Appendix A: Region 5 Vulnerability Assessment Table

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
ARD	Increased tropospheric ozone pollution in certain regions	Likely[1]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could become more difficult to attain NAAQS for ozone in many areas, including areas with existing ozone problems as well as those currently in attainment.	High	Five of the six Region 5 states already struggle with attaining the ozone standard in large urban areas. Increases in tropospheric ozone could result in more nonattainment areas and lengthen the ozone season.	Important across Region, but new non-attainment areas could be in smaller metro areas and in the northern part of the Region.
ARD	Increased frequency or intensity of wildfires	Likely[2]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires.	Medium	Currently wildfires are not a large contributor to PM issues in the Great Lakes States; however, a significant increase in wildfires could change this profile. Could also increase deposition of certain contaminants to the Great Lakes.	Forest areas are mostly in the northern part of the Region.
ARD	Increasing extreme temperatures	Very Likely[3]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could complicate efforts to attain NAAQS for various criteria pollutants and increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations.	Medium	Increased temperatures and extreme weather events could increase demand for electricity (for example, through increased use of air conditioning units), which would require more electricity creating greater pollution from EGUs, back-up generators, and peaker plants. This could increase difficulty of meeting NAAQS for O3, PM2.5, SO2, NO2, and CO.	Important across Region, but risks higher in urban areas and areas with more sources.
ARD	Increasing extreme temperatures Increasing heavy precipitation events	Very Likely[3] Likely[3]	Protect public health by promoting healthy indoor environments through voluntary programs and guidance	Could increase public health risks from indoor air pollution, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations	Medium	Susceptible individuals across Region 5 will be impacted by potentially greater exposure to air pollution, both indoors and outdoors. More time spent inside during extreme weather, mold issues as a result of flooding and storms, and inappropriate energy efficiency measures (i.e., making buildings too "tight") could all increase IAQ problems.	Important across the Region, but particularly in EJ areas and areas with high density of more susceptible populations.

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ARD	Increasing extreme temperatures Increasing heavy precipitation events	Very Likely[3] Likely[3]	Atmospheric deposition initiatives Ecosystem protection from Agency emissions reduction programs	Effects on ecosystems, including the Great Lakes, to increased atmospheric deposition of sulfur, nitrogen, and mercury (and potentially increased methylation of mercury). Also impacts compliance with water quality standards and TMDLs.	High	Mercury is a high priority in Region 5 in both the Great Lakes and inland lakes. All of our states have water bodies impaired by mercury. Increases in mercury deposition, as well as sulfur and nitrogen, would further stress our ecosystems.	Very important across the Region.
EJ	Increasing heavy precipitation events Increasing flood risk	Likely[3] Likely[5]	Drinking water, wastewater and stormwater infrastructure	Inadequate water supply for human consumption (Contaminated wells, water systems) Damage to water infrastructure from intense storms	High	EJ communities will need added assistance and attention if these events compound already existing concerns.	Regionwide
GLNPO	Changes in temperature Increased water temperatures Increasing heavy precipitation events	Very Likely[3] Very Likely[6] Likely[3]	GLRI, GLQWA	Overall climate change impacts to Great Lakes water quality and ecosystem characteristics	High	As a result of its working relationship with Canada under the new GLWQA commitments, GLNPO will be put under increased pressure to develop and coordinate with Canada monitoring, modeling, downscaling and other climate efforts, including capacity building and sharing information needed by GL resource managers. States, tribes and other GLRI partners will face increasing pressure to address various local impacts to Great Lakes resources and begin adaptation efforts. This will increase	Lake Superior, a "cold water" lake, will be extremely affected by climate change in general. The nature of the fish species, aquatic species, wildlife habitat will all be tremendously affected (more so than the other lakes) by climate change.

