West Channel Areas: summary of soils and permafrost data with a preliminary site appraisal

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Report (National Research Council of Canada. Division of Building Research); no. DBR-R-41, 1955-10-01

NATIONAL RESEARCH COUNCIL

CANADA

WEST CHANNEL AREAS -- SUMMARY OF SOILS AND PERMAFROST DATA WITH A PRELIMINARY SITE APPRAISAL

by

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(Prepared for C.L. Merrill, Aklavik Survey Team Leader)

Report No. 41
of the
Division of Building Research

Ottawa
October 1955

(Supersedes Report Issued September 1954)

PREFACE

The authors are both research officers in the Division of Building Research, National Research Council, working in the Permafrost Section. They were members of the Aklavik Relocation Survey Team which was under the auspices of the Department of Northern Affairs and National Resources. During the summer of 1954 this survey team, under the leadership of Mr. C.L. Merrill, Department of Northern Affairs and National Resources, carried out intensive investigations at various potential townsites bordering the Mackenzie Delta.

This report summarizes the soils and permafrost data of the potential site bordering the West Channel on the west side of the Mackenzie Delta. They were obtained by the authors and their colleague who is the Head of the Permafrost Section and also a member of the Survey Team. A preliminary report containing data obtained in the field was submitted to Mr. Merrill in September 1954. The final report includes some of the soil test results which were not available when the prelinimary report was required by the Department of Northern Affairs and National Resources.

Ottawa,
October 1955

Robert F. Legget,
Director.

WEST CHANNEL AREAS -- SUMMARY OF SOILS AND PERMAFROST DATA WITH A PRELIMINARY SITE APPRAISAL

This note summarizes pertinent field information gathered by the Permafrost personnel (J.A. Pihlainen, R.J.E. Brown and G.H. Johnston) on the West Channel area.

The West Channel area site (first suggested by Inspector Fraser of the R.C.M.P. Aklavik detachment -- hence "Fraserville") is situated approximately 24.5 air miles (28.2 channel miles) north of Aklavik immediately adjacent to the West Channel area where the Richardson Mountain benchlands intercept the channel. The area investigated is approximately 3 miles long, bordering the channel, by 1½ miles wide, inland to the west of the channel. To the south and north it is separated from the channel by deposits of the Mackenzie Delta (Fig. 1).

Local Relief

Where the benchlands border the West Channel it rises from it in the form of a fairly steep bank varying in height from 10 to 40 feet. To the west there is a slight but continual rise in elevation. Within this general increase in elevation, the local relief is undulating to rolling with scattered lowlying flat depressions and swales, and rounded knolls. Cutting through this country is a network of shallow V-shaped gullies. Although there are minor local differences in relief, drainage, vegetation, and other features, the benchland area is generally homogeneous and will be considered as such in this discussion.

Bed-rock Features

The underlying bed-rock is exposed in a few scattered outcrops approximately 2 miles inland from the West Channel and does not directly affect the nature of the site. One area of these outcrops is in the form of a series of subdued ridges extending away from and perpendicular to the sides of a gully. Another is a localized outcrop of a few square yards in area on the side of a hill.

The rock is grey sandstone. It is not well cemented as individual grains can be scraped off easily. The surface rock has been fractured into large rectangular blocks and smaller fragments by water and frost action. The surface of the rock is fretted and grooved by combined frost and water erosion.

No rock outcrops were seen anywhere along the shore of the West Channel in the vicinity of the site area.

Hydrography

The area drains to the West Channel through a roughly

parallel series of shallow V-shaped gullies (Fig. 1). Where the site area borders the channel there are three main gullies which enter the channel approximately 3/4 of a mile apart. Between these are several much smaller gullies.

The major gullies vary in depth from 20 to 50 feet. They become shallower toward the headwaters of the streams which are cutting them. The streams flow at a rate of approximately 10 miles per hour. The water is clear indicating a lack of suspended soil material. It is probable that the streams diminish in size or even dry up later in the summer when the snow has disappeared from the higher land to the west. The presence of willow and alder thickets in the stream beds appear to substantiate this.

