ENGINEERING ISSUES - TECHNICAL REPORT

INTRODUCTION

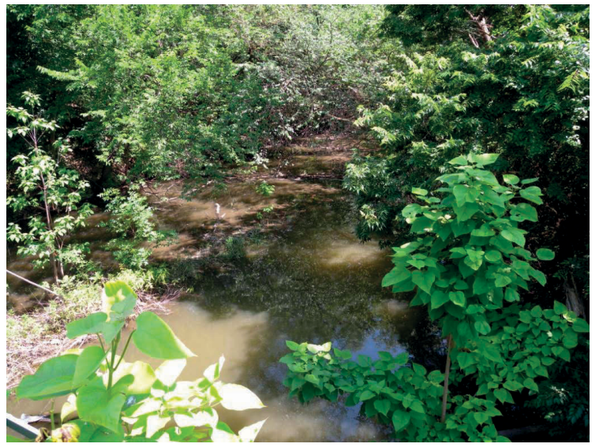
In the 'Discovery' component of Phase One – Public Outreach and Awareness, WWE determined that there was reason for optimism in addressing the technical issues associated with returning flows to the Old Channel of the Smoky Hill River. Technical issues identified at that time, to further determine feasibility of returning flows to the Old Channel, defined many of the issues to be addressed in the Phase Two – Master Plan. Additionally, as planning work progressed through early framework planning, alternatives and the final master plan, it was essential to have the technical engineering support necessary to keep pace with each of those steps in the evolution of the Master Plan.

While planning issues were the primary focus of the MAC and DSW, and technical issues were the purview of the TAC and WWE, an iterative process allowing the implications of each to influence one another was essential to the final Master Plan. During the Phase Two – Master Plan process, DSW and WWE met on a weekly basis to identify and work through issues arising from specific planning and design alternatives that were proposed to meet goals and objectives identified by public input and directed by the MAC. In recognition of the importance of that planning and engineering dialogue, the MAC and TAC met jointly throughout Phase Two. Following joint session meetings, the TAC members held additional sessions, to work further through technical issues as the Master Plan progressed.

In addition to providing technical support for proposed planning alternatives and proposed improvements, WWE and the TAC worked intensively to explore and resolve the technical engineering feasibility associated with basic hydrological, ecological, channel engineering and water quality issues that apply to restoring flows to the Old Channel, regardless of specific proposed planning and design elements.

The final technical report prepared by Wright Water Engineers addressing Smoky Hill River Renewal Master Plan Engineering Issues is presented on the following pages as a comprehensive summary to the work prepared by WWE as coordinated with the TAC and project team. The Engineering Issues Appendices are included in Section 4 – Appendix of this Master Plan Document.

Smoky Hill River Renewal Master Plan Engineering Issues



WWE

Wright Water Engineers, Inc.

August 11, 2010

101-002.000

Smoky Hill River Renewal Master Plan Engineering Issues

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August 11, 2010

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Smoky Hill River Renewal Master Plan
Engineering Issues

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One Dam Alternative – Profile and Cross Sections (4 drawings)

Note: Appendices are provided in separate notebook.

1.0 BACKGROUND AND OVERVIEW

Successful river restoration projects are based on sound engineering analysis of wide-ranging subjects, such as physical and legal water supply, water quality, channel design, regulatory compliance, public safety and many others. Section 1 of this report provides an introduction to the key engineering issues that were addressed by Wright Water Engineers, Inc. (WWE)[1] in the Old Smoky Hill River Renewal Master Plan, including:

- Water Rights and Streamflow Analysis
- Potential Drought Period Operations
- Navigation
- Sediment Management
- Channel Bed Hydraulic Conductivity
- Sediment Characterization Sampling and Brownfields Inventory Survey
- Dam Alternatives
- Channel Characteristics
- Bridge and Culvert Replacement
- Floodplain
- Utilities
- Disturbance Extent
- Water Quality
- City, State and Federal Permits and Regulatory Issues
- Operation and Maintenance Activities and Costs
- Capital Cost Projections

Each of these topics is briefly introduced below, with more detailed discussion in Sections 2 through 17. Table 1–1 summarizes proposed key characteristics of the restored Old River Channel.

- *Water Rights and Streamflow Analysis (Section 2)*—One of the major areas of emphasis in the Master Plan was water rights—that is, securing the legal right to divert flows from the bypass channel into the Old River Channel through the city. As of August, 2010 (the date of this Master Plan), draft water rights permits have been obtained from the Kansas Division of Water Resources (DWR). These draft permits, provided in Appendix 2, have yet to be reviewed and approved by the Chief Engineer, whose approval is required.

[1] The WWE staff who prepared this report are Patricia Flood, P.E., Kenneth Wright, P.E., Jonathan Jones, P.E., Samantha Clark, Noah Greenberg, and Suzanne McNamara (report production).

Comprehensive statistical analyses of historic stream flow data in the Smoky Hill River at the Mentor Gage were conducted in association with this Master Plan and the water rights application. These studies were conducted by the City's water rights consultant, HDR, as well as by WWE and City Utilities staff. The statistical analyses conducted by these three entities are consistent and demonstrate that more than 80 percent of the time on an annual basis, there will be flow available at the confluence of the bypass channel and the Old River Channel for diversion into the Old River Channel. Graphs in Section 2 demonstrate the frequency and magnitude of flow availability.

Two aspects of restoring flow are particularly important to bear in mind, as discussed in Sections 3 and 5: (1) During drought years like 2005 and 2006, although there will be times when diversions into the Old River Channel can be made, there will also be extended periods when it will not be feasible to make diversions, and this was an important design consideration in the Master Plan, and (2) older residents speak of "restoring the flow in the river," yet it must be recognized that the maximum rate of diversion from the Bypass Channel into the restored river channel of 100 cubic feet per second (cfs) is far smaller than historic peak flows in the Smoky Hill River at the confluence of the Bypass Channel and the Old River Channel. This is because 100 cfs is the maximum inflow rate through the 54-inch diameter inlet pipe beneath the levee at Bill Burke Park, and, for many reasons discussed in Section 5, it would not be feasible to increase this flow rate, such as by constructing additional pipes beneath the levee.

- *Potential Drought Period Operations (Section 3)*—Various alternatives are available to enhance supplies during dry years, including, for example: (1) creating ponded water reaches in the restored channel, with permanent and moveable (inflatable) dams; (2) Lakewood Park Lake pumpback recirculation system; (3) utilizing golf course or municipal wells for short periods and limited volumes; (4) purchasing senior water rights; (5) utilizing treated wastewater effluent as a pumpback system, either into the restored river channel or into the Bypass Channel immediately downstream from the diversion into the Old Channel (thereby enabling larger diversions into the Old River Channel); and (6) utilizing existing or constructing new storage facilities.

- *Navigation (Section 4)*—This topic addresses how to provide for recreational boating (for example, canoeing and kayaking) and water taxis on the restored channel and how to assure that there will be adequate water in selected reaches of the channel for boating and other recreation during drought conditions.

- *Sediment Management (Section 5)*—This subject is analyzed in detail in the Master Plan because:

  - Previous planning efforts to restore the Old River Channel identified elevated sediment levels as a major problem.

  - In interviews, Public Works staff and others identified sediment management as a significant problem.

  - Data from sediment studies in the Smoky Hill River indicated that the sediment load is frequently high.

The Master Plan provides three alternatives for sediment management, and compares them on the basis of wide-ranging factors. The Master Plan recommends a multifaceted control strategy.

The subject of sediment management relates closely to water quality and the visual effect of the channel, regulatory requirements (including compliance with section 404 of the Federal Clean Water Act), and to the project's long-term operation and maintenance costs. Conservative estimates of initial sediment removal and annual sediment accumulation and removal frequency were developed for various alternatives.

- *Channel Bed Hydraulic Conductivity (Infiltration Losses) (Section 6)*—An important subject related to both water rights and maintaining water in the channel during periods of drought is infiltration losses through the channel bed. WWE, working with HDR, City staff and KAW Valley Engineering (KAW), analyzed this subject, including researching historic geologic and hydrogeologic reports/data, conducting infiltration tests on channel sediment samples, analyzing groundwater fluctuation data from the City's well field, and related topics. All of this work indicates that infiltration losses will be a small percentage of total diversions—this fact will be especially important in dry years when diversion potential is limited.

- *Sediment Characterization Sampling and Brownfields Inventory Survey (Section 7)*—The recommended plan envisions the removal and disposal (or offsite reuse) of about 65,000 cubic yards (CY) of sediment that has accumulated in the channel over time. If channel sediments contain chemical compounds that exceed numeric limits defined by the Kansas Department of Health and Environment (KDHE) (in the State's hazardous waste regulations), sediment excavation and disposal costs would be much more expensive than if none of the applicable KDHE thresholds are exceeded. As described herein, composite sediment samples collected at many locations were analyzed by Continental Analytic Services, Inc. (CAS). In all cases, the concentrations of applicable chemicals in the sediment samples were significantly less than the KDHE standards, indicating that no special disposal requirements apply.

  Section 7 also summarizes the results of a Brownfields Inventory Survey conducted by Seagull Environmental Technologies, Inc., which provides additional information on potential pollutants present in the channel.

- *Dam Alternatives (Section 8)*—As part of this Master Plan, an engineering analysis of the existing Western Star Mill Dam was conducted. With some improvements, this dam can be utilized as it is, or it could be reduced in height to accommodate a second, upstream dam (the recommended alternative in the Master Plan includes a dam at the Midway), which would create two ponded areas rather than one. The advantages, disadvantages and comparative costs of one dam versus two dams were evaluated and are discussed herein. The public expressed a preference for the Master Plan alternative involving two dams, and this is the recommended long-term plan; however, the initial phase of the

project would rely on the existing single dam. Another alternative was briefly evaluated—removing the Western Star Mill Dam and having no dams in the channel. This was ruled out for reasons related to drought management, aesthetics, boating and others.

- *Channel Characteristics (Section 9)*—Design Studios West (DSW) and WWE evaluated the advantages, disadvantages and costs of different channel cross sections, relative to width, depth, geometry, lining, edge treatment, sediment accumulation, sideslopes, etc. As shown in the engineering drawings (drawings at end of report), various channel cross sections will apply, depending upon location. It is important to recognize that in all cross sections (with the exception of dam overflows and during high stormwater runoff), for a typical flow rate of 40 cfs with no storm runoff, in-channel velocities will be slow, at less than 1 ft/sec. The channel will normally have more of a ponded" appearance than the look of free flow." As engineering design becomes more detailed, the City may decide to deepen the channel (from the typical 3.5-ft depth presented herein) to reduce the frequency of sediment removal.

- *Bridge and Culvert Replacement (Section 10)*—There are 13 bridges and culverts across the Old River Channel over its approximately seven miles from inlet to outlet. The Master Plan recommends that four of these structures be replaced on a higher priority to facilitate boating and other recreational use of the channel, with other replacements in later phases. Many alternative bridge and culvert scenarios were considered, as described herein.

- *Floodplain (Section 11)*—Based on conceptual hydraulic evaluation, the channel improvements called for in the Master Plan will not increase the 100-year flood elevation in the Old River Channel. The current official regulatory floodplain map for the Old River Channel was published in 1986. This regulatory floodplain was recently re-delineated by the URS Corporation for the Federal Emergency Management Agency (FEMA), but the mapping is preliminary as of August, 2010. An important limitation of this mapping is that it was based on Approximate" (Zone A) rather than a Detailed" (Zone AE) study. As project planning and design proceed, WWE recommends that a detailed floodplain study be prepared to provide a proper basis for determining changes in the floodplain due to proposed impoundments and for detailed hydraulic design. The channel improvements are likely to trigger the need for a Letter of Map Revision" from FEMA.

- *Utilities (Section 12)*—Working closely with City staff, WWE located major buried and above-ground utilities. Utility relocation costs have been initially accounted for in the Master Plan.

- *Disturbance Extent (Section 13)*—The Master Plan indicates that disturbances (i.e., grading) of the channel bed and banks will be managed to reasonably maintain bird and wildlife habitat, make the existing channel compatible with anticipated improvements on a reach-by-reach basis, and, in general, limit channel excavation to the minimum extent reasonable to meet Master Plan needs.

- *Water Quality (Section 14)*—Wide-ranging water quality considerations were evaluated during the Master Plan. For example, water quality data were obtained and analyzed for the Smoky Hill River immediately upstream and downstream from the city. Discussions were conducted with KDHE staff to define constituents present in the river that are of concern to the State, and which are being or will likely be regulated under the total maximum daily load (TMDL) program administered by KDHE. Potential water quality problems in the channel were evaluated, including, for example, algae, turbidity and suspended solids, bacterial levels and impact on water-based recreation, trash/debris accumulation, aquatic weeds, geese, mosquitoes, odor and others.

- *Regulatory Requirements and Permitting (Section 15)*—Wide-ranging permits will need to be secured to implement improvements called for in the Master Plan. For example, to disturb wetlands in the channel bottom and waters of the United States," it will be necessary for the City to obtain a 404 permit" from the U.S. Army Corps of Engineers, which regulates dredge and fill in wetlands and waters of the United States. As another example, potential impacts to threatened and endangered species will need to be accounted for as planning proceeds. The various local, state and federal permits that will be required are discussed. Interviews with regulators were conducted to define likely key issues and steps that will need to be taken to secure the permits. Based on present knowledge, securing a 404 permit will be the most challenging regulatory requirement.

- *Operations and Maintenance (Section 16)*—Along with restoring the Old River Channel comes a significant long-term commitment for operations and maintenance involving such activities as sediment removal, trash and debris cleanup, graffiti removal and repainting, regular inspections and maintenance of hydraulic structures such as gates, valves, dams and other features, and other activities of this kind. Section 16 describes the anticipated operation and maintenance activities and frequencies associated with the plan, and provides cost projections.

- *Capital Cost Projections (Section 17)*—Section 17 presents capital costs for project design and construction and related activities for the recommended alternative prepared by WWE and DSW.

All of these subjects were evaluated at a conceptual level. Design characteristics such as lengths, widths, depths, elevations, slopes, capacities, costs and others will be refined as planning and design move forward.

1.1 Approach

To evaluate the key engineering issues described above, WWE adopted the following approach:

1. Built upon the initial analysis performed by DSW and WWE for the Friends of the River (FOR). This work included most of the topics ultimately addressed in the Master Plan, but in less detail.

2. Regularly communicated and met with the overall project planner, DSW, including the development of engineering support for the many drawings provided within this Master

Plan. Many alternatives were discussed and compared/contrasted in regular meetings, such as channel cross sections, channel dimensions, ponding alternatives, sediment removal locations and quantities, and others, as described in the following sections.

3. Regularly communicated with staff from City of Salina Utilities and Public Works Departments on wide-ranging issues, and had regular teleconferences and meetings throughout the course of the project with them.

4. Received periodic review and input from the "Technical Advisory Committee" (TAC) and "Infrastructure Advisory Team" (IAT).

5. Retained the following companies to assist with special subjects:

   - Olsson Associates (Kansas City, Kansas)—Dam evaluation and general permitting requirements.

   - KAW Valley Engineering—Channel sediment sample collection and testing for infiltration, and collecting sediment samples for constituent testing.

   - Continental Analytical Services, Inc.—Analyzed samples (collected by KAW Valley Engineering) for constituents to assess disposal requirements and to ascertain whether hazardous compounds were present in significant quantities, in accordance with regulations of the KDHE.

6. Engineering calculations were performed and multiple alternatives were analyzed related to (for example): number, location and type of dams; channel cross sections; liners; Lakewood Park Lake storage volume and pumpback rates (2 cfs and 10 cfs); sediment accumulation rates and removal approaches; alternative sources of make-up water; and operation/maintenance costs.

7. Reviewed various potential mapping sources for suitability in the Master Plan for channel plan and profile drawings. Ultimately, City Staff surveyed channel cross sections at 16 key locations, and this survey information combined with the year 2005 topographic mapping was utilized in the Master Plan. More detailed topographic mapping in the channel will be required during subsequent design phases.

8. Reviewed background documents such as (to provide a few examples): (1) 1978 river master plan prepared by Wilson & Company, which is a comprehensive document that proved to be helpful throughout the project; (2) current preliminary and previous final Flood Insurance Rate Maps (FIRMs) and Flood Insurance Study (FIS); (3) stream flow and water quality data gathered by the City and KDHE; (4) geologic and hydrogeologic data including groundwater level fluctuation graphs assembled by the City based on its municipal well field, including monitoring wells; and (5) historic correspondence, meeting notes and other information pertaining to previous efforts by the City to revitalize the channel.

9. Made multiple field trips to inspect the Old River Channel over its whole length, as well as the Bypass Channel. During these field trips, representative activities included taking photographs, gathering sediment samples, making measurements of culverts, bridges, channel widths and depths, etc., observing water clarity, and discussing field observations with other field trip participants.

10. Two WWE biologists spent time in the field making initial observations related to aquatic life and terrestrial life, and initially mapping wetlands and waters of the United States in and along the channel (see Sections 14 and 15).

11. Interviewed staff from multiple state and federal regulatory agencies such as the Kansas Division of Water Resources (DWR), KDHE, USEPA, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and others (see Section 15).

12. Gathered representative channel sediment samples and analyzed them for permeability as well as for chemical compounds that could potentially cause the sediment to trigger special disposal requirements.

13. Working closely with City staff, gathered information regarding above-ground and buried utilities below and adjacent to the channel.

14. During WWE's initial reconnaissance-level evaluation of the Old River Channel for the Friends of the River, we gathered data that were pertinent to an environmental audit of the Old River corridor. This background information and data were provided to the City and Kansas State University (KSU) to share with Seagull Environmental Technologies, Inc., which conducted a modified Phase 1 environmental assessment utilizing grant monies from EPA's brownfields program secured by KSU, as summarized herein.

15. Participated in meetings that were attended by Salina residents, including the April, 2010 Open House and the June, 2010 River Festival, in which we were asked questions regarding the technical aspects of the project. WWE also participated in briefings of members of the City Commission and County Commissioners regarding the project.

In general, for each of the engineering topics evaluated, such as water rights, drought year response, sediment management, etc., the issue was defined, alternatives were considered and compared/contrasted, and the preferred approach was defined.

1.2 Key Principles and Assumptions

To proceed with engineering aspects of the Master Plan, the following important principles and assumptions were adopted. All of these are discussed in Sections 2 through 17.

1. *Focus on restoring flow*. Early in the master planning process, interviews with representatives of the City, MAC, TAC, Friends of the River, citizens and other entities clearly indicated that it was essential to obtain the legal right, through the DWR, to divert flows through the Old River Channel. Without the ability to do this, all of the other

aspects of the Master Plan would be moot. The maximum permitted flow rate from DWR, although far less than historic peak flows, will still be substantial, at 100 cfs.

2. *Realistically evaluate flow availability and plan for dry years with limited flow in the Old River Channel*. Include mitigation strategies for periods of low flow or no flow. Develop an approach that will assure that even under drought conditions there will be water in the channel in the downtown area where businesses such as restaurants and shops will locate on the channel. Although DSW and the City ultimately determined that this assurance is necessary to obtain private commitment for implementation of the Master Plan, some concern was expressed about the ―appearance" of having ponded water in the channel under drought conditions, potentially when water use is restricted.

3. *Reduce sediment loading, and plan for periodic sediment removal from the channel*. Where diversions are made from the Bypass Channel into the Old River Channel, sediment concentrations are typically high. Develop a plan to reduce sediment loading to the Old River Channel. Project required sediment removal volume and costs, so the City can budget accordingly.

4. *Recognize that the Smoky Hill River is frequently turbid, with elevated levels of total suspended solids, which means that flows in the Old River Channel will also have turbidity*. Although the water in the restored channel will normally have turbidity and not be clear, it will not have an objectionable appearance (see photograph 5–1) and will be suitable for the intended beneficial uses of boating, warm water aquatic life habitat, passive recreation adjacent to the channel and other activities such as shopping, dining, picnicking, listening to concerts, etc. The feasibility and cost of constructing facilities near the channel inlet to reduce sediment and turbidity were determined.

   If the City chooses to construct and operate a mechanical clarifier (to provide high levels of sediment removal), the discharges would be clear, but the capital and operation and maintenance costs of this facility would be very large, as shown in Section 5.

5. *Acknowledge the fundamental limitations posed by the very mild channel slope*. The slope from the inlet structure (through the levee at Bill Burke Park) to the outlet structure (also through the levee) of about 11 vertical feet over a channel length of roughly 6.8 miles is only 0.0003 feet/foot (or 0.3 ft vertically over a horizontal distance of 1,000 ft). This important limitation has many practical effects, from an engineering perspective. For example:

   - The mild slope, in conjunction with keeping the Western Star Mill Dam and a dam at the Midway, means that much of the channel will be characterized by ―ponded" water rather ―free flowing" water. It is important that the public understands that this will not be a ―free flowing" river, because with a maximum diversion rate 100 cfs and a channel slope of 0.0003, flow velocities will normally be less than 1 foot per second.

   - Flow velocities along the channel bottom will not normally be adequate to scour, resuspend and transport downstream sediments that accumulate over time. However, larger stormwater flows (in the 2-year storm and higher) will periodically increase the flow rate and flow velocity sufficiently to move some of the sediment down channel.

   - The combined conditions of slow-moving water, warm water, high nutrient concentrations and good exposure to sunlight will be conducive to algae growth in the channel, and this must be anticipated and planned for.

6. *The preferred alternative includes two dams: the current Western Star Mill Dam, lowered by two feet, and a second dam upstream at "the Midway," in Kenwood Park*. Early in the master planning process, there was some discussion about removing the Western Star Mill Dam and having the entire 6.8-mile reach without dams, but this concept was dropped from further discussion for various reasons. For example, it is desirable to have one or more dams in the channel to store flows during dry years, and to enhance boating and channel aesthetics. The other major dam alternative was to simply keep the Western Star Mill Dam as is, but the advantages of two dams are compelling.

7. *Design with public safety in mind*. Because the recommended approach in this Master Plan involves either one or two dams, and because people will be boating on the river, it is important to recognize that protection of public safety is of paramount importance. For example, the Western Star Mill Dam, whether it is left at its current height or reduced in height to accommodate an upstream dam, will require downstream slope flattening and other hydraulic modifications to assure that any boaters who inadvertently go over the dam will not be subject to undue risk. Similarly, a second, upstream dam would need to be designed with boater (and other public) safety in mind. In reaches where the channel will be V-shaped, side slopes must be no steeper than 4 horizontal to 1 vertical. There are many other aspects to safety that will need to be accounted for as design proceeds in the future, such as techniques to reduce the risk of pedestrians falling from walkways adjacent to the channel into the restored river channel. Unlike some other riverwalk projects, such as the San Antonio Riverwalk, over much of the Old River Channel in Salina, walkways will be a few feet to 10+ feet above the normal water surface elevation and the safety implications of this will need to be accounted for and mitigated with railings, plantings, grading, materials selection and other approaches, which were accounted for in the capital costs in Section 17.

8. *Public safety questions exist regarding the Bypass Channel*. Early in the master planning process, there was interest in trying to facilitate boating, primarily kayaking, canoeing and rafting, through the Bypass Channel. However, analysis of this concept indicated that there would be significant safety risks to the public and that access would be very difficult and expensive. Consequently, in the context of this Master Plan, no further evaluation of boating or other recreation in the Bypass Channel has been conducted.

9. *The Old River Channel must continue to serve as the primary outfall for storm drainage for about five square miles of largely urbanized area*. Early in the Master Plan, questions were raised about whether it would be feasible to collect some or all of the storm drainage inflows in a central (trunk) storm drain that would parallel the channel and discharge flows downstream in the vicinity of the levee, or at least below the Western

Star Mill Dam. This concept was dropped from further evaluation due to cost and hydraulic constraints, as discussed in Section 9. Costs would rapidly reach into the tens of millions of dollars to capture and convey only the 2-year storm downstream, due to high flows, lack of slope, extensive underground utility conflicts, right-of-way conflicts and potential NPDES permitting difficulties, among other reasons.

10. *Stormwater runoff pollution must be evaluated*. Urban stormwater runoff typically contains debris, sediment, nutrients, bacteria and other constituents, and the impact of these pollutants on the project was evaluated and mitigation alternatives described. The appearance of storm drain discharges into the channel should be accounted for as design proceeds in the future, and techniques to make these more visually appealing should be utilized.

11. *Conceptually plan the project in a manner that will not increase the 100-year flood depths*. For many reasons described herein, such as no proposed change in hydrology, removing significant sediment deposits from the channel and replacing undersized culverts with relatively larger bridges, the maximum 100-year flood elevation is not projected to increase due to channel improvements.

12. *Do not affect the integrity of the existing levees nor general operational characteristics of the City's flood control system, including the pumping facilities near the outlet of the Old River Channel*. It was decided early in the Master Plan to accept the existing 54-inch diameter inflow pipe beneath the levee at Bill Burke Park and 72-inch diameter outflow pipe beneath the levee and downstream from the East Iron Avenue Bridge crossing, as is, without evaluating alternatives to increase capacity. There are many reasons for this decision, presented in Section 5.

13. *Take steps to maintain the very low infiltration rate in the current channel*. Based on considerable engineering analysis described herein by WWE and HDR, infiltration losses through the existing channel bottom and sides are relatively small, and are projected to be less than 2 cfs, provided that the existing channel permeability is not increased by project improvements. To minimize the risk of increasing permeability as construction proceeds, in those reaches of the channel where it will be necessary to remove sediment (see drawings at end of report for channel profiles prepared by WWE, which indicate the sediment that will need to be removed in light yellow shading), sufficient sediment should remain in place to keep seepage rates low and to not disturb the current "seal." [Note: As the design process proceeds, the City may decide to excavate more sediment than shown on the attached drawings to reduce the frequency of sediment removal; this can occur without compromising the tightness of the channel bottom.]

14. *Define future regulatory requirements*. In any river restoration project of this magnitude, no matter what the location in the United States, many regulatory/permitting constraints will arise, at the local, state and federal levels. The Old Smoky Hill Renewal Project is no different—numerous local, state and federal permits will be necessary to proceed with the project. For the Master Plan, initial interviews and/or meetings were conducted with representatives of regulatory agencies to familiarize them with the project, request their initial reaction to the project, and identify key constraints and permitting needs for the

future. This process is summarized herein. Although there will be significant regulatory requirements that need to be met, especially in the area of 404 permitting where compliance costs are projected to be substantial, based on our initial analysis, there are no regulatory "fatal flaws" that emerged.

15. *The project will develop in phases*. Through numerous conversations with representatives of the City, the MAC and TAC, FOR, DSW, citizens and others, a consensus has developed that if funding is approved by the voters, the project should proceed in phases, and the conceptual engineering plan has accounted for this.

16. *Anticipate and budget for ongoing maintenance activities*. Maintenance activities and costs were defined in some detail. Steps to reduce the difficultly and/or frequency of maintenance have been included in the Master Plan, such as numerous channel access ramps to facilitate sediment removal.

Table 1–1
Key Parameters for Restored Old River Channel

Overall Channel

Total length: 6.8 miles (35,900 ft)

Total volume of water in channel for flow of 40 cfs: 63 acre-feet

Flow velocity upstream from Western Star Mill Dam
for flow of 40 cfs in concrete-lined channel: 0.20 ft/sec, or 11 ft/min (See Section 2 for explanation of 40 cfs.)

Flow velocity downstream from Western Star Mill Dam
for flow of 40 cfs in typical channel cross section: 0.50 ft/sec, or 30 ft/min

Peak 100-year flood flow: 1,010 cfs at YMCA and 710 cfs at Iron Avenue[1]

Peak 2-year flood flow: 288 cfs at YMCA and 302 cfs at Iron Avenue[2]

Overall channel slope: 0.0003 ft/ft[3]

South Reach (Levee to Greeley Avenue)

Natural, V-shaped earth channel[4]

Length: Approximately 9,000 ft

Depth: 3.5 ft[5]

Water surface top width: 25 – 30 ft

Ponded water volume: 10 acre-feet

Surface area of water ≈ 6 acres

Boatable in normal water condition (not in drought condition)

Greeley to Midway Entrance

Rectangular earth channel, boulder edge and concrete-lined reaches

Length of earth reach: Approximately 1,000 ft

Length of concrete-lined reach: Approximately 800 ft

Depth: 3.5 ft[5]

Water surface top width: 40 ft

Ponded water volume: 6 acre-feet

Surface area of water ≈ 1 acre

Boatable between moveable dams in drought condition

Midway to between South & Mulberry

Natural, V-shaped earth channel[4]

Length: Approximately 4,500 ft

Depth: 3.5 ft[5]

Water surface top width: 40 ft

Ponded water volume: 7 acre-feet

Surface area of water ≈ 4 acres

Boatable in normal water condition (not in drought condition)

Concrete Channel Riverwalk

Rectangular concrete-lined channel

Length: 3,700 ft

Depth: 3.5 ft[5]

Water surface top width: 40 to 90 ft, with an average of approximately 60 ft

Ponded water volume: 18 acre-feet

Surface area of water ≈ 5 acres

Boatable between dams in drought condition

North Channel Reach

Natural, V-shaped earth channel[4]

Length: Approximately 16,000 ft

Depth: 2.6 ft[6] at flow of 40 cfs with width of approximately 22 ft

Depth: 1.6 ft[6] at flow of 10 cfs with width of approximately 13 ft

Water volume: 22 acre-feet

Surface area of water ≈ 7 acres

[1] The 100-year peak actually decreases in the reach going downstream due to floodplain storage and timing of inflows from tributaries, according to the applicable Flood Insurance Study.

[2] In the 2-year storm, floodplain storage and tributary inflow timing are not as significant as in the 100-year flood, so peak is larger downstream than upstream.

[3] A slope of 0.0003 means that the channel drops 0.30 ft vertically for every 1,000 ft horizontally.

[4] Although a V-shaped channel was used for conceptual design in the Master Plan, as planning and engineering proceed, considerations related to maintenance, water quality, and boating may indicate that a trapezoidal channel shape is preferable.

[5] The maximum depth could be increased by 0.5 to 1.0 ft as more detailed design proceeds. The Master Plan-recommended depth of 3.5 ft was based on minimizing the required excavation and maintaining the existing low channel infiltration rate.

[6] Depth could be increased as design becomes more detailed, to facilitate recreation and channel maintenance. This depth is intended to mimic the general existing condition of the north channel reach.

2.0 WATER RIGHTS AND STREAMFLOW ANALYSIS

One of the primary areas of focus during the Master Plan was water rights. The diversion of water from the mainstem of the Smoky Hill River into the Old Smoky Hill channel will require water rights issued by the Kansas Division of Water Resources (DWR) even though the Old Channel is the former natural channel of the river. As of the date of this Master Plan (August, 2010), the City has obtained two draft permits from DWR with proposed conditions. These conditions have been reviewed and approved by the Water Appropriations Program Manager in DWR. However, the Chief Engineer has not yet reviewed them and his approval is required. Appendix 2 provides the draft permits. One permit enables diversions into the channel, while the other would enable the operation of a pumpback pipeline from the Lakewood Park Lake.

2.1 Background

Historically, the Old Channel had seepage losses into its bed and evaporation from its water surface. The U.S. Army Corps of Engineers (Corps) completed construction of the Bypass Channel in 1960, which substantially reduced the flow rate in the channel. The City continuously used the Old Channel to deliver water to the water treatment plant until the late 1980s and the practice of periodically opening the levee inlet and outlet gates to allow some flow to occur has continued to the present, resulting in ongoing seepage and evaporation losses. Evapotranspiration from trees in the riparian corridor is roughly the same now as under historic conditions, and was not a factor in the water rights approval process.

Water rights acquisition for the proposed use of water in the Old Channel was assigned by the City to HDR Engineering, with technical information provided by WWE. HDR and the City submitted the appropriate applications to the DWR for action on April 5, 2010. A summary of the HDR/City water rights requests to the DWR is presented below, followed by a review of projected divertible streamflow (including many figures) and the highlights of the DWR draft permits, provided in Appendix 2. In general, the permit components requested have been tentatively accepted by DWR.

The streamflow diversion system proposed for the Old River Channel is a flow-through system which will return most of the water diverted. Initial estimates on channel losses and seepage indicate that these losses will be small, and contingency plans will be developed to mitigate channel loss if excessive seepage becomes an issue.

2.2 Master Plan Alternatives

From a water rights standpoint, there was only limited evaluation of alternatives in the master planning process, because water rights are issued and administered by the Kansas DWR. However, during Phase 1 of the river restoration project (performed by DSW and WWE for the Friends of the River) and early in the master planning process, discussions with City staff were conducted as to whether or not a water right from the DWR would be necessary, since the Old River Channel was the former natural channel of the Smoky Hill River prior to construction of the Bypass Channel by the Corps. Based upon many historical documents that the City of Salina has in its files, there is no indication that a water right was assigned to the Bypass Channel when it was constructed, nor is there any indication that the City agreed to forego diversions through

the Old River Channel from a water rights perspective. In fact, from approximately 1960, when the Bypass Channel was constructed, until the late 1980s, the City continuously conveyed raw water from the Bypass Channel through the Old River Channel to the water treatment facility, and it was only when a pipeline (with a senior water right for 15.5 cfs) was constructed in the late 1980s that this practice was no longer continuous. However, from the late 1980s to the present, the inlet and outlet gates have periodically been opened, with resulting flows in the Old River Channel.

Although recognizing that there are arguments for asserting that a water right was not necessary to routinely run flows through the Old River Channel, the City determined that it would be preferable to request a recreational diversion right from DWR. This process was actually initiated during Phase 1 of the overall channel renewal/restoration (whereas the Master Plan is Phase 2). This process culminated with issuance of draft permits in June, 2010. DWR and the City conducted many conversations regarding how to address dry-year conditions, as summarized in Section 3.

2.3 Summary of Conceptual Project Design for Water Rights Application Filed by HDR and City of Salina

The following is a summary of the main design concepts for the water rights application:

- The system is a "flow-through system," i.e., most of the diverted flow will be returned to the stream at the confluence of the Old River Channel and the current river channel.
- Proposed diversion rates:
  - Maximum diversion rate: 100 cfs—For initial filling and occasional channel cleaning/flushing.
  - Dominant diversion rate: 40 cfs—Typical project diversion rate.
  - Low streamflow diversion rate: 10 cfs or smaller.
- Based on field studies, literature review and calculations, seepage is 2 to 5 cfs. (WWE believes that the actual seepage will be 2 cfs or smaller, but the application adopted 5 cfs to be conservative.)
- At the dominant diversion rate of 40 cfs, it is estimated that 35 to 38 cfs will be returned to the existing Smoky Hill River, at the confluence between the existing channel of the Smoky Hill River and the downstream end of the Old River Channel.
- During peak use period, corresponding to the core of the irrigation season (July 1 through September 30), diversions are desired.
- A water right which allows the City to withdraw water for beneficial use whenever the measured streamflow at the Mentor gage exceeds 40 cfs was requested. As explained in Section 2.6, Figures 2–1 through 2–3 were prepared to demonstrate divertible streamflow

quantities during the period of 1999 to 2009. This time period includes 2006, the lowest recorded year of streamflow at the Mentor gage.

- Pending the outcome of more detailed feasibility studies as design proceeds (see Section 3), the Lakewood Park Lake has been identified as the peak season (July 1 through September 30) alternative source of supply for the Old River Channel project. When necessary, water would be pumped from the Lake during peak season to help augment streamflow from the Smoky Hill River diversion (if available), including the make-up of evaporation from the ponded reaches in the channel. If water is not available for diversion from the Smoky Hill River, the Lake would provide water for the Old River Channel project. The water would be pumped through a water recycling system at a flow rate of somewhere between 2 and 10 cfs (to be determined during design, based on various factors including sustained rate of inflow from groundwater, cost, water quality benefits, appearance and others) for a maximum period of 90 days. The recirculation system is projected to return approximately 8 cfs of the 10 cfs diverted back to the lake. Water would not be pumped from the Lake at Lakewood Park during the off-peak season (October 1 through June 30), except under unusual conditions.

  Future feasibility analysis of this Lake must evaluate the effects of extended pumping on local groundwater sources and on the lake itself, which is popular with residents for fishing, boating, etc. WWE has recommended to the City that a trial lake drawdown test be conducted using temporary pumps (it was not feasible for the City to make the necessary arrangements to conduct this test during the Master Plan). During this test, groundwater levels around the lake would be monitored to determine the interrelationship between lake fluctuations and effects of groundwater. This information will be of interest to the DWR because they will impose a maximum drawdown level in the Lake at Lakewood Park as part of the final permit (see final DWR provisions listed in Section 2.7.2).

  Lakewood Park Lake has a volume of approximately 80 acre-feet (AF). A diversion of 10 cfs for a day is 20 AF. Unless there is significant groundwater recharge of the lake, a 10 cfs diversion from the lake will potentially cause significant drawdown in the lake level, which will likely be unacceptable. Because of the small lake volume, a smaller 2-cfs diversion rate has been proposed. The draft water permit would likely need to be revised to facilitate the lower diversion rate, which would not provide a 75-percent return factor as stated in the draft permit. An interview conducted by the City with DWR in August, 2010, indicated that DWR is likely to have flexibility on the 75% factor if the design flow rate is 2 cfs, not 10 cfs. The subject of the Lake at Lakewood Park is further discussed in Section 3.

- Up to roughly one (1) mile of the channel will be lined. The remaining approximately six (6) miles of the channel will be natural or slightly improved (see Table 1–1 for detailed lengths of channel types).

- The improved sections of the stream could be lined in the future if excessive seepage is observed (this is highly unlikely).

- In the water right application, project consumptive use (CU) was estimated as:
  - Seepage = 2 to 5 cfs, or 1,448 to 3,620 AF per year.
  - Net evaporation = 96 AF per year.
  - Total CU = 1,544 to 3,716 AF per year.

These figures represent total consumptive use, not incremental (or increased consumptive use above historic). This refers to the fact that in its existing condition, the channel already has significant consumptive use associated with storm flows, day-to-day dry-weather discharges from the storm drainage system and periodic diversions from the Bypass Channel.

2.4 Existing Water Rights

The existing surface water rights between the Mentor stream gage and the confluence of the Smoky Hill and Saline Rivers were quantified to determine the authorized quantity and flow rates that are senior to any new appropriations along the stream. Only water rights that list both an active point of diversion and an active water use were considered. Table 2–1 and Figure 2–4 provide information on these water rights. From this analysis, the total maximum instantaneous flow rate of all diversions senior to a new appropriation is 28.7 cfs. This value includes the City's large municipal appropriation of about 15 cfs and all active appropriations downstream of the City to the confluence with the Saline River.

2.5 Streamflow Frequency Curves

Streamflow frequency curves (provided in Appendix 2) were developed by HDR in support of the water availability analysis using the mean daily discharge records from the U.S. Geological Survey (USGS) Smoky Hill River (near Mentor) gaging station. The curves refer to flow at the Mentor gage, rather than divertible flows at the Old River Channel inlet, which are addressed in Section 2.6.

The streamflow frequency data from HDR in Appendix 2 are consistent with those of WWE in the Phase 1 feasibility analysis conducted for the Friends of the River in 2009 and of the City Utilities Department in 2009, when they reviewed WWE's analysis.

2.6 Streamflow Available for Diversion

2.6.1 *Graphs to Summarize Results*

As indicated in Appendix 2, the draft permit for river diversions that was issued by DWR in June, 2010 contains a flow threshold of 40 cfs. This threshold was established to assure adequate flow for downstream water rights (totaling 28.7 cfs), with a margin of error included. When flow at the Mentor gage is greater than 40 cfs, and assuming that the draft DWR permit applies, the City will be able to divert the flow in excess of 40 cfs into the Old River Channel. For example, if the flow is 45 cfs, the potential divertible amount is 5 cfs. Figures 2–1, 2–2 and 2–3 summarize divertible flows. In a nutshell, these figures show that there is substantial water available for diversion in all years analyzed except 2006, the worst streamflow year at Salina in

over 100 years of recorded data. For example, as shown in Figure 5–1, during the 11-year study period, nearly half the time (47.4%), potential diversions are greater than 100 cfs; approximately 60% of the time, diversion potential is greater than 50 cfs, and about 75% of the time, diversion potential is greater than 10 cfs. There is at least some diversion potential on 82% of the days during the study period of 1999 to 2009. Even during 2006, there were 7 distinct periods when it would have been feasible to make diversions, thereby enabling the pooled reaches of the river and the Lake at Lakewood Park to be replenished (discussed further in Section 3).

2.6.2 *Long-term Analysis*

Monthly average precipitation data from 1895 to 2009, obtained from the Kansas State Climatologist, were reviewed by HDR to evaluate the variability of precipitation near Salina and its impact on streamflow. This analysis shows the clear impact of the Kanapolis Reservoir management practices on streamflow in the Smoky Hill River. HDR's evaluation indicated that 1999 to 2009 would be a conservative study period.

The impact of the reservoir makes analysis of streamflow based on wet or dry years (by precipitation) impossible; rather, streamflow years need to be characterized as high-flow or low-flow years based on annual mean discharge, which is 377 cfs for the period of 1949 (post-Kanapolis) to 2009. Table 2–2 summarizes the streamflow conditions for the last 11 years (1999 to 2009); the mean annual discharge is 281 cfs, which is 75 percent of the longer term mean annual discharge. In other words, the overall 11-year period for the Smoky Hill River (at Mentor gage) has significantly less flow than the long-term average. HDR evaluated long-term precipitation and streamflow data, and this indicated that 1999 to 2009 would be a conservative study period.

Table 2–2

Mean Annual Flow in Smoky Hill River at Mentor Gage during the Past Decade Salina, Kansas

Year	Annual Average Streamflow (cfs)
1999	637
2000	320
2001	418
2002	126
2003	115
2004	109
2005	81
2006	27
2007	547
2008	389
2009	318
Mean 1999-2009	281

The 1999 to 2009 hydrographs (Figure 2–3) show that water is typically available for diversion during years when the average annual streamflow is near or greater than the historical average mean discharge of 377 cfs. For the years when the average streamflow is much below average (2002, 2003 and 2004), between 10 and 50 cfs streamflow is available for diversion most of the year, except during the summer irrigation period, when diversion would not be continuous. Streamflow was available for diversion periodically, including during the irrigation season, during 2005, which was a very low streamflow year. As noted above, little streamflow was available for diversion in 2006.

To summarize, assuming a flow threshold of 40 cfs as per the draft permit from DWR, based on the analysis of existing water rights and water availability presented, sufficient streamflow exists within the Smoky Hill River to accommodate a new surface water diversion while also satisfying the maximum permitted flow rates for existing water users. During years where the annual streamflow is near or in excess of the historical mean average discharge of 377 cfs, there is sufficient streamflow available to allow for a new diversion, even in the summer months. Potential seasonal issues arise regarding new streamflow diversions during years where the annual average discharge in the Smoky Hill River is well below the mean average discharge. Specifically, in the low streamflow years of the past decade, there was water available for new diversions only occasionally during the summer months.

As discussed in Section 3, to mitigate low streamflow conditions, a contingency plan for a pumpback system that would use the Lake at Lakewood Park as a source of water and would recirculate that water through the Old River Channel and back to the Lake was proposed to DWR, and a draft permit was issued in June, 2010 (see Appendix 2 for copy of draft permit). The City will not be authorized by DWR to concurrently divert flows from the main channel and to pump from the Lakewood Park Lake. As planning continues, the Master Plan recommends that the City give consideration to other options for dry-year flow enhancement including ponding, utilizing municipal wells and/or treated wastewater effluent, purchasing senior water rights, and working with the Kansas Water Office (KWO) on other potential supplies. Phase 1 of this Master Plan includes funding for a 2-cfs recirculating system, based on the Lake at Lakewood Park. As alluded to earlier in this section, the Master Plan adopted 2 cfs rather than a larger design flow, such as 10 cfs, due to the relatively small volume in the lake, the 75% return requirement (to the lake), the establishment of a maximum drawdown level (see Section 3) and uncertainties regarding the rate at which groundwater will be able to infill the lake.

2.7 Key Draft Permit Elements

Key quotations from the two draft permits that were issued by the Kansas DWR, officially entitled –Approval of Application and Permit to Proceed" are as follows. The first quotations are from the draft permit that enables the City of Salina to divert flows through the Old River Channel, while the second draft permit pertains to utilizing a pumpback system in the lake at Lakewood Park. The following are direct quotations—full copies of both permits are provided in Appendix 2.

