THE DESIGN OF EAST LANSING & MICHIGAN STATE COLLEGE AIRPORT

Thesis for the Degree of B. S.
MICHIGAN STATE COLLEGE

Glenn A. Rushman

1946

The Design of East Lansing & Michigan State College Airport

A Thesis Submitted to

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of

AGRICULTURE AND APPLIED SCIENCE

by

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Candidate for the Degree of

Bachelor of Science

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PREFACE

Air transportation in peace and in war has reached the point in it's progress where special engineering consideration must be given the ground facilities which serve as the connecting link between surface and air transportation. Airport engineering must keep pace with the development of planes and the rapid increase in the use of the airways.

The author of this thesis has endeavored in the design and planning of this airport for East Lansing and Michigan State College to meet the requirements of the Civil Aeronautics Administration and to fulfill the needs of the region.

The author is deeply indebted to Professor C.L. Allen, head of the Civil Engineering Department, Professor C. B. Andrews, Michigan State Highway Department, and to the many other instructors who have been of great assistance.

The publications of the Civil Aeronautics Administration and "Airport Engineering", by Sharp, Shaw and Dunlop have been consulted frequently and information from these publications has been used throughout this thesis.

TABLE OF CONTENTS

PRELIMINARY PLANNING

The planning of a new location for an airport should include all the factors of regional planning and the position of the proposed airport in the national network.

1. Population of the City-

A study of the population of East Lansing and Michigan State College and their trends indicate that a class 2 airport would be sufficient to handle all the aeronautical activity in this region.

2. Local Topography-

The topography of all sites and that of the area surrounding each site within about a three-mile radius has received careful study. The study included a comparison of ease of drainage, probable grading required, and obstructions in the vicinity which would limit the effective length available for takeoff and landing in each direction. However, due to the fact that other theses have been written on the plan of airports south of East Lansing, it was suggested that this airport be planned somewhere north of East Lansing.

3. Local Flying-

The amount of traffic has been determined by investigating records of other airports in the vicinity, or in similar localities, and consulting existing air line records. Consideration also has been given to the postal receipts of the city, retail sales of the city and trading area, and express possibilities. The rapid increase of enrollment at Michigan State College and the return of many veterans who will be interested in flying is a contributing factor to the necessity of a local airport.

The recent trend and the future possibilities of aviation in the prevention of crime should make an airport here a necessity for the use of the Michigan State Police. It has proven successful elsewhere and it would materially increase the efficiency of operation of that organization.

4. Accessibility-

It is desirable that an airport be located so that it will be close -in time- to the destination, and to those who will use it. This airport is located on a well constructed highway which could handle the traffic very easily.

5. National Defense-

This important factor cannot be overlooked in planning the location and size of any civil airport.

FACTORS INFLUENCING AIRPORT SIZE

The problem of determining the size of an airport to be developed in any given locality is extremely complex, depending not only on the types of aircraft which are to be accommodated in the immediate future, but also upon some estimate of the future requirements. The individual airplane may be designed for a certain performance, however, this performance is affected by temperature, barometric pressure, and wind conditions which may vary from day to day, by the condition of the surfaces of the airport or runway on which the airplane is operated, as well as upon the technique of the pilot who is flying the plane. It is, therefore, apparent that in determining the airport size it is essential to provide landing areas sufficiently large for the operation of the aircraft to be accommodated under the most unfavorable conditions likely to occur.

In order to determine whether or not an airport is adequate in size for the safe operation of a given airplane, it is necessary to compare the distance required for the airplane to take off and to land with the landing area length available at that airport. Among the various factors which will influence the distance required for a given airplane to take off and land safely are the following:

1. Aircraft Performance-

The most important factors affecting the performance of airplanes are wing loading, power loading, pilot

technique, and friction of runway and landing area surfaces. Of principal importance is the wing loading and the power loading.

A. In general, as the wing loading of an airplane is increased, the stalling speed of the airplane increases. Consequently, the speed which must be attained prior to takeoff is greater, and the minimum safe speed which must be maintained in gliding in for a landing is also greater. Thus it is seen that wing loading affects the flight characteristics of the airplane and the size of the landing area required. The wing loading is obtained by dividing the permissable gross load in pounds by the total wing area in square feet.

B. The power loading of an airplane is obtained by dividing the gross weight of the plane by the total horsepower available. This is another characteristic of the airplane which affects it's performance and consequently, the size of the airport required for it's safe operation. As the power loading in pounds per horsepower is increased, the rate of climb decreases, and, consequently, the take off distance is also increased.

By multiplying the wing loading in pounds per square foot by the power loading in pounds per horsepower, it is possible to obtain an index number which in general, is indicative of the performance of the aircraft in landing and taking off, and which will indicate the landing area length necessary for the safe operation of the aircraft. The length in feet of runway required for safe operation of any airplane at sea level is approximately fifteen times the index number.

2. Characteristics of the Site-

A. Nature of surrounding obstructions and topography- The presence of vertical, natural and manmade obstructions in the approaches to the airport results in reducing the effective length of the landing area available and necessitating a longer area than would otherwise be necessary if they did not exist. This reduction in effective length of usable landing area is computed on the basis of approaches being clear of vertical obstructions within a glide path of 30 feet horizontal to one foot vertical for a class 2 airport.

An "approach zone" for normal usage runways is a trapezoidal area having a width of 500 feet at the ends of the usable landing area and broadening to a width of 2,500 feet two miles away. The center line being a continuation of the center line of the landing strip.

B. Elevation above sea level-

Increased length must be provided at higher altitudes for the takeoff run and the landing run, as airplanes

land and take off at higher speeds and climb at flatter angles as the altitude above sea level increases. This is due to the normal decrease in atmosphere density and the consequent decrease in the lifting effect of the air on the wings, and in certain types of motors, resulting in a decrease in the amount of horsepower delivered.

C. Character of landing Strip and Runway-

Surfaces- It is apparent that when an airport has a soft sod or the runways are of loose gravel, affording greater resistance and friction, a longer ground run will be necessary before sufficient speed is attained for takeoff. Conversely, in the case of smooth bituminous and concrete surfaces a shorter ground run is sufficitnt to attain takeoff speed, and therefore, a shorter landing area may be used by the same type of airplane under such conditions, with the same degree of safety.

3. Meteorological Conditions-

A. Barometric pressure-

In a few cases the barometric pressure prevailing at the site, independent of the effective elevation above sea level, must be taken into consideration.

B. Temperature-

In addition to the effect of increased altitude above sea level in reducing air density, there is also the effect of increases in temperature. On a very hot day an airplane will require a considerably longer run before taking off as a result of decreased air density due to the temperature effect alone, and the rate of climb will be decreased.

C. Wind direction and velocity-

Winds, if of more than negligible velocity, have the effect of decreasing the landing and takeoff runs necessary. It is usually not considered as a factor in determining the size of the airport required because the wind does not blow with absolute regularity and steadiness. The least favorable conditions occur when there is no wind, and this condition is assumed to exist.

