Tomahawk Creek WWTP
Process Improvements Pre-Design Study – 2011 Update
Executive Summary

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Introduction
The Tomahawk Creek Wastewater Treatment Plant (WWTP) treats wastewater from the Tomahawk Creek watershed, the Indian Creek watershed downstream of the Douglas L. Smith Middle Basin WWTP (Lower Indian Creek), and the Dykes Branch sub-watershed. The WWTP treats only a portion of the flow arriving at the plant, with the balance being diverted around the plant to the Linking Interceptor which carries it to Kansas City, Missouri (KCMO) for ultimate treatment at their Blue River WWTP.

In 2006, the Tomahawk Creek WWTP came under regulatory scrutiny due to difficulties in meeting its carbonaceous biological oxygen demand (CBOD) limits and an Administrative Order of Compliance was issued by the Kansas Department of Health and Environment (KDHE). In addition, a provision of the plant’s National Pollutant Discharge Elimination System (NPDES) permit, issued in 2005, required Johnson County Wastewater (JCW) to conduct a study by October 1, 2008 to assess the cost and feasibility for incorporating nutrient removal under KDHE’s Nutrient Reduction Plan. To satisfy these requirements, JCW commissioned HDR/CH2M HILL to prepare the “Tomahawk Creek WWTP Process Improvements Pre-Design Study.”

The 2006 Study concluded that, based on the information available at the time, the best approach would be to upgrade the Tomahawk Creek plant to treat 10 mgd, and send the balance of flow to KCMO.

However, due to uncertainty with future KCMO rate increases and the timing for incorporation of nutrient removal into the NPDES permit, JCW decided to proceed with an interim project to address the CBOD compliance issue, and revisit the long term improvements at such time as more definitive information was made available with respect to the above mentioned uncertainties. The Interim Process Improvements Project, which included automated trickling filter drives, chemically enhanced primary treatment (CEPT) for dry weather flows, sludge conveyance facilities, and various flow control improvements, was undertaken and completed in 2008.
Since that time, a number of developments have occurred:

- KCMO has completed its Overflow Control Plan (OCP) and obtained approval from Missouri Department of Natural Resources (MDNR), USEPA, and the Department of Justice. Although several details are not finalized, the level and timing of the anticipated rate increases for conveyance and treatment of JCW wastewater flows are now better understood.

- On September 30, 2009, KDHE placed the draft NPDES permit renewal for the Tomahawk Creek WWTP on public notice. On November 2, 2009, USEPA issued an objection to the permit, requesting specifically that the continued practice of conveying wet weather flows to KCMO be prohibited due to downstream capacity limitations and associated Sanitary Sewer Overflows (SSO’s) in KCMO’s system. KDHE subsequently advised USEPA that it could not issue the permit with the requested modification in that it would leave JCW with no viable alternative nor time to evaluate and implement one. The matter remains under ongoing negotiations between JCW and these agencies.

- The draft permit stipulates that discharges from the wet weather lagoon be classified and reported as bypasses rather than permitted discharges (as had been the case prior to this reissuance).

This updated Pre-Design Study re-evaluates the various treatment alternatives and capacity scenarios in light of the above more current information and regulatory perspectives.

An aerial view of the Tomahawk Creek WWTP is show in Figure ES-1.

**Figure ES-1**

**Tomahawk Creek WWTP**
Technical Memorandum No. 1 – Basis of Analysis

Technical Memorandum (TM) No. 1 – Basis of Analysis defines the data, assumptions, and existing conditions on which the subsequent evaluations are based. The specific information presented in TM 1 includes:

- Target Effluent Limits
- Performance of Existing WWTP
- Projected Flows and Loads
- Economic Analysis Assumptions (including KCMO cost/rate assumptions)
- Summary of Existing Facilities

Note: Portions of the information presented in TM No. 1 were subsequently updated in TM No. 6, specifically the effluent limits and the KCMO sewer rate increase schedule.

Technical Memorandum No. 2 – Alternatives Identification and Development

Technical Memorandum No. 2 presents descriptive summaries, flow schematics, advantages/disadvantages, unit process sizing, and preliminary site layouts and hydraulic profiles of several dry weather treatment alternatives that were identified as worthy of consideration in Workshop No. 1 (Kickoff Workshop). This preliminary list of alternatives was then screened using qualitative screening criteria, to create a “short list” of the four most viable alternatives for further detailed evaluation.

