

**PRELIMINARY ENGINEERING REPORT**  
**FOR**  
**WEST KNOX UTILITY DISTRICT**

**ENGINEERING EVALUATION OF  
WASTEWATER PLANT EXPANSION FOR  
PROJECTED FUTURE FLOWS**

**SEPTEMBER 2006**



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**WEST KNOX UTILITY DISTRICT  
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**I. Purpose of Report**

**A. General Information**

The West Knox Utility District has experienced a continued accelerated growth of its sewer system and customer base in the last five (5) years. New developments and expansion of existing developments continue to be constructed throughout the boundaries of the Utility District. However in the last two (2) years, a noticeable increase has been seen throughout the District, but particularly on the west side of the Pellissippi Parkway.

The existing collection system has been extended to the west side of the Parkway, but the majority of the gravity sewer lines flow westward and require pumping the collected wastewater back to the east side of the parkway for transportation to the existing Karns wastewater treatment plant. Future developments in the western portions of WKUD boundaries will require new interceptor sewer lines and pump stations to collect and transport the wastewater back to the Karns treatment plant.

The WKUD management and engineering staff is concerned that the existing facilities of the sewer system (both collection system and treatment) may not be able to handle the expected flows within the next 5 to 10 years. GRW Engineers, Inc. was asked to study the future needs of the WKUD sewer system for the next 20 years and make recommendations to meet these needs.

**B. Scope of Report**

This report evaluates past populations from Census data and looks at population projections available from planning offices for the WKUD area in the next 20 years. Wastewater flows from past years are used to determine a correlation with known populations and the number of customers to the sewer system. Future wastewater flows expected from the future projected populations are forecasted from this correlation. Evaluations of the projected flows versus the existing facilities are then used to determine future treatment plant or collection system facilities requirements. This includes possible expansion, upgrade or replacement of the treatment plant and/or parts of the collection system.

C. Conclusion

The existing Karns wastewater treatment plant is presently at about 88% of its design capacity. The current WKUD has on record requests for over 3,711 sewer services that will be needed within the next 2 to 3 years. The capacity of the Karns WWTP will be exceeded within this same period (about 2008). Projected growth of the district indicates flows of at approximately 9.0 MGD will be required by the year 2025. Providing sewer service for the projected growth will require the construction of a new wastewater treatment plant or the expansion of the existing Karns WWTP. The State has indicated in a letter that further expansion of this facility if allowed would have to overcome very significant obstacles. If an expansion was granted, nutrient removal, lower more stringent effluent (discharge) limits would be added to the NPDES permit requirements or the plant discharge would need to be moved to the Clinch River.

Expansion of the existing treatment plant to 9.0 MGD and continued discharge to Beaver Creek was determined to have a probable project cost of approximately \$58,000,000 with no future ability for expansion due to the lack of land and the discharge stream.

Moving the discharge of the Karns plant to the Clinch River requires discharge below all existing water treatment plant intakes; thus, a new discharge would need to be located at river mile 31.5 or below. Moving the discharge point to the Clinch River would require the construction of an effluent pump station capable of handling the existing and future projected flows through 2025 at a cost of approximately \$11,968,000 not including developmental costs (design, easements, inspection, etc). The additional treatment units necessary to treat the additional flow would also have to be built at a cost of about \$5.50 per gallon if it pumped to the Clinch River. The construction cost of expanding the existing Karns WWTP another 5.0 MGD to meet the current and future needs to 2025 (9.0 MGD) would be approximately \$27,500,000. Total probable project cost was estimated at approximately \$47,362,000.

Based on current developments on the west side of the Pellissippi Parkway, the topography of the area, water treatment plant intakes on the Clinch River, new effluent limits and the need for sufficient land to make expansions, a new wastewater treatment plant should be located in the western portion of the district to handle the future growth.

The outfall from the new treatment plant would need to enter the Clinch River near the confluence of Hickory Creek. Large tracts of land are available in this area and should be investigated for possible purchase to construct a new WWTP. Additions to the collection system would be needed to transport the flow to the new plant. Future expansions of the

collection system and treatment plant are possible at a new location. The existing Karns treatment plant has very little land available for future expansion past the current 10 year and possible 20 year needs.

Probable project costs for construction of a new 2.5 MGD secondary wastewater treatment plant with collection system additions and modifications is estimated at approximately \$24,788,000. If a 5.0 MGD plant is built now the probable cost is estimated at \$35,788,000.

**II. EXISTING CONDITIONS**

**A. Existing Flows and Loading to the Treatment Plant**

**1. Existing Flows**

During the past six (6) years the flows at the wastewater treatment plant (WWTP) have increased significantly. The average flow during 2000 was approximately 2.98 million gallons per day (MGD) with a peak flow of 7.93 MGD. The average flow in 2005 was 3.5 MGD with an average winter flow of 3.85 MGD. The WWTP has seen during the first seven (7) months of 2006 an average flow of 3.88 MGD. The average peak winter flow during this same period was 4.55 MGD. Listed below are the average daily, peak day and average daily flow for winter months (defined by NPDES permit November – April and normally considered the wettest months) for the sewer system since 2000:

TABLE II-1  
KARNS WASTEWATER TREATMENT PLANT FLOWS,  
AVERAGE RAINFALL AND CUSTOMER BASE

YEAR (Jan – Dec)	Yearly Average Daily (MGD)	Peak Daily Flow (MGD)	Winter Months Average Daily (MGD)*	Total Annual Rainfall (in)	Total No. Billing Units (July-June)	Average Flow per Billing Unit (gpd/unit)
2000	2.98	7.93	3.11	47.63	14,931	200
2001	2.47	6.21	2.66	41.83	14,924	165
2002	2.76	6.43	3.18	58.41	15,390	179
2003	3.58	8.26	3.78	58.95	15,887	225
2004	4.14	10.20	4.76	50.67	16,269	254
2005	3.50	8.24	3.85	39.57	16,537	212
2006 **	3.88	10.64	4.55	25.79	NA	NA

\*Jan – April and Nov – Dec (same calendar year)

\*\*2006 data through July (7 months – 4 months of winter)

Evaluation of the data in the above table indicates that the average daily flow has been increasing over the past 5-½ years. Peak flows are still high (peak day in 2005 – 8.24 MGD and 2006 – 10.64), but the duration of the peak flows has dropped due to the rehabilitation work ongoing by WKUD personnel. One surprise noted in this table was the sudden increase in flow between 2002 and 2003. The WWTP increased approximately (3.58 – 2.76) 820,000 gpd in 2003. The first thing you would suspect with this large of an increase is a large amount of infiltration/inflow (I/I) entering the sewer system. The

average yearly rainfall for this area is approximately 55 inches per year (Oak Ridge NOAA weather station from 1971 – 2000). The rainfall in 2002 and 2003 was approximately the same (58 inches) so you would assume that the I/I would be approximately the same. The growth of new sewer connections continued, however, no serious increase was seen during this period (about the same as 2002). The WKUD staff indicated that the addition of a new influent screen on the headworks structure at the wastewater treatment plant allowed more flow to enter the plant. WKUD personnel have also raised many manholes adjacent to creek banks to help eliminate inflow entering the collection system due to overflowing creeks. These actions by WKUD have decreased the wastewater that surcharged the sewer collection system and reduced the occurrence of overflowing manholes. Thus, more wastewater (including I/I during rain events) could be transported and treated each day causing an increase in the recorded flow seen.

The number of sewer customers being served in the year 2000 was approximately 14,931. The average daily flow of 2.98 MGD includes the sum of infiltration, inflow, commercial, industrial and residential flows. The average daily flow per customer was therefore approximately 200 GPD as shown in the last column of the table. In 2005 (average daily flow of 3.5 MGD) the number of sewer customers had increased to approximately 16,537 which is an increase of approximately 1,600 in five (5) years. The average daily flow per customer in 2005 was 212 GPD (basically no change). The vast majority of these new customers are residential; however, some are commercial in business parks, shopping centers, apartments, and schools. The average daily flow was about 88% of the total average daily design capacity (4.0 MGD) of the treatment plant.

## 2. Existing Loading to the Treatment Plant

The organic loading to the treatment plant over this same time period has grown with the increased number of customers from 3,780 lbs/day of BOD<sub>5</sub> and 503 lbs/day of ammonia nitrogen in 2000 to approximately 4,677 lbs/day of BOD<sub>5</sub> and 558 lbs/day of ammonia nitrogen in 2005. The treatment of the organic wastes requires approximately 1 lb of oxygen for every 1 lb of BOD<sub>5</sub> and 4.6 lbs of oxygen for every 1 lb of ammonia nitrogen treated and removed from the wastes. Thus, the total oxygen required to treat the average daily organic wastes in 2005 was  $[3,780 + (558 \times 4.6)]$  6,346 lbs/day. The treatment plant has two oxidation ditches with 3-30 ft rotors in each basin capable of providing a total of approximately (2.86 lbs of oxygen per foot of rotor per hour) 12,350 lbs per day of oxygen. Thus it can be stated that the treatment plant is organically loaded to about 50% of its capacity.

