

Technical Memorandum

From: Surface Water Availability Resource Assessment Team – Feng Jiang
To: Regional Planning Councils, EPD Planning Team, Planning Contractors, File
Date: July 8, 2010

Subject: Summary Future (2050) Resource Assessment in Alabama-Coosa-Tallapoosa (ACT) River Basins

Introduction

The purpose of this memorandum is to summarize the results of future Resource Assessment in the ACT Basins with projected 2050 water use conditions. The projected water use conditions (including municipal, industrial, thermal energy, and agricultural) were provided by EPD Planning Team in May 2010 and updated in June 2010.

We used HEC-5 and River Basin Planning Tool (RBPT) in both Current Resource Assessment and 2050 Future Resource Assessment. The objective of 2050 Future Resource Assessment is to provide Regional Planning Councils and their Planning Contractors a starting point in assessing whether available resource can meet both the off-stream and instream needs into the forecast future. If available resource cannot satisfy the needs, then Best Management Practices (BMP's) will have to be considered to satisfy the needs.

Model Settings and Key Assumptions

The ACT Basin model contains 5 Planning Nodes and corresponding sub-basins (or 14 Basic Nodes and corresponding Local Drainage Areas). (See Figure 1.)

The hydrological conditions incorporated in the model include unimpaired incremental flow on daily basis for the period between 1939 and 2007. The flow data have been incorporated at all 14 Basic Nodes.

Forecast annual average withdrawal and discharge of each Sub-basin has been temporally distributed to monthly values according to intra-annual patterns of current conditions. The Sub-basins are the finest spatial resolution in the planning models. The water use data do not reflect any single individual facilities, existing or planned.

There are no additional Management Practices (MP's) beyond those that have been reflected by Current Resource Assessments or by forecast 2050 demands. The amount of storage for each Sub-basin remains the same as in Current Resource Assessment. All of the storage volume has been aggregated at the Sub-basin level. The storage information incorporated in the model does not reflect the site or size of any single reservoir.

In unregulated portion of the basin, Flow Regime is defined by the State's Interim Instream Flow Protection Policy, which calls for the protection of monthly 7Q10 or

natural inflow, whichever is lower. In the ACT Basins, this applies to the Gaylesville, Heflin, and Newell Nodes.

In regulated portion of the basin, Flow Regime is limited to locations where an explicit flow requirement is specified by the Army Corps of Engineers, Tennessee Valley Authority, or Federal Energy Regulatory Commission (FERC). In the ACT Basins, this applies to the Kingston and Rome-C Nodes.

Summary of Results

Gaylesville Node:

With projected 2050 water use and no additional MP's, we did not see a significant gap between the needed withdrawal and the modeled withdrawal at this node. However, gap in stream flow can be observed with Figure "Fut-TS" in file titled "20100708-SWP-2050-NMP-ACT-Gayles-FengJiang.xls." Modeled flow (blue) is below Flow Regime (red) for extended period under 2007 hydrological conditions. For the entire period of record, the percentage of time when there is a shortage to Flow Regime is 9%. The average shortage is 14 cfs. These statistics of Flow Regime shortfall are significantly higher than those of current assessment (see Table 1). The reason for the increased shortfall, in both length and depth of shortfall, is forecast increased consumptive demand. Under forecast 2050 conditions, the annual average increase of consumptive water use is approximately 12 cfs. During the drier month, this increase is even more pronounced. The consumptive water use in August is 13 cfs higher under forecast 2050 conditions than current levels.

Table 1. Summary of flow regime shortage at Gaylesville Node

	Length of Shortfall(% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	7%	4	653	6	119
2050	9%	14	641	20	69

Heflin Planning Node:

With projected 2050 water use and no additional MP's, we did not see a significant gap between the needed withdrawal and the modeled withdrawal at this node. However, gap in stream flow can be observed with Figure "Fut-TS" in file titled "20100708-SWP-2050-NMP-ACT-Heflin-FengJiang". Modeled flow (blue) is below Flow Regime (red) for extended period under 2007 hydrological conditions. For the entire period of record, the percentage of time when there is a shortage to Flow Regime is 6%. The average shortage is 6 cfs. Compared with current assessment, the average shortfall is doubled while the length of shortfall remains unchanged (see Table 2).

Table 2. Summary flow regime shortage at Heflin Node

	Length of Shortfall(% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	6%	3	659	4	65
2050	6%	6	656	7	141

Newell Node:

With projected 2050 water use and no additional MP’s, we did see a gap between the needed withdrawal and the modeled withdrawal at this node. See Figures “TS-Consumptive” and “Dem-Gap” attached file titled “20100708-SWP-2050-NMP-ACT-Newell-FengJiang”. The percentage of time when there is a demand shortage is 1%, with an average shortfall of 9 cfs. Contrarily, there is no demand shortage in current assessment (See Table 3a).

A similar gap in stream flow can be observed with Figure “Fut-TS” in the file titled “20100708-SWP-2050-NMP-ACT-Newell-FengJiang”. Modeled flow (blue) is below Flow Regime (red) for extended period under 2007 hydrological conditions. For the entire period of record, the percentage of time when there is a shortage to Flow Regime is 10%. The average shortage is 19 cfs. These statistics of shortfall are larger than those in current assessment (See Table 3b). The reason is that the annual average consumptive water use is increased by 15 cfs under forecast 2050 conditions than current levels.

Table 3a. Summary of demand shortage at Newell Node

	Length of Shortfall(% of time)	Average Shortfall (cfs)	Long-term Average Demand (cfs)	Maximum Shortfall (cfs)	Corresponding Demand (cfs)
Current	0%	0	12	0	N/A
2050	1%	9	35	19	38

Table 3b. Summary of flow regime shortage at Newell Node

	Length of Shortfall(% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	7%	9	590	12	23
2050	10%	19	574	31	60

Kingston Node:

With projected 2050 water use and no additional MP’s, our model was able to meet all of the consumptive demands. However, we made the assumption that any additional water use from the Army Corps of Engineers, Tennessee Valley Authority, or Georgia Power reservoirs, in this case Allatoona, is considered a potential gap. If such

increased water use is planned, then the planners need to seek authorization from the reservoirs' owner/operator.

