Valued Component – Water and Sediment Quality (Update November 2004)

STATE OF KNOWLEDGE – WHAT IS HAPPENING?

A very brief overview of the state of knowledge with respect to water and sediment quality in the NWT is presented below. This overview is preliminary and not intended to be exhaustive.

❖ **What are the baseline conditions with respect to water and sediment quality?**

- Water and sediment quality are important to the health of both the natural and cultural environment. Water and sediment quality are inextricably linked, particularly in the Mackenzie River, which has the largest sediment load of any river in the Arctic circum-polar world. Its sediments contain very large amounts of non water-soluble organics and metals (up to 20 times greater than larger northern rivers). However monitoring of sediment quality has been very limited compared to water quality monitoring.

- Current monitoring is regional in coverage and has not been integrated with more intensive local research. Baseline water and sediment quality conditions can be expressed statistically and graphically for stream water quality variables sampled a statistically large number of times (total suspended solids, water temperature, pH, conductivity, turbidity, dissolved organic carbon, trace metals), but not for variables rarely or not measured (bacteriologia, organics, radionuclides, some physicals). There is insufficient data for lake/pond water quality and stream/lake/pond sediment quality. Limnological research has been carried out recently on lakes of the Mackenzie Delta/Tuktoyaktuk Peninsula, Mackenzie Valley, Great Bear Lake Area, Fort Simpson-Trout Lake Area, Nahanni NPR, Tuktut Nogait NP and Aulavik NP.

KEY MONITORING INDICATORS

Primary Parameters:

Physicals:
Water Temperature
pH
Conductivity
Turbidity/Color
Dissolved Oxygen
Total Suspended Solids
Total/Dissolved Organic Carbon

Major Ions
Nutrients
Total/Dissolved Metals

Organics:
Polyaromatic Hydrocarbons (PAH)

Bacteria:
Fecal Coliform
Fecal Strep.
E. coli.

Secondary Parameters:

Clarity
Total mercury

Organics :
Extractable Organochlorine Pesticides (e.g. lindane)
Polychlorinated Biphenyls (PCB)
Dioxins/Furans
BTEX

❖ **What are the spatial and temporal trends in standard water and sediment quality variables?**

- Seasonal and shorter term (<10 years) temporal trends, and all spatial trends, can be discerned given statistically large numbers of sample analyses and appropriate quality assurance and quality control. Data is currently insufficient to carry out temporal or spatial trend analyses for headwater stream waters, stream sediments, and lake/pond waters and sediments. CCME Water Quality Index has been applied in the Mackenzie River Basin.
- At present, organic water and sediment quality trend analyses are impossible at all sites due to high analyses costs and low number of samples.

❖ **How are levels of contaminants in water and sediment changing over time and space?**

- Changes in levels of contaminants in sediment over time can be seen on a decadal basis using lake/pond sediment results from age-dated core samples. Temporal trends of contaminants within both water and sediment samples may be highly seasonal, and related to natural biogeochemical cycling. The five-volume Canadian Arctic Contaminants Assessment Report (CACAR) II (2003) by DIAND and partners added significantly to the knowledge of Arctic contaminants in water and sediments. The two-volume Mackenzie River Basin Board's State of the Aquatic Ecosystem Report (2004) used the State-Pressure-Response, five SOER question, and indicators approaches to meeting MRBB goals, including to "Improve Water Quality". CCME Water Quality Guidelines and Index feature prominently in this.

❖ **Can local sources of contaminants be distinguished from long-range transport sources?**

- Research has taken place to discern long-range transport sources and local sources (including natural) for specific contaminants found in water and sediment. The majority of contaminants arrive through long-range transport, for basins located entirely within the Northwest Territories. For example, only one type of PCB, which was used at DEW line sites, originated in the Northwest Territories. All other PCBs which are likely to condense in northern waters, sediment and biota, arrive through long range transport. Similarly, concentrations of herbicides and pesticides (e.g. lindane) are indicators of long-range transport of contaminants as they are not used in the NWT. In addition, concentrations of different polycyclic aromatic hydrocarbons (PAHs) provide a "fingerprint" of various natural and anthropogenic sources of contaminants, and are therefore useful indicators. This is becoming more important due to northern developments (e.g. 2000 discovery of world-class Fort Liard Natural Gas Field, 2000 opening of Ikhil Natural Gas Field near Inuvik, 2003 PIP & 2004 EIS submissions for Mackenzie Gas Project slated to be in operation by 2010).

- Mercury levels are naturally higher in some fault-controlled lakes of the Canadian shield and in the Mackenzie Mountains, thus it can be difficult to distinguish it from long-range transport sources. Still, other total mercury levels in lake sediments are indisputably anthropogenic in origin. NWT and Pan-Northern NCP-NEI studies on Hg enrichment factors in age-dated lake sediment slices have been conducted and reported on.

