

### 3 Watershed Assessment

#### 3.1 Impaired Designated Uses within the Watershed

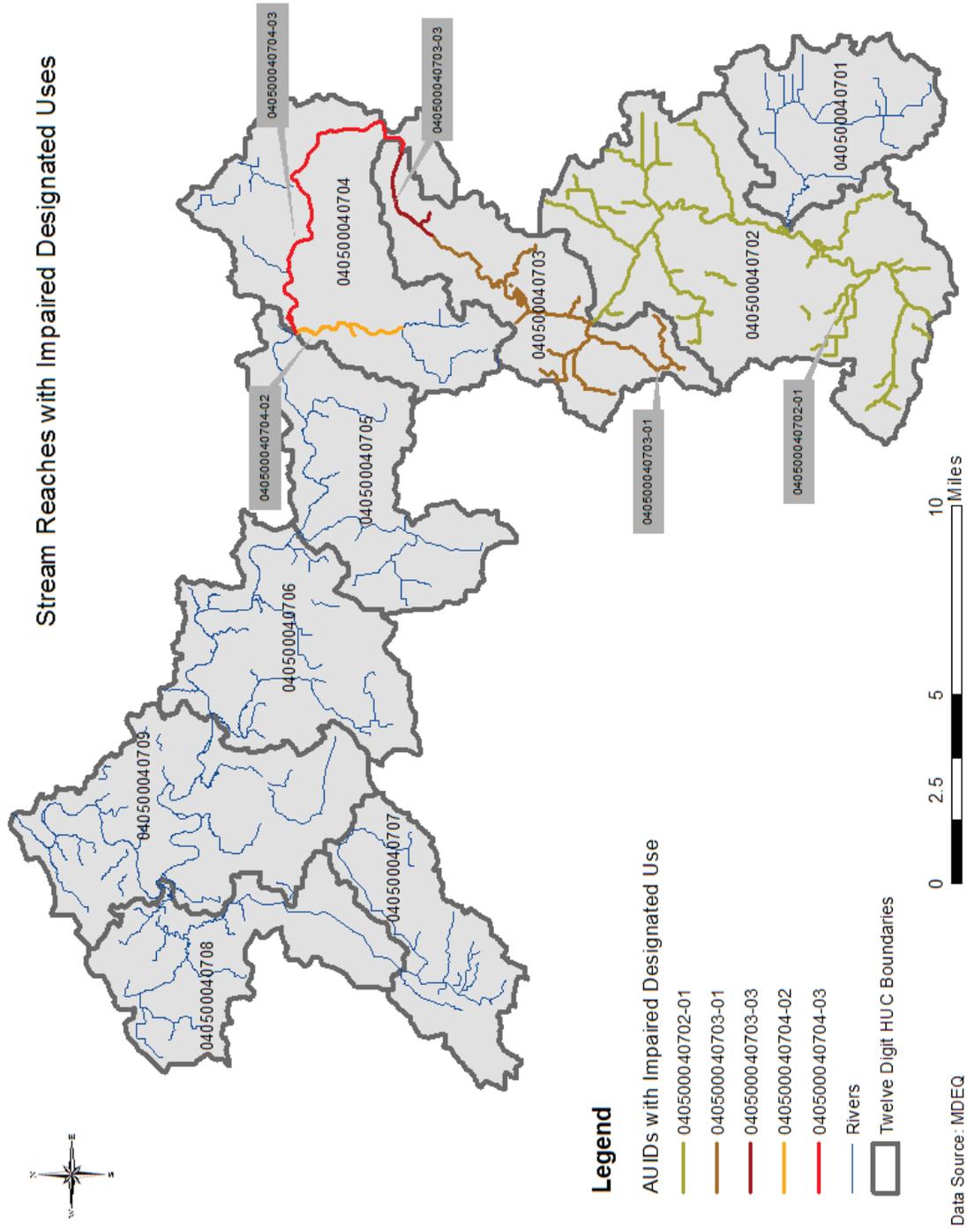
Current water quality impairments were identified and noted to create a focused WMP for addressing nonpoint source pollutants.

A variety of pollutants are impairing water quality within the Watershed (Table 7 and Figure 9). Of the 129 miles of stream, there are 59 miles of stream reaches and 110 acres (Moores Park Reservoir) within the Watershed do not meet the water quality standards. They are identified as not supporting partial body contact recreation (10 miles and 110 acres), total body contact recreation (55 miles and 110 acres), warmwater fishery (8.67 miles) and other indigenous aquatic life and wildlife (12.67 miles) (Table 7 and Figure 9).

Table 7. Assessment Unit Identifiers (AUIDs) and Listings

Subwatershed	Assessment Unit	Area Included in TMDL	Designated Use Not Being Met	Pollutant
Skinner Extension Drain	040500040702-01	16 mi	Total body contact recreation	<i>E.coli</i>
Silver Creek	040500040703-01	17 mi	Total body contact recreation	<i>E.coli</i>
Silver Creek	040500040703-02	110 acres	Partial and total body contact recreation	<i>E.coli</i>
Silver Creek	040500040703-03	12 mi	Total body contact recreation	<i>E.coli</i>
Carrier Creek	040500040704-03	10 mi	Partial and total body contact recreation	<i>E.coli</i>
Carrier Creek	040500040704-03	8.67 mi	Warmwater fishery	Total Suspended Solids
			Other indigenous aquatic life and wildlife	
Carrier Creek	040500040704-02	4 mi	Other indigenous aquatic life and wildlife	Sediment

Figure 9. Stream Reaches with Impaired Designated Uses



### 3.1.1 Total Maximum Daily Loads (TMDL)

As part of assessing the watershed, it was important to take into account existing water quality issues and impacted areas as currently identified by MDEQ. The Clean Water Act requires states to establish TMDLs for bodies of water that do not meet water quality standards. A TMDL is the total amount of a pollutant that can be discharged into a body of water, per day, without impairing water quality standards. In the Watershed, TMDLs exist for *E.coli* levels that exceed total or partial body contact (e.g., downtown Lansing and upstream to Eaton Rapids (55 miles and 110 acres)), and excessive sedimentation impairing aquatic indigenous life (e.g., Carrier Creek in Delta Township (4 miles)). A draft TMDL for low dissolved oxygen levels (e.g., portions of downtown Lansing, Lansing Township and Delta Township (8.67 miles)) is pending approval from EPA.

The following is a summary of the developed TMDLs in the Watershed:

*Skinner Extension Drain (AUID 040500040702-01), Silver Creek (AUID 040500040703-01, AUID 040500040703-03 and AUID 040500040703-02) and Carrier Creek Subwatersheds (AUID 040500040704-03)*

MDEQ published a TMDL for *E.coli* in portions of the Red Cedar River and Grand River Watersheds; including Sycamore, Sullivan, Squaw, and Doan Creeks (August 2012). In the Middle Grand River Watershed this TMDL spans 55 miles and 110 acres (Moores Park Reservoir). Monitoring carried out in 2009 by MDEQ staff and the Ingham County Health Department-Bureau of Environmental Health (ICHD-BEH) indicated that water quality standards (WQS) for total body contact (TBC) are not being met because of current *E. coli* levels. There are also occasional periods where partial body contact (PBC) standards are not being met.

DEQ monitoring data, collected between May 18, 2009 and August 31, 2009, indicated that all sites downstream of the Red Cedar River watershed exceeded TBC WQS 100% of the time. The Red Cedar makes up roughly 31% of the flow in the Grand River and is therefore a significant contributor of *E. coli* to the Middle Grand River Watershed.