2.7.1 Draft Approval of Application and Permit to Proceed for Diversions from the Bypass Channel to the Old River Channel

Key quotations from the Approval of Application and Permit to Proceed for diversions from the Bypass Channel to the Old River Channel are as follows:

- [T]he priority date assigned to such application is **April 5, 2010.**
- [T]he water sought to be appropriated shall be used for recreational use with the original Smoky Hill River channel. . .
- [T]he authorized source from which the appropriation shall be made is surface water from the Smoky Hill River. . .
- [T]he appropriation sought shall be limited to a maximum diversion rate not in excess of 100 cubic feet per second and to a quantity not to exceed 28,952 acre-feet of water for any calendar year.
- [I]nstallation of works for diversion of water shall be completed on or before December 31, 2012 or within any authorized extension thereof.
- [A]n acceptable water flow meter shall be installed and maintained on the diversion works authorized by this permit in accordance with Kansas Administrative Regulations...
- [T]he applicant shall maintain accurate and complete records from which the quantity of water diverted during each calendar year may be readily determined. . .
- [D]iversion of natural flows shall not take place unless there is water available to satisfy all demands by senior water rights and permits.
- [D]uring the period October 1 through June 30, the verbal or written permission of the Chief Engineer, or an authorized representative of the Chief Engineer, shall be obtained in order to divert water each time the applicant desires to divert water.
- [D]uring the period July 1 through September 30 each calendar year, no direct diversions of surface water shall be permitted unless written permission is obtained from the Chief Engineer, or Chief Engineer's authorized representative.
- [T]he division of surface water authorized herein shall be allowed only when flows in the Smoky Hill River at the U.S. Geological Survey stream gage No. 06866500 located near Mentor, Kansas are **equal to or greater than 40 c.f.s.**
- [T]he maximum rate of diversion shall be limited to the flow at the U.S. Geological Survey stream gage. . . near Mentor, Kansas, **less 40 c.f.s.**, to ensure that some volume of water remains in the river when diversion is occurring.

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2.7.2 Approval of Application and Permit to Proceed for the Pumpback System in the Lake at Lakewood Park

Key quotations from the Approval of Application and Permit to Proceed for the pumpback system in the lake at Lakewood Park are as follows:

- [T]he priority date assigned to such application is **April 5, 2010.**
- [T]he water sought to be appropriated shall be used for recreational use…
- [T]he authorized source from which the appropriation shall be made is groundwater from the alluvial aquifer, to be withdrawn by means of an existing groundwater pit…
- [T]he appropriation shall be limited to a maximum diversion rate not in excess of **4,500 gallons per minute (10 c.f.s.)** and to a quantity not to exceed **1,785 acre-feet** of water for any calendar year. [Note: The basis of the volume is 10 cfs × 1.98 AF/cfs day × 90 days ≈ 1,785 AF.]
- [A]n acceptable water flow meter shall be installed and maintained on the diversion works…
- [T]he applicant shall maintain accurate and complete records…
- [T]he applicant shall ensure that at a minimum 75 percent of the water diverted under authority of this permit be returned to the groundwater pit described in Paragraph No. 3 of this permit.
- [I]n order to prevent unreasonable lowering of the water level in the groundwater pit, the applicant must cease diversion when the surface water level in the groundwater pit is at or below elevation XXXX feet mean sea level. [or staff gage reading of ?? feet]

[Note: Blanks are in draft permit.]

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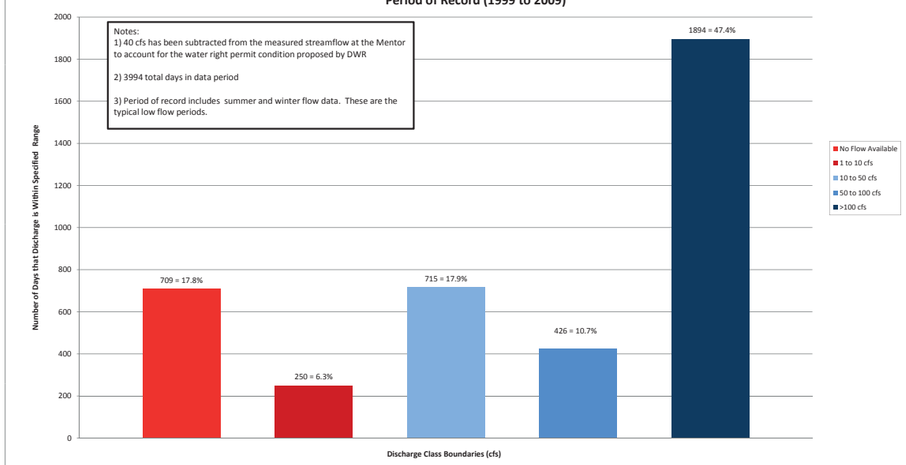
Table 2-1
Active Surface Water Rights Between Mentor Gage and City Diversion

Smoky Hill Flow

WR Number	Type	Use	County	Priority Date	Number of Points of Diversion (if more than one)	Authorized Annual Quantity (ac-ft)	Authorized Rate (gpm)	Authorized Irrigated Acres	Maximum Authorized Diversion - Instantaneous Rate (cfs)	Notes
29407	A	IRR	SA	3/23/1977		47	510	68	1.1	Downstream User east of Salina(before confluence with Saline River)
3043	A	MUN	SA	10/16/1954		5028	6,955		15.5	City intake
42901	A	IRR	SA	7/25/1997		125	1,000		2.2	
46471	A	REC	SA	5/8/2006		12	1,000		2.2	
12027	A	IRR	SA	7/5/1966		80	590	92	1.3	
3096	A	IRR	SA	11/8/1954	2	138	1,350	192	3.0	
569	A	IRR	SA	10/14/1949		95	640	180.00	1.4	
573	A	IRR	SA	10/21/1949	3	139	840	165	1.9	
3096										
573										
573										First point of diversion north of Mentor gage

Max approved diversion between Mentor gage and City (cfs)	12.1
Summer diversions between Mentor gage and City (cfs) - does not include A46471	9.8
Total Water Rights Senior to New Recreational Permit - from Mentor gage to Confluence with Saline River (cfs)	28.7

Figure 2-1
Distribution of Discharge Classes
Showing Divertible Streamflow
Smoky Hill River Mentor Gauge
Period of Record (1999 to 2009)



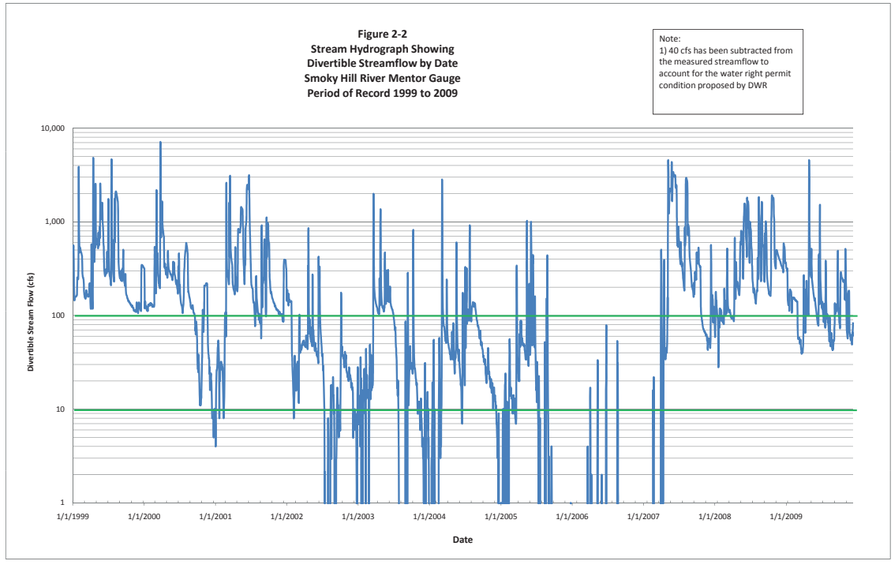


Figure 2-2
Stream Hydrograph Showing
Divertible Streamflow by Date
Smoky Hill River Mentor Gauge
Period of Record 1999 to 2009
Note:
1) 40 cfs has been subtracted from the measured streamflow to account for the water right permit condition proposed by DWR
10,000
1,000
100
10
1
Divertible Stream Flow (cfs)
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
Date

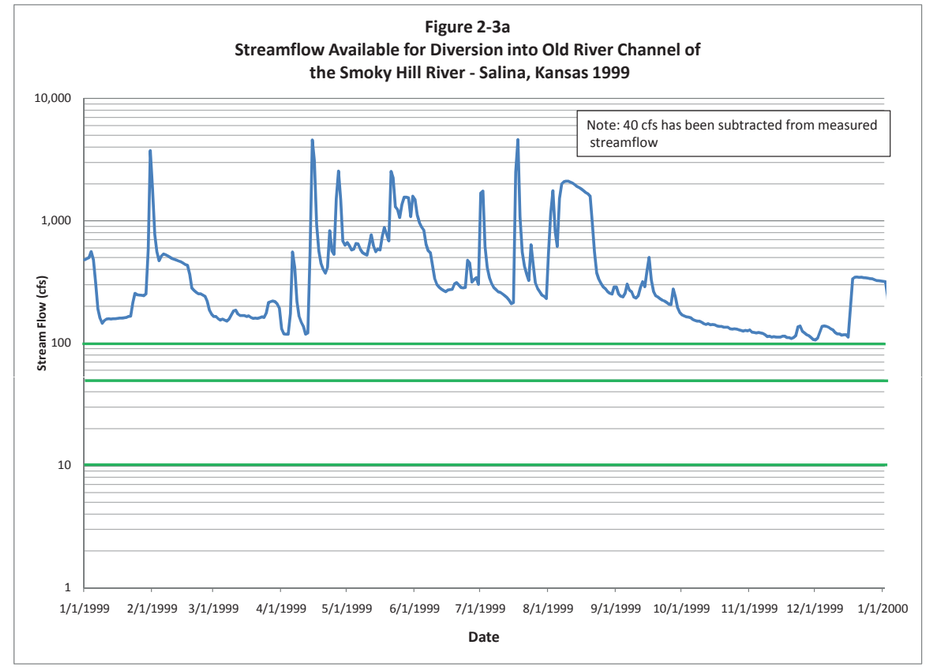


Figure 2-3a
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 1999
Note: 40 cfs has been subtracted from measured streamflow
10,000
1,000
100
10
1
Stream Flow (cfs)
1/1/1999
2/1/1999
3/1/1999
4/1/1999
5/1/1999
6/1/1999
7/1/1999
8/1/1999
9/1/1999
10/1/1999
11/1/1999
12/1/1999
1/1/2000
Date

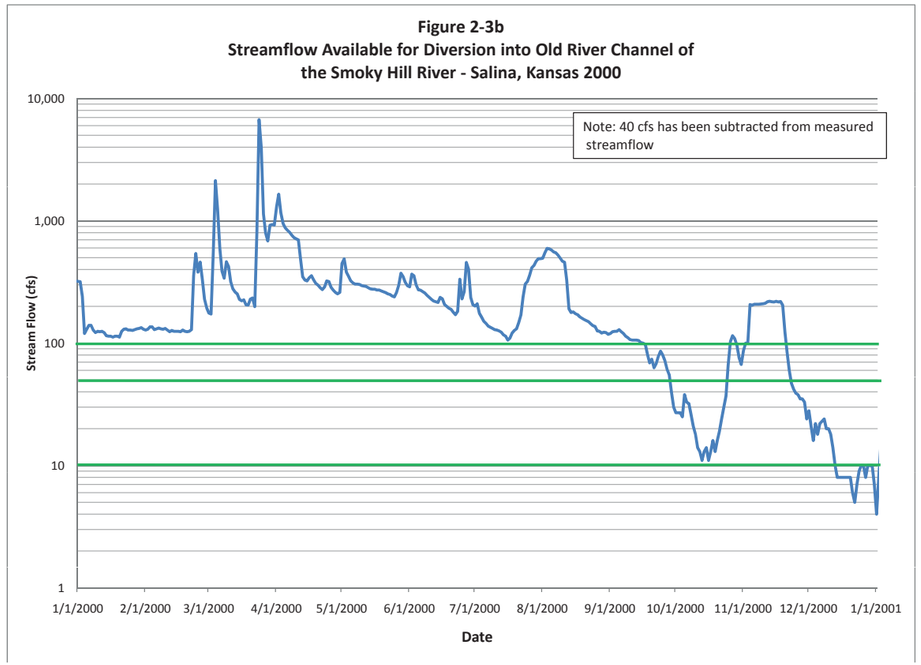


Figure 2-3b
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2000
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2000
2/1/2000
3/1/2000
4/1/2000
5/1/2000
6/1/2000
7/1/2000
8/1/2000
9/1/2000
10/1/2000
11/1/2000
12/1/2000
1/1/2001
Date

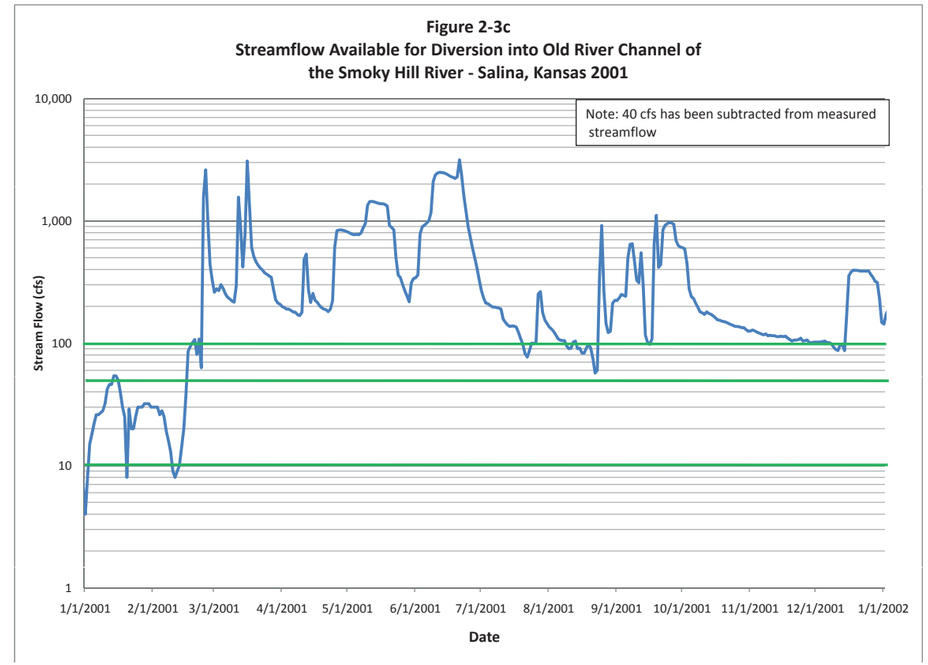


Figure 2-3c
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2001
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2001
2/1/2001
3/1/2001
4/1/2001
5/1/2001
6/1/2001
7/1/2001
8/1/2001
9/1/2001
10/1/2001
11/1/2001
12/1/2001
1/1/2002
Date

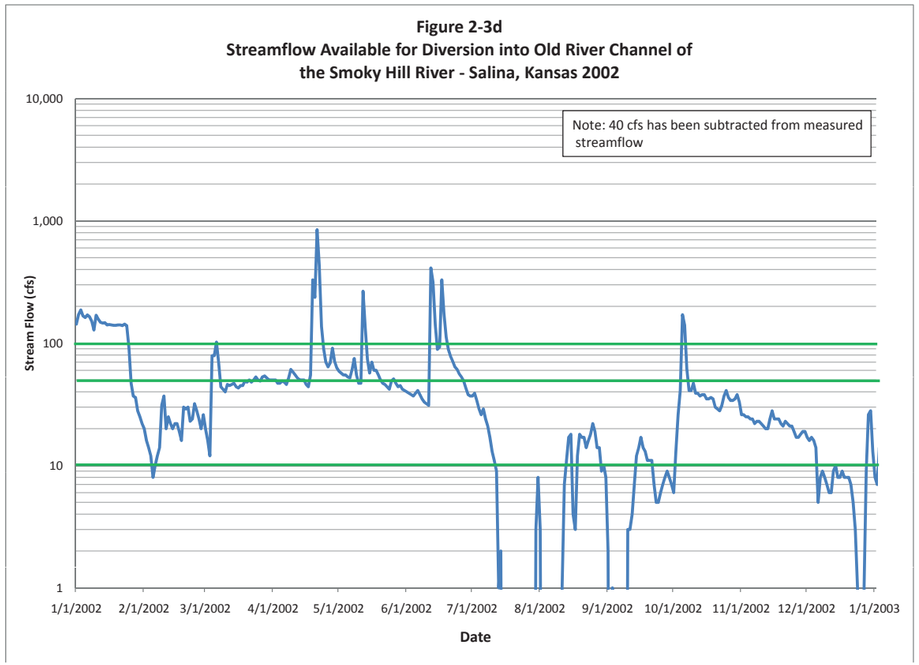


Figure 2-3d
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2002
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2002
2/1/2002
3/1/2002
4/1/2002
5/1/2002
6/1/2002
7/1/2002
8/1/2002
9/1/2002
10/1/2002
11/1/2002
12/1/2002
1/1/2003
Date

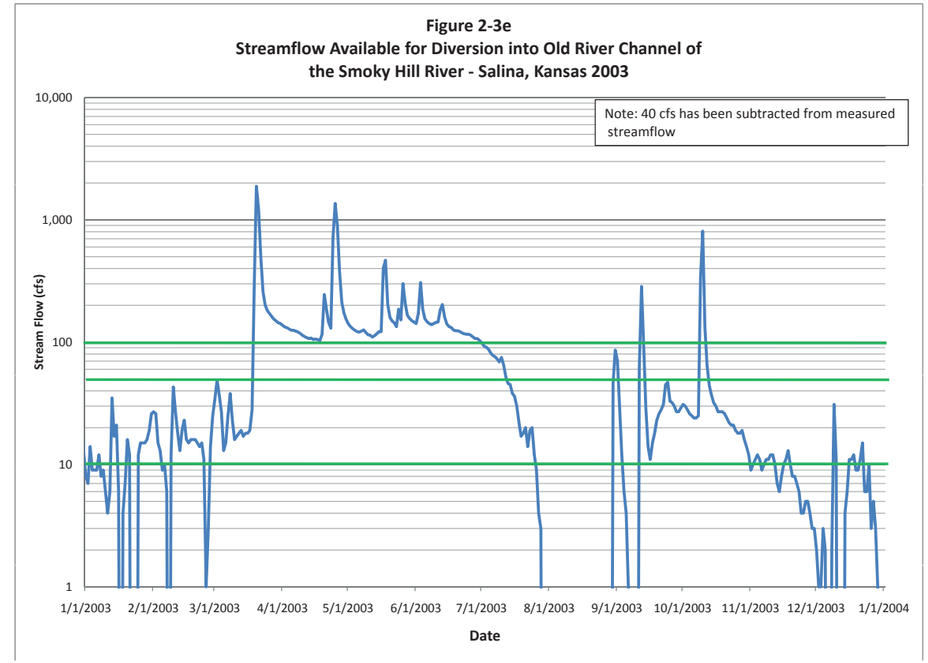


Figure 2-3e
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2003
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2003
2/1/2003
3/1/2003
4/1/2003
5/1/2003
6/1/2003
7/1/2003
8/1/2003
9/1/2003
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11/1/2003
12/1/2003
1/1/2004
Date

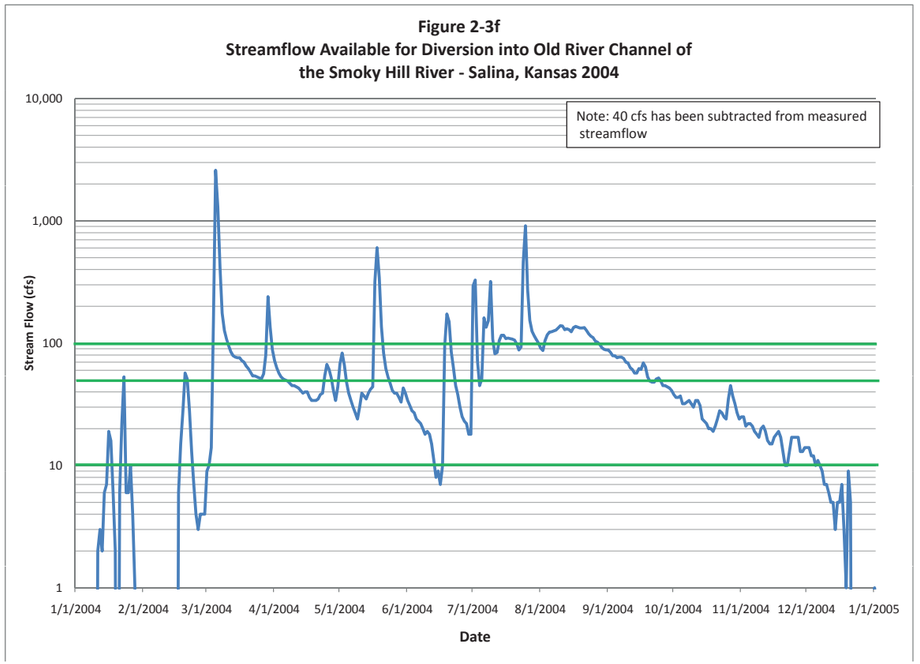
Figure 2-3f
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2004
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2004
2/1/2004
3/1/2004
4/1/2004
5/1/2004
6/1/2004
7/1/2004
8/1/2004
9/1/2004
10/1/2004
11/1/2004
12/1/2004
1/1/2005
Date

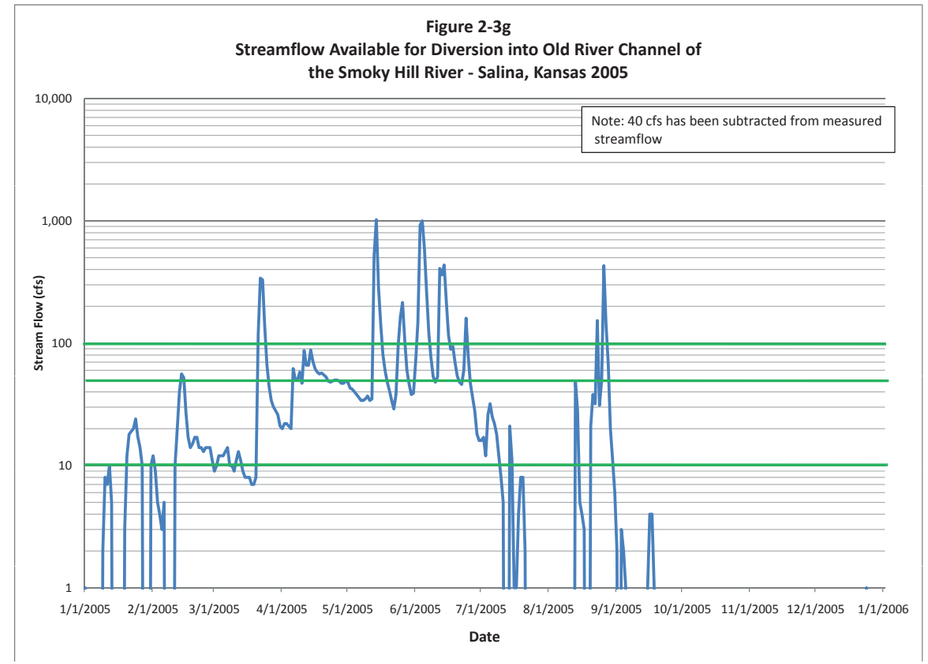
Figure 2-3g
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2005
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2005
2/1/2005
3/1/2005
4/1/2005
5/1/2005
6/1/2005
7/1/2005
8/1/2005
9/1/2005
10/1/2005
11/1/2005
12/1/2005
1/1/2006
Date

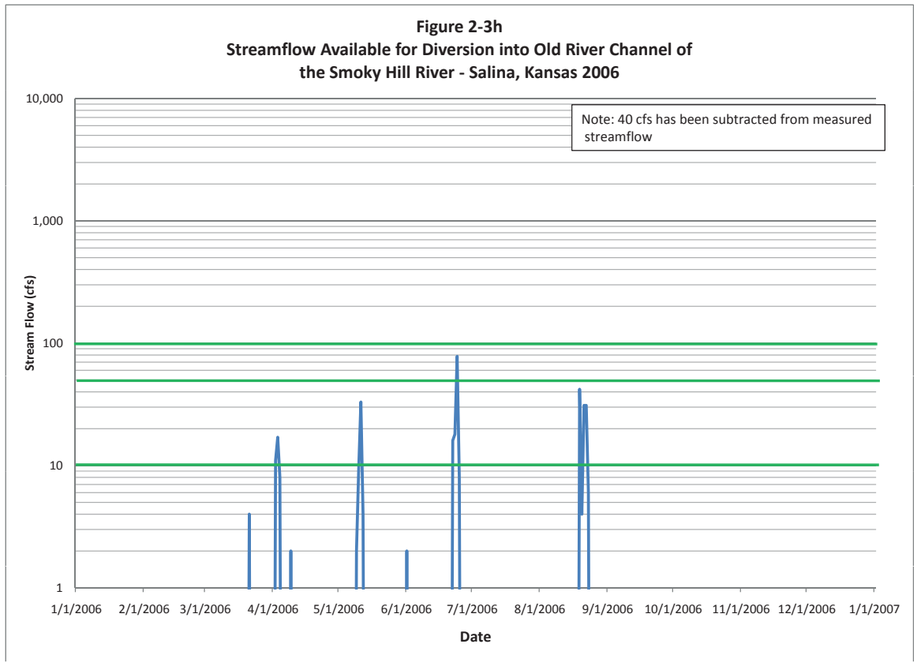
Figure 2-3h
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2006
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2006
2/1/2006
3/1/2006
4/1/2006
5/1/2006
6/1/2006
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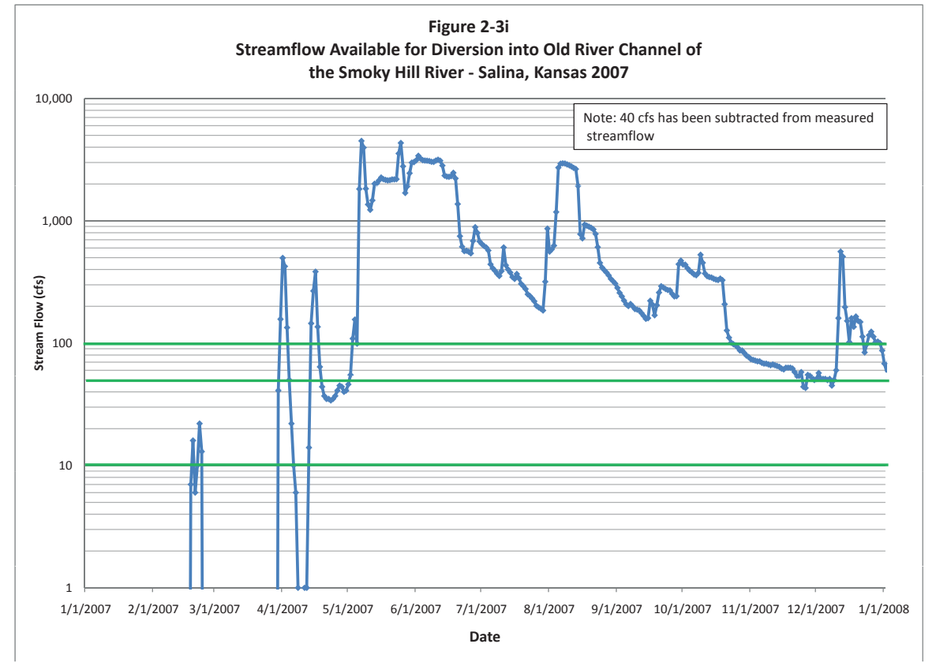
Figure 2-3i
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2007
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2007
2/1/2007
3/1/2007
4/1/2007
5/1/2007
6/1/2007
7/1/2007
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12/1/2007
1/1/2008
Date

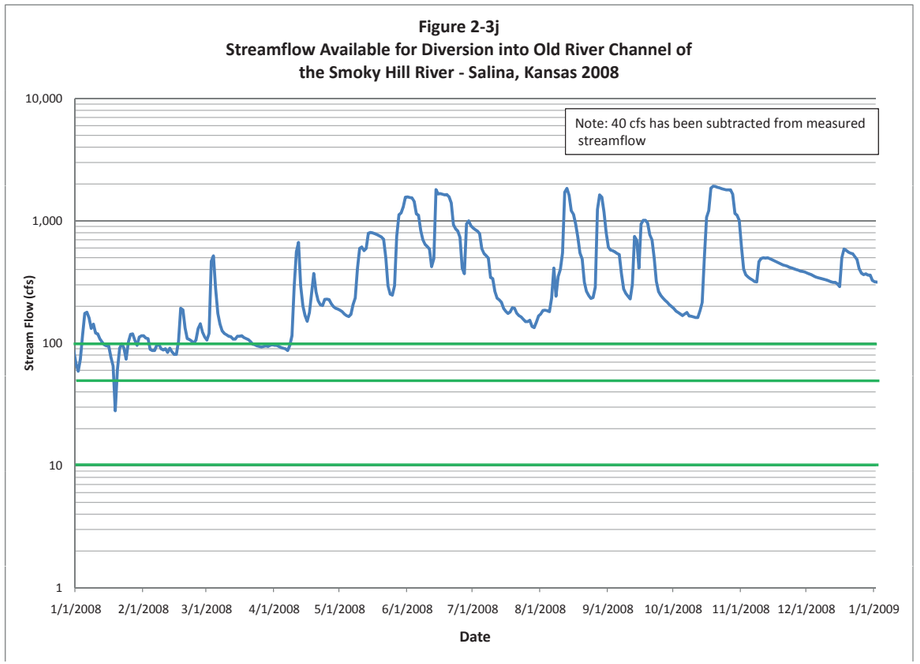
Figure 2-3j
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2008
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2008
2/1/2008
3/1/2008
4/1/2008
5/1/2008
6/1/2008
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12/1/2008
1/1/2009
Date

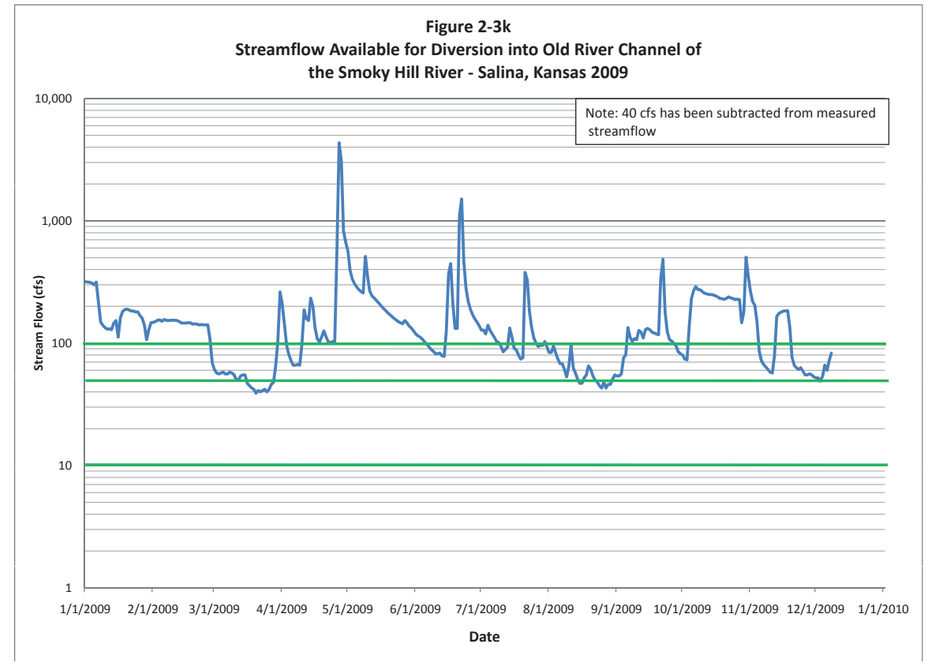


Figure 2-3k
Streamflow Available for Diversion into Old River Channel of
the Smoky Hill River - Salina, Kansas 2009
Note: 40 cfs has been subtracted from measured streamflow
Stream Flow (cfs)
10,000
1,000
100
10
1
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
6/1/2009
7/1/2009
8/1/2009
9/1/2009
10/1/2009
11/1/2009
12/1/2009
1/1/2010
Date

Figure B1: Active Surface Water Right Diversion Points Between Mentor Gauge and Confluence with Saline River

3.0 POTENTIAL DROUGHT PERIOD OPERATIONS

In dry periods, there will be extended time spans during which it will not be feasible to divert flows from the Smoky Hill River into the Old River Channel, or during which diversion potential will be very small. This is demonstrated in Section 2 (Water Rights and Streamflow Analysis), including Figure 2–3, which graphs the quantity of divertible flow in the Smoky Hill River at the Old River Channel inlet pipe for 1999 – 2009. This includes the extended dry period of 2003 – 2006, and the year of lowest recorded streamflow in Salina, 2006.

Although most of the plots of divertible streamflow for 1999 – 2009 show that diversions can be made for nearly every day of the year, inspection of certain years demonstrates periods of no diversion such as 2002 (mid July to early August, and early September), 2003 (the whole month of August) and the very severe drought from October of 2005 through March of 2006, when there was no divertible flow. In summary, these graphs indicate that there is the need to anticipate and plan for drought period operations, as discussed in this section.

This section focuses on the construction of in-channel storage, utilizing available existing storage, constructing new storage, securing additional water rights and utilizing existing municipal supply sources to supplement river diversions. However, there are other aspects of the Master Plan that are relevant during dry periods. For example, as described in Section 14, Water Quality and Aquatic Life, concerns related to algae, weeds, mosquitoes, odor and conditions for aquatic life are magnified when there is little flow through the channel, so the mitigation strategies for those issues (defined in Section 14) are all the more important under dry conditions. Similarly, the sediment management approaches discussed in Section 5 are amplified in importance under dry conditions, because when the normal water level is down, sediment deposits further decrease the effective water depth. In short, multiple considerations enter into drought planning, as discussed in this Master Plan. The capital and operation and maintenance costs provided in the final two sections of this report include many items to address this issue.

Section 3.1 provides an overview of Master Plan alternatives related to drought-period operations, including:

- In-channel ponds
- Lakewood Park Lake recirculation system
- Golf course wells
- Municipal untreated water
- Storm drainage from area tributary to Old River Channel
- Securing additional water rights in Smoky Hill River basin
- Treated municipal wastewater effluent
- Other existing or constructed storage facilities

Section 3.2 provides a more detailed evaluation of the option of in-channel ponds, while Section 3.3 describes the Lakewood Park Lake recirculation system. Section 3.4 provides the Master Plan recommendation for drought period operations.

3.1 Master Plan Alternatives

WWE has discussed drought planning with the City's water rights consultant, HDR, and HDR has observed that central Kansas has fairly limited water resources, generally consisting of alluvial wells or surface water [Note: HDR's perspective on water supplies is based in part on their preparation of a Raw Water Master Plan for the City of Salina]. HDR has observed that there are no reliable bedrock sources near Salina, and that the City cannot install an additional well near the city without obtaining a waiver on well spacing from the Chief Engineer of Division of Water Resources (DWR), because the City's municipal wellfield was permitted above the ~~"s~~afe yield" provision in the Appropriation Act.

Alternatives reviewed in the Master Plan include:

- *In-channel ponds*—Pond water upstream of the Western Star Mill Dam and construct a second small dam to be located at the Midway, in Kenwood Park. The concept behind in-channel storage facilities is that when divertible flow is available, it would be utilized to create ponds which would then be in place during times of little or no diversions. During these times, losses will be limited to evaporation because the reaches are lined.

  The volume to be stored in the two ponded areas during droughts is about 24 acre-feet (AF). The Master Plan envisions that it will be necessary to have water at a normal depth of about 3.5 ft in the ponded reaches, since boating and commercial enterprises will depend on water here. This is a small volume (24 AF) of water to sustain in droughts. For example, 3 cfs of flow for 4 days is 24 AF (this can be compared with the divertible flow graphs in Section 2). As shown in Figure 2–3h, even in 2006, the worst year of recorded streamflow, there were 7 periods when diversion could have been made with available flows well in excess of 24 AF. Moreover, this does not include stormwater runoff into the Old Channel from the over 3,000 acres that drain into the channel. Evaporative losses from the surface area of roughly 7 acres in the ponds will be only about 16 AF/year, and due to the concrete lining (or due to the tightness of the existing sediment if concrete is not ultimately used on the channel bottom), there will not be significant infiltration losses. The ponds will be constantly aerated in droughts to reduce the amount of fresh water which will need to be brought into the ponds for water quality reasons. This alternative is covered in Section 3.2.

- *Lakewood Park Lake recirculation system*—Based on data provided by the City, the Lake in Lakewood Park presently stores roughly 80 AF (one acre-foot is approximately 325,000 gallons of water). It may be feasible to construct a pump station in this lake with a pipeline that would run along Indiana Street approximately 1 mile to discharge into the Old Smoky Hill Channel at Indiana Avenue and Arlington Drive. Pumping rates of both 2 cfs and 10 cfs have been evaluated. There would be a return structure to bring water from the Old River Channel back into the Lake in Lakewood Park, thus making it a ~~"p~~umpback" or ~~"r~~ecirculating" system. Alternatively, if yields from the Lake are restricted by limited groundwater recharge rates, the Lake could be used to offset evaporative losses in the ponded reaches, if acceptable to DWR. This alternative is covered in Section 3.3.

- *Golf course wells*—Golf course wells owned by the City could periodically be utilized to provide makeup water. WWE discussed this alternative with HDR. HDR's initial response (without the benefit of detailed analysis) is that a reasonable range for a sustainable flow through a dry summer would be 500 to 1,000 gallons per minute (gpm), or roughly 1 – 2 cfs per well. Using water from the golf course wells for a recreational application would require a change in the place of use and the use made of the water from DWR.

- *Municipal untreated water*—Untreated municipal water from the City's wells near the Old River Channel (raw water for domestic water supplies) could potentially be utilized under limited and very infrequent conditions. HDR observed that during dry years, a major consideration of using water from these wells is the impact it would have on the City's dry-year contingency plan. As with water from the golf course wells, this would require a change in the place of use and the use made of water from DWR. The golf course would probably present fewer regulatory issues than the municipal wells as a supplemental supply.

- *Storm drainage from area tributary to Old River Channel*—Approximately 70 storm drains discharge into the Old River Channel over its approximately 7-mile length, and these drain a largely urbanized area of about five square miles in size (over 3,000 acres). Thus, these storm drains represent a significant source of water, although the source is unpredictable and erratic. During drought years, there will occasionally be precipitation, and from a drainage area this large, even a small amount of runoff, such 0.1 inches per acre, will generate 25 acre-feet of inflow to the overall channel (with a total volume of 63 AF and an instream pond volume of 24 AF).

- *Secure additional water rights in Smoky Hill River basin*—This could be in the form of purchasing senior irrigation water rights, securing water stored in Kanapolis Reservoir, probably working with the Kansas Water Office (KWO), or participating in a special assurance district that KWO and other entities are currently evaluating. The point of these strategies would be to enable the City to divert water into the Old River Channel during drought conditions, when the 40 cfs threshold is in effect and no diversions would otherwise be possible.

- *Treated municipal wastewater effluent*—The City of Salina's municipal wastewater treatment plant discharges approximately one mile downstream from the outfall of the Old River Channel. Reportedly, the level of treatment provided by this facility is good, as is the Kansas Department of Health and Environment (KDHE) compliance history. The effluent represents a potential source of supplemental water during dry conditions. The current wastewater plant discharge is 4.25 million gallons a day (mgd) and the plant has the capacity of 7.25 mgd. The treated effluent could be pumped and potentially discharged directly into the headwaters of the Old River Channel or it could be pumped to a location immediately downstream from the point of diversion for the Old River

Channel, where it would be discharged into the Bypass Channel. In this scenario, the amount of discharge into the Bypass Channel would be counterbalanced by the equivalent ―extra" diversion into the Old River Channel.

Water rights and water quality regulatory issues with either of these scenarios would be significant, since there are shallow municipal wells in close proximity to the Old River Channel, and ―source water protection requirements" under the federal Safe Drinking Water Act are likely to strictly limit or even prohibit the conveyance of treated effluent through the channel. Additional treatment might be required. Public reaction could be adverse. If the treated effluent were to be pumped upriver and discharged immediately downstream of the Old River diversion (thereby enabling increased diversions into the Old River), an NPDES permit modification would be necessary. This could be problematic because a significant portion of the dilution flow at the current discharge location would consist of treated effluent. DWR was not asked by WWE about effluent reuse (because other reasonable options exist) and KDHE was asked only briefly about this concept. KDHE noted that the alternative would not be automatically rejected, but the constraints would be significant, as described above.

3.2 In-channel Ponds using Western Star Mill Dam and Second Dam at the Midway

As discussed in Sections 8 and 9, an effective means to address periods of no flow is to store water in the channel via a combination of one or more permanent dams and associated upstream dams that raise and lower (i.e., ―moveable" dams). In this concept, referred to in the Master Plan as in-channel or instream storage, there is a permanent downstream dam that backs up the water and then at the upstream end of the desired storage reach, there is a dam that raises and lowers. Under normal flow conditions, the moveable dam is down to permit continuous flow through the system. However, under drought conditions or when diversions are limited to small amounts, the upstream dam ―raises" and a pool is formed between the permanent, downstream dam and temporarily elevated upstream dam. Such dams and pools are integral to this Master Plan.

As shown on the attached profile drawings, during the master planning process, one or two in-channel storage approaches were evaluated. The first involves keeping the Western Star Mill Dam in its current configuration and allowing it to back water all the way up to the Old River Channel intake structure at Bill Burke Park beneath the levee. The second alternative consists of a lowered Western Star Mill Dam with an upstream dam that raises and lowers at approximately Mulberry Street, thus creating a ponded reach about 3,700 ft long. The second storage reach would occur at the Midway, where there would be a pool area approximately 800 ft long. Both of these reaches are proposed to be concrete lined (that is, both the bottom and sides of the channel would be lined). The concrete lining is valuable in various respects. For example, there would not be infiltration losses, and little or no infiltration is essential in those reaches where there will be restaurants, shops and other businesses located along the channel (their expectation is that there will be sufficient water in the channel for boating during dry year conditions). A concrete channel also facilitates sediment removal. The U.S. Army Corps of Engineers has indicated to WWE (see Section 15) that although concrete-lined channels are difficult to initially permit, if they are permitted, they can be maintained via a straightforward ―nationwide permit" rather than the more difficult-to-obtain ―individual permit" (see Section 15). Such channels can

also be aesthetic amenities, when integrated into the overall landscape design and interface between the channel and adjoining areas.

From an operational standpoint, the moveable dams will typically be raised during the summer when river flows at Mentor drop below 40 cfs and there is not divertible water. They will stay elevated until diversions resume. In extended dry periods, the upper pond at Midway will potentially be filled (―topped off") by the Lakewood pipeline. Additional pumping would provide enough water to make up evaporative losses in the lower (Western Star Mill) ponded reach.

Dams that raise and lower have been used in many locations around the United States and have been shown to be effective, reliable and maintainable. For example, such dams have been used in multiple locations on the South Platte River and Cherry Creek in the metro Denver area. In lower Cherry Creek (downtown Denver), these dams raise and lower to create a series of shallow pools in which boating is feasible. Locks have been integrated into the collapsible dams, which enable boats to move from downstream to upstream. A lock has been included for the dam at the Midway in the capital cost table (Section 17).

Section 8 addresses the nature of the one-dam and two-dam alternatives, including an evaluation of the condition of the existing Western Star Mill Dam. The bottom line is that with some enhancements and maintenance, the Western Star Mill Dam will be suitable for use in the future, and it will be feasible to construct a low (2 – 3 foot high) dam which would span a widened channel at the Midway.

It is important to recognize that although perhaps innocuous by appearance, low dams can pose significant public safety hazards unless they are properly designed and maintained. The hydraulics of such structures need to be carefully analyzed to assure that ―reverse rollers" are not created on the downstream sides of the structures, which would trap boaters and people who might be wading in the channel, especially children. Promoting safety of the restored river channel will be an objective of great importance as project planning and design proceed in the future.

3.3 Lakewood Park Recirculation System and Additional Existing or Constructed Storage

3.3.1 *Lakewood Park Lake*

During the Master Plan, it has been anticipated that water would be pumped from and returned to the Lakewood Park Lake to provide baseflow in the Old Smoky Hill River Channel during dry conditions or, alternatively, to make up evaporative losses in the concrete-lined ponded reaches formed by the Western Star Mill Dam. The decision as to which pipeline route and the pipeline capacity will be made during the final design phase when the final water rights permit has been obtained. For purposes of the Master Plan the pipeline is assumed to go to the pool formed by the Western Star Mill Dam.

