



GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

Prepared by

Joe O'Carroll, P.E.,
and Bob Goodfellow, P.E.

for and on behalf of the
Underground Construction Association of SME



CONTENTS

Acknowledgments	3
Preface	4
1. Goals and Objective of This GIRM	5
2. Hazard Identification	5
3. Risk Assessment and Management	6
4. Owner Responsibilities	7
5. Designer Responsibilities	9
6. Contractor Responsibilities	10
7. Insurer Responsibilities	10
8. Project Planning Stage	11
9. Design Stages	13
10. Construction Contract Procurement Stage	16
11. Construction Stage	19

APPENDICES

A. Definitions and Terms Used in This GIRM	24
B. Recommended Minimum Deliverables for Compliance with This GIRM	29

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

NOTE AND ACKNOWLEDGMENT

This Guidelines for Improved Risk Management on Tunnel and Underground Construction Projects in the United States of America (GIRM) has been based on A Code of Practice for Risk Management of Tunnel Works, which was prepared by the International Tunnelling Insurance Group (ITIG) published in 2006 and revised in 2012.

ACKNOWLEDGMENT BY THE INTERNATIONAL TUNNELLING ASSOCIATION

The ITA supports the principles and the spirit of the use of Risk Management and generally agrees with the principles of these Guidelines. ITA supports this initiative to ensure that Risk Management principles are incorporated into the implementation of tunnel and underground projects.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

PREFACE

While adopting the principles and intent of the ITIG Code of Practice, the publication of this GIRM recognizes that there are unique differences that apply to projects undertaken in the United States of America (USA). In other countries, codes and standards are generally universal for the country in which they are being adopted. In the USA, different states and even cities have differing statutory requirements and other legal constraints with respect to procurement of contracts and contracting methodologies. While there might always be exceptions based on new or idiosyncratic laws in local jurisdictions, the intent of this publication is to provide general guidelines that should be acceptable irrespective of the USA state or city in which tunnel and underground construction projects are being planned, designed, procured and constructed.

If all parties to a USA project follow this GIRM, the authors believe that the outcome will be to reduce adversarial relationships between participants while promoting the minimization and management of risks associated with the design and construction of tunnels, caverns, shafts, and associated underground structures. It is not intended to be a "Code" nor a Contract Document, but if these guidelines are adopted, it should give project Owners, Planners, Designers, Contractors, and Insurers a much better understanding of the wide range and importance of risks (and opportunities) associated with the project and provide greater confidence for delivering a successful project.

The authors wish to thank the Owners', Designers', Contractors', and Insurers' personnel involved in various tunnel and underground construction projects who kindly provided their time to review, comment, make recommendations, and ultimately accept this publication as their industry-recommended guidelines for improved risk management in the USA.

This GIRM reflects the consensus of a wide variety of industry experts and other professionals involved in the tunnel and underground construction industry in the USA. As such, the authors believe that it describes the best practices to generally manage and reduce risk in USA tunnel and underground construction projects. Users of this GIRM must appreciate, however, that no risk management regimen is perfect, and that the varying circumstances, conditions, and locations of different projects, including variances in local laws and regulations, may require additional or different risk management practices to further improve safety and better manage risk. The Society for Mining, Metallurgy, and Exploration, Inc. (SME), and its division, the Underground Construction Association of SME (UCA of SME), expressly disclaim any liability of SME, the UCA of SME, their respective officers, directors, members, employees, associates, servants, or agents, including the authors, reviewers, or other individual experts and technical committees associated with the publication of this GIRM, for any claims, losses, damages, remedies, or damages arising from, related to, or caused by, directly or indirectly, the use of or reliance on any guidance, recommendations, or other information in this GIRM, including but not limited to pecuniary losses, damages, claims, or other liabilities arising from personal injury, property damage, or other harm of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses related thereto.

UCA of SME may revise this publication from time to time to reflect recent developments or changes to existing standards but does not undertake to do so on any regular or continuous basis. Users are therefore reminded to note the date of this version and to take reasonable steps to identify any post-publication developments or changes that may affect risk management for their projects.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

1. GOALS AND OBJECTIVE OF THIS GIRM

- 1.1 The objective of this Guidelines for Improved Risk Management (GIRM) is to promote and achieve improved practices for the mitigation and management of risks (and to maximize opportunities) associated with the design and construction of tunnels, caverns, shafts, and other underground structures, including the renovation of existing underground structures, referred to hereafter as projects. It sets out guidelines for the identification of risks; their allocation between the parties to a contract and Project Insurers; and the management and control of risks through the use of risk assessments, risk registers, and risk management processes.
- 1.2 It is a goal of this GIRM to promote systematic risk management as part of the mainstream practice of all projects.
- 1.3 The scope of this GIRM applies to the project planning, design, procurement, and construction phases of projects, wherever these may be carried out geographically within the USA.
- 1.4 Although this GIRM excludes the operational performance of projects beyond the construction contract completion, risk management principles can be extended to address risk throughout the full life cycle of a project. This includes concept through public opinion, political and funding risks, and operation and maintenance costs, which would be important to Owners and Concessionaires involved in public–private partnerships.
- 1.5 This GIRM is intended to operate in parallel with, and does not replace or detract from, statutory duties, responsibilities, and statutory requirements of federal, state, and local legislation relating to health and safety, environmental restrictions, design, or subsequent implementation of construction activities.
- 1.6 Appendix B contains a suggested checklist of minimum deliverables for use by project participants. It should be acknowledged, however, that the checklist as presented cannot and should not be seen as exhaustive. The deliverables on any particular project will be determined by the project requirements, as set out in contract documentation.

2. HAZARD IDENTIFICATION

- 2.1 A “hazard” is defined as an event that has the potential to impact a project and give rise to consequences associated with:
 - a) health and safety;
 - b) the environment;
 - c) the design and construction of the project;
 - d) the cost and schedule; and
 - e) third parties and existing facilities, including buildings, bridges, tunnels, roads, surface and subsurface railways, pavements, waterways, flood protection work, surface and subsurface utilities, and all other structures/infrastructure that could be affected by the project.
- 2.2 Recognizing that projects are politically, economically, or environmentally sensitive and where public opinion can be expected to have a severe impact on the project development, loss of goodwill and reputation could be a relevant hazard category to assess.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

- 2.3 Hazards should be identified and evaluated on a project-specific basis, and their consequent risks should be identified and quantified by risk assessments through all stages of a project, including planning, design, construction contract procurement, construction, commissioning, start up, and operations for any stipulated maintenance period.
- 2.4 The nature of the hazards (and hence their consequent risks) will be dependent on the stage of a project under consideration.
- 2.5 Hazard identification and the management of risk to achieve reduction to a level “as low as reasonably practicable” (ALARP) should be integral practices in the planning, design, procurement, and construction of projects. So far as it is reasonably practicable, risk should be reduced through appropriate design and construction procedures.

3. RISK ASSESSMENT AND MANAGEMENT

3.1 General

- 3.1.1 For the purpose of this GIRM, “risk” is defined as a product of the consequence/severity of a hazard and the likelihood of occurrence of that hazard. The importance of any risk depends not only on the likelihood that something may go wrong, but, if it does occur, how severe the consequence may be. The process of risk management—including risk assessment, characterization, and response, as well as elimination, mitigation, avoidance, transference, or acceptance—is required to identify and clarify ownership of risks and should detail clearly and concisely how the risks are to be allocated, controlled, mitigated, and managed.
- 3.1.2 Risk management is the systematic process of:
 - a) using risk assessment and characterization to identify hazards and associated risks (and opportunities) that influence a project’s outcome in terms of costs, schedule, environment, political decisions, and impacts to third parties;
 - b) characterizing and quantifying risks, including their schedule and cost implications;
 - c) identifying proactive actions planned to eliminate, mitigate, avoid, transfer, or accept the risks;
 - d) allocating risks to the parties to the contract; and
 - e) assigning an individual (risk custodian) to manage the risk(s).
- 3.1.3 Responsibility for risk management should be explicitly allocated to relevant parties via a contract so that risks are addressed adequately and appropriately in the planning, design, and management of a project, and that appropriate financial allowances can be made.
- 3.1.4 The systems used to track risks should enable the management and mitigation of risks through contingency measures and controls to be monitored through all stages of a project.

