CIM Leading Practice Guidelines for Mineral Processing

Prepared by the
CIM Mineral Resource and Mineral Reserve Committee
Adopted by CIM Council November 25, 2022

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1. Introduction

These Leading Practice Guidelines for Mineral Processing (LPGMP) were prepared by the Sub-Committee on Leading Practice Guidelines for Mineral Processing. The Sub-Committee reports to the Executive Committee of the Canadian Mineral Processors (CMP) which is a Technical Society of the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM) and incorporates those members of the CIM who are concerned with the processing of mineral deposits. The LPGMP covers the involvement of mineral processing professionals, referred to as Practitioners in this document, in providing inputs to the estimation of Mineral Resources and Mineral Reserves and providing technical content for internal reports as well as public reports on mineral projects as required under National Instrument 43-101 *Standards of Disclosure for Mineral Projects* (NI 43-101). The LPGMP supplement the CIM Exploration Practice Guidelines (2018) and the CIM Estimation of Mineral Resources and Mineral Reserves Practice Guidelines (2019) which are referenced in Companion Policy 43-101CP to NI 43-101 and recognized internationally.

The LPGMP consist of 3 sections:

- Principles of Process Support in Mineral Resources and Mineral Reserves Estimation;
- Appendix A – Use of Supporting Studies in Process Evaluation and Assessment for NI 43-101 Documentation;
- Appendix B – Glossary of Terms Relevant to the LPGMP.

The LPGMP deal primarily with the description of leading practice as it applies to the mineral processing and extraction of base metals, precious metals, and other mineral products by the application of mineral processing technology. Other commodities may be considered with future updates of these guidelines. It is expected that this is a 'living' document and that these guidelines will develop in the future to address the requirements of the mining industry, investing public, and mining professionals involved. Clarifications and changes to these guidelines will be done under the guidance of the Executive Committee of the CMP.

2. Principles of Process Support in Mineral Resource and Mineral Reserve Estimation

2.1. Principles of Process Support Work

2.1.1. Competence

The key competencies to be possessed by the Practitioner involved in determining a process for a particular mineral deposit are:

- level of education in a field of engineering related to the concentration or extraction of minerals and/or metals;
- general level of experience in the processing of ores;
- prior experience in the concentration or recovery of the mineral or metal, or similar or analogous minerals and metals, being investigated;
- ability to assess the representativity of the samples selected for metallurgical testing;
- ability to assess the scope and quality of the metallurgical work under his or her supervision or that of others being performed to establish the unit operations for use in the extraction of the valuable mineral or metal;
- familiarity with the appropriate unit operations used for the extraction of the valuable mineral or metal;

- familiarity with management and minimization of potential environmental impacts from processing the material mined from the mineral deposit;
- familiarity with the commodity (or commodities) and the impact of deleterious elements;
- familiarity with the economics of that segment of the industry;
- experience with the metallurgy associated with the style of mineralization and basic mineralogy being considered;
- knowledge and understanding of the Practitioner's role in providing inputs to Technical Reports prepared under NI 43-101 and any other disclosure of scientific or technical information considered material to the issuer; this includes familiarity with NI 43-101 itself, and with the various CIM Guidelines.

These competencies are critical in determining that the right individual(s) is (are) providing the metallurgical inputs for Mineral Resource and Mineral Reserve estimation of the deposit being examined. As a general guideline, a person being called upon to act as Practitioner should be clearly satisfied in their own mind that they could face their peers and demonstrate competence in the commodity, metallurgical characterization, processing methods and particulars of the situation under consideration. The Practitioner responsible for determining the process should understand the significance of each supporting discipline's contribution to the reliability of the process design and assessment of economic viability. While supervising Practitioners do not need to be experts in all aspects of the work they supervise, they should be sufficiently knowledgeable about the information for which they are accepting responsibility. They should perform a level of due diligence in those areas of work to an objective level of reasonableness that their peers would accept.

As the confidence level increases, there will be a rising need for input from a Practitioner to evaluate new data leading to increasing the level of confidence in the Mineral Resource or Mineral Reserve category being estimated. Depending on the type of mineral deposit, input from a Practitioner should be obtained even at early stages of work on the deposit in order to demonstrate the reasonable prospects requirements of mineral resources.

2.1.2. Increasing the Level of Process Confidence

The role of the Practitioner is to establish the process response of the mineralization, specifically addressing its variability. Equally important is to establish the recovery of a saleable product(s) at a given economic production cost at a level of accuracy appropriate to support the determination of the cut-off grade of the mineral resource. The process information is one of the factors used to support the confidence categories of Mineral Resource or Mineral Reserve being estimated for the mineral project. The continuity and variability of recovery and production of saleable product(s) is as critical as the geological and geochemical grade continuity which is assessed using drilling and other exploration techniques.

As the confidence level of the Mineral Resource increases with more data gathered by geological techniques including drilling and assaying, the quality of the supporting process information should also increase. This information is developed through the following:

- logging and domaining of the deposit according to geometallurgical parameters;
- testing of samples for recovery, product(s) quality, and physical characteristics;
- interpretation of test work to derive process and engineering parameters;
- modelling of test work information to substantiate design decisions;
- definition of the process approach through flowsheets;

- analysis of storage and/or discharge of waste products (e.g. tailings and effluents);
- design engineering of facilities considering local conditions;
- capital cost estimating;
- operating cost estimating.

Increasing the confidence categories of the Mineral Resources and Mineral Reserves may involve increasing the quality of the information through the performance of studies and engineering work to support the key assumptions in the type of estimate being made.

The purpose of this LPGMP is to assist the process engineer acting as the Practitioner in considering all the factors that determine the continuity of metallurgical recovery, predicted process throughput, and final product(s) quality for the chosen process approach applicable specifically to the deposit being examined. Rather than providing a prescriptive checklist, it is expected that a Practitioner will use his or her judgment in determining the level of work required to support the Mineral Resource or Mineral Reserve classification in question. As deposits increase in size, decrease in grade, and increase in complexity, the Practitioner ensures that the appropriate amount of effort has been used in defining the process response of the material at the level of variability considered in the Mineral Resource or Mineral Reserve Estimates.

2.1.3. Supporting the Definition of the Process

The establishment of the conceptual treatment process for any deposit should include:

- the identification of the mineral beneficiation and hydrometallurgical method(s) that would allow the production of a saleable product(s), or
- the identification of a metal or mineral extraction method allowing the production of a bullion or finished metal product (e.g., the production of cathode copper from a heap leach operation) or a mineral product (e.g., the production of a pentlandite flotation concentrate for nickel recovery);
- the types and levels of contaminants that may attract penalties from downstream processors or reduce/negate the economic value of the product(s);
- the determination if multiple products can potentially be produced from polymetallic deposits (e.g., copper, molybdenum and gold from a primarily copper deposit, nickel and Platinum Group Metals (PGMs) from a primarily nickel deposit);
- characterization of the solid tailings being produced for disposal and/or mine backfilling;
- characterization of the chemistry of waste solutions resulting from the process and requiring discharge.

