Flood Plain Mapping Study
Burnt River
Final Technical Appendices
May 2019

KAWARTHA CONSERVATION

City of KAWARTHA LAKES
Catch the Kawartha spirit

Table of Contents

Appendix A: Modeling Parameters Selection

Converting CN to CN*

Burnt River - Using Haliburton 3 rain data

P = 101.8 *mm*

standard I_a = 5 *mm*

Catchment	CN (AMC II)	CN (AMC III)	S (mm)	Ia	Q	S*	CN* (AMC III)	CN* (AMC II)
100	60	78	72	14.4	47.9	98.7	72	53
200	62	79	68	13.6	49.8	91.3	74	55
300	53	72	99	19.8	37.1	155.4	62	42
400	42	62	156	31.2	22.0	329.2	44	26
500	64	81	60	12.0	53.8	77.3	77	59
600	66	82	56	11.2	56.0	70.6	78	60
700	73	87	38	7.6	67.1	42.8	86	72
800	74	88	35	7.0	69.2	38.5	87	73
900	73	87	38	7.6	67.1	42.8	86	72
1100	73	87	38	7.6	67.1	42.8	86	72
1200	75	88	35	7.0	69.2	38.5	87	73
1300	77	89	31	6.2	72.2	33.0	89	76
1400	73	87	38	7.6	67.1	42.8	86	72
1500	74	88	35	7.0	69.2	38.5	87	73
1600	74	88	35	7.0	69.2	38.5	87	73
1700	76	89	31	6.2	72.2	33.0	89	76
1800	75	88	35	7.0	69.2	38.5	87	73
1900	76	89	31	6.2	72.2	33.0	89	76
2000	76	89	31	6.2	72.2	33.0	89	76
2100	75	88	35	7.0	69.2	38.5	87	73
2200	78	90	28	5.6	74.5	29.0	90	78
2300	76	89	31	6.2	72.2	33.0	89	76
2400	74	88	35	7.0	69.2	38.5	87	73
2500	66	82	56	11.2	56.0	70.6	78	60
2600	66	82	56	11.2	56.0	70.6	78	60
2700	77	89	31	6.2	72.2	33.0	89	76
2800	74	88	35	7.0	69.2	38.5	87	73
2900	76	89	31	6.2	72.2	33.0	89	76
3000	78	90	28	5.6	74.5	29.0	90	78

101.8 mm is antecent rainfall for 100yr 6 hr storm

Procedure:

1. $$CN\ (AMC\ II) = \frac{25400}{(254 + S)}$$, *to calculate S*
2. $I_a = 0.2 * S$, *to give calculated* I_a
3. $$Q = \frac{(P-I_a)^2}{(P-I_a+S)}$$
4. $$Q = \frac{(P-I_a)^2}{(P-I_a+S^*)}$$, Using Q from 3 above, and I_a = 5mm, determine S*
5. $$CN^*\ (AMC\ III) = \frac{25400}{(254 + S^*)}$$

Note:this procedure is outlined in the VO_2 *Reference Manual.*

Manual checks were undertaken to ensure accuracy of GIS-derived product

Summary of values for Burnt - Land Use

Catchment	Area (Ha)	C	T_p (hr)	CN (II)	CN* (II)	X_{imp}	T_{imp}
100	615.4	0.29	1.84	60	53	0.01	0.01
200	7004.9	0.26	5.07	62	55	0.01	0.02
300	300.7	0.20	1.10	53	42	0.01	0.01
400	364.2	0.14	1.23	42	26	0.03	0.01
500	12896.9	0.28	7.76	64	59	0.02	0.02
600	2951.6	0.29	4.75	66	60	0.01	0.01
700	5439.4	0.32	3.60	73	72	0.02	0.02
800	3125.5	0.30	5.00	74	73	0.02	0.03
900	1824.2	0.30	4.07	73	72	0.01	0.02
1100	3229.6	0.28	4.47	73	72	0.01	0.02
1200	2472.1	0.31	3.85	75	73	0.02	0.03
1300	6417.0	0.36	4.98	77	76	0.01	0.02
1400	698.1	0.28	2.27	73	72	0.02	0.03
1500	3641.7	0.31	4.20	74	73	0.03	0.03
1600	5488.9	0.29	4.28	74	73	0.02	0.03
1700	16794.7	0.34	6.46	76	76	0.02	0.03
1800	1008.7	0.28	2.61	75	73	0.03	0.04
1900	3249.4	0.37	3.71	77	76	0.03	0.03
2000	3268.3	0.34	1.41	76	76	0.02	0.03
2100	5333.5	0.33	4.38	75	73	0.02	0.02
2200	3089.2	0.40	3.32	78	78	0.01	0.01
2300	6277.0	0.36	4.59	76	76	0.01	0.01
2400	11213.0	0.30	4.14	74	73	0.02	0.02
2500	12059.3	0.37	4.82	66	60	0.01	0.01
2600	6847.7	0.38	4.15	66	60	0.01	0.01
2700	2465.8	0.37	3.16	77	76	0.01	0.01
2800	1188.8	0.27	2.39	74	73	0.01	0.02
2900	8136.8	0.33	2.28	76	76	0.01	0.02
3000	6379.7	0.40	3.42	78	78	0.01	0.01

Total Area 143,782.3 *Ha*

Appendix B: Subcatchment Data

Summary of values for Burnt - Land Use

Catchment	Area (Ha)	C	T_p (hr)	CN (II)	CN* (II)	X_{imp}	T_{imp}
100	615.4	0.29	1.84	60	53	0.01	0.01
200	7004.9	0.26	5.07	62	55	0.01	0.02
300	300.7	0.20	1.10	53	42	0.01	0.01
400	364.2	0.14	1.23	42	26	0.03	0.01
500	12896.9	0.28	7.76	64	59	0.02	0.02
600	2951.6	0.29	4.75	66	60	0.01	0.01
700	5439.4	0.32	3.60	73	72	0.02	0.02
800	3125.5	0.30	5.00	74	73	0.02	0.03
900	1824.2	0.30	4.07	73	72	0.01	0.02
1100	3229.6	0.28	4.47	73	72	0.01	0.02
1200	2472.1	0.31	3.85	75	73	0.02	0.03
1300	6417.0	0.36	4.98	77	76	0.01	0.02
1400	698.1	0.28	2.27	73	72	0.02	0.03
1500	3641.7	0.31	4.20	74	73	0.03	0.03
1600	5488.9	0.29	4.28	74	73	0.02	0.03
1700	16794.7	0.34	6.46	76	76	0.02	0.03
1800	1008.7	0.28	2.61	75	73	0.03	0.04
1900	3249.4	0.37	3.71	77	76	0.03	0.03
2000	3268.3	0.34	1.41	76	76	0.02	0.03
2100	5333.5	0.33	4.38	75	73	0.02	0.02
2200	3089.2	0.40	3.32	78	78	0.01	0.01
2300	6277.0	0.36	4.59	76	76	0.01	0.01
2400	11213.0	0.30	4.14	74	73	0.02	0.02
2500	12059.3	0.37	4.82	66	60	0.01	0.01
2600	6847.7	0.38	4.15	66	60	0.01	0.01
2700	2465.8	0.37	3.16	77	76	0.01	0.01
2800	1188.8	0.27	2.39	74	73	0.01	0.02
2900	8136.8	0.33	2.28	76	76	0.01	0.02
3000	6379.7	0.40	3.42	78	78	0.01	0.01

Total Area 143,782.3 *Ha*

Catchment	Shape_Length	FlowType	FromNode		ToNode	
100	4088.02	Straightened Overland Flow	tt	297.37	uu	254.84
200	14655.74	Straightened Overland Flow	oo	312.35	pp	256.77
300	2085.05	Straightened Overland Flow	dd	311.16	nn	259.28
400	2033.07	Straightened Overland Flow	f	305.01	vv	262.19
500	29416.06	Straightened Overland Flow	mm	342.96	ww	260.76
600	14411.50	Straightened Overland Flow	kk	324.15	B'	265.10
700	8960.81	Straightened Overland Flow	ii	310.04	ll	274.15
800	14674.48	Straightened Overland Flow	m	336.91	jj	286.75
900	9878.79	Straightened Overland Flow	gg	325.88	F'	291.34
1100	14153.00	Straightened Overland Flow	k	355.91	zz	286.78
1200	13185.72	Straightened Overland Flow	ee	376.37	ss	294.25
1300	20062.69	Straightened Overland Flow	aa	382.94	v	294.29
1400	5850.89	Straightened Overland Flow	C'	362.79	l	303.98
1500	13919.25	Straightened Overland Flow	cc	363.80	ss	294.25
1600	14937.29	Straightened Overland Flow	i	390.75	yy	303.27
1700	27735.46	Straightened Overland Flow	c	417.76	h	319.77
1800	6350.65	Straightened Overland Flow	D'	359.49	A'	312.20
1900	15247.15	Straightened Overland Flow	y	407.26	z	303.77
2000	4727.72	Straightened Overland Flow	G'	415.89	E'	299.55
2100	18290.56	Straightened Overland Flow	e	447.85	j	331.52
2200	12430.73	Straightened Overland Flow	g	407.80	j	331.52
2300	19137.64	Straightened Overland Flow	w	429.63	n	329.06
2400	8395.51	Straightened Overland Flow	qq	484.99	b	356.05
2500	24092.56	Straightened Overland Flow	a	502.08	d	354.43
2600	16834.39	Straightened Overland Flow	u	460.69	x	370.24
2700	10258.56	Straightened Overland Flow	s	451.74	xx	389.83
2800	8395.51	Straightened Overland Flow	qq	484.99	b	356.05
2900	7989.39	Straightened Overland Flow	q	459.73	rr	355.68
3000	15800.25	Straightened Overland Flow	o	507.92	t	380.45

Catchment	Shape_Length	FlowType	FromNode		ToNode	
100	3421.46	Routing Channel flow	pp	256.77	uu	254.84
200	9347.37	Routing Channel flow	nn	259.28	pp	256.77
300	2095.59	Routing Channel flow	ff	260.37	nn	259.28
300	517.83	Routing Channel flow	ww	260.76	ff	260.37
300	450.56	Routing Channel flow	vv	262.19	ff	260.37
400	4213.39	Routing Channel flow	B'	265.10	vv	262.19

600	6105.99	Routing Channel flow	ll	274.15	B'	265.10
700	8286.15	Routing Channel flow	jj	286.83	ll	274.15
800	1004.01	Routing Channel flow	l	303.98	zz	286.72
900	4985.99	Routing Channel flow	ss	294.25	F'	286.83
1100	11455.93	Routing Channel flow	l	303.98	F'	286.83
1100	218.98	Routing Channel flow	yy	303.27	H'	300.68
1100	265.64	Routing Channel flow	F'	286.83	zz	286.72
1200	6879.23	Routing Channel flow	bb	299.85	ss	294.25
1300	2791.09	Routing Channel flow	z	303.77	bb	299.85
1300	121.00	Routing Channel flow	E'	299.55	I'	299.24
1400	1300.84	Routing Channel flow	A'	312.20	H'	300.68
1600	11493.44	Routing Channel flow	j	331.52	H'	300.68
1700	23867.44	Routing Channel flow	d	354.43	h	319.77
1800	4657.29	Routing Channel flow	h	319.77	A'	312.20
2000	10856.39	Routing Channel flow	p	322.75	I'	299.24
2100	13948.55	Routing Channel flow	x	370.24	j	331.52
2400	185.48	Routing Channel flow	n	323.22	p	322.75
2400	25192.27	Routing Channel flow	K'	354.59	p	322.75
2400	582.00	Routing Channel flow	b	356.05	K'	354.59
2800	8984.58	Routing Channel flow	xx	389.83	K'	354.59
2900	13708.02	Routing Channel flow	t	380.45	K'	354.59
2400	151.29	Routing Channel flow	rr	355.68	K'	354.59

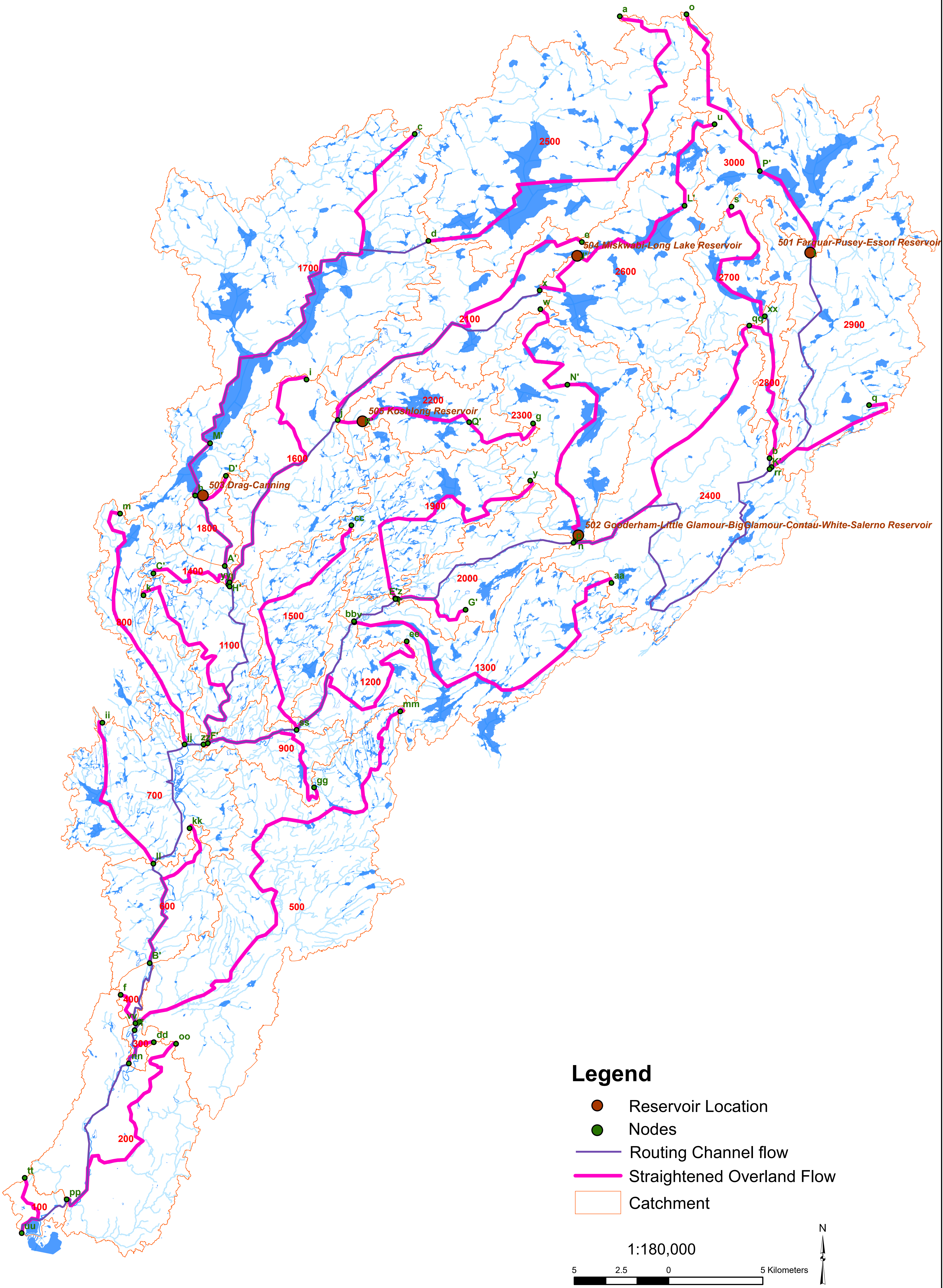
Catchment ID	Area (ha)	Travel Length (m)	From	To	Elevation (m) Top	Elevation (m) Bottom	Slope (%)	Runoff Coeff	ToC (min)	Tp (hr)
100	615.4	4088.02	tt	uu	297.37	254.84	0.010	0.29	165.94	1.84
200	7004.9	14655.74	oo	pp	312.35	256.77	0.004	0.26	456.52	5.07
300	301.0	2085.05	dd	nn	311.16	259.28	0.025	0.20	99.17	1.10
400	364.2	2033.07	f	vv	305.01	262.19	0.021	0.14	110.82	1.23
500	12896.9	29416.06	mm	ww	342.96	260.76	0.003	0.28	698.32	7.76
600	2951.6	14411.50	kk	B'	324.15	265.10	0.004	0.29	427.40	4.75
700	5439.4	8960.81	ii	ll	310.04	274.15	0.004	0.32	324.29	3.60
800	3125.5	14674.48	m	jj	336.91	286.75	0.003	0.30	450.23	5.00
900	1824.2	9878.79	gg	F'	325.88	291.34	0.003	0.30	366.69	4.07
1100	3229.6	14153.00	k	zz	355.91	286.78	0.005	0.28	402.51	4.47
1200	2472.1	13185.72	ee	ss	376.37	294.25	0.006	0.31	346.62	3.85
1300	6417.0	20062.69	aa	v	382.94	294.29	0.004	0.36	448.04	4.98
1400	698.1	5850.89	C'	l	362.79	303.98	0.010	0.28	204.13	2.27
1500	3641.7	13919.25	cc	ss	363.80	292.05	0.005	0.31	378.11	4.20
1600	5488.9	14937.29	i	yy	390.75	303.27	0.006	0.29	385.06	4.28
1700	16794.7	24284.83	c	M'	417.76	324.28	0.004	0.34	529.08	5.88
1800	1008.7	6350.65	D'	A'	359.49	312.20	0.007	0.28	234.80	2.61
1900	3249.4	15247.15	y	z	407.26	303.77	0.007	0.37	333.94	3.71
2000	3268.3	4727.72	G'	E'	415.89	299.55	0.025	0.34	126.56	1.41
2100	5333.5	18290.56	e	j	447.85	331.52	0.006	0.33	394.17	4.38
2200	3089.2	4625.24	g	Q'	407.80	351.03	0.012	0.40	145.05	1.61
2300	6277.0	7972.52	w	N'	429.63	372.52	0.007	0.36	240.47	2.67
2400	11213.0	16996.40	qq	b	484.99	356.05	0.008	0.30	372.46	4.14
2500	12059.3	24092.56	a	d	502.08	354.43	0.006	0.37	434.17	4.82
2600	6846.7	5970.18	u	L'	460.69	394.35	0.011	0.38	175.16	1.95
2700	2465.8	10258.56	s	xx	451.74	389.83	0.006	0.37	284.75	3.16
2800	1188.8	8395.51	qq	b	484.99	356.05	0.015	0.27	215.19	2.39
2900	8136.8	7989.39	q	rr	459.73	355.68	0.013	0.33	205.63	2.28
3000	6379.7	10223.35	o	P'	507.92	383.79	0.012	0.40	216.42	2.40

Route Channel	VO Node	To VO Node	GIS Node From	GIS Node To	Elevation From	Elevation To	Length (m)	Slope m/m
10100	127	128	pp	uu	256.77	254.84	3421.46	0.06
10200	126	127	nn	pp	259.28	256.77	9347.37	0.03
10300	125	126	ff	nn	260.76	259.28	2095.59	0.07
83	500	125	ww	ff	260.76	260.37	517.83	0.08
84	124	125	vv	ff	262.19	260.37	450.56	0.40
10400	123	124	B'	vv	265.10	262.19	4213.39	0.07

