APPENDIX C - Hydrologic Model – Summer Event

Rainfall

- Calibration and Validation Results
- Design Events

Calibration and Validation Results

Hourly streamflow data from the gauges at Moodie Drive and Franktown Road, in conjunction with hourly rainfall data from a temporary gauge at Franktown and the Richmond and Maple Grove gauges, were used in the calibration of the hydrologic model. Peak flow magnitude, timing and runoff volume, for rainfall-runoff during the late spring and early summer of 2003, are illustrated in Figure C1and C2 and show an adequate fit at Moodie Drive (estimated peak magnitudes within 20% of observed) and a less acceptable fit at Franktown Road (estimated peak magnitudes within 50% of observed). Additional effort may have to be expended, in future studies, to fine-tune the model.

The calibrated summer model was not validated, by comparing the simulated flows for peak Summer events with observed flows at the Moodie Drive gauge, since observed hydrographs from past years were not readily available.

Validation of the model (and the design event) is provided by comparison of maximum instantaneous flows determined by the Summer design event with those determined by SSFA of continuous simulation results. The series of maximum instantaneous peak flows derived from continuous simulation over a 38 year period of rainfall record is provided in Table C3(a); the resulting SSFA using an LP3 distribution is provided in Table C3(b). The results are illustrated in Table C4: there is good agreement and peak flows are within 5%, for the 50 year and 100 Year Return Periods and are generally within 10%.

For further validation, Summer peak flows, from the 34 years of daily record at Moodie Drive, were reviewed to identify the annual maximum daily peak summer flow (maximum instantaneous flows are not readily available). SSFA of these annual daily maximums were compared to SSFA of annual daily maximums derived from hourly continuous simulation over 38 years of record. The relevant series of annual daily peaks, both observed and simulated, are provided in Table C1(a) and C2(a) respectively. The detailed results of subsequent SSFA's using LP3 distribution are p0rvided in Table C1(b) and Table C2(b) respectively. The results are summarised in Table C4: there is adequate agreement (within 15%) between the maximum daily observed flow and maximum daily simulated flow.

Design Events

The 100 year peak Summer flow was estimated using a 100 year Design Storm. Ten different Design Storm distributions were assessed, along with various durations. They included:

1. Chicago 4 hour
2. Chicago 24 hour
3. SCS 6 hour
4. SCS Type II 24 hour

5. AES 1
6. AES 12 hour
7. Huff QI 3, 6 12 and 24 hour
8. Huff QII 3, 6 12 and 24 hour
9. Huff QIII 3, 6 12 and 24 hour
10. Huff QIV 3, 6 12 and 24 hour

The Return Period flows derived from the various design storms were compared with the SSFA Return Period flows derived from the series of annual Summer instantaneous peak flows developed from continuous simulation. Table C5 summarises the results of the comparison in which the ratio of the design storm peak to the SSFA peak, for any given Return Period, was identified: a ratio of 1.0 would suggest that the given design storm was the most appropriate event to model summer peak flows. The best agreement occurs using the SCS 24 hour distribution in which the average ratio, for the six Return Period flows (2, 5, 10, 25, 50 and 100 years), is 1.001. The 100 Year SCS Type II 24 Hour design storm is illustrated in Figure C3.

Using the SCS 24 hour distribution as input, the 100 year peak summer flow at Moodie Drive is estimated to be 141m3/s. Return Period hydrographs at Moodie Drive, as a result of design storm input to the Summer hydrologic model, are illustrated in Figure C4.

Table C1a – Annual maximum daily peak flows
Summer - observed - Moodie Drive

WSC STATION NO=02LA007
WSC STATION NAME=Jock River Gauge at Moodie Drive

TOTAL TIME SPAN, YT= 31 YRS. FLOW THRESHOLD = .000
OBSERVED PEAKS, N= 31 HISTORIC PEAKS ABOVE THRESHOLD, NHA= 0

OBSERVED PEAKS ABOVE THRESHOLD, NA= 31
OBSERVED PEAKS BELOW THRESHOLD, NB= 0
MISSING PEAKS BELOW THRESHOLD, NC= 0

MONTH	YEAR	FLOOD	DESCENDING ORDER	RANK M	RANK ADJ.	CUM. PROB.	RET.PERIOD YEARS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
6	1970	20.000	52.900	1	1.00	1.92	52.00
6	1971	1.520	48.400	2	2.00	5.13	19.50
6	1972	38.200	42.700	3	3.00	8.33	12.00
6	1973	9.260	38.200	4	4.00	11.54	8.67
6	1974	5.830	33.400	5	5.00	14.74	6.78
6	1975	5.640	33.200	6	6.00	17.95	5.57
6	1976	13.800	26.900	7	7.00	21.15	4.73
6	1977	11.800	22.700	8	8.00	24.36	4.11
6	1978	1.440	20.000	9	9.00	27.56	3.63
6	1979	18.800	18.800	10	10.00	30.77	3.25
6	1980	11.700	18.800	11	11.00	33.97	2.94
6	1981	42.700	15.500	12	12.00	37.18	2.69
6	1982	9.230	14.800	13	13.00	40.38	2.48
6	1983	26.900	14.700	14	14.00	43.59	2.29
6	1984	10.300	13.800	15	15.00	46.79	2.14
6	1985	2.780	12.700	16	16.00	50.00	2.00
6	1986	48.400	11.800	17	17.00	53.21	1.88
6	1987	14.800	11.700	18	18.00	56.41	1.77
6	1988	18.800	11.500	19	19.00	59.62	1.68
6	1989	11.500	10.300	20	20.00	62.82	1.59
6	1990	12.700	9.260	21	21.00	66.03	1.51
6	1991	1.710	9.230	22	22.00	69.23	1.44
6	1992	15.500	7.290	23	23.00	72.44	1.38
6	1993	33.400	6.150	24	24.00	75.64	1.32
6	1994	14.700	5.830	25	25.00	78.85	1.27
6	1995	52.900	5.640	26	26.00	82.05	1.22
6	1996	22.700	3.450	27	27.00	85.26	1.17
6	1997	7.290	2.780	28	28.00	88.46	1.13
6	1998	3.450	1.710	29	29.00	91.67	1.09
6	1999	6.150	1.520	30	30.00	94.87	1.05
6	2000	33.200	1.440	31	31.00	98.08	1.02

THRESHOLD

Table C1b – Maximum daily peak flows – SSFA – LP3
Summer - observed - Moodie Drive

HISTORICAL FREQUENCY ANALYSIS - LOG PEARSON TYPE III DISTRIBUTION
02LA007 Jock River Gauge at Moodie Drive

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	17.003	14.049	.826	1.160	3.904
LN X SERIES	2.447	.987	.403	-.589	3.172

X(MIN)= 1.440 TOTAL SAMPLE SIZE= 31
X(MAX)= 52.900 NO. OF LOW OUTLIERS= 0
LOWER OUTLIER LIMIT OF X= .907 NO. OF ZERO FLOWS= 0

