

# **Mineral Priority Areas of the Deh Cho Territory – Synoptic Level Results –**

**Prepared by:**

**Brian G. Eddy, MSc  
GSI – GeoSystems Integration  
Ottawa, Ontario K1S 2L2**

**Prepared for:**

**Deh Cho Land-Use Planning Committee  
P.O. Box 199  
Fort Providence, NT, X0E 0L0**

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# Summary and Recommendations for Use of MPA Map

## Summary

- The Mineral Priority Areas (MPA) Map of the Deh Cho territory (Attachment A) provides synoptic level results aimed to better assist the Deh Cho Land-Use Planning Committee in making short to near-term decisions regarding the potential for mineral development along with other land interests.

**It is important to note that the concept of MPA Map is different than that of a Mineral Potential Map (MPM) and may also be different from a Mineral Resource Assessment (MRA). The rankings of the Mineral Priority Areas are 'priorities', not 'potentials'. They are assigned priorities based on an understanding of the potential for the various deposit types considered, as well as synoptic level economic factors.**

- MPAs are derived in part from mineral potential mapping, but aim to highlight priorities, as 'next steps', for different sub-areas within the region of interest for which planning or further work may be required or recommended. The MPAs are identified as eight (8) major regions, derived geographically by aggregating Resource Assessment Domains (RADs) that have a similar range of synoptic priority rankings. The method used to assign these rankings is provided in Section 3.
- All areas ranked as having moderate, high or very high potential, comprise less than 22 % of the study area (using the MPA polygons as a basis for area calculations). It is estimated that the actual high potential areas can be further delineated to less than 5 % of the study area (see recommendations below). Actual development usually requires less than 1% of any broad region.
- A significant portion of the study area received a "Moderate - Uncertain", or "Low - Uncertain" synoptic priority ranking (MPA's F, G and H). These areas comprise almost 80% of the study area. The Moderate and Low portions of these rankings applies only to the deposit types that were included in last years' study, but does not apply to the potential for Diamonds. The potential for Diamonds is 'Uncertain' throughout the entire Deh Cho territory.

## Recommendations For Land-Use Planning Consideration

- Areas that are most likely to offer potential for mineral development are in the western-most portion of the territory (MPAs A, C and D). It is recommended that higher priority be given to these areas for both current land-use planning considerations, and where necessary more detailed mineral potential analysis/mineral resource assessment.
- Locations in the eastern-most portion of the study area, denoted in MPA 'B', are significant occurrences and will require further study. It is recommended that a geological favourability component be completed for this area to delineate the geological controls and mineral potential patterns of this region.
- Areas E and F offer moderate to high potential relative to other areas, however the geological favourability and known mineral deposits and occurrences is relatively lower. These areas can be treated as having a somewhat lessor priority relative to areas A, B, C and D. However, this current priority ranking does not preclude the possibility of uncovering higher mineral potential values under a more detailed analysis.

- The current synoptic level assessment for the potential for Diamonds is 'Uncertain' throughout the entire study area. Although it is not possible to represent diamond potential in map form at this synoptic scale, the highly localized geological controls known to Diamond occurrences, as well as uncertainties about these controls, precludes any possible representation of diamond potential as part of this MPA map at this time. It is recommended that special land considerations be given to Diamond potential throughout the Deh Cho territory. Considering the high risk/high return nature of this commodity, and the high degree of uncertainty in knowing with any foresight where diamonds may be found, as well as the general likelihood for very local mining operations when they are found, the DCLUPC may wish to make special considerations in its planning to allow various types of diamond-related activity in areas that would not otherwise be permitted for other deposit types (e.g. in cases where compromises are needed be made with competing land interests). The DCLUPC may want to conduct further consultations with government and industry geologists on options for inclusion, or implications for diamond exploration with other land interests.

## Recommendations for Further Mineral Potential Analysis / Resource Assessment

- The results of this analysis illustrate areas A, C and D as having significantly high geological favourability (60-90% of these areas shows high-very high geological favourability based on the 1:1M scale geological map that was used). In reality, the actual potential is likely confined to more local areas within these zones, and can be further delineated through a more detailed analysis using 1:250,000 geological maps. The same is true for MPAs E and F, though they are not rated as high. In all cases, further mineral potential mapping using 1:250,000 geology for this region should help delineate the higher potential areas significantly over the current synoptic level.
- In the event that there are competing land interests in some areas, it is recommended that more detailed MRA work be conducted for the respective deposit types and/or commodities at a scale appropriate for reconciling the competing areas. As noted above, a more detailed MRA will help delineate the mineral potential to more confined areas, which may alleviate at least some of the apparent conflicts.

