ADF Fusion Web Application Development:

A Study Based on Hydrometric and Climate Stations in the Grand River Drainage Basin

David Pan

University of Waterloo

# Index

Purpose/Value Proposition
Data model2
FME Workbench & ETL
Tutorial Queries and Results: Sub-Queries and Views
Application
Techniques for Improvements11
Brief Summary of Application11
Appendix12

### **Purpose and Value Proposition**

The purpose of this application is to provide an interactive interface to assist users in observing climate and hydrometric reading and station data from geographic, table and graph views, with the goals of research and data analysis. The scope of this application is limited to the Grand River Drainage Basin. People can find helpful information and statistics to stay informed about the watershed, and navigate through station and reading data quickly and efficiently through tabs and panel splitters.

# REAL YEAL MON DAY MAX MINT MEAL PRES READ YEAP MON DAY TIME TEMI DEW YEAR MONTH MEAN\_N MEAN\_T EXTR\_N EXTR\_N TOT\_PE READI YEAR MONT DAY TIME TEMP DEW\_ MEAN MEAN MEAN MEAN EXTR EXTR READING\_D YEAR MONTH DAY MAXTEMPC MEANTEMPC MEANTEMPC PRECIP\_MM PRO CLIN STAT DATEMIN DATEMA HACCMM HACCMA MAP\_SEL MAP\_SEL DATEMI DATEMA HACCIM HACCIM CA\_DSC CA\_DSC CA\_DSC CA\_DSC MAP\_SI MAP\_SI MAP\_SI PEATURE DATEMA DATEMA HACCME HACCMA MAP\_SEE MAP\_SEE DATEMAN DATEMAN DATEMAN HACCMIN HACCMIN HACCMAN DSC\_EN DSC\_EN DSC\_FR MAP\_SEL MAP\_SEL\_EN MAP\_SEL\_FR GEOM C\_U E\_U\_EN E\_U\_FR E\_USYM E\_USYM E\_USYM MAP\_S MAP\_S GEOM DATEMIN DATEMIN HACCMIN HACCMIN HACCMIN HACCMIN DSC\_EN DSC\_EN DSC\_FR MAP\_SEI MAP\_SEI GPDM Torthese, D DATEMAK, D DATEMAK, D DATEMAK, D DATEMAK, D PERM, PR P TRATEMINE DATEMINE HACCIMAN HACCIMAN HACCIMAN PETMI HACCIMAN SHORELY PETMI HACCIMAN DATEMUX DATEMU DATEMA HACCMM HACCMM PERM F PERM F PERM F PROFET PR DATEMIN DATEMIN HACCIMIN HACCIMIN HACCIMIN HACCIMIN HACCIMIN E\_PTDSCB EPTDSCB EPTDSCB EPTDSCB E\_UT E\_US E\_U E\_US MAP\_SEL MAP\_SEL MAP\_SEL

# Data Model

	Insert points at index	Climate and Hydrometric Stations	OUDDER Grand River Drainage Basin		
CDN_Climate_Stations	VertexCreator				Candbase data
-	Cutput     Kitelested >	CLL_STATIONS	> contour_1		
B GRDB_climate (0)	VertexCreator_3 (3)		elevation_point_0		UPPER_ELEVATION_POINT
	(P Output	GRDB_CLIMATE (			
GRDB_combined () VetexCreator_S ()	► KRijeted>		() watercourse_1 ⊙		
Cutput			> waterbody_2		UPPER_WATERBODY
Conterned in the	using longitude and latitude of the tables for points		wooded_area_2		UPPER_WOODED_AREA
HydroMetStns_1948_2016	WertexCreator 2		residential_area_2		UPPER_RESIDENTIAL
19 19 19 19 19 19 19 19 19 19 19 19 19 1	P Output	HYD_STATIONS	The road_segment_1		UPPER_RDAD_SEGMENT
	► «Rejected»				POPPER_NOND_SEGMENT
GRDB_hydro	WestexCreator_4		commercial_institution_area_2		UPPER_COM_INST_AREA
	Cutput     Asjected>		munidpa_boundary_2 ⊙	Reprotection	UPPER_MUNICIPAL_BOUND
			GR_Watershed_Boundary	Reprojector	
CELORA RCS	Cate and Datetime Formatting			( Reprojected	GRAND_RIVER_DRAINAGE_BASIN
I elorarcs_dimate_hourly	DateFormatter (6)	Climate and Hydrometric Readings		Reproject to the same coordinate	
	Dutput	ELORARCS_CLIMATE_HOURLY	h	system as the rest to allow spatial	
ebrarcs_dimate_dally	DateFormatter_2		Lower Grand River Drainage Basin	quefes such as sdo_nn	
	() Output	ELORARCS_CLIMATE_DAILY	> contour_1		LOWER_CONTOLR
>> elorarcs_dim ate_monthly	DateFormatter_3	ELORARCS_CLIMATE_MONTHLY	evation_point_0		LOWER_ELEVATION_POINT
BRANTFORD AIRPORT	DateFormatter 5 (3)				
BRANTFORD AIRPORT	Date-ormatie_s	BRANTFORDAIR_CLIMATE_HOURLY	wetercourse_1		LOWER_WATERCOURSE
b brantford_airport_dimate_hourly	DateFormatter_6		waterbody_2		LOWER_WATERBODY
	() Output	BRANTFORDAIR_CLIMATE_DAILY			
brantford_airport_climate_daily	DateFormatter_7		wooded_area_2		DOWER_WOODED_AREA
brantford_sirport_climate_monthly	Dutput	BRANTFORDAIR_CLIMATE_MONTHLY			LOWER_RESIDENTIAL
	Format time/datetime to a				LOWER_ROAD_SEGMENT
	standardized format		mad_segment_1		
conestogoriver_stjacobs_hydreadings	DateFormatter_4		> commercial_institution_area_2		LOWER_COM_INST_AREA
	Dutput	CONESTOGORIVER_HYDREADENGS			
pranditiverat_brantford_hydreadings	DateFormatter_8	BRANTFORD_HYDREADINGS	Implement provide the second seco		LOWER_MUNICIPAL_BOUND
	(= cupit	P BAR PORD_AT DREADINGS			

### FME Workbench & ETL process

Tutorial Queries and Results: Appendix C: Sub-Queries and Views

### A. Rework the query using a subquery to get the expected result set:

select a.station\_number, a.station\_name, a.longitude, a.latitude, b.sample\_datetime as hyd\_date, d.reading datetime as cli date, b.water level M,b.discharge m3persec, d.temp c

from hyd stations a, conestogoriver hydreadings b, cli stations c, elorarcs climate hourly d

where a.station\_number= '02GA006' and c.climate\_id= '6142286' and b.sample\_datetime= d.reading\_datetime;

STATION_NUMBER	STATION_NAME		IATITUDE IN HYD_DATE		CLI_DATE	WATER_LEVEL_M	DISCHARGE_M3PERSEC	TEMP_C
1 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 16-Aug-16	23.00	16-Aug-16 23.00	0.371	5.411	16.3
2 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	00.00	17-Aug-16 00.00	0.367	5.304	15.3
3 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	01.00	17-Aug-16 01.00	0.364	5.224	14.8
4 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	02.00	17-Aug-16 02.00	0.362	5.171	14.3
5 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	03.00	17-Aug-16 03.00	0.363	5.198	13.8
6 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	04.00	17-Aug-16 04.00	0.364	5.224	(null)
7 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	05.00	17-Aug-16 05.00	0.366	5.277	(null)
8 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	06.00	17-Aug-16 06.00	0.364	5.224	(null)
9 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	07.00	17-Aug-16 07.00	0.363	5.198	(null)
10 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	08.00	17-Aug-16 08.00	0.36	5.119	15.8
11 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	09.00	17-Aug-16 09.00	0.356	5.014	18.4
12 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	10.00	17-Aug-16 10.00	0.356	5.014	21.5
13 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	11.00	17-Aug-16 11.00	0.356	5.014	23.5
14 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	12.00	17-Aug-16 12.00	0.355	4.988	24.8
15 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	13.00	17-Aug-16 13.00	0.355	4.988	25.3
16 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	14.00	17-Aug-16 14.00	0.354	4.962	25.7
17 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111 17-Aug-16	15.00	17-Aug-16 15.00	0.353	4.936	25.4

