Water Data in Time and Space

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Based in part on material from Brent Watson Horizons Regional Council Palmerston North

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Goals of the Exercise

This exercise shows how hydrologic and water quality data are obtained using water data services, and how to create and work with a stream network for the Selwyn catchment.

Computer and Data Requirements

To carry out this exercise, you need to have a computer, which runs ArcGIS Desktop version 10.5. This exercise will also work with version 10.4.1 if you do not have access to Version 10.5.

In the first part of this exercise using ArcGIS Desktop, you will be working with the following Geodatabase called **Selwyn**, which has a Feature Dataset within it called **Network**, and within that there are two feature classes **Boundary** and **RiverLines**, which are the Boundary of the Selwyn catchment and the River Environment Classification RiverLines for that area.



You can get these data from this zip file:

http://www.caee.utexas.edu/prof/maidment/Canterbury/Ex3/Ex3Data.zip or from the UC Learn web site. You need to establish a working folder to do the exercise. This can be in any convenient location on the computer you are working on (e.g. ...\Ex3\Ex3Data). After you have downloaded the zip file **Ex3Data.zip** double click on the file and you should see Winzip or other zip utility to open the file on your computer (if it doesn't open you'll have to unzip this file on a computer that has a zip utility installed).

Part One: Water Data in Time

When you are querying the LAWA web site for data or charts, what is actually happening behind the scenes is that queries are being made using a protocol called the Sensor Observations Service and the results are being returned in a language called WaterML2. These are standards of the Open Geospatial Consortium, whose protocols have been adopted by the Regional Councils and Crown Research Institutes in New Zealand to support open data sharing. We are hoping that the data services from these organizations will be opened up to all users but in the meantime, the following examples of water data services access from the Horizons Regional Council for data from the Mangatainoka River at Pahiatua Town Bridge are offered as examples.

Getting Flow Data from Mangatainoka River at Pahiatua Town Bridge

This example enables automated acquisition of daily mean flow or discharge data for the past two years. You will make a "Get Observation" request of the Sensor Observation Service (SOS) operated by the Horizons Regional Council, and you are using a service that has 4 parts:

- Feature of Interest: Mangatainoka at Pahiatua Town Bridge
- **Observed Property:** Flow Mean (1 Day) this means the daily mean value of 5 minute observations
- **Procedure of Measurement:** [Water Level] measurements of water level that have been converted to flow using a rating curve
- **Result:** Temporal Filter of P2Y which means the past 2 years backwards from the time that the request is made

Copy the text below, and launch the following web query from a web browser:

http://tsdata.horizons.govt.nz/contactrec.hts?Service=SOS&Request=GetObservation&FeatureOfInt erest=Mangatainoka at Pahiatua Town Bridge&ObservedProperty=Flow Mean (1 Day)[Water Level]&TemporalFilter=om:phenomenonTime,P2Y

The result will emerge like this:



To be turned in: A screen capture of the header of your WaterML response for flow along with the first couple of data values, as shown above. What is the time period of your data request (from date, to date)? What are the units of the flow data? What was the mean daily flow of the Mangatainoka River at Pahiatua Town Bridge on 5 March 2018?

Getting E. Coli Data from Mangatainoka River at Pahiatua Town Bridge

In a similar way as for the flow data, launch the query:

http://hilltopserver.horizons.govt.nz/cr_provisional.hts?Service=SOS&Request=GetObservation&Fea tureOfInterest=Mangatainoka at Pahiatua Town Bridge&ObservedProperty=E. coli by MPN (HRC)[E. coli by MPN (HRC)]&TemporalFilter=om:phenomenonTime,P2Y

and the result appears as:



To be turned in: A screen capture of the header of your WaterML response for E. Coli along with the first couple of data values, as shown above. What is the Feature of Interest, Observed Property, Procedure of Measurement and Temporal Domain of the Result? What is the time period of your data request (from date, to date)? What are the units of the E. Coli data?

Using Water Data Services from Excel

As you would appreciate, web services are great for computers but not easy to interpret for hand computation. Excel knows how to read XML documents and to parse the information they contain into data fields.



Open Excel and within a blank worksheet, select the **Data** ribbon and **From Web** function within the **Get external Data** toolset.



A popup web-query will default to your default webpage.



