Appendix J. Planning

Draft Kansas River Reservoirs Flood and Sediment Study

October 2023

U.S. Army Corps of Engineers
Kansas City District

PLANNING CHARETTE

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E. 12TH STREET
KANSAS CITY, MISSOURI 64106-2824

Planning Branch

MEMORANDUM FOR RECORD 13 April 2021

SUBJECT: Kansas River Reservoirs Flood and Sediment Study, Kansas (KS), Colorado (CO) & Nebraska (NE), Watershed Study Planning Charette

1. References
    a. Attachment 1–Planning Charette Agenda
    b. Attachment 2–Attendees List
    c. Attachment 3–Planning Charette Presentation

2. Kansas City District hosted a Watershed Study, Planning Charette on 29 March 2021 for the Kansas River Reservoirs Flood and Sediment Study, KS, CO & NE. The purpose of the Charette was to bring together the U.S Army Corps of Engineers (USACE), Kansas City District (NWK), Watershed Study Project Delivery Team (PDT) members, Kansas Water Office, and Kansas Department of Wildlife, Parks and Tourism, and the USACE Vertical Team to discuss the working draft measures and strategies. The Charette provided attendees the opportunity to voice any specific concerns and opinions relative to the proposed study methods, the breadth of resource topics covered, and to review the Shared Vision Statement for the study.

    This was also an opportunity to discuss the preliminary screening criteria developed by the study team, which will be used to ensure that proposed measures and strategies are adequately assessed and compared for identification of plans that best contribute towards meeting the planning goals and objectives. Comments and suggestions provided during the Charette will allow the study PDT to incorporate any new information prior to the Shared Vision Milestone meeting scheduled for May 2021.

3. Attendees at the Planning Charette included: NWK PDT staff; NWK Plan Formulation section, Environmental section, and Planning Branch Chiefs; Engineering section, Engineering branch, and Engineering Division Chiefs; study partners/sponsors; representatives from Northwestern Division (NWD); the Office of Water Project Review; the Regional Integration Team (RIT); and the Flood Risk Management (FRM) Planning Center of Expertise.

4. Opening remarks were provided by Jim Fredericks, NWD, Chief, Planning, Environmental Resources, Fish Policy and Support Division; Connie Owen, Kansas Water Office, Director; Cara Hendricks, Assistant Director, Kansas Water Office; and Steve Adams, Chief of Planning, Kansas Department of Wildlife, Parks and Tourism.

5. Ms. Laura Totten, project manager for the study, study sponsors, and technical staff from NWK presented and led discussions that included the following topics:

    a. Summary of the main decisions made during the September 2020 In-Progress Review (IPR):

i. Agreement to work with sponsors, other agencies, and stakeholders in the basin to ensure that opportunities are included for them to participate and identify potential implementation actions for inclusion in the study. The study team has worked to include additional Federal (EPA, USDA-NRCS, USFWS, BOR, USGS, NOAA, NPS, NWS) and non-Federal agencies (Kansas Department of Health and Environment, State Historic Preservation Offices in KS, NE, and CO, Nebraska Game and Parks Commission, Kansas Geologic Survey, Kansas Department of Agriculture, Kansas Forestry Service) in all aspects of the study, including development of draft measures and strategies. The study will also incorporate information from the State of Kansas planning efforts to ensure actions outside of USACE projects and authorities are included as appropriate.

ii. Coordination letters sent, at a minimum, to all required agencies informing them of the study and asking if they would like to participate as a cooperating agency. Letters were sent to all required agencies, tribes, and other state agencies that could have an interest. None indicated they would like to be a cooperating agency, but some (USDA-NRCS Nebraska, NOAA, NWS) responded that they would like to be included in future coordination.

iii. Any future water reallocations or changes in existing operations at reservoirs will need to consider and discuss potential effects to the current DSAC ratings and the need for additional risk assessments as appropriate.

b. Overview of the study authority, study funding, team partnership, study area, problems, study scope, and the shared vision. The sponsors/partners provided a summary of development of the shared vision statement and importance to the State of meeting the shared vision. Opportunities and goals and objectives were not discussed as this was done at the recent September 2020 IPR and were included as read ahead materials for the Planning Charette.

c. Detailed review of the approach/methods used to identify and document baseline/existing conditions and the expected future without project (FWOP) conditions for hydrology and hydraulics/reservoir operations/flood risk management, sediment management, water supply, environmental resources, and recreation.

d. Future Without Project Conditions

i. Sediment Management

1. Future sedimentation in reservoirs threatens crucial flood risk management infrastructure, critical drinking water, recreation, irrigation, and environmental resources.
2. Continued bed degradation and habitat impairment downstream of dams from lack of sediment.
3. Increased operations and maintenance costs for all resource categories as sedimentation increases in reservoirs.
4. The study sediment technical lead, John Shelley, NWK, described the assessment conducted and projected storage remaining in the multipurpose pools (MP) at USACE reservoirs at the end of 25, 50, and 100 years. All of the USACE reservoirs in the basin are projected to lose storage in the multipurpose pool, with the Tuttle Creek, Perry, and Kanopolis projects having the highest losses (Tuttle Creek 0% of MP remaining at 100 years; Perry 25% of MP remaining at 100 years; Kanopolis 10% of MP remaining at 100 years). Tuttle Creek Lake depths for the base condition (2024), and FWOP conditions at 25, 50,

and 100 years were also discussed with only a small area of relatively shallow water remaining near the dam at the end of 100 years.

ii. Flood Risk Management
    1. The watershed would continue to have life safety risk and property damages from flood events with potential increased risk due to climate change.
    2. Continued emergency costs and loss of revenue during and after major flood events.
    3. High risk communities would continue to remain at risk from major flood events (Table with list of communities and population numbers).
    4. Reduction of flood storage capacity from sedimentation, which may require future water operations changes, implementation of physical measures, or sediment by-pass strategies to address.
    5. The flood risk management technical lead, Allen Chestnut, NWK, described the remaining flood control pools for reservoirs with the highest amounts of projected loss at the end of 100 years. Perry Reservoir is expected to lose 6%; Tuttle Creek is expected to lose 14%; and Kanopolis is expected to lose 7%.

iii. Water Management
    1. Future reductions in reservoir multipurpose pool storage from sedimentation and increased drought may impact existing lake infrastructure, drinking water supplies, recreational amenities, irrigation supplies, and environmental resources.
    2. The water management technical lead, Brian Twombly, NWK, described the FWOP conditions for projects with reduced MP storage. These included not meeting current water releases for downstream uses (e.g., municipal and industrial water supply, water quality minimum release requirements, environmental needs, and recreation); resulting in reduced recreational opportunities, reduced economic benefits, loss of fish and wildlife habitat, and the ability to manage downstream and in-lake water quality conditions.

iv. Water Supply
    1. The water supply technical lead, Jennifer Henggeler, NWK, described the expected FWOP condition for water supply. In the future there would be increased future usage to satisfy demands of a growing population; reduced water supply storage due to increased sedimentation in reservoirs; an increased inability to meet all the water quality and supply demands within the basin during extended drought periods; future water shortages to maintain current downstream minimum streamflows; and continued/increasing water quality impairment from agricultural runoff and harmful algal blooms at reservoirs and in river/stream reaches.

v. Recreation
    1. In the future there would be continued impacts to recreation from flooding, drought, and sedimentation. These impacts include loss of visitation leading to reduced future revenue; increased costs for repair of damaged infrastructure; reduced opportunities; shifts in the types of use (i.e., water-based recreation to shore-based activities); and increased safety hazards for recreational users.

vi. Biological Resources

1. These resources include terrestrial and aquatic habitats, fish and wildlife, and special status species. In the future there would be an overall decline in the diversity of fauna and habitats from habitat loss, habitat degradation, and fragmentation. Sedimentation in reservoirs would reduce the quality and quantity of existing aquatic habitats and affect the reproduction of aquatic species. Greater water level fluctuations from sedimentation and climate change would likely alter existing aquatic and terrestrial habitat availability. Invasive species would continue to be a concern and may actually increase as more terrestrial and aquatic habitat is disturbed from future sedimentation and water level changes. The PDT will be identifying potential habitat models and methods to assess existing and future habitat conditions in focused areas of the watershed.

e. Measures and Strategies
   i. Mr. Jeff Tripe, Plan Formulation Section Chief, NWK, presented an overview of the initial development of measures and strategies. The PDT worked with partners and stakeholders to identify the problems, needs, and constraints within the watershed relative to the primary resource categories. Based on this information, project goals, objectives and a vision statement were created. Focused meetings and workshops were used to identify all possible management actions, projects, and follow-on studies that could be examined and screened for potential future implementation. Baseline and future conditions were then developed by using information from expert elicitation, stakeholder input, modeling assessments, and review of existing data sets. Measures and strategies were grouped into an initial set based on primary resource topics (i.e., sediment management, FRM, ecosystem, water supply, etc.). The study team is currently working to identify opportunity or focus areas within the watershed, which will allow for further grouping and more detailed assessment of management measures so that additional screening criteria and associated costs and benefits can be developed. These may include state planning areas, sub-watersheds, reservoirs, or river/stream reaches depending on needs identified.
   ii. The study recently held a small group workshop attended by 50-60 participants from over 20 agencies/organizations with an interest in the basin.
   iii. Ms. Laura Totten, NWK, presented slides that included the working draft list of measures and strategies. While measures were identified that would directly benefit a species resource or focus area (e.g., flood risk management, water supply, recreation, etc.) many would also have multipurpose benefits.

   It was recognized that sediment management should not be done for the sake of sediment management, but rather as a method/strategy or tool to reduce the impacts of sediment on other resource categories (e.g., flood risk management, water supply, recreation, etc.) by focus area. The study team is currently working to assess existing and future sedimentation loads, rates, and outcomes in the basin. Once that is completed, specific sediment-related measures and strategies can be developed to address sedimentation at the source or in-lake to ultimately address problems related to water quality, recreation, water supply, flood risk management, and ecosystems.

The draft working measures and strategies were provided to participants as a read ahead and included descriptions of each, potential funding sources, potential lead agencies for implementation, and notes on detailed considerations and constraints.

Participants were asked to consider and provide questions and input on the draft measures, process for development of measures, the stakeholder engagement process, and the six focus areas. Are there any gaps or missing measures, those that could be controversial, or those that don't connect to a study objective?

Participants asked how the study team would combine measures into strategies and conceptual plans. The study team is currently working to draft the screening and evaluation criteria and develop opportunity or focus areas. Measures could then be combined based on needs within a specific area in the basin to address identified problems. Strategies or conceptual plans could include measures to protect/improve streamflow in reaches of the Kansas River mainstem that would address problems related to water quality, recreation, and/or environmental resources.

Another question asked if the study team would consider prioritization of measures, strategies, and conceptual plans. Prioritization will be a part of the screening and evaluation process and development of recommendations.

The study team will consider for each measure or combined strategies and conceptual plans the impacts that could occur and/or benefits that would be expected. This could include an assessment of the tradeoffs.

Participants also asked how the study team has worked under COVID 19 restrictions. The study team has utilized web tools to hold virtual meetings when needed. This can be more challenging from certain aspects (e.g., reduced opportunities for side conversations; participants multi-tasking) but also likely worked better in some cases (e.g., large workshops were well attended as there was not a need to travel). PDT and working group meetings held virtually allowed the team to discuss status and work through any questions or issues that required discussion. The sponsor offices were closed for a short period at the start of the pandemic which caused a period of loss of regular contact between NWK and partners/sponsors. Overall, COVID 19 restrictions have not had major impacts on the study progress as fortunately large public outreach meetings were held prior to the pandemic with none planned until later in the study.

iv. Mr. Jeff Tripe, NWK, described the draft screening and evaluation process under consideration by the study team. Identification of implementation scale to implement a measure or strategy will be part of the screening and evaluation process. The screening approach will include evaluation of measures and strategies relative to effectiveness (benefits) and efficiency (cost magnitude). Some of the screening metrics would use quantitative data, such as tons of sediment by-passed or reduced; change in habitat quality/quantity; or estimated cost of implementation. Other metrics would use

a qualitative scoring method based on expert knowledge and judgement (e.g., high, medium, low). Evaluation of magnitude of costs could include implementation, monitoring, adaptive management cost, operations and maintenance cost, and mitigation cost. Measures and strategies will be grouped into conceptual plans that could address a single purpose (e.g., flood risk management) or plans with a multi-purpose objective (e.g., Ecosystem Restoration/Water Supply/Recreation).

An example of the draft screening process for sediment management was presented to participants. Participants were asked to provide questions and input on the screening and evaluation and combining measures into strategies and conceptual plans.

6. The next steps for the study include:

    a. Identification of Opportunity / Focus Areas
        i. State Planning Areas
        ii. Sub-watersheds
        iii. Reservoirs
        iv. Downstream/upstream reaches
    b. Conceptual Plan Formulation
        i. Finalize Draft Screening Criteria
        ii. Screen and Evaluate Measures and Strategies
        iii. Compare and Select Measures to Carry Forward
        iv. Combine Measures into Conceptual Plans/Alternatives
        v. Development of Priority List of Potential Plans
    c. Shared Vision Milestone Meeting – May 24

7. Schedule
    a. An overview of the study schedule and task status were provided to participants.

Date	Task/Milestone
Shared Vision Milestone	
May 1, 2019 – September 13, 2019	PMP Development - Complete
May 1, 2019 – May 22, 2020	Review Plan Development and Approval - Complete
September 2019 – January 2020	Initial Round of Stakeholder Coordination and Public Outreach Meetings - Complete
July 2019 – March 2021	Initial Baseline and Existing Conditions and FWOP – A number of resources complete
October 2019 – March 2021	Identify and Screen Conceptual Measures/Alternatives – Measures Identified
May 2021	Shared Vision Milestone Meeting
Recommendations Milestone	
May 2021 – May 2023	Watershed Study Recommendations
May 2023	Recommendations Milestone Meeting
Watershed Study Report	
June 2023 – December 2023	Draft Watershed Study Report

Fall 2023	Draft Watershed Study Report Milestone Meeting
January 2, 2024	Approved Final Watershed Study Report

8. The planning charette was successful in informing the participants on the projected FWOP conditions, draft measures and strategies, screening, evaluation, and combining of measures and strategies, and the importance of the study for the sponsors to support their needs. The following are the main considerations provided by the vertical team that resulted from the planning charette.

    a. Comments were made that the study scope appears to focus on areas that are USACE authorities. It was reinforced that study objectives should be broader to include those outside of USACE authorities (e.g., state or local objectives). We want to include these opportunities for other stakeholders to participate and implement actions in the future, which may be outside of existing USACE projects and authorities.

    Discussions between USACE and state agencies, prior to authorization of the study and signing of the FCSA, identified the primary need for the study is due to issues and concerns related to USACE reservoirs and sedimentation, reservoir operations, and flood risk in the basin. While there may be issues that are outside of USACE authority, the primary focus of the study is on sediment management, flood risk, and reservoir operations as these remain the most pressing problems in the basin currently and are expected to be the most pressing problems into the future.

    The study team is working with the sponsors, other agencies, and stakeholders in the basin to ensure that the study includes opportunities for them to participate and implement actions in the future, including those outside USACE projects and authorities.

    b. The study team should continue to coordinate with federal and state agencies including reaching out to those that have not participated or responded to coordination letters. The study team is planning a federal agency meeting in the near future and will reach out to those agencies that did not provide a response.

    c. During future iterations of the planning process the study team will continue to work to integrate sediment management measures under focus areas and resources and provide details on how these measures benefit each of the focus areas and resources (i.e., water quality, recreation, water supply, flood risk management, and ecosystems).

9. Should you require any additional information please contact Laura Totten, Project Manager, at (816)-389-2137 or Laura.A.Totten@usace.army.mil.

Laura Totten
Project Manager/Planner
Kansas City District

Attachment 1: Planning Charette Agenda

Kansas River Reservoirs Flood and Sediment Study

Planning Charette

March 29, 2021
Webex Meeting

Meeting Information

Start your meeting here:

https://usace1.webex.com/usace1/j.php?MTID=mbf31e11c537dbdc58ab62883b6c73a5c

(If you are unable to access directly using the link above copy and paste the link into your browser to access)

Join by Phone: 844-800-2712
Meeting Number (access code): 199 085 1413
Meeting Password: HSgZbMb@343

Charette Purpose: The purpose of the charette is to bring together the Kansas River Reservoirs Flood and Sediment Study (Watershed Study) PDT members from the USACE NWK, Kansas Water Office, and Kansas Department of Wildlife, Parks and Tourism and the USACE Vertical Team to discuss the working draft measures and strategies and to hear specific concern and opinions to ensure they capture the breadth of interests and support the Shared Vision Statement for the study.

This will also be an opportunity to discuss the screening criteria the study team will use to ensure measures and strategies contribute towards meeting the planning objectives and will allow the study PDT to incorporate any new information prior to the Shared Vision Milestone meeting scheduled for May 2021.

Invited Partners and USACE Organizations

- Northwest Division, USACE (NWD)
  - Jim Fredericks, Chief, Planning, Environmental Resources, Fish Policy and Support Division
  - Office of Counsel
  - Dam Safety
  - Levee Safety
  - Plan Formulation, Programs, Engineering, Economics, Environmental Resources, and Real Estate
- HQUSACE - Regional Integration Team
- HQUSACE - Office of Water Project Review
- Planning Center of Expertise
  - Flood Risk Management
- Kansas Water Office
  - Connie Owens, Director
  - Cara Hendricks, Assistant Director
  - Planning, Hydrology and Evaluation, Communications PDT Members
- Kansas Department of Wildlife, Parks & Tourism
  - Steve Adams, Chief of Planning
  - Public Lands, Fisheries, Wildlife PDT members
- Kansas City District, USACE (NWK)
  - Jennifer Switzer, Planning Branch Chief

Kansas River Reservoirs Flood and Sediment Study

- Jeff Tripe, Plan Formulation Section Chief
- Todd Gemeinhardt, Environmental Section Chief
- Plan Formulation, Economics, Environmental Resources, Engineering, Communications PDT members

Agenda

1:00 – 1:15 p.m.

Opening Remarks – Jim Fredericks (USACE-NWD); Cara Hendricks (Kansas Water Office) and Steve Adams (Kansas Department of Wildlife, Parks, and Tourism)

Charette Purpose – Jennifer Switzer (USACE-NWK)

Watershed Study Overview – Jeff Tripe (USACE-NWK)

Study Area – Laura Totten (USACE-NWK)

1:15 – 1:45 p.m.

Problems Facing the Basin in the Next 50 Years – Laura Totten (USACE-NWK)

Study Scope – Laura Totten (USACE-NWK)

Shared Vision – Cara Hendricks (Kansas Water Office)

Future Without Project – Laura Totten (USACE-NWK) and USACE-NWK PDT members

1:45 – 2:55 p.m.

Measures and Strategies – Laura Totten and Julie MacLachlan (USACE-NWK)

Screening and Evaluation – Jeff Tripe (USACE-NWK)

2:55 – 3:00 p.m.

Next Steps – Laura Totten (USACE-NWK)

Study Schedule – Laura Totten (USACE-NWK)

Closing Remarks – Round Robin

Attachment 2: Attendees List

Attendees List

Name	Office	Contact Information
Jim Fredericks	CENWD-PDD	Jim.K.Fredericks@usace.army.mil
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RISK WORKSHOPS

FLOOD RISK

Kansas River Reservoirs Flood and Sediment Study

MEETING NOTES

DATE: Friday, February 3, 2023
TIME: 1:00 p.m. – 4:00 pm
LOCATION: In-Person / Teleconference
SUBJECT: Flood Risk Working Group Meeting

Location:
Kansas Water Office
900 SW Jackson Street, Suite 404
Large Conference Room
Topeka, KS 66612

Webex Info:
https://usace1.webex.com/usace1/j.php?MTID=me07474099d0f885ffc45b3ff62238b15
844-800-2712
Meeting Number: 2762 246 8918
Meeting Password: fKEs6n8mu@7

Invitees (attendees in bold):

Kansas Water Office

Matt Unruh, Assistant Director; Nate Westrup, Manager – Public Water Supply Programs; Josh Olson, Project Management Lead; Kirk Tjelmeland, Field Services Coordinator; **Richard Rockel, Technical Services Lead; Amelia Nill, Regional Planning and Outreach Coordinator**

Kansas Department of Wildlife, Parks and Tourism

Steve Adams, Chief of Planning; John Reinke, Fisheries Biologist; Jordan Hofmeier, Aquatic Ecologist; Mark VanScoyoc, Survey Coordinator, Ecologist

U.S. Army Corps of Engineers

Laura Totten, Planner/Project Manager; **Jennifer Henggeler, Risk and Communications Section Chief**; **Jeff Tripe, Plan Formulation Section Chief; Ginger Harper, Planner/Communications/Outreach; Julie MacLachlan, Communications/Outreach**; **Brian Twombly, Engineer;** John Shelley, Engineer; **Marvin Boyer, WQ Program Coordinator**; **Sophie Wayne, Economist; Noah Colby George, Economist**; **Kara Cline, Engineer**; **Devin Smith, Economist; Brian Rast, Silver Jackets Coordinator**

Others

Tara Lanzrath, Kansas Department of Agriculture, State NFIP Coordinator; Stephanie Goodman, Kansas Division of Emergency Management, State Hazard Mitigation Officer; **Aaron Deters, Kansas Alliance for Wetlands and Streams**

MEETING NOTES

I. Laura Totten (USACE) led introductions, provided housekeeping items for the group, and shared meeting purpose and desired outcomes.

II. **Meeting Purpose and Desired Outcomes (refer to attached slides presented)**

a. Purpose and Desired Outcome of Problem Area Meetings

i. Conduct and complete Risk Assessment and Evaluation to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study for

each problem area (i.e., Flood Risk, Sedimentation and Erosion, Reduction in the Ability to Meet Water Supply Demands, Degraded/Poor Water Quality, Ecosystem Degradation and Species

ii. Conduct Uncertainty Assessment of Stressors

iii. Review and refinement of existing list of measures and strategies

b. The group is tasked with conducting a Risk Assessment and Evaluation for each problem area to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study.

c. Purpose and Desired Outcome of Recommendations Workshop

i. Using information from problem area meetings, hold a 1-day workshop to develop draft recommendations for all problem areas.

1. Identification of near-term and long-term actions / projects, evaluations, and data needs for each problem area and associated stressors.
2. Framing of Draft Recommendations for each problem area that includes details related to rough order of magnitude costs, potential funding sources, potential partners, and priority areas within the RPAs. The plan is to have draft recommendations by May 2023.

III. Study Accomplishments

a. The Project Management Plan was developed.

b. A Shared Vision Statement and Objectives were developed.

c. The team has conducted extensive stakeholder and public outreach throughout the basin.

d. The team has completed acquisition and analysis of comprehensive datasets and information related to hydrologic conditions, hydraulics, sediment transport, economic data, water supply demand and uses, recreation benefits, biological resources, and cultural resources in the basin.

e. A framework has been developed to perform a comprehensive assessment of existing conditions and expected future conditions, enabling development of a strategic roadmap to inform future investment decisions by multiple parties and to better account for uncertainty.

f. Assessments and Technical Reporting for Existing Conditions and FWOP for reservoir sediment, reservoir operations, climate change, flow frequency, flood risk, water supply, water quality, biological resources, and recreation are complete.

g. Measures have been developed to address issues related to flood risk, sedimentation and erosion, ability to meet water supply demands, degraded/poor water quality, ecosystem degradation and species impact, and loss of recreation opportunities.

h. The Shared Vision Milestone was successfully completed.

IV. Risk Assessment and Evaluation

a. Process Overview

i. Laura Totten (USACE) asked if the process as described from the last meeting is working. Nate Westrup (KWO) shared that the process and methodology is clear; weighting the items is the bigger challenge. It was discussed whether an entire agency should provide a response, but designate differing opinions, perspectives or levels of expertise where necessary. If there are others that can provide value to this assessment, attendees can pass along the information to them or get in touch with Laura Totten (USACE). Laura Totten (USACE) shared the steps in the process (see attached slides). Results of the assessment will be used to develop framework for future solutions.

ii. Kansas River Reservoirs Flood and Sediment Study Flood Risk Assessments

1. The Qualitative Climate Change Assessment is complete; see results and trends in attached slides. Allen Chestnut and Kara Cline (USACE) performed the assessment. Laura Totten (USACE) clarified the qualitative nature of this assessment and that in the future would we want to recommend a more quantitative assessment be completed. The quantitative assessment performed for the watershed study (e.g., reservoir modeling, flow frequency) do not include climate change implications. The climate change assessment would be used qualitatively to strengthen those trend projections. USACE would consider the effects of climate change for future proposed work. The state expressed the need for a more qualitative assessment for climate change. Would the Reservoir Water Control Manual updates include look at efficiency and looking at the probable maximum floods. Brian Twombly (USACE) responded that they would not. Updating the reservoir water control manuals would be for dam safety purposes but would be flexible. The probable maximum flood ranges are updated periodically. The group discussed the opportunity for a quantitative climate change study with a future control manual update. KWO has a Water Smart grant to develop a data set for climate change in the next two years.
2. The Flow Frequency Update is complete; see study areas and more details from the assessment in attached slides. The previous assessment was based on 2002 data. This new assessment uses the most recent period of record up to 2019. Kara Cline (USACE) performed the assessment for existing conditions and developed flow frequencies. There was also an assessment of future flows that shows there could be some minor change in flows the 100-year future without project scenario (i.e., Year 2124 with expected sedimentation in reservoirs). This assessment informs current risk and help facilitate better floodplain management. This is the best tool to determine future flood risk.

3. The Life Safety Assessment is complete. The study looked at life safety and economic damages for 10-, 100-, and 500-year events under existing conditions. Devin Smith (USACE) took flow frequencies and the hydraulics and performed the assessment; see results in attached slides. The life safety assessment was not done for future scenarios as peak flows changed (i.e., increase or decrease) by approximately 2% (very minor) in the future with minor changes expected to life safety risks and economic damages compared to existing conditions. The life safety assessment includes potential life loss occurring in certain areas of the basin. The assessment of economic damages includes structure and content of structures, but does not consider intakes, outfalls or infrastructure of non-structures. The example shown assesses risk at a 100-year event. The question is how much risk is acceptable and how much are communities willing or able to invest to protect life safety or infrastructure. The 500-year event heat map was provided, which shows areas with expanded life safety risk compared to the 100-year event and substantial increases in economic damages. Life loss is usually higher at night because people are home sleeping. The data is also broken out by age group. The economic data is based on USACE structure inventory. HAZUS data is not as accurate.

   Question: Does the heat map for FRM consider levee overtopping elevations and NSI data for the leveed areas?

   Question: Does the 500-year go over top?

   The assessment includes what is there now but does not account for the rise in levee height updates in the basin (e.g., KC Levees) being completed right now. There is a higher risk for older people in a single structure. It does not include military assets at Ft. Riley but includes a lot of small structures and are valued similarly to any other structure based on how the structure is coded. Brian Rast (USACE) shared that Department of Defense (DOD) is assessing all the military installations with projected future climate impacts and is taking action. He has a presentation on this if anyone is interested. Ft. Riley is one of the installations in the DOD Climate Action Tool, which provides lots of insight on climate impacts. Heat is the worst offender. Roads are included, but not bridges. A more site-specific study could look at more details.
   Tara Lanzrath (KDEM) asked if the USACE could share the structure inventory used or any of the spatial data. This cannot be shared due to licensed data sharing constraints.

They would be interested in using it for Technical Assistance projects for remediation if possible. The USACE can talk internally and let KDEM know what could be shared.

iii. Julie MacLachlan (USACE) shared information about environmental justice (EJ) and its relevance to this study, see attached slides. The study team is just at the beginning of considering how EJ is incorporated into the study. The group was asked to think about and share their knowledge of where income, level of education, limited English proficiency and race may affect flood risk in terms of vulnerability and ability to respond to risk and change. Also think about "widening your lens" for risks from various problems in how they impact disadvantaged communities. CEQ and EPA tools were used for EJ screening. These tools provide an intersection of disadvantaged communities and risks (e.g., those within flood zones).This will be ground truthed in the future.

Flood risk is one of many risks being looked at. Richard Rockel (KWO) is looking at places where there are gaps and overlaps when layering EJ screening tools. Multiple federal agencies developing their own screening tools can be confusing if the guidelines and criteria are not consistent. The most important aspect is whether people are being reached and communicated with. NOAA ran the screening using two different tools.

Agencies are required to perform certain screening and can supplement with other tools to better assess risk. The tool will be used and overlayed with other risk factors. Noah Colby-George (USACE) shared that they are using the EJ tool to access future funding or project development.

Brian Rast (USACE) shared that there's interesting overlap that deserves some lining up and cross referencing. Rossville is a very good example he has also looked at. Richard Rockel (KWO) and FEMA noted Rossville is eligible for a 90% cost share in some grants, per their status as economically disadvantaged.

b. Problems and Stressors

i. Problems and stressors have been shared with project partners for feedback and each group will go through the Risk and Uncertainty Assessment. After that step, all information will come together in a summary of actions with individual problem areas ranked or prioritized. It was recognized there could be further discussion and descriptions of stressors, and today starts with flood risk impacts. Many of the measures are multipurpose and intended to address multiple problems, and ultimately there is a desire to prioritize or link benefits that impact multiple problem areas, as they are more appealing for funding. In general, USACE is leaning more towards supporting projects with comprehensive benefits and acknowledged that communication tools are

extremely important.

c. Qualitative Probability and Consequence Evaluation
    i. Risk Categories
        1. Economic Risk – The likelihood and consequences of harm/damage to property, infrastructure, and other assets, as well as economic systems (measured in monetary terms).
        2. Social – The likelihood and consequence of loss of social connectedness, adverse effects to disadvantaged communities, displacement of individuals, and ability for subsistence (ability of individuals/communities to be self-sustaining – reliance on natural resources to support a community and livelihoods).
        3. Environmental – The likelihood and consequence of ecosystem services impacts (the various benefits provided by certain environmental and natural resources to communities), habitat loss, and species loss.
        4. Life Loss / Life Safety – The likelihood and consequence of the stressor occurring and subsequent life loss or risks to public safety including emergency preparedness.
    ii. Focus / Opportunity Areas
        1. **Kansas Regional Planning Area - Today**
        2. Solomon-Republican Regional Planning Area
        3. Smoky Hill-Saline Regional Planning Area
        4. Upper Republican Regional Planning Area
        5. Upper Smoky Hill Regional Planning Area
    iii. Discussion
        - This meeting is focusing on Kansas RPA. Laura Totten (USACE) shared an example of a Risk Assessment from the USACE Honolulu District (see attached). The goal of the exercise is to plot risks on a matrix to gain an understanding of probability and consequences (Risk Assessment), then understand next steps for each problem area such as additional study, form a working group, seek additional funding, monitoring, etc. (Uncertainty Analysis). USACE has vetted this approach internally and with project partners, but this approach is new to this team. As such, this team is open to suggestions for modifications to the model to tailor to this study and study area. The planning team will combine the Risk and Uncertainty summaries to determine action and implementation timelines (immediate action, incremental action) at the end of this phase.

Kansas River Reservoirs Flood and Sediment Study

- Laura Totten (USACE) shared the study's vision statement, objectives and other read-ahead materials (see attached files). She also described the extensive stakeholder engagement to date.
- The group proceeded with the Risk Assessment exercise. In-person participants and online participants were asked to use the annotation tool to place the risks on the matrix.
- There are 5 stressors under the flood risk problem area. Laura Totten (USACE) provided a brief summary of each stressor. Communications issues refers to potential issues related to inadequate communications during a flood event. There could be areas of improvement related to this in the future. The USACE operates the reservoirs to reduce flood risk in the downstream areas but depending on conditions downstream on the Missouri River (KC and Waverly control points) water could be held in the reservoir. The watershed study is assessing several scenarios for operating the Kansas River reservoirs differently (e.g., release behind the peak). If the initial results show the potential for improvements at the Kansas River reservoirs these could be considered under alternatives development during a future water control manual update. Brian Rast (USACE) shared that there are challenges coming with the next manual update. Steve Adams (KDWP) shared that KDWP thinks issues at the Waverly control point(s) need to be addressed in the study.
- The group discussed the appropriateness of "Have Occurred" on the probability scale as it is more factual based. It either has occurred or it hasn't and is less about perspective. The group discussed how strictly the categories should be adhered to and used the example of loss of life versus the economic value.
- Josh Olson (KWO) suggested consolidating probability and risk assessment charts to fully consider qualitative and quantitative considerations. Laura Totten (USACE) shared that the matrices are combined at the end of the process to provide a summary and suggested that the metrics that do not fit the risk category could be removed and not assessed (e.g., has occurred). The group discussed adjusting the probability and consequence scale and simplifying the number of levels in the matrix.
- Laura Totten (USACE) suggested perhaps not including Public Life Safety on the Economic Risk Assessment matrix. Julie MacLachlan (USACE) discussed the cost of resources deployed to prevent life loss and there is an economic aspect to those prevention measures. The stressors do not need to be compared to each other (life loss versus structure loss, for example).

- The USACE LifeSim model results should be considered for this risk assessment and base the risk on what the data shows and ground truth this through actual issues identified by stakeholders/agencies. The model does not assess all areas within the basin, but for RPAs where there is data, it should be used. A scale or categories of consequence could be developed based on the data representing actual life loss instead of relying on opinions or perspectives of the group. Data and qualitative evaluation could also be used to see where they line up on the matrix. The flood event should also be considered in the evaluation on the matrix.
- The group determined that the remaining risk assessment would be done initially by USACE using information developed by the study (e.g., flow frequency, LifeSim results) and then provide to partners and stakeholders for validation.
- The group discussed the desire to ultimately determine priorities for recommendations. Study partners have done their own stakeholder outreach and had discussions about future plans and projects. The study partners could put their list of recommendations together based on their knowledge of the basin. Even if there are recommendations that have been brought forth through a separate planning process the redundancy in recommendations may be helpful to access additional funding sources and exposure to different decision-makers.

V. Uncertainty Analysis

a. Qualitative assessment of uncertainty to identify the level of consensus among stakeholders in implementing potential risk reduction measures for each stressor.

b. Categories

   i. Action – Implementable solutions with a high level of consensus to address a given stressor

   ii. Evaluation Options – Potential solutions defined with existing information

   iii. Fill Data Gaps – Additional data would be required to better define the problem and/or identify potential solutions

c. Supports development of a framework for the appropriate types of and timing for recommendations to help prioritize actions.

   i. Categorize each stressor or parts of a stressor under the appropriate level of uncertainty.

      1. Near-term Actions - Stressors with a high level of risk (e.g., high probability and high consequence) could require immediate steps to reduce risks through actions, evaluation, or filling data gaps.
      2. Incremental Actions - Stressors with less risk (e.g., moderate probability and temporary impacts) could be considered as a lower priority that does not require immediate steps.

VI. Measures

a. The working list of measures related to flood risk was shared and the group discussed details related to these and any potential new ideas.
b. The state asked if we need to separate out actions that the USACE could take versus those that are done through the state or local governments.
c. The flood risk mapping overlaid on areas within the basin could support prioritization of measures with the goal to develop these at a smaller scale (e.g., HUC 8 watershed) then the entire basin.
d. The state recommended that the measure for Reservoir Water Control Manual updates would be a priority.
e. There are measures that there is more certainty on how/where/when to implement. There may be areas where we don't know the best actions needed and may need to charter a working group to brainstorm and determine the best actions.
f. The data from the study could be used to support efforts that KDEM is working on using FEMA funds. There could be ways to leverage the study information for these programs to further advance solutions. A program for looking at nature based solutions is another example of a Technical Assistance Project. KDEM typically looks at potential measures (e.g., up-sizing culverts, detention basins) under different scenarios and modeling a specific number of scenarios and map out what the reductions would be in the floodplain. USACE could participate on teams with KDEM and leverage information. Invites to USACE to kickoff meetings for these efforts could be used to discuss how to use and share data for a common goal. These efforts typically don't look at reservoir operations and the question was asked if that could be incorporated into these efforts. The ResSim and H&H modeling could be useful in the KDEM efforts. USACE will follow up with KDEM on working together on these efforts and next steps.
g. Brian Rast (USACE) suggested that non-structural measures should include land use incentives, such as for soil health measures.

VII. Additional Discussion

The group brainstormed many challenges and possible solutions for how to structure the risk assessment exercise to get the most benefit and leverage other projects or studies already in progress. It is important to include the subject matter experts appropriately in the working group meetings to share information and knowledge to avoid recreating information or datasets. Brian Rast (USACE) shared that the FEMA Tech Assistance work and CTP activities have been an area of overlap for Silver Jackets in both Kansas and Missouri. We have been in communication with Region VII about ways to leverage these activities.

a. USACE will discuss what information and data can be shared outside of the organization.

VIII. Do-outs / Next Steps

a. USACE will update due dates, matrices, etc. and send to participants to complete risk assessment for each RPA and send to USACE.
b. USACE will compile and finalize information on risk and uncertainty and provide to participants for review and comment.
c. Conduct Draft Recommendations Workshop.
d. USACE to follow up with Tara Lanzrath (KDEM) on working together and sharing information.
e. Working Group Meetings
    1. Jan 13 – Ecosystem and Species (complete)
    2. Feb 3 - Flood Risk (today)
    3. Feb 13 – Recreation – To be rescheduled; likely date Feb 27
    4. Feb 15 – Sediment and Erosion
    5. Feb 21 – Water Supply
    6. March 3 – Water Quality

REDUCTION IN THE ABILITY TO MEET WATER SUPPLY DEMANDS

Kansas River Reservoirs Flood and Sediment Study

MEETING NOTES

DATE: Tuesday, February 21, 2023
TIME: 1:00 – 4:00 pm
LOCATION: In-Person / Teleconference
SUBJECT: Water Supply Working Group Meeting

Location:
Kansas Water Office
900 SW Jackson Street, Suite 404
Large Conference Room
Topeka, KS 66612

Webex Info:
https://usace1.webex.com/usace1/j.php?MTID=ma9ffa358f3121e1fa35ed8a37ed3db32
844-800-2712
Meeting Number: 2761 268 6134
Meeting Password: kgQrXfi*286

Invitees (attendees in bold):

Kansas Water Office

Matt Unruh, Assistant Director; Nate Westrup, Manager – Public Water Supply Programs; Josh Olson, Project Management Lead; Kirk Tjelmeland, Field Services Coordinator; Richard Rockel, Technical Services Lead; Amelia Nill, Regional Planning & Outreach Coordinator

Kansas Department of Wildlife, Parks and Tourism

Steve Adams, Chief of Planning; John Reinke, Fisheries Biologist; Jordan Hofmeier, Aquatic Ecologist; Mark VanScoyoc, Survey Coordinator, Ecologist

U.S. Army Corps of Engineers

Laura Totten, Planner/Project Manager; Jennifer Henggeler, Risk and Communications Section Chief; Jeff Tripe, Plan Formulation Section Chief; **Ginger Harper, Planner/Communications/Outreach; Julie MacLachlan, Communications/Outreach; Brian Twombly, Engineer;** John Shelley, Engineer; **Marvin Boyer, WQ Program Coordinator; Noah Colby George, Economist;** Kara Cline, Engineer

Others

Doug Haney, Kansas Water Assurance District

MEETING NOTES

I. Laura Totten (USACE) led introductions, provided housekeeping items for the group, and shared meeting purpose and desired outcomes.

II. **Purpose and Desired Outcomes**

a. Purpose and Desired Outcome of Problem Area Meetings

i. Conduct and complete Risk Assessment and Evaluation to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study for each problem area (i.e., Flood Risk, Sedimentation and Erosion, Reduction in the Ability to Meet Water

Supply Demands, Degraded/Poor Water Quality, Ecosystem Degradation and Species Impact, Loss of Recreation Opportunities) for 5 planning areas - Kansas Regional Planning Area (RPA), Solomon-Republican RPA, Smoky Hill Saline RPA, Upper Republican RPA, Upper Smoky Hill RPA.

ii. Review process for Uncertainty Assessment of Stressors

iii. Review of existing list of measures and strategies

b. Purpose and Desired Outcome of Recommendations Workshop

i. Using information from problem area meetings hold a 1-day workshop to develop draft recommendations for all problem areas.

1. Identification of near-term and long-term actions / projects, evaluations, and data needs for each problem area and associated stressors.
2. Framing of Draft Recommendations for each problem area that includes details related to rough order of magnitude costs, potential funding sources, potential partners, and priority areas within the RPAs.

III. Study Accomplishments

a. The Project Management Plan was developed.

b. A Shared Vision Statement and Objectives were developed.

c. The team has conducted extensive stakeholder and public outreach throughout the basin.

d. The team has completed acquisition and analysis of comprehensive datasets and information related to hydrologic conditions, hydraulics, sediment transport, economic data, water supply demand and uses, recreation benefits, biological resources, and cultural resources in the basin.

e. A framework has been developed to perform a comprehensive assessment of existing conditions and expected future conditions, enabling development of a strategic roadmap to inform future investment decisions by multiple parties and to better account for uncertainty.

f. Assessments and Technical Reporting for Existing Conditions and FWOP for reservoir sediment, reservoir operations, climate change, flow frequency, flood risk, water supply, water quality, biological resources, and recreation are complete.

g. Measures have been developed to address issues related to flood risk, sedimentation and erosion, ability to meet water supply demands, degraded/poor water quality, ecosystem degradation and species impact, and loss of recreation opportunities.

h. The Shared Vision Milestone was successfully completed.