B. Existing Populations and Population Density

The 2000 US Census was used to determine the approximate population and the approximate population per housing unit (population density) in the WKUD boundary area. WKUD serves the northwestern portions of Knox County. The 2000 US Census indicated that the total population of Knox County, Tennessee was 382,032 persons. The total housing for the county was 171,439 housing units with 157,872 units occupied (92.1 %). There are 9 county census subdivisions that make up these totals. Portions of 3 census subdivisions are in the WKUD service area. These subdivisions and their respective populations and number of housing units are as follows:

**TABLE II-2  
POPULATION DATA FOR KNOX COUNTY  
AND SELECTED COUNTY CENSUS DISTRICTS**

County Census District (CCD) - Subdivison	Total Population/ (% of Knox Co.)	Total Housing Units/ (% of Knox Co.)	Occupied Housing Units (% occupied)
Knox County	382,032 (100%)	171,439 (100%)	157,872 (92.1%)
Knoxville (city of)	274,736 (71.9%)	127,826 (74.6%)	116,722 (91.3%)
Hardin Valley	14,672 (3.84%)	6,000 (3.5%)	5,662 (94.4%)
Karns	10,029 (2.63%)	4,106 (2.4%)	3,916 (95.4%)

None of these county census districts are entirely in the WKUD service area, so the districts must be further broken down to determine existing populations in the service area. Only a small portion of the City of Knoxville census district is located in the WKUD service area, however, it makes up over 50% of the customer base.

There are several Census tracts or portions of tracts that make up each county census district. The Census tracts are made up of block groups and broken further down to blocks. Using maps from the Census records and maps indicating the WKUD service area boundaries, a comparison of these maps determined that the WKUD service area included some or all of the following tracts. All of Census tracts 46.03, 46.04, 46.06 and 59.02 are in the WKUD service area. Portions of Census tracts 46.05, 59.01, and 60 are also in the service area and required further breakdown. In summary, the 2000 population and housing units that can be attributed to be part of the WKUD service area are as shown in Table II-3 and Table II-4. The results of these tables indicates that the average population per housing unit (population density per resident) is (40,354/16,157) 2.5 persons. The populations shown in Table II-3 are for the entire WKUD boundary area and does not consider if existing sewer lines are presently available in each census tract, block group or block.

**TABLE II-3  
POPULATION EVALUATIONS FOR WKUD SERVICE AREA**

<b>2000 CENSUS DATA</b>		<b>POPULATIONS</b>			
<b>Tracts</b>	<b>Block Groups</b>	<b>Tract Totals</b>	<b>Block Groups</b>	<b>WKUD Service Area</b>	<b>PERCENTAGE OF TOTALS</b>
46.03	All	9,366	9,366	<b>9,366</b>	<b>100.0%</b>
46.04	All	6,265	6,265	<b>6,265</b>	<b>100.0%</b>
46.06	All	4,948	4,948	<b>4,948</b>	<b>100.0%</b>
59.02	All	6,850	6,850	<b>6,850</b>	<b>100.0%</b>
46.05	Portions	10,658			
	1		4,585	670	14.6%
	2		1,060	482	45.5%
	3		3,007	518	17.2%
	4		2,006	0	0%
	<b>Subtotal of persons in WKUD service area</b>			<b>1,670</b>	<b>15.7%</b>
59.01	Portions	7,822			
	1		3,466	2,951	85.1%
	2		1,910	0	0%
	3		2,446	2,446	100%
	<b>Subtotal of persons in WKUD service area</b>			<b>5,397</b>	<b>69.0%</b>
60.0	Portions	10,029			
	1		2,471	2,471	100.0%
	2		2,032	0	0%
	3		2,297	1,825	79.4%
	4		3,229	1,562	48.4%
	<b>Subtotal of persons in WKUD service area</b>			<b>5,858</b>	<b>58.4%</b>
	<b>Total Population in WKUD service area in 2000</b>			<b>40,354</b>	<b>--</b>

**TABLE II-4  
HOUSING UNIT EVALUATIONS FOR WKUD SERVICE AREA**

<b>2000 CENSUS DATA</b>		<b>OCCUPIED HOUSING UNITS</b>			
<b>Tracts</b>	<b>Block Groups</b>	<b>Tract Totals</b>	<b>Block Groups</b>	<b>WKUD Service Area</b>	<b>PERCENTAGE OF TOTALS</b>
46.03	All	4,435	4,435	4,435	<b>100.0%</b>
46.04	All	2,422	2,422	2,422	<b>100.0%</b>
46.06	All	1,940	1,940	1,940	<b>100.0%</b>
59.02	All	2,608	2,608	2,608	<b>100.0%</b>
46.05	Portions	4,573			
	1		1,874	247	13.2%
	2		513	186	36.3%
	3		1,345	261	19.4%
	4		841	0	0%
<b>Subtotal of occupied housing units in WKUD service area</b>				<b>694</b>	<b>15.2%</b>
59.01	Portions	3,054			
	1		1,403	859	61.2%
	2		735	0	0%
	3		916	916	100%
<b>Subtotal of occupied housing units in WKUD service area</b>				<b>1,775</b>	<b>58.1%</b>
60.0	Portions	3,916			
	1		975	975	100.0%
	2		848	0	0%
	3		873	747	85.6%
	4		1,220	561	46.0%
<b>Subtotal of occupied housing units in WKUD service area</b>				<b>2,283</b>	<b>58.3%</b>
<b>Total occupied housing units in WKUD service area in 2000</b>				<b>16,157</b>	<b>--</b>

In summary, the 2000 population in the WKUD service area was approximately 40,354 or about (40,354/382,032) 10.6% of the county population.

C. Capacity of Wastewater Treatment Plant

The last major modification to the wastewater treatment plant (WWTP) occurred in fall of 1999 through 2000 with the construction of the new headworks, oxidation ditches, sludge holding tanks and demolition of the old aeration basins. The design capacity of the treatment plant was 4.0 MGD with a hydraulic capacity of 10.0 MGD through the oxidation ditches, clarifiers, sand filters, etc. The existing influent screens at the headworks had a hydraulic capacity of only 7.5 MGD, thus, the main pump station was throttled down to prevent overflows at this structure. This method of operation backed up the wastewater in the interceptor sewers and caused surcharging of the manholes.

In 2003, a new screen was added to the existing headworks structure to increase the hydraulic capacity of the entire WWTP. This screen allowed an increase to the hydraulic capacity (or peak daily flow) that the plant could handle of flows over 10.0 MGD matching the peak hydraulic capacity of other treatment units.

D. Capacity of Collection System

The collection system is composed gravity sewers, manholes, pump stations and force mains. The total footage of the collection system has not been calculated as of the date of this report; however, record drawings indicate that there are over 145 miles of gravity sewers and force mains. The gravity sewers are a combination of concrete, asbestos cement, clay, ductile iron, polyvinyl chloride (PVC) and high density polyethylene (HDPE) piping, ranging in size from 6-inch to 30-inch. The older piping is mainly asbestos cement and concrete that contributes much of infiltration and inflow found in the system. The larger gravity sewer lines are located near the middle of the WKUD service area along Beaver Creek (between river miles 10.5 and 12.0), its tributaries and Ten Mile Creek. The largest size is 30-inch in diameter (entering the existing WWTP) which has a capacity of approximately 6.4 MGD if laid at the minimum grade of 0.045ft per 100 ft. The 30-inch lines make up only a small portion of the total lines in the system. This main 30-inch interceptor is feed by an 18-inch line coming from the Hardin Valley area, a 24-inch line coming down Middlebrook Pike and a 20-inch interceptor that collects wastewater along Beaver Creek upstream from the WWTP (north eastern portions of the collection system). The Ten Mile Creek interceptor enters its pump station as a 24-inch gravity sewer and is feed by 12, 15, 18 and 21 inch lines. This pump station handles basically all the flow in the southeastern portion of the collection system. A 16-inch HDPE force

main is used to transport the wastewater back to a manhole on the Middlebrook interceptor near the intersection of Hardin Valley Road and Byington-Beaver Ridge Road where the interceptor changes from an 18-inch to a 24-inch line that feeds into the main 30-inch interceptor going into the WWTP. The capacity of these main interceptors laid at the State minimum grade is as shown in Table II-5. The State recommends a peaking factor of 2.5 for interceptors since most of the flow occurs in an eight to 10 hour period and to account for infiltration/inflow (I/I). Thus, the average design flow capacity of the interceptors is less than the full flow peak capacity of the lines and is shown in the far right column of the table.

TABLE II-5  
INTERCEPTOR CAPACITIES

Pipe Size diameter (inches)	State WPC Minimum Grade (ft per 100 ft)	Interceptor Peak Capacity (MGD)	Interceptor Average Design Flow Capacity (MGD)
12	0.151	1.014	0.4056
15	0.112	1.583	0.6332
18	0.088	2.282	0.9128
20	0.077	2.827	1.1308
21	0.072	3.114	1.2456
24	0.060	4.058	1.6232
30	0.045	6.373	2.549

As Table II-5 indicates the peak capacity of a 30-inch sewer laid at minimum grade is only 6.4 MGD. The 30-inch line entering the Karns WWTP handles over 10.0 MGD during rain events due to the depth of the line (over 15 feet deep) and the ability of the interceptor to surcharge due to the depth. The surcharging line causes the interceptor to act more like a pressure line than a gravity sewer line; thus, the higher flows reaching the WWTP.