Copy and paste the same web query that we used for E Coli previously into the address bar where <u>http://www.canterbury.ac.nz</u> appears above. Here is the web query again:

http://hilltopserver.horizons.govt.nz/cr_provisional.hts?Service=SOS&Request=GetObservation&Fea tureOfInterest=Mangatainoka at Pahiatua Town Bridge&ObservedProperty=E. coli by MPN (HRC)[E. coli by MPN (HRC)]&TemporalFilter=om:phenomenonTime,P2Y

Hit **Go** and you'll see the same XML response that you saw before come up. Click on the little yellow arrow in the top left corner of display area so that it turns into a green check mark, as shown below, and hit **Import**.

New Web Query
A <u>d</u> dress: http://hilltopserver.horizons.govt.nz/cr_proviv
⊆lick ■ next to the tables you want to select, then click Import.
<pre> <?xml version="1.0" ?> - <wml2:collection gml:id="wml2.collection.1" xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:ogc="http://www.opengis.net/ogc" xmlns:om="http://www.opengis.net/om/2.0" xmlns:wml2="http://www.opengis.net/waterml/2.0" xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema- </pre></th></tr><tr><th><pre>instance" xsi:schemalocation="http://www.opengis.net/waterml/2.0 http://schemas.opengis.net/waterml/2.0/waterml2.xsd"> </wml2:collection></pre>
<pre>xlink:href="http://www.opengis.net/def/nil/OGC/0/missing" /> - <wml2:observationmember> - <om:om_observation gml:id="wml2.observationmember.1"> - <om:om_observationg gml:id="wml2.observationmember.1"></om:om_observationg></om:om_observationg></om:om_observationg></om:om_observationg></om:om_observationg></om:om_observationg></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></om:om_observation></wml2:observationmember></pre>
- <gml:timeperiod gml:id="om.phenomenontime.1"></gml:timeperiod>
Import Cancel
Done

Excel doesn't know how to interpret all the header information in the WaterML2.0 Schema; however we are happy to allowing Excel to create a new schema from the (time, value) pairs of data in the repeated rows below the header. Select **OK** when you see the query below.



Select where in the workbook you want to place the data.

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Excel will report at the importing steps and display any errors.

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http://hilltopserver.horizons.govt.nz/cr_pro Some data was imported Comp	lete	
http://hilltopserver.horizons.govt.nz/cr_pro Some data was imported Comp	lete	
http://hilltopserver.horizons.govt.nz/cr_pro Some data was imported Comp	lete	
Details	ж	Help

The final import contains a number of columns due to the complexity of the WaterML2.0 schema. Column S & T contains the (Time,Value) pairs.

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4 wml2.measure	menttimeseries.1 MPN/100mL Di	iscontinuous	http://www.oper	ngis.net/def/water	rml/2.0/interpolationTy	ipe/Discontinua	us 2016-1	12-12T08:40:00+12:00	840			
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note: the date & time is provided in Universal Time Coordinate system format.

Converting UTC time.

If you require the UTC date time format to be converted to more common dd/mm/YYYY HH:MM:SS then you will need to decompose the UTC string. The following instruction is a basic solution that can be undertaken.

Insert a new column and type in the following formula.

=DATEVALUE(MID(##Cell Reference##;1;10))+TIMEVALUE(MID(##Cell Reference##;12;8))

=DATEVALUE(MID([@[ns1:time]];1;10))+TIMEVALUE(MID([@[ns1:time]];12;8))

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Now you have time series data. The time stamp in column S can be converted into a normal Excel date as follows. Create a new column called **NewDate** and set the resulting formula in the first row of this new column as:

=DATEVALUE(MID([@[ns1:time]],1,10))

This query is using two Excel functions, DATEVALUE and MID, one inside the other. The MID function selects the text value from the column that it is pointing to (the time field), and isolates the first 10 characters in that field, 2016-11-30, and then the DATEVALUE function converts these into an Excel Date format.

U		V	W
NewDate	•		
=DATEVALUE(M	ID	[@[ns1:tin	ne]],1,10))

You'll see that Excel creates a column of integers that look incomprehensible. However, if you divide the first number, 42704 by 365.25 you'll get the result 116.9172, which means that this value is 116.91 years from January 1, 1900. This date is actually November 30, 2016 so you can see the connection.

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Right click on this column and select Format Cells



Format Cells		1.0			
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And you'll get a nicely formatted date field.

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2:00	120	D	28/12/2016
2:00	6900	D	4/01/2017
2:00	130	D	9/01/2017
2:00	1100	D	16/01/2017
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Plot a nice time series chart of these data and find the critical percentile values of these data that correspond to the New Zealand coliform data standards.

