Watkins Creek Water Quality Summary Report, 2009
February 25, 2010
By Claire Schosser on behalf of Stream Team 3553

Introduction

The Watkins Creek Water Quality Monitoring Plan was designed by the Missouri Stream Team program to better understand the sources of the excessive levels of E. coli and chloride, which have been measured in the past few years near the mouth of the creek. Excessive levels of chloride are toxic to some of the macroinvertebrates, which would otherwise live in the stream, limiting its ability to support fish that feed on the macroinvertebrates. Excessive levels of E. coli, while not necessarily dangerous in themselves, are an indicator that levels of illness-causing bacteria might be high enough to cause illness to humans using the stream for recreational purposes.

Watkins Creek is listed in the proposed Missouri state 2008 303(d) list for exceedance of Missouri state standards for chloride and E. coli, requiring a plan to be developed to reduce the exceedances. In order to develop such a plan, it would be very helpful to know what the sources of the excessive levels of E. coli and chloride are for Watkins Creek and where they are located.

E. coli bacteria can be found in human sewage and in the feces of domestic and wild animals. Potential sources of contamination might be leaking sewage lines or septic tanks, sewage illegally draining directly into the stream, pet wastes carried into the stream by runoff or dumped into it by pet owners, feces from domestic livestock entering the stream through dumping or runoff, or feces from ducks, geese, or other wildlife entering water bodies in the watershed or into the stream itself. Ponds in watersheds may support large populations of ducks or geese during part or all of the year and these can be a source of E. coli pollution in streams they drain into.

Excessive levels of chloride are typically associated with runoff from salted roads, driveways, parking lots, and sidewalks during the winter season. Improper storage of large amounts of road salt is another potential source for chloride contamination in streams. Chloride may enter a stream from industrial waste drainage into a stream if the permitted conditions for such drainage are not followed. Because humans and animals excrete salt, other potential sources of excessive chloride might be human sewage or animal feces, from the same sources as noted in the discussion about E. coli sources.

Procedure

Six sites were chosen by Missouri Stream Team personnel for monitoring of Watkins Creek and its tributaries by Stream Team 3553, of which the author is a member. Of the six, one site was chosen near the mouth of Watkins Creek (numbered as Site 8 due to Missouri Stream Team conventions for site numbering of the author's sites on various area streams) and a second was chosen near the source (Site 14). Each of the other four sites was chosen at a location that could be accessed without undue difficulty and as close to the mouth as possible of each of four major, unnamed tributaries identified by Metropolitan St. Louis Sewer District (MSD) as Tributaries 1, 2, 3, and 5 in their February 2008 report on Watkins Creek[1]. These are Sites 10, 11, 13, and 7 respectively. The chemical testing, macroinvertebrate surveys, and visual surveys were done using standard Missouri Stream Team

[1] Jim Bergmann, **Watkins Creek Demonstration Project Stream Survey Report**, Metropolitan St. Louis Sewer District Division of Environmental Compliance, 10 East Grand, St. Louis, MO, 63147, February 2008.

equipment and procedures. The author has received Level 3 classification from the Stream Team program; team member Barbara Maynard has received Level 2 classification. Both of the aforementioned individuals received basic sampling training from Missouri DNR in order to properly obtain, handle, and transmit the samples for E. coli testing to contacts at Missouri American Water, who performed the E. coli testing according to procedures accepted by the Missouri DNR.

Results

Figure 1 shows the results for E. coli (given as most probable number or MPN; state standard for whole body contact is 126 or less) at each of the six sites for each of the six sampling dates approximately 1 month apart during which E. coli sampling was undertaken in 2009.

