4317

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE 92I/9W
MAKAOO PROPERTY, KAMLOOPS AREA
KAMLOOPS MINING DIVISION, B.C.
FOR
MAKAOO DEVELOPMENT COMPANY LIMITED

BY

PHILIP G. HALLOF, Ph.D.

And

MARION A. GOUDIE, B.Sc.

NAME AND LOCATION OF PROPERTY:

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS MINING DIVISION, B.C. 50°38'N - 120°25'W

DATE STARTED: JANUARY 24, 1973

DATE FINISHED: JANUARY 29, 1973

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McPHAR GEOPHYSICS

NOTES ON THE THEORY, METHOD OF FIELD OPERATION, AND PRESENTATION OF DATA FOR THE INDUCED POLARIZATION METHOD

Induced Polarization as a geophysical measurement refers to the blocking action or polarization of metallic or electronic conductors in a medium of ionic solution conduction.

This electro-chemical phenomenon occurs wherever electrical current is passed through an area which contains metallic minerals such as base metal sulphides. Normally, when current is passed through the ground, as in resistivity measurements, all of the conduction takes place through ions present in the water content of the rock, or soil, i.e. by ionic conduction. This is because almost all minerals have a much higher specific resistivity than ground water. The group of minerals commonly described as "metallic", however, have specific resistivities much lower than ground waters. The induced polarization effect takes place at those interfaces where the mode of conduction changes from ionic in the solutions filling the interstices of the rock to electronic in the metallic minerals present in the rock.

The blocking action or induced polarization mentioned above, which depends upon the chemical energies necessary to allow the ions to give up or receive electrons from the metallic surface, increases with the time that a d. c. current is allowed to flow through the rock; i. e. as ions pile up against the metallic interface the resistance to current flow increases. Eventually, there is enough polarization in the form of excess ions at the interfaces, to appreciably reduce the amount of current flow through the metallic particle. This polarization takes place at each of the infinite number of solution-metal interfaces in a mineralized rock.

When the d. c. voltage used to create this d. c. current flow is cut off, the Coulomb forces between the charged ions forming the polarization cause them to return to their normal position. This movement of charge creates a small current flow which can be measured on the surface of the ground as a decaying potential difference.

From an alternate viewpoint it can be seen that if the direction of the current through the system is reversed repeatedly before the polarization occurs, the effective resistivity of the system as a whole will change as the frequency of the switching is changed. This is a consequence of the fact that the amount of current flowing through each metallic interface depends upon the length of time that current has been passing through it in one direction.

The values of the per cent frequency effect or F. E. are a measurement of the polarization in the rock mass. However, since the measurement of the degree of polarization is related to the apparent resistivity of the rock mass it is found that the metal factor values or M. F. are the most useful values in determining the amount of polarization present in the rock mass. The MF values are obtained by normalizing the F. E. values for varying resistivities.

The induced polarization measurement is perhaps the most powerful geophysical method for the direct detection of metallic sulphide mineralization, even when this mineralization is of very low concentration. The lower limit of volume per cent sulphide necessary to produce a recognizable IP anomaly will vary with the geometry and geologic environment of the source, and the method of executing the survey. However, sulphide mineralization of less than one per cent by volume has been detected by the IP method under proper geological conditions.

The greatest application of the IP method has been in the search for disseminated metallic sulphides of less than 20% by volume. However, it has also been used successfully in the search for massive sulphides in situations where, due to source geometry, depth of source, or low resistivity of surface layer, the EM method can not be successfully applied. The ability to differentiate ionic conductors, such as water filled shear zones, makes the IP method a useful tool in checking EM anomalies which are suspected of being due to these causes.

In normal field applications the IP method does not differentiate between the economically important metallic minerals such as chalcopyrite, chalcocite, molybdenite, galena, etc., and the other metallic minerals such as pyrite. The induced polarization effect is due to the total of all electronic conducting minerals in the rock mass. Other electronic conducting materials which can produce an IP response are magnetite, pyrolusite, graphite, and some forms of hematite.

In the field procedure, measurements on the surface are made in a way that allows the effects of lateral changes in the properties of the ground to be separated from the effects of vertical changes in the properties. Current is applied to the ground at two points in distance (X) apart. The potentials are measured at two other points (X) feet apart, in line with the current electrodes is an integer number (n) times the basic distance (X).

The measurements are made along a surveyed line, with a constant distance (nX) between the nearest current and potential electrodes. In most surveys, several traverses are made with various values of (n); i.e. (n) = 1, 2, 3, 4, etc. The kind of survey required (detailed or reconnaissance) decides the number of values of (n) used.

In plotting the results, the values of the apparent resistivity, apparent per cent frequency effect, and the apparent metal factor measured for each set of electrode positions are plotted at the intersection of grid lines, one from the center point of the current electrodes and the other from the center point of the potential electrodes. (See Figure A.) The resistivity values are plotted above the line as a mirror image of the metal factor values below. On a second line, below the metal factor values, are plotted the values of the per cent frequency effect. In some cases the values of per cent frequency effect are plotted as superscripts of the metal factor value. In this second case the frequency effect values are not contoured. The lateral displacement of a given value is determined by the location along the survey line of the center point between the current and potential electrodes. The distance of the value from the line is determined by the distance (nX) between the current and potential electrodes when the measurement was made.

The separation between sender and receiver electrodes is only one factor which determines the depth to which the ground is being sampled in any particular measurement. The plots then, when contoured, are not section maps of the electrical properties of the ground under the survey line. The interpretation of the results from any given survey must be carried out using the combined experience gained from field results, model study results and theoretical investigations. The position of the electrodes when anomalous values are measured is important in the interpretation.

In the field procedure, the interval over which the potential differences are measured is the same as the interval over which the electrodes are moved after a series of potential readings has been made. One of the advantages of the induced polarization method is that the same equipment can be used for both detailed and reconnaissance surveys merely by changing the distance (X) over which the electrodes are moved each time. In the past, intervals have been used ranging from 25 feet to 2000 feet for (X). In each case, the decision as to the distance (X) and the values of (n) to be used is largely determined by the expected size of the mineral deposit being sought, the size of the expected anomaly and the speed with which it is desired to progress.

The diagram in Figure A demonstrates the method used in plotting the results. Each value of the apparent resistivity, apparent metal factor, and apparent per cent frequency effect is plotted and identified by the position of the four electrodes when the measurement was made. It can be seen that the values measured for the larger values of (n) are plotted farther from the line indicating that the thickness of the layer of the earth that is being tested is greater than for the smaller values of (n); i.e. the depth of the measurement is increased. When the F. E. values are plotted as superscripts to the MF values the third section of data values is not presented and the F. E. values are not contoured.

The actual data plots included with the report are prepared utilizing an IBM 360/75 Computer and a Calcomp 770/763 Incremental Plotting System. The data values are calculated, plotted, and contoured according to a programme developed by McPhar Geophysics. Certain symbols have been incorporated into the programme to explain various situations in recording the data in the field.

The IP measurement is basically obtained by measuring the difference in potential or voltage (ΔV) obtained at two operating frequencies. The voltage is the product of the current through the ground and the apparent resistivity of the ground. Therefore in field situations where the current is very low due to poor electrode contact, or the apparent resistivity is very low, or a combination of the two effects; the value of (ΔV) the change in potential will be too small to be measurable. The symbol "TL" on the data plots indicates this situation.

In some situations spurious noise, either man made or natural, will render it impossible to obtain a reading. The symbol "N" on the data plots indicates a station at which it is too noisey to record a reading. If a reading can be obtained, but for reasons of noise there is some doubt as to its accuracy, the reading is bracketed in the data plot ( ).

In certain situations negative values of Apparent Frequency Effect are recorded. This may be due to the geologic environment or spurious electrical effects. The actual negative frequency effect value recorded is indicated on the data plot, however the symbol "NEG" is indicated for the corresponding value of Apparent Metal Factor. In contouring negative values the contour lines are indicated to the nearest positive value in the immediate vicinity of the negative value.

The symbol "NR" indicates that for some reason the operator did not attempt to record a reading although normal survey procedures would suggest that one was required. This may be due to inaccessible topography or other similar reasons. Any symbol other than those discussed above is unique to a particular situation and is described within the body of the report.

METHOD USED IN PLOTTING DIPOLE-DIPOLE INDUCED POLARIZATION AND RESISTIVITY RESULTS

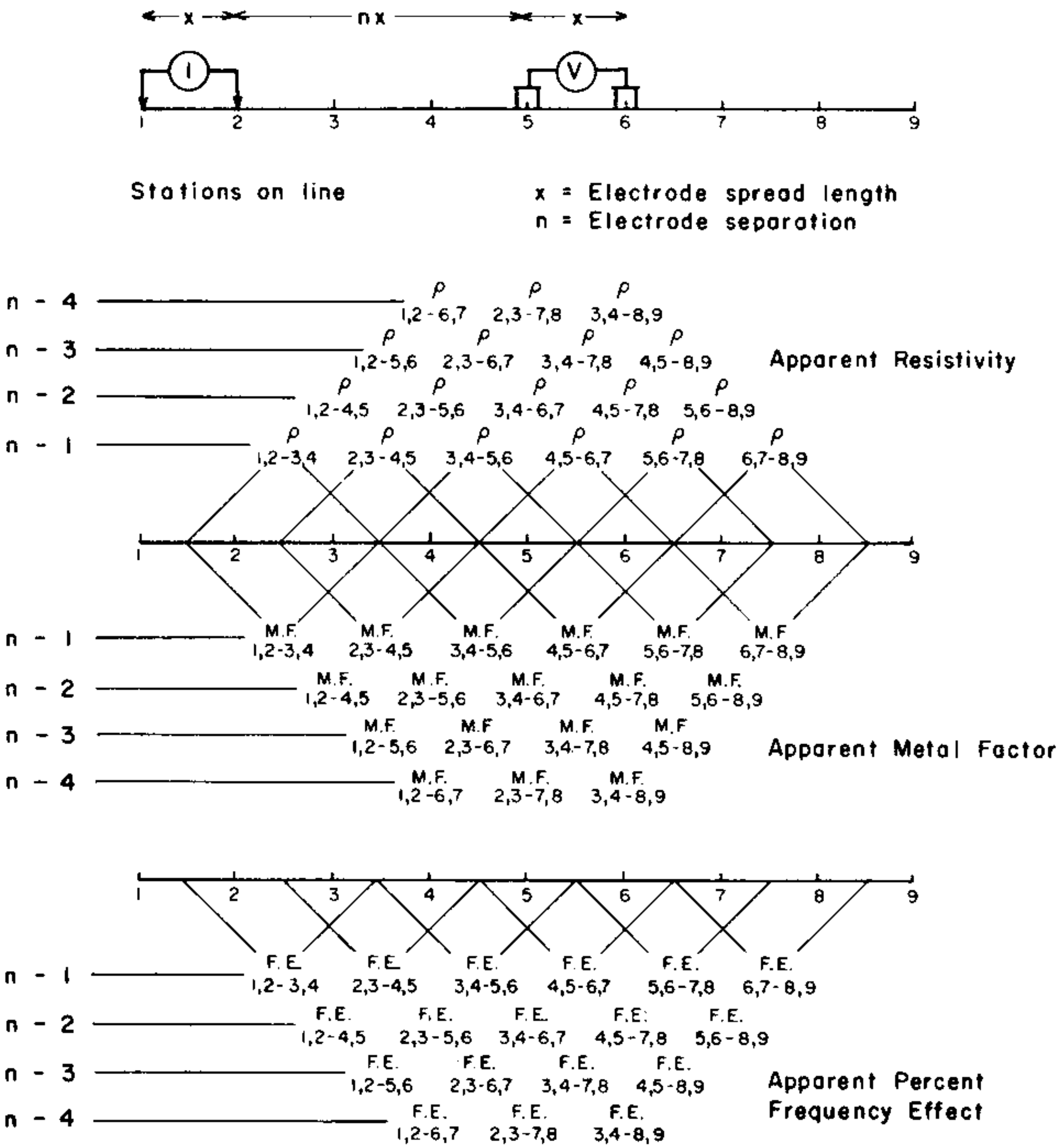

Fig. A

McPHAR GEOPHYSICS LIMITED

REPORT ON THE INDUCED POLARIZATION AND RESISTIVITY SURVEY ON THE MAKAOO PROPERTY, KAMLOOPS AREA, KAMLOOPS MINING DIVISION, B.C. FOR MAKAOO DEVELOPMENT COMPANY LIMITED

1. INTRODUCTION

At the request of Mr. J.M. Carr, chief geologist for Teck Corporation Limited, we have completed an Induced Polarization and Resistivity survey on the Makaoo Property in the Kamloops area, Kamloops Mining Division, B.C. This property, which is owned by the Makaoo Development Company Limited, is held under option by Teck Corporation. It is located 5 miles southwest of Kamloops, B.C. and is accessible by road from Highway #1. The survey grid is situated at 50°38'N latitude and 120°25'W longitude.

The property is underlain by the Iron Mask Batholith which consists of plutonic and hypabyssal intrusions that include the following phases in order of decreasing probable age: coarse grained diorite, monzonite and syenite; picrite-basalt (partly serpentinized); fine grained diorite, monzonite and syenite (partly porphyritic and including the Sugarloaf hornblende porphyry); Cherry Creek latite porphyry and breccia. The batholith is emplaced in Upper Triassic volcanic rocks of the Nicola Group and is locally overlain by Tertiary

(Eocene) sedimentary and volcanic rocks of the Kamloops Group. Elongation of the batholith is east-southeasterly, which is also the direction of major shear and fracture zones and of Pleistocene glacial scouring.

