1-1-2010

The Coal River Basin: A 2009 Water Budget Study

R. Dale Biller
biller6@marshall.edu

Recommended Citation

Biller, R. Dale, "The Coal River Basin: A 2009 Water Budget Study" (2010). *Theses, Dissertations and Capstones.* Paper 470.

THE COAL RIVER BASIN, WEST VIRGINIA:
A 2009 WATER BUDGET STUDY

A Thesis submitted to
the Graduate College of
Marshall University

In partial fulfillment of
the requirements for the degree of
Master of Science

Physical Science
by
R. Dale Biller

Approved by

Dr. Dewey Sanderson, Ph.D., Committee Chairperson
Dr. Ralph Oberly, Ph.D.
Dr. James Brumfield, Ph.D.

Marshall University, June 2010
]

Abstract

The Coal River Watershed covers an area of some 890 square miles in southern West Virginia of which 863 square miles was investigated in this study. Both online and field data were collected over period from January 13, 2009 to January 13, 2010. The basin was studied as a closed system having an input, which was precipitation, and outputs, rainfall interception, evapotranspiration, and stream discharge that was separated into base flow and overland flow.

The effective rainfall of the watershed was calculated using the Thiessen polygon method to be 42 inches for the year, 48% of that water discharged by the Coal River, 33% intercepted by foliage, and 19% lost due to evapotranspiration.

The stream flow was separated into overland and base flow both manually and using digital filtering. About 60% of the stream discharge is from groundwater and 40% from overland flow. During months of larger rainfall the base flow is less, and for low rainfall months the base flow higher.

Acknowledgements

Dr. Dewey Sanderson
Marshall University
Geology Department
Chair

Dr. Ralph Oberly
Marshall University
Physics Department
Physical Science

Dr. Wathig Abdul-Razzaq
West Virginia University
Physics Department
Introductory Physics Education

Dr. Tom Wilson
West Virginia University
Geology Department
Geophysics

Dr. James Brumfield
Marshall University
Biological Sciences Department
Geobiophysical Modeling

Table of Contents

Background

The Coal River Watershed

Water Budget Factors

The Coal River Watershed Budget

Result Analysis

Data Appendix

Figures and Tables

Background

Introduction

A watershed is an area of land that drains down-slope to a lowest point. The Coal River is a tributary system of the greater Kanawha River Watershed that encompasses a large area of southwestern West Virginia, as seen in Figure 1. The Coal River Basin is approximately 891 square miles. The down-slope drainage pathways form a network that may be on the surface or underground. The natural progression of the water is to converge into larger and larger stream systems. Streams, rivers, and tributaries have associated watersheds and small watersheds converge into larger watersheds. The boundaries of a watershed follow major ridgelines around the stream system and end at the lowest elevation or bottom where the water escapes, commonly called the mouth of the stream.

The connectedness of the basin refers to the physical connection between tributaries and rivers and surface water / groundwater discharge at the stream mouth. In the case of the Coal River system, it has developed a dendritic pattern due to the relatively flat lying Pennsylvanian sedimentary strata. This study will focus on the large and small Coal River watershed boundaries and their tributaries. Some issues have emerged as to the quality of the Coal River water drainage basin but are not treated here.

Figure 1 Location of the Coal River Basin, West Virginia.

The shape and condition largely depend on the geology, climate, and human disturbance. The Coal River Basin is a good example of what human inter-environmental disturbance can do to a watershed. The types of soils in the watershed also depend on the geology, climate, and vegetation within the boundaries of the study area (Arnold, J.G., R. Srinivasan, R.S. Muttiah and J.R., Williams, 1998, pgs. 73-89). These variables along with their distribution determine the type and range.

The Coal River, being in the Appalachian region as a channel system was influenced a long time ago. Climatic conditions can vegetation patterns which affect the movement of water as it flows out of the watershed. For example, the type of soil determines the runoff into the stream and then the capacity of the river. The directional positioning or aspect of the watershed determines the amount of solar radiation the area receives. Other variables such as elevation and latitude influence the timing and amount of the solar radiation, this in-turn also influences vegetation pattern and thus intake and discharge at the rivers mouth. In addition to these variables, the pattern and shape of the landscape are prone to disturbance periodically that can influence stream channel conditions. The Coal River does have a propensity to flood, the basin area is too large for the river to handle at times. Natural disturbances like a forest fire can affect runoff conditions. Small scale disturbances like a patch of trees blown over into the river channel can affect measurements downstream, but will be lumped into an overall discharge of the area for the year taking these affects into account. Short periods of change occur daily in the watershed and have been noted during fieldwork measurements. For example, the river floods quite often and large storms have moved sediment into and out of the main channel. The shape of the stream thus influences the discharge, which is ever changing to frequent flooding conditions.

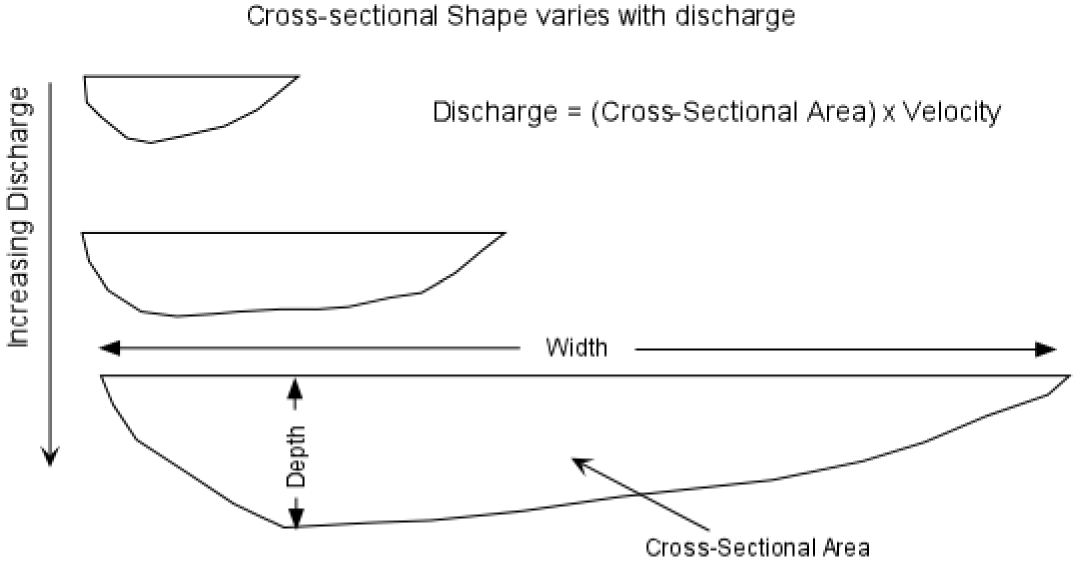


Figure 2 Cross sectional shape variability with position in a stream.

Large floods change the water pattern and create pools that become fish habitats and then they disappear as the channel changes again. The deepest part of channel (thawig) occurs where the stream velocity is the highest, as seen in Figure 2 (Nelson, Stephan A., *Streams and Drainage Systems,* Tulane University, EENS 111, Physical Geology, Catch: http://www.tulane.edu/~sanelson/geol111/streams.htm). Both width and depth increase downstream because discharge increases downstream. As discharge increases the cross sectional shape will change, with the stream becoming deeper and wider. In the Coal River Basin, the timing and intensity of natural disturbance can be uniformly modified by human activity. The urbanization and increased roads change the impervious surfaces and change the routing of water channels enough to influence discharge rates and evapotranspiration measurements. Increased flood occurrence and landslide frequency in the Coal River Basin may be attributable to the majority of the basin population living near the river's edge. The population's location solidifies the channel direction and thus disallows the river channel characteristics to change to an adaptable pattern for the rivers natural flood rate. Invariably, channel gravels build up on point bars and change the river channel course over time. The eco-region of the Coal River Basin is divided into patterns and composition of biotic and a-biotic occurrence that reflect the history of the region which in-turn effect the discharge. These occurrences can be identified as the climate, geology, physiography, vegetation, soil composition, land use, wildlife, and hydrology. The pattern characterization however is limited by the location of the population and therefore pre-measured hydrologic and geologic variability will be used in this study outside of ground temperature, soil moisture content, and rainfall interception.

The Hydrologic Cycle

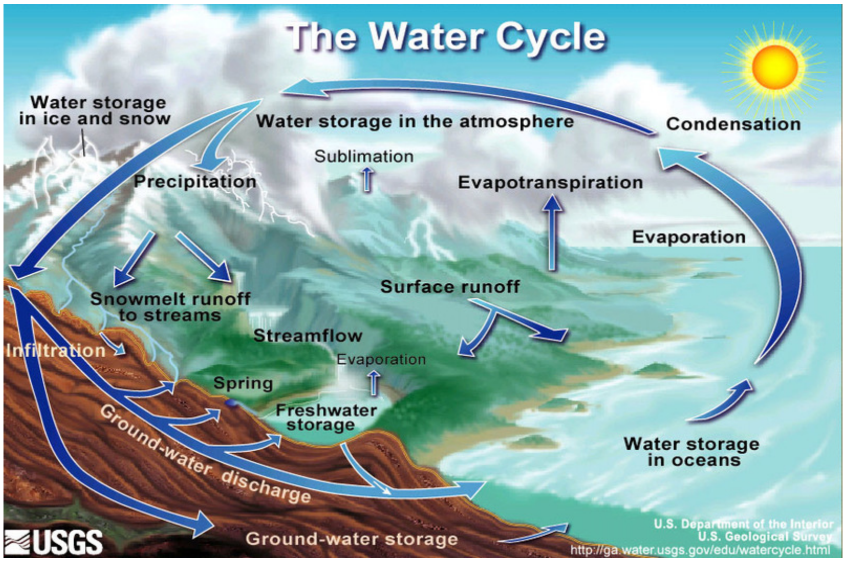


Figure 3 The Water Cycle of the earth.
(The movement of water through the earth and the atmosphere as shown by the United States Geological Survey, Catch: http://en.wikipedia.org/wiki/File:Water_cycle.png).

The hydrologic cycle refers to the circulation of water in the system. The cycle interacts between the earth's surfaces, the atmosphere, and the ocean. The ocean plays a large role in the movement of water as it covers 70% of the earth. The sun creates solar energy which evaporates the ocean and the moisture is carried by the wind. When precipitation falls it reaches the surface of the earth and moves through three pathways:

1. Interception by vegetation and evaporated or transpired back to the atmosphere.
2. Moves down-slope on the surface or through soil to a stream system, eventually making its way back to the ocean.
3. Stored in snowpack, groundwater, ponds, or wetlands for a variable period of time.

The variability of the distribution and movement of water can cause flooding and conversely drought. The water cycle is highly dependent on human interaction for the amount and quality of water.

Water Budgets

"Water Budget" is a term that can have a variety of meanings. The US Geological Survey defines a water budget as an "Estimate of the size of future water resources in an aquifer, catchment area, or geographical region, which involves an evaluation of all the sources of supply or recharge in comparison with all known discharges or extractions." This kind of water budget is sometimes referred as *water balance (Brick, Tim, 2003, et. al.).*

Water-budget studies include inflows and outflows of a drainage basin. The inflows include such things as precipitation, surface water runoff, and groundwater movement. The outflows of a drainage basin include groundwater seepage, spillway discharge, stream flow, and ground water pumping. The change in storage of the groundwater also must be taken into account. The hydro-geologic equation for inflow/outflow measurement is:

Inflow = Outflow +/- changes in storage

For this study, it is assumed that the storage of ground water change is zero over the cycle of a year. The seasonal changes can cancel out any major shifts in groundwater storage. The pumping of groundwater aquifers can change storage data, but is not considered an issue in this study.

The Coal River Watershed

The Watershed Budget

The factors included in a watershed budget should be designed to accommodate the climate of the study area. The Coal River Basin will include the variables that are involved in evapotranspiration on precipitation and comparatively studied against the discharge of the river.

Solar energy from the sun evaporates water from the surface. Vegetation surfaces, ground surfaces, and water bodies exposed to the heat of the sun are all susceptible to evaporative processes. Evaporation rates can increase or decrease with air, air temperature, humidity, and wind variability in conjunction with solar radiation. The loss of water to the atmosphere through living plants is called transpiration. So, the measurement of water in the Coal River basin is highly dependent on the combination of evaporation and transpiration to form evapotranspiration and is commonly referred to as the ET of an area of land. The anticipation of precipitation to drainage for the Coal River can be expected to be in the higher percentiles due to the high humidity of the area. The vegetative cover of a watershed controls the amount of evaporation, transpiration, and intercepted rainfall. Human activity generally decreases vegetative cover increasing the water discharge of a region.

The intensity of precipitation is usually less than infiltration into pervious soil layers, so most precipitation is absorbed into the soil rather than forming runoff. The opposite applies to particularly heavy or intense rainstorms. Heavy rainstorms can also decrease rainwater interception measurements. The resistance of runoff conditions can be found in watersheds with steep slopes, thin soils, or even disturbed watersheds with impervious surfaces as stated in the Oregon Watershed Enhancement Board's manual (*Oregon Watershed Enhancement Board, 1999, pgs. 3-26).* Land usage does increase infiltration rates due to the exposure of the top surface layer and lack of disintegrated foliage cover. Water infiltrates vertically and percolates downward into groundwater system.

The ground water that enters the river becomes surface water and then becomes a component of the total discharge of the river. Most days a stream is discharging much less than its capacity. The dry season will typically have less discharge. A stream depends on the hydraulic gradient and the transmittance of water from ground storage for recharge or discharge of water into the river channel. A losing reach is a stream losing water to groundwater storage and a gaining reach recharges the stream flow. The groundwater storage change measurement is considered to be zero for West Virginia, meaning we usually have equal parts gaining and losing for the year, not necessarily for a season though (Fetter, C.W., 2001, pgs. 15-28). Soil permeability and hydraulic gradient control the exchange of gaining and reaching streams and are highly dependent on the water table height and flooding occurrence. The storage of water can come from seasonal snowpack, groundwater storage, and surface water bodies such as ponds, lakes, rivers, wetlands, and reservoirs. The spring runoff is from snow packs and summer base-flows are from groundwater discharge into streams during drought conditions.

The goal of any forest is to yield just enough water loss in the environment to sustain the area and help grow the demand for new species precipitation (Department of the Interior, U.S. Geological Survey, 2008, et. al.).

Wetlands counteract this method with the actual evapotranspiration rate equaling. The ability of the soil to hold water ultimately decides when the wetland dries up or maintains its ecosystem.

Percolation helps maintain the balance between a saturated wetland and a flooded wetland. The dry ecosystems of the world experience higher evapotranspiration than precipitation. In this case and no other, evapotranspiration can actually be greater than potential evapotranspiration because of the lack of water in the ecosystem and the slow transpiration of the vegetation (Department of the Interior, U.S. Geological Survey, 2008, et. al.).

Foliage provides much surface area for water to evaporate from. Evaporation occurs when the number of molecules transforming to gas exceeds the number of molecules transforming to liquid. This process reacts with the environment when the vapor pressure of the liquid water is proportional the air temperature. When the atmosphere becomes saturated the process will end until more available space in the atmosphere is generated through a change in temperature due to the suns movement, wind variability, or changes in the barometric pressure of the local environment. The wind increases molecular diffusion and keeps the humidity low. The volume of the space taken up in the atmosphere and the quantity of water in that space is called the absolute humidity. The atmosphere can only hold so much water at any given temperature until it reaches saturation. The relative humidity is equal to the percent ratio of the absolute humidity to the saturation humidity. Therefore, when the relative humidity reaches 100 percent the atmosphere is saturated. The all too familiar "dew point" is a function of saturation and causes condensation on our windows in the evening and nighttime hours in the summer.

The proportional nature of the temperature/saturation boundary allows the saturation humidity to drop as the temperature drops (Kohler, M.A., Nordenson, T.J., Fox, W.E., 1955, et. al.). Condensation releases calories of and evaporation absorbs calories of heat. They work in conjunction as the atmosphere and environment changes over a day, a season, and a year.

Impact of Development

The chemical and biological pollution of the Coal River has been an ongoing problem since the river watershed has become more populated. This population increase since the end of World War II helped introduce the area to further extensive timber and coal operations that have decimated the watershed through the environmental exposure of chemical and biological pollution. The mining operations are characterized by underground mining, surface mining, and mountaintop removal. The timbering industries activities increase surface runoff of the river basin and carry the rainfall directly into the river, not allowing for subsurface conductivity filtration and the slow regulation of ground water. These variables have affected the microscopic life of the river (Doyle, M. P., and M. C. Erickson. 2006 & Rahman, Farhana Alamgir; A; R; S 2004). The chemical exposure of the watershed brought on by industry has decreased the level of microorganisms that help the ecosystem thrive and perform the natural cycle of life. The biological exposure of the valley has increased the harmful microorganisms of the watershed and has lead to a decrease in human health in the valley (Doyle, M. P., and M. C. Erickson. 2006. *"Closing the door on the fecal coliform assay."* *Microbe* 1:162-163. ISSN 1558-7460).

. Currently, there is a new sewer system being installed in the lower valley where the concentration of population is highest which should help decrease the levels of coliform bacterium. Unfortunately, work has begun on a new mining operation in the upper tributary range of the watershed. Over time, with ongoing regulation, hopefully the impact on the environment will lessen from these industrial processes and the modification and upgrade of the sewer treatment services will act accordingly.

Groundwater Discharge & Recharge

Ground water recharge of the Coal River watershed occurs through infiltration and percolation of rainfall. Surface runoff and subsurface inflow are included in discharge averages for the river. Beyond the scope of this study is the consideration of groundwater that may flow into or out of the basin from adjacent watersheds. Since the strata is relatively flat lying, the loss or gain would not be expected to be significant.

Water Budget Factors

Land Cover & Leaf Cover

The influence on the amount of precipitation that reaches the ground to enter the water table containing depends on the use of the land. The forested areas tend to have more leaf cover which can catch the rain before it reaches the ground and evaporate back into the atmosphere.

The more development in an area the greater chance of runoff directly into the river, which can increase discharge numbers over a given time period.

Geology of the Coal River Basin

The Coal River basin geology is flat lying Pennsylvanian bedrock approximately 300 million years old and is part of the Carboniferous period. The name Carboniferous derives from the fact that most of the important coal producing rocks are of this age. The late Carboniferous period produced most of the coal reserves found in the Coal River basin. The coal deposits were laid down, the coal being formed from compressed layers of rotting vegetation.

By the Late Carboniferous the continents that make up modern North America and Europe had collided with the southern continents of Gondwana to form the western half of Pangaea. Ice covered much of the southern hemisphere and vast coal swamps formed along the equator. Boone County, which lies within the Coal River Basin, has the highest output coal production in the state. Both surface and underground mining methods are in practice.

Effective Rainfall

The Thiessen polygon method in this study is performed using areas of influence for rain gauging stations. The polygon method is used as described by C. W. Fetter in Applied Hydrogeology (Fetter, C.W., Applied Hydrogeology, Fourth Edition, 0-13-088238-9. 2001, Ch. 1-4). The following formula is given by the N.R.E.M. An [arthritic →arithmetic] mean of all rain stations could have been used, along with the contour method, but required more time. The contour method uses rain gauge values to form a isohyetal map. The weighted average of the contour method is more accurate than either of the other methods, but requires each storm to be contoured to measure each weighted average.

Rain Gauge Map

In Figure 4, below, rain gauge stations are blue, the Tornado discharge station is green, and polygons are drawn for areas of influence. The polygon north of the discharge station was not used in this study because the water past the station is unaccounted for. The precipitation of each rain gauge within the watershed boundaries are measured by what is called *Effective Rainfall*. A breakdown using polygons following the laws set forth by (Fetter, C.W., Applied Hydrogeology, Fourth Edition, 0-13-088238-9. 2001, Ch. 1-4) was used. A total rainfall for the watershed was calculated using the area of influence and daily precipitation

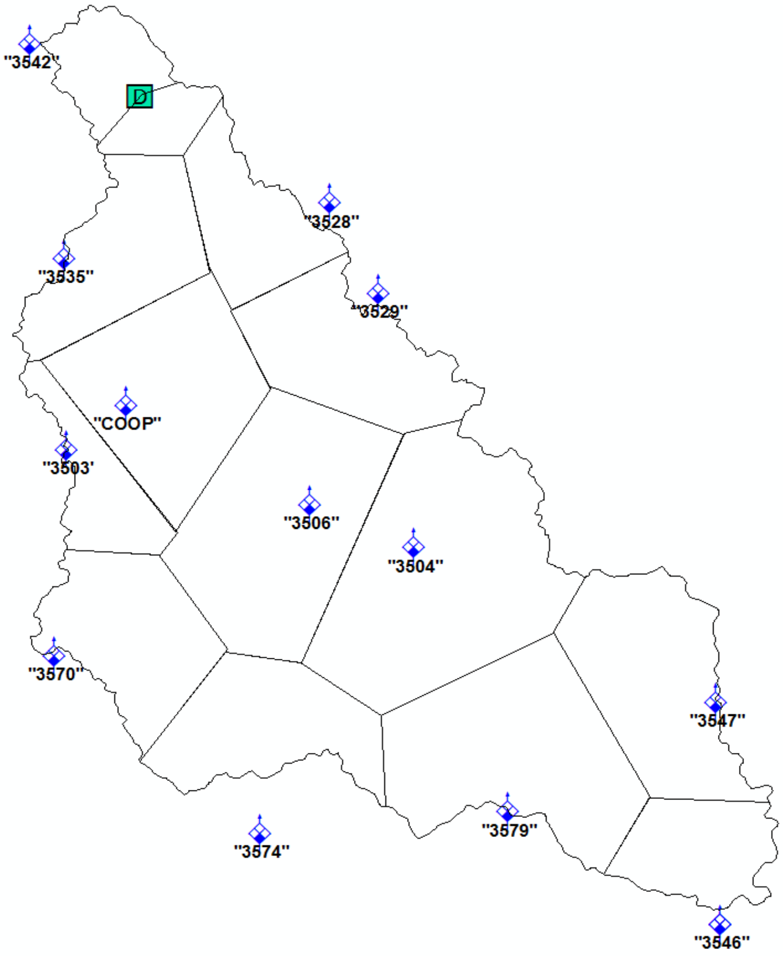


Figure 4 A rain gauge map of the Coal River Basin as used in this study (Compiled and drawn by the author in ArcMap).

(Natural Resources and Environment Management, *"Effective Rainfall"*, http://www.fao.org/docrep/x5560e/x5560e03.htm)

1. *"That part of precipitation that reaches stream channels as direct runoff".*
2. *"In irrigation, the portion of the precipitation that remains in the soil and is available for consumptive use*" (Glossary of Meteorology. http://amsglossary.allenpress.com/glossary/search?id=effective-precipitation1)

Transpiration

Transpiration is essentially water being released to the atmosphere through the leaves of plants through the evaporation of the plant's moisture. This water is brought up from the groundwater soil moisture and accounts for about ten percent of the total atmospheric water content on the earth (Cummins, Benjamin, 2007, pg. 215). The other ninety percent of atmospheric water comes from oceans, seas, and other water bodies such as streams, rivers, and lakes. An average transpiration rate will be estimated in this study. These rates will then be given a yearly average based on temperature, humidity, wind and air movement, and soil moisture. The transpiration of water by plants into plastic bags is a good way to estimate transpiration, as seen in Figure 5. Although, the transpiration for this study used unaccounted water leftover after the calculations were finished.

