Adapting Stormwater Management for Climate Change: Integrating Future Rainfall Scenarios into Hydrology Models

Presented by: Dan Hipple, *Senior Manager* &
Jody Scott, *Technologist*

Water Resources Engineering, Engineering Services,
Development and Engineering Services

October 09, 2024

Toronto and Region Conservation Authority

Outline:

- Motive for including Climate Change
  - Why TRCA is doing this?
  - Climate Change and the Permitting Process
- Climate Change Methodology
  - Extraction
  - Implementation
- Stormwater Infrastructure Evaluation
  - Etobicoke Analysis
- Future Considerations

Toronto and Region Conservation Authority

Why is TRCA Doing This?

- The impacts of a changing climate is understood by many, but direction for infrastructure designers is difficult to find.
  - The purpose of this study and presentation is to prepare rainfall curves representing future storm events based on climate change information.
  - Further, the assessment reviewed the potential impacts on existing SWM infrastructure

Toronto and Region Conservation Authority

Why is TRCA Doing This?

- Provincial Policy Statement 2020
  - 1.6.6.7 states:

b) minimize, or, where possible, prevent increases in contaminant loads;
c) minimize erosion and changes in water balance, and prepare for the *impacts of a changing climate* through the effective management of stormwater, including the use of *green infrastructure*;
d) mitigate risks to human health, safety, property and the environment;

  - 3.1.3 states:

Planning authorities shall prepare for the *impacts of a changing climate* that may increase the risk associated with natural hazards.

Impacts of a changing climate: means the present and future consequences from changes in weather patterns at local and regional levels including extreme weather events and increased climate variability.

Toronto and Region Conservation Authority

Why is TRCA Doing This?

- Further, TRCA Living City Policies discusses incorporating climate change into the overall SWM design, as outlined:

7.4.3.1 **It is the policy of TRCA:**

a) That natural hazards within TRCA's *watersheds* and along the Lake Ontario Shoreline be managed using a comprehensive risk-based approach that considers, but is not limited to, the following factors:

i. risk to life and property;

vii. climate change;

6.7.1 **It is the policy of TRCA:**

a) To continue to advance the research and understanding of the uses and benefits of natural and engineered elements of *green infrastructure* in urban design, to maximize *ecosystem services*, and *mitigate* the impacts of urbanization and the potential impacts of climate change through TRCA partnerships, programs, and operations.

- But, how?
  - To date, lots of asks to consider and mitigate climate change, but little on how to do this.

Toronto and Region Conservation Authority

Climate Change and the Permitting Process

- Both the PPS and LCP policies are currently reflective of planning and strategizing requirements, but not permitting.
  - For this reason, TRCA is considering climate change as a “check” during the planning process.
  - If approved, applications will be asked to design SWM infrastructure to meet TRCA requirements, then “check” the design against the predictive climate rainfall events to determine potential future effectiveness.
  - Currently, there are no conformity requirements to future predictive events, and meeting SWM requirements based on future predictive events will not hold up permits.
  - The start date for this “check” will be provided with updated SWM guidelines.

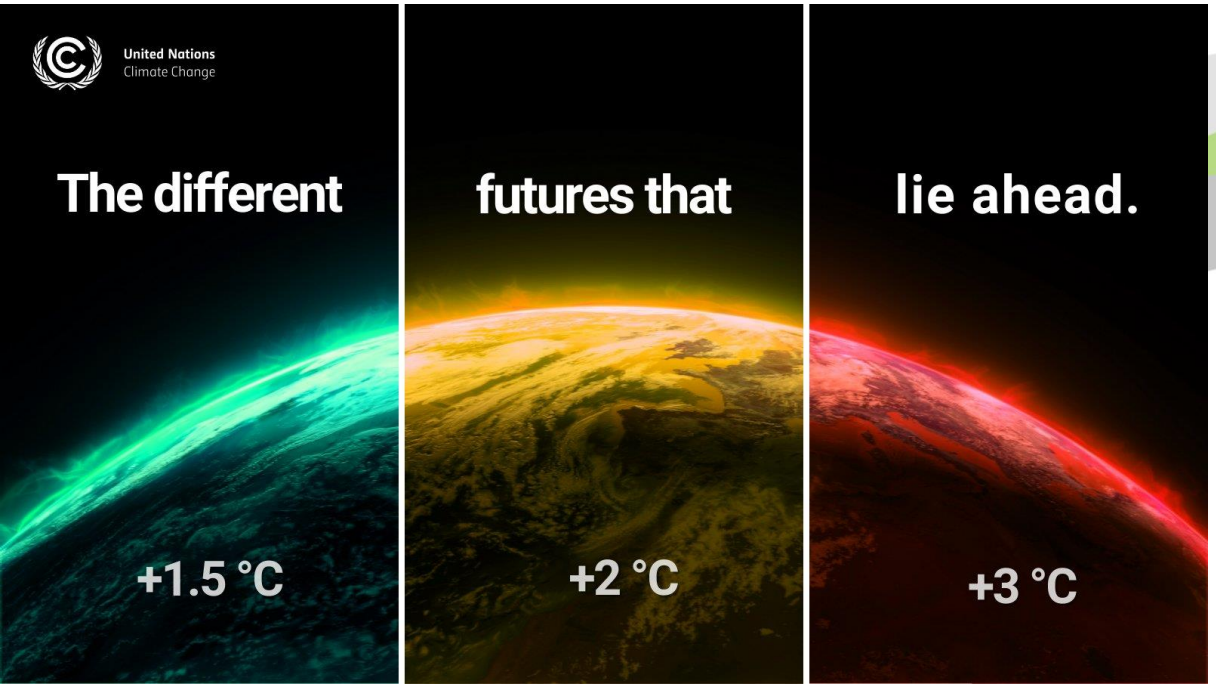
Climate Change Methodology: Background

IDF Curves: Tools for assessing rainfall event probability

Purpose: Design and construct resilient SWM infrastructure

Tradition vs. Future: Shift from traditional historical to future precipitation trends for resilience

Why? Fast changing climate



Toronto and Region Conservation Authority

www.trca.ca

CCM: Regional of Peel Memo

Memo: Region of Peel Flood Vulnerable Road and Crossing Hydraulic Capacity Assessment Project

- Summarize data sources for future IDF curves

Comparison Sources: ClimateData.ca (CDCA), IDF-CC tool, MTO IDF Curve Lookup (MTOC)

Comparison Criteria: Methodological differences, predicted future depth values and update requirements

Toronto and Region Conservation Authority

CCM: Summary of Tools

Toronto and Region Conservation Authority

www.trca.ca

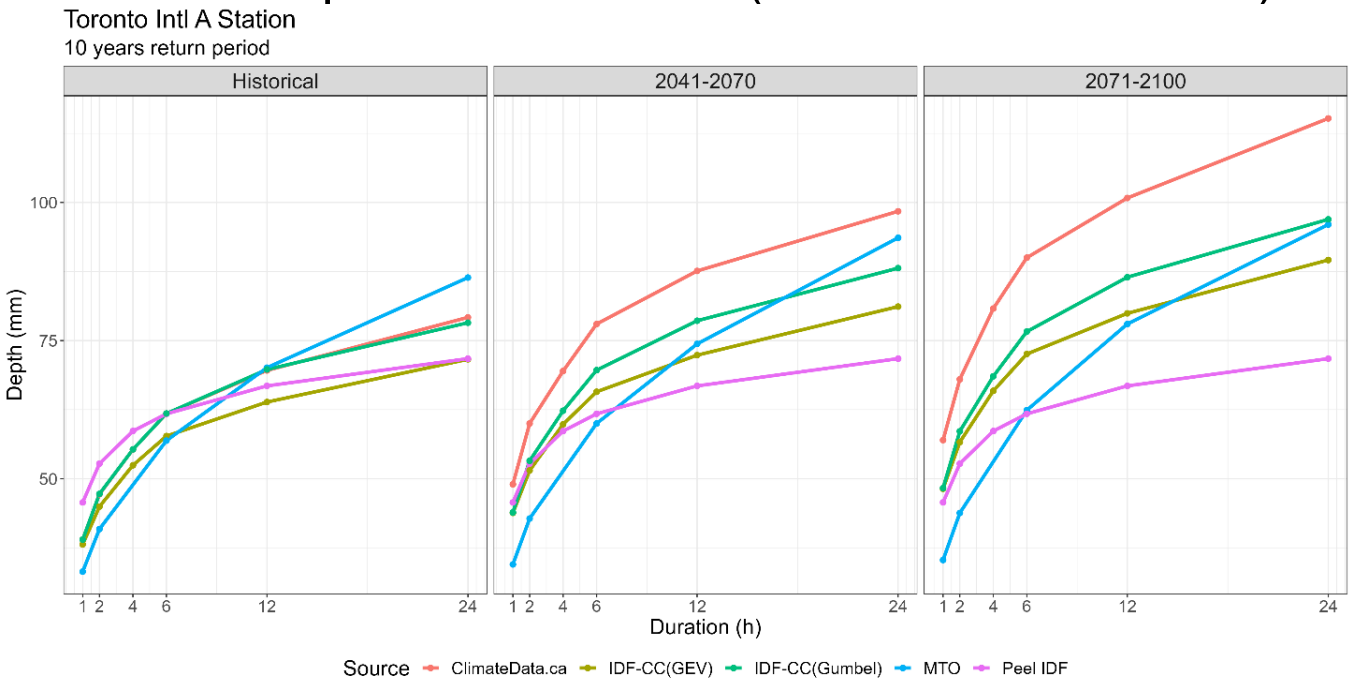
Attributes	CDCA	IDF-CC	MTOC
Climate variable used for calculating future IDF curves	Projected temperature	Projected precipitation	Observed historical precipitation
Methods used for calculating future IDF curves	Change in 30-year mean annual temperature between historical and future periods used with Clausius Clapeyron relationship to scale historical intensities for future periods.	Relative difference between modelled historical and future precipitation is used to scale the current IDF curve values.	A linear trend extrapolated from baseline period (1960-2014) to 2060
Future period	2011-2040, 2021-2050, 2031-2060, 2041-2070, 2051-2080, 2061-2090, 2071-2100	User preference (2015-2100)	User preference (2010-2060)
Extreme value distribution used	Gumbel	Gumbel and GEV	Gumbel
CMIP 5 Bias corrected models	26 GCMs (RCP 2.6, RCP 4.5 and RCP 8.5)	24 GCMs (RCP 2.6, 4.5 and 8.5)	
CMIP 6 Bias corrected models	24 GCMs (SSP1-2.6, SSP2-4.5, SSP5-8.5)	26 GCMs (SSP1-2.6, SSP2-4.5, SSP5-8.5)	