SOLUTION OBTAINED VIA MOMENTS

DISTRIBUTION IS UPPER BOUNDED AT M= 329.9
LP3 PARAMETERS: A= -.2907 B= 11.53 LOG(M)= 5.799
M = 329.9

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	.400
1.050	.952	1.91
1.250	.800	5.25
2.000	.500	12.7
5.000	.200	26.9
10.000	.100	37.8
20.000	.050	48.9
50.000	.020	63.7
100.000	.010	74.9
200.000	.005	86.0
500.000	.002	101

Table C2a – Annual maximum daily peak flows
Summer – simulated - Moodie Drive

WSC STATION NO=02LA007
WSC STATION NAME=JR: Avg 24h Qp from SWMHYMO JRCGSC6.sum

TOTAL TIME SPAN, YT= 38 YRS. FLOW THRESHOLD = .000
OBSERVED PEAKS, N= 38 HISTORIC PEAKS ABOVE THRESHOLD, NHA= 0

OBSERVED PEAKS ABOVE THRESHOLD, NA= 38
OBSERVED PEAKS BELOW THRESHOLD, NB= 0
MISSING PEAKS BELOW THRESHOLD, NC= 0

MONTH	YEAR	FLOOD	DESCENDING ORDER	RANK M	RANK ADJ.	CUM. PROB.	RET.PERIOD YEARS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3	1960	4.930	73.900	1	1.00	1.57	63.67
3	1961	6.390	72.200	2	2.00	4.19	23.88
3	1962	9.560	51.440	3	3.00	6.81	14.69
3	1963	4.690	42.860	4	4.00	9.42	10.61
3	1964	10.710	38.780	5	5.00	12.04	8.30
3	1965	3.470	33.180	6	6.00	14.66	6.82
3	1966	1.830	29.770	7	7.00	17.28	5.79
3	1967	15.160	28.250	8	8.00	19.90	5.03
3	1968	12.540	24.410	9	9.00	22.51	4.44
3	1969	15.220	23.680	10	10.00	25.13	3.98
3	1970	2.740	22.830	11	11.00	27.75	3.60
3	1971	13.760	21.910	12	12.00	30.37	3.29
3	1972	51.440	17.900	13	13.00	32.98	3.03
3	1973	29.770	17.840	14	14.00	35.60	2.81
3	1974	14.910	15.640	15	15.00	38.22	2.62
3	1975	24.410	15.220	16	16.00	40.84	2.45
3	1976	14.550	15.160	17	17.00	43.46	2.30
3	1977	23.680	14.910	18	18.00	46.07	2.17
3	1978	15.640	14.550	19	19.00	48.69	2.05
3	1979	21.910	14.000	20	20.00	51.31	1.95
3	1980	8.040	13.760	21	21.00	53.93	1.85
3	1981	38.780	13.640	22	22.00	56.54	1.77
3	1982	10.290	12.540	23	23.00	59.16	1.69
3	1983	14.000	12.540	24	24.00	61.78	1.62
3	1984	13.640	11.750	25	25.00	64.40	1.55
3	1985	17.840	10.710	26	26.00	67.02	1.49
3	1986	72.200	10.290	27	27.00	69.63	1.44
3	1987	22.830	9.560	28	28.00	72.25	1.38
3	1988	28.250	8.700	29	29.00	74.87	1.34
3	1989	42.860	8.040	30	30.00	77.49	1.29
3	1990	12.540	6.390	31	31.00	80.10	1.25
3	1991	33.180	4.930	32	32.00	82.72	1.21
3	1992	1.580	4.690	33	33.00	85.34	1.17
3	1993	11.750	4.440	34	34.00	87.96	1.14
3	1994	17.900	3.470	35	35.00	90.58	1.10
3	1995	73.900	2.740	36	36.00	93.19	1.07
3	1996	8.700	1.830	37	37.00	95.81	1.04
3	1997	4.440	1.580	38	38.00	98.43	1.02
			THRESHOLD				

Table C2b – Maximum daily peak flows – SSFA – LP3
Summer – simulated - Moodie Drive

HISTORICAL FREQUENCY ANALYSIS - LOG PEARSON TYPE III DISTRIBUTION
02LA007 JR: Avg 24h Qp from SWMHYMO JRCGSC6.sum

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	19.211	17.216	.896	1.870	6.864
LN X SERIES	2.592	.915	.353	-.397	3.402

X(MIN)= 1.580 TOTAL SAMPLE SIZE= 38
X(MAX)= 73.900 NO. OF LOW OUTLIERS= 0
LOWER OUTLIER LIMIT OF X= 1.171 NO. OF ZERO FLOWS= 0

SOLUTION OBTAINED VIA MOMENTS

DISTRIBUTION IS UPPER BOUNDED AT M= 1344.
LP3 PARAMETERS: A= -.1815 B= 25.41 LOG(M)= 7.203
M = 1344.

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	.720
1.050	.952	2.62
1.250	.800	6.33
2.000	.500	14.2
5.000	.200	29.2
10.000	.100	41.2
20.000	.050	53.9
50.000	.020	71.7
100.000	.010	85.9
200.000	.005	101
500.000	.002	121

Table C3a – Annual maximum instantaneous peak flows
Summer – simulated - Moodie Drive

WSC STATION NO=JRSWMS
WSC STATION NAME=Jock River SWMHYMO Summer simulation

TOTAL TIME SPAN, YT= 37 YRS. FLOW THRESHOLD = .000
OBSERVED PEAKS, N= 38 HISTORIC PEAKS ABOVE THRESHOLD, NHA= 0

OBSERVED PEAKS ABOVE THRESHOLD, NA= 38
OBSERVED PEAKS BELOW THRESHOLD, NB= 0
MISSING PEAKS BELOW THRESHOLD, NC= -1

MONTH (1)	YEAR (2)	FLOOD (3)	DESCENDING ORDER (4)	RANK M (5)	RANK ADJ. (6)	CUM. PROB. (7)	RET. PERIOD YEARS (8)
6	1960	21.720	110.133	1	1.00	1.61	62.00
7	1961	11.093	100.833	2	2.00	4.30	23.25
7	1962	17.970	95.511	3	3.00	6.99	14.31
3	1963	55.975	89.164	4	4.00	9.68	10.33
7	1964	32.823	73.589	5	5.00	12.37	8.09
8	1965	29.350	63.342	6	6.00	15.05	6.64
11	1966	16.137	58.449	7	7.00	17.74	5.64
10	1967	43.036	55.975	8	8.00	20.43	4.89
9	1968	25.550	51.935	9	9.00	23.12	4.33
8	1969	45.748	45.748	10	10.00	25.81	3.88
7	1970	36.480	45.644	11	11.00	28.49	3.51
7	1971	17.237	43.986	12	12.00	31.18	3.21
8	1972	58.449	43.036	13	13.00	33.87	2.95
8	1973	73.589	37.162	14	14.00	36.56	2.74
5	1974	21.618	36.480	15	15.00	39.25	2.55
6	1975	35.025	35.025	16	16.00	41.94	2.38
9	1976	32.619	34.629	17	17.00	44.62	2.24
5	1977	28.874	32.823	18	18.00	47.31	2.11
6	1978	18.629	32.619	19	19.00	50.00	2.00
7	1979	17.229	32.438	20	20.00	52.69	1.90
10	1980	32.438	29.963	21	21.00	55.38	1.81
6	1981	43.986	29.350	22	22.00	58.06	1.72
8	1982	20.397	28.874	23	23.00	60.75	1.65
10	1983	34.629	27.631	24	24.00	63.44	1.58
8	1984	27.631	25.550	25	25.00	66.13	1.51
6	1985	18.422	21.720	26	26.00	68.82	1.45
9	1986	95.511	21.618	27	27.00	71.51	1.40
9	1987	37.162	21.440	28	28.00	74.19	1.35
8	1988	110.133	20.397	29	29.00	76.88	1.30
9	1989	51.935	18.629	30	30.00	79.57	1.26
7	1990	63.342	18.422	31	31.00	82.26	1.22
8	1991	21.440	17.970	32	32.00	84.95	1.18
8	1992	29.963	17.508	33	33.00	87.63	1.14
6	1993	17.508	17.237	34	34.00	90.32	1.11
8	1994	45.644	17.229	35	35.00	93.01	1.08
6	1995	89.164	16.137	36	36.00	95.70	1.04
8	1996	100.833	15.216	37	37.00	98.39	1.02
5	1997	15.216	11.093	38	38.00	101.08	.99