TABLE #1

RECOMMENDED AIRPORT DESIGN STANDARDS FOR COMMUNITIES

(Exerpt)

Type of Community	Classification.	Landing Strip Lengths	Type of Aircraft which Airport may safely accommodate.
Larger communities located on present or proposed feeder line airways which have considerable aeronautical activity. General population range 5,000 to 75,000.	2	2,700 to 3,700'	Larger size private owner planes and some small size transport planes. This represents roughly planes in the gross weight classification between 4,000 and 15,000 pounds, or having a wing loading (lbs./sq. ft.) times power loading (lbs./HP.) of 190 to 330.

TABLE #3

AIRPORT SIZE PLANNING STANDARDS

Recommended Minimum Standards	Class 1	Class 2	Class 3	Class 4
Length of Landing Strips	1,800' to 3,700'	2,700' to 3,700'	3,700' to 4,700'	4,700' to 5,700'
Width of Usable Landing Strips	300'	500'	500'	500'
Length of Runways	none	2,500' to 3,500'	3,500' to 4,500	4,500' to 5,500
Width of Runways	none	150' (night op.) 110' (day op.)	200' (instr.) 150' (night op.)	200' (instr.) 150' (night op.)

TABLE #3 - (cont.)

% of Wind Coverage	70	70	80%	90%
Facilities	Drainage Fencing Marking Wind direction Indicator Hangar Basic lighting	Include Class 1 - facilities and lighting Hangar and Shop Fueling Weather information Office space Parking	Include Class 2 facilities and weather bureau Two-way radio Visual traffic control Instrument approach system Administration Building, Taxiways and aprons.	Same as Class 3 " " " " " " " " "

TABLE #3

AIRPLANES ACCOMMODATED BY CLASS 2 AIRPORTS

Company and Model Designation	Index No.	Gross Weight	Horse Power
Abrams Explorer T-2	138	4,000	450
Curtiss-Wright A-19-R	110	2,837	430
Curtiss-Wright CW-22	140	3,200	420
Piper Cub Coupe	157	1,200	50
Piper Cub Sport	136	1,100	50
Piper Cub Trainer	140	1,000	40
Ryan S-T-4 Special	138	1,600	150
Ryan S-C	158	2,150	145
Waco F K S	153	3,250	785
Boeing Z47D	202	1,690	90
Fairchild Z4	235	2,550	165
Waco E G C	206	3,800	320
Bellanca 14-9	216	1,690	90
Cessna C-145	229	2,450	145

TABLE #3 (cont.)

Howard DGA-15P	226	4,350	400
Monocoupe 90-A	218	1,610	90
North America AT-6	197	4,158	650
Stinson S R I O F	209	4,650	450

Class 2 Airports will accommodate planes with index numbers between 0 and 230.

TABLE #4

RECOMMENDED STANDARDS FOR RUNWAY LAYOUTS

Recommended Standards	Class 1	Class 2	Class 3	Class 4
Minimum distance between center lines of parallel runways.	none	700'	700'	800'
Minimum distance between center line of runway and airport buildings. Instrument landing runway.	none	750'	750'	750'
Minimum distance between runway center line and aprons and loading platforms. Instrument landing runway.	none	500'	500'	500'
Distance between center line of runway and airport buildings.	desirable	500'	500'	500'
All other runways.	Minimum	350'	350'	350'

TABLE #4 (cont.)

Minimum distance between center line of runway and aprons and loading platforms and parking areas. All other runways	---	250'	250'	250'
Maximum landing strip and runway grades. Transverse	2%	2%	1½%	1½%
Maximum landing strip and runway grades. Longitudinal	2%	1½%	1½%	1%
Grade breaks longitudinal Maximum algebraic difference	3%	2½%	2%	2%

TABLE #5

RECOMMENDED STANDARDS FOR TAXIWAY LAYOUTS

Recommended Standards	Class 2	Class 3	Class 4
Minimum width of taxiways.	50'	50'	50'
Minimum distance between runway center line and parallel taxiway center line.	275'	275'	275'
Minimum distance from boundary fence, obstructions, etc. to taxiway center line.	100'	150'	150'
Maximum longitudinal grade.	3%	2½%	2½%
Maximum transverse grade.	1½%	1½%	1½%
Minimum angle of taxiway. intersection with runway ends.	60	60	60

TABLE #6

EFFECT OF ALTITUDE ABOVE SEA LEVEL ON AIRPORT SITE

Elevation (in feet)	Run length (in feet) Class 1	Run length (in feet) Class 2	Run length (in feet) Class 3	Run length (in feet) Class 4
Sea level	1,800	2,500	3,500	4,500
1,000	1,920	2,660	3,730	4,670
2,000	2,040	2,840	3,980	4,860
3,000	2,180	3,040	4,250	5,050
4,000	2,340	3,250	4,550	5,250
5,000	2,510	3,490	4,880	5,460
6,000	2,690	3,740	5,230	5,670
7,000	2,980	4,020	5,640	5,910
8,000	3,120	4,350	6,070	6,150
9,000	3,380	4,690	6.550	6,550
10,000	3,660	5,090	7,120	7,120

TABLE #7

AIRPORT LIGHTING STANDARDS

Minimum Recommended Facilities	Class 1	Class 2	Class 3	Class 4
Airport Beacon	include	include	include	include
Bounding lights	include	include	include	include
Obstruction lights	include	include	include	include
Illuminated wind line		include	include	include
Contact lights			include	include
Illuminated wind tee or tetrahedron			include	include
Landing area floodlights			include	include
Apron floodlighting			include	include
Ceiling projector			include	include
Taxi lights				include
Approach lights				include

TABLE #8

WIND DIRECTION

Station----East Lansing Weather Bureau

Latitude----42° 43' 50" N. Longitude----84° 28' 54" W.

Elevation, Gr. 856 feet.

Direct-ion	Jan. hours	Feb. hours	March hours	Apr. hours	May hours	June hours	July hours
N	796	1107	1,171	1,254	1,230	992	1,317
NE	695	621	1,012	1,226	947	774	920
E	948	731	880	1,269	1,010	980	924
Se	1,130	814	1,035	945	1,129	1,180	801
S	1,561	1,261	1,383	1,415	1,918	1,957	1,780
SW	2,690	2,189	1,858	1,596	1,924	1,771	2,107
W	1,923	1,651	1,749	1,332	1,630	1,754	1,714
NW	1,443	1,967	2,060	1,874	1,307	1,369	1,560

This data covers the period from 1931-1945 inclusive.

TABLE #8

(cont.)

