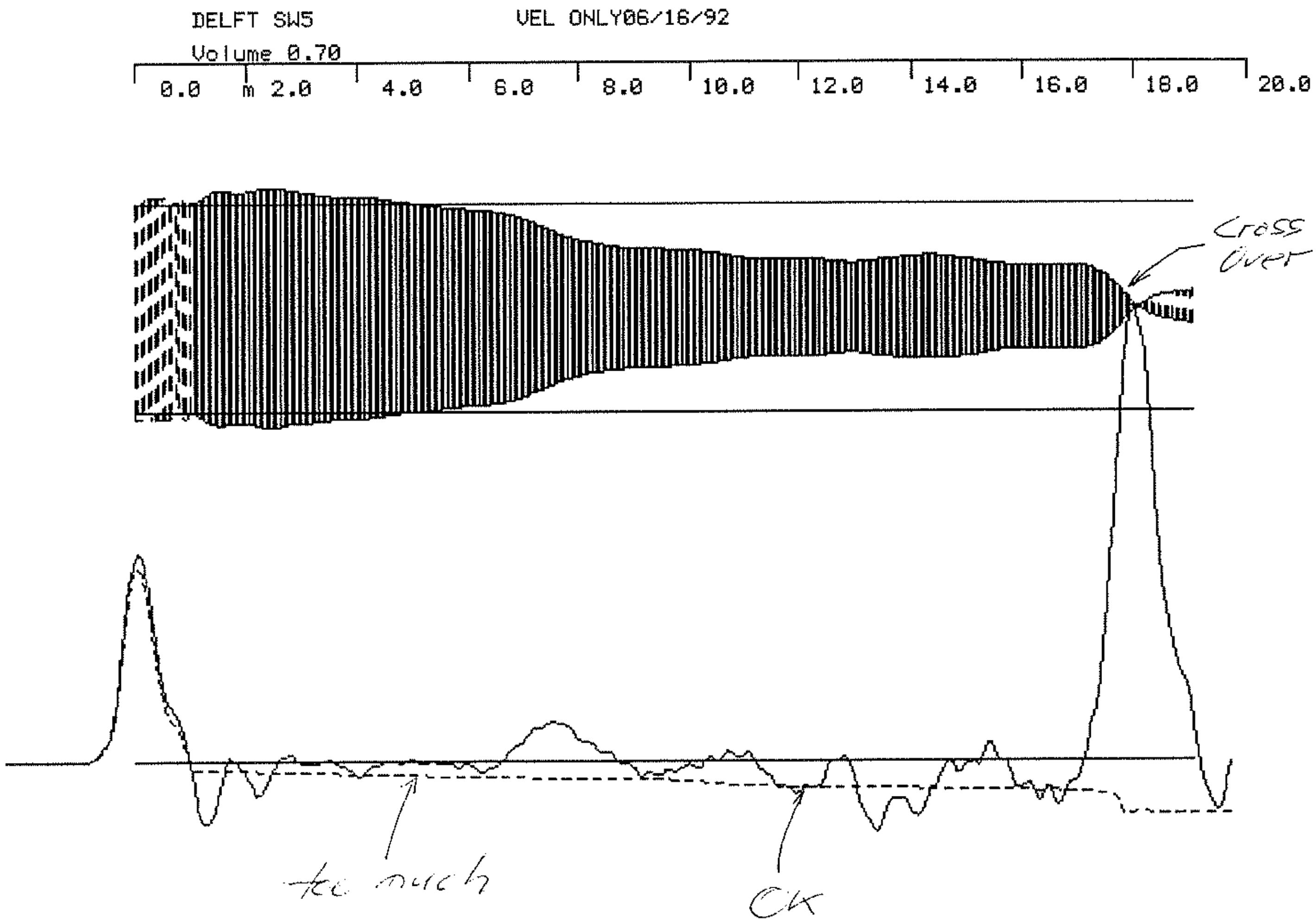


DELFT SW5
VEL ONLY06/16/92
Volume 1.09
0.0
m 2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
low resistance
intuitively better soil effect/reference
Amplified x 30

JSkn	JToe	RUlt
1.000	1.000	5000.0
1.000	1.000	~~5000.0~~ 10.0



To Print Depress P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VEL ONLY06/16/92
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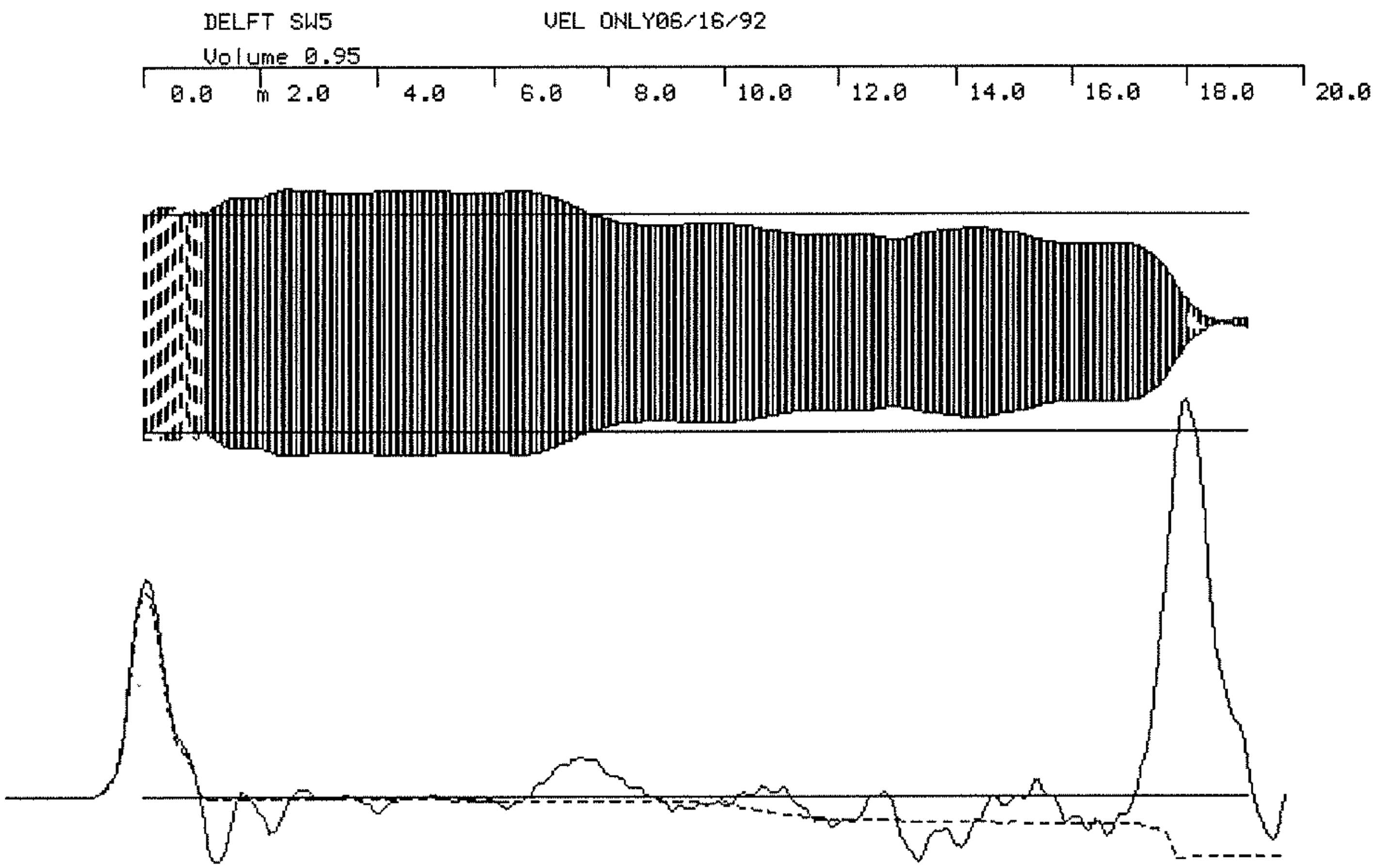
12.0
14.0
16.0
18.0
20.0
Cross Over
too much
OK



Solution using
HPC
HA 25
RI 5000 (3cc at tee)

```
da
Data Adjustments:                    Relative Match Difference at Peak:   -.075

  ACas       .00   TVpk      1.06   T1ad       .00   T2ad     1.08   A12        .00
  TBeg       .19   TEnd     10.69   T3ad      1.08   T4ad    28.44   A34        .00

  VAsh        .0   VCal      3.10   VPcl      1.00   VTsh        0   VFil         0
  FAsh        .0   FCal      3.10   FPcl      1.00   FTsh        0   FFil         0

  TIsc       .50   FOsc 2500.00                      MAgn    20.00   MDep      3.60
  FWpl             FVpl             MOpt        0.   HPfl       -1   TRns         0

NAxxxx to change NAme to xxxx, "H" for Help

 TIME    F M   F/VC   V TP   D TP   F MD   V MD   D MD   F BT   V BT   D BT   R ST   R D
  1.2******     19.   22.7    .68 7991.   14.1    .38 5966.    1.4   .0214000.   465.
  5.2     .0   -15.  -11.4   -.21-1064.  -12.0  -5.72  -367.  -11.3  -5.87      0.******
 10.7     .0   -15.   -3.9   -.20 1048.  -12.0  -5.72  -344.  -11.2  -5.8714000.******
This is a  Fair  Match


    MAIN MENU:
 PV P.I.T.WAP Variables     DA Data Adjustment        SD Store Data/Results
 RI Resistance Input        PS Pile Specifics         NI New Input
 DI Damping Input           PM Pile Model Input       AI Auto Impedance Change
 QI Quake Input             OC Output Control         CM Graph Current Match
 ZI Impedance Input         OU Output                 BM Graph Best Match
 II Impedance Initial.      QU Quit
 PP Simplified Pile Profile Calculation

  .