## Comments from Expert Geologists

### a. Jamie Lariviere, C.S. Lord Northern Geoscience Centre

Jamie felt that the MPA map did not add anything new to the maps provided in last years' report. Additionally, in the preliminary MPA map, some areas were given a synoptic ranking as 'Low' or 'Low-Moderate', and Jamie felt that this compromised the message given in last years results that "nowhere within the Deh Cho territory can it be said that there is low or no mineral potential". Brian agreed that this was in fact misleading. The final MPA map includes a qualifier specifically on area F, which is rated as 'Moderate – Uncertain', and areas G and H which are regarded as 'Low - Uncertain'. In these cases, the 'Low' ranking applies to the deposit types considered in this study 'except Diamonds'. Diamond potential remains uncertain throughout the Deh Cho territory. Jamie's concerns are reflected in the above summary and recommendations.

### b. Malcolm Robb, C.S. Lord Northern Geoscience Centre

Malcolm had no major objections to the MPA map considering Jamie's main concerns were addressed. He agrees with how Diamond potential is considered as uncertain throughout the

region. Malcolm would like to emphasize the unresolved issue regarding the very high potential for MVT Pb-Zn in the Pine Point area, and this region should be given high priority. He sees this MPA as a stepping stone toward further discussion around land use planning, and mineral development planning options, as these results will need to be overlaid against infrastructure and other land interests to see where competing land interests occur.

c. Charlie Jefferson, Mineral Resources Division, Geological Survey of Canada

As principal author of the Nahanni MERA, which occupies the southwest portion of the current Deh Cho study area, Charlie's main concern was how the boundaries for the Resource Assessment Domains (RADs) were determined. This is an important issue since all of the rankings and evaluations are presented within the RAD framework, and that the MPA areas (polygons) are also derived from these RADs. Charlie was informed that the RADs used in last years study, and this MPA map were defined differently than those of his study, or as might be with more local detailed MRAs. In other MRAs, when time and resources permit, it is preferable to delineate RADs on the basis of distinctive geological or metallogenic domains. This was not possible within the constraints of this study (it would take several months to do so for the entire Deh Cho territory). It is also partly incompatible with the Fuzzy Logic approach, in which discreet geological domains do not matter to the MPM processing. The RADs defined in the MPA map, and in last years MPM were delineated 'after' the mineral potential analysis, and were used to as a reporting framework for the ratings values. Charlie is in agreement with this distinction and clarification.

Charlie also pointed out several issues that should be considered. One concern is the possible mis-identification or classification of MVT Pb-Zn with 'Manto' type deposits in the western part of the study area. Although this is not a significant issue for the current synoptic level of representation because the combination of geological favourability for the Skarn deposit types and the MVT Pb-Zn would also represent the potential for Manto at this scale. A more detailed MRA would need to provide better distinctions among these three types. Additional information on the Skarn-MVT-Manto distinction is discussed below in the Economic Factors section.

Charlie would also have preferred to see the analysis include CMDT types 22 (Kiruna/Olympic Dam-type Fe, Cu, U, Au, and Ag) and 23 (Peralkaline rock-associated rare metals). As with Manto-type deposits, their relative potential is also represented by the Skarn-MVT potential. A more detailed analysis (1:250,000 or higher) would need to incorporate their distinction.

Charlie is also of the opinion that Diamond potential 'can' be represented. Data is available from various sources upon which some opinions for Diamond potential can be made. The type of data he is referring to would require significant effort to synthesize and evaluate (est. 6-12 mos. minimum), and would likely 'not' cover the entire Deh Cho territory. Although further discussion around this issue is needed, it does not change the current synoptic level ranking as considering Diamond potential as 'uncertain' throughout the Deh Cho territory.

