Memo

To: Dave Bishop, Ben Rohrbach, and Parvathi Gaddipati, Nashville District Corps of Engineers

From: Stuart Stein and Aaron George, GKY & Associates, Inc. (GKY)

CC: Dave Moore, Tetra Tech

Date: October 26, 2012

Re: Cumberland County Regional Water Supply –Task1 Technical Memorandum

Attachments: Appendix A – Data Collection
Appendix B – Additional Analysis – Lake Tansi Analysis
Appendix C – Additional Analysis – Demand Analysis
Appendix D – Systems Model Schematic

GKY was tasked with developing an existing systems model for Cumberland County to estimate the firm yield of the system, identify areas of need within the system, and identify water supply alternatives to address the areas of need. This technical memorandum summarizes the history of GKY's involvement with the Cumberland County Regional Water Supply project, data collection for this task, engineering report review, additional analysis to support the systems model, systems model setup, systems model analysis/results, identification of areas of need, and potential recommendations for future water supply alternatives.

1.0 History of Project

The Cumberland County Regional Water Supply Study was established by an agreement between the U.S. Army Corps of Engineers (Nashville District) and the City of Crossville, Tennessee. The Cumberland County Regional Water Supply Study has the goal of identifying a long term solution to Cumberland County's water supply needs.

GKY began its involvement in the Water Supply Study in 2005. GKY completed a land-use evaluation for future County population growth, water needs analysis, water conservation analysis, and yield analysis for existing sources. The memos and reports completed documenting this work will be referenced throughout this memo. The significant reports and memos completed by GKY are as follows:

- *Cumberland County Regional Water Supply - Water Needs Assessment and Water Conservation Plan,* dated March 2009. (herein referred to as GKY Water Needs Report)
- *Cumberland County Regional Water Supply – Drought Identification and Existing Sources Yield Analysis,* dated January 2010. (herein referred to as GKY Existing Yield Report)

Work detailed in this Technical Memorandum for Task 1 is a continuation of the Cumberland County Water Supply Study.

2.0 Data Collection

GKY worked with the City of Crossville, the Nashville District Corps of Engineering (Nashville USACE), Tennessee Department of Environment and Conservation (TDEC), and Utility District (UD) managers within

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the County to collect the necessary data needed to develop a complete existing systems model. The City and UD managers provided details on existing water supply sources, interconnections, water sales agreements, and operations. This task was supported by the following key individuals:

- Tim Begley (and staff), City of Crossville, City Engineer
- Kevin Dean, City of Crossville, GIS Planning Administrator
- Everett Bolin (and staff), Crab Orchard UD, UD Manager
- Sandra Brewer (and staff), South Cumberland UD, UD Manager
- David Bell (and staff), West Cumberland UD, UD Manager
- Lyle Bentley, TDEC, Chief, Dam Safety Program
- Ben Rohrbach, Walter Green, Dave Bishop, and Parvathi Gaddipati, Nashville USACE

Appendix A includes a portion of the data collected (i.e., UD data collection sheets, a Cumberland County UD service area map, dam inventory data sheets, and Meadow Park Lake and Lake Holiday dam data sheets) in this task. Section 5 of this memo will also document data collected for systems model setup.

3.0 Report Review

GKY reviewed the following engineering documents from Environmental & Civil Engineering Services (ECE) completed for the City of Crossville:

- Technical Memorandum, *City of Crossville Water System Inter-Basin Transfers* (herein referred to as ECE Project #7035)
- Engineering Report, *Raw Water Supply Expansion* (herein referred to as ECE Project #3002)

The reports provided GKY with alternate sources of data for water demand projections, reservoir/interconnection details, and yield estimates. GKY used the reports to confirm data already acquired in previous tasks. The ECE estimates for future water needs were evaluated but not used in this study. Through data collection, portions of an additional report were also reviewed. This engineering report, *City of Crossville Drinking Water Facilities Plan Downtown Streetscape Improvement Project* (herein referred to as ECE Project #10022), was used to confirm reservoir data.

4.0 Additional Analysis

Additional analysis completed in this task included developing a historic inflow sequence to Lake Tansi, evaluating the yield of the Lake Tansi water supply, and parcel disaggregation of future seasonal water needs projections.

4.1 Lake Tansi Analysis

Lake Tansi was not evaluated in the GKY Existing Yield Report since it was not an existing source at the time of the previous study. A pipeline interconnection was established between Lake Tansi and Meadow Park Lake / Meadow Park Lake Water Treatment Plant (WTP). A water harvesting agreement was established between the City of Crossville and Lake Tansi Property Owners Association (effective October 2, 2009) that allows the City to withdrawal overflow as well as the top four inches of storage in Lake Tansi from October 15th through April 15th. A USACE 404 Permit only allows the City to withdrawal overflow as well as the top four inches of storage from October 31st to April 15th. The interconnection was established in October, 2011.

GKY developed a historic inflow sequence to Lake Tansi using a calibrated hydrologic model. The hydrologic model included the following input data:

- Daily precipitation data (Crossville Exp Stn gage) from September 1913 to August 2008
- Lake Tansi watershed characteristics (i.e. drainage area, infiltration characteristics, and baseflow)
- Lake Tansi reservoir characteristics (i.e. surface area and infiltration characteristics)
- Evapotranspiration (ET) losses

Hydrologic modeling was completed using Hydrologic Engineering Center's Hydrologic Modeling Software (HEC-HMS). Modeling techniques were consistent with the method outlined in the GKY Existing Yield Report.

A detailed stage-storage curve was not provided to GKY. Storage estimates were provided from Crossville in ECE Project #3002 and from the Tennessee dam inventory data sheet. Storage estimates were provided for maximum pool, normal pool, and an eight foot drawdown from normal pool.

GKY developed a stage-storage curve with the known storage estimates provided in ECE Project #3002. Storage available for water supply was calculated as a product of the surface area at normal pool (404 acres) and the four inch drawdown, which yields approximately 43.8 million gallons of available water.

The full inflow sequence was input into a sequent peak analysis to get an estimate for the yield of the Lake Tansi supply. The sequent peak analysis resulted in a firm yield of about 0.49 million gallons per day (MGD). (A separate sequent peak analysis was not included in the scope of work, the critical drought was not investigated, and the sequent peak analysis considers the entire inflow sequence) GKY Existing Yield Report documented a Meadow Park Lake firm yield equal to 3.58 MGD. With the connection to Lake Tansi this estimate could be increased to 4.07 MGD. Since Lake Tansi is only connected to Meadow Park Lake through the connection and not through natural, physical conveyance, adding the Lake Tansi firm yield as developed in this Task to the Meadow Park Lake firm yield is a reasonable estimate for the combined yield of the two sources without developing specific rules for the interconnection operation and testing for firm yield.

Appendix B includes data and results for the Lake Tansi analysis.

4.2 Demand Analysis

GKY was not tasked with reevaluating demand projections. Instead, GKY was tasked with disaggregating the seasonal demands presented in the GKY Water Needs Report for individual UDs and UD service areas. The GKY Water Needs Report demand projection divided water needs by communities within Cumberland County. For water demand in the systems model, GKY disaggregated demand based on UD service boundaries. The "expected" growth scenario was used in this analysis.

Disaggregating demands from the study areas to UDs was accomplished by a parcel-based analysis. A 2006 GIS shapefile of Cumberland County parcels was used to reflect the conditions of the 2006 base year projections. The parcel database included data for each parcel, including its land use type and development status (either developed or undeveloped). Also, from previous analyses, each parcel was assigned to a study area. The basic method used to reaggregate the parcels from study area to UD was simply to complete a spatial join of the UD boundaries to the parcel database. Once joined, the attribute table was exported, which included each parcel's study area and UD. GKY was then able to assign each UD a demand for the base year and 10-yr incremental benchmark projections.

Based on conversation with the City, further definition was given to the City of Crossville's service area's demand, which was broken into three demand areas to differentiate between areas that Meadow Park Lake and Lake Holiday serve. The City provided GKY with a service area map for its sources. Table 1 shows the resulting disaggregated water needs projections used in this Task.

