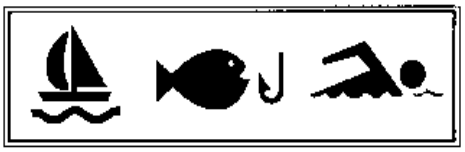
THE ROUGE RIVER PROJECT
A WORLD CLASS EFFORT



BRINGING OUR RIVER BACK TO LIFE

Rouge River National Wet Weather Demonstration Project

Wayne County, Michigan

2011 Rouge River Ecosystem Monitoring and Assessment Report

RPO-WMGT-TR75

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Rouge River National Wet Weather Demonstration Project

MISSION STATEMENT

The mission of the Rouge River National Wet Weather Demonstration Project is to demonstrate effective solutions to water quality problems facing an urban watershed highly impacted by wet weather and develop potential solutions and implement projects which will lead to the restoration of water quality in the Rouge River. The project addresses both conventional and toxic pollutants to:

- provide a safe and healthy recreational river resource for present and future generations;
- re-establish a healthy and diverse ecosystem within the Rouge River Watershed;
- protect downstream water resources such as the Detroit River and Lake Erie; and
- help ensure compliance with federal, state and local environmental laws which protect human health and the environment.

This will be accomplished through the development, implementation and financial integration of technical, social and institutional frameworks leading to cost-efficient and innovative watershed-based solutions to wet weather problems. This watershed-based national demonstration project will provide other municipalities across the nation facing similar problems with guidance and potentially effective solutions.

PREFACE

In the year 2011, the Rouge River National Wet Weather Demonstration Project (Rouge Project) continued to restore and protect designated uses in the Rouge River system through a systematic watershed approach to pollution management. This cost-effective, holistic approach is also providing solutions to other urban watersheds throughout the country on how to restore a polluted urban waterway. The Rouge Project was initiated in 1992 by the Department of the Environment, Wayne County, Michigan. The Rouge River Watershed in Southeast Michigan is largely urbanized, spans approximately 466 square miles, is home to more than 1.4 million people in 48 communities and three counties, and is a tributary to the Detroit River. Multi-year federal grants from the United States Environmental Protection Agency and additional funding from local communities support this cooperative effort between federal, state and local agencies. These grants are managed by Wayne County.

The early focus of the Rouge Project was on the control of combined sewer overflows (CSOs) in the watershed. Although control of pollution from CSOs was identified as a major priority, it was determined that CSO control alone would not provide sufficient improvements to meet water quality standards in the watershed. This is because nonpoint source pollutants — such as storm water runoff, discharges from illicit connections, discharges from failed on-site septic systems, and other sources — would continue to degrade the river. In addition, it was determined that wetlands, habitat restoration, lake restoration, erosion and flow variability all needed to be controlled before full restoration of the river would be achieved throughout the watershed.

Based upon what was learned, the Rouge Project expanded to a holistic approach to consider the impacts from all sources of pollution and use impairments in receiving waters. In 1994, an ad hoc Rouge River Storm Water Advisory Group was formed to develop and guide the implementation of a cooperative strategy to restore the river throughout the watershed. In March of 1995, a storm water management strategy based on the application of watershed-wide management approaches for the Rouge River was developed and implemented. One element of the strategy was to develop a regulatory framework. To fulfill this goal, the Michigan Department of Environmental Quality (MDEQ), the Rouge Project and the communities in the Rouge Watershed worked jointly to develop a watershed based general storm water permit that was issued statewide in 1997 under the National Pollutant Discharge Elimination System (NPDES). This permit, and its successors, has been approved by EPA as meeting the requirements of the Phase II storm water regulations for municipal discharges issued under the Clean Water Act.

Because the Rouge watershed is so large and involves so many stakeholders, the communities chose to subdivide the watershed into seven subwatersheds. Subwatersheds give a means for focusing the local resources to address local problems due to the interest people have in their immediate surroundings. Watershed advisory groups were formed for each subwatershed to develop the watershed management plans required under the general storm water permit. These plans were completed in 2001 and were implemented through a unique partnership of local agencies and communities, state agencies, non-profit organizations, businesses and citizens. The seven subwatershed plans identified alternative steps needed to address remaining problems associated with storm water, combined and sanitary sewers overflows, failing septic systems, and

non-point sources. The goals, action steps, and measures tailored to individual subwatersheds established a strong foundation which guided cooperative efforts to fully restore the impaired uses of the river. Coordination of the efforts of the seven subwatershed groups was initially accomplished by a watershed-wide steering committee, which has since evolved into the new Alliance of Rouge Communities (ARC). In 2008 the ARC updated and consolidated the seven subwatershed management plans completed in 2001 into one sustainable Rouge River Watershed Management Plan (WMP). This plan builds on the successes of the past while laying the groundwork for the future. The plan was approved by MDEQ in July 2012 as meeting EPA's Section 319 requirements.

On August 5, 2003, after nearly two years of discussion, the Rouge watershed communities and counties formed the *Rouge River Watershed Local Management Assembly (Assembly of Rouge Communities)* to guide the Rouge River restoration into the future as the federal grant funding diminishes. The Assembly of Rouge Communities (Assembly) was based on a Memorandum of Agreement (MOA), signed by each local community, which outlined voting and funding shares for the new working arrangement. The Assembly successfully operated for 2.5 years, with 38 community members and three county (Wayne, Oakland and Washtenaw) members. The annual budgets, on the order of $600,000 per year, were used to fund: 1) watershed-wide monitoring; 2) sampling data analyses and reports; 3) the coordination of public education and involvement activities, all of which are required by local units of government under the Michigan watershed based storm water permit. In addition, the funds were used to provide technical guidance and facilitation for the Assembly, its committees and the seven Subwatershed Advisory Groups. Wayne County served as fiduciary for the Assembly during 2003-2005.

In December 2005, the Assembly formally became the ARC when 20 eligible members approved bylaws modeled after the former MOA for operation of the Assembly. The group now acts as a legal public entity under the new Watershed Alliance Act, Public Act 517 of 2004 and is recognized as a 501(c)3 nonprofit agency. In 2012, the ARC has 38 members, two associate members, and five cooperating partners. The annual budgets continue to fund watershed-wide activities such as public education, monitoring, and other technical activities. Much of the work of the ARC is happening through the standing committees: Finance, Technical, Public Involvement/Education, Executive and Organization.

Using the watershed approach requires a number of tools such as a comprehensive sampling and monitoring program, various types of water quality and water quantity modeling, and a geographic information system. The Rouge Project has aggressively invested in these tools and others in order to develop the necessary holistic watershed management strategy. These innovative, readily transferable tools are being shared with other cities and state agencies.

The Rouge River National Wet Weather Demonstration Project is an unqualified success, using any of several measures of achievement. Major progress has been made in the control of pollution being discharged to the Rouge River. For example, CSO pollutant loads to the river have been cut by 90 to 100 percent during most events. In previous years certain water quality standards were violated most of the time at many places in the watershed. Now, the majority of the waters in the Rouge River watershed meet many standards. Coupled with the water quality improvements, the ecosystem health continues to improve as well. This is demonstrated by

several measures such as increased sightings of fish and wildlife along the river since 1999. Improvements in the water quality and removal of contaminated sediment in Newburgh Lake resulted in the lifting of the fish consumption advisory for some species of fish in the lake. This is the first time fish caught in the Rouge River systems have been safe for consumption in decades. The Rouge Project has a very extensive website that contains technical reports, maps, and other information about the details of the Rouge Project, available at www.rougeriver.com.

INTRODUCTION

A Five-Year Monitoring Plan conducted by the Alliance of Rouge Communities (ARC) was completed in 2007. Activities that were part of the Five-Year Monitoring Plan started in 2003 and included a rotational schedule of continuous (15 minute intervals) and intermittent water quality sampling through the seven Rouge River Watershed Storm Water Management Areas (SWMAs). Continuous monitoring was conducted for dissolved oxygen (DO), water temperature, and level and flow. Intermittent sampling included water quality parameters like carbonaceous biochemical oxygen demand ($CBOD_5$), ammonia nitrogen (NH_3-N), total phosphorus (TP), total suspended solids (TSS) and *Escherichia coli* (*E. coli*). Additional biological monitoring was also performed and included benthic macroinvertebrate and frog and toad surveys. In 2008 the ARC took a year off from monitoring to update and consolidate the seven subwatershed management plans which were previously prepared in 2001 into one integrated plan, the 2009 Rouge River Watershed Management Plan. This plan was approved by Michigan Department of Environmental Quality (MDEQ) in July 2012.

The overall purpose of the ARC's 2009 Rouge River Watershed Management Plan (WMP) is to build on past successes and to continue to implement a cost-effective approach to improving water quality in the Rouge River as well as meet the requirements of the NPDES Phase II stormwater permit with which each ARC community must comply (Accessed website May 2010 at http://www.allianceofrougecommunities.com). The 2009 Rouge River WMP is a five-year plan which encompasses the years from 2009 through 2013. The plan includes the collection of several types of data throughout the watershed, which will be used to measure the improvements in water quality. Precipitation, streamflow, and biological health monitoring data will be collected each year. However, dissolved oxygen and temperature, bacteria, and nutrients will not be monitored in each year of the plan, but the collection of these data is planned during at least one year of the plan. In 2011 the following monitoring data were collected:

- Precipitation data (15-minute totals) were collected in 2011 at 21 rain gage locations throughout the watershed. Seven of the rain gages were operated by the Wayne County Department of Public Services (WCDPS), 11 rain gages were operated by the Oakland County Water Resources Commissioner's (OCWRC) Office, and the Detroit Water and Sewerage Department (DWSD) operated three rain gages. Since all of the rain gages were heated, the recorded precipitation amounts include rainfall as well as hail, sleet and snow as equivalent inches of water. Additional precipitation data were also collected for the Detroit and Pontiac area by NOAA's National Weather Service Forecast Office.
- Continuous monitoring of level and flow was performed by the United States Geological Survey (USGS) at eight locations (US1-US5, US7, US10, D06) throughout the watershed in cooperation with Oakland County and the MDEQ.
- Continuous monitoring of dissolved oxygen (DO) and water temperature was performed by the USGS at one location in the Middle Branch of the Rouge River at Hines/Ford Road (D06) and one location in the Main Branch Plymouth Road (US7).
- The USGS collected and analyzed discrete water samples at Plymouth Road (US7) for several organic and inorganic parameters in 2011. The results for total phosphorus and

ammonia nitrogen are presented in this report. The results for all of the sampling performed by the USGS in 2011 at Plymouth Road (US7) can be accessed at: http://nwis.waterdata.usgs.gov/mi/nwis/uv?cb_00060=on&cb_00065=on&cb_00010=on&cb_00300=on&cb_00400=on&cb_00095=on&cb_63680=on&cb_99234=on&format=gif_default&begin_date=2007-10-01&end_date=2012-03-12&site_no=04166500

- Wayne County Department of Public Health, Environmental Health Division collected instream samples for *E. coli* at Newburgh Lake in the Middle Rouge River. These *E. coli* samples were collected to characterize the water body and not to determine compliance with the MDEQ *E. coli* total or partial body contact standards. (These results are not included in this report, but can be obtained by contacting Kathleen McElroy at Wayne County Department of Public Health, Environmental Health Division, 734-727-7444)
- Frog and toad surveys, benthic macroinvertebrate surveys, and winter stonefly searches were performed by Friends of the Rouge (FOTR) and Wayne County. Complete reports on these surveys can be accessed at http://www.therouge.org.

An on-line database is available which allows users to query sampling data collected since 1994 by site, date, and parameter. It allows for online data viewing or download and includes on-line help. The Rouge River Watershed sampling database is available at www.rougeriver.com/database.

A discussion of the data collected in 2011 follows.

WATER QUALITY MONITORING AND SAMPLING

Dissolved Oxygen (DO) and Water Temperature

A key element of a healthy river ecosystem is adequate DO. Instream DO concentrations (over 5 mg/L) are essential for healthy fish and other aquatic life. Even brief declines in DO concentrations to levels below 5 mg/L can have a detrimental effect on aquatic organisms. In general DO and temperature are in compliance with minimum water quality standards on a routine basis throughout the watershed and have remained fairly stable at most locations.

DO has been monitored in the river for over a decade now and is very useful in determining spatial and temporal water quality trends. Prior to 2006 there was at least one continuous DO and water temperature monitoring location in each of the seven SWMAs in the Rouge River watershed, and two in the Main 3-4 SWMA as shown in **Figure 1**. From 2007 through 2011 continuous DO and temperature was monitored in at least one location in the watershed with the exception of 2009. In 2011, as part of the 2009 through 2013 Five Year Monitoring Plan, continuous monitoring of DO and temperature was performed at Hines/Ford Road (D06) in the Middle Branch of the Rouge River and at Plymouth Road (US7) in the Main Branch. Comparison of the amount of DO data expected to be collected in 2011 to the DO data actually collected shows a DO percent completeness of 98.2 percent at D06 and 99.6 percent at US7. Monitoring in the Lower Branch at Military Road (L05D) was planned for 2012, but is postponed until 2013 due to the removal of the Wayne Road dam in 2012. **Figure 2** shows the mean DO values, the percent of DO values greater than 5.0 mg/L, and the mean temperature

values from 1994 through 2011 at Telegraph Road (U05), Plymouth Road (US7), Hines Drive/Ford Road (D06), and Military Road (L05D). The percent of the time dissolved oxygen concentrations were in compliance with the minimum 5 mg/L warm water State standard show an upward trend. Based on a rating scale developed by the Rouge Project the DO data at the continuously monitored locations since 2008 are all rated good (DO $\geq$ 5 mg/L, $\geq$ 95% of the time). In the Rouge River when the DO falls below the state minimum standard it is typically following a low flow condition after a small rainfall event when the water temperature is above the average temperature for that stream. DO values of less than 5 mg/L occurred at the following locations under the conditions described:

- In 2010 at Telegraph Road (U05) - after a small rainfall event (less than 0.20 inches) when the water temperature was 1.2 -5.4 ºC above the average water temperature of 18.7 ºC. (DO was not monitored at this location in 2011.)

- In 2011 at Hines/Ford Road (D06):
    - July 3 (1:15 – 19:00) following a low flow condition and after a small rainfall event of less than 0.10 inches when the water temperature was 4.5 -6.3 ºC above the average water temperature of 19.2 ºC.
    - July 11 20:45 – July 13 3:15 following a low flow condition and after a two hour small rainfall event of 0.43 inches when the water temperature was 4.3 -6.7 ºC above the average water temperature of 19.2 ºC.
    - July 18 21:30 – July 19 23:00 following a low flow condition and after a 1 hour 15 minute medium rainfall event of 0.55 inches when the water temperature was 5.7 – 7.6 ºC above the average water temperature of 19.2 ºC.
    - July 23 (1:00 – 3:30) following a low flow condition and after a 1 hour 15 minute small rainfall event of 0.09 inches when the water temperature was 6.9 – 7.2 ºC above the average water temperature of 19.2 ºC.
    - September 4 (7:15 – 17:00) following a low flow condition and after a 5 hour 15 minute small rainfall event of 0.42 inches when the water temperature was 4.1 – 5.2 ºC above the average water temperature of 19.2 ºC. An additional rainfall event of 0.18 inches and 45 minutes in duration occurred towards the end of this low DO period.

