City of River Falls
North Kinnickinnic River Monitoring Project

2009 Summary

Report prepared by SEH Inc., for the

City of River Falls Engineering Department
December 2009

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Project Introduction:

The Kinnickinnic River is one of the premier, naturally sustaining trout fisheries in the Upper Midwest, primarily producing brown trout. There has been a lot of concern about how new development in River Falls may affect the river, especially due to storm water runoff from impervious surfaces in these urbanizing areas. Not only can storm water runoff contribute chemicals from lawns, cars, etc., but the thermal impacts of untreated storm water are also a concern, as described on the North Kinnickinnic River Monitoring Project website (see "The Thermal Impacts of Storm Water"). In 2002, the City adopted a new Storm Water Management Ordinance, which is designed to protect the Kinnickinnic River from the negative impacts of storm water runoff associated with new development. For new development and re-development projects, the City of River Falls Storm Water Management Ordinance requires that, for a 1.5-inch, 24-hour rainfall event, the post-development runoff volume and peak flow rate must not exceed the pre-development runoff volume and peak flow rate. To achieve this requirement, developers must provide on-site infiltration of storm water.

To take an active role in the river's health and well-being, the City of River Falls implemented the North Kinnickinnic River Monitoring Project in 2004. The goal of the project is to evaluate

the effectiveness of our Storm Water Management Ordinance for preventing degradation of the Kinnickinnic River due to new City development. The project scope includes four primary monitoring elements:

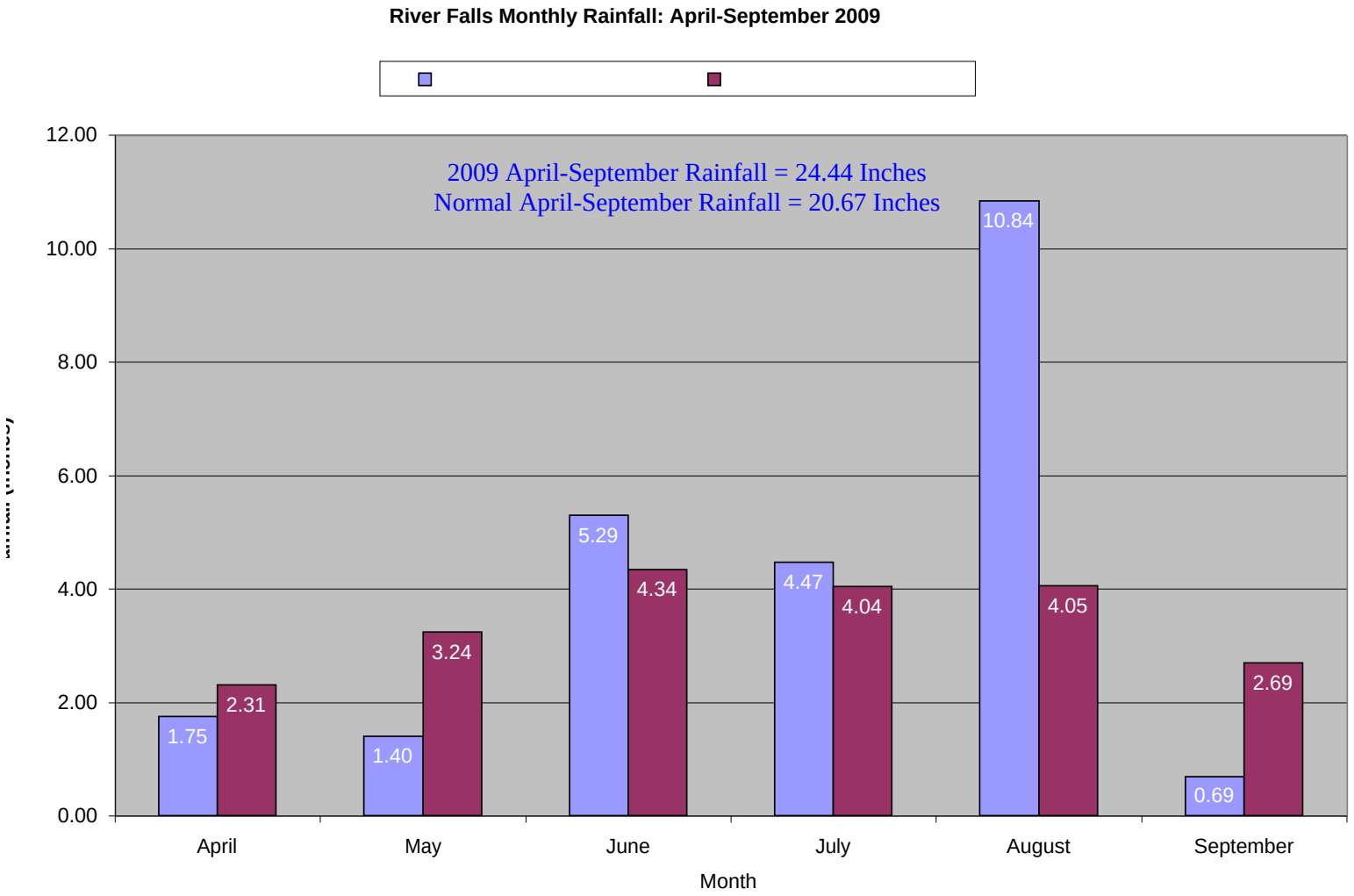
- Temperature Monitoring
- Water Quality Monitoring
- Base Flow Surveys
- Macroinvertebrate Monitoring

The City will examine the long-term results of each of these four monitoring elements to determine whether the storm water ordinance is protecting the river as new development occurs. The project will use an "upstream/downstream" approach to determine if storm water management practices in the Sterling Ponds subdivision protect downstream river conditions. We will also take a focused look at the performance of the on-site storm water management practices that are incorporated into new developments. Our hope is that, due to the ordinance requirements, the thermal, water quality, and biological impacts of new development will be undetectable or greatly reduced.

River Falls Precipitation:

Due to the major influence of precipitation on river flow, temperature, and water quality, an analysis of seasonal precipitation is conducted as a part of this project. A total of 24.44 inches of precipitation was recorded in River Falls during the April-September 2009 period, 3.77 inches more than the normal total of 20.67 inches for this time period. Rain fell on 51 days, or 28% of the April-September 2009 period.

Monthly rainfall amounts during the April-September 2009 period, with a comparison to normal monthly rainfall amounts, are presented in the figure below. August 2009 was the wettest month (10.84 inches), exceeding the normal monthly rainfall amount by 6.79 inches. Discounting August, the remainder of the April-September period was drier than normal, with a total rainfall deficit of 3.02 inches. In April, May, and September, monthly rainfall deficits ranged from 0.56 inch to 2.00 inches. The lowest monthly rainfall amounts occurred in April and September. In contrast, June and July were slightly wetter than normal, with rainfall surpluses of 0.95 inch and 0.43 inch, respectively. In April 2009, moderate drought conditions were apparent in the project area. With below-normal rainfall through July, severe drought conditions were evident by early August. With very heavy August rainfall, drought conditions abated somewhat by early September, when abnormally dry conditions were reported. However, with much lower than normal rainfall in September, moderate drought conditions returned by the end of September.



Besides being wetter than normal, the April-September 2009 monitoring period was slightly cooler than normal. The mean air temperature in River Falls during the April-September 2009 period was 62.5º Fahrenheit (F), 0.7º F lower than the normal mean of 63.2º F for this time period. The mean air temperature in April was normal, while May was slightly warmer than normal. June, July, and August were all colder than normal, with July experiencing the greatest departure (5.4º F). The month of September was 4.4º F warmer than normal.

