

Mackenzie Valley Review Board



**Final Terms of Reference
for the
Environmental Assessment
of
Avalon Rare Metals Incorporated's
Thor Lake Rare Earth Element Project
EA1011-001**

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1. Introduction

1.1 Overview

This document outlines the information required for the environmental assessment of the Avalon Rare Metals Incorporated's ("Avalon" or "the developer") Thor Lake Rare Earth Element Project (the "project" or "development"), a mine and separate processing facility proposed in the Akaitcho area of the Northwest Territories. This Terms of Reference has the following sections:

- Section 1 – Introduction - including the reasons for environmental assessment referral, the legal context, and the *Terms of Reference* development process;
- Section 2 – Description of the scope of the development and the scope of the assessment, including minimum geographic and temporal boundaries for consideration of impacts¹ from the proposed development on valued components of the biophysical and human environments;
- Section 3 – The *Terms of Reference* that directs the production of a *Developer's Assessment Report*; and
- Appendices.

The *Terms of Reference* will direct the developer to organize existing material, and conduct additional study and analysis as appropriate, in order to submit a "stand-alone" *Developer's Assessment Report*. That report will then be used to inform all interested parties about the proposed development during the analytical phase of the environmental assessment.

1.2 Referral to environmental assessment

Avalon has applied to develop a primarily underground mine and milling complex approximately 8km north of the Hearne Channel of Great Slave Lake, 100km southeast of Yellowknife and approximately 100 km west of Lutsel K'e. Avalon proposes to ship concentrate from the proposed mine by barge to a proposed hydrometallurgical facility at Pine Point, Northwest Territories.

In April of 2010 the Mackenzie Valley Land and Water Board received applications for a Type A Land Use Permit (MV2010D0017) and Type A Water License (MV2010L2-005) for the project. A description of the proposed development was submitted by the developer as part of its application. The Mackenzie Valley Land and Water Board initiated a preliminary screening of the project according to Section 124 of the *Mackenzie Valley Resource Management Act (MVRMA)*.

On June 11th, 2010, the Mackenzie Valley Land and Water Board referred the project application to environmental assessment under paragraph 125(1)(b) of the *MVRMA*. The Mackenzie Valley Land and Water Board referred the project to environmental assessment "because the development proposal might have a significant adverse impact on the environment and be of public concern". Key areas identified where these impacts may occur included tailings water quality issues, metal leaching/acid rock drainage, barging, and reclamation/closure.

¹ Any reference to "impact(s)", "change(s)", "effect(s)" and similar words in this document implies that "projected-related deviations from baseline conditions for a valued component" during this environmental assessment are *potential* impacts.

The Review Board notified Avalon on June 25th, 2010, that the development had been referred to environmental assessment.

1.3 Legal context and the Terms of Reference development process

This environmental assessment is subject to the requirements of Part 5 of the *Mackenzie Valley Resource Management Act (MVRMA)*. Section Three of the Review Board's *Environmental Impact Assessment Guidelines* describes the environmental assessment process in detail. That document, as well as the Review Board's *Rules of Procedure*, other guidelines, reference bulletins and relevant policies applicable to this assessment are available online (www.reviewboard.ca) or by contacting Review Board staff.

In accordance with section 115 of the *MVRMA*, the Review Board must conduct an environmental assessment of the proposed development with regard for the protection of the environment from significant adverse impacts, and the protection of the social, cultural and economic well-being of Mackenzie Valley² residents and communities. Subsection 114(c) of the *MVRMA* further requires the Review Board to ensure that concerns of aboriginal people and the general public are taken into account. Accordingly, the Review Board has developed these *Terms of Reference* based on an examination of information from the following sources:

- The public record of the preliminary screening;
- All information on the public registry in relation to the Thor Lake Rare Earth Element Project;
- Issues and information from participants at scoping sessions held
 - in Akaitcho communities in August and September;
 - on the Hay River Katlodeeche First Nation Reserve in October;
 - in Yellowknife at a September technical scoping session; as well as
- Review Board experience in the conduct of environmental assessment.

2. Scope considerations

2.1 Scope of development

Under subsection 117(1) of the *MVRMA*, the Review Board determines the scope of development for every environmental assessment it conducts. The scope of development consists of all the physical works and activities required for the project to proceed. Appendix A outlines a minimum listing of project components for the scope of development for this environmental assessment.

Within this document the term “Thor Lake Rare Earth Element Project”, “project”, “development” and related words mean any and all physical works and activities required to extract, concentrate, further process, store, and transport concentrates or other product out of the Mackenzie Valley, as well as to close and reclaim any and all aspects of the project in the Mackenzie Valley. Where this document refers to the “Thor Lake mine site”, that means the area covered by Avalon’s mineral claims and mining leases at, adjacent to, or near Thor Lake. “Pine Point” means the area that Avalon will either use or discharge into at, adjacent to, or near the

² Throughout this document, the term “Mackenzie Valley” refers to the area as defined in section 2 of the *Mackenzie Valley Resource Management Act*.

proposed hydrometallurgical facility in the former Pine Point mine-site area for the purposes of the Thor Lake Rare Earth Element Project.

In the *Developer's Assessment Report* (see section 3.2.5) the developer is required to fully describe all required facilities and activities for the development, including any not listed in Appendix A. The Review Board may amend the scope of development at any time during the environmental assessment if the proposed development changes.

2.2 Scope of assessment

2.2.1 Overview

The scope of assessment defines which issues will be examined in the environmental assessment. The scope of assessment includes all potential impacts on valued components of the biophysical and the human environment (for example, wildlife species or heritage resources) from the development, by itself and in combination with other past, present and reasonably foreseeable future developments (see section 2.2.3 for details).

To determine the scope of assessment, the Review Board considered Avalon's Project Description Report and the public registry documents from preliminary screening, and written scoping submissions. The Review Board also hosted scoping sessions in Dettah, Hay River, Fort Resolution, Lutsel K'e and Yellowknife.

2.2.2 Geographic scope

The geographic scope will include all areas that may be affected by activities within the Thor Lake Rare Earth Element Project scope of development. The geographic scope for each valued component must be appropriate for the characteristics of that component, or the impact and nature of the impact source. For example, consideration of impacts on air should reflect the airshed, wind patterns and mobility of airborne contaminants, while the habitat ranges of wildlife using the area may be relevant from a project specific and cumulative effects perspective. All of these areas together will be considered in the environmental assessment study area, which will be further defined by the developer in its *Developer's Assessment Report* (see section 3.2.3). The developer will provide rationale for the spatial boundaries it selects for the assessment of potential mine-related impacts on each valued component.

The minimum geographic scope will include the following areas:

1. Avalon's mineral and surface leases and mining claims in the area of the Thor Lake mine site, sub-surface workings, and a reasonable impact footprint radius centered on the mine site. The Review Board excludes from this environmental assessment Avalon's subsurface mineral leases and mining claims for the portion of the Avalon claim block that includes beryllium deposits. However, the Review Board includes surface activities and leases on that same portion of the claim block for the purposes of the project that do not involve the mining and/or processing of beryllium ore;
2. The Thor Lake mine site access road connecting the mine site to the north shore of Great Slave Lake's Hearne channel and a reasonable impact footprint corridor, including any portions of watercourses that may be affected;
3. The watersheds from Ring and Buck Lakes to Thor Lake and downstream of the Thor Lake

mine site to the confluence of the Hearne Channel of Great Slave Lake to the point where reasonably foreseeable project-related impacts cease to occur;

4. Avalon's surface leases and and/or other claims in the area of the Thor Lake Rare Earth Element Project's Pine Point processing site, sub-surface workings, and a reasonable impact footprint radius centered on the processing site including the area(s) proposed for tailings management facilities and associated area(s) receiving project-related water;
5. The Pine Point processing site haul road connecting the hydrometallurgical facility to the southern shore of Great Slave Lake;
6. The road between Hay River and the Pine Point processing site, as well as the road between Fort Resolution, Fort Smith and the Pine Point Processing site;
7. The Hay River railhead transfer facility;
8. The rail line between the Hay River railhead through Woodland Caribou habitat to the extent of the NWT-Alberta border;
9. Any watershed into which Avalon proposes to discharge water from the hydrometallurgical facility to the point where reasonably foreseeable project-related impacts cease to occur;
10. Any underground aquifers leading to Great Slave Lake from either the Thor Lake mine site or Pine Point processing site;
11. The habitat of potentially affected species, including migratory species;
12. Great Slave Lake related to any potential impacts on water quality, fisheries and the human environment from any project-related activity, for example barging or effluent discharge.

The geographic scope for assessing impacts to the human environment includes the physical communities Fort Resolution, Lutsel K'e, Hay River area and Yellowknife area and their residents, as well as the Akaitcho and Métis cultural communities resident in or making traditional use of any part of the environmental assessment study area. Together, these groups are described in this document as "potentially-affected communities".

In its response to section 3.2.3 (below) the developer is required to define and provide rationale for the specific spatial boundaries it used to examine the potential impacts on each of the valued components in its impact assessment. Figure 1 below gives an overview of the minimum geographic scope for this environmental assessment.

Figure 1



2.2.3 Temporal scope

The developer will use temporal boundaries for this environmental assessment according to potential long-term impacts on valued components, rather than on a single generic timeline. In all cases, the temporal boundary may not end with the duration of the operating phase of the Thor Lake Rare Earth Element Project.

For project specific (that is, non-cumulative) impacts, the temporal scope will include all phases of the Thor Lake Rare Earth Element Project lifespan including construction, operation, closure and reclamation, and extends until no potentially significant adverse impacts are predicted. For cumulative impacts, the temporal scope includes the period of the effects of past, present and reasonably foreseeable future projects that are predicted to combine with the impacts of the Thor Lake Rare Earth Element Project.

The developer will place special focus on the consideration of times during the development when activities are particularly intense (such as during initial construction) or when valued components are particularly sensitive to potential impacts (such as during wildlife migration periods, or spawning and incubation periods for fish, key harvesting periods and annual cultural gatherings). The developer will also give special attention to appropriate temporal boundaries for considering any impacts that may require long-term monitoring and management after closure, such as mine water release into the environment (see section 3.3.2 for details on this subject).

The Review Board notes that Avalon has indicated that the Thor Lake Rare Earth Element Project may be a long-term mine, and requires the developer to accurately portray a realistic mine life in the Developer's Assessment Report by indicating the actual life of mine that the proposed project configuration will support, as well as the expected potential life of mine that Avalon has

publicly suggested the deposit will support.

In its response to section 3.2.3 (below) the developer is required to define and provide rationales for the specific temporal boundaries it used to examine the potential impacts on each of the valued components considered in its impact assessment.

2.2.4 Other scope of assessment considerations

The scope of assessment set out in these *Terms of Reference* may be re-examined at any time by the Review Board if new information emerges.

The scope of assessment will also include the various alternative methods for carrying out the proposed development as well as any and all related potential impacts stemming from their construction, operation and closure.

Also, the scope of assessment will include an examination of cumulative effects. This will involve considering impacts from other past, present and reasonably foreseeable future developments or human activities that combine with the impacts of the Thor Lake Rare Earth Element Project to affect the same valued components. Such cumulative effects will be assessed at a spatial and temporal scale appropriate to the particular effect or valued component under consideration.

