SUPPORTING REPORT (2)

ANNEX 3 : HYDROLOGY

THE STUDY ON STORM WATER DRAINAGE PLAN FOR THE COLOMBO METROPOLITAN REGION IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

VOLUME IV : SUPPORTING REPORT (2)

ANNEX 3 : HYDROLOGY

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CHAPTER 1 GENERAL

1.1 Purpose of the Hydrological Analysis

The hydrological analysis for the Feasibility Study was conducted in order to:

1) Understand hydrological and hydraulic phenomenon of the selected basin in detail with enough accuracy for the planning purpose of feasibility study level, and
2) Calculate design flood discharges for each proposed projects.

With the use of 1:2,000 topographic maps prepared by Survey Department of Sri Lanka, sourced from aerial photographs taken in the year of 2000, the hydrological and hydraulic models were constructed with good accuracy.

The flood inundation maps generated in this F/S stage also maintain higher reliability than those in the Master Plan Study stage.

1.2 Basin Division

Utilizing the 1:2,000 topographic map, the Weras Ganga basin (upstream drainage basin from Kospalana bridge) was extracted with enough accuracy as shown in Figure 1.2.1. The total drainage area of the Weras Ganga basin is 55.5 km^2.

The major river channels in the Weras Ganga basin are Bolgoda canal (20.8 km^2), Rattanapitiya Ela (8.2 km^2), Maha Ela (20.4 km^2) and Weras Ganga main stream (55.5 km^2).

For the present hydrological analysis, the Weras Ganga basin was further divided into 187 sub-catchments (refer to Figure 3.3.1 describe later).

1.3 Hydrological Observation in the Weras Ganga Basin

There are three rainfall gauging stations and eight water level gauging stations in or around the Weras Ganga basin. Rainfall gauging stations are maintained by Meteorological Department and water level gauging stations are maintained by SLLRDC, Irrigation Department or Lanka Hydraulic Institute (LHI).

The location of existing rainfall and water level gauging stations are shown in Figure 1.3.1. Data availability of those stations is illustrated in Figure 1.3.2.

Dehiwala and Ratmalana rainfall gauging stations were installed before 1970, while Bolaresgamuwa rainfall station was installed late 1990. However, observations at Dehiwala station suffer from many interruptions and very few records are available

from 1972 to 1985. Continuous observation is conducted at other two stations, Bolaresgamuwa and Ratmalana.

Short duration rainfall records such as 15- or 60-minute are available at Ratmalana station, while other two stations have only daily basis data.

Water levels are recorded by gauge keepers living beside the stations. They are recorded twice a day (morning and evening) in principle. As shown in Figure 1.3.2, all of stations were installed after mid-90s, and water level observation at 5 stations of 8 started in the middle of the year 2000.

Discharge measurements are conducted at two water level gauging stations, i.e. Attidiya-Bolgoda Canal (station No.1 of Figure 1.3.1) and Badowita (station no.2 of Figure 1.3.1), once a month by SLLRDC. Those records are assembled in their respective season, i.e. wet and dry, and the relationship between stage water levels and measured discharges (H-Q curve) are estimated.

However, due to the insufficiency of discharge measurement and water level observation record during flood evens, flood runoff discharges estimated from the H-Q curves do not have enough reliability.

CHAPTER 2 RAINFALL ANALYSIS

2.1 Rainfall Records Available

Three rainfall gauging stations are located in and around the Weras Ganga Basin, at Boralesgamuwa, Dehiwala and Ratmalana. Short-term rainfall records such as 15-, 30- or 60-minute intervals are available in Ratmalana station, while the other two stations have daily basis rainfall records only.

Collected rainfall records are listed below (refer to Figure 1.3.2):

1) Daily rainfall record
   - Boralesgamuwa : 1990 ~ 2001 (12 years)
   - Dehiwala : 1970 ~ 1973, 1986 ~ 2001 (20 years)
   - Ratmalana : 1970 ~ 2001 (32 years)
2) Short-term (hourly) rainfall record
   - Ratmalana : Record of selected 8 large-scaled storm rainfall event out of available 32-year record

Locations of those rainfall gauging stations are shown in Figure 2.1.1.

2.2 Characteristics of Storm Rainfall

Figure 2.2.1 shows the hourly hyetographs of major storm rainfalls observed at Ratmalana rainfall gauging station. It can be clearly seen that every large-scaled storm rainfall has multiple prominent peaks within the duration of a series of storm event. In other word, storm rainfalls that bring about severe damage are comprised of several independent short-term storm rainfalls with duration of 3 to 4 hours.

Isohyetal maps for four large-scaled storm rainfall events occurred in the last decade are illustrated in Figure 2.2.2. These maps were generated using daily rainfall records of 3 stations in the Weras Ganga basin and those of surrounding stations, i.e. Colombo, Bandaragama, Horana and Kalutara.

As to the event of June 1992, there is a trough along the line connecting Dehiwala and Boralesgamuwa stations. The rainfall amount at Dehiwala station is only 52% of that of Ratmalana station and 38% of Colombo station. The aerial skew of this storm event is relatively large.

Another three events shown in the figure have large amount of rainfalls occurring with aerial uniformity on a daily basis.

After the examination of collected daily rainfall record at three gauging stations in the basin and short-term rainfall record at Ratmalana station, the following tendencies were found:

1) There is a large aerial skew in the small-scaled storm events with daily rainfall of less than 30 mm.
2) For the large-scaled storm rainfall with daily rainfall of more than 100 mm, the aerial skew in daily basis is smaller than that of small-scaled ones.

Considering above tendencies and the fact that the probable basin average daily rainfalls with return period of more than 2 years, which are estimated by Thiessen polygon method, are over 100 mm as shown in succeeding subsection, the aerial uniformity of design storm rainfall over the entire Weras Ganga basin is a reasonable basis for the planning purpose.

2.3 Probable Rainfall Amount and Design Storm Rainfall Pattern

2.3.1 Estimation of Basin Average Daily Rainfall

Basin average rainfall was calculated for the entire Weras Ganga basin, employing the Thiessen Polygon method. A polygon system dividing the basin was created by bisectors drawn perpendicular to lines between each station and other neighboring stations as shown in Figure 2.1.1.

The calculated annual maximum basin average rainfall for 31 years from 1970 to 2000 is presented in Table 2.3.1.

2.3.2 Extreme Value Analysis for Probable Basin Average Daily Rainfall

The extreme value analysis was carried out applying three different probability distributions, i.e. Iwai, Log Pearson Type III, and Gumbel as shown Figure 2.3.1.

After the confirmation of applicability of those three methods, the probable basin average daily rainfall is taken as the maximum value obtained from the conservative point of view. Calculated probable basin average daily rainfalls by the three methods and the maximum values are tabulated below:

Calculated Probable Basin Average Daily Rainfalls

(Unit : mm)

Return Period (years)	Probability	Calculation Method			Maximum
		IWAI	PEARSON III	GUMBEL	
2	0.50	137	134	136	137
5	0.20	172	169	175	175
10	0.10	195	193	201	201
25	0.04	224	225	234	234
50	0.02	246	250	258	258

2.3.3 Extreme Value Analysis for Probable 60-min Rainfall

Structural measures proposed in the Study are not only for the Weras Ganga main stream but also for small canals in the upstream basins. Information relating to storms with shorter duration is necessary for the planning of small-scaled basin storm water drainage scheme of less than 10 km^2. This is because rainfall within the flood concentration time controls the peak flood discharge which will determine the conditions for the channel design.

Since no station in the Weras Ganga basin records such a short-duration rainfall except for Ratmalana station, estimation of basin average rainfall in hourly basis is quite difficult. Moreover, the short-term rainfall record in Ratmalana is fragmented and available only for a few (8) samples. The extreme value analysis for probable hourly rainfall was therefore carried out using the short-duration storm record of Colombo automatic rainfall gauging station whose location is about 6 km north from Dehiwala rainfall gauging station.

Gumbel distribution type method was selected for the calculation of probable 60-min rainfall. The method was also applied in JBIC SAPROF for the Lunawa Lake Environment Improvement and Community Development Project (2001) for the verification of DDF curves utilized in GCFC&EIP Phase II and III. Calculated probable 60-min rainfalls are tabulated below:

Calculated Probable 60-min Rainfalls

(Unit : mm)

Return Period (years)	Probability	60-min Rainfall
2	0.50	66
5	0.20	80
10	0.10	89
25	0.04	101
50	0.02	109

2.3.4 Temporal Distribution of Design Storm Rainfall

Normally, design storm rainfall is prepared after comparative examination among a lot of past records and artificial patterns. It is natural that each scheme has its own design storm rainfall pattern in proportion to the flood traveling time from its drainage basin. However, only one design storm rainfall pattern, which has applicability both for the small basin and the entire Weras Ganga basin, is used in the Study for the following reasons:

1) Both peak runoff discharge and flood water level in the lower reaches with a large drainage area such as the Weras Ganga main stream seem to be

controlled mainly by the total rainfall amount and not sensitive to the shape of hyetograph, because of the retarding effect of widely spread lowlands.

2) Considering the flood traveling time of small catchments, flood discharges in the upstream basin are controlled not by temporal distribution of rainfall but by the maximum hourly rainfall amount.

The hourly rainfall pattern at Colombo automatic rainfall gauging station on April 20, 1999 is selected as a prototype of design rainfall pattern in the Study. This pattern was also selected as a design rainfall pattern in the Master Plan Study.

The design storm rainfall pattern is generated by the following manner:

1) Convert the maximum hourly rainfall value of the prototype to the probable 60-minute rainfall value calculated in Subsection 2.3.3 above.
2) Reduce the rainfall amount of remaining portion of prototype proportionally to the original share in order to retain the total rainfall amount.

The derived design storm rainfall pattern is illustrated in Figure 2.3.2. Cumulative rainfall curves of 2-, 10- and 50-year probable design hyetographs are shown in Figure 2.3.3 together with those of observed at Colombo gauging station.

CHAPTER 3 FLOOD RUNOFF ANALYSIS

3.1 Methodology

Flood runoff analysis for the Weras Ganga basin was conducted utilizing MIKE11, a hydrological and hydraulic modeling software. The modeling and simulation procedures are presented in Figure 3.1.1.

A DEM (Digital Elevation Model) of the entire Weras Ganga basin was generated with the size of 10 m x 10 m (0.01 ha) utilizing 1:2,000 topographic maps provided by Survey Department as shown in Figure 3.1.2. This DEM is useful not only for generation of flood inundation map but also for extraction of flood plain characteristics to be reflected in the hydraulic model.

3.2 Branch Network Model

Figure 3.2.1 shows the present branch network system included in the MIKE11 network model. The network model is comprised of 110 branches. This includes not only existing or visible river channel/canal but also water paths found from 1:2,000 topographic maps.

Flood inundation phenomena is expressed only by overtopping from modeled channel in MIKE11. Therefore, small water paths should be included in the network model in addition to the major river channels and canals in order to revive the inundation situation at places apart from the main channels and canals.

The length of extracted branch is also presented in Figure 3.2.1.

Major river channel and canals in the Weras Ganga basin are listed below:

1) Main Bolgoda Canal (upper part of Branch 001)
2) Weras Ganga (lower part of Branch 001)
3) Maha Ela (Branch 002)
4) Nugegoda Ela (Branch 005)
5) Delkanda Ela (Branch 006)
6) Rattanapitiya Ela (lower part of Branch 005)
7) Depawa Ela (Branch 004)

Major structures crossing channels such as bridges, culverts and gates are also included in the network model utilizing the output of inventory survey conducted in this Study. The locations of those structures are shown in Figure 3.2.2.

According to the result of future land use projection, the branch network condition remains unchanged except for the lowest reaches of Bolgoda Canal. If the proposed

runway extension of Ratmalana Airport is realized, Bolgoda canal flows into Weras Ganga swamp directly. As a future branch network condition, the runway extension was taken into account as seen in Figure 3.2.3.

3.3 Basin Runoff Model

The Weras Ganga basin is divided into 187 sub-catchments with area of less than 1 km^2 (100 ha) as shown in Figure 3.3.1. NAM, lumped and conceptual basin runoff model, is utilized.

Parametering concept of this NAM basin runoff model is same as the Master Plan Study, that is, four land use/surface categories are set for fixing NAM parameters referring to the present and future land use maps drawn up in the Study. Those land use categories (land surface conditions) are as follows.

Classified Land Use Types for the Hydrological Analysis

	Land Use (Land Surface) Type			
	Type-1	Type-2	Type-3	Type-4
Land Use Category	urbanized area	semi-urbanized area	rural area, paddy etc.	marsh, water body

Each land use type has its own parameter set, and NAM parameters of each sub-catchment are determined by the area-weighted average of those parameter sets.

There are many parameters to be set in the NAM model, but the following seven parameters are important for estimating flood runoff. They are constituent elements of surface and root zone parameter sets:

1) Maximum water content in surface storage (U_{max})
2) Maximum water content in root zone storage (L_{max})
3) Overland flow runoff coefficient (*CQOF*)
4) Time constant for interflow (*CKIF*)
5) Time constant for routing interflow and overland flow (CK_{12})
6) Root zone threshold value for overland flow (*TOF*)
7) Root zone threshold value for interflow (*TIF*)

Areas of all the sub-catchments in the Weras Ganga basin are less than 1 km^2, while the sub-catchments in the Master Plan Study are mostly more than 1 km^2. To compensate, the parameter CK_{12} concerning the routing that controls the shape of runoff hydrograph is modified so as to be suitable for the size of sub-catchments.

The following table shows the main NAM parameters for each typical basin. All of parameters except for CK_{12} remain unchanged from the Master Plan Study.

NAM Parameters for Typical Land Use Types

	Land Use Type			
	Type-1	Type-2	Type-3	Type-4
U_{max}	5	7	18	1
L_{max}	16	68	177	6.7
CQOF	0.83	0.72	0.54	0.90
CKIF	500	500	500	500
CK_{12}*	0.5 (3.5)	1 (6)	3 (9)	0.5 (0.5)
TOF	0.2	0.2	0.2	0.2
TIF	0	0	0	0

Note: *Figures in parenthesis are CK_{12} values applied in the Master Plan Study.

Table 3.3.1 shows the extracted NAM parameters of all of 187 sub-catchments under present land use condition. NAM parameters under future land use condition are shown in Table 3.3.2.

Maximum flood runoffs and specific discharges from each sub-catchment for each return period under present and future land use conditions are presented in Table 3.3.3.

Runoff discharges from sub-catchments are provided to the above mentioned branch network model as upstream or lateral inflow. Figure 3.3.2 shows the diagram of the connection of branch network and basin runoff.

3.4 Comparison of Simulated Flood Water Level and Observation Record

As explained above, the discharge or water level of a point is simulated through two steps:

1) Calculation of runoff from each sub-catchment (hydrological calculation; NAM), and
2) Unsteady flow calculation in the branch network with input of NAM results (hydraulic calculation)

Strictly speaking, calibration of this total simulation model is therefore comprised of adjustment of hydrological (NAM) and hydraulic parameters (roughness coefficient etc.).

However, considering present conditions of data availability and observation/measurement situation of rainfall, water level and discharge, it is extremely difficult to clarify the runoff parameters of each land use component.

In reality, the parameters are decided in the following manner:

1) Manning's roughness coefficient of each branch section is determined:
   - Existing and visible channel/canal in good condition
     : 0.015 (concrete surface), 0.035 (others)
   - Existing and visible channel/canal in bad condition : 0.060
   - Water path extracted from 1:2,000 topographic maps : 0.060
   - Food plain : 0.060
2) Surveyed cross-sections are input for hydraulic calculation, while the sections of branches without survey are assumed using 1:2,000 topographic maps and DEM (Digital Elevation Model) generated from those maps.
3) Under the conditions of above mentioned hydraulic parameters, NAM parameters are adjusted by trial and error method to make simulated water levels coincide with the observed ones in a large storm rainfall event.

As an event for parameter adjustment, the storm rainfall occurred on April 20, 1999 is selected (refer to Figures 2.2.1 and 2.2.2). The reasons for selection are as follows:

1) This event induced severe damage in the entire basin.
2) Land use conditions in 1999 seem to be relatively similar to the present ones.
3) Since daily rainfall amount on this day is almost same as those of existing three rainfall gauging stations, i.e. Boralesgamuwa, Dehiwala and Ratmalana, the assumption of aerial uniformity of rainfall distribution is reasonable (refer to Figure 2.2.2).
4) Basin average daily rainfall on this day (265 mm) is similar to 50-year probable basin average daily rainfall (258 mm) calculated in Chapter 2.
5) Peak flood water level based on the interview survey is available at two locations in the basin, i.e. Bolgoda Canal at Attidiya road bridge (about 1.75 m above MSL) and Badowita housing scheme bridge (about 1.80 m above MSL), while the record regarding maximum water level is not available or unreliable for other storm events.

One of the important factors in this adjustment is consideration of the existing Attidiya gate located at the lower reaches of Bolgoda Canal (Structure No.8 in Figure 3.2.2). The simulated water levels at two objective points did not reach 1.7 m above MSL even when the NAM parameters which yield the highest peak were introduced. Considering the maximum flood water levels of 1.75 to 1.80 m above MSL at both points, there is a possibility that the operation or trouble (clogging etc.) of Attidiya gate made water level higher. Unfortunately, neither gate operation records nor records concerning gate trouble were available.

Taking this point into consideration, following three cases regarding the gate situation were assessed:

Case-1 : The gate was assumed to be closed or clogged during the storm period. In this condition, flood flows downstream only thorough causeway constructed beside the gate.

Case-2 : The gate was assumed to be open during the storm period. In this condition, flood flows downstream both through the gate and causeway.

Case-3 : The gate was assumed to be closed or be clogged until 12:00 of April 20, when the peak flood water level was observed.

Parameter adjustment was conducted to make the simulated water levels of Case-3 coincide with the observed ones.

Figure 3.4.1 shows the result of reproduction of April 1999 event. Although the gradual decrease of water level between 12:00 to 18:00 is not expressed well, the simulated water level from morning to 12:00 fits to the observed ones.

Although the above result does not prove the correction of selected parameters and room for improvement still remains, it is judged that these parameter conditions are reasonable for planning purpose.

The selected NAM parameters are presented in Section 3.3 above.

3.5 Result of Analysis

3.5.1 Calculated Flood Water Levels and Discharges without Structural Measures

Simulated peak flood water level and runoff under present and future conditions at these 6 points for 5 return periods, i.e. 2-, 5-, 10-, 25- and 50-yr, is presented in Table 3.5.1.

The 50-year probable flood water level and runoff hydrographs under present and future conditions at six selected points are presented in Figure 3.5.1. Due to urbanization especially in the eastern area of the basin, peak flood runoffs at all points increases. At Weras Ganga outfall (point (f) in Figure 3.5.1), 50-year probable flood runoff discharge is assumed to increase from 94 m^3/sec to 113 m^3/sec (increase rate: 20%).

Although flood water levels increase at most of selected points, the increment is about 13 cm (point (d) in Figure 3.5.1) at most even in the 50-year probable flood. This is owing to the retarding effect of lowlands spreading along the lower reaches of Bolgoda canal, Weras Ganga and Maha Ela.

A remarkable time lag between the maximum rainfall and the peak of water level/discharge is observed at Maha Ela outfall (point (e) in Figure 3.5.1), and that is caused by the insufficient width of Colombo-Piliyandala road bridge crossing Maha Ela at its middle reaches.

3.5.2 Estimated Situation of Flood Inundation without Structural Measures

Figure 3.5.2 shows simulated flood inundation area with return periods of 2-, 10-, and 50-year. The rate of increase in the total inundation area due to the urbanization and low-land filling is not so large as seen in the figure. Total inundation area is assumed to increase from 721 ha to 778 ha (+8%) in 2-year probable flood and from 1,101 ha to 1,180 ha (+7%) in 50-year probable flood.

