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MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

105

CRACKING OF CONCRETE PATCHES ON

PROJECT 49,7,C1, US 2, NORTH OF ST. IGNACE

By

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Highway Research Project 44 G-27 (2)

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Research Laboratory
Testing and Research Division
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CRACKING OF CONCRETE PATCHES ON PROJECT 49-7, G1 US 2, NORTH OF ST. IGNACE

In compliance with the request of C. A. Weber, Road Engineer, a survey has been made of the patched areas on Project 49-7, located on US 2 north of St. Ignace, for the purpose of determining the causes for the many cracks which have appeared in the new patches. The patches were placed in June, 1945. This report presents the results of the survey which was made by the writer in company with F. Martin of the Research Laboratory, Davis Sikorski, District Soils Engineer, and subsequently by A. E. Matthews, Assistant Soils Engineer. The survey was made on October 14, 1947.

It is important at this time to mention that in August, 1944 a similar condition survey was made of the entire project at the request of H. C. Coons, Chief Engineer-Deputy Commissioner, in connection with a major concrete patching program suggested for the project by Dan H. Hiles, District Engineer. The results of this survey were reported on September 8, 1944 (Testing and Research Division Report No. 59).

Construction History

The patch work was done under regular contract in accordance with Department specifications. The contractor was the Alpine Construction Co. The work was started on June 1, 1945 and final pouring was made on June 25, 1945. There is nothing in the records or in the finished appearance of the work to indicate that questionable workmanship is involved. Further, it is understood that no special preparation of the foundation or subbase was specified in the contract. Consequently, the concrete patches were evidently placed on the same soil material that supported the old pavement. The patches consist of 8 inch uniform unreinforced concrete pavement.

The concrete contained Petosky Air Entraining cement, 6-A crushed stone and 2SS stone sand from Inland Stone Company at Manistique, Michigan. Seven sacks of cement per cubic yard of concrete were used in order to develop high early strength concrete.

Field records indicate that the concrete had developed the desired strength. See Table 1 below.

TABLE 1, SUMMARY OF FLEXURE STRENGTH DATA

Station	Flexure strength, lbs per sq. in.		
	4 days	7 days	28 days
204+55R	593	—	825
210+70R	707	—	844+
218+42	577	—	844+
229+36R	—	609	844+
232+40R	731	—	844+
218+25L	—	594	844+
353+40L	653	—	844+

Results of Survey

Attention is called to Figures 1 to 5 which illustrated typical cracking of the patches. The crack patterns are clearly defined by the bituminous material used in sealing the cracks. Also following Figure 5 there is included a complete set of condition survey graphs showing the state of cracking at the time of original survey in 1944. The areas patched in 1945 have been superimposed in red color on these graphs. The cracks in the patched areas are illustrated by dashed red lines.

The extent and character of patch cracking which has developed in the past two years has been summarized as follows-

1. With but one exception, at station 420+00, all patches have developed one or more cracks.

2. The cracks, in general, are either a continuation of the old cracks in the adjacent lane, or they coincide in many cases with the

Figure 1. Cracking of patch in right lane at station 204+00 looking north. Note that cracks follow crack pattern in old concrete of adjacent left lane.

Figure 2. Diagonal and transverse cracking of new patch in left lane at Station 352+60 looking north.

Figure 3. Cracking of new patch at Station 419+30 showing subsequent breaking out and faulting of section at slab edge.

Figure 4. Corner break and transverse crack in patch right lane at Station 212+00 looking north.

Figure 5. Cracking of new patch (on light area in right lane) in relation to cracking in old pavement. Station 416+80 looking north; end of project in distance.

cracks in the old slab sections which were replaced.

3. Diagonal cracking and corner breaks are in evidence as well as straight transverse cracks.

4. The cracks are sufficiently open for sealing and differential vertical movement of pavement was observed at cracks and joints.

Probable Causes of Cracking

The cracking phenomena, described above, has all the manifestations of that caused by excessive subgrade volume change. Such volume change may be directly or indirectly attributed to: first, the presence of frost heave material in the subgrade, including silt, clay and peat augmented by a high water table; second, by the presence of different kinds of fill material in the same cross section; third, location of pavement over longitudinal cut and fill sections; and, finally, lack of uniform consolidation. All of these factors are known to exist on this project as disclosed by soil borings taken during the original survey in 1944 and observed from a study of construction plans and specifications as previously reported. Foundation soil conditions are shown on original condition survey graphs.

In addition, the new concrete will undoubtedly undergo volume changes different from those of the adjacent old concrete and thus any aggregate interlock existing at the boundaries of the patch areas may be greatly impaired if not totally destroyed. In such a case the patched slabs, with lack of support from the old pavement, will be subject to high load stresses, which no doubt will influence cracking. Furthermore, the concrete patches were constructed only 8 inches thick, whereas the outside edges of the old pavement were 9 inches in thickness.