- In 2011 at Plymouth Road (US7):
    - May 10 (9:30 – 12:30) following a below average flow condition and after a small rainfall event of 0.38 inches , 2 hours and 15 minutes in duration, when the water temperature was less than the average water temperature of 18.3 ºC.
    - May 14 (2:00 – 5:15) following an above average flow condition and after a 3 hour 15 minute medium rainfall event of 0.88 inches when the water temperature was near the average water temperature of 18.3 ºC.
    - June 23 (3:00 – 7:00) following an above the average flow condition and after a 3 hour 30 minute small rainfall event of 0.39 inches when the water temperature was 3.0 – 3.3 ºC above the average water temperature of 18.3 ºC.
    - July 11 20:45 – July 13 11:15 following a low flow condition and after a 3 hour 45 minute small rainfall event of 0.38 inches when the water temperature was 3.7 – 5.7 ºC above the average water temperature of 18.3 ºC.

- July 18 17:15 – July 27 8:45 following a low flow condition and after a 1 hour 45 minute medium rainfall event of 0.68 inches when the water temperature was 3.9 – 9.7 ºC above the average water temperature of 18.3 ºC.
- August 9 (10:45 – 11:15) following a low flow condition and after a 6 hour 45 minute large rainfall event of 1.67 inches when the water temperature was 2.5 – 2.6 ºC above the average water temperature of 18.3 ºC.
- September 4 (4:30 – 12:00) following a low flow condition and after a 2 hour 45 minute small rainfall event of 0.19 inches when the water temperature was 2.1 – 4.7 ºC above the average water temperature of 18.3 ºC.

Regression analyses (1994 – 2011) of the continuous DO daily averages at Hines/Ford Road (D06) and Plymouth Road (US7) were updated with 2011 data and as in previous years continued to show improvement. The improvement at Hines/Ford Road was 0.04 mg/L/year (**Figure 3**) and at Plymouth Road was 0.11 mg/L **(Figure 4)**. Trend analyses were previously performed on historical continuous daily average DO data collected from 1994 to 2010 (data not collected at each location in all years) at the six other continuous monitoring locations and in general they show improvement or no significant trend **(Table 1).** The improvement in dissolved oxygen is due in large part to the control of untreated sewage being discharged to the Rouge River as well as other pollution control measures implemented throughout the Rouge watershed. Further improvements are expected as the remaining combined sewer overflows, located primarily in Dearborn and Detroit, are controlled.

Overall, these results indicate that pollution control measures implemented through the Rouge Project have improved DO concentrations in the river. Pollution sources that still exist should be addressed in the 2009 WMP.

Figure 1
Rouge River Watershed Dissolved Oxygen and Temperature Measurement Locations

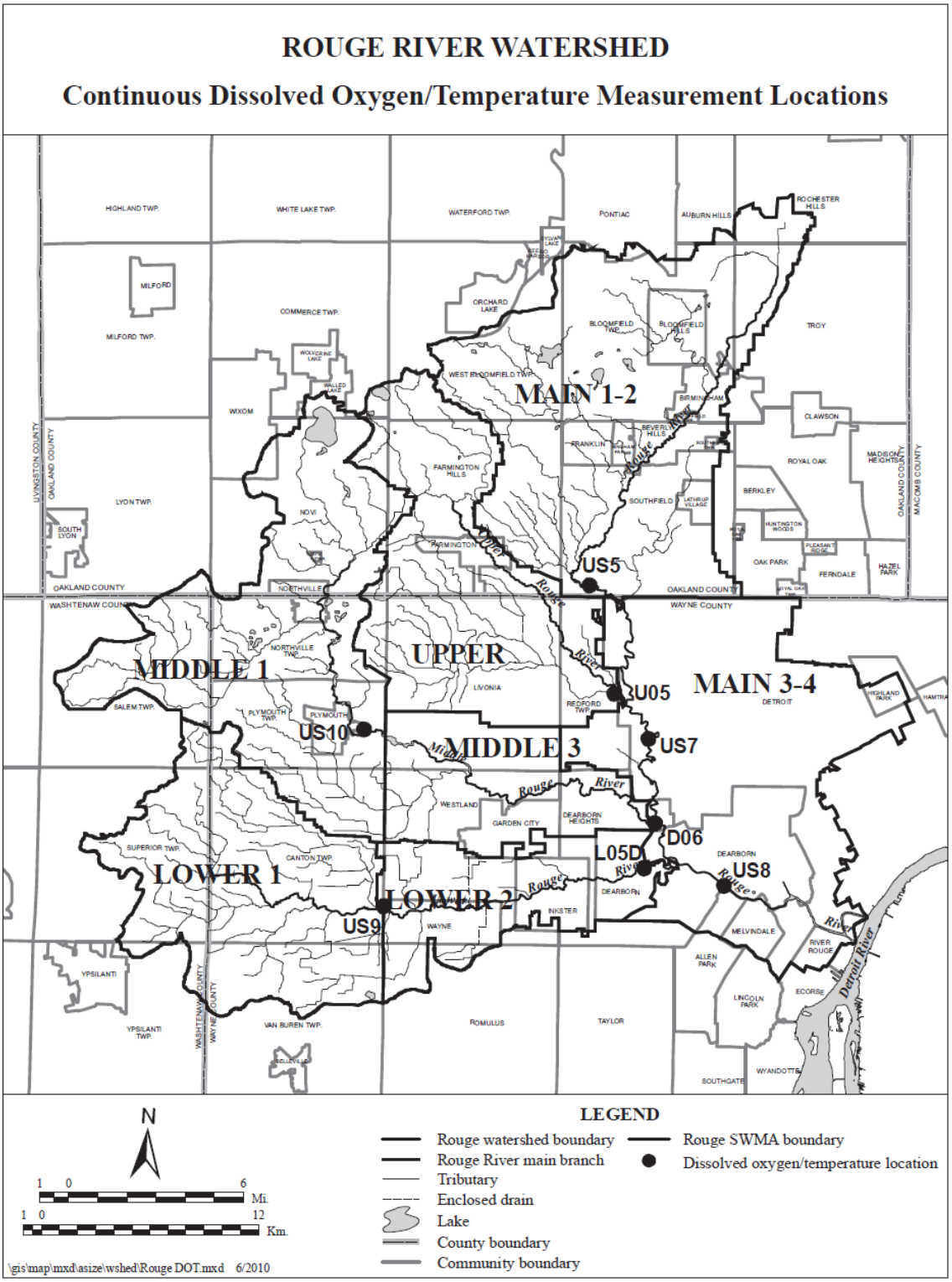
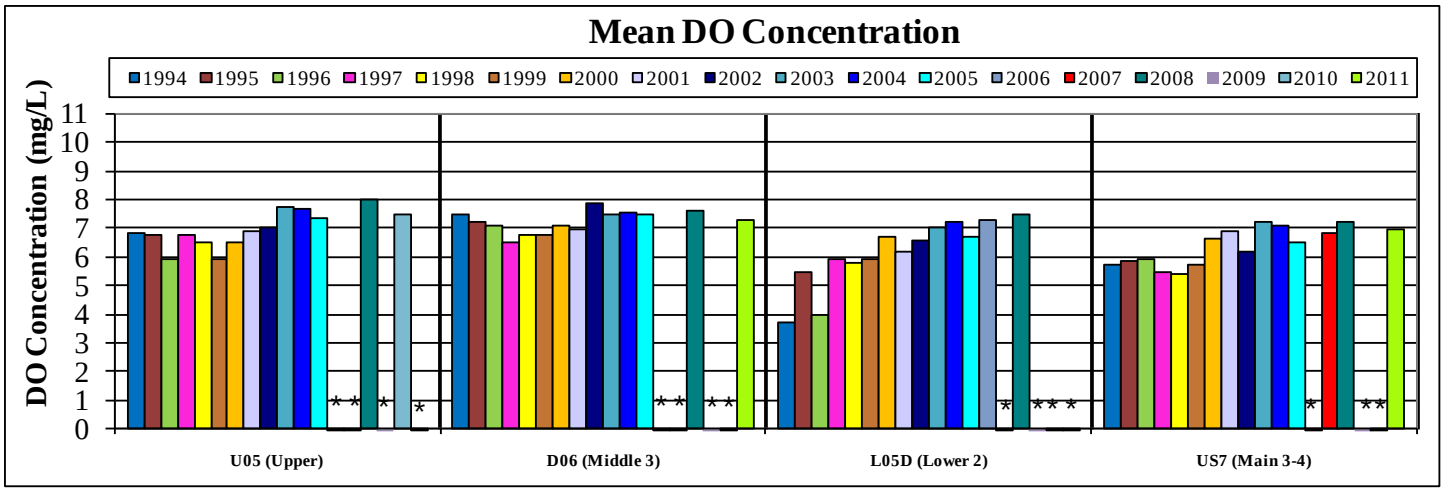
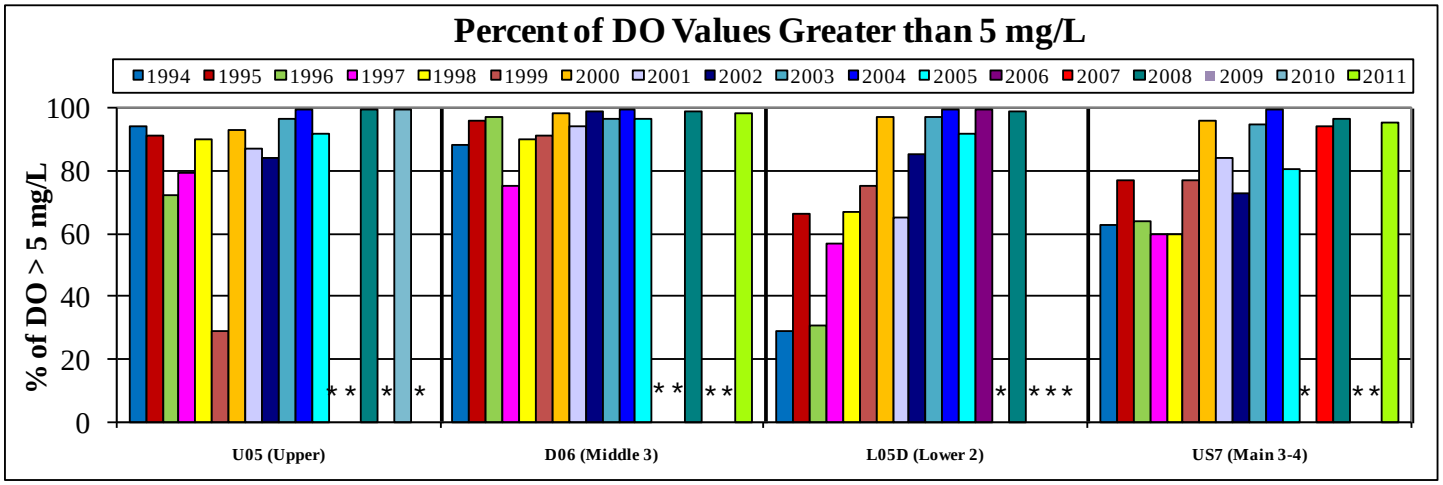
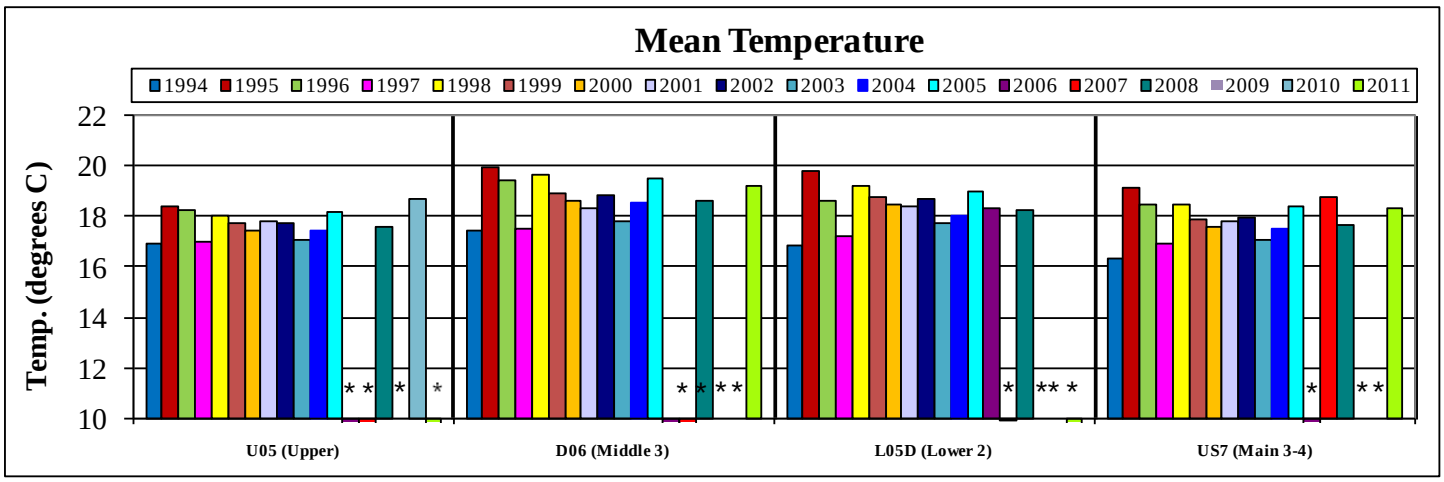


Figure 2
Continuous DO and Temperature Annual Mean Data
May - October 1994 – 2011
Stations U05, D06, L05D, US7

