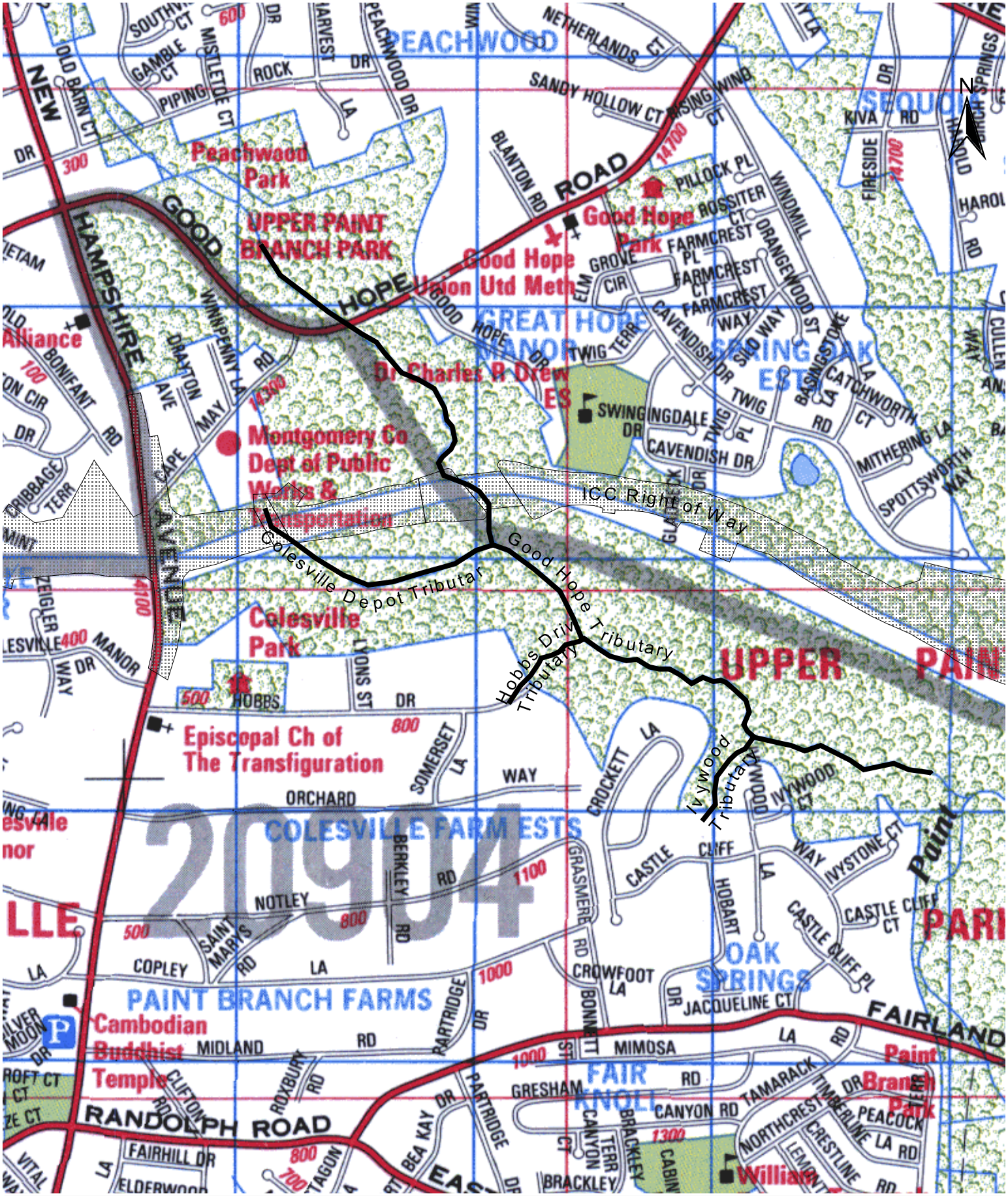
Upper Paint Branch Baseflow and Temperature Monitoring Study Summary
Summer 2004 Data

Introduction

The Maryland State Highway Administration (SHA) conducted baseflow and temperature studies on the Good Hope Tributary of Upper Paint Branch in Montgomery County, Maryland during the summer of 2004. These studies were conducted at the request of the U.S. Fish and Wildlife Service as part of the Intercounty Connector (ICC) National Environmental Policy Act (NEPA) study process. The Paint Branch watershed is noted for being one of the few cold-water streams (suitable as trout habitat) remaining in Montgomery County. As a result the upper portion of the watershed was designated, by the Montgomery County Council, as a Special Protection Area in 1995. The Good Hope Tributary is the primary spawning area for wild brown trout in the Upper Paint Branch system, and the success of the Good Hope as trout habitat is largely dependent on the cool-water baseflows that mitigate warm summer temperatures and runoff events. The studies were performed on the mainstem of the Good Hope and three of its tributaries, including the Colesville Maintenance Depot Tributary (Depot Tributary), the Hobbs Drive Tributary, and the Ivywood Tributary. The location of these tributaries and the Good Hope mainstem are illustrated in ***Figure 1***.

The goal of the baseflow study was to determine the relative baseflow contribution of each of the tributaries to the Good Hope mainstem. The temperature study, which was performed over the same time period as the baseflow study, was designed to monitor the temperature effects of the tributaries on the Good Hope mainstem. Both studies were also targeted to investigate the effects of specific features of the Depot tributary, such as the stormwater management pond at the Maintenance Depot and the wetland just downstream, which have the potential to affect baseflow and temperature. The data collected for this study provide a snapshot of existing temperature and baseflow conditions over one summer season and cannot be extrapolated to predict long-term conditions; however, results are similar to those found over a longer term by other agencies (MCDEP). Results of these two studies conducted by SHA are presented below. Supporting data and graphs are provided in the Appendices.



Upper Paint Branch
Baseflow and Temperature Monitoring

Vicinity Map

Intercounty Connector Study

Figure 1

February 2005

1000 0 1000 Feet

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Upper Paint Branch Baseflow Study

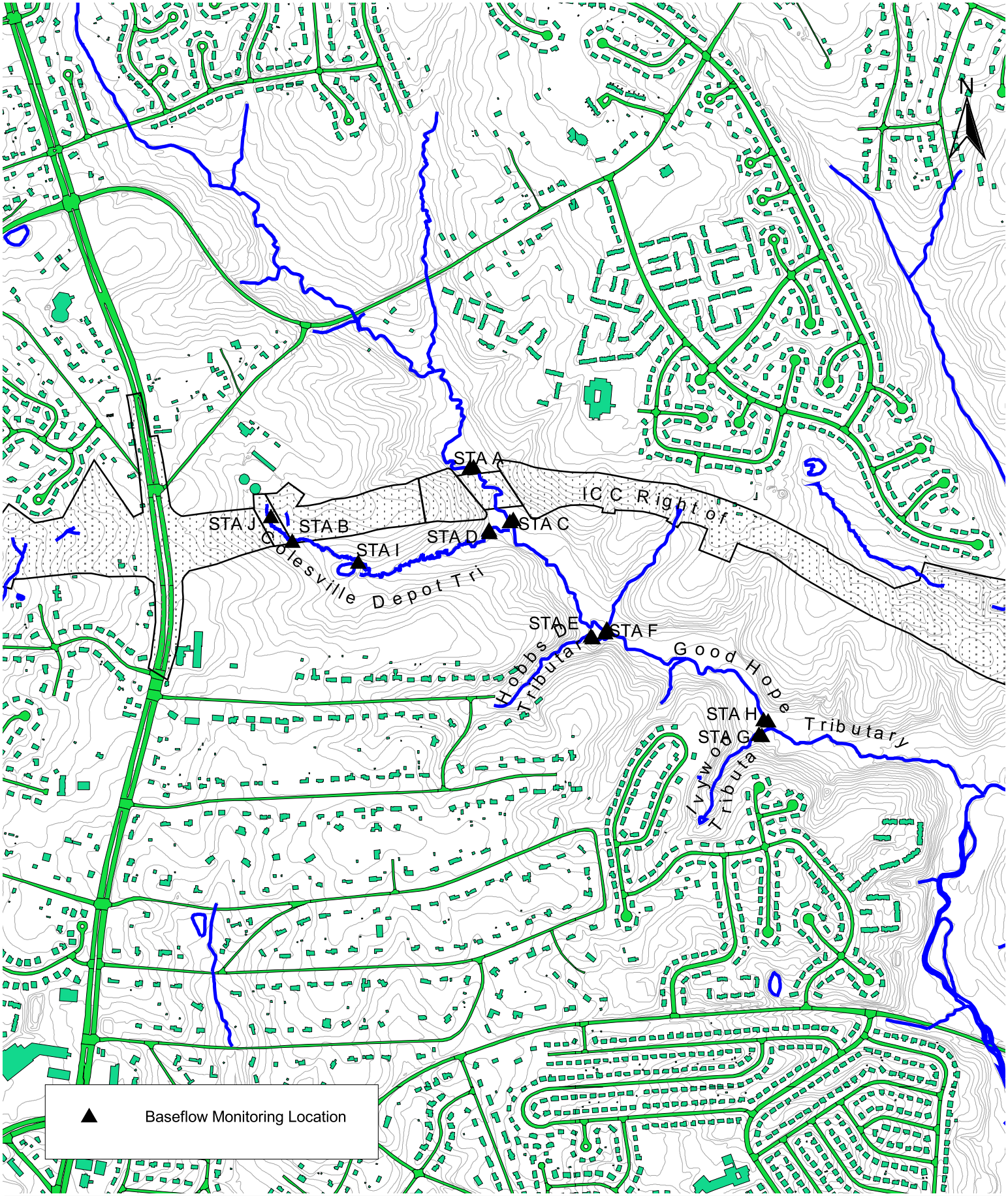
Methodology:

This study was designed to determine the baseflow characteristics of the mainstem of the Good Hope and three tributaries to the Good Hope in the upper portion on the Paint Branch watershed. Ten sampling points were selected within the study area requested by the U.S. Fish and Wildlife Service (USFWS). Three of the sampling points were located on tributaries to the Good Hope; the Depot tributary (Sta. "D"), the Hobbs Drive tributary (Sta. "E"), and the Ivywood tributary (Sta. "G"). Four sampling points were located on the main stem of the Good Hope (Sta. "A", Sta. "C", Sta. "F", and Sta. "H"). The remaining three sampling points were runoff sources to the Depot tributary; the stormwater management outfall at the Colesville Maintenance Depot (Sta. "J"), the wetland downstream of the Maintenance Depot (Sta. "B"), and Forester Pond (Sta. "I"). ***Table 1*** lists the details of each of the sampling points. ***Figure 2*** illustrates the sampling point locations.

Baseflow discharge values were determined by using a USGS Pygmy Current Meter, and a Cutthroat Flume or temporary "V" notch weirs. The current meter was used to determine velocities of cells that comprise the cross sectional area of the stream channel. The cross sectional area was multiplied by the velocity to calculate the discharge at the sampling point. Discharge through both the Cutthroat Flume and "V" notch weir was calculated using an equation expressing the relationship of the depth of flow through a calibrated width of the measuring device.

A cross section was surveyed and monuments were set perpendicular to the stream at each of the sampling points. A GPS unit was used to record the location of each of the monuments.

Temporary plywood "V" notch weirs were set at Sta. "B", Sta. "I" and Sta. "J" as a result of very low flow conditions prior to the start of baseflow data collection. After data collection had begun it was determined that temporary weirs were also needed at Sta. "E" and Sta. "G". The weirs at Stations B, J and G were ultimately removed, as a result of not being able maintain the seal around the weir, and replaced with a Cutthroat Flume. The primary cause of the weir failures appeared to be the "flashiness" of the drainage during heavy rain events.



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Upper Paint Branch
Baseflow and Temperature Monitoring
Baseflow Monitoring Locations
Intercounty Connector Study

Figure 2

February 2005

1000 0 1000 Feet

Table 1
Good Hope Baseflow Study Sampling Point Information

Sample ID	Location	Sampling Method	Drainage Area (sq. mi.)
Station A	Main stem of the Good Hope within the ICC right-of-way	USGS Pygmy Current Meter	0.9
Station B	Just below an existing wetland in the Depot tributary to the Good Hope	"V" notched weir / 4" cutthroat flume	0.1
Station C	In the Good Hope, just upstream of the confluence of the Colesville Maint. Depot tributary	USGS Pygmy Current Meter	1.0
Station D	In the Depot tributary, just upstream of the confluence with the Good Hope	USGS Pygmy Current Meter	0.1
Station E	In the Hobbs Dr. tributary, just upstream of the confluence with the Good Hope	"V" notch weir	0.1
Station F	In the Good Hope, just upstream of the confluence with the Hobbs Dr. tributary.	USGS Pygmy Current Meter	1.1
Station G	In the Ivywood tributary, just upstream of the confluence with the Good Hope	"V" notched weir / 4" cutthroat flume	<0.1
Station H	In the Good Hope, just upstream of the confluence with the Ivywood tributary	USGS Pygmy Current Meter	1.3
Station I	At the spillway of Foresters Pond, just upstream of the Depot tributary	"V" notch weir	<0.1*
Station J	At the head of the Depot tributary, just downstream of a storm water management facility	"V" notched weir / 4" cutthroat flume	<0.1*

* GISHydro rounds drainage area to the nearest tenth of a square mile.