The Lakewood Park Lake has been evaluated for both the existing lake volume and for an enlarged configuration. However, the lake enlarged condition would be problematic for ongoing

activities in the park surrounding the lake and has, for now, been discontinued from further consideration. The pumping system would have the following components:

1. A 2- to 10-cfs lowhead pump station on the west side of the lake, adjacent to Indiana.
2. A 12-inch (2 cfs) to 24-inch (10 cfs) diameter pipeline running from the pump station approximately one mile to connect the ponded area formed by the Western Star Mill Dam.

In the event that in the final design stage it is determined that the pipeline/route should go to Bill Burke Park, then components would include:

1. A discharge structure into the Old River Channel at approximately Indiana Avenue and Arlington Drive.
2. The Old River Channel would then carry the water for about 6 miles back to the east side of Lakewood Park lake.
3. A gated headgate and pipeline would return the flow in the channel directly to the Lakewood Park Lake. During times when flow in the Old Channel is sufficient and the lake is drawn down, this pipeline will be used to refill the lake (rather than rely exclusively on groundwater to refill).

A draft permit for this system at a capacity of 10 cfs was issued by DWR and is included in Appendix 2. Important provisions are found in the draft permit for the Lake and are summarized in Section 2 and in Appendix 2. It is important to recognize that the draft permit specifies that 75% of the diversion must be returned to the Lake for a flow rate of 10 cfs and that there is to be a maximum drawdown level (unspecified in the draft permit pending more technical analysis by the City and DWR). In addition, an August, 2010 interview of DWR conducted by the City indicated that in order to not forfeit the draft permit for this lake, the City must construct the necessary facilities in the first phase of the project. Accordingly, the Section 17 cost tables include these facilities in the primary phase, for a 2-cfs recirculating system.

Make-up water required to balance inflows and outflows to the Lake at Lakewood Park would potentially be provided by one or more of the potential supplemental sources described within this section, such as the golf course wells, and by periodic ―pulses" of divertible flow in drought years (see, for example, Figure 2–3h, which shows that even during the driest year on record, 2006, diversions were possible 7 times).

An alternative to utilizing lake water for recirculation that would involve significantly less pumping (and thus less groundwater drawdown) is to offset evaporative losses from the two ponded reaches (downtown Riverwalk and the Midway), described in Section 9. The surface area of the ponded reaches is roughly 7 acres, so the evaporative loss from May through August would be about 12 AF. This quantity is relatively small, given that the Lake's (at Lakewood Park) storage volume is 80 AF and the 12 AF of evaporative loss would be spread out over 4 months. As negotiations with DWR continue, this alternative operational approach will need to be reviewed, and the 75% required return volume in the draft permit will need to be adjusted or interpreted to allow the City sufficient time to refill the Lake. For example, if the lake is drawn-

down for a few months and significant divertible flows then become available, the City's intent would be to refill the lake with the proposed pipeline from the channel to the Lake. An interview conducted by the City with DWR in August, 2010 indicated that DWR is likely to have flexibility on the 75% factor if the design flow rate is 2 cfs, not 10 cfs.

As of the date of this Master Plan (August, 2010), the feasibility of the Lakewood Park Lake recirculation system has not been proven, and this should be considered a working concept. Indeed, members of the City's Infrastructure Advisory Team (IAT) and Master Plan Technical Advisory Committee (TAC) have expressed some concerns about the concept, including excessive drawdown to the local groundwater table, with associated impacts on wells within the influence zone and inadequate volume for long-term augmentation. The feasibility of this system should be carefully assessed as planning/design proceed in the future; feasibility will depend upon such factors as:

- Cost to construct and operate the system. WWE projects that the rough capital cost for a 10-cfs pumpback system would be approximately $4,000,000, while for a 2-cfs system, approximately $800,000. Annual operation, maintenance and replacement (O/M/R) costs for the 10-cfs system would be about $10,000 year in a dry year when operated in the months of July through September and for the 2-cfs system, about $7,000/year. The system would not need to operate in most years, and this is factored into the operation and maintenance costs in Section 16.
- The optimal flow rate would need to be determined. The logic behind the 2-cfs rate (which is included in the Phase 1 budget in Section 17) is that this would offset infiltration losses without imposing as much stress on local groundwater as a higher pumping rate, and this rate would be more conducive to meeting the conditions in the draft permit. However, 10 cfs would be valuable for maintaining channel water quality and limiting algae growth.
- Recharge to the lake from the adjoining and underlying aquifer. The relationship between the local groundwater table and the lake is not presently well defined, and the maximum extended pumping rate out of the lake that can be sustained by the groundwater has not been determined.
- Investigations to ensure that use of the lake will not reverse the groundwater gradient that presently trends from south to north, adversely affecting surrounding wells and potentially drawing in groundwater of poorer quality.
- Permitting considerations—for example, depending upon the nature of the pump station, a section 404 permit from the U.S. Army Corps of Engineers could be required. As another example, the KDHE could potentially require an NPDES discharge permit where the pipeline outfalls into the Old River Channel. Also, see discussion above regarding remaining draft water right permit topics to be negotiated with DWR.
- Public reaction could be negative; for example, fishermen might object to drawing the lake down.

- Weeds that are currently found in the lake should be carefully inventoried, because it would be ill-advised to enable the colonization of certain weeds into the Old River Channel via a recirculation system.

Despite these concerns, this recirculation system (or source of supplemental supply) has many attractive features. The acquisition of a water right from DWR for this system is highly significant. To assure that the draft water rights permit is not lost, a 2-cfs pumping system with a cost of $800,000 is included in the primary phase budget.

WWE has recommended to the City that a field test be conducted to determine how the lake and adjacent groundwater will respond to prolonged pumping. It was not feasible for the City to conduct this test while the Master Plan was ongoing. Temporary pumps would be installed, flows into and out of the lake would be measured, and groundwater levels would be monitored via piezometers.

3.3.2 *Other Storage Alternatives*

Representatives of the City, TAC and IAT briefly considered other potential lakes in the Salina metropolitan area. Gravel pits to the south of the city and on the west side of the Smoky Hill River were briefly considered, but none of these proved to be worthy of further study based on feasibility issues raised by the TAC members. For example, this alternative involved either a pipeline that was prohibitively expensive or pumping stored water into the river channel to convey it to the Old River intake. However, TAC members expressed the concern that during droughts, this relatively small amount of flow would soak into the channel bottom and not actually reach the intake. Storage options near Bill Burke Park were briefly evaluated and found to not be feasible due to cost and location.

3.4 Recommended Approach for Drought Period Operations

After considering the alternatives described above, the Master Plan recommends the following approach to future drought period operations:

1. The design includes instream ponding via the Western Star Mill Dam and a new dam to be constructed at the Midway. Moveable dams (dams that raise and lower) will be constructed in association with both of these permanent dams, thereby enabling ponded channel reaches to be created during droughts. Section 14, Water Quality and Aquatic Life, discusses steps to take during droughts to promote acceptable water quality in the instream ponds during droughts.

2. Despite the uncertainties associated with utilizing the Lake at Lakewood Park, the Master Plan includes this recirculation system in the preferred alternative, and capital and operation and maintenance costs are provided, accordingly, in Sections 16 and 17. The Master Plan recommends a 2-cfs recirculation system rather than a larger flow due to the conditions listed in the draft water rights permit for this lake (summarized in Section 2 and included in Appendix 2), along with uncertainties regarding what sustained rate of pumping the local groundwater system will be capable of providing.

3. The Master Plan recommends that the City secure additional water rights, and the Phase 1 budget includes $600,000 for this (see Section 17). WWE made initial inquiries into the availability of water rights for purchase between Kanapolis Reservoir and the City of Salina, and we attempted to find water rights transactions in the relevant area, but neither of these efforts provided tangible information. The $600,000 is strictly a conceptual projection.

4. Based on limited discussions with HDR, the potential for utilizing golf course wells for make-up water is promising. The Master Plan budget does not include capital or operation and maintenance costs for this alternative, but WWE recommends that the City further explore this as planning/design continue.

5. Regarding urban stormwater runoff that may enter the restored Old River Channel during drought conditions, the Master Plan recommends that the City move forward with the various stormwater quality management approaches described in Section 14.

The Master Plan has determined that with the combination of measures described above, in conjunction with efforts related to water quality protection and sediment management/ maintenance, it will be feasible for the City to maintain an attractive and usable restored Old River Channel under drought conditions. For perspective, it is important to reiterate that based on the divertible flow analysis in Section 2 and summarized at the start of this section, over 80% of the time (based on long-term data), it will be feasible to divert flows into the channel, and dry periods will be sporadic. During even the worst period of recorded streamflow in the Smoky Hill River at Salina (late in 2005 and throughout 2006), there were specific time periods when diversions would have been feasible, which would have replenished the instream ponds. Furthermore, the volume of water stored in the entire channel (63 acre-feet) and in the ponded area (24 acre-feet) are small, meaning that required make-up volumes to offset evaporation and seepage losses will be small as well.

4.0 NAVIGATION

One of the objectives of restoring the Old River Channel is to create boating opportunities. The Smoky Hill River Renewal Master Plan, Section 2, Figure 2.23, delineates boating areas for (1) normal water conditions, and (2) drought conditions. Normal water condition is defined as having a flow rate of 10 – 40 cubic feet per second (cfs) or greater. Under current normal water conditions, water is backed up in the channel from the existing Western Star Mill Dam a distance of about three-and-a-half miles, all the way to the levee at Bill Burke Park.

Water taxis, which are barge-type boats, are envisioned for the Central Channel Riverwalk reach that would extend upstream from Founders Park (Western Star Mill Dam) approximately 0.7 mile (3,700 feet) to just south of Mulberry Street (see profile drawings, immediately behind the engineering report). The minimum width of the concrete-lined channel to permit the water taxis to pass is 40 feet. Turnarounds for the water taxis must have a radius requirement of approximately 90 feet. The average overall width for the concrete-lined channel is approximately 60 feet. Upstream of the concrete-lined channel, there will be recreational boating for smaller craft such as canoes, kayaks, and small rafts. With the sediment removal that is recommended in the Master Plan, the typical water depth in the channel will be approximately 3.5 feet. [Note: As discussed in Section 5, the typical depth could be increased by roughly 0.5 ft to 1.0 ft (resulting in a depth of 4.0 – 4.5 ft) if the City chooses to do so during more detailed design.]

As described in Sections 8, 9 and 10, the Master Plan preferred alternative includes two dams—(1) the Western Star Mill Dam lowered by 2 feet, and (2) a new 2-foot-high dam at the Midway. Until such time as the Midway dam is constructed, the Western Star Mill Dam can remain at its existing elevation thereby maintaining the pool of water in the channel upstream to the levee in Bill Burke Park. The proposed Midway Dam would have the same elevation as the existing Western Star Mill Dam, and under normal conditions, water would once again pond back to the levee at Bill Burke Park. An 800-foot length of channel is proposed to be concrete lined centered on the Midway Entrance. The two-foot-high dam would provide a water feature and an integrated lock (hydraulic elevator) to allow passage of boats up and down the river channel. A consideration in the master planning of the channel is the goal of minimizing disruption of riparian vegetation and habitat along the corridor. The channel water surface width varies from approximately 40 feet in the Oakdale Park vicinity to minimum widths of about 24 feet in more confined reaches.

4.1 Low-Water Navigation

Questions have arisen as to whether it will be feasible to have boating during dry year conditions, when diversions are small or are prohibited by the Kansas DWR. In particular, it has been emphasized that in the downtown reach of the channel, there is a need to have adequate ponded water to provide water taxi traffic to promote shopping, restaurants and other activities. In the vicinity of the Midway Entrance water feature, a dependable ponded water pool is also needed. Through the use of the Western Star Mill and the Midway dams along with moveable dams, water will be stored in-channel to facilitate navigating long reaches of the channel during low-water conditions.

A moveable dam will be located at the upper end of the concrete-lined channel, upstream of the Western Star Mill Dam (see attached profile drawings). The moveable dam in the Primary Phase facilities about 0.45 miles upstream of the Western Star Mill Dam would be moved farther upstream when the additional 0.25 miles of concrete lining is constructed in a later phase. Two moveable dams that would ~~b~~racket" the permanent dam at the Midway will create a permanent pool with an 800-foot concrete-lined channel and perhaps another 800 feet of earth channel. The total length of impounded water would be about 4,500 to 5,300 feet with a corresponding surface area of approximately 6 to 7 acres.

In summary, in dry periods when no diversions are occurring, there would still be boating opportunity on approximately 4,500 feet of lined channel. During such periods, because there would not be diversions occurring, the water would be impounded and discharges over the Western Star Mill Dam would not be occurring, meaning that there would be little water in the Old River Channel downstream from the Western Star Mill Dam.

5.0 SEDIMENT MANAGEMENT

5.1 Key Questions Regarding Sediment

One of the major areas of analysis in the Master Plan was sediment management, including such questions as:

- How much sediment is presently in the channel?
- How much needs to be excavated? How much will this cost?
- Do the over 70 storm drains discharge significant sediment into the channel?
- What is the composition of the sediment that will be diverted into the channel?
- If the channel is restored and the levee gates are opened, how fast will sediment re-accumulate? Is there assuredly a need for sediment removal as part of the project?
- What will the visual appearance of water be with typical sediment levels in the Smoky Hill River?
- Could flows through the channel be increased enough to scour accumulated sediment and transport it in suspension to the outlet?
- What alternatives are available at or near the point of diversion to reduce sediment inflow? How much do these cost and what are their advantages and disadvantages? Which approach is preferred?
- For various alternatives, how much sediment will accumulate in the channel, how often will it need to be removed, and what will the long-term operation and maintenance costs be?

These questions are addressed in this section; related sections include 6, 9, 14, 15, 16 and 17 because sediment management interfaces closely with project considerations involving aesthetics and water quality, channel cross sections, costs, regulatory permitting and others. Appendix 5 provides additional detail on the topics covered herein.

Section 5 provides background on sediment, then presents three alternatives for managing sediment, including an alternative comparison and recommendation, and concludes with an evaluation of increasing the current maximum diversion rate of 100 cfs to promote sediment scour and downstream transport.

5.2 Background and General Considerations

5.2.1 Approach

The questions above were addressed by WWE, working closely with Mr. Ernest Pemberton, P.E., retired Chief Sediment Transport Engineer for the U.S. Bureau of Reclamation. Sediment

samples were collected and analyzed; past reports were reviewed (such as the 1978 Wilson & Company Master Plan, which devoted considerable attention to sediment); sediment data for the main Smoky Hill River channel and the Old River Channel (such as from City Utilities) were reviewed; the hydraulics of the river diversion were analyzed; interviews about sediment were conducted with members of the IAT, TAC and City staff, related to past sediment assessments and management approaches and costs; and technical and economic engineering calculations were performed for various sediment management alternatives. All sedimentation calculations were performed in accordance with standard U.S. Bureau of Reclamation sedimentation basin guidelines and widely accepted equations developed by Einstein (see Appendix 5 for more detail). The Master Plan has calculated sediment accumulation rates in the channel using a series of conservative assumptions (described below).

5.2.2 Sediment Deposits and Sources

As shown in the profile drawings of the river channel (see figures at end of report), there are extensive sediment deposits in the channel, primarily upstream of the Western Star Mill Dam. For perspective, however, it is important to recognize that (1) these deposits have built up from 1960 (when the bypass became operational) to the present, with no large-scale, significant sediment removal activities occurring, and (2) sediment deposits downstream of the Western Star Mill Dam are far less significant than upstream of the dam.

As indicated in such documents as the 1978 Wilson Master Plan and corroborated by grain size analysis conducted by WWE, the sediment load carried by the Smoky Hill River is a mixture of sand (roughly 2% by volume), silt (35% by volume) and clay (63% by volume). Based on review of USGS sediment data (see Appendix 5 for sediment distribution/probability graph in the Smoky Hill River), during times of heavy flow, main channel total suspended solids (TSS) concentrations can be 2,000 mg/L or higher and the water is very turbid, while under low or base flow conditions, the river is relatively clear, with TSS levels under 100 mg/L. For the sediment loading calculations in the Old River Channel under the various scenarios described in this section, WWE assumed an average annual flow through the channel of 40 cfs (see Section 2 for basis) and a TSS concentration of 200 mg/L (the mean concentration from USGS data), meaning that about 8,900 cubic yards (CY) of sediment would flow into the channel at the proposed river headgate annually, on average. This is a conservative scenario to evaluate. For example, during October through April, if diversions averaged 20 cfs rather than 40 cfs, the annual sediment load would be reduced by one-quarter (25%).

There are not enough particle size distribution data to determine how the composition of the sediment varies as a function of flow or precipitation, such as whether more clay occurs during times of high flow.

Comparison of river TSS data and projected flow volumes diverted into the channel (Section 2) with urban stormwater quality data (from the ―National Stormwater Quality Database" prepared by Dr. Robert Pitt of the University of Alabama–Birmingham) and runoff volumes from the 5-square-mile area that drains into the Old River Channel, indicates that on an annual basis, most of the sediment supply for the Old Channel will be from the Smoky Hill River rather than from stormwater. However, it should be recognized that even if all of the sediment from the main river were removed at the Old River inlet, there would continue to be sediment inflows from

storm drainage sources, including, as examples, wintertime sand use on streets and construction sites. Consequently, during and shortly after runoff events, turbidity levels in the restored channel will increase.

The relatively high instream TSS concentrations in the Smoky Hill River (see Appendix 5 for water quality data) are substantiated by observations of the Old River Channel. For example, Public Works Department staff have indicated to WWE that the current channel between the river and the levee in Bill Burke Park rapidly fills in with sediment. There have been extensive sediment deposits on the south side of Ohio Street, where there was reportedly an 84-inch diameter culvert (shown in the 1978 Wilson Master Plan) that is now completed buried by sediment. When the water level is down in the channel, extensive sediment deposits are visible in many locations, upstream of the Western Star Mill Dam. In the 1990s, the City began a sediment removal project in Oakdale Park, only to have the project shut down by the U.S. Army Corps of Engineers, reportedly for lack of a proper section 404 permit.

5.2.3 Significance of Sediment as a Design and Maintenance Issue

The available water quality data coupled with historic observations clearly indicate that sediment management will be an essential aspect of the restoration project. WWE recommends that the sediment management strategy be multifaceted in nature. For example, when sediment loads in the river are high, it would be preferable either to not make diversions into the Old River Channel or to "skim" water off the top of the river, where sediment concentrations will be smaller and bedload can be avoided, via a specially designed gate structure. In addition, sediment removal near the inlet needs to be provided, and two basic alternatives in this regard are presented below—one consisting of conventional sedimentation basins and the other a mechanical clarifier. Storm flows can be utilized to "sluice" some sediment deposits in the channel downstream, particularly if gates at one or two dams can be open during storm conditions. Despite all of these efforts, there will be the need for periodic sediment removal from the channel, which has important cost implications and regulatory requirements that must be accounted for, as discussed below. Provisions will need to be made for the disposal or reuse of sediments that are captured or removed from the channel.

Section 5.4 evaluates whether the present maximum diversion rate of 100 cfs from the main channel at the current intake pipe at Bill Burke Park could be increased to promote scour and downstream movement of the sediment.

As shown in the attached channel profile drawings at the back of this report, sediment will need to be removed from the Old River Channel in specific reaches to provide a suitable normal water depth of about 3.5 ft (as described in Section 9, as detailed design is conducted in the future, this 3.5-ft depth could be increased by 0.5 to 1.0 ft, which would be beneficial for maintenance, boatability, appearance and other reasons, but the excavation quantity would increase and care would need to be taken to not disrupt the current "seal" in the channel bottom). To the maximum extent feasible, there will not be sediment removal down to the original 1960 channel bottom, so as to maintain the present channel bottom seal, which is addressed in Section 6 of this report. For the one-dam alternative, WWE conceptually projects that 30,000 cubic yards of sediment would need to be removed, while for the two-dam alternative, 65,000 cubic yards of sediment would need to be removed. Substantial work will be required to accomplish this

sediment removal, as indicated by the high cost for this activity of $30/cubic yard provided in Section 17.[2] Access ramps will need to be created (30 are included), and numerous downed trees, debris, shrubs, etc., will need to be removed to gain access to the channel. The sediment will need to be dewatered, which is challenging with silt under favorable conditions, let alone in a channel with numerous storm drain outfalls. Designated locations for disposal of the excavated material will need to be provided, and all of the considerations (traffic, safety, noise, dust, etc.) that go along with hauling substantial fill out of a city will come into play. However, to restore the river channel, significant sediment removal is essential—there are no practical alternatives.

5.3 Sediment Management Alternatives

5.3.1 Overview of Alternatives 1, 2 and 3

The following sediment management alternatives were evaluated in the Master Plan, with considerable input from City staff, members of the TAC and IAT, and DSW: (1) utilize no sediment controls; (2) utilize various controls and management practices but *no* mechanical treatment, and (3) construct mechanical treatment facility (clarifier) near intake. Each of these is presented as follows. Backup for these alternatives is provided in Appendix 5, with cost information in Sections 16 and 17.

Alternative 1: *Adopt no sediment management/control measures*—Under this approach, no sediment control strategies would be adopted. Whenever diversions were being made from the Smoky Hill River into the Old River Channel, the sediment concentration in the river would carry through into the restored channel. There would be no special attempts made to control the time at which diversions were made, no special gates would be utilized on the intake structure, no sedimentation basins would be provided and there would be no special design features in the channel related to sediment.

Alternative 2: *Adopt multifaceted sediment management approach, but do **not** utilize mechanical treatment facility (mechanical clarifier)*—Under this scenario, multiple strategies would be utilized to reduce sediment inflows into the restored channel, including:

- **Monitor river flows:** When the sediment concentrations in the Smoky Hill River are high, diversions would be either reduced or ceased. The diversion threshold would be defined during more detailed design, by comparing current water quality data and river flows. If necessary, diversions could be automated in the future, by linking river intake/gate operations to a continuous water quality monitoring device in the river, likely at the Mentor gage. However, manual gate operations are recommended at first, as this may be sufficient.

- **River intake:** A specially designed, multiple gate intake structure at the river would be utilized to enable water to be withdrawn at multiple levels and, in

[2] WWE appreciates the input on this unit cost that we received from members of the City's Infrastructure Advisory Team [IAT], and Mr. Dick Brown of Salina; their descriptions regarding approaches to channel access, tree/debris removal, and sediment excavation were invaluable. To define the optimal method for sediment excavation, the City of Salina may want to conduct pilot (trial) removals in targeted channel reaches with qualified contractors.

particular, to enable relatively clean surface flows to be ~~"s~~kimmed off" the top of the river. During turbid, high sediment load periods, the gates will be operated for reduced diversions or in some instances closed (see sediment distribution curve in Appendix 5). The operations goal will be to exclude the sediment bed load (the larger particles that move along the channel bed) and to reduce the suspended load (particles that are found in the water column). WWE considered modifying the main river channel at the point of diversion to direct sediment away from the intake, via vanes and ~~"n~~otching" the concrete weirs that currently span the bypass channel to create a preferential flow path, but dropped these from further consideration due to concerns related to potential interference with the City's municipal water intake along with environmental and floodplain permitting.

- **Sedimentation basin:** A concrete-lined sediment settling basin about 40 ft wide, 500 ft long and 6 ft deep will be located on the river side of the levee in Bill Burke Park. There are two 20-inch diameter water lines that cross the inlet channel; therefore, the sedimentation basin would have two cells, one on each side of the city water line crossing. Nearly all of the sand and 40% – 45% of the silt will settle in the basin. The clay will pass through the sedimentation basin. It is expected that the settlement basin will collect about 1,550 CY per year with an average accumulated depth of roughly 1.5 feet. Operation and maintenance costs assume annual cleaning, as discussed in Section 16. If feasible, there should be a long-term agreement between the City of Salina and Corps of Engineers regarding sediment removal from this facility (see Section 14). The design parameters for this basin will need to be carefully checked during preliminary and final design; there is space available for a wider basin (and more total volume) if settleability analysis indicates that this would be cost-effective.

  WWE considered additional sedimentation basins in the channel just inside Bill Burke Park Levee, adjacent to the soccer fields. However, these were not given further consideration due to environmental permitting concerns (the channel in this reach has jurisdictional wetlands) and potential adverse neighborhood reaction. However, a design refinement that may have merit is to overexcavate the channel from approximately the soccer fields downstream to South Ohio, to create a long reach of preferential sediment deposition. This would keep the sediment in the upper channel reach in an area that is accessible, and reduce the frequency of required sediment removal. This should be further evaluated as design proceeds.

- **Storm drainage scour:** Storm drain inflows to the channel (with sediment average concentrations of less than 70 mg/L based on stormwater quality data from numerous sources) would be utilized to scour out accumulated sediment deposits, and techniques would be utilized to promote downstream sediment movement during storm conditions, such as by opening gates in the dam or dams to sluice sediment through the system. The 2-year peak discharge rate ranges from about 200 to 300 cfs upstream of the Western Star Mill Dam and up to 450 cfs above South Ohio Street. When flows of this magnitude are combined with a

base flow of 40 cfs (which could potentially be increased to 100 cfs to capitalize on the high storm flows), there will be scour and downstream transport of sediment in the channel, particularly in the narrower V-shaped channel reaches (in the North and South Reaches).

- **Annual sediment removal from Bill Burke Park sedimentation basin and periodic sediment removal from channel downstream of levee:** Sediment would need to be removed annually from the sedimentation basin in Bill Burke Park. The basin would likely be dewatered and construction equipment would remove sediment from the concrete-lined basin. This sediment would be dewatered by gravity in the vegetated area near the channel, and then trucked offsite. The COE has stated that this could occur with a nationwide permit (see Section 15).

  Sediment would need to be periodically removed from the rest of the channel, either hydraulically (i.e., by a conventional dredge or vacuum [suction] removal) or the channel would be drained and accumulated sediments would be excavated using construction equipment. Table 5–1 summarizes projected sediment deposition by location for Alternative 2. Table 5–1 is conservative in that it assumes a constant diversion rate of 40 cfs every day of the year; does not include periods of no diversion; includes no reduction due to ~~"s~~kimming" at the river intake; and assumes no benefit from periodic high storm flows (although the calculations also do not include sediment inflows from the stormwater discharges into the channel, discussed above). Table 5–1 indicates that sediment will accumulate upstream from the Western Star Mill Dam at a higher rate (conservatively about 3 inches/year) than downstream of the dam (roughly 1.5 inches/year), thus the frequency of required sediment removal will be higher in the upper reaches of the river. This instream TSS concentration for Alternative 2 are 166 mg/L upstream of the Western Star Mill Dam and 126 mg/L downstream of the dam. Sediment removal is discussed further in Section 5.3.2 and in Section 16, which provides costs, while permitting issues are covered in Section 15. Figure 5–2 provides a representation of some of the data in Table 5–1.

In summary, the philosophy of Alternative 2 is that the sediment inflow to the Old Smoky Hill Channel is a natural phenomenon for which reasonable provisions must be made. The plan will be to exclude river sediment to the extent practical and then deal logically with that which does enter through the gated river headgate structure, without mechanical treatment. Alternative 2 would remove all of the sand, roughly 40% – 45% of the silt and essentially none of the clay entering the Old River Channel in a typical year in the sedimentation basin. Appendix 5 provides more technical information on Alternative 2, while Sections 16 and 17 provide operation and maintenance costs and capital costs, respectively.

Table 5–1

Summary of Sediment Metrics for Alternative 2
(see Figure 5–2 for select data)

8,900	CY/Yr	Taken in at river diversion
– 1,550	CY/Yr	Deposited in Bill Burke Park sedimentation basin
7,350	CY/Yr	To reach #1, upstream of Western Star Mill Dam
– 1,740	CY/Yr	Deposited in reach #1
5,610	CY/Yr	To reach #2, downstream of Western Star Mill Dam
– 770	CY/Yr	Deposited in reach #2
4,840	CY/Yr	Pass through to main channel, consisting of clay and very fine silt, which remain in suspension

Total sediment into Old Channel = 8,900 CY/Yr
Total sediment deposited = 4,060 CY/Yr
Total sediment carried through = 4,840 CY/Yr

Deposited in channel = 2,510 CY/Yr
Deposited in sedimentation basin = 1,550 CY/Yr
Total = 4,060 CY/Yr

Average annual percentage of sediment removed in Bill Burke Park basin = 17%

Average annual depth of sediment deposit upstream of Western Star Mill Dam ≈ 3 inches, not including reduction due to scour/transport by storm flows and based on a series of conservative assumptions, described in the text

Average annual depth of sediment deposit downstream of Western Star Mill Dam ≈ 1.5 inches, not including reduction due to scour/transport by storm flows and based on a series of conservative assumptions, described in the text

Average annual TSS concentration in channel upstream of Western Star Mill Dam = 166 mg/L

Average annual TSS concentration in channel downstream of Western Star Mill Dam = 126 mg/L

Note: Average annual TSS in South Platte River in metropolitan Denver in range of 100 to 200 mg/L, for comparison

Alternative 3: *Construct a mechanical clarifier near the inlet to the Old River Channel and mechanically remove sediment to significantly reduce downstream loading and required frequency of sediment removal*—Under this scenario, a mechanical clarifier, either rectangular or circular in shape, would be designed for an average flow of 40 cfs or a peak daily flow of 100 cfs. A surface loading rate of 1,000 gal/ft^2/day is assumed, so the facility size would be substantial (200-ft diameter circular clarifier for 70% TSS removal). WWE assumes that this facility would be located on the soccer fields immediately north of Bill Burke Park (on the city side of the levee). This is similar to the clarifier proposed in the 1978 Wilson Master Plan. [Note: For various reasons, if a mechanical clarifier is adopted, it would be preferable to use two 120-ft diameter circular clarifiers rather than one 200-ft diameter facility. For example, one clarifier could be "down" for maintenance while the other functioned.]

Clarifiers remove settlable particles via settling (sedimentation). Two important variations of the basic circular and rectangular clarifiers were evaluated: (1) *with* chemical addition for coagulation/flocculation versus *without* chemical addition, and (2) collected sediment returned to bypass channel via slurry pipeline versus collected sediment in clarifier dewatered and shipped offsite.

Sedimentation analysis indicates that the use of chemical treatments such as alum or ferric chloride would be necessary to remove fine-grained sediment (fine silts and clays) from the inflows. If very high removal rates are required, a polymer (WWE assumed polyacrylimide for calculations and pricing) would be required as well.

If chemicals are not used for pretreatment, a conventional gravity clarifier would perform at about the same level as the Bill Burke Park sedimentation basins in Alternative 2; consequently, the additional cost of a mechanical system over a sedimentation basin could not be justified (see Table 5–2 for costs).

If chemicals to enhance coagulation and flocculation are used, the clarifier would have much higher sediment removal rates than the sedimentation basin called for in Alternative 2. The efficiency of sediment removal is a function of the surface loading rate (and hence the size of the clarifier, mixer and other facilities) and the types and amounts of chemicals used. With sufficient capital and operation and maintenance funding, the clarifier could produce very clear water. As discussed in Section 5.3.2, with chemical addition, the quantity of accumulated sediment increases substantially, and this material must be managed. Assuming that the City targets a total sediment removal percentage of 70%, the major components of mechanical clarification with chemical addition are described in Appendix 5, and include two 120-ft diameter circular clarifiers, pre-screening grit chamber, pumped slurry pipeline to wastewater treatment plant for drying and trucking of sediment/chemical mixture, about 10 acres of drying beds, and chemical feed/rapid mixing facility. WWE also analyzed the cost of a clarifier to produce 95% TSS removal, discussed in Section 5.3.2 (costs are provided in Table 5–2).

Two sediment management alternatives were evaluated for the mechanical clarifier: (1) sediment return line to river (as was the case in the 1978 Wilson Master Plan) and (2) dewater sediment/chemical mixture and truck offsite for use as fill or landfill. WWE

has determined that it would not be feasible to permit a return line to the Bypass Channel for many reasons. For example, the Smoky Hill River in this reach currently has a Total Maximum Daily Load (TMDL) for sediment. The addition of chemicals such as ferric chloride and a polymer would also be problematic with KDHE. Consequently, this option was eliminated from further consideration.

Dewatering could not practically occur at the soccer fields where the clarifiers are located because roughly 10 acres for drying would be required. Consequently, as noted above, the Master Plan includes a pipeline to the wastewater treatment plant, where dewatering and offsite shipping would occur. The solids content in this line would be high and pipeline operations and maintenance demands would be significant. Further discussion of sediment management for a clarifier is provided in Section 5.3.2.

Sediment accumulation depths in the channel for the clarifier with chemical addition upstream from the Western Star Mill Dam, assuming a target TSS removal of 70%, would be about 1 inch/yr and downstream of the dam roughly 0.50 inches/yr. At 95% removal, the TSS deposition rate upstream from the Western Star Dam would be about one-quarter inch per year, and one-eighth inch/yr downstream of the dam.

Table 5-2
Comparison of Sedimentation Alternatives
(Costs provided without allowance for design, permitting, master plan contingency or other adjustments defined in Section 17)

Sedimentation Alternative	Capital Cost	Annual O&M[3]	Present Worth Factor	Present Worth O&M	Total Present Worth	Removal Efficiency	mg/L in Channel Upstream from Western Star Mill Dam	Frequency Sediment Removal Upstream of Western Star Mill Dam (Yrs)[4]
Sedimentation Basins (500 foot length, 11 ft height walls, access road, 1200 CY concrete, Railings)	$ 900,000	$ 129,000[2]	23.1148	$ 2,982,000	$ 3,882,000	All sand, 40 [illegible] 45% silt, 0% clay	166	4
Clarifier (2-120 ft), Pre screening grit chamber, Slurry pumping, 10,000 LF pipeline, ~10 acres drying beds	$ 3,700,000	$ 99,000[1,2]	23.1148	$ 2,288,000	$ 5,988,000	All sand, 40 [illegible] 45% silt, 0% clay	166	4
Enhanced Primary Clarifiers with chemical feed (Ferric Chloride) additional cost for 70% TSS removal	$ 4,700,000	$ 393,000[1, 2, 5]	23.1148	$ 9,084,000	$ 13,784,000	All sand, 70% silt and 70% clay	60[6]	12
Enhanced Primary Clarifiers with chemical feed (Polymer) additional cost for 95% removal TSS	$ 4,700,000	$ 560,200[1, 2, 5]	23.1148	$ 12,949,000	$ 17,649,000	All sand, 95% silt and 95% clay	10[7]	>30

[1] Annual O&M Cost assumes that clarifier operates successfully, however, when the flow rates drop or stop, the sediments will be deposited and will have to be cleaned out.
[2] Does not account for sediment from other sources such as stormwater inflows, decaying vegetation/leaves/algae, or wind-blown dust and dirt.
[3] Annual O&M costs include costs for sedimentation facility and for sediment removal from the channel with power equipment utilizing the planned access points. Annual O&M components and costs (conceptual) are provided in Appendices 5 and 16.
[4] Assumes that channel sediment removal will occur when average accumulation depth is one foot, which leads to the indicated sediment removal frequencies. These required removal (clean-out) rates are conservative for the reasons described in the report text. Actual removal frequency is likely to be less than indicated.
[5] Due to the variations in sediment loading and flow rates from the Smoky Hill River, it is not practical to remove incremental volumes of sediment with mechanical clarifiers.
[6] Removes roughly three (3) times more sediment than the sedimentation basin, based on calculated TSS concentrations upstream of the Western Star Mill Dam.
[7] Removes roughly sixteen (16) times more sediment than the sedimentation basin, based on calculated TSS concentrations upstream of the Western Star Mill Dam.

The general philosophy of Alternative 3 is that most of the sediment should be removed at the inlet to the Old River Channel to concentrate it in a single location, significantly improve the clarity of the water, and sharply reduce the required frequency of sediment removal from the channel, thereby avoiding the need for frequent 404 approval from the Corps of Engineers.

5.3.2 Alternatives Comparison

Alternative 1 was quickly eliminated from further evaluation because it would not be reasonable to restore the Old River Channel only to have it rapidly fill in again with sediment. The incoming sediment load is simply too large to adopt a do-nothing strategy, even if the current sediment deposits are removed. Alternatives 2 and 3 have been evaluated, and are discussed further below. Each has advantages and disadvantages. When they are evaluated in the context of such criteria as capital cost, operation/maintenance/replacement cost, regulatory permitting constraints, aesthetic appearance of water flowing through the channel, etc., Alternative 2 is advantageous in some respects, whereas Alternative 3 is advantageous in others. The comparison concludes with an overall assessment of engineering feasibility and a recommended alternative for the Master Plan.

- *Capital cost*—At a conceptual level, capital costs were prepared for Alternatives 2 and 3 and are shown in Table 5–2. (Note that Table 5–2 shows that a mechanical clarifier without chemical additions produces the same TSS concentrations as Alternative 2, but at a much higher cost, so this alternative is given no further consideration.) The Alternative 2 capital cost would be approximately $0.9 million, while the Alternative 3 capital cost is approximately $4.7 million for 70% TSS removal and $4.7 million for 95% TSS removal as well. (The difference in cost between the 70% and 95% TTS alternatives is in annual operation and maintenance cost, as shown in Table 5–2.) The basis for these costs is provided in Appendix 5 and in Section 17, where the major components of the alternative were sized and priced. One special design challenge for a mechanical clarifier in this application is that the quantity and quality of river water to be treated are highly variable, with flows ranging from less than 5 cfs to 100 cfs, and TSS concentrations ranging from <100 mg/L to >1,000 mg/L.

  On the basis of capital costs, Alternative 2 has a clear advantage over both variations of Alternative 3, 70% and 95% TSS removal.

- *Operation and maintenance costs*—The major operation and maintenance (O&M) costs for Alternative 2 would consist of operating and maintaining the river headgate structure; annual cleaning of the sedimentation basin in Bill Burke Park; sediment removal once every four years in the reach of the channel upstream from the Western Star Mill Dam and once every 8 years in the channel downstream from the Western Star Mill Dam (conservative projections for removal frequency). The O&M cost estimates in Section 16 assume that it will be feasible to obtain permission from the U.S. Army Corps of Engineers to drain the channel once every 4 years to enable construction equipment to access the channel to remove the sediment. As indicated in Section 16, O&M costs for Alternative 2 would be significantly higher if the Corps prohibited occasional draining of the channel and sediment excavation, because in that case, sediment removal would occur

via dredging. The City would likely need a specially fabricated dredge for the boatable reaches that would also provide trash screening and removal.

The operation and maintenance costs for Alternative 3 include:

- River headgate structure.
- Operation and maintenance of the mechanical clarifier in Bill Burke Park.
- Chemicals, power, maintenance and component replacement. (Component replacement was not factored into Master Plan Costs but will need to be if a mechanical clarifier is utilized.)
- Management of the solids obtained from the clarifier, which will be conveyed via a pipeline to the wastewater treatment facility, where they will be dried (in drying beds).
- Removal of sediment from the channel upstream of Western Star Mill Dam once every 12 years, and downstream from the dam once every 25 years for 70% TSS removal. For 95% TSS removal, sediment cleaning would need to occur less frequently than once every 30 years upstream of the dam and every 50 years below the dam (neglecting other sources).

As shown in Table 5–2, the annual O&M cost for Alternative 2 including the sedimentation facilities and sediment removal from the channel is about $129,000, and about $393,000 for Alternative 3 at 70% TSS removal and $560,200 at 95% TSS removal. O&M costs favor Alternative 2 over Alternative 3.

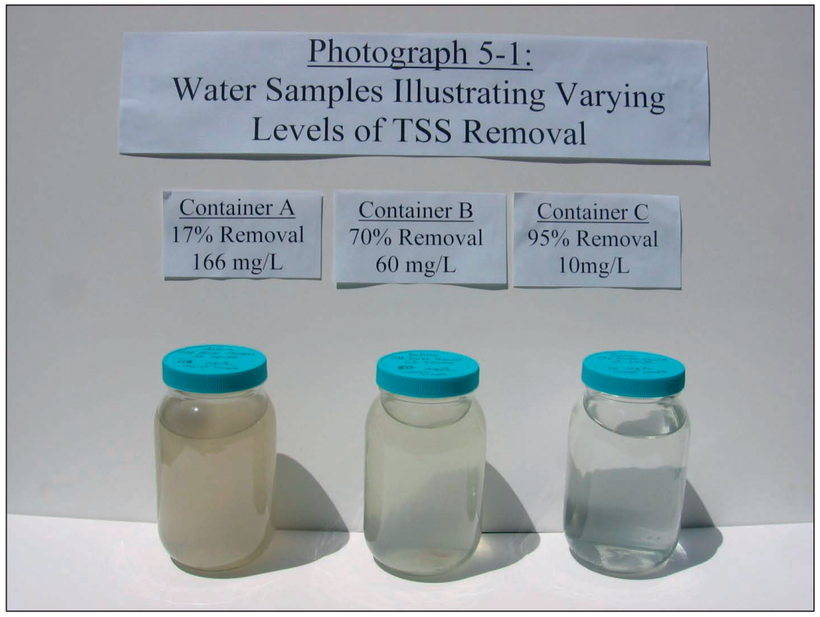
- *Total present worth cost*—The total present worth costs (see Table 5–2) are about $4 million for Alternative 2 and $14 to $18 million for Alternative 3. Alternative 2 has a significant total cost advantage over Alternative 3.

- *Water quality*—Under Alternative 2, the average annual TSS concentration upstream of the Western Star Mill Dam will be 166 mg/L, and 126 mg/L downstream of the dam. Under Alternative 3, for 70% TSS removal, these concentrations drop to 60 mg/L and roughly 50 mg/L, respectively. For Alternative 3, but with 95% TSS removal, the TSS concentrations upstream and downstream of the dam would be about 10 mg/L—very clear water.

  Relative to the reach upstream of the Western Star Mill Dam, to compare the clarity of the water under Alternative 2 and the two variations of Alternative 3, the samples shown in Photograph 5–1 were prepared. The water in Container A has a TSS concentration of 166 mg/L (Alternative 2); Container B has a concentration of 60 mg/L (Alternative 3/70% removal); and Container 3 has a concentration of 10 mg/L (Alternative 3/95% removal). These samples were prepared by WWE using actual sediment from the present Old River Channel bottom and were shaken vigorously just before the photograph was taken.

Please note that this comparison applies only to diversions from the Smoky Hill River channel into the Old River Channel that are treated via either Alternative 2 or Alternative 3; additional downstream sediment inputs from direct runoff into the channel, storm drain inflows, localized scour within the channel itself, algae, leaves other fine debris, etc., are not accounted for. Also, relative to Alternative 3, bear in mind that most of the channel will have compacted bottom comprised of silt and clay that the clear water will be running over, which will affect the appearance of the water.

In terms of water quality (and effectiveness of sediment removal), Alternative 3 is significantly better than Alternative 2.



Photograph 5–1. Comparison of water clarity with different levels of TSS removal.

- *Regulatory approval*—Removal of accumulated sediments on the channel bottom will require approval from the U.S. Army Corps of Engineers (Corps). The nature of the permit issued by the Corps will depend on where and how the sediment removal occurs. This subject is discussed in more detail in Section 15, but to summarize, if sediment is removed while a normal channel water surface is maintained (such as by using a dredge), the Corps would issue a straightforward nationwide permit. By contrast, if the channel is

first drained to provide sediment removal via earth-moving equipment such as front-end loaders, the Corps would issue a nationwide permit for those portions of the channel that have concrete lining, but for the other, unlined reaches, it would be necessary for the City to obtain an individual permit. Individual permits are more challenging than nationwide permits to obtain because they require practicable alternatives analysis, public comment, and are more expensive and time consuming to obtain. In addition, the Corps cannot provide assurance at the start of the individual permitting process that a permit will, in fact, be issued.

From a permitting perspective, Alternative 3 is significantly better than Alternative 2 because of the reduced 404 permitting burden with the U.S. Army Corps of Engineers (sediment removal upstream of Western Star Mill Dam under Alternative 2 conservatively once every 4 years versus once every 12 years for Alternative 3 with 70% TSS removal).

