

# Water Control & Structures Structures Design Manual



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## **SECTION 1 - GENERAL**

### **1.1 INTRODUCTION**

This manual, appendices and references shall be used for the provision of engineering services on projects where an Engineering Service Provider (ESP) is retained by MIT.

Where a discrepancy exists between this document and the documents prepared specifically for a project (e.g. Terms of Reference), the latter shall take precedence. Because of the evolving nature of standards, guidelines, legislation, regulations, specifications and engineering practices, it is impractical to expect all the contents of this document and the documents referenced to be up-to-date. The ESP is responsible for using current standards, design codes and guidelines and for ensuring that all current legislation and regulations are being followed. In the event of discrepancies, the hierarchy of documents shall be as follows, in descending order:

- Legislation and Regulations
- Agreement
- Terms of Reference
- Engineering Technical Standards, Warrants and Processes
- MIT Water Control and Structures - "Structures Design Manual"
- MIT Water Control and Structures - "ESP Engagement and Administration Manual"

The ESP retained by MIT is responsible for the engineering integrity and professional liability of all work performed under their Agreement, including work by any Sub-ESP. The checking of the ESP's or Sub-ESP's work by MIT or the signing of drawings by MIT staff does not relieve the ESP from any responsibility for the work. Therefore, this manual will generally use the terminology of "acceptance" rather than "approval" when referring to engineering issues submitted to MIT by the ESP.

All guidelines, manuals or other documents referred to in this manual are the current edition or version unless specifically noted.

MIT hereby gives permission for the ESP to copy this manual solely for use within the firm.

#### **1.1.1 DEFINITIONS**

The following words, when used in this document, shall have the meaning as defined below:

Acceptance	Work is accepted by MIT without detailed checking of the engineering principles and calculations.
Agreement	Engineering services agreement between MIT and the ESP, normally called the "ESP Agreement".
Approval	Subject work shall be "approved" by MIT for matters relating to things such as MIT policy, funding or agreement extensions. MIT will also accept or approve Design Exceptions as required (for further explanation see Section 1.5.3).
As-Built Drawings	Updated contract drawings that include any changes that occurred during construction.
Bridge Structure	Structure typically built on the provincial highway network and water control system that cross waterways. Major bridges include channel and box precast girder bridges and I-girder bridges. Typically major bridges are river crossings, and major structures are highway overpasses/underpasses or railway crossings.



Condition Assessment	<p>In a Condition Assessment, the overall condition will be described by the results of the following special investigations:</p> <ul style="list-style-type: none"><li>• Level 3 inspections</li><li>• strength evaluation</li><li>• settlement/movement monitoring</li><li>• functionality review.</li></ul> <p><b>Note:</b> the Project TOR will identify which of the investigations shall be included in any particular assessment. The remaining service life of the structure will be determined and management strategy with costs established.</p> <p>Material condition surveys typically form part of the Level 3 inspections and the data collected will be further used to design any rehabilitation work and aid in contract quantity determination in the Detailed Design Phase.</p>
Construction Tender Package	<p>One of the deliverable products of the detailed design phase of the project. This package normally includes drawings, special provisions, tender documents, an “Engineer’s Estimate”, Amendment(s), cover letter, proposed construction schedules/staging plans and traffic control plans where applicable.</p>
Contract	<p>The contract between MIT and the Contractor covering the performance of the work.</p>
Contractor	<p>The person or company that has entered into a construction contract with MIT.</p>
Detailed Design	<p>The project phase where structural engineering design principles and applicable design codes are utilized to produce a structural design complete with Drawings and tender documents in sufficient detail to construct the specific structure/rehabilitation identified as the preferred alternative from the preliminary design phase. While detailed design is primarily structural in nature, it may also include the development of the hydraulic, hydrotechnical, geotechnical, environmental and traffic control aspects of the project to support the structural design of the bridge or structure.</p>
Detailed Design Report	<p>Generally, the Detailed Design Report will include the detailed design calculations, Notes of Meetings, correspondence with stakeholders, notes/emails to MIT, correspondence with utility companies, environmental submissions and approvals, etc. The completed and independently checked package is submitted to MIT. A covering letter is prepared by the ESP for MIT.</p>
Design Exception	<p>A design exception is generally an instance where a value lower than the minimum standard is used. A design exception may also be an instance where a designer has chosen to use a parameter or product which is different from standards or design codes. The product or parameter may be more or less costly to provide. The term is generally used in the context of highway geometric design standards, but may be applicable to bridge design as well. Documentation of the rationale used for the design exception must be filed as part of the design notes for future reference.</p> <p>All design exceptions proposed by an ESP must be submitted in writing to MIT. MIT will ensure that the appropriate parties are consulted and given an opportunity to have input prior to acceptance/approval of Design Exceptions.</p> <p>Because of the diversity of engineering and planning subjects covered by this guide, there is no one person or party given “sole” responsibility for approval of Design Exceptions. The handling of proposed Design Exceptions shall be</p>

managed by MIT in an appropriate way based on the nature of the proposal and project. See Section 1.5.3 for additional information on Design Exceptions.

