A comparison of RDIIs calculation Using Different Methods

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Outline

Company History and Current Services

- SCG Flowmetrix Company and
- SCG Flowmetrix Services

RDII Different Calculation Methods

- A brief introduction about RDII and its impacts
- RDII methods in this study
- Data Collection and Event separation
- Summary of Calculations/comparison/ discussion
- Next, R&D ideas

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Company History

- 20 years of Environmental Measurement services
- Solution based
- Acquired by SCG 2018 and FCG 2021 (KKR)

Flowmetrix Technical Services

Sister Companies

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100+ LOCATIONS

42+ UNIQUE BRANDS

175+ SERVICE TECHNICIANS

400+ TECHNICAL SALES REPS

- Advisory
- Asset & Facilities Management
- Automation
- Chemicals
- Contamination Assessment & Remediation
- Data Management Services
- Emergency Response
- Engagement, Communication & Communities
- EPCM
- Food Processing
- Geotechnical
- HSE Systems & Industrial Hygiene
- HVAC
- Hydraulics
- Hydrogeology
- Impact Assessment & Permitting
- Industrial Water & Waste Management
- Information Services
- Integrated Water Management
- Materials Handling
- Materials Technology
- Mining Engineering
- Mining Geosciences
- Natural Resources
- Oil & Gas
- Planning
- Power Delivery
- Power Generation
- Project Management
- Renewable Energy
- Resource Evaluation
- Risk Assessment
- Tailings (Mines & Residue)
- Urban Planning & Land Development
- Waste Management
- Wastewater &Stormwater Collection Systems
- Wastewater treatment & Recycling
- Water & Wastewater Strategy & Planning
- Water Efficiency
- Water Treatment & Desalination

SCG-Flowmetrix Services
Certification of Authorization 100579290

Collection System
- Flow and Rainfall Monitoring
- Capacity and I/I Analyses

Flow Monitoring and I/I

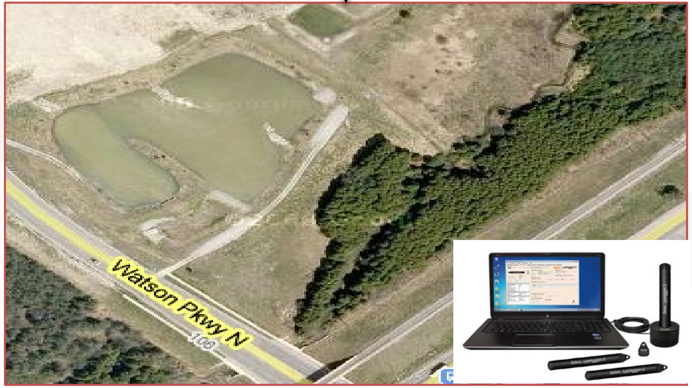
Flood Forecasting

SCG-FMX R&D

SWM Facilities

Data Driven Field Procedure

SWM Ponds and LID Monitoring and Performance Analysis



Water Distribution System
- FFT Test C-Factor Pressure & Flow monitoring
- Pump performance and Rating Curve
- Leak Detection, DMA, and Water Balance
- Meter Calibration flowmeter Inspection and Repair

Infiltration and Inflow (I/I)

What is it?

- Unwanted Water into the System
- Clean storm and groundwater that enters the sewer system

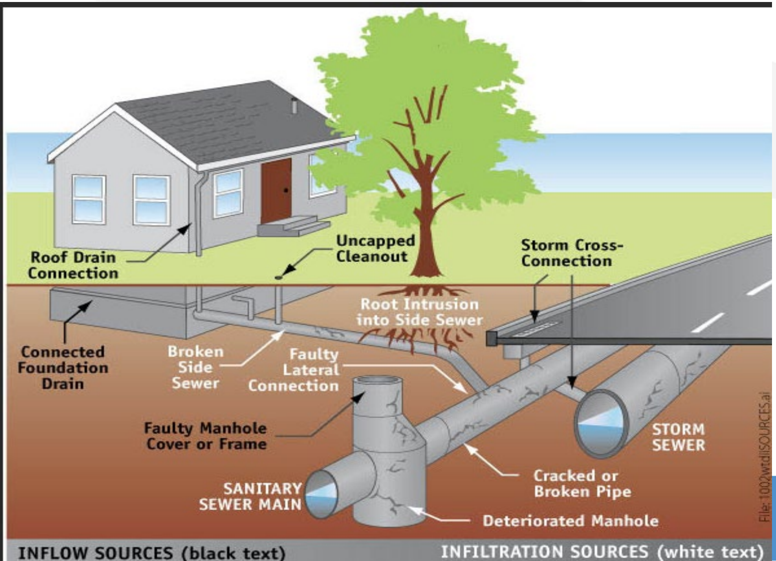
Sources

- Cracked and damaged pipes
- Combined sewers
- Drains from the perimeter where underground water collection systems are placed to collect water
- Leaky manholes

