Source Hydrogeology of Central Highland Valley
Report for Valley Copper Limited by
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4.3 Surficial Geology

4.3.1 Regional

The regional surficial geology of the Thompson Plateau and environs has been described by Ryder (1974) and Fulton (1975).

It is generally believed that valleys such as the Highland Valley formed as part of a Tertiary drainage system which drained and eroded rocks of the Thompson Plateau. During the Pleistocene, the Thompson Plateau was glaciated as many as four times and ice movement across the plateau was to the south southeast. Each glacial advance either buried (in topographic lows) or eroded (on topographic highs) the deposits of the preceding advance. During glacial retreat large deposits of ice, remaining in the valleys, melted and produced additional thicknesses of surficial materials. In general, the surficial deposits of valleys within the Thompson Plateau are thicker and more complex than those on

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4.3.1 Regional continued ...

the plateau itself. On and at the margins of the uplands, gravelly glacial till was deposited either as a thin veneer of glacial drift or as thicker ground moraine. Small, local areas of kames, eskers, and other meltwater ice contact deposits are scattered throughout the Thompson Plateau and are indicative of ice remnants left during the glacial retreat. In the valleys, an extremely thick and complex sequence of glacial tills, glacio-fluvial sands and gravels, and lacustrine silts and clays were deposited by moving and melting tongues of ice. The existing surficial cover in the valleys is related to the last glacial retreat and does not indicate the complex nature of the underlying surficial deposits.

4.3.2 Local Surficial Geology

The surficial geology of the Highland Valley has been generally described by Nasmith (1957) before any wells were drilled in the Valley.

As a fault controlled, Tertiary drainage remnant, the pre-glacial Highland Valley was at an elevation of approximately 3,000 feet A.S.L. The relatively flat bottomed, central portion of the pre-glacial valley was established during the Tertiary while the steeper drainage gradients at both ends of the Valley were formed as a result of uplift and subsequent down cutting. This sequence of events has left the Highland Valley in a "hanging" configuration approximately 3,000 feet above the present level of the Thompson River. During the Pleistocene, the Highland Valley was glaciated numerous times but the surficial deposits present at the surface now are a result of the last glacial events. At depth beneath the valley,

4.3.2 Local Surficial Geology continued ...

however, the sequence of surficial materials present are a result of four successive glacial advances and retreats which took place throughout the Pleistocene and are a complex mixture of glacial tills, glacio-fluvial deposits, and glacial lacustrine deposits up to 1,100 feet thick. These subsurface deposits were formed by moving ice, melting stagnant ice, glacial lakes formed by ice dams, and meltwater rivers. Subsurface drillhole information, which will be discussed in greater detail in a later section of this report indicate that at least four till sheets are present and therefore that the valley was covered with ice four times. Two periods of glacial lakes existed in the Highland Valley and deposits of lacustrine silts and clays are common subsurface surficial deposits. The glacio-fluvial sands and gravels, which are the most important aquifers

4.3.2 Local Surficial Geology continued ...

in the Highland Valley, form five distinct horizons within the surficial sequence. The upper two horizons have been termed the Upper and Lower aquifers by others.

The last melting ice tongue left in the Highland Valley was responsible for the deposition of the surficial deposits covering the present day land surface. As such, most of these deposits are glaciofluvial in nature and are generally sands and gravels occuring as kames, eskers, kame terraces and deltaic deposits. The kame terraces, lining the sides of the valley walls are considered especially important in terms of groundwater recharge. Due to a large block of wasting ice located at Quiltanton Lake, a glacial lake formed in the eastern portion of the Highland Valley and lacustrine deposits mantle the valley floor from one mile east of Little Divide Lake to Guichon Creek. Kame moraine

4.3.2 Local Surficial Geology continued ...

deposits associated with this ice form the present surface water divide in the Highland Valley.

In the immediate vicinity of the Valley Copper Limited open pit, the upper mantle of surficial deposits consists generally of sands and gravels occuring as kame terraces and kame moraines associated with wasting ice remnants. An extensive esker cuts across the southwestern part of the proposed open pit.

