RECLAMATION

Managing Water in the West

Transbasin Effects Analysis Plan of Study

Northwest Area Water Supply Project
Supplemental EIS
Dakotas Area Office

U.S. Department of the Interior
Bureau of Reclamation

November 2011

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Transbasin Effects Analysis Plan of Study and Project Background

This proposed Transbasin Effects Analysis Plan of Study outlines the technical approach and assumptions to be used to evaluate the risk and consequences of invasive microorganism transfer from potential transbasin (interbasin transfer) water diversion associated with the Northwest Area Water Supply Project (NAWS; the Project). The Transbasin Effects Analysis Study will include the development of a framework to evaluate the potential environmental and economic consequences of microorganism transfer from the Missouri River basin (MRB; source basin) to the Hudson Bay basin (HBB; receiving basin).

The primary objectives for the Transbasin Effects Analysis are to inventory both natural and anthropogenic transfer pathways to the HBB in the United States (US) and Canada, complete a relative risk assessment of the Project's influence on microorganism introductions, and outline potential environmental consequences of an invasive aquatic microorganism transfer event and subsequent establishment. The study will also evaluate the potential economic impacts on commercial fishing, recreational fishing, and non-fishing recreation in the HBB.

The Transbasin Effects Analysis will provide qualitative and quantitative analyses of transbasin transfer probabilities and timing and risk. There are a variety of other existing transfer pathways that represent current risk. The risk posed by the Project as a potential source of invasive aquatic species will be presented in terms of its contribution to the total risk. The consequence analysis will seek to estimate the impacts of an establishment of invasive aquatic microorganisms in the receiving basin.

History of Previous Risk Studies

The risk of Project-related interbasin biota transfer was initially evaluated for the NAWS Final Environmental Assessment (Final EA; Houston Engineering et al 2001) and Finding of No Significant Impact (FONSI; Reclamation 2001) submitted in 2001. Previous analyses addressing transfer risk associated with the Project include the following:

- Northwest Area Water Supply Project - NAWS Comparative Risk Analysis (Reclamation and Decision Support 2000; in support of the Final EA)
- Technical Report Supporting the Canadian Appellant's Administrative Appeal to the Bureau of Reclamation Regarding the Final Environmental Assessment and Finding of No Significant Impact for the Northwest Area Water Supply Project (TetrES 2001)

- Report on the Review of the Proposed Pre-Treatment Process for the Northwest Area Water Supply Project (Earth Tech and TetrES 2005)
- Analysis of Risks of Interbasin Biota Transfers Potentially Linked to System Failures in the Northwest Area Water Supply Project (United States Geological Survey [USGS] 2007; in support of the NAWS Final EIS [Reclamation 2008]).

In addition, USGS conducted a risk analysis that addressed potential issues of biota transfer associated with interbasin water diversions between the MRB and Red River basin, which lies within the HBB:

- Risk and Consequence Analysis Focused on Biota Transfers Potentially Associated with Surface Water Diversions between the Missouri River Basin and Red River Basins (USGS 2005); in support of the Red River Valley Water Supply Project Final EIS (Reclamation and Garrison Diversion Conservancy District 2007).

This analysis set the stage for the NAWS Risk Analysis Report (USGS 2007) in terms of analyses employed and the identification of representative species of concern. Invasive biota of concern for NAWS are restricted to microorganisms, because the risk of transferring larger, macroscopic organisms through Project-related water diversion is practically zero for the treatment alternatives evaluated in the Final EIS (Reclamation 2008).

The purpose of the current Transbasin Effects Analysis will be to provide a comprehensive evaluation of the risk and consequences of invasive microorganisms transfer to the HBB, including Canada. The transparent analysis will address impacts to Canadian waterbodies that contain valuable fisheries such as Lake Winnipeg in the Province of Manitoba.

Analysis Components

The major tasks associated with the Transbasin Effects Analysis are provided below. Several of these tasks will occur concurrently, but the general order of analysis components is presented:

- Acquire available data and other information to document presence and distribution of aquatic invasive microorganisms of concern in the MRB, Columbia River basin, Great Lakes basin, Mississippi River basin, and the HBB, including Canada.
- Prepare HBB distribution maps that present the microorganism detection locations and associated host species, if applicable. Include temporal distribution information, where possible.