Engineering Service  
Provider (ESP)

The person or company that has entered into an engineering services agreement with MIT. The agreement for services may include inspection, design, or contract administration.

Estimates

“D” Estimate

A “Program/Planning Estimate” which is a “Ball Park” estimate to be prepared before any design calculations are made for roads and structures.

For structures, this estimate is usually produced at the Programming/Planning stage. For bridges specifically, this estimate is usually based on the typical square metre cost for the overall deck area of a bridge.

For roadway, grading, base and paving projects, the “D” Estimate may be based on a typical cost per kilometre all inclusive cost (including engineering, material costs, right-of-way acquisition, utilities, mobilization, contract costs, etc.) from past experience of average cost in the vicinity. The “D” Estimate may be refined after a Highway Engineering Assessment has been completed.

“C” Estimate

The “C” estimate is produced during the preliminary (functional) design phase. These estimates may be updated one or more times before the “B” estimate is prepared. Each subsequent “C” cost estimate submission must be identified as “C1”, “C2”, and “C3” etc. estimate when a greater accuracy is identified at a later stage of preliminary design. The number will designate generation or occurrence. For structures, the “C” estimate is usually produced when the structure type and overall dimensions are known (length, width, etc.).

For road works, a “C” Estimate is prepared once the preliminary earthwork quantities have been established after 1 or 2 computer runs for grading projects or once the surfacing strategy has been established for surfacing projects.

“B” Estimate

The “B” estimate is produced during the detailed design phase. These estimates may be updated one or more times before the “A” estimate is prepared. Each subsequent “B” cost estimate submission must be identified as “B1”, “B2”, “B3” etc. estimate when a greater accuracy is identified at a later stage of detailed design. The number will designate generation or occurrence.

For structures, the “B” estimate is usually produced, when the specific structural elements have been designed (i.e. for bridge: piers, abutments, girders, deck).

For roadway grading, base and paving projects, it is the estimate that is prepared once the final design has been completed.

“A” Estimate

An “Engineer’s Estimate” that is prepared immediately prior to tendering when the construction drawings and tender quantities are available.

Final Contract  
Administration  
Package

The package of information that must be compiled and submitted at the completion of construction. A detailed description of the requirements of this package is provided in the Contract Administration and Construction Inspection Manual (Part B - Contract Administration).

FIPPA

Government of Manitoba legislation entitled “Freedom of Information and Protection of Privacy Act.”

Land Surveyor	A person registered to perform land surveys in the Province of Manitoba.
Level 1 Inspection	General annual inspection of the structure typically undertaken by MIT Regional staff and used to identify sudden changes in the structure condition.
Level 2 Inspection	Structural inspection defined as a regular detailed visual inspection. It is an element-by-element, "close-up", visual inspection carried out to assess material defects, performance deficiencies and maintenance needs of a structure. MIT conducts these inspections as part of their annual bridge inspection program and uses the process and inspection report format in Ontario Structure Inspection Manual (OSIM).
Level 3 Inspection	<p>Specialized structural inspections to further investigate defects noted in Level 2 or other visual inspections. Examples of specialized inspections are:</p> <ul style="list-style-type: none"><li>• Material Condition Surveys for:<ul style="list-style-type: none"><li>○ Concrete structures (also referred to as a Detailed Condition Survey)</li><li>○ Steel</li><li>○ wood</li></ul></li><li>• Non-destructive Delamination Survey of Asphalt Covered Decks</li><li>• Detailed Coating Condition Survey</li><li>• Underwater Investigation</li><li>• Fatigue Investigations</li><li>• Strength Evaluations</li><li>• Deformation, Settlement and/or Movement Monitoring</li><li>• Appraisal Indices, or functional appraisals of items such as Fatigue, Scour, Flood, Geometrics, Barrier, Curb and Load Capacity to assess performance or obsolescence.</li></ul> <p>Typically, Material Condition Surveys are undertaken as part of Condition Assessments and the data collected will be further used in the Detailed Design Phase to design any rehabilitation works and aide in contract quantity determination.</p>
MIT	Manitoba Infrastructure and Transportation, heirs and successors.
MIT Project Manager	MIT employee responsible for an overall MIT design project from initiation through to close-out. The MIT project manager will act as the liaison between the ESP project manager and MIT during the completion of an ESP assignment.
Preliminary Design	<p>An engineering process undertaken at the pre-structural design phase.</p> <p>For structures, preliminary design includes some or all of the following: collection of survey information, preliminary foundation report (including soils investigation), hydrological analysis, hydraulic analysis and design, hydrogeological investigation, historical ice thickness and ice levels, condition assessment, geometric design, traffic forecasting, hazard protection, site location, environmental determinations, consideration of traffic accommodation, identification of constructability issues and possible construction staging, development of alternatives for advancement to structural design, life cycle cost analysis of alternatives, evaluation and selection of the preferred replacement structure/rehabilitation work. Environmental submissions that satisfy environmental and/or regulatory requirements are prepared and environmental applications are made. During preliminary design, all major stakeholders are consulted and their issues addressed to the extent possible.</p>