IV. Risk Assessment and Evaluation

a. Kansas River Reservoirs Sediment Assessment

i. Laura Totten (USACE) shared the Reservoir Sediment Assessment (see attached slides). It is estimated that 500,000 acre-feet/water lost over the next 100 years and could have substantial risk related to current or expected problems in the basin (e.g., reduced water supply, degraded ecosystems, reduced recreation). The Sediment Assessment included analysis of impacts of future conditions with general observations.

b. Reservoir Modeling

i. Laura Totten (USACE) discussed the results of the Multipurpose Pool Future Conditions model and is looking to the group to help understand the impacts and issues related to reduced storage or more frequent high pool elevations in the flood control pool. The modeling also included looking at changes in flows downstream (e.g., reduced downstream flows that don't meet the target flows) and impacts if navigation flows are made.

ii. The USACE showed several reservoir drought examples and described the potential impacts to reservoir storage in the future with some showing zero to low pool storage under an extreme drought. While the 100-year scenario shows the highest impacts (i.e., reduced pool storage) it is also good to look at the 25 and 50-year scenarios, as the reduced storage under these scenarios may be meaningful as well.

iii. Nate Westrup (KWO) noted that one thing to keep in mind is that future demand is not part of the projections with growth expected in the Kansas RPA and the Smoky Hill RPA. Nate Westrup (KWO) also made a comment that there could be some base flow depletions that are not considered in the USACE modeling or some of the historic data (e.g., 1950s data). Brian Twombly (USACE) shared that the depletion data includes historic and current depletions from the last model run in 2017. This modeling used land use data sets and estimates on cropping patterns. The model does consider municipal and industrial uses, agricultural, and a handful of other uses, as well as evaporation. Laura Totten (USACE) reiterated that while the modeling included depletions the projections do not include future demands or climate change implications, which could make the projections worse. Tuttle Creek, Perry, and Milford are in an area with a high likelihood of development and increased demand. There are also large commercial water users in the area. The KWO has demand projections, usually 20 years at a time, and work with insurance districts to monitor, updating operations agreement every 5 years. This has shown some substantial changes in increased demand with the updated year agreements and also circumstances change that cause other changes. Some of the power needs for water have changed and now they are not planning to retire the power plants as previously thought. All of this uncertainty makes it difficult to create demand projections. Their modeling includes both high and low demand estimates.

iv. Laura Totten (USACE) suggested that a strategy could be a recommendation to perform a detailed demand study. Nate Westrup (KWO) agreed that this is needed with possibly a focus on regional demand potential. KWO has produced demand projections in the past, by populations, municipal and industrial, commercial, with the latest in 2010 and now ready to update this.

c. Other Topics

i. The group briefly discussed nitrates in private wells. This could be done through a partnership with USACE and KWO through a Planning Assistance to States (PAS) study. Wichita State develops population estimates including growth that can be used to support this effort. Ginger Niemann-Harper (USACE) asked about households that may be moving to city utilities versus their own private well. KWO staff did not expect that to be a substantial increase or change.

ii. Topeka and Desoto could experience low flows close together; perhaps the low flow targets need to be changed sooner rather than later. Laura Totten (USACE) asked that the group provide input on what the targets should be. The recommendation could be to start taking action earlier but need to first determine what the triggers would be. We could use a level of storage as the trigger (e.g., Tuttle Creek Reservoir multipurpose pool storage or elevation is at a selected level). Kansas currently has some water assurance districts that are considering some options in 2023 with current drought conditions. What is the potential for stepping down the flow target is desired? USACE noted that there is a drought contingency plan in the manual that will be developed during the Water Control Manual updates that are currently ongoing. The USACE would like stakeholder input on what to consider during these updates related to drought contingency. The Kansas Water Assurance Districts contracted an AE firm to use the KWO model to determine when they need to purchase more storage and also developed scenarios for reduced targets. The scenarios took a basic look at reducing the target flows at Topeka and Desoto by 100 cubic feet per second. They are interested in considering a step-down and have conditions in their agreements. The current plan may not work well in the future if Tuttle Creek Reservoir is full of sediment. KWO feels now is the appropriate time to start planning for risk related to drought and not having adequate storage to meet the target flows. The state of Kansas is under no obligation to provide water to Missouri. The step-down for drought would have the most benefit in maintaining storage at Tuttle to prolong the amount of storage to maintain the base flow needed for the targets. This further highlights the need for sediment management at Tuttle to avoid this breaking point in the system. Perry drawdown probably starts when Milford is low due to depleted inflows with use upstream. Changing thresholds could be alternatives for Water Control Manual updates, but we're not sure what potential alternatives would be related to this. Scoping meetings will likely be held in each watershed for individual reservoirs. The USACE will also coordinate with

Missouri during Water Control Manual updates to understand any concerns they have related to changes in flows (high or low) from the reservoirs.

iii. The only entitlements for Missouri from Kansas reservoirs are for navigation releases. Once the contract is paid off, then arrangements will be made for future operation and maintenance. It will potentially be paid off sooner than 2034. The process to store it includes 100 percent water supply that can be called into service whenever the state desires which could be at the point when navigation releases would be called for. To call into service means the state would make arrangement related to paying for operations and maintenance costs and a notification and taking on the payment. If it's already purchased, then the state is just responsible for operation and maintenance. The agreement might also depend on operation and maintenance future responsibilities. The balance of the three lower reservoirs might be dependent on which entities are paying for the storage.

iv. Navigation releases call for target at Desoto. Specific reservoirs are not provided for making the release, just the general storage. USACE would consider the amount of storage available before releasing storage and determine which reservoir would make the releases. If the state pays their contract in full and calls the water into service Tuttle Creek Reservoir is the only one that would be authorized to make a release for navigation. The study Water Control Manual updates will not include a change to an authorized purpose.

v. Laura Totten (USACE) shared water supply / water quality future conditions (see attached slides).

d. Process Overview
    i. Laura Totten (USACE) explained the process of Risk and Uncertainty Assessment. She also sent the stressors document prior to the meeting for review.
e. Problems and Stressors
f. Qualitative Probability and Consequence Evaluation
    i. Risk Categories
        1. Economic Risk – The likelihood and consequences of harm/damage to property, infrastructure, and other assets, as well as economic systems (measured in monetary terms).
        2. Social – The likelihood and consequence of loss of social connectedness, adverse effects to disadvantaged communities, displacement of individuals, and ability for subsistence (ability of individuals/communities to be self-sustaining – reliance on natural resources to support a community and livelihoods).

3. Environmental – The likelihood and consequence of ecosystem services impacts (the various benefits provided by certain environmental and natural resources to communities), habitat loss, and species loss.
4. Life Loss / Life Safety – The likelihood and consequence of the stressor occurring and subsequent life loss or risks to public safety including emergency preparedness.

ii. Focus / Opportunity Areas

1. Kansas Regional Planning Area
    a. Nate Westrup (KWO), Josh Olson (KWO), and Richard Rockel (KWO) prepopulated the risk matrix for water supply; no additional stressors were suggested. The question is how sediment, groundwater depletion and climate change impact the water supply. As KWO worked through the assessment they thought of the question “What is a threat?”. Sedimentation, evacuation of approximately 25% of the reservoir for storage, and groundwater depletion are threats. Groundwater depletion is not fully understood and KWO is working on development of a groundwater alluvial model to better understand this threat. All of these impact how to approach drought planning. It is thought that groundwater depletions have an effect on the base flow of the Kansas River. KWO does natural flow calculations looking at historically what the flows were prior to reservoir construction. It is difficult to separate surface water and groundwater.
    b. KWO assessed that the economic risk is pretty high for the identified stressors and are exasperated during drought. The predominant source of water in this RPA is from federal reservoirs primarily, so the reduction in multipurpose pool storage of two of the reservoirs in the RPA from sediment is a big deal and the additional threats discussed could also cause substantial risk. Climate change implications are likely to occur but the impacts are not fully known – could be wetter or dryer. Drought seems to be more frequent and more severe with more frequent flash droughts. The flow frequency assessment done for the study will also give us more information to assess risk.
    c. Social Risk: Similar to economic rather than navigation releases potentially being less impactful socially if it doesn’t lead to reductions in water uses. Reduced opportunities for recreation related to reduced water storage or flows could be a social impact. There is a short-term benefit to water quality with navigation releases that leads to reduced storage, but they can be a negative impact if it limits recreation. There are disadvantaged communities in the Kansas RPA. If

the water supply is not what it's expected to be, will it have greater impacts on disadvantaged communities, and to those communities that may not be able to mitigate those impacts. There are potentially a high number of communities that will not be able to mitigate these impacts without support. Larger communities could see less impacts than smaller communities because of funding abilities or distance to access a reliable water source. Access to recreation is important to quality of life and emotional / social wellbeing and reservoir recreation may be the best recreation opportunity available to disadvantaged individuals. The Potawatomi Nation in the basin knows that they need an additional drinking water source, but it is very expensive. Valley Falls' intake is also in jeopardy and may have some issues related to water supply. Potentially they could be approached and ask if they have a need. If they do there could be state or federal support (e.g., PAS). The question is how disadvantaged communities will be supported in the future. An environmental justice (EJ) component will be woven into the study.

d. Environmental Risk: Risk assessed similar to social risk, reservoirs are needed for environmental quality. Laura Totten (USACE) shared that as far as in-reservoir water supply, if the multipurpose pool is not maintained, the fisheries and other habitats could be jeopardized (e.g., cove habitat, reservoir fisheries, water quality). Also, we consider ecosystem services as part of environmental risk. Short-term drought could be beneficial for habitats in reservoirs with exposed flats that grow vegetation that is then inundated providing good habitat for species. However, long-term droughts have a negative impact environmentally. Marvin Boyer (USACE) shared that he is not sure of any well-known impacts to species native to the Kansas River due to an increase in salinity within the range of the Saline River. K State is doing some research tracking the impact of salinity on native species in the Kansas River but the status is not known.
e. Life Loss / Life Safety Risk: The risk assessment shows most stressors are in the middle to upper left part of the matrix. These stressors are not likely to impact life loss or safety. The drought contingency plan could help to address the situation before it becomes dire. We need to consider the safety of EJ communities and the extents they may have to go to in order to get water. We must consider the fire / wildfire risk and the ability to fight fires if supply is low. Existing inner connections might provide some cushion and having a plan in place to do so

before needing to respond is important. We must diversify water sources to make sure there is a sufficient water supply. There are plans in place to get communities to conserve water when it is needed, according to the most recent guidelines. There are water triggers that enact parts of a conservation plan. When the whole community is under restriction, significant cuts in usage can be made. Some funding sources require a conservation plan. Part of the study will include a summary of programs in the basin including the state conservation plan requirements. There are 700 conservation plans statewide that include triggers for water conservation.

f. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Kansas RPA are shown below (Figure 1 through Figure 4). The notes included in the matrix by subject matter experts (KWO) are also included below each table.

			Economic Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring		16	15
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur			
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 1. Kansas RPA Economic Risk Assessment

Kansas River Reservoirs Flood and Sediment Study

			Social Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring		15 16	
	Drought	14		Not Likely to Occur			
	Reduced Water Supply From Navigation Releases	15					
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 2. Kansas RPA Social Risk Assessment

			Environmental Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring		15 16	
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur			
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 3. Kansas RPA Environmental Risk Assessment

			Life Loss / Life Safety Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur		13 14	17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring		15 16	
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur			
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 4. Kansas RPA Life Loss/Life Safety Risk Assessment

Notes: Drought is the extreme condition for which there must be adequate water supply. The primary water supply for municipal and industrial demands is surface water and during drought the predominant source of water to meet demands is federal reservoir storage. Sedimentation is the most substantial and certain threat to maintaining adequate reservoir storage. Evacuation of storage for navigation support on the Missouri River removes about 25% of the available water supply capacity -- this impact will worsen over time, as demand grows and the storage capacity diminishes. Climate change adds an additional layer of uncertainty which speaks to the need for additional safety factors (i.e. More capacity than historic modeling indicates and not evacuating large amounts of storage in a short period of time for minimal out of state benefits - navigation). Groundwater depletions are intermittent, like surface water -- it will refill. However, groundwater development has depleted base flows and increase the reliance on reservoir storage to maintain adequate streamflow during drought.

2. Solomon-Republican Regional Planning Area
    a. KWO assessed the remaining four RPAs. For some of the stressors they would not apply in a given RPA (e.g., those related to reservoirs as no reservoirs in the two western reservoirs). Generally moving west there is increased risk related to groundwater depletions as these regions are more dependent on groundwater rather than surface water.
    b. Laura Totten (USACE) will send out the assessment for additional consideration or discussion.
    c. The matrices for the four risk categories (economic, social, environmental, life loss) that were completed for the Solomon-Republican RPA are shown below (Figure 5 through Figure 8).

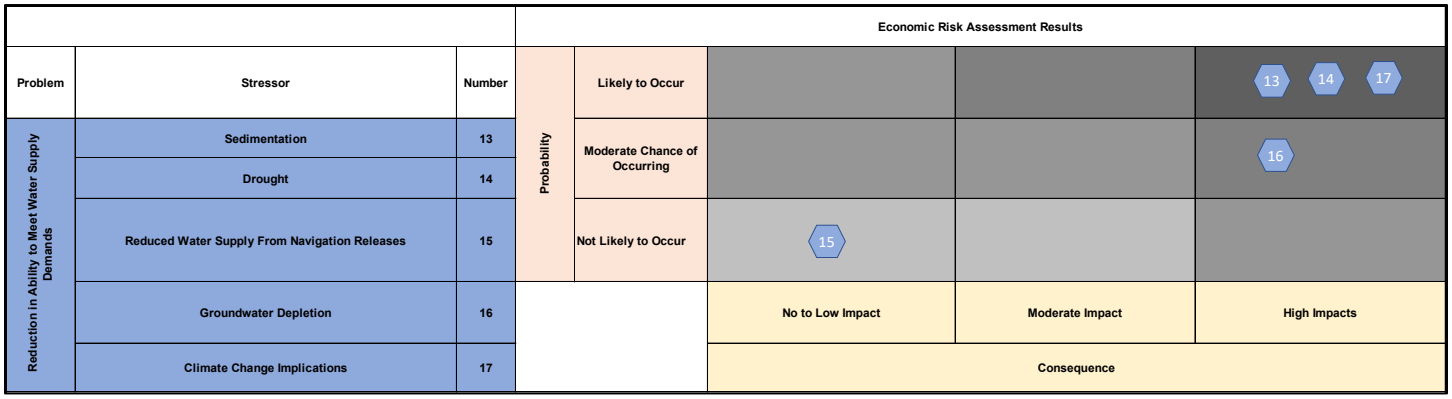


Figure 5. Solomon-Republican RPA Economic Risk Assessment

			Social Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			16
	Drought	14		Not Likely to Occur	15		
	Reduced Water Supply From Navigation Releases	15					
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 6. Solomon-Republican RPA Social Risk Assessment

			Environmental Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring		16	
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 7. Solomon-Republican RPA Environmental Risk Assessment

			Life Loss / Life Safety Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur	13 14	17	
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring	16		
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 8. Solomon-Republican RPA Life Loss/Life Safety Risk Assessment

3. Smoky Hill-Saline Regional Planning Area

a. The matrices for the four risk categories (economic, social, environmental, life loss) that were completed for the Solomon-Republican RPA are shown below (Figure 9 through Figure 12).

			Economic Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 9. Smoky Hill-Saline RPA Environmental Risk Assessment

			Social Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14		Not Likely to Occur	15		
	Reduced Water Supply From Navigation Releases	15					
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 10. Smoky Hill-Saline RPA Social Risk Assessment

			Environmental Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			13 14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 11. Smoky Hill-Saline RPA Environmental Risk Assessment

			Life Loss / Life Safety Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur	13 14 16	17	
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 12. Smoky Hill-Saline RPA Life Loss/Life Safety Risk Assessment

4. Upper Republican Regional Planning Area

a. The matrices for the four risk categories (economic, social, environmental, life loss) that were completed for the Solomon-Republican RPA are shown below (Figure 13 through Figure 16).

			Economic Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	13 15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 13. Upper Republican RPA Economic Risk Assessment

			Social Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14		Not Likely to Occur	13 15		
	Reduced Water Supply From Navigation Releases	15					
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 14. Upper Republican RPA Social Risk Assessment

			Environmental Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	13 15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 15. Upper Republican RPA Environmental Risk Assessment

			Life Loss / Life Safety Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur	14 16 17		
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	13 15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 16. Upper Republican RPA Life Loss/Life Safety Risk Assessment

5. Upper Smoky Hill Regional Planning Area

a. The matrices for the four risk categories (economic, social, environmental, life loss) that were completed for the Solomon-Republican RPA are shown below (Figure 17 through Figure 20).

			Economic Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	13 15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 17. Upper Smoky Hill RPA Economic Risk Assessment

			Social Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14		Not Likely to Occur	13 15		
	Reduced Water Supply From Navigation Releases	15					
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 18. Upper Smoky Hill RPA Social Risk Assessment

			Environmental Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur			14 16 17
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	13 15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 19. Upper Smoky Hill RPA Environmental Risk Assessment

			Life Loss / Life Safety Risk Assessment Results				
Problem	Stressor	Number	Probability	Likely to Occur	14 16 17		
Reduction in Ability to Meet Water Supply Demands	Sedimentation	13		Moderate Chance of Occurring			
	Drought	14					
	Reduced Water Supply From Navigation Releases	15		Not Likely to Occur	13 15		
	Groundwater Depletion	16			No to Low Impact	Moderate Impact	High Impacts
	Climate Change Implications	17			Consequence		

Figure 20. Upper Smoky Hill RPA Life Loss/Life Safety Risk Assessment

V. Uncertainty Analysis

a. Qualitative assessment of uncertainty to identify the level of consensus among stakeholders in implementing potential risk reduction measures for each stressor.

b. Categories

i. Action – Implementable solutions with a high level of consensus to address a given stressor.
ii. Evaluation Options – Potential solutions defined with existing information or additional data would be required to better define the problem and/or identify potential solutions.

c. Supports development of a framework for the appropriate types of and timing for recommendations to help prioritize actions.
    i. Categorize each stressor or parts of a stressor under the appropriate level of uncertainty.
        1. Near-term Actions - Stressors with a high level of risk (e.g., high probability and high consequence) could require immediate steps to reduce risks through actions, evaluation, or filling data gaps.
        2. Incremental Actions - Stressors with less risk (e.g., moderate probability and temporary impacts) could be considered as a lower priority that does not require immediate steps.

VI. Measures

a. Laura Totten (USACE) shared the measures and strategies for water availability and sustainment (see attached slides);
    i. Navigational release is always a risk to water availability at Tuttle Creek Reservoir. The most that could be recommended through the watershed study is a spin-off study or further investigation of the value of navigational releases. If all of the Perry and Milford Reservoirs multipurpose pool storage is purchased by Kansas, it would be important to understand the value that navigation brings to Tuttle Creek Reservoir. The study team may also need to understand the importance of Tuttle Creek Reservoirs' elevation as the trigger for reduced targets. Laura Totten (USACE) will send the Word version of measures and strategies to refine the notes and provide other recent updates. Jen Henggeler (USACE) asked if a benefit was found with the drought tournament in the Neosho Basin. Nate Westrup (KWO) said the response was good but did not gain much knowledge from it. It was a big lift to put it together but was an education and outreach tool.

b. Conservation Measures – Modification to Low Flow Targets
    i. Laura Totten (USACE) asked what triggers conservation measures. The state has measures related to reservoir storage or elevation levels that are considered. It seems most useful on a case-by-case basis depending on multiple factors. They would not unilaterally impose conservation measures.
    ii. USACE suggested no action related to drought contingency (e.g., reduction in downstream targets) until the reservoirs are below multipurpose pool level. The USACE/state would likely need more modeling; perhaps storage should be considered rather than sedimentation, but there may not be much historical information available. Identifying the triggers is important. The approach could also use the drought monitor rather than reservoir storage. Drought contingency

plans are separate but still associated with Water Control Manual updates. The USACE will want to understand what the state would like to consider for drought contingency. The primary need is what are the triggers to begin implementation of drought contingency measures. Also need to understand how the target flows were established. KWO has a document with this information and will send to USACE.

c. Resiliency Planning
    i. Comprehensive climate plan/extreme event planning/drought resiliency plan – USACE asked is there still a need for this or could it be screened out for the watershed study.
    ii. There is a state climatologist and other planning processes related to this, but there is not an official state climate action plan. The measures related to resiliency planning came about during flood resiliency discussion, but the climate plan and drought resiliency plan should be part of the water supply. This measure may come off the list but can be discussed at a later date. Other measures may already include pieces of this measure (e.g., drought contingency planning, hazard mitigation planning).
d. Sediment Reduction Measures
    i. Sediment reduction measures are being taken, or are proposed, to maintain the water supply, recreation benefits, etc. in the basin. There are risks related to water supply in the sedimentation and erosion risk assessment and are described in the notes from that meeting.
e. Water Storage Measures
    i. New water storage measures reflect lots of opportunities to enhance the recharge of the aquifers. Josh Olson (KWO) suggested that the Kansas River modeling of the alluvial aquifer with the Kansas Geological Survey will support this and help to discover where those opportunities exist. This modeling will be complete in approximately three years then implementation or studying in more detail could be done. The model will provide preliminary information on the areas to focus on consideration of enhance artificial recharge. The model could also be used for selection of locations for ecosystem restoration. The state does not need to wait for the model to be completed to start using the data but need a study to identify the appropriate places to look at enhanced recharge of the alluvial aquifer. This will be added to the list of measures for the study. Where there was a deauthorized project (e.g., federal reservoir or a smaller state reservoir project) there could be good locations to do enhanced recharge of the aquifer. There is interest in reallocation to water supply at Harlan County Reservoir. There has been discussion to build another dam on the river. Half of the storage has been allocated to irrigation water supply for the Bostwick Irrigation District, the other half to USACE storage for recreation. Could the elevation be dropped to have an additional supply to allocate? The use in Kansas would be primarily for

irrigation support. A USACE reallocation study at Harlan County was suggested and changes will be made to the description of the measure and carried forward as a recommendation for the watershed study. Further study needs to be done to understand how reallocation could work between Kansas and Nebraska entities. The study team will work together to determine how to frame the recommendation.

f. State Water Plan
    i. The state should think of whether there are any goals from the State Water Plan that they want to include in the watershed study measures list and provide the information to USACE.

VII. Do-outs / Next Steps

a. Participants to review draft risk assessment for water supply for each RPA and provide comments and additional input to USACE.
b. USACE to compile and finalize information on risk and uncertainty and provide to participants for review and comment.
c. Conduct Draft Recommendations Workshop.
d. Working Group Meetings
    1. Jan 13 – Ecosystem and Species (complete)
    2. Feb 3 - Flood Risk (complete)
    3. Feb 15 – Sediment and Erosion (complete)
    4. Feb 21 – Water Supply (today)
    5. Feb 27 – Recreation (rescheduled from Feb 13 to February 27)
    6. March 3 – Water Quality

SEDIMENTATION AND EROSION

Kansas River Reservoirs Flood and Sediment Study

MEETING NOTES

DATE: Wednesday, February 15, 2023
TIME: 1:00 – 4:00 pm
LOCATION: In-Person / Teleconference
SUBJECT: Sedimentation / Erosion Working Group Meeting

Location:
Kansas Water Office
900 SW Jackson Street, Suite 404
Large Conference Room
Topeka, KS 66612

Webex Info:
https://usace1.webex.com/usace1/j.php?MTID=mcff27b35ad4e062f8a46fc6fb4062fc1
844-800-2712
Meeting Number: 2760 511 0765
Meeting Password: 9wPqxjsT?68

Invitees (attendees in bold):

Kansas Water Office

Matt Unruh, Assistant Director; Nate Westrup, Manager – Public Water Supply Programs; Josh Olson, Project Management Lead; Kirk Tjelmeland, Field Services Coordinator; **Richard Rockel, Technical Services Lead; Amelia Nill, Regional Planning and Outreach Coordinator; Lauren Campbell, Regional Planning and Outreach Coordinator**

Kansas Department of Wildlife, Parks and Tourism

Steve Adams, Chief of Planning; John Reinke, Fisheries Biologist; Jordan Hofmeier, Aquatic Ecologist; Mark VanScoyoc, Survey Coordinator, Ecologist

U.S. Army Corps of Engineers

Laura Totten, Planner/Project Manager; Jennifer Henggeler, Risk and Communications Section Chief; Jeff Tripe, Plan Formulation Section Chief; **Ginger Harper, Planner/Communications/Outreach; Julie MacLachlan, Communications/Outreach; Brian Twombly, Engineer; John Shelley, Engineer**; Marvin Boyer, WQ Program Coordinator; Noah Colby George, Economist; Kara Cline, Engineer

Others

Aaron Deters, Kansas Alliance for Wetlands and Streams; Chris Thorton, Ducks Unlimited; Matt Hough, Ducks Unlimited; Jason Sweet, Juniper Environmental

MEETING NOTES

I. **Purpose and Desired Outcomes**

a. Purpose and Desired Outcome of Problem Area Meetings

i. Conduct and complete Risk Assessment and Evaluation to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study for each problem area (i.e., Flood Risk, Sedimentation and Erosion, Reduction in the Ability to Meet Water Supply Demands, Degraded/Poor Water Quality, Ecosystem Degradation and Species Impact, Loss of Recreation Opportunities) for 5 planning areas - Kansas Regional Planning Area (RPA),

Solomon-Republican RPA, Smoky Hill Saline RPA, Upper Republican RPA, Upper Smoky Hill RPA.

ii. Review process for Uncertainty Assessment of Stressors

iii. Review of existing list of measures and strategies

b. Purpose and Desired Outcome of Recommendations Workshop

i. Using information from problem area meetings, hold a 1-day workshop to develop draft recommendations for all problem areas.

1. Identification of near-term and long-term actions / projects, evaluations, and data needs for each problem area and associated stressors.
2. Framing of Draft Recommendations for each problem area that includes details related to rough order of magnitude costs, potential funding sources, potential partners, and priority areas within the RPAs.

II. Study Accomplishments

a. The Project Management Plan was developed.

b. A Shared Vision Statement and Objectives were developed.

c. The team has conducted extensive stakeholder and public outreach throughout the basin.

d. The team has completed acquisition and analysis of comprehensive datasets and information related to hydrologic conditions, hydraulics, sediment transport, economic data, water supply demand and uses, recreation benefits, biological resources, and cultural resources in the basin.

e. A framework has been developed to perform a comprehensive assessment of existing conditions and expected future conditions, enabling development of a strategic roadmap to inform future investment decisions by multiple parties and to better account for uncertainty.

f. Assessments and Technical Reporting for Existing Conditions and FWOP for reservoir sediment, reservoir operations, climate change, flow frequency, flood risk, water supply, water quality, biological resources, and recreation are complete.

g. Measures have been developed to address issues related to flood risk, sedimentation and erosion, ability to meet water supply demands, degraded/poor water quality, ecosystem degradation and species impact, and loss of recreation opportunities.

h. The Shared Vision Milestone was successfully completed.

III. Risk Assessment and Evaluation

a. Kansas River Reservoirs Flood and Sediment Study Sediment Assessments

i. Laura Totten (USACE) and John Shelley (USACE) shared results of the Reservoir Sediment Assessment (see slides attached); the map shows percent multipurpose pool remaining at the end of 2024, 2049 (25 years), 2074 (50 years) and 2124 (100 years). Overall, the USACE

reservoirs will have lost 407,117 acre-feet of storage in 100 years. Attempting to quantify the impacts in terms of economic consequences as the reservoir storage continues to decline. John Shelley (USACE) explained the delta progression and the bed and bank degradation downstream from USACE lakes (see slides attached).

b. Process Overview
    i. Laura Totten (USACE) explained the process of Risk and Uncertainty Assessment. She also sent stressors document prior to the meeting for review.
c. Problems and Stressors
    i. Laura Totten (USACE) reviewed the list of stressors and asked if anything is missing to share so the list can be amended. Sediment is managed because it impacts so many other aspects – water supply, recreation, habitat, etc., for example (see file attached).
d. Qualitative Probability and Consequence Evaluation
    i. Risk Categories
        1. Economic Risk – The likelihood and consequences of harm/damage to property, infrastructure, and other assets, as well as economic systems (measured in monetary terms).
        2. Social – The likelihood and consequence of loss of social connectedness, adverse effects to disadvantaged communities, displacement of individuals, ability for subsistence (ability of individuals/communities to be self-sustaining – reliance on natural resources to support a community and livelihoods).
        3. Environmental – The likelihood and consequence of ecosystem services impacts (the various benefits provided by certain environmental and natural resources to communities), habitat loss, and species loss.
        4. Life Loss / Life Safety – The likelihood and consequence of the stressor occurring and subsequent life loss or risks to public safety including emergency preparedness.
            a. Risk and probability metrics are being simplified based on discussion and feedback at the last meeting to communicate the information and understand the results of the analysis more easily. Laura Totten (USACE) asked for input on the revised approach and the group was in concurrence.
    ii. Focus / Opportunity Areas
        1. Kansas Regional Planning Area
            a. Laura Totten (USACE) shared the risk assessment that was pre-populated by John Shelley (USACE) for review by the group during the meeting.

b. John Shelley (USACE) explained that Stressor 6 is related to bed degradation on the Big Blue River downstream of Tuttle Creek Reservoir and the other river reaches directly below the reservoirs (i.e., Delaware River, Republican River, Wakarusa River, Smoky Hill River). We see degradation below all of the USACE reservoirs with the exception of the reach of the Saline River directly below Wilson Reservoir. Stressor 10 is related to impacts on the Kansas River Mainstream (KRM).Overall we are not seeing the KRM degrading that rapidly. Sand that erodes and comes down the Big Blue River is causing bank collapse.
c. Degradation also directly influences upstream bank stabilization from channelization. While there have been many project related to bank stabilization above Tuttle Creek Reservoir there is still substantial bank stabilization issues here and upstream of other reservoirs. Sediment loads are a lot higher and farmers are losing land due to having to re-channelize the streams. John Shelley (USACE) has data on the deposition per square mile of unregulated area. The trend shows there are more sedimentation issues on the eastern portion of the state than the western portion, but there has not been an effort for the study to tie bank stabilization measures to the rate of sedimentation. More data would be useful to help understand and address the problem. To know if something is working, a lot of continuous water quality data is needed, but going back to evaluate can be problematic because of the many variables affecting the data.
d. John Shelley (USACE) noted that some sediment is a necessary part of the ecosystem, but the study did not conduct an assessment on what the optimal level should be. However, if you stabilize using only hard measures, such as concrete-lining, you could substantially reduce some turbidity in the system that would be desired to support ecological processes.
e. Stressor 8 – Impacts to Reservoir and Dam Infrastructure/ Levees and Stressor 9 – Increased Operations and Maintenance Costs include impacts to reservoir and dam infrastructure, such as gates or other dam infrastructure, and the potential for increased costs for operations and maintenance from reservoir sedimentation. Increased sedimentation can push costs well above basic operation and maintenance costs. The group discussed combining Stressor 8 – Impacts to Reservoir and Dam Infrastructure/Levees and Stressor 9 – Increased Operations and Maintenance Costs.

f. Tuttle Creek and Perry Reservoirs rank the highest in future sedimentation and future loss of multipurpose pool capacity. Watersheds upstream of these lakes are highly altered and not stable.
g. John Shelley (USACE) suggested that the placement of Stressor 10 – Impacts to the KRM should be moved to the lower left corner of the matrix in the Kansas RPA Economic Risk Assessment.
h. The group discussed the challenge of determining the economic impact of these stressors and not knowing the impact on the fisheries industry on the mainstream river. One participant suggested that the grandest economic impacts could be tied to Stressor 7 – Reduced Flood and Water Supply Storage in Reservoirs, and that this stressor has connections to other impacts – recreation, water supply, etc.
i. Laura Totten (USACE) referenced environmental justice (EJ) and high level Council on Environmental Quality (CEQ) map overlays of disadvantaged communities. It was also noted that federal agencies must consider disadvantaged communities and that this study will assess the impact on those communities. John Shelley (USACE) added that streambank erosion will impact adjacent farmers and operation and maintenance costs will trickle down to the individual rate payers, contributing to the social risk of sedimentation.
j. Environmental Risk: John Shelley (USACE) shared that if Tuttle Creek Reservoir doesn't have much of a multipurpose pool from future sedimentation, water is essentially passed through the reservoir to the downstream river reaches and would likely have no to low impact. Brian Twombly (USACE) added that current low flows would be lower, which would be more natural, while the flood control would be similar to existing conditions. Nate Westrup (KWO) added there is an environmental benefit to diluting drinking water contaminants with a higher flood pool. The group discussed moving the placement of Stressor 7 – Reduced Flood and Water Supply Storage in Reservoirs to high impact to be more aligned with Stressor 11 – Degraded Environmental Resources and Loss of Recreation.
k. Life Loss / Life Safety Risk Assessment: The group discussed moving all stressors except for Stressor 7 – Reduced Flood and Water Supply Storage in Reservoirs to the lower left quadrant. Brian Twombly (USACE) shared that the gates would remain operational to prevent life loss, but it may cost more to keep them operational with increased sediment. The existing conditions assessment

for life safety shows high life safety risk under the 100-year and 500-year event. The risk increases slightly in the 100-year projection with the sediment for reduced flood and water supply storage in reservoirs. There was not an increase in surcharge events in the future projections but more than likely a drought event will occur that will stress the system. An event like 1951 in the future could stress the system. Brian Twombly (USACE) concurred with the placement of the stressors on the matrix as a moderate chance of occurring with a moderate consequence.

I. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Kansas RPA are shown below (Figure 1 through Figure 4). The notes included in the matrix by subject matter expert John Shelley (USACE) are also include below each table.

			Economic Risk Assessment Results				
Problem	Stressor	Number	Probability				
Sedimentation / Erosion	Bed Degradation Downstream of Reservoirs	6		Likely to Occur	10	8 9	6 7 12 11
	Reduced Flood and Water Supply Storage in Reservoirs	7		Moderate Chance of Occurring			
	Impacts to Reservoir and Dam Infrastructure / Levees	8					
	Increased Operations and Maintenance Costs	9		Not Likely to Occur			
	Impacts to the Kansas River Mainstem	10					
	Degraded Environmental Resources and Loss of Recreation	11			No to Low Impact	Moderate Impact	High Impacts
	Streambank Erosion	12			Consequence		

Figure 1. Kansas RPA Economic Risk Assessment

Notes: All these stressors are likely to occur. 6- Bed degradation has been observed downstream from Clinton, Perry, and Tuttle. In addition to land loss, specific infrastructure damages are likely. 7- Tuttle Creek Lake and Perry Lake are numbers 1 and 3 in the basin for the projected loss of multipurpose pool storage. 8- More frequent filling and emptying of the flood pool will equate to accelerated erosion of the shoreline. 9- Lake O&M will begin to require targeted sediment removal. 10- Kansas River Mainstem has several locations with bank instability that are likely to continue to erode, though the consequences of such erosion will be localized. 11- Almost total loss of multipurpose pool at Tuttle Creek Reservoir and significant loss at Perry Reservoir that could lead to reduction in recreation. 12- Watersheds upstream of the lakes are highly altered and unstable. Significant bank erosion, head cutting, etc. as a result of prior channelization. Landowners will continue to lose land and the eroded sediment will accumulate in downstream lakes.

Kansas River Reservoirs Flood and Sediment Study

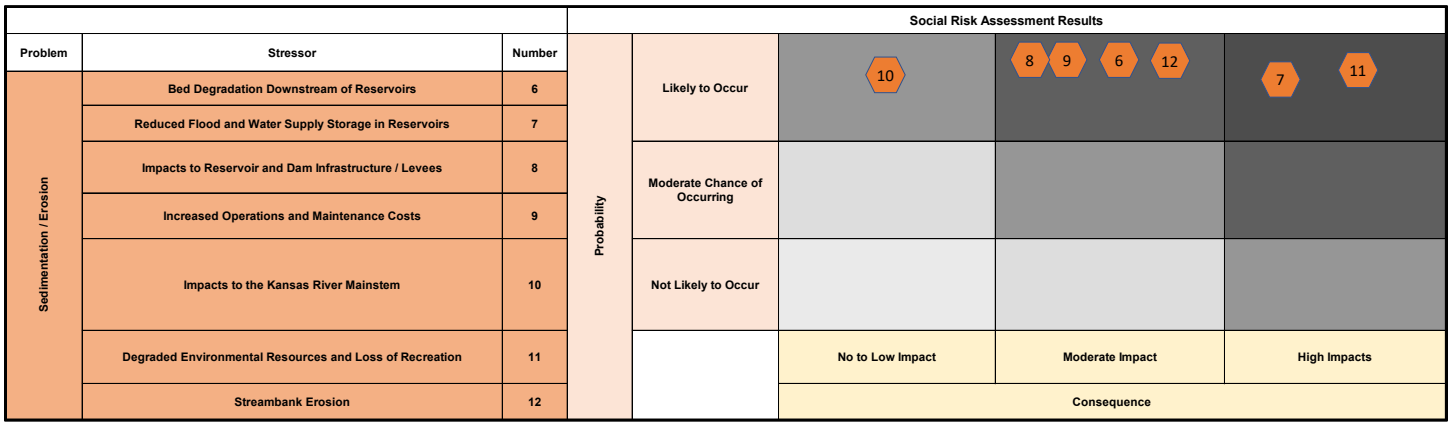


Figure 2. Kansas RPA Social Risk Assessment

Notes: All stressors are likely to occur. 11- Lake recreation supports many local businesses and provides inexpensive, nearby recreation to rural Kansans. 12- Streambank erosion = land loss for upstream farmers.

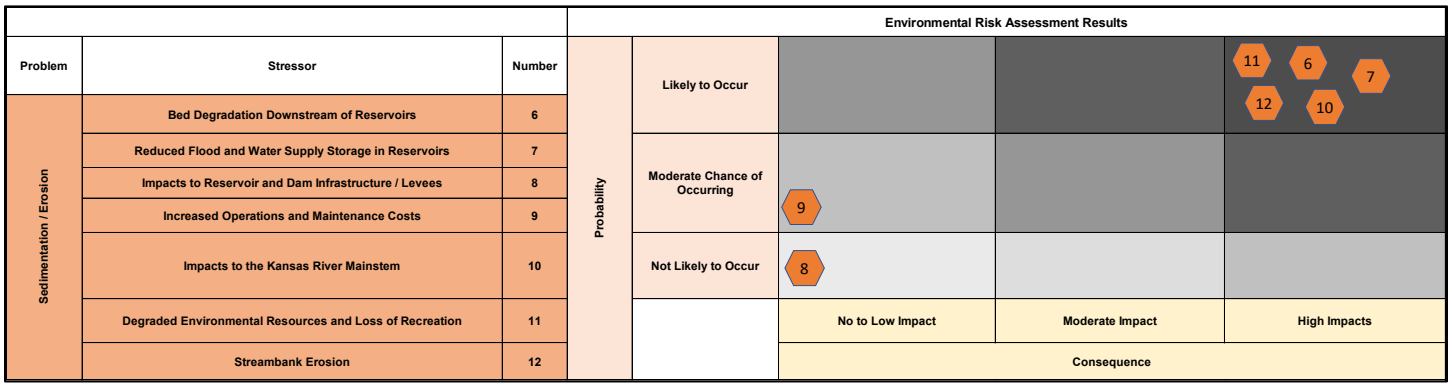


Figure 3. Kansas RPA Environmental Risk Assessment

Notes: 6- Degradation downstream from dams leads to disconnected floodplains. 10- Turbidity levels in the Kansas River will increase over time but will still remain significantly decreased in the future compared to a "no dam" condition, which favors non-native site-feeding fish over native prairie fish. 11-Virtually complete loss of lake fishery at Tuttle Creek Lake, although it would be a shift to a different habitat type which could have value for migratory birds. Other lakes would see disconnected cove habitats. 12-Aggressively eroding banks, particularly eroding farm fields, have less shade and cover and less hydraulic variability. There are hundreds of eroding banks in the entire RPA. 8-Increased O&M costs are unlikely to have an environmental impact.

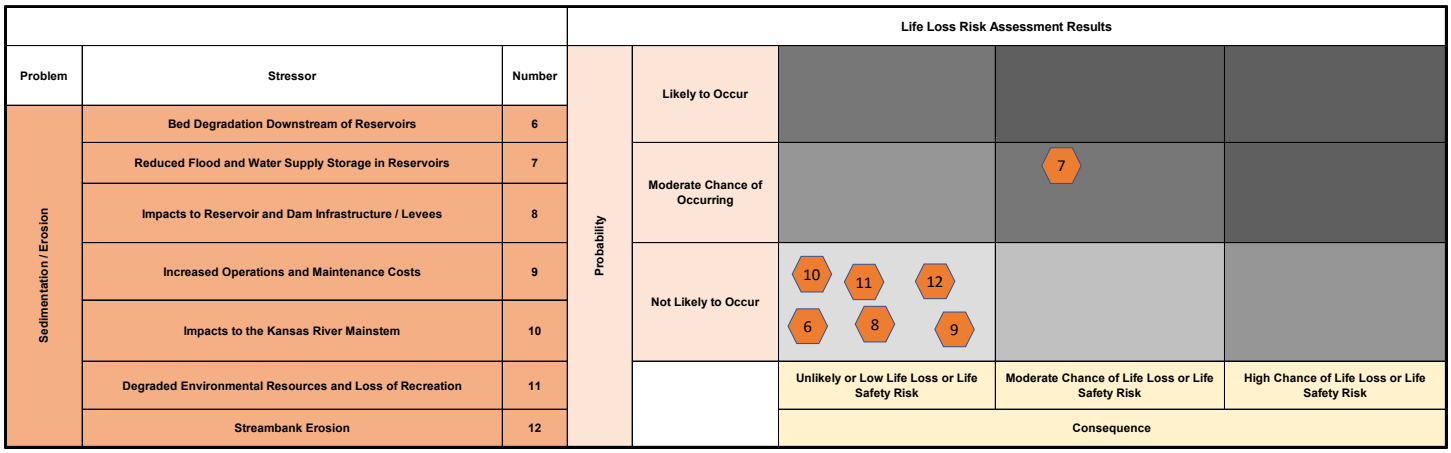


Figure 4. Kansas RPA Life Loss Risk Assessment

Notes: Most of these stressors are likely to occur but would not have independent impacts of life loss and safety risk. Assume if there are impacts they would be reflected in the flood risk metrics.

2. Solomon-Republican Regional Planning Area
    a. Laura Totten (USACE) suggested that most risk categories will mirror the Kansas RPA assessment; the group concurred.
    b. One major difference is the likelihood of flooding in this area and the impacts of Stressor 7 – Reduced Flood and Water Supply Storage in Reservoirs.
    c. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Solomon-Republican RPA are shown below (Figure 5 through Figure 8).