A hydraulic model developed for SHA by the University of Maryland, GISHydro, was used to calculate drainage areas and the associated discharges for differing storm return rate intervals. The GISHydro results are included in ***Appendix A***.

Results:

The baseflow study was conducted from June 10, 2004 to September 22, 2004. A total of eight sampling events were performed. Average discharge values on the main stem were; 0.406 cubic feet per second (cfs) at Sta. "A", 0.644 cfs at Sta. "C", 0.730 cfs at Sta. "F", and 1.025 at Sta. "H".

Data show that the discharge increases with the downstream distance from the most upstream sampling point. This is also true with the discharge of the Colesville

Maintenance Depot and Hobbs Dr. tributaries subtracted out. The contributions by the tributaries to the Good Hope baseflow were 0.161 cfs at Sta. "D", 0.036 cfs at Sta. "E", and 0.017 cfs at Sta. "G". Baseflow contributions to the Colesville Maintenance Depot tributary were 0.011 cfs at Sta. "B", 0.019 at Sta. "I" and 0.012 cfs at Sta. "J". Discharge data are summarized on ***Table 2***.

Chart 1 is a comparison of drainage area and the 1.5 year storm interval and baseflow discharges. Trends for each of the data sets indicate consistency. ***Charts 2 and 3*** illustrate the base flow discharge of the Good Hope main stem and its tributaries, respectively. ***Chart 4*** details the daily precipitation in inches over the study period. ***Chart 5*** is a hydrograph separation, where only sampling events that occurred a minimum of 3 days after precipitation greater than 0.01 inches are shown. The average base flow discharge of the main stem of the Good Hope was calculated to be 0.51 cfs based on data provided by the hydrograph separation

Montgomery County Department of Environmental Protection collected base flow stage and discharge measurements in the main stem of the Good Hope from July 1996 to August 2001. The monitoring station is located just downstream of the confluence of the Colesville Maintenance Depot tributary. These data were used to develop a discharge rating curve. The average base flow discharge from the current study was plotted along with MCDEP's data in the rating curve. Results of the current study are consistent with the Montgomery County data. The rating curve plot is included in ***Appendix B.***

Current base flow data for the main stem of the Good Hope are consistent with data previously collected by Montgomery County. The data collected on the tributaries to the Good Hope represents a snap shot of conditions during the study period. However, additional data collection within the study area over an extended time period would benefit our overall knowledge of tributary contributions to the main stem of the Good Hope.

Table 2

Summary of Discharge Data

Date	GH Within ICC R/W Station A	Wetland Station B	GH Above Depot Trib Station C	Depot Trib, above GH Station D	Hobbs Trib. Station E	GH Trib above Hobbs Station F	Ivywood Trib. Station G	GH above Ivywood Station H	Forester Pond Station I	Depot Trib. Below SWM @ Maint. Yard Station J
11-Jun	0.548	~	0.774	0.137	+	+	+	+	~	~
1-Jul	0.496	0.016	0.662	0.071	*	0.711	*	1.106	0.019	*
20-Jul	0.415	0.002	0.813	0.160	~	0.633	0.008	0.848	0.019	*
6-Aug	0.449	0.007	0.774	0.085	0.058	0.979	0.034	1.160	0.023	0.007
19-Aug	0.644	0.020	0.919	0.109	0.049	0.828	0.017	1.490	@	0.021
31-Aug	0.151	0.005	0.323	0.090	0.016	0.476	0.010	0.703	0.019	*
22-Sep	0.138	0.015	0.246	0.061	0.019	0.752	0.013	0.841	0.015	0.007
Average	**0.406**	**0.011**	**0.644**	**0.102**	**0.036**	**0.730**	**0.017**	**1.025**	**0.019**	**0.012**

