

Is it elk, deer, cattle, human...
or what?

Source tracking
in Boise Creek's stormwater system

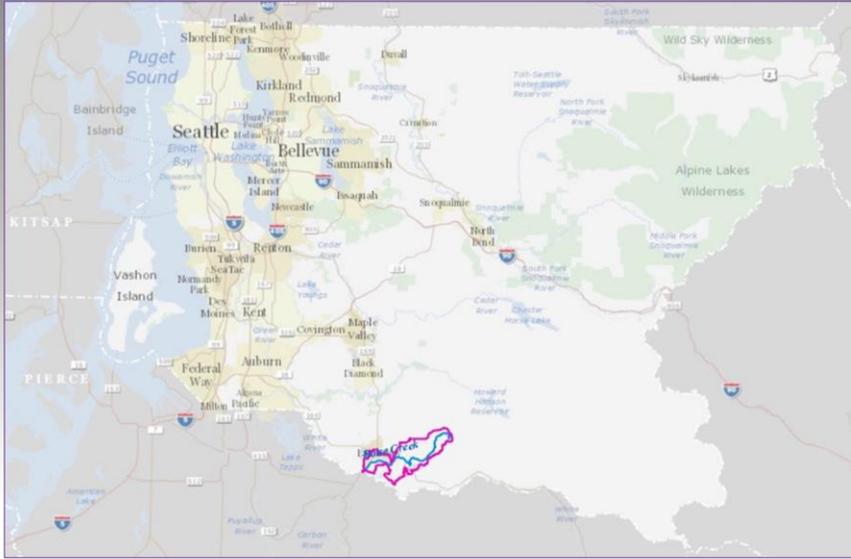
King County

WLRD Stormwater Services

Intro Slide.

Slide show completed November 3 2015 by Jeanne Dorn, King County DNRP WLRD Stormwater Services, Water Quality Compliance Unit, Seattle, Washington. No express guarantees or warranties are implied in this PowerPoint presentation.

Boise basin – location



Boise Creek is located in SE King County, south of City of Enumclaw.

Boise basin – beautiful South King County



Image copied from boisecreekfarm.com website, Bob & Gina Ames, farm owners

Pic of Boise Creek Farm, owned by Bob and Gina Ames, and their fold of Scottish Highland Cattle

Puyallup White River Fecal Coliform Limits

White River and tributaries, especially Boise, exceed allowed fecal coliform (FC) levels.

Required FC reductions at Boise (mouth at White River):

92%, dry weather

61%, wet weather

Impetus for this work in general is the federal Clean Water Act; White River and its tributaries have portions designated as Category 5 impacted by fecal coliform, which means a plan to reduce the pollutant loading is required. The Total Maximum Daily

The TMDL and our stormwater permit work is based on measured high levels of fecal coliform bacteria which exceed regulatory limits.

Required reduction levels that are mandated by the State for Boise Creek by year 2025 are 92% reduction at mouth, dry weather (July to October); and 61% reduction at mouth, wet season (Nov to June).

These required reductions come from the Puyallup River FC TMDL Water Quality Improvement Report, Washington State Department of Ecology, 2011.

Boise Creek is classified as a Primary Contact Recreation Water.