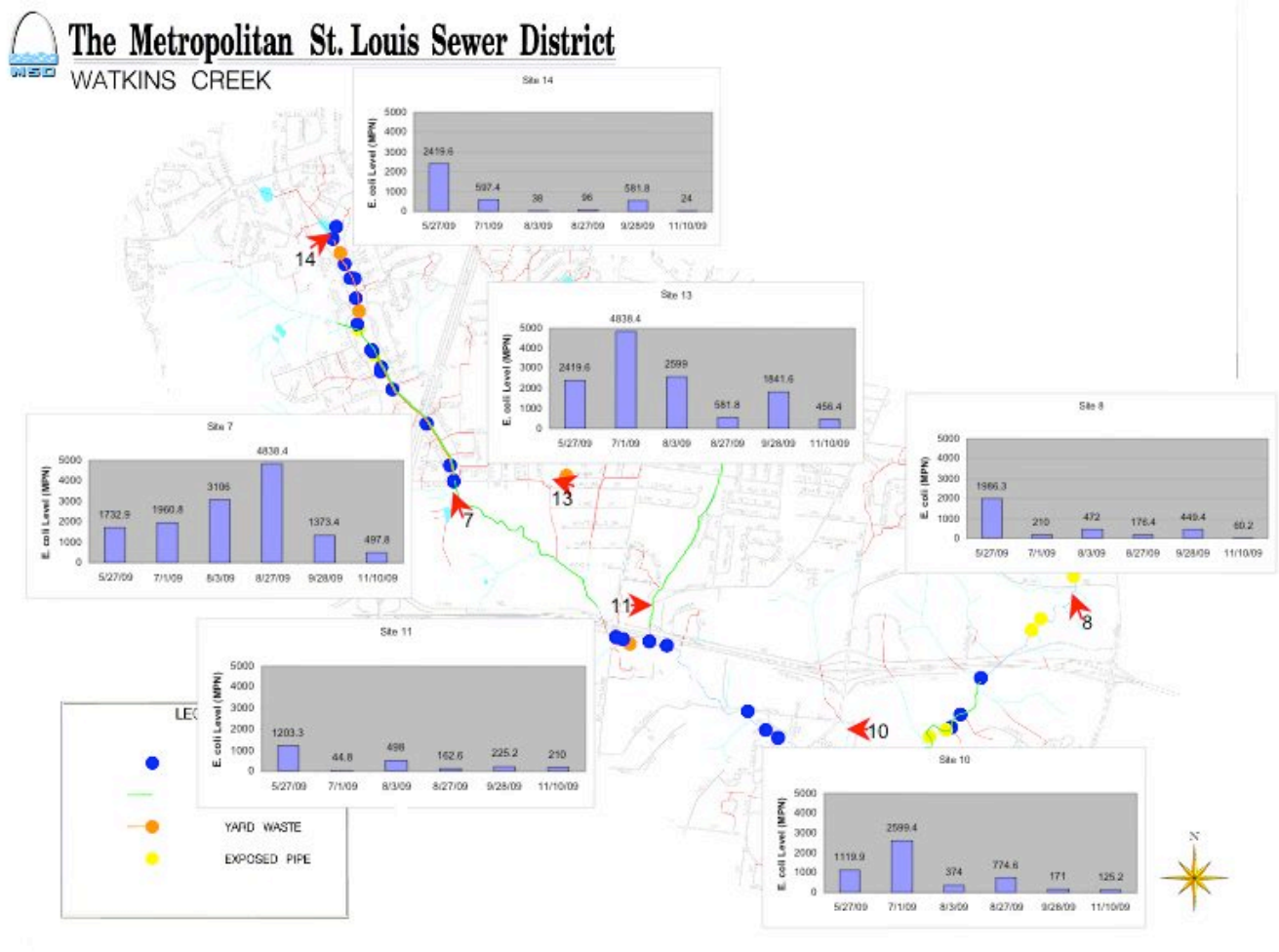

Figure 1. E. coli levels measured at various sites in the Watkins Creek watershed during 2009.

Figure 2 gives the results for chloride (in mg/L; state standard sets acute toxicity as 860 mg/L and chronic toxicity as 230 mg/L) for the same six sites obtained during 2008 and 2009.

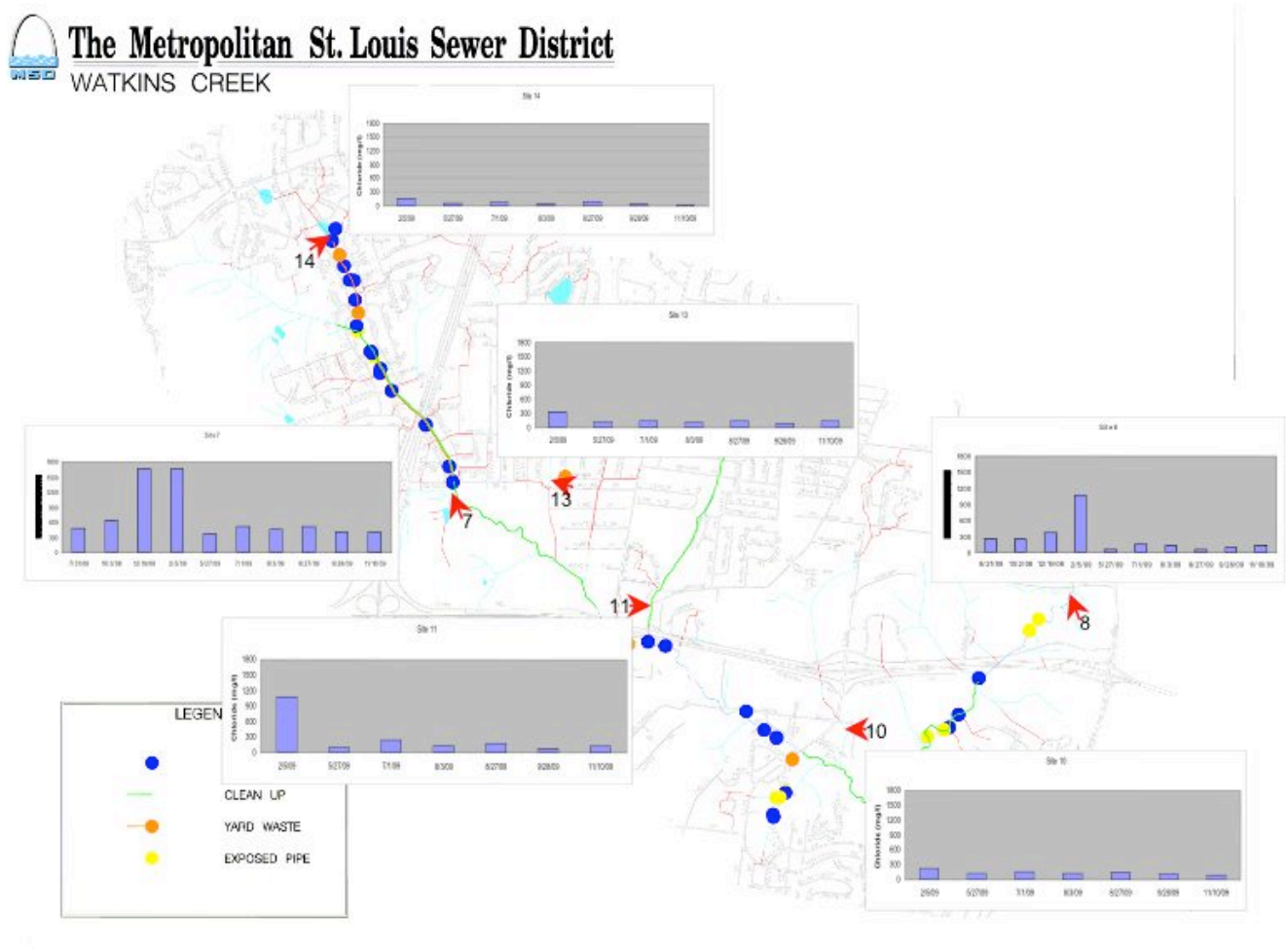

Figure 2. Chloride levels measured at various sites in the Watkins Creek watershed during 2008 and 2009.

The tables for each of these sites and for Site 12 (on MSD's Tributary 4, itself a tributary of Tributary 3) give all the results for all chemical testing, all macroinvertebrate testing, and all visual surveys done on the various sites monitored by Stream Team 3553 starting on 7/31/08 and continuing through January 2010. These tables may be found at the end of this report.