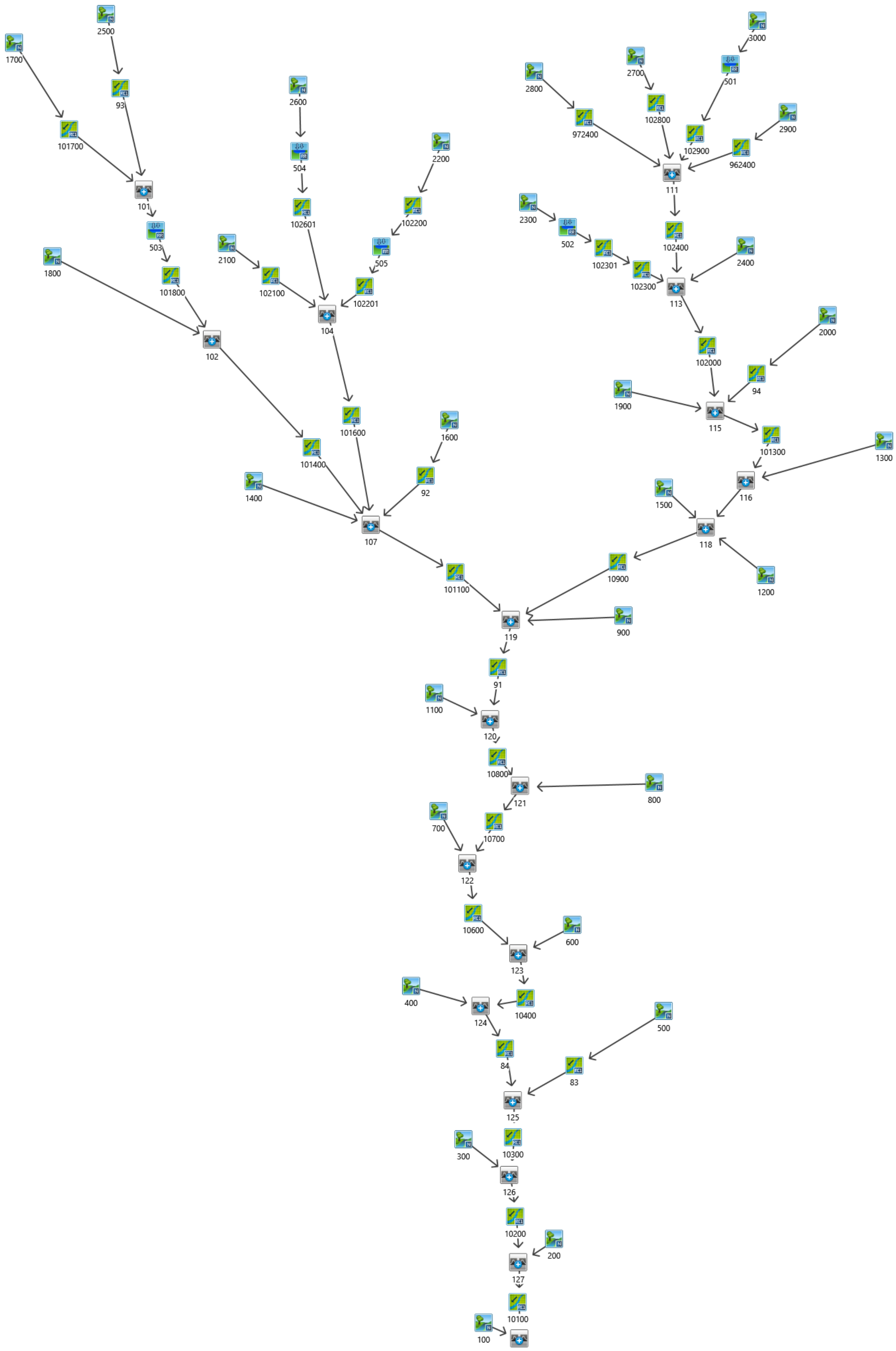
10600	122	123	ll	B'	274.15	265.10	6105.99	0.15
10700	121	122	jj	ll	286.83	274.15	8286.15	0.15
10800	120	121	l	zz	303.98	286.72	1004.01	1.72
10900	118	119	ss	F'	294.25	286.83	4985.99	0.15
101100	107	119	l	F'	303.98	286.72	11455.93	0.15
92	1600	107	yy	H'	303.27	300.68	218.98	1.18
91	119	120	F'	zz	286.83	286.72	265.64	0.04
101200	116	118	bb	ss	299.85	294.25	6879.23	0.08
101300	115	116	z	bb	303.77	299.85	2791.09	0.14
94	2000	115	E'	I'	299.55	299.24	121.00	0.26
101400	106	107	A'	H'	312.20	300.68	1300.84	0.89
101600	104	107	j	H'	331.52	300.68	11493.44	0.27
101700	1700	503	c	M'	417.76	324.28	20415.74	0.46
93	2500	101	d	h	354.43	319.77	20415.74	0.17
101800	101	102	h	A'	319.77	312.20	4657.29	0.16
102000	113	115	p	E'	322.75	299.24	10856.39	0.22
102100	2600	104	x	j	370.24	331.52	13948.55	0.28
102300	12301	113	n	p	323.22	322.75	185.48	0.25
102200	2200	505	g	Q'	407.80	351.03	4625.24	1.23
102201	505	104	R'	j	351.81	331.52	1302.44	1.56
102400	111	113	K'	p	354.59	322.75	25192.27	0.13
102301	502	113	O'	n	332.00	323.22	305.12	2.88
12601	504	104	J'	x	403.16	370.24	3815.37	0.86
972400	2800	111	b	K'	356.05	354.59	582.00	0.25
102800	2700	111	xx	b	389.83	354.59	8402.58	0.42
102900	3000	111	t	K'	380.45	354.59	13708.02	0.19
962400	2900	111	rr	K'	355.68	354.59	151.29	0.72

Appendix C: Subcatchment Maps

Hydrology Model Input Parameters



Appendix D: VH Suite Output



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101
503
101800
1800
102
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102200
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102201
104
101600
101400
1600
92
1400
107
101100
3000
2700
501
2800
102800
2900
972400
102900
962400
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102400
2300
502
2400
102301
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2000
102000
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1900
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101300
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600
123
400
124
10400
500
84
83
125
300
10300
126
10200
200
127
10100
100
128

Appendix E: Hydrology Model Flow Summary

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V   V  I   SSSSS  U   U   A   L          (v 5.1.2004)
V   V  I   SS    U   U  A A  L
 V V   I    SS   U   U  AAAAA  L
 V V   I     SS  U   U  A   A  L
  VV   I   SSSSS  UUUUU  A   A  LLLLL