Preliminary design for a replacement structure identifies: structure type, structure location, alignment, geometric design of the roadway over the structure, required hydraulic opening or clearance box under the structure, foundation type, important superstructure details, bridgerail and hazard protection, preliminary details of traffic accommodation, identification of constructability issues and construction staging, project schedule, and a “Class C” estimate of cost.

For structures that are being rehabilitated and in cases where a Condition Assessment has been undertaken, the Preliminary Engineering phase will involve identifying the optimum strategy for either preservation or rehabilitation or “revisiting” any previously made recommendations.

Professional Engineer	A person registered to practice engineering in the Province of Manitoba under the Engineering and Geoscientific Professions Act.
Project Design Brief	This brief lists key points and design assumptions determined during the preliminary design phase and prior to any detailed design work. The purpose of the document is to ensure that the ESP and MIT agree on the main design assumptions before the detailed design begins.
Request for Proposal	<p>A formal document, including a cover letter that defines: the requirements of the proposal to be submitted, evaluation criteria and methodology, and insurance requirements expected of the ESP. The Terms of Reference are appended to it.</p> <p>A Request for Proposal system seeks the best value through open competition or the competition of short-listed proponents. Most importantly, it is a system that provides for both objective and justifiable reasons for its choices.</p>
Request for Quotation	A formal document, including a letter of intent that defines: the requirements of the quotation to be submitted and insurance requirements expected of the ESP. The Terms of Reference are Appended to it.
Road Drainage Culverts	Culverts with an equivalent diameter of less than 1.8 meters that are typically included with the road design and construction packages.
Specifications	The latest edition of MIT's Standard Construction Specifications.
Sub-ESP	A person or company that enters into an agreement with the ESP to carry out part or all of the work covered in the Agreement.
Terms of Reference	A document that describes the assignment, scope of the work to be performed, provides technical requirements, schedules and expected deliverables.
Traffic Control Devices	Temporary signing, traffic control signals, arrowboards, pavement markings, delineators, message boards, etc., used for traffic accommodation in the Work Zone.
Work Area	The area or location of the actual traffic disruption or hazard. (There may be several Work Areas within the Work Zone.)
Work Zone	The area extending from the “Construction Area” sign to the “Construction Ends” sign.
Work Zone Traffic Control Manual	Manual developed by MIT intended to provide a single source traffic for control standards on Manitoba's roadways. This manual includes sign structures.

Provincial Roads and Highway sign details and Drawings for temporary traffic control situations.

## 1.2 ESP REQUIREMENTS

### 1.2.1 PROFESSIONAL REGISTRATION

All ESP's engaged to provide engineering services for MIT shall be registered to practise with the Association of Professional Engineers and Geoscientists of Manitoba (APEGM) and shall abide by the Association's Act, regulations, code of ethics and bylaws. Any Sub-ESP's hired by the ESP shall also be registered to practise with the Association of Professional Engineers and Geoscientists of Manitoba (APEGM) and shall abide by the Association's Act, regulations, code of ethics and bylaws.

Land surveyors who are doing legal surveys for MIT must be registered Manitoba Land Surveyors.

### 1.2.2 PROFESSIONAL SEAL

Professional Engineers employed by the ESP's and Sub-ESP's shall affix and validate their seal on all Engineering documents they issue as part of any assignment undertaken with MIT. The seal shall be affixed and validated in the manner prescribed in the APEGM bylaws.