### **III. FUTURE NEEDS**

#### **A. Population Projections for 20 Year Needs**

Projecting future populations for the WKUD requires comparisons between Census information of the past, evaluation of the latest construction trends and the job market for the area. The first statistic to look at is a comparison of growth from the 1990 Census to 2000. This was a problem due to the lack of detailed information in the 1990 Census data base. Changes were made to improve the Census information and detail in the 2000 Census by adding more Block Groups to some of the Census Tracts. They also subdivided the Block Groups into smaller blocks. Census Tract 46.02 (found in the 1990 Census, but not in the 2000 Census) was split and renamed as tracts 46.05 and 46.06 in the 2000 Census due to the growth. Also there are fewer block groups in the 1990 Census data making it harder to locate the WKUD customers on the Block Group maps. GRW Engineers has compared the West Knox boundary with the maps available from the US Census to establish approximate percentages for the Block Groups in the 1990 Census data. Tables III-1 and III-2 indicate the same basic information as shown in the Census 2000 tables (II-3 and II-4) using estimated percentages for the Block Groups.

Comparing these tables reveals that there has been a large growth in the WKUD service area. The population grew from about 32,200 in 1990 to approximately 40,350 in 2000 or about 25%. The occupancy of housing units also grew during the same time period, from about 13,100 in 1990 to approximately 16,160 in 2000 or about 23.4%. The average population growth for all of Knox County was about 13.8% for that same time period (335,749 in 1990 & 382,032 in 2000). Thus it can be quickly seen that as Knox County continues to grow, the population and customer base for the West Knox Utility District is expected to grow. One of the main reasons that this will occur is the available rural land located in the northwestern portions of Knox County (Hardin Valley CDD area).

Projecting the possible growth in the WKUD service area can be estimated from the projected growth of Knox County, the proposed developments in the area and the growth seen in the service area from past Census data.

**TABLE III-1  
1990 POPULATION EVALUATIONS FOR WKUD SERVICE AREA**

1990 CENSUS DATA		POPULATIONS			
Tracts	Block Groups	Tract Totals	Block Groups	WKUD Service Area	PERCENTAGE OF TOTALS
46.03	All	8,963		<b>8,963</b>	<b>100.0%</b>
46.04	All	4,592		<b>4,592</b>	<b>100.0%</b>
59.02	All	4,918		<b>4,918</b>	<b>100.0%</b>
46.02	Portions	11,366			
	1		8,490	5,243	70%
	9		2,876	0	0%
	<b>Subtotal of persons in WKUD service area</b>			<b>5,243</b>	<b>52.3%</b>
59.01	Portions	6,184			
	1		3,477	3,129	90%
	2		1,441	0	0%
	<b>Subtotal of persons in WKUD service area</b>			<b>3,129</b>	<b>50%</b>
60.0	Portions	7,753			
	1		5,100	3,315	65%
	2		2,653	1,326	50%
	<b>Subtotal of persons in WKUD service area</b>			<b>4,641</b>	<b>59.9%</b>
	<b>Total Population in WKUD service area in 1990</b>			<b>32,186</b>	<b>--</b>

\*The 1990 Census data has fewer Block Groups (only 2 and not 4) and does not contain the individual blocks shown in the 2000 Census for this Census Tract.

\*\*The 1990 Census data has only 2 Block Groups in Census Tract 59.01 and no individual blocks.

+The 1990 Census data has only 2 Block Groups in Census Tract 60 and no individual blocks.

**TABLE III-2  
1990 HOUSING UNIT EVALUATIONS FOR WKUD SERVICE AREA**

1990 CENSUS DATA		OCCUPIED HOUSING UNITS			
Tracts	Block Groups	Tract Totals	Block Groups	WKUD Service Area	PERCENTAGE OF TOTALS
46.03	All	4,086			<b>100.0%</b>
46.04	All	1,696			<b>100.0%</b>
59.02	All	1,828			<b>100.0%</b>
46.02 *	Portions	4,465			
	1		3,317	2,322	70%
	9		1,148	0	0%
<b>Subtotal of occupied housing units in WKUD service area</b>				<b>2,322</b>	<b>52%</b>
59.01 **	Portions	2,258			
	1		1,576	1,418	90%
	2		662	0	0%
<b>Subtotal of occupied housing units in WKUD service area</b>				<b>1,418</b>	<b>63.4%</b>
60.0+	Portions	2,927			
	1		1,961	1,275	65.0%
	2		956	478	50%
<b>Subtotal of occupied housing units in WKUD service area</b>				<b>1,753</b>	<b>59.9%</b>
<b>Total occupied housing units in WKUD service area in 1990</b>				<b>13,103</b>	<b>--</b>

\*The 1990 Census data has fewer Block Groups (only 2 and not 4) and does not contain the individual blocks shown in the 2000 Census for this Census Tract.

\*\*The 1990 Census data has only 2 Block Groups in Census Tract 59.01 and no individual blocks.

+The 1990 Census data has only 2 Block Groups in Census Tract 60 and no individual blocks.

Population projects for Knox County were found on the internet at the TN Advisory Commission on Intergovernmental Relations ([www.state.tn.us/tacir/population.htm](http://www.state.tn.us/tacir/population.htm)) website. The information contains the actual 2000 data and projects the population for Knox County every 5 years until 2025. This information is reproduced in Table III-3 shown below and the percentage of growth projected for every five years.

**TABLE III-3  
POPULATION PROJECTIONS FOR KNOX COUNTY, TENNESSEE**

<b>Census Year or Projected Year</b>	<b>Total Census Population * or Projected Population +</b>	<b>Per Cent Increase Over Previous Period</b>
<b>1990</b>	<b>335,749*</b>	<b>-</b>
<b>2000</b>	<b>382,032*</b>	<b>13.78**</b>
<b>2005</b>	<b>398,735+</b>	<b>4.37</b>
<b>2010</b>	<b>427,593+</b>	<b>7.24</b>
<b>2015</b>	<b>455,614+</b>	<b>6.55</b>
<b>2020</b>	<b>481,842+</b>	<b>5.76</b>
<b>2025</b>	<b>507,438+</b>	<b>5.31</b>

\* **Census Population**

+ **Projection of Population**

\*\* **Increase over 10 year period (approximately 6.89% for 5 year period)**

As Table II-1 indicated, the number of sewer customers in the WKUD system in 2005 was approximately 16,537 which is an increase of approximately (16,537 – 14,931) 1,606 during the period from 2000 to 2005. This is an increase of approximately (1,606/14,931) 10.8% and helps explain the increase in flows experienced at the WWTP. Another 547 sewer customers were added to the district in 2006 (July 2005 – June 2006). The potential growth for the entire District over the next 2 to 3 years was compiled by WKUD engineering staff (shown in appendix “A” of this report) due to the accelerated growth experienced in the last few years. The WKUD engineering staff has indicated that the rate of requests for sewer connections is continuing at a high rate and a probable increase of approximately 3,711 new sewer connections by 2009 can be expected. Thus, the sewer customers are projected to be approximately (16,537 + 3,711) 20,248 by the year 2009. Assuming a 2.5 person per customer average, the total population connected to the sewer system in 2009 can be estimated at (20,248 x 2.5) 50,620 persons.

One should also be aware that much of the land in the Hardin Valley County Census District (CCD); that is in the WKUD service area, is not served by sewers presently. In fact none of the homes located in that portion of the WKUD service area were provided with sewer service prior to the early to mid 1990's. WKUD serves approximately 77.4% (the area along I-40 is in First UD boundary area) of the homes located in this CCD area with water, but only about 10% of that area (WKUD service area) was provided with sewer service in 2000. The growth in this area has been rapid since 2000 and continues to increase. The continued growth in this area has required the county to build a new elementary school on the west side of the Pellissippi Parkway off of Hardin Valley Road. The students in this area were zoned for Karns Elementary prior to construction of the new Hardin Valley Elementary School. A new high school is presently under construction on an adjacent site.

The Lancaster Ridge subdivision (approximately 78 lots) was built north of the Hardin Valley Elementary School off Steele Road and connected to the sewer system in 2005. This subdivision is still developing (homes still being built), but should be completed (all lots fully developed) in the near future. Information obtained from WKUD staff (see appendix "A"), indicates there are approximately 1,600 known new sewer services needed for projects presently under construction or being developed west of the Pellissippi Parkway. Some of these sewer services are already being used and all are expected to be in use by 2009. All of the flow from these sewer users will require pumping back to the east through existing or new pump stations and force mains for transport to interceptors that can carry the wastewater to the WWTP. Based on the information shown in Table III-3 and the above discussion, GRW has projected probable populations for the West Knox Utility District service area.

**TABLE III-4  
POPULATION PROJECTIONS FOR WEST KNOX UTILITY DISTRICT**

<b>Census Year or Projected Year</b>	<b>Total Census Population * or Projected Population +</b>	<b>Per Cent Increase Over Previous Period</b>
<b>1990</b>	<b>32,186*</b>	<b>-</b>
<b>2000</b>	<b>40,354*</b>	<b>25.38**</b>
<b>2005</b>	<b>51,620+</b>	<b>28</b>
<b>2010</b>	<b>60,900+</b>	<b>18</b>
<b>2015</b>	<b>72,100</b>	<b>16.4</b>
<b>2020</b>	<b>82,480</b>	<b>14.4</b>
<b>2025</b>	<b>93,450</b>	<b>13.3</b>

\*Census Population (Tables II-3 & III-1) \*\*Over ten year period

- + **Projection of Population – based on existing or proposed water customers**
- ++ **Projected at 2.5 times of Knox County projection**

B. Future Projected Wastewater Flows

Assuming a flow of 100 gpd from each person connected to the sewer system indicates that the wastewater flows at the existing treatment plant will be approximately of 5,062,000 gallons per day by the year 2010. This exceeds the capacity of the Karns Wastewater Treatment Plant by approximately 1.062 MGD. As stated previously, the current projects on file with WKUD have 3,711 sewer services in existing projects under construction or presently being developed (land clearing, subdividing, etc.). Over 2,000 of those services are located on the east side of the Pellissippi Parkway and either in or adjacent to existing sewer lines. **At the current rate of development the existing treatment plant could exceed an average daily flow of over 4.0 MGD in the next 12 to 18 months.** Additional capacity for wastewater treatment should be evaluated immediately to prevent the State from placing a moratorium on further development of the wastewater system.