The City of River Falls Storm Water Management Ordinance should have provided infiltration of 84% (20.48 inches) of the total rainfall (24.44 inches) that occurred during the April-September 2009 period. This percentage was determined using some conservative estimates further described in the 2009 technical report.

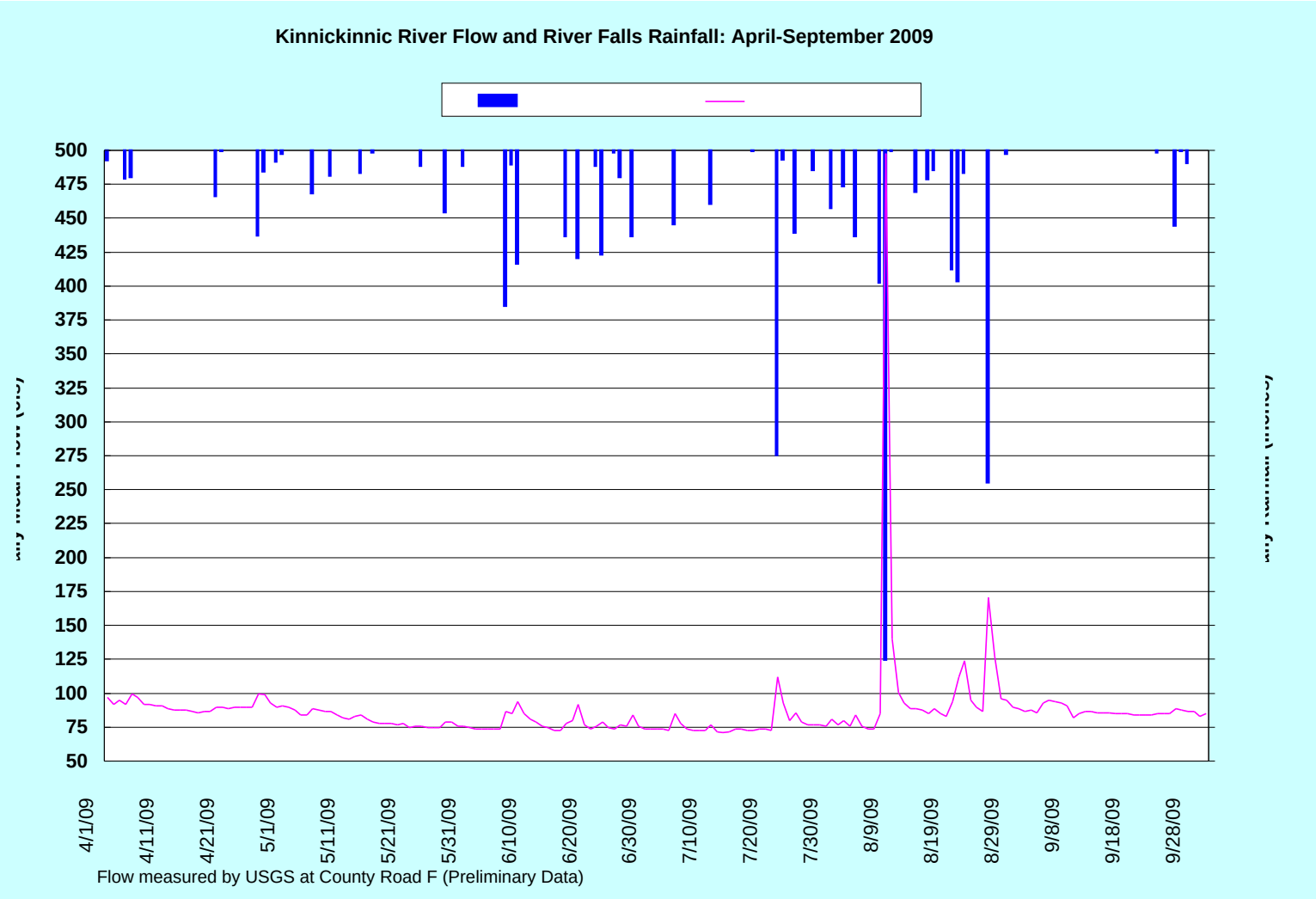
Kinnickinnic River Flow:

The flow of the Kinnickinnic River is a reflection of strong ground water contributions, as well as precipitation-induced storm water runoff from predominantly agricultural and urban land uses throughout the 165-square mile Kinnickinnic River Watershed. The daily mean (average) flow

of the Kinnickinnic River at County Highway F during the April-September 2009 period is presented in the figure below. Daily rainfall, as measured in River Falls at Rocky Branch Elementary School, is also presented in the figure below.

The Kinnickinnic River hydrograph suggests that six significant runoff events occurred during the April-September 2009 period (see the figure below). Peak daily mean flows for all of these runoff events exceeded 90 cubic feet per second (cfs). Two of the six significant runoff events occurred in June. Large rain events on June 6-8 (2.10 inches) and June 16-18 (1.44 inches) produced moderate increases in the Kinnickinnic River hydrograph, with peak daily mean flows of 94 cfs and 92 cfs, respectively. Four of the six significant runoff events occurred in July and August. Large rain events on July 21 (2.25 inches), August 7-8 (4.74 inches), August 19-21 (2.02 inches), and August 25 (2.45 inches) produced significant increases in the Kinnickinnic River hydrograph, with peak daily mean flows of 112 cfs, 498 cfs, 124 cfs, and 171 cfs, respectively. The six runoff events in June, July, and August should be the focus for evaluating possible storm water impacts in the North Kinnickinnic River Monitoring Project Area in 2009, and are further analyzed in the 2009 technical report.

With moderate drought conditions prevailing in early April 2009, and with below-normal precipitation evident in April and May, Kinnickinnic River base flows steadily decreased from 92 cfs in early April to 75 cfs in late May, as measured at County Highway F. Although June and July were slightly wetter than normal, base flows remained in the 73-77 cfs range until early August. After a much wetter than normal August, Kinnickinnic River base flows rebounded in September, remaining in the 83-89 cfs range despite much lower than normal precipitation.



Temperature Monitoring:

The thermal impacts of untreated storm water discharges on segments of the Kinnickinnic River within the City of River Falls, especially in the downtown and Glen Park areas, have been clearly documented by temperature monitoring research conducted by the local Kiap-TU-Wish Chapter of Trout Unlimited (TU). These thermal impacts are also evident in the South Fork of the Kinnickinnic River. The TU temperature monitoring research can be viewed at:

http://www.kiaptuwish.org/storm-water

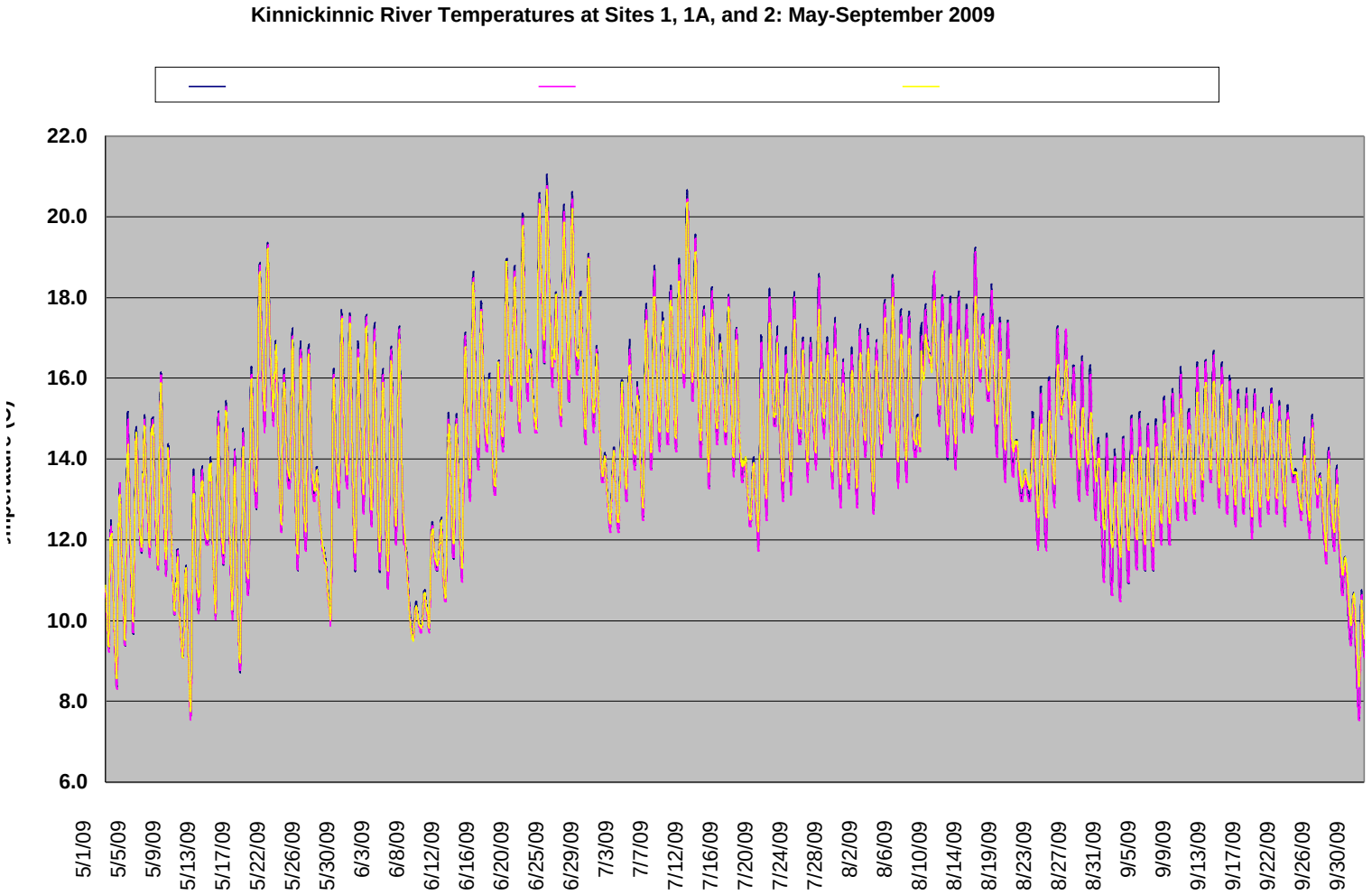
A direct storm sewer discharge to the Kinnickinnic River at Division Street

The intent of the City of River Falls Storm Water Management Ordinance is to prevent storm water impacts on the Kinnickinnic River, including thermal pollution, in areas of the city with new development, such as the Sterling Ponds subdivision.

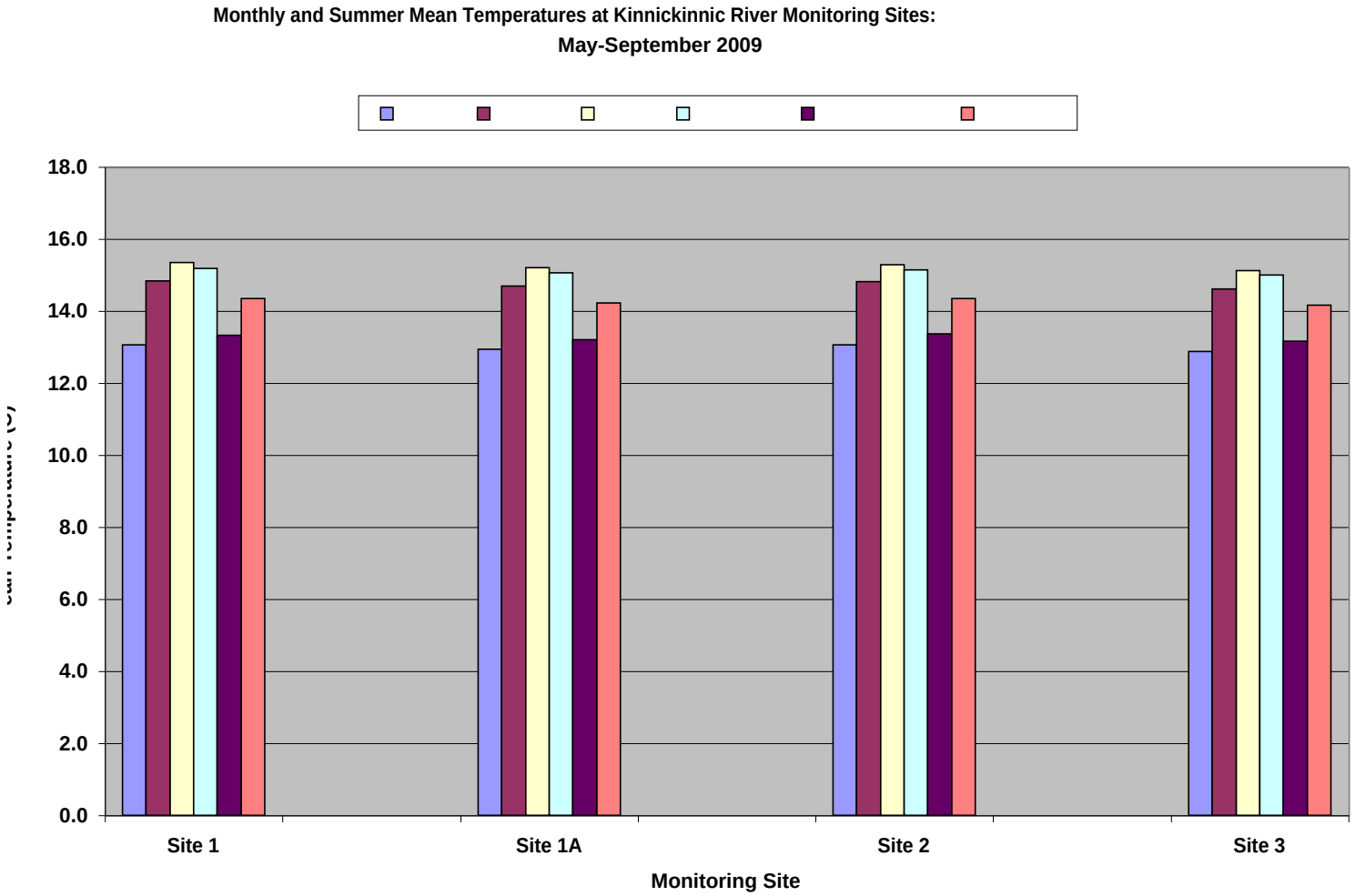
Kinnickinnic River Temperature Monitoring Results:

May-September (summer) 2009 temperature monitoring data were obtained for the Kinnickinnic River at Sites 1, 1A, 2, and 3. River temperatures at these four monitoring sites averaged 14.2° C and ranged from 7.5-21.1° C over the course of the summer. Lower-than-normal river temperatures probably prevailed in the North Kinnickinnic River Monitoring Project Area during the summer of 2009, since the 2009 summer average air temperature of 18.7º C (65.7º F) was notably lower than the normal summer average air temperature of 19.2° C (66.5° F). The 2009 summer average air temperature (18.7º C) was the lowest summer average air temperature recorded in the North Kinnickinnic River Monitoring Project Area since the summer of 2004. The 2009 summer average river temperature of 14.3º C (at Sites 1, 1A, and 2) was slightly warmer than the summer average river temperatures recorded in 2004 (13.8º C) and 2008 (14.1º C), but slightly cooler than the summer average river temperatures recorded in 2005-2007 (14.4º-15.2º C).