For example, contaminated sites in the area that are not part of the Thor Lake Rare Earth Element Project are excluded from the scope of development. However, where the impacts and continuing effects of past activities may combine with the potential impacts of the project, they must be considered in the cumulative effects assessment (see section 3.3.3 for more details).

Section 3.1 indicates the level of effort required in considering specific issues.

3. Terms of Reference

3.1 Considerations

The developer should consider the following when developing the specific material the Review Board requests in Section 3.2 – 3.7 and related Appendices. The developer is encouraged to seek clarification from the Review Board in writing if specific requirements in the *Terms of Reference* are unclear. If the developer finds that an item cannot be addressed, the developer should provide a rationale.

3.1.1 Issues prioritization

The purpose of scoping is not only to identify issues, but also to prioritize them and if possible, focus required additional work on the most important ones. Avalon will consider all the items described in Section 3.3 because every issue identified in this *Terms of Reference* requires a sufficient analysis to demonstrate whether the development is likely to be the cause of – or a contributor to - significant adverse impacts. However, one particular issue was identified during scoping as requiring increased attention, because of high impact potential and concerns raised in scoping sessions. Avalon is required to give special consideration to the following **key line of inquiry** in the *Developer's Assessment Report*:

- **Impacts of the Thor Lake Rare Earth Element Project on water quality**, particularly in relation to the quality of mine water and tailings effluent released to groundwater and surface waters and related impacts to human health and aquatic life downstream from;
 - the Thor Lake mine site;
 - the Pine Point processing site; as well as
 - the prospect of significant adverse impacts to water quality from barging accidents on Great Slave Lake.

Key lines of inquiry are the topics of greatest concern that require the most attention during the environmental assessment and the most rigorous analyses in the *Developer's Assessment Report*. These are designated as key lines of inquiry to ensure a comprehensive analysis of the issues most likely to cause significant environmental impacts or significant public concern. Data collection and analyses for the key line of inquiry in the *Developer's Assessment Report* should be at a level of detail appropriate for other interested parties to understand the technical material prior to any technical sessions on these topics.

The key line of inquiry will be presented in comprehensive stand-alone sections in the *Developer's Assessment Report*. This will facilitate close examination of the developer's response to these key lines of inquiry.

3.1.2 Incorporation of traditional knowledge

The Review Board considers both traditional knowledge and scientific knowledge in its deliberations. In addition, subsection 115(c) of the *MVRMA* provides as a guiding principle for the Review Board the importance of conservation to the well-being and way of life of the aboriginal peoples of Canada to whom Section 35 of the *Constitution Act 1982*, applies and who use an area of the Mackenzie Valley. Avalon will make all reasonable efforts to assist in the collection and consideration of traditional knowledge relevant to the Thor Lake Rare Earth Element Project for the Review Board's consideration. Where applicable, Avalon will make all reasonable efforts to incorporate traditional knowledge from aboriginal culture holders as a tool to

collect information on and evaluate the specific impacts required in this *Terms of Reference*. The developer should refer to the Review Board's *Guidelines for Incorporating Traditional Knowledge into the Environmental Impact Assessment Process*³ and community/culture group-specific traditional knowledge protocols.

3.1.3 Assessing the impacts of the environment on the development

Potential impacts of the physical environment on the development, such as changes in the permafrost regime, other climate change impacts, seasonal flooding and melt patterns, seismic events, geological instability, and extreme precipitation must be considered in each of the applicable items of this *Terms of Reference*. Any changes to the design or management of the Thor Lake Rare Earth Element Project as a result of considering potential impacts of the environment should be noted in the relevant sections.

3.1.4 Use of appropriate media

The Review Board encourages the developer to present information in user-friendly ways. The use of maps, aerial photos, development component/valued component interaction matrices, full explanation of figures and tables, and an overall commitment to plain language is encouraged. When it is necessary to present complex or lengthy documentation to satisfy the requirements of the *Terms of Reference*, the developer should make every effort to simplify its response in the main body of the text and place supporting materials in appendices. Avalon will also produce all electronic documents in *Adobe portable document format*.

The developer is encouraged to visually represent both sites of the Thor Lake Rare Earth Element Project and its surroundings using a diorama-type 3 dimensional landscape model to indicate scale, setting and direct footprint.⁴ This model should include the viewscape of the mine site and barge-docking facility from the surface Great Slave Lake.

The *Developer's Assessment Report* will be submitted as a stand-alone document. Relevant information and analyses from previous project descriptions should be incorporated into the *Developer's Assessment Report* and combined with the supplementary material and analyses required by this *Terms of Reference*. Information referenced will be made accessible.

3.2 General information requirements

This *Final Terms of Reference* document describes the general information required on a subject-by-subject basis. The developer is encouraged to consider the information gaps identified and questions raised by interested parties on the public record in scoping submissions and comments on the *draft Terms of Reference* when determining the level of detail required in its *Developer's Assessment Report* for specific issues covered in this *Final Terms of Reference*.

3.2.1 Summary materials

The following summary materials are required:

1. Plain language, non-technical summaries of the *Developer's Assessment Report* in English, Chipewyan, Yellowknives/Weledeh-Dogrib, South Dene and Tlicho;
2. A concordance table that cross references the items in the *Terms of Reference* with relevant

³ Available at http://www.reviewboard.ca/upload/ref_library/MVEIRB_TK_Guide.pdf.

⁴ For an example, see *EA 0708-07- Taltson Hydroelectric Expansion Project*.

sections of the *Developer's Assessment Report*; and

3. A commitments table listing all mitigation measures the developer will undertake, including but not limited to those described in the project application. These should be organized by subject (e.g. water quality, wildlife) for easy reference.

3.2.2 Developer

The following information is required regarding Avalon as well as its subsidiary companies, related corporations and joint venture partners:

1. A summary of the corporate history and operational experience in Canada and the Northwest Territories;
2. How the developer will ensure that its contractors and subcontractors honour commitments made by Avalon;
3. Environmental performance records for Avalon and its partners during prior exploration and development work in support of the Thor Lake Rare Earth Element Project and any other projects in the NWT. This will include discussion of regulatory compliance (for example, regarding land use permits and water licenses). List any situations where compliance was breached, the issue and cause, and how and when it was mitigated to the regulator's satisfaction; and
4. A description of any corporate policies, codes of practice, programs or plans concerning Avalon's environmental, sustainable development, community engagement and workplace health and safety commitments or policies.

3.2.3 Developer's assessment boundaries

The developer will provide a description, map and rationale for all of the chosen geographic and temporal boundaries used during its impact assessment. Certain minimum requirements and other instructions to assist in the determination of appropriate boundaries are discussed in Section 2.2 of the *Terms of Reference*. Separate boundaries may be required for cumulative effects assessment (see Section 3.3.3).

The developer will describe and provide rationales for:

1. An overall environmental assessment study area and the rationale for its boundaries;
2. Avalon's chosen spatial boundaries for the assessment of potential impacts for each of the valued components considered; and
3. The temporal boundaries chosen for the assessment of impacts on each valued component.

3.2.4 Description of the existing environment

A detailed description of the existing environment is required, including current status and trends for all valued components. Wherever possible, the developer is responsible for providing a clear picture of what typical environmental conditions currently exist in the environmental assessment study area prior to the start of this environmental assessment. This must consider the current state of baseline conditions, the natural variability of background conditions, and to the extent possible differentiate between natural background conditions and any effects from past development such as exploration.

In addition, the developer must provide a description of the methods used to acquire the information used to describe baseline conditions. This description will distinguish between techniques used to measure parameters in the field from information derived from the utilization of models. Avalon will provide complete references for historical data and indicate how and when historical data was used as a basis for conclusion(s).

Biophysical environment

The following description should be at a level of detail sufficient to allow for a thorough assessment of project effects. Describe the biophysical environment within the relevant environmental assessment study areas including:

Both sites

1. The geographic location of both sites and identification of associated ecozones and ecoregions, including the main barging transport corridor between the Thor Lake mine site and the Pine Point processing site.
2. Ambient air quality, including baseline concentrations of criteria air contaminants [total suspended particulates, particulate matter (PM₁₀, PM_{2.5}), nitrogen oxides, sulphur dioxide and carbon monoxide] including dioxins and furans.
3. Baseline ambient noise levels, differentiating between that associated with Avalon's exploration activities and background noise.
4. Climatic conditions, including but not limited to climate trends and extremes in temperature, precipitation and wind patterns.
5. Current and historic data on surface water and groundwater quality for the Thor Lake mine site area, and downstream until Great Slave Lake, including a reasonable neighbouring area of Great Slave Lake. Avalon will include the overall range of natural variability of background conditions. Avalon will also include reference water bodies in this analysis and a rationale for their selection. While describing baseline conditions for water quality, Avalon will include but not be limited to reporting on the following parameters:
 - metals of concern (including but not limited to those commonly listed in *Metal Mining Effluent Regulations [MMER]* and *Canadian Council of Ministers for the Environment [CCME]* guidelines)
 - major ions, nutrients and other
 - commonly CCME- and MMER-listed constituents
 - petroleum products
 - pH
 - salinity
 - sulphate
 - ammonia,
 - chloride
 - nitrate
 - phosphorous
 - total suspended solids
 - dissolved oxygen
 - turbidity
 - bacteria
 - nitrite
6. Current and historic data on surface water and groundwater quality (including but not limited to the parameters listed in line item 5.) for the Pine Point processing site area, and downstream until Great Slave Lake, including a reasonable neighbouring area of Great Slave Lake. Avalon will include the overall range of natural variability of background conditions. Avalon will also include reference water bodies in this analysis and a rationale for their selection.
7. Hydrology and hydrogeology, including surface water and groundwater amounts, direction of flow, likely surfacing points/discharge area (for groundwater), and maps and descriptions of associated watersheds, both in the local area of the project site as well as downstream until the

confluence with Great Slave Lake. Discussion should focus in particular on:

- a. both project sites with sufficient data to capture spatial and temporal variations in water quantity. To this end provide watershed boundaries for both sites, including groundwater and surface drainage patterns;
 - b. seasonal and annual variation in groundwater and surface water quantity around both project sites; including trends over time related to climatic change and extreme events (e.g. high flows);
 - c. the relative contribution of water from the mine site to the volume of Thor Lake (or other water sources) and the downstream environment;
 - d. the relative contribution of water from any water body, surface or underground, from which Avalon proposes to draw water from for processing at the Pine Point processing site;
 - e. surface water and groundwater flow regimes associated with the local area on which both sites are located;
 - f. relationship between the groundwater regime and permafrost and active layer conditions, including a characterization of those conditions, and how permafrost and active layer changes influence hydrogeology at both project sites;
 - g. description of the methodology used to derive the components of the water balance and characterization of flow regimes including a discussion of any uncertainty. Avalon will also produce refresh rates for Drizzle, Murky and Thor Lakes;
 - h. a map indicating the location with rationale of all existing and planned wells, and seeps within the study area and other monitoring locations;
 - i. location of seepage meters, if any, and evaporation pans installed in the study area; and
 - j. a water table elevation map and a map detailing drainage patterns for surface and groundwater for the both project sites, and mine workings.
8. Water quality, total volumes and refresh rates for water bodies that Avalon proposes to use as water sources at both sites.
 9. Water quality, total volumes and refresh rates for water bodies that Avalon proposes to use as points of discharge at both sites.
 10. Aquatic habitat and aquatic organisms in the environmental assessment study area for both project sites. Include water bodies on the mine site, water sources and downstream areas. Describe the following for key aquatic species:
 - a. fish bearing water bodies that the project may affect near both the Thor Lake Mine site and the Pine Point processing site, downstream up to and including the confluence with Great Slave Lake, as well as a reasonable radius of the neighbouring area of Great Slave Lake;
 - b. seasonal and life cycle movements;
 - c. local and regional abundance and distribution;
 - d. key riparian habitat, particularly for any proposed areas for water intake or outfall;
 - e. known or suspected sensitive habitat areas for different development stages and times of year;
 - f. the food chain that supports the species, and that the species supports;