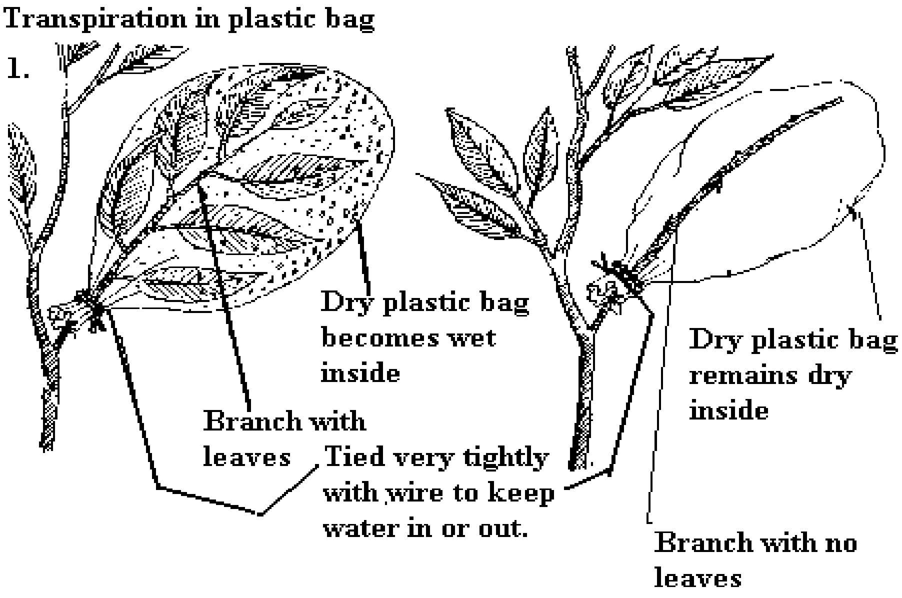


Figure 5 A method of measuring transpiration (Cummins, Benjamin, 2007, pg. 215).

Evapotranspiration

Evapotranspiration is the total evaporation and transpiration from the ground surface and foliage surface to the atmosphere (Fetter, C.W., 2001, pg. 15-28). When water moves to the atmosphere it travels there from the soil, from the vegetation, and from the water body surfaces. An object or surface that helps this movement is called an evapotransirator.

Potential evapotransiration is the total evaporation and transpiration from the ground surface to the atmosphere if there is sufficient water available. The difference between Potential Evapotranspiration and Actual Evapotranspiration is focused on the ability of the lower atmosphere to transport the evaporated water from the storage area after evaporation and transpiration has occurred. The Potential Evapotranspiration measurement is higher in the warmer months of the year. The solar radiation levels rise in the summer which helps evaporation.

Actual evapotranspiration is the amount of evapotranspiration that happens under field conditions and is commonly found to be lower than the potential evapotranspiration of a given study area (Fetter, C.W., 2001, pg. 15-28). The evapotranspiration of a watershed can measured using a formula of the different measurements involved. A soil-type profile should be made with a measurement of soil moisture content and an overview of the vegetation area using the type, size, and proportionality percent during the growing season. The formula is as follows (Fetter, C.W., 1988, pg. 15-28);

$$E.T. = S_i + P + I - S_f - D$$

Where:

S_i = Volume of the highest soil moisture
P = Precipitation
I = Runoff water
S_f = Volume of final soil moisture
D = Discharge

If the hydrologic field capacity of the watershed is met throughout the year, the measurements will be the potential evapotranspiration. Otherwise, if the hydrologic field capacity of the valley reached a wilted-soil level in the drier months during summer (a drought) the measurement should be considered the actual evapotranspiration. There is some uncertainty about the potential and wilting point measurements. It is surmised that the potential point of measurement remains until wilting begins. These variables will be taken into account for this study as the process continues, but will be judged actual or potential at the end of the study dependant on the seasonal progression.

The cold months of the year affect the evaporation of the watershed the same way that the discharge rates are affected: the slow melt process. Although, evaporation numbers drop in the winter months, there can be significant evaporation events when the environment warms within the cold season.

The warm and hot months of the year experience evaporation through its many components at high rates. The hot temperatures accelerate the rates of evaporation through temperature and sunlight radiation and have more available surfaces that include the leaves of living foliage.

Interception

The canopy of the vegetation can intercept rainfall from reaching the ground and reduce the gross overall rainfall from reaching the ground. This process is called rainfall interception (David, J.S., Valente, F. and Gash, J.H.C., 2005, pg. 627-634).
Rainfall interception allows rain to evaporate directly back into the atmosphere and creates an interception loss of moisture from the ground surface. A canopy storage capacity can be reached above which a large percentage of the rainfall becomes runoff. In months where no canopy exists, much more rainfall reaches the ground.

The conversion of a 16th of an inch measurement from the lowest location inside the bottom of a soda can converted to milliliters in a graduated cylinder. The calculation is from field data collected in the Coal River Basin, as seen in Figure 6. The plot is a rainfall calibration curve for the 12 oz. beverage cans measured by 16th's of an inch and converted to milliliters.

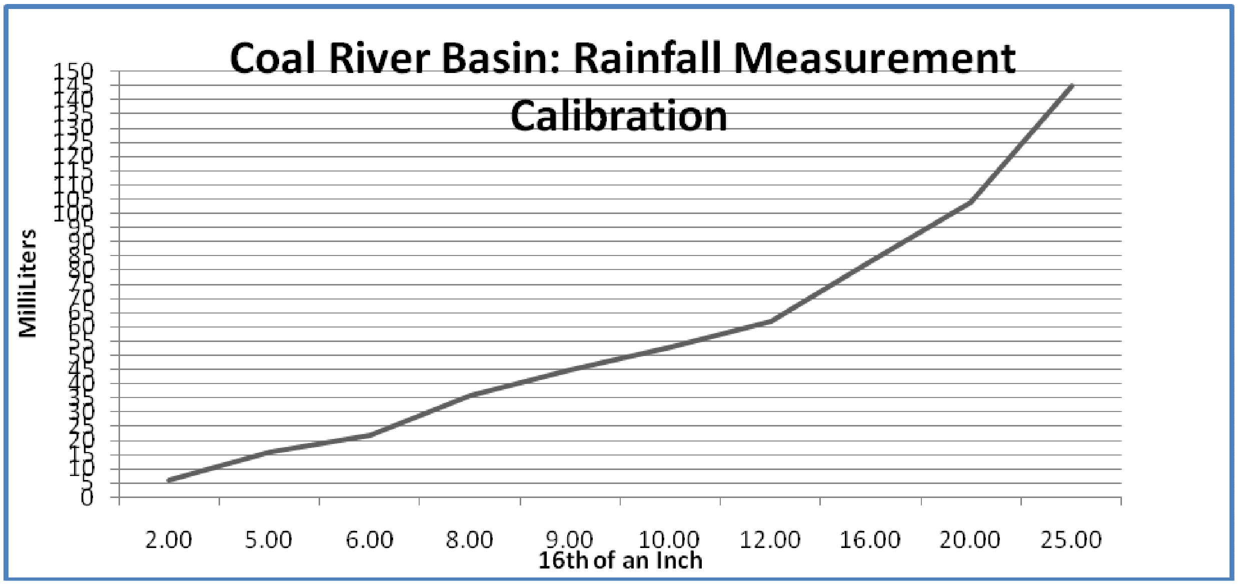


Figure 6 Calibration curve for rainfall collection (As done by author).

Interception depends on three main factors: the distribution and intensity of the rainfall including wind speed, vegetation type, and the canopy storage capacity. The aerodynamic roughness of the surface area also affects the evaporation rate. For example, the forest has a much higher interception rate than low lying vegetation. The conductance rate rises when more surface area is exposed to more elemental conditions. The gross rainfall affected by interception can be as high as sixty percent. Frequent small storms cause more overall gross rainfall loss than large storms over a longer time period. Field interception numbers were collected in cans, as seen in figure 7.

Figure 7 A can used in the field collection of rain water in the Coal River Basin 2009 (Picture taken by author).

Temperature

Seasonal: Soil & Air

The seasonal changes in soil and air temperature affect the evapotranspiration and discharge of the Coal River Basin. The basin is located in a four season area, as is all of West Virginia. The temperature ranges in the basin can go as high as one hundred degrees and reach lows of minus 15 degrees or more.

Ambient air temperature plays a large role in the evaporation of the watershed. The tributaries have cooler water than the main channel. The rule of specific heat applies here, with the air temperature higher than the tributary water temperatures. The inflow of groundwater and the cooling process of evaporation follow the daily change in air temperature. Therefore, it can be assumed that the maximum daily water temperature of the basin occurs in the late afternoon and the minimum daily temperature of the water is in the early morning hours. The total heat received in the basin and the amount of water heated creates the warmest water temperature. This would mean the highest water temperatures would be in the low flow region of the summer with the same annual heat received.

Influence on Discharge

The most immediate impact on discharge in the valley is snowfall. When snow reaches e ground it may lay there for long time periods of below freezing weather, which holds the precipitation from the river to a minimum until the thaw of the frozen precipitation.

Stream Flow

A stream gauging stations is provided [to→ for] the Coal River watershed area by the United States Geological Survey (USGS) (**waterdata.usgs.gov**/usa/nwis/uv?site_no=03200500). They record the discharge of the river and are collected as water resource data. The resource data includes: the mean values for the daily, monthly, and annual flows, annual instantaneous peak flows or the largest annual flow, and the annual minimum flows. Stream flow data can also be found at the National Oceanic and Atmospheric Administration's National Weather Service or NOAA water section. This site provides an abundance of information. The summery of data can be displayed in many ways. One example is a hydrograph, which is a summary of stream flow over time. The measurements are taken as mean monthly flow and discharge values of the region. It is expected that the quantity of water flowing through the river channel will vary by several orders of magnitude from month to month or day to day. The shape of the hydrograph will be a curve and is a type of identification of the watershed

Overland Flow

Overland flow is the water that crosses the terrain down slope to streams and rivers that eventually get discharged by the river system. This water comes from precipitation in the form a rain and snow. It takes roughly a day for the discharge to peak after a rainstorm event.

The snow melt on the Coal River basin could produce short peaks in discharge rates in the snow-melt season, but the basin area wasn't subject to much annual snowfall. Peaks in discharge can occur when a storm passes through the basin area and is measured by the gauging stations. The measurements taken for stream flow at the gauging stations can be measured for this study, but the annual discharge of the watershed through the Coal River to Tornado, WV will be one focus measurement for this study. Because of the thick clay soil of the Coal River basin, the hydrograph for this area should be a smooth curve. Other watersheds with thin soils and limited water retention values would have steep curves illustrating the rapid runoff. In this study, the runoff is delayed and the curve reflects the slow percolation of water into the soil. A comparison to the recent statistical past should have some clues as to what is occurring in the Coal River basin and what to expect in the future. [The statistics of this study should reveal the water availability of the region. OUT]

The hope is that it increases the knowledge of flood and drought probabilities. When a flood passes through the watershed it changes the stream channel shape and can impact the floodplain. When the area experiences a drought, the vegetation and organisms that depend on the watershed for survival suffer from a lack of soil moisture and a supply of water. An analysis of the evapotranspiration rates can help with the determination of an extreme event in the valley. The occurrence of extreme events can be better predicted in this way.

Interflow

Interflow is the lateral movement of water in the unsaturated zone or the vadose zone that directly runs off into a body of water without first being surface runoff as with through-flow. It occurs above the base flow and is therefore is faster to reach streams or rivers than base flow, but slower than through-fall.

Base flow

Base flow is the portion of the stream delayed entry of storm water into the stream that comes from the aquifer seepage. That is the portion of the stream flow that is caused by precipitation events.

Recession Constant

The base flow recession constant is a hydromorphic characteristic of a watershed area, as seen in Figure 8. The recession of the base flow over time in a dry weather event is a function of topography, drainage pattern, soils, and the geology of the watershed bedrock. The recession constant uses the base flow at the start of recession and determines the rate at which the base flow slows over a given time period. The following formula is used to measure this constant.

$$Q = Q_o(e^{-at})$$

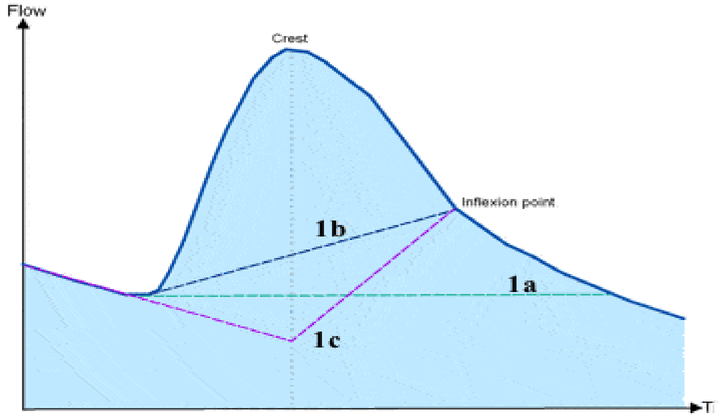


Figure 8 A diagram of the base flow recession constant during a peak stream flow event. The diagram shows base flow vs. surface runoff (University of Texas, “*Base Flow Recession*” Catch: http://www.crwr.utexas.edu/gis/gishydro03/LibHydro/libhydro/baseflow.htm, Feb. 11, 2010).

The equation given by (Fetter 2001) is as follows;

$Q = Q_o e^{-at}$

Q = flow at some time after recession
Q_o = flow at the start of recession
a = a recession constant for the basin
t = time since the start of the recession

Web-Based Hydrograph Analysis Tool (WHAT)

"Web-Based Hydrograph Analysis Tool (WHAT), which separates hydrographs into runoff and base flow. This page also provides a way to select USGS gauging stations using an interactive map, and calculate statistics of model simulations" (Purdue University. *"Web-Based Hydrograph Analysis Tool (WHAT)"*, Catch: http://www.ces.purdue.edu/waterquality/GIS.htm, Feb. 11, 2010)

The Coal River Watershed Budget

Water Balance

"The water balance is an accounting of the inputs and outputs of water. The water balance of a place, whether it be an agricultural field, watershed, or continent, can be determined by calculating the input, output, and storage changes of water at the Earth's surface. The major input of water is from precipitation and output is evapotranspiration" (The University of Wisconsin Stevens Point, *"Water Balance"*, Catch: http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/hydrosphere/waterbalance1.html, Feb 11, 2010)

The Coal River watershed has a discharge station in Tornado, WV and [captures→records] the discharged water of 862 square miles. [of territory OUT]. This discharge calculated from January 13 2009 to January 2010 will be compared to the total precipitation of the coverage area minus collected field data percentages for evapotranspiration. These numbers should give a clear indication of the water gained or lost over the stated calendar year.

Result Analysis

Monthly Precipitation

The discharge of the Coal River Basin @ Tornado, WV as provided by the United States Geological Survey measured in cubic feet per second, as seen in figure 9 (United States Geological Survey, *USGS 03200500 COAL RIVER AT TORNADO, WV,* Catch: http://waterdata.usgs.gov/usa/nwis/uv?site_no=03200500, Feb. 22, 2010, et. al.)

"**LOCATION.--**Lat 38°20'20", long 81°50'30", NAD 27, Kanawha County, Hydrologic Unit 05050009, on downstream side of highway bridge at Tornado, 0.2 mi upstream from Falls Creek, and at mile 11.5.".

"**DRAINAGE AREA.--**862 mi^2, includes that of Falls Creek".

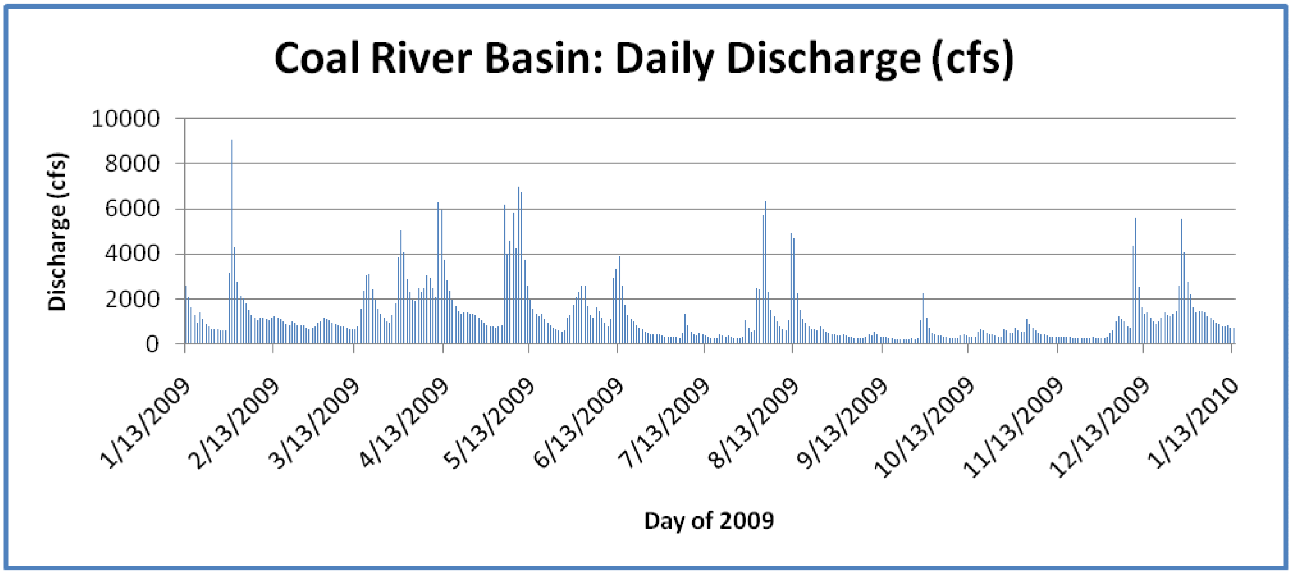


Figure 9 Discharge of the Coal River Basin 2009 in cubic feet per second (As done by author).

Monthly Breakdown (Cubic Feet per Day)

The monthly precipitation here will be represented in cubic feet per day. This study began and ends on January 13 of each year, so the precipitation numbers reflect only a portion of January, as seen in Figure 10.

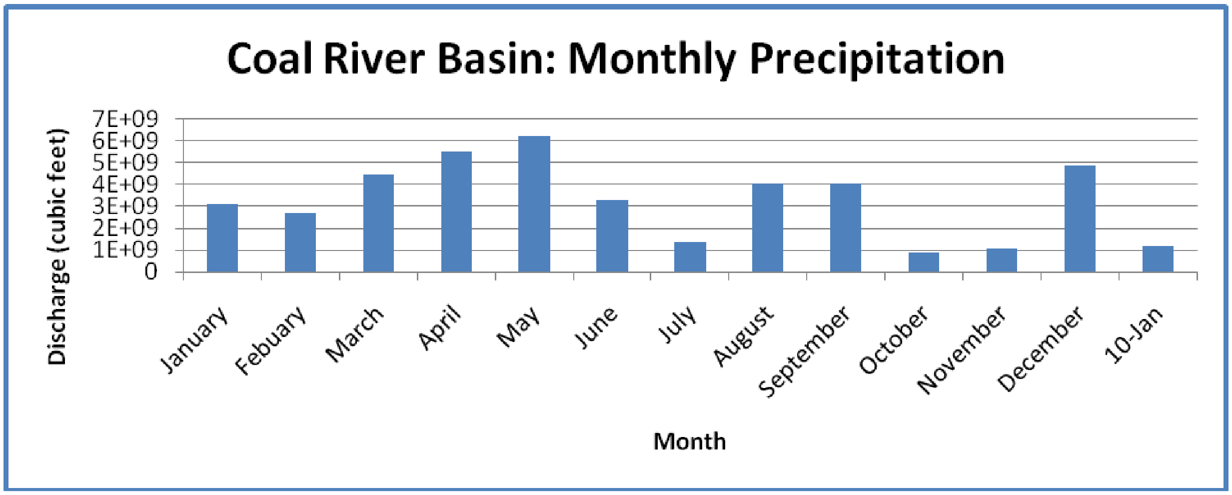


Figure 10 This is the monthly precipitation in the Coal River Basin 2009.

Monthly Intercepted Precipitation

The first graph analyzes the rain water interception by season. The role of leaf cover has a large influence on interception numbers, but rainfall intensity, wind, slope, and other factors also play a major role in the amount of water that actually reaches the ground as will be seen in the monthly statistics, as seen in Table 1.

Table 1 Interception % by Month.

January	18.7
February	18.7
March	59.0
April	52.0
May	63.3
June	65.9
July	64.7
August	65.6

September	58.5
October	62.6
November	30.6
December	18.7

The rainwater interception for January and February are assumed to be equal to winter conditions and therefore were interpolated from the December measurements, but were not collected in the field. The number of total rainfall events affects the average of the monthly totals, as seen in Figure 11.

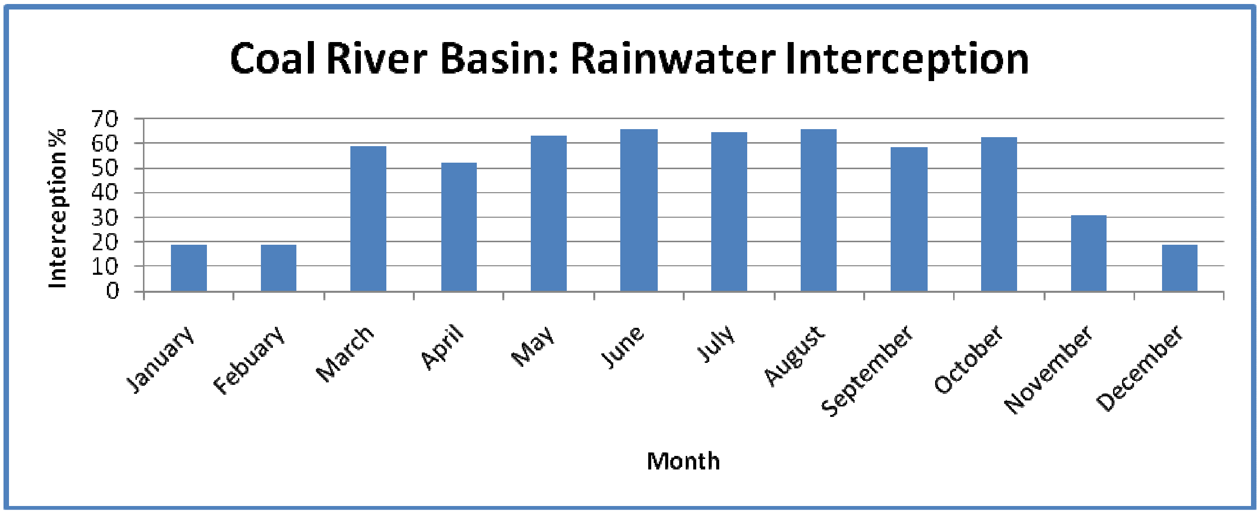


Figure 11 Rainwater interception by forest covers 2009.

Land Cover Precipitation Influence

The analysis of land cover by area statistics using 7 and a half minute quadrangles provided by the WVGIS Tech Center was generated by ER Mapper in an Unsupervised Classification for color analysis have given an 69% forested coverage with 31% residential and industrial use which can increase runoff by a lack of interception variables to catch rainwater before reaching the ground. The total precipitation for the year will have 31% unaffected by interception and minus the monthly precipitation totals as given by month interception, as seen in Table 2.

Input Rainfall = $8.8426 \times 10^{10} \times .31$
= 2.8×10^{10} unaffected

Table 2 This is a calculation of forest coverage and intercepted precipitation in 2009.