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						pressure on GLRI programs and funding sources. GLNPO will face an increased workload to understand the science of climate change in the Great Lakes and monitor climate change variables in assessments of the overall health of the Lakes. GLNPO will face an increased workload in outreach/communication in helping partners, local communities, cities, etc, adapt to a changing climate.	
GLNPO	Increased frequency or intensity of wildfires	Likely[2]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires	Medium	More forest fires will increase emissions of mercury and other contaminants, thereby hindering progress in reducing mercury in the Great Lakes ecosystem under our binational commitments in the new Great Lakes Water Quality Agreement 2012 (GLWQA), and may complicate mercury reduction efforts under GLRI Toxics Focus Area. May also prevent the achievement of the mercury reduction goals of the Lake Superior Zero Discharge Demonstration Program.	Lakes Superior, Huron, Michigan
GLNPO	Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	Likely[4]	Ecosystem protection from Agency emissions reduction programs	Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs.	Medium	Changes in atmospheric deposition patterns of these and other toxic chemicals could adversely affect EPA's ability to fulfill its commitments to reduce toxic chemicals in the Great Lakes ecosystem under the GLWQA and the GLRI Toxics Focus Area.	Lakes Superior, Huron, Michigan

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				Watershed, aquatic ecosystems and wetlands will be at risk from runoff contamination from sulfide mining in the Upper Great Lakes, during heavy precipitation events.		Could potentially affect the ecosystem response with respect to sulfide levels in wild rice habitat.	
GLNPO	Increasing heavy precipitation events Increasing intensity of hurricanes Decreasing precipitation days and increasing drought intensity Increased water temperatures	Likely[3] Likely[3] Likely[5] Very Likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands GLRI, GLQWA	Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. Challenges to coastal wetlands' ability to migrate. Reduced streamflow, altering the aquatic environments and increasing impairments. Higher nutrient loadings will likely lead to an increase in toxic algae blooms. Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	High	GLWQA nutrient loading and concentration targets will be harder to achieve if the Great Lakes experience increased runoff from more frequent and intense precipitation events. GLWQA and GLRI commitments to address risks to water quality from chemicals will be harder to address if increased runoff increases the amount of nonpoint source pollution such as chemicals, pesticides, oil and pharmaceuticals to the Great Lakes. GLRI-funded habitat restoration projects will be at risk from destruction or decreased performance due to increased erosion, scouring, wave action, etc. as a result of increased storm intensity. Additional costs and design considerations will result. Climate change effects on CSOs, NPS and other water pollution loadings will put current cleanup, remediation and restoration activities in Great Lakes Areas of Concern (AOCs) at risk from destruction or decreased performance.	Especially Lake Erie, Green Bay, Saginaw Bay 31 US Areas of Concern spread throughout the GL Basin

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GLNPO	Changes in temperature Increased water temperatures	Very Likely[3]	GLRI, GLQWA	Shifting habitat ranges and migration patterns of Great Lakes species.	High	May force changes in goals for GLRI-funded restoration projects. Protection efforts for GLRI-critical species will require additional analysis and tools to address the increasingly out of sync migrations of some species with the appearance of their food sources.	Regionwide
GLNPO	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased pathogens on Great Lakes beaches	High	Fulfilling EPA's commitments to remove "beach closings" as a beneficial use impairment from Great Lakes AOCs will be hindered if E. coli increasingly over-winters and faces ideal air and water conditions for growth.	Regionwide
GLNPO	Increasing heavy precipitation events Increasing intensity of hurricanes Increasing flood risk	Likely[3] Likely[3] Likely[5]	Drinking water, wastewater and stormwater infrastructure GLQWA	Water infrastructure could be overwhelmed or damaged. Integrity of coastal water infrastructure systems could be put at increased risk. Drinking water and wastewater utilities will need an 'all hazards' approach to planning for emergencies and extreme weather events. Problems of safety as well as access to clean and safe water will be exacerbated for vulnerable and economically deprived communities.	High	A significant number of CSOs still exist in the Great Lakes Basin, so increased precipitation will continue to have a negative impact on EPA's ability to meet its commitments under the GLWQA. The Upper Great Lakes basin has a significant and increasing number of mining operations, which will face new weather conditions that do not match engineering design assumptions, thereby increasing the vulnerability of Great Lakes waters to contamination. CWA Programs, NEPA, and GLRI programs may have an increased burden in dealing with these changes.	Lakes Superior, Huron and Michigan