Direct-ion.	Aug. hours	Sept. hours	Oct. hours	Nov. hours	Dec. hours	Total No. of hours	%
N	1,435	1,108	1,040	936	788	13,145	10,01
NE	1,035	783	634	555	577	9,806	7.56
E	953	994	635	506	758	10,577	8.04
SE	1,065	1,137	1,069	923	974	12,193	9.27
S	2,031	2,082	2,135	1,8[illegible]	1,732	21,100	16.05
SW	1,988	2,003	2,347	2,830	2,738	26,049	19.82
W	1,391	1,380	1,690	1,753	1,706	19,663	14.96
NW	1,234	1,289	1,596	1,446	1,855	19,001	14.45
						Calm	8.94
							100.00

This data covers the period from 1931-1945 inclusive

TABLE #9

WIND VELOCITY

Station----East Lansing Weather Bureau

Latitude----42° 43' 50" S.   Longitude----84° 28' 54" W.

Elevation, Gr.   856 feet.

Direction.	Jan.	Feb.	March	Apr.	May	June	July
N	118.1	137.1	133.6	130.6	118.0	103.8	96.9
NE	115.4	133.2	139.8	134.8	114.9	103.1	96.2
E	107.7	118.5	133.2	138.0	105.3	87.5	79.0
SE	138.0	146.3	146.5	141.0	124.6	111.2	91.7
S	130.5	130.I	136.5	137.4	119.1	103.2	89.9
SW	159.6	156.3	158.7	157.7	137.7	113.4	103.2
W	174.8	166.5	166.6	160.0	134.1	136.5	116.9
NW	155.7	156.8	158.2	164.0	138.8	133.6	131.0

This data covers the period from 1931-1945 inclusive.

TABLE #9

(cont.)

Direction.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Velocity	Average hourly velocity (MPH)
N	98.6	104.3	107.8	137.3	111.7	1,376.7	7.65
NE	91.8	96.0	98.5	111.4	103.6	1,326.7	7.37
E	79.2	84.0	95.3	113.8	109.6	1,231.1	6.84
SE	103.1	112.8	118.5	143.7	134.3	1,509.7	8.39
S	94.3	109.0	124.2	150.4	139.8	1,453.4	8.07
SW	110.5	123.9	133.1	162.9	149.9	1,666.0	9.26
W	112.6	134.2	134.0	158.0	153.2	1,727.4	9.60
NW	117.0	127.1	139.5	151.0	152.5	1,698.2	9.43

This data covers the period from 1931-1945 inclusive.

POPULATION STUDY

FALL TERM REGISTRATION AT M.S.C.

Year	No.	Year	No.	Year	No.
1922	1,611	1931	3,299	1940	6,766
1923	1,609	1932	3,139	1941	6,356
1924	1,873	1933	2,744	1942	6,331
1925	2,314	1934	3,323	1943	3,484
1926	2,534	1935	4,006	1944	3,821
1927	2,800	1936	4,627	1945	5,384
1928	2,813	1937	5,212	1946	8,200
1929	3,019	1938	5,835	1946 (Spring estimated)	9,000
1930	3,211	1939	6,650		

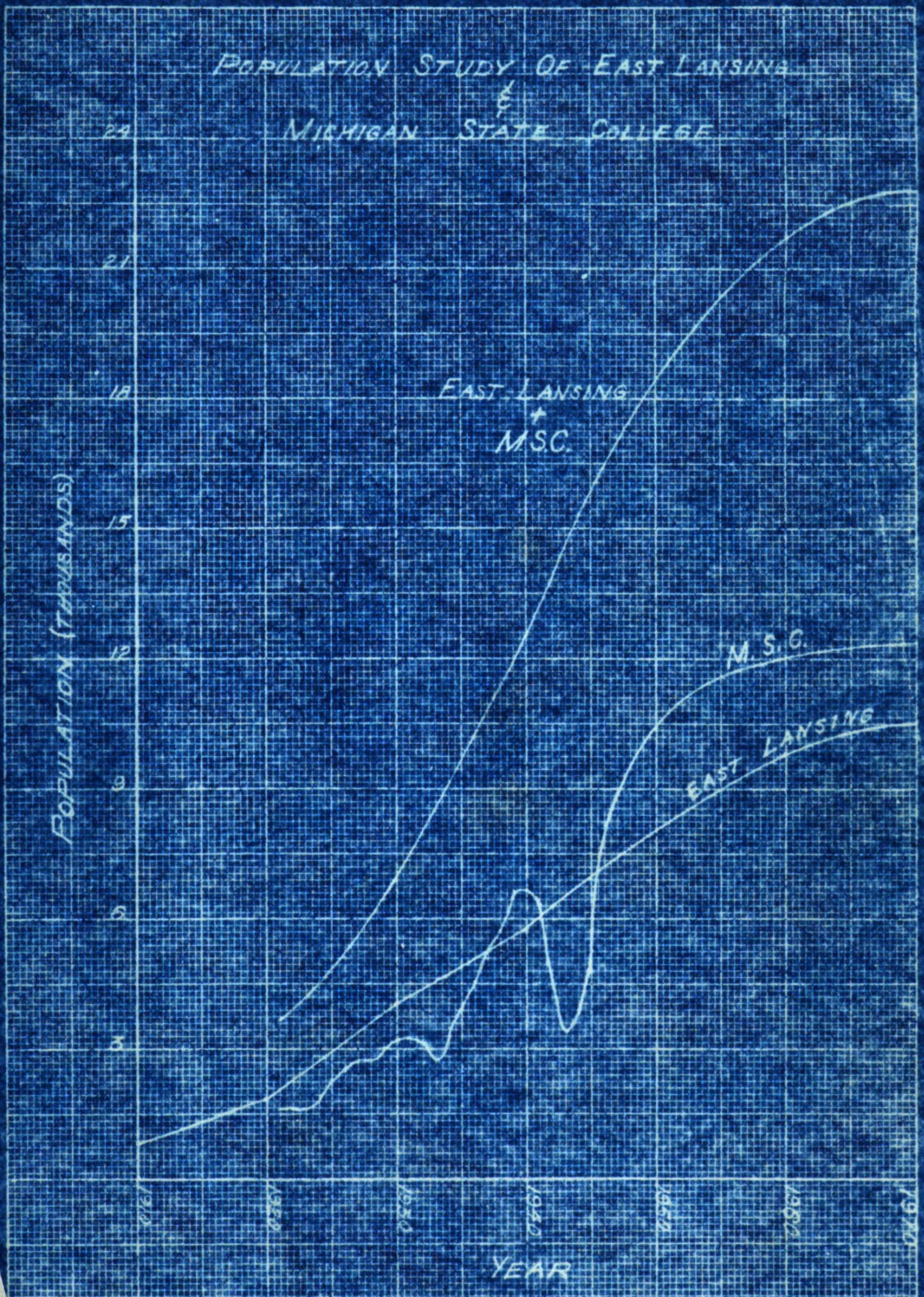
Uniform Percent Rate Of Growth

 5839
-4384
 1450 Change

$\frac{1450}{4389}$-33.1% Change

5039x.331=1933 5839+1933-7772=1950

7773x.331=2573 7772+2573=10,355=1960


POPULATION STUDY OF EAST LANSING
&
MICHIGAN STATE COLLEGE
24
21
18
15
12
9
6
3
POPULATION (THOUSANDS)
EAST LANSING
+
M.S.C.
M.S.C.
EAST LANSING
1910
1920
1930
1940
1950
1960
1970
YEAR

SOIL STABILIZATION

The character of the soil profile, including such factors as ground water level and drainability, subgrade support for runways under all weather conditions, suitability of the soil for runway stabilization, and availability of construction materials, will be a dominant factor not only in the first cost, but also in the adequacy and permanence of many improvements. This is especially true in the case of paved runways and landing areas.