The simulated 2-, 5-, 10-, 25- and 50-year probable flood inundation maps under present and future conditions are illustrated in Figure 3.5.3 to Figure 3.5.7. Inundation depth is large at Bellanwila-Attidiya marsh and at the middle reaches of Maha Ela. The ground elevation of those area is relatively low and back water effect caused by the bridge and culvert is very remarkable at Maha Ela middle reaches.

Tables 3.5.2 and 3.5.3 show estimated flood inundation area by land use category under present and future land use conditions respectively.

3.5.3 Simulation under the Condition with Structural Measures

The simulations under the conditions with structural measures proposed in the succeeding chapters are also conducted utilizing the above concepts and methodology. The results are presented in Annex 8 Storm Water Drainage.

Tables

Table 2.3.1 Estimated Annual Maximum Basin Average Rainfall

(Unit : mm)

Year	Date	1-day Rainfall	Year	Date	1-day Rainfall
1970	Sep. 11	128	1986	Sep. 14	101
1971	Oct. 22	118	1987	Sep. 23	126
1972	Jun. 17	136	1988	Sep. 12	129
1973	Nov. 4	123	1989	Oct. 28	152
1974	Apr. 17	196	1990	Apr. 17	125
1975	Apr. 14	98	1991	Feb. 1	108
1976	Oct. 9	190	1992	Jun. 4	256
1977	May 13	190	1993	Oct. 24	132
1978	May 11	147	1994	Sep. 28	141
1979	May 3	118	1995	May 5	153
1980	Sep. 25	97	1996	Nov. 28	124
1981	Nov. 9	175	1997	Dec. 5	82
1982	Mar. 21	145	1998	Nov. 8	178
1983	Nov. 29	111	1999	Apr. 20	265
1984	Nov. 19	136	2000	Oct. 6	134
1985	Sep. 24	112			

Table 3.3.1 NAM Parameters under Present Land Use Condition (1/3)

Code	Area	Parameter									Initial Conditions				
	(km^2)	Umax	Lmax	CQOF	CKIF	TOF	TIF	CK1,2	TG	CKBF	U	L	QOF	QIF	BF
C001	0.801	12.25	105.74	0.668	500	0.2	0	1.89	0.5	2000	0	0.30	0	0	0.03
C002	0.274	13.03	115.46	0.651	500	0.2	0	2.04	0.5	2000	0	0.30	0	0	0.01
C003	0.661	9.14	67.30	0.738	500	0.2	0	1.30	0.5	2000	0	0.30	0	0	0.03
C004	0.242	16.22	154.95	0.580	500	0.2	0	2.66	0.5	2000	0	0.30	0	0	0.01
C005	0.132	15.57	146.88	0.594	500	0.2	0	2.53	0.5	2000	0	0.30	0	0	0.01
C006	0.448	8.77	62.71	0.746	500	0.2	0	1.22	0.5	2000	0	0.30	0	0	0.02
C007	0.369	12.83	115.33	0.650	500	0.2	0	2.02	0.5	2000	0	0.30	0	0	0.01
C008	0.242	7.75	50.09	0.769	500	0.2	0	1.03	0.5	2000	0	0.30	0	0	0.01
C009	0.268	9.72	74.65	0.724	500	0.2	0	1.41	0.5	2000	0	0.30	0	0	0.01
C010	0.226	10.61	95.59	0.681	500	0.2	0	1.62	0.5	2000	0	0.30	0	0	0.01
C011	0.219	6.87	39.11	0.788	500	0.2	0	0.86	0.5	2000	0	0.30	0	0	0.01
C012	0.412	13.08	128.20	0.621	500	0.2	0	2.10	0.5	2000	0	0.30	0	0	0.02
C013	0.333	13.25	124.96	0.630	500	0.2	0	2.11	0.5	2000	0	0.30	0	0	0.01
C014	0.178	13.47	128.27	0.623	500	0.2	0	2.16	0.5	2000	0	0.30	0	0	0.01
C015	0.146	12.83	116.77	0.646	500	0.2	0	2.02	0.5	2000	0	0.30	0	0	0.01
C016	0.232	8.48	59.05	0.752	500	0.2	0	1.17	0.5	2000	0	0.30	0	0	0.01
C017	0.608	14.12	136.88	0.608	500	0.2	0	2.29	0.5	2000	0	0.30	0	0	0.02
C018	0.079	9.87	90.28	0.688	500	0.2	0	1.50	0.5	2000	0	0.30	0	0	0.00
C019	0.401	14.85	145.76	0.592	500	0.2	0	2.43	0.5	2000	0	0.30	0	0	0.02
C020	0.141	14.27	140.02	0.601	500	0.2	0	2.32	0.5	2000	0	0.30	0	0	0.01
C021	0.325	14.57	142.97	0.596	500	0.2	0	2.38	0.5	2000	0	0.30	0	0	0.01
C022	0.235	14.07	134.40	0.613	500	0.2	0	2.27	0.5	2000	0	0.30	0	0	0.01
C023	0.245	15.33	146.59	0.593	500	0.2	0	2.50	0.5	2000	0	0.30	0	0	0.01
C024	0.210	14.39	141.23	0.599	500	0.2	0	2.34	0.5	2000	0	0.30	0	0	0.01
C025	0.613	9.73	76.79	0.719	500	0.2	0	1.42	0.5	2000	0	0.30	0	0	0.02
C026	0.228	12.87	113.43	0.654	500	0.2	0	2.01	0.5	2000	0	0.30	0	0	0.01
C027	0.297	13.12	125.45	0.627	500	0.2	0	2.10	0.5	2000	0	0.30	0	0	0.01
C028	0.262	14.48	142.10	0.598	500	0.2	0	2.36	0.5	2000	0	0.30	0	0	0.01
C029	0.299	15.68	151.78	0.584	500	0.2	0	2.58	0.5	2000	0	0.30	0	0	0.01
C030	0.226	8.04	53.78	0.762	500	0.2	0	1.08	0.5	2000	0	0.30	0	0	0.01
C031	0.364	8.55	59.97	0.751	500	0.2	0	1.18	0.5	2000	0	0.30	0	0	0.01
C032	0.437	12.31	107.44	0.665	500	0.2	0	1.91	0.5	2000	0	0.30	0	0	0.02
C033	0.102	16.72	162.74	0.568	500	0.2	0	2.78	0.5	2000	0	0.30	0	0	0.00
C034	0.198	14.47	134.09	0.618	500	0.2	0	2.34	0.5	2000	0	0.30	0	0	0.01
C035	0.432	9.83	78.99	0.721	500	0.2	0	1.49	0.5	2000	0	0.30	0	0	0.02
C036	0.090	14.93	146.21	0.605	500	0.2	0	2.55	0.5	2000	0	0.30	0	0	0.00
C037	0.460	14.06	136.56	0.614	500	0.2	0	2.32	0.5	2000	0	0.30	0	0	0.02
C038	0.600	15.88	155.96	0.575	500	0.2	0	2.61	0.5	2000	0	0.30	0	0	0.02
C039	0.459	15.07	148.01	0.588	500	0.2	0	2.47	0.5	2000	0	0.30	0	0	0.02
C040	0.246	16.28	159.96	0.568	500	0.2	0	2.69	0.5	2000	0	0.30	0	0	0.01
C041	0.153	8.22	55.87	0.758	500	0.2	0	1.12	0.5	2000	0	0.30	0	0	0.01
C042	0.040	10.64	86.00	0.704	500	0.2	0	1.59	0.5	2000	0	0.30	0	0	0.00
C043	0.047	10.38	82.74	0.710	500	0.2	0	1.54	0.5	2000	0	0.30	0	0	0.00
C044	0.090	7.31	45.15	0.778	500	0.2	0	0.95	0.5	2000	0	0.30	0	0	0.00
C045	0.082	10.85	88.49	0.699	500	0.2	0	1.63	0.5	2000	0	0.30	0	0	0.00
C046	0.198	7.98	52.86	0.764	500	0.2	0	1.07	0.5	2000	0	0.30	0	0	0.01
C047	0.131	7.29	44.40	0.779	500	0.2	0	0.94	0.5	2000	0	0.30	0	0	0.01
C048	0.216	9.35	69.94	0.733	500	0.2	0	1.34	0.5	2000	0	0.30	0	0	0.01
C049	0.155	7.73	50.07	0.769	500	0.2	0	1.03	0.5	2000	0	0.30	0	0	0.01
C050	0.272	9.05	66.18	0.740	500	0.2	0	1.28	0.5	2000	0	0.30	0	0	0.01
C051	0.072	11.22	93.05	0.691	500	0.2	0	1.70	0.5	2000	0	0.30	0	0	0.00
C052	0.037	10.54	85.21	0.706	500	0.2	0	1.58	0.5	2000	0	0.30	0	0	0.00
C053	0.361	14.79	137.30	0.612	500	0.2	0	2.38	0.5	2000	0	0.30	0	0	0.01
C054	0.306	8.08	54.23	0.761	500	0.2	0	1.09	0.5	2000	0	0.30	0	0	0.01
C055	0.143	12.50	109.45	0.662	500	0.2	0	1.95	0.5	2000	0	0.30	0	0	0.01
C056	0.346	8.09	54.25	0.761	500	0.2	0	1.09	0.5	2000	0	0.30	0	0	0.01
C057	0.583	8.06	57.96	0.752	500	0.2	0	1.11	0.5	2000	0	0.30	0	0	0.02
C058	0.566	7.92	54.69	0.759	500	0.2	0	1.08	0.5	2000	0	0.30	0	0	0.02
C059	0.075	7.60	67.82	0.728	500	0.2	0	1.10	0.5	2000	0	0.30	0	0	0.00
C060	0.738	10.66	94.21	0.684	500	0.2	0	1.62	0.5	2000	0	0.30	0	0	0.03
C061	0.485	7.99	53.01	0.763	500	0.2	0	1.07	0.5	2000	0	0.30	0	0	0.02
C062	0.661	9.30	70.21	0.732	500	0.2	0	1.33	0.5	2000	0	0.30	0	0	0.03
C063	0.184	6.94	48.73	0.768	500	0.2	0	0.92	0.5	2000	0	0.30	0	0	0.01
C064	0.241	12.59	123.36	0.629	500	0.2	0	2.02	0.5	2000	0	0.30	0	0	0.01
C065	0.242	9.62	83.61	0.703	500	0.2	0	1.44	0.5	2000	0	0.30	0	0	0.01
C066	0.044	12.79	117.43	0.644	500	0.2	0	2.02	0.5	2000	0	0.30	0	0	0.00
C067	0.290	5.69	43.91	0.793	500	0.2	0	0.91	0.5	2000	0	0.30	0	0	0.01
C068	0.073	8.48	67.78	0.744	500	0.2	0	1.30	0.5	2000	0	0.30	0	0	0.00

Table 3.3.1 NAM Parameters under Present Land Use Condition (2/3)

Code	Area	Parameter									Initial Conditions				
	(km^2)	Umax	Lmax	CQOF	CKIF	TOF	TIF	CK1,2	TG	CKBF	U	L	QOF	QIF	BF
C069	0.852	14.22	139.52	0.603	500	0.2	0	2.32	0.5	2000	0	0.30	0	0	0.03
C070	0.333	15.77	154.92	0.577	500	0.2	0	2.60	0.5	2000	0	0.30	0	0	0.01
C071	0.092	14.15	138.49	0.619	500	0.2	0	2.41	0.5	2000	0	0.30	0	0	0.00
C072	0.060	16.90	163.64	0.564	500	0.2	0	2.79	0.5	2000	0	0.30	0	0	0.00
C073	0.308	13.66	133.94	0.614	500	0.2	0	2.23	0.5	2000	0	0.30	0	0	0.01
C074	0.205	17.54	172.38	0.548	500	0.2	0	2.92	0.5	2000	0	0.30	0	0	0.01
C075	0.163	14.46	141.90	0.598	500	0.2	0	2.36	0.5	2000	0	0.30	0	0	0.01
C076	0.049	17.96	176.59	0.541	500	0.2	0	2.99	0.5	2000	0	0.30	0	0	0.00
C077	0.460	17.39	169.92	0.552	500	0.2	0	2.88	0.5	2000	0	0.30	0	0	0.02
C078	0.123	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C079	0.067	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C080	0.049	17.97	176.74	0.541	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C081	0.312	16.37	156.90	0.576	500	0.2	0	2.69	0.5	2000	0	0.30	0	0	0.01
C082	0.692	12.81	119.18	0.640	500	0.2	0	2.03	0.5	2000	0	0.30	0	0	0.03
C083	0.367	10.34	94.33	0.682	500	0.2	0	1.58	0.5	2000	0	0.30	0	0	0.01
C084	0.109	14.14	129.68	0.626	500	0.2	0	2.27	0.5	2000	0	0.30	0	0	0.00
C085	0.141	12.66	118.70	0.641	500	0.2	0	2.01	0.5	2000	0	0.30	0	0	0.01
C086	0.580	12.81	125.54	0.625	500	0.2	0	2.06	0.5	2000	0	0.30	0	0	0.02
C087	0.773	15.10	148.28	0.587	500	0.2	0	2.47	0.5	2000	0	0.30	0	0	0.03
C088	0.491	17.26	169.63	0.552	500	0.2	0	2.86	0.5	2000	0	0.30	0	0	0.02
C089	0.368	16.60	163.15	0.564	500	0.2	0	2.75	0.5	2000	0	0.30	0	0	0.01
C090	0.255	13.41	131.53	0.616	500	0.2	0	2.17	0.5	2000	0	0.30	0	0	0.01
C091	0.725	12.27	119.85	0.652	500	0.2	0	2.09	0.5	2000	0	0.30	0	0	0.03
C092	0.360	8.25	79.24	0.746	500	0.2	0	1.56	0.5	2000	0	0.30	0	0	0.01
C093	0.321	16.82	164.76	0.565	500	0.2	0	2.82	0.5	2000	0	0.30	0	0	0.01
C094	0.687	8.25	76.14	0.727	500	0.2	0	1.34	0.5	2000	0	0.30	0	0	0.03
C095	0.216	17.45	171.54	0.549	500	0.2	0	2.90	0.5	2000	0	0.30	0	0	0.01
C096	0.063	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C097	0.029	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C098	0.040	17.16	168.59	0.558	500	0.2	0	2.88	0.5	2000	0	0.30	0	0	0.00
C099	0.068	9.61	92.94	0.718	500	0.2	0	1.77	0.5	2000	0	0.30	0	0	0.00
C100	0.544	16.98	166.90	0.557	500	0.2	0	2.81	0.5	2000	0	0.30	0	0	0.02
C101	0.749	16.25	159.66	0.569	500	0.2	0	2.68	0.5	2000	0	0.30	0	0	0.03
C102	0.446	15.77	154.90	0.576	500	0.2	0	2.59	0.5	2000	0	0.30	0	0	0.02
C103	0.560	12.25	115.24	0.646	500	0.2	0	1.93	0.5	2000	0	0.30	0	0	0.02
C104	0.113	17.30	170.03	0.552	500	0.2	0	2.87	0.5	2000	0	0.30	0	0	0.00
C105	0.183	13.44	131.78	0.615	500	0.2	0	2.17	0.5	2000	0	0.30	0	0	0.01
C106	0.065	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C107	0.418	15.37	149.96	0.585	500	0.2	0	2.52	0.5	2000	0	0.30	0	0	0.02
C108	0.264	14.77	145.02	0.593	500	0.2	0	2.41	0.5	2000	0	0.30	0	0	0.01
C109	0.369	15.59	153.08	0.580	500	0.2	0	2.56	0.5	2000	0	0.30	0	0	0.01
C110	0.172	16.53	162.44	0.564	500	0.2	0	2.73	0.5	2000	0	0.30	0	0	0.01
C111	0.437	15.98	156.95	0.573	500	0.2	0	2.63	0.5	2000	0	0.30	0	0	0.02
C112	0.104	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C113	0.223	17.83	175.26	0.544	500	0.2	0	2.97	0.5	2000	0	0.30	0	0	0.01
C114	0.836	17.60	172.99	0.547	500	0.2	0	2.93	0.5	2000	0	0.30	0	0	0.03
C115	0.179	15.90	156.17	0.575	500	0.2	0	2.62	0.5	2000	0	0.30	0	0	0.01
C116	0.485	16.99	166.99	0.557	500	0.2	0	2.82	0.5	2000	0	0.30	0	0	0.02
C117	0.161	17.84	175.40	0.543	500	0.2	0	2.98	0.5	2000	0	0.30	0	0	0.01
C118	0.118	17.67	173.74	0.547	500	0.2	0	2.95	0.5	2000	0	0.30	0	0	0.00
C119	0.706	14.46	141.96	0.598	500	0.2	0	2.36	0.5	2000	0	0.30	0	0	0.03
C120	0.521	14.43	141.67	0.598	500	0.2	0	2.35	0.5	2000	0	0.30	0	0	0.02
C121	0.418	16.88	165.91	0.558	500	0.2	0	2.80	0.5	2000	0	0.30	0	0	0.02
C122	0.092	17.01	167.19	0.556	500	0.2	0	2.82	0.5	2000	0	0.30	0	0	0.00
C123	0.224	13.86	135.98	0.608	500	0.2	0	2.25	0.5	2000	0	0.30	0	0	0.01
C124	0.300	14.32	140.54	0.600	500	0.2	0	2.33	0.5	2000	0	0.30	0	0	0.01
C125	0.271	14.90	146.25	0.591	500	0.2	0	2.44	0.5	2000	0	0.30	0	0	0.01
C126	0.151	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.01
C127	0.251	16.29	160.05	0.568	500	0.2	0	2.69	0.5	2000	0	0.30	0	0	0.01
C128	0.299	14.03	137.64	0.605	500	0.2	0	2.28	0.5	2000	0	0.30	0	0	0.01
C129	0.298	16.50	162.11	0.565	500	0.2	0	2.73	0.5	2000	0	0.30	0	0	0.01
C130	0.388	17.81	175.12	0.543	500	0.2	0	2.97	0.5	2000	0	0.30	0	0	0.02
C131	0.215	17.67	173.76	0.545	500	0.2	0	2.94	0.5	2000	0	0.30	0	0	0.01
C132	0.345	14.96	146.86	0.590	500	0.2	0	2.45	0.5	2000	0	0.30	0	0	0.01
C133	0.580	14.96	146.91	0.590	500	0.2	0	2.45	0.5	2000	0	0.30	0	0	0.02
C134	0.425	15.61	153.33	0.579	500	0.2	0	2.57	0.5	2000	0	0.30	0	0	0.02
C135	0.213	15.51	152.29	0.581	500	0.2	0	2.55	0.5	2000	0	0.30	0	0	0.01
C136	0.579	15.95	156.70	0.574	500	0.2	0	2.63	0.5	2000	0	0.30	0	0	0.02

Table 3.3.1 NAM Parameters under Present Land Use Condition (3/3)