### Incorporate a SDO\_NN subquery to first determine nearest climate station:

create view view 1 as

select a.station\_number, a.station\_name as hyd\_stn, a.longitude, a.latitude, b.sample\_datetime as hyd\_date, c.name as nearest\_climate\_station, d.reading\_datetime as cli\_date, b.water level M,b.discharge m3persec, d.temp c

from grdb\_hydro a, conestogoriver\_hydreadings b, grdb\_climate c, elorarcs\_climate\_hourly d

where sdo\_nn(c.geom, a.geom,'sdo\_batch\_size=10 sdo\_num\_res=1') = 'TRUE' and a.station\_number= '02GA006' and c.climate\_id= '6142286' and b.sample\_datetime= d.reading\_datetime;

cript Output × 🕨 Query	Result ×								
📇 🝓 🎭 SQL   Fetc	hed 50 rows in 0.059 seconds								
STATION_NUMBER	♦ HYD_STN		LATITUDE	HYD_DATE	INEAREST_CLIMATE_STATION	CLI_DATE	WATER_LEVEL_M	DISCHARGE_M3PERSEC	TEMP_C
1 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	16-Aug-16 23.00	ELORA RCS	16-Aug-16 23.00	0.371	5.411	16.3
2 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 00.00	ELORA RCS	17-Aug-16 00.00	0.367	5.304	15.3
3 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 01.00	ELORA RCS	17-Aug-16 01.00	0.364	5.224	14.8
4 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 02.00	ELORA RCS	17-Aug-16 02.00	0.362	5.171	14.3
5 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 03.00	ELORA RCS	17-Aug-16 03.00	0.363	5.198	13.8
6 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 04.00	ELORA RCS	17-Aug-16 04.00	0.364	5.224	(null)
7 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 05.00	ELORA RCS	17-Aug-16 05.00	0.366	5.277	(null)
8 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 06.00	ELORA RCS	17-Aug-16 06.00	0.364	5.224	(null)
9 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 07.00	ELORA RCS	17-Aug-16 07.00	0.363	5.198	(null)
10 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 08.00	ELORA RCS	17-Aug-16 08.00	0.36	5.119	15.8
11 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 09.00	ELORA RCS	17-Aug-16 09.00	0.356	5.014	18.4
12 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 10.00	ELORA RCS	17-Aug-16 10.00	0.356	5.014	21.5
13 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 11.00	ELORA RCS	17-Aug-16 11.00	0.356	5.014	23.5
14 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 12.00	ELORA RCS	17-Aug-16 12.00	0.355	4.988	24.8
15 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 13.00	ELORA RCS	17-Aug-16 13.00	0.355	4.988	25.3
16 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 14.00	ELORA RCS	17-Aug-16 14.00	0.354	4.962	25.7
17 02GA006	CONESTOGO RIVER AT ST. JACOBS	-80.55333	43.54111	17-Aug-16 15.00	ELORA RCS	17-Aug-16 15.00	0.353	4.936	25.4

# **B.** (one single query)

create view view\_2 as

select a.station\_number as hyd\_id, b.climate\_id,

(select round(sum(discharge\_m3persec/97),3) from conestogoriver\_hydreadings) as avg\_daily\_discharge,

(select round(sum(water\_level\_m/97), 3) from conestogoriver\_hydreadings) as avg\_daily\_waterlevel,

(select round(sum(discharge\_m3persec),3) from conestogoriver\_hydreadings) as tot daily discharge,

(select round(max(water\_level\_m), 3) from conestogoriver\_hydreadings) as max\_water\_hourly,

(select a.sample\_datetime from conestogoriver\_hydreadings a, elorarcs\_climate\_hourly b

where water\_level\_m=(select max(water\_level\_m) from conestogoriver\_hydreadings) and rownum=1 and a.sample\_datetime= b.reading\_datetime) as time\_event1,

c.discharge\_m3persec as discharge,

(select min(water\_level\_m) from conestogoriver\_hydreadings) as min\_waterlevel,

(select a.sample\_datetime from conestogoriver\_hydreadings a, elorarcs\_climate\_hourly b

where water\_level\_m=(select min(water\_level\_m) from conestogoriver\_hydreadings) and rownum=1 and a.sample\_datetime= b.reading\_datetime) as time\_event2,

d.meantempc as avg\_daily\_temp,

(select max(temp\_c) from elorarcs\_climate\_hourly) as max\_temp\_hourly,

(select reading\_datetime from elorarcs\_climate\_hourly where temp\_c=(select max(temp\_c) from elorarcs\_climate\_hourly)) as time\_event3,

(select min(temp\_c) from elorarcs\_climate\_hourly) as min\_temp\_hourly,

(select reading\_datetime from elorarcs\_climate\_hourly where temp\_c=(select min(temp\_c) from elorarcs\_climate\_hourly)) as time\_event4

from grdb\_hydro a, grdb\_climate b, conestogoriver\_hydreadings c, elorarcs\_climate\_daily d, elorarcs\_climate\_hourly e

where e.reading\_datetime= c.sample\_datetime

and e.climate id = b.climate id

and c.station number=a.station number

and a.station number='02GA006'

and b.climate id ='6142286'

order by e.reading\_datetime, b.climate\_id asc;

cript Output X	Query Resi	ult ×												
: 🙀 🚳 昌	SQL   Fetched S	0 rows in 0.504 second	s											
∯ HYD_ID	CLIMATE_ID	AVG_DAILY_DISC	AVG_DAILY_WATER	TOT_DAILY_DISCHARGE	MAX_WATER	TIME_EVENT	DISCHARGE	MIN_WATERLEVEL	TIME_EVENT_1	AVG_DAILY_TEMP	@ MAX_TEMP_HOURLY	TIME_EVENT_2	MIN_TEMP_HOURLY	TIME_EVENT_3
1 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-7.8	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
2 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-11	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
3 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-8.4	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
4 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-10.6	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
5 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-2.2	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
6 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	2.6	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
7 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	(null)	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
8 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-3.4	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
9 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-5.6	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
10 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-12.2	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
11 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-14.4	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
12 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-5.3	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
13 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-3.6	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
14 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	-3.9	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
15 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	9.3	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
16 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	14.6	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00
17 02GA006	6142286	289.148	25.015	28047.374	0.489	13-Aug-16 21.00	3.997	0.183	28-Sep-16 20.00	13.1	31.5	10-Aug-16 15.00	-4.4	26-Oct-16 06.00

# C. Retrieve all the active hydrometric and climate stations (and all their data) within the Grand River Drainage Basin:

select a.\*, b.\* from hyd stations a, cli stations b, grand river drainage basin c

where c.ws type='WATERSHED'

and sdo inside(a.geom, c.geom)= 'TRUE' and a.status='A'

and sdo inside(b.geom, c.geom)= 'TRUE' and b.last year='2016' and b.name is not null;