The detailed sections at the Highmont Operating Corporation well field, at the Bethlehem Copper Corporation well field and in the area of the H-H Dam show the detailed geologic succession of lithologic units now known to be present (please see Figures 4, 5, 6 and 8). The most complete stratigraphic section is present at the Bethlehem Copper Corporation well field. This area will be described first. Please refer to the hydrostratigraphic Diagram J-A Zone, Figure 5.

4.3.2 Local Surficial Geology continued ...

Figure 5 is a fence diagram showing the inter-relationships between the nine wells present in the field. Thickness can be scaled off the diagram on the 45 degree angle set for the wells. The wells are located on a horizontal plane assumed to be 3,900 feet A.S.L. The units and the contacts between the units have been picked in an interpretative manner from the descriptions of the sediments encountered. Please refer to well logs in Appendix A. Bedrock was not encountered in any of the wells drilled in the area. The deepest hole BW7 was drilled to a depth of 895 feet (elevation 3,005 feet A.S.L.) without encountering bedrock. The full thickness of the till at the bottom of BW7 and BW9 has never been penetrated. Information from the Highmont Operating Corporation well field suggests that this lower till sheet is underlain by a water-bearing sand and gravel that overlies bedrock.

4.3.2 Local Surficial Geology continued ...

The elevation of the top of bedrock in the area is reportedly 2,910 feet A.S.L. Therefore the combined thickness of the lowest till and its underlying sand and gravel aquifer should be 95 feet. The overburden should total 990 feet in thickness in this area.

The overburden in the area contains four till sheets ranging from 20 to 100 feet in thickness. The second youngest (second highest) till sheet was eroded in the area of BW2 and BW7. These are typical till sheets deposited from the sole of an ice sheet type glacier that was probably 7,000 feet thick when it passed over the Highland Valley.

Two clay sequences separated by a till and a water-bearing sand and gravel unit are present in BW5, BW7 and BW9. These clay sequences contain organic remains and thin silt and sand interbeds. These sediments were most probably deposited in ice dammed glacial

4.3.2 Local Surficial Geology continued ...

lakes formed by valley glaciers lying in the Thompson and Guichon Valleys. The organic remains show that the climate was relatively warm so that the hills surrounding these lakes were vegetated.

The four sand and gravel zones encountered in the area are all water-bearing and drainable. The top unit is a morainal deposit which is silty and contains minor amounts of clay interbeds. It will not produce useful quantities of water to wells and thus has never been screened or tested. The second aquifer has been screened and tested at BW9 and BW8. Both wells are being pumped at a combined rate of 1,500 lgpm. The third aquifer has been screened and tested in BW3, 4 and 6 and the fourth aquifer in BW5 and 7. These lower two aquifers range in thickness from 0 to 60 feet. They are lying in buried river channels, and do not occur as blanket deposits lying beneath the whole valley.

4.3.2 Local Surficial Geology continued ...

The configuration of the basic hydrostratigraphic units in the area of the Highmont Operating Corporation well field is shown on Figure 6.
This is a fence diagram based upon the logs of the three production wells and four rotary e-logged test wells. In this southeastern part of the Highland Valley two glacial till sheets, two sand and gravel units and one clay sequence are present. The main sand and gravel unit ranges from 100 to 160 feet thick, and is the only unit screened and developed. A lower silty sand and gravel is present above bedrock in the rotary holes and ranges in thickness from zero to 120 feet. It has not been screened and tested.
It is difficult to correlate between the Bethlehem and Highmont well fields because no distinct markers are present. The main aquifer at the Highmont well field is probably related to the middle aquifer developed at Bethlehem.

4.3.2 Local Surficial Geology continued ...

In the area of the H-H Dam three till sheets, four water-bearing sand and gravel zones and one clay unit are present. The lowest sand and gravel zone contains boulders. The second and third zones have been screened and developed in one well near the upper toe of the dam. Please see Figure 4. The Lornex Mining Corporation Ltd. fresh water supply wells (CWT 67-1 and CWT 70-3), located downslope from the Lornex camp at approximate elevation of 3,900 feet A.S.L., indicate the complete valley fill section of eleven hydrostratigraphic units overlying bedrock. Since bedrock is at an elevation of approximately 3,400 feet A.S.L. these units are thinner than at valley center. Thus the four sand and gravel aquifers present at the Bethlehem Copper Corporation well field (J-A Zone) extend

4.3.2 Local Surficial Geology continued ...

across and along the valley a known distance of 7,500 feet. The lowest zone that overlies bedrock in the Highmont Operating Corporation field extends along the valley at least nine miles from the Highmont well field to the H-H Dam.