* No measurable flow

+ Rain, sampling stopped

~ Set Weirs

@ Insufficient water depth

Chart 1

Drainage Area vs. Discharge

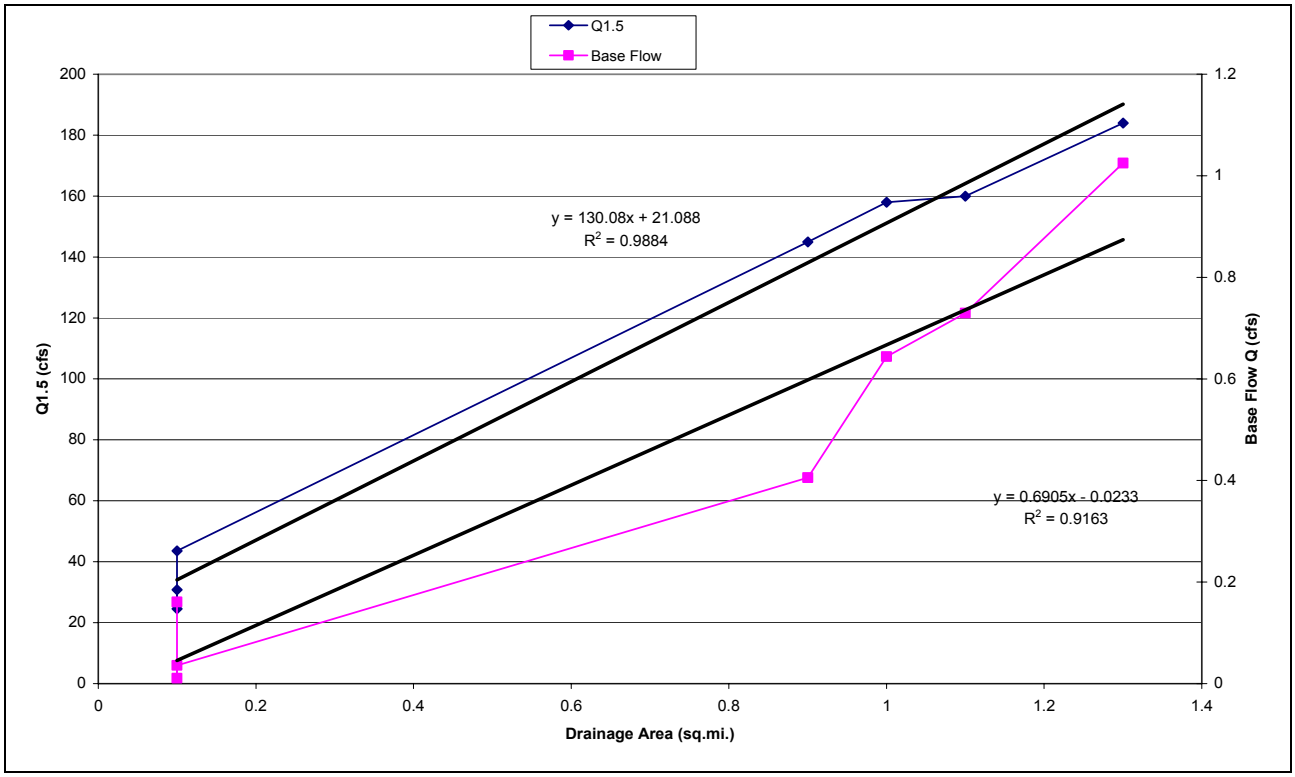


Chart 2

Plot of Main Stem Discharge Data

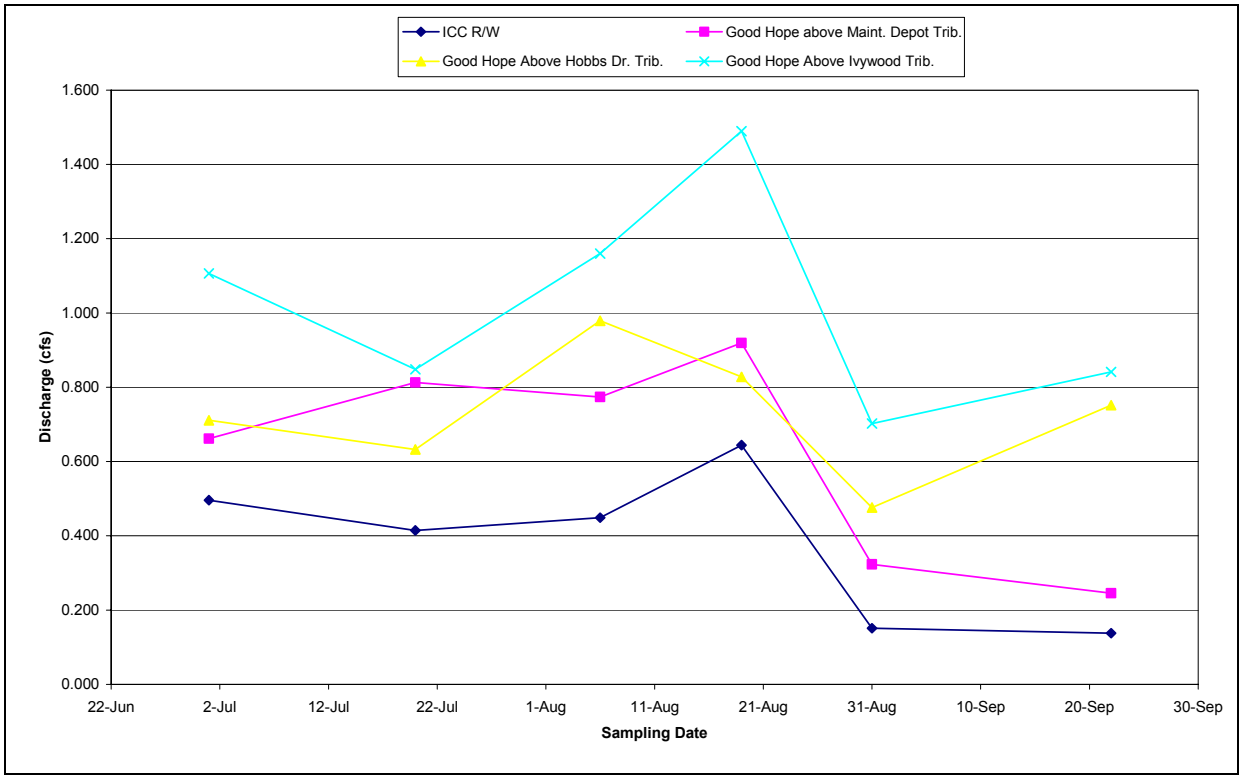


Chart 3
Plot of Tributary Discharge Data

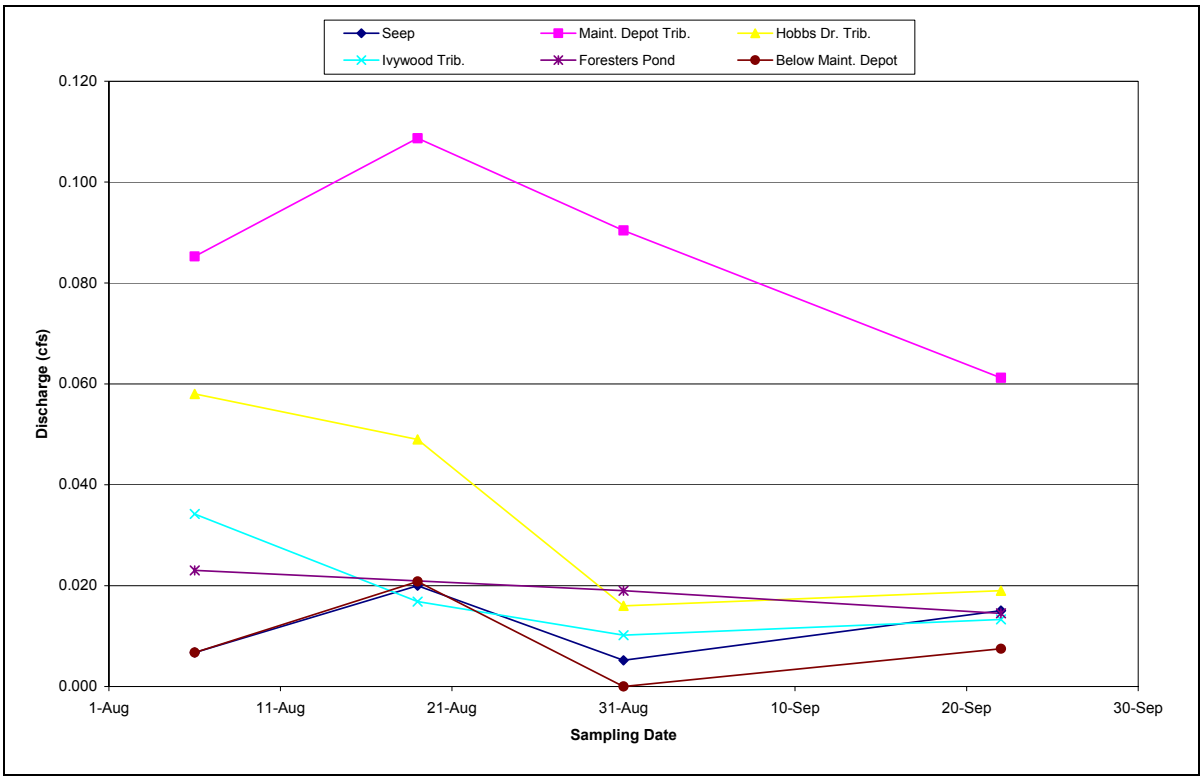


Chart 4
Daily Measurable Precipitation for National Airport

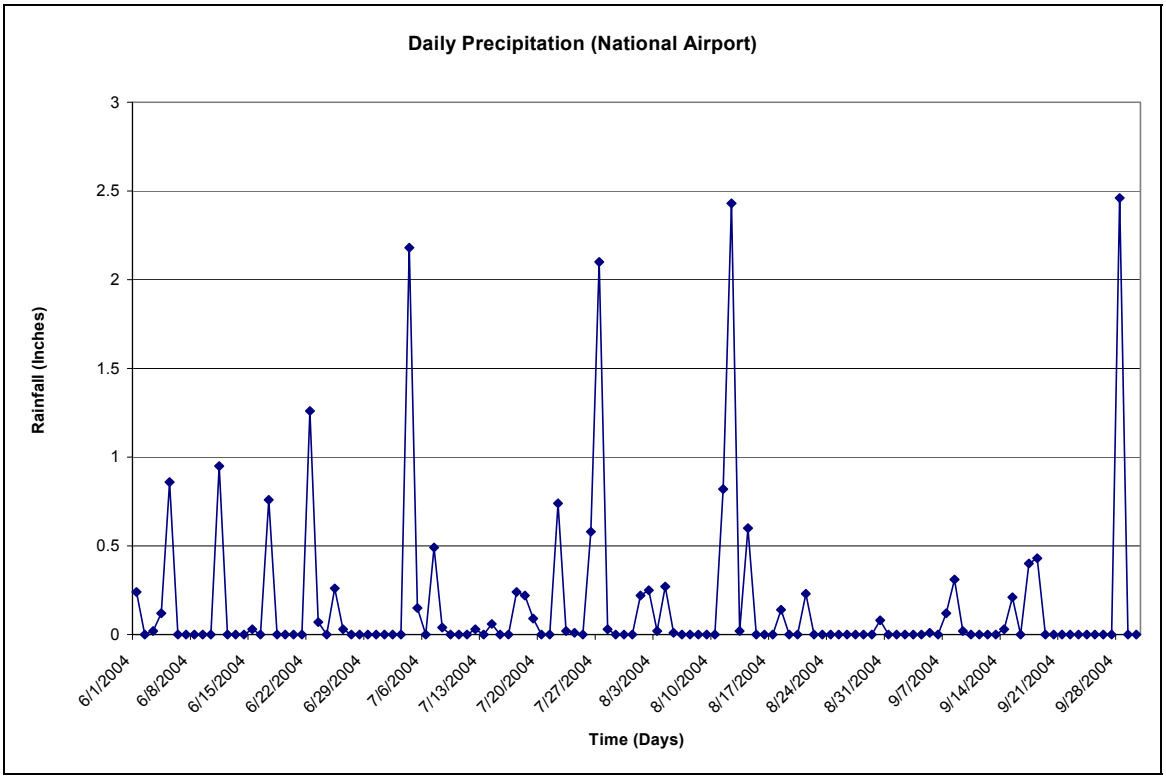
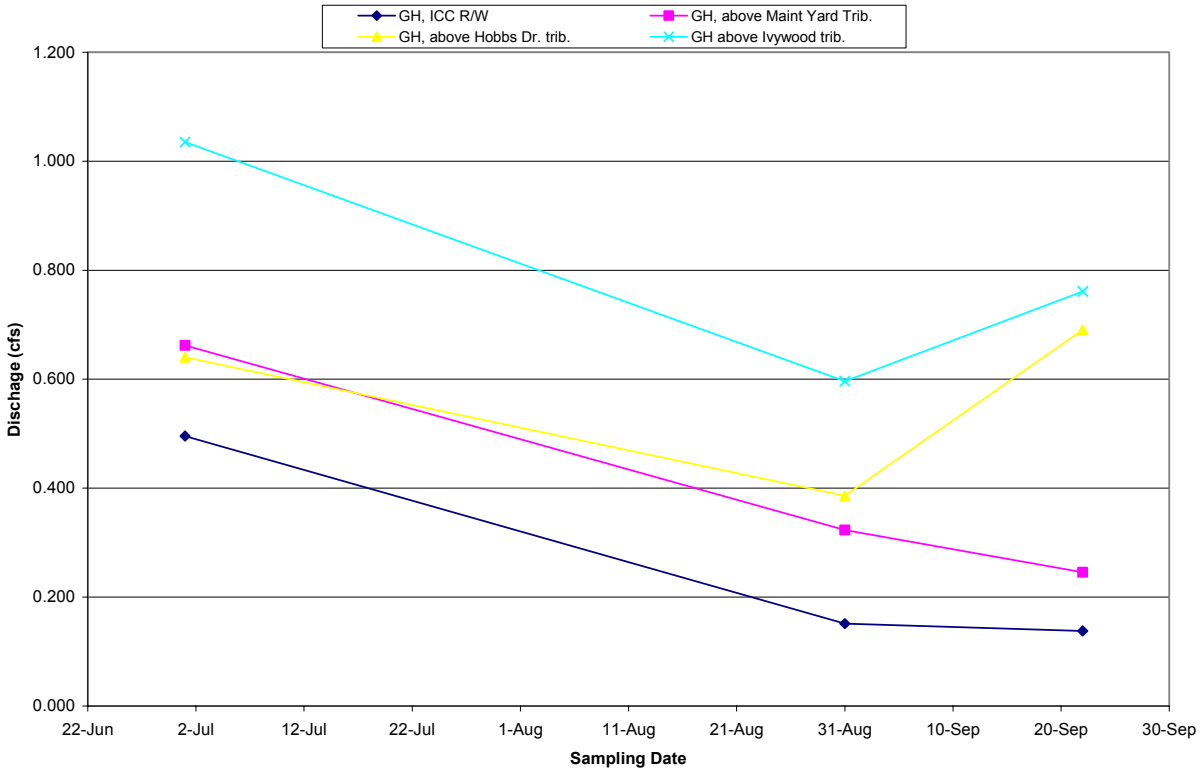


Chart 5
Hydrograph Separation

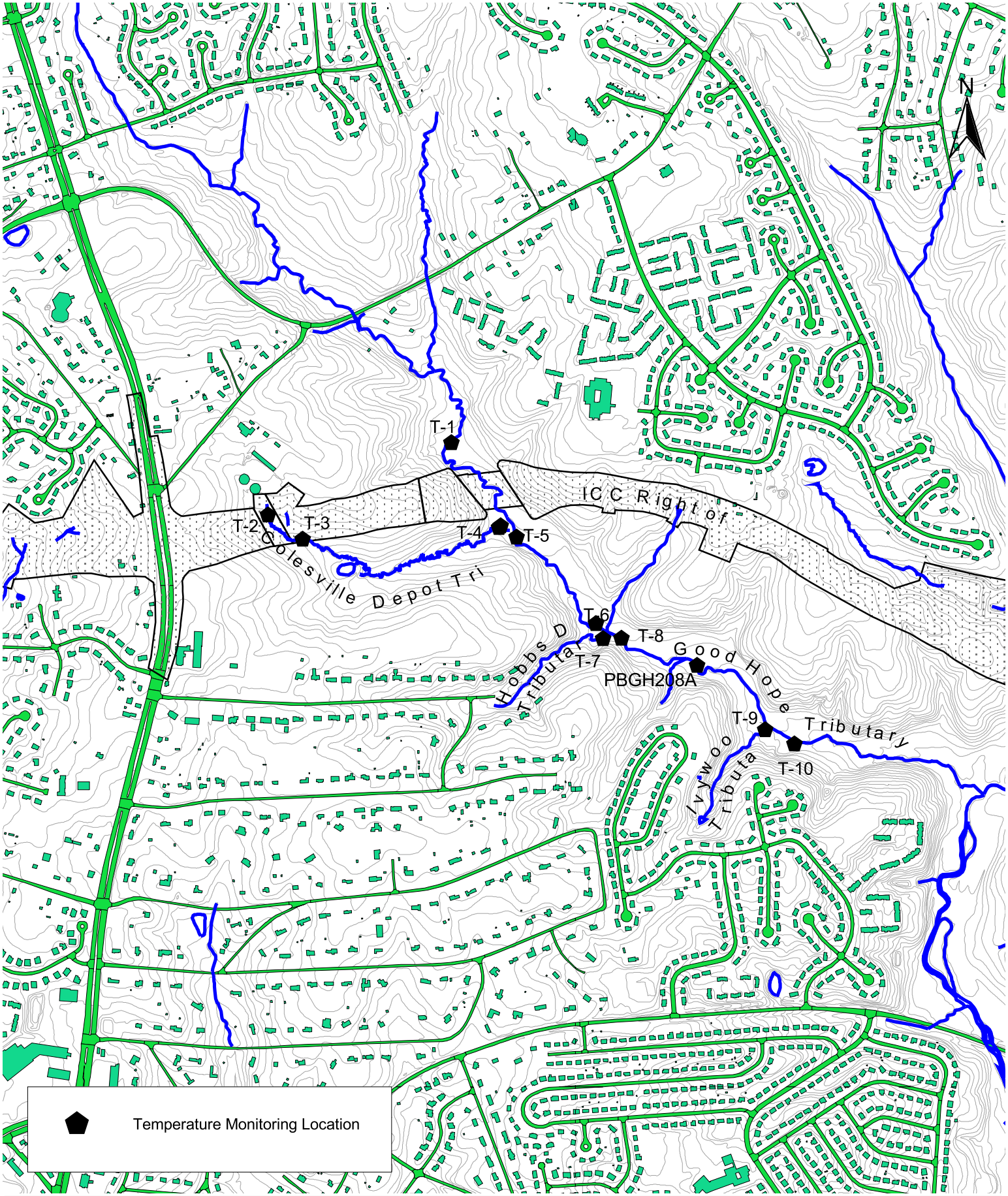


Upper Paint Branch Temperature Monitoring

Temperature monitoring in the Upper Paint Branch, specifically the Good Hope Tributary, was conducted in an effort to better characterize the possible sources of heat stress to the local brown trout population and to add to existing continuous temperature monitoring data. The Upper Paint Branch is classified as a Use III stream (Natural Trout Waters) by the State of Maryland. This stream classification requires stream temperatures to remain below 68°F. Data collected in the past indicate that temperatures within the Good Hope Tributary may exceed this standard during the summer months. Temperature data loggers were placed by SHA specifically to monitor which tributaries may or may not be contributing warm water to the mainstem of the Good Hope Tributary. See ***Figure 3*** for temperature monitoring locations. The monitored tributaries include the Depot Tributary, the Hobbs Drive Tributary, and the Ivywood Tributary. Due to the numerous features on the Depot Tributary that have the potential to affect water temperature, a greater number of loggers were deployed in this tributary to attempt to isolate these potential impact areas and also gauge temperature recovery in the system.

Methodology:

Automated continuous temperature monitoring was conducted for the ICC study from June 1, 2004 to September 30, 2004 to capture the warmest air temperatures of the year as well as the potentially diminished baseflows that often occur in Maryland during the summer months. Both higher air temperatures and diminished cool water inputs from baseflow could be expected to raise overall stream water temperatures in the Good Hope and its tributaries. A total of ten HOBO Water Temperature Pro temperature data loggers were placed on a submerged surface, such as a large tree root, in an area that would likely stay under water for the entire summer. Data loggers were set to record water temperatures every 24 minutes. In addition to the water temperature data logger, an air temperature monitor was deployed on the Colesville Depot Tributary to collect very specific local temperature data. One monitoring site (PBGH208) was established previously by MCDEP. Data from this temperature logger were available for the same time period sampled by SHA.



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Upper Paint Branch
Baseflow and Temperature Monitoring
Temperature Monitoring Locations
Intercounty Connector Study

Figure 3

February 2005

1000 0 1000 Feet

Results:

The Colesville Depot Tributary was suspected of contributing warm stream water to the Good Hope Tributary due to the presence of a storm water management pond located in the headwaters of the tributary. This storm water management pond receives runoff from a large county maintenance facility and parking lot. A temperature data logger was placed just downstream of the storm water management pond outlet to investigate this assumption. Average water temperature measured below this pond was notably higher, 71.1°F, than in other areas measured within the Good Hope and its tributaries. These readings were above the 68°F standard 72.7 percent of the summer. A large forested and emergent wetland is located downstream of the stormwater management pond. This wetland was thought to contribute a large amount of cool baseflow water to the Good Hope tributary. Baseflow and temperature data collected for this study did not indicate that the wetland was providing a substantial cooling effect on the stream in 2004. A temperature data logger placed downstream of where the wetland flows into the Good Hope tributary showed average water temperature only slightly cooler, 69.0°F, than at the storm water management pond outlet. It was noted in the baseflow data collected that discharge from the wetland appeared to be higher during drier times when little or no flows were recorded below the Maintenance Depot SMW pond. It appears possible then, that the wetland may have a more measurable effect on temperatures in years with fewer precipitation events.

One additional logger was placed on the Depot tributary, just upstream of the confluence with the Good Hope Tributary. The average temperature at this site was 65.3°F, less than one degree warmer than the measurement on the Good Hope mainstem above the confluence with the Depot Tributary. This result appears to indicate that cool-water baseflow inputs between the wetland and the Depot Tributary confluence with the Good Hope were, for the most part, mitigating the higher temperatures recorded at the Depot SWM pond in 2004.

Average water temperature measured within the Hobbs Drive Tributary was cooler (63.9°F) than the mainstem of the Good Hope Tributary both upstream and downstream of the confluence with this tributary. These readings were above the 68°F only 2.83 percent of the summer.