- *Neighborhood reaction*—WWE believes that the neighborhood reaction to two 120-foot circular clarifiers with associated buildings on the soccer field immediately west of Bill Burke Park and the levee would probably be negative (see Figure 5–3 and Photograph 5–2). Alternative 2 includes a sedimentation basin on the river side of the levee in Bill

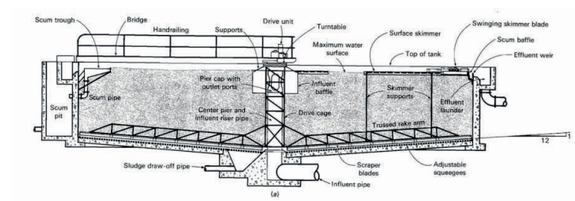
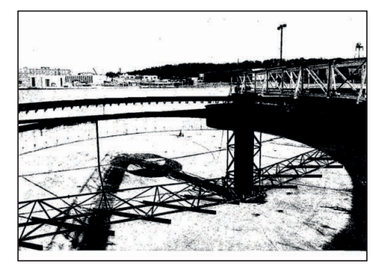


Figure 5–3: Typical circular primary sedimentation basin tank, center feed.



Photograph 5–2: Empty center-feed sedimentation basin equipped with sludge scrapers.

Figure 5–3 and Photograph 5–2 from *Wastewater Engineering: Treatment, Disposal and Reuse,* by George Tchobanoglous and Franklin L. Burton. McGraw-Hill Publishing Company, 1991.

Burke Park, although we do not anticipate as much concern with this facility. From an overall perspective, WWE projects that there would be less negative public reaction to Alternative 2 than to Alternative 3.

- *Summary and recommendation regarding sediment management approach*: On the basis of the evaluation above, WWE recommends that the City of Salina adopt Alternative 2 for sediment management, rather than Alternative 3. Although Alternative 3 has distinct advantages over Alternative 2, including (in particular) better water quality and reduced regulatory permitting burden, the additional present worth cost of approximately $10 million shown in Table 5–2 for the 70% TSS removal clarifier cannot be justified. Furthermore, the overall philosophy of the restoration project has been to acknowledge that the water quality in the main channel of the Smoky Hill River would be the water quality in the Old River, once the river has been restored and flow has returned on a regular basis. This approach is consistent with natural design principles, as opposed to creating a channel that would have mechanically treated, clear water.

5.4 Potential for Increasing Maximum Diversion to Greater than 100 cfs To Enhance Sediment Movement through Channel

Presently, the maximum diversion rate from the Smoky Hill River into the Old River Channel is 100 cfs[3], based on such factors as the size of the pipe beneath the levee at Bill Burke Park (54-inch diameter), the elevation of a concrete weir in the Bypass Channel located downstream from the confluence of the Bypass Channel and the Old River Channel; and hydraulic conditions in the Old River Channel downstream from the 54-inch outlet (i.e., elevated tailwater limits flow through the pipe). During both Phase 1 and early in the master planning process, the benefits and feasibility of increasing the 100-cfs capacity were conceptually evaluated. The benefits could include, for example:

- Increased scour of accumulated sediments.
- Increased flushing flow to move sediment downstream through the Old River Channel, thereby reducing the frequency of required sediment removal, with associated cost savings.
- Improved water quality.
- Re-creating more of a feel of ―flowing river," a desire expressed by various members of the public.

To increase the capacity from 100 cfs, it would be necessary to do one or more of the following: replace the current pipe with a larger diameter pipe; add additional pipes; increase the elevation of the weir in the Bypass Channel to provide a greater driving head at the 54-inch pipe entrance; and/or lower tailwater at the outlet of the 54-inch diameter pipe outlet.

[3] WWE performed hydraulic analysis to confirm that it is feasible to divert 100 cfs into the Old River Channel with the present key physical features (concrete weir in river, inlet channel, 54-inch pipe and Western Star Mill Dam crest elevation, which backs water up to intake pipe).

It is important to recognize that if inflow rates were to be increased, there would need to be a corresponding increase in the outflow capacity, where the Old River Channel presently discharges back into the Bypass Channel.

For various reasons, WWE has determined that it is not feasible to increase the maximum diversion from its present 100-cfs level, including:

1. The inlet and outlet pipes are part of the overall flood control system in Salina that was implemented in the 1950s and early 1960s by the federal government, primarily the U.S. Army Corps of Engineers. Federal approval would be required to increase diversion rates, with the lead agency likely being either the U.S. Corps of Engineers or the Federal Emergency Management Agency (FEMA). WWE believes that it would be a very difficult review and approval process to proceed through, without any certainty of approval, particularly since the federal government is concerned about any actions that could increase flood risk where levees are involved.

2. The proposal would likely trigger the need for an Environmental Impact Statement or Environmental Assessment, both of which would be time-consuming and expensive.

3. Increasing the elevation of the concrete weir in the Bypass Channel would require the approval of FEMA and would increase the regulatory 100-year floodplain and flood depths upstream from the weir. It is unlikely that FEMA would approve this.

4. In all likelihood, additional pipe capacity would necessitate excavating into the existing levee, which would trigger a series of concerns related to levee safety and potentially be at odds with the City's levee recertification activities and requirements.

5. In terms of the benefits that might be derived from higher flows transporting sediment downstream through the Old River Channel, a mean channel velocity of 2 – 3 feet per second would be required. For a rectangular channel 60 feet wide and 3.5 feet deep, this would require a flow of 400 – 600 cfs. This would require the present maximum diversion capacity to increase by a factor of 4 – 6. An increase of this magnitude would be extremely expensive.

6. The existing regulatory floodplain mapping for the Old River Channel would need to be revised, because FEMA would require that the 100-year flood flow consist of a combination of the peak diversion rate and the present 100-year flood peak in the Flood Insurance Study (FIS). This would lead to a larger 100-year regulatory floodplain and would cause properties to be located in the floodplain which are currently out of the floodplain. This would also trigger the need for a ―Letter of Map Amendment" (LOMA), which is the process required by FEMA to modify an existing floodplain map when the peak flow rate is modified. There would be considerable cost and time involved with acquiring a LOMA for the Old River Channel.

To summarize, for many reasons, WWE has determined that the City of Salina should not attempt to increase the present maximum diversion rate of 100 cfs through the Old River Channel, as part of the overall restoration plan.

5.5 Other Sediment Flushing Concepts

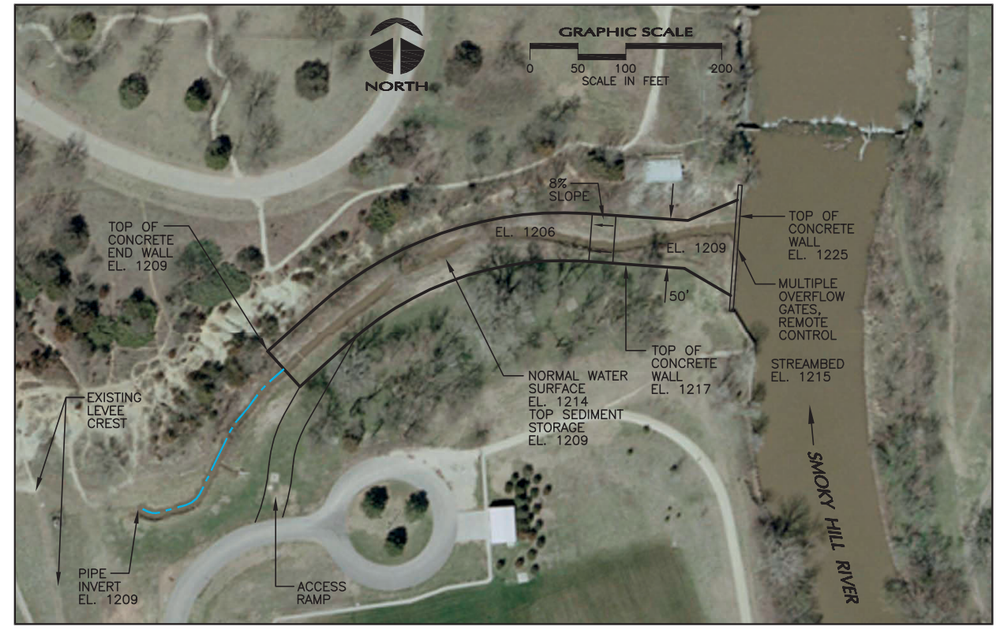
Other concepts for enhanced sediment flushing were briefly considered and found to be infeasible for the reasons given below, including:

- *Build sediment basins on the city side of the levee, and empty these at a high rate of flow*—Basins better located on river side of levee; water surface elevation in basins would be essentially same as in river so little driving head; limited volume of only 2.6 acre-feet; cost of high-capacity outlet high.

- *Elevate sedimentation ponds on side of levee via berms and pumps to provide supplemental dry year storage and capability to release large slugs of flow*—Basins better located on river side of levee; cost prohibitive due to pumping and building storage ~~-a~~bove ground," best to rely on gravity, not pumping.

- *Recirculation system variations*—Various recirculation alternatives were considered, but the required rates of flow where the channel is 60 ft wide and 3.5 ft deep are so large (over 400 cfs) that recirculation is not a suitable sediment management strategy.

Plot Date/Time: 08/02/2010, 08:22:10 AM; Z:\PROJECT FILES\10\101-002\101-002.000\CAD-GIS\CAD\FIGURE 5-1_SEDIMENT BASIN.DWG-RIVER INTAKE



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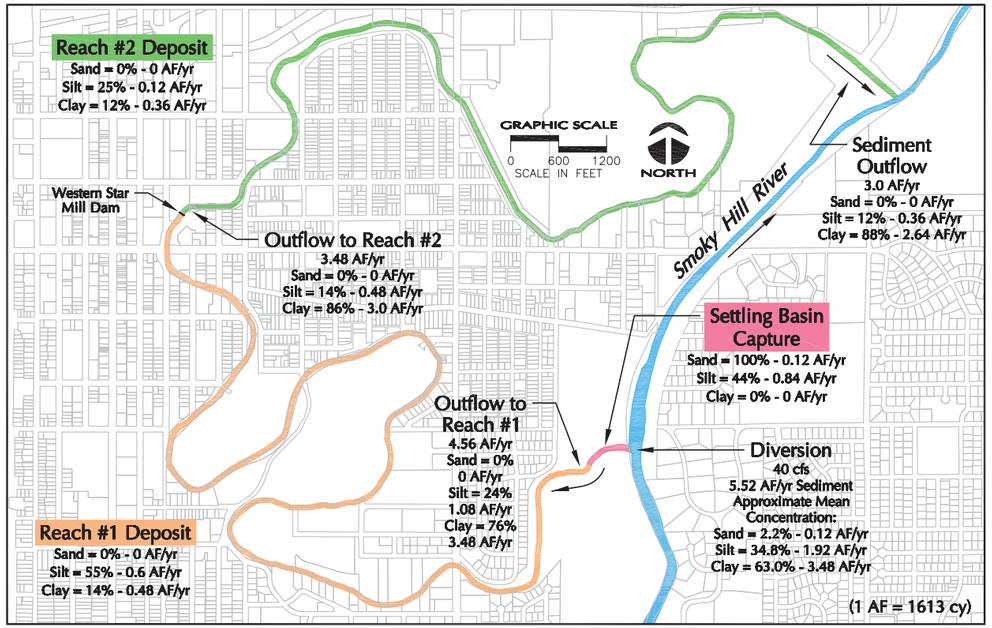
CHECK JEJ
DATE 08/02/10
SCALE 1"=100'

SMOKY HILL RIVER RENEWAL

SEDIMENTATION BASIN AND RIVER INTAKE

FIGURE 5-1

Plot Date/Time: 08/02/2010, 08:23:27 AM; Z:\PROJECT FILES\10\101-002\101-002.000\CAD-GIS\CAD\FIGURE 5-2_SEDIMENT DEPOSITION.DWG-SCHEMATIC



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SMOKY HILL RIVER RENEWAL
SCHEMATIC OF SEDIMENT DEPOSITION WITH 40cfs DIVERSION, ALL YEAR

FIGURE 5-2

6.0 CHANNEL BED HYDRAULIC CONDUCTIVITY

Although approximately one mile of the Old River Channel is proposed for concrete lining, this would leave about 6 miles of channel in an unlined condition. This raises the question about how much water will be lost due to infiltration into the channel banks and bottom.

The extent to which flows or ponded water will infiltrate is important in many respects, including water rights (Section 2), drought period operation (Section 3), boating (Section 4) and sediment removal to create boatable conditions (Section 5), among others. As shown in Appendix 6, WWE used these methods for estimating infiltration rates:

1. Reviewing geologic and hydrologic (municipal well field) reports and data;
2. Relating sediment classifications (based on grain size distribution as determined in previous studies on the Old River Channel and independently by WWE based on recent sediment samples from the channel) to published permeabilities;
3. Conducting laboratory tests for hydraulic conductivity on actual channel sediment samples; and
4. Calculating losses over the full length of the channel for various assumed channel geometries and depths.

Depth to groundwater data provided by the City indicate that the groundwater table is typically below the channel bottom, meaning that the overall channel normally loses flow to groundwater rather than gains flow from groundwater.

Channel bottom sediments consist of about 2% sand, 35% silt and 63% clay, based on particle size distribution analysis for samples upstream from the Western Star Mill Dam. With 98% of the material silt/clay (and predominantly clay), it is apparent that infiltration potential should be small, by reference to published literature. In addition, laboratory tests for infiltration were conducted. These confirmed the tight nature of the material. This is not surprising, given that the channel has been accumulating sediment since the bypass was constructed and water levels have repeatedly gone up and down in the channel, causing some hydrocompaction.

Five test hole samples at two-foot depth were collected and tested for hydraulic conductivity by Kaw Valley Engineering (KAW) under contract to WWE. The samples were collected in March 2010 at the locations shown on Figure 6–1. KAW testing of the samples indicated that the silt and clay under the Old Smoky Hill channel is tight; that is, the clay under the Old Smoky Hill Channel has a very low hydraulic conductivity as shown in Table 6–1.

Table 6–1

Hydraulic Conductivity for Samples Collected in Old River Channel

Hole	Conductivity cm/sec
Test Hole 1	2.7×10^{-7}
Test Hole 2	8.7×10^{-9}
Test Hole 3	2.8×10^{-8}
Test Hole 4	3.8×10^{-9}
Test Hole 5	3.9×10^{-9}

To relate the metric system conductivity values in Table 6–1 to English units, the attached conversion table (Table 6–2) can be used. All of the values in Table 6–1 indicate that the rate of infiltration is less than 1 ft/yr.

In essence, the KAW test results show the channel bed permeability is extremely low, and that as excavation occurs to restore the river channel, it would be prudent to keep some of the sediment intact to preserve the ~~"s~~eal" that currently exists. The sediment excavation plan, shown on the profile drawings at the back of this report, assumed that some of the existing silt/clay deposits remain throughout the channel to maintain its tightness. However, as discussed in Section 9, as design proceeds and if the City desires, the channel could be excavated by 0.5 to 1.0 ft more than shown on the attached profiles without compromising the tightness of the channel bottom. This would provide additional depth for boating, aquatic life and sediment accumulation (thereby reducing the frequency of sediment excavation).

Due to the very low permeability of the existing channel, WWE did not explore alternative approaches to reduce permeability such as chemical amendments to the soil, use of synthetic liners, importing additional clay or other. As noted above, about 4,500 ft of the channel is proposed for concrete lining. However, if negotiations with the U.S. Army Corps of Engineers (see Section 15) indicate that it will be problematic to construct a concrete bottom, the existing channel bottom will have low permeability.

The excavated sediment would probably be useful as a liner at another location, provided that the material is properly compacted and is at optimum moisture content. This subject should be discussed further with a geotechnical engineer.

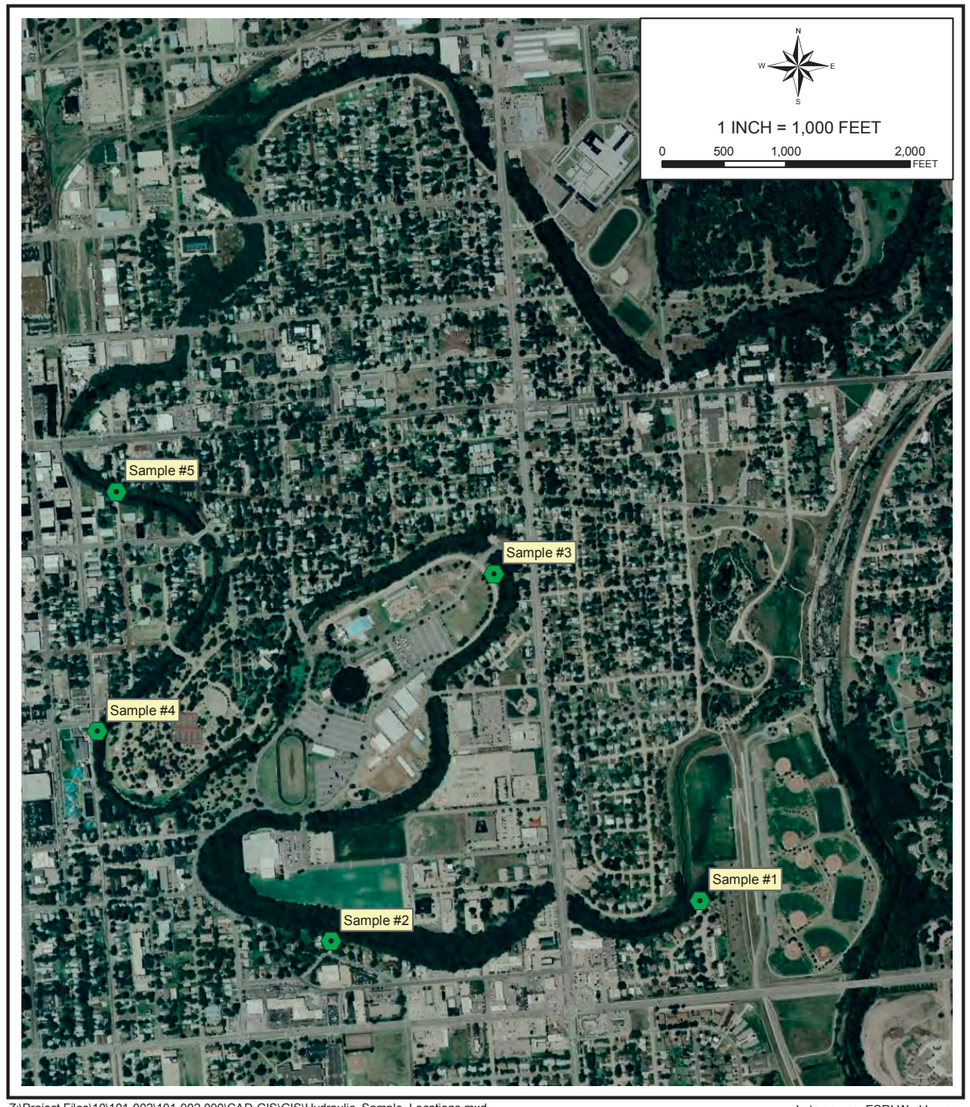

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photo source: ESRI Worl Imagery

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SALINE COUNTY, KANSAS

HYDRAULIC CONDUCTIVITIY TEST LOCATIONS

PROJECT NO. 101-002.000

FIGURE 6-1

29 *Physical Properties and Principles / Ch. 2*

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

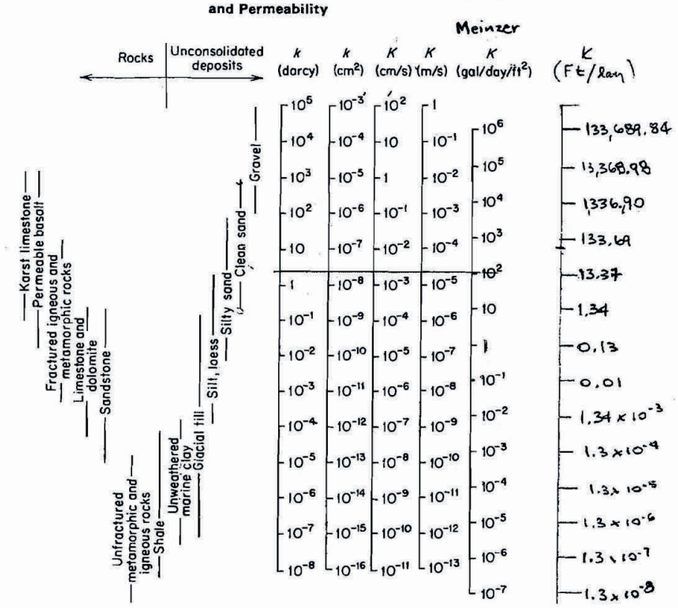


Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm²	ft²	darcy	m/s	ft/s	U.S. gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

*To obtain k in ft², multiply k in cm² by 1.08×10^{-3}

Table 6–2

WRIGHT WATER ENGINEERS, INC.

7.0 SEDIMENT CHARACTERIZATION SAMPLING AND BROWNFIELDS INVENTORY SURVEY

7.1 Sediment Analysis

A key component of channel restoration is removal of some sediments from the Old Channel bottom to increase water depth (enabling boating), improve appearance and increase conveyance capacity. Sediment removal is proposed for locations as shown in the attached profile and cross section drawings (drawings at end of report).

To determine the appropriate disposal method for the excavated sediment, it was necessary to characterize the chemical constituents. Sediment samples were collected by Kaw Valley Engineering (KAW) under contract with WWE approximately every 500 lineal feet at depths of 2 feet and 4 feet and mixed together. Continental Analytical Services (CAS), also under contract with WWE, batched three samples together for one test. A total of fourteen composite samples which represent 84 individual samples were tested by CAS as to waste characterization, land application suitability and organics.

Data in Table 7–1 show that no measured parameters exceed Appendix A, Tier 2 concentrations for Soil Pathway, Residential Scenario, which is the more restrictive of the two possible scenarios (residential and nonresidential). These parameters were established by the KDHE Bureau of Environmental Remediation. In a telephone interview that WWE conducted with Mr. Arthur Fink, KDHE Bureau of Environmental Remediation, he stated that, based on the data in Table 7–1, there should be no restrictions on subsequent use or disposal of the removed soil, including land application. A final decision on this matter would depend on whether there is a reason to believe that the soils might have been impacted by pollutants not included in the Waste Characterization or Land Application analytical parameter sets that provide the basis for Table 7–1. This could be the case if, for example, a known industrial activity with pollutant types not listed in Table 7–1 potentially discharged into the channel, such as dry cleaners and grain elevators.

Without additional information about specific local sources of potential pollutants, an exhaustive set of all potential pollutants was not feasible for the initial screening tests on channel bottom sediments. Therefore, the subset of parameters included in Table 7–1 was selected for analysis. Table 7–1 includes commonly used analyte screening suites found to be of concern for Waste Characterization (11 analytes: metals, pH, and solids), Land Application Suitability (10 analytes: metals and nutrients), and Organics (44 analytes: pesticides, PAHs, PCBs, and organochlorine pesticides). This is a broad list of contaminants.

7.2 Brownfields Inventory Survey

After the initial chemical screening tests were complete, additional information became available concerning potential pollutants through a Brownfields Inventory Survey (BIS) report dated June 10, 2010. The BIS, prepared for Region 7 USEPA by Seagull Environmental Technologies Inc. ("City of Salina River Channel Brownfields Inventory Survey", Mini-Superfund Technical Assessment and Response Team (Mini-START), Contract No. EP-S7-09-01, Task Order No. 0021, June 10, 2010), contains information relevant to Mr. Fink's comment concerning the

possibility that channel sediments might have been impacted by industrial activities in the vicinity. The BIS is provided in Appendix 7.

The BIS encompassed both the Smoky Hill River Channel and the Lee and Mills Districts in downtown Salina, and identified a potential Brownfields site if it (1) was listed in any environmental databases, (2) contained potential ―recognized environmental conditions" (RECs) from current site use, (3) contained potential RECs from historical site use, or (4) was underutilized and/or vacant. The survey team identified 116 potential Brownfields sites from 248 surveyed properties. No attempt was made to determine whether the potential RECs had adequate protective measures in place for environmental protection.

Seagull's survey of the river channel focused on commercial areas along Elmhurst Boulevard and Crawford Avenue in the southern section of the river channel, along 4th and 5th Streets near the western edge of the river channel and along North Street in the northern section of the river channel. Relevant findings from the BIS for the river channel areas are:

1. Total river channel sites surveyed = 115

2. Total river channel potential Brownfields sites identified = 37

   A. Sites in environmental databases = 5
      i. Municipal waterworks
      ii. Kansas State hazardous waste sites
         a. Great Plains Salina Plant 2
         b. Great Plains Salina Plant 7
         c. Great Plains Diesel
         d. City of Salina Household Hazardous Waste Facility

   B. Sites with historic use potential RECs = 0

   C. Sites with current use potential RECs = 14
      i. Sites related to automobile use (gasoline stations, car dealerships, auto repair, etc.) = 10
      ii. Dry Cleaners = 2
      iii. Other chemical uses (pest control, public laundry, etc.) = 2

   D. Sites underutilized or vacant = 18

Because the BIS did not include a soils sampling program, only potential RECs could be identified. It is significant that, in the river channel area, only municipal facilities appear in the environmental databases, and that no historical potential RECs were found. This suggests that all the surveyed sites with current potential RECs seem to have adequate protective measures in place, since they do not appear in the environmental databases.

Although not all of the contaminants that might have been potentially released by the identified potential Brownfields sites are included in Table 7–1, the fact that none of the 65 analytes measured were found to exceed Appendix A, Tier 2 concentrations for residential use, suggests that it is unlikely that river channel sediments are currently impacted by industrial sources.

However, based on findings of the BIS, prior to commencing with sediment excavation, WWE recommends that the City of Salina contact the KDHE Bureau of Environmental Remediation to determine if they will require any additional testing of the channel bottom sediments.

Table 7.1 - Old Smoky Hill Channel Sediment Sampling Results

Constituent	Units	Tier 2 - Risk Based Screening Level	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13	Sample 14	Maximum
Waste Characterization																	
Arsenic, Total, ICP	mg/kg	11	2.8	2.4	3	2.5	2.9	3	3.6	4.7	5	5.5	6.5	3	3.4	4	6.5
Barium, Total, ICP	mg/kg	5500	120	127	109	104	116 QC	93.8	101	123	136	133	153	113	121	126	153
Cadmium, Total, ICP	mg/kg	39	0.3	0.3	0.3	0.3	0.9	0.4	0.7	0.6	0.7	0.7	1	ND(0.9) M	0.7	1.4	1.4
Chromium, Total, ICP	mg/kg	390	8.9	8.3	7.3	6.8	10.1	9.6	11	15	17	18	15.8	14.8	13.3	16	18
Lead, Total, ICP	mg/kg	400	5.3	5	4.9	12.1	9.3	17.4	20	14	14	20	17	65.9	29	38	65.9
Mercury, Total	mg/kg	2	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
Selenium, Total, ICP	mg/kg	390	0.6	0.6	ND(0.5)	ND(0.5)	0.7	0.6	ND(1)	ND(1)	ND(1)	1	ND(2)	ND(2)	0.9	1.4	1.4
Silver, Total, ICP	mg/kg	390	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.4)	ND(0.5)	ND(0.5)	ND(0.4)	ND(0.5)
pH, (1:1 Water Extraction)	Std. units		7.72@23C	7.91@23C	7.87@22C	7.81@22C	7.78@22C	8.12@22C	7.70@22C	7.70@22C	7.62@22C	7..39@22C	7.52@24C	7.78@24C	7.77@24C	7.68@21C	8.12@22C
Solids, Total	% by weight		75.1	77.2	76	75	73.7	71.3	68.3	62.5	63.6	59	61.1	60	65.8	67.2	77.2
Solids, Total Volatile	% by weight		3	1.9	1.5	1.5	2.2	2.2	3.7	4.4	4.5	5.4	3.3	2.6	3.1	5.5	5.5
Land Application																	
Copper, Total, ICP	mg/kg	2900	6.9	6.2	4.3	3.7	6.9	6.4	8.6	10	12	13	13.6	7.51	10.6	14.6	14.6
Molybdenum, Total, ICP	mg/kg		ND(0.5)	ND(0.5)	0.8	0.5	0.6	0.7	ND(1)	ND(1)	1	1	0.8	ND(0.5)	ND(0.5)	1.8	1.8
Nickel, Total, ICP	mg/kg	1600	8.6	7.9	7	6	8.2	8.3	9.6	13	15	16	13.5	7.4	10.8	18	18
Zinc, Total, ICP	mg/kg	23000	24.4	22.1	21.5	24.6	30.8 QC	37.2	63.3	50.3	57.9	62.3	56.1	49.3	48.9	94	94
Kjeldahl Nitrogen, as N	mg/kg		540	440 J	ND(500)	570	550	460 J	700	720	850	920	1120	710	830	930	1120
Ammonia by Distillation, as N	mg/kg		10	11	15	21	29	28	72	83	128	187	130	104	120	90	187
Organic Nitrogen, as N	mg/kg		530	429 J	ND(10)	550	520	430 J	630	640	720	730	990	610	710	840	990
Nitrate/Nitrite, as N (FIA)	mg/kg		2.9	2.5	ND(1.0)	ND(1.0)	1.1	1.1	1.5	1.2	ND(1.0)	ND(1.0)	1	1	1.8	2.7	2.9
Phosphorus, Total, as P	mg/kg		ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
Potassium, Total, ICP	mg/kg		2000	1760	1540. QC	1370 QC	1820. QC	1970. QC	2120. QC	3210. QC	3720. QC	4000 QC	4400	1700	3200	3100	4400
Organics																	
4,4'-DDD	mg/kg	35	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
4,4'-DDE	mg/kg	25	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
4,4'-DDT	mg/kg	25	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
a-BHC	mg/kg	6.4	ND(0.01) QC	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
a-Endosulfan	mg/kg	11	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Aldrin	mg/kg	0.5	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
b-BHC	mg/kg	6.4	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05) QC	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
b-Endosulfan	mg/kg	11	ND(0.01) QC	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Chlordane	mg/kg	24	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.1)	ND(0.1)	0.04	ND(0.2)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.4)	ND(0.4)	ND(0.4)	ND(0.4)	0.04
d-BHC	mg/kg	6.4	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2) QC	ND(0.2) QC	ND(0.2) QC	ND(0.2) QC	ND(0.2)
Dieldrin	mg/kg	0.53	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Endosulfan Sulfate	mg/kg	11	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Endrin	mg/kg	20	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Endrin Aldehyde	mg/kg	20	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
g-BHC (Lindane)	mg/kg	6.6	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
Heptachlor	mg/kg	1.9	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.11 RB)	ND(0.11 RB)	ND(0.11 RB)	ND(0.11 RB)	ND(0.11)
Heptachlor Epoxide	mg/kg	0.87	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.05)	ND(0.05)	ND(0.01)	ND(0.1)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.1) RB	ND(0.1) RB	ND(0.1) RB	ND(0.1) RB	ND(0.1)
Methoxychlor	mg/kg	44	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.50)	ND(0.50)	ND(0.10)	ND(1.0)	ND(0.50)	ND(0.50)	ND(0.50)	ND(2.0) QC	ND(2.0) QC	ND(2.0) QC	ND(2.0) QC	ND(2.0)

Constituent	Units	Tier 2 - Risk Based Screening Level	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13	Sample 14	Maximum
Toxaphene	mg/kg	7.7	ND(0.50)	ND(0.50)	ND(0.50)	ND(2.5)	ND(2.5)	ND(0.50)	ND(5.0)	ND(2.5)	ND(2.5)	ND(2.5)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Polynuclear Aromatics						M	SR	SR M	M				M	M	M	SR	
Acenaphthene	mg/kg	300	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Acenaphthylene	mg/kg		ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Anthracene	mg/kg	13	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Benzo(a)anthracene	mg/kg	12	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2) IL	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Benzo(a)pyrene	mg/kg	1.2	ND(0.5)	ND(0.5)	ND(0.5)	ND(1) IL	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Benzo(b)+(j)fluoranthene	mg/kg	12	ND(0.5)	ND(0.5)	ND(0.5)	ND(1) IL	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Benzo(g,h,i)perylene	mg/kg		ND(0.5)	ND(0.5)	ND(0.5)	ND(1) IL	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Benzo(k)fluoranthene	mg/kg	10	ND(0.5)	ND(0.5)	ND(0.5)	ND(1) IL	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Chrysene	mg/kg	6.4	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2) IL	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Dibenz(a,h)anthracene	mg/kg	1.2	ND(0.5)	ND(0.5)	ND(0.5)	ND(1) IL	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Fluoranthene	mg/kg	220	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Fluorene	mg/kg	270	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Indeno(1,2,3-cd)pyrene	mg/kg	0.76	ND(0.5)	ND(0.5)	ND(0.5)	ND(1) IL	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Naphthalene	mg/kg	104	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
Phenanthrene	mg/kg		ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2)	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1) QC	ND(1)	ND(1)	ND(0.5)	ND(2)
Pyrene	mg/kg	140	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(2) IL	ND(1)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(1)	ND(1)	ND(0.5)	ND(2)
PCB-1016	mg/kg	4.3	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.10) M	ND(0.10) M	ND(0.05)	ND(0.05)	ND(0.10) M	ND(0.05)	ND(0.10) M	ND(0.10) M	ND(0.10) M	ND(0.10)
PCB-1221	mg/kg	4.3	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)
PCB-1232	mg/kg	4.3	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)
PCB-1242	mg/kg	4.3	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.10) M	ND(0.10) M	ND(0.05)	ND(0.05)	ND(0.10) M	ND(0.05)	ND(0.10) M	ND(0.10) M	ND(0.10) M	ND(0.10)
PCB-1248	mg/kg	4.3	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.10) M	ND(0.05)	ND(0.10)
PCB-1254	mg/kg	4.3	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	0.06	0.08	ND(0.05)	0.08
PCB-1260/1262	mg/kg	4.3	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)
Organochlorine Pesticides					CP	M SR CP	M CP	CP	M SR CP	M SR CP	M SR CP	M SR CP	M	M	M	M	

A - Appendix A, Tier 2 risk-based soil screening level, residential scenario. Risk-based standards for Kansas, RSK Manual - 4th Version, June 2007.
ND - Not Detected. Detection Limit is given in ().
CP - Copper cleanup, M3660B was performed on sample and all applicable batch QC samples.
IL - Due to matrix interference, the internal standard for analyte was below imposed or required method control limit. Reported sample concentration is estimated.
J - The concentration or ND is an estimated value below the reporting limit but above the MDL. CAS has demonstrated we can achieve this level in reagent water but not in all sample matrices.
A detectable result has not been verified.
M - Reporting limit higher than normal due to matrix interferences.
QC - Data qualifiers were noted. See the Quality Control Report.
SR - One or more surrogate recoveries for this analysis did not meet quality control limits. Please see the Quality Control Report for the sample surrogate data.

8.0 DAM ALTERNATIVES

The existing Western Star Mill Dam, located downstream of East Iron Avenue, has a crest elevation that, when the gates are closed, will back up water to the inlet levee at Bill Burke Park. As part of the master planning process, dam alternatives addressed included: (1) retain Western Star Mill Dam at its current elevation, (2) lower the Western Star Mill Dam and provide a second dam in the vicinity of the Midway, (3) eliminate the Western Star Mill Dam to provide free flow, and (4) remove Western Star Mill Dam and build new dam in vicinity of Ash Street. The river restoration master planning, with regard to dams, was the use of one or two permanent dams and the use of moveable dams to provide permanent pools of water in drought periods.

The third alternative, to provide "free flow," could essentially be achieved by simply leaving the gates open on the Western Star Mill Dam and sediment removal to provide a continuous grade. There is very little fall on the Old River channel, 11 vertical feet in a distance of 6.8 miles (36,000 feet) for a slope of 0.0003 feet/feet. With this very low channel slope, the velocity is less than 1 foot per second which will not visibly appear "free flowing." Due to the desire to maintain a permanent pool of water in a drought period, this alternative was not evaluated further.

The fourth alternative of removing the Western Star Mill and building a new dam near Ash Street was suggested as a means to provide additional boating in the channel. At Ash Street, the channel area is relatively narrow and it would be difficult to fit in sluice gates and a bypass channel such as exist on the Western Star Mill Dam. The existing sluice gates are helpful in bypassing flows and flushing sediments. Additionally the capital cost to construct a new dam when the existing Western Mill dam is satisfactory does not provide an acceptable benefit cost.

WWE retained Olsson Associates to perform an evaluation of the Western Star Mill Dam. Olsson's technical memorandum is in Appendix 8.

Attached at the back of this report are two profile drawings of the Old Smoky Hill Channel:

- One-Dam Alternative with the existing Western Star Mill Dam at its current crest elevation of 1212.2 feet (per City email of January 18, 2010), and
- Two-Dam Alternative with the Western Star Mill Dam crest elevation lowered to 1210.0 feet and the addition of a second dam near the Midway with a crest elevation of 1212.0 feet.

Considerations in the one- or two-dam alternative are discussed in Section 4, Navigation, and the advantages and disadvantages of one dam and two dams are summarized in Table 8–1.

The sediment quantity removal for the One-Dam Alternative is approximately 30,000 cubic yards (CY) and for the Two-Dam Alternative approximately 65,000 CY. If the dams are constructed in phases, as recommended by the Master Plan, it is recommended that the City excavate all 65,000 CY up front, rather than only 30,000 CY.

Table 8-1

Advantages and Disadvantages of One Dam vs. Two Dams

	Advantages	Disadvantages
One Dam	• Lower Cost • Less sediment removal • Historic nature maintained • More continuous flat water for canoes	• Higher backwater at storm sewers • Less clearance under bridges
Two Dams	• Benefit to some storm sewers • Aesthetics of falling water • Additional clearance at some bridges • Waterfront enhancement of Ohio Street/Downtown Gateway Boulevard, of the Convention Center site entry and of the proposed hotel site	• Higher cost • Maintenance of second dam • Removal of more of the clay seal • Less continuous lake surface area

The preferred Master Plan alternative (at project build-out) is the Two-Dam Alternative, primarily because from an overall planning perspective, two dams provide more benefits than one (although the primary phase begins with a single dam—the Western Star Mill Dam at its current elevation). The Western Star Mill Dam with its current crest elevation of 1212.2 will pond water back to the pipe in the inlet levee which has a bottom of pipe elevation of 1208.0 feet and a top of pipe elevation of 1212.5 feet. Lowering the crest elevation of the Western Star Mill Dam will increase the fall available to move water through the channel when the Western Star Mill Dam sluice gates are closed and will lower the backwater on storm sewers that outfall into the Old Smoky Hill channel. Lowering the Western Star Mill Dam to elevation 1210.0 and removing sediment nearly to the 1960 level would provide an increased slope on the water surface at a flow of 40 cfs.

Boater safety will need to be accounted for as final planning and design for the dams moves forward. For example, it will likely be necessary to place rock against the downstream face of the Western Star Mill Dam to eliminate the nearly vertical drop at the present structure. The new dam at the Midway will need to be designed to prevent a reverse roller in the channel immediately downstream from the dam.

In addition to the Western Star Mill Dam and the Midway dam, moveable dams as described in Sections 3 and 4 are proposed to provide reaches of ponded water during dry periods. Descriptions and illustrations of moveable dams are provided in Appendix 8. The proposed locations of the moveable dams are shown on the drawings behind this report and in a smaller scale in Appendix 8.

9.0 CHANNEL CHARACTERISTICS

9.1 Background

Many alternative channel cross sections and profiles were considered. Planning and permitting considerations and physical constraints strongly influenced the kinds of channel cross sections that required engineering analysis. Section 9 summarizes key factors related to channel characteristics, including an assessment of the feasibility of separating out storm flows from the channel. As planning and design become more detailed in the future, Master Plan recommendations for such parameters as depth, side slopes, cross sections, etc., are likely to be refined to accomplish the most important design objectives.

The overall fall in elevation from the pipe bottoms of the Inlet Levee to the Outlet Levee is 11 feet (Elevation 1208 – 1197 = 11 feet). The current Western Star Mill Dam located at roughly the mid-point of the nearly seven mile Old Smoky Hill River Channel has a crest elevation of 1212.2 feet that ponds water all the way back to the Inlet Levee.

For the preferred Master Plan ―Two Dam" Alternative, a second dam is located in the vicinity of the Midway with a crest elevation of approximately 1212. Under the Two Dam Alternative, the Western Star Mill Dam would be lowered to approximately 1210 feet. See Dam Alternatives (Section 8) for a further discussion.

Three water flow scenarios for diversion into the Old Smoky Hill Channel are proposed. The dominant flow would be 40 cubic feet per second (cfs). In the low-flow periods, the rate would drop to 10 cfs or less, and at times no flow would be available. See Water Rights (Section 2) and Low Flow Options (Section 3) for further detail on flow availability. A higher flushing flow of 100 cfs from the Smoky Hill River would frequently be available as well. The 100 cfs flow rate is the approximate capacity of the 54-inch pipe under the levee at Bill Burke Park.

9.2 Old River Channel as Stormwater Outfall

The Old Smoky Hill Channel is the storm drainage outfall for approximately 70 storm sewers. Storm water discharges for frequency from the 1-year to 100-year are summarized in Table 9–1.

The stormwater flows in the channel for the 1-year frequency are in excess of the 100 cfs that will periodically be available from the River. To address the feasibility of separating at least a portion of the stormwater discharges from the Old River Channel, the cost to convey a portion of the South Slough (a major tributary to the Old River Channel in the south reach) was calculated for various scenarios and they are presented in Appendix 9. To convey about 190 cfs from the South Slough to the channel in the vicinity of Ash Street requires a 6 foot by 6 foot storm sewer with an estimated cost in excess of $7 million. Other separate storm sewer alternatives for the South Slough evaluated are also given in Appendix 9. If the design objective were to collect outflows from numerous storm drains for a 2-year design storm and to convey those flows to the lower channel reach (near the Old River outlet), costs would be measured in tens of millions of dollars. All of these alternatives indicate that it is cost prohibitive to construct a trunk storm

Table 9–1
Peak Discharges by Frequency in Old Smoky Hill Channel

		Peak discharge in cfs				
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Location	Drainage Area, mi^2	1-year	2-year	10-year	50-year	100-year
The Slough						
At Prescott Ave	0.95	**176**	**218**	**325**	660	1090
Old Smoky Hill River Channel						
At Ohio St	0.42	162	201	300	430	500
At YMCA	1.63	232	288	430	720	1010
At the Midway	1.78	200	248	370	600	990
At Walnut St	2.47	232	288	430	600	750
At Iron Ave	2.60	243	302	450	590	710
At Elm St	2.88	254	315	470	600	700
At Ohio St & Riverside Drive	3.61	362	449	670	890	990
At Indiana Ave	3.82	335	415	620	860	970
At Levee	4.55	227	281	420	490	500

Columns (2), (5)-(7) from URS Hydrology Report Saline County, KS, and Incorporated Areas (p.17)

Columns (3) and (4): 1 and 2-year flow estimate based on ratio of rainfall intensity at 60 minutes: 1-yr:10-yr (1.39/2.58 = 54%); 2-yr:10-yr (1.72"/2.58" = 0.67)

drain either under or beside the Old River Channel to reduce urban stormwater inflows to the channel. The major factors that cause such costs to be so high include:

- Approximately 5 square miles of urban area drains into the channel.
- There are over 70 storm drain outfalls.
- Stormwater peak discharges are large, even for small, frequently occurring storms.
- There is very little grade available for piped conveyances.
- There are no good ―daylighting" options for a trunk drain when it reaches the present Old River outfall back into the Bypass Channel.
- Constructing a large conveyance through downtown Salina would involve extensive disruption of existing utilities, traffic problems and potentially, contaminated soils issues.
- If a large storm drain were to directly discharge into the Bypass Channel, KDHE would probably require an NPDES permit, which could be problematic in light of the existing TMDLs for the Smoky Hill River and the City's overall stormwater quality management requirements under the current and future NPDES permits.

9.3 Channel Cross Sections and Depths Called For in the Master Plan

Two sets of channel cross sections (provided at end of report) were prepared which show the proposed channel configuration for the One Dam and for the Two Dam Alternatives. The preferred Master Plan alternative is the Two Dam Alternative.

The length of the Western Star Mill Dam crest is 70 feet. A stage-discharge table for the Western Star Mill Dam is given in Appendix 9. With water ponded behind the dam and assuming a concrete channel bottom as shown on the profile, the typical depth of the channel is 3.5 feet. With a 40 cfs flow rate over the dam, the overall channel depth increases by approximately 0.33 feet.

Table 9–2 is a summary of the general channel geometry and characteristics by reach from upstream to downstream. A brief summary of the Master Plan concepts for the reaches follows; again, the design parameters could be adjusted as more detailed planning and design proceed.

