DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept.Bk.No. 80/148

NORTHEAST TRANSIT CORRIDOR: HAMMER SEISMIC TESTING AT SOME BRIDGE SITES

GEOLOGICAL SURVEY

by

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GEOPHYSICS SECTION

Client: HIGHWAYS DEPT.

D.M. No.207/79

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PLANS

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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ABSTRACT

Hammer refraction seismic testing near some bridge sites in the Northeast Transit Corridor delineated mainly the water table and not the different layers of rock.

To obtain the hard bedrock - water bearing sediments interface a much larger spread and therefore a much greater energy source would have to be used.

It is recommended that shallow refraction seismic investigations not be carried out as the information from them would not enhance the borehole information already obtained.

INTRODUCTION

Some hammer refraction seismic testing was carried out at bridge sites along the route of the Northeast Transit Project as requested by the Highways Department. The aim of the survey was to test whether results from hammer refraction seismic work would define the gravel or bedrock founding horizons. Should this work prove to be of use, it would be used on the other bridge sites as an aid to designing foundations. The two sites where the tests were carried out were near Stephens Terrace, Walkerville and near Bide Street, Royston Park, as shown in Figure I. These sites were selected by the Engineering Geology Section and the seismic spreads were positioned adjacent to boreholes so that the interpretation of the seismic results could be related to borehole logs (Beal, 1980).

METHOD USED

At each bridge site two in-line spreads containing 12 geophones at 5 m intervals were positioned with one end at a borehole and with the spread direction as near as practical to the line of the geological sections provided. Hammer impact points were sited at each end of the spreads and at their centres. As the stacked signal from numerous hammer blows was very small 55 m away from the impact point, it was considered impractical to attempt to obtain a seismic record when the hammer point was more than 50 m from the end of the spread.

The first onsets of energy arriving at the geophones from the hammer impacts were timed with respect to the hammer impacts and plotted as time-distance curves, which were then analysed to obtain the velocities of refracted layers and their thicknesses.

A Nimbus type ES-1210 seismograph was used to stack, amplify and provide the seismic records.

RESULTS

Figures 2 and 3 show geological cross-sections compiled by Beal (1980) from borehole data upon which has been superimposed the information interpreted from the seismic time-distance curves for the two sites. Figures 4 and 5 show the time-distance curves obtained.

Spread I (See Figures 2 and 4)

Time-distance curves show a two layer case refraction curve. The near-surface layer has velocities between 250 m/s to 324 m/s and the second layer has a corrected horizontal velocity of 1750 m/s. Depths to the 1750 m/s layer are shown plotted on figure 2 and it can be seen that this interface is related to the water level. As the spread has insufficient length to delineate the base of the water bearing material, this information is of little use in defining the bedrock founding horizon.

Spread 2 (See Figures 2 and 4)

The record quality was very poor. First breaks from the three geophones furthest away from the impact could not be timed and signal energy received at the next three geophones was very low. All traces from the centre spread impact were timed. Three layers were interpreted. These are:

350 m/s which is fill and sandy silt.

1300 m/s which is probably dry silty and sandy gravel.

1600 m/s-1780 m/s which is probably the water table.

The interpretation agrees quite closely with the geological interpretation.

Spread 3 (See Figure 3)

The time distance curves show that the energy arrivals timed are from only the near surface layer (325 m/s-375 m/s). This implies that either the depth to the second layer is greater than 16 m (this is the depth calculated for a 2 layer case with velocities of 300 m/s & 1300 m/s and a critical distance of 20 m): or if there is a second layer less than 16 m from the surface, the energy refracted from such a layer is too weak to show on the traces.

The log of hole B5E which coincides with geophone 12 shows some 8 m of fill followed by 5½ m of silty gravel to a clayey silty bedrock.

Spread 4 (See Figures 3 and 5)

A two layer case is interpreted from the time distance curves. The first layer is 350-550 m/s and relates to the sandy silt logged in the Borehole B6. The second layer with an average velocity of 1670 m/s is interpreted as being the water table. An extrapolation of the water level to hole B6 follows this layer fairly closely.