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/waterml/2.0/interpo	lationT	ype/Discor	ntinuous	2016-12-2	8T08:44:00+12	:00	120	28/12/	2016	120	
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/waterml/2.0/interpo	lationT	ype/Discor	ntinuous	2017-01-0	9T08:50:00+12	:00	130	9/01/	2017	130	
/waterml/2.0/interpo	lationT	ype/Discor	ntinuous	2017-01-1	6T08:29:00+12	:00	1100	16/01/	2017	1100	
/waterml/2.0/interpo	lationT	ype/Discor	ntinuous	2017-01-2	4T08:28:00+12	:00	4200	24/01/	2017	4200	
/waterml/2.0/interpo	lationT	ype/Discor	ntinuous	2017-01-3	0T08:34:00+12	:00	140	30/01/	2017	140	
/waterml/2.0/interpo	lationT	ype/Discor	ntinuous	2017-02-0	7T08:29:00+12	:00	160	7/02/	2017	160	
/waterml/2.0/interpo	ationT	vne/Discor	ntinuous	2017-02-1	3T08-25-00+12	00	110	13/02/	2017	110	
/waterml/2.0/interpc				ns1:v	/alue				0: =	580	
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/waterml/2.0/interpc	5000		_						017	740	
/waterml/2.0/interpc	4000		•						017	190	
/waterml/2.0/interpc	3000						•		017	380	
/waterml/2.0/interpc	2000								017	150	
/waterml/2.0/interpc	2000			•					017	160	
/waterml/2.0/interpc	1000		• •	e					017	145	
/waterml/2.0/interpc	0					-			017	86	
/waterml/2.0/interpc	18/08	/2016 26/11	/2016 6/03	3/2017 14/06	/2017 22/09/201	17 31/	12/2017 10/0	4/2018	017	121	
/waterml/2.0/interpo	iationI	vpe/Discor	ntinuous	2017-12-0	5100:00:00+12	:00	318	5/12/	2017	318	

You can construct a histogram of these data by using the Excel Analysis Toolpak option Histogram



Using the following options (be careful to click on Cumulative Percentage)

Histogram		? ×
Input Input Range: Bin Range: Itabels	ST:ST	OK Cancel <u>H</u> elp
Output options © Qutput Range: New Worksheet Ply: New Workbook Pareto (sorted histogram Cumulative Percentage Chart Output	SW51	

And you will get a cumulative frequency curve of the E. Coli data:

W	Х	γ	
Bin	Frequency	umulative %	
86	1	2.56%	
92.6608	0	2.56%	
99.3216	0	2.56%	
105.9824	1	5.13%	
112.6432	1	7.69%	
119.304	0	7.69%	
125.9648	2	12.82%	
132.6256	2	17.95%	
139.2864	0	17.95%	
145.9472	2	23.08%	
152.608	1	25.64%	

Below are the New Zealand human health standards for E. Coli. These are taken from p.39 of the **National Policy Statement for Freshwater Management, 2014**, which is posted on the course web page along with this assignment.

Value	Human health for recreation				
Freshwater Body Type	Lakes and riv	ers			
Attribute	Escherichia co	li (E. coli)			
Attribute Unit	<i>E. coli/</i> 100 ml	(number of E.	coli per hundred	l millilitres)	
Attribute State ¹²	Numeric Attı	ribute State			Narrative Attribute State
	% exceedances over 540 cfu/100 mL	% exceedences over 260 cfu/100 mL	Median concentration (cfu/100 mL)	95th percentile of <i>E. colil</i> 100 mL	Description of risk of Campylobacter infection (based on <i>E. coli</i> indicator)
A (Blue)	<5%	<20%	≤130	≤540	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 1%*
B (Green)	5-10%	20-30%	≤130	≤1000	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 2%*
C (Yellow)	10-20%	20-34%	≤130	≤1200	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk) The predicted average infection risk is 3%*
D (Orange)	20-30%	>34%	>130	>1200	20-30% of the time the estimated risk is ≥50 in 1000 (>5% risk) The predicted average infection risk is >3%*

To be turned in: Plot a nice time series chart of these data and find the critical percentile values of these data that correspond to the New Zealand coliform data standards. What quality level do these data represent?

Part 2. Water Data in Space

River Network for the Selwyn Catchment

Open ArcMap, select a base map, open the data file **Ex3Data.zip** and from the **Selwyn** geodatabase, add the **Boundary** and **RiverLines** feature classes to the map display. Symbolize the river lines using the **CatchArea** attribute.



Open the Attribute Table for RiverLines and check if the **Enabled** field is set to **True**. If so, the geometric network cannot be formed with this feature class.

