**MASTER PLAN FOR**

**DRAINAGE OF STORM WATER DRAINAGE OF THE KANJHAWALA BASIN IN UNION TERRITORY OF DELHI**

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**MASTER PLAN ORGANISATION**

**FLOOD CONTROL WING**

**DELHI ADMINISTRATION**

**1976**

 **MASTER PLAN FOR KANJHAWALA SUB-BASIN**

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**MASTER PLAN FOR DRAINAGE OF KANJHAWALA BASIN.**

1. **INTRODUCTION;**

**1.:1** **TOPOGRAPHY AND LAND USE:-** Kanjhawala basin which is a sub-basin of the Najafgarh main basin is situated on the North Western part of the Union Territory of Delhi. This basin is bounded by Alipur basin on its east, Najafgarh sub-basin on its South, and Haryana State on its North & West sides. It is having its boundary with M.C.D. and D.D.A also on its South-East sides. A general feature plan & a contour plan of the basin are enclosed as Drawings K-I & K-II. The N.H.No.10 viz. Rohtak Road runs through this block from East to West direction. The broad-gauge Railway line towards Rohtak also runs parallel to the main Rohtak road. It has got a common border with Rohtak district of Haryana State for about 20 miles length.

 The total area of the sub-basin is approximately 83.50 sq. miles. It is generally slopping towards South. The maximum & minimum contours are R.L. 724 (ft.) and R.L. 687 (ft.) respectively. The whole area is rural except a small part on the South East corner (about 5.20 sq. miles) which is covered by the Master Plan boundary of Delhi. Eight Nos. irrigation channels coming from Haryana State to Irrigate the area of this block. There are three main storm water drains and 24 tributaries already existing in the basin which are described in detail in the chapter on the Existing Drainage system and their remodeling.

 Topographically Kanjhawala basin is a flat area. It contains approximately 46 villages with a population of nearly 1.05 lacs. The drainage zone consists of 53 villages within the Union Territory of Delhi. The present population as per 1971 census is enclosed as Drawing K-III.

 The sub-soil water in this basin generally varies between 1 foot to 25 feet below the ground level. Two plans showing the minimum and the maximum water tables are enclosed as Drawing K-IV & K-V. Part of this basin, particularly on the southern side suffers from water scarcity during dry weather. The drainage zone of Kanjhawala basin is very extensive. In addition to its own catchments, it receives discharges from part of Haryana State and Alipur basin, through west Jua drain & Nangloi drain respectively. A basin map showing the external catchment of Kanjhawala block is enclosed as Appendix: II.

 **1:2 POPULATION STATISTICS OF THE BLOCK:**

There are about 53 villages in the drainage zone of the block within the Union Territory of Delhi. The total population of the zone as per 1971 census is 127380 ( Drawing K-III) Out of the total area of 83.50 sq. miles, only 5.20 sq. miles area on the south eastern boundary of the block is to be developed under the Master Plan program for urbanization of the Union Territory of Delhi by 1981. The remaining area is rural. According to the National Capital region report, there is a proposal of radial arteries being developed all round the Central Core of Urban Delhi. One of the arteries will be the Delhi Rohtak Road passing though this block. However, it has been specifically mentioned in the report that no urbanization should be done in the rural area of Union Territory surrounding the urban zone as it will cause over congestion. Emphasis has been laid by the N.C.R. on the development of rural areas. Accordingly Rural centers have been classified into the following three categories to make the planning more effective, realistic and to disperse the population uniformly:-

1. Growth centers:- These will serve an area of 200-300 Sq. Km.s and 1.2 lakhs to 2.0 lakhs projected population in 1981. These centers would have activities mainly non agricultural in nature with all centralized amenities and facilities in the field of education, medical, public health, better wholesale and retail shopping, civic and cultural and re-creational centers etc.
2. Central Place villages:- These will serve a radius of 3 to 5 Kms. and will serve an area of about 30 to 80 Kms. and a projected population range of 20 to 40,000 in 1981. All the villages will also have a predominantly agricultural economy and will provide central service facilities for all the villages in the cluster.
3. Basic villages:- will serve their own existing abadi areas. Amongst the important villages in the basin, Nangloi Jat has a population of 18200 Mundka 4890 & Tikri Kalan 4360, Kanjhawala 3750. Out of the above towns Kanjhawala will be developed as Growth centre and Nangloi Jat & Tikri Kalan will be developed as Central Place villages and hence may be facing internal drainage problem unless planned in advance.

**2. RAINFALL STUDIES FOR KANJHAWALA BASIN.**

2.1 The Kanjhawala basin which falls under the category of rural areas of U.T. of Delhi covers an area of about 215 Sq. Km. Out of this total area, approximately 15 Sq. Km. is semi-urban. The network of rain gauges within Delhi Territory was limited to only two stations i.e. Palam and Safdarjung for which long term rainfall records are available. The storm rainfall analysis was carried out by the Reddy Committee during 1958 when it was found that the rainfall in Delhi Territory is quite erratic and existing stations are considered inadequate for detailed analysis of the rainfall for the different Blocks. It was then recommended by the Reddy Committee that the network of rain gauges in the Delhi Territory should be suitably strengthened. Accordingly, in consultation with IMD,14 self recording rain gauges have been installed throughout the Delhi Territory during 1973. Besides, there are existing rain gauge stations in adjoining states viz. U.P. and Haryana. Rainfall data from the relevant rain gauge stations for this basin for the year 1973 to 1975 are enclosed as Drawing K-IV.

The rain gauge stations which are considered representative particularly for the Kanjhawala Block are listed below:-

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name of rain gauge station | Type | Authority in charge. | Data Available | Location | The sin Polygon weight age for the catchment |
| A) For 3 day maximum rainfall: |
| 1.Palam | Self recording | Indian Metrological Department | Data Considered for 17 years i.e. 1958-74 | Outside Block | 5% |
| 2.Siraspur | Ordinary | Irrigation DepartmentHaryana Govt. |   -do- | -do- | 20% |
| 3. Jaunti  | --do-- | --do-- |  -do-- | Inside block | 75% |

B) Determination of aerial distribution factor:- All the rain gauge stations as shown in the drawings.

 **2.2: Design storm:**

 **2.2:1 Rural drains**

Kanjhawala basin mostly consists of villages surrounded by vast tracts of agricultural lands drained by natural water courses. The Reddy Committee, in their final recommendations, had suggested that the drainage system in the rural areas of Delhi, should be so designed as to restrict flooding to a maximum period of 5 years. The 3 days maximum rainfall figures of Palam, Siraspur and Jaunti stations are available for a concurrent period of 17 years from 1956-1974 which have been put to frequency analysis. The 3 day maximum rainfall corresponding to 5 years return period comes to 7.64 mm vide Annexure I. For comparative study, the point rainfall at Palam for which the data is available for longer period of 24 years has also been statistically analyzed which gives 3 day maximum rainfall of the order of 8.5” for a return period of 5 years. Vide Annexure II. Similarly, studies of design storm was carried out by the Reddy Committee in 1958, on the basis of Palam data and a figure of 8.2” as 3 days maximum rainfall for 5 years frequency was recommended. The maximum hourly rainfall data of Palam rain gauge station is available for a period of 9 years i.e. 1966 to 1974 and the same has been put to frequency analysis. The hourly maximum rainfall corresponding to 2 years, 5 years, 10 years and 25 years frequency comes to 1.72”, 2.29”, 2.73” and 3.30” respectively vide Annexure-III.

The storm rainfall studies as carried out on the basis of three rain gauge stations viz. Siraspur, Jaunti and Palam which are most representative appear more realistic and a figure of 7.64” for the Kanjhawala Basin is recommended for adoption.

**2.2.2 Urban Drains.**

There are only 3 semi-urban drains in this basin, for which a hourly intensity of 2.29 inches is recommended. This is the five years frequency Rainfall based on the analysis of the Palam rainauge observations vide Annexure-III. Appropriate aerial distribution factor is to be applied on this storm since it is based on an external rain gauge station observations. As the semi-urban drains in this basin are also having considerably large catchment area, it has been decided to adopt the rational method for calculating the discharges in such drains instead of applying a direct design discharge on them.