CONCLUSIONS AND RECOMMENDATIONS

Although the record quality was very poor, as a result of using stacked hammer impacts as an energy source, three out of the four spreads could be interpreted as showing two layers. However, in each of the three spreads, the bottom layer related to the water saturation level. Therefore it is unlikely that the interface between the sandy silt and the silty sandy gravel could be interpreted in other areas.

It may be possible to interpret the depth to the clayey, silty bedrock, but in order to do this, the spreads would have to be at least 110 m long and energy sources would have to be introduced at about 50 m from the ends of the geophone spreads, i.e. a total length of 210 m. To obtain usable seismic records with energy inputs so far away, explosives would have to be used, and to use explosives in such a populated area deep shot holes and possibly multiple shot holes so that the energy could be stacked wherever the shot points are near houses would be required. It is anticipated that the shot holes would need to be no shallower than 3 m and possibly up to 5 m deep for the larger off end shots.

There would be sufficient room to position a suitable spread between boreholes B5E & B6 but not between the first two sites. As there is no bridge proposed between boreholes B5E & B6, the information would have to be extrapolated in either direction to be of use for foundation information for bridges which are planned at either end.

It is recommended that shallow refraction seismic investigations should not be used as it is considered that information derived from them would not enhance borehole information already obtained.

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REFERENCES

Beal, J.C., 1980. Northeast Transit Corridor: Foundation investigation. SADME unpublished report book no. 79/130.