STATION_NUMBER	STATION_NAME	PROVINCE	STATUS	LATITUDE	LONGITUDE	YEAR_FROM	YEAR_TO	DRAINAGE_AREA	SEDIMENT	RHBN	REAL_TIME	DATUM_NAME	GEOM	NAME	PROVINCE_1	CLIMATE_ID
02GA041	GRAND RIVER NEAR DUNDALK	ON	A	44.14003	-80.3627	1984	2016	66.491	N I	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA031	BLUE SPRINGS CREEK NEAR EDEN MILLS	ON	А	43.57614	-80.109	1965	2016	41.5	Y I	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA023	CANAGAGIGUE CREEK NEAR ELMIRA	ON	А	43.57992	-80.50919	1956	2016	114.06	Y I	N	N	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA034	GRAND RIVER AT WEST MONTROSE	ON	A	43.58503	-80.48147	1967	2016	11701	N 1	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA049	SMITH CREEK NEAR NEWTON	ON	A	43.59637	-80.89428	2015	2016	71.61	N 1	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA040	SPEED RIVER NEAR ARMSTRONG MILLS	ON	A	43.63861	-80.27	1973	2016	167	Y I	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA028	CONESTOGO RIVER AT GLEN ALLAN	ON	A	43.65483	-80.70217	1959	2016	571.131	N I	N	N	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA005	IRVINE RIVER NEAR SALEM	ON	А	43.6936	-80.44531	1913	2016	168.331	N 1	N	N	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA016	GRAND RIVER BELOW SHAND DAM	ON	А	43.73094	-80.34094	1950	2016	784.761	9 D	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA039	CONESTOGO RIVER ABOVE DRAYTON	ON	А	43.78353	-80.63778	1973	2016	274.71	Y I	N	N	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA042	MOOREFIELD CREEK NEAR ROTHSAY	ON	A	43.823	-80.71786	1989	2016	60.381	9 I	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GA014	GRAND RIVER NEAR MARSVILLE	ON	A	43.86172	-80.27222	1947	2016	663.01	Y I	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GB010	MCKENZIE CREEK NEAR CALEDONIA	ON	A	43.03394	-79.94981	1961	2016	172.78	Y I	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GB007	FAIRCHILD CREEK NEAR BRANTFORD	ON	A	43.14739	-80.15461	1964	2016	388.64	Y I	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GB008	WHITEMANS CREEK NEAR MOUNT VERNON	ON	А	43.12625	-80.38372	1961	2016	385.861	N 1	N	Y	ASSUMED DATUM	[MDSYS.SDO_GEOMETRY]	ROSEVILLE	ONTARIO	6147188
02GB001	GRAND RIVER AT BRANTFORD	ON	А	43.13272	-80.26731	1912	2016	5200.52	Y I	N	Y	ASSUMED DATUM	[MDSYS.SDO GEOMETRY]	ROSEVILLE	ONTARIO	6147188

# Watershed Calculations

### -- Area of the Grand River Drainage Basin in km<sup>2</sup>

select ws\_type, round(sdo\_geom.sdo\_area(geom, 0.05, 'unit=sq\_km'),2) as area from grand\_river\_drainage\_basin where ws\_type= 'WATERSHED';

	WS_TYPE	🕸 AREA
1	WATERSHED	6803.62

### -- Elevation drop from river head to Lake Erie

select ((select max(E) from upper\_elevation\_point) - (select min(E) from lower\_elevation\_point)) as elevation\_drop\_m from upper\_elevation\_point,

lower\_elevation\_point where rownum=1;

	ELEVATION_DROP_M
1	360

### -- Number of kilometers of river, how many tributaries

### --- kilometers of the river:

select round(((select sum(sdo\_geom.sdo\_length(a.geom, 0.05, 'unit=km')) as upper\_river\_km
from upper\_waterbody a)+

(select sum(sdo\_geom.sdo\_length(b.geom, 0.05, 'unit=km')) as lower\_river\_km from lower\_waterbody b)),2) as total\_river\_km from upper\_waterbody, lower\_waterbody

where rownum=1;

	TOTAL_RIVER_KM
1	2824.11

### ---how many tributaries:

select ((select count(\*) from upper\_watercourse)+(select count(\*) from lower\_watercourse)) as
num\_of\_tributaries from upper\_watercourse,

lower\_watercourse where rownum=1;

	NUM_OF_TRIBUTARIES
1	19410

---Land Use

# --total forest coverage in square kilometers

select round(((select sum(sdo\_geom.sdo\_area(a.geom, 0.05, 'unit=sq\_km')) as upper\_forest\_cover from upper\_wooded\_area a)+

(select sum(sdo\_geom.sdo\_area(b.geom, 0.05, 'unit=sq\_km')) as lower\_forest\_cover from lower\_wooded\_area b)),2) as forest\_cover\_sqkm

from upper\_wooded\_area, lower\_wooded\_area

where rownum=1;

	FOREST_COVER_SQKM
1	1212.13

# --total urban coverage in square kilometers

select round((

(select sum(sdo\_geom.sdo\_area(a.geom, 0.05, 'unit=sq\_km')) from upper\_residential a)+

(select sum(sdo\_geom.sdo\_area(b.geom, 0.05, 'unit=sq\_km')) from lower\_residential b)+

(select sum(sdo\_geom.sdo\_area(a.geom, 0.05, 'unit=sq\_km')) from upper\_com\_inst\_area a)+

(select sum(sdo\_geom.sdo\_area(b.geom, 0.05, 'unit=sq\_km')) from lower\_com\_inst\_area b)

)

,2) as urban\_area\_sqkm

from upper\_residential, lower\_residential, upper\_com\_inst\_area, lower\_com\_inst\_area where rownum=1;

	URBAN_AREA_SQKM
1	135.45

# --Total kilometers of roadways

select round(((select sum(sdo\_geom.sdo\_length(a.geom, 0.05, 'unit=km')) as upper\_road\_km
from upper\_road\_segment a)+

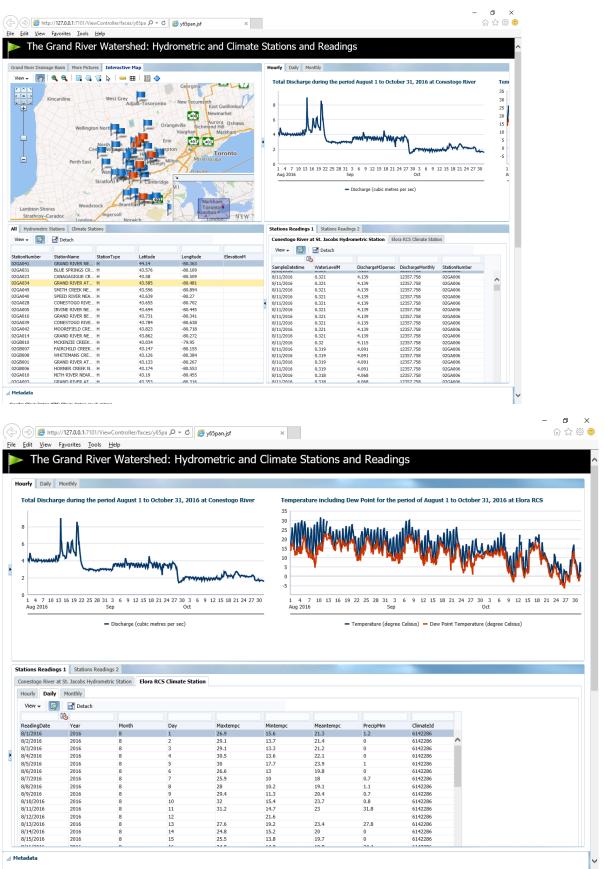
(select sum(sdo\_geom.sdo\_length(b.geom, 0.05, 'unit=km')) as lower\_road\_km from lower\_road\_segment b)),2) as total\_road\_km from upper\_road\_segment, lower\_road\_segment

where rownum=1;