**2.3 Rainfall distribution factor:-**

It may be seen from the above discussion on the design storm analysis, that the design storm for the rural areas in this basin is based on a few rain gauge stations situated within the zone or closely adjacent to it. Therefore, no further aerial distribution factor need be applied in case of the rural drains in this basin.

As regards the urban drains, the design storm is recommended on the basis of the hourly readings of Palam rainfall records. The data from the self recording rain gauge stations within this zone, which is available only for three years, has been considered inadequate for design storm frequency study. Therefore, application of an area distribution factor for the urban drains is necessary. For this purpose, typical storms have been selected from the records available for the last 3 years from the self-recording rain gauges in the basin. Isohyets were plotted and then concentric circles with gradual increasing aerial were drawn around the storm centers. On the basis of the ratio between the average rainfall in these circles and the peak, the aerial distribution factors were worked out. After analyzing a number of such hourly storms, the factors for each sizes of catchments are indicated below. From these values the average aerial distribution factor for the urban catchments of immediate size in this basin are recommended as 80%.

|  |
| --- |
| Catchment area in Rainfall dispersion factor with respect to maximum point rainfall |
| Acres | Sq. Km. | Based on hourly rainfall study. |
| 500 | 2.024 | 94.25 |
| 1,000 | 4.049 | 93.60 |
| 2,000 | 8.097 | 92.50 |
| 3,000 | 12.146 | 91.50 |
| 4,000 | 16.194 | 90.50 |
| 5,000 | 20.943 | 89.60 |
| 6,000 | 24.291 | 88.90 |
| 7,000 | 38.340 | 88.25 |
| 8,000 | 3,383 | 87.50 |
| 9,000 | 36.437 | 86.75 |
| 10,000 | 40,485 | 86.00 |
| 15,000 | 60,740 | 83.00 |
| 20,000 | 80,011 | 80.30 |
| 30,000 | 121.537 | 76.30 |
| 40,000 | 162.063 | 74.75 |
| 50,000 | 202.681 | 73.75 |

Annexure I (a)

 Kanjhawala Basin

Three days max. Rainfall in m.m.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | Station | Weight age | 3 days maximum rainfall in (b) mm. | Weight age value ( axb) | Total rainfall  |
| 1974 | PalamSiraspurJaunti | 5%20%75% | 90.300120.65096.520 | 4.5124.1372.39101.03 | 101.03 |
| 1973 | PalamSiraspurJaunti | 5%20%75% | 122.2073.66080.280 | 6.1114.7360.2181.05 |  81.05 |
| 1972 | PalamSiraspurJaunti | 5%20%75% | 358.30172.720112.268 | 17.0134.5484.20136.65 |  136.65 |
| 1971 | PalamSiraspurJaunti | 5%20%75% | 197.80172.720106.950 | 9.8934.5484.21136.65 | 124.64 |
| 1970 | PalamSiraspurJaunti | 5%20%75% |  83.40103.870124.400 | 4.1720.5793.34118.08 | 118.08 |
|  |  |  |  |  |  |
| Year | Station | Weight age | 3 days maximum rainfall in (b) mm. | Weight age value ( axb) | Total rainfall  |
| 1969 | PalamSiraspurJaunti | 5%20%75% | 125.70111.76076.200 | 6.2822.3551.1587.78 |  85.78 |
| 1968 | PalamSiraspurJaunti | 5%20%75% | 124.30177.800146.050 | 6.2135.56109.53151.30 | 151.30 |
| 1967 | PalamSiraspurJaunti | 5%20%75% | 246.20170.180176.260 | 12.3134.03131.44177.78 | 177.78 |
| 1966 | PalamSiraspurJaunti | 5%20%75% | 153.600139.700148.240 | 7.6817.84106.68 | 142.30 |

Annexure I (b)

 Kanjhawala Block

(Three days max. rainfall in m.m.)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | Station | Weightage | 3 days maximum rainfall in (b) mm. | Weightage value ( axb) | Weightage 3 days max. R.F. in the basin. |
| 1965 | PalamSiraspurJaunti | 5%20%75% | 122.20156.480101.600**Total** | 6.11031.22076.220113.600 | 113.600 |
| 1964 | PalamSiraspurJaunti | 5%20%75% | 202.700148.590143.510**Total** | 10.1329.71107.68147.47 |  147.47 |
| 1963 | PalamSiraspurJaunti | 5%20%75% | 117.10095.250115.570**Total** | 7.3519.0586.67113.07 | 113.07 |
| 1962 | PalamSiraspurJaunti | 5%20%75% | 172.300147.32096.520**Total** | 8.6129.4672.39110.46 | 110.46 |
| 1961 | PalamSiraspurJaunti | 5%20%75% | 194.700100.830134.620**Total** | 9.7320.06100.96130.75 | 130.75 |
| 1960 | PalamSiraspurJaunti | 5%20%75% | 171.000188.160151.770**Total** | 8.5591.53143.82243.90 | 243.90 |
| 1959 | PalamSiraspurJaunti | 5%20%75% | 67.000197.80085.090**Total** | 3.353.3563.8178.71 | 70.71 |
| 1958 | PalamSiraspurJaunti | 5%20%75% | 390.00121.665330.470**Total** | 14.5024.33247.85286.68 | 286.68 |

**RAINFALL FREQUENCY ANALYSIS**

**ANNEXURE I**

Kanjhawala Block.

 (3-days design storm water from the 17 years rainfall data)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Peak+RfIn mm.Y | M | T=N M | X=LogT 10 | XY | X3 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1958 | 286.68 | 1 | 17.00 | 1.2304 | 352.60 | 1.5130 |
| 1960 | 243.90 | 2 | 8.50 | 0.9294 | 226.60 | 0.8638 |
| 1967 | 177.78 | 3 | 5.56 | 0.7528 | 120.30 | 0.5667 |
| 1968 | 161.30 | 4 | 4.25 | 0.6284 | 95.10 | 0.3951 |
| 1964 | 147.47 | 5 | 3.40 | 0.5315 | 73.03 | 0.2825 |
| 1966 | 142.30 | 6 | 2.83 | 0.4518 | 64.30 | 0.2042 |
| 1972 | 136.65 | 7 | 2.42 | 0.3838 | 48.59 | 0.1473 |
| 1961 | 130.75 | 8 | 2.12 | 0.3263 | 42.64 | 0.1341 |
| 1971 | 124.64 | 9 | 1.88 | 0.2504 | 78.36 | 0.0626 |
| 1970 | 118.08 | 10 | 1.64 | 0.1875 | 24.88 | 0.0530 |
| 1965 | 113.600 | 11 | 1.54 | 0.1875 | 20.17 | 0.0315 |
| 1963 | 113.070 | 12 | 1.41 | 0.1492 | 15.73 | 0.0193 |
| 1962 | 110.460 | 13 | 1.307 | 0.1162 | 11.72 | 0.0112 |
| 1974 | 101.030 | 14 | 1.21 | 0.0828 | 8.377 | 0.0068 |
| 1969 | 86.780 | 15 | 1.13 | 0.053 | 4.546 | 0.0028 |
| 1973 | 81.050 | 16 | 1.06 | 0.253 | 2.050 | 0.0006 |
| 1959 | 70.710 | 17 | 1.00 | 0.000 | 0.000 | 0.0000 |
| Total= | 2315.160 |  | 58.417 | 6.3293 | 1194.993 | 4.2945 |

\_

Y = E Y = 2315.150 = X= Ex 6.3293 0.3723

 N 17 N 17

= 126.18

 (x) 2 = 0.1386,B = EXY,NXY-2 = 1194.983-17x126.18x0.3723

 Ex2-Bx 4.2945-17x0.1386 = 187.80

A= Y-BX

= 135.18-187.80x03723

= 136.15-6610 =68.99

 Y= A+B Log 10(T)-)(1) Return

( Line of best fit 69.99 Period T in yar 5

 Y= 69.99+187.80 Log 10(5)

Max. 3 days RF for 5 years = 69.29+`187.80x0.699 = 194.29 mm

 7.64 mm

**Annexure II(a)**

Rainfall frequency analysis of Palam rain gauge station 3 days rainfall intensity.,