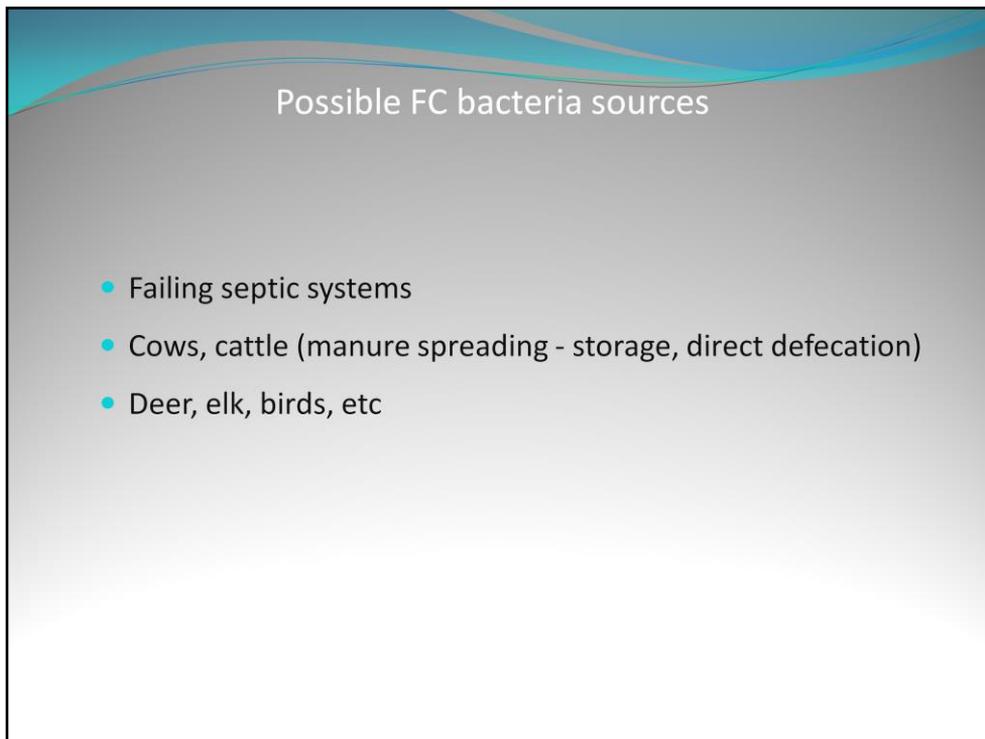
Water Quality State Standard for this is: FC must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.

Load sets the amount of pollutant reductions required to meet water quality standards.

2013-2018 Stormwater Permit Requirement

Requires King County to field screen for bacteria sources discharging from stormwater system.

Stormwater Services is doing bacteria source screening in stormwater system because it's required by our municipal stormwater permit.



There are many possible sources of high bacterial levels, as shown

Boise dairy cows



There are dairy cows in the basin.
Cow manure is kept in piles and lagoons in the basin.
Manure is spread as fertilizer, as well.

Boise beef cattle



There are also beef cattle in the basin. In many cases cattle have been observed in and near ditches.

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Boise - other domestic animals



Goats and chickens in Boise creek area.

Boise wildlife



There are two large herds of elk that roam at will, trampling through fences to get wherever they want.

And the basin has deer and other mammals.

So any fecal matter getting into the creek could be from any or all of these animals, as well as the possible anthropogenic sources.

Boise birds



Black headed grosbeak, redbreasted sapsucker and northern flicker (in flight), all photos from Bob & Gina's boisecreekfarm.com website
About 100 species of birds have been seen throughout the years in the basin.

Stormwater system



County ditches

Boise Creek's stormwater conveyance system is comprised of roadside ditches, and closed conveyance including pipes, catch basins and manholes, discharging via outfalls to the Creek.

Stormwater system



Catch basins & pipes

Boise Creek's stormwater conveyance system is comprised of roadside ditches, and closed conveyance including pipes, catch basins and manholes, discharging via outfalls to the Creek.

Stormwater system



Stormwater pipes
outfalling to
creek

Boise Creek's stormwater conveyance system is comprised of roadside ditches, and closed conveyance including pipes, catch basins and manholes, discharging via outfalls to the Creek.

Major players



Ray Timm w/ help



Jeanne Dorn, w/ lotsa help

Science Section's Ray Timm established sites beginning in 2010 in both unincorporated King County and in the City of Enumclaw; tested for sorbital fermenting bifidobactor and other tests; moved toward using culturable and qPCR bacteria tests to try to differentiate problems (septic versus cattle versus dairy cow).

King County Environmental Lab's Field Science Unit's Stephanie Hess has been hugely instrumental in Science's sampling of Boise.

Stormwater Services staff working in Boise Creek basin's stormwater system; Dorn initiated work, which has been carried forward by Cameron Chapman, with the help of Alexander Jones, Lori Cronin, and the intern Terae.