There are only a few small shallow lakes in the area, the largest being about 300 yards in diameter; they drain through the gullies to the West Channel. Generally, the lakes lie in poorly drained depressions whose surfaces are covered with polygons. The water in these lakes is coloured with iron salts and organic material.

Ground Surface and Soil Features

(a) Beach

There is a thin layer of gravel lying along the shore of the West Channel where it flows adjacent to the site area. It appears to have been washed out from the bank above it. The rounded and subrounded stones are of sedimentary and igneous origin up to approximately 6 inches in diameter. (This gravel appears to be the aggregate from glacial till exposed in the river bank in this location. R.F.L.).

(b) Polygons

Polygons and polygonal cracks are prevalent throughout the site becoming numerous inland from the West Channel. They are mostly associated with the poorly drained areas around the lakes and the headwaters of the streams.

There are both depressed and raised centre polygons varying in diameter from 20 to 50 feet. The interstices vary in width from a few inches to 3 or 4 feet and are filled with water. The centres of the depressed centre polygons are partially filled with water. In some cases where there are polygonal cracks rather than well defined polygons, they are defined by shallow moss-filled trenches.

(c) Frost Mounds and Frost Boils

Outside of the areas of polygons and polygonal cracks,

the site area is mostly covered with frost mounds, frost boils and niggerheads. The mounds vary in diameter from approximately 2 to 4 feet and rise approximately 1 foot above the bottom of the interstices.

One mound was excavated. It consisted mostly of ground vegetation with accompanying roots and partially decomposed organic material. Beneath this cover the soil was domed up slightly consisting of brown clayey silt with organic material mixed in with it.

In the small depressions and interstices among these mounds and grass niggerheads are small frost boils or "pools" of soil varying in diameter from approximately 6 inches to 2 or 3 feet. Apparently this soil has been pushed up to the surface by frost action. The soil is a brownish grey clayey silt. These "pools" are in various stages of desiccation depending on the length of time that they have been exposed. As soon as they are exposed, shrinkage cracks begin to appear on the surface.

Some of the mounds consist of soil with a partial thin covering of ground vegetation. The exposed soil is a friable brown clayey silt with fine sand and some angular to subangular stones up to 1½ inches in diameter.

(d) Soil Slumping

Many of the slopes exhibit areas of soil slumping. These slumps are especially pronounced on the slopes of the deeper V-shaped gullies 2 to 3 miles inland from the West Channel. Individual slumps are generally 2 to 3 feet in height and are especially prominent on the slopes facing north. The slumps are covered with a ground vegetation of grass and moss.

Vegetation

From the vegetation point of view, the main feature of this potential site area is the comparative lack of tree growth. Tree growth is confined to the sheltered gullies where it is densest on the south facing slopes and along the water courses. The trees are willow and alder reaching a maximum height of approximately 8 feet. Interspersed with this thicket growth is ground birch reaching a height of approximately 3 feet. In the deeper gullies approximately 2 to 3 miles inland there are parallel lines of this mixed tree growth extending from the tops of the gullies down slope to the stream beds in which is the aforementioned willow and alder thicket. As the gullies become shallower toward the headwaters of the streams, the trees become more stunted.

The ground vegetation throughout the potential site area is generally uniform being typical of the Arctic tundra.

It consists of closely spaced niggerheads of grass, reindeer and sphagnum moss. Other plants include Labrador Tea and other flowering plants and berry plants. There are areas of ground birch, and dwarf alder and willow, attaining heights of 2 to 3 feet.

Snow Cover

Characteristic of the Mackenzie Delta and adjacent upland regions, the snow cover of this site area reaches a maximum depth of 3 to 4 feet. However, the area extends in a north-south direction and is devoid of any tree growth except in the sheltered gullies. Therefore, the snow cover is modified by the prevailing wind which sweeps across this area from the north.