- Acquire pertinent information from historical microbial invasions to support temporal distribution estimates and consequence analysis.
- Prepare life history summaries, as appropriate.
- Develop a conceptual risk model.
- Obtain/define project operational failure and estimate probabilities.
- Evaluate the Lake Sakakawea (Snake Creek Pumping Plant) to Minot pipeline route including environmental media and extent of contributing drainage to characterize associated transfer potential (to receiving basin).
- Complete an assessment of invasive aquatic microorganism transfer risk.
- Evaluate potential environmental and economic consequences of invasive aquatic species introductions and establishments.
- Prepare a Draft Transbasin Effects Analysis Technical Report (technical report).

The technical report will present the details of each task and the results and conclusions of the risk and consequence evaluation.

Key Assumptions

Developing a list of facts and key assumptions that are integral to the proposed risk and consequence study design is an important early step in the Transbasin Effects Analysis process. The assumptions were developed following a thorough examination of historical Project documents, invasive species databases, and historical microbial invasions.

- **The spread of aquatic invasive species** - Invasive species movement into new aquatic systems is a common result of ongoing human and other naturally occurring activities (e.g., shipping industry, fish stocking, and bird migrations). Introductions of non-indigenous microbes to the receiving basin are to be expected with or without the Project. The Transbasin Effects Analysis will evaluate how the proposed Project may influence/increase the rate and scale of a potential introduction and expansion of the range of these species. This analysis will evaluate the proposed Project in terms of its additive effects upon current or non-Project sources of invasive microorganisms. The Project will be assessed in terms of the influence on risk of invasion or expansion of range (in time and space) as its contribution to non-Project, current risk conditions. NAWS will not be evaluated as a competitive source or pathway, because the proposed water transfer project represents one of many potential sources of non-indigenous microorganisms to the receiving basin; and the potential consequences of a transfer would be the same regardless of the

source and pathway. The risk analysis will not evaluate the possibility of an introduction, because with current transfer pathways, this type of event is likely and may have already occurred.

An associated economic assessment is also proposed, which would focus on the impacts of an invasive species establishment in the receiving basin. The proposed framework to evaluate economic impacts includes both qualitative and semi-quantitative elements.

- **Viability of transferred organisms –** There are many processes that can deactivate microbes in the environment. However, for this conservative analysis, it is assumed that cells are viable and that any transfer, no matter how small (volume of water and number of cells, or organisms), could lead to a transfer. Therefore, the analysis will address consequences of transfer, regardless of the probability of the event. Microbial pathogens and parasites reproduce asexually and therefore, do not need to locate other individuals of the same species to establish a population and expand throughout a system. Pathogens and parasites generally require hosts to complete life cycles and cause an outbreak or other environmental impact. The exception would be facultative pathogens such as bacteria, some protists (e.g., amoebas), fungi, and cyanobacteria that are not dependent upon host availability. It is assumed that introduced microorganisms would eventually locate appropriate hosts within the receiving basin.

- **Uncertainty** - The best available data and information will be used during the assessment. However, data and knowledge gaps may exist that could lead to uncertainty (e.g., lack of distribution data for microorganisms of concern and susceptible hosts in the source and receiving waters). All available data will be acquired and reviewed to support the risk and consequence evaluation. The data mining activities will be described in detail in terms of what was acquired, as well as any shortcomings and limitations. Data sources will include, but not be limited to:

    - The US Fish and Wildlife National Wild Fish Health Survey Database (http://www.fws.gov/wildfishsurvey/)
    - The Province of Manitoba (http://www.gov.mb.ca/)
    - Statistics Canada (http://www.statcan.gc.ca/start-debut-eng.html)

  Uncertainty will be addressed throughout the technical report as it specifically relates to elements of the study or the results of the risk and

consequence analysis under discussion, rather than in a discrete section of the report.

- **Presence of invasive microorganisms of concern in the source waters and the HBB** – The absence of detection records for a particular organism does not rule out the possibility of its existence in an aquatic system. As stated above, there are data gaps regarding pathogen and parasite presence in the potentially contributing and receiving basins. The conservative approach employed assumes that there may be viable microorganisms in even the smallest volume of water. However, not every drop has been analyzed so gaps and uncertainty will be encountered. Microorganisms may be present in hosts, the water column, and basin sediments. Inoculations may have occurred historically via non-Project pathways (anthropogenic or natural) without current detectable impacts. An inoculation would be the portion of a release of water (e.g., pipeline release) containing viable invasive aquatic microorganisms able to locate and infect a vulnerable host ultimately leading to an established population in the receiving basin.

