https://doi.org/10.29321/MAJ.10.A03714

Levelling the new area in Agricultural College and Research Institute, Coimbatore

by
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Introduction: In an area of seventy five acres of land recently acquired near the Millet Breeding Station of the Agricultural College and Research Institute, Coimbatore, levelling of land was done to prevent the twin deleterious effects of the soil erosion and gully formation, to facilitate improved irrigation methods and to improve the field to meet the needs of mechanised farming.

Materials and Methods: The area is almost rectangular in shape with black cotton soil mixed with gravel, making the top soil horizon. The topography of the land showed the existence of uneven slopes, with one local dip on the westernside about 300 feet inside the boundary. Further, the menace of the gully formation on the easternside along the *nalla* was imminent at a number of places. The general slope of the land was from North-west to South-east, with undulation in several places. But the South-west portion of the field for an area of 12 acres was having a slope towards the West, with a ridge at the centre of the field running North South.

A survey for the seventy five acre plot was conducted and levels were taken at 100 feet squares (Grid) after peg marking with 2 feet long pegs. With the aid of the levels, a contour plan was prepared to have an idea of the topography of the field (sketch I). The entire area was divided into four quadrants, with a North South road in middle of the area and a West to East road lying along the contour. In dividing the field, due consideration was given that each quadrant has uniform slopes, so that excess cutting and filling and transporting to long distances are avoided. A road all round the area will facilitate easy transportation of farm produce.

Along the field boundaries on the Western and Northern side two drains were proposed to intercept the run off from the adjoining high level fields, which will otherwise erode the land if left unchecked.

As the entire field was full of perennial weeds, chiseling with D4 tractor upto a depth of 2 feet was done first. Then to loosen the soil it was ploughed using disc harrows. After fixing the red and green flaged pegs, the red at places of cutting and green at corresponding places of

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Received on 25—8—1966.

filling to the proposed levels in the field, the levelling operation was commenced. This was done with a scooper attached to a D4 tractor. The scooper is just like an open box mounted on an axle with two wheels, the bottom of the rear side and sides of which are sharpened. It can be raised or lowered by means of the hydraulic device provided in the tractor. The tractor was worked in between rows of pegs. Where cutting has to be done, the scooper is lowered to the required depth so as to cut the elevation of the land. The scooped out soil contained in the box is conveyed to the low lying areas for filling the depressions.

After the scooping operation was over, the field was ploughed with a disc harrow in both the directions to loosen the compact surface of the land. As there was small undulations near pegs, since the scooper is not expected to disturb their positions, a final smoothening of the surface of the land was done using the land plane attached to a light tractor.

The roads were formed using D4 tractor with dozing blade attachment and the drains with ditcher attachment. Vide sketch No. 3.

Results: Maps with grid points at 100 feet centres for each quadrant was prepared as shown in Appendix I. The calculation is as follows for the first quadrant.

Design of centroid and the average elevation of the field: To reference lines XX and YY were drawn, the line 100 feet East of line A and YY line 100 feet South of line 1. The number of stakes in each line multiplied by the distance (in stations) from the reference line is given below:

With reference to XX

Line	Distance	No. of stakes	Product
1	1 stations	7	7
2	2 stations	7	14
3	3 stations	7	21
4	4 stations	7	28
5	5 stations	7	35
6	6 stations	7	42
7	7 stations	7	49
8	8 stations	7	56
9	9 stations	7	63
		63	315

The distance of the centroid from the reference line XX was then found by dividing the sum of the products by the total number of stakes 370/63 = 5 stations or 500 feet. The centroid was, therefore, 500 feet away from the reference line XX or it was on the line E.

Similarly, with respect to the reference line YY drawn 100 feet South of line 1, the centroid was found to be 400 feet away from line YY i. e on 4th line.

The average elevation was got by adding the elevations at all corners of the grid and dividing it by the number of stakes. Thus the average elevation for the first quadrant was $\frac{6387 \cdot 04}{63} = 101 \cdot 39$

Design of plane of best fit (Percentage of slopes): The presentage of slope of the field in both the directions which will effect the balanced cutting and filling was worked out as detailed below:

$$Mx = \lessgtr \frac{(Dx\ Hy) - (A) \times (H)}{B}$$

$$My = \lessgtr \frac{(Dy\ Hx) - (A) \times (H)}{B}$$

Where Dx = Distance in stations from the Y axis

Dy = Distance in stations from the X axis

H = Sum of the elevation at all grid points

Hx = Sum of the elevation in the direction of XX along the grid line

Hy = Sum of the elevation in the direction of YY along the grid line

Mx = Slope of the plane in the direction of XX

My = Slope of the plane in the direction of YY

A = Constants from table 1

B = Constants from table 1

The calculation of the slopes is shown in Appendix II.