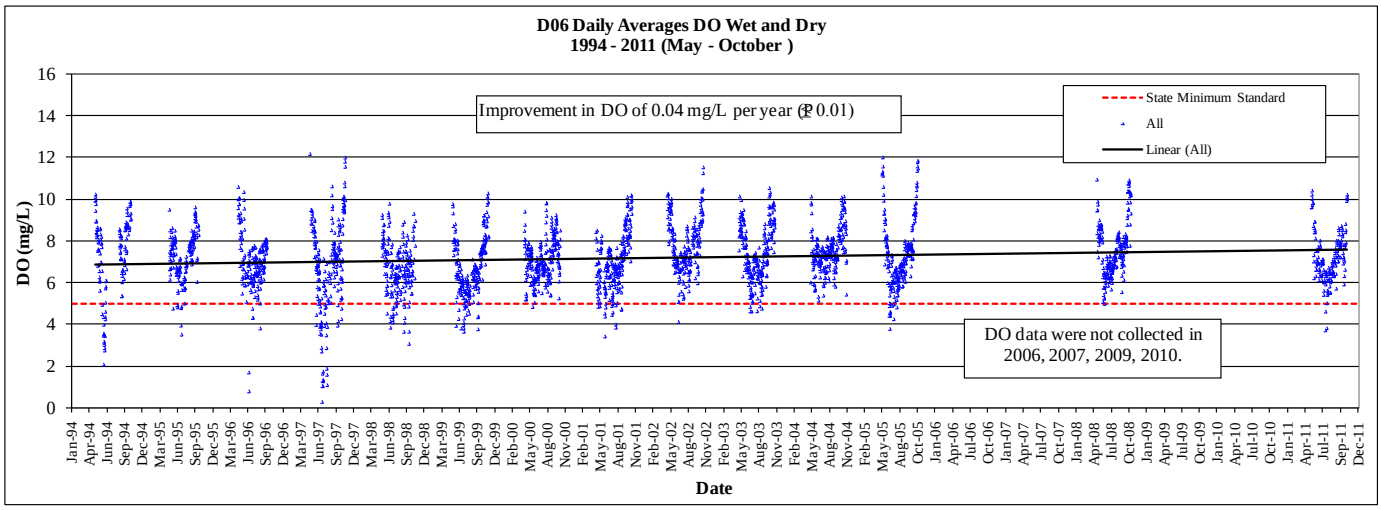






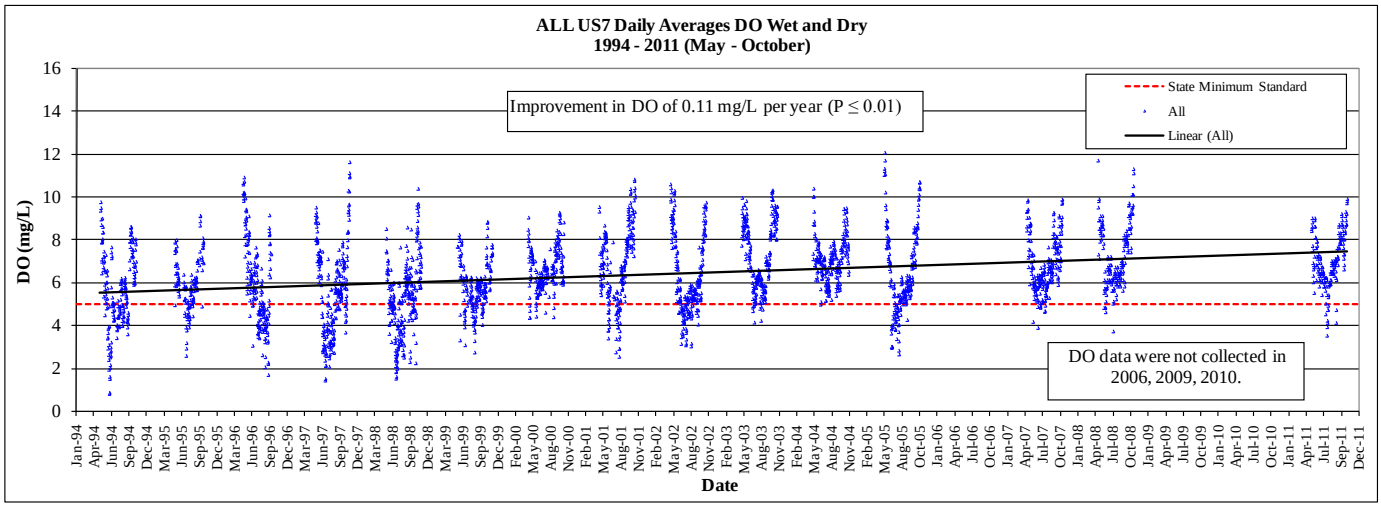
Note: * indicates no data available for year.

Figure 3
Hines/Ford Road (D06)
Regression Analysis of DO Daily Averages 1994 – 2011



These data represent the combined effect of dry and wet weather conditions as well as diurnal variations in the river. Continuous data not collected at D06 in 2006, 2007, 2009 and 2010. Note: Linear in legend means a linear trendline.

Figure 4
Plymouth Road (US7)
Regression Analysis of DO Daily Averages 1994 – 2011



These data represent the combined effect of dry and wet weather conditions as well as diurnal variations in the river. Continuous data not collected at US7 in 2006, 2009 and 2010. Note: Linear in legend means a linear trendline.

Table 1
Trend Analyses: Rouge River Daily Average Dissolved Oxygen Concentrations

Daily Average DO Trend Analyses for the Rouge River Watershed			
SWMA	**Site ID**	**Period of Record**	**Trend**
Main 1-2	US5	1997-2005	Improvement of 0.15 mg/L/year
Main 3-4	US7	1994-2005, 2007, 2008, 2011	Improvement of 0.11 mg/L/year
Main 3-4	US8	2001- 2005, 2007	No significant change
Upper	U05	1994-2005, 2008, 2010	Improvement of 0.10 mg/L/year
Middle 1	US10	2003-2005	No significant change
Middle 3	D06	1994-2005, 2008, 2011	Improvement of 0.04 mg/L/year
Lower 1	US9	2002-2006	Degradation of 0.04 mg/L/year*
Lower 2	L05D	1994-2006, 2008	Improvement of 0.22 mg/L/year

*Since data collection began at US9 in 2001 (May – Oct) DO mean has been $\geq$7.7 mg/L and the percent $\geq$5 mg/L has been 100%.

Ammonia Nitrogen (NH_3-N) and Total Phosphorus (TP)

In 2011 the USGS collected and analyzed discrete water samples at Plymouth Road (US7) for several organic and inorganic parameters. In the ARC's first Five Year Plan (2003 – 2007) samples were collected and analyzed for Carbonaceous Biochemical Oxygen Demand, 5-Day ($CBOD_5$), Total Suspended Solids (TSS), Ammonia (NH_3-N), Total Phosphorus (TP), and *E. coli* and observations were made summarizing these parameters (comparison to state standards, trend analyses). Two of the parameters analyzed by the ARC in the first Five Year Plan were also analyzed by the USGS in 2011 in wet weather, NH_3-N and TP. Wet weather data for these two parameters (1994 – 2011) are summarized below.

Ammonia (NH_3-N). Dissolved ammonia may be produced by organic decay, and can have toxic effects on aquatic animals even at low concentrations. Ammonia toxicity is pH and temperature dependent. The NH_3-N annual mean values in wet weather for Plymouth Road (US7), located in the Main 3-4 SWMA, are summarized in **Table 2** and shown in **Figure 5**. Data for 2011 are compared to data from 1994 through 2011 when available. A target value for NH_3-N has not been established for the Rouge River Watershed. The following observations can be made from the data:

- The 2011 sampling results are not judged for compliance with State standards, as no State standard for NH_3-N exists.
- Trend analyses of the data from 1994 through 2011 indicate a slight improvement in NH_3-N concentrations at Plymouth Road (US7) (**Figure 6**).

Table 2
Plymouth Road (US7) Wet Weather Ammonia Nitrogen
Mean, Maximum and Minimum Concentrations

Plymouth Road	Ammonia Nitrogen					
US7	1994	1995	1996	1998	2007	2011
max(mg/L)	1.70	0.20	0.31	1.66	0.90	0.21
min(mg/L)	<.10	<.10	0.11	0.10	0.02	0.01
mean(mg/L)	0.34	0.13	0.20	0.36	0.16	0.07
no. values	55	6	4	22	39	33

Figure 5
Plymouth Road (US7) Wet Weather Ammonia Nitrogen
Mean Concentration

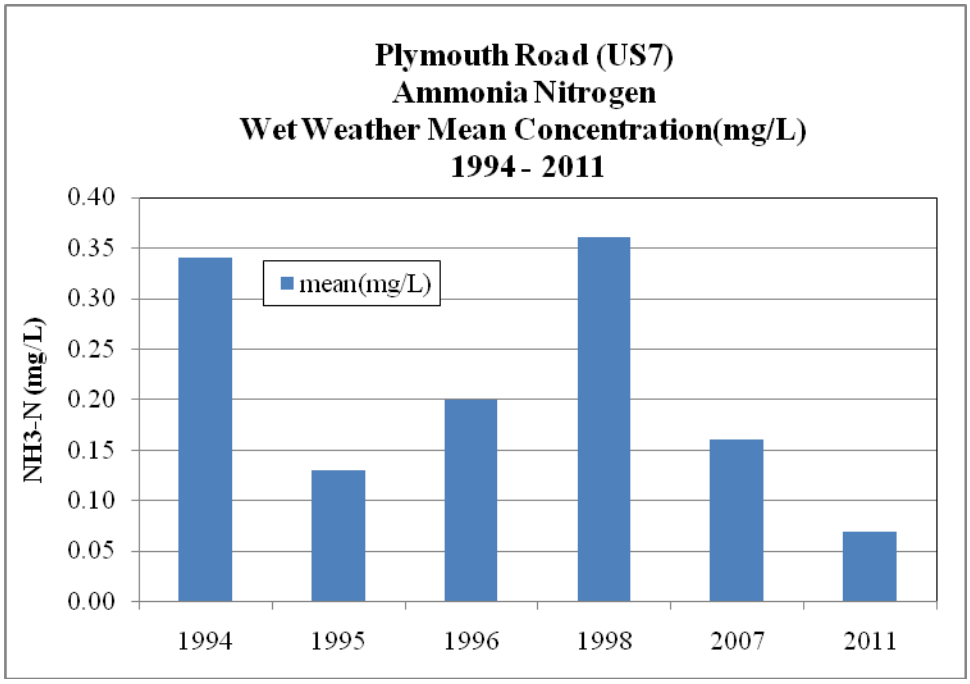
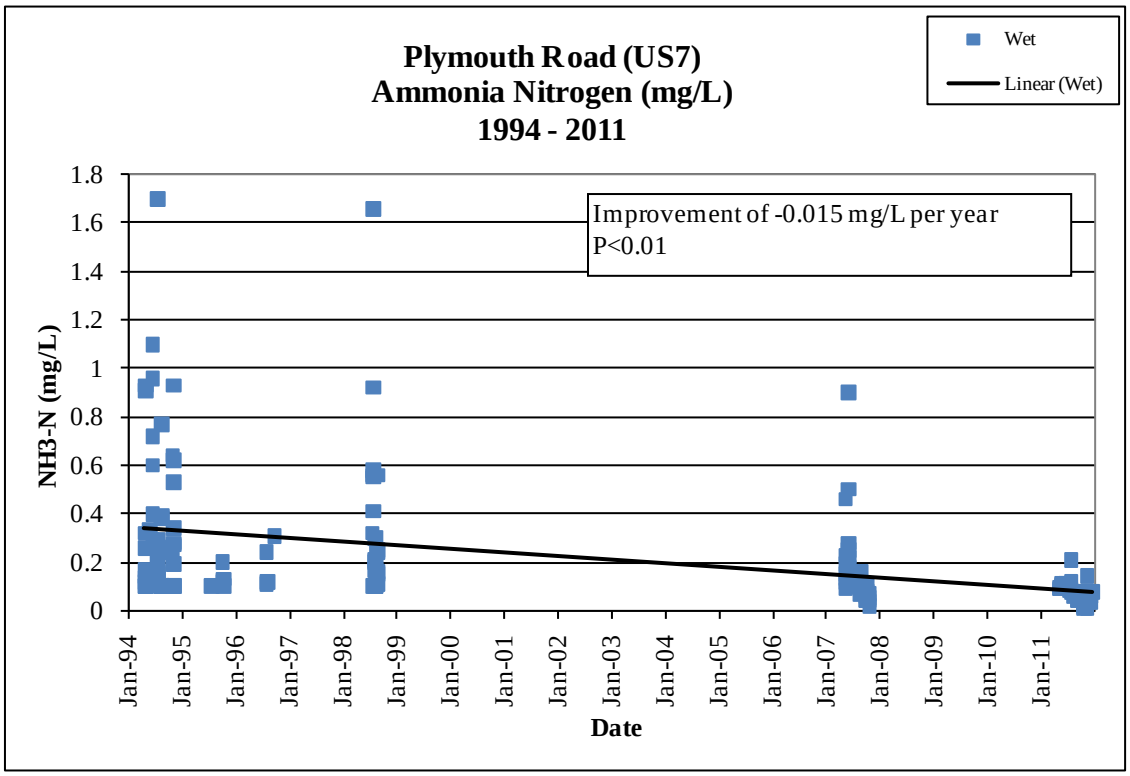


Figure 6
Plymouth Road (US7) Wet Weather Ammonia Nitrogen Regression Analysis 1994 – 2011



Note: Linear in legend means a linear trendline.

Total Phosphorus (TP). Phosphorus in its available forms can stimulate growth of aquatic plants, sometimes to the detriment of animal life. The TP annual mean values in wet weather for Plymouth Road (US7) are summarized in **Table 3** and shown in **Figure 7**. Data for 2011 are compared to data from 1994 through 2011 when available. The Main 3-4 SWAG initially established a total phosphorus target of a decrease in TP in dry weather, but did not set a numeric value for this target level. In 2003, RPO and MDEQ re-examined this target, with a more thorough evaluation of the phosphorus concentration data in each subwatershed. The MDEQ has recommended a dry weather TP target of 0.05 mg/L upstream of the confluence with the Lower Branch, which includes Plymouth Road (US7). Only wet weather data were collected in 2011 and currently no wet weather TP target (or State numeric criteria) exists. The following observations can be made from the data:

- The 2011 sampling results are not judged for compliance with State standards, as no State standard for TP exists.
- Trend analyses of the data from 1994 through 2011 indicated no significant change in wet weather TP concentrations at Plymouth Road (US7) (**Figure 8**).