Tributary 5 in MSD's report (Site 7 in the water quality monitoring data) has the highest chloride load of any of the tributaries. Every measurement of chloride done at this site for the past 1 ½ years has resulted in chloride levels above chronic toxicity; on three occasions the level exceeded acute toxicity. In contrast, chloride levels have been above acute toxicity only once, or not at all, and only once or twice above chronic toxicity, for the other tributaries. The only time the level was over acute toxicity on the other tributaries was for the 2/5/09 sampling following a snowstorm. At the mouth of the creek, the chronic toxicity level was reached or exceeded in all three samplings done in 2008, the 2/5/09 sampling, and the 1/16/10 sampling, but has been below chronic toxicity since then. Near the source, Site 14, the chloride level remained below chronic toxicity for all sampling events.

For E. coli and disregarding the 5/27/09 sampling, done too soon after a heavy rain, levels much higher than the state standard are consistently observed at Site 13 (Tributary 3) and at Site 7 (Tributary 5). Site

10 (Tributary 1) reported a very high level on 7/1/09 and high levels on 8/3/09 and 8/27/09, but had levels well below Sites 7 and 13 in the latest two samplings. Site 11 (Tributary 2) had lower levels of E. coli than Sites 7 and 13 on all dates, roughly similar to the lower values measured at Site 10. In every measurement on all four tributaries (except for once each at Sites 10 and 11), E. coli levels exceeded the state criteria. At the mouth, levels of E. coli tended to be closer to the values at Sites 10 and 11 than at Sites 7 and 13, but still exceeded the state criteria for all sampling events except that on 11/10/09. Near the source, Site 14 had levels above the state standard on 7/1/09 and on 9/28/09 but was below the state standard for the other sampling events.

As part of the water quality monitoring plan, we also sampled for macroinvertebrates at Sites 8 (mouth) and 14 (source). At Site 8, we observed macroinvertebrate diversity rated as Good on the Missouri Stream Team water quality scale during samplings in 2008 and 2009, with smaller numbers of animals and perhaps slightly lower diversity in spring 2009 than in either autumn sampling. Site 14 had a much lower diversity of macroinvertebrates than did Site 8. Site 14 was rated as Poor, with a preponderance of leeches among the macroinvertebrates sampled. Macroinvertebrates were sampled at Site 7 (Tributary 5) on 10/3/08. A low diversity of macroinvertebrates was observed at this site, but with a lower proportion of leeches and overall lower numbers of individuals than at Site 14. The water quality rating for this sampling was Poor.

Discussion

Watkins Creek flows through less-urbanized land once it crosses under I-270 near Bellefontaine Road than it does above I-270. This allows it to heal partially from the effects of runoff from the more highly urbanized upper half of the watershed. The partial healing can be seen in the physical setting of Site 8 and in the chemical and macroinvertebrate samplings conducted at that location. Site 8 manifests the typical physical pattern of a stream flowing through pervious land. It has a shallow and broad U-shaped floodplain. The land surrounding the site is mostly wooded or grassed. It is currently owned by the public as a park. We have observed frogs, toads, snakes, and small fish on-site. Flow is always good at this site. There is no steep slope needing to be negotiated to access this site. Photos of Site 8 are shown below.

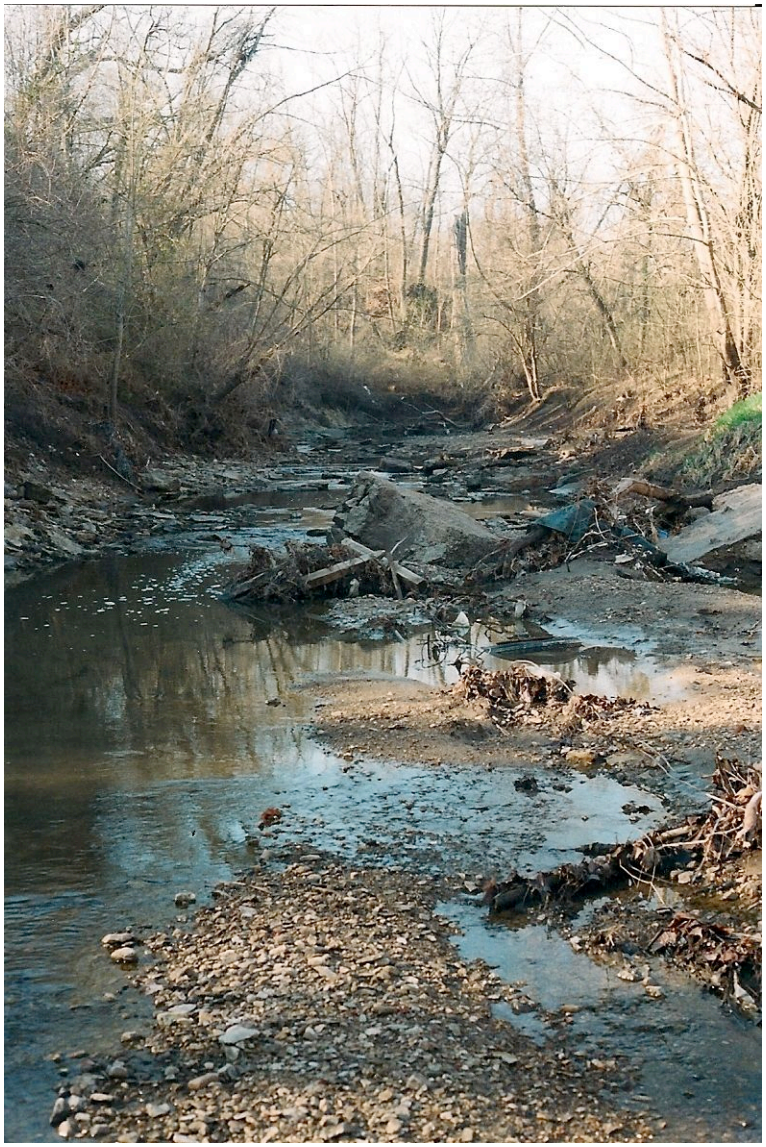

Figure 3. Site 8, looking upstream from the sampling location, March 20, 2009.

Figure 4. Site 8, looking downstream from the sampling location. The Coal Bank Road overpass can be seen. Photo taken March 20, 2009.

Figure 5. Site 8, looking at the west bank of the stream at the sampling location. Photo taken March 20, 2009.