Code	Area	Parameter									Initial Conditions				
	(km^2)	Umax	Lmax	CQOF	CKIF	TOF	TIF	CK1,2	TG	CKBF	U	L	QOF	QIF	BF
C137	0.545	14.03	137.70	0.605	500	0.2	0	2.28	0.5	2000	0	0.30	0	0	0.02
C138	0.537	16.20	159.13	0.570	500	0.2	0	2.67	0.5	2000	0	0.30	0	0	0.02
C139	0.268	16.44	161.54	0.566	500	0.2	0	2.72	0.5	2000	0	0.30	0	0	0.01
C140	0.080	17.22	169.23	0.554	500	0.2	0	2.87	0.5	2000	0	0.30	0	0	0.00
C141	0.192	16.79	164.96	0.560	500	0.2	0	2.78	0.5	2000	0	0.30	0	0	0.01
C142	0.306	13.09	128.32	0.620	500	0.2	0	2.11	0.5	2000	0	0.30	0	0	0.01
C143	0.063	17.58	172.83	0.549	500	0.2	0	2.94	0.5	2000	0	0.30	0	0	0.00
C144	0.393	16.81	165.23	0.559	500	0.2	0	2.78	0.5	2000	0	0.30	0	0	0.02
C145	0.514	15.77	154.94	0.576	500	0.2	0	2.60	0.5	2000	0	0.30	0	0	0.02
C146	0.711	15.02	147.44	0.589	500	0.2	0	2.46	0.5	2000	0	0.30	0	0	0.03
C147	0.317	16.27	159.88	0.568	500	0.2	0	2.69	0.5	2000	0	0.30	0	0	0.01
C148	0.343	14.07	138.06	0.604	500	0.2	0	2.29	0.5	2000	0	0.30	0	0	0.01
C149	0.550	16.42	161.32	0.566	500	0.2	0	2.71	0.5	2000	0	0.30	0	0	0.02
C150	0.398	14.05	137.88	0.605	500	0.2	0	2.28	0.5	2000	0	0.30	0	0	0.02
C151	0.431	12.69	124.42	0.627	500	0.2	0	2.04	0.5	2000	0	0.30	0	0	0.02
C152	0.222	16.62	163.33	0.563	500	0.2	0	2.75	0.5	2000	0	0.30	0	0	0.01
C153	0.219	17.96	176.64	0.541	500	0.2	0	2.99	0.5	2000	0	0.30	0	0	0.01
C154	0.263	14.81	145.41	0.593	500	0.2	0	2.42	0.5	2000	0	0.30	0	0	0.01
C155	0.262	17.94	176.38	0.541	500	0.2	0	2.99	0.5	2000	0	0.30	0	0	0.01
C156	0.315	11.55	113.04	0.646	500	0.2	0	1.83	0.5	2000	0	0.30	0	0	0.01
C157	0.060	17.35	170.52	0.554	500	0.2	0	2.90	0.5	2000	0	0.30	0	0	0.00
C158	0.026	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C159	0.304	16.93	166.31	0.563	500	0.2	0	2.84	0.5	2000	0	0.30	0	0	0.01
C160	0.178	12.03	117.85	0.638	500	0.2	0	1.91	0.5	2000	0	0.30	0	0	0.01
C161	0.165	17.17	168.76	0.554	500	0.2	0	2.85	0.5	2000	0	0.30	0	0	0.01
C162	0.466	16.39	160.98	0.568	500	0.2	0	2.72	0.5	2000	0	0.30	0	0	0.02
C163	0.185	17.05	167.49	0.560	500	0.2	0	2.86	0.5	2000	0	0.30	0	0	0.01
C164	0.156	9.13	88.19	0.728	500	0.2	0	1.70	0.5	2000	0	0.30	0	0	0.01
C165	0.215	8.00	53.20	0.763	500	0.2	0	1.08	0.5	2000	0	0.30	0	0	0.01
C166	0.200	7.15	43.70	0.780	500	0.2	0	0.92	0.5	2000	0	0.30	0	0	0.01
C167	0.267	9.88	76.49	0.721	500	0.2	0	1.44	0.5	2000	0	0.30	0	0	0.01
C168	0.306	11.95	103.91	0.671	500	0.2	0	1.84	0.5	2000	0	0.30	0	0	0.01
C169	0.066	10.61	89.04	0.699	500	0.2	0	1.61	0.5	2000	0	0.30	0	0	0.00
C170	0.107	6.65	46.18	0.783	500	0.2	0	0.96	0.5	2000	0	0.30	0	0	0.00
C171	0.512	6.56	61.49	0.764	500	0.2	0	1.16	0.5	2000	0	0.30	0	0	0.02
C172	0.701	14.27	139.95	0.606	500	0.2	0	2.36	0.5	2000	0	0.30	0	0	0.03
C173	0.124	7.67	73.84	0.744	500	0.2	0	1.37	0.5	2000	0	0.30	0	0	0.00
C174	0.102	16.08	157.88	0.576	500	0.2	0	2.68	0.5	2000	0	0.30	0	0	0.00
C175	0.106	14.85	145.48	0.607	500	0.2	0	2.54	0.5	2000	0	0.30	0	0	0.00
C176	0.382	8.81	63.18	0.745	500	0.2	0	1.23	0.5	2000	0	0.30	0	0	0.02
C177	0.328	11.13	92.38	0.692	500	0.2	0	1.68	0.5	2000	0	0.30	0	0	0.01
C178	0.449	10.81	88.22	0.700	500	0.2	0	1.62	0.5	2000	0	0.30	0	0	0.02
C179	0.092	14.72	140.51	0.603	500	0.2	0	2.39	0.5	2000	0	0.30	0	0	0.00
C180	0.107	17.94	176.45	0.541	500	0.2	0	2.99	0.5	2000	0	0.30	0	0	0.00
C181	0.232	16.14	158.14	0.571	500	0.2	0	2.66	0.5	2000	0	0.30	0	0	0.01
C182	0.408	17.12	168.15	0.558	500	0.2	0	2.87	0.5	2000	0	0.30	0	0	0.02
C183	0.225	10.01	78.91	0.716	500	0.2	0	1.47	0.5	2000	0	0.30	0	0	0.01
C184	0.105	8.63	63.74	0.742	500	0.2	0	1.21	0.5	2000	0	0.30	0	0	0.00
C185	0.073	9.55	88.40	0.697	500	0.2	0	1.50	0.5	2000	0	0.30	0	0	0.00
C186	0.160	6.23	59.27	0.782	500	0.2	0	1.21	0.5	2000	0	0.30	0	0	0.01
C187	0.084	15.45	151.43	0.594	500	0.2	0	2.62	0.5	2000	0	0.30	0	0	0.00

Table 3.3.2 NAM Parameters under Future Land Use Condition (1/3)

Code	Area	Parameter									Initial Conditions				
	(km^2)	Umax	Lmax	CQOF	CKIF	TOF	TIF	CK1,2	TG	CKBF	U	L	QOF	QIF	BF
C001	0.801	10.32	82.81	0.709	500	0.2	0	1.53	0.5	2000	0	0.30	0	0	0.03
C002	0.274	8.11	54.50	0.761	500	0.2	0	1.10	0.5	2000	0	0.30	0	0	0.01
C003	0.661	8.20	55.57	0.759	500	0.2	0	1.11	0.5	2000	0	0.30	0	0	0.03
C004	0.242	9.71	74.38	0.725	500	0.2	0	1.41	0.5	2000	0	0.30	0	0	0.01
C005	0.132	7.03	41.12	0.785	500	0.2	0	0.89	0.5	2000	0	0.30	0	0	0.01
C006	0.448	7.21	43.31	0.781	500	0.2	0	0.92	0.5	2000	0	0.30	0	0	0.02
C007	0.369	12.13	105.04	0.669	500	0.2	0	1.87	0.5	2000	0	0.30	0	0	0.01
C008	0.242	7.75	50.09	0.769	500	0.2	0	1.03	0.5	2000	0	0.30	0	0	0.01
C009	0.268	9.74	74.75	0.724	500	0.2	0	1.41	0.5	2000	0	0.30	0	0	0.01
C010	0.226	9.50	71.71	0.730	500	0.2	0	1.37	0.5	2000	0	0.30	0	0	0.01
C011	0.219	6.87	39.11	0.788	500	0.2	0	0.86	0.5	2000	0	0.30	0	0	0.01
C012	0.412	8.19	55.51	0.759	500	0.2	0	1.11	0.5	2000	0	0.30	0	0	0.02
C013	0.333	9.21	68.24	0.736	500	0.2	0	1.31	0.5	2000	0	0.30	0	0	0.01
C014	0.178	10.73	87.54	0.701	500	0.2	0	1.60	0.5	2000	0	0.30	0	0	0.01
C015	0.146	12.83	116.77	0.646	500	0.2	0	2.02	0.5	2000	0	0.30	0	0	0.01
C016	0.232	8.47	59.01	0.753	500	0.2	0	1.17	0.5	2000	0	0.30	0	0	0.01
C017	0.608	13.90	132.96	0.615	500	0.2	0	2.24	0.5	2000	0	0.30	0	0	0.02
C018	0.079	8.68	61.60	0.748	500	0.2	0	1.21	0.5	2000	0	0.30	0	0	0.00
C019	0.401	13.18	117.29	0.648	500	0.2	0	2.07	0.5	2000	0	0.30	0	0	0.02
C020	0.141	14.27	140.02	0.601	500	0.2	0	2.32	0.5	2000	0	0.30	0	0	0.01
C021	0.325	9.48	71.56	0.730	500	0.2	0	1.36	0.5	2000	0	0.30	0	0	0.01
C022	0.235	11.00	93.68	0.688	500	0.2	0	1.67	0.5	2000	0	0.30	0	0	0.01
C023	0.245	8.81	63.16	0.745	500	0.2	0	1.23	0.5	2000	0	0.30	0	0	0.01
C024	0.210	11.30	93.98	0.690	500	0.2	0	1.71	0.5	2000	0	0.30	0	0	0.01
C025	0.613	9.73	76.25	0.720	500	0.2	0	1.42	0.5	2000	0	0.30	0	0	0.02
C026	0.228	11.86	100.95	0.677	500	0.2	0	1.82	0.5	2000	0	0.30	0	0	0.01
C027	0.297	11.53	96.82	0.684	500	0.2	0	1.75	0.5	2000	0	0.30	0	0	0.01
C028	0.262	13.64	125.54	0.631	500	0.2	0	2.17	0.5	2000	0	0.30	0	0	0.01
C029	0.299	15.70	151.96	0.584	500	0.2	0	2.58	0.5	2000	0	0.30	0	0	0.01
C030	0.226	8.11	54.51	0.761	500	0.2	0	1.10	0.5	2000	0	0.30	0	0	0.01
C031	0.364	8.55	59.97	0.751	500	0.2	0	1.18	0.5	2000	0	0.30	0	0	0.01
C032	0.437	12.31	107.45	0.665	500	0.2	0	1.91	0.5	2000	0	0.30	0	0	0.02
C033	0.102	16.72	162.74	0.568	500	0.2	0	2.78	0.5	2000	0	0.30	0	0	0.00
C034	0.198	7.93	53.06	0.764	500	0.2	0	1.08	0.5	2000	0	0.30	0	0	0.01
C035	0.432	8.04	56.83	0.761	500	0.2	0	1.15	0.5	2000	0	0.30	0	0	0.02
C036	0.090	7.25	51.16	0.776	500	0.2	0	1.07	0.5	2000	0	0.30	0	0	0.00
C037	0.460	8.91	67.53	0.741	500	0.2	0	1.31	0.5	2000	0	0.30	0	0	0.02
C038	0.600	11.50	96.54	0.685	500	0.2	0	1.75	0.5	2000	0	0.30	0	0	0.02
C039	0.459	12.73	111.71	0.658	500	0.2	0	1.99	0.5	2000	0	0.30	0	0	0.02
C040	0.246	15.03	140.26	0.606	500	0.2	0	2.43	0.5	2000	0	0.30	0	0	0.01
C041	0.153	8.22	55.87	0.758	500	0.2	0	1.12	0.5	2000	0	0.30	0	0	0.01
C042	0.040	10.64	86.00	0.704	500	0.2	0	1.59	0.5	2000	0	0.30	0	0	0.00
C043	0.047	10.38	82.74	0.710	500	0.2	0	1.54	0.5	2000	0	0.30	0	0	0.00
C044	0.090	7.31	45.15	0.778	500	0.2	0	0.95	0.5	2000	0	0.30	0	0	0.00
C045	0.082	10.85	88.49	0.699	500	0.2	0	1.63	0.5	2000	0	0.30	0	0	0.00
C046	0.198	7.98	52.86	0.764	500	0.2	0	1.07	0.5	2000	0	0.30	0	0	0.01
C047	0.131	7.29	44.40	0.779	500	0.2	0	0.94	0.5	2000	0	0.30	0	0	0.01
C048	0.216	9.34	69.88	0.733	500	0.2	0	1.34	0.5	2000	0	0.30	0	0	0.01
C049	0.155	7.73	50.05	0.769	500	0.2	0	1.03	0.5	2000	0	0.30	0	0	0.01
C050	0.272	9.05	66.18	0.740	500	0.2	0	1.28	0.5	2000	0	0.30	0	0	0.01
C051	0.072	11.22	93.06	0.691	500	0.2	0	1.70	0.5	2000	0	0.30	0	0	0.00
C052	0.037	6.64	46.78	0.769	500	0.2	0	0.87	0.5	2000	0	0.30	0	0	0.00
C053	0.361	14.89	138.46	0.609	500	0.2	0	2.40	0.5	2000	0	0.30	0	0	0.01
C054	0.306	7.87	52.18	0.765	500	0.2	0	1.06	0.5	2000	0	0.30	0	0	0.01
C055	0.143	12.02	104.63	0.670	500	0.2	0	1.86	0.5	2000	0	0.30	0	0	0.01
C056	0.346	8.09	54.25	0.761	500	0.2	0	1.09	0.5	2000	0	0.30	0	0	0.01
C057	0.583	8.06	57.96	0.752	500	0.2	0	1.11	0.5	2000	0	0.30	0	0	0.02
C058	0.566	7.92	54.69	0.759	500	0.2	0	1.08	0.5	2000	0	0.30	0	0	0.02
C059	0.075	10.03	97.93	0.673	500	0.2	0	1.57	0.5	2000	0	0.30	0	0	0.00
C060	0.738	10.66	94.21	0.684	500	0.2	0	1.62	0.5	2000	0	0.30	0	0	0.03
C061	0.485	7.99	53.01	0.763	500	0.2	0	1.07	0.5	2000	0	0.30	0	0	0.02
C062	0.661	9.30	70.21	0.732	500	0.2	0	1.33	0.5	2000	0	0.30	0	0	0.03
C063	0.184	6.97	49.11	0.767	500	0.2	0	0.93	0.5	2000	0	0.30	0	0	0.01
C064	0.241	12.59	123.36	0.629	500	0.2	0	2.02	0.5	2000	0	0.30	0	0	0.01
C065	0.242	9.93	86.66	0.698	500	0.2	0	1.49	0.5	2000	0	0.30	0	0	0.01
C066	0.044	15.43	150.06	0.586	500	0.2	0	2.53	0.5	2000	0	0.30	0	0	0.00
C067	0.290	8.47	78.31	0.731	500	0.2	0	1.44	0.5	2000	0	0.30	0	0	0.01
C068	0.073	9.63	84.80	0.711	500	0.2	0	1.53	0.5	2000	0	0.30	0	0	0.00

Table 3.3.2 NAM Parameters under Future Land Use Condition (2/3)

Code	Area	Parameter									Initial Conditions				
	(km^2)	Umax	Lmax	CQOF	CKIF	TOF	TIF	CK1,2	TG	CKBF	U	L	QOF	QIF	BF
C069	0.852	14.23	139.63	0.602	500	0.2	0	2.32	0.5	2000	0	0.30	0	0	0.03
C070	0.333	13.89	126.21	0.632	500	0.2	0	2.21	0.5	2000	0	0.30	0	0	0.01
C071	0.092	14.79	141.05	0.610	500	0.2	0	2.46	0.5	2000	0	0.30	0	0	0.00
C072	0.060	17.89	175.86	0.542	500	0.2	0	2.98	0.5	2000	0	0.30	0	0	0.00
C073	0.308	13.66	133.94	0.614	500	0.2	0	2.23	0.5	2000	0	0.30	0	0	0.01
C074	0.205	17.54	172.38	0.548	500	0.2	0	2.92	0.5	2000	0	0.30	0	0	0.01
C075	0.163	14.46	141.90	0.598	500	0.2	0	2.36	0.5	2000	0	0.30	0	0	0.01
C076	0.049	17.96	176.59	0.541	500	0.2	0	2.99	0.5	2000	0	0.30	0	0	0.00
C077	0.460	17.39	169.92	0.552	500	0.2	0	2.88	0.5	2000	0	0.30	0	0	0.02
C078	0.123	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C079	0.067	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C080	0.049	17.97	176.74	0.541	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C081	0.312	17.95	176.48	0.541	500	0.2	0	2.99	0.5	2000	0	0.30	0	0	0.01
C082	0.692	13.50	127.65	0.625	500	0.2	0	2.16	0.5	2000	0	0.30	0	0	0.03
C083	0.367	10.34	94.33	0.682	500	0.2	0	1.58	0.5	2000	0	0.30	0	0	0.01
C084	0.109	17.82	175.18	0.544	500	0.2	0	2.97	0.5	2000	0	0.30	0	0	0.00
C085	0.141	14.83	145.58	0.592	500	0.2	0	2.43	0.5	2000	0	0.30	0	0	0.01
C086	0.580	8.52	59.55	0.752	500	0.2	0	1.18	0.5	2000	0	0.30	0	0	0.02
C087	0.773	9.72	74.47	0.725	500	0.2	0	1.41	0.5	2000	0	0.30	0	0	0.03
C088	0.491	10.26	81.18	0.713	500	0.2	0	1.51	0.5	2000	0	0.30	0	0	0.02
C089	0.368	10.30	82.02	0.712	500	0.2	0	1.53	0.5	2000	0	0.30	0	0	0.01
C090	0.255	8.17	55.39	0.759	500	0.2	0	1.11	0.5	2000	0	0.30	0	0	0.01
C091	0.725	7.35	52.91	0.774	500	0.2	0	1.10	0.5	2000	0	0.30	0	0	0.03
C092	0.360	9.17	85.65	0.728	500	0.2	0	1.65	0.5	2000	0	0.30	0	0	0.01
C093	0.321	8.83	65.87	0.743	500	0.2	0	1.28	0.5	2000	0	0.30	0	0	0.01
C094	0.687	8.93	84.54	0.712	500	0.2	0	1.47	0.5	2000	0	0.30	0	0	0.03
C095	0.216	16.36	157.88	0.574	500	0.2	0	2.69	0.5	2000	0	0.30	0	0	0.01
C096	0.063	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C097	0.029	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C098	0.040	17.16	168.59	0.558	500	0.2	0	2.88	0.5	2000	0	0.30	0	0	0.00
C099	0.068	9.61	92.94	0.718	500	0.2	0	1.77	0.5	2000	0	0.30	0	0	0.00
C100	0.544	10.83	88.18	0.700	500	0.2	0	1.62	0.5	2000	0	0.30	0	0	0.02
C101	0.749	13.90	126.20	0.631	500	0.2	0	2.21	0.5	2000	0	0.30	0	0	0.03
C102	0.446	10.25	80.98	0.713	500	0.2	0	1.51	0.5	2000	0	0.30	0	0	0.02
C103	0.560	9.20	67.97	0.736	500	0.2	0	1.31	0.5	2000	0	0.30	0	0	0.02
C104	0.113	15.92	151.18	0.587	500	0.2	0	2.60	0.5	2000	0	0.30	0	0	0.00
C105	0.183	9.31	69.35	0.734	500	0.2	0	1.33	0.5	2000	0	0.30	0	0	0.01
C106	0.065	17.77	174.21	0.545	500	0.2	0	2.96	0.5	2000	0	0.30	0	0	0.00
C107	0.418	9.78	75.15	0.723	500	0.2	0	1.42	0.5	2000	0	0.30	0	0	0.02
C108	0.264	8.66	61.28	0.748	500	0.2	0	1.20	0.5	2000	0	0.30	0	0	0.01
C109	0.369	11.61	99.44	0.679	500	0.2	0	1.78	0.5	2000	0	0.30	0	0	0.01
C110	0.172	16.14	157.59	0.573	500	0.2	0	2.66	0.5	2000	0	0.30	0	0	0.01
C111	0.437	10.63	85.70	0.704	500	0.2	0	1.58	0.5	2000	0	0.30	0	0	0.02
C112	0.104	15.85	150.41	0.588	500	0.2	0	2.59	0.5	2000	0	0.30	0	0	0.00
C113	0.223	17.00	165.02	0.562	500	0.2	0	2.82	0.5	2000	0	0.30	0	0	0.01
C114	0.836	11.86	101.90	0.675	500	0.2	0	1.82	0.5	2000	0	0.30	0	0	0.03
C115	0.179	15.90	156.17	0.575	500	0.2	0	2.62	0.5	2000	0	0.30	0	0	0.01
C116	0.485	13.55	123.74	0.635	500	0.2	0	2.15	0.5	2000	0	0.30	0	0	0.02
C117	0.161	12.60	110.51	0.660	500	0.2	0	1.97	0.5	2000	0	0.30	0	0	0.01
C118	0.118	17.67	173.74	0.547	500	0.2	0	2.95	0.5	2000	0	0.30	0	0	0.00
C119	0.706	10.25	81.28	0.712	500	0.2	0	1.51	0.5	2000	0	0.30	0	0	0.03
C120	0.521	9.91	76.75	0.721	500	0.2	0	1.44	0.5	2000	0	0.30	0	0	0.02
C121	0.418	11.17	92.43	0.692	500	0.2	0	1.69	0.5	2000	0	0.30	0	0	0.02
C122	0.092	15.34	144.89	0.597	500	0.2	0	2.49	0.5	2000	0	0.30	0	0	0.00
C123	0.224	8.92	64.53	0.743	500	0.2	0	1.25	0.5	2000	0	0.30	0	0	0.01
C124	0.300	10.72	89.95	0.695	500	0.2	0	1.61	0.5	2000	0	0.30	0	0	0.01
C125	0.271	11.52	96.78	0.684	500	0.2	0	1.75	0.5	2000	0	0.30	0	0	0.01
C126	0.151	9.81	75.55	0.723	500	0.2	0	1.42	0.5	2000	0	0.30	0	0	0.01
C127	0.251	12.87	114.57	0.652	500	0.2	0	2.02	0.5	2000	0	0.30	0	0	0.01
C128	0.299	8.65	61.15	0.749	500	0.2	0	1.20	0.5	2000	0	0.30	0	0	0.01
C129	0.298	7.23	43.56	0.780	500	0.2	0	0.93	0.5	2000	0	0.30	0	0	0.01
C130	0.388	8.96	65.01	0.742	500	0.2	0	1.26	0.5	2000	0	0.30	0	0	0.02
C131	0.215	12.08	103.67	0.672	500	0.2	0	1.86	0.5	2000	0	0.30	0	0	0.01
C132	0.345	12.83	112.98	0.655	500	0.2	0	2.01	0.5	2000	0	0.30	0	0	0.01
C133	0.580	9.96	77.47	0.719	500	0.2	0	1.45	0.5	2000	0	0.30	0	0	0.02
C134	0.425	10.69	86.48	0.703	500	0.2	0	1.59	0.5	2000	0	0.30	0	0	0.02
C135	0.213	9.38	70.19	0.732	500	0.2	0	1.34	0.5	2000	0	0.30	0	0	0.01
C136	0.579	9.81	75.62	0.723	500	0.2	0	1.43	0.5	2000	0	0.30	0	0	0.02