The existence of Carlisle muck on part of this area for this airport will result in more earthwork because it has to be removed and earth from other areas of the airport used to fill up to grade.

The rest of the area, which consists of Conover, Brookston and Miami loam, is very suitable to be used as subgrade support.

DRAINAGE

The purpose of the drainage system underlying the landing area is to maintain the soil in a stable condition in all kinds of weather. The drainage system also prevents the ponding of water on the landing area to such an extent that the runways become useless for landings or take-offs during or following heavy rainstorms.

Drainage (cont.)

The drainage system should theoretically be able to carry off the water at the same rate as that at which it falls upon the area. This is not accomplished in practice. Some amount of ponding in the vicinity of the inlets to the drainage system is tolerated. The usual criterion in airport practice is to require the drains to carry off the water from a given storm in one to two hours after the end of the storm.

On the basis of the above conditions an equation has been written expressing the relationship of the quantity of water falling on the area and the pipe capacity of the under drains.

Q--Capacity of pipe necessary, expressed in cubic feet per second.

T--The duration of the rainfall in hours.

t--time, in hours allowed for removal of water after storm has stopped

I--Rainfall in inches per hour (intensity)

R--Per cent of runoff from the type of surface covering the airport.

A--Area of surface drained

$$Q-\frac{AIR}{T+t}$$

The maximum precipitation for this locality was 3.06 inches for a duration of one hour which was used in these calculations.

The time interval following a storm during which the surface water is carried away by the intercepting drains will

DRAINAGE (cont.)

vary with the slopes which carry the surface water to the drains.

A. For average slopes of 0.5 per cent or less, the value of t most commonly used is two hours.

B. The value of t used for areas where the average slope lies between 0.5 and 1.0 per cent is 1.5 hours.

C. Where the average slopes are greater than 1.0 per cent, the time allowed after a storm has ceased is 1.5 hours.

Surface Runoff in Per Cent

Surfaces that are assumed to be watertight	70-95
Asphalt pavements	85-90
Gravel roadways and walks	15-35
Parks, lawns, meadows	15-25

AIRPORT TURF

The purpose of grass and other plants on airports is the surfacing of plane traffic areas.for control of dust and drifting sands, prevention of erosion, and beautification of limited areas.

It should be dense, low growing, wear resisting, and must be established in the shortest time possible. Maximum

AIRPORT - TURF (cont.)

coverage is desired with a minimum of yield, which if distinct from the agricultural viewpoint.

AIRPORT PAVEMENT

The design of standard highway paving takes into consideration the number of vehicles per day, or the frequency to which the paving is subjected to loads, as well as the maximum load at any one time. The repetition of the load upon a runway is much less frequent than upon even a secondary highway, and the factor of fatigue is not so important in runway design. Therefore, the paving types which require the kneeding and compaction of traffic to maintain their density and life are obviously not so suitable for runways. To compensate for the absence of the compaction furnished by frequent traffic, softer asphalts and somewhat richer mixtures, combined with dense graded aggregates, are necessary to insure the density of the pavement and provide characteristics which resist the deteriorating effects of weather and climate. In this regard a tight, well bonded, and sealed surface is of essential importance.

The preferable finishes for concrete surfaces are those approaching a smooth troweled finish. Rough non-skid wearing surfaces are to be avoided because of the excessive tire

AIRPORT PAVEMENT (cont.)

wear which such surfaces impose upon landing aircraft.

Crowns and transverse gradients should be sufficient in pitch to expedite surface water run-off where freezing occurs because of possible ice damage to the surfaces.

Recommended Runway Crowns

Runway Width	Crown
100'	6"
150'	9"
200'	12"

Design Data

Recommended Standards	Class 1	Class 2	Class 3	Class 4
Static design loads for runways, taxiway, and apron paving based on present day aircraft	no paving recommended	30,000	74,000	130,000
Probable future (10 yrs.) maximum static gross loads to be considered in the design of runway, taxiway and apron paving and drainage structures	30,000	60,000	150,000	300,000
Probable range of static airplane tire pressures	10 to 35 lbs. per sq. in.	15 to 50 lbs. per. sq. in.	30 to 75 lbs. per sq. in.	50 to 85 lbs. per sq. in.

AIRPORT PAVEMENT (cont.)

Concrete Mix

Aggregate should be sound and durable and stored so that it will drain out for uniform moisture content. The coarse aggregate should be supplied in 1 inch size and 1 to 2 inch size. About 50% of each size is used. The fine aggregate should be well graded with 10 per cent minimum passing a 50 mesh sieve and 2 per cent passing a 100 mesh sieve.

A 5,000 lb. per sq. in. concrete is to be desired. Using a cement factor of 6.25 sacks per cubic yd. and a water-cement ratio of $5\frac{1}{4}$ gals. per sack of cement, the absolute volumes are computed.

$$\text{Cement: } \frac{6.25 \times 94}{3.1 \times 62.5} = 3.03 \text{ Cu. Ft.}$$

6.25=Cement factor in sacks

94=Weight in pounds of one sack of cement

3.1=Specific gravity of cement

62.5 = pounds per 1 cu. ft. of water

$$\text{Water; } \frac{6.25 \times 5.25}{7.5} = 4.37 \text{ cu. ft.}$$

5.25=number of gallons per sack

7.5=Gallons of water in 1 cu. ft.

For usual aggregates, 34 to 38 per cent of sand is recommended.

Volume of aggregate=27-7.40=19.6 cu. ft.

Volume of sand= .34x19.6=6.66 cu. ft.

Volume of coarse aggregate=19.60-6.66=12.94

Concrete Mix (cont.)

Weight of sand=2.65x62.5x6.66=1103#

Weight of stone=2.65x62.5x12.94=214-#

Yield for above volumes is:

Cement= 3.03 cu.ft.

Water = 4.37 cu. ft.

Sand = 6.66 cu. ft.

Stone =12.94 cu. ft.

Amount of water=5.25x6.25=32.8 gallons of water.