Table 3
Plymouth Road (US7) Wet Weather Total Phosphorus
Mean, Maximum and Minimum Concentrations

Plymouth Road	Total Phosphorus					
US7	1994	1995	1996	1998	2007	2011
max(mg/L)	0.61	0.11	0.32	0.18	0.52	0.62
min(mg/L)	<.10	<.10	<.10	<.01	0.07	0.03
mean(mg/L)	0.17	0.10	0.18	0.09	0.15	0.16
no. values	42	6	4	22	39	33

Figure 7
Plymouth Road (US7) Wet Weather Total Phosphorus
Mean Concentration

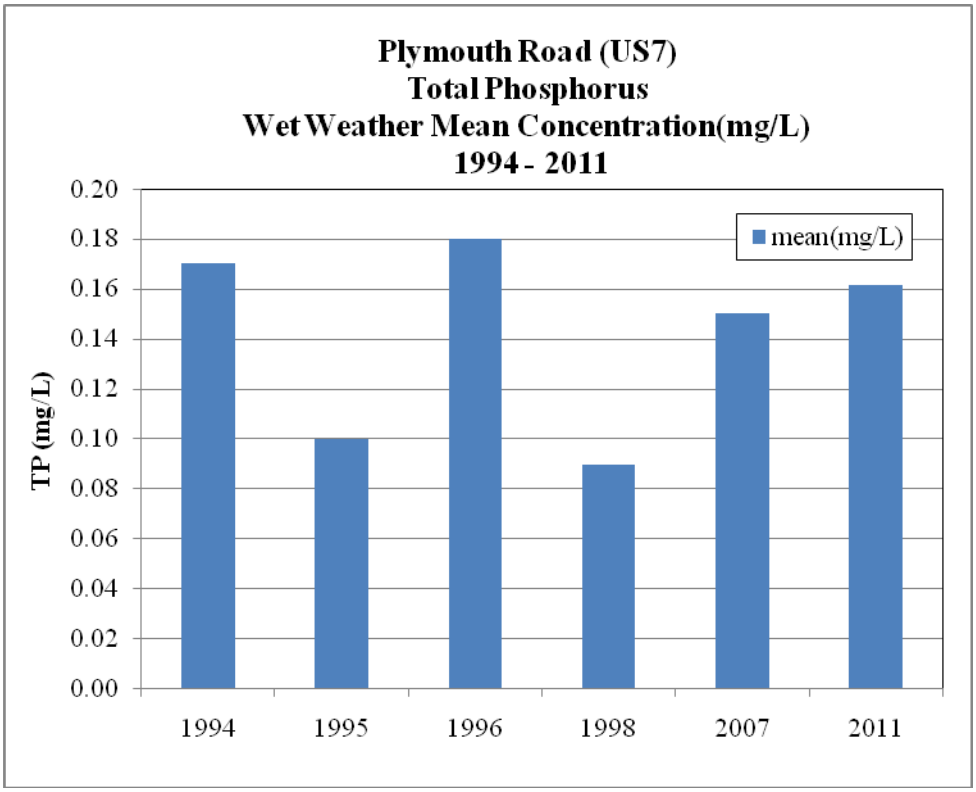
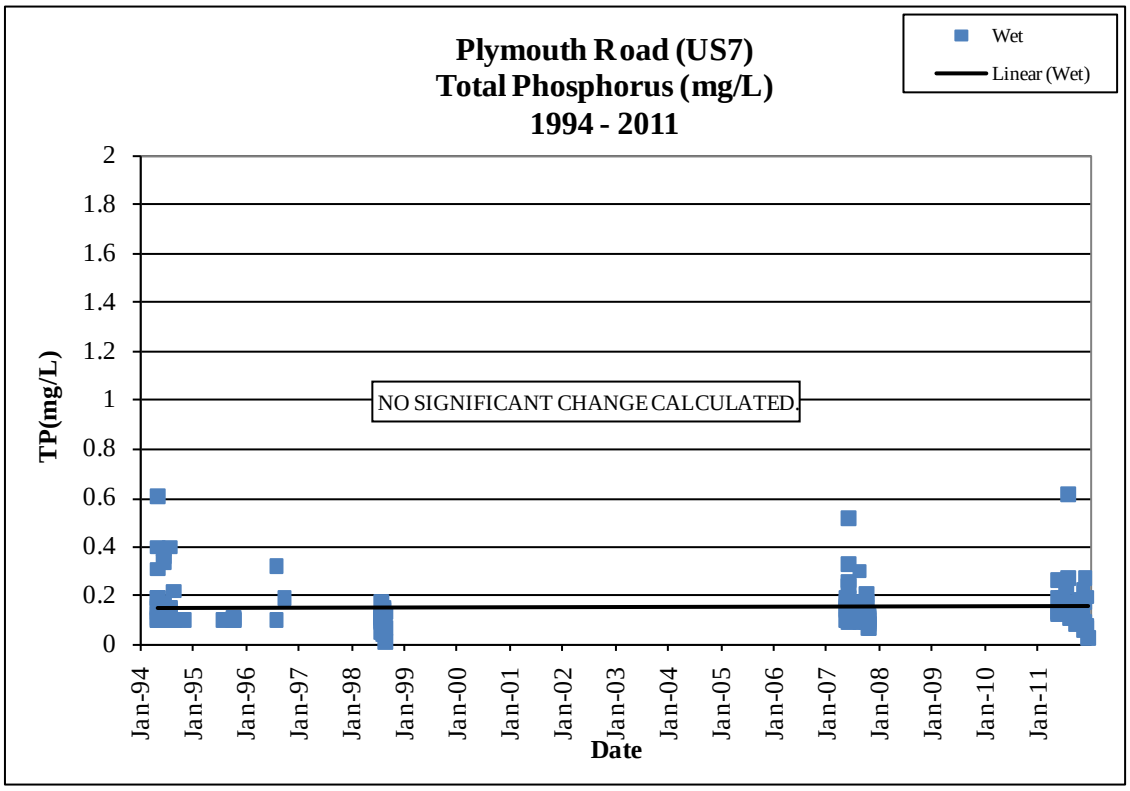


Figure 8
Plymouth Road (US7) Wet Weather Total Phosphorus Regression Analysis 1994 – 2011



Note: Linear in legend means a linear trendline.

HYDROLOGY

Moderate, stable streamflows are generally best for aquatic life and stream habitats. Extreme variation of flow rate and volume during storm events can result in severe bank erosion and sediment resuspension, which can significantly degrade game fish habitats. In 2011, continuous flow and level monitoring data were collected at eight locations throughout the watershed by the United States Geological Survey (USGS). Data were collected in cooperation with Oakland County and the Michigan Department of Environmental Quality (MDEQ) at Maple Road (US4), Beech Road (US5), Plymouth Road (US7), Shiawassee Road (US3), Hines Ford Road (D06), Haggerty Road (US10), Inkster Road (US2), and John Daly Road (US1). Flow and level monitoring was discontinued by the USGS in October 2009 at Evans Ditch (US6). The level and flow continuous monitoring locations, which include the 2011 locations, are shown in **Figure 9.** The 2011 continuous level and flow data along with historical data, which were used for trend detection, are summarized by SWMA (**Figure 10 through Figure 19**). The Detroit Metro Airport Annual Precipitation Totals (1959 – 2011) are also shown in the figures. The precipitation period of record may not align with the period of record for level and flow data in some of the figures. A tabular summary by SWMA of the streamflow data for the period of

record are shown in **Table 4** as well as the 2011 precipitation totals (as percent of long-term average from 1994 through 2010). The rainfall monitoring locations are shown in **Figure 20.**

High streamflow variability continues to negatively impact the water quality and ecosystem health of the Rouge River Watershed. Trend analyses generally indicate that the frequency of high flow is holding steady in the Middle 3 and Lower Rouge River. However, an increase in the frequency of high flow was calculated in the Middle 1. In the Main and Upper Rouge River a decrease in the frequency of high flow was indicated. A goal of the ARC in the 2009 WMP is to control the volume of urban storm water runoff as well as the flow rate. The ARC's current Five Year Monitoring Plan (2009-2013) includes monitoring of continuous river level and flow, which will be used to evaluate progress of the best management practices towards establishing stable streamflow and habitat conditions that are supportive of diverse aquatic life communities.

Figure 9
Continuous Level and Flow Measurement Locations

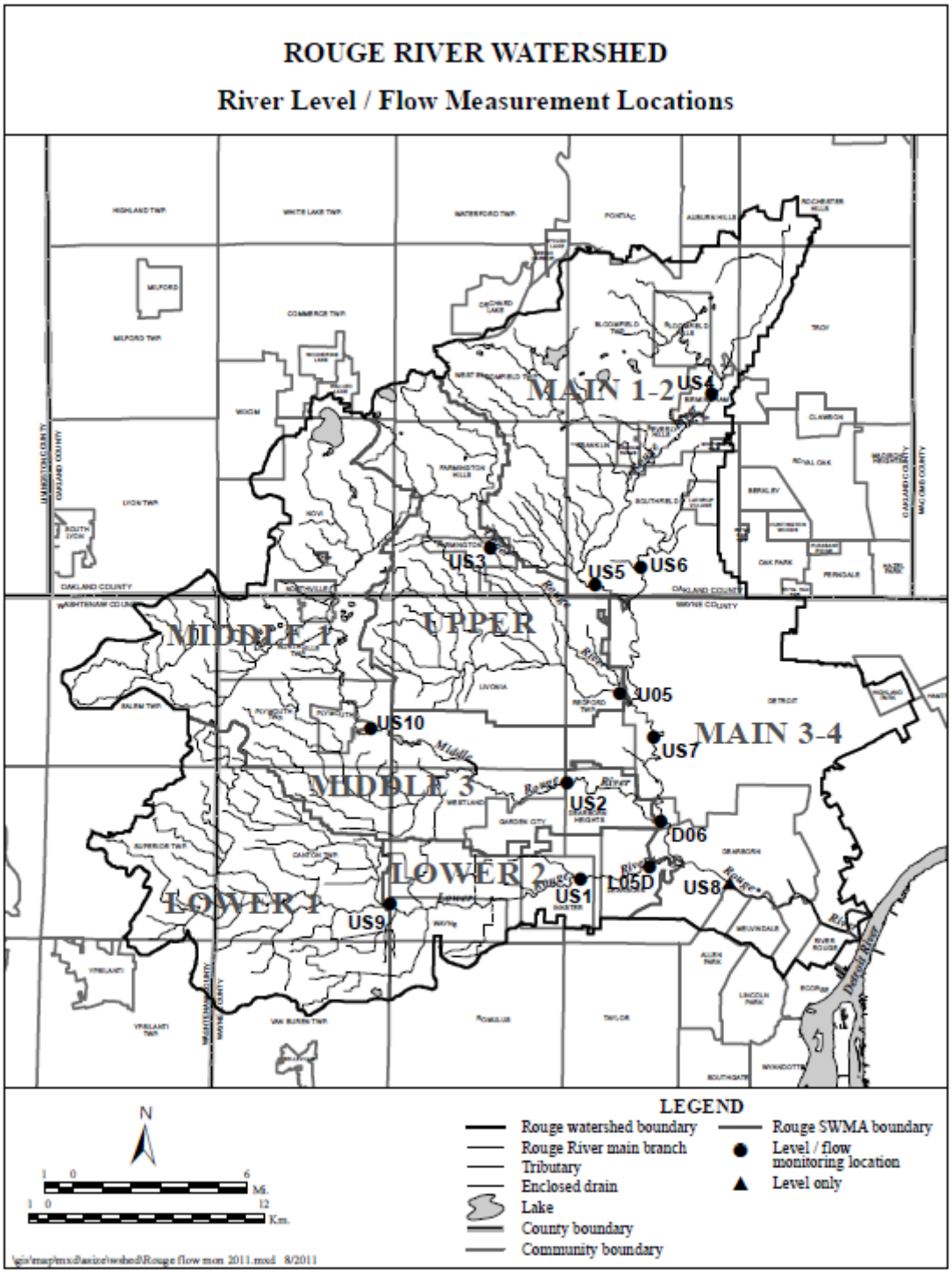
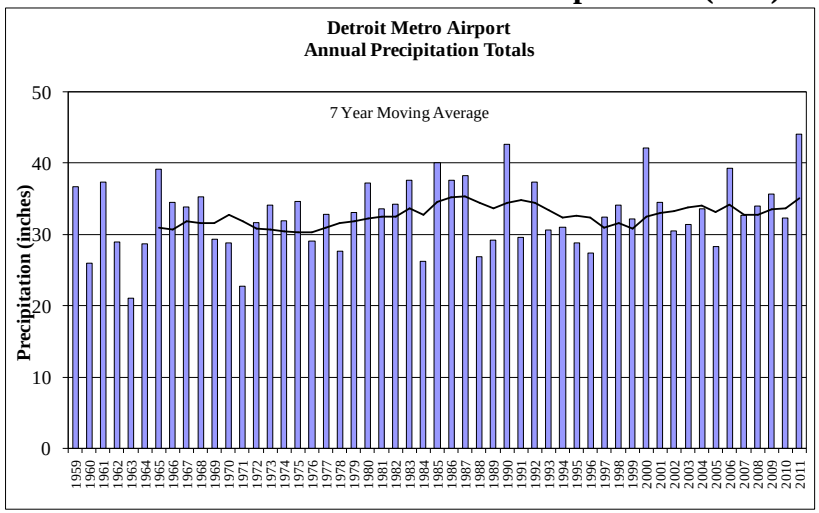
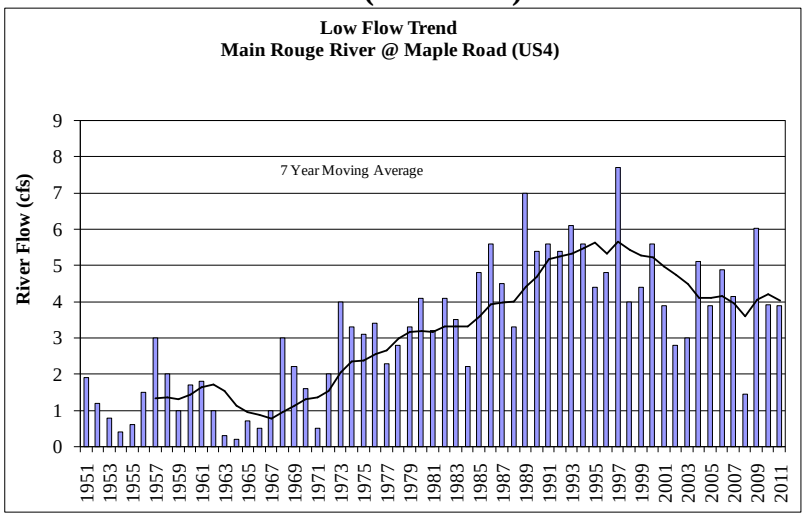
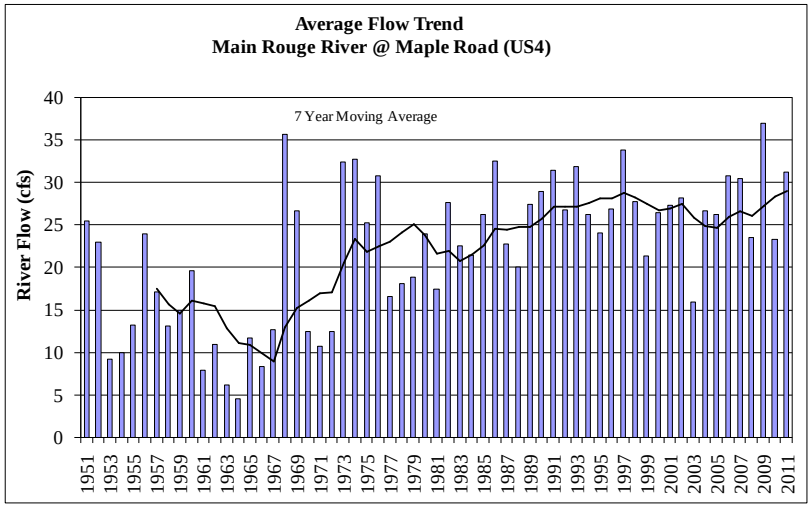
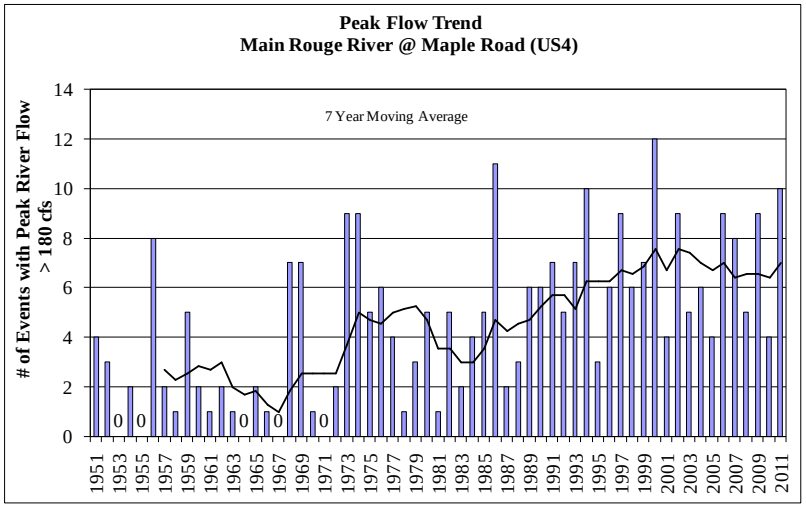