As a result of our model allowing all forecast 2050 demand, the amount of storage shown in Figure "TS-Stor" (file titled "20100708-SWP-2050-NMP-ACT-Kingston-FengJiang") shows a significant drop from current to 2050 conditions. The total amount of storage was used up under the 2050 demand scenario. Consequently, the at-site flow requirement is missed in 30 days. Figure "POR (stor)" shows the exceedance curve of reservoir storage for both current and projected 2050 demand conditions. The reservoir level will be significantly lower under 2050 demand condition. All of these indicate the existence of a gap between available resources and our forecast needs in this sub-basin.

Table 4. Summary of gap at Kingston Node

	Demand Shortage (cfs)	At-site Flow Requirement Shortage (cfs)	Minimum Reservoir Storage (acre-feet)	Minimum Percentage Reservoir Storage	Basin-wide Flow Requirement Shortage
Current	0	0	45,832	15%	N/A
2050	0	12 to 233 in 30 days	0	0%	N/A

Rome-C Node:

With projected 2050 water use and no additional MP's, our model was able to meet all of the consumptive demands. However, we made the assumption that any additional water use from the Army Corps of Engineers, Tennessee Valley Authority, or Georgia Power reservoirs, in this case Allatoona and Carters, is considered a potential gap. If such increased water use is planned, then the planners need to seek authorization from the reservoirs' owner/operator.

The storage at this sub-basin is composed of two parts: One is storage from the Oostanaula River (Carters). The storage change in Figure "TS-Stor" in file titled "20100708-SWP-2050-NMP-ACT-Rome-C-FengJiang" shows a slight drop. Figure "POR (stor)" in the same file shows the exceedance curve of this storage for both current and projected 2050 demand conditions. The other part of storage is from the Etowah River (Allatoona). The storage change can be found in Figure "TS-Stor" and "POR(stor)" in file titled "20100708-SWP-2050-NMP-ACT-Kingston-FengJiang". Generally, the reservoir level will be lower under 2050 demand condition, as a result of increased consumptive water use under 2050 forecast demand.

Table 5. Summary of flow gap at Rome-C Node

	Demand Shortage (cfs)	At-site Flow Requirement Shortage (cfs)	Minimum Reservoir Storage (acre-feet)	Minimum Percentage Reservoir Storage	Basin-wide Flow Requirement Shortage
Current	0	0	120,152 for Carters 45,832 for Allatoona	85% for Carters 15% for Allatoona	N/A
2050	0	12 to 233 in 30 days	117,446 for Carters 0 for Allatoona	83% for Carters 0% for Allatoona	N/A

Note: At semi-regulated Planning Nodes where there are no explicit flow requirements, we do not have a flow regime to measure stream flow against.

Detailed Results

We provide detailed modeling results of each Planning Node in a summary MS Excel file. There are multiple figures in each file. The purposes of these figures are listed in Table 6 below. The file names for each node are listed in Table 7.

Table 6. Metrics in Detailed Evaluation of Modeling Results

Variable Evaluated	Figure Tabs	Purpose of figures
Demand	TS-Consumptive	Time series of consumptive water use for both current and 2050 conditions
	Gap-Dem	Time series of demand shortages or the "Onion" for current and future demands
Storage	TS-Stor	Time series of storage remaining with bottom of pool
	POR (stor)	Exceedance of POR storage remaining with bottom of pool
Stream Flow Time Series	Nat-TS	Unimpaired natural flow time series
	Nat,FR-TS	Unimpaired plus adjusted flow regime
	FR-TS	Adjusted flow regime
	Cur-TS	Adjusted flow regime and current assessment flow
	Fut-TS	Adjusted flow regime and forecasted assessment flow
	Cur,Fut TS	Comparison of current and future modeled flows
	Fut,Nat TS	Comparison of unimpaired natural and future modeled flows
Flow Regime Shortage	Gap-FR	Flow regime shortage or "Onion" for current and future demands
Stream Flow Exceedance	POR-(Nat)	Exceedance of natural, current and future flows
	Jan (cur)	January Monthly Exceedance of natural, current, future flows and Adjusted Flow regimes
	Feb (cur) through Dec (cur)	February through December Monthly Exceedance of natural, current, future flows and Adjusted Flow regimes

Table 7. The file name of detailed modeling results for each node

Node name	File name
Gaylesville	20100708-SWP-2050-NMP-ACT-Gayles-FengJiang
Heflin	20100708-SWP-2050-NMP-ACT-Heflin-FengJiang
Newell	20100708-SWP-2050-NMP-ACT-Newell-FengJiang
Kingston	20100708-SWP-2050-NMP-ACT-Kingston-FengJiang
Rome-C	20100708-SWP-2050-NMP-ACT-Rome-C-FengJiang