THRESHOLD

Table C3b – Maximum instantaneous peak flows – SSFA – LP3
Summer – simulated - Moodie Drive

HISTORICAL FREQUENCY ANALYSIS - LOG PEARSON TYPE III DISTRIBUTION
JRSWMS Jock River SWMHYMO Summer simulation

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	39.329	25.420	.646	1.418	4.613
LN X SERIES	3.498	.583	.167	.386	2.699

X(MIN)= 11.093 TOTAL SAMPLE SIZE= 38
X(MAX)= 110.133 NO. OF LOW OUTLIERS= 0
LOWER OUTLIER LIMIT OF X= 7.005 NO. OF ZERO FLOWS= 0

SOLUTION OBTAINED VIA MOMENTS

DISTRIBUTION IS UPPER BOUNDED AT M= .5110E+06
LP3 PARAMETERS: A= -.3759E-01 B= 254.1 LOG(M)= 13.14
M = .5110E+06

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	.997	6.45
1.050	.952	13.1
1.250	.800	22.0
2.000	.500	36.8
5.000	.200	60.4
10.000	.100	77.7
20.000	.050	95.3
50.000	.020	119
100.000	.010	139
200.000	.005	159
500.000	.002	186

Table C4 – Validation – SSFA/observed **vs**. SSFA/continuous **vs.** Design Event At Moodie Drive

SUMMER (May-November) Flows (m3/s)

			Return Period (years)					
Analyisis Number	**Flow Estimation Technique**	**Flow Type**	**2**	**5**	**10**	**25**	**50**	**100**
1	Design Event (return period storm)	Qmax inst	46	66	82	105	122	141
2	SSFA – LP3 (continuous simulation)	Qmax inst	37	60	78	95	119	139
3	SSFA – LP3 (convert Qi toQd from number 2)	Qmax daily	14	29	41	54	72	86
4	SSFA – LP3 (observed)	Qmax daily	13	27	38	49	64	75

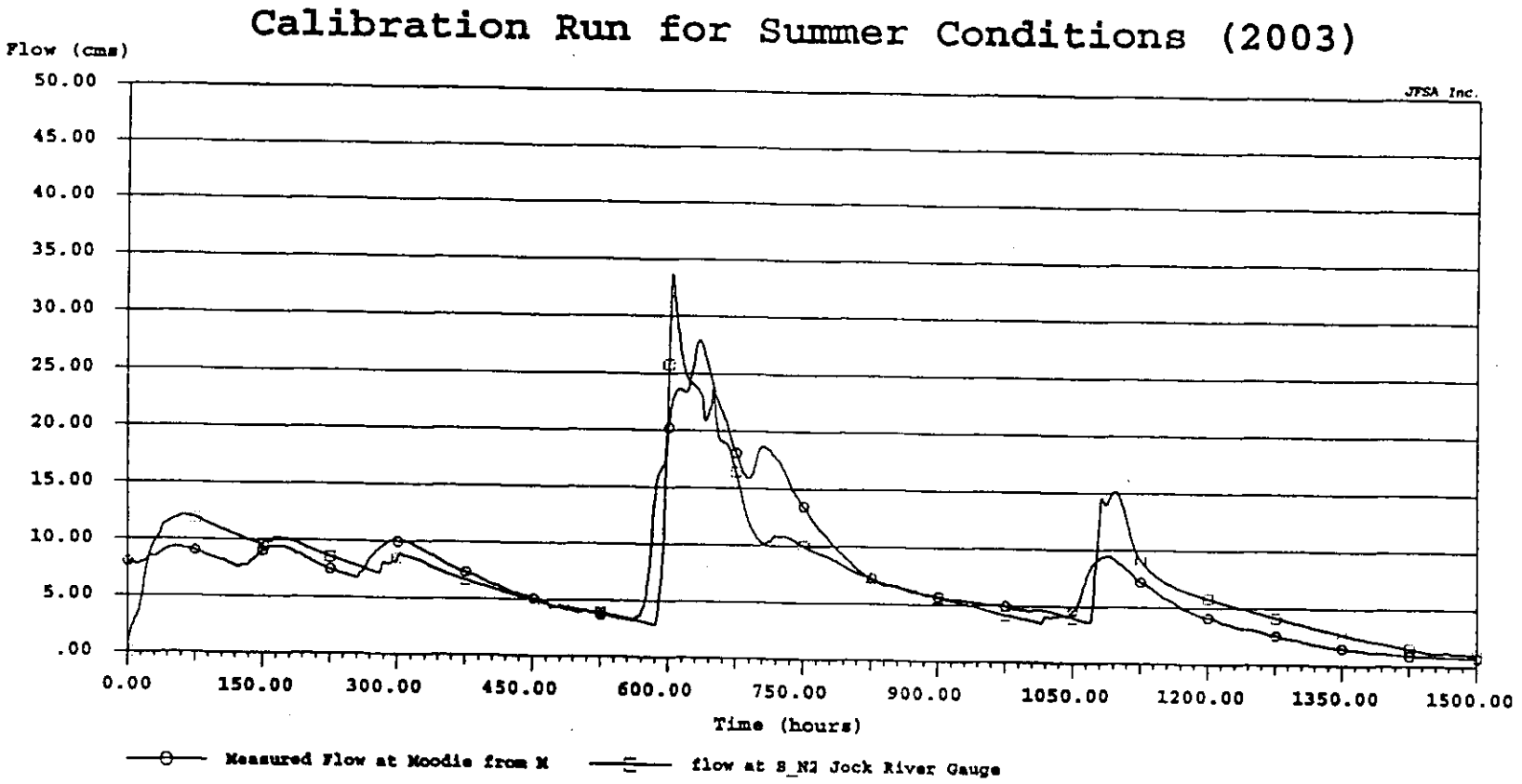
Summary of Design Peak Flows Simulated at Moodie Drive Gauge using Various Synthetic Design Storms and Comparison with CFA of Annual Peak Flows Obtained Through Continuous Simulations