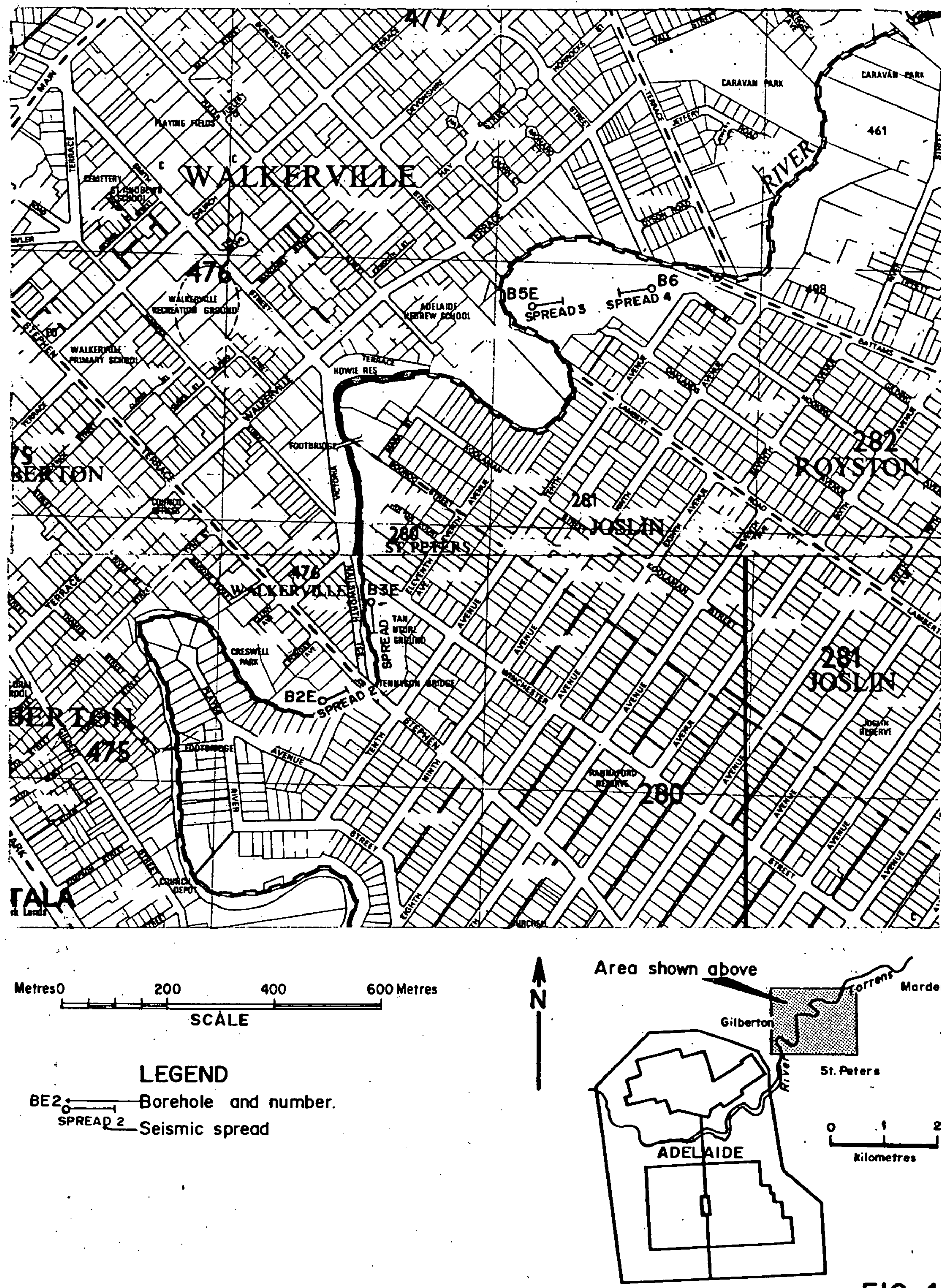

FIG. 1

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