Two plant sizes were considered, 10 mgd which is the current permitted capacity of the facility, and 19 mgd which is the entire flow from the tributary watershed. Each was evaluated under two discharge limit scenarios: Biological Nutrient Removal (BNR) and Limits of Technology (LOT), both of which are further defined under the KDHE Nutrient Reduction Plan.

Note: Portions of the information presented in TM No. 2 were subsequently updated in TM No. 6. Specifically, the treatment processes were modified to reflect updated effluent limits.

Technical Memorandum No. 3 – Alternatives Selection – Dry Weather Treatment

Technical Memorandum No. 3 presents the results of the detailed analysis of the four dry weather treatment alternatives retained in the screening process conducted in TM No. 2. In addition to Life Cycle Costs, Greenhouse Gas emissions were calculated for each alternative, and these, along with other non-economic criteria, were combined with the Life Cycle Cost analysis results into a “Cost per Benefit” comparison. The comparison showed that, while Alternative C1, Three-Stage Biological Nutrient Removal – Activated Sludge, was the most cost effective from a Life Cycle Cost standpoint, Alternative C4, Moving Bed Bio-Reactor (MBBR) followed by Dissolved Air Flotation (DAF), had the lowest overall Cost per Benefit score. This was due in part to it requiring less space, a premium in light of the restricted site at Tomahawk, which is
surrounded on three sides by floodway. However, at the time, C4 was still a developing technology, so it was decided to proceed with the analysis based on C1 and revisit C4 at a later date prior to making a final decision on the choice of treatment process.

TM No. 3 also included an evaluation and condition assessment of existing plant components that could be retained as part of the upgrade.

Note: Portions of the information presented in TM No. 3 were subsequently updated in TM No. 6. Specifically, the treatment processes and comparative analyses were modified to reflect the updated effluent limits.

Technical Memorandum No. 4 – Wet Weather Flow Evaluation and Alternative Definition

Technical Memorandum No. 4 documents the criteria and assumptions used in the wet weather flow analysis for the Tomahawk Creek WWTP, and identifies reasonable alternatives for accommodating these flows. Specifically, TM 4 includes:

- An interpretation and analysis of the assumptions, design wet weather event, flows, and sizing of facilities incorporated by KCMO into its OCP which currently contains provisions to accept and store wet weather flows from Tomahawk Creek at KCMO’s 87th Street Pump Station.

- Definition of the design wet weather event at the Tomahawk Creek WWTP based on JCW criteria, and its implications on sizing of facilities such as storage and peak flow treatment.

- The Tomahawk criteria were then reconciled with the KCMO OCP criteria to the greatest extent possible to allow for an “apples-to-apples” comparison between the two.

A total of eight wet weather management strategies were identified.

19 mgd Dry Weather Plant
  - 19.1 – discharge wet weather flows through an Auxiliary Treatment Facility (ATF)
  - 19.2 – convey wet weather flow to KCMO storage
  - 19.3 – store wet weather flow at Tomahawk Creek

10 mgd Dry Weather Plant
  - 10.1 – discharge wet weather flows through an ATF
  - 10.2 – convey wet weather flow to KCMO storage

No Dry Weather Plant
  - 0.1 – discharge wet weather flows through an ATF
  - 0.2 – convey wet weather flow to KCMO storage
  - 0.3 – store wet weather flow at Tomahawk Creek

All of these alternatives included maximizing use of Tomahawk Creek’s existing storage lagoon. It was noted that the lagoon berms would need to be raised several feet to provide 100 year flood protection.
Technical Memorandum No. 5 – Wet Weather Flow Alternatives Selection

Technical Memorandum No. 5 presents the comparative life cycle cost analysis for the eight wet weather flow alternatives defined in TM No. 4. In developing costs for constructing storage at the Tomahawk Creek WWTP site, three storage methods were evaluated:

- Above ground storage tanks
- Shallow underground storage
- Deep tunnel storage

As storage of wet weather flows required additional facilities beyond the existing storage lagoon, it was concluded that shallow underground storage was preferred in that it didn’t require above ground facilities at a sensitive location in close proximity to residential areas, and was less expensive than deep tunnel storage. It was noted, however, that a probable location for the storage was at Johnson County-owned and City of Leawood-owned soccer fields to the north and east of the treatment plant. These sites would involve considerable disruption during construction that would have to be mitigated, but could ultimately be restored to their original use above the underlying storage facilities.