CCM: Comparison of Data Sources

- *Data Comparison:* Analyzes IDF curves for Toronto City and Toronto Int. Airport station
  - At three time periods (historical, mid-century (2041-2070), and end of the century (2071-2100)
- *Return Periods:* 10-year and 100-year scenarios under RCP scenario 8.5
- *Model Differences:* CDCA, IDF-CC (Gumbel/GEV), MTOC, Original Peel IDF
- *Findings*: Varied depth values for different sources and future periods.

CCM: Results from MEMO

- *Recommendation*: Advises against MTOC due to its reliance on linear regression.
- *Conservative Estimates:* CDCA provides conservative estimates for 1-in-10-year storms.
- *Best Fit:* IDF-CC recommended for its better fit and flexibility
  - Multiple approach with Gumbel and GEV
    - GEV fits upper tail values better
- *Future Research:* Suggests using latest CMIP 6 models and additional return periods if needed (this was with CMIP 5)



Toronto and Region Conservation Authority

CCM: Data Extraction from IDF-CC

Toronto and Region Conservation Authority

www.trca.ca

Station Name	Latitude	Longitude	Starting Year	Ending Year	Number of years (with data)
Heart Lake	43.73	-79.78	1962	1974	11
TORONTO INTL A	43.68	-79.63	1950	2017	64
TORONTO ETOBICOKE	43.63	-79.53	1964	1980	12
TORONTO OLD WESTON RD	43.65	-79.4	1966	1990	22
TORONTO MET RES STN	43.8	-79.55	1966	1987	16
TORONTO NORTH YORK	43.78	-79.47	1964	2014	34
TORONTO CITY	43.67	-79.4	1940	2021	73
TORONTO ISLAND A	43.63	-79.39	1971	1994	24
TORONTO BOOTH	43.65	-79.35	1966	1992	26
MAPLE	43.87	-79.48	1960	1975	12
TORONTO GREENWOOD	43.67	-79.32	1966	1981	16
TORONTO LESLIE EGLINTON	43.72	-79.35	1973	1987	11
TORONTO YORK MILLS	43.75	-79.38	1973	1986	12
WILCOX LAKE	43.95	-79.43	1960	1970	10
TORONTO BUTTONVILLE A	43.86	-79.37	1986	2016	26
TORONTO SENECA HILL	43.78	-79.35	1973	1986	11
TORONTO ELLESMERE	43.77	-79.27	1966	1994	25
GREENWOOD MTRCA	43.9	-79.07	1960	1988	19

CCM: Data Extraction from IDF-CC

IDF for: TORONTO CITY ID:6158355

Station Info | IDF historical data | IDF under climate change

GEV | Gumbel

Climate Model Selection | SSP1.26 | SSP2.45 | SSP5.85 | Comparison Graphs

Tables | Plots | Interpolation Equations | Box Plot - Uncertainty

Total precipitation amounts presented in mm and precipitation intensity rates presented in mm/h for different return periods (T) presented in years

(●) Total PPT (mm) ( ) Intensity rates (mm/h)

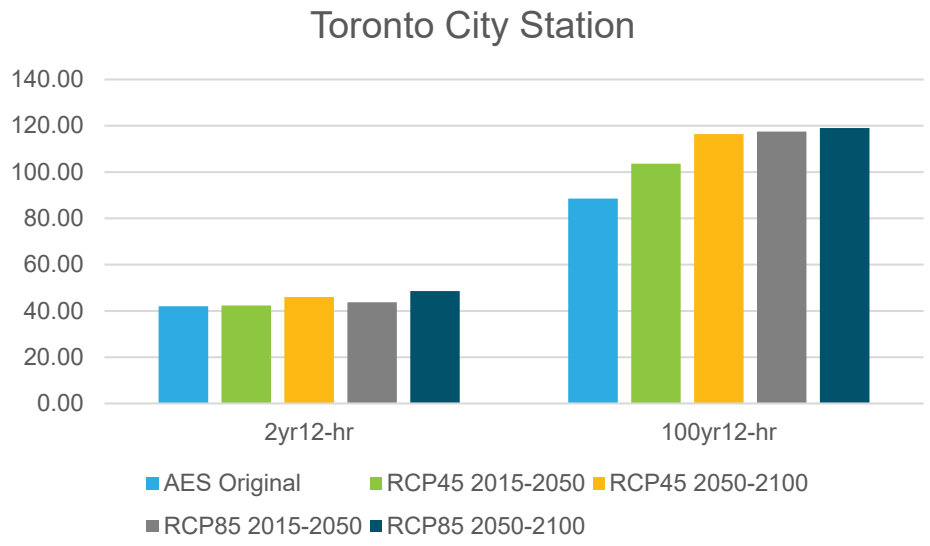
T (years)	2	5	10	20	25	50	100
5 min	9.35	12.78	15.69	19.51	20.68	24.17	27.93
10 min	13.38	17.63	21.13	25.68	26.98	30.83	34.93
15 min	15.85	21.51	26.31	32.63	34.57	40.29	46.46
30 min	20.33	28.33	34.90	43.37	45.78	53.31	61.35
1 h	25.56	35.47	43.30	52.46	54.86	62.35	70.48
2 h	30.06	41.54	50.73	62.02	65.07	74.56	84.91
6 h	37.07	49.76	60.41	74.38	78.57	90.99	104.19
12 h	44.20	58.13	69.43	84.16	88.24	100.40	113.47
24 h	50.70	66.13	77.89	92.90	96.55	107.67	119.53

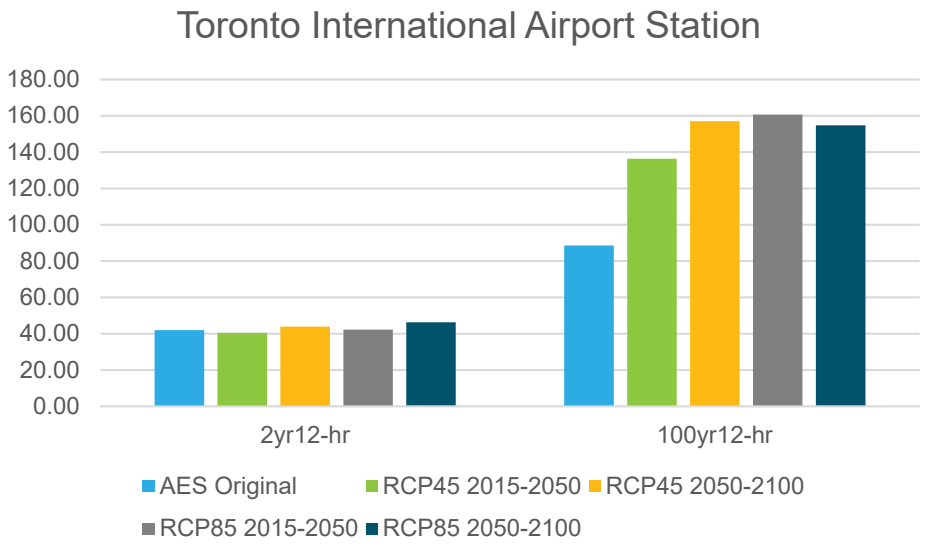
CCM: Data Extraction cont.