Generally, the higher areas between the gullies are covered with snow to a depth of 1 to 2 feet whose surface has been packed and glazed by the wind. Heavy drifts of snow accumulate in the gullies especially on the south facing (i.e. north) slopes, which are oriented in a perpendicular direction to the prevailing wind. Some sections of the gullies are completely filled with snow. The snow cover on the ground between the gullies is melted usually by the third week in June but the heavy drifts on the north slopes of the gullies persist late in July.

Photographs

Fig. 2 shows the location of photographs at the West Channel site.

Soils Data

Accessibility of the site and distance to a source of wash water dictated the location of the exploratory boreholes on this West Channel site. Since the area closest to the channel consists of low hills sloping gently upwards from the channel and dissected by several shallow V-shaped gullies, it appeared that drill holes placed respectively in a low spot and on top of a ridge would indicate, generally, soil conditions over the whole area.

Both a low area and a high spot were adjacent to the campsite located in the southern third of the proposed site area and next to the channel. The location of the two exploratory boreholes is shown in Fig. 1.

Core recovery in AB-28 averaged about 50 per cent and about 33 per cent in AB-29. Whenever stones are struck while drilling, poor core recovery may be expected. Borehole AB-28 was drilled, in the low area, to a total depth of 32 feet-0 inches.

Under the surface organic cover to a depth of 10 feet the soil was a dark blackish-brown organic material, predominantly fibrous with undecomposed material and twigs up to $\frac{1}{2}$ inch in diameter. This soil was well cemented by ice with fine irregular lenses throughout averaging hairline in thickness. (Water content was estimated to be 150 per cent by weight). From 10 feet to 19 feet, the soil was a light brown silt with many angular and some subrounded stones up to 1 inch in diameter and with layers of light brown medium sand and fine sand with pebbles up to $\frac{1}{4}$ inch in diameter. From 10 feet to 10 feet 9 inches there were medium sized ice lenses up to approximately 3/16-inch thick and the estimated water content was 100 per cent by weight. Between 10 feet 9 inches and 17 feet 9 inches some difficulty was encountered while drilling because of many stones. From 10 feet 9 inches to 17 feet 9 inches the soil was predominantly well bonded and contained some very fine ice lenses. Moisture content samples taken at depths of 11 and 16 feet were 34.9 and 20.1 per cent by weight respectively. From 19 feet to 31 feet the soil was a brownish grey silt clay with angular to subangular stones up to 1 inch in diameter. No ice segregation was noticeable in the cores, the soil being well bonded, except for several ice lenses averaging 3/8-inch thick and spaced approximately 6 to 8 inches apart to the 23-foot depth. (Poor core recovery in the last 10 feet prevented confirmation of these lenses throughout). Moisture contents taken at depths of 20 and 22 feet were 21.6 and 16.8 per cent by weight respectively. From 31 feet to 32 feet the soil was a grey sandy silt with many subangular stones up to 3/4 inch in diameter. The last 8 inches was very compact and dense.

Borehole AB-29, drilled to a depth of 22 feet was located on a rounded hill some 500 feet to the north of and approximately 30 feet higher than the location of AB-28 (Fig. 1).

No core was obtained in the first 7 feet on the first attempt, due probably to the use of too much wash water. However core was retained on the second attempt to 6 feet 6 inches. From the ground surface to 3 feet 8 inches the soil was organic material. From 3 feet 8 inches to 12 feet the soil was a brownish grey clayey silt with odd flecks of brown discolorations and roots of hairline thickness. There were some pebbles up to 2 inches in diameter. Down to 6 feet the ice segregation was medium to coarse with ice lenses up to 3/4-inch thick. Moisture contents taken at 4 feet and 6 feet were 59.6 and 27.7 per cent by weight respectively. From 6 feet to 12 feet the ice lenses were spaced approximately $\frac{1}{2}$ inch apart and ranged in size from hairline to 1/8 inch. From 12 to 22 feet the soil was a grey sandy silt with many stones ranging in size from $\frac{1}{4}$ inch to 2 inches. The material was frozen but well bonded; there was no noticeable ice segregation. Layers of stones and many stones in the material itself caused poor core recovery on the whole.