	TOTAL_ROAD_KM
1	11328.55

# **APPLICATION**

East Tien	F <u>a</u> vorites <u>T</u> ools	<u>H</u> elp										
The	Grand Rive	r Waters	hed: Hyc	lrometric a	nd Climate	Stati	ions an	d Readin	gs			
and River Drai	inage Basin More P	ictures Interacti	ive Map			Hourb	y Daily Mo	onthly				
		State of the	Too and			Tot	tal Discharge	e during the peri	od August 1 to Octo	ber 31. 2016 at (	Conestogo River	Te
			ine and	a star	the state of the							35
	and the second sec	子小子	Vice and	1 395 - M	A R A R A							30
		AT AN AL	TREES	Asian		8						25
		A Startes	5 4 P.	a la state de la	Contraction of the							20
	and the			the state of the state		6		AA IN				15
				and the second	Server L		ιΛ	JWN I				
	and the second	The Mark			Station States No.	4	www	-	mounter	wh.		10
			12.33			•		the second second	A	1		5
			A REAL PROPERTY OF A READ PROPERTY OF A REAL PROPER	and the second	Contraction of the local division of the loc	2				Lamm	when we would	0
acts						T						-5
	Drainage Basin covers a					0	4 7 10 12	16 10 22 25 20 21	3 6 9 12 15 18 21	24 27 20 2 6 0	10 15 10 01 04 07 0	0
	nage Basin is 6803.62 s om the river head to Lal						ug 2016		ep	Oct 0	12 13 10 21 24 27 3	0
			ral or urban: the to	tal forest cover is 1212.	.13 square kilometres,	1.1-	-					_
ile the total are	ea of urban land is 135.		res (residential, con	nmercial, institutional).	The total kilometres of		expanda reading	able to show	Discharge (cubic metre	s per sec)		
ile the total and adways is 1132 Hydrometric	ea of urban land is 135. 8.55 km. : Stations Climate Sta	45 square kilometr	res (residential, con	nmercial, institutional).	The total kilometres of		reading o	able to show data	ings 2			
ile the total an adways is 1132 Hydrometric	ea of urban land is 135. 8.55 km.	45 square kilometr	res (residential, con	nmercial, institutional).	The total kilometres of	Con	reading ons Readings	able to show data 1 Stations Read at St. Jacobs Hyd	ings 2	s per sec) ra RCS Climate Stati	ion	
ile the total ari adways is 1132 Hydrometric ew $ ev$	ea of urban land is 135. 8.55 km. : Stations Climate Sta	45 square kilometr	Latitude	Inmercial, institutional).	The total kilometres of ElevationM	Con	reading of the second s	able to show data 1 Stations Read at St. Jacobs Hyd	ings 2		ion	
ile the total ar idways is 1132 Hydrometric ew - E ionNumber	ea of urban land is 135. 18.55 km. Stations Climate Sta Detach	45 square kilometr				Con	reading ions Readings eestogo River ew +	able to show data 1 Stations Read at St. Jacobs Hyd Detach	ngs 2	ira RCS Climate Stati		
Hydrometric ew - E	ea of urban land is 135. 8.55 km. Climate Stations Climate StationName GRAND RIVER NE BLUE SPRINGS CR	45 square kilometr tions StationType H H	Latitude 44.14 43.576	Longitude -80.363 -80.109		Vie	reading of the second s	able to show data 1 Stations Read at St. Jacobs Hyd at St. Jacobs Hyd Detach	ngs 2 rometric Station Ele DischargeM3persec	ira RCS Climate Stati	on StationNumber	
Hydrometric ew V Sis 1132	ea of urban land is 135. 8.55 km. Stations Climate StationName GRAND RIVER NEL BLUE SPRINGS CR. CANAGAGIGUE CR.	45 square kilometr tions StationType H H H	Latitude 44.14 43.576 43.58	Longitude -80.363 -80.109 -80.509		Con Vie Sam 8/11	reading of the second s	able to show data	ngs 2 rometric Station Ele DischargeM3persec 4.139	DischargeMonthly 12357.758	StationNumber 02GA006	
Hydrometric ew - E ionNumber (A041 (A023) (A024) (A024)	ea of urban land is 135. 88.55 km. Climate Sta Detach StationName GRAND RIVER NE. BULE SPRINGS CR. CANAGAGIGUE CR. GRAND RIVER AT	45 square kilometr tions StationType H H H H H	Latitude 44.14 43.576 43.58 43.585	Longitude =80.363 =80.109 =80.481		Con Vie Sam 8/11 8/11	reading of tons Readings testogo River ew - E tons tons tons tons tons tons tons tons	able to show data	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.139	na RCS Climate Stati	StationNumber 02GA006 02GA006 02GA006	^
Hydrometric ew - E ionNumber iA041 iA031 iA023 iA034 iA049	ea of urban land is 135. 8.55 km. Climate Stations Climate Station StationName GRAND RIVER NE. CANAGAGIGUE CR. GRAND RUNCH AT. SMITH CREEK NE	45 square kilometr tions StationType H H H H H	Latitude 44.14 43.576 43.58 43.585 43.596	Longitude -80.363 -80.109 -80.509 -80.481 -80.481		Con Vie Sam 8/11 8/11 8/11 8/11	reading of tons Readings testogo River - ew - E typeDatetime 1/2016 1/2016 1/2016	ble to show data	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.139	ra RCS Climate Stati DischargeMonthly 12357,758 12357,758 12357,758	StationNumber 02GA006 02GA006 02GA006	^
ile the total an dways is 1132 Hydrometric ew ↓ € ionNumber A041 A031 A031 A034 A034 A049 A049 A049	ea of urban land is 135. 84.55 km. Stations Climate Stations GRAND RIVER NE. BLUE SPRINGS CR. CANAGAGIOUE CR. GRAND RIVER AT SMTH CREEX NE SHED RIVER NEA.	45 square kilometr tions StationType H H H H H H H	Latitude 44.14 43.576 43.58 43.585 43.596 43.639	Longitude =00.363 =00.109 =00.509 =00.481 =00.994 =00.27		Con Vie 8/11 8/11 8/11 8/11 8/11	reading ( ions Readings sestogo River : ew - ippleDatetime 1/2016 1/2016 1/2016	able to show data	rometric Station Ele DischargeM3persec 4.139 4.139 4.139	PischargeMonthly 2257,758 12357,758 12357,758	StationNumber O2GA006 02GA006 02GA006 02GA006 02GA006	^
ile the total an advass is 1132           Hydrometric           eew <	ea of urban land is 135. 8.55 km. Climate Stations Climate Station StationName GRAND RIVER NE. CANAGAGIGUE CR. GRAND RUNCH AT. SMITH CREEK NE	45 square kilometr tions StationType H H H H H H H H H	Latitude 44.14 43.576 43.58 43.585 43.596	Longitude -80.363 -80.109 -80.509 -80.481 -80.481		Con Vie Sam 8/11 8/11 8/11 8/11 8/11	reading ( ions Readings estogo River - ew - 	ble to show data	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.139	ra RCS Climate Stati DischargeMonthly 12357,758 12357,758 12357,758	StationNumber 02GA006 02GA006 02GA006	^
ile the total an dways is 1132 Hydrometric ew ↓ ionNumber A041 A023 A034 A034 A034 A034 A049 A040 A028 A055	Estations Climate Stations Climate Stations Climate Stations Climate Stations Estation Station Rurer NE StationName GRAND RURE NE BLIE SPRINGS CR. CANAGAGUE CR. SMITH CREEK NE. SPEED RURE NT. SMITH CREEK NE.	45 square kilometr tions StationType H H H H H H H H H H	Latitude 44.14 43.576 43.585 43.585 43.639 43.639 43.655	Longitude -80.363 -80.109 -80.509 -80.481 -80.894 -80.27 -80.702		Con Vie Sam 8/11 8/11 8/11 8/11 8/11 8/11	reading ( ions Readings sestogo River : ew - E //2016 1/2016 1/2016 1/2016 1/2016	ble to show data	ngs 2 rometric Station Ele DischargeH3persec 4.139 4.139 4.139 4.139	ra RCS Climate Stati DischargeMonthly 12357,758 12357,758 12357,758 12357,758	StationNumber 02GA006 02GA006 02GA006 02GA006 02GA006 02GA006	^
ile the total an dways is 1132 Hydrometric tw ▼	ea of urban land is 135. 8.55 km. Climate State Climate State Climate State Climate State StatenName GRAND RIVER NE. SAUTH CREEK NE. SPEED RIVER NEA. CONESTOG ORIVE. CONESTOG ORIVE.	45 square kilometr trions StationType H H H H H H H H H H H H	Latitude 44.14 43.576 43.58 43.585 43.596 43.639 43.655 43.694	Longitude -80.363 -80.109 -80.509 -80.509 -80.481 -80.481 -80.27 -80.702 -80.702 -80.445		Con Vie Sam 8/11 8/11 8/11 8/11 8/11 8/11 8/11	reading ( ions Readings estogo River - ew - 	Water         Water           1         Stations Read           at St. Jacobs Hyd         Dacobs           Water.evelM         0.321           0.321         0.321           0.321         0.321           0.321         0.321           0.321         0.321           0.321         0.321           0.321         0.321	ngs 2 rometric Station Elec DischargeM3persec 4.139 4.139 4.139 4.139 4.139 4.139	ra RCS Climate Stati DischargeMonthly 12357.758 12357.758 12357.758 12357.758 12357.758	StationNumber 02GA006 02GA006 02GA006 02GA006 02GA006 02GA006 02GA006	