Figure 6. Site 8, stream bed in a riffle that was sampled for macroinvertebrates. Photo taken March 20, 2009.

It is not until one samples for macroinvertebrates and does chemical monitoring that the urban nature of much of the watershed manifests at Site 8. The most obvious manifestation, chemically, is the excessive level of chloride during winter months, when road salting takes place. It is during the winter when chloride exceeds the chronic toxicity level, and it exceeded the acute toxicity level at the 2/5/09 sampling, shortly after a snowfall. In terms of macroinvertebrates, the spring 2009 sampling appears to have a slightly lower number and diversity of macroinvertebrates than do the fall 2008 and 2009 samplings. Similar patterns of higher winter chloride levels and of lower spring macroinvertebrate number and diversity are observed at the author's two sites on the southwest branch of the River des Peres in University City, monitored by Stream Team 1437. It might be that excessive chloride levels due to runoff from salted roads during the winter causes a partial die-off in the macroinvertebrate population, which then repopulates during the summer as adults migrate to Site 8 from the nearby Mississippi River or other water bodies, as has been suggested by Stream Team personnel. Other chemical parameters at this site remain at appropriate levels, except perhaps for conductivity, which varies roughly with chloride level as would be expected. In particular, dissolved oxygen is not a limiting factor in the ability of macroinvertebrates to survive at this site. The high level of dissolved oxygen at all times may explain why the water quality rating for Site 8 of Watkins Creek exceeds that of both sites on the southwest branch of the River des Peres, which is more impacted by urbanization than is the lower half of Watkins Creek and thus suffers from lower flow and lower dissolved oxygen during dry periods.

Figure 7 shows the approximate boundaries of the watersheds at the sampling point on each of Tributaries 1, 2, 3, and 5.

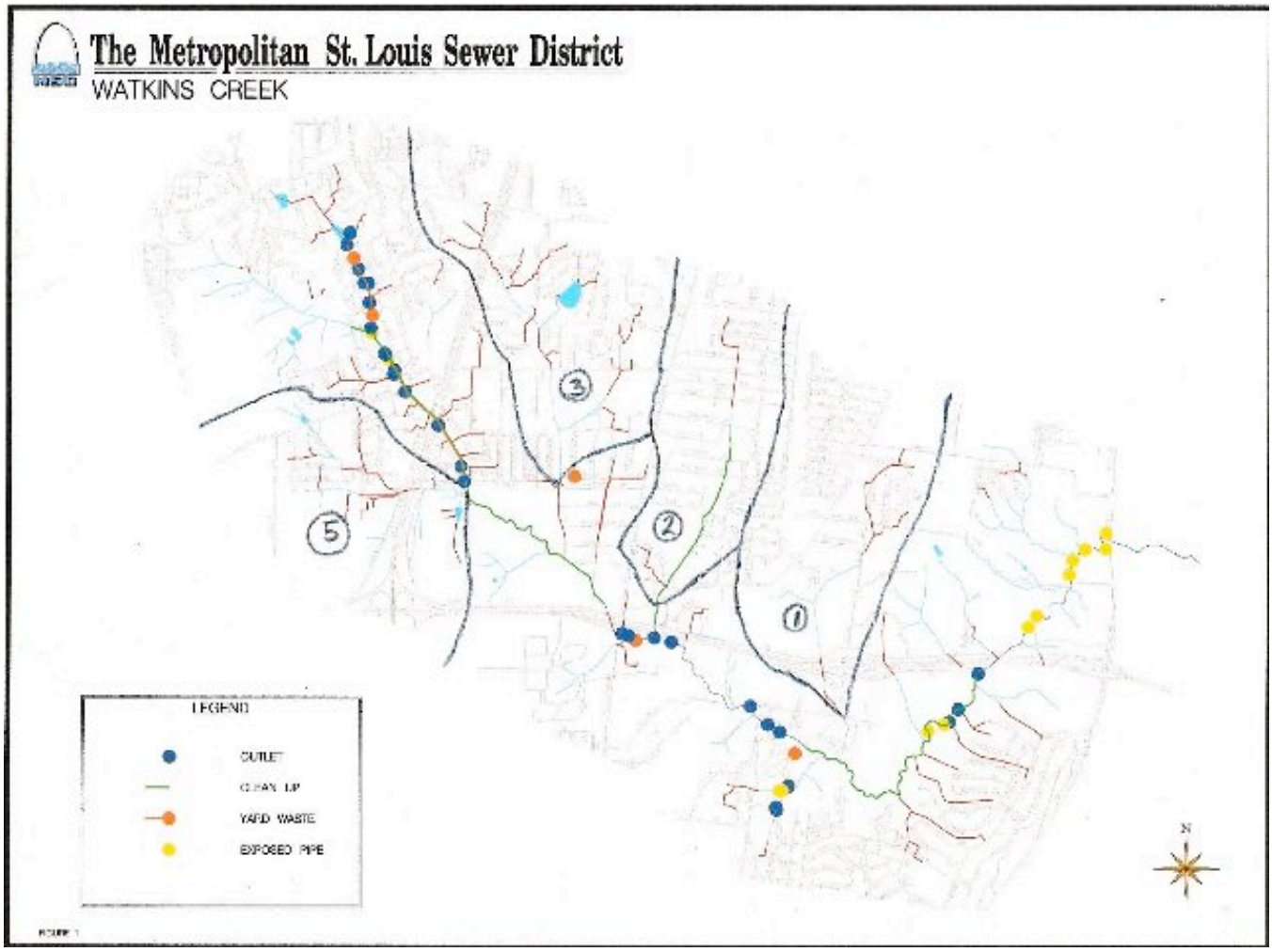

Figure 7. Approximate boundaries of watersheds of Tributaries 1, 2, 3, and 5, determined from a topographical map of the area and transferred onto MSD's watershed map for Watkins Creek.