1	Table										Π×
	🗄 • 🖶 •	🖫 🔀 🔀 📲	×								
	RiverLines								×		
ſ	CSOFGL	CSOFGLNP	CSOFGLNPVL	SPRING	NZFNODE	NZTNODE	CATCHAREA	DISTSEA	Enabled	Shape_Length	-
1	CD/L/AI/P	CD/L/AVP/LO	CD/L/AVP/LO/MG	-	13039623	13039624	234000	75227.51	True	29.9911	
1	CD/H/AI/P	CD/H/AVP/LO	CD/H/AVP/LO/LG	-	13039589	13039728	657900	93567.28	True	1121.225197	
1	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039709	13039728	6057000	93035.44	True	589.53701	
1	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/MG	-	13039778	13039709	5432400	93932.43	True	896.730193	
1	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039728	13039796	7089300	92445.73	True	1385.99865	
1	CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039875	13039709	297900	93672.72	True	637.104612	
ľ	CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/LG	-	13039917	13039778	3579300	94693.97	True	761.33166	
ľ	CD/H/AI/P	CD/H/AVP/LO	CD/H/A/P/LO/HG	-	13039938	13039796	993600	92920.59	True	1860.718912	
ľ	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/HG	-	13039952	13039778	1067400	95788.52	True	1855.585946	
1	CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039995	13039917	307800	95116.1	True	422.015345	
1	CD/L/AVP	CD/L/AVP/LO	CD/L/AVP/LO/LG	-	13040069	13039624	1348200	77613.31	True	2415.103329	
1	CD/L/AI/P	CD/L/A//P/LO	CD/I /A/P/I O/I G	-	13039624	13040103	3733200	75197 51	True	3838 351979	

To avoid this problem, do a calculation that sets the Enabled field to **Null** and then you'll be good to go with these or other river lines that you want to make into a network.

		×				
A [Enabled	Shape_L				
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.28		Sort Descending				
2.44		Advanced Sorting				
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.97	тΣ	Statistics				
.59	T	Field Calculator				
.52	T					
6.1	Т	Field Calculator				
.31	Т	Deputate or update the values of				
.51	Т	Populate or update the values of				
2.79	Т	this field by specifying a				
.71	TJ	the records in the table are				
13.6	т 1	currently selected only the values				
1.72	Т 🗖	of the selected records will be				
.07	True	calculated.				
17	True					

If the field calculator is greyed out, right click of on the right of the ArcMap ribbon, turn on the Editor tool and start editing the data



Here is how to set the calculation in the field calculator:

Parser VB Script Pytho	n
Fields:	I
OBJECTID	A - 6
Shape	
FNODE_	= (
TNODE_	
LENGTH	
REACH_ID	
NZREACH	
FNODE	
TNODE	-
Show Codeblock	
Enabled =	

and you get this result, as needed.

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	- - -	🖣 🔂 🖸 🖓	×								
Ri	verLines										×
Г	CSOFGL	CSOFGLNP	CSOFGLNPVL	SPRING	NZFNODE	NZTNODE	CATCHAREA	DISTSEA	Enabled	Shape_Length	-
Г	CD/L/AVP	CD/L/AI/P/LO	CD/L/AI/P/LO/MG	-	13039623	13039624	234000	75227.51	<null></null>	29.9911	
Г	CD/H/AVP	CD/H/AI/P/LO	CD/H/AI/P/LO/LG	-	13039589	13039728	657900	93567.28	<null></null>	1121.225197	
Г	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039709	13039728	6057000	93035.44	<null></null>	589.53701	
Г	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/MG	-	13039778	13039709	5432400	93932.43	<null></null>	896.730193	
Г	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/LG	-	13039728	13039796	7089300	92445.73	<null></null>	1385.99865	
Г	CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039875	13039709	297900	93672.72	<null></null>	637.104612	
Г	CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/LG	-	13039917	13039778	3579300	94693.97	<null></null>	761.33166	
Г	CD/H/AVP	CD/H/AVP/LO	CD/H/AI/P/LO/HG	-	13039938	13039796	993600	92920.59	<null></null>	1860.718912	
Г	CW/H/HS/P	CW/H/HS/P/LO	CW/H/HS/P/LO/HG	-	13039952	13039778	1067400	95788.52	<null></null>	1855.585946	
Г	CW/H/HS/T	CW/H/HS/T/LO	CW/H/HS/T/LO/HG	-	13039995	13039917	307800	95116.1	<null></null>	422.015345	
	1										1

In ArcCatalog, Right click on the Network Feature Dataset and create a New Geometric Network



