6.0 WATER AVAILABILITY

To assess the availability of water resources in Morrison Cove for existing and future allocation and use, water budget analyses for each base flow basin were developed. The analyses are conservative and designed to support sustainable development of water resources. The assumptions used in the analyses include the following:

- For development to be sustainable, water demands should be satisfied not only during average hydrologic conditions but also during 'moderate' drought years. SRBC has defined the sustainable limit of water resource development as the average annual base flow (recharge) available in the "local" watershed during a 1-in-10-year average annual drought; the selection of the 1-in-10-year drought recharge standard strikes a balance among resource conservation, environmental needs, regulatory restriction of growth and development, and the need for adequate and often expensive constructed water storage facilities (SRBC, 2005). Therefore, recharge available during a 1-in-10-year drought (or a 10-year base flow) was used.
- Limiting water use to sustainable levels will also protect water quality, downstream uses, and ecosystem needs.
- Base flow basins (as opposed to surface watersheds) were used in the analyses to account for the importance of the water resources available in the Gatesburg Formation, and to recognize the watershed areas during low flow periods rather than medium and high flows.
- Water use values represent the quantities of water consumptively used within Morrison Cove. Much of the water withdrawn is eventually returned through wastewater discharges or via on-lot septic systems. SRBC defines consumptive use as that quantity of water not returned to the water resources of the basin, or in this case, to a base flow basin. Examples of consumptive use include evaporation, incorporation into products, direct exports or diversions, and transpiration through irrigation.
- Water availability is derived solely from base flow rather than total flow (which would include surface runoff), even though thunderstorms and other rainfall events may temporarily increase streamflows. However, this water is not considered to be significant or reliable, and is therefore not included in the overall analysis.

For purposes of these analyses, the maximum amount of water available for future use was calculated to be the portion of the 10-year base flow remaining after existing consumptive uses are taken into account. The following sections summarize the streamflow statistics previously derived (Chapter 5.0) that would be used as the basis for quantifying water use and water availability for each base flow basin.

6.1 Flow Statistics

Base flow basins were delineated for the Morrison Cove study area (Figure 4-4). These include Clover, Halter, Piney, Plum, and Yellow Creeks, and the Gatesburg North base flow basins. The flow statistics used in the analyses are shown in Table 6-1.

Ten-year base flows for the Piney Creek, Clover Creek, Yellow Creek, Plum Creek, and Halter Creek base flow basins (as presented in Chapter 4.0, Figure 4-4) are based on actual measurements of groundwater contribution to the basins, and are used in the water availability analyses.

The Gatesburg North Base Flow Basin does not have a corresponding surface watershed that could be monitored directly. However, because the basin is underlain, as a whole, by the Gatesburg Formation, the recharge rate derived by Taylor (1997) was used to estimate 10-year base flow.

Table 6-1. Ten-year Base Flows for Morrison Cove

Base Flow Basin	10-Year Base Flow (cfs)
Piney Creek	19.6
Clover Creek	21.5
Gatesburg North	27.8
Yellow Creek	46.8
Plum Creek	6.9
Halter Creek*	10.6
Roaring Spring	8.3

*The Roaring Spring is included in Halter Creek base flow basin.

Some clarifications need to be made regarding the base flow basins. The first is that the Gatesburg South Terrain, not listed in Table 6-1, drains at a ratio of approximately 40 percent to the Yellow Creek base flow basin and 60 percent to the Roaring Spring and Halter Creek base flow basin. These percentages were determined based on flow measurements made during the seepage run. As stated in Chapter 4.0, the total flow from the Gatesburg South Terrain measured during the seepage run was approximately 14.7 cfs. Based on observations of Yellow Creek and the Roaring Spring, approximate outflows were 5.6 cfs and 9.1 cfs, respectively. Yellow Creek outflow (5.6 cfs) is equal to approximately 40 percent of the total flow (14.7 cfs) from the Gatesburg South Terrain, and the Roaring Spring outflow (9.1 cfs) is equal to approximately 60 percent of the total flow (14.7 cfs). The second clarification is that the Roaring Spring discharges groundwater from the Southern Gatesburg Terrain to the Halter Creek base flow basin.

6.2 Water Use

Water use was grouped by base flow basin and categorized by water use type. Water users located within each base flow basin were determined using records from SRBC and PADEP water use databases and GIS spatial analyses. PADEP water use data were used to supplement SRBC data.

SRBC data include consumptive use and surface water and groundwater withdrawal approvals, current as of June 2011. The quantities used in the analyses are based on approved quantities (peak day for consumptive water use and surface water withdrawals and 30-day averages for groundwater withdrawals) and not reported use quantities.