Potential sources of *E. coli* loading to the TMDL area include illicit residential sewer connections, failing septic systems, biosolid and septage applications, agriculture operations, wildlife and pet waste, stormwater runoff and storm sewer discharges.

See Appendix 2 for the complete report.

*Carrier Creek Subwatershed (AUID 040500040704-02)*

In 2002, MDEQ developed a TMDL for Carrier Creek. Carrier Creek is located in Delta Township on the east side of Eaton County. Due to stream modifications made to support agricultural and urban land use, soil and stream bank erosion created excessive sedimentation. The sediment and changes in hydrology led to habitat loss and an aquatic life impairment. The TMDL developed covered 4 miles of Carrier Creek. The goal of the developed TMDL was to demonstrate a water quality attainment for biota using Procedure 51. Procedure 51 assesses macroinvertebrate communities and habitat quality.

As a result of the TMDL, a watershed management plan was created for Carrier Creek with emphasis on best management practices that minimize and control sediment loadings and buffer high water events by reestablishing the link between the creek's floodplain and adjacent wetlands.

Eaton County Drain Commissioner, Michigan Department of Transportation, MDEQ, U.S. EPA, Friends of Carrier Creek, Eaton County, and Delta and Windsor Townships, began an implementation project to stabilize the stream. The work completed consisted of narrowing and deepening an over wide channel, installing in-stream structures such as j-hooks, crossvanes and lunkers, and removing berms. Post restoration and habitat assessments were conducted in 2007 and 2011. Results show improvement in some areas, but concerns still remain. Currently, the TMDL is still in place and it is unclear as to whether or not the TMDL will be lifted due to the restoration project.

See Appendix 3 for the complete report.

#### *Draft Dissolved Oxygen: Carrier Creek Subwatershed (AUID 040500040704-03)*

Additionally, there is currently a draft TMDL for dissolved oxygen (DO) in the Grand River, Red Cedar River and tributaries. MDEQ sampled eleven sites located in the Watershed. The impacted areas within the Watershed are located in Carrier Creek, spanning 8.67 miles. MDEQ documented spatial and temporal DO variation in the Grand River. This data was also compared with past surveys. A modeling analysis was conducted which included background DO and water quality, and diurnal DO variation values. The modeling analysis shows that Total Suspended Solids (TSS) is the major cause of low DO in the TMDL reaches. DO concentrations are affected through increased Sediment Oxygen Demand (SOD) and algal and macrophyte photosynthesis and respiration through sorbed nutrients. The goal of the TMDL is to achieve a 51% reduction in TSS. MDEQ made several recommendations including best management practices, education, and policy changes.

MDEQ has proposed to submit the draft TMDL for DO to the EPA within the next one to two years (2014-2015).

See Appendix 4 for the complete draft report which includes maps of the TMDL reach and monitoring locations.

## **3.2 Watershed Water Quality Monitoring Data**

A thorough assessment of monitoring data collected within the Watershed was needed. A quality assurance project plan (QAPP) was created prior to the watershed monitoring to outline the procedures to collect valid and reliable data. The assessment encompassed the entire Watershed area, and focused specific types of monitoring in areas where TMDLs exist. Given the water quality concerns documented on the TMDL reaches of the mainstem, *E.coli* concentrations and bacterial source tracking were monitored on several tributaries to determine if upstream sources were contributing. Also, macroinvertebrate communities were evaluated along with physical and habitat characteristics in the Watershed.

During the development of the WMP, *E.coli* data was collected by ICHD and Delhi Charter Township, along with the planned Watershed monitoring completed by ECD.

ICHD and Delhi Charter Township data is referred to in the subwatershed summary sections where collected. The intent is for ICHD and Delhi Charter Township data to provide supplementary information to that which was gained through ECD's data collection. An understanding of the magnitude of the pollutant throughout the subwatersheds monitored - Columbia Creek, Silver Creek, Skinner-Extension Drain and Carrier Creek - is necessary for determining critical areas and implementation projects.

See Appendix 5 for a table and narrative summary of ICHD's 2012 *E.coli* results. See Appendix 6 for Delhi Charter Township's 2010-2012 Water Quality Monitoring Report. See Appendix 16 for ECD's, ICHD's and Delhi Charter Township's *E.coli* Monitoring Sites Map.

### **3.2.1 Methodology**

#### **3.2.1.1 *E.coli***

ECD collected *E.coli* concentrations at 22 sites throughout Columbia Creek, Skinner-Extension Drain and Silver Creek subwatersheds in July and August of 2012. This monitoring was conducted in two phases to delineate the tributary sources of *E.coli*, 10 sites were sampled weekly in July and 12 sites were sampled weekly in August. The first rounds of sites were selected based on being tributaries to the main stem of the Grand River. The second round of sites were selected to move upstream and isolate between several branches of tributaries, or to monitor both above and below suspected sources (agriculture and residential).

During August, 12 sites were sampled for concentration levels. Some of these sites were repeats of the July sampling, to further compare between tributaries and delineate based on area land use. All of the August samples were taken during dry weather with the exception of the last two sites (20 and 21) on 9/4/12.

For each *E.coli* sampling location, three samples (left, right, and center) were collected for four weeks to calculate a geometric mean for each site for each week, and a cumulative monthly geomean. Duplicates and blank samples were taken to ensure accuracy in data collection methods. Samples were sent to the Michigan Department of Environmental Quality Drinking Water Laboratory for colony count analysis. See Appendix 7 for the QAPP. See Appendix 8 for ECD's daily geomean *E.coli* dataset.

Rainfall data information was collected from the MSU Enviro-weather website for the 24 hour period before collection. The Charlotte, MI weather station was used. The 2012 sampling season took place during a drought year in Michigan. According to MSU Enviroweather, July and August rainfall in 2012 totaled 4.41 inches, while the 5 year average for July and August was 5.77 inches.

#### **3.2.1.2 Bacterial Source Tracking (BST)**

The watershed inventory conducted during summer 2012 identified several tributaries from Silver Creek, Skinner Extension Drain, and Columbia Creek subwatersheds that have levels exceeding the PBC or TBC levels of *E.coli*. ECD conducted BST in order to more thoroughly identify the specific sources of

*E. coli*. Identification of the specific sources of *E. coli* in these surface waters within the *E. coli* TMDL area enables the WMP to have targeted actions aimed at prioritizing and reducing any identified sources.

The BST consisted of a three phased approach to confirm (1) *E. coli* concentration levels, (2) presence of human sources of *E. coli*, and (3) presence of other livestock-related (e.g., bovine and equine) sources of *E. coli*. In consultation with contacts from the MDEQ, 11 sites were selected for *E. coli* BST. Latitude and longitude coordinates were recorded for each sampling location. The 11 BST analysis locations were selected based upon the following criteria:

1. Sites having the highest *E. coli* concentrations during summer 2012 monitoring;
2. Catchments to geographically isolate potential sources; and
3. Catchments consisting of a variety of landuses (e.g., agriculture, exurban development, poorly drained soils) making it difficult to rule out potential sources of *E. coli*.

On September 13, 2012, collected samples from the 11 sites selected. At each site, six samples were collected: three for *E. coli* concentration (right center and left), one for human sources, 2 for bovine/equine sources. Blanks and duplicates were also collected. There was no rainfall recorded for this collection date. See Appendix 9 for the BST QAPP.

