Assessing the source of *E. coli* populations in the River Wharfe upstream of Ilkley: samples from Monday 7th October and Tuesday 10th December, 2019

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Our application for Bathing Water status for the R. Wharfe in Ilkley has been submitted. A decision from Defra is expected by May 2020. In anticipation of the application being successful our coliform work continues to focus on identifying potential sources of contamination that could lead to the proposed bathing water site failing to meet the minimum standard, i.e. 900 cfu/100 ml as *E. coli.* We report here on the results from samples collected from sites on both the main River Wharfe and R. Wharfe tributaries upstream of Ilkley on two occasions, October 7th (pictured) and December 10th 2019. The results of the October 7th main river samples have already been reported. For completeness we repeat them here together with data from inflows not previously reported.

October 7th, 2019

E. coli data from ALS Ltd for the October 7th samples during a high flow event and at a time when untreated sewage was being discharged at Ashlands are shown in Figure 1.

Values for the main river (shown in red) from Low Mill Weir in Addingham and as far upstream as Bolton Bridge are consistently not more than 700 cfu/100 ml. Values for inflowing becks (shown in yellow) are considerably higher probably reflecting coliforms coming from a combination of livestock and domestic septic tanks within their catchment. One small tributary, Wine Beck in Addingham, has a very high *E.coli* concentration (11,000 cfu/100 ml), suggesting the presence of a serious pollution source, perhaps from a poorly functioning septic tank. However, these high coliform concentrations in the tributary becks have little or no impact on concentrations in the main river along this stretch of the Wharfe owing to their dilution by the very much greater water volume of the river itself.

A significant increase in concentration to ca. 2000 cfu/100 ml occurs between Addingham and Ilkley. Although on this occasion we did not inspect the outfall from the Addingham Pumping Station nor take a sample from the Mill Stream we believe the sharp elevation in

concentration in the main river from 700 to 2000 cfu/100 ml was caused by spilling from the Pumping Station. Given the dilution capacity of the river noted above no other inflow between Addingham and Ilkley can explain the sustained high levels of coliforms along this stretch.