Design of proposed levels: The following particulars were known:

Centroid	On line E and on line 1
Elevation of centroid	101·39
Down field slope (Mx)	— 0·10%
Cross slope (My)	1·00%

(The minus sign for Mx indicated that the grid points were having lower elevations with the increase of distance from the line XX).

Keeping the elevation of the centroid as 101·39, the elevation for all points on line was calculated by, adding or subtracting 0·10 to the right or left, respectively. The elevation of points on 5 were got by adding 1·00 to the elevation on line 4. By subtracting 1·00 from the elevation of points on line 4, the elevations of points on line 3 were got. Similarly the elevation of all other points were determined. All the cuts and fills for the quadrant were worked out. As the ratio of cuts to fills was less than 1·5, the ground level at the centroid was found out by trial and error as 101·30 for which the ratio of cuts to fill was 1·5 nearly (sketch No. 2). Similarly the design of slopes and proposed levels were found out for all the quadrants.

Discussion: The levelling of field according to the designed slopes has got the following advantages. Economic use of water is ensured as quantity of water can be controlled which is not feasible in an unlevel land. When the flow of water can be controlled, a uniform distribution may be maintained thoughout the field to produce a uniform crop. There is also saving in labour for guiding water as the grade of the field will permit furrow irrigation in which, water can be let by means of a syphon tube. In case of uneven land, the water is to be guided for each plot as there is no uniform grade and the labour requirement will be high. Moreover in a perfectly levelled area it is easy to drain off excess water, where as in an uneven land drainage is a difficult problem. In a level land all cultural operations like sowing, intercultivation, harvesting etc. can be carried out mechanically with case and efficiency which will ultimately result in reduced cost of cultivation. In an unlevel land the mechanised farming will be difficult and uneconomical. The evil effects of erosion are no longer a problem in a level field where as annual constant check is essential in an unlevel land.

Summary: Initially a topographical map of the field was prepared, based on which the field was divided into quadrants for which the centroid, the average elevation at the centroid, the percentage of slopes and proposed levels were determined. The proposed levels were established by means of pegs and the land was scooped and levelled to the proposed level.

Acknowledgements: The land levelling operation would not have been possible but for the kindly help of the Rockefeller Foundation aid, in lending the machinery, equipment and operators at free of cost. We place on record our gratitude to the Rockefeller Foundation and their staff Dr. House and Dr. Wright. Our thanks are also due to our Dean, the Agronomist, the Addl. Superintendent of Central Farm and the Millet Farm Managing Assistant who were of immense help in making this new operation, a success.

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APPENDIX I

										Y	Bows	No. of Stations	Product
	105·35	105·41	105·67	103·68	103·36	104·00	104·36	104·53	104·94	...	7	9	63
	102·74	103·74	103·22	103·50	102·50	103·12	103·46	103·49	104·08	...	6	9	54
	102·84	102·85	102·35	102 00	101·91	101·17	100·89	102·50	103·11	...	5	9	45
	101·38	101·81	101·57	101·21	101:19	101·28	101·54	101·48	101·12	...	4	9	36
	100·49	100·77	100·37	100·26	100·03	101·55	100·25	100·68	100·98	...	3	9	27
	99·11	99·32	98·32	99·08	98·92	98·97	99·56	99·73	100·11	...	2	9	18
	98·44	98·48	98·43	98·22	98·22	98·03	98·26	98·56	99·75	...	1	9	9
X	...	...	...	...	...	...	...	...	...	X	...	X	...
											Total	63	252
										Y			
											Cy = 252/63 = 4 = 400 ft.		
	9	8	7	6	5	4	3	2	1	...	Rows		Total
	7	7	7	7	7	7	7	7	7	...	No. of stakos		63
	63	56	49	42	35	28	21	14	7	...	Product		315
											Cx = 315/63 = 5 = 500 ft.		