The average water temperature within the Ivywood Tributary was greater than one degree warmer (65.6°F) than the average temperature measured both upstream and downstream of the confluence with the Good Hope Tributary. These readings were above the 68°F standard 21.4 percent of the summer. The Ivywood Tributary is a small tributary with a relatively new residential neighborhood and SWM dry-pond in its headwaters. It has a relatively small baseflow contribution in comparison to the other tributaries monitored, which does not appear to be adequate to overcome the temperature effects of the upstream land use. However, though the water temperature is slightly warmer in the Ivywood Tributary, this

most likely does not cause a substantial change in the overall temperature of the Good Hope mainstem.

Generally, temperatures within the study area in the mainstem of the Good Hope Tributary remained constant. See ***Table 3*** below for detailed results. The average water temperatures within the Good Hope ranged from 63.9°F to 64.5°F. The readings from these sites ranged from 6.35 to 9.09 percent above the 68°F standard for Use III waters. These constant temperatures indicate that despite warm water inflows in the headwaters of the tributaries the baseflow contributions to these tributaries and the Good Hope mainstem were able to largely mitigate these effects and maintain an average temperature below the Use III standard in 2004.

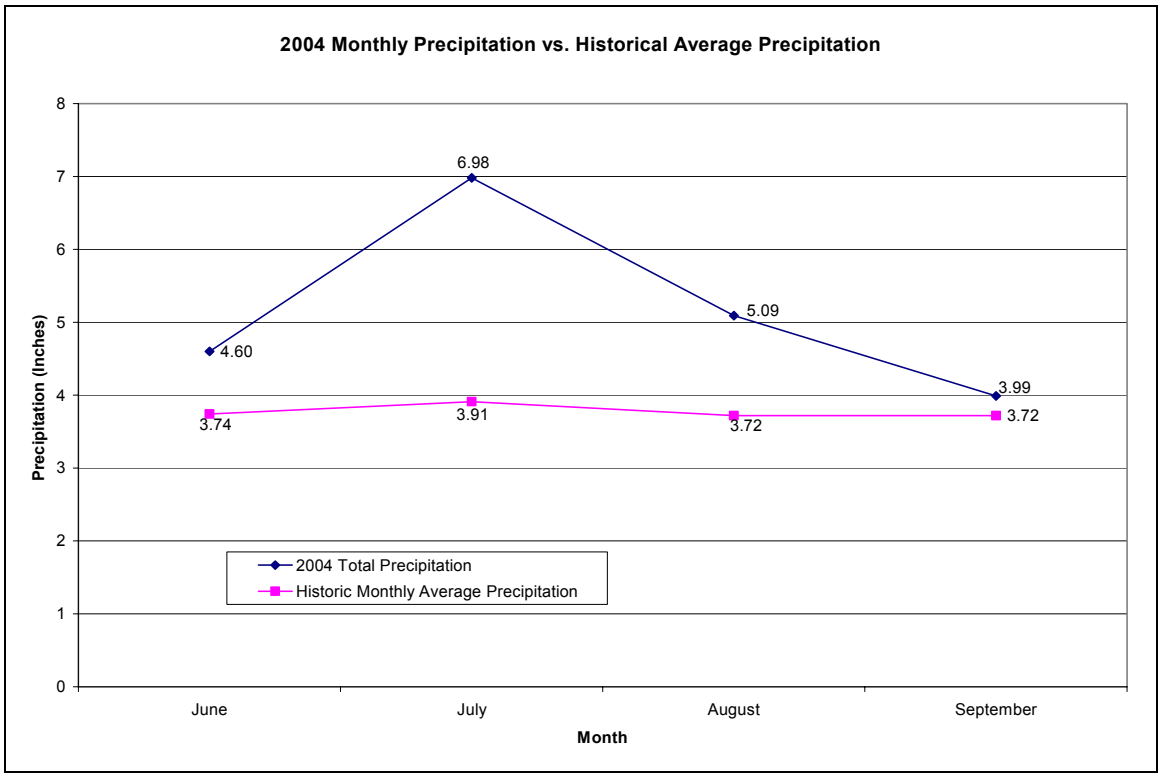
Table 3
Summary of 2004 Temperature Data for Paint Branch

Site Description	Site #	Average Temperature (°F)	Percent of readings above 68°F
Good Hope Tributary at ICC Crossing	T-1	64.4	8.76
Colesville Depot SWM pond outlet	T-2	71.1	72.7
Depot Tributary downstream of seep wetland	T-3	69.0	58.5
Depot Tributary above confluence with Good Hope	T-4	65.3	17.1
Good Hope Tributary downstream of Depot Tributary confluence	T-5	64.3	7.54
Good Hope Tributary upstream of Hobbs Drive Tributary	T-6	64.2	6.44
Hobbs Drive Tributary near confluence with Good Hope	T-7	63.9	2.83
Good Hope Tributary downstream of the Hobbs Drive Tributary	T-8	64.3	6.56
Good Hope Tributary upstream of Ivywood Tributary	PBGH208	63.9	6.35
Ivywood Tributary upstream of Good Hope confluence	T-9	65.6	21.4
Good Hope below Ivywood Tributary	T-10	64.5	9.09

While the Good Hope and its tributaries appear to have been largely able to assimilate temperature impacts from surrounding land uses in the summer of 2004, it should be noted that this period was generally both cooler and wetter than average. A graph showing the 2004 daily temperature readings plotted with average historic monthly temperatures is available in ***Appendix C***. Based on this graph and online weather statistics from NOAA (www.nws.noaa.gov/om/presto), there were no heat waves in 2004. Air temperatures in the region exceeded 90° on only eight days, and temperatures in the Good Hope Valley exceeded 90° on only three occasions. The average regional summer temperature for 2004 of 73.8° was 0.5° below the norm of 74.3°. Average air temperature data, from the Colesville Depot Tributary, during 2004 was 70.0°F.

In addition, historic precipitation data were plotted against total precipitation for the summer months of 2004. See ***Chart 5*** below. This chart indicates that total precipitation in each of the summer months of 2004 was greater than historic average precipitation in these months. Precipitation in July 2004 was almost double the average historic precipitation. It is likely, that the combination of both slightly below average air temperatures and higher than normal precipitation put less overall temperature stress on the Good Hope and its tributaries in 2004. It should be noted that this study provides data from only one year and it is unclear whether the apparent ability of the system to adequately assimilate temperature effects in 2004 can be extrapolated to other years.

Chart 5
2004 Monthly Precipitation vs. Historical Average Precipitation



Watershed Statistics for: **Station "A" – ICC Crossing**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
Quadrangles Used: kensington, beltsville, clarksville, sandy_spring
DEM Coverage: NED DEMs
Land Use Coverage: 2000 MOP Landuse
Soil Coverage: Ragan Soils
Hydrologic Condition: (see Lookup Table)
Impose NHD stream Locations: Yes
Outlet Easting: 400790 m. (MD Stateplane, NAD 1983)
Outlet Northing: 158002 m. (MD Stateplane, NAD 1983)

Findings:
Outlet Location: Piedmont
Outlet State: Maryland
Drainage Area **0.9 square miles**
-Piedmont (100.0% of area)
Channel Slope: 75.0 feet/mile
Land Slope: 0.053 ft/ft
Urban Area: 47.4%
Impervious Area: 18.6%

****
URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
Calculated discharges from USGS Regression
Equations may not be appropriate.
****

Time of Concentration: 2.0 hours [W.O. Thomas, Jr. Equation]
Time of Concentration: 2.0 hours [From SCS Lag Equation * 1.67]
Longest Flow Path: 1.83 miles
Basin Relief: 92.8 feet
Average CN: 67
% Forest Cover: 45.3
% Storage: 0.0
% Limestone: 0.0
% A Soils: 0.0
% B Soils: 88.9
% C Soils: 5.0
% D Soils: 6.1
2-Year,24-hour Prec.: 2.95 inches

Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25): 106 cfs
Q(1.50): 145 cfs
Q(1.75): 171 cfs
Q(2): 192 cfs
Q(5): 379 cfs
Q(10): 559 cfs
Q(25): 873 cfs
Q(50): 1190 cfs
Q(100): 1580 cfs

Q(200): 2060 cfs
Q(500): 2900 cfs

Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25): 106 cfs
Q(1.50): 145 cfs
Q(1.75): 171 cfs
Q(2): 192 cfs
Q(5): 379 cfs
Q(10): 559 cfs
Q(25): 873 cfs
Q(50): 1190 cfs
Q(100): 1580 cfs
Q(200): 2060 cfs
Q(500): 2900 cfs

Watershed Statistics for: **Station "C" – Good Hope above MYT**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
Quadrangles Used: kensington, beltsville, clarksville, sandy_spring
DEM Coverage: NED DEMs
Land Use Coverage: 2000 MOP Landuse
Soil Coverage: Ragan Soils
Hydrologic Condition: (see Lookup Table)
Impose NHD stream Locations: Yes
Outlet Easting: 400869 m. (MD Stateplane, NAD 1983)
Outlet Northing: 157858 m. (MD Stateplane, NAD 1983)

Findings:
Outlet Location: Piedmont
Outlet State: Maryland
Drainage Area 1.0 square miles
-Piedmont (100.0% of area)
Channel Slope: 76.4 feet/mile
Land Slope: 0.056 ft/ft
Urban Area: 41.3%
Impervious Area: 17.6%

****
URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
Calculated discharges from USGS Regression
Equations may not be appropriate.
****

Time of Concentration: 2.1 hours [W.O. Thomas, Jr. Equation]
Time of Concentration: 2.1 hours [From SCS Lag Equation * 1.67]
Longest Flow Path: 1.94 miles
Basin Relief: 99.6 feet
Average CN: 66
% Forest Cover: 49.9
% Storage: 0.0
% Limestone: 0.0

% A Soils: 0.0
% B Soils: 90.0
% C Soils: 4.2
% D Soils: 5.7
2-Year,24-hour Prec.: 2.95 inches
Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25): 116 cfs
Q(1.50): 158 cfs
Q(1.75): 187 cfs
Q(2): 209 cfs
Q(5): 413 cfs
Q(10): 612 cfs
Q(25): 959 cfs
Q(50): 1310 cfs
Q(100): 1740 cfs
Q(200): 2290 cfs
Q(500): 3230 cfs

Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25): 116 cfs
Q(1.50): 158 cfs
Q(1.75): 187 cfs
Q(2): 209 cfs
Q(5): 413 cfs
Q(10): 612 cfs
Q(25): 959 cfs
Q(50): 1310 cfs
Q(100): 1740 cfs
Q(200): 2290 cfs
Q(500): 3230 cfs

Watershed Statistics for: **Station "F" – Good Hope above Hobbs Trib.**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
Quadrangles Used: kensington, beltsville, clarksville, sandy_spring
DEM Coverage: NED DEMs
Land Use Coverage: 2000 MOP Landuse
Soil Coverage: Ragan Soils
Hydrologic Condition: (see Lookup Table)
Impose NHD stream Locations: Yes
Outlet Easting: 401098 m. (MD Stateplane, NAD 1983)
Outlet Northing: 157623 m. (MD Stateplane, NAD 1983)

Findings:
Outlet Location: Piedmont

Outlet State: Maryland
Drainage Area 1.1 square miles
-Piedmont (100.0% of area)
Channel Slope: 78.2 feet/mile
Land Slope: 0.057 ft/ft
Urban Area: 39.4%
Impervious Area: 17.0%

****
URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
Calculated discharges from USGS Regression
Equations may not be appropriate.
****

Time of Concentration: 2.2 hours [W.O. Thomas, Jr. Equation]
Time of Concentration: 2.3 hours [From SCS Lag Equation * 1.67]
Longest Flow Path: 2.14 miles
Basin Relief: 109.2 feet
Average CN: 65
% Forest Cover: 51.8
% Storage: 0.0
% Limestone: 0.0
% A Soils: 0.0
% B Soils: 90.5
% C Soils: 4.0
% D Soils: 5.5
2-Year,24-hour Prec.: 2.95 inches

Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25): 117 cfs
Q(1.50): 160 cfs
Q(1.75): 188 cfs
Q(2): 211 cfs
Q(5): 418 cfs
Q(10): 621 cfs
Q(25): 975 cfs
Q(50): 1330 cfs
Q(100): 1780 cfs
Q(200): 2340 cfs
Q(500): 3320 cfs

Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25): 117 cfs
Q(1.50): 160 cfs
Q(1.75): 188 cfs
Q(2): 211 cfs
Q(5): 418 cfs
Q(10): 621 cfs
Q(25): 975 cfs
Q(50): 1330 cfs
Q(100): 1780 cfs

Q(200): 2340 cfs
Q(500): 3320 cfs

Watershed Statistics for: **Station "H" – Good Hope above Ivywood Trib.**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
  Quadrangles Used: kensington, beltsville, clarksville, sandy_spring
  DEM Coverage: NED DEMs
  Land Use Coverage: 2000 MOP Landuse
  Soil Coverage: Ragan Soils
  Hydrologic Condition: (see Lookup Table)
  Impose NHD stream Locations: Yes
  Outlet Easting: 401507 m. (MD Stateplane, NAD 1983)
  Outlet Northing: 157389 m. (MD Stateplane, NAD 1983)