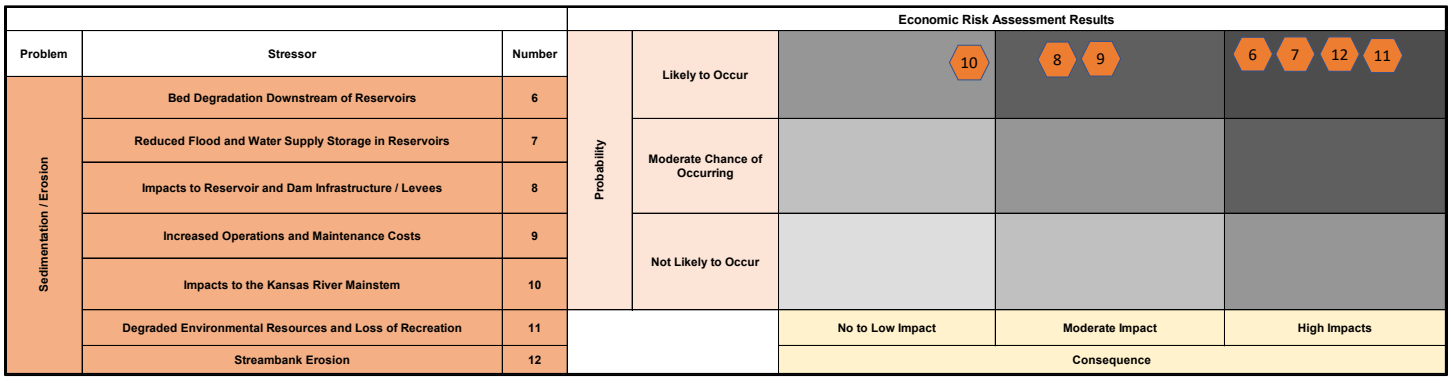


Figure 5. Solomon-Republican RPA Economic Risk Assessment

Notes: All these stressors are likely to occur. 6- Bed degradation likely to continue downstream from Waconda Reservoir. In addition to land loss, specific infrastructure damages are likely. Moreover, the high, in-bank flows released as part of flood control operations exacerbate toe erosion and kill vegetation that otherwise could provide stability. 7- Waconda

Reservoir is projected to be 43% full of sediment by 2124. 8- More frequent filling and emptying of the flood pool will equate to accelerated erosion of the shoreline. 9- Lake O&M will require more frequent sediment removal. 10- Mainstem Kansas River does not occur in this RPA 11- Loss at Waconda Reservoir leads to reduction in recreation. 12- Watersheds upstream of the lakes are highly altered and unstable. Significant bank erosion, head cutting, etc. as a result of prior channelization. Landowners will continue to lose land and the eroded sediment will accumulate in downstream lakes.

			Social Risk Assessment Results			
Problem	Stressor	Number	Probability			
Sedimentation / Erosion	Bed Degradation Downstream of Reservoirs	6		Likely to Occur	10	8, 9, 6, 12	7, 11
	Reduced Flood and Water Supply Storage in Reservoirs	7		Moderate Chance of Occurring			
	Increased Operations and Maintenance Costs	9					
	Impacts to the Kansas River Mainstem	10		Not Likely to Occur			
	Degraded Environmental Resources and Loss of Recreation	11			No to Low Impact	Moderate Impact	High Impacts
	Streambank Erosion	12			Consequence		

Figure 6. Solomon-Republican RPA Social Risk Assessment

Notes: All stressors are likely to occur. 11- Lake recreation supports many local businesses and provides inexpensive, nearby recreation to rural Kansans. 12- Streambank erosion = land loss for upstream farmers.

			Environmental Risk Assessment Results			
Problem	Stressor	Number	Probability			
Sedimentation / Erosion	Bed Degradation Downstream of Reservoirs	6		Likely to Occur	7, 8, 9		11, 6, 12, 10
	Reduced Flood and Water Supply Storage in Reservoirs	7		Moderate Chance of Occurring			
	Impacts to Reservoir and Dam Infrastructure / Levees	8					
	Increased Operations and Maintenance Costs	9					
	Impacts to the Kansas River Mainstem	10		Not Likely to Occur			
	Degraded Environmental Resources and Loss of Recreation	11			No to Low Impact	Moderate Impact	High Impacts
	Streambank Erosion	12			Consequence		

Figure 7. Solomon-Republican RPA Environmental Risk Assessment

Notes: 6- Degradation downstream from dams leads to disconnected floodplains. 10- Kansas River Mainstem does not occur in this RPA. 11-Signficiantly decreased fishery at Waconda Reservoir. 12-Aggresively eroding banks, particularly eroding farm fields, have less shade and cover and less hydraulic variability. There are hundreds of eroding banks in the entire RPA.

			Life Loss Risk Assessment Results			
Problem	Stressor	Number	Probability	Likely to Occur		
Sedimentation / Erosion	Bed Degradation Downstream of Reservoirs	6				
	Reduced Flood and Water Supply Storage in Reservoirs	7		Moderate Chance of Occurring		
	Impacts to Reservoir and Dam Infrastructure / Levees	8				
	Increased Operations and Maintenance Costs	9		Not Likely to Occur	10, 11, 8, 7, 6, 9, 12	
	Impacts to the Kansas River Mainstem	10				
	Degraded Environmental Resources and Loss of Recreation	11			Unlikely or Low Life Loss or Life Safety Risk	Moderate Chance of Life Loss or Life Safety Risk / High Chance of Life Loss or Life Safety Risk
	Streambank Erosion	12			Consequence	

Figure 8. Solomon-Republican RPA Life Loss Risk Assessment

Notes: Stressors are unlikely to occur and unlikely to cause an independent life loss and safety risk. Assume if there are impacts from flood control they would be reflected in the flood risk metrics.

3. Smoky Hill-Saline Regional Planning Area
    a. This RPA includes Kanopolis Reservoir and Wilson Reservoir (owned and operated by USACE) and a few U.S. Bureau of Reclamation reservoirs.
    b. Stressor 10 – The KRM does not occur in this RPA.
    c. Kanopolis provides substantial flood risk benefits and protection to the downstream reaches and to Salina, Kansas.
    d. The state receives a high number of concerns and complaints on erosion and streambank stabilization in the reaches of the Smoky Hill River below Kanopolis Reservoir. Irrigators along the Smoky Hill River are having to go deeper and deeper to get their pumps set.
    e. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Solomon-Republican RPA are shown below (Figure 9 through Figure 12).

Kansas River Reservoirs Flood and Sediment Study

Problem	Stressor	Number
Sedimentation / Erosion	Bed Degradation Downstream of Reservoirs	6
	Reduced Flood and Water Supply Storage in Reservoirs	7
	Impacts to Reservoir and Dam Infrastructure / Levees	8
	Increased Operations and Maintenance Costs	9
	Impacts to the Kansas River Mainstem	10
	Degraded Environmental Resources and Loss of Recreation	11
	Streambank Erosion	12

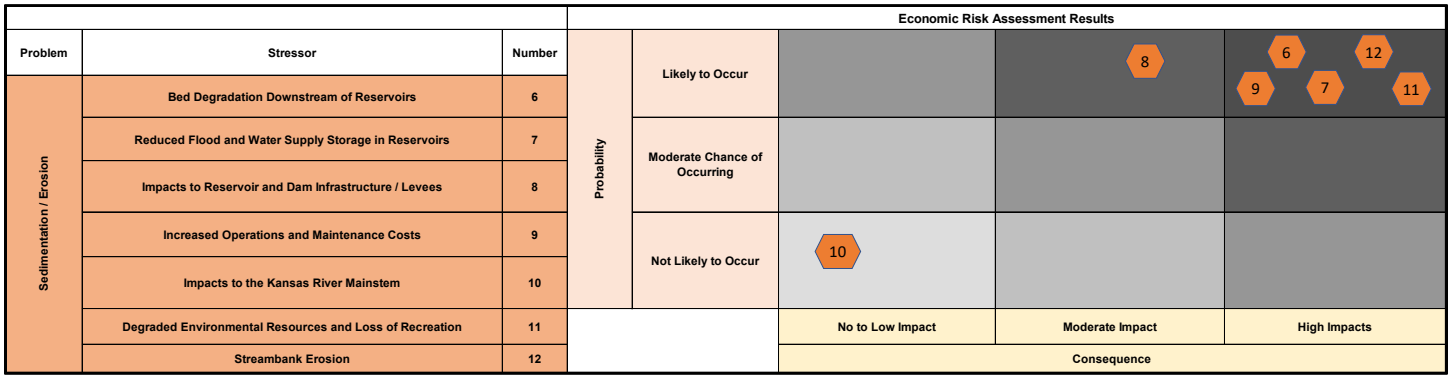


Figure 9. Smoky Hill-Saline RPA Economic Risk Assessment

Notes: Most of these stressors are likely to occur. Stressor 6- Bed degradation has been observed downstream from Kanopolis Reservoir. In addition to land loss, specific infrastructure damages are likely. Moreover, the high, in-bank flows released as part of flood control operations exacerbate toe erosion and kill vegetation that could provide stability. Stressor 7- Kanopolis Lake is number 2 in the basin for projected loss of multipurpose pool storage. Stressor 8- More frequent filling and emptying of the flood pool will equate to accelerated erosion of the shoreline. Kanopolis Reservoir has known shoreline erosion issues. Stressor 9- Lake O&M will require more frequent sediment removal. Kanopolis Reservoir has already seen two such O&M actions. Stressor 10- Kansas River Mainstem is not in the RPA. Stressor 11- Significant loss at Kanopolis Reservoir leads to reduction in recreation. Stressor 12- Watersheds upstream of the lakes are highly altered and unstable. Significant bank erosion, head cutting, etc. as a result of prior channelization. Landowners will continue to lose land and the eroded sediment will accumulate in downstream lakes.

Problem	Stressor	Number
Sedimentation / Erosion	Bed Degradation Downstream of Reservoirs	6
	Reduced Flood and Water Supply Storage in Reservoirs	7
	Increased Operations and Maintenance Costs	9
	Impacts to the Kansas River Mainstem	10
	Degraded Environmental Resources and Loss of Recreation	11
	Streambank Erosion	12

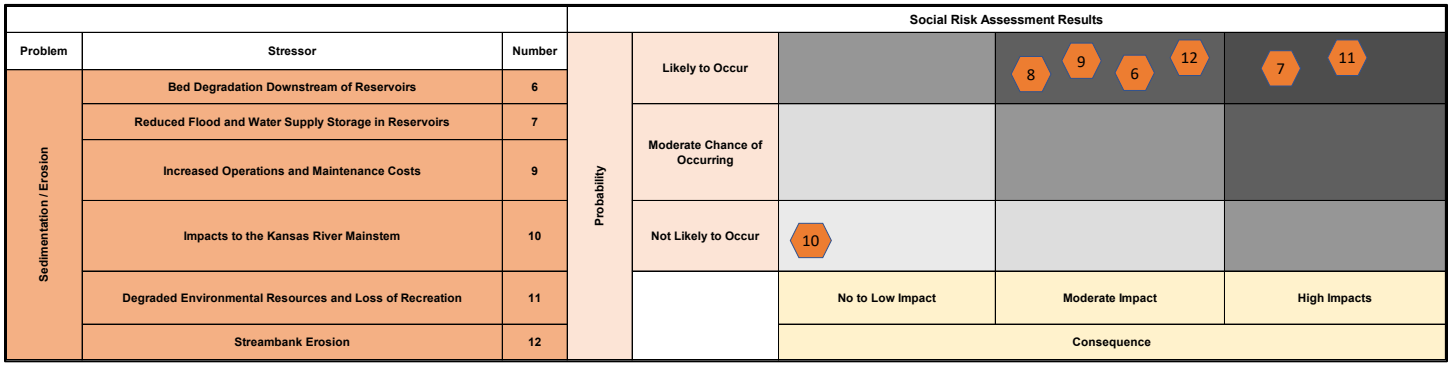


Figure 10. Smoky Hill-Saline RPA Social Risk Assessment

Notes: Stressors 7, 8, 9, 11, and 12 are likely to occur while Stressor 10 is unlikely to occur. Stressor 11- Lake recreation supports many local businesses and provides inexpensive, nearby recreation to rural Kansans. Stressor 12- Streambank erosion = land loss for upstream farmers.

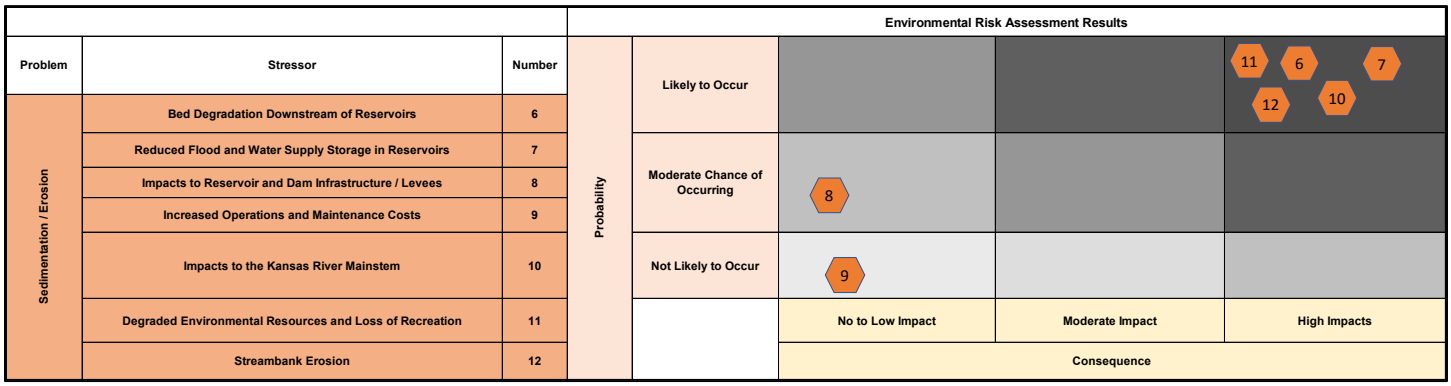


Figure 11. Smoky Hill-Saline RPA Environmental Risk Assessment

Notes: Stressor 6- Degradation downstream from dams leads to disconnected floodplains. Stressor 10- The KRM does not occur in this RPA. Stressor 11-Signficantly decreased fishery at Kanopolis Reservoir. Stressor 12-Aggresively eroding banks, particularly eroding farm fields, have less shade and cover and less hydraulic variability. There are hundreds of eroding banks in the entire RPA.

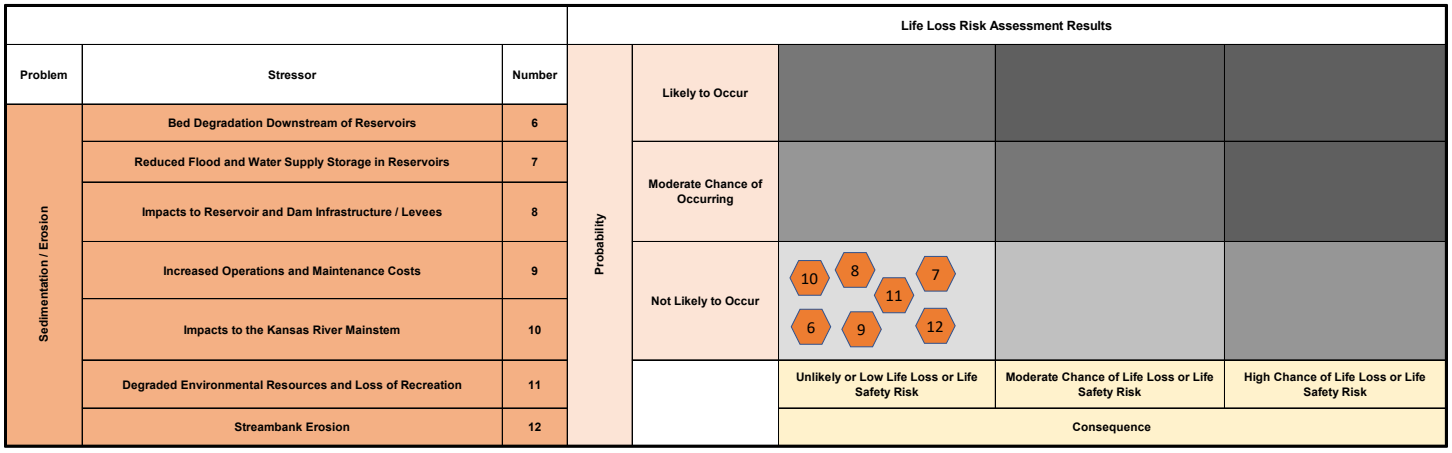


Figure 12.Smoky Hill-Saline RPA Life Loss Risk Assessment

Notes: Stressors are unlikely to cause an independent life loss and safety risk. Assume if there are impacts from flood control they would be reflected in the flood risk metrics.

4. Upper Republican and Upper Smoky Hill Regional Planning Areas
    a. There are no USACE reservoirs in these RPAs.
    b. RPAs #4 and # 5 are combined in the assessment as there are small private levies and fishing reservoirs. They do not have the flows that other RPAs have. Stressors 6-10 are not applicable in these RPAs but streambank erosion does

occur here. Stressors 11 and 12 are applicable here. There is recreation and enjoyment of natural resources on tributaries and river reaches in these RPAs.

c. Invasive species are included in the ecosystem topic, which could include phragmites specifically.

d. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Upper Republican RPA and the Upper Smoky Hill RPA were combined as the risks are highly similar and are shown below (Figure 13 through Figure 16).

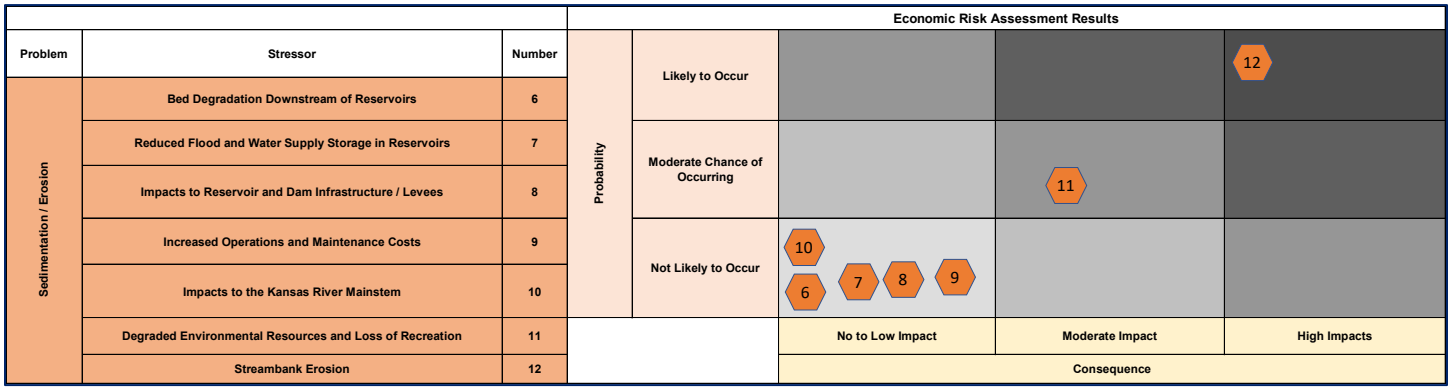


Figure 13. Upper Republican-Upper Smoky Hill RPAs Economic Risk Assessment

Notes: Stressors 6,7,8,9,10 – N/A as no reservoirs in these RPAs. Stressors 11 and 12- Many eroding streambanks and impacts to environmental resources and recreation opportunities. Potential for infrastructure damage as well as agricultural land loss.

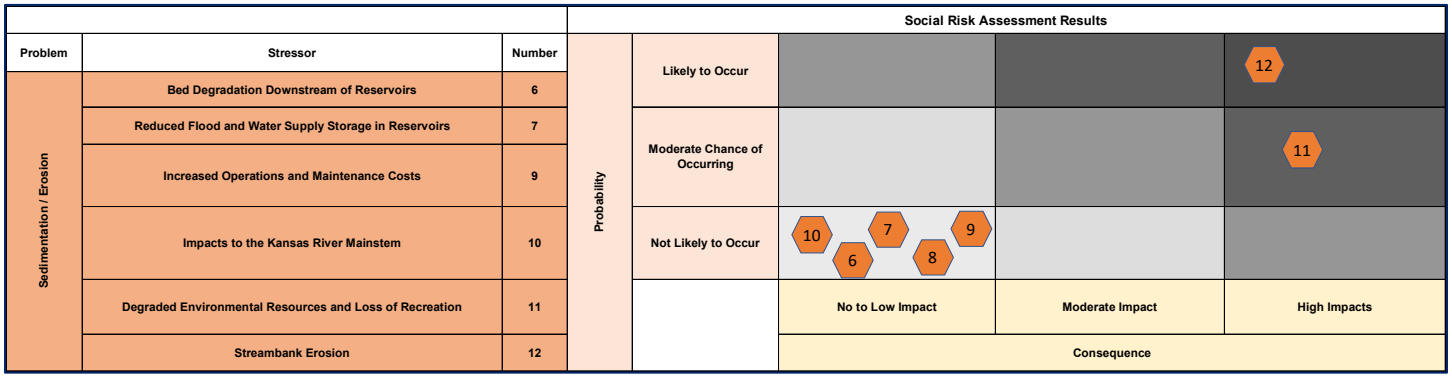


Figure 14. Upper Republican-Upper Smoky Hill RPAs Social Risk Assessment

Notes: Stressors 6,7,8,9,10 – N/A as no reservoirs in these RPAs. Stressors 11 and 12- Many eroding streambanks and impacts to environmental resources and recreation opportunities.

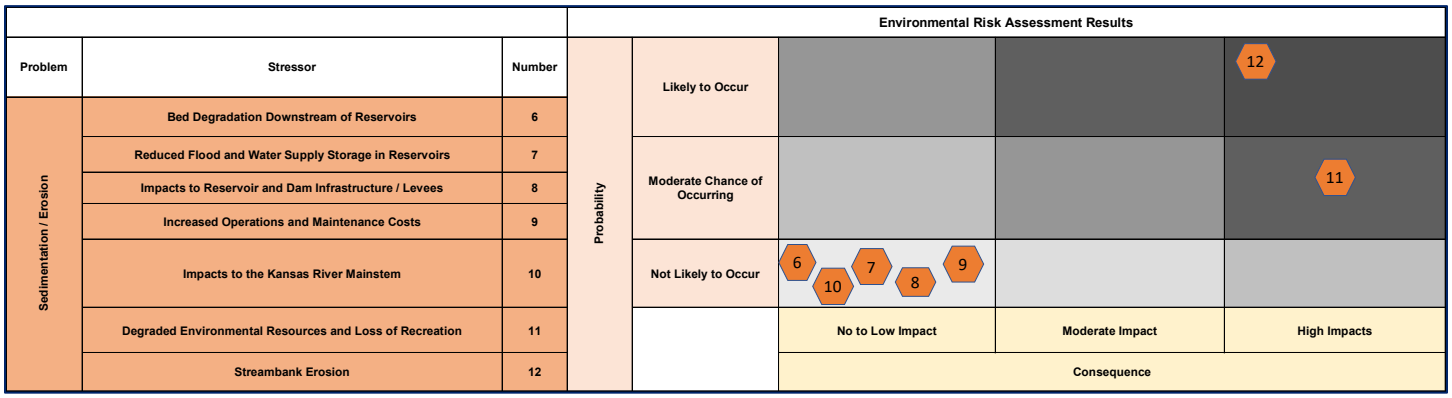


Figure 15. Upper Republican-Upper Smoky Hill RPAs Environmental Risk Assessment

Notes: Stressors 6,7,8,9,10 – N/A as no reservoirs in these RPAs. Stressors 11 and 12— Many eroding streambanks and impacts to environmental resources and recreation opportunities.

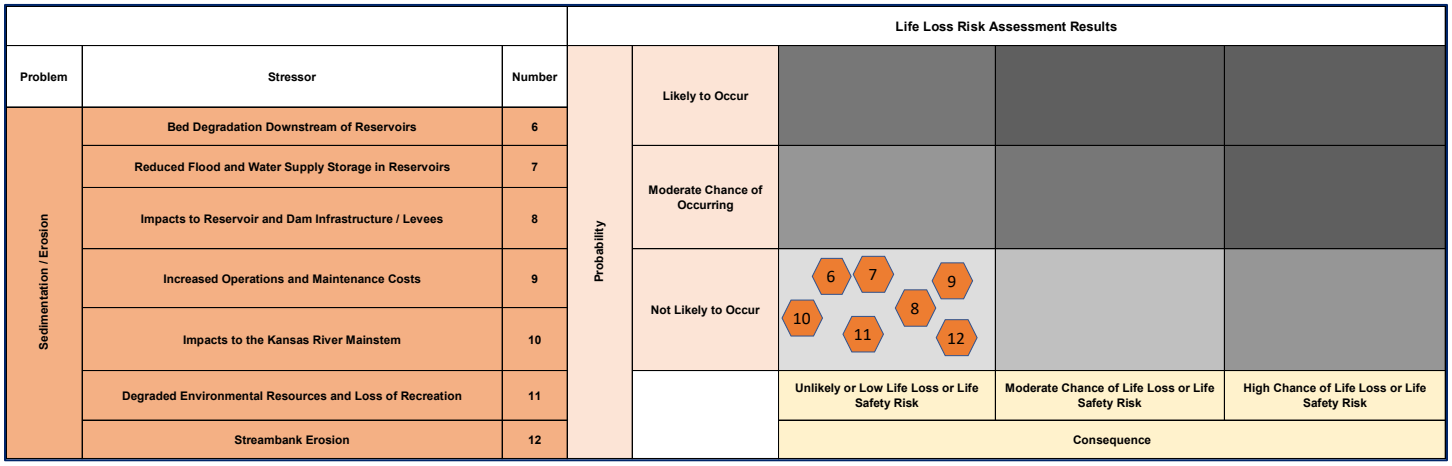


Figure 16. Upper Republican-Upper Smoky Hill Life Loss Risk Assessment

Notes: Stressors are unlikely to cause an independent life loss and safety risk. Assume if there are impacts from flood control they would be reflected in the flood risk metrics.

iii. The group concurred that pre-populating the matrices before the meeting is helpful to the group to react to rather than populating during the meeting. Laura Totten (USACE) is working with subject matter experts to prepopulate by topic area for the remaining 3 meetings.

IV. Uncertainty Analysis

a. Qualitative assessment of uncertainty to identify the level of consensus among stakeholders in implementing potential risk reduction measures for each stressor.

b. Categories
    i. Action – Implementable solutions with a high level of consensus to address a given stressor
    ii. Evaluation Options – Potential solutions defined with existing information
    iii. Fill Data Gaps – Additional data would be required to better define the problem and/or identify potential solutions
c. Supports development of a framework for the appropriate types of and timing for recommendations to help prioritize actions.
    i. Categorize each stressor or parts of a stressor under the appropriate level of uncertainty.
        1. Near-term Actions – Stressors with a high level of risk (e.g., high probability and high consequence) could require immediate steps to reduce risks through actions, evaluation, or filling data gaps.
        2. Incremental Actions – Stressors with less risk (e.g., moderate probability and temporary impacts) could be considered as a lower priority that do not require immediate steps.

V. Measures

a. Review and refinement of existing measures for sedimentation and erosion.
    i. Laura Totten (USACE) reviewed initial measures related to sedimentation and erosion. The group was asked if there are any ideas for revision or additions to the list of measures. Additionally are there any more site specific details that could be added.
    ii. John Shelley (USACE) has done a lot of work on sediment management measures. Laura Totten (USACE) noted that these measures have impacts across several areas and reviewed sediment and erosion measures related ecosystem restoration and management.
    iii. Laura Totten (USACE) asked the group to provide input on priorities to include more detail in the strategies to accomplish measures.
    iv. John Shelley (USACE) shared sedimentation impacts and measures and discussed additional information related to degradation downstream of reservoirs (see slides attached).
    v. John Shelley (USACE) shared several different approaches to streambank stabilization measures (i.e., hard structures versus more nature-based solutions).
    vi. One new measure could include low-tech stream stabilization (cedar tree revetments). Not enough data was obtained to assess the effectiveness of new low-tech stream stabilization to reduce sedimentation. John Shelley (USACE) shared some information on hotspots in the basin and showed an example of stabilizing all of the known hotspots and the percent of annual accumulation of sediment to Tuttle Creek Reservoir this could reduce. The amount is approximately 2.4% annually of all sediment received in Tuttle Creek Reservoir.
    vii. Other sources of sediment in reservoirs is from head cutting in the watershed.

viii. John Shelley (USACE) provided information on the channel evolution process and the trend we are seeing in the basin.

ix. Other potential solutions for channel instability includes rock riffles and/or creating stream/wetland complexes.

x. Stream/wetland complexes (or Stage Zero) could be created in the upper watershed that would provide sediment reduction and also provide other benefits (i.e., water quality benefits, habitat, etc.). Would provide habitat units that could make them a likely candidate for federal project funding (e.g., CAP Section 206 or Section 1135). These projects significantly increase acreage of riverine, wetland, and riparian habitat while slowing down water through an area. They can be constructed with woody debris structures that slow water and encourage overbank flow. Engineered rock riffles could be installed at the downstream end to prevent head cutting. It was noted that on a watershed scale it would require hundreds of these types of projects to make a meaningful reduction in the current sedimentation occurring and is not a replacement for the need for in-lake solutions for sediment management. NRCS is implementing some of these in the region with support from the Kansas Alliance of Wetland and Streams (KAWS) and Ducks Unlimited (DU). The practice is currently an NRCS Equip Program practice. Permitting should be considered a factor in future programming. Events to build more of these are planned in March and October. The October event will be a workshop hosted in Manhattan, Kansas, for about 50 agency attendees to attend education sessions and participate in a small build project, which hopefully will include a pre-build survey and monitoring device.

xi. Looking ahead to the measures and strategies to reduce sedimentation, these questions were posed to the group.

1. Where: Brian Twombly (USACE) suggested that the aquifer recharge benefit would be valuable in the western regions and probably valuable in the middle regions too.
2. Matt Unruh (KWO) shared that a huge question to ask, particularly if the benefits are watershed-wide, it is important for the state to know where the needs are. Efforts to show where the benefits of projects would be maximized would be very helpful in further communicating the need and the value of spending money on these efforts. This is extremely helpful in partnership building. This could be a study recommendation to conduct an assessment of “where the need is” in order to maximize the benefits for the costs. There should also be consideration of goal and what level of effort would be needed (or acreage, needed load reduction, etc.). However, additional studies may need to be done to determine the overall goal, sites, and priorities to optimize the benefits. The RACs and some of the 9-element WRAPS plans set goals for sediment reduction. We

could determine how a set goal for sediment reduction could reduce the amount of overall sedimentation that would occur in the future. Determine how the sediment projections from the Watershed Study would improve (e.g., graph/table).

3. The recommendation could also be to assess what it would take to get reservoir sedimentation to a level that is sustainable (i.e., no net increase in sedimentation). This could be a baseline point that then could have goals set that would at a minimum help the overall goal.
4. Also a recommendation for sediment management should be considered as Kanopolis Reservoir has the second highest sedimentation rate. There are users that are solely dependent on this as a water supply (e.g., Salina, Kansas). A sediment management plan could be added to the recommendations.
5. The USACE Grand River Feasibility Study is an example of a comprehensive effort to determine the level of effort/site locations needed. Laura Totten (USACE) suggested this could also be a PAS study where there would be a federal cost share. This could be a better fit for this type of assessment if a project that would lead to construction is not an option or preferred. State investments become more valuable when there are federal, private and NGO partners.
6. Who wants to partner?
7. Other measures we missed?

xii. Other discussion:

1. Projects such as these constructed by the USACE typically require fee title from landowners at sites recommended for restoration. Many rural landowners typically are not open to these types of real estate agreements causing these efforts to not move forward.
2. Future legislation may be needed to obtain federal funding for projects.
3. Laura Totten (USACE) asked how effective WRAPS projects are and how they actually become funded and implemented. The original iteration of these projects was generated heavily from NRCS engagement and some were implemented with federal funding from them. Ginger Harper (USACE) asked if USACE should ask for updates on the WRAPS plans once the USACE study is complete. This was already requested.
4. The level of connection to the watershed would determine the downstream and instream reservoir sediment management needed.
5. The RCPP program is active in the state and could contribute to funding for USACE study projects; it is likely being revised to a 50/50 partnership with a federal and a local agency. Future RCPP efforts could be done with a grants program. There was a proposal

for RCPP above Tuttle but the status is not known. Opinion of their effectiveness depends on what the measure of success is. The benefits of instream water quality benefits are unknown from these measures. This is a typical question that is asked and also how will these be continually funded. Not a good answer to these questions.

6. There was an assessment done through the USACE Silver Jackets Program – Healthy Watersheds in the Soldier Creek Watershed that estimated the amount of infiltration that could occur from using best management practices such as cover crops.
7. With the new emphasis on research and development in the USACE could we possibly recommend a reservoir, or several, as an R&D site? Possibly could think about this.

VI. Do-outs / Next Steps

a. Participants will review draft risk assessment for sedimentation and erosion for each RPA and provide comments and additional input to USACE.
b. USACE will compile and finalize information on risk and uncertainty, which will be provided to participants for review and comment.
c. Conduct Draft Recommendations Workshop.
d. Working Group Meetings
    1. Jan 13 – Ecosystem and Species (complete)
    2. Feb 3 – Flood Risk (complete)
    3. Feb 15 – Sediment and Erosion (today)
    4. Feb 21 – Water Supply – February 21
    5. Feb 27 – Recreation (rescheduled from Feb 13 to Feb 27)
    6. March 3 – Water Quality – March 3

DEGRADED / POOR WATER QUALITY

Kansas River Reservoirs Flood and Sediment Study

MEETING NOTES

DATE: Friday, March 3, 2023
TIME: 1:00 – 4:00 pm
LOCATION: In-Person / Teleconference
SUBJECT: Water Quality Working Group Meeting

Location:
Kansas Water Office
900 SW Jackson Street, Suite 404
Large Conference Room
Topeka, KS 66612

Webex Info:
https://usace1.webex.com/usace1/j.php?MTID=mce92cd699c01d1f123d17c0c359bd59f
844-800-2712
Meeting Number: 2763 630 8133
Meeting Password: FBwqFmm2*32

Attendees:

Kansas Water Office

Matt Unruh, Assistant Director; Nate Westrup, Manager – Public Water Supply Programs; **Josh Olson, Project Management Lead; Kirk Tjelmeland, Field Services Coordinator; Richard Rockel, Technical Services Lead; Amelia Nill (Regional Planning & Outreach Coordinator)**

Kansas Department of Wildlife, Parks and Tourism

Steve Adams, Chief of Planning; John Reinke, Fisheries Biologist; Jordan Hofmeier, Aquatic Ecologist; Mark VanScoyoc, Survey Coordinator, Ecologist

U.S. Army Corps of Engineers

Laura Totten, Planner/Project Manager; Jennifer Henggeler, Risk and Communications Section Chief; Jeff Tripe, Plan Formulation Section Chief; **Ginger Harper, Planner/Communications/Outreach**; **Julie MacLachlan, Communications/Outreach**; **Brian Twombly, Engineer;** John Shelley, Engineer; **Marvin Boyer, WQ Program Coordinator; Noah Colby George, Economist**; Kara Cline, Engineer

Others

Tom Stiles, KDHE; **Tony Stahl, KDHE; Chris Thorton, Ducks Unlimited; Doug Haney (Kansas River Water Assurance District #1, Cottonwood Neosho #3)**

MEETING NOTES

I. Laura Totten (USACE) led introductions and shared meeting purpose and desired outcomes.

II. **Purpose and Desired Outcomes**

a. Purpose and Desired Outcome of Problem Area Meetings

i. Conduct and complete Risk Assessment and Evaluation to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study for each problem area (i.e., Flood Risk, Sedimentation and Erosion, Reduction in the Ability to Meet Water Supply Demands, Degraded/Poor Water Quality, Ecosystem Degradation and Species Impact, Loss of Recreation Opportunities) for 5 planning areas - Kansas Regional Planning Area (RPA),

Solomon-Republican RPA, Smoky Hill Saline RPA, Upper Republican RPA, Upper Smoky Hill RPA.

ii. Review process for Uncertainty Assessment of Stressors.

iii. Review and refinement of existing list of measures and strategies.

b. Purpose and Desired Outcome of Recommendations Workshop

i. Using information from problem area meetings, hold a 1-day workshop to develop draft recommendations for all problem areas.

1. Identification of near-term and long-term actions / projects, evaluations, and data needs for each problem area and associated stressors.
2. Framing of Draft Recommendations for each problem area that includes details related to rough order of magnitude costs, potential funding sources, potential partners, and priority areas within the RPAs.

III. Study Accomplishments

a. The Project Management Plan was developed.

b. A Shared Vision Statement and Objectives were developed.

c. The team has conducted extensive stakeholder and public outreach throughout the basin.

d. The team has completed acquisition and analysis of comprehensive datasets and information related to hydrologic conditions, hydraulics, sediment transport, economic data, water supply demand and uses, recreation benefits, biological resources, and cultural resources in the basin.

e. A framework has been developed to perform a comprehensive assessment of existing conditions and expected future conditions, enabling development of a strategic roadmap to inform future investment decisions by multiple parties and to better account for uncertainty.

f. Assessments and Technical Reporting for Existing Conditions and FWOP for reservoir sediment, reservoir operations, climate change, flow frequency, flood risk, water supply, water quality, biological resources, and recreation are complete.

i. Brian Twombly (USACE) completed Impacts of Future Conditions assessment (see attached slides).

1. It does not account for population growth or climate change (qualitative analysis).

g. Measures have been developed to address issues related to flood risk, sedimentation and erosion, ability to meet water supply demands, degraded/poor water quality, ecosystem degradation and species impact, and loss of recreation opportunities.

h. The Shared Vision Milestone was successfully completed.

IV. Risk Assessment and Evaluation

a. Process Overview

b. Problems and Stressors
c. Qualitative Probability and Consequence Evaluation
    i. Risk Categories
        1. Economic Risk – The likelihood and consequences of harm/damage to property, infrastructure, and other assets, as well as economic systems (measured in monetary terms).
        2. Social – The likelihood and consequence of loss of social connectedness, adverse effects to disadvantaged communities, displacement of individuals, and ability for subsistence (ability of individuals/communities to be self-sustaining – reliance on natural resources to support a community and livelihoods).
        3. Environmental – The likelihood and consequence of ecosystem services impacts (the various benefits provided by certain environmental and natural resources to communities), habitat loss, and species loss.
        4. Life Loss – The likelihood and consequence of the stressor occurring and subsequent life loss.
    ii. Focus / Opportunity Areas (USACE is coordinating with Nebraska but they are not a partner in the study). Marvin Boyer (USACE) pre-populated the matrix.
        1. Kansas Regional Planning Area
            a. Economic Risk – Several of the stressors are already occurring; algae blooms show no signs of slowing down and lake conditions are prime for them to continue to occur. Impairments at reservoirs (i.e., nutrients, metals, chemicals, herbicides), are also likely to increase with these stressors in the future. Water quality for residential, commercial, and industrial use is already being impacted. Stormwater management is not in the expertise of the subject matter expert and any input for this will be added to the assessment. Sedimentation and erosion are occurring, which are also expensive problems for this RPA.
                i. Laura Totten (USACE) noted that while there's a tendency to focus on the stressors in this area that are related to the USACE reservoirs, a lot of the problems are happening upstream of the reservoirs or in the mainstream. Laura Totten (USACE) clarified this is a watershed study, not a specific reservoir study. The two western RPAs may not have much difference in existing conditions related to water quality but may require different actions to make improvements compared to the eastern RPAs.

ii. Marvin Boyer (USACE) explained that existing conditions for the stormwater management area will likely need more input from the group.
iii. Tony Stahl (KDHE) shared that one concern is the increase in salinity. KWO has concerns about drainages, especially bromide, as well as the impacts of climate change and drought. We also need to consider the resources that are available for water quality and water quantity (drinking water and water habitat). Salinity is expensive to deal with. Nutrient enrichment is also a stressor without a means to control it, which will impact the use of water resources in the long-term.
iv. Marvin Boyer (USACE) agreed and mentioned specific ion occurrence and salinity in the risk assessment.
v. Marvin Boyer (USACE) mentioned future projections for ions and management strategies to be in alignment with water quantity guidelines.
vi. Marvin Boyer (USACE) noted that future conditions include water quality compounds. The inflow streams are higher than what is leaving the lake, with the exception of August conditions. A future without any projects means the outflows will match the water quality inflows at some point without having attenuation.
vii. Laura Totten (USACE) pointed out that the goal is to maintain multipurpose reservoir storage where possible and to consider measures that support this goal. The proposed water injection dredging at Tuttle is an example of a measure to maintain storage. There are concerns with the release of sediment and any associated contaminants for this demonstration. Those are being considered with baseline monitoring and monitoring during the demonstration. There will also be measures to address potential unexpected effects during the demonstration.
viii. Tony Stahl (KDHE) mentioned that naturally occurring decay or radioactive materials could affect the drinking water and asked if there is consideration of this for the water injection dredging demonstration. Marvin Boyer (USACE) shared this issue has not been looked into yet. KDHE often encountered potassium K40, which has an extremely long half-life, and other particles that indicate radioactive materials. The levels increase moving west, but the water flows east and can carry these

elements with it and could be built up in the sediment in Tuttle Creek Reservoir.

ix. Laura Totten (USACE) suggested this could be an even bigger issue than was previously thought and it should be considered.

x. Julie MacLachlan (USACE) asked if communities considered to be disadvantaged will have a harder time managing the risk of these issues. Marvin Boyer (USACE) suggested that rural western communities could face more challenges. Julie MacLachlan (USACE) suggested economic and social risk may be difficult to separate, but we need to consider what this will mean for communities with low literacy levels, low-income levels, etc. Marvin Boyer (USACE) suggested addressing the issues above the reservoirs could help alleviate the issues in areas where there are more resources.

xi. Julie MacLachlan (USACE) noted that small communities may be represented in a larger critical mass. A watershed study could expose issues or create solutions in ways that otherwise may not be realized.

b. Social Risk

i. Marvin Boyer (USACE) pointed out that smaller communities with fewer resources may be more reliant on surface water.

ii. Marvin Boyer (USACE) shared the example of sedimentation and erosion at Tuttle Creek Reservoir and tried to equate the impact to other lakes. He wouldn't consider the social impacts as severe for just one lake, but it would increase if all of the lakes had the same sediment levels.

iii. Josh Olson (KWO) shared that sediment/erosion is always likely to occur but in certain contexts of water quality, sediment may not be as negative as some would think. This is because the rating captures not only the adverse effects, but also the beneficial effects.

c. Environmental Risk

i. Marvin Boyer (USACE) suggested there is still a big impact from a water quality standpoint. Impacts include habitat loss with lack of oxygen and an increase of algae in the streams, which is not good for the environment.

ii. Laura Totten (USACE) asked if water quality issues related to increased sedimentation has a substantial impact on fisheries, for example. Marvin Boyer (USACE) said yes, the reduction of habitat would be significant (e.g., oxygen sags).

iii. Tony Stahl (KDHE) pointed out that taking sediment from the lake to the river can cause a host of problems because of the charged particles, which play a role in whether the water can support oxygen. Nitrogen is of concern, but we're still learning how it controls other chemistry in a stream environment. Sediment is one of the largest pollutants in the state, not only because of the harmful elements in it, but also because of the positive elements that cannot exist due to the presence of harmful elements.

iv. Tony Stahl (KDHE) mentioned fingerprinting of rivers and looking at the chemical makeup of the sediment, among other things. Sediment that covers interstitial areas on stream beds causes substantial impacts to the feeding dynamics of fisheries. There are also organisms that are sensitive to sediment and are good indicators of potential impacts to other species in the food chain. Sediment that would be released from reservoirs (during the water injection dredging demonstration) is not the same sediment that enters the reservoir and should not be assumed to be. Reservoirs are a sink that is gathering incoming contaminants and these bond with sediment particles and could be harmful to macroinvertebrates.

v. Tony Stahl (KDHE) will provide more detailed comments on the environmental risk matrix.

d. Life Loss / Life Safety

i. Laura Totten (USACE) mentioned the difficulty in assessing the risk of life loss and somehow quantifying this. She emphasized the probability aspect and the consequence of life loss and life safety.

ii. Julie MacLachlan (USACE) suggested separating life loss from life safety. Laura Totten (USACE) suggested having separate categories for life loss versus health and safety. Marvin Boyer (USACE) focused more on life safety risk in his assessment. Illnesses are more likely than life loss risk related to the water quality issues in the basin.

iii. Tony Stahl (KDHE) noted that the Kansas River is very difficult to work in because of the unstable base and sharp drop-offs. This comment should be included in the Recreation risk assessment. Ginger Niemann-Harper (USACE) noted that unexpected increased flows can be dangerous.

e. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Kansas RPA are shown below (Figure 1 through Figure 4). The notes included in the matrix by subject matter experts are also included below each table.

