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THESIS

A COMPLETE RAILROAD SURVEY

SPRING 1904

E. F. Smith G. W. White

THESIS



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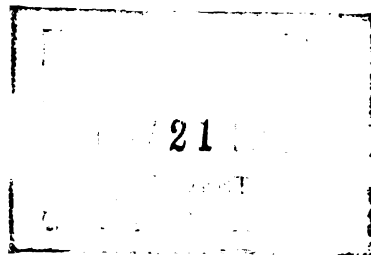
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T H E S I S.

A COMPLETE RAILROAD SURVEY.

Spring -- 1904.

E. F. Smith.

G. W. White.

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PURPOSE OF SURVEY.

The purpose of this survey was to locate and estimate the most economical route by which the Grand Trunk railroad could pass through the Michigan Agricultural College grounds, and compare this estimate with the actual cost of the present location of the G. T. R. R. between the terminals of the proposed route.

THE SURVEY.

1. RECONNOISSANCE. Upon looking over a map of Ingham County, it was decided that the line of the proposed relocation would probably have one of its terminals near Trowbridge and the other in the vicinity of Haslett Park. In view of this fact, the territory between Trowbridge and Haslett Park was carefully looked over and no objectionable features or unsurmountable difficulties of the country were found. The time spent in making this reconnoissance was one-half day.
2. PRELIMINARY SURVEY. On account of the small size of the squad and the short time in which the work was to be done, it was necessary to abbreviate work as much as

1. The first of these is the fact that the
is well known that the fact of the
could possibly have one of the
and the other in the vicinity of the
of this fact, the territory between the
fact that was generally looked upon as
features or unaccountable differences of the
a found. The time spent in making this
the country day.

2. The second of these is the fact that the
agreed and the other that in which the
home, it was necessary to spend the work as much as

2.

possible. In view of this fact it was decided that the stadia method would be used for taking all measurements in the preliminary survey. The preliminary survey was begun at Trowbridge and run with magnetic bearings. Stations were located every 500 or 600 feet and levels were taken over the line as soon as the survey was completed. The line was now ready for the topographical survey. The length of this preliminary was 21,416 feet and the time spent on this work was 25 hours. For detail of line see map.

3. TOPOGRAPHY. The purpose of the topographic survey was to secure all necessary data for making a complete topographical map of the country extending 600 or 700 feet each side of the preliminary line. The only instruments used were the Buff and Berger transit and stadia rod. The stadia method was used for taking all measurements. The instrument was set up on nearly every station and the distance, horizontal angles, and vertical angles where necessary, were taken for every governing point and feature of this section, and recorded and sketched in a note book. Following each day's work the notes were plotted and contours drawn on the topographical map. (See Map) The scale used was 400' to the inch. Where vertical angles were taken the elevations were computed with a Colby's slide rule. The time spent at field work in the topographical survey was about 17 hours.

4. PAPER LOCATION. After the topographical map was completed, the next consideration was the paper location of the proposed line. The chief aim of this location was to obtain minimum curvature and also the least amount of cut and fill. The country being comparatively level, it was found to be principally a matter of minimum curvature. The map showed that this proposed route could be located with only three slight curves; one at each terminal and one near the college. The paper location was then made as shown on topographical map. (See Map).

5. LOCATION SURVEY. The location survey was made with a Buff and Berger transit and a 100 foot steel tape. The survey was begun at a point between the Grand Trunk tracks and 100 feet west of the intersection of the Pere Marquette railroad with the north track of the Grand Trunk, and a tangent was run N. $60^{\circ}18'$ E. a distance of 9144 feet. The angle of intersection with the Grand Trunk was $30^{\circ}12'$. The 1° curve as per location map brought the starting point 1546 feet west of the intersection, and the curve was then run in by the deflection method (deflecting $1/2$ of the degree of curvature for each 100 foot chord). In this location survey, stations were established and stakes set every 100 feet. The line was based on the magnetic bearing, but after starting, it was continued by making alidade deflections, and using the needle only for a check. At the point

4.

9144 feet from the first intersection (Sta. 106 + 18 on located line, 100 feet east of college orchard fence and 25 feet south of the center of North Lansing road) changed bearing to N. $84^{\circ} 18'$ E., thus making an intersection angle of 24° , and ran out tangent to the point of tangency of the curve (1218 feet from the intersection). Beginning at this P.T. we ran in the curve and then went back to the P.T. (Sta. 118) and projected the tangent without a stop until we reached the Grand Trunk railroad. The intersection angle here was found to be $30^{\circ} 7'$. The tangent distances were then measured and the 2° curve run in, thus making the total length of the located line 23661.7 feet or 4.48 miles. In this location survey all necessary data for locating all highways and property lines was taken and a location map showing the exact location of the proposed line was drawn. (See Map). The levels were then taken on every 100 foot station on this line and a profile plotted on profile paper (See Profile.)