Of these sites, only Site 10 (Tributary 1) has a more U-shaped floodplain profile rather than the deep, narrow V-shaped profile typical of streams in urbanized areas, making it easier to access than any of the other tributaries or Site 14 near the source. This is likely because its watershed is less highly developed (less impervious surface) in its lower half than the watersheds of the other tributaries of Watkins Creek. On the other hand, this site has by far the highest level of algae seen at any site. The site is sunny, which may contribute to algae formation. Interestingly, the level of E. coli on this tributary was very high on 7/1/09, much higher than at Sites 11 and 14, and even higher than at Site 7. Perhaps a short-term problem adversely affected the level of E. coli during this time. There are no ponds on this tributary. The dissolved oxygen level is high and other chemical parameters are at appropriate levels, and flow was always observed at this site despite its small size. This was the only tributary at which we observed any fish (minnows).

At all other sites, including Site 14 near the source of Watkins Creek, the stream exhibited the V-shaped floodplain profile typical of streams in areas with a high level of impervious surface. This made it difficult to find sites for sampling and to climb into and out of the sites that were chosen. In addition, flows were very low at Sites 11, 13, and 14 (no flow at Site 14 on one occasion) relative to the flow at Site 10. In flow terms, Site 7 was closer to Site 10.

Site 11, on Tributary 2, had low levels of E. coli compared to the two tributaries farther upstream and comparable levels of chloride to Site 10, mostly below chronic toxicity. As with Site 10, the highest level of chloride was measured on 2/5/09 following a snowstorm. The level on that day at Site 11 was much higher than at Site 10, possibly suggesting heavier salting of roads and parking lots in this tributary's watershed. Dissolved oxygen levels were low for this site compared to Site 10. The watershed for this tributary includes an apartment complex and a small commercial area, suggesting a high amount of impervious surface that in turn leads to the observed low base flow and low dissolved oxygen. Much of this tributary is piped. It does not have any ponds on it.

Site 13, Tributary 3, seems to contribute disproportionately to E. coli levels compared to the two tributaries already discussed; chloride level compares well to the two downstream tributaries. Because the tributary flows into a concreted culvert just below Site 13, it pools and has very little flow where we take samples. This may adversely affect the E. coli reading as well as the other chemical parameters. Unfortunately, there seems to be no place where access to the tributary is any easier. The deep canyon the tributary has cut is dismayingly apparent to anyone attempting to approach it. Impervious surface resulting from the dense suburban development of Northgate Estates, Francis Farms, and Hidden Lake subdivisions and the school and church campuses in this tributary's watershed contributes to the canyonized profile. As would be expected from the very small flow we observe, dissolved oxygen levels are low. We have observed ducks at the site in the past, and Hidden Lake, at the upper end of this tributary's watershed, hosts a population of ducks and geese. Possible sources of E. coli in this tributary may be wild ducks and geese, sewer or septic tank leaks, or waste from domestic animals. Without further testing for leaks or genetic testing of the E. coil to determine whether it is due to human or animal feces, we cannot determine the source of the excessive E. coli observed at this site.

Site 7, Tributary 5, seems to contribute disproportionately to both E. coli and chloride levels in Watkins Creek. This tributary flows through a small suburban development west of Christian Northeast Hospital, through the hospital grounds, under Highway 367, and finally through the campus of Hazelwood East High School where we sample it just before its confluence with the main stem. While the Hazelwood

East campus has a goodly amount of wooded area, the rest of the watershed is quite impervious. Still, the high chloride levels might be due to factors in addition to the proportion of impervious surface, which is probably similar to the proportion of impervious surface for the watershed of Tributary 3. Several sources have indicated that the Department of Transportation used to have an uncovered pile of road salt near Christian Northeast, an area expected to be in the watershed of this site. The salt pile no longer exists and so far our sources have not been able to be more specific about its former location. It is possible that it was located somewhere within the reconfigured area of Highway 367 and/or its outer roads. If so, rains soaking into an uncovered salt pile and wind blowing across the pile would have carried salt onto and into the soil, leaving a reservoir of salt to be carried into the tributary as rains soak through the reservoir, becoming salty groundwater. Such a salt reservoir could explain the high levels of chloride we observe at this site. It would be very helpful if MoDOT were able to confirm if a salt pile once existed and if so, where it was located, so that soil sampling for salt could be done. If such a reservoir of salt exists, remediation might drop the chloride content of this tributary to levels then determined by winter road salting, similar to what is seen in the other tributaries and at Watkins Creek's mouth. Another possibility may be proportionally heavier salting of the hospital parking lots and/or of Highway 367 relative to the suburban streets and school, church, and business parking lots in the watersheds of the other tributaries. Similar heavier salting of I-270 versus county streets may explain why Site 8 has a higher chloride load than Tributaries 1, 2, and 3.

Site 7 also exhibits high levels of E. coli, similar to those at Site 13. The same factors that might lead to excessive E. coli at Site 13 may lead to it at this site as well (there is a small pond just north of Redman Road that is on this tributary, at which we have observed ducks and geese). As at Site 13, we cannot determine the source of E. coli at this time.

The one macroinvertebrate sampling that occurred at this site, in fall 2008, gave results consistent with the toxicity of chloride measured in the chemical sampling: a Poor water quality rating, with low numbers and diversity of macroinvertebrates present. The results were quite similar to macroinvertebrate samples taken in the spring on Stream Team 1437's two sites on the southwest branch of the River des Peres, which also exhibit chronic levels of chloride toxicity during the winter (and occasionally acute toxicity) and low levels of dissolved oxygen during dry periods.

Site 14 also exhibits a V-shaped floodplain profile, the result of damming of Watkins Creek in Pennyrich Farms subdivision just above the sampling location which leads to very low flows most of the time and very high flows during periods of excessive rainfalls. The photos, shown below, and site survey indicate the poor physical condition of the stream at this site.

Figure 8. Site 14, looking downstream from the sampling location, March 20, 2009.

Figure 9. Site 14, looking upstream from the sampling location. The dam can be seen. Photo taken March 20, 2009.

Figure 10. Site 14, east bank at sampling location. Photo taken March 20, 2009.

Figure 11. Site 14, creek bottom at sampling location. Photo taken March 20, 2009.