Improperly connected storm pipes and Down spots

Source Detection Methods

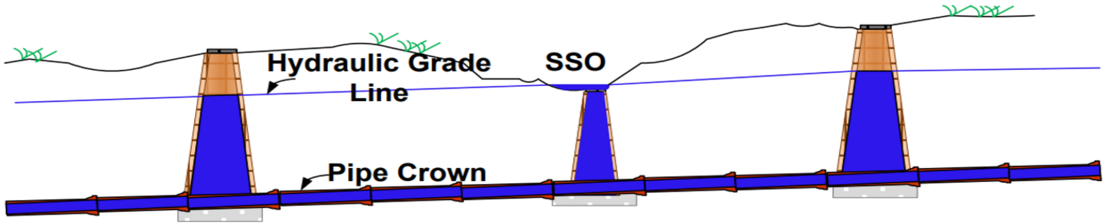
- Dye testing, smoke testing
- CCTV, visual inspection
- Hydrostatic isolation testing,
- Flow measurement- essential for wet weather analysis and capacity analysis; it can also be used to identify the I/I sources before using other techniques to pinpoint the locations.



I & I Impact

- **Overflows in the collection system and basement Flooding**
- **Threatening public health and the environment**
- **Increasing operating costs by unnecessary rainwater processing**

- ***Example: a recent report claims that up to 44% of water sent to treatment plants is unwanted water (I/I) into the system that "causing the City of London, Ontario about $1.4-million a year while adding to the risk of basement flooding" (CBC News, 2021).***



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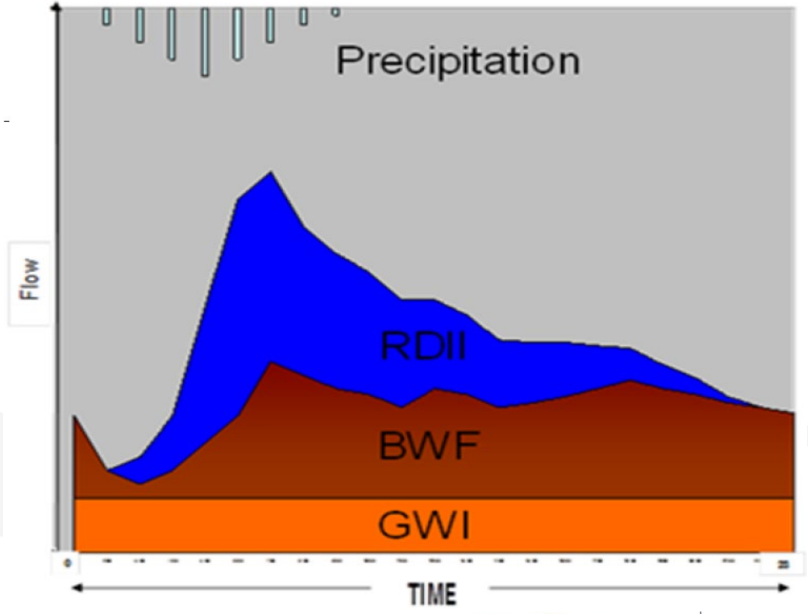
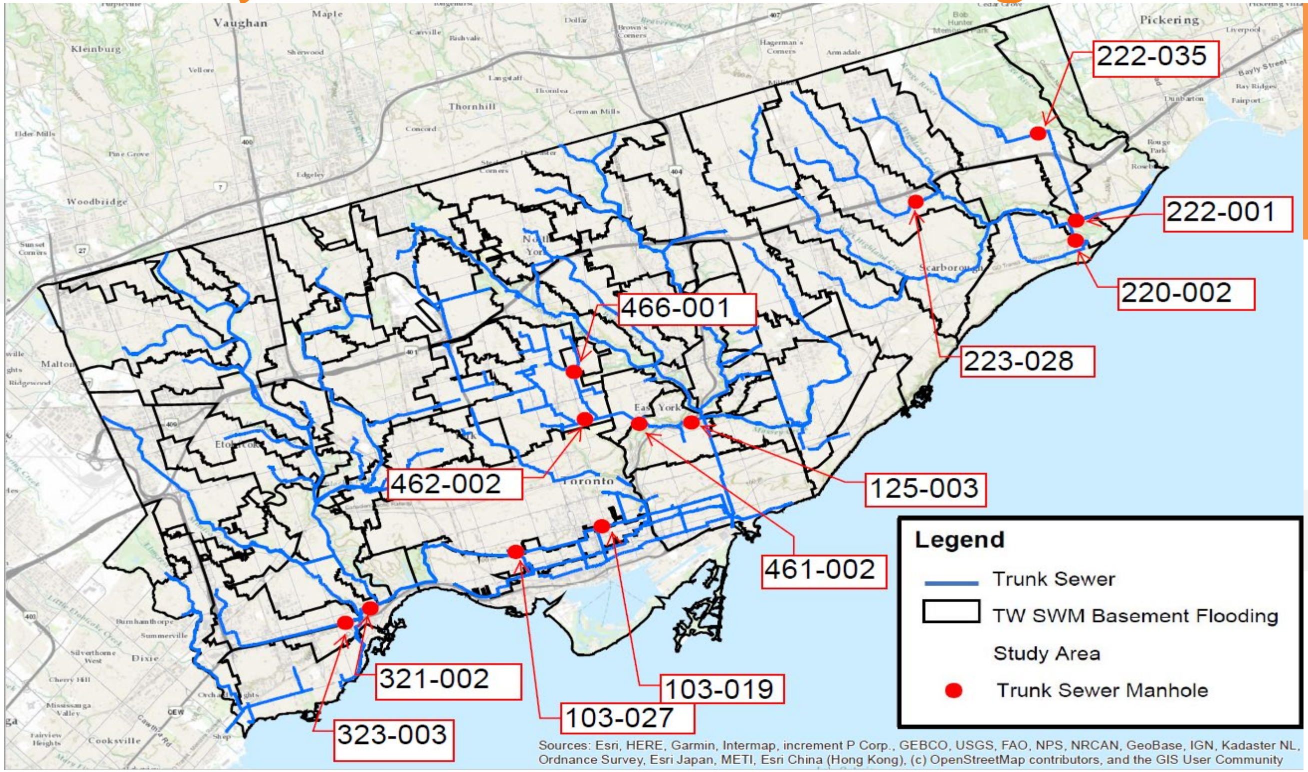
RDII Prediction Methods