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GLNPO	Changes in temperature Increased water temperatures Increasing heavy precipitation events	Very Likely[3] Very Likely[6] Likely[3]	GLRI, GLQWA	Changing Seasonality of Great Lakes precipitation, evaporation, tributary flows Seasonal ice cover over the Great Lakes has been decreasing measurably, and will affect evapotranspiration, local weather, etc.	High	Depending upon changes in evaporation, lake levels, and seasonality of tributary flows, the concentration of some toxic chemicals may increase in some places. This will create negative conditions for management of toxic chemicals of concern to Great Lakes waters under the GLWQA and GLRI. These changes will complicate goal-setting, design and implementation phases of habitat/species restoration under GLRI and to fulfill GLWQA commitments, including projects associated with the AOCs.	Regionwide
GLNPO	Changes in temperature Increased water temperatures Increasing heavy precipitation events Decreasing precipitation days and increasing drought	Very likely[3] Very likely[6] Likely[3] Likely[5]	GLRI, Other non- EPA programs including Great lakes Compact & IJC Water Regulation Authorities	If GL water levels decrease significantly, costs to pollution abatement, habitat restoration and the economy could be significant. If GL levels increase, current GLRI remediation projects and activities (including those at AOCs) may be in jeopardy.	High	Further modeling and monitoring of lake levels is needed, which will require the investment of GLNPO's federal, state and academic partners.	Throughout Great Lakes Basin
GLNPO	Increased water temperatures	Very likely[6]	GLWQA	Increased potential for aquatic invasives to enter the Great Lakes. Some invasives already present in Great Lakes can be	High	The new GLWQA commits US and Canada to undertake an assessment of climate change impacts on AIS. EPA's contributions to AIS monitoring, prevention, control, and eradication programs may be affected, requiring shifts in priorities or added costs.	Regionwide

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				triggered to become more invasive or increase their range. Some species may become less invasive in some places with new conditions. Longer shipping season increases the risk that a greater amount of ballast delivered might include a greater number of species not yet established in the Great Lakes. More flooding, due to greater numbers of severe precipitation events, means that species established (from pathways such as pet, water garden, bait, recreation, etc.) in isolated inland lakes and rivers near the Great Lakes will be more likely to be transported within watersheds and into the Great Lakes.			
GLNPO	Increasing heavy precipitation events	Likely[3]	Cleaning up Contaminated Sites and Waste Management	Increased risk of contaminate release from EPA Sites. May need to alter selected remedies to ensure protection.	Medium	Increased volatility of weather and loss of predictability will complicate planning and implementation of AOC remediation projects.	Regionwide

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				Erosion and flooding could increase the potential for chemical and hazardous substances contamination from Superfund and other sites within Great Lakes AOCs.		The GL Basin is vulnerable to resuspension and volatilization of toxic chemicals from sediments due to the increased storm intensity. May render some remedies less effective in AOCs, may require changes in design.	
GLNPO	Increasing heavy precipitation events	Likely[3]	Emergency Response	Increased need for emergency response. Possible limitations to response capability due to staff and financial resource constraints.	High	Increased storm intensity will increase the risk of toxic spills to the Great Lakes from shipping. ER must be coordinated with Coast Guard and the Canadians.	Regionwide
GLNPO	Increasing risk of floods Increasing intensity of hurricanes Increasing extreme temperatures	Likely[5] Likely[3] Very likely[3]	Operations of Agency facilities, personnel safety, physical security, and emergency communications Emergency management mission support (protective gear and acquisition)	Facilities in coastal or flood-prone areas Personnel engaged in field work and vulnerable to extreme temperatures or events Security, lighting and communication systems without backup power Personnel and real property supporting emergency response and management	Medium	Increased storm intensity will increase the risk to EPA vessels and crews on the Great Lakes.	Regionwide
Homeland Security	Increasing risk of floods	Likely[5] Likely[5]	COOP Occupant Emergency Plan Activation of Homeland Security Frameworks	Increased occurrence and intensity of natural disasters increase the risks to Region 5 personnel and facilities	Medium	Impact to EPA Personnel and facilities; response to Natural Disasters; Emergency Communications; Activation of FEMA	Regionwide