Month	Precipitation	69%	interception	After Int.	Avail.
January	2979029105	2055530083	18.7	0.813	1.7E+09
February	1815336196	1252581975	18.7	0.813	1E+09
March	5900227169	4071156747	59	0.41	1.7E+09
April	6035162489	4164262118	52	0.48	2E+09
May	13060060543	9011441775	63.3	0.367	3.3E+09
June	8504580925	5868160838	65.9	0.341	2E+09
July	12869699326	8880092535	64.7	0.353	3.1E+09
August	11074238295	7641224424	65.6	0.344	2.6E+09
September	7813555886	5391353562	58.5	0.415	2.2E+09
October	4555727479	3143451960	62.6	0.374	1.2E+09
November	1768820012	1220485808	30.6	0.694	8.5E+08
December	8044314188	5550576790	18.7	0.813	4.5E+09
Jan-10	268163441.1	185032774	18.7	0.813	1.5E+08
				Total	2.8E+10

Total Precipitation Unaffected by Interception + Diminished Rainfall after Interception

$1.0671 \times 10^{10} + 3.5 \times 10^{10}$
Total Precipitation Available = 4.596E+10

Leaf Cover

Leaf cover was determined by sight through observations while collecting intercepted rainwater. A scale of 1 through 10 was used meaning 10 as complete leaf cover to 1 being very little leaf cover. December, January, and February were determined to have no leaf cover, as seen in Figure 12.

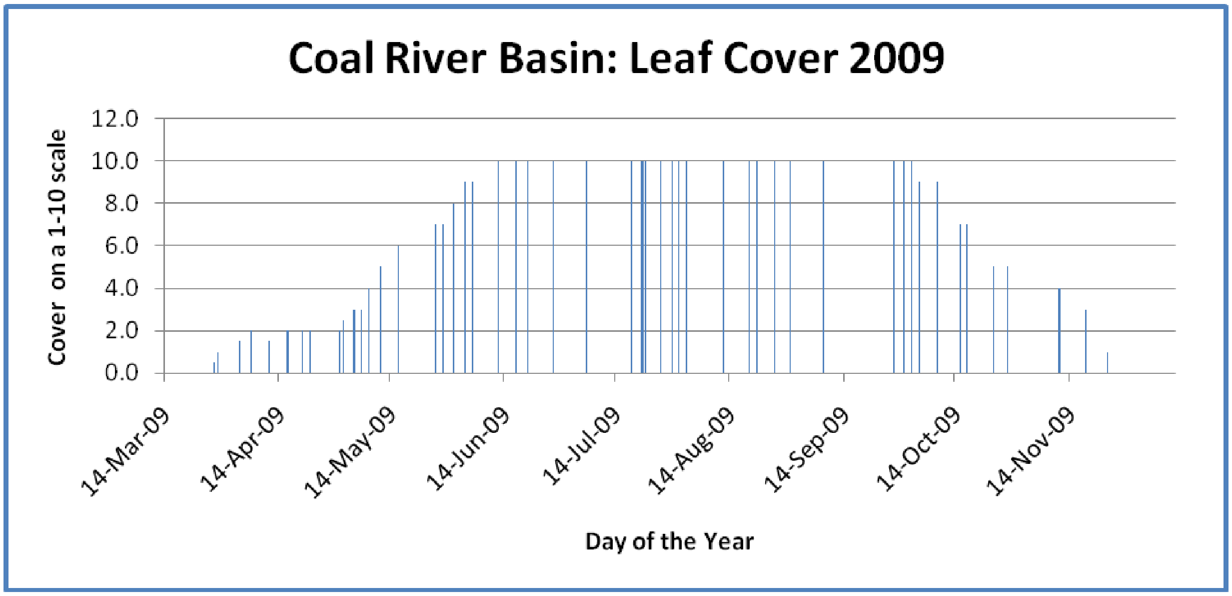


Figure 12 This is leaf cover on a 1-10 scale for the months of 2009.

Ground Temperature

The temperature of the ground was measured using a standard temperature thermometer. The data was collected on trip to retrieve soil for moisture content evaluations, as seen in Table 3.

Table 3 The ground temperature measurements for the Coal River Basin 2009.

Month	Degrees F
March	45.3
April	47.7
June	56
July	66.3
September	59.7
November	50.3
December	44.7
January	30

The ground temperature reacted just as to be expected. The winter temperature in degrees F averaged about 30 to 32 degrees for the basin and reached a high of about 67 degrees F in mid-summer.

Base Flow

The base flow for the Coal River basin was determined using three methods as given by the Web-Based Hydrographic Analysis Tool program (W.H.A.T.) and a manual method using the runoff equation $D = A^{0.2}$ which correlates to 4 days of runoff for the Coal River basin before river discharge (Q) is totally base flow (Lim, K. J., Engle, Z., Choi, J., Kim, K., Tripathy, D., *AUTOMATED WEB GIS BASED HYDROGRAPH ANALYSIS TOOL, WHAT,* Catch: http://cobweb.ecn.purdue.edu/~what/faq/Automated_Web_GIS_based_Hydrograph_Analysis_Tool_WHAT_JAWRA_Dec_2005.pdf, Feb 21. 2010, et. al. and Fetter, C.W., Applied Hydrogeology, Fourth Edition, 0-13-088238-9. 2001, Ch. 1-4).

The base flow as measured by the WHAT program is given by three examples in graph form below. These methods were used for environments dissimilar to the conditions in the Coal River basin but are good comparisons to the manual method for determining base flow discharge. The models use formulas that are unique to the environments for which they were meant to be measured and most likely depend on unique geological variables in their given area of use. The following formulas were used in Excel to calculate base flow for each method, as seen in Table 4. Figure 15 is a comparison of the Lyne Filter and the manual method and the other filters in comparison to overland flow and base flow can be found in figures 14, 15, and 16.

Formulas: W.H.A.T. program

Each given formula below was used for each base flow digital filtration method from the "W.H.A.T. "program.

Lyne & Hollick 1979

$$q_t = \alpha \times q_{t-1} + \frac{(1+\alpha)}{2} \times (Q_t - Q_{t-1})$$

qt is the filtered direct runoff at the t time step (m3/s)

qt-1 is the filtered direct runoff at the t-1 time step (m3/s)

α is the filter parameter

Qt is the total stream flow at the t time step (m3/s)

Qt-1 is the total stream flow at the t-1 time step (m3/s)

Chapman & Maxwell, 1996

$$b_t = \frac{\alpha}{2-\alpha} \times b_{t-1} + \frac{1-\alpha}{2-\alpha} \times Q_t$$

bt is the filtered base flow at the t time step

bt-1 is the filtered base flow at the t-1 time step

α is the filter parameter

Qt is the total stream flow at the t time step (m3/s)

Eckhardt 2005

$$b_t = \frac{\left(1-BFI_{\max}\right) \times \alpha + b_{t-1} + \left(1-\alpha\right) \times BFI_{\max} \times Q_t}{1-\alpha \times BFI_{\max}}$$

bt is the filtered base flow at the t time step

bt-1 is the filtered base flow at the t-1 time step

*BFI*max is the maximum value of long term ratio of
base flow to total stream flow

α is the filter parameter

Qt is the total streamflow at the t time step

Table 4 This is the Base Flow Index of the three digital filtering methods of the W.H.A.T. program. The Lyne and Hollick method was able to produce a matching BFI to the manual method with an alpha numarical of .98.

Lyne & Hollick 1979

alpha =	0.98
BFI_{calc}	0.75

Chapman & Maxwell, 1996

alpha =	0.60
BFI_{calc}	0.50

Eckhardt 2005

alpha =	0.70
BFI_{max}	0.6
BFI_{calc}	0.60

month	Overland	base flow	Base flow(%)	Overland	base flow	Base flow(%)	Overland	base flow	Base flow(%)
jan	14,710.2	36,904.8	50	25,904.0	25,711.0	50	30,871.4	20,743.6	40
feb	1,606.6	24,568.4	67	13,231.1	12,943.9	49	15,919.2	10,255.8	39
mar	16,388.9	49,609.1	51	32,419.2	33,578.8	51	38,717.9	27,280.1	41
apr	24,749.4	56,369.6	50	39,017.5	42,101.5	52	46,447.2	34,671.8	43
may	6,833.1	38,009.9	60	24,440.5	20,402.5	45	29,859.5	14,983.5	33
jun	7,509.7	21,758.3	55	14,853.9	14,414.1	49	17,881.6	11,386.4	39
jul	12,637.3	20,817.7	62	16,634.0	16,821.0	50	19,902.5	13,552.5	41
aug	7,799.7	19,764.3	52	13,867.6	13,696.4	50	16,694.8	10,869.2	39
sep	2,948.5	10,061.5	61	6,557.4	6,452.6	50	7,880.4	5,129.6	39
oct	2,589.3	13,675.7	55	8,115.8	8,149.2	50	9,726.7	6,538.3	40
nov	9,332.4	13,718.6	60	10,009.1	13,041.9	57	11,705.5	11,345.5	49
dec	8,372.3	42,066.7	53	26,575.4	23,863.6	47	32,145.6	18,293.4	36
		mean=	58%		mean=	50%		mean=	40%

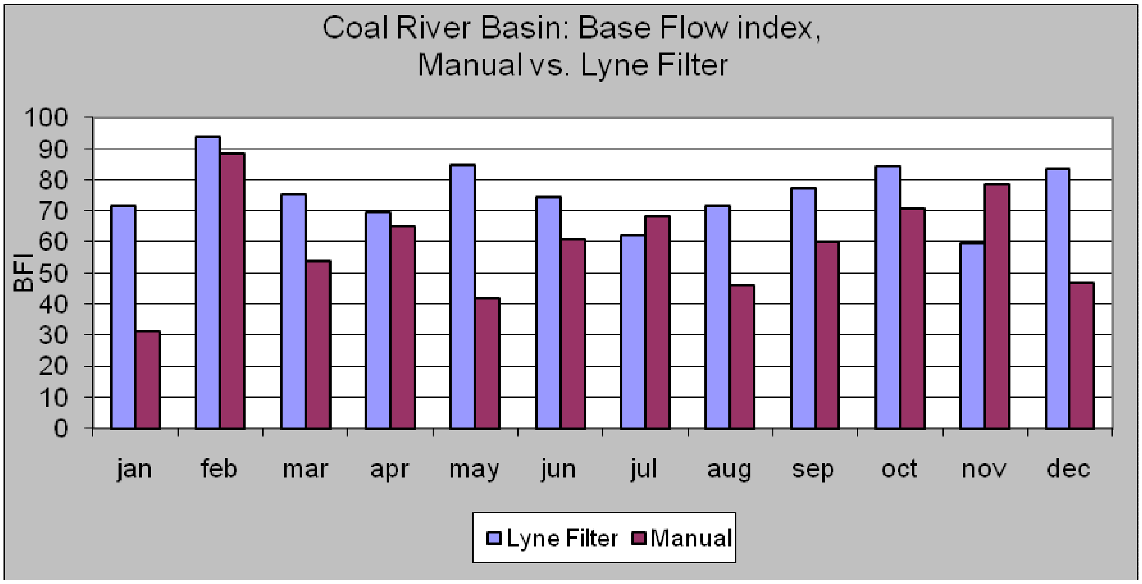


Figure 13 The manual method for determining base flow and a comparison to the Lyne and Hollick filters here displays little difference in the Base Flow Index in the Coal River basin.

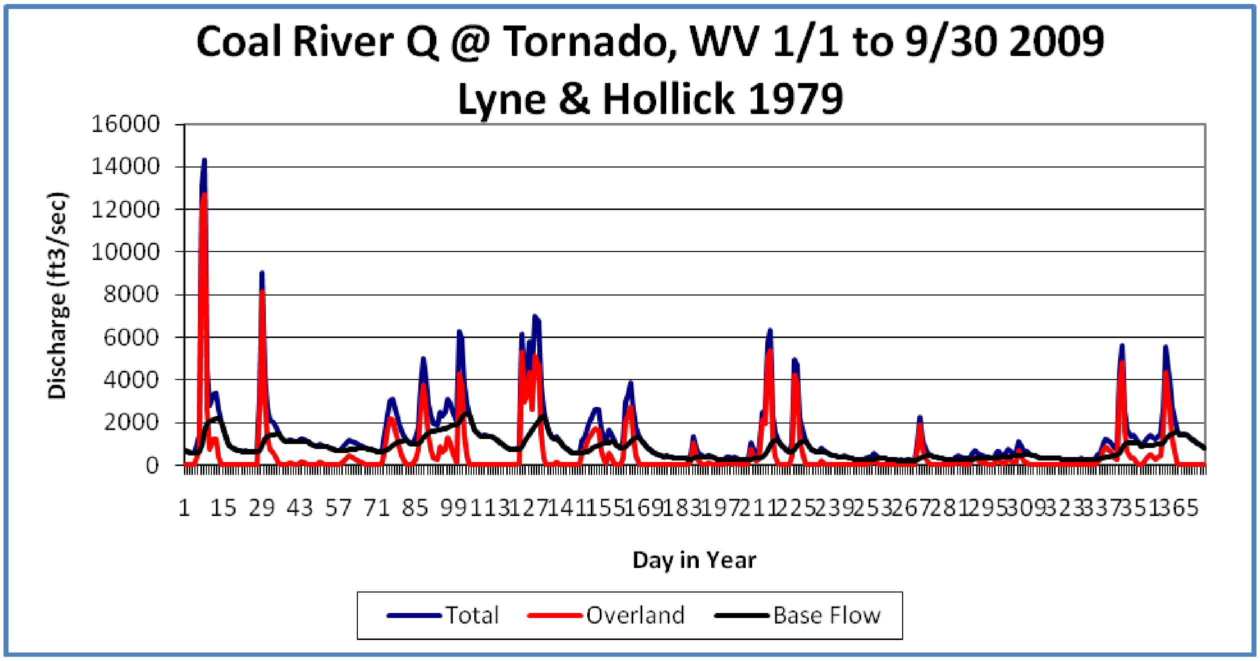


Figure 14 The Lyne and Hollick digital filter here shows how base flow, overland flow, and the total flow compare on the chart.

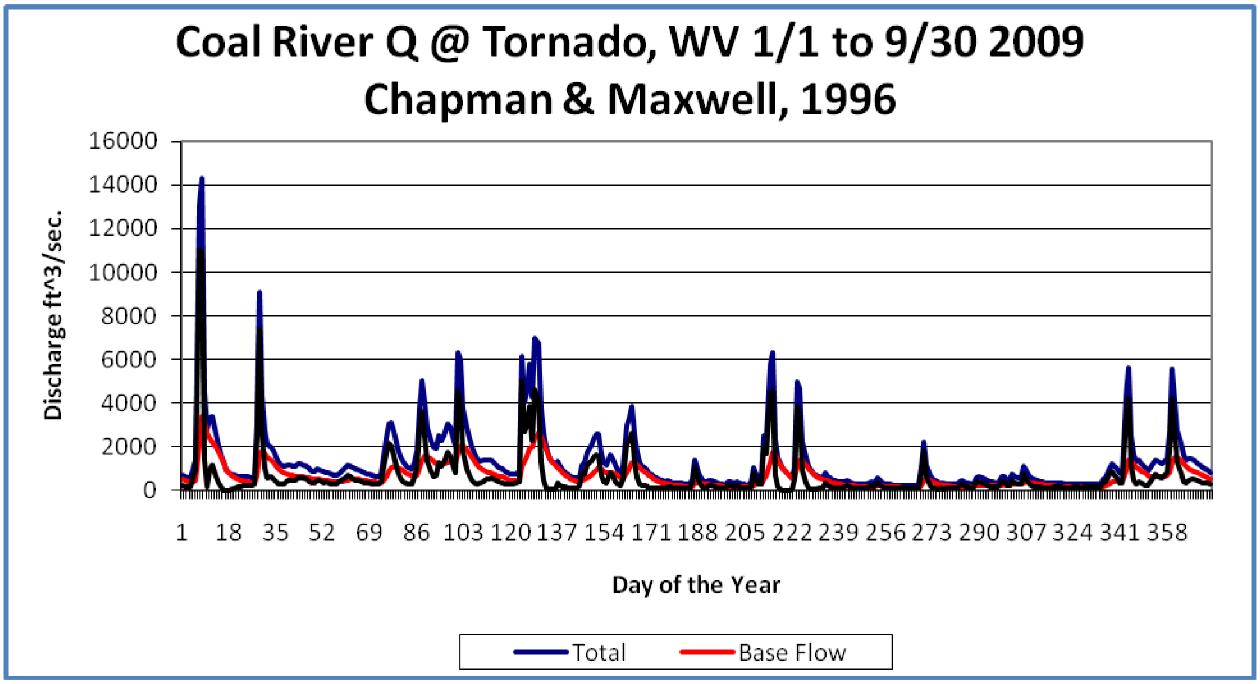
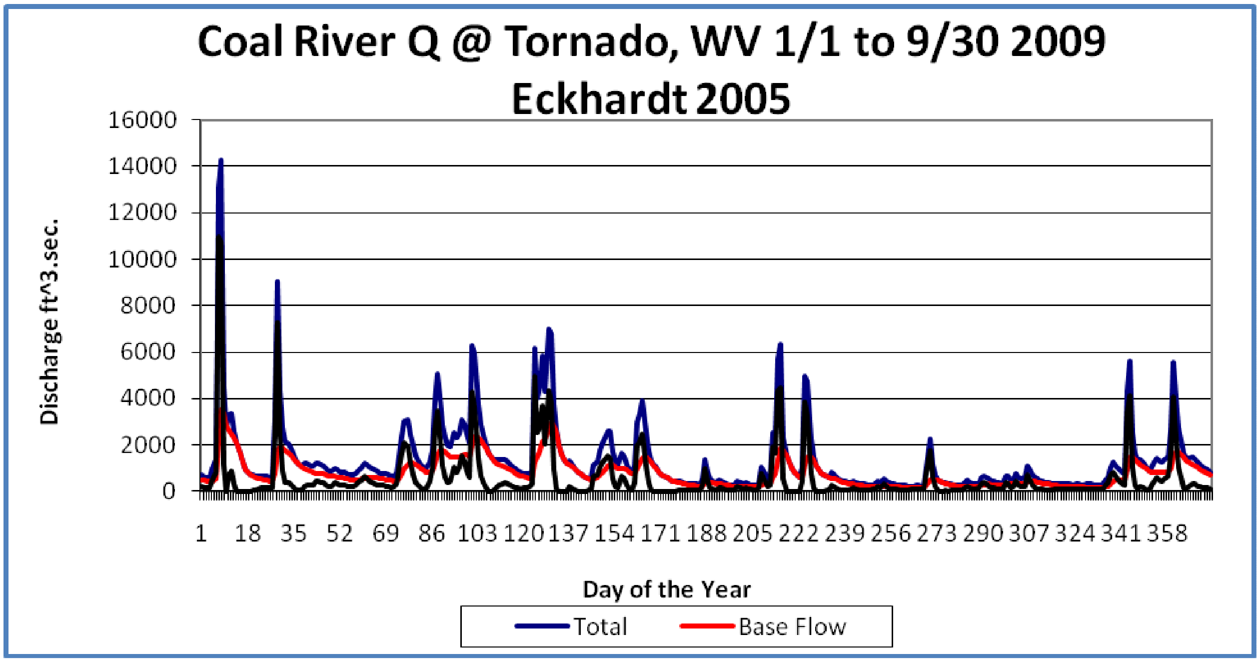


Figure 15 The Chapman and Maxwell digital filter here shows how base flow, overland flow, and the total flow compare.



Figures 16 The Eckhardt digital filter here shows base flow, overland flow, and the total flow comparison.

The following manual methodology was used to determine base flow discharge and seems to best represent the ideals of the geological environment of the Coal River basin. The manual runoff equation was used as stated above to determine base flow separate from continued base flow as a percentage, as seen in Figure 19.

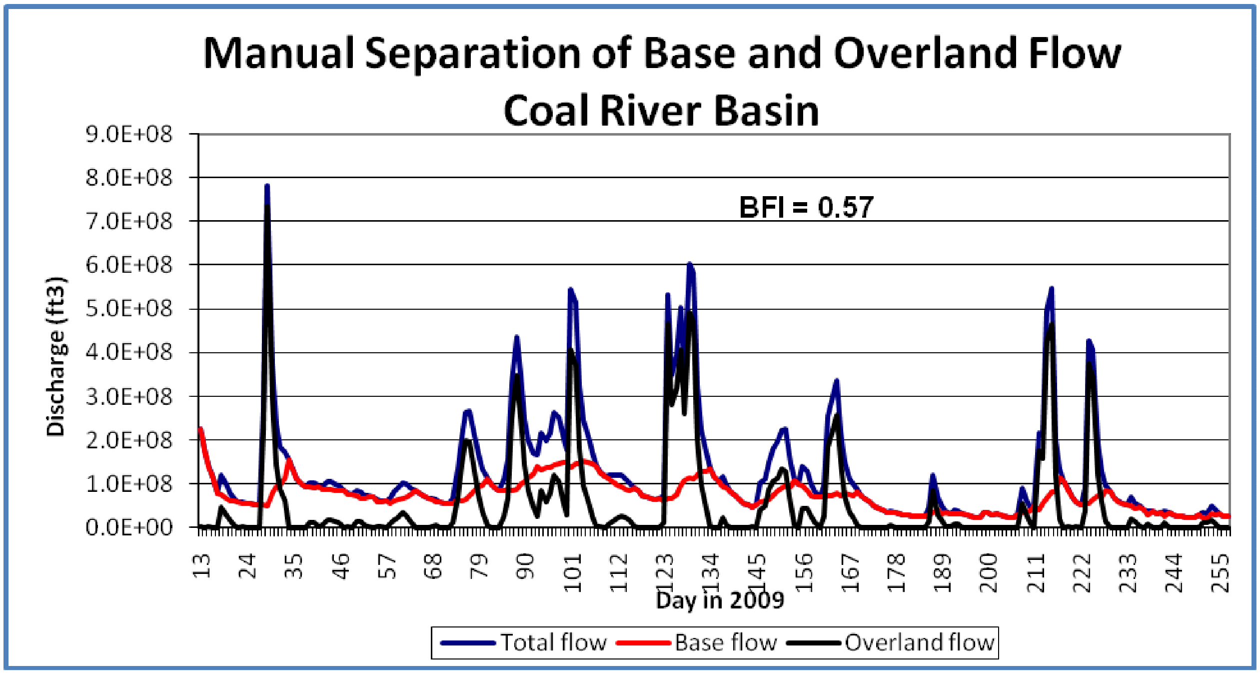


Figure 17 This is a manual separation of the base flow, the overland flow, and the total flow, the base flow and overland flow equal the total flow.

Base Flow Recession

The base flow recession will be determined by Excel using rain events that are separate from other events or that stand alone. A best fit line will be applied to those events and a given formula for the exponential curve. The base flow events will be measured after 4 days as given by the runoff formula $D = A^{0.2}$ (Fetter, C.W., Applied Hydrogeology, Fourth Edition, 0-13-088238-9. 2001, Ch. 1-4).

Base Flow Events 2009

The following graphs represent one of four rainfall events that [will be→ were] used to [measure→ calculate] base flow recession using Excel on the fifth day after peak flow in following the rule given by (Fetter 2001) for runoff time, as seen in Figures 18, 19, 20, and 21. This average of the events has given 0.1 as the recession constant.