## ECONOMIC FACTORS

The following is a synopsis of the economic factors considered by the geologists who participated in the ranking of the RADs, captured via a teleconference call on April 2, 2004. As discussed below in the methodology, it is important to note that the initial weightings assigned by each geologist were done independently (i.e. the geologists did not consult with each other when they assigned their individual scores). When assigning their respective scores, each geologist applied their knowledge and economic criteria in different ways. Malcolm Robb and Jamie Lariviere did their ratings on a case-by-case basis for each RAD. Charlie Jefferson created a formula that multiplied each mineral potential rating for each deposit type by a consistent weighting factor for development potential according to the deposit type. The end results were remarkably similar because, as summarized below, very similar fundamental criteria influenced their individual decisions.

This section provides details on the economic factors that influenced the scores assigned to the RADs by each geologist individually, as well as their consensus on the relative importance to the overall potential of the Deh Cho region. They are presented in two portions: 1) general factors that apply to the study area as a whole, and 2) specific factors that apply to individual deposit types.

### General Factors:

- If done on geographic basis, the scores would have down-rated low-value commodities in more remote areas. Relative to other mineral producing regions across Canada, most of the Deh Cho territory is considered remote. Numerous geographical factors will influence whether or not a given deposit type will be economically feasible, most importantly, the proximity to existing transportation infrastructure. Other factors include physiography and drainage, environmental sensitivities to specific mining operations or specific by-products, and the potential for more than one deposit enhancing critical mass.
- Considering these other factors will require modelling the potential at another level (taking these and other factors into account). Although transportation infrastructure is probably most critical, it represents only one factor of many that would need to be considered. For expediency, and to keep it simple, each RAD was thus treated independent of its geographical location in this analysis.
- Malcolm Robb ranked RADs higher if they had potential contain fairly large deposits. This is based on their likelihood of yielding large scale deposits in the Deh Cho territory, given his knowledge of existing deposits around the world. Larger scale deposits are more likely for some deposit types (e.g. SEDEX, Skarn) than others (e.g. Vein Cu, Pegmatites), and this is one factor that was taken into account in his scores. Jamie Lariviere and Charlie Jefferson agreed that these general considerations also influenced their rankings.
- Jamie Lariviere tended to consider MVT and Pb-Zn-Ag Skarn together in terms of their economic importance in ranking (not the genetic link, geological setting) given the similarities of these deposit types in the geological setting of the Deh Cho territory with those in other areas. In some cases what were once thought of as MVT deposits turned out to be Skarn-type deposits, and the converse is also a possibility. We discussed the issue that the Skarn-Manto family of deposits may be mis-identified as MVT deposits, but in practical terms their development potential is much greater because of the associated silver and other precious metal values, and because of their coarser grain size and ease of processing. Regardless of interpretation, a base metal deposit with high precious metal values has higher development potential no matter how it is classified.

- A number of similarities in the economic criteria correspond with other assumptions and criteria applied in parallel by Brian Eddy when remodeling the geological favourability component of the MPA map. The geological controls used in modelling the potential for Skarn and MVT deposit types, taken together (e.g. location of proximity to igneous intrusions, in combination with carbonate rocks) provides adequate representation for the potential both of these deposit types, as well as the possibility for Manto-type deposits. The precious metal content of known mineral occurrences is also a key factor.
- The expert geologists placed less emphasis on Stratiform Fe, Sedimentary Cu and Vein Cu, whereas an increased emphasis was placed on SEDEX, MVT Pb-Zn, and Skarn types deposits. Pegmatite deposits remained relatively neutral. This is also reflected in modelling the geological favourability component of the MPA map, whereby the geological controls that pertain to SEDEX, MVT Pb-Zn, Skarn and Pegmatites are emphasized over these other types.

## Specific Factors

### DT 3.0 Stratiform Fe

Among the deposit types considered, relatively little emphasis was given to Stratiform Fe primarily because of the difficulty in competing economically with existing deposits around the world (e.g. Australia). These are usually low-dollar, bulk commodities that require a significantly large operation close to tidewater to be both competitive and economically feasible.

### DT 6.1 SEDEX

In contrast to the de-emphasis given to Stratiform Fe, all three reviewers gave a higher emphasis to SEDEX deposit potential. These deposits tend to be large enough and with sufficient dollar value per tonne to justify the development of infrastructure. An encouraging number of existing very large high grade SEDEX deposits around the world have favourable development histories. On the other hand, SEDEX deposits tend to be fine grained with complex metallurgy required to separate the economic commodities. These are thus downgraded somewhat relative to Skarn and Manto deposits that may contain the same commodities, but have coarse grained, easily separated mineralogy.