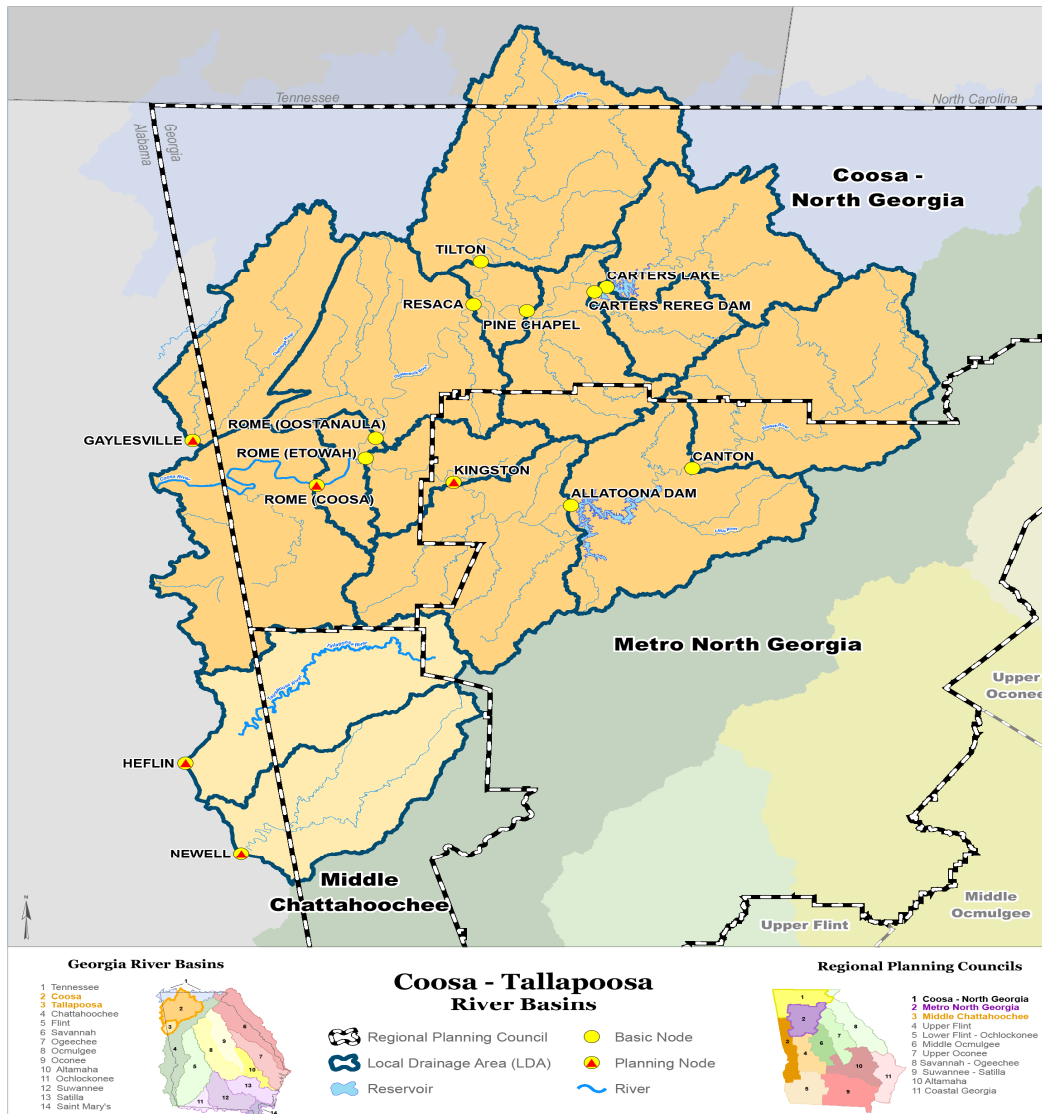


Figure 1. The Coosa-Tallapoosa River Basins

Technical Memorandum

From: Surface Water Availability Resource Assessment Team – Hailian Liang
To: Regional Planning Councils, EPD Planning Team, Planning Contractors, File
Date: July 14, 2010

Subject: Summary Future (2050) Resource Assessment in Tennessee (TN) River Basin

Introduction

The purpose of this memorandum is to summarize the results of future Resource Assessment in the Tennessee River Basin with projected 2050 water use conditions. The projected water use conditions (including municipal, industrial, thermal energy, and agricultural) were provided by EPD Planning Team in May 2010.

We used River Basin Planning Tool (RBPT) in both Current Resource Assessment and 2050 Future Resource Assessment. The objective of 2050 Future Resource Assessment is to provide Regional Planning Councils and their Planning Contractors a starting point in assessing whether available resource can meet both the off-stream and instream needs into the forecast future. If available resource cannot satisfy the needs, then Best Management Practices (BMP's) will have to be considered to satisfy the needs.

Model Settings and Key Assumptions

The TN Basin model contains 6 Planning Nodes and corresponding sub-basins (or 7 Basic Nodes and corresponding Local Drainage Areas). (See Figure 1.)

The hydrological conditions incorporated in the model include unimpaired incremental flow on daily basis for the period between 1939 and 2007. The flow data have been incorporated at all 7 Basic Nodes.

Forecast annual average withdrawal and discharge of each Sub-basin has been temporally distributed to monthly values according to intra-annual patterns of current conditions. The Sub-basins are the finest spatial resolution in the planning models. The water use data do not reflect any single individual facilities, existing or planned.

There are not additional Management Practices (MP's) beyond those that have been reflected by Current Resource Assessments or by forecast 2050 demands. The amount of storage for each Sub-basin remains the same as in Current Resource Assessment. All of the storage volume has been aggregated at the Sub-basin level. The storage information incorporated in the model does not reflect the site or size of any single reservoir.

In unregulated portion of the basin, Flow Regime is defined by the State's Interim Instream Flow Protection Policy, which calls for the protection of monthly 7Q10 or natural inflow, whichever is lower. In the TN Basin, this applies to the England, Chickamauga, and Little_TN Nodes.

In regulated portion of the basin, Flow Regime is limited to locations where an explicit flow requirement is specified by the Army Corps of Engineers, Tennessee Valley Authority (TVA), or Federal Energy Regulatory Commission (FERC). In the TN Basin, this applies to the Copperhill, Nottely and Chatuge Nodes.

Summary of Results

England Planning Node:

With projected 2050 water use and no additional MP’s, there is a very small chance of gap occurring between the needed withdrawal and the modeled withdrawal at this node. See Figures “TS-Consumptive” and “Gap-Dem” in the attached file titled 20100714-SWP-2050-NMP-TN-England-HailianLiang.xls. The percentage of time when there is a demand shortage is 0.1%, with an average shortfall of 4 cfs.

A small gap in stream flow can be observed in Figure “Fut-TS” in the attached file (titled 20100714-SWP-2050-NMP-TN-England-HailianLiang.xls). Modeled flow (blue) is slightly below Flow Regime (red) from June to December except late July and late December under 2007 hydrological conditions. For the entire period of record, the percentage of time when there is a shortage to Flow Regime is 7%. The average shortage is 3 cfs (See Table 1.).

Table 1. Summary of England Node.

