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MCAS EL TORO
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MARINE CORPS AIR STATION
EL TORO
EL TORO, CALIFORNIA
INSTALLATION RESTORATION PROGRAM
GEOPHYSICAL SURVEY REPORT

9 JULY 1991

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1.0 GEOPHYSICAL INVESTIGATIONS

1.1 Introduction

Geophysical investigations were performed at several sites at the Marine Corps Air Station (MCAS) El Toro as part of the Remedial Investigation/Feasibility Study (RI/FS) in a Federal Facilities Agreement under the U.S. Navy Comprehensive Long-term Environmental Action, Navy (CLEAN) Program. The work was performed by CH2M HILL between 13 May and 24 May 1991. Investigations were performed at the following sites:

- Site 1 - Explosive Ordnance Disposal Range
- Site 2 - Magazine Road Landfill
- Site 3 - Original Landfill
- Site 5 - Perimeter Road Landfill
- Site 9 - Crash Crew Pit No. 1

The objectives and work performed at each site were site specific. The work and results at each site are described separately in this report.

The work performed at each site consisted primarily of an electromagnetic (EM) ground conductivity survey. Ground-penetrating radar (GPR) was also used at selected locations to establish whether EM or GPR methods would provide better results. In all cases, the EM survey provided more specific indications of landfill boundaries. In some cases, the GPR data did not show buried wastes where the EM data showed strong anomalies.

1.2 EM Conductivity Methods

A Geonics Model EM31 (EM31) ground conductivity meter was used to collect the EM conductivity data at the MCAS El Toro sites. The EM31 consists of two coplanar coils spaced 12 feet apart. The coils are oriented with vertical axes. One coil is the transmitter coil, and the other is the receiver. An alternating current is passed through the transmitter coil, causing an EM field to be transmitted that produces eddy currents that flow in the ground. The receiver coil measures the sum of the fields due to the transmitting coil (the primary field) and due to the eddy currents in the ground (secondary field). The primary field strength at the receiver coil is known and is subtracted from the total field measured at the receiver; the remainder is the secondary field. The secondary field is divided into two components, one in phase with the transmitted field and one out of phase. The strength of the out-of-phase component is linearly proportional to the ground conductivity over a range of typical soil conductivities. At higher conductivities, the response is no longer linear and may result in negative measurements. The in-phase response provides an indication of buried metal, as it generally requires higher conductivities than the out-of-phase component to cause an instrument response. The effective depth of investigation of the EM31 is about 15 to 20 feet.

1.3 GPR Methods

A GSSI model SIR-3 ground-penetrating radar with a 120-MH antenna was used for this investigation. This unit uses a small antenna that transmits high-frequency radio waves into the ground and records reflected signals arriving at the receiver. The transmitter and receiver are the same unit.

The transmitted signal is reflected from interfaces between subsurface materials that have different electrical properties. The reflections can occur at changes in soil and rock type and at buried pipes and other metal. Often it can distinguish between disturbed and undisturbed soil because the natural soil layering has been altered.

The depth of investigation of GPR is site specific and usually a function of the electrical conductivity of the material. The depth of investigation in clayey or conductive soils is often limited to a couple of feet or less. This method is best suited for use in areas of sandy soil.

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2.0 SITES INVESTIGATED

2.1 Site 1 - Explosive Ordnance Disposal Range

2.1.1 Background

The Explosive Ordnance Disposal (EOD) Range is used for detonation and disposal of small munitions. It is uncertain how long the site has been used. Metals, nitrated toluenes, sulfates, acidic wastes, and possibly low-level radioactive wastes may have been disposed of or detonated at this site. Drums of sulfur trioxide chlorosulfonic acid (FS smoke) were disposed here in 1982.

Evidence of past and current activities is evident on the surface. One small pit (about 8 feet wide, 6 feet deep, and 15 feet long), which had been excavated for burning and disposal, was present. Several small mounds apparently covering previous disposal pits were also visible. An area devoid of vegetation was reported to be an area where FS smoke was dumped on the surface. An area east of the dry pond was used as landfill for scrap metal, including drums that could be seen partially buried, and possibly other wastes.

2.1.2 Geophysical Investigations

The site was investigated using EM conductivity methods. The objective of the work was to identify pits used for material incineration and disposal at the site. GPR was used to test the site of one of the stronger EM anomalies.

Figure 1 shows the extent of the EM investigation over the EOD Range. The investigation covered a total of about 16.7 acres. Data collection started at the north end of the range where disposal activities were known to have occurred, and progressed to the south where the disposal history was less certain. The investigation extended south to line 400 N although the range extended for several hundred feet farther south. No EM anomalies indicating buried material were encountered between lines 700 N and 400 N, and it appeared that the investigation adequately covered the areas of the range involved in munitions and waste disposal.

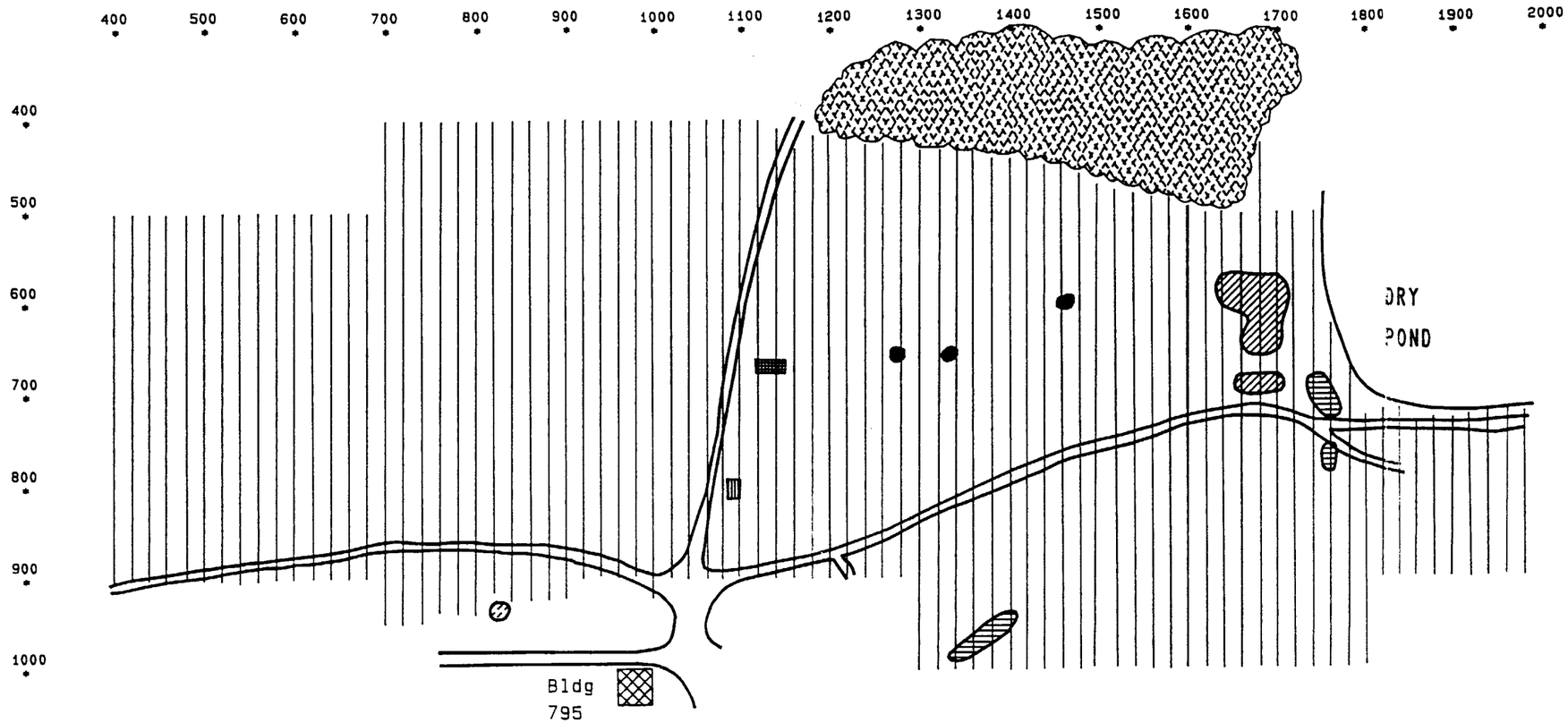
2.1.2.1 Site Grid

A grid was established over the site prior to collection of any data. Building 795, the range operations building, was used as the origin of the grid. The northwest corner of the building was assigned grid coordinates 1000 N, 1000 E. East-west grid lines were oriented parallel to the north side of Building 795. North-south grid lines were parallel to the west side of the building. Grid markers were put at 20-foot intervals along north-south grid lines 100 feet apart.

Grid markers used during the investigation were removed at the completion of data collection, but wooden stakes were placed at selected locations to help reestablish the grid if necessary. These stakes were put in areas where they would not be affected by mowing and other site activities.

2.1.2.2 EM Conductivity Data Collection

Electromagnetic measurements were made at 5-foot intervals along east-west grid lines 20 feet apart. The 5-foot interval was estimated by pacing between



LEGEND:

- Vegetation
- Building
- Metal Shed
- Surface Scrap Metal
- Area Void of Vegetation
- Burn Pit
- White Phosphorous Spill Area
- Road
- EM Survey Line
- Bomb Crater

Grid North

0 100 200 300

SCALE IN FEET

Figure 2-1
EOD RANGE
Extent of Investigation

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corresponding flagged grid locations. Each measurement consisted of conductivity and in-phase values.

Data were stored automatically in a digital recorder along with the station coordinates. Every tenth conductivity value was recorded in the field logbook to allow for a check against the data stored in the logger. Data were transferred daily to a computer and reviewed.

2.1.2.3 Interpretation

Graphs of the conductivity and in-phase measurements along each line are presented in Attachment A. Conductivity values are presented contoured in Figure 2 and in-phase values are shown contoured in Figure 3. The graphs were used to identify EM anomalies that were due to buried material. Several types of anomalies were observed at the site, probably related to several factors including conductivity of the waste, amount of metal, and geometry of the waste (depth, thickness, and width). In most cases, anomalies were present in both in-phase and conductivity data. In some cases the anomalies were apparent only in the conductivity data and others were present only in the in-phase data. Since all types of anomalies were interpreted to be due to buried wastes, no distinction among types was made.

The location of the sources of the anomalies were determined from the graphs and the locations were transferred to the base map. The resulting interpretation map is Figure 4. Anomalies thought to be related to the same source were grouped together. If there was no corresponding anomaly on adjacent lines, the anomaly location is shown as either a distinct response or a weak response. Weak responses observed along the north-south dirt track are apparently

unrelated to buried material and are not shown on the map. Similar weak responses not related to the road are shown on the map but may also be unrelated to wastes.

2.1.2.4 Results

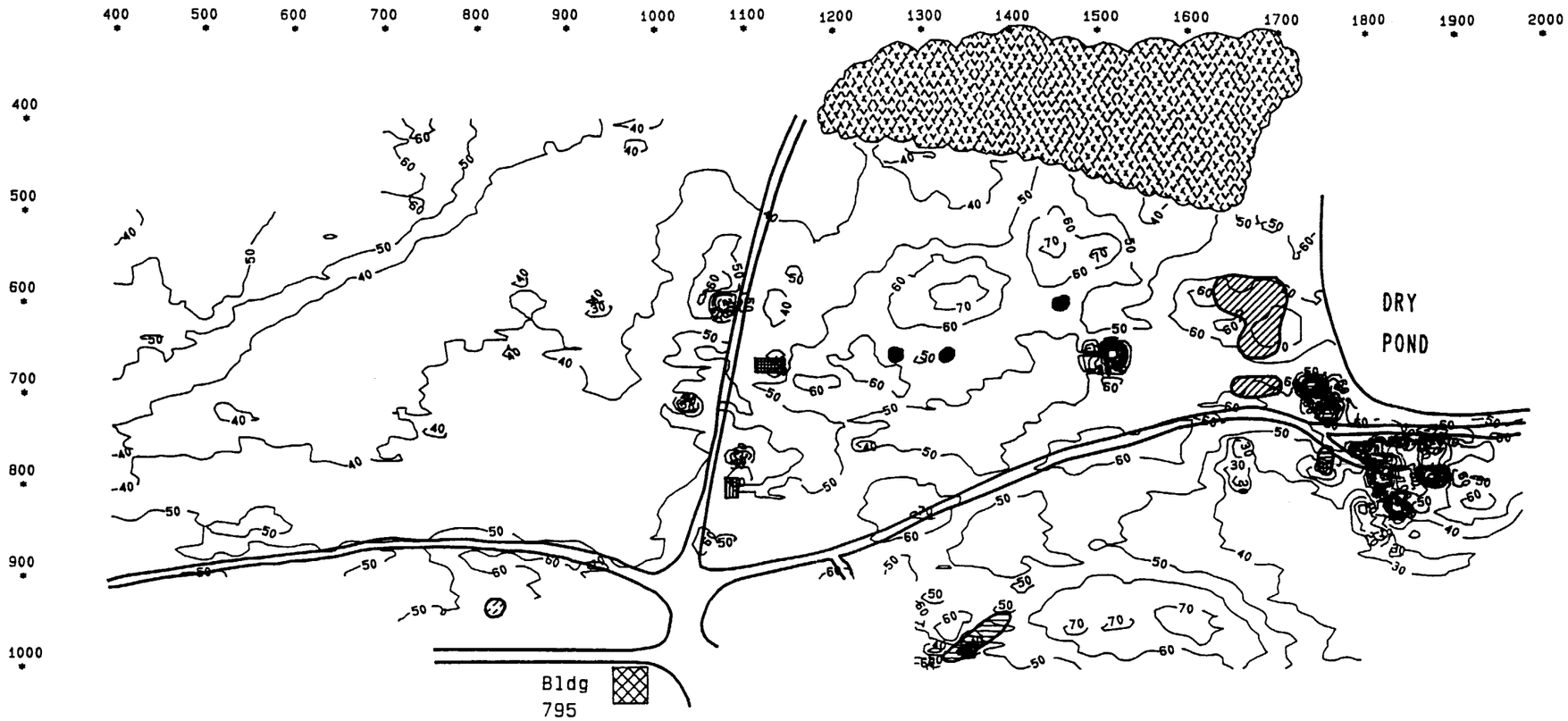
The largest area of interpreted buried waste is between 1800 N to 1900 N and 740 E to 850 E. There is evidence on the surface that this area has been used for disposal of scrap metal including drums. Mounds of dirt with partially exposed metal are present in this area.

Most of the areas of buried wastes were identified about 100 feet west of the dirt track that extends north-south across the site. Several areas, however, were identified east of the track. South of the east-west track that crosses the site, anomalies were generally more scattered and weaker than to the north and may represent mostly scattered wastes rather than disposal trenches.

Several areas shown in Figure 4 are related to surface scrap metal. These areas have been included in the figure because it is possible that buried wastes are also present in these areas. These areas are located at:

- 700 E, 1750 N
- 770 E, 1760 N
- 980 E, 1340 N to 950 E, 1400 N

Surface scrap metal was observed at other locations but was not extensive enough to significantly affect the interpretation.



LEGEND:

- Vegetation
- Building
- Metal Shed
- Surface Scrap Metal
- Area Void of Vegetation
- Burn Pit
- White Phosphorous Spill Area
- Road
- EM Conductivity Contour
  Contour Interval of 10 mmhos/m
- Bomb Crater

Grid North

0 100 200 300

SCALE IN FEET

Figure 2-2
EOD RANGE
EM Conductivity Contours

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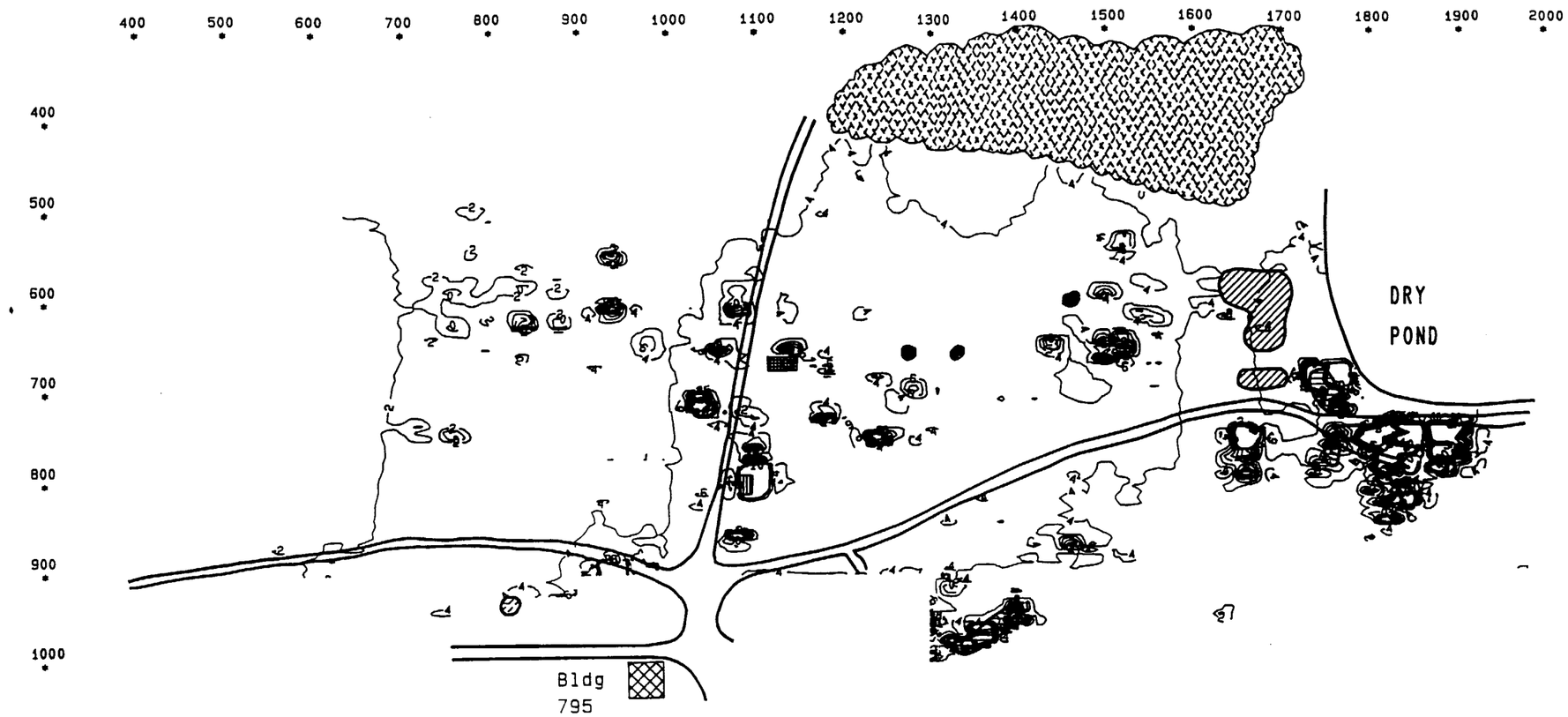

LEGEND:

- Vegetation
- Building
- Metal Shed
- Surface Scrap Metal
- Area Void of Vegetation
- Burn Pit
- White Phosphorous Spill Area
- Road
- EM In-Phase Response Contour Contour Interval of 2 parts per thousand
- Bomb Crater

Grid North

0 100 200 300

SCALE IN FEET

Figure 2-3
EOD RANGE
EM In-Phase Response Contours

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LEGEND:

- Vegetation
- Building
- Metal Shed
- Surface Scrap Metal
- Area Void of Vegetation
- Burn Pit
- White Phosphorous Spill Area
- Intrepreted Areas of Buried Waste
- Road
- Distinct Single Line Response
- Weak Single Line Response
- Bomb Crater

Grid North

0 100 200 300

SCALE IN FEET

Figure 2-4
EOD RANGE
Interpreted Results

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The contour map of EM conductivity data (Figure 2) does not adequately show areas of buried wastes except in a few areas. Most of the variations in conductivity across the site are too broad to be related to waste trenches and are probably related to soil type. The in-phase measurement was apparently more sensitive to buried wastes, and the contour map of the in-phase values (Figure 3) shows many of the waste burial sites.

2.1.2.5 GPR Test

Ground-penetrating radar data were collected across the interpreted area of buried waste located at 1460 N, 880 E. No response GPR indicating the presence of buried wastes was apparent in the data. Since the GPR could not detect buried material at the location of one of the stronger EM indications, no further GPR work was performed at the site.

2.1.3 Conclusions

Most of the interpreted disposal trenches are located west of the dirt track running north-south across the site, although some buried wastes are present in discrete areas east of the track. No evidence of buried wastes were observed south of grid line 700 N.

A large portion of the EOD Range (as delineated by the perimeter fence) was not investigated. The area not investigated is primarily south of grid line 400 N, but also includes areas east, west, and north of the area that was investigated. If there is reason to believe that wastes are present beyond the limits of the survey, then additional investigations should be considered.

Electromagnetic conductivity methods performed better than GPR at this site. The depth of investigation of the GPR may have been limited by the clay content of the soil and, therefore, the radar could not penetrate to sufficient depths to detect wastes. A more powerful GPR unit or use of an antenna with a different frequency might have provided more positive results. It is not likely that the GPR could have been used to investigate the site as quickly and with as much detail as the EM survey. Even with better GPR results, conductivity methods are still recommended.

2.2 Site 2 - Magazine Road Landfill

2.2.1 Background

The Magazine Road Landfill was used from the late 1960s until about 1980. Waste materials disposed here consist of construction debris, municipal wastes, batteries, waste oils, hydraulic fluids, paint residues, transformers, and waste solvents. The material was placed in an old borrow pit and not burned, as was the case at other landfills.

A GPR survey was performed over portions of the site during the Solid Waste Assessment Test (SWAT) investigations. Landfill boundaries determined by the GPR survey were marked with stakes at the time of the survey. Some of the stakes marking the edge of buried wastes as determined by the GPR work appear to still be in place.

2.2.2 EM Conductivity Investigation

The EM conductivity data were collected over five lines at the landfill to verify results of the SWAT GPR investigation. Four lines were run across the southeast boundary of the landfill, and one was run across its northern edge.

No grid was established over the site because of the limited investigation that was performed. The location of the lines crossing the southeast edge of the landfill were measured relative to the dirt track that entered near the center of the landfill's eastern side (Figure 5). The line names refer to the distance south of the track, with distance measurements made along the eastern boundary road. The lines were run roughly perpendicular to the boundary road with Station 0 W at the west edge of the road. Line 999 was run north-south across the north edge of the landfill. The southern end of the line (Station 0) was at an unlabeled soil gas probe east of the manmade channel and north of the east-west dirt track crossing the site. Station 500 was near the end of a gully extending west from the man-made channel.

2.2.2.1 Data Collection

The EM measurements were made at 5-foot intervals along each line. Each line was marked with flags every 100 feet, and the station locations were determined by pacing between the markers. Measurements were recorded in a digital data logger, transferred to a computer at the end of the day, and reviewed. Each measurement consisted of the conductivity and in-phase response.

2.2.2.2 Interpretation

Graphs of the conductivity and in-phase measurements along each line are presented in Attachment B. No contour map or map of interpreted results were prepared because of the limited amount of data.

The presence of buried wastes was characterized in the data by generally elevated conductivity values and by conductivity and in-phase values that were relatively variable over short distances (appearing noisy). No effort was made to identify individual anomalies.

2.2.2.3 Results

Southeastern Side

Responses indicating buried wastes were apparent in the data starting as close 5 feet or less to the eastern boundary road in lines 200 S and 400 S, with weak indications of the same conditions in the other 2 lines. All lines showed distinct indications of buried wastes within 40 feet of the road. Since the lines did not extend across the road to the east, it is not known if evidence of buried wastes is present there.

The SWAT Report indicates a distance of 10 to 25 feet between the road and the fill in the same area, which is in general agreement with the limited EM data.

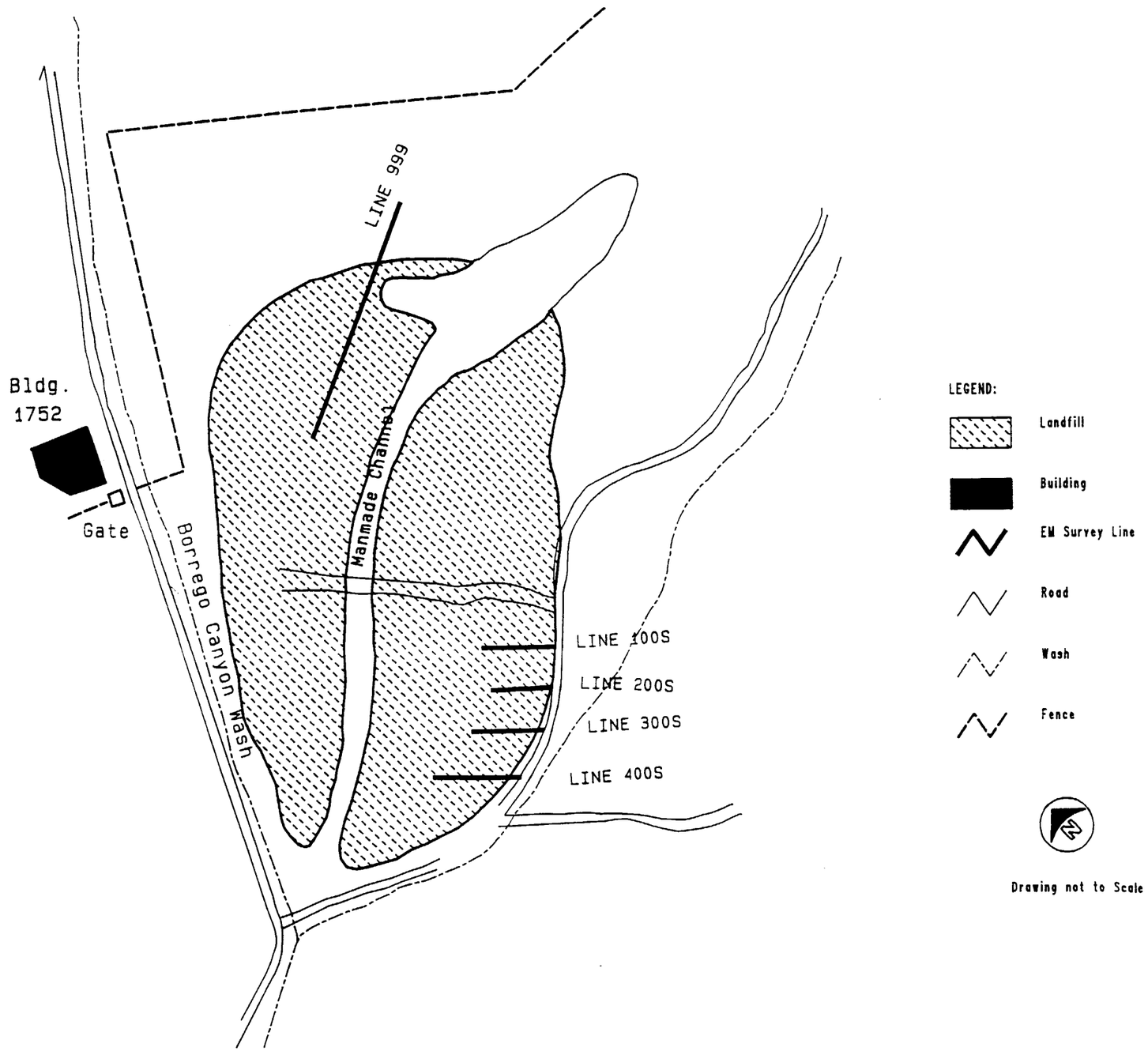

Figure 2-5
MAGAZINE ROAD LANDFILL
Extent of Investigation

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Northern Side

Line 999 shows that buried wastes are present from the southern end of the line up to station 500 at the end of the gully. Waste material is apparently absent from stations 300 to 375.

It is not known how this line relates to the SWAT GPR results because the gully (at station 500) does not show up on the SWAT map, and the SWAT map is apparently not to scale. The GPR results do not indicate the area without waste material within the outer boundary of the landfill that is indicated by the EM data.

2.2.3 Conclusions

The limits of waste based on the GPR work and depicted in the SWAT Report are probably reasonable, considering the wide line spacing employed. However, based on the distance measurements taken during the EM investigation, the map in the SWAT Report is not to scale, and it would not be possible to use it to delineate the landfill edges if the stakes left during the GPR work were missing. Some of the stakes, were observed during the EM work, but no attempt was made to locate all the stakes and it is possible that some are missing.

Depending on how precisely the landfill boundary needs to be defined, additional work may be required. The additional work would be needed because of the large distances between GPR lines (possibly greater than 200 feet) and because some of the stakes left during the GPR survey might be missing. If more work is performed to delineate the landfill, EM conductivity methods are recommended.

2.3 Site 3 - Original Landfill

2.3.1 Background

The Original Landfill was used from 1943 to 1955. Historical data indicate it was a "cut-and-fill" type of facility. Three of the trenches were from 200 to 400 feet long, 20 to 30 feet wide; and 20 to 25 feet deep. Also reported are a 4-acre disposal pit and two 1-acre disposal pits. The latter two pits were uncovered during excavation for Building 746 and a parking area north of Building 380.

Wastes received at the Original Landfill included metals, incinerator ash, liquid wastes (including solvents), paint residues, oily wastes, hydraulic fluids, engine coolants, municipal solid wastes, and various inert solid wastes.

A GPR survey was performed over portions of the site as part of the SWAT activities in early 1990. Boundaries of buried wastes as determined by the GPR were marked by wooden stakes at the time of the SWAT investigation.

2.3.2 Current Geophysical Investigations

The objective of the geophysical investigations performed for this study was to verify results of the SWAT GPR investigation. An initial visit to the site indicated that the stakes left during the SWAT work were missing and the landfill boundaries could no longer be determined in the field. The objective was changed to provide sufficient information to delineate the landfill boundaries. Subsequently, it was determined that the maps in the SWAT Report were not to scale and could not be used to accurately reestablish the landfill locations.

Electromagnetic ground conductivity methods were used to investigate the site. In addition, GPR data were collected to compare the two methods. The area covered by the EM investigation is approximately 6.5 acres and is shown in Figure 6.

2.3.2.1 Site Grid

A grid was established across the site to permit methodical collection of data. The southeastern corner of the asphalt parking lot north of Building 746 was used as the grid origin and was assigned the grid coordinates 1000 E and 1000 N (Figure 6). The eastern side of the parking lot defines grid north-south, and the southern side of the parking lot defines grid east-west. Grid markers were placed at 40-foot intervals along east-west grid lines and labeled with the grid coordinates. The marked east-west grid lines were 100-feet apart.

2.3.2.2 Data Collection

EM measurements were made at 5-foot intervals along north-south lines 40 feet apart. The 5-foot intervals were estimated by pacing between corresponding grid markers. Each measurement consisted of the conductivity and in-phase response.

Data were stored automatically, along with grid coordinates, in a digital recorder. Every tenth conductivity value was manually recorded in the field logbook. Digital data were transferred daily to a computer and reviewed.

2.3.2.3 Interpretation

Graphs of the conductivity and in-phase measurements along each line are presented in Attachment C. Conductivity values are presented contoured in Figure 7. The EM in-phase values are shown contoured in Figure 8. The graphs were used to identify EM anomalies that were due to buried wastes. Anomalies were observed either in the conductivity data, in-phase data, or both. The differences in anomalies are related to several factors including conductivity of the waste, amount of metal, and geometry of the waste (depth, thickness, and width). In most cases, anomalies were present in both in-phase and conductivity data. Since all types of anomalies were interpreted to be due to buried wastes, no distinction between types was made.

The location of the sources of the anomalies were estimated from the graphs, and the locations were transferred to the base map. Anomalies thought to be related to the same source were grouped together. The resulting interpretation map is Figure 9.

2.3.2.4 Results

Several types of buried features have been identified and are shown in Figure 9. These features are as follows:

- Areas of buried wastes that may be waste trenches
- Weak anomalies possibly related to buried wastes
- Isolated buried metal
- Buried utilities such as pipes or wires

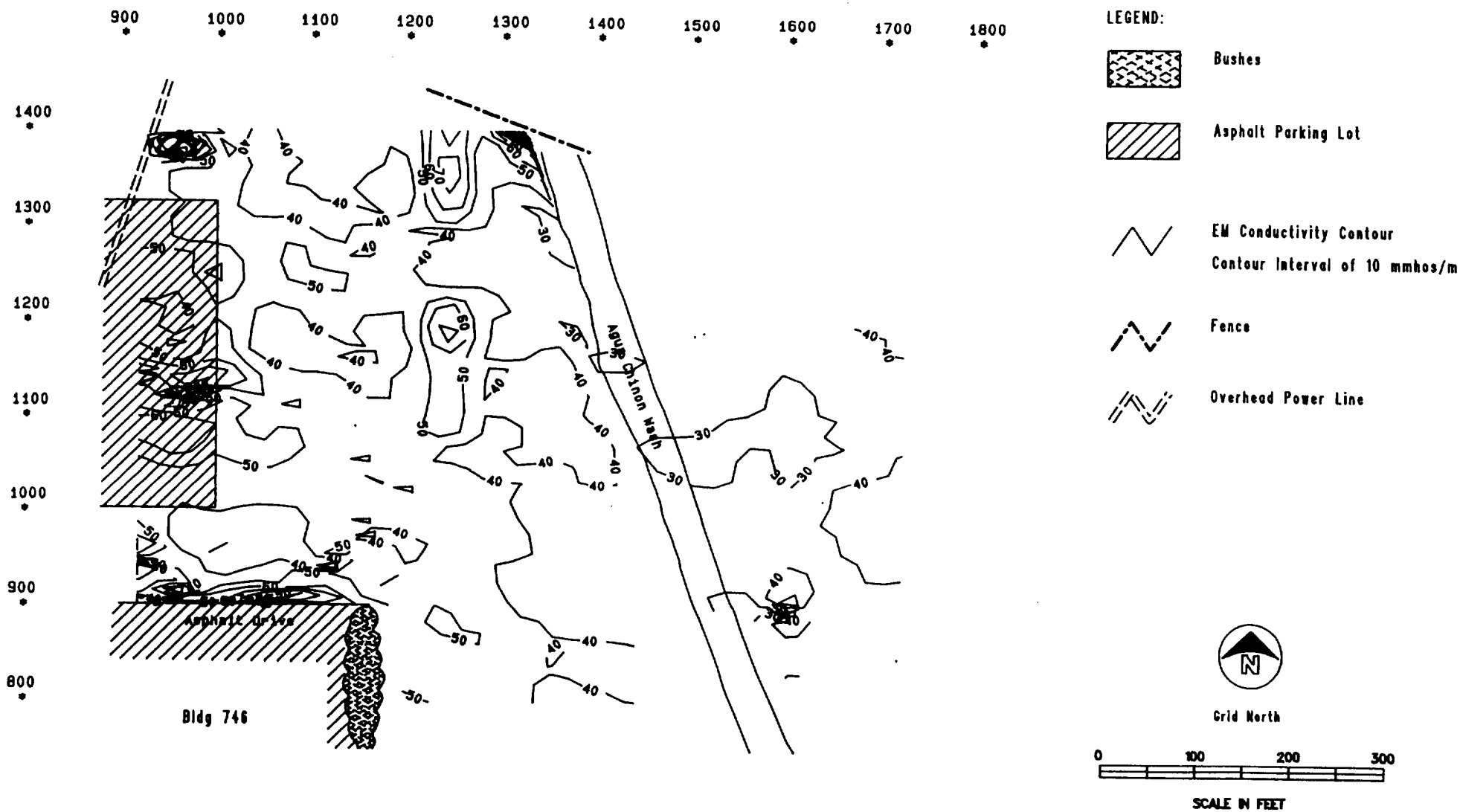

Figure 2-7
ORIGINAL LANDFILL
EM Conductivity Contours

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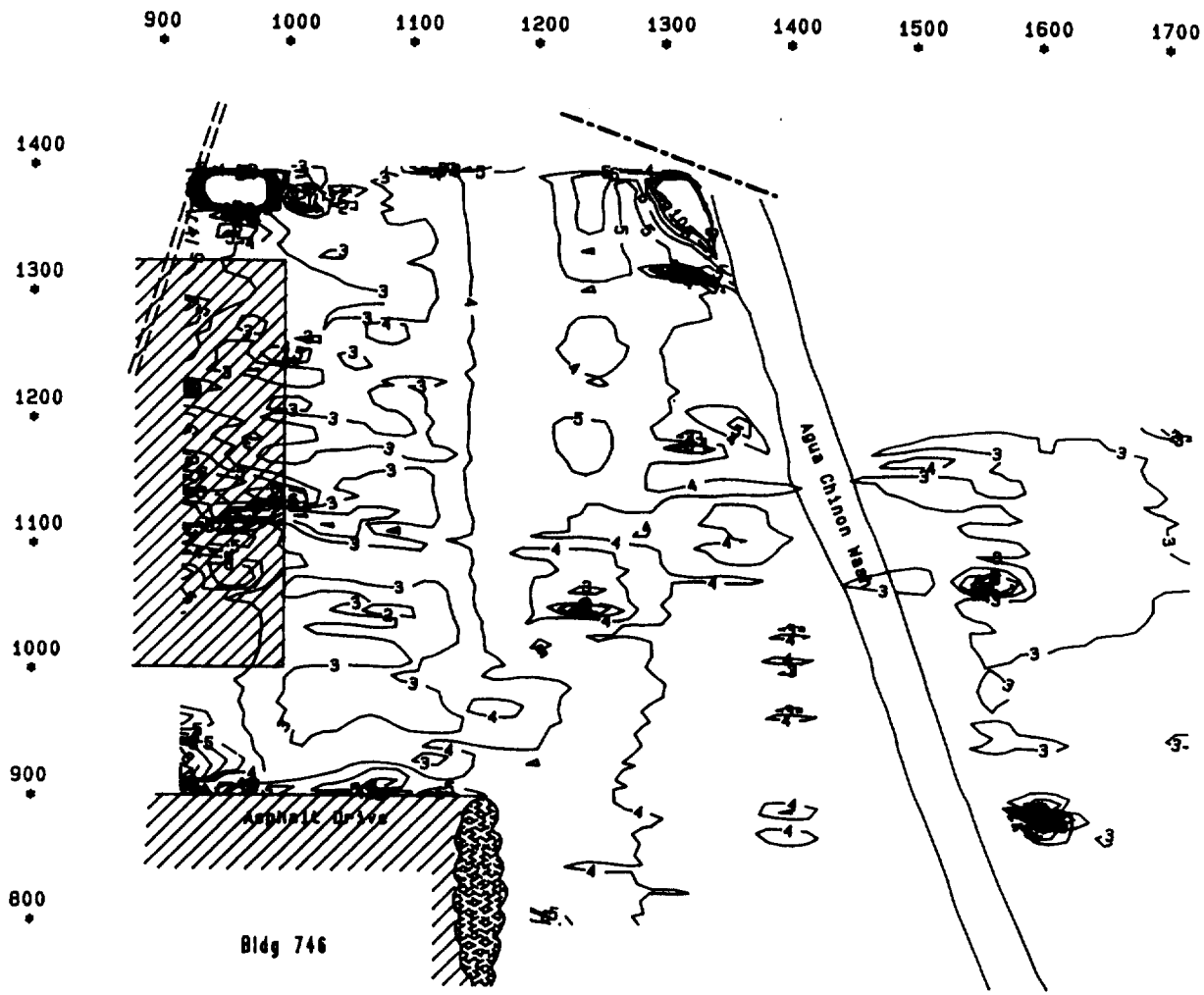

LEGEND:

Bushes

Asphalt Parking Lot

Fence

Overhead Power Line

EM In-Phase Response Contour
Contour Interval of
1 part per thousand

Grid North

0 100 200 300

SCALE IN FEET

Figure 2-8
ORIGINAL LANDFILL
EM In-Phase Response Contours

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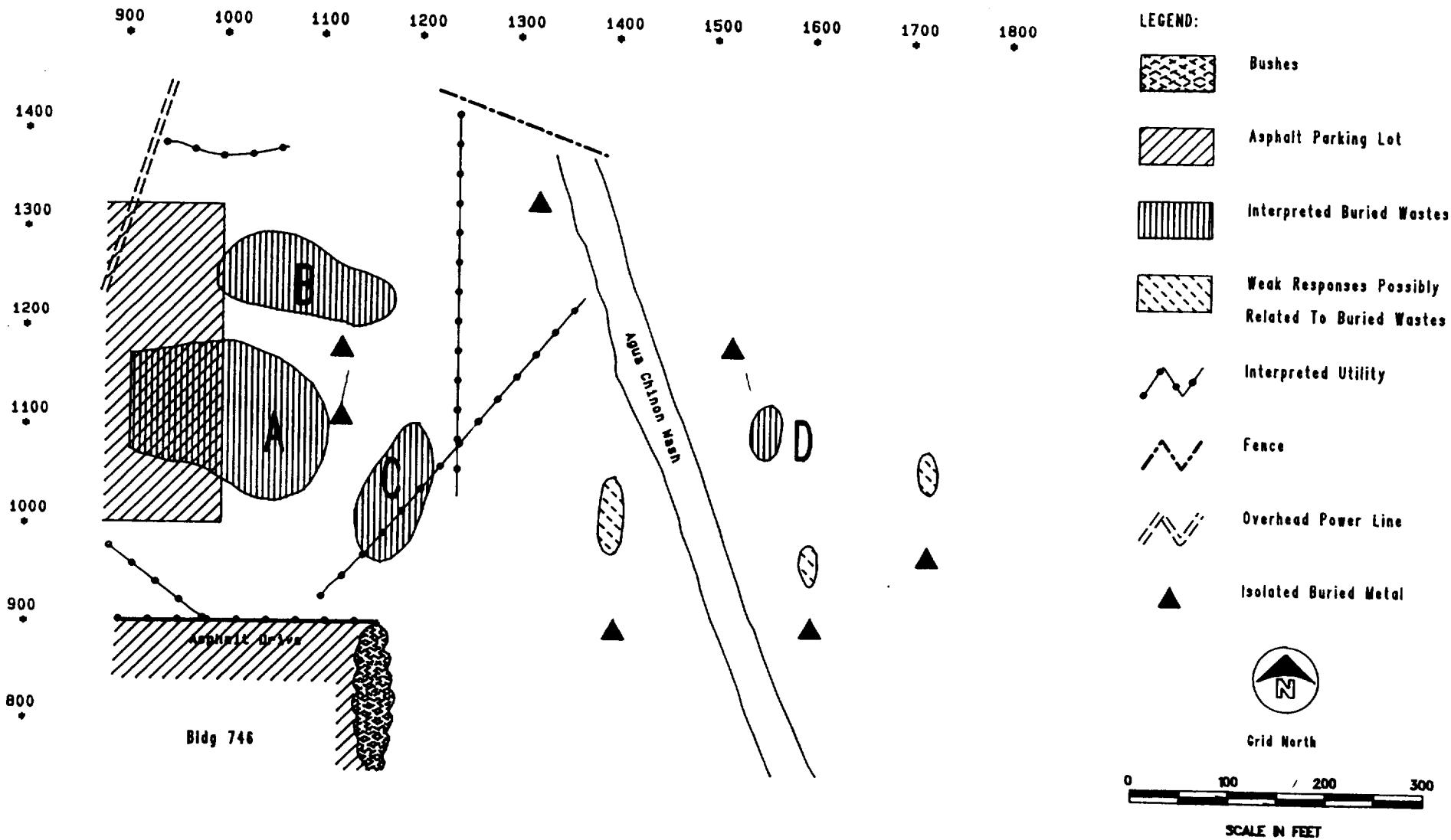

Figure 2-9
ORIGINAL LANDFILL
Interpreted Results

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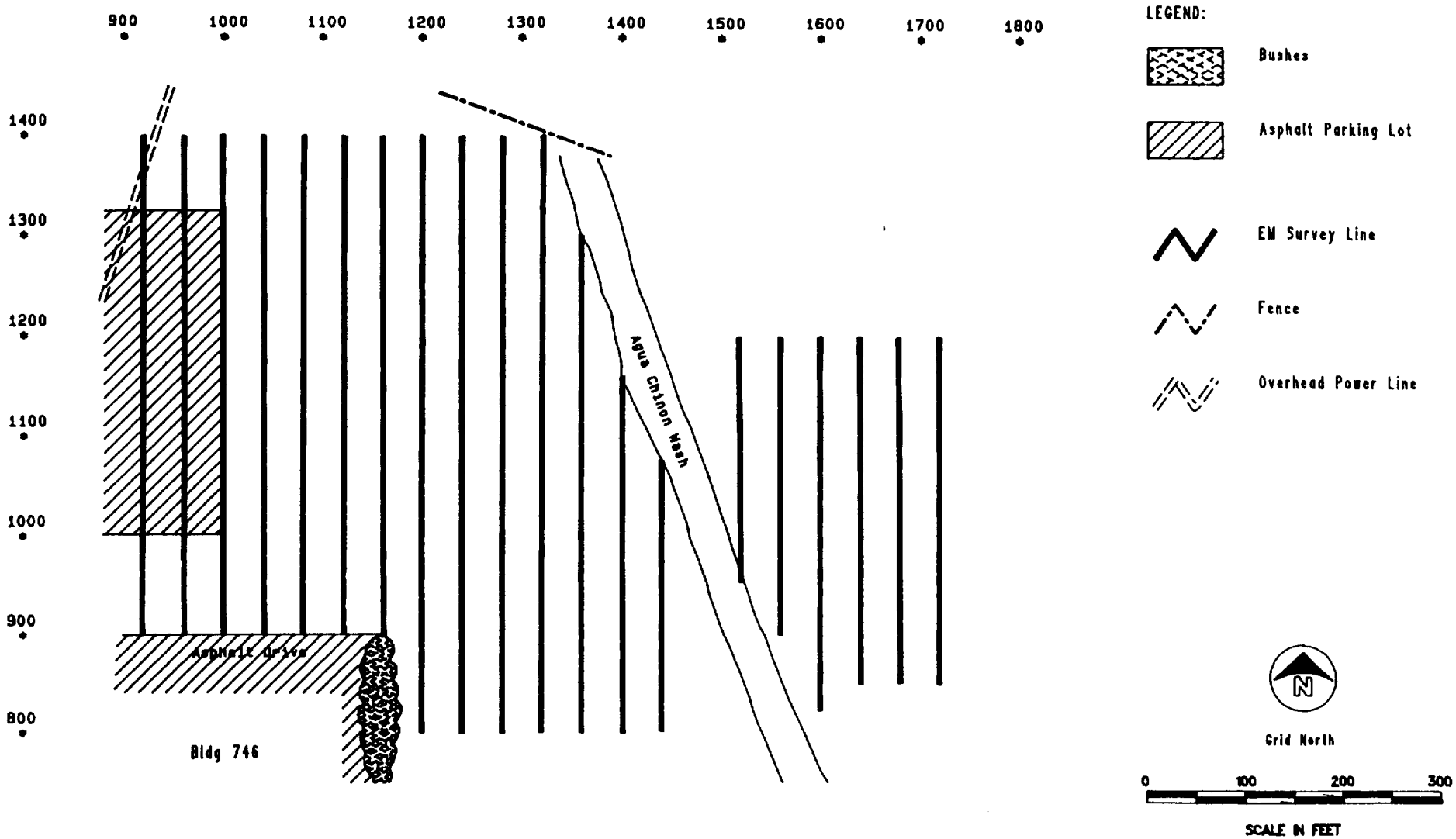

Figure 2-6
ORIGINAL LANDFILL
Extent of Investigation

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Four areas identified as Areas A to D in Figure 8 were interpreted to be areas of buried wastes that, because of their areal extent, possibly represent waste trenches. These areas were defined by anomalies seen on two or more adjacent lines.

- Area A - This is the largest area and the one with the strongest anomalies (probably indicating the most buried metal). The western limit was not defined because an overhead powerline and fence at the western side of the parking lot would have interfered with the data in that area. The area between Areas A and B and the area beneath the parking lot north of Area A may also contain buried wastes; however, the anomalies are relatively weak. The powerline crossing the northern portion of the parking lot may be contributing to the anomalies.

- Area B - The anomalies are distinct, but weaker than at Area A. Buried metal is clearly indicated in this area.

- Area C - This area covers a portion of an interpreted utility line that may be affecting the delineation of the boundaries of this area.

- Area D - This area is defined only by an anomaly on line 1560 and corresponding anomalies were not seen on adjacent lines. Although this area is defined by only one line, the anomaly was strong enough to consider as an area of buried wastes and include in the same group as Areas A to C. This area may not represent a trench of the same size or type suggested by Areas A to C.

Several areas shown in Figure 9 are described as "weak responses possibly related to buried wastes." These areas have been defined by weak anomalies seen only on single lines. Buried wastes are probably present at these areas, but the wastes may be sparser (more mixed with soil), thinner, or of a different nature than at areas such as Area A.

Several buried utility lines, such as pipes or cables, have been interpreted and are shown in Figure 9. The interpretation of these features as utility lines is based on anomaly shapes that indicate narrow conductors and a sequence of these anomalies on adjacent lines. Anomalies that indicate narrow sources but did not have corresponding anomalies on adjacent lines were identified as isolated buried metal.

The most prominent feature in the EM conductivity contour map (Figure 7) is the interpreted buried wastes beneath the parking lot (Area A in Figure 9). Also apparent are anomalies related to Area B and the interpreted buried utility line running north-south near grid line 1240 E. The contour map of in-phase values (Figure 8) suggests that most of the site west of about grid line 1100 may contain buried wastes. The most distinct anomalies, however, correspond to Areas A, B, and D, as well as the interpreted utility lines.

2.3.2.5 GPR Results

The GPR data were collected along line 960, over the portion of Area A with the strongest EM anomalies. The buried wastes were not apparent in the GPR data. Additional GPR data were not collected elsewhere at this site since the inability to detect the wastes at this location indicates that it would not be reliable elsewhere at the site.

2.3.3 Conclusions

The largest concentration of buried wastes was detected west of grid line 1200 E and north of grid line 1000 N. Some waste material is present at other scattered locations including east of Agua Chinon Wash. The distribution of buried wastes east of Chinon Wash suggests different disposal practices may have been used there as compared to the western part of the site.

Some of the areas of weak responses and isolated buried metal shown in Figure 9 may be larger than shown. The 40-foot line spacing used to collect data at the site may have resulted in missing the strongest responses over these areas and not fully identifying the extent of the buried wastes.

The GPR used at the time of the EM investigation did not adequately identify buried wastes. The SWAT GPR investigation apparently was able to detect the buried wastes since there appears to be a general agreement between the EM results and the SWAT results. The GPR work done for the SWAT investigation may have been successful either because an antenna with a different frequency or a more powerful GPR unit was used.

2.4 Site 5 - Perimeter Road Landfill

2.4.1 Background

The Perimeter Road Landfill was a cut-and-fill type of facility that was used after 1955 until the late 1960s. Wastes disposed at the site may have included burnable trash, municipal solid waste, unspecified fuels and solvents, cleaning fluids, scrap metals, and paint residues. Wastes were typically burned before

burial. Additional soil was periodically added to fill areas above the landfill that have settled with time.

Ground-penetrating radar investigations were performed to define the edges of the landfill as part of SWAT investigations at the site. Stakes placed at the time of the GPR survey to mark the landfill boundaries are no longer present.

2.4.2 Geophysical Investigations

A limited EM conductivity investigation was planned for the site to verify the SWAT GPR results. The EM survey was expanded when it was found that the stakes marking the landfill boundaries were missing. The objective was correspondingly changed to delineate the landfill boundaries.

Ground-penetrating radar data were also collected in selected areas to compare against the EM results. The comparison was made to determine which method would yield the best results at the site.

2.4.2.1 Site Grid

A grid was established over the site prior to collection of geophysical data. The reference for the grid was the north-south fence between the site and perimeter road. The fence corner on the southern side of the gate at the site's northern end was assigned 1000 N, 1000 E (Figure 10). Grid markers were placed at 50-foot intervals along the fence. Additional markers were placed 100 and 200 feet west of the markers at the fence. Approximately 6 acres were covered by the investigation.

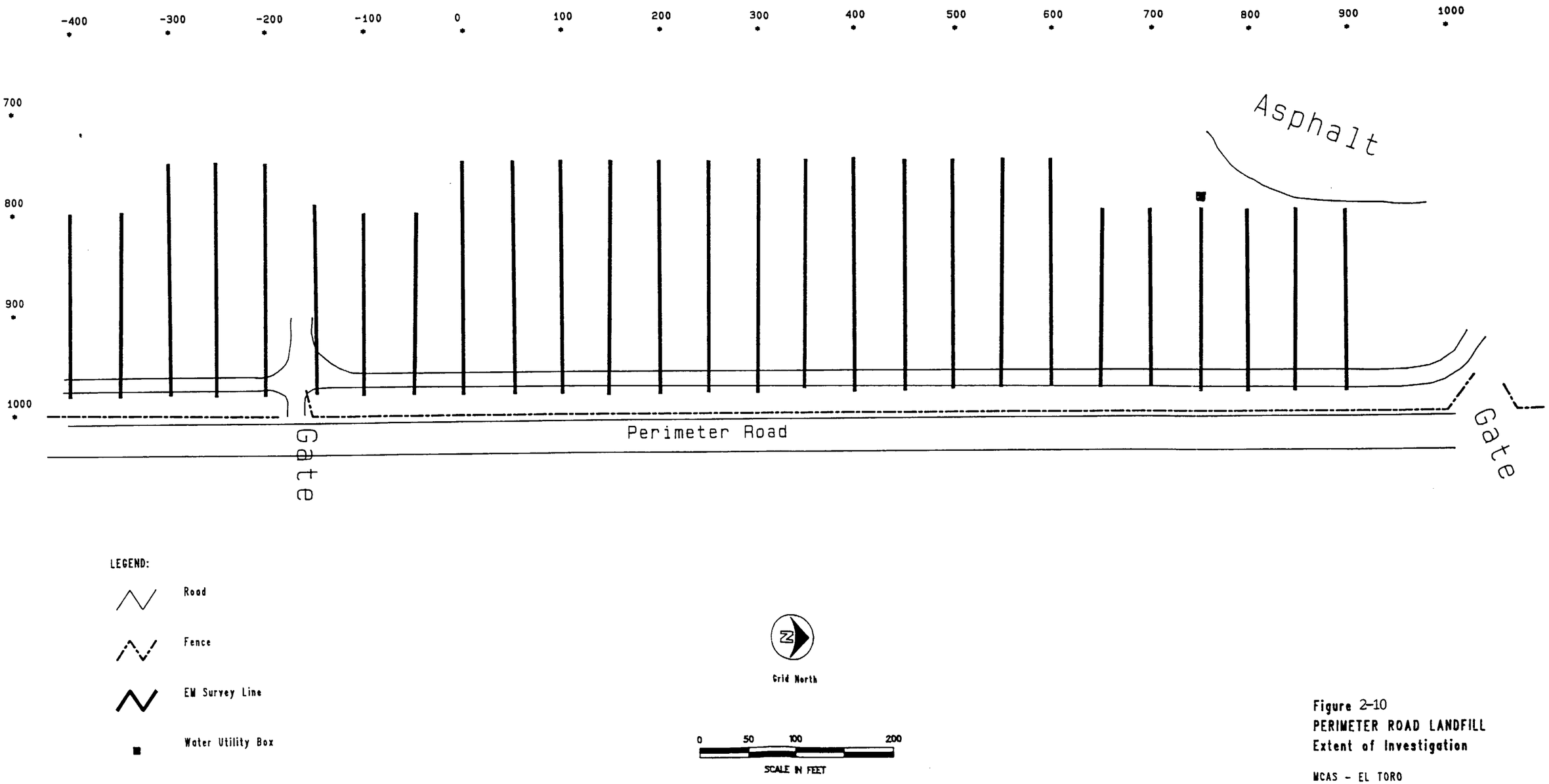

Figure 2-10
PERIMETER ROAD LANDFILL
Extent of Investigation

MCAS - EL TORO

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2.4.2.2 Data Collection

Measurements were made at 5-foot intervals along east-west lines 50 feet apart and corresponding with the markers along the fence. Lines were approximately 200 feet long, starting typically 20 feet from the fence and extending to 200 feet west of the fence. Many lines were extended an additional 50 feet west to better define a conductor present 200 feet from the fence.

Measurements were automatically recorded in a digital data logger, and every tenth measurement was recorded in the field logbook. Each measurement consisted of conductivity and in-phase response. Data were transferred daily from the data logger to a computer and reviewed.

2.4.2.3 Interpretation

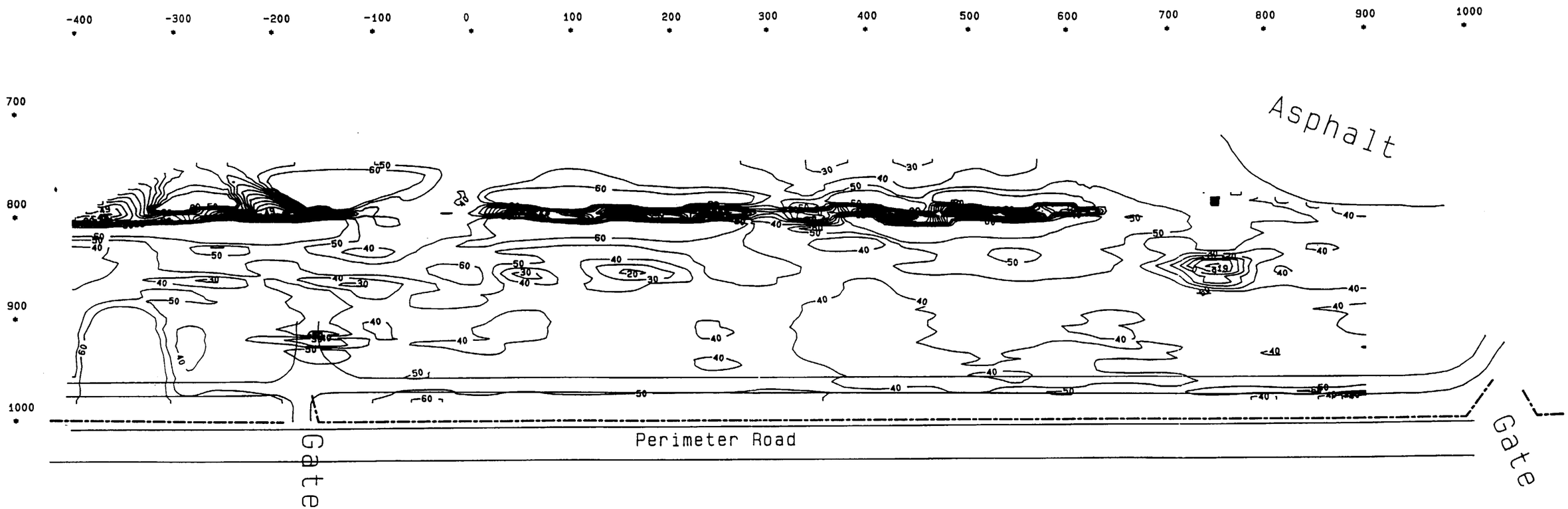
Graphs of the conductivity and in-phase measurements along each line are presented in Attachment D. Conductivity values are presented contoured in Figure 11. Figure 12 is a contour map of the EM in-phase values. The graphs were used to identify anomalies that were due to buried materials. The source locations of the anomalies were estimated, and the locations were transferred to the base map (Figure 13). Anomalies may have appeared in the data only in the conductivity values, in-phase values, or both. No distinction between types of anomalies has been made in Figure 13 since most anomalies, regardless of appearance, were interpreted as being due to buried wastes.

2.4.2.4 Results

Areas of buried wastes identified by the EM investigation are shown in Figure 13. The buried material extends from about 300 S to 800 N and is centered about 150 feet west of the fence. The width of the buried wastes appears to be about 50 feet. Not all responses were equally strong due to the variability of the waste material. Relatively weak responses were encountered primarily between 300 N and 600 N, and lesser amounts of wastes are interpreted in this area compared to the rest of the landfill.