In view of these facts and since no foundation correction was authorized for this work, it is only logical to expect that the new concrete patches will crack in the manner of the old pavement, but perhaps to a lesser extent on account of the gradual reworking of the foundation with age. At the present time the cracking of the patched area is not serious.

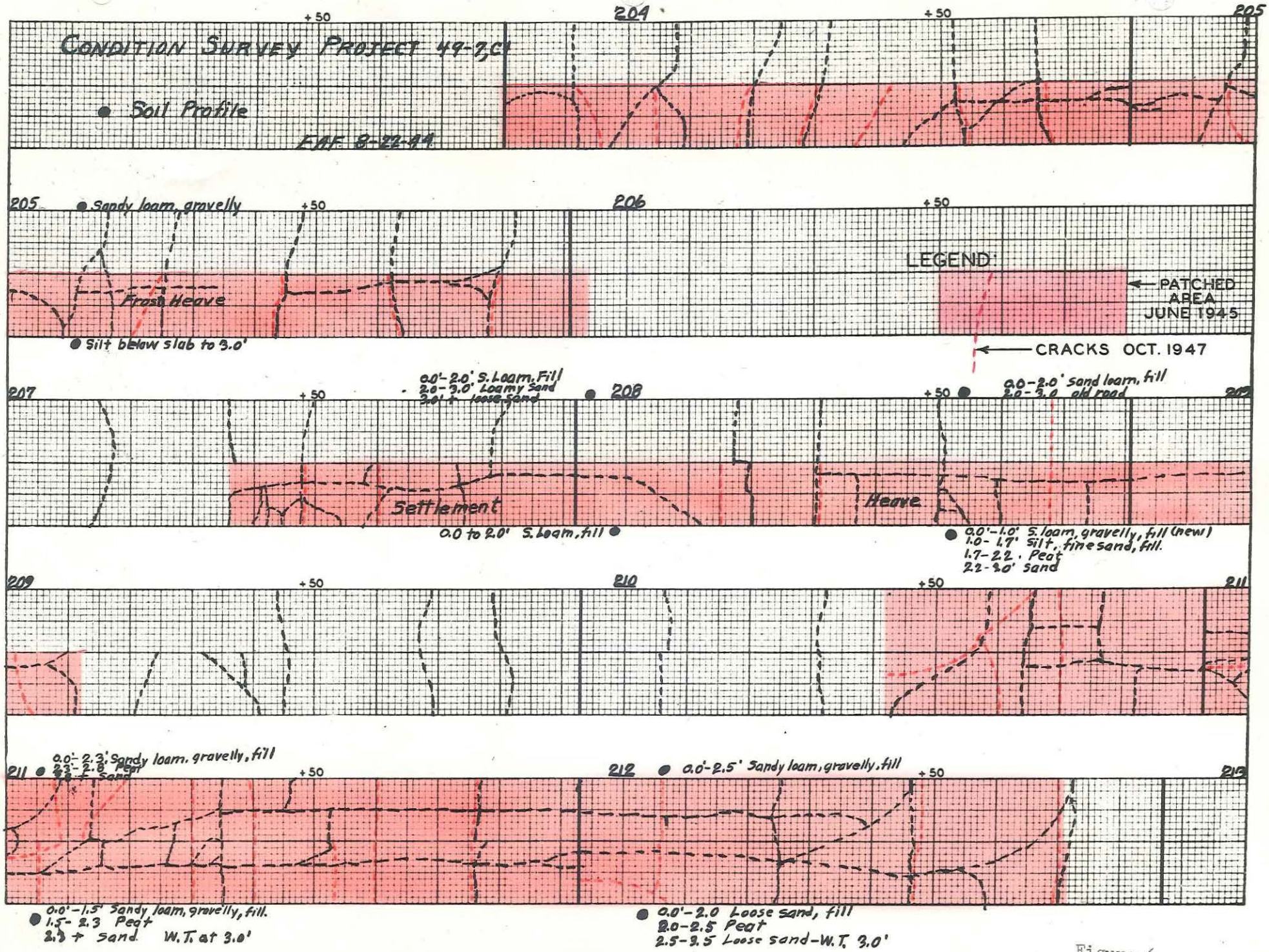
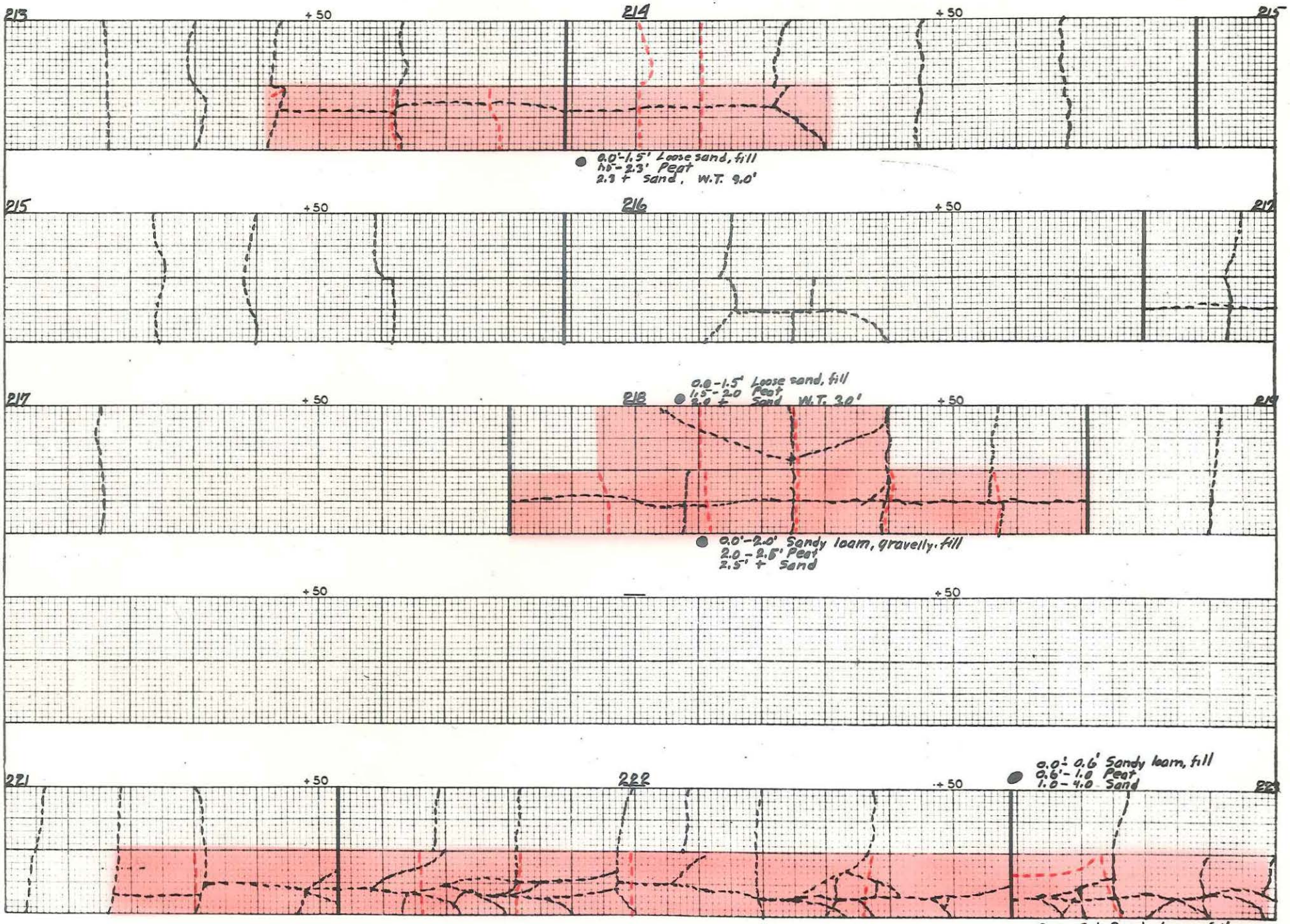