### DT 8.3 Sediment-hosted Cu

Sediment-hosted Cu deposits were only slightly de-emphasized relative to the other deposit types. They tend to be geographically extensive (large in an aerial sense), but relatively thin and low grade. The economic feasibility of such a deposit in the Deh Cho territory would be regarded as less attractive than other deposit types to develop because of the large volume of rock that would need to be displaced, and would be more likely to conflict with other land interests and environmental sensitivities.

### DT 10.0 MVT Pb-Zn

If MVT deposits could be considered individually, it would be important to consider their relatively smaller size and dispersion patterns, characteristic in other known regions. Economic MVT deposits usually consist of numerous genetically related bodies of mineralization. We also know that significant MVT deposits remain undeveloped at Pine Point because of technological problems such as dewatering during mining. Under these normative scenarios, MVT deposits would tend to be de-emphasized relative to the other deposit types in this analysis. However,

because of the potential ambiguity concerning their geological controls and other metallogenic properties (especially with respect to Skarn and Manto type deposits), their emphasis is maintained in this study as being similar to SEDEX.

### DT 17.0 Vein Cu

Vein Cu deposits tend to be high grade but too small to develop on their own. Although geological criteria in the Deh Cho region suggest prospectivity, there is not enough information to warrant significant emphasis relative to the other deposit types considered. If there was an existing Vein Cu deposit known within the region, or another existing mine with Vein Cu potential near it, then this might elevate the relative importance of Vein Cu in that locality. Because of the lack of known Vein Cu deposits, their economic development potential is considered low to moderate throughout the Deh Cho territory, thereby not influencing the contrasts in overall mineral potential.

### DT 20.1/20.3/20.5 Skarn Pb-Zn/Au/W

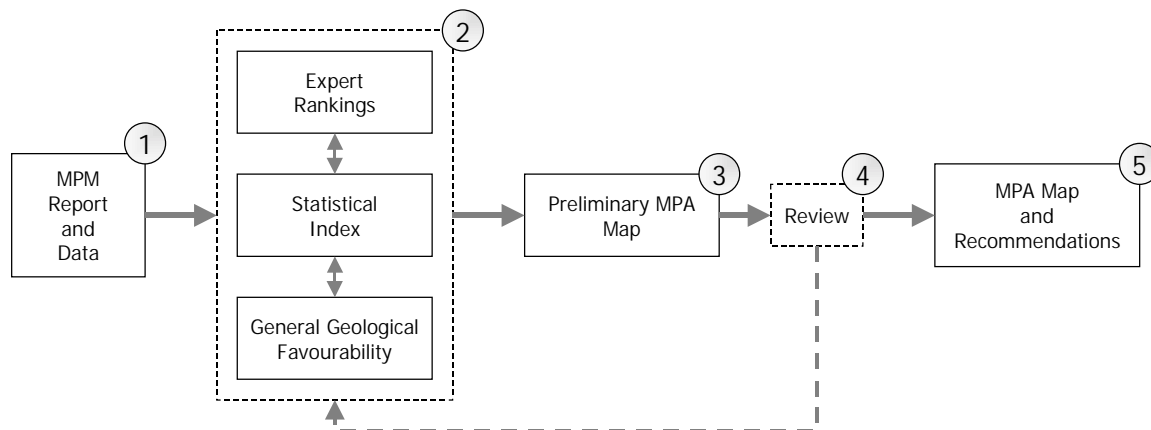
Skarn-Manto deposits of combined base and precious metals represent the most significant mineral development potential in the region. The Prairie Creek Ag-Pb-Zn deposit represents an actual example that is now undergoing development. Although they tend to be under-explored, there has been an increase in understanding of these deposit types on the international scene, primarily because they represent generally large, compact, and high-grade targets. Their metallurgical qualities are more attractive to the industry, which makes them easier to mine, and therefore easier for companies to raise investment for their exploration. These factors combined with the favourable geological controls and known deposits and occurrences, makes Skarn-Manto deposits the most likely type to see development in the Deh Cho region.