No cable tool test holes have been drilled in the area of the Valley Copper Limited open pit so that the details of the surficial geology within the pit area must be inferred from the areas of the H-H Dam, the Lornex, Bethlehem and Highmont well fields and from diamond and Becker drill logs of the overburden made by others. We judge that the bedrock, along the southern perimeter of the open pit and above elevation 4,100 feet A.S.L., will be overlain by glacial till capped with a gravelly sandy soil. Below this

4.3.2 Local Surficial Geology continued ...

surface elevation and to the north the units described above at the H-H Dam and the Lornex and Bethlehem wells will become developed and in the deep part of the buried valley a nearly complete section of surficial materials is expected. Organic silts and clays directly underlie Quiltanton Lake and its surrounding marshes at ground surface. Figure 8, a section through the proposed open pit shows the extrapolated depths of the main hydrostratigraphic units. The four groundwater-bearing zones shown represent the five units present in the existing well fields. Unit 7 may be present in the vicinity of the open pit. Only four water-bearing sand and gravel zones are present at the H-H Dam.

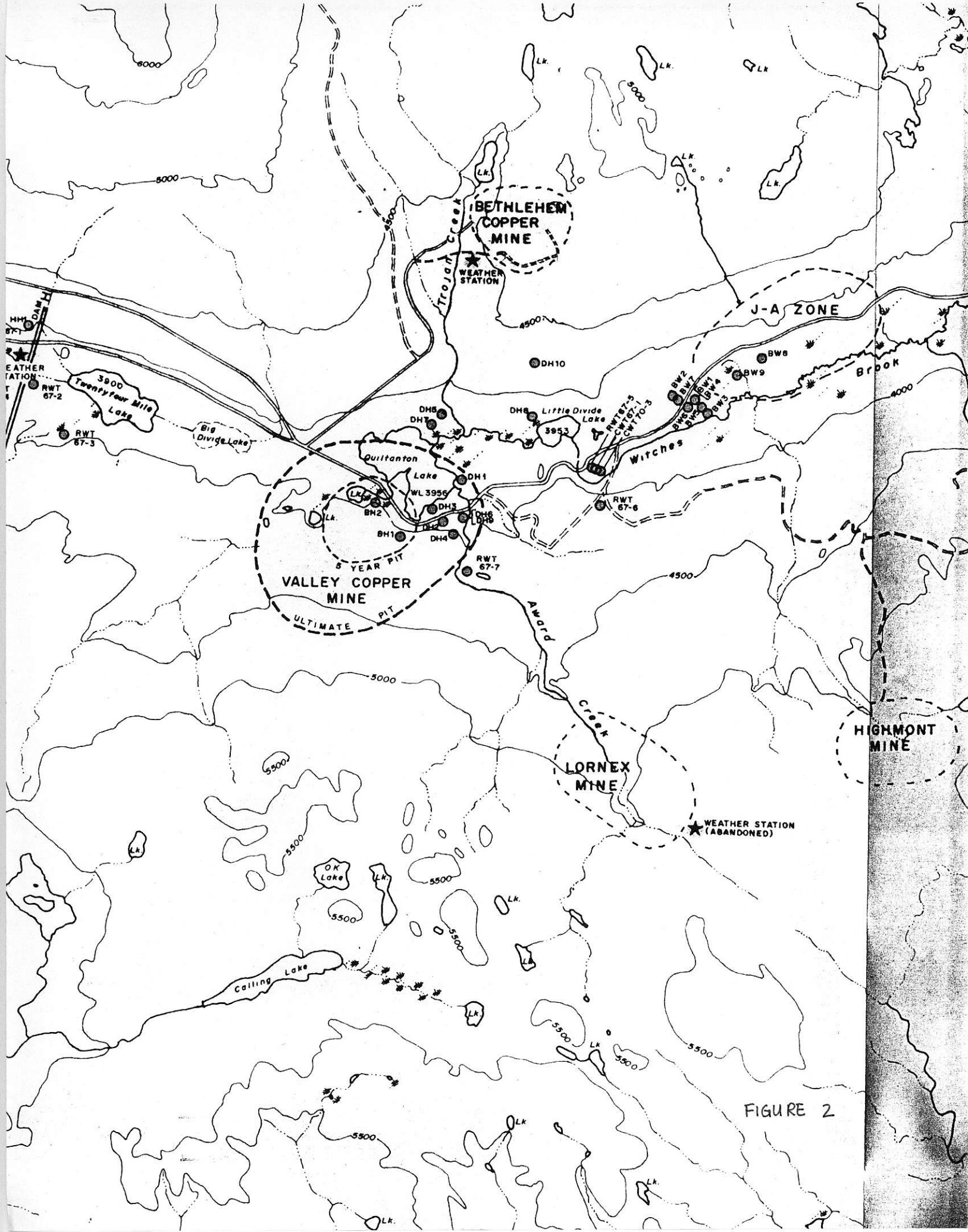
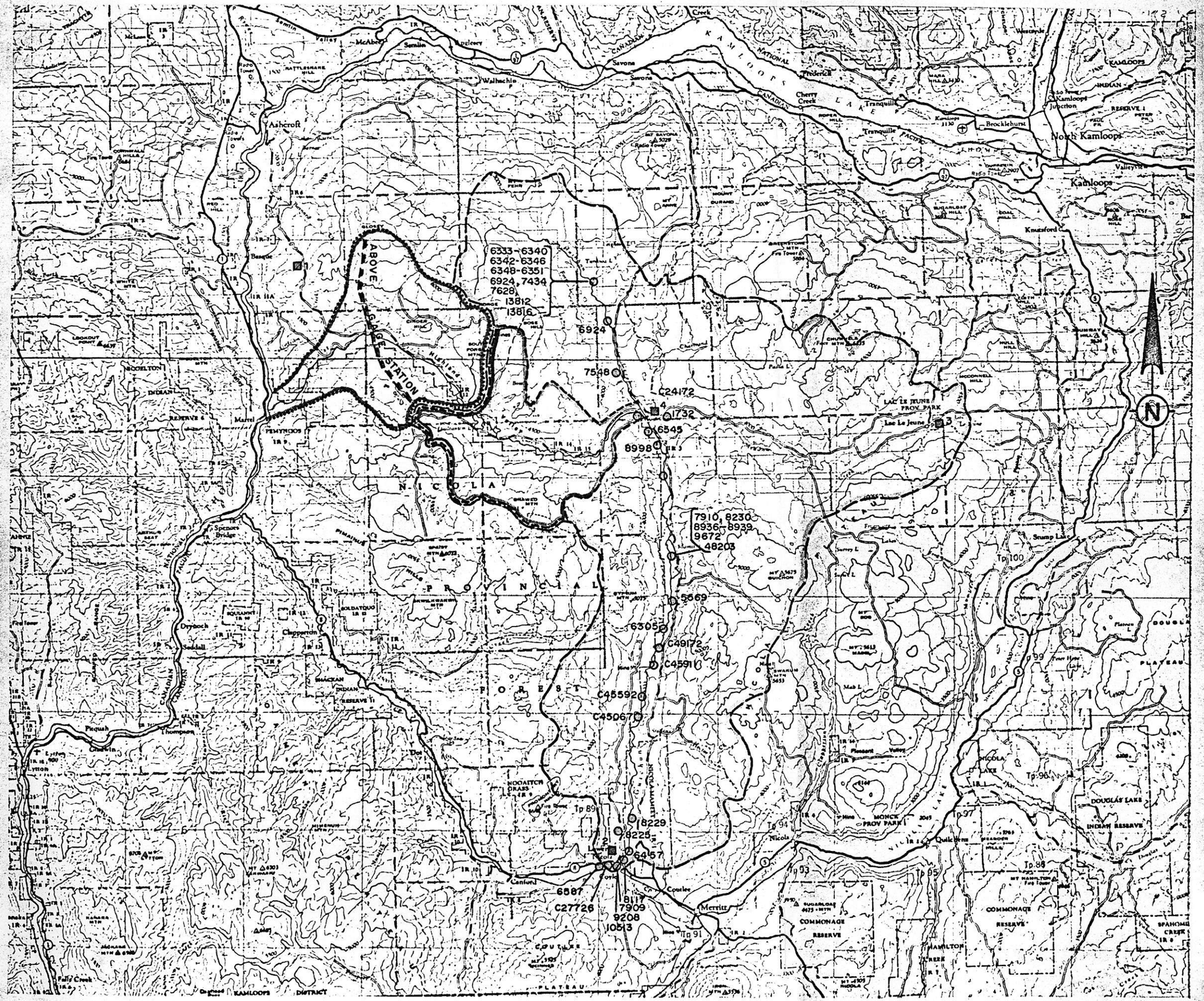