Table 3.3.2 NAM Parameters under Future Land Use Condition (3/3)

Code	Area	Parameter									Initial Conditions				
	(km^2)	Umax	Lmax	CQOF	CKIF	TOF	TIF	CK1,2	TG	CKBF	U	L	QOF	QIF	BF
C137	0.545	9.11	66.92	0.738	500	0.2	0	1.29	0.5	2000	0	0.30	0	0	0.02
C138	0.537	15.12	142.23	0.602	500	0.2	0	2.45	0.5	2000	0	0.30	0	0	0.02
C139	0.268	11.35	98.38	0.679	500	0.2	0	1.74	0.5	2000	0	0.30	0	0	0.01
C140	0.080	17.22	169.23	0.554	500	0.2	0	2.87	0.5	2000	0	0.30	0	0	0.00
C141	0.192	12.13	107.26	0.664	500	0.2	0	1.88	0.5	2000	0	0.30	0	0	0.01
C142	0.306	9.71	74.32	0.725	500	0.2	0	1.41	0.5	2000	0	0.30	0	0	0.01
C143	0.063	17.58	172.83	0.549	500	0.2	0	2.94	0.5	2000	0	0.30	0	0	0.00
C144	0.393	7.66	48.98	0.771	500	0.2	0	1.01	0.5	2000	0	0.30	0	0	0.02
C145	0.514	10.73	86.96	0.702	500	0.2	0	1.60	0.5	2000	0	0.30	0	0	0.02
C146	0.711	9.82	75.63	0.723	500	0.2	0	1.43	0.5	2000	0	0.30	0	0	0.03
C147	0.317	12.49	108.74	0.663	500	0.2	0	1.94	0.5	2000	0	0.30	0	0	0.01
C148	0.343	10.77	87.44	0.701	500	0.2	0	1.61	0.5	2000	0	0.30	0	0	0.01
C149	0.550	10.37	82.51	0.710	500	0.2	0	1.53	0.5	2000	0	0.30	0	0	0.02
C150	0.398	12.82	112.90	0.655	500	0.2	0	2.00	0.5	2000	0	0.30	0	0	0.02
C151	0.431	9.11	66.89	0.738	500	0.2	0	1.29	0.5	2000	0	0.30	0	0	0.02
C152	0.222	11.81	100.38	0.678	500	0.2	0	1.81	0.5	2000	0	0.30	0	0	0.01
C153	0.219	13.58	122.31	0.639	500	0.2	0	2.15	0.5	2000	0	0.30	0	0	0.01
C154	0.263	14.40	135.23	0.614	500	0.2	0	2.32	0.5	2000	0	0.30	0	0	0.01
C155	0.262	12.60	110.25	0.660	500	0.2	0	1.96	0.5	2000	0	0.30	0	0	0.01
C156	0.315	10.51	87.17	0.700	500	0.2	0	1.57	0.5	2000	0	0.30	0	0	0.01
C157	0.060	17.35	170.52	0.554	500	0.2	0	2.90	0.5	2000	0	0.30	0	0	0.00
C158	0.026	18.00	177.00	0.540	500	0.2	0	3.00	0.5	2000	0	0.30	0	0	0.00
C159	0.304	14.30	133.69	0.621	500	0.2	0	2.34	0.5	2000	0	0.30	0	0	0.01
C160	0.178	9.75	75.61	0.722	500	0.2	0	1.42	0.5	2000	0	0.30	0	0	0.01
C161	0.165	7.42	45.96	0.776	500	0.2	0	0.97	0.5	2000	0	0.30	0	0	0.01
C162	0.466	13.18	118.22	0.647	500	0.2	0	2.09	0.5	2000	0	0.30	0	0	0.02
C163	0.185	14.70	138.40	0.612	500	0.2	0	2.41	0.5	2000	0	0.30	0	0	0.01
C164	0.156	9.13	88.19	0.728	500	0.2	0	1.70	0.5	2000	0	0.30	0	0	0.01
C165	0.215	8.00	53.20	0.763	500	0.2	0	1.08	0.5	2000	0	0.30	0	0	0.01
C166	0.200	7.36	46.34	0.775	500	0.2	0	0.96	0.5	2000	0	0.30	0	0	0.01
C167	0.267	9.90	76.74	0.721	500	0.2	0	1.44	0.5	2000	0	0.30	0	0	0.01
C168	0.306	12.07	105.09	0.669	500	0.2	0	1.87	0.5	2000	0	0.30	0	0	0.01
C169	0.066	16.33	159.93	0.571	500	0.2	0	2.71	0.5	2000	0	0.30	0	0	0.00
C170	0.107	13.95	136.51	0.621	500	0.2	0	2.37	0.5	2000	0	0.30	0	0	0.00
C171	0.512	7.06	67.60	0.753	500	0.2	0	1.25	0.5	2000	0	0.30	0	0	0.02
C172	0.701	12.52	115.91	0.651	500	0.2	0	2.01	0.5	2000	0	0.30	0	0	0.03
C173	0.124	7.67	73.84	0.744	500	0.2	0	1.37	0.5	2000	0	0.30	0	0	0.00
C174	0.102	16.08	157.88	0.576	500	0.2	0	2.68	0.5	2000	0	0.30	0	0	0.00
C175	0.106	14.85	145.48	0.607	500	0.2	0	2.54	0.5	2000	0	0.30	0	0	0.00
C176	0.382	8.81	63.18	0.745	500	0.2	0	1.23	0.5	2000	0	0.30	0	0	0.02
C177	0.328	11.13	92.40	0.692	500	0.2	0	1.68	0.5	2000	0	0.30	0	0	0.01
C178	0.449	10.93	89.45	0.698	500	0.2	0	1.64	0.5	2000	0	0.30	0	0	0.02
C179	0.092	14.72	140.51	0.603	500	0.2	0	2.39	0.5	2000	0	0.30	0	0	0.00
C180	0.107	17.94	176.45	0.541	500	0.2	0	2.99	0.5	2000	0	0.30	0	0	0.00
C181	0.232	16.14	158.14	0.571	500	0.2	0	2.66	0.5	2000	0	0.30	0	0	0.01
C182	0.408	17.12	168.20	0.558	500	0.2	0	2.87	0.5	2000	0	0.30	0	0	0.02
C183	0.225	10.35	82.23	0.711	500	0.2	0	1.53	0.5	2000	0	0.30	0	0	0.01
C184	0.105	9.74	74.71	0.724	500	0.2	0	1.41	0.5	2000	0	0.30	0	0	0.00
C185	0.073	9.83	91.26	0.692	500	0.2	0	1.54	0.5	2000	0	0.30	0	0	0.00
C186	0.160	6.23	59.27	0.782	500	0.2	0	1.21	0.5	2000	0	0.30	0	0	0.01
C187	0.084	15.45	151.43	0.594	500	0.2	0	2.62	0.5	2000	0	0.30	0	0	0.00

Table 3.3.3 Runoff from Sub-catchments (1/3)

