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Technical Memorandum

To: City of Franklin IWRP Team

From: CDM

Date: July 29, 2011

Subject: Integrated Water Resources Plan - Feasibility of Robinson Lake Flow Augmentation

1.0 Introduction

As part of the Integrated Water Resources Plan (IWRP) for the City of Franklin (City), Camp Dresser & McKee (CDM) has evaluated and developed a preliminary cost estimate for structural improvements to Robinson Lake for the purpose of augmenting seasonal low flows in the Harpeth River.

The Integrated Water Resources Plan Phase I Final Report (CDM, 2010) included an option to augment seasonal low flows in the Harpeth River by pulling water from Robinson Lake (the Lake) and discharging directly into the Harpeth River. The purpose of this memorandum is to determine the recommended flow rate and associated duration that the Lake can be drawn down to augment stream flow, provide a recommendation for the type of structure that can be used to draw down the Lake, and develop a conceptual opinion of probable cost to construct the structure.

2.0 Robinson Lake Dam Existing Conditions

CDM reviewed the following available information related to the existing Robinson Lake Dam:

- State of Tennessee Safe Dams Program website;
- USACE National Inventory of Dams (NID) website; and
- USGS topographic maps and aerial photos of the dam location.

Based upon this review, the existing dam is assumed to be an earth fill dam with a riprap/rock-lined spillway in the right abutment area discharging to the Harpeth River. The dam has a structural height of 22.5 feet and hydraulic height of 19 feet, with a storage capacity of 91 acre-feet at normal pool and 136 acre-feet at maximum pool. The downstream slope of the dam is covered with trees and other woody vegetation. The dam is identified on the Safe Dams database as being Significant or Low Hazard (HPC-2 or HPC-3). The storage capacity of Robinson Lake places the dam size category in SMALL. The dam was constructed in 1950 and it is not known if the dam has an existing low-level outlet pipe.

The NID database lists the dam as being owned by a private individual and is currently an unregulated structure. For this analysis, CDM assumed that this structure is currently unregulated because it is considered a "farm pond" as defined by Safe Dams. However, if this pond were to be used for any other purpose than providing water for agricultural, we assume it will become a regulated structure.

Proposed Improvements

The proposed improvements would raise normal pool in Robinson Lake to provide additional storage capacity upstream of the existing plant. The additional storage capacity would be obtained by raising the top of dam to provide an additional two feet of storage above existing normal pool and constructing a new intake in the lake with a drawdown elevation one foot below existing normal pool. The existing spillway would be replaced by a new emergency spillway to pass the regulated design storm (100-year or 1/3 Probable Maximum Precipitation (PMP), 6-hour duration) without overtopping the dam. The freeboard above the higher normal pool elevation (assumed to be at elevation 645 feet above mean sea level (MSL)) would need to contain the regulated design storm and run-up from wave action. It is assumed that the minimum freeboard height would be 4 feet resulting in a dam crest elevation of 649 feet MSL.

The additional storage volume and duration of flow augmentation were calculated based on the proposed structural improvements as shown in Table 1. The Harpeth River has a mean flow rate of 3.78 million gallons per day (5.85 cubic feet per second (cfs)) in September. The Lake has a surface area of approximately 11 acres (487,000 square feet) at the principal spillway, approximate elevation 645 feet. It is assumed for this evaluation that up to 1 foot of storage below the principal spillway and 2 feet of storage above the principle spillway can be used to augment stream flows, resulting in an available volume of 12.6 million gallons. **Table 1** summarizes the duration that stored water could be withdrawn from Robinson Lake based on varying flow rates (CDM, 2010). Robinson Lake, as a reservoir, is capable of providing flow to the Harpeth to raise the median low flow from 3.78 (5.85 cfs) to 6.46 MGD (10.0 cfs), which is the required minimum for City water withdrawals, for a period of 5.4 days.