Table 1: Projected Total Water Needs (MGD)

Service Area	2006	2016	2026	2036	2046	2056
Crab Orchard	1.17	1.54	2.17	3.01	3.89	4.14
Crossville (Total)	2.94	3.47	3.87	4.01	4.19	4.37
Crossville (MPL/Holiday)	*2.27*	*2.73*	*3.08*	*3.21*	*3.38*	*3.54*
Crossville (MPL/Holiday Optional)	*0.43*	*0.45*	*0.47*	*0.48*	*0.49*	*0.50*
Crossville (MPL Only)	*0.25*	*0.29*	*0.32*	*0.32*	*0.32*	*0.33*
South Cumberland	0.56	0.83	1.32	1.74	2.12	2.38
West Cumberland	0.24	0.26	0.29	0.31	0.34	0.40
Total	***4.91***	***6.11***	***7.64***	***9.08***	***10.54***	***11.28***

Seasonal variations, as presented in the GKY Water Needs Report, were used in this study. Although seasonal variations may differ significantly based on areas within the County, GKY deemed it most appropriate to assign an average seasonal variation multiplier to all demands in the County (Table 3 in GKY Water Needs Report). The following seasonal multipliers were used in this study:

- **Summer** – 1.12 (applied to 122 days per year, June - September)
- **Winter** – 0.94 (applied to 243 days per year, October - May)

The previous study and communication with the Crab Orchard UD Manager shows that the seasonal variation in demand for the Crab Orchard UD could be as high as 1.35 to 1.5 times the average for summer demand. However, it is assumed that as UDs develop, these seasonal variations will move towards the average for the entire system, as calculated in the GKY Water Needs Report. Therefore, GKY deemed it most appropriate to use the system average seasonal multipliers for all UDs. The seasonal multipliers are in good agreement with Crossville water use data evaluated over the past several years.

A Crossville filtration plant service area map and a complete table of water needs projections for future benchmark years are included in Appendix C.

5.0 Systems Model Setup

OASIS is a water system modeling software developed by HydroLogics, Inc. GKY incorporated data collected during this and previous studies, along with additional analysis described previously, to develop an existing systems model using OASIS.

Original Data / Model Assumptions:

Through data collection and review of existing studies, GKY was able to collect a majority of the necessary data to build a system model for Cumberland County. Reasonable assumptions were made in instances where data was not provided. The data and assumptions in this section, as well as data included in Appendix A, B, and C, outline the input for the existing system model.

GKY used historical inflow sequences for all four existing reservoirs. Meadow Park Lake, Lake Holiday, and Otter Creek Lake used historical inflow sequences described in the GKY Existing Yield Report and Lake Tansi's which was developed in this Task. All four historic inflow sequences were developed by GKY and cover the same period of record (September 1913 to August 2008).

GKY was provided with physical/institutional transfer constraints as well as transfer agreements (contracts) for existing interconnections. The following agreements were supplied to GKY:

- Crossville – Town of Monterey Agreement – Approved October 31st, 2002
- Crossville – Grandview Agreement – Approved April 10th, 2007
- Crossville – Falls Creek Falls / South Cumberland Agreement– Approved May 11th, 2007
- Crossville – Lake Tansi Water Harvesting Agreement – Approved October 2nd, 2009
- West Cumberland – Bon De Croft Agreement – Approved October 15, 2007

Interconnection capacities were provided during the data collection task. Interconnection transfer capacity is limited by the minimum of the physical capacity of the connection and the institutional constraint. Note that if no agreement exists between UDs, then the assumed institutional capacity was set to 0 MGD. Capacities for interconnections can be found in Appendix A and in Table 2.

Lake Tansi's interconnection to the City of Crossville system is through a pipeline to Meadow Park Lake and Meadow Park Lake WTP. The City provided guidance on operations for this connection. The primary objective of activating this connection is to supply water to the Meadow Park Lake WTP and then any additional water goes to Meadow Park Lake. The pump has the ability to supply water to both locations up to its 14 MGD capacity but a TVA Inter-basin Transfer Permit, from TDEC, restricts transfer to 5 MGD. GKY assumed that the pump would activate in the permitted months (October 31th to April 15th) anytime there is available storage/overflow in Lake Tansi. Elevation triggers in Meadow Park Lake were not considered in the model.

Table 2: Interconnection capacities

Interconnection		Physical Capacity	Institutional Constraint	Notes
From UD	To UD	(MGD)	(MGD)	
Bon De Croft	West Cumberland	0.75	1.5	Outside County transfer
Crab Orchard	Crossville	1.81	No Agreement	Emergency connection only
Crab Orchard	Grandview	0.22	No Agreement	Outside County transfer, emergency connection only
Crossville	Crab Orchard	1.81	No Agreement	Emergency connection only
Crossville	Grandview	0.72	No Limit	Outside County transfer
Crossville	South Cumberland	2.17	No Limit	
Crossville	West Cumberland	0.5	No Agreement	Emergency connection only
South Cumberland	Falls Creek Falls	0.33	0.33	Outside County transfer

The existing system relies on three WTPs. There are WTPs located at Meadow Park Lake, Lake Holiday, and Otter Creek Lake. The capacities of each were provided to GKY and are as follows:

- Meadow Park Lake WTP – 3.5 MGD
- Lake Holiday WTP – 2.0 MGD
  (Lake Holiday WTP capacity is 4.0 MGD, but the WTP only has staffing to run at 2.0 MGD)
- Otter Creek Lake WTP – 4.0 MGD

No stage-storage information was provided for the existing reservoirs and limited intake/pool elevation data was provided during the data collection task. GKY relied heavily on information collected for the GKY Existing Yield Report as well as the limited new data collected in this task. The data used for each existing source is detailed below:

- Meadow Park Lake – Stage-storage information was developed by GKY for the GKY Existing Yield Report. The City provided estimates for normal pool elevation, storage, etc. from a Meadow Park Lake data sheet included in the ECE Project #10022. GKY adjusted elevations to match the two sources of data (i.e., vertical shift from new surveying).
- Lake Holiday – Stage Storage information was provided for the GKY Existing Yield Report. Newer data from ECE Project #10022 had discrepancies in the reported normal and maximum pool. GKY deemed the data collected for the GKY Existing Yield Report more accurate since it agreed with safe dams and storage estimates provided previously and, thus, this was used for this task.
- Otter Creek Lake – Stage-storage information was developed by GKY for the GKY Existing Yield Report. The Crab Orchard UD Manager confirmed normal pool elevation, max pool elevation, and intake elevations.
- Lake Tansi –GKY used stage-area-storage information from Safe Dams and ECE Project #3002.

Seasonal demand was assigned to all UDs based on the demand disaggregation portion of this Task. See section 4.2 of this memo for discussion on demand within the County.

The Cumberland County Water Supply System has several connections to outside UDs. Crossville has connections/agreements with Falls Creek Falls (sell, through South Cumberland), Grandview (sell), and the Town of Monterey (buy). Crab Orchard has a connection to Grandview (no agreement). The West Cumberland UD has a connection Bon De Croft (buy).

The scope of work did not cover modeling outside sources or demands. Therefore, the following assumptions were made for transfers with UDs outside the County:

- **Crossville – Town of Monterey Agreement** – 0 MGD – This interconnection is utilized only during outages, maintenance, and other localized conditions that were not be modeled.
- **Crossville – Grandview Agreement** –The City provided transfer projections for Grandview. The transfer projections are shown in Table 3.
- **Crossville – Falls Creek Falls Agreement** – The City provided transfer projections for Falls Creek Falls. The transfer projections are shown in Table 3.
- **Crab Orchard – Grandview Connection**– Crab Orchard has stated that this connection can be utilized as an emergency supply. An emergency interconnection was added between the UDs.
- **West Cumberland – Bon De Croft Agreement** – <= 0.75 MGD - Since West Cumberland relies solely on Bon De Croft for its water supply and GKY was not scoped with modeling the outside sources, GKY assumed that Bon De Croft provides the West Cumberland demand up to the institutional constraint at all times. In other words, West Cumberland's demand will be met by Bon De Croft up to the contractual limit, with any shortfall to be handled though the Crossville connection. {Note: All future West Cumberland UD water needs projections can be satisfied by the Bon De Croft interconnection}

Table 3: Outside UD Projected Transfer (MGD)

Service Area	2006	2016	2026	2036	2046	2056
Falls Creek Falls	0.00	0.03	0.07	0.10	0.13	0.17
Grandview	0.09	0.11	0.14	0.17	0.20	0.25

NOTE: Seasonal multipliers were applied to the outside UD transfers.

Though not covered under the SOW, GKY reviewed the *Water Utility Districts of Cumberland County Drought Management Plan* (dated August 2010) provided from the City, Crab Orchard UD, and West Cumberland UD. Drought operations/emergency interconnections were not used in the existing systems model. Drought operations, including demand reduction and emergency interconnection activation, are a safety factor for the system and would increase the firm yield estimate for the Cumberland County system. Drought operations may be revisited during Task 2 of this project.