Code	Area (km^2)	2-yr probable				5-yr probable				10-yr probable				25-yr probable				50-yr probable			
		Present		Future		Present		Future		Present		Future		Present		Future		Present		Future	
		Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*
C001	0.80	4.63	*5.78*	7.37	*9.21*	7.65	*9.55*	10.43	*13.02*	9.65	*12.05*	12.35	*15.42*	12.13	*15.14*	14.66	*18.31*	13.92	*17.38*	16.31	*20.37*
C002	0.27	1.25	*4.59*	3.37	*12.33*	2.21	*8.09*	4.27	*15.59*	2.88	*10.52*	4.85	*17.70*	3.72	*13.58*	5.57	*20.34*	4.33	*15.83*	6.10	*22.29*
C003	0.66	7.41	*11.20*	8.10	*12.25*	9.73	*14.71*	10.26	*15.51*	11.19	*16.92*	11.66	*17.63*	12.97	*19.61*	13.40	*20.26*	14.26	*21.56*	14.68	*22.21*
C004	0.24	0.56	*2.30*	2.50	*10.35*	0.93	*3.85*	3.39	*14.02*	1.18	*4.89*	3.94	*16.32*	1.74	*7.20*	4.61	*19.10*	2.18	*9.02*	5.10	*21.10*
C005	0.13	0.35	*2.63*	1.74	*13.11*	0.55	*4.17*	2.17	*16.36*	0.77	*5.83*	2.45	*18.52*	1.11	*8.35*	2.89	*21.80*	1.37	*10.31*	3.24	*24.46*
C006	0.45	5.23	*11.67*	5.82	*12.98*	6.75	*15.06*	7.27	*16.21*	7.72	*17.21*	8.23	*18.36*	8.91	*19.86*	9.49	*21.16*	9.77	*21.80*	10.70	*23.87*
C007	0.37	1.73	*4.67*	2.20	*5.95*	3.02	*8.18*	3.59	*9.73*	3.92	*10.61*	4.51	*12.22*	5.05	*13.66*	5.65	*15.31*	5.87	*15.90*	6.48	*17.54*
C008	0.24	3.06	*12.61*	3.06	*12.61*	3.84	*15.83*	3.84	*15.83*	4.35	*17.95*	4.35	*17.95*	5.00	*20.61*	5.00	*20.61*	5.47	*22.58*	5.47	*22.58*
C009	0.27	2.77	*10.32*	2.76	*10.31*	3.75	*13.99*	3.75	*13.98*	4.37	*16.29*	4.37	*16.28*	5.11	*19.06*	5.11	*19.06*	5.65	*21.06*	5.65	*21.05*
C010	0.23	1.76	*7.76*	2.42	*10.69*	2.61	*11.54*	3.24	*14.30*	3.16	*13.95*	3.75	*16.57*	3.82	*16.88*	4.37	*19.31*	4.30	*18.97*	4.82	*21.29*
C011	0.22	2.90	*13.23*	2.90	*13.23*	3.61	*16.49*	3.61	*16.49*	4.09	*18.67*	4.09	*18.67*	4.89	*22.34*	4.89	*22.34*	5.46	*24.94*	5.46	*24.94*
C012	0.41	1.52	*3.69*	5.05	*12.26*	2.80	*6.81*	6.39	*15.52*	3.73	*9.06*	7.26	*17.63*	4.92	*11.96*	8.34	*20.27*	5.81	*14.10*	9.14	*22.21*
C013	0.33	1.26	*3.79*	3.70	*11.10*	2.33	*6.99*	4.87	*14.63*	3.10	*9.29*	5.61	*16.84*	4.08	*12.24*	6.51	*19.54*	4.80	*14.42*	7.16	*21.49*
C014	0.18	0.62	*3.47*	1.52	*8.52*	1.16	*6.55*	2.20	*12.39*	1.56	*8.79*	2.64	*14.84*	2.08	*11.69*	3.16	*17.79*	2.46	*13.85*	3.54	*19.90*
C015	0.15	0.67	*4.57*	0.67	*4.57*	1.17	*8.03*	1.17	*8.03*	1.52	*10.43*	1.52	*10.43*	1.96	*13.46*	1.96	*13.46*	2.29	*15.68*	2.29	*15.68*
C016	0.23	2.78	*11.98*	2.78	*12.00*	3.55	*15.31*	3.56	*15.32*	4.05	*17.44*	4.05	*17.45*	4.66	*20.07*	4.66	*20.09*	5.11	*22.01*	5.11	*22.03*
C017	0.61	1.89	*3.11*	1.97	*3.23*	3.31	*5.44*	3.58	*5.88*	4.58	*7.53*	4.89	*8.04*	6.26	*10.28*	6.61	*10.87*	7.53	*12.37*	7.90	*12.99*
C018	0.08	0.68	*8.65*	0.93	*11.77*	0.97	*12.34*	1.19	*15.15*	1.15	*14.67*	1.36	*17.29*	1.37	*17.48*	1.57	*19.94*	1.53	*19.48*	1.72	*21.88*
C019	0.40	1.11	*2.76*	1.75	*4.35*	1.77	*4.42*	3.12	*7.79*	2.52	*6.29*	4.09	*10.20*	3.55	*8.86*	5.31	*13.26*	4.35	*10.84*	6.21	*15.50*
C020	0.14	0.42	*3.00*	0.42	*3.00*	0.73	*5.13*	0.73	*5.13*	1.01	*7.15*	1.01	*7.15*	1.39	*9.85*	1.39	*9.85*	1.68	*11.90*	1.68	*11.90*
C021	0.33	0.94	*2.88*	3.48	*10.71*	1.54	*4.74*	4.65	*14.31*	2.17	*6.68*	5.39	*16.57*	3.03	*9.32*	6.28	*19.30*	3.68	*11.33*	6.92	*21.27*
C022	0.24	0.75	*3.18*	1.81	*7.70*	1.34	*5.69*	2.72	*11.56*	1.84	*7.82*	3.30	*14.03*	2.50	*10.62*	4.00	*17.03*	2.99	*12.74*	4.51	*19.17*
C023	0.25	0.66	*2.67*	2.85	*11.62*	1.03	*4.18*	3.69	*15.03*	1.46	*5.96*	4.22	*17.18*	2.08	*8.49*	4.87	*19.84*	2.57	*10.45*	5.34	*21.77*
C024	0.21	0.62	*2.96*	1.58	*7.51*	1.05	*4.99*	2.39	*11.41*	1.47	*6.99*	2.92	*13.91*	2.03	*9.66*	3.56	*16.95*	2.46	*11.70*	4.01	*19.13*
C025	0.61	6.19	*10.10*	6.22	*10.14*	8.44	*13.77*	8.47	*13.82*	9.86	*16.07*	9.88	*16.12*	11.56	*18.85*	11.59	*18.90*	12.78	*20.85*	12.81	*20.90*
C026	0.23	1.10	*4.81*	1.47	*6.46*	1.91	*8.38*	2.35	*10.31*	2.46	*10.82*	2.92	*12.82*	3.17	*13.90*	3.62	*15.91*	3.68	*16.15*	4.13	*18.13*
C027	0.30	1.14	*3.82*	2.11	*7.10*	2.08	*7.02*	3.26	*10.98*	2.76	*9.31*	4.00	*13.48*	3.63	*12.24*	4.91	*16.54*	4.28	*14.41*	5.56	*18.73*
C028	0.26	0.76	*2.92*	0.93	*3.55*	1.28	*4.87*	1.75	*6.68*	1.79	*6.84*	2.35	*8.97*	2.49	*9.50*	3.12	*11.91*	3.02	*11.53*	3.69	*14.10*
C029	0.30	0.74	*2.47*	0.74	*2.47*	1.19	*4.00*	1.19	*4.00*	1.60	*5.35*	1.60	*5.35*	2.32	*7.75*	2.32	*7.75*	2.88	*9.64*	2.88	*9.64*
C030	0.23	2.79	*12.37*	2.78	*12.33*	3.52	*15.61*	3.52	*15.59*	4.00	*17.72*	3.99	*17.70*	4.59	*20.36*	4.59	*20.34*	5.03	*22.31*	5.03	*22.29*
C031	0.36	4.34	*11.91*	4.34	*11.91*	5.56	*15.25*	5.56	*15.25*	6.33	*17.38*	6.33	*17.38*	7.30	*20.02*	7.30	*20.02*	8.00	*21.96*	8.00	*21.96*
C032	0.44	2.46	*5.63*	2.46	*5.63*	4.09	*9.36*	4.09	*9.36*	5.18	*11.85*	5.18	*11.85*	6.53	*14.94*	6.53	*14.94*	7.51	*17.18*	7.51	*17.18*
C033	0.10	0.21	*2.01*	0.21	*2.01*	0.36	*3.52*	0.36	*3.52*	0.46	*4.52*	0.46	*4.52*	0.64	*6.22*	0.64	*6.22*	0.81	*7.92*	0.81	*7.92*
C034	0.20	0.62	*3.15*	2.47	*12.44*	1.08	*5.44*	3.11	*15.68*	1.50	*7.56*	3.53	*17.80*	2.05	*10.36*	4.05	*20.44*	2.48	*12.48*	4.44	*22.39*
C035	0.43	4.22	*9.77*	5.28	*12.24*	5.85	*13.56*	6.71	*15.55*	6.88	*15.93*	7.63	*17.68*	8.11	*18.80*	8.78	*20.33*	9.00	*20.85*	9.62	*22.29*
C036	0.09	0.25	*2.73*	1.15	*12.70*	0.39	*4.27*	1.44	*15.97*	0.54	*6.02*	1.63	*18.10*	0.77	*8.57*	1.87	*20.78*	0.95	*10.56*	2.05	*22.76*
C037	0.46	1.44	*3.12*	5.17	*11.23*	2.49	*5.41*	6.79	*14.76*	3.45	*7.49*	7.81	*16.98*	4.72	*10.27*	9.06	*19.69*	5.69	*12.36*	9.96	*21.64*
C038	0.60	1.40	*2.33*	4.27	*7.12*	2.31	*3.85*	6.61	*11.02*	3.00	*4.99*	8.11	*13.52*	4.38	*7.30*	9.95	*16.58*	5.48	*9.13*	11.26	*18.78*
C039	0.46	1.22	*2.67*	2.29	*4.99*	1.91	*4.17*	3.94	*8.60*	2.75	*5.99*	5.07	*11.06*	3.90	*8.51*	6.49	*14.15*	4.79	*10.46*	7.52	*16.39*
C040	0.25	0.53	*2.15*	0.72	*2.91*	0.90	*3.67*	1.16	*4.73*	1.14	*4.63*	1.65	*6.70*	1.65	*6.69*	2.31	*9.38*	2.07	*8.44*	2.81	*11.43*
C041	0.15	1.88	*12.23*	1.88	*12.23*	2.38	*15.50*	2.38	*15.50*	2.70	*17.61*	2.70	*17.61*	3.11	*20.25*	3.11	*20.25*	3.40	*22.19*	3.40	*22.19*
C042	0.04	0.35	*8.70*	0.35	*8.70*	0.51	*12.57*	0.51	*12.57*	0.60	*15.01*	0.60	*15.01*	0.72	*17.96*	0.72	*17.96*	0.81	*20.07*	0.81	*20.07*
C043	0.05	0.43	*9.18*	0.43	*9.18*	0.61	*13.01*	0.61	*13.01*	0.72	*15.42*	0.72	*15.42*	0.86	*18.33*	0.86	*18.33*	0.96	*20.40*	0.96	*20.40*
C044	0.09	1.15	*12.89*	1.15	*12.89*	1.44	*16.10*	1.44	*16.10*	1.63	*18.24*	1.63	*18.24*	1.88	*20.94*	1.88	*20.94*	2.09	*23.30*	2.09	*23.30*
C045	0.08	0.68	*8.30*	0.68	*8.30*	1.00	*12.20*	1.00	*12.20*	1.20	*14.66*	1.20	*14.66*	1.45	*17.64*	1.45	*17.64*	1.62	*19.77*	1.62	*19.77*
C046	0.20	2.46	*12.43*	2.46	*12.43*	3.10	*15.67*	3.10	*15.67*	3.52	*17.78*	3.52	*17.78*	4.04	*20.43*	4.04	*20.43*	4.43	*22.38*	4.43	*22.38*
C047	0.13	1.70	*12.93*	1.70	*12.93*	2.12	*16.15*	2.12	*16.15*	2.40	*18.29*	2.40	*18.29*	2.76	*20.99*	2.76	*20.99*	3.09	*23.52*	3.09	*23.52*
C048	0.22	2.36	*10.90*	2.36	*10.90*	3.13	*14.47*	3.13	*14.47*	3.61	*16.71*	3.61	*16.71*	4.20	*19.43*	4.20	*19.43*	4.62	*21.40*	4.62	*21.40*
C049	0.15	1.95	*12.61*	1.95	*12.62*	2.45	*15.83*	2.45	*15.84*	2.78	*17.95*	2.78	*17.95*	3.19	*20.61*	3.19	*20.61*	3.50	*22.58*	3.50	*22.58*
C050	0.27	3.08	*11.32*	3.08	*11.32*	4.03	*14.80*	4.03	*14.80*	4.62	*17.00*	4.62	*17.00*	5.35	*19.68*	5.35	*19.68*	5.88	*21.62*	5.88	*21.62*
C051	0.07	0.55	*7.62*	0.55	*7.62*	0.83	*11.53*	0.83	*11.53*	1.00	*14.02*	1.00	*14.02*	1.22	*17.05*	1.22	*17.05*	1.38	*19.22*	1.38	*19.22*
C052	0.04	0.32	*8.82*	0.46	*12.56*	0.47	*12.69*	0.58	*15.75*	0.56	*15.12*	0.66	*17.88*	0.66	*18.06*	0.77	*20.88*	0.74	*20.16*	0.86	*23.50*
C053	0.36	1.10	*3.04*	1.08	*2.99*	1.84	*5.09*	1.79	*4.94*	2.58	*7.14*	2.51	*6.96*	3.57	*9.88*	3.50	*9.68*	4.33	*11.97*	4.25	*11.75*
C054	0.31	3.78	*12.34*	3.82	*12.48*	4.78	*15.59*	4.81	*15.71*	5.42	*17.70*	5.46	*17.82*	6.23	*20.34*	6.27	*20.47*	6.83	*22.29*	6.87	*22.43*
C055	0.14	0.76	*5.33*	0.86	*6.01*	1.29	*9.02*	1.40	*9.80*	1.64	*11.49*	1.76	*12.29*	2.09	*14.59*	2.20	*15.37*	2.41	*16.83*	2.52	*17.60*
C056	0.35	4.26	*12.34*	4.26	*12.34*	5.38	*15.58*	5.38	*15.58*	6.11	*17.69*	6.11	*17.69*	7.03	*20.33*	7.03	*20.33*	7.70	*22.28*	7.70	*22.28*
C057	0.58	7.02	*12.03*	7.02	*12.03*	8.91	*15.28*	8.91	*15.28*	10.14	*17.38*	10.14	*17.38*	11.66	*19.99*	11.66	*19.99*	12.79	*21.92*	12.79	*21.92*
C058	0.57	6.95	*12.28*	6.95	*12.28*	8.78	*15.51*	8.78	*15.51*	9.98	*17.62*	9.98	*17.62*	11.47	*20.25*	11.47	*20.25*	12.57	*22.19*	12.57	*22.19*
C059	0.07	0.84	*11.21*	0.58	*7.80*	1.07	*14.38*	0.86	*11.48*	1.23	*16.43*	1.03	*13.83*	1.42	*18.98*	1.25	*16.68*	1.56	*20.86*	1.40	*18.72*
C060	0.74	5.80	*7.86*	5.80	*7.86*	8.60	*11.66*	8.60	*11.66*	10.39	*14.08*	10.39	*14.08*	12.56	*17.02*	12.56	*17.02*	14.10	*19.11*	14.10	*19.11*
C061	0.49	6.03	*12.42*	6.03	*12.42*	7.60	*15.65*	7.60	*15.65*	8.62	*17.76*	8.62	*17.76*	9.90	*20.40*	9.90	*20.40*	10.85	*22.35*	10.85	*22.35*
C062	0.66	7.20	*10.89*	7.20	*10.89*	9.55	*14.44*	9.55	*14.44*	11.03	*16.67*	11.03	*16.67*	12.82	*19.38*	12.82	*19.38*	14.11	*21.34*	14.11	*21.34*
C063	0.18	2.31	*12.52*	2.31	*12.50*	2.89	*15.70*	2.89	*15.68*	3.29	*17.82*	3.28	*17.79*	3.78	*20.49*	3.77	*20.46*	4.22	*22.89*	4.19	*22.73*
C064	0.24	1.02	*4.23*	1.02	*4.23*	1.81	*7.52*	1.81	*7.52*	2.37	*9.84*	2.37	*9.84*	3.08	*12.78*	3.08	*12.78*	3.61	*14.95*	3.61	*14.95*
C065	0.24	2.28	*9.44*	2.18	*9.01*	3.16	*13.09*	3.07	*12.72*	3.72	*15.39*	3.64	*15.06*	4.39	*18.16*	4.32	*17.88*	4.87	*20.15*	4.81	*19.90*
C066	0.04	0.20	*4.55*	0.11	*2.57*	0.35	*8.00*	0.18	*4.08*	0.45	*10.39*	0.25	*5.65*	0.58	*13.42*	0.35	*8.10*	0.68	*15.64*	0.44	*10.02*
C067	0.29	3.80	*13.11*	2.96	*10.20*	4.75	*16.37*	4.03	*13.91*	5.38	*18.55*	4.71	*16.24*	6.25	*21.57*	5.53	*19.07*	7.04	*24.27*	6.12	*21.09*
C068	0.07	0.82	*11.28*	0.67	*9.18*	1.08	*14.80*	0.94	*12.97*	1.24	*17.02*	1.12	*15.37*	1.44	*19.72*	1.33	*18.26*	1.58	*21.68*	1.48	*20.32*
C069	0.85	2.57	*3.02*	2.57	*3.01*	4.40	*5.17*	4.39	*5.15*	6.13	*7.19*	6.11	*7.17*	8.43	*9.90*	8.42	*9.88*	10.19	*11.95*	10.17	*11.93*
C070	0.33	0.79	*2.37*	1.14	*3.43*	1.30	*3.89*	2.17	*6.50*	1.70	*5.09*	2.92	*8.77*	2.47	*7.43*	3.91	*11.72*	3.09	*9.26*	4.64	*13.91*
C071	0.09	0.28	*3.07*	0.27	*2.91*	0.47	*5.11*	0.43	*4.67*	0.66	*7.16*	0.61	*6.63*	0.91	*9.90*	0.86	*9.29*	1.10	*11.99*	1.04	*11.34*
C072	0.06	0.12	*1.96*	0.09	*1.53*	0.21	*3.46*	0.17	*2.89*	0.27	*4.46*	0.23	*3.89*	0.37	*6.07*	0.31	*5.12*	0.47	*7.74*	0.37	*6.16*
C073	0.31	0.99	*3.23*	0.99	*3.23*	1.82	*5.90*	1.82	*5.90*	2.48	*8.05*	2.48	*8.05*	3.35	*10.86*	3.35	*10.86*	4.00	*12.98*	4.00	*12.98*
C074	0.21	0.34	*1.66*	0.34	*1.66*	0.63	*3.07*	0.63	*3.07*	0.84	*4.07*	0.84	*4.07*	1.09	*5.29*	1.09	*5.29*	1.36	*6.63*	1.36	*6.63*
C075	0.16	0.48	*2.92*	0.48	*2.92*	0.79	*4.87*	0.79	*4.87*	1.11	*6.84*	1.11	*6.84*	1.55	*9.50*	1.55	*9.50*	1.88	*11.53*	1.88	*11.53*
C076	0.05	0.07	*1.50*	0.07	*1.50*	0.14	*2.85*	0.14	*2.85*	0.19	*3.85*	0.19	*3.85*	0.25	*5.08*	0.25	*5.08*	0.29	*6.07*	0.29	*6.07*
C077	0.46	0.80	*1.74*	0.80	*1.74*	1.46	*3.17*	1.46	*3.17*	1.92	*4.18*	1.92	*4.18*	2.48	*5.38*	2.48	*5.38*	3.19	*6.92*	3.19	*6.92*
C078	0.12	0.18	*1.49*	0.18	*1.49*	0.35	*2.83*	0.35	*2.83*	0.47	*3.83*	0.47	*3.83*	0.62	*5.07*	0.62	*5.07*	0.74	*6.02*	0.74	*6.02*
C079	0.07	0.10	*1.49*	0.10	*1.49*	0.19	*2.83*	0.19	*2.83*	0.26	*3.83*	0.26	*3.83*	0.34	*5.07*	0.34	*5.07*	0.40	*6.02*	0.40	*6.02*
C080	0.05	0.07	*1.50*	0.07	*1.50*	0.14	*2.84*	0.14	*2.84*	0.19	*3.84*	0.19	*3.84*	0.25	*5.08*	0.25	*5.08*	0.30	*6.03*	0.30	*6.03*
C081	0.31	0.69	*2.22*	0.47	*1.51*	1.18	*3.76*	0.89	*2.86*	1.48	*4.73*	1.21	*3.86*	2.16	*6.92*	1.59	*5.10*	2.72	*8.71*	1.90	*6.10*
C082	0.69	3.05	*4.40*	2.42	*3.49*	5.40	*7.80*	4.55	*6.57*	7.04	*10.17*	6.11	*8.82*	9.13	*13.18*	8.13	*11.73*	10.65	*15.38*	9.63	*13.90*

Table 3.3.3 Runoff from Sub-catchments (2/3)