The property is four miles east of the Afton Mines' orebody and closely adjoins the Galaxy Minerals and Cominco (Ajax-Monte Carlo) deposits. The Orphan Boy, Python-Copperhead, Noonday, and Lost Chord are some of the copper occurrences known on the property, being relatively small, steeply-emplaced stockworks and disseminations of chalcopyrite, with or without minor introduced magnetite and pyrite and accompanied by rock alteration of either, a red (K-feldspar) or white (albite) type. These copper occurrences are in batholithic rocks adjoining sheared, steep contacts of the picrite basalt with other rock units. In the early 1900's, some 7% copper ore was shipped from the Python workings.

Glacial drift obscures large areas of the property, in places to depths exceeding 100 feet.

Previous work includes percussion drilling, geophysical, geochemical and IP surveys and diamond drilling. None of these results are available to the author at the time of writing the report.

The IP survey was carried out to investigate recently defined geochemical anomalies. The work was completed in late January, 1973, using a McPhar P660 high frequency variable frequency IP unit, operating at 0.3 and 5 Hz over the following claims:

Lot 1036	Lot 1050
Golden Star Lot 845	Sunrise Lot 879
Evening Star Lot 1013	Cub No. 3
Cub No. 4	Cub No. 5
Cub. No. 6	Cub No. 9

Cub No. 10	Top No. 2 Fr.
Key No. 2	Line No. 1
Line No. 2	Colt No. 1
Python No. 3	Python No. 4
Python Lot 2565	Copperhead Lot 2564

References: Minister of Mines, B.C. Annual Report, 1956, pp. 47-69
1967, pp. 137-147.

2. PRESENTATION OF RESULTS

The Induced Polarization and Resistivity results are shown on the following data plots in the manner described in the notes preceding this report.

Line	Electrode Intervals	Dwg. No.
Northwest Grid		
10400W	200 feet	IP 6051-1
10000W	200 feet	IP 6051-2
9600W	200 feet	IP 6051-3
9200W	200 feet	IP 6051-4
8800W	200 feet	IP 6051-5
8000W	200 feet	IP 6051-6
7200W	200 feet	IP 6051-7
6400W	200 feet	IP 6051-8
Southeast Grid		
3600W	200 feet	IP 6051-9
3200W	200 feet	IP 6051-10
2800W	200 feet	IP 6051-11
2400W	200 feet	IP 6051-12

Also enclosed with this report is Dwg. I.P.P. 4891, a plan map of the Makaoo Property Grid at a scale of 1" = 400'. The definite, probable and possible Induced Polarization anomalies are indicated by bars, in the manner shown on the legend, on this plan map as well as on the data plots. These bars represent the surface projection of the anomalous zones as interpreted from the location of the transmitter and receiver electrodes when the anomalous values were measured.

Since the Induced Polarization measurement is essentially an averaging process, as are all potential methods, it is frequently difficult to exactly pinpoint the source of an anomaly. Certainly, no anomaly can be located with more accuracy than the electrode interval length; i.e. when using 200' electrode intervals the position of a narrow sulphide body can only be determined to lie between two stations 200' apart. In order to definitely locate, and fully evaluate, a narrow, shallow source it is necessary to use shorter electrode intervals. In order to locate sources at some depth, larger electrode intervals must be used, with a corresponding increase in the uncertainties of location. Therefore, while the centre of the indicated anomaly probably corresponds fairly well with source, the length of the indicated anomaly along the line should not be taken to represent the exact edges of the anomalous material.

3. DISCUSSION OF RESULTS

The two anomalous areas which are being investigated essentially divide the survey into two grids and as such they will be discussed.

The host rocks generally show moderate to high resistivities, especially in the northwest grid. There the resistivity changes show no significant relationship to the IP anomalies and thus the probable mineralization. The changes from high to low resistivity in the southeast grid are shown on Dwg. I.P.P. 4891.

Northwest Grid

A description of one line in this grid will be typical of all of the lines in the grid.

Line 9600W

A broad, weak anomaly extends from 26N, where it is incomplete, to 40N. The magnitude of the metal factors lies within the general range of 10 to 20, although the frequency effects vary from 2 to 4.9. The resistivities are moderate to high and the higher resistivities may have a masking effect on the metal factors. The pattern of the anomaly suggests a source of weakly disseminated mineralization.

In general, the anomalies in this area are discontinuous from line to line and do not appear to represent a source which would be large enough to be of economic interest in itself.

Southeast Grid

The IP anomalies in this grid are of greater potential interest than those to the northwest. The anomalies are broad, with magnitudes increasing from probable to definite and are continuous from line to line. A detailed discussion follows.

Line 3600W

The line is anomalous throughout and beyond both ends as are the three lines to the south. The anomaly is probable from the south to 76N, definite from 76N to 78N, probable to 80N, possible to 82N (this may be the effect of conductive swamp sediments) and definite to the end of the line. This line as well as the other three lines to the south should be extended to the north and south to complete the delineation of the source.

The top of the source is shallow relative to the electrode interval and some depth extent is indicated.

Line 3200W

The anomaly is probable from 68N to 69N, possible to 76N, definite to 78N, probable to 82N, definite to 84N and probable to 87N. The anomaly correlates well with Line 3600W.

Line 2800W

A narrow, barren band from 68N to 70N separates a weak anomaly from 67N to 68N from the remainder of the anomaly which is similar to that on Line 3200W, but of slightly lower magnitude from 78N to the north.

Line 2400W

The anomaly on this line is similar to the anomaly on Line 2800W.

4. CONCLUSIONS AND RECOMMENDATIONS

The pattern of the IP anomalies in the northwest portion of the survey grid suggest a discontinuous source of weakly disseminated mineralization which is likely to be of secondary importance at this time.

The southeast portion of the grid is of greater importance. A zone of mineralization was incompletely outlined by the survey. It is recommended that the survey be continued to extend the grid in all directions to determine the extent of the source. At that time, detail using shorter electrode intervals should be used to better locate and define drill targets (see Appendix). Our experience in this area indicates that the anomalies should be of sufficient interest to warrant this additional work. However, if drill hole locations are required now, several possible ones are listed below.

Line 3600W 1) a hole to a vertical depth of 200' below 77N

2) a hole to a vertical depth of 150' below 73N

3) a hole to a vertical depth of 150' below 84N

Line 2400W - a hole to a vertical depth of 150' below 84N.

McPHAR GEOPHYSICS LIMITED

Philip G. Hallof,
Geophysicist.

Marion A. Goudie,
Geologist.

Dated: February 16, 1973

ASSESSMENT DETAILS

PROPERTY: Makaoo		MINING DIVISION: Kamloops	
SPONSOR: Makaoo Development Company Limited		PROVINCE: British Columbia	
LOCATION: Kamloops Area			
TYPE OF SURVEY: Induced Polarization			
OPERATING MAN DAYS:	20	DATE STARTED:	Jan. 24, 1973
EQUIVALENT 8 HR. MAN DAYS:	30	DATE FINISHED:	Jan. 29, 1973
CONSULTING MAN DAYS:	3	NUMBER OF STATIONS:	170
DRAUGHTING MAN DAYS:	3	NUMBER OF READINGS:	936
TOTAL MAN DAYS:	36	MILES OF LINE SURVEYED:	5.98

CONSULTANTS:

Philip G. Hallof, 15 Barnwood Court, Don Mills, Ontario.
Marion A. Goudie, 739 Military Trail, West Hill, Ontario.

FIELD TECHNICIANS:

J. Parker, Box 340, Choiceland, Saskatchewan.
K. Hoeberg, SS#1 - 1370 Springhill Drive, Kamloops, B.C.
Plus Extra Labour:
V. Graves, 344 West Seymour, Kamloops, B.C.
D. Henry, National Trailer Park, Kamloops, B.C.

DRAUGHTSMEN:

B. Boden, 58 Glencrest Blvd. Toronto 16, Ontario.
N. Lade, 299 Jasper Avenue, Oshawa, Ontario.
V. Young, 703 Cortez Avenue, Bay Ridges, Ontario.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
PHILIP G. HALLOF

McPHAR GEOPHYSICS LIMITED

Philip G. Hallof,
Geophysicist.

Dated: February 16, 1973

Expiry Date: February 2[illegible], 1973

STATEMENT OF COST

Makaoo Development Company Limited - Makaoo Property
Kamloops Area, Kamloops Mining Division, B.C. - IP Survey

Crew: J. Parker & K. Hoeberg

Total Survey Cost:

5 days	@ $435.00/day	$2,175.00

Breakdown of Cost

5 days	Operating		@ $284.39	$1,421.95
½ day	Standby)	1 day	@ $100.00/day	100.00
½ day	Preparation)			

Expenses		
Truck Rental	105.66	
Vehicle Expense	12.12	
Meals & Accommodation	125.10	
Supplies	23.50	
	266.38	
Plus 10%	26.64	
		293.02
Extra Labour	300.00	
Plus 20%	60.00	
		360.00
		$2,174.97

McPHAR GEOPHYSICS LIMITED

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
PHILIP G. HALLOF

Philip G. Hallof,
Geophysicist.

Dated: February 16, 1973

Expiry Date: February 26, 1973

STATEMENT OF COST

Makaoo Development Company Limited - Makaoo Property
Kamloops Area, Kamloops Mining Division, B.C. - IP Survey

Crew: J. Parker & K. Hoeberg

Total Survey Cost:

5 days @ $435.00/day — $2,175.00

Breakdown of Cost

5 days Operating	@ $284.39	$1,421.95
½ day Standby ½ day Preparation	1 day @ $100.00/day	100.00
Expenses		
Truck Rental	105.66	
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Meals & Accommodation	125.10	
Supplies	23.50	
	266.38	
Plus 10%	26.64	293.02
Extra Labour	300.00	
Plus 20%	60.00	360.00
		$2,174.97

Dated: February 16, 1973

McPHAR GEOPHYSICS LIMITED

Philip G. Hallof
Geophysicist

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — PHILIP G. HALLOF

Expiry Date: February 25, 1973

Declared before me at the City, in the
of [illegible]
Province of British Columbia, this [illegible]
day of [illegible], 1973, A.D.

A Commissioner for taking Affidavits within British Columbia
or Notary Public in and for the Province of British Columbia

SUB-MINING RECORDER

CERTIFICATE

I, Philip George Hallof, of the City of Toronto, Province of Ontario, do hereby certify that:

1. I am a geophysicist residing at 15 Barnwood Court, Don Mills, Ontario.

2. I am a graduate of the Massachusetts Institute of Technology with a B.Sc. Degree (1952) in Geology and Geophysics, and a Ph.D. Degree (1957) in Geophysics.

3. I am a member of the Society of Exploration Geophysicists and the European Association of the Exploration Geophysicists.

4. I am a Professional Geophysicist, registered in the Province of Ontario, the Province of British Columbia and the State of Arizona.

5. I have no direct or indirect interest, nor do I expect to receive any interest directly or indirectly, in the property or securities of Makaoo Development Company Limited or any affiliate.

6. The statements made in this report are based on a study of published geological literature and unpublished private reports.

7. Permission is granted to use in whole or in part for assessment and qualification requirements but not for advertising purposes.

Dated at Toronto

This 16th day of February 1973.

PROFESSIONAL PROVINCE OF PHILIP G. HALLOF BRITISH COLUMBIA ENGINEER

Philip G. Hallof, Ph.D.

Expiry Date: February 25, 1973

CERTIFICATE

I, Marion A. Goudie, of the City of Toronto, Province of Ontario, do hereby certify that:

1. I am a geologist residing at 739 Military Trail, West Hill, Ontario.

2. I am a graduate of the University of Western Ontario with a B.Sc. Degree (1950) in Honours Geology.

3. I am a member of the Geological Society of America.

4. I have been practising my profession for 23 years.

5. I have no direct or indirect interest, nor do I expect to receive any interest directly or indirectly, in the property or securities of Makaoo Development Company Limited or any affiliate.

6. The statements made in this report are based on a study of published geological literature and unpublished private reports.

7. Permission is granted to use in whole or in part for assessment and qualification requirements but not for advertising purposes.

Dated at Toronto

This 16th day of February 1973.

Marion A. Goudie

Marion A. Goudie, B.Sc.

McPHAR GEOPHYSICS

APPENDIX
THE INTERPRETATION OF INDUCED POLARIZATION ANOMALIES FROM RELATIVELY SMALL SOURCES

The induced polarization method was originally developed to detect disseminated sulphides and has proven to be very successful in the search for "porphyry copper" deposits. In recent years we have found that the IP method can also be very useful in exploring for more concentrated deposits of limited size. This type of source gives sharp IP anomalies that are often difficult to interpret.

The anomalous patterns that develop on the contoured data plots will depend on the size, depth and position of the source and the relative size of the electrode interval. The data plots are not sections showing the electrical parameters of the ground. When the electrode interval (X) is appreciably greater than the width of the source, a large volume of unmineralized rock is averaged into each measurement. This is particularly true for the large values of the electrode separation (n).

The theoretical scale model results shown in Figure 1 and Figure 2 indicate the effect of depth. If the depth to the top of the source is small compared to the electrode interval (i. e. d X) the measurement for n = 1 will be anomalous. In Figure 1 the depth is 0. 5 units (X = 1. 0 units) and the n = 1 value is definitely anomalous; the pattern on the contoured data plot is typical for a relatively shallow, narrow, near-vertical tabular source. The results in Figure 2 are for the same source with the depth increased to 1. 5 units. Here the n = 1 value is not anomalous; the larger values of (n) are anomalous but the magnitudes are much lower than for the source at less depth.

When the electrode interval is greater than the width of the source, it is not possible to determine its width or exact position between the electrodes. The true IP effect within the source is also indeterminate; the anomaly from a very narrow source with a very large true IP effect will be much the same as that from a zone with twice the width and 1/2 the true IP effect. The theoretical scale model data shown in Figure 3 and Figure 4 demonstrate this problem. The depth and position of the source are unchanged but the width and true IP effect are varied. The anomalous patterns and magnitudes are essentially the same, hence the data are insufficient to evaluate the source completely.