Number of years of records N= 24 (1951-1975)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Annual Peak in M.M.(Y) | M | T=N M | X=Log 10 T | XY | X2 |
| 1972 | 382.60 | 1 | 24 | 1.3802 | 528 | 1.9100 |
| 1967 | 246.20- | 2 | 12 | 1.0792 | 266 | 1.1600 |
| 1955 | 225.55 | 3 | 8 | 0.0031 | 204 | 0.8200 |
| 1964 | 202.70 | 4 | 6 | 0.7782 | 158 | 0.6100 |
| 1971 | 197.80 | 5 | 4.8 | 0.6812 | 135 | 0.4600 |
| 1961 | 194.70 | 6 | 4 | 0.6021 | 117 | 0.3600 |
| 1958 | 192.00 | 7 | 3.43 | 0.5353 | 102 | 0.2870 |
| 1966 | 188.70 | 8 | 3 | 0.4771 | 90 | 0.2270 |
| 1956 | 185.93 | 9 | 2.67 | 0.4265 | 79 | 0.1820 |
| 1962 | 172.30 | 10 | 2.40 | 0.0.3802 | 67 | 0.1450 |
| 1954 | 166.62 | 11 | 2.18 | 0.3385 | 56 | 0.1150 |
| 1963 | 147.10 | 12 | 2 | 0.3010 | 44 | 0.0910 |
| 1957 | 140.90 | 13 | 1.85 | 0.2672 | 38 | 0.712 |
| 1969 | 125.70 | 14 | 1.71 | 0.2330 | 29 | 0.0544 |
| 1968 | 124.30 | 15 | 1.6 | 0.2041 | 25 | 0.0416 |
| 1973 | 122.20 | 16 | 1.5 | 0.1761 | 22 | 0.0310 |
| 1965 | 119.20 | 17 | 1.41 | 0.1492 | 18 | 0.223 |
| 1953 | 117.35 | 18 | 1.33 | 0.1239 | 15 | 0.0177 |
| 1960 | 117.10 | 19 | 1.26 | 0.1004 | 12 | 0.0104 |
| 1952 | 103.63 | 20 | 1.20 | 0.0792 | 8 | 0.0063 |
| 1974 | 87.70 | 21 | 1.14 | 0.0569 | 5 | 0.0032 |
| 1970 | 86.20 | 22 | 1.09 | 0.0374 | 3 | 0.0014 |
| 1959 | 67.00 | 23 | 1.04 | 0.0170 | 1 | 0.0003 |
| 1951 | 63.50 | 24 | 1.0 | 0 | 0 | 0 |
|  | 3774.98 |  |  | 2.2270 | 2022 | 6.6265 |

Annexure-II(b)

\_

Y = E Y = 3774.98 = 157

 N 24

-

X = E X = 9.2270 = 0.384 = 0.384

 N 24 24

-

(X) 2 = 0.1475

 B = EX = NXY

 X2 – N(X) 2

 = 2022-24 x 157x0.384

 6.6265-24x0.1475

 = 2022-1450

 6.6265 -3.54 = 572

 3.0865

 = 185

A= Y-BX = 157.185x0.384

 = 157-71 = 86

 5

Y 5 Years = A+B Log 10 OT = 85+185 Log 10

 = 86+185+0.69909

 = 86+130

 = 216 mm

 = 8.5 inches.

 Max. Hourly rainfall of Palam rain gauge station

 For the years from 1966 to 1974 N = 94 years.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Hourly R.F. max. in a year in MM | “M”  | T= N M | X=Log T | XY | X2 |
| 1967 | 63.00 | 1 | 9.00 | 0.9542 | 60.1146 | 0.9105 |
| 1973 | 58.00 | 2 | 4.50 | 0.6532 | 37.8856 | 0.4267 |
| 1972 | 55.00 | 3 | 3.00 | 0.4771 | 26.2405 | 0.2276 |
| 1971 | 50.00 | 4 | 2.25 | 0.3522 | 17.6100 | 0.1240 |
| 1970 | 40.00 | 5 | 1.80 | 0.2553 | 10.2120 | 0.0652 |
| 1966 | 39.00 | 6 | 1.50 | 0.1761 | 6.8679 | 0.0310 |
| 1974 | 38.80 | 7 | 1.28 | 0.1072 | 4.1593 | 0.0115 |
| 1968 | 36.20 | 8 | 112 | 0.0492 | 1.7810 | 0.0024 |
| 1969 | 25.30 | 9 | 1.00 | 0.0000 | 0.0000 | 0.0000 |
|  | 405.30 |  |  | 3.0245 | 164.8709 | 1.7989 |

**Annexure-III (b)**

Calculation:

Y = EY = 405.30 = 45.03

 N 9

X = EX 30245 = 0.3361

 N 9

(X)2 = 0.1130

B = EX2 NXY = 1644,8709-9x0.3361x45.03

 EX-N(X) 2 1.7989-9x(0.1130)

 164.8709-136.2114 = 28.6895

 1.7989-1.0170 0.7839

A = Y-BX = 45.03-36.65x0.3361

 = 45.03-12.32

 = 32.71

Line of best fit Y = A+B Log T

 = 32.71+36.65 Log T

|  |  |  |
| --- | --- | --- |
| Retain period T in years | Log T | Estimated Rainfall |
| 2 Years | 0.3010 | 43.74 m.m= 1.72” |
| 5 Years | 0.6990 | 58.33 m.m = 2.24” |
| 10 Years | 1.0000 | 69.36 m.m. = 2.73” |
| 25 Years | 1.3979 | 83.84 m.m = 3.30” |

**3. JURISDICTION OF M.C.D & DELHI ADMINISTRATION AS REGARDS DRAINAGE ARRANGEMENTS.**

As already mentioned, Kanjhawala basin is mainly agricultural. The whole area is rural except an area of about 6.7 Sq. miles along the South eastern boundary of the basin which is likely to be urbanized as per Master Plan prepared by DDA.

As per National Capital Region report, the rural centers have been classified into following three categories viz. a) Growth centers b) central place villages c) Basic villages ( described in detail in para 1.2 above). The following villages of the block namely Kanjhawala, Nangloi, Jat and Tikri Kalan are at present semi-urban and will be developing as the growth centers and central basic villages respectively in future as per above report.

The internal drainage of all these villages are being maintained by MCD. Even the smaller villages within the Laldora are also maintained by M.C.D. It is found that in a number of such villages the internal drainage systems are not properly maintained. The following remedial measures are therefore suggested.

1. **Central Place & Basic villages:-**
	1. Absence of any planned drainage system in the basic villages at present creates a very serious unhygienic condition resulting in various diseases amongst the villagers. All drains must be covered in the villages properly with suitable gradients for quick drainage. The drains must outfall into sumps at the periphery of the villages wherefrom these effluent water can be distributed to the fields for irrigation purpose. If necessary, the sewage content may be diluted by mixing it with tube well water.

A complete plan of the villages showing its drainage system is to be prepared by the local body and submitted to Delhi Administration, Flood Control Wing for necessary improvements to the same.

* 1. Wherever the villages are normally flooded by river water or by surrounding storm water, the plinths of all new construction should be raised above the maximum expected flood level. The existing structures liable to flooding shall also be gradually raised. No authorized construction at depressed areas should be permitted. Necessary acts in this respect must be enforced.
	2. Villages which are liable to flooding normally must be provided with permanent pumping sets for draining out the water to the nearest available arterial drain. Development charges will be levied from the villages for installing such pumps.
1. **Growth centers.**

The growth centers are at present having some sort of drainage arrangement which is very inadequate. No plan exists showing the details of the drainage. This must be properly surveyed and completed drainage plan with L-Sections of the drains should be submitted to the Delhi Administration, Flood Control Wing for approval. Here also the drains must be terminated at sump wells through which irrigation in the fields will be done. The drains must be well planned keeping in view the future increase in population, increase in the paved areas and increase in the industrial waste. All drains must be covered. The construction of buildings in low lying areas should be dismantled either by the Administration /local bodies or by the owners themselves. If at all, buildings are to be constructed at low areas, the plinth must be above the expected flood level. All roads should also be above such flood levels. Any construction of road must have a provision of covered drainage system by its side. Persons misusing the drains or responsible for their checking shall be punished under law. Local bodies must employ sanitary Personnel to clean out the drains and regularly spread DDT etc. in them Cattle must not be allowed to squat on the road and cause nuisance and block the drainage system. Prizes may be awarded to the villages keeping their sanitary conditions above average.