Code	Area (km^2)	2-yr probable				5-yr probable				10-yr probable				25-yr probable				50-yr probable			
		Present		Future		Present		Future		Present		Future		Present		Future		Present		Future	
		Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*
C083	0.37	2.95	*8.03*	2.95	*8.03*	4.32	*11.78*	4.32	*11.78*	5.20	*14.16*	5.20	*14.16*	6.26	*17.04*	6.26	*17.04*	7.02	*19.11*	7.02	*19.11*
C084	0.11	0.36	*3.31*	0.17	*1.56*	0.65	*6.00*	0.32	*2.93*	0.90	*8.20*	0.43	*3.93*	1.21	*11.09*	0.56	*5.17*	1.45	*13.25*	0.68	*6.26*
C085	0.14	0.63	*4.50*	0.39	*2.77*	1.11	*7.91*	0.62	*4.43*	1.45	*10.29*	0.89	*6.30*	1.87	*13.29*	1.25	*8.87*	2.18	*15.50*	1.53	*10.85*
C086	0.58	2.29	*3.95*	6.94	*11.95*	4.15	*7.15*	8.87	*15.29*	5.47	*9.43*	10.11	*17.43*	7.17	*12.35*	11.64	*20.07*	8.42	*14.50*	12.77	*22.01*
C087	0.77	2.06	*2.67*	7.99	*10.34*	3.22	*4.16*	10.83	*14.01*	4.62	*5.98*	12.61	*16.32*	6.56	*8.49*	14.76	*19.09*	8.06	*10.43*	16.30	*21.09*
C088	0.49	0.86	*1.76*	4.63	*9.43*	1.57	*3.20*	6.50	*13.23*	2.06	*4.20*	7.67	*15.61*	2.67	*5.44*	9.08	*18.49*	3.44	*7.01*	10.09	*20.54*
C089	0.37	0.75	*2.03*	3.42	*9.30*	1.30	*3.53*	4.83	*13.12*	1.66	*4.51*	5.71	*15.52*	2.31	*6.28*	6.78	*18.42*	2.93	*7.97*	7.54	*20.48*
C090	0.25	0.84	*3.30*	3.13	*12.26*	1.60	*6.27*	3.96	*15.53*	2.16	*8.46*	4.50	*17.64*	2.88	*11.30*	5.17	*20.27*	3.42	*13.43*	5.66	*22.22*
C091	0.73	3.15	*4.34*	9.14	*12.61*	5.60	*7.73*	11.52	*15.90*	7.33	*10.11*	13.07	*18.03*	9.53	*13.15*	15.01	*20.71*	11.16	*15.39*	16.44	*22.68*
C092	0.36	3.59	*9.98*	3.22	*8.94*	5.00	*13.89*	4.64	*12.90*	5.89	*16.37*	5.55	*15.42*	6.97	*19.35*	6.65	*18.48*	7.74	*21.49*	7.44	*20.66*
C093	0.32	0.62	*1.93*	3.65	*11.39*	1.10	*3.43*	4.77	*14.87*	1.42	*4.43*	5.47	*17.07*	1.91	*5.96*	6.34	*19.76*	2.44	*7.62*	6.96	*21.71*
C094	0.69	7.23	*10.52*	6.50	*9.47*	9.66	*14.07*	9.04	*13.17*	11.19	*16.30*	10.65	*15.51*	13.05	*19.00*	12.59	*18.33*	14.39	*20.96*	13.97	*20.35*
C095	0.22	0.36	*1.68*	0.47	*2.20*	0.67	*3.10*	0.80	*3.73*	0.88	*4.10*	1.01	*4.70*	1.14	*5.31*	1.48	*6.85*	1.45	*6.72*	1.86	*8.63*
C096	0.06	0.09	*1.49*	0.09	*1.49*	0.18	*2.83*	0.18	*2.83*	0.24	*3.83*	0.24	*3.83*	0.32	*5.07*	0.32	*5.07*	0.38	*6.02*	0.38	*6.02*
C097	0.03	0.04	*1.49*	0.04	*1.49*	0.08	*2.83*	0.08	*2.83*	0.11	*3.83*	0.11	*3.83*	0.15	*5.07*	0.15	*5.07*	0.17	*6.02*	0.17	*6.02*
C098	0.04	0.07	*1.78*	0.07	*1.78*	0.13	*3.24*	0.13	*3.24*	0.17	*4.25*	0.17	*4.25*	0.22	*5.50*	0.22	*5.50*	0.28	*7.08*	0.28	*7.08*
C099	0.07	0.53	*7.86*	0.53	*7.86*	0.81	*11.84*	0.81	*11.84*	0.98	*14.41*	0.98	*14.41*	1.20	*17.56*	1.20	*17.56*	1.35	*19.82*	1.35	*19.82*
C100	0.54	1.02	*1.87*	4.56	*8.38*	1.82	*3.34*	6.68	*12.27*	2.36	*4.34*	8.01	*14.73*	3.15	*5.80*	9.63	*17.70*	4.04	*7.42*	10.79	*19.82*
C101	0.75	1.62	*2.17*	2.56	*3.42*	2.76	*3.68*	4.86	*6.49*	3.47	*4.64*	6.56	*8.76*	5.05	*6.75*	8.76	*11.70*	6.37	*8.50*	10.40	*13.89*
C102	0.45	1.06	*2.37*	4.21	*9.44*	1.73	*3.89*	5.90	*13.24*	2.28	*5.11*	6.96	*15.63*	3.32	*7.45*	8.24	*18.50*	4.14	*9.29*	9.16	*20.55*
C103	0.56	2.82	*5.03*	6.22	*11.12*	4.80	*8.57*	8.20	*14.64*	6.14	*10.97*	9.44	*16.86*	7.83	*13.99*	10.94	*19.55*	9.06	*16.18*	12.04	*21.50*
C104	0.11	0.20	*1.75*	0.28	*2.46*	0.36	*3.19*	0.45	*4.01*	0.47	*4.19*	0.60	*5.33*	0.61	*5.41*	0.88	*7.74*	0.79	*6.97*	1.09	*9.63*
C105	0.18	0.60	*3.29*	2.01	*10.97*	1.14	*6.25*	2.66	*14.53*	1.54	*8.44*	3.07	*16.76*	2.06	*11.28*	3.56	*19.47*	2.45	*13.41*	3.92	*21.43*
C106	0.07	0.10	*1.49*	0.10	*1.58*	0.18	*2.83*	0.19	*2.96*	0.25	*3.83*	0.26	*3.97*	0.33	*5.07*	0.34	*5.20*	0.39	*6.02*	0.41	*6.35*
C107	0.42	1.07	*2.57*	4.28	*10.24*	1.70	*4.07*	5.83	*13.93*	2.37	*5.67*	6.79	*16.24*	3.40	*8.13*	7.96	*19.02*	4.20	*10.04*	8.79	*21.02*
C108	0.26	0.74	*2.80*	3.11	*11.79*	1.20	*4.53*	4.00	*15.15*	1.70	*6.43*	4.56	*17.29*	2.38	*9.02*	5.26	*19.93*	2.91	*11.01*	5.77	*21.87*
C109	0.37	0.91	*2.46*	2.49	*6.76*	1.46	*3.97*	3.92	*10.62*	1.97	*5.35*	4.84	*13.12*	2.85	*7.74*	5.97	*16.19*	3.54	*9.61*	6.78	*18.39*
C110	0.17	0.35	*2.06*	0.39	*2.24*	0.61	*3.56*	0.65	*3.76*	0.78	*4.54*	0.81	*4.73*	1.10	*6.39*	1.20	*6.98*	1.40	*8.10*	1.51	*8.77*
C111	0.44	1.00	*2.29*	3.83	*8.76*	1.66	*3.80*	5.52	*12.62*	2.13	*4.87*	6.58	*15.05*	3.12	*7.14*	7.87	*17.99*	3.91	*8.95*	8.78	*20.09*
C112	0.10	0.16	*1.49*	0.26	*2.49*	0.29	*2.83*	0.42	*4.04*	0.40	*3.83*	0.56	*5.41*	0.53	*5.07*	0.82	*7.84*	0.63	*6.02*	1.01	*9.74*
C113	0.22	0.35	*1.56*	0.43	*1.91*	0.65	*2.93*	0.76	*3.40*	0.88	*3.93*	0.98	*4.40*	1.15	*5.17*	1.32	*5.90*	1.40	*6.26*	1.68	*7.54*
C114	0.84	1.37	*1.63*	5.34	*6.38*	2.53	*3.03*	8.54	*10.22*	3.37	*4.04*	10.63	*12.72*	4.39	*5.26*	13.21	*15.80*	5.46	*6.54*	15.06	*18.02*
C115	0.18	0.41	*2.32*	0.41	*2.32*	0.69	*3.84*	0.69	*3.84*	0.89	*4.96*	0.89	*4.96*	1.30	*7.26*	1.30	*7.26*	1.62	*9.08*	1.62	*9.08*
C116	0.48	0.90	*1.86*	1.79	*3.70*	1.61	*3.33*	3.35	*6.91*	2.10	*4.33*	4.47	*9.22*	2.79	*5.76*	5.91	*12.19*	3.58	*7.38*	6.98	*14.40*
C117	0.16	0.25	*1.55*	0.83	*5.14*	0.47	*2.91*	1.42	*8.78*	0.63	*3.92*	1.81	*11.25*	0.83	*5.15*	2.31	*14.34*	1.00	*6.21*	2.67	*16.59*
C118	0.12	0.19	*1.60*	0.19	*1.60*	0.35	*2.99*	0.35	*2.99*	0.47	*4.00*	0.47	*4.00*	0.62	*5.23*	0.62	*5.23*	0.76	*6.42*	0.76	*6.42*
C119	0.71	2.06	*2.92*	6.64	*9.41*	3.44	*4.87*	9.32	*13.21*	4.83	*6.84*	11.00	*15.59*	6.70	*9.50*	13.03	*18.46*	8.13	*11.53*	14.47	*20.51*
C120	0.52	1.53	*2.93*	5.24	*10.05*	2.56	*4.92*	7.18	*13.77*	3.59	*6.89*	8.39	*16.09*	4.98	*9.55*	9.85	*18.90*	6.04	*11.59*	10.90	*20.91*
C121	0.42	0.79	*1.90*	3.22	*7.72*	1.41	*3.38*	4.85	*11.62*	1.83	*4.37*	5.89	*14.11*	2.46	*5.89*	7.16	*17.14*	3.14	*7.52*	8.06	*19.30*
C122	0.09	0.17	*1.86*	0.25	*2.73*	0.31	*3.32*	0.39	*4.27*	0.40	*4.32*	0.56	*6.12*	0.53	*5.75*	0.80	*8.69*	0.68	*7.36*	0.98	*10.68*
C123	0.22	0.70	*3.15*	2.57	*11.50*	1.26	*5.65*	3.34	*14.93*	1.73	*7.76*	3.82	*17.11*	2.35	*10.53*	4.42	*19.77*	2.82	*12.63*	4.85	*21.71*
C124	0.30	0.89	*2.98*	2.48	*8.27*	1.52	*5.05*	3.64	*12.12*	2.12	*7.05*	4.37	*14.56*	2.92	*9.74*	5.26	*17.51*	3.54	*11.78*	5.89	*19.62*
C125	0.27	0.75	*2.75*	1.93	*7.10*	1.19	*4.37*	2.98	*10.98*	1.69	*6.24*	3.66	*13.48*	2.39	*8.80*	4.49	*16.54*	2.92	*10.77*	5.08	*18.73*
C126	0.15	0.23	*1.49*	1.55	*10.21*	0.43	*2.83*	2.10	*13.90*	0.58	*3.83*	2.45	*16.21*	0.77	*5.07*	2.87	*19.00*	0.91	*6.02*	3.18	*21.00*
C127	0.25	0.54	*2.15*	1.18	*4.68*	0.92	*3.67*	2.06	*8.20*	1.16	*4.63*	2.67	*10.63*	1.68	*6.69*	3.44	*13.70*	2.12	*8.44*	4.00	*15.94*
C128	0.30	0.92	*3.09*	3.53	*11.81*	1.62	*5.42*	4.53	*15.17*	2.24	*7.49*	5.17	*17.32*	3.05	*10.23*	5.96	*19.96*	3.67	*12.31*	6.54	*21.90*
C129	0.30	0.61	*2.07*	3.86	*12.97*	1.06	*3.57*	4.82	*16.20*	1.35	*4.55*	5.46	*18.34*	1.91	*6.41*	6.27	*21.05*	2.42	*8.12*	7.07	*23.73*
C130	0.39	0.60	*1.56*	4.44	*11.45*	1.13	*2.92*	5.77	*14.89*	1.52	*3.93*	6.62	*17.08*	2.00	*5.16*	7.65	*19.74*	2.42	*6.25*	8.41	*21.68*
C131	0.22	0.34	*1.60*	1.30	*6.07*	0.64	*2.99*	2.12	*9.87*	0.86	*3.99*	2.66	*12.38*	1.12	*5.21*	3.33	*15.47*	1.38	*6.43*	3.81	*17.70*
C132	0.34	0.94	*2.72*	1.67	*4.83*	1.48	*4.29*	2.90	*8.40*	2.12	*6.14*	3.74	*10.85*	2.99	*8.68*	4.80	*13.93*	3.67	*10.65*	5.58	*16.18*
C133	0.58	1.51	*2.61*	5.77	*9.95*	2.40	*4.15*	7.93	*13.67*	3.30	*5.70*	9.28	*16.01*	4.73	*8.16*	10.91	*18.82*	5.85	*10.09*	12.08	*20.84*
C134	0.42	1.05	*2.46*	3.67	*8.65*	1.69	*3.97*	5.32	*12.52*	2.28	*5.37*	6.35	*14.96*	3.30	*7.76*	7.61	*17.91*	4.09	*9.63*	8.50	*20.01*
C135	0.21	0.51	*2.41*	2.32	*10.87*	0.84	*3.96*	3.08	*14.44*	1.10	*5.16*	3.56	*16.68*	1.60	*7.51*	4.14	*19.40*	2.00	*9.37*	4.56	*21.36*
C136	0.58	1.33	*2.30*	5.89	*10.19*	2.21	*3.82*	8.04	*13.89*	2.83	*4.89*	9.38	*16.21*	4.15	*7.17*	11.00	*19.01*	5.19	*8.98*	12.16	*21.01*
C137	0.55	1.68	*3.09*	6.13	*11.24*	2.96	*5.42*	8.03	*14.73*	4.08	*7.49*	9.23	*16.93*	5.58	*10.23*	10.69	*19.62*	6.71	*12.31*	11.75	*21.56*
C138	0.54	1.18	*2.20*	1.53	*2.84*	1.99	*3.71*	2.44	*4.55*	2.51	*4.67*	3.48	*6.48*	3.68	*6.85*	4.89	*9.11*	4.63	*8.62*	5.98	*11.14*
C139	0.27	0.56	*2.09*	1.88	*7.01*	0.96	*3.59*	2.91	*10.86*	1.22	*4.56*	3.57	*13.34*	1.73	*6.47*	4.39	*16.37*	2.20	*8.19*	4.97	*18.55*
C140	0.08	0.14	*1.78*	0.14	*1.78*	0.26	*3.22*	0.26	*3.22*	0.34	*4.23*	0.34	*4.23*	0.44	*5.47*	0.44	*5.47*	0.56	*7.05*	0.56	*7.05*
C141	0.19	0.37	*1.95*	1.11	*5.76*	0.66	*3.43*	1.82	*9.50*	0.85	*4.42*	2.30	*11.97*	1.16	*6.03*	2.89	*15.05*	1.48	*7.68*	3.32	*17.27*
C142	0.31	1.12	*3.65*	3.17	*10.35*	2.07	*6.75*	4.29	*14.03*	2.75	*9.00*	5.00	*16.33*	3.64	*11.89*	5.85	*19.11*	4.29	*14.04*	6.46	*21.10*
C143	0.06	0.10	*1.63*	0.10	*1.63*	0.19	*3.03*	0.19	*3.03*	0.25	*4.04*	0.25	*4.04*	0.33	*5.27*	0.33	*5.27*	0.41	*6.53*	0.41	*6.53*
C144	0.39	0.76	*1.94*	4.98	*12.67*	1.35	*3.42*	6.25	*15.89*	1.74	*4.41*	7.08	*18.00*	2.36	*6.01*	8.13	*20.67*	3.01	*7.66*	8.90	*22.65*
C145	0.51	1.22	*2.36*	4.40	*8.57*	2.00	*3.88*	6.40	*12.44*	2.61	*5.08*	7.65	*14.89*	3.81	*7.41*	9.18	*17.84*	4.75	*9.24*	10.26	*19.95*
C146	0.71	1.92	*2.70*	7.24	*10.19*	3.02	*4.25*	9.88	*13.89*	4.33	*6.09*	11.53	*16.21*	6.13	*8.62*	13.51	*19.01*	7.52	*10.58*	14.94	*21.01*
C147	0.32	0.68	*2.15*	1.70	*5.38*	1.16	*3.67*	2.88	*9.07*	1.47	*4.63*	3.66	*11.55*	2.12	*6.69*	4.64	*14.65*	2.68	*8.44*	5.35	*16.89*
C148	0.34	1.05	*3.07*	2.91	*8.48*	1.84	*5.36*	4.24	*12.36*	2.54	*7.42*	5.08	*14.82*	3.48	*10.16*	6.09	*17.78*	4.19	*12.23*	6.82	*19.90*
C149	0.55	1.16	*2.11*	5.08	*9.23*	1.99	*3.62*	7.18	*13.05*	2.52	*4.58*	8.50	*15.45*	3.60	*6.54*	10.09	*18.34*	4.55	*8.27*	11.22	*20.41*
C150	0.40	1.23	*3.08*	1.94	*4.87*	2.15	*5.41*	3.36	*8.45*	2.97	*7.48*	4.33	*10.89*	4.06	*10.22*	5.56	*13.97*	4.89	*12.30*	6.45	*16.22*
C151	0.43	1.77	*4.10*	4.85	*11.24*	3.17	*7.35*	6.36	*14.73*	4.17	*9.66*	7.31	*16.93*	5.43	*12.59*	8.46	*19.62*	6.36	*14.75*	9.30	*21.56*
C152	0.22	0.45	*2.02*	1.46	*6.57*	0.78	*3.52*	2.32	*10.43*	1.00	*4.50*	2.87	*12.94*	1.39	*6.26*	3.56	*16.03*	1.77	*7.95*	4.05	*18.25*
C153	0.22	0.33	*1.50*	0.83	*3.79*	0.62	*2.85*	1.54	*7.05*	0.84	*3.85*	2.05	*9.39*	1.11	*5.08*	2.71	*12.39*	1.33	*6.07*	3.19	*14.61*
C154	0.26	0.73	*2.79*	0.82	*3.13*	1.18	*4.50*	1.43	*5.44*	1.68	*6.39*	1.98	*7.55*	2.36	*8.98*	2.72	*10.33*	2.88	*10.96*	3.27	*12.44*
C155	0.26	0.40	*1.52*	1.36	*5.21*	0.75	*2.87*	2.32	*8.88*	1.01	*3.87*	2.97	*11.35*	1.34	*5.10*	3.78	*14.44*	1.60	*6.11*	4.36	*16.68*
C156	0.31	1.76	*5.58*	2.73	*8.67*	2.88	*9.17*	3.93	*12.50*	3.63	*11.55*	4.69	*14.91*	4.57	*14.52*	5.61	*17.83*	5.25	*16.68*	6.27	*19.91*
C157	0.06	0.10	*1.72*	0.10	*1.72*	0.19	*3.15*	0.19	*3.15*	0.25	*4.16*	0.25	*4.16*	0.32	*5.38*	0.32	*5.38*	0.41	*6.85*	0.41	*6.85*
C158	0.03	0.04	*1.49*	0.04	*1.49*	0.07	*2.83*	0.07	*2.83*	0.10	*3.83*	0.10	*3.83*	0.13	*5.07*	0.13	*5.07*	0.16	*6.02*	0.16	*6.02*
C159	0.30	0.57	*1.89*	0.97	*3.18*	1.02	*3.37*	1.67	*5.50*	1.33	*4.38*	2.32	*7.62*	1.77	*5.82*	3.17	*10.44*	2.27	*7.46*	3.82	*12.57*
C160	0.18	0.88	*4.96*	1.82	*10.21*	1.50	*8.42*	2.48	*13.89*	1.92	*10.78*	2.89	*16.20*	2.45	*13.75*	3.38	*18.98*	2.84	*15.91*	3.74	*20.98*
C161	0.16	0.30	*1.79*	2.12	*12.85*	0.53	*3.24*	2.65	*16.06*	0.70	*4.24*	3.00	*18.19*	0.91	*5.54*	3.44	*20.88*	1.17	*7.12*	3.78	*22.96*
C162	0.47	0.98	*2.11*	1.97	*4.24*	1.69	*3.62*	3.56	*7.64*	2.14	*4.60*	4.68	*10.04*	3.04	*6.54*	6.09	*13.09*	3.85	*8.27*	7.14	*15.33*
C163	0.18	0.34	*1.84*	0.55	*3.00*	0.61	*3.31*	0.92	*4.96*	0.80	*4.32*	1.29	*6.98*	1.05	*5.67*	1.79	*9.71*	1.34	*7.28*	2.18	*11.79*
C164	0.16	1.34	*8.59*	1.34	*8.59*	1.96	*12.58*	1.96	*12.58*	2.36	*15.14*	2.36	*15.14*	2.84	*18.24*	2.84	*18.24*	3.19	*20.47*	3.19	*20.47*

Table 3.3.3 Runoff from Sub-catchments (3/3)

Code	Area (km^2)	2-yr probable				5-yr probable				10-yr probable				25-yr probable				50-yr probable			
		Present		Future		Present		Future		Present		Future		Present		Future		Present		Future	
		Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*	Qmax	*Qs*
C165	0.22	2.68	*12.42*	2.68	*12.42*	3.37	*15.66*	3.37	*15.66*	3.83	*17.77*	3.83	*17.77*	4.40	*20.41*	4.40	*20.41*	4.82	*22.37*	4.82	*22.37*
C166	0.20	2.59	*12.95*	2.56	*12.80*	3.23	*16.17*	3.20	*16.01*	3.66	*18.32*	3.62	*18.14*	4.21	*21.08*	4.16	*20.83*	4.75	*23.80*	4.59	*22.99*
C167	0.27	2.68	*10.07*	2.68	*10.06*	3.67	*13.79*	3.67	*13.77*	4.29	*16.11*	4.29	*16.10*	5.04	*18.92*	5.04	*18.91*	5.58	*20.93*	5.58	*20.92*
C168	0.31	1.89	*6.16*	1.82	*5.95*	3.05	*9.96*	2.98	*9.73*	3.81	*12.45*	3.74	*12.22*	4.76	*15.53*	4.69	*15.31*	5.44	*17.75*	5.37	*17.54*
C169	0.07	0.56	*8.38*	0.14	*2.15*	0.81	*12.25*	0.24	*3.67*	0.97	*14.69*	0.31	*4.64*	1.17	*17.66*	0.44	*6.67*	1.31	*19.77*	0.56	*8.42*
C170	0.11	1.39	*12.92*	0.34	*3.14*	1.73	*16.15*	0.57	*5.34*	1.96	*18.30*	0.80	*7.42*	2.25	*21.01*	1.09	*10.19*	2.50	*23.26*	1.32	*12.30*
C171	0.51	6.17	*12.06*	5.90	*11.53*	7.87	*15.38*	7.66	*14.97*	8.97	*17.53*	8.78	*17.16*	10.33	*20.18*	10.15	*19.83*	11.33	*22.14*	11.15	*21.79*
C172	0.70	2.10	*3.00*	3.31	*4.73*	3.54	*5.05*	5.76	*8.23*	4.95	*7.06*	7.45	*10.64*	6.84	*9.76*	9.59	*13.69*	8.28	*11.82*	11.15	*15.92*
C173	0.12	1.35	*10.85*	1.35	*10.85*	1.80	*14.48*	1.80	*14.48*	2.08	*16.76*	2.08	*16.76*	2.42	*19.53*	2.42	*19.53*	2.67	*21.52*	2.67	*21.52*
C174	0.10	0.23	*2.24*	0.23	*2.24*	0.38	*3.77*	0.38	*3.77*	0.48	*4.73*	0.48	*4.73*	0.71	*6.95*	0.71	*6.95*	0.89	*8.74*	0.89	*8.74*
C175	0.11	0.29	*2.76*	0.29	*2.76*	0.46	*4.31*	0.46	*4.31*	0.65	*6.12*	0.65	*6.12*	0.92	*8.70*	0.92	*8.70*	1.14	*10.69*	1.14	*10.69*
C176	0.38	4.44	*11.62*	4.44	*11.62*	5.75	*15.03*	5.75	*15.03*	6.57	*17.18*	6.57	*17.18*	7.58	*19.84*	7.58	*19.84*	8.32	*21.77*	8.32	*21.77*
C177	0.33	2.55	*7.77*	2.55	*7.77*	3.83	*11.66*	3.83	*11.66*	4.64	*14.15*	4.64	*14.15*	5.63	*17.17*	5.63	*17.17*	6.34	*19.32*	6.34	*19.32*
C178	0.45	3.76	*8.38*	3.68	*8.20*	5.50	*12.27*	5.42	*12.09*	6.61	*14.73*	6.53	*14.56*	7.94	*17.70*	7.87	*17.55*	8.89	*19.82*	8.83	*19.69*
C179	0.09	0.27	*2.93*	0.27	*2.93*	0.45	*4.84*	0.45	*4.84*	0.63	*6.81*	0.63	*6.81*	0.87	*9.49*	0.87	*9.49*	1.06	*11.53*	1.06	*11.53*
C180	0.11	0.16	*1.52*	0.16	*1.52*	0.31	*2.87*	0.31	*2.87*	0.41	*3.87*	0.41	*3.87*	0.55	*5.10*	0.55	*5.10*	0.65	*6.11*	0.65	*6.11*
C181	0.23	0.52	*2.23*	0.52	*2.23*	0.87	*3.75*	0.87	*3.75*	1.09	*4.71*	1.09	*4.71*	1.61	*6.95*	1.61	*6.95*	2.03	*8.73*	2.03	*8.73*
C182	0.41	0.74	*1.81*	0.74	*1.81*	1.33	*3.27*	1.33	*3.27*	1.75	*4.28*	1.75	*4.28*	2.27	*5.57*	2.27	*5.57*	2.92	*7.16*	2.92	*7.16*
C183	0.22	2.19	*9.77*	2.08	*9.26*	3.03	*13.51*	2.94	*13.08*	3.56	*15.86*	3.48	*15.49*	4.20	*18.69*	4.13	*18.38*	4.65	*20.72*	4.59	*20.45*
C184	0.10	1.21	*11.57*	1.08	*10.31*	1.57	*14.94*	1.47	*13.98*	1.79	*17.08*	1.71	*16.29*	2.07	*19.71*	2.00	*19.06*	2.27	*21.63*	2.21	*21.06*
C185	0.07	0.65	*8.90*	0.62	*8.51*	0.93	*12.61*	0.90	*12.25*	1.10	*14.95*	1.07	*14.62*	1.30	*17.78*	1.28	*17.48*	1.45	*19.80*	1.43	*19.53*
C186	0.16	1.99	*12.43*	1.99	*12.43*	2.53	*15.86*	2.53	*15.86*	2.88	*18.06*	2.88	*18.06*	3.32	*20.79*	3.32	*20.79*	3.64	*22.78*	3.64	*22.78*
C187	0.08	0.21	*2.51*	0.21	*2.51*	0.34	*4.07*	0.34	*4.07*	0.45	*5.41*	0.45	*5.41*	0.66	*7.83*	0.66	*7.83*	0.81	*9.73*	0.81	*9.73*

Note : Qmax : Maximum Flood Runoff (m^3/sec)
Qs : Specifice Discharge (m^3/sec/km^2)

Table 3.5.1 Calculated Maximum Flood Water Level and Runoff at Selected Points

(1) Maximum Water Level of Each Return Period (Unit : meter above MSL)

Point	Land Use	Return Period				
		2-yr	5-yr	10-yr	25-yr	50-yr
(a) Bolgoda Canal at Attidiya Rd.	Present	1.05	1.21	1.30	1.40	1.47
	Future	1.05	1.20	1.28	1.39	1.46
(b) Rattanapitiya Ela at Colombo-Piliyandala Rd.	Present	1.48	1.60	1.67	1.74	1.78
	Future	1.57	1.69	1.75	1.81	1.87
(c) Bolgoda Canal at Elewalla Rd.	Present	1.01	1.17	1.26	1.36	1.43
	Future	0.96	1.11	1.20	1.30	1.37
(d) Weras Ganga at Ratmalana-Orupana Rd.	Present	0.61	0.67	0.73	0.81	0.88
	Future	0.65	0.75	0.83	0.93	1.01
(e) Maha Ela Outfall	Present	0.83	0.93	1.00	1.08	1.12
	Future	0.94	1.06	1.12	1.17	1.21
(f) Weras Ganga Outfall	Present	0.53	0.54	0.55	0.58	0.60
	Future	0.53	0.55	0.57	0.61	0.63