Sum of Elevations = 6387·94
No. of Points 63
Average Elevation : 101·39

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APPENDIX II

Determination of Plane of Best fit (Percentage of slope)

Hx	DY	HxDy										
941·30	7	6589·10	105·35	105·41	105·67	103·68	103·36	104·00	104·36	104·53	104·94	G
928 85	6	5579·10	102·74	103·74	103·22	103·50	102·50	103·12	103·46	103·49	104·08	F
919·62	5	4598·10	102·84	102·85	102·35	102·00	101·91	101·17	100·89	102·50	103·11	E
913·28	4	3653·12	101·38	101·81	101·57	101·21	101·19	101·28	101·54	101·48	101·82	D
905·33	3	2716·14	100·49	100·77	100·37	100·26	100·03	101·55	100·25	100·68	100·98	C Y axis
892·12	2	1784·24	99·11	98·32	98·32	99·08	98·02	98·97	99·56	99·73	100·11	B
886·39	1	886·39	98·44	98·48	98·43	98·22	98·22	98·03	98·26	98·56	99·75	A
			9	8	7	6	5	4	3	2	1	

Σ HX = 6387·94 Σ HxDy = 25806·19

Σ Hy = 6387·94

710·35	711·38	709·93	707·95	706·13	708·12	708·32	710·97	714·79	Hy
9	8	7	6	5	4	3	2	1	Dx
6393·15	5691·04	4969·51	4247·70	3530·65	2832·48	2124·96	1421·94	714·79	HyDx