Findings:
  Outlet Location: Piedmont
  Outlet State: Maryland
  Drainage Area 1.3 square miles
    -Piedmont (100.0% of area)
  Channel Slope: 77.7 feet/mile
  Land Slope: 0.062 ft/ft
  Urban Area: 42.8%
  Impervious Area: 16.8%
****
  URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
  Calculated discharges from USGS Regression
  Equations may not be appropriate.
****
  Time of Concentration: 2.3 hours [W.O. Thomas, Jr. Equation]
  Time of Concentration: 2.5 hours [From SCS Lag Equation * 1.67]
  Longest Flow Path: 2.47 miles
  Basin Relief: 116.7 feet
  Average CN: 65
  % Forest Cover: 49.7
  % Storage: 0.0
  % Limestone: 0.0
  % A Soils: 0.0
  % B Soils: 92.4
  % C Soils: 3.2
  % D Soils: 4.4
  2-Year,24-hour Prec.: 2.95 inches
Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25): 135 cfs
Q(1.50): 184 cfs
Q(1.75): 217 cfs
Q(2): 243 cfs
Q(5): 480 cfs
Q(10): 712 cfs

Q(25): 1120 cfs
Q(50): 1530 cfs
Q(100): 2050 cfs
Q(200): 2690 cfs
Q(500): 3820 cfs

Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25): 135 cfs
Q(1.50): 184 cfs
Q(1.75): 217 cfs
Q(2): 243 cfs
Q(5): 480 cfs
Q(10): 712 cfs
Q(25): 1120 cfs
Q(50): 1530 cfs
Q(100): 2050 cfs
Q(200): 2690 cfs
Q(500): 3820 cfs

Watershed Statistics for: **Station "D" – MY Trib**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
Quadrangles Used: kensington, beltsville, clarksville, sandy_spring
DEM Coverage: NED DEMs
Land Use Coverage: 2000 MOP Landuse
Soil Coverage: Ragan Soils
Hydrologic Condition: (see Lookup Table)
Impose NHD stream Locations: Yes
Outlet Easting: 400833 m. (MD Stateplane, NAD 1983)
Outlet Northing: 157849 m. (MD Stateplane, NAD 1983)

Findings:
Outlet Location: Piedmont
Outlet State: Maryland
Drainage Area 0.1 square miles
-Piedmont (100.0% of area)
Channel Slope: 150.2 feet/mile
Land Slope: 0.068 ft/ft
Urban Area: 9.5%
Impervious Area: 10.8%
Time of Concentration: 1.3 hours [W.O. Thomas, Jr. Equation]
Time of Concentration: 0.9 hours [From SCS Lag Equation * 1.67]
Longest Flow Path: 0.62 miles
Basin Relief: 70.8 feet
Average CN: 61
% Forest Cover: 75.5
% Storage: 0.0
% Limestone: 0.0
% A Soils: 0.0
% B Soils: 94.6

% C Soils: 0.0
% D Soils: 5.4
2-Year,24-hour Prec.: 2.95 inches
Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25): 22.3 cfs
Q(1.50): 30.8 cfs
Q(1.75): 37.0 cfs
Q(2): 42.7 cfs
Q(5): 89.9 cfs
Q(10): 138 cfs
Q(25): 226 cfs
Q(50): 317 cfs
Q(100): 435 cfs
Q(200): 584 cfs
Q(500): 853 cfs

Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25): 22.3 cfs
Q(1.50): 30.8 cfs
Q(1.75): 37.0 cfs
Q(2): 42.7 cfs
Q(5): 89.9 cfs
Q(10): 138 cfs
Q(25): 226 cfs
Q(50): 317 cfs
Q(100): 435 cfs
Q(200): 584 cfs
Q(500): 853 cfs

Watershed Statistics for: **Station "B" – Seep below Cloesville Maint. Depot**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
Quadrangles Used: beltsville, kensington
DEM Coverage: NED DEMs
Land Use Coverage: 2000 MOP Landuse
Soil Coverage: Ragan Soils
Hydrologic Condition: (see Lookup Table)
Impose NHD stream Locations: Yes
Outlet Easting: 400360 m. (MD Stateplane, NAD 1983)
Outlet Northing: 157826 m. (MD Stateplane, NAD 1983)

Findings:
Outlet Location: Piedmont
Outlet State: Maryland

Drainage Area **0.1 square miles**
-Piedmont (100.0% of area)
Channel Slope: 160.0 feet/mile
Land Slope: 0.058 ft/ft
Urban Area: 19.5%
Impervious Area: 19.1%

****
URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
Calculated discharges from USGS Regression
Equations may not be appropriate.
****

Time of Concentration: 0.8 hours [W.O. Thomas, Jr. Equation]
Time of Concentration: 0.5 hours [From SCS Lag Equation * 1.67]
Longest Flow Path: 0.30 miles
Basin Relief: 36.8 feet
Average CN: 66
% Forest Cover: 56.5
% Storage: 0.0
% Limestone: 0.0
% A Soils: 0.0
% B Soils: 87.0
% C Soils: 0.0
% D Soils: 13.0
2-Year,24-hour Prec.: 2.94 inches

Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25): 17.8 cfs
Q(1.50): 24.6 cfs
Q(1.75): 29.3 cfs
Q(2): 33.6 cfs
Q(5): 68.1 cfs
Q(10): 101 cfs
Q(25): 159 cfs
Q(50): 215 cfs
Q(100): 285 cfs
Q(200): 371 cfs
Q(500): 517 cfs

Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25): 17.8 cfs
Q(1.50): 24.6 cfs
Q(1.75): 29.3 cfs
Q(2): 33.6 cfs
Q(5): 68.1 cfs
Q(10): 101 cfs
Q(25): 159 cfs
Q(50): 215 cfs
Q(100): 285 cfs

Q(200): 371 cfs
Q(500): 517 cfs

Watershed Statistics for: **Station "E" – Hobbs Trib.**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
Quadrangles Used: kensington, beltsville, clarksville, sandy_spring
DEM Coverage: NED DEMs
Land Use Coverage: 2000 MOP Landuse
Soil Coverage: Ragan Soils
Hydrologic Condition: (see Lookup Table)
Impose NHD stream Locations: Yes
Outlet Easting: 401083 m. (MD Stateplane, NAD 1983)
Outlet Northing: 157593 m. (MD Stateplane, NAD 1983)

Findings:
Outlet Location: Piedmont
Outlet State: Maryland
Drainage Area 0.1 square miles
-Piedmont (100.0% of area)
Channel Slope: 187.8 feet/mile
Land Slope: 0.075 ft/ft
Urban Area: 84.7%
Impervious Area: 22.6%

****
URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
Calculated discharges from USGS Regression
Equations may not be appropriate.
****

Time of Concentration: 0.9 hours [W.O. Thomas, Jr. Equation]
Time of Concentration: 0.7 hours [From SCS Lag Equation * 1.67]
Longest Flow Path: 0.57 miles
Basin Relief: 80.3 feet
Average CN: 68
% Forest Cover: 12.5
% Storage: 0.0
% Limestone: 0.0
% A Soils: 0.0
% B Soils: 100.0
% C Soils: 0.0
% D Soils: 0.0
2-Year,24-hour Prec.: 2.95 inches

Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25): 31.7 cfs
Q(1.50): 43.6 cfs
Q(1.75): 51.8 cfs
Q(2): 58.8 cfs

Q(5): 116 cfs
Q(10): 171 cfs
Q(25): 264 cfs
Q(50): 354 cfs
Q(100): 465 cfs
Q(200): 599 cfs
Q(500): 826 cfs

Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25): 31.7 cfs
Q(1.50): 43.6 cfs
Q(1.75): 51.8 cfs
Q(2): 58.8 cfs
Q(5): 116 cfs
Q(10): 171 cfs
Q(25): 264 cfs
Q(50): 354 cfs
Q(100): 465 cfs
Q(200): 599 cfs
Q(500): 826 cfs

Watershed Statistics for: **Station "G" – Ivywood Trib.**
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Data Selected:
Quadrangles Used: beltsville, kensington
DEM Coverage: NED DEMs
Land Use Coverage: 2000 MOP Landuse
Soil Coverage: Ragan Soils
Hydrologic Condition: (see Lookup Table)
Impose NHD stream Locations: Yes
Outlet Easting: 401491 m. (MD Stateplane, NAD 1983)
Outlet Northing: 157359 m. (MD Stateplane, NAD 1983)

Findings:
Outlet Location: Piedmont
Outlet State: Maryland
Drainage Area 0.0 square miles
-Piedmont (100.0% of area)
Channel Slope: 222.9 feet/mile
Land Slope: 0.100 ft/ft
Urban Area: 86.5%
Impervious Area: 31.5%
****
URBAN DEVELOPMENT IN WATERSHED EXCEEDS 15%.
Calculated discharges from USGS Regression
Equations may not be appropriate.
****
Time of Concentration: 0.6 hours [W.O. Thomas, Jr. Equation]
Time of Concentration: 0.4 hours [From SCS Lag Equation * 1.67]
Longest Flow Path: 0.42 miles
Basin Relief: 68.0 feet

Average CN:	72
% Forest Cover:	13.5
% Storage:	0.0
% Limestone:	0.0
% A Soils:	0.0
% B Soils:	100.0
% C Soils:	0.0
% D Soils:	0.0
2-Year,24-hour Prec.:	2.95 inches

Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: June 15, 2004
Hydro Extension Version Date: May 10, 2004

Overall Weighted Fixed Region Estimated Discharges

Q(1.25):	22.3 cfs
Q(1.50):	**30.8 cfs**
Q(1.75):	37.0 cfs
Q(2):	42.7 cfs
Q(5):	89.9 cfs
Q(10):	138 cfs
Q(25):	226 cfs
Q(50):	317 cfs
Q(100):	435 cfs
Q(200):	584 cfs
Q(500):	853 cfs

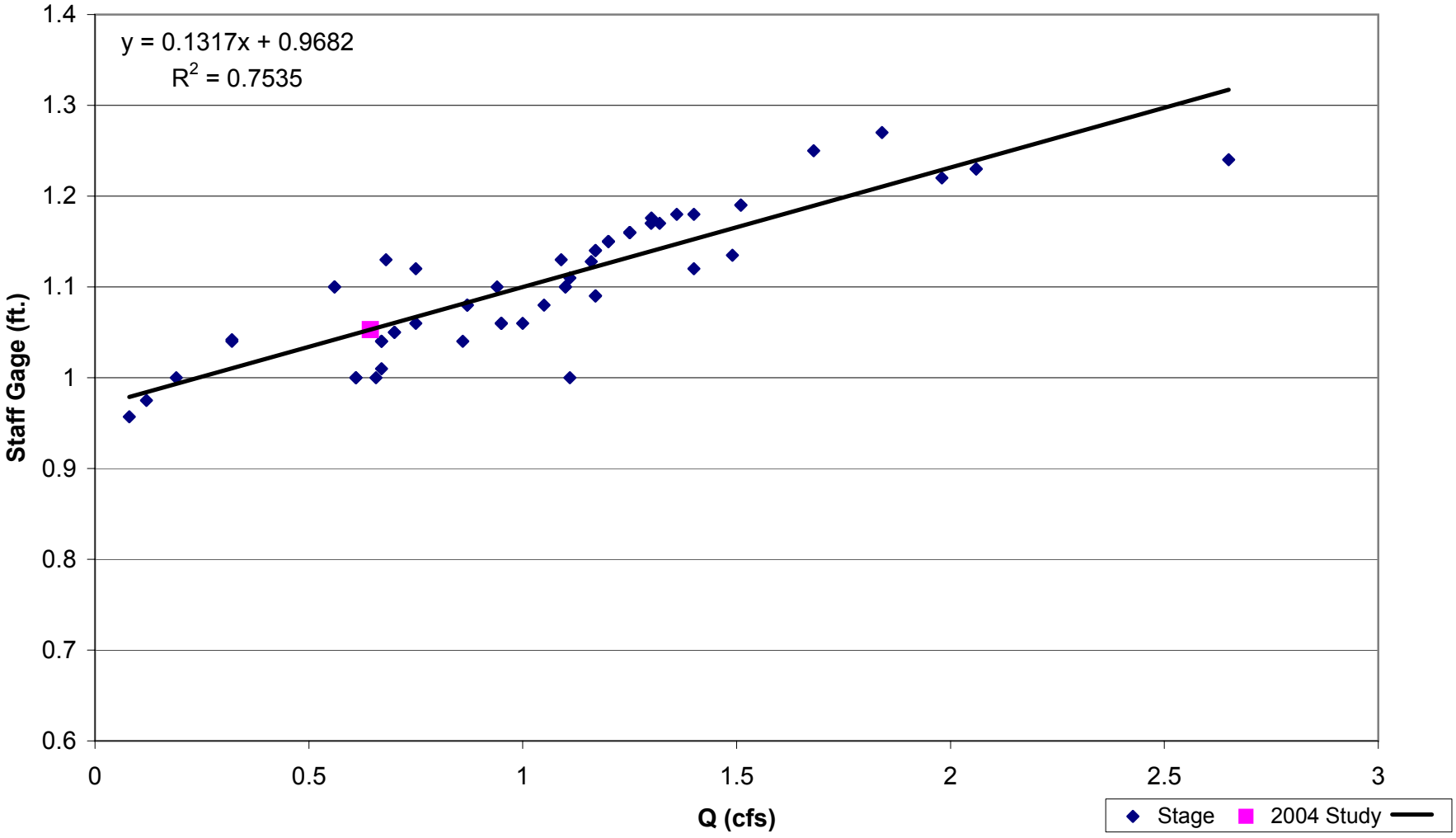
Individual Province Predictions Follow:

Fixed Region Estimated Discharges for: Piedmont region

Q(1.25):	22.3 cfs
Q(1.50):	30.8 cfs
Q(1.75):	37.0 cfs
Q(2):	42.7 cfs
Q(5):	89.9 cfs
Q(10):	138 cfs
Q(25):	226 cfs
Q(50):	317 cfs
Q(100):	435 cfs
Q(200):	584 cfs
Q(500):	853 cfs

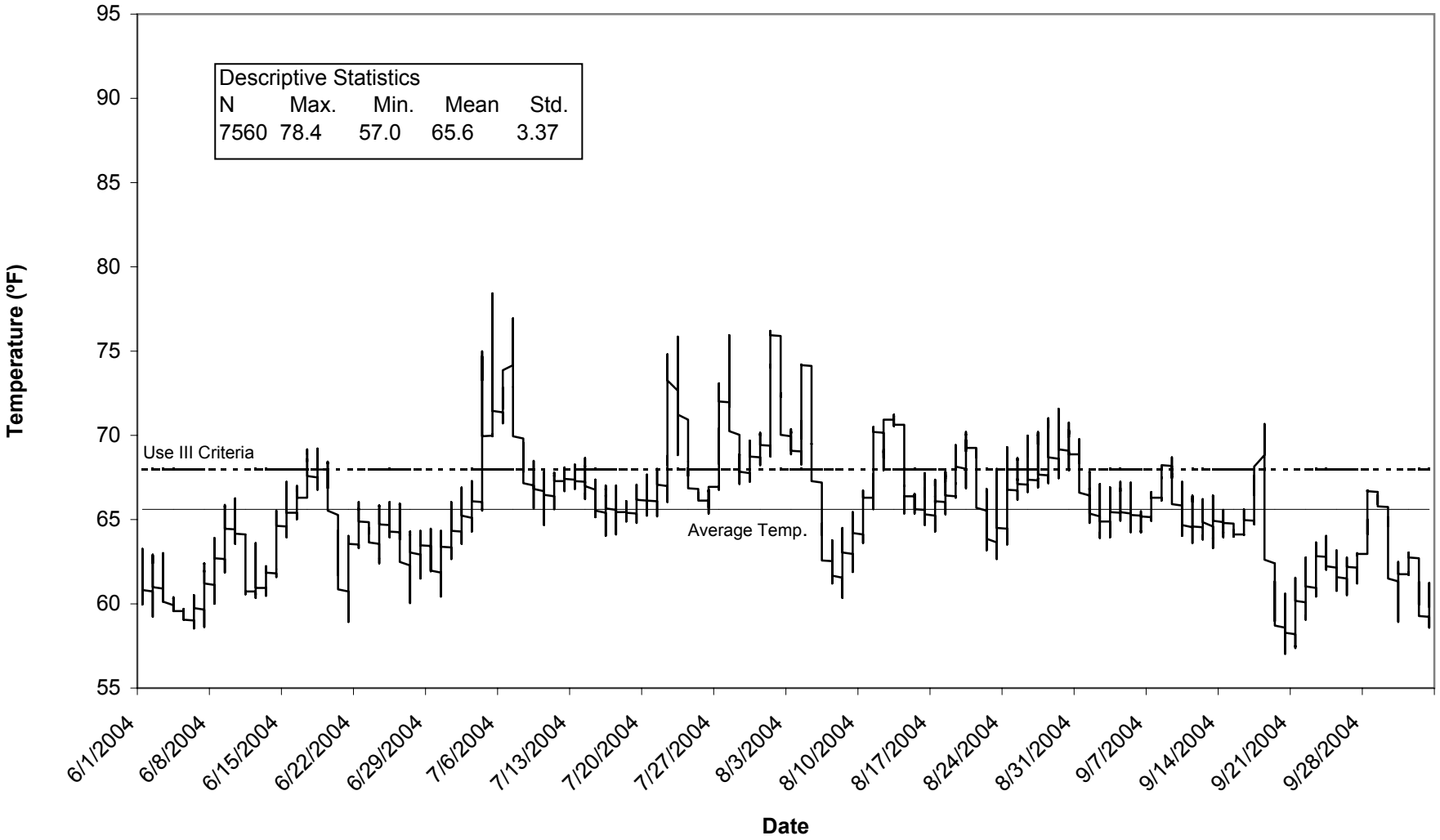
Rating Curve

Anacostia Watershed, Main Stem of the Good Hope
Montgomery County Department of Environmental Protection
September 1996 - August 2001



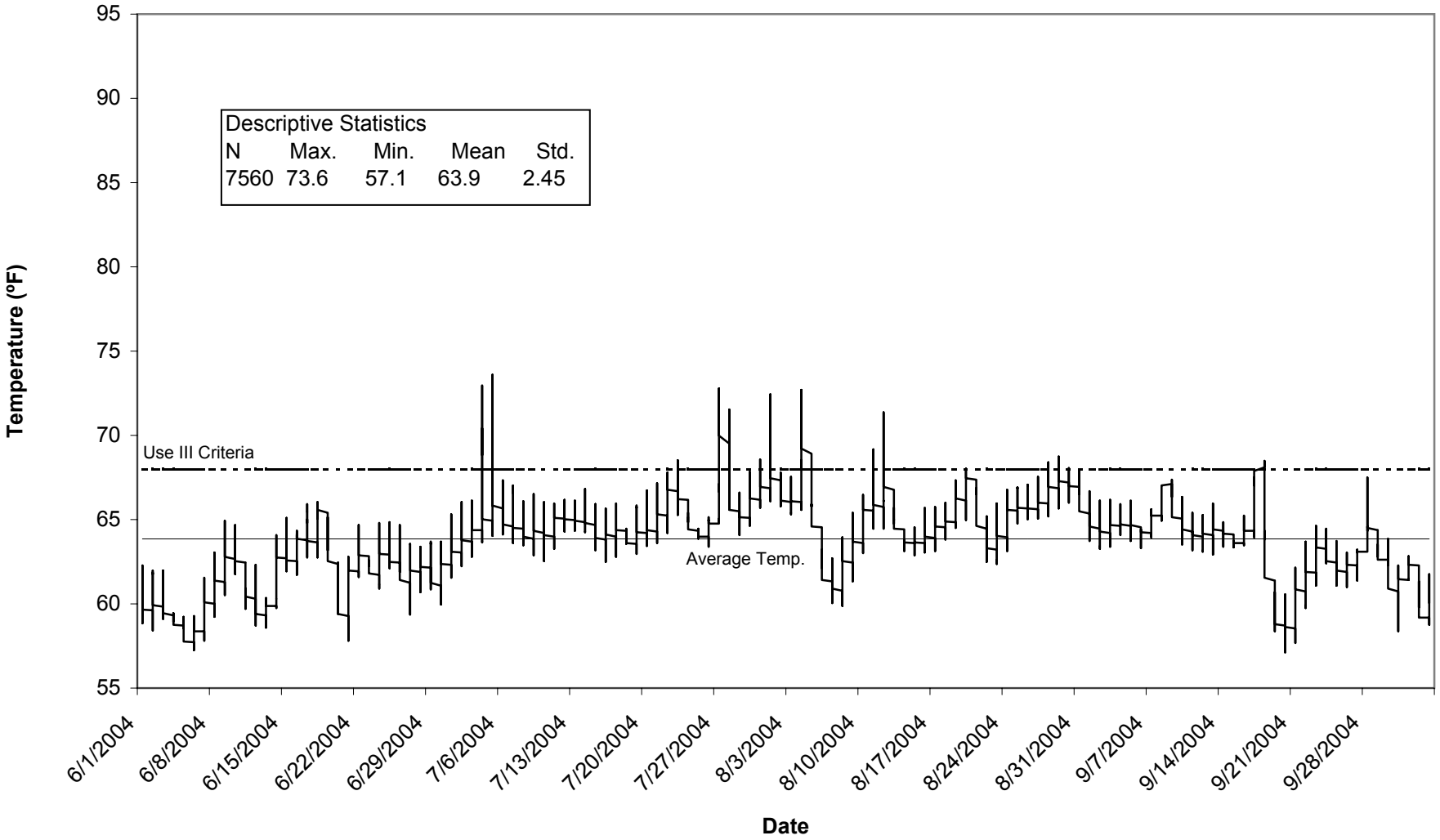
Ivywood Tributary upstream of Good Hope confluence

Average Temperature = 65.6ºF
21.4% of readings above 68ºF



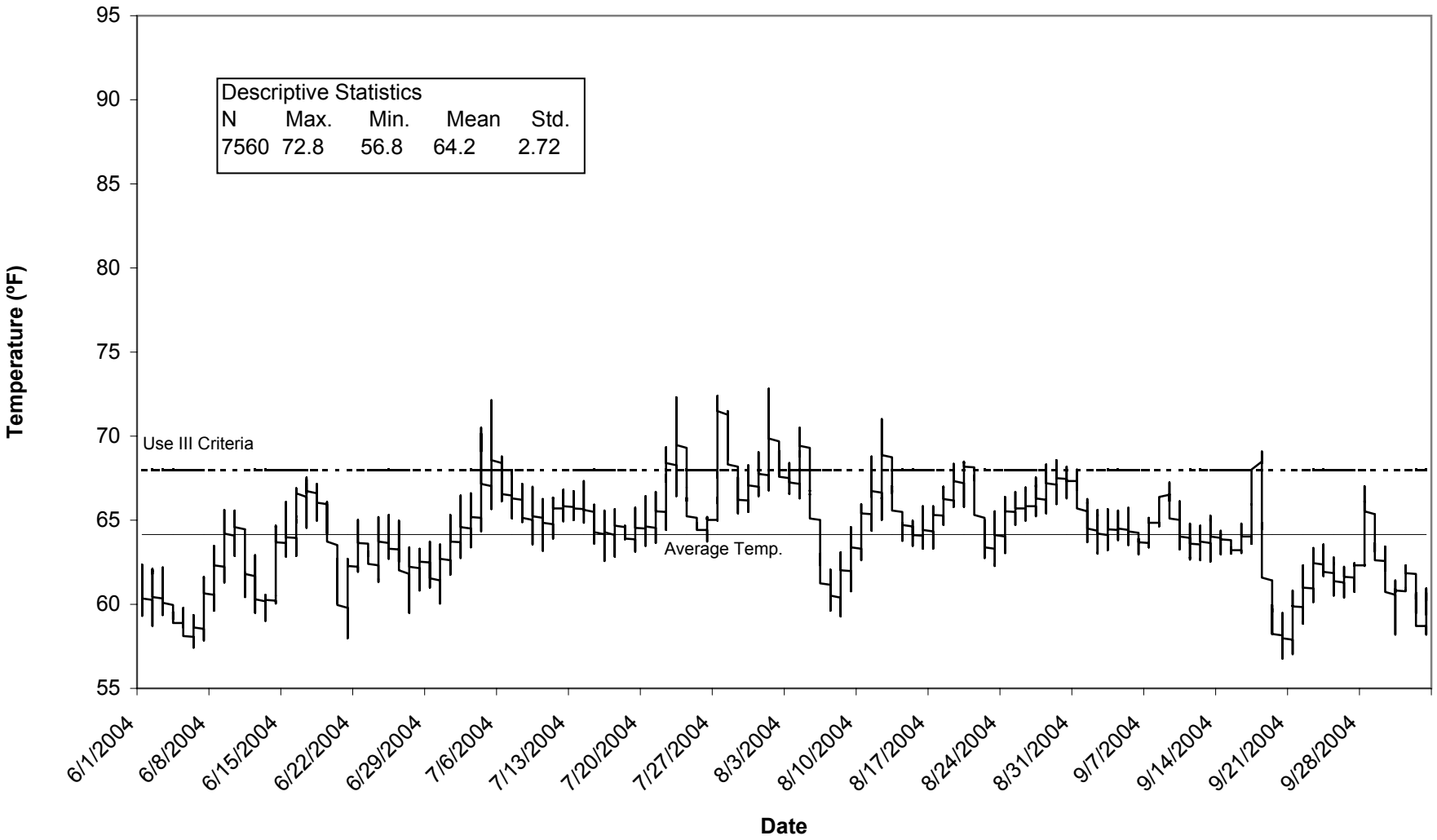
Hobbs Drive Tributary near confluence with Good Hope