❖ **How do water and sediment quality variables and contaminant levels relate to current guidelines and standards?**

- End-use specific CCME (Canadian Council of Ministers of the Environment) Guidelines for water and sediment quality have existed for 20 and 5 years respectively. Both are constantly being refined and improved (latest update are the Canadian Environmental Quality Guidelines, 1999). Water and sediment quality values are routinely compared to CCME water and sediment quality guidelines, and flagged if exceeded.

- Median values of up to 40 years of monitoring can be set as site specific water and sediment quality objectives, thus extreme values can be noted as an early warning for detecting environmental change. Site specific, variable-specific water and sediment quality objectives have been set in Nahanni National Park and Mackenzie-Great Bear Sub-basin of Mackenzie River basin.

- Canadian water quality indices (CWQIs) can be derived from approximately 20 key variables and additional site-specific variables, resulting in a number from 0 to 100 which characterizes water quality. CCME Water Quality Index Version 1.0 papers, guidance manuals and macros were prepared in 2001-2003, and the CCME WQI was applied in the NWT portion of the Mackenzie River basin in 2002-2003.

❖ **What are the major unconfined and confined aquifers in the NWT, and what are their depths, thickness, and volumes?**

- Unconfined aquifers come to surface in springs and recharge areas on the earth surface, while confined aquifers are completely buried. Major aquifers are not as well-known in the NWT as in southern Canada.

- Geophysical surveys, followed by drilling, are performed to find reservoirs and rock formations that might contain oil and gas, coal and uranium. Reviews of well logs determine the location, depths, and thickness of these geologic formations. These steps would need to be undertaken to find and subsequently monitor aquifers in the NWT. Dr. Steve Kokelj of DIAND Yellowknife is carrying out some ground water research along the Mackenzie Gas Project corridor, using Northern Energy MC finding.

❖ **What is the baseline ground water quality like in the NWT, including karst?**

- Baseline ground water quality, and to a greater extent baseline karst formation water quality, are poorly known in the NWT. As there are no specific monitoring programs, spatial and temporal trend analyses are extremely limited.

- The existence of karst formation water is known in the Ram Plateau, Nahanni National Park Reserve, Wood Buffalo National Park, Great Bear Lake and Fort Smith-Fitzgerald areas.

CURRENT MONITORING

Ongoing monitoring programs with respect to water and sediment quality in the NWT are found below.

► Northern Rivers Ecosystem Initiative (NREI) (Environment Canada and numerous other agencies since 1998)

The NREI (1998-2003) is a follow-up to the Northern River Basins Study (NRBS). The Ministers agreed with the direction of the NRBS recommendations and committed to focus their efforts in the areas of pollution prevention, science-based ecological management, resolving contaminant and nutrient issues, endocrine disruption, long-range transport of atmospheric pollutants and continuing environmental research in northern rivers. The NREI will work with industry, Aboriginal peoples, academia, communities and others to address the recommendations from the NRBS. The main partners are Environment Canada, Government of the Northwest Territories, Government of Alberta. Other key partners are Indian and Northern Affairs Canada, Health Canada and Alberta Health. NREI completed information reporting on its water, sediment and biota data and that information is stored in and displayed by Eco Atlas CE IMS/GIS.

► Northwest Territories water quality monitoring program (Environment Canada since 1960)

► Inter-Jurisdictional Rivers (IJR) Interim Aquatic Quality Monitoring Program (Environment Canada and Alberta Environment since 1988, and Government of the Northwest Territories, 1984-1995)

Water and sediment quality data reports are available for the Hay and Slave River sites

► Nahanni National Park Reserve aquatic quality follow-up monitoring program (Environment Canada and Parks Canada since 1992)

Ongoing monitoring is taking place to fill in gaps found during intensive monitoring between 1992 and 1997, resulting in a 1998 EC-Parks report. Base flow water quality is monitored at all sites each February. Lake and pond

limnology and palaeolimnology on age-dated slices of sediment are analyzed for chemistry and diatom paleolimnology at several lakes and ponds.

- Spatial and temporal trends in loading and historical inputs of mercury (and other trace metals and organics) from age-dated pan-northern lake/pond sediment cores (Environment Canada and Parks Canada since 1998)

  Transects being sampled in the Northwest Territories include Ft. Liard/Fisherman Lake area, Nahanni NPR, Tuktut Nogait NP, and Aulavik NP.

- Forest fire effects on water quality and quantity at Tibbitt Lake (Indian and Northern Affairs Canada since 1998)

- Aquatic effects monitoring program (BHP Diamonds Inc. since 1998)

  Lakes and streams near the EKATI mine are monitored to determine potential effects of the mine. A surveillance network program monitor the health of lakes and streams, providing an early warming system. Specific effects monitoring is undertaken where potential adverse effects have been identified. A sewage effects study was conducted at Kodiak Lake. Aquatic baseline and monitoring data was gathered from 1993 to 1997.