3.2 Risk Assessment

- 3.2.1 Risk assessment is the formalized process of identifying hazards and evaluating their consequence and probability of occurrence together with strategies for preventive and contingent actions. Risk assessment work in all stages of a project should be completed in sufficient time that any risk reduction measure identified can be implemented.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

3.2.2 Risk (and opportunity) assessment workshops should be performed periodically throughout each stage of a project, the outcome of which should be summarized in a project risk register.

3.2.3 The parameters to be used in the assessment of risks, in terms of probability of occurrence of a hazard and its severity/consequence on impact categories listed in Paragraphs 2.1 and 2.2, should be both project-specific and appropriate to the project stage under consideration.

3.3 Risk Registers

3.3.1 The use of formalized risk registers and risk matrices should be employed as a means of formally documenting the identification, evaluation, characterization, mitigation, and allocation of risks to the party best able, and with the incentive, to manage the risks. Risk matrix methodology uses a practical method to effectively evaluate the combined effect of both likelihood and severity into a single meaningful number, greatly simplifying the prioritization and management of risks.

3.3.2 Risk registers should clearly indicate the party responsible for the control and hence management of an identified risk (respecting any contract responsibilities and liabilities), as well as contingency measures available for the mitigation of the risk.

3.3.3 Risk registers should be “living” documents that are continually reviewed and revised as appropriate and auditable at any time. They should provide an auditable trail through the life of a project to demonstrate compliance with the intent of this GIRM.

3.4 Risk Response

3.4.1 Risk response planning is a critical part of the risk management process. Sufficient time should be provided to develop risk mitigation measures (both technical and financial) in addition to management plans for key risks—in particular those risks that are low probability but present a very high, potentially catastrophic impact on the project.

3.4.2 Insurance should not be considered as a primary response, contingency, or mitigation measure in risk assessments for projects until the risk has been mitigated to an ALARP level.

4. OWNER RESPONSIBILITIES

4.1 The ability of an Owner to plan, administer, design, construct, and manage a project, particularly a large project that exhibits a high risk profile, is paramount to the overall management of risk. In this respect, establishing minimum project management capabilities for the Owner is an integral part of this GIRM.

4.2 The Owner should have demonstrable technical and contract management competence appropriate to the type, scope, and extent of the project to be planned, designed, and procured for construction in the:

- a) Project Planning Stages;
- b) Design Stages;
- c) Construction Contract Procurement Stage procedures, including selection of a Form of Contract;
- d) Construction Stage and management; and
- e) commissioning and start-up.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

- 4.3 Such competence should be demonstrable and evaluated on the basis of:
- the corporate competence of the Owner organization in relation to the proposed project; and
 - the competence of individual staff members within the Owner organization, including their availability for the project.
- 4.4 In the absence of appropriate experience for any part of the project, the Owner should appoint an Owner's Representative. The appointment of an Owner's Representative should be based on a structured selection exercise. The criteria for the selection and appointment of an Owner's Representative should be similar to those with which the Owner assesses its own capability at the outset and include consideration of the following:
- the corporate capability of the Company;
 - the competence of staff;
 - compatibility of key personnel proposed for the project and confirmation of their availability. Resumes of key personnel should demonstrate the competence of those persons designated for the design, construction, and project management of the works;
 - project planning competence, including the planning, procurement, execution, and interpretation of site and geotechnical investigations;
 - design capability, including competence in the type of tunnel projects to be designed and associated construction techniques;
 - capability in respect of the management (or procurement in the case of Design-Build arrangements) of design, design checking and review procedures, and the preparation of appropriate design-related risk assessments and risk registers; and
 - capability in respect of the identification and management during the design stage of health and safety design-related matters. This includes matters relating directly to all persons directly engaged on the project as well as such matters arising from design arrangement(s) that will impact third parties and the preparation of appropriate risk assessments and risk registers.
- 4.5 The Owner (or the Owner's Representative, herein interchangeable with "the Owner" if so employed) should take full responsibility for the information it prepares and issues to bidders as bid documents.
- 4.6 The Owner should make sure that provision is made for the appointment(s) of an identified individual [Risk Manager] or individuals who are suitably qualified and experienced and hence competent in risk management practices. These individuals will be responsible for execution of the risk management process, including the identification, collection, collation, and coordination of hazards and associated risks, and the development and preparation of appropriate risk assessments, risk registers, and risk response planning for each and all stages of a project consistent with the provisions of this GIRM. The Risk Manager should report directly to the Owner's Project Director or Project Manager.
- 4.7 The Owner should identify and make available arrangements for checking of designs, construction supervision, and monitoring of the project. The Owner should consider the use of Consulting Boards and Subject Matter Experts to provide independent advice through all stages of the project.
- 4.8 During the course of the project, the Owner should develop and maintain an overall Management Organization Chart that should identify reporting structures and lines of communication between the Owner, the

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

Designer(s), and the Contractor(s), demonstrating, in particular, the role and authority of the respective Risk Managers. This organization chart should be reviewed periodically and updated when there are changes to key personnel.

- 4.9 Through the course of the project, the Owner should maintain a risk register in accordance with the provisions outlined in Section 3.3.
- 4.10 The Owner should prepare a Project Risk Management Plan incorporating risk mitigation, response and management strategies throughout every stage of the project, including ensuring that the Designer's and the Contractor's contracts contain provision to implement the required risk management program.
- 4.11 The Owner should allow reasonably sufficient time in the Contract for the Contractor to complete the project.
- 4.12 The Owner should take into account all other matters relating to its role and responsibilities referred to in subsequent sections of this GIRM.

5. DESIGNER RESPONSIBILITIES

- 5.1 The Designer should have demonstrable technical and management competence appropriate to the type, scope, and stage of the project for which it is being contracted to perform design services.
- 5.2 Such competence should be demonstrable and evaluated on the basis of the:
 - a) corporate capability of the Company in relation to the proposed project; and
 - b) competence of individual staff members, including their availability for the project.
- 5.3 The Designer should have demonstrable experience in the assessment and management of risks as outlined in Paragraph 3.1.1 appropriate to the type, scope, and phase of the project for which it is being contracted to perform design services.
- 5.4 The Designer should make sure that provision is made for the appointment(s) of an identified individual [Risk Manager] or individuals who are suitably qualified and experienced and hence competent in risk management practices. These individuals will be responsible for execution of the risk management process, including the identification, collection, collation, and coordination of hazards and associated risks, and the development and preparation of appropriate risk assessments, risk registers, and risk response planning for the project type, scope, and phase of the project for which it is being contracted to perform design services consistent with the provisions of this GIRM. The Risk Manager should be report directly to the Designer's Project Director or Project Manager.
- 5.5 Through the course of the project, the Designer should maintain a risk register in accordance with the provisions outlined in Section 3.3. The Owner should contract with the Designer to be available throughout construction to coordinate with the Owner and Contractor as required.
- 5.6 The Designer should take into account all other matters relating to its role and responsibilities referred to in subsequent sections of this GIRM.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

6. CONTRACTOR RESPONSIBILITIES

- 6.1 The Contractor should have demonstrable technical and management competence appropriate to the type, scope, and phase of the project for which it is being contracted to execute.
- 6.2 Such competence should be demonstrable and evaluated on the basis of the:
 - a) corporate capability of the Company in relation to the proposed project; and
 - b) competence of individual staff members, including their availability for the project.
- 6.3 The Contractor should make sure that provision is made for the appointment(s) of an identified individual [Risk Manager] or individuals who are suitably qualified and experienced and hence competent in risk management practices. These individuals will be responsible for execution of the risk management process, including the identification, collection, collation, and coordination of hazards and associated risks, and the development and preparation of appropriate risk assessments, risk registers, and risk response planning for the project consistent with the provisions of this GIRM. The Risk Manager should be report directly to the Contractor's Project Director or Project Manager and his/her duties should not detract from those of the Safety, Quality, Construction, or Contract Managers.
- 6.4 The Contractor should, through the course of execution of the contract, maintain a risk register in accordance with the provisions outlined in Section 3.3.
- 6.5 In a Design-Build Form of Contract, the role of the Contractor's Designer should include, at a minimum, all of the provisions of Section 5.
- 6.6 The Contractor should take into account all other matters relating to its role and responsibilities referred to in subsequent sections of this GIRM.