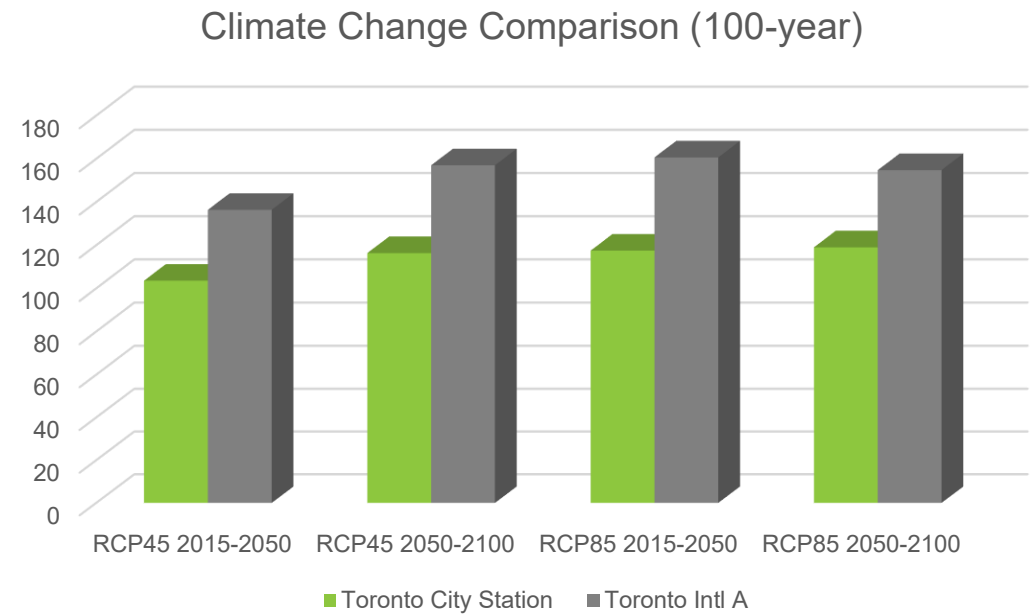
Toronto and Region Conservation Authority

www.trca.ca

	Cumulative Depth (mm)	Percent Difference from Original							
		Toronto City Station				Toronto Intl A			
Design Storm (12-hr)	**Original AES**	**RCP45 2015-2050**	**RCP45 2050-2100**	**RCP85 2015-2050**	**RCP85 2050-2100**	**RCP45 2015-2050**	**RCP45 2050-2100**	**RCP85 2015-2050**	**RCP85 2050-2100**
2-yr	42.00	0.9%	9.6%	4.2%	15.7%	-3.7%	4.5%	0.5%	10.1%
5-yr	54.38	2.7%	10.4%	8.2%	15.6%	-3.0%	7.9%	4.8%	12.9%
10-yr	62.71	5.0%	12.9%	12.2%	17.4%	4.7%	14.1%	12.5%	20.7%
25-yr	73.10	9.1%	22.7%	19.5%	24.8%	19.3%	32.9%	29.3%	37.9%
50-yr	80.82	14.4%	27.3%	27.5%	29.7%	37.0%	52.0%	51.2%	53.9%
100-yr	88.54	17.0%	31.4%	32.7%	34.4%	54.0%	77.3%	81.4%	74.8%







CCM: Data Extraction Cont.

Toronto and Region Conservation Authority

www.trca.ca

CCM: Data Extraction cont.

Toronto and Region Conservation Authority
www.trca.ca

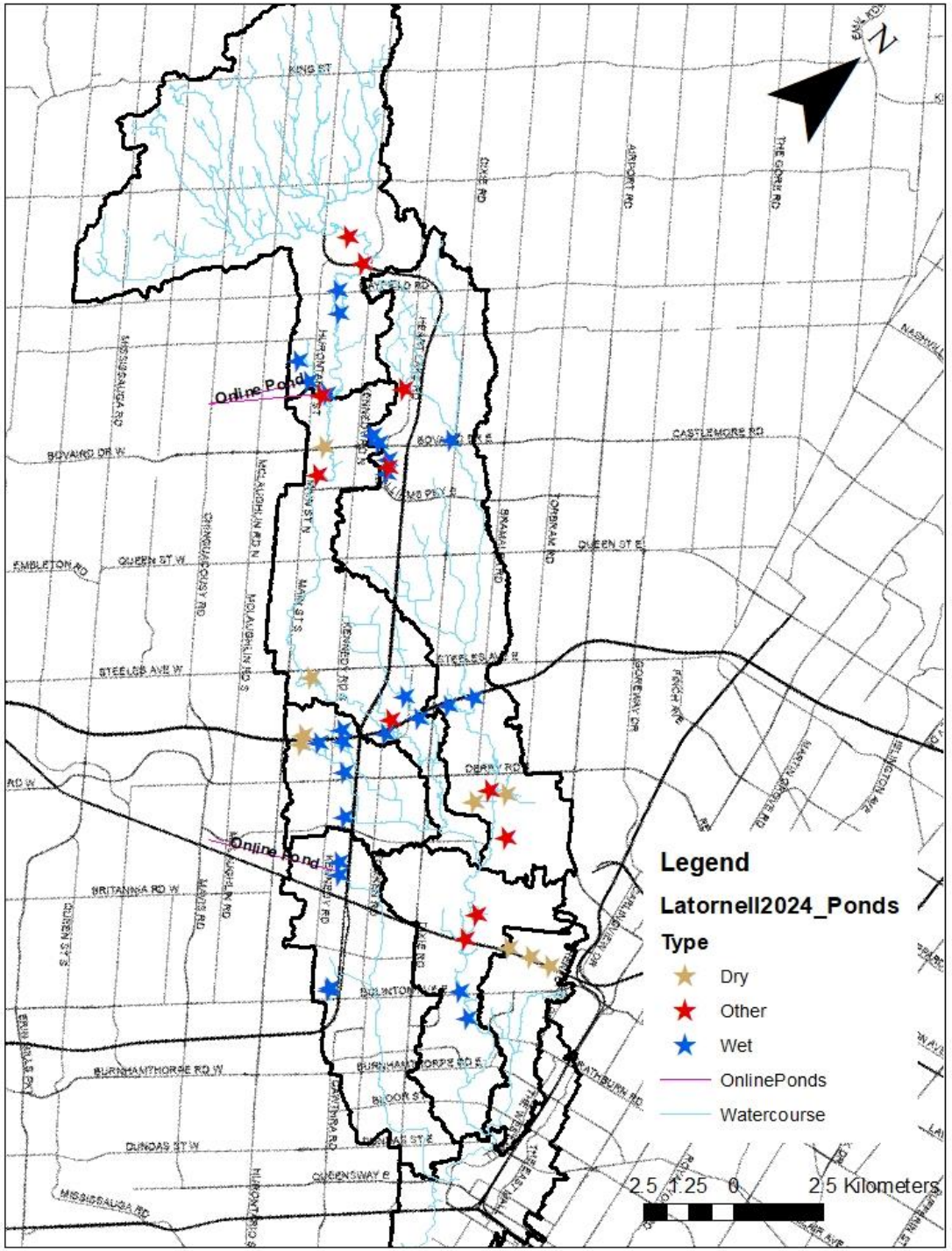
	Cumulative Depth (mm)				
Design Storm AES	**No Change**	**5%**	**10%**	**15%**	**20%**
2yr12-hr	42.00	44.10	46.20	48.30	50.40
5yr12-hr	54.38	57.10	59.82	62.54	65.26
10yr12-hr	62.71	65.85	68.98	72.12	75.25
25yr12-hr	73.10	76.76	80.41	84.07	87.72
50yr12-hr	80.82	84.86	88.90	92.94	96.98
100yr12-hr	88.54	92.97	97.39	101.82	106.25

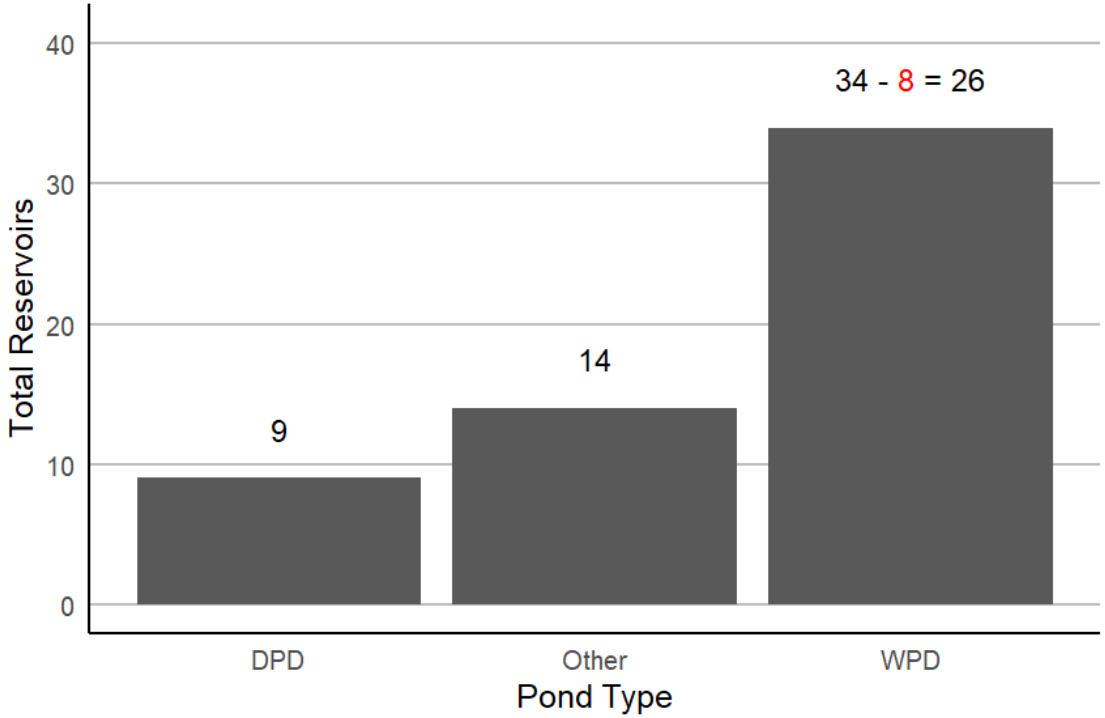
Toronto and Region Conservation Authority