(2) Maximum Flood Runoff of Each Return Period (Unit : m^3/sec)

Point	Land Use	Return Period				
		2-yr	5-yr	10-yr	25-yr	50-yr
(a) Bolgoda Canal at Attidiya Rd.	Present	18.5	25.3	29.8	35.9	40.8
(7.0 km^2)	Future	20.2	27.7	32.5	39.1	44.3
(b) Rattanapitiya Ela at Colombo-Piliyandala Rd.	Present	20.2	27.2	32.8	39.5	45.3
(6.7 km^2)	Future	25.5	34.7	40.6	50.6	58.9
(c) Bolgoda Canal at Elewalla Rd.	Present	19.5	26.9	33.0	40.4	46.0
(20.8 km^2)	Future	25.5	35.2	42.7	53.8	62.7
(d) Weras Ganga at Ratmalana-Orupana Rd.	Present	25.2	33.7	40.9	50.3	57.5
(27.6 km^2)	Future	32.7	43.9	52.7	63.7	72.6
(e) Maha Ela Outfall	Present	7.9	10.6	12.6	15.3	17.3
(20.4 km^2)	Future	11.0	14.7	17.2	20.3	22.4
(f) Weras Ganga Outfall	Present	48.3	60.6	69.8	83.6	94.0
(55.5 km^2)	Future	52.0	69.9	82.4	99.0	112.9

Note : Locations of above points are shown in Figure 3.5.1

Table 3.5.2 Estimated Flood Inundation Area for Each Return Period under Present Land Use Condition

(Unit : ha)

Return Period (Years)	Maximum Inundation Depth	Total	Land Use Category														Net Inundation Area*
			Water	Airport	Dumping Site	Factory	Grassland	Garden	High Density	Paddy	Shanty	Vacant	Homestead	Marsh	Vegetation	Others	
2	Below 20 cm	305.8	0.0	0.9	0.3	0.3	32.6	35.5	20.3	80.9	2.2	4.6	31.1	57.8	16.7	39.4	305.8
	20 - 50 cm	270.9	0.0	0.0	0.0	1.0	23.8	22.6	10.5	58.7	3.1	3.5	14.7	105.0	13.4	27.9	270.9
	50 - 100 cm	134.4	0.0	0.0	0.0	2.0	18.8	7.3	2.0	14.1	0.0	0.3	3.7	78.2	2.3	8.0	134.4
	100 - 200 cm	9.7	0.0	0.0	0.0	0.0	4.4	1.3	0.4	2.0	0.0	0.0	0.3	0.5	0.7	0.9	9.7
	Over 200 cm	120.3	120.3	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
	Total	841.1	120.3	0.9	0.3	3.4	79.6	66.7	33.2	155.7	5.3	8.5	49.9	241.5	33.1	76.3	720.8
5	Below 20 cm	326.3	0.0	1.1	0.7	0.6	34.3	38.7	25.3	88.7	2.5	6.2	35.6	37.1	31.9	55.4	326.3
	20 - 50 cm	323.4	0.0	0.1	0.1	0.1	32.5	32.1	13.2	77.7	3.7	4.4	24.5	99.1	16.9	36.0	323.4
	50 - 100 cm	192.1	0.0	0.0	0.0	2.1	20.3	12.8	4.4	18.3	0.0	1.4	5.9	113.6	4.5	13.3	192.1
	100 - 200 cm	30.9	0.0	0.0	0.0	0.9	10.6	2.5	0.9	7.3	0.0	0.0	1.2	4.9	0.9	2.7	30.9
	Over 200 cm	120.8	120.6	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.0	0.1	0.1	0.1	0.0	0.0	0.2
	Total	993.4	120.6	1.3	0.8	3.7	97.7	86.1	43.9	192.1	6.2	12.2	67.1	254.8	54.1	107.4	872.8
10	Below 20 cm	313.8	0.0	2.6	0.8	0.9	35.7	41.1	25.1	90.6	3.9	7.2	38.4	28.1	17.9	39.5	313.8
	20 - 50 cm	367.3	0.0	0.3	0.6	0.1	37.2	37.2	15.0	92.5	4.1	5.9	28.9	89.8	32.3	55.7	367.3
	50 - 100 cm	209.3	0.0	0.0	0.0	0.7	16.6	15.1	5.6	18.7	0.0	1.9	7.4	124.1	7.4	19.2	209.3
	100 - 200 cm	61.8	0.0	0.0	0.0	2.3	18.2	5.6	0.9	11.2	0.0	0.2	2.0	17.6	1.0	3.8	61.8
	Over 200 cm	121.0	120.7	0.0	0.0	0.0	0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.3
	Total	1,073.1	120.7	2.9	1.4	4.0	108.0	99.1	46.6	213.0	8.0	15.3	76.6	259.6	58.7	118.2	952.4
25	Below 20 cm	306.0	0.0	3.6	0.2	1.0	34.3	42.2	27.8	89.8	3.1	6.6	41.3	23.0	11.4	33.1	306.0
	20 - 50 cm	391.1	0.0	1.7	0.7	0.3	42.6	40.9	18.0	103.4	3.6	7.4	34.9	72.9	38.0	64.8	391.1
	50 - 100 cm	248.9	0.0	0.0	0.0	0.1	17.6	22.0	7.1	31.9	1.3	3.3	10.5	130.2	11.4	24.8	248.9
	100 - 200 cm	92.7	0.0	0.0	0.0	2.9	20.8	7.6	0.8	12.3	0.0	0.5	2.8	40.5	0.8	4.4	92.7
	Over 200 cm	124.2	120.7	0.0	0.0	0.0	2.5	0.2	0.0	0.3	0.0	0.1	0.0	0.1	0.6	0.2	3.5
	Total	1,162.8	120.7	5.3	1.0	4.3	117.8	113.0	53.7	237.6	8.0	17.8	89.6	266.7	62.2	127.3	1,042.2
50	Below 20 cm	298.0	0.0	3.3	0.4	1.2	33.0	44.1	28.6	85.9	3.3	5.7	42.1	20.8	7.6	29.5	298.0
	20 - 50 cm	397.2	0.0	1.9	0.8	0.3	44.2	40.3	20.5	112.1	3.4	8.3	37.8	60.1	39.1	67.5	397.2
	50 - 100 cm	282.3	0.0	0.0	0.0	0.0	20.6	28.4	8.2	42.1	2.1	4.4	15.0	130.4	15.6	30.9	282.3
	100 - 200 cm	115.8	0.0	0.0	0.0	3.0	21.4	9.2	0.8	11.9	0.0	0.8	3.6	59.2	1.2	6.0	115.8
	Over 200 cm	128.4	120.7	0.0	0.0	0.0	4.9	0.8	0.0	1.2	0.0	0.1	0.2	0.1	0.7	0.5	7.8
	Total	1,221.6	120.7	5.2	1.2	4.5	124.1	122.8	58.1	253.3	8.9	19.3	98.6	270.6	64.2	134.3	1,100.9

Note : *Net inundation area is total inundation area except for water body.

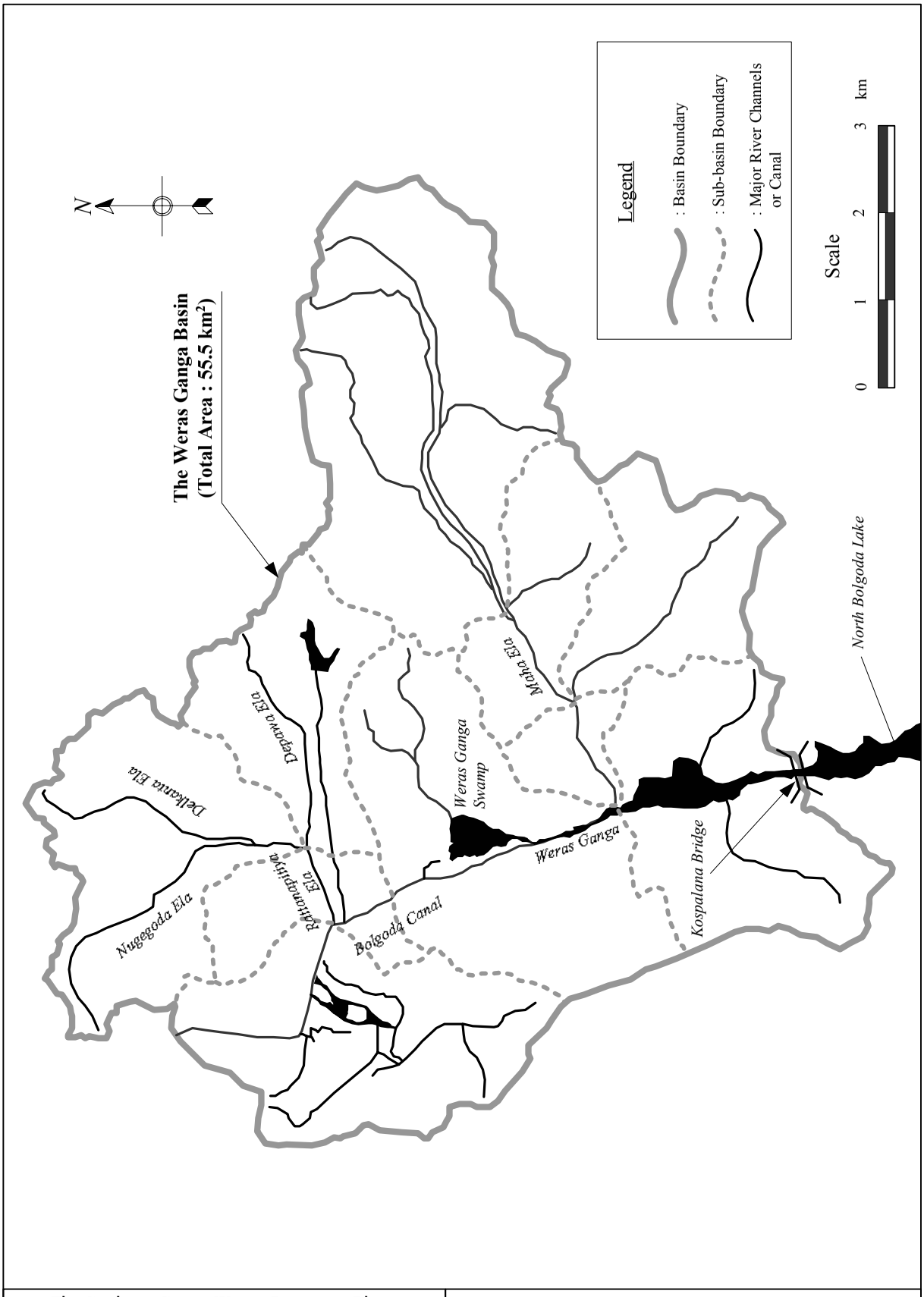
Table 3.5.3 Estimated Flood Inundation Area for Each Return Period under Future Land Use Condition

(Unit : ha)

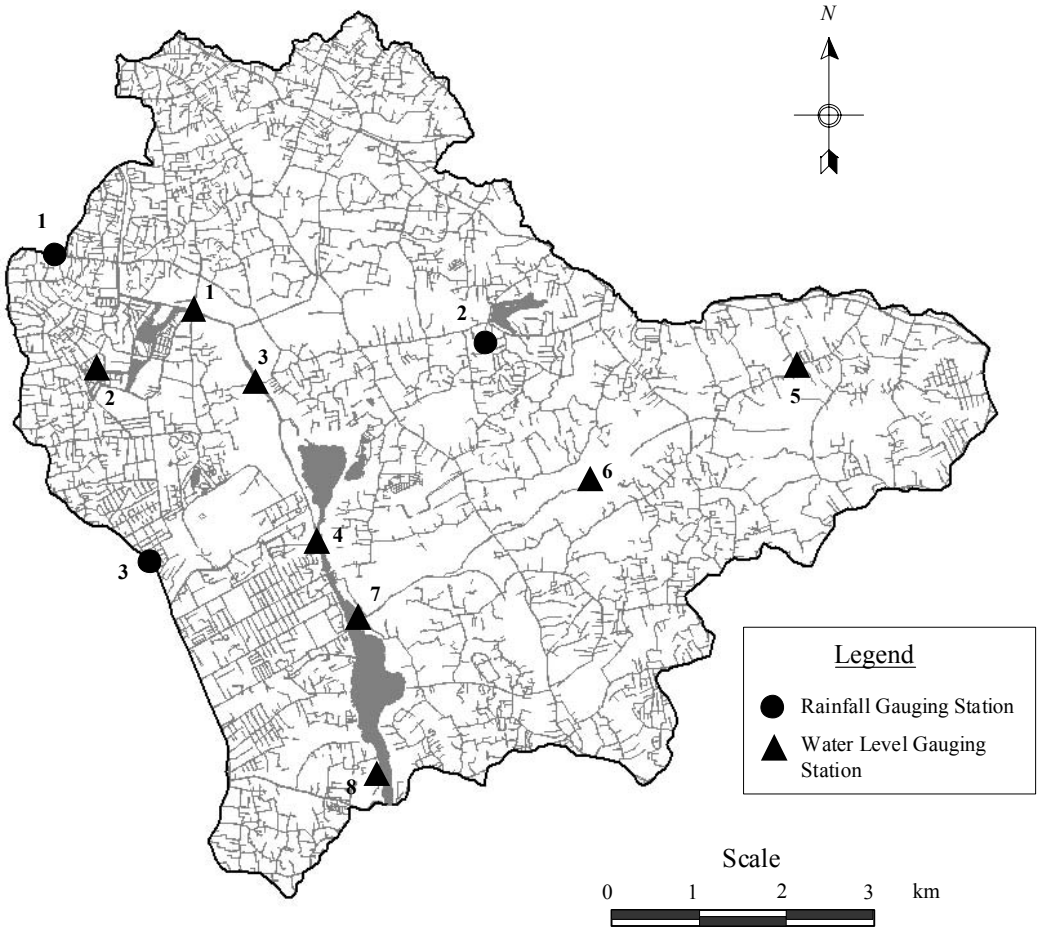
Return Period (Years)	Maximum Inundation Depth	Total	Land Use Category														Net Inundation Area*
			Water	Airport	Dumping Site	Factory	Grassland	Garden	High Density	Paddy	Shanty	Vacant	Homestead	Marsh	Vegetation	Others	
2	Below 20 cm	277.2	0.0	0.0	0.1	0.2	0.0	25.8	13.6	90.1	2.1	3.7	73.1	40.9	8.4	27.7	277.2
	20 - 50 cm	318.8	0.0	0.0	0.0	0.0	0.0	21.4	8.2	99.4	3.3	3.5	57.2	100.3	11.2	25.5	318.8
	50 - 100 cm	149.4	0.0	0.0	0.0	1.8	0.0	8.7	2.5	24.2	0.0	1.1	26.6	75.7	2.5	8.8	149.4
	100 - 200 cm	32.8	0.0	0.0	0.0	1.1	0.0	2.9	1.1	8.9	0.0	0.0	13.7	3.5	0.1	1.6	32.8
	Over 200 cm	117.2	117.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.1
	Total	895.2	117.1	0.0	0.1	3.2	0.0	58.8	25.3	222.6	5.4	8.3	170.8	220.5	22.1	63.5	778.1
5	Below 20 cm	305.9	0.0	0.0	0.7	0.5	0.0	28.1	32.8	83.1	2.2	6.3	83.6	32.0	13.2	36.7	305.9
	20 - 50 cm	373.2	0.0	0.0	0.1	0.1	0.0	26.9	18.6	113.8	4.2	5.3	82.9	86.0	13.3	35.2	373.2
	50 - 100 cm	224.0	0.0	0.0	0.0	0.1	0.0	12.5	6.9	43.0	0.0	2.3	35.1	108.4	4.7	15.7	224.0
	100 - 200 cm	64.3	0.0	0.0	0.0	2.9	0.0	7.1	1.6	12.4	0.0	0.4	23.2	13.1	0.3	3.6	64.3
	Over 200 cm	123.2	119.9	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.1	3.0	0.1	0.0	0.0	3.3
	Total	1,090.5	119.9	0.0	0.8	3.6	0.0	74.8	60.0	252.5	6.5	14.4	227.7	239.5	31.5	91.2	970.7
10	Below 20 cm	284.1	0.0	0.2	0.4	0.9	0.0	28.0	33.0	74.3	2.6	6.8	83.4	23.4	10.4	31.1	284.1
	20 - 50 cm	387.5	0.0	0.0	0.4	0.1	0.0	27.4	20.4	122.5	3.7	5.5	89.4	76.2	15.8	41.9	387.5
	50 - 100 cm	271.4	0.0	0.0	0.0	0.0	0.0	17.5	8.3	59.3	1.3	3.7	43.5	117.0	8.0	20.8	271.4
	100 - 200 cm	81.7	0.0	0.0	0.0	3.0	0.0	8.3	1.5	12.2	0.0	0.8	24.4	27.6	0.5	4.0	81.7
	Over 200 cm	128.2	119.9	0.0	0.0	0.0	0.0	0.9	0.0	1.4	0.0	0.1	6.1	0.1	0.0	0.0	8.3
	Total	1,152.8	119.9	0.2	0.7	4.1	0.0	82.1	63.3	269.7	7.6	16.9	246.7	244.3	34.7	97.7	1,032.9
25	Below 20 cm	273.4	0.0	0.7	0.3	1.0	0.0	28.8	37.1	58.3	3.1	6.5	83.4	24.0	8.3	30.2	273.4
	20 - 50 cm	386.3	0.0	0.0	0.7	0.2	0.0	28.7	23.9	122.3	3.3	6.9	95.8	58.1	17.6	46.4	386.3
	50 - 100 cm	342.4	0.0	0.0	0.0	0.0	0.0	22.4	10.4	86.0	3.1	4.6	63.4	123.4	13.0	29.2	342.4
	100 - 200 cm	109.1	0.0	0.0	0.0	2.1	0.0	11.1	1.6	10.2	0.0	1.4	28.0	49.7	0.7	5.2	109.1
	Over 200 cm	140.0	120.1	0.0	0.0	0.9	0.0	2.1	0.0	6.0	0.0	0.1	10.1	0.1	0.0	0.7	20.0
	Total	1,251.1	120.1	0.7	1.0	4.3	0.0	93.0	73.0	282.7	9.5	19.4	280.7	255.2	39.6	111.6	1,131.1
50	Below 20 cm	271.9	0.0	1.2	0.4	1.2	0.0	30.6	38.6	52.0	3.7	5.5	86.2	23.1	7.4	29.4	271.9
	20 - 50 cm	377.1	0.0	0.0	0.8	0.3	0.0	29.5	27.2	114.5	3.2	8.2	98.2	49.2	17.7	46.2	377.1
	50 - 100 cm	368.2	0.0	0.0	0.1	0.0	0.0	24.7	11.5	100.9	3.7	4.6	67.4	122.2	15.1	33.2	368.2
	100 - 200 cm	129.8	0.0	0.0	0.0	0.9	0.0	11.2	1.8	13.1	0.0	2.0	29.5	65.2	0.9	6.1	129.8
	Over 200 cm	152.9	120.1	0.0	0.0	2.1	0.0	4.8	0.0	8.9	0.0	0.2	15.7	0.1	0.0	1.0	32.8
	Total	1,299.9	120.1	1.2	1.2	4.5	0.0	100.7	79.1	289.3	10.5	20.5	297.1	259.9	41.1	115.9	1,179.8

Note : *Net inundation area is total inundation area except for water body.