  Invasive microorganisms of concern will be addressed within major organismal categories. The range of life histories assessed during this analysis will be representative of the current list of microorganisms, as well as future emerging organisms that may become of concern during the life of the Project. The presence of potentially invasive aquatic organisms of concern in the MRB, especially in Lake Sakakawea would be carefully tracked and efforts to prevent interbasin transfer would be implemented.

- **Water release volume** - The volume of water released is one of many factors affecting risk. However, the consequences of a transfer are independent of the volume of water that may contain invasive microorganisms released (inoculum size), because the potential consequences would be the same regardless of water volume or transfer pathway. For instance, several release events from different sources may present greater risk for introduction and establishment, but the consequences would be the same. Engineering controls would be put in place to ensure that volume losses from a pipeline failure would be minor, however, an introduction can occur with similar consequences no matter what volume. Larger release volumes could theoretically increase the probability of a transfer event, but there is no *de minimis* volume below which a transfer would be prevented

- **Release location** – Although the release volume may not affect the potential outcomes, the location of the release and the type of media contacted are critical variables. The threat of invasive microorganism transfer is spatially segregated into three compartments:

    - **MRB:** Within the pipeline route beginning at the proposed Project intake at the Snake Creek Pumping Plant and terminating at the Continental Divide following treatment at the proposed Max biological treatment facility. It is assumed that there would be practically zero risk for interbasin biota transfer within this segment because it is located within the MRB (even though a portion of the pipeline would be carrying raw, untreated water).
    - **HBB:** Within the pipeline route but north of the Continental Divide, downgradient of the proposed Max facility, and prior to treatment at the Minot facility. Risk of introduction to the receiving basin is inherent within this segment due to the containment and transport of pre-treated water through terrain, some of which may be hydraulically connected to the HBB. Initial treatment and containment measures would reduce the risk of transfer within this segment of the pipeline.
    - **Post-Minot:** MRB water would be treated to Safe Drinking Water Act (SDWA) standards. The type of treatment alternative at Max will be integral to the risk analysis. No treatment is 100% effective against all potential microbial invaders. Therefore, this water would have inherent risk whether or not there was a treatment failure. However, water treatment at Max and Minot and containment measures would significantly reduce cell viability and transfer risk within this pipeline segment.

- **Release media** – Environmental media contacted during a release could affect the probability of a transfer event. The pipeline between Lake Sakakawea and Minot is buried below the frost zone. It is assumed that media including water, surface soil, and subsurface soil would interact differently with microorganisms. For example, subsurface soil may entrap or inactivate microbes preventing migration to surface waterbodies in the HBB. In addition, it could be miles before a stream hydraulically connected to the receiving basin is contacted. The media contacted during a release will be considered in the risk analysis.

- **Qualitative consequence analysis** - The consequence analysis will be largely qualitative and extrapolated from historical microbial invasions.

One such invasion is whirling disease (caused by the parasite *Myxobolus cerebralis*) in Utah, Colorado, and Montana. Ultimately, the consequences of a microbial establishment in the HBB will be similar for all potential pathways, whether Project or non-Project in nature. Potential consequences of a transfer would not vary by the inoculation event; however, they would likely be dependent upon the type of organism introduced and the presence of susceptible hosts in the receiving basin. The impacts of microorganisms of concern in the source waters (e.g., Lake Sakakawea), if any, will be described and considered in the consequence analysis, as well.

- **Human health impacts** –There could be human health impacts associated with pathogens transported by NAWS; however, the human pathogens of concern in this study including Cryptosporidium and Giardia are ubiquitous and are present in both basins. Therefore, it would not be possible to directly relate exposures and impacts from individual pathways of invasive aquatic species transfer.

General Approaches

The Transbasin Effects Analysis will estimate the qualitative likelihood of Project-related transfer risk within the context of a variety of potentially complete transfer pathways. The likelihood of increased risk will be presented in a spatiotemporal scale for each treatment alternative and pipeline segment as discussed. This analysis will seek to elucidate the Project's effect or influence on the timing of invasive microorganism transfers to the HBB.