 OOO  TTTTT  TTTTT  H   H  Y   Y  M   M  OOO   TM
O   O   T      T    H   H   Y Y   MM MM  O   O
O   O   T      T    H   H    Y    M   M  O   O
 OOO    T      T    H   H    Y    M   M   OOO
```

Developed and Distributed by Civica Infrastructure

***** S U M M A R Y   O U T P U T *****

Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.1\VO2\voin.dat

Output filename: C:\Users\nparacha\AppData\Local\Civica\VH5\26d0da80-2810-4509-ab0a-c453ed50a310\e470f204-8579-4c73-8117-a03904a48428\sce

Summary filename: C:\Users\nparacha\AppData\Local\Civica\VH5\26d0da80-2810-4509-ab0a-c453ed50a310\e470f204-8579-4c73-8117-a03904a48428\sce

DATE: 05-14-2019   TIME: 03:03:08

USER:

COMMENTS: ____

****

** SIMULATION : Timmins(66) **

****

W/E COMMAND HYD ID DT AREA ' Qpeak Tpeak R.V. R.C. Qbase

min ha ' cms hrs mm cms

START @ 0.00 hrs

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

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[CN=64.0]

[N = 3.0:Tp 7.20]

*

RESRVR [2: 3000] 0501 1 1.0 6379.70 0.38 33.32 0.33 n/a 0.000

{ST=347.51 ha.m }

*

CHANNEL[2: 0501] 102900 1 1.0 6379.70 0.36 33.32 0.26 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 2900 1 1.0 8136.80 97.78 15.12 29.23 0.23 0.000

[CN=67.0]

[N = 3.0:Tp 6.84]

*

CHANNEL[2: 2900] 962400 1 1.0 8136.80 97.78 15.15 59.16 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 2700 1 1.0 2465.80 20.68 16.63 16.95 0.13 0.000

[CN=64.0]

[N = 3.0:Tp 9.48]

*

CHANNEL[2: 2700] 102800 1 1.0 2465.80 20.22 19.48 49.22 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 2800 1 1.0 1188.80 15.35 15.37 31.15 0.24 0.000

[CN=72.0]

[N = 3.0:Tp 7.17]

*

CHANNEL[2: 2800] 972400 1 1.0 1188.80 15.34 15.48 65.69 n/a 0.000

*

ADD [102800+102900] 0111 3 1.0 8845.50 20.39 19.53 13.91 n/a 0.000

*

ADD [0111+962400] 0111 1 1.0 ******* 114.31 15.65 35.59 n/a 0.000

*

ADD [0111+972400] 0111 3 1.0 ******* 129.64 15.63 37.56 n/a 0.000

*

CHANNEL[2: 0111] 102400 1 1.0 ******* 87.63 20.70 28.90 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 2400 1 1.0 ******* 71.17 16.63 11.40 0.09 0.000

[CN=67.0]

[N = 3.0:Tp12.42]

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 2300 1 1.0 6277.00 61.71 16.23 21.94 0.17 0.000

[CN=64.0]

[N = 3.0:Tp 8.01]

*

RESRVR [2: 2300] 0502 1 1.0 6277.00 0.56 33.32 0.47 n/a 0.000

{ST=333.99 ha.m }

*

CHANNEL[2: 0502] 102301 1 1.0 6277.00 0.56 33.32 0.47 n/a 0.000

*

CHANNEL[2:102301] 102300 1 1.0 6277.00 0.56 33.32 0.47 n/a 0.000

*

ADD [102300+102400] 0113 3 1.0 ******* 87.99 20.70 21.60 n/a 0.000

*

ADD [0113+ 2400] 0113 1 1.0 ******* 167.42 20.60 29.62 n/a 0.000

*

CHANNEL[2: 0113] 102000 1 1.0 ******* 164.07 22.12 27.71 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 2000 1 1.0 3268.30 55.51 12.83 46.28 0.36 0.000

[CN=67.0]

[N = 3.0:Tp 4.23]

*

CHANNEL[2: 2000]   0094 1 1.0 3268.30   55.51 12.83 60.48 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   1900 1 1.0 3249.40   24.07 16.63 13.93 0.11   0.000

[CN=67.0   ]

[N = 3.0:Tp11.13]

*

ADD [102000+ 1900] 0115 3 1.0 ******* 188.28 21.77 29.62 n/a   0.000

*

ADD [0115+ 0094] 0115 1 1.0 ******* 199.01 20.53 32.01 n/a   0.000

*

CHANNEL[2: 0115] 101300 1 1.0 ******* 198.72 20.78 31.50 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   1300 1 1.0 6417.00   28.14 16.63   7.32 0.06   0.000

[CN=64.0   ]

[N = 3.0:Tp14.94]

*

ADD [101300+ 1300] 0116 3 1.0 ******* 233.77 21.13 32.30 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 1200 1 1.0 2472.10 17.42 16.63 13.04 0.10 0.000

[CN=67.0]

[N = 3.0:Tp11.55]

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 1500 1 1.0 3641.70 22.62 16.63 11.09 0.09 0.000

[CN=67.0]

[N = 3.0:Tp12.60]

*

ADD [0116+ 1200] 0118 3 1.0 ******* 252.23 21.03 33.13 n/a 0.000

*

ADD [0118+ 1500] 0118 1 1.0 ******* 277.66 20.98 34.03 n/a 0.000

*

CHANNEL[2: 0118] 10900 1 1.0 ******* 276.62 21.63 33.01 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 2500 1 1.0 ******* 37.89 16.63 5.17 0.04 0.000

[CN=49.0]

[N = 3.0:Tp14.46]

*

CHANNEL[2: 2500] 0093 1 1.0 ******* 39.72 29.27 18.38 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 1700 1 1.0 ******* 58.56 16.63 5.58 0.04 0.000

[CN=67.0]

[N = 3.0:Tp17.64]

*

CHANNEL[2: 1700] 101700 1 1.0 ******* 83.99 27.68 30.37 n/a 0.000

*

ADD [101700+ 0093] 0101 3 1.0 ******* 123.48 28.23 25.36 n/a 0.000

*

RESRVR [2: 0101] 0503 1 1.0 ******* 0.81 33.32 0.09 n/a 0.000

{ST=729.10 ha.m }

*

CHANNEL[2: 0503] 101800 1 1.0 *******   0.67 33.32   0.07 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   1800 1 1.0 1008.70   12.09 15.97 27.67 0.22   0.000

[CN=72.0   ]

[N = 3.0:Tp 7.83]

*

ADD [101800+ 1800] 0102 3 1.0 *******   12.13 16.00   2.25 n/a   0.000

*

CHANNEL[2: 0102] 101400 1 1.0 *******   12.13 16.15   2.25 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   2600 1 1.0 6847.70   60.00 14.40 21.87 0.17   0.000

[CN=49.0   ]

[N = 3.0:Tp 5.85]

*

RESRVR [2: 2600]   0504 1 1.0 6847.70   0.42 33.32   0.38 n/a   0.000

{ST=260.19 ha.m }

*

CHANNEL[2: 0504] 102601 1 1.0 6847.70   0.42 33.32   0.37 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   2100 1 1.0 5333.50   31.06 16.63 10.23 0.08   0.000

[CN=67.0   ]

[N = 3.0:Tp13.14]

*

CHANNEL[2: 2100] 102100 1 1.0 5333.50   33.55 24.48 38.52 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   2200 1 1.0 3089.20   45.06 13.37 38.96 0.31   0.000

[CN=64.0   ]

[N = 3.0:Tp 4.83]

*

CHANNEL[2: 2200] 102200 1 1.0 3089.20   44.72 13.85 56.32 n/a   0.000

*

RESRVR [2:102200]   0505 1 1.0 3089.20   0.42 33.30   0.89 n/a   0.000

{ST=171.25 ha.m }

*

CHANNEL[2: 0505] 102201 1 1.0 3089.20 0.42 33.32 0.88 n/a 0.000

*

ADD [102100+102201] 0104 3 1.0 8422.70 33.95 24.52 24.71 n/a 0.000

*

ADD [0104+102601] 0104 1 1.0 ******* 34.34 24.53 13.80 n/a 0.000

*

CHANNEL[2: 0104] 101600 1 1.0 ******* 33.19 27.32 12.08 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 1600 1 1.0 5488.90 33.92 16.63 10.98 0.09 0.000

[CN=68.0]

[N = 3.0:Tp12.84]

*

CHANNEL[2: 1600] 0092 1 1.0 5488.90 38.56 20.82 46.98 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 1400 1 1.0 698.10 8.61 15.08 30.13 0.24 0.000

[CN=68.0]

[N = 3.0:Tp 6.81]

*

ADD [101400+101600] 0107 3 1.0 ******* 38.40 25.22 5.57 n/a 0.000

*

ADD [0107+ 1400] 0107 1 1.0 ******* 41.71 23.28 6.41 n/a 0.000

*

ADD [0107+ 0092] 0107 3 1.0 ******* 79.72 21.87 10.75 n/a 0.000

*

CHANNEL[2: 0107] 101100 1 1.0 ******* 77.83 24.05 9.75 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 0900 1 1.0 1824.20 11.87 16.63 11.77 0.09 0.000

[CN=67.0]

[N = 3.0:Tp12.21]

*

ADD [101100+ 10900] 0119 3 1.0 ******* 352.73 22.17 21.75 n/a 0.000

*

ADD [0119+ 0900] 0119 1 1.0 ******* 365.57 22.17 22.19 n/a 0.000

*

CHANNEL[2: 0119] 0091 1 1.0 ******* 365.44 22.33 22.00 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 1100 1 1.0 3229.60 18.22 16.63 9.84 0.08 0.000

[CN=67.0]

[N = 3.0:Tp13.41]

*

ADD [1100+ 0091] 0120 3 1.0 ******* 386.63 22.28 22.65 n/a 0.000

*

CHANNEL[2: 0120] 10800 1 1.0 ******* 386.63 22.35 22.61 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 0800 1 1.0 3125.50 14.64 16.63 7.86 0.06 0.000

[CN=67.0]

[N = 3.0:Tp15.00]

*