The data collected for this task was input into the OASIS systems model. The model simulates the entire period of record of the historic inflow sequences. The information collected and outlined, above, was built into OASIS features including reservoirs, nodes (demand/terminal), arcs (interconnections), time series data (historic inflow sequence), and user programming. Appendix D presents a schematic of the OASIS systems model.

6.0 Systems Model Analysis

For the purposes of this task, firm yield was defined as the maximum amount of treated water that can be delivered to the Cumberland County Water Supply System without any of the UDs experiencing shortage. The demand was set for the future benchmark years based on the water needs projections. Modeling was performed for all of the 10-yr benchmark projections. Once a shortage, or failure, occurred anywhere in the system it was determined that the preceding benchmark year defined the firm yield for the system. For example, if the UDs had no shortage using the 2016 benchmark demands, which totals 6.11 MGD, and a shortage was encountered using the 2026 benchmark demand, which totals 7.64 MGD, then the systems firm yield is reported as 6.11 MGD.

Firm yield analysis was completed for the existing system with and without existing WTP constraints. The firm yield with the existing WTP capacities highlights the need for major infrastructural investments that will be required to meet Cumberland County's future water needs. TDEC, Division of Water Supply, water supply rules require that once a public water system demand reaches eighty percent of its treatment capacity, it must upgrade the facilities capacity. For this reason, GKY and the Corps assumed that the WTP capacity will be required to be upgraded, as necessary, so the system was also modeled with the WTP capacities turned off.

The existing systems model yield results are as follows:

With WTP capacity constraints turned on:

- Firm yield is equal to the 2016 demand, **6.25 MGD**, including all demand in the Cumberland County system and outside UDs supplied by sources within the County (i.e., Grandview and Falls Creek Falls).
- Shortage is experienced in the 2026 benchmark year. There is a 0.52 MGD shortage to the City of Crossville service area during the summer months due to WTP capacity of the City of Crossville system.

With WTP capacity constraints turned off:

- Firm yield is equal to the 2026 demand, **7.85 MGD**, including all demand in the Cumberland County system and outside UDs supplied by sources within the County (i.e., Grandview and Falls Creek Falls).
- Shortage is experienced in the 2036 benchmark year. Crab Orchard UD's demand cannot be met multiple times during the period of record. Otter Creek Lake is depleted of usable water during significant droughts (this occurs during 14 different calendar years) causing Crab Orchard to experience shortages of as much as 3.4 MGD. The rest of the Cumberland County system is able to meet demand. These results align closely with previous firm yield estimates for Otter Creek Lake in the GKY Existing Yield Report.

An additional goal of this Task was to identify areas of need within the system. Two areas of need were already identified during the firm yield analyses: insufficient storage in Otter Creek Lake limits the ability to meet future Crab Orchard UD demand and WTP capacity limits the ability to meet future Crossville UD demand. To identify other areas of need, GKY modeled the 2046 and 2056 benchmark years with WTP capacity constraints lifted.

2046 Benchmark Areas of Need:

- Crossville's service area experiences shortage due to the physical capacity of the Crossville-South Cumberland interconnection. The summer demand from South Cumberland and Falls Creek Falls is 2.51 MGD and the physical capacity of the interconnection is 2.17 MGD, leaving summer shortage of 0.33 MGD.
- Crab Orchard UD experiences a greater frequency of shortage due to insufficient capacity in Otter Creek Lake. {Note: Firm yield of Otter Creek Lake is approximately 2.35 MGD and the 2046 benchmark year Crab Orchard UD demand is 3.89 MGD}

2056 Benchmark Areas of Need:

- Crossville's service area experiences shortage due to the physical capacity of the Crossville-South Cumberland interconnection. The summer and winter demand from South Cumberland and Falls Creek Falls is 2.84 MGD and 2.40 MGD, respectively. The physical capacity of the interconnection is 2.17 MGD, leaving an annual summer shortage of 0.67 MGD and annual winter shortage of 0.23 MGD.
- Crab Orchard UD experiences a greater frequency of shortages due to insufficient capacity in Otter Creek Lake. {Note: Firm yield of Otter Creek Lake is approximately 2.35 MGD and the 2056 benchmark year Crab Orchard UD demand is 4.14 MGD}

To address the areas of need within the system for future benchmark years (i.e., 2026-2056), GKY makes the following recommendations for water supply alternatives in order of priority:

- **Upgrade WTPs** – As required by TDEC, the County should upgrade its existing WTPs as necessary so that the yield is not constrained by treated water.
- **Establish water sales agreements** – The City of Crossville could potentially supply Crab Orchard enough water to eliminate shortage for the 2046 benchmark. This would allow water transfer from the supply available in Meadow Park Lake, Lake Tansi, and Lake Holiday. The 2056 benchmark would likely require both an agreement and an upgrade to the existing interconnection between the entities. The existing interconnection between Crossville and Crab Orchard has a physical capacity of 1.81 MGD.
- **Upgrade interconnections** – Provide a larger physical interconnection capacity between Crossville and South Cumberland. This upgrade should allow demand to be met through the 2056 benchmark year with the existing sources. Other interconnections may need upgrades with changes to the existing system.
- **Upgrade water supplies** – With upgrades to interconnections and establishment of new agreements, Meadow Park Lake, Lake Tansi, and Lake Holiday may lack capacity, therefore creating the need for modifications to existing water supplies (i.e., raising Meadow Park Lake's Dam) or building new impoundments. The SOW lists potential water supply alternatives that could be considered to address shortages.

The identification of areas of need and recommendations for water supply alternatives are limited to addressing the results from this Task. The recommendations may change as Task 2 modeling is completed (i.e., initial changes to the existing system model from Task 1 could highlight additional/different areas of need). Per the SOW for Task 2, GKY will perform up to six modeling scenarios with interconnection and operation modifications and then an additional three scenarios incorporating future water supply alternatives.

Appendix A – Data Collection

A.1 UD Data Collection Sheets

- A.1.1 Crab Orchard UD Data Collection Sheet
- A.1.2 Crossville Data Collection Sheet
- A.1.3 South Cumberland Data Collection Sheet
- A.1.4 West Cumberland UD Data Collection Sheet

A.2 Cumberland County UD Service Area Map

A.3 Dam Inventory Data Sheets

- A.3.1 Meadow Park Lake Dam Inventory Data Sheet (TDEC)
- A.3.2 Lake Tansi Dam Inventory Data Sheet (TDEC)
- A.3.3 Lake Holiday Dam Inventory Data Sheet (TDEC)
- A.3.4 Otter Creek Dam Inventory Data Sheet (TDEC)

A.4 Dam Data Sheets

- A.4.1 Lake Holiday Dam Data Sheet (ECE Report #10022)
- A.4.2 Meadow Park Lake Dam Data Sheet (ECE Report #10022)

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Agency:	Crab Orchard Utility District
Person(s):	Everett Bolin
Date:	5/11/2012 & 5/18/2012

Water Supply Sources	**Verify Existing Source Utilized (Y or N)**	**Withdrawal transferred to? (i.e. Water Treatment Plant, Alternate Source, etc.)**
Otter Creek Impoundment*	Y	WTP
Any additional sources? (document name, yield, treatment type, transfer connection, etc.)	N/A	

*Stage-storage information is required for all reservoir water supply sources. Please provide stage-storage information in a tabular format of elevation (specified in feet, with vertical datum reference) versus storage (specify unit).

Water Treatment Plants:	**Existing Maximum Treatment Capacity**	**Future Expansion Maximum Treatment Capacity**	**Date of Future Expansion**
	(MGD)	**(MGD)**	
Crab Orchard Water Treatment Plant	4	N/A	
Additional Treatment Facility(s)			
Additional Treatment Facility(s)			
Additional Comments:			

Interconnections:		**Physical Transfer Constraints[1]**	**Institutional Transfer Limitations[2]**	**Transfer Agreement[3]**	**Connection Type[4]**
		(MGD)	**(MGD)**	**(Buy, Sell, or Both)**	
Crossville (Catoosa) Utility District		1.81 (one-way meter)	No Agreement		
Falls Creek Falls Utility District		N/A			
Grandview Utility District		0.216	No Agreement		
South Cumberland Utility District		N/A			
West Cumberland Utility District		N/A			
Additional Interconnections	Name (U.D. or jurisdiction)				
Additional Interconnection 1:	Crossville	None			
Additional Interconnection 2:					
Additional Interconnection 3:					
Please provide contract agreements and any supporting interconnection info that would assist in modeling. Are there preferred connections/agreements? **We are presently only connected with Grandview and furnish them water in an emergency. A connection is possible w/Crossville, but not presently connected. (Everett Bolin)** NOTE: (GKY) Crossville connection capacity is assumed to be 1.81 MGD. Current one-way meter would need upgraded to monitor this transfer.					