In the South Reach the channel will be a V-shaped earth channel with side slopes of 4 feet horizontal to 1 foot vertical. At the normal flow of 40 cfs, the depth of the water is generally in the 3.5 foot range. The top width of the water will vary depending on location ranging from about 25 to 30 feet. For the 10 cfs flow rate, because of the ponded nature of the South Reach, the depth and width of the water in the channel will decrease only slightly.

For the concrete-lined channel portion (downtown Riverwalk and the Midway), the width of the channel will be 40 feet at a minimum and 90 feet at boat turnarounds. The water depth in the channel will be approximately 3.5 feet. An average freeboard of one and a half feet will be provided to generally bring the concrete wall heights to 5 feet in height. Additional wall height will be required in localized areas to accommodate steeper sloped areas. Pressure relief valves may be provided in the concrete lining to avoid potential floatation of the concrete channel under certain water table conditions. Perforated underdrains will also be considered to avoid floatation tendencies. As discussed in Section 15, based on initial interviews with U.S. Army Corps of Engineers (Corps) staff, the Corps would prefer that the relevant sections consist of concrete walls and an earth bottom, although a concrete bottom will be considered as permitting discussions continue.

The channel downstream of the Western Star Mill Dam, the North Reach, will generally remain in its current configuration but with clearing of debris along the channel, removal of trees in the flow line of the channel, trimming of trees or tree branches overhanging the channel. The water flow in the North Channel Reach will typically have a depth of 2.7 feet and a top width of 22 feet with a normal flow of 40 cfs. At 10 cfs flow, the depth will be approximately 1.6 feet with a width of 13 feet. On the east side of the Lake at Lakewood Park, the Old River Channel is separated from the Lake by only roughly 100 feet. During recent flooding conditions, a breach developed in this location. The City backfilled this breach and created an overflow section, utilizing riprap to protect against scour when overtopping occurs again in the future. A 5-year storm was selected by the City for this breach stabilization project, and this reach of the channel will need to be carefully evaluated as more detailed design occurs in the future.

In the South Reach and North Reach, the channel top widths will typically range from 25 to 30 feet for a flow of 40 cfs. Consideration was given to a wider typical water surface, but 25 to 30 feet is more consistent with the current channel appearance and overall master concept and is expected to facilitate regulatory approval. Additional discussion is provided in Section 13, Disturbance Extent.

9.4 Future Refinements to Channel Geometry

As indicated in the footnotes in Table 9–2, the typical water depth could be increased from 3.5 ft to 4.0 – 4.5 ft as the design process becomes more detailed. Similarly, the triangular cross section could easily be modified to a trapezoidal cross section. Channel widths in the south and north reaches could be increased. The final design basis for the channel (reach-by-reach) will involve balancing wide-ranging factors, including, as examples: frequency of sediment removal/regulatory permitting considerations; public safety; maintenance; initial excavation costs; maintaining the tight ~~s~~eal" that currently characterizes the channel; boating types and requirements; water quality; fishing; and others.

Table 9–2

Key Parameters for Restored Old River Channel

Overall Channel

Total length: 6.8 miles (35,900 ft)

Total volume of water in channel for flow of 40 cfs: 63 acre-feet

Flow velocity upstream from Western Star Mill Dam
for flow of 40 cfs in concrete-lined channel: 0.20 ft/sec, or 11 ft/min (See Section 2 for explanation of 40 cfs.)

Flow velocity downstream from Western Star Mill Dam
for flow of 40 cfs in typical channel cross section: 0.50 ft/sec, or 30 ft/min

Peak 100-year flood flow: 1,010 cfs at YMCA and 710 cfs at Iron Avenue[1]

Peak 2-year flood flow: 288 cfs at YMCA and 302 cfs at Iron Avenue[2]

Overall channel slope: 0.0003 ft/ft[3]

South Reach (Levee to Greeley Avenue)

Natural, V-shaped earth channel[4]

Length: Approximately 9,000 ft

Depth: 3.5 ft[5]

Water surface top width: 25 – 30 ft

Ponded water volume: 10 acre-feet

Surface area of water ≈ 6 acres

Boatable in normal water condition (not in drought condition)

Greeley to Midway Entrance

Rectangular earth channel, boulder edge and concrete-lined reaches

Length of earth reach: Approximately 1,000 ft

Length of concrete-lined reach: Approximately 800 ft

Depth: 3.5 ft[5]

Water surface top width: 40 ft

Ponded water volume: 6 acre-feet

Surface area of water ≈ 1 acre

Boatable between moveable dams in drought condition

Midway to between South & Mulberry

Natural, V-shaped earth channel[4]

Length: Approximately 4,500 ft

Depth: 3.5 ft[5]

Water surface top width: 40 ft

Ponded water volume: 7 acre-feet

Surface area of water ≈ 4 acres

Boatable in normal water condition (not in drought condition)

Concrete Channel Riverwalk

Rectangular concrete-lined channel

Length: 3,700 ft

Depth: 3.5 ft[5]

Water surface top width: 40 to 90 ft, with an average of approximately 60 ft

Ponded water volume: 18 acre-feet

Surface area of water ≈ 5 acres

Boatable between dams in drought condition

North Channel Reach

Natural, V-shaped earth channel[4]

Length: Approximately 16,000 ft

Depth: 2.6 ft[6] at flow of 40 cfs with width of approximately 22 ft

Depth: 1.6 ft[6] at flow of 10 cfs with width of approximately 13 ft

Water volume: 22 acre-feet

Surface area of water ≈ 7 acres

[1] The 100-year peak actually decreases in the reach going downstream due to floodplain storage and timing of inflows from tributaries, according to the applicable Flood Insurance Study.

[2] In the 2-year storm, floodplain storage and tributary inflow timing are not as significant as in the 100-year flood, so peak is larger downstream than upstream.

[3] A slope of 0.0003 means that the channel drops 0.30 ft vertically for every 1,000 ft horizontally.

[4] Although a V-shaped channel was used for conceptual design in the Master Plan, as planning and engineering proceed, considerations related to maintenance, water quality, and boating may indicate that a trapezoidal channel shape is preferable.

[5] The maximum depth could be increased by 0.5 to 1.0 ft as more detailed design proceeds. The Master Plan-recommended depth of 3.5 ft was based on minimizing the required excavation and maintaining the existing low channel infiltration rate.

[6] Depth could be increased as design becomes more detailed, to facilitate recreation and channel maintenance. This depth is intended to mimic the general existing condition of the north channel reach.

9.4.1 *Freeboard for Storm Discharges*

Table 9–1, Peak Discharges, gives a 2-year discharge at Iron Avenue of 302 cfs and a 10-year discharge of 450 cfs. The 5-year peak discharge would likely be in the range of 375 cfs. As shown in Appendix 9, page 5, the discharge over the Western Star Mill Dam at a depth of 1.5 feet is 385 cfs. With the normal operating flow of 40 cfs, a freeboard of 1.5 feet could nearly carry the 5-year frequency storm.

9.4.2 Winter Conditions

The channel will become ice covered in the winter, which has implications related to water quality and aquatic life (discussed in Chapter 14), maintenance access, structural design (ice thrust) and public safety. Diversions throughout the winter are anticipated, which will be beneficial for water quality and aquatic life. The City will need to take steps to warn the public of ice risks, such as posting signs frequently along the channel and education in local schools.

9.4.3 Typical Recreational Trail Elevation

As addressed in the section of this Master Plan that addresses trail design, the recreational trail will typically be higher than the 5-year flood level, thus minimizing trail maintenance requirements (erosion, mud, debris, trash, etc.) due to flooding. The trail will be inundated more frequently at bridges and underpasses; as a result, more frequent maintenance should be anticipated in those locations.

10.0 BRIDGE AND CULVERT REPLACEMENT

Considerable time was devoted to analyzing the multiple bridges and culverts crossing the channel and the subject is strongly influenced by both planning and engineering considerations. Many bridges or culverts are proposed for replacement in this Master Plan. The replacements are required to provide sufficient clearance under the bridge to permit passage of pedestrians, bicyclists and/or boat traffic and in the case of South Ohio Street to allow unimpeded flow beyond South Ohio Street. To provide safe passage for pedestrian and bicyclists, it is important to minimize trail and roadway crossings, particularly on busy streets.

Ideally, a minimum clearance of nine (9) feet is desired between the bottom of bridge chords and the trail or normal water surface where water taxi boating is anticipated. For pedestrian and bike trail underpasses, a clearance of eight (8) feet is desired. Because of the slightly different normal water operation levels under the one dam or two dam scenarios, two vertical clearance figures are given in Table 10–1. A minimal allowance of 3 vertical feet was made for a future roadway/bridge chord depth in determining vertical clearance available assuming a new bridge (this is reflected by the —3" values in the second row of Table 10–1). The bridge or culvert replacements would be designed to meet Master Plan objectives as to appearance, span and clearance.

Table 10–1 outlines the higher priority proposed bridge (2) and culvert replacements (3) and the estimated clearance that can be provided with a replacement bridge or culvert without raising the roadway elevation. While the Two Dam Alternative is the Master Plan preferred alternative, in the initial phase, likely just the Western Star Mill Dam will be in place at its current elevation.

Table 10–1

High-Priority Bridge and Culvert Replacement Elevation Data

		South Ohio	Midway	Walnut	East Iron	North Ohio
	Roadway Elevation	1224.9	1,222.0	1222.2	1223.8	1217.3
	Assumed Bridge Chord Depth	–3.0	–3.0	–3.0	–3.0	–3.0
	Assumed Bridge Bottom Elevation	1221.9	1219.0	1219.2	1220.8	1214.3
One Dam	Water Surface Elevation	1212.5	1212.5	1212.5	1212.5	1201.0
	Clearance, ft	9.4	6.5	6.7	8.3	13.3
Two Dams	Water Surface Elevation	1212.5	1211.1	1211.1	1211.3	1201.0
	Clearance, ft	9.4	7.9	9.6	13.3	13.3

South Ohio Street. Record drawings indicate that there is an 84-inch diameter culvert under South Ohio Street with the bottom of the culvert (invert of culvert) indicated as being several feet below Old River Channel bottom. The culvert is likely filled with sediment at its entrance and at its exit as the culvert is not visible. For the initial phase of the River Restoration Project, to

delay incurring the cost of the South Ohio Street Bridge, a temporary conveyance (culvert) under South Ohio Street is proposed to transmit flows past the Ohio Street bottleneck.

Midway Entrance. The Midway Entrance Bridge will need to be integrated into the design of the Midway Dam water feature and the lock for boat traffic. The clearance available without raising the bridge roadway elevation is minimal. Locating the dam upstream of the bridge will maximize the clearance available.

Walnut Street. The existing Walnut Street Bridge has deep chords with the existing clearance to the normal operating water surface behind the Western Star Mill Dam of only about 3 feet. The Walnut Street bridge replacement would not occur until the south half of the Riverwalk is constructed and the Western Star Mill Dam lowered. To provide 9 feet of clearance, it may be necessary to raise the roadway elevation.

East Iron Avenue and North Ohio Avenue. There are existing culverts under East Iron Avenue and North Ohio Avenue, both with heavy traffic, where an underpass for foot and bicycle traffic is needed.

Bridge Opinion of Probable Costs. The span and width of the high-priority proposed bridge replacements along with the opinion of probable construction costs are summarized Table 10–2 in the likely order of construction phasing.

Table 10–2

Proposed Bridge Replacement Probable Construction Costs

Location	Span (ft)	Width (ft)	Opinion of Cost*
East Iron Avenue	110	75	$1,400,000
Midway Entrance	100	50	$ 900,000
Walnut Street	90	34	$ 800,000
South Ohio Street	100	75	$1,300,000
North Ohio Street	100	64	$1,100,000

*22% allowance and 30% master plan construction contingency not included.

11.0 FLOODPLAIN

A basic requirement of channel improvements is that the 100-year (regulatory) flood elevation should not be increased.

Based on conversations with city staff, the current official Flood Insurance Study (FIS) and floodplain mapping for the Old River Channel were prepared in 1986. The current FIRM is shown on an exhibit in the Master Plan.

In 2007 – 08, URS Corporation (URS) performed Flood Studies and provided *Flood Profiles Old Smoky Hill River Channel* FEMA (Federal Emergency Management Agency) Sheets 01P-06P in 2007. This work is preliminary and has not been officially adopted as of August, 2010. In fact, the City has appealed various aspects of this analysis. The URS Study was a Limited Detailed Study performed as part of a Saline County-wide study as described below:

> *A detailed survey by a licensed surveyor was not performed for this flooding source* [Old River] *because this area is considered to be a ponding area where exact elevations and dimensions of the structures were not needed. In addition, since the floodplain mapping of this flooding source only considers the 1-percent-annual-chance flood event a limited detailed study is considered appropriate.* (Page 3-1, URS December 5, 2007 Field Surveys and Reconnaissance for Saline County, Kansas and Incorporated Areas)

The preliminary URS floodplain mapping for the Old River Channel is approximate Zone A mapping, and does not include a regulatory floodway. WWE recommends that as planning and design of channel restoration proceeds, it will be necessary to prepare a detailed floodplain study, resulting in an ―AE" floodplain and a regulatory floodway. This would have many benefits, including (1) more accurate accounting for the ―ponding area" referenced in the quotation above; (2) improved accuracy; (3) the new hydraulic model could provide the basis for final hydraulic design; and (4) the impacts of replacing undersized bridges and culverts with larger crossing structures on floodplain storage (and related upstream ponding elevations and downstream peak flows) can be determined. The cost of this analysis is not included in Section 17.

The URS initial elevations are given in NAVD88 datum (NGVD29+0.39 feet). Data from the year 2005 City of Salina two-foot contour mapping was used by WWE for the Master Plan to create a triangulated irregular network (TIN) model and channel inverts were obtained by subtracting URS field measured depths from top of road elevation in the TIN. According to URS, the outlet gate at the downstream levee would be closed during a flood event causing water to backup in the channel.

An XP-SWMM model was developed to quantify flows and delineate flood depths by URS. Early in the Master Plan, WWE attempted to utilize this model, but for various reasons discussed with and accepted by City staff, further efforts to run the model were discontinued, and more basic hydraulic calculations were performed.

The preliminary URS Flood Profiles show the resulting 100-year water surface elevations, which are the basis for the newest proposed FEMA floodplain designation. These profiles, as well as the 1986 floodplain mapping and profiles, were referred to for this Master Plan project. Some modifications were made to the channel bottom profile shown on the preliminary URS profile:

- The URS stream bed elevation of 1193±, was raised about 4 feet in accordance with other information available including the original drawings for the levee and as shown on the Wilson & Associates Engineering 1978 Master Plan.
- The Levee Inlet channel invert on the URS Profile is 5 to 6 feet higher than other elevations indicated for the 54-inch invert of the pipe through the levee. The City 2010 Survey elevation of 1208.0 is used for the inlet channel.
- The overall elevation change for the URS channel invert is 21.6 feet (1214.6 - 1193.0 = 21.6 feet) as compared to the City 2010 survey that indicated level change of 11 feet (1208 – 1197 = 11 feet).
- The Western Star Mill Dam is not shown on the URS profile, however, the Western Star Mill Dam is shown on the Master Plan channel profiles.
- The URS profile of the channel bottom for the Old Smoky Hill Channel invert was revised to reflect the City's Year 2010 survey for the Master Plan of the Recreational Channel.

Based on conceptual engineering and without performing hydraulic modeling, the proposed Preliminary Master Plan channel modifications and improvements will not increase either the 1986 or 2008 100-year floodplain, because:

1. The normal water surface elevation associated with a base flow of 100 cfs is not being increased.
2. The crest of the Western Star Mill Dam is being lowered to accommodate the dam at the Midway. The dam at the Midway will have the same crest elevation as the current Western Star Mill Dam.
3. 65,000 CY of sediment will be removed from the channel.
4. Relatively small culverts will be replaced by large bridges.
5. The flood hydrology of the Old River Channel is not being changed, and will be in accordance with the Saline County FIS.
6. The existing levee/flood control system is not being changed.
7. Where the channel geometry is being modified, adequate conveyance will be provided to accommodate the 100-year flood with appropriate freeboard. Changes in channel geometry will not be major, and will tend to balance out over the length of the river.
8. The current floodplain is generally confined to the channel.
9. The current floodplain is approximate (Zone A), so any changes will be within the tolerance of the current delineation.

While opportunities may exist to increase the Old Channel flow capacity through sediment removal, replacement of culverts and other measures which might lower the floodplain elevation, the changes are probably not going to be significant due to backwater effects in the 100-year flood. For Master Planning purposes, the 1986 FEMA Floodplain boundary has been shown due to pending questions regarding the preliminary 2008 mapping.

Channel improvements may trigger the need for the City to request and obtain a Letter of Map Revision (LOMR) from FEMA to officially modify the then-current regulatory floodplain. Depending on the length of time to implement channel modifications, the LOMR could be obtained in phases or all at once. As project planning and design proceed, the City should meet with FEMA to review the overall project, nature of the current floodplain mapping, and determine the most cost-effective and technically sound manner for proceeding.

12.0 UTILITIES

The need to relocate buried and above-ground utilities can significantly affect channel restoration costs. Consequently, as part of the Master Planning, WWE worked with City staff on a preliminary identification of utilities in the vicinity of the channel. During the design phase, locations of the channel facilities can be optimized to minimize utility conflicts. Utilities in proximity to the channel are described and anticipated conflicts requiring relocation are identified below:

Gas. The gas pipelines and facilities of Kansas Gas Service are identified, working from the South Reach to the North Reach of the Old Channel, as follows:

Pipelines in Road Crossings of Channel. Many of the roadways that cross the Old Channel have gas lines. The streets and the size of pipeline are listed as follows:

- South Ohio – 2" District Pressure Regulator west side of Street, costly to relocate.
- Greeley Avenue – 2" bored crossing of channel at a diagonal north of bridge
- Oakdale Avenue – 2" bored crossing of channel
- Walnut Street – 2" bored crossing of channel
- Ash Street – 4"
- Elm Street – 4"
- North Ohio – 4"

Pipelines Paralleling Channel.

Fourth Street in vicinity of Iron Avenue – 8" high pressure on west side of channel top of bank and District Pressure Regulator and 12" high pressure on 4th Street west of railroad tracks – prohibitive to relocate.
Front Street – 4" and District Pressure Regulator on southeast side of channel.

Power. The Westar Energy mapping of primary overhead power lines includes approximately 20 crossings or segments paralleling the Old Channel. Kenwood Park and much of Oakdale Park have primary overhead lines along the perimeter. There is a segment of primary underground power crossing the channel twice in the vicinity of Kenwood Park between Edison and Greeley Avenue. There is also the transmission line running east and west that crosses the North Reach of the channel is several locations. Secondary overhead and underground lines are also in the vicinity of the channel.

Fiber Optic. The fiber optic loop serving the medical center area follows Oakdale Avenue and loops around Oakdale Park with a crossing of the Old Smoky Hill channel at Mulberry. The line is on the east side of the channel along Oakdale Drive south of the Walnut Street Bridge.

Cox Internet/Cable. The Cox internet and cable lines that cross or are adjacent to the Old Smoky Hill channel are on power poles. Locations that are in proximity to the channel are noted as follows.

Power poles are located close to the channel in a reach west of South Ohio in the vicinity of Lewis and Waverly Street. Power poles and lines parallel the Old Channel at the rear of lots fronting Hazel Court. Overhead lines cross the channel to Oakdale Park as an extension of Third Street.

Storm Sewer. The Old Smoky Hill Channel serves as the outlet for more than 70 storm sewers, most of them 24-inch diameter or smaller. Some of the major storm sewers that discharge into the Old Channel include the 8' × 8' box culvert from the South Slough area, a 66" diameter pipe that discharges near the Oakdale Park pedestrian bridge adjacent to the water treatment plant, a 60" diameter storm sewer that outlets approximately 200 feet downstream of the Western Star Mill Dam, and a 48" storm sewer in the North Reach Riverside Park area near the power transmission line. The outlet area of the storm sewers will be designed to protect the channel bank from erosion.

Water. The City municipal water intake is located south of the inlet channel to the Old Smoky Hill Channel. Two 20-inch diameter pipelines cross under the inlet channel where the concrete-lined sedimentation basin is proposed. The top of the pipelines where the inlet channel crosses is approximately elevation 1207.5 feet. The sedimentation basin will have two cells one on each side of the existing water line crossing.

Water line crossings of the channel are summarized below; crossings that appear to or potentially conflict with the proposed channel restoration are underlined:

- South Ohio Street—<u>8" cast iron pipe (CIP) with cover of 4 – 5 feet; relocate with new bridge construction</u>.
- YMCA Drive—24" ductile iron pipe (DIP) river water and 6" CIP with cover of 3 – 5 feet above the 60" corrugated metal pipe (CMP) culvert.
- Greeley Avenue—12" CIP under river; 8" PVC lime sludge line on bridge.
- Mulberry—6" DIP under river to northeast of bridge.
- Walnut Avenue—12" DIP under river to south of bridge.
- East Iron Avenue—<u>12" CIP with 4 – 5 feet cover; relocate with new bridge construction</u>.
- Ash Street—6" CIP with 4 – 5 feet cover.
- Elm Street—6" CIP with 4 – 5 feet cover.
- Indiana Avenue—8" steel hanging on bridge.

Sanitary Sewer. Sanitary sewer crossings of the channel include:

- Midway Drive—8" VCP encased in concrete; handle with Midway Drive entrance construction.
- YMCA Drive—8" VCP located above the existing 60" CMP culvert.
- South Ohio—8" VCP located in the channel flow area; 16" force main below channel at center, may be a conflict at channel banks; handle with South Ohio Bridge construction.

Allowances totaling $700,000 are included in the opinions of probable cost for the relocation of utilities.

13.0 DISTURBANCE EXTENT

The Master Plan channel layout will result in disturbance of some of the bed and banks of the Old Smoky Hill channel; however, it is the intent to minimize the disturbance so as to:

- Reasonably maintain bird and wildlife habitat.
- Limit existing channel bank reshaping and grading where the existing channel can be made compatible with the improvements.
- Provide equipment access points at regular intervals to facilitate construction and future maintenance activities.
- Limit channel excavation to the minimum reasonable to meet the master plan needs and to demonstrate to the applicable regulators that channel disturbance is not excessive.

The water surface area for the natural, earth channels is approximately 19 acres, the water surface area in the sedimentation basin and concrete lined channels is approximately 7 acres, permanent channel access approximately 2 acres, and temporary disturbance at edge of channel 10 acres for a total disturbance area of 38 acres.

Section 15 provides additional discussion about the regulatory aspects of disturbance extent and nature of disturbance. As discussed in Section 15, an initial and conceptual mitigation allowance of $5 million for total project impacts to jurisdictional wetlands/Waters of the U.S. has been provided (see cost tables in Section 17).

14.0 WATER QUALITY AND AQUATIC LIFE

Water quality and aquatic life encompass such aspects as sediment control, trash, algae, storm drainage inflows, applicable regulations, goose control, aquatic weeds, mosquitoes, the potential for an urban fishery to be established, dry year flow enhancement and others. Various alternatives have been evaluated for addressing these issues, as provided below. Section 14 summarizes WWE's initial water quality assessment of the Smoky Hill River, which will be the dominant influence on water quality in the restored channel, and addresses storm drainage as well, because it will be a major influence of instream conditions during wet-weather conditions (see peak flow rates in Section 9).

14.1 Background

This subject was evaluated by reviewing water quality data, interviewing staff with Kansas Department of Health and Environment (KDHE) and the Kansas Department of Wildlife and Parks, making field observations of the channel sediment and pools in the channel, and referring to other assignments where these topics have been relevant. Members of the IAT, TAC and City staff also provided valuable perspectives on water quality.

The Smoky Hill River at the point of diversion for the Old Channel and the Lake at Lakewood Park have the following beneficial use classifications from KDHE:

- Aquatic life
- Primary contact recreation
- Domestic water supply
- Food procurement
- Industrial water supply
- Groundwater recharge
- Irrigation
- Livestock watering

Interviews with KDHE indicate that these classifications would likely apply to the Old River Channel in the future, after regular flow is restored.

WWE was unable to locate field data for fish or other aquatic life in the immediate area, based on the interviews we conducted and documents reviewed. Initial field observations by WWE biologists indicated few fish in the Old River Channel, and a very limited macroinvertebrate community. The current ecological condition in the old channel is significantly degraded. Biological limitations and stresses include lack of consistent flow; episodic urban stormwater inflows with adverse physical (scour, temperature, erosion, etc.) and chemical (pollutants)

effects; flow diversions from the main channel into the Old Channel that are highly variable (sometimes off and sometimes on); and extensive sediment deposits in the channel bottom.

Water quality data from KDHE are available for the Smoky Hill River US (–Mentor") and DS (–Salina") from the City; these data are summarized in Table 14–1 and are provided in Appendix 14. Figure 14–1 shows the locations of these sampling locations.

Table 14-1 demonstrates that the river periodically had elevated concentrations of such constituents as sediments/turbidity, nutrients, *E. coli* bacteria and some others. The Lake at Lakewood Park has elevated levels of lead and silt. KDHE has established Total Maximum Daily Loads (TMDLs) due to impairments for recreation, water supply and aquatic life for the Smoky Hill River near Salina for *E. coli*, nitrate, total phosphorus, total suspended solids and –biology." The Lake at Lakewood Park has TMDLs for lead and silt. A TMDL is a regulatory pollutant allocation process to bring a waterbody into compliance with the applicable numeric standards.

The table which summarizes TMDLs for this reach of the Smoky Hill River, entitled –2010 303(D) List of All Impaired/Potentially Impaired Waters Smoky Hill–Saline Basin" is provided in Appendix 14.

With this information as background, the following topics related to water quality are addressed:

14.2 Tie to Mainstem Water Quality and Sediment Inflow

14.3 Storm Drainage Inflows

14.4 Trash and Debris Management

14.5 Management of Other Targeted Pollutants

14.6 Feasibility of Swimming and Elevated Bacteria Levels

14.7 Algae Management

14.8 Management of Upland and Aquatic Weeds, Mosquitoes, Geese and Odor

14.9 Creation of Fishery in Restored Channel

14.10 Regulatory Issues Regarding Water Quality

14.2 Tie to Mainstem Water Quality and Sediment Inflows

The water quality in the restored channel will generally be similar to the mainstem Smoky Hill River water quality except that sediment will be removed near the intake, so total suspended solids (TSS) concentrations will be less in the restored channel. As described in Section 5, Sediment Management, river inlet gates will allow diversions at various flow levels to reduce the intake of stream bed load. These gates can also be closed in times of high stream turbidity. The sedimentation basin in Bill Burke Park will allow settlement of nearly all the sand and about one-

40% – 45% of the silt carried into the inlet channel, which will be beneficial for water quality. However, fine silts and clay will not be removed; therefore, there will normally be observable turbidity in the water, and the water would not be described as ―clear" (see Photograph 5–1). Nevertheless, following sedimentation in the Bill Burke Park basins, the water will not have an objectionable appearance and would be comparable to or better than the appearance of many rivers in the United States that support ―riverwalks" and public recreation. The turbidity of water in the Old Channel will vary in accordance with such factors as the turbidity of flows in the main channel, storm flows from the local drainage area, the quality of supplemental sources during dry periods such as municipal well water, algae levels, maintenance frequency and type of maintenance, and other factors.

As also noted in Section 5, mechanical clarifiers could potentially be constructed near the channel entrance to remove much higher sediment loads than the sedimentation basin. Although this would be beneficial for water quality and appearance, the cleaned flow would still be conveyed in a channel with a silt/clay bottom over most of its length and storm inflows will introduce solids and other pollutants.

14.3 Storm Drainage Inflows

The over 70 storm drains discharging into the Old Channel represent typical urban storm drainage water quality that can carry a wide range of pollutants ranging from trash and debris to coliform bacteria, oil and grease, organic compounds, heavy metals and the nutrients nitrogen and phosphorus, among others. Early in the master planning process and during the Phase I work of DSW and WWE for the Friends of the River, the feasibility of capturing storm drain flows in a large collector pipe which would outfall into the Bypass Channel was discussed with City staff and members of the TAC and Friends of the River. As discussed in Section 9, this concept is infeasible and cost prohibitive, even for relatively small flows such as a 2-year or 5-year storm event. Moreover, stormwater inflows are valuable in that they (1) provide additional flow (supplementing diversions), (2) are often lower in TSS than river diversions, and (3) can help flush sediment through the channel.

Opportunities exist to install Best Management Practices (BMPs) in the drainage area tributary to the Old Channel. For instance, the South Slough area has a concrete-lined low-flow channel that conveys debris and storm pollutants toward the Old Channel. Running the frequent, smaller storms over grass areas will reduce the pollutants carried to the Old Channel. Grass acts as a natural filter collecting some particulates and pollutants. BMP retrofitting and the implementation of new structural and nonstructural BMPs will be valuable for river water quality and will facilitate compliance with the City's stormwater NPDES permit (costs for BMP retrofitting are not included in Section 17).

14.4 Trash and Debris Management

Out of the wide range of pollutants found in urban stormwater runoff (such as sediment/dust/dirt; heavy metals; organic compounds; nutrients; bacteria, and others), trash will have the most significant day-to-day effect on the visual appearance of the channel to the public. In the engineering literature regarding urban stormwater quality management, what we commonly think of as ―trash" in an urban setting is referred to as ―gross solids," and this includes not only

conventional trash such as cups, wrappers, cans, plastic bags, etc., but also grass clippings, pet wastes, leaves, tree branches, construction debris and myriad other kinds of discarded items that are observed in nearly all urban streams—particularly those that are not regularly maintained.

Trash control and management has been an important subject addressed in the master planning process. To evaluate this topic, WWE has relied on our previous experience in places like Estes Park and Pueblo, Colorado; Sioux Falls, South Dakota; Tulsa, Oklahoma; and the South Platte River in Denver. We have also interviewed staff at other riverwalks. Many alternatives were considered, ranging from public education to trash BMPs in the watershed to in-channel trash ―screening" measures.

There is extensive contemporary literature on the subject of gross solids management, and many advertisements in engineering magazines for devices which purport to remove trash from stormwater runoff. These are typically below grade, vault-like devices that are integrated into the storm drain network. Trash-laden stormwater inflows enter the vaults and are removed via settling, screens, ―swirling" and other processes. The difficulty with these buried devices is that they tend to be ―out of sight, out of mind," leading to inadequate maintenance and poor performance.

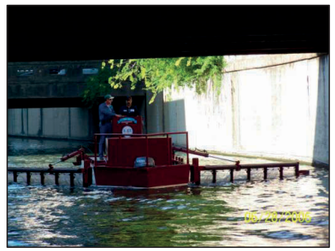
In the case of the Old River Channel in Salina, trash control is particularly challenging. First, it is not economical to capture storm drainage flows and keep them out of the channel (see Section 9). Even if it were feasible to remove all of the trash from the dozens of storm drain outfalls into the Old River Channel, the channel would still accumulate trash because it is the ―low ground" in the city (as rivers typically are), meaning that when the wind blows, much of the trash on city streets will inevitably find its way into the channel. This bears heavily on future approaches to trash management for the River Renewal Project.

An important consideration is that the drainage area that contributes flows to the Old River Channel is quite large (at roughly 5 square miles) and is predominantly urbanized. The practical effect of this is that even if the public were highly motivated to control trash to protect the channel (and, indeed, public education is an important component of the recommended long-term strategy and is required by the City's current stormwater NPDES permit), there would still be ample trash to create an aesthetic problem in the channel unless the long-term management strategy includes trash removal in the channel, itself. Another consideration is that a primary objective of the renewal project is to bring the public adjacent to the channel for shopping, eating, walking, boating, etc. Inevitably, when the public is close to waterbodies, even if the large majority of the people responsibly dispose of their trash, some will not, so this trash winds up in the channel where it creates a visual problem. In short, there are many factors which indicate that trash inputs to the Old River Channel will be a significant long-term problem that must be addressed by the master plan.

At a conceptual level, the broad strategies that are recommended for trash management include:

1. Plan on regular trash removal from the channel (see schedule in Section 16). For example, interviews conducted by WWE with managers of other riverwalk projects nationally indicate that regular trash pick-up occurs. At the San Antonio river walk, a special ―skimmer barge" (see photos below) runs through the channel twice per day

skimming off floatable trash. In addition, the walkways adjacent to the river walk are regularly maintained for trash. The same kind of approach for the restored river channel in Salina is recommended, with emphasis on those reaches of the channel where there will be heaviest public use. Periodic trash removal in the drainage area would also be valuable. Budget for these activities is included in Section 16.



Photograph 14–1

Photograph 14–2

Skimmer barge at the San Antonio, Texas, Riverwalk.

Courtesy of Joseph E. Cruz, Downtown Operations Superintendent, City of San Antonio, Texas.

2. Mount a strong public education program in the city regarding litter control and not utilizing the storm drain system to dispose of wastes. If residents can come to understand that their trash and household waste products that are dumped into the drainage system will go directly into the restored river channel, and if many trash canisters are provided in the community (to make it ―easy" to dispose of wastes), there should be some benefit to the channel. An ―adopt the channel" campaign to list organizations or individuals to pick up litter is another means to control litter.

3. Take advantage of existing, relatively easy-to-implement trash and debris control opportunities in the storm drainage system. For example, install trash racks at culverts in high-trash locations and in neighborhoods and near schools where children are likely to play, thereby promoting public safety as well. Existing detention ponds can have their outlets modified to enhance trash retention. Curb-opening inlets in areas with high trash potential (such as convenience stores and fast-food restaurants) can be retrofitted with catch basin inserts. All trash control practices of this kind create an ongoing maintenance responsibility (see discussion in Section 16 on operation and maintenance).

4. There are too many storm drain discharges into the channel to routinely implement subsurface, proprietary devices for trash removal. However, through observing wet weather discharges of the outfalls, it may be feasible to identify some that are significant trash contributors. These could then be targeted for trash removal devices (as well as targeted source controls in the watershed). WWE views this as a trash control strategy that would be implemented after the first phase of construction, and only if necessary. Such devices are not included in the project budget (Section 17).

5. As the project moves from master planning into design, consideration should be given to screens, racks, booms, and comparable devices that can be placed in the channel itself to capture trash or route (direct) trash to a particular location where it can be cleaned up. Various factors would enter into the design of such facilities including, for example, public safety, appearance, functionality and longevity, behavior during flood conditions, accessibility for cleaning and maintenance and costs (both capital and O/M/R). Budget for in-channel screens is included in Section 17.

   Debris, dead animals, shopping carts, etc. will need to be periodically removed from the channel, especially tree branches and downed trees. The operation and maintenance budgets in Section 17 include an allowance for this.

14.5 Management of Other Targeted Pollutants

In addition to sediment and trash, the City should attempt to control certain other pollutants in urban stormwater runoff, to the extent feasible. Looking to the future, it will be necessary to control some of these pollutants for other reasons as well, including (in all likelihood) compliance with TMDL requirements and new USEPA initiatives (such as the agency's present focus on nutrient reductions) and requirements under the City's municipal stormwater NPDES permit. For example, controlling the key nutrient phosphorus would be beneficial for promoting water quality in the restored river channel. Algae require phosphorus to grow, and to the extent that concentrations can be reduced in stormwater runoff, this would be helpful. Phosphorus can be reduced through a combination of nonstructural BMPs, such as public education and utilizing specially designed fertilizers, and structural BMPs, such as retention ponds, detention ponds, filter strips, bioretention facilities and others that have been shown to remove phosphorus. As existing components of the city's storm drainage system are updated or replaced (such as when redevelopment occurs), it would be desirable to utilize BMPs that are effective at reducing phosphorus (not included in project budget, Section 17).

Another pollutant that lends itself to source control is oil/grease/gasoline/diesel fuel, at locations where the materials are found in higher concentrations than on typical streets. For example, service stations, areas of concentrated, high-use parking, maintenance facilities and others of this kind can have relatively high concentrations of these pollutants in runoff, and when opportunities exist to install BMPs that remove these pollutants, such as oil-water separators, slow-flow surface swales, etc., their use will be desirable.

As mentioned in Section 5 and earlier in this section, although stormwater runoff from urbanized and stabilized areas typically has low concentrations of total suspended solids (generally less than 70 mg/L, based on various national databases), there are certain areas that are sediment generators, such as construction sites, and these should be checked carefully for stormwater pollution prevention plan (SWPP) compliance and adequate BMPs.

14.6 Feasibility of Swimming and Elevated Bacteria Levels

Some members of the public have asked whether it will be feasible to swim in the restored channel. The Old Channel will normally not be suitable for swimming due to elevated bacterial

levels but will often be satisfactory for boating (including kayaking) and limited body contact such as wading where ingestion of water is incidental.

This subject was researched by reviewing applicable KDHE regulations and interviewing KDHE staff. Key text included the draft February 17, 2010, KDHE document entitled *Methodology for the Evaluation and Development of the 2010 Section 303(D) List of Impaired Water Bodies for Kansas,* and specifically Section 14.2.2. ―Contact Recreation." WWE also reviewed the April 28, 2004, KDHE document *Kansas Implementation Procedures: Surface Water Quality Standards,* Section G ―Recreational Use." The key text from this document addresses the different classes of primary contact recreational use (the beneficial use classification that is likely to be attached to the Old River Channel once flow is restored). Specifically, there are three different classes of primary contact recreational use, ―A," ―B" and ―C." Discussions with KDHE indicated that either class A or class B will apply, with definitions as follows:

- ―Primary contact recreational use, Class A applies to those classified stream segments that have been designated as public swimming areas. Uses supported in this category include activities such as kayaking, mussel harvesting, swimming, skin diving, water skiing and wind surfing. During the non-recreational season, the secondary contact recreation use: Class A criteria will apply."

- ―Primary contact recreation use Class B applies to classified stream segments where moderate full body contact from activities that include kayaking, mussel harvesting, swimming, skin diving, water skiing and wind surfacing shall occur. A classified stream segment under this classification must be by law or written permission of the landowner open to and accessible by the public. During the non-recreational season, the secondary contact recreational use: Class A will apply"

With these definitions in mind, the December 6, 2004, KDHE document *Kansas Surface Water Quality Standards Tables of Numeric Criteria* is relevant, specifically Table 1i. *Escherichia coli* Criteria for Classified Stream Segments. This table indicates that for class A, the applicable standard for *E. coli* would be 160 cfu/100 ml from April 1 to October 31, and 2,358 cfu/100 mL from November 1 to March 31. For class B, the applicable standards would be 262 cfu/100 mL from April 1 to October 31, and 2,358 cfu/100 mL from November 1 to March 31. As project planning proceeds into Phase 3, follow-up discussions with KDHE will be necessary to determine whether class A or class B applies, along with actions that the City may need to implement to reduce instream bacteria levels.

WWE has reviewed *E. coli* data for the Smoky Hill River at the station a short distance upstream from Salina (see Figure 14.1) from 2003 (when such samples began to be collected) through 2010. These data are provided in Appendix 14. As is common for bacteria, there is a wide range in parameter values from a low of 10 cfu/100 mL to a high of 1,607 cfu/100 mL. There are 38 total samples for *E. coli,* and 7 exceed the numeric standard both for class A of 160 cfu/100 mL and for class B of 262 cfu/100 mL. All 7 of these exceedances occurred during the April 1 – October 31 season, when recreational water use is assumed to occur. This is one of the primary reasons why WWE cautions that swimming is likely to not be supported by the restoration project and even incidental contact could be problematic at times. In addition, data collected by the USEPA and the U.S. Geological Survey during the National Urban Runoff Program as well

as data in the *National Stormwater Quality Database* indicate that urban stormwater runoff can have high levels of fecal coliform and *E. coli*—well in excess of applicable standards of 160 and 262 cfu/100 mL. Consequently, during wet weather conditions and in the first few days following runoff, *E. coli* levels in the restored river could regularly exceed the applicable standards.

Appendix 14 contains papers regarding bacteria sources, control and the difficulty in meeting standards coauthored by WWE staff. These papers demonstrate that it is very difficult to implement BMPs on a widespread basis to meet bacterial standards.

14.7 Algae Management

During ―No Diversion" or low-flow periods, ponded water behind the Western Star Mill Dam and the dam at the Midway can be expected to form algae on a routine basis. Floating and suspended algae growth is a natural phenomenon, which will be accentuated in the Old River Channel by such factors as lack of ―flow through" water and associated long residence times, shallow water depth, warm temperatures and high nutrient concentrations (characteristic of both river water and urban stormwater runoff). During times when flows are 10 cfs or larger, there will be adequate ―flow through" (turnover) to keep algal levels manageable because the residence (or detention) time within the entire channel will be about one week. Algae management was discussed with the Kansas Department of Wildlife and Parks, especially regarding the use of fish to consume algae.

Algal blooms could consist of suspended algae (phytoplankton), algae that are attached to the channel lining and/or floating (filamentous) algae, which are often found on the surface. To control the blooms of this type, it may be necessary to employ a combination of some of the following approaches, which can be considered during both design and actual operation and maintenance of the restored river. Following an overview of algae control practices, WWE provides recommendations for Phase 1 algae control measures, which are included in the cost projections in Sections 16 and 17.

14.7.1 *Potential In-Channel Management Tools for Algae*

1. Physical:

a. Oxygenation: One of the most important and easily implemented tools for limiting algae development is aeration. Aeration can be provided through in-channel design considerations (e.g., overflows at the dams) or supplemental features (e.g. fountains or bubbling features). Aeration will help oxygenate the water, promote conditions that lead to the consumption of nutrients by non-algal organisms and mix the water, cycling the algae down from the surface.

b. Ultrasound: Ultrasonic algae control is a developing technology that uses ultrasonic sound waves to disrupt algal cells. This technique is purportedly safe for humans, animals and higher plants.

c. Recirculation/pumpback approach: The Lakewood pumpback system is described in Section 3 relative to its ability to provide supplemental water to the channel in dry periods. This system will also be beneficial for water quality, because it will

provide a source of relatively clean water, offset evaporative losses and will potentially promote flow-through, depending on the safe yield of the lake. Other smaller recirculation system, such as in the ponds upstream from the Western Star Mill Dam and at the Midway would be beneficial for water quality in dry periods, because they would aerate the water and keep it circulating (avoiding stagnation, which could lead to loss of oxygen with accompanying nutrient release from the sediments, algae growth and odors).

2. *Mechanical:* Mechanical removal of algae could be achieved if maintenance workers used nets and strainers to remove larger mats of algal growth. This would likely be a labor-intensive management tool, and is not practical under normal, day-to-day conditions.

3. *Chemical* (Note: The regulatory constraints of any chemical option are likely to be significant and will need to be reviewed with applicable KDHE staff in Phase 3 of the Project):

   a. Alum: Adding alum to the restored channel would likely help water clarity by causing phytoplankton to settle out of the water column. In addition to potential issues regarding the addition of a chemical to a potentially regulated water body, adding alum to the restored channel would likely lower pH. If used at all, alum treatment would likely be restricted to emergency water clarifications.

   b. Algaecide: A variety of proprietary chemicals are available for killing algae. Two commonly used algaecides include copper sulfate (trade name "Cutrine-plus") and polyquat. These chemicals could be problematic from a permitting perspective, although under dry conditions when a limited volume of water would need to be treated, WWE views regulatory approval as likely.

4. *Biological Controls:*

   a. Fish: Many freshwater fish species are natural grazers of algae. While larval fish consume phytoplankton, larger adult fish consume fixed algae. Algae consuming species that are already present in the vicinity of the project include catfish and carp. WWE has effectively used sterile grass carp for filamentous algae control in Springfield, Missouri, and Denver, Colorado, but it was necessary to obtain the approval of state fish and game agencies in both cases. The Kansas Department of Wildlife and Parks indicated that sterile grass carp could be permitted, so long as they are certified triploid (sterile) fish. Grass carp would not harm the other fish species present in the channel (see Section 14.9).

   b. Invertebrates: Algae consuming invertebrates (e.g. *Daphnia*) naturally limit algal populations in ponds and lakes. While these invertebrates may not be present in substantial numbers in the restored channel, adding them during periods of low flow could establish temporary populations that could be capable of keeping algal growth in check.

   c. Bacteria: Several companies provide bacterial inoculations that can purportedly be used to establish nutrient consuming bacterial populations. The companies selling these products claim that the bacteria will outcompete algae for nutrients and rapidly alleviate algal blooms. In many cases, an initially large dose of bacteria is required to "seed" a water body and then subsequent and routine smaller doses are required to "maintain" the bacterial population.