BETHLEHEM COPPER MINE
WEATHER STATION
Trojan Creek
J-A ZONE
DH10
BW6
BW9
Brook
DH5
DH7
DH8
Little Divide Lake
3953
RWT67-5
CWT67-1
CWT10-3
BW2
BW7
BW1
BW4
BW3
BW5
BW8
Witches
RWT 67-2
3900
Twenty four Mile Lake
RWT 67-3
Big Divide Lake
Quiltanton Lake
WL 3956
DH1
BH2
DH3
DH6
DH9
BH1
DH4
RWT 67-6
RWT 67-7
5 YEAR PIT
VALLEY COPPER MINE
ULTIMATE PIT
Award Creek
HIGHMONT MINE
LORNEX MINE
WEATHER STATION (ABANDONED)
OK Lake
Calling Lake
6000
5000
4500
5500
4000
Lk.

FIGURE 2



REFERENCE

DRAINAGE BASINS:

- GUICHON CREEK
- PUKAIST CREEK
- WITCHES BROOK

WATER USE:

- O6457 SURFACE WATER LICENCE (NO.)
- ■1 COMMUNITY WATER SUPPLY SYSTEM

0 5 10 15 Miles
0 5 10 15 20 25 Km
SCALE

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DRAINAGE BASIN MAP OF HIGHLAND VALLEY AREA

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FIGURE 3

FIGURE 4

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HYDROSTRATIGRAPHIC SECTION UPPER DAM SITE (H-H DAM)

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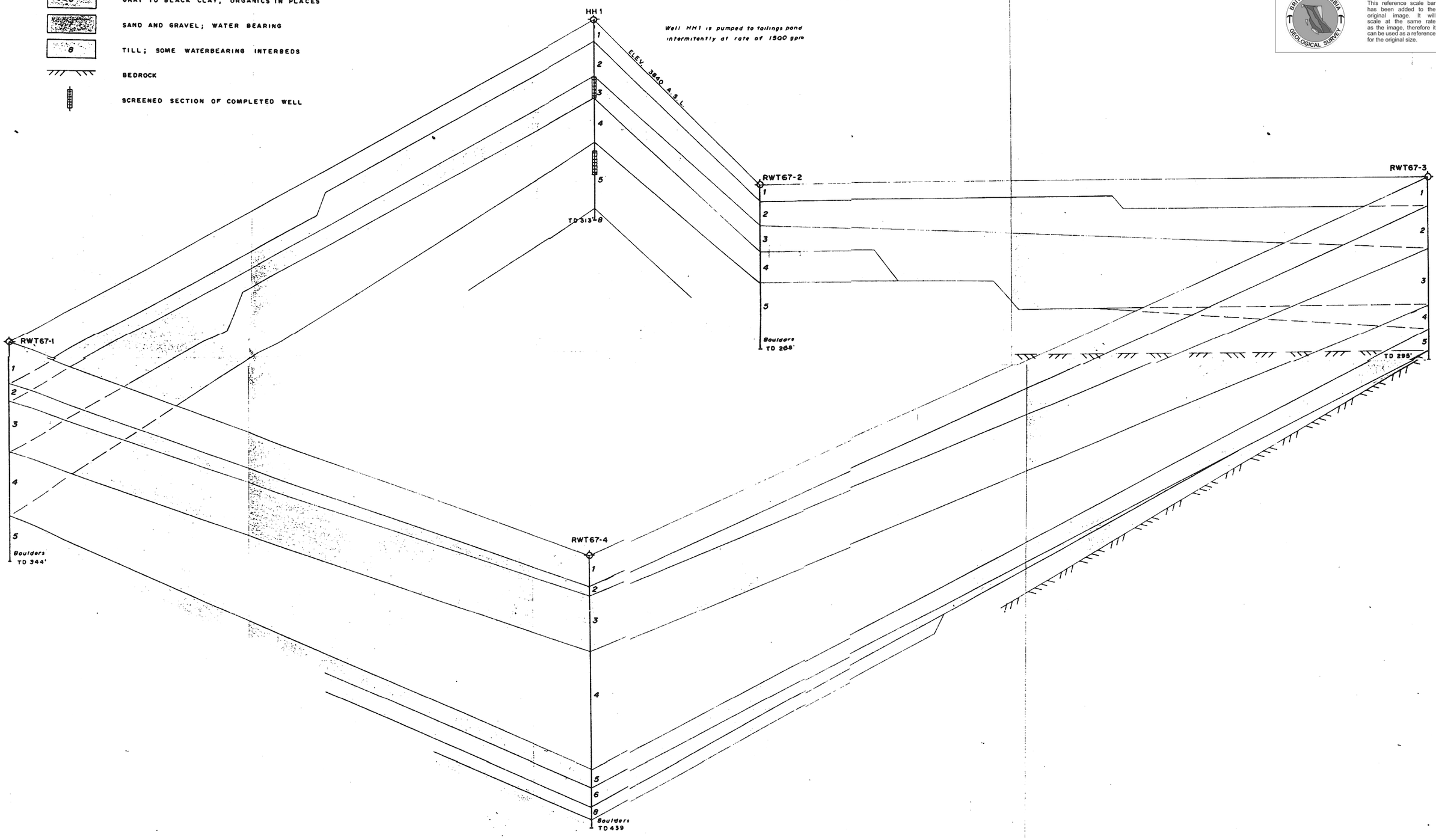
LEGEND