[1]Maximum transfer rate possible within the existing system (i.e. limited by pipe size or pump capacity)

[2]Maximum transfer rate based on contractual agreements. For transfers to or from connections outside the county, please provide a single required transfer rate.

[3]Contractual agreement/physical system allows for buying, selling, or transfer both directions

[4]Water supply connected through source, system, W.T.P., etc.

An overall map is attached showing the approximate boundary for areas served by the Crab Orchard Utility District as well as other Utility Districts in Cumberland County. The boundary lines shown in this map are included in a GIS shapefile that is attached to this data request. Please revise the boundary if it is incorrect and/or provide any additional notes or guidance for area served by the Crab Orchard Utility District (this information will assist in more accurately determining the demand of the Utility District):

Agency:	Crossville (w/Catoosa) Utility District
Person(s):	Compiled by Kevin Dean. Data obtained from Tim Begley, Billy Martin, Jerry Kerley, and Jerry Garrison.
Date:	

Water Supply Sources	**Verify Existing Source Utilized (Y or N)**	**Withdrawal transferred to? (i.e. Water Treatment Plant, Alternate Source, etc.)**
Lake Holiday*	**Yes**	**WTP**
Meadow Park Lake*	**Yes**	**WTP**
Lake Tansi*	**Yes**	**WTP / Meadowpark Lake**
Any additional sources? (document name, yield, treatment type, transfer connection, etc.)		

*Stage-storage information is required for all reservoir water supply sources. Please provide stage-storage information in a tabular format of elevation (specified in feet, with vertical datum reference) versus storage (specify unit).

NOTE: GKY has completed yield analysis on Lake Holiday and Meadow Park Lake. Additional information will be required for Lake Tansi yield analysis (sheet 2 of data request).

Water Treatment Plants:	**Existing Maximum Treatment Capacity (MGD)**	**Future Expansion Maximum Treatment Capacity (MGD)**	**Date of Future Expansion**
Holiday Hills Water Treatment Plant			
Meadow Park Lake Water Treatment Plant			
Additional Treatment Facility(s)			
Additional Treatment Facility(s)			
Additional Comments:			

Interconnections:		**Physical Transfer Constraints[1] (MGD)**	**Institutional Transfer Limitations[2] (MGD)**	**Transfer Agreement[3] (Buy, Sell, or Both)**	**Connection Type[4]**
Crab Orchard Utility District		**1.8144**	**No Contract or Agreement**	**None**	**System (two locations)**
Falls Creek Falls Utility District		**Connection through South C umberland UD**	**0.3333**	**Sell**	**System**
Grandview Utility District		**0.7200**	**None**	**Sell**	**System**
South Cumberland Utility District		**2.1744**	**None**	**Sell**	**System (three locations)**
Town of Monterey (Putnam Count)		**0.3600**	**0.2 (max of 250gpm)**	**Buy**	**System**
West Cumberland Utility District		**0.5040**	**None**	**None**	**System**
Additional Interconnections	Name (U.D. or jurisdiction)				
Additional Interconnection 1:					
Additional Interconnection 2:					
Additional Interconnection 3:					
Please provide contract agreements and any supporting interconnection info that would assist in modeling. Are there preferred connections/agreements?					

[1]Maximum transfer rate possible within the existing system (i.e. limited by pipe size or pump capacity)

[2]Maximum transfer rate based on contractual agreements. For transfers to or from connections outside the county, please provide a single required transfer rate.

[3]Contractual agreement/physical system allows for buying, selling, or transfer both directions

[4]Water supply connected through source, system, W.T.P., etc.

LAKE TANSI		
Drainage Area		
Normal Pool	Elevation (w/Vertical Datum)	**1861.71 (NAVD88)**
	Surface Area	**401 acres**
	Storage	
Maximum Pool	Elevation (w/Vertical Datum)	
	Surface Area	
	Storage	
Water Supply Intake Elevation (w/Vertical Datum)		**1848.25 (NAVD88)**
Physical Transfer Capacity (MGD)		**14**
Contractual Transfer Agreement (MGD)		**Top 4 inches (Oct. 15 to Apr. 15)**
NOTE: This information is required for a yield analysis for Lake Tansi. Please also provide any additional documentation that may assist in this task (i.e. stage-storage curves, survey data, safe dams sheet, etc.)		

Please describe how Lake Tansi will operate in the existing water supply system. Raw water from Lake Tansi will be transferred to which location? Is this agreement permanent?

Raw water will be pumped from Lake Tansi to the Meadowpark Water Treatment Plant or to Meadow Park Lake per the conditions of the agreement. This agreement is for a term of fourty (40) years.

Additional Information:

Please describe how the Crossville Utility District and Catoosa Utility Department function together. Are they separate entities? Should they be modeled separately in the systems model?

The Catoosa Utility Department is a part of the City of Crossville. They should be considered and modeled as one system.

An overall map is attached showing the approximate boundary for areas served by the City of Crossville Utility District as well as other Utility Districts in Cumberland County. The boundary lines shown in this map are included in a GIS shapefile that is attached to this data request. Please revise the boundary if it is incorrect and/or provide any additional notes or guidance for area served by the City of Crossville U. D. (this information will assist in more accurately determining the demand of the Utility District):

A complete set of utility boundary shapefiles have been included in the data sets provided. As far as the map is concerned, there are a few corrections, as listed: There is no connection between Crab Orchard UD and Fall Creek Falls. / It is only a one way connection for the Town of Monterey to Catoosa. / There is only a one way connection between the City of Crossville to Crab Orchard UD. Also on the Data DVD is a jpeg of a "marked up" map.

Agency:	South Cumberland Utility District
Person(s):	Sandra Brewer
Date:	5/11/2012

Water Supply Sources*	**Verify Existing Source Utilized (Y or N)**	**Withdrawal transferred to? (i.e. Water Treatment Plant, Alternate Source, etc.)**
Groundwater Harvesting	N	N
Any additional sources? (document name, yield, treatment type, transfer connection, etc.)	South Cumberland Utility District purchases 100% of its water from the City of Crossville	

*Stage-storage information is required for all reservoir water supply sources. Please provide stage-storage information in a tabular format of elevation (specified in feet, with vertical datum reference) versus storage (specify unit).

Water Treatment Plants:	**Existing Maximum Treatment Capacity (MGD)**	**Future Expansion Maximum Treatment Capacity (MGD)**	**Date of Future Expansion**
Additional Treatment Facility(s)	N/A		
Additional Treatment Facility(s)			

Additional Comments:

Interconnections:		**Physical Transfer Constraints[1] (MGD)**	**Institutional Transfer Limitations[2] (MGD)**	**Transfer Agreement[3] (Buy, Sell, or Both)**	**Connection Type[4]**
Bondecroft Utility District					
Crab Orchard Utility District					
Crossville (Catoosa) Utility District					
Falls Creek Falls Utility District		Fall Creek Falls Utility District has the option to purchase up to 300,000 gpd from the City of Crossville with South Cumberland Utility District being the transfer agent			
Grandview Utility District					
West Cumberland Utility District					
Additional Interconnections	Name (U.D. or jurisdiction)				
Additional Interconnection 1:					
Additional Interconnection 2:					
Additional Interconnection 3:					

Please provide contract agreements and any supporting interconnection info that would assist in modeling. Are there preferred connections/agreements?

[1]Maximum transfer rate possible within the existing system (i.e. limited by pipe size or pump capacity)

[2]Maximum transfer rate based on contractual agreements. For transfers to or from connections outside the county, please provide a single required transfer rate.

[3]Contractual agreement/physical system allows for buying, selling, or transfer both directions

[4]Water supply connected through source, system, W.T.P., etc.