14.7.2 Off-Channel Management Tools for Algae

If the channel is designed with an off-channel recirculation system, such as in association with the Lakewood recirculation/pumpback system, there are tools that can be incorporated to remove/destroy algal cells and reduce concentrations of the nutrients that support algal growth:

1. *Mechanical filtration*: Mechanical filtration would likely be a beneficial component of any filtration system. In designing the recirculation system, the desirable recirculation flow rate will depend, in part, on the specifications of the restored channel and the filter system chosen.

   a. Gravity: Gravity filters are used to trap suspended solids. Gravity filters typically use sand and/or anthracite as the filtering media. These filters may be large (a 10' square building that is 15' high would be typical for a 500 gpm [or roughly 1 cfs] system) and require routine maintenance.

   b. Disc: Disc filters use a fabric membrane or metal screen to separate solids from water. These filters use less space and can have lower maintenance requirements than gravity filters.

2. *Biological Filtration:* Biological filtration can be incorporated into mechanical filtration as a means for reducing nutrient concentrations. Biological filtration can be as simple as adding porous filter media to the mechanical filter system. In doing this, the filter provides habitable space for bacteria that naturally consume those nutrients that are required for algal growth. Biological filtration systems may require constant water flows to support the established microbial population. Because the restored channel may only require seasonal recirculation, this requirement may influence the incorporation of a biological filtration component.

3. *Chemical Filtration*:

   a. Nutrient Removal: Chemical media can be added to mechanical filter systems to remove nutrients from the water column through sorption (e.g., ion exchange resins) or precipitation.

   b. Disinfection:

      i. Ozone gas can be added through the incorporation of an ozone generator in-line following biological filtration. Ozone is a powerful disinfecting agent and consideration should be given so that humans and wildlife exposure to generated ozone is controlled.

ii. Chlorine additions to water in the filter system could be used to sterilize the water column, effectively killing resident algae. Chlorine could be added continuously at lower levels or infrequently at higher concentrations. In addition to the challenge of ensuring that it is not harmful to human or environmental health, obtaining environmental permits for the addition of chlorine may be problematic.

4. *Physical:* In-line UV light sterilizers can be used to disinfect water as it flows through a recirculation filter. A benefit of UV sterilization is that no toxic chemicals are added to the water and concerns regarding inadvertent exposure are minimal.

14.7.3 *Master Plan Recommendation Regarding Near-Term Algae Control*

In summary, many potential methods are available for algae control during low-flow conditions. Based on evaluating the wide-ranging alternatives above, WWE recommends that the Phase 1 algae management approach consist of channel aeration in the ponded reaches of the channel, and the assumption that chelated copper sulfate or another algaecide will need to be applied twice each year. If an additional initial step needs to be taken, WWE recommends the use of sterile grass carp. When flows through the restored channel are 10 cfs or larger, which will be the case roughly three quarters of the time, algae should not be a significant aesthetic problem.

14.8 Management of Upland and Aquatic Weeds, Mosquitoes and Geese

In addition to algae control, the City will need to anticipate the control of upland and aquatic weeds, mosquitoes and geese as part of operation and maintenance of the restored channel.

14.8.1 Weed Management

Following completion of channel construction activities, it is reasonable to expect that the channel and riparian corridor will have increased light and nutrient levels as well as widespread surface disturbance. These environmental conditions typically favor weeds over desirable native plant species. At the end of construction activities at a particular site, the following steps could be taken to minimize the potential for opportunistic weed colonization:

- Use of appropriate weed-free soil
- Planting seeds, plugs and saplings of native species with rapid growth habits
- Mulching around plantings
- Initially heightened routine maintenance including weed removal and watering/fertilizing new plantings

There is the perpetual threat that a weed problem could develop along portions of the restoration project following minor disturbance or happenstance introduction. If a weed problem is identified, the species of weed and infested site conditions will drive the development of the weed control program. It is likely that the weed control program would employ a combination of the following management practices:

- Herbicides: Selective herbicides can be used to control specific weed problems. Before application, the City would likely need to seek consultation with local and state environmental authorities. Potential issues that could arise following herbicide application include incidental damage to desirable plants; development of hypoxic conditions resulting from decay of treated plants; and the potential for currently unidentified long-lasting environmental effects.
- Shading: Complete sunlight blocking with plastic membranes is an effective, chemical-free solution that can be used to kill stands of weeds. Drawbacks of this method include its unsightly nature; it may not be usable within the channel's ordinary high water mark; and it is nonselective and results in killing all plants within the treatment area.
- Mechanical Removal: Mechanical removal includes mowing and hand pulling. Drawbacks include the potential for weed reestablishment if roots remain intact and potentially high labor costs. Mechanized clearing in forested wetlands may be subject to regulation under Section 404 of the Clean Water Act.
- Biological Control Agents: Introduction of fish (within channel) and/or invertebrates (within channel and riparian zone) that are adapted to consumption or parasitism of nuisance plants can provide long-term weed control with minimal disturbance and cost. Potential drawbacks could include permitting requirements and the possibility that the control agent may not adequately control the nuisance plants.
- Nutrient Control: In limiting the in-channel and in-soil nutrient levels, nuisance plant growth could be slowed.
- Water Level Drawdown: Many aquatic weeds are not tolerant of fluctuating water levels. Periodic water level drawdown can establish conditions that are favorable for the development of native aquatic plant communities. Drawdown during the winter to freeze the soil can be valuable.

The publication *Nuisance Aquatic Plants in Missouri Ponds and Lakes* (Barbara Bassett *et al.*) was the primary reference used for this section. If specific weed issues should arise, it may be useful to consult with the local agricultural extension office and other natural resource agency offices for assistance in developing weed control programs.

The operation and maintenance costs provided in Section 17 include budget for weed management.

14.8.2 Mosquitoes

The proposed channel improvements are likely to result in conditions for mosquitoes that are less favorable than current conditions, including:

- Fish and other aquatic life feed on mosquito larvae.
- There will typically be flowing water in the channel (rather than standing water).

- In the pools formed by the Western Star Mill Dam and the Midway Dam, there will be fountains or other aeration systems which will keep the water surface fluctuating, which discourages mosquito growth (mosquito larvae require stagnant water).

- There are numerous stagnant pools in the current channel because the channel geometry is highly irregular. This will be significantly reduced by regrading.

If necessary, the City may need to use approved sprays for mosquito control.

14.8.3 Goose Control

By incorporating landscape features that dissuade geese (e.g., designing banks to impede goose movement, installing tall plants to create undesirably confined spaces), the risk of developing a goose problem in restored portions of the Smoky Hill River can be reduced. If goose problems develop following restoration construction activities, ongoing management tools could include hazing (e.g., noise and visual techniques that drive geese away) and chemical treatment of turf grass to make it unpalatable; these are not budgeted in the initial operation and maintenance plan (Section 16).

14.8.4 *Odor*

Objectionable odors in slow-moving streams and ponds typically result from oxygen depletion, caused by such conditions as rapid algae die-off and resulting oxygen , inadequate inflow and flow-through, poor aeration, wintertime ice cover and others. These factors are not anticipated to be significant in the Old River Channel, because there will normally be flow-through from the main river, aeration is being provided, algae will be controlled, and the effects of ice will be mitigated with adequate flow and aeration. Consequently, odor is not anticipated to be an issue.

14.9 Creation of Fishery in Restored Channel

WWE conducted initial research into the fish communities that could likely exist in restored portions of the old channel of the Smoky Hill River (Old Channel) and the existing bypass channel of the Smoky Hill River (Bypass) in Salina, Kansas. The two main objectives of this research were to identify which fish species would likely be able to exist in the Old Channel and the Bypass, and determine their respective habitat requirements. WWE's main sources of information were interviews with biologists Mr. Tommie Berger and William Stark, Ph.D. Please note that both individuals were enthused about the restoration project and offered to provide additional assistance in the future. WWE also reviewed the available water quality data and projected stream flows (Section 2) in the context of fish and aquatic life requirements, and this indicates that there will be adequate hydrology and water quality for a fishery.

Mr. Berger, a fisheries biologist with the Kansas Department of Wildlife and Parks, suggests that catfish and possibly trout recreational fishing could likely be established in the restored Old Channel. Mr. Berger stated that bass are not likely to succeed in the Old Channel since the relative amount of habitat is small compared to the probable levels of fishing pressure. Mr. Berger had the following thoughts and recommendations for establishing catfish and trout fishing in the Old Channel:

- **Catfish:** A stocked catfish fishery could succeed with minimal modifications to the conditions observed when the Old Channel is flooded for the River Festival. In general, catfish should have pools with minimum depths of four to five feet and widths of ten feet. These pools should be approximately 60 feet long. While year-round inundation is preferable, seasonal stocked fishing could occur if the Old Channel is periodically dry. Mr. Berger was not especially concerned about the water quality requirements of catfish. He stated that if abundant leafy material entered the stream in the fall during no-flow conditions, low oxygen levels could develop. Additionally, if nutrient levels were high, algal blooms could result in the development of low oxygen conditions. The applicable surface water quality standards for aquatic life would be sufficiently (if not overly) protective of a catfish population in the Old Channel.

- **Trout:** If the Old Channel has continuous flow during winter months, seasonal trout fishing would be possible. The continuous flows would keep the channel largely ice-free and of sufficiently high quality that a stocking program could provide a winter season recreational fishery. Trout would use the same pools that were established for catfish. Water quality in the Old Channel would probably be acceptable for establishing recreational winter trout fishing.

William Stark, Ph. D., is a stream ecologist at the Fort Hays State University. Dr. Stark concurred with Mr. Berger's information on recreational fish species and habitat requirements in the Old Channel. He suggested that by installing submerged rock structures and/or root-wads, it might be possible to encourage catfish to breed. This could reduce the need to stock as frequently and might make the Old Channel more interesting for fly-fishing. He agreed that water quality is not likely to be an issue with the development of catfish and trout recreational fishing. The Master Plan does not currently call for fish habitat structures, but these could be added in the future at relatively low cost in suitable reaches of the restored channel.

In the Bypass, Dr. Stark reported that an existing concrete structure has created a large pool of slow moving water. He would expect to find catfish, green sunfish and largemouth bass within this pool. The structure likely impedes upstream fish migration in all but the highest flow conditions. Establishing riffle-pool sequences could further enhance the existing fish habitat in the Bypass. As noted in Section 1, providing safe public access to the Bypass Channel is a major challenge, and this must be considered if attempts are made to enhance the fishing in the Bypass.

Interviews highlighted the differences between establishing recreational fishing opportunities and restoring native biological communities. Native fish species that are typically expected in this type of river system are primarily minnow species that thrive in sandy-bottomed channels with "active" substrate. These are not typically sought after recreational fish species and restoring this type of habitat could be difficult in channelized urban streams. Additionally, non-native predatory fish species are often present and threaten the existence of native species. There could be opportunities to establish areas with high recreational fishing value as well as more natural areas that could potentially support native aquatic species.

As noted in Section 15.6, one effective means of filamentous algae control is to introduce sterile grass carp. WWE interviewed the Kansas Wildlife and Parks Department regarding this and they

indicated that this would be feasible, provided that the fish are sterile, the inlet and outlet screened, and the Department consulted with before this activity is conducted.

Another issue related to fish and overall water quality is wintertime freezing and the creation of an ice layer, which could lead to low oxygen levels. Fortunately, wintertime diversion potential is high (see Section 2) and aeration is called for, both of which will reduce icing potential.

In conclusion, initial research indicates that there is good potential to establish fish in the restored channel.

14.10 Regulatory Issues Regarding Water Quality

The earlier text in this section refers to various regulatory concerns. A bullet-point summary of these and other issues follows. Please see Section 15 for additional discussion.

- The same beneficial use classification and numeric standards that are presently effective for the applicable reach of the Smoky Hill River are likely to apply to the restored river channel.
- The Total Maximum Daily Loads (TMDLs) in the mainstem of the Smoky Hill River will likely apply to the Old River Channel. In the Smoky Hill River, as discussed in Section 14.1, these TMDLs apply to such pollutants as nutrients and sediment, and can be thought of as enforceable management plans to enable river water quality to meet numeric limits for the relevant parameters. KDHE is anticipated to apply these TMDLs to the restored channel, which could have an impact of the renewal of the City's municipal stormwater discharge permit.
- Source water protection requirements under the federal Safe Drinking Water Act related to City's municipal wellfield would apply if further consideration is given to utilizing treated municipal effluent as a dry period supply (see Section 3).
- Potential need for NPDES discharge permit for recirculation alternatives (see Section 3).
- City's stormwater NPDES permit requirements will evolve with time, are likely to become more strict and could be influenced by TMDLs.
- To secure an individual 404 permit for dredge and fill in wetlands and waters of the U.S., 401 (water quality) certification from KDHE would be necessary.
- The construction of proposed channel improvements would require a construction NPDES permit and dewatering NPDES permit from KDHE.
- If mechanical clarification is selected to remove sediment (see Section 5), the discharge of sediment back to the Bypass Channel would require an NPDES permit. WWE believes that it is unlikely that KDHE would issue the permit, because there is a TMDL for sediment on the river.

These regulatory issues will require more analysis in Phase 3 and shortly before and during actual construction.

Table 14–1
Smoky Hill River Water Quality Summary Statistics for Mentor (MS 514) and Salina (MS 268)
Between January 2000 and February 2010

All data was provided by the Kansas Department of Health and Environment

Parameter (all units are mg/L unless otherwise noted)	Minimum		Maximum		Average		Applicable Numeric Standard	Exceedances Between 1/2000 and 2/2010 (13)
	MS 514	MS 268	MS 514	MS 268	MS 514	MS 268		
Ammonia	0.02	0.02	0.159	0.388	0.086	0.096	1.5-5.2 (3)	0
Biological Oxygen Demand (1)	1	1	3.78	3.66	2.34	2.39	(4)	NA
Chloride	94.06	94.74	514	268	167.96	148.43	250 (5)	6
E. coli, Colony Forming Units (2)	10	10	5980	2382	398	316	262 (6)	11
Lead	0.001	0.001	0.0174	0.018	0.003	0.003	0.015 (7)	2
Nitrate	0.01	0.35	1	10.71	0.33	1.56	10 (8)	1
Phosphorus	0.024	0.146	0.8	2.33	0.187	0.48	.201 (9)	67
Potassium	7.5	8.55	12.87	24.87	10.01	11.73	(4)	N/A
Sulfate	50.28	47.25	239.46	238.57	147.97	146.9	250 (10)	0
Temperature (degrees Celsius)	0	0	28	27	13.5	14.1	32 (11)	0
Total Suspended Solids	10	10	988	980	117	119	50 (12)	69

Notes:

(1) Measurements of this parameter were not conducted following 2001
(2) Measurements of this parameter began in 2003
(3) Approximate Aquatic Life standard is dependent on season, pH and temperature
(4) Numeric criteria are not provided in the Methodology for the Evaluation and Development of the 2010 303(d) List of Impaired Water Bodies for Kansas or the Kansas Surface Water Quality Standards Tables of Numeric Criteria.
(5) Domestic Water Supply standard
(6) Primary Contact Recreation Class B summer standard
(7) Domestic Water Supply standard
(8) Domestic Water Supply standard
(9) Standard used for 2010 303(d) listing. A site's 12 sample median must exceed this value to be listed.
(10) Domestic Water Supply standard
(11) Aquatic Life standard
(12) Aquatic Life standard
(13) Individual exceedances are not necessarily sufficient for inclusion on the 303(d) list. Please refer to the KDHE's 2010 303(d) listing methodology for parameter specific listing criteria.

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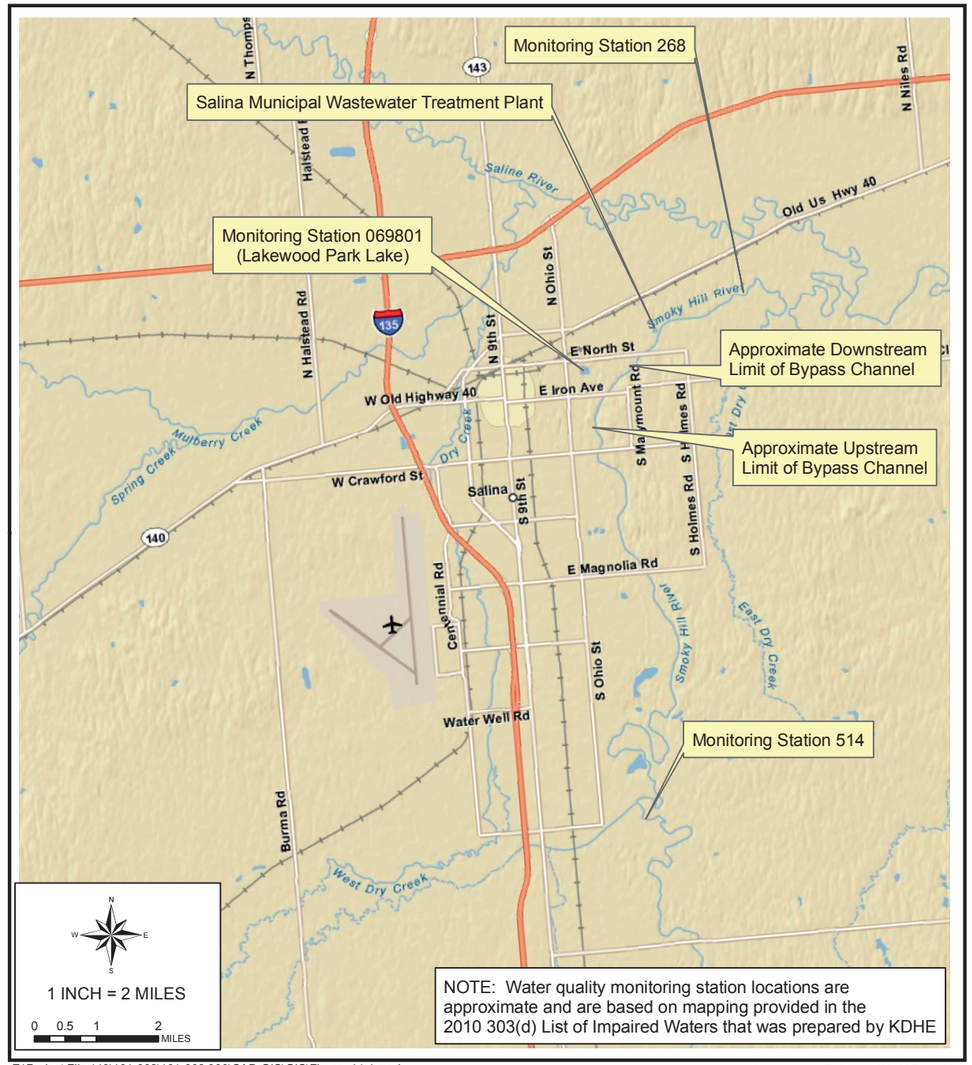

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photo source: DeLorme World Base Map

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SALINE COUNTY, KANSAS

KDHE MONITORING STATIONS

SMOKY HILL RIVER
RESTORATION PROJECT

PROJECT NO. 101-002.000

FIGURE 14-1

15.0 CITY, STATE AND FEDERAL PERMITS AND REGULATORY ISSUES

Construction of the Old River restoration project will require authorization from a range of city, state and federal permitting agencies, and will trigger various regulatory considerations. Section 15 provides a summary of the likely permitting requirements. This section was prepared with assistance from City staff and Olsson Associates in Kansas City, Kansas.

Please note that the key topic of water rights permitting is addressed in Section 2, and is not covered in this section. Based on current information (as of August, 2010), Section 404 of the Clean Water Act and associated permits (refer to Section 15.3.1 below) will pose the most significant permitting challenges for the restoration project, so this topic is addressed in some detail below. Moreover, the project budget (Section 17) includes approximately $5 million to mitigate potential impacts to "Waters of the United States," as defined in section 404 regulations, including the creation of replacement wetlands and other activities.

No actual permits were obtained during the master planning process. Instead, the Master Plan identifies and discusses the permits, and defines key issues. Permit acquisition will come in the next phases (Phase 3 and shortly before or during actual construction) of the overall process. Most permits require design drawings for review and approval. At this stage in the planning process, no fatal flaws from a regulatory perspective have been identified, although requirements under Section 404 are significant from the standpoint of project timeline and overall cost.

15.1 City Permits

In order to adhere to the City of Salina's (City) requirements for development, permits will likely be required. During the permitting phase of the project, required permit applications and information submittals will be identified with assistance from the City's Development Review Team. The following list is a sample of possible requirements:

- Floodplain Development Fill Permit Application (Planning)
- Traffic Study (Engineering)
- Application for Excavation Within Right-of-Way & Street/Alley Pavement (Public Works)
- License Agreement Application (City Commission)
- Heritage District Application (Heritage Commission)
- Right-of-Way Dedication Request (City Commission)
- Land Disturbance Permit

15.2 State Permits

The two State entities that would issue permits for the project include the Kansas Division of Water Resources (DWR) and the Kansas Department of Health and Environment (KDHE).

15.2.1 DWR

Construction along the Old Smoky River channel will require permits from the DWR, through two separate permits under two different state statutes. Activities for this project that will include placing fill in a FEMA floodplain or modification to a levee will typically require a **Permit for Levees and Floodplain Fills**. Activities for this project that would involve modifying a bridge or large culvert, modifying the stream cross-section, or modifying or constructing a dam will typically require a **Permit for Dams, Stream Obstructions and Channel Changes**. Each bridge crossing, separate fill location, and separate channel change location will likely require a separate permit. Further discussion with DWR staff during preliminary design can establish methods to efficiently obtain permits.

15.2.2 KDHE

The role of KDHE in water quality permitting is described in Section 14 (Water Quality and Aquatic Life), and highlights are provided as follows.

Construction for the project will disturb more than 1 acre. A Notice of Intent to the State will be required to obtain coverage under the State General Permit for discharging stormwater from a construction site under the federal National Pollutant Discharge Elimination System (NPDES). In relevant areas, dewatering (groundwater) discharge permits will be necessary.

KDHE will potentially be asked to prepare a Clean Water Act Section 401 certification as part of the Section 404 Permit process completed through the U.S. Army Corps of Engineers (see below for more information). Section 401 refers to assessing the water quality effects of a proposed activity.

As discussed in Section 14 (Water Quality), KDHE has established and is currently preparing Total Maximum Daily Loads (TMDLs) for the Smoky Hill River and the lake at Lakewood Park. It should be anticipated that these TMDLs will also be applied to the Old River Channel in the future, which could have implications for the City's stormwater NPDES permit. With regard to the Salina stormwater NPDES permit, WWE observes that the restoration project is compatible with the basic permit objective of improving stormwater quality, since much of the city drains into the channel.

If future consideration is given by the City to reusing treated effluent as a supplemental water source for the Old River Channel during dry periods, either directly or by exchange (pump to immediately below the diversion, discharge and divert the equivalent amount in to the Old Channel), KDHE would be involved from both the drinking water (source water protection) and discharge permit perspectives.

KDHE approval may also be required for sanitary sewer upgrades or relocations completed as part of the project.

15.3 Federal Permits

15.3.1 Section 404 of the Clean Water Act Impact Permitting

Due to the importance of Section 404 of the Clean Water Act (Section 404) permitting for the project, some detail is provided below, including a summary of key points.

It is important to note that the Kansas City District U.S. Army Corps of Engineers (Corps) out of the Kanopolis Regulatory Field Office, has section 404 permitting authority over *activities* (such as fill placement, dredging, excavation with fill, etc.) affecting "Waters of the United States" (Waters) in Salina, Kansas. Waters include surface waters such as navigable waters and their tributaries, all interstate waters and their tributaries, natural lakes, all wetlands adjacent to other waters, and all impoundments of these waters. Key aspects of 404 permits are discussed below, including general background followed by project-specific information.

15.3.1.1 Waters Delineation/Jurisdictional Determination

Background. Typically, the first step in the section 404 process is to complete a delineation of potential features (Waters) within a project area that the Corps may regulate. The delineation may include information such as quality, quantity, isolation, man-induction, etc. of identified features. Subsequently, the delineation is submitted to the Corps to obtain a Jurisdictional Determination (JD). The purpose of a JD is to identify if there are any Waters that the Corps intends to regulate. Depending on the formality, a JD can be appealed by the applicant and reevaluated by the Corps. Once a JD is obtained, project impacts to jurisdictional Waters can be assessed.

Project Specific Information. On March 2 – 4, 2009, WWE conducted a field visit to the Old Smoky Hill River Channel to observe its condition. The following general observations were made:

1. The channel has been historically impacted by flow reduction and alteration, extensive sediment deposits, installation of a levee and bypass channel, installation of the Western Star Mill Dam, roadway construction and crossings, municipal wells, formal and ad hoc bank stabilization measures, utility line crossings, modifications to original channel configuration, urban development, and others.

2. All of the above impacts have contributed to a steep sloped, confined channel not reminiscent of natural conditions.

3. Water is sporadically allowed to flow through the channel via opening up the water control structure in the levee. During the Master Plan, the water levels were lowered prior to WWE's site visits to allow for easier channel access/observations.

4. The sporadic flow has resulted in the formation of a low-flow depression within segments of the original channel bottom.

5. The low flow depression was primarily dry during the field visit. Isolated pockets of water were observed, especially in the park areas and in areas of the channel constricted by sedimented-in culverts (for example, Ohio Street). A primary source of the pockets of water appeared to be from stormwater discharge and remnants of past flow.

6. Intermittent flow has allowed forested riparian vegetation to fill in a majority of the original channel bottom outside of the low flow depression. The species observed appeared to be homogenous in nature and included weedy, non-native species.

7. Pockets of emergent vegetation dominated by cattails were observed adjacent to manicured parks where little or no canopy was present and more consistent ponding of water appears to occur.

8. Limited fish and macroinvertebrates were observed in the pockets of water. The species observed were typical of disturbed, urban environments.

Following the field visit, WWE produced a "Working Draft of Original Channel" map (see Appendix 15) schematically depicting conditions observed during the March 2009 field trip. It is important to note that WWE did not complete a delineation of Waters during the field trip and the boundaries indicated on the map are likely to change when a more detailed delineation is completed.

On August 31, 2009, the City of Salina requested a JD from the Corps. The JD request was not accompanied by a delineation of Waters. On September 10, 2009, Mr. Lee Wolf, Regulatory Specialist with the Kanopolis Regulatory Field Office of the Kansas City District, Corps, issued a Preliminary JD for the Original Smoky Hill River Channel (Regulatory File No. NWK-2009-01503) (provided in Appendix 15). Mr. Wolf indicated that "based upon a review of the information furnished we have made a preliminary jurisdictional determination that the Original Smoky Hill River Channel possesses an ordinary high water mark at this location and is a jurisdictional water of the United States. Discharges of dredged or fill material in Waters of the United States, including wetlands, require prior authorization from the Corps under Section 404 of the Clean Water Act (33 USC 403) and/or Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403)." While the Preliminary Jurisdictional Determination is not appealable, the City of Salina could request an Approved JD that would be appealable, according to the letter in Appendix 15.

15.3.1.2 Permitting Options

Background. There are typically two avenues of permitting impacts under Section 404 of the Clean Water Act, the *Nationwide Permit Program* and *Individual Permits,* as discussed below.

- **Nationwide Permit Program.** The Corps administers the Nationwide Permit Program (NWP) Program under Section 404. The purpose of the NWP Program is to streamline the evaluation and approval process throughout the nation for certain activities that have only minimal impacts to the aquatic environment (Waters). Projects qualifying for a NWP usually require a 30 to 45 day review period by the Corps and a public comment period is not required. A list of available NWPs can be found at:

  http://www.usace.army.mil/CECW/Documents/cecwo/reg/nwp/2007nwp_sum_table.pdf.

Each NWP has a list of conditions including potential mitigation requirements for project impacts to Waters. Mitigation refers to the creation, restoration or enhancement of wetlands or other Waters to compensate for that which will be lost due to regulated activities. NWPs are valid only if all the applicable conditions (including applicable regional conditions) are met. A listing of regional conditions can be found at:

(http://www.nwk.usace.army.mil/regulatory/NWP_2007/KS/KS_RegCond.pdf).

It is important to note that many of the NWPs require formal notification to the Corps under various circumstances. Irrespective of whether notification is explicitly required, the Corps must be notified prior to beginning work if there are federally listed threatened or endangered species or their designated critical habitat that might be affected by the project. No activity is authorized by a NWP which ~~"~~may affect" a listed species or critical habitat, unless what is known as ~~"~~Section 7 consultation" has been completed (this refers to section 7 of the Endangered Species Act). If necessary, Section 7 consultation would involve communication between the Corps and U.S Fish and Wildlife Service (USFWS) in conjunction with the Kansas Department of Wildlife and Parks. While separate notification is not required for state listed species designated critical habitat, similar agency coordination would need to occur (NWP Standard Operating Procedures (NSOPs) in Kansas, March 9, 2000).

Similar reporting requirements for historic properties are required in the NWP conditions. If a proposed project may affect properties listed, or eligible for listing in the National Register of Historic Places, the activity is not authorized under Section 106 of the National Historic Preservation Act (NHPA) unless Corps coordination with the State Historic Preservation Office has occurred.

As mentioned in 15.2.2, Kansas Water Quality Certification for the NWPs has been issued by the KDHE pursuant to Clean Water Act Section 401 and Kansas Administration Regulation 28-16-28f(c)(1) (Final Kansas Section 404 NWP 401 Water Quality Certification – May 11, 2007). It is important to note that ~~"~~any person wishing to use a Section 404 Nationwide General Permit shall prepare a written project water quality protection plan (PWQPP). The PWQPP shall identify components of the permitted activity (i.e. solid waste handling, fuel storage and leaks, sediment from construction etc.) which may result in the discharge of pollutants to waters of the state (Final Kansas Section 404 NWP 401 Water Quality Certification – May 11, 2007)."

- **Individual Permit Process.** If a project does not qualify for a NWP, then it can potentially be authorized by an Individual Permit (IP). IPs are issued for activities that are perceived to have more than minimal adverse impacts to Waters. IPs are more difficult, expensive and time-consuming to acquire than NWPs. Mitigation for impacts is required by the Corps; IPs are likely to have greater mitigation requirements that NWPs. Evaluation of each IP permit application involves a more thorough review of the potential environmental and socioeconomic effects of a proposed activity than a NWP authorization. Additionally, an alternatives analysis and a public review and comment period are required. This permit requires a lengthy review process by the Corps and other agencies, with no guarantee that an IP will be issued.

The first step in the IP process is typically pre-application consultation. Pre-application consultation can involve one or several meetings between an applicant, Corps staff, interested resource agencies (federal, state, and/or local), and sometimes the interested public. The purpose of these meetings is to discuss, and potentially reduce, a project's impacts on Waters during the planning stages, as well as to inform the applicant as to the factors that the Corps must consider in its decision making process. After the pre-application consultation, an application with an alternatives analysis is submitted to the Corps and formal review begins. The Corps submits a public notice (if required), evaluates project impacts, addresses potential modifications to the project if appropriate, and drafts a document to support a recommended permit decision. Public meeting(s) may occur. The permit decision document identifies environmental impacts of the project, public comments, and any special evaluation required.

15.3.1.3 *Project-Specific Information*

In early 2010, WWE reviewed proposed project concepts to identify whether the project could be permitted utilizing NWPs or if an IP(s) would need to be obtained from the Corps. Many of the proposed project components appeared to qualify for NWPs such as road crossings, bridge/culvert replacements/installations, maintenance of existing structures, and limited and specific dredging activities. Some project components did not appear to conform to existing NWPs such as concrete channel lining and installation of a new water control structure (a Midway Dam [low dam]).

On April 13, 2010, Wright Water Engineers, Inc. (Samantha Clark) and the City of Salina (Martha Tasker) had a Pre-application meeting with Mr. Wolf to discuss various conceptual plans for the project including potential permitting and mitigation requirements.

Permitting. Mr. Wolf expressed that both Nationwide Permits and Individual Permits may be used to authorize the project. Nationwide Permits could be utilized for project components that would cause minor impacts to Waters (for example, bridge or culvert replacements/installations). IPs could be used for portions of the project that would cause more than minor impacts to Waters and would not qualify for NWPs. The Corps can issue a 5 year IP, under the condition that if the work starts then all of the mitigation needs to be completed regardless of whether the work is finished. If no work is started, no mitigation is required.

Mr. Wolf indicated that if project impacts are perceived by the Corps to be significant, then a National Environmental Policy Act (NEPA) study could be required, generally in the form of an Environmental Impact Statement or Environmental Assessment. Whether NEPA is required or not would be determined after the Waters delineation and impacts analysis are complete.

Mitigation. It is important to note that Mr. Wolf's reference above to mitigation is referring to both wetland and stream (ephemeral, intermittent with or without pools, or perennial) mitigation. With respect to wetlands, Mr. Wolf indicated that the on-site mitigation ratio may be 1.5:1 except for wooded wetlands which require a mitigation ratio of 2:1. Off-site wetland mitigation and out-of-kind mitigation (typically refers to compensatory mitigation of one habitat type with another habitat type) both have higher ratios than on-site mitigation (potentially 3:1 or 4:1). Additionally, the mitigation ratio will increase if it cannot occur within the HUC 8 (Hydrologic

Unit Code) area for the Old Smoky Hill River (this means that the mitigation should occur in the general area, not in a remote location).

With respect to stream mitigation, Mr. Wolf referred to the ―Kansas Stream Mitigation Guidance (SMG)" and the ―In-Lieu Fee Program Instrument Outline for Proposed In-Lieu Fee Programs in the States of Kansas and Missouri". The SMG ―describes the method for quantifying the unavoidable adverse impacts (debits) and the acceptable compensatory mitigation (credits) in relation to a project that would have more than minimal adverse impacts to a stream." Based on a review of the SMG, it is WWE's opinion that the Old Smoky Hill River appears to fall in the ―Secondary priority"(because it is impaired by sediment and has impaired biology), and is a ―Functionally Impaired Stream" (due to being channelized, having no evidence of self-recovery, is leveed and thus artificially impounded). The SMG indicates that the order of preference for stream mitigation is (1) purchase ―bank" credits, (2) pay an in-lieu fee, (3) construct project-specific mitigation and (4) and combination of the above. A wetland ―bank" refers to a COE-approved constructed wetland from which ―credits" can be purchased. Mr. Wolf indicated that the required stream mitigation for concrete lining the channel bottom may be substantial (both in amount and cost); he indicated that the City of Salina may want to consider only lining the channel banks, to facilitate approval and reduce mitigation costs.

It is important to note that no wetland banks are available for the project area, as of August, 2010. However, two in-lieu fee providers (these are private organizations that will obtain mitigation credits for an applicant) are currently available that are approved by the Corps: The Watershed Institute and the Sunflower Land Trust. WWE contacted these entities to identify potential costs for in-lieu fee mitigation. Generally, based on interviews with in-lieu fee providers, wetland mitigation may be $50,000/acre; stream credits may be $50 per credit. The concept of stream ―credits" is from the SMG, and relates to mitigation for streams. This is highly specific to the stream in question and the specific project proposed, and will be the subject of negotiations between the City and the Corps in the future. Costs may vary based on quantity of impacts, location of the project, etc. Additionally, it is recommended that an analysis of project specific mitigation occur to identify whether it may be more economical than in-lieu fee banking.

It is important to recognize that without a formal and approved delineation of Waters and a detailed project plan including initial design drawings, it is not feasible to identify how much mitigation (or type) may be required. As the project progresses, contact with Mr. Wolf should continue to solidify mitigation requirements. Based on the uncertainty of the impacts and thus the quantity of required mitigation, the Master Plan cost projection for the restoration project conservatively includes $5 million (total over all of the phases) for wetland and stream mitigation (see Section 17) and assumes that concrete lining will be part of the project.

Field Visit. A field visit to various parts of the Old Smoky Hill River Channel was conducted to observe the condition of the Old Smoky Hill River Channel. It was explained to Mr. Wolf that for much of the time from the late 1980s to the present, little or no water flowed through the levee into the channel; however, occasionally the City of Salina would open the inlet and outlet gates to create flow (especially during the River Festival). During the field visit, most of the channel was dry with isolated pockets of ponded water. Additionally, WWE and Mr. Wolf

agreed that defining the ―ordinary high water mark" (typically used to define stream limits) of the channel versus associated wetland would be a technical challenge during the delineation of wetland and other Waters of the U.S. Mr. Wolf confirmed that the Corps would take jurisdiction over the channel, meaning the channel is subject to regulation under section 404 of the Clean Water Act.

Additional Pre-Application Communication Related to 404 Permit. During the Pre-Application meeting, it was recognized that other agency input was necessary to identify additional permitting challenges. WWE asked Mr. Wolf to provide a list of agency contacts that should be contacted for input. On May 3, 2010, Mr. Wolf provided a list of individuals with the U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), State Historic Preservation Agency (SHPO), Osage Nation, Kansas Department of Wildlife and Parks (KDWP), and KDHE. WWE contacted these agencies, explained the components of the concepts, and asked for the feedback, as follows:

- **USFWS/KDWP—**The Endangered Species Act and Fish and Wildlife Coordination Act are regulated by the U.S. Fish and Wildlife Service. WWE interviewed Ms. Susan Blackford with the USFWS regarding the project. Ms. Blackford expressed concerns with respect to upsetting the balance of the stream, modifying the channel, degrading the system, concrete lining, and the installation of water control structures. Ms. Blackford recommended a pre-application meeting which would include visiting the site and reviewing the project. She indicated that this meeting could help alleviate her concerns.

  The KDWP reviews projects that are presented to the Corps or the Kansas Department of Agriculture Division of Water Resources (DWR), impacts to state listed threatened and endangered species may require additional coordination with KDWP and the completion of a Special Action Permit by the department. WWE spoke with Mr. James Larson with KDWP and learned that Mr. Larson could not think of any major concerns with respect to the project. Additionally, he was not aware of any concerns in Saline County. Once a concept plan is solidified, he would like to conduct a review of the project.

- **SHPO/Osage Nation—**The National Historic Preservation Act is regulated by the State Historic Preservation Office (SHPO). WWE contacted Ms. Kim Norton Gant and Mr. Tim Weston with SHPO. Ms. Gant indicated that a suspension bridge is listed on the National Register. Ms. Gant indicated that this structure has recently been relocated and could possibly be moved again. Additionally, Ms. Gant thought that there would probably be little difficulty lowering the Western Star Mill Dam, even if it is greater than fifty years old. Mr. Tim Weston, an archeologist with SHPO, indicated that while there are many big sites in the valley, there are probably none in the developed portion of Salina. He would want to evaluate the tie-in point to the main channel and where major earthwork is proposed to look for unknown sites. He did not believe there would be concern with removing silt from the channel.

  WWE attempted unsuccessfully to contact Mr. James Munkres with the Osage Nation to discuss the project. The Osage Nation will most likely want to review the project to identify any sites that may be significant to the Osage Nation.

- **EPA/KDHE**—As discussed above in this section and in Section 14 (Water Quality), an individual 404 permit application normally triggers the need for Section 401 Water Quality Certifications, issued by the Kansas Department of Health and Environment (KDHE) and also reviewed by the U.S. Environmental Protection Agency. WWE interviewed Mr. Scott Satterthwaite with KDHE. Mr. Satterthwaite is aware of the project and he would be responsible for preparing the Section 401 Water Quality Certification. Mr. Satterthwaite stated there would need to be an Operation and Maintenance Plan for the project. He expressed concerns including mowing down to the edge of the channel (which can attract geese) and potential hydrologic impacts (faster velocities) downstream, and erosion issues. Recommendations that Mr. Satterthwaite presented included the use of native vegetation, not mowing to the water's edge, wetland ~~eye~~b ows" at stormwater outfalls, and wetland detention. Mr. Satterthwaite would review the project for water quality issues when a detailed plan is available.

- **NRCS**—The 1985 Food Security Act and NRCS Wetland Protection Policy are regulated by the Natural Resources Conservation Service (NRCS). Upon notification by the Corps of Engineers of the 404 application, the NRCS may choose to review the project for potential impacts directly or indirectly to agricultural land. WWE has not contacted the NRCS to date but this contact should be made during the permitting phase (Phase 3) of the project. The NRCS review is anticipated to be straightforward.

  All of the above agencies interviewed anticipate continued interaction with the City in the future as design becomes more detailed.

Corps Discussion Regarding Sediment Removal in the Channel. On July 20, 2010, WWE explained to Mr. Wolf that sediment will need to be removed periodically from the channel (see Section 5). The COE has indicated that in all likelihood, Nationwide Permit No. 43: Stormwater Management Facilities will cover this task for the sedimentation basins in Bill Burke Park, on the river side of the levee. A long-term agreement with the Corps should be obtained for this facility, if feasible. This has occurred for other municipalities and drainage districts.

Nationwide Permit No. 3: Maintenance (NWP 3) will likely be applicable for sediment removal in the concrete-lined portions of the channel (again, a long-term agreement is recommended).

NWP 3 may also be used for unlined portions of the channel (natural bottom) as long as dredging does not involve lowering water levels and bringing in construction equipment to re-grade the channel. A form of dredging that would qualify for NWP 3 would be hydraulic dredging where sediment/water is discharged into a sedimentation basin (outside of the channel) protected by hay bales. Once sediment is settled out, water can be re-introduced into the channel via an additional NWP. Mr. Wolf indicated that there is a one-half–acre limit for NWP 3. However, timing (alternating areas) or placement of projects (associating the one-half–acre area with different structures) can be used to accommodate most of the proposed dredging area. If the proposed sediment removal cannot conform to NWP 3, such as if the channel and sediment are dewatered and the sediment is then removed with construction equipment, the unlined portions of the project would require an IP. The City has expressed concern about needing to obtain an IP every time it is necessary to drain and excavate accumulated sediment from the channel.

15.3.1.4 *Summary and Conclusions Regarding Section 404 Permit*

The following is a brief summary of key Section 404 of the Clean Water Act permitting challenges that will be faced as the project proceeds.

1. Many of the components of the project will qualify for available Nationwide Permits (NWPs). Some components of the project, such as concrete lining and a new dam, will not qualify for NWPs and will require authorization under an IP (or multiple IPs, depending on how the project progresses). An IP authorization requires a more thorough review of potential environmental and socioeconomic effects of a proposed activity than a NWP authorization. Additionally, IPs require an alternatives analysis, going out for public comment, and take significantly longer and are more costly to obtain than NWPs.

2. If project impacts are identified as significant, the U.S. Army Corps of Engineers (Corps) may require a National Environmental Policy Act (NEPA) study, usually in the form of an Environmental Impact Statement (EIS) or an Environmental Assessment (EA). If required, the NEPA study would involve the evaluation of environmental effects of a project including its alternatives (see additional discussion in 15.3.2.2. on NEPA documents).

3. Wetland impact mitigation can range between 1.5:1 to 4:1 depending on whether done onsite versus offsite. Based on information obtained from the Corps, stream impact mitigation will also need to be resolved during the permitting process. However, it is important to note that modifications to the channel such as concrete lining may significantly increase stream mitigation costs. The Corps has preliminarily indicated that the mitigation required is likely to be less if the banks of the channel, and not the bottom, are concrete lined.

4. The Corps has indicated that sediment removal in the channel can be authorized under NWPs in the concrete-lined sedimentation basins and concrete lined portions of the channel. In unlined portions of the channel, sediment removal can be authorized under a NWP as long as the sediment is hydraulically removed. Otherwise, sediment removal would need to be authorized as an IP, such as if the channel were dewatered so that the sediment could be removed via excavation.

5. Other laws affect processing of the Section 404 permit. WWE contacted the U.S. Fish and Wildlife Service, Kansas Department of Wildlife and Parks, State Historic Preservation Office, Kansas Department of Health and Environment, and the U.S. Environmental Protection Agency for preliminary thoughts on the project. All of these entities would be interested in reviewing a proposed project plan and visiting the project area as part of a pre-application meeting. Preliminary concerns that were brought up included upsetting the balance of the stream, modifying the channel, degrading the system, concrete lining, installation of water control structures, mowing down to the edge of the water (attracting geese), and potential hydrologic downstream impacts.

6. Section 17 of this report includes a conservative cost projection of $5 million for mitigation to comply with section 404.

In summary, although none of the items listed above are considered "fatal flaws," they are all significant from the standpoint of project timeline and overall cost.

15.3.2 Additional Federal Requirements

15.3.2.1 Floodplain Permits

As discussed in Section 11, to the extent that the existing regulatory floodplain will be modified, such as through the replacement of culverts with bridges or widening the channel at the Midway, a "Letter of Map Revision" (LOMR) will be necessary from the Federal Emergency Management Agency (FEMA). LOMRs can be expensive and lengthy, particularly (as is the case for the Old River Channel), if there is not presently a detailed floodplain study available.