Where the ESP is required by the APEGM bylaws to hold a Certificate of Authorization, all Engineering documents issued by the ESP shall contain the Certificate of Authorization stamp near the Professional Engineers seal as prescribed in the APEGM bylaws.

### 1.2.3 INSURANCE REQUIREMENTS

A summary of the insurance levels from the Standard Agreement are as follows, however, the ESP shall familiarize themselves with all the insurance requirements specified in the Department's Standard Agreement and submit proof of insurance with their proposal submission.

The ESP shall maintain throughout the term of the Agreement, and in the case of claims-made based policies for a period of at least 24 months following completion of all Services under the Agreement, the following insurance:

- (a) commercial general liability insurance covering the Services provided by ESP or its officers, employees, sub-consultants or agents under this Agreement; such insurance shall:
  - i provide a minimum of \$2 million (\$2,000,000.) per occurrence limit of liability; and
  - ii name Manitoba, its Ministers, officers, and employees and agents as Additional Insureds with respect to this Agreement.
- (b) professional liability insurance covering the Services provided by ESP, or its officers, employees, or sub-consultants under this Agreement, subject to a minimum limit of \$2 million (\$2,000,000.) per claim.

## 1.3 ROLES AND RESPONSIBILITIES

### 1.3.1 ESP

#### 1.3.1.1 General

The ESP shall complete the assignment as described in the Agreement and shall supply all personnel, materials and equipment required to provide the services in accordance with the Agreement and the

Terms of Reference. The ESP shall be solely responsible for all work performed under the Agreement, including work done by any Sub-ESP's.

The ESP shall monitor all aspects of safety and health and environmental protection measures as they apply to the work that is being undertaken.

### 1.3.1.2 Responsibilities

The responsibilities outlined below are offered to clarify working relationships with MIT and other stakeholders. The list is not intended to be exhaustive, nor does it supersede any of the obligations outlined in the Agreement.

Generally, the ESP is responsible to:

- Undertake the work in accordance with the prescribed scope, standards and specifications provided by MIT and the agreed project fees and schedule.
- Confirm requirements by submitting Project Design Brief prior to starting detailed design.
- After agreement regarding the scope of work, the ESP undertakes the work in accordance with the prescribed scope, standards and specifications provided by MIT within approved budget and time frame.
- Liaise with MIT Project Manager and provides reports (monthly status reports, invoices, earned value reports for assignment).
- Keep the MIT Project Manager informed of progress, issues and problems. All communications with MIT are through the MIT Project Manager.
- Prepare and confirm a check list of requirements before submitting design/tender package: examples: Historical Resources Impact Assessment (HRIA), Environmental Design Review, Stakeholder right-of-way.
- Liaise with other MIT staff, major stakeholders and the public, as required. The Project Manager should be kept informed of all communications with other MIT staff and all stakeholders.
- Ensure that Utility Companies are contacted well in advance of construction commencement and to determine if there are impacts to the existing plant.
- Be proactive in identifying and addressing any landowner issues.
- Be familiar with all the environmental conditions throughout the proposed construction area and ensure that the tender documents thoroughly address all aspects where environmental impacts can occur.
- Notify the MIT Project Manager of any potential scope changes that may affect the quality, fees and schedule in a timely manner before any additional work is done.
- Obtain approval for costs or schedule changes for any work beyond the scope of the agreement prior to undertaking work
- Manage work undertaken by Sub-ESPs.
- Maintain documentation to support all fees and disbursements claimed from MIT.

## 1.3.2 MIT

### 1.3.2.1 General

The MIT Project Manager is a MIT employee who is responsible for the delivery of a design project from the initiation stage through to completion and project close-out. MIT may also assign a Project Co-Manager who is responsible for a particular major component of the work on a combined project (e.g. bridge structure and associated road works).

### 1.3.2.2 Responsibilities of Project Manager

The responsibilities outlined below are offered to clarify working relationships with the ESP and other stakeholders. The list is not intended to be exhaustive, nor does it supersede any other responsibilities or obligations contained in other manuals or the Agreement. The MIT Project Manager:

- Ensures funding and necessary approvals are in place prior to issuing a RFP/RFQ or requesting work directly from an ESP.
- Prepares RFP/RFQ and TOR for the project, reviews the proposals/quotes and participates in the selection process.
- Chairs Project Initialization Meeting.
- Manages all aspects of the ESP assignment to ensure that the project-specific engineering services are completed to proper standards and within approved budget and time frame.
- Prepares the necessary project management documents such as work breakdown schedule, overall project schedule, monthly status reports, and Project Close-Out report.
- Liaises closely with the ESP to monitor budget, quality of work, schedule, compliance with MIT requirements and overall performance of the ESP.
- Obtains input from appropriate Regional personnel (Director, Construction Engineer, Technical Services Engineer, etc.) or other Branch/Divisional personnel.
- Liaises with various Branches of MIT (administrative, technical, contractual, right-of-way, etc.) and other MIT branches and agencies as required.
- Liaises with ESPs during all phases of the work and reviews reports, Meeting Notes, test results, expenditures, invoices, etc.
- Reviews and administers Change(s) in Scope of Work, project team changes and contract date extensions. Ensures funding and necessary approvals are in place for all scope and contract changes.
- Assesses the performance of the ESP on a continual basis and prepares the final ESP Performance Evaluation in a timely manner.
- Reviews all ESP invoices and earned value reports for accuracy and recommends approval if satisfied that the appropriate fee for service has been charged.
- Ensures financial coding is accurate on all invoices.

### 1.3.2.3 Responsibilities of Project Manager and Project Co-Manager

In combined design projects that include both associated road works and bridge construction, the roles of the Roadworks Project Manager and Bridge Project Manager are to some extent integrated. It takes considerable communication and co-ordination during the process of delivering a combined design project from initiation through to close-out. For such a combined project, either the Roadworks Project Manager or the Bridge Project Manager will be the overall MIT Project Manager for the entire project. This will depend largely on the predominance of the roadwork and bridge work involved as well as the specialty of the work.

On combined design projects, the Project Manager and Project Co-Manager are responsible for the following:

- The Project Manager ensures funding and necessary approvals are in place prior to issuing a RFP/RFQ or requesting work directly from an ESP.
- The Project Manager is responsible for preparing the RFP/RFQ and the Terms of Reference after obtaining input from the Project Co-Manager, technical specialist(s), or others as required and will circulate Requests for Proposal/Request for Quote for review.
- The Project Manager will distribute copies of the ESPs proposals/quotes to the Project Co-Manager and other team members for review.
- After the ESP is selected, the Project Manager will arrange and chair an initialization meeting. Areas of responsibility and reporting procedures will be outlined so that the ESP can effectively communicate with the respective Project Manager/Project Co-Manager.

- The Project Manager will deal with administrative processes, approvals, Changes in Scope, changes to the agreement, project team changes, fee schedules, etc., after input from the Project Co-Manager is received. He/she will also deal with technical aspects in his/her area of expertise.
- The Project Co-Manager can deal directly with the ESP staff involved with the project in so far as the technical aspects are concerned and shall apprise the Project Manager of all communications.
- The Project Manager and Project Co-Manager will review and recommend approval of invoices. Both the Project Manager and Project Co-Manager may attend design review meetings, progress meetings, tender review meetings, etc.
- Both the Project Manager and Project Co-Manager (where applicable), sign off on the tender package before submission to Contract Services Branch.
- Each will ensure that communication is maintained and necessary information is exchanged during the course of the project implementation; that the Directors/Executive Directors are kept informed.
- Final deliverable packages are to be submitted to the Project Manager for review and approval. ESP Performance Evaluations are completed by both Project Manager and Project Co-Manager.

## 1.4 COMMUNICATION AND REPORTING

### 1.4.1 GENERAL

MIT will designate a representative to act as the Project Manager on behalf of MIT. It is expected that the ESP will also designate a representative to act as the Project Manager on their behalf. Information or direction obtained from sources other than MIT's Project Manager should be verified with MIT's Project Manager as correct and appropriate before proceeding further with the project.

The MIT Project Manager will have the overall responsibility for managing the ESP assignment and confirming that the project requirements and schedules, as specified in the Terms of Reference, are met. The MIT Project Manager will arrange quality assurance reviews of the deliverables by MIT staff, but this will in no way relieve the ESP of their responsibility for the work. MIT Project Manager will liaise between the ESP, and other stakeholders to resolve any administrative, technical or contractual matters. Open, interactive communication between the ESP and the Stakeholders involved in the project is promoted, on the understanding that the MIT Project Manager is kept apprised of the content of this communication.

The final timing of construction works will be decided at the discretion of MIT.