ADD [10800+ 0800] 0121 3 1.0 ******* 405.13 22.37 23.09 n/a 0.000

*

CHANNEL[2: 0121] 10700 1 1.0 ******* 402.29 23.37 21.75 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 0700 1 1.0 5439.40 41.92 16.63 14.69 0.12 0.000

[CN=67.0]

[N = 3.0:Tp10.80]

*

ADD [10700+ 0700] 0122 3 1.0 ******* 441.16 22.87 23.10 n/a 0.000

*

CHANNEL[2: 0122] 10600 1 1.0 ******* 438.90 23.73 22.03 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 0600 1 1.0 2951.60 12.71 16.63 7.25 0.06 0.000

[CN=60.0]

[N = 3.0:Tp14.25]

*

ADD [10600+ 0600] 0123 3 1.0 ******* 454.35 23.68 22.36 n/a 0.000

*

CHANNEL[2: 0123] 10400 1 1.0 ******* 452.43 24.37 21.52 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 0400 1 1.0 364.20 2.00 12.67 14.39 0.11 0.000

[CN=26.0]

[N = 3.0:Tp 3.69]

*

ADD [10400+ 0400] 0124 3 1.0 ******* 452.50 24.35 21.51 n/a 0.000

*

CHANNEL[2: 0124] 0084 1 1.0 ******* 452.50 24.37 21.47 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 0500 1 1.0 ******* 19.84 16.63 2.27 0.02 0.000

[CN=57.0]

[N = 3.0:Tp23.27]

*

CHANNEL[2: 0500] 0083 1 1.0 ******* 39.37 31.15 17.87 n/a 0.000

*

ADD [0083+ 0084] 0125 3 1.0 ******* 488.00 24.68 21.13 n/a 0.000

*

CHANNEL[2: 0125] 10300 1 1.0 ******* 487.89 24.72 20.81 n/a 0.000

*

READ STORM 10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   0300 1 1.0 300.70   2.83 12.27 24.85 0.20   0.000

[CN=39.0   ]

[N = 3.0:Tp 3.31]

*

ADD [10300+ 0300] 0126 3 1.0 ******* 487.93 24.72 20.82 n/a   0.000

*

CHANNEL[2: 0126] 10200 1 1.0 ******* 475.63 26.47 18.77 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD   0200 1 1.0 7004.90   22.49 16.63   5.23 0.04   0.000

[CN=53.0   ]

[N = 3.0:Tp15.21]

*

ADD [10200+ 0200] 0127 3 1.0 ******* 503.73 26.47 19.23 n/a   0.000

*

CHANNEL[2: 0127] 10100 1 1.0 ******* 499.09 27.05 18.01 n/a   0.000

*

READ STORM   10.0

[Ptot=127.38 mm]

fname : C:\Users\nparacha\AppData\Local\Temp\40726d39-d6ac-4129-a484-52e453d5e9d8\91faaf18-1069-4793-858c-be

remark: Timmins(66)

*

** CALIB NASHYD 0100 1 1.0 615.40 6.26 14.08 25.97 0.20 0.000

[CN=53.0]

[N = 3.0:Tp 5.52]

*

ADD [0100+ 10100] 0128 3 1.0 ******* 499.77 27.05 18.12 n/a 0.000

*

FINISH

===
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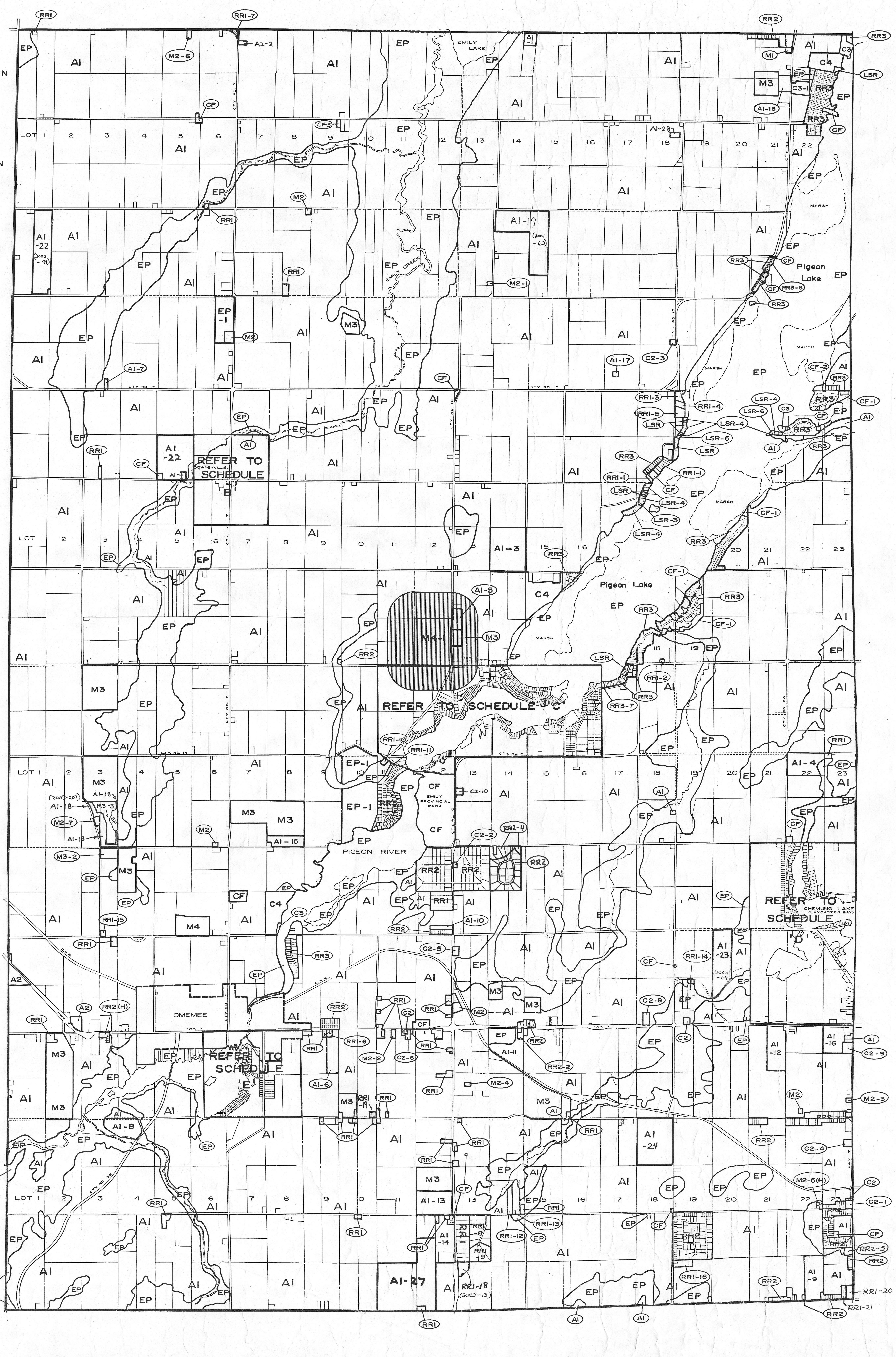
Appendix F: Official & Secondary Plan Maps



THE CORPORATION OF THE TOWNSHIP OF EMILY

SCHEDULE 'A'

TO

ZONING BY-LAW NO. 1996-30

AS AMENDED

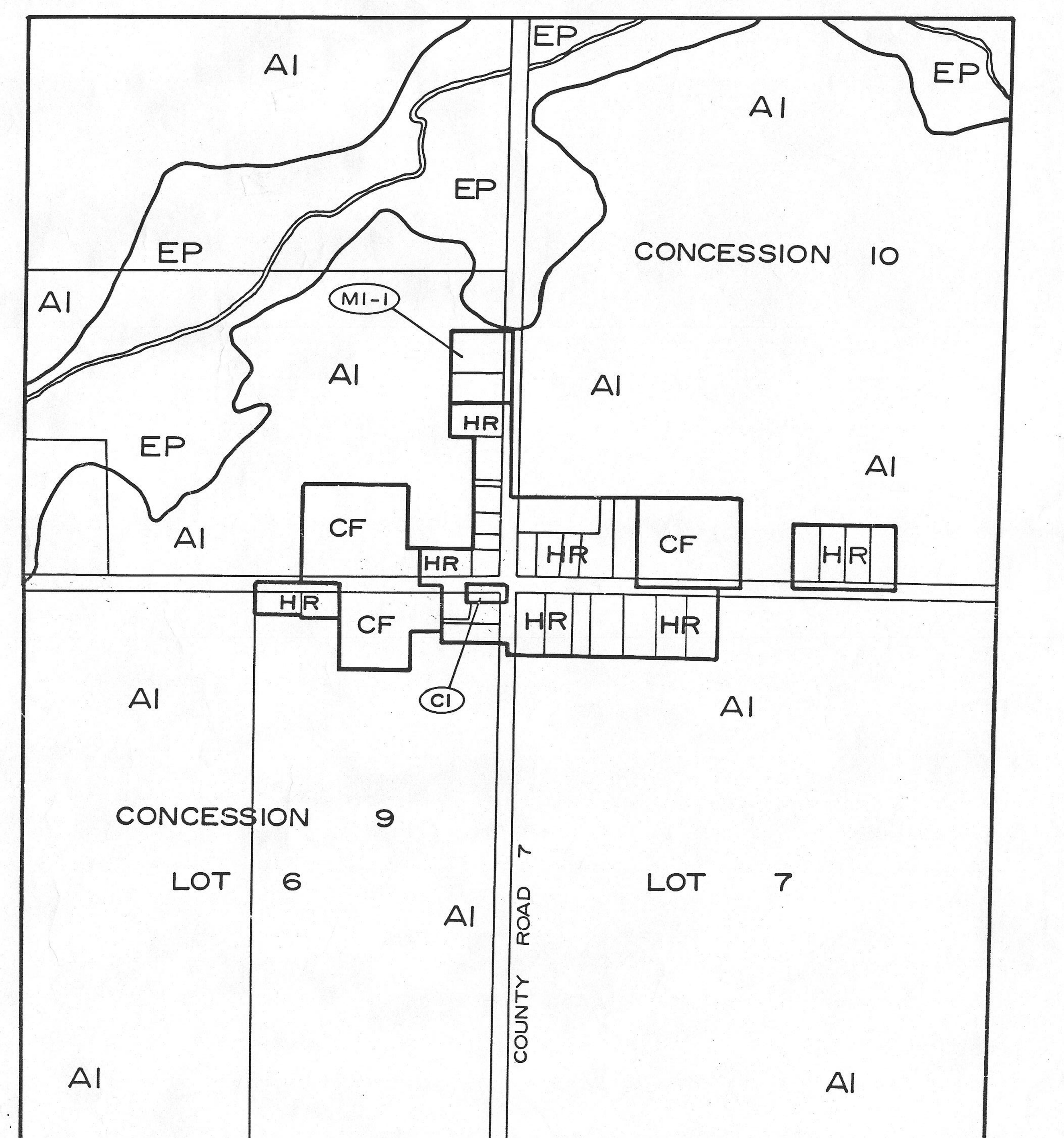
CONSOLIDATION JULY 2012

THIS SCHEDULE REFLECTS A DRAFT CONSOLIDATION AND REFERENCE SHOULD BE HAD TO THE ACTUAL AMENDING BY-LAWS FOR COMPLETE ACCURACY.

0 1000 3000 5000 FEET
0 500 1000 1500 METRES

ZONES

- EP — ENVIRONMENTAL PROTECTION ZONE
- CF — COMMUNITY FACILITY ZONE
- A1 — AGRICULTURAL ZONE
- A2 — RURAL GENERAL ZONE
- HR — HAMLET RESIDENTIAL ZONE
- RR1 — RURAL RESIDENTIAL TYPE ONE ZONE
- RR2 — RURAL RESIDENTIAL TYPE TWO ZONE
- RR3 — RURAL RESIDENTIAL TYPE THREE ZONE
- LSR — LIMITED SERVICE RESIDENTIAL ZONE
- C1 — GENERAL COMMERCIAL ZONE
- C2 — HIGHWAY COMMERCIAL ZONE
- C3 — RECREATION COMMERCIAL ZONE
- C4 — CAMPGROUND COMMERCIAL ZONE
- M1 — RESTRICTED INDUSTRIAL ZONE
- M2 — GENERAL INDUSTRIAL ZONE
- M3 — EXTRACTIVE INDUSTRIAL ZONE
- M4 — DISPOSAL INDUSTRIAL ZONE
- (shaded) — REFER TO SECTION 3.18.1.4
- ——— ZONE BOUNDARY
- (H) — REFER TO SECTION 3.8



THIS IS SCHEDULE 'B' TO BY-LAW NO. 1996-30

AS AMENDED

DOWNEYVILLE AREA

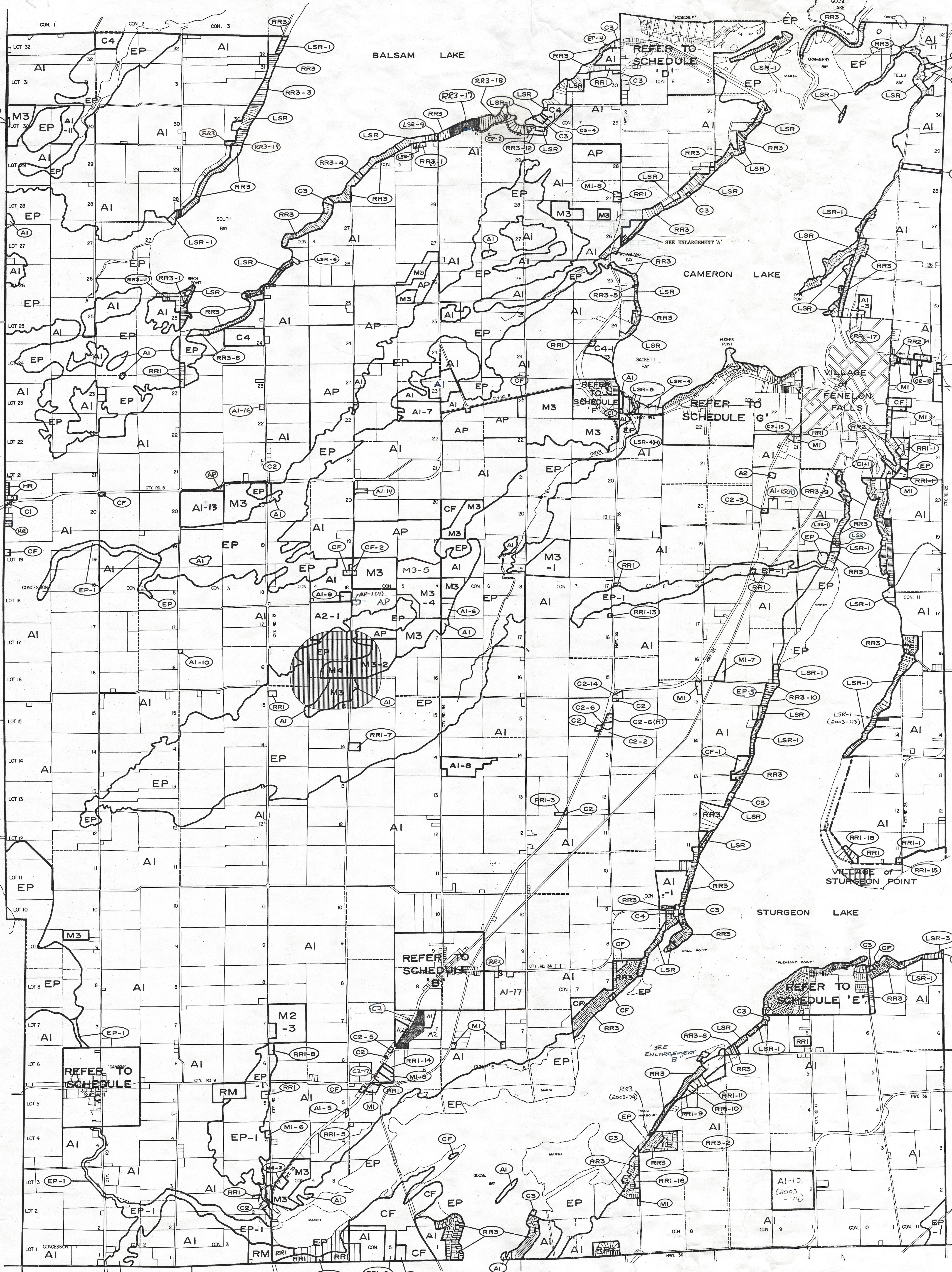
0 200 400 800 FEET
0 50 100 200 METRES

THIS SCHEDULE REFLECTS A DRAFT CONSOLIDATION AND REFERENCE SHOULD BE HAD TO THE ACTUAL AMENDING BY-LAWS FOR COMPLETE ACCURACY.

THE CORPORATION OF THE TOWNSHIP OF FENELON

SCHEDULE 'A' TO ZONING BY-LAW NO. 12-95 AS AMENDED

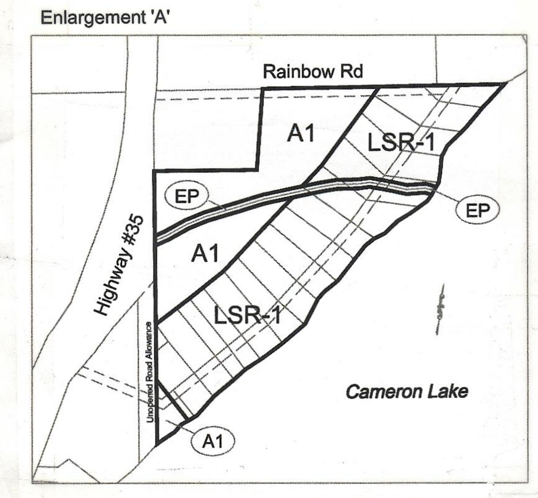
CONSOLIDATED JANUARY 2014



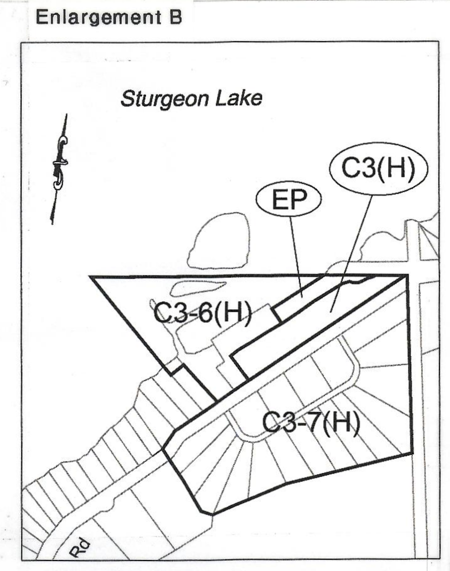
LEGEND

Symbol	Zone
EP	ENVIRONMENTAL PROTECTION
AP	AGGREGATE PROTECTION
CF	COMMUNITY FACILITY
AI	AGRICULTURAL
A2	RURAL GENERAL
HR	HAMLET RESIDENTIAL
RRI	RURAL RESIDENTIAL TYPE ONE
RR2	RURAL RESIDENTIAL TYPE TWO
RR3	RURAL RESIDENTIAL TYPE THREE
RM	RESIDENTIAL MOBILE HOME PARK
LSR	LIMITED SERVICE RESIDENTIAL
CI	GENERAL COMMERCIAL
C2	HIGHWAY COMMERCIAL
C3	TOURIST COMMERCIAL
C4	CAMPGROUND COMMERCIAL
MI	RESTRICTED INDUSTRIAL
M2	GENERAL INDUSTRIAL
M3	EXTRACTIVE INDUSTRIAL
M4	DISPOSAL INDUSTRIAL
(H)	REFER TO SECTION 3.8.1
(shaded)	REFER TO SECTION 3.18.1.4
(line)	ZONE BOUNDARY

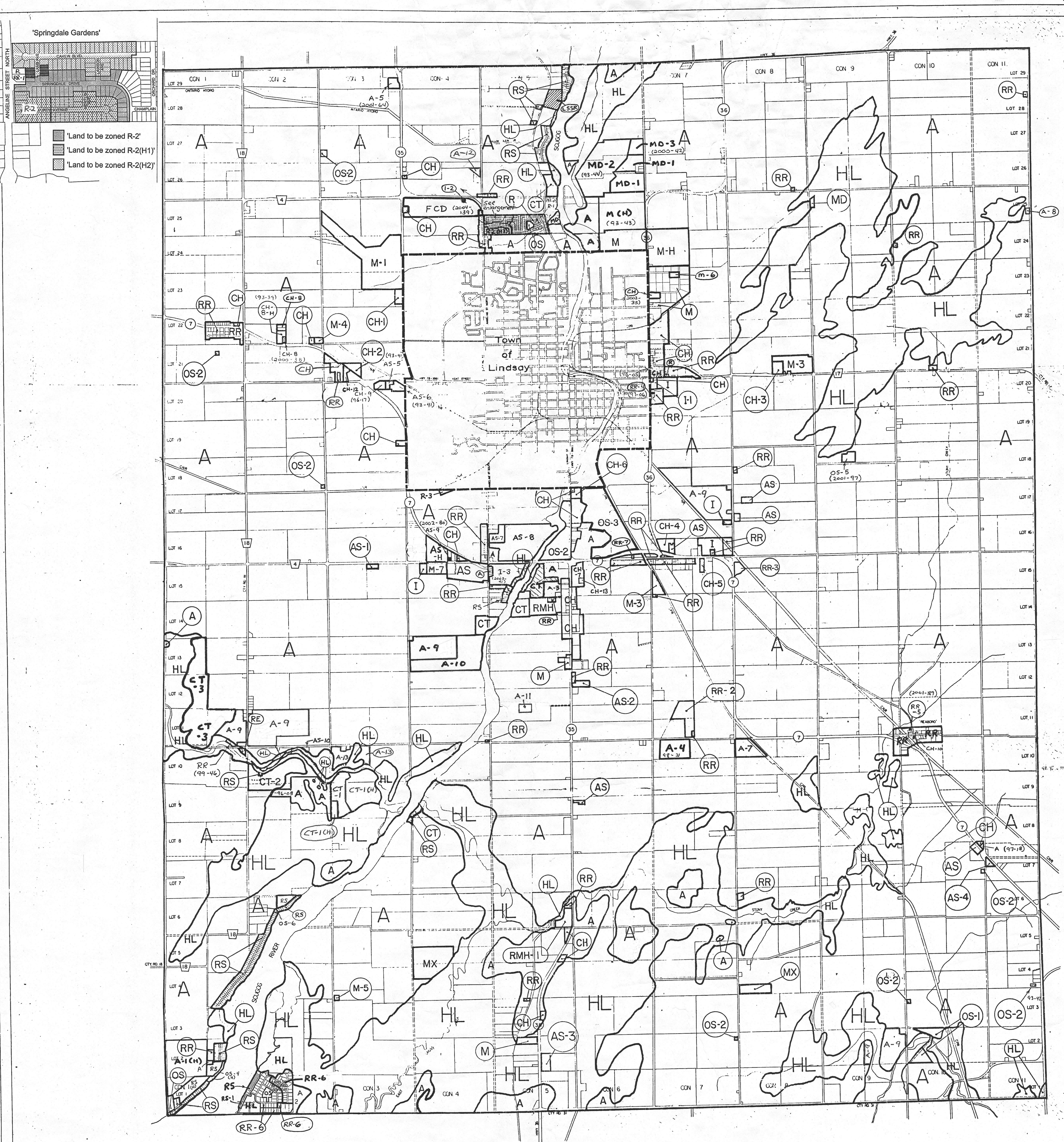
Enlargement 'A'



Enlargement B



AS AMENDED IN ACCORDANCE WITH THE DECISION OF THE ONTARIO MUNICIPAL BOARD. (FILE NO. R950145) AUGUST 23, 1995



Schedule "A"
Township of Ops
Zoning By-Law

THIS SCHEDULE REFLECTS A DRAFT CONSOLIDATION AND REFERENCE SHOULD BE HAD TO THE ACTUAL AMENDING BY-LAWS FOR COMPLETE ACCURACY.

CONSOLIDATED 2012

This is Schedule "A" to By-Law No. 93-30
Passed the 20th day of September, 1993

Sharon McCrae
Reeve

Sandra Richardson
Clerk

LEGEND

Town of Lindsay Boundary
Zone Boundary
Provincial Highway
County Road
Township Road

ZONE	SYMBOL
Estate Residential	RE
Rural Residential	RR
Shoreline Residential	RS
Residential	R
Mobile Home Residential	RMH
Institutional	I
Highway Commercial	CH
Tourist Commercial	CT
General Industrial	M
Extractive Industrial	MX
Disposal Industrial	MD
Open Space	OS
Agricultural	A
Agricultural Support	AS
Hazard Land	HZ
Future Community Development	FCD
Lands not subject to By-law	
LIMITED SERVICE SHORELINE RESIDENTIAL	LSSR

Number	Revision	Revised By	Date
2	CHANGES	J.MITCHELL	AUG 17/93
1	MINOR CHANGES	J.MITCHELL	JUNE 25/93

Drawn By: J.MITCHELL
Checked By:
Date: JUNE 7,1993
Scale: 1000 0 2000 4000FT

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50 Yorkville Avenue Suite 200 Toronto, Ontario M4W 1L4 (416) 975-1556

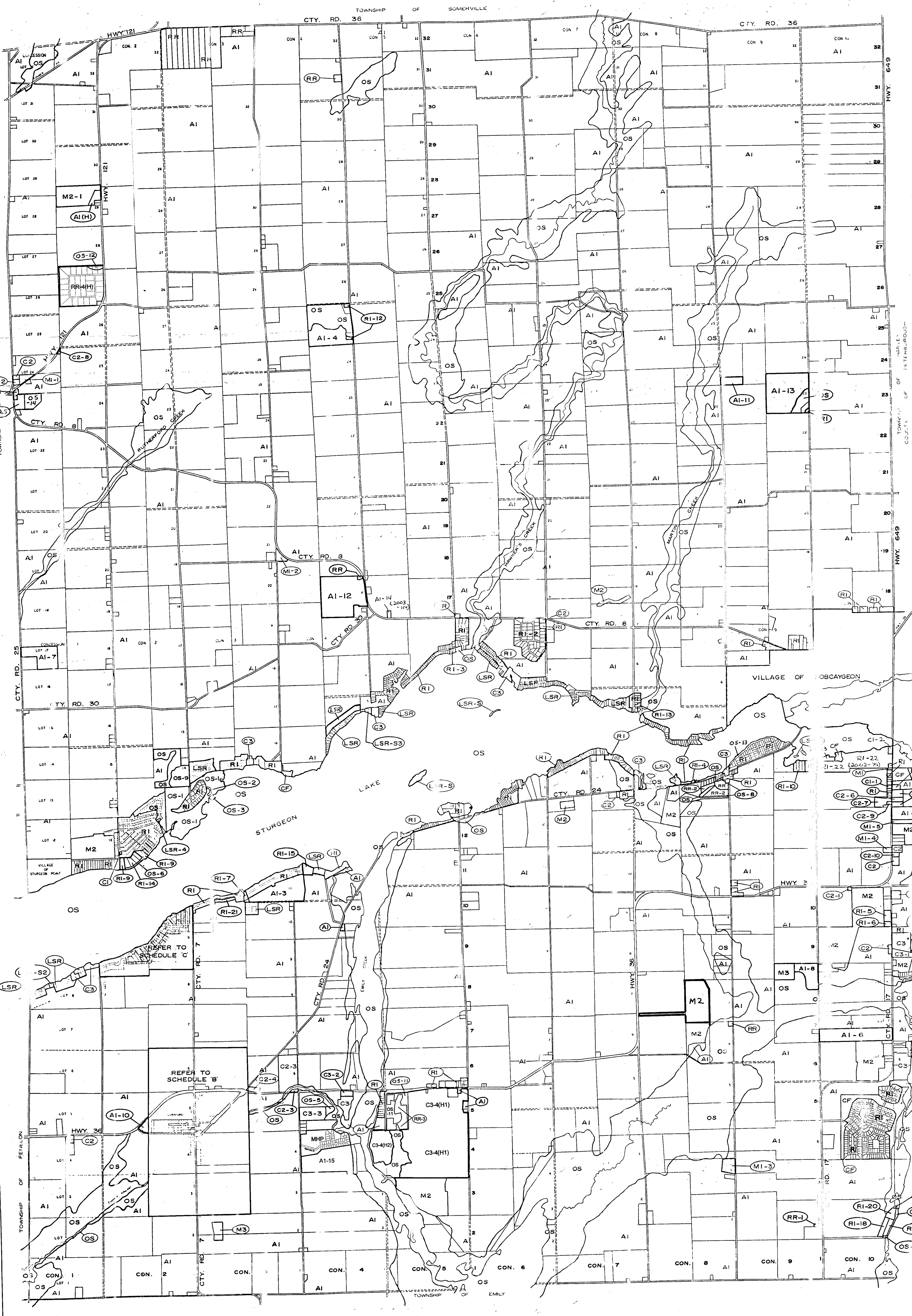
THIS SCHEDULE REFLECTS A DRAFT CONSOLIDATION AND REFERENCE SHOULD BE HAD TO THE ACTUAL AMENDING BY-LAWS FOR COMPLETE ACCURACY.

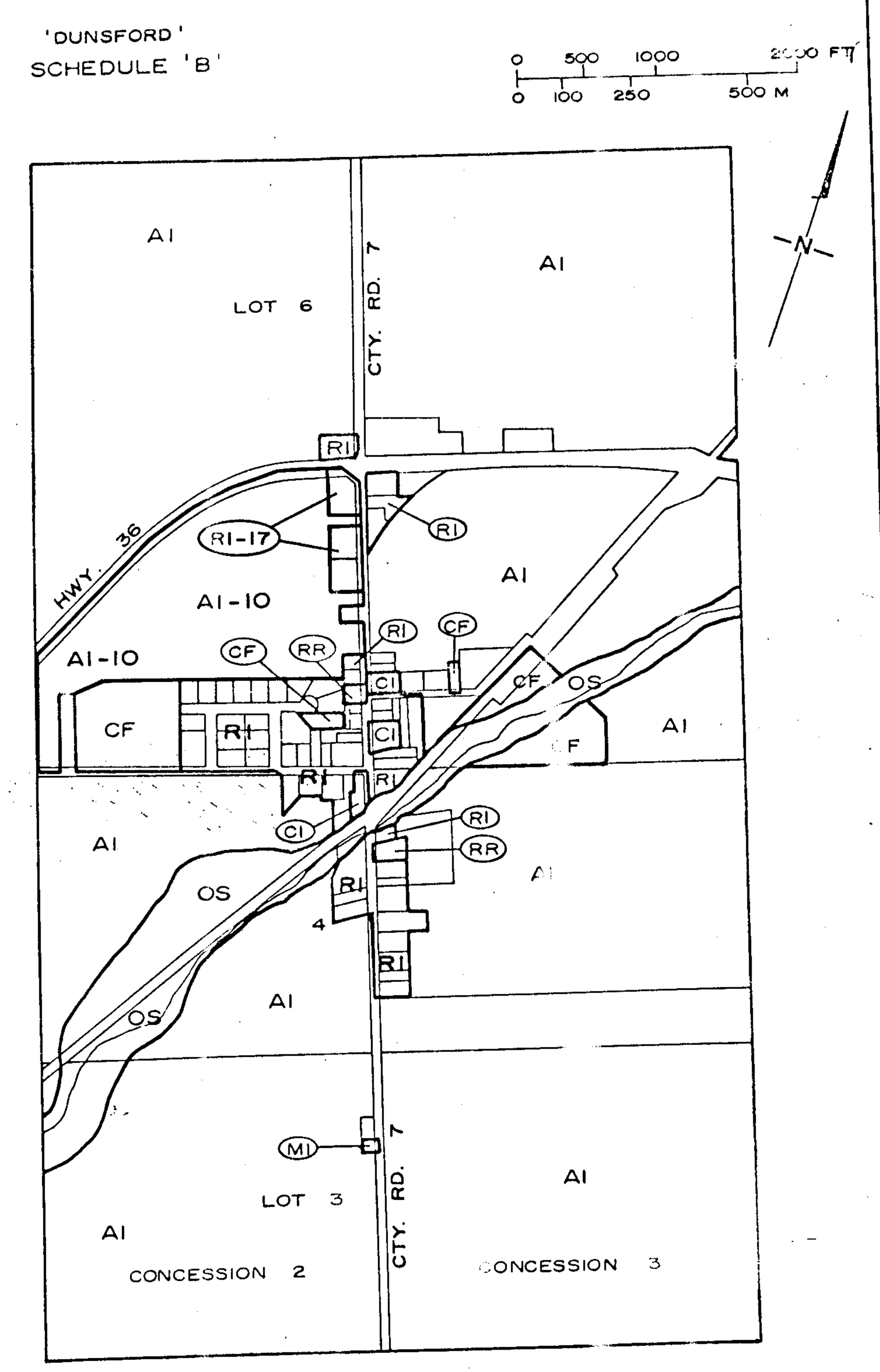
THE CORPORATION OF THE TOWNSHIP OF VERULAM

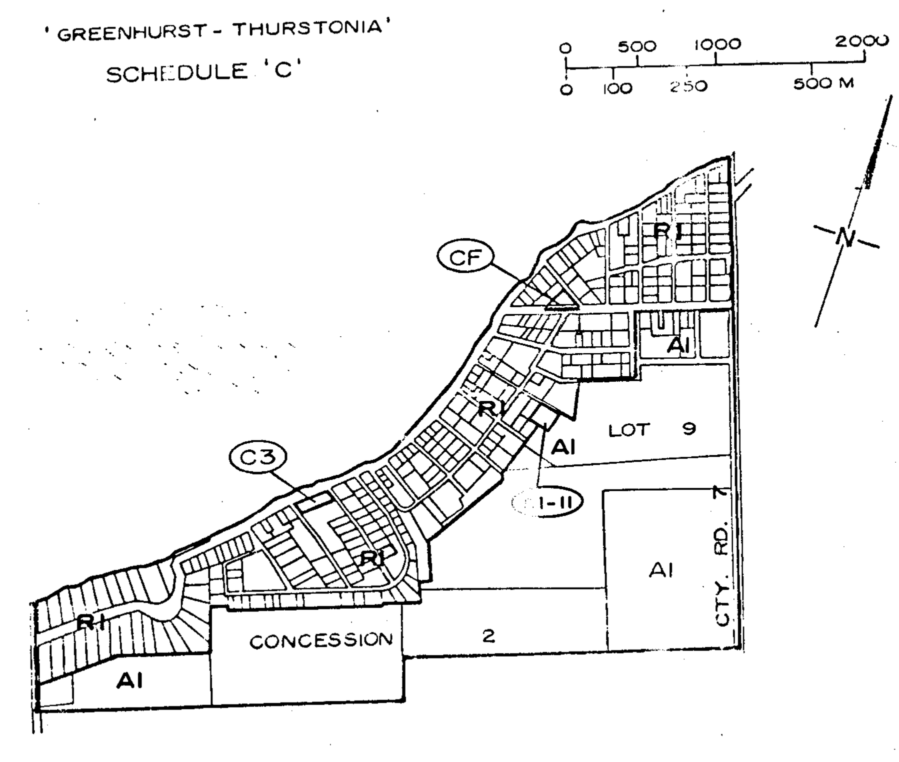
SCHEDULE 'A' TO ZONING BY-LAW NO. 6-87 AS AMENDED

CONSOLIDATED APRIL 2009

ZONES	SYMBOLS
RESIDENTIAL ZONES	
Rural Residential Zone	RR
Residential Type One Zone	R1
Residential Type Two Zone	R2
Limited Service Residential Zone	LSR
COMMERCIAL ZONES	
General Commercial Zone	C1
Highway Commercial Zone	C2
Recreational Commercial Zone	C3
INDUSTRIAL ZONES	
General Industrial Zone	M1
Extractive Industrial Zone	M2
Disposal Industrial Zone	M3
COMMUNITY FACILITY ZONE	CF
OPEN SPACE ZONE	OS
RURAL ZONES	
General Rural Zone	A1
MOBILE HOME PARK ZONE	MHP







Appendix G: Cross-section Photo Inventory (Upon Request)

Appendix H: Structure Photo Inventory Record (Upon Request)

Appendix I: Manning's n Values

River Station	n #1	n #2	n #3	n #4	n #5	n #6
19582	0.1	0.03	0.035			
19501	0.035	0.01	0.03	0.01		
19482 Hillside Bridge						
19459	0.07	0.035	0.03	0.035		
19403	0.03	0.03	0.05			
19344	0.03	0.03	0.05			
19125	0.03	0.03	0.05			
18934	0.045	0.03	0.045			
18569	0.035	0.03	0.07			
18407	0.035	0.045	0.03	0.07		
18245	0.03	0.03	0.07			
18006	0.045	0.035	0.045	0.03	0.045	
17689	0.035	0.045	0.03	0.045		
17318	0.045	0.03	0.04			