The costs for storage at Tomahawk derived in this evaluation differed somewhat from those used by KCMO in their OCP for storage at 87th Street. The JCW derived estimates were used in the cost comparison for storage at both locations to provide an “apples-to-apples” comparison.

A comparative Life Cycle Cost analysis was conducted for the eight alternatives. The analysis included only capital and O&M costs at the THC site. Consideration of KCMO rates and charges was deferred to TM No. 6 in which a combined analysis of the wet/dry facilities was preformed.

Technical Memorandum No. 6 – Combined Dry and Wet Weather Alternative Selection

Introduction:

Technical Memorandum No. 6 presents the results of the combined Life Cycle Cost evaluation for the preferred 10 mgd and 19 mgd dry weather alternatives, and also the 0 mgd (no WWTP at THC) alternative, in conjunction with each of the corresponding wet weather alternatives. Life Cycle Costs, non-economic criteria scoring, and Cost-per-Benefit Scores are evaluated and compared for each combined alternative. The results of the combined dry and wet weather alternatives comparison will determine the preferred overall capacity and treatment scheme.

Dry Weather Analysis:

In TM No. 6, the regulatory information originally presented in TM No. 1 was updated. This included the likely impact of the Kansas Anti-Degradation Policy on the 19 mgd alternative, since it involved increasing capacity from the currently permitted level. This would result in lower effluent limits for several parameters. In addition, in a meeting with KDHE, additional
water quality concerns came to light and it was determined that phosphorus limits would need to be lower than initially assumed.

As a result of this updated regulatory information, the process scheme, cost estimates, and Life Cycle Cost (LCC) for the dry weather process (Alternative C1 – BNR/Activated Sludge) from TM No. 3 were revised. In addition, treatment components that were not included in the prior comparative analysis because they were common to all alternatives were added into the totals.

**Wet Weather Analysis:**

The wet weather alternatives and cost information from TM No. 5 were summarized. It was pointed out that Auxiliary Treatment Facilities (ATF’s) for wet weather treatment are currently not considered approvable by USEPA Region 7; however, this policy is currently under review. This element of risk must be kept in mind when comparing wet weather alternatives.

**Combined Dry and Wet Weather Analysis:**

TM No. 6 included a detailed discussion of environmental permitting requirements for the project, including floodplain, wetlands, wildlife habitat, and the City of Leawood. It was pointed out that preliminary flood modeling has revealed that there may be a 100-year flood elevation rise as a result of this project, and this would trigger a Conditional Letter of Map Review (CLOMR), a fairly lengthy process involving the City of Leawood and the Federal Emergency Management Agency (FEMA). This finding reinforces the prior conclusion that a “small footprint” technology that would help minimize flood elevation impacts may be desirable.

The prior separate cost analyses of the dry and wet weather alternatives in TM No. 3 and TM No. 5 did not include KCMO treatment costs for those alternatives in which all or a portion of the flow was being treated by KCMO. These were added in to the combined dry/wet analysis in TM No. 6. Prior to completing the analysis, the KCMO schedule of rate increases was updated based on meetings with KCMO that took place after the schedule was originally presented in TM No. 1. KCMO advised that the proposed rates were “all inclusive”, i.e., they included conveyance, storage, and treatment. However, in reviewing the storage facility costs and the annual payments from JCW to KCMO, it was discovered that this assumption would not be valid for Alternative 19.2, in which JCW sent only wet weather flow to KCMO which resulted in a large KCMO storage facility but very small JCW annual payments. Therefore, Alternative 19.2 was modified to include a capital cost component for the KCMO storage.