### 1.4.2 PROJECT INITIALIZATION MEETING

MIT is responsible for ensuring that each activity and phase of the work is completed as scheduled. To do this, prior to any work commencing on a project, the MIT Project Manager will normally call and chair a Project Initialization Meeting with the ESP, and any appropriate stakeholders, to clarify the assignment, expectations and staff roles, to review the scope of the work to be done, safety strategy, reporting requirements (during preliminary or detailed design as identified in the Terms of Reference), design codes and standards to be used, time frame for the overall project, as well as any significant milestone dates within that time frame for specific activities. The MIT Project Manager will advise the ESP of all issues that may affect the ESP's work plan (e.g. tendering schedule).

Project administration information such as invoicing requirements, sample forms, revised procedures, etc. will also be provided to the ESP at this meeting.

Details on the ESP Performance Evaluation process will be discussed at the Project Initialization Meeting. The MIT Project Manager will advise the ESP of appropriate form(s) to be used, and as required, also identify the criteria/weighting/timing that will be used as the basis in the evaluation process. Further information on the Performance Evaluation process can be found in Section 6 of the "ESP Engagement and Administration Manual."



This meeting will normally be held at the MIT offices.

#### 1.4.3 REPORTING PROCEDURES

If stipulated in the Terms of Reference or at the Project Initialization Meeting, there may be a requirement to send copies of correspondence to other persons and/or stakeholders.

During preliminary and detailed design, the ESP shall advise the MIT Project Manager, as required, of progress on the project and discuss upcoming work, milestones and critical issues. Regular meetings shall be held with the MIT Project Manager, as required.

Progress Review Meetings shall be called by the ESP at the conclusion of milestone events and when technical or other progress matters need to be reviewed. The ESP shall review the work of Sub-ESP's before being brought forward to the Progress Review Meetings for discussion. These meetings will generally be held at MIT offices.

Minutes of all meetings will be taken by the ESP and circulated within 5 working days.

Electronic reporting is to be used when available and MIT programs will be made available to ESP's unless restricted by licensing or other requirements.

#### 1.4.4 SUBMISSION OF DRAWINGS AND REPORTS

Submissions to MIT shall be submitted in a timely manner and in the format specified in this manual. The submissions shall take into account the 'milestone dates' specified in the Terms of Reference and this manual, and allow sufficient time for MIT to undertake a level of review appropriate for the work involved. Typically, the Terms of Reference specify appropriate timelines for MIT's review process for each specific project.

**All structure drawings and reports submitted to MIT must reference the unique structure site number that has been assigned by MIT.**

#### 1.4.5 REVIEW OF WORK BY MIT

Any review of the ESP's work, signing of drawings and the acceptance of documents by MIT staff does not relieve the ESP from any responsibility for the work.

#### 1.4.6 APPROVAL OR ACCEPTANCE

The following, and other unforeseen matters, shall be referred to MIT for approval or acceptance unless authority is delegated elsewhere:

- Approval – Refer to Section 1.1.1 for definition
  - Change of Project Personnel
  - Public Participation Programs
  - Changes to project funding requirements
  - Design Exception(s)
  - Changes to scope of work and fee revisions
  - Changes to schedule specified in the Terms of Reference
- Acceptance – Refer to Section 1.1.1 for definition
  - Environmental submissions
  - Geotechnical investigation and report
  - Hydraulic report
  - Preliminary design report
  - Project Design Brief

- Construction tender package
- Detailed design report
- Design Exception(s)

#### **1.4.7 CHANGES TO SCOPE OF WORK FOR ENGINEERING ASSIGNMENT**

Any requests for changes in the scope of work or the Terms of Reference of the Agreement that impacts upon the schedule or costs of the project shall be brought to the attention of the MIT Project Manager by the ESP. These requests for changes to the scope of work shall be in writing (using MIT's standard form), including the estimated costs and possible extensions in time. The request for change in scope of work shall be submitted by the ESP as soon as it becomes apparent, for review and approval by MIT. Once agreement has been established between MIT and the ESP on the costs and schedule impacts arising from the proposed changes to scope, the MIT Project Manager will determine if funding is available and an extension to the contract is possible. Once funding has been secured, MIT will prepare the Change in Scope of Work form in duplicate and forward to the ESP for signatures. Both copies of the form will be returned to MIT who will sign and return one copy to the ESP and append MIT's copy to the agreement. Work shall not be undertaken prior to approval of the scope change by MIT.

**NOTE: *Except for emergency situations, the ESP shall not proceed unless a written authorization to do the work is given by MIT.***

#### **1.4.8 ESP DOCUMENTS AND FIPPA**

Any information collected or generated by an ESP, when providing engineering services, is the sole property of MIT. This information is subject to FIPPA. When asked to give out information, the ESP must contact the MIT Project Manager prior to doing so, in order that FIPPA is not violated in regards to privacy and personal information.