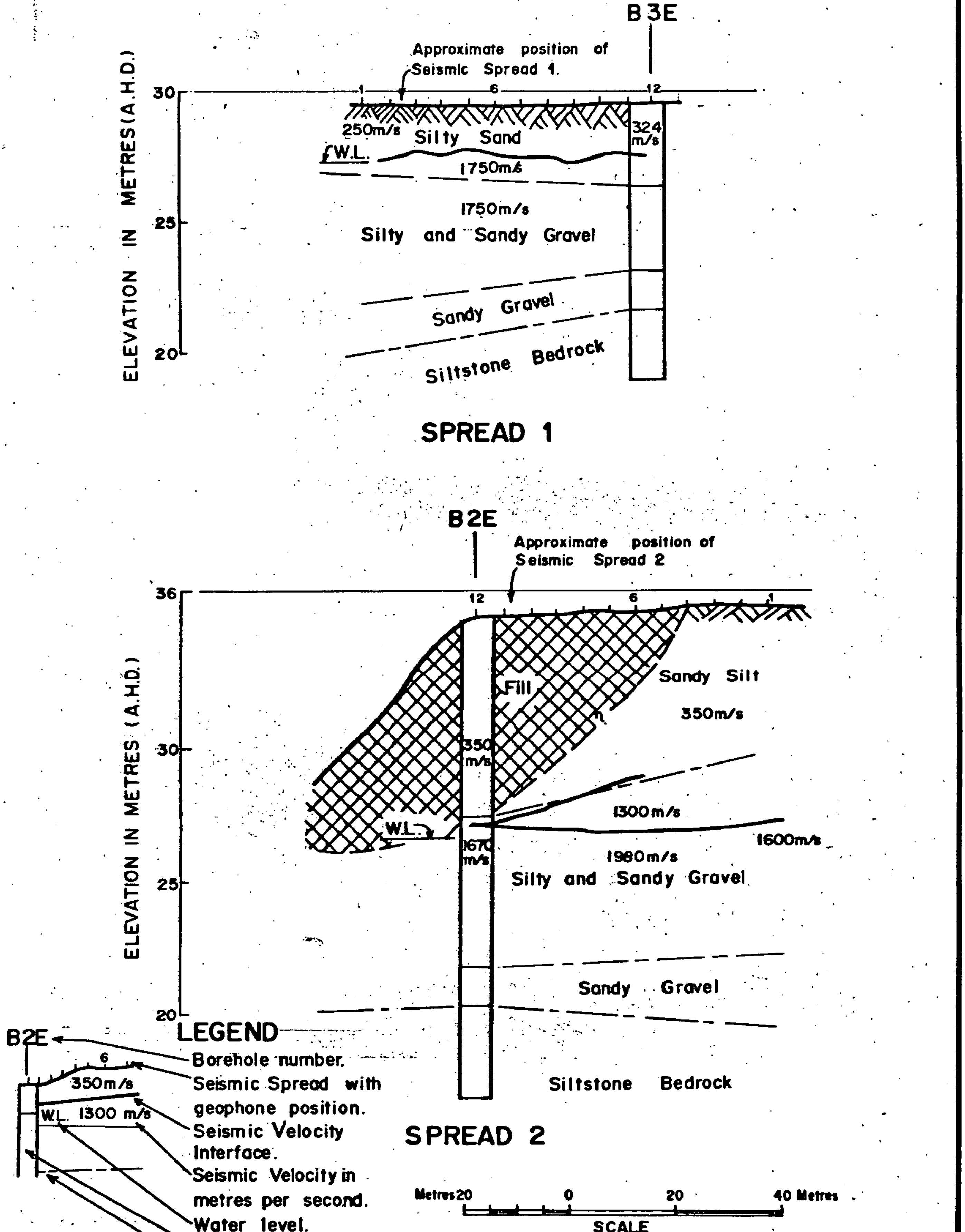
NORTHEAST TRANSIT PROJECT
LOCATIONS OF SEISMIC SPREADS AND BOREHOLES