The normal practise is to indicate the IP anomalies by solid, broken, or dashed bars, depending upon their degree of distinctiveness. These bars represent the surface projection of the anomalous zones as interpreted from the location of the transmitter and receiver electrodes when the anomalous values were measured. As illustrated in Figure 1, Figure 2, Figure 3 and Figure 4, no anomaly can be located with more accuracy than the spread length. While the centre of the solid bar indicating the anomaly corresponds fairly well with the source, the length of the bar should not be taken to represent the exact edges of the anomalous material.

If the source is shallow, the anomaly can be better evaluated using a shorter electrode interval. When the electrode interval used approaches the width of the source, the apparent effects measured will be nearly equal to the true effects within the source. When there is some depth to the top of the source, it is not possible to use electrode intervals that are much less than the depth to the source. In this situation, one must realize that a definite ambiguity exists regarding the width of the source and the IP effect within the source.

Our experience has confirmed the desirability of doing detail. When a reconnaissance IP survey using a relatively large electrode interval indicates the presence of a narrow, shallow source, detail with shorter electrode intervals is necessary in order to better locate, and evaluate, the source. The data of most usefulness is obtained when the maximum apparent IP effect is measured for n = 2 or n = 3. For instance, an anomaly originally located using X = 300' may be checked with X = 200' and then X = 100'. The data with X = 100' will be quite different from the original reconnaissance results with X = 300'.

The data shown in Figure 5 and Figure 6 are field results from a greenstone area in Quebec. The expected sources were narrow (less than 30' in width) zones of massive, high-grade, zinc-silver ore. An electrode interval of 200' was used for the reconnaissance survey in order to keep the rate of progress at an acceptable level. The anomalies located were low in magnitude.

The very weak, shallow anomaly shown in Figure 5 is typical of those located by the X = 200' reconnaissance survey. Several anomalies of this type were detailed using shorter electrode intervals. In most cases the detail measurements suggested broad zones of very weak mineralization. However, in the case of the source at 20N to 22N, the measurements with shorter electrode intervals confirmed the presence of a strong, narrow source. The X = 50' results are shown in Figure 6. Subsequent drilling has shown the source to be 12.5' of massive sulphide mineralization containing significant zinc and silver values.

The change in the anomaly that results when the electrode interval is reduced is not unusual. The X = 50' data more accurately locates the narrow source, and permits the geophysicist to make a better evaluation of its importance. The completion of this type of detail is very important, in order to get the maximum usefulness from a reconnaissance IP survey.

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Theoretical Induced Polarization and Resistivity Studies

Scale Model Cases

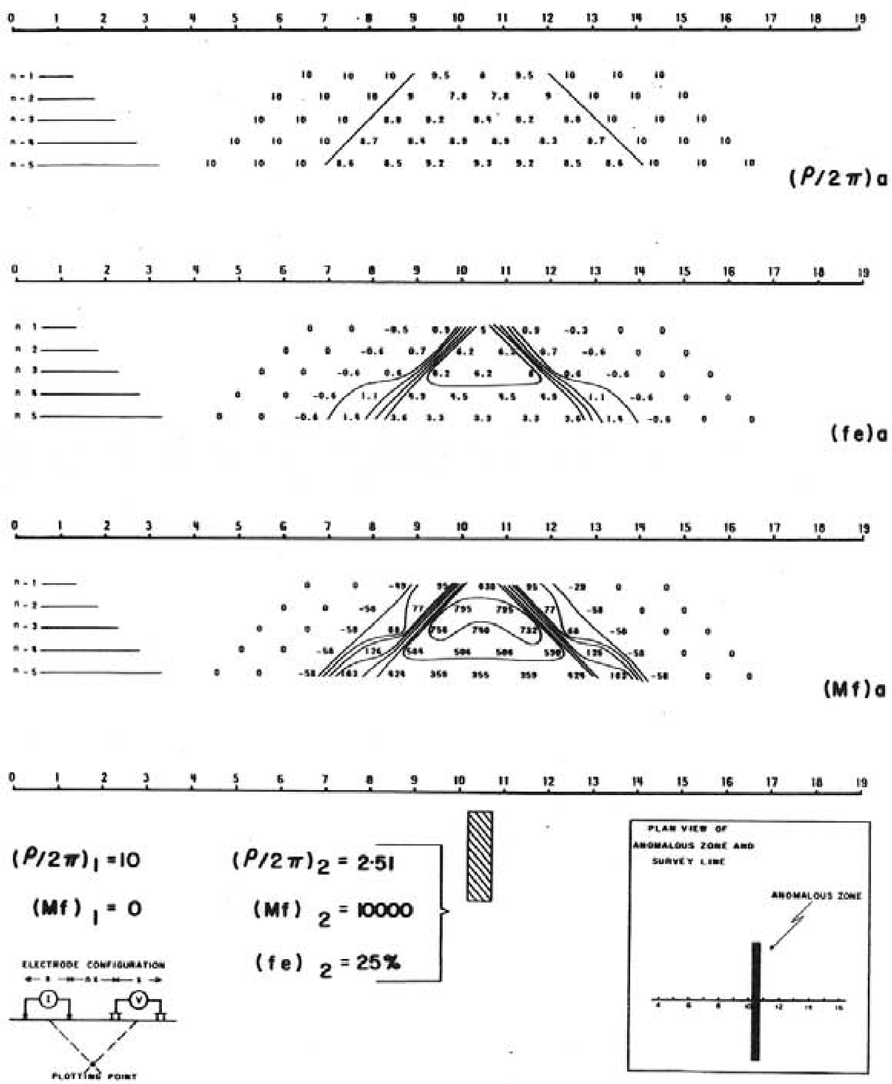

FIG. 1

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Theoretical Induced Polarization and Resistivity Studies

Scale Model Cases

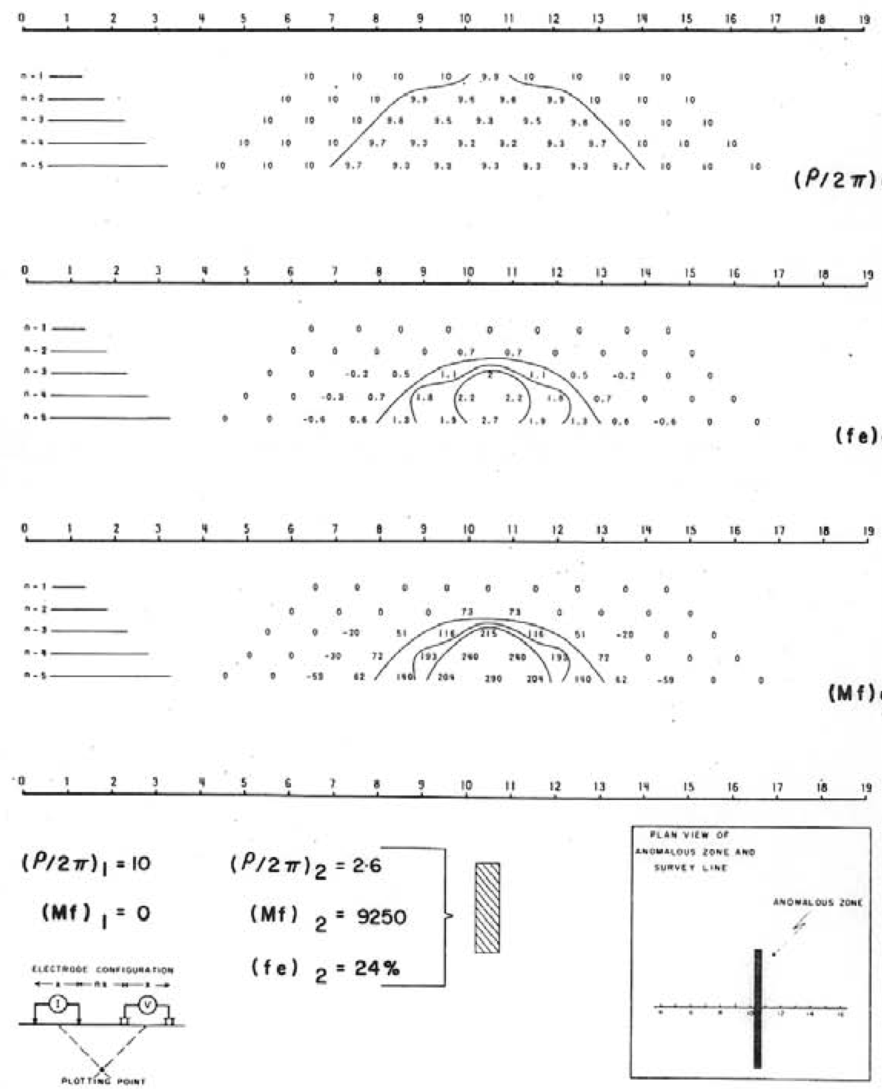


FIG. 2

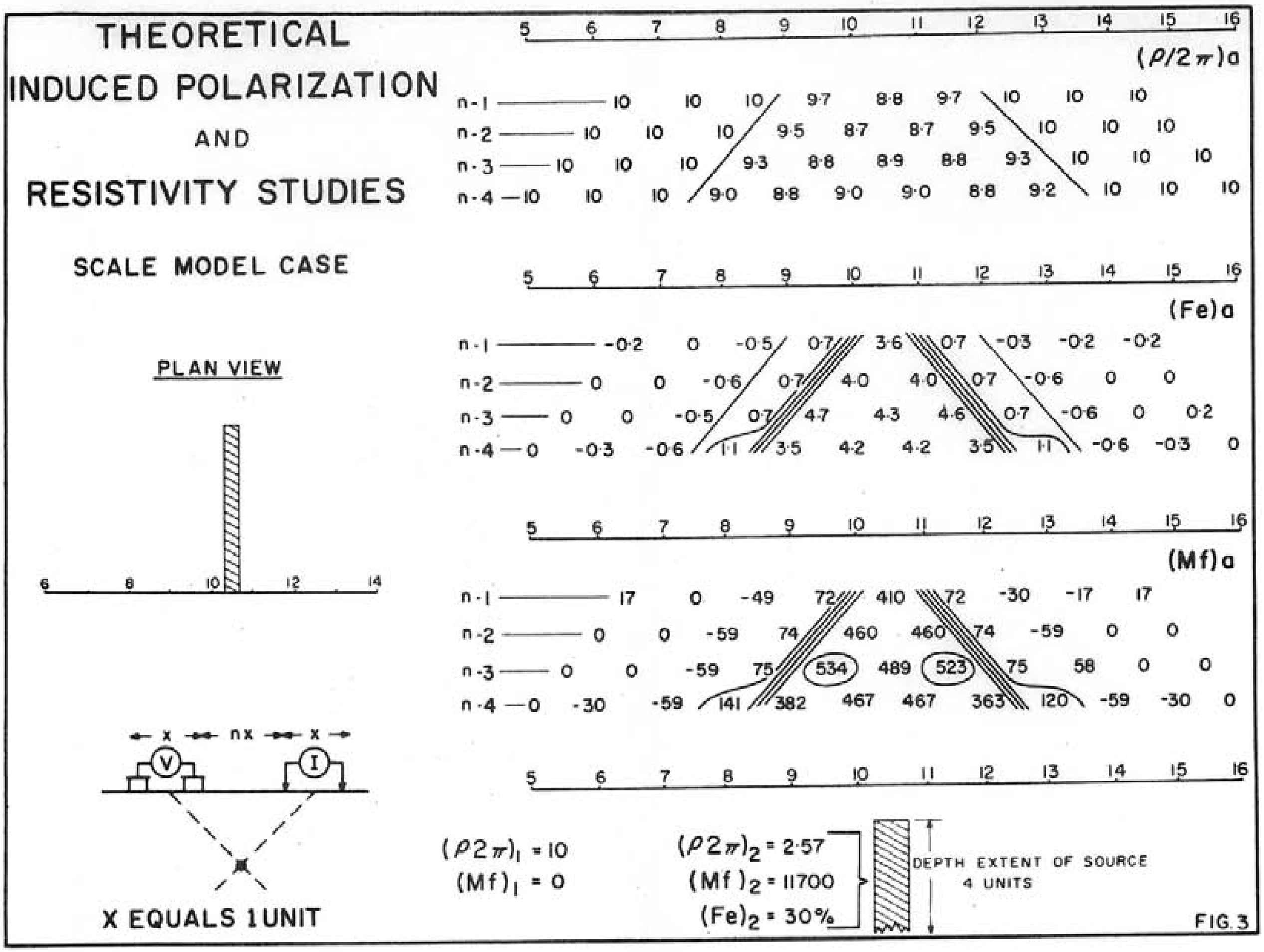

THEORETICAL
INDUCED POLARIZATION
AND
RESISTIVITY STUDIES
SCALE MODEL CASE
PLAN VIEW
6 8 10 12 14
X EQUALS 1 UNIT
5 6 7 8 9 10 11 12 13 14 15 16
(ρ/2π)a
n-1 10 10 10 9.7 8.8 9.7 10 10 10
n-2 10 10 10 9.5 8.7 8.7 9.5 10 10 10
n-3 10 10 10 9.3 8.8 8.9 8.8 9.3 10 10 10
n-4 10 10 10 9.0 8.8 9.0 9.0 8.8 9.2 10 10 10
(Fe)a
n-1 -0.2 0 -0.5 0.7 3.6 0.7 -0.3 -0.2 -0.2
n-2 0 0 -0.6 0.7 4.0 4.0 0.7 -0.6 0 0
n-3 0 0 -0.5 0.7 4.7 4.3 4.6 0.7 -0.6 0 0.2
n-4 0 -0.3 -0.6 1.1 3.5 4.2 4.2 3.5 1.1 -0.6 -0.3 0
(Mf)a
n-1 17 0 -49 72 410 72 -30 -17 17
n-2 0 0 -59 74 460 460 74 -59 0 0
n-3 0 0 -59 75 534 489 523 75 58 0 0
n-4 0 -30 -59 141 382 467 467 363 120 -59 -30 0
(ρ2π)1 = 10
(Mf)1 = 0
(ρ2π)2 = 2.57
(Mf)2 = 11700
(Fe)2 = 30%
DEPTH EXTENT OF SOURCE 4 UNITS