CONDITION SURVEY PROJECT 49-3,C1
Soil Profile
FAF 8-22-49
YEAR OF SURVEY
SURVEYED BY
+50
204
205
206
207
208
209
210
211
212
213
Sandy loam, gravelly
Frost Heave
Silt below slab to 3.0'
LEGEND:
PATCHED AREA JUNE 1945
CRACKS OCT. 1947
0.0'-2.0' S. Loam, Fill
2.0-3.0' Loamy Sand
3.0'+ loose sand
Settlement
0.0 to 2.0' S. Loam, fill
0.0'-2.0' sand loam, fill
2.0-3.0 old road
Heave
0.0'-1.0' S. loam, gravelly, fill (new)
1.0-1.7' Silt, fine sand, fill.
1.7-2.2. Peat
2.2-3.0' sand
0.0'-2.3' Sandy loam, gravelly, fill
2.3-2.8' Peat
2.8'+ Sand
0.0'-2.5' Sandy loam, gravelly, fill
0.0'-1.5' Sandy loam, gravelly, fill.
1.5-2.3 Peat
2.3 + Sand W.T. at 3.0'
0.0'-2.0 Loose sand, fill
2.0-2.5 Peat
2.5-3.5 Loose sand-W.T. 3.0'

Figure 6



YEAR OF SURVEY

SURVEYED BY

Figure 6

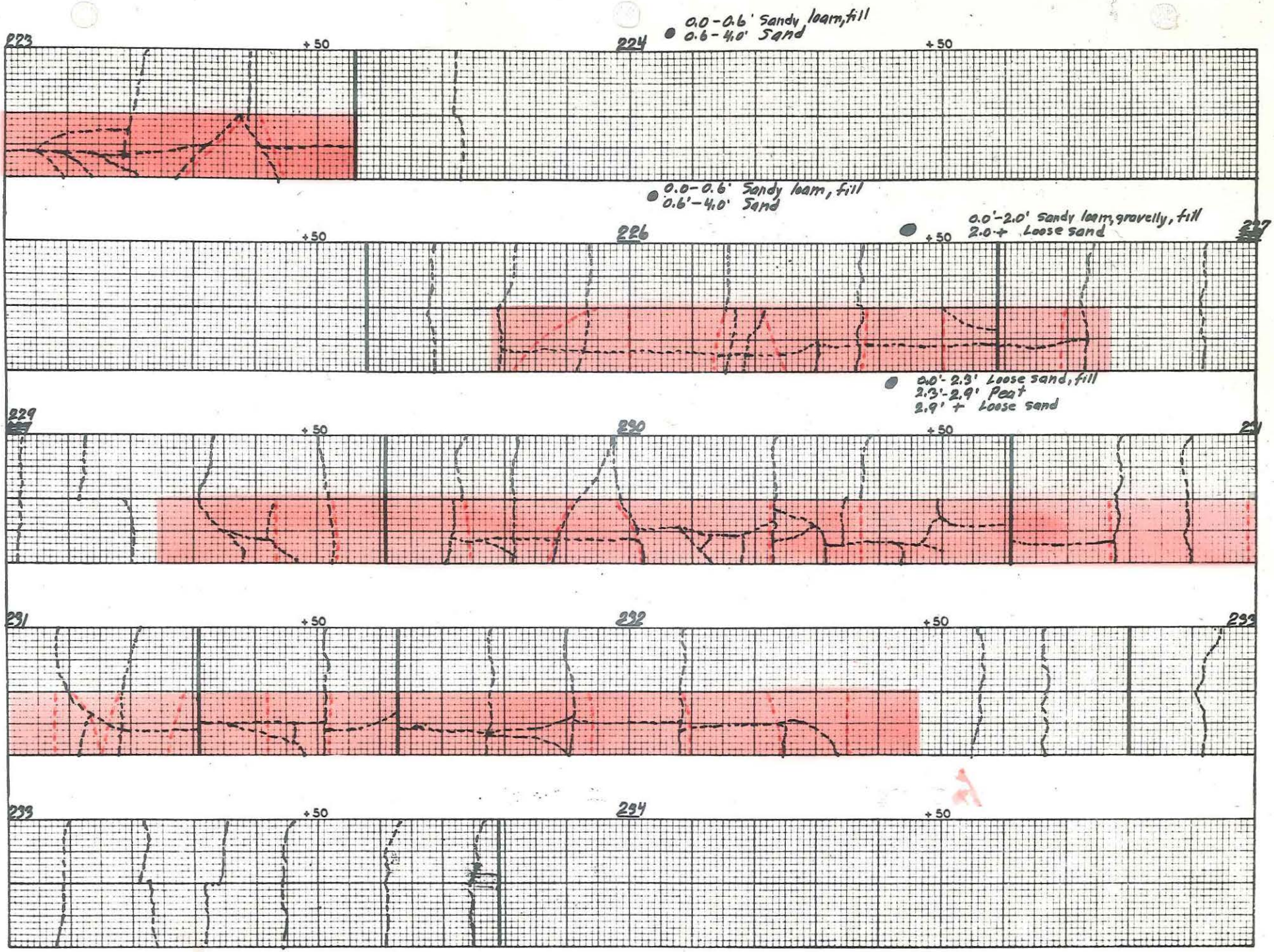


Figure 6

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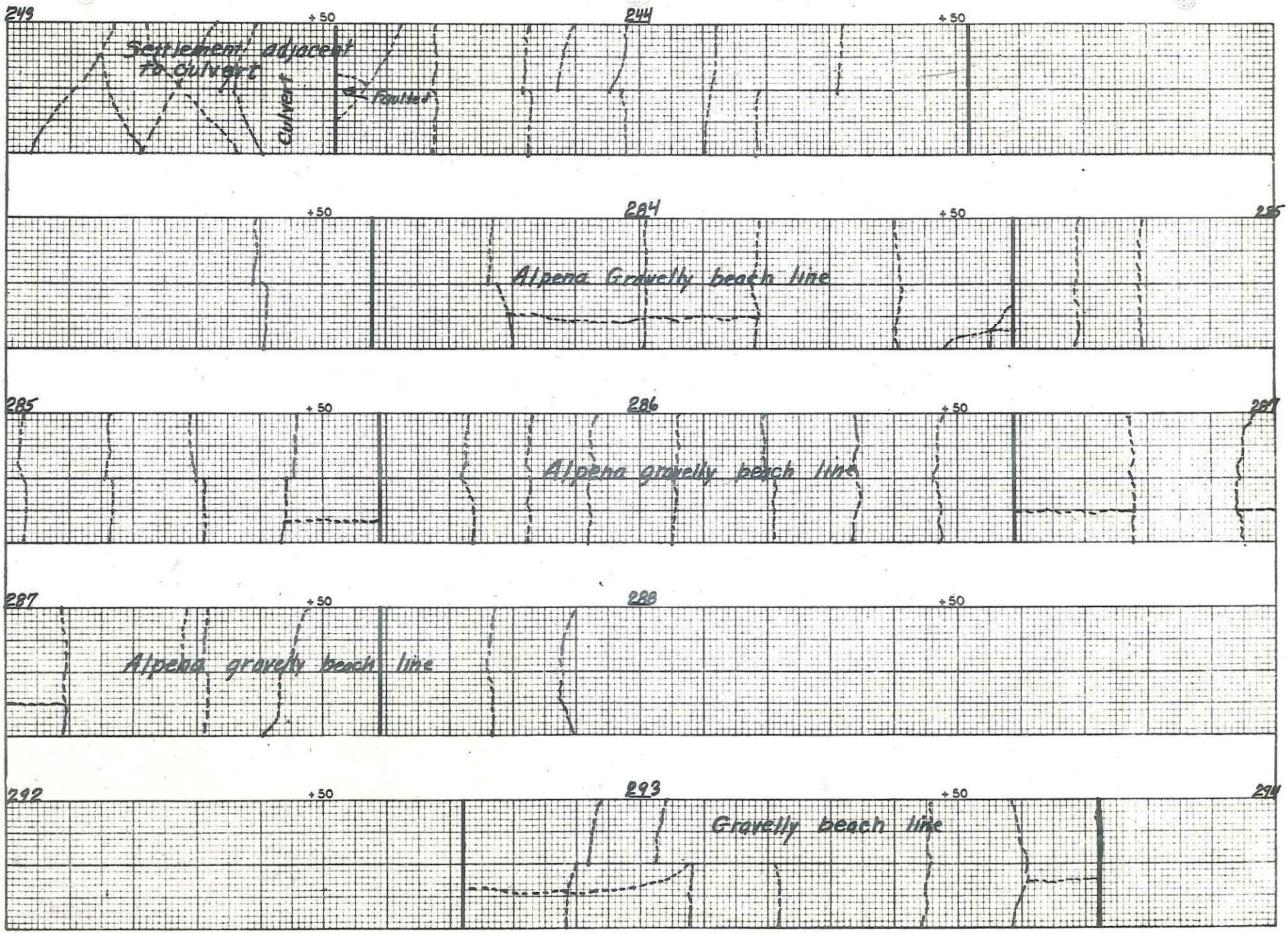