Probabilities will be assigned to various kinds of infrastructure/pipeline failures such as corrosion-, mechanical-, and maintenance-related incidents. These pipeline failures can be catastrophic and immediately detected or subtle and undetectable such as in the case of small leakages from pipeline joints and connectors.

Rates of microbial expansions (from introduction to spread), extents of species expansions in aquatic systems, and potential environmental consequences will be extrapolated from historical invasions involving similar types of microorganisms. The consideration of real-world impacts directly caused by the establishment of invasive species in other systems may represent a practical approach to predicting potential consequences in the basin of concern. However, there may be a significant level of uncertainty in the consequence analysis, because impacts are difficult to predict with so many site-specific variables.

Economic Analysis

The general framework for the economic analysis in this study is valuation and, in particular, the potential economic gains and losses associated with interbasin water transfers. The gains are likely centered on water supply enhancement, which will be discussed in the Water Needs and Supply Assessment technical report. Losses are those associated with the effects of invasive microorganism transfers on fish populations for both commercial and recreational purposes.

Economic consequences will be proportional to the potential contribution of the Project. However, it will be difficult to assign economic values/losses back to the Project or any other potential introduction mechanism.

Data required for the economic analyses of impacts on commercial fishing, recreational fishing, and other recreation include:

- Temporal and spatial patterns of transfers, by species
- Probabilities of adverse impacts from those transfers on each of the resources of interest.

For example, should interbasin water transfers result in increased movements of waterborne diseases harmful to fish, analysis of the economic impacts of those movements will require, among others, data on existing conditions relative to the organisms; the rates at which the subject populations of those agents are likely to increase because of the Project; and resulting adverse impacts on the populations of key commercial and recreational fish populations.

Approaches for the analysis of impacts differ for commercial and recreational fishing, and other recreation. Impacts on commercial fishing can be estimated using market-based measures. For example, if the proposed Project causes an increase in organisms harmful specifically to a commercial fish species and if the population (and catch rate) for that species declines because of increased organism incidence, the decrease in the population could be applied to typical landed fish prices to estimate a market-based value lost because of the increased infestation.

However, market values are not available for recreational fishing or other recreational activities, which may be adversely affected by invasive species transfers. Increased microorganism concentration may result in closures of some areas suitable for recreational fishing and adversely affect sport fishery populations. Such impacts reduce the economic values associated with recreation, and non-market valuation techniques are needed to estimate those values. Examples are the travel-cost and contingent valuation methodologies.

Absent specific project data required for such analyses, a “benefit transfer” approach is more commonly used. When an analysis for a specific project is not possible for budgetary, data limitations, limited time, or other reasons, the benefit

transfer method may be used to estimate economic values by transferring information and data from studies completed in other locations.

Invasive Microorganisms of Concern

A comprehensive inventory of microorganisms of concern for inclusion in the Transbasin Effects Analysis in support of the Supplemental EIS (SEIS) has been prepared (Table 1). Biota will be evaluated as major categories of microorganisms including:

- Cyanobacteria
- Protozoa
- Fungi
- Bacteria
- Viruses
- Animal parasites
- Mollusk larvae/juveniles

The invasive species of concern were addressed in the Draft and Final EIS documents (Reclamation 2007 and 2008, respectively) and the Manitoba Water Stewardship's comments on the Draft EIS dated March 26, 2008 (http://www.usbr.gov/gp/dkao/naws/DEIS/comments_deis/manitoba_water_stewardship_03_26.pdf). Mollusks including quagga mussels, zebra mussels, and the New Zealand mud snail are technically macroorganisms, but their larval and juvenile forms are small enough to challenge biological treatment facilities. Life history summaries will be prepared and/or amended, as appropriate to describe life stages and sizes of each major category, treatability of individual species (if available), environmental requirements and tolerances, mechanisms for dispersal, historic range, history of spread, propagule survival, resting cell forms, and potential for establishment.

Some bacteria with "resting" cell forms including spores, endospores, or cysts (Mayer 1999) may be of greater concern based on their resistance to traditional water treatment technologies and environmental extremes (e.g., solar radiation, desiccation, freezing). Endospores can remain viable long after a release until favorable conditions are encountered.

