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**Technical Memorandum 7 – Capital Improvements Recommendations - DRAFT**  
Wastewater Treatment Capacity and Effluent Disposal Study  
Murfreesboro Water and Sewer Department

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The purpose of this Technical Memorandum (TM) is to provide recommendations to the Murfreesboro Water and Sewer District (MWSD) on alternatives for wastewater treatment capacity expansion and effluent disposal. This TM is to focus on several of the more feasible recommended alternatives based on total project costs in addition to other non-cost factors. This TM includes a phased Capital Improvements Plan (CIP), an improvement prioritization and decision matrix, and a discussion of funding opportunities for capital improvements in Murfreesboro.

**Table of Contents**

<b>1.</b>	<b>Phased Capital Improvements Plan</b>	<b>3</b>
1.1	Construction Cost Estimate Development	4
1.2	Operation and Maintenance Cost Estimate Development	5
1.3	Capital Improvements Phasing	5
1.4	Net Present Value	5
1.5	Summary of Recommended Alternative Cost	5
<b>2.</b>	<b>Capital Improvement Prioritization and Decision Analysis</b>	<b>11</b>
2.1	Summary of Highest Ranked Alternatives	11
<b>3.</b>	<b>Funding Opportunities</b>	<b>13</b>
3.1	State Grants	13
3.2	Federal Grants	13
3.3	Federal Loans	14
<b>4.</b>	<b>References</b>	<b>15</b>

**Tables**

Table 1-1:	Summary of 201 Facilities Plan Collection System Improvement Costs	5
Table 1-2:	Summary of Capital, Operation and Maintenance, Net Present Value, Equivalent Annual Cost, and Collection System Deferral Costs	6
Table 2-1:	Summary of Alternatives Ranked According to Independent Prioritization and Decision Evaluations	12

**Figures**

Figure 1-1:	Graphical Summary of Capital Cost, Operation and Maintenance Costs, and 20 Year Equivalent Annual Cost for Eleven Recommended Alternatives	9
Figure 1-2:	Graphical Summary of Net Present Value of Eleven Recommended Alternatives	10

## **1. Phased Capital Improvements Plan**

The goal of this *Wastewater Treatment Capacity and Effluent Disposal Study* is to develop a set of comprehensive wastewater treatment solutions to address near and long-term planning requirements. The evaluation of the issues associated with the potential wastewater treatment expansion and effluent disposal alternatives resulted in a matrix of eleven recommended alternatives. These eleven recommendations were selected from the list of twelve satellite treatment facilities and the myriad of effluent disposal combinations and several centralized treatment options. The purpose of this TM is to focus on several of the more feasible recommended alternatives based on total construction cost and other non-cost factors.

A summary of the eleven recommended alternatives is as follows:

### Centralized Expansion Alternatives

- Alternative #1: Expand Sinking Creek WWTP by 11 mgd with a seasonal discharge to East Fork Stones River and spray/drip irrigation on Jordan/Coleman Farms and acquired property.
- Alternative #8: Expand Sinking Creek WWTP by 11 mgd with a continuous 4 mgd discharge to West Fork Stones River, a seasonal discharge to East Fork Stones River, and spray/drip irrigation on Jordan/Coleman Farms and acquired property.
- Alternative #9: Expand Sinking Creek WWTP by 11 mgd with a seasonal discharge to East Fork Stones River and a seasonal discharge to the Cumberland River.

### Centralized and Decentralized Alternatives

- Alternative #5: Expand Sinking Creek WWTP by 8 mgd with a seasonal discharge to East Fork Stones River and spray/drip irrigation on Jordan/Coleman Farms and acquired property; and construct a 3 mgd satellite facility (S3) with spray/drip irrigation on acquired property.
- Alternative #6: Expand Sinking Creek WWTP by 8 mgd with spray/drip irrigation on Jordan/Coleman Farms and acquired property; and construct a 5 mgd satellite facility (S6) with spray/drip irrigation on acquired property.
- Alternative #7: Expand Sinking Creek WWTP by 4 mgd with a continuous 4 mgd discharge to West Fork Stones River; construct a 4 mgd satellite facility (S4) with spray/drip irrigation on Jordan/Coleman Farms and acquired property; and construct a 5 mgd satellite facility (S6) with spray/drip irrigation on acquired property.
- Alternative #10: Expand Sinking Creek WWTP by 4 mgd with a continuous 4 mgd discharge to West Fork Stones River; construct a 9 mgd satellite facility (S1) with spray/drip irrigation on Jordan/Coleman Farms and acquired property.