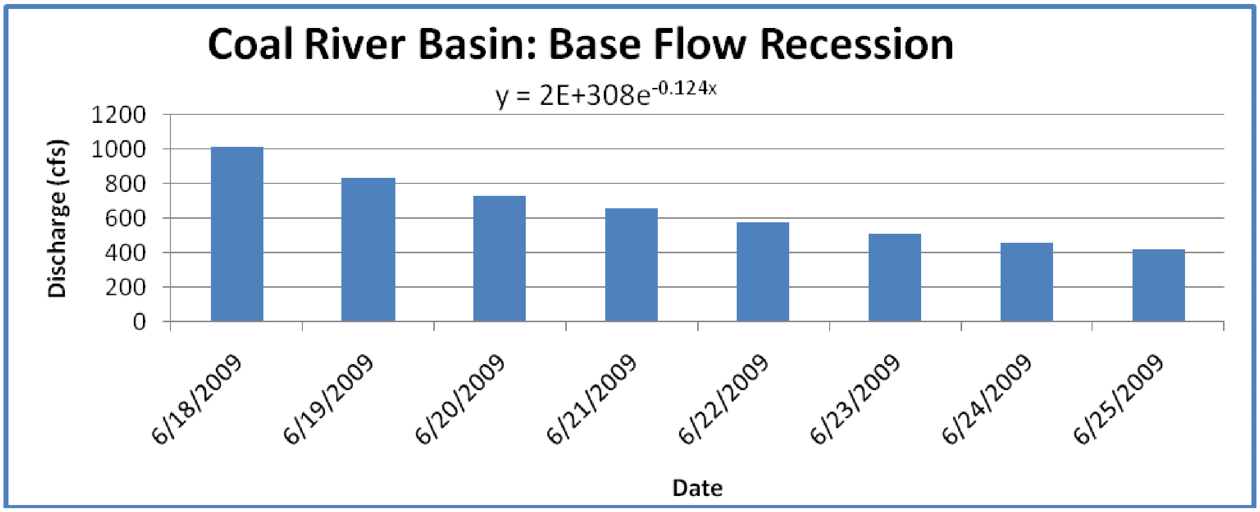


Figure 18 Calculations 1 of Base Flow Recession.

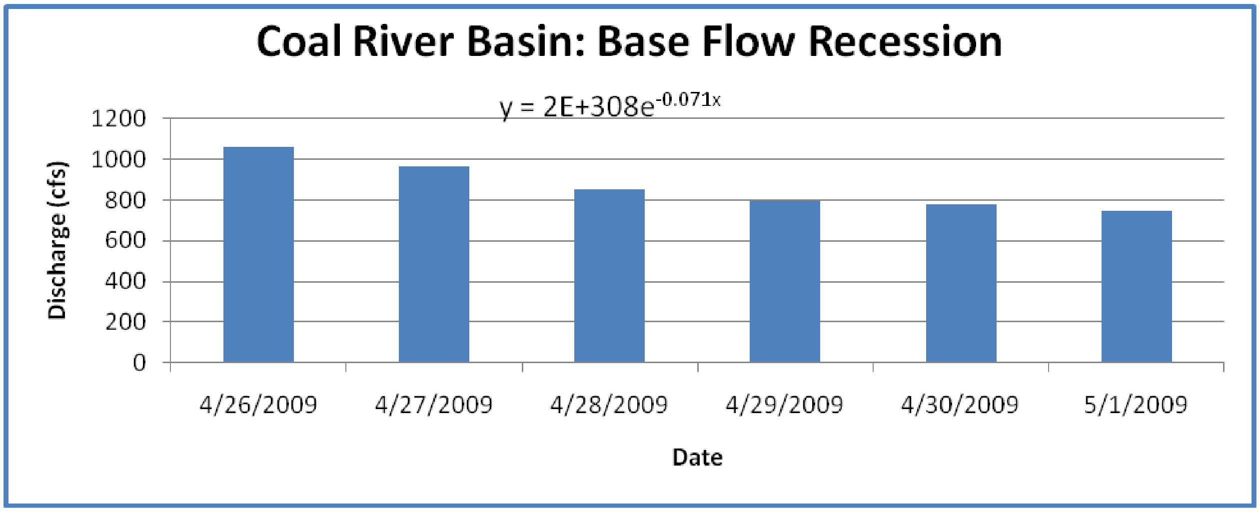


Figure 19 Calculations 2 of Base Flow Recession.

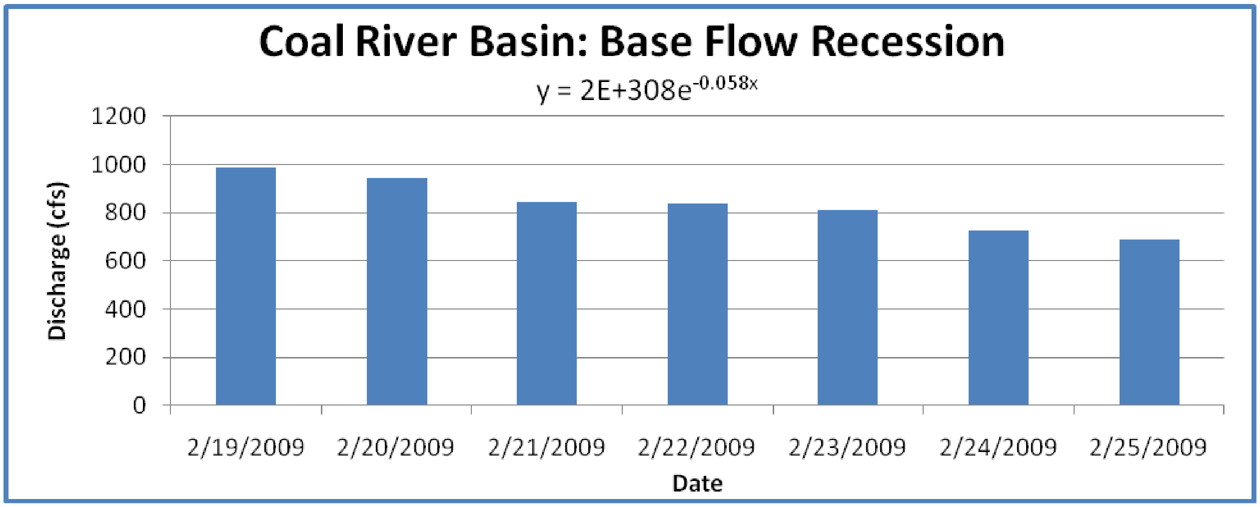


Figure 20 Calculations 3 of Base Flow Recession.

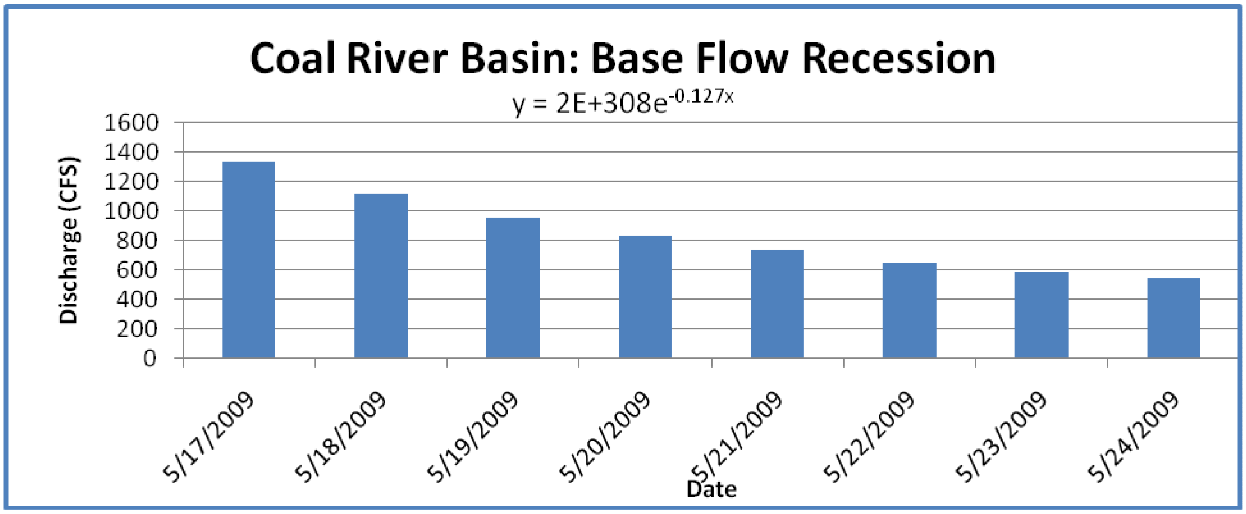


Figure 21 Calculations 4 of Base Flow Recession.

The Coal River Basin: Base Flow Recession Average, The average base flow was found to be 0.10 on an exponential curve as given by Excel over a period of 4 rain events 4 days after the peak discharge, as seen in Table 6.

Table 5 This is a calculation of the mean of the four events measured for the year 2009 after 4 days runoff time. On average, the stream flow decreases by 10 percent of the previous day.

Event 1	0.124
Event 2	0.071
Event 3	0.058
Event 4	0.127
Mean	0.10

Water Budget

The water budget of this study measures the output discharge (Q) of the Coal River at Tornado, WV and compares the total precipitation minus intercepted rainfall by vegetation over that spans 69% of the land cover of the river basin. The remaining 31% of rainfall is unaffected by interception and is allowed to become part of the water table or become overland flow. The following analysis has been surmised taking into account the difference as left over evaporate moisture or evapotranspiration which isn't measured in this study.

Jan. 13 2009 to Jan. 13 2010

Input = 8.468 x 10^{10} cubic feet
Output = 4.007 x 10^{10} cubic feet

Total Precipitation – Intercepted Rainfall
8.468 x 10^{10} cubic feet – 2.8 x 10^{10} cubic feet = 5.648 x 10^{10} cubic feet

Available Rainfall - Output
5.648 x 10^{10} cubic feet – 4.007 x 10^{10} cubic feet = 1.61 x 10^{10} cubic feet

Evapotranspiration = 1.61 x 10^{10} cubic feet

Precipitation breakdown [from→into] 100%

Interception 33%
Base flow 29%
Overland flow 19%
Evapotranspiration 19%

Conclusion

The Coal River basin had 33% of its rainfall for the year intercepted by vegetation, 29% of the discharge of the Coal River was base flow, 19% of the river discharge was overland flow, and roughly 19% of the water that entered the watershed as precipitation evaporated or transpired back into the atmosphere, for a total of 100% of the water that entered the watershed basin. The watershed flooded many times in the spring months and had several dry events in the fall of 2009. A study was performed by the United States Department of Agriculture on the evapotranspiration of plants in the summer months in southern West Virginia, it is to be expected that the evapotranspiration rate covering a year in comparison done in the evaporative summer season and would be lower and that is represented in this study (United States Department of Agriculture, *Forage evapotranspiration and photosynthetically active radiation interception in proximity to deciduous trees, Catch:* *http://ddr.nal.usda.gov/dspace/bitstream/10113/30313/1/IND44198605.pdf, March 18, 2010, et. al.).* Evapotranspiration slows in the winter months without leaf cover and ice freezing water traps the process from occurrence, this study found a 5% drop over the span of year from the USDA study done in the summer.

References

1. Department of the Interior, U.S. Geological Survey
URL:http://ga.water.usgs.gov/edu/*watercycleevapotranspiration*.html,
Page Last Modified: Friday, 07-Nov-2008 15:48:18 EST

2. Fetter, C.W., Applied Hydrogeology, Fourth Edition, 0-13-088238-9. 2001, Ch. 1-4

3. Kohler, M.A., Nordenson, T.J., Fox, W.E., *Evaporation from Ponds and Lakes*, U.S. Weather Bureau Research 38, 1955, et. al.

4. David, J.S., Valente, F. and Gash, J.H.C., *Evaporation of Intercepted Rainfall*, Ch 43, Encyclopedia of Hydrological Sciences, (Ed: MG Anderson), John Wiley, Chichester: 2005, pg. 627-634.

5. Singhal, B.B.S., Gupta, R. P., *Applied Hydrogeology of Fractured Rocks*, University of Roorkee, India, 0-412-75830-x,1999, pg. 329-331

6. Oregon Watershed Enhancement Board , *Oregon Watershed Assessment Manual*, 775 Summer Street NE, Suite 360, Salem, Oregon 97301, July, 1999 http://www.oregon.gov/OWEB/docs/pubs/OR_wsassess_manuals.shtml

7. Fongers, Dave, *Black River Watershed Hydrologic Study*, Hydrologic Studies Unit, Land and Water Management, Michigan Department of Environmental Quality, September 2008, Catch: http://www.michigan.gov/documents/deq/lwm-nps-black-river_250860_7.pdf, et. al.

8. Arnold, J.G., R. Srinivasan, R.S. Muttiah and J.R., Williams. *Large Area Hydrologic Modeling and Assessment*, part 1: model development. Journal of the American Water Resources Association pg. 1998, pgs.73-89.

9. Nelson, Stephan A., *Streams and Drainage Systems,* Tulane University, EENS 111, Physical Geology, Catch: http://www.tulane.edu/~sanelson/geol111/streams.htm

10. Cummins, Benjamin, *Biological Science* 3 ed., Freeman, Scott, 2007, p. 215

11. Martin, J.; W. Leonard; D. Stamp, *Principles of Field Crop Production (Third Edition)*, New York: Macmillan Publishing Co., Inc., 1976, et. al., ISBN 0-02-376720-0

12. Brick, Tim, *A Water Budget for the Arroyo Seco Watershed,* Arroyo Seco Foundation, http://www.arroyoseco.org/AS_Water_Budget.pdf, 2003, et. al.

13. Doyle, M. P., and M. C. Erickson. 2006. *"Closing the door on the fecal coliform assay." Microbe* 1:162-163. ISSN 1558-7460, et. al.

14. Rahman, Farhana Alamgir; A; R; S (2004). "*Arsenic Availability from Chromated Copper Arsenate (CCA)–Treated Wood*". *Journal of Enviromental Quality* **33** (1): 173–180. http://jeq.scijournals.org/cgi/reprint/33/1/173.

15. United States Geological Survey, *"Precipitation"*, Catch: http://ga.water.usgs.gov/, "Feb. 11, 2010, et. al.

16. Natural Resources and Environment Management, *"Effective Rainfall"*, Catch: http://www.fao.org/docrep/x5560e/x5560e03.htm, Feb 11, 2010, et. al.

17. Hoblit, Brian C., Curtis, David C., *Radar Estimates and Gauge Data, A Perfect Union,* http://www.swhydro.arizona.edu/archive/V4_N3/feature4.pdf, et al.

18. University of Texas, "*Base Flow Recession*" Catch: http://www.crwr.utexas.edu/gis/gishydro03/LibHydro/libhydro/baseflow.htm, Feb. 11, 2010, et al.

19. Purdue University. *"Web-Based Hydrograph Analysis Tool (WHAT)"*, Catch: http://www.ces.purdue.edu/waterquality/GIS.htm, Feb. 11, 2010, et. al.

20. The University of Wisconsin Stevens Point, *"Water Balance"*, Catch: http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/hydrosphere/water_balance_1.html, Feb 11, 2010, et. al.

21. Western Regional Climate Center, Catch: http://www.wrcc.dri.edu/pcpn/wv.gif, *"Mean Annual Precipitation"*, Feb. 12, 2010, et. al.

22. National Resource Conservation Service (NRCS), *Soil Data Mart,* Catch: http://soildatamart.nrcs.usda.gov/USDGSM.aspx, Feb. 21, 2010, et. al.

23. National Oceanic and Atmospheric Administration, National Weather Service, *Automatic Flood Warning System,* Catch: http://afws.erh.noaa.gov/afws/national.php, Feb. 21, 2010, et. al.

24. Lim, K. J., Engle, Z., Choi, J., Kim, K., Tripathy, D., *AUTOMATED WEB GIS BASED HYDROGRAPH ANALYSIS TOOL, WHAT,* Catch: http://cobweb.ecn.purdue.edu/~what/faq/Automated_Web_GIS_based_Hydrograph_Analysis_Tool_WHAT_JAWRA_Dec_2005.pdf, Feb 21. 2010, et. al.

25. Coal River Group, *Basin Elevation and Stream channel Map,* Catch: http://www.coalrivergroup.com/P/6/River_Information.aspx, Feb. 22, 2010, et. al.

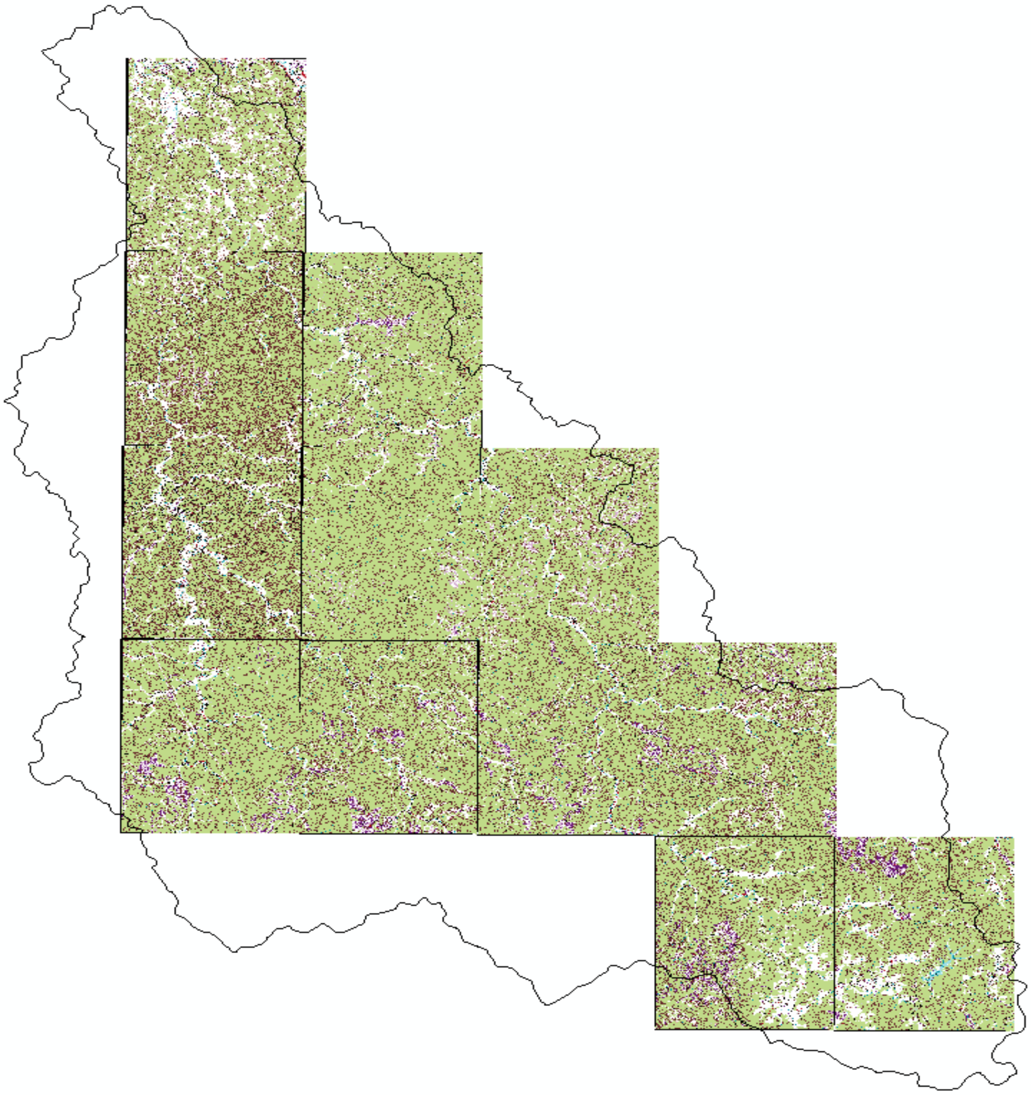
26. United States Geological Society, *USGS 03200500 COAL RIVER AT TORNADO, WV,* Catch: http://waterdata.usgs.gov/usa/nwis/uv?site_no=03200500, Feb. 22, 2010, et. al.

27. United States Department of Agriculture, Forage evapotranspiration and photosynthetically active radiation interception in proximity to deciduous trees, Catch: *http://ddr.nal.usda.gov/dspace/bitstream/10113/30313/1/IND44198605.pdf*, March 18, 2010, et. al.

Data Appendix

1. Land Use Base Map

The Coal River basin base map here shows vegetation and an outline of the basin boundaries which are ridgelines that close the basin to the influence of precipitation into one river system. The ER Mapper analysis of 7.5 minute quadrangles used Alum Creek, Arnett, Clothier, Dorthy, Eccles, Williams Mt., Julian, Wharton, Madison, Whitesville, Sylvester, and Racine Quads for color analysis after a 4 class (for number of available colors) Unsupervised Classification method.

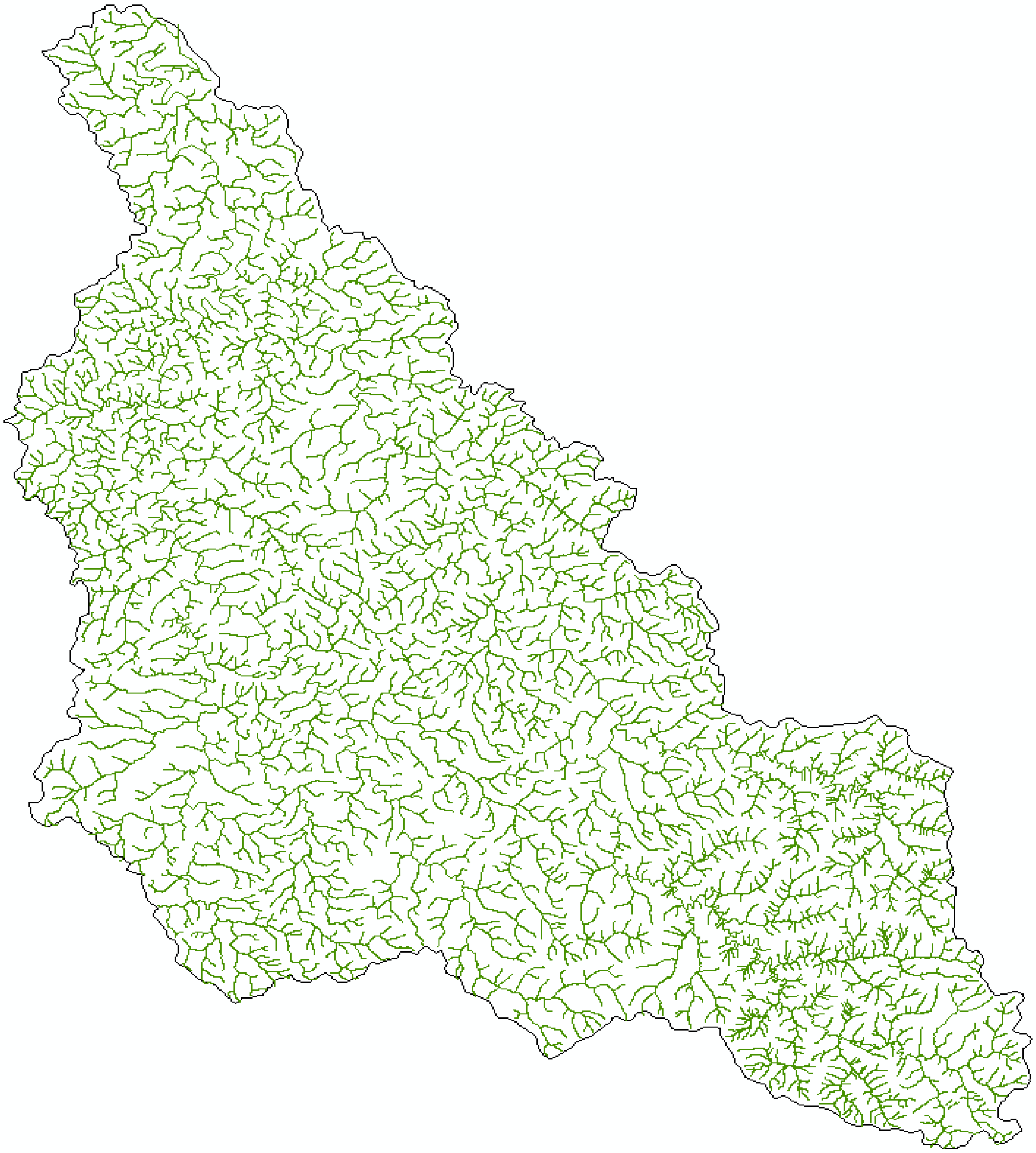


No scale for hectaracres was used in the map creation so the representation of numbers will vary from the actual acreage on the ground of the watershed basin; the goal in this exercise was to establish a good methodology for determining % forest cover using the green areas set in these quadrangles as forest when they were created. The change in land use is thought to equal-out over time where used land in the past is now forest and some forest is now used for other purposes.