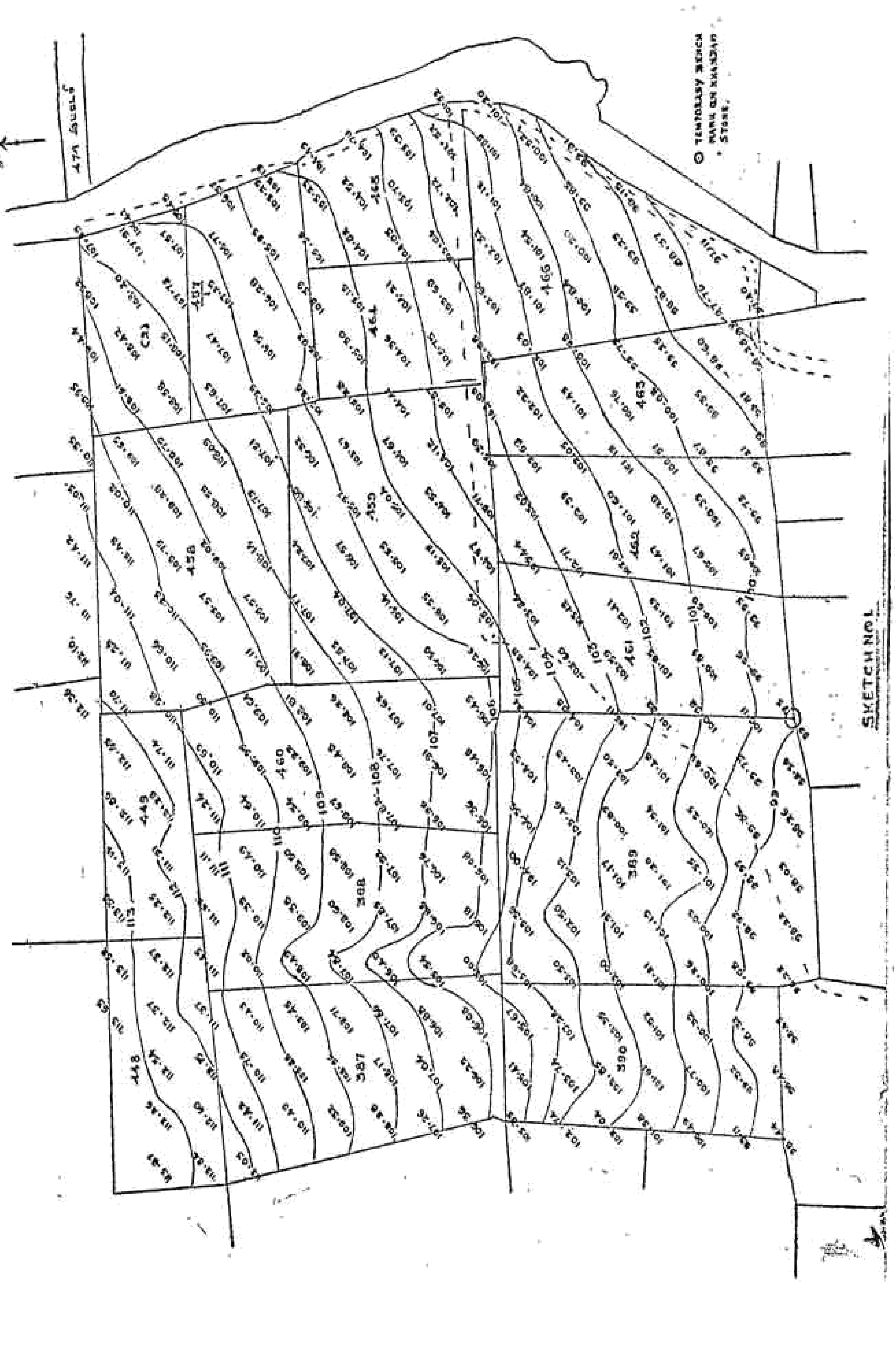
Σ HyDx = 31,926·22

$$Mx = \frac{\Sigma(HyDx) - A(\Sigma Hy)}{B} = \frac{31926{\cdot}32 - 5 \times 6387{\cdot}94}{420} = -0{\cdot}003 \text{ percent.}$$

$$My = \frac{\Sigma(HxDy) - A(\Sigma Hx)}{B} = \frac{25806{\cdot}19 - 4 \times 6387{\cdot}94}{252}$$

= 1·09 percent
or 1 percent

NOTE :— The percentage of slope in the direction of XX axis is — Ve. That means the elevation decrease as the distance increases from the Y axis. The value of Mx = — 0·003 percent. As this slope is very flat, to have gravitational flow a slope of — 0·10 percent was adopted.