Economic Risk Assessment Results

Problem	Stressor	Number	Probability		No to Low Impact	Moderate Impact	High Impact
Degraded / Poor Water Quality	Harmful Algal Blooms	18	Probability	Likely to Occur		21	18, 19, 20, 22
	Impaired Waters	19		Moderate Chance of Occurring			
	Reduced Availability of High Water Quality for Residential, Commercial/Industrial, and Recreation Uses	20					
	Inadequate Stormwater Management	21		Not Likely to Occur			
	Sedimentation and Erosion	22					
					Consequence		

Figure 1. Kansas RPA Economic Risk Assessment

Notes: Most stressors are likely to occur in this RPA with estimated stormwater management and being the least economic impact in my estimation.

Social Risk Assessment Results

Problem	Stressor	Number	Probability		No to Low Impact	Moderate Impact	High Impact
Degraded / Poor Water Quality	Harmful Algal Blooms	18	Probability	Likely to Occur		20, 22	18, 19
	Impaired Waters	19		Moderate Chance of Occurring		21	
	Reduced Availability of High Water Quality for Residential, Commercial/Industrial, and Recreation Uses	20		Not Likely to Occur			
	Inadequate Stormwater Management	21			No to Low Impact	Moderate Impact	High Impact
	Sedimentation and Erosion	22			Consequence		

Figure 2. Kansas RPA Social Risk Assessment

Notes: Social impacts should be slightly less than economic impacts since there is generally more water available than in other areas. Also, urban areas may have steep social consequences proportional to rural areas with fewer resources and a higher dependence on surface water.

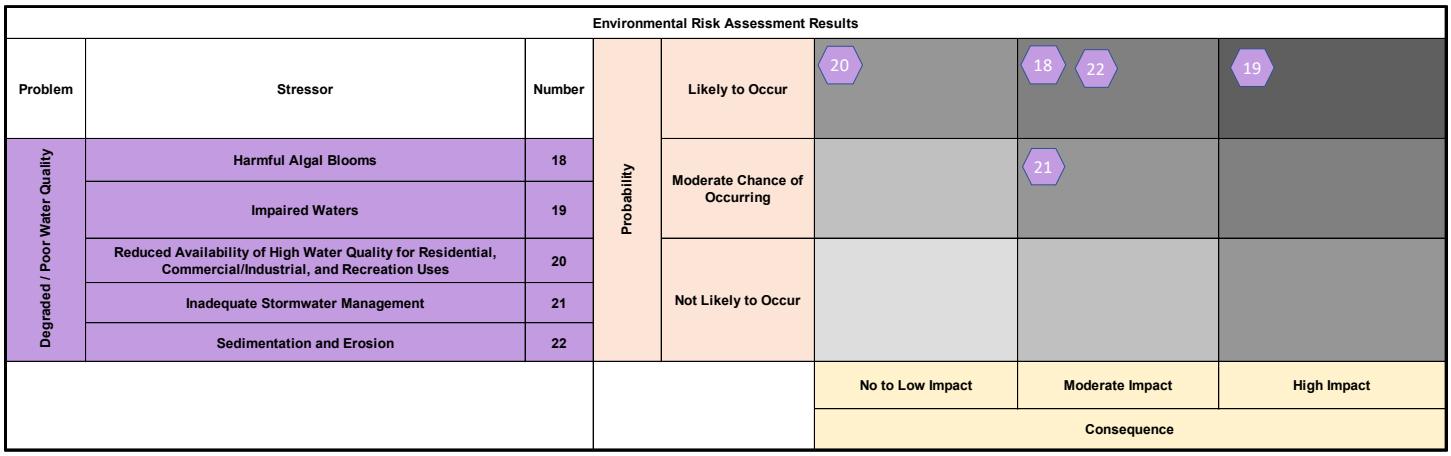


Figure 3. Kansas RPA Environmental Risk Assessment

Notes: Social impacts should be slightly less than economic impacts since there is generally more water available than in other areas. Also, urban areas may have steep social consequences proportional to rural areas with fewer resources and a higher dependence on surface water.

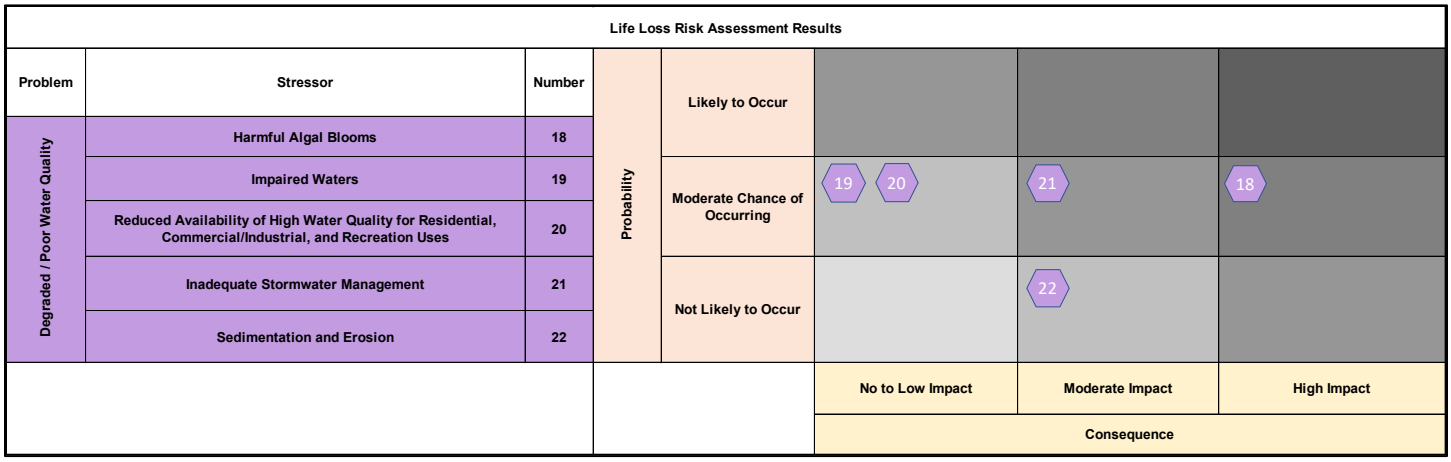


Figure 4. Kansas RPA Life Loss Risk Assessment

Notes: Many of these stressor will occur, but not likely at a risk to life safety. Stormwater management, availability of high quality water, and HABS may take considerable economic input to manage risk and reduce impacts.

2. Solomon-Republican Regional Planning Area
    a. Marvin Boyer (USACE) focused more on the economic and environmental risk in impaired waters; salinity and ions are also part of the evaluation.
    b. The matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Solomon-Republican RPA are shown below (Figure 5-9).

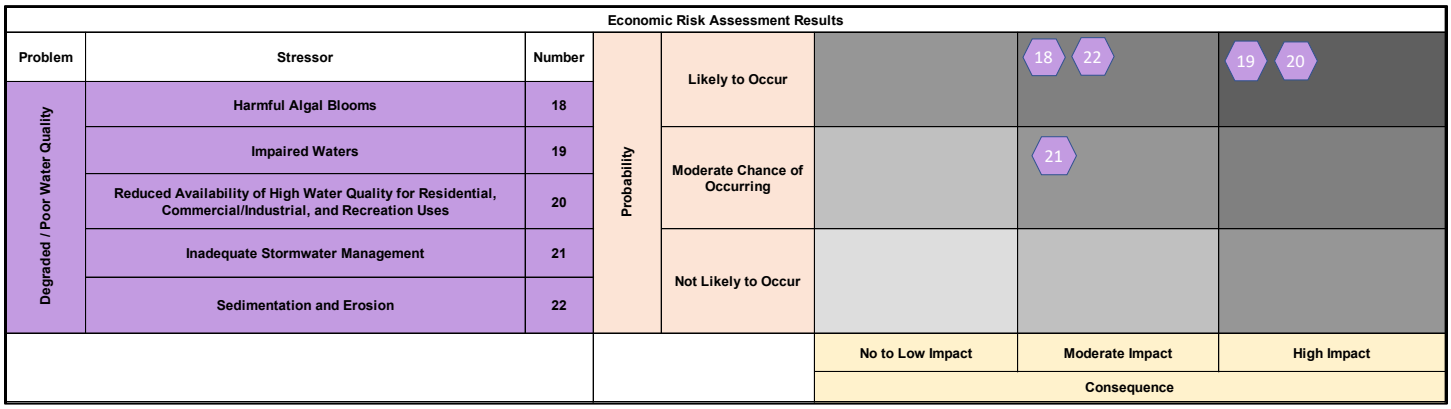


Figure 5. Solomon-Republican RPA Economic Risk Assessment

Notes: All stressors are likely to occur. It is not as likely that stormwater management will have significant economic impact on the 6 larger impoundments with expected population trends. HABs, impaired waters, and reduced availability of high quality water are likely to increase and have moderate to significant economic consequence.

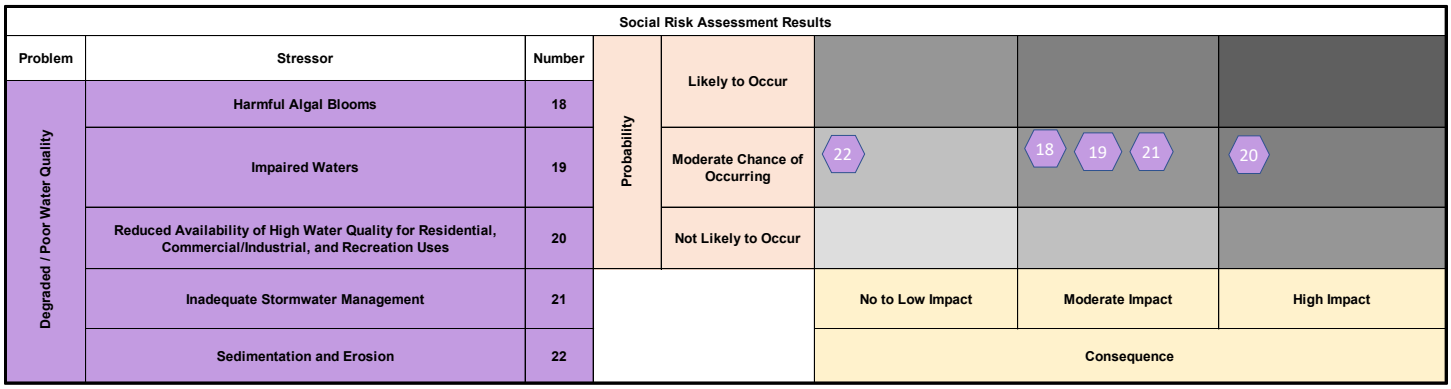


Figure 6. Solomon-Republican RPA Social Risk Assessment

Notes: All stressors are likely to occur, with moderate impacts to social metrics. It is not as likely that stormwater management will have significant social impact. Impaired waters, reduced availability of high quality water, increased HABs and sedimentation will work together as lakes age to have at least a moderate impact to recreation and businesses in the local communities.

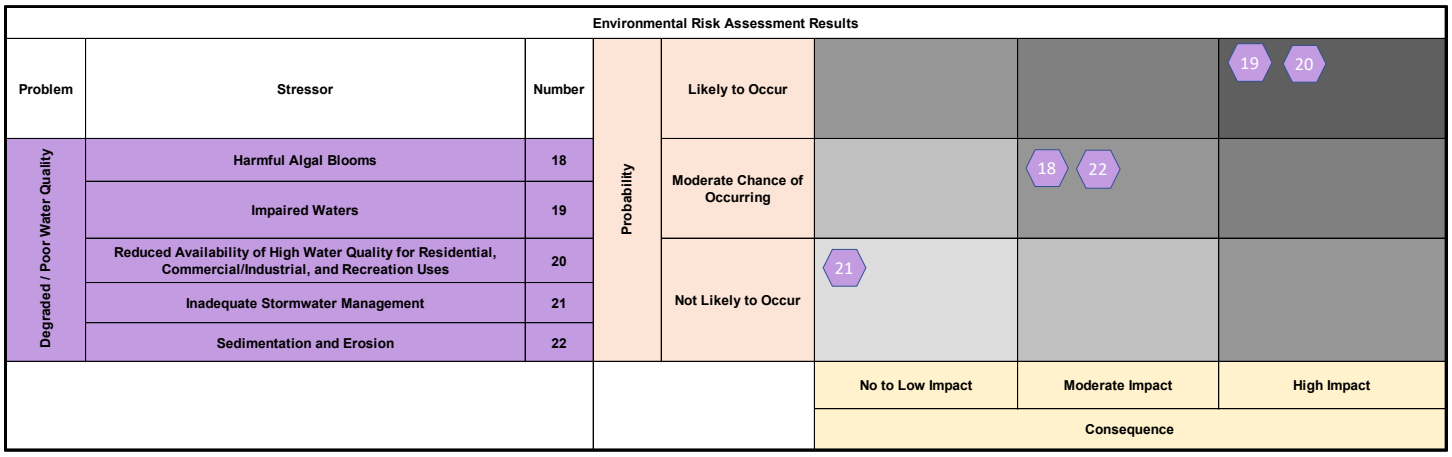


Figure 7. Solomon-Republican RPA Environmental Risk Assessment

Notes: Impairment and reduced availability of high quality water are likely the most significant environmental impact in the Solomon and Republican RPAs. HABs and sedimentation will have moderate impact on aquatic habitat and environmental resources at lakes in this RPA.

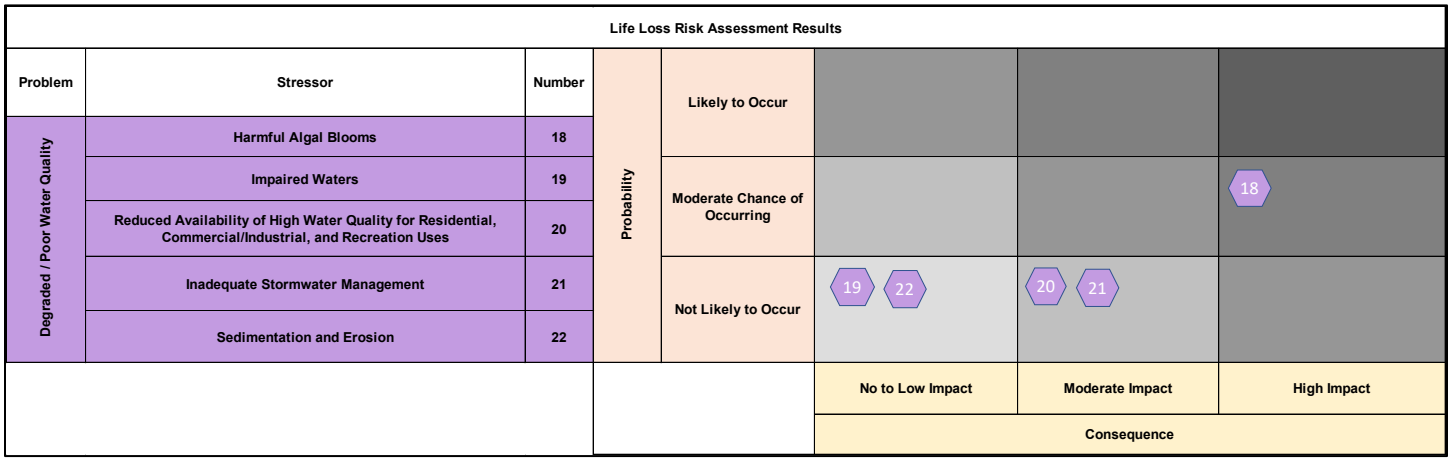


Figure 8. Solomon-Republican RPA Life Loss Risk Assessment

Notes: All stressors are likely to occur. It is unlikely they will occur to the extent of life safety risk. HABs and reduced availability of high quality water may increase to a level that poses low-moderate life safety risk.

3. Smoky Hill-Saline Regional Planning Area
    a. The matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Smoky Hill-Saline RPA are shown below (Figure 9 through Figure 12).

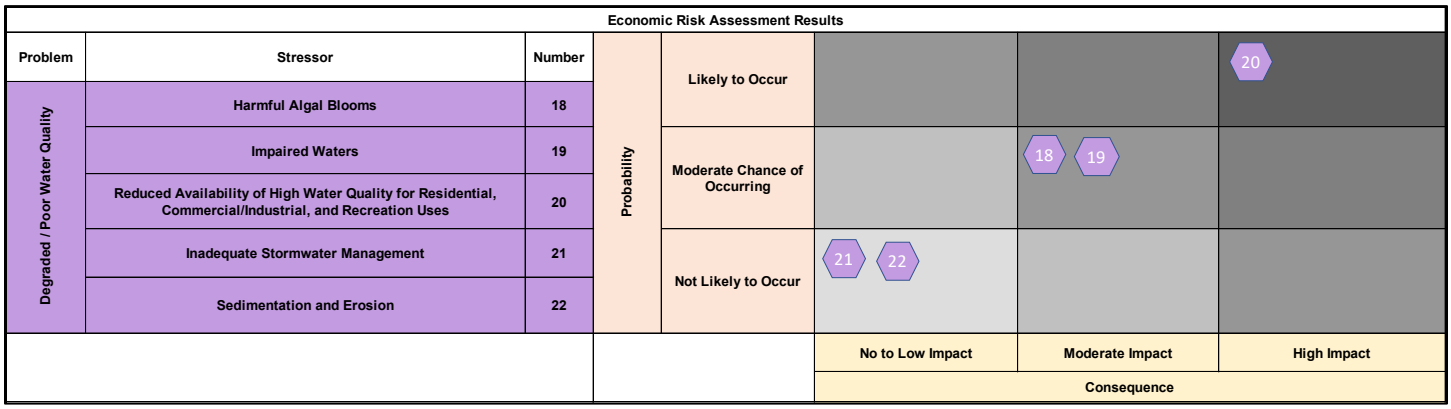


Figure 9. Smoky Hill/Saline RPA Economic Risk Assessment

Notes: Two USACE reservoirs (Kanopolis and Wilson Reservoirs) and one USBR reservoir (Cedar Bluff Reservoir) are located in this RPA. Reservoir conditions affected by sedimentation and climate change could lead to increased impact from availability of high quality water. Harmful algal blooms at reservoirs have caused closure of areas or warning/watches to be issued. Persistent warnings are not likely to grow proportionally to other District Lakes due to nutrient dynamics and light limited by turbidity. Blooms at these lakes would have a moderate economic impact from a decrease in recreation or water supply.

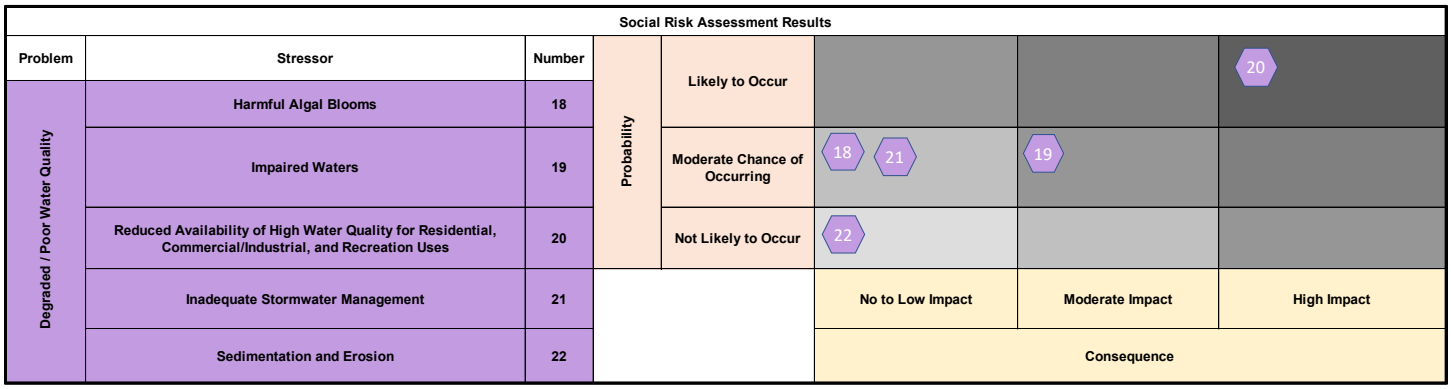


Figure 10. Smoky Hill/Saline RPA Social Risk Assessment

Notes: Social risks are at the lower end of probability and consequence. Blooms at these lakes would have a relatively low impact from a decrease in recreation.

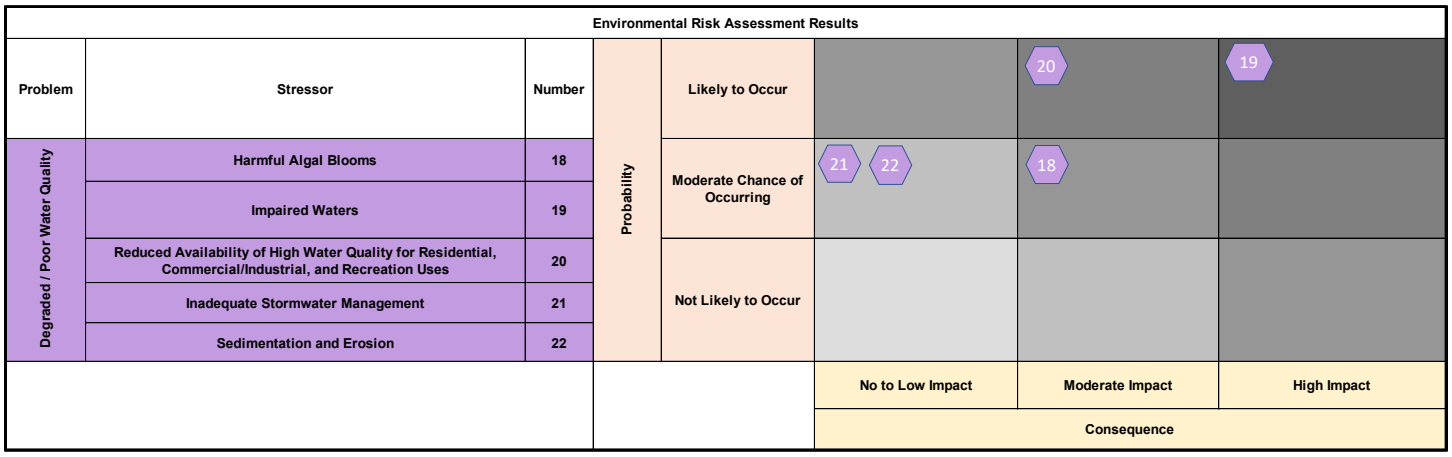


Figure 11. Smoky Hill/Saline RPA Environmental Risk Assessment

Notes: Environmental impacts from changes in water quality/quantity, harmful algal blooms, and impairment could increase in the future to moderate levels.

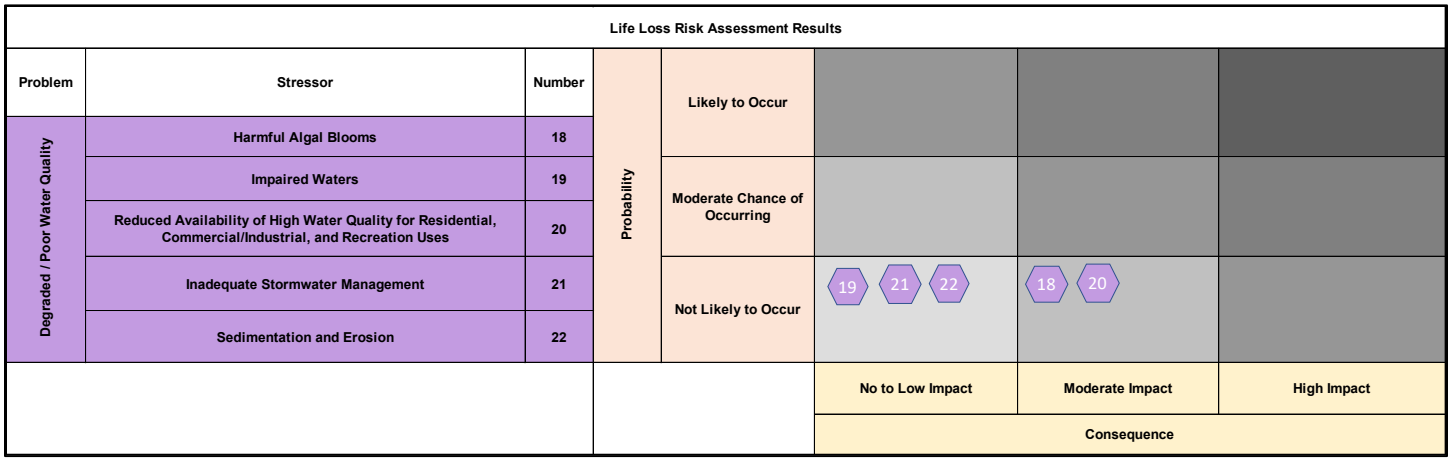


Figure 12. Smoky Hill/Saline RPA Life Loss Risk Assessment

Notes: Life safety risks are relatively low in this RPA due to current and future water quality conditions. HABs and impacts from reduced availability of high quality water could increase risks at some time in the future depending on climate change uncertainty and potential for algae populations to adapt to current and future WQ conditions.

4. Upper Republican Regional Planning Area
    a. Water quality issues have caused some other problems downstream. Streams are more sensitive to contaminants and more susceptible to impacts on drinking water and water for industrial uses.
    b. The removal of the USBR Bonny Reservoir in Colorado did cause changes in the flow regime as water enters Kansas. Previously there was a sustained release

from the Bonny Reservoir and regular flow at the Colorado/Kansas state line from this.

c. There are no USACE reservoirs in this RPA and the stressors related to these are not applicable.

d. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Upper Republican RPA are shown below (Figure 13 through Figure 16).

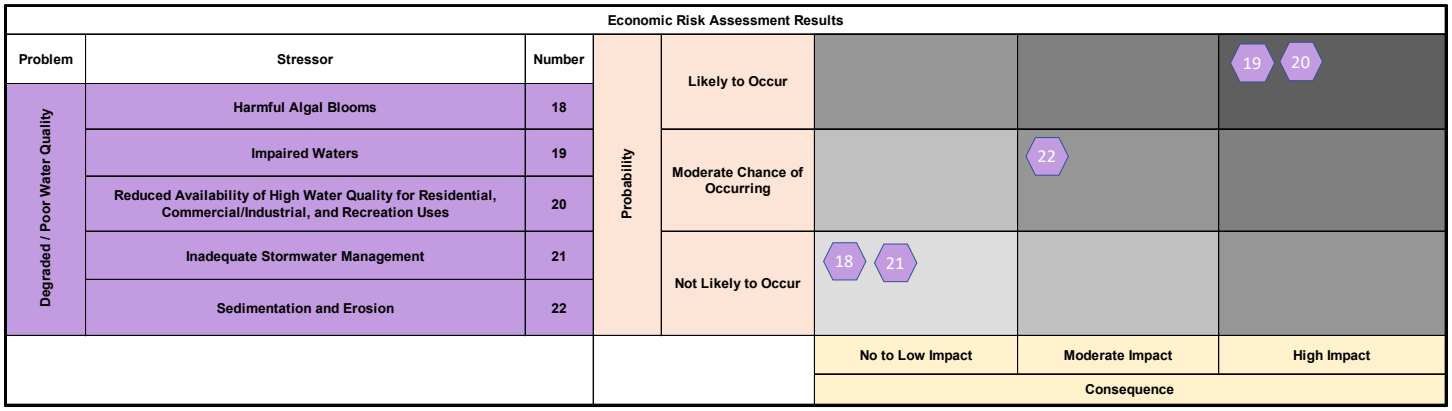


Figure 13. Upper Republican RPA Economic Risk Assessment

Notes: No federal reservoirs occur in this RPA. Streams are sensitive to contaminants and likely to become impaired from nonpoint nutrients and possibly by naturally occurring compounds, but with minimal risk of HABS in smaller flowing waters.

Drought conditions and climate change could interact with groundwater depletion to increase risks to Economic, Social, and Environmental impacts due to reduced availability of high water quality or limited supply of surface water in streams in this RPA.

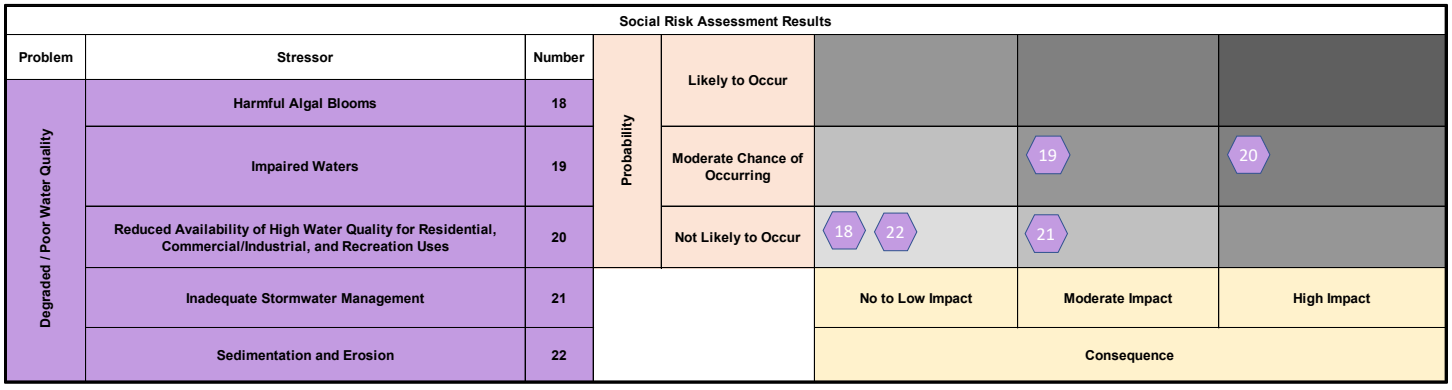


Figure 14. Upper Republican RPA Social Risk Assessment

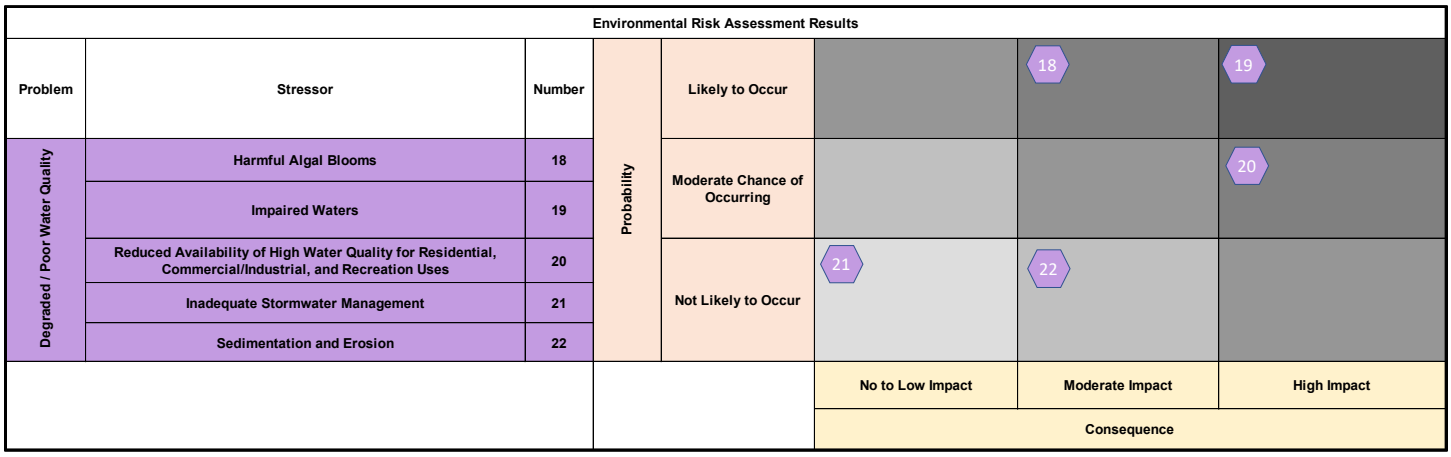


Figure 15. Upper Republican RPA Environmental Risk Assessment

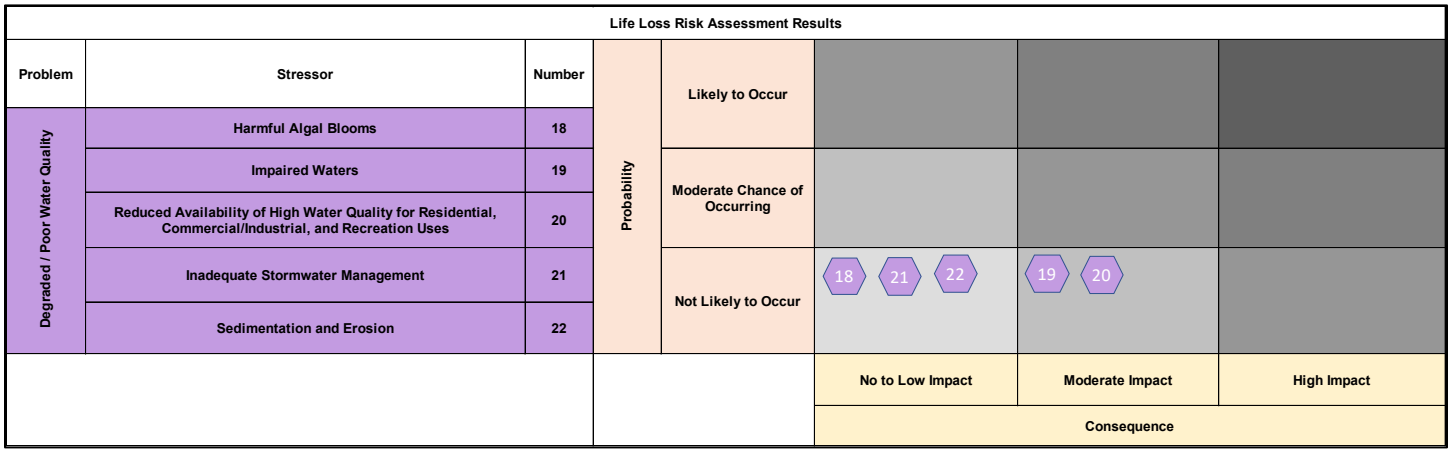


Figure 16. Upper Republican RPA Life Loss Risk Assessment

5. Upper Smoky Hill Regional Planning Area

   a. There are no USACE reservoirs in this RPA and the stressors related to these are not applicable.

   b. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Upper Smoky Hill RPA are shown below (Figure 17 through Figure 20).

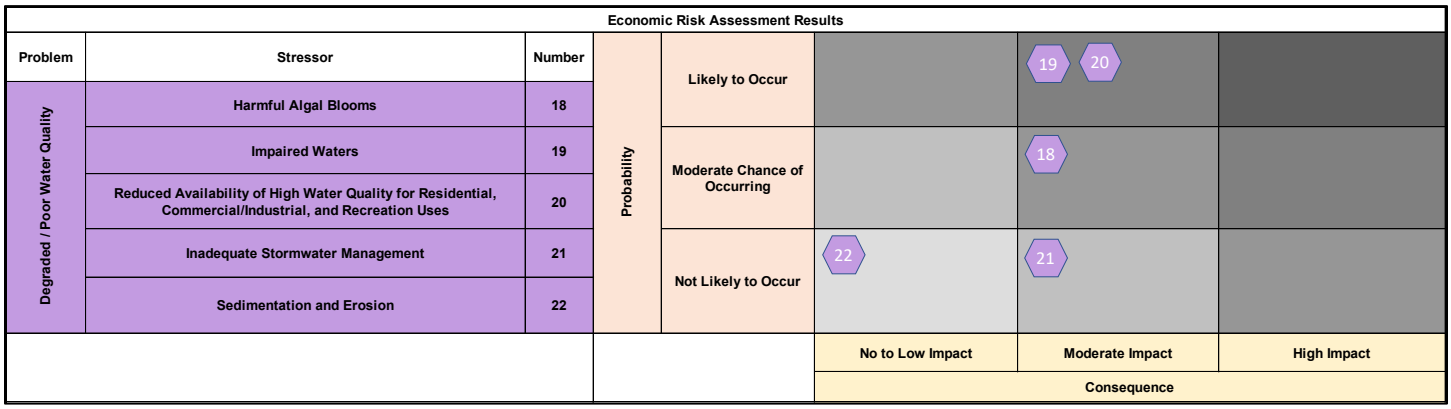


Figure 17. Upper Smoky Hill RPA Economic Risk Assessment

Notes: No federal reservoirs occur in this RPA. Streams are sensitive to contaminants and likely to become impaired from nonpoint nutrients and may increase due to naturally occurring compounds and salt ions with minimal risk of HABS in smaller flowing waters.

Drought conditions and climate change could interact with groundwater depletion to increase risks to Economic, Social, and Environmental impacts due to reduced availability of high water quality or limited supply of surface water in streams in this RPA.