7. INSURER RESPONSIBILITIES

- 7.1 The Insurer should have, or engage in an advisory role, a person with demonstrable technical and management competence appropriate to the type and scope of the project for which it is being contracted to provide insurance. That person should have knowledge and experience of the design and construction processes and methodologies being employed on the project.
- 7.2 Project Insurers should actively encourage compliance with this GIRM as it applies to projects involving tunnel and underground construction, to minimize the risk of physical loss or damage and associated delays. It follows that insurance policies covering tunnel and underground construction projects should benefit from provisions set forth in this GIRM.
- 7.3 Project Insurers should, in agreement with the Insured, add specific provisions, endorsements, and incentives to their Policy in recognition of the intent of the Parties to comply with this GIRM. There should be no ambiguity between the Insured and the Project Insurers as to insurance policy/contract requirements relative to the provisions of this GIRM.
- 7.4 Project Insurers (whether they are providing an Owner Controlled Insurance Program [OCIP], a Contractor Controlled Insurance Program [CCIP], or other types of insurance policies) should reserve the right to enter and inspect any project insured under an insurance policy and/or related documents within a reasonable

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

time once a request is made. The purpose of any inspection should be to assess compliance with the requirements of the insurance policy, including any specific provisions added to the policy in respect of this GIRM. Such inspections should be carried out by persons with technical competence appropriate to the type and scope of the project for which they are being contracted to provide insurance for as outlined in Paragraph 7.1 and may be accompanied by a representative from the insured party. The inspection should be viewed as a precursor to meetings and discussions regarding the ongoing management of risk on the project site(s).

- 7.5 On projects where the Owner chooses not to have an OCIP or CCIP and relies on the Designers' Professional Liability Insurance and Contractor's General Liability Insurance, the Owner should actively encourage compliance with this GIRM and, in agreement with the Designer and the Contractor, add specific provisions, endorsements, and incentives to their contracts or policies in recognition of the intent of the Parties to comply with this GIRM.

8. PROJECT PLANNING STAGE

8.1 General

- 8.1.1 For the purpose of this GIRM, the Project Planning Stage includes:
- a) project feasibility, conceptual, and preliminary engineering studies;
 - b) site and geotechnical investigations;
 - c) assessment and evaluation of project alternatives and the identification of a preferred project alternative and form of contract for construction (for example, design-bid-build or design-build); and
 - d) project design studies appropriate to the Form of Contract for construction.
- 8.1.2 The scope of work required under the Project Planning Stage should not be unnecessarily constrained by schedule considerations or the terms and conditions for the appointment of an Owner's Representative. The Owner should make sure that sufficient time and budget are available to:
- a) investigate and subsequently demonstrate the technical and financial viability of a project prior to proceeding to the Detail Design Stage and/or Construction Contract Procurement Stage;
 - b) initiate a systematic risk management program and develop appropriate risk registers for the Project Planning Stage; and
 - c) prepare designs appropriate to the Form of Contract to be adopted.

8.2 Site and Geotechnical Investigations

- 8.2.1 The nature, scope, and extent of site and geotechnical investigations to be carried out should be based on the nature, scope, and extent of the project; its location; and its geological/hydrogeological environments.
- 8.2.2 The Designer should make sure that the site investigation is planned and designed to obtain, inter alia, ground and groundwater information and geotechnical properties appropriate for the construction of the project, recognizing the likely method(s) of excavation and construction that may be employed. Such investigations should be designed, planned, and procured by personnel who are suitably qualified and experienced, and therefore competent in respect to the nature of the site and geotechnical investigations required for the proposed project.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

- 8.2.3 Site and geotechnical investigations should be carried out in accordance with applicable local and or national standards. In the absence of such, the basis on which site and geotechnical investigations are carried out should be clearly stated.
- 8.2.4 Site and geotechnical investigations carried out by the Owner should be comprehensive, phased appropriately, designed, and planned as to:
- identify, so far as reasonably practicable, artificial (human-made) and natural (geological/hydrogeological) hazards (including gases such as H₂S, methane, or radon) that will enable consequent risk to be assessed;
 - provide sufficient information on site conditions, adjacent structures, utilities, groundwater conditions, and previous history of the project site, including any constraints of an engineering significance relevant to the project, such as mining/mineral extraction and contamination;
 - enable realistic and reliable assessments of different excavation and tunneling methodologies to be made in terms of technical viability, cost, schedule, and impact to Third Parties. These assessments are equally applicable to temporary and permanent support/lining requirements and health and safety issues;
 - enable the financial and technical viability of the project to be assessed and confirmed at milestone stages throughout the planning and design project phases; and
 - enable alignment alternatives to be compared and evaluated in terms of feasibility, cost, schedule, risk, and constructability.
- 8.2.5 Site and geotechnical/geologic investigations should be executed and supervised by organizations that are suitably qualified and experienced for the scope, site, and ground conditions in which the investigations are being undertaken. The scope of the investigations should be revised to suit the conditions being encountered in relation to the proposed nature and scope of the project. The method of reporting should be stated clearly and unequivocally, and the results of the investigations, including laboratory and field testing, should be recorded factually.

8.3 Assessment and Evaluation of Project Alternatives

- 8.3.1 Assessments and evaluations of project alternatives should be carried out during the Project Planning Stage by the Owner. For a selected location, alignment, or alignment alternatives, such assessments and evaluations should take into account:
- the geology (including the potential for gases of a potentially harmful nature) and the hydrogeology (as characterized by site and geotechnical investigations);
 - tunnel construction methodologies (and other construction methodologies, as appropriate, associated with caverns, shafts, adits, and other underground structures) appropriate to the nature of the ground and the environment;
 - temporary and permanent ground support systems (for example, shotcrete linings, rock bolts/dowels, spilings, pre-cast concrete segmental linings, cast in-situ concrete, or other forms of tunnel linings);
 - ground and groundwater treatment measures (for example, the use of grouting, dewatering/depressurization, ground freezing, or other forms of ground stabilization) and their impact on the environment and to third parties (for example, groundwater abstraction/depressurization leading to settlements, noise, vibrations);

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

- e) ground movements and settlements at the ground surface and their impact on Third-Party structures or subsurface ground movements and their impact on buried structures such as utility services, adjacent tunnels, and underground structures (as characterized by site investigations);
 - f) environmental considerations, including dust, noise, vibrations, traffic, and movement of equipment;
 - g) health (including occupational health considerations) and safety;
 - h) hazardous materials, including gases, chemicals, and other pollutants or naturally occurring substances that could impact health or affect the durability of the permanent facility;
 - i) all other particular factors relevant to the proposed project location, geology, and environment, including permitting requirements from jurisdictional authorities;
 - j) recommendations for instrumentation and monitoring necessary during construction; and
 - k) cost and schedule implications.
- 8.3.2 The assessments and evaluations of project alternatives should include the identification and evaluation of associated alternative-related hazards and consequent risks. These should be presented in formalized risk assessments for each identified project alternative. The risk assessments should be continually reviewed and revised as appropriate during the Project Planning Stage to take into account the results of site and geotechnical investigation results and any other relevant information that becomes available during this stage.
- 8.3.3 For identified project alternatives (in terms of, for example, alignment, tunneling methodology, environmental considerations, and Third-Party considerations), the Owner should establish overall estimates of cost and time for each project alternative with costs assigned to scheduled activities. Furthermore, cost and schedule risk analyses should be undertaken to determine the potential out-turn costs and schedule durations in relation to project-alternative-related risks.
- 8.3.4 By such means, the Owner should determine a technically and financially viable preferred project alternative.
- 8.3.5 A risk assessment should be carried out and a risk register prepared for the preferred project alternative (or alternatives). This risk register should include the perceived hazards and associated risks, and indicate potential mitigating measures with comprehensive explanations for their basis, based on the studies carried out during the Project Planning Stage. The risks that have not been totally mitigated should be included within the contract information provided to the Designer in the design phase. For guidelines on addressing similar transfer of risk information from the Project Planning Stage to a contractor in a Design-Bid-Build method of procurement, refer to Section 10 of this document.

9. DESIGN STAGES

9.1 General

- 9.1.1 For the purpose of this GIRM, Design Stages include continued or advanced preliminary engineering and detailed or final designs for both permanent and temporary works. The design process for safety-critical works and/or temporary works that support the ground during construction shall be the same as for permanent works.
- 9.1.2 Prospective Designers should be provided with a comprehensive project brief (description and scope of work) from either the Owner or Contractor. The prospective Designers should review this brief and iden-

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

tify any deficiencies or omissions that could lead to a risk to the project. The Owner (or Contractor in the case of Design-Build) should be required to address these issues and make adjustments to the terms and scope of engagement prior to awarding the design contract.