Two additional datasets were used to supplement SRBC data, which included PADEP user registration data and USGS Water-Analysis Screening Tool (WAST) data. All public water agencies and hydropower facilities, as well as those users withdrawing or using greater than 10,000 gallons per day averaged over a 30-day period, are required to register their water use with PADEP. PADEP user registration data are reported withdrawal data through the year 2010 and were normalized to an average annual use quantity.

Use quantities from the WAST data from 2003 were determined based on actual days used rather than average annual use (Stuckey, 2008). Several water use categories were known to be underrepresented. These include unregistered withdrawals, irrigation, livestock, and golf course irrigation. Gaps for residential and non-residential use were filled with estimated data (Stuckey, 2008). Details on how the residential and non-residential information were calculated can be found in the USGS Open-File Report 2008-1106, "Development of the Water-Analysis Screening Tool Used in the Initial Screening for the Pennsylvania State Water Plan Update of 2008."

Agricultural consumptive use was based on estimates for the Juniata Subbasin by Jarrett and Hamilton (2002). The Jarrett and Hamilton (2002) study was performed under contract to SRBC and was the basis for estimating agricultural consumptive use in SRBC's Pennsylvania Agricultural Consumptive Use Study (Dehoff et al., 2005). For purposes of these analyses, it was assumed that the amount of consumptive use is directly proportional to agricultural land use area in each base flow basin.

Consumptive water use was taken directly from SRBC-approved quantities. For PADEP registration data, consumptive water use was determined as the difference between a project's withdrawal and wastewater discharge. WAST estimated residential withdrawals were adjusted with the assumption that 90 percent of the water is returned to the system and only 10 percent is consumptively used; all other WAST data were assumed to have 100 percent consumptive use (Stuckey, 2008).

Water use was divided between base flow basins to account for groundwater flow paths. Groundwater in the Southern Gatesburg Terrain discharges to both the Yellow Creek and Halter Creek base flow basins. The percentage of flow is equal to an approximate 40 percent flow to Yellow Creek base flow basin and an estimated 60 percent flow to the Halter Creek base flow basin during periods of base flow. Similarly, because the Roaring Spring contributes flow to the Halter Creek base flow basin, 60 percent of the water use in the Southern Gatesburg Terrain was incorporated into the water use values for the Halter Creek base flow basin.

Water use values, separated by sector, have been determined for each base flow basin and are listed in Table 6-2. All values have been rounded to the nearest hundredth place.

Table 6-2. Water Use by Sector and Base Flow Basin

Base Flow Basin	Water Use by Sector (mgd)							Total Water Use (mgd)	Total Water Use as a Percent of 10-Year Base Flow
	Agricultural	Residential	Municipal	Commercial	Industrial	Recreational	Mining		
Piney	0.10	0.01	---	---	---	---	---	**0.10**	**0.8**
Clover	0.17	0.01	0.04	0.01	0.26	---	---	**0.49**	**3.5**
Gatesburg North	0.10	0.01	0.29	0.01	0.24	---	---	**0.65**	**3.6**
Yellow	0.36	0.03	0.26	0.01	0.23	0.11	---	**0.99**	**3.3**
Plum	0.11	0.01	0.16	<0.01	---	---	0.20	**0.48**	**10.8**
Halter*	0.12	0.02	0.41	0.03	5.75	0.16	---	**6.49**	**87.2**
Roaring Spring	0.07	0.01	0.41	<0.01	5.13	0.16	---	**5.78**	**108**
Total Water Use (mgd)**	**0.96**	**0.08**	**1.16**	**0.06**	**6.48**	**0.26**	**0.20**		

Note:
*The Roaring Spring use is included in the Halter Creek base flow basin.
**The Roaring Spring use is excluded from the water use by sector totals.

6.3 Water Availability

For each base flow basin, the water use was compared to the estimated 10-year base flow to determine the water available for future development.

As described previously in Chapter 3.0, there may be an amount of flow from the Southern Gatesburg Terrain leaving as underflow. This sub-surface flow path moves roughly 50 percent of the 10-year base flow from the Southern Gatesburg Terrain to the Northern Gatesburg Terrain. This underflow component is not well documented. Including the underflow could result in an overestimation of the water availability, potentially resulting in overallocation. Therefore, the underflow was not taken into consideration in the analysis.

The water use for each base flow basin has been calculated as both total water use and as a percentage by water use type. The results of the water availability analysis for each base flow basin are presented in the following series of pie charts (Figures 6-1 through 6-7).

Based on the water availability analyses, the base flow basins of Piney Creek, Clover Creek, Gatesburg North, and Yellow Creek have less than 10 percent of the 10-year base flow currently being consumptively used (Figures 6-1, 6-2, 6-3, and 6-4, respectively). Less than 1 percent of the 10-year base flow is consumptively used in Piney Creek, with the largest water use sector in Piney Creek being agriculture.