The sewer system on the west side of the Pellissippi Parkway has been installed by developers in the past 5 years. The only interceptor presently in this area is parallel to Conner Creek that is adjacent to Hardin Valley Road. The interceptor flows westward to the pump station constructed at the Hardin Valley Elementary School, where it is pumped back to the east towards the parkway to the pump station at the Pellissippi State College. This station pumps to the 18-inch Hardin Valley Interceptor (on the east side of the parkway). This interceptor should be able to handle flows from approximately 4,000 sewer connections. There are approximately 1,100 sewer services projected for this interceptor over the next 2 to 3 years. The existing homes and businesses presently served by this interceptor total nearly 400; thus, there presently is sufficient capacity in the 18-inch interceptor for approximately 2,500 additional sewer customers based on the average daily flow rate.

The only other area presently served by sewers (on the west side of the Pellissippi) is along Yarnell Road off Lovell Road. This sewer system was installed by the developer and pumps into the 12-inch Plumb Creek Interceptor. This interceptor is near capacity and will not be able to handle flows projected for this area in the next 5 years. Presently there have been approximately 500 sewer connections projected for addition in this area over the next 2 to 3 years. Until the Plumb Creek Interceptor is replaced with a larger line, the future development in the Yarnell Road area should be closely watched and monitored to prevent overloading the interceptor.

Projecting the additional demands of the sewer system for the years 2011 through 2025 requires an assumption that additional capacity or a new facility will be constructed to handle the additional loading demands. Table III-5 shown below indicates the probable sewer services that will be needed during the next 20 years assuming sufficient plant and interceptor capacity is made available.

**TABLE III-5  
PROJECTIONS FOR SEWER SERVICES  
AND WASTEWATER FLOWS  
IN WKUD SERVICE AREA**

<b>Census Year or Projected Year</b>	<b>Projected Populations for WKUD</b>	<b>Per Cent Served by Sewer System</b>	<b>Existing or Projected Sewer Billing Units</b>	<b>Projected Wastewater Flows (MGD)</b>
<b>2000</b>	<b>40,354</b>	<b>78</b>	<b>14,931</b>	<b>2.5</b>
<b>2005</b>	<b>51,620</b>	<b>80</b>	<b>16,537</b>	<b>3.5</b>
<b>2010</b>	<b>60,900</b>	<b>83</b>	<b>20,250</b>	<b>5.06 *</b>
<b>2015</b>	<b>72,100</b>	<b>85</b>	<b>24,514</b>	<b>6.13</b>
<b>2020</b>	<b>82,480</b>	<b>88</b>	<b>29,033</b>	<b>7.26</b>
<b>2025</b>	<b>93,450</b>	<b>90</b>	<b>33,642</b>	<b>8.41</b>

**\*Projected flow of 1.06 MGD above existing plant capacity by 2010 (about 3 years)**

C. Wastewater Treatment Plant Improvements

As can be seen from Table III-5 the projected flows of the sewer system will exceed the existing treatment plant capacity by 2010 by over 1.06 MGD. Projected flows over the next 20 years, indicates a new or expanded facility will be needed to handle the flows. The Tennessee Division of Water Pollution Control (TNDWPC) was contacted by GRW Engineers, Inc. in a letter dated June 26, 2006, concerning the possible expansion of the existing Karns wastewater treatment plant. TNDWPC (WPC) responded to this inquiry in a letter dated August 4, 2006. A copy of both letters can be seen in Appendix A of this report.

The WPC letter indicated that the existing discharge stream (Beaver Creek) was listed as “impaired waters” and would therefore require nutrient removal and stringent limits for any expansion of the facility. They also indicated that even without expansion of the existing facility, future discharge permits would require nutrient removal. Nutrient removal indicates that the current plant will be faced with total nitrogen and phosphorus limits in the future. This will require additional treatment units and chemical addition, raising the costs of wastewater treatment. The letter also indicated that prior to allowing expansion of the wastewater treatment plant, the new anti-degradation regulation would require alternative analysis for discharge to a larger body of water such as the Clinch River/Melton Hill Reservoir.

At the current organic loading rate, the existing Karns treatment plant could handle the expected increase in flow over the 4.0 MGD capacity; however, WPC would consider the facility in violation of the NPDES (National Pollutant Discharge Elimination System) permit. A request to WPC would therefore be necessary to officially increase the discharge. However, when this request is made, a new NPDES permit will be issued and nutrient limits will probably be added at that time. Construction of a new anoxic basin will be necessary to provide total nitrogen and phosphorus removal. If the total nitrogen limit is less than 5.0 mg/l (ppm), chemical addition will be necessary to provide the proper environment for biological treatment. Another chemical addition may be required for successful phosphorus removal if that limit is very stringent (less than 1.0 mg/l).

The existing oxidation ditches would require modification and a different method of providing mixing of the tank contents. Also new anoxic basins would be required preceding the oxidation ditches. Probable costs to make these modifications are estimated at between \$6,000,000 and \$12,000,000 (\$1.5 to \$3 per gallon) depending on the actual discharge limits set by WPC. This would not provide any additional plant capacity, but only provide for nutrient removal for the existing plant. The operational and maintenance cost for a nutrient removal plant would also escalate significantly if chemical additional is required.

D. Collection System Improvements

The continued growth in the areas west of the Pellissippi Parkway will require additional pump stations and possible enlargement of existing pump stations to transport the wastewater to the east side of the parkway (where the interceptors are located).

The existing pump stations transporting the flows collected along Hardin Valley Road will be sufficient for the next 2 to 3 years (based on current proposed development). The main pump station for this area is located at Pellissippi State College and pumps to the 18-inch Hardin Valley Interceptor. There is presently sufficient capacity in the interceptor to handle flows through 2010 and possibly through 2015 (depending on the future development).

The Plumb Creek Interceptor, however, located on the east side of the parkway, south and parallel to Lovell Road will need to be enlarged or a second interceptor added to handle proposed developments located along Hickory Creek (Yarnell Road) within the next 2 to 3 years. This interceptor carries the flow from the Dutchtown Road pump station and existing flows along Yarnell Road. GRW Engineers, Inc. is presently in the design stage of two new pump stations for the Yarnell Road area to handle the proposed flows that will be generated within the next two years. There are two projects already under construction (served by developer installed pump station), two other projects under development (434 new sewer connections) and two in the planning stages (over 275 acres – possibly 600 or

more new sewers). GRW Engineers, Inc. and WKUD staff have evaluated this need and propose that the existing 12-inch Plumb Creek Interceptor be replaced with a new 18-inch PVC interceptor. Probable cost for the replacement is approximately \$1.6 million which includes developmental costs (design, inspection, contingencies, etc).

#### IV. EVALUATION OF EXISTING FACILITIES TO HANDLE FUTURE NEEDS

##### A. Treatment Plant Needs

As discussed previously, the existing Karns wastewater treatment plant will require several modifications if the WPC allows further expansion of this facility and discharge into Beaver Creek (the existing discharge point). Recently projects in the southeast have seen a large increase in the cost of construction due to the steel and concrete demands around the world. Plants that could once be constructed for \$3 or \$4 per gallon are now costing between \$4 and \$6 dollars a gallon. Where plants are required to have nutrient removal as part of their treatment processes, the costs have risen to between \$7 and \$9 per gallon. Assuming that a new plant is bid and starts construction in the next 24 to 30 months, GRW has chosen to use a value of \$5.50 per gallon as a probable cost for a new treatment plant without tertiary or nutrient removal treatment. This may seem high but a recent bid in Johnson City, TN was for a 6.0 MGD plant for \$30 million (\$5 per gallon). This facility had filters (tertiary treatment), but it was bid earlier this year and not 2 to 3 years from now. Costs will probably continue to escalate unless there is a drop in the amount of construction going on, thus, the \$5.50 per gallon value is a realistic number for this initial planning stage. Where tertiary and nutrient removal is required, a cost of \$8 per gallon has been used. There are basically three (3) alternatives that must be considered for WKUD and are presented below:

##### 1. Expansion of Existing Karns Wastewater Treatment Plant and Continued Discharge to Beaver Creek.

The existing Karns wastewater treatment plant has an average design capacity of 4.0 MGD and provides tertiary treatment. Expansion of this facility and the continued discharge into Beaver Creek will involve a major change in the treatment plant processes, if nutrient removal is added to the discharge requirements. The limited space at this facility also presents a problem with the type of treatment units that can be used for the expansion. The small footprint available at this plant will probably require the addition of deep aeration basins and the use of membranes instead of clarifiers for separation of the treated wastewater from the suspended solids.