Scenario	Length of Shortfall (% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	7%	3 (1.9 MGD)	249 (161 MGD)	4 (2.6 MGD)	12 (7.8 MGD)
2050 Forecast	7%	3 (1.9 MGD)	249 (161 MGD)	4 (2.6 MGD)	12 (7.8 MGD)

Chickamauga Planning Node:

With projected 2050 water use and no additional MP’s, there is a very small chance of gap occurring between the needed withdrawal and the modeled withdrawal at this node. See Figures “TS-Consumptive” and “Gap-Dem” in the attached file titled 20100714-SWP-2050-NMP-TN-Chickamauga-HailianLiang.xls. The percentage of time when there is a demand shortage is 0.1%, with an average shortfall of 10 cfs.

A gap in stream flow can be observed with Figure “Fut-TS” in the attached file (20100714-SWP-2050-NMP-TN-Chickamauga-HailianLiang.xls). Modeled flow (blue) is below Flow Regime (red) from June to October except a few days in September under 2007 hydrological conditions. For the entire period of record, the percentage of time when there is a shortage to Flow Regime is 3%. The average shortage is 14 cfs (See Table 2.) The reason for the increased gap in both length and depth is that under the forecast 2050 demand, the consumptive use in this basin will increase by approximately 15 cfs on an annual basis. The maximum increase of consumptive use in the basin is in June in the amount of 18 cfs.

Table 2. Summary of Chickamauga Node

Scenario	Length of Shortfall (% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	1%	6 (4 MGD)	691 (447 MGD)	9 (5.8 MGD)	48 (31 MGD)
2050 Forecast	3%	14 (9 MGD)	676 (437 MGD)	27 (17 MGD)	48 (31 MGD)

Copperhill Planning Node:

With projected 2050 water use and no additional MP’s, there is not a gap between available resource and the combined off-stream and instream needs.

There is no shortage in meeting water demand in this Sub-basin, as shown by Figures “TS-Consumptive” and “Gap-Dem” in the attached file (titled 20100714-SWP-2050-NMP-TN-Copperhill-HailianLiang.xls) and Table 3. There is no shortage in meeting at site flow requirement, as shown by Figures “Fur-TS” and “Gap-FR” in the attached file (titled 20100714-SWP-2050-NMP-TN-Copperhill-HailianLiang.xls) and Table 3.

Table 3. Summary of Copperhill Node

Scenario	Demand Shortfall	At-site Flow Requirement Shortage	Minimum Reservoir Con. Storage (acre-feet)	Minimum Percentage Reservoir Con. Storage	Basin-wide Flow Requirement Shortage
Current*	0	0	73874 At Blue Ridge	98% At Blue Ridge	None
2050 Forecast	0	0	73792 At Blue Ridge	98% At Blue Ridge	None

*Current condition has been updated to reflect the new information of TVA reservoir minimum flow requirement and reservoir elevation guidance curves. We assume TVA Flood Guide Curve represents the top of the conservation pool and TVA Balancing Guide Curve represents the bottom of the conservation pool.

Figure “TS-Stor” in the attached file (titled 20100714-SWP-2050-NMP-TN-Copperhill-HailianLiang.xls) shows storage remaining under both current and 2050 demand scenarios. The reservoir storage under 2050 demand condition is very similar to what is modeled under current demand conditions, with slightly increased consumptive water demand in this Sub-basin. The reservoir storage modeled was far from depletion. This is not to assume that increased water use directly from the big storage projects, are authorized by owners and operators of the projects. If any planning activity is based on this assumption, then the planners need to confirm the assumption with the project owners.

The modeled flow under forecast demand is generally similar to what is modeled under current demand conditions, with slightly increased consumptive water demand in the Sub-basin. This is shown in Figure “Cur,FutTS” in the attached file (titled 20100714-SWP-2050-NMP-TN-Copperhill-HailianLiang.xls).

Nottely Planning Node:

With projected 2050 water use and no additional MP’s, there is not a gap between available resource and the combined off-stream and instream needs.

There is no shortage in meeting water demand in this Sub-basin, as shown by Figures “TS-Consumptive” and “Gap-Dem” in the attached file (titled 20100714-SWP-2050-NMP-TN-Nottely-HailianLiang.xls) and Table 4. There is no shortage in meeting at site flow requirement, as shown by Figures “Fur-TS” and “Gap-FR” in the attached file (titled 20100714-SWP-Future-2050-NMP-Nottely-HailianLiang.xls) and Table 4.

Table 4. Summary of Nottely Node

Scenario	Demand Shortfall	At-site Flow Requirement Shortage	Minimum Reservoir Con. Storage (acre-feet)	Minimum Percentage Reservoir Con. Storage	Basin-wide Flow Requirement Shortage
Current*	0	0	71645 At Nottely	93% At Nottely	None
2050 Forecast	0	0	70888 At Nottely	92% At Nottely	None

*Current condition has been updated to reflect the new information of TVA reservoir minimum flow requirement and reservoir elevation guidance curves. We assume TVA Flood Guide Curve represents the top of the conservation pool and TVA Balancing Guide Curve represents the bottom of the conservation pool.

Figure “TS-Stor” in the attached file (titled 20100714-SWP-2050-NMP-TN-Nottely-HailianLiang.xls) shows storage remaining under both current and 2050 demand scenarios. The reservoir storage under 2050 demand condition is slightly lower than what is modeled under current demand conditions, because of slightly increased consumptive water demand in this Sub-basin. The reservoir storage modeled was far from depletion. This is not to assume that increased water use directly from the big storage projects, are authorized by owners and operators of the projects. If any planning activity is based on this assumption, then the planners need to confirm the assumption with the project owners.

The modeled flow under forecast demand is slightly lower than what is modeled under current demand conditions, because of increased consumptive water demand in the Sub-basin. This is shown in Figure “Cur,FutTS” in the attached file (titled 20100714-SWP-2050-NMP-TN-Nottely-HailianLiang.xls).

Chatuge Planning Node:

With projected 2050 water use and no additional MP’s, there is not a gap between available resource and the combined off-stream and instream needs.