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	Decreasing precipitation days and increasing drought intensity Increasing intensity of hurricanes	Likely[3]				Support Functions	
IEO	Increasing heavy precipitation events Increasing risk of floods Changes in temperature	Likely[3] Likely[5] Very likely[3]	General Assistance Program (GAP) capacity building program	Flooding, heat waves, droughts, etc. can interrupt essential services such as drinking water systems and wastewater treatment facilities. Subsistence resources may also be affected.	Medium	Increased requests for assistance from tribes that are experiencing climate-related hazards and impacts. Tribes will likely contact IEO to request assistance from EPA. IEO and the media Divisions will need to identify the types of assistance (technical, financial, personnel, etc.) that may be available from the Agency and if there are other federal agencies that should coordinate activities. May need to adjust how the Indian Environmental General Assistance Program (GAP) can be used by the tribes to plan for or respond to climate change impacts.	Tribal impacts would mostly be limited to MI, WI and MN
LCD	Increasing heavy precipitation events Increasing risk of floods Changes in temperature	Likely[3] Likely[5] Very likely[3]	Cleaning up Contaminated Sites and Waste Management	Increased risk of contaminant release from EPA Sites. GW and subsurface contamination could be impacted by drought and flood conditions. Contaminants increase risk of migration from floods.	Low	May need to consider altering selected remedies to ensure protection; altering (hazardous/nonhazardous) landfill criteria and BMPs to ensure protection; conduct more frequent targeted inspections at hazardous waste disposal facilities; increase oversight of authorized states and/or provide increased technical assistance. Climate changes may trigger the following impacts at Corrective Action sites and the	Little variation in impact across Midwest; potentially increased risk in Great Lakes Basin and Ohio River Valley

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						selected remedies will reflect these considerations: Increased flood and drought conditions will impact mobilization of contaminants at sites and may alter the time, cost, and effectiveness of cleanups. Vegetation considerations: Whatever plants are used may not be tolerant to heat or excessive water. May need to change plant species or do additional maintenance. Drier conditions might cause severe erosion issues on terrain and constructed landfills. Might have 500 year flood events. Drier conditions combined with larger rain events might contribute to additional erosion concerns. Could have water table fluctuations - wells might need to be screened in different zones. Contaminant plumes might change direction. Remedies might become ineffective due to fluctuating water tables which could increase smear zones and additional remedy options may need to be considered. Frequent Flooding – may need to design corrective action to ensure it is protective given possible increased flooding. High flood event might wash away constructed remedies and increase contamination to the environment. Standing water could bring	

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						contaminants to the surface and increase exposure potential. Colder weather and erratic weather - could change construction season. Investigations and remedies may take longer to construct. Increased sedimentation and scouring due to larger rain events could impact sediment sites.	
LCD	Increasing intensity of hurricanes Increasing heavy precipitation events Increasing risk of floods Increasing extreme temperatures	Likely[3] Likely[3] Likely[5] Very likely[3]	Emergency Response Emergency Response Support Remedial Response Clean-Up & Corrective Action	Increased PBT chemical impacts to surface water	Low	Programs will need to consider updates to operating facility SPCC, contingency and other risk management and P2 plans for listed wastes, solid wastes and PBTs/Chemicals of Concern. Consideration/evaluation of appropriate work times for remedial/removal activities, and impacts to clean-up timelines. Consideration of facility and siting issues, as permitting occurs.	Regionwide, particularly for permitting and planning activities, where facilities may not have previously required an awareness for water releases, or risk management for water/flooding.
LCD	Increasing intensity of hurricanes Increasing heavy precipitation events Increasing risk of floods	Likely[3] Likely[3] Likely[5] Very likely[3]	Emergency Response (debris management and recovery related to disaster response to storm events, flooding, etc.) Emergency Response Support	Increased need for emergency response and debris/waste management due to storms resulting in large-scale releases of chemicals and/or air emissions (e.g., asbestos, PCBs, Hg, PBTs, SO2) from flooded/damaged and/or demolished buildings.	High	Possible limitations to response capability due to staff and financial resource constraints. Possible increased need for emergency disposal permits.	Regionwide