COMPILED B.T.	for C.D.O. 29/1/81 DATE
DRAWN S.R.	SCALE 1:10 000
DATE 16/12/80	PLAN NUMBER
CHECKED	S15249



For location of sections (spreads) see plan S15249

FIG. 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED B.T.	*[signature]* 29/1/81 for C.D.O. DATE
NORTHEAST TRANSIT PROJECT GEOLOGICAL SECTION WITH SEISMIC INTERPRETATION OF SPREADS 1 AND 2	DRAWN S.R.	SCALE 1:1000
	DATE 19/12/80	PLAN NUMBER
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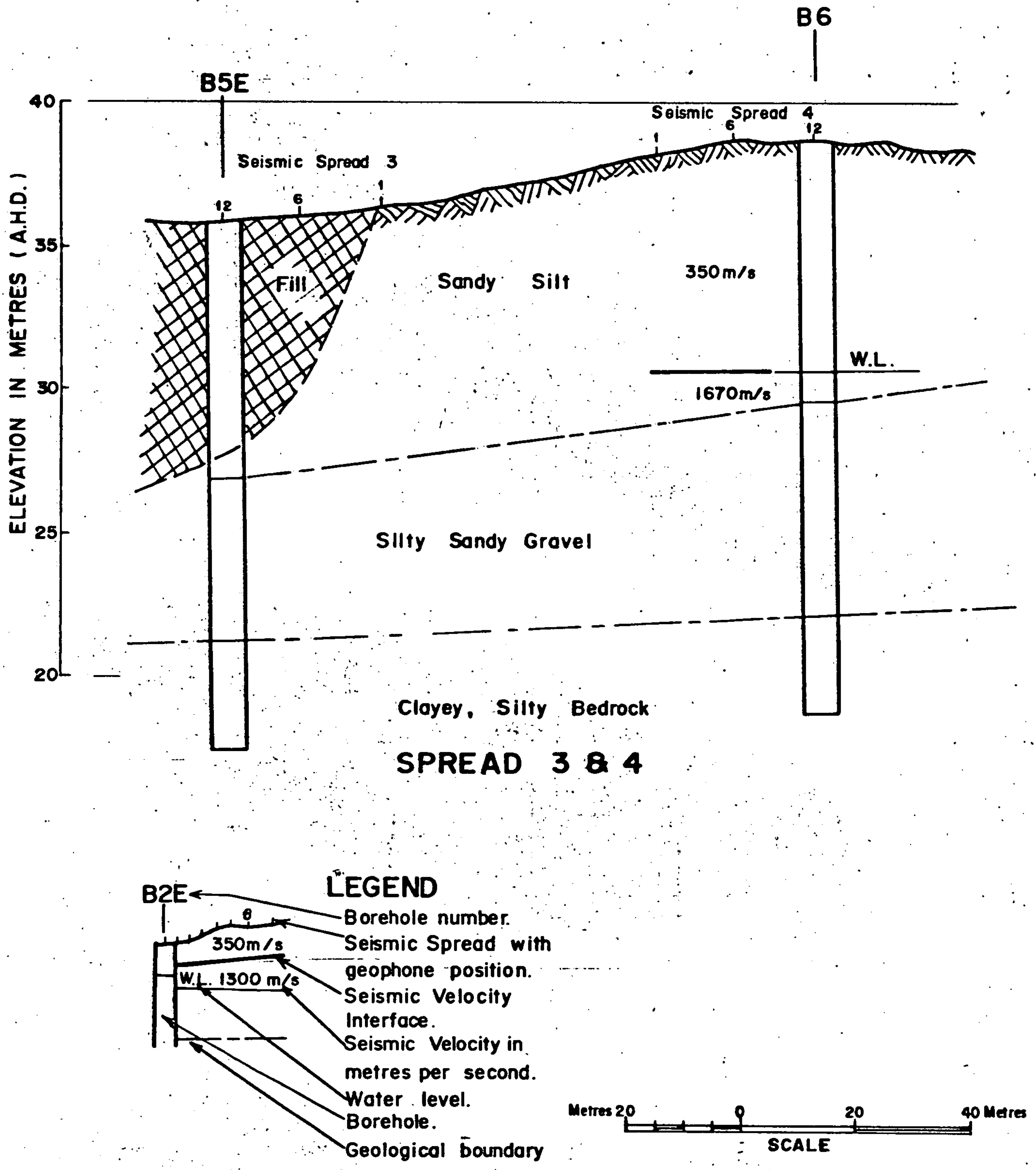
2245