- Rainfall/sewer flow regression method
- Percentage of rainfall volume method (AKA Envelope Method)
- SUH method (AKA RTK Method)
- Constant Unit Rate Method
- Percentage of streamflow method
- Probabilistic method
- Synthetic streamflow regression method



Data Collection
Sanitary Sewer Flow Monitoring Locations - CoT



- 12 Sites
- Drainage Areas 460 m^2 to 9092 m^2

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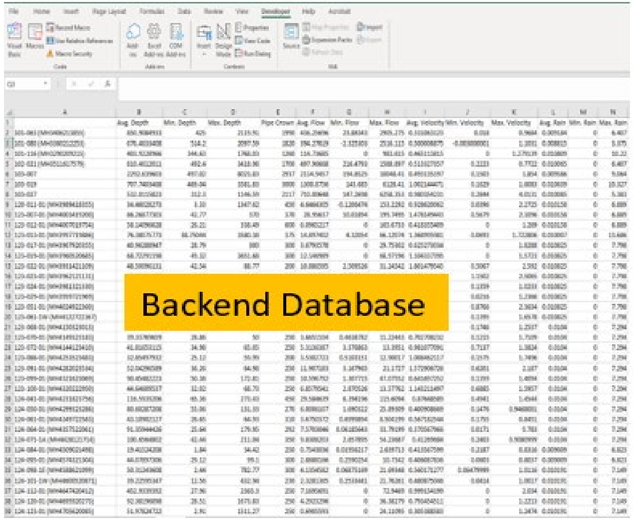
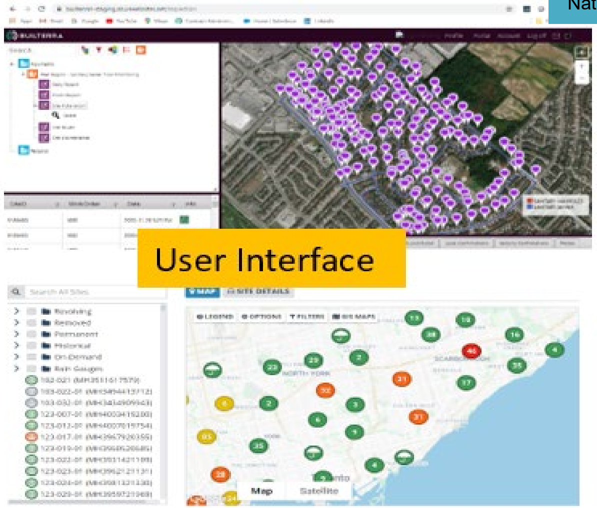
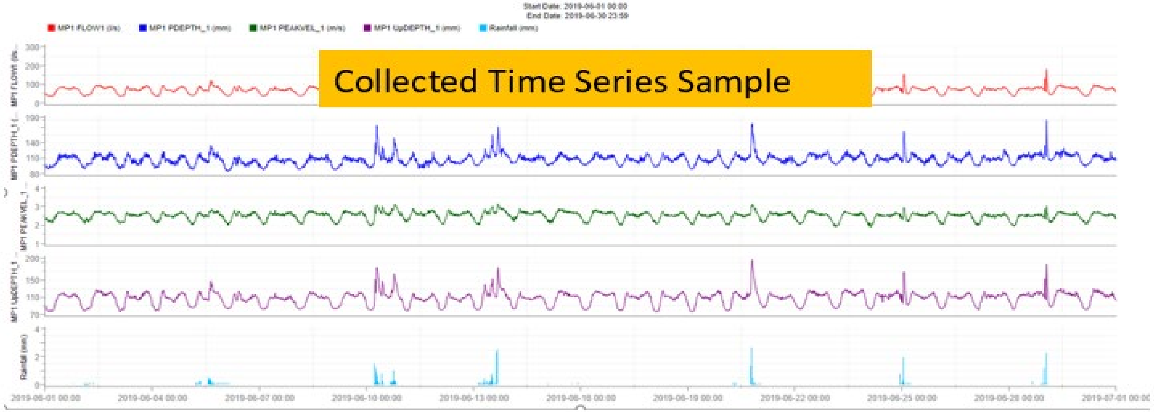
Workflow