1	SILTY SAND AND GRAVEL, MINOR CLAY LENSES; SOME WATER
2	TILL (HARDPAN)
3	SILTY SAND AND GRAVEL, SOME WATER
4	TILL (HARDPAN); A FEW THIN WATERBEARING INTERBEDS
5	SAND AND GRAVEL; WATER BEARING
6	GRAY TO BLACK CLAY, ORGANICS IN PLACES
7	SAND AND GRAVEL; WATER BEARING
8	TILL; SOME WATERBEARING INTERBEDS
	BEDROCK
	SCREENED SECTION OF COMPLETED WELL

SCALE: HORIZONTAL (PLAN VIEW) 1" = 200 FEET
VERTICAL (BOREHOLE AXIS) 1" = 100 FEET
V.E. = 2

Well HH1 is pumped to tailings pond intermitently at rate of 1500 gpm



inches
0 1 2
0 1 2 3 4 5
centimetres

BRITISH COLUMBIA GEOLOGICAL SURVEY

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FIGURE 5

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HYDROSTRATIGRAPHIC SECTION J-A ZONE

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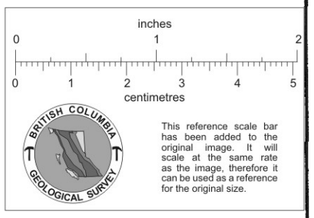

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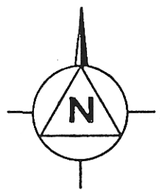
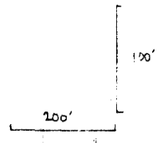


SCALE: HORIZONTAL (PLAN VIEW) 1"= 200 FEET
VERTICAL (BOREHOLE AXIS) 1"= 100 FEET
V.E. = 2X



LEGEND

1	SILTY SAND AND GRAVEL, MINOR CLAY LENSES, SOME WATER
2	TILL (HARDPAN)
3	SILTY SAND AND GRAVEL; SOME WATER
4	TILL (HARDPAN); A FEW THIN WATERBEARING INTERBEDS
5	SAND AND GRAVEL; WATER BEARING
6	GRAY TO BLACK CLAY, ORGANICS IN PLACES
7	SAND AND GRAVEL; WATER BEARING
8	TILL; SOME WATERBEARING INTERBEDS
9	GRAY TO BLACK CLAY, ORGANICS IN PLACES
10	TILL; SOME WATERBEARING INTERBEDS