For location of sections (spreads) see plan S15249

FIG. 3

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NORTHEAST TRANSIT PROJECT
GEOLOGICAL SECTION WITH SEISMIC INTERPRETATION OF SPREADS 3 AND 4

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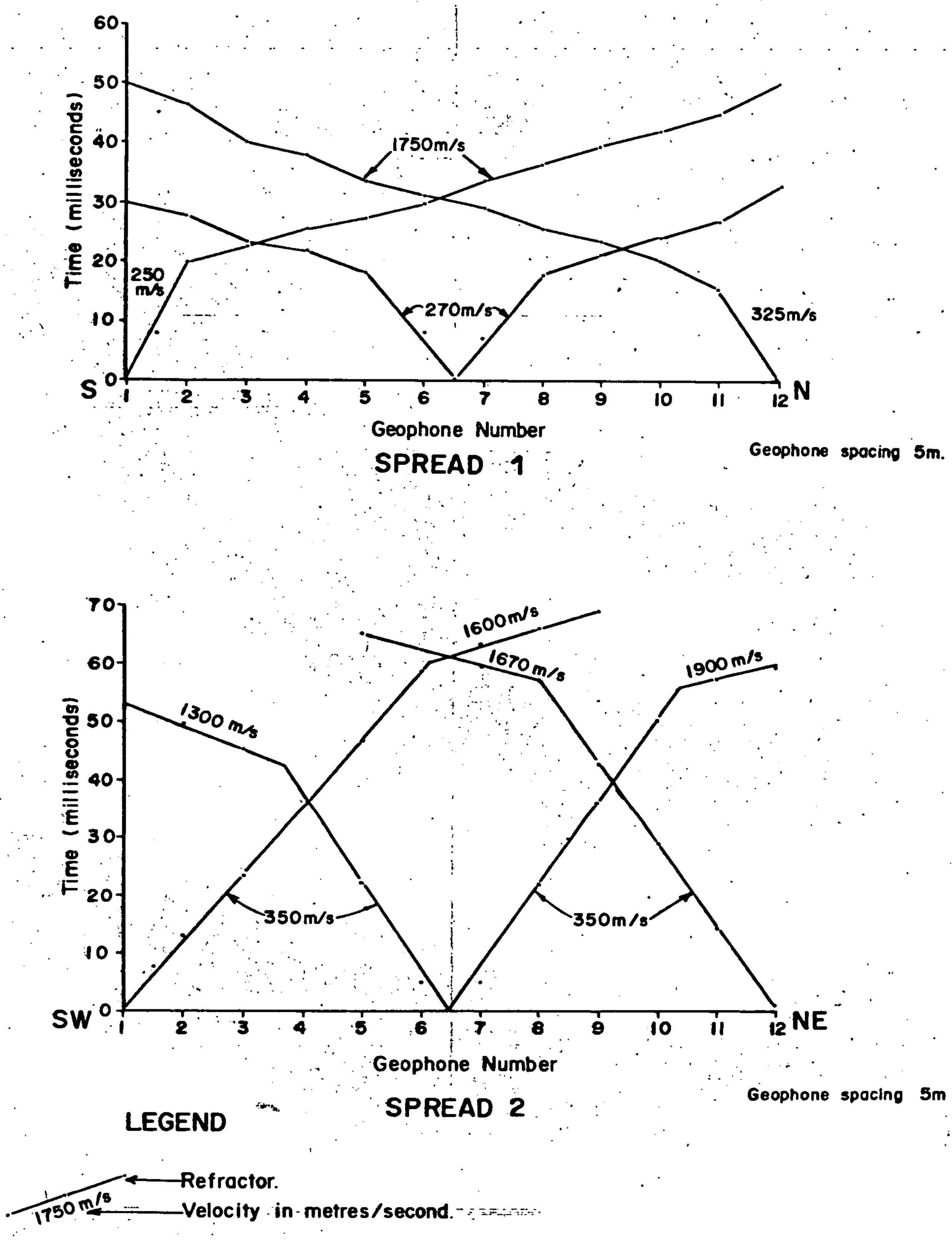