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Figure 6

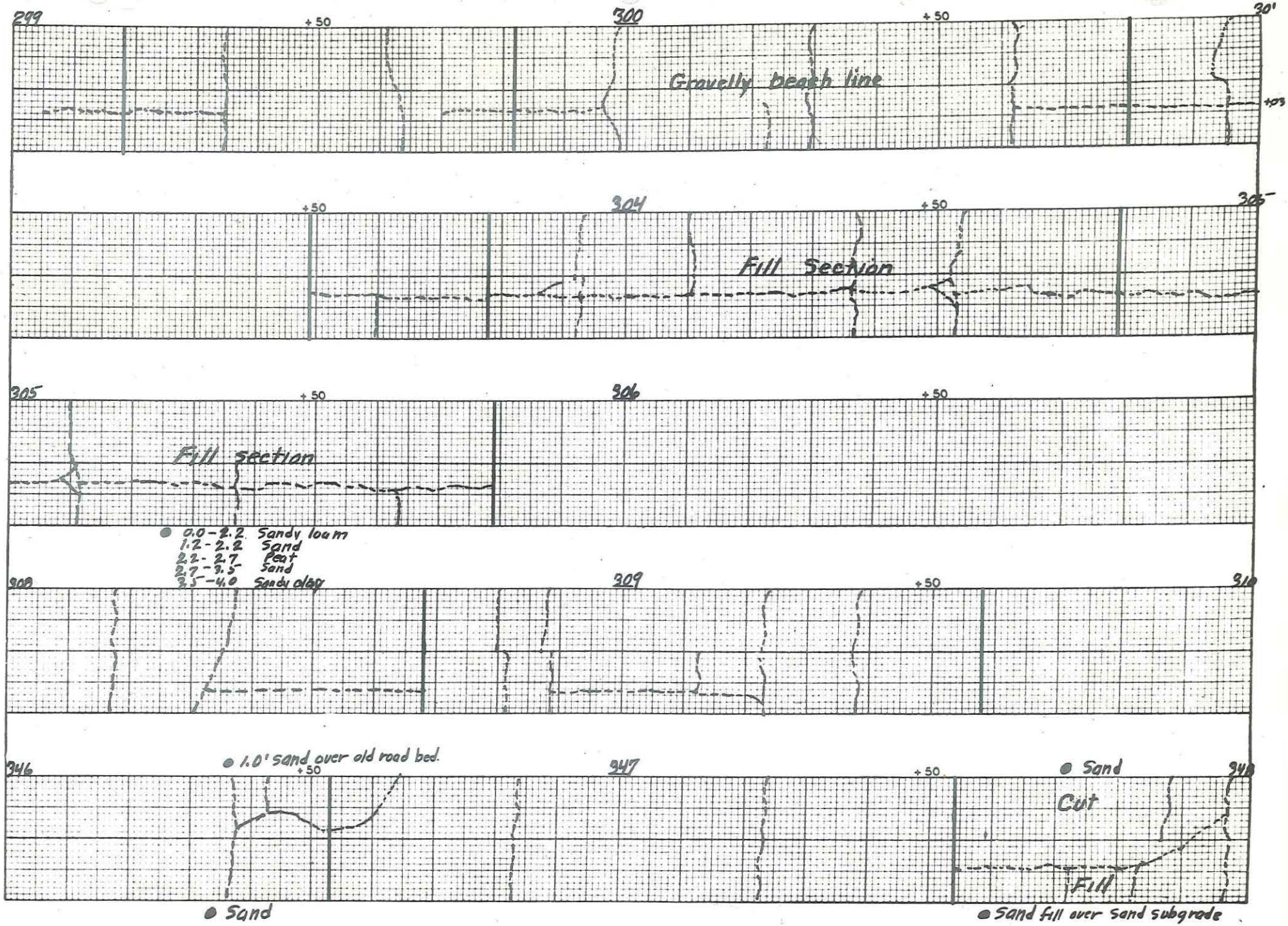

Figure 6

SURVEYED BY _____ YEAR OF SURVEY _____