The dam causes a no-flow condition during drought periods. Chloride levels at this site are the lowest at any site and always below chronic toxicity criteria, consistent with the lower proportion of salted surface at this site high in the watershed. E. coli levels were also lower at this site than any other on all but two occasions (7/1/09 and 9/28/09), and below MPN=126 on three occasions, suggesting that the major sources of E. coli in Watkins Creek are downstream of this location most of the time. This may be because there is very little watershed above the site to contribute to E. coli levels: few domestic animals or leaky sewers, for instance. The pond is known to attract ducks and geese - our team observed them on some of our sampling dates - but at least at certain times, wild birds do not seem to contribute much to E. coli levels at this site. This may be a result of fluctuating populations of birds on the pond. If sampling for E. coli could be conducted at times of high and low bird pressure, it might help to tease out any relationship or lack of it.

The lack of chloride at this site does not help the macroinvertebrate population, which was low in number (except for leeches) and in diversity in both spring and fall 2009 sampling. Dissolved oxygen is extremely low during no-flow and low-flow conditions (four measurements in 2009 were under 5 mg/L). According to Voshell, it is when leeches form a high population of the macroinvertebrates at a site that it may indicate that some form of pollution has appreciably reduced the dissolved oxygen[2]. In this case it is likely that the very low flows due to damming are the cause of low dissolved oxygen. It is also possible that some pollutant in the pond reduces the dissolved oxygen content, but this seems less likely absent any current evidence for such pollution.

Overall, the results suggest a stream that is impaired in its upper, more urbanized half by impervious surface; the presence of dams; routing of the stream and its tributaries through culverts and pipes; road

[2] J. Reese Voshell, Jr., **A Guide to Common Freshwater Invertebrates of North America** (McDonald & Woodward Publishing Co., Blacksburg, VA, 2002), p. 207.

salting during winter; a possible unknown source or sources of excess chloride affecting one upstream tributary; and unknown sources of E. coli that seem to be concentrated on two upstream tributaries but sometimes affect two downstream tributaries as well. Because it flows through more pervious, less-urbanized stretches in its lower half, the hydrology becomes more like that of an undisturbed stream. Near the mouth it can support a higher number and diversity of macroinvertebrates and a healthier, more diverse surrounding ecosystem than near its source. However, the excess levels of E. coli mean that even near the mouth, it is not safe for swimming, and the excess levels of chloride during winter limit the potential diversity of macroinvertebrates everywhere on the stream except at upper reaches of the watershed, where uneven flows and low dissolved oxygen levels limit macroinvertebrates more than chloride does.

Further work needs to be done to determine the source of the excess levels of E. coli and chloride in Watkins Creek and to reduce those levels. The results to date suggest that initial efforts should be concentrated on reducing E. coli pollution in the watersheds of Tributaries 3 and 5. Concentrating initial efforts on determining the source or sources of the very high year-round levels of chloride in Tributary 5 is also suggested by the results reported here.

Acknowledgements

Stream Team 3553 members gratefully acknowledge the following people and organizations for their help in this work:

Missouri Stream Team staff members
Missouri American Water, for carrying out the E. coli analyses reported herein
Metropolitan St. Louis Sewer District
Spanish Lake Community Association
Brenda Bobo-Fisher, administrator of the EPA 319 grant for Watkins Creek out of which Stream Team 3553 formed
U. S. EPA, for the 319 grant for Watkins Creek
Americorps
Thomas Ball, for getting Stream Team 3553 underway in 2008 while employed with Americorps

Watkins Creek, site 8: eastern end of Coal Bank Rd., upstream of overpass														
Main stem of creek not far from MS River confluence														
N lat +38.77207 W long -90.1825 +/-11'														
Date	Rainfall	Weather	Time	Air	Water	Dislvd	pH	Nitrate	Conduct.	Turbd.	Cl^-	Hardness	Discharge	E.coli
	inches		24hr	temp °C	temp °C	O_2 mg/L		mg/L	umhos/cm	JTU	mg/L	mg/L	ft^3/sec	MPN
8/21/08	0.3	cloudy	11:12	24.3	22.5	8	7.8	<0.25	970	15	250		1.6	
10/2/08	0.35	sunny	11:11	14.7	13.1	8	7.4	0.5	900	10	250	380		
12/19/08	1.01	cloudy	11:12	2.5	1.5	12	7.2	0.25	970	117	370			
2/5/09	trace	sunny	12:09	11.2	0.0				>1990		1077			
3/20/09	0.29	sunny	9:19	3.9	6.0	10	6.6	0.25	1050	22	166			
5/27/09	1.5	cloudy	9:16	22.4	20.5	8	6.7		550	25	65			1986.3
7/1/09	0.1	partly sunny	9:30	23.0	22.0	8	7.6		1090	13	166			201
8/3/09	0.2	partly cloudy	9:35	24.0	21.5	8	7.4		960	23	139			472
8/27/09	0.1	partly cloudy	9:30	20.5	22.5	10	7.7		600	19	65			176.4
9/11/09	1.6	sunny	9:31	19.4	20.0			0.25						
9/28/09	1.35	sunny	9:32	11.5	16.0	7	6.3		600	35	93			449.4
11/10/09	none	partly cloudy	9:34	16.0	8.7	11	7.2		1120	13	143			60.2
1/16/10	trace	cloudy	9:40	3.5	-1.0	15	7.8	0.25	>1990	22	563			

Watkins Creek Site 8: eastern end of Coal Bank Rd., upstream of overpass													
N lat +38.77207 W long -90.1825 +/- 11'													
Macroinvertebrate sampling data													
Date	Set 1	Sensitive	Somewhat	Tolerant	Set 2	Sensitive	Somewhat	Tolerant	Set 3	Sensitive	Somewhat	Tolerant	Water qual
	time		Sensitive		time		Sensitive		time		Sensitive		rating
	(min)				(min)				(min)				
10/2/08	60	17 caddisfly lar	2 crayfish	2 aquatic worms	48	9 caddisfly lar	1 damselfly ny	3 aquatic worms	60	10 caddisfly lar	2 damselfly ny	2 aquatic worms	18 (good)
	N +38.77174	2 mayfly ny	1 damselfly ny	2 black fly lar	N +38.77168	1 mayfly ny		3 black fly lar	N +38.77158	2 mayfly ny		1 black fly lar	
	W -90.18548		3 sowbugs	25 midge lar	W -90.18545			11 midge lar	W -90.18567	2 riffle beetles		11 midge lar	
3/20/09	50	2 caddisfly lar	1 scud	>18 midge larva	39			1 aquatic worm	75	1 caddisfly lar	1 crayfish	>30 midges	16 (good)
								>30 midge larva		1 riffle beetle	1 damselfly ny		
											11 scuds		
											1 sowbug		
9/11/09	100	>100 caddisfly lar	1 other beetle lar	1 black fly lar	65	>75 caddisfly lar	1 other beetle lar	2 aquatic worms	65	>50 caddisfly lar	3 other beetle lar	4 aquatic worms	21 (good)
		>20 mayfly ny	2 damselfly ny	>10 midge lar		>20 mayfly ny	1 crayfish	1 black fly lar		>25 mayfly ny	3 damselfly ny	1 leech	
			2 sowbugs	2 pouch snails			1 damselfly ny	11 midge lar				5 midge lar	
							2 scuds						
							3 sowbugs						