Figures



The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 1.2.1 Objective Drainage Basin for the Hydrological Analysis



Rainfall Gauging Stations

No.	Station Name	Longitude (m)	Latitude (m)	Elevation (El.m)
1	Dehiwala	100,177	183,416	-
2	Boralesgamuwa	105,000	182,000	11.0
3	Rathmalana	101,216	180,097	5.2

Water Level Gauging Stations

No.	Station Name	Longitude (m)	Latitude (m)
1	Attidiya-Bolgoda Canal	101,780	182,869
2	Badowita	101,229	182,389
3	Attidiya	102,476	182,719
4	Weras Ganga	103,450	179,632
5	Arrawwala Bridge	107,146	181,725
6	Bokundara	105,748	180,908
7	Weras Ganga Outlet	103,717	179,505
8	LHI	103,928	177,412

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Figure 1.3.1
Location of Existing Rainfall and Water Level Gauging Stations in the Weras Ganga Basin

List of Rainfall Gauging Stations

	Name	Location(m)		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	Dehiwala	Lon.	100,177 E											
		Lat.	183,416 N											
		El.	-											
2	Boralesgamuwa	Lon.	105,000 E											
		Lat.	182,000 N											
		El.	11.0											
3	Ratmalana	Lon.	101,216 E											
		Lat.	180,097 N											
		El.	5.2											

	Name	Location(m)		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	Dehiwala	Lon.	100,177 E											
		Lat.	183,416 N											
		El.	-											
2	Boralesgamuwa	Lon.	105,000 E											
		Lat.	182,000 N											
		El.	11.0											
3	Ratmalana	Lon.	101,216 E											
		Lat.	180,097 N											
		El.	5.2											

	Name	Location(m)		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	Dehiwala	Lon.	100,177 E											
		Lat.	183,416 N											
		El.	-											
2	Boralesgamuwa	Lon.	105,000 E											
		Lat.	182,000 N											
		El.	11.0											
3	Ratmalana	Lon.	101,216 E											
		Lat.	180,097 N											
		El.	5.2											

List of Water Level Gauging Stations

No.	Station Name	Longitude (m)	Latitude (m)	1996	1997	1998	1999	2000	2001
1	Attidiya - Bolgoda Canal	101,780	182,869						
2	Badowita	101,229	182,389						
3	Attidiya	102,476	182,719						
4	Weras Ganga	103,450	179,632						
5	Arrawwala Bridge	107,146	181,725						
6	Bokundara	105,748	180,908						
7	Weras Ganga Outlet	103,717	179,505						
8	L.H.I.	103,928	177,412						

The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka

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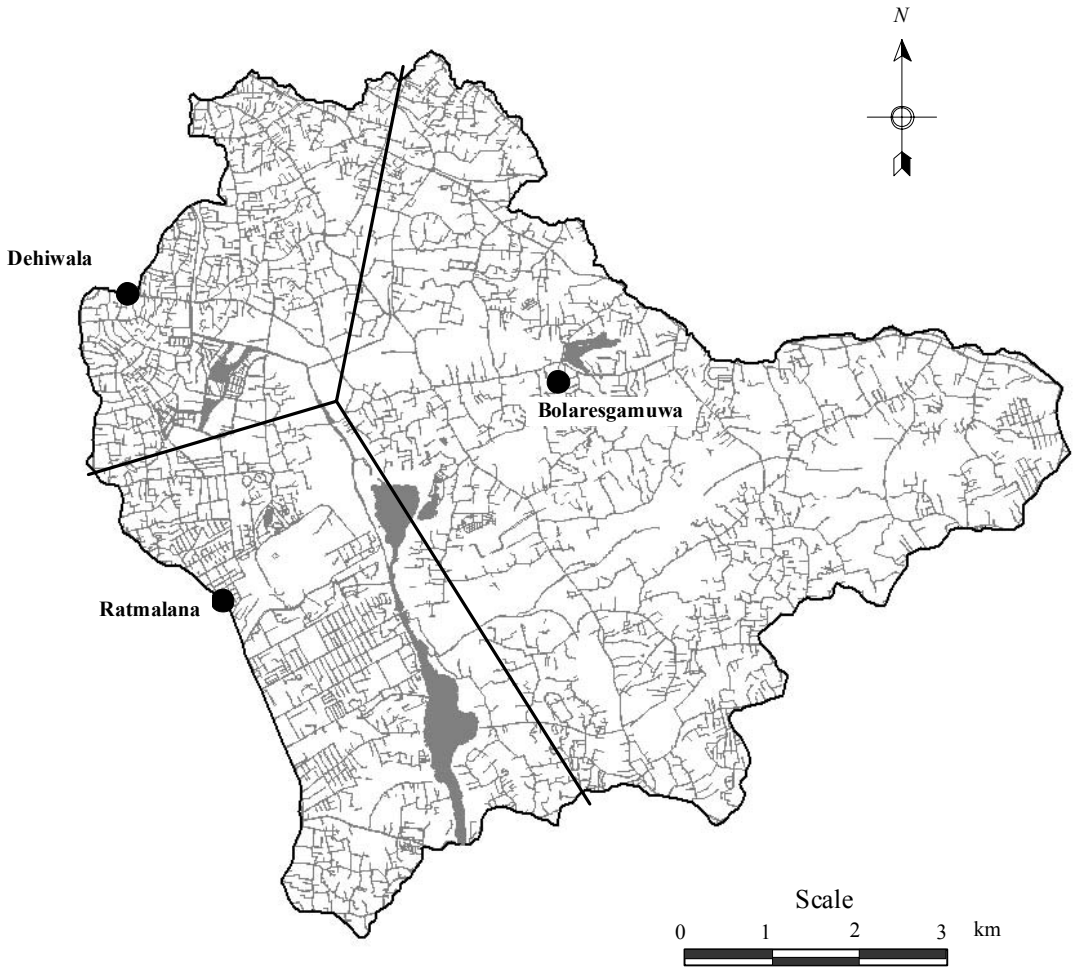
Figure 1.3.2
List of Rainfall and Water Level Gauging Stations and Available Data Period



No.	Station Name	Longitude (m)	Latitude (m)	Elevation (MSL)	Thiessen Ratio
1	Dehiwala	100,177	183,416	-	0.15
2	Boralesgamuwa	105,000	182,000	11.0	0.63
3	Ratmalana	101,216	180,097	5.2	0.22

The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka

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Figure 2.1.1
Location and Thiessen Polygons of Rainfall Gauging Stations in the Weras Ganga Basin

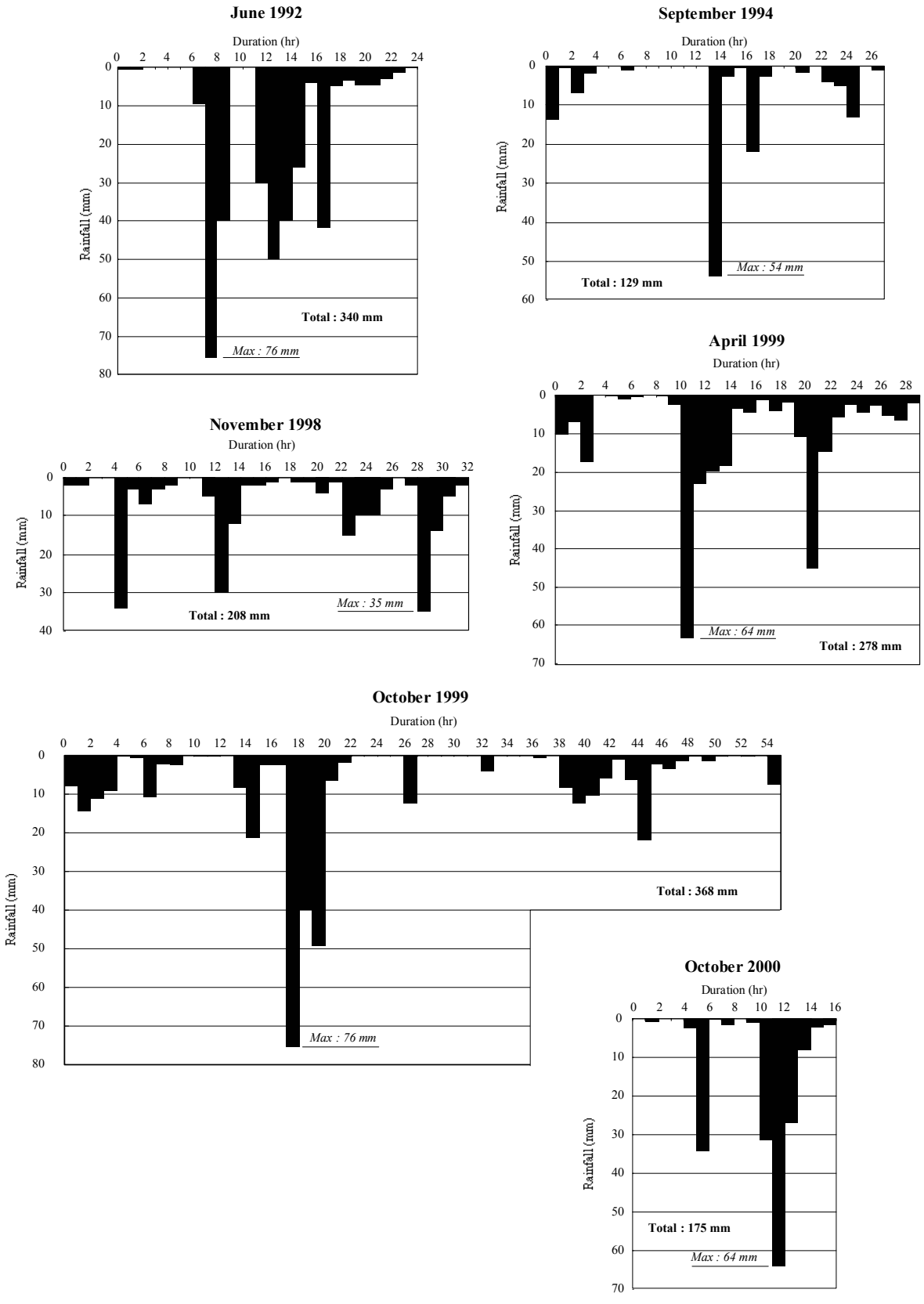

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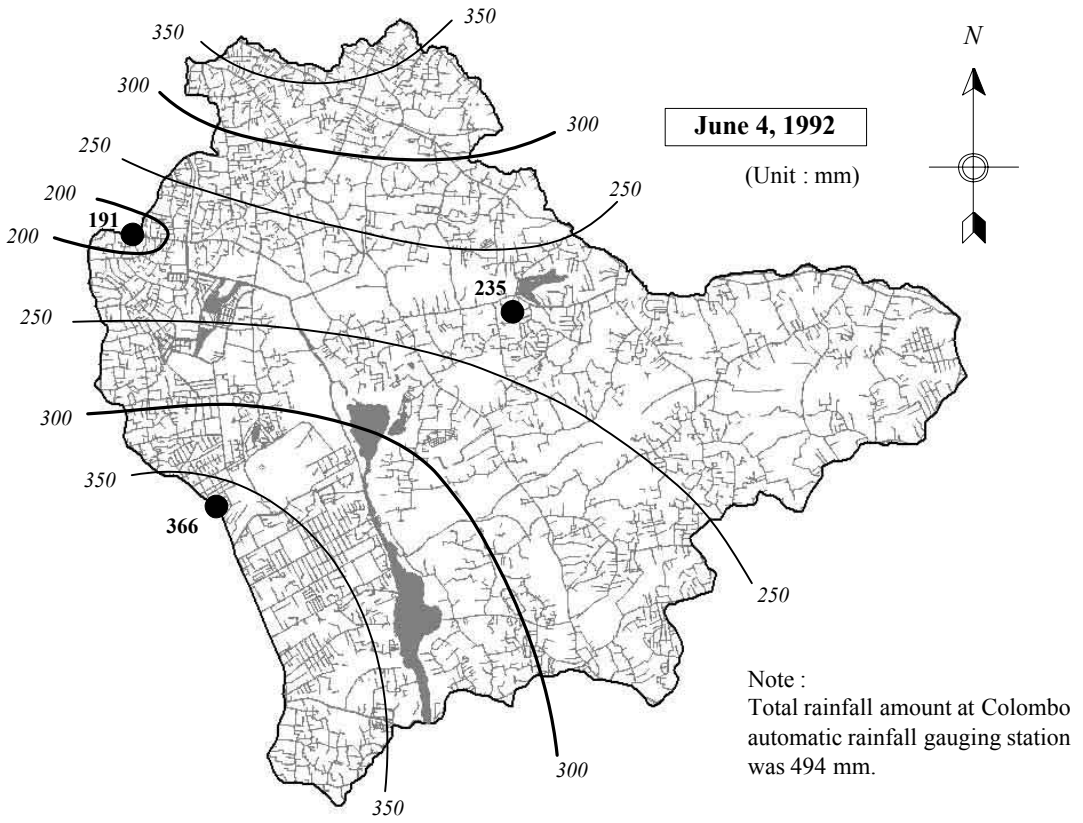
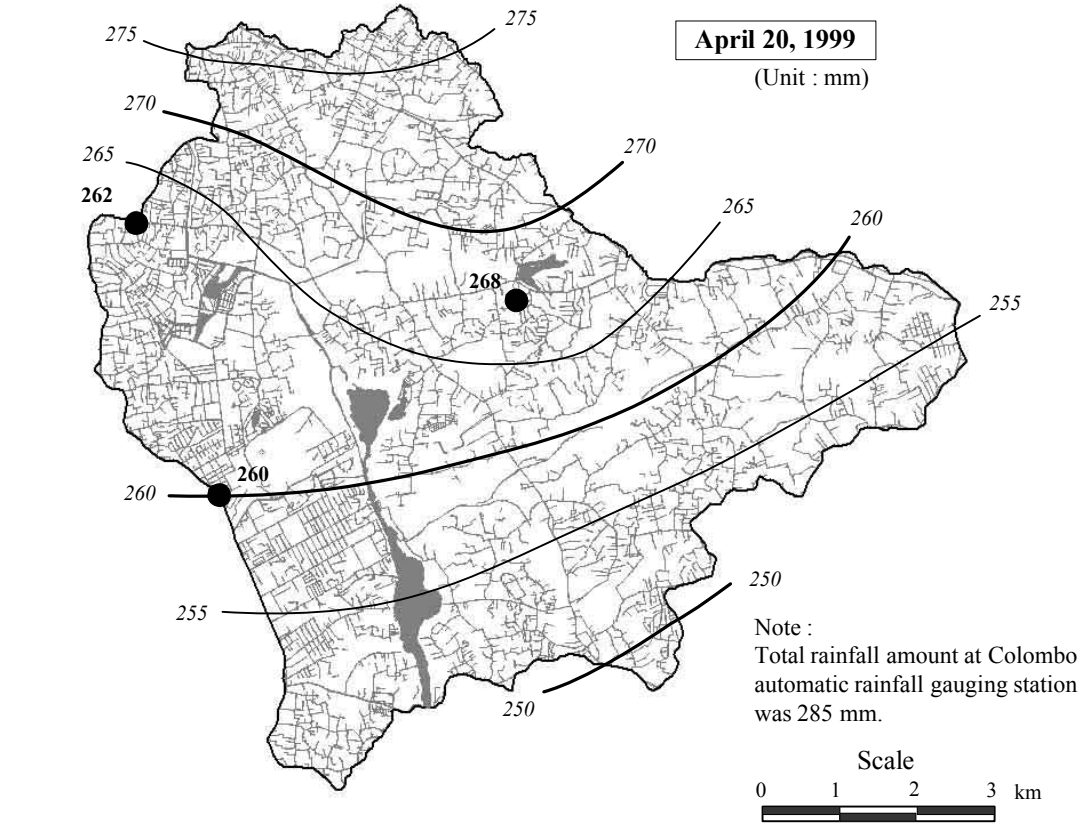
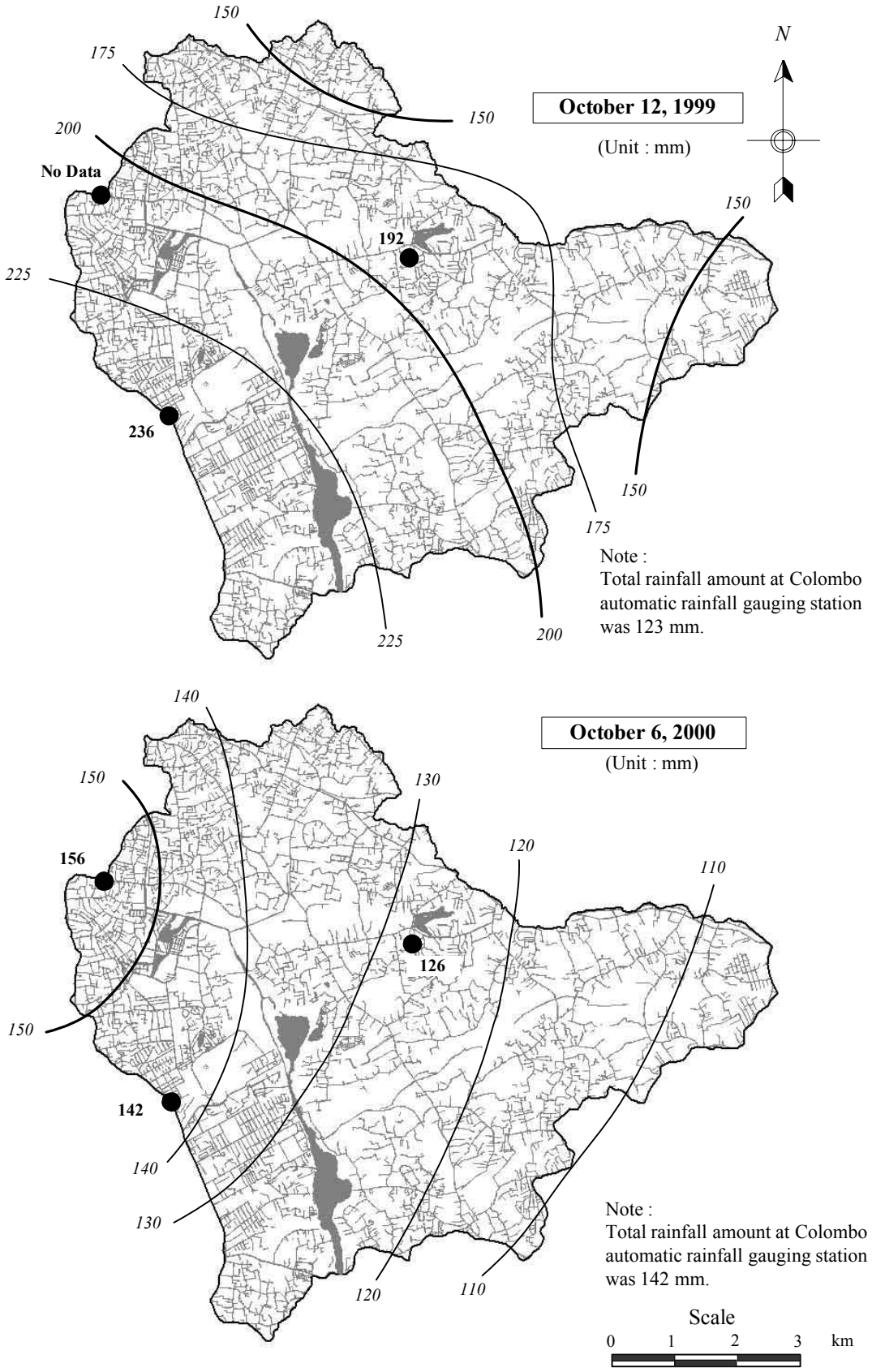
Figure 2.2.1
Storm Record at Ratmalana Rainfall Gauging Station





The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 2.2.2 Isohyetal Maps for the Past Large-scaled Storm Events (1/2)



The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka

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Figure 2.2.2
Isohyetal Maps for the Past Large-scaled Storm Events (2/2)