15.3.2.2 Potential EA or EIS

As discussed above, relative to 404 permitting, the restoration project could trigger the need for an Environmental Assessment (EA) or Environmental Impact Statement (EIS). If significant federal funding is acquired to assist with construction, this could trigger an EA or EIS. The practical effects of having to prepare an EA or EIS are:

- Time—This could require 1 – 2 years.
- Expense—This is typically an expensive process for a project of this kind, with potential costs of over $0.5 million.
- Multi-agency Review—Numerous agencies at all levels, as well as the public, contribute to the preparation of the EA/EIS, so considerable administrative effort is involved.
- Uncertainty Regarding Nature of Preferred Alternative—The basic objective of the process is to review a series of alternatives and to select the preferred alternative. The preferred alternative that emerges from the environmental review process may differ from the City's preferred alternative in some ways.

16.0 OPERATION AND MAINTENANCE ACTIVITIES AND COSTS

Evaluation of the annual operations and maintenance activities and costs associated with the selected alternative of the Master Plan with the detailed results is presented in the following pages.

The annual total and full-time equivalents (FTE) are summarized on sheet 1. The operation and maintenance costs are presented in phases, 1A through 6.

The computation of annual O&M costs did not make allowances for foregone O&M costs such as existing bridge inspections, lawn mowing and trash removal. As a result, some ongoing City O&M costs would be reduced.

The O&M estimates do not account for the use of volunteers for some identified functions; however, such reductions would tend to be small.

Regarding costs of periodic sediment removal from the channel, it is assumed that it will be feasible to drain the water out of the channel once every 4 years, for cleaning upstream of the Western Star Mill Dam and once every 8 years downstream of the Western Star Mill Dam, allow the sediment to dewater and then excavate the accumulated sediment with construction equipment such as front-end loaders. The alternative scenario, hydraulic dredging (discussed in Section 5), is not included in these cost tables, but it would be expected to add roughly $50,000 to $75,000 per year in operation and maintenance costs. As discussed in Section 5, the 4 year/8 year frequency priced out in the attached tables is based on conservative assumptions, and the actual sediment cleaning frequency is likely to be longer.

WWE anticipates that as the City continues to carefully review and refine these maintenance activities, the list and associated cost will need to be refined.

Summary of Opinion of Probable Annual Operation & Maintenance Costs
8/11/2010

Phase		Annual O&M (Cumulative) in year 2010 dollars	Full Time Equivalents (FTEs) (Cumulative)
1B	Phase1	$ 421,300	4.2
2	Kenwood Park - East Gateway	$ 591,700	5.8
3	Downtown Riverwalk (South Half)	$ 712,500	6.9
4	South Reach Enhancements	$ 807,500	7.9
5	Main Channel Bypass	$ 958,500	9.2
6	North Reaches	$ 1,092,300	10.5

Phase 1 - Opinion of Probable Annual Operation and Maintenance Cost
(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
1	Trash and Debris Removal/Walkway Sweeping and Washing						
1a	Riverwalk and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	800	$ 24,000	$ 10,000	$ 34,000
1b	Natural Areas and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	600	$ 18,000	$ 4,000	22,000
2	Mowing/Vegetation Management						
2a	Riverwalk	Weekly Mar-Nov	9 ac	320	9,600	1,500	11,100
2b	Natural Areas	1 x mo. Apr-Sept	18 ac	400	12,000	1,500	13,500
3	Sediment Removal						
3a	Sediment Basin @ Inlet in Bill Burke Park	Every 1 year	1,550 CY	750	22,500	22,500	45,000
3b	Riverwalk Concrete Lined Channel	Every 4 years	435 CY	500	15,000	15,000	30,000
3c	Natural Areas	Every 4 years					
3d	Channel downstream Western Star Mill Dam	Every 8 years	100 CY	150	4,500	4,500	9,000
4	Inspections regarding structural condition, public safety, appearance, trail, etc.	Quarterly	4	360	10,800	2,000	12,800
5	Channel Maintenance (riprap, sloughing, erosion, etc.)	Semi-Annual	2	360	10,800	10,800	21,600
6	Structure Maintenance (railings, signs, lights, walls, drains, etc.)	Weekly, Apr-Sep	24	600	18,000	18,000	36,000
7	Aeration system Maintenance	Monthly, Apr-Sep	6	100	3,000	3,000	6,000
8	Algae Control Activities	Monthly Apr-Sep	6	40	1,200	2,000	3,200
9	Pumpback System O&M	Annual run to assure functional; every 3rd yr, run 3 mo	For a 2 cfs capacity	80	$ 2,400	400	$ 2,800
10	Dam Inspection and Maintenance	Quarterly	8	360	10,800	10,800	21,600
11	Bike & Pedestrian Trail Maintenance, including bridge/culvert underpasses	Quarterly	4	400	12,000	6,000	18,000

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Phase 1 - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
12	Levee and river gate operation & maintenance, and any link to Mentor gage for operation	Levee gates, annual; river/sediment gates and link to Mentor gage semi-annual	1 and 2	100	3,000	500	3,500
13	Bridges, culverts, racks, transitions and other hydraulic structures - large debris and trash	Annual and after significant storm event as needed.	4	160	4,800	4,800	9,600
14	Storm drain outfalls into river, including erosion control in channel, dry weather flow screening, etc.	Annual	1	120	3,600	3,600	7,200
15	Channel access routes, trash removal, mow, add gravel, etc.	Annual	1	160	4,800	2,400	7,200
16	Stormwater BMPs that are associated with river channel such as trash removal devices at storm drains	Monthly Mar-Oct & after significant storm events	Cleaning storm detention basin debris 4 x	240	7,200	3,600	10,800
17	Maintenance with equipment used specifically in channel such as trash skimmer for channel vacuum for sediment deposits, etc.	Annual and as needed		240	7,200	7,200	$ 14,400
18	Administration	On-going		600	18,000	10,000	28,000
19	Miscellaneous, Recreational Amenities, Restrooms, Lighting			900	27,000	27,000	54,000
	TOTAL			8,340	$ 250,200	$ 171,100	**$ 421,300**
			FTE	4.2			

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2. Addition Kenwood/East Gateway - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
1	Trash and Debris Removal/Walkway Sweeping and Washing						
1a	Riverwalk and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	1600	$ 48,000	$ 20,000	$ 68,000
1b	Natural Areas and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	600	$ 18,000	$ 4,000	22,000
2	Mowing/Vegetation Management						
2a	Riverwalk	Weekly Mar-Nov	12 ac	440	13,200	1,500	14,700
2b	Natural Areas	1 x mo. Apr-Sept	18 ac	400	12,000	1,500	13,500
3	Sediment Removal						
3a	Sediment Basin @ Inlet in Bill Burke Park	Every 1 year	1,550 CY	750	22,500	22,500	45,000
3b	Riverwalk Concrete Lined Channel	Every 4 years	435 CY	500	15,000	15,000	30,000
3c	Natural Areas	Every 4 years					
3d	Channel downstream Western Star Mill Dam	Every 8 years	100 CY	150	4,500	4,500	9,000
4	Inspections regarding structural condition, public safety, appearance, trail, etc.	Quarterly	4	540	16,200	5,000	21,200
5	Channel Maintenance (riprap, sloughing, erosion, etc.)	Semi-Annual	2	400	12,000	12,000	24,000
6	Structure Maintenance (railings, signs, lights, walls, drains, etc.)	Weekly, Apr-Sep	24	1000	30,000	30,000	60,000
7	Aeration system Maintenance	Monthly, Apr-Sep	6	200	6,000	6,000	12,000
8	Algae Control Activities	Monthly Apr-Sep	6	80	2,400	4,000	6,400
9	Pumpback System O&M	Annual run to assure functional; every 3rd yr, run 3 mo	For a 2 cfs capacity	80	$ 2,400	400	$ 2,800
10	Dam Inspection and Maintenance	Quarterly	8	600	18,000	18,000	36,000
11	Bike & Pedestrian Trail Maintenance, including bridge/culvert underpasses	Quarterly	4	600	18,000	12,000	30,000

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2. Addition Kenwood/East Gateway - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
12	Levee and river gate operation & maintenance, and any link to Mentor gage for operation	Levee gates, annual; river/sediment gates and link to Mentor gage semi-annual	1 and 2	100	3,000	500	3,500
13	Bridges, culverts, racks, transitions and other hydraulic structures - large debris and trash	Annual and after significant storm event as needed.	4	320	9,600	9,600	19,200
14	Storm drain outfalls into river, including erosion control in channel, dry weather flow screening, etc.	Annual	1	160	4,800	4,800	9,600
15	Channel access routes, trash removal, mow, add gravel, etc.	Annual	1	200	6,000	2,400	8,400
16	Stormwater BMPs that are associated with river channel such as trash removal devices at storm drains	Monthly Mar-Oct & after significant storm events	Cleaning storm detention basin debris 4 x	240	7,200	3,600	10,800
17	Maintenance with equipment used specifically in channel such as trash skimmer for channel vacuum for sediment deposits, etc.	Annual and as needed		360	10,800	10,800	$ 21,600
18	Administration	On-going		800	24,000	10,000	34,000
19	Miscellaneous, Recreational Amenities, Restrooms, Lighting			1500	45,000	45,000	90,000
	TOTAL			11,620	$ 348,600	$ 243,100	**$ 591,700**
			FTE	5.8			

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3. Addition Downtown Riverwalk (South) - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
1	Trash and Debris Removal/Walkway Sweeping and Washing						
1a	Riverwalk and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	1600	$ 48,000	$ 20,000	$ 68,000
1b	Natural Areas and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	600	$ 18,000	$ 4,000	22,000
2	Mowing/Vegetation Management						
2a	Riverwalk	Weekly Mar-Nov	9 ac	320	9,600	1,500	11,100
2b	Natural Areas	1 x mo. Apr-Sept	18 ac	400	12,000	1,500	13,500
3	Sediment Removal						
3a	Sediment Basin @ Inlet in Bill Burke Park	Every 1 year	1,550 CY	750	22,500	22,500	45,000
3b	Riverwalk Concrete Lined Channel	Every 4 years	435 CY	500	15,000	15,000	30,000
3c	Natural Areas	Every 4 years					
3d	Channel downstream Western Star Mill Dam	Every 8 years	100 CY	150	4,500	4,500	9,000
4	Inspections regarding structural condition, public safety, appearance, trail, etc.	Quarterly	4	600	18,000	9,000	27,000
5	Channel Maintenance (riprap, sloughing, erosion, etc.)	Semi-Annual	2	400	12,000	12,000	24,000
6	Structure Maintenance (railings, signs, lights, walls, drains, etc.)	Weekly, Apr-Sep	24	1500	45,000	45,000	90,000
7	Aeration system Maintenance	Monthly, Apr-Sep	6	300	9,000	9,000	18,000
8	Algae Control Activities	Monthly Apr-Sep	6	120	3,600	5,000	8,600
9	Pumpback System O&M	Annual run to assure functional; every 3rd yr, run 3 mo	For a 2 cfs capacity	80	$ 2,400	400	$ 2,800
10	Dam Inspection and Maintenance	Quarterly	8	800	24,000	24,000	48,000
11	Bike & Pedestrian Trail Maintenance, including bridge/culvert underpasses	Quarterly	4	800	24,000	18,000	42,000

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3. Addition Downtown Riverwalk (South) - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
12	Levee and river gate operation & maintenance, and any link to Mentor gage for operation	Levee gates, annual; river/sediment gates and link to Mentor gage semi-annual	1 and 2	100	3,000	500	3,500
13	Bridges, culverts, racks, transitions and other hydraulic structures - large debris and trash	Annual and after significant storm event as needed.	4	320	9,600	9,600	19,200
14	Storm drain outfalls into river, including erosion control in channel, dry weather flow screening, etc.	Annual	1	160	4,800	4,800	9,600
15	Channel access routes, trash removal, mow, add gravel, etc.	Annual	1	200	6,000	2,400	8,400
16	Stormwater BMPs that are associated with river channel such as trash removal devices at storm drains	Monthly Mar-Oct & after significant storm events	Cleaning storm detention basin debris 4 x	240	7,200	3,600	10,800
17	Maintenance with equipment used specifically in channel such as trash skimmer for channel vacuum for sediment deposits, etc.	Annual and as needed		600	18,000	18,000	$ 36,000
18	Administration	On-going		1200	36,000	10,000	46,000
19	Miscellaneous, Recreational Amenities, Restrooms, Lighting			2000	60,000	60,000	120,000
	TOTAL			13,740	$ 412,200	$ 300,300	**$ 712,500**
			FTE	6.9			

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4. Addition South Reach Enhancements - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
1	Trash and Debris Removal/Walkway Sweeping and Washing						
1a	Riverwalk and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	1600	$ 48,000	$ 20,000	$ 68,000
1b	Natural Areas and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	720	$ 21,600	$ 5,000	26,600
2	Mowing/Vegetation Management						
2a	Riverwalk	Weekly Mar-Nov	9 ac	320	9,600	1,500	11,100
2b	Natural Areas	1 x mo. Apr-Sept	18 ac	400	12,000	1,500	13,500
3	Sediment Removal						
3a	Sediment Basin @ Inlet in Bill Burke Park	Every 1 year	1,550 CY	750	22,500	22,500	45,000
3b	Riverwalk Concrete Lined Channel	Every 4 years	435 CY	500	15,000	15,000	30,000
3c	Natural Areas	Every 4 years					
3d	Channel downstream Western Star Mill Dam	Every 8 years	100 CY	150	4,500	4,500	9,000
4	Inspections regarding structural condition, public safety, appearance, trail, etc.	Quarterly	4	720	21,600	10,400	32,000
5	Channel Maintenance (riprap, sloughing, erosion, etc.)	Semi-Annual	2	400	12,000	12,000	24,000
6	Structure Maintenance (railings, signs, lights, walls, drains, etc.)	Weekly, Apr-Sep	24	1800	54,000	54,000	108,000
7	Aeration system Maintenance	Monthly, Apr-Sep	6	300	9,000	9,000	18,000
8	Algae Control Activities	Monthly Apr-Sep	6	120	3,600	5,000	8,600
9	Pumpback System O&M	Annual run to assure functional; every 3rd yr, run 3 mo	For a 2 cfs capacity	80	$ 2,400	400	$ 2,800
10	Dam Inspection and Maintenance	Quarterly	8	800	24,000	24,000	48,000
11	Bike & Pedestrian Trail Maintenance, including bridge/culvert underpasses	Quarterly	4	1400	42,000	20,000	62,000

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4. Addition South Reach Enhancements - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
12	Levee and river gate operation & maintenance, and any link to Mentor gage for operation	Levee gates, annual; river/sediment gates and link to Mentor gage semi-annual	1 and 2	100	3,000	500	3,500
13	Bridges, culverts, racks, transitions and other hydraulic structures - large debris and trash	Annual and after significant storm event as needed.	4	600	18,000	18,000	36,000
14	Storm drain outfalls into river, including erosion control in channel, dry weather flow screening, etc.	Annual	1	160	4,800	4,800	9,600
15	Channel access routes, trash removal, mow, add gravel, etc.	Annual	1	200	6,000	2,400	8,400
16	Stormwater BMPs that are associated with river channel such as trash removal devices at storm drains	Monthly Mar-Oct & after significant storm events	Cleaning storm detention basin debris 4 x	240	7,200	3,600	10,800
17	Maintenance with equipment used specifically in channel such as trash skimmer for channel vacuum for sediment deposits, etc.	Annual and as needed		720	21,600	21,600	$ 43,200
18	Administration	On-going		1500	45,000	10,000	55,000
19	Miscellaneous, Recreational Amenities, Restrooms, Lighting			2240	67,200	67,200	134,400
	TOTAL			15,820	$ 474,600	$ 332,900	**$ 807,500**
			FTE	7.9			

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5 Addition Main Channel Bypass - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
1	Trash and Debris Removal/Walkway Sweeping and Washing						
1a	Riverwalk and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	1600	$ 48,000	$ 20,000	$ 68,000
1b	Natural Areas and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	720	$ 21,600	$ 5,000	26,600
2	Mowing/Vegetation Management						
2a	Riverwalk	Weekly Mar-Nov	9 ac	320	9,600	1,500	11,100
2b	Natural Areas	1 x mo. Apr-Sept	18 ac	400	12,000	1,500	13,500
3	Sediment Removal						
3a	Sediment Basin @ Inlet in Bill Burke Park	Every 1 year	1,550 CY	750	22,500	22,500	45,000
3b	Riverwalk Concrete Lined Channel	Every 4 years	435 CY	500	15,000	15,000	30,000
3c	Natural Areas	Every 4 years					
3d	Channel downstream Western Star Mill Dam	Every 8 years	100 CY	150	4,500	4,500	9,000
4	Inspections regarding structural condition, public safety, appearance, trail, etc.	Quarterly	4	1000	30,000	15,000	45,000
5	Channel Maintenance (riprap, sloughing, erosion, etc.)	Semi-Annual	2	400	12,000	12,000	24,000
6	Structure Maintenance (railings, signs, lights, walls, drains, etc.)	Weekly, Apr-Sep	24	2500	75,000	75,000	150,000
7	Aeration system Maintenance	Monthly, Apr-Sep	6	300	9,000	9,000	18,000
8	Algae Control Activities	Monthly Apr-Sep	6	120	3,600	5,000	8,600
9	Pumpback System O&M	Annual run to assure functional; every 3rd yr, run 3 mo	For a 2 cfs capacity	80	$ 2,400	400	$ 2,800
10	Dam Inspection and Maintenance	Quarterly	8	800	24,000	24,000	48,000
11	Bike & Pedestrian Trail Maintenance, including bridge/culvert underpasses	Quarterly	4	1600	48,000	24,000	72,000

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5 Addition Main Channel Bypass - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
12	Levee and river gate operation & maintenance, and any link to Mentor gage for operation	Levee gates, annual; river/sediment gates and link to Mentor gage semi-annual	1 and 2	100	3,000	500	3,500
13	Bridges, culverts, racks, transitions and other hydraulic structures - large debris and trash	Annual and after significant storm event as needed.	4	600	18,000	18,000	36,000
14	Storm drain outfalls into river, including erosion control in channel, dry weather flow screening, etc.	Annual	1	160	4,800	4,800	9,600
15	Channel access routes, trash removal, mow, add gravel, etc.	Annual	1	320	9,600	3,200	12,800
16	Stormwater BMPs that are associated with river channel such as trash removal devices at storm drains	Monthly Mar-Oct & after significant storm events	Cleaning storm detention basin debris 4 x	240	7,200	3,600	10,800
17	Maintenance with equipment used specifically in channel such as trash skimmer for channel vacuum for sediment deposits, etc.	Annual and as needed		720	21,600	21,600	$ 43,200
18	Administration	On-going		1,400	42,000	13,000	55,000
19	Miscellaneous, Recreational Amenities, Restrooms, Lighting			3,600	108,000	108,000	216,000
	TOTAL			18,380	$ 551,400	$ 407,100	**$ 958,500**
			FTE	9.2			

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6. Addition North Reaches - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
1	Trash and Debris Removal/Walkway Sweeping and Washing						
1a	Riverwalk and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	1840	$ 55,200	$ 30,000	$ 85,200
1b	Natural Areas and Channel	2 x wk Mar-Nov; 1 x wk Dec-Feb	68 x	720	$ 21,600	$ 5,000	26,600
2	Mowing/Vegetation Management						
2a	Riverwalk	Weekly Mar-Nov	9 ac	360	10,800	1,500	12,300
2b	Natural Areas	1 x mo. Apr-Sept	18 ac	400	12,000	1,500	13,500
3	Sediment Removal						
3a	Sediment Basin @ Inlet in Bill Burke Park	Every 1 year	1,550 CY	750	22,500	22,500	45,000
3b	Riverwalk Concrete Lined Channel	Every 4 years	435 CY	500	15,000	15,000	30,000
3c	Natural Areas	Every 4 years					
3d	Channel downstream Western Star Mill Dam	Every 8 years	100 CY	150	4,500	4,500	9,000
4	Inspections regarding structural condition, public safety, appearance, trail, etc.	Quarterly	4	1200	36,000	15,000	51,000
5	Channel Maintenance (riprap, sloughing, erosion, etc.)	Semi-Annual	2	400	12,000	12,000	24,000
6	Structure Maintenance (railings, signs, lights, walls, drains, etc.)	Weekly, Apr-Sep	24	2800	84,000	84,000	168,000
7	Aeration system Maintenance	Monthly, Apr-Sep	6	300	9,000	9,000	18,000
8	Algae Control Activities	Monthly Apr-Sep	6	120	3,600	5,000	8,600
9	Pumpback System O&M	Annual run to assure functional; every 3rd yr, run 3 mo	For a 2 cfs capacity	80	$ 2,400	400	$ 2,800
10	Dam Inspection and Maintenance	Quarterly	8	800	24,000	24,000	48,000
11	Bike & Pedestrian Trail Maintenance, including bridge/culvert underpasses	Quarterly	4	1800	54,000	24,000	78,000

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6. Addition North Reaches - Opinion of Probable Annual Operation and Maintenance Cost

(Costs in year 2010 dollars)

Item No.	Channel Maintenance Activity	Frequency	Annual Unit	Manhours	Labor $ 30	Materials/Supplies	Total
12	Levee and river gate operation & maintenance, and any link to Mentor gage for operation	Levee gates, annual; river/sediment gates and link to Mentor gage semi-annual	1 and 2	100	3,000	500	3,500
13	Bridges, culverts, racks, transitions and other hydraulic structures - large debris and trash	Annual and after significant storm event as needed.	4	720	21,600	21,600	43,200
14	Storm drain outfalls into river, including erosion control in channel, dry weather flow screening, etc.	Annual	1	200	6,000	6,000	12,000
15	Channel access routes, trash removal, mow, add gravel, etc.	Annual	1	320	9,600	3,200	12,800
16	Stormwater BMPs that are associated with river channel such as trash removal devices at storm drains	Monthly Mar-Oct & after significant storm events	Cleaning storm detention basin debris 4 x	240	7,200	3,600	10,800
17	Maintenance with equipment used specifically in channel such as trash skimmer for channel vacuum for sediment deposits, etc.	Annual and as needed		800	24,000	24,000	$ 48,000
18	Administration	On-going		2,400	72,000	30,000	102,000
19	Miscellaneous, Recreational Amenities, Restrooms, Lighting			4,000	120,000	120,000	240,000
	TOTAL			21,000	$ 630,000	$ 462,300	$ 1,092,300
			FTE	10.5			

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17.0 CAPITAL COST PROJECTIONS

Section 17 provides tables which summarize Master Plan opinion of probable costs for the project recommended in the Master Plan.

In preparing these costs, WWE and DSW assumed that neither an environmental impact statement (EIS) nor an environmental assessment (EA) will be necessary. The Master Plan recommends that a detailed floodplain study of the Old River Channel be prepared—that cost is not included herein, nor is the cost of a "Letter of Map Revision" (LOMR) from the Federal Emergency Management Agency (FEMA). There is no indication in the current channel sediment sampling data that environmental remediation will be necessary; thus, costs for environmental remediation are not included in these projections. The attached tables present capital costs according to project phase and geographic location. Comments/descriptions have been prepared for many of the items, although these are summary in nature and supporting information is provided in Appendix 17 and elsewhere in the Master Plan.

A 22% allowance has been made for landscape architecture and engineering design, surveying, geotechnical engineering, structural engineering, construction-related permitting, construction-phase services, grants/funding applications, economic analysis, project administration (including design guidelines and local regulatory structure) and legal review. This 22% factor is based on the present understanding that DSW and WWE have, but as planning and design progress, unforeseen circumstances could cause this percentage to change. In addition, because these costs have been projected at a master planning level (and are based on conceptual design), a 30% contingency has been utilized.

To facilitate phasing decisions, the City requested that when developing the attached probable cost tables, DSW and WWE show the 22% factor for planning/engineering design and related activities and the 30% contingency factor (to reflect master-plan–level design) for each individual item in the table rather than for each overall phase, as would normally be the case in tables of this kind. These factors are typically assigned to the overall cost without knowing how the additional cost factors will actually be distributed among the individual items. However, WWE and DSW have provided the costs as requested by the City to assist with their prioritization and decision-making.

A land acquisition allowance, included in the Primary Phase, has been estimated by the City to be $3,500,000 for the entire project, excluding the Kenwood Park Midway Gateway at South Ohio and the relocation cost associated with the City of Salina General Services Facility located on East Ash Street. The value assigned to specific phases is anticipated to vary, considering potential negotiated donations and dedications. The land acquisition allowance does not include acquisition of property associated with the Kenwood Park Midway Gateway at South Ohio Street and the relocation cost associated with the City of Salina General Services Facility located on East Elm Street.

A summary of probable costs based on the Master Plan is presented in Table 17–1.

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Table 17-1
Master Plan Cost Summary
Prepared by DSW and WWE

Phase	Projected Construction Cost	22% Factor	Subtotal	30% Master Plan Contingency	Grand Total
Primary Phase	$23,362,000	$4,374,000	$27,736,000	$7,278,000	$35,014,000
Kenwood Park/East Gateway	$10,626,000	$2,339,000	$12,965,000	$3,894,000	$16,859,000
Downtown Riverwalk (South Half)	$7,205,000	$1,587,000	$8,792,000	$2,641,000	$11,433,000
South Reach Enhancements	$8,000,000	$1,760,000	$9,760,000	$2,931,000	$12,691,000
Main Channel Bypass	$5,515,000	$1,214,000	$6,729,000	$2,021,000	$8,750,000
North Reaches	$6,742,000	$1,484,000	$8,226,000	$2,471,000	$10,697,000
			$74,208,000	**Grand Total**	**$95,444,000**

Smoky Hill River Channel Restoration Potential Phasing

Master Plan Opinion of Probable Cost in Year 2010 Dollars

Primary Phase

Water flowing; sediment removal, sedimentation basins; Lakewood Park delivery to concrete channel, trails

No.	Item	Unit	Quantity	Unit Cost	Subtotal	22% Allowance[1]	Subtotal	30% Construction Contingency[2]	Total Cost	Comments/Descriptions
1	Water Rights Firming Allowance	L.S.			$ 600,000	$ 132,000	$ 732,000	$ 220,000	$ 952,000	Cost Placeholder.
2	River Intake Wall and Gates at Bill Burke Park	L.S.			600,000	$ 132,000	$ 732,000	$ 220,000	$ 952,000	Length of 100 feet, 3 sets of overflow weirs
3	Sedimentation Basin (2 concrete lined cells, total length 500', bottom width 40', height 11', 10" thickness, railings) at Bill Burke Park	L.S.			900,000	$ 198,000	$ 1,098,000	$ 330,000	$ 1,428,000	1200 CY Concrete. City Municipal Raw Water Pipelines Cross the Basin Area
4	Temporary conveyance (culvert) under South Ohio	L.S.			300,000	$ 66,000	$ 366,000	$ 110,000	$ 476,000	Temporary conveyance required until new bridge is constructed, following Primary Phase
5	Clearing and Trimming Trees and Brush from Channel, Allowance	acres	38	15,000	570,000	$ 126,000	$ 696,000	$ 209,000	$ 905,000	Area based on Urban reach 6,000 LF @ 80 ft width; Natural areas 27,000 LF @ 40 ft; Park area 3,000 LF @ 0 ft; & 30 construction access points at 20 ft width
6	Sediment Removal	CY	65,000	30	1,950,000	$ 429,000	$ 2,379,000	$ 714,000	$ 3,093,000	Area of sediment removal shown in yellow color on the Profile drawing and on cross sections
7	Wetland/Stream Mitigation Allowance	LS			1,000,000	$ 220,000	$ 1,220,000	$ 366,000	$ 1,586,000	Cost Placeholder. 404 permit mitigation requirements cannot defined more accurately at this time and will be dependent on the outcome of consultations with the USCOE and other agencies.
8	Initial Multi-Use Trails System Bill Burke Park to Walnut St.	LS	12054 LF		2,451,000	$ 540,000	$ 2,991,000	$ 898,000	$ 3,889,000	BWR multi-use 10' concrete trail segments 1, 2, 4
9	Multi-use trail lighting	LF	3,337	42	141,000	$ 32,000	$ 173,000	$ 52,000	$ 225,000	BWR multi-use 10' concrete trail segment 4 (Oakdale Park to Walnut St Bridge)
10	Lakewood Park Lake Delivery to Concrete Channel	LS			800,000	$ 176,000	$ 976,000	$ 293,000	$ 1,269,000	2 cfs Pumping Plant and 6,400 LF 12-inch diameter pipe (Note: If 10 cfs recirculation rate from Lakewood Park proves feasible, the pump station & pipeline capacity would be increased with an associated cost of approximately $4 million.)

1. A 22% allowance has been made for landscape architecture and engineering design, surveying, geotechnical engineering, structural engineering, construction-related permitting, construction-phase services, grants/funding applications, economic analysis, project administration (including design guidelines and local regulatory structure) and legal review.
2. Because these costs have been projected at a Master Planning level (and are based on conceptual design), a 30% contingency has been utilized.
3. In preparing these costs, WWE and DSW assumed that neither an environmental impact statement nor an environmental assessment will be necessary. The Master Plan recommends that a detailed floodplain study of the Old River Channel be prepared—that cost is not included herein, nor is the cost of a "Letter of Map Revision" from the FEMA. There is no indication in the current channel sediment sampling data that environmental remediation will be necessary; thus, costs for environmental remediation are not included in these projections.
4. A land aquisition allowance, included in the Primary Phase, has been estimated by the City to be $3,500,000 for the entire project, excluding the Kenwood Park Midway Gateway at South Ohio and the relocation costs associated with the City of Salina General Services Facility located on East Ash Street.

Smoky Hill River Channel Restoration Potential Phasing

Master Plan Opinion of Probable Cost in Year 2010 Dollars

Primary Phase (Continued)

No.	Item	Unit	Quantity	Unit Cost	Subtotal	22% Allowance[1]	Subtotal	30% Construction Contingency[2]	Total Cost	Comments/Descriptions
11	Founders Park/Mill Plaza Improvements	SF	70,000	22	1,540,000	$ 339,000	$ 1,879,000	$ 564,000	$ 2,443,000	
12	Iron Ave. Bridge & Streetscape Enhancements	LS			2,000,000	$ 440,000	$ 2,440,000	$ 732,000	$ 3,172,000	Span 110 ft, width 75 ft
13	Concrete Lined Channel (60' width, average 6.5' walls, 8" thickness) Western Star Mill Dam to Walnut St	LF	2,300	1,200	2,760,000	$ 608,000	$ 3,368,000	$ 1,011,000	$ 4,379,000	Average width 60 feet, wall ht 8 ft between Dam & Iron Ave, wall ht 5 ft upstream of Iron Ave, 2 cy per LF, pressure relief valves in base
14	Riverwalk - Streamside Amenities Western Star Mill Dam to Walnut St. Channel Amenities and Lighting	LF	2,300	1,200	2,760,000	$ 608,000	$ 3,368,000	$ 1,011,000	$ 4,379,000	
15	Western Star Mill Dam Rehabilitation	LS			400,000	$ 88,000	$ 488,000	$ 147,000	$ 635,000	Riprap downstream of dam, Dam safety features, Rehabilitation of dam faces, Lowering of dam not included until Midway improvements constructed
16	Vegetation/Landscape Planting	acres	2	145,000	290,000	$ 64,000	$ 354,000	$ 107,000	$ 461,000	
17	Utility Relocation & Power along trail	LS			200,000	$ 44,000	$ 244,000	$ 74,000	$ 318,000	Relocate 12-inch water line on Iron St Bridge; misc. relocations; allowance for electrical
18	Aeration System	LS			300,000	$ 66,000	$ 366,000	$ 110,000	$ 476,000	Fountains or air diffusers in concrete lined channel
19	Moveable Dam	LS			300,000	$ 66,000	$ 366,000	$ 110,000	$ 476,000	Upstream end of concrete-lined channel
20	Land Acquisition & Easements[4]	Allow			3,500,000		$ 3,500,000		$ 3,500,000	See Note #4 Below
				Total Primary Phase 1	23,362,000	4,374,000	$ 27,736,000	7,278,000	$ 35,014,000	

1. A 22% allowance has been made for landscape architecture and engineering design, surveying, geotechnical engineering, structural engineering, construction-related permitting, construction-phase services, grants/funding applications, economic analysis, project administration (including design guidelines and local regulatory structure) and legal review.
2. Because these costs have been projected at a Master Planning level (and are based on conceptual design), a 30% contingency has been utilized.
3. In preparing these costs, WWE and DSW assumed that neither an environmental impact statement nor an environmental assessment will be necessary. The Master Plan recommends that a detailed floodplain study of the Old River Channel be prepared—that cost is not included herein, nor is the cost of a "Letter of Map Revision" from the FEMA. There is no indication in the current channel sediment sampling data that environmental remediation will be necessary; thus, costs for environmental remediation are not included in these projections.
4. A land aquisition allowance, included in the Primary Phase, has been estimated by the City to be $3,500,000 for the entire project, excluding the Kenwood Park Midway Gateway at South Ohio and the relocation cost associated with the City of Salina General Services Facility located on East Ash Street.

Smoky Hill River Channel Restoration Potential Phasing

Master Plan Opinion of Probable Cost in Year 2010 Dollars

Kenwood Park - East Gateway

No.	Item	Unit	Quantity	Unit Cost	Subtotal	22% Allowance[1]		30% Construction Contingency[2]	Total Cost	Comments/Descriptions
21	Concrete Lined Channel (70' width, average 5' walls, 8" thickness) at Midway	LF	800	1,200	960,000	$ 212,000	$ 1,172,000	$ 352,000	$ 1,524,000	Average width 70 feet, wall ht 5 ft, 2.0 cy per LF, pressure relief valves in base
22	Channel Amenities at Midway	LF	800	1,000	800,000	$ 176,000	$ 976,000	$ 293,000	$ 1,269,000	
23	New Dam at Midway	LS			650,000	$ 143,000	$ 793,000	$ 238,000	$ 1,031,000	with lock (hydraulic elevator) integrated into dam
24	Moveable Dam at Midway	each	2	300,000	600,000	$ 132,000	$ 732,000	$ 220,000	$ 952,000	
25	Bridge at Midway	LS			900,000	$ 198,000	$ 1,098,000	$ 330,000	$ 1,428,000	span 100 ft, width 50 ft
26	Gateway Entry, Bridge Enhancements and Streetscape	LS			2,000,000	$ 440,000	$ 2,440,000	$ 732,000	$ 3,172,000	
27	Aeration System	LS			300,000	$ 66,000	$ 366,000	$ 110,000	$ 476,000	Fountains or air diffusers in concrete lined channel
28	Lowering Western Star Mill Dam	L.S.			150,000	$ 33,000	$ 183,000	$ 55,000	$ 238,000	
29	Multi-Use Trail System Bicentennial Loop	LS			730,000	$ 161,000	$ 891,000	$ 268,000	$ 1,159,000	
30	Multi-Use Trail Lighting	LF	3237	42	136,000	$ 30,000	$ 166,000	$ 50,000	$ 216,000	
31	Channel Amenities - South	LF	800	1,000	800,000	$ 176,000	$ 976,000	$ 293,000	$ 1,269,000	
32	Wetland/Stream Mitigation Allowance	LS			2,000,000	$ 440,000	$ 2,440,000	$ 732,000	$ 3,172,000	Cost Placeholder. 404 permit mitigation requirements cannot defined more accurately at this time and will be dependent on the outcome of consultations with the USCOE and other agencies.
33	Utility Relocation & Power along trail	LS			200,000	$ 44,000	$ 244,000	$ 74,000	$ 318,000	8" Sanitary Sewer Relocation; misc relocations; allowance for electrical
34	Vegetation/Landscape Planting	acres	4	100,000	400,000	$ 88,000	$ 488,000	$ 147,000	$ 635,000	
				Total for Kenwood Park - East Gateway	$ 10,626,000	$ 2,339,000	$ 12,965,000	$ 3,894,000	$ 16,859,000	

1. A 22% allowance has been made for landscape architecture and engineering design, surveying, geotechnical engineering, structural engineering, construction-related permitting, construction-phase services, grants/funding applications, economic analysis, project administration (including design guidelines and local regulatory structure) and legal review.
2. Because these costs have been projected at a Master Planning level (and are based on conceptual design), a 30% contingency has been utilized.
3. In preparing these costs, WWE and DSW assumed that neither an environmental impact statement nor an environmental assessment will be necessary. The Master Plan recommends that a detailed floodplain study of the Old River Channel be prepared—that cost is not included herein, nor is the cost of a "Letter of Map Revision" from the FEMA. There is no indication in the current channel sediment sampling data that environmental remediation will be necessary; thus, costs for environmental remediation are not included in these projections.
4. A land aquisition allowance, included in the Primary Phase, has been estimated by the City to be $3,500,000 for the entire project, excluding the Kenwood Park Midway Gateway at South Ohio and the relocation cost associated with the City of Salina General Services Facility located on East Ash Street.

Smoky Hill River Channel Restoration Potential Phasing

Master Plan Opinion of Probable Cost in Year 2010 Dollars

Downtown Riverwalk (South Half)

No.	Item	Unit	Quantity	Unit Cost	Subtotal	22% Allowance[1]	30% Construction Contingency[2]	Total Cost	Comments/Descriptions
35	Concrete Lined Channel (60' width, 5' walls, 8" thickness) Walnut St to south of Mulberry St	LF	1,400	1,150	1,610,000	$ 355,000	$ 590,000	$ 2,555,000	Average width 60', wall ht 5'. 1.9 cy per LF, pressure relief valves in base
36	Riverwalk - Channel Amenities Walnut to south of Mulberry and Lighting	LF	1,400	1,200	1,680,000	$ 370,000	$ 615,000	$ 2,665,000	
37	Walnut Street Bridge -Realignment with Front Street	LS			800,000	$ 176,000	$ 293,000	$ 1,269,000	Span = 90', width = 34'
38	Walnut Street Bridge Enhancements and Streetscape	LS			2,000,000	$ 440,000	$ 732,000	$ 3,172,000	
39	Front Street Regional Trail Bypass	LF	1,500	150	225,000	$ 50,000	$ 83,000	$ 358,000	12' concrete on-street trail lane with C&G median separation
40	Utilities	LS			$ 200,000	$ 44,000	$ 74,000	$ 318,000	allowance for misc. relocations, electrical allowance
41	Rest Rooms	EA	1	250,000	250,000	$ 55,000	$ 92,000	$ 397,000	
42	Vegetation/Landscape Planting	acres	2	100,000	200,000	$ 44,000	$ 74,000	$ 318,000	
43	Oakdale Park Boardwalk	LF	200	1,200	240,000	$ 53,000	$ 88,000	$ 381,000	
				Downtown Riverwalk (South) Total	$ 7,205,000	$ 1,587,000	$ 2,641,000	$ 11,433,000	

1. A 22% allowance has been made for landscape architecture and engineering design, surveying, geotechnical engineering, structural engineering, construction-related permitting, construction-phase services, grants/funding applications, economic analysis, project administration (including design guidelines and local regulatory structure) and legal review.
2. Because these costs have been projected at a Master Planning level (and are based on conceptual design), a 30% contingency has been utilized.
3. In preparing these costs, WWE and DSW assumed that neither an environmental impact statement nor an environmental assessment will be necessary. The Master Plan recommends that a detailed floodplain study of the Old River Channel be prepared—that cost is not included herein, nor is the cost of a "Letter of Map Revision" from the FEMA. There is no indication in the current channel sediment sampling data that environmental remediation will be necessary; thus, costs for environmental remediation are not included in these projections.
4. A Land Acquisition Allowance of $3.5 million has been estimated by the City to provide 100' R.O.W. for the 6.8 miles of channel based on an average current assessed land value. The value assigned to specific phases is anticipated to vary, considering potential negotiated donations and dedications. Land Acquisition allowance does not include acquisition of property associated with the Kenwood Park Midway Gateway at S. Ohio Street and the relocation cost associated with the City of Salina General Services Facility located on E. Ash Street.

Smoky Hill River Channel Restoration Potential Phasing

Master Plan Opinion of Probable Cost in Year 2010 Dollars

South Reach Enhancements

No.	Item	Unit	Quantity	Unit Cost	Subtotal	22% Allowance[1]		30% Construction Contingency[2]	Total Cost	Comments/Descriptions
44	Pedestrian Bridges	EA	2	150,000	$ 300,000	$ 66,000	$ 366,000	$ 110,000	$ 476,000	
45	South Ohio Street Permanent Bridge	LS			1,300,000	$ 286,000	$ 1,586,000	$ 476,000	$ 2,062,000	span 100 ft, width 75 ft
46	YMCA Avenue Bridge	LS			700,000	$ 154,000	$ 854,000	$ 257,000	$ 1,111,000	
47	Greeley Avenue Bridge	LS						$ -		Not included--Carry over bridge replacement funding currently on hold
48	Utilities	LS			100,000	$ 22,000	$ 122,000	$ 37,000	$ 159,000	Relocate 8"sanitary sewer (400 LF - $20,000 allowance);16" Force Main along bank edge to be avoided during design; replace 8" water line and attach to bridge (200 LF - $10,000 allowance); other misc. relocations and electrical
49	Rest Rooms - (Lincal Park)	EA	1	250,000	250,000	$ 55,000	$ 305,000	$ 92,000	$ 397,000	
50	Wetland/Stream Mitigation/Habitat	LS			2,000,000	$ 440,000	$ 2,440,000	$ 732,000	$ 3,172,000	Cost Placeholder. 404 permit mitigation requirements cannot defined more accurately at this time and will be dependent on the outcome of consultations with the USCOE and other agencies.
51	Regional Trail	LS			3,000,000	$ 660,000	$ 3,660,000	$ 1,098,000	$ 4,758,000	
52	BMX Off-Road Bike Course - Allowance	EA	1	150,000	150,000	$ 33,000	$ 183,000	$ 55,000	$ 238,000	
53	Vegetation/Landscape Planting	acres	2	100,000	200,000	$ 44,000	$ 244,000	$ 74,000	$ 318,000	
				South Reach Enhancements	$ 8,000,000	$ 1,760,000		$ 2,931,000	$ 12,691,000	

1. A 22% allowance has been made for landscape architecture and engineering design, surveying, geotechnical engineering, structural engineering, construction-related permitting, construction-phase services, grants/funding applications, economic analysis, project administration (including design guidelines and local regulatory structure) and legal review.
2. Because these costs have been projected at a Master Planning level (and are based on conceptual design), a 30% contingency has been utilized.
3. In preparing these costs, WWE and DSW assumed that neither an environmental impact statement nor an environmental assessment will be necessary. The Master Plan recommends that a detailed floodplain study of the Old River Channel be prepared—that cost is not included herein, nor is the cost of a "Letter of Map Revision" from the FEMA. There is no indication in the current channel sediment sampling data that environmental remediation will be necessary; thus, costs for environmental remediation are not included in these projections.
4. A land aquisition allowance, included in the Primary Phase, has been estimated by the City to be $3,500,000 for the entire project, excluding the Kenwood Park Midway Gateway at South Ohio and the relocation cost associated with the City of Salina General Services Facility located on East Ash Street.

Smoky Hill River Channel Restoration Potential Phasing

Master Plan Opinion of Probable Cost in Year 2010 Dollars

Main Channel Bypass

No.	Item	Unit	Quantity	Unit Cost	Subtotal	22% Allowance[1]		30% Construction Contingency[2]	Total Cost	Comments/Descriptions
54	Indian Rock Park Suspension Bridge	LS			$ 3,200,000	$ 704,000	$ 3,904,000	$ 1,172,000	$ 5,076,000	
55	Multi-Use Trail - Diversion Bypass	LS			1,200,000	$ 264,000	$ 1,464,000	$ 440,000	$ 1,904,000	BWR Multi-Use 10' Concrete Trail Segments 11, 12
56	Regional Trail Addition	LF			800,000	$ 176,000	$ 976,000	$ 293,000	$ 1,269,000	12' Concrete Trail
57	Historic Interpretive Installation	LS			75,000	$ 17,000	$ 92,000	$ 28,000	$ 120,000	
58	Boardwalk/Accessible Fishing	LF	200	1,200	240,000	$ 53,000	$ 293,000	$ 88,000	$ 381,000	
	Main Channel Bypass Total				$ 5,515,000	$ 1,214,000	$ 6,729,000	$ 2,021,000	$ 8,750,000	

1. A 22% allowance has been made for landscape architecture and engineering design, surveying, geotechnical engineering, structural engineering, construction-related permitting, construction-phase services, grants/funding applications, economic analysis, project administration (including design guidelines and local regulatory structure) and legal review.
2. Because these costs have been projected at a Master Planning level (and are based on conceptual design), a 30% contingency has been utilized.
3. In preparing these costs, WWE and DSW assumed that neither an environmental impact statement nor an environmental assessment will be necessary. The Master Plan recommends that a detailed floodplain study of the Old River Channel be prepared—that cost is not included herein, nor is the cost of a "Letter of Map Revision" from the FEMA. There is no indication in the current channel sediment sampling data that environmental remediation will be necessary; thus, costs for environmental remediation are not included in these projections.
4. A land aquisition allowance, included in the Primary Phase, has been estimated by the City to be $3,500,000 for the entire project, excluding the Kenwood Park Midway Gateway at South Ohio and the relocation cost associated with the City of Salina General Services Facility located on East Ash Street.