Table 1 Invasive Microorganisms of Concern for the Hudson Bay Basin

Cyanobacteria	Protozoa	Fungi	Bacteria	Viruses	Parasitic Animals	Mollusk Larvae/Juveniles
Anabaena flos-aqua	Flagellates (Phylum Mastigophora; e.g., *Giardia lamblia*)	Branchiomycosis (*Branchiomyces sanguinis, B. demigrans*)	Bacterial Kidney disease (*Renibacterium salmoninarum*)	Infectious Pancreatic Necrosis Virus (*Aquabirnavirus* spp.)	*Polypodium hydriforme*	*Dreissena polymorpha* (larval form)
Microcystis aeruginosa	Amoebae (Phylum Rhizopoda; e.g., *Entamoeba histolytica*)	Oomycetosis (*Achyla* spp., *Saprolegnia* spp.)	Furunculosis (*Aeromonas salmonicida*)	Infectious Hematopoietic Viral Necrosis (Family Rhabdoviridae)	Myxosporidia (Phylum Myxozoa, including *Myxobolus cerebralis*)	*Dreissena rostiformis bugensis* (larval form)
Aphanizomenon flos-aqua	Coccidia (Phylum Apicomplexa; e.g., *Cryptosporidium parvum*)	Ichthyophonosis (*Ichthyophonus hoferi*)	Streptococcal fish infections (*Streptococcus faecalis*)	Viral Haemorrhagic Septicemia (*Novirhabdovirus* spp.)	*Actheres pimelodi*	*Potamopyrgus antipodarum* (juvenile form)
	Ciliates (Phylum Ciliophora; e.g., *Ichthyophthirius multifiliis*)	*Exophiala* spp.	Myxobacterial infections (*Flavobacterium columnarae*)	Channel Catfish Virus	*Ergasilus* spp.	
		Coelomycetosis (*Phoma herbarum*)	*Pseudomonas* spp.	Spring Viremia of Carp (*Rhabdovirus carpio*)	*Icelanochophaptor microcotyle*	
			Vibrio spp.	Infectious Salmon Anemia Virus (*Isavirus* spp.)	*Corallotaenia minutia*	
			Edwardsiella spp.			
			Mycobacterium spp.			
			Enteric Redmouth Disease (*Yersinia ruckeri*)			
			Escherichia coli (various serotypes)			
			Legionella spp.			
			Salmonella spp.			

Data sources including databases and scientific literature and reports will be evaluated to determine the presence of invasive microorganisms in potentially contributing basins (Columbia River basin, Great Lakes basin, Mississippi River basin, MRB) and the HBB. The presence of microorganisms in the MRB and not found in the HBB will be of special consideration. However, it should be reiterated that the lack of detection or documentation of an organism in the receiving basin does not eliminate the possibility of its presence.

Data sources will be explored to capture and evaluate the most current data regarding detections of microbes in the source waters and the receiving basin. Data acquisition will support efforts to characterize baseline conditions in the receiving basin, and maps will be generated using Geographic Information Systems (GIS) to present these data. However, the lack of a rigorous and comprehensive data set could preclude the determination of microorganism presence and distribution. Sources of any data that are acquired during the acquisition process will be thoroughly cited and described. The lack of data integral to the analysis will also be described including explanations regarding any absence of pursued information. General summaries of detection methods and accuracies will also be completed.

Conceptual Risk Model

Conceptual models portray the preliminary understanding of the links between sources and effects within systems under evaluation during risk assessments (Suter 2007). A conceptual risk model will be developed that characterizes the linkages of potential sources of invasive microbes (e.g., transfer pathways) and ecological and human receptors. A graphical representation will be constructed to elucidate the Project and non-Project pathways that could lead to the introduction and subsequent establishment of a microbial invasive species in the receiving waters.

Potentially Complete Transfer Pathways

Anthropogenic and natural non-Project transfer pathways will be identified to support the conceptual risk model. Several potential transfer pathways were documented in Table 3 of USGS 2007. Further research will be conducted to identify additional pathways that could introduce invasive microbes to the receiving basin, such as current or proposed water divergence projects.

Conveyance risk may be unique for different water transfer projects, and the potential consequences would likely vary by the type of organisms introduced. The risk and consequence analysis will seek to qualify whether an additional transfer pathway (e.g., the Project) would be problematic if there are already existing transfer pathways exhibiting significant risk.