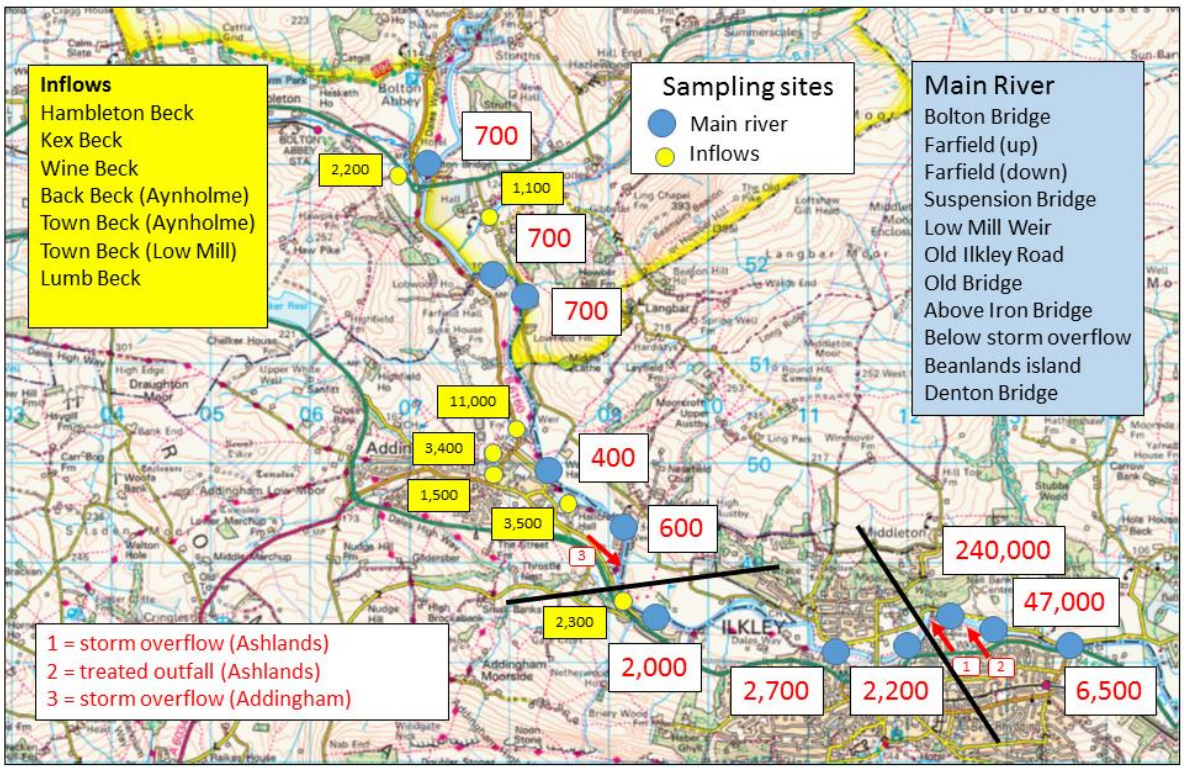

Figure 1. Data for E. coli (cfu/100 ml) from samples taken on 7th October 2019 during high flow conditions and at the time of untreated sewage being discharged from the Ashlands WWTP. Main river samples are shown in red and inflow samples are shown in yellow. Sites are listed sequentially downstream from Bolton Bridge. Red arrows show the discharge points of waste water.

As expected concentrations around the Ashlands WwTP are high. The very high value of 240,000 cfu/100 ml shown on the map relates to the spill from the storm overflow tanks that was occurring at the time of sampling. The decrease in concentrations from Ashlands to Denton Bridge has been observed on all previous sampling occasions and can be most readily explained by downstream *E. coli* die-off.

In summary the results from this October data-set indicate that:

- Coliform sources upstream of Addingham are likely to have little or no effect on concentrations arriving at the Ilkley bathing beach
- The Addingham Pumping Station is the most likely source of elevated coliform bacteria arriving at the bathing beach

- Tributaries draining agricultural land are relatively unimportant, at least in high flow conditions when high inflow concentrations are greatly diluted by main river water
- Nevertheless, the relatively high concentrations in some tributaries are of local concern and point to the need to track down the sources and differentiate between coliforms derived from livestock and those derived from people via septic tanks (or leaking sewers?)
- Further sampling is needed in different flow conditions to assess in more detail sources of coliforms between Addingham and Ilkley
- The time is ripe to consider how the Addingham Pumping Station can be re-engineered to prevent the occurrence of damaging spills.

December 10th 2019

On the 10th December we collected samples upstream of Ilkley including a number of main river and tributary sites (e.g. as pictured) previously sampled in October (see above), but also focussing on inflows not previously sampled between Addingham and Ilkley. Our objective was to assess whether there are any sources of coliforms other than those from the Addingham Pumping Station that might explain an increase in main river coliform concentrations between the two settlements. On this occasion the weather had been relatively dry prior to sampling and untreated sewerage spills were not occurring. There was no opportunity therefore to examine the impact of the Addingham Pumping Station on the river directly.

Figure 2 shows the data for samples collected on the 10th December. An additional sample (not shown) was collected from the Main River at Bolton Bridge. It gave a value of 300 cfu/ml, the same as for the sample from Low Mill Weir. These low values are in agreement with data from October indicating the main source of coliforms arriving in Ilkley is likely to be found downstream of Addingham Low Mill. Unlike the October samples there is no elevation in values in the main river between Addingham and Ilkley, most likely because no discharge was occurring from the Addingham Pumping Station (red arrow and point 3 in Figure 2) on this occasion. Equally the concentration at Ashlands immediately downstream of the storm water outfall (red arrow and point 1 in Figure 2) is relatively low (800 cfu/ml) also indicating that no untreated discharge was occurring at the time of sampling. Values at Beanlands and Denton Bridge downstream of the treated outfall are high as expected.