You'll see the following screen pop up, and hit Next



Name your network Selwyn_Net and hit Next



Select RiverLines to participate in the network and hit Next



and hit Next again

New Geometric Network
Do you want to preserve existing enabled values?
All network features are initially enabled unless they belong to a feature dass that already has an enabled field.
© <u>№</u> 0
Enable all network features.
Mesi Second
Enable network features using the existing enabled attribute values. Any features with invalid enabled attributes will be reinitialized to enabled.
< <u>Back</u> <u>Next</u> Cancel

Select RiverLines to be your SimpleEdge feature class in the network

seer joies for the the fields	ork feature classes:	
eature Class Name	Role	Sources & Sinks
RiverLines	Simple Edge	<none></none>

Hit Next

Veight Name	Туре	<u>N</u> ew
		Delete
lds associated with the se	lected weight:	
eature Class Name	Field Name	
to and the set		

and lastly **Finish.** You'll see the computer think for a while and then come up with a new Geometric Network that has Junctions to connect every Edge. What has happened is that each RiverLine feature now knows what river lines it is connected to.



There seems to be a systematic displacement between the REC river lines and the river line images below in the **Generic New Zealand** base map we've been using, so let's use the **World Topo Map** basemap instead and zoom in to a particular area within the network.



If we do a query using the tool, you'll see a set of attributes for each reach that includes its **NZREACH** number that is unique for all of the 600,000 reaches in New Zealand, and also **DISTSEA** which is the distance downstream from this reach that the water flow reaches the sea in meters. In the example shown this is 103485 meters or 103.485 km.

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	-	
	Location:	1,502,987.393 5,191,939.064 Meters
	Field	Value
	OBJECTID	417
	Shape	Polyline
	FNODE_	42862
588 m	TNODE_	42583
	LENGTH	1038.82251
	REACH_ID	42443
	NZREACH	13042443
	FNODE	42862
N21	TNODE	42583
	ORDER_	4
	CLIMATE	CW
	SRC_OF_FLW	н
	GEOLOGY	Al
• / ~	LANDCOVER	P
	NET_POSN	MO
	VLY_LNDFRM	LG
	CSOF	CW/H
	CSOFG	CW/H/AI
	CSOFGL	CW/H/AI/P
	CSOFGLNP	CW/H/AI/P/MO
3 8	CSOFGLNPVL	CW/H/AI/P/MO/LG
$\{$	SPRING	
	NZFNODE	13042862
	NZTNODE	13042583
1 million	CATCHAREA	88406112
	DISTSEA	103485.4

Right click on the grey area on the right hand side of the top ribbon in ArcMap and select **Utility Network Analyst**. Select **Flow/Display Arrows** 

Utility Network Analys		- 1
Selwyn_Net	Flow ▼ P= Analysis ▼ Find Common An	cestors 👻 🖉
	Display Arrows For	
4	🚛 🖌 Display Arrows	
<u>}</u>	Properties	~ ~

and you'll see lots of blobs appear. This means that the network edges don't know in what direction water flows on them.



Use the Search Function to select the Set Flow Direction function

Search 🕈	×
< 🔶 🟠 🌫 🗄 🔻 Local Search	-
ALL Maps Data Tools Images	* g
set flow direction	Ę
Any Extent	odalo
Search returned 1 items	E
Set Flow Direction (Data Managemen Sets the flow direction for a geometric toolboxes\system toolboxes\data manage	

Select the **Selwyn_Net** for the Flow Direction and **WITH_DIGITIZED_DIRECTION** for the flow direction. This means that the flow will go in the direction of the nodes that make up the river lines and these are in a sequence that points downstream.

Set Flow Direction
Geometric Network
P:\WATR404\Ex3\Selwyn.mdb\Network\Selwyn_Net
Flow Option
WITH_DIGITIZED_DIRECTION

Now you can see that the network knows in what direction that the water flows. Pretty cool!!



Now let's set an Edge Flag on a network edge.





588 m

low • 🖳 🛛 Analysi:	▼ ↓ Trace Downstream →	X
3	Find Common Ancestors Find Connected Find Loops Find Disconnected Find Path Upstream	
5	Trace Downstream Find Upstream Accumulation Trace Upstream	

Click on the  $\stackrel{\checkmark}{\frown}$  and now you'll see a path showing how the flow goes downstream.

yst	- x
Flow ▼ 🖧 │ Analysis ▼ 💐 ▼ Trace Downstre	eam 🔹 📈
458 m	
	The second secon
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If you Zoom to Layer extent and turn off the Show Arrows option,

	Сору					
🖃 🗹 RiverLin 🗙	Remove					
CAT	Open Attribute Table					
- 0.000	loins and Relates					
- 32317	yours and relates					
-11615 🔷	Zoom To Layer					
	Zo Zoom To Laver					
-46413	Vie					
-07207	Zoom to the extent of the selected					
-97397	La laver					
Rec2Ws						

And you'll see a flow path all the way down to the sea.