### DT 21.0 Pegmatites

Pegmatite deposits are valuable for producing rare types of elements such as Lithium (Li), Tantalum (Ta), other Rare Earth Elements (REE's) and gemstones. The former three require a special type of deposit that matches a specific global market. The latter are generally very small individually "harvested" targets more suitable for a cottage industry. Currently, the rare metal markets are very difficult to predict, primarily because a single deposit may meet the entire needs of the world. The risk is very high, as is the opportunity because of their varied use and technological application (i.e. REE's are finding increasing use in high-tech instruments and medical technologies). However risky, they cannot be ruled-out for the Deh Cho region. The geological controls for such deposits are similar to Skarns, and could also possibly be considered a spin-off production from an existing Skarn deposit. Gemstones might be attractive to a cottage industry, but would be difficult to market and to control theft.

## Methodology

The method used to prepare the MPA map is summarized as five steps.



### Step 1 – Evaluation of Requirement

The results of the previous report indicate that the mineral potential throughout the Deh Cho territory is consistently moderate to high, considering nine major deposit types. One of the main conclusions was that nowhere within the Deh Cho territory can it be said that there is little or no potential. While this conclusion remains true, it presented a problem for the DCLUPC in determining how to make better use of these results for near-term planning purposes. One of the main factors to consider was the variation in mineral potential when the cumulative mineral potential was differentiated according to deposit type. Not all deposit types show equal potential, and not all deposit types would likely receive equal attention by industry. So the question was how to present the results in such a way that the DCLUPC can more clearly identify where the high priority areas are located in terms of mineral development, and what actions might be taken with respect to these areas.

As stated above, the concept of a 'Mineral Priority Areas' (MPA) map is different than a mineral potential map (MPM) or mineral resource assessment (MRA). While it uses the results of the previous study, it extends the information to a level whereby actual recommendations are made based on the results. Whereas the mineral potential remains moderate to high throughout the study area when considering all deposit types, the priorities that need to be or should be taken with regard to planning purposes or more detailed resource assessment can be differentiated based on an analysis of those results using expert opinion. The analytical method devised in Step 2 took these factors into account.

### Step 2 – Analysis

There are three sub-components to the analysis: 1) a geological favourability component, 2) a statistical index based on the RAD ratings values, and 3) an expert evaluation of synoptic priority. (See Attachments A through D for more detailed information)

## Geological Favourability

For mapping the geological favourability component, deposit types that are relatively 'equi-possible' throughout the study region are removed from the analysis. This applies primarily to Vein Cu and Stratiform Fe, both of which whose potential is considered relatively uniform throughout the region. The removal of these deposit types from the analysis (of the geological favourability component only) leaves a residual of geological favourability that applies to deposit types that are more locally constrained, thereby highlighting areas that are 'more probable' than what was conveyed through the original Cumulative Mineral Potential (CMP) map. What this aims to achieve is to highlight the geological patterns of the higher priority areas that can be used to augment the priority values assigned to the MPAs. This approach is reinforced by considerations given to the economic factors associated with these deposit types. The result is the geological favourability component of the MPA map, also takes into account the economic factors.

The fuzzy logic method was used to prepare the geological favourability component by enhancing the geological features associated with deposit types 6.1 (SEDEX), 8.3 (Sediment-hosted Cu), 10 (MVT Pb-Zn), 20.1/20.3/20.5 (Skarn Pb-Zn,Au,W), and 21 (Pegmatites), and de-emphasizing the geological features associated with CMD 3 (Stratiform Fe) and 17 (Vein Cu). All of the former criteria apply to more locally constrained geological features (specific rock types or structural elements), whereas the geological criteria of latter two deposit types are less locally constrained. By de-emphasizing the latter two, the geological features that contrast the higher priority areas are better revealed.

Note that the large grey areas in the MPA map are rated as 'Low' in geological favourability as an overall ranking for all deposit types, but this does not include Diamond potential. Hence the general favourability rating for this fourth category is 'Low or Uncertain' (depending upon whether it pertains to Diamonds or the other deposit types).

The legend for this map intentionally shows an overlapping gradation of favourability (from Low, to Moderate, to High to Very-High). This is a more appropriate means to convey the gradational geological favourability as an aggregate of all deposit types (excluding diamonds).

## Statistically Derived Rankings

The Cumulative Mineral Potential (CMP) map from the previous study showed 'Sum of Ratings' values for each RAD. Although the sum of ratings helped contrast the relative cumulative potential for all deposit types, they proved to be difficult to interpret for a comparative evaluation. The approach used here was to devise a type of statistical index that would better illustrate one view of what a synoptic priority would look like from using the existing RAD rating values. The following considerations informed this approach:

- Each RAD contains a range of ratings values corresponding to the deposit types considered.
- Some RADs show higher ratings values for two or more deposit types, which logically, would suggest the overall priority for such RADs would be higher than for those with only 1 or 2 deposit types rated highly, and significantly higher than RADs for which there are low-moderate ratings values.