Figure 10
Main 1-2 SWMA Maple Road (US4) Streamflow Data and Trends (1951-2011)



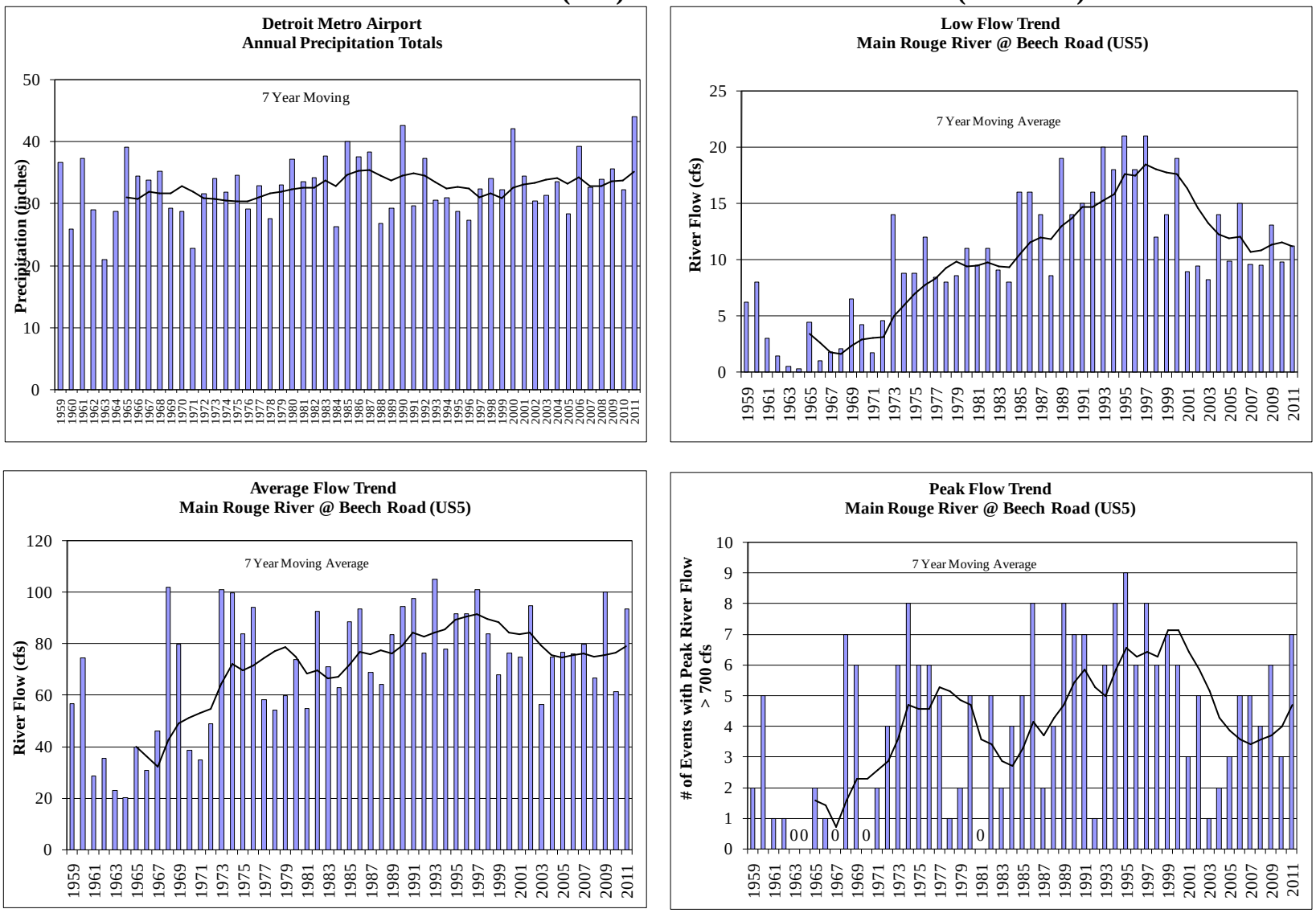






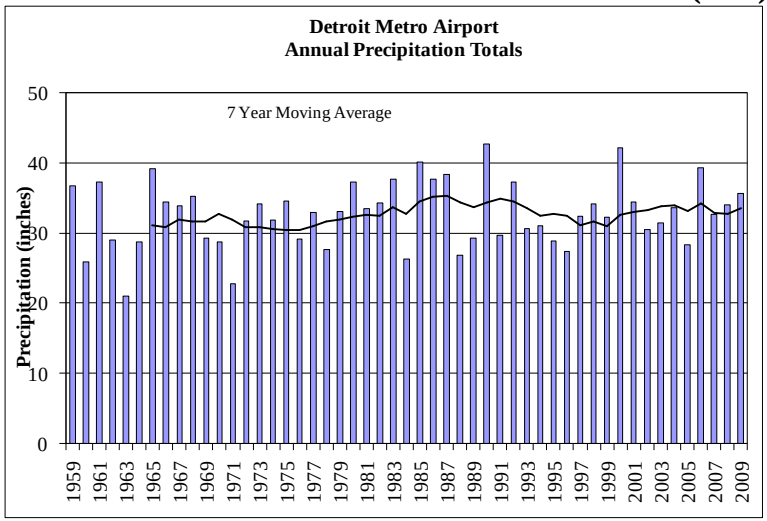
Note: (0) in figure means flow of 180 cfs was not exceeded.

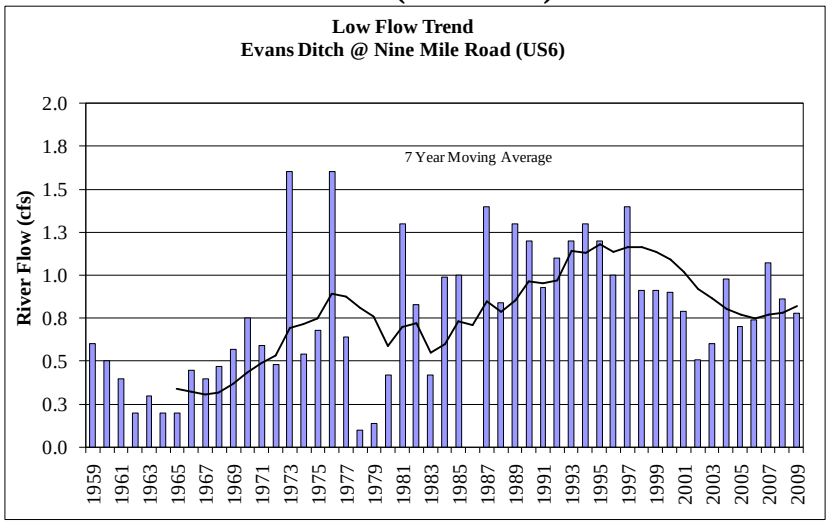
Figure 11
Main 1-2 SWMA Beech Road (US5) Streamflow Data and Trends (1959-2011)

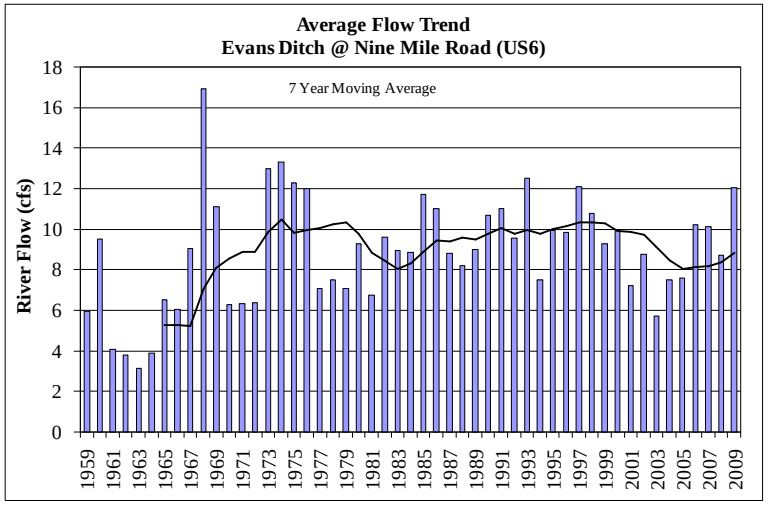


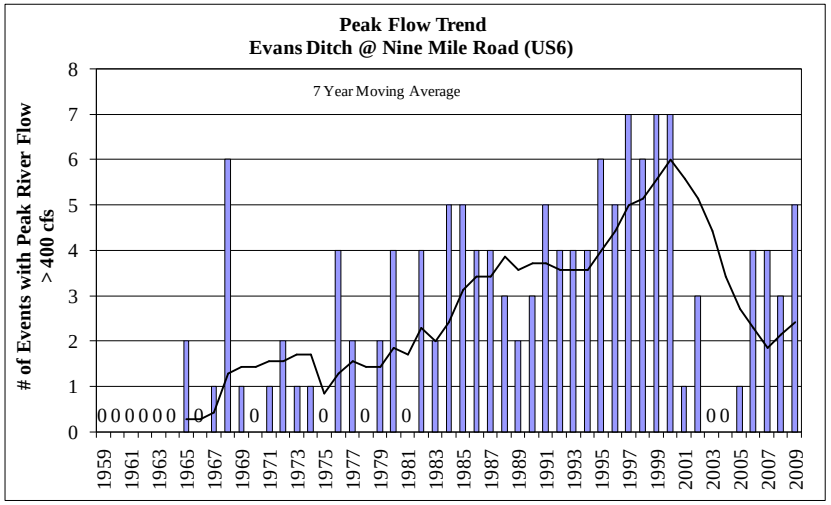
Note: (0) in figure means flow of 700 cfs was not exceeded.

Figure 12
Main 1-2 SWMA Evans Ditch (US6) Streamflow Data and Trends (1959-2009)



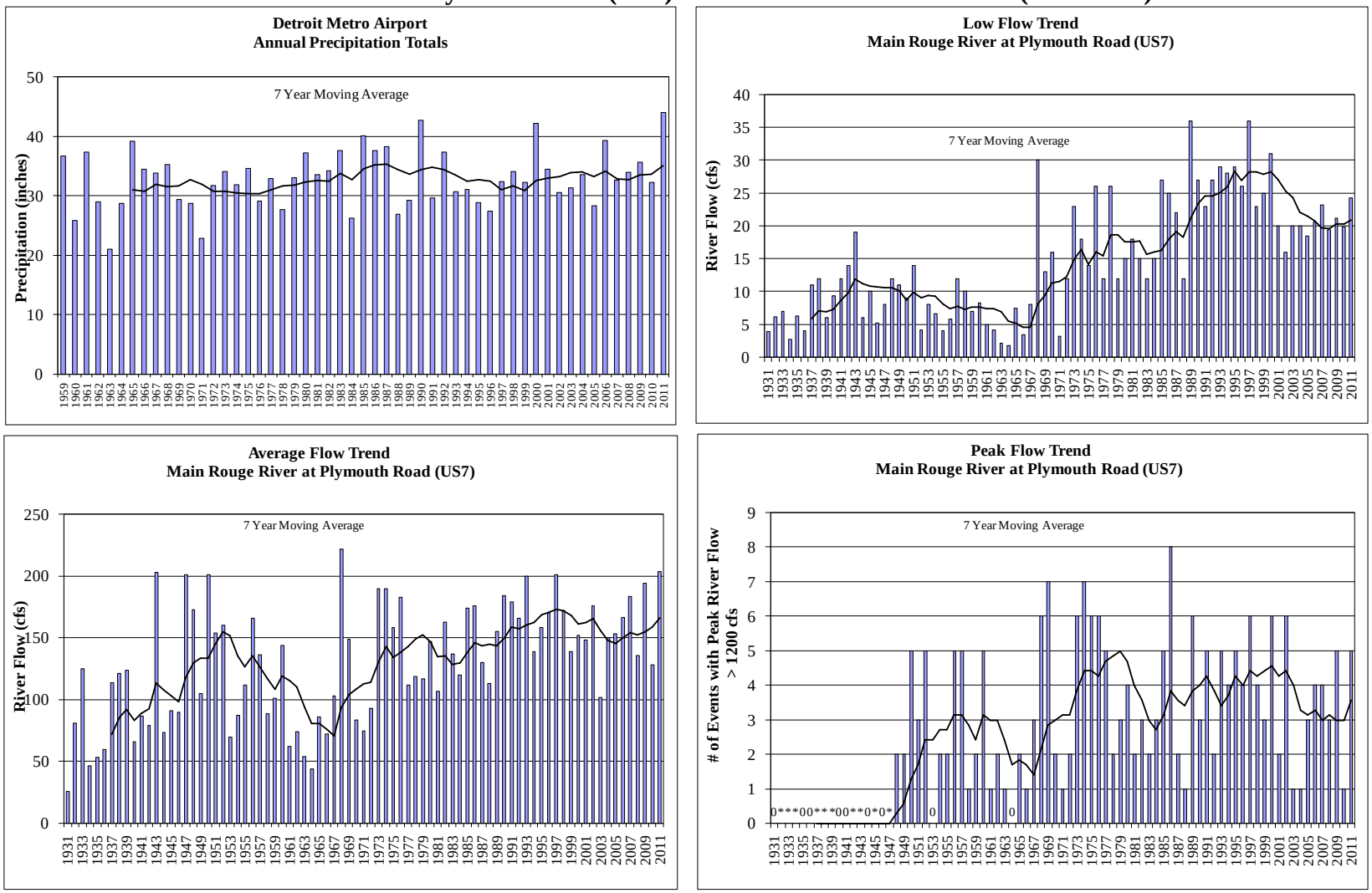






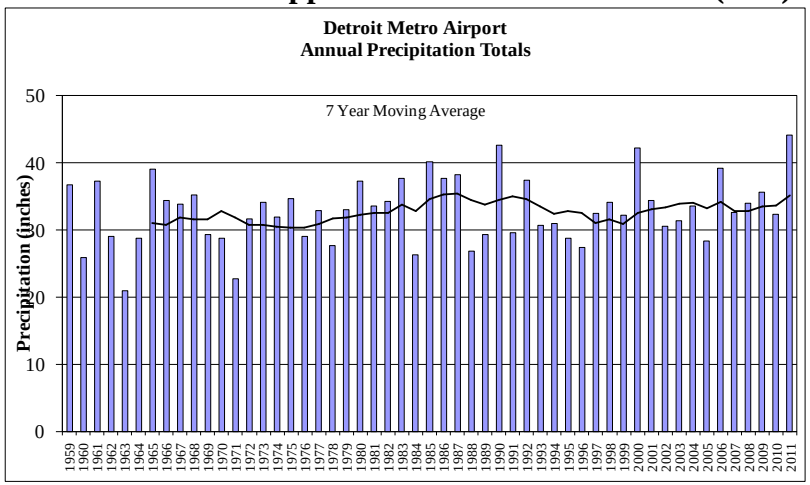
Note: USGS stopped collecting data at US6 in October 2009. (0) in figure means flow of 400 cfs was not exceeded.