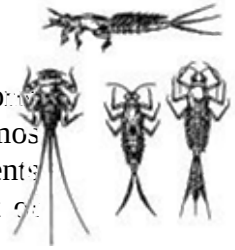
The most direct way to determine if any thermal impacts occurred in the Kinnickinnic River as a result of the Sterling Ponds subdivision is to compare the temperature monitoring data at Site 1, located immediately downstream from Sumner Creek, to the temperature monitoring data at Sites 1A and 2, located immediately upstream from Sumner Creek. In 2009, upstream summer temperatures at Sites 1A and 2 were nearly identical to downstream summer temperatures at Site 1, as shown below.



The 2009 monthly and summer mean (average) temperatures at Sites 1, 1A, 2, and 3 were also nearly identical, as shown below.

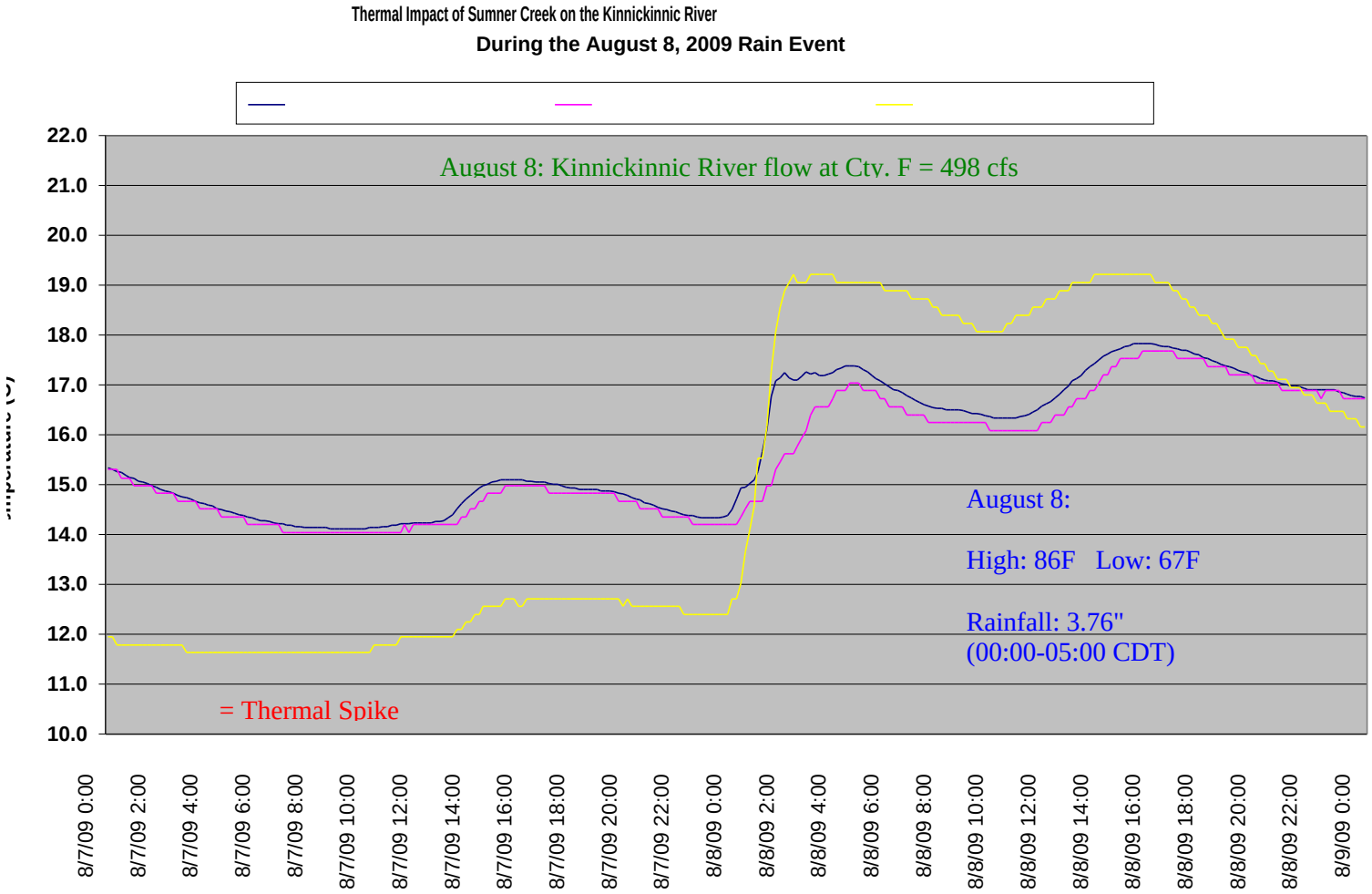


The summer 2009 temperature regime in the Kinnickinnic River at Sites 1, 1A, and 2 was excellent for coldwater macroinvertebrate and brown trout communities. Approximately 90% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2009 period were less than or equal to (≤) 17° C, which is the top of the optimum temperature range for a healthy coldwater macroinvertebrate community. A temperature of 17° C is also considered to be the optimum for brown trout survival. Approximately 99% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2009 period were ≤ 19° C, which is the top of the optimum temperature range for brown trout growth. Nearly 100% of all temperatures recorded at Sites 1, 1A, and 2 during the May-September 2009 period were ≤ 20° C, which is the top of the optimum temperature range for brown trout survival. River temperatures exceeding 20º C were only recorded on 5 dates in June and one date in July.



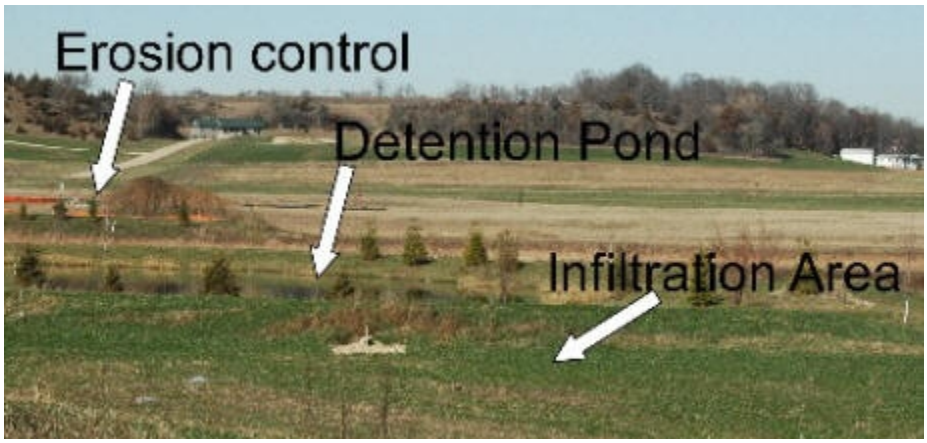
Downstream from Sumner Creek and Sterling Ponds, no storm water-related thermal impacts were apparent at Site 1 after most summer rain events, including five significant rainfall events in June, July, and August 2009. However, the largest rain event o

the summer on August 8 (3.76 inches) caused a significant thermal spike at Site 1, due to warm water contributed by Sumner Creek, as shown below.