For polymetallic deposits, if the Practitioner is considering the use of metal equivalents, the calculation formula used should be documented and at a minimum the formula should include:

- individual grades for all metals which have a reasonable potential to be recovered and sold;
- assumed commodity prices for all metals;
- assumed metallurgical recoveries for all metals (based on metallurgical test work, detailed mineralogy, similar deposits, etc.).

The use of metal equivalents is not considered appropriate if metallurgical recovery information is not available or is not able to be estimated with reasonable confidence.

The process should incorporate a logical chain of unit operations necessary to produce the saleable product(s) and prepare the solid tailings and any solution effluents for suitable disposal or, if required, release to the environment. Tailings may be used for mine backfill. The level of definition will vary with the size, complexity, and stage of development of the Mineral Resource and Mineral Reserve being examined. The level of definition should be appropriate to the confidence categories of Mineral Resources or Mineral Reserves being supported and the current stage of project development. This level of definition is supported by the work as described in Appendix A. This appendix provides an outline of the key parameters that should be established by testwork to evaluate the level of technical risk and costs associated with the selected process method.

At the stage of an Inferred Mineral Resource, it may be too early in the project development to engage a Practitioner specifically for process evaluation. However, the Practitioner preparing the Mineral Resource estimate should seek the advice of a mineral processing specialist even at these initial stages to provide assurance that the style of mineralization can reasonably be expected to allow economic recovery of a saleable product, unless they are clearly satisfied in their own mind that they could face experienced mineral processing experts and demonstrate competency in fatal flaw assessment at this initial stage. As the deposit evaluation progresses and the level of confidence in the Mineral Resource categories increase to Indicated and Measured, a Practitioner qualified in process development is recommended to properly develop the process information necessary to support the Mineral Resource and Reserve estimate.

2.1.4. Sample Selection

The most important concept behind sample selection and collection is that it should be similar to the role played by drilling density in establishing geological and grade continuity. The number of samples collected from a conceptual volume of mineralization to be processed, and their use in the supporting testwork confirming the classification of the mineral resources, should increase at a level appropriate to the Mineral Resource or Mineral Reserve classification category being supported.

The criteria for sample description and representativity include:

- spatial distribution;
- rock type distribution (lithology, alteration, geotechnical characteristics);
- mining phase or mineralization production schedule;
- grade distribution of all economic mineral species, considering credits and penalties;
- mineralogical domains.

Sample selection should consider:

- the stage of development of the project and the confidence level of the Mineral Resource or Mineral Reserve categories being supported;
- the geological complexity of the project;
- the existence of different metallurgical characteristics;
- evaluation of potential difficulties in material handling and flow characteristics, for example sticky and/or bridging material;
- the complexity of the process route;
- the size of the samples appropriate to carry out the testwork;
- the availability of samples from exploration work that could be reasonably obtained;
- the physical size of sample material required by various test procedures, e.g., the sample

dimensions needed for certain comminution or coarse ore separation tests;
- samples such that a range of material head grades can be tested to generate a correlation between process feed grade, recovery, and processing costs.

The selection of samples should be from within the area of the Mineral Resource and Mineral Reserve estimate, and should represent all the major geological, mineralogical, and metallurgical domains. The extent of sampling is dependent on the expected confidence level of the Mineral Resource and Mineral Reserve estimate but should have a spatial density and range appropriate to the size and complexity of the deposit. Samples should not only include those areas of mineralization expected as being of the average grade within the deposit, but should include material approaching cut-off grade as well as higher grade areas of the deposit. In addition, the impact of mineralogically problematic material and/or gangue minerals resulting from dilution of mineralization should be considered in the selection of samples. If applicable, the impact of eventual dilution of mineralization from tailings-derived backfill from underground mining of secondary stopes should also be considered. The sample suite should allow determination of the relationship between process plant feed grade and product recovery and associated costs.

The sampling protocol used and the results of the sampling for metallurgical purposes should be verified by the Practitioner. The Practitioner should establish with the other Practitioner's (geology, mining, etc.) how representative the metallurgical samples are of the expected mill feed. Selection of the samples should be appropriate for the intended testing purpose and consider the mining sequence of the deposit. Any potential biases within the samples that could affect metallurgical test work should be identified and methods for reducing these biases should be undertaken. To reduce project risk, the samples selected should emphasize those parts of the deposit critical to the project economics.

The potential effect of size distribution, storage time, conditions, and transportation on the quality of the metallurgical samples should be considered when appraising whether the samples are appropriate for process test work.

The quality control of the sampling process is an activity which the Practitioner (or their delegate) should audit to ensure that samples are being properly controlled (including during the shipment and preparation phases) and processed.

2.1.5. Testing of Samples

Testwork is the use of industry-accepted scientific procedures to determine the preparation and separation/extraction characteristics of the mineralization of economic interest within the deposit. It is essential that testing represent a balanced approach to the majority of the deposit and not concentrate work on only a small portion of the deposit. The goal of the testwork is to establish the continuity and variability of mineral or metal recovery, together with the ability to safely and economically produce a saleable product(s) and to characterize the product(s), the tailings, and effluent solutions to be stored or disposed, as required.

The number and size of samples tested, and the confidence level of parameter definition, vary with the complexity of the mineralization, the complexity of the expected process route, and the expected confidence categories of Mineral Resources and Mineral Reserves to be determined. The nature and style of both mineralization and gangue material should be considered to determine their impact on process and recovery.

These influences include but are not limited to:

- mineral species;
- mineral compositions;
- contaminants of high potential risk to human health and/or the environment;
- grain size and morphology;
- grain texture;
- mineral associations;
- assay levels of elements of interest, both valuable and deleterious.

The level of detail in the investigation should increase as the project advances through the various stages of development.

During the early stages of mineral project, evaluation conceptual process development may be based on similar deposits. The Practitioner should judge whether it is appropriate to use broad composite or point samples for preliminary metallurgical test work. During this work, process alternatives are examined and considered with the goal of selecting a recovery/extraction method most suitable for the deposit. With the development of a suitable mineral processing method in terms of cost and mineral recovery, it is recommended to test the method with variability samples to explore the impact of spatial and domain mineralization variability, and process feed grades, at the prefeasibility and feasibility level of study used to support the categorization Mineral Resources and Mineral Reserves. The complexity and novelty of the selected process flowsheet will also drive the level of work necessary to investigate performance and interaction between unit operations. The influence of gangue minerals, contaminants and impurities should be investigated in greater detail as the level of the project advances.

The quantity of test work supporting the results at the various stages of project development should be indicated together with the level of confidence achieved in these results. Early work (especially when there is limited sample available) or work from small scale projects may be limited in scope. In general, the quantity and quality of test work will increase during more advanced studies. This is especially recommended with large and complex mineral deposits where the process is being applied at the lowest possible cut-off grade to maximize the quantity of the resource or reserve, or when novel technology is required to develop an economically viable project. The Practitioner plays an important role in providing assessment of recovery values, capital and operating costs and the review of smelter terms, or other revenue determinants, supplied for cut-off grade determination used in geological/mine modelling and should clearly state all assumptions and sensitivities. Where different cut-off grades are provided (e.g., for ores to be sent to heap leaching instead of milling, or ore types exhibiting different metallurgical responses,) these should be separately identified and provided.

