

David Huer	14-Jun-19
(C)	MITIGATING FUTURE FLOOD DAMAGE
	and
Image:	http://www.vancouversun.com/Gallery+Duncan+North+Cowichan+flood+photos/2252175/story.html
	Why is surface pending hoppening at Kelejiah Industrial Area (Duppen DO)2
My Activities Customer Outcome:	Recognizing presence of original river channel, buried ~100 years ago. Reducing potential loss of public works' investments. Saving \$millions of dollars in property losses from future flood damage.
SCENARIO:	The Ecological Accounting Process Initiative team collaborated with government to investigate whether Wetlands could mitigate Busy Creek (BCP) flooding in the Koksilah Industrial Area (KIA). Traditional civil methods (concrete drains, weirs, dikes) had failed to stop Koksilah River backflooding. We were to study the site history, legal regime, and site civil engineering to develop an infrastructure proposal (wetlands, ponds, riparian controls, etc.).
(A) Cowichan River (modern channel)	Source: 2009 Post-Flood Report, Stantec Place" in Coast Salish. In pre-contact
(B) Industrial Area (dotted block)	(Public Domain) and colonial times, the Cowichan River and Koksilah River met at Busy Creek
(C) Pre-industrial Cowichan River channel (yellow line)	Busy Creek Place Confluence of Cowichan River and Koksilah River in pre-
(D) Confluence of Busy Creek (black line) with Koksilah River	industrial times <u>Busy Creek</u> = black line <u>Busy Creek</u> = black line
MY ACTIVITIES	
1) Reviewing Issues	History: Mapping site history from colonial to modern times Laws, Regulations & By-Laws: Federal, Provincial, First Nation, District by-laws Water rights rules: Riparian rights, water licenses, etc. 2009 Cowichan Flood: Deep study of hydrodynamics of flood/post-flood works Site Inspections: Flown to Vancouver Island for site visits
2) Review Site Plan	Member of core team developing a flooding mitigation plan
	Reviewing EAP engineer's site engineering proposals. These included multiple retention ponds, located at edge of the floodplain.
Noticing the tiny clue	While comparing geotechnical maps, historic maps, and post-2009 flood reports, I noticed strange ponds where the hard rock uplands met floodplain gravels. Similar features are at the edge of Vancouver's Strathcona Flats. This reminded me (caver) of soluble and non-soluble geology contact zones.
Connecting the dots	I made "connections" while walking the site with our Project Manager.
Reviewing site engineering brief	The Client brief indicated that ponding is caused by storm surface runoff, but this did not make sense to me, when we knew that KIA was protected by modern dikes that were built to stop flooding by the Cowichan River; dikes that were laid across historic river channels filled with gravel, silt, and debris.
Thinking through 3D arrangements & cross- section of gravels, flows & infrastructure	Local stormwater Map: 2009 Flood Review:   Petalled data study The ponding pattern mirrored the location of the original channels mapped by Crown Colony surveyors in 1859.   1859 Maps are copyright UK National Archives and are not reproducible here.



Ran the permutations in my head Despite not being a hydrogeologist or engineer, I am an expert whitewater kayaker, and caver, and 'think spatially'; here, theorizing that ponding is caused by a hidden stream's waters forced to the surface when pressurized by floodwaters undermining the dike; like water backing up in a bathtub.

## Do Floodwaters in the Cowichan River pressurize (P) subsurface parallel flows at the edge of Cowichan River Dike, and are these sufficient to force water under the Dike and up into the depressions?

## Asking the new question H

**Developing Hypothesis** 

## Hypothesis framework:

(a) Are flows pressurized into gravel interstices of the Gravel Base Layer (GBL)?

- (b) Do forces pressurize water to flow under the dike into historic buried channels?
- (c) Will flows convert GBL into a hidden subsurface Floodway (red layer)?

(d) Will subsidence (orange layer) create natural sinks/depressions at the surface?

(e) Will migrating flows get forced upwards into depressions (inverted red triangles)?



3) Alerting Team PM Concern: Capital, Operating, Damage and Reput
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a) There is a hidden streamway that becomes a Subsurface Flood
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- b) The Subsurface Floodway creates ponding events.
- c) Ponding occurs where we plan to put floodwater retention ponds.
- d) During a flood event, pressures will force ponds to fill up from the bottom.
- e) Surface floodwaters will not be captured as designed.
- f) The ponds will act as hard surfaces, forcing surface runoff to back-flood.
- g) The BCP/KIA commercial area will flood from these unexpected in-area sources.
- h) Exacerbating back-flooding by meeting Koksilah River waters in a "haystack/boil".<sup>1</sup>
- i) This will defeat the purposes of the strategy to use retention ponds.

4) Team's Response Our PM reminded me that there is no mention of this in the Client Brief. But he trusts my ability to look at all sides of a problem.

**Persuading Time** 3-days spread over 3-weeks.

- **5) Expert Review** Client's Civil Engineers validated the hypothesis. The hidden streamway is the original Cowichan River channel.
- **6) Results** EAP Team: We offered site recommendations differing from the previous engineering reports.

Page 3 of 3

<sup>&</sup>lt;sup>1</sup> In whitewater, haystacks occur when waves meet an obstruction. Boils form when upwelling currents reach lower density waters at the surface.