- g. identification of key species that would serve as biological indicators of change before changes reach higher trophic levels;
 - h. any known issues currently affecting fish and other aquatic life forms in the area.
11. Describe any and all connectivity – temporary or continuous – between Drizzle Lake and Murky Lake, as well as between Egg Lake and Drizzle Lake. Further describe any and all connectivity – temporary or continuous – between the various waterbodies at the main project site.
 12. Wildlife (including resident and migratory bird species), wildlife habitat and migration corridors. Special emphasis will be placed on key harvested species including moose, caribou and furbearers. Where available, the following information is required for each species:
 - a. population trends, including abundance, distribution and demographic structures;
 - b. habitat requirements, including identification of local areas of important habitat, attributes of the seasonal habitats that relate to how the species use them (e.g. travel routes, forage) and sensitive time periods;
 - c. migration routes, patterns and timings including typical patterns and the range of known variation;
 - d. factors known or suspected to be currently affecting the species in the environmental assessment study area (e.g. harvesting, disease);
 - e. known or suspected sensitivities to human activities; and
 - f. gaps in current knowledge of the species such as the impacts of disturbance on behaviour or abundance.
 13. Wildlife at risk occurring in the environmental assessment study area. The developer will:
 - a. identify any species present or potentially present in the environmental assessment study area that are listed under schedule 1 of the federal SARA, including but not limited to Woodland caribou and aquatic species;
 - b. identify any species present or potentially present in the project area assessed by the COSEWIC; and
 - c. describe each species in terms of the requirements of Item #11 above.
 14. Vegetation and plant communities, including identification of any areas where rare plants are known or suspected to be present.
 15. Terrain, surficial geology, structural geology, mineralogy, bedrock geology (type, depth, composition, and permeability), seismic activity records and risk factors, permafrost locations and types within the environmental assessment study area. In particular:
 - a. describe the structure, permeability, stability, and other relevant characteristics of the area on which both project sites are located;
 - b. describe permafrost conditions at the site including thermal conditions and ground ice/moisture contents of underlying material, particularly if maintenance of frozen conditions is required;
 - c. identify the chemical composition of host rock and ore bodies at the mine site including:
 - i. potential for acid rock drainage; and
 - ii. uranium, thorium and beryllium content in ore.

- d. describe and map the ground composition underlying the proposed mine site;
- e. identify the location, amounts and type of granular material deposits including any information on ground ice;
- f. a description of existing fractures and faults at the project sites;
- g. describe the ground conditions under and around both project-Great Slave Lake access roads proposed by Avalon, with emphasis on identifying areas susceptible to erosion, and permafrost instability;
- h. include maps, cross-sections and figures to illustrate geological features, where appropriate.

16. Physical and chemical makeup of:

- a. soils, within a reasonably established radius from both project sites, and at reasonably established far-field points with the intention of establishing a baseline to track potential impacts from mine-related emissions potential; and,
- b. water body sediments downstream [until Great Slave Lake, including a reasonable neighbouring area of Great Slave Lake] of the potentially affected water bodies of both project sites, including baseline concentrations of dioxins and furans.

Human environment

- 17. Physical infrastructure present in the environmental assessment study area, including habitations, roads, buildings, quarries, power lines and industrial works.
- 18. Available information pertaining to the project area from land use planning in the region of potentially affected communities.
- 19. The availability and average training or skill levels of people in the region of potentially affected communities and other Aboriginal and Northern resident regional labour pool.
- 20. The local and regional business capacity available to support the project.
- 21. Current socio-economic conditions and relevant trends in the potentially-affected communities and in the region of potentially affected communities as a whole, using appropriate indicators of well-being and quality of life.
- 22. A summary of historic and present land use in the study area, including identification of traditional land use groups, areas used and traditional travel routes and timings. This summary will include a description of the current use of Great Slave Lake for traditional, commercial or recreational pursuits.
- 23. Traditional harvesting activities, relevant species (wildlife, fish and plants), observed trends and any traditional values expressed about harvested species.
- 24. Known physical heritage resources locations, areas of high potential for undiscovered physical heritage resources and cultural values associated with the environmental assessment study area.
- 25. Other current economic activities in the environmental assessment study area.

3.2.5 Development description

Avalon will ensure that a description of all its planned facilities and activities is included in the *Developer's Assessment Report*, including any proposed or existing facilities and activities not listed in Section 2.1 of this *Terms of Reference*. In this section, Avalon is only asked to provide details on

the Thor Lake Rare Earth Element Project itself, not to comment on potential impacts from the development. During scoping the issue of a well-defined project design was raised by various parties - for example, Avalon's lack of a definite plan for tailings management and water treatment at the hydrometallurgical facility. For the purpose of an efficient and effective environmental assessment, the Review Board requires the developer to present the project description in its final configuration in the *Developer's Assessment Report*, or to apply this terms of reference to all alternatives under consideration.

In the *Developer's Assessment Report*, Avalon must also describe alternative development components, management systems, or alternative locations for physical works and activities considered for the Thor Lake Rare Earth Element Project. Where applicable, the developer will provide reference to research that identifies the successful use of the specific technologies being proposed, and their relevance for this environmental setting.

Overall, Avalon must describe the proposed Thor Lake Rare Earth Element Project, providing details of all works and activities throughout construction, operation, closure and reclamation, and long-term monitoring phases, with a description of major activities by phase.

Provide a development description including descriptions of:

General items

1. The estimated lifespan of the Thor Lake Rare Earth Element Project broken down into construction, operation, closure and reclamation, and long-term monitoring phases, with a description of major activities by phase.
2. The direct physical footprint of both project sites (outlining efforts made to reduce the footprint), with locations and descriptions of all structures and all aboveground and underground infrastructure.
3. A list of all regulatory permits, licenses and other authorizations required to carry out the development.
4. Land tenure and any existing or anticipated agreements related to access to facilitate the proposed development.
5. A list of any other required developments that need to be constructed or improved in order for the project to proceed.

Thor Lake

6. All underground and open pit facilities, including ramps, portals, declines, location of infrastructure, machinery requirements, and water management facilities and methods.
7. The mining, crushing, and ore transportation methods used in the open pit and underground works.
8. A description of the milling process from initial separation to concentrate, including primary and secondary crushing and flotation and filtration processes.
9. A description of the expected spatial volume of the mine, how much of that volume Avalon anticipates to fill with paste-backfill, and the number and volume of bulkheads throughout the mine.
10. A description of expected physical properties of paste backfill, including mineralogy, chemical characterization, as well as expected long term stability, reactivity and structural integrity.
11. Mine rock management area including location, underlying ground conditions and volume of

waste rock over the life of mine.

12. Construction and operation of the airstrip, frequency of use, type of aircraft and estimated number of passengers and volume of materials.
13. The proposed upgrade to the Thor Lake mine-Great Slave Lake access road and any roads within the mine site, including construction (width of right-of-way, vegetation removal, road bed type) and maintenance, and the expected number of trips on that road, water crossings, as well as the type and weight of load, any related storage, transfer and handling, etc.

Pine Point

14. The expected number of trips per day to and from the Pine Point processing site from Hay River by truck, type and weight of load, any related storage, transfer and handling, and estimated duration of the annual haul season.
15. A description of the entire hydrometallurgical cycle.
16. A description of any proposed use of the existing Teck Cominco tailings management facility.
17. A description of the tailings management facility or facilities proposed in existing open pits at Pine Point including storage capacity, operational life of each facility, pit floor conditions and permeability, presence of standing water, distance to groundwater table, rock types, presence of faults, pit wall stability and any containment dams or dykes.
18. A description of the total amount of limestone required for the entire life-of-project and the expected source for that amount.

Both sites

19. Tailings management facility including a description of:
 - a. dams and dykes with proposed techniques ensure their stability and containment. If frozen conditions are necessary, describe techniques for the maintenance of frozen conditions;
 - b. estimated tailings volumes over the life of project at both sites, as well as expected supernatant volume;
 - c. expected capacities of tailings facilities at both sites. Include a description of potential expansions to primary facilities, as well as use of nearby pits or water bodies (for example Cressy Lake at the Thor Lake site). Include a discussion on the likelihood of mine-life expansion from that proposed.
20. Provide a comprehensive water balance for both sites (with various proposed water recycling scenarios) that includes both freshwater and process water withdrawals. Include a reference to the total and available volumes of all water sources, and description of the time of year the water will be withdrawn.
21. The expected number of single, one-way trips per day to and from the mine site by barge; the main and any alternate routes for barging; the type and weight of all loads; any related storage, transfer and handling procedures and related events on Great Slave Lake or near its shore related to concentrate and other materials handling; estimated duration of the annual barging season; the thresholds that guide Avalon's go/no-go decisions on barging safety; the schedule and methodology for temporary barge installation and removal.
22. All proposed project access roads – at both sites – water crossings, including construction/upgrade schedule, amount of water and other materials required and a description of techniques to be utilized to minimize erosion and bank instability.

23. The volume and management of sludge produced at the water treatment facilities.
24. The types and estimated amounts of explosives to be used, their storage, handling and application, both aboveground and underground.
25. The location, contents and estimated amounts of mined materials, soil and overburden at all surface storage facilities, along with estimates of storage requirements, storage capacity limits, separation of materials, and maintenance of materials to facilitate reclamation.
26. Location(s) and proposed activities of aggregate production and storage, with an estimate of the amount of aggregate that will be produced per year over the life of the mine, by location.
27. The siting and design of any waste disposal facilities (including landfills, landfarms, soil treatment facilities, incineration facilities, other temporary waste management facilities) and management of all wastes generated including storage and disposal plans with contingencies, treatment and testing programs.
28. The type, volume, storage (location and method), handling, transport and disposal of all waste, as well as fuel, reagents and hazardous materials used on site.
29. List the storage location of mill reagents including maximum volumes and concentrations of reagents to be stored on site.
30. The water collection, management and treatment systems and all of their component parts, reagents, including drainage and other control structures, water and sewage treatment facilities, water storage facilities, and water transport components. Indicate how treatment systems will function to achieve stated mitigation objectives.
31. The total amount of water in cubic meters estimated to be collected from all water sources for both project sites presented separately, and other project site components and eventually be released into local watercourses, with consideration of changes during the life of the Thor Lake Rare Earth Element Project and the range of seasonal fluctuations.
32. Water intake locations, withdrawal methods and estimated amounts of water required from all water sources for all on-site activities.
33. Energy requirements and generation sources.
34. Fuel storage facilities including a justification for the fuel storage container type selected, on-site fuel transport and handling procedures.
35. All other infrastructure and activities at both project sites including intensity and type of on-site vehicle traffic required.
36. The number of full-time job equivalents and person years of work associated with the Thor Lake Rare Earth Element Project, broken down by life cycle phase.
37. Worker transportation and proposed work scheduling.