Test work should include aspects of quality assurance and quality control appropriate to the category of Mineral Resource and Mineral Reserve. Quality control is through the examination of assay and metallurgical laboratory and audit procedures on results, and adherence to standard or industry-accepted operating procedures.

The quality of the laboratory should be verified by the Practitioner and, in most cases, especially in the case of complex or novel processes, the Practitioner should visit the facility performing the work. In the case of complex test work, novel processes, or where the number of samples is limited, or where work has been performed in the past by reputable groups, the

Practitioner should ensure that audit procedures involve the use of internal or external peer reviews of this critical work.

An important measure of test work quality is the Practitioner's assessment of the degree to which all the test results are consistent and verifiable. If the suite of testing results does not point to a coherent process design, then it should be concluded that the metallurgical characteristics of the material driving the process outcomes are not properly understood, and additional or repeat sampling and testing will be necessary.

The Practitioner should ensure that the identification and description of the various test programs are summarized, and the relevant results explained. In addition, there should be a review and evaluation attesting that the analytical methods used to establish process sample grades, material characteristics, and final product(s) quality were appropriate to the material.

2.2. Essential Components of Process Support

2.2.1. Support of the Process Design by Sampling and Testing

Initially, the mineralogical and physical characterization of samples is used to define a potential processing route in early stages of appraisal of the deposit. This processing route is then confirmed by test work used to establish the response of the mineralization.

The level of the test work should be appropriate to the level of study supporting the categorization of the Mineral Resource and Mineral Reserve. It is the responsibility of the Practitioner to determine if the interpretation of the test work explains the metallurgical response in a satisfactory manner and to an appropriate level of detail, consistency, and confidence. The Practitioner will establish the Process Design Criteria (PDC) which are a critical part of the document outlining the key parameters of the process design. The process design should be appropriate for the size, variability, and mineralogy of the deposit. The PDC will typically include the following factors:

- design factors (throughput, availability, etc.);
- bulk density of ore, per ore type (in conjunction with Geology and Mining Practitioners), broken materials and of product(s);
- specific gravity of ore, per ore type (in conjunction with Geology and Mining Practitioners) and of product(s);
- product(s) recoveries, per ore type;
- product(s) quality (grade, deleterious elements, etc.), per ore type;
- production basis and key values from the metallurgical balance (including stream flow rates, % solids, etc.) as average and design values, and as relevant, specific to predominant ore types and/or relevant mining periods;
- grindability;
- particle sizes and slurry densities being used in the unit operations;
- settling and/or filtration characteristics of solids in process, products and tailings, as called for by the process;
- methodology for sizing major equipment, stating the relevant input data and their source (test work, client, equipment vendor, other expert, industry-accepted practice, or the Practitioner);
- presence and distribution of the deleterious elements within concentrate or product, and within tailings and effluent(s);
- process selection.

In determining the information which goes into the PDC, the Practitioner may have applied modifications/scale-up-factors to the information provided from test work and presented in the PDC. The appropriate use of modifications/scale-up-factors is at the discretion of the Practitioner based on experience and the stage of the project. The Practitioner should provide justification(s) for modifications.

The process design should result in the production of process flowsheet diagrams (PFDs), a material balance, an equipment list, an electrical load list, piping and instrumentation diagrams (P&IDs), and operating and control philosophies. These shall either have been created by the process Practitioner or created under the Practitioner's supervision for review and acceptance by the process Practitioner. Some of these process design elements may be missing from early stages of project development but should be available to support Mineral Reserve Estimates in order to provide the level of details required for capital and operating cost estimates at the expected level of accuracy.

The design documents supporting the studies are outlined in Appendix A, but critical in determining the economic impact of the design, will be the economic deliverables indicating:

- initial capital cost for process facilities;
- operating cost for processing;
- sustaining capital cost for process facilities.

The Practitioner contributes to the parameters supporting calculation of cut-off grades, and thus directly contributes to meeting the definition of confidence categories within the Mineral Resource and Mineral Reserve model.

Where non-commercialized technology is being considered for the processing method or plant design for a particular mineral deposit, the process Practitioner should provide, (1) proof of concept at the preliminary economic assessment level, (2) substantial proof of economic and technical viability and applicability at the prefeasibility level, or (3) high-confidence proof of the foregoing at the feasibility level. The Practitioner should ensure that the technical risks associated with any of the considered technologies are clearly communicated.

If the processing method, plant design, or other parameter has not successfully been used to commercially extract the valuable product from the mineralization, then the processing method and its constituents, plant design or other parameter should be demonstrated with enough rigor to support the project's stage of development.

The Practitioner should consider that long-term stockpiling of process plant feed may result in weathering of the mined material, which may negatively impact process plant metallurgical recoveries. An example is oxidation of sulphide minerals that may reduce froth flotation recovery. This oxidation may also produce acid mine drainage which may impact site water quality and water treatment requirements.

It is expected that the process design will not only consider economic factors but will also address worker health and safety in the process facilities to an appropriate level. The design should also reasonably deal with the production of any odious and toxic emissions produced by the process facilities. The Practitioner will also be involved in the characterization of the process tailings being disposed or stored, any excess solutions requiring treatment and disposal, and any gaseous emissions. At early stages of property work, the Practitioner may provide some guidance as to the appropriate storage or disposal of tailings and effluents. However, as the level of Mineral Reserve category is increased, the level of work involved in the disposal of wastes, tailings and control of emissions will increase. It is expected that, at a minimum, experts will be involved in the prefeasibility study and at the feasibility study and operations level, and there will be a suitably qualified Practitioner specifically guiding environmental issues. This Practitioner should be aware of national and international codes and standards, as well as local laws and regulations applicable to the process facility under study.

2.2.2. Process Plant Initial Capital Cost Estimating

In estimating capital costs, the Practitioner should consider, discuss if relevant, and allow for situations that risk requiring added capital during plant ramp-up. One such situation is the use of new technology in the process plant.

The role of an initial capital cost estimate is to provide an estimate of the process plant cost to the required level of accuracy necessary to achieve the throughput, recovery, the product(s) quality, and preparation of tailings for disposal or use as mine backfill material, and preparation of effluents for disposal or discharge, as required, that were used in the estimation of the Mineral Resources and Mineral Reserves.

The initial direct capital cost estimate of the processing plant and other required facilities should be appropriate to:

- the selected process at the selected process rate;
- the project geography;
- topography;
- ground conditions;
- seismicity;
- availability and usage of water;
- supply of electrical power to the process plant;
- climate;
- logistics;
- region-specific factors, such as the availability of skilled tradesmen, etc.

The Practitioner will judge which factors are influential in the costing of the process plant and that these have been addressed. Note that in addition to the initial direct capital cost, the estimate should include Indirect Capital, and Owner’s Cost and Contingency. There should be an indication of how the costs are developed and to what level of definition and accuracy (see Appendix A).

Given that there are differences in these levels of definition and accuracy, it is expected that an adequate contingency appropriate to the level of the supporting study is provided. The contingency allowance is intended to cover the costs for items not specifically estimated and is not intended to cover changes to project scope, external risks, etc. It is expected that in most studies, especially of large and complex projects, that the Practitioner will be supported by experienced initial capital cost estimators. The Practitioner is responsible for providing accurate input processing data to support the initial capital cost estimate.