7:30 Quads	WVGIS Tech Center					
Hectaracres	Total	Black	Blue	Green	White	% Green
Alum creek	15434	621	1799	9261	3753	60
Arnett	15407	539	2633	11230	1131	66
Clothier	15507	482	2430	11190	1405	72
Dorthy	15380	366	2952	10458	1605	68
Eccles	15364	376	2411	10455	2120	68
Williams Mt.	15440	387	1946	12428	679	81
Julian	15456	520	3956	9501	1427	62
Wharton	15491	415	3090	10544	1441	68
Madison	15483	976	3366	9320	1821	60
Whitesville	15424	446	2648	11053	1276	72
Sylvester	15424	446	2648	11053	1275	72
Racine	15416	617	1827	11650	1321	76

2. Drainage Network

The stream order map displays the river system from tributary at the head of the watershed to the mouth of the Coal River @ St. Albens, WV. The Coal River is considered a level 4 dendritic stream in order classification along with the Big Coal River, all other tributaries of the system are considered higher order streams.



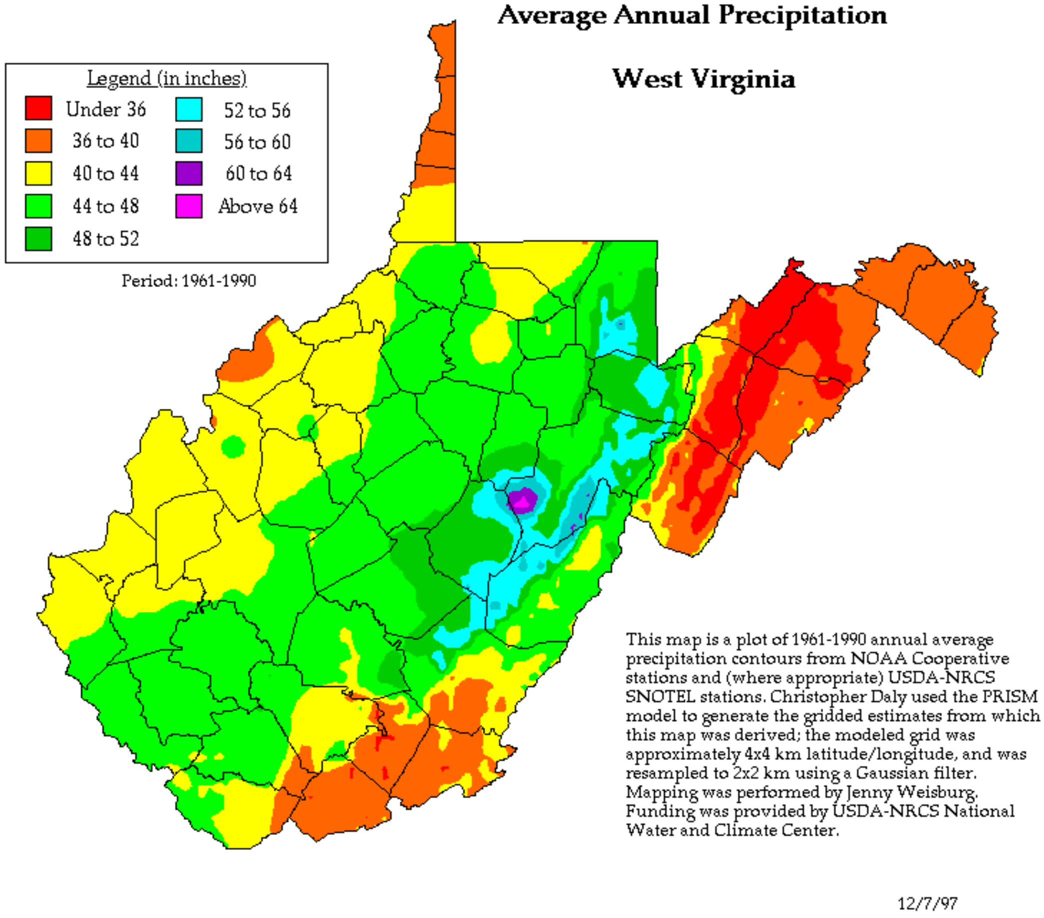
3. Leaf Cover

Leaf coverage calculations were done on a 1-10 scale by sight taking into account any remnant of coverage that existed on the measurement date. These measurements will be used as a factor for interception and play a large role in evapotranspiration.

Date	Reading	%
14-Mar-09	0.0	0
15-Mar-09	0.0	0
27-Mar-09	0.5	5
28-Mar-09	1.0	10
3-Apr-09	1.5	15
6-Apr-09	2.0	20
11-Apr-09	1.5	15
16-Apr-09	2.0	20
20-Apr-09	2.0	20
22-Apr-09	2.0	20
30-Apr-09	2.0	20
1-May-09	2.5	25
4-May-09	3.0	30
6-May-09	3.0	30
8-May-09	4.0	40
11-May-09	5.0	50
16-May-09	6.0	60
26-May-09	7.0	70
28-May-09	7.0	70
31-May-09	8.0	80
3-Jun-09	9.0	90
5-Jun-09	9.0	90
12-Jun-09	10.0	100
17-Jun-09	10.0	100
20-Jun-09	10.0	100
27-Jun-09	10.0	100
6-Jul-09	10.0	100
18-Jul-09	10.0	100
21-Jul-09	10.0	100
22-Jul-09	10.0	100
26-Jul-09	10.0	100
29-Jul-09	10.0	100

31-Jul-09	10.0	100
2-Aug-09	10.0	100
12-Aug-09	10.0	100
19-Aug-09	10.0	100
21-Aug-09	10.0	100
26-Aug-09	10.0	100
30-Aug-09	10.0	100
8-Sep-09	10.0	100
27-Sep-09	10.0	100
30-Sep-09	10.0	100
2-Oct-09	10.0	100
4-Oct-09	9.0	90
9-Oct-09	9.0	90
15-Oct-09	7.0	70
17-Oct-09	7.0	70
24-Oct-09	5.0	50
28-Oct-09	5.0	50
11-Nov-09	4.0	40
18-Nov-09	3.0	30
24-Nov-09	1.0	10
26-Nov-09	0.0	0
3-Dec-09	0.0	0
6-Dec-09	0.0	0
8-Dec-09	0.0	0
12-Dec-09	0.0	0

4. Mean Annual Precipitation



Average Annual Precipitation

West Virginia

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4x4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.

12/7/97

Mean Annual Precipitation – WV: The Coal River basin has an average annual precipitation of approximately 42 inches per year with higher rainfalls concentrated in the southern edge of the watershed (Catch: http://www.wrcc.dri.edu/pcpn/wv.gif, *"Mean Annual Precipitation"*, Western Regional Climate Center, Feb. 12, 2010).

5. 24 Hour Precipitation Data

http://www.afws.net/, The Automatic Flood Warning System site provided by the (NOAA) National Weather Service was used to gather daily precipitation data that was compiled from rain gauging stations that had an area of influence on the Coal River watershed boundaries and interior, in inches.

			AFWS.Net Precip.										
Date	Boone Co.			Kanawha		Lincoln	Putnam	Raleigh		logan		Wy	Madison
2009 - 10	3503	3504	3506	3528	3529	3535	3542	3546	3547	3570	3574	3579	COOP
13-Jan	0	0	0.04	0	0	0.04	0	0	0	0	0	0	0
14-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0.07
15-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0.03
16-Jan	0	0.04	0	0	0	0	0	0	0	0	0	0	0
17-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0.09
19-Jan	0.04	0	0.04	0	0	0.04	0	0	0	0	0	0	0
20-Jan	0	0	0	0	0	0.04	0	0	0	0	0	0	0.07
21-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jan	0	0	0	0	0	0.04	0	0	0	0	0	0	0
23-Jan	0	0.12	0.12	0	0	0	0	0	0	0	0	0	0
24-Jan	0	0	0.12	0	0	0	0	0	0	0	0	0	0
25-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0.4
26-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0.45
28-Jan	0.32	0.96	0	0.16	0.36	0.12	0.28	1.04	0.8	0.32	1.04	1.24	0.95
29-Jan	1.32	0.72	0.84	1.16	0.4	0.8	0.56	0.44	0.4	0.36	0.44	0.24	0.51
30-Jan	0.08	0	0.08	0.08	0.2	0.12	0.08	0	0	0.04	0	0.04	0
31-Jan	0	0	0	0	0	0.04	0	0	0	0	0	0	0.07
1-Feb	0	0	0	0	0	0.08	0	0	0	0	0	0	0
2-Feb	0.08	0	0.08	0.04	0.28	0.56	0.68	0	0	0	0	0.2	0
3-Feb	0	0	0	0.04	0.08	0.12	0	0	0	0.04	0	0	0.16
4-Feb	0	0.04	0	0	0	0.04	0	0	0	0	0	0	0.1
5-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0.03
6-Feb	0	0.04	0	0	0	0	0	0	0	0	0	0	0
7-Feb	0.08	0.08	0.2	0	0	0.04	0	0	0	0	0	0.04	0
8-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0

9-Feb	0	0	0	0	0	0.04	0	0	0	0	0	0	0
10-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Feb	0	0	0	0.04	0	0	0	0.08	0	0	0	0	0.35
13-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0.08
19-Feb	0.32	0.32	0	0.12	0	0.24	0.12	0.52	0.52	0.28	0.32	0.4	0.33
20-Feb	0	0	0	0.04	0	0.04	0.04	0	0	0	0.04	0.04	0
21-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Feb	0.04	0.08	0	0	0	0	0	0	0	0	0	0	0.2
23-Feb	0	0	0	0	0	0.04	0	0	0	0.04	0	0	0
24-Feb	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Feb	0	0.08	0	0	0	0	0	0	0	0	0	0	0
26-Feb	0	0	0	0	0	0	0	0	0	0	0	0.08	0
27-Feb	0	0	0	0	0.04	0	0	0	0	0	0	0	0.05
28-Feb	0.4	0.24	0	0.24	0.24	0.28	0.16	0.32	0.36	0.28	0.36	0.44	0.4
1-Mar	0.04	0	0	0	0	0.04	0	0	0	0	0	0	0.1
2-Mar	0.08	0	0	0.08	0	0.08	0	0	0	0	0.08	0	0
3-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Mar	0	0.04	0	0	0	0	0	0	0	0	0	0	0
6-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Mar	0	0	0	0.2	0	0	0	0.24	0	0	0	0	0.42
10-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Mar	0	0.04	0	0	0	0	0	0	0	0	0	0	0.05
13-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0.53
14-Mar	0.52	0.44	0	0.32	0.32	0.36	0.24	0.24	0	0.4	0.4	0.04	0.02
15-Mar	0.36	0.44	0	0.28	0.32	0.24	0.36	0.48	0.52	0.28	0.32	0.6	0.46
16-Mar	0.2	0.16	0.04	0.2	0.16	0.12	0.08	0.28	0.2	0.16	0.24	0.28	0.12
17-Mar	0.32	0.24	0.32	0.28	0.2	0.32	0.04	0.28	0.64	0.36	0.24	0.36	0.44
18-Mar	0	0	0	0.04	0	0.04	0	0	0	0	0	0	0
19-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0.08
20-Mar	0.12	0.08	0	0.16	0	0.16	0	0	0.04	0	0.12	0	0.05
21-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0

22-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0.05
26-Mar	0.2	0.28	0	0.12	0.32	0.32	0.24	0.2	0.16	0.16	0.24	0.32	0.4
27-Mar	0.6	0.48	0.12	0.56	0.68	0.64	0.64	0.44	0.4	0.56	0.56	0.48	0.5
28-Mar	0.76	0.64	0.56	0.48	0.44	0.48	0.44	0.44	0.56	0.6	0.72	0.72	0.7
29-Mar	0.08	0	0	0.04	0	0	0	0	0	0.04	0	0	0.4
30-Mar	0.44	0.3	0.36	0.24	0.52	0.6	0.4	0	0.32	0.32	0.32	0.16	0
31-Mar	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0.12
2-Apr	0.2	0.16	0.12	0.12	0.24	0.2	0.32	0.16	0.12	0.16	0.2	0.32	0.05
3-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0.4
4-Apr	0.36	0.52	0	0.36	0.44	0.2	0.4	0.64	0.36	0.56	0.76	0.68	0.06
5-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0.06
6-Apr	0.32	0	0	0.08	0.12	0	0.28	0	0	0.24	0	0	0
7-Apr	0.28	0.68	0	0.36	0.36	0.28	0.32	0.48	0.6	0.28	0.76	0.56	0.25
8-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Apr	1.19	0.91	0	0.72	0.84	0.88	0.84	0.68	0.6	0.88	0.96	0.92	1.61
12-Apr	0.48	0.32	0	0.44	0.48	0.32	0.4	0.08	0.2	0.28	0.2	0.24	0
13-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Apr	0	0	0	0	0	0.36	0	0	0	0	0	0	0
15-Apr	0.28	0.16	0	0.16	0.24	0.24	0.2	0.12	0.16	0.16	0.12	0.2	0.25
16-Apr	0.08	0.16	0	0.04	0	0.08	0	0	0	0	0	0	0.08
17-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Apr	0.16	0.12	0	0.12	0.24	0.2	0.32	0.16	0.16	0.16	0.2	0.2	0.3
21-Apr	0.04	0.24	0	0.08	0.16	0.16	0.16	0.28	0.28	0.16	0.36	0.44	0.12
22-Apr	0.08	0.16	0	0.04	0.04	0.08	0.16	0.12	0.48	0.12	0.36	0.48	0.19
23-Apr	0.04	0	0	0.04	0	0.08	0	0	0	0.04	0	0	0
24-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Apr	0	0	0	0	0	0	0	0	0	0	0	0	0.08
30-Apr	0	0.2	0.04	0	0	0.08	0.04	0	0	0	0.04	0	0.05
1-May	0	0.08	0.04	0	0.08	0.04	0	0	0	0	0	0	0.15

2-May	0	0.08	0.08	0.12	0.2	0.2	0.12	0.12	0.12	0.12	0.12	0.16	0.3
3-May	0	0.2	0.04	0.16	0.28	0.32	0.2	0.76	0.44	0.25	0.36	0.52	0.35
4-May	0	0.6	0.04	0.52	0.56	0.44	0.64	1.04	0.88	0.52	0.76	0.92	1.55
5-May	0	0.2	0.32	1.68	1.96	1.84	2.44	0.04	0.08	0.4	0.12	0.08	0.1
6-May	0	0.44	0	0.4	0.44	0.44	0.28	0.16	0.48	0.36	0.16	0.24	0.75
7-May	0	0.48	0.76	0.36	0.6	0.4	0.28	0.32	0.2	0.28	0.4	0.4	0.7
8-May	0	0	0.04	0.04	0.68	0.04	0.56	0.24	0.04	0.08	0	0.04	0.1
9-May	0	0.72	0.99	0.48	0.72	0.76	0.96	0.76	0.92	0.92	0.96	1.08	1.19
10-May	0	0.16	0.04	0.04	0.04	0.12	0.12	0.92	0.4	0.2	0.32	0.56	0
11-May	0	0	0	0	0	0	0	0	0	0	0	0	0
12-May	0	0	0	0	0	0	0	0	0	0	0	0	0.06
13-May	0	0	0	0	0	0	0	0	0	0	0	0	0
14-May	0	0	0	0	0	0.08	0	0	0	0	0	0	0
15-May	0	0.04	0	0	0	0	0	0	0	0	0	0	0.21
16-May	0	0	0	0	0	0	0	0	0	0	0	0	0.03
17-May	0	0.52	0	0.56	0.56	0.99	0.32	0.04	0.56	0.44	0.36	0.44	0.4
18-May	0	0.04	0	0	0	0	0	0	0	0	0	0	0
19-May	0	0	0	0	0	0	0	0	0	0	0	0	0
20-May	0	0	0	0	0	0	0	0	0	0	0	0	0
21-May	0	0	0	0	0	0	0	0	0	0	0	0	0
22-May	0	0	0	0	0	0	0	0	0	0	0	0	0
23-May	0	0	0	0	0	0	0	0	0	0	0	0	0
24-May	0	0	0	0	0	0	0	0	0	0	0	0	0
25-May	0	0.16	0	0	0	0	0	0	0	0	0	0	0
26-May	0	1.12	0	0.12	0.2	0.4	1.19	0.76	1.16	0.32	0.64	0.68	1.14
27-May	0	0.55	0	0.16	0.16	0.36	0.16	0	0.04	0.2	0.28	0.12	0.5
28-May	0	0.91	0	1.08	0.44	0.16	1.18	0.24	0.64	0.52	0.6	1.27	0.3
29-May	0.55	0.95	0.44	0.08	0.08	0.2	0.95	1.24	0.4	0.88	1.3	0.68	0.3
30-May	0	0.08	0.04	0	0	0	0	0	0	0	0	0	0
31-May	1.47	0.08	0.44	0.08	0.24	0.44	0	0	0.04	0.08	0.12	0	1.4
1-Jun	0.32	0.24	0.28	0.04	0.04	0.08	0.15	1.23	0.48	0.52	1.08	0.84	0
2-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Jun	0.04	0.28	0.52	0.04	0.04	0.08	0.04	0	0	0.32	0.04	0	0.16
4-Jun	0	0	0	0.24	0.56	0.47	0.75	0	0	0	0.04	0	0.2
5-Jun	0.84	0.32	0.48	0.84	0.56	0.52	0.76	0.44	0.32	0.36	0.12	0.56	0.94
6-Jun	0.36	0.2	0.16	0.36	0.52	0.28	0.16	0.2	0.36	0.04	0.12	0.2	0
7-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Jun	0.04	0.16	0	0	0	0.16	0	0	0	0	0	0	0
10-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Jun	0.63	0.84	1.26	1.03	1.07	1.28	1.7	0.76	1.55	0.4	0.28	0.56	1.31

12-Jun	0.6	0.56	0.72	0.4	0.4	0.64	0.4	1.03	1.56	0.88	0.84	0.99	1.26
13-Jun	0.48	0.24	0.36	0.48	0.96	0.44	0.08	0.4	0.24	0.48	0.36	0.28	0.3
14-Jun	0	0	0	0.04	0	0	0	0	0	0	0	0	0
15-Jun	0.12	0.04	0.04	0	0	0.04	0	0	0	0	0	0	0.08
16-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Jun	0.24	0.2	0.16	0.04	0.2	0.24	0.12	0.08	0.04	0.2	0.24	0.2	0.38
18-Jun	0.08	0.2	0.16	0.12	0.24	0.16	0.24	0.28	0.24	0.16	0.08	0.2	0
19-Jun	0	0	0.04	0	0	0	0	0	0	0	0	0	0
20-Jun	0	0	0	0	0	0.24	0	0	0	0	0	0	0
21-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Jun	0.04	0.44	0.16	0.24	0.56	0.32	0.04	0.04	0.04	0	0.12	0.36	0.17
27-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Jul	0	0	0	0	0	0	0	0	0	0	0.04	0	0
3-Jul	0	0.04	0.04	0	0	0	0	0	0	0	0	0	0
4-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Jul	0.32	0.6	0.4	0.16	0.12	0.32	0.12	0	0.2	0.04	0.08	0.04	1.17
6-Jul	1.8	1.84	1.88	1.64	1.56	1.48	0.88	1.32	4.11	1.4	1.64	2.36	0.75
7-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Jul	0	0	0	0	0	0.04	0	0	0	0	0	0	0
9-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Jul	0.56	0.4	0.32	0.16	0.28	0.64	0.24	0.24	0.52	0.08	0.2	0.48	0.35
13-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Jul	0	0.08	0	0	0	0	0	0	0	0	0	0	0.06
17-Jul	0	0	0.04	0	0	0	0	0	0	0	0	0	0
18-Jul	0	1.15	0.24	0.04	0.35	0.04	0.04	0.76	0.96	0.12	1.12	0.8	0
19-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0.2
21-Jul	0.04	0.56	0.56	0.36	0.12	0.04	0.04	0.04	0.04	0.28	0.72	0.44	0.1
22-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0

23-Jul	0.12	0.08	0.04	0	0	0.32	0	0	0	0	0	0	0.08
24-Jul	0.08	0.04	0.04	0	0	0.04	0	0	0	0	0	0	0
25-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Jul	0.08	0.28	0.28	0	0.36	0.12	1.61	0.8	0.28	0.36	0.51	0.48	1
27-Jul	0.84	0.56	0.72	0.28	0.36	0.28	0.44	1.44	1	0.72	1.04	1	0.15
28-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0.15
30-Jul	0.44	0.56	0.52	1.27	1.12	1.08	1.08	0.32	1	0.4	0.56	0.68	0.48
31-Jul	0.48	1.86	1.32	0.68	0.91	1.35	1.35	0.04	2.4	0.48	0.16	0.52	0.85
1-Aug	0.76	0.6	0.88	1	1.79	1.2	1.36	0.12	0.48	0.12	0.36	0.32	0.32
2-Aug	0	0	0	0	0	0	0	0	0	0	0	0	1.56
3-Aug	1.87	2.18	2.23	1.76	2.08	1.52	0.72	0.8	2.42	0.08	1.03	1.35	0
4-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Aug	0.36	0.04	0.2	0.16	0.12	0.08	0.12	0	0.04	0.04	0.08	0.04	0.22
6-Aug	0.12	0.12	0.16	0.08	0.2	0.24	0.16	0.04	0.08	0.04	0.24	0.56	0.22
7-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Aug	0.64	0.44	0.95	0.72	1.36	0.64	2.73	0.56	1.54	0.04	1.15	0.64	0.71
12-Aug	0.16	1.08	1.44	1.07	0.63	0.12	0.32	0.12	0.47	0.04	0.28	0.44	1.9
13-Aug	0.48	0.72	0.8	0.12	0.12	0.79	0.95	0.52	1.02	0.04	0.64	0.76	0
14-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Aug	0	0.48	0.2	0	0	0	0	0	0	0	0	0	0
20-Aug	0	0.04	0.08	0	0	0.04	0	0	0	0	0	0	0
21-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0.24
22-Aug	0.48	0.64	0.92	0.59	0.44	0.76	0.12	0.24	0.24	0.04	0.12	0.32	0.2
23-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Aug	0	0	0.12	0	0	0	0	0	0	0	0	0	0
30-Aug	0.55	0.2	0.28	0	0.16	0.04	0.4	0.08	0	0.04	0.04	0.2	0.41
31-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0