An overall map is attached showing the approximate boundary for areas served by the South Cumberland Utility District as well as other Utility Districts in Cumberland County. The boundary lines shown in this map are included in a GIS shapefile that is attached to this data request. Please revise the boundary if it is incorrect and/or provide any additional notes or guidance for area served by the South Cumberland Utility District (this information will assist in more accurately determining the demand of the Utility District):
The map appears to be accurate

Agency:	West Cumberland Utility District
Person(s):	David Bell
Date:	5/21/2012

Water Supply Sources*	**Verify Existing Source Utilized (Y or N)**	**Withdrawal transferred to? (i.e. Water Treatment Plant, Alternate Source, etc.)**
	Y	
Any additional sources? (document name, yield, treatment type, transfer connection, etc.)	Bon De Croft UD	

*Stage-storage information is required for all reservoir water supply sources. Please provide stage-storage information in a tabular format of elevation (specified in feet, with vertical datum reference) versus storage (specify unit).

Water Treatment Plants:	**Existing Maximum Treatment Capacity (MGD)**	**Future Expansion Maximum Treatment Capacity (MGD)**	**Date of Future Expansion**
Additional Treatment Facility(s)			
Additional Treatment Facility(s)			

Additional Comments:

Interconnections:		**Physical Transfer Constraints[1] (MGD)**	**Institutional Transfer Limitations[2] (MGD)**	**Transfer Agreement[3] (Buy, Sell, or Both)**	**Connection Type[4]**
Bondecroft Utility District		1.5 MGD	N/A	0.75 MGD Max BUY	8" mtr 12" line
Crab Orchard Utility District					
Crossville (Catoosa) Utility District					
Falls Creek Falls Utility District					
Grandview Utility District					
South Cumberland Utility District					
Additional Interconnections	Name (U.D. or jurisdiction)				
Additional Interconnection 1:	Crossville	Emergency Only			4" mtr 10" line
Additional Interconnection 2:					
Additional Interconnection 3:					

Please provide contract agreements and any supporting interconnection info that would assist in modeling. Are there preferred connections/agreements?

[1]Maximum transfer rate possible within the existing system (i.e. limited by pipe size or pump capacity)

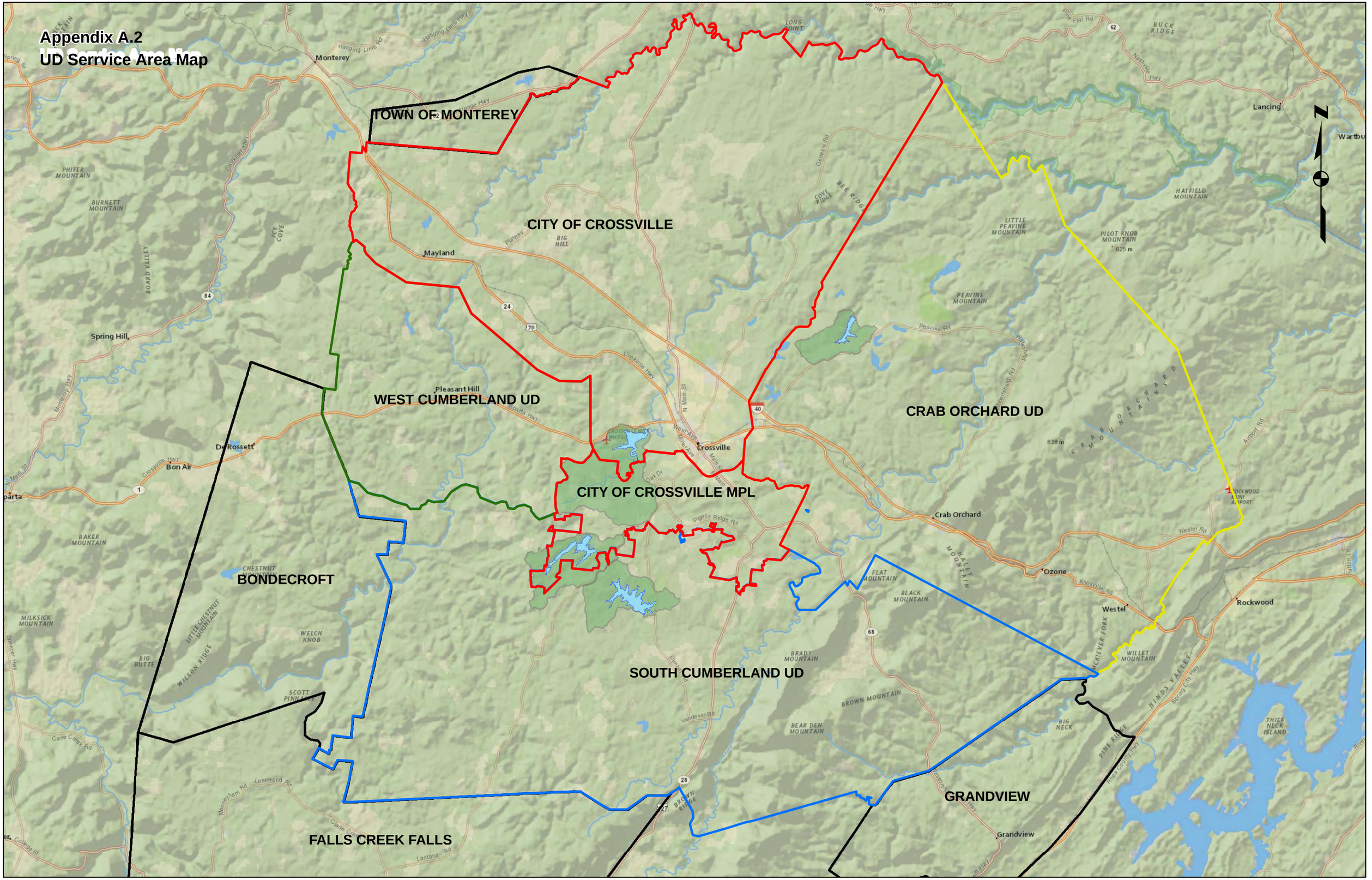
[2]Maximum transfer rate based on contractual agreements. For transfers to or from connections outside the county, please provide a single required transfer rate.

[3]Contractual agreement/physical system allows for buying, selling, or transfer both directions

[4]Water supply connected through source, system, W.T.P., etc.

An overall map is attached showing the approximate boundary for areas served by the West Cumberland Utility District as well as other Utility Districts in Cumberland County. The boundary lines shown in this map are included in a GIS shapefile that is attached to this data request. Please revise the boundary if it is incorrect and/or provide any additional notes or guidance for area served by the West Cumberland Utility District (this information will assist in more accurately determining the demand of the Utility District):
Map looks accurate

Appendix A.2
UD Serrvice Area Map



Appendix A.3.1

DAM INVENTORY DATA SHEET
DEPARTMENT OF HEALTH & ENVIRONMENT
DIVISION OF WATER SUPPLY

ID NUMBERS STATE (ID): 18-7001 FEDERAL (FED ID) TN 03501

NAME (PROJECT): Meadow Park Dam REGION(R): KFO

OWNER(S): City of Crossville

ADDRESS: P.O. Drawer 528 Crossville, TN 38555

TELEPHONE: BUSINESS (615) 484-7060 RESIDENCE

COUNTY Cumberland QUAD: 109 NE- Crossville

LOCATION LATITUDE: 35 ° 54 ' 09 " LONGITUDE 85 ° 05 ' 59 49 "

STREAM (SOURCE): RIVER MILE BASIN

PURPOSE OF DAM: Water Supply, Recreation YEAR COMPLETED: 1938

CONTRACTOR (CONT): LOCATION:

ENGINEER(ENG): Freeland and Roberts LOCATION: Nashville

TYPE OF DAM (TYC): Concrete Arch SIZE CLASSIFICATION: Intermediate

DOWNSTREAM HAZARD POTENTIAL CLASSIFICATION: STATE(H) 2 FEDERAL (FH)

CERTIFICATE EXPIRATION DATE (EXP DATE):

STRUCTURAL HEIGHT (SHT): 32 FEET, HYDRAULIC HEIGHT (HHT): 28 FEET

CREST LENGTH (LGTH): 274* FEET, CREST WIDTH (WDTH): 3.5 FEET

UPSTREAM SLOPE (U/S): Vertical :1, DOWNSTREAM SLOPE(D/S): 0.2 :1

POOL AREA NORMAL(INSUF): 274 ACRES, MAXIMUM(M/SURF): 390*** ACRES

	ELEVATION (FEET MSL),		STORAGE CAPCITY (ACRE-FEET)
TOP OF DAM	(ELEVI) 1821.5 ,	(TO/STR)	4397***
EMERGENCY SPILLWAY CREST	(ELEV 2) ,	(EM/STR)	
NORMAL POOL	(ELEV 3) 1817.5 ,	(N/STR)	3069**
EMERGENCY SPILLWAY MATERIAL(ESM) ,		SIZE(SZ)	
SERVICE SPILLWAY MATERIAL(SSM) Concrete ,		SIZE(SZ)	49' X 4' -right;54'X4'-left