2.2.3. Process Plant Operating Cost Estimate

The role of an operating cost estimate is to provide an estimate of the process plant operating cost necessary to achieve the recovery and product(s) quality that were used in the estimation of the Mineral Resources and Mineral Reserves.

The factors typically contributing to the operating cost include:

- media and liner consumption in comminution;
- reagent usage and cost;
- water consumption by type (fresh, reclaimed, recycled) and associated costs (acquisition, pumping, pre-treatment, etc.);
- maintenance consumables and cost;
- labour costs;
- costs associated with transportation of supplies and products;
- tailings and effluent treatment for disposal or discharge, as required;
- if relevant, backfill preparation cost to cover mine requirements;
- spare parts and maintenance supplies;
- power and energy usage and costs.

Operating cost estimation activities should be appropriate to the level of the study forming the basis of the Mineral Resource and Mineral Reserve estimate (see Appendix A). The level of estimate support should be defined by the Practitioner. As the level of study progresses, the variable response of the plant to mineralization, hardness, and other metallurgical parameters such as flotation and/or leaching response should be accounted for in the financial analysis, when converting the estimated Mineral Resources to Mineral Reserves. The impact of location in determining the supply of skilled human resources on the appropriate schedule, consumables and spare parts to the mine site or mineral products from the mine site to market should be indicated, especially if transportation is a potentially complex undertaking. Also, of critical importance to the cost estimate is the determination of water and power availability and cost. This especially applies to the processing of large low-grade deposits or complex projects in remote locations. An operating cost estimate typically does not include a contingency.

It is expected that in most studies, especially of large and complex projects, that the Practitioner will be supported by experienced and expert operating cost estimators. The Practitioner is responsible for providing accurate input processing data to the operating cost estimate.

2.2.4. Off-Site Treatment of Product(s)

One of the significant costs frequently attributable to the process is that of the off-site treatment of the product(s) generated at the mine site. In the case of concentrates or other intermediate product(s), the cost of producing a saleable product(s) by smelting, hydrometallurgical or other subsequent treatment contracted to third parties should be included. In addition to these costs, factors such as the presence of penalty elements or the sensitivity of the downstream processor, e.g., a smelter, to concentrate purity and grade should be indicated. The impact of location in determining the ease of shipping the process product(s) should be assessed, and whether this is logistically complex or impeded by seasonal weather or other factors. Losses of concentrate or other product during transportation should also be evaluated. In the case of both mineral concentrates and extracted metal or bullion, off-site treatment costs should include transportation, marketing, and insurance costs.

Since the product treatment costs are included within the parameters contributing to the determination of the Mineral Resources and Mineral Reserves, the Practitioner should provide a judgment as to the impact to cost and whether there is a risk in marketing the end product(s) as to the quantity supplied within the existing market or as it relates to quality. If the quantity or quality is unusual, this should be commented on. Any relationship between the project promoter/sponsor and proposed end user(s) may require comment. While the Practitioner may comment on the marketability for the end product(s) in early studies, it is expected that marketing experts will be used at later levels of study.

2.2.5. Use of Experts

The Practitioner is likely to have to consider areas where the assistance of experts should be sought. Examples of these include, but are not limited to, project execution and constructability, logistical capability, infrastructure support, environmental factors, local weather, topography and geography, offsite treatment of product(s), marketing, and the community response to the impacts of the type of processing facility being envisaged (dust, noise, water consumption and contamination, dwellings or existing infrastructure relocation, road traffic, etc.). In these cases, especially at advanced project levels, the Practitioner is expected to rely on the work of other experts, especially where the Practitioner should provide an opinion that extends beyond the bounds of their direct experience. If the Practitioner is taking responsibility for the assessment of these sections, it is the duty of the Practitioner to conduct sufficient due diligence to be assured that the expert has the required background and training to complete the task and to explain the result to the Practitioner.

2.2.6. Providing Recommendations

For early-stage projects, and to provide support for estimation of Mineral Resources, the Practitioner is expected to provide a preliminary estimate of the costs of additional test work and/or studies and time required to establish the more detailed work leading to the risk reduction required for satisfying the next stage of the project development. Further, the Practitioner will indicate opportunities and risks, and how information should be developed to address those issues pertinent to process in the continuing assessment of the project.

2.2.7. Risk

Risk should be considered by the Practitioner when agreeing to the confidence categories of Mineral Resources and Mineral Reserves, the level of study, the test work, and process design support. The Practitioner should pay particular attention to providing indications of process risk. This risk may arise from PDC based on inadequate or insufficient sampling and/or insufficient test work to characterize the main types of mineralization and assign statistical markers against selected PDC, inadequate process development for reflecting appropriately the complexity of the mineral deposit. The Practitioner should further indicate in the report the approaches used at this point and to be implemented at later stages. The Practitioner is responsible for providing accurate input processing data to the initial capital cost estimate the project to mitigate these various risks. Where the risk is considered to have a potentially serious negative impact on the economics of the project, it should be clearly identified, and the likelihood of its occurrence discussed. Identification of a serious risk may result in the level of Mineral Resource or Mineral Reserve confidence category being downgraded, despite the level of confidence achieved within the geological and grade continuity of the deposit, and may cause the confidence category of the overall project to be downgraded.

The Practitioner should also, once a study reaches the definition of a Mineral Reserve category, identify any potential risk weighing not only on the long-term continuous production capability of the project, but also on the initial production period and metallurgical ramp-up schedules which may be resulting from potential lack of qualified personnel and/or supplies or services, or the supply of inappropriate early feed to the plant.

Where cautionary statements or contingencies are used due to gaps in knowledge from lack or inadequacy of sampling, testing, and/or engineering parameters, the assumptions used to bridge these gaps should be benchmarked on analogous deposits.

2.2.8. Transparency of Language

The Practitioner should use clear language and provide sufficient detail in an unambiguous manner to ensure that the Practitioner's work discloses all the material factors affecting the design and application of a process to the Mineral Resource or Mineral Reserve towards the production of saleable product(s).

At an early stage of project development, there may be relatively little process information available. What is available should be presented and be accompanied by a discussion of the risks imposed by the limited information. As more detailed information becomes available, the sensitivity of the process plant design to fluctuations in throughput, recovery and product(s) quality should be indicated.

Attention should be paid to the presentation of information. All information that is materially important in defining the level of process response should be presented unambiguously and should not be misleading. Where problems in process are expected, steps that have been taken to mitigate the risk should be indicated. For example, it should be acknowledged when recovery values and product(s) quality differ between tests within the completed testing programs, even at early stages of project development. Adjusted recoveries and product(s) qualities should be explained and risks identified and discussed where appropriate.

In addition to the discussion of process response, the Practitioner should consider mineralogical factors which could influence metallurgical response including:

- product recovery;
- deleterious elements in the saleable product(s) and, in conjunction with geochemical specialists, in the rejects (tailings and effluent);
- fragmentation characteristics;
- mineral grain size, complexity, distribution, and ratios.