Once all samples were collected, the concentration samples were taken to the DEQ Drinking Water Lab in Lansing, MI for analysis. The samples for Human sources were brought to a neutral location in Dimondale, MI for Environmental Canine Services (ECS) to review. ECS uses a dog trained to signal when human sources of *E. coli* are detected in water samples. Canine scent tracking has a minimum detection limit correlated with levels of *E. coli* at 10 colony forming units/100 mL. Water samples were analyzed by ECS dogs within 6 hours of collection.

A scent test analysis consists of a command from the handler that directs the canine to investigate a sample for target scents (human sources of *E. coli*) for approximately 10 to 30 seconds. The result is measured as either an active response (bark or sit) or no response (no barking, no sitting). Duplicate samples were used to elicit the same response, while blank samples were used to elicit no response. The handler was not knowledgeable of sample source locations or previous *E. coli* concentrations.

ECD subcontracted with Helix Biological Laboratory (HBL) for *E. coli* genotyping. This genotyping analysis focused on detecting bovine (e.g., cow) or equine (e.g., horse) source *E. coli* genetic markers in the water samples. To maximize limited resources, BST analysis was conducted on samples that had been determined to have high *E. coli* concentrations, defined as exceeding the WQS of 300 *E. coli* counts/100 mL.

For the human, bovine and equine testing, the results tell if the genetic marker is present or absent, but does not give quantity or percentage information.

### 3.2.1.3 Results by Subwatershed

#### 3.2.1.3.1 Columbia Creek

##### *ECD E.coli Monitoring July 2012*

During the month of July, *E.coli* concentration samples were collected at ECD site 6 and further upstream at ECD site 7.

ECD site 6 had a daily geomean ranging from 725-1,864 cfu/100 mL (Figure 10). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of 1,864 cfu/100 mL (the highest *E.coli* concentration for that site) (Figure 10). This was an increase from the dry weather sample (1,258 cfu/100 mL daily geomean) on 7/24/12 (Figure 10). ECD site 6 had a 30 day geomean of 1,290 cfu/100 mL. Samples exceeded TBC 100% of the time and exceeded PBC 75% of the time.

ECD site 7 had a daily geomean ranging from 1,570- $\geq$ 10,000 cfu/100 mL (Figure 10). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of  $\geq$ 10,000 cfu/100 mL (Figure 10). This was a significant increase from the dry weather sample (2,594 cfu/100 mL daily geomean) on 7/24/12 (Figure 10). ECD site 7 had a 30 day geomean of 2,852 cfu/100 mL. Samples exceeded PBC and TBC 100% of the time.

During the wet weather event ECD site 7 experienced a significantly higher daily geomean ( $\geq$ 10,000 cfu/100 mL) than ECD site 6 (1,864 cfu/100 mL daily geomean) (Figure 10). For all samples taken on the same day, ECD site 7 always had *E.coli* concentrations exceeding that of ECD site 6. Both ECD sites 6 and 7 exceeded TBC 100% of the time.

##### *ECD E.coli Monitoring August 2012*

During the month of July, *E.coli* concentration samples were collected at ECD sites 15-19. ECD sites 15, 16, and 17 were selected to monitor concentrations of contributing tributaries; ECD sites 18 and 19 were selected to directly compare which branch was contributing more to *E.coli*. Zero wet weather events occurred for all sites samples. ECD site 16 was the only site to never exceed the WQS Standard for both TBC and PBC. ECD site 16 had a daily geomean ranging from 25-277 cfu/100 mL and a 30 day geomean of 106 cfu/100 mL. One sampling event was dry at ECD site 16 making it unable to collect an *E.coli* concentration.

ECD site 15 had a daily geomean ranging from 331-6,659 cfu/100 mL (Figure 10). Samples exceeded TBC 100% of the time and exceeded PBC 50% of the time. ECD site 15 had a 30 day geomean of 1,136 cfu/100 mL.

ECD site 17 had a daily geomean ranging from 349-2,220 cfu/100 mL (Figure 10). Samples exceeded TBC 100% of the time and exceeded PBC 75% of the time. ECD site 17 had a 30 day geomean of 1,095 cfu/100 mL.

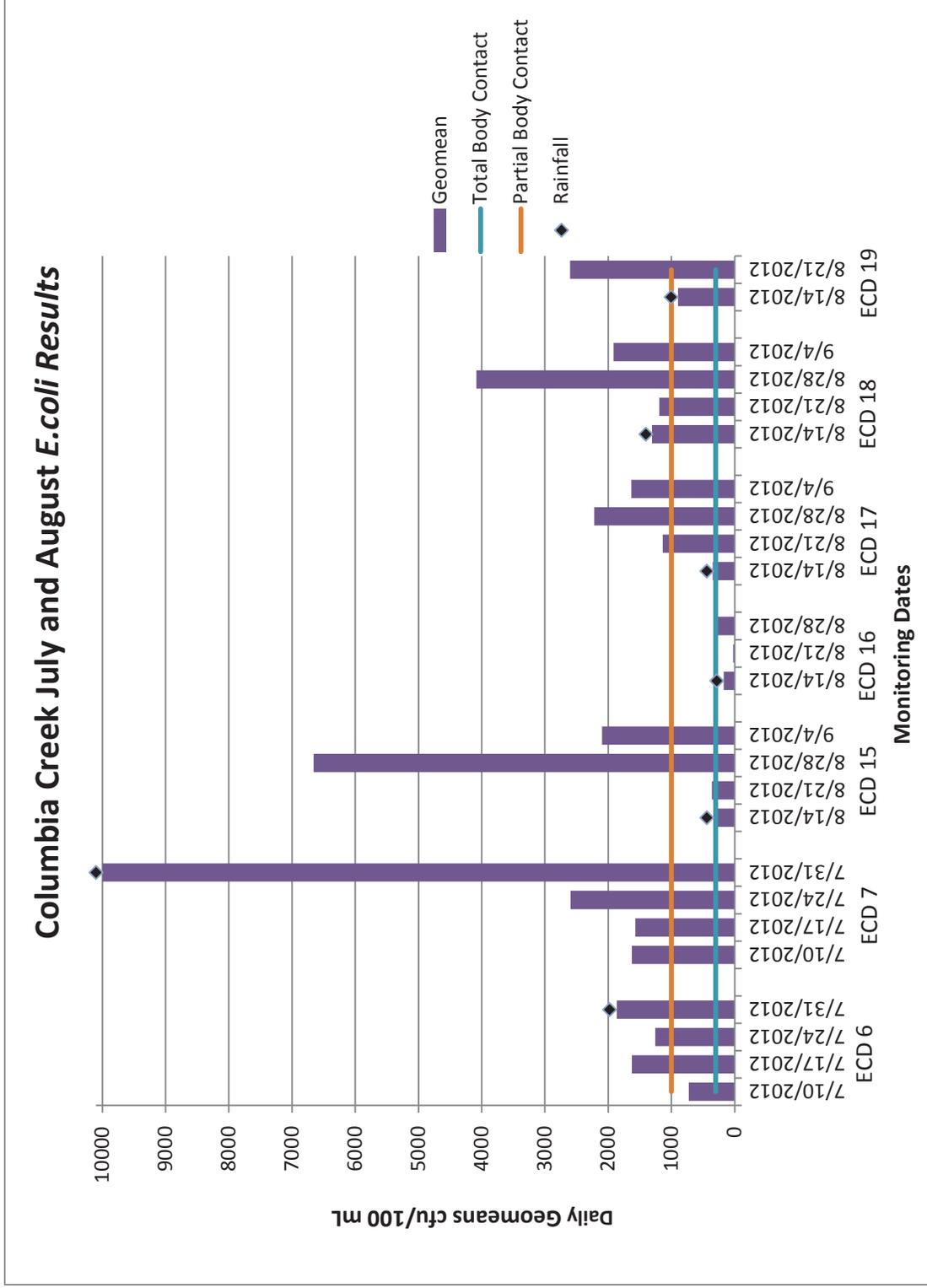
ECD site 18 had a daily geomean ranging from 1,193-4,087 cfu/100 mL (Figure 10). Samples exceeded TBC and PBC 100% of the time. ECD site 18 had a 30 day geomean of 1,870 cfu/100 mL.