3.2.6 Public engagement

Engagement with Akaitcho communities, other Aboriginal groups from section 2.2.2, other governments, or other organizations with interests related to areas that might be affected by the Thor Lake Rare Earth Element Project should be considered in this section. Aboriginal groups, government agencies and other interested parties may have information useful to the conduct of this impact assessment and all reasonable efforts should be made to engage with them. The Review Board encourages the developer to meet with interested groups outside the environmental assessment process, and to place any information from those discussions they consider may be

relevant to the Review Board's decision on the public record. The following items are required for consideration of public engagement:

- An engagement log, describing dates, individuals and organizations engaged with, the mode of communication, discussion topics and positions taken by participants, including:
 - All commitments and agreements made in response to issues raised by the public during these discussions, and how these commitments altered the planning of the proposed Thor Lake Rare Earth Element Project;
 - All issues that remain unresolved, documenting any further efforts envisioned by the parties to resolve them.
- Description of all methods used to identify, inform and solicit input from potentially-interested parties, and any plans Avalon has to keep engagement moving forward;
- Discussion of the implications for environmental monitoring and management of any relevant agreement between the developer and other interested parties; and
- How Avalon has engaged, or intends to engage, traditional knowledge holders in order to collect relevant information for establishing baseline conditions and the effects assessment of potential impacts, as well as a summary table indicating where and how in which of the subsequent sections (3.3-3.7) traditional knowledge was incorporated, and who was consulted (see Review Board's *Guidelines for Incorporating Traditional Knowledge in Environmental Impact Assessment*).

3.3 Impacts on the biophysical environment

3.3.1 Impact assessment steps and significance determination factors

In order to facilitate the consideration of the specific questions posed in this section, the developer is required to address the following impact assessment steps. In assessing impacts on the biophysical environment, the *Developer's Assessment Report* will for each subsection:

- Identify any valued components used and how they were determined;
- For each valued component, identify and provide a rationale for the criteria and indicators used;
- Identify the sources, timelines and methods used for data collection;
- Identify natural range of background conditions (where historic data are available), and current baseline conditions, and analyze for discernible trends over time in each valued component, where appropriate, in light of the natural or existing variability for each;
- Identify any potential direct and indirect impacts on the valued components that may occur as a result of the proposed development, identifying all analytical assumptions;
 - Predict the likelihood of each impact occurring prior to mitigation measures being implemented, providing a rationale for the confidence held in the prediction. The developer must also present predictions in a way that facilitates the formulation of testable questions for future follow-up programs, as well as textually and schematically indicate the pathways of predicted impacts;
 - Compare the predicted impact to pre-development condition. Include a description of any plans, strategies or commitments to avoid, reduce or otherwise manage and mitigate the identified potential adverse impacts, with consideration of best management practices in relation to the valued component or development component in question;
 - Describe techniques, such as models utilized in impact prediction including techniques used where any uncertainty in impact prediction was identified.
- Identify, and provide an opinion on the significance of, any residual adverse impacts predicted to remain after any mitigation measures and indicate the methodologies for reaching such

conclusions; and

- Identify any monitoring, evaluation and adaptive management plans required to detect potential unexpected changes as well as to ensure that predictions are accurate, and if not, to proactively manage against developing adverse impacts when they (or unexpected changes) are encountered.

The developer will describe how the predicted impacts are expected to arise from the proposed development. This will include describing the mechanisms for cause and effect and providing supporting references (including where Traditional Knowledge was used). Where professional judgment has been used in determining impacts, this must be made clear. Avalon will also provide a discussion on the uncertainty involved with each prediction. For each predicted impact, the developer will also describe:

- the nature or type of the impact;
- the geographical range of the impact;
- the timing of the impact (including duration, frequency and extent);
- the magnitude of the impact (what degree of change is expected);
- the reversibility of the impact; and,
- the likelihood and certainty of the impact.

These criteria will be used by the developer as a basis for its justification of significance for potential impacts from this project. The Review Board will make ultimate determinations of significance after considering all the evidence on the public record later in the environmental assessment. For more information on the above criteria, please refer to section 3.11 of the Review Board's *Environmental Impact Assessment Guidelines* available on the Review Board's public registry.

3.3.2 Key line of inquiry: water quality

Avalon proposes to have an underground mine in the proximity of lakes (proposed tailings management facility) that have been drawn down, in addition to bypassing the flow of volumes of water around Murky Lake by pumping directly from Drizzle Lake into Thor Lake while discharging effluent into, and recycling certain volumes of water from this watershed. This complex water management within a small area – and any potential impact(s) that may come from it – deserves a thorough analysis in this environmental assessment.

Thor Lake

Potential Pathways for Impacts to Water Quality from Project Components

For the locally impacted watershed and downstream water bodies (up to, and including a reasonable local area after, the confluence with Great Slave Lake) Avalon must:

1. Describe impacts to water quality from the following sources:
 - a. the water quality resulting from processing ore to concentrate, including an analysis of pathways and destinations for the end-products of concentrate, all reagent chemicals, process byproducts, hydrocarbons, sludge, incinerator residue, explosives, greywater constituents and any other potentially hazardous products used at the mine site that enter the water treatment stream;
 - b. mine water quality and quantity from interaction with underground operations;
 - c. interaction of water with paste backfill and resulting effects to water quality;

- d. the mine rock management area runoff water quality and quantity, including but not limited to effects from waste rock blasting residue;
- e. other site runoff including but not limited to impacts to water quality from dust suppression activities, as well as airstrip runoff given the nature of airstrip construction materials;
- f. any other materials stored on surface at the Thor Lake mine site, including aggregates;
- g. the tailings management facility supernatant water quality and quantity due to inputs to the facility from points 1a through 1f, as well as due to leachate from the tailings. On this matter, Avalon must give particular attention to uranium, thorium and beryllium levels in supernatant water – in addition to any other radioactive minerals/materials regardless of level of radioactivity, and any other metals or substances of concern. Include analysis of percent water content of tailings;
- h. describe how metals solubility under site conditions (both acidic and neutral) has been considered in long term mine planning and engineering designs;
- i. a comparison of the contaminant levels to natural background variability.

Avalon will both list the constituent contaminants and estimate their respective amounts from the above sources at the mine site. Also describe how each of the above sources, alone or in combination, may contribute to the leaching of metals, creation of acid rock drainage, or otherwise affect water quality. Avalon will include all results of testing to support such conclusions.

- 2. Provide test results for substances that may leach from the concentrate that Avalon produces including levels of uranium, thorium, beryllium, any other radioactive element or minerals (regardless of level of radioactivity), as well as any other metals.

Other Potential Pathways for Impacts to Water Quality

- 3. Describe the long-term effect(s) to water quality from Avalon’s proposed plans for water recycling for different water recycling scenarios, including the build-up of substances in recycled water. Include a discussion of effects to surface water quality from repeated drawdowns over the project life.
- 4. Predict the effects to water quality from winter withdrawal from Thor Lake and Drizzle Lake on both lakes and the downstream environment to the extent of Great Slave Lake.
- 5. Describe the effects to water quality in Murky Lake stemming from:
 - a. the proposed re-routing of flow from Drizzle directly into Thor Lake (bypassing Murky);
 - b. describe how this re-routing may interact with Avalon’s proposed discharge of effluent into the Drizzle-Thor-Murky watershed; and
 - c. include a discussion of downstream impacts from a) and b).
- 6. Describe and predict impacts to surface water quality from the discharge of (dewatering or drawdown) water from Ring Lake and Buck Lake, including:
 - a. short term water quality changes associated with discharging de-watering (or drawdown) water;
 - b. erosion potential from increased flow volumes both at and downstream of the de-watering (or drawdown) discharge point.
- 7. Describe and predict impacts to downstream surface water quality from the potential long-term effects of the removal of Ring Lake and Buck Lake flow volumes from the watershed.

8. Describe effects to the local water table. Include a discussion of:
 - a. the immediate effects of de-watering or drawdown of Ring Lake and Buck Lake;
 - b. the long-term effects from a reduced local water table around the Ring Lake and Buck Lake area (the tailings management facility);
 - c. the effects from groundwater loss through inflows to the underground mine;
 - d. any other mechanisms for groundwater loss to occur, as well as changes to groundwater flow regimes;
 - e. how the above changes may affect the refresh rates for Drizzle, Murky, Egg and Thor Lakes and other lakes in the vicinity of the mine site these changes may potentially affect;
 - f. how the above changes may contribute to changes in local permafrost and active layers; and
 - g. how the above changes may translate into surface water impacts, groundwater impacts or effluent water quality.
9. Identify any sources of potentially contaminated groundwater not captured in the mine water management system, for example leakage beneath the tailings pond basin. Describe and predict impacts to ground water quality and to groundwater flows in the project area. This discussion should identify:
 - a. where losses to the water management system is expected to occur, including an analysis of liquid migration pathways and expected travel time to Great Slave Lake;
 - b. estimated quantities of potentially contaminated groundwater loss; and
 - c. impacts of potentially contaminated groundwater on the environment, including surface water and ground water quality.
10. Predict impacts to water quality for any other water bodies that the project may reasonably affect at the Thor Lake mine site.
11. Describe the collective impact of all changes listed above on the watershed.
12. Describe the long-term effects of all changes listed above on the watershed. Include a discussion of changes to water quality from chemical loading of the receiving environment.

Pine Point

Potential Pathways for Impacts to Water Quality from Project Components

At the Pine Point processing site, Avalon proposes to deposit tailings into a porous pit and use a second pit to hold supernatant water – this requires thorough analysis. For the locally impacted watershed and downstream water bodies of the Pine Point processing site (up to, and including a reasonable local area after, the confluence with Great Slave Lake):

12. Describe impacts to water quality from the following sources:
 - a. the water quality resulting from processing concentrate, including an analysis of pathways and destinations for reagent chemicals, process byproducts hydrocarbons, sludge, incinerator residue, explosives, greywater constituents and any other potentially hazardous products used at the project site that enter the water treatment stream;
 - b. runoff from the coal storage area. Avalon will provide an analysis on the range of water quality that can come from the use of varying ‘grades’ of coal, from poor to high;
 - c. runoff from the sulphur storage area;
 - d. any other materials stored on surface at the processing site, including limestone, aggregates

reagents and hazardous materials;

- e. other site runoff such as impacts to water quality from dust suppression activities;
- f. the tailings management facility (or facilities) supernatant water quality and quantity due to inputs to the facility from points 12a through 12f, as well as due to leachate from the tailings. On this matter, Avalon must give particular attention to uranium, thorium and beryllium levels in supernatant water – in addition to any other radioactive minerals/materials regardless of level of radioactivity, and any other metals or substances of concern. Include analysis of percent water content of tailings;
- g. impacts on local aquifer(s) if exfiltration through an existing pit is selected as one of the preferred options for the Pine Point site, the hydrogeological information must include a review of, travel time to Great Slave Lake, volume of ex-filtrate, migration pathway (location and depth), monitoring points, distinct points of control and contingencies for non-compliant discharges;
- h. a comparison of the contaminant levels to natural background variability;
- i. describe how metals solubility under site conditions (both acidic and neutral) has been considered in long term project planning and engineering designs.