The drains in the rural area are being looked after by the FCD, Delhi Administration, Delhi. It has been observed during inspection that annual maintenance of a number of drains has been neglected altogether. In some cases no regular banks are there where as at certain places cart tracks are crossing the drains, thus obstructing the natural flow.

There is a lot of weed growth in certain reaches of the drains and more over sections of the drains are not uniform. Farmers are using the bed of the drain for cultivation purposes at a number of places. Such practices are to be checked completely and constant vigil by the field staff of the FCD is required to stop any unauthorized blocking of the drain any time during the year. The blockings are sometimes due to crossing of irrigation channels, which is to be totally discouraged. Crossing if any, shall be with pipes allowing proper water way for the drain to pass unobstructed. The field staff of FCD of Delhi Administration has to submit a report of all the obstructions created along the drainage channels every fortnight and these are to be cleared before the next three days positively. Before the start of monsoon, silt clearance of the drains must be taken up every year and sections to be restored to designed sizes. Cultivators blocking the drains or cultivating in the beds of the drains, shall be legally punished. Sectional Officer allowing such practices are to be dismissed. Villagers causing blockage to drains shall be punished under law. Relevant acts shall be made known to the villagers for strict compliance. It is also observed that the irrigation channels in the Kanjhawla block oncoming from Haryana State often overflow near their tailends in the monsoon season, there being no surplus sing arrangement. This inundates the neighboring low lying areas.

Problem is sometimes created by small breaches in the bank by seepage etc. Constant watch, therefore, should be kept by FCD and such breaches may be immediately brought to the notice of the Haryana Government for immediate remedial measures. The Haryana Government must take up construction of surplusing arrangements and connecting them to the regular drains.

**4.0 Design criteria**

**4.1 Design discharge**

**4.1.1 Rural drains.** The rural drains in the Kanjhawala basin have been designed to restrict the flooding to a maximum period of 3 days with a return period of 5 years. Studies have been conducted for the 3 days max. rainfall for 5 years return period vide para 2.0 for the Palam, Siraspur and Jaunti Stations for which long term data is available and the 3 days max. Rainfall intensity works out to 7.64” and the same has been adopted for design as discussed in para 2.

Studies have also been conducted for the rainfall/runoff co-efficient for Nangloi drain flowing within the block and having considerable catchment by taking the actual runoff and rainfall for a number of days for normal storms and a runoff factor of 15% has been arrived at as per recommendations of outline of Master Plan. Rainfall for Kanjhawala and Badli rain gauge stations has been taken into account for the reason of their being very close to the catchment of Nangloi drain. After applying the runoff factor of 15% the discharge from the rural

Drains works out to 10 cusecs/sq. miles as under:-

Runoff from 7.64” of rainfall

 = 7.64 x 640 x 15 = 190.18 cusecs.

 12 2x3 100

 Say 10 cusecs . sq. miles.

**4.1:2 Urban drains:** As a few drains in Kanjhawala basin are all having a large catchment and thus their time of concentration is much more than the one hour, these have been designed on the basis of Calfornia formula viz. Q= C.I. ( TC /H)

Where C is coefficient depending upon the runoff

I – Rainfall intensity and T c time of concentration =

( 11.9 x L ) 0 . 385

 H

A rainfall intensity of 2.29” has been adopted.

This is the max. rainfall intensity for 5 years frequency and is based on the Palam rain gauge data. A distribution factor of 80% has been adopted as discussed in para 2.0 above.

Studies have been conducted for the actual runoff co-efficient by taking the actual runoff and rainfall data for Ramesh Nagar Nalla and Daryai Nalla which are fully in Urban areas for a number of dates for normal storms and a runoff factor of 0.40 has been arrived at and thus the same has been adopted for arriving at the design discharge.

**4.2 Design section:-** The section of the drain has been designed with Manning’s formula for open channels for uniform flow viz.

 Q = A x 1.486 x R2/3 x S1/2

 N

 Where N is rugosity co-efficient depending upon the type of surface

= A= surface Area and S= Bed slope.

**4.2:1 Value of N =** The flowing values of N have been adopted.

1. Unlined sections

In natural earth = 0.025

1. Lined sections

( Brick lining & = 0.017

Rubble masonry) to 0.018

**4.2.2 Bed slope:-** The Bed slopes in the drains have generally been kept with the following consideration:

a) To limit the velocities in the drain in the drain within non silting and non securing values.

b) To avoid falls in the drain as far as possible.

c) To maintain the existing sections of bridges and Culverts.

Generally the Bed slopes vary between in I in 1000 to I in 7000. But in exceptional cases they have been kept flatter or steeper, where the levels of the main drain do not permit it otherwise.

**4.2.3 Velocities:-** Velocity in the drain has been kept within the non-silting and non-scouring limits as follows;-

Unlined sections 0.45 to 1.50 meters/Sec.

Lined sections

( Brick lining &

Rubble Masonry) 1.50 to 3.0 metres/Sec.

However, in exceptional cases velocities upto 0.3 meters per second has also been allowed in the drains where discharge are very low of the order of 5 cusecs to 10 cusecs with the following considerations:-

1. To limit the bed slope as per topography of the area.
2. To retain the existing section of the drain.
3. To adopt the minimum section of the drain.
4. To adjust the level at the outfall points.

  **4.2.4. Side slopes.**

 Unlined.

1. Cuttings : 1:1
2. Filling 1/1/2 1 to 2:1

 Lined with brick: ½:1

**4.2.5. Free board:** A minimum free board of 1 ft. has been provided where the section of the drains is very small. In other cases free board has been provided as below:-

Discharge upto 150 cumecs. : 0.5 metre

Discharge 150 and above : 1 metre.

 In exceptional cases, free board slightly varying from above has been allowed to retain the existing sect of the drain.

**4.2.6 Provision of roadway:** A minimum roadway of 15 ft. has been provided on both sides of the drain in case of major drains only.

**4.3 Bridges.**

**4.3.1 Waterway:-**Waterway for the bridges and culverts has been provided for the full design discharge with negligible head loss at the structure. Slight variations from the above has been allowed to retain the existing section of the bridges and culverts wherever necessary.

**4.3.2 Afflux**: - Afflux in the bridges/culverts has been allowed as below:-

1. New Bridges/culverts closely located

 : 3” to 6”

1. New bridges/culverts far off located

 : 6” to 9”

1. Existing bridges cum culverts.

 : 9” to 12”

* + 1. **Vertical clearance:-** Minimum vertical clearance in the bridges/culverts has been provided as below:-

 Discharge upto 0.3 m3 per second 150 mm

 Discharge above 0.3 metre m3 per second

 0.3 m3 per sec; 450 mm

 Discharge above 3 m3 per second; 600 mm

 Discharge above 30 m3 per second: 900 mm

 **5. PROBLEM OF DRAINAGE CONGESTION AT PRESENT.**

 The water logging and drainage problems in this basin can be generally categorized as follows:-

 **5.1: DRAINAGE CONGESTION DURING RAINY SEASON.**

On account of depressions at several places in the block the storm water from the surrounding areas collect during the monsoon in these depressions, which do not have proper outlets into some regular drain. The major problems in this category are as follows:-

* + 1. **LADPUR, GARHI RANDHAWA JAUNTI VILLAGES.**

There is a depression surrounded by the fields of three villages namely,. Ladpur, Garhi Randhawa & Jaunti near the tailend of the Jaunti minor. The above depression gets filled up during the monsoon virtually every year and inundates the surrounding agricultural area. The water stands in the fields to a depth of 3-4’ in an area of 100 acres. The problem is still worsened by the overflowing of the Jaunti minor near its tailend due to plugging of outlets in the upper reaches by the farmers. A temporary drain was dug up in the past, out falling into Mungeshpur drain ( alignment marked on the plan) to drain off the area but the same was filled up by the affected farmers. The above drain off taking from the area and out falling into Mungeshpur drain should be dug up again along the same alignment to relieve the problem as a permanent measure. The alignment of the drain is marked on the plan enclosed as Drawing K-II. The L-section & the cross section of the drain along with other relevant details are enclosed as Drawing K-II. The L-section & the cross section of the drain along with other relevant details is enclosed as Drawing K VII.