ECD site 19 had a daily geomean ranging from 897-2,604 cfu/100 mL (Figure 10). At this site only two samples were taken due to dry weather. Of the two samples taken, TBC exceeded 100% of the time and PBC exceeded 50% of the time.

Of ECD sites 15-19, ECD site 15 had the highest single daily geomean (6,659 cfu/100mL) (Figure 10) and ECD site 18 had the highest 30 day geomean (1,870 cfu/100 mL). All sites sampled exceeded TBC 100% of the time. ECD site 18 was the only site to exceeded TBC and PBC 100% of the time.

See Appendix 17 for ECD's Columbia Creek *E.coli* Monitoring Sites Map.

Figure 10. Columbia Creek July and August *E. coli* Results



ECD BST 2012

The two sites in Columbia Creek monitored for BST were site F and site E (Table 8). These were selected based on the high *E.coli* concentration results of the July and August monitoring and the upstream landuse. Bovine and equine markers were positive at both sites (Table 8). Human markers were positive at site E and negative at site F (Table 8).

- BST site F (same location as ECD site 18)
- BST site E (same location as ECD site 7)

Table 8. Columbia Creek BST Results

Subwatershed: Columbia Creek						
ID	Road Name	Creekshed	Geomean (cfu/100 mL)	Human	Bovine	Equine
E	Eifert Rd. (Middle)	Columbia Creek	722	+	+	+
F	Eifert Rd.	Columbia Creek	693	-	+	+

Notes:

**Red**= exceeding total and partial body contact    **Orange**= exceeding total body contact    Plus sign (+)= Positive Presence    Negative sign (-)= Negative Presence

See Appendix 17 for ECD’s Columbia Creek *E.coli* and BST Monitoring Sites Map.

3.2.1.3.1.1 Columbia Creek Subwatershed Summary

*E.coli* data collection in Columbia Creek was conducted by ECD in 2012. Seven sites were monitored with a total of 27 samples taken. Of those samples, 24 exceeded TBC (89%) and 17 exceeded PBC (63%) (Table 9). Two of the seven sites exceeded TBC and PBC 100% of the time. ECD site 16 was the only site to never exceed the WQS.

Seven wet weather samples were taken (Table 9). Three of the samples exceeded TBC and PBC and three of the samples exceeded TBC only. Rainfall ranged from .04 inches-.31 inches (Table 9).

Two sites were monitored for BST. Both of the monitored sites were found to have a presence of bovine and equine DNA. Only one site marked positive for a presence of human sources.

TBC exceedances ranged from a daily geomean of 311-≥10,000 cfu/100 mL (top of scale used). PBC exceedances ranged from a daily geomean of 1,139-≥10,000 cfu/100 mL (top of scale used).

Table 9. Columbia Creek *E.coli* 2012 Data Collection Summary

Subwatershed: Columbia Creek						
2012 Data Collection						
	Total Body Contact Exceedances	Partial Body Contact Exceedances	Total Samples	BST Presence	Wet Weather Exceedances	Rainfall
ECD	24	17	27	Equine, Bovine and Human	6 out of 7 samples	.04-.31 inches

### 3.2.1.3.2 Skinner-Extension Drain

#### *ECD E.coli Monitoring July 2012*

During the month of July, *E.coli* concentration samples were collected at ECD sites 1, 4, 5, 8, 9, and 10. ECD sites 4, 5, 8, 9, and 10 are all tributaries to the mainstem. ECD site 1 is further upstream of ECD site 5.

The original site # 1 was dry, and was moved to North Smith Road and Windsor Drain following MDEQ approval. This resulted in one collection sample collected a week later than the rest of the July monitoring.

ECD site 1 had a daily geomean ranging from 885-≥10,000 cfu/100 mL (Figure 11). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of 5,686 cfu/100 mL (Figure 11). This was a significant increase from the dry weather sample (885 cfu/100 mL daily geomean) on 7/24/12 (Figure 11). Samples exceeded TBC 100% of the time and PBC 66% of the time. Only three samples were collected due to one dry weather event that resulted in no flow, making it unable to collect a sample. Due to this an additional sample was collected on 8/7/12 resulting in a daily geomean of 263 cfu/100 mL (Figure 11). The variable daily geomean pattern is currently unexplained due to a spike during dry weather. ECD site 1 had a 30 day geomean of 1,907 cfu/100 mL.

ECD site 4 had a daily geomean ranging from 594-5,716 cfu/100 mL (Figure 11). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of 2,258 cfu/100 mL (Figure 11). This was a significant increase from the dry weather sample (1,100 cfu/100 mL daily geomean) on 7/24/12 (Figure 11). The highest daily geomean occurred during dry weather. Samples exceeded TBC 100% of the time and PBC 75% of the time. ECD site 4 had a 30 day geomean of 1,704 cfu/100 mL.

ECD site 5 had a daily geomean ranging from 1,704-9,244 cfu/100 mL (Figure 11). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of 9,244 cfu/100 mL (Figure 11). This was a significant increase from the dry weather sample (1,704 cfu/100 mL daily geomean) on 7/24/12 (Figure 11). The highest daily geomean occurred during a wet weather event. Samples exceeded TBC and PBC 100% of the time. ECD site 5 had a 30 day geomean of 3,641 cfu/100 mL. This site had the highest 30 day geomean for the sampling period.

ECD site 8 had a daily geomean ranging from 1,762-2,691 cfu/100 mL (Figure 11). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of 1,762 cfu/100 mL (Figure 11). This was a significant decrease from the dry weather sample (2,653 cfu/100 mL daily geomean) on 7/24/12 (Figure 11). The highest daily geomeans occurred during dry weather. Samples exceeded TBC and PBC 100% of the time. ECD site 8 had a 30 day geomean of 2,262 cfu/100 mL.

ECD site 9 had a daily geomean ranging from 750-6,819 cfu/100 mL (Figure 11). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of 6,819 cfu/100 mL (Figure 11). This was an extreme increase from the dry weather sample (750 cfu/100 mL daily geomean) on 7/24/12 (Figure 11). The highest daily geomean occurred during wet weather. Samples exceeded TBC 100% of the time and PBC 75% of the time. ECD site 9 had a 30 day geomean of 1,775 cfu/100 mL.

ECD site 10 had a daily geomean ranging from 2,207- $\geq$ 10,000 cfu/100 mL (Figure 11). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of  $\geq$ 10,000 cfu/100 mL (Figure 11). This was an extreme increase from the dry weather sample (2,207 cfu/100 mL daily geomean) on 7/24/12 (Figure 11). The highest daily geomean occurred during wet weather. Samples exceeded TBC and PBC 100% of the time. ECD site 10 had a 30 day geomean of 3,449 cfu/100 mL.