9.2 Transfer of Information Between Designers

- 9.2.1 As a design moves from one stage to the next over the course of a project in a conventional Design-Bid-Build procurement, the Owner should make sure that all information developed and collated during previous Design Stages is made available to the Designer of the next stage, including risk assessments and risk registers. (For transfer of information through contract procurement, refer to Section 10.)
- 9.2.2 The Designer appointed and responsible for later Design Stages should—to the extent that it is responsible for the design—be required to evaluate this information and make recommendations to the Owner (or Contractor in the case of Design-Build) as appropriate with regard to further investigations and/or studies for the subsequent Design Stage to fulfill its scope of work.

9.3 Design Process

- 9.3.1 A fundamental objective of the design process is to achieve a design where the risk of failure or damage to the projects or to a Third Party from all reasonably foreseeable causes, including health and safety considerations, is minimized. High-consequence but low-probability events that could affect the project or a Third Party should also be considered.
- 9.3.2 The design process should include, where appropriate, sensitivity studies to assess the impact of:
 - a) construction tolerances;
 - b) variation in geotechnical design values;
 - c) variation in materials characteristics;
 - d) variation in workmanship and geometry;
 - e) methods of construction and the implementation of mitigation/contingency measures; and
 - f) natural perils exposure in the region of the project such as flood, storm, seismic, or tidal effects.
- 9.3.3 The Designer should prepare documentation that should include but not necessarily be limited to:
 - a) a description of the project component to be designed;
 - b) the design requirements and criteria to be adopted for each component;
 - c) a geotechnical assessment that should evaluate the geological and geotechnical information available (including the presence or generation of harmful gases, and ground and groundwater contamination) and ascribe design values to assessed ground and groundwater;
 - d) a description of the method of design (including reference to any applicable best practices and/or standards);
 - e) a description of the method(s) of analysis to be used for the design and justification thereof;
 - f) a design risk assessment that should consider the impact on the design of any realistic variation in the design criteria and/or design values adopted, based on the information available in relation to the anticipated/proposed method(s) of construction. The design risk assessment should take account of

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

potential failure mechanisms and include mitigation/contingency measures appropriate to the anticipated/proposed method(s) of construction;

- g) the checking procedure to be implemented for the design; and
- h) a description of the proposed instrumentation and monitoring.

This work should be collated by the Designer and presented in a Basis of Design Report (BODR).

- 9.3.4 Calculations, analyses, and assessments should also consider intermediate stages of construction.
- 9.3.5 The design process should include an assessment of the impact of construction on Third-Party infrastructure—including impacts on utilities—and buildings within the influence zone of the excavations. In this respect, the Designer should assemble, as far as reasonably practicable, all available records of foundations and other structures/artificial obstructions that could affect and/or be affected by the project.
- 9.3.6 The results from assessments of permit requirements, right-of-way applications, impacts to stakeholders and other third parties, design and contractual issues, construction issues, operational issues, health and safety issues, and other hazards assessed during the design phase should be presented in an appropriately formatted risk register.

9.4 Design Checks

- 9.4.1 All designs should be subject to a design check to make sure that the designs meet the fundamental requirement of Section 9.3.
- 9.4.2 The extent and scope of design checks should be appropriate to:
 - a) the complexity, degree of difficulty, and type of construction of the project (including excavation/support sequencing for intermediate construction stages, if applicable);
 - b) the level of risk assessed from the design risk assessment; and
 - c) any statutory or other requirements by an Owner or Third Party.

- 9.4.3 Design schedules should allow for sufficient time for the appropriate level of checking.

- 9.4.4 Both intradisciplinary and interdisciplinary reviews should be performed appropriate to the scope of the project.

9.5 Constructability of the Design

- 9.5.1 In a Design-Bid-Build procurement, the Owner should make sure that adequate construction expertise is available to undertake formal reviews of the design and to participate in the risk assessments and development of the risk registers. The review should include health and safety considerations and impacts on third parties.
- 9.5.2 The Designer should take into account the impact of staged or sequential excavations when assessing the feasibility of construction stages and hence the appropriateness of the design. Provisions should be made by the Owner for ensuring that the Designer's intent and requirements are adhered to during construction.
- 9.5.3 Where appropriate, the design should detail excavation support sequences and identify appropriate monitoring measures during the project for the range of anticipated ground and groundwater conditions. It should also include for the provision of contingency measures. The Designer should make sure the design is consistent with the fundamental requirements of Sections 8.2 and 8.3 in terms of geotechnical variability, workmanship, and construction tolerances.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

9.6 Validation of Design During Construction

- 9.6.1 Provision should be made for sufficient monitoring of the project during the construction stage to make sure that the design being implemented remains valid at all times.
- 9.6.2 Monitoring of the project should be executed by organizations and/or persons who are suitably qualified and experienced in the type, scope, and extent of the project to be constructed and hence competent for such work. The Designer should be involved or represented in the monitoring process.
- 9.6.3 Where design changes are implemented during construction, the Owner or Contractor (as appropriate to the method of procurement) should require the Designer of Record to validate the implementation of the proposed design change.
- 9.6.4 Design calculations and assumptions should be validated, as and where appropriate, through the monitoring and results of the specified geotechnical instrumentation.

10. CONSTRUCTION CONTRACT PROCUREMENT STAGE

10.1 General

- 10.1.1 For the purpose of this GIRM, the Construction Contract Procurement Stage includes:
 - a) the preparation and issue of contract documentation for bidding purposes;
 - b) the pre-qualification and selection of contractors for bidding where local and or state legislation allows;
 - c) bid assessment and selection of the Contractor; and
 - d) negotiations.

10.2 Preparation of Contract Documentation for Bidding Purposes

- 10.2.1 The preparation of contract documentation for bidding purposes should take due regard of the type of contract to be awarded (for example, Design-Bid-Build, Design-Build, Construction Management General Contractor, or other forms) and the Form of Contract.
- 10.2.2 The selection of a Form of Contract by the Owner and the drafting of its conditions should take due regard of the allocation of risks to each of the parties to the Contract, and consequently their liabilities.
- 10.2.3 Contract documentation (as well as subcontract documentation where deemed appropriate) should clearly demonstrate how the parties to the contract are to implement the provisions of this GIRM.
- 10.2.4 Contract documentation (as well as subcontract documentation where deemed appropriate) should include full disclosure of those hazards and associated risks identified during the Project Planning and Design Stages for the preferred project alternative and that continue to have a bearing on the project, including all data and interpretations that have any bearing on the risks. In a Design-Bid-Build procurement, the Owner should determine an appropriate method to provide this information with the contract documents during the procurement phase and reward good risk mitigation practices by the bidders within the constraints of the selection process.
- 10.2.5 Contract documentation (as well as subcontract documentation as appropriate) should clearly identify key work plans to be submitted that the Owner or its Representative considers critical for the construction of the project.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

- 10.2.6 Contract documentation (as well as subcontract documentation where appropriate) for a Design-Bid-Build procurement should include a Geotechnical Baseline Report (GBR) prepared by the Owner.
- 10.2.7 When prepared by the Owner, the GBR should be issued to bidders as integral and formative information on which bids should be based, and the Owner should take responsibility for the information so issued.
- 10.2.8 Under Design-Build Contracts, the Owner should require each bidder to submit, with their bid, their own interpretation and assessment of geotechnical conditions and identify any supplemental geotechnical investigations considered by the Design-Builder to be necessary for contractual baselines to be determined. If supplemental geotechnical investigations are not required, the requirements of the Geotechnical Baselines at time of bid and award should be defined and fully described in the Contract Documentation.
- 10.2.9 Where supplemental geotechnical investigations are proposed and accepted, the successful bidder should perform these investigations under the contract, following which a contract GBR should then be prepared and agreed on jointly with the Owner, using both pre-bid and post-bid geotechnical information as a baseline for design and construction.
- 10.2.10 When prepared by a bidder, the assessment of the geotechnical conditions and their associated risk and/or proposed geotechnical baselines should be used by the Owner in the bid assessment process.
- 10.2.11 In a Design-Build contract where the Owner provides bidders with only the Geotechnical Data Report (GDR), the Owner should require the Design-Build Contractor to provide a bid-phase Geotechnical Interpretive Report (GIR) with its bid documents based on its interpretation of the GDR, identifying at the same time locations where supplemental site investigation is needed to be undertaken to confirm the interpretations and to establish baselines. The bid-phase GIR should be used by the bidder for preliminary design and development of construction concepts. The GIR and the proposed supplemental site investigations should be used by the Owner in the assessments of the bids. Following award of the contract, and when the Design-Build Contractor has performed the agreed supplemental site investigations, the GIR should be updated, in agreement with the Owner, and the geotechnical baselines (GBR) established.
- 10.2.12 The GBR (prepared by either the Owner or the successful bidder in a Design-Build Form of Contract and then accepted by the Owner) should form part of the Contract and should provide the baseline against which encountered conditions can be assessed and compared.
- 10.2.13 The GBR should be realistic, not overly conservative, align with the work to be performed, be focused on construction parameters, and enable a Contractor to assess the geotechnical risks and reasonably price the project.
- 10.2.14 The Owner should, prior to the procurement phase, perform due diligence confirming that the goals in the bid documentation for Small/Minority/Disadvantaged Business Enterprise participation is achievable, taking due cognizance of the nature and scope of the work to be performed and the availability of such skills in the local marketplace.