  lt14000.00
         1       2       3       4       5       6       7       8       9      10
  1  145.6   145.6   145.6   145.6   145.6   145.6   145.6   145.6   145.6   145.6
 11  145.6   145.6   145.6   145.6   145.6   145.6   145.6   145.6   145.6   145.6
 21  207.0   295.7   384.4   384.7   384.7   384.7   384.7   384.7   384.7   384.7
 31  384.7   384.7   384.7   384.7   384.7   384.7  5200.0

Enter Rult (14000.00); Type "C" for Current Match


Resistance Distribution - Nsoil:   36
I1, R1, I2, R2
                          Unresolved:     .00
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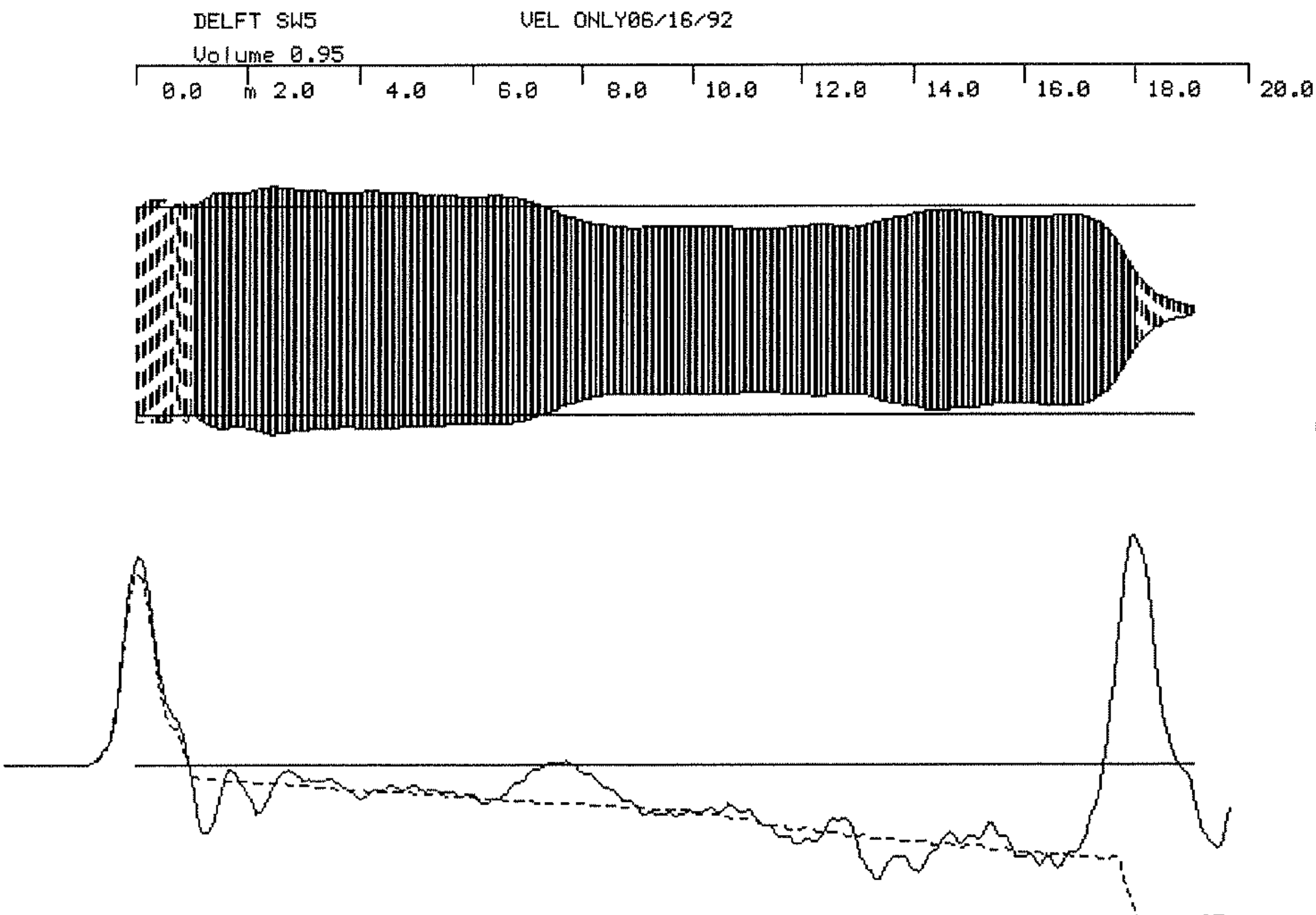
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VEL ONLY06/16/92
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m 2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0

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CLEVELAND, OHIO

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