Avalon will both list the constituent contaminants and estimate their respective amounts from the above sources at the Pine Point processing site. Also describe how each of the above sources, alone or in combination, may contribute to the leaching of metals, creation of acid rock drainage, or otherwise affect water quality. Avalon will include all results of testing to support such conclusions.

Other Potential Pathways for Impacts to Water Quality

13. Regarding Avalon's water source(s) at the hydrometallurgical site, describe effects to the local water table. Include a discussion of:
- a. impacts to groundwater flows and water quality in the Presquile Aquifer - or other water bodies including but not limited to the T-37N pit - stemming from its potential use as a source of water;
 - b. the immediate effects of drawdown of water sources;
 - c. the long-term effects from a reduced local water table around water sources that have been drawn down;
 - d. effects to water quality from winter withdrawal for any water body or bodies that Avalon proposes to use a source for water [including downstream water bodies until the confluence with Great Slave Lake and a reasonable local area of Great Slave Lake];
 - e. impacts to connecting waterways (including any streams and/or ephemeral springs that form during freshet) stemming from that use;
 - f. how the above changes may affect the refresh rates for water bodies in the vicinity of the processing site that may be affected by project operation;
 - g. how the above changes may contribute to changes in local permafrost and active layers; and
 - h. how the above changes may translate into surface water impacts, groundwater impacts or effluent water quality.
14. Describe specific impacts from de-watering any pits for use as tailings ponds, including:
- a. short term water quality changes associated with discharging de-watering (or drawdown) water;
 - b. erosion potential from increased flow volumes both at and downstream of the de-

watering (or drawdown) discharge point.

Impacts to Water Quality after mitigation and Avalon's last point of control

15. At the Pine Point processing site, Avalon proposes to primarily discharge tailings into a pit that will likely not contain the tailings water. Avalon must therefore describe:
 - a. where losses to the water management system is expected to occur, including an analysis of liquid migration pathways and expected travel time to Great Slave Lake;
 - b. estimated quantities of potentially contaminated groundwater loss;
 - c. impacts of potentially non-compliant tailings water loss on the environment, including impacts to downstream surface water and ground water quality;
 - d. provide an analysis on points 15a-15c for the secondary pit Avalon proposes to store potentially non-compliant water in.
16. Predict impacts to water quality for any other water bodies that the project may reasonably affect at the processing plant site.
17. Describe the collective impact of all potential changes listed above on the local watershed.
18. Describe the long-term effects of all changes listed above on the watershed. Include a discussion of changes to water quality from chemical loading of the receiving environment.

Impacts to Water Quality after mitigation and Avalon's last point of control

Both sites

19. For the local watershed and downstream water bodies (up to and including a reasonable local area after the confluence with Great Slave Lake, describe impacts to water quality and quantity from final effluent discharged to the environment during all phases of the Thor Lake Rare Earth Element Project life cycle, incorporating:
 - a. identification of the constituents of, and quantity likely to come out of, each on-site water source;
 - b. method and location of effluent discharge;
 - c. present discharge criteria for treated water;
 - d. predicted changes over time in the amount or quality of project water outflows;
 - e. all relevant water quality parameters;
 - f. contaminant mobility in water under likely environmental conditions;
 - g. plume behaviour of effluent for these lakes and downstream of these lakes including an estimate of mixing behaviour and an estimate of where the plume would be sufficiently mixed to the point of no chronic toxicity;
 - h. identification of the uncertainties and confidence levels in the predictions, the assumptions used, and the likely range of variation for the parameters identified.

Great Slave Lake

20. At and after the confluence of the downstream environment of both project sites with Great Slave Lake, describe and predict the potential impacts to the local water quality of Great Slave Lake from the plumes of discharged effluent from both sites. Include a discussion of how project-related changes to any and all discharge into aquifers at both sites may affect the local water quality of Great Slave Lake.

3.3.3 Cumulative effects from the project

Pursuant to paragraph 117(2)(a) of the *Mackenzie Valley Resource Management Act*, the Review

Board considers cumulative effects in its determinations. Cumulative effects are the combined effects of the development in combination with other past, present or reasonably foreseeable future developments and human activities. The processing facility at the Pine Point site would sit in an area that has been adversely affected by past development. In addressing cumulative effects, the developer is encouraged to refer to Appendix H of the Review Board's *Environmental Impact Assessment Guidelines*.

The following items are required for consideration of cumulative effects:

Both sites

1. Predict potential impacts of the project in combination with impacts from past or present effects from previous development in the area for both sites on:
 - a. water quality, air quality, soil vegetation and other terrain features;
 - b. fish and wildlife via the pathways from 1a.

Avalon will give consideration to the former Pine Point mine site and the reasonably foreseeable progression of Tamerlane's Pine Point Pilot Project, as well as past development of any kind near Thor Lake.

2. In terms of cumulative effects, predict:
 - a. impacts of the project on both Barren-ground and Woodland caribou in combination with impacts of other developments in the range of respective habitats;
 - b. socio-economic changes, cultural changes and changes to community well-being from the project using publicly available data;
 - c. socio-economic changes, cultural changes and changes to community well-being from the project in combination with other with other industrial developments using publicly available data including:
 - i. existing and proposed diamond mines;
 - ii. the proposed Yellowknife Gold Project; and
 - iii. the proposed Mackenzie Gas Project.
3. Determine how any other past, present and reasonably foreseeable human activities or developments that may affect the same valued components as this project. Provide the rationale for including the developments that are chosen for examination on specific valued components, as well as a description of and rationale behind the chosen geographic cumulative effects study area and temporal boundary.
4. Identify means for Avalon, either on its own or cooperatively with others, to reduce or avoid the predicted cumulative effects.
5. Describe how Avalon's liabilities may interact with that of Tamerlane's and Teck Cominco's with regard to reclamation issues.

3.3.5 Fish and aquatic habitat

For the following analyses, the developer will include at minimum Thor Lake, Drizzle Lake, Murky Lake, Cressy Lake and Egg Lake, other reasonably relevant water bodies in the vicinity of the mine site, as well as the downstream environment to the extent of Great Slave Lake. For the Pine Point processing site, the developer will include reasonably relevant water bodies in the vicinity of the processing site, as well as the downstream environment to the extent of Great Slave Lake. Effects/impacts to habitat are changes up to and including loss of habitat during all phases

of the project. The developer will also consider the potential for fish to migrate into or out of these water bodies. The developer will:

Both sites

1. For Drizzle, Murky, Thor Lake and downstream water bodies (up to and including a reasonable local area after the confluence with Great Slave Lake) describe - incorporating seasonal variation - the impacts to fish, aquatic life and respective habitats from project-related changes to water quality, any changes to water quantity from project use, any introduction of contaminants to aquatic food chains from effluent discharge, project related changes to riparian areas, or other potential pathway(s) including but not limited to:
 - a. any changes to flow volumes, velocities and patterns, to habitat, including alterations to banks, shores and riparian areas of water bodies near road water crossings, and associated changes in habitat quality and availability;
 - b. reduced dissolved oxygen concentration;
 - c. increased concentrations of metals, ammonia and other nutrients as well as other contaminants in water, sediment and the aquatic food chain;
 - d. increased sedimentation and turbidity in Thor Lake and watercourses downstream until Great Slave Lake, especially from the mine rock management area, the mine site, airstrip and road activities;
 - e. alteration of pH;
 - f. any other specific changes to water quality and aquatic environment as identified in section 3.3.2; and
 - g. how potential impacts to fish and aquatic life due to changes in the aquatic environments from the above points – or any changes to water quality identified in section 3.3.2 – may be magnified during specific timing windows such as spawning and incubation periods.
2. Provide an analysis of points 1.a. through 1.g. for the Pine Point processing site for affected water bodies.
3. For line items 1 and 2 above, identify if an aquatic species as listed in the *Species at Risk Act* is affected and describe the impacts.

Thor Lake

4. Provide all data Avalon has acquired that supports any declaration of Ring and Buck Lakes as non-fish-bearing water bodies, and include the methodologies used to collect such data.
5. Describe the effects that removal of Ring and Buck Lakes would have on downstream fish and aquatic habitat until the confluence of the watershed with Great Slave Lake.
6. Describe the effects to aquatic habitat from water withdrawal from Thor Lake and Drizzle Lake - on both lakes as well as on the downstream environment to the extent of Great Slave Lake. Include an analysis on the effects of winter (ice-covered) withdrawal from Thor Lake and Drizzle Lake.
7. Predict and describe the potential impacts that repeated drawdowns may cause to this fish habitat.
8. Describe the effects to aquatic habitat in Murky Lake stemming from the proposed re-routing of flow from Drizzle directly into Thor Lake (bypassing Murky). Include a discussion of potential impacts related to the intake and discharge points of redirected water.

Pine Point

9. Predict the effects to aquatic habitat from winter withdrawal from any surface water body or bodies for use at the Pine Point hydrometallurgical processing facility.

Great Slave Lake

10. Predict the impacts to fish habitat from the installation, operation and removal of the seasonal mooring barges at the proposed sites on both sides of Great Slave Lake.
11. At and after the confluence of the downstream environment of both project sites with Great Slave Lake, describe and predict the impacts to the local fish and fish habitat of Great Slave Lake from any possible plumes of discharged effluent from both sites. Include a discussion of how project-related changes to any and all discharge into aquifers at both sites may affect the local fish and aquatic habitat of Great Slave Lake.

3.3.6 Wildlife

Section 79 of the federal *Species at Risk Act* (SARA) requires that the Review Board identify the adverse effects of the project on all *SARA*-listed wildlife and its critical habitat, and if the project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plans. Cumulative effects on wildlife are examined in section 3.3.3. For potential impacts to wildlife, the developer will:

Both sites

1. Describe the impacts the development at both sites may have on wildlife and wildlife habitat. For each species, and/or species group consider the following:
 - a. potential impacts to habitat, including degradation and fragmentation, with a focus on important wildlife habitat. Include a discussion on impacts occurring during vulnerable periods including but not limited to nesting or rearing;
 - b. potential for increased sources of direct or indirect mortality including from vehicle collisions on the Pine Point-Hay River road, the Thor Lake airstrip, as well as the increased rail traffic through Woodland caribou habitat and changes to hunting access;
 - c. potential for increased attraction to both project sites, risk of bear-human encounters, risk to people and associated carnivore mortality;
 - d. potential for increased sensory disturbance from all sources (e.g., noise, odours, activity, vibrations from blasting, overflights, dust, transports trucks, locomotives, barge traffic). Predict effective habitat loss resulting from changed behaviour;
 - e. potential for disruption of movement and migration patterns; and
 - f. potential for increased contamination of food and water, including bio-accumulation, from all sources. Discuss effects of tailings ponds on waterfowl, other aquatic birds and furbearers.
2. Describe potential adverse impacts from both project sites on any species-at-risk or other species of concern known or suspected to reside in the environmental assessment study area or potential adverse impacts on their habitat including residences. Include a discussion of both Woodland and Barren-ground caribou.