10.3 Selection or Pre-Qualification of Contractors for Bidding Purposes

- 10.3.1 Wherever state legislation allows for pre-qualification, this key activity should have dedicated time and resources allocated to it by the Owner. The selection or pre-qualification of contractors for bidding purposes should require contractors to demonstrate relevant experience and qualifications.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

- 10.3.2 The requirements for selection or pre-qualification should be prescribed. Appropriate information to be sought should include:
- a) experience obtained on projects of similar scope and complexity, and the Owners of those projects. Previous Owners should be contacted for references (for example, on matters relating to the Contractor's performance and working relationships);
 - b) performance details on previous relevant projects;
 - c) financial status;
 - d) any proposed joint venture arrangements;
 - e) key staff available with the required qualifications;
 - f) current work load and available resources;
 - g) proposed use of subcontractors, supply chains, and details of any long-term working relationships; and
 - h) a statement of the Contractor's commitment to an ongoing systematic risk management program.

10.4 Time for Bidding

- 10.4.1 Provision should be made by the Owner for reasonable time for bidding. The time period should reflect the type of contract, the complexity of the project, and the requirements of the contract documentation, including the provisions of work plans and risk registers.

10.5 Risk Allocation Report

- 10.5.1 A Risk Allocation Report should be prepared that clearly identifies project risks from the risk register and how each risk is allocated among the project parties (Owner or Contractor).

10.6 Procurement

- 10.6.1 Risk assessment work carried out during the procurement stage of a "best value" procurement should provide an important contribution to the selection of the Contractor and in the finalization of the Contract for construction.

- 10.6.2 Notwithstanding the issue of a Project Risk Register in the Contract Documentation (whether it be for reference only or otherwise), bidders in a best-value procurement should be required to prepare and submit their own project risk register based on the contract information provided, with descriptions of risk mitigation/control/contingency measures.

- 10.6.3 Contract documentation should clearly set out the information required for assessment of bidders, together with the criteria and the weighting on which the evaluation of the bidders will be based. This should include the weighting assigned to the approach to risk management throughout the project life cycle.

- 10.6.4 Pre-award risk management and risk allocation discussions and agreements should be fully documented and included (where appropriate) in the escrow bid documents.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

11. CONSTRUCTION STAGE

11.1 General

11.1.1 This section of this GIRM identifies the elements that a Contractor should comply with as a minimum (in addition to any statutory requirements), prior to and during construction, and should be read in conjunction with all other sections of this GIRM.

11.2 Pre-Construction Activities

11.2.1 Following award of contract, but prior to the Notice to Proceed (NTP), time should be allowed in the schedule for the following activities:

- a) carrying out a risk workshop between Owner, Designer, Construction Manager, and Contractor to generate a construction risk register, using, as appropriate, the existing project risk register, Risk Allocation Report, and or the successful bidder's risk register as the basis for this workshop; and
- b) the preparation and submission of a Project Risk Management Plan incorporating a Construction Stage Project Risk Register.

11.2.2 Following the NTP, but prior to commencing on site, time should be allowed in the schedule for the following activities:

- a) the preparation and submission of Health and Safety, Quality, and Environmental Plans;
- b) the preparation of a Construction Management Plan;
- c) the identification, design (as necessary under the Contract), and procurement of items that involve long lead items;
- d) pre-construction planning and work plans;
- e) obtaining all necessary statutory consents;
- f) constructability reviews;
- g) any necessary third-party agreements, memorandums of understanding (MOUs), and right-of-way acquisitions; and
- h) photographic (and, where appropriate, video) documentation of the pre-construction conditions of all structures within the potential zone of influence of the project excavations.

11.3 Risk Management Procedures

11.3.1 The Project Risk Management Plan should include the Construction Stage Project Risk Register that is used to record all project-related risks identified for the Construction Stage of the project, including the unmitigated project-related risks brought forward from the Owner's pre-contract risk register.

11.3.2 The Project Risk Management Plan should identify the process and procedures for:

- a) regular monitoring and review of the Construction Stage Project Risk Register;
- b) the means of identifying and formally recording hazards and associated risks that may arise during the course of the Construction Stage and possible mitigating actions;
- c) identifying progress in the reduction/mitigation of the overall impact and number of risks;

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

- d) updating the frequency of the Construction Stage Project Risk Register (recommended on a monthly basis, and no less than quarterly depending on the nature of the risks and the stage of the project) and the ability to identify any changes to the project risk;
 - e) management and control procedures;
 - f) proposed contingency measures, and
 - g) cost and schedule implications (regardless of liability) of the implementation of contingency measures.
- 11.3.3 The Construction Stage Project Risk Register should identify the party responsible for management of the risks, actions, and measures required to mitigate the impact of the identified risks on the project. The Construction Stage Project Risk Register may also include the health and safety risk assessments related to the construction activities (in respect of any pertaining statutory or legislation requirements). Disagreements between the Owner and the Contractor as to the ownership or responsibility for the risk should be resolved and not set aside for future dispute.

11.4 Contractors' Staff and Organization

- 11.4.1 Prior to commencing work on site (and thereafter whenever there is a significant change), the Contractor should submit an overall site organization chart. This chart should identify the reporting structure and lines of communication of key personnel and those persons nominated for safety-critical work (including a designated Safety Representative) and a Quality Assurance/Quality Control Manager.
- 11.4.2 The site organization chart should be in sufficient detail to enable the Owner to identify how and with whom the Contractor intends to manage the project. The chart should be submitted together with the names and resumes of all key personnel, and their roles and responsibilities, to demonstrate the competence of those persons who will be employed in the management of the project. The organization chart should be updated when personnel are added or changed.
- 11.4.3 The Contractor should identify the policy it uses to ensure that all workers have the necessary competency to carry out the processes required for the construction of the project and should include details of the Contractor's training policy for all workers.
- 11.4.4 The Contractor should provide a training plan that indicates how it intends to ensure that all staff members are and will remain adequately and suitably trained for the positions and responsibilities that they are to hold.
- 11.4.5 The Contractor should develop and implement a procedure for the dissemination and cross communication of information to all parts of the project. The method of communication should be agreed on with the Owner.

11.5 Constructability

- 11.5.1 In a Design-Bid-Build Contract, the Contractor should, through the duration of the contract, carry out constructability reviews jointly with the Owner and Designer where the selected construction methods are different than the assumptions adopted during the Design Stages. The frequency of such reviews should be consistent with the requirement of ensuring that the construction methods being employed and to be employed are suitable and appropriate in light of the nature and scope of the project and the monitoring of the project.
- 11.5.2 In a Design-Build Contract, the Contractor should, through the duration of the contract, carry out constructability reviews jointly with its Designer. The frequency of such reviews should be consistent with the requirement of ensuring that the construction methods being employed and to be employed are suitable

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

and appropriate in light of the nature and scope of the project and the monitoring of the project. The Owner should be kept apprised of these constructability reviews.