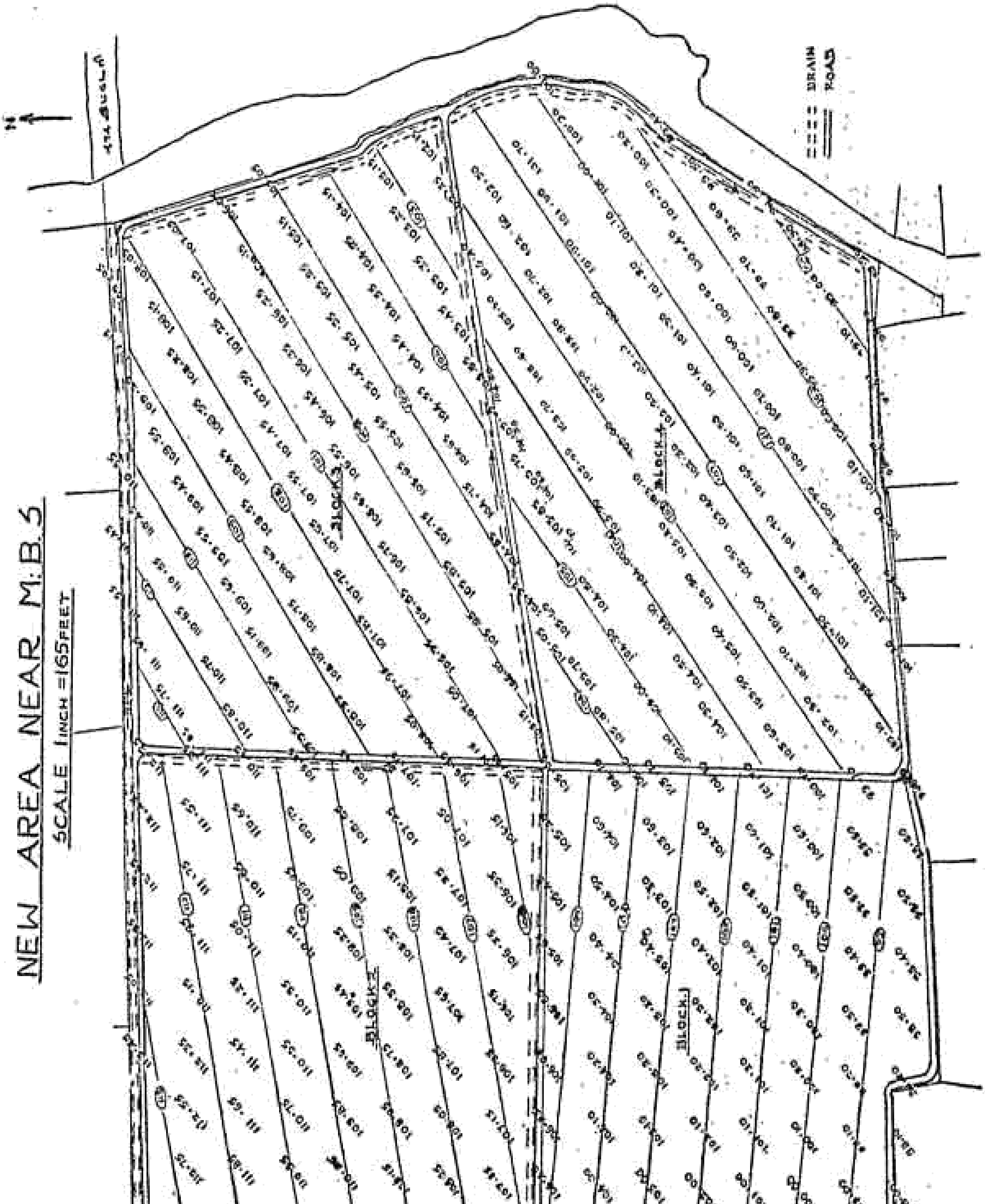

SKETCH No. I

BLOCK 1

+ Cutting.	— Filling	Proposed Level Original Level	I	H	G	F	E	D	C	B	A	
4·67	2·07		103 90 —105 35 + 1 45	104 00 — 105 41 + 1 41	104 10 — 105 67 + 1 57	104 20 — 103 68 — 0 52	104 30 — 103 36 — 0 94	104 40 — 104 00 — 0 40	104 50 — 104 36 — 0 14	104 60 — 104 53 — 0 07	103 70 — 104 94 — + 0 24	7
1·54	1·39		102 90 — 102 74 — 0 16	103 00 — 103 74 + 0 74	108 10 — 103 22 + 0 12	103 20 — 103 50 + 0 30	103 30 — 102 80 — 0 80	103 40 — 103 12 — 0 28	103 50 — 103 46 — 0 04	103 60 — 103 49 — 0 11	103 70 — 101 08 — + 0 38	6
1·65	3·68		101 90 — 102 04 + 0 14	102 00 — 102 85 + 0 85	102 10 — 102 35 + 0 25	102 20 — 102 00 — 0 20	102 30 — 101 91 — 0 39	102 40 — 101 17 — 1 23	102 50 — 100 89 — 1 61	102 60 — 102 50 — 0 10	102 70 — 103 11 — + 0 41	5
1·93	0·35		100 99 — 101 38 + 0 48	101 00 — 101 61 + 0 81	101 10 — 101 57 + 0 47	101 20 — 101 21 + 0 01	101 30 — 101 19 — 0 11	101 40 — 101 28 — 1 12	101 50 — 101 54 + 0 04	101 60 — 101 48 — 0 12	101 70 — 101 82 — + 0 12	4
3·20	0·52		99 90 — 100 49 + 0 59	100 00 — 100 77 + 0 77	100 10 — 100 37 + 0 27	100 20 — 100 26 + 0 06	100 30 — 100 08 — 0 27	100 40 — 101 55 + 1 15	100 50 100 25 — 0 25	100 60 100 68 + 0 08	100 70 100 98 — + 0 28	3
1·13	1·71		98 90 99 11 + 0 21	99 00 99 32 + 0 32	99 10 98 32 — 0 78	99 20 99 08 — 0 12	99 30 98 92 — 0 35	99 40 98 07 — 0 43	99 50 99 56 + 0 06	99 60 99 73 + 0 13	99 70 100 11 + 0 41	2
2·42	0·73		97 90 98 44 + 0 54	98 00 98 48 + 0 48	98 10 98 48 + 0 33	98 20 98 22 + 0 02	98 30 98 22 — 0 08	98 40 98 03 — 0 37	98 50 98 26 — 0 24	98 60 98 56 — 0 04	98 70 99 75 + 1 05	1
Σ 16·54	10·30											

$$C/F = \frac{16·54}{10·30} = \underline{1·60}$$

SKETCH No. 2


NEW AREA NEAR M.B.5
SCALE 1 INCH = 165 FEET
N
DRAIN
ROAD
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4