- Alternative #11: Expand Sinking Creek WWTP by 4 mgd with a continuous 4 mgd discharge to West Fork Stones River; construct a 9 mgd pump station at site S1 then pump to satellite facility S5; collect an additional 1.5 mgd at S5; construct a satellite facility (S5) with spray/drip irrigation on acquired property.

#### Decentralized Alternatives

- Alternative #2: Construct a 12 mgd satellite facility (S11) with spray/drip irrigation on acquired property.
- Alternative #3: Construct a 9 mgd satellite facility (S1) with spray/drip irrigation on acquired property; and construct a 3 mgd satellite facility (S10) with spray/drip irrigation on acquired property.
- Alternative #4: Construct a 9 mgd satellite facility (S1) with spray/drip irrigation on acquired property; and construct a 3 mgd satellite facility (S8) with spray/drip irrigation on acquired property.

### 1.1 Construction Cost Estimate Development

Construction costs were estimated for treatment, piping infrastructure, effluent disposal, and collection system improvements for each of the eleven recommended alternatives. Wastewater treatment capacity costs were estimated on a dollar per volume basis. The unit cost depends on the size of facility and on the type of treatment (e.g. an oxidation ditch versus a MBR). A range of wastewater treatment capacity costs was provided in TM 3 – *Evaluation of Treatment Technologies*. Piping infrastructure was estimated as a unit cost per inch diameter per linear foot of pipe. Pipe sizes were selected based on a maximum velocity of 4 ft/s. Land costs were estimated at \$25,000 per acre, per information provided by MWSD.

This evaluation also identifies specific collection system improvements that were recommended in the *201 Wastewater Facilities Plan* (Smith Seckman Reid, 2002). An analysis was performed to determine which collection system improvements could possibly be deferred for each capacity and effluent disposal alternative, per TM 6 – *Collection System Evaluation*. For example, the construction of a satellite treatment facility and associated effluent disposal would offset a capacity expansion in the associated interceptor. The costs for these improvements were updated to 2011 dollars using the Engineering News Record (ENR) construction index.

The 201 Master Plan described collection system improvements in three phases. Short-term range improvements were scheduled for the first five year period, medium-term range improvements were scheduled for a five to ten year period, and long-term range improvements were scheduled for greater than fifteen years. The total project value of these collection system improvements are provided in Table 1-1. Most of the collection system deferrals in this study were designated in the short-term range.

**Table 1-1: Summary of 201 Facilities Plan Collection System Improvement Costs**

	<b>Short-term Range <sup>1</sup></b>	<b>Medium-term Range <sup>1</sup></b>	<b>Long-term Range <sup>1</sup></b>	<b>Total Sum of Improvements</b>
Project Value (2002\$) <sup>2</sup>	\$40,800,000	\$90,860,000	\$62,500,000	\$194,000,000
Project Value (2011\$) <sup>2</sup>	\$56,800,000	\$126,500,000	\$87,000,000	\$270,000,000

<sup>1</sup> Short-term range improvements are in a five-year time frame, medium-range improvements are in a five to ten year period, and long range improvements are in a greater than fifteen year period.

<sup>2</sup> Costs for projects that were completed between 2002 and 2010 were removed from the overall cost evaluation in Table 1-2.

## 1.2 Operation and Maintenance Cost Estimate Development

Operation and maintenance (O&M) costs were estimated for pumping, wastewater treatment, and land application for each alternative, as applicable. The energy costs for pumping were estimated by calculating assuming a pump efficiency, total dynamic head, and hours of operation per year using \$0.06/kW•hr. The pumping costs include pumping to land application sites or costs associated with regional pump stations pumping influent wastewater to a satellite treatment facility. Wastewater treatment O&M costs were based on a dollar per 1,000 gallons of treatment capacity. Different unit costs were used for different types of treatment technologies. For example, the O&M for an oxidation ditch is less than the O&M for a MBR facility. Land application O&M costs were based on a dollar per acre unit cost.