11.6 Methods and Equipment

- 11.6.1 Prior to commencement of any operation or process in connection with construction of the project, the Contractor should provide the Owner with fully detailed work plans, inspection and test plans, and risk assessments.
- 11.6.2 Work plans should clearly and unequivocally detail the methods and resources with which the Contractor intends to construct the project and should cover all aspects of the project, including specification, design, environment, health and safety, and quality. Work plans should reflect and demonstrate compliance with accepted current practice and standards for the operations to be carried out.
- 11.6.3 Inspection and test plans should clearly and unequivocally detail how the Contractor intends to inspect, check, and certify (where contractually required) the project throughout the construction process and should detail “hold” points requiring approval by others such as the Designer, Owner, or Owner’s Representative if required in accordance with the Contract requirements. Inspection and test plans should identify those sections of the specification that are being referred to and the tolerances permitted.
- 11.6.4 Risk assessments should deal with specific risks associated with the construction methods, plant, equipment, and materials to be employed, including fire, flood, and ground-collapse-related risks associated with the working environment, construction methods, specific material, and equipment to be used in the construction of the project, having due regard to any local, state and federal legislation, standards, or codes, including those relating to health and safety. Risk assessments should demonstrate that the hazards and associated risks involved in the construction process have been fully identified and assessed. The Construction Stage Project Risk Register should demonstrate that appropriate work plans have been developed to include all mitigation measures necessary to reduce the impacts of identified risks to ALARP levels and that contingency plans are in place in the event that a risk event is realized.
- 11.6.5 The work plans and inspection and test plans should indicate what monitoring and checking should be carried out, by whom, and at what intervals. Quality records should be produced and provided to satisfy compliance with the Contract requirements. Procedures for dealing with non-compliances should be included.
- 11.6.6 A register of approved signatures should be maintained together with authority levels for all staff members employed in the checking and certifying of inspection and test plans and quality records.
- 11.6.7 The work plans (or method statements) should identify what equipment and method is intended to be used for the project and the criteria for selection of that method or equipment, with regard to operation, ground conditions, safety systems, maintenance, environmental monitoring, access, settlement, and emergency procedures.

11.7 Management Systems

- 11.7.1 Following NTP, the Contractor should provide the Owner with a copy of its Health and Safety Plan, Quality Plan, Environmental Plan, and Construction Stage Risk Management Plan together with an overall Project Management Plan.
- 11.7.2 In addition to the requirements of the Health and Safety, Quality, and Environmental Plans, the overall Management Plan should identify and demonstrate the systems the Contractor intends to use to manage and control the construction process with regard to the requirements of the Contract and also relating to this GIRM.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

11.7.3 This Management Plan should include, as a minimum, procedures for the management and control of the following:

- a) procurement of materials, equipment, and designs (either for temporary or permanent work, according to the requirements of the Contract);
- b) project planning and construction staging;
- c) staff and workforce training;
- d) health and safety, including emergency procedures and tunnel rescue teams;
- e) quality control, including inspection, testing, and control/calibration of test equipment;
- f) risk management; and
- g) surveying.

If any of the above are included in other project-specific plans (such as the Quality Plan, for example), the Management Plan should merely include a reference to the relevant sections of the other project-specific plans to avoid duplication.

11.8 Monitoring

11.8.1 Monitoring of the construction processes should be carried out by use of inspection and test plans, audits, and management reviews. Inspection and test plans should clearly identify the responsibilities for monitoring by the Owner and Contractor in accordance with the construction contract. A comprehensive real-time monitoring program that will provide confirmation of design assumptions and early detection of any unexpected behavior should be implemented.

11.8.2 With particular regard to projects in urban areas and where Third-Party equipment or structures are within the influence zone, work plans should clearly identify “trigger levels” at which contingency action should be taken. The work plans should clearly identify the reporting roles and responsibilities and what actions are to be taken and by whom at each trigger level.

11.8.3 Where risks with a high severity rating are identified and/or where the design is based on an observational approach, instrumentation and the frequency of measurements should be increased to provide comprehensive real-time monitoring. The Contractor should provide the Owner with an Emergency and Contingency Plan for dealing with the risk in the event that it is realized.

11.8.4 The Owner or the Contractor should give an early warning notice to the other as soon as either becomes aware of anything that may affect safety, involve the contract price, delay completion, impair the performance of the works in use, and/or impede meeting key dates. The early warning should be given to maximize the time available to consider the problem and thereby to increase the likelihood of finding the best mitigation. The Owner and the Contractor should follow up with a risk-reduction meeting and, if they both agree that there would be added value, should invite other key people to the risk-reduction meeting. The intention for the Owner, Contractor, and any other individuals attending the meeting should be to cooperate and ensure, as much as possible, that actions are taken and decisions made that avoid or mitigate the effects of identified risks on safety, cost, quality, and time. Following the risk-reduction meeting, the Construction Stage Project Risk Register should be reviewed and updated. Regardless of, and in addition to, a

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

risk-reduction meeting being called in response to an early warning notice, risk-reduction meetings should be scheduled on a regular basis.

- 11.8.5 The Contractor should include a section on risk management in the monthly/period progress reports. This section should include reports on its risk mitigation efforts, early warnings, potential impacts and how these may impact safety, the use of provisional sums, potential contract modifications, key milestones, and the completion date.

11.9 Management of Change

- 11.9.1 Insurers and the Insured Party should agree, as part of the insurance policy, how changes to the design and/or method of working, which result in significantly greater assessed risks to the project, should be communicated.
- 11.9.2 All Value Engineering proposals submitted by the Contractor to the Owner for approval during the construction phase should include a statement setting out in full the technical benefits together with any variation in the project risk assessments as a consequence of the proposed change. Value Engineering proposals should be evaluated for potential negative impacts to the project's risk profile. Full specifications and drawings, as appropriate, should be prepared for review and approval by the Owner before the change is implemented.
- 11.9.3 Regardless of the party that proposes a Value Engineered change to the project design or construction, or the phase of the project in which the change is first raised, all appropriate requirements for the management of risk resulting from the change included in this GIRM should apply.

11.10 Feedback to Industry

- 11.10.1 As an improved management practice, all Owners should, at the earliest opportunity following settlement and or resolution of outstanding legal and commercial issues pertaining to completion of the project, permit "lessons learned" documentation to be provided to the industry on both what worked and what didn't work, hazards that were expected and didn't happen, those hazards that weren't expected and did happen, new management techniques, new engineering analysis methods, new means and methods, including (where appropriate) equipment performance.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

APPENDIX A: Definitions and Terms Used in This GIRM

ALARP

An acronym for “as low as reasonably practicable.” A principle used for defining a level of risk that can be achieved and that is acceptable to all those that may be affected by the risk being realized.

Bid Documentation

Documentation prepared and issued by an Owner when requiring the services or goods of a supplier that detail the services or goods required and issued.

Basis of Design Report (BODR)

A report that records the concepts, calculations, decisions, and product selections used to meet the Owner's project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

BODR

See Basis of Design Report.

CCIP

See Contractor Controlled Insurance Program.

Constructability

An objective review of the design drawings and specifications by experienced construction individuals to assess the practicalities of constructing the designed project.

Construction Contract Procurement Stage

The stage of a project that involves the preparation and issue of Contract Documentation for bidding purposes following the selection or pre-qualification of contractors for bidding and bid assessment where possible.

Construction Stage

The stage of a project that involves all aspects relating to the implementation of designs for completion of the project to the requirements of the Owner.

Construction Stage Project Risk Register

A register that records all project-related risks identified for the Construction Stage of the project and includes and identifies the project-related risks brought forward from the Owner's pre-contract Risk Register, the owners of the risks and actions, and measures required to mitigate the impact of the identified project-related risks on the project.

Contract Award

The award of a construction contract to a principal Contractor by the Owner.

Contract Documentation

Documentation that defines the scope of work, the nature, the Form and Conditions of Contract (including specifications for the project), and the allocation and or apportionment of risk and payment mechanisms.

Contractor

The organization appointed by the Owner for the implementation of the project, appropriate to the Form of Contract.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

Contractor Controlled Insurance Program (CCIP)

Under a Contractor Controlled Insurance Program (commonly referred to as “CCIP Insurance”), insurance coverage is typically provided for physical loss or damage to the contract work and may include/allow for physical loss or damage to construction plant and equipment or machinery and Third-Party property. In addition, it may also include coverage for removal of debris; architects’, engineers’, or surveyors’ fees; and expediting expenses. A CCIP can include insurance coverage for all subcontractors.

Corporate Competence

The competence of an organization as a whole gained through precedent experience in relation to the nature, form, complexity, and extent of tunnel and underground design and construction projects proposed and the services to be provided.

Design Checking

The management process for checking that the design is correct and internally consistent, including numerical accuracy of the calculations, the dimensional accuracy of the drawings, and the constructibility of the overall concept.