For location of sections (spreads) see plan S15249

FIG. 4

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NORTHEAST TRANSIT PROJECT

TIME—DISTANCE CURVES
SPREADS 1 AND 2

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DATE 17/12/80	PLAN NUMBER
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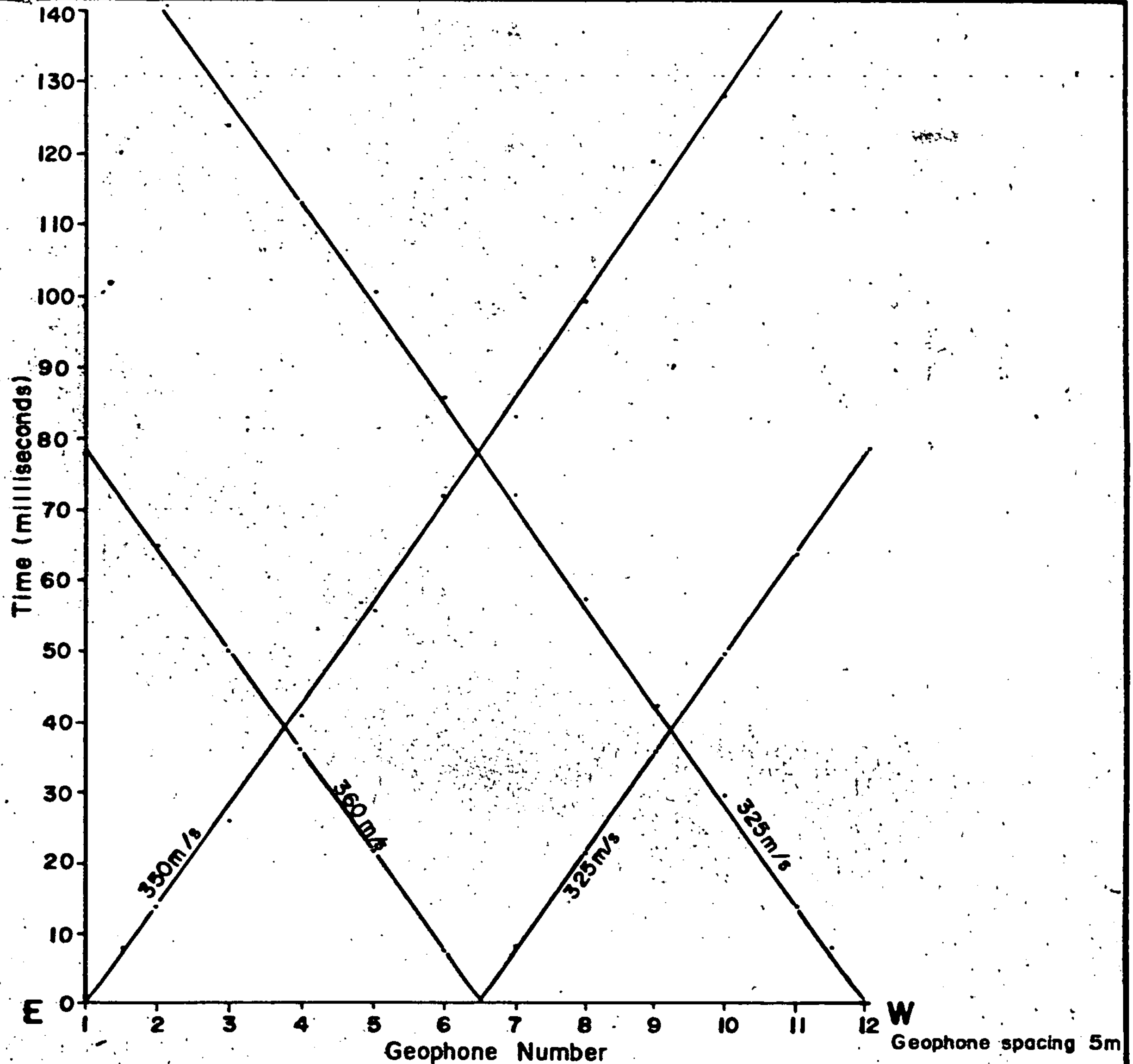
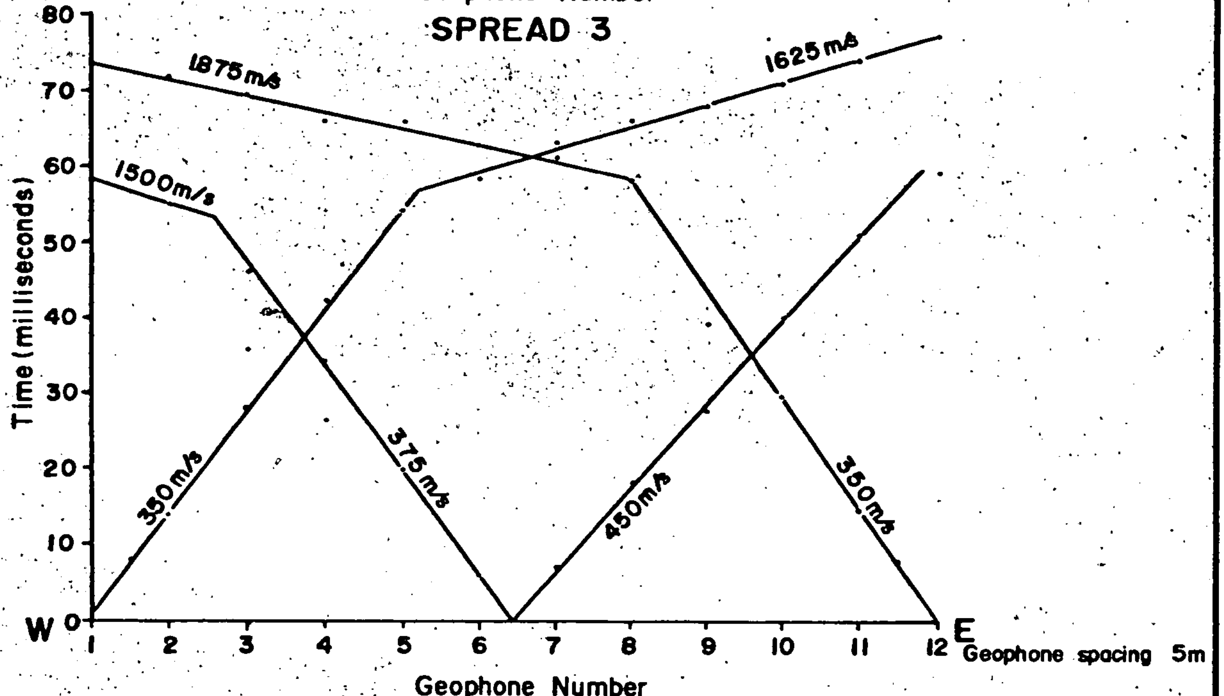


SPREAD 3



SPREAD 4

For location of sections (spreads) see plan S15249

FIG. 5

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NORTHEAST TRANSIT PROJECT
TIME–DISTANCE CURVES
SPREADS 3 AND 4

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DATE 17/12/80	PLAN NUMBER
CHECKED	S15251

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