FIG. 3

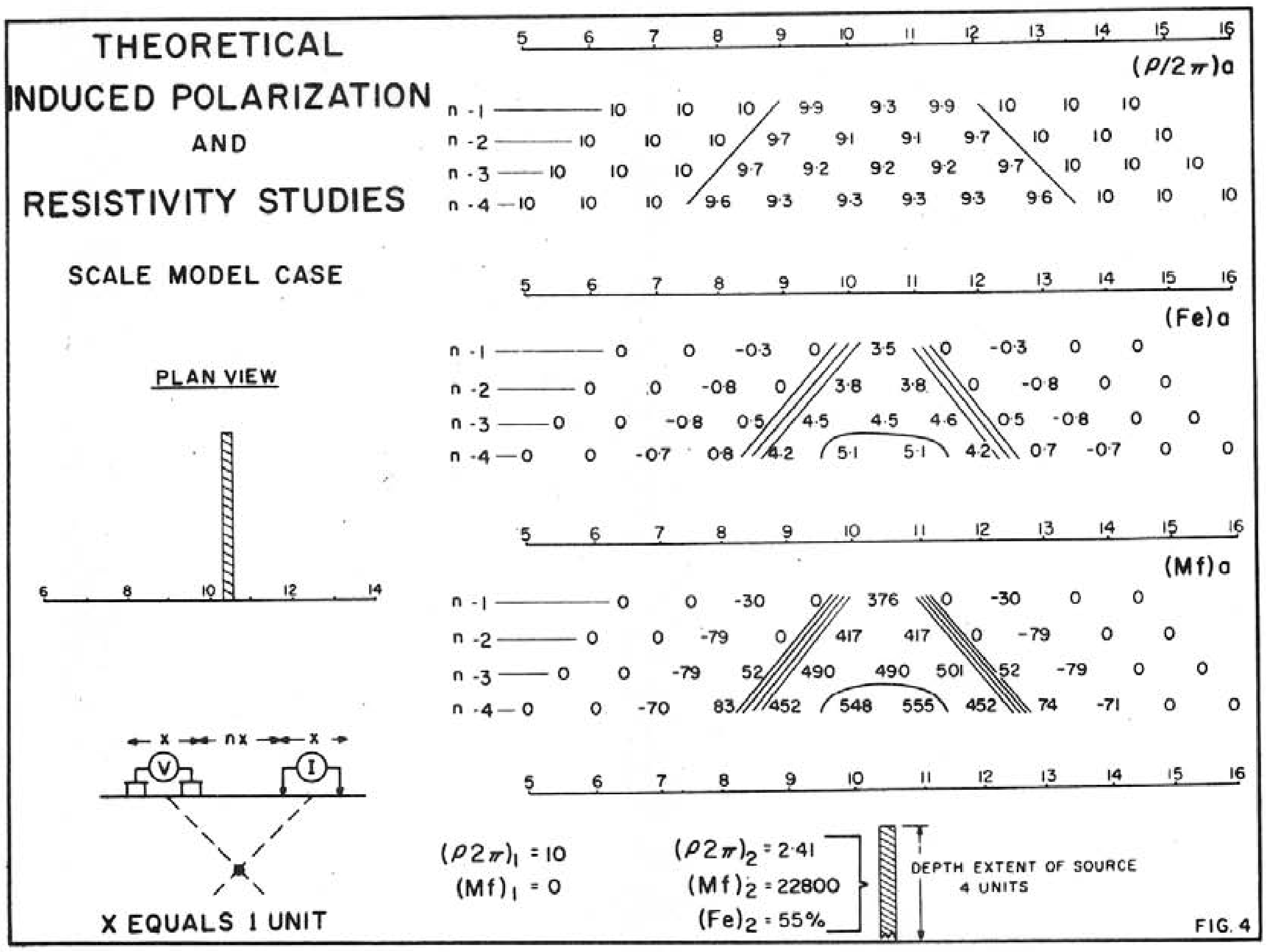

THEORETICAL
INDUCED POLARIZATION
AND
RESISTIVITY STUDIES
SCALE MODEL CASE
PLAN VIEW
6 8 10 12 14
X EQUALS 1 UNIT
5 6 7 8 9 10 11 12 13 14 15 16
(ρ/2π)a
n-1 10 10 10 9.9 9.3 9.9 10 10 10
n-2 10 10 10 9.7 9.1 9.1 9.7 10 10 10
n-3 10 10 10 9.7 9.2 9.2 9.2 9.7 10 10 10
n-4 10 10 10 9.6 9.3 9.3 9.3 9.3 9.6 10 10 10
(Fe)a
n-1 0 0 -0.3 0 3.5 0 -0.3 0 0
n-2 0 0 -0.8 0 3.8 3.8 0 -0.8 0 0
n-3 0 0 -0.8 0.5 4.5 4.5 4.6 0.5 -0.8 0 0
n-4 0 0 -0.7 0.8 4.2 5.1 5.1 4.2 0.7 -0.7 0 0
(Mf)a
n-1 0 0 -30 0 376 0 -30 0 0
n-2 0 0 -79 0 417 417 0 -79 0 0
n-3 0 0 -79 52 490 490 501 52 -79 0 0
n-4 0 0 -70 83 452 548 555 452 74 -71 0 0
(ρ2π)1 = 10
(Mf)1 = 0
(ρ2π)2 = 2.41
(Mf)2 = 22800
(Fe)2 = 55%
DEPTH EXTENT OF SOURCE 4 UNITS

FIG. 4

INDUCED POLARIZATION AND RESISTIVITY RESULTS

BATCHELOR LAKE AREA, QUEBEC.

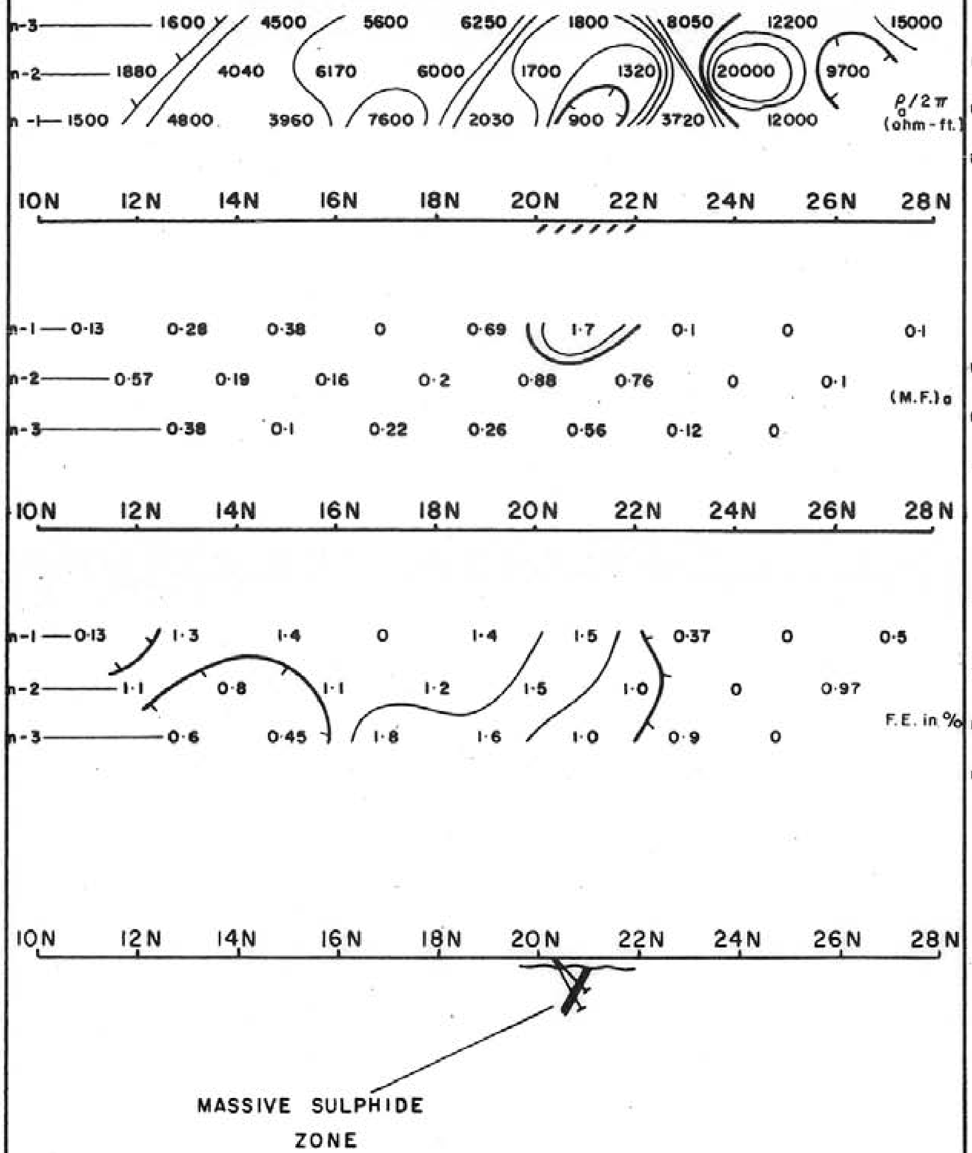


FIG. 5

INDUCED POLARIZATION AND RESISTIVITY RESULTS

BATCHELOR LAKE AREA, QUEBEC.

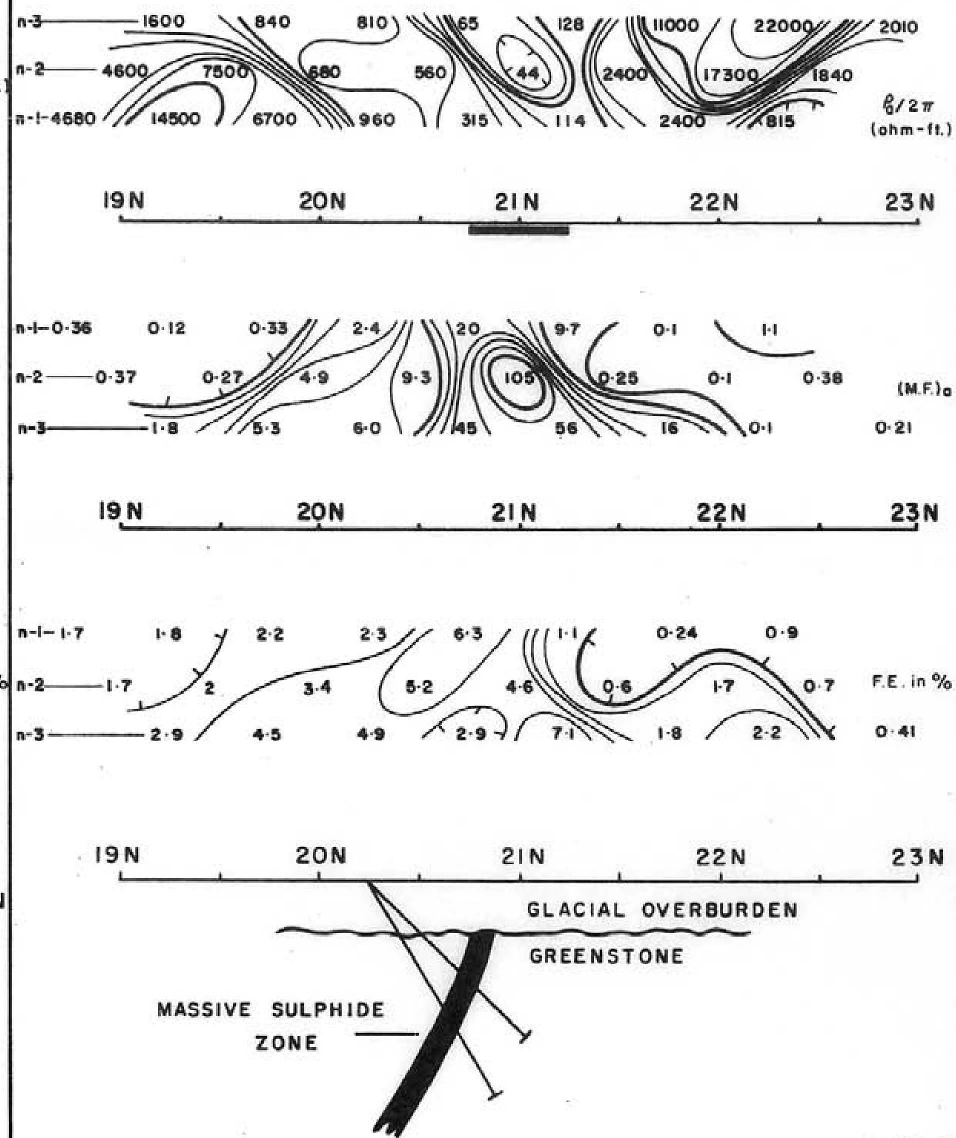
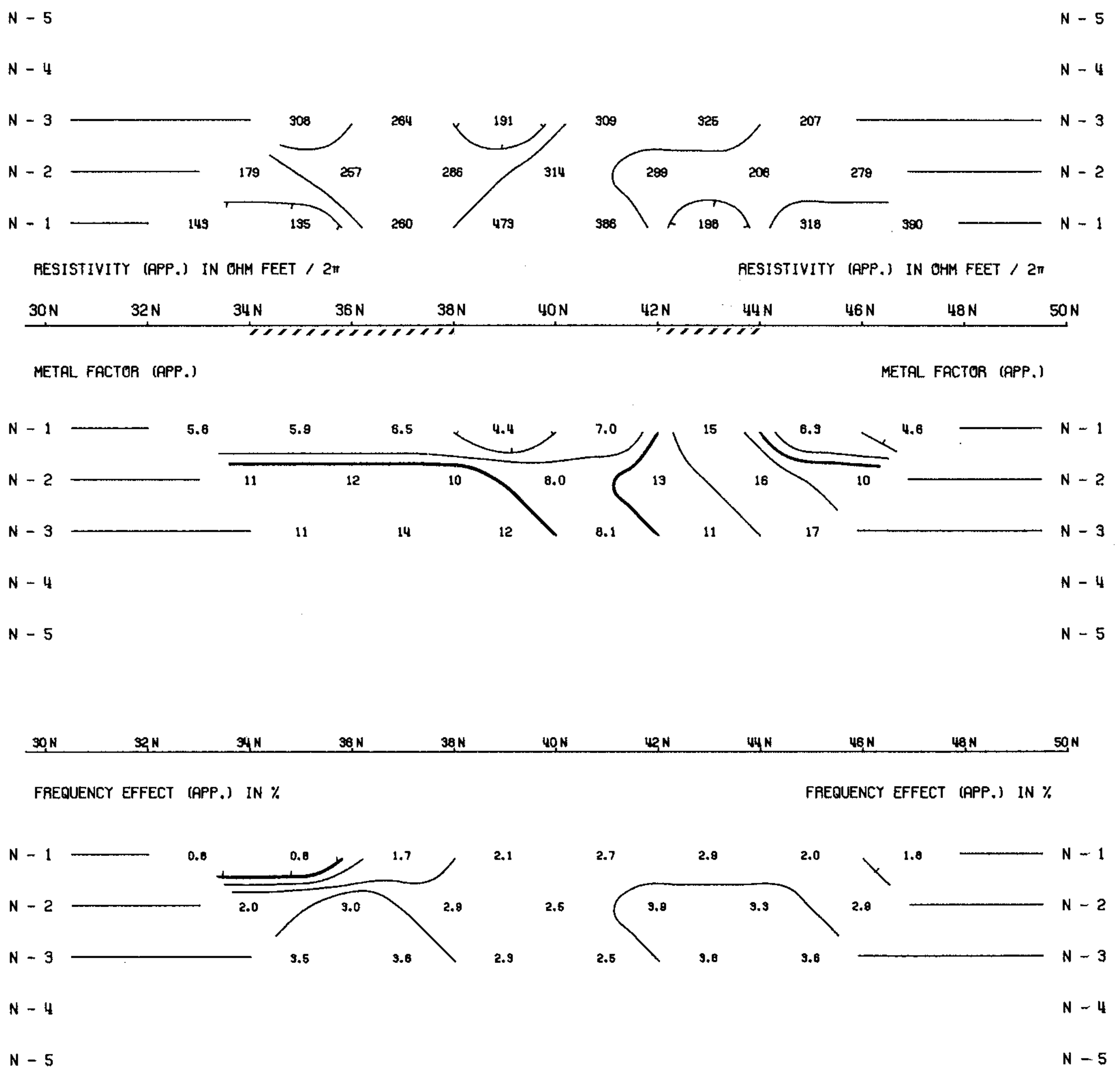