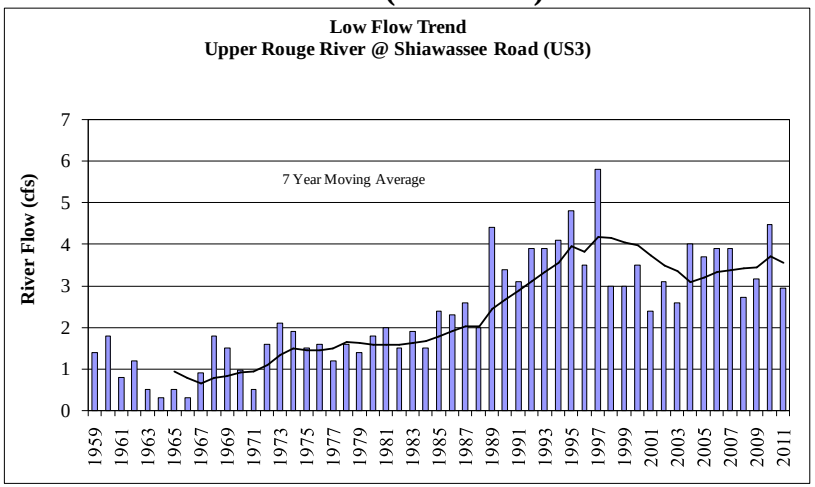
Figure 13
Main 3-4 SWMA Plymouth Road (US7) Streamflow Data and Trends (1931-2011)

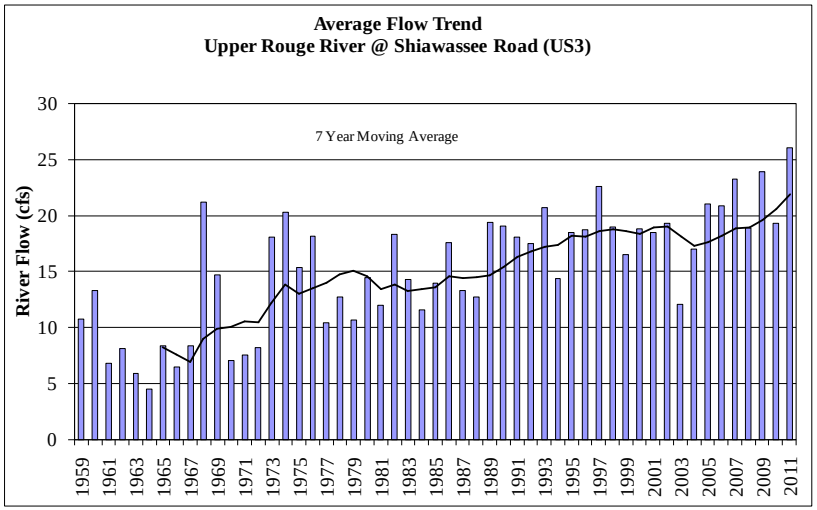


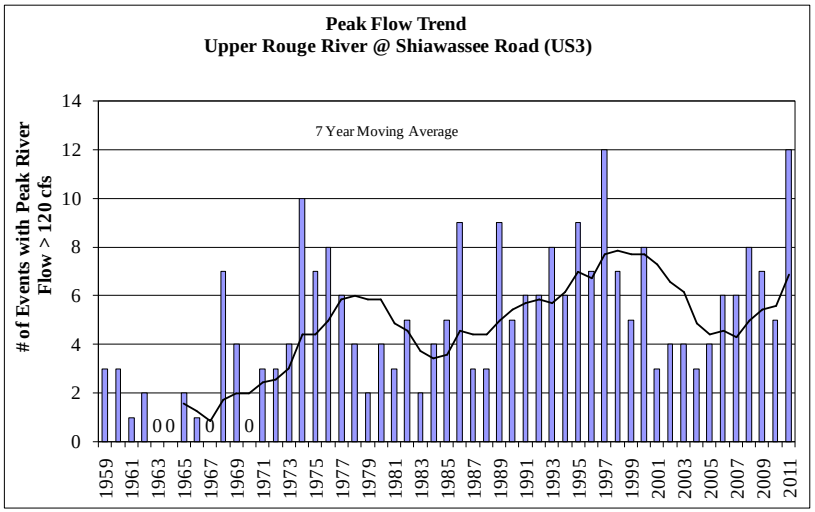
Note: (0) in figure means flow of 1200 cfs was not exceeded. (*) = no data collected in that year.

Figure 14
Upper SWMA Shiawassee Road (US3) Streamflow Data and Trends (1959-2011)



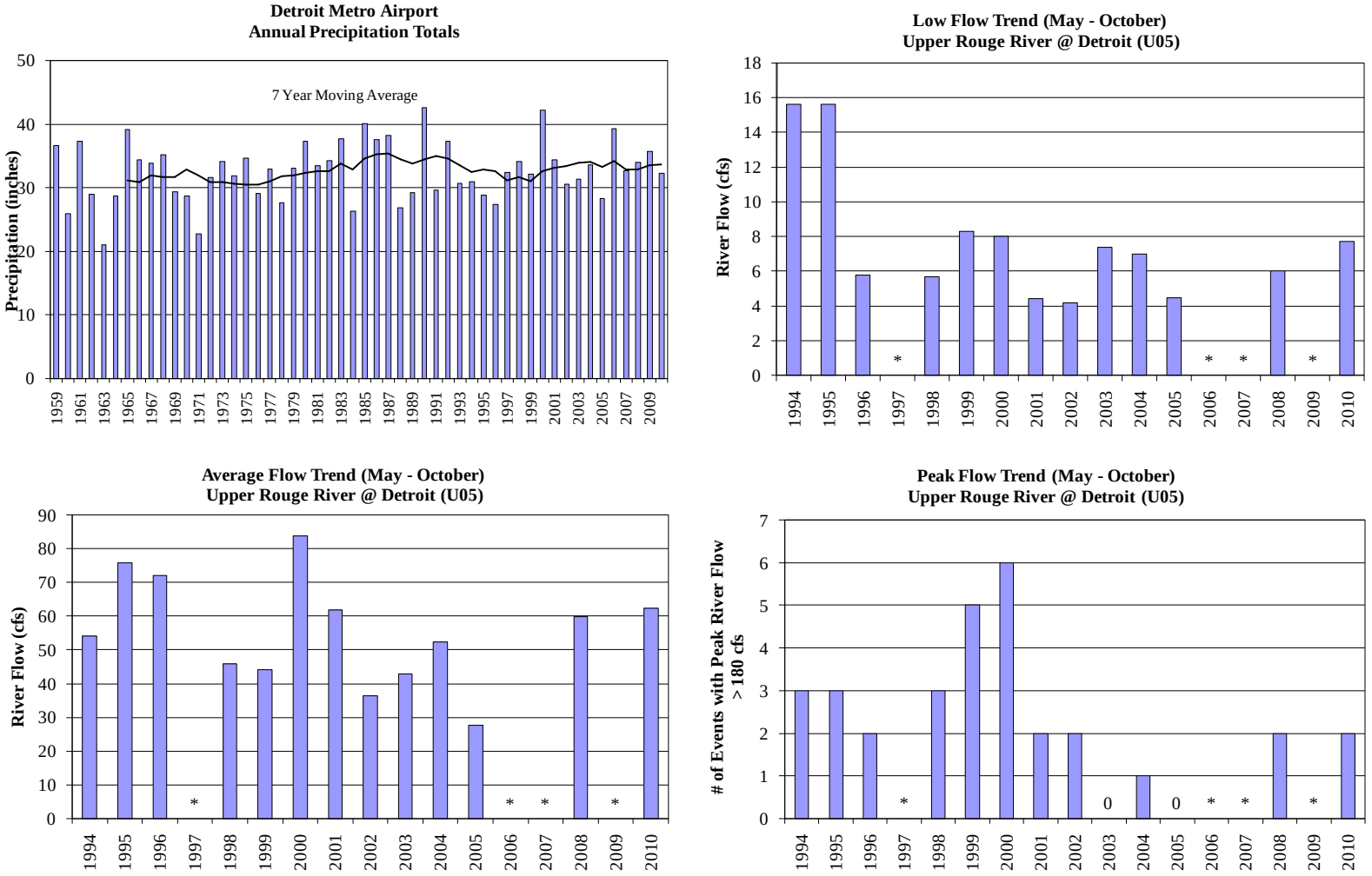






Note: (0) in figure means flow of 120 cfs was not exceeded. (*) = no data collected in that year.

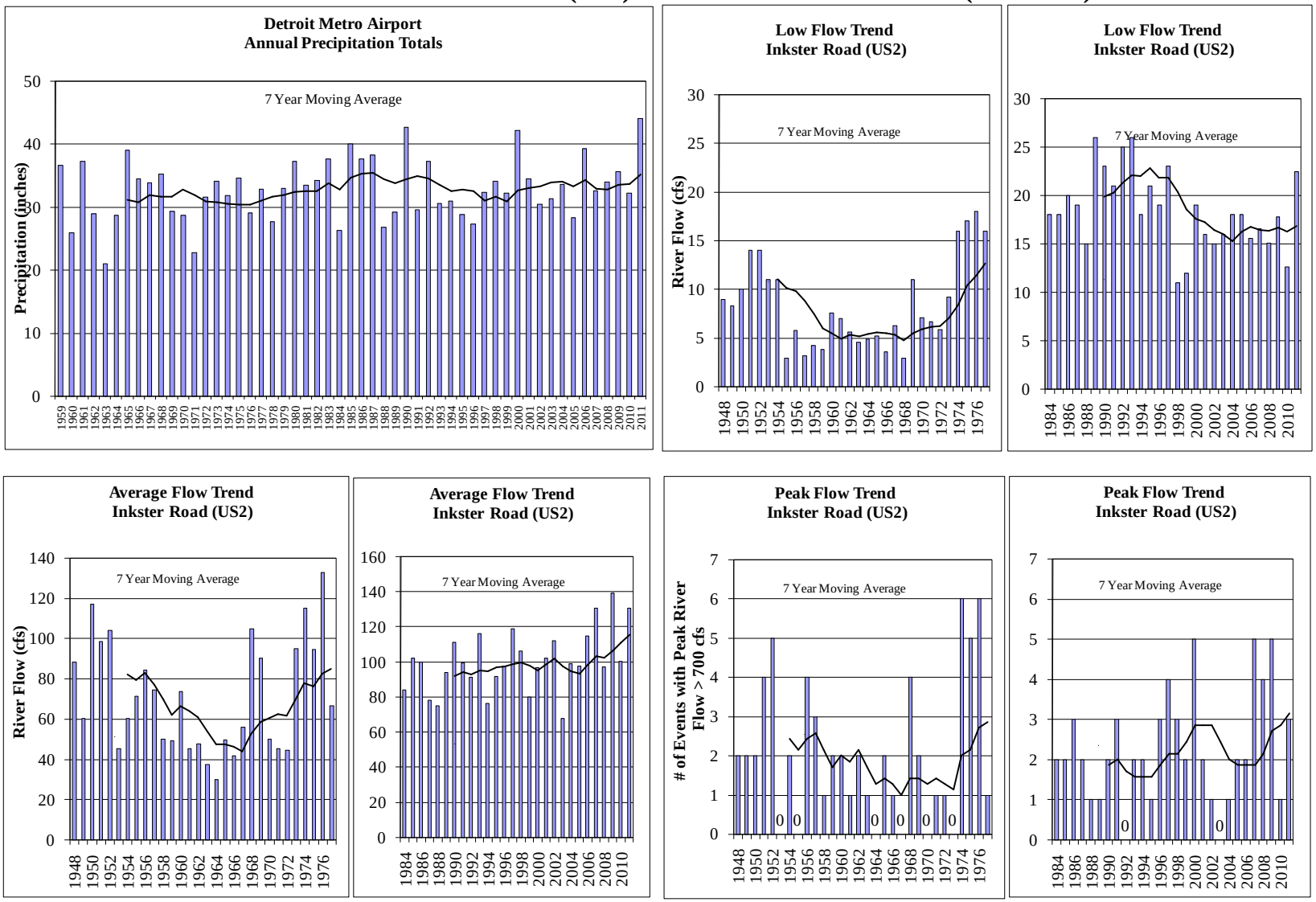
Figure 15
Upper SWMA Telegraph Road (U05)[1] Streamflow Data and Trends (1994-2010)



Note: (0) in figure means flow of 180 cfs was not exceeded. (*) = no data collected in that year. (Flow data not available in1997 due to an unstable rating curve from bridge construction.