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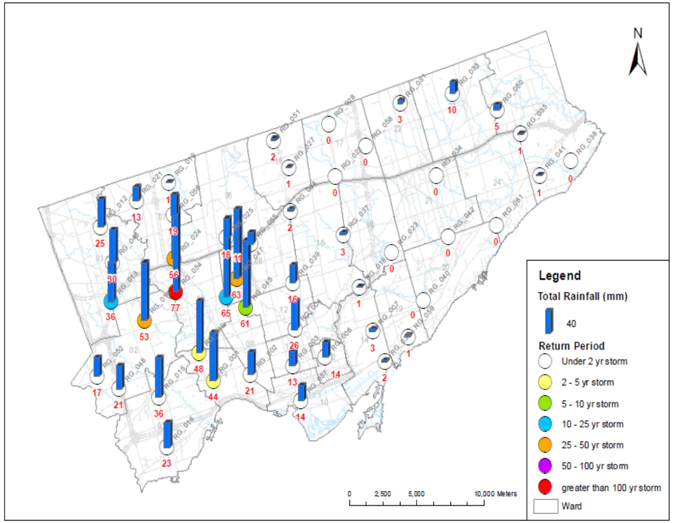
Events Separation Based on Toronto Criteria

- Number of Separated Events: 68 to 107
- Over 1000 RDII Analysis

July 08, 2020 STORM EVENT - RAINFALL DATA

The rain event started Jul 08, 2020 at 3:00 AM and ended on Jul 08, 2020 at 6:00 PM EST



Site Name	Number of Events	Rainfall (mm)		Max Flow During the Event (l/s)	
		Min	Max	Min	Max
103-019	68	9.99	31.93	2197	6851
103-027	87	9.99	90.17	1514	7203
125-003	102	10.01	52.32	1112	2783
220-002	104	10.01	49.28	1988	4643
222-001	104	10.00	27.91	415	1043
222-035	93	10.00	38.10	231	478
223-028	86	10.00	38.10	360	682
321-002	92	10.00	44.03	609	2069
323-003	90	10.00	40.66	171	876
461-002	102	10.01	52.32	118	4458
462-002	100	10.02	49.28	610	7188
466-001	107	10.04	49.28	63	2767

Rainfall/Sewer Flow Regression Method

Components To Examine

- Dry weather flow
- Domestic flow
- Stormwater inflow

I & I

- Infiltration = 85% minimum dry weather flow (2:00 am – 6:00 am)
- Inflow = peak flow during the event – dry flow at the specific time of measured peak flow
- Most Inflow originates from stormwater, and most Infiltration derives from groundwater.