**5.1.2 POOTH KALAN:-** A low lying area on the left side of Qutabngarh-Delhi Road near the Pooth Kalan village gets filled up submerging the neighbouring area during heavy rains. Although there is already a drain taking off from the above pond and out falling into Karari Suleman Nagar drain, it is not functioning due to neglected maintenance. There is neither a regular section nor proper banks for the drain. The silt clearance of the drain should therefore be taken up immediately and the drain should therefore be taken up immediately and the drain be remodeled into properly designed section.

**5.1.3 Rithala Village:-** There are two problems of drainage congestion surrounding the Rithala village. Near the Rithala village, water collects during the floods on the right side of the Nangloi drain. The water stands to a depth of 2-3’ in an area of about 25 acres. Water also enters into the area through the breached banks of the Nangloi drain. No proper links are there to drain off the above discharge. It is, therefore, necessary to have a link drain. The banks of the Nangloi drain also need to be repaired near the above area. The alignment of the drain is marked on plan enclosed as Drawing K-II. The L-section and cross-section of the drain are also enclosed as Drawing K-VIII. (ii) the upstream reach of the Rithala link drain has been blocked by the newly constructed road from Rithala to Badli by the M.C.D. thus, blocking the regular flow of the storm water from upstream areas. This inundates the surrounding areas of the Rithala village. A regular drain is to be constructed in the above reach as a remedial measure. The L-section and cross-section of the drain are enclosed as Drawing.

 **5.1.4 Mundka Village:-** Drainage congestion also exists in the area to the north of railway line & west of Mundka minor near the Mundka village due to the area being low-lying. The water accumulates here to a depth of about 3’ in an area of about 1000 acres during monsoon and stands here upto Feb. and March thus causing damage to the crops. Karari Suleman Nagar drain of F.C.D. is about 6000 ft. away from this point. However, a crossing with the Mundka minor has to be provided. A proper link for this area to the Karari Suleman drain should therefore be provided as marked on the plan enclosed as Drawing K-II to drain out the area. The L-section and the cross section along with other relevant details are enclosed as Drawing K-X.

* 1. **Village ponds situated in the Abadis.**

A few villages are having ponds in their neighborhood where all the storm water collects during the monsoon. These ponds should be connected to the nearest regular drain at a reasonable safe level. These ponds will thus be able to recharge the ground water table and will also serve the villagers for the use of their cattle.

**5.2.1: Rithala village:-**This village is facing a similar problem. The existing links are silted up and are rendered in-effective. The silt clearance of chocked up culverts and the link drain offtaking from the pond and out falling into Rithala link drain should be immediately done for proper functioning. The L-section & the cross section of the above drain are enclosed as Drawing K-IX.

**5.2.2 Bakkarwala village:-** This village is also facing the problem of water logging. Low lying area near the villages gets flooded during monsoon and also due to the over flowing of the Mundka minor which is having its tailend near the village, There was about 2 feet of water on the road during 75 vain and crops were also damaged in an area of about 25 acres. A proper link drain therefore has to be constructed off taking from the Pond of the village and out falling into Najafgarh drain as shown on the plan. The L-section of the drain is enclosed as Drawing K-XII.

**5.2.3 Kamruddin Nagar:-** The low lying area to the west of Kamruddin Nagar village gets filled up during the monsoon submerging fields and a part of the village every year. The above area therefore needs to be connected to nearest regular drain. A link drain should therefore be constructed off taking from the area and out falling into the Karari Suleman Naar drain. The alignment of the said link is marked in the enclosed plan as Drawing K-II. The L-section & cross-section is also enclosed as Drawing K-XIII.

  **5.2.4 Budhanpur village:-** There is a big pond in the east of village Budhanpur and Sulehpur. Duing the 1975 monsoon, lot of water got collected causing great hardship to the village abadi. Water also stand in the nearby fields in an area of 100 acres to a depth of 1 foot. The village was also cut off from the main road. Water stands here upto the end of March. Bazidpur drain is flowing on the other side of the village at a distance of about 1500 ft. from the pond. A link drains therefore suggested to be constructed off taking from the pond and out falling into the Bazidpur drain passing through the village Salahpur Nagar to solve the problem permanently. The alignment of the drain is marked on the plan enclosed as Drawing K-II. The L-section and cross-section of the drain is also enclosed as Drawing K-XIV.

**5.3 Inadequate Surplusing arrangement of Irrigation channels.**

The following irrigation minors off taking from WJC in Haryana state are flowing through Kanjhawala basin:-

* 1. Delhi tail distributory.
	2. Jaunti Minor
	3. Bawana Distributory
	4. Auchandi Minor
	5. Budhanpur Minor
	6. Sultanpur minor
	7. Mundka minor
	8. Mangolpur minor

Most of the above minors are having their tail ends in this basin. None of the above minors is having surplusing arrangements near their tailend. During the rainy season, when the water is not needed for irrigation purposes, farmers plug the outlets of minor near the tailends. With the result, the minors start overflowing low lying areas. Sometimes seepage water from the above minors also creates problems. The major problems of drainage congestion due to overflow or seepage of the irrigation water exists near the tailend of the Jaunti minor. A depression surrounded by the three villages namely Jaunti, Ladpur and Garhi Randhawa near the tailend of the minor gets flooded inundating the neighboring agriculturable areas. Water stands in the field to a depth of 3-4’ in area of about 100 acres till March thus damaging the crops.

 A similar problem but of lesser magnitude also exists near the tailend of the Mundka minor. The surplus water collects into the low lying ares near the Bakarwala village, thus flooding the village partly. The villages of Karari and Nithari which are situated near the banks of the above minor are also affected due to the overflowing of the minor. The following remedial measures are therefore suggested to overcome the problem permanently.

1. Jaunti Minor:- Jaunti minor is having its tailend near the depression surrounded by the three villages namely Jaunti. Ladpur and Garhi Randhawa. Surplusing arrangements should be constructed near the tailend as marked on the plan enclosed as Drawing K-II. A link drain as suggested vide para 5.1.1 connecting the above depression & surplusing arrangements to Mungeshpur drain should immediately be provided.
2. Mundka Minor:- Surplusing arrangements near the tailend connected to the link drain as suggested vide para No.5.,2.2 should immediately be constructed.
3. Auchandi minor:- The above minor is having its tailend near the village Kannels. Necessary surplusing arrangements should be constructed near the tailend and it should be connected to Mungeshpur drain which is flowing nearby at an approx. distance of 600 feet by means of a link drain as per the alignment marked in the plan enclosed as Drawing K-II. The L-sections and cross sections of the drain is also enclosed as Drawing K-XV.
4. Budhanpur Minor:- Surplusing arrangement on the minor near the village Budhanpur slightly U/S of the tailend connected to the link drain suggested vide para 5.2.4 should immediately be constructed.
5. Sultanpur Minor:- It is being proposed in the draft Master Plan for irrigation that the above minor should be extended upto Najafgarh drain along the alignment marked in the plan enclosed as Drawing-II. It is therefore suggested that its tailend should also be provided with surplusing arrangement connected to Najafgarh drain so that the surplus water could easily flow to N.D. without causing submergence to the neighboring low lying areas.

**5.4: Drains carrying storm water from outside Delhi.**

 Some of the branch drains Mungeshpur drain in Kanjhawala Block viz. West Jua drain, Thana Khurd drain & Mandrola drain have their origin in Haryana State and they carry considerable discharge into Delhi. With the construction of diversion drain No.8 part of the catchment of the West Jua drain and Thana Khurd drains have been diverted into it but still the present sections of the above drains are not sufficient to carry the entire discharge. Moreover, the annual maintenance of the above drains is also neglected. With the result, during heavy rains, low lying areas of the basin adjacent to Haryana State get flooded by over flowing of said drains or by way of seepage through breached banks. Haryana Govt. should therefore be asked for remodeling the sections of drains carrying discharge into Delhi and to provide proper banks to the above drains in the areas near

The border and also to provide adequate out falling arrangements

5.5 In order to relieve the drainage problems enumerated in the foregoing paragraphs, the proposed alignments of all the existing rains, including additional sub-drains wherever required, are marked in the plan enclosed as Drawing K-II.

