APPENDICES

A. Adaptation Tools and Documents

The tools and documents found in this appendix are organized by the adaptation action areas identified by WUCA (Engage, Understand, Plan, Implement, Sustain) in its **Leading Practices report**. These resources supplement that report and provide a survey of the existing tools and information available—especially for people recently embarking on adaptation efforts or who have limited capacity—to support adaptation processes leading to and including implementation.

Engage

Motivation and support are essential for successfully initiating, implementing, and sustaining adaptation action.

Resilient Metrics - Job Aid: Identifying and Effectively Engaging Stake- and Rights-holders

Antioch University's Center for Climate Preparedness and Community Resilience - Strategies for 21st Century Risk Management and Climate Change Communication webinar

Yale Program on Climate Change Communication - Visualizations and Data Tools

WUCA - Training and Presentation Resources

Climate Central – Surging Seas Maps and Tools

NOAA Office of Coastal Management – Sea Level Rise Viewer

San Francisco Bay Conservation & Development Commission (BCDC) – Community Vulnerability Mapping and Community-Based Organization Directory Map

California Coastal Commission - California King Tides Project

I-Storm

Understand

Knowing you water system—how it currently functions, how it has faltered or failed under previous conditions, and how future conditions (e.g., sea level rise, flooding, extreme heat, wildfires, drought) may impact its ability to operate effectively—will help you identify and understand existing and potential future limitations as well as provide context to assess risk and opportunities for adaptation action.

NOAA's Tides and Currents Initiative - Extreme Water Levels Tool

NOAA – 2022 Sea Level Rise Technical Report

NOAA – Application Guide for the 2022 Sea Level Rise Technical Report

California Energy Commission, University of California, Berkeley, California Strategic Growth Council - Cal-Adapt

WUCA - Options for Improving Climate Modeling to Assist Water Utility Planning for Climate Change

City and County of San Francisco, CA - Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability and Risk to Support Adaptation

The Washington Coastal Resilience Project - How to Choose: A Primer for Selecting Sea Level Rise Projections for Washington State

Global Water Operators' Partnerships Alliance (GWOPA) - A Tool for Coastal and Small Island State Water Utilities to Assess and Manage Climate Change Risk

San Diego Association of Governments (SANDAG) - Regional Transportation Infrastructure Sea Level Rise Assessment and Adaptation Guidance

San Diego Association of Governments (SANDAG) - Adapting to Climate Change: A Planning Guide for State Coastal Managers

Azevedo de Almeida BA, Mostafavi A. 2016. - Resilience of Infrastructure Systems to Sea Level Rise in Coastal Areas: Impacts, Adaptation Measures, and Implementation Challenges. Sustainability 8(1115):1-28

Brown C, Ghile Y, Laverty M, Li K. 2012. - Decision Scaling: Linking Bottom-up Vulnerability Analysis with Climate Projections in the Water Sector. Water Resources Research 48(9)

Eakin H, Parajuli J, Yogya Y, Hernandez B, Manheim M. 2021. - Entry Points for Addressing Justice and Politics in Urban Flood Adaptation Decision Making. Current Opinion in Environmental Sustainability 51: 1-6

Lempert RJ, Groves DG. 2010. Identifying and Evaluating Robust Adaptive Policy Responses to Climate Change for Water Management Agencies in the American West. Technological Forecasting & Social Change 77(6):960-974 https://www.rand.org/pubs/external_publications/EP201000193.html

Sadler JM, Goodall, JL, Behl M, Bowes BD, Morsy MM. 2020. Exploring Real-Time Control of Stormwater Systems for Mitigating Flood Risk Due to Sea Level Rise. Journal of Hydrology 583: 124571

Miller IM, Morgan H, Mauger G, Newton T, Weldon R, Schmidt D, Welch M, Grossman E. 2018. Projected Sea Level Rise for Washington State: A 2018 Assessment. Prepared for the Washington Coastal Resilience Project. Updated July 2019.

U.S. Army Corps of Engineers – Sea Level Change Curve Calculator

Asefa T, Clayton J, Adams A, Anderson D. 2014. – Performance Evaluation of a Water Resources System Under Varying Climatic Conditions: Reliability, Resilience, Vulnerability and Beyond. Journal of Hydrology 208: 53-65

Adapting to Rising Tides – Maps and Data

EPA – Storm Water Management Model (SWMM)

Plan

Planning for adaptation includes identifying, evaluating, and prioritizing adaptation options. This action area provides for the explicit identification of consensus-based desired outcomes, management and planning targets, and adaptation options from which to prioritize. During the planning process, it is important to address uncertainties associated with climate science, how ecosystems and built systems will respond, and the social and governance structures in which adaptation measures need to be implemented. An adaptive management approach helps decision-makers consider a range of future conditions and prioritize options that spread risk across different adaptation options (e.g., protect versus retreat). Practitioners may decide to continue to pursue current management activities, make modifications to current strategies to better address sea level rise, and/or advance new and novel approaches to sea level rise.