#### *ECD E.coli Monitoring August 2012*

During the month of August, *E.coli* concentration samples were taken at ECD sites 10-14. ECD site 11 is upstream of ECD site 10; ECD sites 12, 13, and 14 are upstream of ECD site 9 and were selected to directly compare which branch was contributing more *E.coli*. There were zero wet weather samples taken during the month of August. Only one sample was collected at ECD site 13 due to dry weather conditions resulting in no flow the remaining dates (8/21/2012-9/4/2012). ECD site 13 had a daily geomean of 790 cfu/100 mL on 8/14/12 (Figure 12).

ECD site 10 (same location as ECD site 10 monitored in July) had a daily geomean ranging from 1,512-8,586 cfu/100 mL (Figure 12). Samples exceeded TBC and PBC 100% of the time. ECD site 10 had a 30 day geomean of 2,993 cfu/100 mL.

ECD site 11 had a daily geomean ranging from 2,825-4,517 cfu/100 mL (Figure 12). Samples exceeded TBC and PBC 100% of the time. ECD site 11 had a 30 day geomean of 3,563 cfu/100 mL. This was the highest 30 day geomean for the sampling period.

ECD site 12 had a daily geomean ranging from 2,482-4,080 cfu/100 mL (Figure 12). Samples exceeded TBC and PBC 100% of the time. ECD site 12 had a 30 day geomean of 3,407 cfu/100 mL.

ECD site 14 had a daily geomean ranging from 49-1,687 cfu/100 mL (Figure 12). The variable daily geomean pattern is currently unexplained. Samples exceeded TBC 50% of the time and PBC 25% of the time. ECD site 14 had a 30 day geomean of 301 cfu/100 mL, which was the lowest for the sampling period.

See Appendix 18 for ECD's Skinner-Extension Drain *E.coli* Monitoring Sites Map.

Figure 11. Skinner-Extension Drain July *E.coli* Results

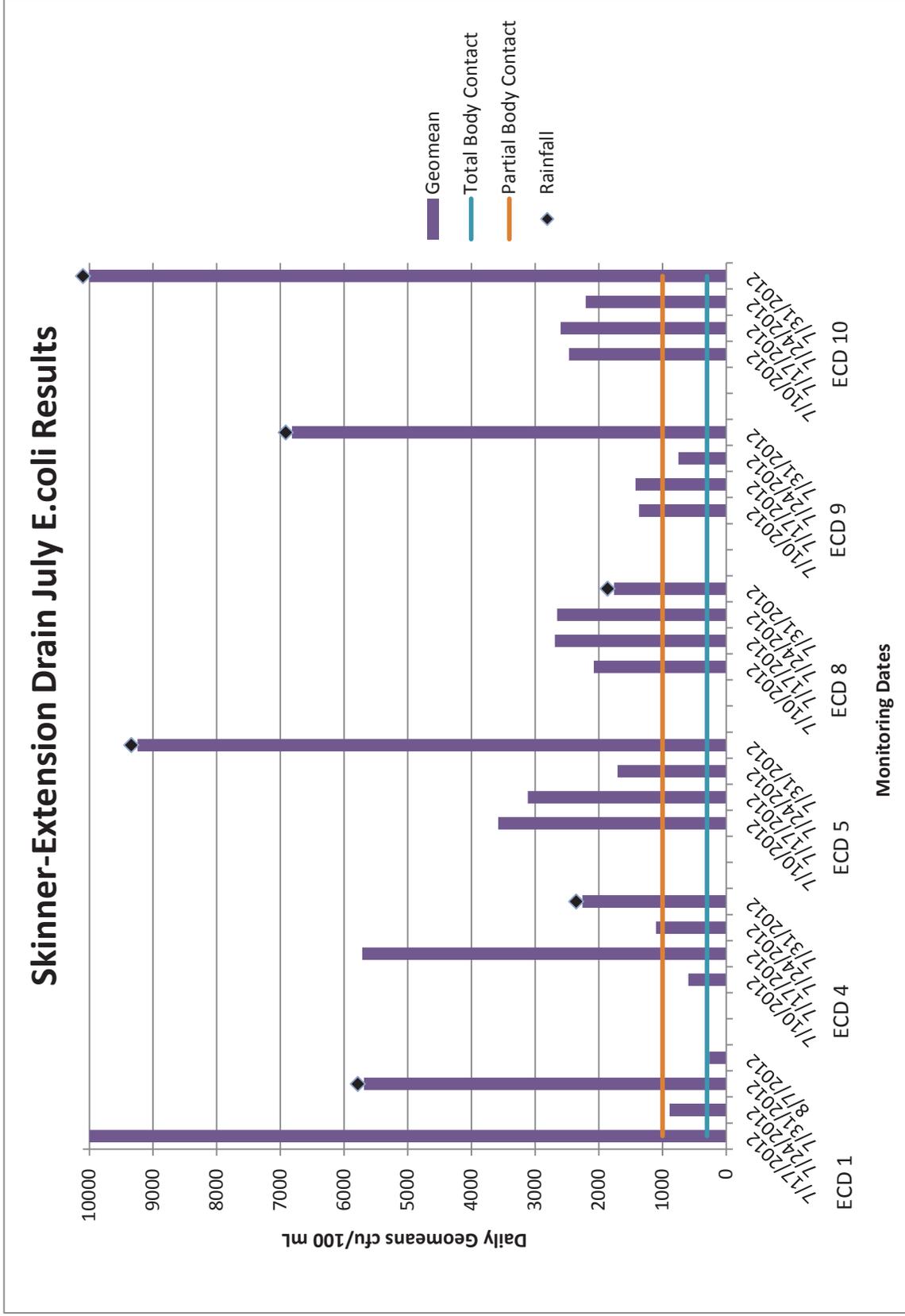
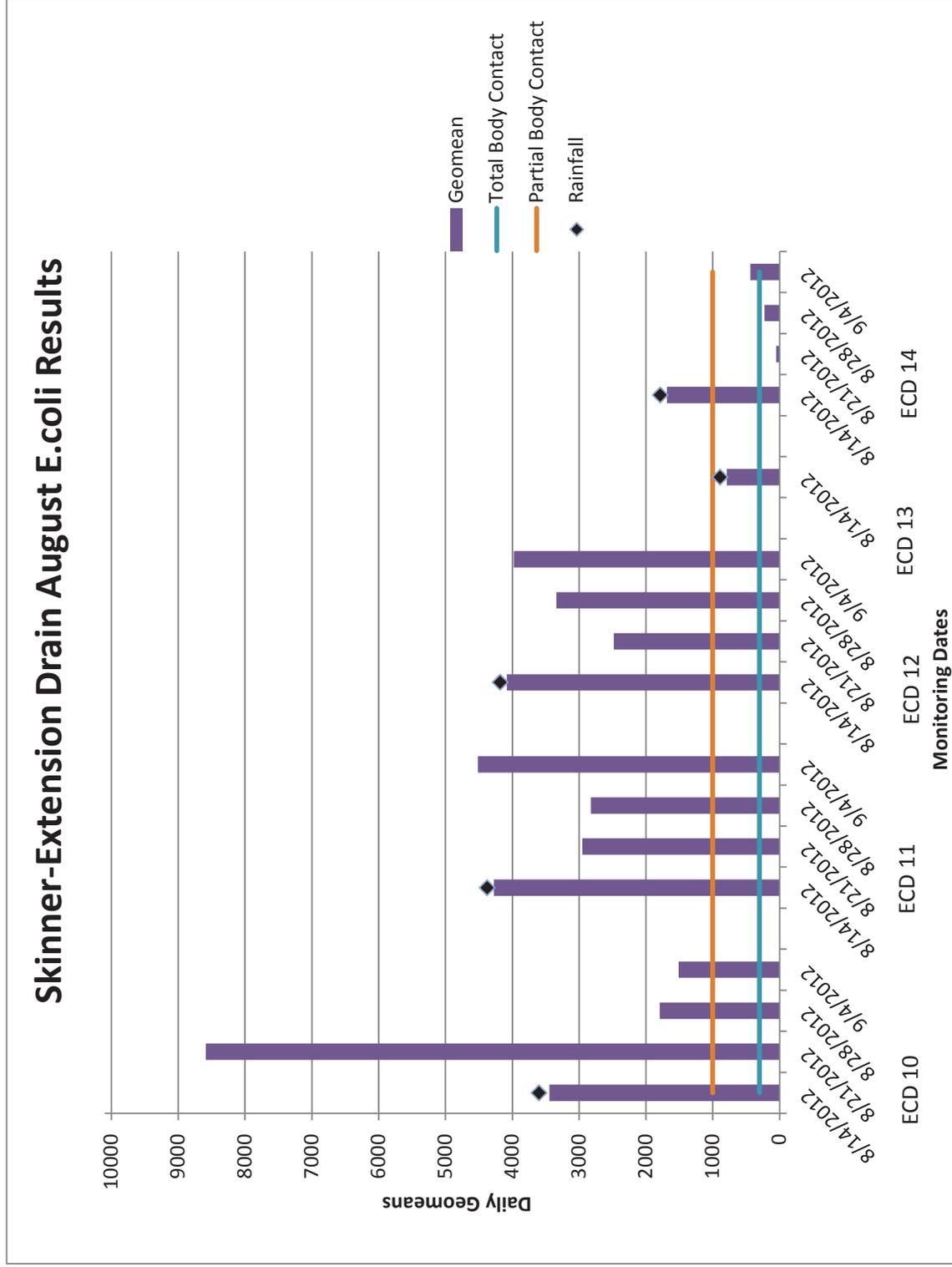