2-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Sep	0	1.5	0.63	0.12	0.2	0.08	0.12	0.56	0.52	0.04	0.79	0.44	0.15
8-Sep	0.24	0.36	0.32	0.08	0.2	0.4	0.2	0.4	1.04	0.04	0.24	0.76	0.03
9-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0.02
10-Sep	1.16	0.59	0.84	0.12	0.04	0.56	0.16	0.04	0.44	0.04	0.36	0.2	0.11
11-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Sep	0.04	0	0	0	0	0.04	0	0	0	0	0	0	0.08
22-Sep	0.08	0.04	0.04	0.08	0.2	0.28	0.12	0.28	0.56	0.04	0.04	0.24	0.15
23-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
24-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Sep	0.28	0.12	0.16	0.04	0.04	0.12	0.08	0.16	0.32	0.08	0.6	0.52	0.38
26-Sep	0.2	0.92	0.92	0.72	1.16	1.44	1	0.32	2.1	0	0.04	0.12	0.97
27-Sep	1.52	1.88	1.44	1.96	2.63	2	1.8	1.28	0.08	0.04	1.08	1.24	1.32
28-Sep	0.04	0	0	0	0	0.04	0	0	0	0	0	0	0
29-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0.04
30-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
2-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Oct	0	0	0	0	0.04	0	0	0	0	0	0	0	0.1
4-Oct	0.08	0	0	0.16	0	0	0	0	0	0	0	0	0
5-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Oct	0.04	0	0	0	0.04	0.04	0	0	0	0	0	0	0
8-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Oct	0.56	0.54	0.54	0.36	0.68	0.56	0.54	0.54	0.56	0.54	0.5	0.54	0
10-Oct	0.2	0.13	0.13	0.16	0.04	0.12	0	0.13	0	0.13	0.13	0.13	0.71
11-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Oct	0.04	0	0	0	0	0	0	0	0	0	0	0	0

13-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	0.48	0.224	0.224	0.16	0.16	0.28	0.224	0.224	0.04	0.224	0.224	0.224	
15-Oct	0.36	0.312	0.312	0.36	0.32	0.4	0.312	0.312	0.12	0.312	0.312	0.312	0.55
16-Oct	0.04	0.032	0.03	0.04	0.04	0.04	0.03	0.03	0	0.03	0.03	0.03	0.29
17-Oct	0.12	0.08	0.08	0.08	0.16	0.04	0.08	0.08	0	0.08	0.08	0.08	0.03
18-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0.09
19-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
23-Oct	0.12	0.152	0.15	0.32	0.16	0.08	0.15	0.15	0.08	0.15	0.15	0.15	0
24-Oct	0	0	0	0	0	0	0	0	1.4	0	0	0	0.25
25-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Oct	0.32	0.208	0.21	0.16	0.24	0.2	0.21	0.21	0.12	0.21	0.21	0.21	0
28-Oct	0.08	0.104	0.1	0.04	0.2	0.2	0.1	0.1	0	0.1	0.1	0.1	0.35
29-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Oct	0.44	0.368	0.37	0.24	0.4	0.4	0.37	0.37	0.36	0.37	0.37	0.37	0
1-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0.42
2-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
7-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
8-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
9-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	0.04	0.14	0.14	0	0	0	0.14	0.14	0.24	0	0.14	0.14	0
11-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
13-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Nov	0.04	0	0	0	0	0	0	0	0	0	0	0	0
17-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	0.08	0.06	0	0	0.04	0	0.06	0	0	0.06	0	0.06	0
19-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0.13
20-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0

23-Nov	0.2	0.133	0.13	0	0.13	0.08	0.13	0.13	0.12	0.13	0.13	0.13	0.17
24-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	0.04	0.04	0.04	0	0.08	0.04	0.04	0.04	0	0.04	0.04	0.04	0.09
28-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0.04
29-Nov	0.04	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	0.91	0.558	0.56	0.48	0.68	0.4	0.56	0.56	0.32	0.56	0.56	0.56	0.42
1-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0.4
2-Dec	0.52	0.518	0.52	0.4	0.56	0.44	0.52	0.52	0.67	0.52	0.52	0.52	0.04
3-Dec	0.04	0.072	0.08	0.04	0.08	0.08	0.08	0.08	0.12	0.08	0.08	0.08	0.7
4-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
6-Dec	0.16	0.24	0	0.08	0.12	0.04	0.106667	0.16	0.08	0.1	0.1	0.1	0
7-Dec	0.04	0	0.16	0.08	0.12	0.47	0.145	0.04	0	0.15	0.15	0.15	0
8-Dec	0.92	0.68	0.64	0.68	0.88	0.8	0.766667	1.12	0	0.77	0.77	0.77	0
9-Dec	0.4	0.4	0.32	0.32	0.48	0.4	0.386667	0.6	1.92	0.39	0.39	0.39	1.25
10-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Dec	0	0.08	0	0	0	0	0	0	0	0	0	0	0
13-Dec	0.28	0.24	0.24	0.28	0.4	0.48	0.32	0.32	0.4	0.32	0.32	0.32	0
14-Dec	0.04	0	0	0	0	0	0	0	0	0	0	0	0.3
15-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
16-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
17-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
18-Dec	0.6	0	0.04	0.4	0.4	0.48	0.04	0	0	0.04	0.04	0.04	0
19-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
20-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0.12
21-Dec	0.04	0	0.04	0	0.16	0	0.04	0.04	0	0.04	0.04	0.04	0
22-Dec	0.2	0.22	0.2	0.16	0.36	0.04	0.196667	0.2	0	0.2	0.2	0.2	0
23-Dec	0.2	0.8	0.32	0.44	0.28	0.32	0.393333	0.68	0.2	0.4	0.4	0.4	0
24-Dec	0.63	0.28	0.76	0.36	0.12	0.52	0.445	0.45	0.04	0.45	0.45	0.45	0
25-Dec	0.16	0.16	0.12	0.08	0.16	0.12	0.133333	0.04	1.24	0.13	0.13	0.13	0.1
26-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0.15
27-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
28-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
29-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
31-Dec	0.32	0.28	0.28	0.24	0.32	0.28	0.286667	0.32	0.12	0.3	0.3	0.3	0.15
1-Jan	0	0.04	0.04	0	0	0	0.04	0	0	0.04	0	0.04	0.04
2-Jan	0	0	0	0	0	0	0	0	0	0	0	0.03	0.03

3-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0
4-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Jan	0	0	0	0	0	0	0	0	0	0	0	0.07	0.07
6-Jan	0	0	0	0	0	0	0	0	0	0	0	0.06	0.06
7-Jan	0	0.04	0	0	0.04	0	0.04	0.12	0	0	0.04	0	0
8-Jan	0	0	0	0	0	0.04	0	0	0	0	0	0.15	0.15
9-Jan	0	0	0	0	0	0	0	0	0	0	0	0.04	0.04
10-Jan	0	0	0	0	0.08	0	0	0	0	0	0	0	0
11-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Jan	0	0	0	0	0	0	0	0.04	0	0	0	0.04	0.04
13-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0

6. Soil Temperature

Coal River Ground Temperature Measurements in Degrees					
Date	Site	A	B	C	Ave.
18-Mar	Site1	48.0	45.0	42.0	45.0
	Site 2	47.0	42.0	46.0	45.0
	Site3	47.0	46.0	44.0	45.7
	Site 4	48.0	45.0	48.0	47.0
	Site 5	48.0	40.0	44.0	44.0
				Ave.	45.3
16-Apr	Site1	50.0	47.0	45.0	47.3
	Site 2	48.0	47.0	45.0	46.7
	Site3	45.0	50.0	44.0	46.3
	Site 4	48.0	52.0	48.0	49.3
	Site 5	50.0	46.0	50.0	48.7
				Ave.	47.7
5-Jun	Site1	57.0	54.0	55.0	55.3
	Site 2	55.0	58.0	58.0	57.0
	Site3	53.0	56.0	53.0	54.0
	Site 4	58.0	59.0	57.0	58.0
	Site 5	52.0	56.0	59.0	55.7
				Ave.	56.0
28-Jul	Site1	68.0	67.0	67.0	67.3
	Site 2	65.0	65.0	65.0	65.0
	Site3	67.0	68.0	68.0	67.7
	Site 4	64.0	68.0	64.0	65.3
	Site 5	68.0	64.0	67.0	66.3
				Ave.	66.3
25-Sep	Site1	60.0	62.0	58.0	60.0
	Site 2	58.0	58.0	57.0	57.7
	Site3	60.0	60.0	63.0	61.0
	Site 4	61.0	60.0	61.0	60.7
	Site 5	59.0	58.0	60.0	59.0
				Ave.	59.7
10-Nov	Site1	52.0	50.0	50.0	50.7
	Site 2	50.0	49.0	52.0	50.3
	Site3	50.0	48.0	52.0	50.0
	Site 4	48.0	52.0	50.0	50.0
	Site 5	52.0	50.0	49.0	50.3

				Ave.	50.3
2-Dec	Site1	42.0	46.0	46.0	44.7
	Site 2	40.0	43.0	43.0	42.0
	Site3	45.0	44.0	42.0	43.7
	Site 4	42.0	44.0	42.0	42.7
	Site 5	47.0	42.0	45.0	44.7
				Ave.	43.5
5-Jan	Site1	30.0	29.0	30.0	29.7
	Site 2	32.0	30.0	30.0	30.7
	Site3	30.0	29.0	28.0	29.0
	Site 4	30.0	30.0	31.0	30.3
	Site 5	32.0	30.0	29.0	30.3
				Ave.	30.0

7. Base flow

Web-Based Hydrographic Analysis Tool (WHAT) Program

Three methods were used from the WHAT program and a manual interpretation of the base flow of the coal river basin have been performed. The lyne & hollick digital filter can be used in other studies of the Coal River Basin with an alpha number of .97 to match the calculated manual base flow index of 57% (Lim, K. J., Engle, Z., Choi, J., Kim, K., Tripathy, D., *AUTOMATED WEB GIS BASED HYDROGRAPH ANALYSIS TOOL, WHAT,* Catch: http://cobweb.ecn.purdue.edu/~what/faq/Automated_Web_GIS_based_Hydrograph_Analysis_Tool_WHAT_JAWRA_Dec_2005.pdf, Feb 21. 2010, et. al.)

Lyne & Hollick 1979		Chapman & Maxwell, 1996		Eckhardt 2005	
alpha =	0.97	alpha =	0.60	alpha =	0.70
BFI_{calc}	0.57	BFI_{calc}	0.50	BFI_{max}	0.6
				BFI_{calc}	0.60

Date	Total(ft3/s)	overland	base flow	Total(ft3/s)	base flow	overland	Total(ft3/s)	base flow	overland
1/1/2009	697	10.0	687.0	697	500.0	197.0	697	500.0	197.0
1/2/2009	615	0.0	615.0	615	390.0	225.0	615	432.2	182.8
1/13/2009	2600	1,786.5	813.5	2600	910.0	1690.0	2600	1015.6	1584.4
1/14/2009	2060	943.2	1,116.8	2060	978.6	1081.4	2060	1129.6	930.4
1/15/2009	1650	385.6	1,264.4	1650	890.8	759.2	1650	1057.4	592.6
1/16/2009	1280	0.0	1,280.0	1280	747.5	532.5	1280	907.7	372.3
1/17/2009	923	0.0	923.0	923	584.1	338.9	923	724.6	198.4
1/18/2009	1390	420.3	969.7	1390	647.5	742.5	1390	781.2	608.8
1/19/2009	1130	102.2	1,027.8	1130	600.3	529.7	1130	727.8	402.2
1/20/2009	903	0.0	903.0	903	515.3	387.7	903	631.6	271.4
1/21/2009	779	0.0	779.0	779	443.4	335.6	779	546.7	232.3
1/22/2009	687	0.0	687.0	687	386.3	300.7	687	477.1	209.9
1/23/2009	660	0.0	660.0	660	354.1	305.9	660	435.2	224.8
1/24/2009	652	0.0	652.0	652	338.1	313.9	652	412.4	239.6
1/25/2009	633	0.0	633.0	633	325.7	307.3	633	395.5	237.5
1/26/2009	604	0.0	604.0	604	312.2	291.8	604	378.4	225.6
1/27/2009	602	0.0	602.0	602	305.8	296.2	602	369.5	232.5
1/28/2009	3160	2,302.2	857.8	3160	1033.9	2126.1	3160	1159.1	2000.9
1/29/2009	9060	7,151.8	1,908.2	9060	3031.7	6028.3	9060	3371.3	5688.7
1/30/2009	4320	1,455.4	2,864.6	4320	2533.6	1786.4	4320	2968.2	1351.8
1/31/2009	2740	0.0	2,740.0	2740	1868.7	871.3	2740	2283.3	456.7
2/1/2009	2120	0.0	2,120.0	2120	1406.6	713.4	2120	1760.2	359.8
2/2/2009	2010	0.0	2,010.0	2010	1177.1	832.9	2010	1473.5	536.5
2/3/2009	1790	0.0	1,790.0	1790	1015.9	774.1	1790	1266.9	523.1
2/4/2009	1540	0.0	1,540.0	1540	875.4	664.6	1540	1089.5	450.5
2/5/2009	1270	0.0	1,270.0	1270	738.0	532.0	1270	920.1	349.9
2/6/2009	1160	0.0	1,160.0	1160	647.7	512.3	1160	804.2	355.8

2/7/2009	1090	0.0	1,090.0	1090	589.0	501.0	1090	726.5	363.5
2/8/2009	1190	90.0	1,100.0	1190	592.4	597.6	1190	720.0	470.0
2/9/2009	1180	63.0	1,117.0	1180	591.0	589.0	1180	713.8	466.2
2/10/2009	1120	0.0	1,120.0	1120	573.3	546.7	1120	692.2	427.8
2/11/2009	1080	0.0	1,080.0	1080	554.3	525.7	1080	669.3	410.7
2/12/2009	1200	108.0	1,092.0	1200	580.4	619.6	1200	695.5	504.5
2/13/2009	1220	104.4	1,115.6	1220	597.3	622.7	1220	714.4	505.6
2/14/2009	1160	29.5	1,130.5	1160	587.4	572.6	1160	704.9	455.1
2/15/2009	1100	0.0	1,100.0	1100	566.0	534.0	1100	681.7	418.3
2/16/2009	993	0.0	993.0	993	526.3	466.7	993	637.3	355.7
2/17/2009	898	0.0	898.0	898	482.1	415.9	898	586.3	311.7
2/18/2009	864	0.0	864.0	864	453.5	410.5	864	551.2	312.8
2/19/2009	987	110.7	876.3	987	476.4	510.6	987	572.4	414.6
2/20/2009	944	49.9	894.1	944	473.9	470.1	944	569.3	374.7
2/21/2009	842	0.0	842.0	842	443.7	398.3	842	536.1	305.9
2/22/2009	839	0.0	839.0	839	429.9	409.1	839	519.2	319.8
2/23/2009	810	0.0	810.0	810	415.7	394.3	810	502.0	308.0
2/24/2009	728	0.0	728.0	728	386.1	341.9	728	468.3	259.7
2/25/2009	690	0.0	690.0	690	362.6	327.4	690	440.2	249.8
2/26/2009	698	7.2	690.8	698	354.8	343.2	698	429.1	268.9
2/27/2009	759	60.7	698.3	759	368.9	390.1	759	442.7	316.3
2/28/2009	926	198.8	727.2	926	422.7	503.3	926	501.1	424.9
3/1/2009	1030	252.7	777.3	1030	475.4	554.6	1030	561.6	468.4
3/2/2009	1190	346.1	843.9	1190	543.8	646.2	1190	640.4	549.6
3/3/2009	1130	222.9	907.1	1130	555.9	574.1	1130	659.9	470.1
3/4/2009	1040	97.3	942.7	1040	535.4	504.6	1040	641.3	398.7
3/5/2009	974	18.5	955.5	974	507.7	466.3	974	611.9	362.1
3/6/2009	921	0.0	921.0	921	480.7	440.3	921	581.2	339.8
3/7/2009	856	0.0	856.0	856	450.6	405.4	856	546.2	309.8
3/8/2009	788	0.0	788.0	788	418.3	369.7	788	508.3	279.7
3/9/2009	771	0.0	771.0	771	399.5	371.5	771	484.6	286.4
3/10/2009	737	0.0	737.0	737	381.8	355.2	737	462.7	274.3
3/11/2009	680	0.0	680.0	680	357.9	322.1	680	434.4	245.6
3/12/2009	638	0.0	638.0	638	335.7	302.3	638	407.7	230.3
3/13/2009	646	7.2	638.8	646	328.4	317.6	646	397.3	248.7
3/14/2009	766	113.8	652.2	766	359.6	406.4	766	429.5	336.5
3/15/2009	1560	805.6	754.4	1560	599.8	960.2	1560	691.5	868.5
3/16/2009	2370	1,373.5	996.5	2370	934.2	1435.8	2370	1069.3	1300.7
3/17/2009	3040	1,701.8	1,338.2	3040	1268.9	1771.1	3040	1459.7	1580.3
3/18/2009	3090	1,406.4	1,683.6	3090	1426.7	1663.3	3090	1663.6	1426.4
3/19/2009	2440	540.1	1,899.9	2440	1308.6	1131.4	2440	1560.4	879.6
3/20/2009	1950	0.0	1,950.0	1950	1118.0	832.0	1950	1358.5	591.5
3/21/2009	1560	0.0	1,560.0	1560	924.8	635.2	1560	1139.9	420.1
3/22/2009	1320	0.0	1,320.0	1320	773.5	546.5	1320	960.0	360.0
3/23/2009	1160	0.0	1,160.0	1160	662.9	497.1	1160	823.4	336.6
3/24/2009	1030	0.0	1,030.0	1030	578.4	451.6	1030	717.2	312.8
3/25/2009	968	0.0	968.0	968	524.5	443.5	968	646.6	321.4
3/26/2009	1270	271.8	998.2	1270	587.6	682.4	1270	706.3	563.7
3/27/2009	1780	676.4	1,103.6	1780	760.4	1019.6	1780	893.4	886.6
3/28/2009	3830	2,386.2	1,443.8	3830	1420.2	2409.8	3830	1619.9	2210.1

3/29/2009	5040	2,997.9	2,042.1	5040	2048.6	2991.4	5040	2346.2	2693.8
3/30/2009	4060	1,516.3	2,543.7	4060	2038.0	2022.0	4060	2392.6	1667.4
3/31/2009	2860	133.1	2,726.9	2860	1690.6	1169.4	2860	2042.6	817.4
4/1/2009	2290	0.0	2,290.0	2290	1378.8	911.2	2290	1696.8	593.2
4/2/2009	1960	0.0	1,960.0	1960	1150.9	809.1	1960	1427.4	532.6
4/3/2009	1910	0.0	1,910.0	1910	1039.0	871.0	1910	1281.9	628.1
4/4/2009	2500	531.0	1,969.0	2500	1159.6	1340.4	2500	1394.7	1105.3
4/5/2009	2290	235.8	2,054.2	2290	1151.2	1138.8	2290	1384.0	906.0
4/6/2009	2490	368.6	2,121.4	2490	1204.8	1285.2	2490	1440.9	1049.1
4/7/2009	3060	807.9	2,252.1	3060	1390.6	1669.4	3060	1645.3	1414.7
4/8/2009	2910	511.3	2,398.7	2910	1427.4	1482.6	2910	1697.4	1212.6
4/9/2009	2460	4.1	2,455.9	2460	1314.6	1145.4	2460	1582.9	877.1
4/10/2009	2070	0.0	2,070.0	2070	1154.8	915.2	2070	1406.6	663.4
4/11/2009	6300	3,807.0	2,493.0	6300	2294.9	4005.1	6300	2634.2	3665.8
4/12/2009	5970	2,748.6	3,221.4	5970	2689.3	3280.7	5970	3124.4	2845.6
4/13/2009	3760	209.9	3,550.1	3760	2226.8	1533.2	3760	2675.2	1084.8
4/14/2009	2850	0.0	2,850.0	2850	1768.6	1081.4	2850	2176.0	674.0
4/15/2009	2390	0.0	2,390.0	2390	1440.8	949.2	2390	1792.2	597.8
4/16/2009	1990	0.0	1,990.0	1990	1186.1	803.9	1990	1482.8	507.2
4/17/2009	1670	0.0	1,670.0	1670	985.5	684.5	1670	1234.1	435.9
4/18/2009	1470	0.0	1,470.0	1470	842.3	627.7	1470	1052.0	418.0
4/19/2009	1360	0.0	1,360.0	1360	749.6	610.4	1360	929.9	430.1
4/20/2009	1380	18.0	1,362.0	1380	715.5	664.5	1380	877.2	502.8
4/21/2009	1380	14.4	1,365.6	1380	700.9	679.1	1380	851.8	528.2
4/22/2009	1370	2.5	1,367.5	1370	691.8	678.2	1370	836.4	533.6
4/23/2009	1370	2.0	1,368.0	1370	687.9	682.1	1370	828.9	541.1
4/24/2009	1270	0.0	1,270.0	1270	657.7	612.3	1270	794.3	475.7
4/25/2009	1170	0.0	1,170.0	1170	616.2	553.8	1170	746.6	423.4
4/26/2009	1060	0.0	1,060.0	1060	566.9	493.1	1060	689.4	370.6
4/27/2009	965	0.0	965.0	965	518.7	446.3	965	632.3	332.7
4/28/2009	855	0.0	855.0	855	466.6	388.4	855	570.6	284.4
4/29/2009	799	0.0	799.0	799	428.2	370.8	799	523.4	275.6
4/30/2009	776	0.0	776.0	776	405.2	370.8	776	493.5	282.5
5/1/2009	745	0.0	745.0	745	386.5	358.5	745	469.5	275.5
5/2/2009	766	18.9	747.1	766	384.5	381.5	766	464.4	301.6
5/3/2009	853	93.4	759.6	853	408.5	444.5	853	488.9	364.1
5/4/2009	6170	4,860.0	1,310.0	6170	1937.9	4232.1	6170	2150.8	4019.2
5/5/2009	4040	1,971.0	2,069.0	4040	1984.8	2055.2	4040	2292.1	1747.9
5/6/2009	4580	2,062.8	2,517.2	4580	2159.2	2420.8	4580	2527.9	2052.1
5/7/2009	5810	2,757.3	3,052.7	5810	2585.4	3224.6	5810	3023.5	2786.5
5/8/2009	4270	819.8	3,450.2	4270	2328.0	1942.0	4270	2784.8	1485.2
5/9/2009	6980	3,094.8	3,885.2	6980	2992.0	3988.0	6980	3510.6	3469.4
5/10/2009	6750	2,268.9	4,481.1	6750	3210.9	3539.1	6750	3789.6	2960.4
5/11/2009	3750	0.0	3,750.0	3750	2447.5	1302.5	3750	2993.3	756.7
5/12/2009	2620	0.0	2,620.0	2620	1797.5	822.5	2620	2258.1	361.9
5/13/2009	1980	0.0	1,980.0	1980	1336.1	643.9	1980	1704.6	275.4
5/14/2009	1590	0.0	1,590.0	1590	1026.9	563.1	1590	1316.4	273.6
5/15/2009	1360	0.0	1,360.0	1360	828.7	531.3	1360	1057.6	302.4
5/16/2009	1220	0.0	1,220.0	1220	703.7	516.3	1220	889.2	330.8
5/17/2009	1340	108.0	1,232.0	1340	684.4	655.6	1340	845.1	494.9