## 1.3 Capital Improvements Phasing

Each capital improvement recommendation was phased over a 20 year time period, if applicable. The first phase considers improvements that should be constructed in the very near term, or a one to two year time frame. The second phase considers improvements in a ten year time frame. The phasing was determined based on the growth needs in the urban services boundary, as discussed in TM 1 – *Population and Wastewater Flow Projections*.

## 1.4 Net Present Value

The net present value (NPV) analysis was evaluated for capital and O&M costs over a 20 year period. An interest rate of 4 percent and an annual O&M inflation rate of 2 percent were used. The NPV was amortized over the 20 year period with the calculation of the equivalent annual cost (EAC).

## 1.5 Summary of Recommended Alternative Cost

Table 1-2 provides a summary of the capital cost, O&M cost, 20 year EAC, NPV, and the cost of deferred collection system improvements.

**Table 1-2: Summary of Capital, Operation and Maintenance, Net Present Value, Equivalent Annual Cost, and Collection System Deferral Costs**

Alternative	Capital Cost		Annual Operation and Maintenance Cost			20-Year Equivalent Annual Cost	20-Year Net Present Value	Collection System Improvement Deferral Cost
	Treatment <sup>1</sup>	Piping <sup>2</sup>	Pumping	Treatment	Land Application			
<b>Alternative #1:</b> Expand Sinking Creek by 11 mgd with seasonal discharge to East Fork Stones River, spray/drip irrigation Jordan/Coleman Farms and acquired property.	\$124,350,000	\$77,400,000	\$200,000	\$2,410,000	\$700,000	\$14,690,000	\$199,600,000	\$0
<b>Alternative #8:</b> Expand Sinking Creek by 11 mgd with continuous 4 mgd discharge to West Fork Stones River; seasonal discharge to East Fork Stones River; spray/drip irrigation on Jordan/Coleman Farms and acquired property.	\$95,270,000	\$78,630,000	\$120,000	\$2,410,000	\$510,000	\$12,360,000	\$168,000,000	\$0
<b>Alternative #9:</b> Expand Sinking Creek by 11 mgd with seasonal discharge to East Fork Stones River and seasonal discharge to Cumberland River.	\$52,000,000	\$111,710,000	\$380,000	\$2,410,000	\$0	\$11,370,000	\$154,450,000	\$0
<b>Alternative #5:</b> Expand Sinking Creek by 8 mgd with seasonal discharge to East Fork Stones River; spray/drip irrigation on Jordan/Coleman Farms and acquired property; and construct a 3 mgd satellite facility (S3) with spray/drip irrigation on acquired property.	\$147,850,000	\$82,710,000	\$270,000	\$3,120,000	\$760,000	\$17,910,000	\$243,350,000	\$0

**Table 1-2: Summary of Capital, Operation and Maintenance, Net Present Value, Equivalent Annual Cost, and Collection System Deferral Costs**