	AREA (ha)	Qpeak (cms)	Tpeak (hrs)	R.V. (mm)	CFA	Ratio QpDes/CFA	
Chicago 4 hrs 1:2 yrs for Ottawa CDA	52595.010	22.33	5:30	5.76	36.8	0.607	
Chicago 4 hrs 1:5 yrs for Ottawa CDA	52595.010	38.33	5:40	9.58	60.4	0.635	
Chicago 4 hrs 1:10 yrs for Ottawa CDA	52595.010	51.31	5:40	12.59	77.7	0.660	
Chicago 4 hrs 1:25 yrs for Ottawa CDA	52595.010	70.53	5:45	17.01	95.3	0.740	
Chicago 4 hrs 1:50 yrs for Ottawa CDA	52595.010	86.97	5:45	20.83	119	0.731	
Chicago 4 hrs 1:100 yrs for Ottawa CDA	52595.010	105.01	5:35	24.95	139	0.755	0.688
Chicago 24 hrs 1:2 yrs for Ottawa CDA	52595.010	40.09	2:55	13.09	36.8	**1.089**	
Chicago 24 hrs 1:5 yrs for Ottawa CDA	52595.010	60.92	1:45	19.46	60.4	**1.009**	
Chicago 24 hrs 1:10 yrs for Ottawa CDA	52595.010	77.40	1:30	24.37	77.7	**0.996**	
Chicago 24 hrs 1:25 yrs for Ottawa CDA	52595.010	101.38	1:15	31.38	95.3	**1.064**	
Chicago 24 hrs 1:50 yrs for Ottawa CDA	52595.010	121.81	1:05	37.26	119	**1.024**	
Chicago 24 hrs 1:100 yrs for Ottawa CDA	52595.010	143.41	12:55	43.39	139	**1.032**	**1.036**
SCS 6 hrs 1:2 yrs for Ottawa CDA	52595.010	26.80	7:45	7.07	36.8	0.728	
SCS 6 hrs 1:5 yrs for Ottawa CDA	52595.010	46.39	7:45	11.73	60.4	0.768	
SCS 6 hrs 1:10 yrs for Ottawa CDA	52595.010	62.31	7:40	15.52	77.7	0.802	
SCS 6 hrs 1:25 yrs for Ottawa CDA	52595.010	84.80	7:40	20.93	95.3	0.890	
SCS 6 hrs 1:50 yrs for Ottawa CDA	52595.010	103.60	7:30	25.45	119	0.871	
SCS 6 hrs 1:100 yrs for Ottawa CDA	52595.010	123.94	7:30	30.34	139	0.892	0.825
SCS 24 hrs 1:2 yrs for Ottawa CDA	52595.010	41.24	6:25	12.44	36.8	**1.121**	
SCS 24 hrs 1:5 yrs for Ottawa CDA	52595.010	60.42	5:20	18.42	60.4	**1.000**	
SCS 24 hrs 1:10 yrs for Ottawa CDA	52595.010	75.17	5:10	22.98	77.7	**0.967**	
SCS 24 hrs 1:25 yrs for Ottawa CDA	52595.010	96.53	5:00	29.52	95.3	**1.013**	
SCS 24 hrs 1:50 yrs for Ottawa CDA	52595.010	113.69	4:55	34.77	119	**0.955**	
SCS 24 hrs 1:100 yrs for Ottawa CDA	52595.010	132.04	4:50	40.33	139	**0.950**	**1.001**
AES 1 hr 1:2 yrs for Ottawa CDA	52595.010	11.54	4:00	2.92	36.8	0.313	
AES 1 hr 1:5 yrs for Ottawa CDA	52595.010	20.08	4:00	5.04	60.4	0.333	
AES 1 hr 1:10 yrs for Ottawa CDA	52595.010	27.21	4:00	6.78	77.7	0.350	
AES 1 hr 1:25 yrs for Ottawa CDA	52595.010	37.95	4:05	9.30	95.3	0.398	
AES 1 hr 1:50 yrs for Ottawa CDA	52595.010	47.30	4:10	11.47	119	0.398	
AES 1 hr 1:100 yrs for Ottawa CDA	52595.010	57.63	4:15	13.81	139	0.415	0.368
AES 12 hrs 1:2 yrs for Ottawa CDA	52595.010	39.93	1:55	10.32	36.8	**1.085**	
AES 12 hrs 1:5 yrs for Ottawa CDA	52595.010	59.96	1:25	15.76	60.4	**0.993**	
AES 12 hrs 1:10 yrs for Ottawa CDA	52595.010	75.44	1:15	19.90	77.7	**0.971**	
AES 12 hrs 1:25 yrs for Ottawa CDA	52595.010	98.15	1:05	26.00	95.3	**1.030**	
AES 12 hrs 1:50 yrs for Ottawa CDA	52595.010	116.84	1:05	31.12	119	**0.982**	
AES 12 hrs 1:100 yrs for Ottawa CDA	52595.010	136.47	1:05	36.56	139	**0.982**	**1.007**
Huff (Q1) 3 hrs 1:2 yrs for Ottawa CDA	52595.010	17.60	4:45	4.56	36.8	0.478	
Huff (Q1) 3 hrs 1:5 yrs for Ottawa CDA	52595.010	30.77	4:55	7.80	60.4	0.509	
Huff (Q1) 3 hrs 1:10 yrs for Ottawa CDA	52595.010	41.95	5:00	10.41	77.7	0.540	
Huff (Q1) 3 hr 1:25 yrs for Ottawa CDA	52595.010	59.06	5:00	14.35	95.3	0.620	
Huff (Q1) 3 hr 1:50 yrs for Ottawa CDA	52595.010	73.01	5:00	17.55	119	**0.614**	
Huff (Q1) 3 hrs 1:100 yrs for Ottawa CDA	52595.010	75.09	5:00	18.03	139	**0.540**	**0.550**
Huff (QI) 6 hrs 1:2 yrs for Ottawa CDA	52595.010	27.52	5:55	7.24	36.8	**0.748**	
Huff (QI) 6 hrs 1:5 yrs for Ottawa CDA	52595.010	46.28	5:55	11.82	60.4	**0.766**	
Huff (QI) 6 hrs 1:10 yrs for Ottawa CDA	52595.010	61.57	5:55	15.61	77.7	**0.792**	
Huff (QI) 6 hrs 1:25 yrs for Ottawa CDA	52595.010	83.32	5:55	21.03	95.3	**0.874**	
Huff (QI) 6 hrs 1:50 yrs for Ottawa CDA	52595.010	101.62	5:55	25.55	119	**0.854**	
Huff (QI) 6 hrs 1:100 yrs for Ottawa CDA	52595.010	121.15	5:55	30.43	139	**0.872**	**0.818**
Huff (QI) 12 hrs 1:2 yrs for Ottawa CDA	52595.010	35.65	11:45	10.47	36.8	**0.969**	
Huff (QI) 12 hrs 1:5 yrs for Ottawa CDA	52595.010	53.24	10:15	15.89	60.4	**0.882**	
Huff (QI) 12 hrs 1:10 yrs for Ottawa CDA	52595.010	67.27	9:45	20.01	77.7	**0.866**	
Huff (QI) 12 hrs 1:25 yrs for Ottawa CDA	52595.010	87.82	9:30	26.20	95.3	**0.921**	
Huff (QI) 12 hrs 1:50 yrs for Ottawa CDA	52595.010	104.47	9:10	31.28	119	**0.878**	
Huff (QI) 12 hrs 1:100 yrs for Ottawa CDA	52595.010	122.21	8:50	36.74	139	**0.879**	**0.899**
Huff (QI) 24 hrs 1:2 yrs for Ottawa CDA	52595.010	34.56	2:15	12.68	36.8	**0.939**	
Huff (QI) 24 hrs 1:5 yrs for Ottawa CDA	52595.010	49.23	1:05	18.65	60.4	**0.815**	
Huff (QI) 24 hrs 1:10 yrs for Ottawa CDA	52595.010	60.71	12:25	23.20	77.7	**0.781**	
Huff (QI) 24 hrs 1:25 yrs for Ottawa CDA	52595.010	77.30	11:50	29.69	95.3	**0.811**	
Huff (QI) 24 hrs 1:50 yrs for Ottawa CDA	52595.010	90.67	11:35	34.87	119	**0.762**	
Huff (QI) 24 hrs 1:100 yrs for Ottawa CDA	52595.010	105.13	11:30	40.43	139	**0.756**	**0.811**
Huff (QII) 3 hrs 1:2 yrs for Ottawa CDA	52595.010	17.85	5:05	4.56	36.8	0.485	
Huff (QII) 3 hrs 1:5 yrs for Ottawa CDA	52595.010	31.26	5:10	7.83	60.4	0.517	
Huff (QII) 3 hrs 1:10 yrs for Ottawa CDA	52595.010	42.61	5:15	10.47	77.7	0.548	
Huff (QII) 3 hrs 1:25 yrs for Ottawa CDA	52595.010	60.02	5:15	14.44	95.3	0.630	
Huff (QII) 3 hrs 1:50 yrs for Ottawa CDA	52595.010	74.23	5:20	17.68	119	0.624	
Huff (QII) 3 hrs 1:100 yrs for Ottawa CDA	52595.010	89.60	5:20	21.21	139	0.645	0.575
Huff (QII) 6 hrs 1:2 yrs for Ottawa CDA	52595.010	28.58	7:35	7.54	36.8	0.777	
Huff (QII) 6 hrs 1:5 yrs for Ottawa CDA	52595.010	48.17	7:25	12.12	60.4	0.797	
Huff (QII) 6 hrs 1:10 yrs for Ottawa CDA	52595.010	63.89	7:15	15.72	77.7	0.822	
Huff (QII) 6 hrs 1:25 yrs for Ottawa CDA	52595.010	86.67	7:10	21.07	95.3	0.909	
Huff (QII) 6 hrs 1:50 yrs for Ottawa CDA	52595.010	105.95	7:05	25.62	119	0.890	
Huff (QII) 6 hrs 1:100 yrs for Ottawa CDA	52595.010	126.77	7:05	30.53	139	0.912	0.851
Huff (QII) 12 hrs 1:2 yrs for Ottawa CDA	52595.010	38.93	11:50	10.72	36.8	**1.058**	
Huff (QII) 12 hrs 1:5 yrs for Ottawa CDA	52595.010	59.88	11:15	16.29	60.4	**0.991**	