There is no shortage in meeting water demand in this Sub-basin, as shown by Figures “TS-Consumptive” and “Gap-Dem” in the attached file (titled 20100714-SWP-2050-NMP-TN-Chatuge-HailianLiang.xls) and Table 5. There is no shortage in meeting at site flow requirement, as shown by Figures “Fur-TS” and “Gap-FR” in the attached file (titled 20100521-SWP-2050-NMP-TN-Chatuge-HailianLiang.xls) and Table 5.

Table 5. Summary of Chatuge Node

Scenario	Demand Shortfall	At-site Flow Requirement Shortage	Minimum Reservoir Con. Storage (acre-feet)	Minimum Percentage Reservoir Con. Storage	Basin-wide Flow Requirement Shortage
Current*	0	0	70197 At Chatuge	95% At Chatuge	None
2050 Forecast	0	0	70032 At Chatuge	95% At Chatuge	None

*Current condition has been updated to reflect the new information of TVA reservoir minimum flow requirement and reservoir elevation guidance curves. We assume TVA Flood Guide Curve represents the top of the conservation pool and TVA Balancing Guide Curve represents the bottom of the conservation pool.

Figure “TS-Stor” in the attached file (titled 20100714-SWP-2050-NMP-TN-Chatuge-HailianLiang.xls) shows storage remaining under both current and 2050 demand scenarios. The reservoir storage under 2050 demand condition is very similar to what is modeled under current demand conditions, with slightly increased consumptive water demand in this Sub-basin. The reservoir storage modeled was far from depletion. This is not to assume that increased water use directly from the big storage projects, are authorized by owners and operators of the projects. If any planning activity is based on this assumption, then the planners need to confirm the assumption with the project owners.

The modeled flow under forecast demand is generally similar to what is modeled under current demand conditions, with slightly increased consumptive water demand in the Sub-basin. This is shown in Figure “Cur,FutTS” in the attached file (titled 20100714-SWP-2050-NMP-TN-Chatuge-HailianLiang.xls).

Little TN Planning Node:

With projected 2050 water use and no additional MP’s, there is no gap between the needed withdrawal and the modeled withdrawal at this node. See Figures “TS-Consumptive” and “Gap-Dem” in the attached file titled 20100610-SWP-2050-NMP-TN-LittelTN-HailianLiang.xls.

A small gap in stream flow can be observed in Figure “Fut-TS” in the attached file (titled 20100714-SWP-2050-NMP-TN-LittleTN-HailianLiang.xls). Modeled flow (blue) is slightly below Flow Regime (red) from September to December except a few days under 2007 hydrological conditions. For the entire period of record, the percentage of time when there is a shortage to Flow Regime is 9%. The average shortage is 5 cfs

(See Table 6). The reason for the increased gap in both length and depth is that under the forecast 2050 demand, the consumptive use in this basin will increase by approximately 6 cfs on an annual basis.

Table 6. Summary of Little_TN Node

Scenario	Length of Shortfall (% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	0%	0	150 (97 MGD)	0	N/A
2050 Forecast	9%	5 (3.1 MGD)	143 (92 MGD)	6 (4.1 MGD)	19 (12 MGD)

Detailed Results

We provide detailed modeling results of each Planning Node in a summary MS Excel file. There are multiple figures in each file. The purposes of these figures are listed in Table 7. The list of Planning Node and corresponding summary MS Excel file is shown in Table 8.

Table 7. Metrics in Detailed Evaluation of Modeling Results

Variable Evaluated	Figure Tabs	Purpose of figures
Demand	TS-Consumptive	Time series of consumptive water use for both current and 2050 conditions
	Gap-Dem	Time series of demand shortages or the "Onion" for current and future demands
Storage	TS-Stor	Time series of storage remaining with bottom of pool
	POR (stor)	Exceedance of POR storage remaining with bottom of pool
Stream Flow Time Series	Nat-TS	Unimpaired natural flow time series
	Nat,FR-TS	Unimpaired plus adjusted flow regime
	FR-TS	Adjusted flow regime
	Cur-TS	Adjusted flow regime and current assessment flow
	Fut-TS	Adjusted flow regime and forecasted assessment flow
	Cur,Fut TS	Comparison of current and future modeled flows
	Fut,Nat TS	Comparison of unimpaired natural and future modeled flows

Flow Regime Shortage	Gap-FR	Flow regime shortage or "Onion" for current and future demands
Stream Flow Exceedance	POR-(Nat)	Exceedance of natural, current and future flows
	Jan (cur)	January Monthly Exceedance of natural, current, future flows and Adjusted Flow regimes
	Feb (cur) through Dec (cur)	February through December Monthly Exceedance of natural, current, future flows and Adjusted Flow regimes

Table 8. Planning Node and corresponding summary MS Excel file List.

Planning Node	Summary MS Excel File
England	20100714-SWP-2050-NMP-TN-Englan-HailianLiang.xls
Chickamauga	20100714-SWP-2050-NMP-TN-Chickamauga-HailianLiang.xls
Copperhill	20100714-SWP-2050-NMP-TN-Copperhill-HailianLiang.xls
Nottely	20100714-SWP-2050-NMP-TN-Nottely-HailianLiang.xls
Chatuge	20100714-SWP-2050-NMP-TN-Chatuge-HailianLiang.xls
Little_TN	20100714-SWP-2050-NMP-TN-LittleTN-HailianLiang.xls