DRAINAGE AREA(DA): 5.19 SQ. MILES CURVE NUMBER(CN): 6667 AMCII

TIME OF CONCENTRATION(TC) 0.73 HOURS, MAXIMUM 6-HR RAIN: INCHES

COMMENTS: INVENTORIED BY: L. Bentley DATE: 8-15-90

REVISED BY: DATE D/S HAZARD BY: FFK DATE 1988

OTHER NAME OF PROJECT: POOL AREAS OBTAINED BY: Planimeter

OTHER CONTACT AT DAM: Buford Sutton PHONE: (615)788-5515

DATA OBTAINED FORM: Wauford report of July, 1990

EMER. SPIL. DESC.:

SERV. SPIL. DESC.: Two concrete, rectangular, Ogee weirs

ELEVATIONS REF, TO: Wauford report APPROX. ELEV: FT MSL

DRAWDOWN DRAIN: MATERIAL: Cast iron SIZE: 20" ELEVATION: 1789.75

OTHER COMMENTS: *Including spillways. ** (28)(274)(0.4) = 3069

***See back.

dik

LB 6/22
MS 6/22
cc: KFO 6/22

Appendix A.3.2

INVENTORY DATA SHEET
SAFE DAMS SECTION

STATE ID NUMBER 18-7004 *FEDERAL ID NUMBER* TN03504

DAM NAME Lake Tansi *COUNTY* Cumberland

OWNER Lake Tansi Village P. O. A.

ADDRESS 5050 Shoshone Loop Crossville, TN 38572

TELEPHONE *BUSINESS:* (931) 788-2700 *HOME:*

OTHER CONTACT David Sutton - General Manager
Gary Dillon - Maintenance supervisor

LOCATION AND HISTORY

LATITUDE 35° 51′ 46" *LONGITUDE* 85° 03′ 59"

QUAD 109 SE - Vandever *STREAM* Basses Creek

PURPOSE OF DAM Development, recreation *YEAR COMPLETED* 1959

ORIGINAL ENGINEER

ORIGINAL CONTRACTOR

ENGINEER FOR REPAIRS Law Engineering

CONTRACTOR FOR REPAIRS

DAM INFORMATION

TYPE OF DAM Earth

HAZARD POTENTIAL CATEGORY: *STATE* 1 *FEDERAL* High

SIZE CLASS Intermediate *REGULATORY CLASS* Regulated

HEIGHT: *STRUCTURAL* 69 FEET *HYDRAULIC* 60.1 FEET

CREST: *LENGTH* 2400 FEET *WIDTH* 25 FEET

UPSTREAM SLOPE 2:1 *DOWNSTREAM SLOPE* 2:1

LAKE DATA

	NORMAL POOL	*EMERGENCY SPILLWAY*	*TOP OF DAM*
ELEVATION	1862	N/A	1870.9
AREA (ACRES)	425	N/A	655[1]
VOLUME (ACRE-FEET)	9,000[2]	N/A	13,806

SPILLWAYS

PRINCIPAL SPILLWAY 175′ wide L-shaped weir control section with a 75′ wide rectangular rock outlet channel at left EOD.

EMERGENCY SPILLWAY None.[3]

DRAWDOWN MECHANISM Three 30″ steel siphons near right EOD.

WATERSHED DATA

DRAINAGE AREA 2850 ACRES 4.453 SQUARE MILES

CURVE NUMBER 76 T_C 1.5 HOURS *6-HR RAIN* 29.4 INCHES

MISCELLANEOUS

INVENTORIED BY Al Dunn *DATE* 4/5/1978

REVISED BY Lyle Bentley *DATE* 5/29/2007

HAZARD CATEGORY BY Al Dunn *DATE* 4/5/1978

DATA OBTAINED FROM Law Engineering reports and plans for 1981 repairs and topo measurements.

COMMENTS

1. Area @ 1862: 425 ac. Area @ 1880: 890 ac.
(890-425)/18 = 25.8 ac./ft.
Area @ TOD: 425 + 8.9(25.8) = 655 ac.

2. From 1980 spillway design report from Law engineering.

3. There is another small spillway about 13′ wide and 6′ deep cut into rock at the right EOD. This spillway was originally used to control the lake level by the use of stoplogs. The stoplogs have been replaced with a concrete weir, through which water flows via a 6″ PVC pipe. This spillway is negligible compared to the main spillway installed in 1981 at the left EOD.

LB 8/12
MS 8/14

Appendix A.3.3

INVENTORY DATA SHEET
SAFE DAMS SECTION

STATE ID NUMBER 18-7022 *FEDERAL ID NUMBER* TN03522

DAM NAME Holiday Lake *COUNTY* Cumberland

OWNER City of Crossville

ADDRESS 99 Municipal Ave.; Crossville, TN 38555

TELEPHONE *BUSINESS:* (931) 484-5113 *HOME:*

OTHER CONTACT

LOCATION AND HISTORY

LATITUDE 35° 57′ 23" *LONGITUDE* 85° 03′ 34"

QUAD 109 NE *STREAM* Obed River

PURPOSE OF DAM Recreation and Water supply *YEAR COMPLETED* 1959

ORIGINAL ENGINEER Hart, Freeland, & Roberts

ORIGINAL CONTRACTOR

ENGINEER FOR REPAIRS Environmental & Civil Engineering Services

CONTRACTOR FOR REPAIRS Wright Brothers Construction Co.

DAM INFORMATION

TYPE OF DAM Earth

HAZARD POTENTIAL CATEGORY: *STATE* 1 *FEDERAL* High

SIZE CLASS Intermediate *REGULATORY CLASS* Regulated

HEIGHT: *STRUCTURAL* 44 FEET *HYDRAULIC* 31.4 FEET

CREST: *LENGTH* ~~498~~ 500 FEET *WIDTH* 50 FEET

UPSTREAM SLOPE 2.6:1 *DOWNSTREAM SLOPE* 2:1

LAKE DATA

	NORMAL POOL	*EMERGENCY SPILLWAY*	*TOP OF DAM*
ELEVATION	1768.4		1781
AREA (ACRES)	232		338
VOLUME (ACRE-FEET)	3,573		7,100

SPILLWAYS

PRINCIPAL SPILLWAY 225' long X ~4.5' high concrete weir narrowing to a 152' wide X 14' high rectangular rock channel under bridge.

EMERGENCY SPILLWAY Same as principal

DRAWDOWN MECHANISM 42" metal pipe valved on downstream end. There are also four 24" manual valves through the lower half of the principal spillway weir that can lower the lake a few feet.

WATERSHED DATA

DRAINAGE AREA 5,446 ACRES 8.51 SQUARE MILES

CURVE NUMBER 67 T_C ** HOURS *6-HR RAIN* 29.13 INCHES

MISCELLANEOUS

INVENTORIED BY _____ *DATE* 1987

REVISED BY Terrell Hendren *DATE* 8/12/2009

HAZARD CATEGORY BY _____ *DATE* _____

DATA OBTAINED FROM Engineering Plans by ECE 2009, Hydologic analysis 2003

COMMENTS

**Due to the size of the watershed, it was broken up into a number of different sub-basins, so there is no single value for the time of concentration.