Table C5 Comparison of Return Period peak flows – Summer

Seven design storms (various durations)
vs SSFA of maximum instantaneous peak flows

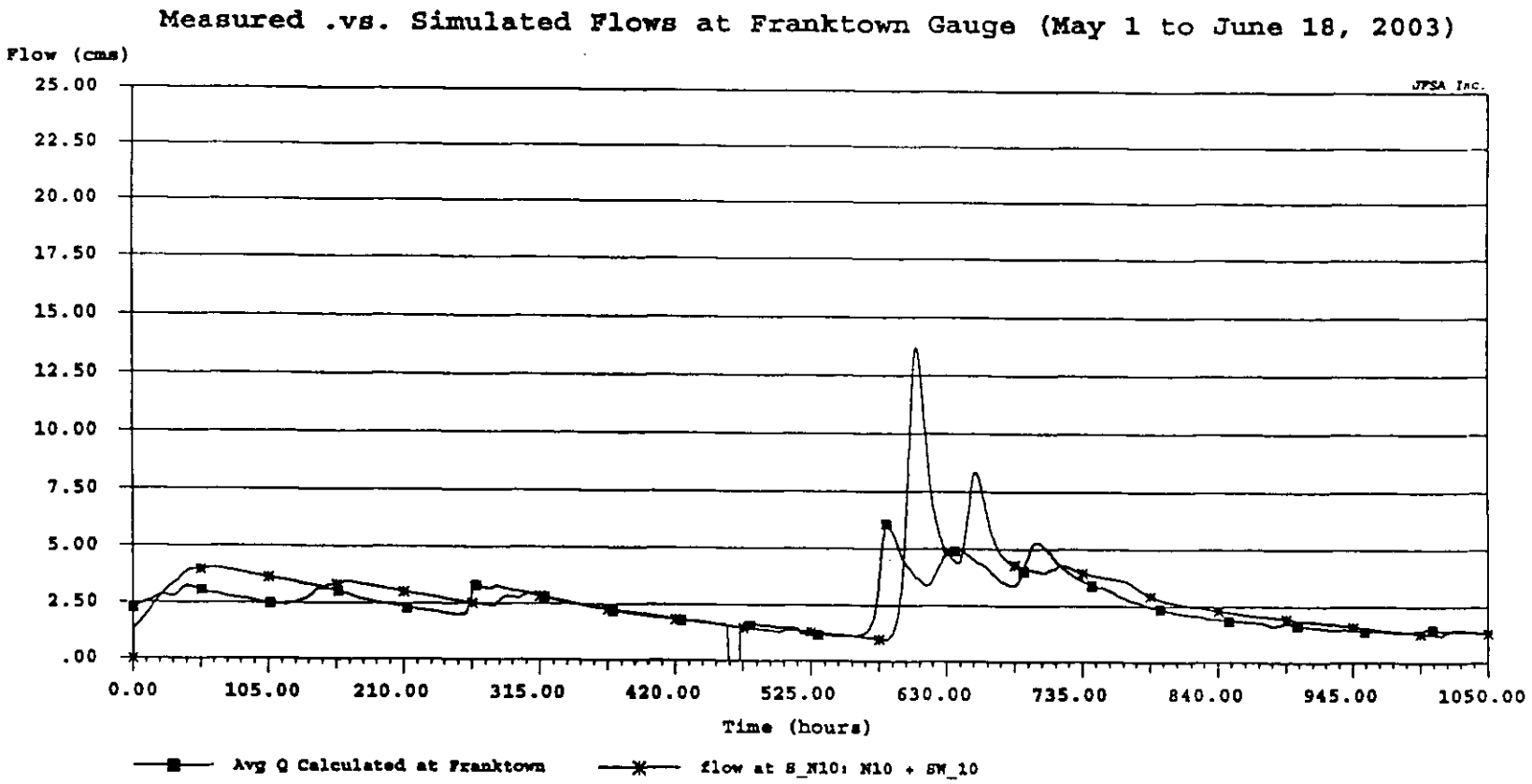
Huff (QII)	**12 hrs 1:10 yrs for Ottawa CDA**	52595.010	76.20	11:00	20.53	77.7	**0.981**	
Huff (QII)	**12 hrs 1:25 yrs for Ottawa CDA**	52595.010	99.80	10:45	26.50	95.3	**1.047**	
Huff (QII)	**12 hrs 1:50 yrs for Ottawa CDA**	52595.010	118.79	10:40	31.31	119	**0.998**	
Huff (QII)	**12 hrs 1:100 yrs for Ottawa CDA**	52595.010	139.05	10:35	36.79	139	**1.000**	**1.013**
Huff (QII)	24 hrs 1:2 yrs for Ottawa CDA	52595.010	41.00	5:45	12.55	36.8	1.114	
Huff (QII)	24 hrs 1:5 yrs for Ottawa CDA	52595.010	58.52	5:25	18.53	60.4	0.969	
Huff (QII)	24 hrs 1:10 yrs for Ottawa CDA	52595.010	71.66	5:05	23.10	77.7	0.922	
Huff (QII)	24 hrs 1:25 yrs for Ottawa CDA	52595.010	90.59	4:55	29.63	95.3	0.951	
Huff (QII)	24 hrs 1:50 yrs for Ottawa CDA	52595.010	105.84	4:55	34.86	119	0.889	
Huff (QII)	24 hrs 1:100 yrs for Ottawa CDA	52595.010	121.70	4:50	40.42	139	0.876	0.953
Huff (QIII)	3 hrs 1:2 yrs for Ottawa CDA	52595.010	17.89	5:30	4.55	36.8	0.486	
Huff (QIII)	3 hrs 1:5 yrs for Ottawa CDA	52595.010	31.37	5:35	7.82	60.4	0.519	
Huff (QIII)	3 hrs 1:10 yrs for Ottawa CDA	52595.010	42.77	5:40	10.46	77.7	0.550	
Huff (QIII)	3 hrs 1:25 yrs for Ottawa CDA	52595.010	60.28	5:45	14.44	95.3	0.633	
Huff (QIII)	3 hrs 1:50 yrs for Ottawa CDA	52595.010	74.56	5:45	17.67	119	0.627	
Huff (QIII)	3 hrs 1:100 yrs for Ottawa CDA	52595.010	90.04	5:50	21.22	139	0.648	0.577
Huff (QIII)	6 hrs 1:2 yrs for Ottawa CDA	52595.010	27.89	7:50	7.10	36.8	0.758	
Huff (QIII)	6 hrs 1:5 yrs for Ottawa CDA	52595.010	48.21	7:55	11.79	60.4	0.798	
Huff (QIII)	6 hrs 1:10 yrs for Ottawa CDA	52595.010	64.83	7:55	15.60	77.7	0.834	
Huff (QIII)	6 hrs 1:25 yrs for Ottawa CDA	52595.010	88.45	7:55	21.05	95.3	0.928	
Huff (QIII)	6 hrs 1:50 yrs for Ottawa CDA	52595.010	108.22	7:50	25.61	119	0.909	
Huff (QIII)	6 hrs 1:100 yrs for Ottawa CDA	52595.010	129.60	7:45	30.54	139	0.932	0.860
Huff (QIII)	12 hrs 1:2 yrs for Ottawa CDA	52595.010	40.83	11:55	10.40	36.8	1.110	
Huff (QIII)	12 hrs 1:5 yrs for Ottawa CDA	52595.010	64.25	11:55	15.86	60.4	1.064	
Huff (QIII)	12 hrs 1:10 yrs for Ottawa CDA	52595.010	82.25	11:55	20.01	77.7	1.059	
Huff (QIII)	12 hrs 1:25 yrs for Ottawa CDA	52595.010	108.33	11:55	26.15	95.3	1.137	
Huff (QIII)	12 hrs 1:50 yrs for Ottawa CDA	52595.010	129.33	11:55	31.28	119	1.087	
Huff (QIII)	12 hrs 1:100 yrs for Ottawa CDA	52595.010	151.68	11:55	36.79	139	1.091	1.091
Huff (QIII)	**24 hrs 1:2 yrs for Ottawa CDA**	**52595.010**	**46.38**	**9:15**	**12.40**	**36.8**	**1.260**	
Huff (QIII)	**24 hrs 1:5 yrs for Ottawa CDA**	**52595.010**	**66.62**	**9:05**	**18.39**	**60.4**	**1.103**	