A feature interpreted as a utility line was encountered along much of grid line 800 E. The shape of the EM response indicates a narrow, good conductor, such as a pipe. The length and straightness of the feature also suggests a buried utility. A water utility box was observed at grid location 750 N, 790 E indicating a water line may be the source of the anomalies.

The contour map of conductivity values (Figure 11) is dominated by the response along grid line 800 E, which is interpreted to be due to a buried utility line. Responses related to buried wastes can be seen in many locations centered along grid line 850 E. Similar features are apparent in the in-phase values (Figure 12). The in-phase response was apparently more sensitive to buried wastes. Thus, the landfill is generally more apparent in the map of in-phase data than in the conductivity data map.



LEGEND:

Road

Fence

EM Conductivity Contour
Contour Interval of 10 mmhos/m

Water Utility Box

Grid North

0 50 100 200
SCALE IN FEET

Figure 2-11
PERIMETER ROAD LANDFILL
EM Conductivity Contours

MCAS - EL TORO

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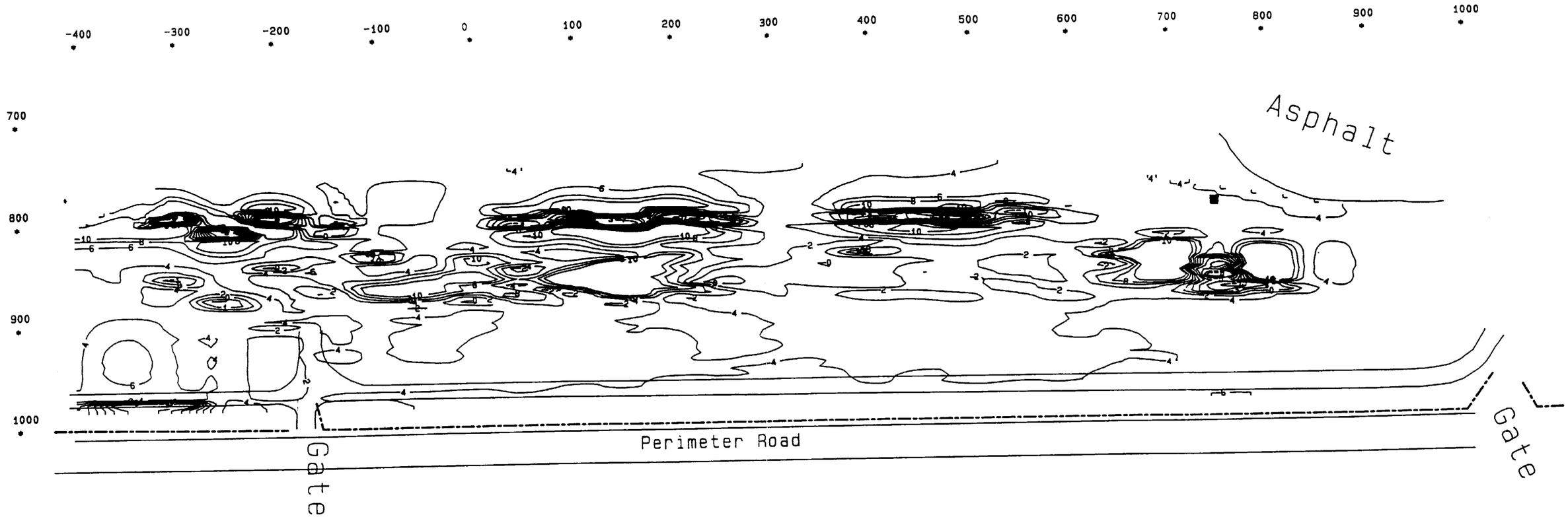

LEGEND:

Road

Fence

EM In-Phase Response Contour
Contour Interval of
2 parts per thousand

Water Utility Box

Grid North

0 50 100 200
SCALE IN FEET

Figure 2-12
PERIMETER ROAD LANDFILL
EM In-Phase Response Contours

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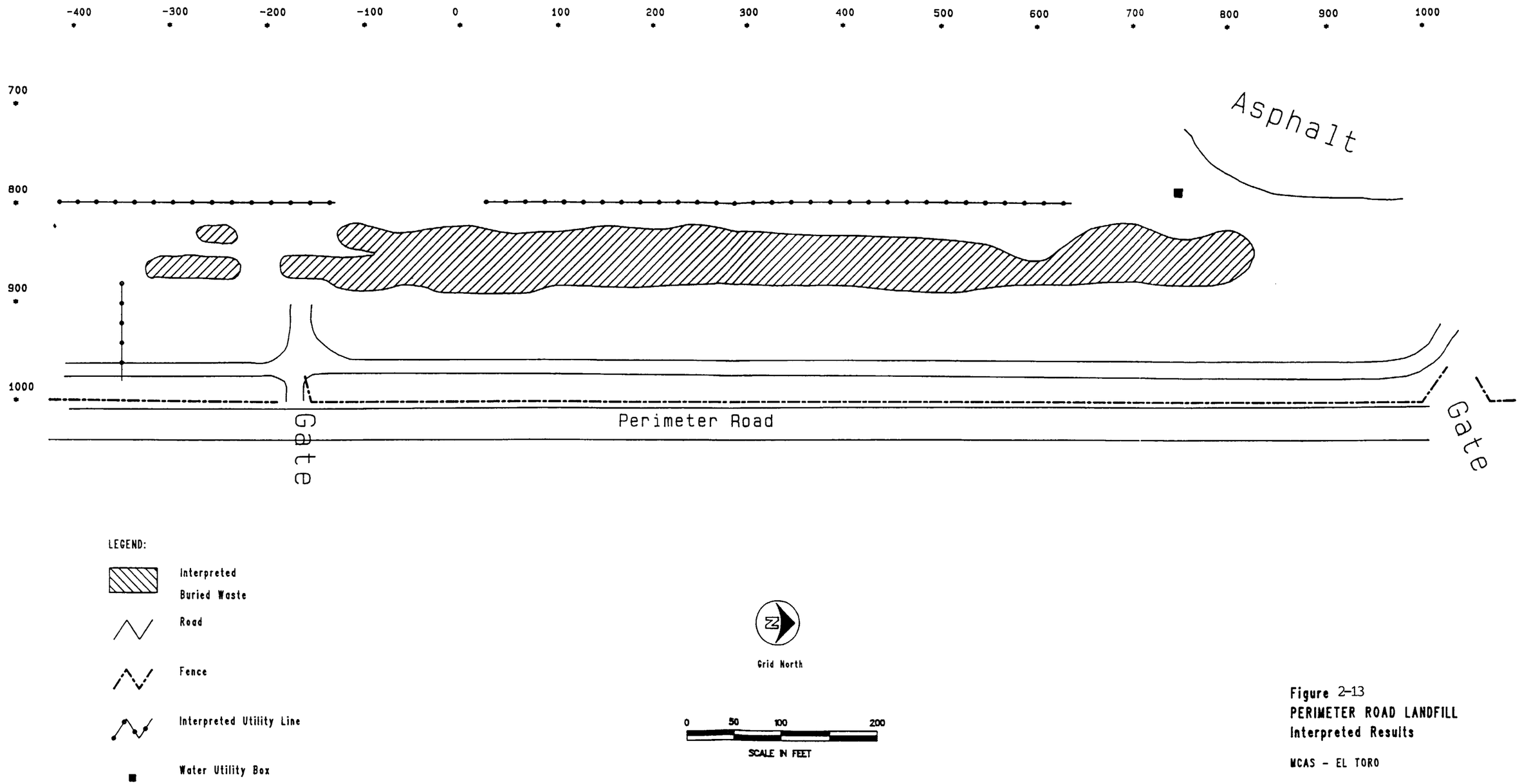

Figure 2-13
PERIMETER ROAD LANDFILL
Interpreted Results

MCAS - EL TORO

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2.4.2.5 GPR Test

GPR data were collected along lines 350 N and 750 N. No buried wastes could be identified in the GPR data collected along line 350 where the EM data contained a weak anomaly. Buried wastes were seen in the GPR data from 840 E to 875 E on line 750 N, which closely matches the landfill limits interpreted from the EM data.

2.4.3 Conclusions

The landfill boundaries were readily apparent in the EM data, and EM anomaly strengths probably indicate relative amounts of waste within the landfill. Although relative amounts of waste were not depicted in the interpretation map (figure 13), the data can be used for this characterization at any later date.

A buried utility line was interpreted along much of grid line 800 E. The western edge of the landfill is not as well defined as the eastern edge because of interference from this feature. Another possible buried utility was identified along grid line -350 (350).

The SWAT GPR and EM results are in general agreement, although the landfill is probably better defined by the EM data because of the closer line spacing used. The EM survey identified some buried wastes south of the area covered by the SWAT GPR survey. The stakes marking the landfill's limits based on the SWAT GPR data are missing, but the map in the SWAT Report appears to be to scale based on measurements taken during the EM investigation.

EM conductivity methods did provide better results than the GPR used at the time of the EM survey. It is not possible at this time to compare it against the GPR results obtained during the swat investigation. The GPR used for the swat investigation was probably better suited to detect the buried wastes than the GPR used at the time of the EM investigation.

2.5 Site 9 - Crash Crew Pit No. 1

2.5.1 Background

The crash crew pit was a ground depression about 3 to 4 feet deep and with a diameter of about 70 feet. It was used from 1965 to 1971 for fire fighting training. Flammable liquids were put in the pit and set on fire. There is no reported metal buried at this site.

2.5.2 Geophysical Investigations

The objective of the geophysical investigations at the site was to delineate the boundary of the crash crew pit. Electromagnetic conductivity and GPR methods were used.

2.5.2.1 Site Grid

A grid was established over the site prior to collection of geophysical data. A utility box at the corner of the steel matting and the edge of the taxiway was used as the reference point for the grid and was assigned grid coordinates 300 E, 200 N. Grid markers were placed at 20-foot intervals along north-south grid lines 100 feet apart. The west edge of the steel matting was used to establish grid

north-south. Grid east-west was made parallel to the edge of the taxiway (Figure 14).

2.5.2.2 EM Conductivity Survey

Electromagnetic conductivity measurements were made at 5-foot intervals along east-west grid lines 20 feet apart. Each measurement consisted of conductivity and in-phase values. Data were recorded in a digital data logger with the corresponding grid coordinates. Data were transferred daily to a computer and reviewed. Every tenth measurement was recorded in the field logbook.

2.5.2.3 EM Conductivity Interpretation

Graphs of conductivity and in-phase measurements along each line were prepared and are presented in Attachment E. A contour map of the conductivity is shown in Figure 15. The graphs were used to identify anomalies and estimate the locations of their sources. Locations of the interpreted locations of the buried material causing the anomalies are shown in Figure 16.

2.5.2.4 Results of the EM Conductivity Investigation

Features identified by the EM investigation are presented in Figure 16. Anomalies thought to be due to the crash crew pit could not be identified by this investigation. Large anomalies due to what is probably a storm drain dominated the data and are clearly seen in the contoured EM conductivity data (Figure 15). The feature is thought to be storm drain because a storm water grate with a steel culvert aligned with the anomalies was observed nearby. If anomalies related to the crash crew pit were present, they would have been obscured by the large

anomalies from the storm drain. Another interpreted utility line was also encountered crossing the site's southwestern portion.

2.5.2.5 GPR Investigation

A storm water grate was observed approximately 200 feet west of the limits of the EM investigation. A metal culvert at a depth of about 2 feet could be seen through the grate. However, no GPR response to the culvert was observed. GPR lines run over what may be the same culvert seen by the EM investigation also did not detect it. Since such a reasonable target as the culvert could not be detected at an estimated depth of about 2 feet, GPR work over the remainder of the site was discontinued. The clay content of the soil probably limited the GPR depth of investigation.

2.5.3 Conclusions

Geophysical methods could not determine whether the crash crew pit was present or not. Strong EM anomalies due to a buried utility (probably a storm drain) prevented the method from identifying smaller anomalies that would have been due to the pit. The depth of investigation of the GPR was apparently less than 2 feet since it could not detect the culvert.

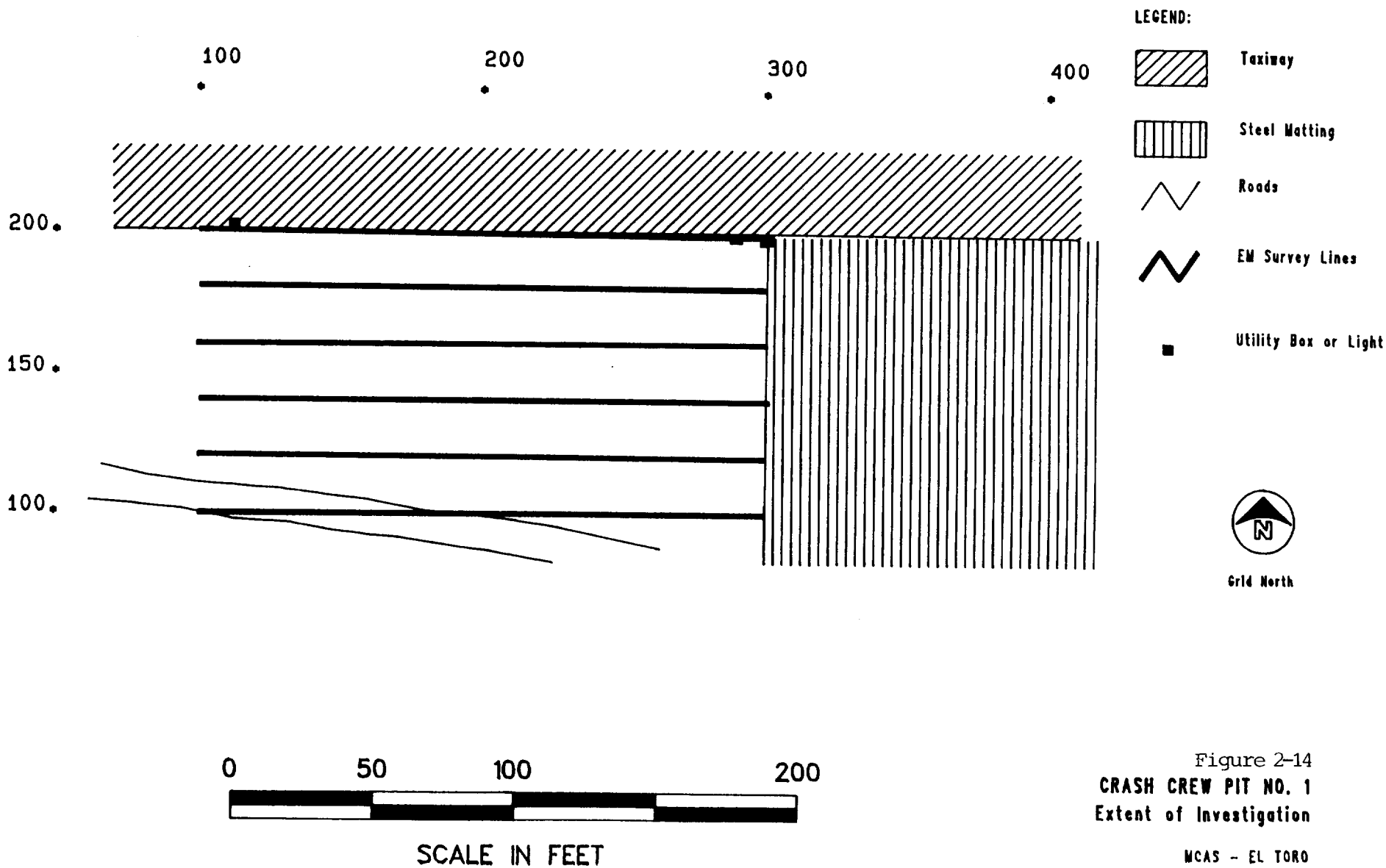

Figure 2-14
CRASH CREW PIT NO. 1
Extent of Investigation

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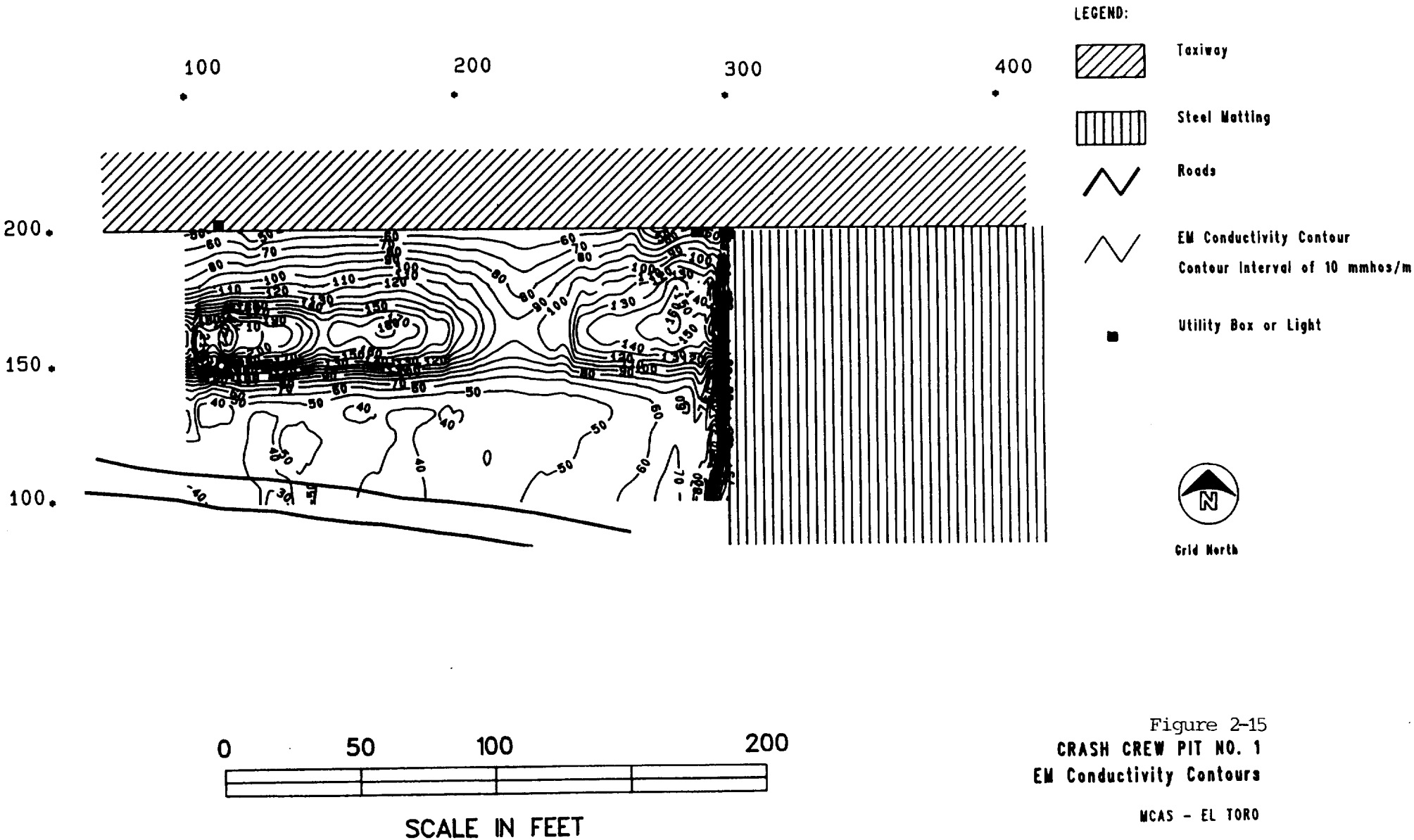

Figure 2-15
CRASH CREW PIT NO. 1
EM Conductivity Contours

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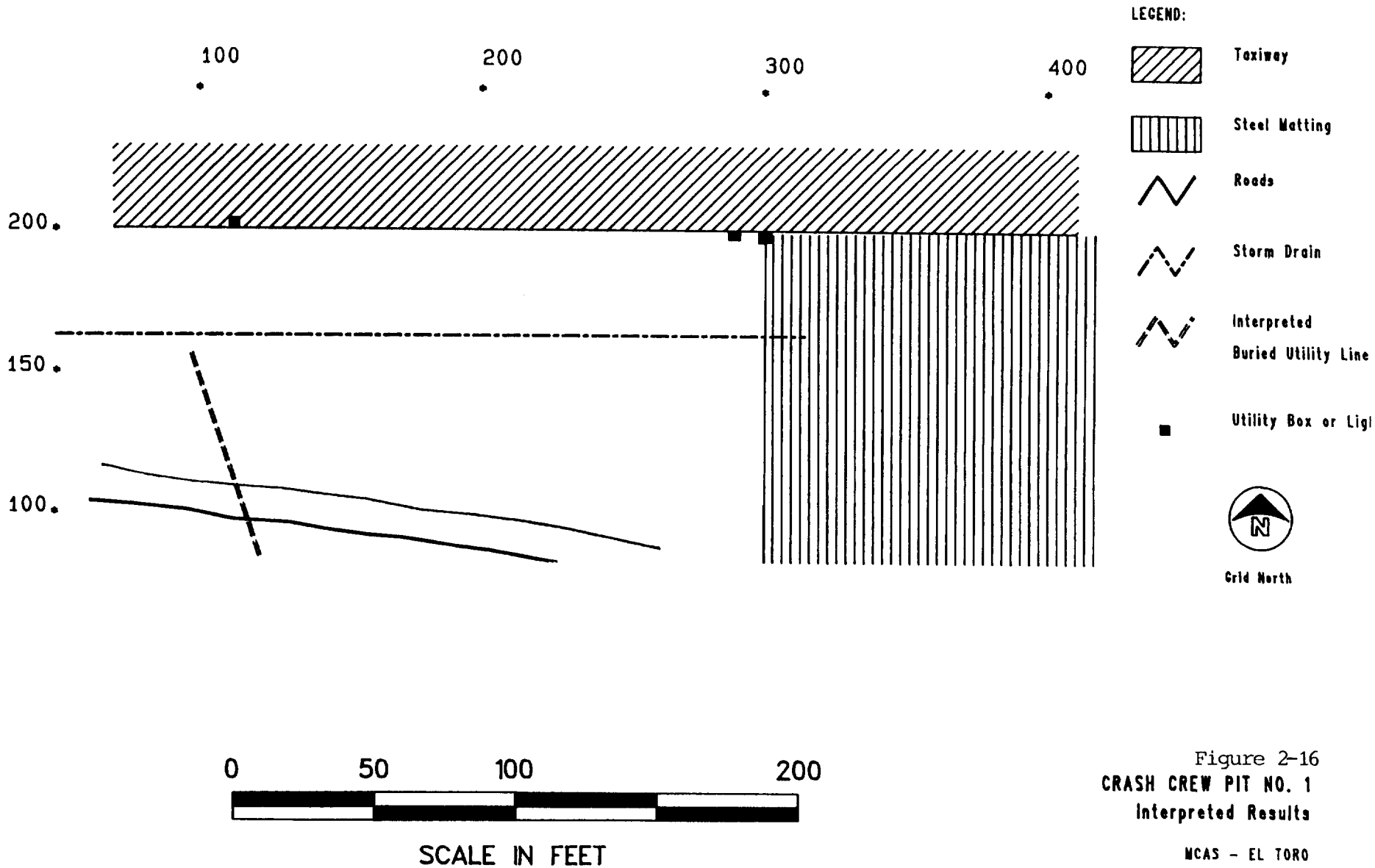

Figure 2-16
CRASH CREW PIT NO. 1
Interpreted Results

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Attachment A

EOD RANGE

EM DATA

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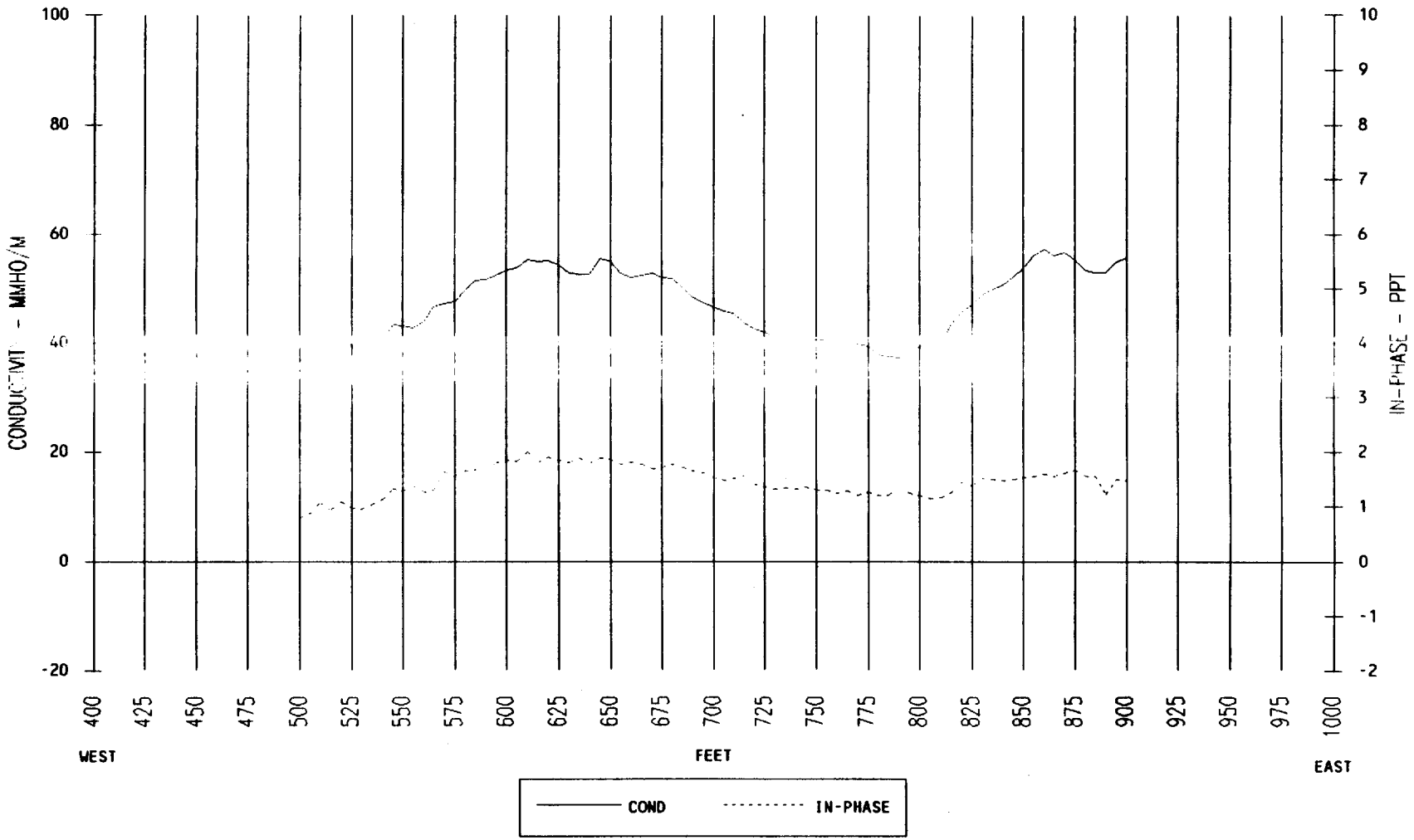

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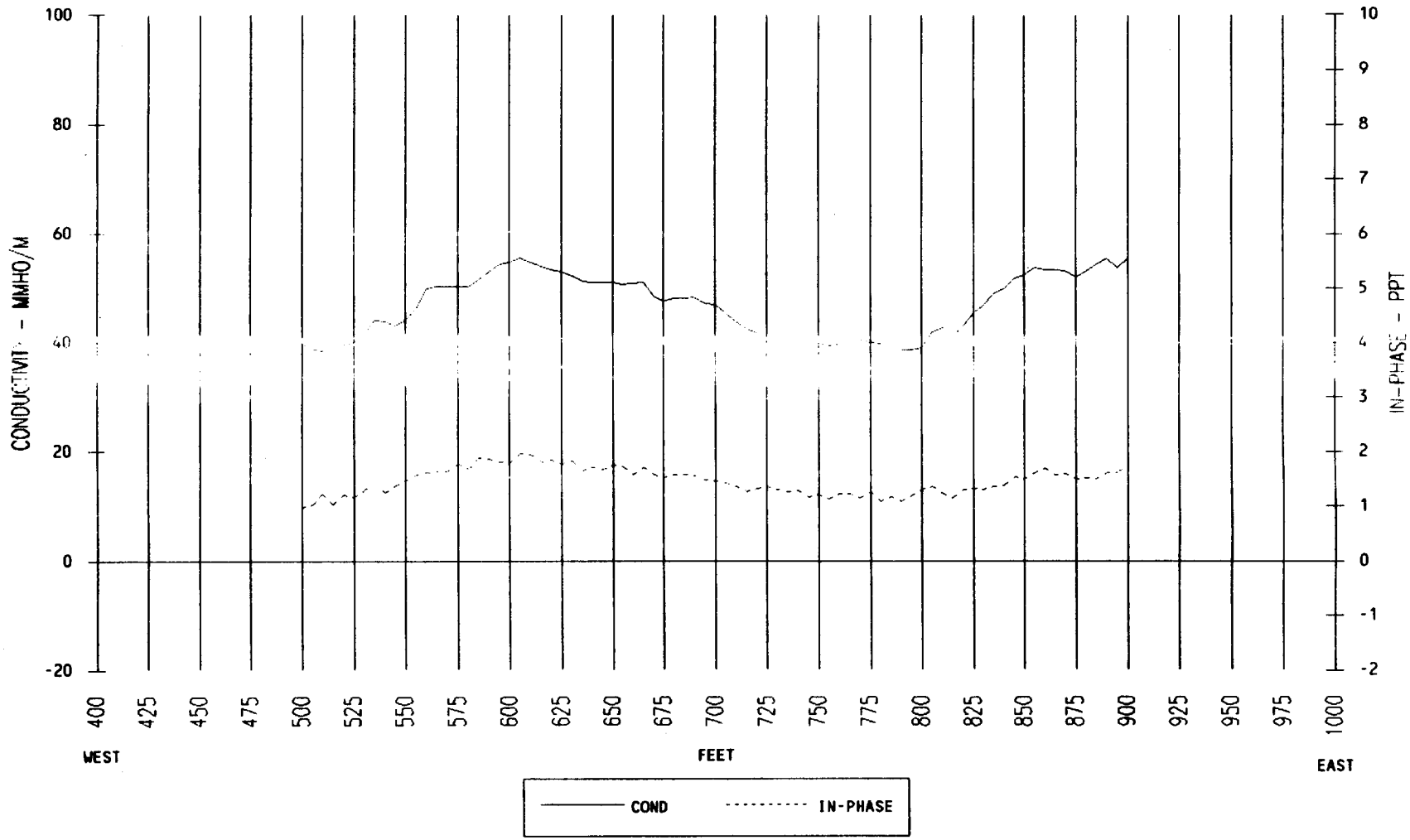

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EOD RANGE - LINE 460

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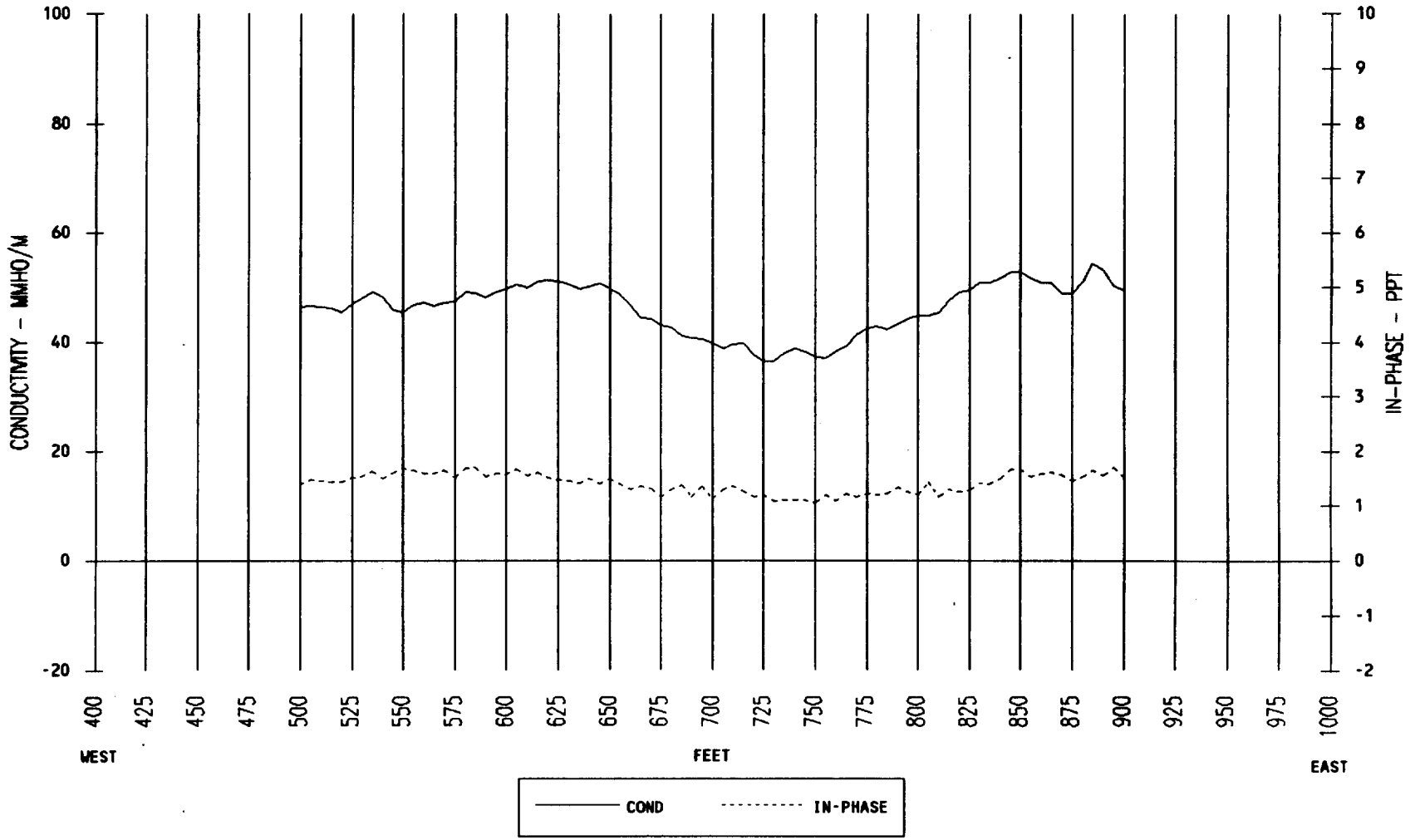

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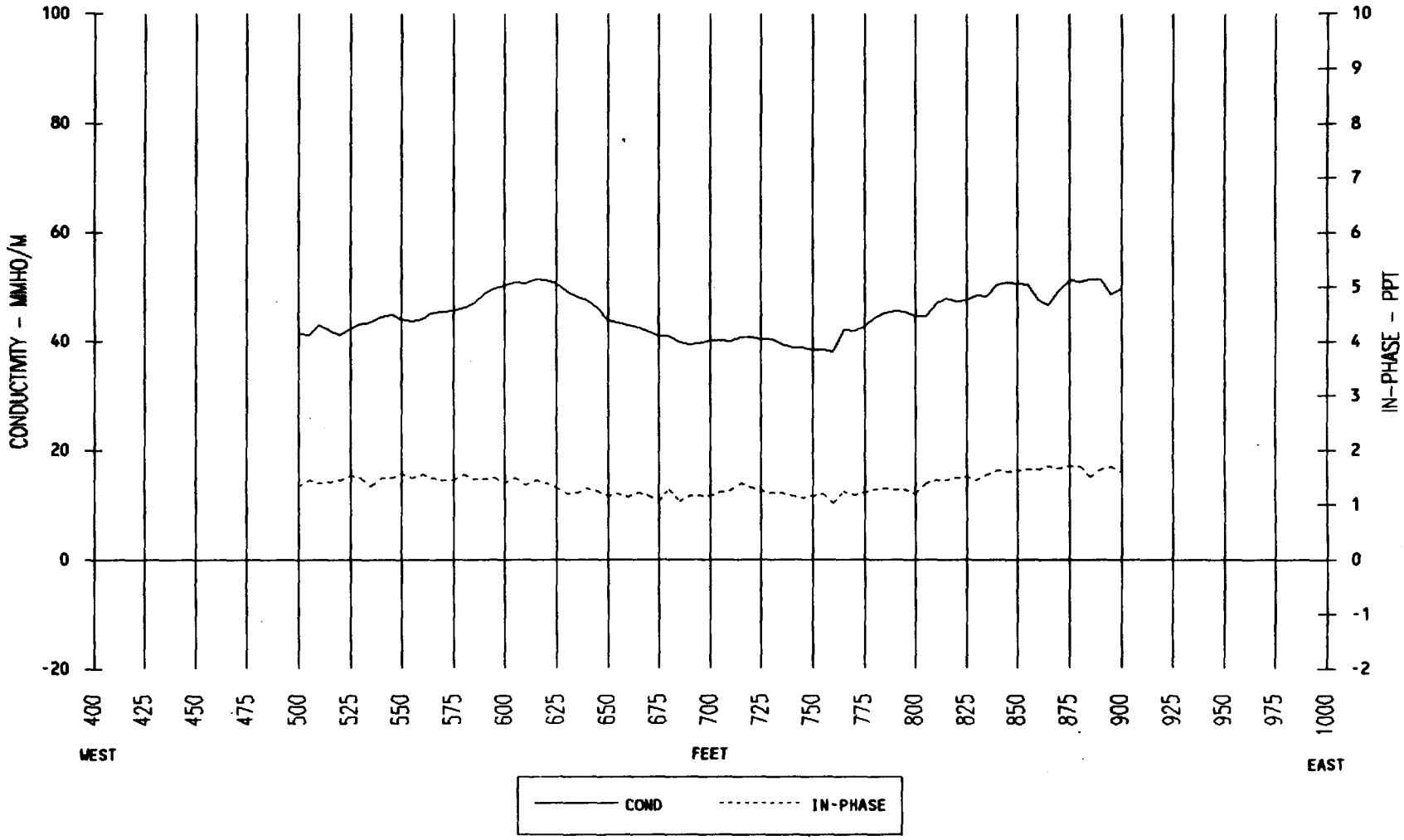

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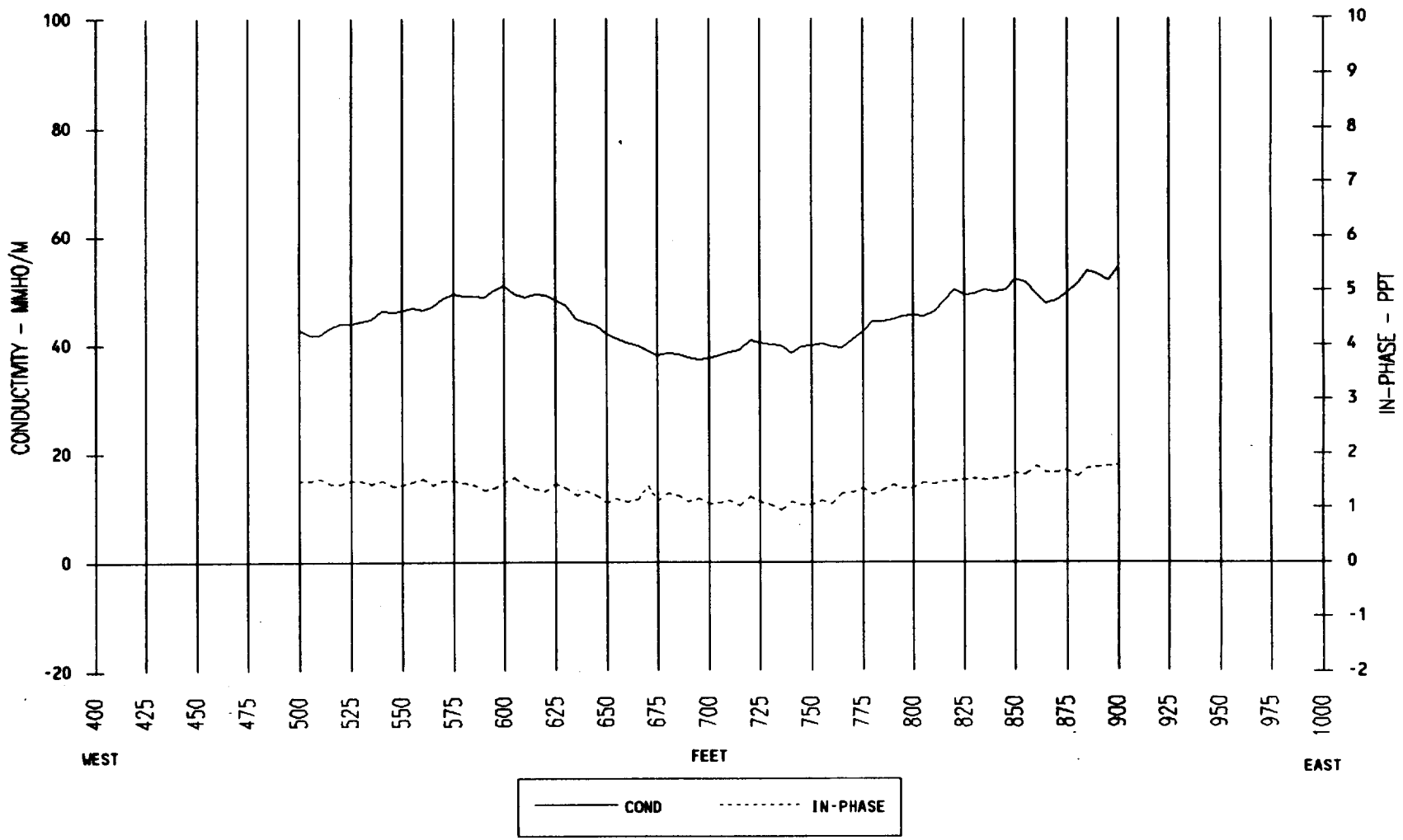

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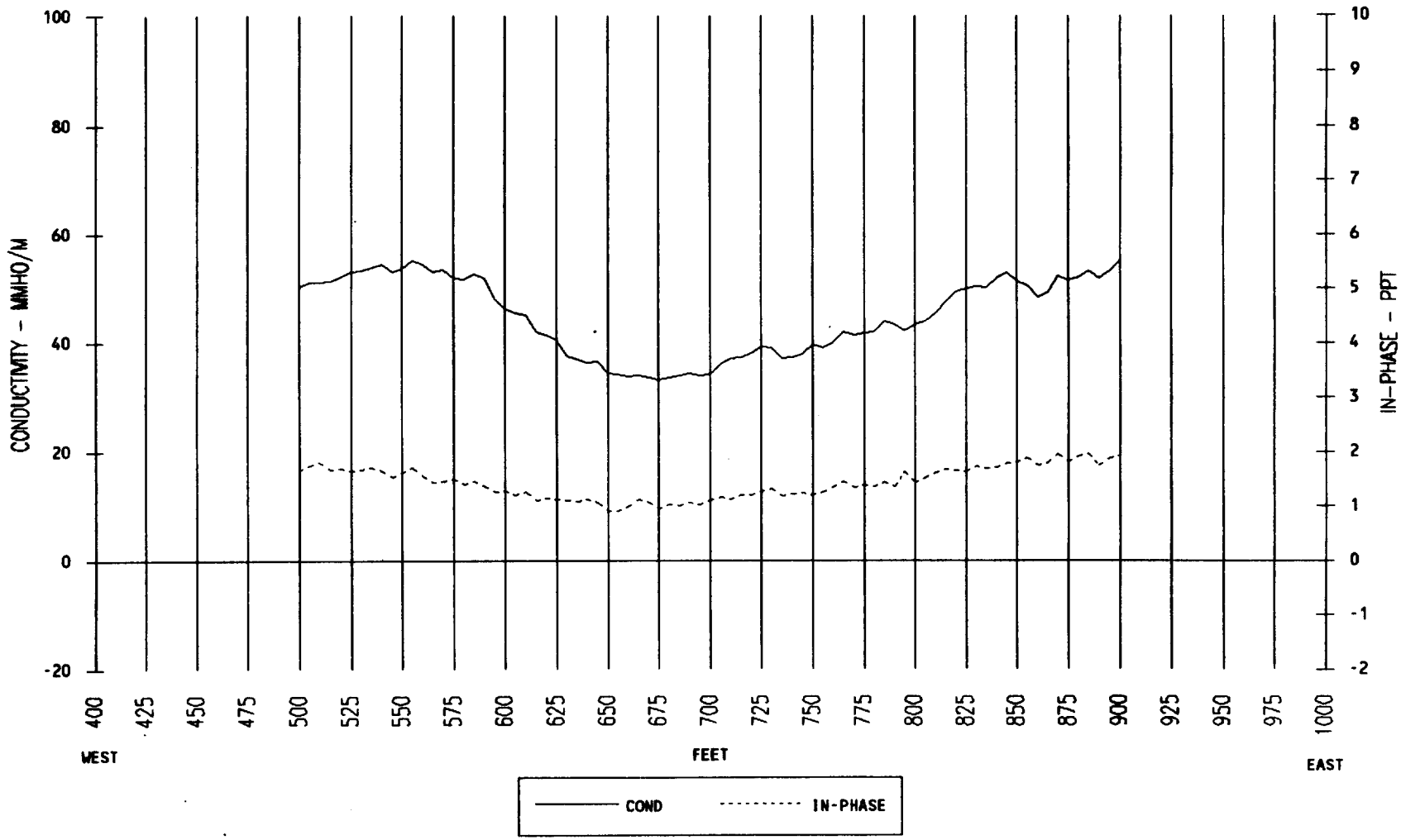

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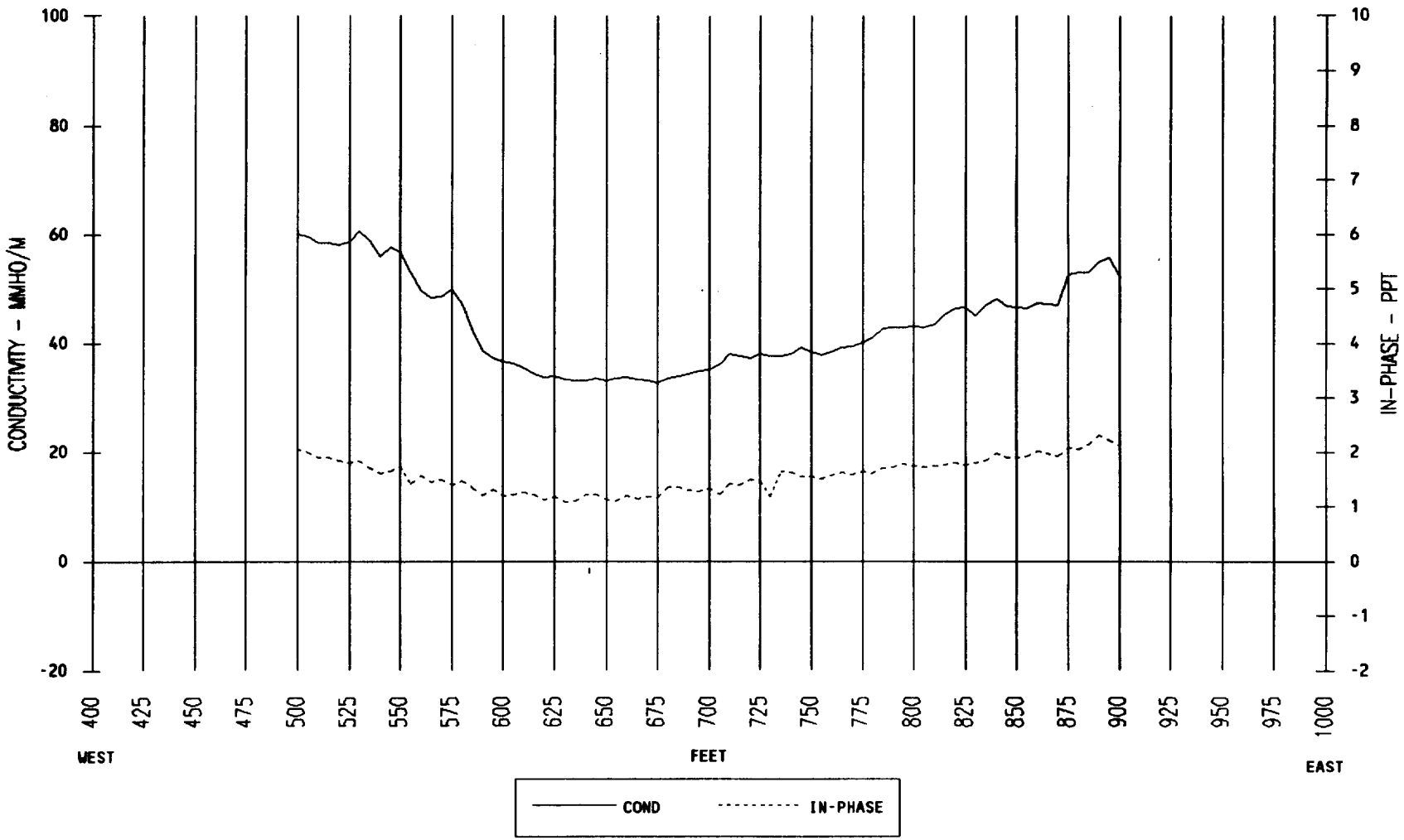

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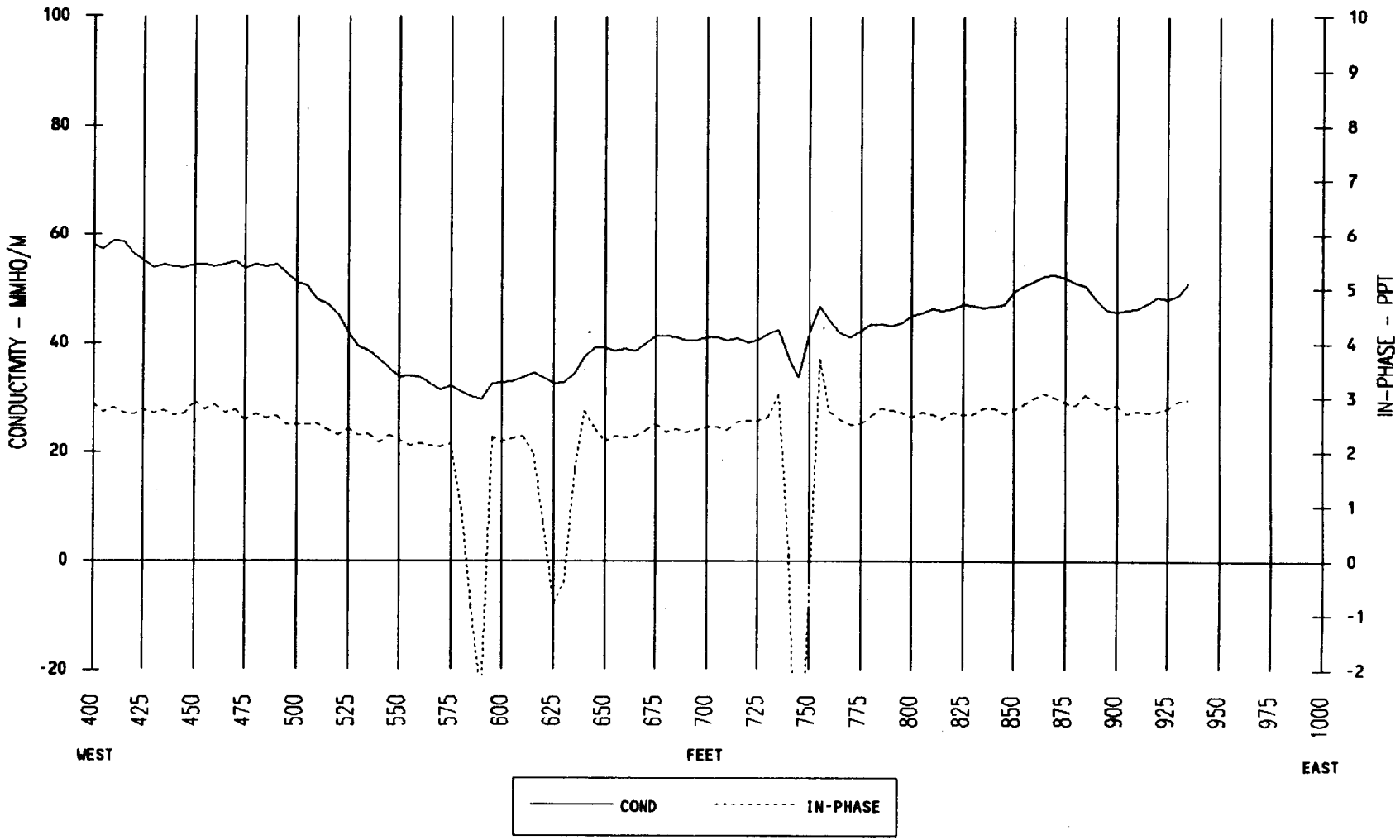

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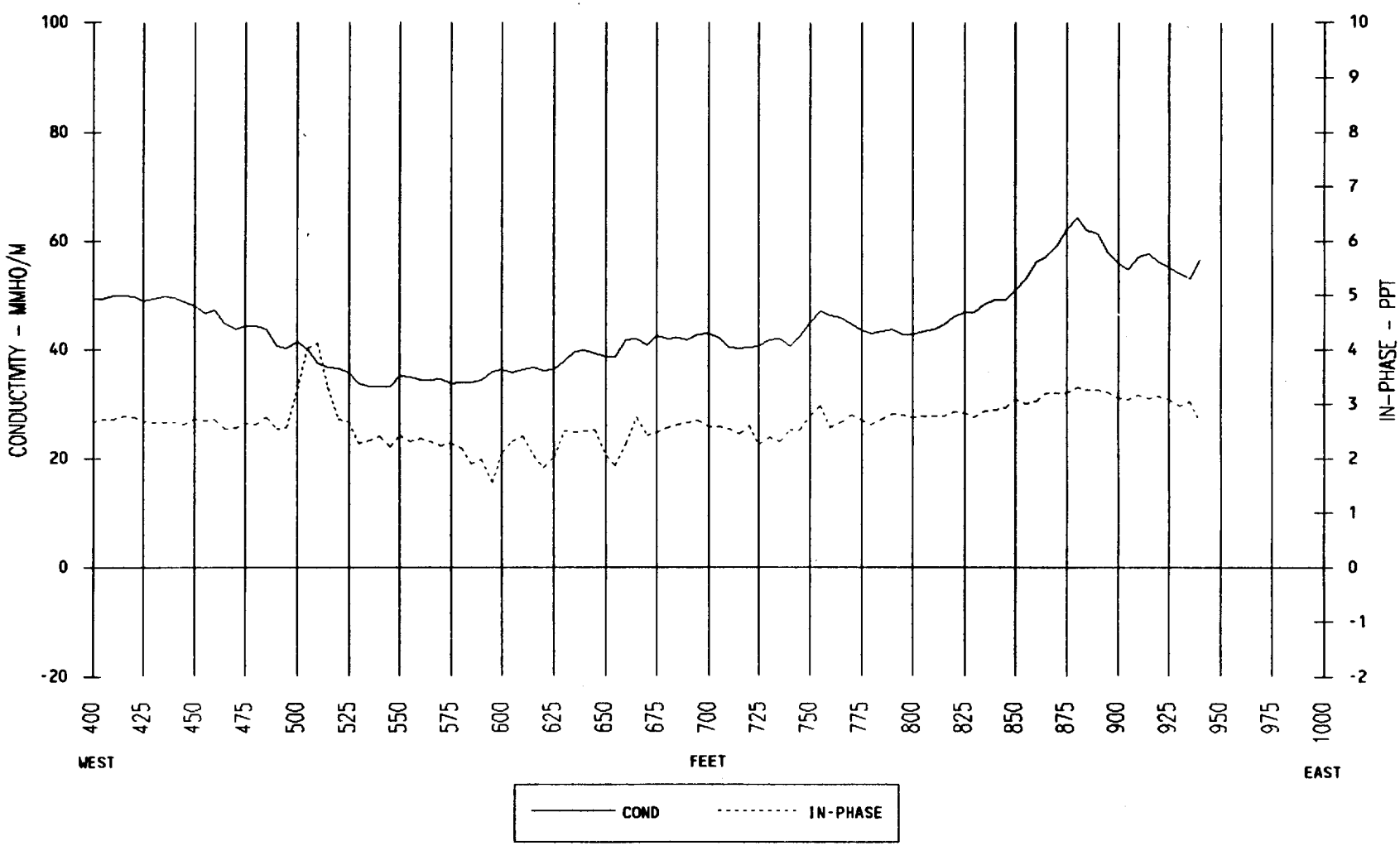

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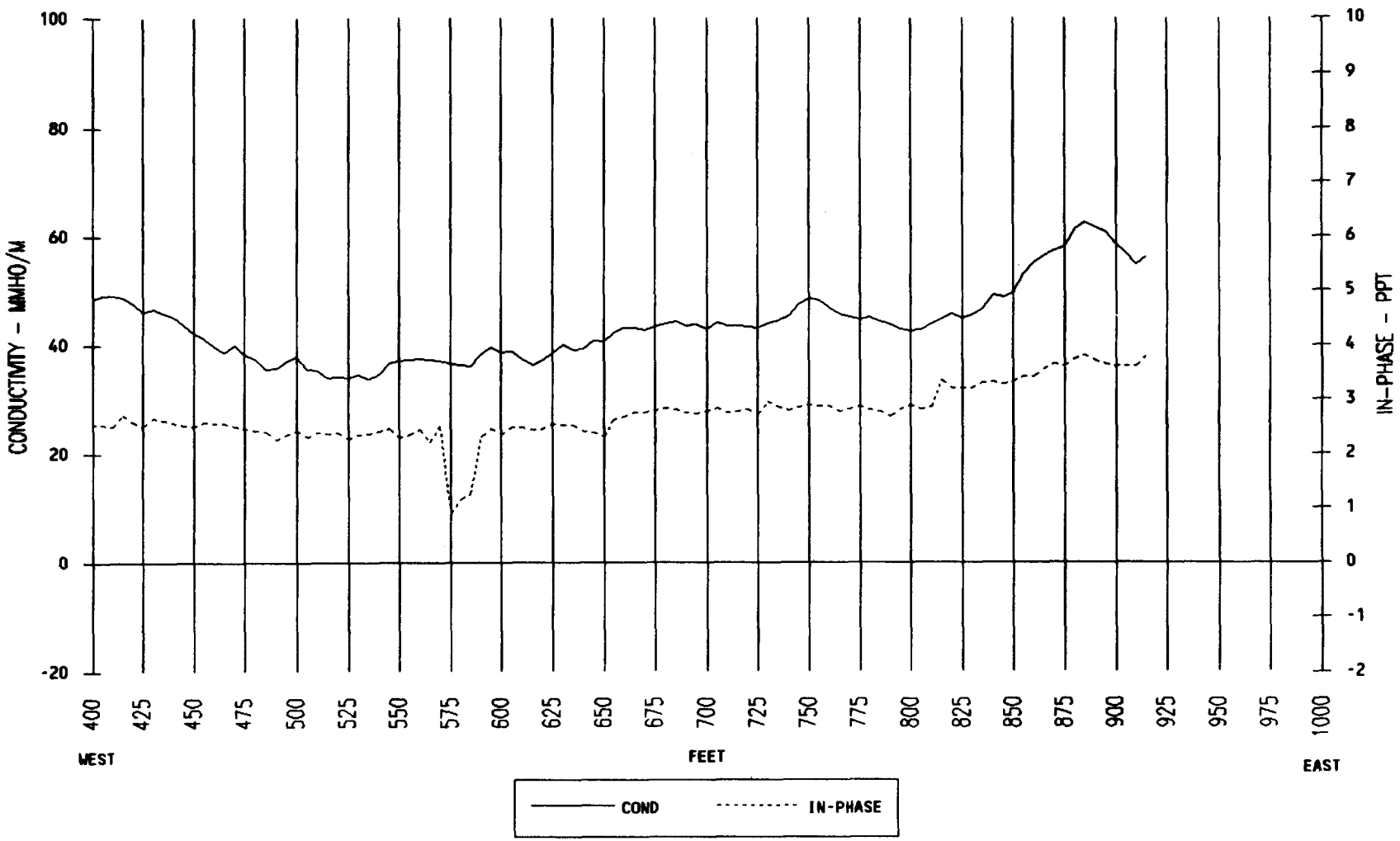