Figure 12. Skinner-Extension Drain August *E.coli* Results



Monitoring results showed that ECD sites 4, 5, 8, 10 and 12 maintained high *E. coli* concentrations. These sites were selected for follow-up BST analysis (Table 10). All sites monitored for BST were found to have a positive presence of bovine and equine and negative for human markers (Table 10).

- BST site A (same location as ECD site 10)
- BST site C (same location as ECD site 12)
- BST site D (same location as ECD site 8)
- BST site H (same location as ECD site 5)
- BST site I (same location as ECD site 4)

Table 10. Skinner-Extension Drain BST Results

Subwatershed: Skinner-Extension Drain						
ID	Road Name	Creekshed	Geomean (cfu/100 mL)	Human	Bovine	Equine
A	Michigan Rd. (M-99)	Skinner Extension Drain	2894	–	+	+
B	McCue Rd.	Skinner Extension Drain	695	–	+	+
C	N. Smith Rd. (South)	Skinner Extension Drain	9090	–	+	+
D	Bunker Rd.	Skinner Extension Drain	529	–	+	+
H	Michigan Rd. (M-99)	Skinner Extension Drain	432	–	+	+
I	Jarvis Rd.	Skinner Extension Drain	598	–	+	+

Notes:

Red= exceeding total and partial body contact    Orange= exceeding total body contact    Plus sign (+)= Positive Presence    Negative sign (-)= Negative Presence

See Appendix 18 for ECD’s Skinner-Extension Drain *E. coli* and BST Monitoring Sites Map.

*3.2.1.3.2.1 Skinner-Extension Drain Subwatershed Summary*

*E. coli* data collection in Skinner-Extension Drain was conducted by ECD, ICHD and Delhi Charter Township in 2012 (Table 11). It is important to note that ECD monitored on tributaries only, Delhi Charter Township monitored on tributaries and the mainstem and ICHD monitored solely on the mainstem of the Grand River.

ECD monitored ten sites with a total of 47 samples taken (Table 11). ECD samples exceeded TBC 45 times (96%) and PBC 36 times (77%) (Table 11). The ECD sampling in Skinner-Extension Drain exceeding TBC 96% of the time was the highest for all three subwatersheds sampled. Five of ECD’s sites exceeded TBC and PBC 100% of the time.

Eleven wet weather samples were taken (Table 11), of those 100% of them exceeded TBC and PBC. All of the wet weather samples had a daily geomean over 780. Eight of the samples had a daily geomean over 2,000 cfu/100 mL and one of the samples reached the top of the scale at ≥10,000 cfu/100 mL. Rainfall ranged from .04 inches-.48 inches (Table 11).

ECD's TBC exceedances ranged from a daily geomean of 436- $\geq$ 10,000 cfu/100 mL (top of scale used). ECD's PBC exceedances ranged from a daily geomean of 1,100- $\geq$ 10,000 cfu/100 mL (top of scale used).

ECD monitored six sites for BST and all six were found to have a presence of bovine and equine DNA (Table 11). None of the sites were found to have a presence of human sources.

Delhi Charter Township monitored nine sites with a total of 54 samples taken (Table 11). Delhi Charter Township samples exceeded TBC 32 times (59%) and PBC 11 times (20%) (Table 11). Sixteen wet weather samples were taken during Delhi Charter Township's sampling (Table 11). Two of the samples exceeded TBC and PBC. Rainfall ranged from .01 inches-.14 inches (Table 11).

Delhi Charter Township's TBC exceedances ranged from a daily geomean of 307.5- >2419.6 cfu/100 mL (top of scale used). Delhi Charter Township's PBC exceedances ranged from a daily geomean of 1084.7- >2419.6 cfu/100 mL (top of scale used).

ICHD monitored two sites with a total of 40 samples taken (Table 11). None of the samples taken on the mainstem by ICHD exceeded TBC or PBC during dry and wet weather.

Table 11. Skinner-Extension Drain 2012 *E.coli* Data Collection Summary

Subwatershed: Skinner-Extension Drain						
2012 Data Collection						
	Total Body Contact Exceedances	Partial Body Contact Exceedances	Total Samples	BST Presence	Wet Weather Exceedances	Rainfall
ECD	45	36	47	Equine and Bovine	11 out of 11 samples	.04-.48 inches
Delhi Charter Township	32	11	54	n/a	7 out of 16 samples	.01-.14 inches
ICHD	0	0	40	n/a	0 out of 14 samples	.01-.42 inches

### 3.2.1.3.3 Silver Creek

#### *ECD E.coli Monitoring July 2012*

During the month of July, *E.coli* concentration samples were collected at ECD sites 2 and 3. ECD sites 2 and 3 represent two contributing branches of a tributary of the mainstem near Dimondale.

ECD site 2 had a daily geomean ranging from 746- $\geq$ 10,000 cfu/100 mL (Figure 13). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of  $\geq$ 10,000 cfu/100 mL (Figure 13). This was an extreme increase from the dry weather sample (1,080 cfu/100 mL daily geomean) on 7/24/12 (Figure 13). The highest daily geomean occurred during wet weather. Samples exceeded TBC 100% of the time and PBC 75% of the time. ECD site 2 had a 30 day geomean of 1,765 cfu/100 mL.