Assuming that a 5.0 MGD expansion of the existing Karns WWTP can be done on this site, the construction cost per gallon will be about \$8 per gallon; thus, the expansion will cost approximately (5.0 MGD x \$8/gal) \$40,000,000. Another \$6 to \$12 million may be needed to provide nutrient removal capabilities to the existing treatment train (4.0 MGD). The operation and maintenance costs of this type of plant will go up due to constant operation of the membrane units (must be pressurized continuously) and chemical costs for total nitrogen removal below 5.0 mg/l and phosphorus removal below 1.0 mg/l. It should also be noted that further expansion of the plant would not be

possible due to the lack of available and surrounding the site. The probably cost for this alternative are as follows:

• Modification of Existing Train for nutrient removal.	\$ 9,000,000
• Expansion of 5.0 MGD w/nutrient removal.....	<u>\$40,000,000</u>
Probable construction cost.....	\$49,000,000
Developmental cost (20%) (design, inspection, contingencies, etc.).....	<u>\$9,800,000</u>
<b>TOTAL PROBABLE PROJECT COST</b>	<b>\$58,800,000</b>

2. Effluent Pumping to the Clinch River

Another alternative is to move the discharge point of the Karns WWTP to the Clinch River. Locating a new discharge point requires evaluation of the existing water intakes on the Clinch River. WKUD has two intakes on the river in the proximity of the service area. The City of Oak Ridge and the National Oak Ridge Laboratories have intakes in this area. Complying with State regulations requires that a wastewater treatment plant discharge be located at least one (1) mile downstream from a water intake and/or 5 miles upstream. Figure IV-1 of this report is a map that shows the location of the described water intakes on the Clinch River. The map indicates that a new sewer plant discharge would have to be located at river mile 31.5 (southwest of Gallaher Bend) or below. If the effluent of the Karns WWTP was pumped to the Clinch River the logical route would follow the existing Hardin Valley Interceptor to Hardin Valley Road, westward under the Pellissippi Parkway down the road or along Conner Creek to Hickory Creek Road and finally into the river at the confluence (intersection) of Hickory Creek into the Clinch River. The effluent force main would be approximately 47,800 feet (about 9 miles) in length and be required to handle flows from 3.5 to 10.0 MGD to meet current flow conditions. The static head (highest elevation on force main route minus pump location elevation) on the effluent pumps would only be between 60 and 70 feet. The friction head, however, would be significant. Table IV-1 below indicates possible head conditions on different size effluent force mains. A “C” factor of 120 was used to determine these friction heads.

TABLE IV-1  
 FRICTION HEADLOSS  
 PROPOSED EFFLUENT FORCE MAINS

Pipe Diam. (in)	FRICTION HEADLOSS (ft)			
	FLOWS in MGD			
	4.0	8.5	10.0	17.0
18	114	460	621	1,658
21	54	217	293	783
24	28	113	153	409
30	10	38	52	138
36	4	16	21	57

Inflow conditions presently cause the existing treatment plant to experience hydraulic flows of up to 2.5 times the design flow. WKUD continues to remove as much of this inflow as possible, but some consideration for this problem must be addressed to be able to handle these high flows during rain events. Assume for this evaluation, that the rain event hydraulic flows will be reduced to a peaking factor of 2. Table III-5 above indicated the 20 year expected wastewater flow will be approximately 8.5 MGD. Thus, the force main should be size to handle at least (8.5 x 2) 17.0 MGD. Adding the static head to the friction headloss would increase the head on the pumps by another 60 to 70 feet. Thus, the 30 or 36 inch force main would be necessary to pump the varied flows that would be seen and keep the total head below or near 200 feet.

One (1) horsepower is equivalent to approximately 33,000 foot pounds (ft lb) per minute. Thus, assuming a pump with 85% efficiency, pumping 10.0 MGD through a 30-inch force main with a head of (52 + 60) 112 feet would require approximately [(7000 gpm x 8.33 lbs/gal x 112 ft) / (33,000 x .85)] 233 horsepower. If a flow of 17.0 MGD was to be pumped through the force main it would take a pump with approximately 700 horsepower. If a 36-inch force main is used, the horsepower requirements could be reduced to 168 horsepower at 10.0 MGD and about 414 horsepower at 17.0 MGD. The variable flow rates that could be seen at the treatment plant would require variable speed pumps (probably vertical turbine) with 500 horsepower motors. Probable construction costs for an effluent pump station, 36-inch force main and submerged outfall into the Clinch River is shown below.

- Effluent Pump Station, wet well & controls. \$ 2,000,000.00
  - 46,000 ft. of 36-inch Coated  
DIP FM (\$200/ft)..... \$ 9,200,000.00
  - 1,800 ft of river crossing pipe (\$400/ft).....\$ 720,000.00
  - 60 ft of submerged diffusers (\$800/ft).....\$ 48,000.00
- Total Probable Construction Costs \$ 11,968,000.00

The above cost is for pumping treated wastewater to the Clinch River and does not include any costs for additional treatment facilities that would be needed to increase the size to the treatment plant. The costs also do not reflect any easement costs or the design costs that would be involved.

The existing Karns treatment plant (4.0 MGD design capacity) would require additional treatment units to handle the expected through 2025 of 9.0 MGD. At a minimum aeration basins and clarifiers capable of handling another 5.0 MGD would be required. The sludge treatment and disposal processes would also require additional units or a change to the existing method of treatment

and disposal. The additional flows would also require the method of disinfection to be reviewed and possibly changed. An effluent flow equalization basin may also be necessary to handle the peak flow conditions experienced during heavy rainfall events. The available land at this site is very limited and will require a smaller footprint for the new treatment units. Deep aeration basins and advanced clarification units will be necessary. Using the \$5.50 per gallon value, the expanded Karns plant has a probable minimum construction cost of approximately (5.0 MGD x \$5.50/gallon) \$27,500,000. The existing Karns plant would not be able to expand past 9.0 MGD due to the lack of available land surrounding the existing facility. The total probable cost for this alternative is as follows:

• Effluent pump station & force main.....	\$ 11,968,000
• Expansion of Karns WWTP to 9.0 MGD.....	\$ 27,500,000
Probable Construction Costs.....	\$ 39,468,000
Developmental Costs (20%).....	\$ 7,894,000
<b>TOTAL PROBABLE PROJECT COST</b>	<b>\$ 47,362,000</b>

3. New Treatment Plant

A third alternative to consider is the location of a second wastewater treatment plant on the west side of the Pellissippi Parkway. Since most of the developable land in the Utility District is located in this area it makes sense to consider having a second facility to handle the immediate (through 2010) and future (2010 through 2025) needs of the district. Constructing a second plant to handle the future flows and maintaining the existing Karns plant at 4.0 MGD would require a plant designed for approximately 5.0 MGD. The plant could be constructed in two (2) phases of 2.5 MGD each. The first phase (2.5 MGD) should be able to handle the expected flows through 2015 if the Karns plant remains in operation. The second phase of construction would add another 2.5 MGD to the new plant and could be done in 2015 providing the treatment capacity needed for the projected flows through 2025. If the State sets effluent limits for nutrient removal in the future that are too stringent, WKUD should evaluate the costs to construct the new treatment units versus pumping to the new treatment plant and expanding this facility. This could be considered phase 3 and would occur if the need arises. The plant capacity should be increased to 10.0 MGD if this phase is required.

Based on the evaluation of pumping the treated wastewater to the Clinch River (shown above), a suitable site for discharge is at the confluence of Hickory Creek. Locating a new treatment plant on the western portion of the district near Hickory Creek will allow the use of gravity sewers through most of the area. Hickory Creek runs south west in Hines Valley between Beaver and Blackoak Ridges. All drainage between these two ridges flows down Hickory Creek to approximate river mile 28.2 of the Clinch River. Hardin Valley lies

of the north side of Beaver Ridge and is drained by Conner Creek which follows the same general path as Hickory Creek till it reaches Hickory Creek Road. It then turns north and flows into the Clinch River at approximate river mile 35.5 (up stream from Oak Ridge Labs water intake). The wastewater would have to be pumped over a small ridge (about 80 feet above low point) at this location for about 6,000 feet and it would then flow by gravity approximately 5,900 feet to Hickory Creek.

Since both of these gravity sewer interceptors would converge near Hickory Creek, Buttermilk and Everett Roads, a treatment plant site in this area would be considered ideal. Potential sites have been evaluated along and adjacent Hickory Creek. One of the needs for a treatment plant site is sufficient buffer around the plant to meet State requirements. The proposed northern route of I-475 goes through the eastern side of this area between Hickory Creek and Buttermilk Roads. A site next to the proposed interstate would be a nice buffer that would prevent future problems with developers. The total acreage needed for a plant with buffers and room for future expansion has been estimated at between 80 and 100 acres. There are several large undeveloped tracts west of the I-475 corridor as found on KGIS information website as shown in appendix "C". The purchase of several of these tracts (totaling about 100 acres) would be sufficient for the construction of a treatment plant that should handle the needs of WKUD through the year 2025 and beyond.

The initial construction costs of the treatment plant would be for preparation of the site for phase 1 and future phases. Phase 1 would consist of a 2.5 MGD facility with a plant main pumping station and submerged outfall line to the Clinch River. The outfall would need to be sized to handle the maximum discharge flow expected from the phase 1 plant and all future phases. The main pump station for the plant should be designed and sized to handle the expected flows through 2025. The pumps would need to be variable speed and/or space provided for addition pumps in the future.