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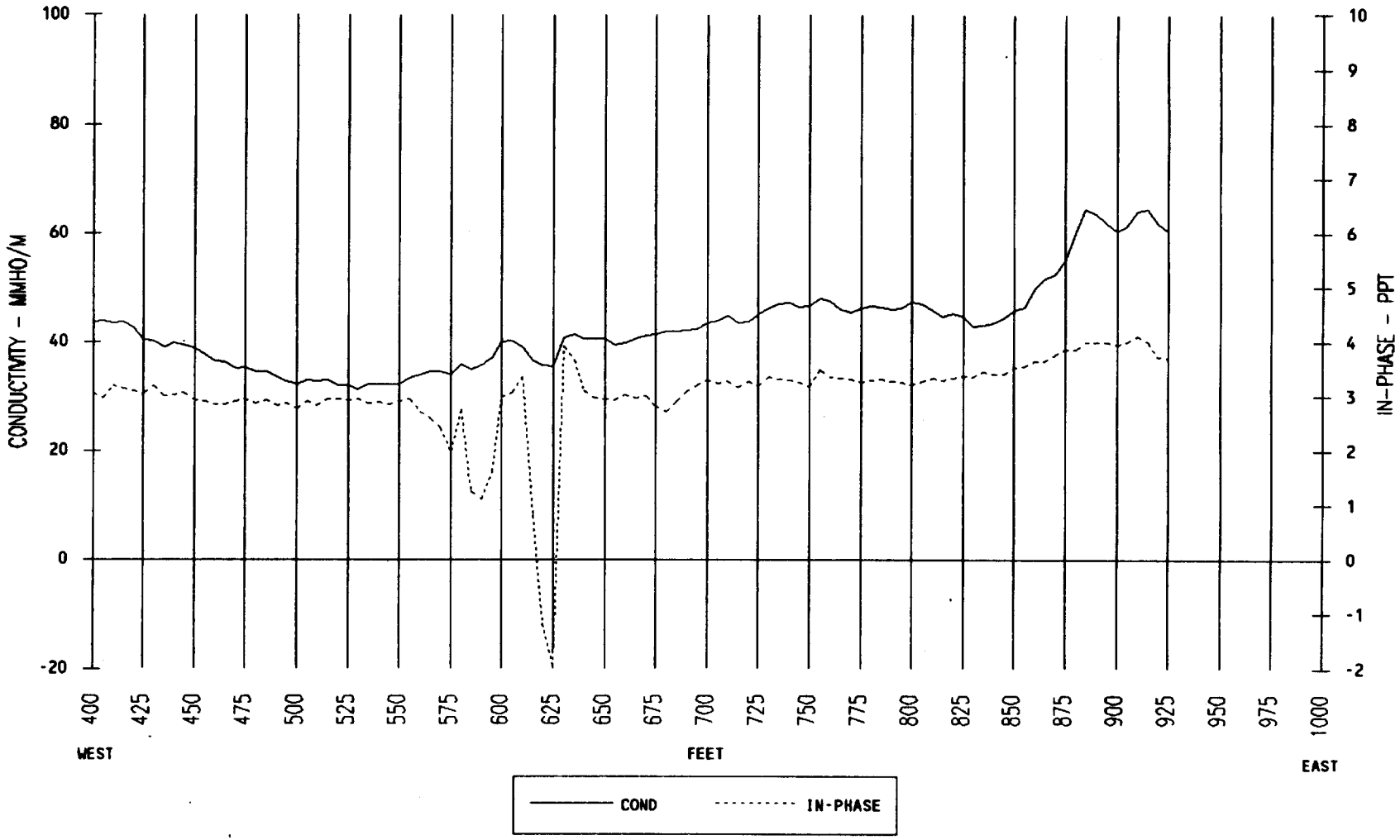

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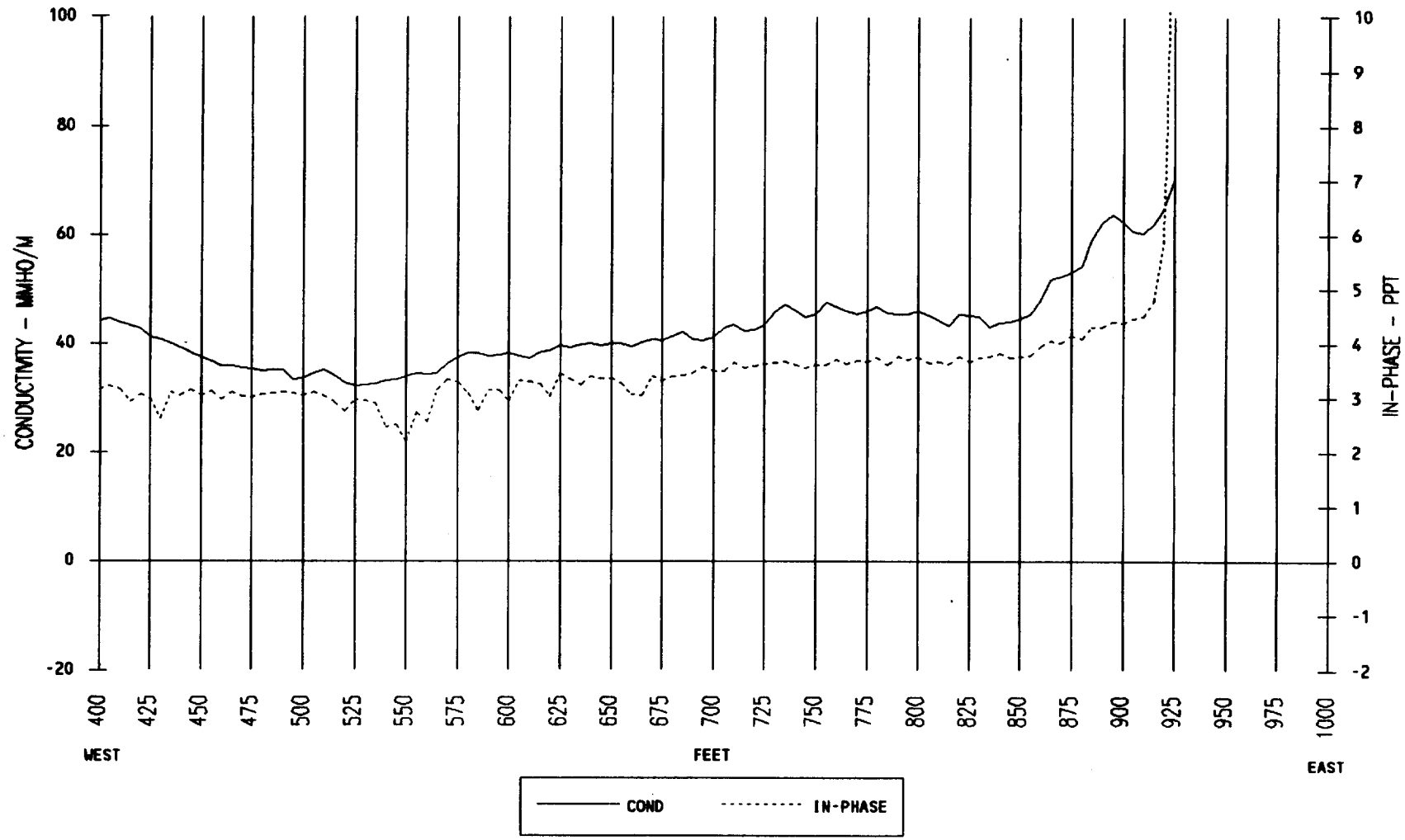

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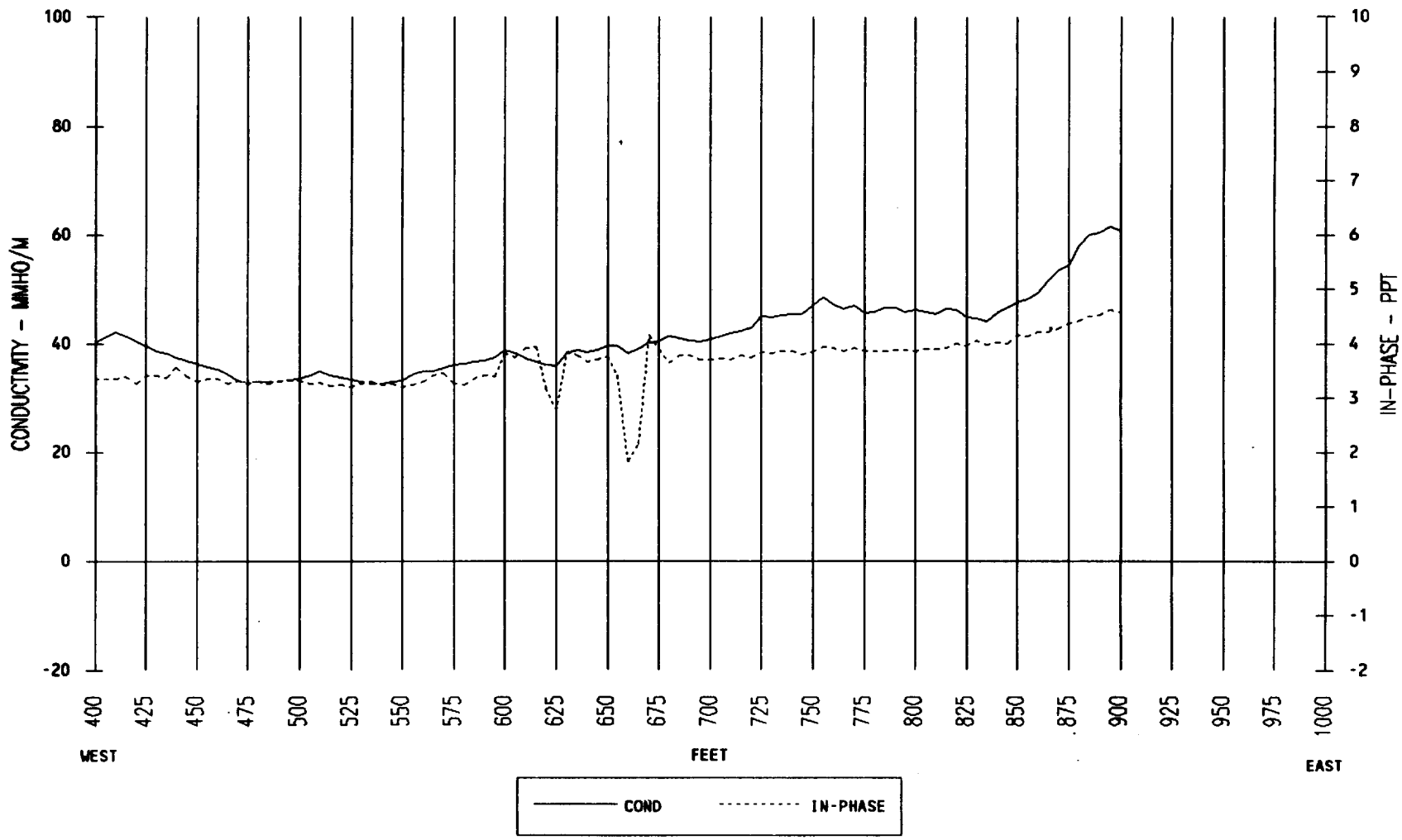

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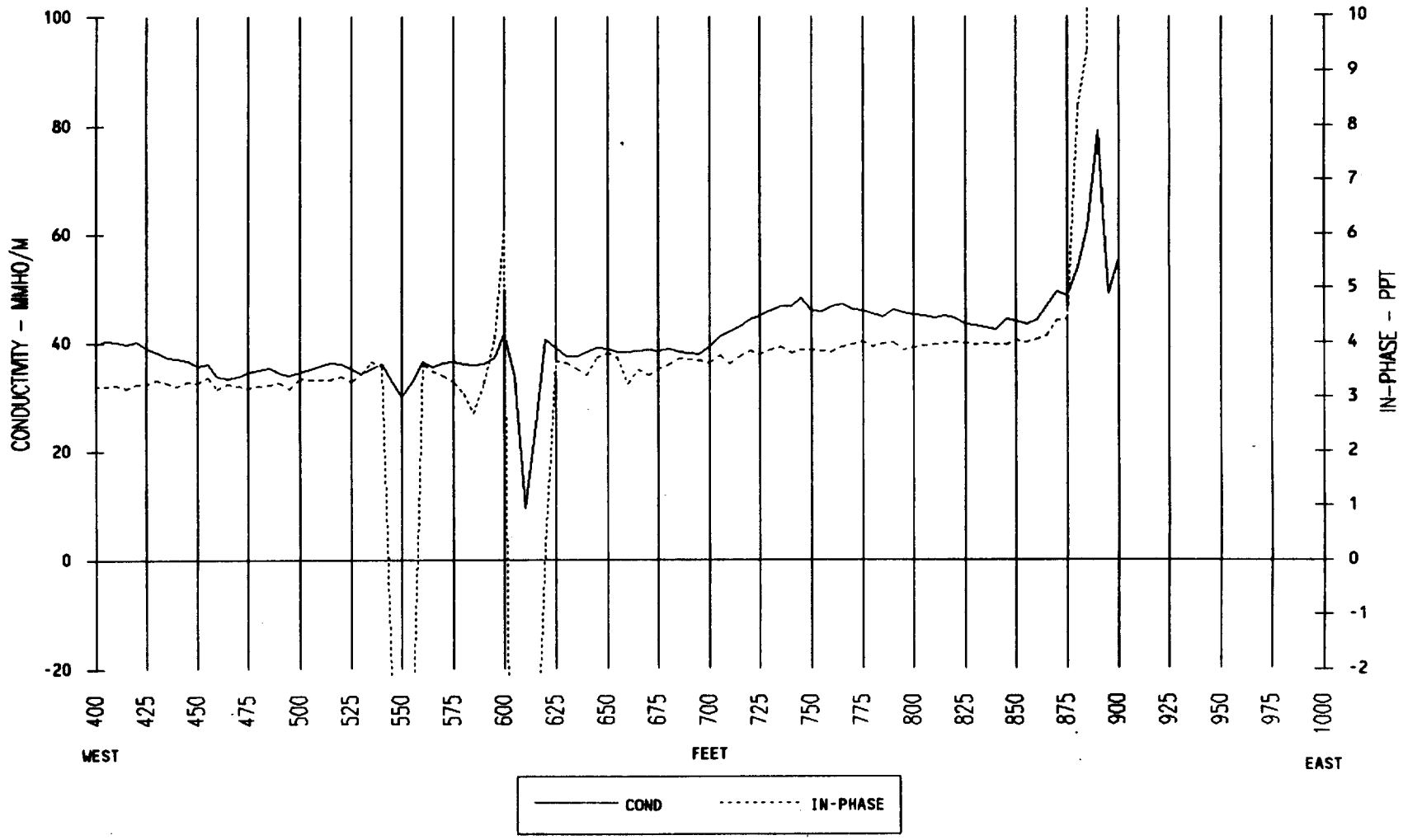

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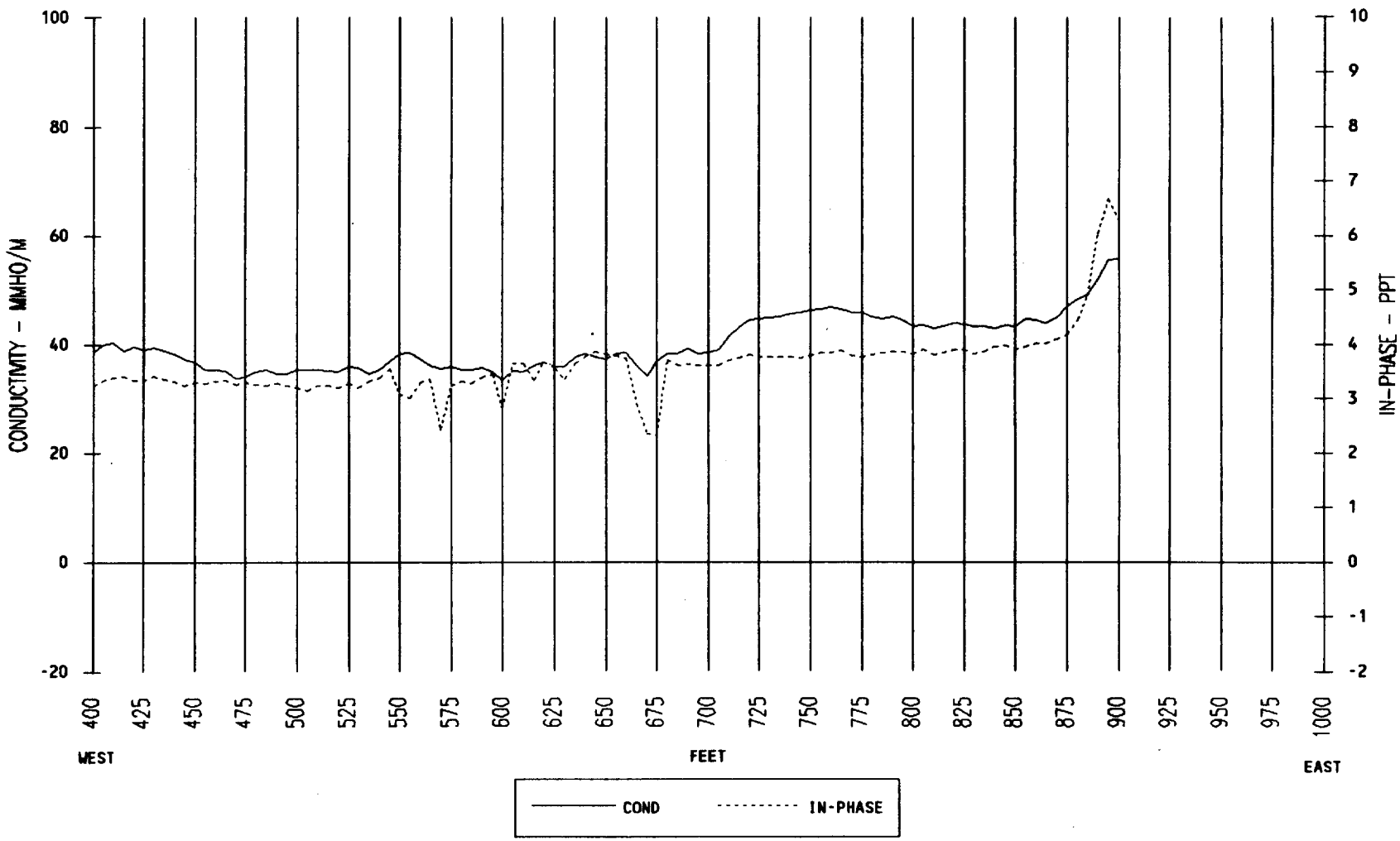

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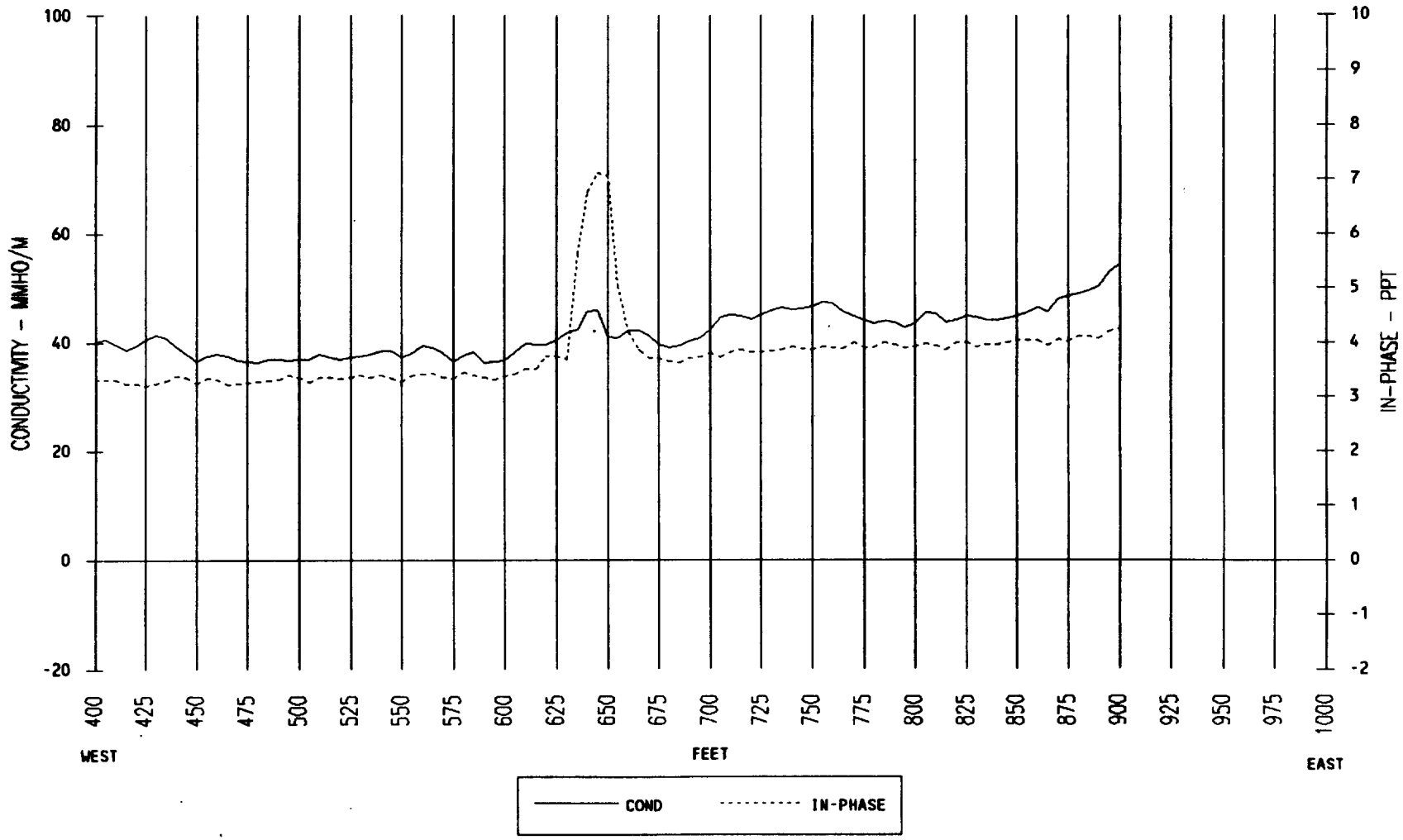

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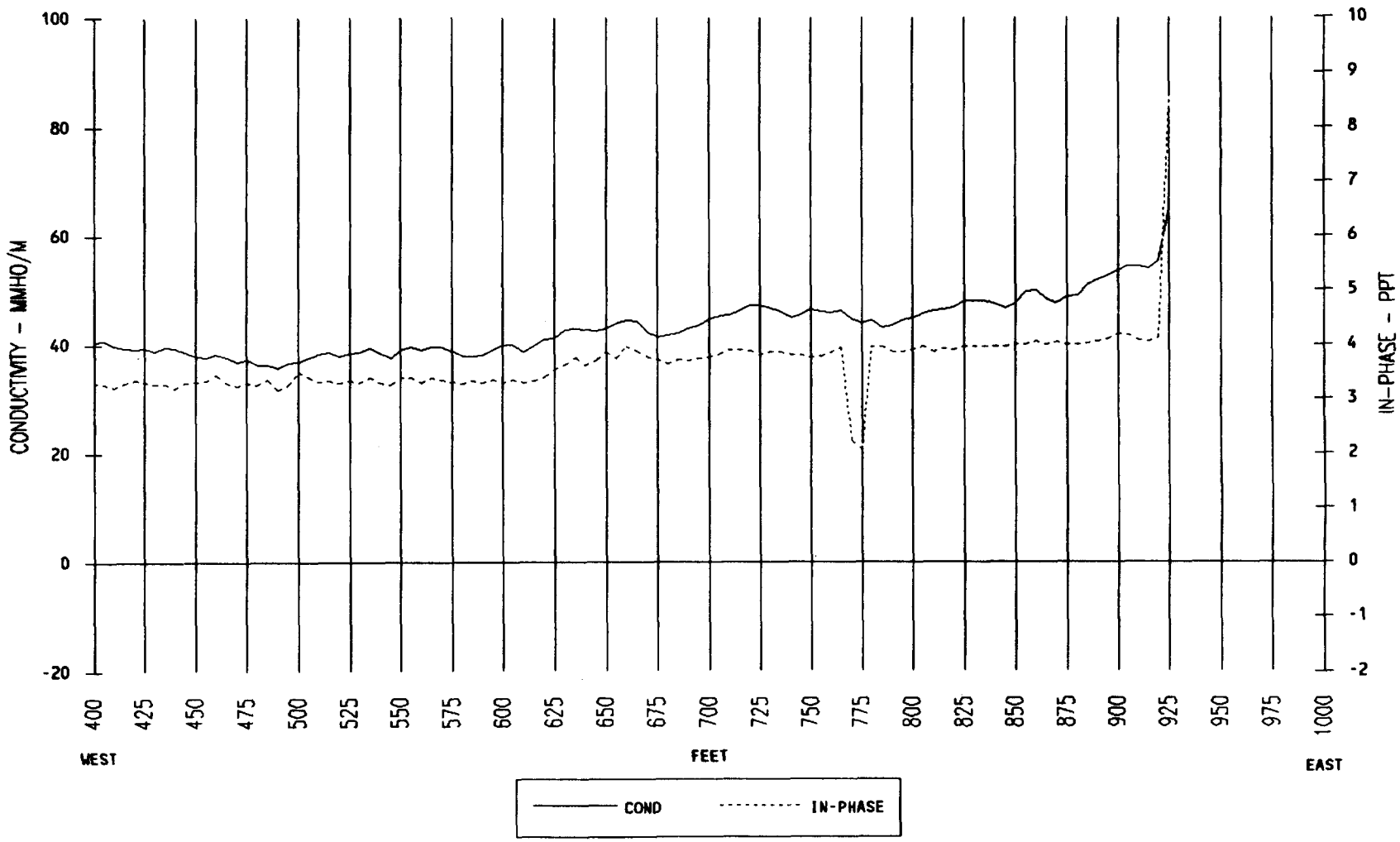

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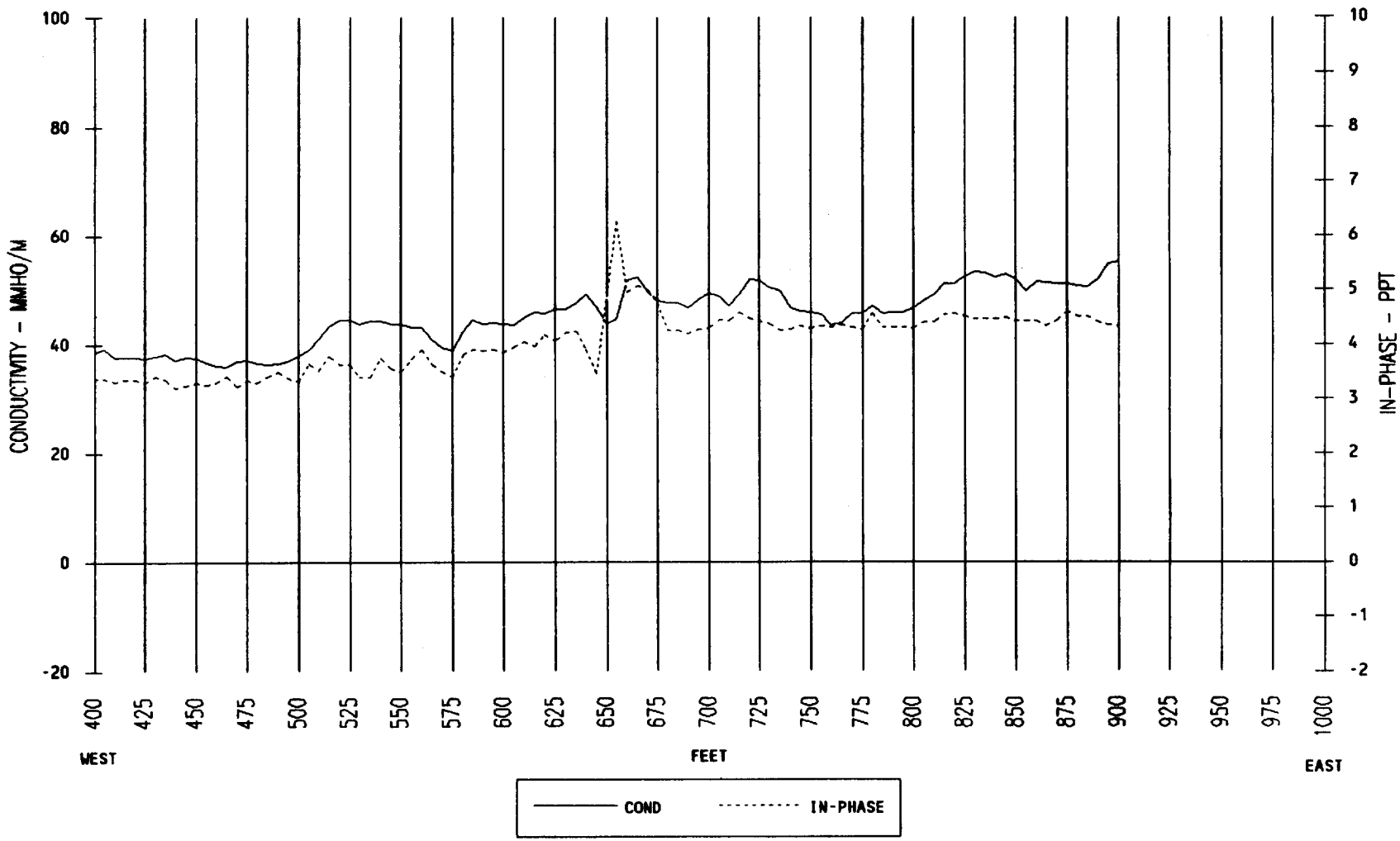

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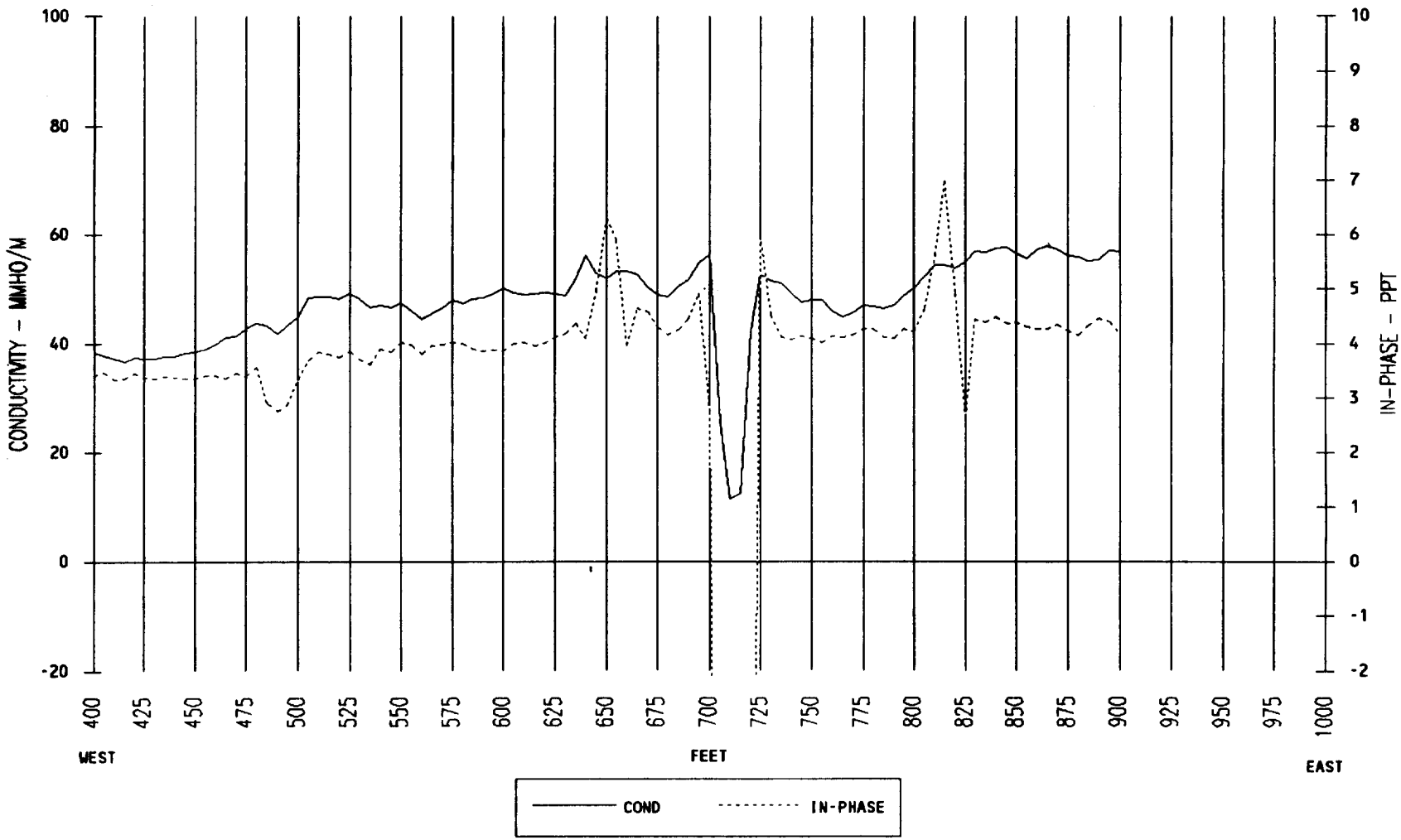

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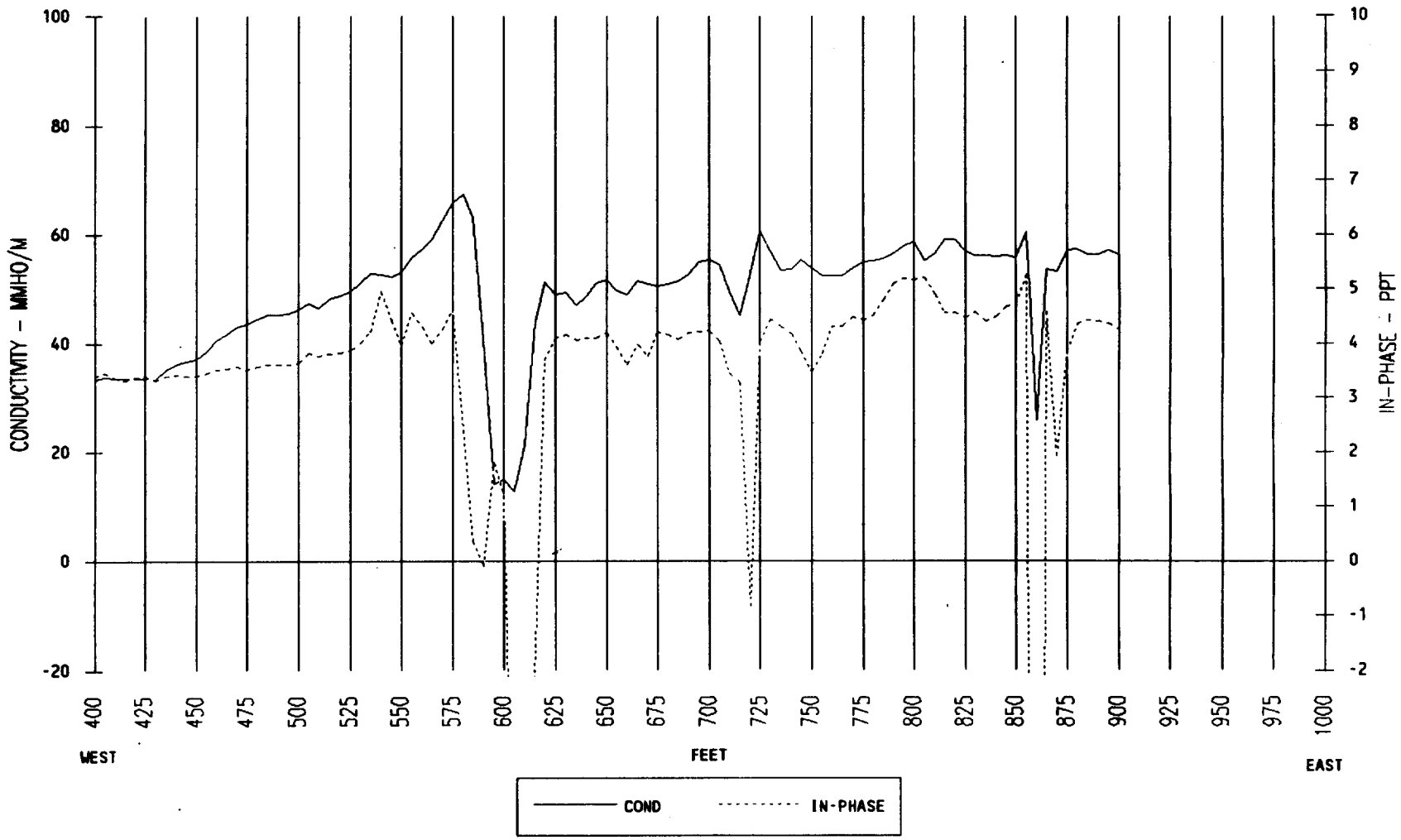

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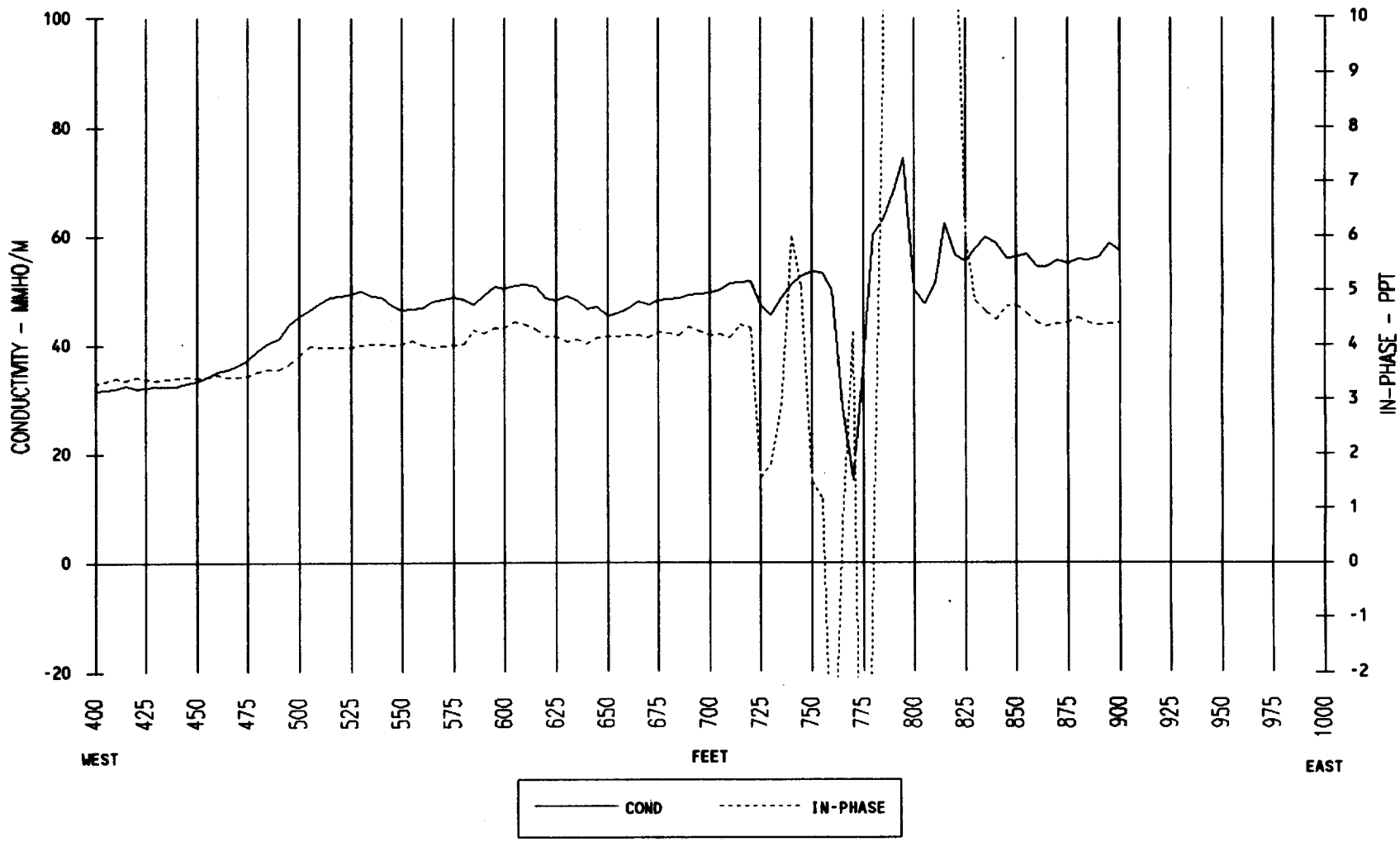

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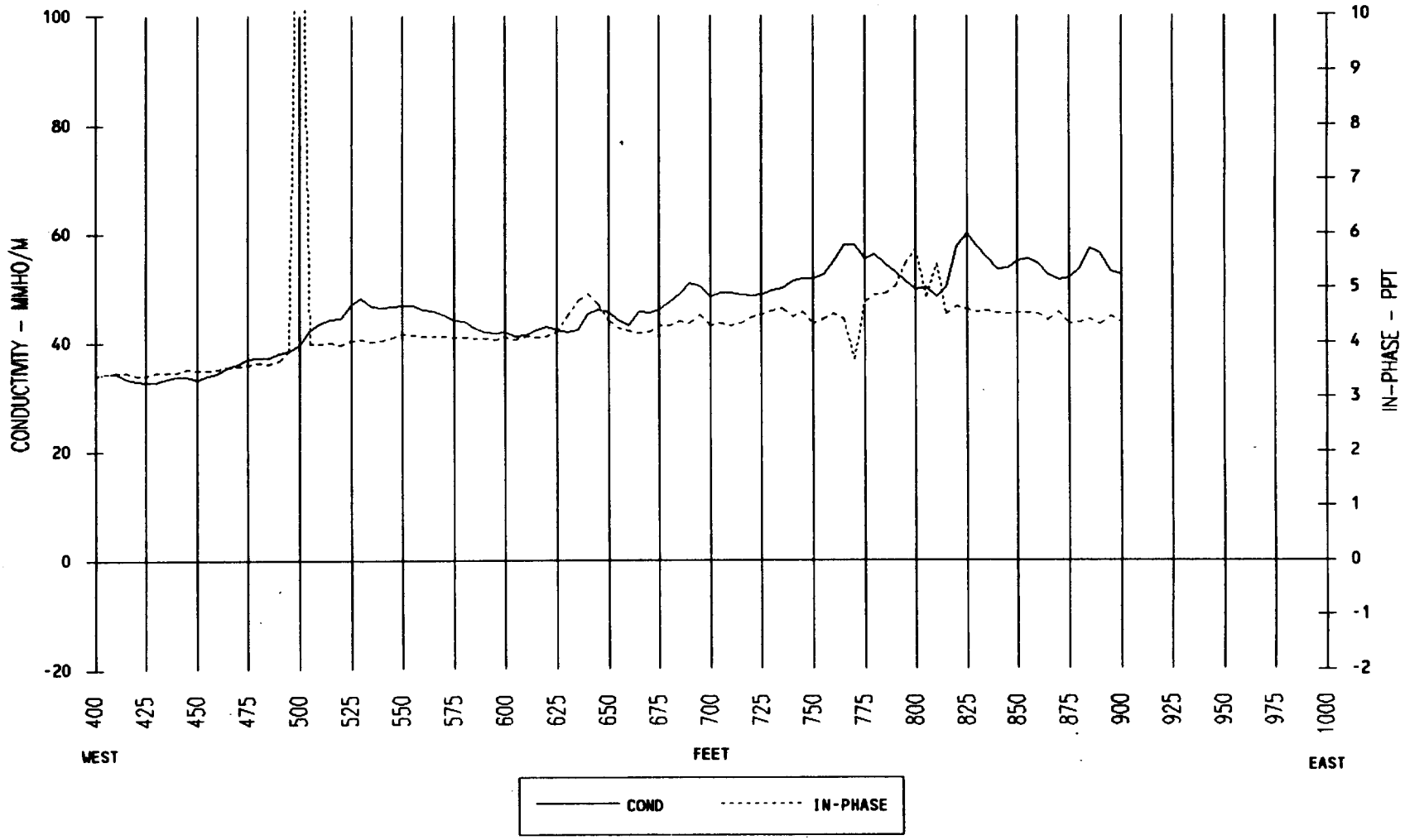

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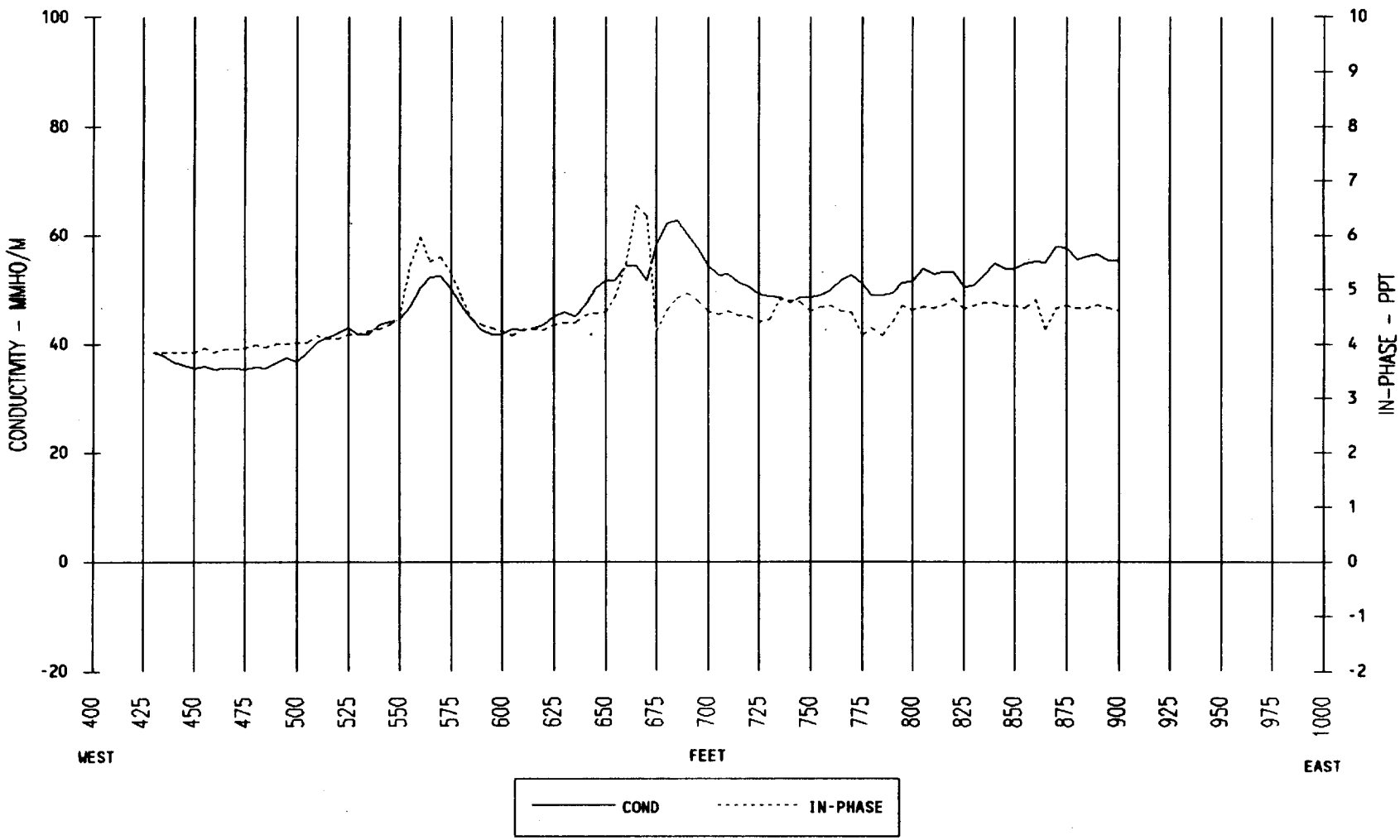

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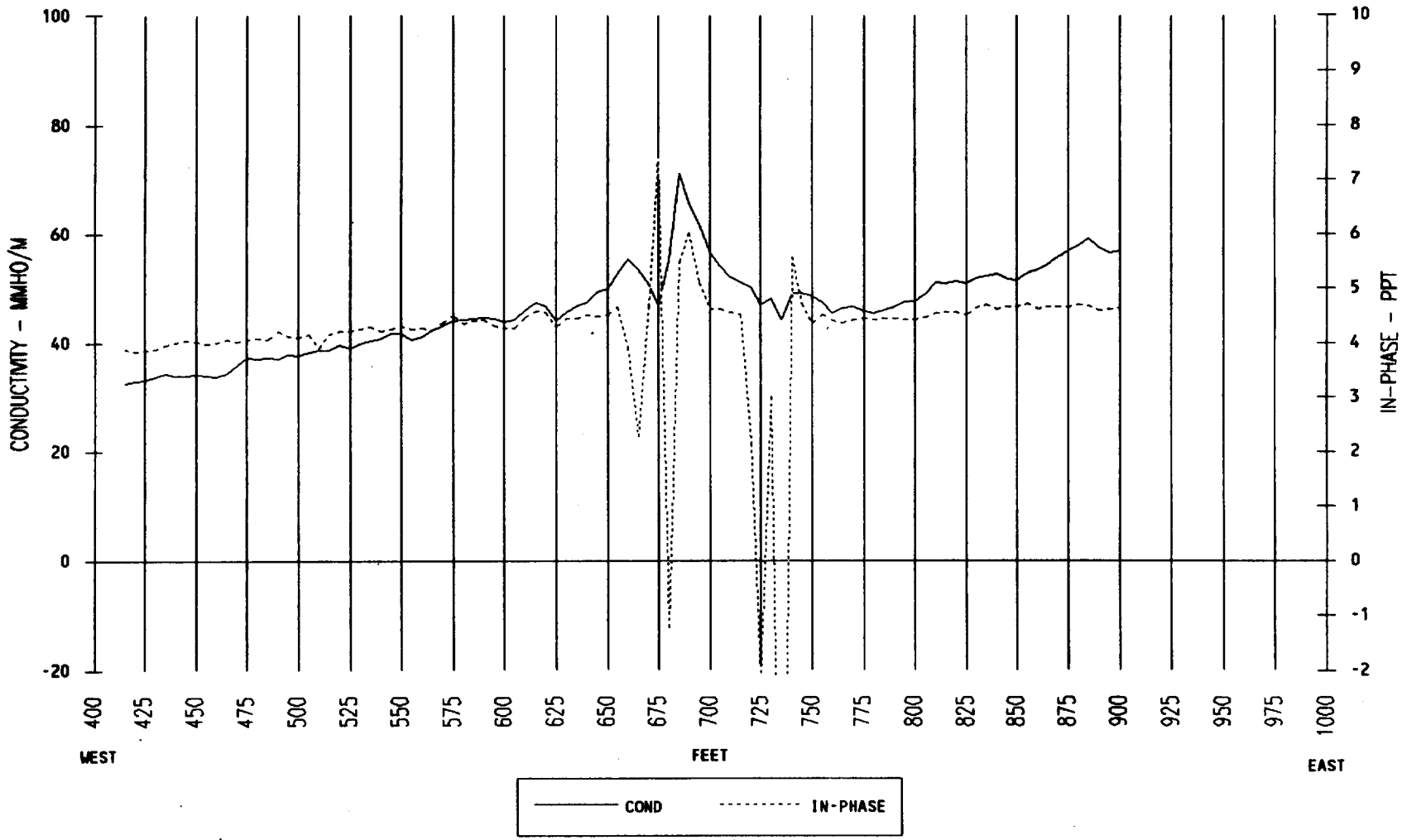

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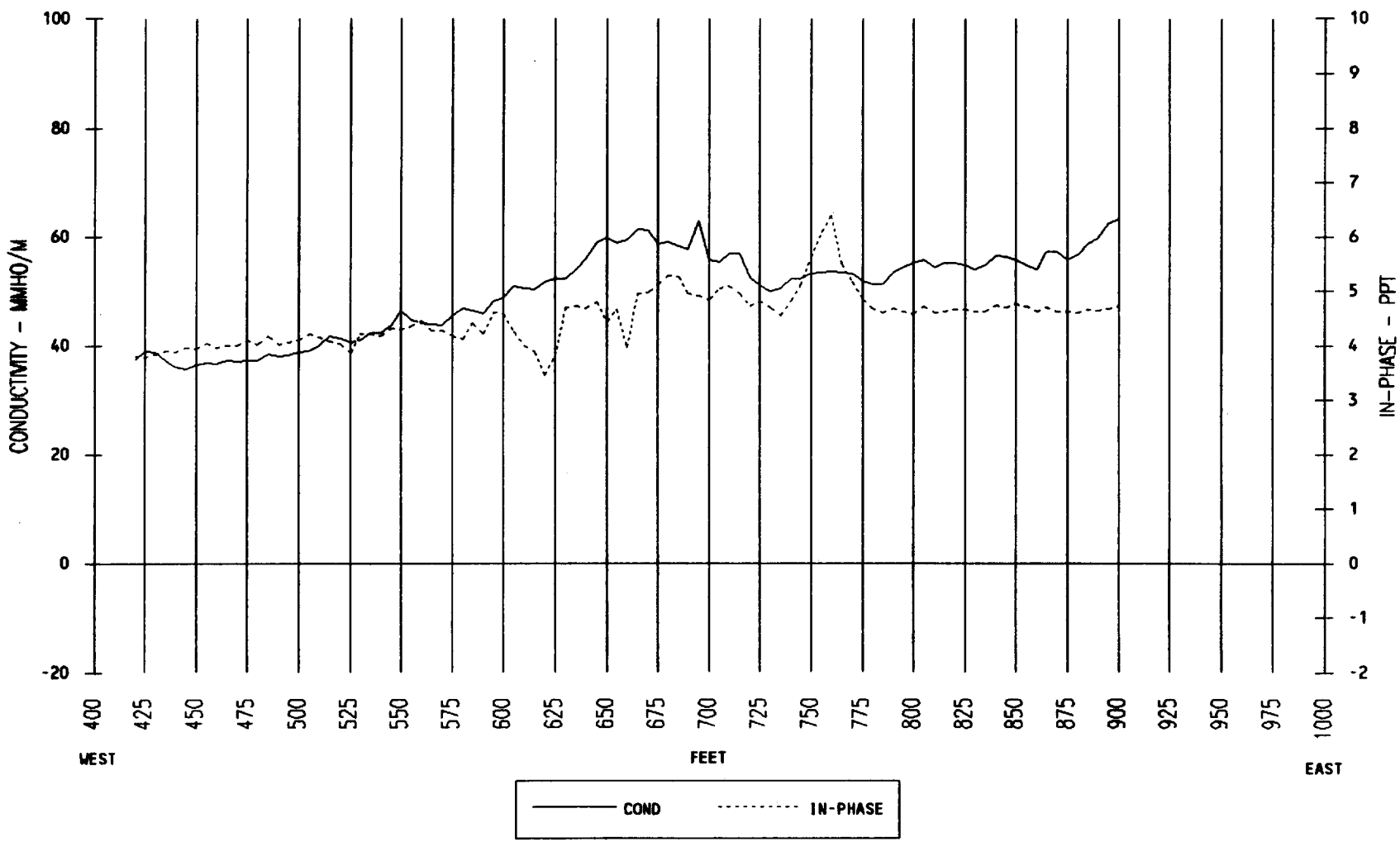

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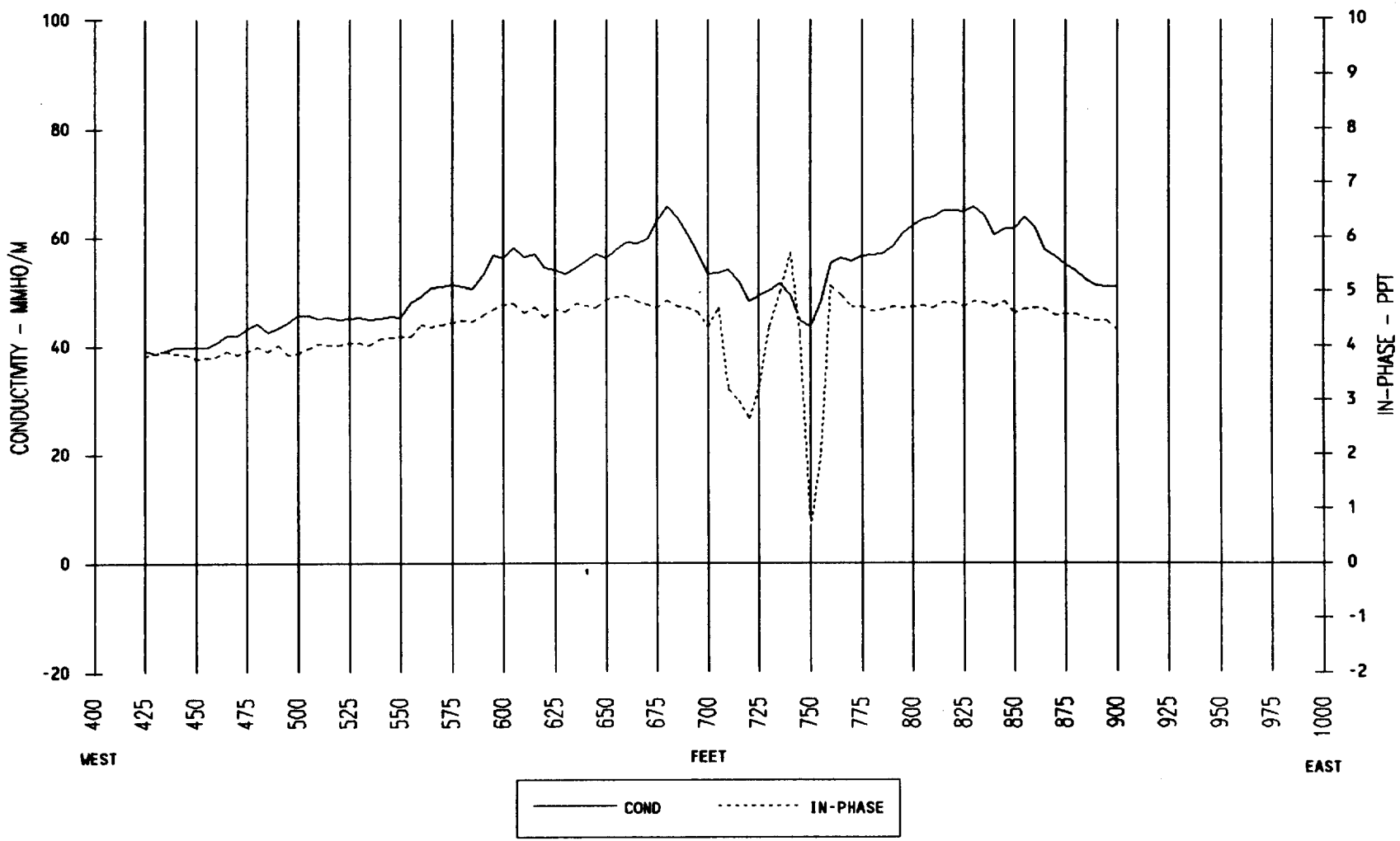