5/18/2009	1120	0.0	1,120.0	1120	613.3	506.7	1120	755.6	364.4
5/19/2009	951	0.0	951.0	951	534.6	416.4	951	659.9	291.1
5/20/2009	834	0.0	834.0	834	467.4	366.6	834	577.4	256.6
5/21/2009	740	0.0	740.0	740	411.7	328.3	740	508.4	231.6
5/22/2009	652	0.0	652.0	652	362.7	289.3	652	447.8	204.2
5/23/2009	588	0.0	588.0	588	323.5	264.5	588	398.7	189.3
5/24/2009	550	0.0	550.0	550	295.8	254.2	550	363.1	186.9
5/25/2009	593	38.7	554.3	593	296.2	296.8	593	359.3	233.7
5/26/2009	1170	550.3	619.7	1170	461.2	708.8	1170	536.6	633.4
5/27/2009	1270	530.2	739.8	1270	560.5	709.5	1270	653.2	616.8
5/28/2009	1730	838.2	891.8	1730	734.5	995.5	1730	852.2	877.8
5/29/2009	2060	967.5	1,092.5	2060	903.4	1156.6	2060	1050.7	1009.3
5/30/2009	2310	999.0	1,311.0	2310	1047.2	1262.8	2310	1224.1	1085.9
5/31/2009	2580	1,042.2	1,537.8	2580	1185.9	1394.1	2580	1391.7	1188.3
6/1/2009	2590	842.8	1,747.2	2590	1248.3	1341.7	2590	1475.6	1114.4
6/2/2009	1690	0.0	1,690.0	1690	1017.8	672.2	1690	1236.9	453.1
6/3/2009	1290	0.0	1,290.0	1290	804.8	485.2	1290	997.4	292.6
6/4/2009	1150	0.0	1,150.0	1150	673.5	476.5	1150	838.4	311.6
6/5/2009	1620	423.0	1,197.0	1620	751.5	868.5	1620	907.5	712.5
6/6/2009	1480	212.4	1,267.6	1480	744.9	735.1	1480	897.4	582.6
6/7/2009	1160	0.0	1,160.0	1160	650.7	509.3	1160	793.2	366.8
6/8/2009	927	0.0	927.0	927	543.7	383.3	927	670.6	256.4
6/9/2009	808	0.0	808.0	808	463.9	344.1	808	574.5	233.5
6/10/2009	1120	280.8	839.2	1120	518.8	601.2	1120	624.9	495.1
6/11/2009	2960	1,880.6	1,079.4	2960	1068.1	1891.9	2960	1220.3	1739.7
6/12/2009	3340	1,846.5	1,493.5	3340	1412.0	1928.0	3340	1625.7	1714.3
6/13/2009	3880	1,963.2	1,916.8	3880	1713.7	2166.3	3880	1988.9	1891.1
6/14/2009	2580	400.6	2,179.4	2580	1471.6	1108.4	2580	1760.9	819.1
6/15/2009	1740	0.0	1,740.0	1740	1127.8	612.2	1740	1390.1	349.9
6/16/2009	1290	0.0	1,290.0	1290	851.9	438.1	1290	1071.4	218.6
6/17/2009	1130	0.0	1,130.0	1130	688.0	442.0	1130	867.9	262.1
6/18/2009	1010	0.0	1,010.0	1010	583.4	426.6	1010	732.4	277.6
6/19/2009	835	0.0	835.0	835	488.6	346.4	835	612.7	222.3
6/20/2009	733	0.0	733.0	733	418.8	314.2	733	523.3	209.7
6/21/2009	655	0.0	655.0	655	366.6	288.4	655	455.9	199.1
6/22/2009	576	0.0	576.0	576	321.7	254.3	576	398.8	177.2
6/23/2009	509	0.0	509.0	509	283.3	225.7	509	350.5	158.5
6/24/2009	456	0.0	456.0	456	251.7	204.3	456	310.7	145.3
6/25/2009	417	0.0	417.0	417	227.0	190.0	417	279.4	137.6
6/26/2009	438	18.9	419.1	438	222.4	215.6	438	270.8	167.2
6/27/2009	411	0.0	411.0	411	212.8	198.2	411	258.3	152.7
6/28/2009	367	0.0	367.0	367	196.0	171.0	367	238.6	128.4
6/29/2009	340	0.0	340.0	340	181.2	158.8	340	220.7	119.3
6/30/2009	321	0.0	321.0	321	169.4	151.6	321	206.2	114.8
7/1/2009	315	0.0	315.0	315	162.6	152.4	315	197.3	117.7
7/2/2009	309	0.0	309.0	309	158.0	151.0	309	191.1	117.9
7/3/2009	299	0.0	299.0	299	153.1	145.9	299	185.1	113.9
7/4/2009	282	0.0	282.0	282	146.2	135.8	282	176.9	105.1
7/5/2009	521	215.1	305.9	521	211.5	309.5	521	247.1	273.9
7/6/2009	1370	936.2	433.8	1370	482.1	887.9	1370	544.4	825.6

7/7/2009	814	248.5	565.5	814	439.2	374.8	814	515.5	298.5
7/8/2009	559	0.0	559.0	559	347.9	211.1	559	422.3	136.7
7/9/2009	429	0.0	429.0	429	271.7	157.3	429	337.0	92.0
7/10/2009	382	0.0	382.0	382	225.6	156.4	382	281.3	100.7
7/11/2009	472	81.0	391.0	472	231.5	240.5	472	282.3	189.7
7/12/2009	446	41.4	404.6	446	226.7	219.3	446	274.7	171.3
7/13/2009	374	0.0	374.0	374	204.0	170.0	374	248.7	125.3
7/14/2009	316	0.0	316.0	316	177.7	138.3	316	218.1	97.9
7/15/2009	284	0.0	284.0	284	157.3	126.7	284	193.4	90.6
7/16/2009	264	0.0	264.0	264	142.8	121.2	264	175.3	88.7
7/17/2009	251	0.0	251.0	251	132.9	118.1	251	162.5	88.5
7/18/2009	413	145.8	267.2	413	175.0	238.0	413	206.6	206.4
7/19/2009	387	93.2	293.8	387	185.6	201.4	387	219.9	167.1
7/20/2009	321	15.2	305.8	321	171.2	149.8	321	205.8	115.2
7/21/2009	377	62.6	314.4	377	181.1	195.9	377	216.3	160.7
7/22/2009	341	17.6	323.4	341	175.0	166.0	341	210.3	130.7
7/23/2009	289	0.0	289.0	289	157.6	131.4	289	191.2	97.8
7/24/2009	268	0.0	268.0	268	144.1	123.9	268	175.5	92.5
7/25/2009	250	0.0	250.0	250	133.2	116.8	250	162.3	87.7
7/26/2009	327	69.3	257.7	327	150.5	176.5	327	179.8	147.2
7/27/2009	1040	697.1	342.9	1040	361.6	678.4	1040	409.6	630.4
7/28/2009	737	285.0	452.0	737	365.6	371.4	737	426.4	310.6
7/29/2009	549	58.8	490.2	549	313.5	235.5	549	376.3	172.7
7/30/2009	583	77.6	505.4	583	300.9	282.1	583	362.6	220.4
7/31/2009	2500	1,787.4	712.6	2500	843.3	1656.7	2500	950.9	1549.1
8/1/2009	2430	1,366.9	1,063.1	2430	1055.7	1374.3	2430	1213.2	1216.8
8/2/2009	5720	4,054.5	1,665.5	5720	2086.7	3633.3	5720	2360.9	3359.1
8/3/2009	6320	3,783.6	2,536.4	6320	2700.0	3620.0	6320	3101.1	3218.9
8/4/2009	2330	0.0	2,330.0	2330	1822.9	507.1	2330	2220.2	109.8
8/5/2009	1540	0.0	1,540.0	1540	1221.2	318.8	1540	1540.0	0.0
8/6/2009	1240	0.0	1,240.0	1240	877.7	362.3	1240	1128.3	111.7
8/7/2009	1000	0.0	1,000.0	1000	661.9	338.1	1000	855.0	145.0
8/8/2009	799	0.0	799.0	799	511.9	287.1	799	660.7	138.3
8/9/2009	683	0.0	683.0	683	414.5	268.5	683	530.9	152.1
8/10/2009	604	0.0	604.0	604	350.2	253.8	604	443.8	160.2
8/11/2009	1060	410.4	649.6	1060	453.0	607.0	1060	543.2	516.8
8/12/2009	4950	3,829.3	1,120.7	4950	1608.4	3341.6	4950	1798.4	3151.6
8/13/2009	4710	2,847.5	1,862.5	4710	2035.0	2675.0	4710	2329.9	2380.1
8/14/2009	2230	46.0	2,184.0	2230	1509.3	720.7	2230	1816.9	413.1
8/15/2009	1490	0.0	1,490.0	1490	1072.6	417.4	1490	1339.5	150.5
8/16/2009	1120	0.0	1,120.0	1120	779.7	340.3	1120	994.3	125.7
8/17/2009	950	0.0	950.0	950	605.6	344.4	950	774.8	175.2
8/18/2009	774	0.0	774.0	774	480.7	293.3	774	614.3	159.7
8/19/2009	694	0.0	694.0	694	404.3	289.7	694	511.9	182.1
8/20/2009	654	0.0	654.0	654	360.1	293.9	654	450.1	203.9
8/21/2009	605	0.0	605.0	605	327.2	277.8	605	405.0	200.0
8/22/2009	794	170.1	623.9	794	367.1	426.9	794	442.0	352.0
8/23/2009	647	3.8	643.2	647	342.2	304.8	647	414.2	232.8
8/24/2009	553	0.0	553.0	553	304.6	248.4	553	371.6	181.4
8/25/2009	483	0.0	483.0	483	268.6	214.4	483	329.3	153.7

8/26/2009	431	0.0	431.0	431	238.2	192.8	431	292.7	138.3
8/27/2009	419	0.0	419.0	419	221.8	197.2	419	271.3	147.7
8/28/2009	381	0.0	381.0	381	203.9	177.1	381	249.2	131.8
8/29/2009	389	7.2	381.8	389	198.5	190.5	389	241.0	148.0
8/30/2009	437	49.0	388.0	437	209.9	227.1	437	252.0	185.0
8/31/2009	389	0.0	389.0	389	201.1	187.9	389	242.4	146.6
9/1/2009	341	0.0	341.0	341	183.6	157.4	341	222.8	118.2
9/2/2009	305	0.0	305.0	305	165.8	139.2	305	202.2	102.8
9/3/2009	293	0.0	293.0	293	154.8	138.2	293	188.6	104.4
9/4/2009	270	0.0	270.0	270	143.5	126.5	270	174.8	95.2
9/5/2009	268	0.0	268.0	268	138.1	129.9	268	167.6	100.4
9/6/2009	274	5.4	268.6	274	137.5	136.5	274	165.9	108.1
9/7/2009	322	47.5	274.5	322	150.9	171.1	322	180.0	142.0
9/8/2009	416	122.6	293.4	416	183.5	232.5	416	216.0	200.0
9/9/2009	362	49.5	312.5	362	182.1	179.9	362	216.6	145.4
9/10/2009	553	211.5	341.5	553	236.0	317.0	553	276.2	276.8
9/11/2009	454	80.1	373.9	454	230.9	223.1	454	274.2	179.8
9/12/2009	350	0.0	350.0	350	198.9	151.1	350	241.0	109.0
9/13/2009	301	0.0	301.0	301	171.3	129.7	301	209.8	91.2
9/14/2009	298	0.0	298.0	298	158.5	139.5	298	193.7	104.3
9/15/2009	279	0.0	279.0	279	147.7	131.3	279	180.1	98.9
9/16/2009	249	0.0	249.0	249	134.4	114.6	249	164.2	84.8
9/17/2009	238	0.0	238.0	238	125.6	112.4	238	153.1	84.9
9/18/2009	239	0.9	238.1	239	122.1	116.9	239	148.1	90.9
9/19/2009	235	0.0	235.0	235	119.5	115.5	235	144.4	90.6
9/20/2009	237	1.8	235.2	237	118.9	118.1	237	143.3	93.7
9/21/2009	236	0.5	235.5	236	118.4	117.6	236	142.4	93.6
9/22/2009	239	3.1	235.9	239	119.0	120.0	239	142.9	96.1
9/23/2009	241	4.3	236.7	241	119.9	121.1	241	143.8	97.2
9/24/2009	234	0.0	234.0	234	118.2	115.8	234	142.0	92.0
9/25/2009	254	18.0	236.0	254	123.2	130.8	254	147.4	106.6
9/26/2009	1050	730.8	319.2	1050	352.8	697.2	1050	397.0	653.0
9/27/2009	2240	1,655.6	584.4	2240	791.2	1448.8	2240	886.8	1353.2
9/28/2009	1150	343.5	806.5	1150	667.7	482.3	1150	785.0	365.0
9/29/2009	701	0.0	701.0	701	486.4	214.6	701	596.5	104.5
9/30/2009	508	0.0	508.0	508	353.6	154.4	508	445.6	62.4
10/1/2009	436	0.0	436.0	436	276.1	159.9	436	350.4	85.6
10/2/2009	378	0.0	378.0	378	226.3	151.7	378	286.5	91.5
10/3/2009	361	0.0	361.0	361	200.1	160.9	361	250.3	110.7
10/4/2009	323	0.0	323.0	323	178.1	144.9	323	221.1	101.9
10/5/2009	307	0.0	307.0	307	164.0	143.0	307	202.0	105.0
10/6/2009	286	0.0	286.0	286	152.0	134.0	286	186.3	99.7
10/7/2009	268	0.0	268.0	268	141.7	126.3	268	173.1	94.9
10/8/2009	275	6.3	268.7	275	139.3	135.7	275	168.9	106.1
10/9/2009	264	0.0	264.0	264	135.1	128.9	264	163.5	100.5
10/10/2009	379	103.5	275.5	379	166.2	212.8	379	196.5	182.5
10/11/2009	463	158.4	304.6	463	203.5	259.5	463	238.6	224.4
10/12/2009	369	42.1	326.9	369	192.6	176.4	369	229.7	139.3
10/13/2009	319	0.0	319.0	319	173.7	145.3	319	209.9	109.1
10/14/2009	299	0.0	299.0	299	159.9	139.1	299	194.1	104.9

10/15/2009	348	44.1	303.9	348	167.9	180.1	348	201.7	146.3
10/16/2009	573	237.8	335.2	573	235.7	337.3	573	275.2	297.8
10/17/2009	663	271.2	391.8	663	290.4	372.6	663	338.6	324.4
10/18/2009	590	151.3	438.7	590	293.0	297.0	590	346.6	243.4
10/19/2009	514	52.6	461.4	514	272.4	241.6	514	326.8	187.2
10/20/2009	453	0.0	453.0	453	246.2	206.8	453	298.4	154.6
10/21/2009	414	0.0	414.0	414	223.8	190.2	414	272.5	141.5
10/22/2009	375	0.0	375.0	375	203.1	171.9	375	247.9	127.1
10/23/2009	352	0.0	352.0	352	187.6	164.4	352	228.9	123.1
10/24/2009	348	0.0	348.0	348	179.8	168.2	348	218.5	129.5
10/25/2009	656	277.2	378.8	656	264.5	391.5	656	309.1	346.9
10/26/2009	627	195.7	431.3	627	292.5	334.5	627	343.8	283.2
10/27/2009	476	20.6	455.4	476	261.4	214.6	476	313.7	162.3
10/28/2009	492	30.9	461.1	492	252.6	239.4	492	304.1	187.9
10/29/2009	742	249.7	492.3	742	320.2	421.8	742	377.1	364.9
10/30/2009	623	92.7	530.3	623	315.2	307.8	623	375.4	247.6
10/31/2009	547	5.7	541.3	547	291.4	255.6	547	351.0	196.0
11/1/2009	570	25.3	544.7	570	287.7	282.3	570	346.3	223.7
11/2/2009	1110	506.2	603.8	1110	440.5	669.5	1110	511.7	598.3
11/3/2009	913	227.7	685.3	913	449.6	463.4	913	530.4	382.6
11/4/2009	708	0.0	708.0	708	395.0	313.0	708	475.8	232.2
11/5/2009	598	0.0	598.0	598	340.1	257.9	598	415.3	182.7
11/6/2009	520	0.0	520.0	520	294.3	225.7	520	361.9	158.1
11/7/2009	455	0.0	455.0	455	256.1	198.9	455	315.9	139.1
11/8/2009	420	0.0	420.0	420	229.8	190.2	420	282.8	137.2
11/9/2009	378	0.0	378.0	378	206.5	171.5	378	253.9	124.1
11/10/2009	350	0.0	350.0	350	188.5	161.5	350	231.2	118.8
11/11/2009	333	0.0	333.0	333	175.9	157.1	333	214.9	118.1
11/12/2009	338	4.5	333.5	338	172.0	166.0	338	208.7	129.3
11/13/2009	346	10.8	335.2	346	172.6	173.4	346	208.1	137.9
11/14/2009	333	0.0	333.0	333	169.1	163.9	333	203.8	129.2
11/15/2009	332	0.0	332.0	332	167.3	164.7	332	201.4	130.6
11/16/2009	316	0.0	316.0	316	162.0	154.0	316	195.3	120.7
11/17/2009	301	0.0	301.0	301	155.4	145.6	301	187.7	113.3
11/18/2009	297	0.0	297.0	297	151.5	145.5	297	182.8	114.2
11/19/2009	288	0.0	288.0	288	147.2	140.8	288	177.6	110.4
11/20/2009	295	6.3	288.7	295	147.4	147.6	295	177.3	117.7
11/21/2009	297	6.8	290.2	297	148.0	149.0	297	177.8	119.2
11/22/2009	289	0.0	289.0	289	146.0	143.0	289	175.5	113.5
11/23/2009	283	0.0	283.0	283	143.4	139.6	283	172.6	110.4
11/24/2009	297	12.6	284.4	297	146.3	150.7	297	175.5	121.5
11/25/2009	306	18.2	287.8	306	150.1	155.9	306	179.7	126.3
11/26/2009	293	2.8	290.2	293	148.1	144.9	293	177.7	115.3
11/27/2009	286	0.0	286.0	286	145.2	140.8	286	174.5	111.5
11/28/2009	288	1.8	286.2	288	144.5	143.5	288	173.6	114.4
11/29/2009	286	0.0	286.0	286	143.6	142.4	286	172.6	113.4
11/30/2009	301	13.5	287.5	301	147.6	153.4	301	176.7	124.3
12/1/2009	493	183.6	309.4	493	204.1	288.9	493	238.3	254.7
12/2/2009	592	236.0	356.0	592	256.6	335.4	592	298.8	293.2
12/3/2009	1010	565.0	445.0	1010	398.5	611.5	1010	457.7	552.3

12/4/2009	1250	668.0	582.0	1250	527.9	722.1	1250	608.9	641.1
12/5/2009	1120	417.4	702.6	1120	546.3	573.7	1120	641.5	478.5
12/6/2009	987	214.2	772.8	987	516.1	470.9	987	616.0	371.0
12/7/2009	799	2.2	796.8	799	449.5	349.5	799	545.4	253.6
12/8/2009	745	0.0	745.0	745	405.5	339.5	745	494.5	250.5
12/9/2009	4330	3,226.5	1,103.5	4330	1410.9	2919.1	4330	1582.5	2747.5
12/10/2009	5620	3,742.2	1,877.8	5620	2210.4	3409.6	5620	2508.1	3111.9
12/11/2009	2540	221.8	2,318.2	2540	1673.0	867.0	2540	1999.1	540.9
12/12/2009	1650	0.0	1,650.0	1650	1188.4	461.6	1650	1477.1	172.9
12/13/2009	1360	0.0	1,360.0	1360	897.9	462.1	1360	1135.2	224.8
12/14/2009	1380	18.0	1,362.0	1380	779.1	600.9	1380	976.3	403.7
12/15/2009	1200	0.0	1,200.0	1200	676.8	523.2	1200	843.7	356.3
12/16/2009	1030	0.0	1,030.0	1030	584.3	445.7	1030	727.0	303.0
12/17/2009	894	0.0	894.0	894	505.9	388.1	894	628.4	265.6
12/18/2009	1000	95.4	904.6	1000	502.5	497.5	1000	613.7	386.3
12/19/2009	1150	211.3	938.7	1150	543.9	606.1	1150	653.2	496.8
12/20/2009	1410	403.1	1,006.9	1410	636.0	774.0	1410	752.9	657.1
12/21/2009	1310	232.4	1,077.6	1310	646.8	663.2	1310	770.0	540.0
12/22/2009	1250	132.0	1,118.0	1250	634.4	615.6	1250	759.7	490.3
12/23/2009	1350	195.6	1,154.4	1350	657.6	692.4	1350	785.7	564.3
12/24/2009	1460	255.5	1,204.5	1460	699.0	761.0	1460	832.4	627.6
12/25/2009	2610	1,239.4	1,370.6	2610	1045.3	1564.7	2610	1211.9	1398.1
12/26/2009	5570	3,655.5	1,914.5	5570	2039.4	3530.6	5570	2313.7	3256.3
12/27/2009	4080	1,583.4	2,496.6	4080	2039.7	2040.3	4080	2383.1	1696.9
12/28/2009	2750	69.7	2,680.3	2750	1659.9	1090.1	2750	2003.9	746.1
12/29/2009	2200	0.0	2,200.0	2200	1340.0	860.0	2200	1650.2	549.8
12/30/2009	1620	0.0	1,620.0	1620	1037.1	582.9	1620	1299.4	320.6
12/31/2009	1420	0.0	1,420.0	1420	850.2	569.8	1420	1068.0	352.0
1/1/2010	1440	18.0	1,422.0	1440	775.8	664.2	1440	962.5	477.5
1/2/2010	1470	41.4	1,428.6	1470	752.5	717.5	1470	920.8	549.2
1/3/2010	1390	0.0	1,390.0	1390	719.6	670.4	1390	875.9	514.1
1/4/2010	1250	0.0	1,250.0	1250	665.6	584.4	1250	810.8	439.2
1/5/2010	1170	0.0	1,170.0	1170	619.5	550.5	1170	754.5	415.5
1/6/2010	1060	0.0	1,060.0	1060	568.4	491.6	1060	693.2	366.8
1/7/2010	965	0.0	965.0	965	519.3	445.7	965	634.1	330.9
1/8/2010	905	0.0	905.0	905	481.1	423.9	905	587.0	318.0
1/9/2010	797	0.0	797.0	797	433.9	363.1	797	530.7	266.3
1/10/2010	758	0.0	758.0	758	402.5	355.5	758	491.5	266.5
1/11/2010	854	86.4	767.6	854	416.5	437.5	854	502.3	351.7
1/12/2010	720	0.0	720.0	720	384.2	335.8	720	465.9	254.1
1/13/2010	697	0.0	697.0	697	363.8	333.2	697	441.2	255.8
Totals	465073	115563.73	349509.27	465073	232790.14	232282.86	465073	279161.6	185911.4

8. Base Flow

Manual

Baseflow	Baseflow	Overland flow	Tot. Flow
ft3/day	ft3/day	ft3/day	ft3/day
223,557,274	223557273.8	1,082,726	224,640,000
177,403,880	177403880.3	580,120	177,984,000
141,345,719	141345719.5	1,214,281	142,560,000
111,057,252	110592000	0	110,592,000
83,653,631	79747200	0	79,747,200
74,999,784	74999783.65	45,096,216	120,096,000
67,788,013	67788013.03	29,843,987	97,632,000
62,019,012	62019011.93	16,000,188	78,019,200
62,019,012	62019011.93	5,286,588	67,305,600
59,134,165	59134165.22	222,635	59,356,800
54,807,241	54807241.31	2,216,759	57,024,000
56,250,011	56250010.82	82,789	56,332,800
56,250,011	54691200	0	54,691,200
51,923,087	51923086.91	262,513	52,185,600
53,365,164	52012800	0	52,012,800
51,923,087	51923086.91	221,100,913	273,024,000
49,038,240	49038240.2	733,745,760	782,784,000
79,326,708	79326707.56	293,921,292	373,248,000
92,307,479	92307479.29	144,428,521	236,736,000
95,192,326	95192326	87,975,674	183,168,000
112,500,022	112500021.6	61,163,978	173,664,000
157,211,338	154656000	0	154,656,000
132,691,872	132691871.7	364,128	133,056,000
112,500,022	109728000	0	109,728,000
102,403,404	100224000	0	100,224,000
96,634,403	94176000	0	94,176,000
92,307,479	92307479.29	10,508,521	102,816,000
90,865,402	90865402.09	11,086,598	101,952,000
93,749,556	93749556.49	3,018,444	96,768,000
87,980,555	87980555.38	5,331,445	93,312,000
87,980,555	87980555.38	15,699,445	103,680,000
87,980,555	87980555.38	17,427,445	105,408,000
85,095,709	85095708.67	15,128,291	100,224,000
83,653,631	83653631.47	11,386,369	95,040,000
85,095,709	85095708.67	699,491	85,795,200
74,999,784	74999783.65	2,587,416	77,587,200
74,999,784	74649600	0	74,649,600
72,114,937	72114936.94	13,161,863	85,276,800
66,345,936	66345935.83	15,215,664	81,561,600
66,345,936	66345935.83	6,402,864	72,748,800
69,230,783	69230782.54	3,258,817	72,489,600
70,672,860	69984000	0	69,984,000