lie the total an idways is 1132 Hydrometric ew v ionNumber Adv11 A031 A034 A040 A040 A040 A040 A040 A040 A040	ea of urban land is 135. 8.55 km. Stations Climate Station Climate StationName GRAND RUPER NE. BLIE SPRINGS CR. CANAGAGIQUE CR. SMITH CREEN KE. SPEED RUPER NEA. COMESTOGO RUPE. IRVINE RUPER NE.	45 square kilometr stations H H H H H H H H H H H H H H H H	Labtude 44.14 43.576 43.58 43.595 43.639 43.639 43.639 43.639 43.639 43.731 43.784 43.784 43.823	Longitude =00.363 =00.109 =00.509 =00.481 =00.27 =00.445 =00.27 =00.445 =00.341 =00.341 =00.38		Con Vie 8/11 8/11 8/11 8/11 8/11 8/11 8/11 8/1	reading : ons Readings lestogo River : ew - Es w - Es w - Es w - Es w - W w -	ble to show data I Stations Read at St. Jacobs Hyd ☐ Detach WaterLevelM 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.139 4.139 4.139 4.139 4.139 4.139 4.139 4.139	ra RCS Climate Stati Dischargetionthly 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758	StationNumber 02GA006 02GA006 02GA006 02GA006 02GA006 02GA006 02GA006 02GA006	^
ile the total an ile the total an Hydrometric ew - Ep ionNumber A041 A023 A034 A049 A040 A040 A040 A005 A016 A039 A042	ea of urban land is 135. 8.55 km. Climate Stations Climate Station StationName GRAND RIVER NE. BLIE SPRINKS CR. CANAGAGIGUE CR. GRAND RUNER AT. SPEED RIVER NE. CONSTOCO RIVE. CONSTOCO RIVE. CONSTOCO RIVE.	45 square kilometr station H H H H H H H H H H H H H H H H H H	Latitude 44.14 43.576 43.58 43.596 43.639 43.655 43.694 43.731 43.784	Longitude -80.363 -80.109 -80.509 -80.481 -80.894 -80.27 -80.702 -80.445 -80.341 -80.338		Con Vie 8/11 8/11 8/11 8/11 8/11 8/11 8/11 8/1	reading ( ions Readings sestogo River ew - E (2016 1/2016 1/2016 1/2016 1/2016 1/2016 1/2016 1/2016 1/2016	Water           1         Stations Read           1         Stations Read           1         Stations Read           1         Detach           0         Detach           0         S21           0.321         0.321           0.321         0.321           0.321         0.321           0.321         0.321           0.321         0.321           0.321         0.321	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.139 4.139 4.139 4.139 4.139 4.139 4.139 4.139	ra RCS Climate Stati DischargeMonthly 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758	StationNumber           02GA006         02GA006	^
ile the total an ile the total an indways is 1132 Hydrometric ew ↓ ↓ ionNumber A041 A031 A031 A049 A040 A049 A040	ea of urban land is 135. 84.55 km. Stations Climate State Climate State GRAND RIVER NE. CANAGAGIGUE CR. GRAND RIVER NE. CONESTOGO RIVE. SWITH CREEK NE. SPEED RIVER NEA. CONESTOGO RIVE. MORE RIVER NE. GRAND RIVER NE. GRAND RIVER NE. GRAND RIVER NE. GRAND RIVER NE. GRAND RIVER NE. GRAND RIVER NE. MOREFIELD CRE. GRAND RIVER RIE. GRAND RIVER NE.	45 square kilometr tions StationType H H H H H H H H H H H H H H H H H H H	Latitude 44.14 43.576 43.58 43.585 43.596 43.639 43.655 43.694 43.731 43.731 43.784 43.823 43.862 43.034	Longitude =80.363 =80.109 =80.599 =80.481 =80.27 =80.445 =80.718 =8		Con Vie Sam 8/11 8/11 8/11 8/11 8/11 8/11 8/11 8/1	reading : ions Readings iestop River : ew - Ee //2016 1/2	Water           1         Stations Read           at St. Jacobs Hyd         Dacob           Image: Strategy S	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.130 4.115 4.1	ra RCS Climate Stati Discharge Monthly 12557.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758	Stationfumber           02GA006         02GA006	^
Hydrometric           ew +         Image: Second	Estations Climate Stations Climate Stations Climate Stations Climate Stations Climate Station Station Rules Revealed Rules Revealed Rules Revealed Rules Ru	45 square kilometr tions StationType H H H H H H H H H H H H H H H H H H H	Lattude 44.14 43.576 43.58 43.595 43.694 43.694 43.731 43.784 43.731 43.784 43.823 43.862 43.862 43.034 43.147	Longitude =00.363 =00.109 =00.481 =00.994 =00.481 =00.27 =00.445 =00.341 =00.341 =00.218 =00.718 =00.272 =79.95 =00.155		Con Vie 8/11 8/11 8/11 8/11 8/11 8/11 8/11 8/1	reading , ions Readings iestopo River , ew - we - w	ble to show data 1 Stations Read at St. Jacobs Hyd → Detach 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321 0.321	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.1	ra RCS Climate Stati DischargeHonthly 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758	StationNumber           02cA006	
Hydrometric           Hydrometric           ew +         Image: Comparison of the comparis	ea of urban land is 135. 8.55 km. Stations Climate State Climate State StationName GRAND RUREN RL SULUS SPRINGS CR. CANAGAGIGUE CR. CANAGAGIGUE CR. CANAGAGIGUE CR. SPEED RUVEN NAS. SHTH CREEK NE. SPEED RUVEN RL CONESTOGO RIVE. RVINE RIVER NE. GRAND RUVER RL CONESTOGO RIVE. CONESTOGO RIVE. CONESTOSO RIVE. CONESTOSO RIVE. CONESTOSO RIVE. CONE	45 square kilometr tions StationType H H H H H H H H H H H H H H H H H H H	Latitude 44.14 43.576 43.58 43.585 43.596 43.639 43.655 43.694 43.731 43.784 43.823 43.862 43.842 43.034 43.147 43.126	Longitude -80.363 -80.109 -80.509 -80.509 -80.481 -80.481 -80.27 -80.445 -80.27 -80.445 -80.27 -80.445 -80.27 -79.95 -80.155 -80.155		Con Vie 8/11 8/11 8/11 8/11 8/11 8/11 8/11 8/1	reading ions Readings westogo River ew - Ew - Ew - ipleDate i/2016	ble to show data 1 Stations Read at St. Jacobs Hyd → Detach → → → → → → → → → →	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.135 4.911 4.091 4.	ra RCS Climate Stati DischargeMonthly 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758	StationNumber           02GA006         02GA006 <t< td=""><td></td></t<>	
wile the total an advays is 1132           Hydrometric           ew <	ea of urban land is 135. 8.55 km. Stations Climate State Climate State StationAlame GRAND RUPER NE. BLUE SPRIVOS CR. CONSTOGO RIVE. RIVINE RUPER NE. SPEED RUPER NEA. CONESTOGO RIVE. RIVINE RUPER NE. SPEED RUPER NEA. CONESTOGO RIVE. GRAND RUPER RE. GRAND RUPER RE. FAIRCHLD CREEK. FAIRCHLD CREEK.	45 square kilometr tions StationType H H H H H H H H H H H H H	Labtude 44.14 43.576 43.585 43.595 43.639 43.639 43.655 43.694 43.731 43.784 43.784 43.822 43.862 43.823 43.862 43.034 43.147 43.126 43.133	Longitude =00.363 =00.109 =00.481 =00.894 =00.27 =00.445 =00.718 =00.718 =00.718 =00.718 =00.718 =00.718 =00.718 =00.718 =00.384 =00.384 =00.384		Con Vie 8/11 8/11 8/11 8/11 8/11 8/11 8/11 8/1	reading : ons Readings lestogo River w ▼ w ▼ w ♥ pleDatetime 1/2016	ble to show     data      Stations Read      at St. Jacobs Hyd      Detach      Detach      O.321      O.32      O.33       O.33	rometric Station Electrometric Station Elect	na RCS Climate Statis DischargeHonthly 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758 12357,758	StationNumber           02cA006         02cA006	
	ea of urban land is 135. 8.55 km. Stations Climate State Climate State StationName GRAND RUREN RL SULUS SPRINGS CR. CANAGAGIGUE CR. CANAGAGIGUE CR. CANAGAGIGUE CR. SPEED RUVEN NAS. SHTH CREEK NE. SPEED RUVEN RL CONESTOGO RIVE. RVINE RIVER NE. GRAND RUVER RL CONESTOGO RIVE. CONESTOGO RIVE. CONESTOSO RIVE. CONESTOSO RIVE. CONESTOSO RIVE. CONE	45 square kilometr tions StationType H H H H H H H H H H H H H H H H H H H	Latitude 44.14 43.576 43.58 43.585 43.596 43.639 43.655 43.694 43.731 43.784 43.823 43.862 43.842 43.034 43.147 43.126	Longitude -80.363 -80.109 -80.509 -80.509 -80.481 -80.481 -80.27 -80.445 -80.27 -80.445 -80.27 -80.445 -80.27 -79.95 -80.155 -80.155		Con Vie 8/11 8/11 8/11 8/11 8/11 8/11 8/11 8/1	reading ions Readings westogo River ew - Ew - Ew - ylpichater we - we - w	ble to show data 1 Stations Read at St. Jacobs Hyd → Detach → → → → → → → → → →	ngs 2 rometric Station Ele DischargeM3persec 4.139 4.135 4.911 4.091 4.	ra RCS Climate Stati DischargeMonthly 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758 12357.758	StationNumber           02GA006         02GA006 <t< td=""><td></td></t<>	