The discharge into the Clinch River should allow less stringent effluent (secondary) standards than the existing Karns wastewater treatment plant which presently has tertiary effluent standards. Thus, the construction costs would probably be for a secondary plant without the need for tertiary (filtration). Therefore for planning purposes we can assume that the costs for a new 2.5 MGD will be approximately \$13,750,000. A probable breakdown of these costs is shown below:

- Land clearing (30 acres at \$5,000/acre) 150,000.00
- Excavation (20,000 ft<sup>3</sup> at \$18/ cu yd) 360,000.00
- Main Pump Station w/metering & sampling 2,000,000.00
- Headworks w/screens, grit removal & washing 1,400,000.00
- Flow Splitter Structure w/weir gates 100,000.00

• 2-Oxidation Ditches (1.25 MG each)	2,000,000.00
• 4-Clarifiers	800,000.00
• UV Disinfection	700,000.00
• Return/waste Sludge Pumping Building	350,000.00
• Electrical Power and Control Building	1,000,000.00
• Sludge Holding/Digesters (4 basins)	800,000.00
• Sludge Dewatering Building w/2-thickeners, And 2-centrifuges and room for expansion	1,700,000.00
• Outfall to Clinch River (3,000 ft at \$200/ft, 3100 ft at \$400/ft and 60 ft at \$800/ft)	1,888,000.00
• Administrative, lab & maintenance building	400,000.00
• Site Roads and sidewalks	<u>102,000.00</u>
<b>TOTAL PROBABLE CONSTRUCTION COSTS</b>	<b>\$13,750,000.00</b>

B. Collection System Needs

1. Hardin Valley Area

As discussed in Section IV of this report, the largest potential growth for the collection system is west of the Pellissippi Parkway. The existing pump stations transporting wastewater in the Hardin Valley area are sufficient to handle the current and future needs presently known to WKUD. This should serve the district through 2008 without the need to increase the pumping capabilities of these stations. The 18-inch interceptor on the east side of the parkway also has sufficient capacity and will not need to be enlarged until the year 2010 if the Karns WWTP remains open and is enlarged to handle additional capacity.

The watershed area of Hardin Valley runs west to Hickory Creek Road and then turns northward towards the Clinch River. If a second WWTP is constructed off Hickory Creek near Everett Road, it would make sense to construct an interceptor that could handle the growth projected in this area. The interceptor would be able to handle the flows from Pellissippi State College and westward (all on the west side of the parkway). If the Karns WWTP is to be abandoned in the future, the force main route to the new plant would logically need to go through Hardin Valley. Thus, the size of this interceptor may need to be as large as 24-inches in diameter to handle the growth and existing flows (11.7 MGD capacity at 0.5% grade – minimum natural slope in this area) from the Karns WWTP.

There is a 12-inch gravity sewer already located from Brighton Farms westward to Steele Road where a pump station is located next to the new Hardin Valley Elementary School. It would take approximately 10,000 feet of 24-inch line to reach the point where a pump station would be needed to be built to pump the flow over the ridge on Hickory Creek Road towards a new

plant. This would allow the complete drainage of the valley and pumping to a new WWTP near Hickory Creek. This would provide additional capacity to the existing Karns WWTP for future growth. When or if the Karns WWTP plant is abandoned the force main from the plant could be constructed to end at the beginning of the 24-inch interceptor (at Steele Road).

The construction of a new sewage pumping station at the intersection of Hickory Creek Road and Hardin Valley Road would allow pumping the collected wastewater over the ridge. It would take approximately 5,850 feet of force main to reach the top of the ridge. The natural slope of the existing terrain on the west side of the ridge would allow the construction of a 24-inch gravity sewer with a minimum slope of 1.5% having a capacity of up to 20.0 MGD. The distance from the top of the ridge to the area presently under consideration for a new plant is approximately 5,700 ft.

In summary, the possible needs in the Hardin Valley area would be the construction of a new 24-inch interceptor, pump station and force main to pump the collected wastewater to a new 24-inch interceptor on the west side of the ridge. The second interceptor would convey the wastewater to the new plant for treatment and disposal into the Clinch River. Probable construction costs for these projects are as follows:

- West Harden Valley Interceptor (10,000 ft of 24-inch line w/manholes at \$130/ft)..... \$1,300,000.00
  - 5.0 MGD Pump Station (capable of expansion).. \$ 800,000.00
  - Force Main west on Hickory Creek Road over Ridge (5,850 ft of 16-inch at \$90/ft)..... \$ 526,500.00
  - Hickory Creek Road Interceptor (5,700 ft of 24-inch line w/manholes at \$130/ft)..... \$ 741,000.00
- PROBABLE CONSTRUCTION COSTS            \$3,367,500.00**

2. Yarnell Road (Hines Valley) Area

This area has seen rapid growth by developers in the past 2 years. As discussed in Section III of this report, WKUD has over 500 new sewer connections scheduled for addition to the sewer system over the next 2 to 3 years. There are other areas in the valley that are being purchased by developers and who plan to start new developments within the next 3 to 5 years. At the present rate of development occurring in this area the district could see an additional 1,000 connections in 4 to 5 years if sewers are available. Presently all wastewater collected in the Yarnell area is pumped back to the existing 12-inch Plumb Creek Interceptor. This line carries collected wastewater from the Pellissippi Parkway down to the Middlebrook Interceptor for transport to the Karns WWTP. This line is near capacity now

and will not be able to continue to provide for new development in the Yarnell area. In a previous evaluation of the Yarnell Road area, GRW Engineers, Inc. proposed the replacement of the Plumb Creek Interceptor with a new 18-inch line. The probable cost for this project was reported to be approximately \$1,600,000 which included some developmental costs.

Hines Valley is drained by Hickory Creek which convergences to the Clinch River adjacent to Everett, Buttermilk and Hickory Creek roads (near the proposed new WWTP site). As this area develops an interceptor should be constructed adjacent to the creek and be brought into the new WWTP site. The distance from North Campbell Station Road to the new proposed plant site (following Hickory Creek) is approximately 23,000 feet (4.4 miles). As this area continues to develop over the next 10 years, WKUD should require that larger sewer lines (interceptors) be installed along the creek so that the entire area will eventually drain by gravity to the new treatment plant site. Until that time the flow will be pumped back to the Plumb Creek Interceptor.

3. Watts Road/Everett Road Area

The north side of the interchange exit on I-40 is located in this area of the WKUD service area. Wastewater collected in this area is presently pumped to First Utility District (First UD) for treatment and disposal. This area is continuing to develop and will exceed the current pump station capacity in the near future. First UD has already indicated that their collection system capacity in this area is nearly at maximum and will not accept additional flow from the WKUD pump station. Without sewer service availability the development of this area will be hampered.

The construction of a new wastewater treatment plant off Everett Road would allow continued growth in this area. The interchange is about 5,000 feet from the proposed WWTP site. Developers could be required to install a new force main to the new WWTP site if the treatment plant is constructed. This area is expected to be commercially developed with of motels, restaurants and businesses, etc.

V. **RECOMMENDED IMPROVEMENTS FOR FACILITIES TO HANDLE 20 YEAR NEEDS**

A. Treatment Plant

Projected flows through the year 2025 indicate flows of approximately 9.0 MGD will need to be treated at a wastewater treatment plant. The existing Karns wastewater treatment plant should continue to operate at the present design capacity of 4.0 MGD until such time as the new effluent standards requiring nutrient removal make the costs for treatment improvements not feasible.

A new wastewater treatment plant should be located off of Hickory Creek Road near the intersection of Everett and Buttermilk Roads to handle the projected future flows of the district. Sufficient land (minimum of 80 to 100 acres) should be purchased to allow elimination of the Karns WWTP in the future if costs become prohibitive to modify the facility for nutrient removal. The new facility should be planned for expansion in at least three (3) phases. Phase 1 would be for the construction of a new 2.5 MGD plant that would handle the flows expected through 2015. Phase 2 would add another 2.5 MGD to handle future flows expected through 2025. If the existing Karns wastewater treatment plant becomes too expensive to modify due to new effluent standards that the State might require, a phase 3 project would be done to add another 5.0 MGD for a total design of 10.0 MGD. Future growth past 2025 could be handled at this same location if sufficient property is acquired now.

Probable costs for this project are as follows:

• Purchase of land for treatment plant site	\$ 2,500,000
• Construct New 2.5 MGD WWTP	<u>\$ 13,750,000</u>
Probable Construction Cost	\$16,250,000
• Developmental Costs & Contingencies	<u>\$ 2,750,000</u>
<b>Probable Treatment Plant Costs</b>	<b><u>\$ 19,000,000</u></b>

B. Collection System

If the new treatment plant is constructed, the wastewater from the west side of the Pellissippi Parkway should be redirected towards the new facility. Construction of 24-inch interceptors at two locations is recommended. The first would be located adjacent to Conner Creek in Hardin Valley from Steele Road to the intersection of Hickory Creek and Hardin Valley Roads. Initially a 5.0 MGD pump station would be constructed at this location to handle the existing and future flows expected for the next 20 years. The station would be designed so that the pumping capacity could be increased to 10.0 MGD or 15.0 MGD in the event that the Karns WWTP is abandoned in the future (some of the flow would be transported down a gravity interceptor along Hickory Creek and not go through this station). A 16-inch force main would pump to the top of the ridge on

Hickory Creek Road where the second 24-inch interceptor would transport the flow to the new treatment plant main pump station.