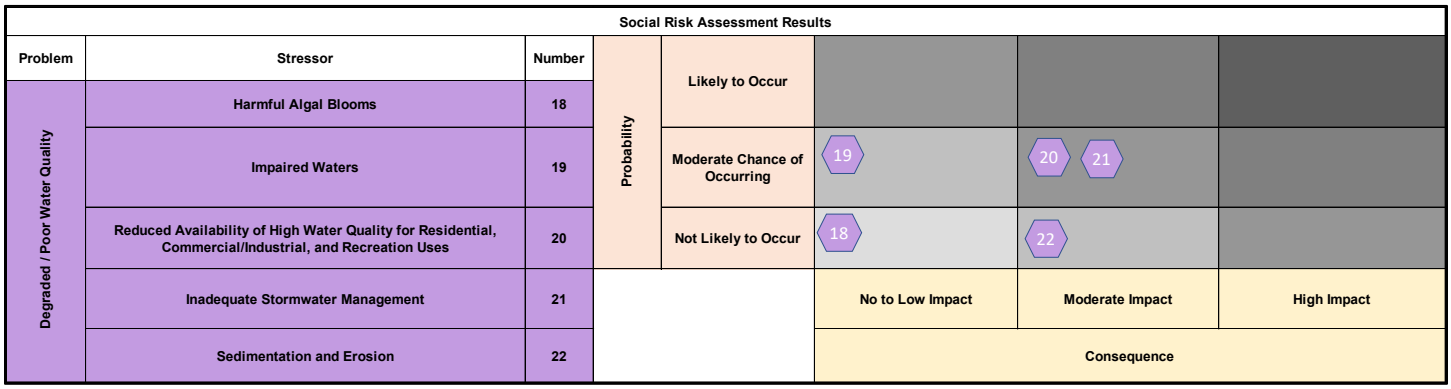


Figure 18. Upper Smoky Hill RPA Social Risk Assessment

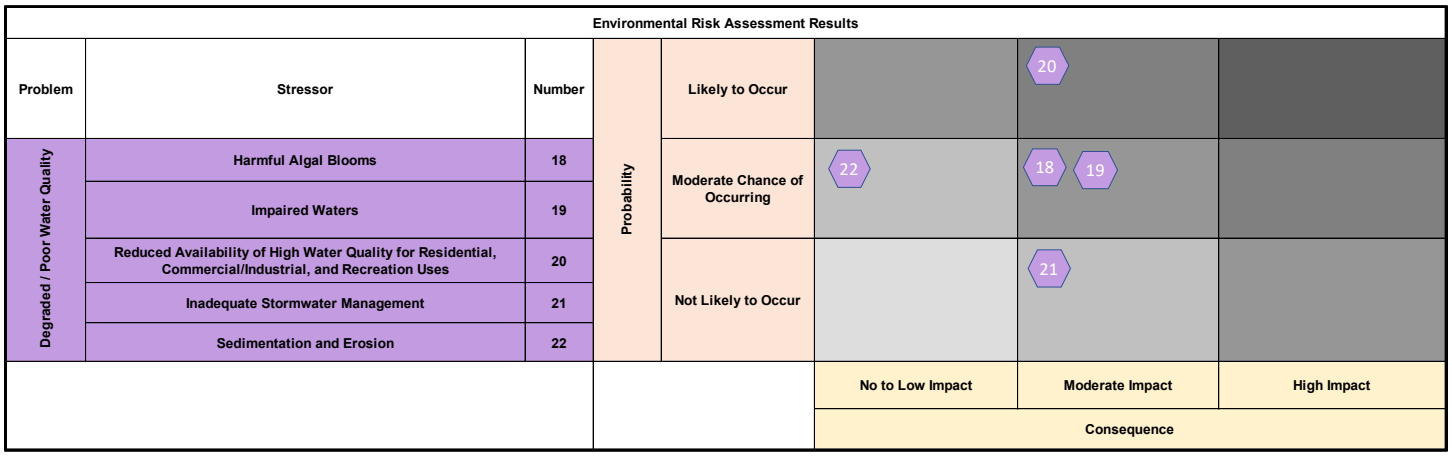


Figure 19. Upper Smoky Hill RPA Environmental Risk Assessment

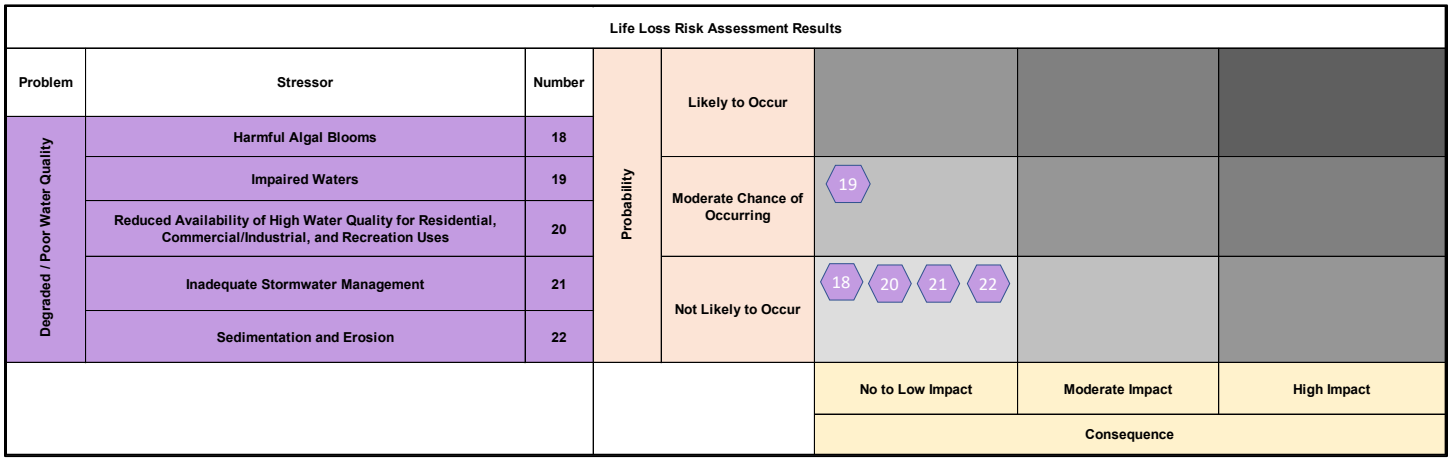


Figure 20. Upper Smoky Hill RPA Life Loss Risk Assessment

iii. Other Discussion

1. Tony Stahl (KDHE) noted the importance of collaboration and the opportunity to be involved.
2. Tony Stahl (KDHE) mentioned the importance of protecting the state's water resources and that groundwater could be pushed to surface water.
3. Doug Haney (Kansas River Water Assurance District #1, Cottonwood Neosho #3) suggested the need to resolve the bromide issue and that only having the Kansas River as a water source is a concern. Others use the Missouri River as a second source and can switch when bromide is high. Doug Haney (Kansas River Water Assurance District #1, Cottonwood Neosho #3) focuses on groundwater and surface water supply.

V. Uncertainty Analysis

a. Qualitative assessment of uncertainty to identify the level of consensus among stakeholders in implementing potential risk reduction measures for each stressor.
b. Categories
    i. Action – Implementable solutions with a high level of consensus to address a given stressor.
    ii. Evaluation Options – Potential solutions defined with existing information or additional data would be required to better define the problem and/or identify potential solutions.
c. Supports development of a framework for the appropriate types of and timing for recommendations to help prioritize actions.
    i. Categorize each stressor or parts of a stressor under the appropriate level of uncertainty.
        1. Near-term Actions - Stressors with a high level of risk (e.g., high probability and high consequence) could require immediate steps to reduce risks through actions, evaluation, or filling data gaps.
        2. Incremental Actions - Stressors with less risk (e.g., moderate probability and temporary impacts) could be considered a lower priority that does not require immediate steps.

VI. Measures

a. Review and refinement of existing measures for water quality. Laura Totten (USACE) reviewed the water quality measures and shared that sediment measures are included under other focus areas to provide multiple benefits across all the problem areas (see attached slides).
b. Water Management Measures
    i. Brian Twombly (USACE) is interested in knowing more about operating Perry, Milford, and Tuttle Creek Reservoirs as a system. Laura Totten (USACE) shared the description provided in the notes in the Measures document (see the read ahead).
    ii. The water control manuals in the basin are currently undergoing updates starting with Milford, Tuttle Creek, Perry, and Clinton Reservoirs. These will have stakeholder and public meetings as the water control manuals are updated.
    iii. Perry and Milford have contracts for storage in the multipurpose pools that are not in service that can currently be used for other things. Once the state pays off their contracts at Perry and Milford Reservoirs and calls the storage into service, releases for navigation would no longer be made and they would continue to make releases for water quality. If this happens this measure would no longer be needed. If the state of Kansas determines they do not need all of the multipurpose pool storage for water supply, they could request a Section 216 Study through USACE to repurpose storage for the intended use of storage specific for water quality.
    iv. Brian Twombly (USACE) noted that there are water quality needs in Milford and Perry Reservoirs. Laura Totten (USACE) suggested the possibility of the state of Kansas continuing to make

releases that support water quality and water supply. This would occur as the state's contracts with water assurance districts provide for this as well.

v. Richard Rockel (KWO) noted that this year was a good example of following the agreement. A portion of storage will need to be used to maintain the targets in Milford and Perry Reservoirs once the contracts are paid.

c. Harmful Algal Blooms Measures
   i. There are currently funds available through the federal research group related to these and work that is ongoing. The current list should remain as these are still needed.
   ii. It was noted there is not a "silver bullet" for HAB treatment.
   iii. Tony Stahl (KDHE) suggested replacing "treatment" with "mitigation and remediation."

d. Operational Measures
   i. Brian Twombly (USACE) asked for clarification on the measure to lower target flows when the water control manuals are updated. If they are adjusted, USACE would like to understand the impacts to water quality, fish and wildlife. The group discussed the importance of balancing the positive and negative impacts, and that we should consider reducing the targets by 100 cubic feet per second.
   ii. What would the trigger points be for lower target flows for drought contingency planning? There is already a plan in place to lower target flows as the Tuttle Creek Reservoir multipurpose pool drops. This would require more discussion with multiple parties with interest and concerns.

e. Sediment Reduction Measures
   i. The state of Kansas recently received a renewal for 5 years of the Milford Reservoir Regional Conservation Partnership Program for nutrient reduction. This work would also support sediment reduction. Would there be an interest in something similar in the watershed above Tuttle Creek Reservoir? The WRAPs are doing work here, but it is unknown if there is anything additional that would further support this.
   ii. Tony Stahl (KDHE) asked about the Kansas Forest Service's participation. Laura Totten (USACE) noted they have participated and advocated for reestablishment of riparian corridors. The issue is typically funding and willing landowners, as the majority of these areas are privately owned.
   iii. Tony Stahl (KDHE) noted that riparian restoration and armoring streams are the future of sediment reduction in Kansas and the associated water contaminants. Additionally, these habitats provide important functional requirements for species (e.g., shading, nutrients) The group discussed how some are removed by the natural environment (erosion/die-off from prolonged inundation) and others are intentionally removed by landowners, and how stream incision is

widespread in the basin. Regardless, it is important to look beyond the short-term benefits of removal and maintain stream banks long term. Finding ways to incentivize these measures and having realistic requirements for private landowners would further support this.

iv. The Kansas Forest Service (KFS) has done some focused assessments on riparian vegetation in specific watersheds in the basin. It would be good to look at these and see if there is any useful information that would help to identify priority areas for riparian protection or restoration. KFS provided several documents to the study team, and these reports were included. USACE will review these to determine if there is any information related to specific areas.

VII. Do-outs / Next Steps

a. Participants to review draft risk assessment for water supply for each RPA and provide comments and additional input to USACE.
b. USACE to compile and finalize information on risk and uncertainty and provide to participants for review and comment.
c. Conduct Draft Recommendations Workshop.
d. Laura Totten (USACE) asked that the group invite others to the 1-day workshop, which will likely be in early April.
e. Working Group Meetings
    1. Jan 13 – Ecosystem and Species (complete)
    2. Feb 3 - Flood Risk (complete)
    3. Feb 15 – Sediment and Erosion (complete)
    4. Feb 21 – Water Supply (complete)
    5. Feb 27 – Recreation (complete)
    6. March 3 – Water Quality (today)

ECOSYSTEM DEGRADATION AND SPECIES IMPACTS

Kansas River Reservoirs Flood and Sediment Study

MEETING NOTES

DATE: Friday, January 13, 2023
TIME: 9:00 a.m. – 12:00 p.m.
LOCATION: In-Person / Teleconference
SUBJECT: Ecosystem / Species Working Group Meeting

Location:
Kansas Water Office
900 SW Jackson Street, Suite 404
Large Conference Room
Topeka, KS 66612

Webex Info:
https://usace1.webex.com/usace1/j.php?MTID=m6e5ff187da8c0284ed8829ab344fd755
844-800-2712
Meeting Number: 2760 435 0087
Meeting Password: p2aFiP2S6u@

Invitees (attendees in bold):

Kansas Water Office

Matt Unruh, Assistant Director; Nate Westrup, Manager – Public Water Supply Programs; **Josh Olson, Project Management Lead**; **Kirk Tjelmeland, Field Services Coordinator**; **Richard Rockel, Technical Services Lead**

Kansas Department of Wildlife, Parks and Tourism; Amelia Nill, Regional Planning and Outreach Coordinator

Steve Adams, Chief of Planning; John Reinke, Fisheries Biologist; **Jordan Hofmeier, Aquatic Ecologist; Mark VanScoyoc, Survey Coordinator, Ecologist**

U.S. Army Corps of Engineers

Laura Totten, Planner/Project Manager; **Jennifer Henggeler, Risk and Communications Section Chief; Jeff Tripe, Plan Formulation Section Chief; Ginger Niemann-Harper, Planner/Communications/Outreach; Julie MacLachlan, Communications/Outreach; Brian Twombly, Engineer**; John Shelley, Engineer; Marvin Boyer, WQ Program Coordinator; **Sophie Wayne, Economist; Noah Colby George, Economist**; Kara Cline, Engineer

Others

Aaron Deters, Kansas Alliance for Wetlands and Streams; Chris Thorton, Ducks Unlimited; Matt Hough, Ducks Unlimited; **Jason Sweet, Juniper Environmental**

MEETING NOTES

I. Laura Totten (USACE) led introductions, provided housekeeping items for the group, and shared meeting purpose and desired outcomes.

II. **Meeting Purpose and Desired Outcomes (refer to attached slides presented)**

a. Purpose and Desired Outcome of Problem Area Meetings

i. Conduct and complete Risk Assessment and Evaluation to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study for each problem area (i.e., Flood Risk, Sedimentation and Erosion, Reduction in the Ability to Meet Water Supply Demands, Degraded/Poor Water Quality, Ecosystem Degradation and Species

Impact, Loss of Recreation Opportunities) for 5 planning areas - Kansas Regional Planning Area (RPA), Solomon-Republican RPA, Smoky Hill Saline RPA, Upper Republican RPA, Upper Smoky Hill RPA. Detailed information about the "problems and stressors" in the problem area are included in meeting handouts and should be referred to during the exercise.

ii. Conduct Uncertainty Assessment of Stressors

iii. Review and refinement of existing list of measures and strategies

b. The group is tasked with conducting a Risk Assessment and Evaluation for each problem area to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study.

c. Purpose and Desired Outcome of Recommendations Workshop

i. Using information from problem area meetings hold a 1-day workshop to develop draft recommendations for all problem areas.

1. Identification of near-term and long-term actions / projects, evaluations, and data needs for each problem area and associated stressors.
2. Framing of Draft Recommendations for each problem area that includes details related to rough order of magnitude costs, potential funding sources, potential partners, and priority areas within the RPAs. The plan is to have draft recommendations by May 2023.

III. Study Accomplishments

a. The Project Management Plan was developed.

b. A Shared Vision Statement and Objectives were developed.

c. The team has conducted extensive stakeholder and public outreach throughout the basin.

d. The team has completed acquisition and analysis of comprehensive datasets and information related to hydrologic conditions, hydraulics, sediment transport, economic data, water supply demand and uses, recreation benefits, biological resources, and cultural resources in the basin.

e. A framework has been developed to perform a comprehensive assessment of existing conditions and expected future conditions, enabling development of a strategic roadmap to inform future investment decisions by multiple parties and to better account for uncertainty.

f. Assessments and Technical Reporting for Existing Conditions and FWOP for reservoir sediment, reservoir operations, climate change, flow frequency, flood risk, water supply, water quality, biological resources, and recreation are complete.

g. Measures have been developed to address issues related to flood risk, sedimentation and erosion, ability to meet water supply demands, degraded/poor water quality, ecosystem degradation and species impact, and loss of recreation opportunities.

h. The Shared Vision Milestone was successfully completed.

IV. Risk Assessment and Evaluation

a. Process Overview

i. Laura Totten (USACE) shared an example of a Risk Assessment from the USACE Honolulu District (see attached). The goal of the exercise is to plot risks on a matrix to gain an understanding of probability and consequences (Risk Assessment), then understand next steps for each problem area such as additional study, form a working group, seek additional funding, monitoring, etc. (Uncertainty Analysis). USACE has vetted this approach internally and with project partners, but this approach is new to this team. As such, this team is open to suggestions for modifications to the model to tailor to this study and study area. The planning team will combine the Risk and Uncertainty summaries to determine action and implementation timelines (immediate action, incremental action) at the end of this phase.

ii. The intent is to provide this type of information to a group such as the Kansas Legislature to share basin priorities, so the final product needs to be a tool everyone can use. Laura Totten (USACE) shared that more work needs to be done to finalize the framework and asked if the framework itself would work for the group. Laura Totten (USACE) suggested the addition of a lead agency and timeframe to each action in an implementation schedule. It should also be recognized that several organizations have good work in process, but there may not be funding behind the plans—which would necessitate the utilization of other organizations to leverage funding and resources.

iii. The group concluded that it makes sense to have quickly digestible information to easily communicate with a wide range of audiences. The group likes the decision-making matrix as presented (i.e., risk assessment methodology), and is also interested in knowing the federal ask and USACE comfort level with additional stakeholder outreach for federal asks. Laura Totten (USACE) suggested USACE could use this matrix/implementation plan as a starting point but agreed that more detail would be needed to actually fund a federal project. USACE headquarter will ask the study team to identify programs and projects, and this process will help identify new and validate known problems and solutions, as well as justify future funding.

iv. Participants suggested more detailed estimated costs would be needed for legislative discussions. Partner agencies/stakeholders will develop costs through further study, and any further process beyond the watershed study would include identifying alternatives earlier in the process. The group noted that costs cannot be developed until the “what” and “where” are identified; after which the “when” and “how much” can be determined. Some costs can be estimated based on past experience, although some costs will still be

unknown. The group acknowledged that cost estimating takes money, too, and it is important to prioritize further study to determine additional project details.

v. USACE shared that costs quickly become outdated but having a reference point is helpful. The format will change based on the audience and the needs will change over time. This study is a snapshot in time at a granular level but overall the plan will need to be careful about the level of detail. This approach is aimed at bringing partners together.

vi. USACE provided overview steps (see attached slides).

b. Problems and Stressors

i. Problems and stressors have been shared with project partners for feedback and each group will go through the Risk and Uncertainty Assessment. After that step, all information will come together in a summary of actions with individual problem areas ranked or prioritized. It was recognized there could be further discussion and descriptions of stressors, and today starts with ecosystem degradation and species impacts. Many of the measures are multipurpose and intended to address multiple problems, and ultimately there is a desire to prioritize or link benefits that impact multiple problem areas, as they are more appealing for funding. In general, USACE is leaning more towards supporting projects with comprehensive benefits and acknowledged that communication tools are extremely important.

c. Qualitative Probability and Consequence Evaluation

i. Risk Categories – Risk Definitions were provided to the group (see attached) and noted they could still be tailored to the needs of the group.

1. Economic Risk – The likelihood and consequences of harm/damage to property, infrastructure, and other assets, as well as economic systems (measured in monetary terms).
2. Social – The likelihood and consequence of loss of social connectedness, adverse effects to disadvantaged communities, displacement of individuals, ability for subsistence (ability of individuals/communities to be self-sustaining – reliance on natural resources to support a community and livelihoods).
3. Environmental – The likelihood and consequence of ecosystem services impacts (the various benefits provided by certain environmental and natural resources to communities), habitat loss, and species loss.
4. Life Loss / Life Safety – The likelihood and consequence of the stressor occurring and subsequent life loss or risks to public safety, including emergency preparedness.

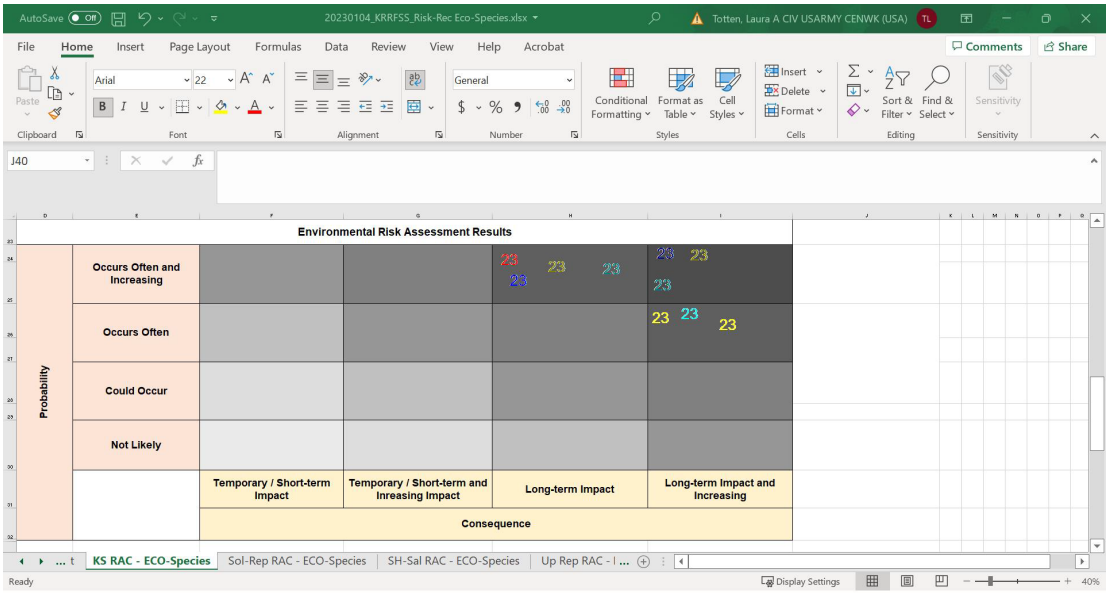
ii. Focus / Opportunity Areas

1. **Kansas Regional Planning Area - Today**
2. Solomon-Republican Regional Planning Area
3. Smoky Hill-Saline Regional Planning Area
4. Upper Republican Regional Planning Area
5. Upper Smoky Hill Regional Planning Area

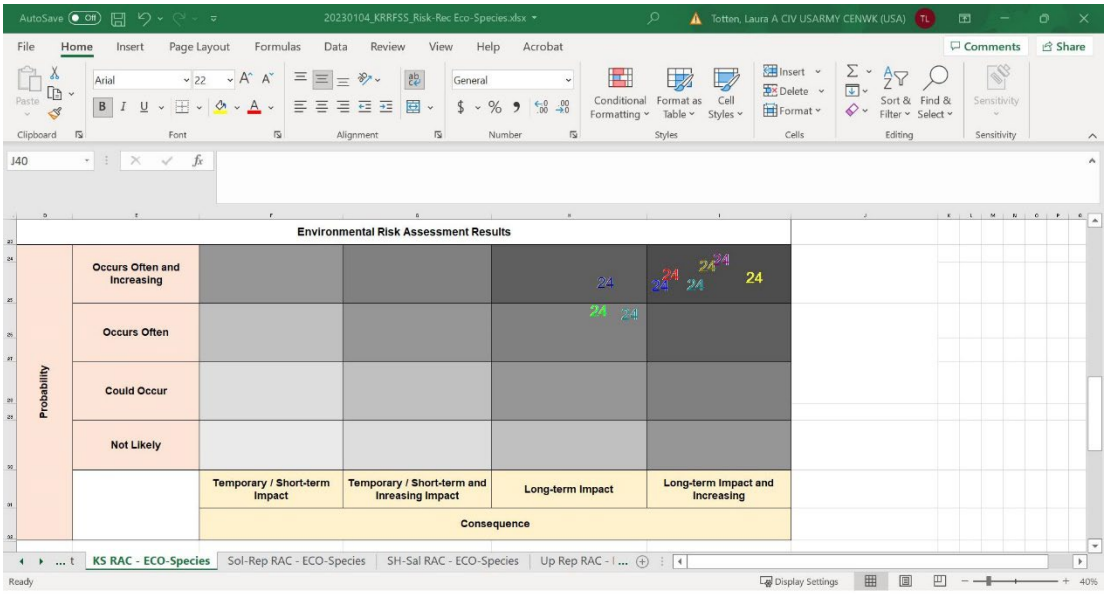
iii. Discussion

- USACE provided an overview of the Risk Assessment exercise and shared that no final decisions or commitments will be made for this meeting, but rather the intention is to take the temperature of the room. USACE added that names are not attached to the assessment in any reporting, but relevant notes and reasoning will be included.
- After the meeting, participants will be able to submit their Risk Assessment exercise with their own notes to reflect their answers, hopefully eliminating the possibility of "group think" during live exercises. If anyone is missing from this assessment process, they can be included to provide assessment feedback.
- The group should note there is no weighting within each box. The Risk could be identified as a range rather than a single dot on the matrix or be an average. USACE will send out the workbook and add all stressors on the same matrix.
- If the participant doesn't have enough information or knowledge to respond, they can still respond but should include notes to their response with confidence and/or knowledge level, as well as what information would help them make a more confident assessment. The group agreed that the rating should be weighted more heavily based on the source. Agencies responsible for representing citizens should also carry more weight. This is a large enough basin that there are commonalities and inherent differences because of the broad geographic areas, which are important to identify. Laura instructed the group to put the number of the stressor + "E" (expert) or "NE" (non-expert) on the matrix if the distinction is significant.
- The workbook to be distributed includes five RPAs, four risk categories, the entire list of stressors, the definition of probability and consequence categories.
- One participant noted that actual data should be used where it exists for probability rather than a "gut feel".

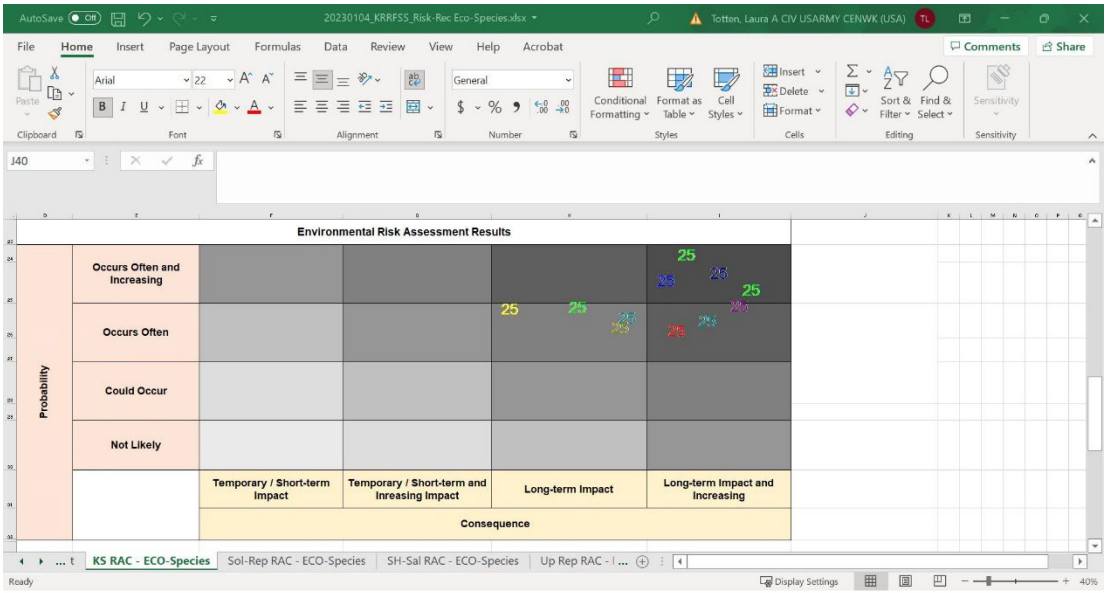
- The group proceeded with the Risk Assessment exercise. In-person participants and online participants were asked to use the annotation tool to place the risks on the matrix.
    - Environmental Risk #23: Loss of Habitat Leading to Species Decline. The group noted that different species and habitats may have different probability and consequences.



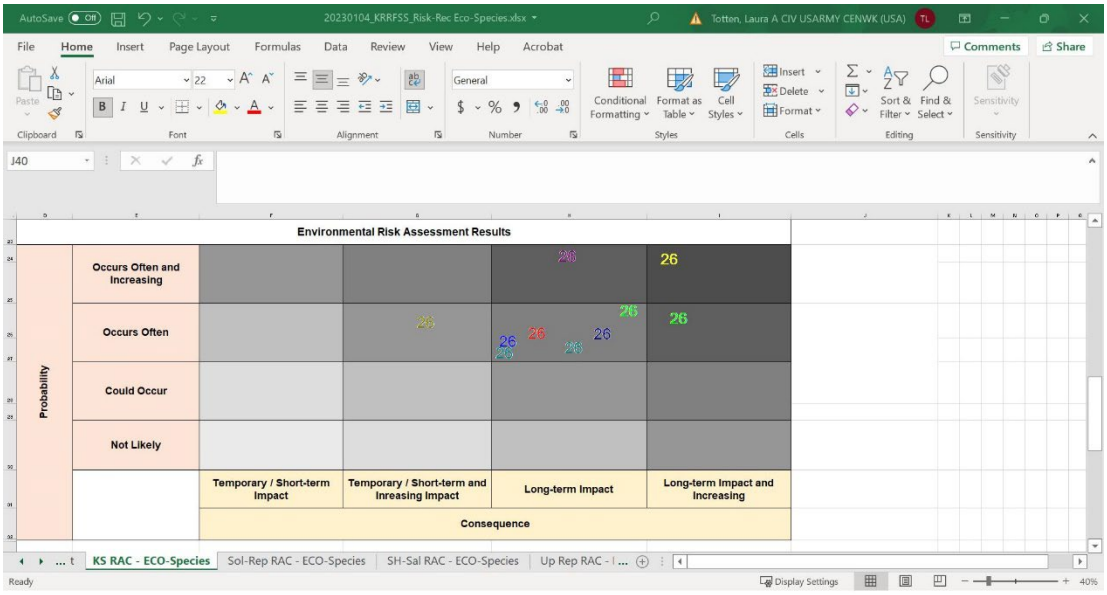
- Environmental Risk #24: Invasive / Non-Native Species: Is the threat increasing or decreasing?



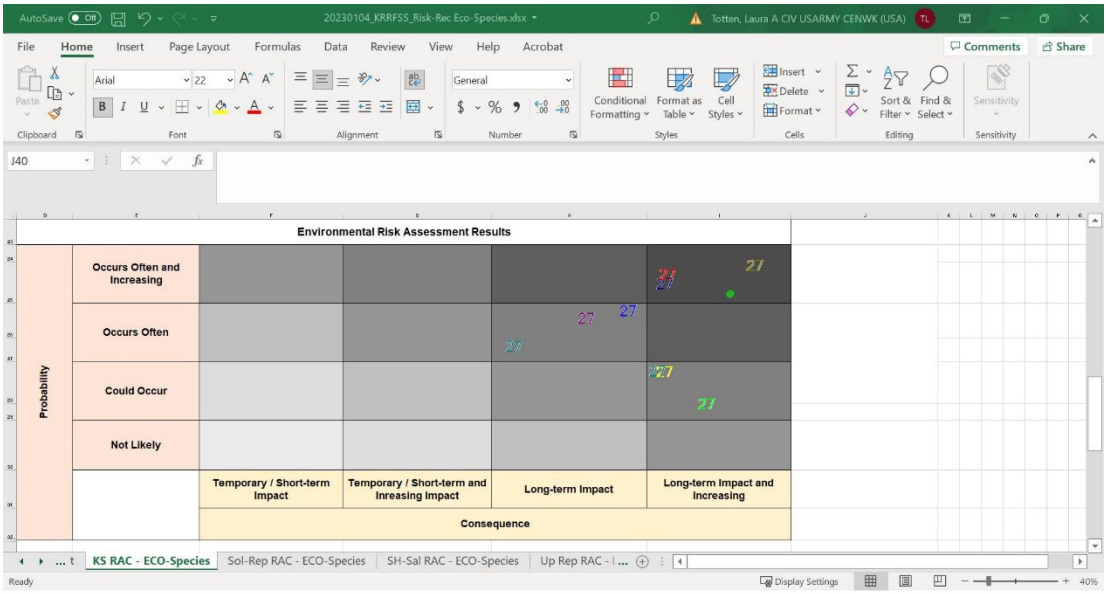
- Environmental Risk #25: Loss of Heterogeneity in Hydrologic and Geomorphic Processes in Rivers, Streams, and Floodplains.



- Environmental Risk #26: Impacts to Reservoir Fisheries. The group noted the potential to restock from fisheries while native species are harder to restock.



- Environmental Risk #27: Groundwater Depletion.



- The group discussed the exercise, and some were surprised by the general consensus. Most responses selected are in the upper right area of the matrix, meaning a higher probability of occurring, and potentially increasing, with high consequences.

- Discussion occurred about the reason some stressors are not increasing and noted an overall species decline on the river. There could be as much restocking as possible, but until the habitat problems are fixed, it is a waste of time and money.
- The group noted that native species and species of concern continue to increase. They did not include an “increasing” (consequence axis) component but considered depletion from system. The group noted the previous loss of a bunch of species but agreed that the losses seem to have leveled out. They noted survey efforts are improving but overall the basin is still seeing species decline. There may not be enough information to know what’s causing species decline.
- It was noted both higher risk and uncertainty of what’s going to happen in the future, which could increase all the problems.
- The study anticipates future periods where Milford and Perry are at zero storage as a result of comprehensive factors (sediment, climate change, reduced precipitation).
- The group noted that part of the variation in responses is due to the variability of each participant’s understanding of the issues. Being familiar with the issue might mean more extreme or severe responses.
- The group moved to Uncertainty Analysis rather than move through more Risk Assessment categories due to time constraints.

V. Uncertainty Analysis

a. Qualitative assessment of uncertainty to identify the level of consensus among stakeholders in implementing potential risk reduction measures for each stressor.

b. Categories
   i. Action – Implementable solutions with a high level of consensus to address a given stressor
   ii. Evaluation Options – Potential solutions defined with existing information
   iii. Fill Data Gaps – Additional data would be required to better define the problem and/or identify potential solutions

c. Supports development of a framework for the appropriate types of and timing for recommendations to help prioritize actions.
   i. Categorize each stressor or parts of a stressor under the appropriate level of uncertainty.
      1. Near-term Actions - Stressors with a high level of risk (e.g., high probability and high consequence) could require immediate steps to reduce risks through actions, evaluation, or filling data gaps.

2. Incremental Actions - Stressors with less risk (e.g., moderate probability and temporary impacts) could be considered as a lower priority that does not require immediate steps.

d. Discussion

i. USACE provided an overview of the Uncertainty Analysis process (see attached slides) and shared that actions are not necessarily project construction, but could be a study, monitoring, funding, etc. The group decided to discuss uncertainties at the RPA scale.

ii. The group asked if enough is known about habitat degradation to recommend action to be taken. Some information is known, and the table for uncertainty could be formatted to include a stressor in each column based on the issue around the stressor. The State Wildlife Action Plan as an example: we know we are losing this habitat and we don't want to lose this habitat for X reason.

iii. One participant pointed out that loss of floodplain habitat is a major concern and asked if it could be studied further to understand if it could be restored. Practice-wise it could be restored, but the question is whether or not it would be acceptable to the landowners (social aspects). A possible action might be to expand those research questions or identify target locations.

iv. It was suggested to identify by number or size of projects (fewer large projects or more small projects).

v. The group discussed starting with near- and long-term actions, then moving to uncertainties about what needs to be done to address the stressors. They also pointed out the importance of addressing uncertainties, but actions and measures should come first.

vi. The plan should be cautious about pinpointing actions but rather identify more general areas (watershed above Perry, for example) and ways to address the issue.

vii. Other agencies may need to be included as champions.

viii. The group discussed how the Milford Regional Conservation Partnership Program included a number of successes and the desire to continue/expand and use the value of cover crops and structural measures to justify getting more dollars.

ix. It was shared that people are wondering how we know this is working. The group identified the need to do a better job of gathering baseline data to know if something is working. A lot of current data is anecdotal from property owners. Not many new property owners are participating, and money has gone to people already using the measures. It was suggested that peers are what bring new people to the program.

x. There was discussion of a wish list to include bringing more people together to better understand the issue, success has been shown in peer-to-peer grant program.

VI. Measures

a. The working list of measures was provided as a read-ahead and will be used during the 1-day workshop.

VII. Do-outs / Next Steps

a. Participants to complete risk and uncertainty assessment for each RPA and send to USACE.
b. USACE to compile and finalize information on risk and uncertainty and provide to participants for review and comment.
c. Conduct Draft Recommendations Workshop.
d. USACE will prepare information on uncertainty and near-term and long-term actions.
    i. The group should focus on the near- and long-term table. USACE shared examples that could be included in the Recommendations table and noted that more work will be done on Recommendations during a future workshop.
    ii. The group clarified that other people in their organizations can contribute to share the information and those present today should ask for input from other subject matter experts as appropriate.
    iii. The USACE team would like one matrix per person and emphasized the importance of getting feedback from experts. If feedback is missing from a group, the USACE team will reach out. This piece is critical to the plan and members of this group are the experts in Kansas. USACE cannot fill in the gaps.
    iv. After this phase is complete, additional public input will be sought. The message is the Kansas River Basin is worth the work and investment. The group will contribute to the designation of expert / non-expert.
    v. The report will share a discipline range but will not name individual experts and their evaluations.
    vi. The group discussed outreach efforts to target experts that may not be involved currently, and while it was determined to keep the group smaller now, there will be an opportunity to be involved in the next phase to vet the outcome of the current phase.
e. Participants will review measures to prepare for a 1-Day Workshop that will focus framing of Draft Recommendations for each problem area.

i. USACE shared that the measures and strategies were identified using input from study partners, stakeholders, and subject matter experts but if there is something missing or a new idea emerges, it can be added.

ii. Determining the proper level of exploration and implementation remains a question.

iii. The group discussed some measures and strategies and how to promote them through pilot programs that would provide multiple benefits.

iv. USACE asked the group to review the measures and strategies to determine whether there is a consensus on implementable solutions.

v. Should constraints be considered and included in a separate assessment? We need to consider sub-basins with currently available data and tools, but the report should acknowledge constraints and strategies may not be known. One of the biggest benefits of this report is identifying what the problems are and if solutions are known. Constraints don't necessarily mean the solution isn't known, but we will have to strategize around each one individually.

vi. There has been a focus on the eastern end of the state previously; perhaps one of the recommendations of the study could be to include other areas to focus on with additional experts and context.

vii. Reference materials are available and include the sediment assessment, fisheries information, the water quality assessment, a water supply draft document, the life safety Res-SIM document, and the updated flow frequency assessment.

viii. Schedule moving forward:

1. Jan 18 – USACE team will share matrix + instructions and contact information. Participants should let USACE team know if it is shared outside the group to track, so the team knows to expect additional feedback.
2. Feb 8 – Responses due

ix. Future Working Group Meetings

1. Feb 3 – Flood Risk
2. Feb 13 – Recreation – To be rescheduled; likely date Feb 27
3. Feb 15 – Sediment and Erosion
4. Feb 21 – Water Supply
5. March 3 – Water Quality

x. USACE thanked participants and outlined next steps with a Draft Watershed Study completed in December 2023. She also reminded the team that the study needs to be

completed within the 5-year study timeframe (March 2024).

LOSS OF RECREATION OPPORTUNITIES

Kansas River Reservoirs Flood and Sediment Study

MEETING NOTES

DATE: Monday, February 27, 2023
TIME: 1:00 – 4:00 pm
LOCATION: In-Person / Teleconference
SUBJECT: Recreation Working Group Meeting

Location:
Kansas Water Office
900 SW Jackson Street, Suite 404
Large Conference Room
Topeka, KS 66612

Webex Info:
https://usace1.webex.com/usace1/j.php?MTID=mad23ad636509580776779f6a9ac44c91
844-800-2712
Meeting Number: 2763 694 2276
Meeting Password: vYYYQ3vd@62

Invitees (attendees in bold):

Kansas Water Office

Matt Unruh, Assistant Director; Nate Westrup, Manager – Public Water Supply Programs; Josh Olson, Project Management Lead; **Kirk Tjelmeland, Field Services Coordinator**; **Richard Rockel, Technical Services Lead; Amelia Nill, Regional Planning & Outreach Coordinator**

Kansas Department of Wildlife, Parks and Tourism

Steve Adams, Chief of Planning; **John Reinke, Fisheries Biologist**; Jordan Hofmeier, Aquatic Ecologist; Mark VanScoyoc, Survey Coordinator, Ecologist; **Linda Lanterman, Parks Supervisor; Conner O'Flannagan, Parks Supervisor; Kyle Hoover, Natural Resources Officer; Levi Gantenbein, Natural Resources Officer; Willis Ohl, State Park Manager**

U.S. Army Corps of Engineers

Laura Totten, Planner/Project Manager; Jennifer Henggeler, Risk and Communications Section Chief; Jeff Tripe, Plan Formulation Section Chief; **Ginger Harper, Planner/Communications/Outreach**; **Julie MacLachlan, Communications/Outreach; Brian Twombly, Engineer**; John Shelley, Engineer; Marvin Boyer, WQ Program Coordinator; **Noah Colby George, Economist**; Kara Cline, Engineer; **Holly Bender, Economist (Abt – USACE consultant)**

Others

Dawn Buehler, Kansas River Keeper / Friends of the Kaw; **Aaron Deters, Kansas Alliance for Wetlands and Streams**; Chris Thorton, Ducks Unlimited; Matt Hough, Ducks Unlimited

MEETING NOTES

I. Laura Totten (USACE) led introductions and shared meeting purpose and desired outcomes.

II. **Purpose and Desired Outcomes**

a. Purpose and Desired Outcome of Problem Area Meetings

i. Conduct and complete Risk Assessment and Evaluation to support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study for each problem area (i.e., Flood Risk, Sedimentation and Erosion, Reduction in the Ability to Meet Water

Supply Demands, Degraded/Poor Water Quality, Ecosystem Degradation and Species Impact, Loss of Recreation Opportunities) for 5 planning areas - Kansas Regional Planning Area (RPA), Solomon-Republican RPA, Smoky Hill Saline RPA, Upper Republican RPA, Upper Smoky Hill RPA.

ii. Review process for Uncertainty Assessment of Stressors

iii. Review and refinement of existing list of measures and strategies. Laura Totten (USACE) shared that there are no measures that directly impact Nebraska. They are looking at recreation with a water-based aspect, although they are sometimes tied to land-based recreation. There are over 50 measures that impact recreation, directly and indirectly.

b. Purpose and Desired Outcome of Recommendations Workshop

i. Using information from problem area meetings, hold a 1-day workshop to develop draft recommendations for all problem areas.

1. Identification of near-term and long-term actions / projects, evaluations, and data needs for each problem area and associated stressors.
2. Framing of Draft Recommendations for each problem area that includes details related to rough order of magnitude costs, potential funding sources, potential partners, and priority areas within the RPAs. Laura Totten (USACE) shared that the draft recommendations are due May 31.

III. Study Accomplishments

a. The Project Management Plan was developed.

b. A Shared Vision Statement and Objectives were developed.

c. The team has conducted extensive stakeholder and public outreach throughout the basin.

d. The team has completed acquisition and analysis of comprehensive datasets and information related to hydrologic conditions, hydraulics, sediment transport, economic data, water supply demand and uses, recreation benefits, biological resources, and cultural resources in the basin.

e. A framework has been developed to perform a comprehensive assessment of existing conditions and expected future conditions, enabling development of a strategic roadmap to inform future investment decisions by multiple parties and to better account for uncertainty.

f. Assessments and Technical Reporting for Existing Conditions and FWOP for reservoir sediment, reservoir operations, climate change, flow frequency, flood risk, water supply, water quality, biological resources, and recreation are complete.

g. Measures have been developed to address issues related to flood risk, sedimentation and erosion, ability to meet water supply demands, degraded/poor water quality, ecosystem degradation and species impact, and loss of recreation opportunities.

h. The Shared Vision Milestone was successfully completed.
i. The draft study will be available in late 2023, which will include public meetings to request input and stakeholder meetings along the way as needed.