16971	0.05	0.03	0.05			
16676	0.05	0.03	0.045			
16367	0.05	0.03	0.03	0.05		
16026	0.035	0.03	0.035	0.05	0.05	0.035
15860	0.035	0.03	0.035	0.05	0.035	0.05
15677	0.045	0.03	0.035			
15631	0.045	0.03	0.045			
15618 BurntRiver Bride						
15609	0.045	0.03	0.045			
15502	0.035	0.045	0.03	0.04		
15405	0.035	0.045	0.03	0.035		
15197	0.035	0.03	0.045			
15070	0.05	0.03	0.045			
14717	0.045	0.03	0.035	0.07		
14548	0.045	0.03	0.05			
14323	0.045	0.03	0.045			
14064	0.045	0.03	0.045			
13783	0.045	0.05	0.03	0.05		
13636	0.05	0.03	0.05			
13296	0.05	0.03	0.05			
12872	0.05	0.03	0.03	0.05		
12673	0.07	0.045	0.03	0.07	0.045	
12103	0.07	0.03	0.07			
11779	0.07	0.03	0.07			
11228	0.07	0.03	0.07			
10952	0.07	0.035	0.03	0.07		
10765	0.07	0.035	0.03	0.07		
10680	0.07	0.03	0.07			
10658	0.07	0.03	0.07			
10537	0.07	0.045	0.03	0.07		
10240	0.07	0.035	0.03	0.07		
9643	0.07	0.035	0.03	0.07		

		8953	0.07	0.045	0.01	0.03	0.035	0.07
		8468	0.07	0.035	0.03	0.035	0.07	
		7993	0.07	0.035	0.03	0.035	0.07	
		7491	0.07	0.03	0.035	0.07		
		6916	0.07	0.035	0.03	0.035	0.07	
		6741	0.07	0.035	0.03	0.035	0.07	
		6358	0.07	0.35	0.03	0.035	0.07	
		5830	0.07	0.035	0.03	0.035	0.07	
		5385	0.07	0.035	0.03	0.045	0.01	0.07
		5004	0.04	0.03	0.045	0.01	0.07	
		4787	0.045	0.03	0.045	0.01	0.045	
		4479	0.035	0.03	0.05			
		4092	0.035	0.03	0.035			
		3875	0.045	0.03	0.06			
		3829	0.04	0.03	0.04			
3820	Northline Bridge							
		3812	0.04	0.03	0.04			
		3707	0.05	0.03	0.05			
		3365	0.035	0.03	0.06			
		3112	0.035	0.03	0.035			
		3022	0.035	0.03	0.035	0.045		
		2853	0.04	0.03	0.035	0.07		
		2665	0.07	0.03	0.035	0.07		
		2495	0.07	0.01	0.04	0.03	0.035	0.07
		2222	0.065	0.03	0.065			
		2057	0.065	0.03	0.065			
		1763	0.065	0.035	0.03	0.04	0.065	
		1494	0.06	0.035	0.03	0.045	0.06	

Appendix J: Digital Elevation Model and Orthoimagery Data Accuracy Assessment Report

Digital Elevation Model and Orthoimagery Data Accuracy Assessment Report

Flood Plain Mapping Study – Burnt River

June 2018

1.0 Objective

The objective of this report is to assess and report the positional accuracy of the bare earth Base digital elevation model (Base DEM) and orthoimagery data for Burnt River flood plain mapping study.

2.0 Assessment Procedures

2.1 Test Data

All test data was acquired by Kawartha Conservation staff in the following datums and projection:

Horizontal datum: NAD83 (CSRS)
Vertical datum: CGVD28
Projection: UTM Zone 17N

2.1.1 Checkpoints – Burnt River

Kawartha Conservation field staff captured checkpoints using Real-Time Kinematic Global Navigation Satellite System (RTK GNSS) survey equipment within the project area.

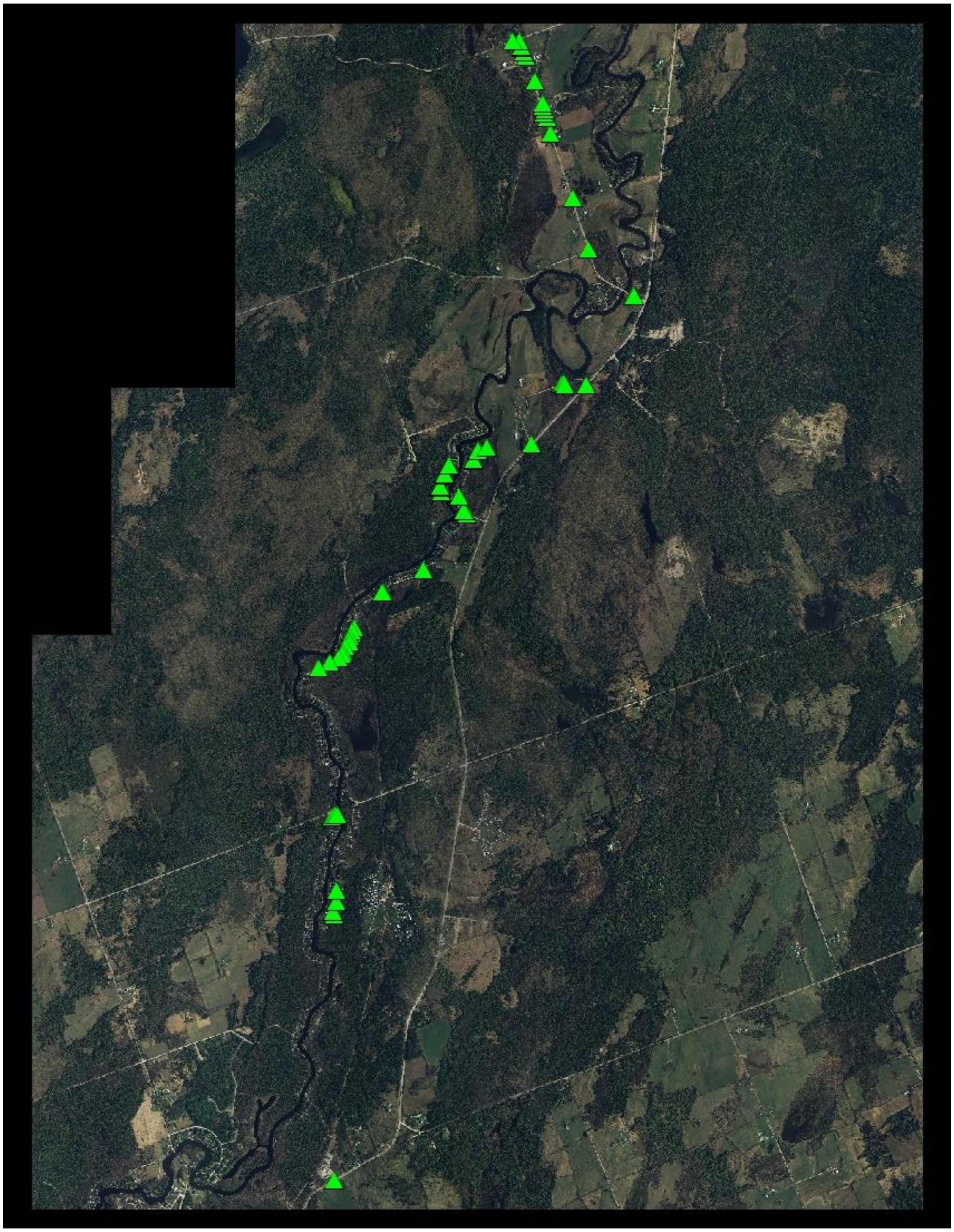


Figure 1 All RTK GNSS survey checkpoints shown over orthoimagery for Burnt River project area

2.1.2 Base DEM – Burnt River

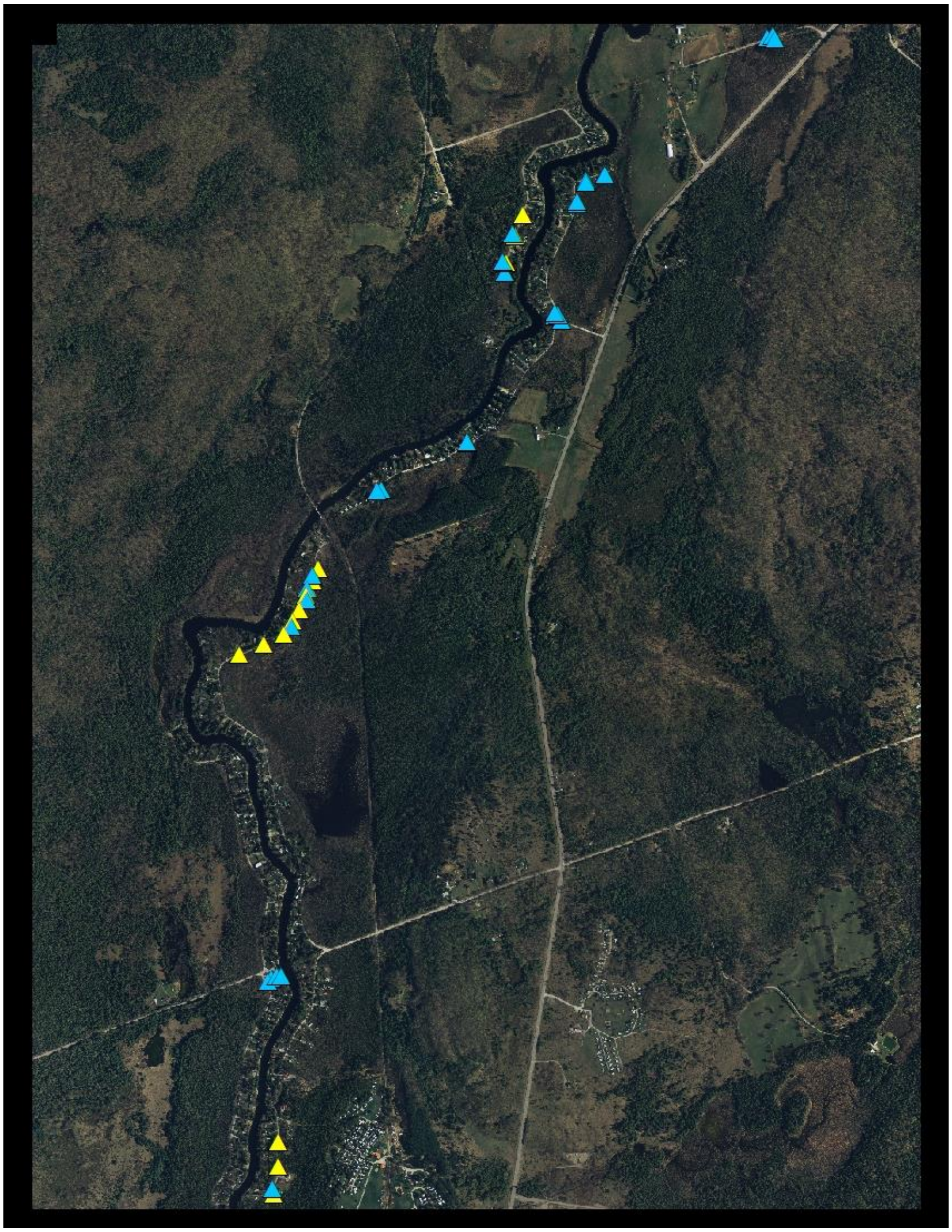


Figure 2 Vertical checkpoints shown over Base DEM for Burnt River project area (yellow = non-vegetated vertical accuracy (NVA), blue = vegetated vertical accuracy (VVA)

2.1.3 Orthoimagery – Burnt River

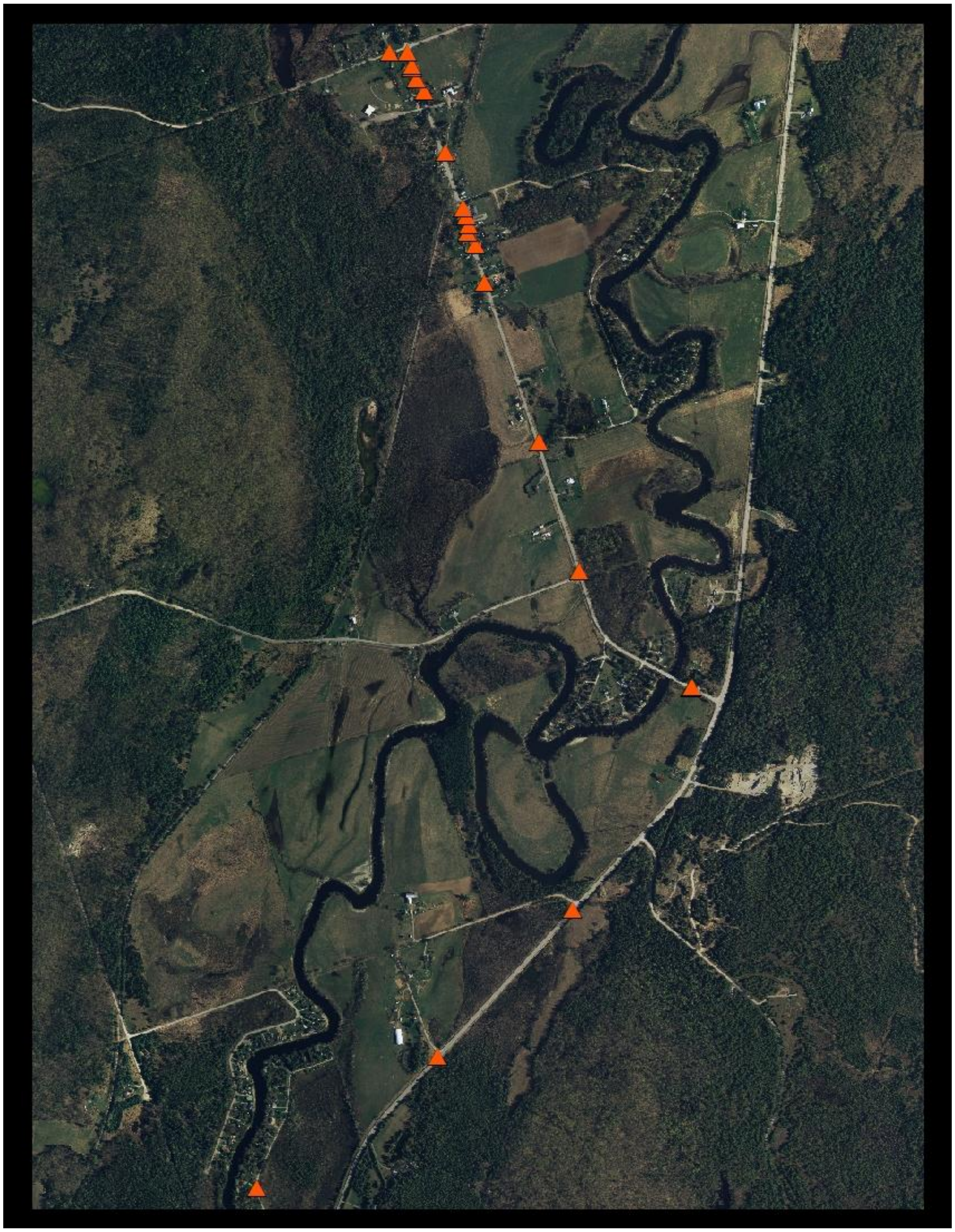


Figure 3 Horizontal checkpoints (orange) shown over orthoimagery for Burnt River project area

3.0 Results

3.1 Base DEM – Burnt River Accuracy Reporting Statement

This dataset was tested to meet ASPRS Positional Accuracy Standards for Geospatial Data (2014) for a 33.3 (cm) RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be +/- 39.8 cm at the 95th percentile. Actual VVA accuracy was found to be +/- 33.5 cm at the 95th percentile.

3.2 Orthoimagery – Burnt River Accuracy Reporting Statement

This data set was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 30.0 (cm) RMSEx/RMSEy Horizontal Accuracy Class. Actual positional accuracy was found to be RMSEx = 17.0 cm and RMSEy = 16.5 cm which equates to Positional Horizontal Accuracy = +/- 41.0 cm at a 95% confidence level.

Appendix A: Non-vegetated Vertical Accuracy Statistics – Base DEM – Burnt River

Point ID	Map-Derived Values	Survey Checkpoint Values	Residuals (Errors)
	Elevation (H)	Elevation (H)	Δz Elevation (H)
	metres	metres	metres
1	261.8599854	261.862	0.002015
2	261.1000061	261.108	0.007994
3	261.5700073	261.579	0.008993
4	258.3299866	258.3	-0.02999
5	261.1499939	261.117	-0.03299
6	258.0299988	258.077	0.047001
7	259.019989	259.07	0.050011
8	259.0100098	259.063	0.05299
9	261.6300049	261.697	0.066995
10	261.0799866	261.147	0.067013
11	261	261.091	0.091
12	259.7399902	259.856	0.11601
13	258.6499939	258.768	0.118006
14	262.0799866	262.198	0.118013
15	260.8399963	260.975	0.135004
16	257.1799927	257.328	0.148007
17	260.9899902	261.139	0.14901
18	258.0700073	258.229	0.158993
19	259.3099976	259.145	-0.165
20	257.0700073	257.237	0.166993
21	257.7600098	257.928	0.16799

22	261.019989	261.192	0.172011
23	259.1499939	259.324	0.174006
24	257.7000122	257.875	0.174988
25	258.4299927	258.608	0.178007
26	259.019989	259.213	0.193011
27	258.0100098	258.244	0.23399
28	258.3999939	258.636	0.236006
29	257.6300049	257.875	0.244995
30	257.1900024	257.439	0.248998
31	257.6400146	257.932	0.291985
32	261.019989	261.313	0.293011
33	257.9400024	258.242	0.301998
34	260.0400085	259.725	-0.31501
35	259.4200134	259.764	0.343987
36	257.8800049	258.246	0.365995
37	260.9299927	260.552	-0.37799
38	258.6700134	259.062	0.391987
39	260.4700012	260.867	0.396999
40	258.1199951	258.541	0.421005
41	258.480011	258.943	0.462989
42	260.9299927	260.379	-0.55099
43	261.1099854	260.465	-0.64499
Number of Checkpoints			**43**
Mean Error (m)			**0.046**
Percentile Rank			**40.9**
Percentile (Qp)			**0.398**

Appendix B: Vegetated Vertical Accuracy Assessment Statistics – Base DEM – Burnt River

Point ID	Map-Derived Values	Survey Checkpoint Values	Residuals (Errors)
	Elevation (H)	Elevation (H)	Δz Elevation (H)
	metres	metres	metres
1	258.7099915	259.084	0.374009
2	258.5599976	258.869	0.309002
3	258.8699951	258.977	0.107005
4	257.7999878	257.872	0.072012
5	257.6499939	257.772	0.122006
6	260.3599854	260.329	-0.03099
7	258.0700073	258.075	0.004993
8	258.1400146	258.272	0.131985
9	258.0799866	257.69	-0.38999
10	257.7900085	257.746	-0.04401
11	257.3599854	257.272	-0.08799
12	258.269989	258.356	0.086011
13	257.0299988	257.035	0.005001
14	258.1499939	258.088	-0.06199
15	258.0599976	258.008	-0.052
16	258.3099976	258.301	-0.009
17	258.519989	258.424	-0.09599
18	257.6700134	257.71	0.039987
19	258.7600098	258.847	0.08699
20	258.6900024	258.663	-0.027

21	258.230011	258.248	0.017989
22	258.6499939	258.786	0.136006
23	258.0599976	258.036	-0.024
24	258.3500061	258.464	0.113994
25	257.7900085	257.94	0.149991
26	257.8200073	258.005	0.184993
27	258.4599915	258.315	-0.14499
28	258.3299866	258.095	-0.23499
29	257.7200012	257.855	0.134999
30	257.7000122	257.771	0.070988
31	257.8500061	257.518	-0.33201
32	257.7999878	257.394	-0.40599
33	257.25	257.444	0.194
34	257.0899963	257.268	0.178004
35	257.6499939	257.551	-0.09899
Number of Checkpoints			**35**
Mean Error (m)			**0.339**
Percentile Rank			**33.3**
Percentile (Qp)			**0.335**

Appendix C: Horizontal Accuracy Assessment Statistics – Orthoimagery – Burnt River

Point ID	Map-derived values		Survey Check Point Values		Residuals (Errors)	