Design Stage(s)

The stage or stages of a tunnel and or underground projects that involve the preparation of preliminary and/or detailed designs for permanent and temporary work designs during the Construction Stage.

Designer

The individual/organization chosen to undertake the design process. Different designers may be appointed for different stages of the design process. The designer is typically a firm of consulting engineers but may be the design unit of a contractor, or an individual.

Form of Contract

The contractual arrangement between the purchaser of services/goods and the provider of the services/goods.

GBR

See Geotechnical Baseline Report.

GDR

See Geotechnical Data Report.

Geotechnical Baseline Report (GBR)

A contract document that defines the baseline conditions on which contractors will base their bids and select their construction methods.

Geotechnical Baselines

Definitive statements about the nature, form, composition, structure, and behavior of the ground (both artificial and natural) and groundwater, together with geotechnical properties of the ground, that serve as a basis for construction contract bidding purposes and for the subsequent application of the contract with respect to the conditions actually encountered during construction of the project(s). The Geotechnical Baselines represent a contractual definition of “what is assumed will be encountered.” However, the provision of such conditions in the contract is not a warranty that those same conditions will actually be encountered.

Geotechnical Data Report (GDR)

A document that presents the factual subsurface data for the project without including an interpretation.

Geotechnical Interpretive Report (GIR)

A document that presents an assessment of the geotechnical and geological conditions for the proposed project.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

GIR

See Geotechnical Interpretive Report.

GIRM

An acronym for this Guidelines for Improved Risk Management of Tunnel and Underground Construction Projects in the United States of America document.

Hazard

An event that has the potential to impact a project and give rise to negative consequences associated with, among other things, health and safety, environment, design and construction of the project, cost and schedule, third parties, and existing facilities.

Inspection and Test Plan

A description and definition of the methods and procedures to be used to monitor, maintain, and check quality within the construction process.

Insured

The collective nomenclature for the insured parties named in the Insurance Policy. This may include the Owner and the Principal Contractor, and may include subcontractors and design professionals (for their on-site activities).

Key Personnel

Named staff members identified by an organization nominated to undertake important roles within the work scope required.

Local/State/Federal Legislation

The legal and legislative framework applicable in terms of federal, state, county, and city in which the projects are to be carried out that give rise to statutory duties, responsibilities, and requirements to Owners and/or Owner's Representatives, Designers, and/or Contractors.

Management Plan

A plan, in addition to the requirements of Health and Safety, Quality, and Environmental Plans, that identifies and demonstrates the systems and procedures the Contractor will use to manage and control the construction process.

Memorandum of Understanding (MOU)

A document that describes a bilateral or multilateral agreement between two or more parties. It expresses a convergence of will between the parties, indicating an intended common line of action.

MOU

See Memorandum of Understanding.

Notice to Proceed (NTP)

A written notice from the project Owner to the Contractor in which the Contractor is authorized to proceed with the work on a specified date.

OCIP

See Owner Controlled Insurance Program.

Owner

The final owner of the project and the purchaser of goods or services. The purchase is generally governed by a contract.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

Owner Controlled Insurance Program

An insurance policy held by the Owner that is typically designed to cover virtually all liability and loss arising from the construction project (subject to exclusions). The policy package usually contains a Commercial General Liability Policy, Workers' Compensation Policy with Employers' Liability, and, depending on the project or program in place, specific forms outlining coverage via forms endorsement. Also known as a "Wrap-Up" in the industry.

Owner's Representative

An individual, or company, that has been retained by the Owner to look after the interests of the Owner.

Pre-Qualification

A process used by project Owners to assess prospective Designers, Contractors, or Suppliers against pre-determined criteria.

Project

A tunnel(s), cavern(s), shaft(s), and associated underground structures however constructed and including the renovation of existing underground structures.

Project Brief

The performance specification created by the Owner that provides a description and details (scope) about the requirements of the completed project. Within the brief there should be details of intended usage of the project, capacity requirements, and lifespan specification. Additionally, there should be an indication of overall budget availability and proposed time for delivery.

Project Insurers

The collective nomenclature for the providers of the Insurance Policy, (OCIP, CCIP, or other forms) for a project. The Project Insurers may be a single company or a number of insurers operating in a co-insurance arrangement. In the instance of co-insurance, there is likely to be a nominated Lead Insurer who will be the main point of contact for the Insured.

Project Planning Stage

The stage of a project that includes project feasibility studies, site and geotechnical investigations, and the assessment and evaluation of project alternatives, including identification of a preferred project alternative (or alternatives) and Form of Contract for construction.

Project Risk Management Plan

A document identifying the means and methods for the regular monitoring and review of the Project Risk Register at each stage of the project wherein the hazards and associated risks that arise during the course of the Construction Stage are formally recorded; progress in the reduction/mitigation of the overall impact/number of risks is documented; and the Project Risk Register and hence any changes to the project risk profile are updated. Risk management plans can be prepared for each phase of the project.

Project Risk Profile

An assessment of the residual risks at any point in time during a project that potentially impacts the outcome of that project.

Risk

The consequence (or severity) of a hazard times the probability for occurrence of the hazard.

GUIDELINES FOR IMPROVED RISK MANAGEMENT ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA

Risk Assessment

The formalized process of identifying hazards and associated risks; of evaluating their consequence and probability of occurrence; and of preparing strategies as appropriate for preventive, mitigating, and contingent actions.

Risk Management

The overall systematic process of risk assessment and providing for risk mitigation and control.

Risk Register

A formalized record of risks identified from the risk assessment process, including full descriptive details of mitigation and control measures, risk owners, and with appropriate cross-references. The Risk Register is the primary means of recording and monitoring the Risk Management process.

Third Party

A party that is affected by the actions of two other parties who are in a contractual relationship.

Value Engineering

The process of adding value to a project (for example, by reducing cost and/or time) during the design and construction process.

Work Plan (or Method Statement)

A document prepared in advance of undertaking design or construction work that details the methods to be adopted as well as the people, equipment, and supporting documentation required to undertake the work.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

APPENDIX B: Recommended Minimum Deliverables for Compliance with This GIRM

SECTION/ PARAGRAPH	RESPONSIBLE PARTY	DELIVERABLES	RECOMMENDATIONS
4. OWNER RESPONSIBILITIES			
4.8	Owner	Overall Management Organization Chart	During the course of the project, the Owner should develop and maintain an overall Management Organization Chart that should identify reporting structures and lines of communication between the Owner, the Designer(s), and the Contractor(s), demonstrating, in particular, the role and authority of the respective Risk Managers. This organization chart should be reviewed periodically and updated when there are changes to key personnel.
4.9	Owner	Project Risk Register	Through the course of the project, the Owner should maintain a risk register in accordance with the provisions outlined in Section 3.3.
4.10	Owner	Project Risk Management Plan	The Owner should prepare a Project Risk Management Plan incorporating risk mitigation, response and management strategies throughout every stage of the project, including ensuring that the Designer's and the Contractor's contracts contain provision to implement the required risk management program.
5. DESIGNER RESPONSIBILITIES			
5.5	Designer	Risk Register	Through the course of the project, the Designer should maintain a risk register in accordance with the provisions outlined in Section 3.3. The Owner should contract with the Designer to be available throughout construction to coordinate with the Owner and Contractor as required.
6. CONTRACTOR RESPONSIBILITIES			
6.4	Contractor	Risk Register	The Contractor should, through the course of execution of the contract, maintain a risk register in accordance with the provisions outlined in Section 3.3.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

APPENDIX B, Continued

SECTION/ PARAGRAPH	RESPONSIBLE PARTY	DELIVERABLES	RECOMMENDATIONS
8. PROJECT PLANNING STAGE			
8.3.1	Owner	Assessments and evaluations of project alternatives	Assessments and evaluations of project alternatives should be carried out during the Project Planning Stage by the Owner.
8.3.2	Owner	Formalized risk assessments for each identified project alternative	The assessments and evaluations of project alternatives should include the identification and evaluation of associated alternative-related hazards and consequent risks. These should be presented in formalized risk assessments for each identified project alternative.
8.3.3	Owner	Estimates of cost and time	For identified project alternatives (in terms of, for example, alignment, tunneling methodology, environmental considerations, Third-Party considerations), the Owner should establish overall estimates of cost and time for each project alternative with costs assigned to scheduled activities.
8.3.5	Owner	Risk Register	A risk assessment should be carried out and a risk register prepared for the preferred project alternative (or alternatives).
9. DESIGN STAGES			
9.1.2	Owner	Project Brief	Prospective Designers should be provided with a comprehensive project brief (description and scope of work) from either the Owner or Contractor.
9.2.1	Owner	Risk Assessments and Risk Registers	As a design moves from one stage to the next over the course of a project in a conventional Design-Bid-Build procurement, the Owner should make sure that all information developed and collated during previous Design Stages is made available to the Designer of the next stage, including risk assessments and risk registers.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