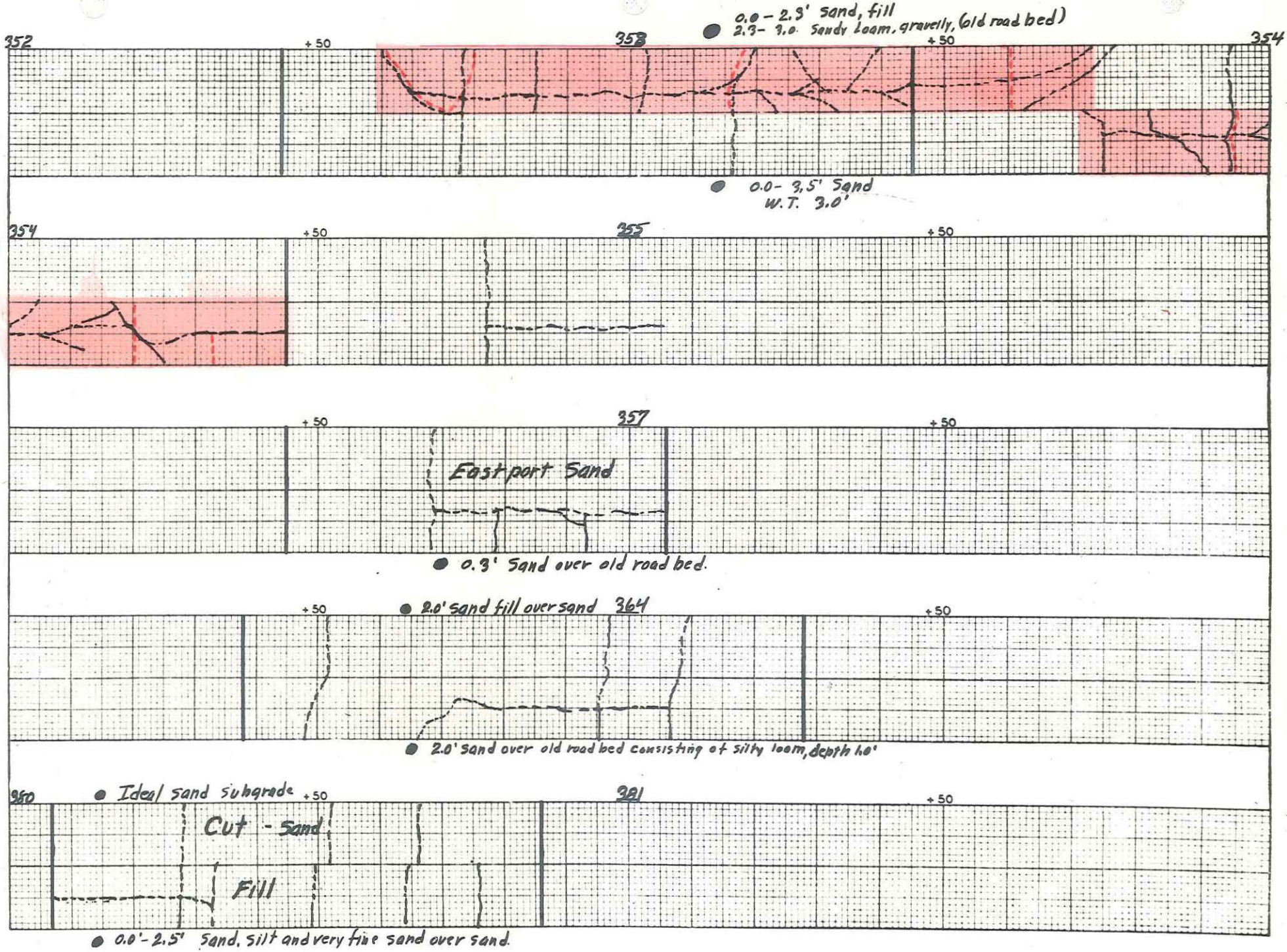

Figure 6

YEAR OF SURVEY

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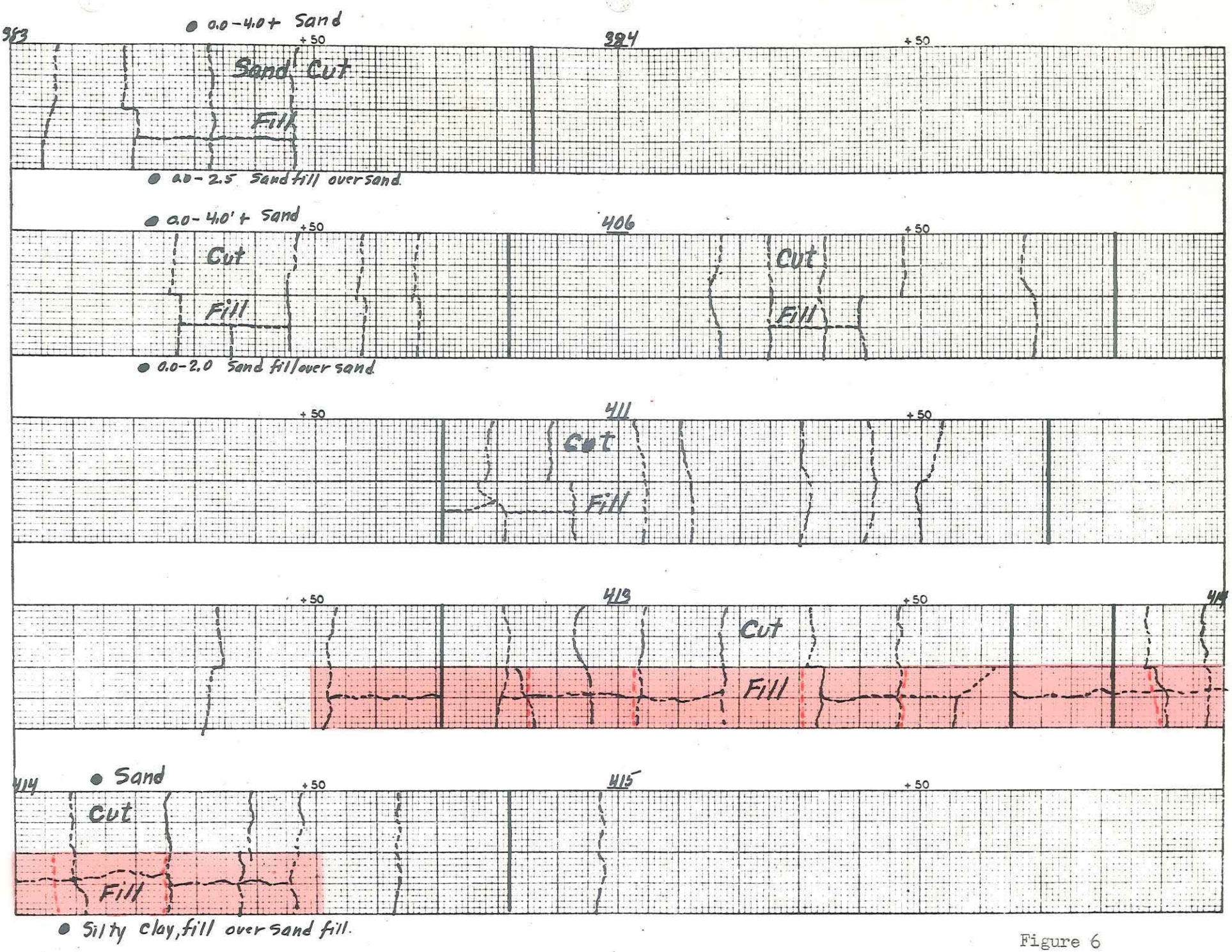