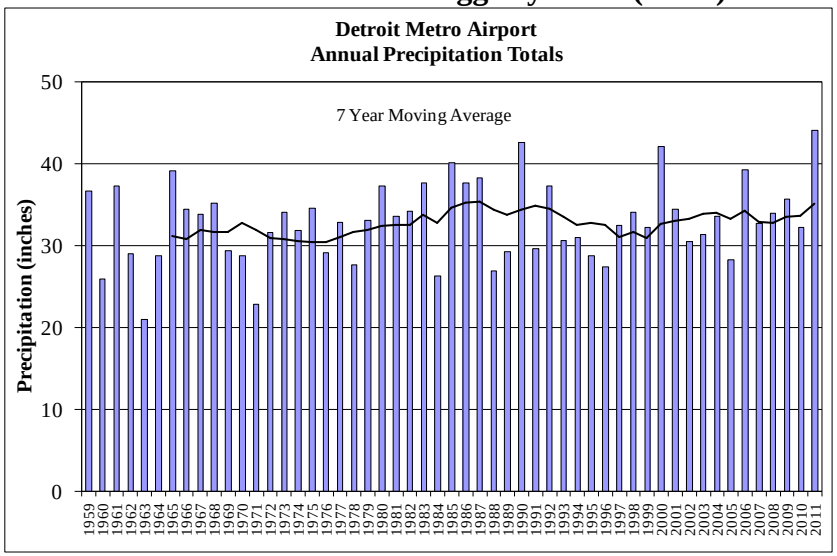
[1] Level/flow data were not collected at U05 in 1997, 2006, 2007, 2009, or 2011.

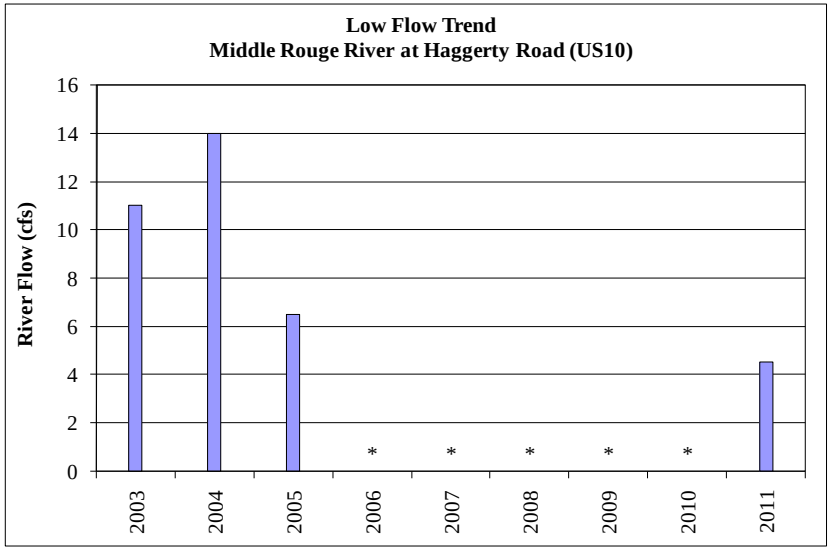
Figure 16
Middle 3 SWMA Inkster Road (US2) Streamflow Data and Trends (1948-2011)

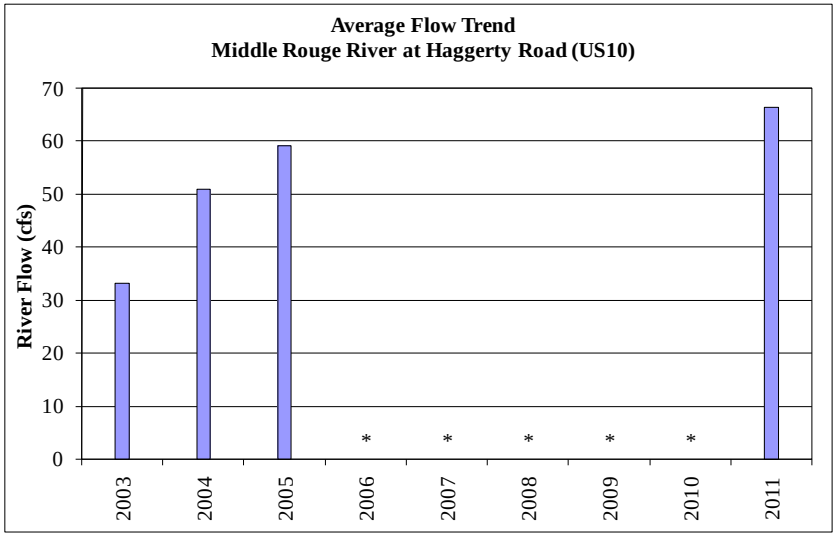


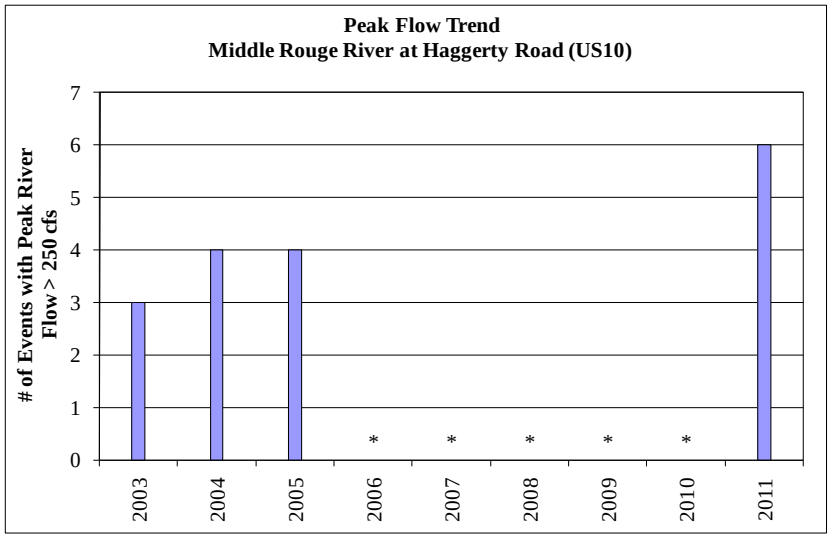
Note: (0) in figure means flow of 700 cfs was not exceeded.

Figure 17
Middle 1 Haggerty Road (US10)[1] Streamflow Data and Trends (2003-2005, 2011)





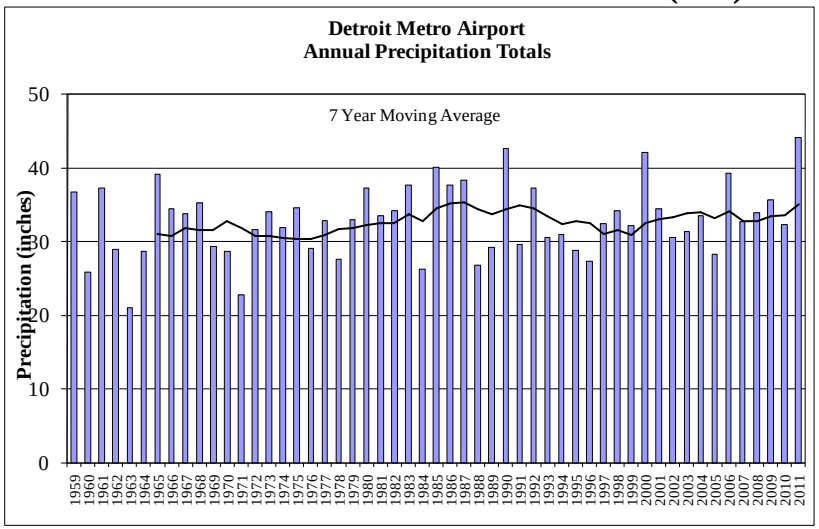


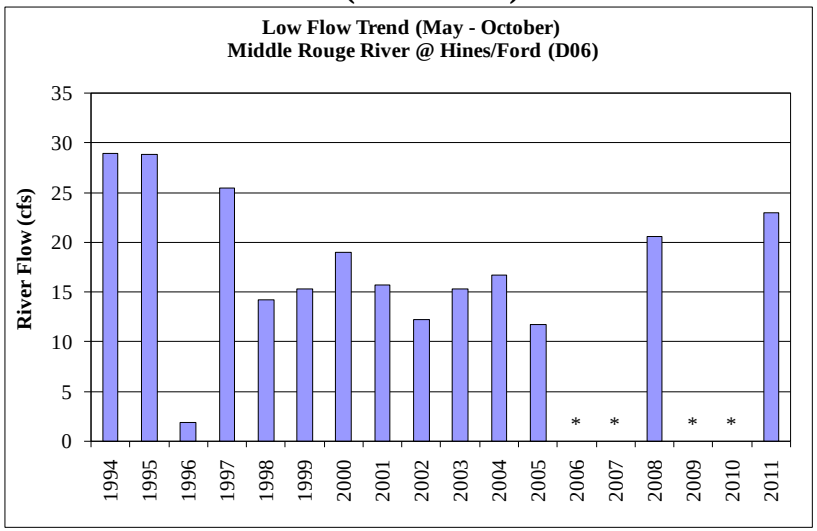


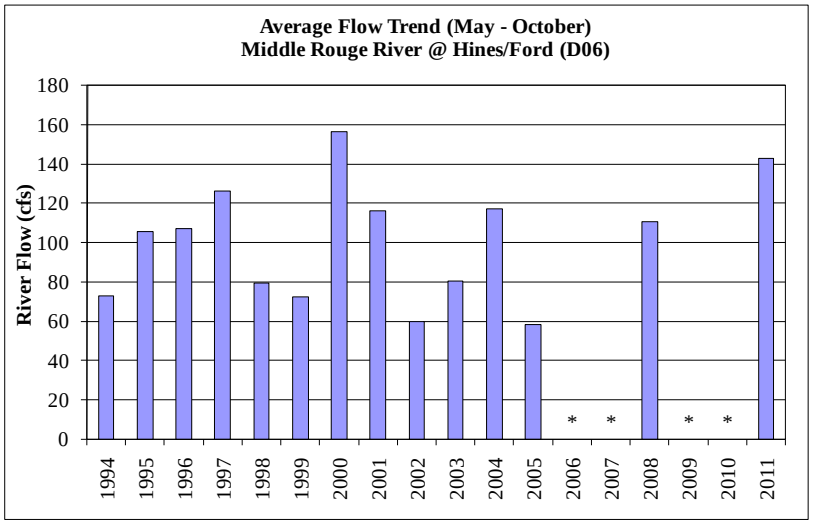
Note: (*) = no data collected in that year.

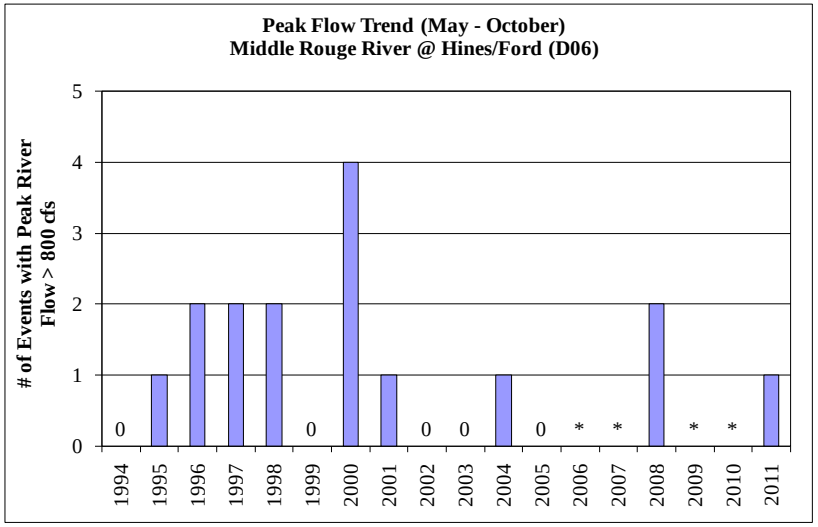
[1] Level/flow data were not collected in 2006, 2007, 2008, 2009, or 2010 at this location in the Middle 1 SWMA.

Figure 18
Middle 3 Hines/Ford Road (D06)[1] Streamflow Data and Trends (1994 - 2011)





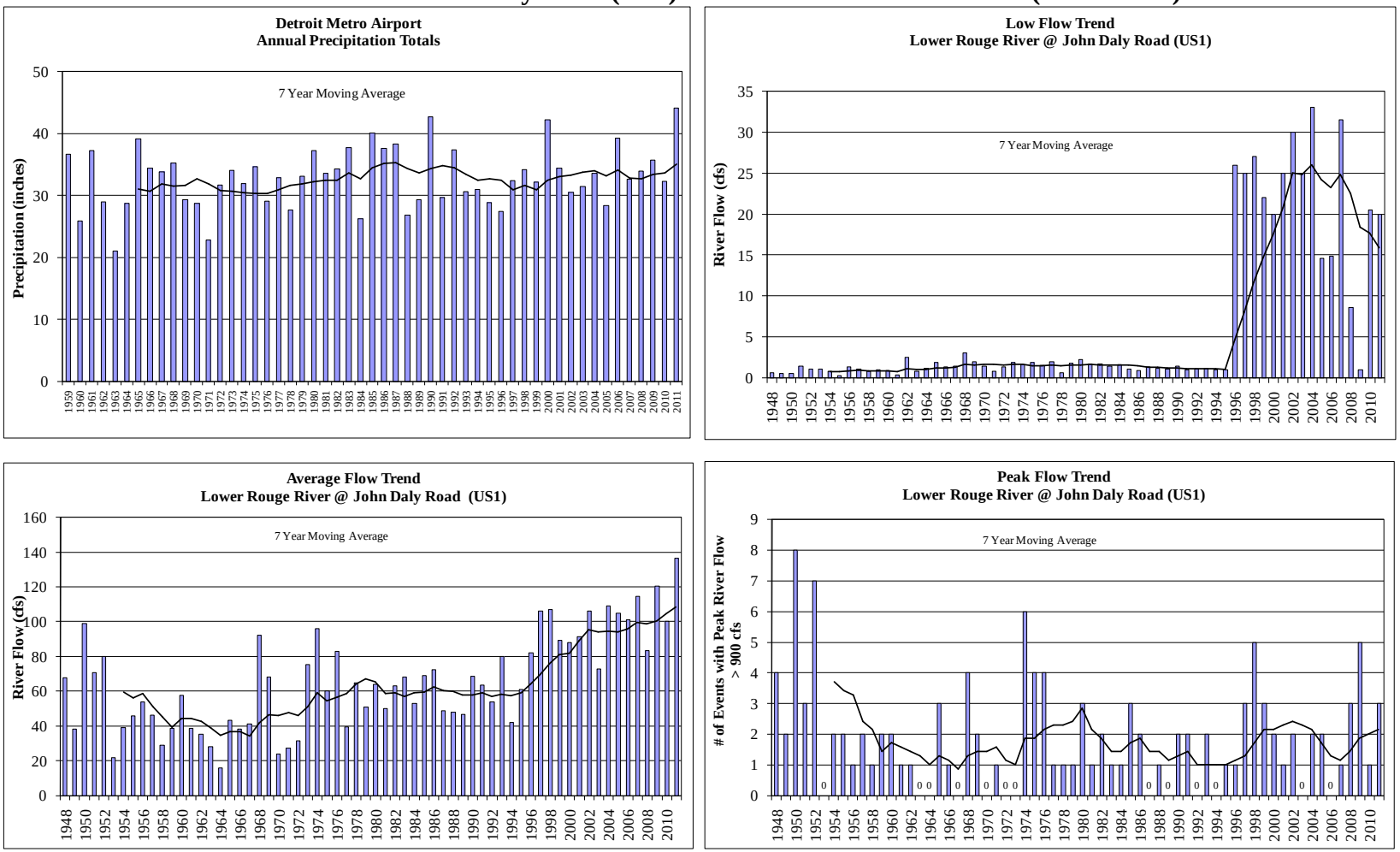




Note: (0) in figure means flow of 800 cfs was not exceeded. (*) = no data collected in that year.