### **1.5 DESIGN PROCESS**

#### **1.5.1 DESIGN STANDARDS**

All design work shall be done in accordance with the latest edition or version of the relevant codes, standards, specifications, and recognized engineering practices as stated in the further sections on preliminary and detailed design or in the Terms of Reference.

#### **1.5.2 BACKGROUND INFORMATION**

Project specific information will be made available by MIT for the ESP's review and use. The following is a general list of information available for existing structures; however, it is important to note that not all the information may be available for each specific site:

- design notes for the original structure and any rehabilitations or major repairs,
- construction drawings for the original structure and any rehabilitations or major repairs,
- construction reports for the original structure and any rehabilitations or major repairs,
- soils information (i.e. log borings) for the site,
- latest inspection reports,
- most recent load rating,
- maintenance information, and
- photographs.

A detailed description of additional information available for each project is included in the Terms of Reference.

The ESP shall review all historic records, archives and information relating to the project and identify any additional information that is required in order to complete the assignment during the proposal period and

prior to starting any of the work. The ESP proposal shall identify any additional material required to complete the assignment. In order to mitigate any delays to the ESP, MIT will provide any of the additional information that is in their inventory as soon as possible. In the event MIT does not have the information, the ESP will have to obtain the information in an alternate manner and their proposal prepared accordingly.

**Original copies of all documents or photographs shall not be removed from MIT offices.**

### 1.5.3 DESIGN EXCEPTIONS

While undertaking preliminary or detailed design, ESP's are expected to achieve "best value" for the project dollars while still achieving a safe, functional and efficient design for the road-user, and meeting the long-term performance and quality standards specified by MIT. The guidelines, warrants, and practices specified by MIT should be followed in general. However, where there are significant constraints (e.g. in the case of roadway design: areas with rough terrain conditions such as steep hills, sharp river valleys, winding river crossings, widening of narrow roads, existing developed infrastructure, etc.), it may not be practical or desirable to maintain normal standards. In these circumstances, to ensure that designs are "optimized", some design parameters may be adjusted in a safe manner to reduce construction costs. Occasionally, a design exception may also involve the use of a design parameter that exceeds normal standards or practices.

The use of modified design parameters (lower or higher standards) shall be analyzed, documented (to show the rationale used for the exception, generally including economic justification, impacts on general public and risk analysis), reviewed and approved or accepted by MIT. The approval/acceptance process shall include a written submission by the ESP to MIT, referral to technical experts within MIT as required and signing off for "acceptance" or "approval" by MIT. The ESP should indicate in their initial submission whether they are requesting approval or acceptance. MIT acceptance is appropriate where the ESP is willing to assume the engineering risk associated with the exception. In cases where the ESP wishes to share the risk with MIT, it should be clearly indicated that approval is sought. Documentation shall be filed for future reference.

### 1.5.4 INDEPENDENT DESIGN CHECK

Prior to submission of the work to MIT, the ESP shall undertake an independent check of all preliminary and detailed designs, drawings, Construction Tender Packages and reports by a qualified and experienced Professional Engineer other than the Professional Engineer responsible for the design. Tender quantities, cost estimates and schedules shall be prepared and independently checked by a qualified and professional engineer. All documents and drawings shall show the names and/or signatures of persons responsible for the work and checking. The Professional Engineer who has undertaken these checks shall provide design check notes with their seals affixed and validated as prescribed by the APEGM by-laws. This independent check shall be carried out by a Sub-ESP when the ESP does not have adequate in-house capabilities to provide this check.

Typically, an "Independent Design Check" involves but is not limited to the following activities:

- Complete re-analysis of all aspects of the detailed design, preferably (but not essentially) by a methodology other than that used in the original design.
- Independent determination of element capacities.
- Ensuring that the engineering drawings accurately convey the design philosophies of the original design and the checkers review.
- Ensuring the completeness, integrity, and accuracy of all aspects of the Engineering Drawings.

To resolve issues of concern, an independent check of a specific component of the design may be requested by MIT at any time throughout the design process.

### 1.5.5 COST ESTIMATES

Accurate and timely submission of cost estimates is extremely important for MIT's programming and cash flow functions.

The ESP shall provide the following cost estimates during the design process at the following stages:

- "C" cost estimates during preliminary design stage
- "B" cost estimates during detailed design stage
- Utility relocation estimates
- "A" cost estimate immediately prior to tendering ("Engineers Estimate")

## 1.6 WORKPLACE SAFETY AND HEALTH

### 1.6.1 GENERAL

The ESP shall familiarize themselves, their staff and their sub-ESP's with the terms of the Workplace Safety and Health Act and Regulations to ensure complete understanding of the responsibilities given and compliance required.