3.3.7 Terrain

When assessing impacts and risks related to terrain the developer will:

1. Describe the existing geotechnical stability of the areas proposed for the mine rock

management and tailings management areas at both sites, including:

- a. soil and hydrological conditions;
 - b. permafrost, ground thermal conditions and ground ice conditions;
 - c. description of the physical and chemical characteristics of mine rock and tailings; and
 - d. topography and slope stability.
2. Describe how the geotechnical stability of all engineered structures at both project sites will be ensured against a range of climate, seismic and precipitation scenarios.
 3. Identify any plans to mitigate and monitor against impacts on terrain, including:
 - a. erosion control measures;
 - b. prevention of permafrost degradation at both project site locations where it is found to be present;
 - c. how the geotechnical stability of the mine rock management area, tailings management area and the system of dykes and dams will be monitored, and for what extent of time.

3.3.8 Air quality, including noise, light and viewshed

The *Developer's Assessment Report* will evaluate the development's potential impacts on air quality due to project emissions. The developer is encouraged to enter dialogue with Environment Canada and the Government of the Northwest Territories about appropriate methods for modeling air quality to ensure compatibility between the developer's and government's analysis. The same is true for strategies for minimizing air quality impacts.

Both sites

1. Describe potential impacts from project emissions during construction, operation and closure phases:
 - a. estimate criteria air contaminant emissions and their potential impacts on valued components of the surrounding environment using an established air quality model during all phases of the project. The model shall locally and regionally predict both dispersion and deposition potential and incorporate seasonal variation. Also:
 - i. provide an analysis on the range of emissions that can come from the coal Avalon will be using at the Pine Point processing site;
 - ii. predict annual carbon emissions over the life of the mine and describe any offsets proposed to mitigate carbon emissions;
 - iii. include an analysis on dispersion deposition and impacts from fly-ash related to coal burning;
 - iv. contrast point 1.a.i. against alternative sources of power as listed in section 3.6.
 - b. provide test results for the general composition of and impacts from dispersion and deposition of dust from tailings facilities, stockpiles, waste-rock piles and similar dust-producing components of the project. Include an analysis of the levels of uranium and thorium in fugitive tailings dust, or any other radioactive element from any mineral;
 - c. discuss potential sources and quantities of contaminants from the handling and transport of ore and concentrate, and their expected deposition range, including the expected impacts from any dust that may contain radioactive elements, minerals or substances of any kind;

- d. compare predicted ambient concentrations and deposition rates during the different phases of the project to relevant ambient air quality guidelines and standards;
- e. discuss and quantify any potential links between predicted air quality impacts and other valued components such as water quality, fish, wildlife and human health. Include a discussion on expected emission levels for and impacts related to dioxins and furans from waste incineration.

Thor Lake

- 2. Describe existing noise, light and viewshed conditions at Thor Lake with particular reference to Blachford Lake Lodge.
- 3. Predict impacts of noise, light and viewshed during mine construction and operations on Blachford Lake Lodge, with emphasis on the lodge's aurora viewing services.
- 4. Describe mitigation measures to reduce impacts from noise, light and viewshed on Blachford Lake Lodge.

3.3.9 Vegetation

The developer will:

Both sites

- 1. Estimate the total amount of land clearing required for the project, with estimates of losses of trees and other plants. Include a description of how the soil materials will be removed, conserved or stored, and the likely impacts of loss of soil or compaction on long-term re-growth capacity.
- 2. Describe the potential for the project to impact rare plants, with particular emphasis on species that the *Species at Risk Act* lists, as well as on culturally or economically significant harvested plants.
- 3. Describe the potential impacts of vehicle, project equipment and power plant emissions on vegetation around both project sites and roads.

3.3.10 Biophysical environmental monitoring and management plans

Monitoring is an action that the developer can take to recognize a significant adverse impact as it potentially develops. From there, monitoring information can direct preventive measures to ensure that significant adverse impacts do not develop further. In line with its duties to prevent significant adverse impacts on the environment, as well as in the spirit of integrated resource management in the Mackenzie Valley, the Review Board will analyze the adequacy of monitoring programs towards the end of detecting and preventing potential significant adverse impacts from development. Below, Avalon will demonstrate that the monitoring and management plans have representative near-field and far-field baseline information, consider the natural range of variability, and will detect and mitigate any relevant changes - expected or unexpected – before they become significant adverse impacts.

- 1. Describe the framework for monitoring plans that will guide Avalon's evaluation of and adaptive management for impacts to water quality. Specify:
 - a. which phase of the development the plan is for;
 - b. the framework for surface water and ground water monitoring;
 - c. what parameters the plan monitors for changes and how this relates to detection of a significant adverse impact to water quality;

- d. how monitoring data will be used to determine if action is required such as definitions of any methodologies used, critical values, and threshold conditions;
 - e. how Avalon's proposed mitigations fit into adaptive management plans, including how project management will be adapted if necessary to prevent significant adverse impacts, including but not limited to:
 - i) unexpected deviations from environmental assessment predictions for any substance of concern that may impact water quality;
 - ii) contingency plans in case metals leaching or acid rock drainage occurs;
 - iii) contingency plans for unacceptable treated-water quality.
2. For all valued component other than water⁵, describe the framework for monitoring plans that will guide Avalon's evaluation of and adaptive management for impacts to valued components. Specify:
- a. which phase of the development the plan is for;
 - b. what parameters the plan monitors for changes and how this relates to detection of a significant adverse impact to a valued component;
 - c. how monitoring data will be used to determine if action is required such as definitions of any methodologies used, critical values, and threshold conditions;
 - d. how Avalon's proposed mitigations fit into adaptive management plans, including how project management will be adapted if necessary to prevent significant adverse impacts, including but not limited to:
 - i) unexpected deviations from environmental assessment predictions for any substance of concern that may impact the valued component;
 - ii) provide a summary table listing all biophysical environmental monitoring and management systems, where they are described in the Developer's Assessment Report, the length of time the monitoring is proposed for, and a rationale for each timeline.
 - e. The framework for an overall Incineration and Waste Management Plan, including commitments for management of solid, liquid, hazardous and airborne wastes, and associated monitoring programs.

See Appendix B for additional information on monitoring and management plans.

3.4 Impacts on the human environment

The *Mackenzie Valley Resource Management Act* lists social impacts, cultural impacts, impacts on heritage resources and impacts on wildlife harvesting in the definition of impacts on the environment. In addition, the Guiding Principles of Part 5 of the MVRMA require the consideration of the social, economic and cultural well being of residents and communities of the Mackenzie Valley during every environmental assessment. The Review Board's *Socio-economic Assessment Guidelines* provide a context for assessing impacts on the human environment.

The developer is encouraged to work with communities and responsible government authorities to identify valued components of the human environment, appropriate indicators and sources of information to measure change, pathways by which change may likely occur, and mitigation and

⁵ Due to the complexity of cultural and socio-economic impact assessment, the line items for human environment monitoring and management will appear in the human environment section.

monitoring strategies that may be required to maximize benefits and minimize adverse impacts. Mitigation may not be entirely the responsibility of the developer, as governments and communities have social, economic and cultural protection mandates. However, it is primarily the responsibility of the proponent of the project to initially document these issues in its Developer's Assessment Report.

K1 Employment and business opportunities

The developer will assess the potential impacts of the Thor Lake Rare Earth Element Project on the economy of the Mackenzie Valley, with a focus on the Akaitcho region generally and each potentially-affected community from section 2.2.2.

In assessing access to employment and business opportunities, the developer will provide the following:

Employment

1. An estimate of human resource requirements for the development that includes a listing of all direct and contract employment requirements by skills category for each phase of the life of the Thor Lake Rare Earth Element Project. The developer will identify the skill-levels that each position requires, and shall include employment in all aspects of the operation of the project, including monitoring and as well as transportation to and from site.
2. An assessment of the likely percentage of direct employment for NWT and aboriginal residents at the project, in light of the current and likely future (extending to the expected life of the mine), labour pool context (i.e., likely available numbers of workers in light of total regional economic activity), and identification of any target goals for NWT resident and Aboriginal employment.
3. A qualitative description of any barriers to direct or contract employment, advancement and retention for Mackenzie Valley residents, with particular emphasis on potentially affected communities, other Aboriginal and Northern people and women where possible. This description must include employee availability and employability in light of minimum skill requirements and an investigation of current training opportunities for community members. The developer will also discuss:
 - a. estimates of current skills gaps in the available labour pool that require additional training programs;
 - b. hiring and retention policies related to minimum education levels, criminal records and drug and alcohol use; and
 - c. any identified barriers to maximizing regional and Aboriginal employment.
4. The developer's plans, strategies and commitments for maximizing direct employment, advancement and retention of residents from potentially affected communities, other Aboriginal and NWT residents.
5. Employment policies for Aboriginal and other Northern women including training initiatives, measures for security and safety at the project sites and anti-harassment policies.
6. A description of any plans, strategies or other commitments the developer has to support increasing the project-ready workforce, support career paths in mining, and assist training programs in related support activities. The developer will outline how these strategies will create or contribute to training opportunities for NWT residents and Aboriginal persons in general, and its employees in particular, over the life of the mine. The developer will also identify when any committed-to mitigations will be enacted, incorporating the lead time

required for job-ready training programs.

7. A discussion of whether and how the developer's strategies and commitments for maximizing employment of Aboriginal and NWT residents will extend to its contractors.

Business opportunities

8. An estimate of all contractor and subcontractor goods and services that the project will require, by project phase, as well as an estimate of what percentage of required goods and services can feasibly be sourced from local and regional businesses.
9. The developer's policies, plans, and commitments associated with maximizing contracting to Aboriginal and NWT-owned and operated businesses, with emphasis on assisting business development initiatives and joint ventures with:
 - a. impacted communities;
 - b. regional communities;
 - c. the greater NWT community.
10. An assessment of any barriers to maximizing the utilization of NWT businesses.
11. An assessment of what Avalon can do to employ NWT residents with criminal records.
12. An assessment of how Avalon's Thor Lake operations may impact business operations at the Blachford Lake Lodge and suggested mitigations.
13. The developer's prediction for any training, education or other improvements necessary to maximize local and regional business capacity to benefit from the project.

K2 Distribution of beneficial and adverse socio-economic impacts

The developer will provide the following information and analysis:

14. Qualitative and quantitative estimates of all beneficial and adverse economic impacts from the project, including at minimum:
 - a. capital costs associated with placing the Thor Lake Rare Earth Element Project in operation, broken down by major components (estimates should be in 2009 dollars CAD. and may be in a +/- 20% range);
 - b. annual operating costs during the life of the Thor Lake Rare Earth Element Project (estimates should be in 2009 dollars CAD. and may be in a +/- 20% range); and
 - c. total employment impact on potentially affected communities and Mackenzie Valley, including a prediction of employment multipliers from the development.
15. Discussion potential role of the Thor Lake Rare Earth Element Project on the following:
 - a. socio-economic impacts potentially resulting from increased disposable income and larger reliance on the wage economy;
 - b. any impacts on social services provision, infrastructure and costs (e.g., emergency medical care or family social services); and
 - c. whether and how the project may create or contribute to impacts on other organizations and businesses servicing the region through mobilization of local skilled labour away from smaller communities and associated impacts on maintenance of infrastructure and basic service provision.
16. The developer's policies, strategies, plans, and commitments, alone or in combination with other parties, for the mitigation of any adverse socio-economic impacts.