6. CROSS SECTIONING. As the country was very level and there being practically no side hill work, it was thought unnecessary to do any cross section work in the field. In the earth work computations the mean ordinate for each 100 feet was determined from the profile and with this as an argument we entered table 19 of "Nagle's Field Manual" where the volume in cubic yards per 100

feet is given for any slope or base. A slope of $1\frac{1}{2}$ to 1 was taken for both cut and fill and a base of 32 feet for the double track (the base is the distance between shoulders on road bed at top of the sub grade). In all cuts, 8 feet was added to the 32 feet for side ditches. The cut and fill in cu. yds. was estimated and noted on the profile. As all excavations were of ordinary earth, a shrinkage of 10 per cent was allowed in all embankments.

ESTIMATE.

This estimate was made for a double track system with a 100 foot right of way.

1. CLEARING AND GRUBBING. The clearing and grubbing will consist in removing all stumps and second growth brush etc. It was estimated that this work would cost \$30.00 per acre. The ground to be cleared is about $2\frac{3}{4}$ acres. This makes the cost of grubbing and clearing \$82.50.
2. EARTHWORK. The cost of earthwork was taken from Baker's tables 14 and 15 "Roads and Pavements." The quantities of earth to be moved together with the different hauls was taken from the profile. All embankments thrown up from the ditches and the material wasted was considered to be hauled 50 feet.

COMPUTATIONS.

Cu. Yds.	Haul.	Price.	Amount.
11561.0	50	10.83¢	\$1252.05
1992.0	200	11.08¢	220.71
2027.5	300	12.25¢	248.36
4387.5	500	13.71¢	601.52
1964.0	600	14.82¢	291.06
13148.0	700	15.93¢	2094.47
4809.0	900	18.00¢	865.62
5380.0	1300	22.00¢	1183.60
19988.0	1400	23.00¢	4597.24
2841.0	1600	25.00¢	<u>710.25</u>
Total			\$12064.88

3. TIES. From Camp's "Notes on Track" it was found that 18 ties per 30' rail is about average practice (3070 per mile). At an estimated cost of 40¢ each, the ties for 4.48 miles of double tracking will cost \$11361.60.

4. RAILS. A rail 30 feet long 80# per yard was used for this estimate, at a cost of \$25.00 per ton. The total amount of steel required for both tracks is 1261.57 tons, and at \$25.00 per ton amounts to \$31539.20.

5. SPIKES. The common sized spikes (5½ x 9/16 and 360 per 200# keg) were considered best for this road. The quan-

tity of spikes required for the total distance was estimated at 315 kegs and an allowance of 5 kegs was made for spiking road crossings etc., thus making a total of 320 kegs. 320 kegs of spikes at the average price of \$4.50 per keg amounts to \$1440.00.

6. JOINTS. The joints (360 to mile or 720 for double track) at a probable cost of 60¢ apiece, amount to \$1935.60.
7. TRACK LAYING. An estimate of \$225.00 per mile for laying of the track (hand work) was made from a consideration of the data given in Camp's "Notes on Track". The laying of double track for 4.48 miles at this estimate amounts to \$2016.00.
8. BALLASTING. A gravel ballast of 16 inches (10" below ties) or 115 cu. yds. per 100 feet, makes a total of 27200 cu. yds. for whole track. The gravel can be secured on the right of way so that it was estimated that gravel could be hauled, put in place, topped and surfaced for 45¢ per cu. yd. The ballasting and surfacing then amounts to \$12240.00.
9. BRIDGE AND CULVERTS. A plate girder bridge (2 spans, 80 ft. each) was considered for the crossing of the Red Cedar river. The weight of this bridge was computed from Merriman and Jacoby's formulae ($w = 1070 + 10.7 l$ where

w = wt. of bridge per lineal foot and l = span in feet). The weight thus computed was 308160#. The cost of bridge erected was taken at 5¢ per lb. and amounting to \$15408.00, without masonry. Two wing abutments and one pier were estimated for bridge. The quantity in cu. yds. of masonry required for abutments was taken from Baker's, table 19, and the quantity of masonry in the pier was taken from table 41 of Baker's "Masonry Construction". The total amount of masonry thus computed amounts to 406.8 cu. yds. Assuming the masonry to be of concrete construction at a cost of \$5.00 per cu. yd., this amounted to \$2034.0. Thus the total cost of the bridge is estimated at \$17442.00.