at Credence (CD): Climate Cred

9

# - **⊡ ×** ☆☆戀®

1

$\langle \langle \neq \rangle$	🥖 htt	p:// <b>127.0.0.1</b>	:7101/Vi	ewController/faces/y65pa 🔎 🕆 🖒 🥖 y65pan.jsf 🛛 🗙	
		F <u>a</u> vorites			

File	Edit	View	F <u>a</u> vorites	Tools	E
- C	0/ 1/20	10	2010		

9 112010	2010	0		30.5	13.0	22.1	0	0112200
8/5/2016	2016	8	5	30	17.7	23.9	1	6142286
8/6/2016	2016	8	6	26.6	13	19.8	0	6142286
B/7/2016	2016	8	7	25.9	10	18	0.7	6142286
3/8/2016	2016	8	8	28	10.2	19.1	1.1	6142286
3/9/2016	2016	8	9	29.4	11.3	20.4	0.7	6142286
B/10/2016	2016	8	10	32	15.4	23.7	0.8	6142286
8/11/2016	2016	8	11	31.2	14.7	23	31.8	6142286
B/12/2016	2016	8	12		21.6			6142286
3/13/2016	2016	8	13	27.6	19.2	23.4	27.8	6142286
8/14/2016	2016	8	14	24.8	15.2	20	0	6142286
8/15/2016	2016	8	15	25.5	13.8	19.7	0	6142286
o la c looa c				24.0		10.0	24.4	