What We Did



Got out there with our eyes, ears and noses!

We then drove and walked the basin, familiarizing ourselves with the stormwater system of ditches, pipes and catch basins. We selected sampling points in our MS4 to screen and sample for high levels of bacteria. Water samples for Coliscan Easygels and for fecal coliform, human *Bacteroides* and ruminant *Bacteroidales* have been tested. Slide shows Jeanne Dorn and Terae Jones walking near a County roadside ditch in Boise Creek.

What We Did



Conducted water sampling

Slide shows Terae and Jeanne obtaining water from a stormwater catch basin to culture a Coliscan Easygel (rapid *E. coli* culture method, commercially available).

We also submitted samples to our County lab for analyses for Hu-1-Bacteroides and Ruminant-2-Bacteroidales. Later the method for human gut bacteria DNA was changed to Hu-2-Bacteroides, a more specific and less sensitive genetic marker, which we consider more reliably indicates the presence of human waste than Hu-1 did.

Good old fashioned methods

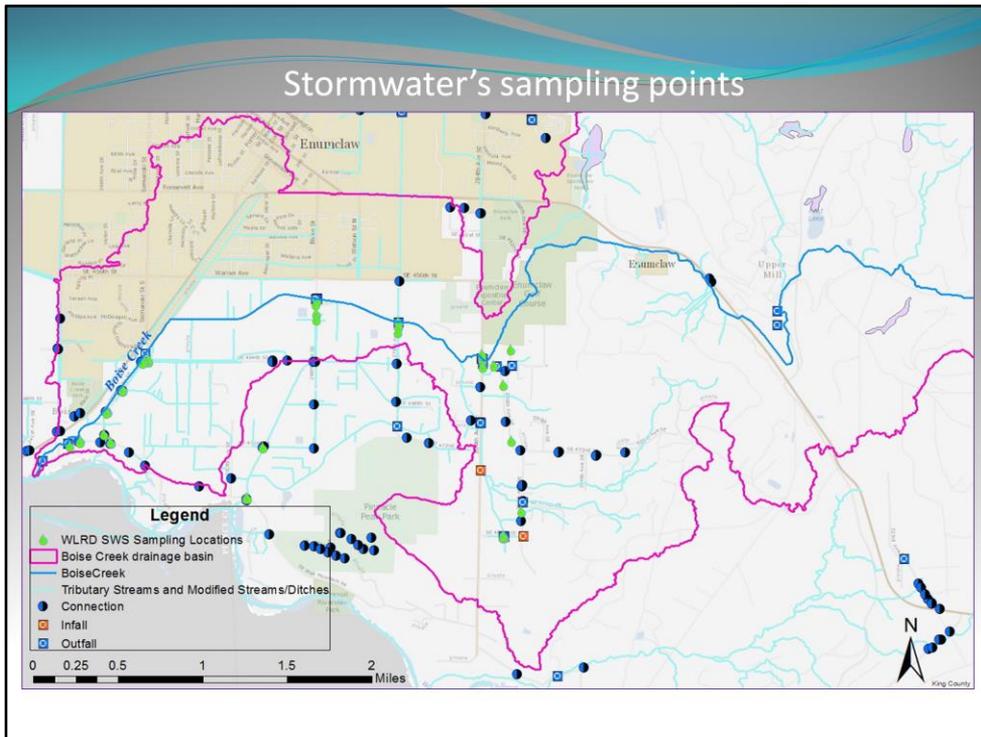
- We got out there! On foot, by vehicle, year round, rain & shine
- Studied stormwater system drainage patterns
- Pulled manhole lids, clambered into ditches
- Looked, smelled, listened
- Talked to locals
- Took pics & notes

Emphasize that good old fashioned getting out and walking/driving around, in all kinds of weather conditions, is needed for this kind of work—not just relying on sampling and analysis alone, but in conjunction with field observations and rudimentary knowledge of area hydrology, and stormwater drainage patterns.