The supplies for the culverts were estimated as follows:

275 ft. 24" tile @ 86¢ per foot -----	\$236.25
130 ft. 30" tile @ \$1.58 per foot -----	205.40
60 ft. 36" iron pipe (12.5 tons) @ \$16.50 per	
	<u>ton 206.25</u>

Total for culverts \$647.85.

10. ROAD CROSSINGS. The plank required for 20 private and public highway crossings was estimated at 25,600 feet (board measure). At an average cost of \$25.00 per thousand feet this bill will amount to \$640.00.

11. CATTLE GUARDS. Twelve wooden cattle guards each 12' long to be placed at each highway crossing (estimated at \$30.00 each for double track) amounts to \$360.00.
12. FENCING. The fencing was estimated at 60¢ a rod in place, thus making a cost of \$1720.32 to fence the whole line.
13. TELEGRAPH LINE. The poles were estimated at \$2.50 each and to be placed 36 to the mile. A two wire line was allowed for. The weight and cost of wire and insulators were taken from Mauer's "American Telegraphy". Copper wire No. 12 B. W. G. weighing 170#. per mi. (single wire) was taken.

The allowance for poles and wiring per mi. is as follows:--

36 poles @ \$2.50 -----	\$90.00
340# of copper wire @ 14¢ per lb.-----	47.60
72 insulators @ 4¢ each -----	2.88
Erection of 36 poles at 40¢ each -----	14.40
Wire Stringing -----	<u>10.00</u>

Total cost per mi. \$164.88

At this rate the 4.48 miles amounts to \$738.66.

14. RIGHT OF WAY. The correct estimate of the right of way was a difficult problem owing to the uncertainty of the amount of damage to the property through which the pro-

posed line was run. The property owners were not interviewed with regard to this matter, but we estimated the average value of the right of way at \$100.00 per acre. For the total length of line (4.48 mi. with 100 ft. right of way or 52.8 acres) at \$100.00 per acre this would amount to \$5280.00.

15. DEPOT. \$3000.00 was allowed for a depot to be located at the Michigan Agricultural College and \$2000.00 for two side tracks and switches at this depot.

11.

ESTIMATE OF COST OF R. R. CONSTRUCTION;

THESIS, R. R. SURVEY.

GRADUATION.

Earthwork -----	\$12064.88
Clearing and Grubbing -----	82.50

BRIDGING, CULVERTS, etc.

Bridge -----	17742.00
Culverts -----	647.85
Cattle Guards -----	360.00
Road Crossings -----	640.00

TRACK.

Ballast -----	12240.00
Ties -----	11361.60
Rails (80# per yd.) -----	31539.20
Spikes -----	1440.00
Joints -----	1985.60
Track Laying -----	2016.00
Side Tracks -----	2000.00

MISCELLANEOUS.

Fencing -----	1720.32
Telegraph Poles -----	403.20
Wire and Wiring -----	335.46
Right of Way -----	5280.00
Depot -----	<u>3000.00</u>

\$104808.61

Engineering 5%	<u>5240.43</u>
----------------	----------------

12.

Total cost	\$110,049.04.
Cost per mi.	\$24,564.00

CONCLUSION.

The proposed relocation was found 428 feet shorter than the present location of the Grand Trunk between the same terminals. The total curvature in the relocation is $84^{\circ} 19'$ whereas in the present location, the total curvature between terminals is $34^{\circ} 52'$. There were three curves on each line between terminals, this extra curvature being due to the fact that the relocation had to be started and finished on tangents of the old line. Since no record could be obtained regarding the cut, fill, and grades of the Grand Trunk between the terminals of the relocation, it was impossible to make an accurate comparison of these items of the two lines. By making careful observation of the cut and fill on the old line, we decided that the earthwork on the proposed route would not be greater, and probably not nearly so great, as that on the old line. The maximum grade on the proposed route is .256% which does not exceed any grade on the old line.