FIELD APPRAISAL

Location

That portion of the area which lies within half a mile of and extends parallel to the channel might be considered as a townsite building area. An airstrip might be located parallel to the channel on the higher land approximately 2 to 3 miles inland. One very noticeable feature of the area is the absence of any trees or heavier growth other than the low willow brush in the gullies. This lake of growth makes the area a bleak and wind blown location -- an important consideration.

Drainage

The parallel dendritic drainage pattern runs from far inland through the gently rolling hills to the channel, i.e. from west to east. An airstrip location in a north-south direction would impede this natural drainage and adequate provision would have to be made to take care of the water. The local water is mainly surface run-off and that from the wind-blown snow which drifts the gullies full during the winter. The drifts remain into late July and after that it is believed that very little water might be expected in the smaller gullies. Generally the drainage pattern is well marked as may be seen from the aerial photographs.

Roads and Airstrip

The nature of the soil, i.e. predominantly silt size, with much ice segregation within the first 10 feet dictates the use of gravel fill roads with great care being taken to preserve the permafrost. The low areas surrounding the stream beds and also lying along the channel contain much organic material and ice segregation to some depth and are to be avoided if possible. Roads across them should be as short as possible and particular care taken to preserve the permafrost table. The above applies in principle to airstrip construction as well.

Engineering Materials

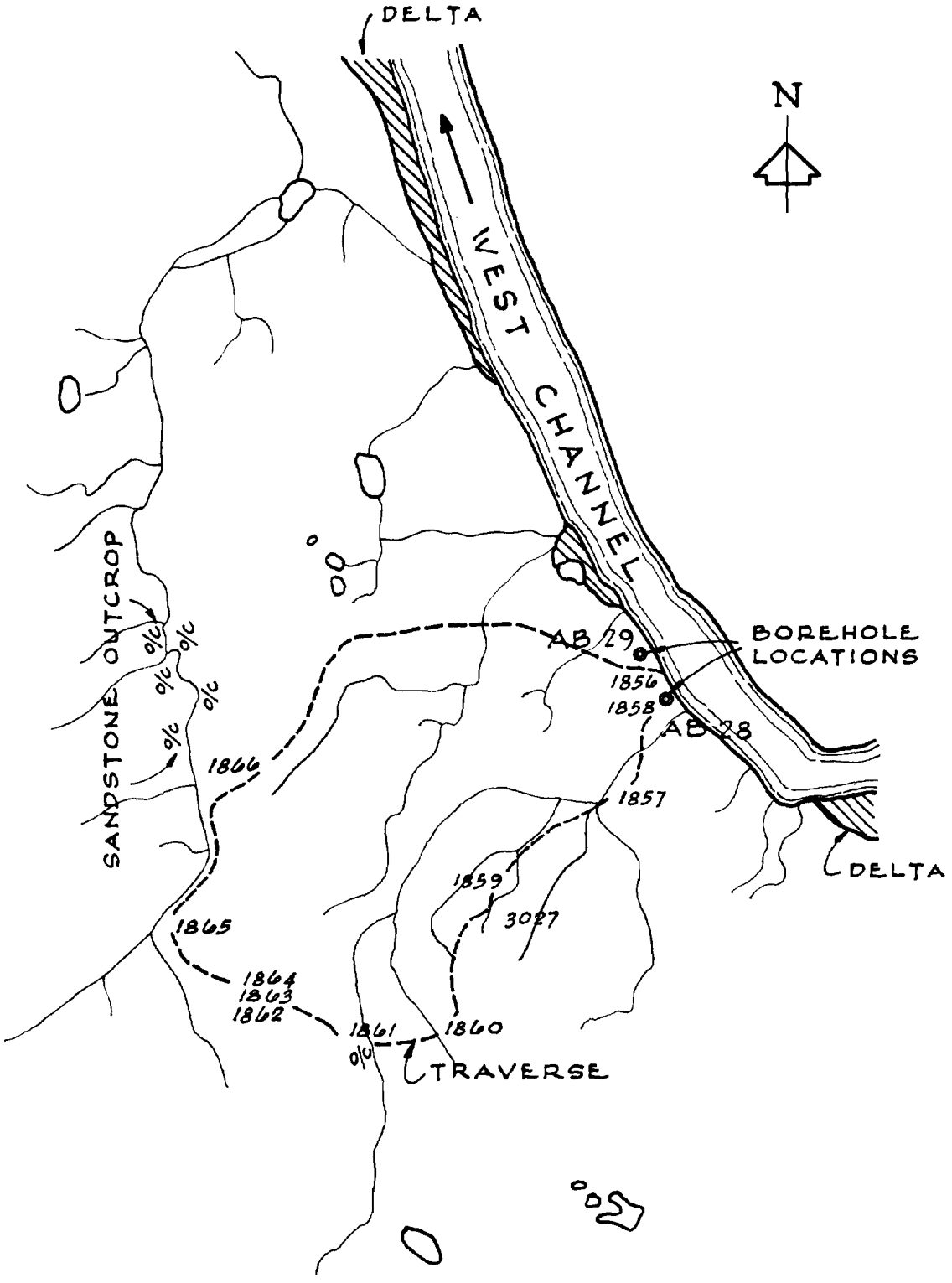
Reports of gravel deposits along the West Channel seem unfounded. Pebbles and stones are prevalent along the banks in places but are only surface deposits -- probably through river action. Sandstone which outcrops in the area could be utilized as fill material after quarrying but would not be suitable for aggregate. Any suitable aggregate would necessarily have to be brought into the area from deposits some distance away (East Branch, Arctic Red, etc.).