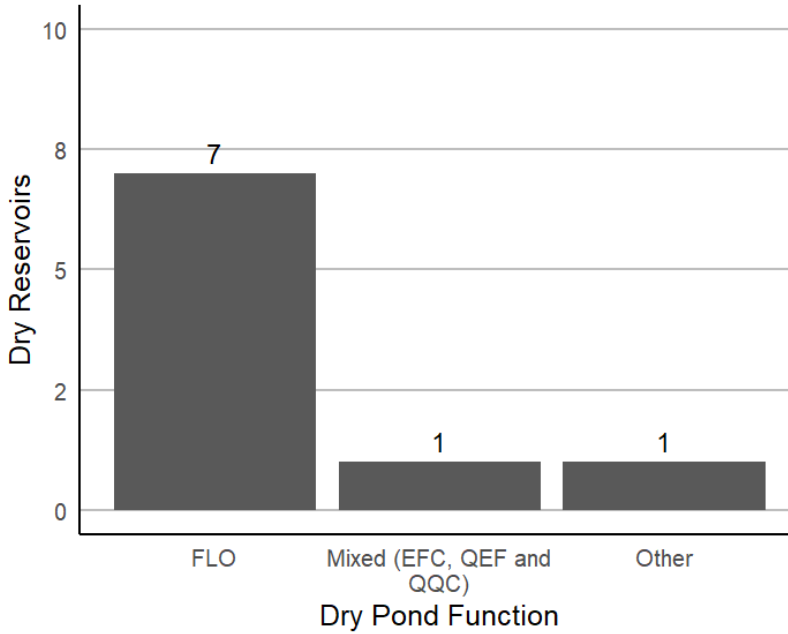
www.trca.ca

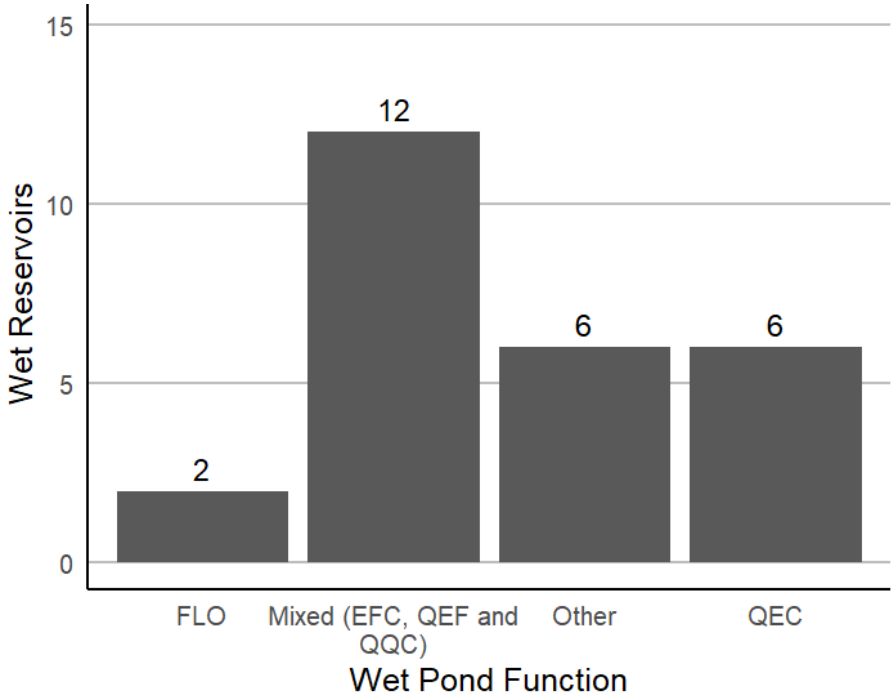
Stormwater Infrastructure Evaluation: Etobicoke Creek

57 Total Ponds
34 Wet Ponds
14 Other Ponds
9 Dry Ponds









SWI Eval.: Pond Count

www.trca.ca

Toronto and Region Conservation Authority

SWI Eval.: Wet Pond Assessment

NHYD	Type	Function	Output	2 Year 12 Hour AES (Bloor, TRCA)	AES2yr12hr5%	AES2yr12hr10%	AES2yr12hr15%	AES2yr12hr20%	5 Year 12 Hour AES (Bloor, TRCA)	AES5yr12hr5%	AES5yr12hr10%	AES5yr12hr15%	AES5yr12hr20%	10 Year 12 Hour AES (Bloor, TRCA)	AES10yr12hr5%	AES10yr12hr10%	AES10yr12hr15%	AES10yr12hr20%	25 Year 12 Hour AES (Bloor, TRCA)	AES25yr12hr5%	AES25yr12hr10%	AES25yr12hr15%	AES25yr12hr20%	50 Year 12 Hour AES (Bloor, TRCA)	AES50yr12hr5%	AES50yr12hr10%	AES50yr12hr15%	AES50yr12hr20%	100 Year 12 Hour AES (Bloor, TRCA)	AES100yr12hr5%	AES100yr12hr10%	AES100yr12hr15%	AES100yr12hr20%	Max RC D	Online Pond
6471	WPD	Other	PKFW (m3/s)	0.01	0.01	0.01	0.01	0.01	0.011	0.011	0.025	0.038	0.049	0.039	0.05	0.065	0.082	0.097	0.087	0.104	0.12	0.134	0.151	0.122	0.138	0.156	0.198	0.223	0.155	0.198	0.228	0.286	0.342	0.965	0
6472	WPD	Other	PKFW (m3/s)	0.023	0.023	0.024	0.025	0.026	0.027	0.032	0.037	0.042	0.046	0.042	0.047	0.053	0.058	0.063	0.06	0.066	0.072	0.079	0.085	0.073	0.08	0.087	0.094	0.102	0.087	0.094	0.102	0.11	0.118	4	0
6473	WPD	Other	PKFW (m3/s)	0.025	0.026	0.026	0.026	0.027	0.027	0.028	0.028	0.029	0.029	0.029	0.029	0.03	0.03	0.031	0.03	0.031	0.031	0.032	0.032	0.032	0.032	0.033	0.033	0.034	0.033	0.033	0.034	0.034	0.034	0.059	0
6474	WPD	Other	PKFW (m3/s)	0.014	0.014	0.014	0.014	0.015	0.015	0.015	0.016	0.016	0.016	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.018	0.018	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.031	0
6475	WPD	Other	PKFW (m3/s)	0.027	0.028	0.028	0.028	0.029	0.03	0.03	0.03	0.031	0.032	0.031	0.032	0.032	0.033	0.033	0.033	0.033	0.034	0.034	0.035	0.034	0.034	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.06	0
6476	WPD	Other	PKFW (m3/s)	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.03	0
6013	WPD	FLO	PKFW (m3/s)	4.387	4.602	4.804	5.009	5.209	6.896	8.305	9.798	11.52	13.124	11.614	13.511	15.489	17.528	18.52	17.951	18.961	20.062	21.238	22.47	20.191	21.496	22.85	24.22	25.623	22.732	24.225	25.772	27.325	28.957	136.16	0
6158	WPD	FLO	PKFW (m3/s)	0.074	0.076	0.076	0.077	0.078	0.079	0.081	0.082	0.083	0.084	0.083	0.084	0.086	0.087	0.089	0.088	0.089	0.091	0.093	0.095	0.091	0.093	0.103	0.202	0.271	0.102	0.202	0.271	0.269	0.327	1.825	0
6129	WPD	QEC	PKFW (m3/s)	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.021	0
6214	WPD	QEC	PKFW (m3/s)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.031	0
6268	WPD	QEC	PKFW (m3/s)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.026	0
6281	WPD	QEC	PKFW (m3/s)	0.598	0.672	0.843	0.95	1.22	1.531	1.615	1.7	1.987	2.279	2.007	2.304	2.445	2.588	2.732	2.634	2.803	2.909	2.996	3.144	2.918	3.028	3.191	3.354	3.516	3.175	3.354	3.532	3.726	3.925	7.47	0
6313	WPD	QEC	PKFW (m3/s)	0.154	0.259	0.41	0.524	0.612	0.752	0.847	1.374	1.465	1.432	1.462	1.425	1.544	2.074	2.426	2.247	2.431	2.442	2.452	2.461	2.443	2.454	2.465	2.68	3.024	2.463	2.68	3.027	3.065	3.102	8.7	0
6381	WPD	QEC	PKFW (m3/s)	0.013	0.013	0.013	0.014	0.014	0.039	0.06	0.079	0.098	0.119	0.099	0.123	0.145	0.182	0.231	0.196	0.259	0.313	0.368	0.418	0.319	0.38	0.431	0.481	0.54	0.427	0.482	0.547	0.632	0.701	1.587	0
6033	WPD	QEF	PKFW (m3/s)	2.9	3.474	4.116	4.616	5.007	5.66	6.052	6.479	7.034	7.555	7.065	7.652	8.192	8.685	9.197	8.849	9.445	10.06	10.824	11.807	10.141	10.991	12.146	13.368	14.863	12.032	13.368	15.015	16.732	18.508	26.91	1
6152	WPD	QEF	PKFW (m3/s)	0.825	0.837	0.851	0.865	0.88	0.908	0.927	0.946	0.966	0.987	0.967	0.991	1.171	1.371	1.563	1.434	1.645	1.857	2.031	2.196	1.879	2.068	2.245	2.428	2.622	2.23	2.429	2.64	2.839	3.04	3.5	0
6153	WPD	QEF	PKFW (m3/s)	1.418	1.511	1.603	1.698	1.793	1.979	2.107	2.237	2.369	2.502	2.377	2.53	2.686	2.843	3.003	2.894	3.08	3.268	3.458	3.673	3.289	3.499	3.743	3.995	4.247	3.72	3.995	4.272	4.509	4.738	12.95	0
6219	WPD	QEF	PKFW (m3/s)	0.12	0.131	0.143	0.154	0.166	0.189	0.205	0.222	0.239	0.256	0.24	0.26	0.28	0.3	0.321	0.307	0.332	0.356	0.382	0.407	0.359	0.387	0.415	0.444	0.473	0.413	0.444	0.476	0.508	0.541	0.5	0
6269	WPD	QEF	PKFW (m3/s)	0.457	0.571	0.721	0.83	0.957	1.145	1.284	1.485	1.652	1.884	1.667	1.933	2.2	2.449	2.689	2.529	2.78	2.998	3.279	3.514	3.022	3.34	3.583	3.851	4.235	3.561	3.851	4.267	4.607	4.884	9.766	0
6270	WPD	QEF	PKFW (m3/s)	0.511	0.677	0.863	0.999	1.117	1.302	1.537	1.737	1.9	2.049	1.91	2.077	2.225	2.35	2.47	2.388	2.527	2.657	2.786	2.92	2.671	2.813	2.962	3.105	3.244	2.948	3.105	3.258	3.412	3.566	8.836	0
6282	WPD	QEF	PKFW (m3/s)	1.043	1.259	1.368	1.447	1.595	1.991	2.161	2.297	2.433	2.546	2.441	2.568	2.689	2.819	2.96	2.864	3.028	3.192	3.364	3.543	3.21	3.401	3.6	3.803	3.993	3.581	3.803	4.011	4.216	4.424	5.313	0
6331	WPD	QEF	PKFW (m3/s)	0.303	0.347	0.417	0.496	0.572	0.728	0.827	0.918	1.008	1.097	1.014	1.115	1.214	1.315	1.43	1.347	1.496	1.651	1.867	2.062	1.668	1.91	2.121	2.33	2.511	2.101	2.33	2.529	2.721	2.909	5.9	0
6962	WPD	QEF	PKFW (m3/s)	4.848	4.967	5.084	5.203	5.71	6.467	6.936	7.375	7.791	8.191	7.813	8.28	8.761	9.382	9.921	9.56	10.171	10.811	11.438	12.062	10.883	11.572	12.246	12.874	13.507	12.189	12.877	13.574	14.301	15.104	31.2	0
6963	WPD	QEF	PKFW (m3/s)	0.361	0.441	0.449	0.457	0.465	0.478	0.504	0.533	0.561	0.59	0.562	0.596	0.628	0.662	0.695	0.673	0.711	0.75	0.791	0.829	0.755	0.799	0.841	0.885	0.93	0.837	0.885	0.934	0.983	1.031	13.46	0
6964	WPD	QEF	PKFW (m3/s)	0.618	0.741	0.753	0.778	0.813	0.881	0.929	0.978	1.026	1.075	1.029	1.086	1.142	1.199	1.256	1.217	1.284	1.352	1.42	1.486	1.36	1.434	1.507	1.583	1.659	1.501	1.584	1.667	1.75	1.832	23.42	1
6961	WPD	QQC	PKFW (m3/s)	1.327	1.403	1.478	1.555	1.856	2.602	3.016	3.393	3.749	4.143	3.778	4.221	4.576	4.934	5.33	5.058	5.511	5.858	6.173	6.565	5.891	6.257	6.682	7.093	8.098	6.645	7.094	8.193	9.146	9.986	23.45	0