Huff (QIII)	**24 hrs 1:10 yrs for Ottawa CDA**	**52595.010**	**82.04**	**8:50**	**22.99**	**77.7**	**1.056**	
Huff (QIII)	24 hrs 1:25 yrs for Ottawa CDA	52595.010	103.88	8:55	29.55	95.3	1.090	
Huff (QIII)	24 hrs 1:50 yrs for Ottawa CDA	52595.010	121.20	8:50	34.80	119	1.018	
Huff (QIII)	24 hrs 1:100 yrs for Ottawa CDA	52595.010	139.80	8:55	40.43	139	1.006	1.089
Huff (QIV)	3 hrs 1:2 yrs for Ottawa CDA	52595.010	17.42	5:55	4.43	36.8	0.473	
Huff (QIV)	3 hrs 1:5 yrs for Ottawa CDA	52595.010	30.56	6:00	7.63	60.4	0.506	
Huff (QIV)	3 hrs 1:10 yrs for Ottawa CDA	52595.010	41.76	6:05	10.21	77.7	0.537	
Huff (QIV)	3 hrs 1:25 yrs for Ottawa CDA	52595.010	58.86	6:10	14.11	95.3	0.618	
Huff (QIV)	3 hrs 1:50 yrs for Ottawa CDA	52595.010	72.89	6:15	17.28	119	0.612	
Huff (QIV)	3 hrs 1:100 yrs for Ottawa CDA	52595.010	88.13	6:10	20.76	139	0.634	0.563
Huff (QIII)	6 hrs 1:2 yrs for Ottawa CDA	52595.010	27.89	7:50	7.10	36.8	0.758	
Huff (QIII)	6 hrs 1:5 yrs for Ottawa CDA	52595.010	47.92	8:50	11.64	60.4	0.793	
Huff (QIII)	6 hrs 1:10 yrs for Ottawa CDA	52595.010	64.55	8:50	15.43	77.7	0.831	
Huff (QIII)	**6 hrs 1:25 yrs for Ottawa CDA**	**52595.010**	**88.21**	**8:50**	**20.84**	**95.3**	**0.926**	
Huff (QIII)	**6 hrs 1:50 yrs for Ottawa CDA**	**52595.010**	**108.07**	**8:40**	**25.36**	**119**	**0.908**	
Huff (QIII)	**6 hrs 1:100 yrs for Ottawa CDA**	**52595.010**	**129.48**	**8:40**	**30.26**	**139**	**0.932**	**0.858**
Huff (QIII)	**12 hrs 1:2 yrs for Ottawa CDA**	**52595.010**	**40.29**	**2:05**	**9.70**	**36.8**	**1.095**	
Huff (QIII)	**12 hrs 1:5 yrs for Ottawa CDA**	**52595.010**	**64.26**	**2:00**	**15.27**	**60.4**	**1.064**	
Huff (QIII)	**12 hrs 1:10 yrs for Ottawa CDA**	**52595.010**	**82.73**	**1:55**	**19.65**	**77.7**	**1.065**	
Huff (QIII)	**12 hrs 1:25 yrs for Ottawa CDA**	**52595.010**	**109.68**	**1:55**	**26.02**	**95.3**	**1.151**	
Huff (QIII)	**12 hrs 1:50 yrs for Ottawa CDA**	**52595.010**	**131.18**	**1:50**	**31.12**	**119**	**1.102**	
Huff (QIII)	**12 hrs 1:100 yrs for Ottawa CDA**	**52595.010**	**154.27**	**1:50**	**36.63**	**139**	**1.110**	**1.098**
Huff (QIII)	**24 hrs 1:2 yrs for Ottawa CDA**	**52595.010**	**50.61**	**11:55**	**12.25**	**36.8**	**1.375**	
Huff (QIII)	**24 hrs 1:5 yrs for Ottawa CDA**	**52595.010**	**73.41**	**11:55**	**18.21**	**60.4**	**1.215**	
Huff (QIII)	**24 hrs 1:10 yrs for Ottawa CDA**	**52595.010**	**90.92**	**11:55**	**22.85**	**77.7**	**1.170**	
Huff (QIII)	**24 hrs 1:25 yrs for Ottawa CDA**	**52595.010**	**115.42**	**11:55**	**29.42**	**95.3**	**1.211**	
Huff (QIII)	**24 hrs 1:50 yrs for Ottawa CDA**	**52595.010**	**134.92**	**11:55**	**34.72**	**119**	**1.134**	
Huff (QIII)	**24 hrs 1:100 yrs for Ottawa CDA**	**52595.010**	**155.81**	**11:55**	**40.37**	**139**	**1.121**	**1.204**
								1.204