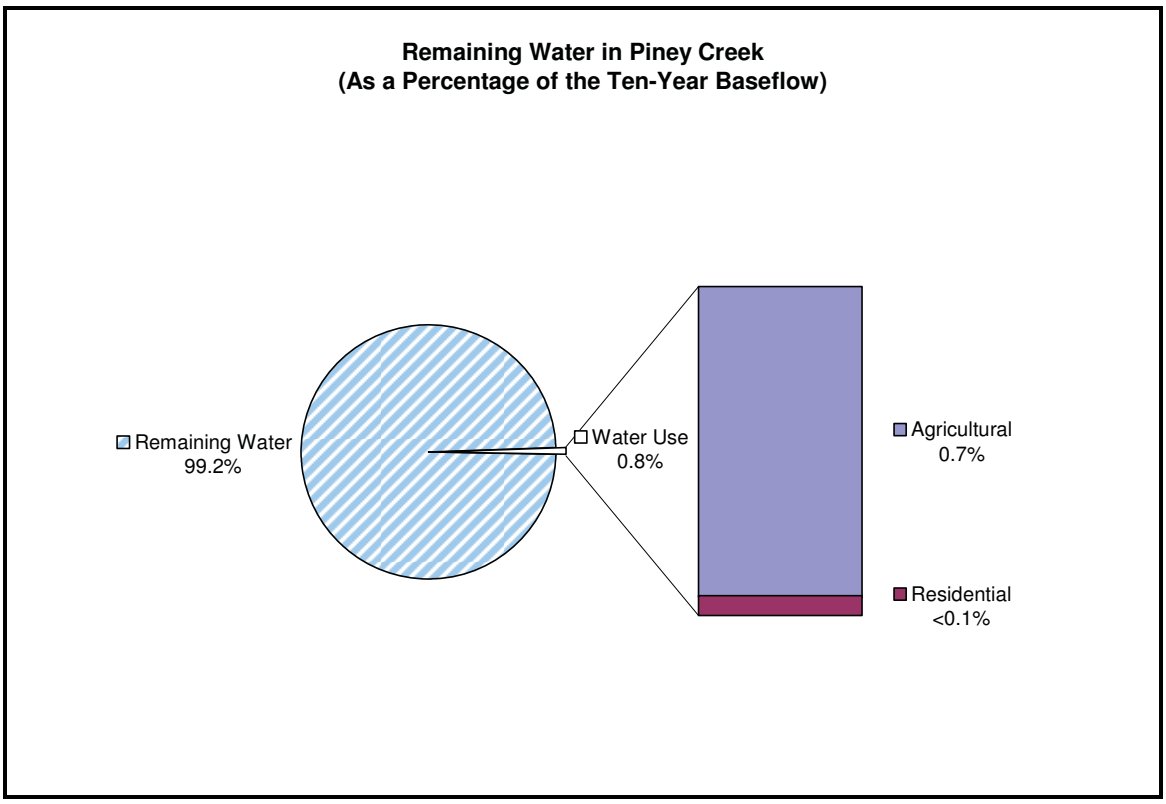

Figure 6-1. Remaining Water in Piney Creek

As indicated in Figure 6-2, approximately 3.5 percent of the 10-year base flow is consumptively used in the Clover Creek base flow basin. Water use primarily resides in the industrial and agricultural sectors with these sectors' consumptive use equaling about 1.9 percent and 1.2 percent, respectively.

The Northern Gatesburg base flow basin has approximately 96.4 percent of the 10-year base flow remaining after considering water use. The top two water use sectors are municipal and industrial, which account for an estimated 1.6 and 1.3 percent of total use, respectively.

Water use within the Yellow Creek base flow basin is approximately 3.3 percent of the 10-year base flow. The largest water use sectors in this basin are agricultural, municipal, and industrial. About 96.7 percent of the 10-year base flow remains in this basin.