Figure ES-2 presents the results of the LCC analysis for the eight combined dry/wet alternatives.
In addition to LCC, an annual cash flow analysis was completed in order to compare the required annual cash allocation between alternatives. As the name implies, this was an effort to identify the actual cash disbursements that would need to occur each year to make bond principal and interest payments, pay O&M expenses, etc. The analysis was completed for the following three alternatives; Alternative 19.1, Alternative 10.2, and Alternative 0.2. Figure ES-3 presents the annual cash outlays through 2039 for these three alternatives based on the 2020 start date used in this study. This figure also presents four key events, or “triggers”, that affect the timing of JCW’s decisions:

- 2015 – The earliest date that new ammonia criteria would be added to the discharge permit and require an update to the existing THC WWTP.
- 2016 – Expiration of JCW contract with KCMO.
- 2018 – The earliest date that compliance with the new ammonia criteria would go into effect.
- 2019 – Per the KCMO OCP, design of the final phase of storage at the 87th Street Pump Station will begin in 2020, with the completion of construction in 2024. JCW would need to make a decision on participation in KCMO storage before design begins.
Figure ES-3 Annual Cash Outlays for 2020 Start Date

Note: Annual cash outlays are shown in dollar values corresponding to the year in which they occur (i.e. cash outlays for Year 2020 are shown in 2020 Dollars).
Finally, a break even analysis was conducted to calculate what percentage reduction in the KCMO revenue requirement/rate increase schedule would be required in order for the 10 mgd or 0 mgd alternatives to break even with Alternative 19.1. The results of this analysis is summarized below in Table ES-1 and shown graphically in Figure ES-4.

**TABLE ES-1**
*Break Even Rate Increases*

<table>
<thead>
<tr>
<th>Year</th>
<th>Total KCMO Projected Revenue Requirement Increase (%)</th>
<th>KCMO Rate Increase Required to Break Even with NPV of Alternative 19.1</th>
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<tr>
<td></td>
<td>Alt. 10.1</td>
<td>Alt. 10.2</td>
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<tr>
<td>2012</td>
<td>9.9%</td>
<td>9.9%</td>
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<tr>
<td>2013</td>
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<tr>
<td>2040</td>
<td>4.6%</td>
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Figure ES-4
Total Net Present Value (NPV) Summary and Break Even Chart

Assumptions:
- 1.8% Annual Inflation Rate
- 4.6% Total Annual Rate Increases for Years 2022 - 2040
- 97 MGD Linking Interceptor Capacity
- JCW Storage Sizing and Allocation Methodology
- KCMO Storage Cost is Included in the Rates for all alternatives except 19.2.
- See Table ES-1 for Detailed Rate Schedules

* % reduction in KCMO revenue increases required to break even with Alternative 19.1.
** Alternative cannot break even with Alt. 19.1 by reducing the revenue requirement rate increases from Years 2013 - 2021. The annual rate increase of 4.6% used for Years 2022 - 2040 and/or the current KCMO rate would need to be reduced in order for alternative to break even.
Green House Gas Emissions were calculated and were applied along with other appropriate criteria in a non-economic scoring process. These were then combined with Net Present Value (NPV) figures from the LCC analysis to obtain a Cost-per-Benefit score. The results of this effort are presented in Figure ES-5.

Figure ES-5
Weighted Benefits and Cost-Benefit Scores of Combined Alternatives

Selection of the Preferred Alternative:

Based on the results of the Life Cycle Cost Analysis, the Annual Cash Flow Analysis, and the Non-Economic Analysis and Cost-Per-Benefit Ranking, the 19 mgd dry weather capacity set of alternatives is preferred. Alternative 19.1 has the lowest NPV, and second lowest cost-per-benefit score among the 19-mgd alternatives and is the recommended alternative for implementation. The total capital cost for Alternative 19.1, expressed in 2011 dollars, is $242 million. The total capital cost expressed in 2013 dollars is $251 million. A preliminary layout of the preferred alternative is presented in Figure ES-6.
A recommended schedule for implementing this project is shown in Figure ES-7.

Figure ES-7
Tomahawk Creek WWTP – Project Implementation Schedule

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It is recommended that the implementation of the project begin with a Project Definition Phase which addresses the following:

- Continue discussion with KCMO in an effort to optimize the overall plan.
- Finalize regulatory negotiations with respect to final dry weather treatment discharge limits and the acceptability of an Auxiliary Treatment Facility for the wet weather flow.
- Re-evaluate and refine design flows to the plant.
- Perform a technology review to identify viable small footprint technologies and assess their impact on flood elevations in an effort to identify the best choice of site specific technology.
- Once a technology has been selected and a preliminary layout established, begin the floodplain permitting process.