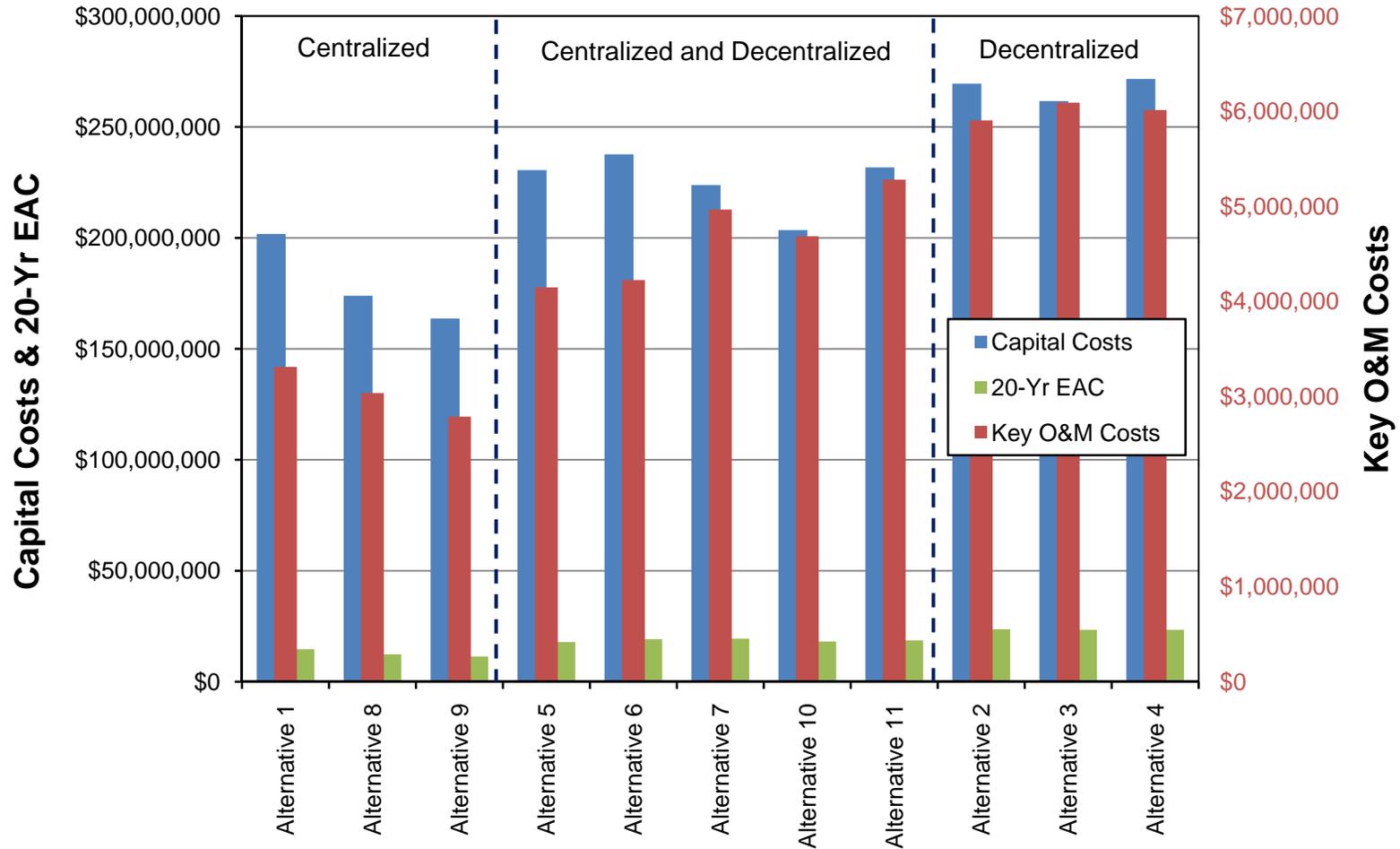
Alternative	Capital Cost		Annual Operation and Maintenance Cost			20-Year Equivalent Annual Cost	20-Year Net Present Value	Collection System Improvement Deferral Cost
	Treatment <sup>1</sup>	Piping <sup>2</sup>	Pumping	Treatment	Land Application			
<p><b>Alternative #6:</b> Expand Sinking Creek by 8 mgd with spray/drip irrigation on Jordan/Coleman Farms and acquired property; construct 5 mgd satellite facility (S6) with spray/drip irrigation on acquired property.</p>	\$157,760,000	\$79,910,000	\$240,000	\$3,120,000	\$870,000	\$19,150,000	\$260,270,000	\$3,600,000
<p><b>Alternative #7:</b> Expand Sinking Creek by 4 mgd with continuous 4 mgd discharge to West Fork Stones River; construct a 4 mgd satellite facility (S4) with spray/drip irrigation on Jordan/Coleman Farms/acquired property; and construct a 5 mgd satellite facility (S6) with spray/drip irrigation on acquired property.</p>	\$152,680,000	\$71,090,000	\$390,000	\$4,070,000	\$500,000	\$19,410,000	\$263,730,000	\$3,600,000
<p><b>Alternative #10:</b> Expand Sinking Creek by 4 mgd with continuous 4 mgd discharge to West Fork Stones River; construct 9 mgd satellite facility (S1) with spray/drip irrigation on Jordan/Coleman Farms and acquired property.</p>	\$147,080,000	\$58,410,000	\$130,000	\$4,070,000	\$490,000	\$18,270,000	\$248,260,000	\$24,000,000
<p><b>Alternative #11:</b> Expand Sinking Creek by 4 mgd with continuous 4 mgd discharge to West Fork Stones River; construct 9 mgd pump station at site S1 then pump to satellite facility S5; collect an additional 1.5 mgd at S5; construct a satellite facility (S5) with spray/drip irrigation on acquired property</p>	\$186,110,000	\$53,670,000	\$210,000	\$4,540,000	\$520,000	\$19,270,000	\$261,870,000	\$24,000,000