Toronto and Region Conservation Authority

SWI Eval.: Wet Pond Assessment

Out of 26 Wet ponds with different functions, how many ponds cannot contain the flows?

AES % Increase

- one Mixed (QEF)
  - **ID 6219**: failed AES 100-year 12-hr 15% and 20%

Climate Change – Toronto City Station

- Two mixed (QEF)
  - **ID 6152:** could not handle TC 100-year 12-hr RCP4.5 2050-2100, RCP8.5 2015-2050 and 2050-2100
  - **ID 6219**: could not handle TC 50-year 12-hr RCP4.5 2050-2100, RCP8.5 2015-2050 and 2050-2100 *and* 100-year 12-hr RCP4.5 2015-2050 and 2050-2100, RCP8.5 2015-2050 and 2050-2100

Climate Change – Toronto International Station

- Four mixed (QEF)
  - **ID 6033 (online pond)** & **6282**: could not handle TI 100-year 12-hr Climate Change
  - **ID 6152:** could not handle storms beyond the 50-year 12-hr RCP4.5 2015-2050
  - **ID 6219:** could not handle storms beyond the 25-year 12-hr RCP8.5 2015-2050

SWI Eval.: Dry Pond Assessment

NHYD	Type	Function	Output	2 Year 12 Hour AES (Bloor, TRCA)	AES2yr12 hr5%	AES2yr12 hr10%	AES2yr12 hr15%	AES2yr12 hr20%	5 Year 12 Hour AES (Bloor, TRCA)	AES5yr12 hr5%	AES5yr12 hr10%	AES5yr12 hr15%	AES5yr12 hr20%	10 Year 12 Hour AES (Bloor, TRCA)	AES10yr12hr5%	AES10yr12hr10%	AES10yr12hr15%	AES10yr12hr20%	25 Year 12 Hour AES (Bloor, TRCA)	AES25yr12hr5%	AES25yr12hr10%	AES25yr12hr15%	AES25yr12hr20%	50 Year 12 Hour AES (Bloor, TRCA)	AES50yr12hr5%	AES50yr12hr10%	AES50yr12hr15%	AES50yr12hr20%	100 Year 12 Hour AES (Bloor, TRCA)	AES100yr12hr5%	AES100yr12hr10%	AES100yr12hr15%	AES100yr12hr20%	Max RC Dis
6609	DPD	EFC	PkFW (m3/s)	0.908	1.094	1.242	1.403	1.543	1.826	2.013	2.241	2.475	2.734	2.489	2.824	3.268	3.66	3.977	3.768	4.128	4.487	4.849	5.199	4.526	4.927	5.288	5.607	5.925	5.259	5.607	5.956	6.307	6.725	14.091
6023	DPD	FLO	PkFW (m3/s)	17.42	17.557	17.811	17.836	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837	17.837
6099	DPD	FLO	PkFW (m3/s)	0.032	0.034	0.036	0.038	0.04	0.044	0.047	0.049	0.052	0.055	0.052	0.055	0.058	0.061	0.065	0.062	0.066	0.07	0.073	0.077	0.07	0.074	0.078	0.082	0.087	0.078	0.082	0.087	0.091	0.096	0.15
6105	DPD	FLO	PkFW (m3/s)	0.598	0.613	0.627	0.649	0.691	0.772	0.829	0.895	0.97	1.044	0.974	1.06	1.147	1.236	1.332	1.266	1.388	1.525	1.66	1.797	1.539	1.69	1.838	1.993	2.15	1.825	1.994	2.166	2.342	2.516	3.2
6601	DPD	FLO	PkFW (m3/s)	0.777	0.832	0.888	0.945	1.002	1.113	1.19	1.268	1.346	1.426	1.351	1.443	1.536	1.629	1.724	1.66	1.771	1.882	1.995	2.109	1.894	2.019	2.145	2.272	2.399	2.133	2.272	2.412	2.553	2.695	2
6602	DPD	FLO	PkFW (m3/s)	0.225	0.242	0.259	0.277	0.295	0.33	0.354	0.378	0.403	0.428	0.405	0.434	0.463	0.493	0.523	0.502	0.538	0.573	0.609	0.646	0.577	0.617	0.657	0.698	0.738	0.653	0.698	0.743	0.788	0.833	0.8
6603	DPD	FLO	PkFW (m3/s)	0.163	0.175	0.187	0.2	0.213	0.238	0.255	0.272	0.29	0.308	0.291	0.312	0.333	0.354	0.375	0.361	0.386	0.411	0.437	0.463	0.414	0.442	0.471	0.5	0.53	0.469	0.5	0.533	0.565	0.598	0.7
6605	DPD	FLO	PkFW (m3/s)	0.088	0.089	0.089	0.09	0.09	0.092	0.093	0.094	0.095	0.095	0.095	0.096	0.097	0.098	0.099	0.098	0.099	0.1	0.101	0.102	0.1	0.101	0.102	0.103	0.104	0.102	0.103	0.104	0.105	0.106	0.24
6470	DPD	Other	PkFW (m3/s)	0.011	0.011	0.012	0.012	0.012	0.013	0.013	0.014	0.014	0.015	0.014	0.015	0.015	0.016	0.016	0.016	0.016	0.017	0.017	0.018	0.017	0.017	0.018	0.018	0.019	0.018	0.018	0.019	0.031	0.051	2.434

SWI Eval.: Dry Pond Assessment

Out of 9 Dry ponds with different functions, how many ponds cannot contain the flows?