Sumner Creek and Sterling Ponds Temperature Monitoring Results:

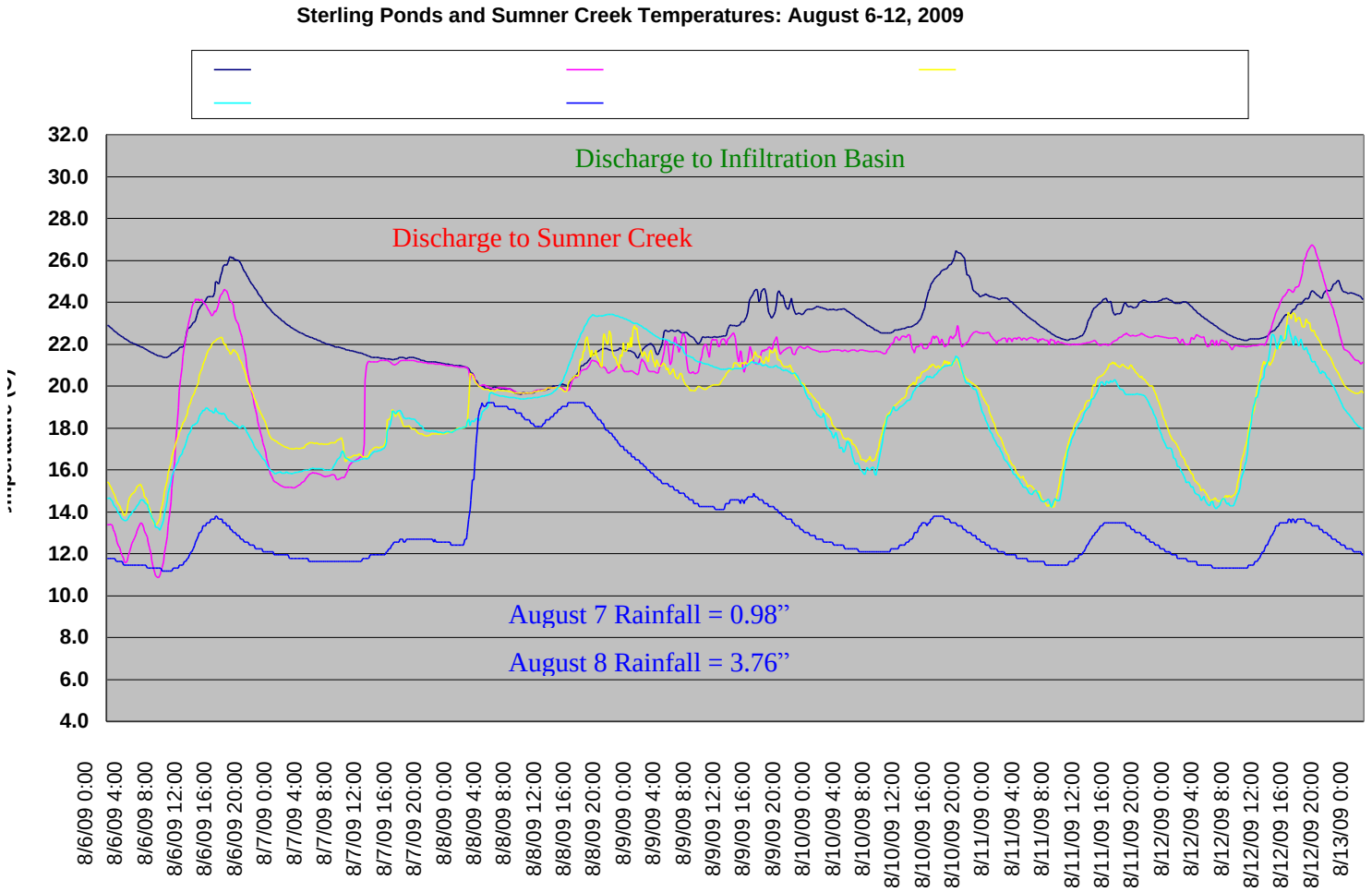
May-September (summer) 2009 temperature monitoring data were obtained for Sumner Creek at Site 6 (upstream from Sterling Ponds) and at Sites 4 and 4A (downstream from Sterling Ponds). Site 4 is located immediately downstream from Sterling Ponds, while Site 4A is located 1.5 miles downstream, near the mouth of Sumner Creek. Temperature monitoring data for the Sterling Ponds storm water management practices were obtained in the wet detention pond (Site 5P), at the wet pond discharge to the infiltration basin (Site 5IB), and at the wet pond discharge to Sumner Creek (Site 5MHW). The Sumner Creek and Sterling Ponds temperature monitoring results helped document the effectiveness of the City of River Falls Storm Water Management Ordinance in 2009.



Storm water best management practices at Sterling Ponds

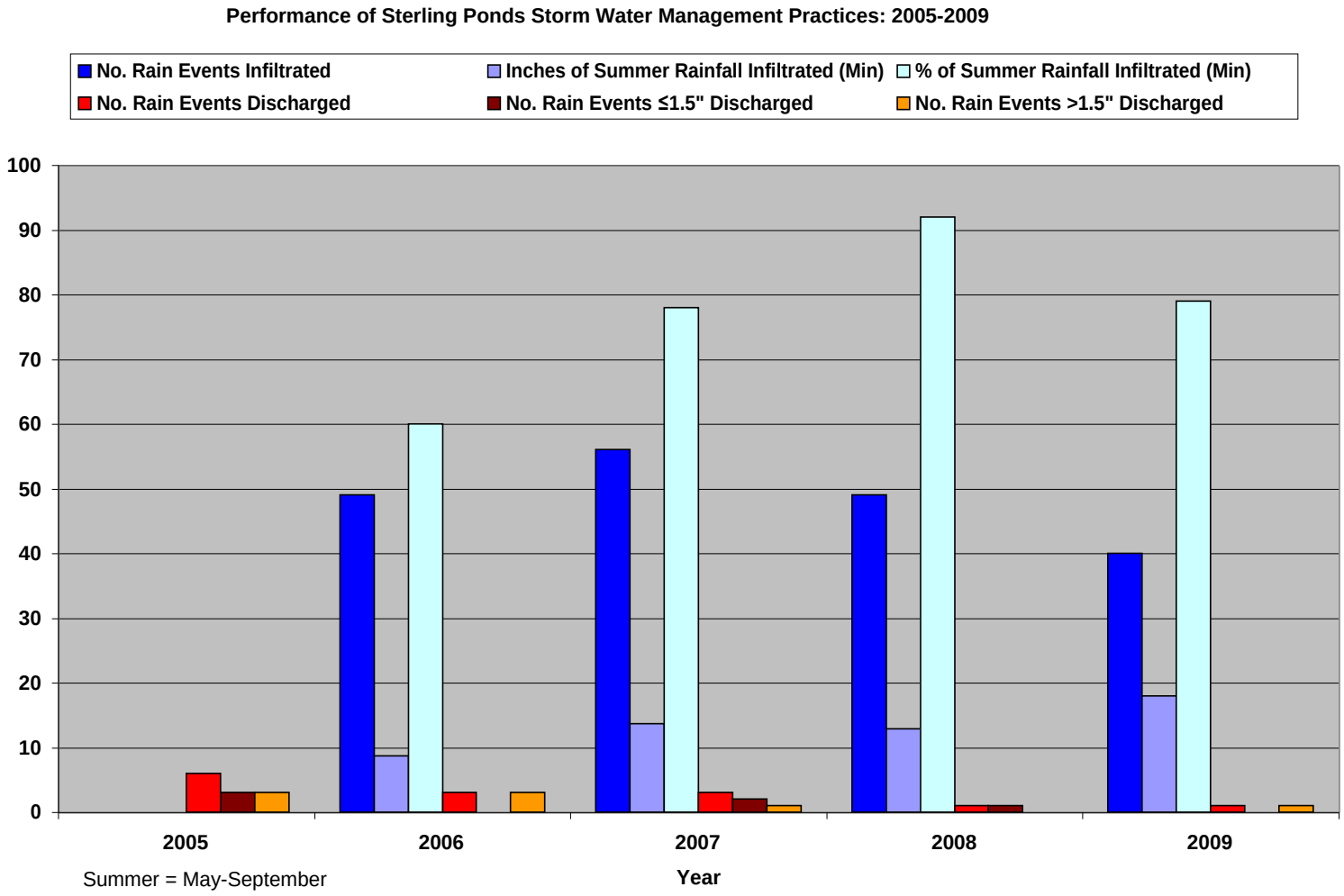
Temperature monitoring data indicate that the storm water management practices at Sterling Ponds prevented thermal impacts on the Kinnickinnic River during the May-September 2009 period, with the exception of the largest rain event of the summer on August 8 (3.76 inches). The summer mean temperature of the Sterling Ponds wet detention pond at Site 5P was 20.2º C (range = 11.5-30.4° C), but much of this warm storm water was effectively infiltrated in the wet pond and/or discharged to the adjacent infiltration basin. With the exception of the large rain events on August 7-8 (a combined 4.74 inches), all summer rainfall events were fully infiltrated, as required by the River Falls Storm Water Management Ordinance. These 40 rain events, ranging in magnitude from 0.01-2.45 inches, represent a total of 17.95 inches of precipitation, or 79% of the total summer rainfall amount (22.69 inches).