Hydrograph Statistics:

Legend	Filename & Comment	Time Step (min)	Drainage Area (ha)	Peak Flow (cms)	Time to Peak (hrs)	Runoff Volume (mm)	Runoff Volume (cu.m)	Duration of flow (hrs)	Average flow (cms)
—○—	MOOD-03.HYD : Measured Flow at Moodie from May 1st, 2003	60.00	52595.00	27.950	634.000	75.46	3.969E+07	1500.000	7.350
—□—	M_SN2.001 : flow at S_N2 Jock River Gauge at Moodie Dr.	30.00	52483.00	33.648	603.500	75.32	3.953E+07	1500.000	7.320

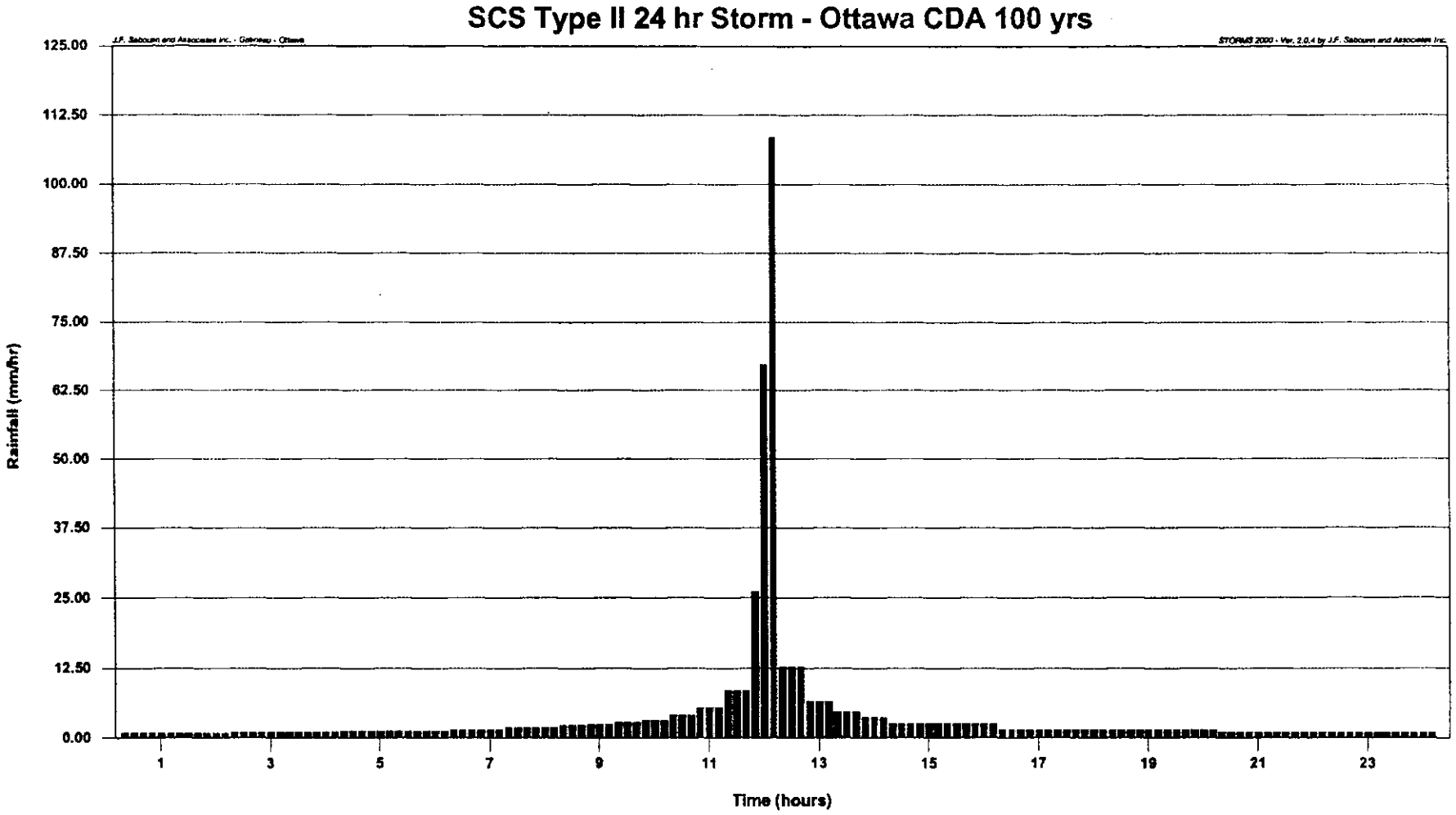
Figure C1 - Summer Hydrograph – Moodie Drive – 2003 - observed/simulated