#### 🔺 Metadata

Canadian Climate Stations (CDN_Climate_Stations.csv; eli_stations)	o Other Constraints	
<ul> <li>Description: All climate stations in Canada available in point data.</li> </ul>	<ul> <li>This supplementary information is about the validity date of the wooded areas have been generated</li> </ul>	
Credit: N/A	using the Landcover product (CIRCA2000) available on the GeoBase Website. The validity date	
Reference System: ESPG: 4269	(VALIDITY_DATE) of the wooded areas of a given NTS 50k unit is set using the validity date of	
<ul> <li>Distribution Format: Comma Separated Values</li> </ul>	one of the images that have been used to generate the associated 250K NTS unit of the Landcover	
Canadian Hydrometric Stations (HydroMetStus_1948_2016; kyd_stations)	product. The validity date age, ranging from 19960623 to 20040812. This range can be considered	
Description: All hydrometric stations in Canada available in point data.     Credit: N/A	for all wooded areas	
Credit: N/A     Reference Statem: ESPG- 4269	<ul> <li>Lower Grand River Drainage Basin (canvec 161128 155807; CanVec):         <ul> <li>Description: CanVec is a digital cartographic reference product of Natural Resources Canada (NRCan). It</li> </ul> </li> </ul>	
Reference System: ESPC #209     Distribution Format Comma Securated Values	<ul> <li>Description - carves in a suggitar carographic resentes product or resonant Resources Cannae (recomption) in originates from the best available data sources covering Canadian territory, offers quality topographical</li> </ul>	
Distribution Format: Comma Separate Values     Grand River Drainage Basin (GR Watershed Boundarn)	information in vector format and counciles with international geomatics standard. Camily opposite	
Description: the watersheed boundary of the Grand River Drainage Basin	product coming mainly from the National Topographic Data Base (NTDB), the Mapping the North process	
Credit: NA	conducted by the Canada Center for Mapping and Earth Observation (CCMEO), the Atlas of Canada data,	
<ul> <li>Extent: West -80.957444 East -79.454692. North 44.225320 South 42.788681</li> </ul>	the GeoBase initiative, and the data update using satellite imagery coverage (e.g. Landsat 7, Spot, Radarsat,	
Reference System: EPSG: 4269	etc). CanVec contains more than 60 topographic entities organized into 8 distribution themes: Transport	
<ul> <li>Distribution Format: ESRI Shapefile</li> </ul>	Features, Administrative Features, Hydro Features, Land Features, Man-Made Features, Elevation Features, Resource Management Features, and Tononymic Features.	
Environment Canada data	<ul> <li>Geographic Location: North: 43.42693 East: -79.4701256 South: 42.8474915 West: -80.82992</li> </ul>	
<ul> <li>Conestogoriver_stjacobs_hydreadings; conestogoriver_hydreadings</li> </ul>	o Publication Date: 016-09-13	
<ul> <li>Description: hydrometric readings from Conestogo River at St. Jacobs hydrometric station for the period</li> </ul>	<ul> <li>Development phase of the dataset: complete</li> </ul>	
August 1, 2016 to October 31, 2016 Credit: Environment Canada	<ul> <li>Revision cycle: unknown</li> </ul>	
<ul> <li>Credit: Environment Canada</li> <li>Distribution Format: Comma Separated Values</li> </ul>	<ul> <li>Reference system: ESPG: 4617</li> </ul>	
Grandriverat branchord hydreadines: branchord hydreadines	<ul> <li>Horizontal Accuracy: between 2 and 200 meters</li> </ul>	
<ul> <li>Description: hydrometric readings from Grand River at Brantford hydrometric station for the period August</li> </ul>	<ul> <li>Vertical Accuracy: 5 meters</li> <li>Distribution format: ESRI Shapefile (unknown version)</li> </ul>	
1, 2016 to October 31, 2016	<ul> <li>Distribution format: ESRI Shapefile (unknown version)</li> <li>Point of Contact</li> </ul>	
<ul> <li>Credit: Environment Canada</li> </ul>	Orzanisation: Government of Canada: Natural Resources Canada: Earth Sciences Sector	
<ul> <li>Distribution Format: Comma Separated Values</li> </ul>	Email: prcan resolution medicanda, ca	
Elorarcz_climate_daily; hourly; monthly	o Usage Licence	
<ul> <li>Description: hourly, daily, and monthly weather readings from Elora RCS climate station including the period of August 1-October 31, 2016</li> </ul>	<ul> <li>Open Government Licence – Canada</li> </ul>	
o Credit Environment Canada	<ul> <li>Other Constraints</li> </ul>	
O Distribution Format: Comma Separated Values	<ul> <li>This supplementary information is about the validity date of the wooded areas. Wooded areas have</li> </ul>	
Brantford airport climate daily, houry, month	been generated using the Landcover product (CIRCA2000) available on the GeoBase Web site. The validity date (VALIDITY DATE) of the wooded areas of a given NTS 50k unit is set using the	
<ul> <li>Description: hourly, daily, and monthly weather readings from Brantford Airport climate station including</li> </ul>	valuative (value) (value) is value) of the wooden areas of a given (vis ) sok that is set using the valuative value of the images that have been used to espect the associated 250K INTS unit of	
the period of August 1-October 31, 2016	the Landcovering out. The validity date are ranging from 19960623 to 20040312. This range can	
<ul> <li>Credit: Environment Canada</li> </ul>	be considered for all wooded areas.	
<ul> <li>Distribution Format: Comma Separated Values</li> </ul>	Canadian Digital Surface Model Mosaic	
Natural Resources Canada Canvec data: Unner Grand River Drainage Basin (canvec 161128 155742; CanVec):	<ul> <li>Description: The Canadian Digital Surface Model (CDSM) is part of Natural Resources Canada's altimetry</li> </ul>	
<ul> <li>Copyr Ordina River Dealange Batton (Conversion 201762-155742, Canvers).</li> <li>Description: Canversion (NRCan). It</li> </ul>	system designed to better meet the users' needs for elevation data and products. The 0.75 second (~20 m)	
originates from the best available data sources covering Canadian territory, offers quality topographical	CDSM consists of a derived product from the original 1-second (30 m) Shuttle Radar Topographic Mission (SRTM) digital surface model (DSM). In these data, the elevations are captured at the top of buildings, trees,	
information in vector format, and complies with international geomatics standards. Can Vec is a multi-source	(SKIA) digital surface model (DSA), in these data, the electronois are captured at the top or duiloungs, trees, structures, and other objects rather than at ground level. A CDSM mosaic can be obtained for a ure-defined or	
product coming mainly from the National Topographic Data Base (NTDB), the Mapping the North process	subcludes, and other objects rather than a ground rever. A CLOSH model, can be obtained for a pre-defined of the	
conducted by the Canada Center for Mapping and Earth Observation (CCMEO), the Atlas of Canada data,	area. Derived products such as slope, shaded relief and colour shaded relief maps can also be generated on	
the GeoBase initiative, and the data update using satellite imagery coverage (e.g. Landsat 7, Spot, Radarsat, etc.) CanVec contains more than 60 tonographic entities organized into 8 distribution themes. Transport	demand.	
etc.). Can Vec contains more man ou topographic entries organized into a distribution themes. Iransport Features, Administrative Features, Hydro Features, Land Features, Man-Made Features, Elevation Features,	<ul> <li>Geographic Location: North: 60 East: -52 South: 41 West: -140</li> </ul>	
Permites, Administrative Festures, Hyuro Festures, Land Festures, Man-Akide Festures, Electricion Festures, Resource Management Festures, and Toponymic Festures.	<ul> <li>Publication Date: 2016-09-13</li> </ul>	
<ul> <li>Generable Continer Features East-80 02726. South:43.14137. West -80.95696</li> </ul>	<ul> <li>Validity Date: 2000/2000</li> </ul>	
<ul> <li>Publication Date: 2014-09-13</li> </ul>	Development phase of the dataset: ongoing     Revision cycle: as needed	
<ul> <li>Development phase of the dataset: complete</li> </ul>	o Reference system: ESDC: 4617	
<ul> <li>Revision cycle: unknown</li> </ul>	<ul> <li>Horizontal Accuracy: between 2 and 200 meters</li> </ul>	
<ul> <li>Reference system: ESPG: 4617</li> </ul>	<ul> <li>Vertical Accuracy: 5 meters</li> </ul>	
<ul> <li>Horizontal Accuracy: between 2 and 200 meters</li> <li>Vertical Accuracy: between 5 and 10 meters</li> </ul>	<ul> <li>Distribution format: GeoTIFF (version)</li> </ul>	
<ul> <li>Vertical Accuracy: networks 5 and 10 meters</li> <li>Distribution format: ESRI Stabelle (unknown version)</li> </ul>	<ul> <li>Point of Contact</li> </ul>	
Distribution format: ESRL Sndpene (unknown version)     Point of Constact	<ul> <li>Organisation: Government of Canada; Natural Resources Canada; Earth Sciences Sector</li> <li>Email: arcan seoinfo mcan@canada ca</li> </ul>	
Orenization: Government of Canada; Natural Resources Canada; Earth Sciences Sector	<ul> <li>Email: nrcm geomto mcm@canada.ca</li> <li>Unare Licence</li> </ul>	
<ul> <li>Email: arcan geoinfo.mcan@canada.ca</li> </ul>	Open Government Licence - Canada	
<ul> <li>Usage Licence</li> </ul>	Other Constraints	
<ul> <li>Open Government Licence – Canada</li> </ul>	<ul> <li>none</li> </ul>	
		$\sim$

# What techniques could be employed to improve the performance and functionality of your application in the database and presentation tier?

Of the three tier architecture, the database tier deals with the data that drive the application. Functionality and performance could improve if data are stored efficiently in one table rather than in many, and if there are 1 to M relationships between entities.

Presentation tier deals with user interaction and APIs. To facilitate the performance and functionality of the application, I could employ page flows and listeners, and the technique of processing data without refreshing the page (Lecture 8).

### **Brief Summary**

In the application, I successfully created the layout (top, centre and bottom), the panel boxes, panel splitters and tabbed panels, and imported ADF tables and the geographic map from the datasets with labels to distinguish climate and hydrometric stations using dvt: mapPointStyleItem. When a table receives an input value, the corresponding map or graph also changes. However, the tables that had many rows in them did not show a scroll bar to scroll left and right to see the other fields. Also, the dvt:mapPointStyleItem of the map sometimes fail to load, which distinguish hydrometric and climate stations from one another using Flags of different colors. It works again after the jsf page is restarted.

If more time is available, I would further decorate the application interface with icons and graphics, and improve its functionality further by making the interface more user-friendly through adding permanent left-to-right scroll bars to tables that have many rows.

11

### Appendix

### **Terms:**

*Primary Key:* an identification for one or more fields, used to represent relationships. Primary keys must be unique, and must not be blank empty or null. Every unique record has a unique primary key.

*Foreign Key:* used to define associations between entities by duplicating an attribute in one or more entities. Foreign key values do not need to be unique, but must be the same datatype as the primary key.

Primary and Foreign Keys are also known as "constraints", "sub-queries", "joins" and "views"

(Sept 23 Lecture; Assignment 4B).