The Sterling Ponds wet detention pond only discharged to Sumner Creek after the largest rain event of the summer (3.76 inches), on August 8. During this event, the wet detention pond discharged warmer water (19.2-21.3º C) to Sumner Creek for an extended time period (15 hours). This warm storm water discharge caused a thermal spike in Sumner Creek at Site 4, contributed to the extended duration of much warmer-than-normal water at Site 4A, and likely contributed to the thermal spike evident in the Kinnickinnic River at Site 1. Although a wet pond discharge to Sumner Creek occurred on August 8, it seems likely that the majority of the August 7-8 rainfall event (a combined 4.74 inches) was infiltrated rather than discharged. The duration of the discharge to Sumner Creek was relatively short (15 hours), compared to the duration of discharge to the infiltration basin (120 hours). The Sterling Ponds and Sumner Creek temperature monitoring results for the August 7-8 rain event are shown below.

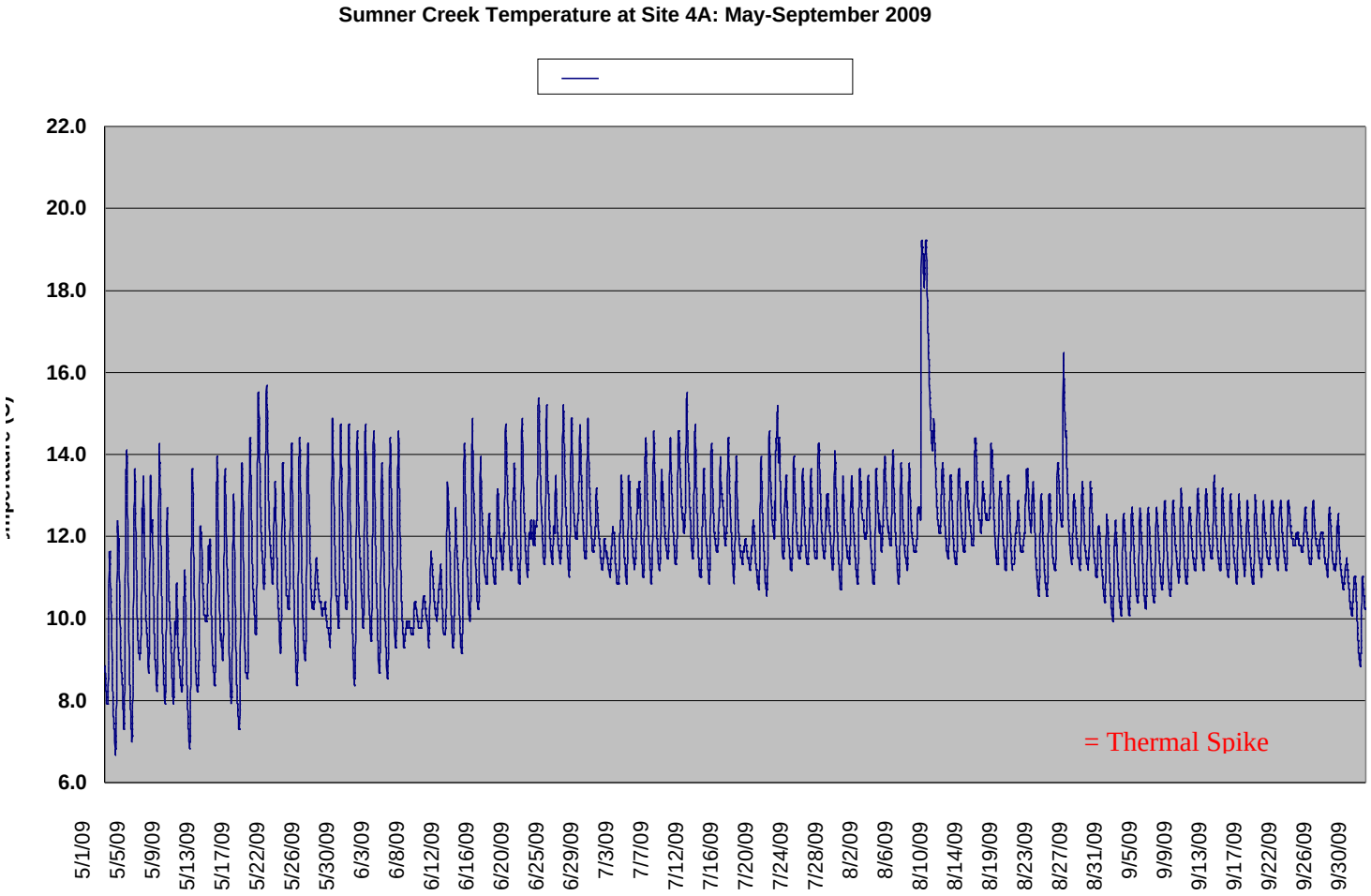


Temperature monitoring of the Sterling Ponds storm water practices during the 2005-2009 period indicates that storm water discharges to Sumner Creek typically occur during rain events larger than 1.5 inches, during back-to-back rain events, when rainfall amounts range from 1.0-1.5 inches and time periods between rain events are less than 48 hours, and during very intense rain events, when rainfall amounts range from 1.0-1.5 inches. Modifications made to the control structure for the Sterling Ponds wet pond outlet in June 2007 seemed to improve storage and infiltration capacity for these types of events in 2007, 2008, and 2009. Rain events larger than 1.5 inches exceed the intent of the River Falls Storm Water Management Ordinance, so storm water discharges to Sumner Creek might be expected. However, storm water discharges to Sumner Creek during back-to-back or very intense rain events, when rainfall amounts are less than the 1.5-inch ordinance requirement, may need further attention. For back-to-back rain events, more rapid delivery of storm water to the infiltration basin may be desirable between rain events, to ensure infiltration of the first rain event within a 24-hour period. In addition, perhaps some provision should be made in the River Falls Storm Water Management Ordinance to ensure adequate infiltration of back-to-back 1.5-inch, 24-hour rain events. Additional capacity in the Sterling Ponds wet pond may be helpful for capturing more storm water volume during very intense rain events, but the increased volume in the pond could require more infiltration time, which may prove problematic when large, back-to-back rain events occur.