Average Temperature = 63.9ºF
2.83% of readings above 68ºF



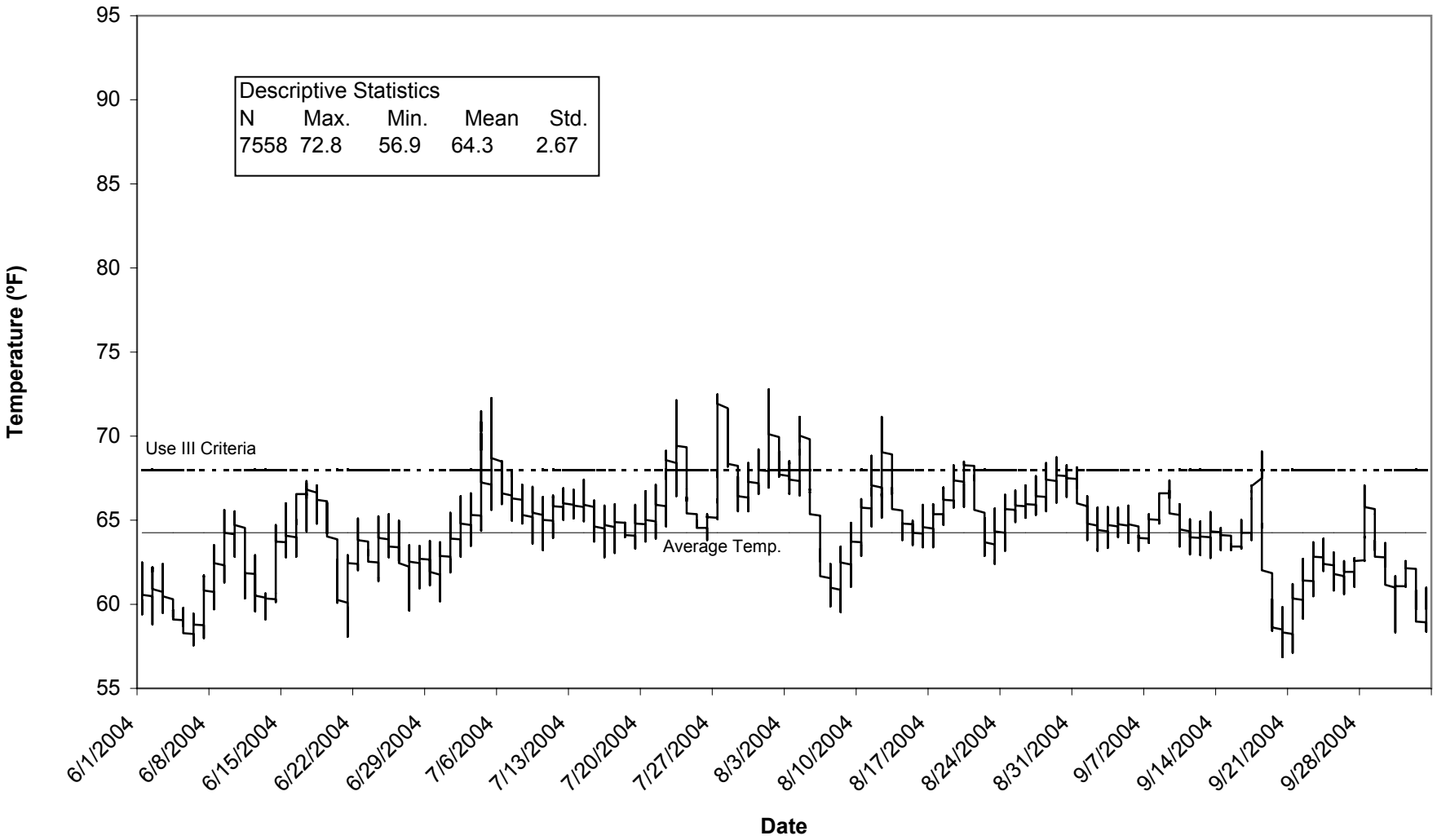
Good Hope Tributary Upstream of Hobbs Drive Tributary

Average Temperature = 64.2ºF
6.44% of readings above 68ºF



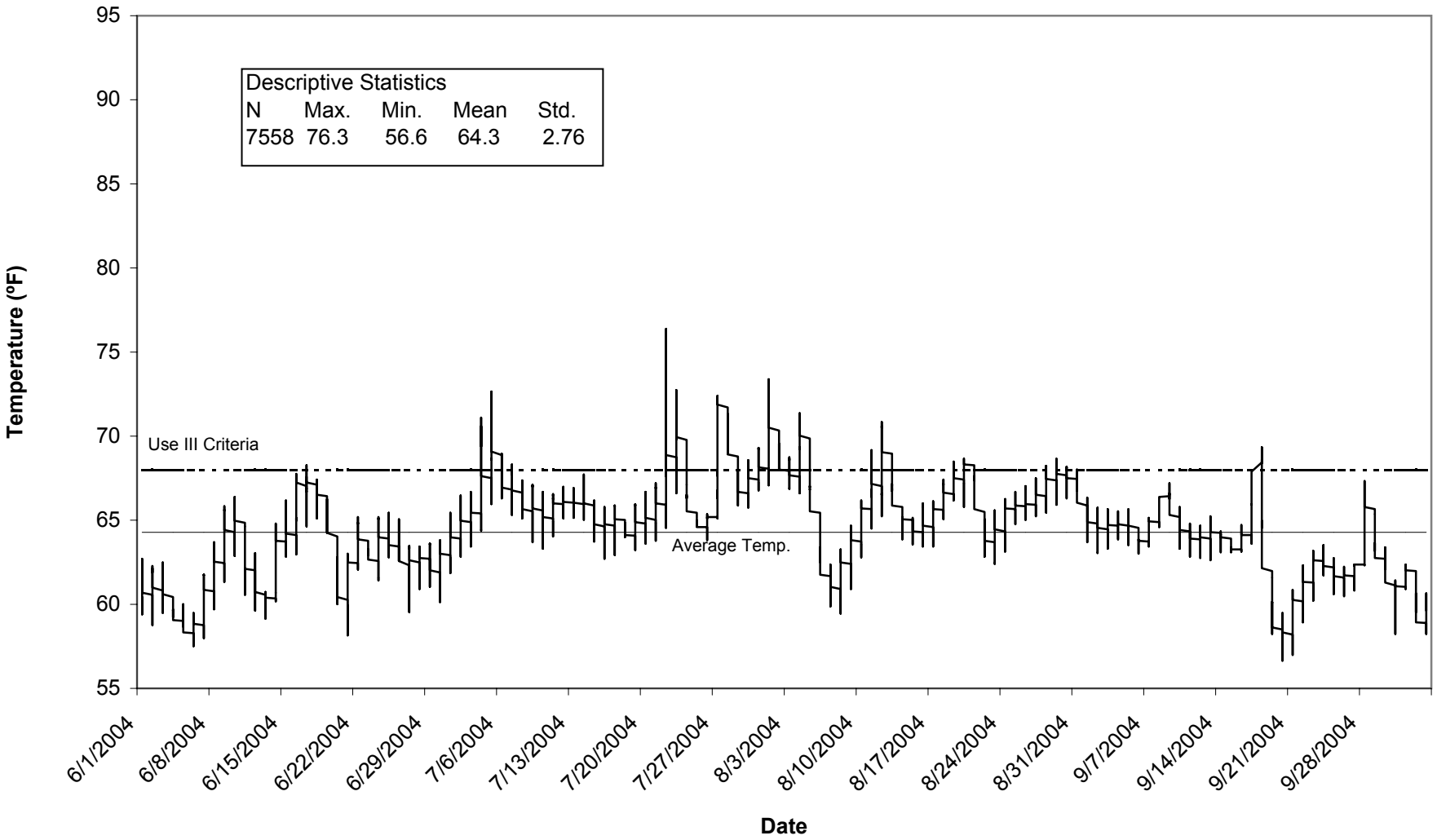
Good Hope Tributary Downstream of the Hobbs Drive Tributary

Average Temperature = 64.3ºF
6.56% of readings above 68ºF



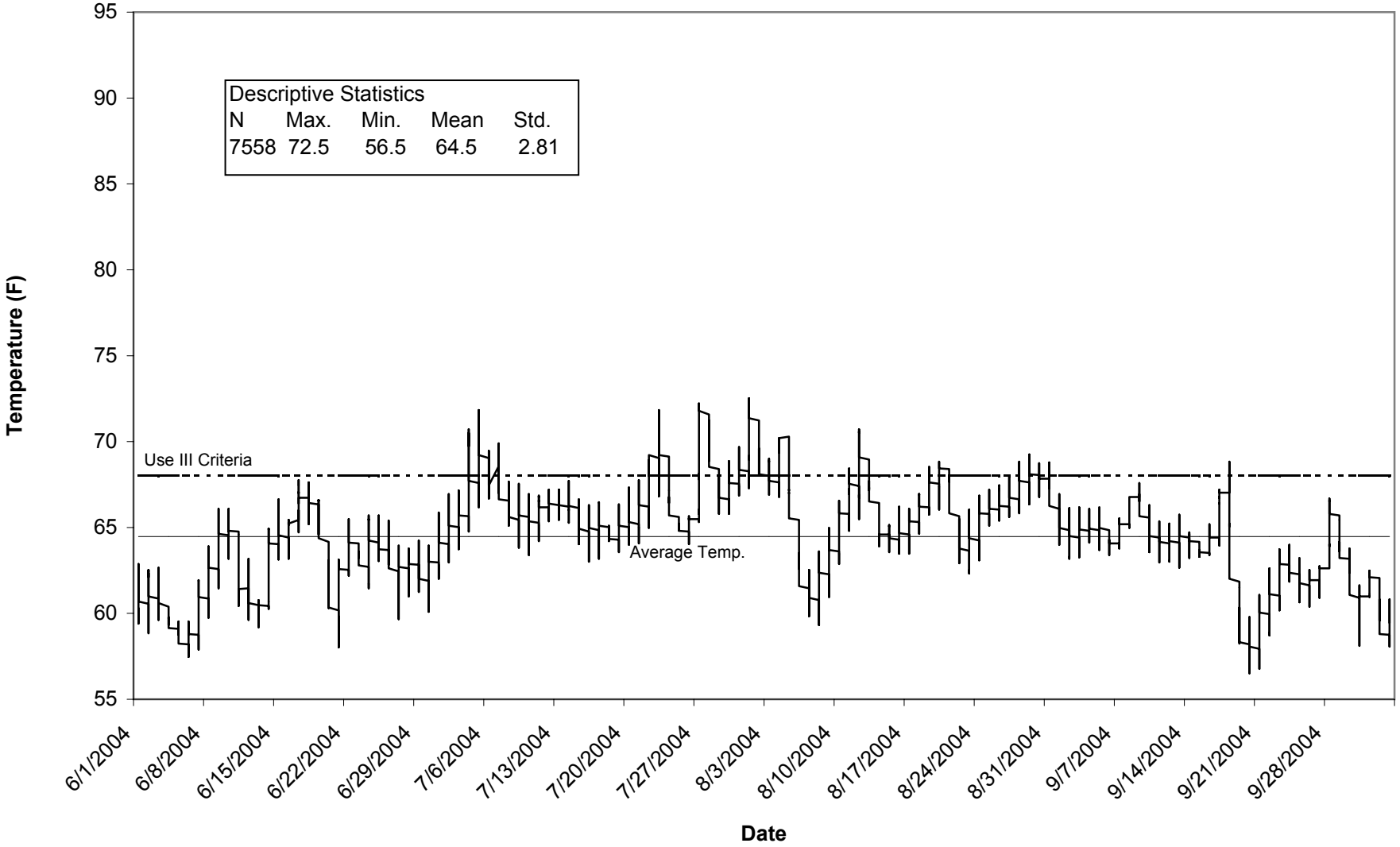
Good Hope Tributary Downstream of Depot Tributary Confluence