The consistency as indicated by the slump test is usually $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

COST ESTIMATE

Excavation	
439,450 cu. yds. @ $.40	$175,780.00
Runways and Apron	
Grading - 278,788 cu. yds. @ $.09	25,090.92
Construction and Material- 27,898 cu. yds. @ $8.88	247,734.24
Trenching	
28,450 lineral feet @ $.15	4,367.50
Gravel or Crushed Stone- 4,395 cu. yds. @ $2.00	8,790.00
Drain Tile	
Perforated Steel	
8"...14,850 ft. @ $ .56	8,316.00
10"... 4,200 ft. @ .62	2,604.00
12"..., 4,650 ft. @ .74	3,441.00
15"... 1,950 ft. @ .94	1,833.00
18"... 175 ft. @ 1.13	197.75
21"... 450 ft. @ 1.28	576.00
24"... 75 ft. @ 1.84	138.00
27"... 475 ft. @ 2.14	1,016.50
30"... 535 ft. @ 3.33	1,233.25
36"... 900 ft. @ 3.86	3,474.00
	$22,819.50

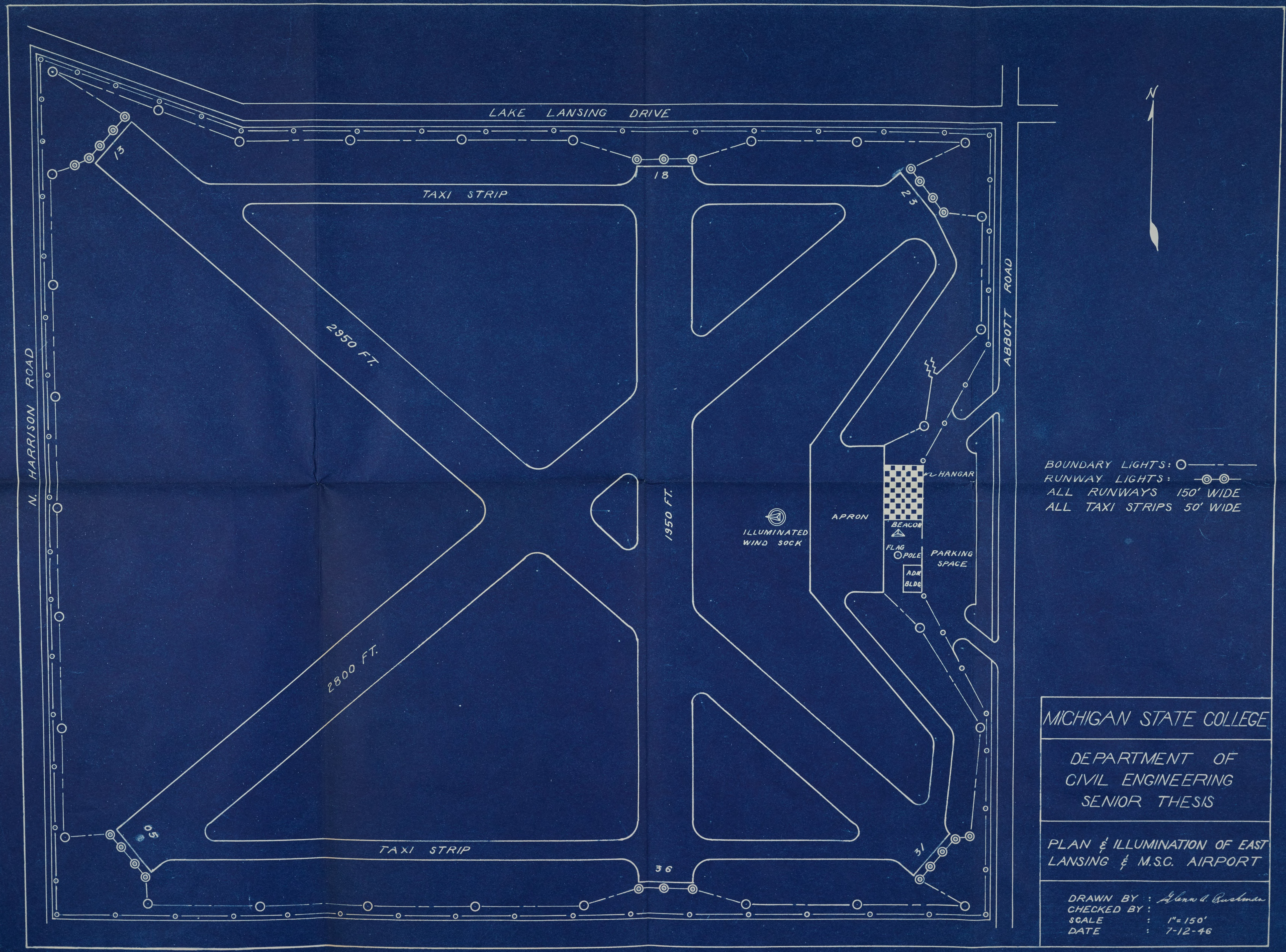
COST ESTIMATE (cont.)

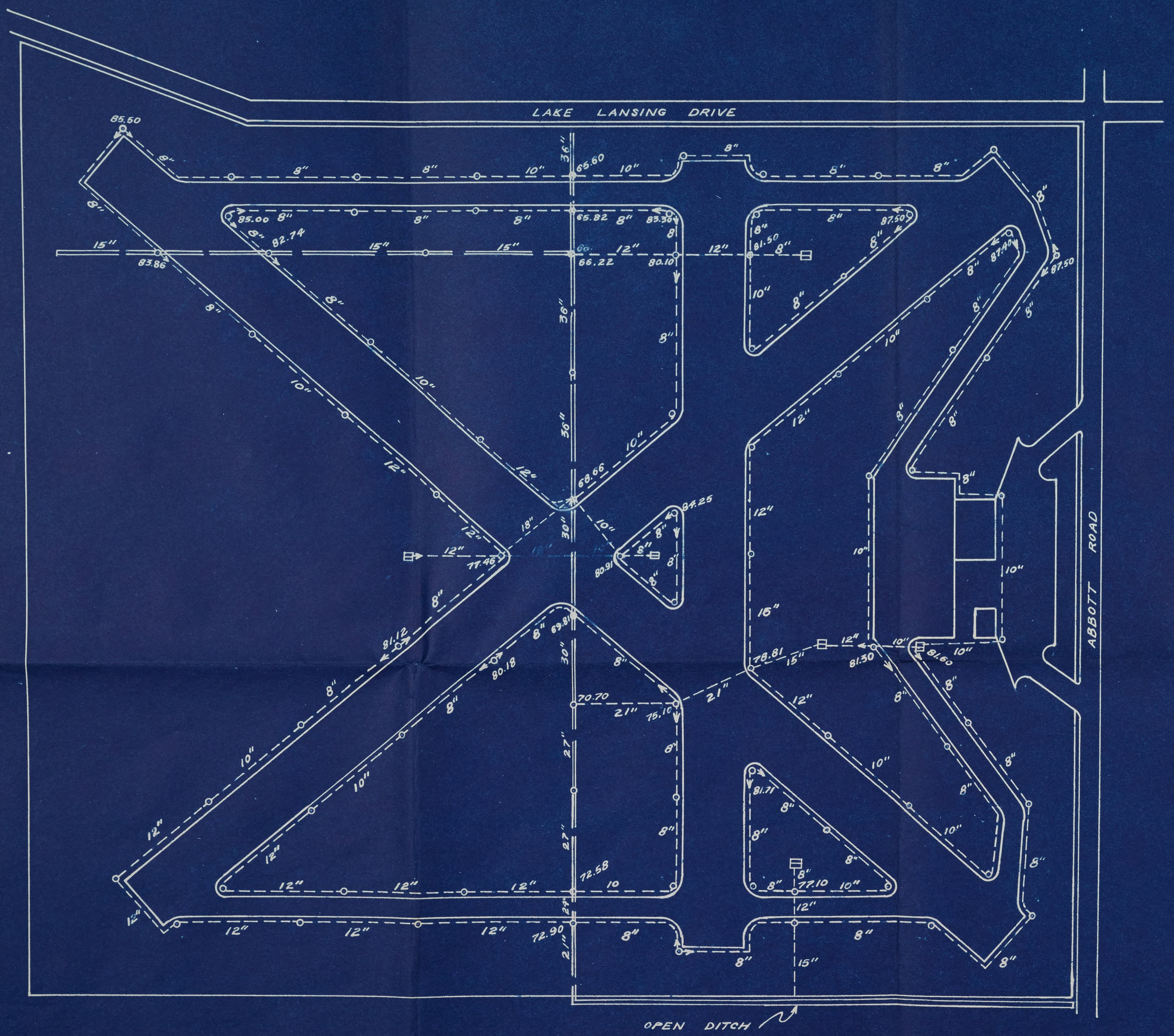
Catch Basins	
6 @ $35.00	$ 210.00
Manholes	
Drop type... 5 @ $100.00	500.00
80 @ 60.00	4,800.00
Hangar	
100'x75' @ $2.50/sq. ft.	18,750.00
Administration Building	
50'x40' two story @ $.30/cu. ft.	12,000.00
Lighting	
Beacon Light	144.00
Wind Indicator	64.40
Flood Lights 2 @ $300.00	600.00
Obstruction Lights 3 @ $14.40	43.20
Boundary Lights and Cone 29 @ $179.00	5,191.00
Approach Lights and Cone 24 @ $170.00	4,080.00
	$10,122.60