FIG. 6



4317

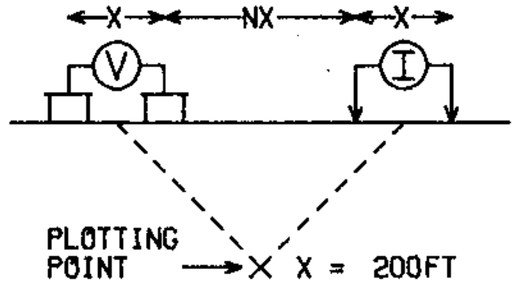
DWG. NO.- I.P.-6051-1

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 10400W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED: PHILIP G. HALLOF

DATE: 2/7/73

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA

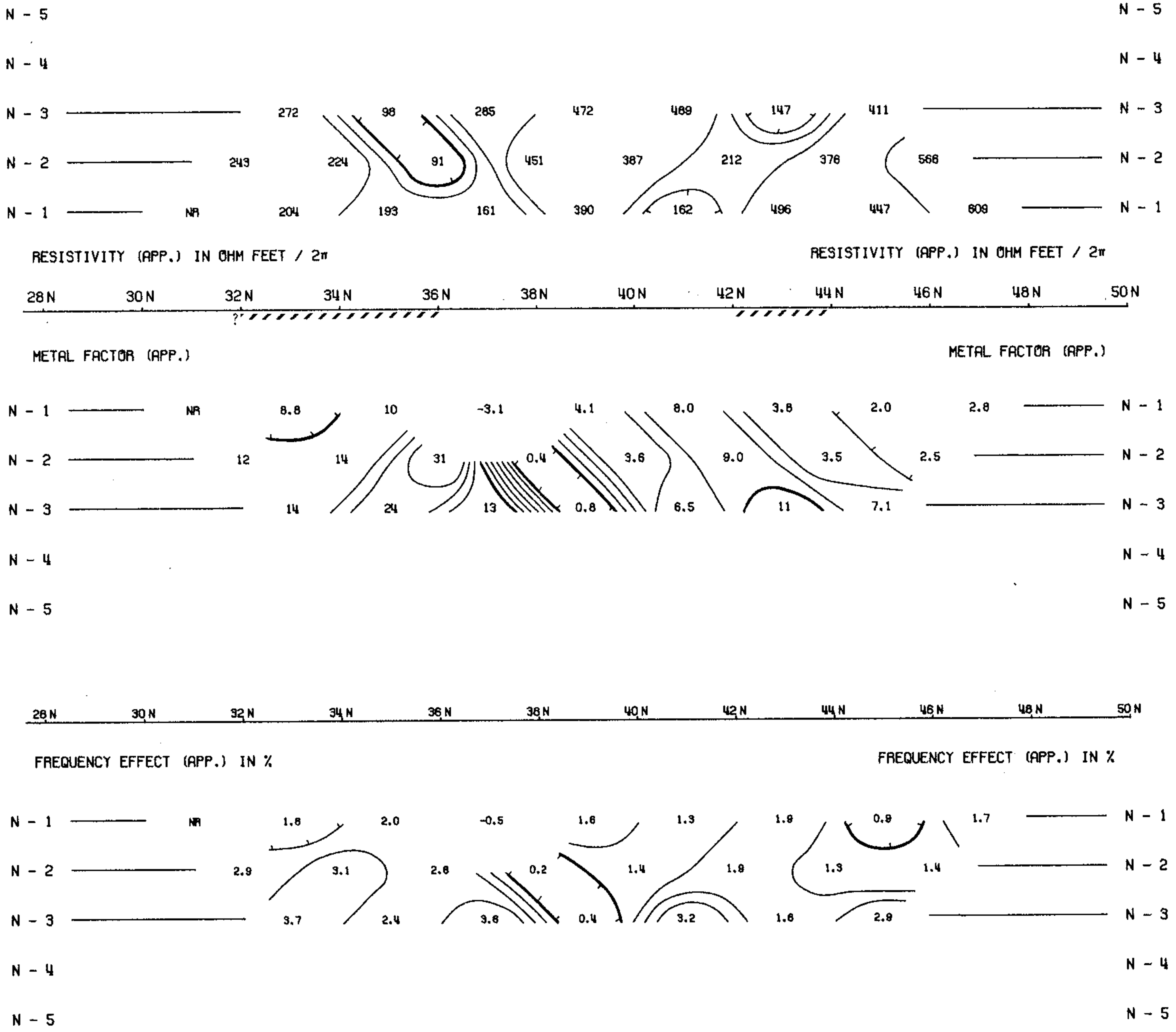
Expiry Date: February 25, 1973

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



4317

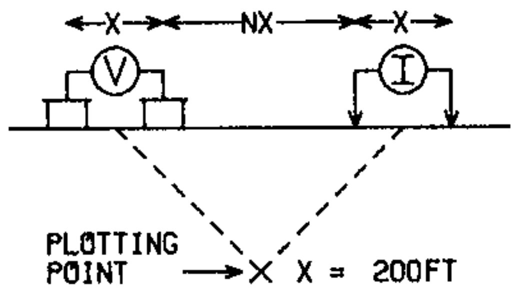
DWG. NO.- I.P.- 6051-2

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 10000W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED: PHILIP G. HALLOF

DATE: 2/13/73

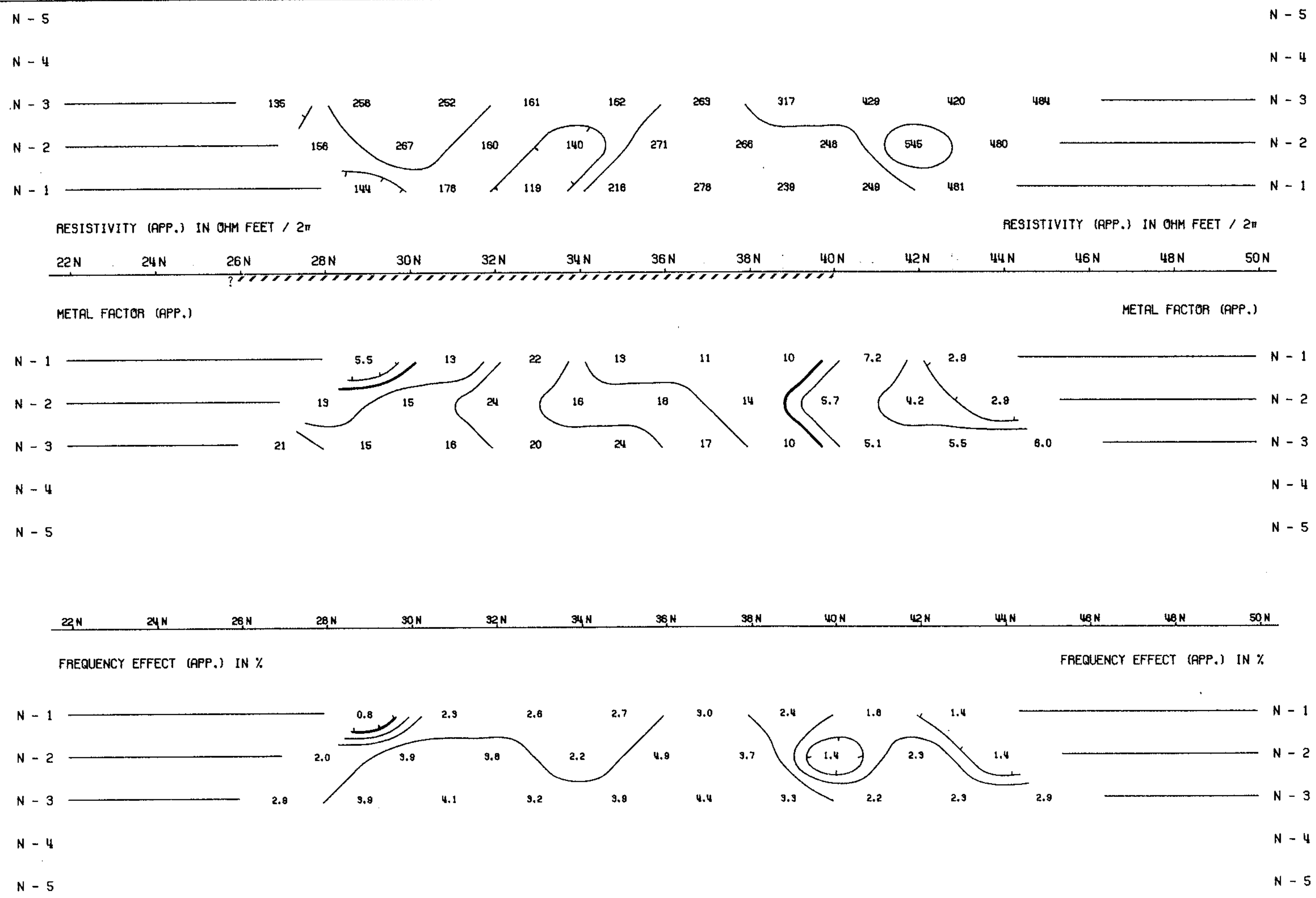
PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA
Expiry Date: February 25 1973

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



4317

DWG. NO.- I.P.- 6051-3

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 9600W

ELECTRODE CONFIGURATION

X NX X

PLOTTING POINT X X = 200FT

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE:

PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA, PHILIP G. HALLOF

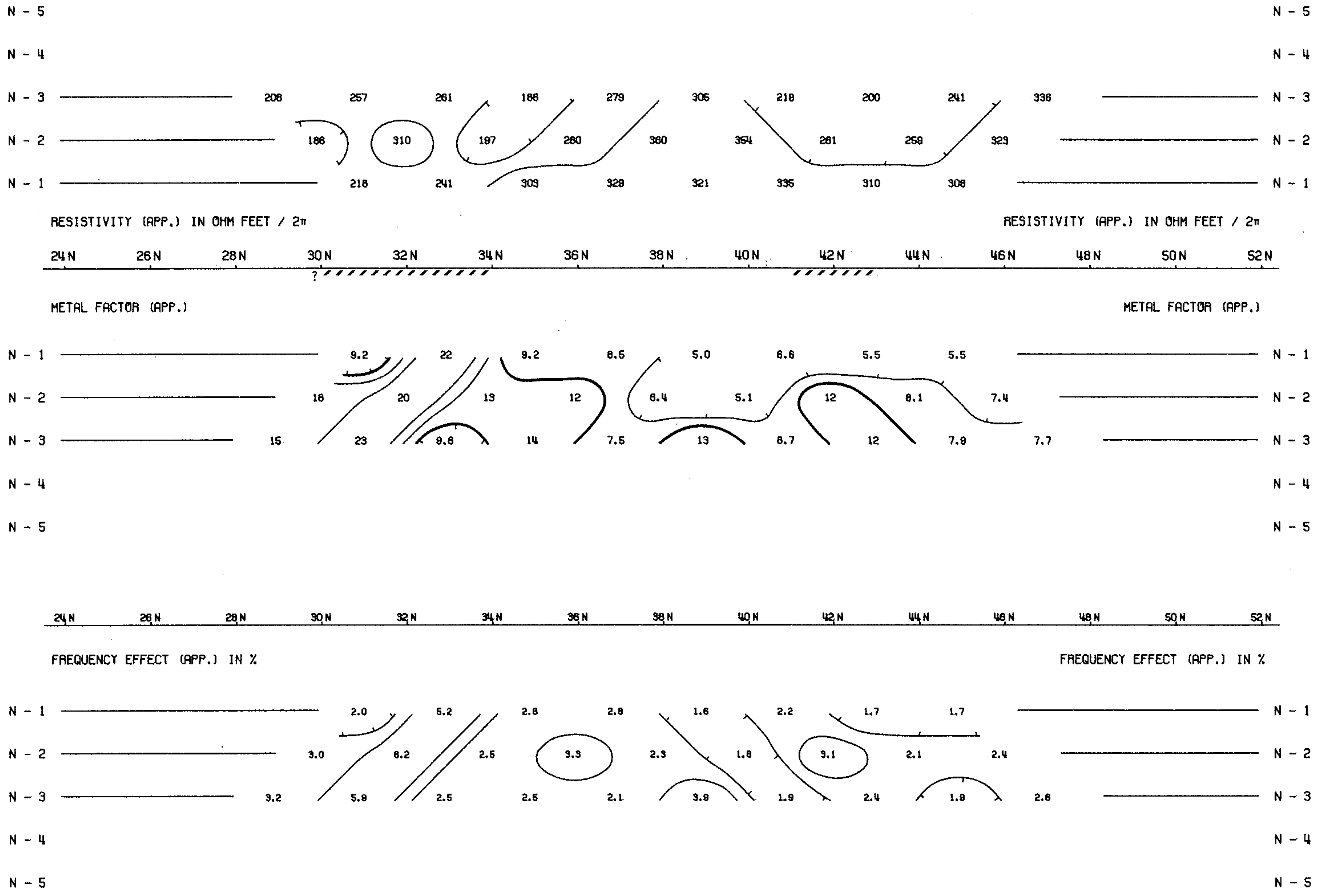
Expiry Date: February 25, 1973

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



4317

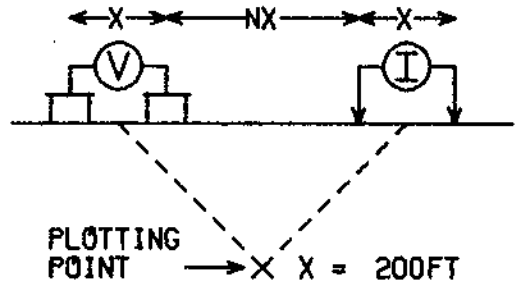
DWG. NO.- I.P.-6051-4

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 9200W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE:

PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA — PHILIP G. HALLOF

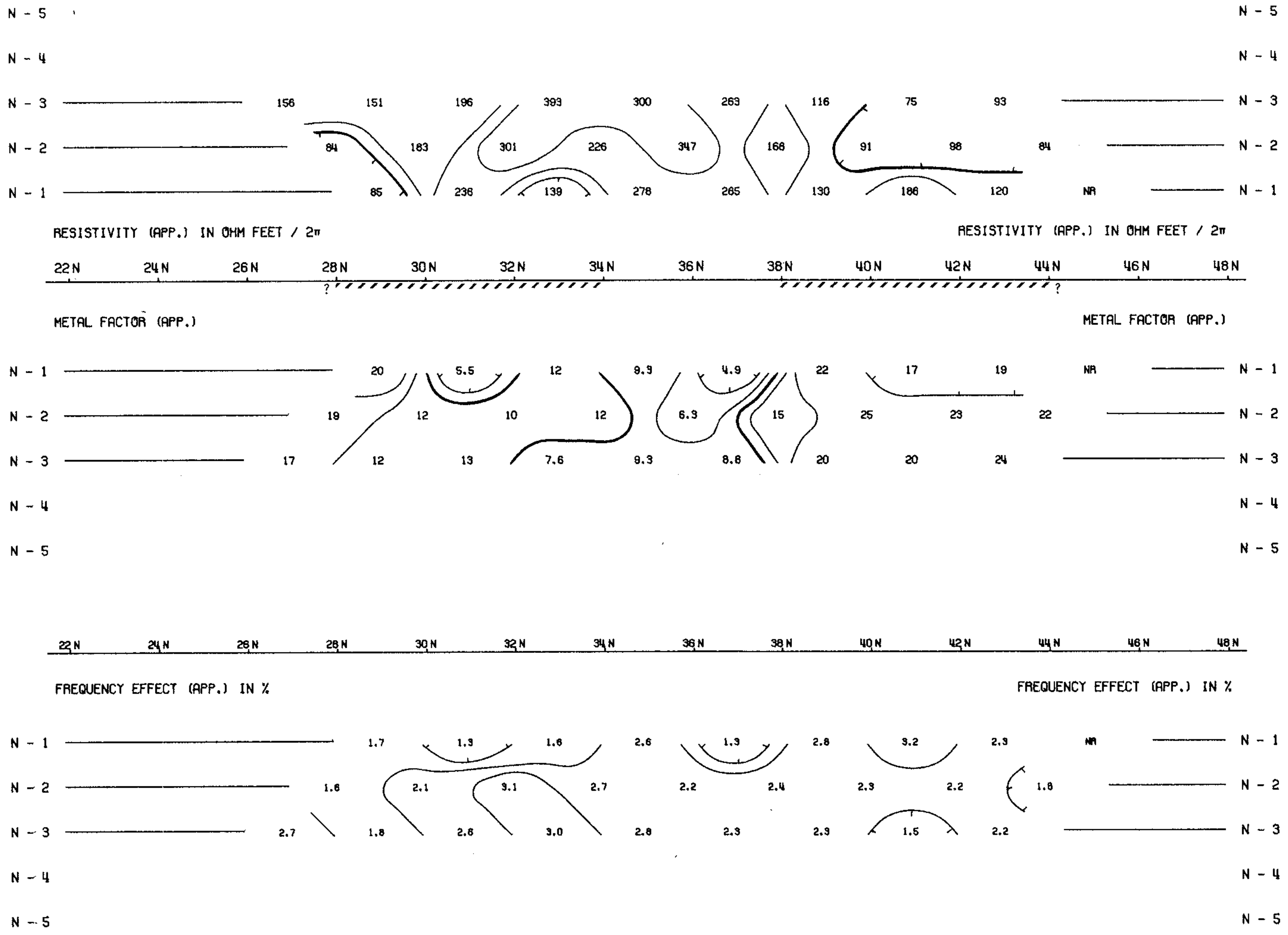
Expiry Date: February 25, 1973

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



4317

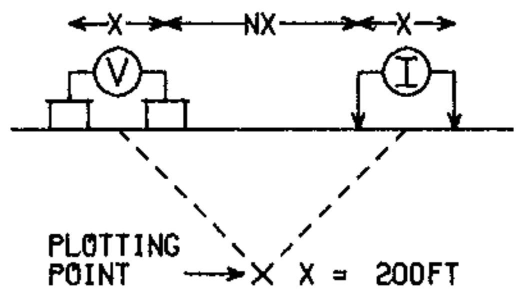
DWG. NO.- I.P.- 6051-5

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 8800W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE ▬▬▬
PROBABLE ||||||||||
POSSIBLE / / / / /

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE:

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — PHILIP G. HALLOF

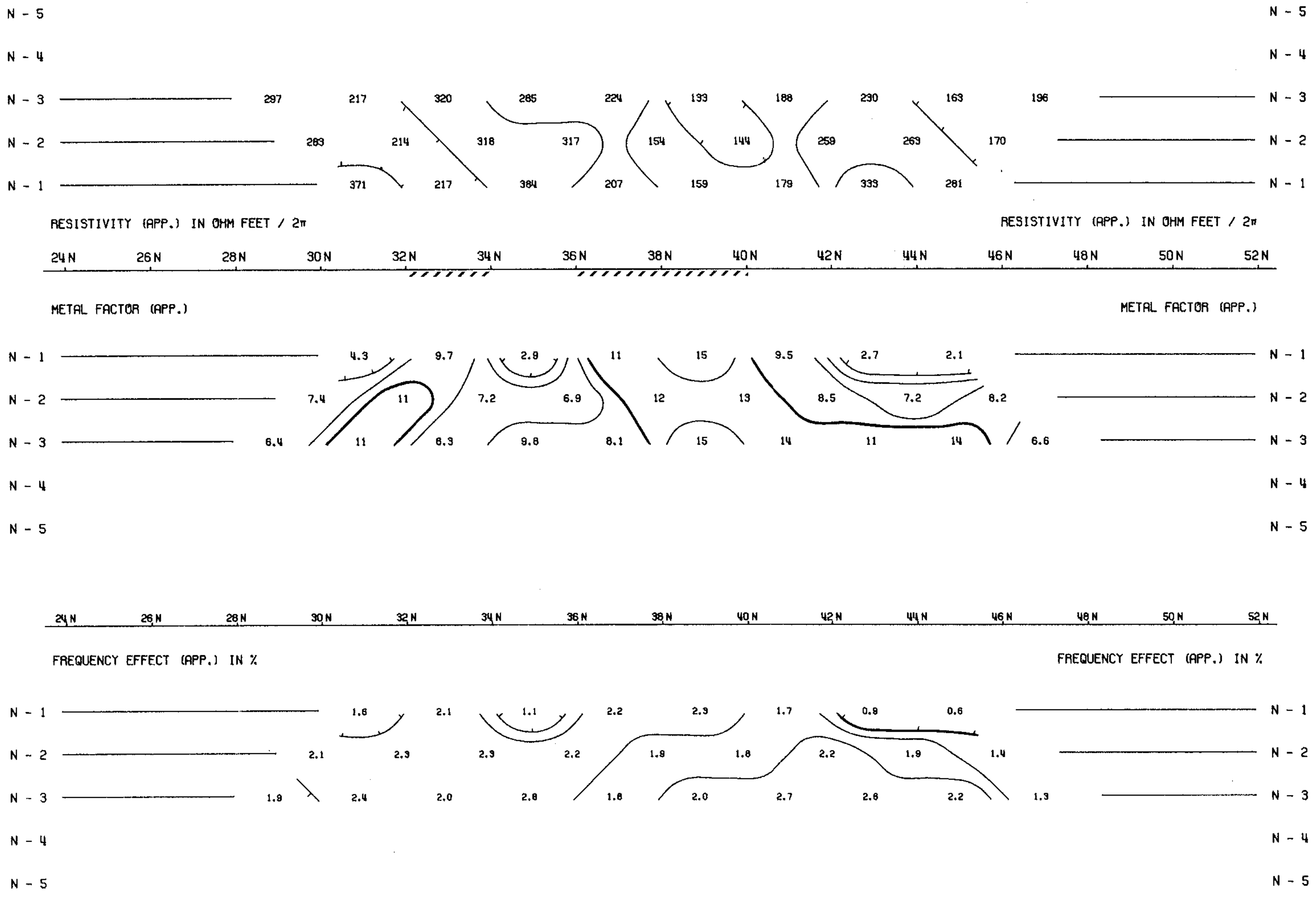
Expiry Date: February 25, 1973

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



4317

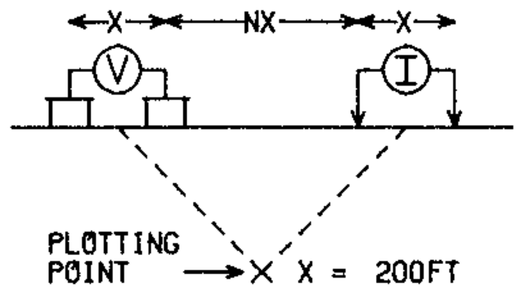
DWG. NO.- I.P.- 6051-6

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 8000W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE:

PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA, PHILIP G. HALLOF, 3/16/73