	Easting (E)	Northing (N)	Easting (E)	Northing (N)	Δx Easting (E)	Δy Northing (N)
	metres	metres	metres	metres	metres	metres
1	680809.0797	4940581.782	680808.852	4940581.8	0.227706	0.05185
2	681819.5442	4946119.572	681819.553	4946119.526	-0.00879	7.72E-05
3	682405.8775	4946544.728	682405.771	4946544.415	0.106478	0.011338
4	683226.0975	4947740.2	683226.015	4947740.398	0.082524	0.00681
5	683229.315	4947746.147	683229.193	4947746.393	0.122039	0.014894
6	682734.7937	4948539.375	682734.576	4948539.435	0.217709	0.047397
7	682556.494	4949055.92	682556.458	4949056.235	0.035981	0.001295
8	682527.6352	4949181.755	682527.652	4949181.651	-0.01681	0.000283
9	682501.8547	4949221.036	682502.014	4949221.147	-0.15933	0.025386
10	682507.7913	4949244.008	682507.729	4949244.008	0.06235	0.003888
11	682497.5655	4949274.973	682497.626	4949274.893	-0.06047	0.003657
12	682489.4083	4949298.649	682489.328	4949298.79	0.080343	0.006455
13	682428.4899	4949479.672	682428.447	4949479.445	0.042868	0.001838
14	682362.0289	4949678.812	682362.185	4949678.937	-0.15615	0.024382
15	682337.276	4949720.412	682337.221	4949720.362	0.055029	0.003028
16	682323.2428	4949755.548	682323.543	4949755.353	-0.30023	0.090136
17	682321.389	4949761.485	682321.586	4949761.235	-0.19701	0.038814
18	682306.4384	4949807.499	682306.256	4949807.506	0.182352	0.033252
19	682249.3164	4949804.94	682249.387	4949804.806	-0.0706	0.004985
20	682843.5491	4947022.23	682844.005	4947022.167	-0.45587	0.207817
Number of checkpoints					**20**	**20**
Mean Error (m)					**0.289**	**0.027**

Standard Deviation (m)	**0.174**	**0.169**
RMSE (m)	**0.170**	**0.164**
RMSEr (m)		**0.237**
NSSDA Horizontal Accuracyr (ACCr) at 95% Confidence Level (m)		**0.410**

Appendix K: Excerpts of Previous Studies

Appendix J

Digital Elevation Model and Orthoimagery Data Accuracy Assessment Report

Appendix K
Excerpts from previous reports

Application of the above equation (r^2 = 0.91) resulted in a reduction of the 1928 flood estimate from 367 m^3/s to 235 m^3/s (36% reduction). Noteworthy, however, is that the revised estimate of the flow rate still represents the highest flow for the entire period of record.

A check of this estimate was made by review of two regional flood flow analyses. The analyses were performed for the 216 km^2 (83.4 m^2) area between the upstream gauges and the Burnt River gauge to estimate the flow which should be added from this area to the observed flows from upstream (i.e. added to the 164 m^3/s total flows from Gelert and Furnace Falls). It was assumed here (and shown in the next section of the report) that,this 1928 flood had a return period of about 1 in 100 years.

The first approach (Sangal & Kallio, 1977) suggests that the runoff for this area would be about 0.24 m^3/s per km^2, or about 52 m^3/s. This would bring the flow to 216 m^3/s at Burnt River.

The second approach (Moin & Shaw, 1985) suggests a slightly higher rate 0.30 m^3/s per km^2, or about 65 m^3/s. This would bring the total flow to about 229 m^3/s at Burnt River.

Both of these estimates are reasonably close to the 235 m^3/s estimate derived by regression and provide confidence in the regression result.

5.7 <u>Frequency Analysis of Daily Flood Flows</u>

The annual maximum daily flood flows at each of the three gauges were subject to frequency analyses to determine the return period open water flood flows (shown in Technical Appendix TA-1). The Consolidated Frequency Analysis Package (Inland Waters Directorate, Environment Canada; 1985) was employed to develop probability distributions, which included:

- Generalized Extreme Value (GEV)

- Three Parameter Log Normal (3PLN)
- Log Person Type III (LP3)
- Wakeby Distribution (Wakeby).

The frequency analysis results of the daily data for the above distributions are summarized in Table 5-8 and in the Technical Appendix. Other than the Wakeby distribution, which appears to over estimate peak flows, there is very little difference between the GEV, 3PLN and LP3 distributions. Of these four, however, the 3PLN distribution (Figure 5-7) provides the best fit to the data (both graphically and statistically), and is the distribution which is best suited to match the regional statistics of other nearby rivers. This latter consistency with other rivers in the region as well as reasonable fit to the data make the Three Parameter Log Normal distribution (3PLN) the distribution of choice for determining flood flow frequencies from the historical streamflow data in the Burnt River area.

5.8 Instantaneous Flood Flows Estimates

The above described daily flood flow estimates do not account for the slight, but noteworthy, differences between maximum daily values and the recorded instantaneous flood peaks. As noted in Section 4.1.6, there is a +2.4% "peaking" factor in the most recent 24 year of data, which is a sufficiently representative record length to lend confidence to the application of this factor to the daily results given in Table 5-8.

Results of this transformation from daily to instantaneous peak flows for various return period flood flows are presented in Table 5-9. It shows, for example, that the 100-year instantaneous peak flow at the Burnt River WSC location (231 $m^3/2$) is slightly higher than the daily flood flow estimate of 226 m^3/s (given in Table 5-8).

Table 5-8
Summary of Frequency Analysis Results at Flow Gauging Stations

Flow Gauging Station	Probability Distribution	1:2yr	1:5yr	1:10yr	1:20yr	1:50yr	1:100yr
		Maximum Daily Flood Flow Estimates (m^3/s)					
Burnt River[1] (02HF003)	GEV	112	147	168	186	208	223
	3PLN	**112**	**147**	**168**	**186**	**209**	**226**
	LP3	112	147	167	186	207	222
	WAKEBY	112	144	166	187	215	237
Furnace Falls[2] (TSW6)	GEV	50	63.1	70.9	77.8	85.9	91.5
	3PLN	**50.1**	**63.1**	**70.7**	**77.6**	**86.0**	**91.9**
	LP3	50.1	62.8	70.4	77.2	85.3	91.1
	WAKEBY	51.1	61.2	69.0	77.4	89.8	100.0
Gelert[3] (TSW5)	GEV	35	45	51.2	56.7	63.5	68.2
	3PLN	**34.8**	**45.2**	**52.0**	**58.2**	**66.3**	**72.2**
	LP3	35.1	45.1	51.3	56.9	63.9	69.0
	WAKEBY	34.9	45.8	52.7	58.6	65.3	69.5

[1] 76 years of data, drainage area 1269 km^2

[2] 47 years of data, drainage area 527 km^2

[3] 43 years of data, drainage area 525 km^2

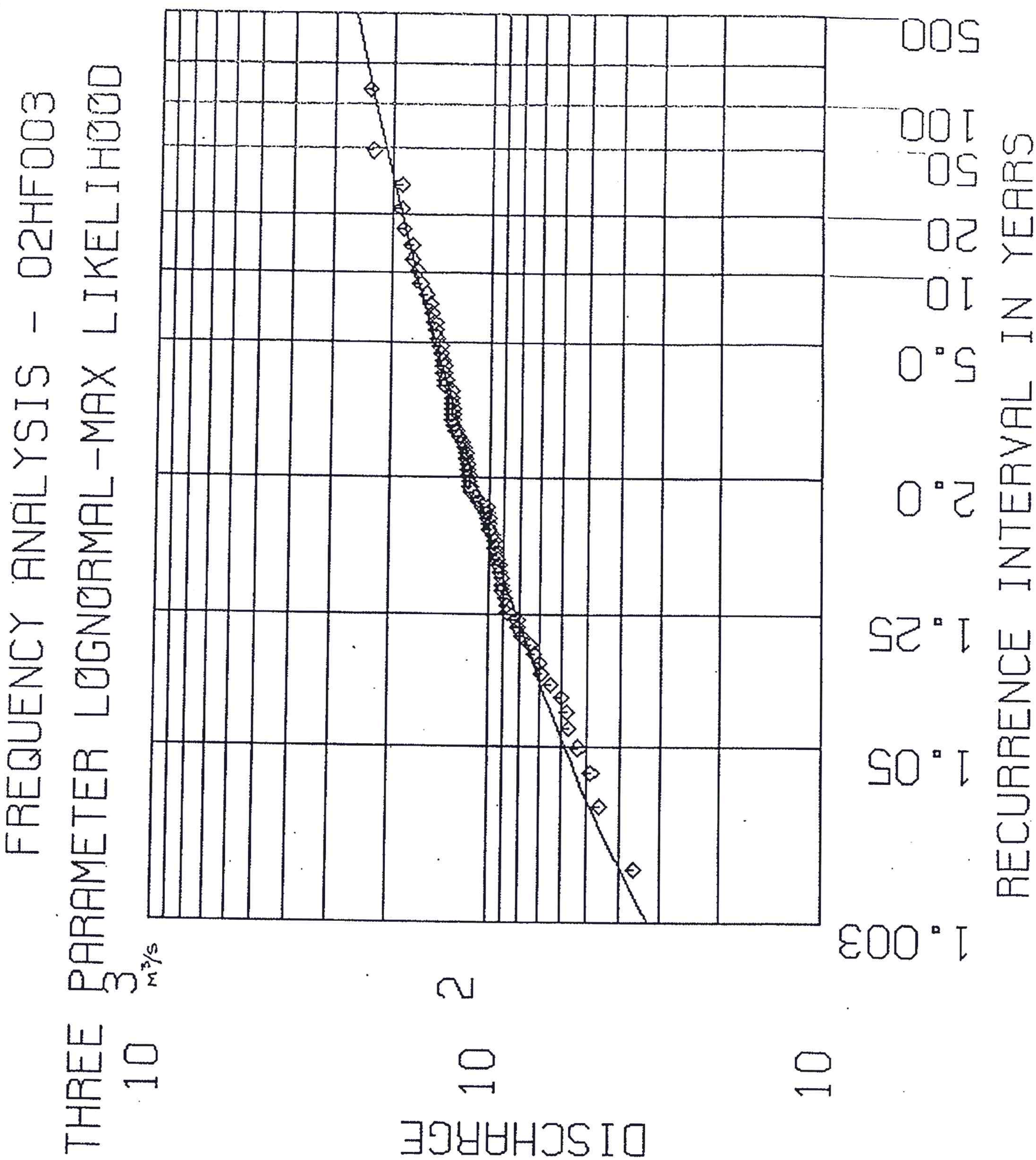


Figure 5-7 Burnt River WSC (02HF003)
Daily Discharge Frequency Analysis

Table 5-9

Summary of Design Flows - Burnt River

Location	Peak Instataneous Return Period Flows (m^3/s)*						
	1:2 m^3/s	1:5 m^3/s	1:10 m^3/s	1:20 m^3/s	1:50 m^3/s	1:100 m^3/s	Regional Storm m^3/s
Irondale River at Furnace Falls (TSW6)	52.8	66.6	74.6	81.8	90.5	96.7	191
Outlet of Irondale River	60.7	76.6	85.8	94.1	104	111	198
Drag River at Gelert (TSW5)	35.6	46.3	53.2	59.6	67.9	73.9	110
Burnt River upstream of confluence with Irondale River	39.5	51.4	59.1	66.2	75.4	82.0	113
Confluence of Burnt and Irondale Rivers	94.3	123	141	145	175	189	283
Village of Kinmount	106	138	158	176	197	213	305
Burnt River WSC Gauge (02HF003)	115	150	172	191	214	231	282
Community of Burnt River	138	180	206	229	257	277	330
Outlet of Burnt River at Cameron Lake	143	186	213	236	265	286	330

* Three Parameter Lognormal Distribution (3PL)

TABLE TA-5a