ECD site 3 had a daily geomean ranging from 665-4,226 cfu/100 mL (Figure 13). One wet weather event occurred on 7/31/12 resulting in a rainfall of .31 inches and a daily geomean of 4,226 cfu/100 mL (Figure 13). This was a significant increase from the dry weather sample (1,120 cfu/100 mL daily geomean) on 7/24/12 (Figure 13). The highest daily geomean (4,226 cfu/100 mL) occurred during wet weather (Figure 13). Samples exceeded TBC 100% of the time and PBC 75% of the time. ECD site 3 had a 30 day geomean of 1,419 cfu/100 mL.

During the wet weather event ECD site 2 experienced a significantly higher daily geomean ( $\geq 10,000$  cfu/100 mL) than ECD site 3 (4,226 cfu/100 mL) (Figure 13). Both sites spiked with the highest daily geomean during wet weather and exceeded TBC 100% of the time and PBC 75% of the time. ECD site 2 had a higher 30 day geomean than ECD site 3.

#### *ECD E.coli Monitoring August 2012*

During the month of August, *E.coli* concentration samples were collected at ECD sites 20 and 21. ECD sites 20 and 21 are located on separate tributaries upstream of ECD site 2.

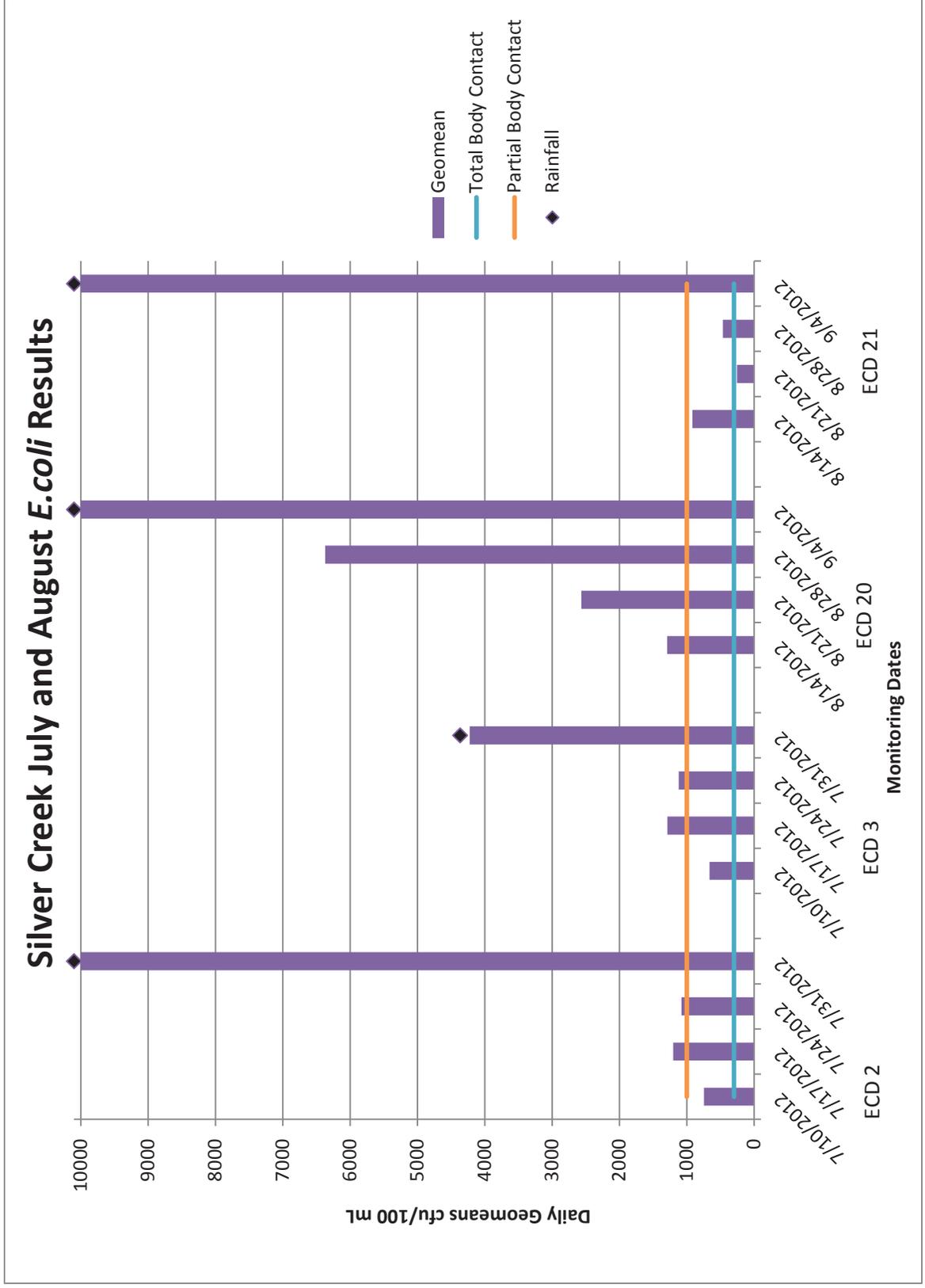
ECD site 20 had a daily geomean ranging from 1,293- $\geq 10,000$  cfu/100 mL (Figure 13). One wet weather event occurred on 9/4/12 resulting in a rainfall of .63 inches and a daily geomean of  $\geq 10,000$  cfu/100 mL (Figure 13). This was a significant increase from the dry weather sample (6,372 cfu/100 mL daily geomean) on 8/28/12 (Figure 13). The highest daily geomean occurred during wet weather. Samples exceeded TBC and PBC 100% of the time. ECD site 20 had a 30 day geomean of 3,813 cfu/100 mL.

ECD site 21 had a daily geomean ranging from 256- $\geq 10,000$  cfu/100 mL (Figure 13). The variable pattern in daily geomeans is currently unexplained. One wet weather event occurred on 9/4/12 resulting in a rainfall of .63 inches and a daily geomean of  $\geq 10,000$  cfu/100 mL (Figure 13). This was a substantial increase from the dry weather sample (467 cfu/100 mL daily geomean) on 8/28/12 (Figure 13). The highest daily geomean occurred during wet weather. Samples exceeded TBC 75% of the time and PBC 25% of the time. ECD site 21 had a 30 day geomean of 1,024 cfu/100 mL.

During the wet weather event both sites spiked to a daily geomean of  $\geq 10,000$  cfu/100 mL (Figure 13). ECD site 20 had a higher 30 day geomean than ECD 21 and was the only one to exceeded TBC and PBC 100% of the time.

See Appendix 19 for ECD's Silver Creek *E.coli* Monitoring Sites Map.

Figure 13. Silver Creek July and August *E. coli* Results



ECD BST 2012

ECD sites 3, 20, and 21 maintained high *E.coli* concentrations and were selected for follow-up BST analysis (Table 12). During sampling on 9/13/12 BST G did not exceed the WQS (207 cfu/100 mL daily geomean) and was not sampled for bovine or equine DNA (Table 12). BST site G tested negative for human markers (Table 12). BST site K tested positive for bovine and equine (Table 12). BST site J tested positive for bovine, equine and human markers (Table 12).

- BST site J (same location as ECD site 3)
- BST site K (same location as ECD site 20)
- BST site G (same location as ECD site 21)

Table 12. Silver Creek BST Results

Subwatershed: Silver Creek						
ID	Road Name	Creekshed	Geomean (cfu/100 mL)	Human	Bovine	Equine
G	Jacarnada Dr.	Silver Creek	207	–	n/a	n/a
J	Windsor Hwy.	Silver Creek	337	+	+	+
K	Slee Dr.	Silver Creek	2138	–	+	+

Notes:

**Red**= exceeding total and partial body contact    **Orange**= exceeding total body contact    Plus sign (+)= Positive Presence    Negative sign (-)= Negative Presence

See Appendix 19 for ECD’s Silver Creek *E.coli* and BST Monitoring Sites Map.