- A 'Mineral Priority Index' (MPI) derived from the base statistics of the RAD ratings values would attempt to capture and rank the RADs according to the overall potential.
- Note that in this approach, we are only looking at the mineral potential from strictly a geological perspective and are not considering economic, logistical, environmental or other factors.

Calculation of the MPI:

There are 5 basic statistics calculated from the initial ratings values – Sum, Min, Max, Average, and SD (Std. Deviation) (See Attachment C). A sixth statistic was calculated to capture the 'relative' variation in the range of values for each RAD. This is listed as the Coefficient of Variation (CV). It is a simple calculation of the SD divided by the Average, so it is an expression of the SD as a percent of the average. The result is a value between 0-1, which can represent a percent of variability relative to the mean (average). Low CV values (e.g. 0.25) represent a low relative variability, and higher CV values (e.g. 0.75) represent higher variability. For example, if the average rating for one RAD was 4, but it had a CV of .75, it would contain a wider range of values (say many 1's, and one '5'). Another RAD with an average of 4, and a CV of 0.25 might contain fewer low scores, and more higher scores (say a few 3's, and maybe two 5's). For this application, where we are dealing with nominal values in the range of 1-7, and a limited number of inputs (9 deposit types), this is a reasonable statistical approach.

The IMPI (initial Mineral Potential Index) is calculated as the following:

$$iMPI = \frac{\text{Sum}}{\text{CV}} \quad (\text{Eq. 1})$$

As with many 'indices', it is deterministic in a way that reflects a certain way of valuing or ranking. In this case, what we are saying is that the greater the overall rankings (expressed in the Sum of Ratings), and the lower the relative variation (expressed as the CV), the higher the priority. The iMPI is reclassified according to the following table:

<u>IMPI Value</u>	<u>Priority Ranking</u>
85-100	Very High
70-85	High-Very High
55-70	High
40-55	Moderate to High
25-40	Moderate
10-25	Low-Moderate
1-10	Low
0	Not Assessed

Expert Assigned Rankings

The third component involved collecting additional synoptic priority values using expert opinion from three geologists familiar with the mineral potential of the study area. In this approach, each expert was asked to assign an overall ranking for each RAD, based solely on the RAD values. The individual rankings are provided in Attachment C. Each geologist was asked to assign a value in the range of 0-7 for each RAD, what they would consider to be a fair overall representative rating. The economic factors that informed their decisions are provided below.

The results of this exercise turned out to be very interesting. Whereas each geologist used somewhat different approaches, with different assumptions and criteria, their comparative results were very strongly correlated (within 5 – 10% overall) (See Attachments C and D). Because of this strong correlation, it is appropriate to take the average of the three values as a consensus among the expert opinion (EAvg in RAD Data Table, Attachment C).

### **Step 3 – Preparation of Preliminary MPA Map**

This step involved the preparation of a draft MPA Map for review by the participating geologists. This map attempted to capture the consensus among the three experts, as well as the geological favourability and the statistical index approach. It is worth noting that there is a very strong correlation among the geological favourability component, the statistical index (iMPI) and the average of expert opinion (EAvg). These correlations can be seen in both map form and graphically in Attachment D.

As an aggregate representation of results, the RADs were further delineated into eight MPAs within the Deh Cho region (A-H), that contrast the major 'Priority' areas and their associated Synoptic Priority Rankings capture the three components used in the analysis.

### **Step 4 – Review**

A draft MPA Map, as well as accompanying data, visualizations, and explanation of processing was sent out for review by the three expert geologists for comment. The result of this process is captured in the above summary. Issues and concerns raised by this feedback resulted in several changes to the initial draft MPA Map.

### **Step 5 – MPA Map and Recommendations**

The final MPA map was prepared that captures the results of this phase of study. Recommendations were formulated from the feedback received and from further examination of the overall synoptic priority rankings. The recommendations presented above aim to provide the DCLUPC with considerations that can be taken in both current and near-term land-use planning, as well as highlight areas that will or might require more detailed mineral resource assessment.