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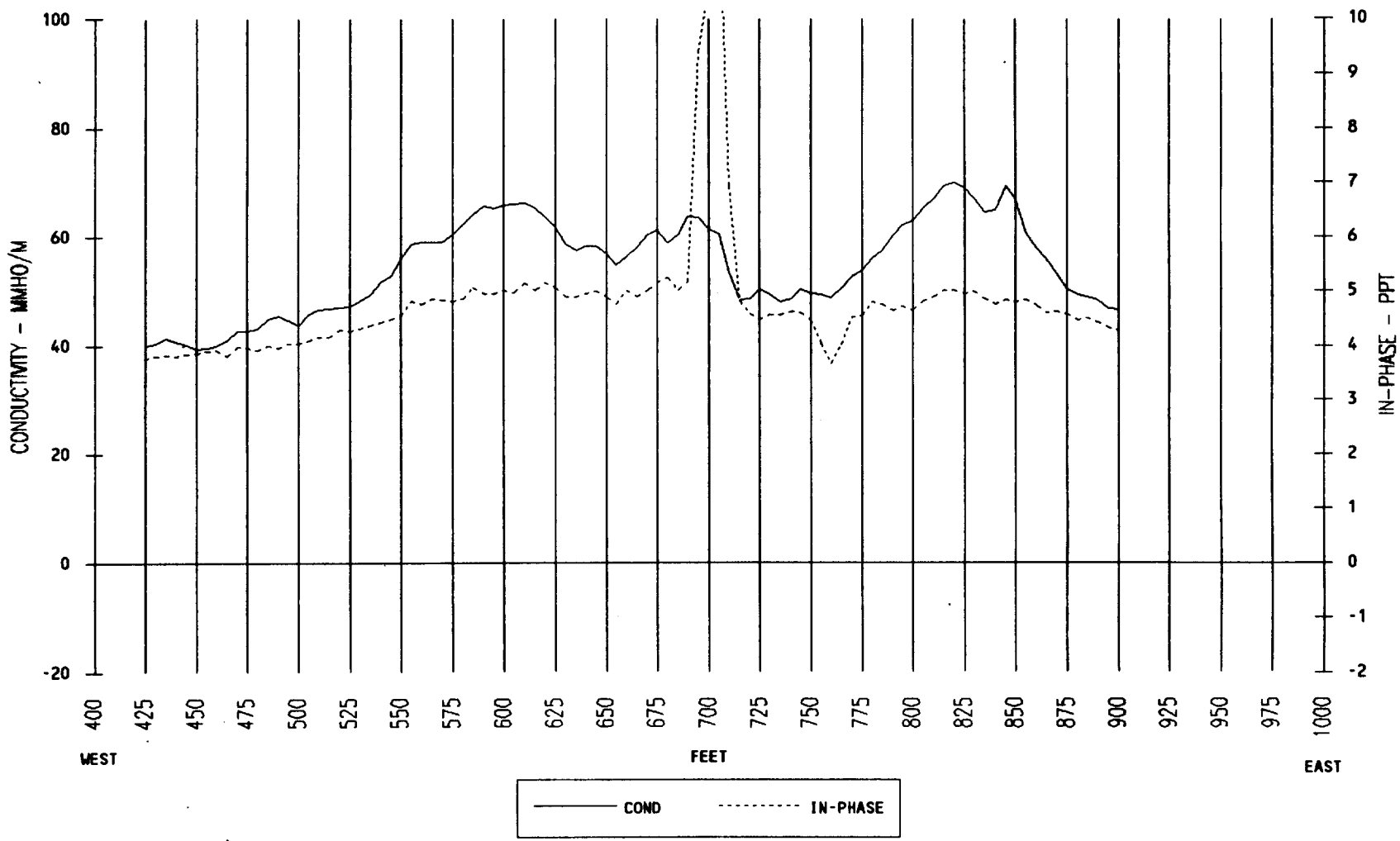

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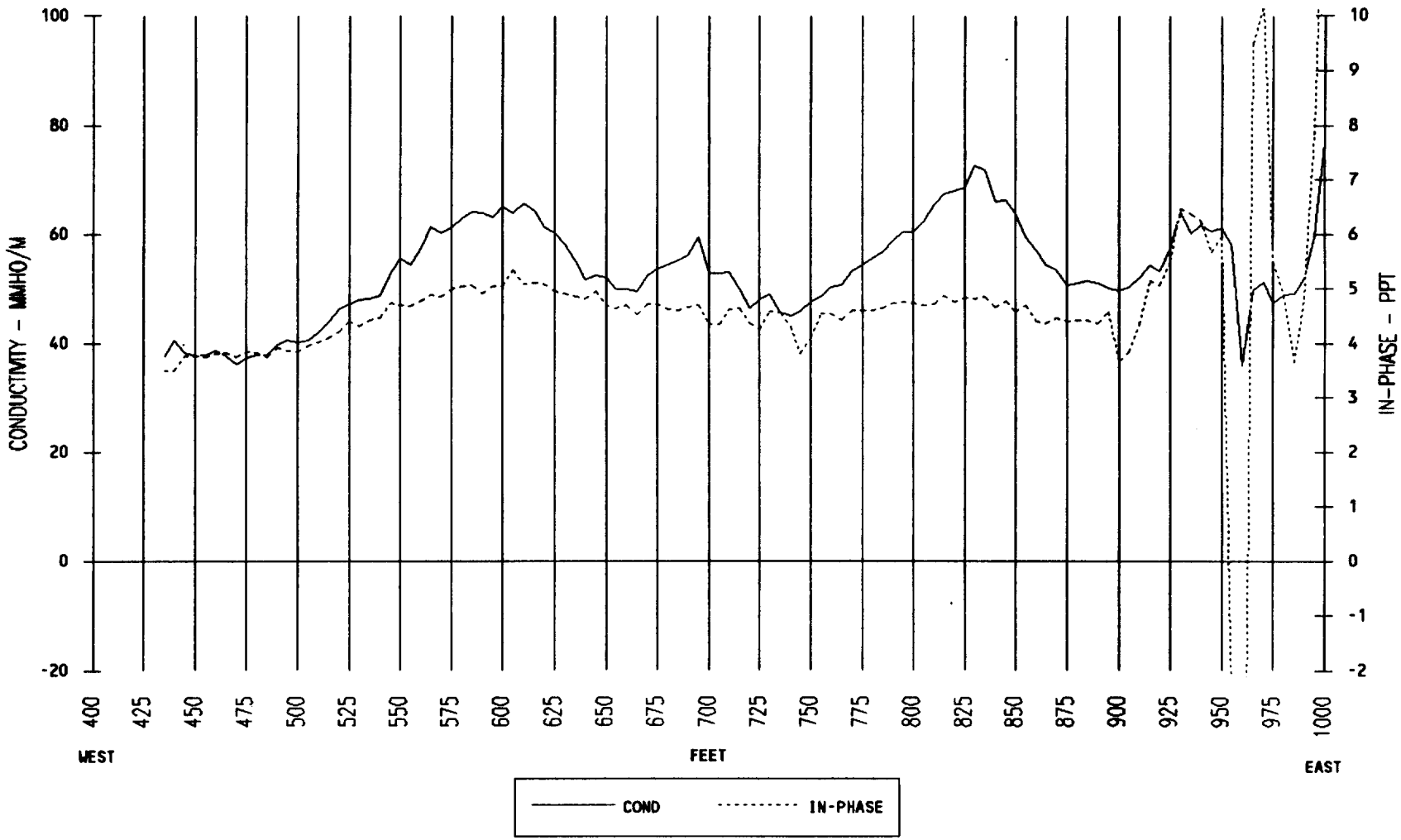

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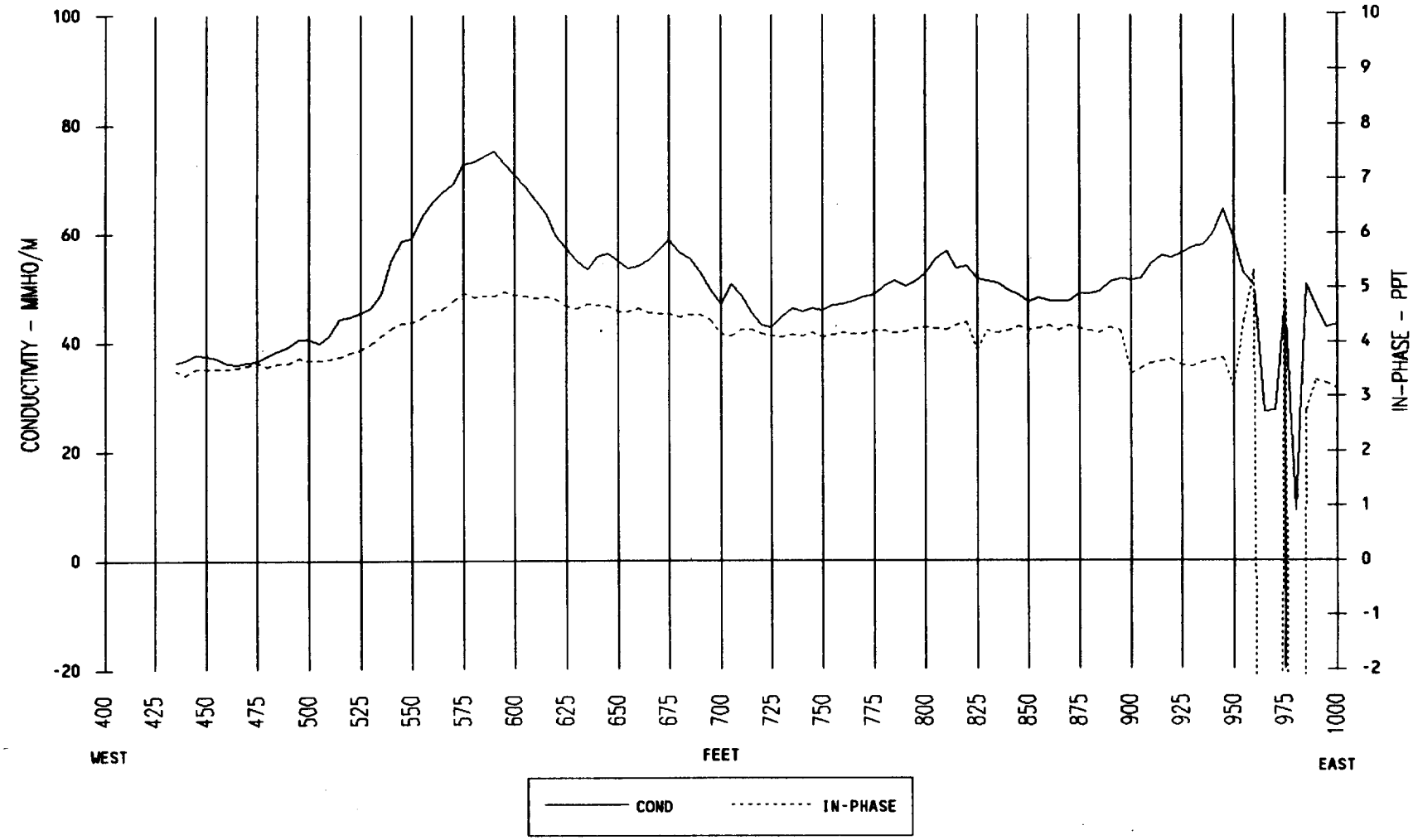

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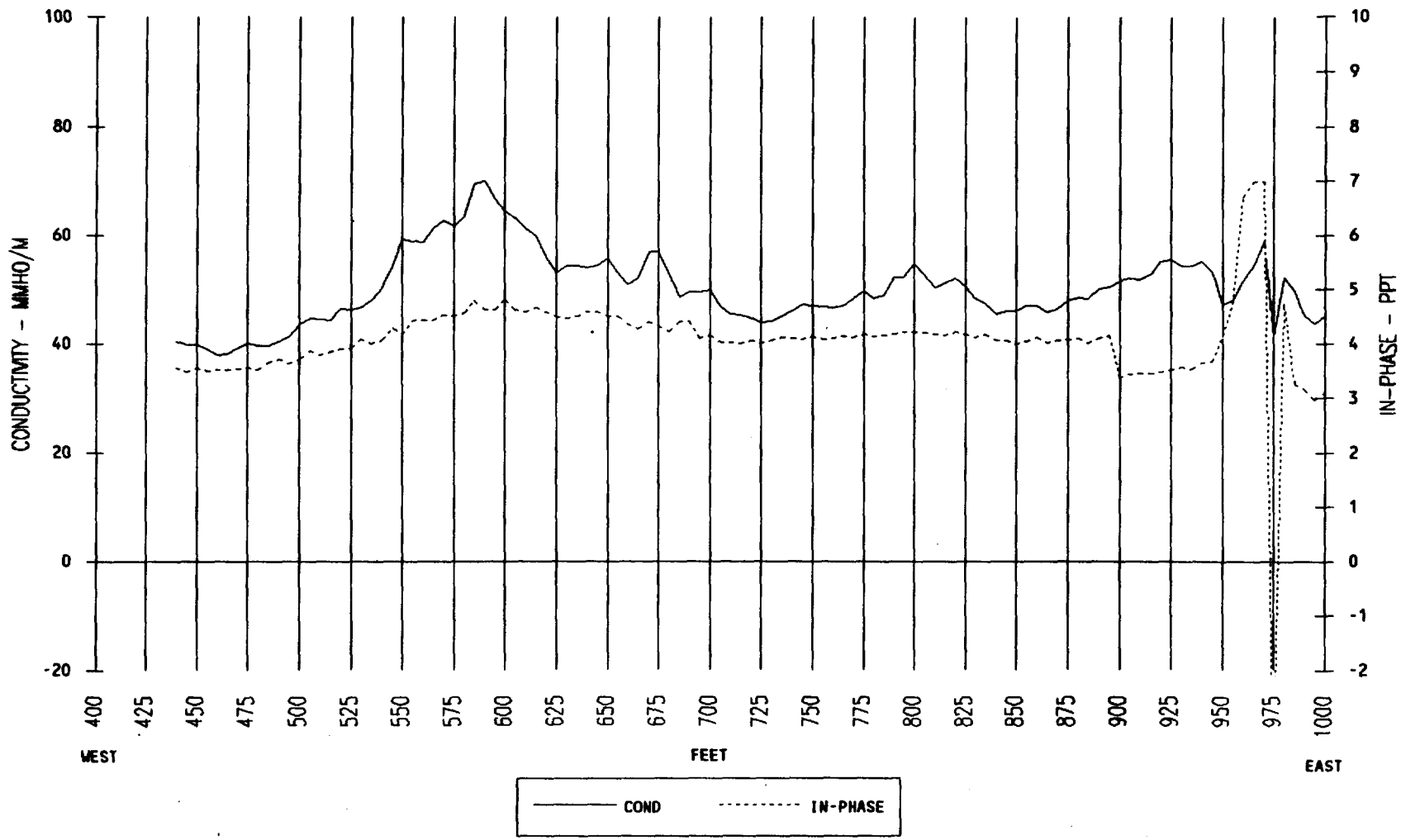

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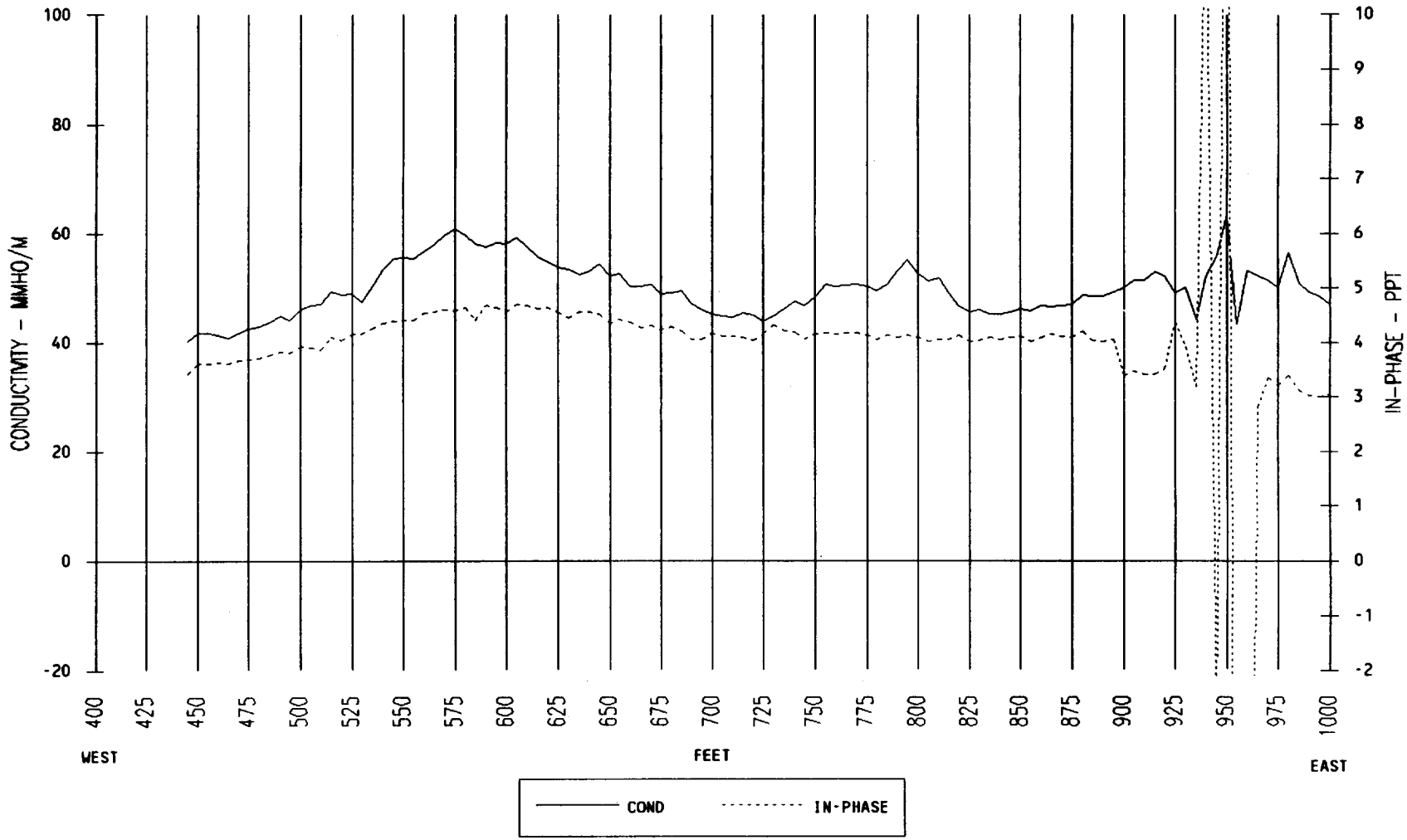

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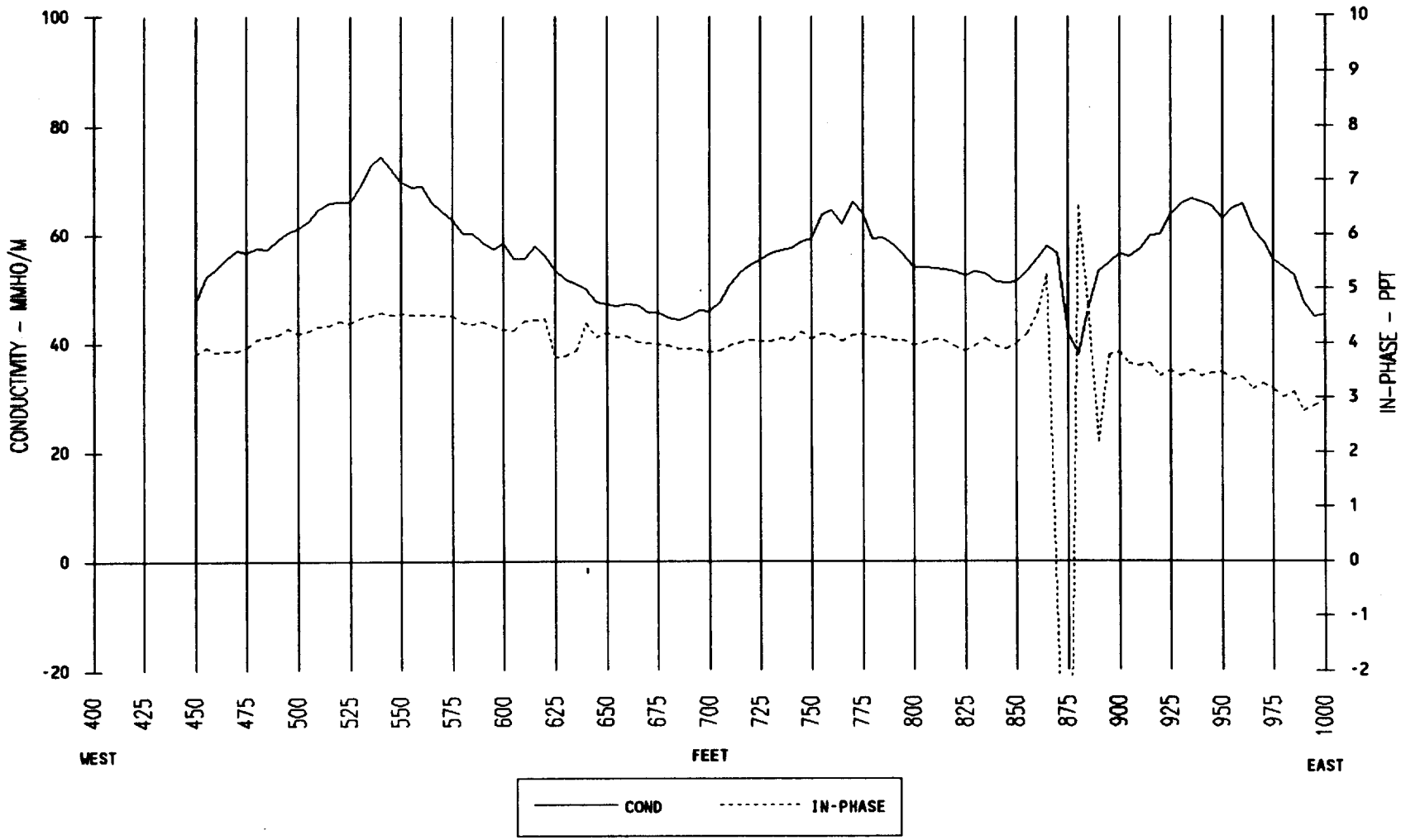
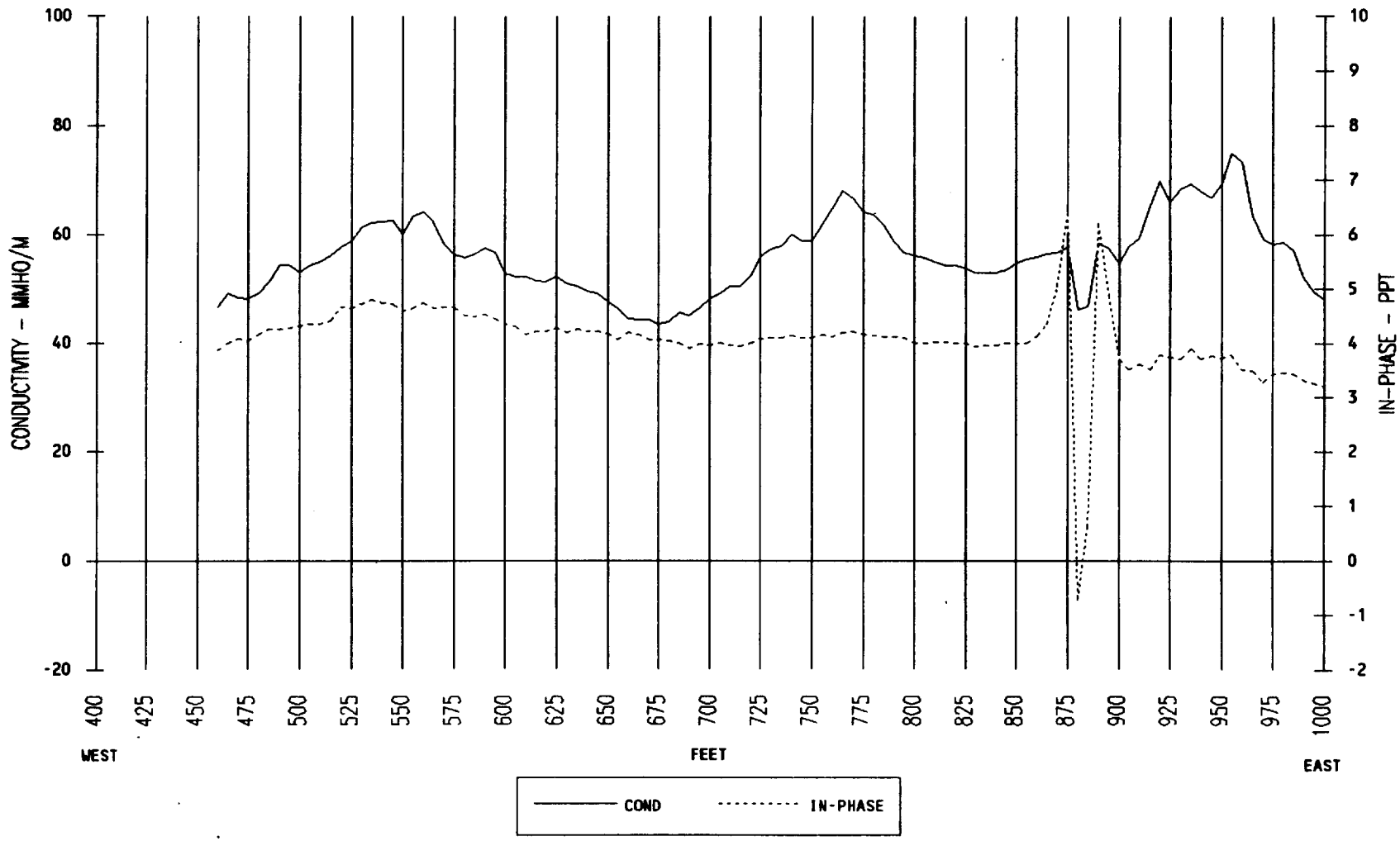
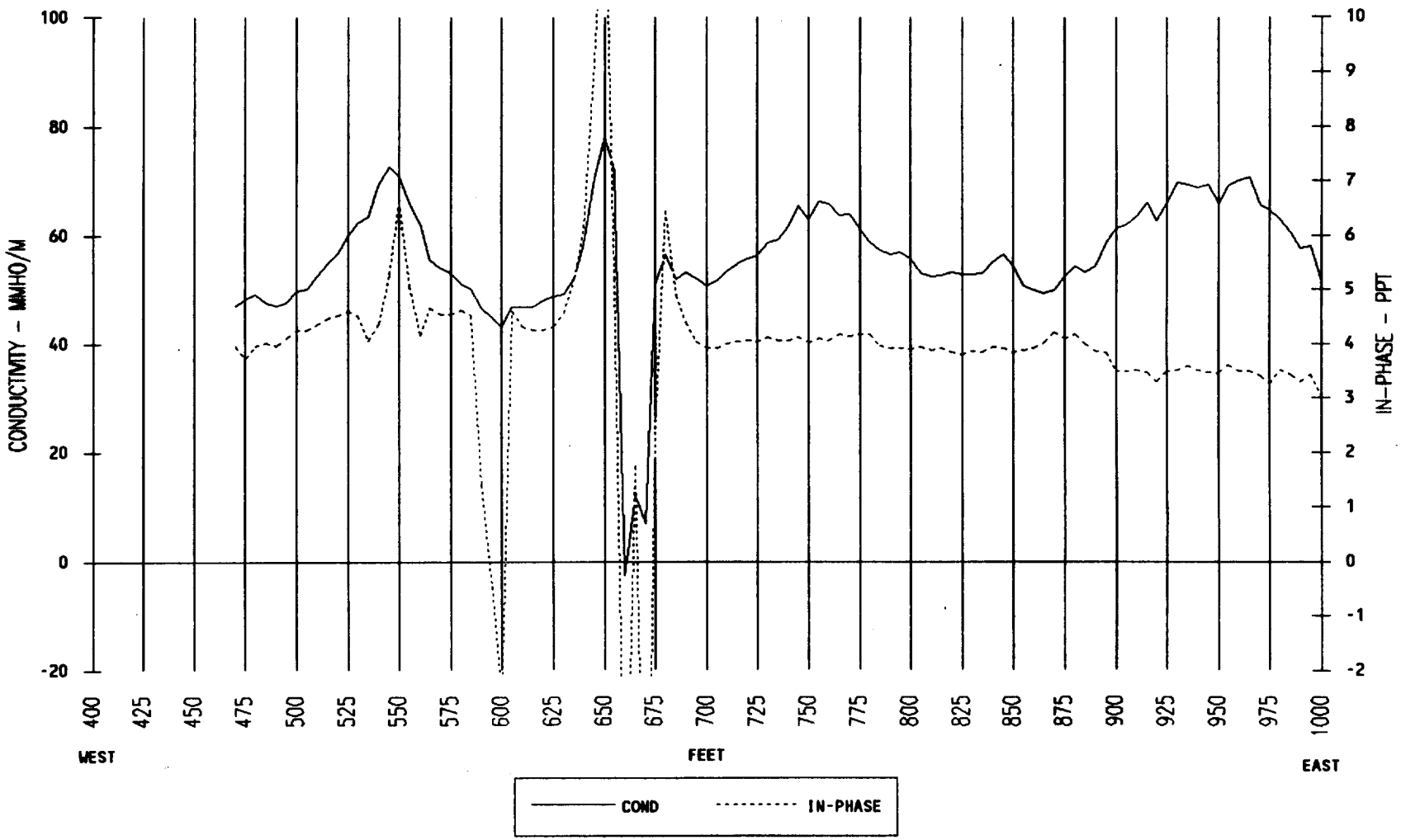


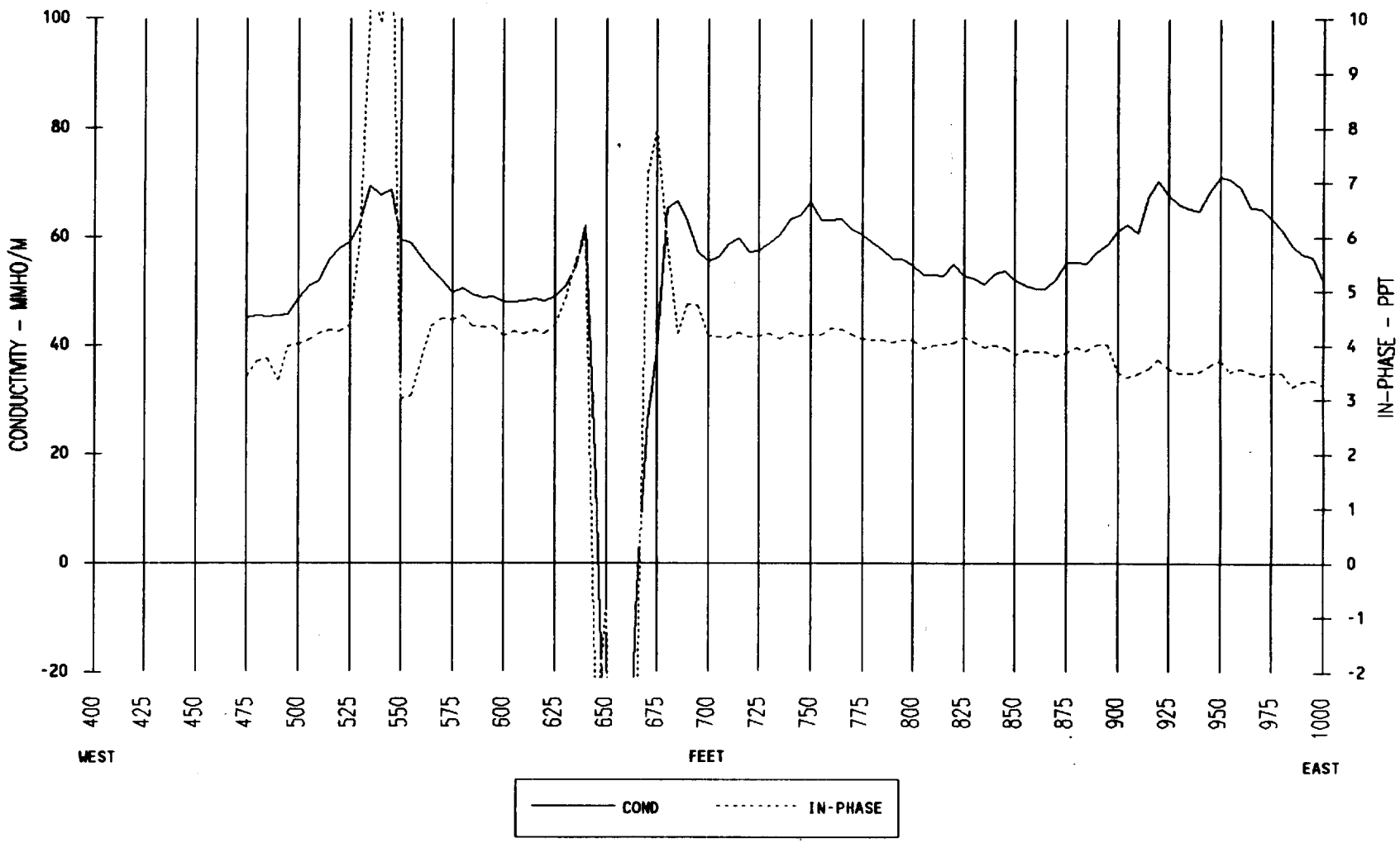
EOD RANGE - LINE 1480



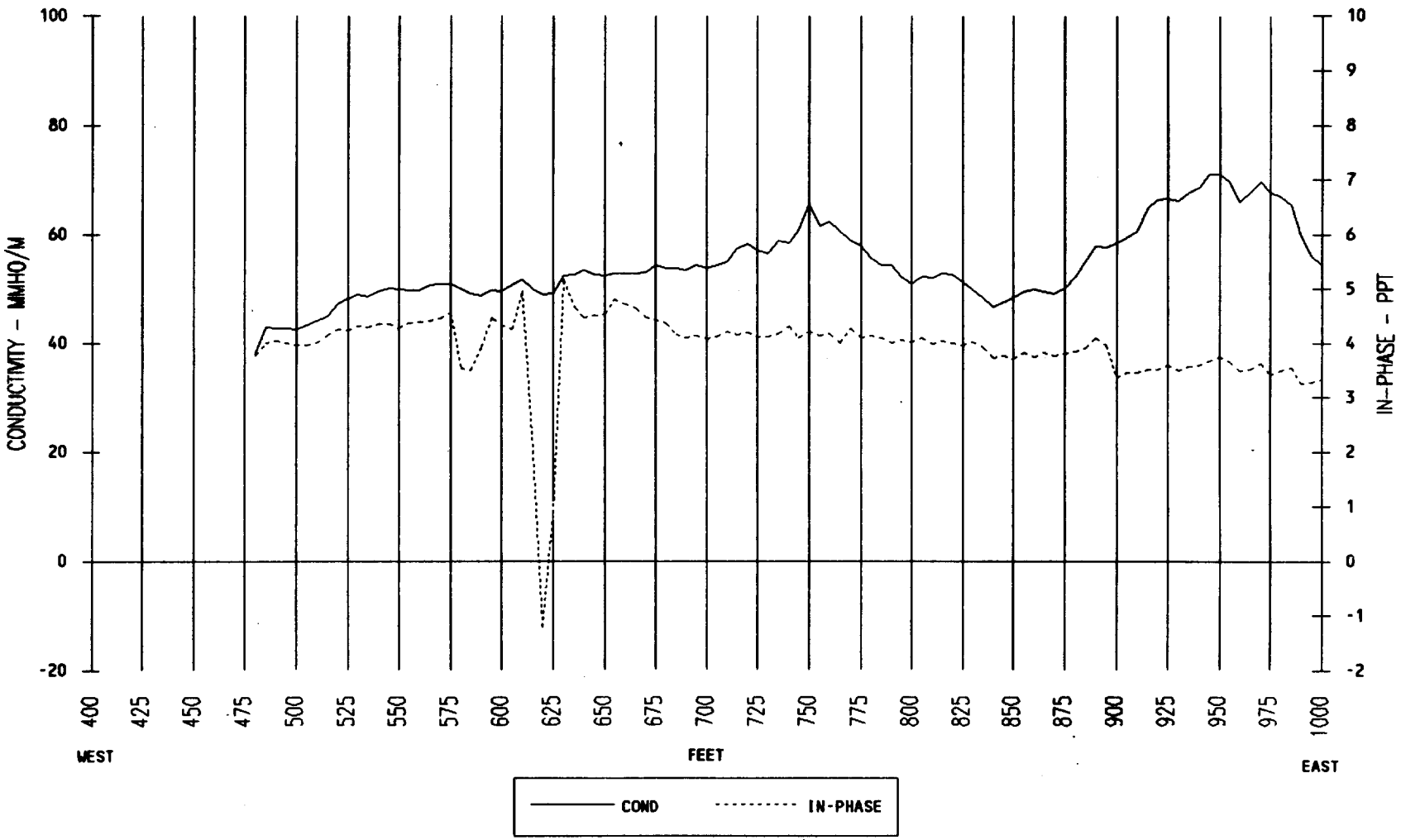
EOD RANGE - LINE 1500



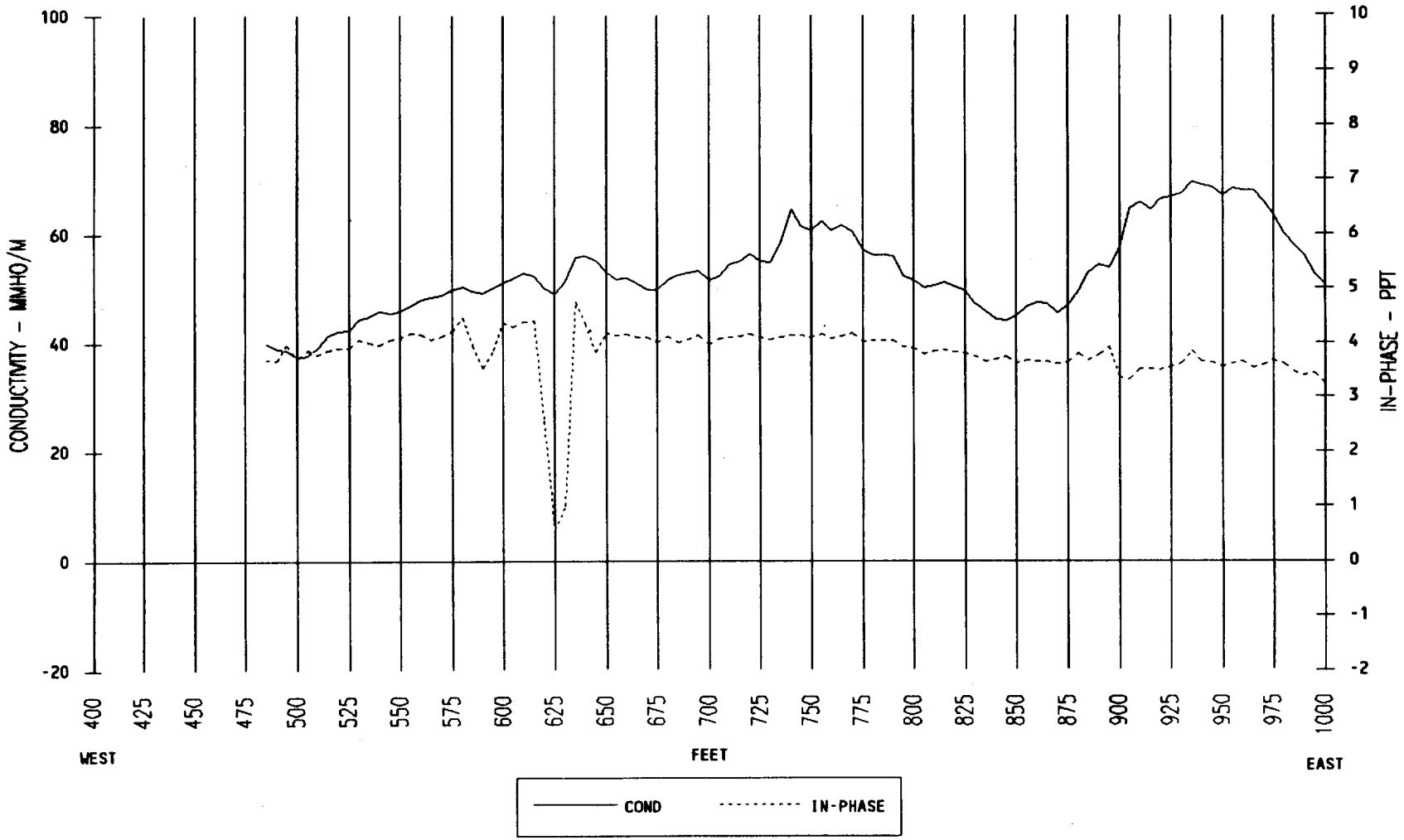
EOD RANGE - LINE 1520



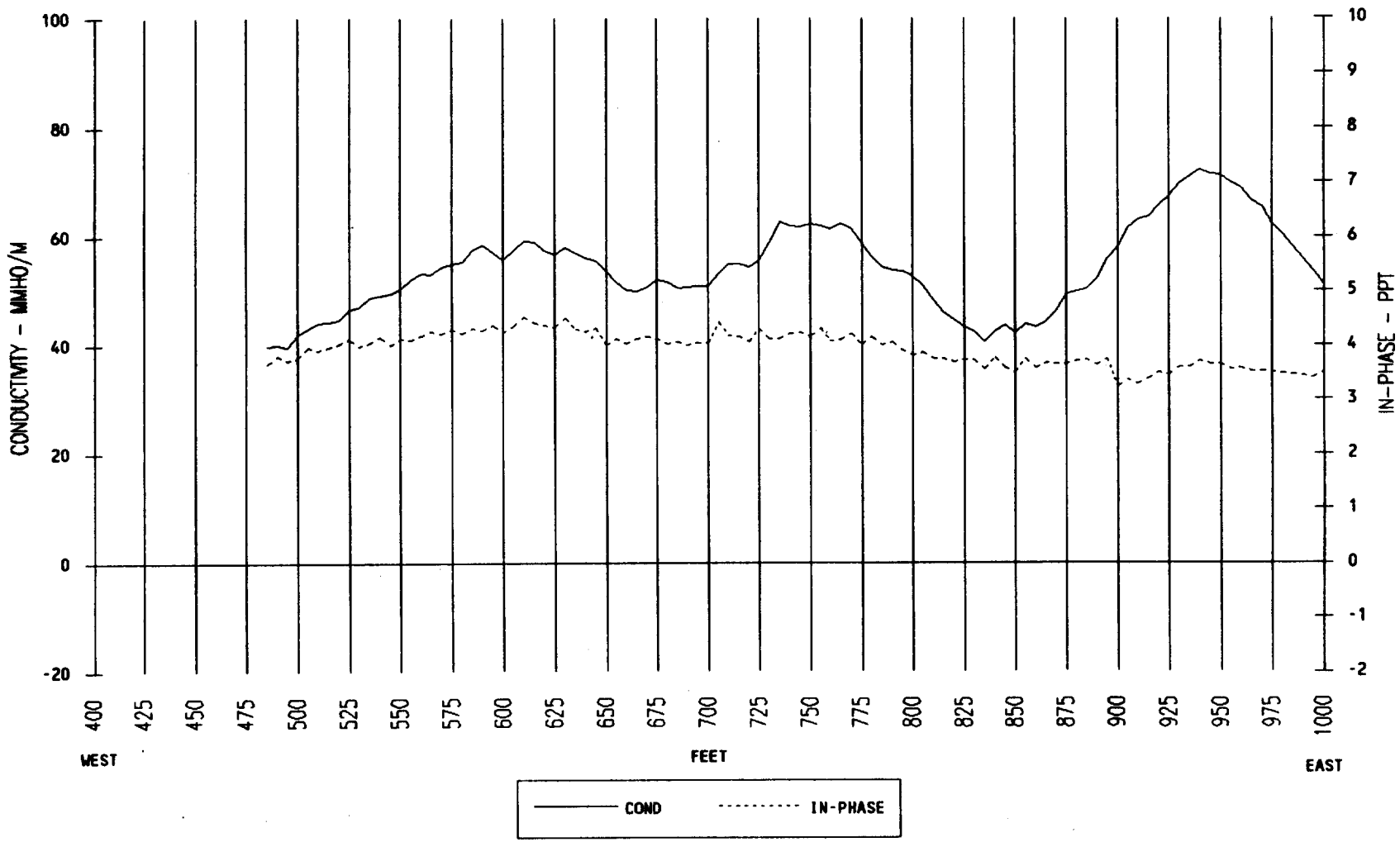
EOD RANGE - LINE 1540



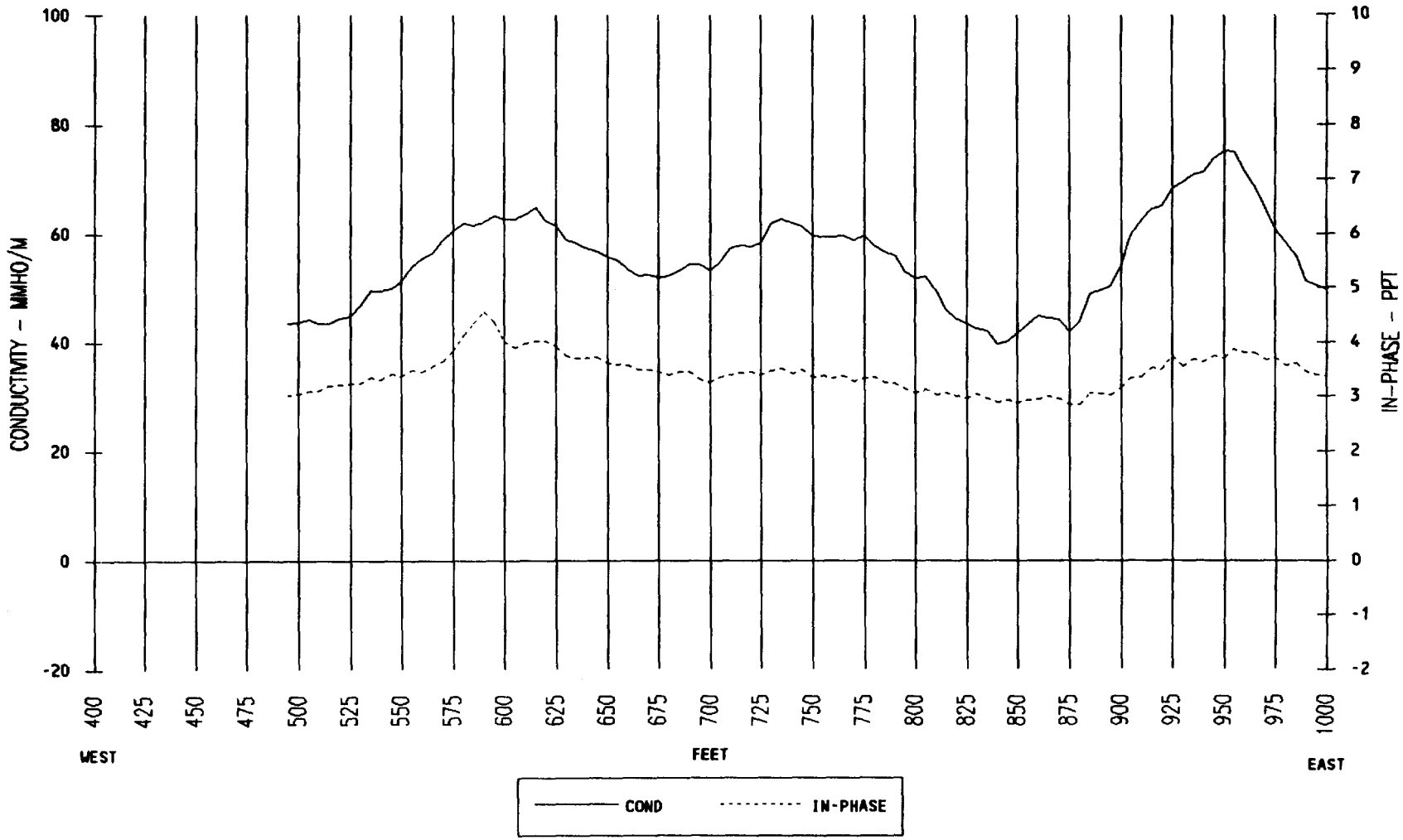
EOD RANGE - LINE 1560



EOD RANGE - LINE 1580



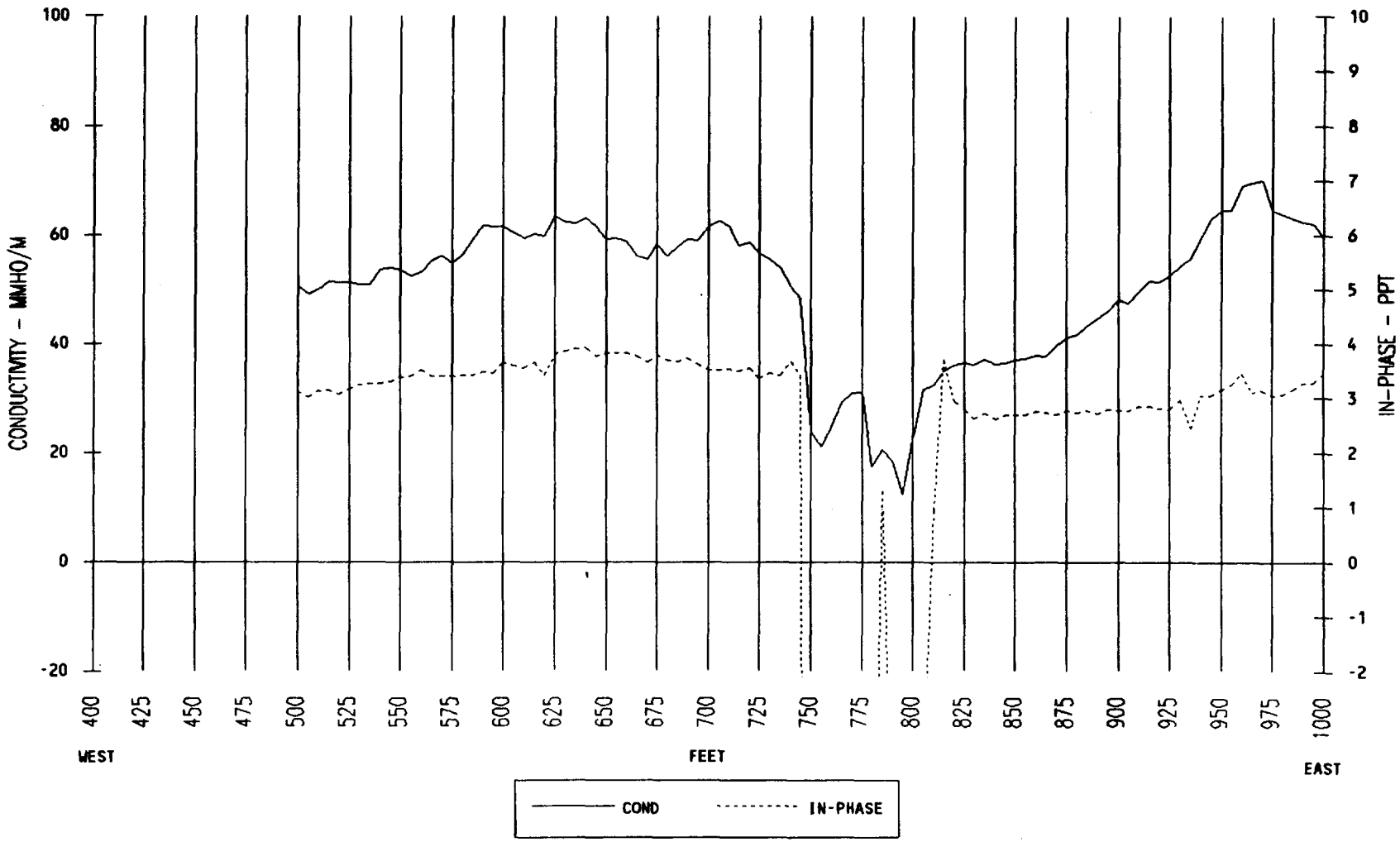
EOD RANGE - LINE 1600



EOD RANGE - LINE 1620

EOD RANGE - LINE 1640

EOD RANGE - LINE 1660

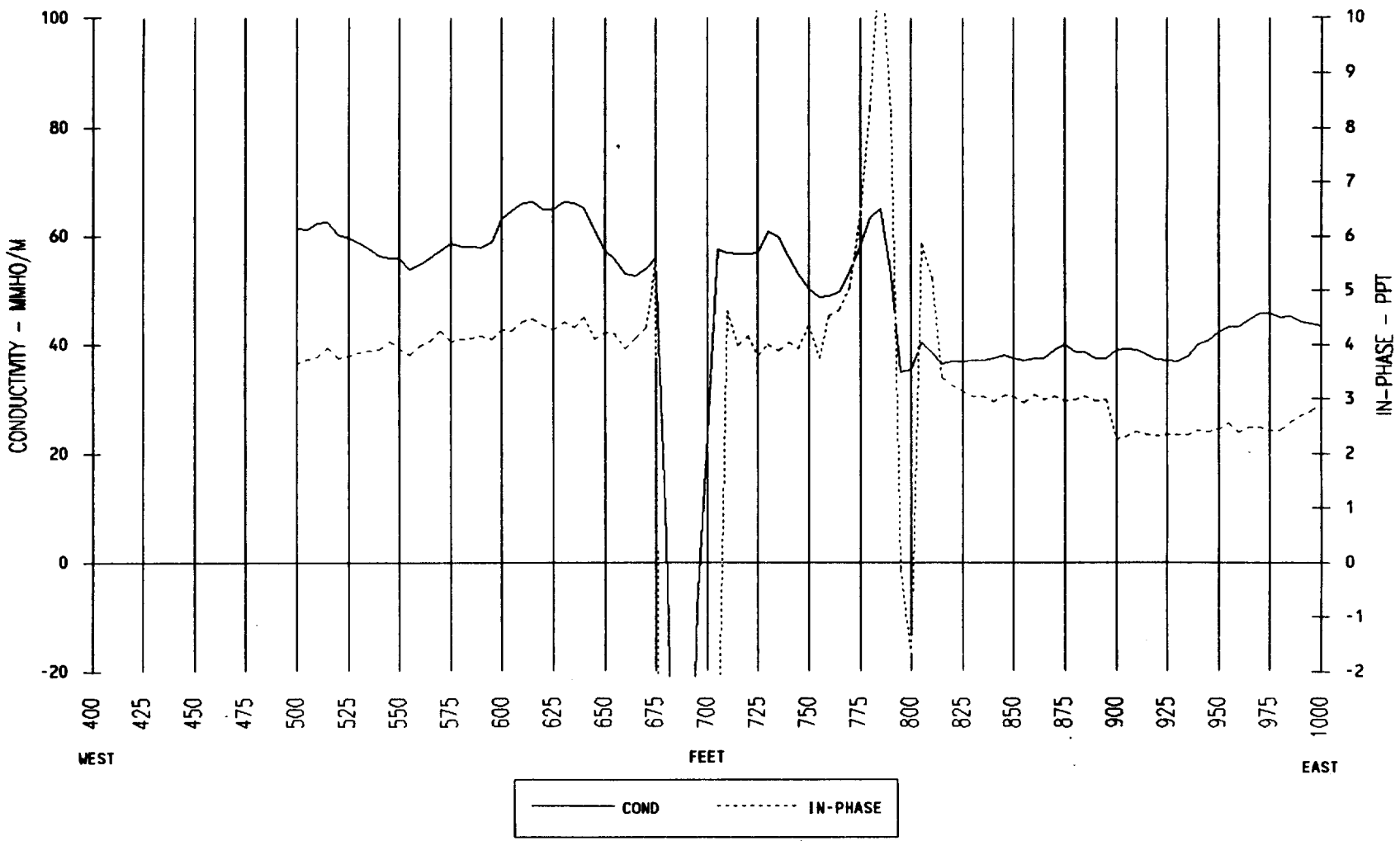


EOD RANGE - LINE 1680

EOD RANGE - LINE 1700

EOD RANGE - LINE 1720

EOD RANGE - LINE 1740



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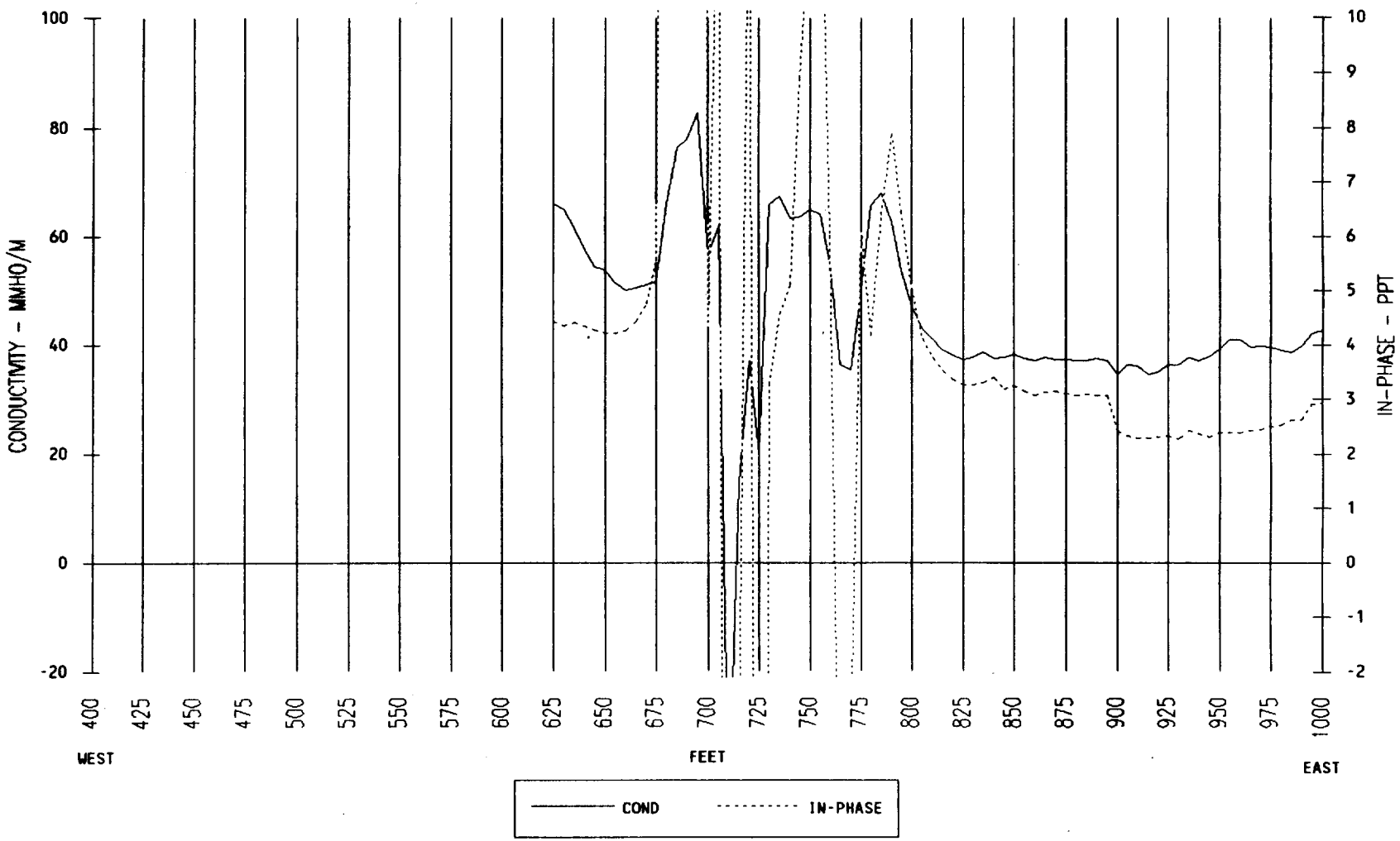