17. Discussion of any plans, strategies or other commitments the developer has to help potentially-affected communities avoid over-exposure to cyclical economic fluctuations, with a focus on:
 - a. potential social and economic effects of project closure (including unforeseen early closure or project hiatus) on potentially-affected communities as well as NWT businesses; and
 - b. any plans to assist post-closure transition for project employees.
18. Describe any lessons learned about short and long-term social and economic impacts of previous mine developments in the Mackenzie Valley and the Canadian North, and how the developer has incorporated such lessons into its impact assessment and mitigation commitments for the Thor Lake Rare Earth Element Project.

K3 Social impacts

While conducting a social impact assessment, the developer will describe:

19. Potential impacts associated with the development on community wellness and population health issues such as:
 - a. population in- and out-migration;
 - b. alcohol and drug access and use;
 - c. sexually-transmitted infections rates;
 - d. crime rates;
 - e. access to child care;
 - f. language retention and other key indicators of cultural maintenance;
 - g. education completion rates by level; and
 - h. community cohesiveness and pride in cultural identity.

The description of community wellness and population health issues may consist of a review of publicly available quantitative statistics and key informant interviews with community health providers and social service providers where possible.

20. How each identified potential impact may affect individual potentially-affected communities.
21. The physical, mental, and cultural health of project workers and project workers' families, considering potential impacts of long-distance commuting and greater engagement in the wage economy based on a review of select and pertinent peer-reviewed studies and through key informant interviews with residents of potentially affected communities currently working at mines in the NWT. This discussion should identify any alternative shift rotations considered by the developer, with the rationale for the chosen rotation.
22. Human resources management plans and programs the developer will offer at the project site to identify and mitigate potential social problems associated with the project, that will include but not be limited to discussion of:
 - a. increased income and money management;
 - b. potential stressors associated with long-distance commuting and stress management programs;
 - c. substance abuse and treatment policies;

- d. cross cultural training and avoidance of cross-cultural conflicts at the work site; and
 - e. “home” – community and family - support programs.
23. Predict potential impacts on public safety, especially in regards to the use of the Great Slave Lake as a barging corridor in light of the use of the East Arm in the summer.
 24. Predict potential impacts on public safety from barging accidents, including from the public consumption of fish from Great Slave Lake and any mitigation to minimize the potential for vehicle accidents. Also include a discussion on impacts to Great Slave Lake fisheries and tourism activities.
 25. Predict potential impacts to public safety due to project-related open- or thin-ice areas downstream of both project sites.
 26. Predict potential impacts to public safety from the increase in traffic on the Pine Point-Hay River road.
 27. Describe the specific hazards to employees as well as to public safety and health from project-related radiation or other hazards that may arise from Thor Lake Rare Earth Element Project operations.

K4 Cultural impacts

The analysis of heritage resources is inclusive of both sites and objects of cultural significance, and cultural impacts include both tangible and intangible aspects of culture.

K4a Physical heritage resources

The developer will report on:

28. Consultation with traditional knowledge holders, archaeologists, anthropologists, and the Prince of Wales Northern Heritage Centre, that the developer conducted during its cultural impact assessment, indicating how such interactions influenced:
 - a. heritage resource survey locations;
 - b. the identification of locations of known or high potential for heritage resources; or
 - c. heritage resource management plans.
29. Identification of all known archaeological and heritage resources, sites or areas of cultural significance, and areas of high potential for unfound heritage resources in the environmental assessment study area.
30. All recommended mitigation measures that consultation produced for the protection of local known and high potential areas of physical heritage resources and other sites of cultural significance, and associated developer’s commitments or reasons for not adopting recommendations.
31. Describe any potential impacts from the Thor Lake Rare Earth Element Project on physical heritage near both project sites and any other point within the geographic scope of the development.

K4b Traditional land use and wildlife harvesting

The developer will:

32. Describe any potential impacts of the project on traditional harvesting activities for Aboriginal residents of potentially affected communities, including changes from impacts to wildlife, changes in all-season access from potentially affected communities due to the Thor Lake mine site-Great Slave Lake access road, and any changes in access by non-resident hunters.

33. Provide a prediction of the total impact of the project on traditional activities, and on the potential for increased or reduced harvesting success. For visual and audible changes perceptible from the Great Slave Lake:
- describe and illustrate any potential visual impacts to the viewshed as seen from Great Slave Lake;
 - describe any other points along remainder of the Great Slave Lake and islands where the project will be visible or audible, illustrate and describe how it will look and sound;
 - describe any measures taken to minimize these sensory disturbances; and
 - describe how any remaining sensory changes will affect the traditional authenticity of users' experiences along the Great Slave Lake.
34. Describe potential impacts from the project – including from barging activities – on traditional lifestyles, pursuits and activities on or near Great Slave Lake.

K5 Human environment monitoring and management plans

35. Describe any commitments, plans and strategies to engage with responsible authorities and potentially-affected communities in monitoring impacts on the human environment such as:
- success of local and regional residents and Aboriginal people in gaining employment at the Thor Lake Rare Earth Element Project, and the success of training initiatives;
 - success of local and regional businesses in providing goods and services to the Thor Lake Rare Earth Element Project, with identification of gaps to maximizing engagement;
 - employee retention;
 - worker and family wellness;
 - the contribution of the project to beneficial and adverse social impacts at the regional and local levels across a spectrum of appropriate indicators to be determined in collaboration with potentially affected communities and government authorities;
 - impacts on wildlife harvesting and practice of traditional culture on the land;
 - impacts on Great Slave Lake fisheries and tourism activities.
36. Identify relevant existing initiatives monitoring community wellness and investigate how it will engage with, contribute to, and consider results from these programs in its ongoing monitoring and adaptive management programs.
37. Provide a summary table listing all human environment monitoring and management systems and where they are described in the *Developer's Assessment Report*.
38. Describe how the developer will involve the residents of potentially affected communities in heritage assessments and monitoring of impacts on culture.
39. Identify all mitigation commitments by the developer, alone or in combination with other parties, to minimize adverse impacts on traditional land use and resource harvesting, or to compensate for losses that the developer cannot prevent. This should include discussion of:
- how access along the Thor Lake mine site-Great Slave Lake access roads at both sites will be monitored and, if feasible, managed; and,
 - any plans for any ongoing monitoring, adaptive management and harvester compensation.

3.5 Accidents and malfunctions

For this section, the developer will first discuss impacts to a valued component from an accident or malfunction as though it has happened, then discuss the associated probability of the event. For water quality related accidents or malfunctions, Avalon will provide analysis of potential impacts to water quality with the same depth and breadth of analysis as similar line items under that key-line-of-inquiry section.

1. Predict the effects to water quality from a complete overturning of all barges during a typical Great Slave Lake transit of a barge-train fully-loaded with concentrate, at various points along the barge corridor between Thor Lake and the delivery point on the south shore of Great Slave Lake. This analysis will include:
 - consideration of overturning at points that coincide with maximum, minimum and moderate depths along the route.
 - consideration of overturning at points that coincide with any potentially vulnerable areas along the route.
 - consideration of a spreading of concentrate from surface to lake bottom in a potential worst case scenario of concentrate containers also being compromised.
 - a consideration of the impacts from one container to all containers opening fully upon submersion, from a fully-loaded barge train.
 - a. a discussion of the associated radioactivity with such an event.
2. Describe and predict the potential impacts to the local water quality of Great Slave Lake from concentrate spillage at both barge loading/unloading sites, both in the short term and over the life of the mine.
3. Discuss what could leach from Avalon's frozen-concentrate transport container if left to thaw over a summer season or during a temporary shutdown of operations. Also discuss the likelihood of that happening over the course of a transport season and suggested mitigations to prevent any impacts.
4. Describe consequences of accidents, malfunctions, or "impacts of the environment on the development" that may affect water quality and quantity and the ability of the water management system to function. For both sites the following scenarios, at a minimum, will be considered:
 - a. extreme short-term precipitation events, snowpack buildup or other factors leading to flooding events;
 - b. geologic instability or seismic activity causing slope failures at or near either project site, including impacts on the site workings, or of the tailings management facilities. Consider:
 - i. geotechnical instability, especially of the mine rock management area, the tailings management area and the system of dykes and dams on site;
 - ii. changes to ground thermal conditions and permafrost failure at the both sites from project-related activities and/or climate change; and
 - iii. impacts to permafrost and ground thermal conditions from vegetation removal.
 - c. failure of existing dams/containment structures, tailings management facilities at both sites;

- d. freezing effects on pipelines or other water transportation systems;
 - e. interaction of water with improperly mixed or cured paste backfill;
 - f. how mine water will be managed if the water treatment system malfunctions, with a focus on retention capacity timelines for water storage facilities and contingency water treatment plans;
 - g. potential impacts to water from accidents in transport of processing chemicals and other dangerous goods;
 - h. potential impacts to water from tailings spills or leaks;
 - i. potential impact to any valued components from any spill of any product.
5. Predict the effects to fish and fish habitat from the above situations and other potential impacts to water quality from accidents or malfunctions.
 6. Conduct a best-practice risk assessment for the project, exploring the potential for events listed in points 1 through 5. Discuss systems, components, hazards and associated failure modes. The developer will assess likelihood and severity of each risk identified from the points 1-5.
 7. Describe the impacts of any other potential accidents or malfunctions not listed here.
 8. Describe contingency plans for accidents, malfunctions or unforeseen impacts including emergency response plans that will be in place during the construction phase and operations phase. This discussion should include the required circumstances for a failure to occur, and what monitoring, evaluation and adaptive management systems will be in place to identify, proactively avoid and rectify them.
 9. Describe the likelihood that invasive species will be introduced, by what means, and potential impacts.

3.6 Alternatives means to carry out the project

The *MVRMA* requires the Review Board's to consider the potential impacts from alternatives to a proposed development. Accordingly, the developer may present the most probable alternatives to the proposed development description and potential impacts stemming from their potential adoption, and suggested mitigations. Examples of alternatives that were either presented by Avalon during scoping, or alternative configurations that the public inquired about during scoping include:

- Avalon's suggested geothermal electric power plants in place of coal.
- Avalon's suggested wind generators to supplement power needs.
-

Other potential alternatives such as:

- Alternative tailings disposal sites or methods at Pine Point and Thor Lake
 - alternative mining methods and ore/concentrate processing
 - alternatives for discharge of water into any aquifers
 - use of alternative fuels for heat and electricity generation, such as oil, natural gas and hydro-electricity
- techniques
 - alternatives to barging
 - alternatives to proposed water treatment

3.7 Closure and Reclamation

Avalon will present its framework Closure and Reclamation Plan for the Thor Lake Rare Earth Element Project in the *Developer's Assessment Report*. The developer should consider existing guidance, such as Indian and Northern Affairs Canada's mine closure and reclamation policy and guidelines for the NWT when developing its reclamation plan for the Thor Lake Rare Earth Element Project (see <http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/MSR-eng.asp>). The developer is also advised to work with communities and other parties to determine clear closure objectives and link them to measurable closure criteria and indicators. The formation of a Closure and Reclamation working group composed of regulators and other groups will assist in the development of closure objectives and reclamation standards for the Closure and Reclamation Plan.