Figure 6

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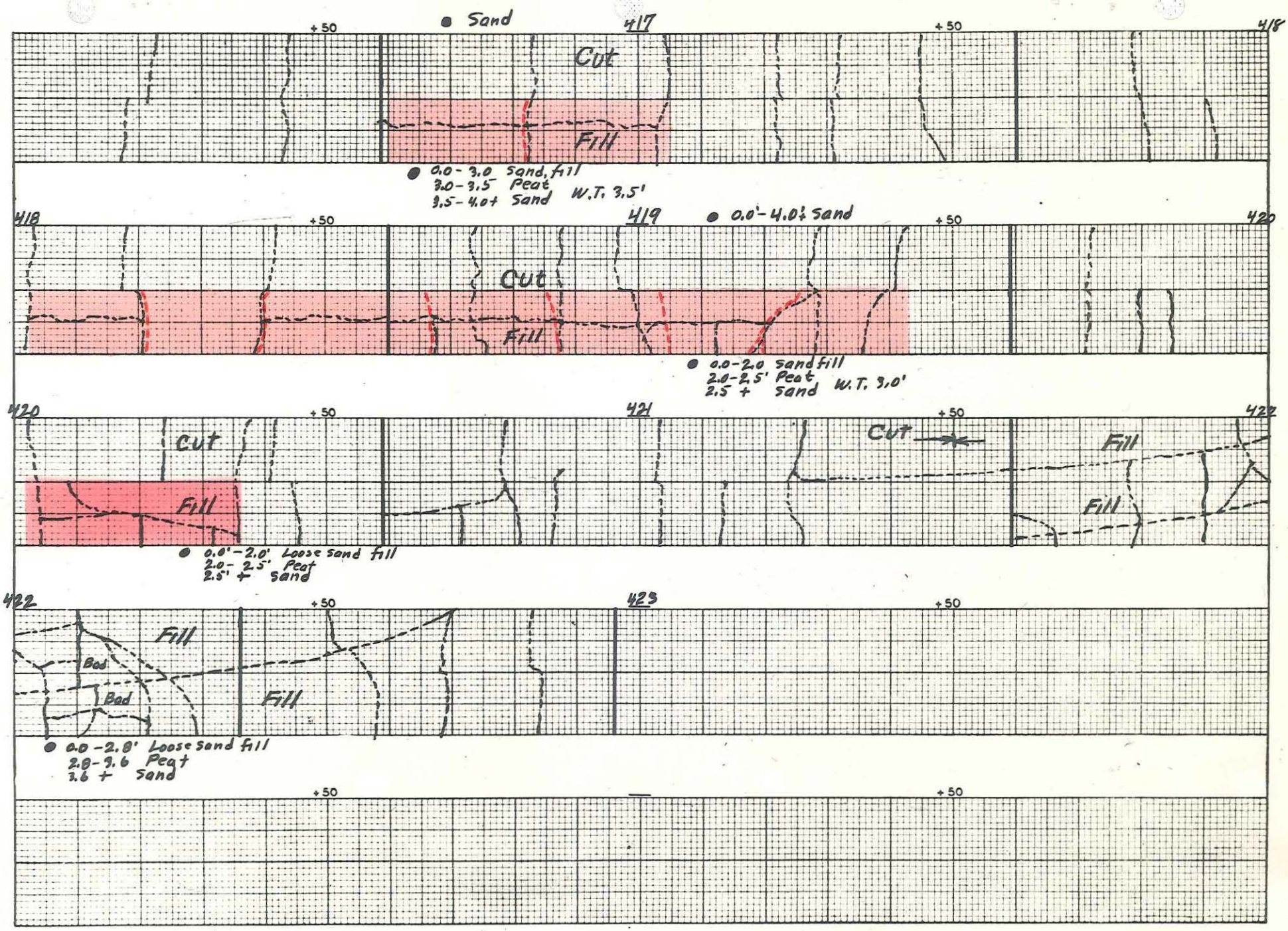

Figure 6

YEAR OF SURVEY

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