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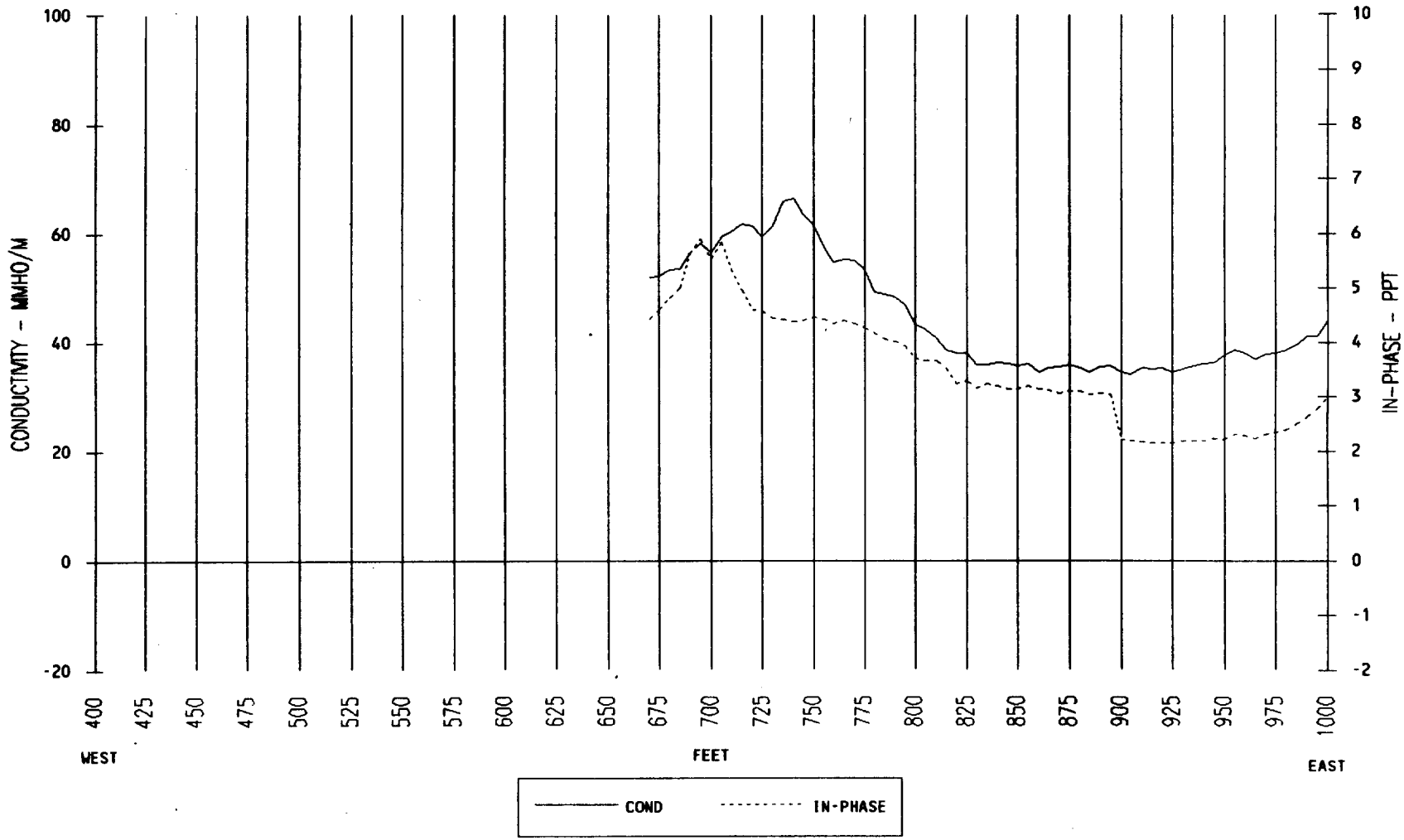
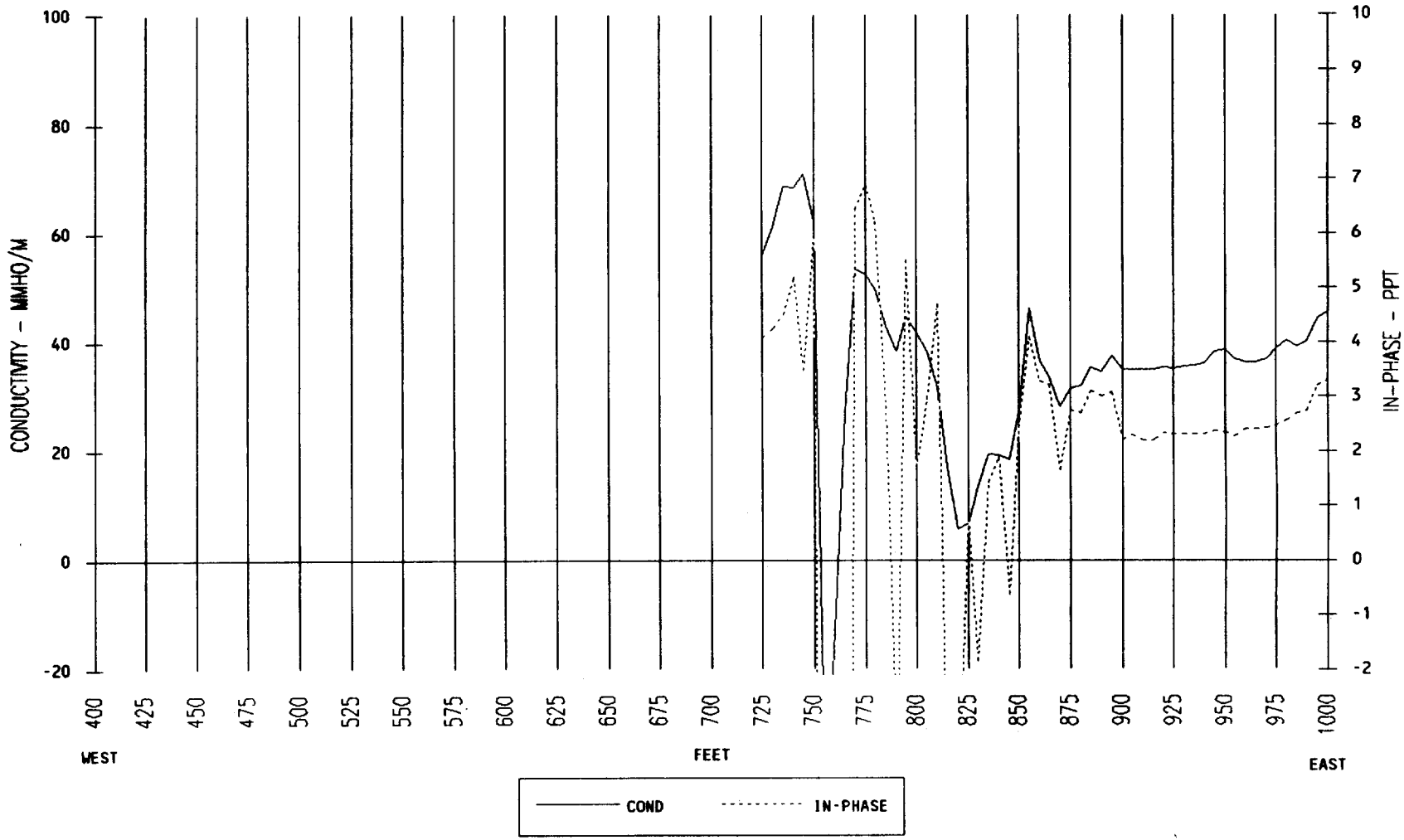
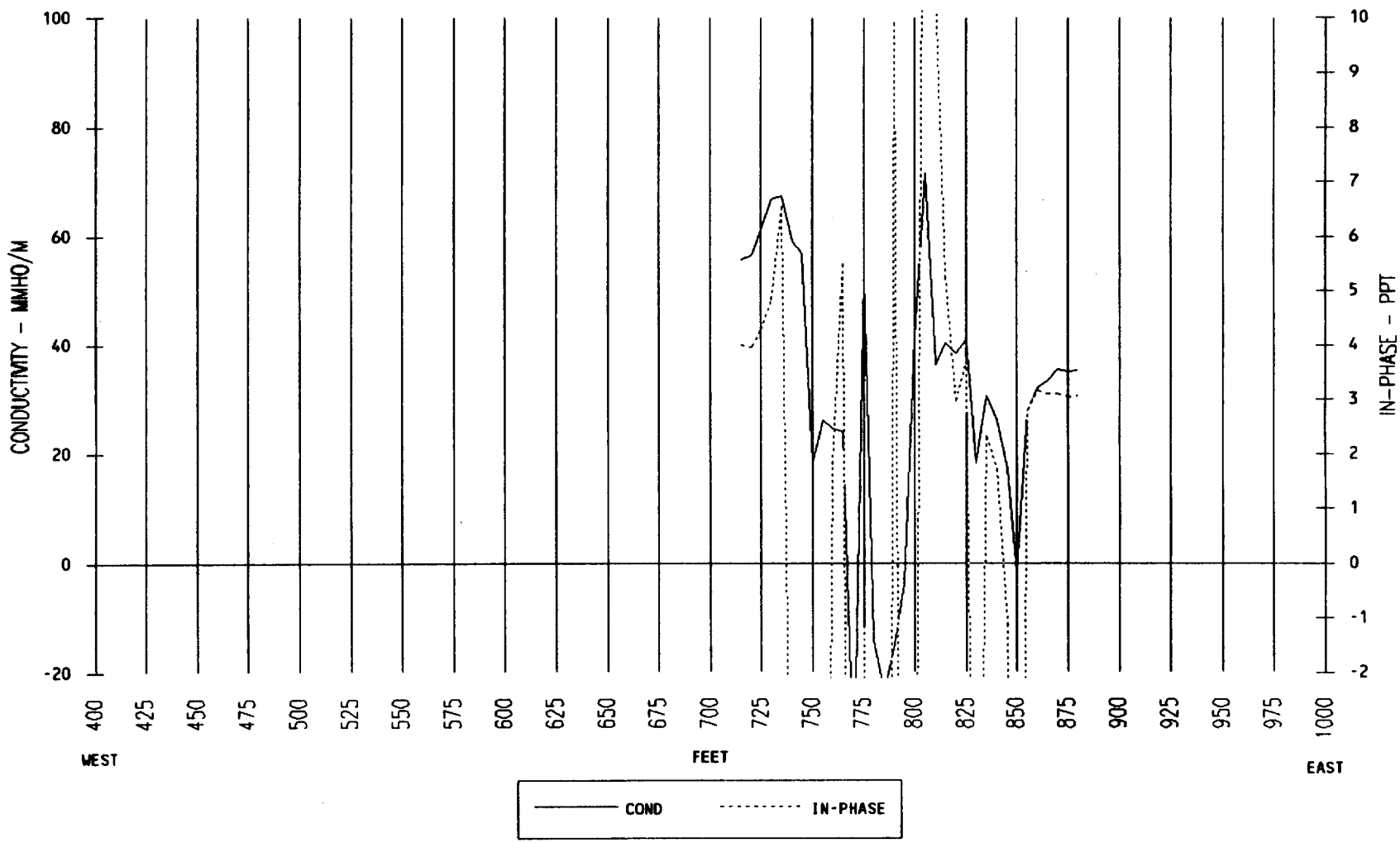