COST ESTIMATE (cont.)

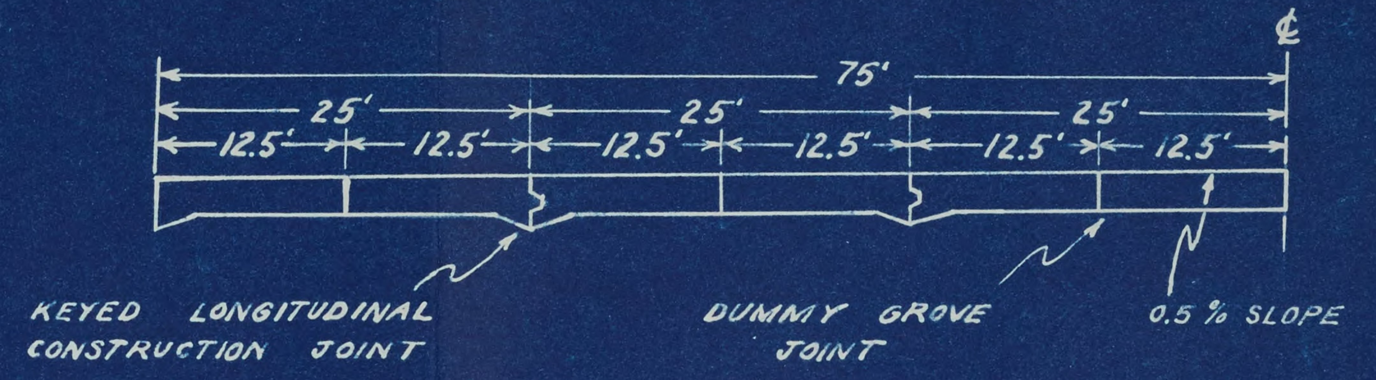
Fire Equipment		2,500.00
Fencing		
588 rods @ $2.35		1,381.80
Seeding		669.60
	Total	$535,416.16
Engineers Fee 5%		26,770.81
		$562,186.97

The calculated costs represent the conditions that existed in 1939

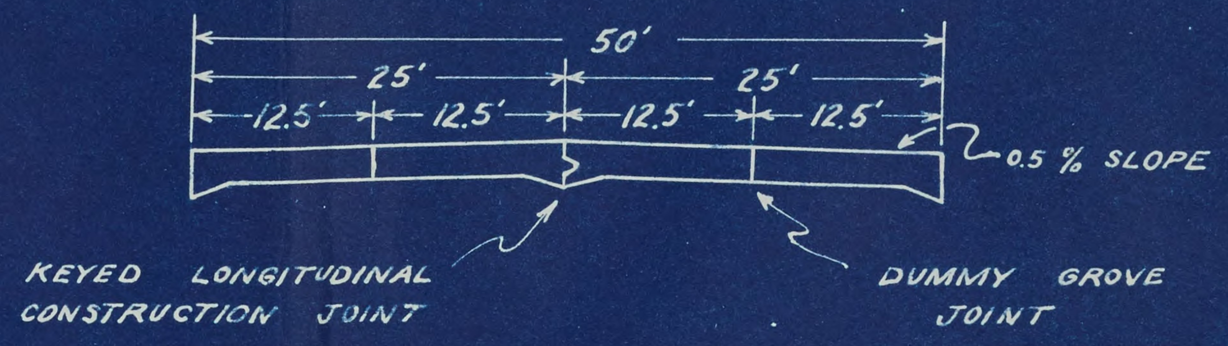

LAKE LANSING DRIVE
N. HARRISON ROAD
ABBOTT ROAD
N
TAXI STRIP
TAXI STRIP
13
18
23
05
36
31
2950 FT.
2800 FT.
1950 FT.
ILLUMINATED WIND SOCK
APRON
HANGAR
BEACON
FLAG POLE
ADM. BLDG.
PARKING SPACE
BOUNDARY LIGHTS:
RUNWAY LIGHTS:
ALL RUNWAYS 150' WIDE
ALL TAXI STRIPS 50' WIDE
MICHIGAN STATE COLLEGE
DEPARTMENT OF CIVIL ENGINEERING SENIOR THESIS
PLAN & ILLUMINATION OF EAST LANSING & M.S.C. AIRPORT
DRAWN BY : Glenn A. Rushman
CHECKED BY :
SCALE : 1"=150'
DATE : 7-12-46