59,134,165	59134165.22	3,765,035	62,899,200
57,692,088	57692088.02	1,923,912	59,616,000
60,576,935	60307200	0	60,307,200
56,250,011	56250010.82	9,327,589	65,577,600
62,019,012	62019011.93	17,987,388	80,006,400
64,903,859	64903858.63	24,088,141	88,992,000
67,788,013	67788013.03	35,027,987	102,816,000
70,672,860	70672859.74	26,959,140	97,632,000
74,999,784	74999783.65	14,856,216	89,856,000
87,980,555	84153600	0	84,153,600
80,768,785	79574400	0	79,574,400
79,326,708	73958400	0	73,958,400
69,230,783	68083200	0	68,083,200
64,903,859	64903858.63	1,710,541	66,614,400
59,134,165	59134165.22	4,542,635	63,676,800
59,134,165	58752000	0	58,752,000
57,692,088	55123200	0	55,123,200
56,250,011	55814400	0	55,814,400
56,250,011	56250010.82	9,932,389	66,182,400
64,903,859	64903858.63	69,880,141	134,784,000
62,019,012	62019011.93	142,748,988	204,768,000
64,903,859	64903858.63	197,752,141	262,656,000
72,114,937	72114936.94	194,861,063	266,976,000
83,653,631	83653631.47	127,162,369	210,816,000
92,307,479	92307479.29	76,172,521	168,480,000
96,634,403	96634403.2	38,149,597	134,784,000
109,615,175	109615174.9	4,432,825	114,048,000
103,846,174	100224000	0	100,224,000
90,865,402	88992000	0	88,992,000
83,653,631	83635200	0	83,635,200
83,653,631	83653631.47	26,074,369	109,728,000
86,538,478	86538478.18	67,253,522	153,792,000
83,653,631	83653631.47	247,258,369	330,912,000
87,980,555	87980555.38	347,475,445	435,456,000
98,076,480	98076480.4	252,707,520	350,784,000
105,288,251	105288251	141,815,749	247,104,000
112,500,022	112500021.6	85,355,978	197,856,000
122,595,947	122595946.7	46,748,053	169,344,000
139,903,642	139903642.3	25,120,358	165,024,000
132,691,872	132691871.7	83,308,128	216,000,000
138,461,565	138461565.1	59,394,435	197,856,000
137,018,796	137018795.6	78,117,204	215,136,000
144,230,566	144230566.2	120,153,434	264,384,000
147,115,413	147115412.9	104,308,587	251,424,000
149,999,567	149999567.3	62,544,433	212,544,000
149,999,567	149999567.3	28,848,433	178,848,000
138,461,565	138461565.1	405,858,435	544,320,000
145,672,643	145672643.4	370,135,357	515,808,000

147,115,413	147115412.9	177,748,587	324,864,000
151,442,337	151442336.8	94,797,663	246,240,000
148,557,490	148557490.1	57,938,510	206,496,000
147,115,413	147115412.9	24,820,587	171,936,000
141,345,719	141345719.5	2,942,281	144,288,000
125,480,793	125480793.4	1,527,207	127,008,000
119,711,100	117504000	0	117,504,000
111,057,252	111057252.1	8,174,748	119,232,000
103,846,174	103846173.8	15,385,826	119,232,000
95,192,326	95192326	23,175,674	118,368,000
93,749,556	93749556.49	24,618,444	118,368,000
86,538,478	86538478.18	23,189,522	109,728,000
85,095,709	85095708.67	15,992,291	101,088,000
89,422,633	89422632.58	2,161,367	91,584,000
83,653,631	83376000	0	83,376,000
76,441,861	73872000	0	73,872,000
72,114,937	69033600	0	69,033,600
66,345,936	66345935.83	700,464	67,046,400
67,788,013	64368000	0	64,368,000
67,788,013	66182400	0	66,182,400
62,019,012	62019011.93	11,680,188	73,699,200
67,788,013	67788013.03	465,299,987	533,088,000
67,788,013	67788013.03	281,267,987	349,056,000
76,441,861	76441860.85	319,270,139	395,712,000
96,634,403	96634403.2	405,349,597	501,984,000
108,173,098	108173097.7	260,754,902	368,928,000
112,500,022	112500021.6	490,571,978	603,072,000
111,057,252	111057252.1	472,142,748	583,200,000
119,711,100	119711099.9	204,288,900	324,000,000
126,922,871	126922870.6	99,445,129	226,368,000
126,922,871	126922870.6	44,149,129	171,072,000
135,576,718	135576718.4	1,799,282	137,376,000
116,826,946	116826945.5	677,054	117,504,000
105,288,251	105288251	119,749	105,408,000
93,749,556	93749556.49	22,026,444	115,776,000
90,865,402	90865402.09	5,902,598	96,768,000
83,653,631	82166400	0	82,166,400
72,114,937	72057600	0	72,057,600
69,230,783	63936000	0	63,936,000
56,250,011	56250010.82	82,789	56,332,800
54,807,241	50803200	0	50,803,200
46,153,393	46153393.49	1,366,607	47,520,000
57,406,222	51235200	0	51,235,200
59,258,667	59258666.67	41,829,333	101,088,000
61,111,111	61111111.11	48,616,889	109,728,000
62,961,778	62961777.78	86,510,222	149,472,000
72,222,222	72222222.22	105,761,778	177,984,000
85,184,000	85184000	114,400,000	199,584,000

88,888,889	88888888.89	134,023,111	222,912,000
96,295,111	96295111.11	127,480,889	223,776,000
92,592,000	92592000	53,424,000	146,016,000
107,406,222	107406222.2	4,049,778	111,456,000
103,703,111	99360000	0	99,360,000
96,295,111	96295111.11	43,672,889	139,968,000
83,333,333	83333333.33	44,538,667	127,872,000
74,072,889	74072888.89	26,151,111	100,224,000
70,369,778	70369777.78	9,723,022	80,092,800
72,222,222	69811200	0	69,811,200
70,369,778	70369777.78	26,398,222	96,768,000
72,222,222	72222222.22	183,521,778	255,744,000
74,072,889	74072888.89	214,503,111	288,576,000
77,777,778	77777777.78	257,454,222	335,232,000
72,222,222	72222222.22	150,689,778	222,912,000
77,777,778	77777777.78	72,558,222	150,336,000
75,925,333	75925333.33	35,530,667	111,456,000
74,072,889	74072888.89	23,559,111	97,632,000
81,480,889	81480888.89	5,783,111	87,264,000
75,925,333	72144000	0	72,144,000
74,072,889	63331200	0	63,331,200
61,111,111	56592000	0	56,592,000
55,555,556	49766400	0	49,766,400
50,000,000	43977600	0	43,977,600
46,295,111	39398400	0	39,398,400
35,184,000	35184000	844,800	36,028,800
33,333,333	33333333.33	4,509,867	37,843,200
35,184,000	35184000	326,400	35,510,400
35,184,000	31708800	0	31,708,800
35,184,000	29376000	0	29,376,000
29,628,444	27734400	0	27,734,400
27,777,778	27216000	0	27,216,000
31,480,889	26697600	0	26,697,600
29,628,444	25833600	0	25,833,600
29,628,444	24364800	0	24,364,800
29,628,444	29628444.44	15,385,956	45,014,400
35,184,000	35184000	83,184,000	118,368,000
40,739,556	40739555.56	29,590,044	70,329,600
31,480,889	31480888.89	16,816,711	48,297,600
33,333,333	33333333.33	3,732,267	37,065,600
31,480,889	31480888.89	1,523,911	33,004,800
31,480,889	31480888.89	9,299,911	40,780,800
31,480,889	31480888.89	7,053,511	38,534,400
33,333,333	32313600	0	32,313,600
27,777,778	27302400	0	27,302,400
27,777,778	24537600	0	24,537,600
29,628,444	22809600	0	22,809,600
27,777,778	21686400	0	21,686,400

35,184,000	35184000	499,200	35,683,200
33,333,333	33333333.33	103,467	33,436,800
27,777,778	27734400	0	27,734,400
33,333,333	32572800	0	32,572,800
33,333,333	29462400	0	29,462,400
27,777,778	24969600	0	24,969,600
27,777,778	23155200	0	23,155,200
29,628,444	21600000	0	21,600,000
27,777,778	27777777.78	475,022	28,252,800
33,333,333	33333333.33	56,522,667	89,856,000
33,333,333	33333333.33	30,343,467	63,676,800
37,036,444	37036444.44	10,397,156	47,433,600
53,703,111	50371200	0	50,371,200
40,739,556	40739555.56	175,260,444	216,000,000
53,703,111	53703111.11	156,248,889	209,952,000
66,666,667	66666666.67	427,541,333	494,208,000
81,480,889	81480888.89	464,567,111	546,048,000
81,480,889	81480888.89	119,831,111	201,312,000
112,961,778	112961777.8	20,094,222	133,056,000
107,406,222	107136000	0	107,136,000
83,333,333	83333333.33	3,066,667	86,400,000
74,072,889	69033600	0	69,033,600
57,406,222	57406222.22	1,604,978	59,011,200
57,406,222	52185600	0	52,185,600
53,703,111	53703111.11	37,880,889	91,584,000
53,703,111	53703111.11	373,976,889	427,680,000
64,814,222	64814222.22	342,129,778	406,944,000
72,222,222	72222222.22	120,449,778	192,672,000
70,369,778	70369777.78	58,366,222	128,736,000
83,333,333	83333333.33	13,434,667	96,768,000
88,888,889	82080000	0	82,080,000
74,072,889	66873600	0	66,873,600
59,258,667	59258666.67	702,933	59,961,600
59,258,667	56505600	0	56,505,600
51,850,667	51850666.67	421,333	52,272,000
50,000,000	50000000	18,601,600	68,601,600
42,592,000	42592000	13,308,800	55,900,800
46,295,111	46295111.11	1,484,089	47,779,200
42,592,000	41731200	0	41,731,200
29,628,444	29628444.44	7,609,956	37,238,400
37,036,444	36201600	0	36,201,600
37,036,444	32918400	0	32,918,400
33,333,333	33333333.33	276,267	33,609,600
25,925,333	25925333.33	11,831,467	37,756,800
35,184,000	33609600	0	33,609,600
35,184,000	29462400	0	29,462,400
29,628,444	26352000	0	26,352,000
29,628,444	25315200	0	25,315,200

27,777,778	23328000	0	23,328,000
29,628,444	23155200	0	23,155,200
27,777,778	23673600	0	23,673,600
27,777,778	27777777.78	43,022	27,820,800
24,072,889	24072888.89	11,869,511	35,942,400
20,369,778	20369777.78	10,907,022	31,276,800
31,480,889	31480888.89	16,298,311	47,779,200
29,628,444	29628444.44	9,597,156	39,225,600
31,480,889	30240000	0	30,240,000
25,925,333	25925333.33	81,067	26,006,400
27,777,778	25747200	0	25,747,200
17,974,813,774	17,728,156,877		31,115,059,200
0.58	0.57		

Discharge (Tornado, WV)

Date	Q(cfs)	Q(cfd)
1/13/2009	2600	224640000
1/14/2009	2060	177984000
1/15/2009	1650	142560000
1/16/2009	1280	110592000
1/17/2009	923	79747200
1/18/2009	1390	120096000
1/19/2009	1130	97632000
1/20/2009	903	78019200
1/21/2009	779	67305600
1/22/2009	687	59356800
1/23/2009	660	57024000
1/24/2009	652	56332800
1/25/2009	633	54691200
1/26/2009	604	52185600
1/27/2009	602	52012800
1/28/2009	3160	273024000
1/29/2009	9060	782784000
1/30/2009	4320	373248000
1/31/2009	2740	236736000
2/1/2009	2120	183168000
2/2/2009	2010	173664000
2/3/2009	1790	154656000
2/4/2009	1540	133056000
2/5/2009	1270	109728000
2/6/2009	1160	100224000
2/7/2009	1090	94176000
2/8/2009	1190	102816000
2/9/2009	1180	101952000
2/10/2009	1120	96768000
2/11/2009	1080	93312000
2/12/2009	1200	103680000
2/13/2009	1220	105408000
2/14/2009	1160	100224000
2/15/2009	1100	95040000
2/16/2009	993	85795200
2/17/2009	898	77587200

2/18/2009	864	74649600
2/19/2009	987	85276800
2/20/2009	944	81561600
2/21/2009	842	72748800
2/22/2009	839	72489600
2/23/2009	810	69984000
2/24/2009	728	62899200
2/25/2009	690	59616000
2/26/2009	698	60307200
2/27/2009	759	65577600
2/28/2009	926	80006400
3/1/2009	1030	88992000
3/2/2009	1190	102816000
3/3/2009	1130	97632000
3/4/2009	1040	89856000
3/5/2009	974	84153600
3/6/2009	921	79574400
3/7/2009	856	73958400
3/8/2009	788	68083200
3/9/2009	771	66614400
3/10/2009	737	63676800
3/11/2009	680	58752000
3/12/2009	638	55123200
3/13/2009	646	55814400
3/14/2009	766	66182400
3/15/2009	1560	134784000
3/16/2009	2370	204768000
3/17/2009	3040	262656000
3/18/2009	3090	266976000
3/19/2009	2440	210816000
3/20/2009	1950	168480000
3/21/2009	1560	134784000
3/22/2009	1320	114048000
3/23/2009	1160	100224000
3/24/2009	1030	88992000
3/25/2009	968	83635200
3/26/2009	1270	109728000
3/27/2009	1780	153792000
3/28/2009	3830	330912000
3/29/2009	5040	435456000
3/30/2009	4060	350784000

3/31/2009	2860	247104000
4/1/2009	2290	197856000
4/2/2009	1960	169344000
4/3/2009	1910	165024000
4/4/2009	2500	216000000
4/5/2009	2290	197856000
4/6/2009	2490	215136000
4/7/2009	3060	264384000
4/8/2009	2910	251424000
4/9/2009	2460	212544000
4/10/2009	2070	178848000
4/11/2009	6300	544320000
4/12/2009	5970	515808000
4/13/2009	3760	324864000
4/14/2009	2850	246240000
4/15/2009	2390	206496000
4/16/2009	1990	171936000
4/17/2009	1670	144288000
4/18/2009	1470	127008000
4/19/2009	1360	117504000
4/20/2009	1380	119232000
4/21/2009	1380	119232000
4/22/2009	1370	118368000
4/23/2009	1370	118368000
4/24/2009	1270	109728000
4/25/2009	1170	101088000
4/26/2009	1060	91584000
4/27/2009	965	83376000
4/28/2009	855	73872000
4/29/2009	799	69033600
4/30/2009	776	67046400
5/1/2009	745	64368000
5/2/2009	766	66182400
5/3/2009	853	73699200
5/4/2009	6170	533088000
5/5/2009	4040	349056000
5/6/2009	4580	395712000
5/7/2009	5810	501984000
5/8/2009	4270	368928000
5/9/2009	6980	603072000
5/10/2009	6750	583200000

5/11/2009	3750	324000000
5/12/2009	2620	226368000
5/13/2009	1980	171072000
5/14/2009	1590	137376000
5/15/2009	1360	117504000
5/16/2009	1220	105408000
5/17/2009	1340	115776000
5/18/2009	1120	96768000
5/19/2009	951	82166400
5/20/2009	834	72057600
5/21/2009	740	63936000
5/22/2009	652	56332800
5/23/2009	588	50803200
5/24/2009	550	47520000
5/25/2009	593	51235200
5/26/2009	1170	101088000
5/27/2009	1270	109728000
5/28/2009	1730	149472000
5/29/2009	2060	177984000
5/30/2009	2310	199584000
5/31/2009	2580	222912000
6/1/2009	2590	223776000
6/2/2009	1690	146016000
6/3/2009	1290	111456000
6/4/2009	1150	99360000
6/5/2009	1620	139968000
6/6/2009	1480	127872000
6/7/2009	1160	100224000
6/8/2009	927	80092800
6/9/2009	808	69811200
6/10/2009	1120	96768000
6/11/2009	2960	255744000
6/12/2009	3340	288576000
6/13/2009	3880	335232000
6/14/2009	2580	222912000
6/15/2009	1740	150336000
6/16/2009	1290	111456000
6/17/2009	1130	97632000
6/18/2009	1010	87264000
6/19/2009	835	72144000
6/20/2009	733	63331200

6/21/2009	655	56592000
6/22/2009	576	49766400
6/23/2009	509	43977600
6/24/2009	456	39398400
6/25/2009	417	36028800
6/26/2009	438	37843200
6/27/2009	411	35510400
6/28/2009	367	31708800
6/29/2009	340	29376000
6/30/2009	321	27734400
7/1/2009	315	27216000
7/2/2009	309	26697600
7/3/2009	299	25833600
7/4/2009	282	24364800
7/5/2009	521	45014400
7/6/2009	1370	118368000
7/7/2009	814	70329600
7/8/2009	559	48297600
7/9/2009	429	37065600
7/10/2009	382	33004800
7/11/2009	472	40780800
7/12/2009	446	38534400
7/13/2009	374	32313600
7/14/2009	316	27302400
7/15/2009	284	24537600
7/16/2009	264	22809600
7/17/2009	251	21686400
7/18/2009	413	35683200
7/19/2009	387	33436800
7/20/2009	321	27734400
7/21/2009	377	32572800
7/22/2009	341	29462400
7/23/2009	289	24969600
7/24/2009	268	23155200
7/25/2009	250	21600000
7/26/2009	327	28252800
7/27/2009	1040	89856000
7/28/2009	737	63676800
7/29/2009	549	47433600
7/30/2009	583	50371200
7/31/2009	2500	216000000

8/1/2009	2430	209952000
8/2/2009	5720	494208000
8/3/2009	6320	546048000
8/4/2009	2330	201312000
8/5/2009	1540	133056000
8/6/2009	1240	107136000
8/7/2009	1000	86400000
8/8/2009	799	69033600
8/9/2009	683	59011200
8/10/2009	604	52185600
8/11/2009	1060	91584000
8/12/2009	4950	427680000
8/13/2009	4710	406944000
8/14/2009	2230	192672000
8/15/2009	1490	128736000
8/16/2009	1120	96768000
8/17/2009	950	82080000
8/18/2009	774	66873600
8/19/2009	694	59961600
8/20/2009	654	56505600
8/21/2009	605	52272000
8/22/2009	794	68601600
8/23/2009	647	55900800
8/24/2009	553	47779200
8/25/2009	483	41731200
8/26/2009	431	37238400
8/27/2009	419	36201600
8/28/2009	381	32918400
8/29/2009	389	33609600
8/30/2009	437	37756800
8/31/2009	389	33609600
9/1/2009	341	29462400
9/2/2009	305	26352000
9/3/2009	293	25315200
9/4/2009	270	23328000
9/5/2009	268	23155200
9/6/2009	274	23673600
9/7/2009	322	27820800
9/8/2009	416	35942400
9/9/2009	362	31276800
9/10/2009	553	47779200

9/11/2009	454	39225600
9/12/2009	350	30240000
9/13/2009	301	26006400
9/14/2009	298	25747200
9/15/2009	279	24105600
9/16/2009	249	21513600
9/17/2009	238	20563200
9/18/2009	239	20649600
9/19/2009	235	20304000
9/20/2009	237	20476800
9/21/2009	236	20390400
9/22/2009	239	20649600
9/23/2009	241	20822400
9/24/2009	234	20217600
9/25/2009	254	21945600
9/26/2009	1050	90720000
9/27/2009	2240	193536000
9/28/2009	1150	99360000
9/29/2009	701	60566400
9/30/2009	508	43891200
10/1/2009	436	37670400
10/2/2009	378	32659200
10/3/2009	361	31190400
10/4/2009	323	27907200
10/5/2009	307	26524800
10/6/2009	286	24710400
10/7/2009	268	23155200
10/8/2009	275	23760000
10/9/2009	264	22809600
10/10/2009	379	32745600
10/11/2009	463	40003200
10/12/2009	369	31881600
10/13/2009	319	27561600
10/14/2009	299	25833600
10/15/2009	348	30067200
10/16/2009	573	49507200
10/17/2009	663	57283200
10/18/2009	590	50976000
10/19/2009	514	44409600
10/20/2009	453	39139200
10/21/2009	414	35769600

10/22/2009	375	32400000
10/23/2009	352	30412800
10/24/2009	348	30067200
10/25/2009	656	56678400
10/26/2009	627	54172800
10/27/2009	476	41126400
10/28/2009	492	42508800
10/29/2009	742	64108800
10/30/2009	623	53827200
10/31/2009	547	47260800
11/1/2009	570	49248000
11/2/2009	1110	95904000
11/3/2009	913	78883200
11/4/2009	708	61171200
11/5/2009	598	51667200
11/6/2009	520	44928000
11/7/2009	455	39312000
11/8/2009	420	36288000
11/9/2009	378	32659200
11/10/2009	350	30240000
11/11/2009	333	28771200
11/12/2009	338	29203200
11/13/2009	346	29894400
11/14/2009	333	28771200
11/15/2009	332	28684800
11/16/2009	316	27302400
11/17/2009	301	26006400
11/18/2009	297	25660800
11/19/2009	288	24883200
11/20/2009	295	25488000
11/21/2009	297	25660800
11/22/2009	289	24969600
11/23/2009	283	24451200
11/24/2009	297	25660800
11/25/2009	306	26438400
11/26/2009	293	25315200
11/27/2009	286	24710400
11/28/2009	288	24883200
11/29/2009	286	24710400
11/30/2009	301	26006400
12/1/2009	493	42595200

12/2/2009	592	51148800
12/3/2009	1010	87264000
12/4/2009	1250	108000000
12/5/2009	1120	96768000
12/6/2009	987	85276800
12/7/2009	799	69033600
12/8/2009	745	64368000
12/9/2009	4330	374112000
12/10/2009	5620	485568000
12/11/2009	2540	219456000
12/12/2009	1650	142560000
12/13/2009	1360	117504000
12/14/2009	1380	119232000
12/15/2009	1200	103680000
12/16/2009	1030	88992000
12/17/2009	894	77241600
12/18/2009	1000	86400000
12/19/2009	1150	99360000
12/20/2009	1410	121824000
12/21/2009	1310	113184000
12/22/2009	1250	108000000
12/23/2009	1350	116640000
12/24/2009	1460	126144000
12/25/2009	2610	225504000
12/26/2009	5570	481248000
12/27/2009	4080	352512000
12/28/2009	2750	237600000
12/29/2009	2200	190080000
12/30/2009	1620	139968000
12/31/2009	1420	122688000
1/1/2010	1440	124416000
1/2/2010	1470	127008000
1/3/2010	1390	120096000
1/4/2010	1250	108000000
1/5/2010	1170	101088000
1/6/2010	1060	91584000
1/7/2010	965	83376000
1/8/2010	905	78192000
1/9/2010	797	68860800
1/10/2010	758	65491200
1/11/2010	854	73785600

1/12/2010	720	62208000
1/13/2010	697	60220800
	total	40068950400
		4.007×10^{10}