```
*------------------------------------*
|              S U M P O             |
|                                    |
|    Interactive Summary Printout    |
| for MS-DOS/PC-DOS micro computers  |
|          July 1988 version         |
*------------------------------------*
```

NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

TIMMINS FLOOD EVENT 30 metre Floodway

Summary Printout

	SECNO	CWSEL	VLOB	VCH	VROB	TOPWID	QLOB	QROB
	4.00	255.04	.00	1.15	.11	961.86	.00	4.0
	5.50	255.32	.00	1.13	.30	675.07	.00	23.7
*	6.10	255.44	.00	1.77	.15	375.52	.00	6.4
	7.00	255.82	.20	1.38	.19	526.82	4.54	28.7
	7.50	255.97	.25	1.87	.17	500.83	6.84	12.2
	8.00	256.28	.25	1.78	.16	104.00	3.48	.7
	8.50	256.69	.34	1.36	.15	107.00	6.62	.3
	9.00	256.83	.18	1.46	.28	112.62	.28	1.7
*	10.00	256.94	.15	1.33	.21	86.55	.56	1.2
	11.00	257.07	.31	1.18	.20	99.78	4.57	2.8
	12.00	257.20	.35	1.10	.00	92.70	8.08	.0
	13.10	257.22	.00	1.62	.00	44.20	.00	.0
	13.20	257.24	.00	1.61	.00	44.20	.00	.0
	14.00	257.33	.20	1.27	.15	99.13	6.80	2.2
	15.00	257.41	.27	1.24	.00	84.69	5.84	.0
*	16.00	257.55	.13	.90	.12	98.10	3.58	.5
*	16.50	257.63	.30	1.50	.50	101.00	10.17	16.6
	17.00	257.89	.28	1.49	.46	101.00	9.38	14.9
	18.00	258.15	.31	1.35	.23	94.00	14.33	6.3
	19.00	258.38	.26	1.32	.27	96.00	9.17	9.6
	19.50	258.53	.09	1.34	.30	72.61	.05	12.0
	20.00	258.62	.23	1.26	.25	97.00	9.23	9.8
	21.00	258.78	.14	.98	.23	104.00	3.29	11.6
	22.00	258.89	.23	1.17	.22	93.00	8.66	7.9
	23.00	259.00	.20	1.02	.15	97.00	10.41	4.5
*	24.00	259.09	.29	1.31	.20	91.00	11.42	4.0
	25.00	259.32	.29	1.17	.28	95.00	18.44	19.3
	26.00	259.48	.17	1.16	.22	98.00	4.31	9.4
	27.00	259.54	.13	1.21	.00	67.84	1.63	.0
	28.10	259.59	.00	.96	.00	48.30	.00	.0
	28.20	259.59	.00	.96	.00	48.35	.00	.0
	28.30	259.59	.00	.96	.00	48.35	.00	.0
	28.40	259.59	.00	.96	.00	48.30	.00	.0
	29.00	259.60	.31	1.07	.24	98.00	21.47	12.7
	30.00	259.64	.36	1.17	.23	92.00	22.60	8.3
	31.00	259.81	.29	1.14	.21	95.00	16.10	8.3
	31.50	260.00	.27	1.10	.26	95.00	13.45	13.2

	32.00	260.13	.25	.90	.23	100.00	16.95	14.2
	33.00	260.19	.29	.98	.26	99.00	14.50	14.1
	34.00	260.27	.23	.68	.20	112.00	13.70	10.8
*	35.00	260.33	.31	.99	.24	98.00	17.37	10.2
	36.00	260.54	.27	.96	.32	99.00	10.85	14.4
*	37.00	260.64	.18	.68	.21	110.00	7.34	11.2
*	38.00	260.65	.39	.95	.29	98.00	26.89	12.7
	39.00	260.73	.37	1.03	.32	96.45	11.20	12.8
	40.10	260.71	.00	1.64	.35	35.77	.00	7.4
	40.20	260.82	.00	1.65	.00	26.90	.00	.0
*	41.00	260.94	.15	1.07	.25	75.39	1.36	18.0
	42.00	260.99	.25	.99	.19	76.30	14.53	1.4
	43.00	261.04	.20	.77	.14	111.00	9.38	3.4
	44.00	261.09	.27	.96	.14	99.00	17.75	2.9
*	45.00	261.16	.11	.68	.20	104.00	3.87	16.0
*	46.00	261.19	.31	.94	.15	98.00	22.11	1.8
	47.00	261.26	.20	.79	.18	98.41	4.61	9.2
	48.00	261.30	.23	.77	.18	90.91	11.16	1.9
	48.50	261.35	.22	1.09	.29	94.00	6.83	16.5
	49.00	261.43	.29	1.19	.25	71.52	2.72	9.0
	50.00	261.57	.32	.95	.13	96.00	25.10	1.6
	51.00	261.67	.30	.87	.24	98.32	18.44	16.2
	52.00	261.72	.22	.70	.23	108.00	18.59	19.0
*	53.10	261.71	.20	1.22	.26	87.00	7.46	16.4
	53.20	261.71	.20	1.22	.26	87.00	7.50	16.4
	53.50	261.74	.21	1.03	.21	90.73	14.49	5.1
	54.00	261.76	.34	.98	.28	74.86	32.72	5.8
	55.00	261.80	.31	1.05	.19	94.78	27.69	6.7

IOTE - Asterisk (*) at left of profile number
indicates message in summary of errors
list

TIMMINS FLOOD EVENT 50 metre Floodway

Summary Printout

	SECNO	CWSEL	VLOB	VCH	VROB	TOPWID	QLOB	QROB
	4.00	255.04	.00	1.15	.11	961.86	.00	4.0
	5.50	255.32	.00	1.13	.30	675.07	.00	23.7
*	6.10	255.44	.00	1.77	.15	375.52	.00	6.4
	7.00	255.82	.20	1.38	.19	526.82	4.54	28.7
	7.50	255.97	.25	1.87	.17	500.83	6.84	12.2
	8.00	256.28	.23	1.77	.14	144.00	5.20	1.4
	8.50	256.68	.34	1.33	.15	147.00	13.90	.8
	9.00	256.82	.18	1.46	.27	131.89	.24	3.2
	10.00	256.92	.14	1.33	.20	85.71	.51	1.1
	11.00	257.05	.30	1.18	.20	119.72	4.46	4.8
	12.00	257.19	.31	1.09	.00	112.69	11.32	.0
	13.10	257.21	.00	1.62	.00	44.20	.00	.0
	13.20	257.22	.00	1.62	.00	44.20	.00	.0
	14.00	257.32	.18	1.27	.15	119.07	8.72	2.1
	15.00	257.40	.25	1.23	.00	104.67	8.69	.0
*	16.00	257.54	.12	.90	.12	108.53	3.54	.5
*	17.00	257.73	.24	1.51	.44	141.00	10.24	21.0
	18.00	258.00	.30	1.35	.21	134.00	22.06	8.0
	19.00	258.24	.25	1.32	.25	136.00	13.70	14.1
	20.00	258.46	.22	1.25	.24	137.00	13.75	14.7
	21.00	258.63	.12	.99	.21	144.00	4.16	15.9
	22.00	258.74	.21	1.18	.21	133.00	11.08	11.9
	23.00	258.85	.20	1.02	.14	137.00	15.36	6.7
*	24.00	258.95	.28	1.31	.17	131.00	18.27	4.7
	25.00	259.18	.27	1.12	.27	135.00	24.87	29.9
	26.00	259.33	.14	1.19	.19	138.00	4.50	9.9
	27.00	259.40	.13	1.24	.00	61.02	1.32	.0
	28.10	259.45	.00	.97	.00	48.30	.00	.0
	28.20	259.45	.00	.97	.00	48.35	.00	.0
	28.30	259.45	.00	.97	.00	48.35	.00	.0
	28.40	259.45	.00	.97	.00	48.30	.00	.0
	29.00	259.47	.28	1.07	.22	138.00	24.05	15.9
	30.00	259.51	.33	1.14	.21	132.00	33.43	11.8
	31.00	259.68	.27	1.14	.20	135.00	21.41	11.4
	31.50	259.87	.24	1.10	.24	135.00	17.33	16.7
	32.00	260.00	.24	.86	.22	140.00	25.71	21.0
	33.00	260.06	.25	.97	.25	139.00	17.18	22.1
*	34.00	260.13	.23	.65	.20	152.00	23.50	18.9
*	35.00	260.19	.28	.99	.21	138.00	19.35	12.9
	36.00	260.41	.25	.97	.28	136.42	14.14	13.4
*	37.00	260.51	.17	.68	.20	134.24	6.34	17.3
*	38.00	260.52	.36	.96	.27	132.00	27.14	16.9
	39.00	260.61	.38	1.04	.28	111.18	10.33	14.9
	40.10	260.59	.00	1.67	.35	35.53	.00	7.1
	40.20	260.68	.00	1.68	.00	26.90	.00	.0
*	41.00	260.81	.15	1.09	.23	95.08	1.23	18.2
	42.00	260.86	.23	.99	.18	96.00	19.39	1.3

43.00	260.92	.16	.77	.14	151.00	10.37	5.7
44.00	260.97	.25	.96	.13	138.07	20.12	3.8
45.00	261.04	.10	.67	.19	144.00	5.70	22.9
* 46.00	261.07	.29	.93	.16	120.95	29.39	1.4
47.00	261.14	.20	.79	.17	116.94	4.17	10.7
48.00	261.19	.21	.78	.18	110.72	14.06	1.8
48.50	261.23	.18	1.08	.27	134.00	6.53	24.2
49.00	261.32	.29	1.21	.22	91.30	2.52	9.1
50.00	261.47	.31	.92	.12	116.41	39.39	1.2
51.00	261.56	.29	.86	.23	117.80	17.39	24.7
52.00	261.61	.21	.70	.21	148.00	23.82	19.0
* 53.10	261.59	.17	1.24	.23	128.00	7.89	16.7
53.20	261.59	.17	1.24	.23	127.00	7.86	16.7
53.50	261.63	.21	1.03	.21	106.82	21.67	4.8
54.00	261.65	.32	.99	.28	94.77	32.77	5.6
55.00	261.69	.29	1.04	.18	114.52	34.30	5.9

NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

TIMMINS FLOOD EVENT 70 metre Floodway

Summary Printout

	SECNO	CWSEL	VLOB	VCH	VROB	TOPWID	QLOB	QROB
	4.00	255.04	.00	1.15	.11	961.86	.00	4.0
	5.50	255.32	.00	1.13	.30	675.07	.00	23.7
*	6.10	255.44	.00	1.77	.15	375.52	.00	6.4
	7.00	255.82	.20	1.38	.19	526.82	4.54	28.7
	7.50	255.97	.25	1.87	.17	500.83	6.84	12.2
	8.00	256.28	.22	1.76	.16	178.88	5.45	2.6
	8.50	256.68	.33	1.30	.15	187.00	20.37	1.2
	9.00	256.81	.17	1.46	.26	151.43	.22	4.6
	10.00	256.91	.14	1.34	.20	85.00	.48	1.1
	11.00	257.04	.30	1.18	.20	139.68	4.37	6.5
	12.00	257.18	.29	1.09	.00	132.68	14.38	.0
	13.10	257.19	.00	1.63	.00	44.20	.00	.0
	13.20	257.21	.00	1.62	.00	44.20	.00	.0
	14.00	257.31	.17	1.27	.15	139.02	9.91	2.1
	15.00	257.39	.24	1.23	.00	119.65	10.56	.0
*	16.00	257.53	.12	.90	.12	108.15	3.48	.5
*	17.00	257.72	.22	1.44	.45	181.00	11.88	34.0
	18.00	257.97	.29	1.31	.19	174.00	29.22	10.0
	19.00	258.20	.24	1.29	.24	176.00	16.75	18.4
	20.00	258.42	.21	1.21	.24	177.00	18.06	22.0
	21.00	258.57	.12	.99	.20	184.00	5.05	19.5
	22.00	258.68	.19	1.17	.20	173.00	13.35	15.3
	23.00	258.79	.19	1.00	.14	177.00	19.61	9.3
*	24.00	258.89	.27	1.29	.15	171.00	24.57	5.3
	25.00	259.11	.24	1.08	.26	175.00	28.26	39.6
	26.00	259.26	.14	1.19	.17	178.00	5.56	10.8
	27.00	259.33	.10	1.25	.00	77.00	1.47	.0
	28.10	259.38	.00	.98	.00	48.30	.00	.0
	28.20	259.38	.00	.98	.00	48.35	.00	.0
	28.30	259.38	.00	.98	.00	48.35	.00	.0
	28.40	259.39	.00	.98	.00	48.30	.00	.0
	29.00	259.40	.26	1.07	.20	178.00	25.37	18.7
	30.00	259.44	.31	1.12	.20	172.00	37.43	15.0
	31.00	259.61	.25	1.12	.19	175.00	26.00	14.2
	31.50	259.80	.23	1.09	.21	175.00	21.04	17.3
	32.00	259.93	.22	.84	.21	180.00	28.45	27.6
	33.00	259.98	.23	.95	.25	179.00	18.98	29.2
*	34.00	260.06	.22	.63	.18	192.00	31.81	24.1
*	35.00	260.11	.25	.99	.20	178.00	20.87	15.1
	36.00	260.33	.23	.97	.28	154.29	17.40	12.4
*	37.00	260.44	.17	.68	.20	153.30	5.70	22.4
*	38.00	260.44	.36	.97	.24	151.31	26.08	17.8
	39.00	260.53	.38	1.06	.27	120.65	9.93	14.1
	40.10	260.51	.00	1.69	.35	35.40	.00	6.9
	40.20	260.61	.00	1.70	.00	26.90	.00	.0
*	41.00	260.73	.15	1.10	.23	114.91	1.17	17.5
	42.00	260.80	.22	.98	.18	115.82	25.84	1.2

	43.00	260.85	.15	.78	.14	191.00	10.85	7.8
	44.00	260.90	.25	.97	.12	157.37	19.38	4.0
	45.00	260.98	.10	.66	.18	184.00	7.04	29.8
*	46.00	261.00	.27	.93	.17	125.30	34.91	1.3
	47.00	261.07	.20	.80	.15	136.09	3.95	10.8
	48.00	261.12	.19	.79	.18	130.62	14.42	1.8
	48.50	261.17	.16	1.07	.26	174.00	5.68	31.5
	49.00	261.25	.29	1.23	.21	98.09	2.41	8.2
	50.00	261.41	.29	.90	.12	131.42	47.48	1.0
	51.00	261.50	.29	.85	.22	137.51	16.71	31.3
	52.00	261.54	.21	.70	.21	169.44	23.11	18.6
*	53.10	261.53	.16	1.24	.21	168.00	8.64	16.2
	53.20	261.53	.16	1.24	.21	168.00	8.71	16.2
	53.50	261.57	.20	1.01	.21	124.62	28.10	4.5
	54.00	261.59	.30	1.00	.29	114.72	33.06	5.5
	55.00	261.62	.27	1.03	.18	134.37	40.30	5.4

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*----------------------------------------*
|              S U M P O                 |
|                                        |
|    Interactive Summary Printout        |
|  for MS-DOS/PC-DOS micro computers     |
|         July 1988 version              |
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NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

TIMMINS FLOOD EVENT 100 metre Floodway

Summary Printout

	SECNO	CWSEL	VLOB	VCH	VROB	TOPWID	QLOB	QROB
	4.00	255.04	.00	1.15	.11	961.86	.00	4.0
	5.50	255.32	.00	1.13	.30	675.07	.00	23.7
*	6.10	255.44	.00	1.77	.15	375.52	.00	6.4
	7.00	255.82	.20	1.38	.19	526.82	4.54	28.7
	7.50	255.97	.25	1.87	.17	500.83	6.84	12.2
	8.00	256.28	.22	1.75	.18	208.94	5.44	4.9
	8.50	256.67	.31	1.29	.15	247.00	23.71	2.0
	9.00	256.80	.17	1.46	.26	181.03	.20	6.6
*	10.00	256.90	.14	1.34	.20	84.45	.45	1.0
	11.00	257.03	.30	1.17	.19	169.64	4.28	9.1
	12.00	257.17	.27	1.08	.00	159.67	17.26	.0
	13.10	257.18	.00	1.63	.00	44.20	.00	.0
	13.20	257.20	.00	1.63	.00	44.20	.00	.0
	14.00	257.30	.16	1.27	.15	154.58	10.20	2.0
	15.00	257.38	.23	1.22	.00	149.63	13.85	.0
*	16.00	257.51	.12	.90	.12	114.87	3.43	.5
*	17.00	257.70	.16	1.11	.58	241.00	11.26	100.6
	18.00	257.86	.28	1.30	.17	234.00	35.98	11.0
	19.00	258.09	.21	1.30	.23	236.00	17.02	22.4
	20.00	258.32	.20	1.18	.24	237.00	22.60	31.1
	21.00	258.47	.10	.99	.19	244.00	5.47	23.5
	22.00	258.58	.18	1.17	.19	233.00	15.47	18.1
	23.00	258.70	.17	1.00	.14	229.93	18.95	12.8
*	24.00	258.79	.26	1.29	.13	220.25	31.76	4.3
	25.00	259.02	.21	1.05	.25	235.00	27.21	52.3
	26.00	259.16	.16	1.19	.16	238.00	10.53	11.7
	27.00	259.23	.10	1.26	.00	101.38	3.33	.0
	28.10	259.28	.00	1.00	.00	48.30	.00	.0
	28.20	259.28	.00	1.00	.00	48.35	.00	.0
	28.30	259.29	.00	1.00	.00	48.35	.00	.0
	28.40	259.29	.00	1.00	.00	48.30	.00	.0
	29.00	259.30	.24	1.08	.19	238.00	24.77	22.0
	30.00	259.34	.28	1.13	.19	232.00	37.11	18.8
	31.00	259.51	.23	1.11	.17	235.00	30.53	17.3
	31.50	259.70	.21	1.09	.19	235.00	25.43	17.1
	32.00	259.83	.20	.83	.20	224.37	25.87	37.8
	33.00	259.89	.20	.93	.24	239.00	19.93	38.3

*	34.00	259.96	.20	.61	.17	252.00	40.39	28.2
*	35.00	260.01	.23	1.00	.18	238.00	20.73	17.4
	36.00	260.24	.22	.99	.29	165.85	17.15	11.5
*	37.00	260.35	.16	.68	.19	182.35	5.11	26.6
*	38.00	260.36	.37	.99	.21	171.66	25.15	15.4
	39.00	260.45	.38	1.08	.26	116.22	9.54	12.7
	40.10	260.43	.00	1.71	.36	35.25	.00	6.7
	40.20	260.52	.00	1.72	.00	26.90	.00	.0
*	41.00	260.65	.15	1.12	.23	118.70	1.09	16.8
	42.00	260.72	.21	.99	.18	145.63	26.40	1.1
	43.00	260.77	.15	.76	.13	251.00	18.84	10.6
	44.00	260.83	.25	.99	.10	176.73	18.65	3.2
*	45.00	260.90	.09	.64	.17	240.26	6.50	39.8
*	46.00	260.93	.25	.92	.17	145.52	39.21	1.2
	47.00	260.99	.20	.81	.14	164.92	3.73	10.2
	48.00	261.05	.17	.80	.18	160.50	14.21	1.7
	48.50	261.10	.15	1.06	.25	222.83	4.75	37.5
	49.00	261.18	.29	1.24	.21	94.79	2.30	7.4
	50.00	261.34	.29	.92	.12	134.18	46.43	.8
	51.00	261.43	.29	.86	.22	140.28	16.46	30.4
	52.00	261.48	.21	.71	.21	167.61	22.60	18.1
	53.10	261.47	.15	1.25	.21	195.54	9.65	15.3
	53.20	261.47	.15	1.25	.21	196.16	9.74	15.4
	53.50	261.51	.19	.98	.20	152.71	38.75	4.3
	54.00	261.53	.27	1.00	.28	144.67	34.96	5.3
	55.00	261.57	.26	.97	.17	164.25	59.13	4.8

APPENDIX TA-1

STREAMFLOW ANALYSIS

- Irondale River at Furnace Falls
- Burnt River below Gelert
- Burnt River below Burnt River

WSC STATION NO=FURNOBS
WSC STATION NAME=IRONDALE RIVER @ FURNACE FALLS —DRAINAGE AREA 527 KM^2

MONTH (1)	YEAR (2)	DATA (3) (CMS)	ORDERED (4) (CMS)	RANK (5)	PROB. (6) (%)	RET. PERIOD (7) (YEARS)
4	1915	32.800	98.100	1	1.27	78.667
4	1916	53.200	83.000	2	3.39	29.500
4	1917	50.900	71.900	3	5.51	18.154
4	1918	53.200	70.300	4	7.63	13.111
3	1919	53.500	69.600	5	9.75	10.261
3	1920	47.600	67.300	6	11.86	8.429
3	1921	53.600	66.500	7	13.98	7.152
4	1922	71.900	66.200	8	16.10	6.211
5	1923	66.500	62.800	9	18.22	5.488
4	1924	30.300	62.600	10	20.34	4.917
3	1925	52.000	60.000	11	22.46	4.453
4	1926	69.600	59.700	12	24.58	4.069
3	1927	49.000	59.300	13	26.69	3.746
4	1928	98.100	58.700	14	28.81	3.471
4	1929	66.200	58.200	15	30.93	3.233
4	1930	49.600	57.100	16	33.05	3.026
4	1931	17.500	53.600	17	35.17	2.843
4	1932	45.000	53.500	18	37.29	2.682
4	1933	47.800	53.200	19	39.41	2.538
4	1934	70.300	53.200	20	41.53	2.408
3	1935	33.000	52.200	21	43.64	2.291
3	1936	44.400	52.000	22	45.76	2.185
4	1937	30.300	50.900	23	47.88	2.088
3	1938	83.000	50.800	24	50.00	2.000
4	1939	60.000	50.000	25	52.12	1.919
4	1940	36.800	49.600	26	54.24	1.844
4	1941	45.000	49.600	27	56.36	1.774
4	1942	34.100	49.000	28	58.47	1.710
4	1943	67.300	47.800	29	60.59	1.650
4	1944	27.700	47.600	30	62.71	1.595
3	1945	49.600	45.800	31	64.83	1.542
3	1946	34.400	45.800	32	66.95	1.494
4	1947	62.600	45.400	33	69.07	1.448
3	1948	62.800	45.000	34	71.19	1.405
3	1949	45.800	45.000	35	73.31	1.364
4	1950	43.600	44.400	36	75.42	1.326
3	1977	30.100	43.600	37	77.54	1.290
4	1978	45.800	36.800	38	79.66	1.255
4	1979	59.700	34.400	39	81.78	1.223
4	1980	52.200	34.100	40	83.90	1.192
5	1983	59.300	33.000	41	86.02	1.163
4	1984	45.400	32.800	42	88.14	1.135
4	1985	58.700	30.300	43	90.25	1.108
4	1986	50.800	30.300	44	92.37	1.083
4	1987	57.100	30.100	45	94.49	1.058
4	1988	58.200	27.700	46	96.61	1.035
4	1989	50.000	17.500*	47	98.73	1.013

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
FURNOBS IRONDALE RIVER @ FURNACE fALLS

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	51.198	15.086	0.295	0.455	4.371
LN X SERIES	3.890	0.316	0.081	-0.754	4.650

X(MIN)= 17.500
X(MAX)= 98.100
LOWER OUTLIER LIMIT OF X= 20.531

TOTAL SAMPLE SIZE= 47
NO. OF LOW OUTLIERS= 1
NO. OF ZERO FLOWS= 0

AFTER REMOVAL OF ZEROES AND/OR LOW OUTLIERS

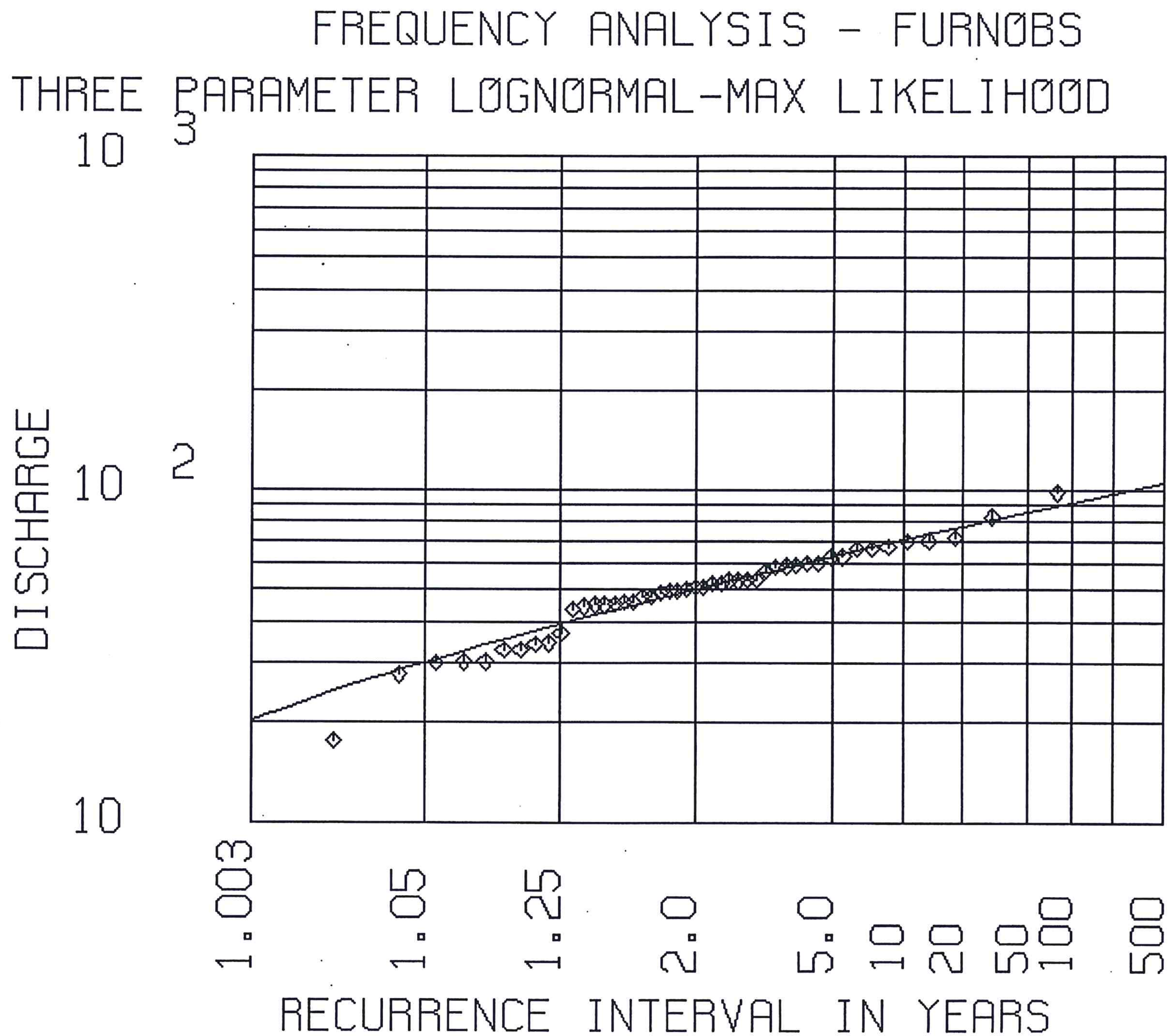
	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	51.930	14.383	0.277	0.676	4.491
LN X SERIES	3.912	0.280	0.072	-0.214	3.196
LN(X-A) SERIES	4.263	0.196	0.046	0.015	3.324