Based upon the 2005-2009 temperature monitoring results, it appears that the Sterling Ponds storm water management practices are producing long-term positive results that protect the Kinnickinnic River. A summary of the performance of Sterling Ponds storm water management practices during the 2005-2009 period is presented in the figure below. Note that the number of summer rain events infiltrated far exceeds the number of rain events (partially) discharged to Sumner Creek each year. Also note that the minimum percentage of summer rainfall infiltrated ranged from 60-92% during the 2006-2009 period. Beyond 2009, these same trends will be monitored from year to year, to determine if favorable results are apparent in the future.



Permanent flow occurred in lower Sumner Creek at Site 4A throughout the summer. The summer mean temperature (11.7º C) reflects strong spring flow. The creek potentially provides a good thermal environment for a brook trout fishery, and is an important contributor of cold water to the Kinnickinnic River. However, thermal spikes of notable magnitude (4.1-6.8º C) occurred at this location during two large August rain events, as shown in the figure below. Storm water discharge at Sterling Ponds likely contributed to the largest thermal spike on August 8; but both thermal spikes in August also had a more local cause that needs further investigation.

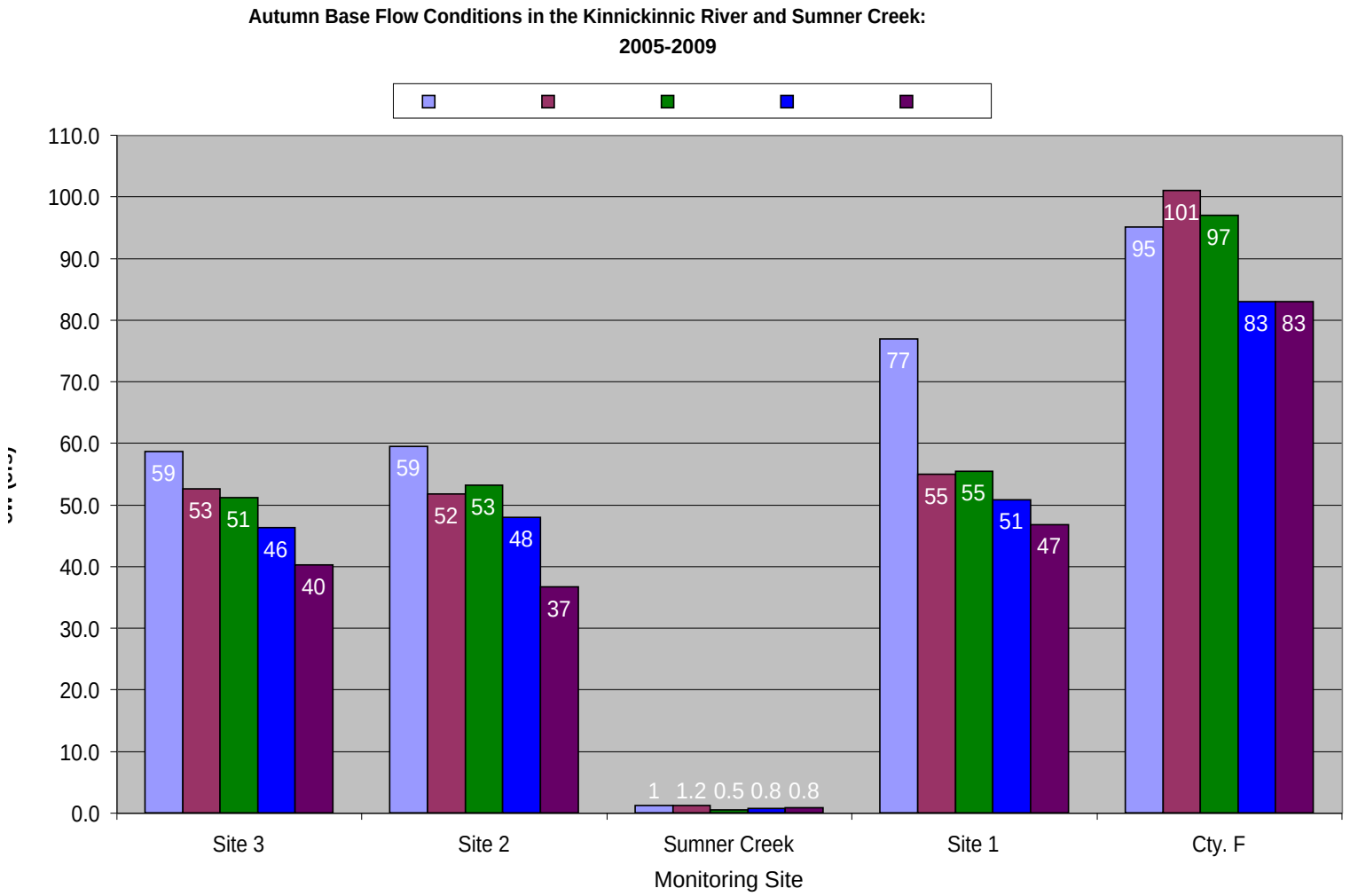


Base Flow Surveys:

In May (spring) and September (autumn) 2009, base flow surveys were conducted at Sites 1-3 in the Kinnickinnic River and at the mouth of Sumner Creek (Site 4A) within the North Kinnickinnic River Monitoring Project Area. Spring base flow surveys have been conducted for four consecutive years (2006-2009), while autumn base flow surveys have been conducted for five consecutive years (2005-2009). The Kinnickinnic River was assumed to be in a base flow condition when 3-4 days of "flat-line" flow were observed at the USGS stream flow gauging station located at County Highway F (as described in the 2009 technical report). During the April-September 2009 period, the Kinnickinnic River generally maintained a base flow condition of approximately 73-92 cfs at County Highway F.

The autumn 2009 base flow survey results are presented below, with a comparison to the autumn 2005-2008 survey results. In autumn 2009, Kinnickinnic River base flows increased slightly from upstream (Site 3) to downstream (Site 1), with Sumner Creek providing a small contribution upstream of Site 1. The autumn 2009 base flows were the lowest recorded since monitoring began in 2005. The low autumn 2009 base flows and a downward trend in autumn

base flows since 2005 may be attributed to three consecutive summers of below-normal precipitation (2006-2008) and a continuation of moderate-severe drought conditions throughout the summer of 2009, in spite of above-normal precipitation.



More information on the spring and autumn base flow survey results can be found in the 2009 technical report. Based upon several years of base flow survey data, it seems apparent that climatic variability can cause significant annual changes in spring and autumn base flows within the North Kinnickinnic River Monitoring Project Area. One goal of the River Falls Storm Water Management Ordinance is to maintain strong base flow conditions in the Kinnickinnic River by requiring storm water management practices that promote infiltration of rainfall, thereby maintaining shallow aquifer levels, as well as the springs that provide cold water for the river. Performance monitoring at Sterling Ponds has demonstrated that the storm water management practices have provided excellent infiltration capacity since 2004, thereby helping to sustain groundwater recharge during an extended dry period. Annual spring and autumn base flow surveys will provide an ongoing measure for determining if base flow conditions will be sustained in the future as development progresses in the North Kinnickinnic River Monitoring Project Area.