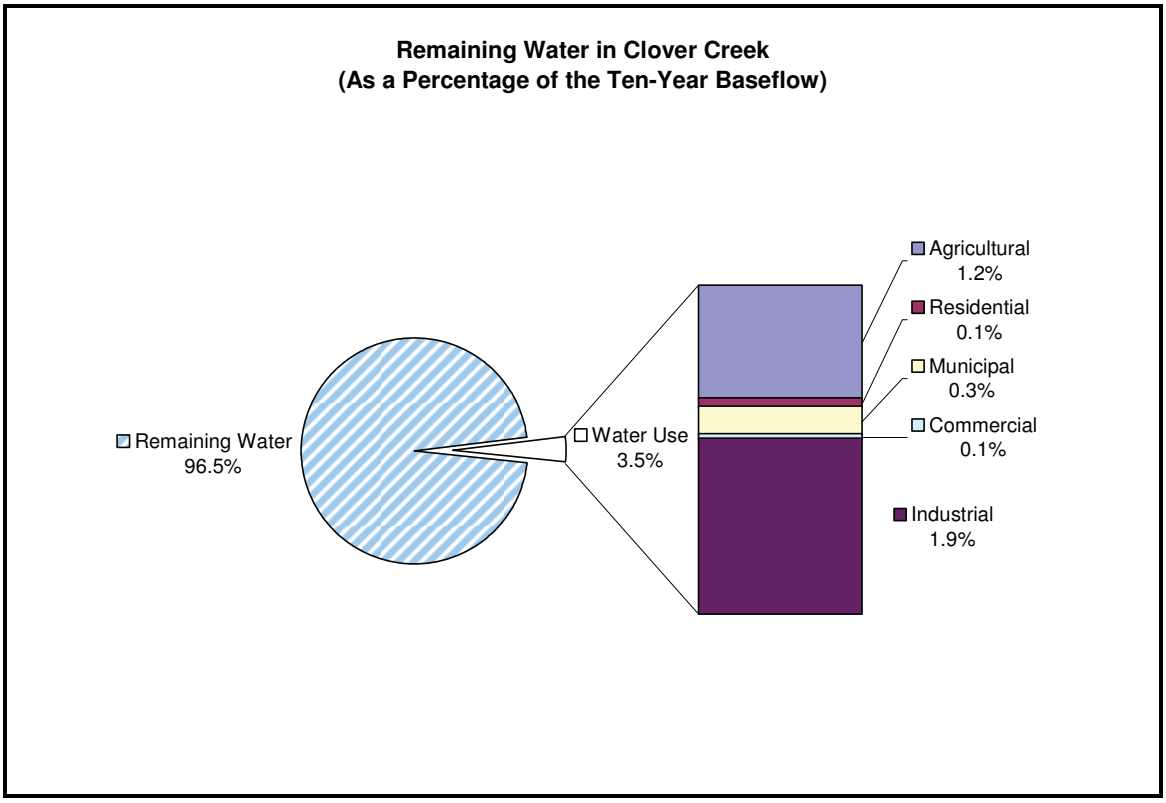

Figure 6-2. Remaining Water in Clover Creek

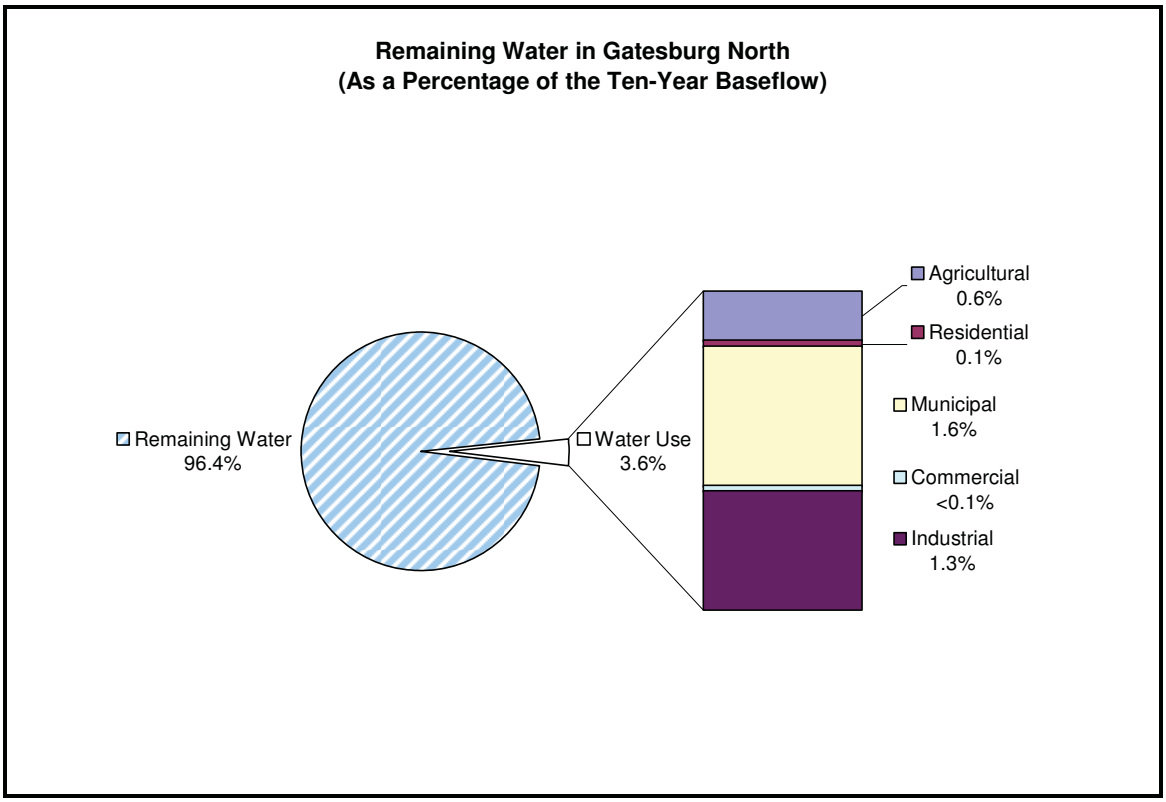

Figure 6-3. Remaining Water in Gatesburg North

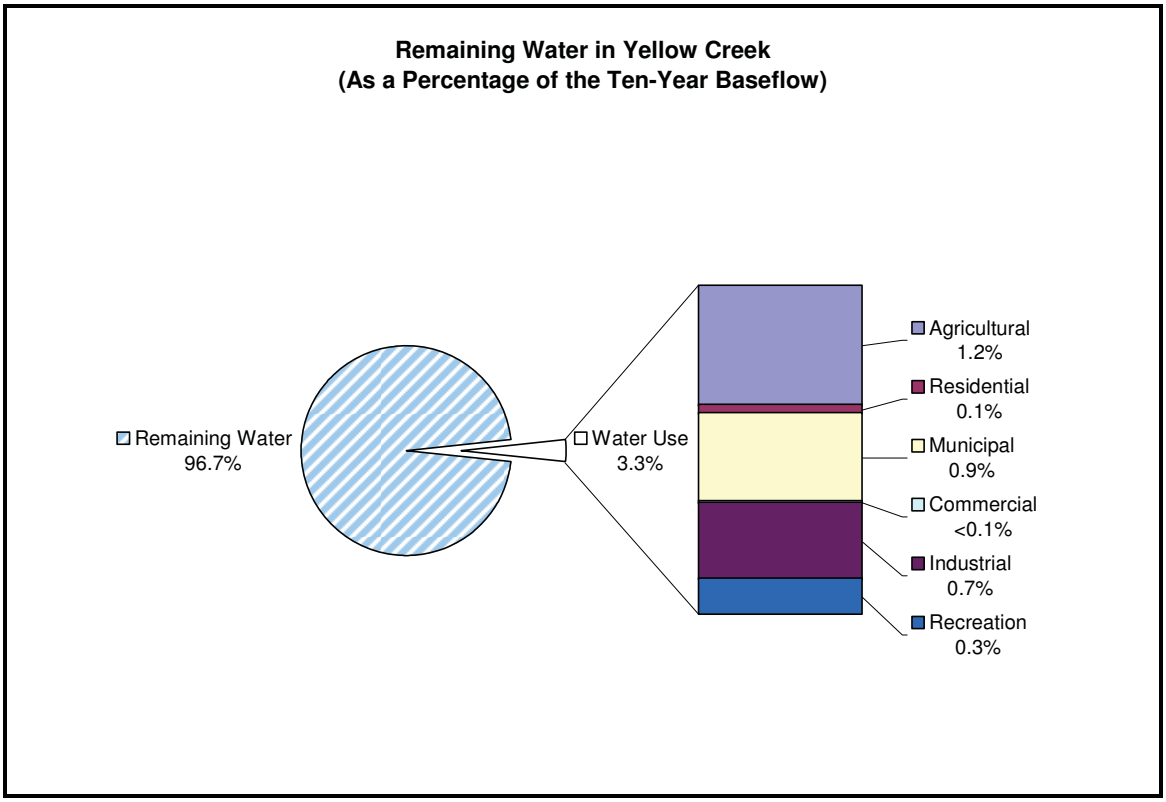

Figure 6-4. Remaining Water in Yellow Creek

Consumptive water use in Piney Creek, Clover Creek, Gatesburg North, and Yellow Creek base flow basins is less than 10 percent of the 10-year base flow. Consumptive water use in Plum Creek, Halter Creek, and the Roaring Spring base flow basins accounts for more than 10 percent of the 10-year base flow. The pie charts for these basins are depicted in Figures 6-5, 6-6, and 6-7.

Approximately 10.8 percent of the 10-year base flow has been used upgradient of the outlet of Plum Creek. The major water use types or sectors include mining, municipal, and agricultural, with mining being the largest use sector at about 4.4 percent of the total water use.