Designed sections of the different drains are also enclosed along with l-sections.

**6.0 Improvement proposals made by previous consultants.**

 Four different committees had previously examined the drainage problems of the Union Territory of Delhi, they are:-

 a) Reddy Committee 1950

 b) Moti Ram committee 1964

 c) J.P. Jain Committee 1968

 d) J.P. Tripathy Members ( Floods committee) 1973

 Shri J.P. Jain and Shri Moti Ram had discussed in detail the drainage problems of Kanjhawala basin and the summary of their recommendations is given below:-

**6.1 Moti Ram Committee**:-

6.1.1 The bed level of diversion drain no.8 below R.D. 60,000 should be lowered so that its full supply level may suit the ordinary flood levels in the Yamuna and its banks widened, strengthened and properly finished. Strict watch may not be deliberate cutting of banks or failure due to other causes.

6.1.2 Inlets may be provided in the left banks of diversion drain No.8 to avoid flooding of low areas whole drainage has been obstructed by its.

6.1.3 The remodeling of Mungeshpur and Nangloi drains designed to incurable their capacity may be completed as soon as possible.

**6.2 J.P. Jain Committee**.

6.2.1 It is essential that the work of preparing a Master Plan for drainage of Delhi is taken up without any further delay and completed as early as possible so that no difficulty maybe experienced later on either in constructing the new drains o remodel ling the existing ones within the urbanized limits.

6.2.2 In order to deal effectively with the waters coming down from the rural and urban areas of Delhi State itself, supplementary drain of a capacity varying from 4000 cusecs at head to 4500 cusecs at the tailend which will take off from Najafgarh drain on its left bank near RD 88,000 opposite the outfall of the proposed Pankha Road and run in a north eastern direction for about 7 miles and then take a turn towards the east until it meets the Shah Alam Bund which will form its right bank and fall into Najafgarh drain below its tail regulator should be constructed now or later as may be feasible. However, necessary steps of acquire the land required for constructing the drain which will be 15 to 16 miles long and will have a bed slope of 1 in 8000 should be taken up as early as possible as the acquisition procedure takes a long time.

6.2.3 Automatic rain gauges should be installed at 15 places

given in the text before the rainy season so that we may have a reliable date of hourly rainfall after a few years.

6.2.4 Mungeshpur drain which is reported to have a catchment area of 192 sq. miles should be remodeled on the basis of 5 cusecs per sq. mile. Proper drainage crossings for its branch drains viz. Madanpur on roads where they do not exist should be constructed before the next rainy season as also link drains connecting Mohamadpur Majri Rasulpur, Renikhera etc. with Madanpur drain.

6.2.5 Capacities of culverts of Karari Suleman Nagar drain in Delhi-Rohtak Railway line and road which have inadequate water way should be increased.

6.2.6 Nangloi drain should be regarded to a slope of 1 in 4000 and a link drain connecting village Nangloi Jat with it should be constructed.

6.2.7 Until a Master Plan for drainage of Delhi State is prepared, clearance of all drainage scheme out falling into Barapulla Nalla should be given by the MCD and their out falling into Najafgarh drain or River Yamuna by FCD, Delhi Administration. However, after the Master Plan is ready and approved by the competent authority, the clearance of all drainage schemes, whether old or new, should be obtained from the FCD before they are taken up for execution.

**7.0 Existing drainage system & their proposed remodeling.**

 Most of the drains Kanjhawala basin do not have adequate capacity. These have been designed to carry a discharge of 5 cusecs/sq. miles of their catchment area, which is insufficient. During the year 1975 there was a drainage problem in this basin mainly due to inadequate4 capacity of the drain as well as due to unprecedented rainfall coupled with high water level in Mungeshpur drain due to high discharge from Haryana Territory. The village situated on the banks of Mungeshpur Bazidpur, Karari Suleman & Nangloi drains viz. Mungeshpur, Ladpur, Kanjhawala, Punjab Khor, Sauda, Jharodha Kalan Bhudhanpur, Mundka Puth Kalan were mainly affected. The drains in the Kanjhawala basin should therefore be immediately remodeled as per design discharge discussed vide para No.4.00 above.

There are three major drainage systems in the Kanjhawala basin.

1. Mungeshpur drain.
2. Karari Suleman Nagar Drain.
3. Nangloi drain.

 **7.1 Mungeshpur drain:-**

This drain starts from Mundrola village in Haryana State where it is called Mandrola drain and after running in South & South Eastern directions joins Najafgarh drain about half a mile below Kakrola regulator at about 67000. During the course it mainly passes through Kanjhawala Block and is intended to relieve flooding in low lying areas of the block and part of neighboring Haryana State. It is joined by the following branch and link drains during its course through Haryana & U.T. of Delhi.

1. Mandrola drain ( length) 6.48 miles.

2. Thana Khurd drain ( length) 7.6 miles.

3. Katewara link drain ( length) 0.96 miles.

4. Mungeshpur link drain( length) 0.54 miles

5. West Juan Drain ( length) ( Not available as it is in Haryana )

6. Madanpur drain ( length) 5.10 miles

 a) Sultanpur drain ( length) 5.60 miles

 b) Mohammadpur Majri link drain 1.00 miles

 c) Gheora link drain ( length) 0.33 miles

 d) Rasulpur link drain ( length) 0.47 miles.

 e) Rani Khera link drain 0.57 miles.

 f) Mundka link drain 1.02 miles.

7. Bazidpur drain ( length) 4.99 miles

 a) Jatkhore link drain \* length) 2.44 miles

8. Bawana drain ( length) 7.18 miles.

 a) Bawana Jheel link drain ( length) 1.23 miles.

 b) Nangal Thakaran drain ( length) 1.61 miles.

 c) Chandpur link drain ( length) 1.57 miles.

Out of the above drains, Thana Khurd drain and Mandrola drains have their catchment areas partly in Haryana and partly in Delhi, whereas that of West Jua drains entirely in Haryana State. With the construction of Division Drain No.8 in the Haryana State, part of the U/S catchments of West Jua drain, Thana Khurd drain and Mandrola drain have been diverted into this drain, which are directly flowing into the Yamuna through Haryana area.

The present proportionate details of Thana Khurd, Mandrola & West Jua drains in Haryana & Delhi are as given:-

**S.No**. **Name of drain Detail Haryana Delhi Total**

1. Mandrola Drain C.A. 11.11 0.74 11.85

 Length 5.4 1.44 Sq.miles

 6.88 mile

2. Thana Khurd drain C.A. 26.80 0.49 27.20sq.miles

 Length 7.0 0.63 7.63 miles.

3. West Jua drain C.A. 1800 - 180 Sq.miles

 **Length not available as it is in Haryana.**

 The total catchment area served by the Mungeshpur drain at present as per contour plan at its outfall point except west Jua drain is 111.20 sq. miles. The catchment area of West Jua drain as intimated by the Haryana Irrigation Department vide their approved L-section received with letter No.6283 dated 30.7.1975 is 180.00 sq. miles. No plan has been furnished showing the catchment basin. The discharge for the above catchment contributed by the drain has been assumed as 335 cusecs by them. The records of Flood Control Div..1 reveals that total catchment of West Jua is 71 Sq. miles. Assuming whole catchment is rural the expected discharge from the above drain will be 710 cusecs. % the rate of 10 cusecs/sq. miles as per design cretaria vide para 4.0 for rural drains. The discharge of 710 cusecs is much higher than 335 cusecs assumed by Haryana Government. Therefore, catchment area of 71 sq. miles for West Jua drain has been retained to be on the safer side. The total catchment area of Mungeshpur drain at outfall point will thus be 111.2071 sq. miles = 182.20 Sq. miles As the entire catchment area of drain lies in rural areas, the drain has been designed for 1820 cusecs at the outfall point at the rate of 10 cusecs/sq. miles. The branch and the link drains of the Mungeshpur drains have also been designed on the same basis. The remodeled L-section and cross section of Mungeshpur drain along with its branch and link drain are enclosed as drawings K-XVI to K-XXX to K-XXXX.