SECTION/ PARAGRAPH	RESPONSIBLE PARTY	DELIVERABLES	RECOMMENDATIONS
9.2.2	Designer	Recommendations with regard to further investigations and/or studies for the subsequent design stage	The Designer appointed and responsible for later Design Stages should—to the extent that it is responsible for the design—be required to evaluate this information and make recommendations to the Owner (or Contractor in the case of Design-Build) as appropriate with regard to further investigations and/or studies for the subsequent Design Stage to fulfill its scope of work.
9.3.3	Designer	Basis of Design Report (BODR)	Project documentation during the design stages should be collated by the Designer and presented in a BODR.
9.3.5	Designer	Available Third-Party building records	The design process should include an assessment of the impact of construction on Third-Party infrastructure—including impacts on utilities—and buildings within the influence zone of the excavations. In this respect, the Designer should assemble, as far as reasonably practicable, all available records of foundations and other structures/artificial obstructions that could affect and/or be affected by the project.
10. CONSTRUCTION CONTRACT PROCUREMENT STAGE			
10.2.6	Owner	Geotechnical Baseline Report (GBR)	Contract documentation (as well as subcontract documentation where appropriate) for a Design-Bid-Build procurement should include a GBR prepared by the Owner.
10.2.8	Bidder	Geotechnical Interpretive Report (GIR)	Under Design-Build Contracts, the Owner should require each bidder to submit, with their bid, their own interpretation and assessment of geotechnical conditions and identify any supplemental geotechnical investigations considered by the Design-Builder to be necessary for contractual baselines to be determined. If supplemental geotechnical investigations are not required, the requirements of the Geotechnical Baselines at time of bid and award should be defined and fully described in the Contract Documentation.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

APPENDIX B, Continued

SECTION/ PARAGRAPH	RESPONSIBLE PARTY	DELIVERABLES	RECOMMENDATIONS
10.2.9	Owner/Contractor	Geotechnical Baseline Report (GBR)	Where supplemental geotechnical investigations are proposed and accepted, the successful bidder should perform these investigations under the contract, following which a contract GBR should then be prepared and agreed on jointly with the Owner, using both pre-bid and post-bid geotechnical information as a baseline for design and construction.
10.2.11	Bidder	Bid-phase Geotechnical Interpretive Report (GIR)	In a Design-Build contract where the owner provides bidders with only the Geotechnical Data Report (GDR), the Owner should require the Design-Build Contractor to provide a bid-phase GIR with its bid documents based on its interpretation of the GDR, identifying at the same time locations where supplemental site investigation is needed to be undertaken to confirm the interpretations and establish baselines. The bid-phase GIR should be used by the bidder for preliminary design and development of construction concepts. The GIR and the proposed supplemental site investigations should be used by the Owner in the assessments of the bids. Following award of the contract and when the Design-Build Contractor has performed the agreed supplemental site investigations, the GIR should be updated, in agreement with the Owner, and the geotechnical baselines (GBR) established.
10.5.1	Owner	Risk Allocation Report	A Risk Allocation Report should be prepared that clearly identifies project risks from the risk register and how each risk is allocated among the project parties (Owner or Contractor).
10.6.2	Bidder	Project Risk Register	Notwithstanding the issue of a Project Risk Register in the Contract Documentation (whether it be for reference only or otherwise), bidders in a best-value procurement should be required to prepare and submit their own project risk register based on the contract information provided, with descriptions of risk mitigation/control/contingency measures.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

SECTION/ PARAGRAPH	RESPONSIBLE PARTY	DELIVERABLES	RECOMMENDATIONS
11. CONSTRUCTION STAGE			
11.3.1	Contractor	Project Risk Management Plan	The Project Risk Management Plan should include the Construction Stage Project Risk Register that is used to record all project-related risks identified for the Construction Stage of the project, including the unmitigated project-related risks brought forward from the Owner's pre-contract risk register.
11.4.1	Contractor	Site organization chart	Prior to commencing work on site (and thereafter whenever there is a significant change), the Contractor should submit an overall site organization chart. This chart should identify the reporting structure and lines of communication of key personnel and those persons nominated for safety-critical work (including a designated Safety Representative) and a Quality Assurance/Quality Control Manager.
11.4.4	Contractor	Training plan	The Contractor should provide a training plan that indicates how it intends to ensure that all staff members are and will remain adequately and suitably trained for the positions and responsibilities that they are to hold.
11.4.5	Contractor	Communications procedure	The Contractor should develop and implement a procedure for the dissemination and cross communication of information to all parts of the project. The method of communication should be agreed on with the Owner
11.5.1	Contractor	Constructability reviews	In a Design-Bid-Build Contract, the Contractor should, through the duration of the contract, carry out constructability reviews jointly with the Owner and/or the Owner's Representative and Designer where the selected construction methods are different than the assumptions adopted during the Design Stages.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

APPENDIX B, Continued

SECTION/ PARAGRAPH	RESPONSIBLE PARTY	DELIVERABLES	RECOMMENDATIONS
11.5.2	Design-Build Contractor	Constructability reviews	In a Design-Build Contract, the Contractor should, through the duration of the contract, carry out constructability reviews jointly with its Designer.
11.6.1	Contractor	Work plans	Prior to commencement of any operation or process in connection with construction of the project, the Contractor should provide the Owner or the Owner's Representative with fully detailed work plans, inspection and test plans, and risk assessments.
11.6.6	Contractor	Approved signatures	A register of approved signatures should be maintained together with authority levels for all staff members employed in the checking and certifying of inspection and test plans and quality records.
11.7.1	Contractor	Health and Safety Plan Quality Plan Environmental Plan Construction Stage Risk Management Plan	Following Notice to Proceed, the Contractor should provide the Owner or the Owner's Representative with a copy of its Health and Safety Plan, Quality Plan, Environmental Plan, and Construction Stage Risk Management Plan together with an overall Project Management Plan.
11.8.3	Contractor	Emergency and Contingency Plan	Where risks with a high severity rating are identified and/or where the design is based on an observational approach, instrumentation and the frequency of measurements should be increased to provide comprehensive real-time monitoring. The Contractor should provide the Owner with an Emergency and Contingency Plan for dealing with the risk in the event that it is realized.

**GUIDELINES FOR IMPROVED RISK MANAGEMENT
ON TUNNEL AND UNDERGROUND CONSTRUCTION PROJECTS IN THE UNITED STATES OF AMERICA**

SECTION/ PARAGRAPH	RESPONSIBLE PARTY	DELIVERABLES	RECOMMENDATIONS
11.8.4	Owner/ Contractor	Early warning notice	The Owner (or Owner's Representative) or the Contractor should give an early warning notice to the other as soon as either becomes aware of anything that may affect safety, involve the contract price, delay completion, impair the performance of the works in use, and/or impede meeting key dates.
11.8.5	Contractor	Progress reports	The Contractor should include a section on risk management in the monthly/period progress reports. This section should include reports on its risk mitigation efforts, early warnings, potential impacts and how these may impact safety, the use of provisional sums, potential contract modifications, key milestones and the completion date.
11.9.2	Owner/ Contractor	Value Engineering proposals	All Value Engineering proposals submitted by the Contractor to the Owner or the Owner's Representative for approval during the construction phase should include a statement setting out in full the technical benefits together with any variation in the project risk assessments as a consequence of the proposed change.
11.10.1	Owner	Lessons learned	As an improved management practice, all Owners should, at the earliest opportunity following settlement and or resolution of outstanding legal and commercial issues pertaining to completion of the project, permit "lessons learned" documentation to be provided to the industry on both what worked and what didn't work, hazards that were expected and didn't happen, those hazards that weren't expected and did happen, new management techniques, new engineering analysis methods, new means and methods, including (where appropriate) equipment performance.



12999 E. Adam Aircraft Circle
Englewood, CO 80112

www.smenet.org/uca