- Coppermine cumulative effects monitoring program (Indian and Northern Affairs Canada since 2000)

  The Coppermine River Basin is the focus of this monitoring program. An enhanced water quality sampling program is underway which includes monthly sampling at 6 to 8 sites, seasonal sampling at several other sites, and continuous monitoring at the outlet of Lac de Gras. Upcoming studies include snow surveys in a small representative basin to develop snowmelt runoff and basin rainfall-runoff ratios, and monitoring of river-ice breakup using a remote web-cam.

- Slave River Environmental Quality Monitoring Program (Indian and Northern Affairs Canada)

  Water, suspended sediment and fish quality is monitored on the Slave River at Fort Smith, to address transboundary issues. A five year follow up program is currently being conducted to determine if any changes in water/sediment quality has occurred.

- Liard River Environmental Quality Monitoring Program (Indian and Northern Affairs Canada)

  Water, suspended sediment, and fish tissue quality is monitored on the Liard River above the Kotanelee River, to address transboundary issues. A five year follow up program is currently being conducted to determine if any changes in water/sediment quality has occurred.

- Peel River Water & Sediment Quality Monitoring Program (Indian and Northern Affairs Canada)

  Water and suspended sediment are monitored on the Peel River above Fort McPherson, to address transboundary issues including community concerns about contaminants. Sampling was conducted in July 2002, June 2003 and August 2004.

- Hay River Water & Sediment Quality Monitoring Program (Indian and Northern Affairs Canada and Environment Canada)

  Water and suspended sediment are monitored on the Hay River at the NWT/Alberta Border, to address transboundary issues. Sampling was initiated in 2004.

- Ecological Monitoring and Assessment Network (EMAN) (coordinated by Environment Canada)

  Water and sediment quality is monitored at selected EMAN sites in the NWT. See Appendix A for a complete description of EMAN.

- Northern Energy (Oil & Gas) MC funded studies by EC-ECB (Halliwell-Cash) and EC-NHRC (Evans, Dubé) were carried out

in 2004 in lakes near Mackenzie Gas Project Anchor Sites in the Mackenzie Delta/Tuktoyaktuk Peninsula Area. Studies involve baseline water, sediment and (zooplankton, phytoplankton, benthic invertebrates) biota characterization. 2005 and 2006 stream and lake studies will be carried out along the MGP pipeline route and near MGP anchor sites. Government, ENGO and development proponent aquatic data will be stored in an Eco Atlas CE IMS/GIS which will link/join with DIAND-BGC Engineering Geotechnics IMS/GIS for the MGP development corridor.

► A 1999-2004 EC-ECB and EC-MSC study was completed to characterize the pre-construction baseline conditions in waterfowl (e.g. lesser scaup)-utilized ponds and borrow pits in CWS' YellowKnife Study Area (YKSA) along the Yellowknife-Rae Highway. The report by Walsh, Halliwell, Hines, Fournier, Czarnecki and Dahl collates four field seasons of water, sediment, invertebrate and waterfowl data collection within the YKSA and Yellowknife EMAN-North site.

GAPS AND RECOMMENDATIONS FOR MONITORING

A list of monitoring gaps and recommendations for future monitoring under the NWT Cumulative Impact Monitoring Program is found below.

Gaps

❖ Intensive sampling of water, sediment and biota on specific streams and lakes in the NWT is not completed. Intensive studies have been carried out by EC-ECB, EC-NHRC and DFO in YellowKnife Study Area (YKSA), Husky/Eskimo Lakes Area (Tuktoyaktuk Peninsula) and near Mackenzie Delta MGP anchor sites near Kendall Island Bird Sanctuary and Parsons Lake Area. Funding sources include A-Base, Northern Energy MC and PERD.

❖ Continual monitoring of physical water quality parameters is lacking at all existing water quality monitoring stations in the North. The exceptions to this are Lac de Gras at the mouth and the Slave River at Fort Smith sites.

❖ Data on organics such as PCBs, pesticides, polycyclic aromatic hydrocarbons (PAH), Dioxins/Furans and heavy metals in centrifugate water and sediment is very poorly known, with the exception of the Slave River at Fort Smith, the Liard River above the Kotaneelee River, the Peel River above Fort McPherson.and Hay River at the NT-AB boundary.

❖ Traditional knowledge about water and sediment quality is poorly documented. NWT CIMP and Mackenzie River Basin Board (MRBB) have begun to close this gap with the Mackenzie Valley Tariuq Inventory/ Metadatabase, workshop presentations (e.g. MRBB 2001 Yellowknife Workshop) and MRBB 2003 State of the Aquatic Ecosystem Report (2004)-where TK indicators where described and rated.