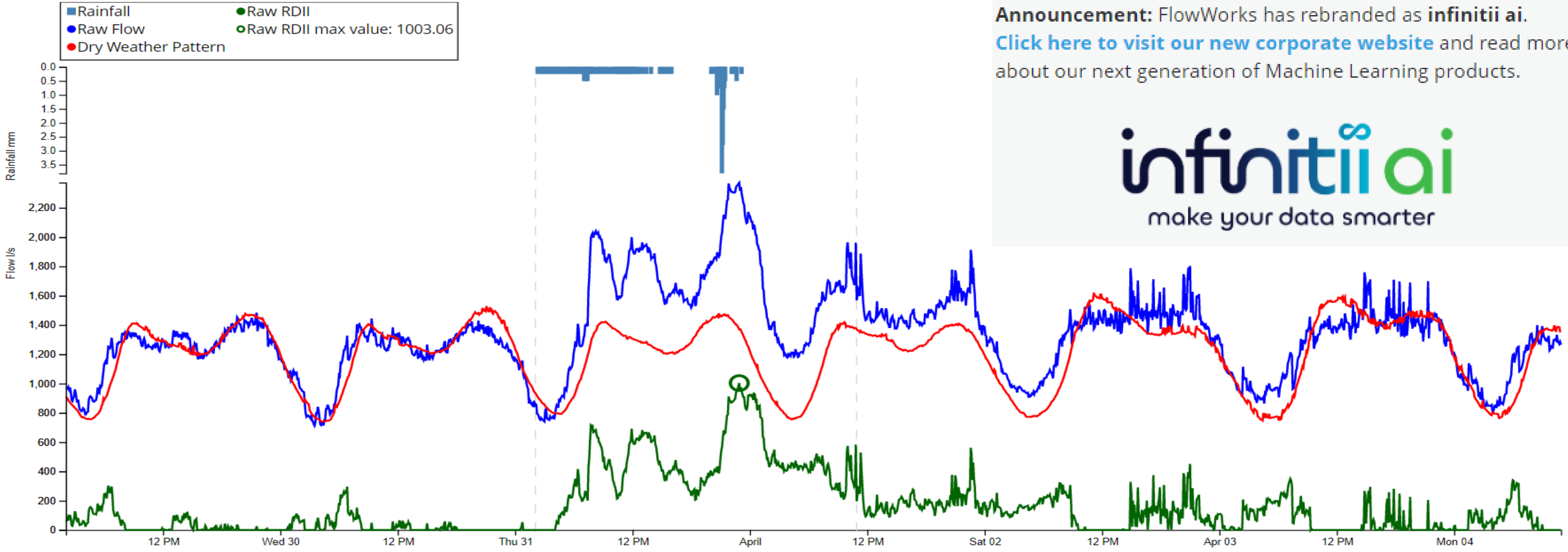
Steps

- Separate DWF (7+ days with no rain)
- Separate Rainfall Events
- Max Flow During the Events
- Time of Max Flow
- Typical DWF @ Times
- Calculate Inflow (Max flow – typical DWF)
- Infiltration = 85% of Min DWF
- I & I = Infiltration + Inflow

Typical DWF @ Times	
Time of the Day	Average Flow (l/s)
12 AM	4.62
1 AM	4.27
2 AM	3.60
3 AM	3.36
4 AM	3.66
5 AM	4.72
6 AM	5.92
7 AM	9.71
8 AM	9.30
9 AM	10.19
10 AM	10.19
11 AM	9.55
12 PM	9.24
1 PM	9.22
2 PM	8.80
3 PM	7.96
4 PM	8.01
5 PM	8.68
6 PM	9.10
7 PM	8.81
8 PM	8.49
9 PM	8.20
10 PM	6.88
11 PM	5.44

								Infiltratior	3.210	53.74
Event	Total Precipitation (mm)	Start	End	Duration (hr)	Max Flow During the event (L/s)	Time of Max Flow	Typical dry Weather peak flow @ time of Max Flow (L/s)	Inflow (L/s)	I&I (L/s)	I&I (L/s/ha)
1	36.03	2018-07-16 12:55	2018-07-16 15:40	6.9	14.37	2018-07-16 13:35	9.22	5.15	8.357	0.156
2	20.19	2018-07-22 2:45	2018-07-22 12:35	24.6	14.32	2018-07-22 7:35	9.71	4.61	7.824	0.146
3	28.65	2018-08-06 14:05	2018-08-06 15:35	3.7	10.23	2018-08-06 14:35	8.80	1.44	4.646	0.086
4	30.41	2018-08-17 4:10	2018-08-17 20:00	39.6	12.21	2018-08-17 6:45	5.92	6.29	9.498	0.177
5	37.45	2018-08-21 7:05	2018-08-21 17:55	27.1	22.82	2018-08-21 9:35	10.19	12.63	15.841	0.295