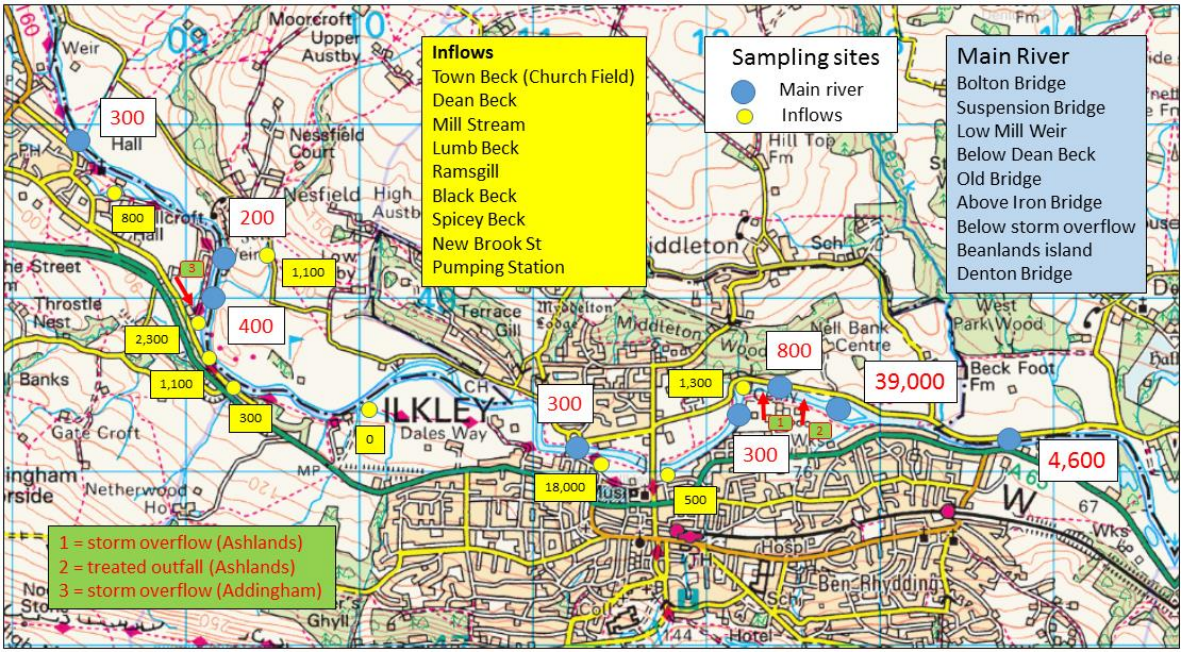

Figure 2. Data for E.coli (cfu/100 ml) for samples collected on 10th December 2019. Legends are as for Figure 1.

Data for the inflows between Addingham and Ilkley show a variety of concentrations reflecting the characteristics of their catchments:

- The Mill Stream (pictured) has a relatively high concentration ((2,300 cfu/100 ml) reflecting contamination from Low Mill village and/or the input of coliforms from polluted sediments created by repeated spills from the Pumping Station
- Lumb Beck drains an almost entirely agricultural catchment but the values could also be influenced by contamination from septic tanks
- Black Beck is remarkably clean, with on this occasion zero coliforms being detected, the value expected in treated drinking water; but
- Spicey Beck, that enters the Wharfe close to the Riverside Hotel has an exceptionally high concentration of 18,000 cfu/100 ml, reflecting serious contamination from an unknown upstream source. This Beck deserves further investigation by a responsible authority.

Perhaps surprisingly the input from Spicey Beck has little or no effect on the concentrations in the main river which remain at 300 cfu/100 ml. The values do allow us, however, without having access to official discharge data for the Wharfe, to estimate that on this occasion the Wharfe is providing greater than a 60x dilution of the pollutants entering. It is for this reason and despite the highly polluted nature of some of the inflowing tributaries that attention needs to be focussed mainly on the Addingham Pumping Station. As the *E. coli* concentration of untreated sewage is in the order of 7,000,000 cfu/100 ml (Kay et al. 2008) that alone is able to seriously elevate coliform concentrations in the river during periods of storm water spillage.

We can conclude that:

- *E.coli* values for the main river are consistently low upstream of Addingham
- Some tributaries have surprisingly high concentrations of *E. coli* that deserve further investigation
- All tributaries whether servicing agricultural land, rural septic tanks or culverted through built-up urban areas have little impact on *E. coli* concentrations in the main river owing to the dilution capacity of the river; and
- although not yet directly proven, but as previously suggested, spills from the Addingham Pumping Station appear to be the most likely source of elevated *E. coli* concentrations responsible for contaminating the bathing beach in Ilkley during high flow events.

The caveat to these conclusions is that sampling has not yet taken place under all flow conditions. Once the bathing season begins in 2020 we aim to sample repeatedly at the main Ilkley bathing beach site (just upstream from the Iron Bridge) for both *E. coli* and Enterococci and at key points upstream and downstream of the Addingham Pumping Station. In this way we can mimic the protocol for the Bathing Waters Directive and at the same time investigate sources of contamination that might cause the bathing designation to fail.

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Reference

Kay, D., Crowther, J., Stapleton, C.M., Wyer, M.D., Fewtrell, L., Edwards, A., Francis, C.A., McDonald, A.T., Watkins, J. & Wilkinson, J. 2008 Faecal indicator organism concentrations in sewage and treated effluents. *Water Research*, 42, 442-454.

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