Analytical tools used so far

- King County Lab
 - FC (culture)
 - *E. coli* (culture)
 - Hu-1 and Hu-2-*Bacteroides* (qPCR DNA)
 - Rum-2-*Bacteroidales* (qPCR DNA)
- In house, King Street
 - Coliscan® Easygels®
- Private Lab
 - Cow specific markers & human specific markers

Many questions remain about FC TMDLs in general. For source tracking work, it would help to get better handles on mechanisms of FC transport into creeks. Is it all overland flow or can there be significant shallow subsurface flow between septic systems and creeks directly? Stormwater Services is only responsible for high levels of bacteria discharging via our stormwater conveyance system to the creeks. Who else needs to be doing source tracking/bacteria screening in these areas?



We established 45 sample locations in the stormwater conveyance system so far.

Green dots are SWS sampling points.

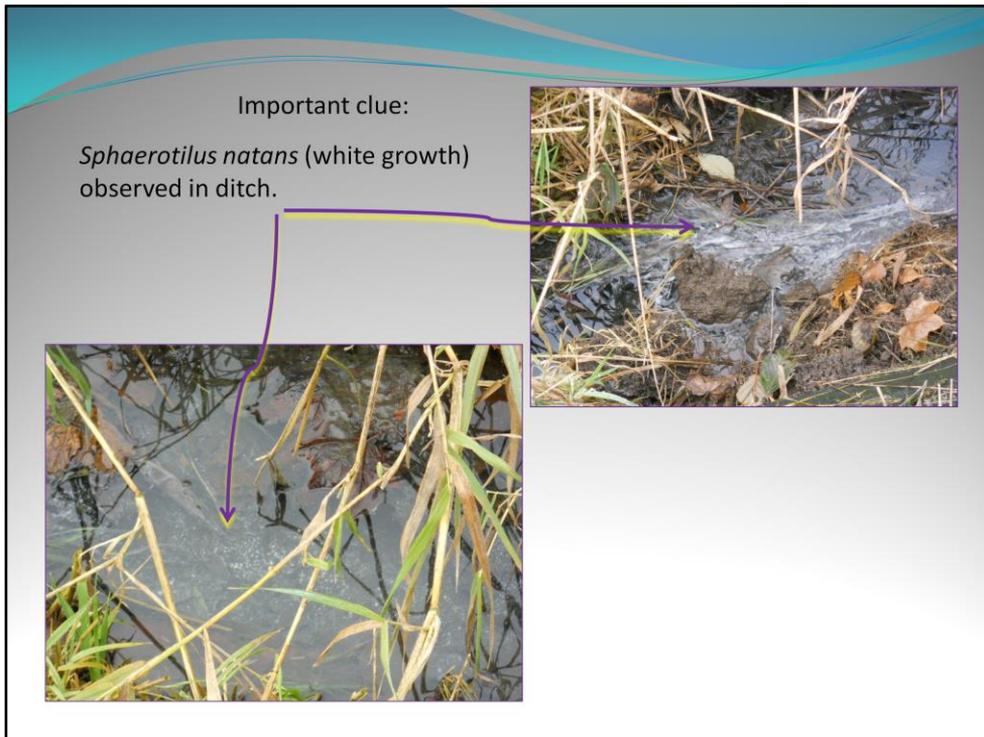
Blue question marks are places where stormwater leaves King County conveyance system.

1st illicit discharge

High hits of Hu-1-*Bacteroides* in 2011 found by Science.