Visual Stream Survey, Site 8: eastern end of Coal Bank Rd., upstream of overpass
N lat +38.77207, W long -90.1825 +/-11'

Date	Time	Floodplain Land Use	Riparian Cover	Streambank Conditions	Bed comp of riffle	% embd	Signs of human use	Algae %	Close %, filament %	Water color, odor	Weather
10/2/08	10:45	woods 100%	trees 70% grasses 25% bare 5%	trees 10% grasses 20% bare 60% bedrock 5% concrete 5%	silt 5% gravel 60% cobble 30% bould 5%	35%	trail w/ human & dog footprints	33%	95%, 5%	colorless odorless	sunny
3/20/09	9:52	woods 100%	trees 75% bare 25%	trees 10% bare 85% bedrock 5%	silt 5% sand 20% gravel 30% cobble 40% bould 5%	20%	4-wheelers use trail in floodplain	50%	90%, 10%	colorless odorless	sunny

Watkins Creek, site 10: about 20ft downstream of Bellefontaine Estates Ct. overpass, near Lilac intersection													
N 38°45.830', W 90°12.183'													
Date	Rainfall	Weather	Time	Air	Water	Dislvd	pH	Nitrate	Conduct.	Turbd.	Cl^-	E. coli	
	inches		24hr	temp °C	temp °C	O_2 mg/L		mg/L	umhos/cm	JTU	mg/L	MPN	
2/5/09	trace	sunny	13:03	5.0	2.0				1570		233		
5/27/09	1.5	cloudy	9:49	22.0	17.2	9	7.0		1020	10	139	1119.9	
7/1/09	0.1	partly sunny	10:10	25.9	20.0	11	7.3		1150	<10	166	2599.4	
8/3/09	0.2	mostly cloudy	10:02	31.5	19.0	9	7.1		1020	<10	139	374, 870	
8/27/09	0.1	partly cloudy	10:03	30.0	19.5	8	7.1		1150	<10	152	774.6	
9/28/09	1.35	sunny	10:06	19.8	16.0	8	6.2		990	19	114	171	
11/10/09	none	partly sunny	9:59	16.3	9.8	11	7.1		1090	<10	108	125.2	
1/16/10	trace	cloudy	10:34	5.5	2.4	13	7.7	0.25	1430	<10	215		

Watkins Creek, site 11: just downstream of Larimore Rd. overpass, near Bellefontaine Rd. intersection													
N 38°46.278', W 90°13.070'													
Date	Rainfall	Weather	Time	Air	Water	Dislvd	pH	Nitrate	Conduct.	Turbd.	Cl^-	E. coli	
	inches		24hr	temp °C	temp °C	O_2 mg/L		mg/L	umhos/cm	JTU	mg/L	MPN	
2/5/09	trace	sunny	13:36	5.2	1.0				>1990		1077		
5/27/09	1.5	mostly cloudy	10:10	22.7	17.5	6	7.1		790	<10	103	1203.3	
7/1/09	0.1	partly cloudy	10:41	23.5	19.6	5	7.2		1400	<10	253	44.8	
8/3/09	0.2	mostly cloudy	10:27	22.0	20.0	3	7.3		870	<10	139	498	
8/27/09	0.1	mostly sunny	10:30	23.6	20.5	5	7.4		980	<10	182	162.6, 155.2	
9/28/09	1.35	sunny	10:33	17.5	15.0	5	6.4		530	<10	83	225	
11/10/09	none	mostly cloudy	10:26	15.2	9.8	9	7.2		1120	17	131	210	
1/16/10	trace	cloudy	11:16	5.9	1.3	10	7.5	0.25	1630	<10	318		

Watkins Creek, site 12: just downstream of culvert in back of Trinity High School on Redman Rd.												
N 38°47.039', W 90°13.323'												
Date	Rainfall	Weather	Time	Air	Water	Dislvd	pH	Nitrate	Conduct.	Turbd.	Cl^-	
	inches		24hr	temp °C	temp °C	O_2 mg/L		mg/L	umhos/cm	JTU	mg/L	
2/5/09	trace	sunny	14:20	7.8	0.5				940		126	

Watkins Creek, site 13: just upstream of Claudine Rd. overpass, near intersection of Sherrington												
N 38°46.714', W 90°13.533'												
Date	Rainfall	Weather	Time	Air	Water	Dislvd	pH	Nitrate	Conduct.	Turbd.	Cl^-	E. coli
	inches		24hr	temp °C	temp °C	O_2 mg/L		mg/L	umhos/cm	JTU	mg/L	MPN
2/5/09	trace	sunny	15:02	8.0	0.0				1720		342	
5/27/09	1.5	partly cloudy	10:40	23.5	18.5	6	7.1		920	<10	139	2419.6
7/1/09	0.1	partly cloudy	11:11	23.6	19.3	6	7.2		1060	17	152	4838.4
8/3/09	0.2	mostly cloudy	10:52	27.3	19.0	6	7.2		740	14	114	2599
8/27/09	0.1	mostly sunny	10:59	24.2	20.0	6	7.5		1020	12	152	581.8
9/28/09	1.35	mostly sunny	11:03	18.5	14.0	5	6.7		820	<10	108	1841.6
11/10/09	none	cloudy	10:55	15.3	9.1	8	7.2		1120	<10	143	456.4
1/16/10	trace	cloudy	11:52	5.4	0.0	11	7.8	0.25	1780	<10	342	