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	Increasing extreme temperatures						
LCD	Increasing extreme temperatures Increasing heavy precipitation events Increasing flood risk	Very likely[3] Likely[3] Likely[5]	Protecting human health and ecosystems from chemical risks. EPCRA (TRI): o Maintaining inventory of chemical releases o Maintaining lists of facilities releasing chemicals TSCA: o Maintaining chemical database (inventories, dossiers and information) on chemicals within U.S. commerce (currently and previously, including allowances and prohibitions) o Maintaining lists of major chemical manufacturers, processors and formulators (MPFs) FIFRA: o Maintain Registration Review schedules/information o Maintaining establishment (facility) information	Increased need for emergency response and debris/waste management due to storms resulting in large-scale releases of chemicals from flooded/damaged and/or demolished buildings. Any regional risk assessments could be affected as weather and climate events could affect RCRA/TSCA and Superfund interpretations of risk at the facility level.	High	Risk Assessment Framework may need adjustments in order to: Assure that chemical exposure models reflect changes in the environment; Perform climate change assessments on chemicals/substances with a climate change impact; Address risk-shifting and new risk considerations where chemicals impact---or are impacted by---climate change (e.g., changes in chemical applications or uses). Will need to keep other media offices aware of chemical use trends that affect their programs. Facility awareness of these emerging chemical and risk issues and addressing them within their Operation and Emergency Management plans, as needed, but particularly where risk shifting or new risk considerations occur.	More relevant near sites with large densities of chemical Manufacturers, Processors and Formulators (MPFs), and RCRA and Superfund sites. Extremely relevant, particularly for permitting and planning activities, where facilities may not have previously required an awareness for water releases, or risk management for water/flooding.

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RMD	Increased water temperatures Decreasing precipitation days and increasing drought intensity	Very likely[6] Likely[5]	Water usage at EPA facilities	Water temperatures impact research activities or cooling requirements. Facilities could be located in areas with water shortages	Low	Use of water in facilities is of medium importance since GSA owns the majority of EPA buildings in the region. R5 has COOP and extensive flexiplace availability.	All field offices except the Lake Guardian
RMD	Increasing risk of floods Increasing intensity of hurricanes Increasing extreme temperatures	Likely[5] Likely[3] Very likely[3]	Operations of Agency facilities, personnel safety, physical security, and emergency communications Emergency management mission support (protective gear and acquisition)	Facilities in flood-prone areas Personnel engaged in field work and vulnerable to extreme temperatures or events Security, lighting and communication systems without backup power Personnel and real property supporting emergency response and management	Medium	R5 office is located in an area with low probability for flooding, tornadoes, and earthquakes. There is a greater probability for blizzards. Severe Lake Weather is of high regional importance (affects GLNPO operations on Lake Guardian) R5 has COOP and extensive flexiplace availability. In addition, the Region has MOAs with R3 and R4 to assist in emergencies.	Lake Guardian is a vessel that is affected by changes in the Great Lakes weather
SFD	Increasing heavy precipitation events Increasing risk of floods Changes in temperature	Likely[3] Likely[5] Very likely[3]	Cleaning up Contaminated Sites and Waste Management	Increased risk of contaminant release from EPA Sites May need to alter selected remedies to ensure protection.	Medium	Increased flood and drought conditions will impact mobilization of contaminants at sites and may alter the time, cost, and effectiveness of cleanups. Vegetation considerations: Whatever plants are used may not be tolerant to heat or excessive water. May need to change plant species or do additional maintenance.	Regionwide