AES % Increase

- Three Quantity Control (FLO)
    - **ID 6023:** could only contain AES 2-year 12-hr normal, 5%, 10% and 15%, failed the rest
    - **ID 6601:** failed AES 25-year 12-hr 20% and everything beyond AES 50-year 12-hr normal.
    - **ID 6602:** failed only AES 100-year 12-hr 20%

Climate Change – Toronto City Station

- Three Quantity Control (FLO)
    - **ID 6023:** could not handle storms beyond the 2-year 12-hr climate change events
    - **ID 6601:** could not handle storms beyond the 25-year 12-hr RCP4.5 2015-2050 climate change event
    - **ID 6602:** could not handle storms beyond the 50-year 12-hr RCP4.5 2050-2100 climate change event

Climate Change – Toronto International Station

- Six Quantity Control (FLO)
    - **ID 6023:** could not handle storms beyond the 2-year 12-hr climate change events
    - **ID 6099:** could not handle the 100-year 12-hr RCP8.5 2015-2050
    - **ID 6105:** could not handle TI 100-year 12-hr Climate Change events
    - **ID 6601:** could not handle storms beyond the 10-year 12-hr climate change events
    - **ID 6602:** could not handle storms beyond the 25-year 12-hr climate change events
    - **ID 6603:** could not handle storms beyond the 50-year 12-hr RCP4.5 2015-2050 climate change event

Conclusions

- Majority of wet ponds were able to withstand climate change
  - only mixed ponds failed

- Dry ponds - difficult to contain peak flows
  - these were all quantity control ponds
  - 4 that failed designed pre-1994

- Maximum fail rate
  - Wet Pond - 15% (4/26)
  - Dry Pond – 67% (6/9)

- First Step for incorporating climate change
  - This was just a ‘check’

Future Considerations

- Currently completing the analysis on Humber River Watershed ponds
- Start looking at other climate change documents for other sections of watershed
- 2012 SWM quantity control criteria will be updated to reflect climate change notes
  - Added as a check

Questions?

Contact Information

Dan Hipple
Email: dan.hipple@trca.ca
Phone: (437) 880-2371

Jody Scott
Email: jody.scott@trca.ca
Phone: (437) 880-2373

APPENDIX

Toronto and Region Conservation Authority

Methodological Differences: ClimateData.ca (CDCA)

- *Data Source:* Pacific Climate Impact Consortium (PCIC)
- *Downscaling:* Clausius-Clapeyron scaling algorithm (temperature scaling)
- *Advantages:* Relies on temperature data for better confidence

ClimateData.ca (CDCA) (cont.)

1. Statistically downscaled projected temperature data from PCIC
   I. Based on moisture-holding capacity in at atmosphere ↑ 7.6% for every 1ºC ↑ in temperature
2. Use Equation 1 below to find *future rainfall intensities*, values change based on latitude and avg. mean daily temperature variations
3. CDCA does not account for these variations in (2)

(eqn. 1) $R_P = R_C \times 1.07^{\Delta T}$

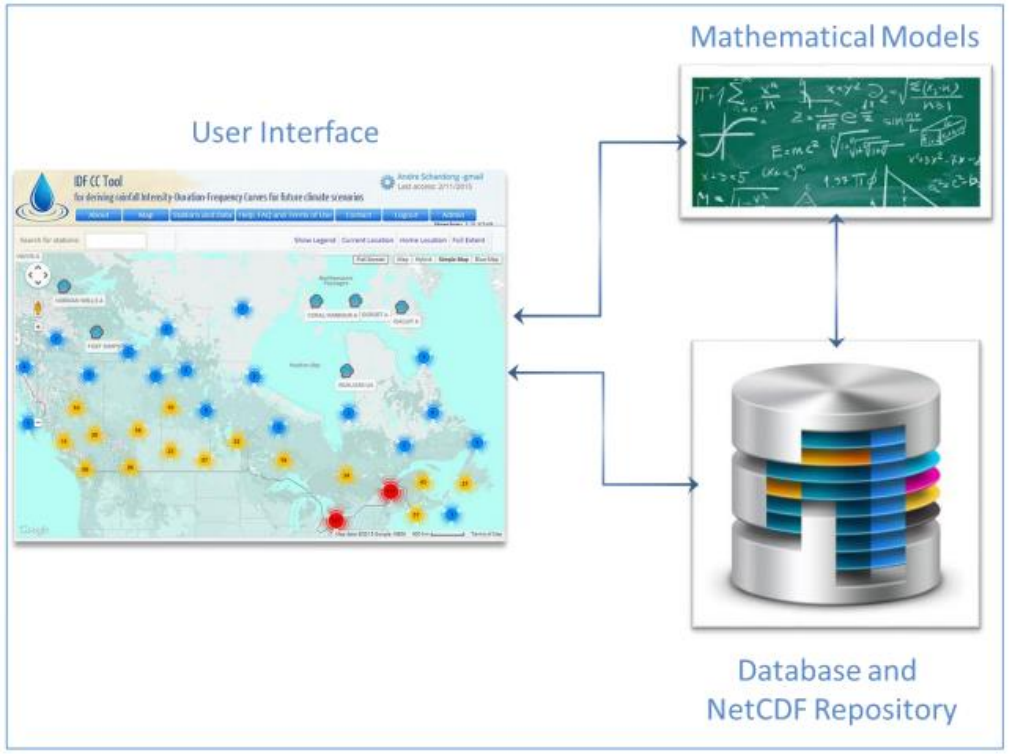
- Future rainfall intensities (R_P)
- historical rainfall intensity from the **historical IDF curve** (R_C)
- long-term (30-year mean) annual mean temperature change between the historical and future periods for a specific location and emission scenario (ΔT)

Toronto and Region Conservation Authority

www.trca.ca

Methodological Differences: IDF-CC (Simonovic et al. 2015)

- *Data Source:* Pacific Climate Impact Consortium (PCIC) (SR: 10 km x10 km)
- *Downscaling:* Uses statistically downscaled precipitation data
- *Temporal Resolution: ONLY* Daily, extrapolated to sub-daily for future scenarios



www.trca.ca

Toronto and Region Conservation Authority

IDF-CC (cont.)

1. PCIC takes outputs from Global Climate Models (GCMs) (reso. 100 km) and downscale to local scale (10 km x 10 km)
2. To downscale: relationship between local climate data and GCM inputs for a historical period
3. Relationship extended into future period to downscale GCM outputs to local finer resolution
4. PCIC uses gridded observed climate dataset available for Canada (NRCan) to establish statistical relationship

- Assumptions*:*
  - Statistical downscaling relies on quality and spatial distribution of observed climate data
  - Relationship derived for current climate will hold for future

Methodological Differences: MTO IDF Curve Lookup Tool

- *Approach:* Linear trend extrapolation from historical values
- *Considerations*: Ignores projected climate data, assumes constant rate and combines all Ontario stations to determine the trend (ignores spatial heterogeneity)

CCM: Data Extraction cont.

www.trca.ca

CUMULATIVE Depth (mm)									
		Toronto City Station				Toronto Intl A			
Design Storm (12-hr)	**Original AES**	**RCP45 2015-2050**	**RCP45 2050-2100**	**RCP85 2015-2050**	**RCP85 2050-2100**	**RCP45 2015-2050**	**RCP45 2050-2100**	**RCP85 2015-2050**	**RCP85 2050-2100**
2-yr	42.00	42.36	46.02	43.75	48.59	40.43	43.91	42.19	46.26
5-yr	54.38	55.87	60.01	58.84	62.88	52.77	58.67	57.00	61.41
10-yr	62.71	65.83	70.8	70.35	73.65	65.68	71.57	70.55	75.72
25-yr	73.10	79.78	89.7	87.36	91.25	87.22	97.16	94.53	100.81
50-yr	80.82	92.43	102.86	103.07	104.82	110.74	122.84	122.17	124.38
100-yr	88.54	103.57	116.36	117.49	119.02	136.37	157.01	160.65	154.77

SWI Eval.: Wet Pond Assessment

Out of 26 Wet ponds with different functions, how many ponds cannot contain the flows?

AES % Increase

- one Mixed (QEF)
  - ID 6219: failed AES 100-year 12-hr 15% and 20%

Climate Change – Toronto City Station

- Out of the 26 wet ponds with different functions, two Mixed (QEF) ponds were not able to control all the flows
  - 6152: could not handle TC 100-year 12-hr RCP4.5 2050-2100, RCP8.5 2015-2050 and 2050-2100
  - 6219: could not handle TC 50-year 12-hr RCP4.5 2050-2100, RCP8.5 2015-2050 and 2050-2100 *and* 100-year 12-hr RCP4.5 2015-2050 and 2050-2100, RCP8.5 2015-2050 and 2050-2100