CROSS-SECTION OF RUNWAY

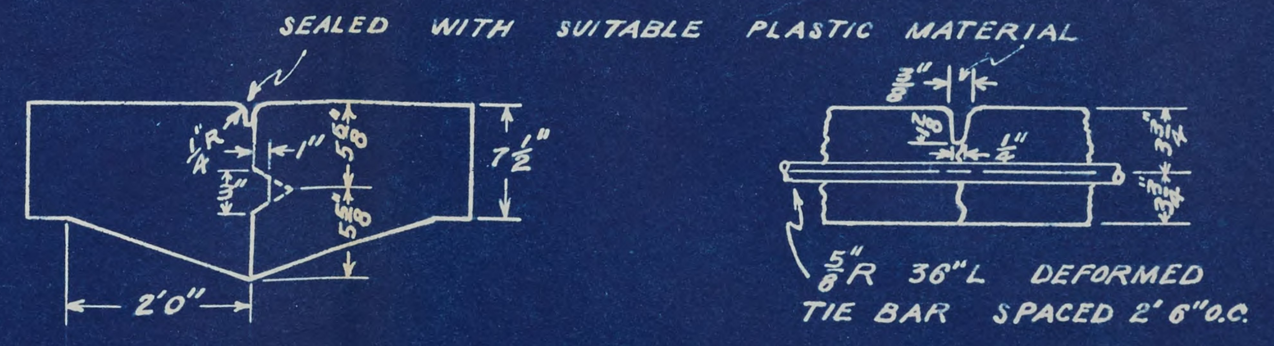


CROSS-SECTION OF TAXIWAY

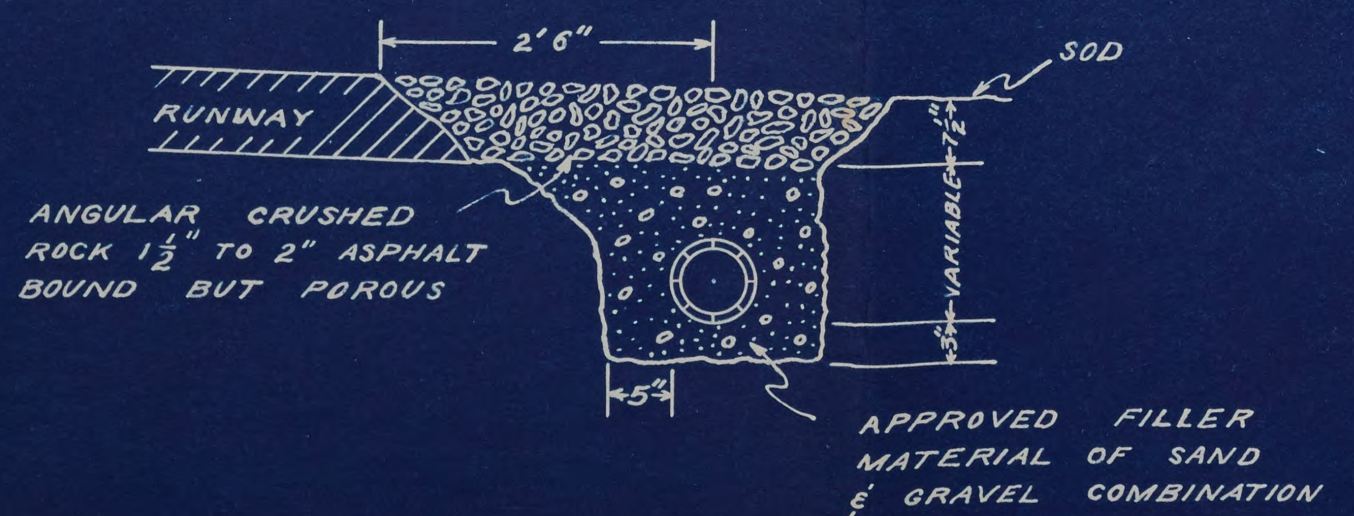


KEYED LONGITUDINAL CONSTRUCTION JOINT

DUMMY GROVE JOINT



INTERCEPTING DRAIN



LEGEND

CONCRETE INTERCEPTOR

COLLECTING DRAIN

MANHOLE (DROP TYPE) MANHOLE

CATCH BASIN (DOUBLE INLET)

NOTE:

ALL DRAINAGE HAS A 0.4 % SLOPE.
ARROWS INDICATE DIRECTION OF FLOW.

QUANTITY

DRAIN	CONCRETE
8" - 14,850'	15" - 1,275'
10" - 4,200'	21" - 200'
12" - 4,650'	24" - 75'
15" - 675'	27" - 475'
18" - 175'	30" - 525'
21" - 450'	36" - 900'

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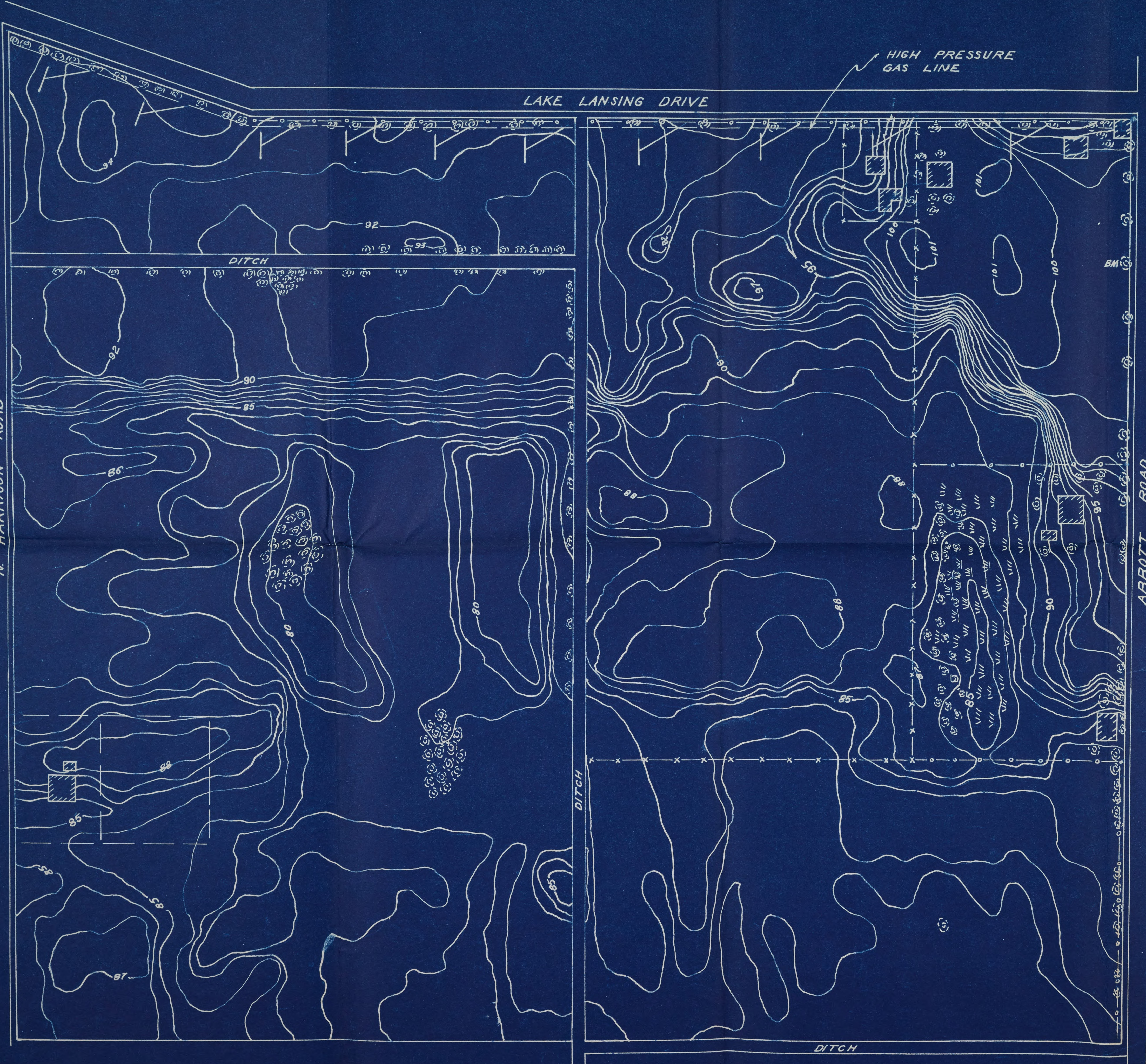
DEPARTMENT OF CIVIL ENGINEERING SENIOR THESIS