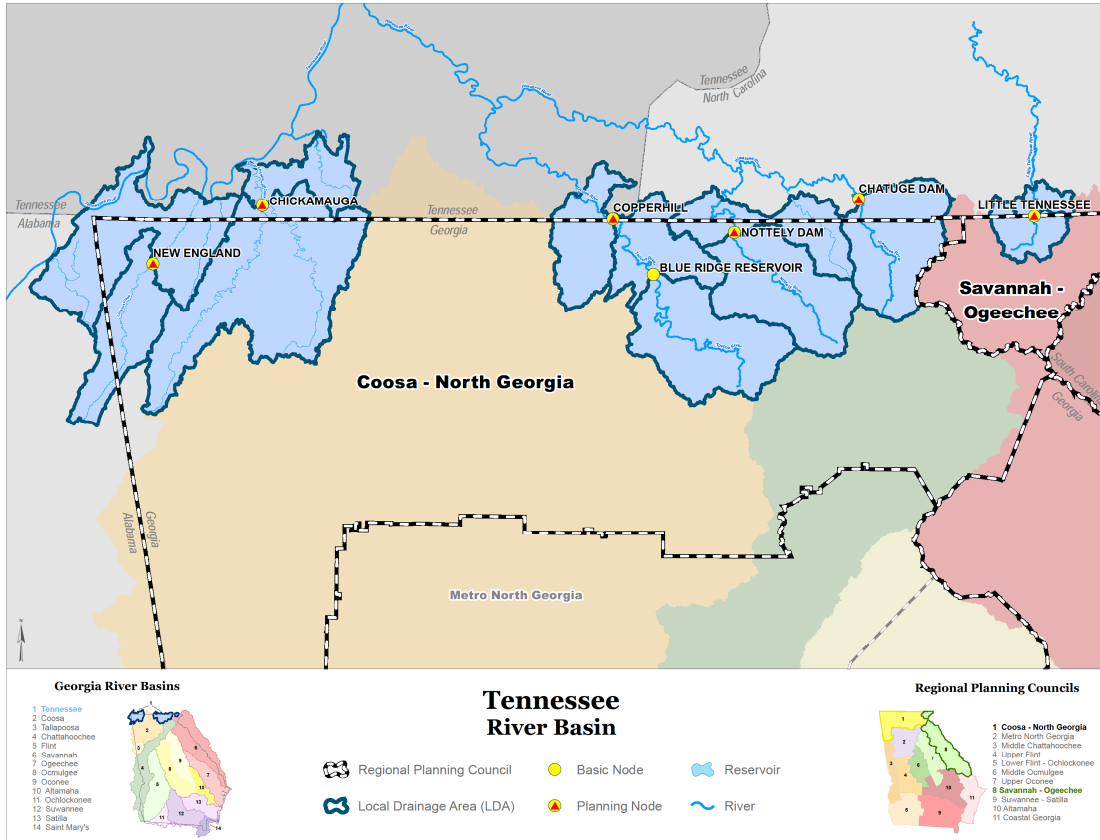


Figure 1. The Tennessee River Basin.

Technical Memorandum

From: Surface Water Availability Resource Assessment Team – Yi Zhang
To: Regional Planning Councils, EPD Planning Team, Planning Contractors, File
Date: July 16, 2010

Subject: Summary Future (2050) Resource Assessment in Apalachicola – Chattahoochee – Flint (ACF) River Basins

Introduction

The purpose of this memorandum is to summarize the results of future Resource Assessment in the ACF Basins with projected 2050 water use conditions. The projected water use conditions (including municipal, industrial, thermal energy, and agricultural) were provided by EPD Planning Team in May 2010.

We used Hec-5 model in both Current Resource Assessment and 2050 Future Resource Assessment. The objective of 2050 Future Resource Assessment is to provide Regional Planning Councils and their Planning Contractors a starting point in assessing whether available resource can meet both the off-stream and instream needs into the forecast future. If available resource cannot satisfy the needs, then Best Management Practices (BMP's) will have to be considered to satisfy the needs.

Model Settings and Key Assumptions

The ACF Basin model contains 6 Planning Nodes and corresponding sub-basins (or 15 Basic Nodes and corresponding Local Drainage Areas). (See Figure 1.)

The hydrological conditions incorporated in the model include unimpaired incremental flow on daily basis for the period between 1939 and 2007. The flow data have been incorporated at all 15 Basic Nodes.

Forecast annual average withdrawal and discharge of each Sub-basin has been temporally distributed to monthly values according to intra-annual patterns of current conditions. The Sub-basins are the finest spatial resolution in the planning models. The water use data do not reflect any single individual facilities, existing or planned.

There are not additional Management Practices (MP's) beyond those that have been reflected by Current Resource Assessments or by forecast 2050 demands. The amount of storage for each Sub-basin remains the same as in Current Resource Assessment. All of the storage volume has been aggregated at the Sub-basin level. The storage information incorporated in the model does not reflect the site or size of any single reservoir.

We assumed continued operation of the ACF system per the Army Corps of Engineers' Revised Interim Operation Plan (RIOP), as we have modeled under Current Resource Assessment.

In unregulated portion of the basin, Flow Regime is defined by the State’s Interim Instream Flow Protection Policy, which calls for the protection of monthly 7Q10 or natural inflow, whichever is lower. In the ACF Basins, this applies to the Montezuma and Bainbridge Nodes.

In regulated portion of the basin, Flow Regime is limited to locations where an explicit flow requirement is specified by the Army Corps of Engineers, Tennessee Valley Authority, or Federal Energy Regulatory Commission (FERC). In the ACF Basins, this applies to the Whitesburg, Columbus, Columbia, and Jim Woodruff Nodes.

Summary of Results

Montezuma Planning Node:

With projected 2050 water use and no additional MP’s, there is almost no gap between simulated flow and Flow Regime. The percentage of time when there is a flow shortage is almost 0%, with an average shortfall of 1 cfs.

There is no shortage in meeting water demand in this Sub-basin, as shown by Figures “TS-Consumptive” and “Gap-Dem” in the attached file titled 20100521-SWP-2050-NMP-ACF-Montezuma-YiZhang.xls.

Table 1. Summary of Montezuma Node

	Length of Shortfall(% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	0%	<1 0.6 mgd	3421 2211 mgd	<1 0.6 mgd	593 383 mgd
2050	0%	<1 0.6 mgd	3409 2203 mgd	<1 0.6 mgd	593 383 mgd

Bainbridge Planning Node:

With projected 2050 water use and no additional MP’s, we do see a significant gap between the simulated flow and the flow regime at this node as shown in Table 2. The percent of time when there is a flow shortage is 13%, with an average shortfall of 355 cfs. Under 2050 forecast water demand, both length and depth of the gap are almost the same as those of current Resource Assessment. This is because total consumptive water use above Bainbridge node under forecasted 2050 demand (annual average 327 cfs) is very close to that under current demand condition (annual average 378 cfs). This is due

to increased return rate under 2050 demand condition although the withdrawals also increase.