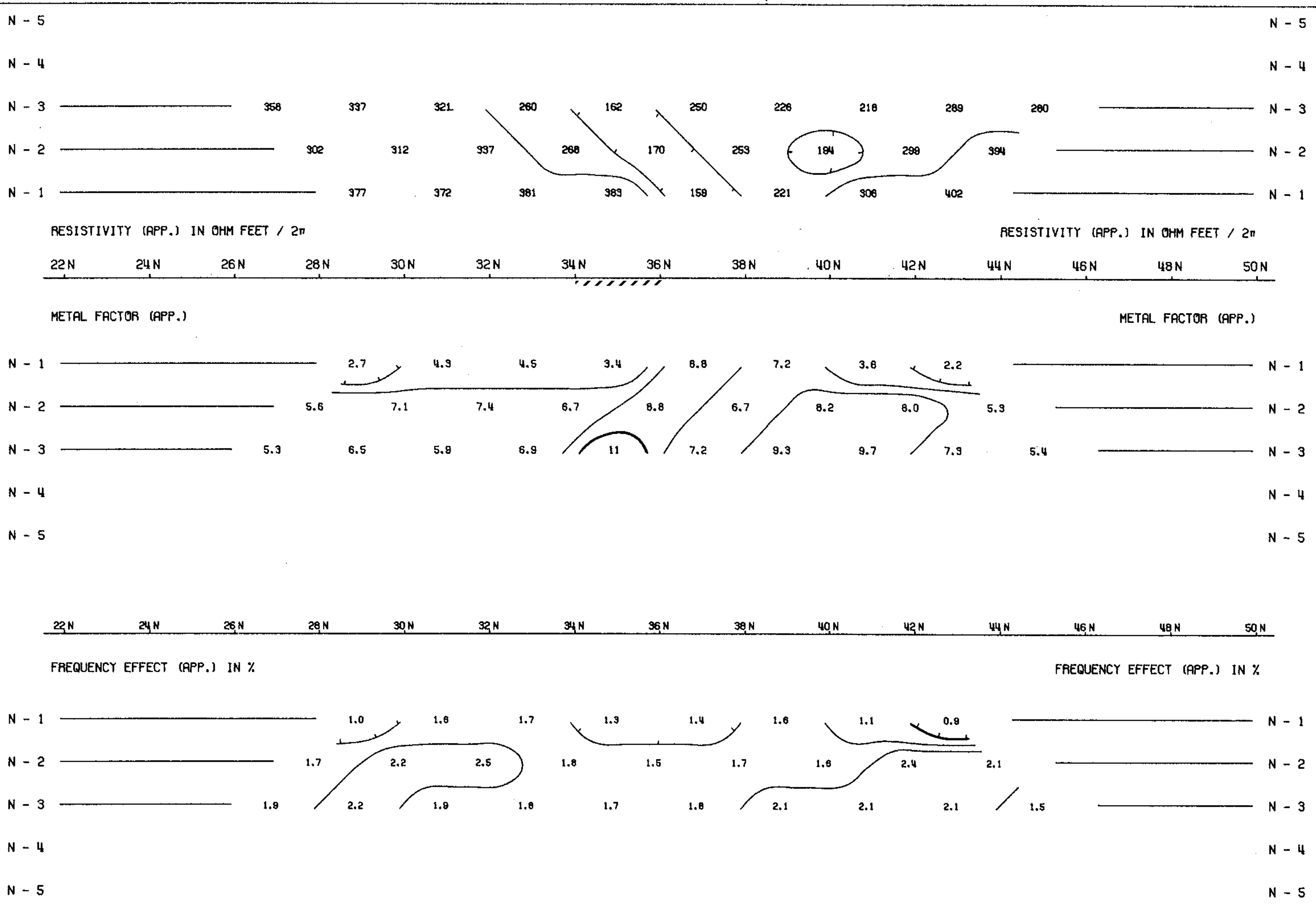
Expiry Date: February 25, 1973

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



4317

DWG. NO.- I.P.- 6051-7

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 7200W

ELECTRODE CONFIGURATION

X = 200FT

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE:

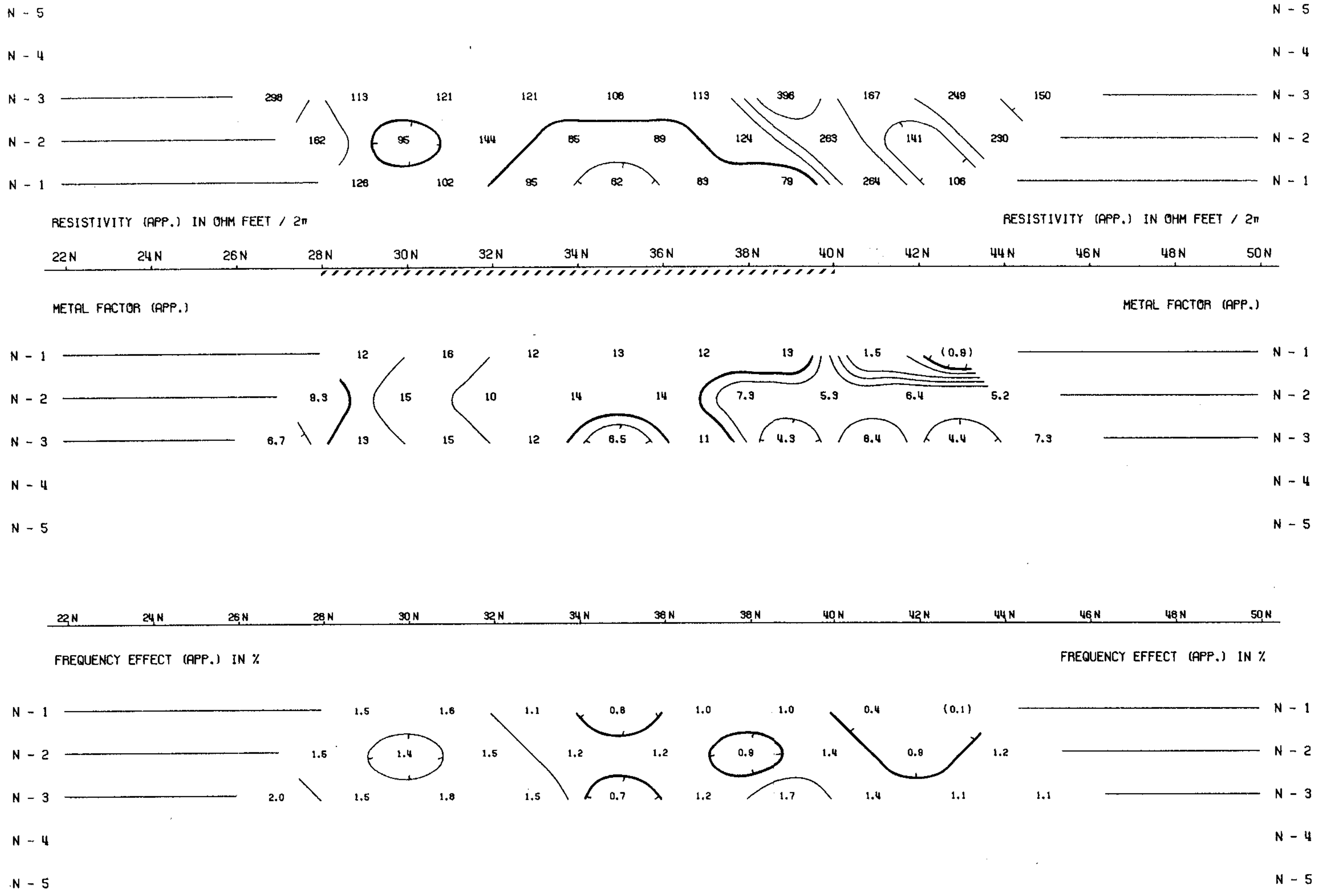
NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

Expiry Date: February 25, 1973

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



4317

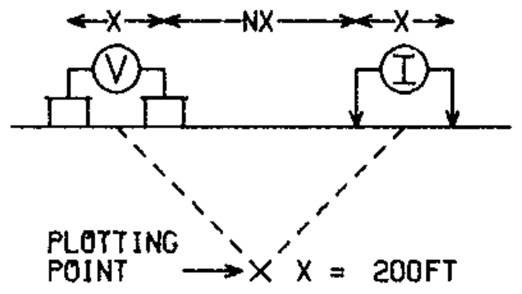
DWG. NO.- I.P.- 6051-8

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 6400W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE:

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

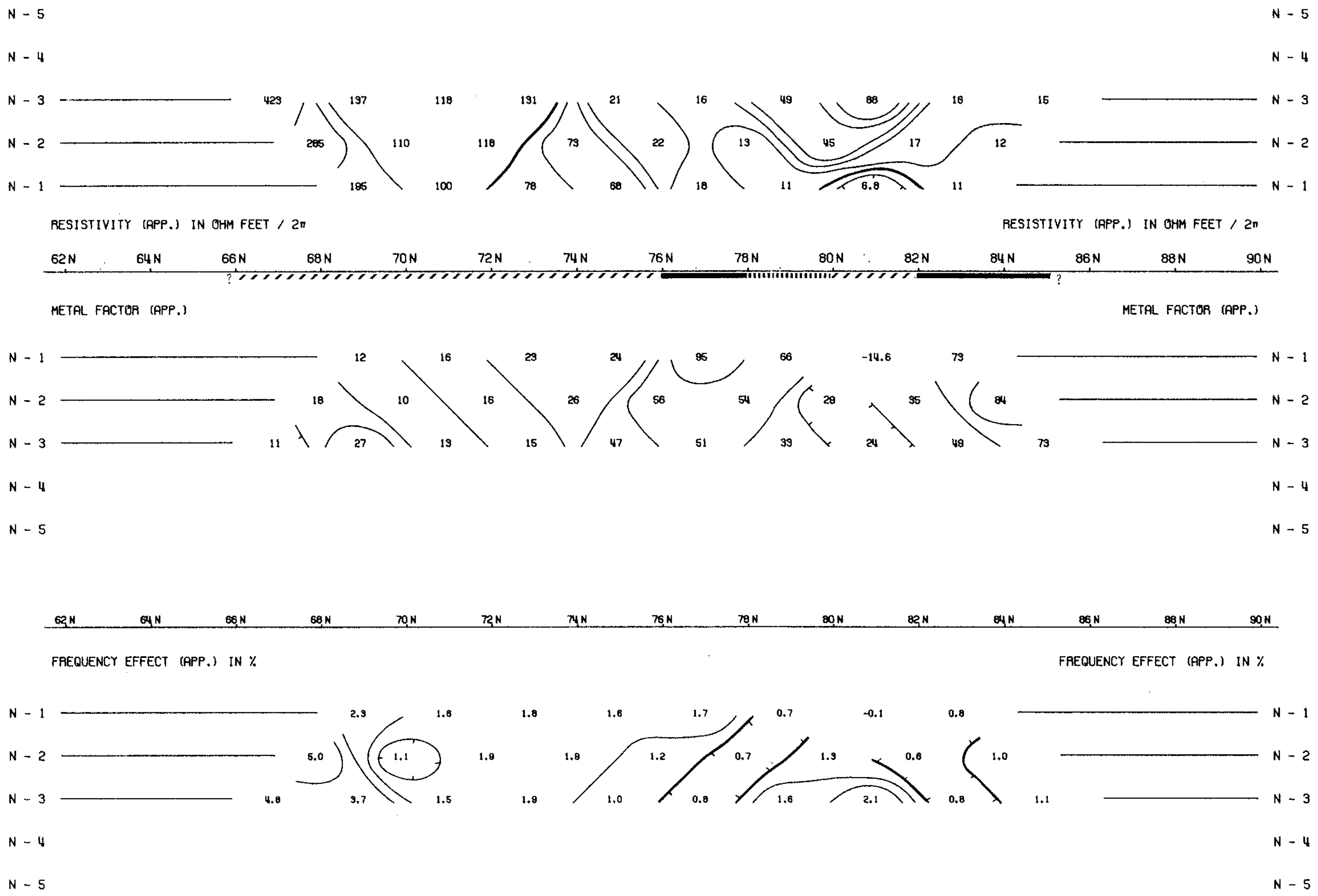
PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA PHILIP G. HALLOF

Expiry Date: February 25, 1973

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



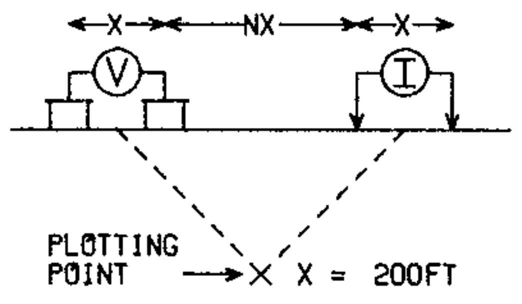
4317 DWG. NO.- I.P.- 6051-9

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 3600W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