Watkins Creek, site 7: Hazelwood East HS Shadrack Nature Center													
Confluence of major tributaries, elevation 527ft													
(site is on the tributary passing under 367, just before the confluence)													
Lat/long N 38.77788 W 090.23289, acc 11ft, av of 1245 counts													
Date	Rainfall	Weather	Time	Air	Water	Dislvd	pH	Nitrate	Conduct.	Turbd.	Cl^-	Hardness	E. coli
	inches		24hr	temp °C	temp °C	O_2 mg/L		mg/L	umhos/cm	JTU	mg/L	mg/L	MPN
7/31/08	3.87	partly cloudy	11:52	25.5	22.9	7	7.3	2	1320	<10	477		
10/3/08	0.35	sunny	12:51	19.1	14.1	5	7.4	2	1890	<10	638	660	
12/19/08	1.01	cloudy	12:34	3.0	4.5	11	7.0	0.25	>1990	10	1674		
2/5/09	trace	sunny	15:37	5.0	0.2				>1990		1674		
5/27/09	1.5	partly cloudy	11:09	24.5	18.3	8	7.2		1730	<10	368		1732.9
7/1/09	0.1	mostly cloudy	11:47	23.0	20.0	5	7.2		>1990	<10	582		1960.8
8/3/09	0.2	mostly cloudy	11:22	27.6	19.0	7	7.1		1920	<10	456		3106
8/27/09	0.1	mostly sunny	11:28	25.5	20.5	8	7.5		1920	10	525		4838.4
9/28/09	1.35	sunny	11:33	15.5	16.0	5	7.0		1800	<10	400		1373.4, 1454.0
11/10/09	none	cloudy	11:26	14.8	9.5	7	6.9		1950	<10	400		497.8
1/16/10	trace	cloudy	12:34	5.5	3.8	12	7.5	0.25	>1990	<10	2256		

Watkins Creek Site 7: Hazelwood East HS Shadrack Nature Center													
Macroinvertebrate sampling data													
Date	Set 1	Sensitive	Somewhat	Tolerant	Set 2	Sensitive	Somewhat	Tolerant	Set 3	Sensitive	Somewhat	Tolerant	Water qual
	time		Sensitive		time		Sensitive		time		Sensitive		rating
	(min)				(min)				(min)				
10/3/08	45			4 leeches	30			1 aquatic worm	30		1 damselfly ny	2 aquatic worms	6 (poor)
								1 leech				1 leech	
								1 midge larva				1 midge larva	
								3 pouch snails				4 pouch snails	

Visual Stream Survey, Site 7: Hazelwood East HS, Shadrack Nature Center

Date	Time	Floodplain Land Use	Riparian Cover	Streambank Conditions	Bed comp of riffle	% embd	Signs of human use	Algae %	Close %, filament %	Water color, odor	Weather
10/3/08	12:28	woods 100%	trees 75% grasses 5% bare 20%	trees 5% grasses 10% bare 80% pavement 5%	sand 40% gravel 30% cobble 20% boulders 10%	58%	none	25%	95%, 5%	colorless odorless	sunny (1 toad seen)

Watkins Creek, site 14: just below pond on main stem at El Camaro and Red Barn												
Date	Rainfall	Weather	Time	Air	Water	Dislvd	pH	Nitrate	Conduct.	Turbd.	Cl^-	E. coli
	inches		24hr	temp °C	temp °C	O_2 mg/L		mg/L	umhos/cm	JTU	mg/L	MPN
2/5/09	trace	sunny	16:24	5.5	0.0				790		166	
3/20/09	0.29	sunny	11:37	11.7	10.2	11	6.5	0.25	800	<10	152	
5/27/09	1.5	partly cloudy	11:52	23.8	22.5	6	6.9		470	28	65	2419.6
7/1/09	0.1	partly sunny	12:36	24.0	19.0	1	6.8		760	<10	83	597.4
8/3/09	0.2	mostly cloudy	11:56	23.7	21.0	3	7.0		410	<10	57	38
8/27/09	0.1	mostly sunny	12:10	22.0	19.5	2	7.1		760	<10	93	96
9/11/09	1.6	sunny	12:06	21.2	19.0			0.25				
9/28/09	1.35	mostly sunny	12:22	15.0	16.0	3.4	6.7		380	25	46	581.8
11/10/09	none	cloudy	12:08	14.5	10.0	10	6.7		310	11	33	24.0, 37.2
1/16/10	trace	cloudy	13:40	6.8	1.2	13	7.9	0.25	470	13	57	

Watkins Creek Site 14: just below pond on main stem at El Camaro and Red Barn													
Macroinvertebrate sampling data													
Date	Set 1	Sensitive	Somewhat	Tolerant	Set 2	Sensitive	Somewhat	Tolerant	Set 3	Sensitive	Somewhat	Tolerant	Water qual
	time		Sensitive		time		Sensitive		time		Sensitive		rating
	(min)				(min)				(min)				
3/20/09	30		1 other beetle lar	1 aquatic worm	20		4 scuds	4 leeches	30		3 scuds	>30 leeches	10 (poor)
			1 damselfly ny	4 leeches				1 pouch snail				2 pouch snails	
				2 midge lar									
				1 pouch snail									
9/11/09	24	1 mayfly ny		1 aquatic worm	30			13 aquatic worms	24			>40 leeches	6 (poor)
				5 leeches				1 leech					
								1 midge lar					

Visual Stream Survey, Site 14: just below pond on main stem at El Camaro and Red Barn

Date	Time	Floodplain Land Use	Riparian Cover	Streambank Conditions	Bed comp of riffle	% embd	Signs of human use	Algae %	Close %, filament %	Water color, odor	Weather
3/20/09	12:01	residential 100%	trees 45% grasses 25% bare 10% bldgs 20%	trees 20% grasses 20% bare 10% pavement 50%	gravel 20% cobble 75% bould 5%	39%	maybe a trail next to culvert	70%	30%, 70%	colorless odorless	sunny