It is expected that the Practitioner will indicate for life of mine (including the potential level of variance and its impact):

- process plant throughput capability, as it may be related to plant feed grindability variation;
- the metallurgical projection approach derived from variability testing;
- recovery of the valuable material;
- quality of the final product(s) (including impurities and deleterious elements) sold to an end user or downstream processor;
- handling of tailings and effluent;
- rate of output of product(s) exiting the process plant.

Within the report, the Practitioner should include at minimum a simplified process flowsheet beginning with mineralized material arrival to the process and ending at shipment of the end product(s) off site and the discharge of tailings to the tailings facilities, and treated effluent to the environment, with preparation and delivery of backfill to the mine operations, where applicable. Apart from the most preliminary level work, there should be a site plan indicating the location of the process and tailings management facilities relative to mining areas and also required infrastructure. Wherever possible, data should be explained through the use of tables.

Where it has not been possible to develop the support to a level normally applicable to the classification level of the Mineral Resource and Mineral Reserve as judged by the Practitioner, it is recommended to communicate such a risk exists and discuss its potential impact upon the classification of the Mineral Resource and Mineral Reserve.

Similar to the reporting of tonnage and grade figures of Mineral Resource and Mineral Reserve estimates by rounding off to an appropriate number of significant figures to reflect the order of accuracy or precision of the estimate, the Practitioner performing the process work should use the same considerations regarding significant figures when reporting metallurgical recovery percentages which will reflect the feed characteristics including grade and mineralogy, and, in some cases, product(s) quality.

2.2.9. Transparency of Cost Estimates

Development of process plant initial capital cost estimates typically includes the following items:

- process design;
- engineering design;
- material take-off development;
- estimate execution plan;
- basis of estimate;
- unit rate development including the following:
    - labour rate and labour productivities;
    - bulk material costs;
- process equipment vendor pricing;
- subcontractor development;
- construction equipment rental costs;
- indirect cost development.

Process plant operating cost estimates typically include the following items:

- fixed labour and overhead costs;
- labour;
- general and administrative;
- management;
- expatriate costs;
- variable operating costs;
- raw materials;
- chemicals and reagents;
- power and water;
- fuels;
- operating and maintenance consumables;
- product transportation and insurance;
- post operational acceptance costs.

Process plant sustaining capital is typically estimated as an agreed fraction of the process plant initial capital cost. This fraction is expected to be relatively lower for a simpler plant and relatively higher for a more complex plant.

2.2.10. General

The Practitioner should use peer review by other suitably qualified experts in ascertaining if the level of detail included in their work is appropriate to support the classification level of Mineral Resource and Mineral Reserves as established by the CIM Definition Standards for Mineral Resources and Mineral Reserves adopted by CIM Council, as amended from time to time (CIM Definition Standards). The Practitioner should be aware of the level of support that is currently considered to be industry leading practice for the level of study that they are using to support the classification of the estimates.

Appendix A – Use of Supporting Studies in Process Evaluation and Assessment

A1. Foreword

Appendix A serves as support documentation within the LPGMP and supplements the Principles of Process Support for Mineral Resources and Mineral Reserves estimation. The tables included in this document serve only as a guideline as the nature of mineral deposits can vary significantly in terms of tonnage, grade, continuity, and complexity. It is the role of the Practitioner to make the assessment of the proper level of work appropriate to the mineral deposit and consider what would be appropriate in the judgment of their peers.

As Mineral Resources are converted to Mineral Reserves, a large amount of work should be performed to support the conversion including engineering studies which should be completed to provide both technical and economic assessments of the mineral deposit. After the initial identification of the Mineral Resource, typically three levels of studies with increasing detail and precision are undertaken. The process involvement in these studies generally begins with a preliminary economic assessment or scoping study, then advances to a prefeasibility study, and finally to a feasibility study, with an increasing degree of project definition at each stage. Particularly important in the conversion of Mineral Resources to Mineral Reserves is the use of the prefeasibility study, as required by the CIM Definition Standards.
Given the importance of these engineering studies as supporting documents, a general definition of the contents relevant to the development of the selected metallurgical and process associated contributions is warranted. This definition is provided in the tables below.

In general, the level of detail increases with the progression of the study stages. Definition at each succeeding level is built on the work of the previous stage. From a process viewpoint, these studies typically contain the following content and objectives:

A2. Level of Sample Verification

FACTOR	PRELIMINARY ECONOMIC ASSESSMENT	PREFEASIBILITY	FEASIBILITY
Intent of Sample Representativity	Indicative	Representative	Comprehensive
Sample Types	Composites and Point Samples	Point Samples & Domain Composites	Domain Samples and Variability Samples (either point or composite).
Identification of Samples in the Report	List to identify sample source and attributes. The Practitioner should comment on how representative the sample is believed to be in terms of grade and domain.	List to identify sample source and attributes. For composites, there should be an explanation of how these are derived. Sample attributes should be reconciled to the resource model to describe the limits of the influence of the sample.	List identifying sample source and attributes. Sample sources typically located on diagram of the deposit.

Information Supporting Process Concept	Concept developed from mineralogy, typical practice for the type of deposit investigated, and selected bench-scale tests on samples.	Concept developed from previous information and optimization factor testing of domain composites. On large or complex deposits, key unit operations or novel process steps may be pilot tested under simulated plant conditions. Testing of the impact of grade variance is typically included in the testwork. Testing of metallurgical variance by domain is also a recommended task especially for complex deposits.	Concept brought forward from previous studies and performance confirmed by additional testwork. Key unit operations or novel process steps should be pilot plant tested under simulated plant conditions. Variability due to grade, domain, and spatial location is determined.
Environment	Samples might be tested if issues are expected.	Process and environmental experts should select initial samples and undertake standard and other environmental tests on waste rock, tailings and effluent.	Process and environmental experts should select samples and undertake standard and other environmental tests needed to support the process design and satisfy environmental regulations.
Definition of Saleable Product	Product output should match process selected. Marketability of the product is indicated.	Actual product(s) are produced by testing and marketability is assessed. Identification of deleterious components should be performed, and the impact identified.	Building upon prior work, there is a further demonstration that a product of acceptable quality produced regardless of feed variability. Produced products should undergo market assessment with the exception of bullion products.
Testing QA/QC	Chain of sample custody is demonstrated. Credibility of testing lab is assessed.	Internal QA/QC procedures in testwork should be explained. The ability to duplicate the results of the primary process (es) should be demonstrated.	Internal and external QA/QC procedures in the testwork program are explained. Key tests are duplicated by a reference lab to demonstrate consistent results. Where duplication of tests is not possible, the alternative is an independent peer review.