DRAINAGE & CROSS-SECTION OF EAST LANSING & M.S.C. AIRPORT

DRAWN BY: Glenn A. Rushman
CHECKED BY:
SCALE : 1" = 200'
DATE : 8-7-46



NOTE:
B.M. - MAPLE TREE 17 INS. IN DIAMETER. LOCATED ON WEST SIDE OF ABBOTT RD. 338 FT. SOUTH OF LAKE LANSING DR.
ASSUMED ELEV. OF 100 FT. ON NOTCH CUT ON WEST SIDE OF TREE 1.2 FT. ABOVE GROUND.

CONTOUR INTERVAL - 1 FT.

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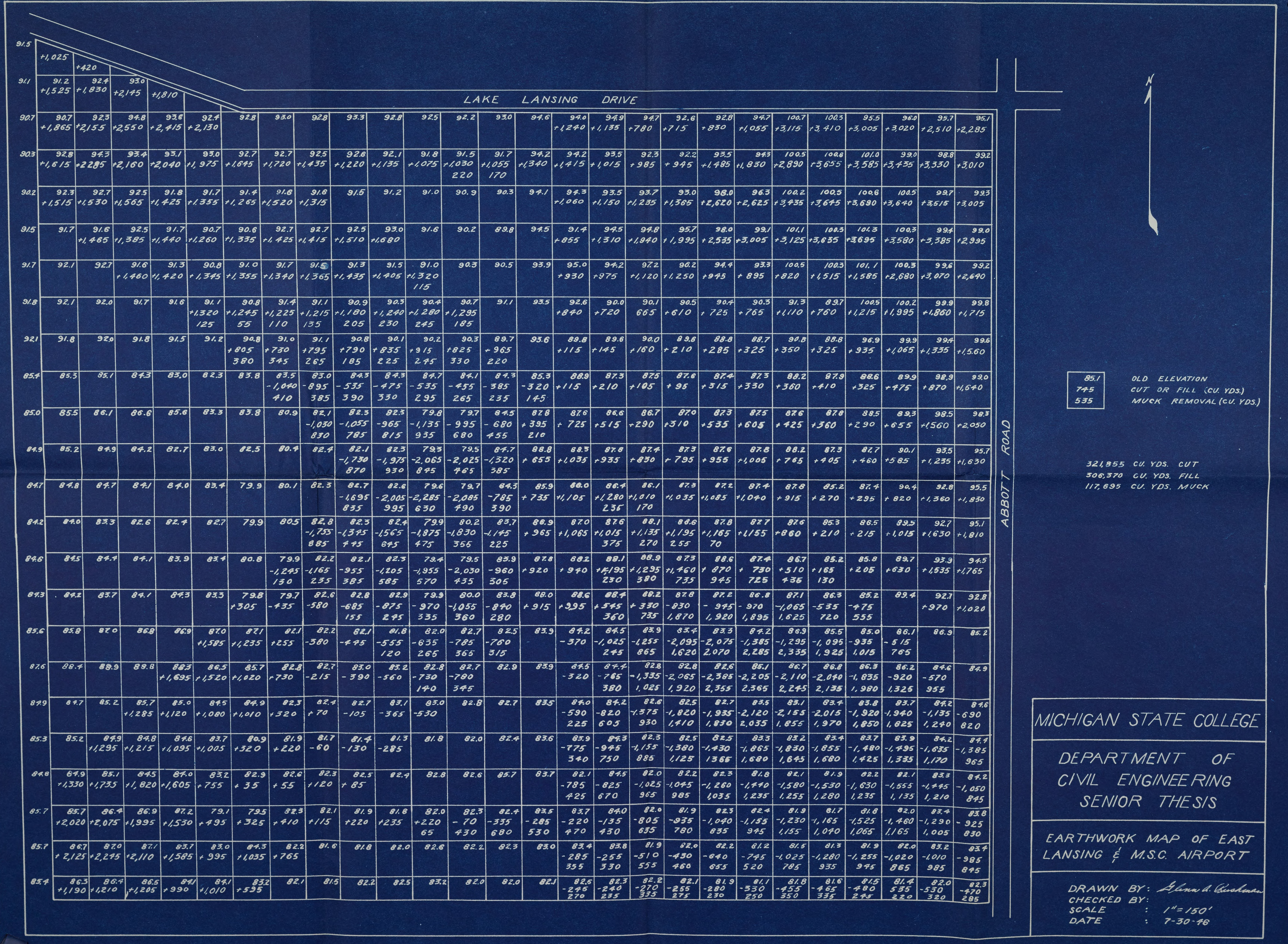
DEPARTMENT OF CIVIL ENGINEERING SENIOR THESIS

TOPOGRAPHIC MAP OF EAST LANSING & M.S.C. AIRPORT

DRAWN BY : Glenn A. Bushman
CHECKED BY:
SCALE : 1" = 150'
DATE : 6-27-46


LAKE LANSING DRIVE
ABBOTT ROAD
N
85.1 OLD ELEVATION
745 CUT OR FILL (CU. YDS.)
535 MUCK REMOVAL (CU. YDS.)
321,855 CU. YDS. CUT
306,370 CU. YDS. FILL
117,695 CU. YDS. MUCK
MICHIGAN STATE COLLEGE
DEPARTMENT OF CIVIL ENGINEERING SENIOR THESIS
EARTHWORK MAP OF EAST LANSING & M.S.C. AIRPORT
DRAWN BY: Glenn A. Bushman
CHECKED BY:
SCALE : 1" = 150'
DATE : 7-30-46