Volume or Envelope Method



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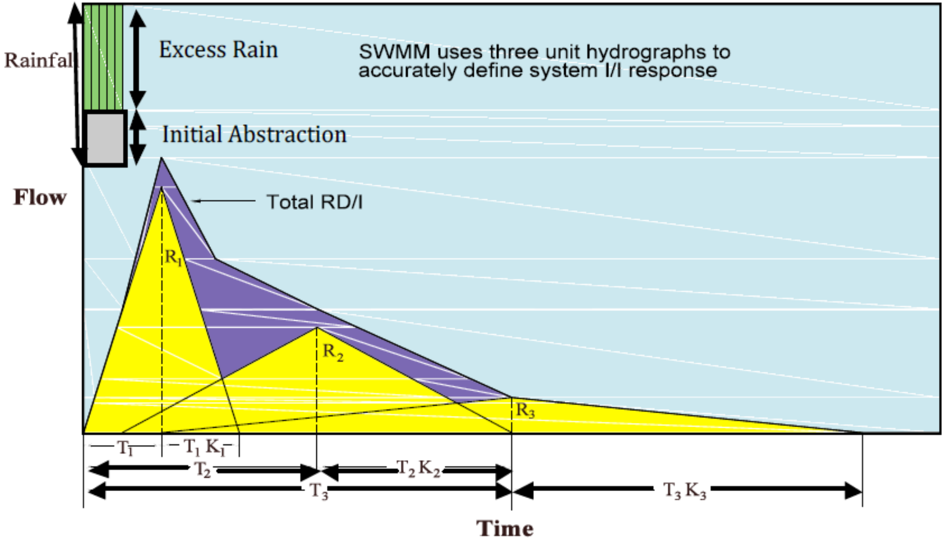
SUH Method (RTK Method)

- Three Unit Hydrographs (fast, medium and slow responses)
- R is a fraction of Rainfall volume (runoff) entering the sewer systems as RDII during and immediately after the rainfall events, which is a function of the level and size of structure defects
- T is Time to peak
- K is Ratio of the time of recession to T
- T.D – Control the hydrograph shape; represent RDII response time, the function of sewershed and collection system dimensions.



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SUMMARY OF CALCULATED RDIIs

Site Name	RDII (l/s) Envelope Method			RDII (l/s) Regression Method			RDII (l/s) SUH Method		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
103-019	1221.55	5965.17	3573.99	1642.94	6829.78	4309.57	1647.90	5138.10	3530.59
103-027	217.32	6289.11	2591.20	407.69	6680.31	3016.20	746.55	5402.03	2528.70
125-003	169.38	2318.41	1603.51	707.02	2530.57	2014.34	834.08	2087.10	1728.50
220-002	309.09	2600.18	1055.11	1252.01	3914.65	2275.86	1490.70	3482.18	2240.89
222-001	109.32	730.49	216.64	206.78	839.51	333.87	311.18	782.40	402.45
222-035	35.31	257.57	93.54	80.33	340.67	152.82	173.18	358.73	217.59
223-028	36.21	325.52	140.62	139.90	469.23	252.78	269.70	511.58	348.07
321-002	124.26	1528.07	620.32	300.15	1842.46	825.78	457.05	1551.96	809.70
323-003	29.65	691.91	169.04	72.34	776.37	237.66	127.89	656.63	236.19
461-002	25.12	4279.00	1172.32	89.70	4439.01	1245.35	88.65	3343.20	953.40
462-002	228.51	6708.27	1747.28	355.50	6954.67	2032.98	457.33	5391.06	1668.07
466-001	42.26	2685.18	376.21	48.28	2750.86	397.18	47.60	2075.25	308.75
Average	212.33	2864.91	**1113.32**	441.89	3197.34	**1424.53**	554.32	2565.02	**1247.74**