**Table 1-2: Summary of Capital, Operation and Maintenance, Net Present Value, Equivalent Annual Cost, and Collection System Deferral Costs**

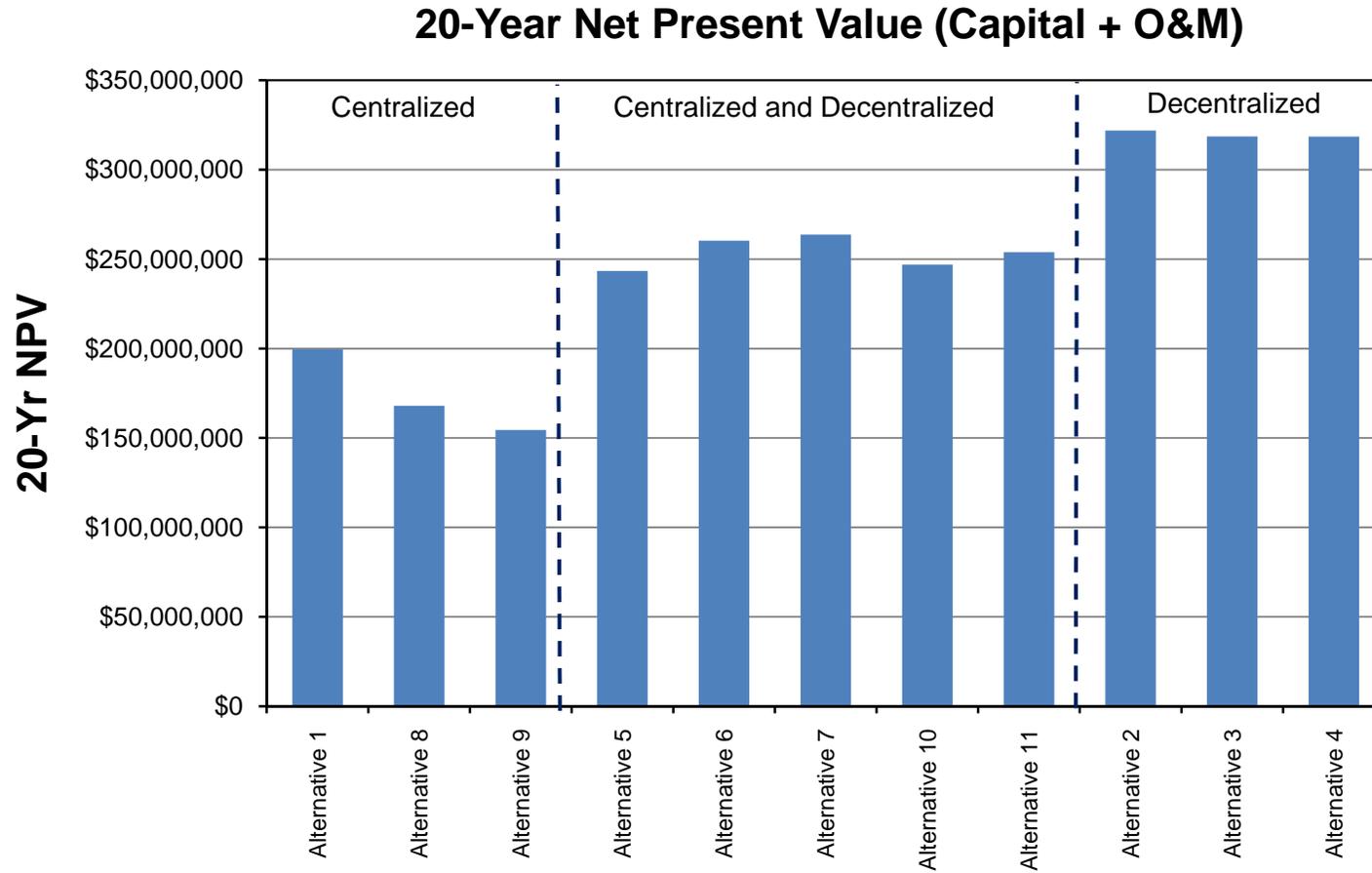
Alternative	Capital Cost		Annual Operation and Maintenance Cost			20-Year Equivalent Annual Cost	20-Year Net Present Value	Collection System Improvement Deferral Cost
	Treatment <sup>1</sup>	Piping <sup>2</sup>	Pumping	Treatment	Land Application			
Alternative #2: Construct 12 mgd satellite facility (S11) with spray/drip irrigation on acquired property.	\$192,620,000	\$60,870,000	\$280,000	\$5,020,000	\$600,000	\$22,460,000	\$305,230,000	\$24,000,000
Alternative #3: Construct 9 mgd satellite facility (S1) with spray/drip irrigation on acquired property; and construct 3 mgd satellite facility (S10) with spray/drip irrigation on acquired property.	\$209,260,000	\$56,430,000	\$270,000	\$5,020,000	\$800,000	\$23,640,000	\$321,300,000	\$28,130,000
Alternative #4: Construct 9 mgd satellite facility (S1) with spray/drip irrigation on acquired property; and construct a 3 mgd satellite facility (S8) with spray/drip irrigation on acquired property.	\$214,760,000	\$60,850,000	\$310,000	\$5,020,000	\$680,000	\$23,640,000	\$321,210,000	\$24,000,000