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						Drier conditions might cause severe erosion issues on terrain and constructed landfills. Might have 500 year flood events. Drier conditions combined with larger rain events might contribute to additional erosion concerns. Could have water table fluctuations - wells might need to be screened in different zones. Contaminant plumes might change direction. Remedies might become ineffective due to fluctuating water tables which could increase smear zones and additional remedy options may need to be considered. Frequent Flooding – may need to design corrective action to ensure it is protective given possible increased flooding. High flood event might wash away constructed remedies and increase contamination to the environment. Standing water could bring contaminants to the surface and increase exposure potential. Colder weather and erratic weather - could change construction season. Investigations and remedies may take longer to construct. Increased sedimentation and scouring due to larger rain events could impact sediment sites.	

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SFD	Increasing heavy precipitation events Increasing flood risk	Likely[3] Likely[5]	Emergency Response	Increased need for emergency response. Possible limitations to response capability due to staff and financial resource constraints.	High	Due to population densities along rivers in the Midwest, increased precipitation will lead to increased riverine flooding and to additional hazardous waste and domestic white goods (refrigerators, stoves) removal and cleanup as a result. Additionally, the frequency of events may stress availability of emergency response teams to react quickly. Hotter during days, and longer "summers" – health and safety considerations for the workers; Might need to take mid-day breaks and need more breaks - could change construction season; could take longer to conduct investigations and construct remedy; need to consider health and safety of workers. More severe weather- could take longer to conduct investigations and construct remedy; need to consider health and safety of workers May have a great proliferation of pests if we have no freeze and thaw to control them. This could then require additional safety concerns for workers.	Hurricanes are not much of a risk in R5, but there may be an increased risk of extreme weather especially in the southern part of the Region (Illinois, Indiana, Ohio).
SFD	Increasing extreme temperatures Increasing heavy precipitation events	Very likely[3] Likely[3]	Protecting human health and ecosystems from chemical risks	Changing in planting timing or location may affect the volume and timing of agricultural chemical use which could impact the	Low	Assure that chemical exposure models reflect changes in the environment	Unknown (Chemical Preparedness & Prevention)

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				appropriate risk management decisions.			
WD	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health.	High	Increased demand for re-evaluation of controls and effluent limitations in NPDES permits; re-evaluation of development of WQBELs and TBELs to account for the pollutant loads. There could be increased requests for variances from water quality standards. Pretreatment programs may need to be assessed for local limit revisions and other controls on industries to ensure protection of a wastewater treatment plant and the receiving water body.	Regionwide
WD	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health.	High	Increased need for wet weather inspections (CSO/SSO communities, stormwater discharges), to assess compliance and confirm appropriate level of control; may lead to increased enforcement action, requests for revisions to consent decrees.	Majority of CSO communities are in IL, IN, OH, however SSO communities are spread across region.
WD	Decreasing precipitation days and increasing drought intensity	Likely[5]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Reduced streamflow during summer months, altering the aquatic environments and increasing impairments.	Medium	Changes in watershed hydrology due to climate change will need to be reflected in changes to watershed assessment methodologies and models as well as TMDL development processes in order to predict the effects of pollutant loadings on water quality. These methodologies and models, which are critical in state and EPA development of TMDLs, will need to be revised to ensure TMDLs continue to be effective in attaining water quality standards.	Regionwide