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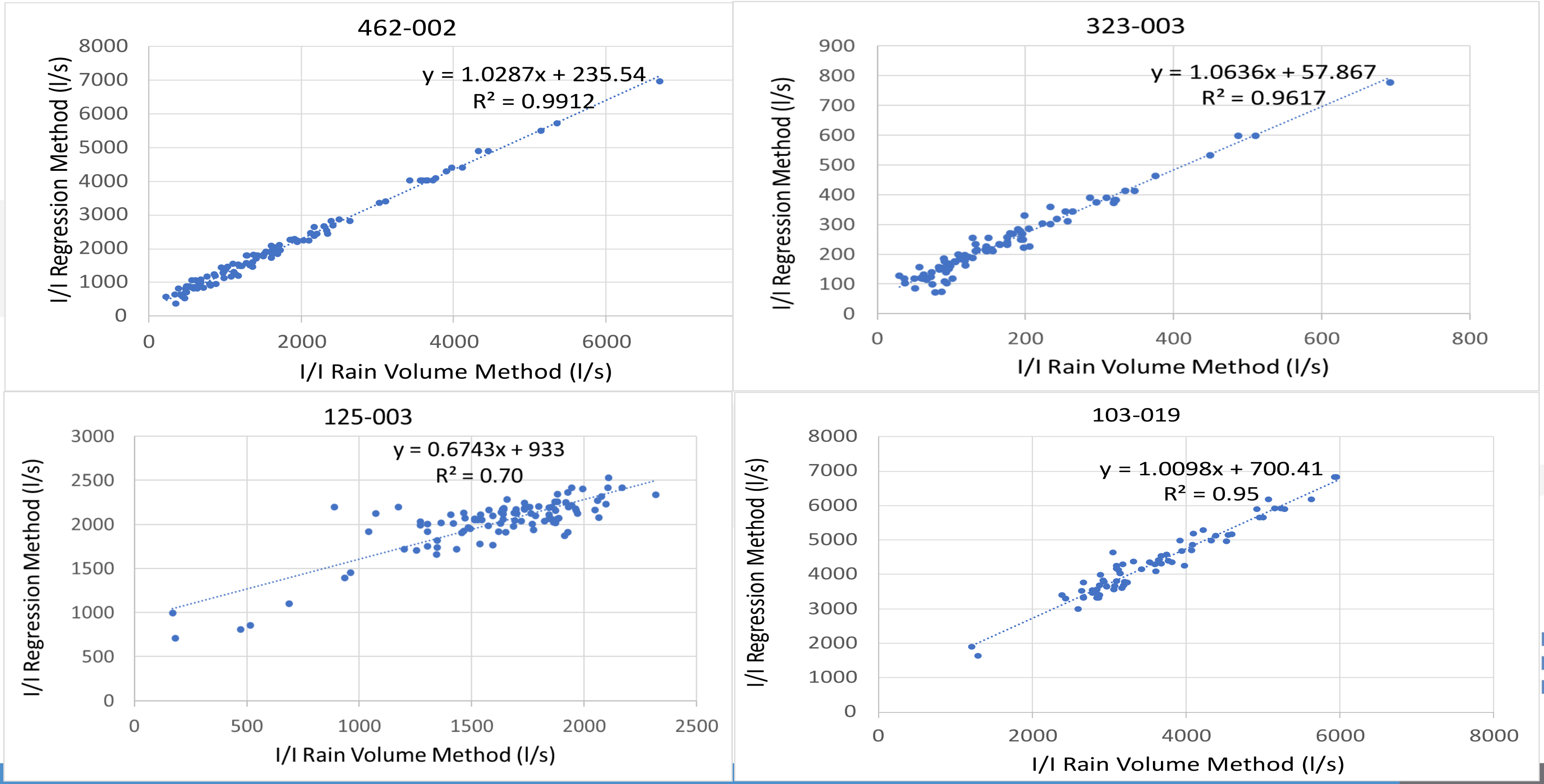
Avg Difference of Envelope and SUH from regression method 22% and 12% for the examined data.

Volume Method Vs Regression Method



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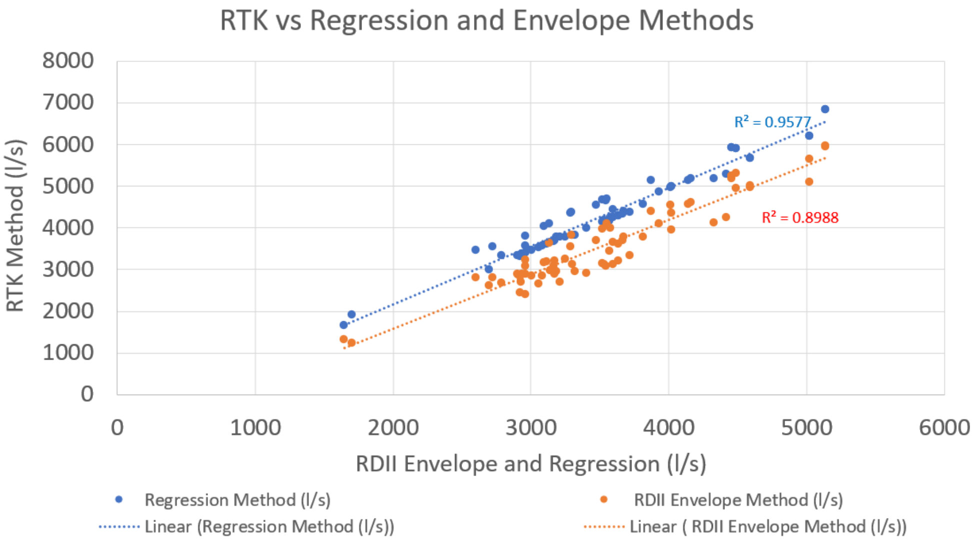
RTK vs Regression and Envelope Methods

RTK correlation with Regression and Envelope

Site	R^2 (Regression)	R^2 (Envelope)
103-019	0.9577	0.8988
103-027	0.9057	0.7074
125-003	0.8838	0.5468
220-002	0.9872	0.6435
222-001	0.9419	0.7257
222-035	0.9399	0.6353
223-028	0.7896	0.5906
321-002	0.9553	0.8512
323-003	0.9587	0.9197
461-002	0.9999	0.9984
462-002	0.9956	0.9882
466-001	0.9995	0.9988