-

SWI Eval.: Wet Pond Assessment

NHYD	Type	Function	Output	2 Year 12 Hour AES (Bloor, TRCA)	TC-2yr12hr RCP45 2015-2050	TC-2yr12hr RCP45 2050-2100	TC-2yr12hr RCP85 2015-2050	TC-2yr12hr RCP85 2050-2100	5 Year 12 Hour AES (Bloor, TRCA)	TC-5yr12hr RCP45 2015-2050	TC-5yr12hr RCP45 2050-2100	TC-5yr12hr RCP85 2015-2050	TC-5yr12hr RCP85 2050-2100	10 Year 12 Hour AES (Bloor, TRCA)	TC-10yr12hr RCP45 2015-2050	TC-10yr12hr RCP45 2050-2100	TC-10yr12hr RCP85 2015-2050	TC-10yr12hr RCP85 2050-2100	25 Year 12 Hour AES (Bloor, TRCA)	TC-25yr12hr RCP45 2015-2050	TC-25yr12hr RCP45 2050-2100	TC-25yr12hr RCP85 2015-2050	TC-25yr12hr RCP85 2050-2100	50 Year 12 Hour AES (Bloor, TRCA)	TC-50yr12hr RCP45 2015-2050	TC-50yr12hr RCP45 2050-2100	TC-50yr12hr RCP85 2015-2050	TC-50yr12hr RCP85 2050-2100	100 Year 12 Hour AES (Bloor, TRCA)	TC-100yr12hr RCP45 2015-2050	TC-100yr12hr RCP45 2050-2100	TC-100yr12hr RCP85 2015-2050	TC-100yr12hr RCP85 2050-2100	Max RC D	Online Pond
6471	WPD	Other	PKFW (m3/s)	0.01	0.01	0.01	0.01	0.01	0.011	0.011	0.025	0.019	0.04	0.039	0.01	0.01	0.01	0.01	0.087	0.118	0.163	0.149	0.184	0.122	0.197	0.3	0.303	0.326	0.155	0.309	0.391	0.396	0.402	0.965	0
6472	WPD	Other	PKFW (m3/s)	0.023	0.023	0.024	0.023	0.025	0.027	0.03	0.037	0.035	0.042	0.042	0.023	0.024	0.024	0.025	0.06	0.071	0.089	0.085	0.092	0.073	0.094	0.112	0.112	0.115	0.087	0.113	0.139	0.142	0.146	4	0
6473	WPD	Other	PKFW (m3/s)	0.025	0.025	0.026	0.025	0.026	0.027	0.028	0.028	0.028	0.029	0.029	0.026	0.026	0.026	0.026	0.03	0.031	0.033	0.032	0.033	0.032	0.033	0.034	0.034	0.034	0.033	0.034	0.034	0.034	0.034	0.059	0
6474	WPD	Other	PKFW (m3/s)	0.014	0.014	0.014	0.014	0.014	0.015	0.015	0.016	0.016	0.016	0.016	0.014	0.014	0.014	0.015	0.017	0.017	0.018	0.018	0.018	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.031	0
6475	WPD	Other	PKFW (m3/s)	0.027	0.027	0.028	0.028	0.028	0.03	0.03	0.031	0.03	0.031	0.031	0.028	0.028	0.028	0.029	0.033	0.034	0.035	0.035	0.035	0.034	0.035	0.035	0.035	0.035	0.035	0.035	0.036	0.036	0.036	0.06	0
6476	WPD	Other	PKFW (m3/s)	0.016	0.016	0.017	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.016	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.019	0.019	0.019	0.03	0
6013	WPD	FLO	PKFW (m3/s)	4.387	4.423	4.786	4.566	5.038	6.896	7.67	9.935	9.188	11.727	11.614	4.601	4.925	4.895	5.106	17.951	19.875	23.121	22.345	23.638	20.191	24.043	27.712	27.799	28.434	22.732	27.97	32.656	33.02	33.606	136.16	0
6158	WPD	FLO	PKFW (m3/s)	0.074	0.075	0.076	0.075	0.077	0.079	0.08	0.082	0.081	0.083	0.083	0.076	0.077	0.077	0.078	0.088	0.091	0.122	0.095	0.16	0.091	0.189	0.268	0.268	0.296	0.102	0.268	0.519	0.522	0.525	1.825	0
6129	WPD	QEC	PKFW (m3/s)	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.021	0
6214	WPD	QEC	PKFW (m3/s)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.008	0.008	0.008	0.008	0.009	0.009	0.01	0.009	0.01	0.009	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.031	0
6268	WPD	QEC	PKFW (m3/s)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.026	0
6281	WPD	QEC	PKFW (m3/s)	0.598	0.612	0.825	0.66	0.99	1.531	1.577	1.706	1.669	2.026	2.007	0.672	0.887	0.881	1.083	2.634	2.895	3.224	3.129	3.287	2.918	3.333	3.774	3.783	3.862	3.175	3.804	4.37	4.418	4.481	7.47	0
6313	WPD	QEC	PKFW (m3/s)	0.154	0.2	0.417	0.266	0.512	0.752	0.71	1.414	1.183	1.461	1.462	0.257	0.5	0.433	0.485	2.247	2.439	2.467	2.461	2.471	2.443	2.61	3.074	3.076	3.091	2.463	3.08	3.187	3.209	3.259	8.7	0
6381	WPD	QEC	PKFW (m3/s)	0.013	0.013	0.013	0.013	0.014	0.039	0.05	0.08	0.072	0.1	0.099	0.013	0.013	0.013	0.014	0.196	0.305	0.44	0.414	0.457	0.319	0.474	0.649	0.652	0.68	0.427	0.66	0.922	0.944	0.974	1.587	0
6033	WPD	QEF	PKFW (m3/s)	2.9	2.954	4.076	3.361	4.673	5.66	5.881	6.528	6.306	7.1	7.065	3.469	4.405	4.335	4.807	8.849	9.948	12.4	11.695	12.868	10.141	13.214	17.159	17.237	17.942	12.032	17.427	22.634	23.083	23.696	26.91	1
6152	WPD	QEF	PKFW (m3/s)	0.825	0.827	0.849	0.835	0.867	0.908	0.918	0.947	0.939	0.969	0.967	0.837	0.859	0.857	0.872	1.434	1.825	2.281	2.18	2.35	1.879	2.403	2.886	2.896	2.976	2.23	2.918	3.513	3.562	3.63	3.5	0
6153	WPD	QEF	PKFW (m3/s)	1.418	1.434	1.595	1.495	1.712	1.979	2.049	2.247	2.19	2.386	2.377	1.51	1.658	1.644	1.745	2.894	3.236	3.795	3.65	3.891	3.289	3.963	4.564	4.574	4.665	3.72	4.599	5.281	5.347	5.436	12.95	0
6219	WPD	QEF	PKFW (m3/s)	0.12	0.122	0.142	0.13	0.156	0.189	0.198	0.223	0.216	0.241	0.24	0.131	0.143	0.148	0.16	0.307	0.352	0.421	0.405	0.432	0.359	0.441	0.516	0.517	0.53	0.413	0.521	0.616	0.625	0.636	0.5	0
6269	WPD	QEF	PKFW (m3/s)	0.457	0.472	0.707	0.543	0.856	1.145	1.223	1.501	1.406	1.681	1.667	0.57	0.786	0.772	0.905	2.529	2.961	3.632	3.491	3.723	3.022	3.801	4.673	4.685	4.796	3.561	4.715	5.521	5.593	5.69	9.766	0
6270	WPD	QEF	PKFW (m3/s)	0.511	0.53	0.852	0.644	1.019	1.302	1.445	1.749	1.664	1.921	1.91	0.676	0.942	0.923	1.059	2.388	2.634	2.993	2.906	3.047	2.671	3.087	3.449	3.456	3.517	2.948	3.473	3.92	3.959	4.012	8.836	0
6282	WPD	QEF	PKFW (m3/s)	1.043	1.079	1.362	1.223	1.458	1.991	2.1	2.307	2.248	2.45	2.441	1.257	1.413	1.402	1.494	2.864	3.164	3.641	3.524	3.719	3.21	3.777	4.266	4.275	4.358	3.581	4.298	4.898	4.951	5.023	5.313	0
6331	WPD	QEF	PKFW (m3/s)	0.303	0.311	0.411	0.339	0.508	0.728	0.784	0.924	0.885	1.02	1.014	0.346	0.463	0.452	0.535	1.347	1.625	2.164	2.042	2.243	1.668	2.303	2.768	2.776	2.851	2.101	2.797	3.244	3.279	3.326	5.9	0
6962	WPD	QEF	PKFW (m3/s)	4.848	4.869	5.074	4.949	5.271	6.467	6.713	7.404	7.22	7.842	7.813	4.967	5.154	5.138	5.476	9.56	10.7	12.378	11.997	12.619	10.883	12.797	14.473	14.506	14.825	12.189	14.589	17.172	17.382	17.667	31.2	0
6963	WPD	QEF	PKFW (m3/s)	0.361	0.378	0.448	0.44	0.459	0.478	0.491	0.535	0.522	0.564	0.562	0.441	0.453	0.452	0.461	0.673	0.744	0.85	0.825	0.867	0.755	0.88	0.994	0.997	1.016	0.837	1.002	1.141	1.153	1.17	13.46	0
6964	WPD	QEF	PKFW (m3/s)	0.618	0.642	0.752	0.734	0.783	0.881	0.907	0.981	0.96	1.032	1.029	0.741	0.763	0.759	0.795	1.217	1.34	1.523	1.479	1.552	1.36	1.574	1.77	1.774	1.806	1.501	1.783	2.013	2.033	2.061	23.42	1
6961	WPD	QQC	PKFW (m3/s)	1.327	1.34	1.472	1.39	1.566	2.602	2.82	3.417	3.251	3.811	3.778	1.403	1.522	1.512	1.593	5.058	5.809	6.766	6.525	6.922	5.891	7.04	9.389	9.436	9.744	6.645	9.527	11.53	11.693	11.926	23.45	0