<sup>1</sup> Treatment includes wastewater capacity, land acquisition, land application, and wet weather storage reservoir costs.

<sup>2</sup> Piping includes infrastructure to route influent wastewater from the collection system to satellite facilities or treated effluent to land application effluent disposal.



**Figure 1-1: Graphical Summary of Capital Cost, Operation and Maintenance Costs, and 20 Year Equivalent Annual Cost for Eleven Recommended Alternatives**



**Figure 1-2: Graphical Summary of Net Present Value of Eleven Recommended Alternatives**

## **2. Capital Improvement Prioritization and Decision Analysis**

A prioritization and decision matrix was developed to focus on several of the more highly recommended alternatives out of the set of eleven total recommendations. A set of evaluation criteria was developed to reflect both cost and non-cost factors. Each recommended alternative may have distinct advantages or disadvantages that may not be reflected in an absolute cost value. The non-monetary factors may have a significant role in the decision making process.

The criteria used in this evaluation are comprised of the following:

- Capital cost
- Operation and maintenance cost
- Sufficient for long-term capacity needs
- Reuse of existing infrastructure
- Public perception
- Environmental impacts
- Regulatory issues

Two independent prioritization and decision evaluations were performed on the eleven recommended alternatives. Each prioritization analysis consisted of two different scoring methods. The evaluation criteria for each prioritization method were assigned a percentage out of 100 percentage points. A higher assigned percentage reflects an increased importance of the criteria. The criteria were weighted according to an individual score for each alternative, and then ranked according to score.

### **2.1 Summary of Highest Ranked Alternatives**

Out of the eleven recommended alternatives, six alternatives are ranked the highest in both independent prioritization evaluations. Additionally, both of the independent prioritization analyses scored three of the eleven alternatives as the lowest-ranked alternatives. The highest ranked alternatives were 1, 5, 6, 8, 9, and 11. The lowest ranked alternatives were 2, 3, and 4. Table 2-1 provides a summary of the preliminary rankings. It is suggested that MWSD work through the process of weighing evaluation criteria and ranking alternatives during the April workshop.