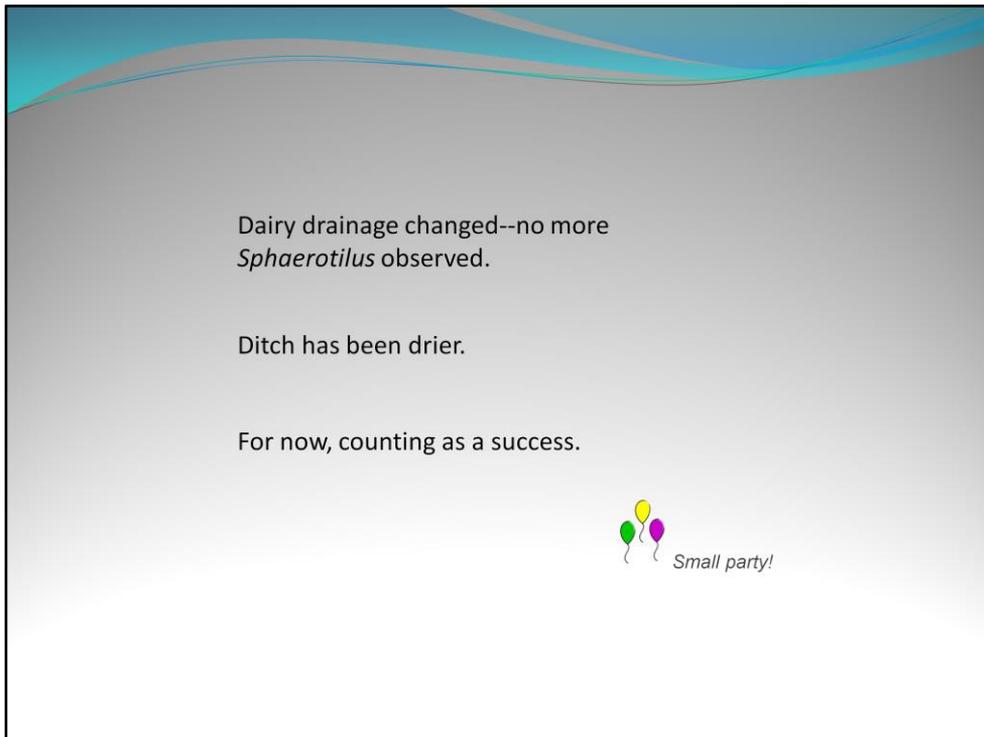
This slide shows Science's sample location 10, which is where a County ditch discharges to Boise Creek. Ray found high hits of Hu-1-*Bacteroides* at his station 10, which is at the intersection of the creek and a County stormwater ditch. Creek at top right is Boise, flows westward (toward top of slide).



Science reported the high levels of Hu-1-*Bacteroides* to Stormwater Services. We followed up by sampling numerous points up the ditch, and confirmed high levels of Hu-1-Bac in the ditch. At time of first Stormwater Services visit in late December 2011, a white filamentous growth was noted and photographed. Later, we determined this could be *Sphaerotilus natans*, a bacteria that flourishes in flowing sewage.

More testing confirmed human waste.

Our Health Dept performed inconclusive dye testing of the residence, so we never found pathway mechanism of this discharge.



As the property was a commercial dairy licensed by Wash State Dept of Ag, we contacted Ag. The Ag inspector did a site visit in 2012, and recommended some drainage improvements, specifically re-routing some roof drainage to a filter strip rather than flowing offsite directly into the County ditch. For the last few years, we have not witnessed the white growth (suspected *Sphaerotilus*) in the ditch; we are “counting” this as an illicit discharge of some sort that has been eliminated. However, we plan to keep sampling the ditch as we can.

2nd illicit discharge



Found during dry weather screening at BSE_115 site (catch basin north across street here).

Illicit discharge tracked to CB here.