Average Temperature = 64.3ºF
7.54% of readings above 68ºF



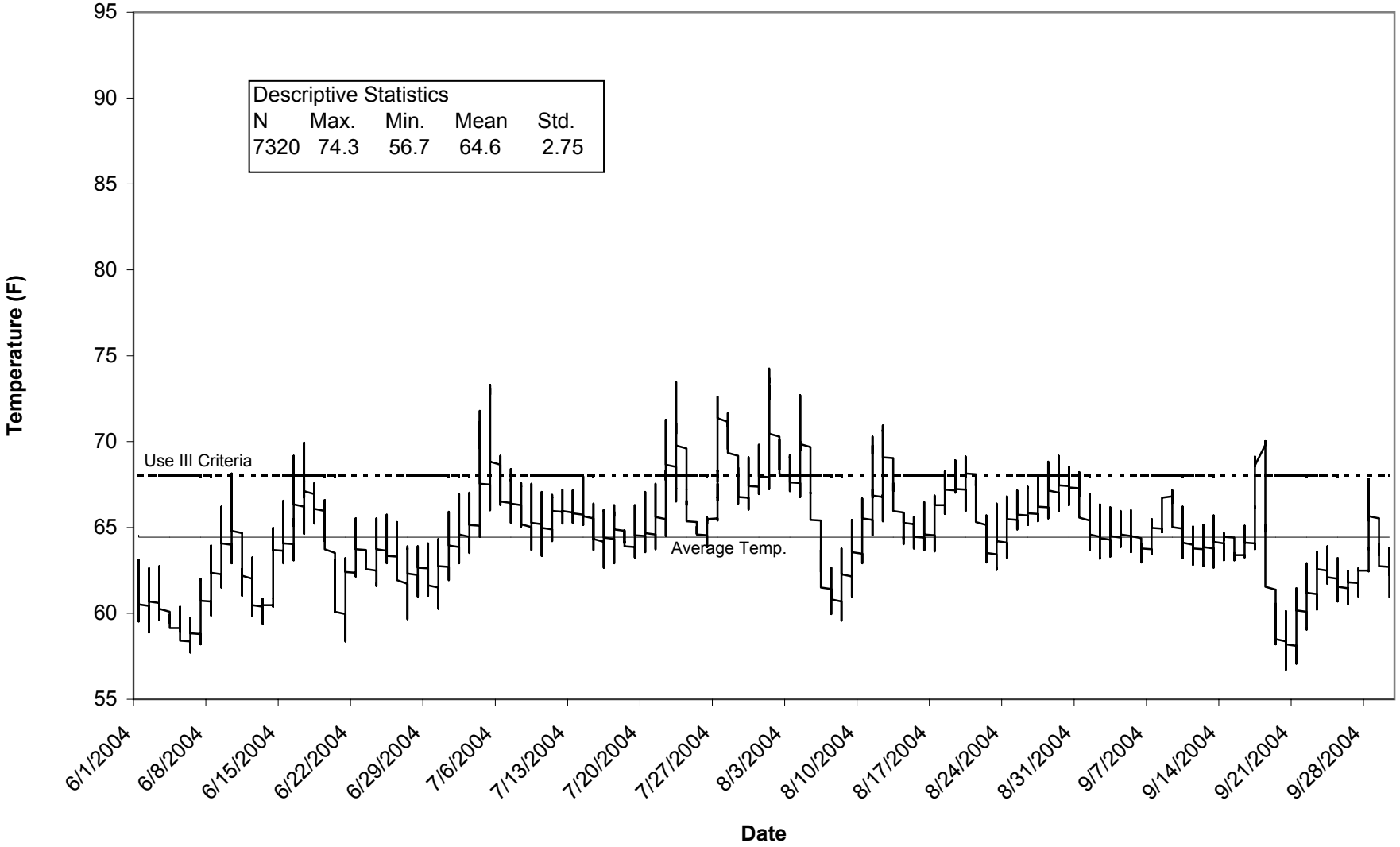
Good Hope Below Ivywood Tributary

Average Temperature = 64.5 ºF
9.09% of readings above 68ºF



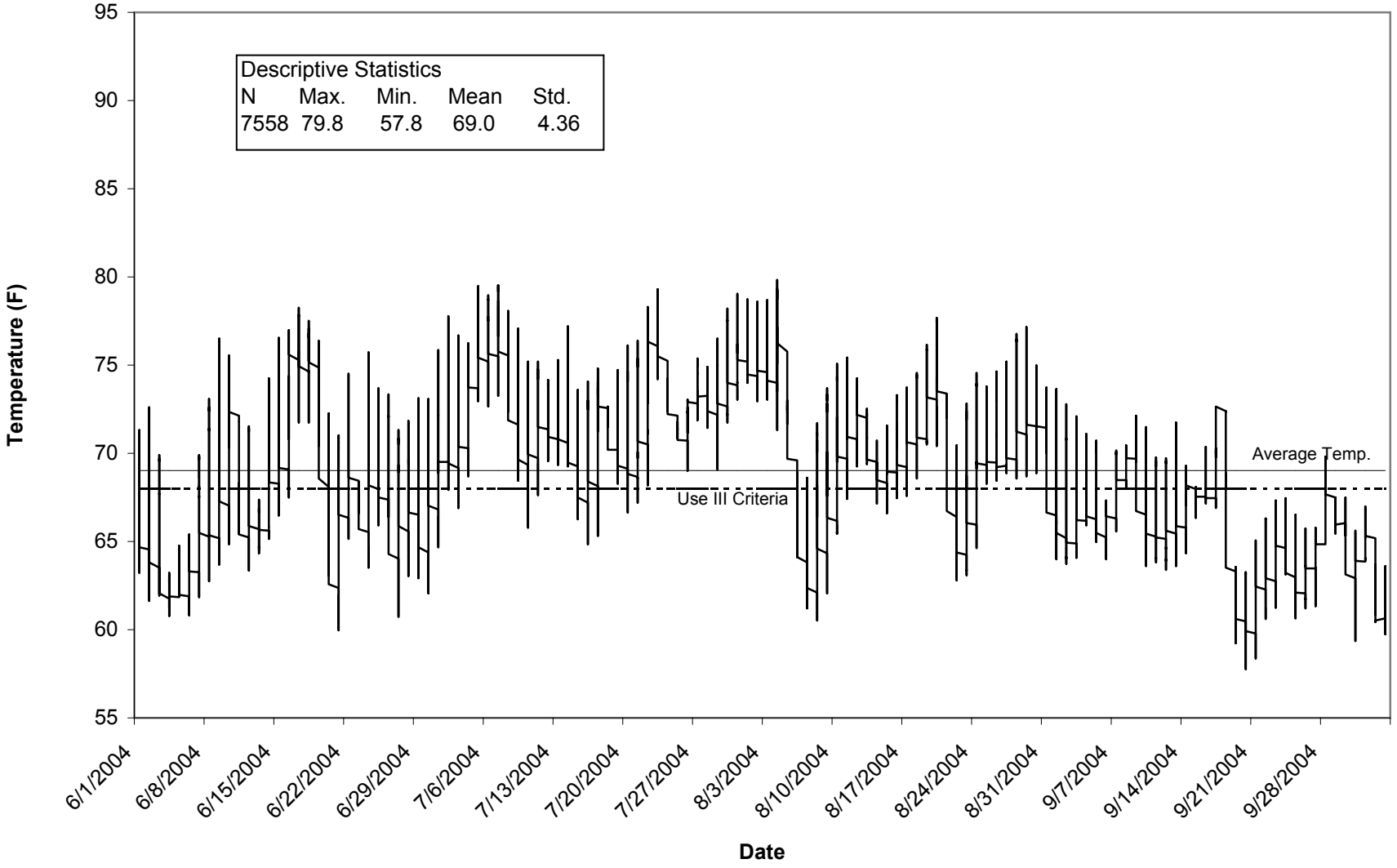
Good Hope Tributary at ICC Crossing

Average Temperature = 64.6ºF
8.76% of readings above 68ºF



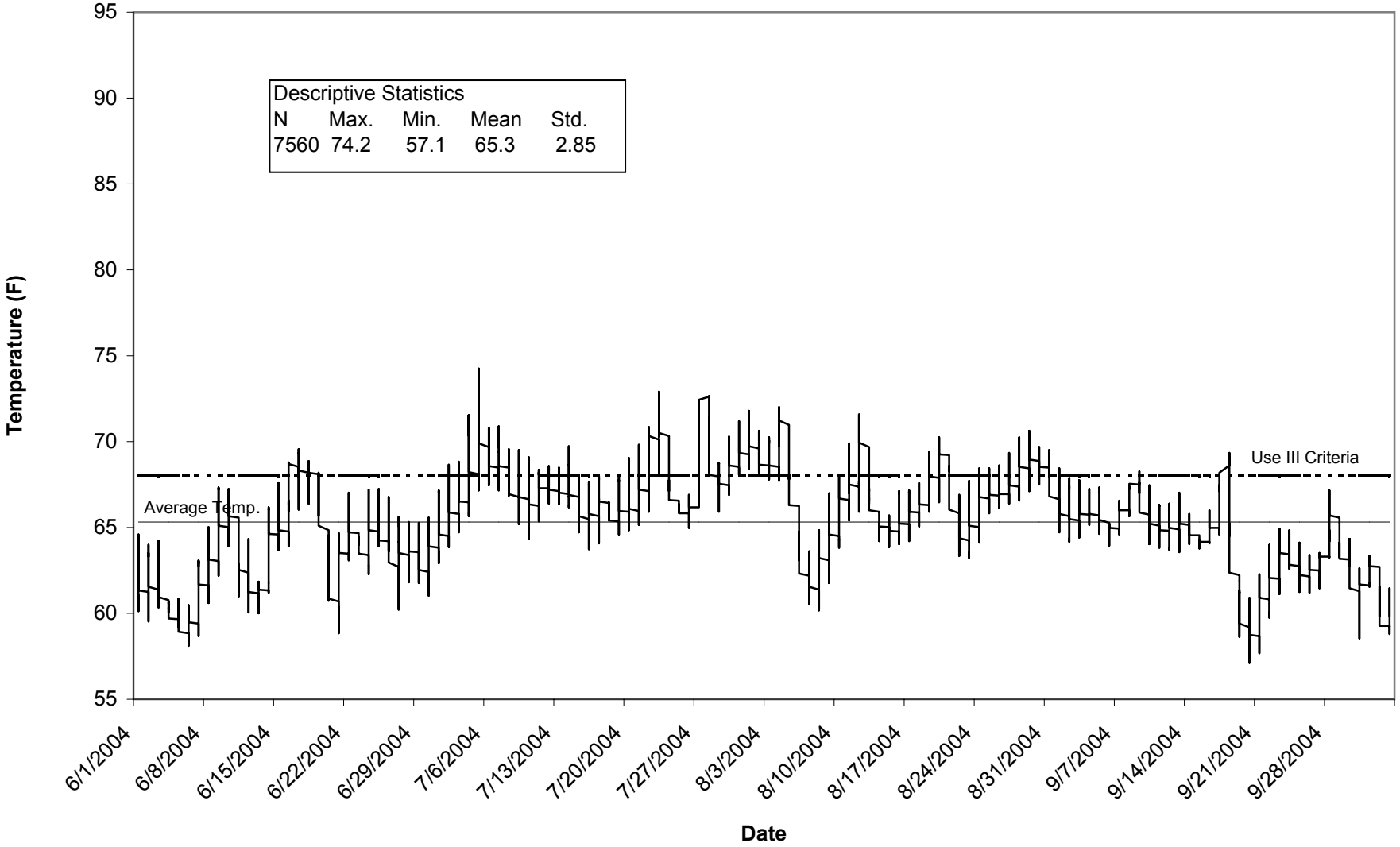
Depot Tributary downstream of seep wetland

Average Temperature = 69.0ºF
58.5% of readings above 68ºF



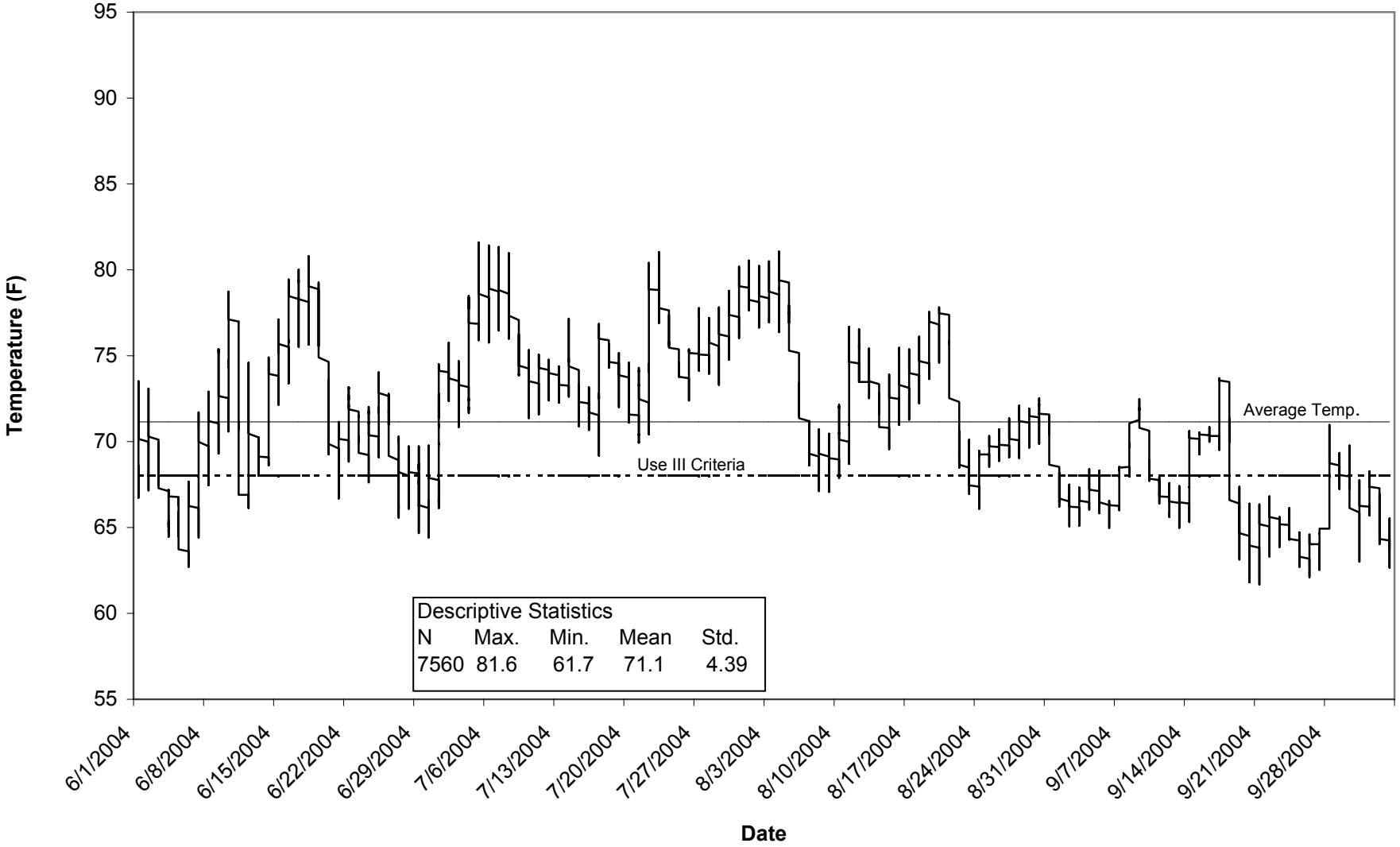
Depot Tributary above confluence with Good Hope

Average Temperature = 65.3ºF
17.7% of readings above 68ºF



Colesville Depot SWM Pond Outlet

Average Temperature = 71.1ºF
72.7% of readings above 68ºF



Air Temperature Monitor on Depot Tributary

Average Temperature = 70.0ºF