Buildings

The nature of the underlying soil (i.e. silt size) would dictate largely the use of pile foundations. The permafrost level is to be preserved in all cases whether the structure is large or small. Any building in the area should be kept to the higher ridges and the low areas avoided wherever possible.

Opinion

From the soils and permafrost point of view, as well as from other considerations -- namely wharf facilities, water supply etc., the area is by no means an ideal location. A more intensive soils survey would have to be undertaken to provide complete coverage of the whole area.



NOTE:

NUMBERS INDICATE LOCATION OF PHOTOGRAPHS

FIGURES 1 AND 2

WEST CHANNEL SITE

TRAVERSE AND PHOTOGRAPH LOCATIONS

FROM R.C.A.F AIR PHOTO A12861-98
D.B.R. REPORT 41

FIGURE 3 D.B.R. REPORT 41 (REVISED)

TEST HOLE LOG & SOIL TESTING RESULTS

HOLE NO. AE-28

Legend: GRAVEL, SAND, SILT, CLAY, ORGANIC

SOIL PROFILE — DEPTH IN FEET (0–33)

Profile annotations: Bw to Def (0–3 ft); De f.s, some Bw (11 ft); Bw (32 ft)

DESCRIPTION of SOIL

Dark blackish brown organic material predominantly fibrous with some decomposed material and twigs up to 1/2" ø.

Light brown silt with many stones up to 1" ø (most are angular and sub-rounded) with layers of light brown medium sand & fine sand with pebbles up to 1/4" ø.

Brownish grey silty clay with angular to sub-angular stones up to 1" ø.

Grey sandy silt with many sub-angular stones ≤ 3/4" ø. Last 8" very compact and dense.