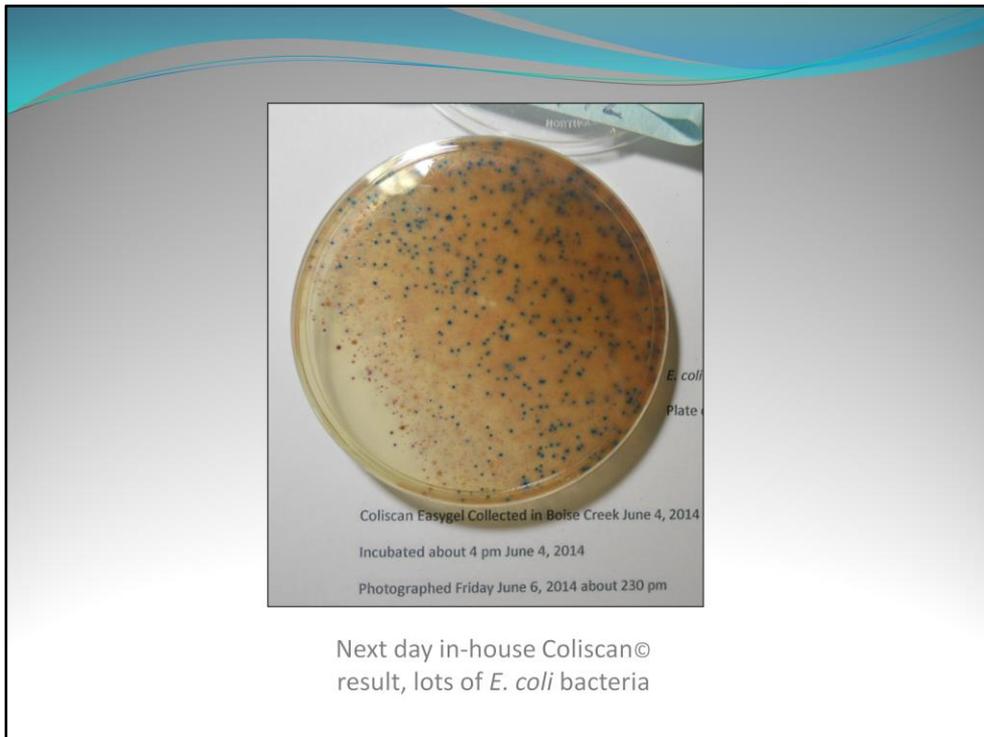
While performing one of the iterations of screening and sampling in the Boise Creek MS4, a catch basin (Sample BSE_115) on the north side of the street (background of this picture) was found that had milky-appearing water flowing in from the catch basin on the south side across the street (foreground of picture).



Ugly water flowing into this County CB from a private pipe.

Coming from a cattle ranch with an old house on septic system.

Milky, ugly, smelly water found in County catch basin, trickle flow of this water observed in private discharge pipe coming from the area of an old house, on septic system, on a cattle ranch.



The Coliscan Easygel test on a sample of the inflow was immediately sampled the day of the discovery; we incubated it overnight in our downtown Seattle office building lab room. Test results the next day (right slide) in our office confirmed high levels of *E. coli*.

Lab results

Submitter: King County DNRP
Date Received: June 19, 2014
Date Reported: June 27, 2014

SM #	Client #	Analysis Requested	Species	Human Specific Marker Quantified*	DNA Analytical Results
SM-4F19015	KC142	Human Bacteroidetes ID 1	Dorei	1.55E+06	Present
SM-4F19016	KC142	Human Bacteroidetes ID 2	EPA	ND***	Absent

*Numbers reported as copy numbers per 100 mL of water
**Below limit of detection (10 copy numbers per reaction)
***Non-Detect