3.2.1.3.3.1 Silver Creek Subwatershed Summary

*E.coli* data collection in Silver Creek was conducted by ECD and ICHD in 2012 (Table 13). It is important to note that monitoring by ECD took place on tributaries and ICHD monitored sites on the mainstem of the Grand River.

ECD monitored four sites on the tributaries with a total of 18 samples taken (Table 13). Of the tributary monitored sites, 17 samples exceeded TBC (94%) and 12 exceeded PBC (67%) (Table 13). ECD site 20 was the only site to exceed TBC and PBC 100% of the time.

Six wet weather samples were taken (Table 13), of those 100% of them exceeded TBC and PBC. Three of the samples had a daily geomean reaching the top of the scale at  $\geq 10,000$  cfu/100 mL. All of the wet weather samples had a daily geomean over 900 cfu/100 mL. For all four sites, the highest *E.coli* concentration occurred during a rain event. Rainfall ranged from .04 inches-.63 inches (Table 13).

ECD monitored two sites for BST and both were found to have a presence of bovine and equine DNA (Table 13). Only one site marked positive for a presence of human sources (Table 13).

ICHHD monitored one site on the mainstem with a total of 20 samples taken (Table 13). None of the samples taken on the mainstem by ICHD exceeded TBC or PBC during dry or wet weather (Table 13).

Table 13. Silver Creek 2012 *E.coli* Data Collection Summary

Subwatershed: Silver Creek						
2012 Data Collection						
	Total Body Contact Exceedances	Partial Body Contact Exceedances	Total Samples	BST Presence	Wet Weather Exceedances	Rainfall
ECD	17	12	18	Equine, Bovine and Human	6 out of 6 samples	.04-.63 inches
ICHHD	0	0	20	n/a	0 out of 7 samples	.01-.42 inches

### 3.2.1.3.4 Carrier Creek

#### Results and Summary

*E.coli* data collection in 2012 was conducted by ICHD on the mainstem of the Grand River (Table 14). Four sites were monitored with a total of 80 samples taken (Table 14). Of those samples 15 exceeded TBC (19%) and six exceeded PBC (7.5 %) (Table 14). Twenty-eight wet weather sampling events occurred with six of them exceeding TBC and/or PBC (Table 14). Rainfall ranged from .01 inches-.42 inches (Table 14).

TBC exceedances ranged from a daily geomean of 312-≥2,400 cfu/100 mL (top of scale used). PBC exceedances ranged from a daily geomean of 1,523-≥2,400 cfu/100 mL (top of scale used).

Table 14. Carrier Creek 2012 *E.coli* Data Collection Summary

Subwatershed: Carrier Creek						
2012 Data Collection						
	Total Body Contact Exceedances	Partial Body Contact Exceedances	Total Samples	BST Presence	Wet Weather Exceedances	Rainfall
ICHHD	15	6	80	n/a	6 out of 28 samples	.01-.42 inches

### **3.3 Biological Monitoring**

Staff and volunteers from Mid-Michigan Environmental Action Council, Ingham Conservation District, and ECD, collected and enumerated macroinvertebrate samples throughout June of 2012 at 22 sites throughout the watershed. MDEQ completed biological surveys in 2001 and found evidence of sediment and silt covering existing habitat and affecting macroinvertebrate communities in Picket Drain and Sebewa Creek. The collection and identification of macroinvertebrates and ranking of each site was conducted in accordance with the MiCorps protocol.

Macroinvertebrate data was collected to give a baseline indicator of stream health throughout the Watershed. Macroinvertebrates are sensitive to changes in stream quality such as sediment, temperature, and dissolved oxygen. Certain species are more or less tolerant to pollutants or poor stream quality. Each site was given a cumulative score based on the number and diversity of species found. This score correlates with a ranking of excellent, good, fair, or poor. Additional site data was collected regarding wildlife observed substrate and embeddedness. Embeddedness records the percentage of the substrate rocks in the river channel that are covered in sediment. This measures the amount of sedimentation at the site.

See Appendix 20 for ECD's Macroinvertebrate Monitoring Sites Map.

Table 15. Macroinvertebrate Monitoring Results

Site	Subwatershed	Score	Rank	Embeddedness
1	Silver Creek	27	Fair	>50%
2	Silver Creek	35	Good	0-25%
3	Silver Creek	22	Fair	0-25%
4	Skinner-Extension Drain	36	Good	25-50%
5	Skinner-Extension Drain	22	Fair	0-25%
8	Skinner-Extension Drain	27	Fair	>50%
9	Skinner-Extension Drain	28	Fair	0-25%
10	Skinner-Extension Drain	26	Fair	>50%
6	Columbia Creek	40	Good	0-25%
7	Columbia Creek	16	Poor	>50%
11	Sandstone Creek	52	Excellent	25-50%
12	Sandstone Creek	42	Good	>50%
13	Framer Creek	33	Fair	0-25%
14	Framer Creek	24	Fair	25-50%
15	Framer Creek	36	Good	0-25%
16	Cryderman Lake Drain	31	Fair	25-50%
17	Cryderman Lake Drain	24	Fair	>50%
18	Winchell Union Drain	47	Good	0-25%
19	Winchell Union Drain	36	Good	>50%
20	Sebewa Creek	28	Fair	25-50%
21	Sebewa Creek	45	Good	0-25%
22	Sebewa Creek	34	Good	0-25%

The highest-ranking site was #11, Willow Highway in Sandstone subwatershed, with a score of 52 (excellent). Nine sites ranked as good, with 11 sites ranking as fair (Table 15). The lowest ranking site was #7, Eifert Road in Columbia Creek subwatershed with a score of 16 (poor) (Table 15). Site #7 also had >50% embeddedness, meaning that the low score may be due to sediment (Table 15). For the *E. Coli* TMDL reach subwatersheds: Skinner Extension Drain had four sites out of five ranking as Fair quality and Silver Creek had two sites out of three ranking as fair (Table 15).

Overall, the sites ranged in embeddedness from 0 -25% to >50% (Table 15). Of the 22 sites, 45% (10 sites) of the sites had a 0-25% score, 23% (5 sites) scored from 25-50%, and 32% (7 sites) scored greater than 50% embeddedness (Table 15). Sediment is a suspected pollutant in the Watershed, and can contribute to *E.coli* loading through transport.

Future data collection can show changes in macroinvertebrate scores over time, which can indicate stream improvement or degradation.

### 3.4 Watershed Assessment Summary

In summary, the watershed monitoring process revealed that *E.coli* concentrations are exceeding WQS in Columbia Creek, Skinner-Extension Drain and Silver Creek subwatersheds. Skinner-Extension Drain subwatershed is experiencing the greatest level of *E.coli* exceedances for TBC (96%) and PBC (77%). Silver Creek subwatershed is the second highest for TBC (94%) and PBC (67%) and Columbia Creek subwatershed ranks as the third highest for TBC (89%) and PBC (63%).

Due to the current TMDL in place and the connection between *E.coli* and human health concerns, the WMP has identified *E.coli* as the primary pollutant of concern. Through the monitoring process, *E.coli* sources have been linked back to human, equine and bovine.

Through examining the data collected by MDEQ, sediment and total suspended solids have been identified as secondary pollutants of concern in Carrier Creek subwatershed.