There is no shortage in meeting water demand in this Sub-basin, as shown by Figures “TS-Consumptive” and “Gap-Dem” in the attached file titled 20100521-SWP-2050-NMP-ACF-Bainbridge-YiZhang.xls.

Table 2. Summary of Bainbridge Node

	Length of Shortfall(% of time)	Average Shortfall (cfs)	Long-term Average Flow (cfs)	Maximum Shortfall (cfs)	Corresponding Flow Regime (cfs)
Current	13%	352 227 mgd	7910 5113 mgd	1376 890 mgd	2506 1620 mgd
2050	13%	355 229 mgd	7904 5108 mgd	1295 837 mgd	2506 1620 mgd

Whitesburg Planning Node:

With projected 2050 water use and no additional MP’s, our model was able to meet all consumptive water demand in this Sub-basin, as shown by Table 3 as well as by Figures “TS-Consumptive” and “Gap-Dem” in the attached file titled 20100521-SWP-2050-NMP-ACF-Whitesburg-YiZhang.xls. However, this is not to assume that increased water use directly from Lake Lanier, is authorized by owners and operators of the project. If any planning activity is based on this assumption, then the planners need to confirm the assumption with the project owners. The portion of demand increase that comes directly from the federal storage reservoir is therefore considered potential gaps, unless and until appropriate authorization is granted.

There is no shortage in meeting at-site flow requirements, such as minimum flow requirement at Buford Dam and flow requirement (750 cfs) at Atlanta.

Table 3. Summary of gap at Whitesburg Node

	Demand Shortage (cfs)	At-site Flow Requirement Shortage (cfs)	Minimum Reservoir Conservation Storage (acre-feet)	Minimum Percentage Reservoir Conservation Storage	Basin-wide Flow Requirement Shortage
Current	0	0	540,021	50%	None
2050	0	0	424,998	39%	None

There is still 39% water of conservation storage remaining in Lake Lanier. The reservoir storage is generally lower than modeled under current demand conditions, because of increased demand in this Sub-basin. However, the reservoir storage modeled was far from depletion.

Columbus Planning Node:

With projected 2050 water use and no additional MP's, our model was able to meet all consumptive water demand in this Sub-basin, as shown by Table 4 as well as Figures "TS-Consumptive" and "Gap-Dem" in the attached file titled 20100521-SWP-2050-NMP-ACF-Columbus-YiZhang.xls. However, this is not to assume that increased water use directly from Lake Lanier, is authorized by owners and operators of the project. If any planning activity is based on this assumption, then the planners need to confirm the assumption with the project owners. The portion of demand increase that comes directly from the federal storage reservoir is therefore considered potential gaps, unless and until appropriate authorization is granted.

There is no shortage in meeting at-site flow requirements, such as minimum flow requirement at West Point Dam.

Table 4. Summary of gap at Columbus Node

	Demand Shortage (cfs)	At-site Flow Requirement Shortage (cfs)	Minimum Reservoir Conservation Storage (acre-feet)	Minimum Percentage Reservoir Conservation Storage	Basin-wide Flow Requirement Shortage
Current	0	0	14,310	5%	None
2050	0	0	14,269	5%	None

Going through the most critical drought on record, there is about 5% water of conservation storage remaining in West Point reservoir, which is about the same as that under current demand condition although total consumptive use in 2050 is somewhat higher than that under current demand condition in this Sub-basin, as shown by Figure "TS-Consumptive" in the attached file titled 20100521-SWP-2050-NMP-ACF-Columbus-YiZhang.xls. Increased consumptive demand directly taken from West Point Lake is assumed to be a potential gap, unless and until appropriately authorized.

Columbia Planning Node:

With projected 2050 water use and no additional MP's, there is no shortage in meeting water demand in this Sub-basin, as shown by Table 5 and by Figures "TS-Consumptive" and "Gap-Dem" in the attached file titled 20100521-SWP-2050-NMP-ACF-Columbia-YiZhang.xls. There is no at-site flow requirements.

Table 5. Summary of gap at Columbia Node

	Demand Shortage (cfs)	At-site Flow Requirement Shortage (cfs)	Minimum Reservoir Conservation Storage (acre-feet)	Minimum Percentage Reservoir Conservation Storage	Basin-wide Flow Requirement Shortage
Current	0	0	41,076	17%	None
2050	0	0	45,770	19%	None

There is about 19% water of conservation storage remaining in W.F. George reservoir, which is slightly higher than that under current demand condition.

Jim Woodruff Planning Node:

With projected 2050 water use and no additional MP's, there is no shortage in our model meeting water demand in this Sub-basin, as shown by Table 6 and by Figures "TS-Consumptive" and "Gap-Dem" in the attached file titled 20100521-SWP-2050-NMP-ACF-Woodruff-YiZhang.xls. There is also no shortage in meeting basin-wide flow requirement at Chattahoochee gage as shown by Figures "Fut-TS" in the attached file titled 20100521-SWP-2050-NMP-ACF-Woodruff-YiZhang.xls. However, any increased water demand from all federal storage projects are considered potential gaps, unless and until such increase is appropriately authorized.

Table 6. Summary of gap at Jim Woodruff Node

	Demand Shortage (cfs)	At-site Flow Requirement Shortage (cfs)	Minimum Composite Conservation Storage (acre-feet)	Minimum Percentage Composite Conservation Storage	Basin-wide Flow Requirement Shortage
Current	0	0	652,974 at Buford, WP, & WFG	40% at Buford, WP, & WFG	None
2050	0	0	565,765 at Buford, WP, & WFG	35% at Buford, WP, & WFG	None

There is about 35% water of conservation storage remaining in composite storage of Buford, West Point and W.F. George reservoirs, which is little smaller than that under

current demand condition. This is because the consumptive water use during drought period under forecasted 2050 condition is larger than that under current demand condition in Chattahoochee basin, therefore more storage is needed to meet this increased consumptive demand.