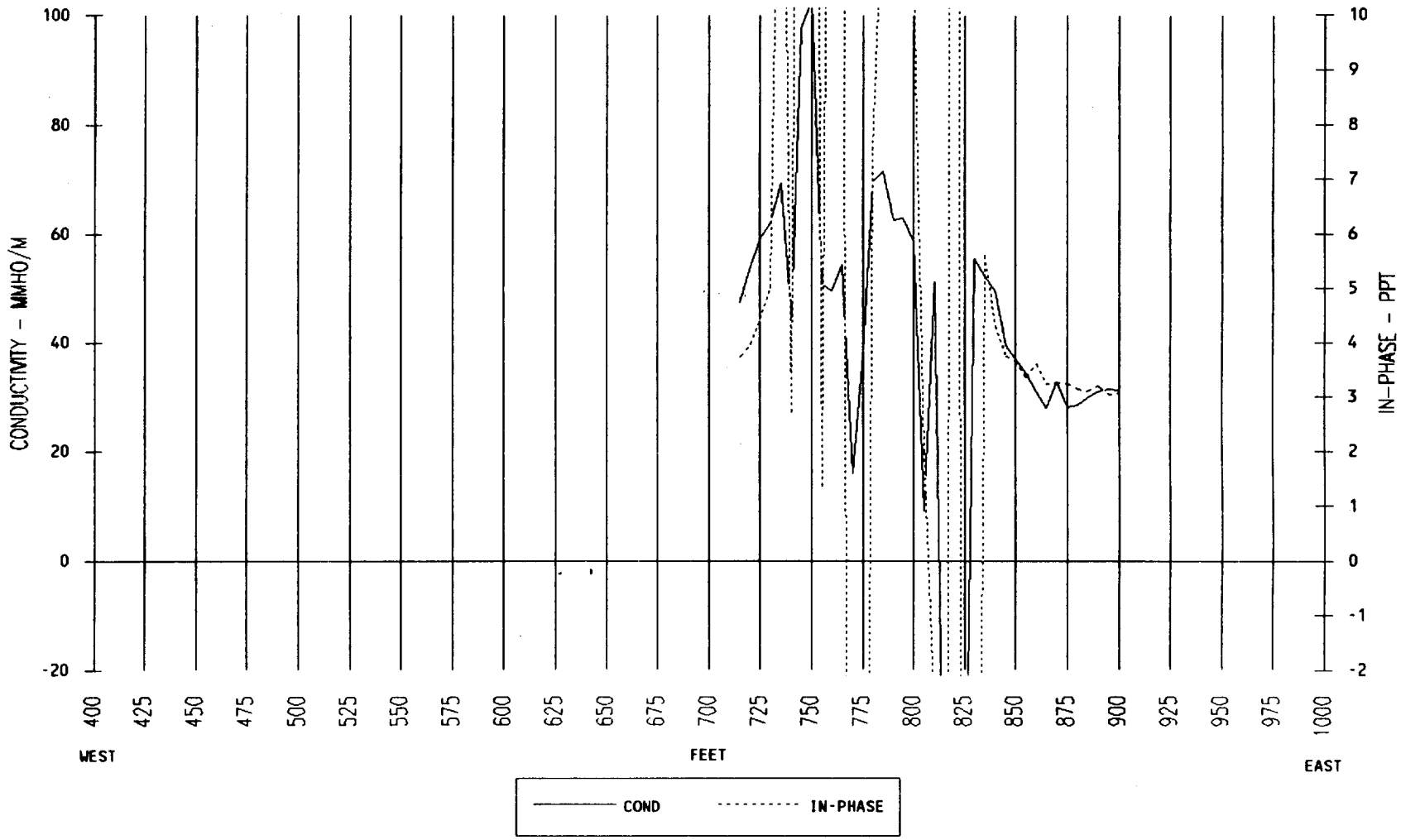
EOD RANGE - LINE 1800



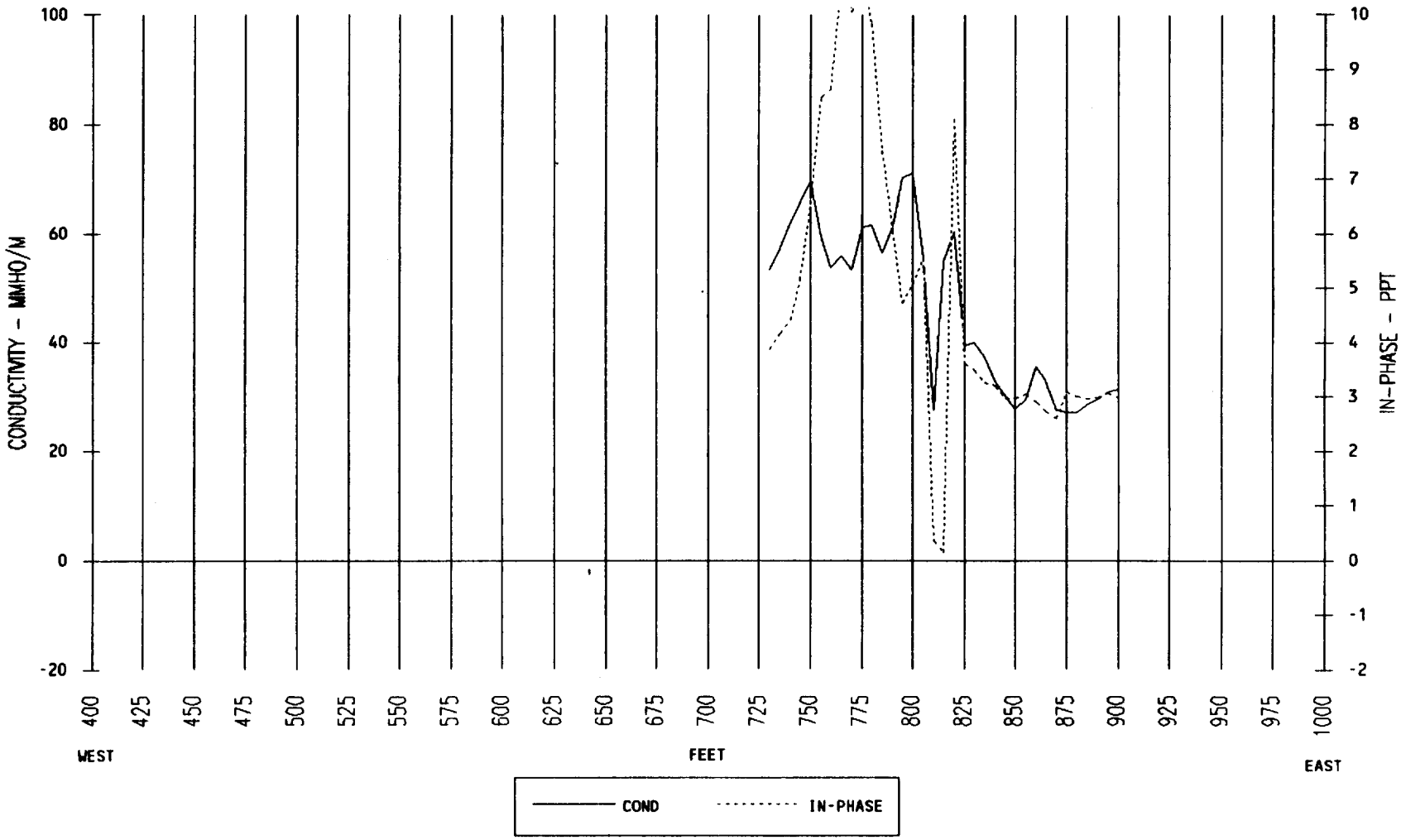
EOD RANGE - LINE 1820



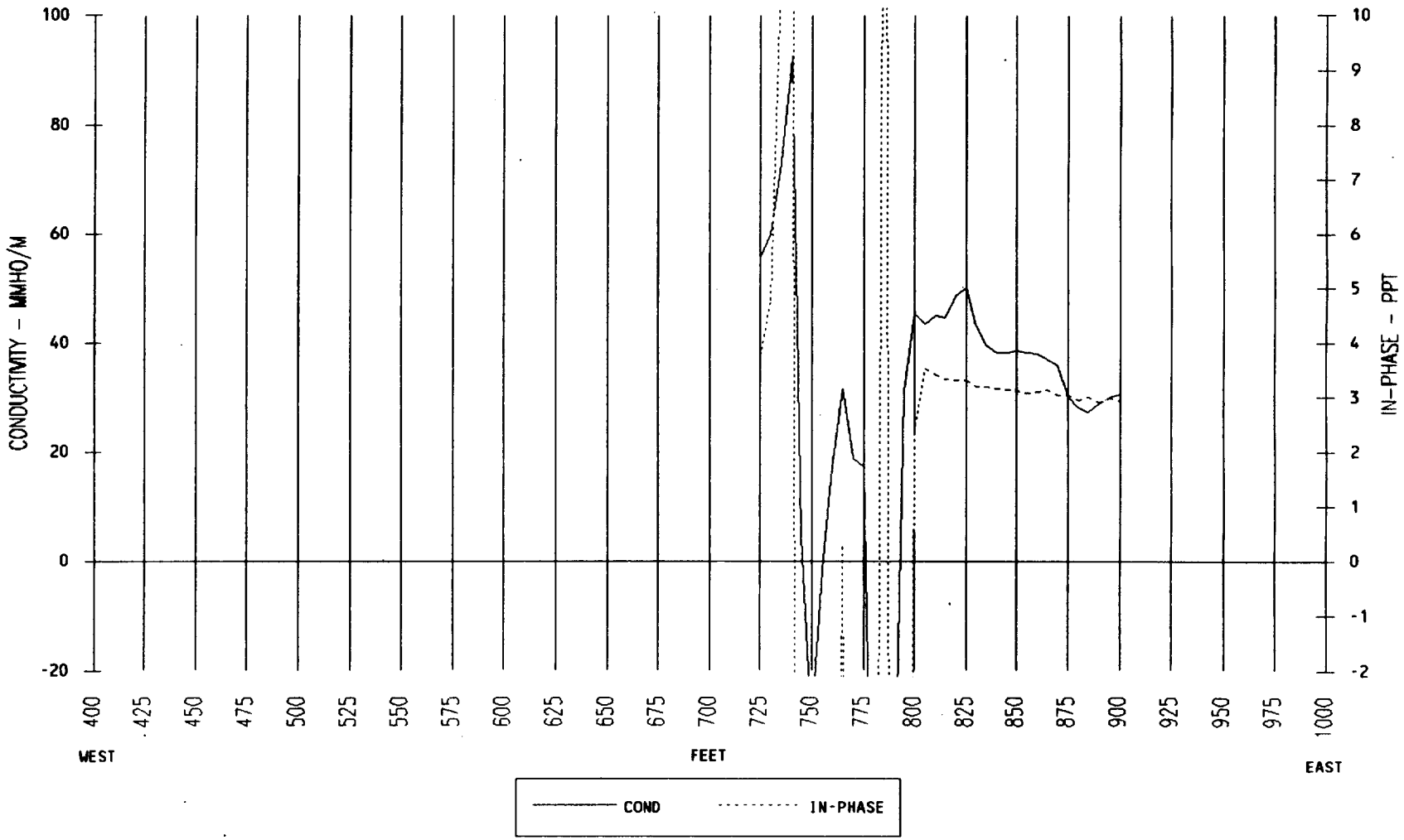
EOD RANGE - LINE 1840



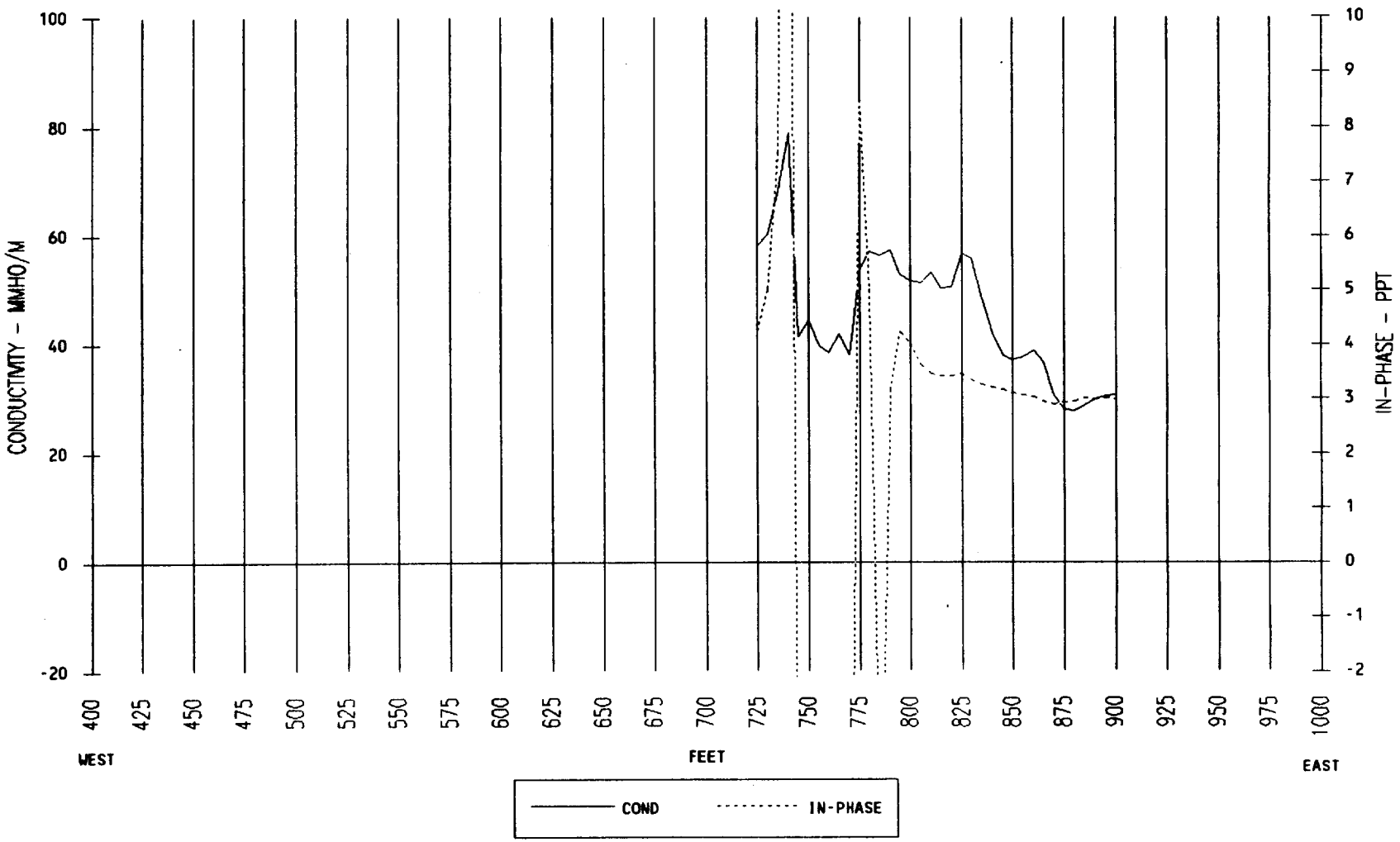
EOD RANGE - LINE 1860



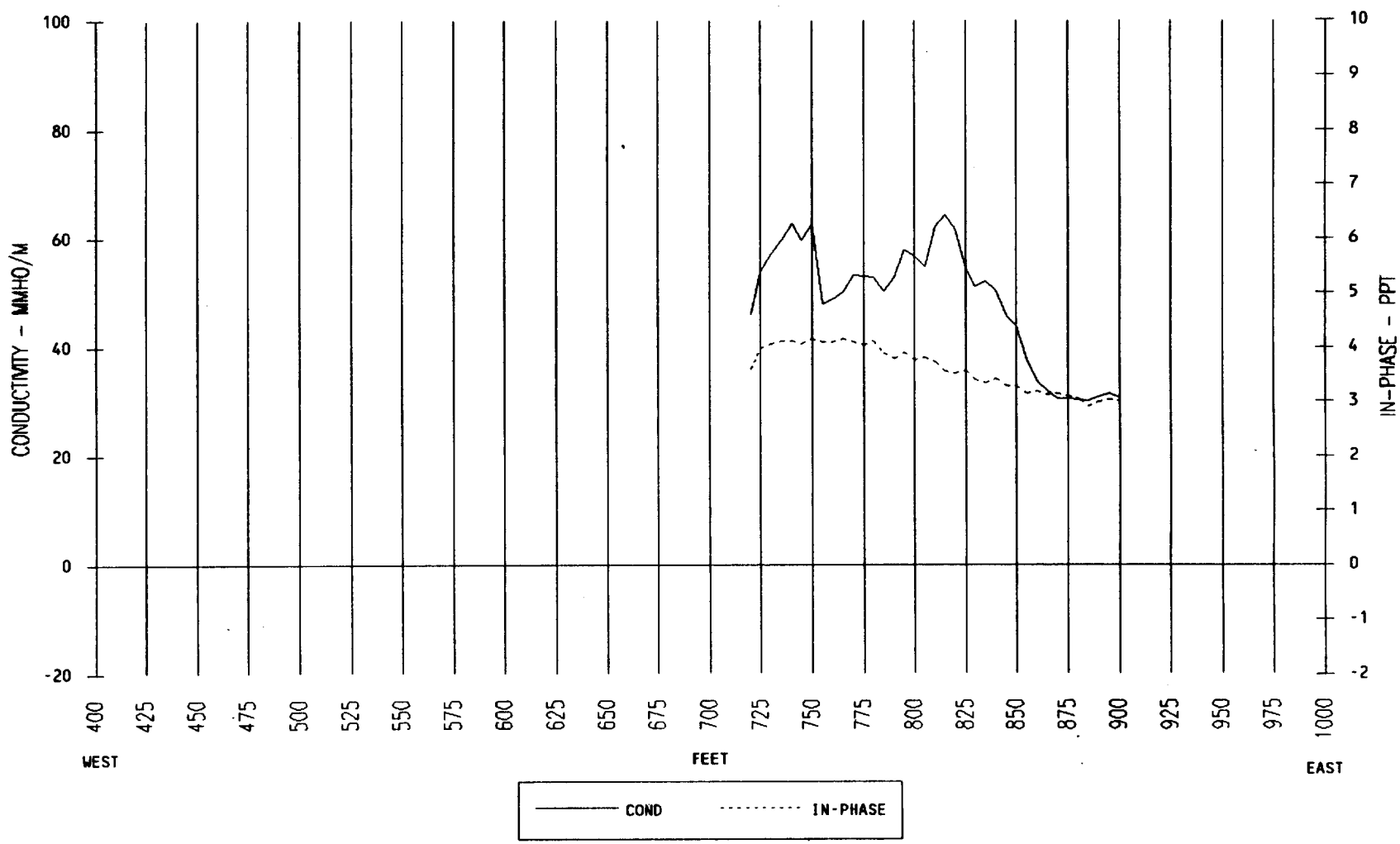
EOD RANGE - LINE 1880



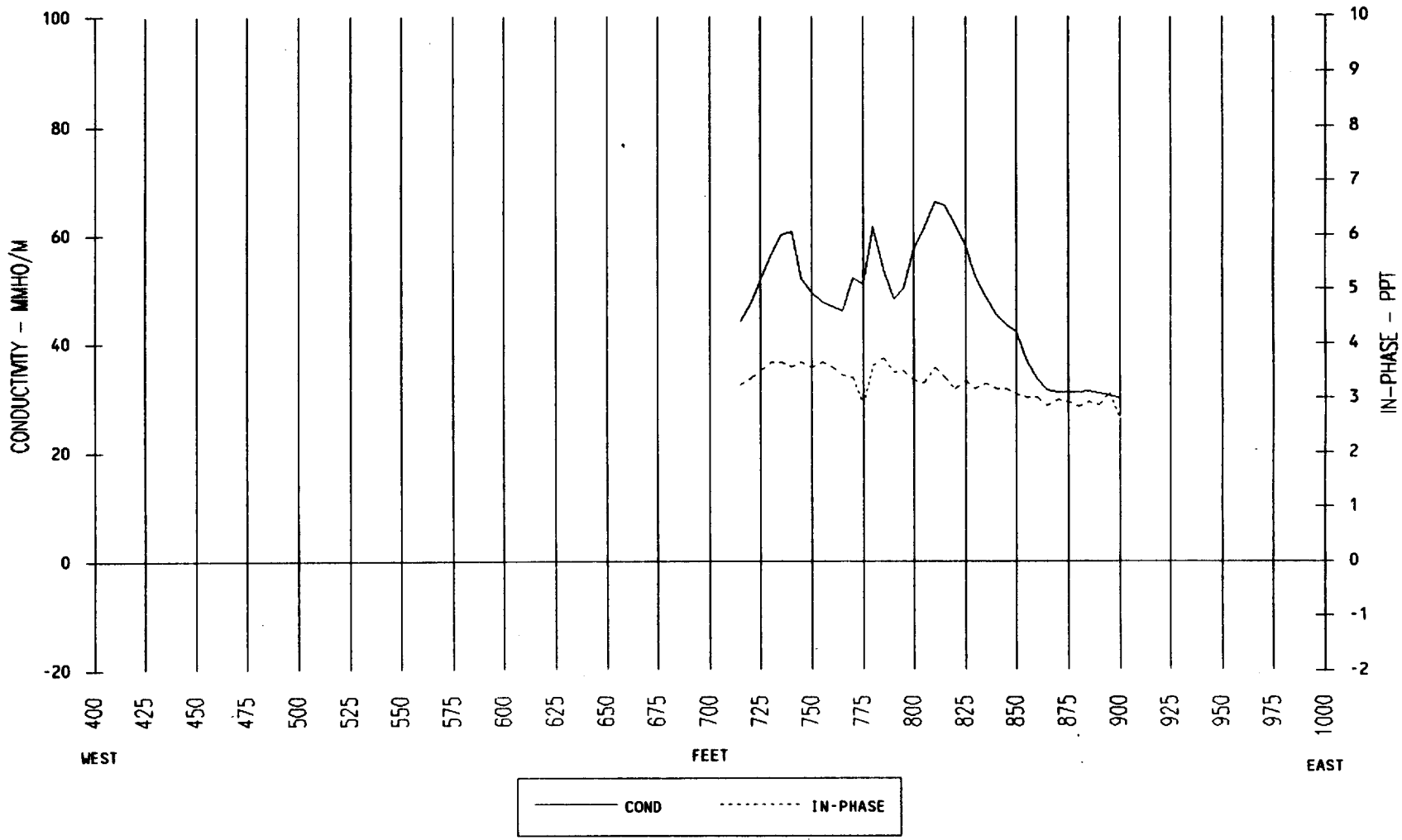
EOD RANGE - LINE 1900



EOD RANGE - LINE 1920



EOD RANGE - LINE 1940



EOD RANGE - LINE 1960

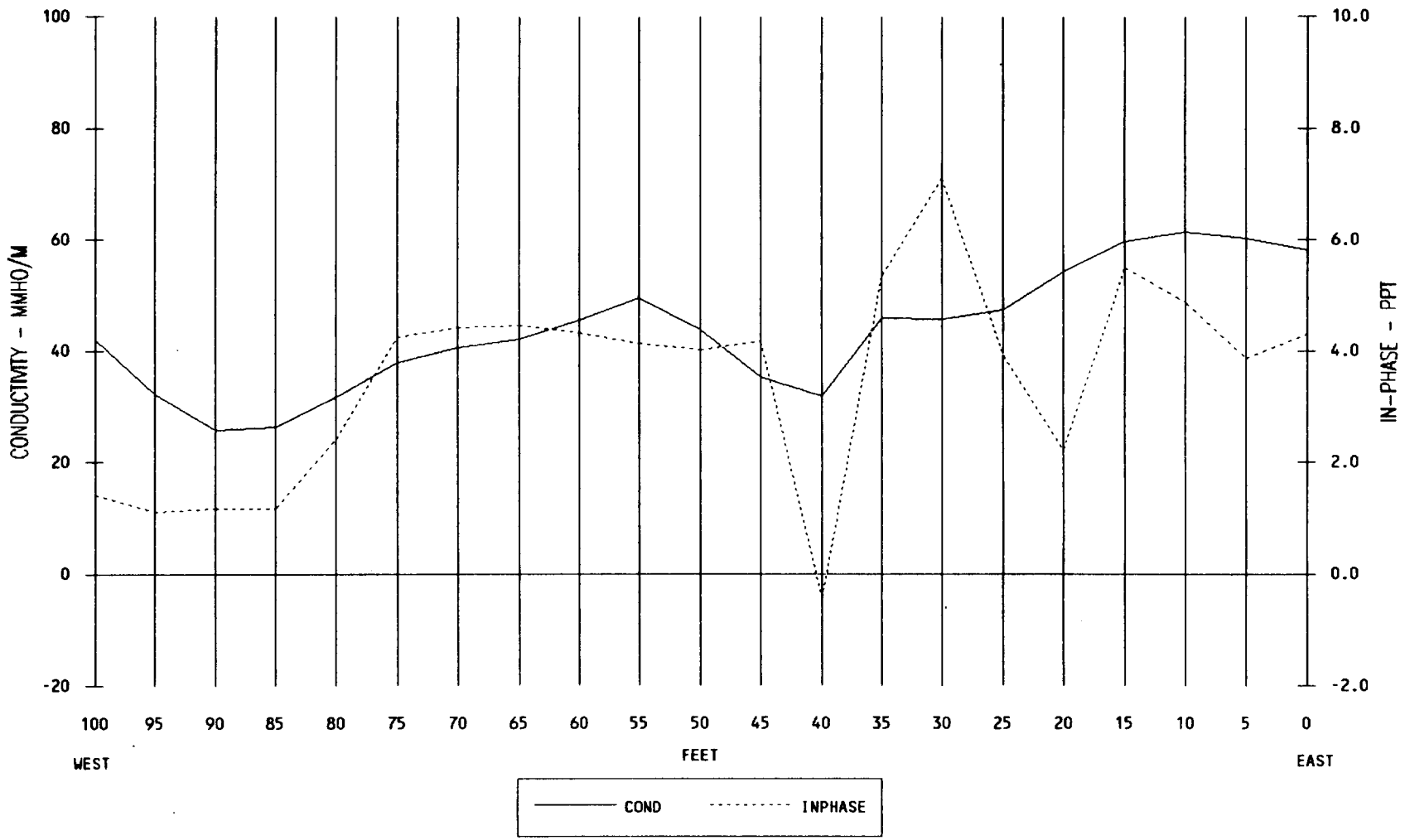
EOD RANGE - LINE 1980

Attachment B

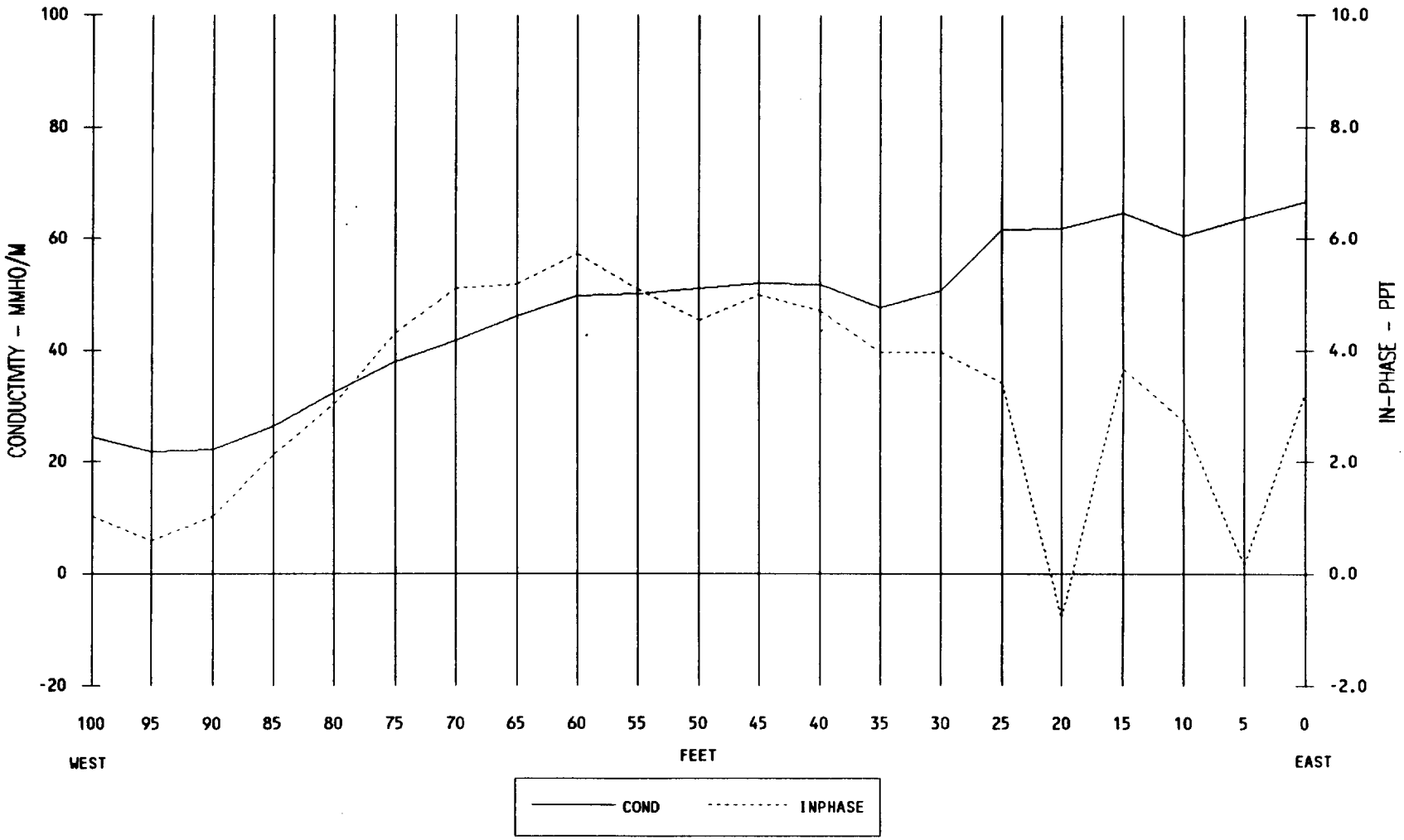
MAGAZINE ROAD LANDFILL

EM DATA

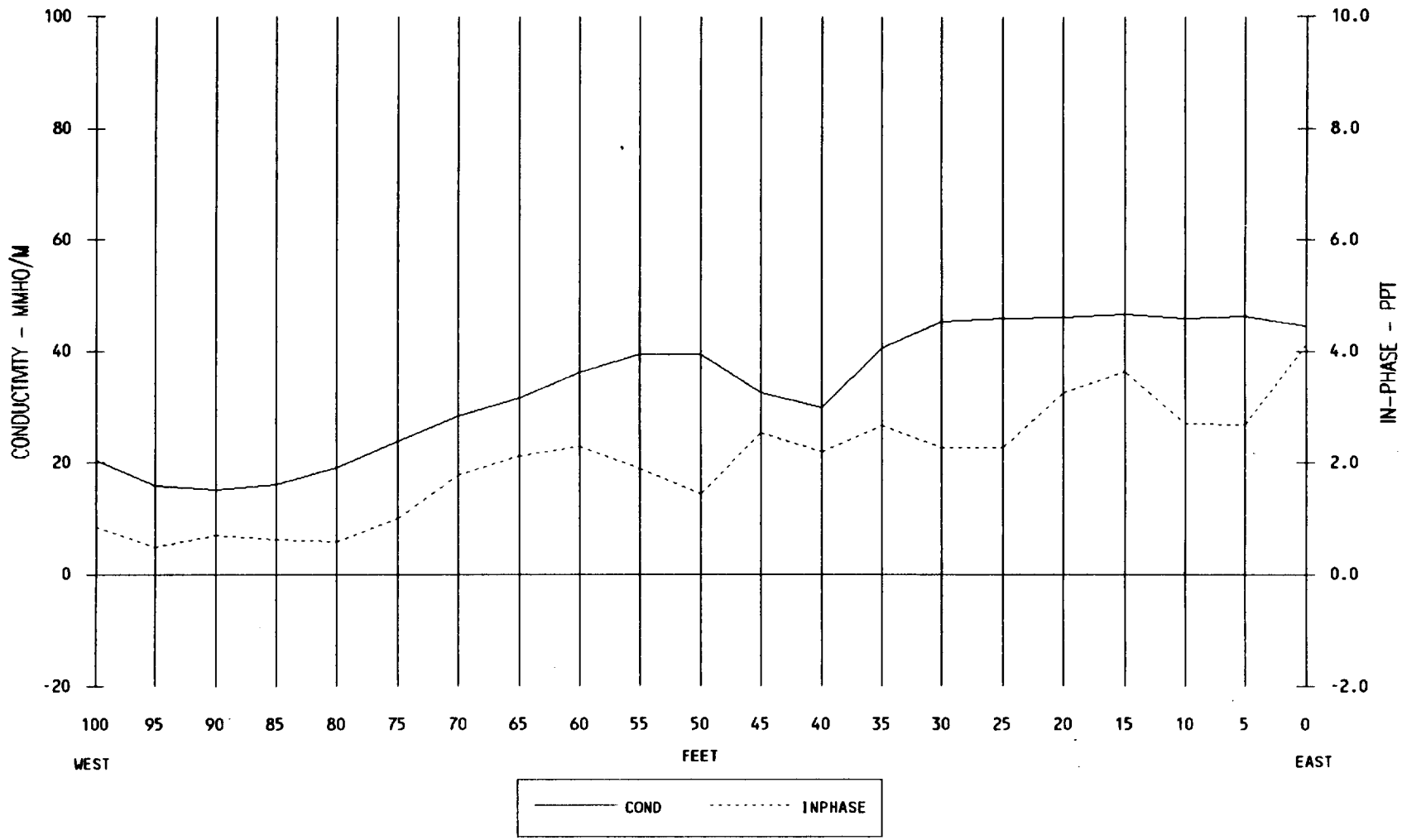
MAGAZINE ROAD LANDFILL - LINE 100 SOUTH



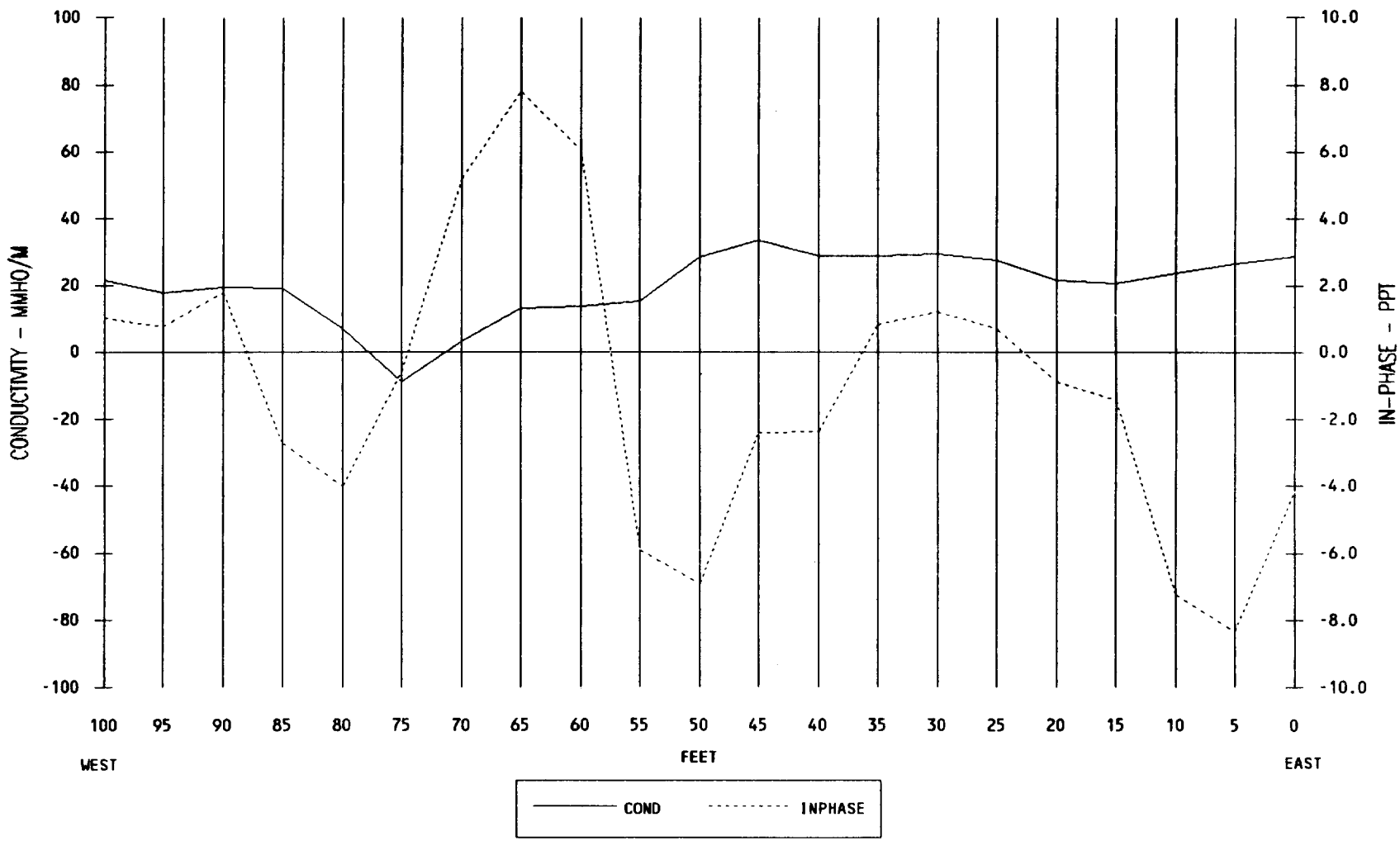
MAGAZINE ROAD LANDFILL - LINE 200 SOUTH



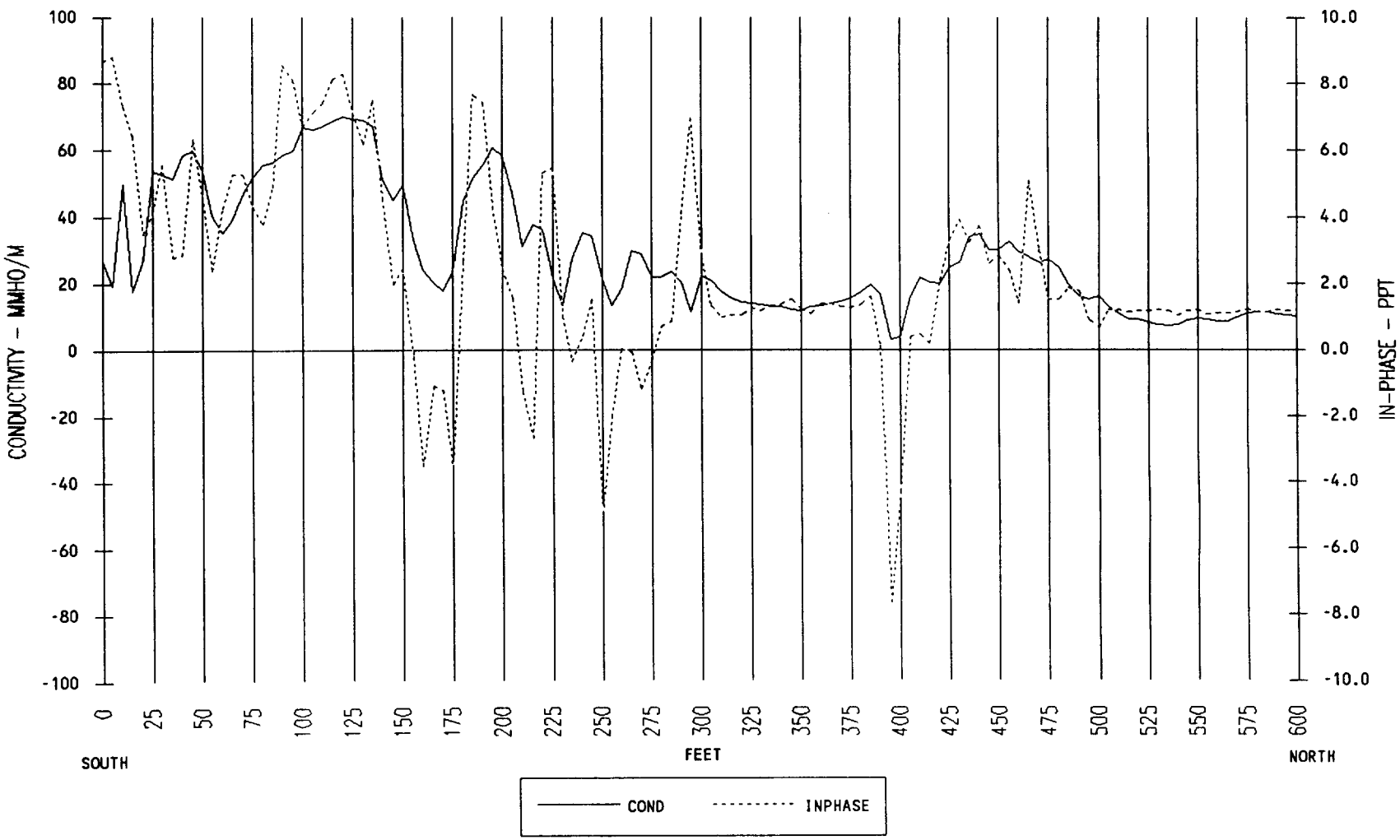
MAGAZINE ROAD LANDFILL - LINE 300 SOUTH



MAGAZINE ROAD LANDFILL - LINE 400 SOUTH



MAGAZINE ROAD LANDFILL - LINE 999

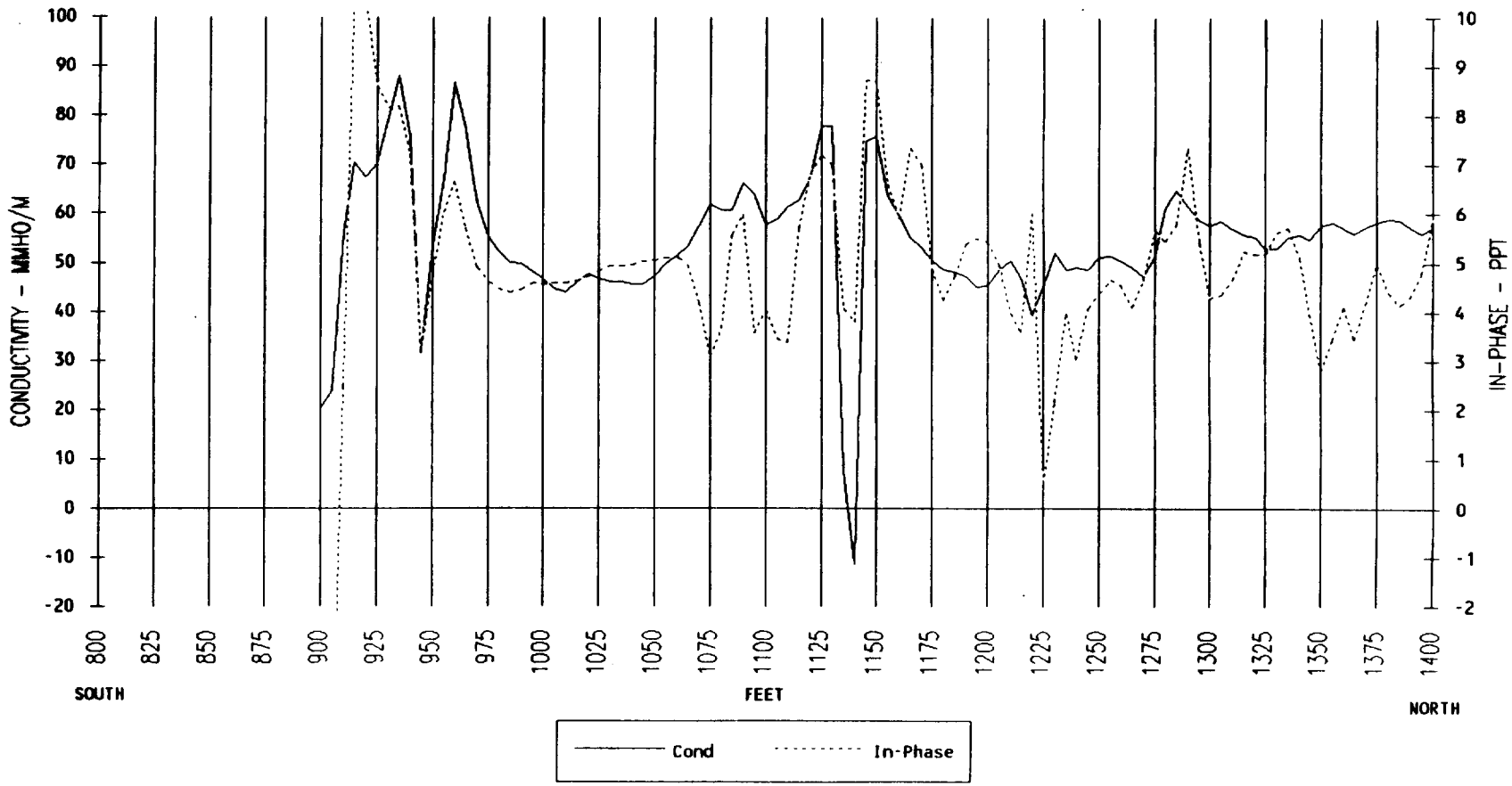


Attachment C

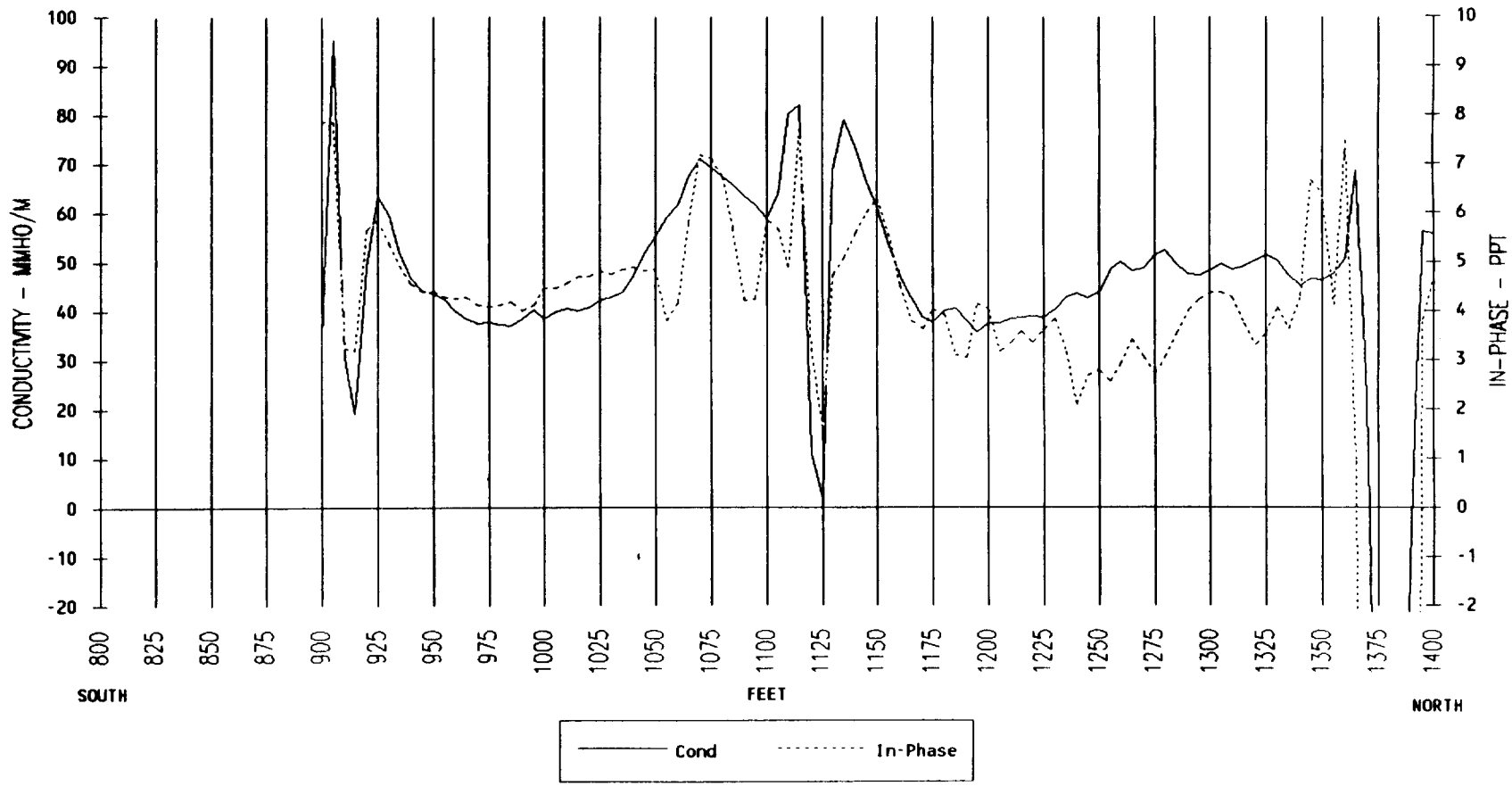
ORIGINAL LANDFILL

EM DATA

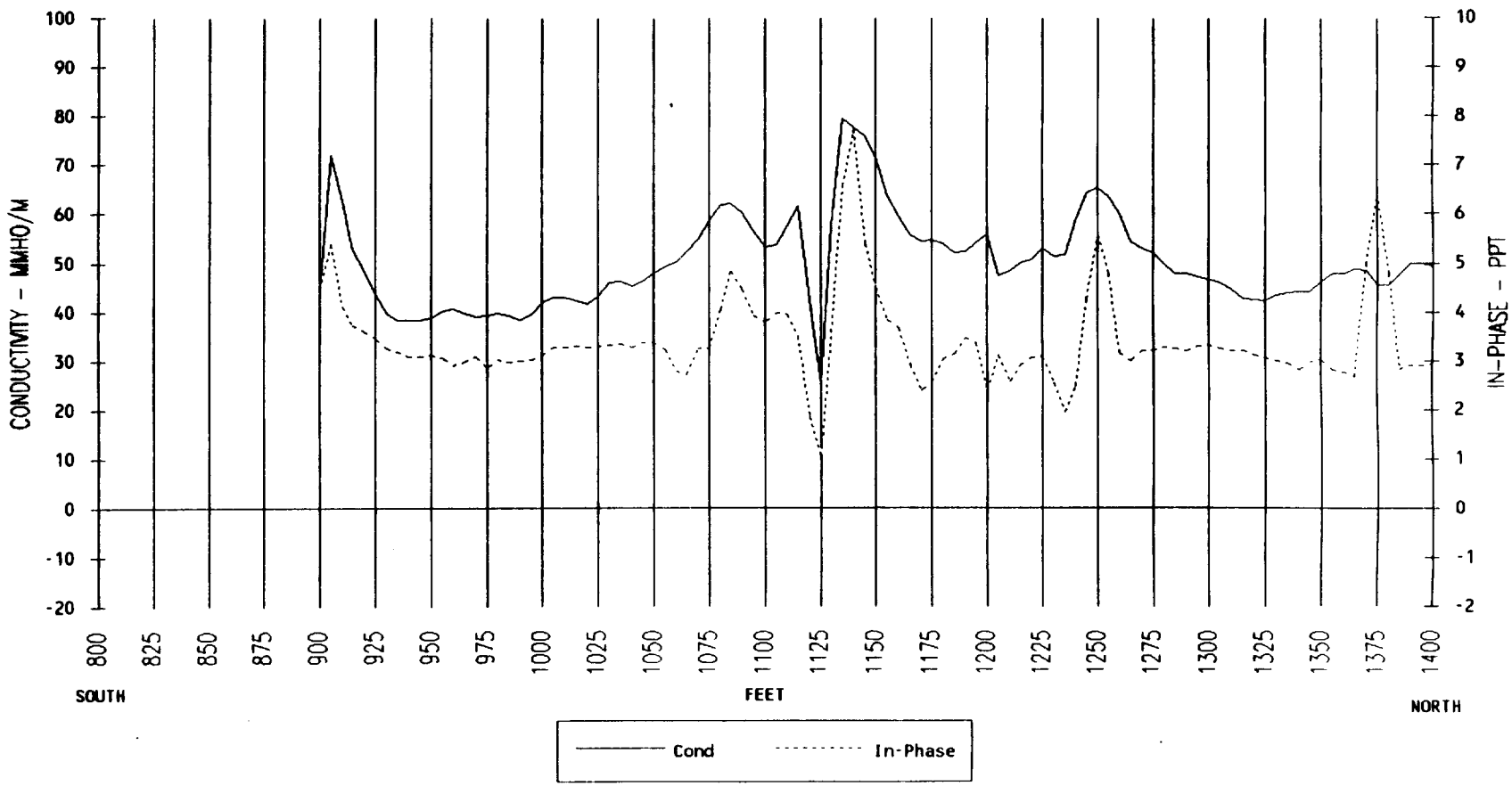
ORIGINAL LANDFILL - LINE 920



ORIGINAL LANDFILL - LINE 960

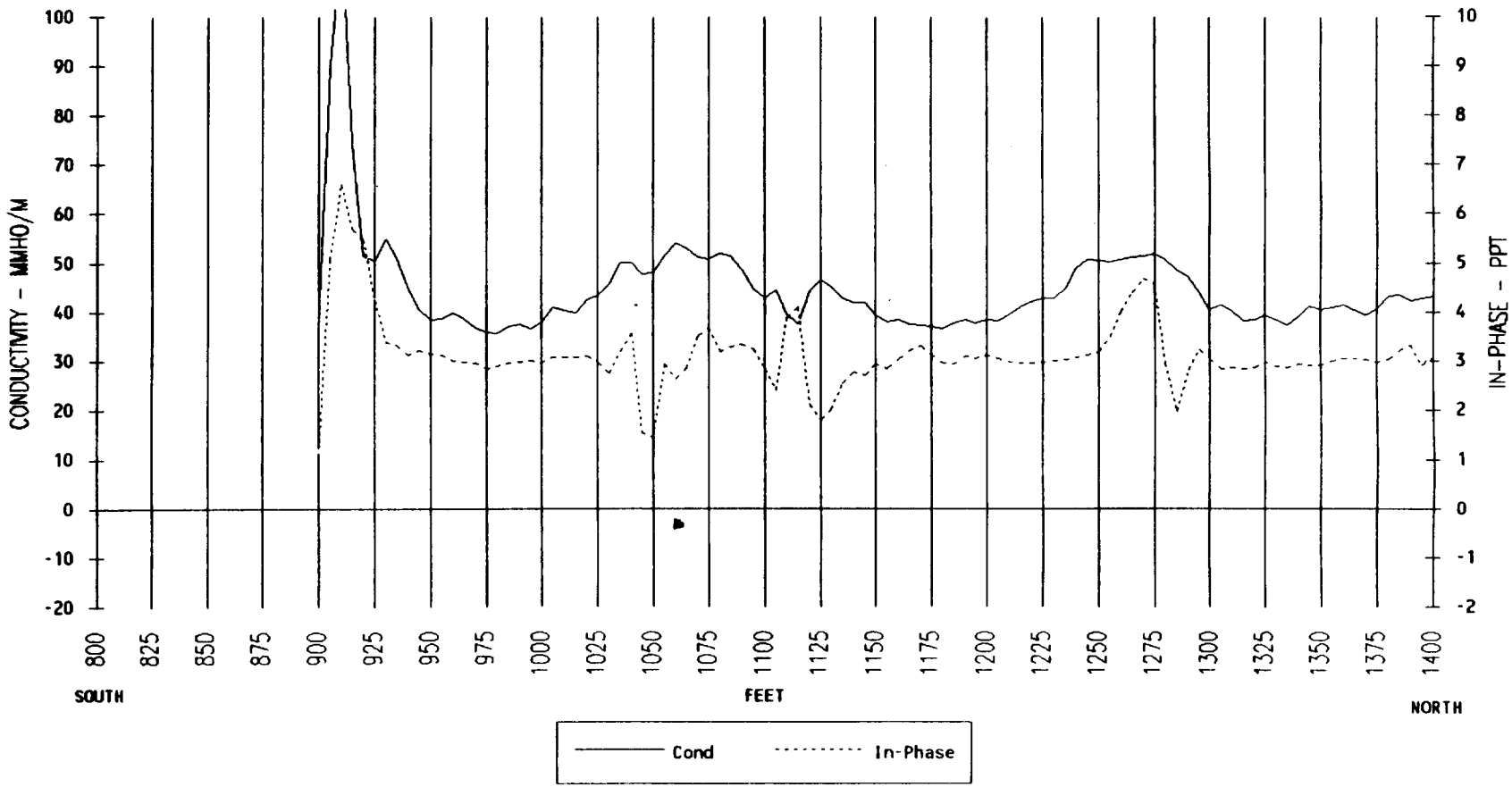


ORIGINAL LANDFILL - LINE 1000



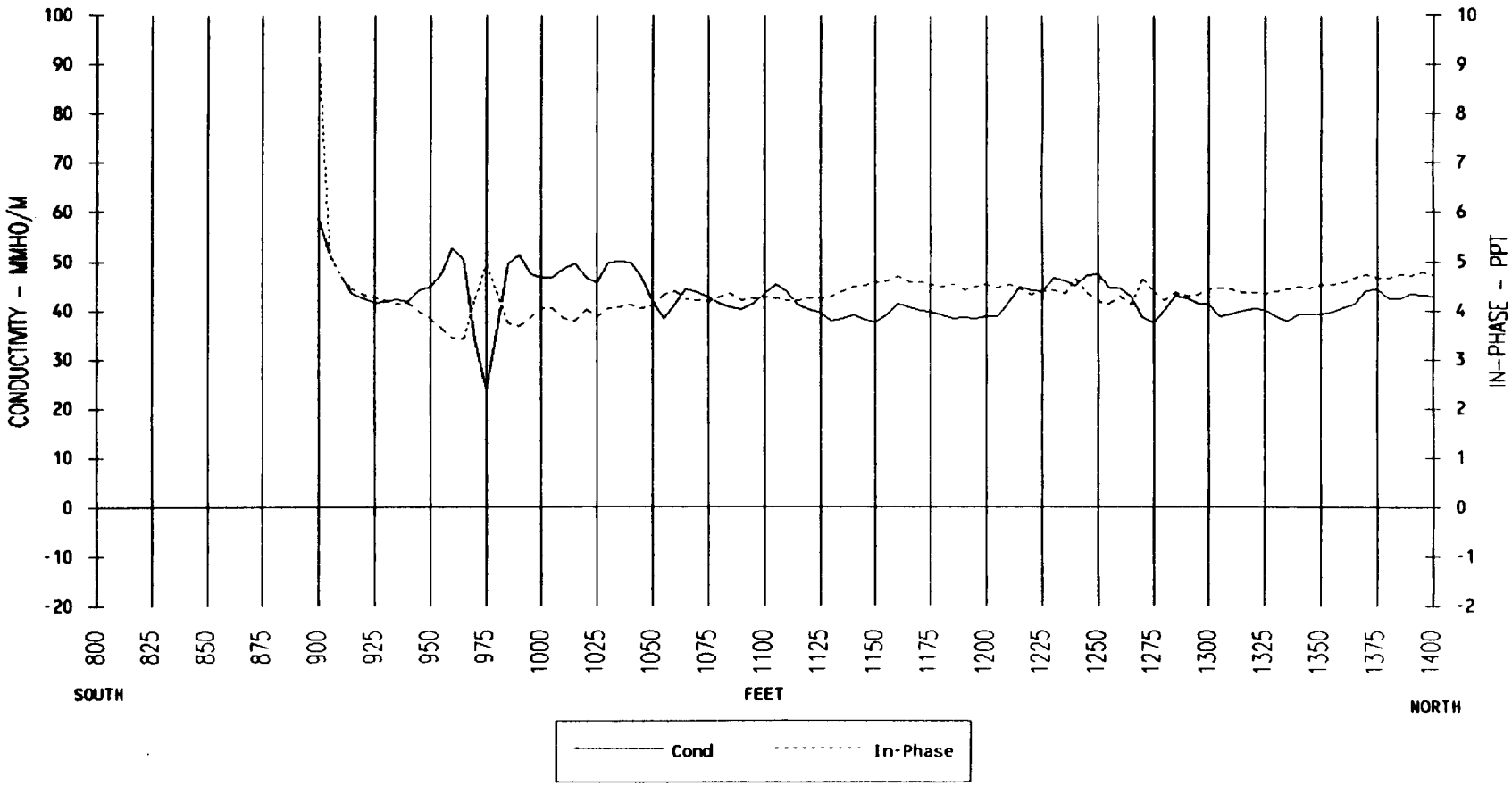
ORIGINAL LANDFILL - LINE 1040

ORIGINAL LANDFILL - LINE 1080

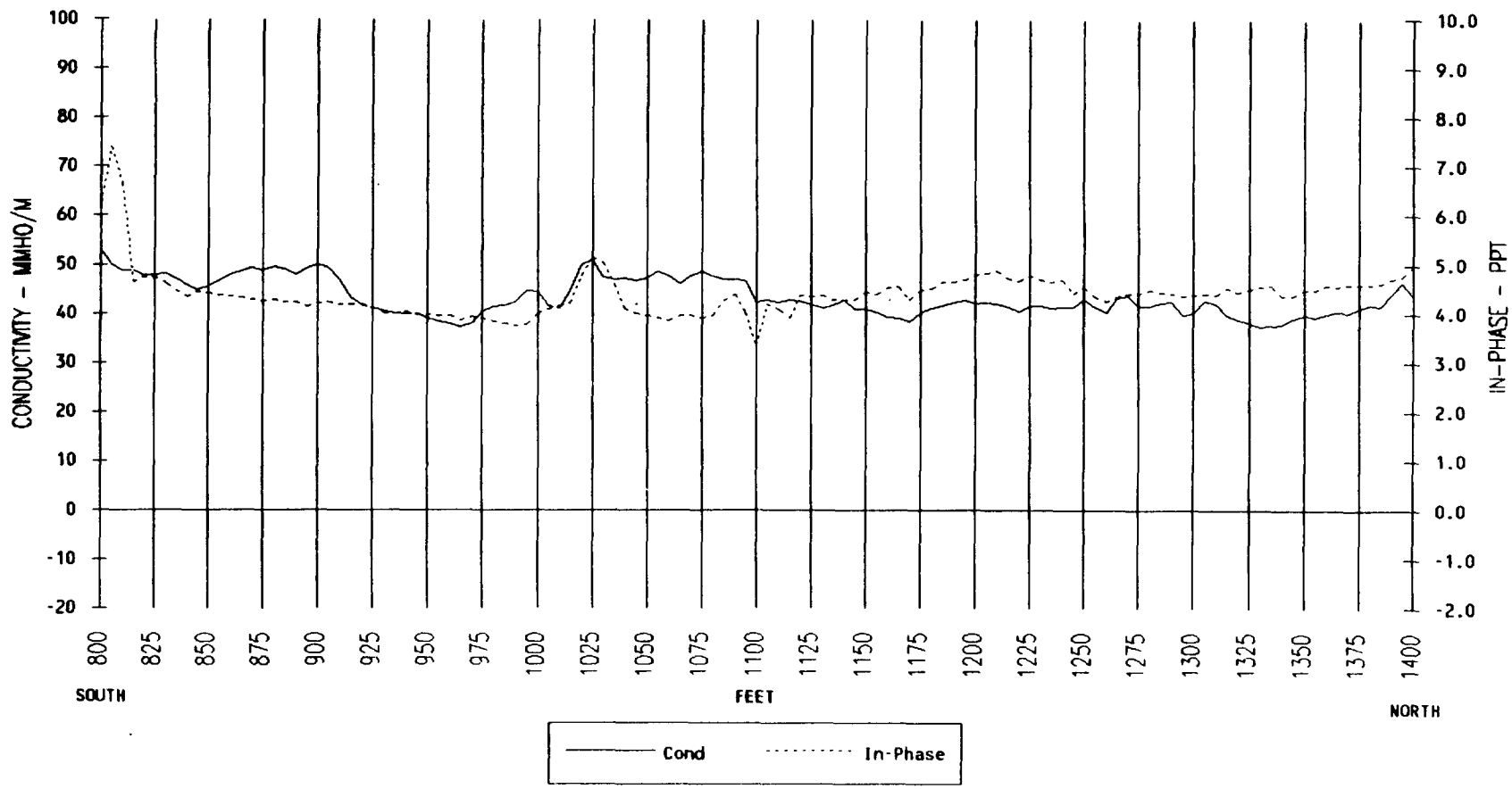


ORIGINAL LANDFILL - LINE 1120

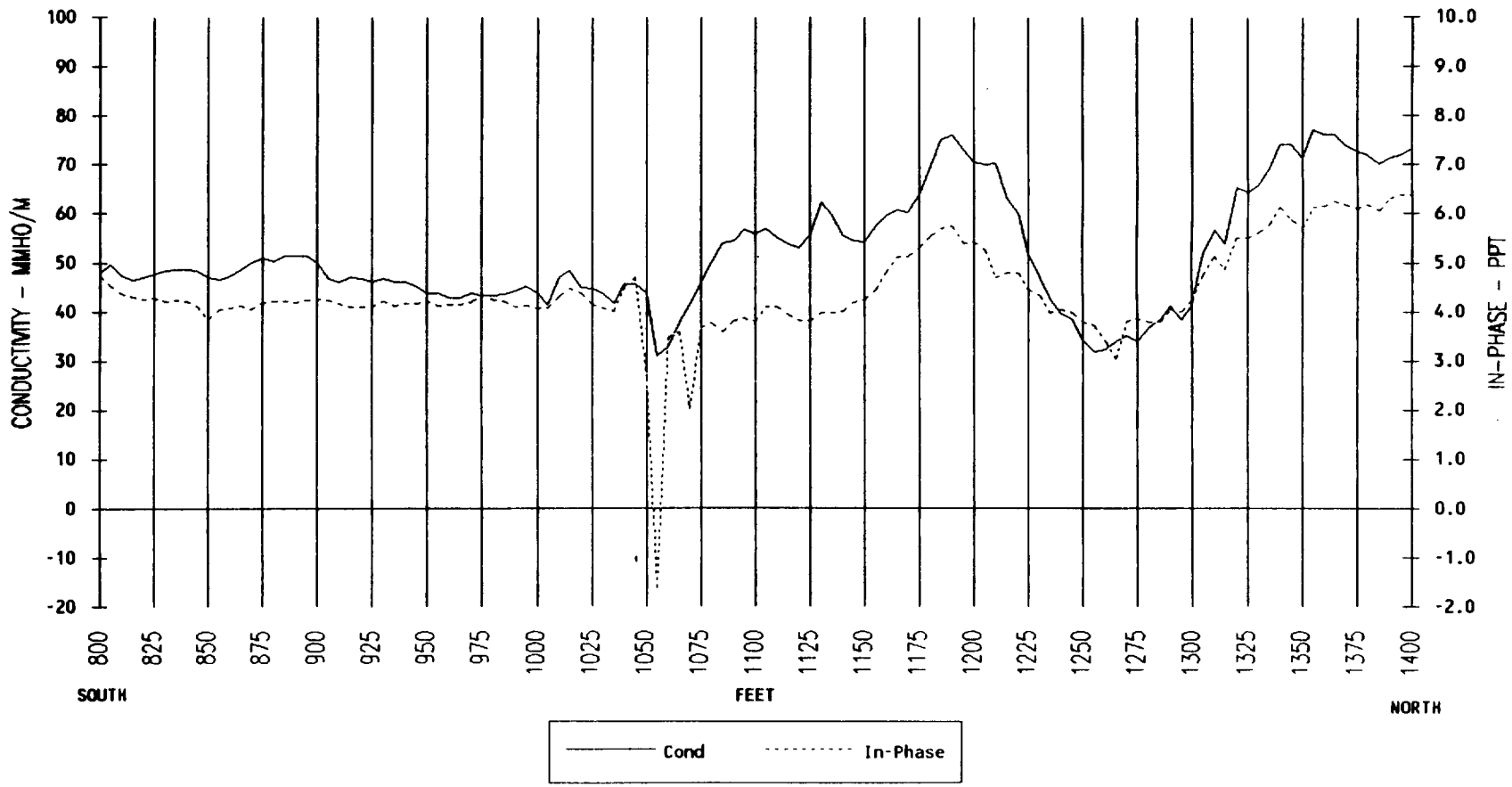
ORIGINAL LANDFILL - LINE 1160



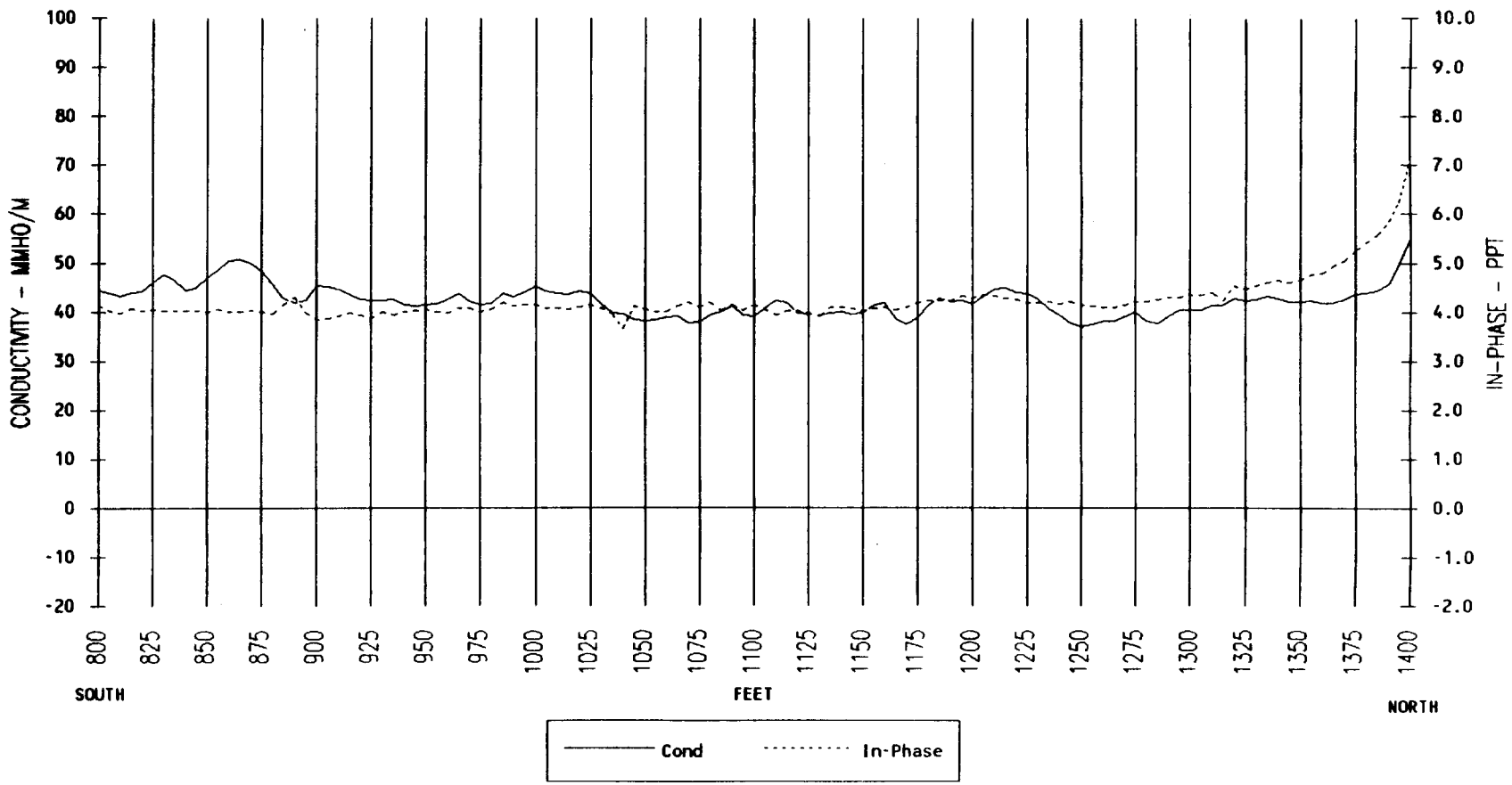
ORIGINAL LANDFILL - LINE 1200



ORIGINAL LANDFILL - LINE 1240

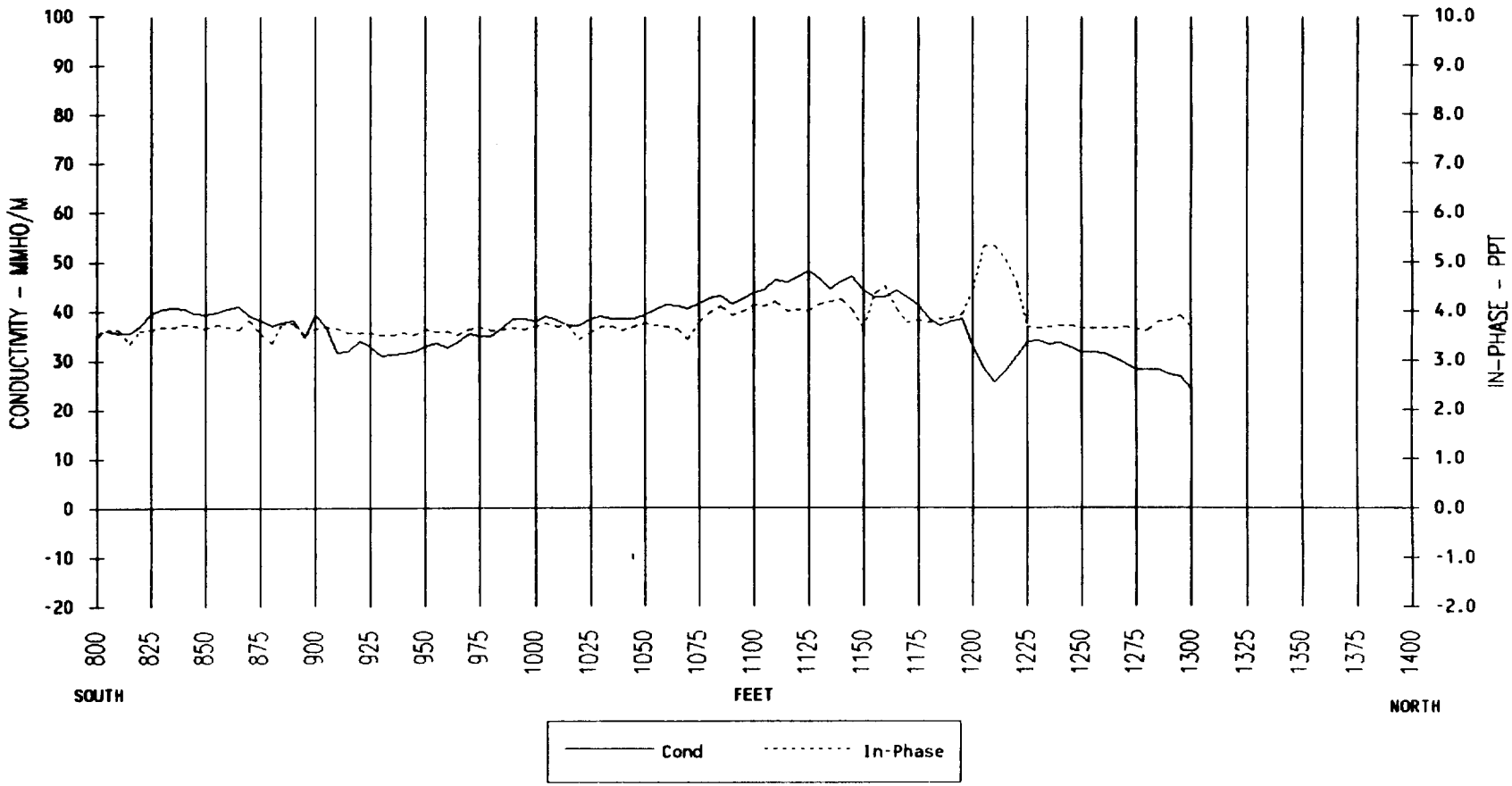