For assessment of the impact on Lake Ellesmere/Te Waihora, we don't want the distance all the way to the sea but rather to the shoreline of the lake, so let's zoom in there, and set a Barrier Barrier Tool, which is a red X that is a bit hard to see in this display.



We select Analysis/Clear Results and it's a bit easier to see



Now, let's select Analysis/Options and



And return results as Selection rather than Drawings

Analysis O	ptions				×	
		-				
General	Weights	Weight Filter	Results			
Resu Retu	lts format – m results a Drawings	s:				
Draw individual elements of complex edges						
Trace task result color						
0	Selection					

And now let's do our Trace Downstream again

And you'll see that the riverlines are now selected in the display



And if you Zoom to Layer again, you can see a very nice tracing of the flow path from our selected reach to Te Waihora.



If you open the Attribute Table, hit the Selected Record button at the bottom of the screen, and then calculate the Statistics on the Length attribute

Image: The stage is an analysis of the selected statistics of the selected statistics will only be generated for the selected st	Tal	ble									
RiverLines         OBJECTID*       Shape*       FNODE_       TMODE_       LENGTH       REACH ID       NZREACH       FNODE       TMODE         305       Polyline       42330       42331       42342       Sort Ascending       42332         314       Polyline       42337       42330       971.54       Sort Ascending       42332         315       Polyline       42337       42337       42342       Advanced Sorting       42337         318       Polyline       42337       42337       42343       42437       42351         336       Polyline       42337       42343       439.70       Statistics       42251         336       Polyline       42384       42364       42217       42364       42254         337       Polyline       42583       42649       422.11       Statistics       Generates a report of statistics for the selected values in this numeric. If any of 73         3382       Polyline       42264       42263       1038.2       Statistics       Generates a report of statistics for the selected values in this numeric. If any of 73         448       Polyline       43023       43086       584.55       Only be generated for the selected generated for the selected sites will on yb seperated fo	0		N 🖸 🕂	×	St # ×	5					
OBJECTID*       Shape*       FNODE       TNODE       LENGTH       REACH ID       NZREACH       FNODE       TNODE         305       Polyline       42320       42338       42.42       Sort Ascending       42337         311       Polyline       42337       42320       971.54       Sort Ascending       42337         313       Polyline       42337       42337       971.54       Sort Ascending       42337         313       Polyline       42337       42337       821.54       Summarize       42337         313       Polyline       42337       42337       821.54       Summarize       42337         328       Polyline       42240       42338       42649       422.13       Statistics       Generates a report of statistics for the selected values in this numeric field. This command is disabled if this field is not numeric. If any of the selected values in this numeric field. This command is disabled if the selected values in the solutes will converted values in the solutes will converted	Riv	rerLines									
305       Polyline       42320       42338       4242         314       Polyline       42337       42320       971.54       Sort Ascending       42332         315       Polyline       42337       42320       971.54       Sort Ascending       42332         315       Polyline       42354       477.83       Advanced Sorting       42373         328       Polyline       42333       42347       Statistics       42373         3320       Polyline       42333       42649       42213       Statistics       42374         368       Polyline       42383       42649       422.13       Statistics       42563         381       Polyline       42669       42774       746.98       886.69       Statistics       Feld         444       Polyline       42669       42774       746.98       886.69       Statistics       Generates a report of statistics for the selected values in this numeric. field. This command is disabled if this field is not numeric. If any of 73       4448       Polyline       42802       42801       766.69       77       40138.63       77       Polyline       42802       42873       718.99       71       414       0       116.3961       43454       1304		OBJECTID *	Shape *	FNODE	TNODE	LENGTH		REACH ID	NZREACH	FNODE	TNODE
314       Polyline       42337       42320       971.54       Sort Descending       42324         315       Polyline       42333       42354       471.87       Sort Descending       42354         318       Polyline       42337       42337       621.54       Sort Descending       42370         318       Polyline       42370       42337       621.54       Summarize       42370         328       Polyline       42341       684.85       Statistics       42370         3319       Polyline       42541       42649       422.13       Statistics       42370         3319       Polyline       42724       746.99       Statistics       684.85       Statistics       686.69         3319       Polyline       42724       746.99       Statistics       686.69       Statistics       686.69       Statistics       697.69         3320       Polyline       42724       746.99       1356.3       103.82       X       42541       136.82       X       444.07       1356.3       103.82       X       444.07       136.31       138.82       X       444.07       136.63       104.07       43065       43065       43936       4366.5	H	305	Polyline	42320	42338	42.42		Sort Ascen	ding		42338