Table 1 - Robinson Lake to Harpeth River Flow Augmentation Duration

Flow Rate (MGD)	% of Differential Flow ^[1]	Duration ^[2] (Days)
0.50	8%	28.8
1.00	48%	14.4
1.50	64%	9.6
2.00	80%	7.2
2.50	96%	5.8
2.68	100%	5.4

Notes:

- 1.) 2.68 MGD is difference between minimum river flow specified by the 2007 Aquatic Resource Alteration Permit of 6.46 MGD (10 cfs) and median low flow in September of 3.78 MGD (Phase I, 2010).
- 2.) Duration based on an available volume of 12.6 million gallons.

3.0 Conceptual Evaluation

The conceptual evaluation was based upon available data, which are extremely limited. The proposed modifications as described above should be technically feasible provided the following assumptions are valid:

- The existing crest of the dam provides adequate freeboard above the emergency spillway for the design storm.
- The existing dam is in good condition with adequate seepage measures and raising normal pool by 2 feet will not adversely impact the stability of the dam.
- The existing dam can be raised by 3 feet and still provide a crest width of 12 feet and stable upstream/downstream slopes (3H:1V preferred).
- Raising the crest height will require construction of a berm (less than 4 feet high) to tie in to existing grades at the abutments. There is adequate space to construct this berm with a crest width of at least 8 feet and upstream/downstream slopes of 3H:1V.
- Raising the normal pool and dam crest elevation will not result in flooding of adjacent properties/roads and will not require wetland or stream restoration.

The modifications proposed would require easement from the private owner and conversion of the dam to a regulated structure subject to Safe Dams requirements. A complete set of design documents prepared by registered professional engineer experienced in dam design will be

required for the permit through the Tennessee Safe Dams Program. The scope of work may include, but not be limited to, the following:

- Complete subsurface exploration and laboratory testing program;
- Seepage and stability analyses for the existing and proposed structures;
- Hydrologic and Hydraulic analyses to assess peak stages and size emergency spillway to meet freeboard requirements;
- Evaluation of any existing low-level outlet or other pipes through the dam;
- Permit Application for Safe Dams;
- Contract Documents for the Dam Modifications; and
- Construction observation by the Engineer of Record to satisfy Safe Dams post-construction certification.

Construction of the proposed modifications would likely include:

- Select fill to raise earthen embankment and construct abutment berms;
- Additional seepage control measures;
- Replacement of the low-level outlet (if needed);
- Removal of trees and other woody vegetation from the existing dam;
- Vegetation and riprap stabilization of the regraded dam slopes;
- New intake; and
- New emergency spillway channel.

4.0 Conceptual Opinion of Probable Cost

The conceptual opinion of probable cost is detailed in **Table 2** below, with a total of \$990,000.

Table 2 - Siphon and Dam Installation Cost Estimate

Item	Quantity	Unit Price	Estimated Cost
Gated Intake Structure	\$100,000	\$100,000	\$100,000
Lake Dewatering and Bypass	\$25,000	\$25,000	\$25,000
Earthen Fill	\$20,000	\$20,000	\$20,000
Structural Spillway	\$100,000	\$100,000	\$100,000
Tree/Vegetation Removal	\$25,000	\$25,000	\$25,000
Seepage/Slope Stabilization	\$40,000	\$40,000	\$40,000
Engineering	\$200,000	\$200,000	\$200,000
Permitting	\$50,000	\$50,000	\$50,000
Property Easement	\$100,000	\$100,000	\$100,000
Subtotal =			\$660,000
50% Contingency =			\$330,000
Total =			\$990,000

Based on this total estimated cost, the unit cost associated with augmenting Harpeth River seasonal low flows in the City of Franklin is \$78,570 per million gallons.

5.0 Conclusions and Recommendations

Based on the above evaluation, alterations to the lake to augment streamflows would require a significant investment of nearly \$1 million and will provide only five additional days of flow withdrawal capability at the plant. The benefits of this project do not appear to justify the cost. Before further consideration, this project should be evaluated in comparison to the cost vs. benefits of other projects being considered as part of the Integrated Water Resources Plan.

6.0 Conclusions and Recommendations

Camp Dresser and McKee (2010). Integrated Water Resources Plan Phase I Final Report, City of Franklin. Retrieved from: <http://www.franklin-gov.com/index.aspx?page=729>