IV. Risk Assessment and Evaluation

a. Sediment and Erosion/Reservoir/Recreation Assessments
    i. Laura Totten (USACE) shared John Shelley's (USACE) Reservoir Sediment Assessment, which looks at how bad the sediment could get if nothing is done (see attached slides). The study will be complete in 2024, and includes 25-, 50-, and 100-year projections. Tuttle Creek Reservoir would be impacted the most; Kanopolis and Perry Reservoirs would also be greatly impacted. Also included in the assessment are impacts of future conditions, multipurpose pool future conditions, and future conditions for recreation. The models do not quantitatively account for climate change and can only use qualitative information for projections. Laura Totten (USACE) noted that the models are based on historical data, which means drought events could be more frequent, last longer, etc. in the future.
    ii. Laura Totten (USACE) shared the quantitative models for the six Kansas USACE reservoirs and Waconda based on multipurpose and flood pool future conditions. Drought will have a direct and meaningful impact on recreation. Total visitation at Milford Reservoir is estimated at 1.6 million per year (2018), which includes some data for hunting and other land-based uses. Losses are projected annually. Very little recreation can occur when pools are really high or really low. Data from 2018 is used as the base or benchmark.
    iii. Holly Bender (Abt) shared there are two different metrics – an evaluation of decreased economic benefits in the local economy and an evaluation based on visitor spending; both are tied to visitation numbers.
b. Process Overview
    i. Laura Totten (USACE) explained the process of Risk and Uncertainty Assessment.
c. Problems and Stressors
    i. Laura Totten (USACE) shared that losing opportunity for public lands impacts recreation, revenue, etc. Land acquisition opportunities for water recreation in Kansas are limited.
d. Qualitative Probability and Consequence Evaluation
    i. Risk Categories (see attached file)
        1. Economic Risk – The likelihood and consequences of harm/damage to property, infrastructure, and other assets, as well as economic systems (measured in monetary terms).

2. Social – The likelihood and consequence of loss of social connectedness, adverse effects to disadvantaged communities, displacement of individuals, and ability for subsistence (ability of individuals/communities to be self-sustaining – reliance on natural resources to support a community and livelihoods).
3. Environmental – The likelihood and consequence of ecosystem services impacts (the various benefits provided by certain environmental and natural resources to communities), habitat loss, and species loss.
4. Life Loss – The likelihood and consequence of the stressor occurring and subsequent life loss.

ii. Focus / Opportunity Areas

1. Laura Totten (USACE) explained the exercise of assessing each of the stressors in Risk categories in preparation for the working group meeting. TJ (KWO) used the Kansas Water Plans as the basis for his assessment. Laura Totten (USACE) also conducted the assessment and primarily used information and assessments from the watershed study. USACE will share both pre-populated matrices with the group, including notes about their assessments. The goal of the assessments is to generate discussion, not necessarily to gain consensus.
2. Julie MacLachlan (USACE) is using the CEQ disadvantaged community tool to understand the impact of a loss of recreation dollars. At first glance it appears Junction City would be additionally burdened by a loss of revenue at Milford Reservoir. Holly Bender (Abt) asked about including environmental justice (EJ) considerations in the social risk and environmental risk categories. Julie MacLachlan (USACE) is trying to figure out how detailed to make the assessment and noted that judgment calls will have to be made and would include appropriate documentation about the EJ assessments.
3. Laura Totten (USACE) shared that the risk assessment is specific to USACE reservoirs and does leave room for interpretation.
4. Kansas Regional Planning Area
    a. Environmental Risk – Laura Totten (USACE) noted the need to identify areas where more research needs to be done, given where development is occurring, primarily in the eastern side of the state.
        i. Laura Totten (USACE) questioned if Environmental Risk #28 (Land Management Issues) should be included as a stressor. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) suggested that it should remain because, for example, if an area floods, the access to fishing is

lost. Fishing can be for recreation, but flooding would have a higher impact for those dependent on fishing as a source of food.

ii. Holly Bender (Abt) thinks this stressor is focused on the scarcity of public lands and the loss of access when there are minimal substitutes or alternatives and can contribute to economic losses. Stressor #28 could be added to the other Loss of Recreational Opportunities stressors, but loss of access should be accounted for at least as a moderate impact.

iii. John Reinke (KDWP) commented that KDWP spends quite a bit of money on land for access for hunters and fishers and agrees with changing the risk to a moderate impact.

b. Social Risk – Dawn Buehler (Kansas River Keeper / Friends of the Kaw) suggested the consideration of language barriers and the relationship between game officers and the public during interactions of hunting / fishing.

c. Environmental Risk – The group discussed the impact of the stressors and there being room for interpretation. Stressor #31 impacts different divisions and should be a high impact. Linda Lanterman (KDWP) shared from a state park perspective the state is still recovering from 2019 flooding and it will likely take years. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) shared that one of the big losses is the ability to regain the attention of the public once the connection is lost because of drought or flood. This impacts the environmental aspect of recreation (e.g., people are less likely to support cleanup efforts on the river).

d. Life Loss – Dawn Buehler (Kansas River Keeper / Friends of the Kaw) mentioned water quality issues. Julie MacLachlan (USACE) asked about observations of recreators over time. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) and John Reinke (KDWP) suggested there are more users. They started a user survey on the Kansas River and had to have the survey translated, as well as education materials on invasive carp, primarily into Spanish. KDWP is starting to publish their regulations booklet in Spanish, as well as signage and visual communication. They are also trying to figure out what they don't know.

i. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) noted that some areas have good safety along the river, while others do not. It seems based on proximity to emergency services and resources in the adjacent communities. Safety kiosks are now being installed at all of the boat ramps on the river because of an incident that occurred. Also, it

would be beneficial to have these in multiple languages and in consideration of literacy levels.

ii. Laura Totten (USACE) clarified that Stressor #31 is related to loss of revenue. The group discussed the probability and consequence of this happening and decided that, if it does occur, it would likely have a high impact on life loss.

iii. Currently there have not been any instances of water quality/harmful algal blooms (Stressor #30) primarily related to human life loss/life safety. All instances have been more related to animals. It is not likely to occur, but it should be accounted for, as it could occur in the future.

iv. Reservoir sedimentation (Stressor #29) – would it have a life loss/life safety risk? It is likely to occur but would have a low impact. It could be a safety issue related to boating.

e. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Kansas RPA are shown below (Figure 1 through Figure 4). The notes included in the matrix by subject matter experts are also included below each table.

Economic Risk Assessment Results							
Problem	Stressor	Number	Probability	Likely to Occur		28	29, 30, 31
Loss of Recreational Opportunities	Land Management Issues	28					
	Reservoir Sedimentation	29		Moderate Chance of Occurring			
	Water Quality / Harmful Algal Blooms	30					
	Loss of Recreational Opportunities, Increased Operational Costs, and Lost Revenues From Flooding and Drought	31		Not Likely to Occur			
					No to Low Impact	Moderate Impact	High Impact
					Consequence		

Figure 1. Kansas RPA Economic Risk Assessment

Notes: This region is highly populated and has multiple federal reservoirs and rivers that support recreation. Land management is noted on page 81 in the "Increase Awareness of Kansas Water Resources" section of the Kansas Water Plan (KWP), used in the same sentence as economic impact. Reservoir sedimentation is listed on pages 37 and 41 of the KWP in the Reservoir section. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and specifically in the Kansas Region on page 122. Water quality is listed over 200 times in the KWP and specifically on

pages 123 and 124 where it is tied to HABs. Flooding is listed over 30 times in the KWP and in particular on pages 124 and 125 in the Kansas Regional section.

Four USACE reservoirs (Milford, Tuttle Creek, Perry, and Clinton) and the Kansas River mainstem occur in this RPA. The reservoirs have a variety of recreation amenities, including 10 parks managed by KDWP or USACE, with several city and county parks. Other amenities include boat ramps, beaches, campsites, picnic areas, hiking and biking trails, disc golf course, golf course, cross country ski trail, equestrian trails, ORV trails, yacht club, wildlife areas, archery hunting areas, archery and shooting ranges, and marinas.

The Kansas River mainstem has 19 access points along the river that allow for many types of recreational opportunities and boating. A popular recreation area is the Kaw River State Park. The mainstem is designated as a National Water Trail. Common recreation activities include sightseeing, boating, fishing, camping on sandbars, hiking, hunting, and biking. Large, organized events draw people to the river with approximately 1,500 people attending these events regularly (2017). Businesses rent canoes and kayaks along the river as well as host guided paddle trips and fishing trips. Friends of the Kaw provides educational paddle trips for the public.

Flooding can result in large adverse effects to river recreation, especially boating and other water-based activities. Hunters, anglers, and campers often utilize the sandbars, which are not available in the event of a flood. Excessive flows (dependent on experience of boater) can prohibit people from accessing the river because of safety concerns. Businesses and others that benefit from river trips, such as restaurants and retail establishments, experience a decrease in revenue. If severe enough, floods can destroy boat ramps. Flooding substantially impacts the economics of reservoir recreation. Flooding causes lost revenues from closures (at times they have been for long periods or the entire summer season) and substantial costs for repairs/lake staff time. Economic losses during flooding have been substantial (reduction in visitation and spending, repair costs).

Drought can also have adverse effects on recreation on the Kansas River. Low flows can cause water quality effects (unpleasant odors) that cause unpleasant experiences for recreators and make conditions difficult to boat the river. Drought conditions that have caused low water levels cause economic impacts related to reservoir visitation (limiting access to boating and other recreational activities).

Sedimentation now and in the future that reduces reservoir storage capacity will have serious impacts economically to the local, regional. and national economy from loss of recreational use. Sedimentation could also cause more frequency in water level fluctuations that create unfavorable conditions for recreators (e.g., poor fisheries, flooded recreation facilities, access issues). Sedimentation at Tuttle Creek with substantial lost storage could require increased releases at Perry and Milford, leading to greater water level fluctuations at these reservoirs and causing increased impacts to recreation. Additionally there could be reduced flows in the Kansas River mainstem impacting recreation on the river.

Harmful algal blooms at reservoirs have caused closure of areas or warning/watches to be issued. Milford Reservoir has seen the most severe impacts from HABs in the RPA, with extended periods of closures in portions of the reservoir. Persistent warnings can decrease visitation at a lake, which can adversely affect economic activity in adjacent communities.

Reductions of fisheries caused by adverse conditions (flooding/emigration, water quality, drought, ANS) that requires stocking takes above normal annual amounts can cause an economic impact to the state.

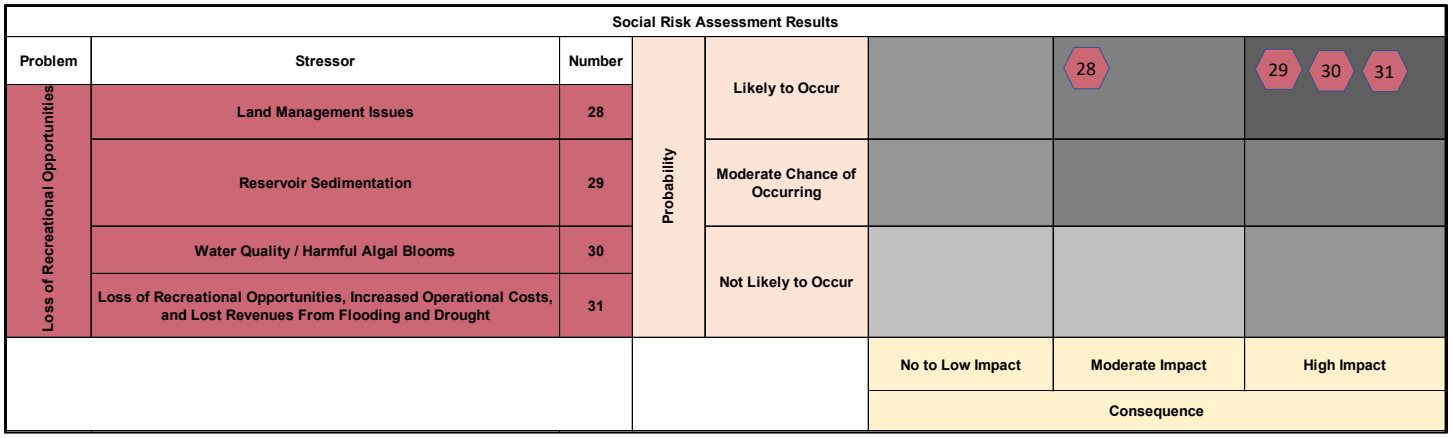


Figure 2. Kansas RPA Social Risk Assessment

Notes: This is one of the more populated regions. With millions of days spent on recreational hobbies, loss of opportunities could have health impacts. Page 80 of the KWP notes the use of social marketing related to Kansas Runs on Water.

Lack of shoreline access at reservoirs can limit the ability of recreators to enjoy some types of recreation (e.g., fishing). At some reservoirs, shoreline access is quite limited because there is not public access (most are privately owned). Bank fish can be restricted as well when water levels are elevated and access areas are submerged. High water can also limit access from road closures, which further distances recreators from the water. Flood debris can cause boating issues as well.

Drought can further exacerbate conditions from reduced water-based and shore-based recreation during these periods. Drought has also caused reductions in game bird species that are often sought after in wildlife areas associated with reservoirs, leading to a reduction in visitor opportunities and spending in the surrounding communities.

At reservoirs with high sedimentation (i.e., Tuttle Creek) many of the historically popular areas in the upper end of the reservoir have been lost or changed to land-based recreation (even with conversion there were drastic drops in visitation). Many of the accessible shoreline areas were in this area at Tuttle Creek and there are few shoreline areas developed in the lower reaches of the reservoir. With almost total loss of the multi-purpose pool at Tuttle Creek for projected sedimentation, most, if not all, of the water-based recreation would be lost. With increased use of water at Perry and

Milford to supplement the loss of flow from Tuttle, recreation opportunities could be impacted there as well. Modeling shows periods of low to no storage at these reservoirs during extreme drought conditions. This would have multi-year impacts.

Some reservoirs do not have an adequate number of boat ramps to support high boating numbers (e.g., Tuttle Creek). Some of these have been lost to sedimentation, road closures, or lack of maintenance. When reservoir levels are high, boat ramps can become even more inaccessible, which further reduces the ability for boaters to gain access. High and low water hazards can contribute to low use of a reservoir and could create safety concerns.

Rapid water level fluctuations can also make it harder for fisherman to have a successful fishing trip, thereby lowering the quality of the overall experience.

Harmful algal blooms at reservoirs have caused closures of areas or warning/watches to be issued. Milford Reservoir has seen the most severe impacts from HABs in the RPA, with extended periods of closures in portions of the reservoir. Persistent warnings can decrease visitation at a lake or affect the overall visitor experience if they have concerns about their safety or are unable to access preferred areas of a reservoir (swimming areas, boating areas).

Because there is only a small amount of public land used for recreation (0.7%) there are limited opportunities to expand or replace recreation opportunities in the watershed. It is imperative to protect these resources to promote sufficient recreation opportunities.

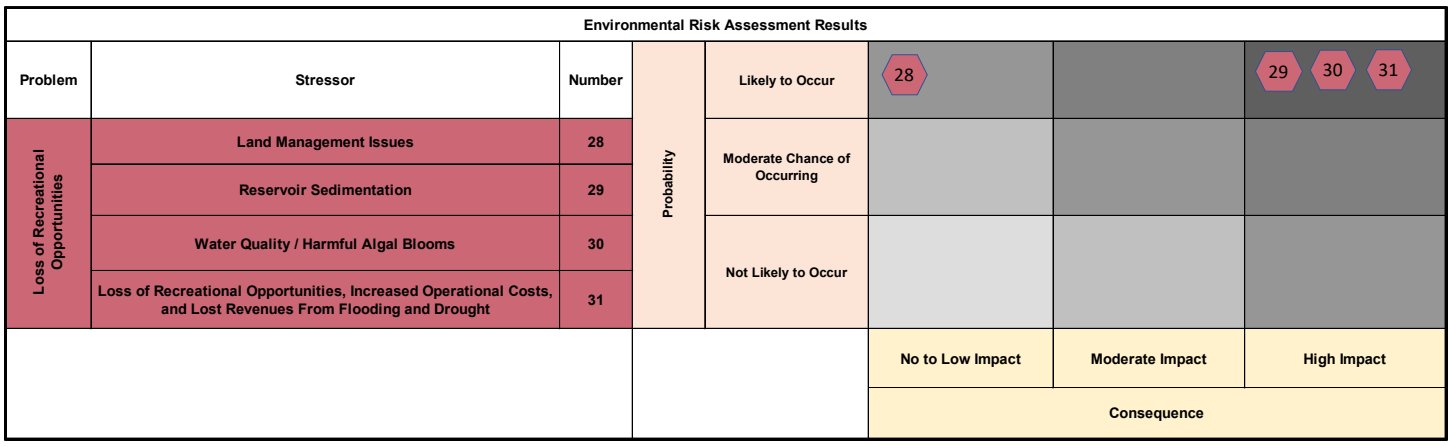


Figure 3. Kansas RPA Environmental Risk

Notes: This region is highly populated and has multiple federal reservoirs and rivers that support recreation. Land management is noted on page 81 in the "Increase Awareness of Kansas Water Resources" section of the Kansas Water Plan (KWP), used in the same sentence as economic impact. Reservoir sedimentation is listed on pages 37 and 41 of the KWP in the Reservoir section. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and specifically in the Kansas Region on page 122. Water quality is listed over 200 times in the KWP and specifically on

pages 123 and 124, where it is tied to HABs. Flooding is listed over 30 times in the KWP and in particular on pages 124 and 125 in the Kansas Regional section.

Reservoir sportfish are affected by water level fluctuations, abundance and distribution of flooded terrestrial vegetation, invasive species, turbidity or lack of, and sedimentation. Frequent dynamic water levels have restricted the angling potential of a reservoir from high fish emigration rates and inconsistent recruitment of many of the popular sportfish species.

The current lake level management plan at Tuttle Creek has not changed substantially since 1990. The current plan is not ideal for the production of a good fishery and is mostly irrelevant, as water levels here rarely meet the requirements of the LLMP.

Sedimentation affects the natural resources at reservoirs with water quality concerns and conditions that limit fishery production for native and game fish species. However, sedimentation can create terrestrial habitat (i.e., wetlands) and create expanded opportunities for wildlife viewing and hunting.

Aquatic nuisance species can alter the food web in reservoirs, creating recruitment issues (poor health, slow growth) for fish.

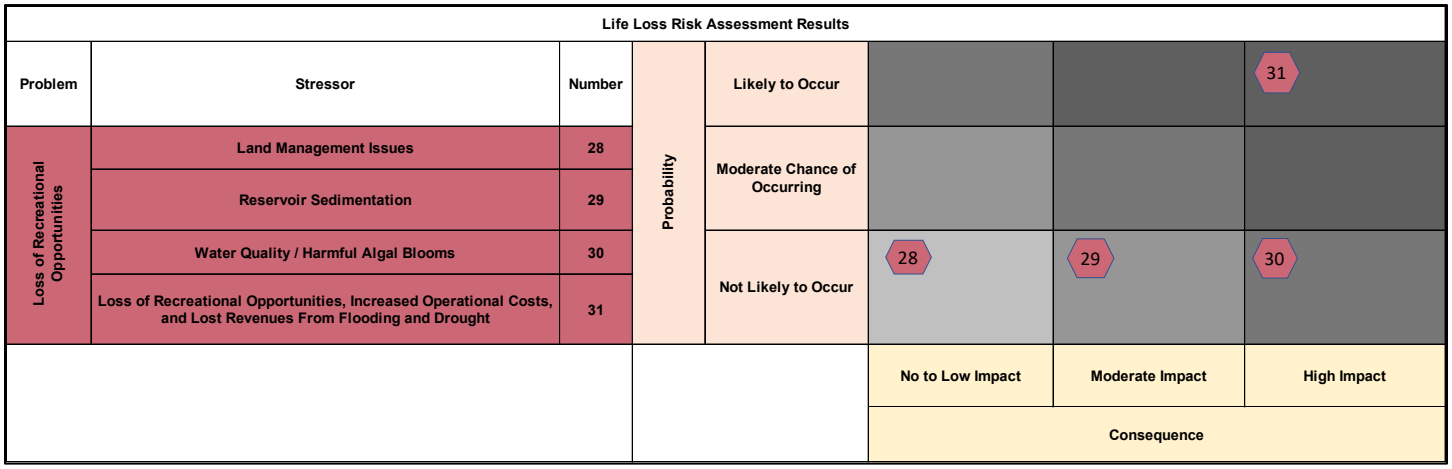


Figure 4. Kansas RPA Life Loss Risk Assessment

Notes: This is one of the more populated regions, with millions of days spent on recreational hobbies. Loss of life is only mentioned once on page 143 of the KWP. However, there are lives lost almost every year to hunting and boating accidents. Extreme events is listed multiple times in the KWP, some of which could potentially lead to the loss of life.

On the Kansas River, safety concerns include boating safety at the Topeka Water Plant Weir. Rock structures have been constructed within the weir to improve water currents and flows to reduce safety concerns for boaters. There are also safety concerns during flood and drought conditions that result in streamflow or water levels that are too high or too low for safe recreational activities.

Local emergency services are experiencing an increased need to help boaters who are not prepared for the river and have acquired additional equipment to meet these demands (e.g., airboats, inflatable rafts). If boaters attempt to recreate on the river during periods when flows are too high for their level of experience, there could be safety concerns.

Sand and gravel dredging along the Kansas River mainstem can cause dangerous conditions for boaters/fishers because of cables that attach the dredge to the bank, which are at times hard to see by boaters. If dredgers are not aware of boaters, they cannot respond to removal of the cable in time for passing of boaters, particularly if the flows are moving fast or if there is excessive noise. This occurs mainly in the Desoto area.

High and low water hazards at reservoirs can contribute to low use of a reservoir and could create safety concerns.

HABs can cause safety concerns to humans and animals if they are exposed to HABs that can cause illness or even death.

If impacts occur to the economics related to recreation and these funds are used for additional safety measures (river recreation emergency response), this could lead to a higher likelihood of safety concerns with high impacts.

5. Solomon-Republican Regional Planning Area
    a. The matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Solomon-Republican RPA are shown below (Figure 5-9).

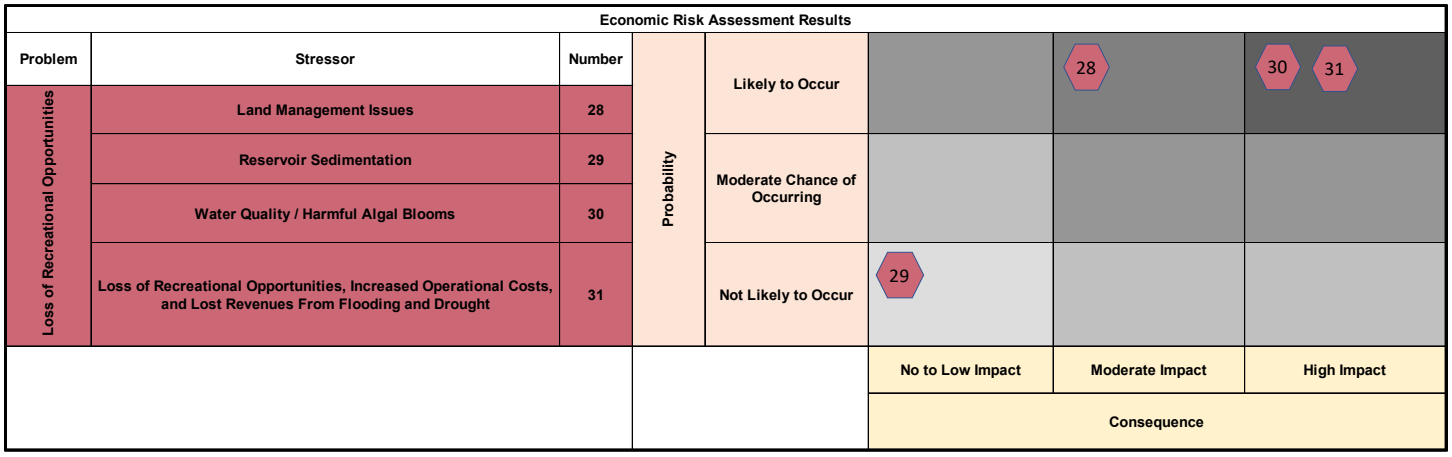


Figure 5. Solomon-Republican RPA Economic Risk Assessment

Notes: This region has multiple federal reservoirs and rivers that support recreation. Land management is noted on page 81 in the "Increase Awareness of Kansas Water Resources" section of the Kansas Water Plan (KWP), used in the same sentence as economic impact. Reservoir sedimentation is listed on pages 37 and 41 of the KWP in the Reservoir section. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and specifically in the Solomon-

Republican Region on pages 174 & 175. Water quality is listed over 200 times in the KWP and specifically on pages 176 and 177, where it is tied to HABs. Flooding is listed over 30 times in the KWP.

Five USBR reservoirs (Keith Sebelius, Kirwin, Lovewell, Waconda, and Webster Reservoirs) occur in this RPA.

The reservoirs have a variety of recreation amenities, including parks managed by KDWP and a National Fish and Wildlife Refuge managed by USFWS. Other amenities include boat ramps, beaches, campsites, picnic areas, trails, wildlife areas, rental cabins, and marinas.

Flooding substantially impacts the economics of reservoir recreation. Flooding causes lost revenues from closures (at times they have been for long periods or the entire summer season) and substantial costs for repairs/lake staff time. Economic losses during flooding have been substantial (reduction in visitation and spending, repair costs).

Drought conditions that have caused low water levels cause economic impacts related to reservoir visitation (limiting access to boating and other recreational activities). Drought can further exacerbate conditions from reduced water-based and shore-based recreation during these periods. Drought has also caused reductions in game bird species that are often sought after in wildlife areas associated with reservoirs, which leads to a reduction in visitor opportunities and spending in the surrounding communities.

Harmful algal blooms at reservoirs have caused closure of areas or warning/watches to be issued. Persistent warnings can decrease visitation at a lake, which can adversely affect economic activity in adjacent communities.

Reductions of fisheries caused by adverse conditions (flooding/emigration, water quality, drought, ANS) that requires stocking takes above normal annual amounts can cause an economic impact to the state.

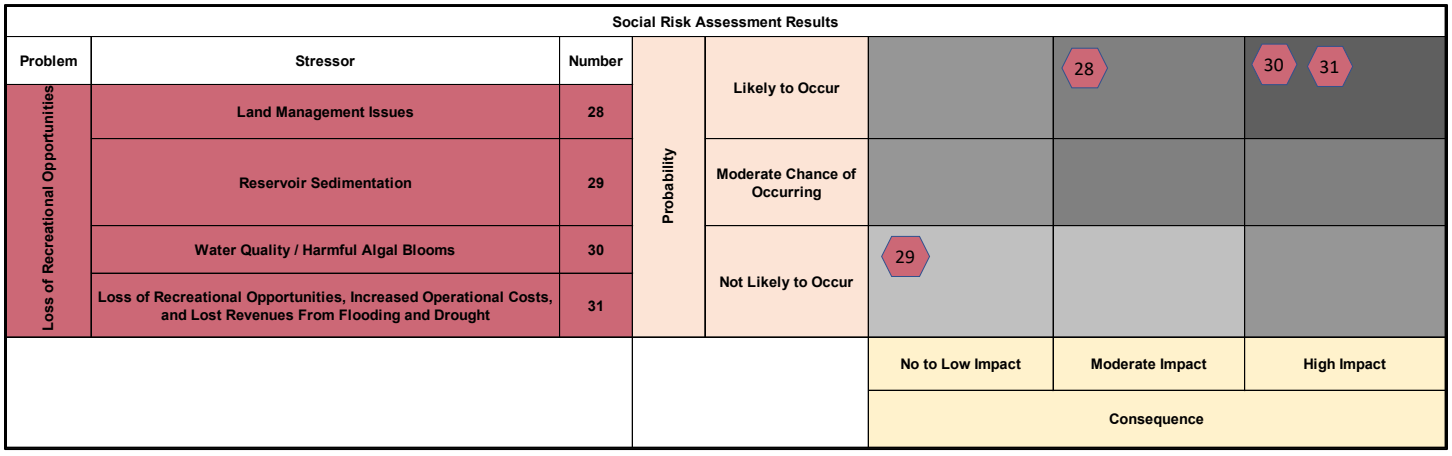


Figure 6. Solomon-Republican RPA Social Risk Assessment

Notes: This is one of the more populated regions. With millions of days spent on recreational hobbies, loss of opportunities could have health impacts. Page 80 of the KWP notes the use of social marketing related to Kansas Runs on Water.

Lack of shoreline access at reservoirs can limit the ability of recreators to enjoy some types of recreation (e.g., fishing). At some reservoirs, shoreline access is quite limited because there is not public access, since most are privately owned. Bank fish can be restricted as well when water levels are elevated and access areas are submerged. High water can also limit access from road closures, which further distances recreators from the water. Flood debris can cause boating issues as well.

Drought can further exacerbate conditions from reduced water-based and shore-based recreation during these periods. Drought has also caused reductions in game bird species that are often sought after in wildlife areas associated with reservoirs, which leads to a reduction in visitor opportunities and spending in the surrounding communities.

Some reservoirs do not have an adequate number of boat ramps to support high boating numbers. Some of these have been lost to sedimentation, road closures, or lack of maintenance. When reservoir levels are high, boat ramps can become even more inaccessible, which further reduces the ability for boaters to gain access. High and low water hazards can contribute to low use of a reservoir and could create safety concerns.

Rapid water level fluctuations can also make it harder for fisherman to have a successful fishing trip, thereby lowering the quality of the overall experience.

Harmful algal blooms at reservoirs have caused closure of areas or warning/watches to be issued. Persistent warnings can decrease visitation at a lake or affect the overall visitor experience if they have concerns about their safety or are unable to access preferred areas of a reservoir (swimming areas, boating areas).

Because there is only a small amount of public land used for recreation (0.7%) there are limited opportunities to expand or replace recreation opportunities in the watershed. It is imperative to protect these resources to promote sufficient recreation opportunities.

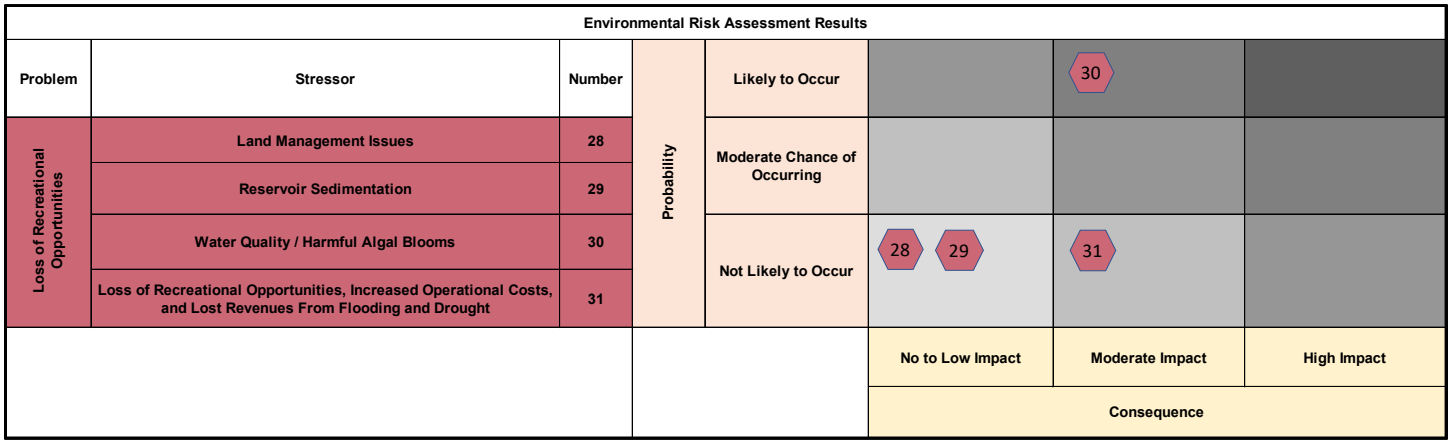


Figure 7. Solomon-Republican RPA Environmental Risk Assessment

Notes: This region is not as populated as the Kansas Region; however, it has multiple federal reservoirs and rivers that support recreation. Land management is noted on page 81 in the "Increase Awareness of Kansas Water Resources" section of the KWP, used in the same sentence as economic impact. Reservoir sedimentation is listed on pages 37 and41 of the KWP in the Reservoir section. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and specifically in the Solomon-Republican Region on pages 174 & 175. Water quality is listed over 200 times in the KWP and specifically on pages 123 and 124, where it is tied to HABs. Flooding is listed over 30 times in the KWP.

Reservoir sportfish are affected by water level fluctuations, abundance and distribution of flooded terrestrial vegetation, invasive species, poor water quality, turbidity or lack of, and sedimentation. Rapid declines in lake elevations lead to decreased fish species reproduction, especially if the decline occurs during a spawning period.

Sedimentation affects the natural resources at reservoirs with water quality concerns and conditions that limit fishery production for native and game fish species. However, sedimentation can create terrestrial habitat (i.e., wetlands) and create expanded opportunities for wildlife viewing and hunting.

Aquatic nuisance species can alter the food web in reservoirs, which creates recruitment issues (poor health, slow growth) for fish.

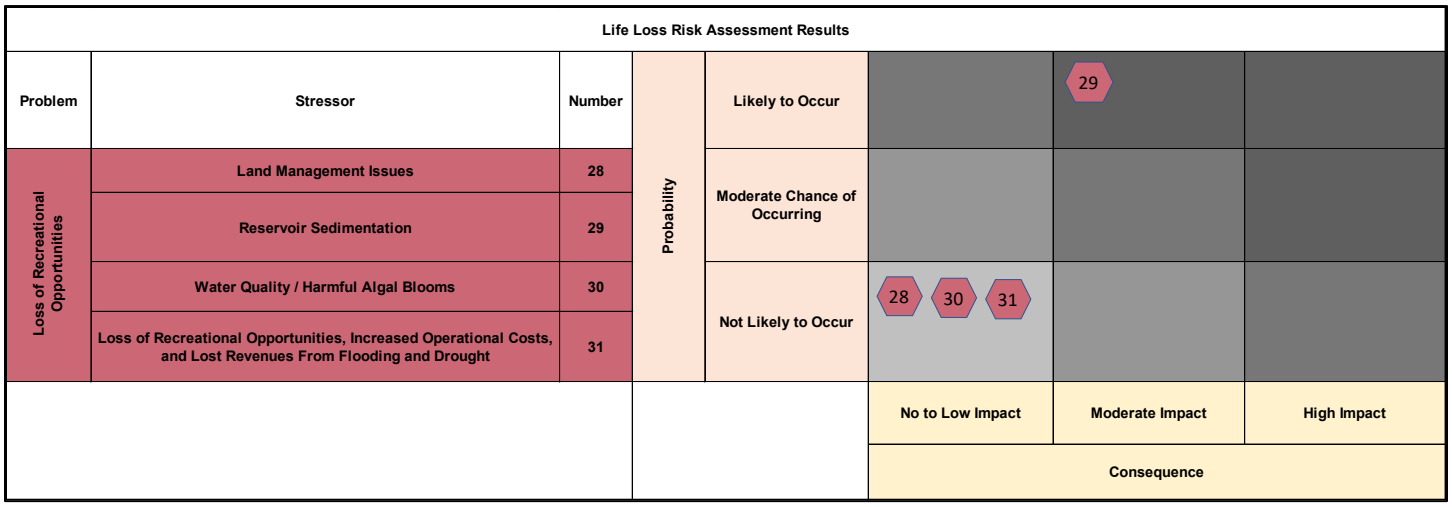


Figure 8. Solomon-Republican RPA Life Loss Risk Assessment

Notes: This region is less populated than the Kansas Region, but with the federal reservoirs and rivers, there are millions of days spent on recreational hobbies,. Loss of life is only mentioned once on page 143 of the KWP. However, there are lives lost almost every year to hunting and boating accidents. Extreme events is listed multiple times in the KWP, some of which could potentially lead to the loss of life.

High and low water hazards at reservoirs can contribute to low use of a reservoir and could create safety concerns.

HABs can cause safety concerns to humans and animals if they are exposed to HABs that can cause illness or even death.

6. Smoky Hill-Saline Regional Planning Area
    a. The matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Smoky Hill-Saline RPA are shown below (Figure 9 through Figure 12).

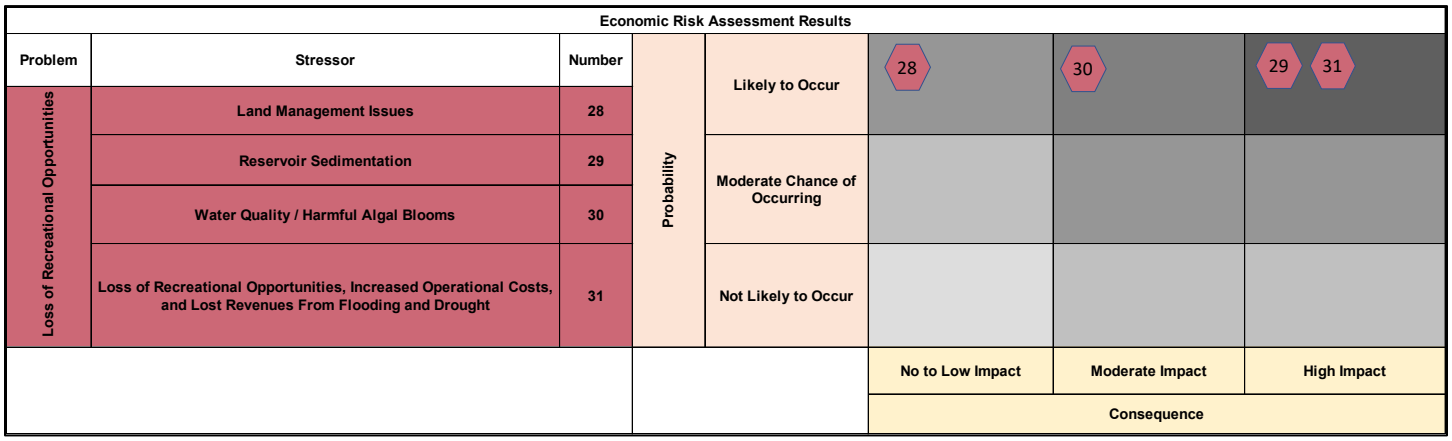


Figure 9. Smoky Hill-Saline RPA Economic Risk Assessment

Notes: This region is not as populated and has multiple federal reservoirs and rivers that support recreation. Land management is noted on page 81 in the "Increase Awareness of Kansas Water Resources" section of the Kansas Water Plan (KWP), used in the same sentence as economic impact. Reservoir sedimentation is listed on pages 37 and 41 of the KWP in the Reservoir section. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and specifically in the Smoky Hill-Saline Region on page 164. Water quality is listed over 200 times in the KWP and specifically on pages 123 and 124, where it is tied to HABs. Flooding is listed over 30 times in the KWP and in particular on page 169 in the Smoky Hill-Saline Regional section. Drought is listed over 30 times in the KWP and in the Regional Sections on page 168.

Two USACE reservoirs (Kanopolis and Wilson Reservoirs) and one USBR reservoir (Cedar Bluff Reservoir) occur in this RPA.

The reservoirs have a variety of recreation amenities, including parks managed by KDWP or USACE. Other amenities include boat ramps, beaches, campsites, picnic areas, trails, wildlife areas, rental cabins, and marinas.

Flooding substantially impacts the economics of reservoir recreation. Flooding causes lost revenues from closures (at times they have been for long periods or the entire summer season) and substantial costs for repairs/lake staff time. Economic losses during flooding have been substantial (reduction in visitation and spending, repair costs).

Drought conditions that have caused low water levels cause economic impacts related to reservoir visitation (limiting access to boating and other recreational activities). Drought can further exacerbate conditions from reduced water-based and shore-based recreation during these periods. Drought has also caused reductions in game bird species that are often sought after in wildlife areas associated with reservoirs, which leads to a reduction in visitor opportunities and spending in the surrounding communities.

Sedimentation now and in the future that reduces reservoir storage capacity will have serious economic impacts to the local, regional, and national economy from loss of recreational use. Sedimentation could also cause more frequency in water level fluctuations that create unfavorable conditions for recreators (e.g., poor fisheries, flooded recreation facilities, access issues).

Harmful algal blooms at reservoirs have caused closure of areas or warning/watches to be issued. Persistent warnings can decrease visitation at a lake, which can adversely affect economic activity in adjacent communities.

Reductions of fisheries caused by adverse conditions (flooding/emigration, water quality, drought, ANS) that requires stocking takes above normal annual amounts can cause an economic impact to the state.

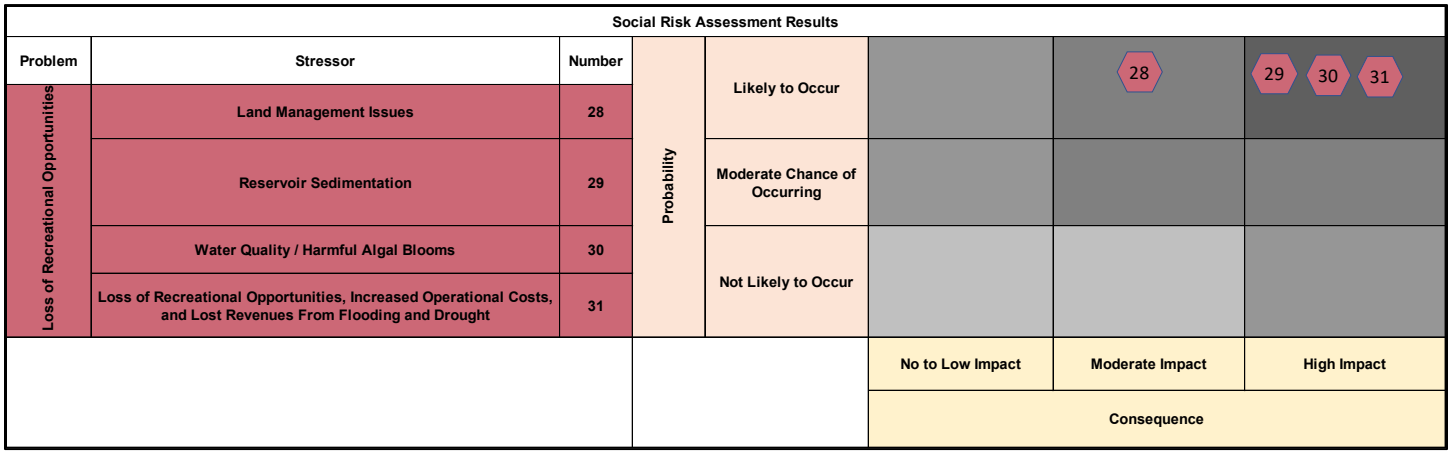


Figure 10. Smoky Hill-Saline RPA Social Risk Assessment

Notes: This region is not as populated as some; however, it pulls folks to the region and there are millions of days spent on recreational hobbies. Loss of opportunities could have health impacts. Page 80 of the KWP notes the use of social marketing related to Kansas Runs on Water.