Bottom of hole — 32'-1"

SAMPLE NO.	DEPTH FT.	SOIL TYPE	ICE SEGR. TYPE	MOISTURE CONTENT %	GRAIN SIZE – % CLAY <0.002mm	SILT .002 to .06 mm	SAND .06 to 1-2 mm	GRAVEL >1-2 mm	PLASTICITY L.L./P.I.	FIELD UNIT WEIGHT LBS./FT³	SPECIFIC GRAVITY	SOIL TEMP °F
	11	ML	De f.s	34.9								
	16	ML	De f	20.1								
	20	CL	Unfrozen	21.6					20.1/8.9			
	20.5	"	"									
	22	"	De f	16.8					23.9/8.6		2.76	
	22.5	"	"									

PROJECT: P.S.S. [illegible]
SITE: [illegible]
LOCATION: Low Spot
DEPTH: 32'-1"

BORING BY: P.S.S. DATE: 6/7/54
TESTING BY: P.S.S. DATE: [illegible]
PLOTTED BY: G.H.J. DATE: 14/3/55
CHECKED BY: ____ DATE: ____

ORGANIC TERRAIN: E1HF (smcb)
REMARKS: Core recovery ~41%

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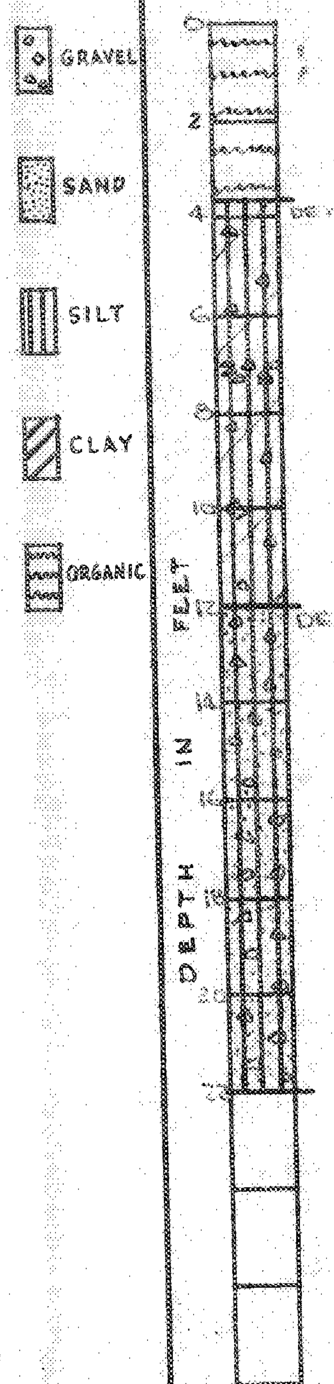
FIGURE 4 D.B.R. REPORT 41 (REVISED)

TEST HOLE LOG & SOIL TESTING RESULTS

HOLE NO. AE-29



DESCRIPTION of SOIL

- 0–4 ft: ORGANIC MATERIAL
- 4 ft (DE m-l): BROWNISH GREY CLAYEY SILT WITH ODD FLECKS OF REDDISH DISCOLORATION & ODD ICE PEBT. SOME STONES UP TO 2"Ø
- 12 ft (DE m): GREY SANDY SILT WITH MANY STONES RANGING IN SIZE FROM 1/4" TO 2". STONES INCLUDE GRANITE, SANDSTONE ETC.
- BOTTOM OF HOLE – 22'-0"

SAMPLE NO.	DEPTH FT.	SOIL TYPE	ICE SEGR. TYPE	MOISTURE CONTENT %	GRAIN SIZE – % CLAY <0.002 mm	SILT .002 to .06 mm	SAND .06 to 1.2 mm	GRAVEL >1.2 mm	PLASTICITY L.L./P.I.	FIELD UNIT WEIGHT LBS./FT.³	SPECIFIC GRAVITY	SOIL TEMP. °F.		
	4	ML	DE m-l	59.6										
									30.9/11.5		2.77			
	5.5	ML	"											
	6	ML	"	22.7										
	21	ML	Unfrozen						21.0/4.7					

PROJECT: R55 AKLAVIK RELOCATION
SITE: FRASERVILLE
LOCATION: TOP OF KNOLL
DEPTH: 22'-0"

BORING BY: R.E.S. DATE: 7/7/54
TESTING BY: [illegible] DATE: 1/55
PLOTTED BY: G.M.J. DATE: 14/2/55
CHECKED BY: DATE:

ORGANIC TERRAIN: [illegible] (Smdg)
REMARKS: [illegible]

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