ORIGINAL LANDFILL - LINE 1280

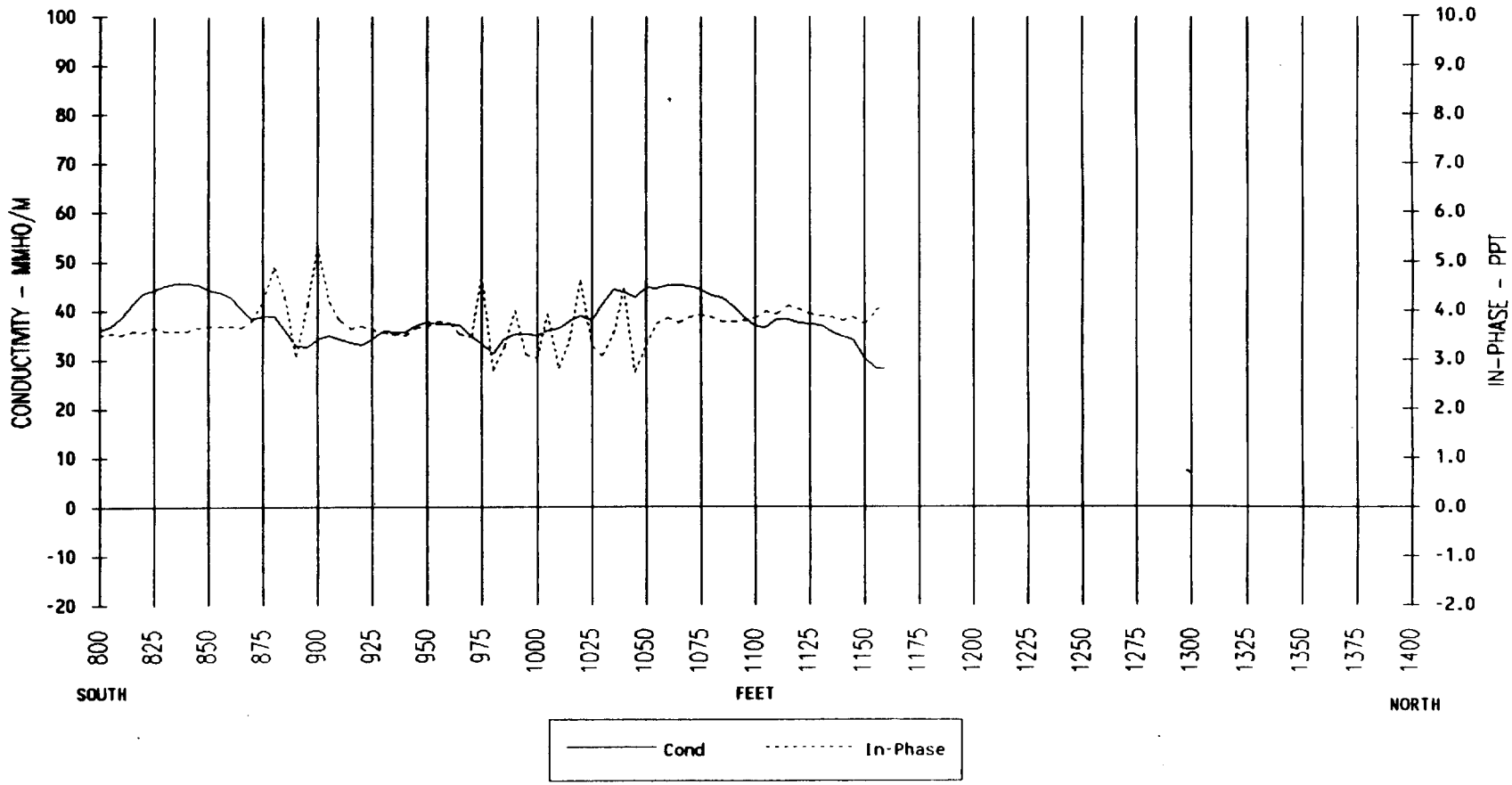


ORIGINAL LANDFILL - LINE 1320

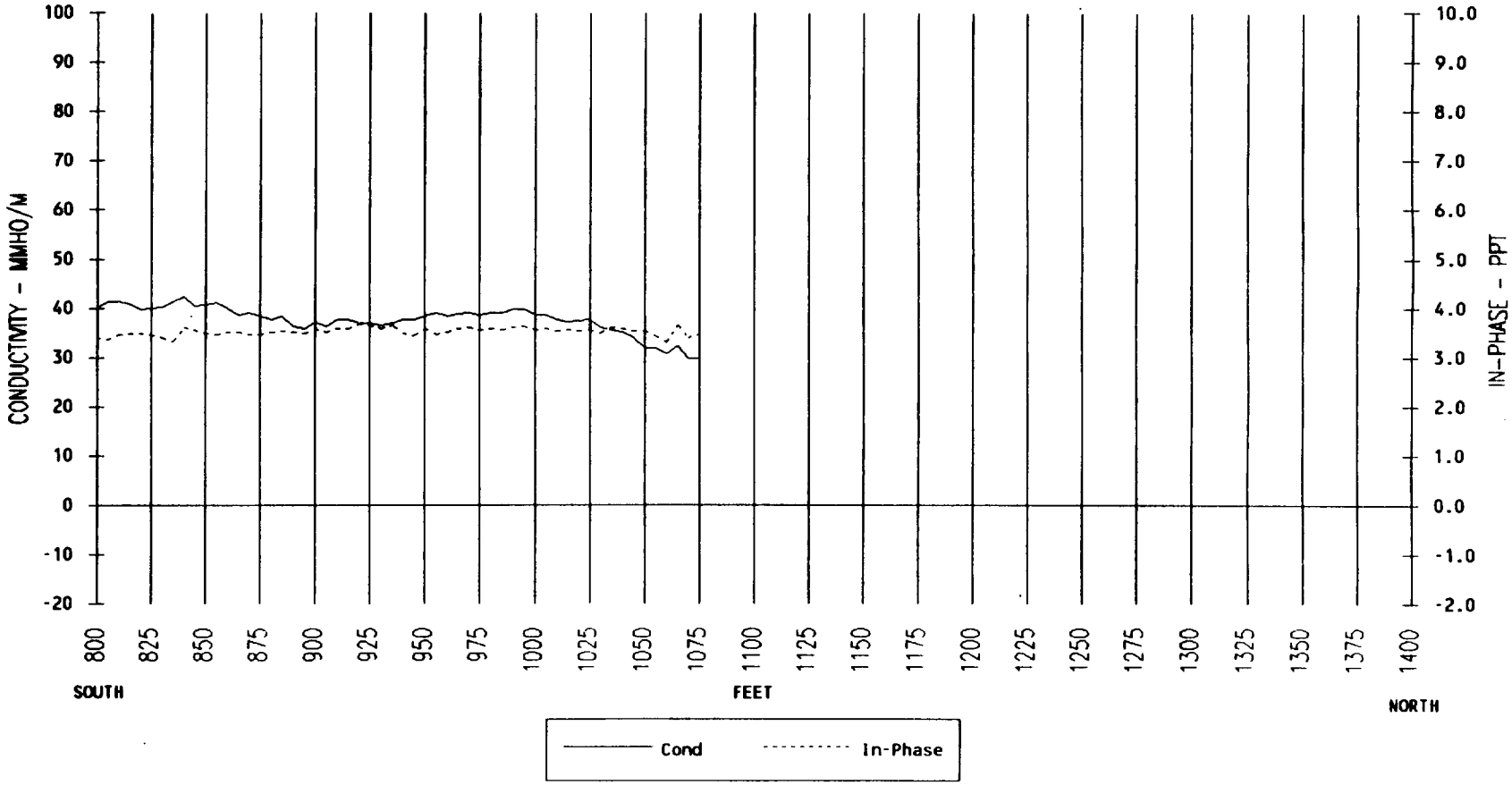
ORIGINAL LANDFILL - LINE 1360



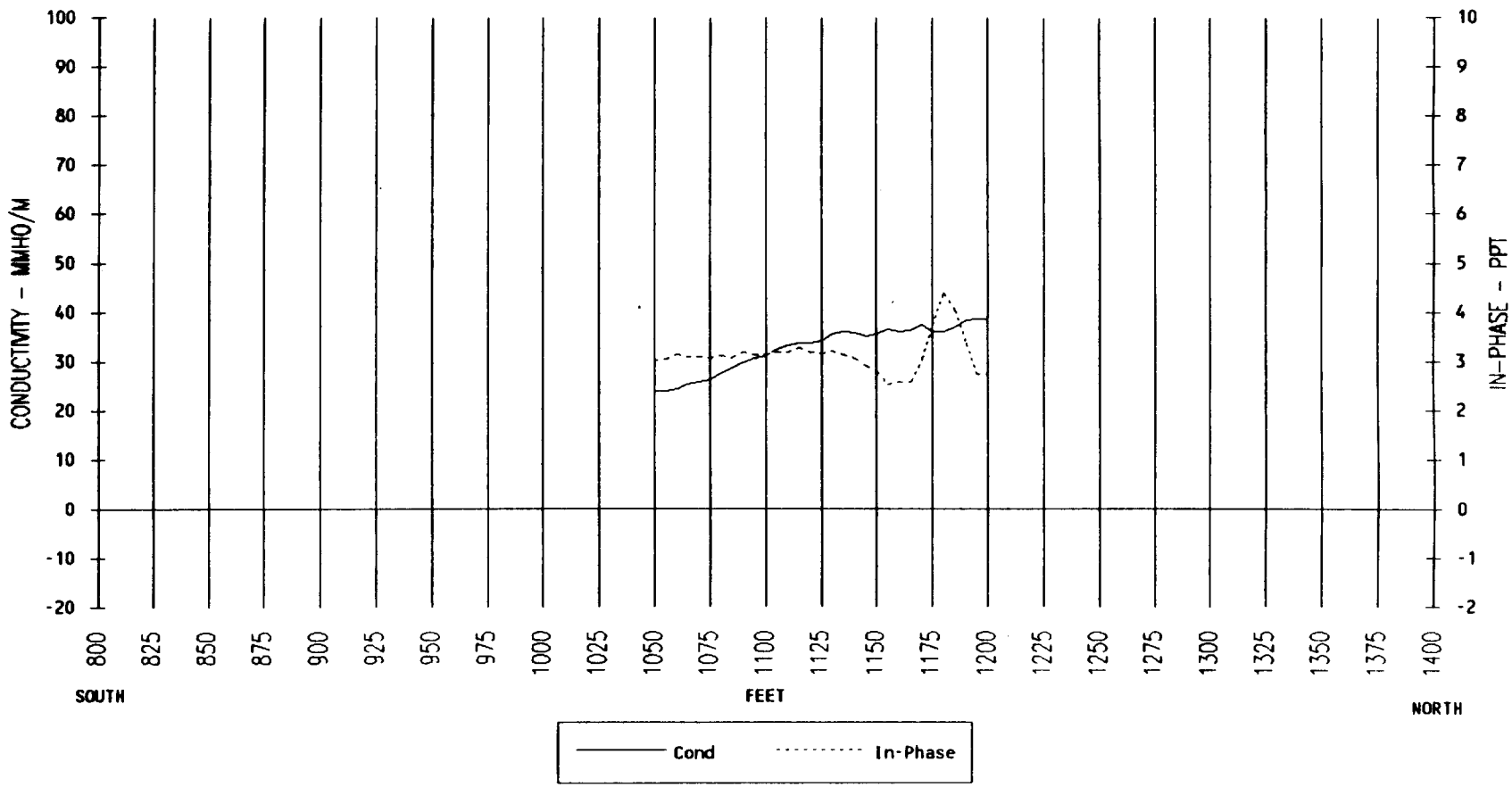
ORIGINAL LANDFILL - LINE 1400



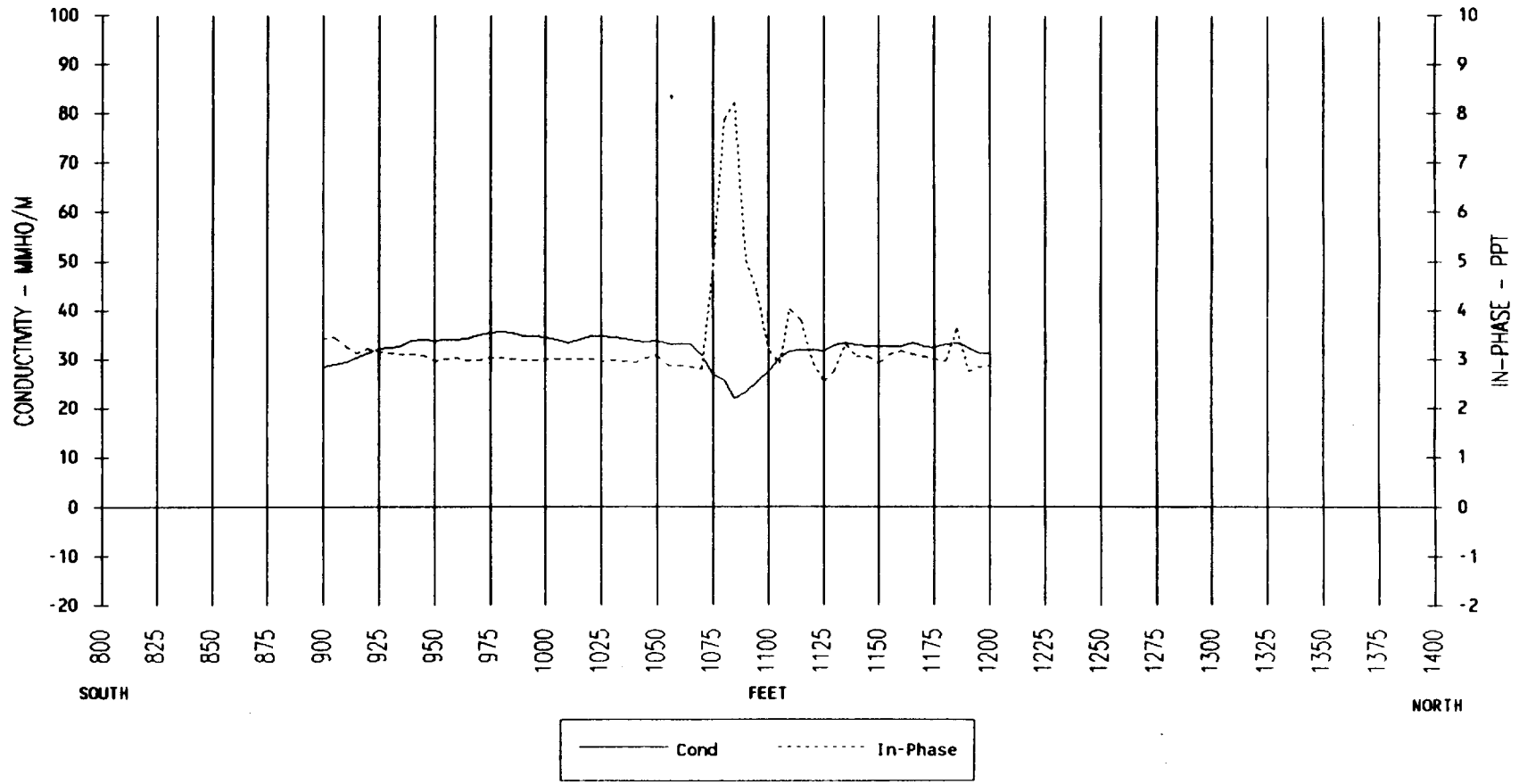
ORIGINAL LANDFILL - LINE 1440



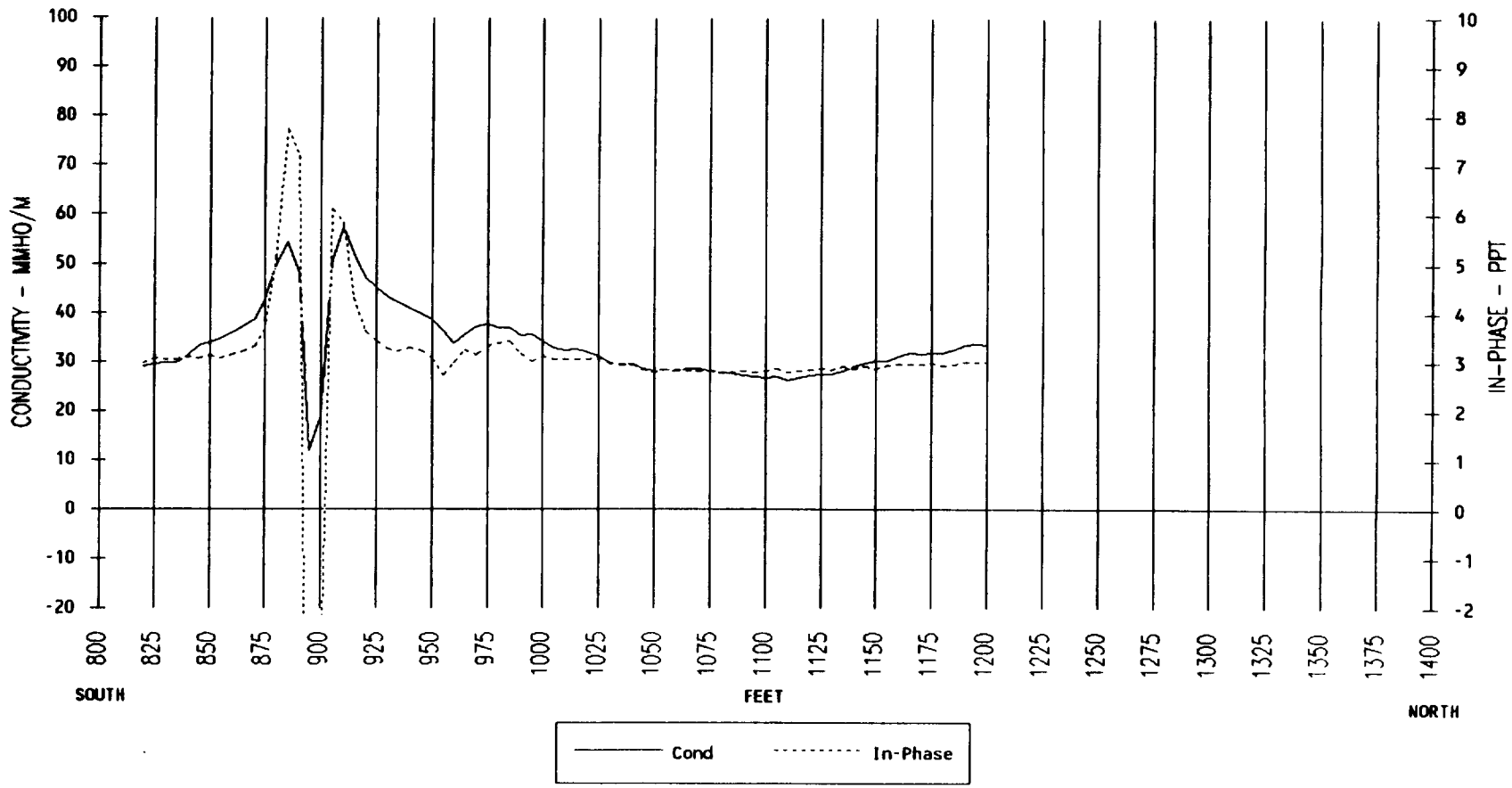
ORIGINAL LANDFILL - LINE 1520



ORIGINAL LANDFILL - LINE 1560

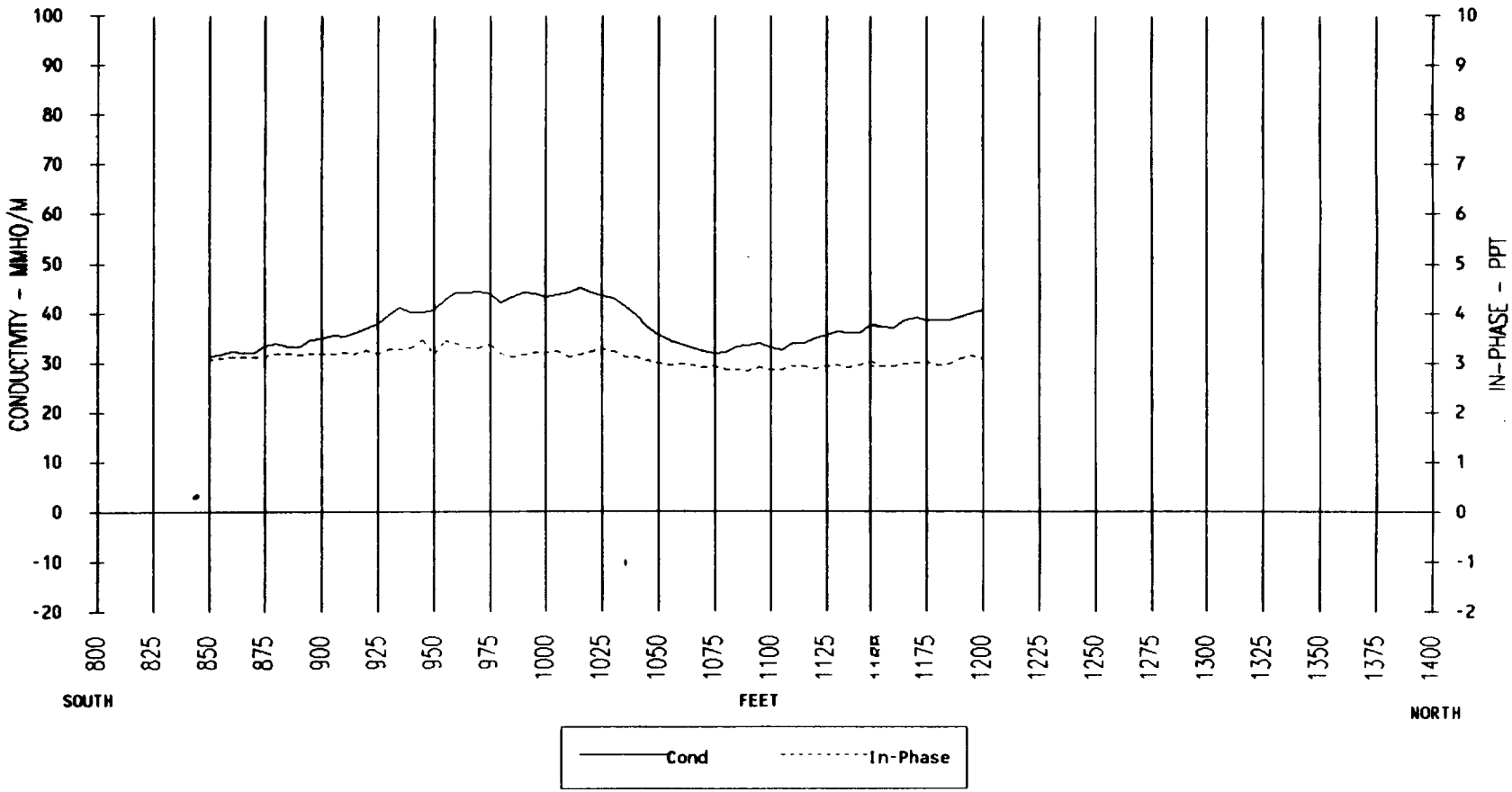


ORIGINAL LANDFILL - LINE 1600

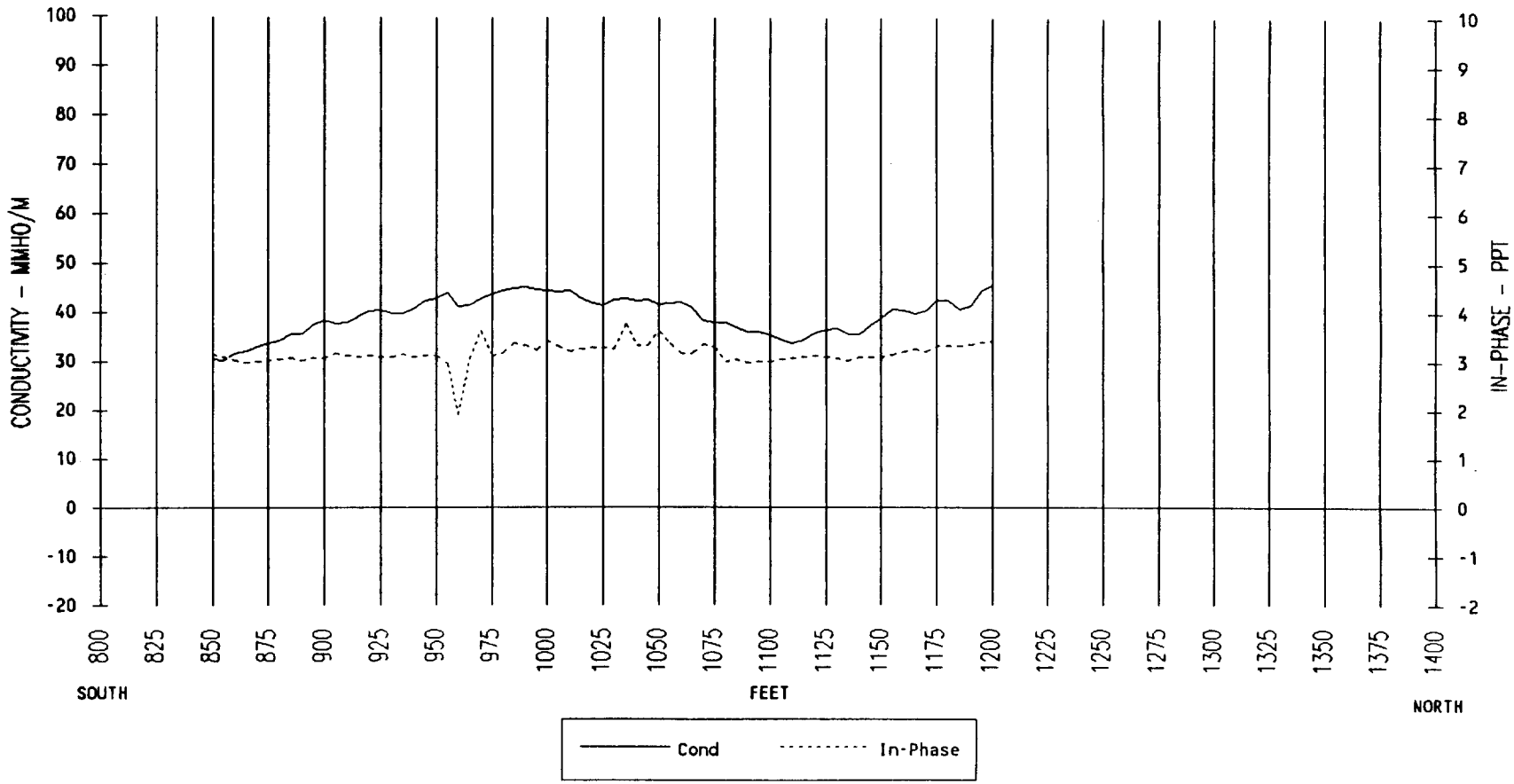


ORIGINAL LANDFILL - LINE 1640

ORIGINAL LANDFILL - LINE 1680



ORIGINAL LANDFILL - LINE 1720



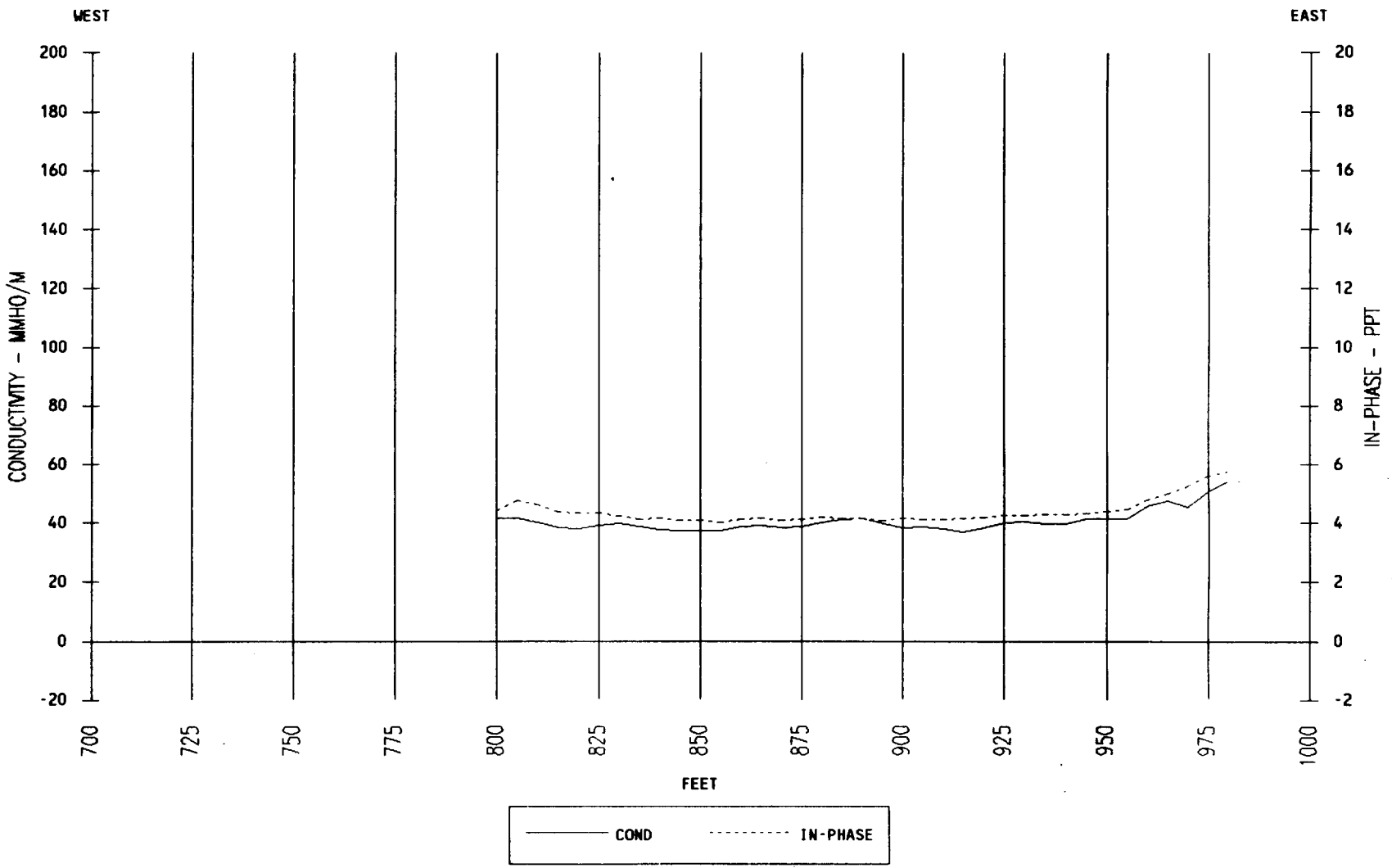
Attachment D

PERIMETER ROAD LANDFILL

EM DATA

PERIMETER ROAD LANDFILL

LINE 900

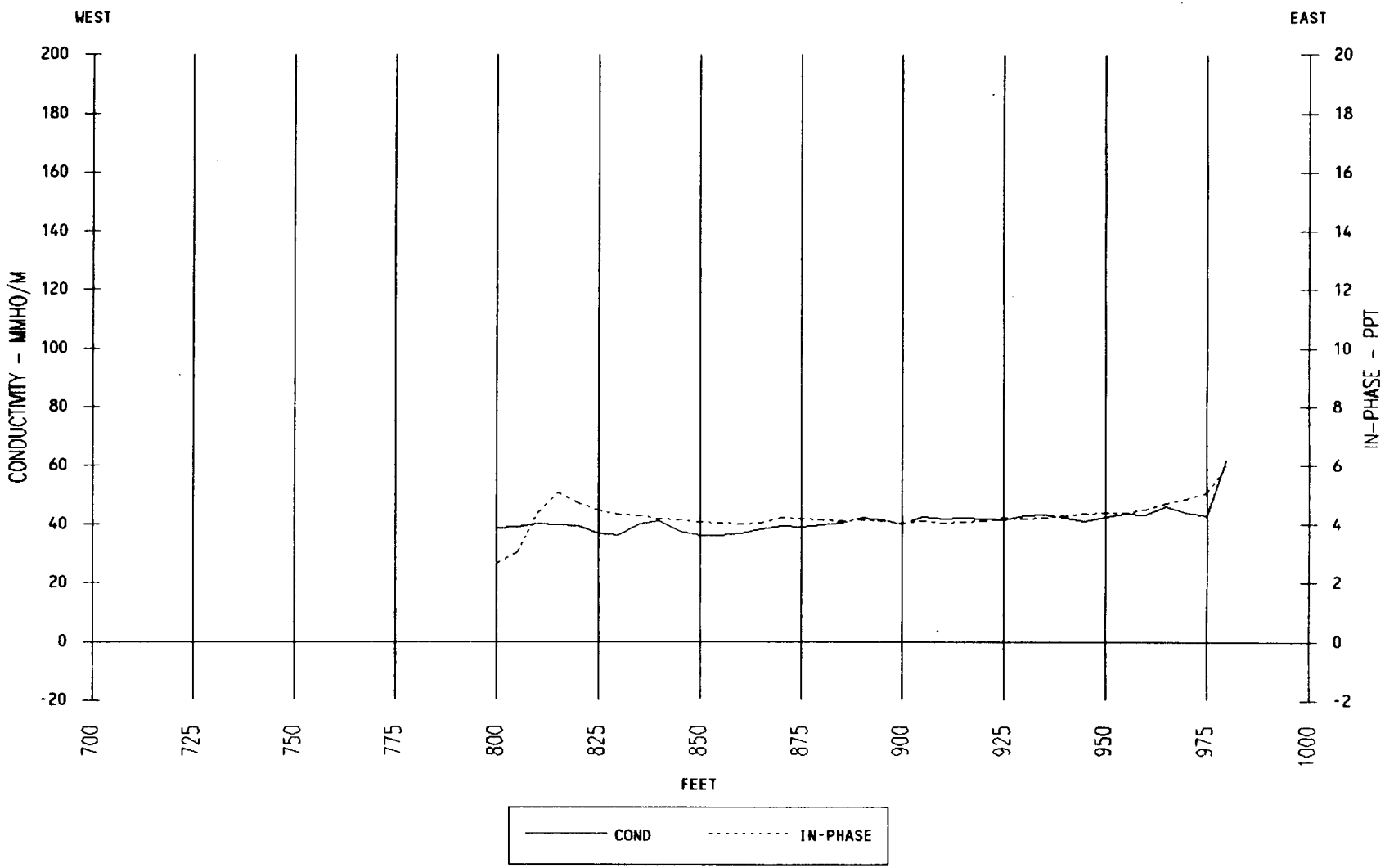


PAGE D-2

UNAVAILABLE AT THIS TIME

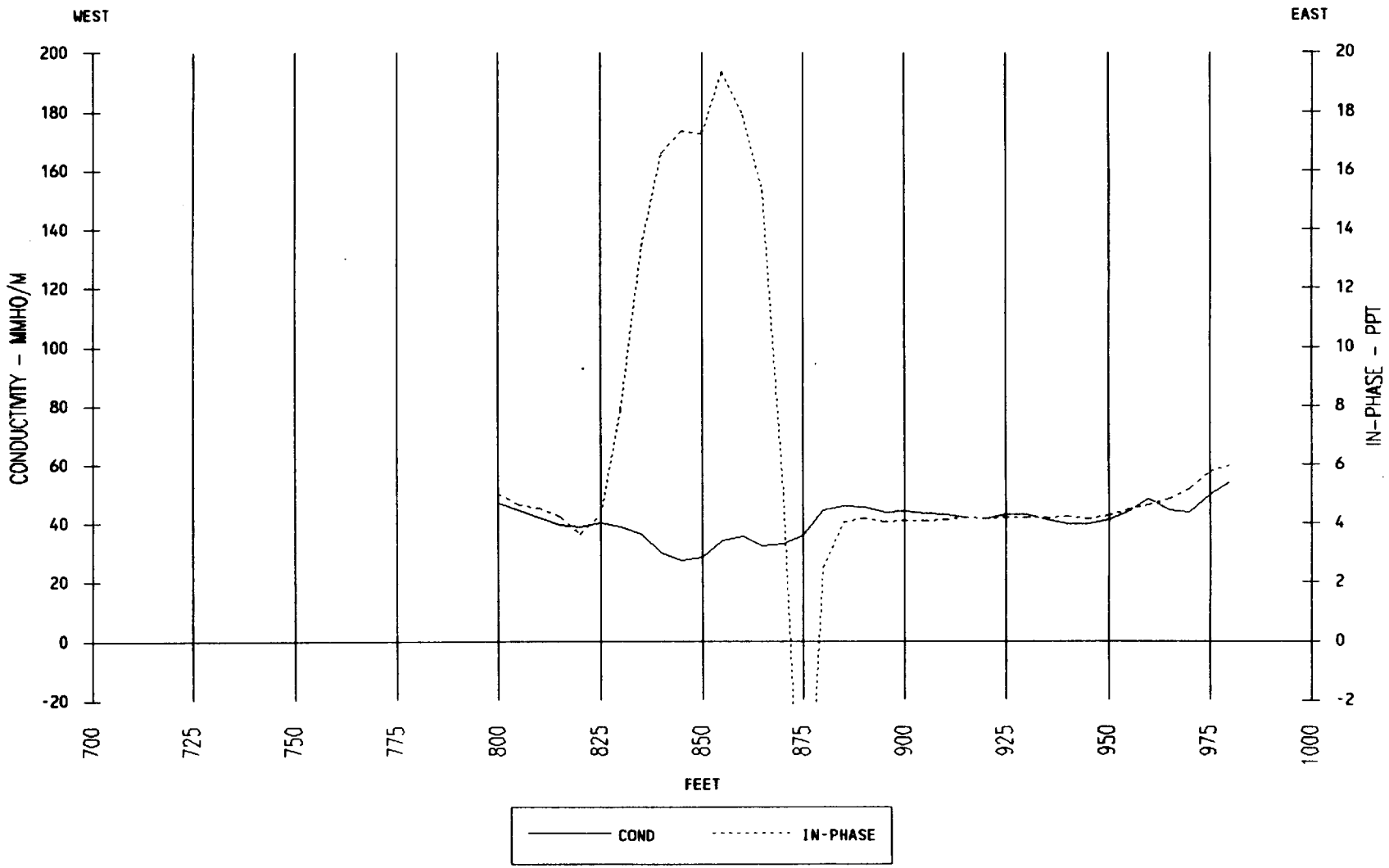
PERIMETER ROAD LANDFILL

LINE 850



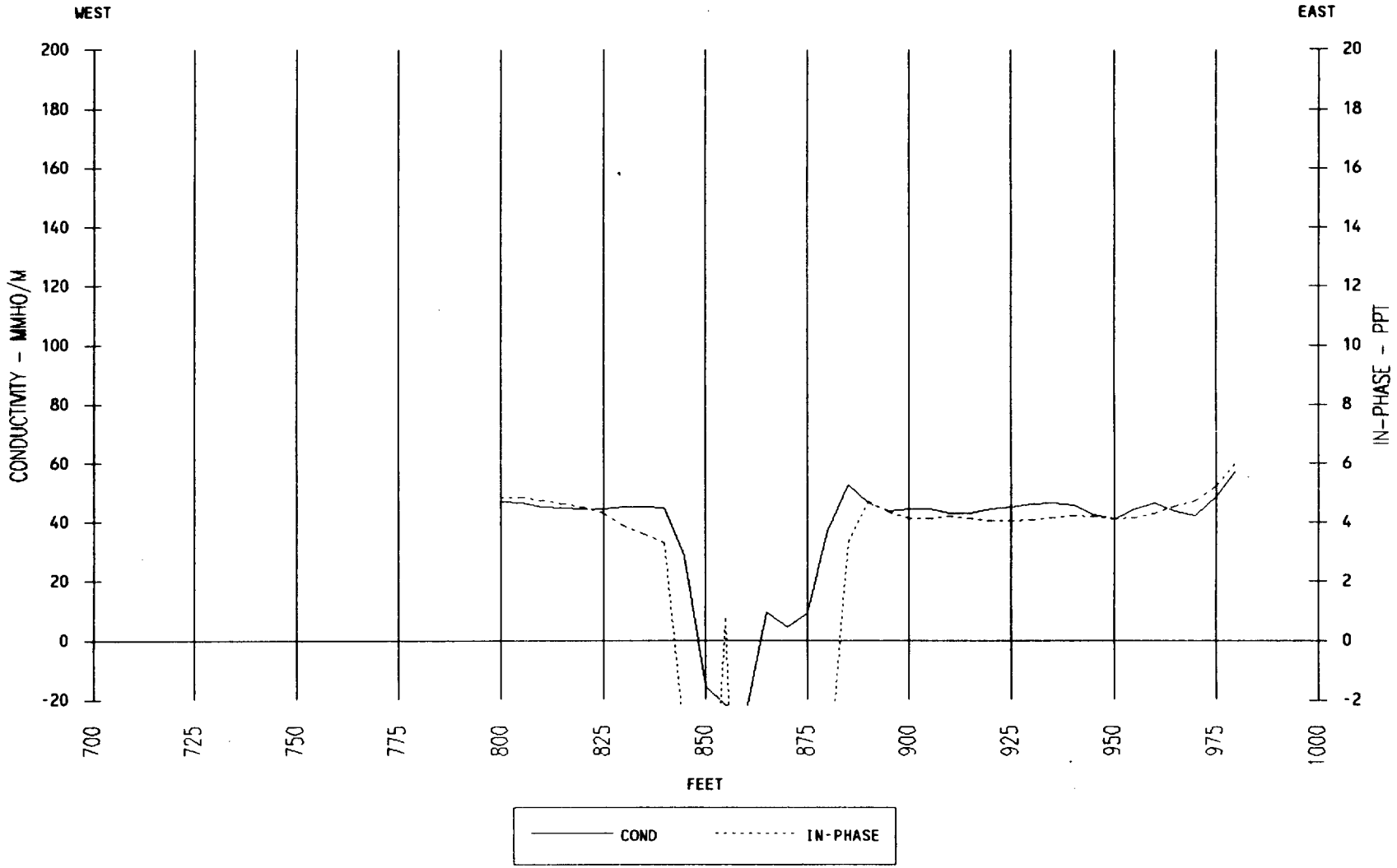
PERIMETER ROAD LANDFILL

LINE 800



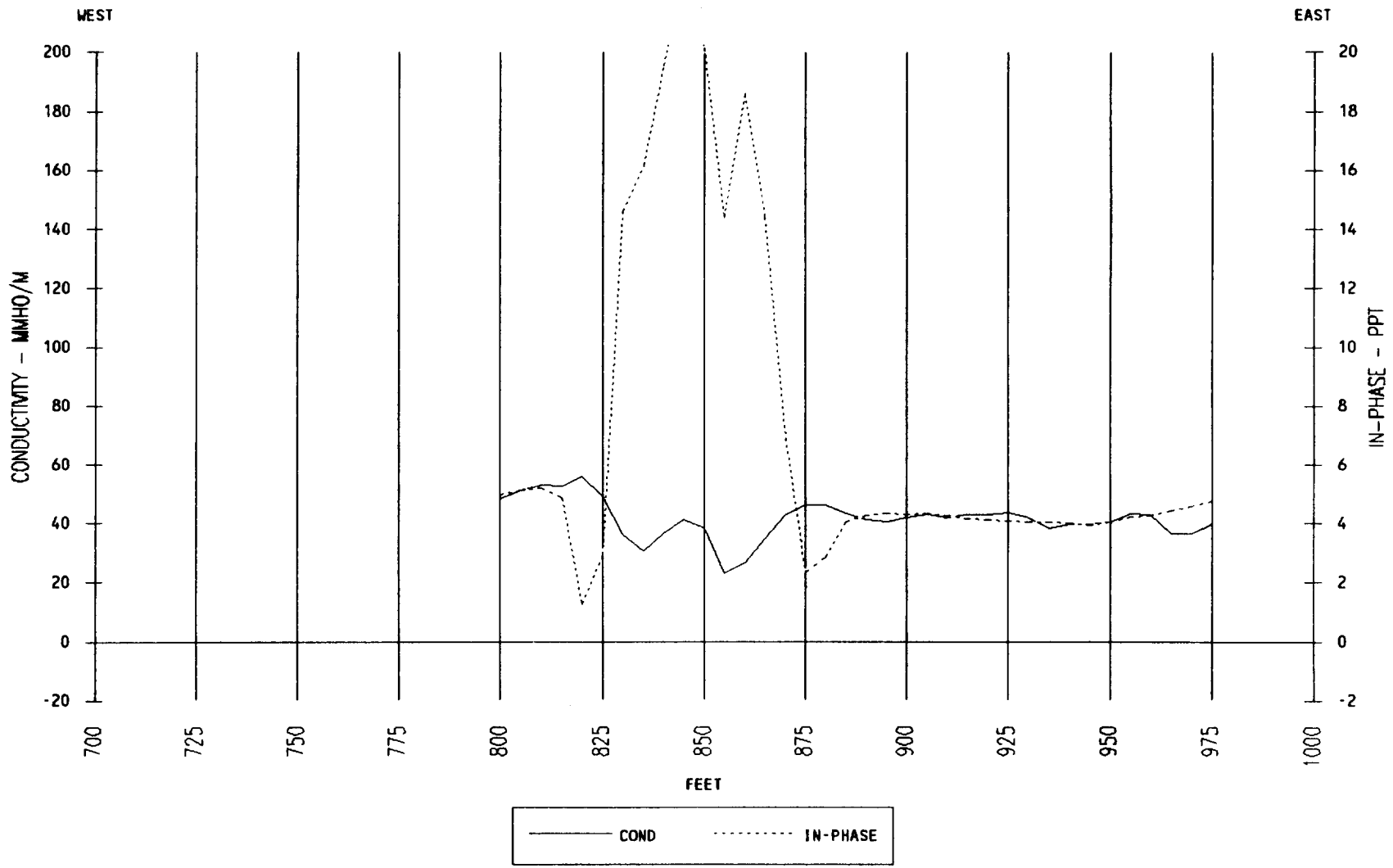
PERIMETER ROAD LANDFILL

LINE 750



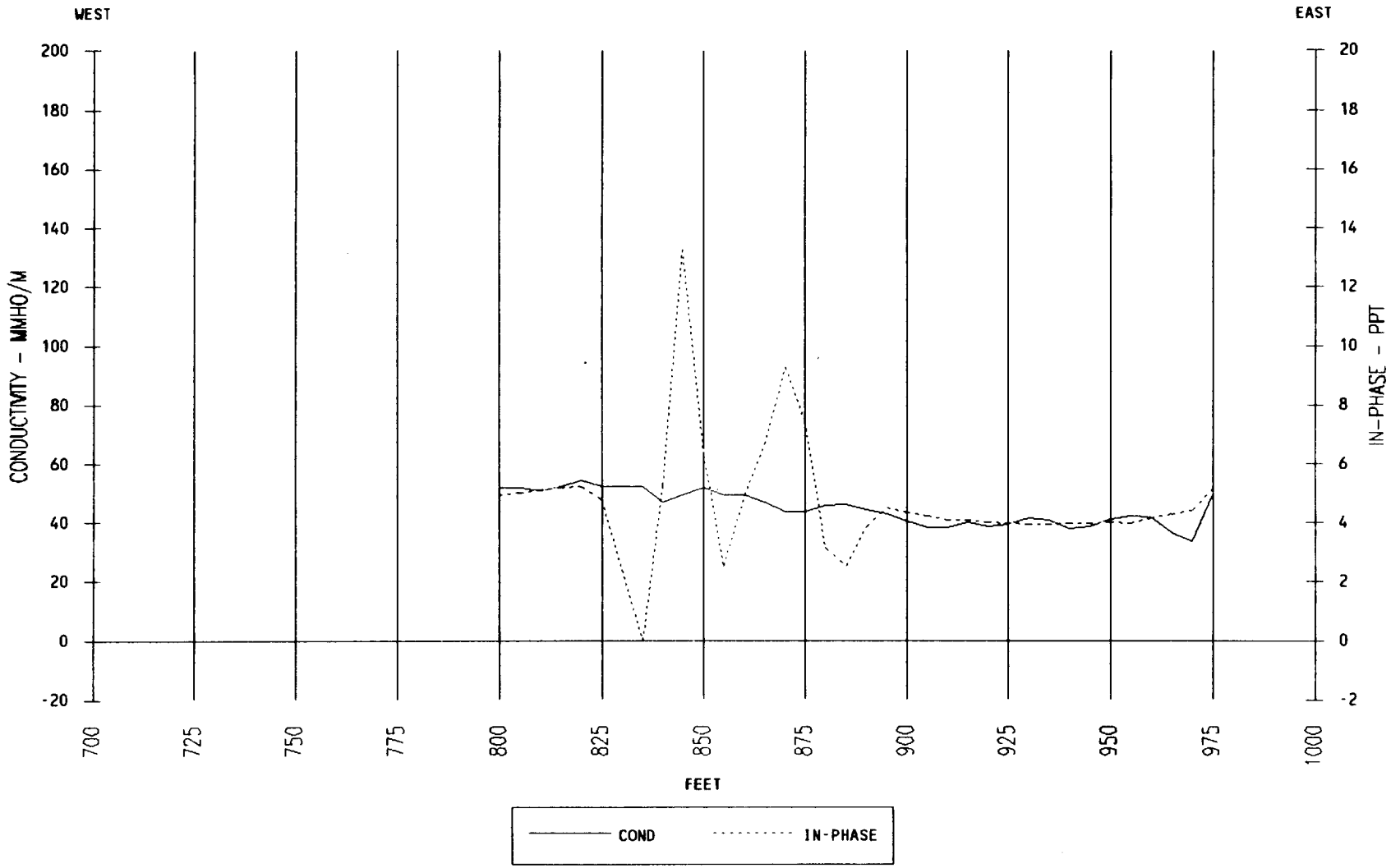
PERIMETER ROAD LANDFILL

LINE 700



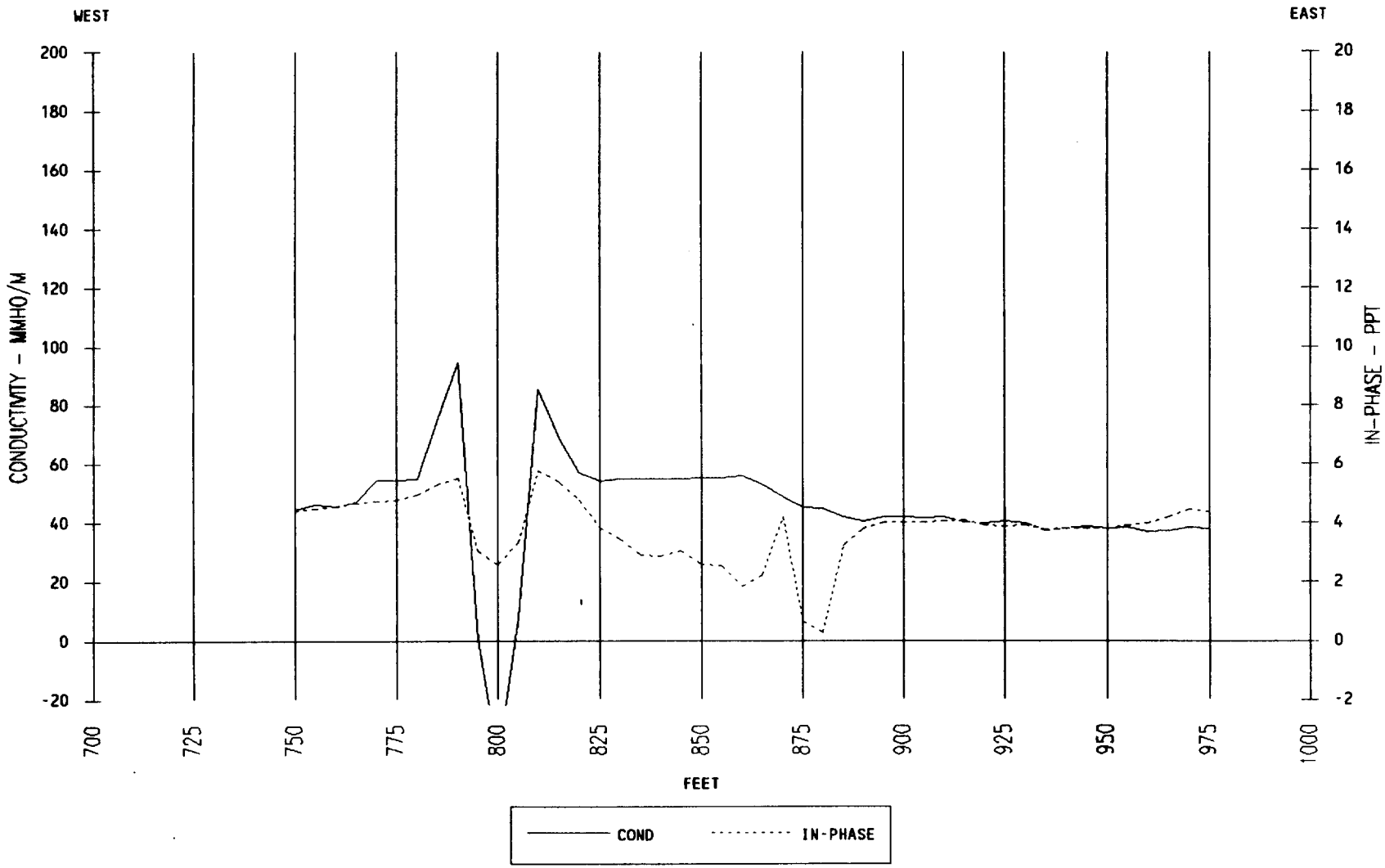
PERIMETER ROAD LANDFILL

LINE 650



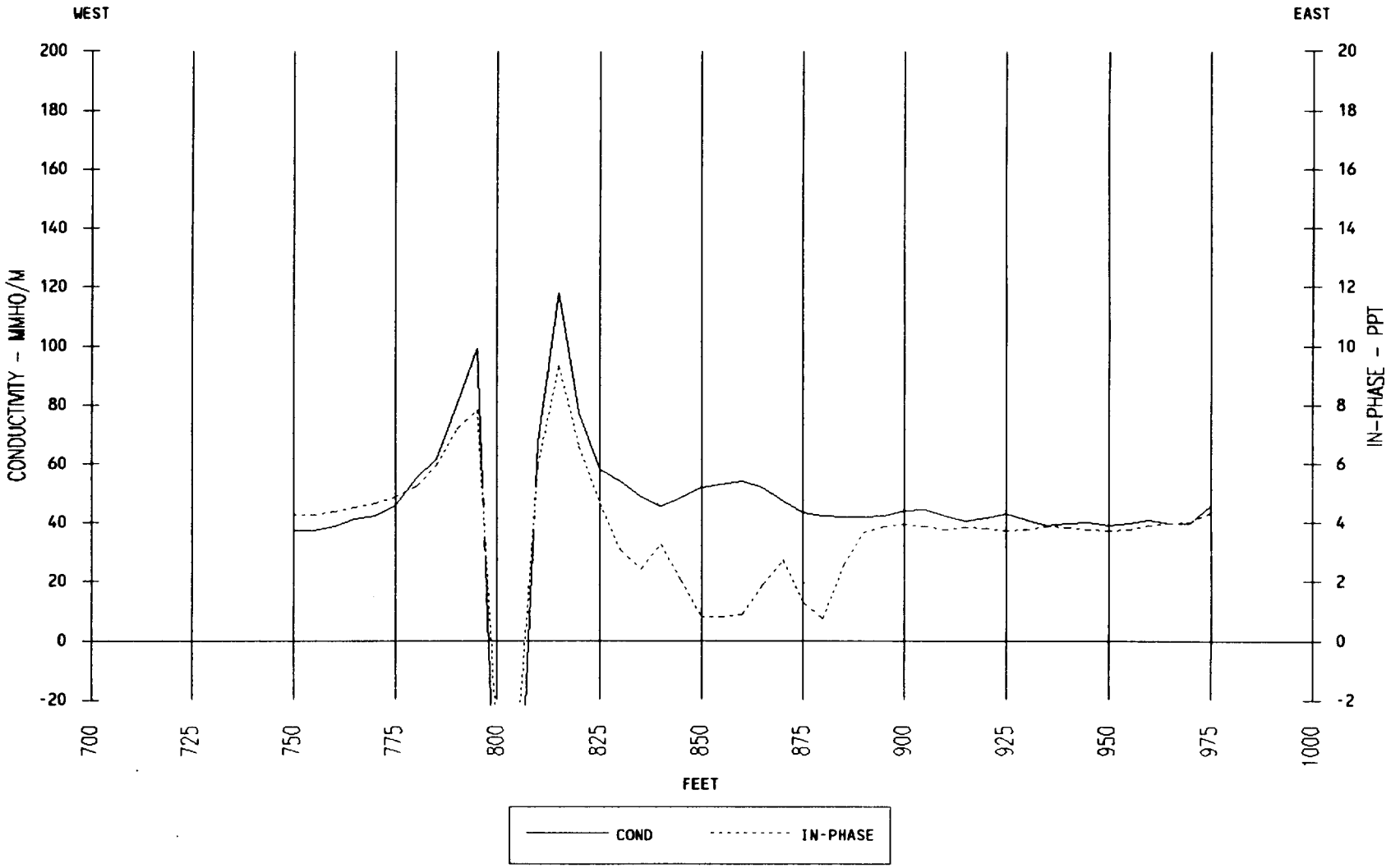
PERIMETER ROAD LANDFILL

LINE 600



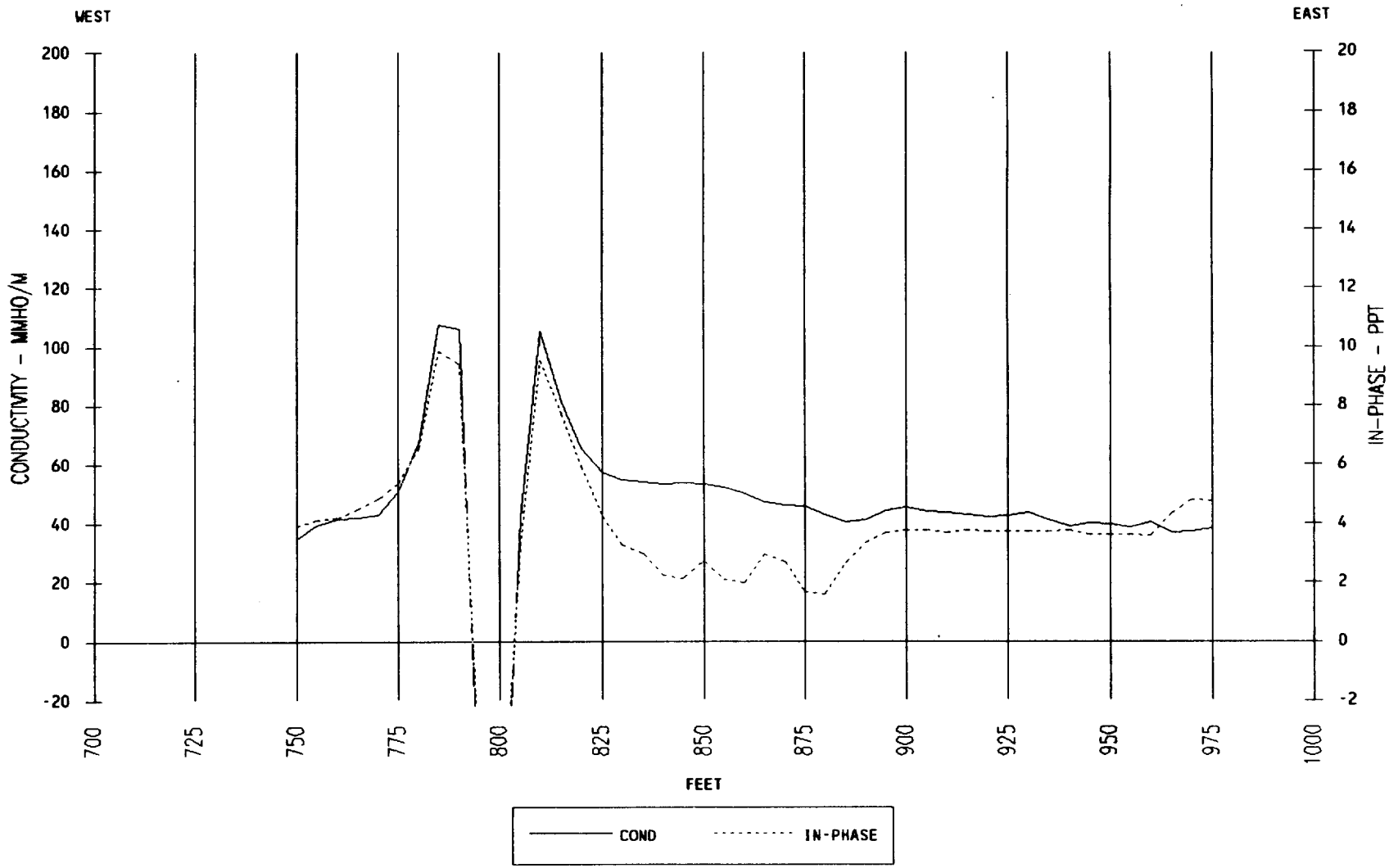
PERIMETER ROAD LANDFILL

LINE 550



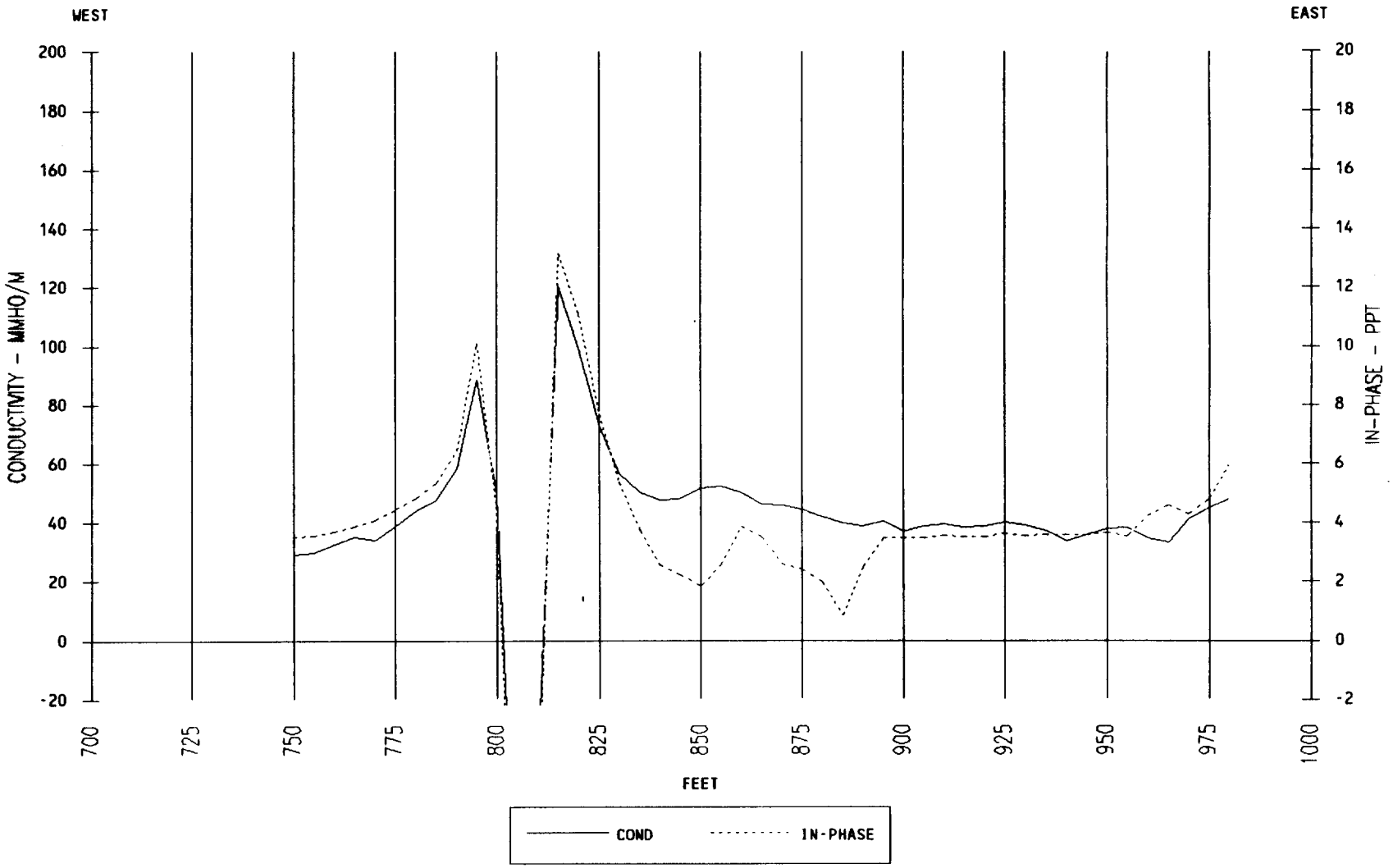
PERIMETER ROAD LANDFILL

LINE 500



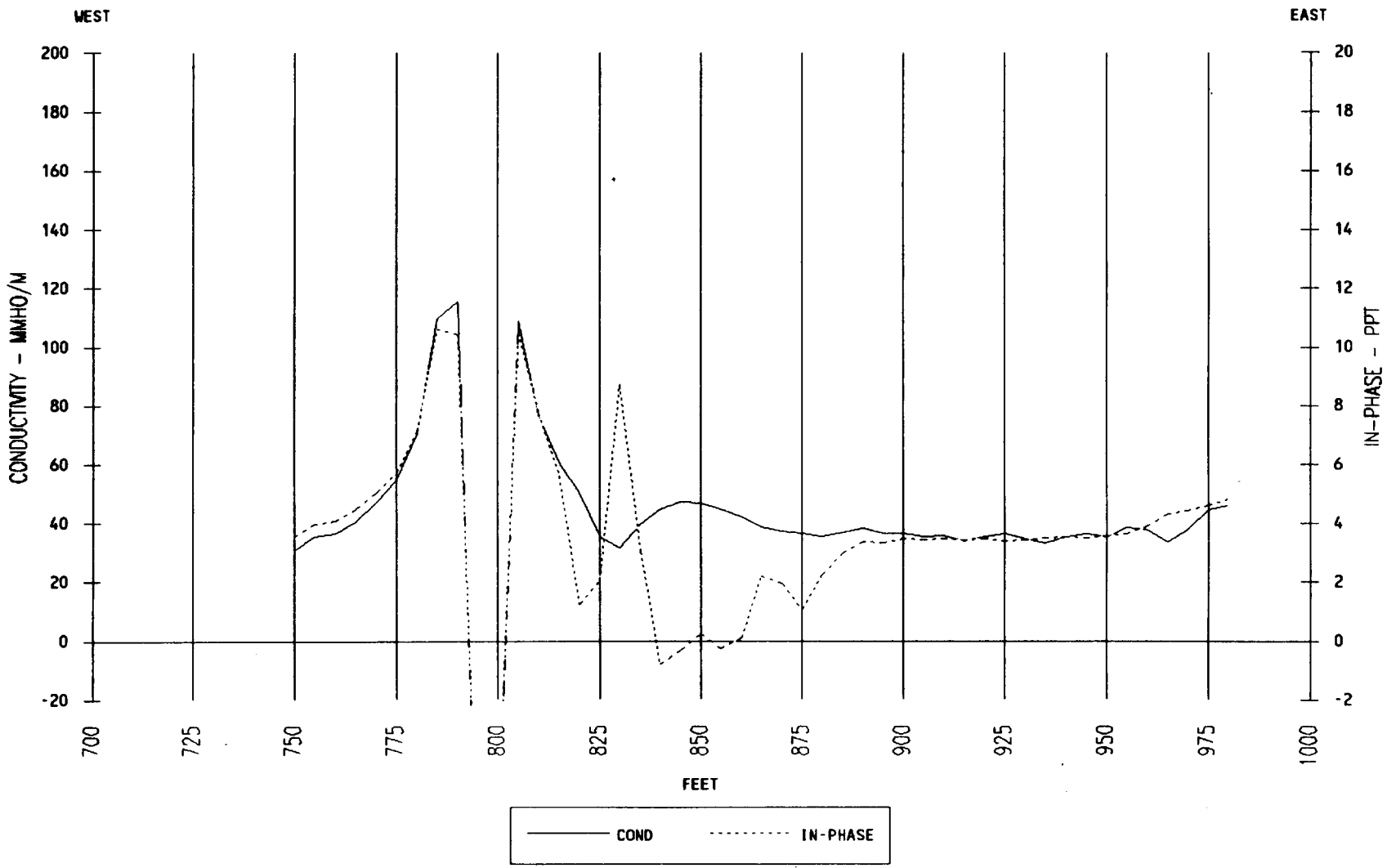
PERIMETER ROAD LANDFILL

LINE 450



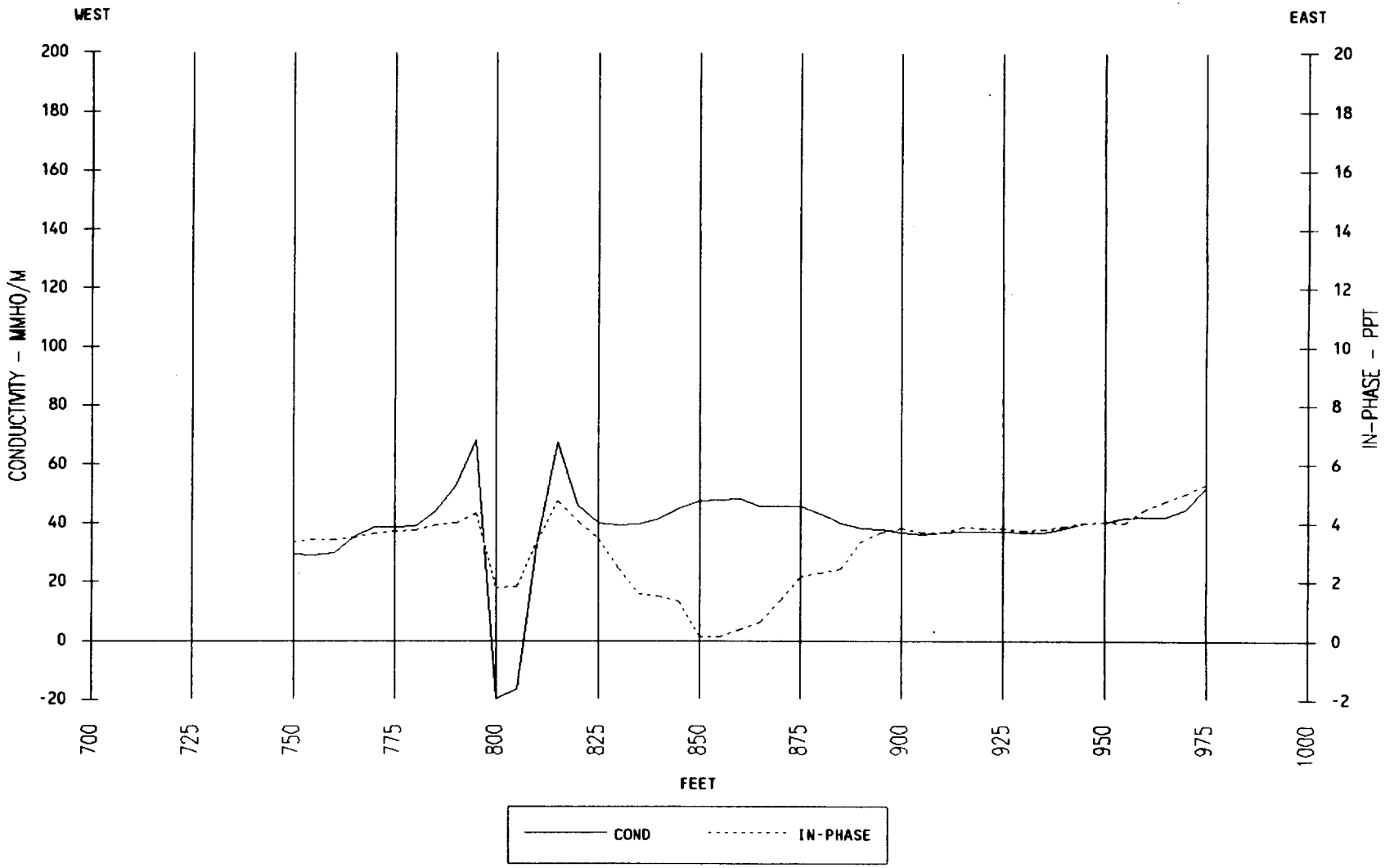
PERIMETER ROAD LANDFILL

LINE 400



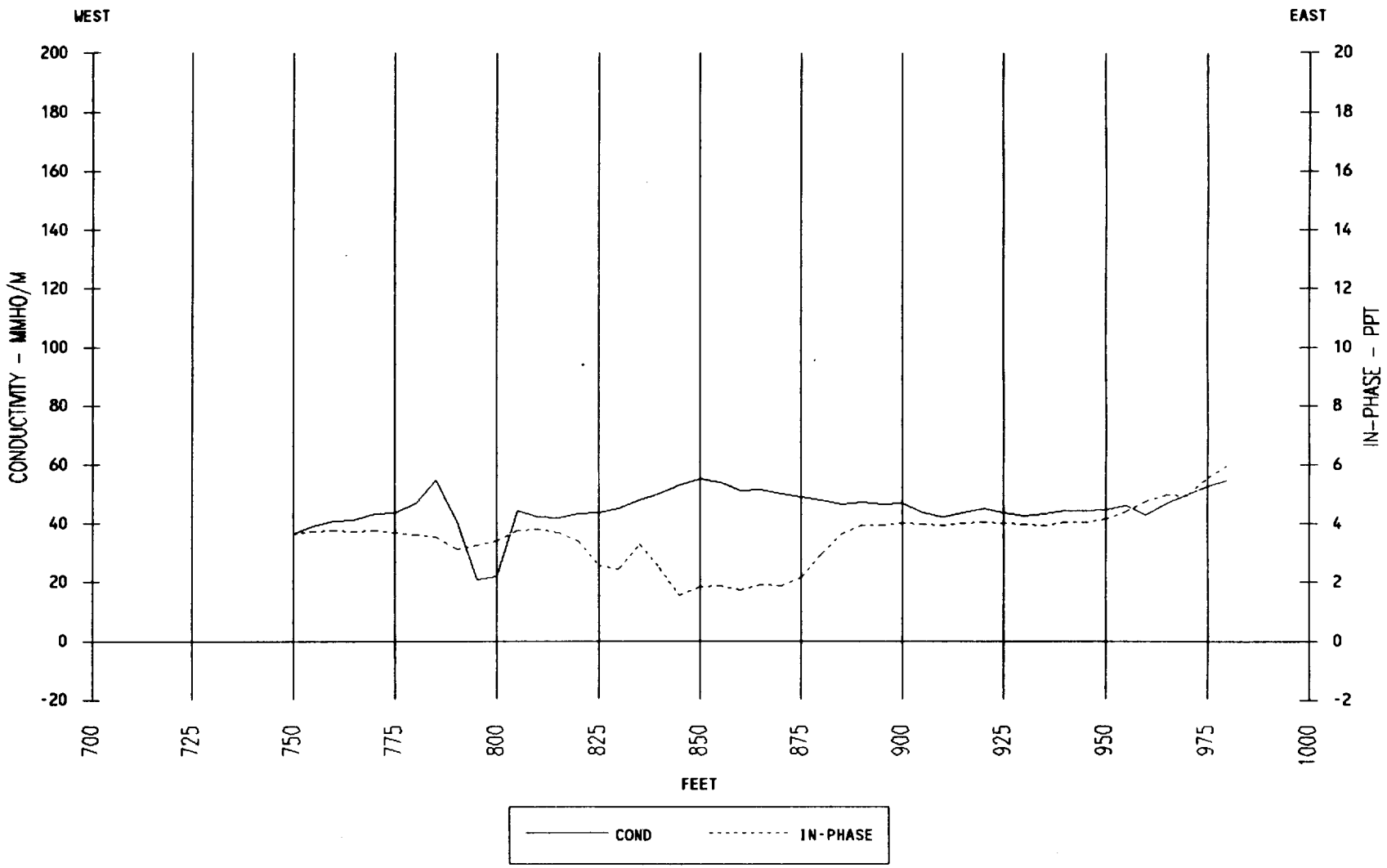