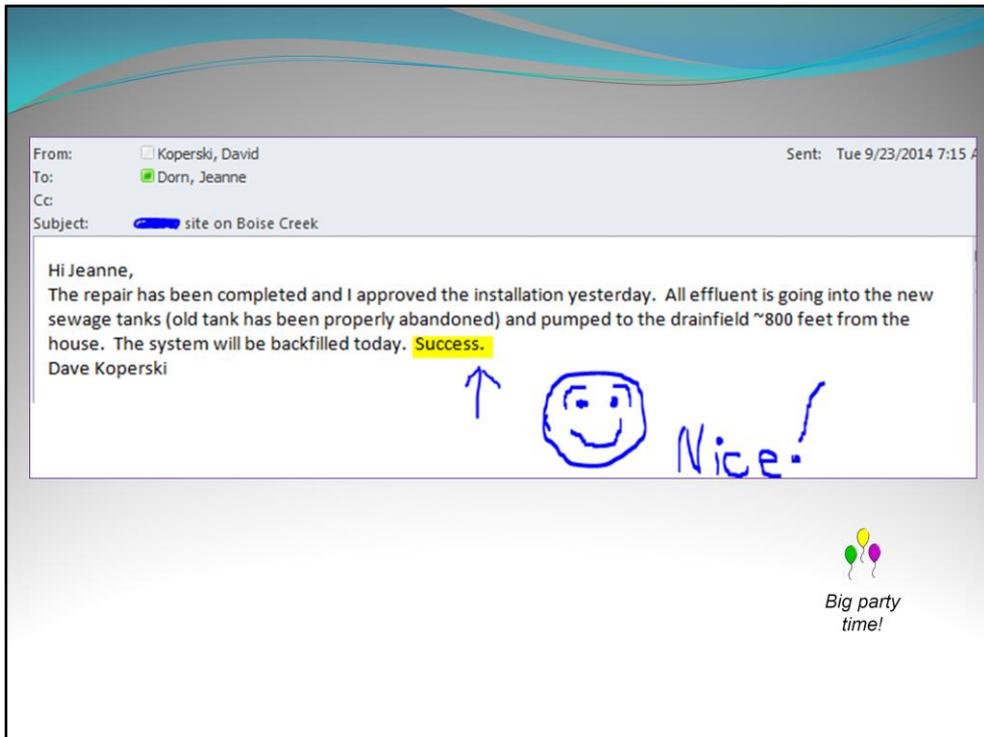
Positive hit for human: **Bingo!**

Submitter: King County DNRP
Date Received: June 19, 2014
Date Reported: June 27, 2014

SM #	Client #	Analysis Requested	DNA Analytical Results
SM-4F19017	KC142	Cow Bacteroidetes ID 1	Absent
SM-4F19018	KC142	Cow Bacteroidetes ID 2	Absent

(Negative hit for cattle)

Property was a home on a cattle ranch in Boise. We needed to differentiate between cattle and human waste, so grabbed a sample of the CB water the following week, and sent it to a private lab to conduct qPCR tests on two human waste tracers and two cow waste tracers. Tests came back positive for human tracer, negative both cow tracers.



A new septic system was permitted, installed and approved within months of our findings. Screen shot shows clip from Dept of Public Health-Seattle & King County email to Jeanne Dorn, regarding this site.

3rd and 4th illicit discharges



Stormwater's sample site BSE_109
(catch basin)

During dry weather screening and sampling, test results for FC and Hu-2-*Bac* came back high for this catch basin, which discharges directly to Boise Creek.

Sampling done dry weather September 2014. No Rum-2-*Bacteroidales* detected.



Ray points at just-discovered illicit discharge pipes--covered by blackberry vines

Jeanne and Ray conducted follow-up work at this site during a rain event in October 2014.

Ray noticed the sound of flowing water in a location we'd never heard that sound.

We poked around in overhanging blackberry vines until we discovered a pipe with flowing water (later was discovered to be two adjacent pipes, one discharging sewage, one discharging laundry washwater).



Pipes after removal; photos by property owner



Excavating & removing illicit drainage pipes



Two illicit pipes to County ditch (sewage and wash water) were subsequently ripped out, after our Health Dept contacted owner and requested they design a septic system repair.

Remaining questions, Boise basin

- Are there other sources of high FC?
- Could subsurface flows directly to creek be carrying FC from septics?
- Could canine scent tracking work here? Should we use it?
- Will we ever have “instant” FC field test tools for tracking?

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Next steps, Stormwater Services



Continue focused Boise basin stormwater system bacteria screening work until February 2016.

We still focusing source tracking efforts in our stormwater system in Boise Creek, until the Permit requirement to conduct such work ends in Feb. 2016. W



All images from Internet: bald eagle (one of over 100 species of birds seen in Boise Creek basin), Mt Rainier from the Enumclaw plateau, and a chum salmon at spawning time.

If you see, hear or smell something in our stormwater system or a natural water, contact Stormwater Services' water quality complaint line, 206-477-4811.