Fate and Transport

There are many variables that could affect the fate and transport of microorganisms within transfer pathways. For example, a pipeline breach could release water containing invasive microorganisms into subsurface soil. Microbes released from the pipeline below ground surface would likely be entrapped and deactivated.

The geotechnical evaluation report prepared by Arman Engineering Testing Ltd. (1997) will be reviewed to evaluate soil characteristics from test boreholes prior to the installation of the buried pipeline. The Transbasin Effects Analysis will evaluate the soil data in terms of the potential physical effects on microbial fate and transport.

The environmental fate of an organism is also dependent upon niche availability in the receiving basin. There may be specific conditions required by the microorganism of concern, which may be more or less adept at exploiting limited resources than the native competition. The examination of life histories will be integral for evaluating the competitiveness of invasive microorganisms and the potential for exclusion of present species in the receiving basin.

Potential Ecological Receptors

Ecological receptors may represent vulnerable species that could be adversely affected by infection (host; direct effect) or organisms that would suffer from a change in conditions caused by a transbasin movement of a non-indigenous species (e.g., loss of food source prey for a commercially valuable fish species; indirect effect). Susceptible host species in the receiving basin will be identified from scientific literature and other data sources. The geographic distribution and extent of potential host species may influence the potential consequences of an establishment, which would be specific to the transferred organism.

Potential Human Receptors

Human receptors that could be directly affected by pathogens in the receiving basin will be identified and classified based on the link to associated water bodies (e.g., recreational users including swimmers and anglers, commercial fishers, fish consumers). However, since these organisms are widespread and common in North America, impacts to humans would not be readily attributable to specific sources, including introductions from other basins and pathogens/parasites currently present in the Hudson Bay basin.

Candidate Assessment Endpoints

Assessment endpoints are an explicit expression of the environmental value to be protected (Suter 2007). Candidate assessment endpoints will be identified for the risk and consequence analysis. The types of endpoints that would be appropriate for the NAWS project could include the following:

- Community (ecological) structure shifts/changes
- Population declines of commercially or recreationally valuable fish species.

The assessment endpoints of the risk analysis will represent potential impacts that can be measured or estimated. Ultimately, these risk endpoints would be analogous to environmental consequences.

Treatment Alternatives Analysis

A set of biota treatment alternatives including a preferred alternative for the proposed Max facility will be evaluated in the SEIS. All treatment alternatives will have unique levels of effectiveness for prevention of introductions to the receiving basin. The end goal of identifying a range of proposed alternatives is the selection of effective treatability of all invasive microorganisms of concern. Effective, yet practical treatment alternatives will be identified and proposed.

Risk Analysis

The risk characterization analysis will estimate the Project's impact on potential invasive species transfer to the HBB. The Project's influence on transfer risk will be evaluated as an additive contribution to existing biota transfer pathways. Project-related influence of transfer risk will be estimated for each spatial segment of the pipeline and all treatment alternatives.

The assigned risk estimates will also be temporally qualified. Time estimates will be assigned for the risk of potential transfers to occur. One option will be to divide the life of the Project (extends to year 2060) into three time increments over 50 years. For example, the qualitative likelihood of a transfer to occur may be unlikely, likely, or very likely to occur within the first year, within 10 years, or within 50 years of Project inception.

Environmental and Economic Consequence Analysis

Invasions of aquatic microorganisms are likely considering the variety of transfer pathways in a system as large as the HBB. Potential environmental and economic consequences of an establishment in the HBB, including Canada will be qualitatively (and semi-quantitatively, if possible) assessed and assigned based on extrapolations from historical invasions and outbreaks.

Environmental Consequences

A portion of the anticipated output of the environmental consequence analysis could be the following:

- Percent declines of recreational fishery populations
- Percent declines of commercial fishery populations
- Forecasts of ecological community structure changes due to population reductions or collapses of native fish species.

The major life history category responsible for the potential environmental impacts will be provided. The environmental consequences including percentages and other qualitative output will also be temporally qualified as described above for risk. For example, it may be determined that a percent decline of a commercially valuable fish species could occur as a result of a transfer within the first year, within 10 years, or within 50 years.