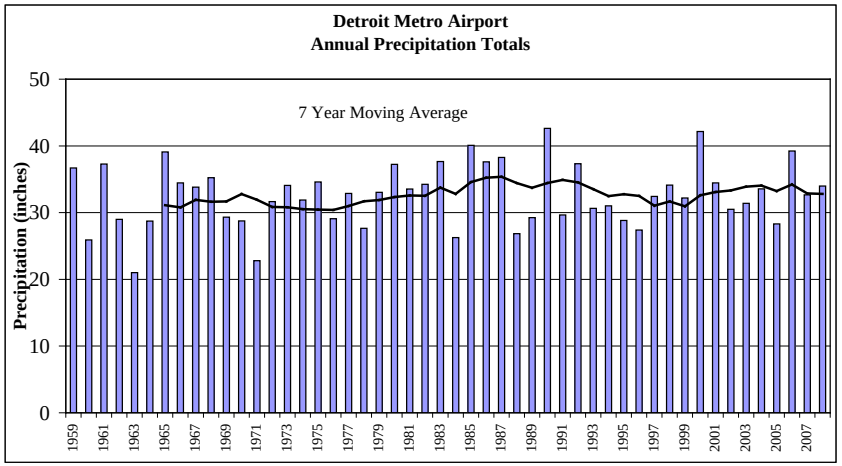
[1] Level/flow data were not collected in 2006, 2007, 2009 or 2010 at this location in the Middle 3 SWMA.

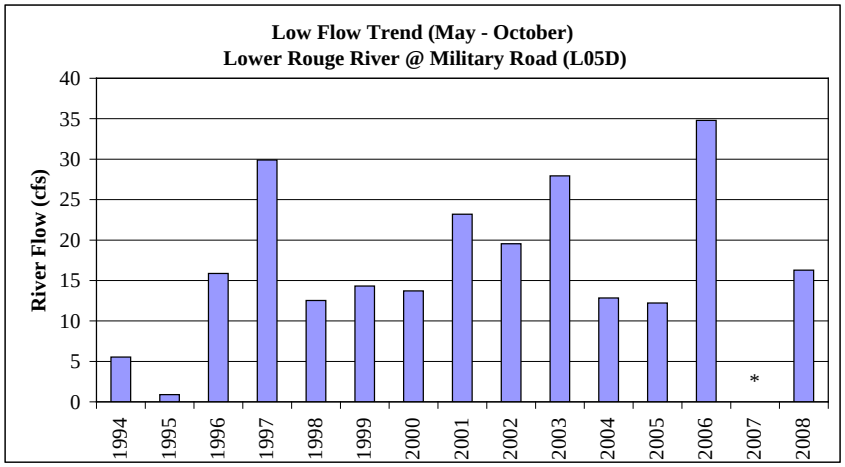
Figure 19
Lower 2 SWMA John Daly Road (US1) Streamflow Data and Trends (1948 - 2011)

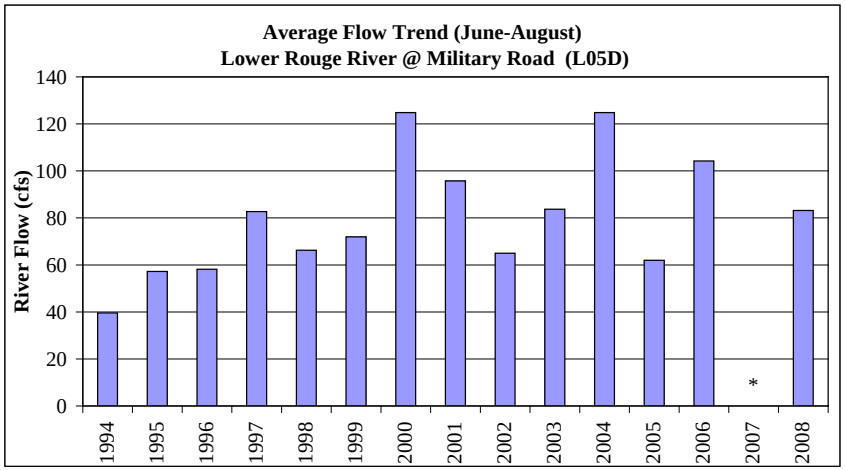


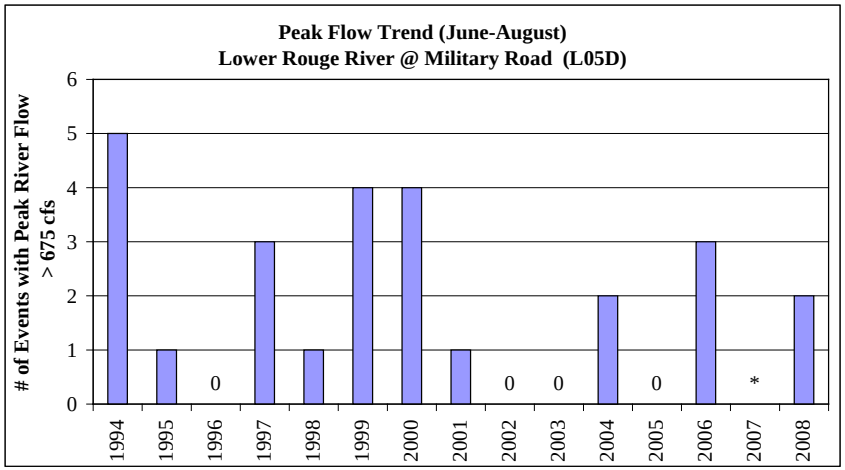
Note: YCUA discharge began in 1996. (0) in figure means flow of 900 cfs was not exceeded.

Figure 20
Lower 2 SWMA Military Road (L05D) Streamflow Data and Trends (1994-2008)









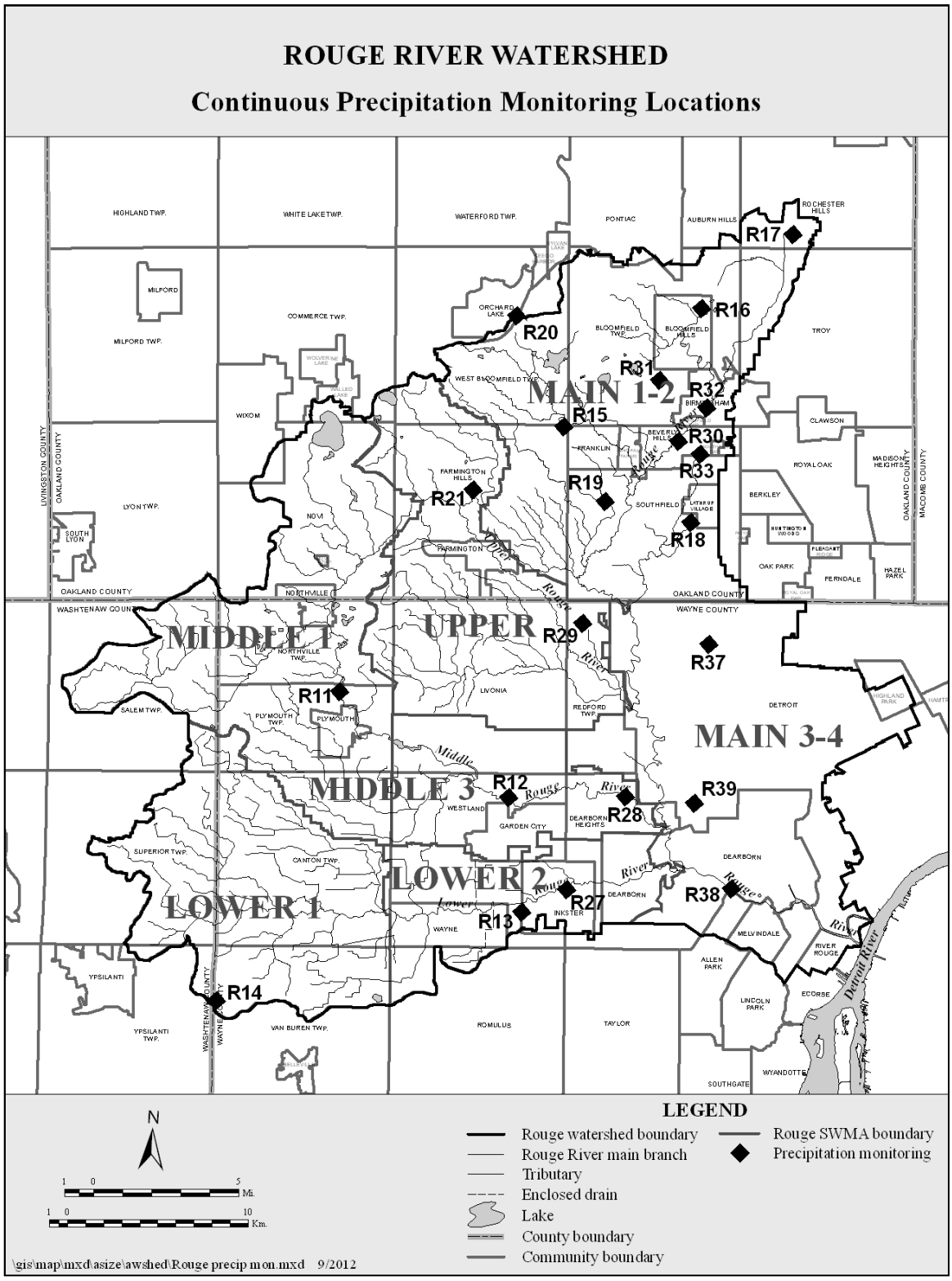
Note: YCUA discharge began in 1996. (0) in figure means flow of 675 cfs was not exceeded. (*) = no data collected in that year.
Level/flow data were not collected at this location in the Lower 2 SWMA in 2007, 2009, 2010 or 2011.

Table 4
Streamflow Trend Analyses Summary and 2011 Precipitation Totals

Streamflow Trend Analyses Summary and 2011 Precipitation Totals for the Rouge River Watershed						
SWMA	**Site ID**	**Low Flow (Base Flow)**	**Average Flow**	**Peak Flow Exceeding Gage-Specific Threshold[2]**	**Streamflow Period of Record**	**2011 Precipitation Total (as percent of long-term average, 1994-2010)[1]**
Main 1-2	**US4**	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then no change	⇑ from mid 1960s to mid 1990s, then no change	1951-2011	125.84% (average of gages R15- R20, R30-R33)*
	US5	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then ⇓	1959-2011	
	US6	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then no change	⇑ from mid 1960s to mid 1990s, then ⇓	1959-2009	
Main 3-4	**US7**	⇑ from mid 1960s to mid 1990s, then ⇓	Cyclical, but no change in recent years	Cyclical	1931-2011	129.04% (average of gages R37-R39)*
Upper	**US3**	⇑ to mid 1990s, then no change in recent years	⇑since data collection began in 1959	Cyclical	1959-2011	120.71% (average of gages R21, R29)*
	U05	⇓ since mid 1990s	⇓ since mid 1990s, but no change in recent years	⇓ since mid 1990s	1994-2011	
Middle 1	**US10**	No change	⇑	⇑	2002-2005, 2011 (2002 partial year)	126.67% (average of gages R11, R12, R28)*
Middle 3	**US2**	⇑ since mid 1980s to mid 1990s, then no change since mid 1990s	No change to mid 1990s, then ⇑	No change since the mid 1980s	1948-1977 1984-2011	126.67% (average of gages R11, R12, R28)*
	D06	No change since mid 1990s	No change	No change	1994-2008, 2011	
Lower 1	**US9**	No change	No change	No change	2001-2006* (2001 partial year)	124.34% (average of gages R13, R14, R27)*
Lower 2	**US1**	1948 to 1995 ⇑, then ⇓	No change since 1948	⇓ 1948 to 1995, then no change	1948-2011*	124.34% (average of gages R13, R14, R27)*
	L05D	No change since 1996	No change since 1996	No change since 1996	1994-2008*	

Note: ⇑=increasing trend, ⇓=decreasing trend, *YCUA WWTP began discharging in upstream end of Lower Rouge in 1996.
[1]Rouge River Watershed Rain gages used for calculation of precipitation totals. *Partial month not included in calculation of average.
[2]The discharge exceeded 1% of the time (calculated in the mid-1990s over the period of record).

Figure 20
Continuous Precipitation Monitoring Locations



RECOMMENDATIONS FOR FUTURE SAMPLING AND MONITORING

Significant contributors to water quality and ecosystem health impairment in the Rouge River have included: uncontrolled CSOs, Sanitary Sewer Overflows (SSOs), polluted stormwater, illicit connections, failing Onsite Sewage Disposal System (OSDS), and increased runoff resulting in unstable and highly variable streamflow. In the Rouge River Watershed many of the CSOs have been controlled and the plans are underway to control the remaining CSOs. Similarly, those communities with SSOs are working toward their elimination. The 2009 Watershed Management Plan (2009-2013) identifies activities which are being implemented by communities and others to:

- Reduce pollutant loads and runoff volumes from stormwater
- Eliminate illicit connections and failing OSDS
- Restore and protect ecosystem health.

Monitoring and sampling of the river system is recommended into the future to assess progress of the best management practices toward meeting the goals for the Rouge River Watershed. These recommendations include:

- Monitor continuous river level and flow until established targets are met and stable stream habitat conditions that are supportive of diverse aquatic life communities are established.
- Repeat the analyses comparing Rouge River flow to Wiley-Seelbach fish community flow targets developed for the Rouge.
- Monitor continuous DO during the 2009-2013 Five-Year Plan to assess trends.
- Conduct water quality monitoring, in cooperation with the MDEQ, other agencies and organizations, and communities, to measure progress of the best management practices.
- Conduct periodic biological assessments of habitat, fish community and other aquatic populations in order to raise public awareness and help track improvements as pollution control activities are implemented. This includes continued collection and analysis of benthic macroinvertebrate and frog and toad data by WCDPS and FOTR staff and volunteers.

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