- DEFINITE ▬▬▬
- PROBABLE ||||||||
- POSSIBLE / / / / /

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE: 2/15/73

PROVINCE OF BRITISH COLUMBIA — PROFESSIONAL ENGINEER — PHILIP G. HALLOF

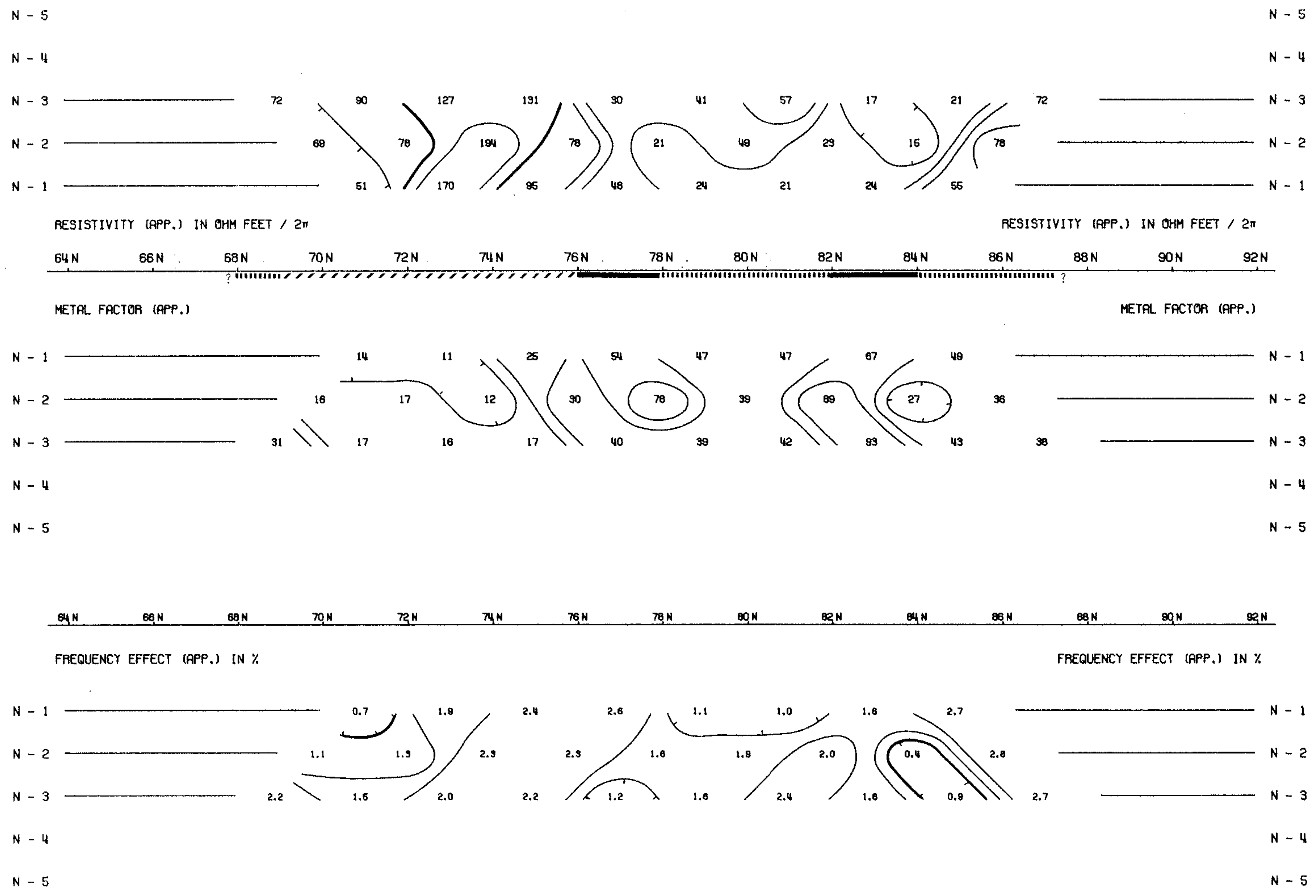
Expiry Date: February 25, 1973

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY McPHAR COMPUTER DIVISION



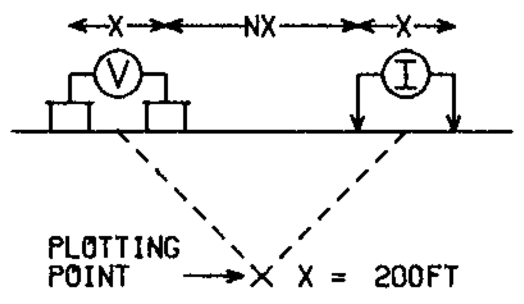
4317 DWG. NO.- I.P.-6051-10

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 3200W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE ▬▬▬
PROBABLE ||||||||||
POSSIBLE / / / / /

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE:

NOTE: CONTOURS AT LOGARITHMIC INTERVALS
1.-1.5-2.-3.-5.-7.5-10

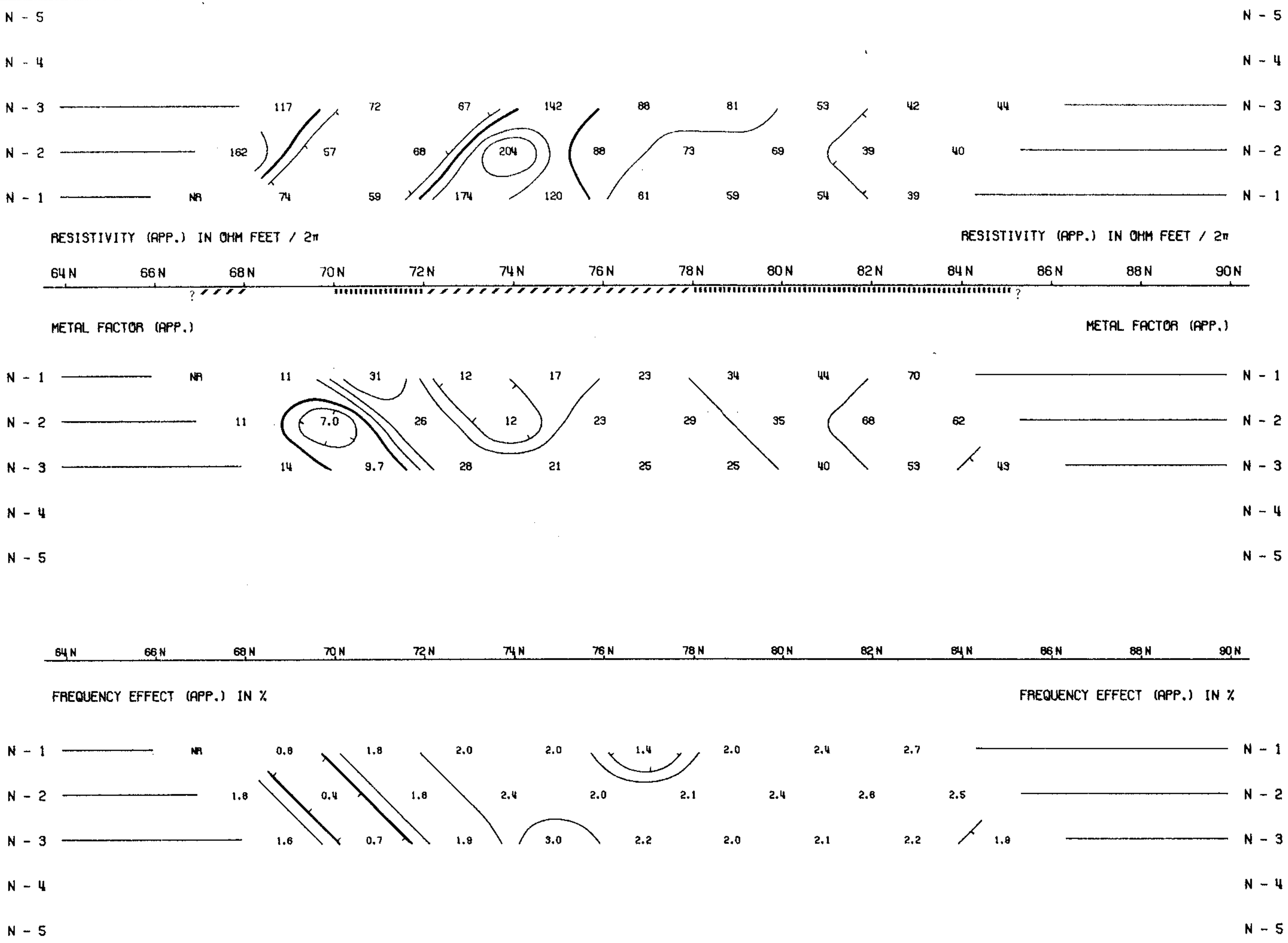
PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA, PHILIP G. HALLOF

Expiry Date: February 2_, 19_3

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



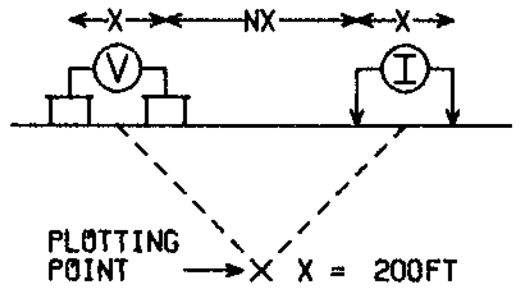
4317 DWG. NO. - I.P. - 6051 - 11

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO. - 2800W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN. 1973

APPROVED:

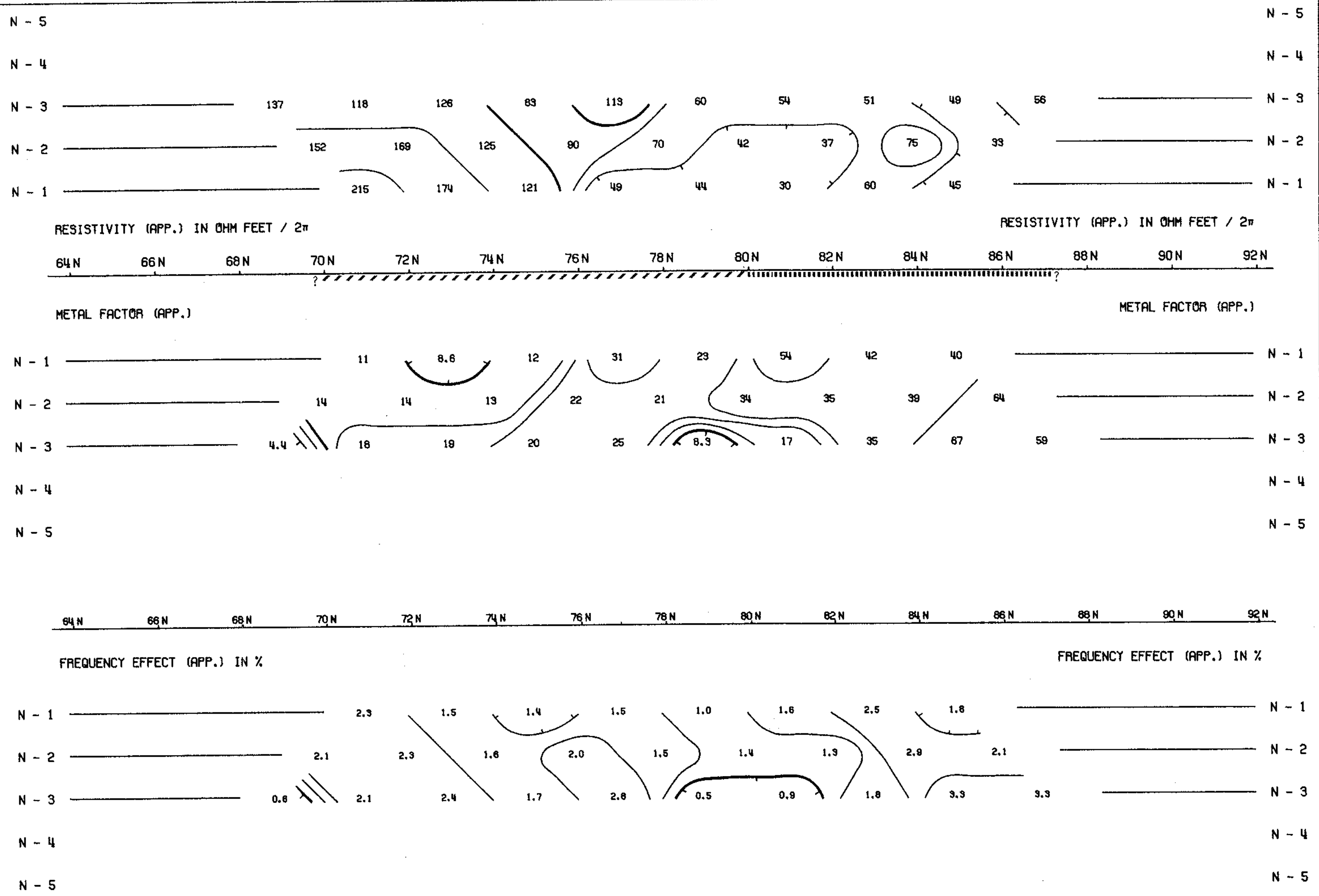
DATE: 3/15/73

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION



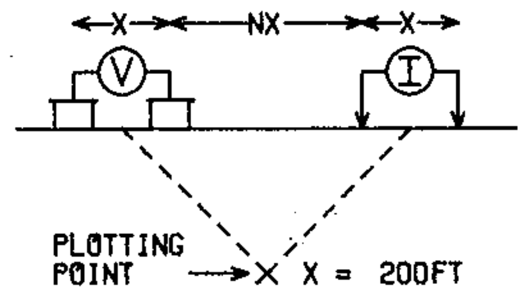
4317 DWG. NO.- I.P.- 6051-12

MAKAOO DEVELOPMENT COMPANY LIMITED.

MAKAOO PROPERTY, KAMLOOPS AREA,
KAMLOOPS M.D., B.C.

LINE NO.- 2400W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: JAN 1973

APPROVED:

DATE: 2/15/73

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

McPHAR GEOPHYSICS

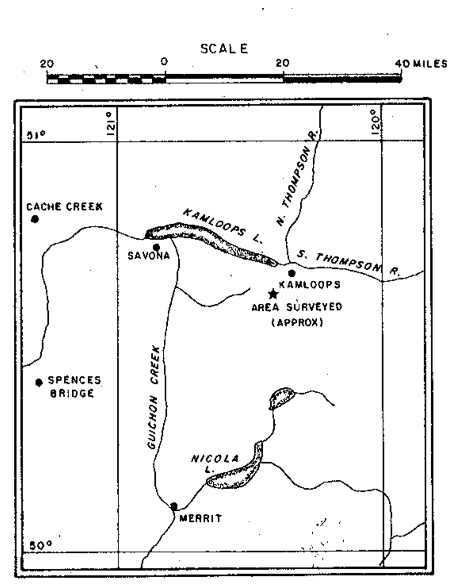
INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

PLAN MAP



NOTE TO ACCOMPANY GEOPHYSICAL REPORT FOR MAKAOO DEVELOPMENT COMPANY LIMITED, MAKAOO PROP., KAMLOOPS AREA, KAMLOOPS M.D., B.C. BY P.G.HALLOF, P.ENG. AND M.A. GOUDIE, GEOLOGIST.

DATED: FEB.16, 1973

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 4317 MAP #1

4317 M-1

SURFACE PROJECTION OF ANOMALOUS ZONES

- DEFINITE
- PROBABLE
- POSSIBLE

Number at the end of anomaly indicates spread used.

MAKAOO DEVELOPMENT COMPANY LIMITED

MAKAOO PROPERTY, KAMLOOPS AREA

KAMLOOPS M.D., B.C.

SCALE

ONE INCH EQUALS FOUR HUNDRED FEET

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
PHILIP G. HALLOF