Site 103-019

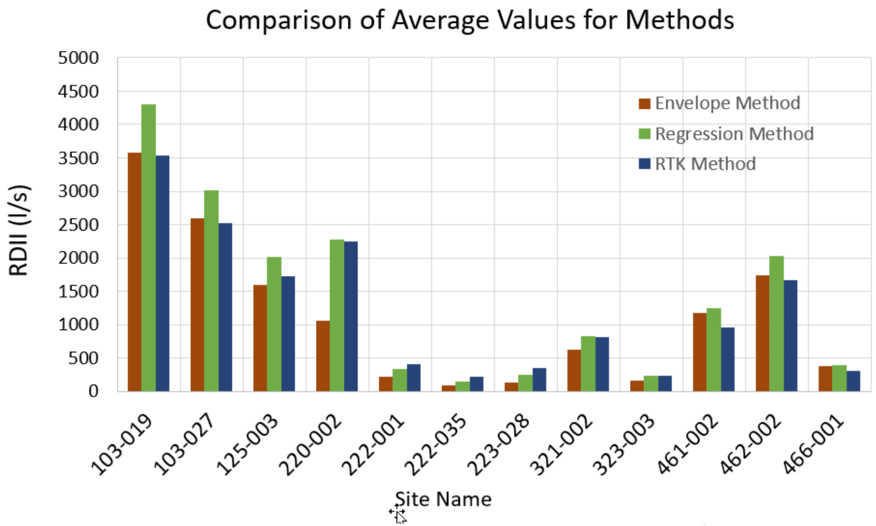


Result and Discussion

Result

- The estimated RDII using the three methods are highly correlated with each other. R squares are varied in a range of 0.60 to 0.999.
- The current study shows that the regression model provides a more conservative result than the two other methods.

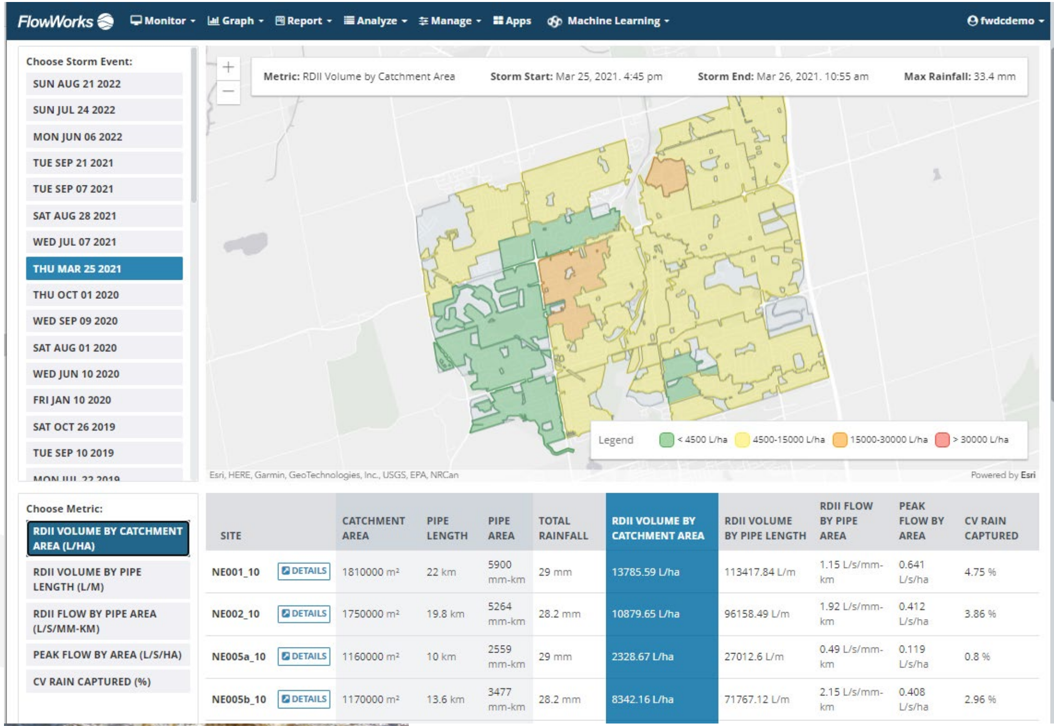
Comparison of Average Values



SCG-FMX R & D

Next

- FlowWroks FACE PRO I/I prediction Tool result comparison with other methods
- Is there any meaningful statistical difference?
- Comparison of the normalized RDII (l/s/ha) with acceptable RDII required in guidelines, e.g., 0.26 l/s/ha
- Real-time RDII as a flood forecasting and surcharge prediction tool
- RDII and Sanitary Sewer Network Pipes Characteristics WEAO 2023
- Flood forecasting using changes in Flow pattern WEAO 2023



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THANK YOU!

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