Note: At semi-regulated Planning Nodes where there are no explicit flow requirements, we do not have a flow regime to measure stream flow against.

Detailed Results

We provide detailed modeling results of each Planning Node in a summary MS Excel file. There are multiple figures in each file. The purposes of these figures are listed in Table 7 below:

Table 7. Metrics in Detailed Evaluation of Modeling Results

Variable Evaluated	Figure Tabs	Purpose of figures
Demand	TS-Consumptive	Time series of Consumptive Demand
	Gap-Dem	Time series of demand shortages or the "Onion" for current and future demands
Storage	TS-Stor	Time series of storage remaining with bottom of pool
	POR (stor)	Exceedance of POR storage remaining with bottom of pool
Stream Flow Time Series	Nat-TS	Unimpaired natural flow time series
	Nat,FR-TS	Unimpaired plus adjusted flow regime
	FR-TS	Adjusted flow regime
	Cur-TS	Adjusted flow regime and current assessment flow
	Fut-TS	Adjusted flow regime and forecasted assessment flow
	Cur,Fut TS	Comparison of current and future flows
Flow Regime Shortage	Gap-FR	Flow regime shortage or "Onion" for current and future demands
	POR-(Nat)	Exceedance of natural, current and future flows
Stream Flow Exceedance	Jan (cur)	January Monthly Exceedance of natural, current, future flows and Adjusted Flow regimes
	Feb (cur) through Dec (cur)	February through December Monthly Exceedance of natural, current, future flows and Adjusted Flow regimes

Table 8. Planning Node and corresponding summary MS Excel file List.

Planning Node	Summary MS Excel File
Montezuma	20100521-SWP-2050-NMP-ACF-Montezuma-YiZhang.xls
Bainbridge	20100521-SWP-2050-NMP-ACF-Bainbridge-YiZhang.xls
Whitesburg	20100521-SWP-2050-NMP-ACF-Whitesburg-YiZhang.xls
Columbus	20100521-SWP-2050-NMP-ACF-Columbus-YiZhang.xls
Columbia	20100521-SWP-2050-NMP-ACF-Columbia-YiZhang.xls
Woodruff	20100521-SWP-2050-NMP-ACF-Woodruff-YiZhang.xls

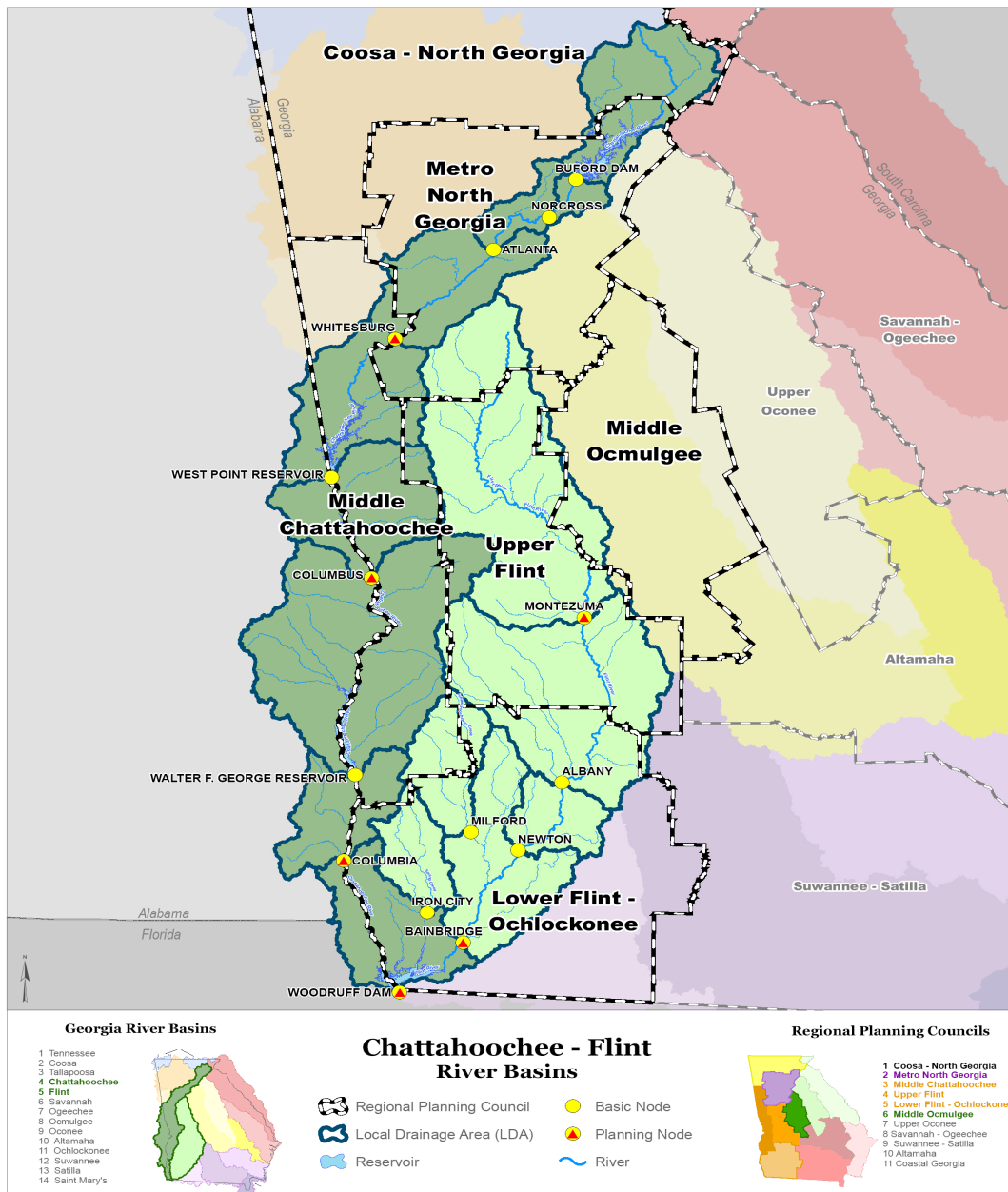


Figure 1. The Chattahoochee – Flint River Basins