315       Polyline       42353       42354       471.83       Advanced Sorting       42354         318       Polyline       42370       42373       821.54       Summarize       42323         326       Polyline       42240       42353       439.70       223.53       423.54       423.54         326       Polyline       42240       42353       439.70       223.53       422.54         336       Polyline       42240       42353       439.70       22.54       423.54         336       Polyline       42269       422.11       Statistics       422.54         337       Polyline       422.669       886.69       886.69       766.69       766.69         338       Polyline       42260       42600       776.69       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       716.99       710.99       716.99 <th>П</th> <th>314</th> <th>Polyline</th> <th>42337</th> <th>42320</th> <th>971.54</th> <th>-</th> <th>Cart Darca</th> <th>ndina</th> <th>1</th> <th>42320</th>	П	314	Polyline	42337	42320	971.54	-	Cart Darca	ndina	1	42320
318       Polyline       42354       42370       976.69         319       Polyline       42370       42337       821.54         326       Polyline       42338       42337       821.54         3326       Polyline       42338       42337       821.54         3326       Polyline       42338       42351       438.70       2         3344       Polyline       42383       4269       886.66         3311       Polyline       422641       42649       422.13         332       Polyline       422641       4269       422.14         332       Polyline       422641       4269       422.13         332       Polyline       422641       42600       766.69         440       Polyline       42200       766.93       1038.82         441       Polyline       42302       951.83       1038.82         443       Polyline       43023       951.83       1038.82       43065       354.855.97         54       Polyline       43005       433050       354.855.97       10       10       10       10       10       10       10       10       10       10       10		315	Polyline	42353	42354	471.83		Sort Descending			42354
319       Polyline       42370       42337       821.54       Summarize       42333         326       Polyline       42440       42353       43977       Statistics       42533         334       Polyline       42233       42341       684.85       Statistics       42541         366       Polyline       42541       42649       422.13       W       42541         371       Polyline       42583       42669       886.69       Statistics       666         381       Polyline       422649       42200       766.69       The selected values in this numeric.       field.         417       Polyline       42774       42440       1356.38       Y       Generates a report of statistics for the selected values in this numeric. If any of the records in the table are cords.       Y         448       Polyline       42023       951.83       Y       Statistics will 22         554       Polyline       43068       584.55       Y       Statistics will 22         554       Polyline       43005       43605       354.85281       Socce       Socce       Socce       43454       43605       43454       43605       43454       43605       43454       436454       43		318	Polyline	42354	42370	976.69		Advanced	Sorting	-	42370
326       Polyline       42440       42353       439.70       ∑       Statistics       42353         344       Polyline       42334       42541       684.88       ∑       Statistics       42353         366       Polyline       42583       42669       886.68       ∑       Statistics       42353         381       Polyline       42583       42669       886.68       ∑       Statistics         399       Polyline       42724       746.98       Statistics       Generates a report of statistics for the selected values in this numeric. If any of 73         417       Polyline       42862       42801       766.69       This field is not numeric. If any of 73         417       Polyline       42862       42831       1038.82       ×       ×         448       Polyline       43003       43068       584.55       or the selected, statistics will only be generated for the selected for		319	Polyline	42370	42337	821.54		Summarize	•		42337
344       Polyline       42338       42541       684.85       2       Statistics		326	Polyline	42440	42353	439.70		Courses.		[	42353
366       Polyline       42541       42649       422.13         371       Polyline       42583       42669       886.69         381       Polyline       42669       42724       746.98         399       Polyline       42724       42440       1356.3         399       Polyline       42800       766.69       1382       Polyline       42800         417       Polyline       42802       42583       1038.82       Y       this field is not numeric. If any of the records in the table are currently selected, statistics will only be generated for the selected statistics will statistics will addited at the selected statistics will addite	Ц	344	Polyline	42338	42541	684.85	2	Statistics			42541
371       Polyline       42583       42669       886.69       Statistics       66         381       Polyline       42669       42724       746.98       Generates a report of statistics for the selected values in this numeric. If any of the field. This command is disabled if this field is not numeric. If any of the records in the table are currently selected, statistics will only selected, statistics will only selected, statistics will only selected.       383       Polyline       42864       42800       766.69       X       X       Statistics       Stati	Ц	366	Polyline	42541	42649	422.13					42649