Halter Creek has a considerable amount of consumptive water use, as approximately 87.2 percent of the 10-year base flow is currently being utilized upgradient of the outlet of Halter Creek. The largest water use sector in Halter Creek is industrial. The amount of water currently being used indicates that any new or existing water use approvals within the Halter Creek base flow basin should be conditioned to provide low flow protection for downstream uses.

Results of the water availability analysis indicate that water use at the Roaring Spring is greater than the sustainable 10-year base flow. The peak approved water use exceeds 100 percent of the available water upgradient of the outlet. The major water use in this base flow basin is industrial, as this sector comprises more than 92 percent of the total water use from the Roaring Spring.

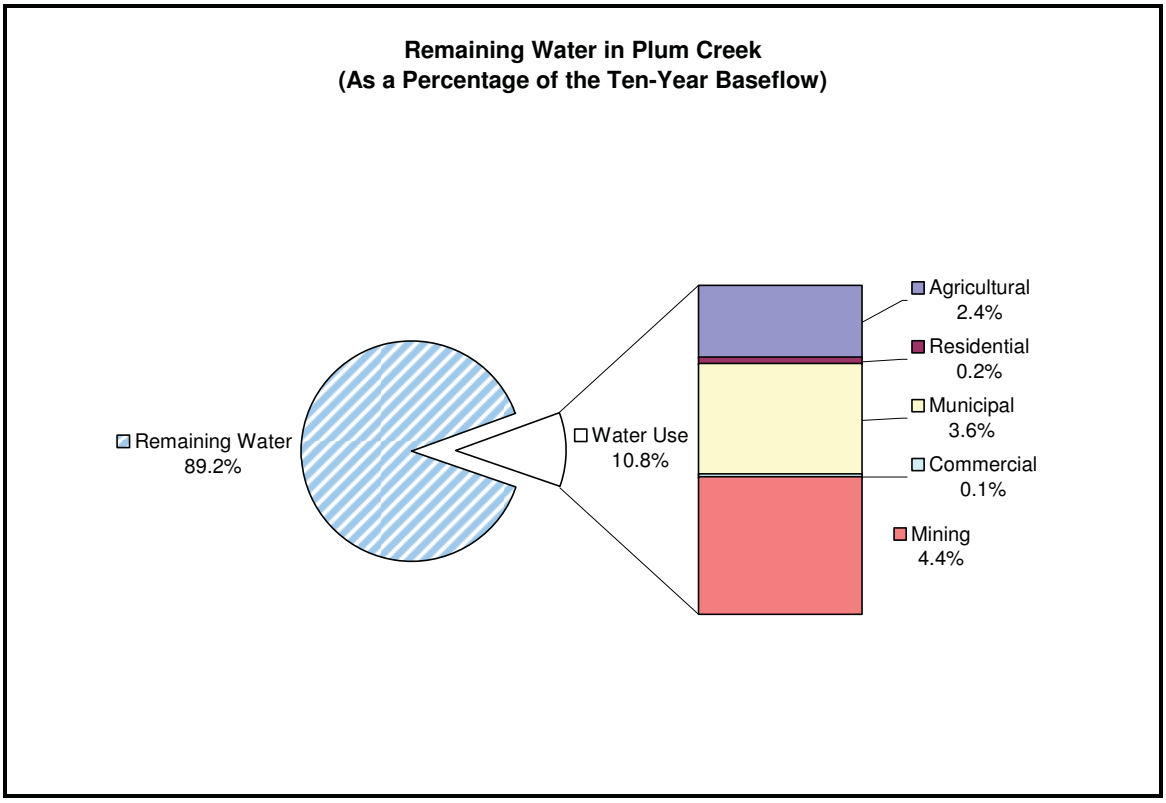

Figure 6-5. Remaining Water in Plum Creek

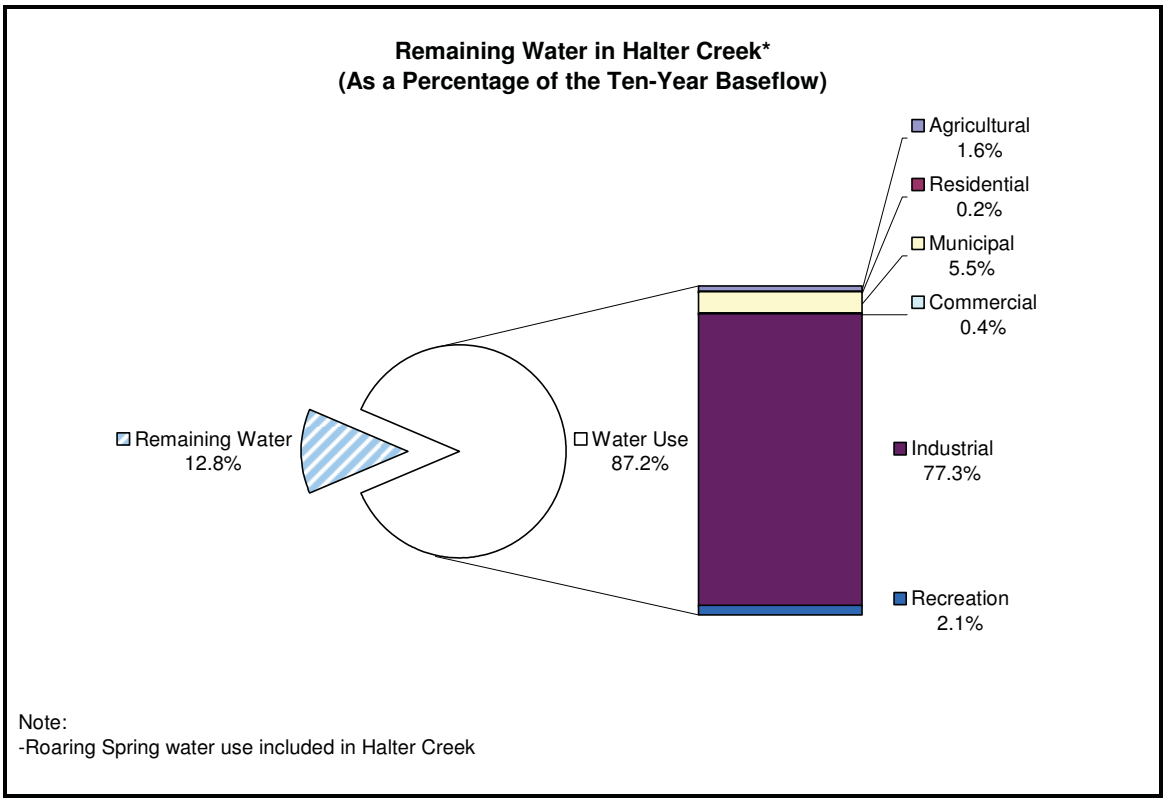

Figure 6-6. Remaining Water in Halter Creek

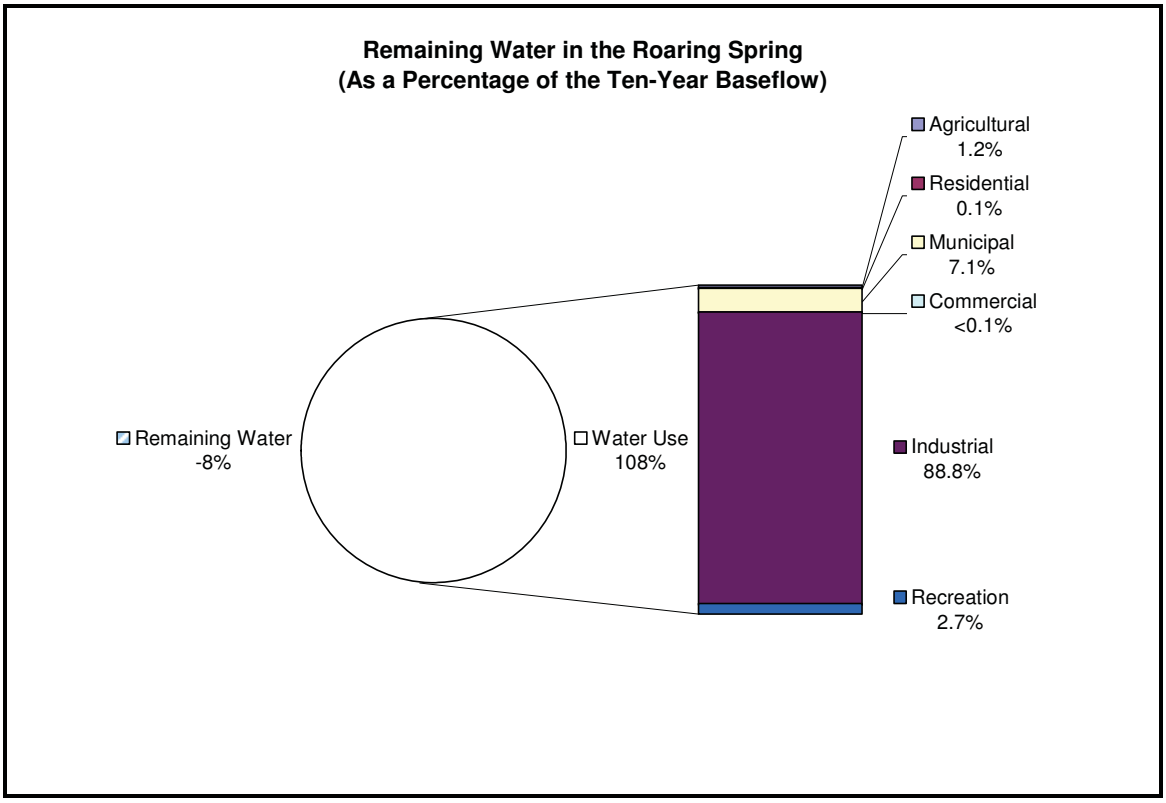

Figure 6-7. Remaining Water in the Roaring Spring

6.4 Screening for Identification of Critical Water Planning Areas (CWPAs)

The major watersheds in Morrison Cove were screened according to guidelines for identification of CWPAs (Stuckey, 2008). The consumptive use in each major watershed was compared to the appropriate ISC, which is 50 percent of the 7Q10 flow for all streams, except those designated as Class A trout streams in areas of carbonate bedrock, where 30 percent of the 7Q10 flow was used. The streams of Morrison Cove, with the exception of Halter Creek, meet the criteria for evaluation as 30 percent of the 7Q10 flow, rather than 50 percent of the 7Q10 flow. This determination was made in conjunction with information presented in Chapter 7.0. Based on field observations, Halter Creek is functioning as a Class A stream; however, the stream is not currently classified with this designation. For the purposes of this analysis, Halter Creek will be screened using both the 30 percent and the 50 percent criteria.