Toronto and Region Conservation Authority

SWI Eval.: Wet Pond Assessment

NHYD	Type	Function	Area (ha)	2 Year 12 Hour AES (Bloor, TRCA)	TI 2yr12hr RCP45 2015-2050	TI 2yr12hr RCP45 2050-2100	TI 2yr12hr RCP85 2015-2050	TI 2yr12hr RCP85 2050-2100	5 Year 12 Hour AES (Bloor, TRCA)	TI 5yr12hr RCP45 2015-2050	TI 5yr12hr RCP45 2050-2100	TI 5yr12hr RCP85 2015-2050	TI 5yr12hr RCP85 2050-2100	10 Year 12 Hour AES (Bloor, TRCA)	TI 10yr12hr RCP45 2015-2050	TI 10yr12hr RCP45 2050-2100	TI 10yr12hr RCP85 2015-2050	TI 10yr12hr RCP85 2050-2100	25 Year 12 Hour AES (Bloor, TRCA)	TI 25yr12hr RCP45 2015-2050	TI 25yr12hr RCP45 2050-2100	TI 25yr12hr RCP85 2015-2050	TI 25yr12hr RCP85 2050-2100	50 Year 12 Hour AES (Bloor, TRCA)	TI 50yr12hr RCP45 2015-2050	TI 50yr12hr RCP45 2050-2100	TI 50yr12hr RCP85 2015-2050	TI 50yr12hr RCP85 2050-2100	100 Year 12 Hour AES (Bloor, TRCA)	TI 100yr12hr RCP45 2015-2050	TI 100yr12hr RCP45 2050-2100	TI 100yr12hr RCP85 2015-2050	TI 100yr12hr RCP85 2050-2100	Max RC Discharge	Online Pond
6471	WPD	Other	PKFW (m3/s)	0.01	0.01	0.01	0.01	0.01	0.011	0.011	0.018	0.011	0.031	0.039	0.05	0.08	0.075	0.099	0.087	0.149	0.226	0.203	0.274	0.122	0.365	0.424	0.416	0.443	0.155	0.551	0.659	0.677	0.648	0.965	0
6472	WPD	Other	PKFW (m3/s)	0.023	0.022	0.023	0.023	0.024	0.027	0.026	0.035	0.032	0.04	0.042	0.047	0.057	0.055	0.064	0.06	0.084	0.102	0.097	0.108	0.073	0.126	0.156	0.154	0.16	0.087	0.19	0.242	0.251	0.237	4	0
6473	WPD	Other	PKFW (m3/s)	0.025	0.025	0.025	0.025	0.026	0.027	0.027	0.028	0.028	0.029	0.029	0.029	0.03	0.03	0.031	0.03	0.032	0.034	0.033	0.034	0.032	0.034	0.034	0.034	0.034	0.033	0.035	0.035	0.035	0.035	0.059	0
6474	WPD	Other	PKFW (m3/s)	0.014	0.013	0.014	0.014	0.014	0.015	0.015	0.016	0.015	0.016	0.016	0.016	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.019	0.019	0.019	0.031	0
6475	WPD	Other	PKFW (m3/s)	0.027	0.027	0.028	0.027	0.028	0.03	0.029	0.03	0.03	0.031	0.031	0.032	0.033	0.032	0.033	0.033	0.035	0.035	0.035	0.035	0.034	0.035	0.036	0.036	0.036	0.035	0.036	0.037	0.037	0.037	0.06	0
6476	WPD	Other	PKFW (m3/s)	0.016	0.016	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.018	0.019	0.019	0.019	0.019	0.03	0
6013	WPD	FLO	PKFW (m3/s)	4.387	4.232	4.582	4.405	4.81	6.896	6.006	9.104	8.267	10.826	11.614	13.406	17.183	16.527	18.651	17.951	22.304	25.7	24.771	26.969	20.191	30.544	35.079	34.824	35.666	22.732	40.279	48.428	49.874	47.535	136.16	0
6158	WPD	FLO	PKFW (m3/s)	0.074	0.071	0.076	0.075	0.076	0.079	0.079	0.081	0.081	0.082	0.083	0.084	0.087	0.087	0.089	0.088	0.095	0.271	0.241	0.269	0.091	0.427	0.533	0.532	0.536	0.102	0.56	0.689	0.699	0.684	1.825	0
6129	WPD	QEC	PKFW (m3/s)	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.021	0
6214	WPD	QEC	PKFW (m3/s)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.01	0.01	0.01	0.009	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.031	0
6268	WPD	QEC	PKFW (m3/s)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.026	0
6281	WPD	QEC	PKFW (m3/s)	0.598	0.54	0.665	0.605	0.85	1.531	1.481	1.664	1.612	1.855	2.007	2.297	2.563	2.517	2.753	2.634	3.124	3.524	3.418	3.682	2.918	4.128	4.65	4.62	4.718	3.175	5.234	6.077	6.23	5.983	7.47	0
6313	WPD	QEC	PKFW (m3/s)	0.154	0.105	0.258	0.201	0.407	0.752	0.682	1.15	0.834	1.478	1.462	1.427	1.984	1.811	2.428	2.247	2.461	3.027	2.899	3.058	2.443	3.14	3.386	3.364	3.437	2.463	3.881	4.372	4.473	4.309	8.7	0
6381	WPD	QEC	PKFW (m3/s)	0.013	0.013	0.013	0.013	0.013	0.039	0.026	0.071	0.059	0.09	0.099	0.122	0.175	0.157	0.239	0.196	0.412	0.543	0.505	0.616	0.319	0.783	1.041	1.032	1.059	0.427	1.16	1.293	1.313	1.281	1.587	0
6033	WPD	QEF	PKFW (m3/s)	2.9	2.639	3.407	2.927	4.132	5.66	5.416	6.281	6.041	6.817	7.065	7.626	8.595	8.436	9.271	8.849	11.657	14.943	13.936	16.348	10.141	20.337	25.27	24.932	25.761	12.032	27.27	27.968	27.918	27.806	26.91	1
6152	WPD	QEF	PKFW (m3/s)	0.825	0.817	0.836	0.826	0.851	0.908	0.897	0.938	0.926	0.958	0.967	0.99	1.342	1.281	1.587	1.434	2.175	2.631	2.506	2.795	1.879	3.25	3.803	3.772	3.873	2.23	4.429	5.421	5.592	5.312	3.5	0
6153	WPD	QEF	PKFW (m3/s)	1.418	1.35	1.502	1.426	1.606	1.979	1.904	2.182	2.104	2.314	2.377	2.523	2.816	2.765	3.026	2.894	3.642	4.259	4.094	4.459	3.289	4.974	5.662	5.622	5.752	3.72	6.324	7.378	7.585	7.261	12.95	0
6219	WPD	QEF	PKFW (m3/s)	0.12	0.112	0.13	0.121	0.143	0.189	0.18	0.215	0.205	0.232	0.24	0.259	0.297	0.29	0.324	0.307	0.404	0.475	0.456	0.501	0.359	0.574	0.665	0.66	0.677	0.413	0.769	0.93	0.959	0.913	0.5	0
6269	WPD	QEF	PKFW (m3/s)	0.457	0.332	0.555	0.464	0.725	1.145	1.073	1.393	1.281	1.59	1.667	1.92	2.406	2.325	2.716	2.529	3.484	4.251	4.008	4.539	3.022	5.169	5.931	5.889	6.026	3.561	6.722	7.882	8.087	7.756	9.766	0
6270	WPD	QEF	PKFW (m3/s)	0.511	0.448	0.658	0.52	0.868	1.302	1.24	1.651	1.532	1.832	1.91	2.069	2.328	2.288	2.487	2.388	2.901	3.252	3.161	3.379	2.671	3.725	4.147	4.123	4.2	2.948	4.621	5.344	5.471	5.265	8.836	0
6282	WPD	QEF	PKFW (m3/s)	1.043	0.884	1.237	1.062	1.371	1.991	1.823	2.239	2.157	2.376	2.441	2.562	2.794	2.75	2.98	2.864	3.517	4.002	3.879	4.171	3.21	4.637	5.193	5.172	5.221	3.581	5.345	5.385	5.44	5.351	5.313	0
6331	WPD	QEF	PKFW (m3/s)	0.303	0.269	0.342	0.307	0.42	0.728	0.659	0.879	0.824	0.971	1.014	1.11	1.298	1.264	1.45	1.347	2.036	2.52	2.404	2.68	1.668	3.062	3.454	3.431	3.506	2.101	3.87	4.475	4.585	4.41	5.9	0
6962	WPD	QEF	PKFW (m3/s)	4.848	4.767	4.957	4.859	5.088	6.467	6.164	7.194	6.922	7.619	7.813	8.256	9.281	9.08	9.998	9.56	11.977	13.541	13.112	14.139	10.883	16.07	18.421	18.283	18.738	12.189	21.171	24.62	25.166	24.297	31.2	0
6963	WPD	QEF	PKFW (m3/s)	0.361	0.281	0.441	0.369	0.449	0.478	0.473	0.52	0.503	0.549	0.562	0.594	0.656	0.645	0.699	0.673	0.824	0.932	0.903	0.972	0.755	1.079	1.213	1.205	1.23	0.837	1.363	1.59	1.631	1.565	13.46	0
6964	WPD	QEF	PKFW (m3/s)	0.618	0.514	0.74	0.629	0.754	0.881	0.854	0.957	0.928	1.006	1.029	1.083	1.189	1.171	1.264	1.217	1.477	1.663	1.613	1.732	1.36	1.913	2.127	2.115	2.153	1.501	2.36	2.706	2.767	2.668	23.42	1
6961	WPD	QQC	PKFW (m3/s)	1.327	1.269	1.396	1.333	1.48	2.602	2.294	3.229	3.005	3.531	3.778	4.205	4.871	4.756	5.384	5.058	6.513	8.145	7.405	8.915	5.891	10.726	12.577	12.46	12.843	6.645	14.994	18.94	19.62	18.46	23.45	0

Toronto and Region Conservation Authority