Hydrograph Statistics:

Legend	Filename & Comment	Time Step (min)	Drainage Area (ha)	Peak Flow (cms)	Time to Peak (hrs)	Runoff Volume (mm)	Runoff Volume (cu.m)	Duration of flow (hrs)	Average flow (cms)
——■——	M_FRKQT2.TXT: Avg Q Calculated at Franktown (2003: May 1 at	60.00	17589.00	6.106	584.000	52.87	9.299E+06	1050.000	2.460
——✳——	R_SW10.003 : flow at S_N10: N10 + SW_10	30.00	17589.00	13.697	606.000	60.51	1.064E+07	1050.000	2.816

Figure C2 - Summer Hydrograph – Franktown Road – 2003 observed/simulated



Storm Statistics:

Storm Filename: D:\Proj\411-02\SWMHYMO\Summer\C24SC100.stm
Storm File Comment: SCS Type II 24 hr Storm - Ottawa CDA 100 yrs

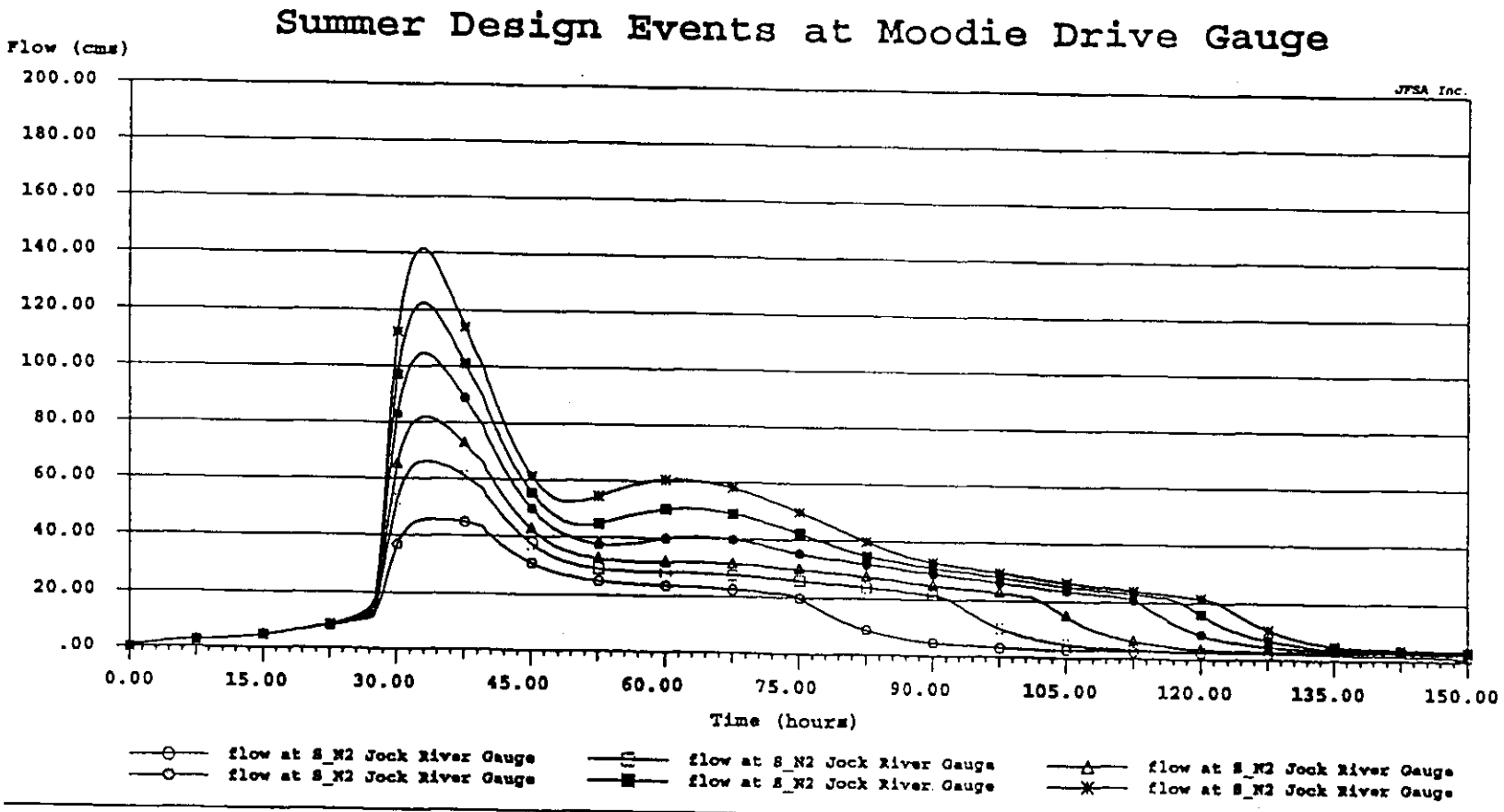
Total Rain	=	88.57 (mm)
Storm Duration (hrs):	=	24:00:00
Ave. Intensity	=	3.69 (mm/hr)
Max. Intensity	=	108.45 (mm/hr) at 710.00 (minutes)

Maximum Average Intensities: (mm/hr)

Time Window	5 min	10 min	15 min	30 min	1 hr	2 hrs	3 hrs	6 hrs	12 hrs	24 hrs
Ave. Intensity (mm/hr)	108.45	108.45	94.75	67.34	40.05	23.79	17.57	10.38	6.17	3.69

Figure C3 – Synthetic Hyetograph

SCS II 24 hour design storm – 100 Year



Hydrograph Statistics:

Legend	Filename & Comment	Time Step (min)	Drainage Area (ha)	Peak Flow (cms)	Time to Peak (hrs)	Runoff Volume (mm)	Runoff Volume (cu.m)	Duration of flow (hrs)	Average flow (cms)
—○—	N_SN2.002 : flow at S_N2 Jock River Gauge at Moodie Dr.	30.00	52483.00	45.676	33.500	12.73	6.681E+06	391.500	4.740
—□—	N_SN2.005 : flow at S_N2 Jock River Gauge at Moodie Dr.	30.00	52483.00	66.292	33.000	18.28	9.594E+06	401.000	6.646
—△—	N_SN2.010 : flow at S_N2 Jock River Gauge at Moodie Dr.	30.00	52483.00	82.076	33.000	22.52	1.182E+07	409.500	8.017
—◇—	N_SN2.025 : flow at S_N2 Jock River Gauge at Moodie Dr.	30.00	52483.00	104.643	33.000	28.62	1.502E+07	427.500	9.760
—■—	N_SN2.050 : flow at S_N2 Jock River Gauge at Moodie Dr.	30.00	52483.00	122.469	33.000	33.53	1.760E+07	446.000	10.960
—✳—	N_SN2.100 : flow at S_N2 Jock River Gauge at Moodie Dr.	30.00	52483.00	141.415	32.500	38.74	2.033E+07	467.000	12.094

Figure C4 – 2 Year through 100 Year simulated runoff – Moodie Drive - Summer