As shown in Table 6-3, consumptive use exceeded the ISC of 30 percent of 7Q10 in the Plum Creek Watershed and exceeded the ISC of both 30 percent and 50 percent of the 7Q10 in the Halter Creek Watershed. These watersheds meet the ISC for consideration as potential CWPAs. However, the consumptive use in these watersheds is due to a few relatively stable, long-established, high volume withdrawals, and both watersheds currently support high quality aquatic habitats downstream of the withdrawal locations. Water use in Halter Creek and the Roaring Spring is largely driven by industrial use. Municipal and residential consumptive use is a small fraction of total use. Therefore, water use is not a function of population growth. Available data for industrial water use suggest overall stability, with no net increases in water demand in recent years. Designation of these watersheds as CWPAs does not appear to be warranted.

Table 6-3. Screening for Critical Water Planning Areas (CWPAs)

Watersheds	Water use (mgd)	ISC of 30% of 7Q10		ISC of 50% of 7Q10	
		30% of 7Q10 (mgd)	ISC Met (Yes/No)	50% of 7Q10 (mgd)	ISC Met (Yes/No)
Piney Creek	0.10	1.20	No	---	---
Clover Creek	0.49	1.51	No	---	---
Yellow Creek	0.99	1.98	No	---	---
Plum Creek	0.48	0.43	Yes	---	---
Halter Creek	6.49	0.64	Yes	1.07	Yes

6.5 Conclusions

The findings of the water availability analyses for Morrison Cove demonstrate that Piney Creek, Clover Creek, Northern Gatesburg, and Yellow Creek base flow basins have a small percentage of existing water use (i.e., less than 5 percent) as compared to the 10-year base flow. Substantial water is available in these areas for future development. Plum Creek base flow basin currently has a moderate water use of approximately 10.8 percent of the 10-year base flow and development is unlikely to be constrained by water availability.