381       Polyline       42669       42724       746.98       Generates a report of statistics for the selected values in this numeric field. This command is disabled if 000 fi	Ц	371	Polyline	42583	42669	886.69		Statistics			169
382       Polyline       42724       42440       1356.3       the selected values in this numeric field. This command is disabled if this field is not numeric. If any of the records in the table are currently selected, statistics will only be generated for the selected selected.       448       Polyline       42802       42802       4583       1038.82       *       *       the selected values in this numeric field. This command is disabled if this field is not numeric. If any of the records in the table are currently selected, statistics will only be generated for the selected selected.       554         448       Polyline       43008       43504       2857.93939       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *	Ц	381	Polyline	42669	42724	746.98		Generates	a report of	statistics	for 24
399       Polyline       42649       42800       766.69       field. This command is disabled if       70         404       Polyline       42800       42773       716.98       *       field. This command is disabled if       70         417       Polyline       42862       42583       1038.82       *       *       field. This command is disabled if       70         448       Polyline       42023       43068       584.55       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       *       * <td< th=""><th>Ц</th><th>382</th><th>Polyline</th><th>42724</th><th>42440</th><th>1356.3</th><th></th><th>the select</th><th>ed values in</th><th>this num</th><th>eric 40</th></td<>	Ц	382	Polyline	42724	42440	1356.3		the select	ed values in	this num	eric 40
404       Polyline       42800       42773       716.98       this field is not numeric. If any of the records in the table are currently selected, statistics will only be generated for the selected records.       83         448       Polyline       43068       43504       2657.93939       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83       951.83	Ц	399	Polyline	42649	42800	766.69		field. This	command	is disable	dif 🚺
417       Polyline       42882       42583       1038.82       ★       the records in the table are currently selected, statistics will only be generated for the selected       22         448       Polyline       42023       43023       951.83       Currently selected, statistics will only be generated for the selected       22         554       Polyline       43068       545.42       2657.93939       1016.3961       43454       13043454       43605       43936         577       Polyline       43605       43936       1116.3961       43454       13043454       43605       43936         668       Polyline       43605       43936       1116.3961       43454       13043454       43605       43936         14       0       ▶       ▶       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ●       ● <t< th=""><th>Ц</th><th>404</th><th>Polyline</th><th>42800</th><th>42773</th><th>716.98</th><th></th><th>this field</th><th>is not nume</th><th>ric. If any</th><th>of 73</th></t<>	Ц	404	Polyline	42800	42773	716.98		this field	is not nume	ric. If any	of 73
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459       Polyline       43023       43068       584.55       only be generated for the selected for	Н	448	Polyline	42773	43023	951.83	-	currently	selected, sta	itistics wil	23
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	42.4 1213.7 2385.0 3556.2 4727.5 5898.8										
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In this the Sum value is 88033 meters or 88.033 Km. This means that water and contaminants flowing along this reach will have to travel about 88 Km to get to Te Waihora. As contaminants travel in water, they are transformed – the concentration of bacteria, for example, drops significantly with time (say 80% loss in 1 days travel time). So travel distance and time are important indicators of the likelihood of deleterious downstream impacts from upstream contamination.

To be turned in: Make a nice map of the Selwyn catchment with a pathway from one of the upstream reaches to Lake Ellesmere/Te Waihora shown as selected. What is the length of this flow path in Km?

#### Summary of Items to be Turned in:

- (1) A screen capture of the header of your WaterML response for flow along with the first couple of data values, as shown above. What is the time period of your data request (from date, to date)? What are the units of the flow data? What was the mean daily flow of the Mangatainoka River at Pahiatua Town Bridge on 5 March 2018?
- (2) A screen capture of the header of your WaterML response for E. Coli along with the first couple of data values, as shown above. What is the Feature of Interest, Observed Property, Procedure of Measurement and Temporal Domain of the Result? What is the time period of your data request (from date, to date)? What are the units of the E. Coli data?
- (3) Plot a nice time series chart of these data and find the critical percentile values of these data that correspond to the New Zealand coliform data standards. What quality level do these data represent?
- (4) Make a nice map of the Selwyn catchment with a pathway from one of the upstream reaches to Lake Ellesmere/Te Waihora shown as selected. What is the length of this flow path in Km?