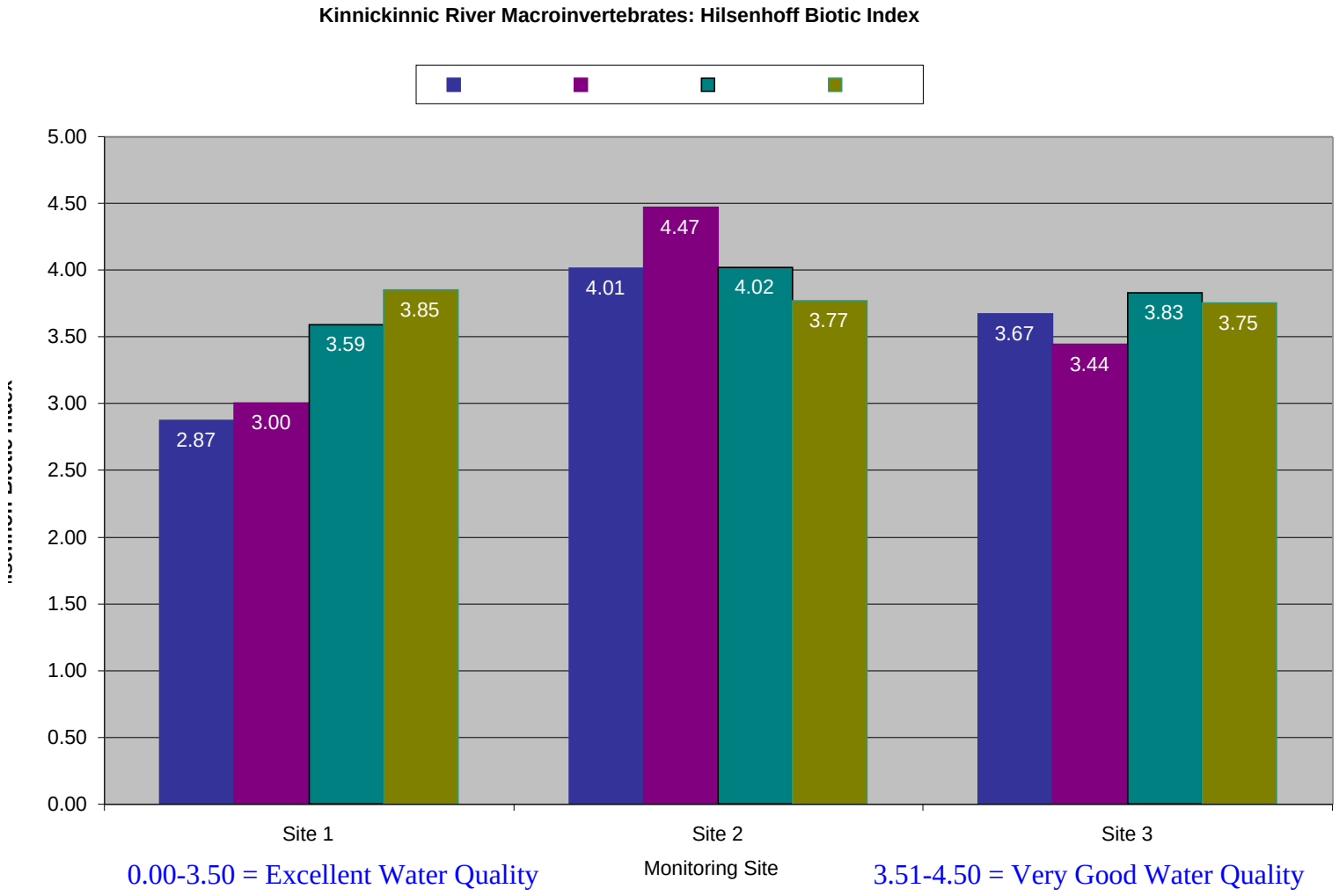
Macroinvertebrate Monitoring:

Biological indicators such as macroinvertebrates (aquatic insects) are often used to complement physical and chemical measurements in stream monitoring programs. Because macroinvertebrates live in the stream environment for a year or more, they are excellent indicators of past as well as present water quality conditions. Annual macroinvertebrate samples are collected at Sites 1-3 within the North Kinnickinnic River Monitoring Project Area. Organisms are identified and counted in the laboratory, and various biological indices can then be calculated for each monitoring site. The index values are indicative of water quality, depending upon the pollution tolerances of the macroinvertebrates collected at the monitoring sites.

The Hilsenhoff Biotic Index (HBI) is particularly useful for determining the influence of organic pollution on macroinvertebrates. The Wisconsin Department of Natural Resources has used this index for many years in long-term stream monitoring programs. Each macroinvertebrate taxon (genus and/or species) has been assigned a specific tolerance value, ranging from 0 (extremely intolerant of organic pollution) to 10 (extremely tolerant of organic pollution). The more intolerant taxa that are present, the lower the HBI value, indicating better water quality, as follows:

HBI Value	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

The 2004-2007 macroinvertebrate HBI values at Sites 1-3 in the North Kinnickinnic River Monitoring Project Area are presented below. The 2004-2007 data establish a baseline for assessing the long-term health of the macroinvertebrate community within the project area. During the 2004-2007 period, HBI values at Site 1 were indicative of very good-excellent water quality, HBI values at Site 2 were indicative of very good water quality, and HBI values at Site 3 were indicative of very good-excellent water quality. The annual HBI values at Site 1 are all less than or comparable to the annual HBI values at Sites 2 and 3, indicating slightly better water quality at Site 1. The comparability of annual macroinvertebrate HBI values at Sites 1-3 during the 2004-2007 period indicates that no storm water impacts were apparent at Site 1, downstream from Sumner Creek and the Sterling Ponds subdivision.



Macroinvertebrate monitoring was again conducted in May 2008 and May 2009, but the sample analysis has not yet been completed by the University of Wisconsin-Stevens Point laboratory. Annual HBI values and other macroinvertebrate indices will continue to be posted as they become available, and long-term trends in these indices will continue to be evaluated, to assess the ongoing health of the Kinnickinnic River macroinvertebrate community.

Water Quality Monitoring:

No runoff event-based water quality monitoring was conducted in 2009, due to ongoing logistical and technical difficulties with the automated monitoring equipment at Kinnickinnic River Sites 1 and 2, and at the Sterling Ponds wet detention pond outlet (Site 5MHW). If these equipment difficulties can be resolved, the water quality monitoring component of the North Kinnickinnic River Monitoring Project will be initiated in 2010. At a minimum, it seems likely that automated monitoring can be conducted at Site 5MHW, to characterize the water quality of any Sterling Ponds wet pond discharges to Sumner Creek in 2010.

North Kinnickinnic River Monitoring Project Indicators:

As a part of the North Kinnickinnic River Monitoring Project, key physical and biological indicators have been monitored to evaluate the effectiveness of the River Falls Storm Water Management Ordinance for preventing degradation of the Kinnickinnic River due to development-related storm water impacts. These ten key indicators, which have been monitored since the onset of the project in 2004, include:

- Total rainfall in River Falls during the April-September period
- % April-September rainfall infiltrated, per the River Falls Storm Water Management Ordinance
- Number of summer (May-September) rain events infiltrated and % summer rainfall infiltrated, as measured by monitoring at Sterling Ponds
- Summer (May-September) average air temperature in River Falls
- Summer (May-September) average temperatures in the Kinnickinnic River and Sumner Creek
- % of the summer Kinnickinnic River temperatures favorable for biota
- % of the summer Sumner Creek temperatures favorable for biota
- Spring base flow conditions in the Kinnickinnic River and Sumner Creek
- Autumn base flow conditions in the Kinnickinnic River and Sumner Creek
- Kinnickinnic River macroinvertebrate HBI values

The North Kinnickinnic River Monitoring Project Indicators for the 2004-2009 period can be found on the project website. As monitoring continues in the future, these indicators can evaluate the annual effectiveness of the River Falls Storm Water Management Ordinance and track long-term trends that document protection of the Kinnickinnic River.