The environmental effects of a Project-mediated expansion of microorganisms will be described as beneficial or adverse, significant or insignificant, direct or indirect, and short- or long-term per the Statement of Work (Reclamation 2011). Recommendations regarding post-assessment monitoring and emergency response will be addressed in the SEIS, and may be included in the Adaptive Management Framework, if applicable.

Economic Consequences

Analysis of the economic consequences of increased microorganism transfers will be both quantitative and qualitative. Quantitative analysis will rest on information and data taken from the risk analysis, including such factors as:

- Spatial patterns of inoculation of specific organisms within the HBB attributable to interbasin water transfers
- Temporal patterns of inoculation of specific organisms through 2060

- Reductions in key commercial and recreational fishing species due to inoculations attributable to interbasin water transfers.

Because of the size of the HBB, it will be necessary to limit the spatial dimensions of the economic analysis. For purposes of this analysis, the estimated impacts on Lake Winnipeg will be assumed representative of those water bodies throughout the HBB that could potentially be affected by a Project-related transfer.

Commercial and Recreational Fishing

The quantification of economic impacts will differ depending upon the specific resource being analyzed. For commercial fishing, the reduction in species counts from the risk analysis will be utilized in combination with changes in expected numbers of fish caught and the unit values of those species at pertinent geographical points in the study area.

For recreational fishing, it is expected that a benefits transfer approach will be utilized. Specifically, the expected reductions in key sport fishing species will be utilized in combination with data, as available from other studies, on the resultant changes in numbers of recreational anglers and of numbers of days fishing, and on representative expenditures per "fishing day" for the study area or similar areas.

Non-Fishing Recreation

Non-fishing recreation activities in HBB locations (e.g., Lake Winnipeg) include camping, picnicking, hiking, hunting, cycling, boating, rafting, windsurfing, sunbathing, swimming, wildlife viewing, and others. Estimating the non-fishing recreation impacts of microorganism transfers attributable specifically to the interbasin water transfers would require, at minimum, the following information and data, assumed for water-based recreational activities at Lake Winnipeg:

- Current and historic numbers of visitors to recreational sites, by location and type of recreation.
- Temporal and spatial patterns and direct impacts of microorganism establishments on recreational venues (e.g., closed sites because of contamination by pathogens).
- Temporal reductions in number of visitors to recreational sites, by location and type of recreation.
- Representative values per visitor day for each type of recreation activity occurring.
- Substitute locations to which recreationists, who would recreate at Lake Winnipeg but for the increased levels of invasive microorganisms, would visit as alternatives.

With the data described, the economic impacts on non-fishing recreation activities could be estimated. The net economic loss to Manitoba or other locations would

depend directly on the substitute locations to which recreationists, who would otherwise visit Lake Winnipeg, would go to. If such locations are available and provide ample recreational opportunities for those displaced from Lake Winnipeg, the net economic impacts may be quite small. However, if such locations are not available and visitors delay or cancel their recreational activities, then the economic losses to the affected regions may be large.

Coordination

The development of the Transbasin Effects Analysis will be coordinated with Reclamation and the Cooperating Agencies. Periodic meetings and conference calls will be organized to maintain connectivity and involvement among the Transbasin Effects technical lead, Reclamation, and the Cooperating Agencies. Initially, the development of this Transbasin Effects Analysis Plan of Study has been coordinated with the involved parties. Following the Plan of Study, the Transbasin Effects Analysis will require coordination with: 1) the water supply and needs assessment, 2) conceptual and appraisal engineering, and 3) multiple sections of the SEIS.

Review

A rigorous Quality Assurance/Quality Control (QA/QC) process of the data acquisition process, input data, calculations and estimations, and final results of the Transbasin Effects Analysis will be conducted prior to submittal of the technical report to Reclamation. Initial QA/QC will be provided by technical staff members involved in the risk and consequence analysis efforts, followed by review by the technical lead, and finally reviewed by the Project Manager. Following the comprehensive review process, the draft Transbasin Effects Analysis Technical Report will be provided to Reclamation and reviewed prior to release to the Cooperating Agencies. Deliverables will be finalized after comments from Federal, State, and Cooperating Agencies are addressed, to the extent possible.

Documentation

All details supporting the Transbasin Effects Analysis will be documented and presented in the Technical Report. Raw calculations and qualitative determinations will be provided in a complete and transparent manner to streamline the review process. Data sources including database management information and dates of acquisition will also be documented.

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