A3. Level of Design Definition

FACTOR	PRELIMINARY ECONOMIC ASSESSMENT	PREFEASIBILITY	FEASIBILITY
Process Design Criteria (PDC)	Preliminary design criteria used to support resource/reserve modelling are recommended. These	In addition to process design criteria, major design selection criteria for	Design criteria for process, major equipment and support systems (water, air, HVAC, etc.) are established.

	should include tonnage, feed grade, recovery, and major design parameters considered important in the judgment of the Practitioner.	equipment (size, power, type) are established.	
Process Flow Diagram (PFD)	A block flow diagram of the major unit operations showing significant flows is sufficient.	The PFDs indicate the major inputs and outputs of the major unit operation equipment components.	The PFDs show the process flow diagrams of major and minor equipment including bleed and intermittent streams. P&IDs are needed to allow proper cost estimating and a HAZOP review.
Process Description (PD)	The process description should define the concentration or extraction method	Selection of candidate process flowsheet should be confirmed, and selection explained. Major components and sizing influences should be described.	Details of major and minor processes within process are provided. This includes major components, power draws and sizing influences.
Equipment List (EL)	Type of equipment is indicated.	Major equipment components are identified.	Major equipment and supporting equipment are identified and power requirements are indicated.
Control & Operations Strategy	None is recommended	Basic description should be provided.	The control and operating strategy including strategy in dealing with ore variability should be described.
Mass Balances (MB)	A simplified MB should be provided.	A plant MB of the major flows complete with stream densities is provided.	A plant MB of major and minor flows complete with stream characteristics (pH, densities, etc.) product and intermediate grades, is provided.
Energy Balances (EB)	Very high level analysis, possibly a simple factored estimate based on similar operations.	A preliminary energy balance should be constructed indicating ability to source electrical power and other energy sources, and the level of consumptions.	A detailed energy balance should be constructed indicating ability to source electrical power and other energy sources, and the level of consumptions.
Environment	The project will likely require waste rock and tailings storage areas, aqueous effluent treatment plant, and perhaps gaseous emission controls. These should be discussed at a preliminary level.	The waste rock and tailings storage areas should have definition, environmental characteristics determined, and all necessary testwork undertaken to demonstrate that an environmentally acceptable project can be constructed, operated and decommissioned.	All environmental aspects of the project should be designed and costed in detail. Acceptance by local communities and the regulatory agencies is a key aspect of any project.

Level of Capital Expenditures (Capex) Reference: AACE Recommended Practice No. 47R-11: Cost Estimate Classification System – As Applied in the Mining and Mineral Processing Industries	Capex is by factored comparison to similar project in similar location considering site location impacts (e.g. elevation, geography). Capex may also be by major equipment quotes and factoring from this basis. **Accuracy should be from: -20% to -50% and +30% to +100%.**	Capex is determined with major equipment by budgetary quotations, minor equipment from database, and installation costs by factoring. The basis of estimate is developed from database information. Material take-offs developed or indicated as not developed. **Accuracy should be from: -15% to -30% and +20% to +50%.**	Capex is determined with major and minor equipment by firm supplier quotations, and installation costs by material take-offs The basis of estimate is developed from local information. Construction and logistical execution plans are developed and support the design. **Accuracy should be from: -10% to -20% and +10% to +20%.**
Level of Operating Costs (OPEX) Reference: AACE Recommended Practice No. 47R-11: Cost Estimate Classification System – As Applied in the Mining and Mineral Processing Industries	Operating cost can be developed by benchmarking for very early-stage studies. Alternatively, or where a higher level of resource category above inferred is being considered, an effort to derive major costs (labour, power, reagents, etc.) should be developed for the project location. **Accuracy should be from ±25 to ±35%.**	Operating costs are developed from testwork (reagent and energy consumption) and local or database costing of labour and reagents relevant to the locale. Cost of power is an especially important local cost, and its derivation should be identified and described. Operating costs include sustaining capital. **Accuracy should be from ±25 to ±15%.**	Process operating costs are developed from testwork (reagent and energy consumption) and using local costs for labour and reagents. Cost of power is an especially important local cost, and its derivation should be identified and described. Individual influence of major operating costs components identified. Supply costs are from creditable, preferably local suppliers capable of providing the supplies. Supply costs from remote suppliers include supply-chain costs, duties, freight, taxes, etc. Labour rates for locals and expatriates should be realistic. Influence of ore variability on operating costs is identified. Operating costs include sustaining capital. Influence of variable operating costs in the financial model is identified. **Accuracy should be from ±15 to ±10%.**

A4. Process Risks

FACTOR	PRELIMINARY ECONOMIC ASSESSMENT	PREFEASIBILITY	FEASIBILITY
Deposit/Orebody Complexity	Influence of mineral deposit complexity (mineralogically complex materials, variances in hardness, etc.) upon the process should be identified.	Influence of deposit complexity on recovery or product quality should be indicated. Indicate if this complexity has been considered with the process design.	Influence of orebody complexity upon the process should be assessed. The impact of this complexity on recovery and ability to produce a marketable product should be indicated. Explains how the process design deals with orebody complexity.
Flowsheet Complexity or Novelty	It should be indicated whether the process is novel or is a common process involving well known techniques for this sort of mineralogy.	Where either complexity or novelty is present, bench scale testwork confirming proof of concept is recommended. Where the process has not previously been implemented on an industrial level, pilot plant testing should be carried out.	Pilot plant or demonstration scale work has been conducted for novel processes. Variances in performance should be confirmed and explained. Typically, an independent peer review process should be performed.
Reference to Ramp-up	Not recommended.	Suggested. Indicate expected ramp-up for production and costs and assumptions for the basis.	Recommended. Indicate expected ramp-up for production and costs and assumptions for the basis.

A5. Other Risks

FACTOR	PRELIMINARY ECONOMIC ASSESSMENT	PREFEASIBILITY	FEASIBILITY
Tailings Disposal, Effluent Treatment, and Gaseous Emissions Control	The nature of the tailings, effluents and gaseous emissions should be indicated, and the form of tailings disposal and effluent and gaseous emissions treatment being contemplated.	An appropriate level of detail should go into the definition of plant emissions and how they will be handled in an appropriate manner. Environmental experts should be involved as necessary tonsure a solid design and mitigate risk. Review social acceptance and regulatory compliance.	At this level, consideration should be made of the impact of ore variability on the ability to provide proper tailings disposal and effluent treatment. The process expert will typically work with environmental experts in the review of all environmental aspects of the project to ensure social acceptance and regulatory compliance.
Health and Safety	It should be indicated where the process involves the use of potentially hazardous processes or chemicals and the level of risk which might	In delineating the process, accommodation should be made for the appropriate control of worker health and safety risks. Where a	At this level, the presence of hazardous processes or chemicals means plans should indicate how these issues will be dealt with. There should be

	be encountered.	hazardous process is envisaged, there should be consideration as to how uncontrolled incidents will be managed	a response plan in the event of an uncontrolled incident. A HAZOP review should be completed.
Interactions with Other Disciplines	Influence of non-process factors (weather, location, potential ARD, etc.) should be identified if they are likely to impact the process.	In addition to factors indicated as problems at the scoping level, water supply and quality is an especially critical process factor and comments should be made regarding any potential difficulties.	Impact from other areas on the process and plant design should be indicated and described. In particular, the plans for storage of tailings and release of excess water to the environment should be reviewed and commented on considering the local environmental regulations.
Community Relations (CSR)	Contribute process and process design specific information to assist in determining the influence of location on local community or communities, and the general community perception of mining development.	Input to CSR activities related to the processing plant, including use of specific reagents, environmental discharges or emissions, noise from operations, etc.	Input to CSR activities related to the processing plant, including use of specific reagents, environmental discharges or emissions, noise from operations, etc. Develop processing-related plans to minimize impacts and manage community relations.