A new 18-inch interceptor will need to be constructed in the next 1 to 3 years to replace the existing 12-inch Plumb Creek Interceptor due to present growth in the Yarnell Road area. The existing interceptor carries all the flow collected in the Lovell Road vicinity between the Pellissippi Parkway and Middlebrook Road.

Probable costs for these projects are as follows:

- West Hardin Valley Interceptor..... \$ 1,300,000
- 5.0 MGD Pump Station (capable of expansion).. \$ 800,000
- 16-inch Force Main to Hickory Creek Road..... \$ 526,500
- Hickory Creek Road Interceptor..... \$ 741,000
- Plumb Creek Interceptor Replacement..... \$ 1,263,000
- **Total Probable Construction Costs** **\$4,630,500**
- Developmental Costs & Contingencies (25%) \$ 1,157,500

**Probable Collection System Costs** **\$ 5,788,000**

C. Summary of Recommended Projects for Next 5 Years

- Purchase of Land in the Western Portion of the WKUD Service Area for the Construction of a New Wastewater Treatment Plant
- Construct a New 2.5 (or 5.0 MGD) Wastewater Treatment Plant and outfall to the Clinch River on the Purchased Land
- Construct New Gravity Interceptors, a force main and pump station to transport the wastewater down Hardin Valley to the New Wastewater Treatment Plant.
- Replace the Existing 12-inch Plumb Creek Interceptor with a new 18-inch interceptor.

TOTAL PROBABLE COST FOR THESE PROJECTS IS AS SHOWN BELOW:

- New treatment plant \$ 19,000,000
- Collection System \$ 5,788,000
- **TOTAL PROBABLE COST** **\$ 24,788,000**

*If WKUD decides to construct the entire 5.0 MGD capacity (20 year need) initially, the total probable cost for the treatment plant will be approximately \$30,000,000 for a total probable project cost including the collection system work of approximately \$35,788,000.*

## **APPENDIX – A**

List of projects on record with WKUD for sewer service

**WKUD - As of 09/14/2006, this is a summary of developments that have either occurred in the past approximately 1 year, developments that are currently underway and developments that are planned or have been inquired about. This list generally includes the vast majority of development within the District, although some commercial parcels and minor residential developments may not be included.**

DEVELOPMENT	LOCATION	STATUS	APPROX. # OF LOTS OR POTENTIAL CONNECTIONS	WEST OF PELLISSIPPI PKWY?	NOTES
84 Lumber	Quality Lane	Complete	commercial		
Andes Road LPS - lots 3/4	Andes Road	Land being developed	4		
Bakertown Village	Bakertown Rd	Land being developed	31		
Beaver Ridge Rd S.S. Extension	Beaver Ridge Road	Complete	8		
Brass Lantern S/D (Maitland Woods)	Sands Road	Homes under construction	57		
Brinks Home Security	Kemp Fain Lane	Complete	commercial		
Carmichael Road - S&E property	Carmichael Rd	Planning stage	35	yes	Approx. number of lots - no plans received yet. Other nearby properties have been inquired about.
Carpenter Ridge S/D & offsite sewer (Housley Farms)	Carpenter Road	Homes under construction	55		
Cascade Falls S/D	Ball Camp Pike	Homes under construction	87		
Centerpoint Commons	Yarnell Road at Lovell	Land being developed	commercial	yes	Several multi-level office buildings
Century Park Blvd Phase 1	Sherrill Blvd & Mabry Hood	Land developed for buildings	commercial		Commercial tracts, some construction complete
Chesney Hills S/D	Bob Kirby Rd	Construction to start soon	87		
Chesterfield S/D	Hickey Road	Homes under construction	74		Phase 1 being built, plans for Phase 2 have been submitted
Commercial development	Btwn Carmichael Rd/Hardin Valley	Planning stage	commercial	yes	Have inquired about utilities and surveyed land
Commercial development	Hardin Valley at Pellissippi Pkwy (behind Conoco)	Land being developed	commercial		Several commercial tracts being developed
Copper Ridge S/D	Emory Road	Land being developed	117		
Countryside Center	Middlebrook Pike	Land being developed	7		Multiple commercial tracts
Covered Bridge S/D	Hickory Creek Road	Land being developed	330	yes	Multiple phases - Phase 1 is under construction
Creeside S/D S.S.	George Light Road	Complete	7		
Creston Court S/D	Old Middlebrook Pike	Homes under construction	31		
Cutters Run Phase I / Phase II	Yarnell Road	Homes under construction	69	yes	
Devanshire Unit 3	Lovell Road	Homes under construction	61		
Devanshire Unit 4	Lovell Road	Homes under construction	37		
Dollar General Market	Middlebrook Pike	Complete	commercial		
Dutchtown Professional Bldg	Dutchtown Road	Plans approved - not built yet	commercial		Commercial building
Eagle Bend - Pittman Road	Pittman Road	Planning stage - no plans yet	180	yes	Property purchased - intended to be developed
ETS Veteran's Home	Coward Mill Road	Complete	institutional		
Food City Shopping Center	Middlebrook & Hoyles Beals	Complete	commercial		Grocery store, additional commercial businesses are being planned for construction start soon
Forestbrook Condos	Middlebrook Pike	Plans approved - not built yet	16		
Fowler's Furniture Distribution	El Camino Land	Building under construction	commercial	yes	Large new distribution/showroom/warehouse facility
Franklin Creek S/D	Yarnell Road	Homes under construction	81	yes	
Grace Christian Academy H.S. addition	Beaver Ridge Road	Land being developed	institutional		
Gray Eagle Springs S/D	Bob Gray	Homes under construction	44		
Greenbrook S/D Phases 1 & 2	Solway Road	Homes under construction	120	yes	Further phase (Phase 3) may occur - approx. 55 more lots*

Hampton Inn reconstruction	Cedar Bluff	Construction virtually done	commercial		Added approx. 70 rooms, more facilities.
Hannah's Park S/D	Meredith Road	Homes under construction	19		
Hardin Valley High School	Hardin Valley Rd	Under construction	institutional	yes	
Hardin Valley office buildings	Hardin Valley Rd	Plans submitted for review	commercial		Internal medicine office bldg and additional 2-story office bldg - just west of Westbridge Ind. Park
Hardin Valley Road Development	Hardin Valley Rd	Planning stage	100	yes	Across from Pellissippi State College - commercial & residential development planned (estimated number). No plans have been received yet.
Hardin Valley Road Developments - Reveiz	Hardin Valley Rd	Land being developed	commercial		Several commercial and office buildings, possible food service - just west of Westbridge Ind. Park
Hardin Valley Station	Hardin Valley Rd	Land being developed	commercial		Several commercial establishments, possible restaurants
Harrison Springs S/D	Schaeffer Road	Homes under construction	96		Phase 3 being designed - # of homes unknown (maybe 75 more lots +/- expected)*
Highers Estates	Bakertown Rd	Land being developed	101		
Highers Place	Bakertown Rd	Land being developed	94		
Property NE quadrant of Bakertown/Ball Camp Pike	Bakertown Rd	Speculative			Same owners as Highers Estates/Highers Place. Have mentioned developing this portion also. Could be 100+ more units at later date.
Holrob Development - Oak Ridge Hwy	Oak Ridge Hwy	Construction to start soon	commercial		Several commercial/retail outlets, possible food service
Jenkins Creek S/D	Jenkins & Joe Hinton	Homes under construction	116		Some of Phase 1 homes occupied, construction of Phase 2 underway
Lancaster Ridge	Steele Road	Homes under construction	88	yes	
Long property - west of Campbell Station Rd/Yarnell Rd	Near N. Campbell Station @ Yarnell	Planning stage		yes	2 different developers have inquired about developing - approximately 275 acres are contiguous*
Lovell Crossing	Yarnell Road	Land being developed	216	yes	
Lovell Road Animal Hospital	Lovell Road	Land being developed	commercial	yes	
Magnolia Pointe	Coward Mill Road	Homes under construction	42		
McCoy/Proffitt Partnership	Oak Ridge Hwy Comm. Park	Complete	commercial		Commercial buildings
Middlebrook Gardens	Middlebrook Pike	Complete	1		
N. Campbell Station Rd Development	N. Campbell Station @ Yarnell	Land being developed	130	yes	This is one of the developments that will flow into the new Yarnell Road WWPSs
Nora's Path & offsite sewer	Thompson Road	Homes under construction	60		
Paidela Academy	Yarnell Road	Complete	commercial	yes	
Painter Farms S/D	Emory Rd @ Harrell	Homes under construction	83		
Parkway Business Park	Braden-Dickey Lane	Complete	commercial		
Pilot Food Mart/McDonald's/Car Wash	Middlebrook Pk @ Joe Hinton	Plans approved	commercial		Construction not started yet
Property west of Cascade Falls S/D	Ball Camp Pike	Planning/speculating			Have inquired about utilities, may develop approx. 50 lots*
Racquet Club Villas	Fox Lonas Road	Complete	35		Not sure if this is built out yet?
Reagan Landing S/D	Reagan Road	Homes under construction	134		
Reagan Woods S/D	Andes Road	Homes under construction	22		
Restaurants - Cedar Bluff	Cedar Bluff	Planning/speculating	commercial		At least 2 new restaurants have inquired about developing
River Birch II Phase 1	Oak Ridge Hwy	Construction virtually done	20		
Rodefer Moss Development	Sherrill Blvd & Mabry Hood	Land being developed	commercial		3 multi-level office buildings