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WD	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Challenges to coastal wetlands' ability to migrate.	High	Watershed planning and permitting would be impacted should waterbody boundaries move or are displaced.	Regionwide
WD	Increasing heavy precipitation events Decreasing precipitation days and increasing drought intensity Increased water temperatures	Likely[3] Likely[5] Very likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Changes in hydrology may alter aquatic habitat, ability of water bodies to support historic aquatic life communities may be compromised, prompting requests for use designation changes, revised water quality standards. CWA programs, such as assessments, 303(d) lists, TMDLs may not provide adequate protections without revisions. Current practices to control nonpoint sources and nutrient pollution may be less effective. Economic and cultural practices of tribal communities may be adversely affected.	Medium	Watershed planning efforts will need to be modified to include projections related to climate change. The 319 program may not have adequate funds and the needed technical expertise to support states/tribes/local units of government in their efforts to continue to meet/maintain water quality standards. The research and models used to inform nonpoint source controls measures may need to be updated to reflect new runoff situations and effectiveness of practices at reducing pollution, particularly nutrient pollution from agricultural sources. Biennial listing process for TMDLs likely to be more challenging as hydrology changes. Hydrology strongly affects pollutant loadings, so changes in hydrology will affect the model and TMDL assumptions used to determine pollutant loading capacities. Impact on staff - more time on evaluating listings, more sophisticated training on models used in the program , more frequent reviews of TMDLs to determine if loadings are still sufficient to attain water quality standards. Impact to states/tribes: more time to evaluate the specific hydrodynamics of assessed waterbodies, possible changes in use designations, more frequent reviews of TMDLs to determine if loadings are still	Regionwide; tribal impacts limited to MI, WI and MN

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						sufficient to attain water quality standards For tribes, wild rice, occurring in both lakes and streams, conditions may be impacted by climate change, new methods of protecting that crop will be necessary.	
WD	Increasing heavy precipitation events Increasing risk of floods	Likely[3] Likely[5]	Drinking water, wastewater and stormwater infrastructure	Water and wastewater infrastructure could be overwhelmed or damaged, potentially resulting in noncompliance and causing human health and aquatic life risks. Existing emergency contingency plans may be insufficient for affected water and wastewater utilities. Problems of safety as well as access to clean and safe water may be exacerbated for vulnerable and economically deprived communities.	High	Particularly likely to affect direct implementation (DI) tribal program (provides oversight of and technical assistance to tribal public water systems), for example: tribes may need more assistance related to infrastructure impacts associated with climate change, putting demands on the region to be aware of changes occurring at the system level and educate systems about how best to adapt, (e.g., implement an "all hazards" approach to emergency planning); the DI program could be called on to prioritize an increasing number of projects for contractors and Indian Health Service (IHS) public health officials; we may see demands to assist in emergency response efforts. State and tribal technical assistance (promote awareness and information exchange)—the region may face increased demands to assist states and tribes with information sharing on available downscaled models and tools (climate ready water utilities (CRWU) and climate resilience evaluation and awareness tool (CREAT)), as well as lessons learned associated with climate change adaptation at	DI—significant (as of 10/4/12, there are 101 tribal water systems in Region 5)

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
						states, tribes, and systems. State and tribal grant management and oversight may become more complicated.	
WD	Increased water temperatures Increasing heavy precipitation events Decreasing precipitation days and increasing drought intensity	Very likely[6] Likely [3] Likely[5]	The quality and availability of safe drinking water	High water temperatures and increased stormwater runoff may increase the need for drinking water treatment, raising costs, or compromise quality of drinking water. Water supplies may be affected, forcing communities to seek alternative sources. Water demand may shift to underground aquifers or prompt development of reservoirs or underground storage of treated water, requiring EPA to ensure safety.	Medium	DI tribal program—water quality changes may result in more Safe Drinking Water Act (SDWA) violations, which would increase the work of the regional compliance officers; State and tribal voluntary programs—the region could see demands to increase technical assistance, outreach, and education to further implementation of state and tribal: (1) source water protection programs, including encouraging systems to track water quality/quantity trends (particularly static water levels) and (2) WaterSense/water conservation/green infrastructure/water recycling and reuse programs.	Regionwide; tribal impacts limited to MI, WI and MN
WD	Increased water temperatures	Very likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Pollutant limitations in NPDES wastewater permits may no longer be protective of water quality standards.	Medium	Water quality standards and/or effluent limitations may be revised to continue to be protective of the water body. As water temperatures increase thermal loads in permits would need to be evaluated possibly restricting thermal limitations to lower levels in permits to continue to be protective of the aquatic life in the water body. Inability of permittees to meet revised limits may prompt	Regionwide