Appendix B – Glossary of Terms Relevant to the CIM LPGMP

This appendix serves as support documentation for the CIM LPGMP. The terms are explained as they apply to application of these guidelines.

accuracy – the degree to which an estimate or measurement is free from error.

acid mine drainage (AMD) – a sulphuric acid solution produced when water chemically reacts with sulphide minerals (in waste rock, for example,) in the presence of oxygen (that is, air,) and common bacteria. AMD often contains dissolved metals that may pose a threat to humans and to wild flora and fauna.

backfill – a material sometimes prepared with the tailings stream from a process plant and used to fill the mined cavities in underground operations to provide local ground support to the operations.

basis of estimate – a formal document produced by a cost estimator which establishes how the estimate is performed.

bench scale testwork – testwork that is performed at the laboratory scale where sample mass used in the testwork is typically less than 10 kg and can be processed in equipment handled by an individual. This level of work is usually done on a batch basis rather than a continuous basis.

beneficiation – the process of upgrading material by froth flotation, gravity separation or another method into a concentrate in which the minerals are not physically changed.

bleed stream – a minor stream of material that is removed from a recirculating process flow to prevent the accumulation of material in the recirculating flow and thus to maintain a material balance in the circuit.

block flow diagram – a simplified representation of a process showing major unit operations and without representation of individual pieces of equipment.

budgetary quotation – a preliminary cost quotation provided by a vendor qualified to supply a particular type of equipment or service.

bullion – gold or silver or other precious metals at a high level of purity.

capital cost – the estimate that indicates the cost of engineering, procuring and installing equipment on suitable foundations and in an appropriate building along with all piping, electrical, instrumentation, infrastructure and other items sufficient to provide a workable facility.

category of study – engineering studies are generally classified in three levels – scoping (or preliminary economic assessment), prefeasibility and feasibility – which reflect the level of detail and accuracy used to produce these studies.

chain of sample custody – denotes the procedure where a sample is processed through an unbroken trail of accountability that ensures the physical security of the sample, data and records. This system helps to prevent accidental or willful contamination or loss of the sample or manipulation of records and allows the determination of who had control of the sample or information if such should ever happen.

classification – a process by which the solid particles in a stream are separated into two or more separate streams according to the particle size.

comminution – that process where the mined material containing mineralization of economic interest is reduced in size from a coarse size, through crushing and/or grinding, to a finer size suitable for concentration or extraction.

community response – in the circumstance used in this document, the response of the communities that might be impacted by a processing development can be of great significance. Community response should be determined to support the various environmental permitting processes.

complexity – in the process sense, complexity involves the preparation (through comminution, etc.), concentration (through flotation, etc.), or extraction (through agitation leaching, etc.), and the degree to which these may be made difficult by the mineralogy or the range of variability of the material processed.

concentrate – where minerals in a material have been upgraded sufficiently to produce a product suitable for downstream processing or sale.

concentration method – a process that reduces the mass of the material hosting the minerals of economic interest, such that the grade or quality of the product is increased relative to that of the process feed.

conceptual process development – a very high level of process development that establishes a general method to process plant feed to recover minerals or to extract metal to produce a saleable product.

construction execution plan – is typically provided in a feasibility study to define the schedule of cost expenditures and construction activities for the facilities presented in the study.

contingency – on direct and indirect capital, with the exception of Owner's Costs, contingency is the allocation of costs to cover items or functions needed for the completion of the project but not specifically included in the cost estimate within the defined scope of the project. It should be clearly understood that the contingency allowance will be spent and that it is not intended to cover scope changes.

continuity of recovery – where the recovery from a mineral deposit can be continuously met to an economic level the operating life of the project.

control and operating strategy – is typically provided in a feasibility study to indicate the philosophy of detecting and responding to variability within the process operating parameters.

credibility of testing laboratory – a testing laboratory is credible if it meets the requirements of relevant standards published by the International Organization for Standards (ISO) or equivalent. Credibility is further established when the Practitioner has audited the testwork directly through a visit to the testing facilities and/or performed a review of documents provided by the laboratory covering the testwork. The Practitioner may also be able to establish, from their peers or others, that the laboratory has a solid reputation for delivering reliable results.

cut-off grade level – the grade of the element or component of economic interest which, if exceeded, means that the material can be mined and processed at a profit, or, if not exceeded, means the material in question is classified as waste.

defensible estimate – in this context, a defensible estimate at a prescribed study level is one where sufficient work has been performed to successfully defend the estimate if it should be questioned by external or independent peer reviews, regulators, or due diligence providers.

demonstration scale work – testwork to justify a large capital expenditure in cases where a process is novel or process feed variance is extreme. A demonstration plant is recommended to accurately assess operating performance on a scale that mimics commercial scale operation more closely than typical pilot plants, and which produces a quantity of product allowing comprehensive assessment by customers.

design criteria – the information that provides the facts and assumptions upon which the design and the production results are based.

differential flotation – a process used for the concentration of minerals whereby minerals are recovered into separate concentrate products.

dilution – the inclusion of rock containing little or no economic mineralization that, by necessity, is extracted along with the mineralized material in the mining process, subsequently lowering the overall grade of the mined material.

direct capital – the total costs of materials, equipment and subcontracted work permanently incorporated into the final facility plus the direct craft labour employed in the installation of these materials and equipment items.

domain – commonly known as a geometallurgical unit, defined as a mineral assemblage that has a common lithological and mineralogical composition and that is expected to have a specific metallurgical response.

Domain composites – those groups of point samples combined into a composite to represent a domain.

Due diligence – an investigation, audit, or review performed to confirm facts or details of a matter under consideration.

Economic production cost – the cost of producing the product, accounting for the repayment of the cost of capital and that of operating costs (including any off-site treatment of the product).

Effluent – an outflowing of water or an aqueous solution to a natural body of water, from a structure such as a wastewater treatment plant, sewer pipe, or industrial outfall.

Environmental factors – insofar as processing is concerned, those factors associated with the processing of mineralized material, disposal of solid and aqueous waste products, and treatment of gaseous effluents to comply with standards set by the controlling government jurisdiction.

Equipment list – typically, a list of equipment required in the process plant, which will vary in depth and detail according to the level of study which it supports.

estimate – the estimation of costs as part of determining the viability of building and operating a process facility.

expatriates – the term referring to those workers that are not native to the jurisdiction in which the mineralized body is found.

extraction method – a physical or chemical method used to extract a metal or a mineral product from mineralized material to produce a marketable product.

external or independent peer review – a review conducted by peers, intended to confirm that a reasonable interpretation of scientific and testing information supports the design.

factored comparison – a type of estimate used at the preliminary level, which is based on comparing a proposed facility to an analogous situation with, as necessary, modifications for throughput, location, date, or other factors.

finished product – a saleable product achieved by elemental extraction, which has a high enough level of purity to be marketable.

flotation – a process used for the concentration of minerals.

geological environment – from the processing perspective, a geological setting that implies a characteristic metallurgical response or level of complexity (e.g., Mississippian type lead deposits, Athabasca Basin type uranium deposits).

grade – the quantity of the mineralized material expressed as a mass fraction of the specific component. Units are commonly %, ppm, g/t, and oz/t and need to be carefully defined.

hazard – the intrinsic property of a hazardous substance or physical situation with potential for a dangerous deleterious effect on human health and/or the environment.