Lack of shoreline access at reservoirs can limit the ability of recreators to enjoy some types of recreation (e.g., fishing). At some reservoirs, shoreline access is quite limited because there is not public access, since most are privately owned. Bank fish can be restricted as well when water levels are elevated and access areas are submerged. High water can also limit access from road closures, which further distances recreators from the water. Flood debris can cause boating issues as well.

Drought can further exacerbate conditions from reduced water-based and shore-based recreation during these periods. Drought has also caused reductions in game bird species that are often sought after in wildlife areas associated with reservoirs, which leads to a reduction in visitor opportunities and spending in the surrounding communities.

At reservoirs with high sedimentation (i.e., Kanopolis), historically popular areas in the upper end of the reservoir have been lost or changed to land-based recreation (even with conversion there were drastic drops in visitation).

Some reservoirs do not have an adequate number of boat ramps to support high boating numbers. Some of these have been lost to sedimentation, road closures, or lack of maintenance. When reservoir levels are high, boat ramps can become even more inaccessible, which further reduced the ability for boaters to gain access. High and low water hazards can contribute to low use of a reservoir and could create safety concerns.

Rapid water level fluctuations can also make it harder for fisherman to have a successful fishing trip, thereby lowering the quality of the overall experience.

Harmful algal blooms at reservoirs have caused closure of areas or warning/watches to be issued. Persistent warnings can decrease visitation at a lake or affect the overall visitor experience if they have concerns about their safety or are unable to access preferred areas of a reservoir (swimming areas, boating areas).

Because there is only a small amount of public land used for recreation (0.7%), there are limited opportunities to expand or replace recreation opportunities in the watershed. It is imperative to protect these resources to promote sufficient recreation opportunities.

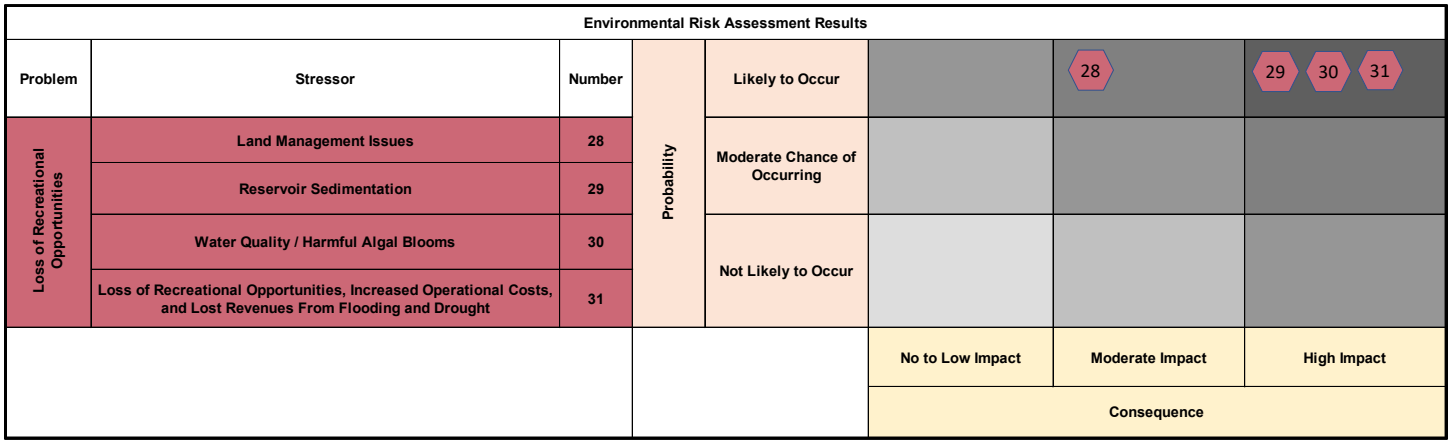


Figure 11. Smoky Hill-Saline RPA Environmental Risk Assessment

Notes: This region is not as populated and has multiple federal reservoirs and rivers that support recreation. Land management is noted on page 81 in the "Increase Awareness of Kansas Water Resources" section of the Kansas Water Plan (KWP), used in the same sentence as economic impact. Reservoir sedimentation is listed on pages 37 and 41 of the

KWP in the Reservoir section. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and specifically in the Smoky Hill-Saline Region on page 164. Water quality is listed over 200 times in the KWP and specifically on pages 123 and 124, where it is tied to HABs. Drought is listed over 30 times in the KWP and in particular on page 168 of this section. Flooding is listed over 30 times in the KWP and in particular on page 169 in the Smoky Hill-Saline Regional section.

Reservoir sportfish are affected by water level fluctuations, abundance and distribution of flooded terrestrial vegetation, invasive species, poor water quality, turbidity or lack of, and sedimentation. Rapid declines in lake elevations lead to decreased fish species reproduction, especially if the decline occurs during a spawning period.

Sedimentation affects the natural resources at reservoirs with water quality concerns and conditions that limit fishery production for native and game fish species. However, sedimentation can create terrestrial habitat (i.e., wetlands) and create expanded opportunities for wildlife viewing and hunting.

Aquatic nuisance species can alter the food web in reservoirs, which creates recruitment issues (poor health, slow growth) for fish.

Life Loss Risk Assessment Results							
Problem	Stressor	Number	Probability	Likely to Occur	29	30	
Loss of Recreational Opportunities	Land Management Issues	28		Moderate Chance of Occurring			
	Reservoir Sedimentation	29					
	Water Quality / Harmful Algal Blooms	30		Not Likely to Occur	28, 31		
	Loss of Recreational Opportunities, Increased Operational Costs, and Lost Revenues From Flooding and Drought	31					
					No to Low Impact	Moderate Impact	High Impact
					Consequence		

Figure 12. Smoky Hill-Saline RPA Life Loss Risk Assessment

Notes: This region is less populated than the eastern regions, but with the federal reservoirs and rivers, there are millions of days spent on recreational hobbies. Loss of life is only mentioned once on page 143 of the KWP. However, there are lives lost almost every year throughout the state due to hunting and boating accidents. Extreme events is listed multiple times in the KWP, some of which could potentially lead to the loss of life.

High and low water hazards at reservoirs can contribute to low use of a reservoir and could create safety concerns.

HABs can cause safety concerns to humans and animals if they are exposed to HABs that can cause illness or even death.

7. Upper Republican and Upper Smoky Hill Regional Planning Areas
    a. There are no USACE reservoirs in these RPAs and the stressors related to these are not applicable.
    b. The two RPAs are combined for the assessment, as there are only minimal differences and many similarities.
    c. TJ (KWO) noted that there's a US Fish and Wildlife Service study out for review right now on the economic impact of hunting in the Upper Republican and Upper Smoky Hill RPA. There are other tourist draws and recreation opportunities that are not tied to water.
    d. This region is a large recreational resource, but it's mainly upland hunting by individuals from out-of-state that brings substantial economic benefits to the region.
    e. There is one state lake in this region (Scott County Lake).
    f. The revised matrices for the four risk categories (economic, social, environmental, life loss) that were discussed and completed during the meeting for the Upper Republican RPA and Upper Smoky Hill RPA are shown below (Figure 13 through Figure 16).

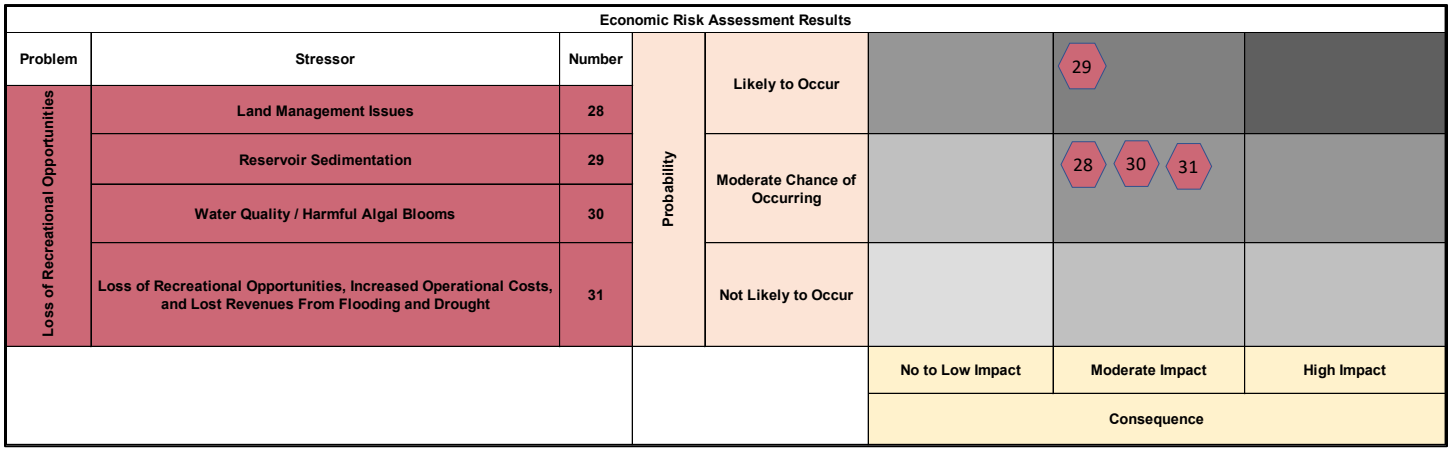


Figure 13. Upper Republican/Upper Smoky Hill RPAs Economic Risk Assessment

Notes: This region is less populated and has no federal reservoirs, but it does have some small lakes and rivers that support recreation. Land management is noted on page 81 in the "Increase Awareness of Kansas Water Resources"

section of the Kansas Water Plan (KWP), used in the same sentence as economic impact. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and still applies to smaller impoundments on page 196, where it is showing the results of a mineralization study. Water quality is listed over 200 times in the KWP and specifically on page 196. Flooding is listed over 30 times in the KWP, however not in this region.

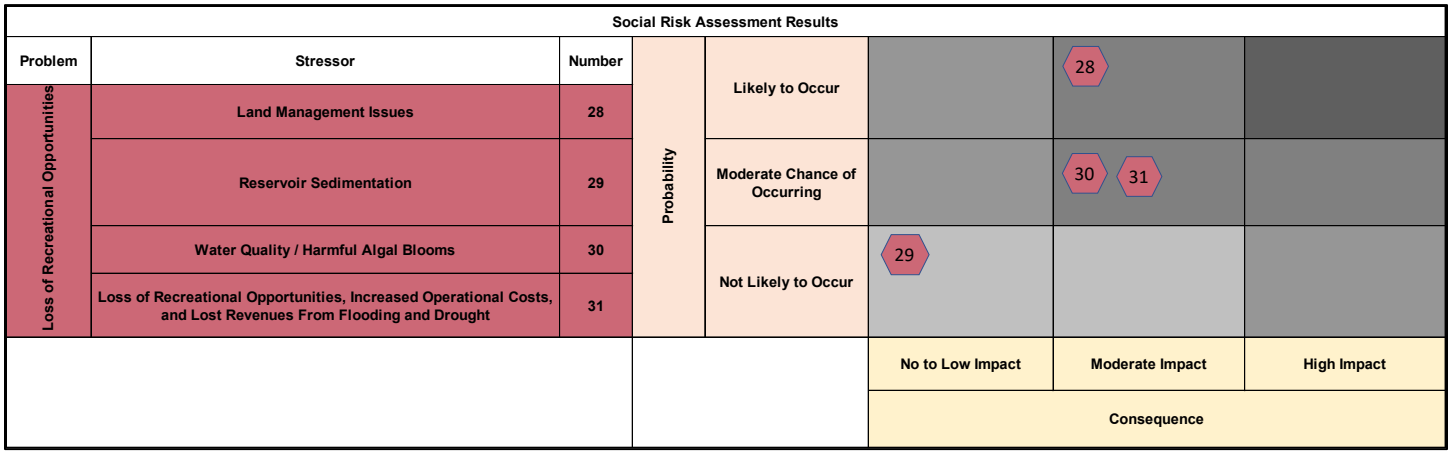


Figure 14. Upper Republican/Upper Smoky Hill RPAs Social Risk Assessment

Notes: This region is not as populated as some; however, it pulls folks to the region and there are millions of days spent on mostly non-water related recreational hobbies. Loss of opportunities could have health impacts. Page 80 of the KWP notes the use of social marketing related to Kansas Runs on Water.

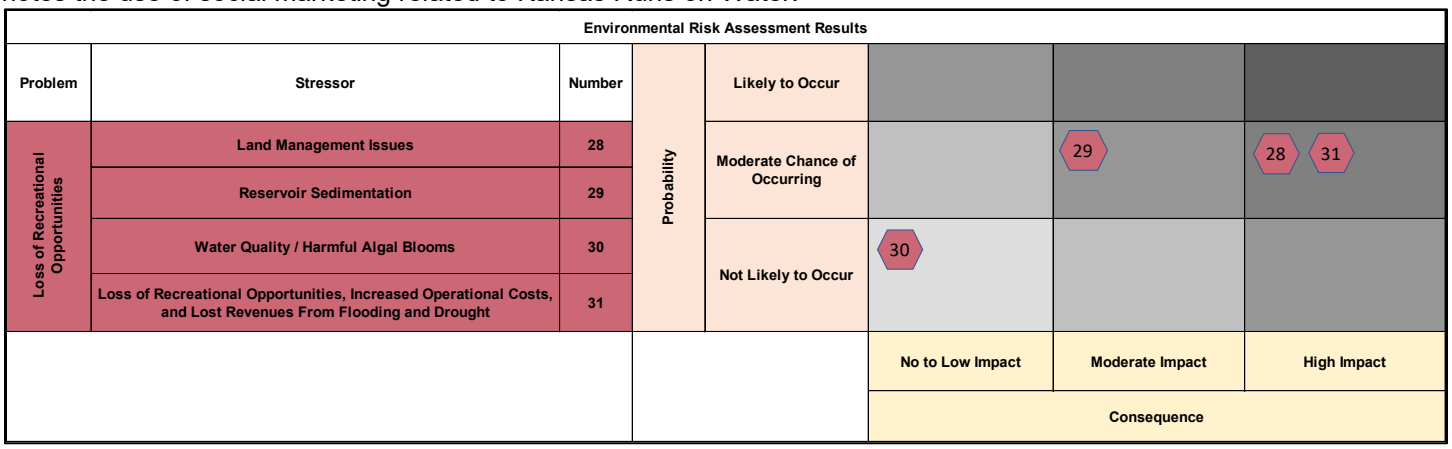


Figure 15. Upper Republican/Upper Smoky Hill RPAs Environmental Risk Assessment

Notes: This region is less populated and has no federal reservoirs, but it does have some small lakes and rivers that support recreation. Land management is noted on page 81 in the “Increase Awareness of Kansas Water Resources” section of the Kansas Water Plan (KWP), used in the same sentence as economic impact. Reservoir sedimentation is listed multiple times in Regional Sections of the KWP and still applies to smaller impoundments on page 196, where it is showing the results of a mineralization study. Water quality is listed over 200 times in the KWP and specifically on page 196. Flooding is listed over 30 times in the KWP, however not in this region. Drought is listed over 30 times in the KWP.

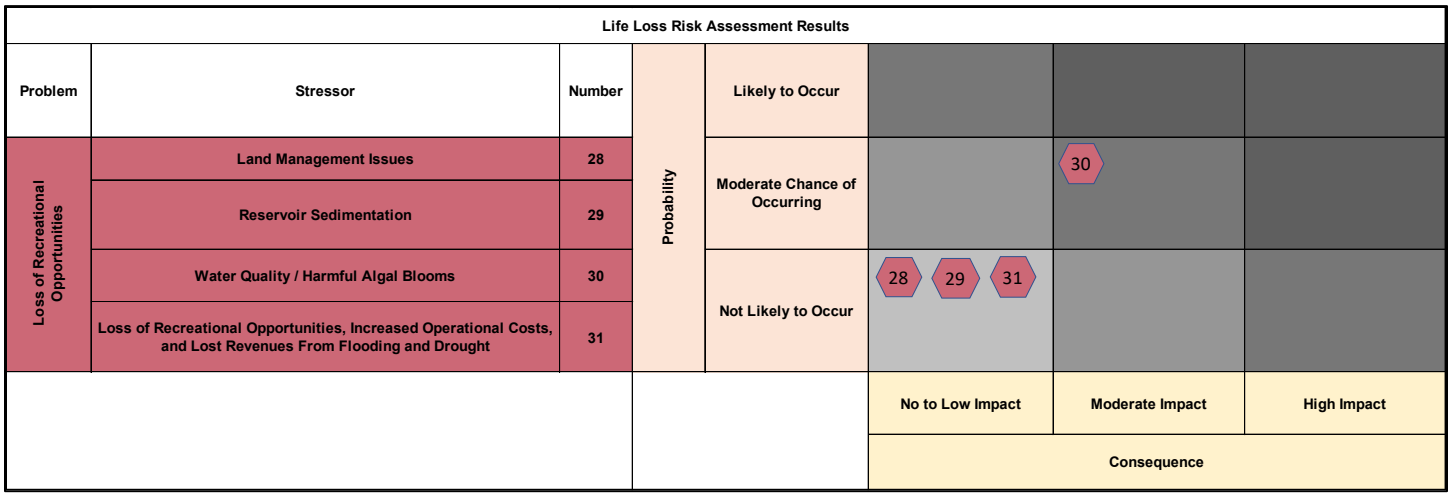


Figure 16. Upper Republican/Upper Smoky Hill RPAs Life Loss Risk Assessment

Notes: This is one of the least populated regions, with fewer days spent on recreational hobbies. Loss of life is only mentioned once on page 143 of the KWP. However, there are lives lost almost every year to hunting and boating accidents throughout the state. Extreme events is listed multiple times in the KWP, some of which could potentially lead to the loss of life.

iii. Other Discussion

1. Land management stressors also cross over into recreation stressors.
2. The walk-in program is considered public land for this purpose, 20-25% for hunting. We do not have the numbers for fishing.

V. Uncertainty Analysis

a. Qualitative assessment of uncertainty to identify the level of consensus among stakeholders in implementing potential risk reduction measures for each stressor.

b. Categories

i. Action – Implementable solutions with a high level of consensus to address a given stressor.

ii. Evaluation Options – Potential solutions defined with existing information or additional data would be required to better define the problem and/or identify potential solutions.

c. Supports development of a framework for the appropriate types of and timing for recommendations to help prioritize actions.

i. Categorize each stressor or parts of a stressor under the appropriate level of uncertainty.

1. Near-term Actions - Stressors with a high level of risk (e.g., high probability and high consequence) could require immediate steps to reduce risks through actions, evaluation, or filling data gaps.

2. Incremental Actions - Stressors with less risk (e.g., moderate probability and temporary impacts) could be considered a lower priority that does not require immediate steps.

VI. Measures

a. Review and refinement of existing measures for recreation. Laura Totten (USACE) reviewed the current list of measures for the watershed study and noted that some of the measures may need to be updated and refined. Possibly there are new ideas that should be added.

b. Discussion

i. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) asked about high flow diversions, which could mean diversion to an oxbow or other retention strategy to provide additional recreation. Laura Totten (USACE) noted USACE would need more authority to do that. USACE can only buy land for MRRP right now.

ii. Richard Rockel (KWO) noted that tying into the alluvial system could be used to recharge the aquifer. Laura Totten (USACE) noted it would be important to determine the best location to do that in order to have the largest impact.

iii. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) noted that right now a rescue vehicle could not be launched into the river at Eudora because the water level is low and the ramps are not long enough.

iv. Laura Totten (USACE) would like participants to send USACE their recommendations, as they are the ones closest to the issues and resolutions.

v. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) noted that recreationists were moving to tributaries that feed into the reservoirs that did not have access during the flooding in 2019. She wondered if public access points could be added to the tributaries.

vi. Linda Lanterman (KDWP) has had requests for ADA-accessible accommodations on ramps.

vii. John Reinke (KDWP) noted that improving the quality and quantity of boat ramps and access to existing boat ramps would be favorable. Boat ramps are on the public lands side of their house, but fisheries could add piers and other shoreline measures.

viii. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) suggested a private or public entity rent kayaks, canoes, etc. to provide more access to the river. Linda Lanterman (KDWP) has kayak and canoe rentals, fishing clinics; KDWP may need to better promote those services.

ix. Laura Totten (USACE) noted that cost share measures are sometimes not attainable, but the state should take advantage of opportunities where possible.

x. Linda Lanterman (KDWP) shared her desire to take care of the resources and assets they have.

xi. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) noted the lack of 3-day outlook updates to changes in river flow and has not had enough advance notice of release from reservoirs. There is not a way to let the public know about releases.

xii. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) shared that USGS includes low flow and high flow indicators of safety to the public and would like to see a similar level of communication of safety. On the Buffalo River, they use “empty” for low flow and “runable” (high, medium and low). We could reach out to USGS to determine if there is information that could be provided there.

xiii. TJ (KWO) noted that maintenance is a major issue for communities that don’t have the equipment. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) agreed that maintenance is an issue, and local communities like Bellevue don’t have the time, money or desire to make repairs.

xiv. Dawn Buehler (Kansas River Keeper / Friends of the Kaw) has a map of new river access points to share with the group.

xv. Laura Totten (USACE) asked if John Reinke (KDWP) maintains the sportsman data. John Reinke (KDWP) says it is maintained by a contractor.

xvi. Laura Totten (USACE) asked the group if a recreation dashboard is still a need. The group discussed that people are looking for something specific and generally know where to go to get their info. KDWP has new and updated camping apps. A new “dashboard” is likely not needed.

VII. Do-outs / Next Steps

a. Participants to review draft risk assessment for recreation for each RPA and provide comments and additional input to USACE.

b. USACE to compile and finalize information on risk and uncertainty and provide to participants for review and comment.

c. Conduct Draft Recommendations Workshop.

d. Working Group Meetings

1. Jan 13 – Ecosystem and Species (complete)
2. Feb 3 – Flood Risk (complete)
3. Feb 15 – Sediment and Erosion (complete)
4. Feb 21 – Water Supply (complete)
5. Feb 27 – Recreation (today)
6. March 3 – Water Quality

RISK ASSESSMENT ROLL-UP WORKSHOP

Kansas River Reservoirs Flood and Sediment Study

WORKSHOP SUMMARY

DATE: Friday, June 2, 2023

TIME: 10:00 a.m. – 3:00 pm

LOCATION: Teleconference

SUBJECT: Risk and Recommendations Workshop

Invitees (attendees in bold):

Kansas Water Office

Matt Unruh, Assistant Director; **Nate Westrup, Manager – Public Water Supply Programs; Josh Olson, Project Management Lead;** Kirk Tjelmeland, Field Services Coordinator; **Richard Rockel, Technical Services Lead; Amelia Nill, Regional Planning & Outreach Coordinator**

Kansas Department of Wildlife, Parks and Tourism

Steve Adams, Chief of Planning; Linda Lanterman, Kansas State Parks Director; John Reinke, Fisheries Biologist; Jordan Hofmeier, Aquatic Ecologist; **Mark VanScoyoc, Survey Coordinator, Ecologist;** Kyle Hoover, Natural Resources Officer; Conner O'Flannagan, Parks Supervisor; Levi Gantenbein, Natural Resources Officer; Willis Ohls, State Park Manager

U.S. Army Corps of Engineers

Laura Totten, Planner/Project Manager; Jennifer Henggeler, Risk and Communications Section Chief; Jeff Tripe, Plan Formulation Section Chief; **Ginger Harper, Planner/Communications/Outreach; Julie MacLachlan, Communications/Outreach; Brian Twombly, Engineer; John Shelley, Engineer; Marvin Boyer, WQ Program Coordinator; Noah Colby George, Economist; Kara Cline, Engineer**

Advisory Team* / Others

Heidi Mehl, The Nature Conservancy*; Doug Haney, Kansas Water Assurance District*; Kent Askren, Kansas Farm Bureau*; Rex Buchanan, Kansas Geological Survey, Retired*; Darci Meese, WaterOne*; Ty Arneson, Thunderbird Marina*; Eric Sartorius, League of Kansas Municipalities*; Greg Wilson, Kansas Water Assurance District; **Tom Stiles, Kansas Department of Health and Environment; Tara Lanzrath, Kansas Department of Agriculture; Greg Totzke, WaterOne; Chris Thornton, Ducks Unlimited; Sarah Tuite, WaterOne;** Dawn Buehler, Kansas River Keeper, Friends of the Kaw; Tony Stahl, Kansas Department of Health and Environment; Matt Hough, Ducks Unlimited; Stephanie Goodman, Kansas Division of Emergency Management; Christian Dirk, Kansas Division of Emergency Management

MEETING NOTES

I. Laura Totten (USACE) led introductions, provided housekeeping items for the group, shared meeting purpose and desired outcomes, and provided a study background summary (study framework status, study area, important outcomes of the study, and challenges in the Kansas River Watershed) (see attached presentation).

II. **Purpose and Desired Outcomes**

a. Purpose and Desired Outcome of Risk and Recommendations Workshop

i. Review rollup of risk assessment and discuss uncertainty evaluation related to stressors in the watershed.
ii. Review and validation of initial draft near-term and long-term actions / projects, evaluations, and data gaps for each problem area and associated stressors.
iii. Review and validation of preliminary framing of Draft Recommendations.

III. Study Framework Status

a. PMP Development and Approval (includes a communications plan) - Complete
b. Review Plan Development and Approval – Approved
c. Identify Problems and Opportunities – Complete
d. Shared Vision Statement / Goals, Objectives, Constraints – Complete
e. Initial Baseline and Existing Conditions and FWOP
f. Sediment Management EC and FWOP Analysis – Complete
g. Water Management and Operations EC and FWOP Analysis – Complete
h. Climate Change Assessment / H&H and Flood Risk EC and FWOP – Complete
i. Other resource topics (Water Supply, Recreation, Water Quality, Biological Resources, Cultural Resources, Socioeconomics) – Finalizing Completion
j. Identify and Screen Conceptual Measures – Complete
k. Shared Vision Milestone Meeting – May 2021 - Complete
l. Risk Assessment and Uncertainty Evaluation - Complete
m. Strategy Comparison and Selection / Draft Recommendations – Complete
n. Recommendations Milestone Meeting – June

IV. Important Outcomes of the Study

a. Extensive partner / stakeholder engagement and coordination generated important information related to problems in the basin and where needs / prioritization goals exist.
b. The engagements also supported identification of areas where agencies / stakeholders could work together through collaborative partnerships to address the problems.
c. Study assessments (e.g., flood risk, water availability, water quality, sediment, reservoirs, biological resources, recreation) generated new information (e.g., future water shortages, economic impacts, changes to flows, life safety concerns) on the stressors and the risks related to them in the future.
d. In many cases stressors could become worse leading to high risks. What is acceptable risk? This creates a benchmark for prioritization of actions / evaluations.
e. A framework for future actions that includes potential funding sources, partners, and priority areas.

f. Two spin-off studies started – Water Control Manual Updates and the Tuttle Creek Water Injection Dredging Demonstration

V. Challenges in the Kansas River Watershed

a. The study area is “really big” (60,000 square miles) and “highly variable” (climatically, environmentally, economically, socially, etc.) making it difficult to assess risk even in smaller geographic areas.
b. Differing viewpoints on priorities with numerous interest groups utilizing the same resources.
c. 18 federal reservoirs with variable uses and issues (e.g., sedimentation, water quality, harmful algal blooms).
d. Multiple uses of water resources (water supply, water quality, ecosystems, navigation, electric power production, irrigation, recreation, commercial/industrial, etc.).

VI. Problems and Stressors (see attached presentation and read-ahead materials)

a. Laura Totten provided information of the problems and stressor identified in the basin and changes made to these following the risk assessment working group meetings recently held. The sedimentation and erosion problems area and the associated stressors were combined with the other problem areas (e.g., reduction in ability to meet water supply demands, flood risk, recreation) as applicable. Sedimentation and erosion are essentially overarching issues related to multiple problem areas and if management is conducted for sedimentation and erosion it would be done to reduce the risks related to these other problem areas.
b. A conceptual ecological model was prepared to provide information on the problems and stressors and the risks that result from these. This is a tool for communication of these.

VII. Objectives and Future Without Project

a. Laura Totten (USACE) reviewed the study objectives and provided a high level summary of the main takeaways from the Future Without Project (FWOP) assessments.
b. Main takeaways include:
    i. Continued and potential increase in flood risk (life safety, damages, loss of flood pool capacity at several reservoirs)
    ii. Unable to provide water supply for expected increased future usage to satisfy the demands of growing populations
    iii. Future shortages to meet all the water quality and supply demands within the basin during times of extended drought
    iv. Future shortages to maintain a base level of streamflow

v. Continued or increased water quality impairment at reservoirs and in river/stream reaches; increases in turbidity, warm-season water temperatures, and harmful algal blooms in reservoirs; decreased chemical buffering due to loss of reservoir storage
vi. Loss of existing reservoir benefits (fisheries, recreational access and use)
vii. Impacts to ecological resources (habitats, species) in the reservoirs and river/stream reaches

c. Increased impacts to above resources due to climate change (extreme storm events, more extreme droughts, more extensive storms)

VIII. Measures and Strategies (see attached presentation)

a. Laura Totten (USACE) provided a summary of the approach and work to identify possible management measures that support the Shared Vision and address the planning objectives.
   i. Screening of measures to determine if they address the stressors and meet the objectives using qualitative metrics and expert judgement
   ii. Measures used to develop single or multiple purpose strategies
   iii. Measures and strategies include those that could lead to construction but also include those that go beyond (i.e., outreach, proposed policy or procedure, regulatory actions)
   iv. Developed in the context of options or choices
   v. Strategies comparison using the four evaluation criteria (completeness, effectiveness, efficiency, and acceptability)

b. The categories of measures and the measures were reviewed for each problem area.

IX. Risk Assessment and Uncertainty Evaluation Process

a. Process Overview
   i. Laura Totten (USACE) explained the process of the Risk Assessment and Uncertainty Evaluation.
      1. To support identification and prioritization of recommendations for the Kansas River Reservoirs Flood and Sediment Study.
      2. Conducted by PDT and subject matter experts and validated with partner input.
      3. Conducted by problem area (i.e., Flood Risk, Sedimentation and Erosion, Reduction in the Ability to Meet Water Supply Demands, Degraded/Poor Water Quality, Ecosystem Degradation and Species Impact, Loss of Recreation Opportunities).
      4. 4 planning areas - Kansas Regional Planning Area (RPA), Solomon-Republican RPA, Smoky Hill-Saline RPA, Upper Republican RPA-Upper Smoky Hill RPA.
      5. Step 1: Identification of the stressors (conditions or events that relate to the problem).

6. Step 2: Qualitative assessment of stressors for risks under relevant categories:
    a. Economic losses / damages
    b. Social vulnerabilities / reduced opportunities
    c. Environmental impacts (habitat, species, eco services, cultural resources)
        i. Assess the potential for increased probability and consequences of risks under future conditions.
7. Step 3: Risk and uncertainty assessment helps identify appropriate recommendations.
    a. Actions with a low level of uncertainty may be implementable.
    b. Actions with a high level of uncertainty may need more evaluation and data before they can be implemented.
    c. Useful in development of framework for the appropriate types and timing for recommendations (i.e., higher risks more immediate action).

b. Risk Assessment – Qualitative Probability and Consequence Evaluation
    i. Risk Categories (see attachments)
        1. Economic – The likelihood and consequences of harm/damage to property, infrastructure, and other assets, as well as economic systems (measured in monetary terms).
        2. Social – The likelihood and consequence of loss of social connectedness, adverse effects to disadvantaged communities, displacement of individuals, public health and safety, ability for subsistence (ability of individuals/communities to be self-sustaining – reliance on natural resources to support a community and livelihoods).
        3. Environmental – The likelihood and consequence of ecosystem services impacts (the various benefits provided by certain environmental and natural resources to communities), habitat loss, and species loss.
    ii. Risk Assessment Results (see attached presentation)
        1. Laura Totten (USACE) presented the results of the risk assessment rollup for the four RPAs by risk category (i.e., economic, social, environmental).
        2. Risks assessed, under any risk category, that were “likely to occur” and have a “high impact” were considered a high risk. All others were considered a moderate to low risk.
        3. During the risk assessment working group meetings attendees were asked to consider whether there are communities or groups of people who are at a higher level of risk for

the consequences from the stressor or problem under discussion or who might bear a greater burden from action or inaction.

X. Framework for Recommendations

a. Risk and uncertainty results used to develop a framework for the timing for (risk-based) recommendations and appropriate types of (uncertainty based).
b. Timing – Risk Based
    i. Immediate (near-term = 1-10 years) - Stressors with a high level of risk (e.g., high probability and high consequence) could require immediate steps to reduce risks through actions, evaluations, or filling data gaps.
    ii. Incremental (long-term = 10+ years) - Stressors with less risk (e.g., moderate probability and temporary impacts or consequence) could be considered as a lower priority that does not require immediate steps.
c. Qualitative Uncertainty Evaluation (see attached presentation)
    i. Qualitative assessment to identify knowledge of solutions needed to address stressors.
    ii. Categories
        1. Actions – Implementable solutions with a high level of consensus among stakeholders to address the risk resulting from a given stressor
        2. Evaluate Options and Fill Data Gaps – Potential solutions are defined with existing information (evaluate options); or additional data would be required to better define the extent and consequence of the problem and/or identify potential solutions (fill data gaps)
    iii. Laura Totten (USACE) provided the outcome of the use of risk assessment and uncertainty evaluation to frame recommendations.

XI. Draft Recommendations (see attached presentation)

a. Recommendations address problem area(s) and/or stressor(s)
b. Rough order of magnitude costs used (i.e., $ = $0 - $1M; $$ = $1 - $5M; $$$ = $5M+)
    i. Used to rank or prioritize and to compare effectiveness versus efficiency.
c. Potential funding sources and other partners / stakeholders were/are identified
    i. Who could be the champion for these recommendations?
d. Recommendations Include:
    i. Immediate Actions = high risk and low implementation uncertainty (1-10 years)
    ii. Immediate Evaluate Options / Fill Data Gaps = high risk and moderate to high level of implementation uncertainty (1-10 years)

iii. Incremental Actions = moderate to low risk and low implementation uncertainty (with limited resources these may be taken as incremental steps and may not have partners identified)(10+ years)

iv. Incremental Evaluate Options / Fill Data Gaps = low risk and moderate to high level of implementation uncertainty (10+ years)

e. The draft recommendations were presented in both a table and graphical format. USACE asked attendees for input on the presentation approaches and whether these would be appropriate ways to communicate these recommendations to different audiences. Ultimately the study should provide tools for communication for multiple users. A read-ahead document was provided that give a description of the measures/recommendations (see attachments).

f. Specific discussion is included below.

i. Tara Lanzrath (KDA) commented that the FEMA funded items need to be identified in the Kansas Hazard Mitigation Plan and the Regional Hazard Mitigation Plans. No work has been done with local or state entities to include these there.

ii. The assessments show that there could be some areas along the Kansas River mainstem with a high flood risk (e.g., life safety or property damages). These are areas where more outreach is needed.

iii. Floodplain Mapping/Regulations – Are these related to regulatory Flood Insurance Rate mapping that are already in production? Or additional studies. Are we proposing additional regulations. Some of the Regional Hazard Mitigation Plans state a need for this and want to keep this on the list of needs. The state has a 5-year business plan for mapping as required as part of their grant. To cite that here would be good to share with a wider number of people. Part of the study includes describing where there is already work ongoing and additional needs in the hopes of working collaboratively to support these needs. The state also has technical assistance that can be provided through CPT grants. KDA can share their business plan and a factsheet on their technical assistance program to incorporate in study materials as needed.

iv. Nate Westrup (KWO) generally validated the list of recommendations and that the majority of the issues that are identified have been recognized and actions developed. Putting these in the framework using problems areas is digestible and provides a comprehensive document that can be referenced.

v. Overarching Statement/Recommendations

1. Something that could be more powerful and that KWO envisioned that the watershed study might accomplish is some bold language that most of the infrastructure is based on the federally authorized projects under USACE operations and that sediment management is the biggest threat to water supply in the region, especially the Kansas River proper.
2. Individual measures related to sediment management are identified but some bold language that there should be a federal interest in reservoir sustainment and maintaining capacity is needed. Currently this is included in a more piecemeal method rather than in an overarching purpose.
3. There should be a partnered interest in reservoir sustainability of the multipurpose pool. This would include the state, water users, and the USACE.
4. Consider recommendations that could lead to a federal interest in a partnered way.
5. Another issue is related to the Tuttle Creek Reservoir Water Injection Dredging Demonstration is that the state cannot contribute or cost-share funds for this project based on the way the federal funds were appropriated. A recommendation could be developed to draft an authority for non-federal and federal entities to provide funds to accomplish projects like these to reduce the current barriers in working collaboratively.
6. Is there a place in the study to include a reinforcement or over-arching idea of being a reference for decision makers for federal authority. Original discussions with the USACE and state of Kansas were that this study could lead to more and accomplish things that we normally would not be able to do. Would like to see potential policy change that could allow for more partnership and/or cost-sharing in areas where we currently do not (e.g., water supply). More direct language in the study on consideration of a federal interest in reservoir sustainability. KWO asked if they study could have this opinion. Ability to "tweak" authorities to close these gaps that the state sees.
7. Does sustainability mean upper watershed measures, operating on a watershed basis, or something else? Watershed work could be a part of it but in-lake sediment management will need to occur to slow the loss of capacity in the reservoirs. Ensuring long-term reservoir storage maintenance.
8. Potential information could be included related to policy changes that would support this. May not be in the formal recommendations but considered in an appropriate way through the study documentation. There may be a new mindset in the USACE along these lines

but no official guidance. Through the USACE guidance related to “comprehensive benefits” there are more opportunities to describe items like these in the study.

9. Steve Adams (KDWP) agreed with the discussion and the watershed study has been a good demonstration of partnership and through watershed work we know that the problems go beyond the boundaries of the reservoirs. Whether it’s the infrastructure of the reservoir for water supply, recreation, fish and wildlife, etc. there are aspects of this that are going to be landscape scale and that go beyond any one organization or entity can handle alone. If policy is a barrier then would like to see some language around this in the watershed study. If we see missing areas or potential modifications to policy that would help us to better manage the resources in the future we should take a close look and make sure it is adequately covered.
10. The group worked to craft some ideas on what to include think about including some information in the Recommendations Milestone meeting planned for late June with the USACE Vertical Team. Also would want to work with NWK staff and leadership to best craft this. There could also be some state policy that should be considered to support this.
11. There are some policies related to reservoir sediment management, economic reservoir sediment management, restoring flow through of sediment. Also the requirement to have fee title for restoration in the upper watershed is often a barrier to doing this kind of work using federal funds. Some language related to this would be good. There are other examples of this in other districts as well and could leverage lessons learned for these.
12. Looking at state policies in how the reservoirs are managed will be of interest at USACE HQ and congress.
13. When you have a multiple purpose project and you have to justify through one business line rather than multipurpose justification this often creates barriers. Consideration of a method to monetize ecosystem benefits may better promote these types of projects and provide justification for a federal interest and potentially a better plan.
14. Could frame it as a consideration of a greater federal interest to extend the useful life of the reservoirs in the reservoir to maintain the benefits provided. The state has experienced some roadblocks to this in the past. There will be a limit to how much the state can invest. The state would like to have the ability to contribute and perform research and development to discover technologies and methods in a cost-sharing way

with USACE. Some policy related to this to include a mechanism for long-term funding. Where the state has water supply contracts, USACE could pay share of O&M costs. What is the bridge to conduct partnered studies and do research and development?

15. John Shelley (USACE) described the recommendations from the Environmental Advisory Board related to reservoirs. This came in the form of a letter to General Semonite in August 2020. The EAB is composed of outside scientific experts who were asked “What could the USACE do differently/better related to reservoir sediment management”. These include:
    a. Recognize the downstream channel system and receiving coastal systems as preferred beneficial uses for reservoir and dredging sediments, subject to the principles discussed in the attached document.
    b. Expand the footprint for assessing cost-benefits of reservoir sediment management measures to include both downstream and upstream river corridors.
    c. Analyze storage lost to sedimentation as a reallocation, with an assessment of lost benefits and associated increased costs both upstream and downstream of the project footprint.
    d. Highlight existing sediment passage pilot projects and implement new projects that demonstrate different management options.
    e. Hold reoccurring reservoir sediment management training courses. The Regional Sediment Management (RSM) program has produced and held two such courses, one for regulators, managers, and planners (held in 2017) and one for engineers (held in 2018).
16. Other ideas relate to this include:
    a. Adopt sustainability economics for analysis of reservoir storage. The World Bank uses a declining discount rate, for example.
    b. Allow USACE to implement low-cost watershed restoration measures without fee title. Things like beaver dam analogs, cedar tree revetments, riparian plantings, etc.
    c. Streamline regulatory permit for sediment management that restores sediment continuity (i.e., outgoing sediment loads from lakes do not exceed the inflow to lakes).

d. Allow monetized ecosystem benefits to be added to typical National Economic Development benefits for combined plans. Rollin Hotchkiss and USBR has done some work related to how to best monetize the benefits related to reservoir sediment management.
e. Consider broader reservoir sustainability needs (such as watershed efforts) in suggested policy, authorities, and budget recommendations.
f. Floodplain reconnection/wetland and oxbow restoration emphasized more, both above reservoirs and on the river and located for flood storage and sediment/nutrient benefits. Organizations like The Nature Conservancy can be a partner for land acquisition/easements/incentive payments to landowners.
g. Should review the current guidance (focus on reservoir sedimentation) to ensure we all have the same understanding of where the impediments lie. Then determine where a change could benefit.
h. These could be presented as “Sponsor Viewpoints”.
i. Comprehensive Benefits – We would be realizing benefit form all four accounts (National Economic Development, Regional Economic Development, Environmental Justice, Other Social Effects) but need a better way to justify a project by recognizing inputs from regional entities. If a benefit is largely regional in nature versus national then could use this as justification.
j. We all have limitations related to policy or budget availability. If we really want to protect the resources what do we need in the future. The current conditions at the reservoirs could not have been envisioned when the reservoirs were built. And it is broader than any one single agency or entity. The struggle is how to coordinate these efforts to get the maximum benefit.

vi. Statewide building codes would be helpful in qualifying for FEMA grants like BRIC that can help fund infrastructure projects.
vii. Josh Olson (KWO) commented that he liked the way that the recommendations are laid out and the visual tools to communicate these. One of the big struggles he typically hears is that there is not a clear path to long-term implementation for reservoir sediment management. The steps to get to this could be described clearer to reduce the confusion related to the required steps. The two means for this currently in USACE include an authority from Congress to perform a study (feasibility study) with appropriations in which we would develop measures. Another way might be

through a routine maintenance activity but not sure of the process or potential for this without an individual reservoir general investigation study. Not sure that it is a one size fits all list of steps either.