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
						permit challenges or lead to noncompliance, increasing administrative or enforcement workloads, respectively.	
WD	Increased water temperatures	Very likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Ability of water bodies to support historic aquatic life communities may be compromised, prompting requests for use designation changes, revised water quality standards.	Medium	Requests for more WQS revisions/reviews, including revised uses, criteria, variances; more pressure from states, industry for flexibility, less stringent WQS; more stresses on listed species will mean more ESA BE work in conjunction with WQS changes; staff will spend more time working with states to develop climate change monitoring strategies.	Variable for two reasons: 1) climate maps appear to show some inter-regional variability in degree of change; and 2) cold water systems will be substantially affected, warm water systems less so.
WD	Increasing intensity of hurricanes Increasing heavy precipitation events	Likely[3] Likely[3]	Drinking water, wastewater and stormwater infrastructure	Damage from intense storms may increase the demand for public infrastructure funding and may require re-prioritizing of infrastructure projects.	High	Increased demands on the clean water and drinking water State Revolving Fund. Investments in water infrastructure may be needed to manage both decreases in rainfall (e.g. reservoirs) and increased in rainfall (e.g. increases in pipe and storm water management facilities), straining water financing generally including the State Revolving Funds.	Regionwide
WD	Decreasing precipitation days and increasing drought intensity Increasing heavy precipitation events	Likely[5] Likely[3]	The quality and availability of safe drinking water Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased number of applications, increased evaluation of more complex applications, and more assistance to primacy states	Medium	Increased use of lower quality aquifers could mean more drinking water treatment residuals that are sometimes disposed of down injection wells. Increased use of aquifer recharge wells. Some of these may be injecting water from waste water treatment plants.	Regionwide

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
	Increased water temperatures	Very likely[6]				Increased use of aquifer storage and recovery wells to extend drinking water infrastructure. Competition for water use between agricultural, municipal/residential and energy uses. This may result in how the Agency evaluates aquifer exemptions. In some cases, aquifers could be so polluted that cleaning them up may be too expensive and they might then be granted exemption from protection under SDWA. However, if the cost of water sources rises due to droughts and dwindling resources, then the comparative cost of cleaning them up might be cheaper than exempting them. Increased number of storm water drainage and agricultural drainage wells Increased use of non-hazardous and hazardous injection wells to dispose of increased fluids that exceed the capacity of their systems (e.g., landfill leachate). Increased use of warm water for cooling (e.g., power plants) may result in more brackish water that will need to be disposed of instead of discharged via NPDES	

[a] Climate Change impacts are based upon peer-reviewed scientific literature.
[b] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, additional discussion on the likelihood term is provided in the associated footnote.
[c] High assumes the program will be affected by the impact; Medium assumes the program could be affected under some conditions by the impact; Low assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within EPA at this time. Please note, this column does not reflect several important considerations. For example it does not distinguish timeframes (current, near-term, long-term). It does not account for regional and local variations. And it does not reflect the priority of actions the agency may undertake now or in the future.

[1] Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[2] C.B. Field et al., "North America," Chapter 14 in Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).
[3] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea,K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.
[4] Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, p. 114
[5] USGCRP, 2009: Global Climate Change Impacts in the United States . Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.
[6] USGCRP, 2009: p. 46. [In the case of freshwater] "Increased air temperatures lead to higher water temperatures, which have already been detected in many streams, especially during low-flow periods." For the purposes of this table "very likely" is used.