*Indexes:* Spatial indexing is used to facilitate spatial selection and enhance spatial query performance as well as other operations such as spatial joins. It organizes space and the objects in space so that only a subset of the objects are considered to answer a query instead of the whole. R-Tree indexing is an example where indexes are two three or four dimensions, and include all elements of a geometry such as points, lines and polygons. Non-spatial database indexes create a hierarchical tree based on the column values indexed

(Oct 7 Lecture).

### **Resources:**

- Canadian Climate Stations csv table
- Canadian Hydrometric Stations csv table
- Grand River Drainage Basin shapefile
- Environment Canada Hydrometric station reading data
- Environment Canada Climate station reading data
- Natural Resources Canada Grand River Drainage Basin Canvec data

# Metadata:

# Canadian Climate Stations (CDN\_Climate\_Stations.csv; cli\_stations)

- **Description:** All climate stations in Canada available in point data.
- Credit: N/A
- **Reference System:** ESPG: 4269
- Distribution Format: Comma Separated Values

# Canadian Hydrometric Stations (HydroMetStns\_1948\_2016; hyd\_stations)

- Description: All hydrometric stations in Canada available in point data.
- Credit: N/A
- **Reference System:** ESPG: 4269
- Distribution Format: Comma Separated Values

# Grand River Drainage Basin (GR\_Watershed\_Boundary)

- Description: the watershed boundary of the Grand River Drainage Basin
- Credits: N/A
- Extent: West -80.957444 East -79.454692, North 44.225320 South 42.788681
- **Reference System:** EPSG: 4269
- Distribution Format: ESRI Shapefile

# Environment Canada data

- Conestogoriver\_stjacobs\_hydreadings; conestogoriver\_hydreadings
  - **Description:** hydrometric readings from Conestogo River at St. Jacobs hydrometric station for the period August 1, 2016 to October 31, 2016
  - **Credit:** Environment Canada
  - **Distribution Format:** Comma Separated Values

# • Grandriverat\_brantford\_hydreadings; brantford\_hydreadings

- **Description:** hydrometric readings from Grand River at Brantford hydrometric station for the period August 1, 2016 to October 31, 2016
- **Credit:** Environment Canada
- **Distribution Format:** Comma Separated Values
- Elorarcs\_climate\_daily; hourly; monthly
  - **Description:** hourly, daily, and monthly weather readings from Elora RCS climate station including the period of August 1-October 31, 2016
  - Credit: Environment Canada
  - **Distribution Format:** Comma Separated Values
- Brantford\_airport\_climate\_daily; hourly; montly

- **Description:** hourly, daily, and monthly weather readings from Brantford Airport climate station including the period of August 1-October 31, 2016
- Credit: Environment Canada
- Distribution Format: Comma Separated Values

#### Natural Resources Canada Canvec data:

- Upper Grand River Drainage Basin (canvec\_161128\_155742; CanVec):
  - Description: CanVec is a digital cartographic reference product of Natural Resources Canada (NRCan). It originates from the best available data sources covering Canadian territory, offers quality topographical information in vector format, and complies with international geomatics standards. CanVec is a multisource product coming mainly from the National Topographic Data Base (NTDB), the Mapping the North process conducted by the Canada Center for Mapping and Earth Observation (CCMEO), the Atlas of Canada data, the GeoBase initiative, and the data update using satellite imagery coverage (e.g. Landsat 7, Spot, Radarsat, etc). CanVec contains more than 60 topographic entities organized into 8 distribution themes: Transport Features, Administrative Features, Hydro Features, Land Features, Man-Made Features, Elevation Features, Resource Management Features, and Toponymic Features.
  - Geographic Location: North: 44.22348, East:-80.02726, South:43.14137, West:
     -80.95696
  - **Publication Date:** 2016-09-13
  - Development phase of the dataset: complete
  - Revision cycle: unknown

- **Reference system:** ESPG: 4617
- Horizontal Accuracy: between 2 and 200 meters
- Vertical Accuracy: between 5 and 10 meters
- **Distribution format:** ESRI Shapefile (unknown version)
- Point of Contact
  - Organization: Government of Canada; Natural Resources Canada; Earth Sciences Sector
  - Email: nrcan.geoinfo.mcan@canada.ca
- Usage Licence
  - Open Government Licence Canada
- Other Constraints
  - This supplementary information is about the validity date of the wooded areas have been generated using the Landcover product (CIRCA2000) available on the GeoBase Website. The validity date (VALIDITY\_DATE) of the wooded areas of a given NTS 50k unit is set using the validity date of one of the images that have been used to generate the associated 250K NTS unit of the Landcover product. The validity date are ranging from 19960623 to 20040812. This range can be considered for all wooded areas

### • Lower Grand River Drainage Basin (canvec\_161128\_155807; CanVec):

 Description: CanVec is a digital cartographic reference product of Natural Resources Canada (NRCan). It originates from the best available data sources covering Canadian territory, offers quality topographical information in vector format, and complies with international geomatics standards. CanVec is a multisource product coming mainly from the National Topographic Data Base (NTDB), the Mapping the North process conducted by the Canada Center for Mapping and Earth Observation (CCMEO), the Atlas of Canada data, the GeoBase initiative, and the data update using satellite imagery coverage (e.g. Landsat 7, Spot, Radarsat, etc). CanVec contains more than 60 topographic entities organized into 8 distribution themes: Transport Features, Administrative Features, Hydro Features, Land Features, Man-Made Features, Elevation Features, Resource Management Features, and Toponymic Features.

- Geographic Location: North: 43.42693 East: -79.4701256 South: 42.8474915
   West: -80.82992
- Publication Date: 2016-09-13
- Development phase of the dataset: complete
- Revision cycle: unknown
- **Reference system:** ESPG: 4617
- Horizontal Accuracy: between 2 and 200 meters
- Vertical Accuracy: 5 meters
- **Distribution format:** ESRI Shapefile (unknown version)
- Point of Contact
  - Organisation: Government of Canada; Natural Resources Canada; Earth Sciences Sector
  - Email: nrcan.geoinfo.mcan@canada.ca
- Usage Licence

- Open Government Licence Canada
- **o** Other Constraints
  - This supplementary information is about the validity date of the wooded areas. Wooded areas have been generated using the Landcover product (CIRCA2000) available on the GeoBase Web site. The validity date (VALIDITY\_DATE) of the wooded areas of a given NTS 50k unit is set using the validity date of one of the images that have been used to generate the associated 250K NTS unit of the Landcover product. The validity date are ranging from 19960623 to 20040812. This range can be considered for all wooded areas.

### • Canadian Digital Surface Model Mosaic

- Description: The Canadian Digital Surface Model (CDSM) is part of Natural Resources Canada's altimetry system designed to better meet the users' needs for elevation data and products. The 0.75second (~20 m) CDSM consists of a derived product from the original 1-second (30 m) Shuttle Radar Topographic Mission (SRTM) digital surface model (DSM). In these data, the elevations are captured at the top of buildings, trees, structures, and other objects rather than at ground level. A CDSM mosaic can be obtained for a pre-defined or user-defined extent. The coverage and resolution of a mosaic varies according to the extent of the requested area. Derived products such as slope, shaded relief and colour shaded relief maps can also be generated on demand.
- Geographic Location: North: 60 East: -52 South: 41 West: -140

- **Publication Date:** 2016-09-13
- Validity Date: 2000/2000
- Development phase of the dataset: ongoing
- **Revision cycle:** as needed
- **Reference system:** ESPG: 4617
- Horizontal Accuracy: between 2 and 200 meters
- Vertical Accuracy: 5 meters
- **Distribution format:** GeoTIFF (version)
- Point of Contact
  - Organisation: Government of Canada; Natural Resources Canada; Earth
     Sciences Sector
  - Email: nrcan.geoinfo.mcan@canada.ca
- Usage Licence
  - Open Government Licence Canada
- Other Constraints
  - none