 It is a general complaint from the farmers in the Kanjhawala basin that water table goes down in winter season and thus irrigation by means of tube wells becomes difficult. It is therefore suggested that gates of the outfall structure of Mungeshpur drain should be closed in winter season to allow the water to stagnate in the drain as well in the fields for automatic recharging of the water table. The above water can also be used for water supply purposes after treatment if necessary. Possibility of construction of gated structure in the intermediate parts of the above drained also providing gates to the inles of the drain which could be closed when necessary should also be explored.

 It is however pointed out that portions of Mungeshpur, West Jua, Thana Khurd and Mandrola drain in Haryana State are not having adequate sections and not even maintained properly. At several places no proper banks are there. With the results, the above drains over flow during heavy rains in that State and submerge neighboring low lying area in the U.T. of Delhi. The major problem due to

overflow occurred in 1975 in the villages, Jhardoa Kalan, Mungeshpur, Ladpur, Kanjhawala, Punjabkher & Sauda which are situated near the banks of the above drain. Haryana Government should therefore remodel & embank the section of the drains in their territory and should maintain them properly.

* 1. **Karari Suleman Nagar Drain:**

Karari Suleman Nagar drain starts from pond near the village Putrh kalan and after running in West and South directions joins the Najafgarh drain at RD. 80500. Begumpur link drain falls into it near the Delhi Qutabgarh Road. During the course, it is joined by the following link drains:-

1. Mubarakpur link drain.
2. Nithari link drain.

This drain is having its entire catchment area in Kanjhawala block and thus mainly relieves the drainage congestion of the block. The whole area covered by this drain is rural and is 11.10 Sq. miles. The drain along with the link drains has therefore been designed @ 10 cusecs/sq. miles of the catchment. area as per design criteria discussed vide para 4.0.

The remodeled L-section of the drain along with is link drains are enclosed as drawings K-XXXI to K XXXIII.

**7.3 Nangloi Drain.**

This drains off takes from a pond near the village Puth Khurd in Alipur Block and almost runs in South Eastern and Southern directions. It is about 12 miles long and joins Najafgarh Drain on its left bank at RD 98000. It relieves the drainage congestion of both Kanjhawala and Alipur Block During its course it is joined by the following branch and link drains:-

1. Sahibabad Daulatpur Link drain.
2. Mangolpur Link drain.
3. Rithala Link drain.
	1. Naharpur link drain.
	2. Rithala Pond link drain.
4. Puthkalan link drain.

The total catchment area of the drain as calculated from the contour plan is 26.60 sq. miles. Out of the above 16.40 sq. miles is rural and rest 10.20 sq. mile is either urban or is likely to be urbanized by 1981 as per Master plan report of D.D.A Firstly the drain was designed @ the rate of 10 cusecs/sq. miles and 320 cusecs/sq. mile for rural and urban respectively based on the recommendations of the Experts Committee for urban areas and the discharge @ the outfall was coming to 3430 cusecs. The above discharge was considered to be on the higher side. The design was thus reviewed taking into account the same rate of 10 cusecs/sq. mile for the rural area and calculating the discharge for the urban area by the rational formula Q-C I A- where Ic = (2)

 to+1

 In the above formula Ic the intensity of rainfall has been considered as 2.29”, the maximum once in the five years frequency. The run off factor and the serial distribution factor has been considered as discussed vide para 4.02 above.

 On the basis of above the discharge at the outfall point has been worked out as 1900 cusecs

 which is considered to be reasonable and has been adopted for design. The discharge at various change points along the length of drain has also been calculated by the same method.

 Out of the link and branch drains, Rithala link drain and the Naharpur link drain are having their entire catchment in urban areas and have thus been designed by the above method. The discharge work out to be 1150 & 510 cusecs respectively. The rest of the drains lie entirely in rural areas and have been designed at the rate of 10 cusecs/sq. miles. The remodeled L-section and X-section of Nangloi drain along with its branch and link drains are enclosed as Drawing K-XXXXIV to K-XXXVIII.

**7.4 Proposed new link drains & remodeling of present system.**

 The system of drainage at present in Kanjhawala basin is neither adequate nor maintained properly. The following new link drains are needed for relieving the drainage congestion of the basin more effectively.

These are all marked in the Plan.

1. Ladpur pond link drain.
2. Bakarwala Pond link drain.
3. Kamrudin Nagar Pond link drain.
4. Mundka Pond link drain.
5. Rithala sub-link drain.
6. Bhudhanpur Pond link drain,.
7. Auchandi Minor link drain.
8. Rithala Pond link drain.

It is necessary that all the drains of the basin should be immediately remodeled as per L-sections enclosed. All the bridges and culverts whose floors are higher are to be lowered to the design bed level. Widening of culverts are also to be done wherever these are liable to cause more than the permissible afflux, in order to carry the new design discharge. Necessary approach roads to the bridge where not constructed should immediately be constructed.

* 1. **Outfall structure**:- The whole Kanjhawala basin as well as part of Haryana State and Alipur basin are being drained into Najfgarh drain through Mujngeshpur, Karari and Nangloi drains. At present there is no outfall structure at any of the above drains though the construction of outfall structure at Mungeshpur and Nangloi drains have been taken up. There are however chances of back water entering them from Najafgarh drain at the time of heavy floods. It is therefore recommended that construction of outfall structures at Mungeshpur drain and Nangloi drain should ibe expedited and construction of outfall at Karari of adequate capacity should immediately be taken up.

The outfall structures in future should be constructed on the following guide lines:-

1. Masonry structure with open foundation will generally be constructed.
2. Gates are to be provided only in case water is to be stored in the respective drains’ where this is not necessary gates are to be provided. Gates should be normally manually operated. Screw type gates are to be provided where the span is big.
3. Scour depth to be provided for 1.25 D only for pairs and abutments.
4. Fluming should not be more than 80%.
5. Flared type wing walls to be preferred against right angled ones.
6. Where the inspection path is to cross the regulation single lane class. A loading to be adopted for the bridge. 3.0’ footpath on either side will also be provided.
7. **Sub-soil water conditions of Kanjhawala block**

 The Flood Control Department, Delhi Administration is maintaining a number of soil-soil water observation points fixed by them all over the union Territory of Delhi at an approximate spacing of one km. The observations of these are taken normally four times a year. This work was started from 1972 end. Since then whatever data collected upto date has been analyzed and two plans are enclosed as Drawings K-IV & K-V indicating there in the contours of sub-soil table the highest and lowest saturation conditions. The post monsoon plan shows that water levels are generally high throughout the water levels are generally high throughout the basin varying from 1 ft. to 10 ft. below ground except at two places in the north where the water depth is 13 ft. below ground level. It is however felt that after the drains are remodeled as suggested vide para 4 above and new drains are constructed, the water table at water logged sports would come down and there will not be any water logging problem.

 Pre-monsoon plan shows that water table generally varies from 5 ft. to 15 ft. below the G.L. except at a few spots where depths more than 25 ft. below the G.L. on the southern side the water table is relatively lower, various below ground level from 10 ft. to 20 ft. and hence it is a general complaint that irrigation by means of wells/tubewells becomes difficult in that area. The following remedial measures are therefore suggested to improve the sub-soil water level in the pre-monsoon season on the southern side.

* 1. Irrigation by means of tubewells should be discouraged; on the other hand the present irrigation channels should be extended and a few more should be constructed as suggested in the plan enclosed to cover larger areas. CGWB also has mentioned in their report on “Report on the Ground Water Condition Around Najafgarh Jheel in parts of Delhi and Haryana State” that three factors namely (a) continuous low rainfall ( b) effective drainage of the Jheel area and (c) increase in withdrawal from ground water reservoir are mainly the causecs for the decline in water levels of the area. It has been found by them that factor ( b) and (c) constituted the causes of decline of water table but the chief cause for fall is rise in installation of tubewells/pumping sets. The extract of conclusions and the recommendation of the report is enclosed as Annexure in the report on Najafgarh sub-basin.

ii) In winter season, when the water table goes down, the gates of the outfall structures of the Mungeshpur drain should Closed to allow the water to stagnate in the drains as well as in the fields for automatic recharging of the water table. Possibility of construction of gated structures in the intermediate parts in the above drains as well as inlets to the bunds which can be closed when necessary should also be explored.