PERIMETER ROAD LANDFILL

LINE 350



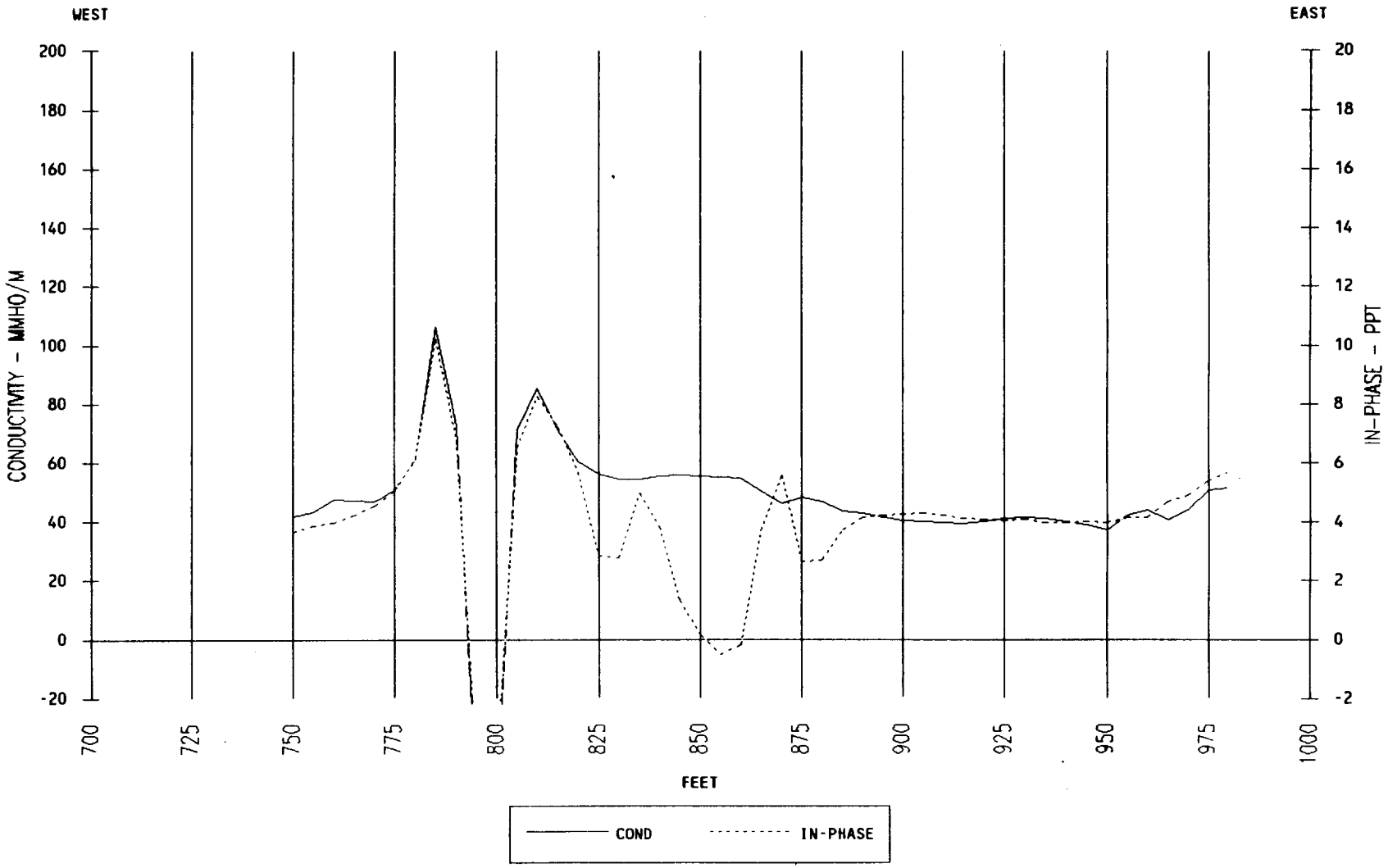
PERIMETER ROAD LANDFILL

LINE 300



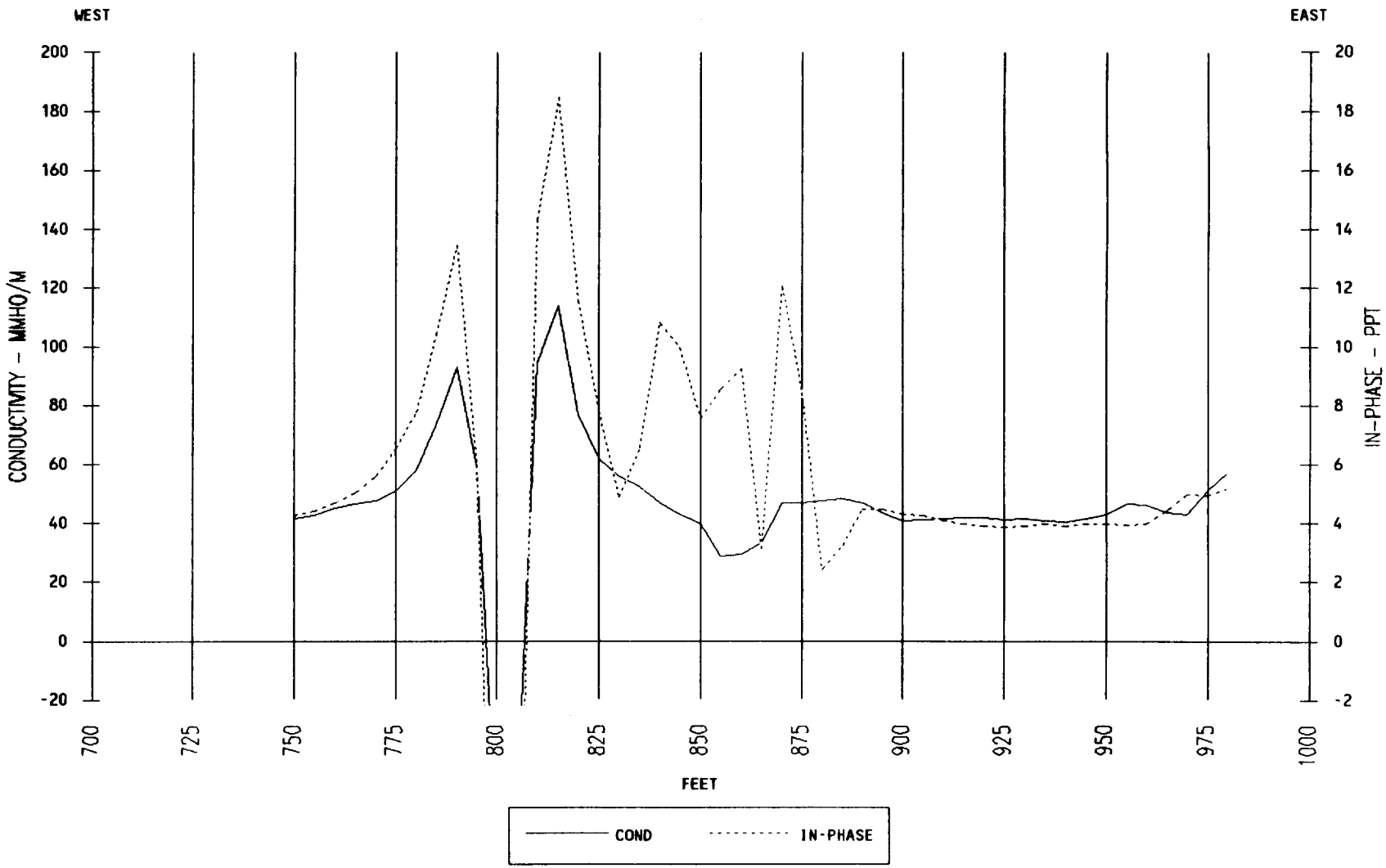
PERIMETER ROAD LANDFILL

LINE 250



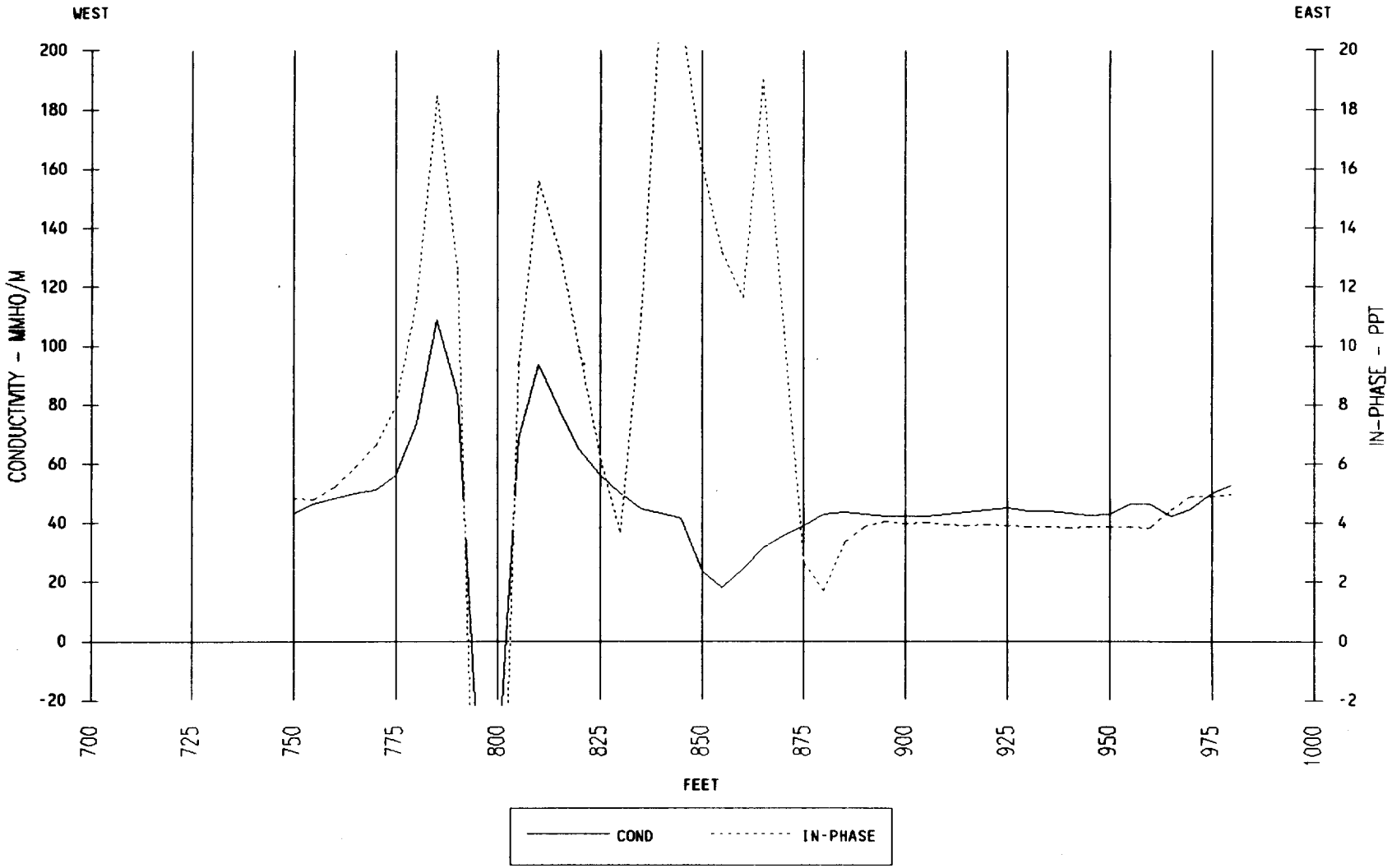
PERIMETER ROAD LANDFILL

LINE 200



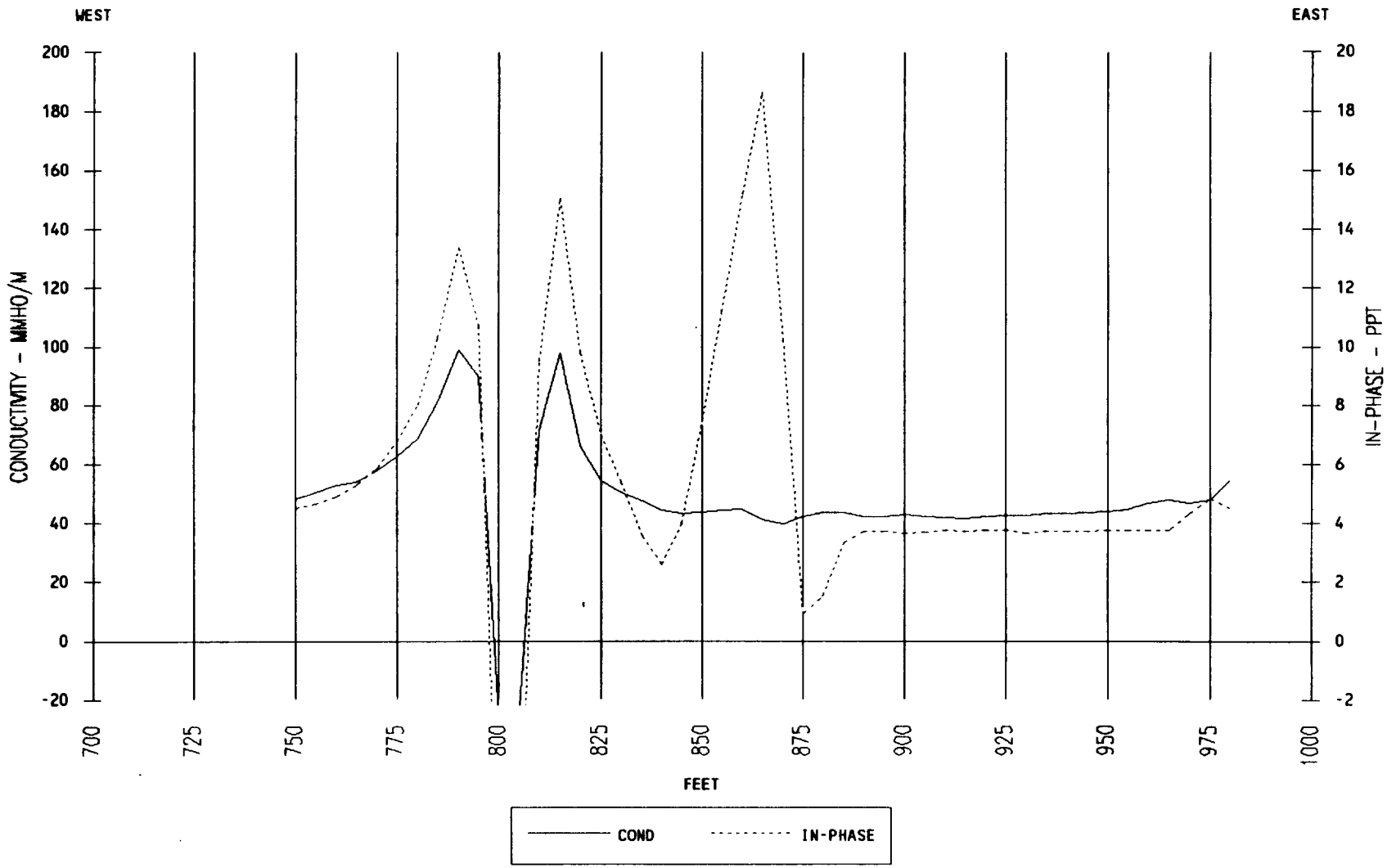
PERIMETER ROAD LANDFILL

LINE 150



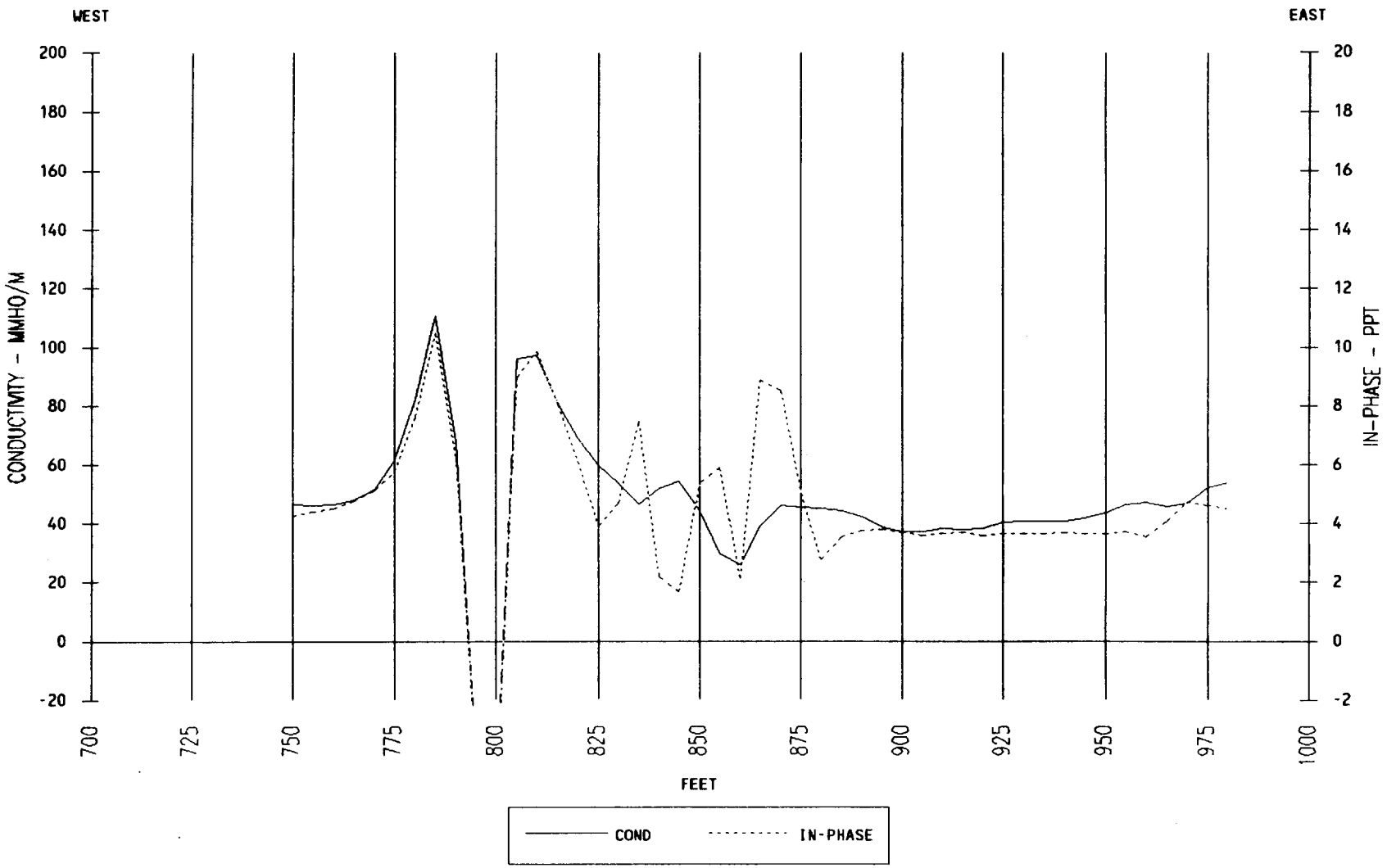
PERIMETER ROAD LANDFILL

LINE 100



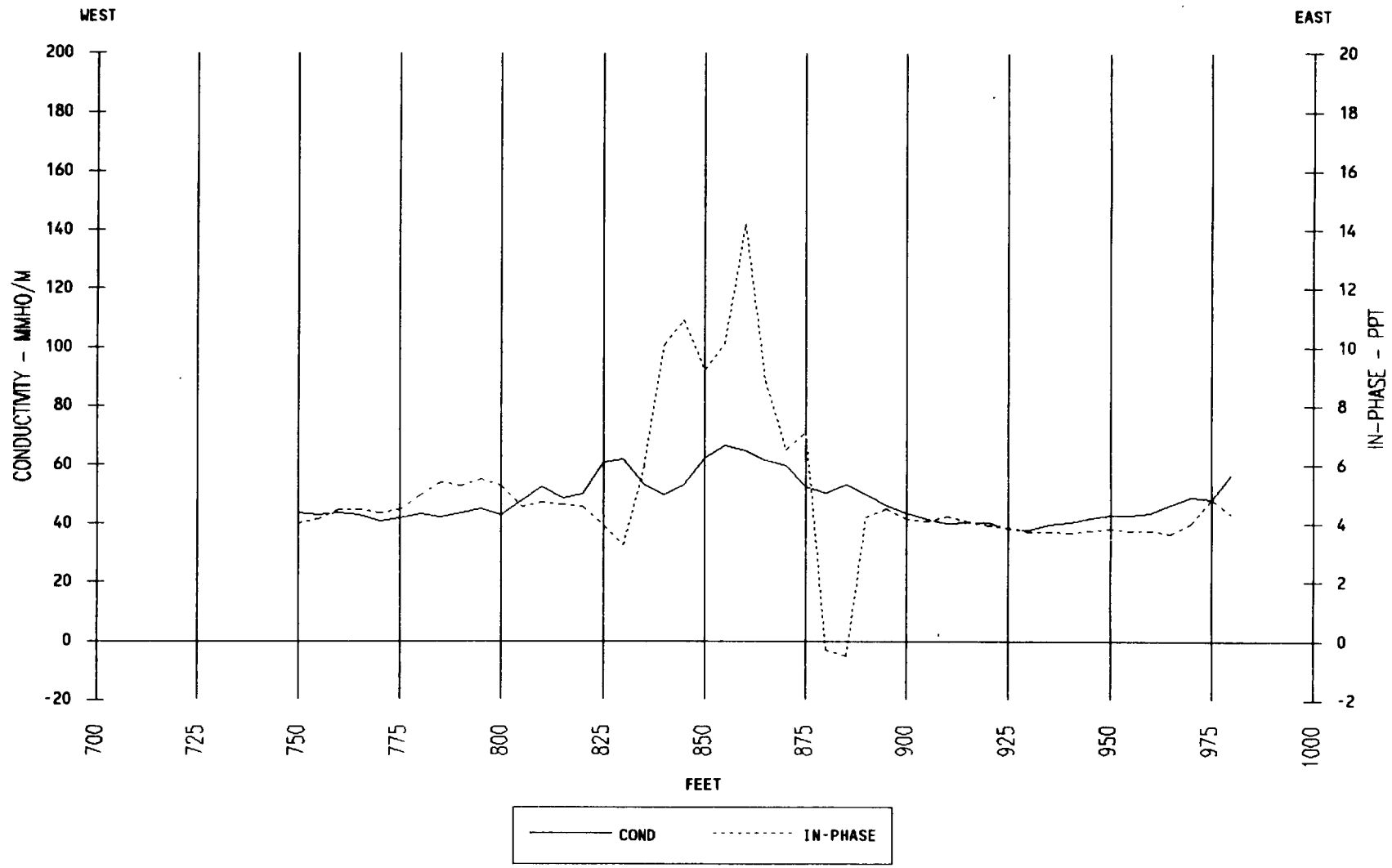
PERIMETER ROAD LANDFILL

LINE 50



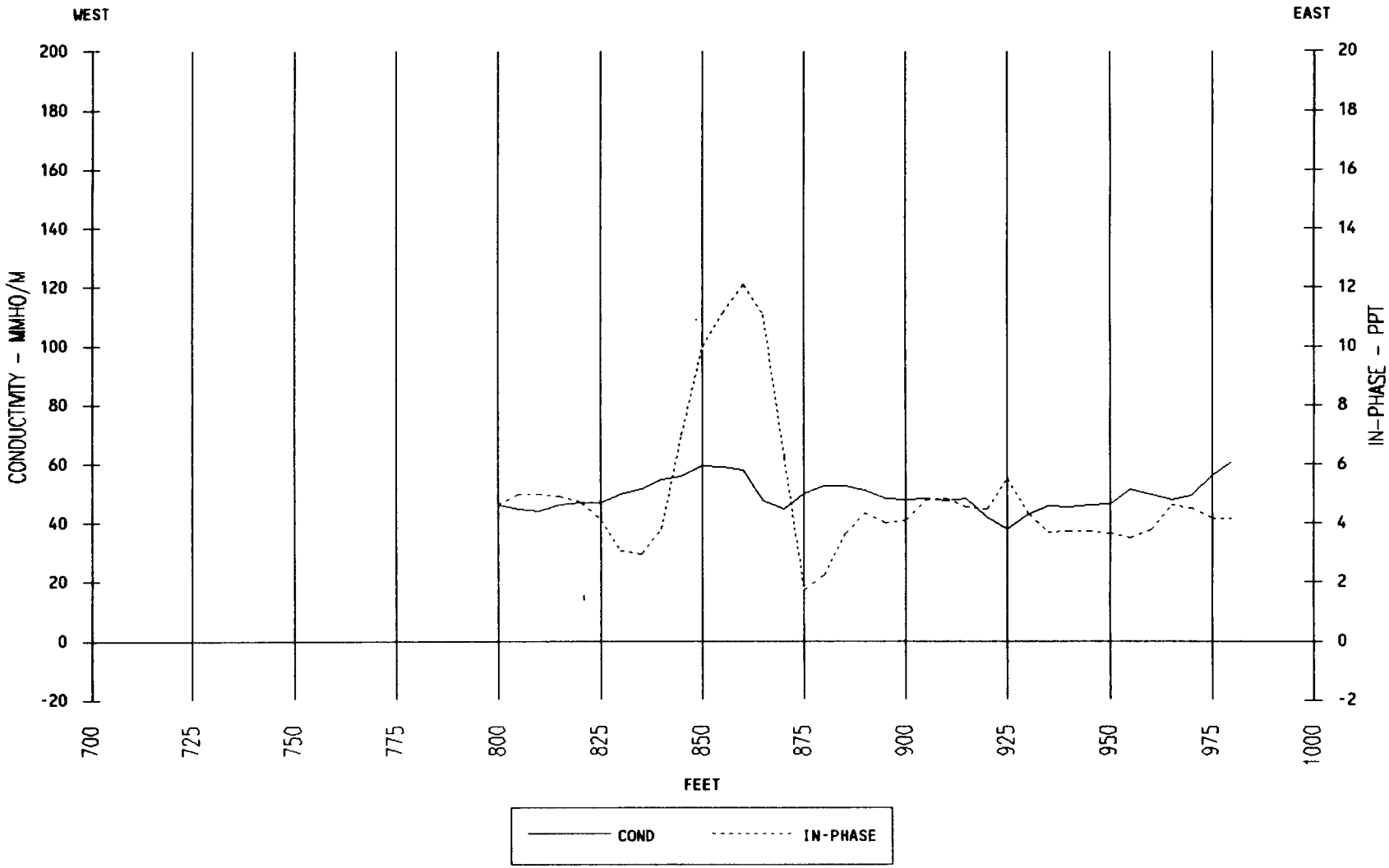
PERIMETER ROAD LANDFILL

LINE 0



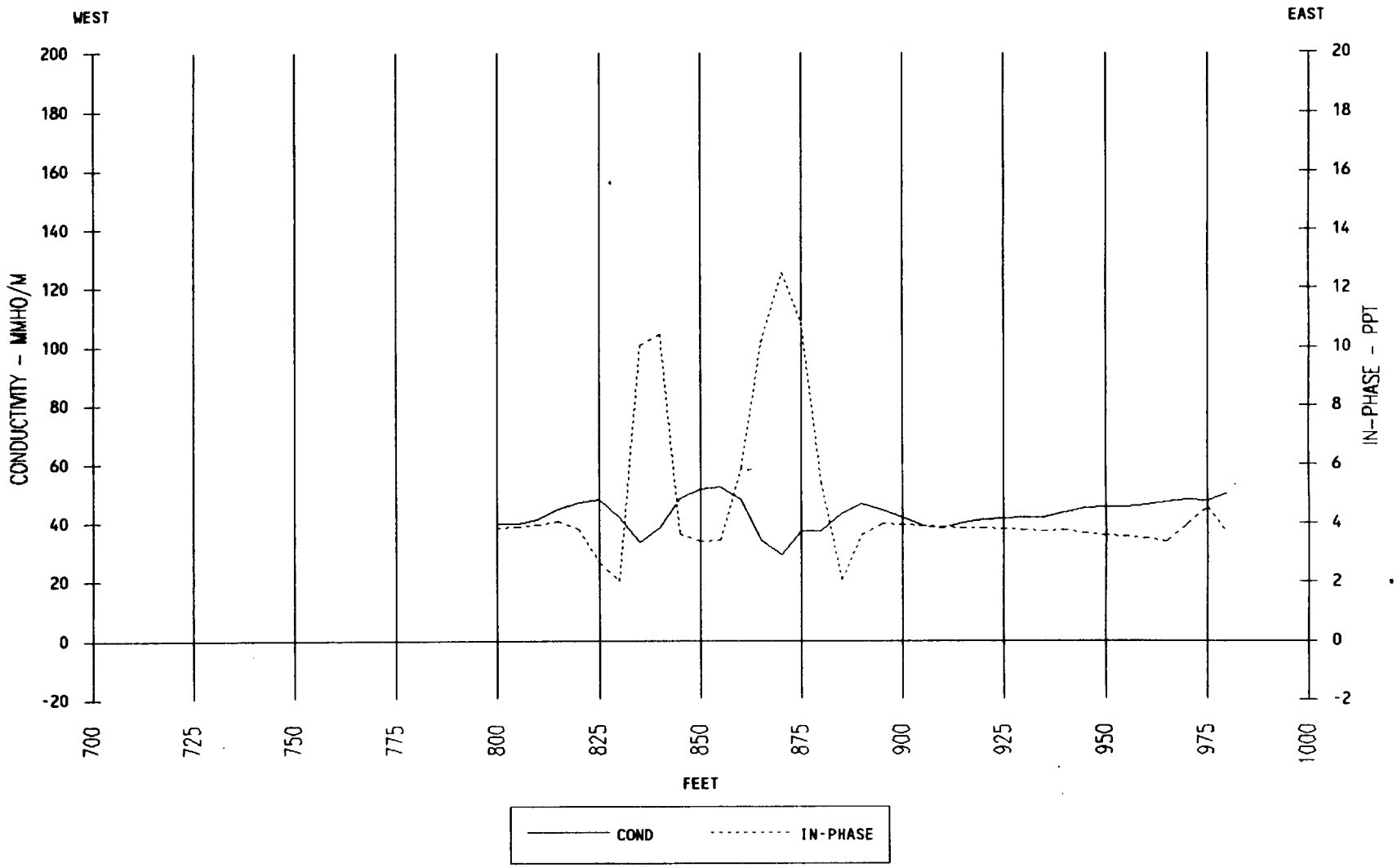
PERIMETER ROAD LANDFILL

LINE -50



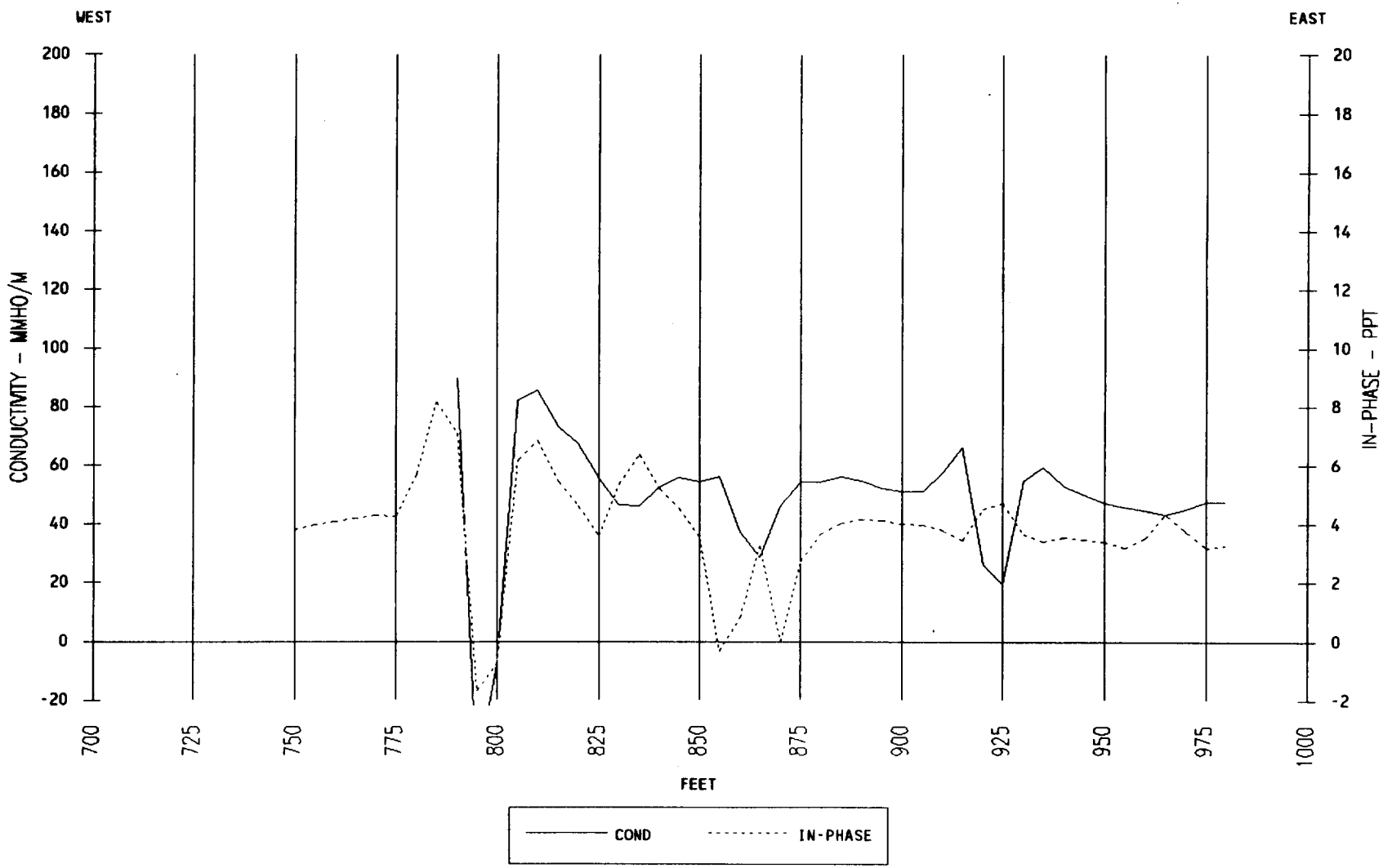
PERIMETER ROAD LANDFILL

LINE -100



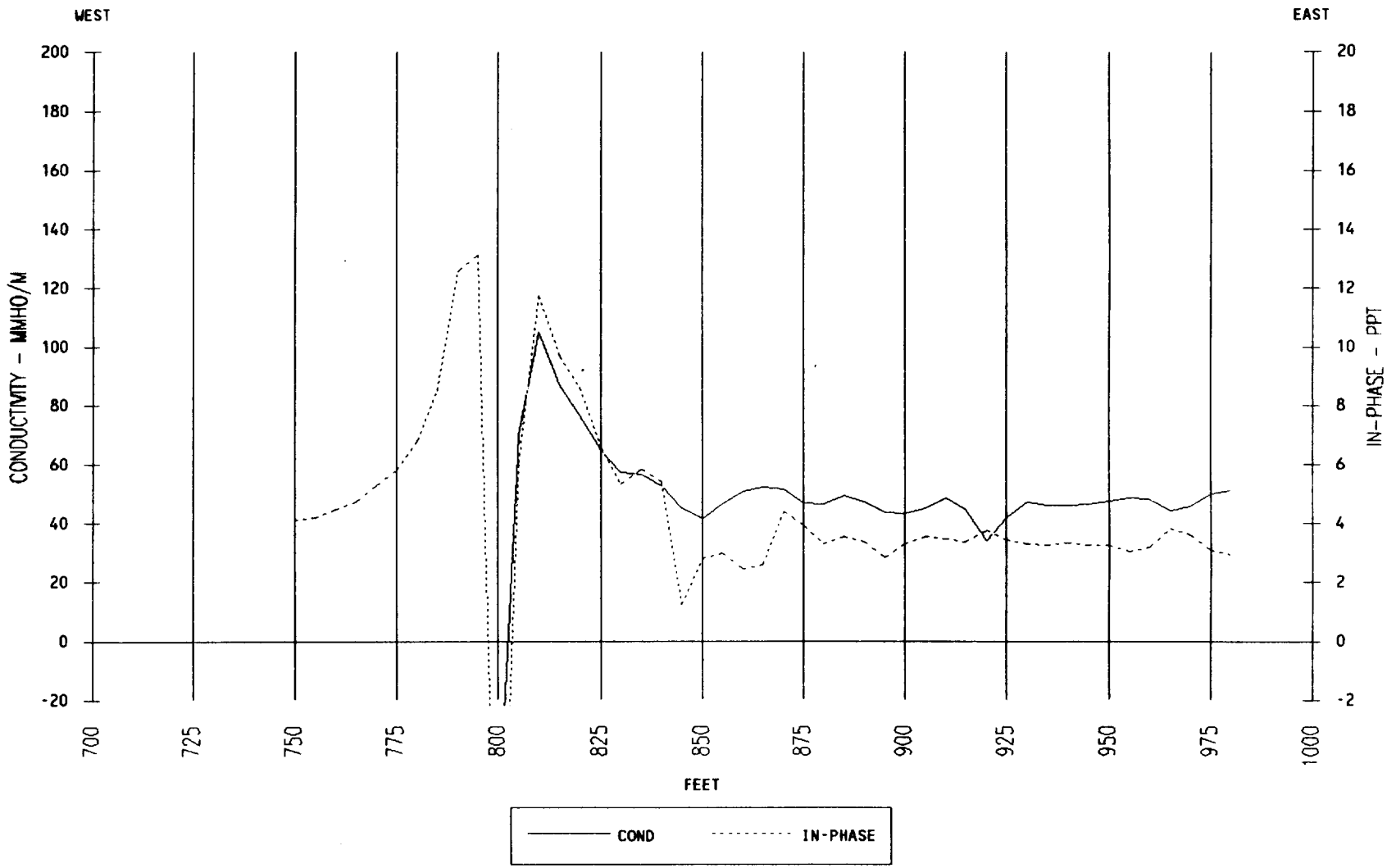
PERIMETER ROAD LANDFILL

LINE -150



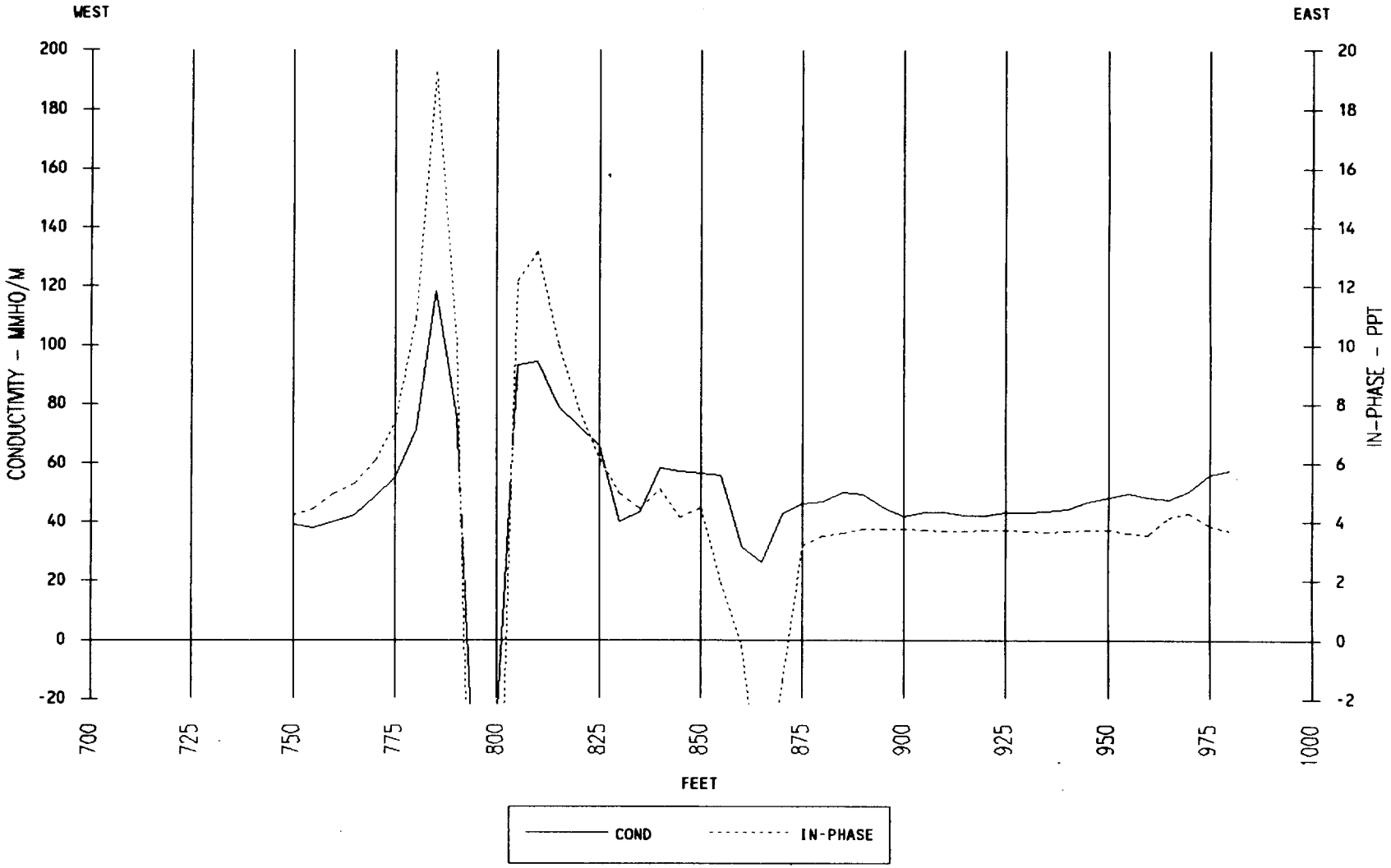
PERIMETER ROAD LANDFILL

LINE -200



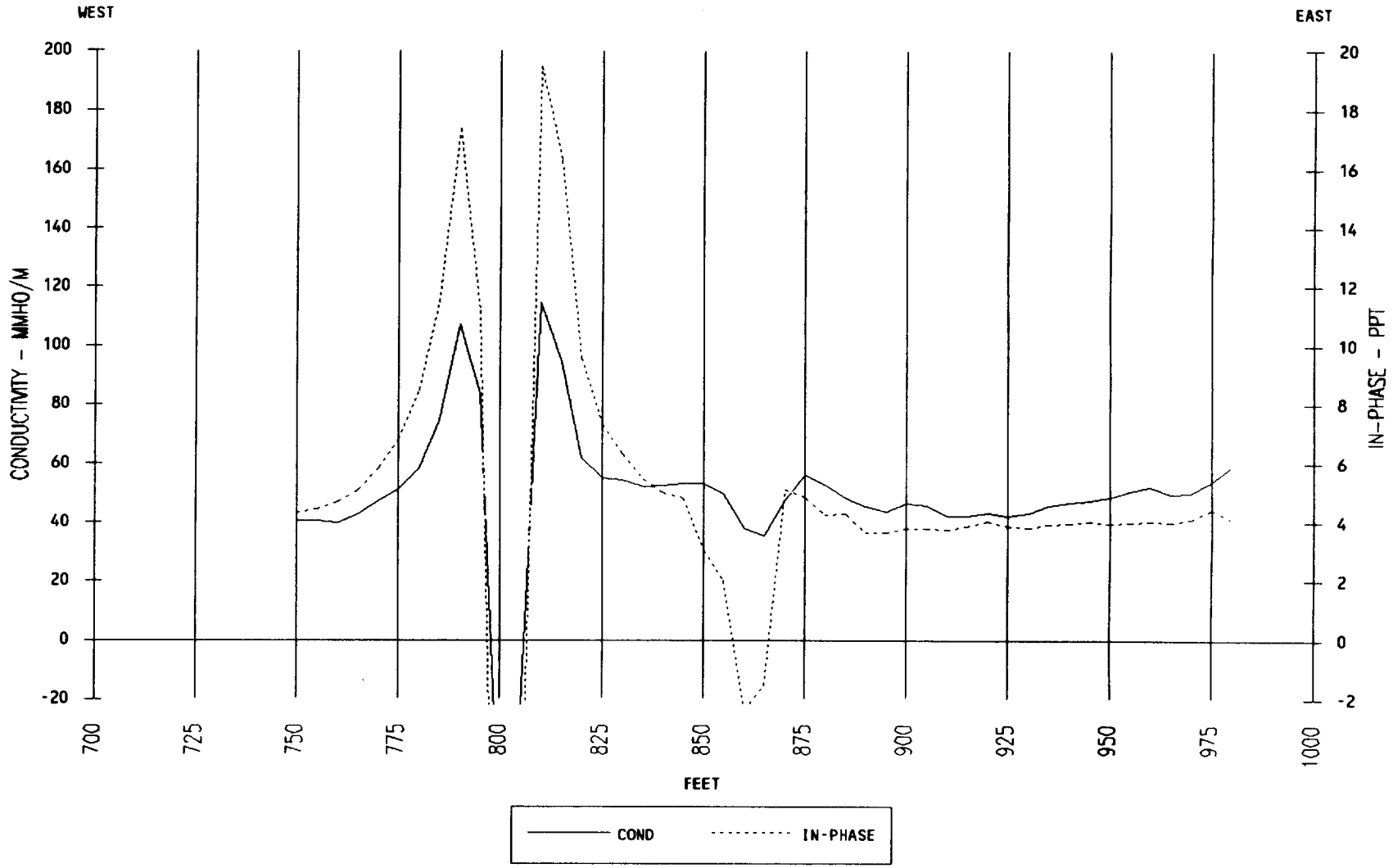
PERIMETER ROAD LANDFILL

LINE -250



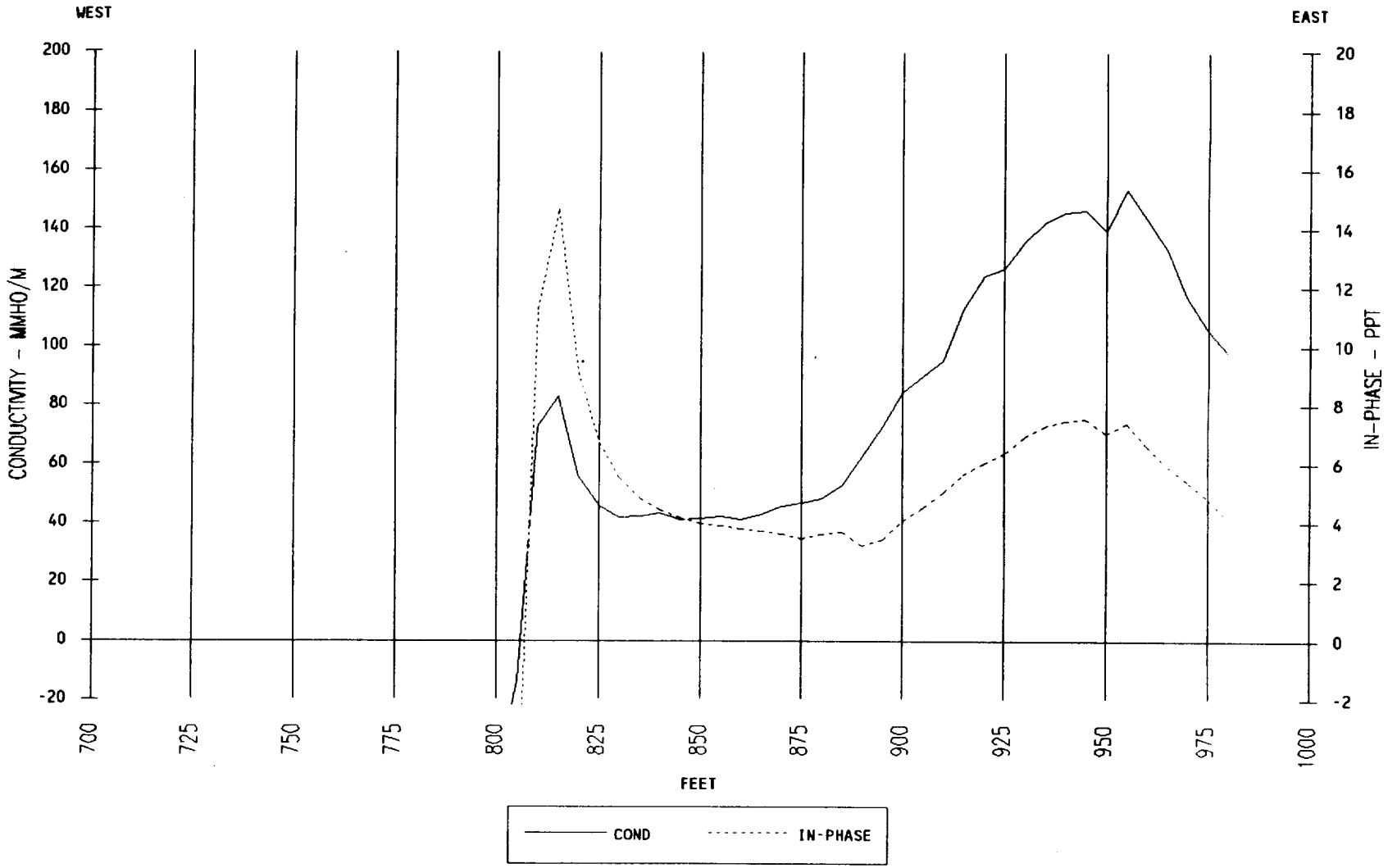
PERIMETER ROAD LANDFILL

LINE -300



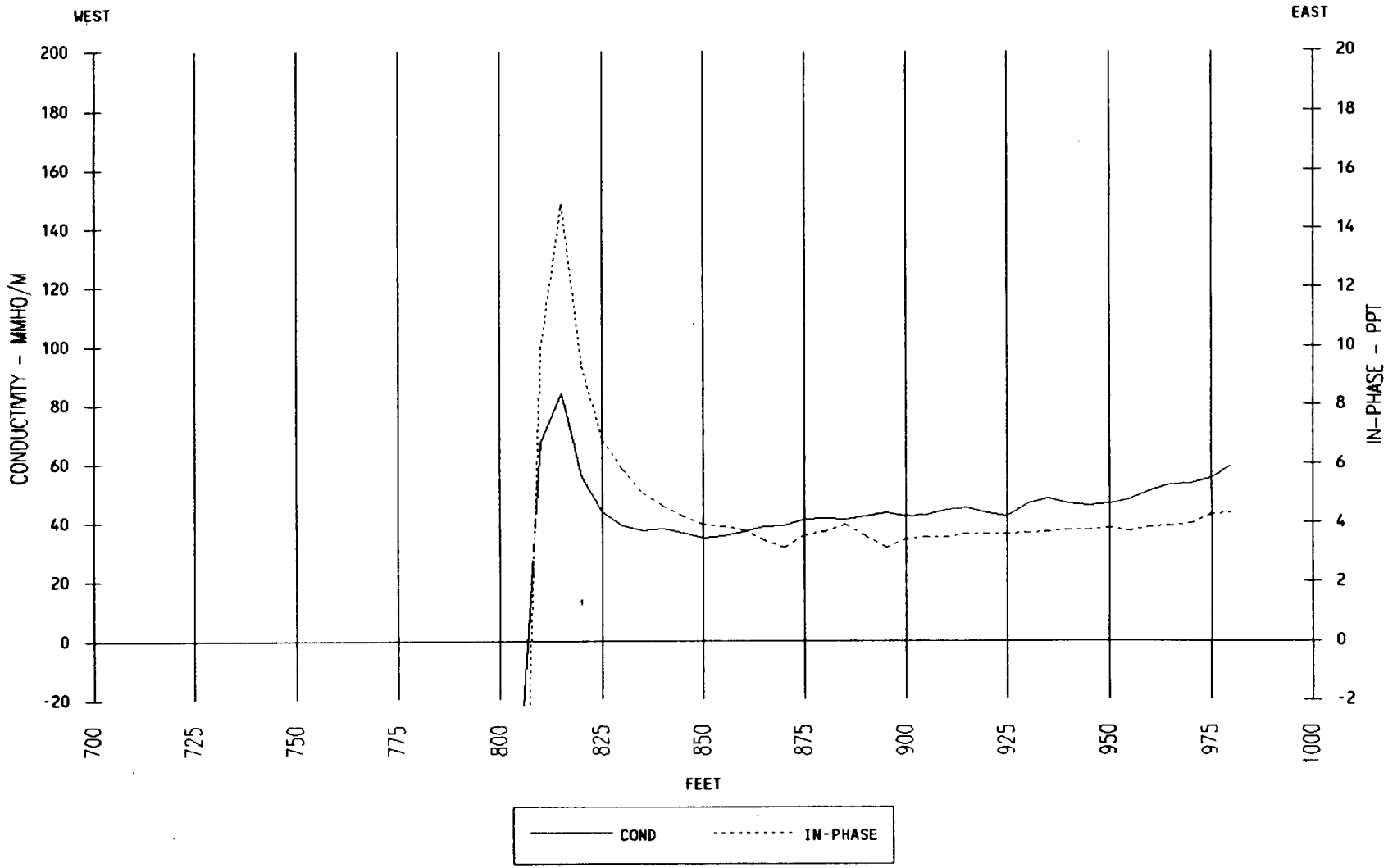
PERIMETER ROAD LANDFILL

LINE -350



PERIMETER ROAD LANDFILL

LINE -400

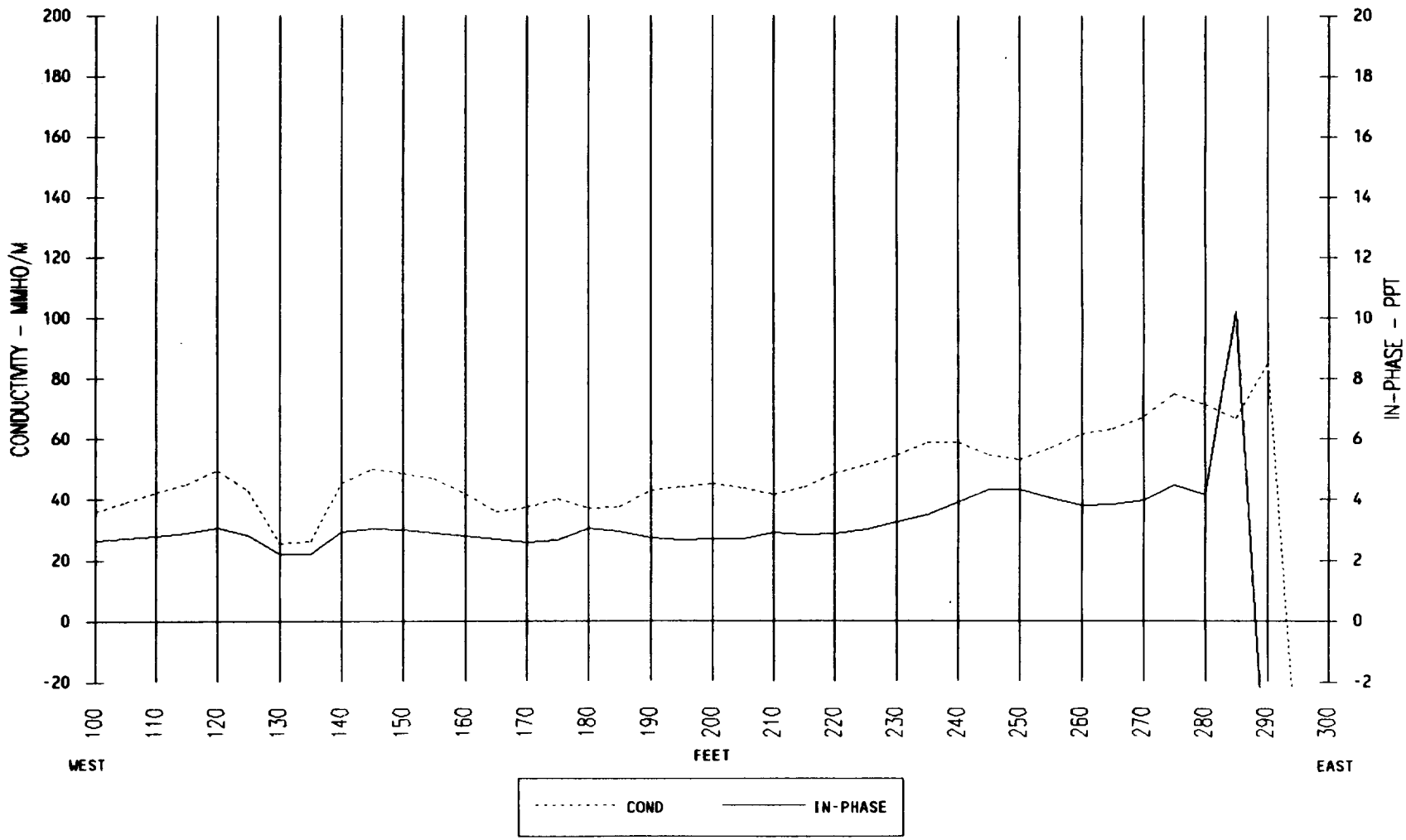


Attachment E

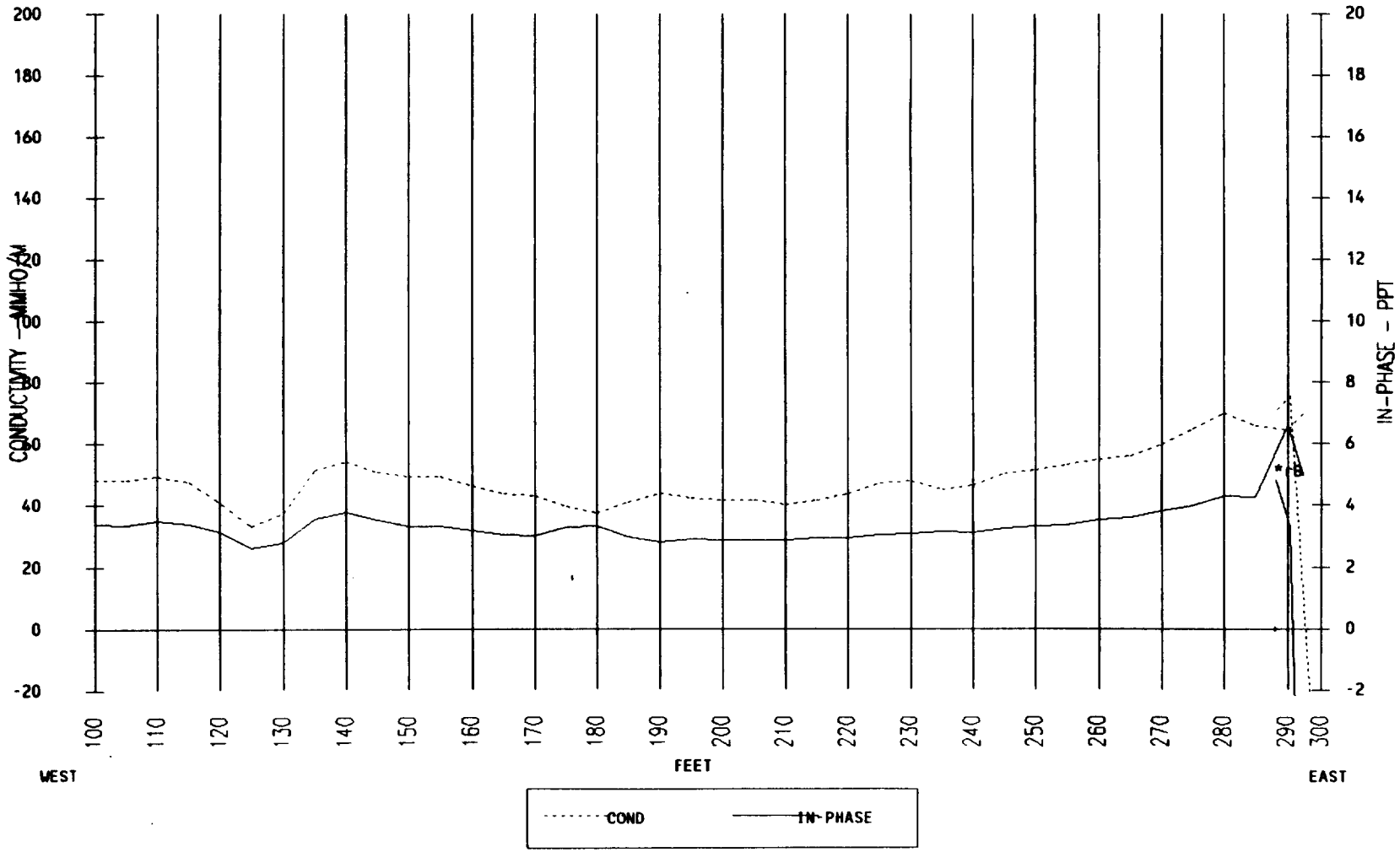
CRASH CREW PIT No. 1

EM DATA

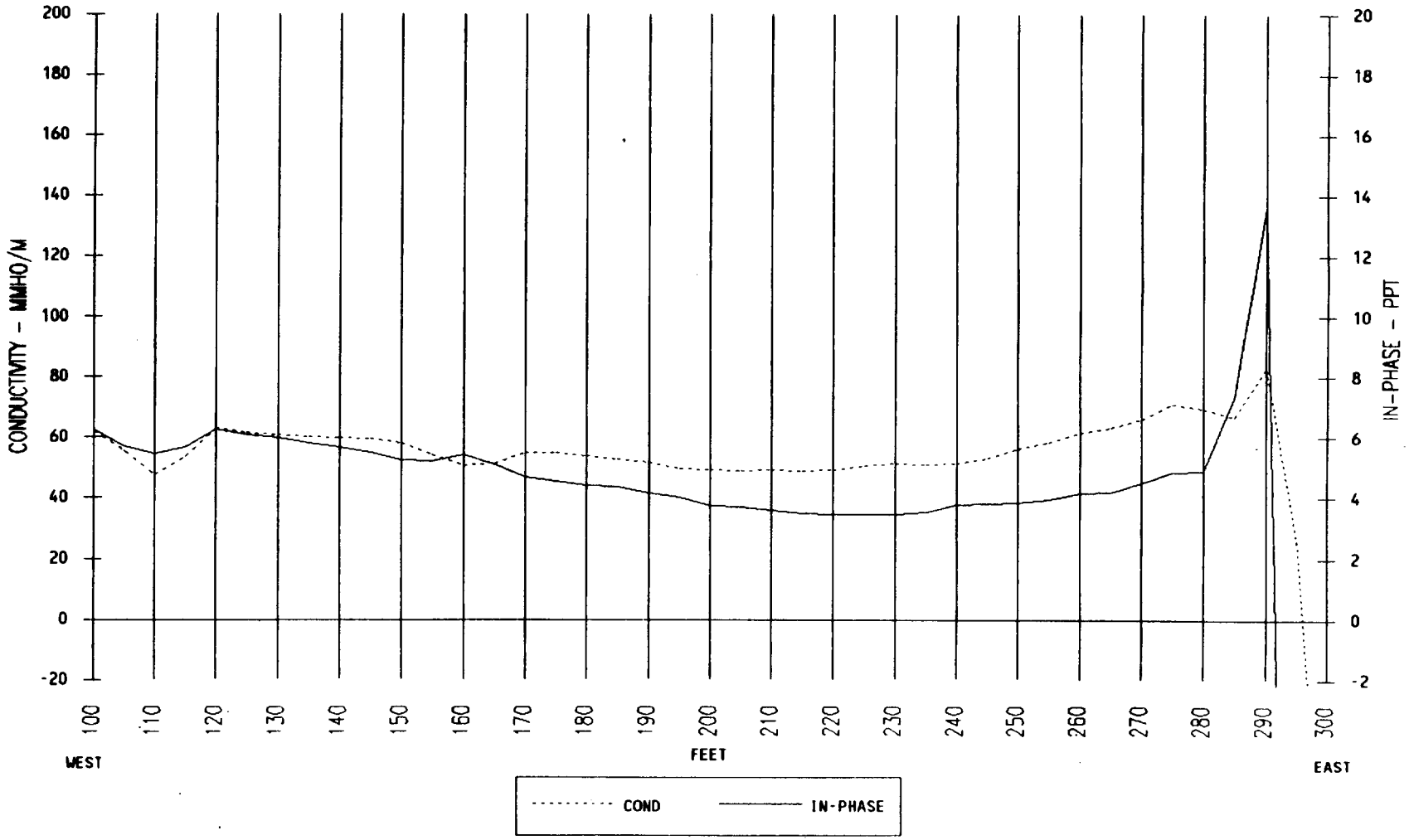
CRASH CREW PIT NO. 1 - LINE 100



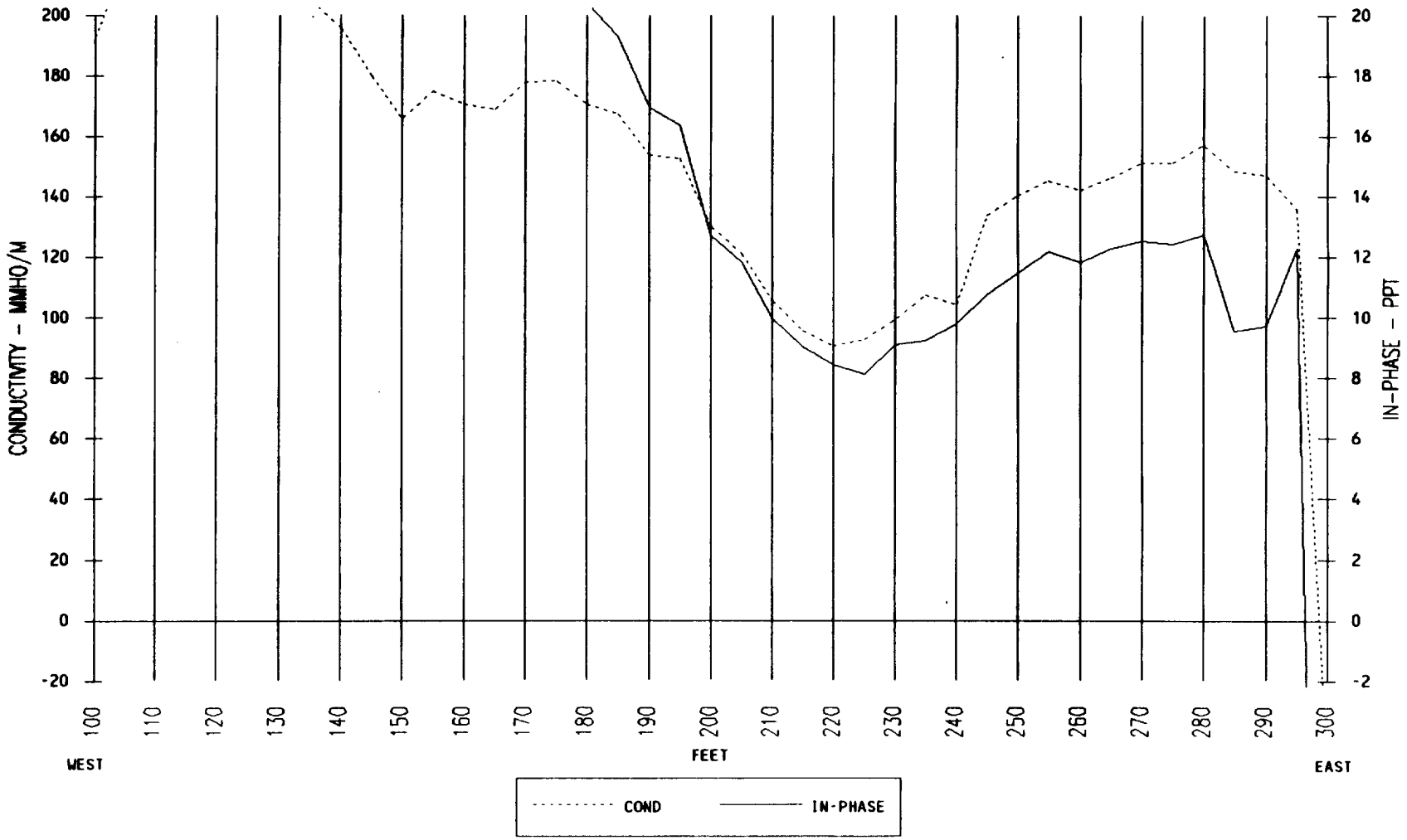
CRASH CREW PIT NO. 1 - LINE 120



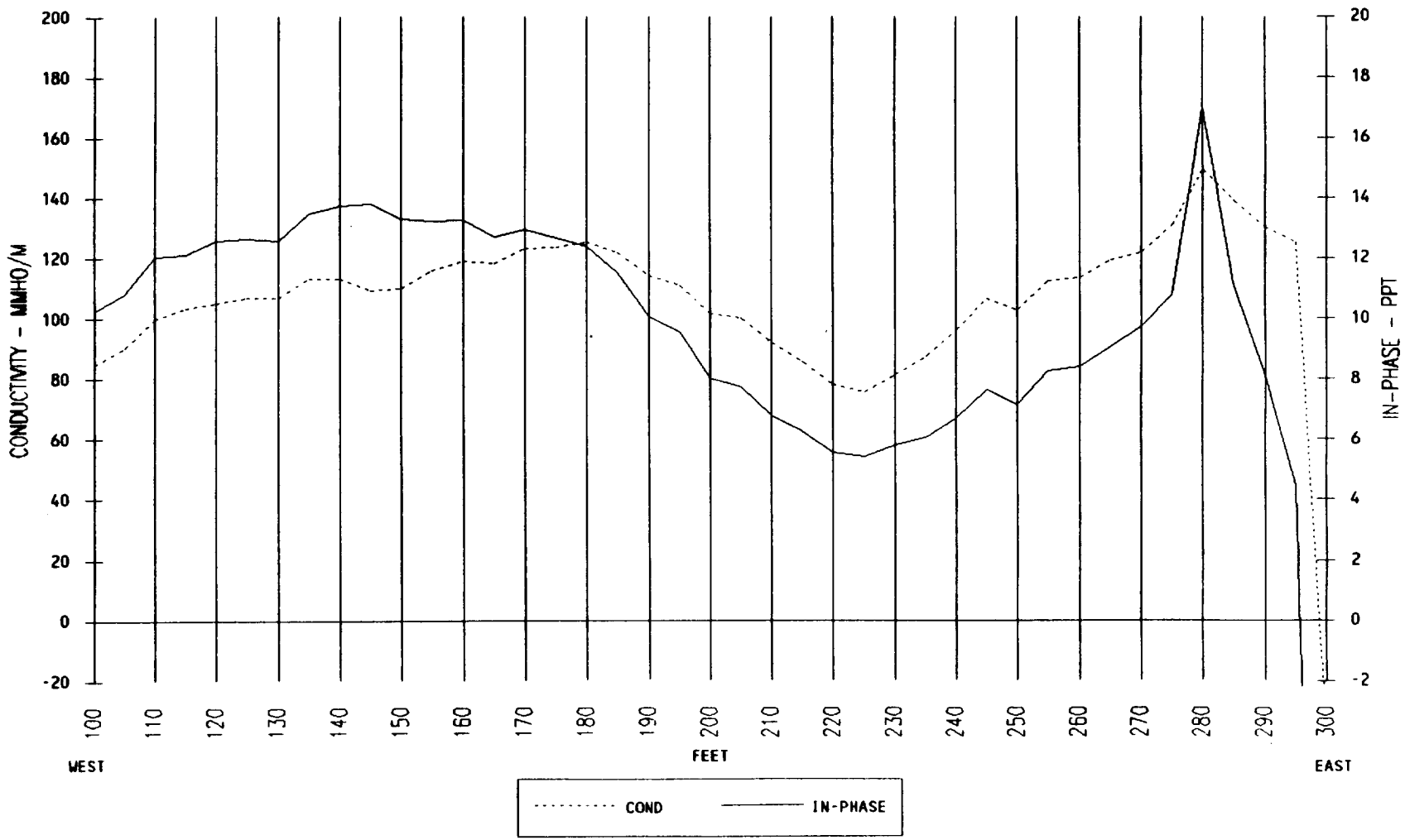
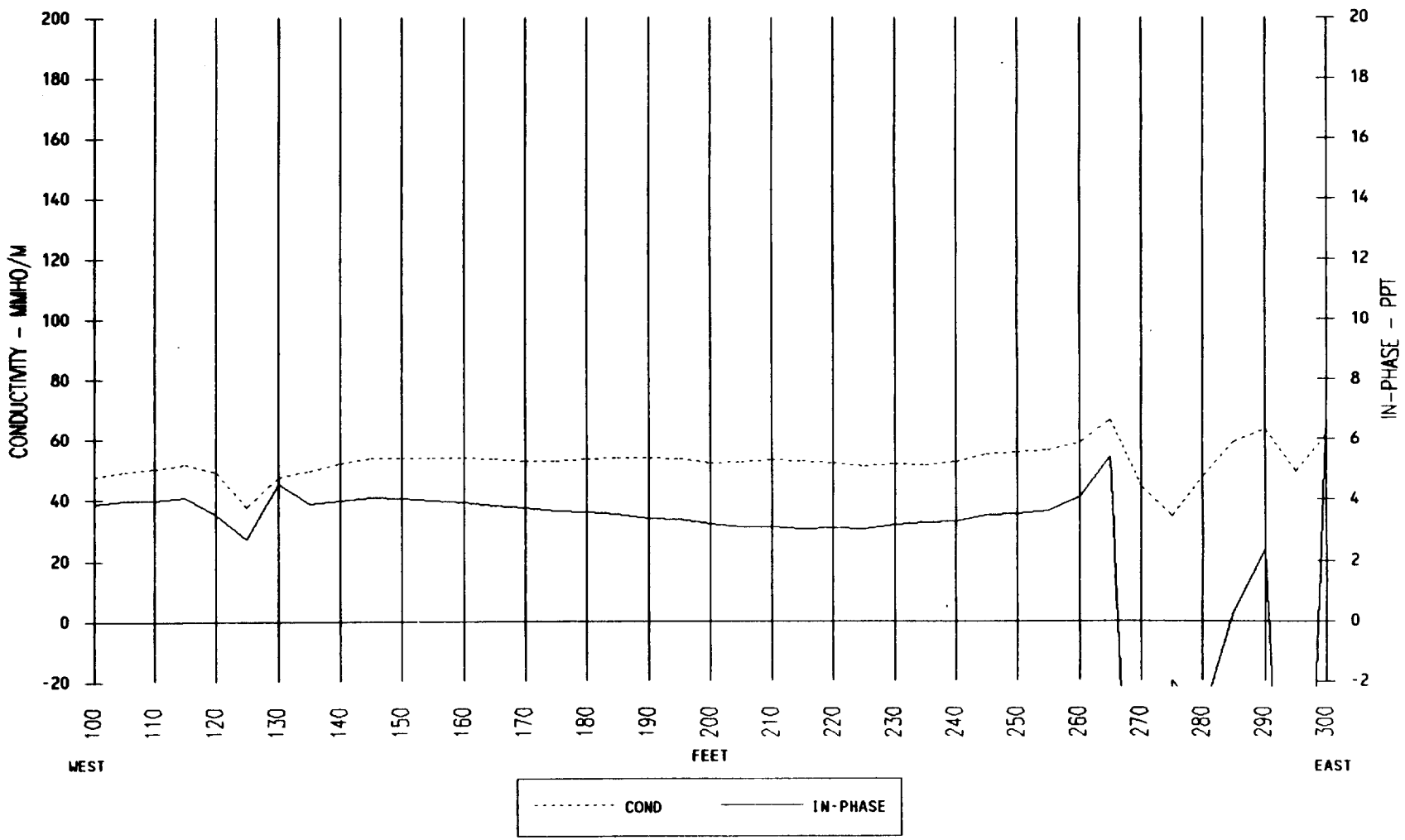
CRASH CREW PIT NO. 1 - LINE 140



CRASH CREW PIT NO. 1 - LINE 160



CRASH CREW PIT NO. 1 - LINE 180



CRASH CREW PIT NO. 1 - LINE 200