**Table 2-1: Summary of Alternatives Ranked According to Independent Prioritization and Decision Evaluations**

	<b>Centralized Only</b>	<b>Hybrid of Centralized / Decentralized</b>	<b>Decentralized Only</b>	<b>Preliminary Rank</b>
Alternative #1	X			High
Alternative #8	X			High
Alternative #9	X			High
Alternative #5		X		High
Alternative #6		X		High
Alternative #7		X		Medium
Alternative #10		X		Medium
Alternative #11		X		High
Alternative #2			X	Low
Alternative #3			X	Low
Alternative #4			X	Low

**NOTE: Draft TM7 as presented does not incorporate the findings, results, and preferences discussed during the Project Team’s March status meeting and April Board workshop. Results and recommendations will be incorporated into the final report.**

### 3. Funding Opportunities

The following sections describe funding opportunities on the state and federal level.

#### 3.1 State Grants

- The Fast Track Infrastructure Development Program (FIDP)
  - Administered by Tennessee Department Of Economic and Community Development.
  - Funding on an annual basis.
  - Local governments are eligible to receive funding for collection lines, treatment plants, and other improvements connected with the public wastewater supply.
  - [http://tennessee.gov/e cd/BD\\_FIDP.html](http://tennessee.gov/e cd/BD_FIDP.html).

#### 3.2 Federal Grants

- Community Development Block Grant Program (CDBG)
  - Funding is annually allocated to the State of Tennessee by the U.S. Department of Housing and Urban Development
  - Administered by Tennessee Department Of Economic and Community Development.
  - Local governments are eligible to receive funding for collection lines, treatment plants, and other improvements connected with public wastewater supply
  - Potential applicants for CDBG funds include cities and counties.
  - Must prove that project will create jobs and new capital investment.
  - Applicants may receive:
    - Non-distressed areas - \$500,000 per project.
    - Distressed areas - \$750,000 per project
  - [http://tennessee.gov/e cd/BD\\_CDBG\\_block\\_grant\\_program.html](http://tennessee.gov/e cd/BD_CDBG_block_grant_program.html).
- USDA Rural Development Program
  - [http://www.rurdev.usda.gov/Community\\_Development.html](http://www.rurdev.usda.gov/Community_Development.html).
  - <http://www.rurdev.usda.gov/UWP-dispdirectloansgrants.html>.
  - <http://www.rurdev.usda.gov/ne/wwlngrtfsht.pdf>.
  - To develop the capacity and ability of private, nonprofit community-based

housing and community development organizations, and low income rural communities to improve housing, community facilities, community and economic development projects in rural areas

- Economic Development Administration (EDA)
  - Provides funding to cities or counties for infrastructure required to support industry development in Tennessee.
  - Local governments are eligible to receive funding for collection lines, treatment plants, and other improvements connected with public wastewater supply.
  - Applicants may receive up to \$1,500,000 per project.
    - Required to contribute 30 to 50% of total project costs depending on area distress level.
    - <http://www.eda.gov/InvestmentsGrants/FFON.xml>

### 3.3 Federal Loans

- SRF: TDEC's Clean Water State Revolving Fund Loan Program:
  - <http://www.tennessee.gov/environment/srf/>.
  - Eligible projects: new construction or the upgrading/expansion of wastewater treatment plants, pump stations, force mains, collector sewers, interceptors, elimination of combined sewer overflows, and/or nonpoint source pollution remedies.
  - Most CWSRF loan recipients qualify for interest rates between 2 and 4 percent
  - Maximum loan term is the shorter of either 20 years or the design life of proposed facility
  - Program director contact info: Sam Gaddipatti (sam.gaddipatti@state.tn.us).
- Tennessee Local Development Authority
  - Provides loans to local governments for water and sewer capital improvement projects
  - <http://www.tn.gov/comptroller/bf/bftlda.htm>

#### **4. References**

East Tennessee Development District. Accessed January 2011. <http://www.discoveret.org/etdd/tdda.htm>

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