The temporal scope of the Closure and Reclamation Plan should focus on impacts to water, fish, wildlife and people during the closure and post-closure phases of the project. This discussion is not intended to duplicate the requirements of Section 3.3.6. Long-term project effects on caribou should specifically focus impact predictions in the context of the current serious decline in caribou populations, particularly the Bathurst herd. As well, Avalon must describe plans for reclaiming the barging area laydown and littoral habitat underneath the temporarily moored barges at both project sites. The developer will:

Both sites

1. Provide a framework for Avalon's *Closure and Reclamation Plan*, which will include:
 - a. identification of the overall reclamation objectives, standards and criteria the Closure and Reclamation Plan is designed to achieve and over what time period;
 - b. given the ostensibly long-term project life for the Thor Lake Rare Earth Element Project, a description of how climatic change was considered in the development of the Closure and Reclamation Plan in order to ensure long-term physical integrity of permanent structures; and
 - c. a conceptual program and schedule for any progressive reclamation envisioned.
2. In the *Conceptual Closure and Reclamation Plan*, discuss management and monitoring programs for any materials/locations (including the underground works) that may cause acid rock drainage or metals leaching. Include:
 - a. creating a sufficient barrier for the prevention of tailings and waste rock oxidation at closure;
 - b. other actions to prevent long-term tailings oxidation and metal leaching (under varying acidic conditions);
 - c. the likely rate of movement of water (including groundwater) through the tailings, mine rock management area and underground workings, associated uptake of acids, metals or any other contaminants into groundwater or surface waters, and monitoring location requirements and contingency plans for greater than expected rates of contaminant release;
 - d. a description of how any water may interact with paste backfill after mine closure, under what conditions that interaction may lead to a breakdown of paste backfill, and a discussion of related impacts to water and suggested mitigations;
 - e. the long-term physical integrity of any permanent features; and

- f. monitoring coverage required to track any other reasonably foreseeable post-closure contamination pathways.
3. At both sites, describe how closure and reclamation activities and monitoring will ensure long-term suitability of all fish-bearing waters potentially affected by the project for fish and fish habitat.
4. Describe how reclamation will manage ongoing hazards to wildlife at both the Thor Lake mine site and the Pine Point processing site, and how reclamation will affect wildlife movements.

4. Conclusion

The Review Board anticipates that the requirements described in this document will help Avalon produce a *Developer's Assessment Report* that clearly describes Avalon's predictions of impacts from the Thor Lake Rare Earth Element Project while providing sufficient basis for the Review Board and parties to analyze and evaluate those predictions.

Appendix A: Scope of Development

At a minimum the scope of the development includes but is not limited to:

Construction

Thor Lake

- Construction of the waste rock management area;
- Construction of any tailings pond and tailings management area, including any water management systems;
- Construction of the underground mine and associated support structures;
- Construction of a waste disposal facility;
- Construction of facilities for milling, initial separation and concentration of ore;
- Construction of power generation and heat recovery facilities;
- Construction of any water treatment facility that will treat water from the tailings pond and other sources;
- Construction of any sewage treatment facilities;
- Construction of drainage control structures, process pipelines and waste water pipelines from mine to surface, on surface at the mine site, run-off collection trenches and sedimentation pond;
- Construction of water management facilities, including the pump house and water intake, water discharge system (including seasonal water storage areas, all drainage ditches and discharge points), potable water supplies for camp and a sewage treatment plant;
- Construction of fuel storage facilities on-site;
- Construction of the permanent camp south of Thor Lake;
- Upgrades to the Thor Lake mine site-Great Slave Lake access road as well as construction of any new roads at the mine site;
- Expansion or any other modification to the existing airstrip;
- Development of borrow sources for aggregate production at the mine site or along the Thor Lake mine site-Great Slave Lake access road;
- Seasonal construction and demobilization of the barge-docking facility on the north shore of Great Slave Lake's Hearne Channel;
- Construction of the concentrate and supply storage/laydown area adjacent to barge docking facility.

Pine Point

- Construction of the hydrometallurgical plant;
- Construction of project-related buildings including garages, maintenance and administration;
- Construction of a waste disposal facility;
- Construction of power generation and heat recovery facilities;
- Construction of storage facilities for fuel, coal, sulphur, limestone and other reagents;
- Construction of any water treatment facility that will treat water from the tailings pond and other sources;
- Construction of any sewage treatment facilities;
- Construction and/or upgrade of the haul road from the hydrometallurgical facility to Great Slave Lake shore and any other new roads;
- Development of borrow sources for aggregate production at the mine site or along the facility-Great Slave Lake access road;
- Seasonal construction and demobilization of the barge-docking facility on the south shore of Great Slave Lake near the Pine Point site;
- Construction of the concentrate and supply storage/laydown area adjacent to barge docking facility near the Pine Point site;
- Construction of any water treatment facility that will treat water from the hydrometallurgical facility or tailings pond and other sources;
- Construction of drainage control structures, process pipelines and waste water pipelines from mine to surface, on surface at the mine site, run-off collection trenches and sedimentation pond;
- Construction of water management facilities, including the pump house and water intake, water discharge system (including seasonal water storage areas, all drainage ditches and discharge points), potable water supplies for camp and a sewage treatment plant; and
- Construction of any tailings management facilities, including any water management systems.

Operations - Mining and materials storage

Thor Lake

- Development of underground workings, including crosscut and drift development;
- Extraction and crushing of ore-bearing rock;
- Transport, storage and use of explosives;
- Transport, storage and management of fuel and reagents;
- Mine dewatering and deposit of mine water on surface;
- Transportation of materials, management of ore and tailings, the mine rock management area;
- Operation of tailings management facility, including waste management systems and paste backfill plant;
- Management of a waste disposal facility;
- Management of initial separation and concentration reject materials, ore and tailings stockpiles on surface, including construction of any associated foundations, buildings, and water treatment and management systems; and
- Operation of mining equipment, including vehicles and materials conveyance systems.

Pine Point

- Hydrometallurgical facility equipment operation, including vehicles and material conveyance systems;
- Transport, storage and use of fuel and all reagents, including sulphur, limestone and site-manufactured reagents such as sulphuric acid;
- Transport, storage and use of all Thor Lake-bound fuel, reagents and other materials;
- Transport, storage and use of coal;
- Transportation of materials, management of ore and tailings, tailings pond and tailings management facility, including waste management systems;
- Transport and storage of concentrate;
- Management of a waste disposal facility within the tailings management area.

Operations - Milling

Thor Lake

- Use of facilities for milling, initial separation and concentration of ore including:
 - Conventional concentrator with ball mills;
 - Initial flotation, secondary flotation of bulk rougher concentrate, bulk cleaner flotation and any other processing;
 - Extraction, transportation, consumption, recycling, treatment and discharge to the environment of mine water and process water;
 - Storage, handling, use and disposal of milling process additives and chemicals; and
 - Thickening, filtration and packaging of concentrate for transportation.

Pine Point

- Use of facilities for processing concentrate via any of the proposed refining techniques, as well as the regeneration of reagents;
- Storage, handling, use and disposal of milling process additives and chemicals;
- Use of facilities to create useable reagents such as sulphuric acid;
- Use of coal-burning or other heat-producing facility; and
- Extraction, transportation, consumption, recycling, treatment and discharge to the environment of mine water and process water.

Other on-site facilities and activities

Both sites

- Power generation and heat recovery facilities;
- Paste backfill facility;
- Water usage, management and treatment actions, including Avalon's proposed points of control
- Use of any water treatment plant;
- Use during mine operations of the pump house and water intake, water discharge system (including seasonal water storage areas, all drainage ditches and discharge points) and potable water supplies for camps;
- Use of fuel storage facilities on-site;
- Use of the exploration camp at Thor Lake and permanent camp south of Thor Lake;
- Sewage treatment plants;

- Service complex and mine equipment management building;
- Use of vehicles and all other emissions sources both the Thor Lake and Pine Point sites;
- Use of any water treatment facility that may treat water from the tailings pond and other sources;
- Use of drainage control structures, process pipelines and waste water pipelines from mine to surface, on surface at the mine site, run-off collection trenches and sedimentation pond;
- Use of roads at both sites;
- Use of waste incinerators.

Support/ancillary facilities and activities

Both sites

- Transportation activities by air that support the project's operation, including transportation of goods, fuel, contractors, and employees into and out of the mine;
- Use of the airstrip at the mine site;
- Transportation activities by road (including the project-site-Great Slave Lake access road) that support the project's operation, including transportation of goods, fuel, contractors, and employees into and out of the mine as well as the road transport of goods, fuel, contractors, employees and product between Pine Point and Hay River, as well as between Pine Point and Fort Resolution and Fort Smith;
- Transportation activities by water including the barging corridor between the Thor Lake Project and Pine Point barge loading sites for concentrate, goods, and fuel;
- Loading/unloading activities at the barge docking and transfer facilities as well as the transfer of concentrate, goods and fuel on and off the barges;
- Transportation activities by rail between the Hay River railhead through Woodland Caribou habitat to the NWT-Alberta border;
- Removal and disposal of wastes or other materials;
- Any sites for the alternative energy sources (wind, solar, geothermal, etc.) for either project site;
- Use of borrow sources for aggregate production at the Thor Lake mine site or along the access road; and
- Use of borrow sources for aggregate production at or near the Pine Point mine site.

Closure and reclamation

Both sites

- Removal or stabilization of all structures and equipment;
- Reclamation of tailings management facilities, as well as any and all other site water management facilities at both the Thor Lake and Pine Point sites;
- Decommissioning and reclamation of all waste management facilities;
- Reclamation of the waste rock management area;
- Reclamation of the access and haul roads at the Thor Lake mine site and Pine Point processing site, including the airstrip at the Thor Lake site;
- Reclamation of infrastructure foundations, piping, and all built structures at the mine site and Pine Point site;
- Reclamation of any stockpiles and materials storage locations;
- Re-vegetation of areas affected by mining, access road, Thor Lake airstrip or other support activities;
- Bulkhead installation and other capping of the underground works at the Thor Lake site; and
- Long-term mine water outflow monitoring and water management around the mine site.

Appendix B: Guidelines for monitoring and management programs

In the interest of a fair, efficient and effective environmental assessment that successfully meshes with integrated resource management in the Mackenzie Valley, the Review Board encourages the developer to review the following non-comprehensive list of documents while assessing potential impacts from the development, as well as in creating and presenting monitoring and mitigation programs for the project. The documents include but are not limited to:

Mackenzie Valley Environmental Impact Review Board

- Environmental Impact Assessment Guidelines (2004)
- Socio-Economic Impact Assessment Guidelines (2007)
- Guidelines for Incorporating Traditional Knowledge in Environmental Impact Assessment (2005)

Mackenzie Valley Land and Water Board

- Any relevant guidelines published by the Mackenzie Valley Land and Water Board

Natural Resources Canada

- Dam Safety Guidelines (Canadian Dam Association 2007)

Department of Fisheries and Oceans

- Protocols for Winter Water Withdrawal in the NWT (2005)

Indian and Northern Affairs Canada

- Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories (2009)
- Mine Site Reclamation Guidelines (2007)
- Mine Site Reclamation Policy for the Northwest Territories (2002)
- NWT Cumulative Impact Monitoring Program
- Guidelines for Spill Contingency Planning (2007)

Canadian Council of Ministers for the Environment (CCME)

- Canadian Environmental Quality Guidelines

Environment Canada

- Environment Canada's Technical Document on Batch Waste Incineration

Government of the Northwest Territories

- Guideline for Ambient Air Quality Standards in the Northwest Territories
- Government of the Northwest Territories Guideline for Dust Suppression.2004

Transport Canada

- Aerodrome Standards and Recommended Practices
- Flight Impact Management Plan