Appendix A.3.4

INVENTORY DATA SHEET
SAFE DAMS SECTION

STATE ID NUMBER 18-7063 FEDERAL ID NUMBER TN03557

DAM NAME Otter Creek COUNTY Cumberland

OWNER Crab Orchard Utility District

ADDRESS P. O. Box 78 Crab Orchard, TN 37723

TELEPHONE: BUSINESS: (615) 484-6987 HOME: (615) 456-4292

OTHER CONTACT:

LOCATION AND HISTORY

QUAD ~~128~~ 116 SW STREAM Otter Creek

LATITUDE 36 00 46 LONGITUDE 84 55 35

PURPOSE OF DAM Water Supply YEAR COMPLETED 1995

ORIGINAL ENGINEER TARE Engineering GRW Engineers

ORIGINAL CONTRACTOR Thomas Brothers

ENGINEER FOR REPAIRS

CONTRACTOR FOR REPAIRS

DAM INFORMATION

TYPE OF DAM Earth Fill

SIZE CLASSIFICATION Intermediate

HAZARD POTENTIAL CATEGORY: STATE: 2 (Sign.) FEDERAL: S

HEIGHT: STRUCTURAL 95 FEET HYDRAULIC 85 FEET

CREST: LENGTH 650 FEET WIDTH 25 FEET

UPSTREAM SLOPE 2.5H /1V DOWNSTREAM SLOPE 3H /1V

LAKE DATA

	NORMAL POOL	EMERGENCY SPILLWAY	MAXIMUM POOL
ELEVATION	~~1770~~ 1775	1775	1785
AREA (ACRES)	~~106~~ 120	120	162
VOLUME (ACRE-FEET)	~~3176~~ 3808	3808	5227

SPILLWAYS

PRINCIPAL SPILLWAY ~~4" dia pipe and valve to maintain minimum flow below dam. Empties into 36" drawdown pipe.~~

EMERGENCY SPILLWAY Reinforced concrete channel (See plans), 80' wide

DRAWDOWN MECHANISM 36" dia Ductile Iron Pipe with valve and riser tower.

WATERSHED DATA

DRAINAGE AREA 1710 ACRES 2.67 SQUARE MILES

CURVE NUMBER 65 T_c 1.23 HOURS 6-HR RAIN 14.7 INCHES

MISCELLANEOUS

INVENTORIED BY: Tom S. Godwin DATE: 10/16/95

REVISED BY: DATE:

HAZARD CATEGORY BY: Lyle Bentley DATE: 7/24/91

DATA OBTAINED FROM: Plans & Robert D. Stigall, GRW

OTHER COMMENTS Dam has 4" pipe @ elev. 1755 draining into 36" drawdown pipe to maintain flow in Otter Creek.

D.I. Pipe or concrete pipe?
Hydraulic or manual?

Table 2 – Lake Holliday and Lake Holliday Dam Data			
State Dam ID No.	18-7022	**Federal Dam ID No.**	TN
Latitude	35 deg 57 min 20 sec N	**Longitude**	85deg 03 min 35 sec W
Year Completed	1963	**Engineer**	Freeland and Roberts
Type of Dam	Earth gravity		
Downstream HPC	2	**Size Classification**	Intermediate
Structural Height	47.4 feet		
Hydraulic Height	34.8 feet		
Crest Length	621 feet	**Crest Width**	40 feet
Upstream Slope	2:1	**Downstream Slope**	2:1
Normal Pool Area	232 acres	**Maximum Pool Area**	338 acres
Top of Dam El.	1781.00	**Storage @ Top of Dam**	7100 acre-feet
Normal Pool El.	1768.38	**Storage @ Normal Pool**	3573 acre-feet
Spillway Sizes	230 ft concrete weir		
Drainage Area	5446 acres or 8.51 square miles		
Ratio of Surface Area to Drainage Area		0.0426	
Storage Available for Water Treatment			
Water Plant Intake Elevation			

Table 1 - Meadow Park Lake and Meadow Park Dam Data

State Dam ID No.	18-7001	**Federal Dam ID No.**	TN 03501
Latitude	35 deg 54 min 09 sec N	**Longitude**	85deg 05 min 49 sec W
Year Completed	1938	**Engineer**	Freeland and Roberts
Type of Dam	Concrete Arch		
Downstream HPC	2	**Size Classification**	Intermediate
Structural Height	32 feet		
Hydraulic Height	28 feet		
Crest Length	274 feet	**Crest Width**	3.5 feet
Upstream Slope	Vertical	**Downstream Slope**	0.2:1
Normal Pool Area	274 Acres	**Maximum Pool Area**	390 Acres
Top of Dam El. 1822.20 ~~1821.5 ft (1823.62)~~		**Storage @ Top of Dam**	4397 Acre Feet
Normal Pool El. 1818.10 ~~1817.5 ft (1819.62)~~		**Storage @ Normal Pool**	3069 Acre Feet
Spillway Sizes	49 x 4 ft, right and 54 x 4 ft left		
Drainage Area	3317 acres or 5.183 square miles		
Ratio of Surface Area to Drainage Area	0.0826		
Storage Available for Water Treatment	2513 acre-feet at centerline of low intake 1967 acre-feet at 4 ft submergence of low intake		
Water Plant Intake Elevation	High Intake is 24" dia. at centerline el. ~~1813.00 (1815.12)~~		1813.60
	Low Intake is 24" dia at centerline el. ~~1803.00 (1805.12)~~		1803.60
	Intake pump well invert elevation is ~~1797.00 (1799.12)~~		1797.60
	Intake pump floor elevation is ~~1832.00 (1834.12)~~		1832.60

From rehab project

+0.6

Appendix B – Additional Analysis – Lake Tansi Analysis

B.1 Lake Tansi Results Data Sheet

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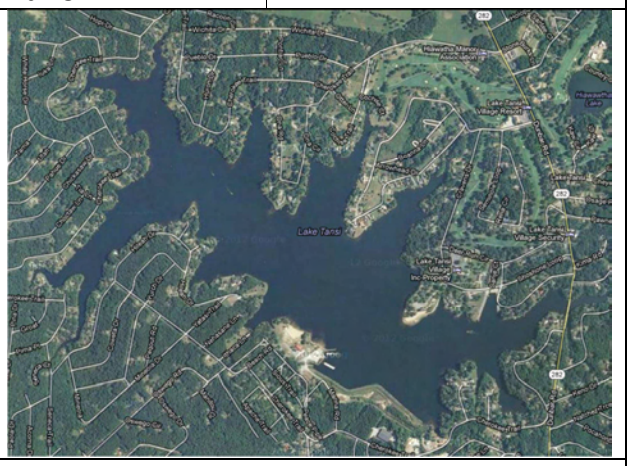
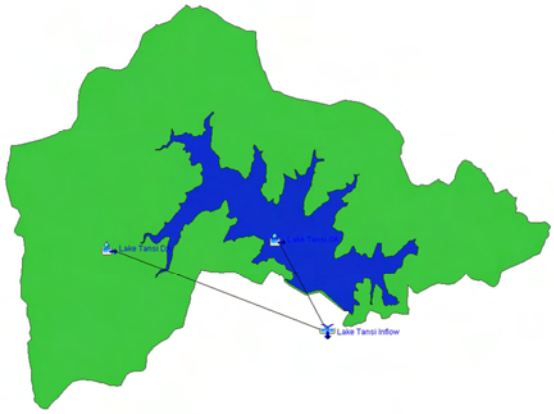
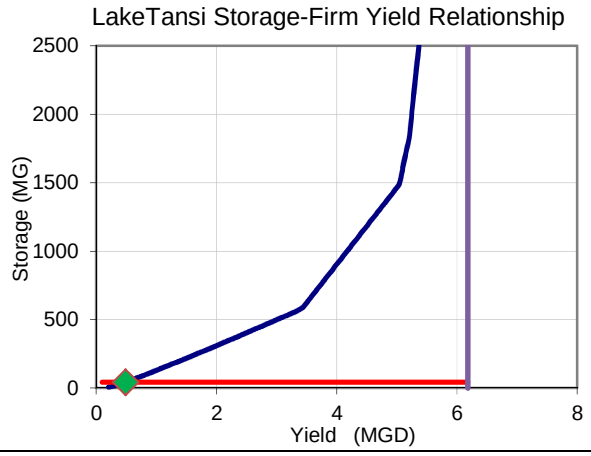
4229 LAFAYETTE CENTER DRIVE : SUITE 1850 : CHANTILLY, VA 20151
WATER RESOURCES & ENVIRONMENTAL SOLUTIONS

APPENDIX B.1	Lake Tansi	
Utility District:	City of Crossville	
Built (year):	1959	
Surface Area (ac)	404 (Calc)	
Total Storage (MG)	919 (ECE)	
Usable Storage (MG)	43.8 (Calc)	
Elevation- ft (NGVD29)	1861.71	
Latitude (N)/ Longitude (W)	35º 51’ 46”/ 85º 03’ 59”	
Watershed Area (ac)	2844 (Calc)	