❖ Basin-wide mapping of unconfined and confined aquifers has not been completed.

❖ Important unconfined and confined aquifers are not identified.

❖ Ground water and karst formation water quality, isotope and chemistry data is lacking, with the exception of specific work in Mackenzie Valley, Mackenzie Delta, Nahanni National Park Reserve and Lower Hornaday River.

Recommendations

❖ Longer term (>10 years) temporal trends require open-ended water and sediment quality monitoring at selected sites. Monthly water quality sampling and quarterly suspended sediment sampling is recommended

❖ Conduct automatic hourly real-time water quality monitoring for physical water quality variables in areas of development on a

year round basis. With future developments, additional sites should be added as needed.

- Environmental effects monitoring of multiple developments, including water quality monitoring, should be considered for the diamond mining and petroleum industry. Northern Energy MC research should help with this.
- Incorporate site specific ground water monitoring for NWT developments, within water license applications.
- Finish entering all recent water quality data (late 1990s) from the entire Northwest Territories, including quality assurance and quality control information, in the new Aquatic Chemistry and Biological Information System (ACBIS). EC-ECB Yellowknife and Regina completed this in October 2004.
- Gather traditional and local knowledge about water and sediment quality in the Mackenzie. This was done in the Mackenzie River Basin Board's 2003 State of the Aquatic Ecosystem Report (2004).
- For selected sites compare median values of water quality variables in each decade (1960s to 1990s) to discern trends. Subsequently, compare these trends with trends shown in Eco Atlas CE (Cumulative Effects) display module software for updated ACBIS data. Projects are underway, mostly along the Mackenzie and Liard Rivers in 2004, funded by Northern Energy MC (Aquatic Quality Science) and Northern Ecosystem Initiative (NEI) Resource Use/Cumulative Effects Assessment Table and Northern Thresholds Project, and led by EC's Dr. M. Dubé,
- Collect strategically located water and sediment quality samples at least three years prior to a development to help distinguish contaminants originating in the Northwest Territories from those resulting from long-range transport. This was carried out by DIAND and EC in the Slave Geologic Province for current diamond mines. It is now being carried out by DIAND and EC in the Mackenzie Delta/Valley and Liard Valley for future petroleum developments.
- With respect to monitoring programs, incorporate community participation and training, where applicable. Environmental Monitors and Technicians are currently being trained by DIAND and EC (e.g. 2-week Taiga Lab/Field Course in Yellowknife, EMAN-North plain language Northern Water Quality Manual). CCHREI is asking DIAND, EC and other scientists/managers to help write Canada-wide use job descriptions for Environmental Monitors and Technicians.

REFERENCES

Relevant monitoring reports, past monitoring programs, research documents, and scientific publications are found below. This list is a sample of what is available.

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Canadian Arctic Contaminants Assessment Report (CACAR) II (2003). DIAND et al. 5 Volume & 1 CD-ROM set.

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Environment Canada (Blachford, D.P., B. Olding et al.) (1991). ***Nahanni National Park resource aquatic quality study – Protecting the water of Nahanni National Park Reserve, NWT.*** *Environment Canada, Inland Waters Directorate and Parks Canada. Report C&P-IWD-NWT-91-002, TR-I/NAH.*

An intensive study was undertaken between 1988 and 1991 to collect baseline water, sediment and fish tissue quality data in Nahanni National Park Reserve.

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Halliwell, D.R. and Catto (1998). ***Protecting the aquatic quality of Nahanni National Park Reserve, NWT.*** *Environment Canada, Atmospheric and Hydrologic Sciences Division, Yellowknife, NT. 96pp.*

Baseline water, sediment and fish tissue quality data were collected in Nahanni National Park Reserve as part of a monitoring program (1992-1997) following-up on an intensive study undertaken from 1988 to 1991. The results are presented in this report.

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water-related research in the Northwest Territories and Nunavut. This research resulted in the production of 218 publications, including several on water quality. The Arctic Science and Technology Information System (ASTIS) produced "An Annotated Bibliography of the Northwest Territories Action on Water Component of the Arctic Environmental Strategy", available at http://www.aina.ucalgary.ca/aes/.

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The objectives of this five year investigation of contaminants in the aquatic ecosystem of the Slave River were to: address concerns of northerners regarding possible contamination of fish, water and suspended sediment from pulp mill, hydrocarbon and agricultural developments upstream; and, provide baseline data on contaminant levels in fish, water and suspended sediment at the territorial boundary to support transboundary water negotiations with Alberta. An annotated bibliography of the Northwest Territories Action on Water component of the Arctic Environmental Strategy, which includes information on the SREQMP, is available at http://www.aina.ucalgary.ca/aes/.

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