Smoky Hill River Channel Restoration Potential Phasing

Master Plan Opinion of Probable Cost in Year 2010 Dollars

North Reaches

No.	Item	Unit	Quantity	Unit Cost	Subtotal	22% Allowance[1]		30% Construction Contingency[2]	Total Cost	Comments/Descriptions
59	Multi-Use Trail	LS			$ 1,420,000	$ 313,000	$ 1,733,000	$ 520,000	$ 2,253,000	BWR Multi-use 10' Concrete Trail Segments 6 (north half), 7, 8, 9, 10
60	Environmental Education Facilities at Lakewood Middle School	LS			500,000	$ 110,000	$ 610,000	$ 183,000	$ 793,000	Allowance
61	Riverside Streetscape Enhancements	LF	2,400	30	72,000	$ 16,000	$ 88,000	$ 27,000	$ 115,000	
62	Regional Trail	LS			1,350,000	$ 297,000	$ 1,647,000	$ 495,000	$ 2,142,000	12' Concrete Trail
63	North Ohio Street Bridge	LS			1,100,000	$ 242,000	$ 1,342,000	$ 403,000	$ 1,745,000	Span = 100', width = 64'
64	Elm Street Bridge or Box Culvert	LS			900,000	$ 198,000	$ 1,098,000	$ 330,000	$ 1,428,000	Long-Term Future Phase Allowance
65	Ash Street Bridge or Box Culvert				900,000	$ 198,000	$ 1,098,000	$ 330,000	$ 1,428,000	Long-Term Future Phase Allowance
66	Lakewood Marina/Launch Area	LS			500,000	$ 110,000	$ 610,000	$ 183,000	$ 793,000	
	North Reaches Total				$ 6,742,000	$ 1,484,000	$ 8,226,000	$ 2,471,000	$ 10,697,000	

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4. A land aquisition allowance, included in the Primary Phase, has been estimated by the City to be $3,500,000 for the entire project, excluding the Kenwood Park Midway Gateway at South Ohio and the relocation cost associated with the City of Salina General Services Facility located on East Ash Street.

DRAWINGS

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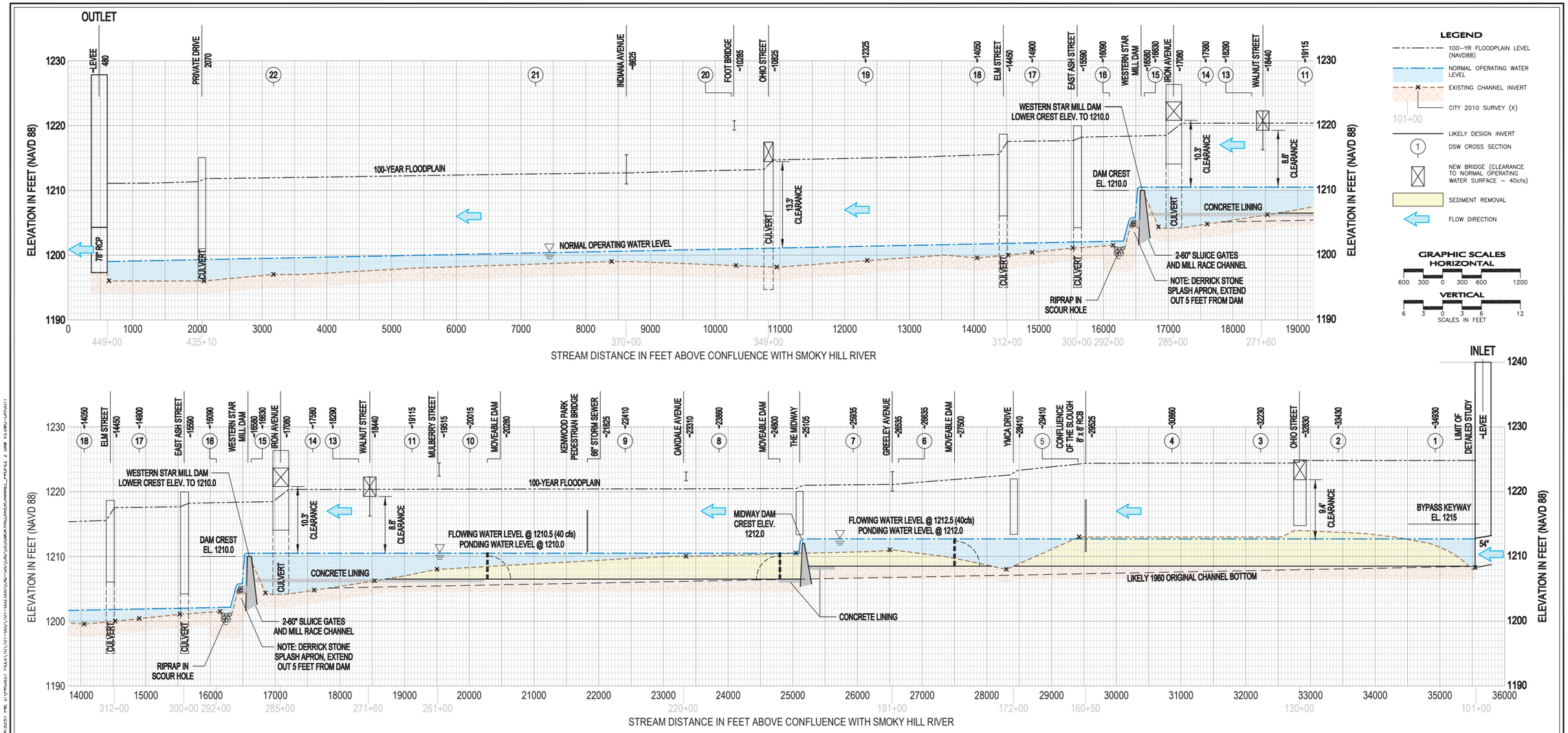

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	
1	PKF	7/26/10	ADDITION OF INFLATABLE DAMS	–

		DATE
DESIGN	PKF/KRW	5/5/10
DETAIL	KAL	5/5/10
CHECK	JEJ	5/5/10
APPROVAL	DSW	
SCALE	AS NOTED	
OldSmokyHillRiverChannel_Profile 2 Dam v3.dwg		

OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS

OLD SMOKY HILL RIVER CHANNEL PROFILE
- TWO DAMS -

JOB NO. 101-002.000
REVISION NO. 1
SHEET NO. 1

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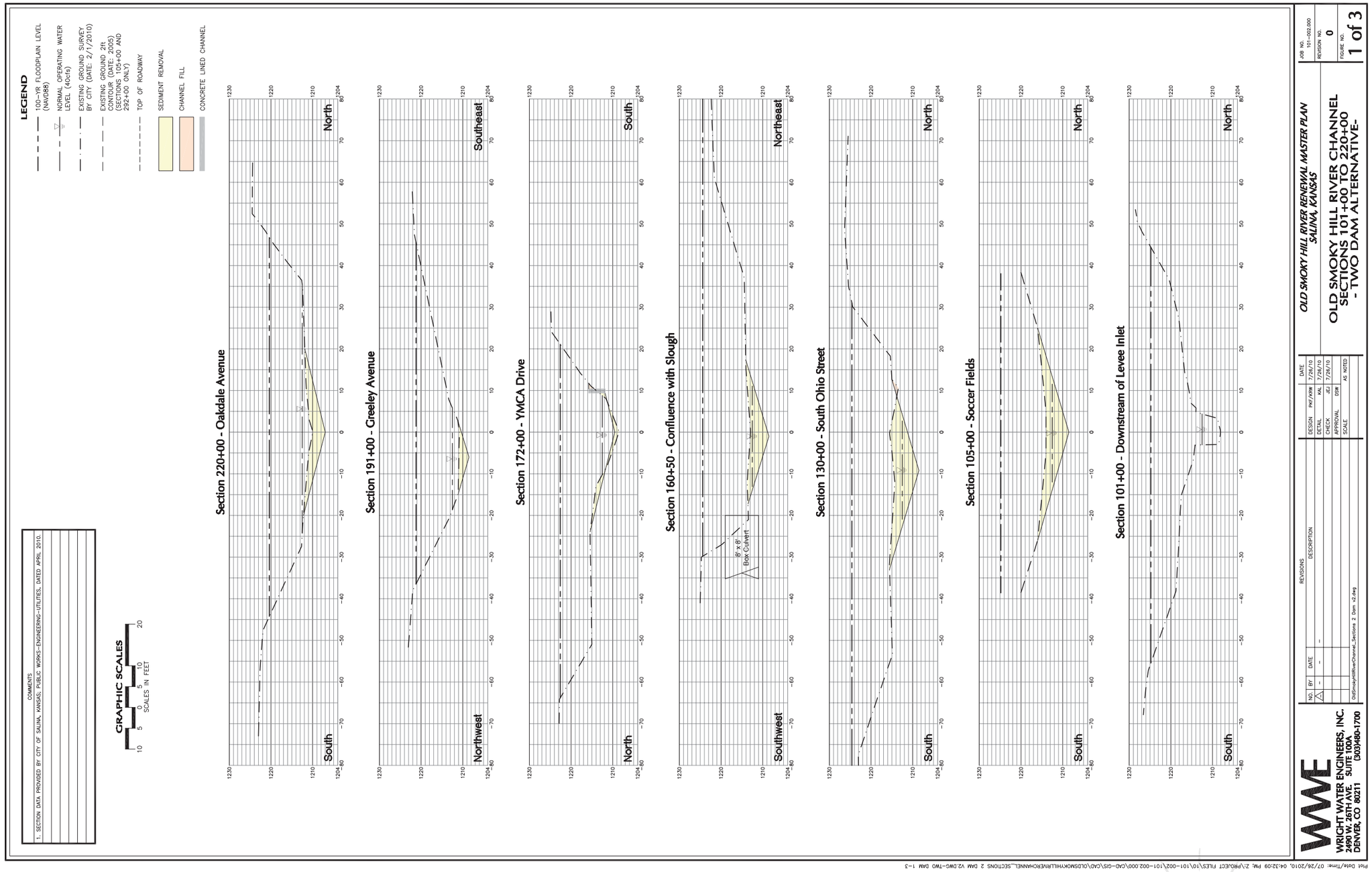
LEGEND
100-YR FLOODPLAIN LEVEL (NAVD88)
NORMAL OPERATING WATER LEVEL (40cfs)
EXISTING GROUND SURVEY BY CITY (DATE: 2/1/2010)
EXISTING GROUND 2ft CONTOUR (DEC 2005) (SECTIONS 105+00 AND 292+00 ONLY)
TOP OF ROADWAY
SEDIMENT REMOVAL
CHANNEL FILL
CONCRETE LINED CHANNEL
Section 220+00 - Oakdale Avenue
Section 191+00 - Greeley Avenue
Section 172+00 - YMCA Drive
Section 160+50 - Confluence with Slough
8' x 8' Box Culvert
Section 130+00 - South Ohio Street
Section 105+00 - Soccer Fields
Section 101+00 - Downstream of Levee Inlet
South
North
Southeast
Northwest
Southwest
Northeast
GRAPHIC SCALES
SCALES IN FEET
COMMENTS
1. SECTION DATA PROVIDED BY CITY OF SALINA, KANSAS; PUBLIC WORKS-ENGINEERING-UTILITIES, DATED APRIL 2010.
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700
OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS
OLD SMOKY HILL RIVER CHANNEL
SECTIONS 101+00 TO 220+00
- TWO DAM ALTERNATIVE-
JOB NO. 101-002.000
REVISION NO. 0
FIGURE NO. 1 of 3
DESIGN PKF/KRW 7/26/10
DETAIL KAL 7/26/10
CHECK JEJ 7/26/10
APPROVAL DSW
SCALE AS NOTED
REVISIONS
NO. BY DATE DESCRIPTION
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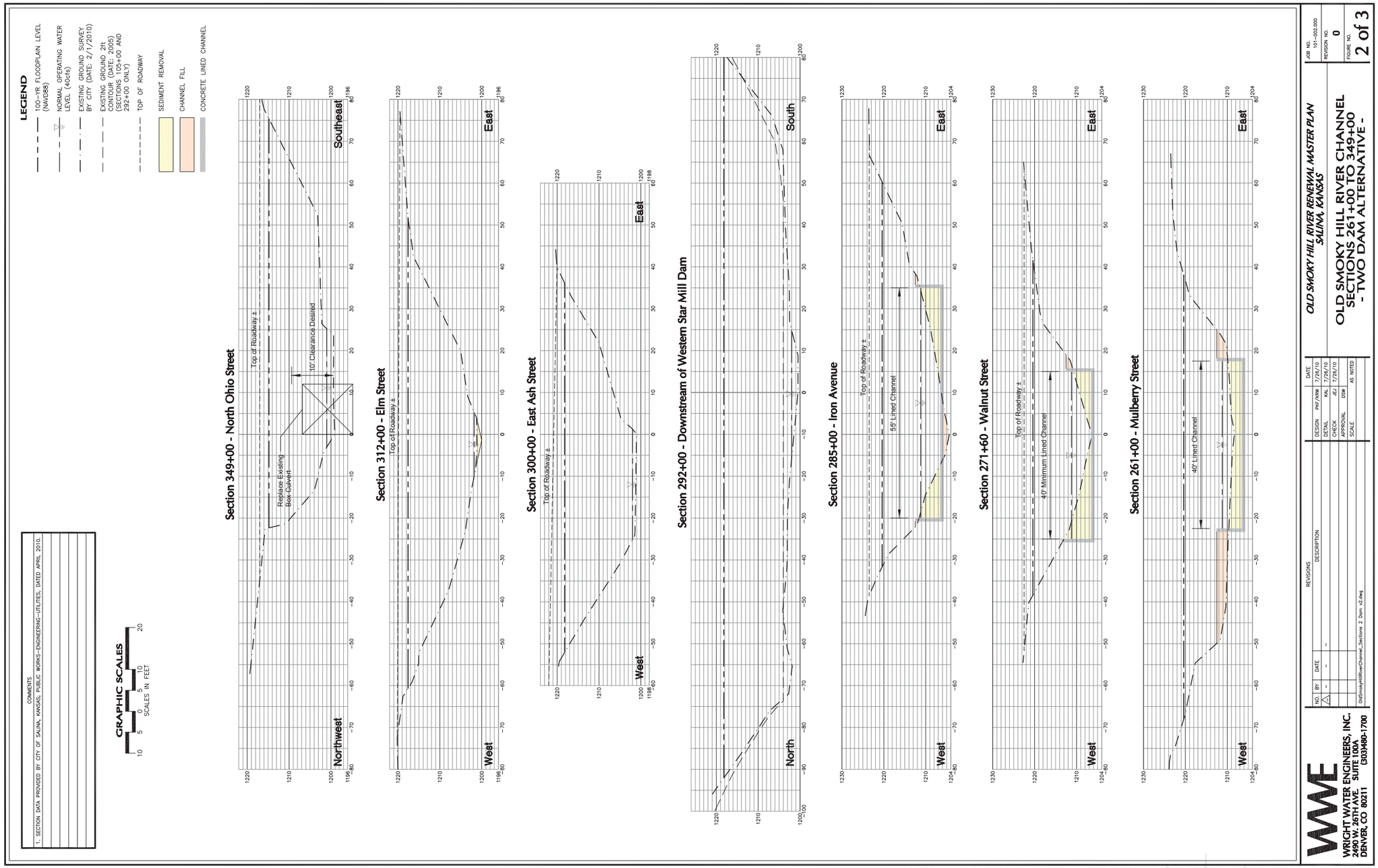
LEGEND
100-YR FLOODPLAIN LEVEL (NAVD88)
NORMAL OPERATING WATER LEVEL (40cfs)
EXISTING GROUND SURVEY BY CITY (DATE: 2/1/2010)
EXISTING GROUND 2ft CONTOUR (DATE: 2005) (SECTIONS 105+00 AND 292+00 ONLY)
TOP OF ROADWAY
SEDIMENT REMOVAL
CHANNEL FILL
CONCRETE LINED CHANNEL
COMMENTS
1. SECTION DATA PROVIDED BY CITY OF SALINA, KANSAS; PUBLIC WORKS-ENGINEERING-UTILITIES, DATED APRIL 2010.
GRAPHIC SCALES
SCALES IN FEET
Section 349+00 - North Ohio Street
Top of Roadway ±
10' Clearance Desired
Replace Existing Box Culvert
Northwest
Section 312+00 - Elm Street
Top of Roadway ±
West
Section 300+00 - East Ash Street
Top of Roadway ±
East
Section 292+00 - Downstream of Western Star Mill Dam
South
North
Section 285+00 - Iron Avenue
Top of Roadway ±
55' Lined Channel
East
West
Section 271+60 - Walnut Street
Top of Roadway ±
40' Minimum Lined Channel
East
West
Section 261+00 - Mulberry Street
40' Lined Channel
East
West
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700
DESIGN PKF/KRW 7/26/10
DETAIL KAL 7/26/10
CHECK JEJ 7/26/10
APPROVAL DSW
SCALE AS NOTED
NO. BY DATE DESCRIPTION
REVISIONS
OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS
OLD SMOKY HILL RIVER CHANNEL
SECTIONS 261+00 TO 349+00
- TWO DAM ALTERNATIVE -
JOB NO. 101-002.000
REVISION NO. 0
FIGURE NO. 2 of 3
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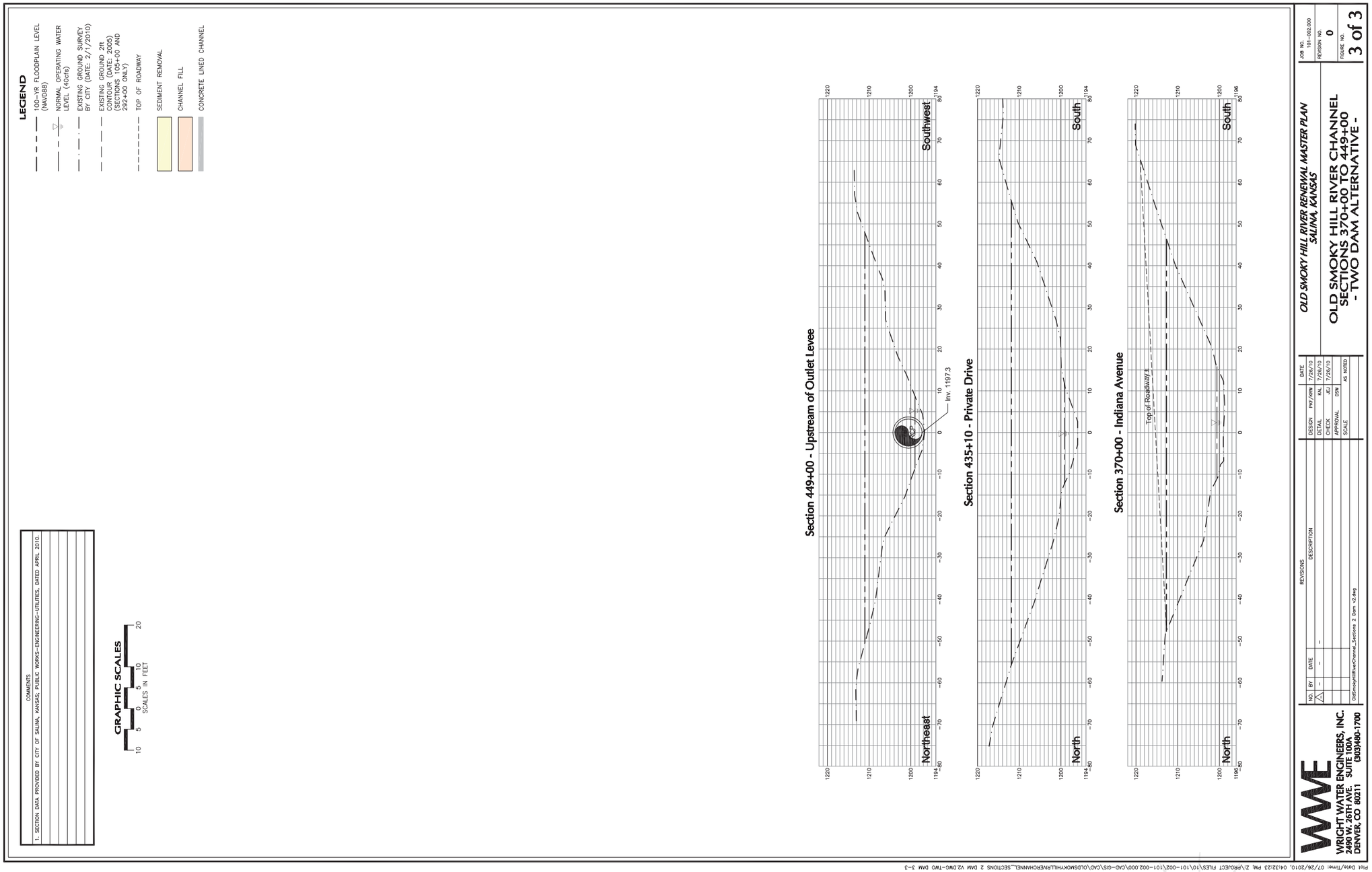
LEGEND
100-YR FLOODPLAIN LEVEL (NAVD88)
NORMAL OPERATING WATER LEVEL (40cfs)
EXISTING GROUND SURVEY BY CITY (DATE: 2/1/2010)
EXISTING GROUND 2ft CONTOUR (DATE: 2005) (SECTIONS 174+00 AND 292+00 ONLY)
TOP OF ROADWAY
SEDIMENT REMOVAL
CHANNEL FILL
CONCRETE LINED CHANNEL
COMMENTS
1. SECTION DATA PROVIDED BY CITY OF SALINA, KANSAS; PUBLIC WORKS-ENGINEERING-UTILITIES, DATED APRIL 2010.
GRAPHIC SCALES
SCALES IN FEET
Section 449+00 - Upstream of Outlet Levee
Northeast
Southwest
CCP
Inv. 1197.3
Section 435+10 - Private Drive
North
South
Section 370+00 - Indiana Avenue
Top of Roadway ±
North
South
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700
NO. BY DATE REVISIONS DESCRIPTION
DESIGN PKF/KKW 7/26/10
DETAIL KAL 7/26/10
CHECK JEJ 7/26/10
APPROVAL DSW
SCALE AS NOTED
OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS
OLD SMOKY HILL RIVER CHANNEL
SECTIONS 370+00 TO 449+00
- TWO DAM ALTERNATIVE -
JOB NO. 101-002.000
REVISION NO. 0
FIGURE NO. 3 of 3
Plot Date/Time: 07/26/2010, 04:32:23 PM, Z:\PROJECT FILES\10\101-002\101-002.000\CAD-GIS\CAD\OLDSMOKYHILLRIVERCHANNEL_SECTIONS 2 DAM V2.DWG-TWO DAM 3-3

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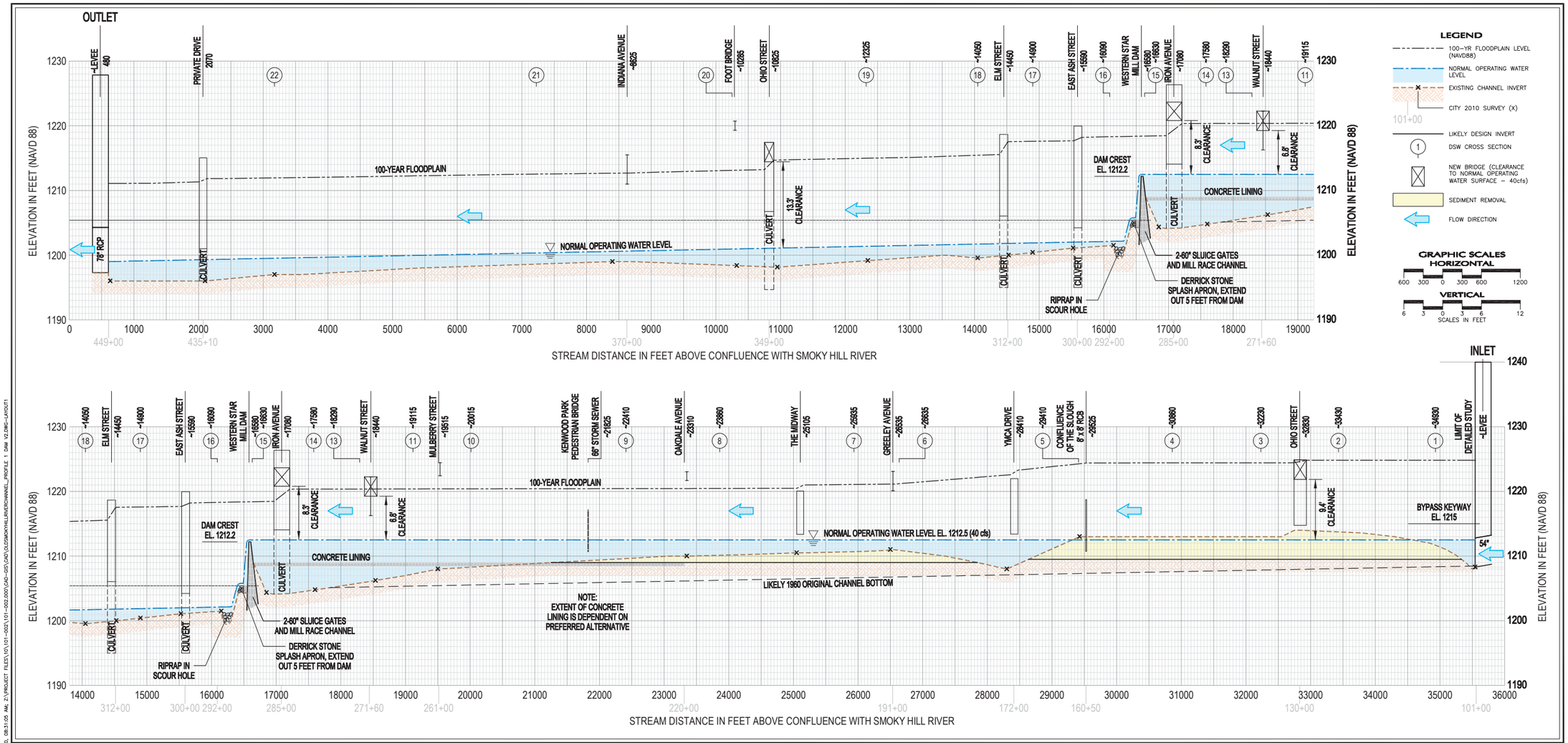

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WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	
0	–	–	–	–

		DATE
DESIGN	PKF/KRW	5/5/10
DETAIL	KAL	5/5/10
CHECK	JEJ	5/5/10
APPROVAL	DSW	
SCALE		AS NOTED
OldSmokyHillRiverChannel_Profile 1 Dam v2.dwg		

OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS

OLD SMOKY HILL RIVER CHANNEL PROFILE
- ONE DAM -

JOB NO. 101-002.000
REVISION NO. 0
SHEET NO. 1

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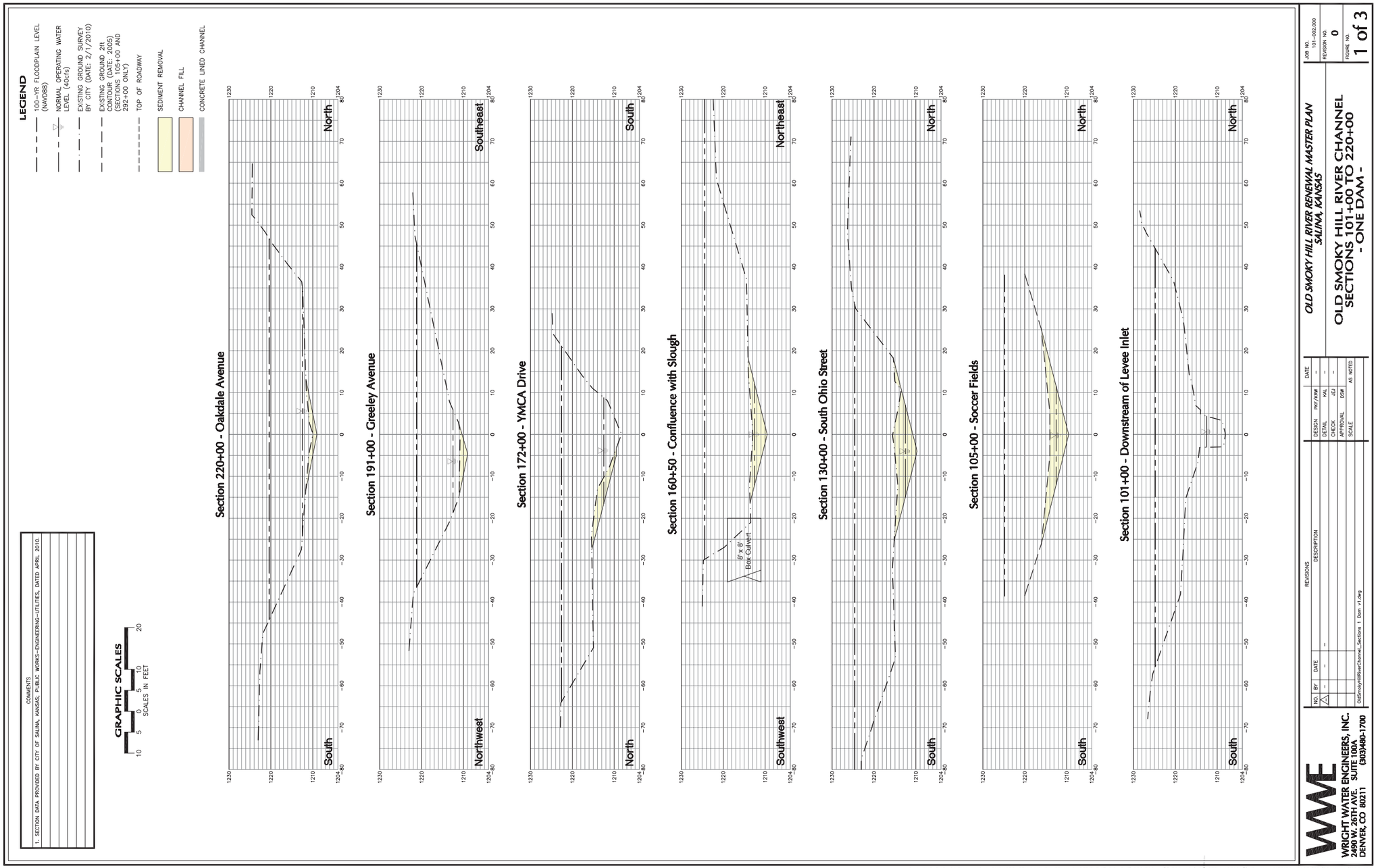
LEGEND
100-YR FLOODPLAIN LEVEL (NAVD88)
NORMAL OPERATING WATER LEVEL (40cfs)
EXISTING GROUND SURVEY BY CITY (DATE: 2/1/2010)
EXISTING GROUND 2ft CONTOUR (DATE: 2005) (SECTIONS 114+00 AND 232+00 ONLY)
TOP OF ROADWAY
SEDIMENT REMOVAL
CHANNEL FILL
CONCRETE LINED CHANNEL
COMMENTS
1. SECTION DATA PROVIDED BY CITY OF SALINA, KANSAS; PUBLIC WORKS-ENGINEERING-UTILITIES, DATED APRIL 2010.
GRAPHIC SCALES
SCALES IN FEET
Section 220+00 - Oakdale Avenue
Section 191+00 - Greeley Avenue
Section 172+00 - YMCA Drive
Section 160+50 - Confluence with Slough
8' x 8' Box Culvert
Section 130+00 - South Ohio Street
Section 105+00 - Soccer Fields
Section 101+00 - Downstream of Levee Inlet
South
Southeast
Northwest
North
Southwest
Northeast
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE, SUITE 100A
DENVER, CO 80211
(303)480-1700
OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS
OLD SMOKY HILL RIVER CHANNEL
SECTIONS 101+00 TO 220+00
- ONE DAM -
JOB NO. 101-002.000
REVISION NO. 0
FIGURE NO. 1 of 3
DESIGN PKF/KKW
DETAIL KAL
CHECK JEJ
APPROVAL DSW
SCALE AS NOTED
DATE
REVISIONS
NO. BY DATE DESCRIPTION
Plot Date/Time: 08/02/2010, 08:32:04 AM, Z:\PROJECT FILES\10\101-002\101-002.000\CAD-GIS\CAD\OLDSMOKYHILLRIVERCHANNEL_SECTIONS 1 DAM V1.DWG-ONE DAM 1-3

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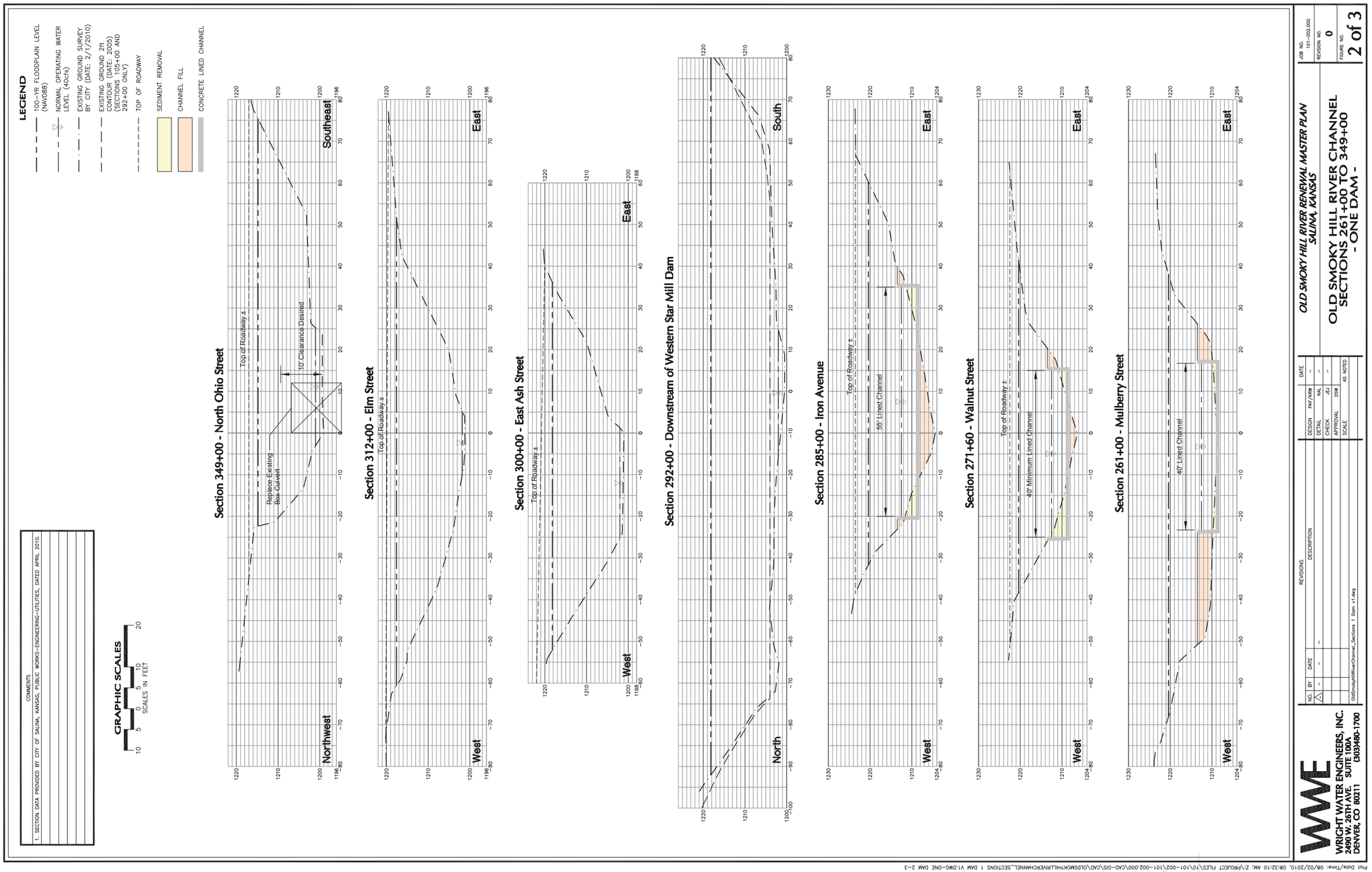
LEGEND
100-YR FLOODPLAIN LEVEL (NAVD88)
NORMAL OPERATING WATER LEVEL (40cfs)
EXISTING GROUND SURVEY BY CITY (DATE: 2/1/2010)
EXISTING GROUND 2ft CONTOUR (DATE: 2005) (SECTIONS 1+00 AND 292+00 ONLY)
TOP OF ROADWAY
SEDIMENT REMOVAL
CHANNEL FILL
CONCRETE LINED CHANNEL
COMMENTS
1. SECTION DATA PROVIDED BY CITY OF SALINA, KANSAS; PUBLIC WORKS-ENGINEERING-UTILITIES, DATED APRIL 2010.
GRAPHIC SCALES
SCALES IN FEET
Section 349+00 - North Ohio Street
Top of Roadway ±
Replace Existing Box Culvert
10' Clearance Desired
Northwest
Southeast
Section 312+00 - Elm Street
Top of Roadway ±
West
East
Section 300+00 - East Ash Street
Top of Roadway ±
West
East
Section 292+00 - Downstream of Western Star Mill Dam
North
South
Section 285+00 - Iron Avenue
Top of Roadway ±
55' Lined Channel
West
East
Section 271+60 - Walnut Street
Top of Roadway ±
40' Minimum Lined Channel
West
East
Section 261+00 - Mulberry Street
40' Lined Channel
West
East
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700
DESIGN PKF/KRW
DETAIL KAL
CHECK JEJ
APPROVAL DSW
SCALE AS NOTED
DATE
REVISIONS
NO. BY DATE DESCRIPTION
OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS
OLD SMOKY HILL RIVER CHANNEL
SECTIONS 261+00 TO 349+00
- ONE DAM -
JOB NO. 101-002.000
REVISION NO. 0
FIGURE NO. 2 of 3
Plot Date/Time: 08/02/2010, 08:32:10 AM, Z:\PROJECT FILES\10\101-002\101-002.000\CAD-GIS\CAD\OLDSMOKYHILLRIVERCHANNEL_SECTIONS 1 DAM V1.DWG-ONE DAM 2-3

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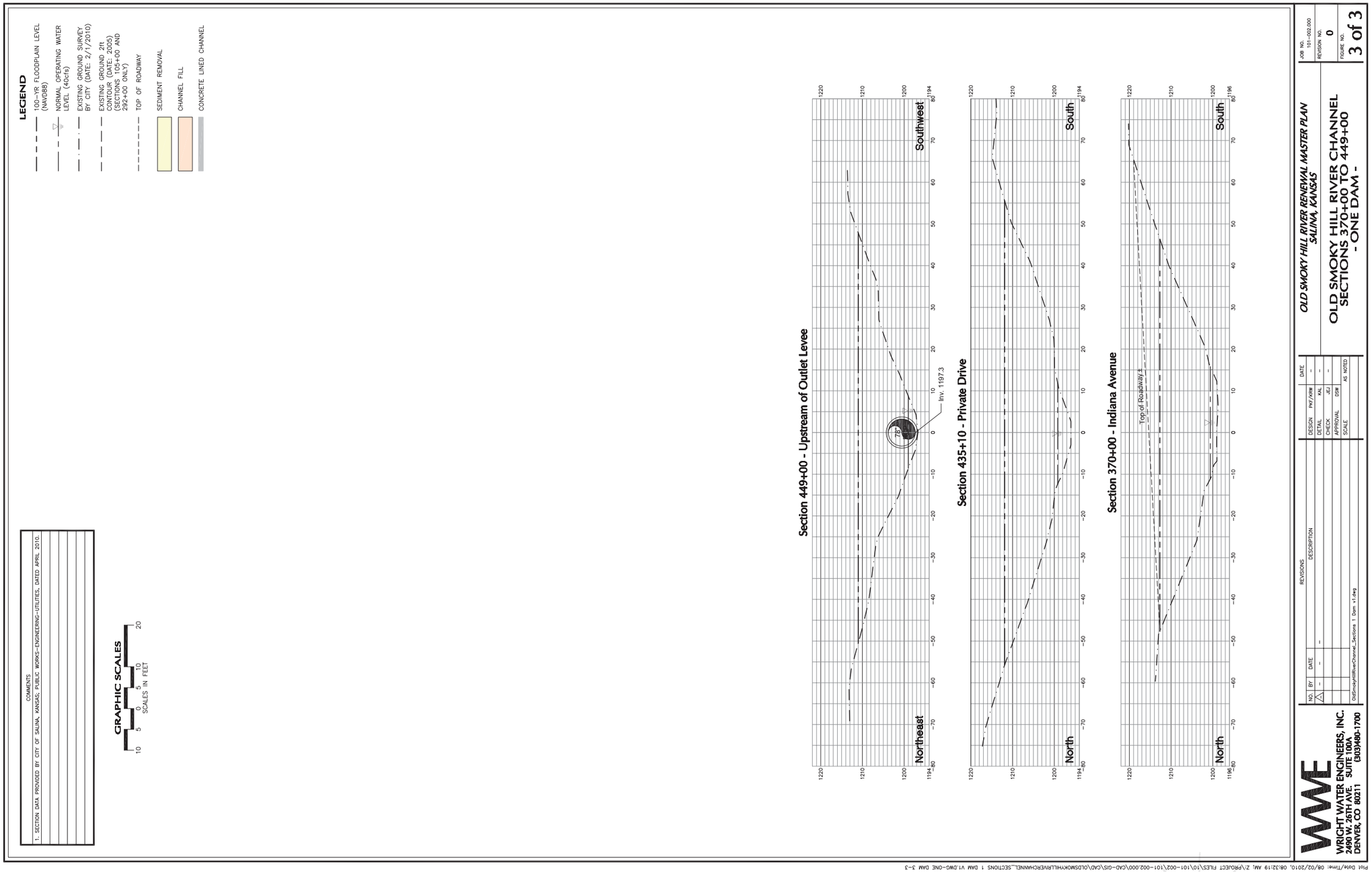
LEGEND
100-YR FLOODPLAIN LEVEL (NAVD88)
NORMAL OPERATING WATER LEVEL (40cfs)
EXISTING GROUND SURVEY BY CITY (DATE: 2/1/2010)
EXISTING GROUND 2ft CONTOUR (DATE: 2005) (SECTIONS 1+00 AND 292+00 ONLY)
TOP OF ROADWAY
SEDIMENT REMOVAL
CHANNEL FILL
CONCRETE LINED CHANNEL
COMMENTS
1. SECTION DATA PROVIDED BY CITY OF SALINA, KANSAS; PUBLIC WORKS-ENGINEERING-UTILITIES, DATED APRIL 2010.
GRAPHIC SCALES
SCALES IN FEET
Section 449+00 - Upstream of Outlet Levee
Northeast
Southwest
78'
INV. 1197.3
Section 435+10 - Private Drive
North
South
Section 370+00 - Indiana Avenue
Top of Roadway ±
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211 (303)480-1700
NO. BY DATE
REVISIONS
DESCRIPTION
DESIGN PKF/KKW
DETAIL KAL
CHECK JEJ
APPROVAL DSW
SCALE AS NOTED
DATE
OLD SMOKY HILL RIVER RENEWAL MASTER PLAN
SALINA, KANSAS
OLD SMOKY HILL RIVER CHANNEL
SECTIONS 370+00 TO 449+00
- ONE DAM -
JOB NO. 101-002.000
REVISION NO. 0
FIGURE NO. 3 of 3
Plot Date/Time: 08/02/2010, 08:32:19 AM, Z:\PROJECT FILES\10\101-002\000\CAD-GIS\CAD\OLDSMOKYHILLRIVERCHANNEL_SECTIONS 1 DAM V1.DWG-ONE DAM 3-3

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