HAZOP – a hazard and operability study done in a structured and systematic examination of a planned or existing system to identify hazards and risks.

HVAC – the heating, ventilation and air conditioning of a space.

hydrometallurgical treatment – the treatment of a mineralized material by selectively dissolving materials and applying other processing steps to produce a desired product.

indirect capital – typically includes EPCM (Engineering, Procurement and Construction Management), Third Party Consultants, Construction Facilities, Construction Services, Construction Site Operation, Freight, Vendor Support, First Fills and Spares.

infrastructure support – those systems such as water, power, roads, camps and logistics that are used to support the operation of a property.

installation cost – the component of the capital cost that includes labour and material cost of installing equipment at a site.

intent of sample representativity – a sample is selected based on its ability to represent some form of mineralization and this term indicates the use of the sample.

intermittent stream – a stream of material that does not flow on a continuous basis, but which is provided as part of the process system to allow flexibility in the distribution of the sub-unit products.

labour – comprised of staff and non-staff personnel, labour is one of the principal costs items making up the total operating expense of a property.

leaching – a process used for the extraction or removal of metals or other components by dissolution.

level of confidence – the term used to express the belief in the reliability of the information.

level of recovery – usually expressed in quantitative terms and referring to that fraction of valuable material that is recovered to the saleable product.

list identifying sample source and attributes – in these documents, a list identifying the original spatial location of the sample, its grade and any other attributes that are involved in its selection as being representative.

local weather – that local weather and climate that is a consideration in the design of process facilities, in particular, climatic and seasonal extremes.

logistical capability – the capacity of the infrastructure or company systems to provide transportation, storage and control of materials and equipment.

logistical execution plan – a plan typically included in a feasibility study that identifies key aspects (including cost) of transporting materials and equipment to site.

major equipment – the more massive or important items of equipment within a process plant.

marketing – an activity involving the sale of a product.

material take-offs – quantity information based on materials usage in the construction of facilities, which is used to estimate capital costs – typically estimated for civil works, concrete, steel, etc.

mineral beneficiation method – the method used to concentrate the valuable minerals for further processing, or into a saleable product.

mineralogy – the study of the minerals and their interrelationships with each other.

novel approach – an approach that has not been previously applied commercially in an industrial situation for that particular type of resource.

operating cost – the operating expense of concentrating or extracting the product, and is typically composed of power, labour, reagents, consumables, and spare parts costs.

optimization factor testing – the optimization of a process that involves modifying the parameters but not the basic technology to find an optimum process point.

ore – a mineralized material that can be mined and processed profitably.

orebody complexity – when the orebody demonstrates a high degree of variability in process response, either spatially or within domains.

owner's costs – typically include Pre-operations personnel and training, Pre-Production and Initial Production Mine Equipment, Mine Pre-stripping, Mine Development, Owner's Project Team, Insurance, Housing, Permitting, Commissioning, Corporate and Owner's Contingency.

peer – an individual with education and experience similar to the Practitioner.

penalty elements – those constituents of the saleable product that carry a negative economic impact for the purchaser and could result in product rejection by the purchaser.

pilot plant scale work – testwork to support design and estimation activities, which is performed continuously on a relatively small scale (but at a larger scale than laboratory bench scale testwork), typically incorporating all recycle streams, to emulate unit operations and predict steady state performance of a full-scale process plant.

point sample – a sample that is derived from a continuous interval of material in a specific location.

power draw – the level of power consumption expected by a particular piece of equipment.

preconcentration – application of equipment and process to reject material that is sub-economic and thereby reduce the mass of material subjected to concentration processes.

problematic material – any material that requires a level of treatment that is beyond the level normally considered for a typical ore of that commodity, sometimes called "refractory material".

process concept – the grouping of unit operations such as comminution and flotation to alter a mineralized unit to concentrate or extract a product of value.

process design criteria – the detailed information necessary to support a process concept at the higher levels of study.

process flow diagram (PFD) – the description of the process facilities in graphic fashion showing essentially all major process equipment and flows.

P&IDs – diagrams that are used to detail piping and instrumentation/control devices within a process facility.

project execution and constructability – a component of feasibility studies that helps refine the cost and impact of installing equipment within the process facilities.

proof of concept – a preliminary set of tests demonstrating that an unconventional or atypical process has the possibility of providing a solution to a particular problem.

proof of economic and technical viability – tests that are performed to provide design information supporting the use of an atypical process as a solution to a particular problem.

proof of applicability – tests to support the use of an atypical process indicating the ability to handle variations.

QA/QC procedures – those systematic procedures that are used to validate the control and testing of samples in a specified manner.

reagents – those chemicals that are used in concentration or extraction processes to enable the production of a saleable product.

representative sample – sample(s) selected to effectively capture specific chemical or physical attributes such as grade, mineralogy, hardness for domains, geometallurgical units, or designated portions of a mineral deposit.

saleable product – product that can be a concentrate, an intermediate process product (e.g. precipitate), a finished metal product (e.g., copper cathode), or bullion that can be sold into a commodities market or to an end-user.

sampling protocol – those procedures that describe how sampling is performed and to what level of diligence.

sample selection and collection – the procedure that shows how and why certain samples were collected as being representative.

sizing influences – those process characteristics that determine what equipment to use in the design.

smelting treatment – a pyrometallurgical treatment of concentrate or metal product to recover material to a product of higher marketability.

Solvent Extraction (SX) – a process in which an aqueous solution containing an element of interest is contacted with an immiscible organic solution (solvent) that preferentially extracts the element of interest, which can subsequently be removed from the solvent into an aqueous solution, allowing the solvent to be recycled and the extracted element of interest further processed.

spatial density – the level of sample concentration within a particular volume of space of the mineralized zone.

spatial location – the location of samples within the mineralized zone.

stream densities – the concentration of material mass in a slurry stream.

subject matter expert – is a person with extensive knowledge or ability based on research, experience, or occupation in a particular area of study.

summary design criteria – a basic level of design criteria used at scoping level indicating throughput, level of recovery and concentrate grade or final product quality.

supporting equipment and systems – those systems (e.g., pressurized air) that do not alter the mineralization, but which provide support to the process equipment.

sustaining capital – the periodic addition of capital to the process plant that is required to maintain operations at existing levels.

SX/EW – a two-stage process to extract metal ions from a low-grade leach solution using a solvent extraction process and then recovering the metal from the strip solution by electrowinning (EW).

tailings – uneconomic material produced by a mineral processing plant which is disposed of in a manner meeting government regulation, and which usually involves a permanent impoundment facility.

throughput – the amount of material that is processed through a facility based on an hour, a calendar day, a month or a year.

tonnage – the amount of material available in the mineralized deposit that is subject to economic processing.

variability samples – those samples, which may be point or composite, that cover the range of mineralization quality, grade, or location within the volume of the mineralized deposit that is to be treated.