Adaptation Pathways Generator

EPA - Adaptation Strategies Guide for Water Utilities

UN Environment - Climate Change Adaptation Technologies for Water: A Practitioner's Guide to Adaptation Technologies for Increased Water Sector Resilience

EPA - Flood Resilience: A Basic Guide for Water and Wastewater Utilities

Toronto and Region Conservation for the Living City and Credit Valley Conservation - Low Impact Development Stormwater Management Planning and Design

Bertule M, Appelquist LR, Spensley J, Trærup SLM, Naswa P. 2018 - Climate Change Adaptation Technologies for Water: A Practitioner's Guide to Adaptation Technologies for Increased Water Sector Resilience. UNEP DTU Partnership

Brodmerkel A, Carpenter AT, Morley KM. 2020 - Federal Financial Resources for Disaster Mitigation and Resilience in the U.S. Water Sector. Utilities Policy 63

de Graaf R, van de Giesen, van de Ven F. 2009.- Alternative Water Management Options to Reduce Vulnerability for Climate Change in the Netherlands. Natural Hazards 51(407)

Goodhew T. 2014. - Coastal Flood Defenses: Strategies for Protection in the United Kingdom. In Water Resources in the Built Environment: Management Issues and Solutions. Eds. Booth CA, Charlesworth SM

Center for Planning Excellent – Advancing Community Adaptation: A Framework for Project Prioritization and Decision Making

Erfani T, Pachos K, Harou JJ. 2018 – Real-Options Water Supply Planning: Multistage Scenario Trees for Adaptive and Flexible Capacity Expansion Under Probabilistic Climate Change Uncertainty. Water Resources Research 54(7):5069-5087

Sadr SMK, Casal-Campos A, Fu G, Farmani R, Ward S, Butler D. 2020. Strategic Planning for the Integrated Urban Wastewater System Using Adaptation Pathways. Water Research 182: 116013

EPA Climate Ready Estuaries – Synthesis of Adaptation Options for Coastal Areas

Indiana University Environmental Resilience Institute – Adaptation Strategies for Sea Level Rise

Coastal-Marine Ecosystem-Based Management Tools Network, NatureServe - Tools for Coastal Climate Adaptation Planning

Implement

Adaptation implementation includes changes made to an agency's activities, operations, and assets. These changes put priority adaptation options into action and can build resilience to sea level rise. Many adaptation initiatives encounter barriers in the transition from planning to implementation (WUCA, 2021).

Maryland Department of Planning - Maryland's Plan to Adapt to Saltwater Intrusion and Salinization

San Francisco Estuary Partnership - Transforming Shorelines: Advancing Nature-Based Solutions and Building Capacity for Innovative Approaches Linked to Wastewater Treatment

Molinaroli E, Guerzoni S, Suman D. 2019. - Do the Adaptations of Venice and Miami to Sea Level Rise Offer Lessons for Other Vulnerable Coastal Cities? Environmental Management 64:391-415

London Climate Change Partnership - Adaptation Pathways Started Kit

EcoAdapt and Foresight Partners Consulting – Climate Change Adaptation Certification Tool

Considine C, Covi M, (Wie) Yusuf JE. 2017. Mechanisms for Cross-Scaling, Flexibility and Social Learning in Building Resilience to Sea Level Rise: Case Study of Hampton Roads, Virginia. American Journal of Climate Change 6:385-402

Sustain

In order for climate adaptation efforts to be effective in the long term, there must be a pathway/plan to sustain these actions from the start. Monitoring and evaluation of implemented strategies, maintaining partnerships, and continually learning how you can integrate adaptive management approaches into your utility are essential to sustaining action. Mainstreaming climate adaptation into your organization's mission and operations help sustain the processes needed to adapt to climate change beyond the creation of an adaptation plan.

Brown S, Wadey MP, Nicholls RJ, Shareef A, Khaleel Z, Hinkel J, Lincke D, McCabe MV. 2019. - Land Raising as a Solution to Sea Level Rise: An Analysis of Coastal Flooding on an Artificial Island in the Maldives. Journal of Flood Risk Management 13:e12567

Cecchetti AR, Stiegler AN, Graham KE, Sedlak DL. 2020. - The Horizontal Levee: A Multi-Benefit Nature-Based Treatment System That Improves Water Quality and Protects Coastal Levees from the Effects of Sea Level Rise. Water Research X. 7: 100052

Davtalab R, Mirchi A, Harris RJ, Troilo MX, Madani K. 2020. - Sea Level Rise Effect on Groundwater Rise and Stormwater Retention Pond Reliability. Water. 12(4) 1129

Heal KV. 2014. - Constructed Wetlands for Wastewater Management. In Water Resources in the Built Environment: Management Issues and Solutions. Eds. Booth CA, Charlesworth SM.

Mensah KO, FitzGibbon J. 2013. - Responsiveness of Ada Sea Defense Project to Salt Water Intrusion Associated with Sea Level Rise. Journal of Coastal Conservation 17:75-84