XII. **Selection and Implementation Strategy (see attached presentation)**

a. Continue to work with partners to define appropriate agencies and funding sources. Existing authorities and programs should be utilized, when possible, to implement recommendations.

b. Examples of federal support:
   i. General Investigations
   ii. Planning Assistance to States (PAS)
   iii. Floodplain Management Services (FPMS)
   iv. Silver Jackets
   v. Continuing Authorities Program
   vi. Engineering with Nature

c. Examples of State / Local Programs Support:
   i. Kansas Hazard Mitigation Planning
   ii. Flood Control and Lakes Program
   iii. Kansas Watershed Restoration and Protection Strategy Planning
   iv. KDHE Stream Chemistry Monitoring Program/Stream Biological Monitoring Program/Harmful Algal Bloom Response Program
   v. Milford Lake Regional Conservation Partnership Program
   vi. KDWP Stream Survey and Monitoring Program
   vii. Riparian Quality Enhancement Initiative
   viii. Sediment and Nutrient Reduction Initiative
   ix. Streambank Protection Program
   x. Water Quality Buffer Initiative
   xi. Water Resources Cost Share Program
   xii. Watershed Planning Assistance Program
   xiii. Playa Lakes Joint Venture
   xiv. KDWP Aquatic Nuisance Species Program
   xv. Kansas Wetland Program

d. The use of acronyms should be reduced to include the full name as many may not know when these mean. The USACE will work to update this.

e. A map with recommendations (ongoing, proposed) placed on it was shown as an example for another method to communicate the recommendation. If used moving forward this would be improved and a legend included.

f. A draft proposed implementation strategy for the draft recommendations was presented (see tables below).

Priority	Stressor	Recommendation	0-5 years	5-10 years	10+ years
Immediate (1-10 years) (Actions/Projects)	Riverine Flooding / High Reservoir Water Levels	Lower Kansas River Basin Master Manual and/or Individual Reservoir Project Water Control Manual Updates	Implement	-	-
		Flood Risk Feasibility Studies - Shungununga Creek	Implement	-	-
	Sedimentation / Drought / Water Shortages / Loss of Recreational Opportunities	Tuttle Creek Reservoir Long-term Sediment Management Plan	Implement	-	-
		Promote and Incentivize the Adoption of Watershed Practices	Implement	-	-
		Tuttle Creek Water Injection Dredging Demonstration	Implement	-	-
		Kanopolis Reservoir Long-Term Sediment Management Plan	Implement	-	-
		Regional Sediment Management Plans	Implement	-	-
		Modification of Low Flow Target Values to Extend Period of Low Flow Support	Implement	-	-
		Promote Water Conservation Measures	Implement	-	-
		Drought Communication and Outreach	Implement	-	-
	Loss of Reservoir Fisheries Habitat Leading to Declines	Biological Monitoring / Surveying Needs	Implement	-	-
		Lake Level Management Plans	Implement	-	-
	Invasive / Non-native Species	Invasive / Non-native Species Management (Kansas RPA)	Implement	-	-
	Loss of Heterogeneity in Hydrologic and Geomorphic Process in Rivers, Streams, and Floodplains	Construct and Maintain Wetlands and Rehabilitate Old Oxbows - Rocky Ford, Smoky Hill River, etc.	Implement	-	-
		Support of Sustainable Rivers Project Environmental Flow Proposals	Implement	-	-
	Impaired Waters	Promote and Incentivize the Adoption of Watershed Practices	Implement	-	-

Priority	Stressor	Recommendation	0-5 years	5-10 years	10+ years
Incremental (10+ years) (Evaluations / Fill Data Gaps)	Riverine Flooding / High Reservoir Water Levels / Climate Change Implications / Flood Response Communication Issues, Sedimentation in Reservoirs and Downstream Erosion	New or Modified Levees / Dikes / Floodwalls	-	Evaluate	Implement
		High Flow Diversions	-	Evaluate	Implement
		New Reservoir / Dam Construction or Detention Basins	-	Evaluate	Implement
		Channel Modifications	-	Evaluate	Implement
		Authority for Land Acquisition or Easement Purchase for Flood Control	-	Fill Data Gaps	Evaluate
		Floodplain Mapping	-	Fill Data Gaps	Evaluate
		Flood Warning / Emergency Action Plans	-	Fill Data Gaps	Evaluate
		Floodplain Regulations	-	Fill Data Gaps	Evaluate
		Floodplain Management Plans	-	Fill Data Gaps	Evaluate
	Sedimentation / Drought / Water Shortages / Reduced Water Supply from Navigation Releases / Groundwater Depletion / Loss of Recreational Opportunities	Kansas River Alluvial System as a Filtration and Storage System	-	Fill Data Gaps	Evaluate
		Water Quality Monitoring of the Ogallala Aquifer	-	Fill Data Gaps	Evaluate
		Small Watershed Dam Assessment	-	Fill Data Gaps	Evaluate
		Kansas Research Priorities Support	-	Fill Data Gaps	Evaluate
		Reservoir Bathymetry	-	Fill Data Gaps	Evaluate
		Kanopolis Reservoir Conservation Pool Raise Study	-	Evaluate	Implement
		Construction of Multipurpose Small Lakes	-	Evaluate	Implement
		Harlan County Reservoir Reallocation Study	-	Evaluate	Implement
	Harmful Algal Blooms	HAB Research (Solomon-Republican, Smoky-Hill Saline, Upper Republican, Upper Smoky Hill RPAs)	-	Fill Data Gaps	Evaluate
		HAB Treatment (Solomon-Republican, Smoky-Hill Saline, Upper Republican, Upper Smoky Hill RPAs)	-	Fill Data Gaps	Evaluate

g. Laura Totten (USACE) presented draft recommendations for USACE spin-off studies.
   i. Individual Reservoir Project Water Control Manual Updates – Ongoing
   ii. Tuttle Creek Lake Water Injection Dredging Demonstration – Ongoing
   iii. Kansas Water Sustainment Comprehensive Plan (PAS) - Ongoing
   iv. Long-term Sediment Management Plan for Tuttle Creek Reservoir (GI) – New Start Request
   v. Long-term Sediment Management Plan for Kanopolis Reservoir (GI)
   vi. Rocky Ford Restoration (GI) – New Start Request
   vii. Smoky Hill Restoration GI Conversion – New Start Request
   viii. Shungununga Creek Flood Risk Management GI Conversion – New Start Request
   ix. Jersey Creek Ecosystem Restoration GI – New Start Request
   x. Harlan County Lake Reallocation Study
   xi. Kanopolis Reservoir Conservation Pool Raise Study
   xii. Regional Sediment Management Plans (PAS)
   xiii. Water Supply Demand Study (PAS)
   xiv. South Johnson County Wastewater Study (PAS)

xv. Silver Jackets Projects – Healthy Watersheds
xvi. Armourdale / Muncie Watershed Study (PAS)
xvii. Kansas Research Priorities Support (PAS)
xviii. Kansas City, Kansas Flood Risk Study (PAS)

Flood Risk
Flooding is a reoccurring challenge in the Kansas River Basin that can be costly, both in property lost and more significantly in loss of lives. Flooding events in the Kansas River Basin has caused riverine and overland flooding and high reservoir water levels that threatens life safety; damages homes, businesses, public facilities, agricultural lands, and critical infrastructure (e.g., roads, railroads, utilities); displaces individuals and businesses; damages cultural resources; increases environmental degradation; and causes public health issues.
Stressors
Riverine Flooding: The entire Kansas River Basin is subject to severe riverine flooding at infrequent intervals, erratically interspersed by less severe floods of varying magnitudes. Flooding is a reoccurring challenge in the basin that can be costly, both in property lost and more significantly in loss of lives. Floods in the basin have damaged millions of dollars of private property and crop land, as well as critical infrastructure such as interstate highways, railroads, and state highways, displaced individuals, impacted delivery of services, and caused repetitive losses occurring in many areas in the basin. Additionally, floods have caused damages and lost revenue at recreational facilities managed by federal and state agencies, private entities, and non-profit organizations. The most obvious threat to health and safety is the danger of drowning in flood waters. Swiftly flowing flood waters can easily overcome even good swimmers. If flooding occurs suddenly, people may become trapped in their homes and drown. Additionally, when people attempt to drive through flood waters, their vehicles can be swept away in as little as two feet of water.
High Reservoir Water Levels: The lower Kansas River reservoir system (Milford, Tuttle Creek, Perry, and Clinton) is operated to provide flood protection for the Kansas River and the Missouri River. High rainfall events that lead to extended periods of storing inflows in the reservoirs causes extended periods of elevated pool elevations and adds to the risk of large surcharge releases from these projects. Extensive impacts can occur when high reservoir water levels occur causing damages and lost revenue at facilities managed by federal and state agencies, private entities, and non-profit organizations and damaging roadways and utility services surrounding the reservoirs. Additionally agricultural lands in the upper regions of the reservoirs can flood during high reservoir water levels causing damages and loss of revenue to producers on these lands. Missouri River flood criteria exists for the Kansas City and Waverly gages. Sometimes elevated Missouri River flows can have the effect of keeping the lower Kansas tributary projects' releases at low-flow levels for weeks or months on end. That extended period of storing inflows causes extended periods of elevated pool elevations and adds to the risk of large surcharge releases from these projects.
Climate Change Implications – Increasing Risk to Urban Areas and Agricultural Lands: Climate change in the basin is expected to show increasing temperatures and precipitation resulting in increased frequency in the occurrence of extreme storm events. These extremes in climate will result in larger more extensive storms and increases in streamflow in the basin, particularly for the Republican River and the lower Kansas River. Larger flood volumes in the future could cause higher pool elevations at reservoirs and an inability to contain flood events with more frequent occurrence of surcharge releases and uncontrolled flows. Hundreds of levees exist within the basin ranging in size from small agricultural levees to protect farmland to large urban levees constructed to protect people and property. Damages to levees have occurred during past flood events causing life safety risks and property damages in the areas affected by water that flowed behind these leveed areas. With larger flood events under climate change

higher water surface elevations will cause a higher probability of overtopping and cause longer loading durations on existing levee systems with greater likelihood of levee breach. Under climate change is also expected that greater flood extents will occur in non-leveed areas causing higher damages to those unprotected areas.
Flood Response Communications Issues: Communications / coordination / planning between flood risk management entities and the public in the basin need improvement to better communicate the risks to the public. This includes improved flood forecasting, flood warning systems, and emergency action plans. Many communities do not currently have adequate tools. Under climate change the need for improved communications will increase with more the likelihood of more frequent activation of flood forecasting / warning systems and more frequent updates to emergency operations plans needed.
Sedimentation in Reservoirs and Downstream Erosion: Sedimentation in reservoirs within the basin is a looming problem to be addressed so that benefits provided by the reservoirs for flood risk management can be realized into the future. Sedimentation in the reservoirs threatens crucial flood risk management infrastructure. Sediment accumulation could impede the ability to maintain the function of flood control gates and other appurtenances, which could seriously impact the flood risk mission of the USACE. Without deliberate restorative action sedimentation issues will increase operations and maintenance costs at reservoirs and in the downstream river channels. Historical data and projected estimates indicate that the flood control pools of the reservoirs will experience sedimentation, with some filling by as much as 17% over the next 100 years and experiencing greater frequency of higher water levels compared to existing conditions. Channels downstream of most federal reservoirs in the basin are experiencing bed degradation and bank erosion as a consequence of the sediment trapping in the reservoirs with varying degrees of downstream bed and bank loss in different reaches. Continued degradation is expected in the future which will cause risk to downstream infrastructure and uses. Downstream riverbed degradation can impact the long-term sustainability of flood risk reduction levees.
Reduction in Ability to Meet Water Supply Demands
The water supply system throughout the Kansas River Basin is vulnerable to naturally occurring and anthropogenic stressors including reservoir sedimentation, drought, groundwater depletions, the risk of reduced water supply from navigation releases, and climate change implications. Lack of reliable water supply and shortages of water could have a devastating effect on the economy in the basin and the health and welfare of its citizens.
Stressors

Sedimentation: Loss of water supply storage in Federal reservoirs - Every year, thousands of acre-feet of water storage are lost, as millions of cubic yards of sediment accumulate in the federal reservoirs. All federal reservoirs in the basin have experienced loss of water supply storage and will continue to lose water supply storage in the future. The most extreme case being Tuttle Creek Reservoir, a vital source of water supply, which is expected to have only 25% of the multipurpose pool remaining in 50 years. In the future under increased sedimentation reservoirs may not be able to meet water supply targets downstream for intake or reservoir levels in the multipurpose pools may become depleted causing impacts within the reservoirs to water quality, fisheries, recreation, etc. Lack of reliable water supply and shortages of water could have a devastating effect on the economy of Kansas and the health and welfare of its citizens.

Sediment management on the mainstem of the Kansas River is important to infrastructure, such as water supply intakes, irrigation diversion structures, and other uses such as recreation and ecological resources.

An increase in more extreme flood events under climate change would lead to an increase in sediment loading in reservoirs that are already impacted by current inflows of sediment. This will lead to an increase in the loss of additional storage expected.

Drought: Societal consequences and economic impacts associated with drought risk – Periods of drought are normal occurrences in all parts of the basin. Drought can adversely affect surface and groundwater supplies, farming and ranching, and uses of surface water for other purposes (e.g., recreation). Many economic impacts have occurred in agriculture and related sectors including losses in yields of both crop and livestock production leading to loss of income and increasing food costs. Drought can severely impact a public water supply through depletion of the raw water supply and increased customer water demand. Other associated problems that could require additional costs include limited treatment capacity or limited distribution system capacity that may be encountered. Planning for extreme events (e.g., water conservation management planning) that secure and improve the reliability of water supplies is essential for the future prosperity of Kansas communities and the health of citizens.

Reduced Water Supply From Navigation Releases: Releases for navigation on the Missouri River can be made from Milford, Tuttle Creek, and Perry reservoirs. Currently approximately 230,000 acre-feet is subject to these releases. If these releases are made there is the potential that the reduction in storage at the 3 reservoirs could lead to inadequate water supply for in-reservoir purposes (e.g., recreation, fisheries), and for downstream releases to support water supply, water quality, fish, and wildlife, and recreation. These effects are especially significant during drought periods when excessive drawdowns would decrease capabilities of meeting flow targets and reduce water supply resiliency for multiple communities.

Groundwater Depletion: Groundwater is the predominant public water supply source in many areas within the basin. Groundwater depletions in the basin has led to reductions in available water supply. Groundwater in the basin, primarily from the High Plains Aquifer, is used for domestic, municipal, industrial, and agricultural purposes. In western Kansas the primary source of water is groundwater drawn from wells that reach into the water bearing aquifers, such as the Ogallala portion. Alluvial aquifers also supply water to many citizens in the basin where in many parts it is the only source of drinkable water for public water suppliers and individual domestic wells. Alluvial aquifers are generally recharged by flow in associated rivers and streams. Groundwater depletion has led to loss of base stream flows, particularly in western Kansas, from groundwater irrigation to crop production and land practices. In recent years, drought has affected certain communities and regions of the basin

on a more recurring basis. With a recent drought event (2012-2013), there was observed a significant reduction in baseflow gain as irrigation demands increased, requiring significant sustained releases from federal reservoirs to maintain low flow targets and ensure adequate supply to downstream municipal and industrial diversion point. With the possibility of climate change, this may affect more regions of the state more often.

Climate Change Implications: Lack of reliable water supply and shortages of water could have a devastating effect on the economy of Kansas and the health and welfare of its citizens. Every industry from agriculture, electric power generation and manufacturing to tourism relies on water to grow and ultimately sustain its business.

Under climate change there would be an increase in the occurrence of droughts periods with longer more severe droughts expected. This will cause lower inflows in reservoirs and potentially a lack of water available to support need reservoir releases and withdrawals causing inadequate water supply for users in the basin.

Degraded / Poor Water Quality

Water quality throughout the Kansas River Basin is vulnerable to naturally occurring and anthropogenic stressors including harmful algal blooms, impaired waters, risk to high quality water, stormwater management, and sedimentation. There is a risk with loss of reservoir storage and future water shortages that there could be reduced ability to meet water quality demands within the basin during times of extended drought or maintain a base level of streamflow. Currently 17 of the 18 federal reservoirs in the basin are listed as "impaired" and with expected sedimentation in reservoirs there could be a reduction in their ability to provide current benefits of chemical buffering.

Stressors

Harmful Algal Blooms: Harmful algal blooms continue to plague the region, with many reservoirs experiencing blooms. If conditions lead to a decrease in reservoir volumes and streamflow during drought or low inflow periods this could lead to an increase in nutrient concentrations and an increased frequency and intensity of harmful algal blooms.

Impaired Waters: Negative impacts from degrading / poor water quality conditions can include increased costs to treat water for public water supply needs, decreased yields for agricultural producers, decreased recreational opportunities, fish consumption advisories, and diminished biological diversity in streams and reservoirs.

Water Shortages (Causing Reduced Availability of High Water Quality for Residential, Commercial / Industrial, and Recreation Uses): Water quality storage is used to maintain minimum flow targets on the Kansas River downstream of the reservoirs. As water quality conditions degrade in reservoirs use of water from that source as well as downstream uses are negatively impacted. A decrease in water volumes in reservoirs and streams could lead to increased nutrient concentrations with an increase in water quality degradation. Lower reservoir storage volumes would decrease the ability to maintain water quality reservoir releases.

Inadequate Stormwater Management: Absence of appropriate stormwater management in some areas contributes to degradation in water quality and supply. Pollutants from housing and urban areas, industrial sources, and agricultural activities can end up in water sources where they change water chemistry and thereby impact aquatic vegetation, invertebrate communities, amphibians, and fish. Pollution can be from direct and indirect sources, which can make it difficult to identify, quantify, and remediate.

Sedimentation: Water quality storage is used to maintain minimum flow targets on the Kansas River downstream of the reservoirs. As accumulation of sediment reduces storage capacity of reservoirs, water quality problems are expected to intensify as reservoir temperature increases. Currently only Tuttle Creek Reservoir has a portion of the conservation pool allocated for water quality. This water quality allocation is too small to support low flow targets on the lower Kansas River through drought. Currently water quality releases are also made from Milford and Perry reservoirs water supply storage volumes to support minimum flow criteria on the Kansas River. With current sedimentation at Tuttle Creek Reservoir the water quality allocation will be further reduced and less water will be available to support downstream uses. Additionally, at a point in future the remaining water supply storage may be called into service for water supply further reducing the availability of water for water quality purposes.

Ecosystem Degradation and Species Impact

Changes, loss, and fragmentation of terrestrial and aquatic habitats in the basin has led to habitat degradation, loss of heterogeneity, and loss of connectivity of these habitats leading to declines in species populations in the Kansas River Basin. Invasive and non-native species have caused declines in native species and degradation of terrestrial and aquatic habitat.

Stressors

Loss of Riverine / Floodplain Habitat Leading to Species Declines: Historically there has been a substantial loss and fragmentation of terrestrial and aquatic habitats in the basin from agricultural conversion, urban development, and construction of dams and levees. This has led to a reduction in native plant and animal populations. Dams and the use and management of water in the basin has replaced stream and floodplain habitats and affects the timing and volume of downstream flows as well as timing a volume of water within the reservoirs affecting fish and wildlife and their habitats. Many streams in the basin are experiencing areas of streambank erosion and headcuts. Excessive erosion has caused stream reaches to become incised, reducing floodplain connectivity and the quality and quantity of riparian habitat. There are currently five federally threatened and seven federally endangered species listed in the basin and designated critical habitat is found at a variety of locations in the basin including the Kansas River and other streams in watershed affected by reservoir management. There are also numerous state listed species that occur in the basin. Many of the listed species rely upon surface waters associated with basin streams and impoundments, adjacent riparian habitats, and/or wetlands for some portion of their life cycles.

Sediment trapping behind reservoirs has reduced the turbidity in downstream reaches causing a reduction in species that occurred in more turbid environments pre-impoundment. Lack of floodplain connectivity in river reaches below reservoirs has led to loss of habitat and species that once thrived in these areas. Streambank erosion is a significant cause of reservoir sedimentation in the basin. Agricultural development and activity and urban development in the watersheds above the reservoirs has led to streambank erosion that then contributes to sedimentation. Numerous head-cuts have also occurred within in the basin on various streams above and below reservoirs leading to loss of habitat.

Sedimentation in reservoirs has led to loss or changes of habitat for species and reductions in species that require certain habitat for their life history needs (e.g., cove habitat). As sedimentation continues under extreme conditions (e.g., Tuttle Creek Reservoir) the majority of the reservoir fisheries would not remain due to the highly reduced lake volumes and only areas of shallow water remaining.

There are also barriers to aquatic species movement in rivers and streams in the basin which fragment populations, prevent individuals from moving up and down river systems, and cut off movement during droughts.

Under climate change streamflow is expected to decrease and reservoir levels are expected to be lower during times of increased drought frequency. This could lead to a decrease in suitable habitat for aquatic species and a decline of species. Drought conditions have caused damages to plant and animal species, wildlife habitat, degradation of landscape quality, loss of biodiversity , and soil erosion. A drought period can last for months, years, and even decades. The cost of drought locally and nationally is high and with climate change the economic impacts could dramatically increase in the future.

Invasive / Non-native Species: Invasive and non-native species can degrade and impact natural ecosystem functions. Invasive species impact riparian areas by reducing streamflow, out-compete native species, create monocultural stands with little diversity, and reduce habitat richness that fish and wildlife species require for life requirements. Aquatic nuisance species in the basin threaten the diversity or abundance of native species, the ecological stability of infested waters, and recreational activities dependent on such waters. Several aquatic nuisance species have been introduced and dispersed in the basin. These species have few natural controls and spread rapidly causing alterations to food webs, nutrient dynamics, and biodiversity. Multiple impoundments within the basin are infested with invasive non-indigenous plant species. These species are known to reduce or clog water intakes, reduce property values, cause declines in native species, decrease spawning habitat, and reduce useable recreational areas on reservoirs. Currently there are not enough resources (funding and capacity) to manage, monitor, and enforce best management practices (e.g., watercraft decontamination and inspection stations) to prevent the spread of invasive species (e.g., zebra mussels).

Under climate change conditions could lead to changes in habitat and a potential for the increase in the spread of invasive species.

Loss of Heterogeneity in Hydrologic and Geomorphic Process in Rivers, Streams, and Floodplains: Seasonal patterns of high and low river flows support animal and plant lifecycles, preserve water quality, and maintain diverse habitats. Dams and the use and management of water in the basin has replaced stream and floodplain habitats and affects the timing and volume of downstream flows as well as timing a volume of water within the reservoirs affecting fish and wildlife and their habitats.

Loss of Reservoir Fisheries Habitat Leading to Declines: Maintaining habitat for fish is important for the reservoir sport fishery. Sedimentation in reservoirs has led to impacts to fish populations as shorelines erode, habitats become inaccessible (e.g., coves, spawning habitat, nursery habitat), loss of fish habitat structure, and loss of vegetation. High-water events have also impacted the fisheries with flooding of habitat leading to reduced aquatic vegetation and entrainment of fish through the dam during high water releases. Low water conditions in reservoirs often leaves areas dewatered for long periods of time and reduces primary productivity needed by the fisheries reducing habitat quality and diversity which limits fish species abundance and welfare.

Groundwater Depletion: In western Kansas the primary source of water is groundwater drawn from wells that reach into the water bearing aquifers. Groundwater used for domestic, municipal, industrial, and agricultural purposes. Groundwater depletion has led to loss of base stream flows, particularly in western Kansas, from groundwater irrigation to crop production and land practices.

Loss of Recreation Opportunities
Water-based recreational opportunities are threatened by flooding, low water levels, reservoir sedimentation, poor water quality, diminished in-stream flows, and invasive species. These impacts cause a loss of visitation leading to lost revenue and high costs to repair damages to recreation facilities. Public lands that provide recreation opportunities are rare in Kansas, with privately-owned lands accounting for the majority of land. State-owned and controlled lands for recreation account for only 0.7% of the lands in the state of Kansas. Because of the scarcity of federal and state public lands for recreation, it is imperative that these lands are protected and managed to promote sufficient recreational opportunities to meet the needs of residents and visitors.
Stressors
Limited Public Lands: Currently only a small amount of land is publicly owned and used for recreation (0.7%), limiting the opportunities to expand or replace any lost facilities (e.g., recreation facilities lost from sedimentation, facilities damaged from flood waters). Because of the scarcity of federal and state public lands for recreation in Kansas, it is imperative that these lands are protected and managed to promote sufficient recreational opportunities to meet the needs of residents and visitors.
Reservoir Sedimentation: Sedimentation in reservoirs within the basin is a looming problem to be addressed so that benefits provided by the reservoirs for recreation and fish and wildlife can be realized into the future. Parks and private recreation facilities have been closed from sedimentation in reservoirs. Boating safety is also a concern with sedimentation. As sedimentation continues these impacts are expected to increase and recreational opportunities decrease in the basin.
Water Quality / Harmful Algal Blooms: Harmful algal blooms can impact use of recreation areas in reservoirs, closing swim beaches, reducing boating activities, decreasing visitation, and lost revenue. Harmful algal blooms could also cause health and safety concerns for recreators that are exposed during activities causing illness and even death. The causes and treatment of harmful algal blooms needs further study and research.
Increased Operational Costs and Lost Revenues From Flooding and Drought: Floods have caused damages to recreational infrastructure and facilities, increased operating costs, required closures, and lost revenue at recreational facilities managed by federal and state agencies, private entities, and non-profit organizations. There are limited opportunities to expand or replace lost facilities due to a very small portion of land publicly owned in the basin. Droughts have also caused impacts to recreation by reducing access to areas (e.g., coves) and use of infrastructure (e.g., boat ramps), reducing fishing opportunities, causing hazards for boaters and beach impacts, exposing shorelines and increasing erosion potential, and reducing the aesthetic values of the reservoirs. During drought conditions, lakes with substantial sediment depositions (e.g., Tuttle Creek, Perry, and Kanopolis) in the future will be shallower, exacerbating adverse effects to access, boater safety, fish habitat, and recreation. Both drought and flooding have adverse impacts on riverine recreational opportunities on the lower Kansas River from decreased streamflow or water levels that are too high to allow safe recreational activities. During drought conditions when flows are low water quality impacts can cause unpleasant odors impacting the recreation experience and can make recreating by boaters / paddlers difficult. Flooding and high river flows can cause unsafe conditions for recreators on the Kansas River or limit access for various activities (e.g., limit riverine access points, reduce angling, hunting, and camping opportunities).

Kansas River Reservoirs Flood & Sediment Study
Shared Vision Statement – Objectives

Shared Vision Statement

"Within the Kansas River Watershed there are significant water resource challenges including increased flood risk, reduced water availability, reservoir sedimentation, water quality concerns, streambank erosion, increased demand for recreational opportunities, and loss of wetlands and riparian habitat. Sustainable measures must be identified and developed to reduce flood risk, improve sediment management, and mitigate drought, and to address additional existing water resource problems within the watershed. Measures include those necessary to increase the resiliency and sustainability of the system, and identification of viable opportunities for investment in critical infrastructure throughout the basin, including existing reservoirs, to increase their resiliency and maintain capacity for water availability and sustainment, ecosystem restoration, water quality, and recreational amenities."

Objectives

The primary objective of the Watershed Study is to develop a comprehensive plan to support the Shared Vision to identify actions within the Kansas River Watershed necessary to address significant water resource challenges. Specific study objectives include recommended solutions to:

- Reduce risks to life safety in the Kansas River Watershed with a focus on improved flood risk system flexibility under a variety of climate change and land use development patterns.
- Reduce both societal consequences and economic damages associated with flood risk in the study area, with an emphasis on improving system resiliency and increasing the long-term integrity of the flood system.
- Increase the reliability, quality, and availability of water in the basin.
- Reduce both societal consequences and economic impacts associated with drought risk in the study area, with an emphasis on improving system resiliency and increasing the long-term integrity of water availability.
- Address adverse effects of sedimentation in the watershed including at existing reservoirs and in river reaches.
- Identify watershed practices to address existing water resource problems within the watershed and increase the resiliency and sustainability of the system that would be implemented by local, regional, state, or federal entities.
- Protect critical water resource infrastructure and investments (e.g., reservoirs, lakes, levees, public water supply infrastructure).
- Protect and improve biological resources.
- Protect, promote, and expand recreational opportunities and amenities.
- Increase the adaptability and resiliency of the water supply, flood risk management, and ecological systems of the Kansas River Watershed in relation to climate change, including planning for extreme events (i.e. flooding and drought).

Risk Assessment Categories Definitions and Metrics	
Economic Risk - Probability	
Probability	***Definition***
Not Likely to Occur	A stressor would not occur, happen infrequently, and is not expected to increase in the future.
Moderate Chance of Occurring	A stressor has a moderate chance of occurring and contributing to this risk, with a slight increase in the future.
Likely to Occur	A stressor is likely to occur, contribute frequently to this risk, and increase in the future.
Economic Risk - Consequence	
Magnitude of Consequence	***Definition***
No to Low Impact	No impacts are anticipated or impacts are anticipated to affect a single individual, household, or business.
Moderate Impact	Impacts are anticipated to affect a community / town.
High Impact	Impacts are anticipated to affect multiple areas within a watershed and be more widespread.

Social Risk - Probability	
Probability	***Definition***
Not Likely to Occur	A stressor would not occur, happen infrequently, and is not expected to increase in the future.
Moderate Chance of Occurring	A stressor has a moderate chance of occurring and contributing to this risk, with a slight increase in the future.
Likely to Occur	A stressor is likely to occur, contribute frequently to this risk, and increase in the future.
Social Risk - Consequence	
Magnitude of Consequence	***Definition***
No to Low Impact	No impacts are anticipated or if they do occur would cause temporary or short-term impacts to resources (i.e., utilities, roads, services, agricultural) and would not become more severe.
Moderate Impact	A stressor causes moderate, short to long-term impacts to resources (i.e., utilities, roads, services, agricultural) and they may become more severe.
High Impact	A stressor causes severe, long-term impacts to resources (i.e., utilities, roads, services, agricultural) and they will become more severe.

Environmental Risk - Probability	
Probability	***Definition***
Not Likely to Occur	A stressor would not occur, happen infrequently, and is not expected to increase in the future.
Moderate Chance of Occurring	A stressor has a moderate chance of occurring, happen more frequently, and may increase slightly in the future.
Likely to Occur	A stressor is likely to occur, contribute frequently to this risk, and increase in the future.
Environmental Risk - Consequence	
Magnitude of Consequence	***Definition***
No to Low Impact	No impacts are anticipated or if they do occur would cause temporary or short-term impacts to resources (i.e. habitats, species, ecological processes, cultural) and would not become more severe.
Moderate Impact	A stressor causes moderate, short to long-term impacts to resources (i.e., habitats, species, ecological processes, cultural) and they may become more severe.
High Impact	A stressor causes severe, long-term impacts to resources (i.e., habitats, species, ecological processes, cultural) and they will become more severe.

KRRFSS Measures / Strategies			
	Type of Measure	**Measures**	**Description**
Flood Risk	**Operational Measures / Dams and Reservoir Upgrades**	**Lower Kansas River Basin Master Manual and/or Individual Reservoir Project Water Control Manuals Update**	Recommendation to initiate Spin-off Studies to update the Lower Kansas River Basin Master Manual and/or individual reservoir project WCMs within the Kansas River Basin (e.g., Tuttle Creek, Perry, Clinton, Milford WCMs). During the study period USACE NWK was appropriated funding to update the seven USACE WCMs (i.e. Milford, Tuttle Creek, Perry, Clinton, Harlan County, Wilson, and Kanopolis) in the Kansas River Basin. The updates for the Milford, Tuttle Creek, Perry, and Clinton WCMs are currently underway. WCM updates will include drought contingency plans and coordination with stakeholders during development of alternatives. This would include coordination with the KRWAD concerning the KRWAD Operations Agreement with DWR/KWO/KRWAD.
		Missouri River Control Point Modification	Recommendation to initiate a Spin-off study to evaluate modification to control point (i.e. Waverly) operations for the Kansas River Basin. This could be done as part of the water control manual update which would be a recommended Spin-off USACE project. This could allow for greater flexibility during extreme/high events and quicker evacuation of flood storage at the reservoirs, decreasing risk of surcharge releases, and possible downstream flooding along the Kansas River and tributaries caused by surcharge releases. During the study period USACE NWK was appropriated funding to update the seven USACE WCMs (i.e. Milford, Tuttle Creek, Perry, Clinton, Harlan County, Wilson, and Kanopolis) in the Kansas River Basin. The updates for the Milford, Tuttle Creek, Perry, and Clinton WCMs are currently underway. WCM updates will include coordination with stakeholders during development of alternatives and may if appropriate consider changes to control point operations.
		New Reservoir/Dam Construction or Detention Basins	Study to identify specific sites to investigate the feasibility of construction of new reservoirs/dams or detention basins to provide additional temporary storage of runoff waters, extending the period of runoff with the intent of reducing flood peaks. This could include smaller reservoirs constructed by state agencies and county or local government. The sites could be prioritized based on problem and flood risk and which would provide the highest benefits. The Watershed Study Flood Risk Assessment identified areas with potential high life safety risk or economic damages and the Regional Hazard Mitigation Plans have identified areas with potential need.
	Levee Upgrades	**New or Modified Levees/Dikes/Floodwalls**	Coordination with communities with identified high-risk (i.e., potential life loss of damages) that would benefit from new or modified levees/dikes/floodwalls to determine the need for support from the federal or state government agencies (e.g., USACE, FEMA, KDEM). The Watershed Study Flood Risk Assessment and the Regional Hazard Mitigation Plans identify communities with a need for an investigation to determine if there is a need and the cost/benefit of constructing measures. The existing dikes, levees, and floodwalls protect a portion of the floodplain from flooding, up to a design level.

KRRFSS Measures / Strategies			
	Type of Measure	**Measures**	**Description**
	Flow Improvements	**Channel Modifications**	Study to identify specific sites to widen or deepen the channel to increase flood conveyance. The site list should be prioritized based on problem areas and flood risk and which would provide the highest benefits. The Watershed Study Flood Risk Assessment identified areas with potential high life safety risk or economic damages and the Regional Hazard Mitigation Plans have identified areas with potential need.
		High Flow Diversions	Study to identify specific sites for diversions to redirect excess flows away from developed areas using naturally or artificially constructed bypass channels or conduits. Site list could be prioritized based on problem areas and flood risk and where benefits could be realized. The Watershed Study Flood Risk Assessment and the Regional Hazard Mitigation Plans have identified areas with potential need and the WS identified areas with potential high life safety risk or economic damages.
	Floodplain Improvements	**Authority for Land Acquisition or Easement Purchase for Flood Control**	USACE currently does not have authority to acquire lands or easements for flood control. This would require a new authority and would consist of USACE acquisition of lands, reconnection of old oxbows, or easements along the Kansas River mainstem or major tributaries for flood control measures (levee setbacks, floodplain expansion, restoration of oxbows, etc.). The state of Kansas may have some instruments for this.
		Floodplain Management Plans	Identification of regional/local areas with a need for floodplain management plans (FMPs) to incorporate evaluation of risk and recommend concrete steps to address the risk using a variety of structural and non-structural solutions. Development of an FMP is also intended to increase public awareness of flood risk. The Regional Hazard Mitigation Plans have identified areas with potential need. Possible to work with Silver Jackets Program to develop proposals for plans in high-risk communities.
	Non-structural Measures	**Kansas Flood Center/Flood Information System (using IA as an example)**	Establishment of a flood center and flood information system. The flood center would give Kansans access to the latest technology and resources to help prepare for floods and become more resilient in their effects. This would be accomplished by providing direct services and engaging in flood-related projects that help Kansans understand their flood risks and make better flood-related decisions.
		Floodplain Regulations	Work with local communities, counties, and regional floodplain managers, to establish ordinances, zoning, subdivision regulations, building and housing codes, and sanitary codes with specific flood hazard provisions.
		Flood and Drought Forecasting	Improvement of flood and drought forecasting using available data/tools. KWO currently has a contract with KU to develop an initial forecasting tool. (KWO please expand on this and if there is a follow on action should we add it here?) Continue development of real-time flood inundation mapping and other water-related disaster support tools and resources. Continue the development of advanced flow modeling for future flood planning and identify basins lacking the data necessary to support more sophisticated modeling methods. Work with state and federal partners to identify existing data gaps, including needs for additional stream gages within the monitoring network to improve river forecasting.

KRRFSS Measures / Strategies			
	Type of Measure	**Measures**	**Description**
			Evaluate past climate and stream gage data, current climate trends, and projections for extreme event frequency, size, and duration to update flood planning based on such statistics as appropriate. Improve collaboration between state, federal, and public stakeholders and encourage pooling of resources to enhance flood planning and response. Work with federal partners to maximize matching funds and pursue cost-effective measures that address data and infrastructure needs
		Flood Risk Studies	Support existing proposals/requests for flood risk management projects. Current project that is listed on USACE new start list for GI conversion includes conversion of the Shungununga Creek CAP Section 205 Study to a General Investigation Study for flood risk management. The study is needed by the City of Topeka, KS to reduce recurring impacts related to potential life safety risks and significant and dynamic flooding in urban residential and commercial areas.
		Flood Warning/Emergency Plans	Development of flood warning/emergency plans for high-risk communities. Plans could include flood emergency measures (flood-fighting plans, contingency and emergency floodproofing, emergency evacuation plans).
		Floodplain Mapping	Assess flood prone areas to implement future flood reduction measures in Belvue, Havensville, Louisville, Onaga, St. George, St. Mary's, Wamego, Alma, McFarland, and Paxico. Increasing availability of floodplain maps beyond standard FEMA products would increase understanding of flood risk given good communication.
		Silver Jackets Projects Related to Healthy Watersheds	
Reduction in Ability to Meet Water Supply Demands	**Operational Measures**	**Modification of Low Flow Target Values to Extend Period of Low Flow Support**	Recommendation to initiate Spin-off Studies to update the Lower Kansas River Basin Master Manual and/or individual reservoir project WCMs within the Kansas River Basin (e.g., Tuttle Creek, Perry, Clinton, Milford WCMs) to include modification of the low flow target values to extend the period of low flow support during extended drought periods. During the study period USACE NWK was appropriated funding to update the seven USACE WCMs (i.e. Milford, Tuttle Creek, Perry, Clinton, Harlan County, Wilson, and Kanopolis) in the Kansas River Basin. The updates for the Milford, Tuttle Creek, Perry, and Clinton WCMs are currently underway. WCM updates will include drought contingency plans and coordination with stakeholders during development of alternatives.
	Resiliency Planning	**Water Supply Demand Study**	Study to determine future water supply demands in the Lower Big Blue, Lower Republican, Delaware, Upper Kanas, Middle Kansas, and Lower Kansas HUC 8 Watersheds.

KRRFSS Measures / Strategies			
			Description
		Kansas Research Priorities Support	
		Small Watershed Dam Assessment	
		Promote Water Conservation Measures	
		Drought Communication and Outreach	-
		Kansas River Alluvial Model	
	Sediment Reduction	**Regional Sediment Management Plans**	Conduct USACE PAS Study to prepare sediment management plans for multiple watersheds in the basin.
		Bank Stabilization / Stabilize Head-cuts	-
		Reservoir Bathymetry	
	Sediment Removal	**Tuttle Creek Reservoir Long-Term Sediment Management Plan**	- -
		Tuttle Creek Reservoir Water Injection Dredging Demonstration	- - -

KRRFSS Measures / Strategies			
		Kanopolis Reservoir Long-Term Sediment Management Plan	
	New Water Storage	**KS River Alluvial System Utilized as a Filtration and Storage System**	Study to determine areas of potential artificial recharge in the Kansas River Alluvial Aquifer.
		Construction of Multipurpose Small Lakes	
		Harlan County Reservoir Reallocation Study	Initiate a spin-off study to evaluate the possibility of reallocation of water supply at Harlan County Reservoir.
		Kanopolis Reservoir Conservation Pool Raise	Initiate a spin-off study to evaluate the possibility of a permanent conservation pool raise at Kanopolis Reservoir.
Degraded / Poor Water Quality	**Nutrient and Sediment Reduction**	**Promote and Incentivize the Adoption of Watershed Practices**	
		Water Quality Flood Monitoring	
	Water Management	**Water Quality Communication and Outreach**	
		Water Quality Monitoring for the Ogallala Aquifer	
	Harmful Algal Blooms	**Operational Strategies for HAB Management in Inland Reservoirs**	

KRRFSS Measures / Strategies			
		HAB Research	
		HABs Mitigation and Remediation	
Ecosystem Degradation and Species Impacts Measures	**Reservoir Habitat Improvements**	**Lake Level Management Plans**	
	Riverine / Off-Channel / Watershed Improvements	**Support of SRP**	
		Upstream Floodplain Ecosystem Restoration	
		Removal of Stream Impediments / Fish Barriers	
		Construct and Maintain Wetlands and Rehabilitate Old Oxbows	USACE new start list for GI or CAP or conversion list include Smoky Hill River GI, Jersey Creek GI, Rocky Ford GI,
		Riparian Corridor Restoration	
	Invasive Species Management	**Watercraft Decontamination and Inspection**	

KRRFSS Measures / Strategies			
		Invasive /Non-native Species Control	
	Research / Monitoring / Surveys / Stocking	**Riverine Fisheries Monitoring (species management, recruitment, habitat variables)**	Monitor reintroduced populations to determine success and inform adaptive management for future efforts.
		Reintroduction of Imperiled Species	
		Western Streams Baseline Flow Monitoring	
Loss of Recreation Opportunities Measures	**Reservoir Recreation**	**Construct New Boat Ramps or Extend Existing Boat Ramps**	
	Riverine Recreation	**Public River Access Points Along the Kansas River Mainstem**	
	Other Recreation Needs	**Expansion/Improvement of Visitation Data**	
		Dashboard to Serve Water Quality and Recreation	