Comparisons of water use and water availability indicate that water use in the Halter Creek base flow basin nearly equals the quantity of water available for development and that current consumptive water use exceeds the sustainable 10-year base flow at the Roaring Spring. These base flow basins may exhibit supply shortages under drought conditions. Extreme caution should be taken in the review of any requests for new or increased water use within these two base flow basins. Withdrawals may be interruptible for downstream resource protection. In addition, the potential effects of cumulative water use in the Halter Creek and Plum Creek base flow basins on the aquatic habitat in the reach downstream of their confluence has to be taken into account. This may considerably reduce the water availability for the Plum Creek base flow basin.

The available water for future development estimated in this study is conservative considering 100 percent of the 10-year base flow is allowed to be used. Severe droughts and increased water use potentially could create serious deficits that may jeopardize environmental needs and should be taken into consideration for water resource planning.

According to guidelines for identification of CWPAs, consumptive water use values in Piney, Clover, and Yellow Creeks are less than the ISC of 30 percent of 7Q10. Consumptive use exceeded the ISC of 30 percent of 7Q10 in the Plum Creek Watershed and exceeded the ISC of both 30 percent and 50 percent of the 7Q10 in the Halter Creek Watershed. Plum and Halter Creek Watersheds are not recommended for nomination as CWPAs, because of the nature of the withdrawals and the high quality aquatic habitat they support.