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

PARAMETERS OF THE 3LN WHICH DUPLICATES THE CONDITIONAL FUNCTION:
A= -20.472 M= 4.257 S= 0.200

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	20.30
1.050	0.952	30.10
1.250	0.800	39.20
2.000	0.500	50.10
5.000	0.200	63.10
10.000	0.100	70.70
20.000	0.050	77.60
50.000	0.020	86.00
100.000	0.010	91.90
200.000	0.005	97.70
500.000	0.002	105.00

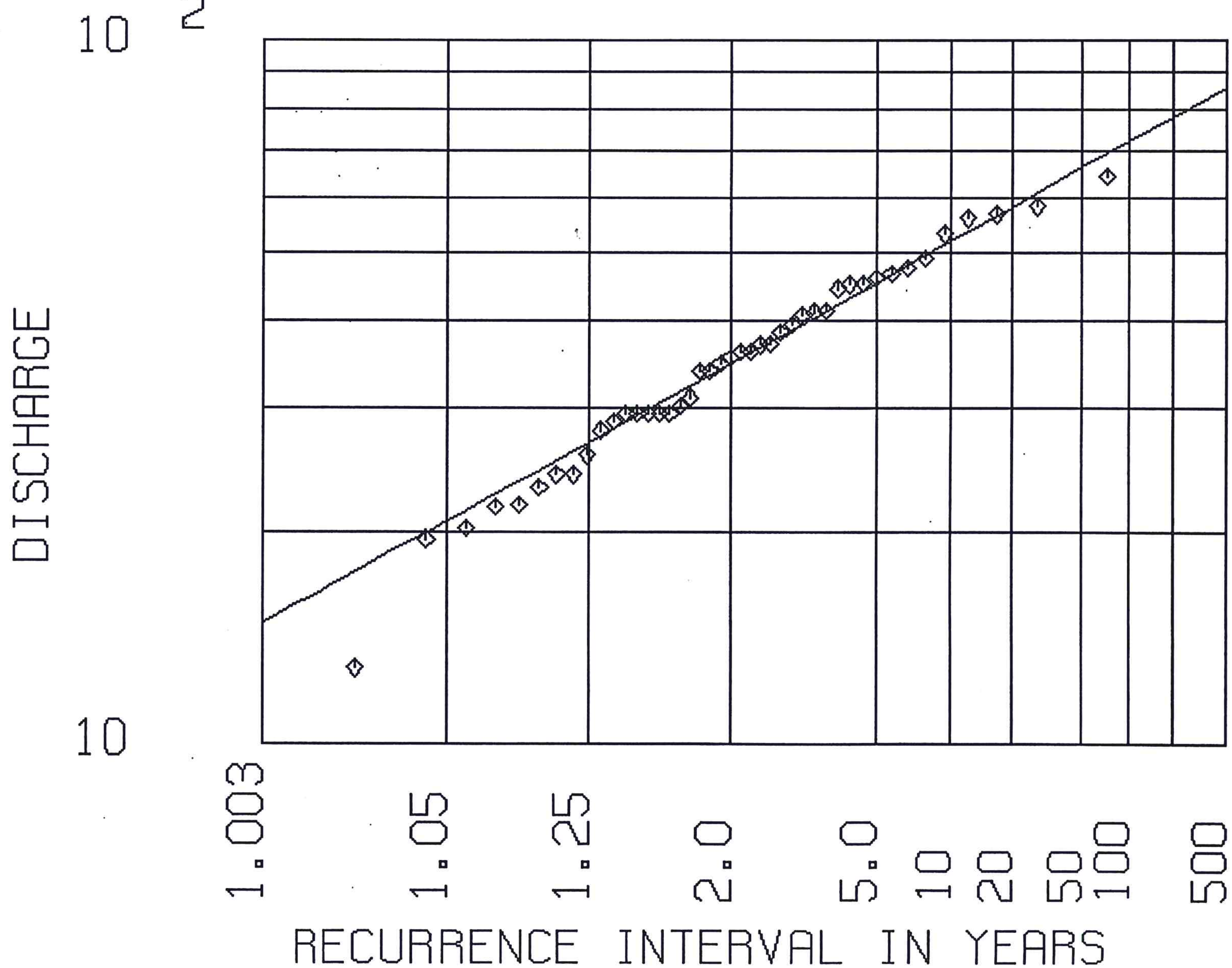

FREQUENCY ANALYSIS - FURNØBS
THREE PARAMETER LØGNØRMAL-MAX LIKELIHØØD
10 3
10 2
10
DISCHARGE
1.003
1.05
1.25
2.0
5.0
10
20
50
100
500
RECURRENCE INTERVAL IN YEARS

WSC STATION NO=GELOBS
WSC STATION NAME=BURNT RIVER BELOW GELERT - DRAINAGE AREA 525 KM²

MONTH	YEAR	DATA	ORDERED	RANK	PROB.	RET. PERIOD
(1)	(2)	(3) (CMS)	(4) (CMS)	(5)	(6) (%)	(7) (YEARS)
4	1918	23.100	64.200	1	1.39	72.000
3	1919	29.500	58.300	2	3.70	27.000
4	1920	36.200	56.800	3	6.02	16.615
3	1921	41.300	56.100	4	8.33	12.000
4	1922	45.300	53.300	5	10.65	9.391
5	1923	56.100	49.100	6	12.96	7.714
5	1924	25.700	47.600	7	15.28	6.545
4	1925	24.100	46.700	8	17.59	5.684
5	1926	31.100	46.100	9	19.91	5.023
6	1927	29.500	45.300	10	22.22	4.500
4	1928	64.200	45.100	11	24.54	4.075
4	1929	44.500	44.500	12	26.85	3.724
4	1930	34.000	41.300	13	29.17	3.429
11	1931	12.800	41.200	14	31.48	3.176
11	1932	29.500	40.900	15	33.80	2.959
4	1933	34.000	39.500	16	36.11	2.769
4	1934	38.500	38.500	17	38.43	2.602
3	1935	20.200	37.100	18	40.74	2.455
5	1936	29.500	37.000	19	43.06	2.323
4	1937	27.900	36.200	20	45.37	2.204
3	1938	37.000	36.200	21	47.69	2.097
4	1939	35.500	35.500	22	50.00	2.000
5	1940	24.100	34.800	23	52.31	1.912
4	1941	30.300	34.000	24	54.63	1.831
4	1942	29.500	34.000	25	56.94	1.756
5	1943	58.300	31.100	26	59.26	1.687
4	1944	19.500	30.300	27	61.57	1.624
3	1945	28.700	29.500	28	63.89	1.565
4	1946	21.800	29.500	29	66.20	1.510
4	1947	49.100	29.500	30	68.52	1.459
3	1948	46.100	29.500	31	70.83	1.412
3	1977	21.700	29.500	32	73.15	1.367
5	1978	39.500	28.700	33	75.46	1.325
4	1979	45.100	27.900	34	77.78	1.286
4	1980	47.600	25.700	35	80.09	1.249
4	1981	41.200	24.100	36	82.41	1.213
4	1982	53.300	24.100	37	84.72	1.180
5	1983	56.800	23.100	38	87.04	1.149
4	1984	34.800	21.800	39	89.35	1.119
4	1986	40.900	21.700	40	91.67	1.091
4	1987	37.100	20.200	41	93.98	1.064
4	1988	46.700	19.500	42	96.30	1.038
4	1989	36.200	12.800*	43	98.61	1.014

FREQUENCY ANALYSIS - GELØBS

THREE PARAMETER LØGNØRMAL-MAX LIKELIHØØD



FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
GELOBS BURNT RIVER BELOW GELERT

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	36.228	11.659	0.322	0.389	2.964
LN X SERIES	3.536	0.340	0.096	-0.480	3.598

X(MIN)= 12.800
X(MAX)= 64.200
LOWER OUTLIER LIMIT OF X= 13.682

TOTAL SAMPLE SIZE= 43
NO. OF LOW OUTLIERS= 1
NO. OF ZERO FLOWS= 0

AFTER REMOVAL OF ZEROES AND/OR LOW OUTLIERS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	36.786	11.204	0.305	0.527	2.900
LN X SERIES	3.560	0.306	0.086	-0.056	2.523
LN(X-A) SERIES	3.541	0.312	0.088	-0.067	2.526

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

PARAMETERS OF THE 3LN WHICH DUPLICATES THE CONDITIONAL FUNCTION:
A= 0.633 M= 3.530 S= 0.318

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	14.90
1.050	0.952	20.70
1.250	0.800	26.70
2.000	0.500	34.80
5.000	0.200	45.20
10.000	0.100	52.00
20.000	0.050	58.20
50.000	0.020	66.30
100.000	0.010	72.20
200.000	0.005	78.10
500.000	0.002	86.00

WSC STATION NO=02HF003
WSC STATION NAME=BURNT RIVER NEAR BURNT RIVER

MONTH (1)	YEAR (2)	DATA (3) (CMS)	ORDERED (4) (CMS)	RANK (5)	PROB. (6) (%)	RET. PERIOD (7) (YEARS)
4	1961	57.600	97.400	49	63.78	1.568
3	1962	56.800	96.600	50	65.09	1.536
3	1963	97.400	96.300	51	66.40	1.506
4	1964	64.800	95.000	52	67.72	1.477
4	1965	93.400	94.300	53	69.03	1.449
12	1966	100.000	93.400	54	70.34	1.422
6	1967	90.900	93.000	55	71.65	1.396
4	1968	81.600	91.700	56	72.97	1.371
5	1969	96.300	91.700	57	74.28	1.346
4	1970	87.800	90.900	58	75.59	1.323
4	1971	130.000	89.200	59	76.90	1.300
4	1972	115.000	87.800	60	78.22	1.279
3	1973	124.000	87.500	61	79.53	1.257
5	1974	131.000	82.000	62	80.84	1.237
4	1975	118.000	81.600	63	82.15	1.217
4	1976	188.000	79.300	64	83.46	1.198
3	1977	70.000	74.800	65	84.78	1.180
4	1978	96.600	72.500	66	86.09	1.162
4	1979	120.000	70.000	67	87.40	1.144
4	1980	117.000	69.000	68	88.71	1.127
2	1981	140.000	64.800	69	90.03	1.111
4	1982	148.000	60.000	70	91.34	1.095
5	1983	130.000	57.600	71	92.65	1.079
4	1984	95.000	56.800	72	93.96	1.064
4	1985	130.000	53.200	73	95.28	1.050
4	1986	113.000	48.600	74	96.59	1.035
4	1987	108.000	45.900	75	97.90	1.021
4	1988	118.000	36.000*	76	99.21	1.008

WSC STATION NO=02HF003
WSC STATION NAME=BURNT RIVER NEAR BURNT RIVER - DRAINAGE AREA 1269 km²

MONTH (1)	YEAR (2)	DATA (3) (CMS)	ORDERED (4) (CMS)	RANK (5)	PROB. (6) (%)	RET. PERIOD (7) (YEARS)
3	1913	228.500	235.000	1	0.79	127.000
4	1914	48.600	228.500	2	2.10	47.625
4	1915	60.000	188.000	3	3.41	29.308
4	1916	142.000	188.000	4	4.72	21.167
4	1917	144.400	184.200	5	6.04	16.565
4	1918	138.300	174.400	6	7.35	13.607
3	1919	101.900	173.200	7	8.66	11.545
3	1920	126.900	167.300	8	9.97	10.026
3	1921	130.700	163.500	9	11.29	8.860
4	1922	173.200	157.000	10	12.60	7.937
5	1923	174.400	151.900	11	13.91	7.189
4	1924	79.300	150.400	12	15.22	6.569
3	1925	93.000	148.000	13	16.54	6.048
4	1926	140.800	147.000	14	17.85	5.603
3	1927	115.700	144.400	15	19.16	5.219
4	1928	235.000	142.000	16	20.47	4.885
4	1929	147.000	140.800	17	21.78	4.590
4	1930	94.300	140.000	18	23.10	4.330
4	1931	36.000	138.300	19	24.41	4.097
4	1932	100.700	138.300	20	25.72	3.888
4	1933	101.900	137.100	21	27.03	3.699
4	1934	163.500	137.100	22	28.35	3.528
3	1935	69.000	131.000	23	29.66	3.372
3	1936	100.000	130.700	24	30.97	3.229
4	1937	82.000	130.700	25	32.28	3.098
3	1938	188.000	130.000	26	33.60	2.977
4	1939	129.400	130.000	27	34.91	2.865
4	1940	87.500	130.000	28	36.22	2.761
4	1941	91.700	129.400	29	37.53	2.664
4	1942	72.500	126.900	30	38.85	2.574
5	1943	157.000	124.000	31	40.16	2.490
4	1944	53.200	120.800	32	41.47	2.411
3	1945	116.900	120.000	33	42.78	2.337
3	1946	74.800	118.000	34	44.09	2.268
4	1947	184.200	118.000	35	45.41	2.202
3	1948	137.100	117.000	36	46.72	2.140
12	1949	138.300	116.900	37	48.03	2.082
4	1950	120.800	115.700	38	49.34	2.027
4	1951	151.900	115.000	39	50.66	1.974
4	1952	137.100	114.500	40	51.97	1.924
4	1953	130.700	113.000	41	53.28	1.877
4	1954	109.600	109.600	42	54.59	1.832
4	1955	114.500	108.000	43	55.91	1.789
5	1956	91.700	101.900	44	57.22	1.748
7	1957	150.400	101.900	45	58.53	1.709
4	1958	45.900	100.700	46	59.84	1.671
5	1959	89.200	100.000	47	61.15	1.635
4	1960	167.300	100.000	48	62.47	1.601

FREQUENCY ANALYSIS - THREE-PARAMETER LOGNORMAL DISTRIBUTION
02HF003 BURNT RIVER NEAR BURNT RIVER

SAMPLE STATISTICS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	115.592	39.713	0.344	0.546	3.787
LN X SERIES	4.688	0.367	0.078	-0.586	3.657

X(MIN)= 36.000
X(MAX)= 235.000
LOWER OUTLIER LIMIT OF X= 37.188

TOTAL SAMPLE SIZE= 76
NO. OF LOW OUTLIERS= 1
NO. OF ZERO FLOWS= 0

AFTER REMOVAL OF ZEROES AND/OR LOW OUTLIERS

	MEAN	S.D.	C.V.	C.S.	C.K.
X SERIES	116.653	38.880	0.333	0.624	3.848
LN X SERIES	4.703	0.346	0.074	-0.388	3.228
LN(X-A) SERIES	5.214	0.205	0.039	0.003	3.094

SOLUTION OBTAINED VIA MAXIMUM LIKELIHOOD

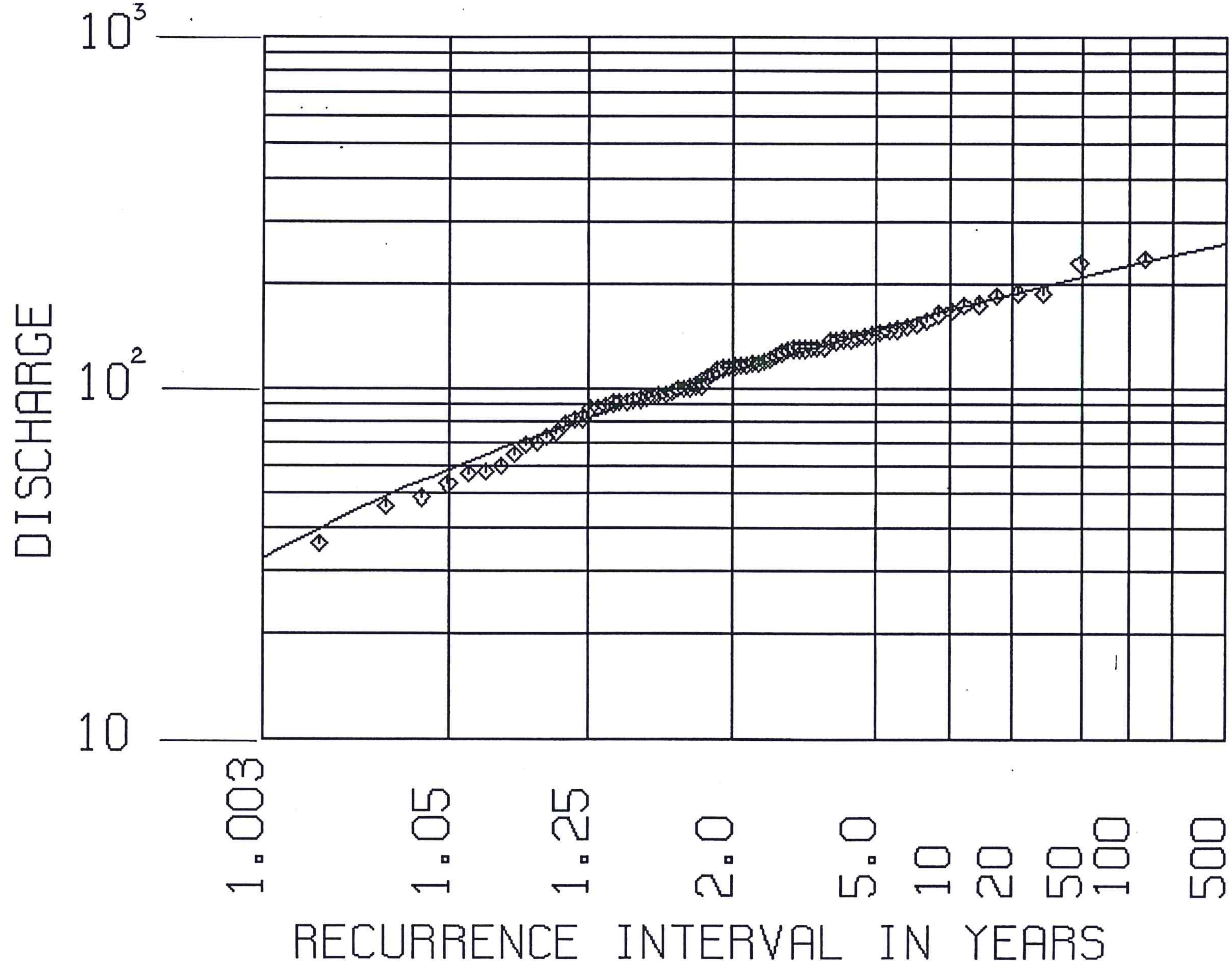
PARAMETERS OF THE 3LN WHICH DUPLICATES THE CONDITIONAL FUNCTION:
A= -71.062 M= 5.210 S= 0.207

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	32.50
1.050	0.952	58.50
1.250	0.800	82.80
2.000	0.500	112.00
5.000	0.200	147.00
10.000	0.100	168.00
20.000	0.050	186.00
50.000	0.020	209.00
100.000	0.010	226.00
200.000	0.005	241.00
500.000	0.002	262.00

FREQUENCY ANALYSIS - 02HF003

THREE PARAMETER LØGNØRMAL-MAX LIKELIHØØD



Appendix L

Terms of Reference for Digital Elevation and Othoimagery Data Control

Appendix L: Terms of Reference for Digital Elevation and Orthoimagery Data Quality Control

Digital Elevation and Orthoimagery Data Quality Control

It is important that the accuracy of the digital elevation models (DEM) and orthoimagery datasets be tested in order to understand the confidence that can be placed on the hydraulic model and flood maps.

A LiDAR and orthoimagery full-suite remote sensing data delivery was acquired by the City of Kawartha Lakes in 2012. The acquisition included orthophotos, LiDAR-derived point cloud data, elevation raster tiles, and other geospatial/non-geospatial datasets produced by the vendor. At the time of the acquisition, the *2009 Ontario Imagery and Elevation Guidelines* (herein referred to as the *2009 Ontario Guidelines*) was the technical document that set geospatial data acquisition specifications in Ontario and defined geospatial data accuracy targets based on levels or risk.

In 2014, the American Society of Photogrammetry and Remote Sensing (ASPRS) published updated standards for quantifying, testing, and reporting accuracy of geospatial data, titled "*ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014)"* (herein referred to as the *2014 ASPRS Standards*). The 2014 ASPRS Standards provides a more up-to-date and robust way of measuring and communicating the accuracy of geospatial data for the purposes of quality control (QC).

In summary, the original project data accuracy requirements established using the 2009 Ontario Guidelines will be fully maintained with only reporting statistics following the 2014 ASPRS Standards format.

Steps to carry out Quality Control:

1. At the initiation of each project the project engineer and the remote sensing (RS) technician will direct the KRCA survey team where to collect QC survey control points for testing accuracy of both digital elevation and orthoimagery data to be used to produce flood plain maps.

2. At the completion of the survey, the survey team will provide the project engineer and the RS technician with the QC survey data. The engineer and RS technician will review the survey data collected for survey completeness. If required, they will direct the KRCA survey team where additional survey is needed for the QC check.

3. Once all survey data has been collected, the RS technician will complete the QC analysis. The result of the analysis will be provided to the project engineer in the QC report.

Vertical Accuracy Goal – Elevation Data

The 2009 Ontario Guidelines states the minimum vertical geospatial data accuracy to be used for the risk level defined as "…densely to moderately populated urban areas that may or may not fall within the Regulated Flood Line" shall be mapped to an accuracy of +/- 0.25 m Linear Map Accuracy Standard (LMAS). This LMAS minimum accuracy level converts to +/- 0.30 m at the 95% confidence level, in accordance with the 2014 ASPRS Standards. This implies that 38 of 40 checkpoints must be within +/- 0.30 m of their true elevation.

Vertical Accuracy Checking - Elevation Data

In accordance with the 2014 ASPRS Standards, a minimum of 70 checkpoints (survey points) will need to be collected using RTK GNSS survey equipment for each project area. To confirm optimal equipment performance in the field, a Precise Point Positioning (PPP) monument should be established at KRCA Main Office to allow for easy equipment performance checks as survey crews enter the field and return to the office.
The terrain from which the checkpoints are acquired should be either flat or, if sloped, be of uniform slope not exceeding 20%. The checkpoints should consist of:

- A minimum of 40 checkpoints for non-vegetated terrain
- A minimum of 30 checkpoints for vegetated terrain

"Non-vegetated" is defined by the 2014 ASPRS Standards as being open terrain (bare soil, sand, rocks, and short grass) and elevation errors can be assumed to follow a normal distribution. Accuracy statistics can be represented as Non-vegetated Vertical Accuracy (NVA) at a 95% confidence interval.

"Vegetated" is defined by the 2014 ASPRS Standards as being non-open terrain (tall weeds and crops, brush lands, and fully forested areas). The vertical error in vegetated areas cannot be assumed to follow a normal distribution. Therefore, accuracy statistics must be reported as Vegetated Vertical Accuracy (VVA) at the 95th percentile of the absolute value of vertical errors.

Horizontal Accuracy Goal - Orthoimagery

The 2009 Ontario Guidelines states the minimum horizontal geospatial data accuracy to be used for the risk level defined as "…densely to moderately populated urban areas that may or may not fall within the Regulated Flood Line" shall be mapped to an accuracy of +/- 0.25 m Circular Map Accuracy Standard (CMAS). This CMAS minimum accuracy level converts to +/- 0.29 m at the 95% confidence level, in accordance with the 2014 ASPRS Standards. This implies that 38 of 40 checkpoints must be within +/- 0.29 m of their true elevation.

Horizontal Accuracy Checking - Orthoimagery

A minimum of 20 checkpoints will need to be collected using RTK GNSS survey equipment for each project area.
The checkpoints should be of clearly defined, readily identifiable features within each project area that are not elevated with respect to the surrounding terrain. The checkpoints should consist of:

- A minimum of 20 checkpoints for photo-identifiable objects, randomly distributed

Q/C Report

The report should include:

- Detailed list of test datasets used for quality control analysis
- Confirmation that datums and projections are consistent across all tested datasets
- Table comparing the field surveyed spot elevations with DEM spot elevations
- Table comparing the field surveyed photo-identifiable objects with orthoimagery test points
- Orthomap with labelled survey locations for all checkpoints used in the QC analysis
- Vertical Accuracy Reporting Statement consistent with the 2014 ASPRS Standards
- Horizontal Accuracy Reporting Statement consistent with the 2014 ASPRS Standards

The ASPRS Vertical Accuracy Reporting Statement should follow the 2014 ASPRS Standards format:

"This data was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for an ***X*** cm RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be RMSEz = ***X*** cm, equating to +/- ***X*** cm at 95% confidence level. Actual VVA accuracy was found to be +/- ***X*** cm at the 95th percentile."

The Horizontal Accuracy Reporting Statement should follow the 2014 ASPRS Standards format:

"This data set was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a X cm RMSEx/RMSEy Horizontal Accuracy Class. Actual positional accuracy was found to be RMSEx = ***X*** cm and RMSEy = ***X*** cm which equates to Positional Horizontal Accuracy = +/- ***X*** cm at a 95% confidence level."

References

American Society for Photogrammetry and Remote Sensing (ASPRS), 2014. *ASPRS Positional Accuracy Standards for Digital Geospatial Data, Edition 1, Version 1.0.*

Government of Ontario, 2009. *Imagery And Elevation Acquisition Guidelines, Version 1.2, Queen's Printer of Ontario.* Prepared by Mapcon Mapping Ltd.