**10.00 Irrigation system in Kanjhawla basin and their problem.**

Kanjhawala basin is being irrigated by means of tubewells and irrigation minors from WJC system. There are about 8 irrigation channels evenly spread out in this basin, except in the southern portion. They are:-

1. Delhi Tail Distributory.
2. Jaunti Minor.
3. Bawana Distributory.
4. Auchandi Minor.
5. Budhanpur Minor.
6. Sultanpur Minor.
7. Mundka Minor.
8. Mangolpur Minor.

All the above minors are coming from the Haryana State. The main problems relating to above minors are:-

1. There are no regular surplusing channels in any of these minors. Whenever any excess water flows out of their tail portion, it simply spreads over the fields and ultimately reaches the nearest depressions. This often causes water logging in the surrounding areas.
2. Secondly the water in the minor is stopped without any notice and thus depriving utilization of water in the hours of need.

As these irrigation channels are under the control of the Haryana Government and they do not attend to them whenever necessary, it would be desirable if the irrigation system in these blocks are taken over by Delhi Administration.

It is also necessary that these minors are connected to nearest drains for disposal of surplus water as suggested vide para 5.3 above. Additional irrigation water from other sources may also be obtained to irrigate the fields of the block particularly in the Southern part. The capacity of the existing minors should also be increased to cover a large commanding area.

**11.00 Summary for the improvement of drainage system in the Kanjhawala basin.**

 **1. Mungeshpur drain.**

 The bed width of the drain should be increased to 32’,34’50’52’54’76’,85 from the existing bed width of 23’,28’,43’,43’72’ and 80 ft. in the reaches between the R.D.’s 112100 to 96800, 96800 to 79120,76850 to 62100 to 56,500, 56,400 to 43,600,43,600 to 21,900 and 21900 to o RD respectively.

1. The bed slope of the drain should be regarded to 1 in 5000, 1 in 4000, 1 in 6000, 1 in 7000, 1 in 9,000, 1 in 6,000., 1 in 7000, 1 in 9.000, 1 in 9000 from. The existing bed slope of 1 in 3600, 1 in 4,000, 1 in 4000, 1 in 4,000 1 in 7000 and 1 in 10,000 in the reaches between the RD’s 120900 to 112100, 112100 to 96800, 96800 to 79120, 79120 to 76850 to 56500,56,600 to 52,500 and 52500 to o respectively.

Small falls of 1.7’, 0.8’ , 2.41, 060 and 1.60’ should be constructed at R.D’s 11100, 96800, 79120, 76850 and 43600 respectively. There is an average deepening of about 2’ in the entire length of the drain.

The bridges/culverts at R.D’s 15125, 43500, 75700 ft. should be remodeled and one or two spans should be added or slight modifications should be done in the floor levels of the existing structures at R.D’s 8845,29600,47090,62100,63900,76815,87300,96800,98100,102375,109700,112100,114350,120700 as necessary to pass the design discharge.

1. **Madanpur drain:-** The bed width of the drain should be increased to 11’ and 14’ from existing of 7’ and 11’ in the reaches between the R.D’s 27000 to 20,000 and 13500 to o’ respectively. The bed slopes should also be regarded to 1 in 4500, 1 in 6500 and 1 in 6500 from 1 in 3500, 1 in 6000 and 1 in 6000 respectively. A small fall of 1.3’ should also be provided at R.D. 13500. There is thus average of deepening of about ½’ in the entire length of drain.
2. **Sultanpur drain:-** The bed of the drain should be depend by on ½ ‘ in the reached between the RD 18500 to 0 RD thus increasing the depth of fll by ½ at rd-18500.
3. **Mohammadpur Majri Drain:-** The existing section of the drain should be remodeled to a bed width of 3.5’ and to a bed slope of 1 in 3500 for its proper functioning.
4. **Gheora Link drain:-** The bed width of the drain should be increased to 5’ from existing of 3’
5. **Bazidpur drain:-** The bed width of the drain should be increased by 1 ft. from RD 10000 to 15000.
6. **Bawana drain:-** The bed width of the drain should be increased to 6’,8’,11’ & 12 from existing bed width of 5’,6’,7,11, & 12 from existing bed width of 5’,6’,8’ and 10’ in the reaches between the R.D’s 38000 to 30,000, 26000 to 20,000, 20,000 to 10,000 and 10,000 to 0 respectively. Small falls of 0.50’ and .5’ should also be constructed at R.D. 26,000 and 20,000 respectively. There is average deepening of 0.75’ in the reach between the R.D. 26,000 to 0 culverts at R.D’s 37,500, 5560, 36,550, 31,400, 25,875, 23,900,11350,97500,8350 & 1550 should be remodeled to pass the design discharge. Floor levels of culverts at R.D’s 32950,29475, should also be lowered to designed bed level of the drain.
7. **Mundka link drain;-** Though the existing section of drain is adequate. Yet it should be remodeled to 5’ BW and 1 in 3500 bed slope for its proper functioning.
8. **Chandpur link drain:-** The bed width of the drain should be increased to 5’ from 3’ and one pipe of same size should also be added to the culverts at R.D.4000 to 0 to cater for the proposed design discharge.
9. **Karari Suleman Nagar Drain.**

(a) The bed width of the drain should be increased to 10’,12’,12’ and 14’ from existing of 8,8,10 and 10 ft in the reaches between the RD’s 29700 to 24000,24000 to 15300,15300 to 13500 and 13500 to 0 respectively. Falls of 0.5’, 0.5’ and 1.0’ be provided at RD’s 20000 and 13500, 3500 respectively. The culverts at RD’s 29700,28300,21500,20,000,15,300,13485,10250,7135,5050,815 should be remodeled completely or one span should be added as feasible to cater for the proposed design discharge.

11. **Nithari drain:-** The bed width of the drain should be increased to 4’ from 3’ and bed slope should be regarded to 1 in 2000 from 1 in 2500.

12. **Nangloi Drain:-** The bed width of the drain should be increased to 10’,12’,20’,20’,36’ 36’ and 36’ from the existing bed width of 6’,8’,9’,11,11’,17’ and 20’ in the reaches between in the RD’s 62800 to 47000,47000 to 28000,38000 to 26000,26000 to 23500. 23500 to 20,000,20000 to 9800 and 9800 to 0 respectively. The bed slope should be regarded to 1 in 4000 and 1 in 2500 from 1 in 3500 in the reaches from 62800 t0 23500 and 23500 to 20000 respectively. Falls of 1’,4’,2’,1’ and 2’ should be constructed at RD’s 38000,23500,20000,9800 and 9000 respectively. There is average deepening of 4’ in drain from 38000 to 0 RD. All the bridges/culverts except at RD 50800,48800 should be remodeled to suit the proposed design discharge.

13. **Mangole Pur Drain:-** The bed width of the drain should be increased to 14’ from 4’

14. **Rithala Link drain:-** The bed width of the drain should be increased to 30’ and 35’ from 4’ in the reaches between the RDs 11300 to 3300 and 3300 to 0 respectively.

The bed slope should be regarded to 1 in 3000 from 1 in 2500 in the reached 3300 to 0. A fall of 2’ should be provided at RD 3300. There is average deepening of 4.5 in the entire length of the drain.

15**. Nahar Pur Link Drain:-** The bed width of the drain should be increased to 22’ from 4’ and bed slope regarded to 1 in 2800 from 1 in 2500. There is average deepening of the drain of about 5’.

16. **Sahibabad Daultapur Drain:-** The drain should be remodeled to a bed width of 4’ and bed slope of 1 in 2500.

17. The following link drain as discussed vide para 3.0 connected with surplussing arrangements where necessary should be constructed.

1. Ladpur Pond Link Drain.
2. Bakarwala Pond Link Drain.
3. Kamruddin Nagar Pond Link Drain.
4. Mundka Pond Link Drain.
5. Rithala sub-link drain.
6. Budhan Pur Pond Link Drain.
7. Auchandi Minor Link drain.
8. Rithala Pond Link Drain.
9. The surplussing arrangements on Jaunti Minor, Budhanpur Minor, Auchandi Minor, Mundka Minor, Sultanpur Minor near the tail and or 20 cusecs capacity connected to regular drains by means of link drains as discussed vide Para 3.3 should be constructed.