SCREENED SECTION OF COMPLETED WELL

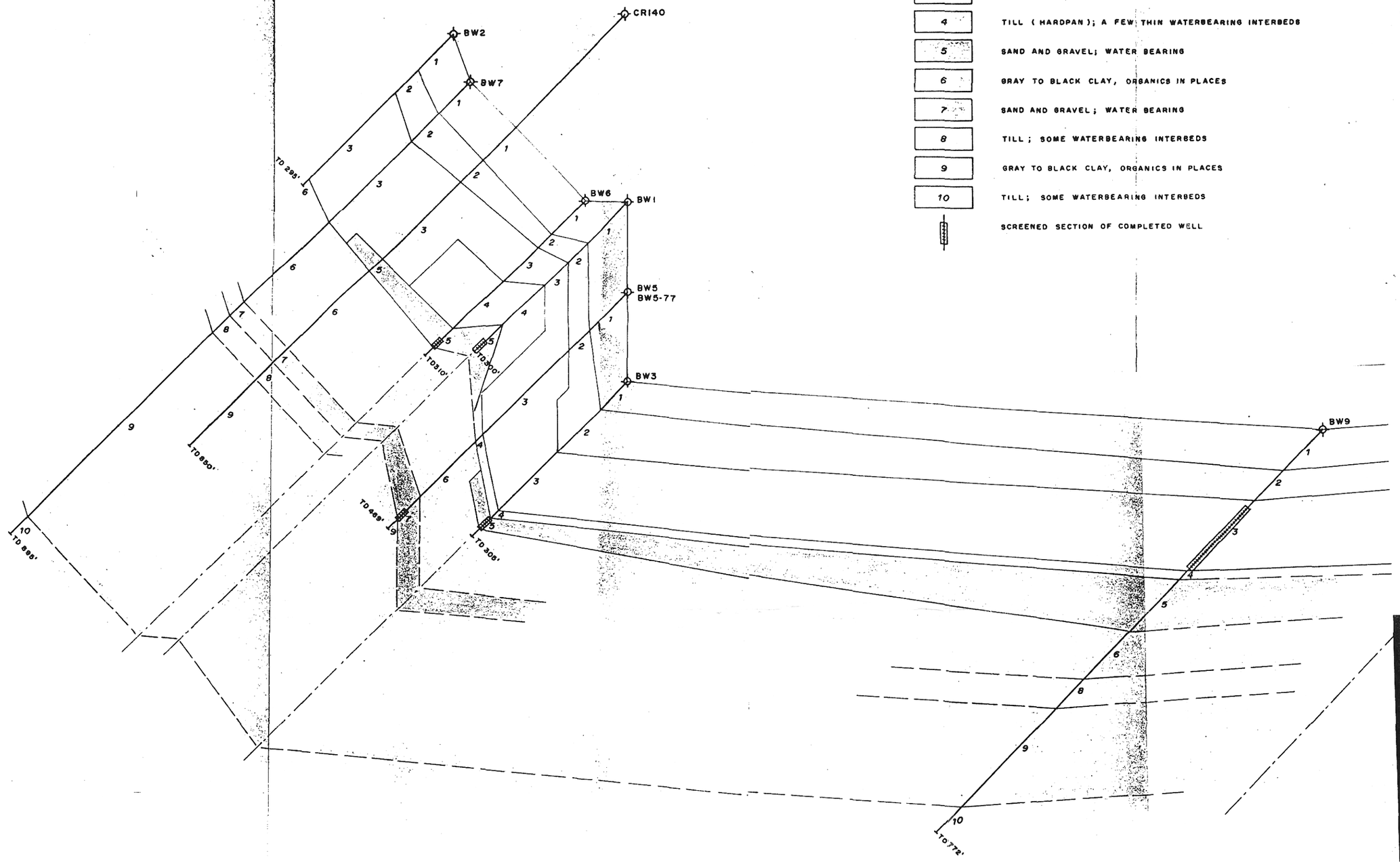


FIGURE 6

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HYDROSTRATIGRAPHIC SECTION HIGHMONT WELL FIELD

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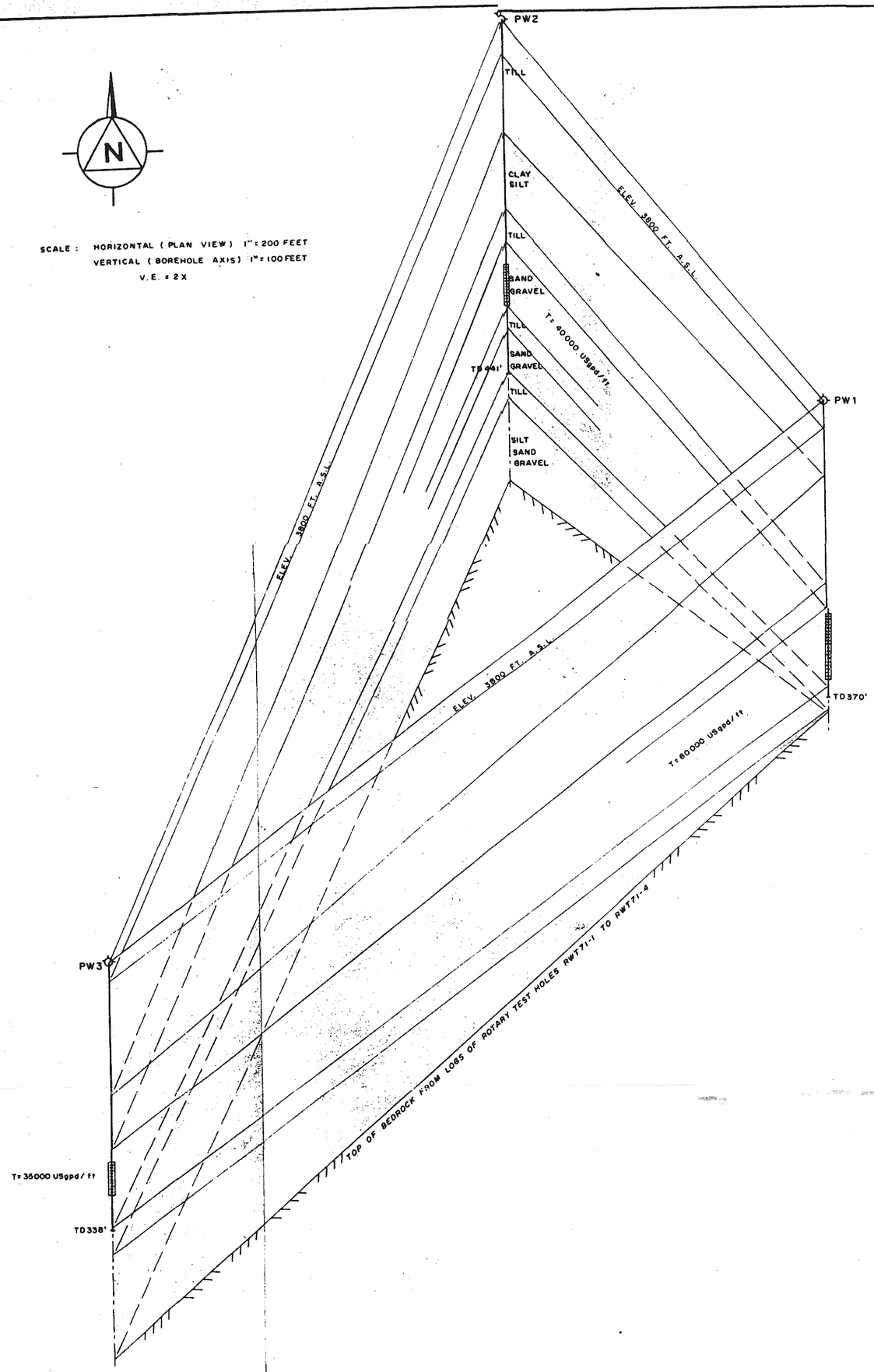
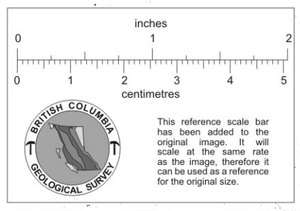
SCALE : HORIZONTAL (PLAN VIEW) 1" = 200 FEET
VERTICAL (BOREHOLE AXIS) 1" = 100 FEET
V.E. = 2X



LEGEND

- TILL
- CLAY AND SILT, INTERBEDDED
- SAND AND GRAVEL; WATER BEARING
- SILTY GRAVEL
- BEDROCK
- SCREENED SECTION OF COMPLETED WELL



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