Lake and Drainage Area

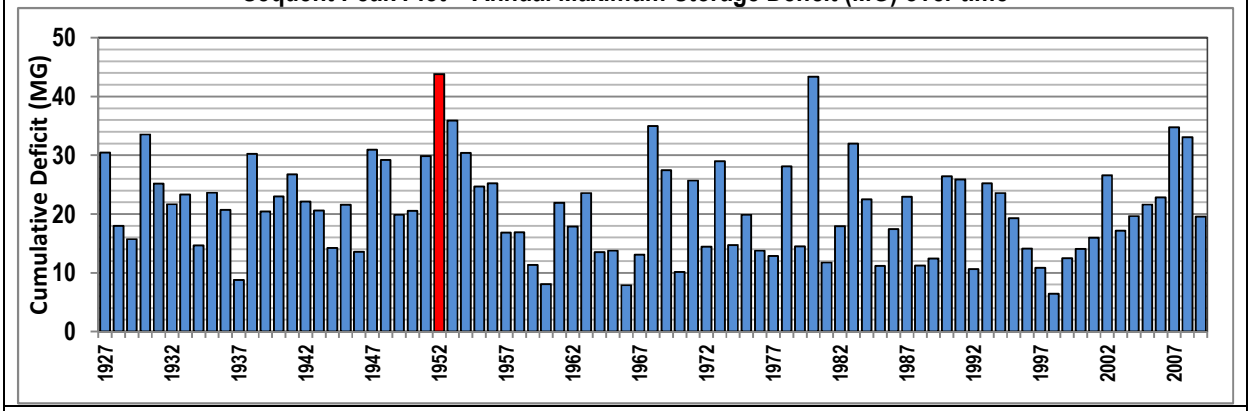




Firm Yield: 0.49 MGD	Critical Drought: Nov 9,1952
Prior Yield Estimates:	Average Daily Inflow: 6.18 MGD

Notes: Lake Tansi is owned by the Lake Tansi Property Owners Association. Under current contract, the top four inches (43.8 MG) can be used for water supply from October 15th to April 15th.

Sequent Peak Plot – Annual Maximum Storage Deficit (MG) over time



Appendix C – Additional Analysis – Demand Analysis

C.1 Crossville Filtration Plant Service Area Map
C.2 Projected Total Water Needs

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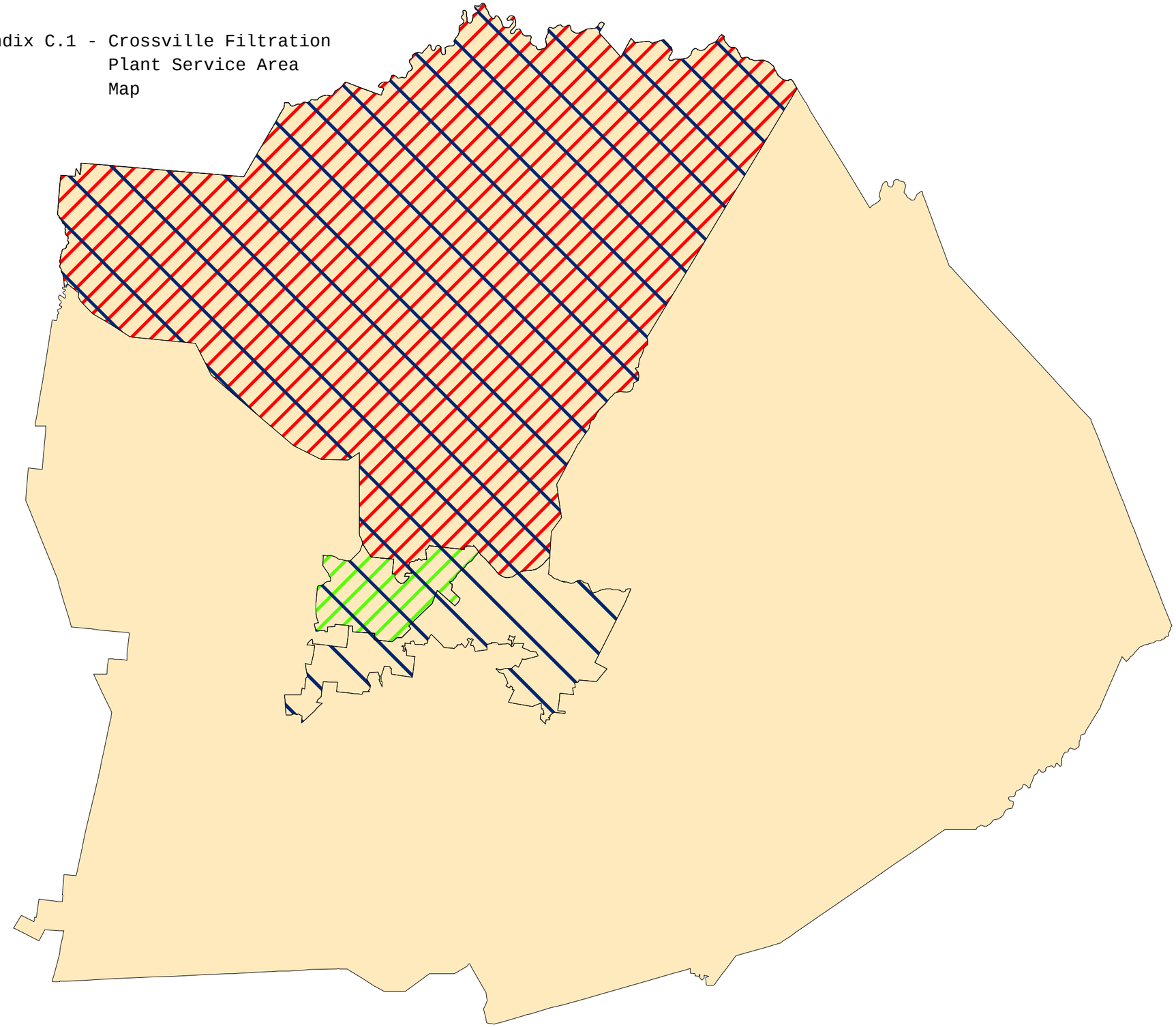
WATER RESOURCES & ENVIRONMENTAL SOLUTIONS

Appendix C.1 - Crossville Filtration Plant Service Area Map



N
W E
S
NTS

Legend

Crossville Utility Service Area

- Normal Holiday Service Area
- Potential Holiday Service Area
- Meadowpark Service Area

- Cumberland County

Data Prepared by:
City of Crossville
Engineering / Planning Staff

Appenidix C.2
Projected Total Water Needs (MGD)

		2006	2016	2026	2036	2046	2056
Res	Crab Orchard	0.71	0.96	1.38	1.95	2.53	2.69
	Crossville	1.05	1.21	1.35	1.42	1.51	1.62
	South Cumberland	0.39	0.58	0.92	1.21	1.47	1.63
	West Cumberland	0.16	0.17	0.19	0.21	0.23	0.27
NonRES	Crab Orchard	0.19	0.22	0.29	0.38	0.47	0.49
	Crossville	1.23	1.47	1.63	1.64	1.67	1.68
	South Cumberland	0.04	0.06	0.09	0.13	0.16	0.20
	West Cumberland	0.03	0.03	0.03	0.03	0.04	0.04
CMC	Crossville	0.07	0.09	0.12	0.14	0.16	0.18
UAW	Crab Orchard	0.27	0.36	0.49	0.69	0.89	0.95
	Crossville	0.59	0.69	0.78	0.81	0.85	0.89
	South Cumberland	0.13	0.19	0.30	0.40	0.49	0.55
	West Cumberland	0.06	0.06	0.06	0.07	0.08	0.09
Total	**Crab Orchard**	**1.17**	**1.54**	**2.17**	**3.01**	**3.89**	**4.14**
	Crossville (Total)	**2.94**	**3.47**	**3.87**	**4.01**	**4.19**	**4.37**
	Crossville (MPL/Holiday)	2.27	2.73	3.08	3.21	3.38	3.54
	Crossville (MPL/Holiday Optional)	0.43	0.45	0.47	0.48	0.49	0.50
	Crossville (MPL Only)	0.25	0.29	0.32	0.32	0.32	0.33
	South Cumberland	**0.56**	**0.83**	**1.32**	**1.74**	**2.12**	**2.38**
	West Cumberland	**0.24**	**0.26**	**0.29**	**0.31**	**0.34**	**0.40**

Appendix D – OASIS Systems Model Schematic

D.1 OASIS Systems Model Schematic

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WATER RESOURCES & ENVIRONMENTAL SOLUTIONS

Appendix D.1

OASIS Systems Model Schematic