In consideration of all of these items of comparison, and also the high cost of the right of way for the new route, it was considered inadvisable to make the change from the old route to the new. If, however, this

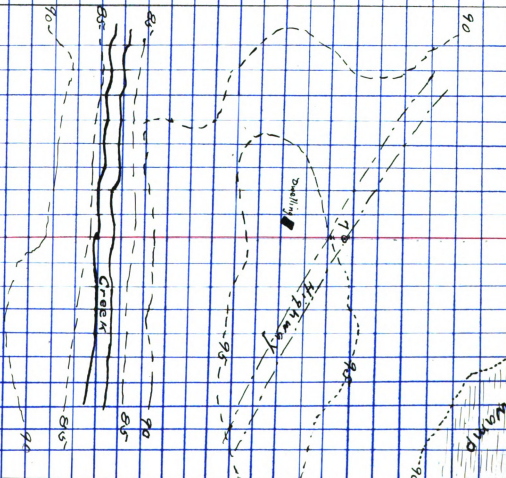
location had been considered at the time of building of the Grand Trunk, it would undoubtedly have been found equally as good and at no greater cost, besides securing the advantages of a depot and the railroad traffic at the college.

30 TOPOGRAPHY OF R.R. SURVEY

Sta.	Dis.	Bearing	Length	H.I.	F.S.	Elev
1	370	N45°E		99.29	5.4	93.9
"	460	N115°E		"	8.7	90.6
"	200	N2°15'E		"	5.6	93.7
"	160	S43°45'E		"	4.7	94.6
"	320	S41°E		"	4.7	94.6
"	900	S41°E		"	8.4	90.1
"	500	S12°15'E		"	8.7	90.6
"	500	S5°45'E		"	2.5	94.8
"	480	S70°W	-10	"	8.4	94.3
"	420	S89°30'W		"	12.3	90.8
"	220	N73°W		"	8.8	92.8
1	90	S83°W		99.29	3.7	93.6

4	560	N22°30'W		99.45	8.4	91.05
"	500	N7°20'W		"	8.5	90.95
"	440	N20°30'E		"	8.4	91.05
"	340	N44°45'E		"	10.2	89.25
"	340	N82°30'E		"	10.5	88.95
4	440	S29°45'E		99.45	5.5	94.45
4	220	S29°45'E		"	"	93.95

April 4, 1904. (8 hrs. 30 min.) Clear and Warm
 Used 3473 Transit and Stadia Rod.
 Swamp (G.W. White) Data
 Swamp (E. Smith) Road



72 TRANSIT NOTES for R.R. LOCATION.

(100 Ft. Scale)

Sta. Curve Ver. A. Defl Mg. Br.

$$\begin{cases} I = 24^\circ \\ D = 10' \\ T = 1218' \\ L = 2400' \end{cases}$$

Curve $\begin{cases} 1 = 24^\circ \\ D = 10' \\ T = 1218' \\ L = 2400' \end{cases}$

P.C. 0°00'

N 60°18'E

93

94

95

96

97

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99

100

101

102

103

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107

108

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110

111

112

113

114

115

Apr 1, 23, 1904. - Clear and Warm (4 1/4 hrs)
Used Transit
Commenced at Sta 79
Spaced { E.F.S. 1/4 in - 1 foot
(G.W. 1/4 in - 2 feet
(T.L. 1/4 in - 3 feet)

College Orchard

Crops

No Fence
Wire Fence

Dairy Barn

Barn Yard

College Farm Lane

Wire Fence

Bowling

Red Cedar River

Medium

N 60°18'E

LEVEL NOTES ON R.R. LOCATION					
Sta.	B.S.	M.I.	F.S.	Elev.	
114			6.97	90.82	✓
115			9.74	88.05	✓
116			12.67	85.12	✓
117			7.31	90.48	✓
211.18			5.66	92.13	✓
211.18	2.654	95.380	5.073	(92.723)	✓
119			5.8	89.6	✓
120			5.5	89.9	✓
121			5.6	89.8	✓
122			6.3	89.1	✓
123			14.0	81.4	✓
124			8.1	87.3	✓
125			8.5	86.9	✓
126			6.3	89.1	✓
127			1.3	94.1	✓
0128	2.943	98.228	0.1	98.280	✓
129			2.4	95.8	✓
130			1.9	96.3	✓
131			3.9	94.3	✓
132			5.4	92.8	✓
133			5.9	92.3	✓
134			6.3	91.9	✓
135			6.7	91.5	✓
136			6.8	91.4	✓

May, 2, 1904 - Clear and Warm (Bhrs)
 Used 2000 Level, Rod, Hatchet and Turning St.
 Begun at Sta. 119

211.18 - A 3' Dia. Black Ash Stamp. In the center of meadow directly N of Mr. Jackson's barn. The only stamp in field. The point is near center of stamp on highest point.

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