Taylor's View S/D - Phase 2	Meredith Road	Land being developed	22		
The Glen at Hardin Valley S/D	Hardin Valley Rd	Land being developed	169	yes	
The Ridgeland at Hardin Valley	Castaic Lane	Partially completed	commercial	yes	Commercial/office buildings
Thompson Trail S/D	Thompson Road	Land being developed	35		
Tippitt Village	Andes Road	Land being developed	73		
Walden Legacy Apartments	Middlebrook Pike	Construction virtually done	237		Construction recently completed - probably not near full occupancy at this time. At last site visit, building construction was still ongoing.
Walker's Gate	Karns Valley Drive	Land being developed	102		
Watt Road commercial developments	Watt Road	Land being developed	commercial	yes	Several commercial lots - developer planning possible hotel(s)/restaurant(s)
Webb School - new Science Building	Webb School campus	Land being developed	institutional		New bldg - they anticipate moderate amount of water use/sewerage
Willows at Hardin Valley & offsite sewer	Hardin Valley @ Reagan Rd	Homes under construction	38		2-story office building already added, commercial development planned (Development Corporation/Graves property across road from Willows)
Windsor Point (Wellington Chase)	Thompson Road	Homes under construction	52		
Wisteria Park	Yarnell Road	Plans submitted to WKUD for review & approval	88	yes	Plans submitted - this development will flow into one of the new Yarnell Road WWPSs

sum = 3711

**SUMMARY:**

Number of new connections at buildout = 3,711  
Add: potential additional connections (in red above right side) 830 (assuming only 2 DU/ac for 275 acres)  


---

TOTAL = 4,541

**Note: These numbers are for the residential portion only. No flow information/allowance is included for all of the commercial and institutional developments shown above, including potential hotels/restaurants, numerous office buildings as well as potential additional industrial customers in the Hardin Valley area.**

## **APPENDIX - B**

1. LETTER TO TENNESSEE DIVISION OF WATER POLLUTION CONTROL DATED JUNE 26, 2006 REQUESTING POSSIBLE EFFLUENT STANDARDS FOR THE EXPANSION OF THE EXISTING KARNS WWTP.
2. LETTER FROM THE TENNESSEE DIVISION OF WATER POLLUTION CONTROL DATED AUGUST 4, 2006 IN RESPONSE TO JUNE 26, 2006 LETTER.



404 BNA Drive  
Suite 201  
Nashville, TN 37217  
Tel 615 / 366-1600  
Fax 615 / 366-0406

Engineering  
Architecture  
Planning  
GIS  
Aviation Consultants

Arlington, TX  
Cincinnati, OH  
Indianapolis, IN  
Knoxville, TN  
Lexington, KY  
Louisville, KY

File - West Knox, 1527A - Melton Lake

**GRW Engineers, Inc.**

June 26, 2006

Mr. Lanny Bonds  
Division of Water Pollution Control  
TDEC - EAC  
2700 Middlebrook Pike, Suite 220  
Knoxville, TN 37921-5602

Re: West Knox U. D.  
Planning for Future Needs  
Wastewater Treatment Plant Expansion  
NPDES Permit No. TN0060020

Dear Mr. Bonds:

This letter is written as a follow up to our previous phone conversation concerning the future expansion of the Karns Wastewater Treatment Plant operated by the West Knox Utility District (WKUD). As I explained to you, GRW Engineers, Inc. has been requested to evaluate the future wastewater flows that the Utility District might expect during the next 20 years and determine if the existing plant can be expanded to handle these flows. As part of this evaluation we are trying to determine if the existing treatment plant site will be allowed to expand and continue to discharge into Beaver Creek at river mile 10.7. Another alternative being evaluated is the possible purchase of land west of the existing plant for a second plant that would discharge into Clinch River.

The WKUD's service area has continued to see significant growth with the addition of over 1,700 new customers (increase flow of over 450,000 gpd) to the sewer system in the past 4 years. Developers continue to submit new proposed projects to WKUD each month. At the current rate of requests for new sewer connections, WKUD projects another 600 customers will be added during 2006. One area that has seen rapid development in the past 18 months is along Yarnell Road just off Lovell Road. There are two (2) developments that are already under construction (with occupied homes), a third development now doing site work and 2 other developments in the planning stages. These five developments have over 350 single family lots planned, a commercial/business area and one apartment complex. A recent evaluation of the area along Yarnell Road from Lovell Road to North Campbell Station Road, projects flows of up to 443,000 gpd when this area fully develops. Since the average daily flow at the treatment plant in 2005 was 3.5 MGD, this one area could take the remaining capacity of the existing treatment plant over the next 5 to 10 years, without any other areas developing. Since there are many other areas in the service district developing, WKUD fully expects the need to expand the treatment plant capacity in the next 3 to 5 years.



Mr. Lanny Bonds

June 26, 2006

Page 2

As part of our evaluation of the treatment plant needs, we request that the Division of Water Pollution Control provide this office with probable effluent standards that could be expected for the following:

1. An increase in the existing treatment plant capacity to 6.0 MGD, 8.0 MGD and 10.0 MGD with the continued discharge into Beaver Creek?
2. Will nutrient removal be required on the next NPDES permit renewal and/or the expanded treatment plant capacities?
3. What type of effluent standards could be expected with discharge into the Clinch River (Melton Lake) downstream (below river mile 31) from the WKUD and Oak Ridge water treatment plants?

We are aware that normally a model must be ran to determine the specific effluent standards for a proposed discharge, however, this report can use general statements from your office concerning probable effluent standards. Specific standards with these flows and locations will be requested at a later date as more information is compiled and decisions made.

WKUD has requested that our report be completed in mid to late July 2006, thus, your immediate attention and response to this letter would be greatly appreciated.

If you need further information from this office or have any questions regarding this request, please feel free to call.

Sincerely,

Robert G. Threadgill, Jr., P.E.

GRW Engineers, Inc.

Cc: Mr. Drexel Heidel – WKUD  
GRW – Knox  
File 7527



STATE OF TENNESSEE  
**DEPARTMENT OF ENVIRONMENT AND CONSERVATION**  
KNOXVILLE ENVIRONMENTAL FIELD OFFICE  
3711 MIDDLEBROOK PIKE  
KNOXVILLE, TENNESSEE 37921-6538  
PHONE (865) 594-6035      STATEWIDE 1-888-891-8332      FAX (865) 594-6105

August 4, 2006

Mr. Robert G. Threadgill, Jr., P. E.  
GRW Engineers, Inc.  
404 BNA Drive, Suite 201  
Nashville, Tennessee 37217

RE: West Knox Utility District  
NPDES Permit No. TN0060020  
Wastewater Treatment Plant Expansion  
Knox County

Dear Mr. Threadgill:

This is reply to your letter June 26, 2006, which requested guidance on the possible expansion of the West Knox Utility District Karns sewage treatment plant which currently discharges to Beaver Creek. Any proposal to increase discharges to Beaver Creek would have to overcome the following significant obstacles:

1. Beaver Creek has been listed by the State under Section 303(d) of the Clean Water Act as impaired waters. The 2004 303(d) list stated that the stream segment from the origin to mile 22.5 is failing to meet designated uses due to phosphorus, nitrate, E. coli, siltation, and habitat loss due to stream alteration. The 2006 draft 303(d) list includes all of the above, plus low dissolved oxygen, as causes as to why the stream is impaired. The introduction of additional loading would aggravate this situation.
2. As noted above, nutrients are among the constituents contributing to the impairment of this stream. An applicant for an expanded discharge at this location should expect nutrient removal requirements and stringent limits.
3. As Beaver Creek is on the 303(d) list, a TMDL (Total Maximum Daily Load) must be developed in the future for nutrients and low dissolved oxygen, with a plan for restoring the stream to where it supports its designated uses. This could lead to more stringent permit limits even on existing facilities.

The Division's design criteria and the antidegradation statement contained in Section 1200-4-3-.06 of the Department's regulations call for an exhaustive alternatives analysis. Such an analysis must consider Clinch River/Melton Hill Reservoir as an alternative, with a major advantage as a discharge point compared to Beaver Creek due to its much greater volume. Notwithstanding this it should be noted that the Environmental Protection Agency has mandated the establishment of nutrient criteria for reservoirs and this could affect discharges here in the future as well.

Your cooperation with this office is appreciated. Should you have any questions, please do not hesitate to call me at 594-5521.

Sincerely,

A handwritten signature in black ink, appearing to read "W. L. Smith", with a stylized flourish at the end.

Woodson L. Smith  
Knoxville Environmental Field Office  
Division of Water Pollution Control

cc: Division of Water Pollution Control, Nashville

## **APPENDIX – C**

**Map of Possible Treatment Plant Site showing Area with Large Land Tracts Adjacent to Proposed I-475 Corridor and Near the Intersection of Hickory Creek, Buttermilk and Everett Roads**

**KGIS - Knoxville, Knox County, K.U.B. Geographic Information System**



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**Legend**

- |                   |  |
|-------------------|--|
| High School       | SR-475 Recommended Alignment Footprint label |
| Collectors        | SR-475 Recommended Alignment Footprints      |
| Arterials         | SR-475 Planning Corridor                     |
| Expressways       | Subdivisions                                 |
| Interstate Shield | Knoxville City Boundary                      |
| Interstates       | Farragut Boundary                            |
| Neighborhoods     | Knox County Boundary                         |
| Parcels           |  |
| Water Bodies      |  |
| City Park         |  |
| County Park       |  |
| Golf Course       |  |

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