### 1.6.2 SITE HAZARD

While undertaking site inspection for condition assessments, preliminary engineering and/or detailed design assignments, the ESP has the responsibility to identify site hazards and develop operational safety policies, procedures and plans that are specific to the work being performed to ensure the safety of all staff on site, whether employed by the ESP or Sub-ESP. The impact of the public travelling through the site must be considered when developing these plans (if applicable). When requested by the MIT Project Manager, the ESP shall provide copies of these safety policies, procedures and plans to MIT prior to the commencement of the work.

If Workplace Safety and Health conducts a site inspection that results in "orders" being issued to the ESP or Sub-ESP, the ESP shall immediately supply copies of these orders to MIT.

In cases of recognized imminent danger or when the ESP fails to comply with safety orders issued or fails to rectify previously identified hazards, MIT will order the cessation of the work until it is safe for the work to resume. MIT's interpretation of a worksite hazard will be considered as final in all cases.

### 1.6.3 ACCIDENT INVESTIGATION AT THE SITE

In the event of an injury or accident involving staff of the ESP, or his/her Sub-ESP, at the site as defined by the Workplace Safety and Health Act, the ESP shall conduct an accident investigation as required by the Workplace Safety and Health Act. In addition, the ESP shall supply a copy of this investigation report to the MIT Project Manager within 24 hours of knowledge of the occurrence.

## 1.7 PUBLIC SAFETY REQUIREMENTS (TRAFFIC ACCOMMODATION THROUGH THE WORK ZONE)

### 1.7.1 GENERAL

Accommodation of traffic may be required at any time while the ESP is completing on-site condition inspection; survey operations; geotechnical investigations such as test holes/test piles; and site visitations during preliminary design, detailed design or post construction phases. The ESP shall be responsible for provision of suitable traffic accommodation measures when working in or near the travelling lanes. The ESP shall install and maintain any required traffic control devices in accordance with latest version of MIT's "Manitoba Work Zone Traffic Control Manual – Provincial Roads and Provincial Trunk Highways". The ESP shall inform the MIT Project Manager of their intent to visit the site and where Traffic

Accommodation is required, provide details of their proposed Traffic Control plans for MIT review in advance of establishing traffic control works.

If traffic control is found to be inadequate, the ESP shall take appropriate and timely action to rectify the situation.

### **1.7.2 FLAGPERSON**

When the ESP is undertaking surveying/inspection/field investigation operations that may cause interruption, delay or hazards to the traveling public or anyone on the roadway, qualified flagpersons shall be provided as required for the direction and control of traffic. The ESP shall ensure that flagpersons are instructed in the use of proper traffic control procedures appropriate for the prevailing conditions. Flagpersons shall have proof of certification from a recognized training program on traffic control procedures through construction zones.

Flagpersons shall be dressed in accordance with the guidelines in MIT's "Manitoba Work Zone Traffic Control Manual – Provincial Roads and Provincial Trunk Highways".

### **1.7.3 ACCIDENT REPORT**

Should any third party accident involving highway users (vehicular or pedestrian) occur when the ESP is undertaking surveying/inspection/field investigation operations on a roadway, the ESP shall summarize the details of the accident and provide the MIT Project Manager with a report within 24 hours of knowledge of the occurrence.

If a fatal or major accident involving serious personal injury or major property damage occurs, the ESP shall immediately notify the MIT Project Manager of the incident.

The accident report will include a record of conditions at the time of the accident, photos, description of all pertinent signing and other traffic control devices in place at the time.

## **1.8 COORDINATION WITH RAILWAY OPERATIONS**

Where inspections of structures that cross railway lines, or for railway structures, the ESP will contact the appropriate railway authorities to advise of the activity and coordinate field inspection requirements such as flagging, UIU operation, etc. Associated costs for railway structure inspections shall be included in the proposed costs for the ESP assignment.

Refer to Section 3 of this manual for additional design requirements for the design of structures that cross railway lines or railway structures.

Development of preliminary or detailed designs shall consider co-ordination of construction staging with railway agency needs and requirements and their respective safety plans.

## **1.9 BRIDGE INSPECTION AND SURVEY VEHICLES**

### **1.9.1 UNDERBRIDGE INSPECTION UNIT**

The MIT Underbridge Inspection Units (UIU 50 & UIU 30) can be made available for use on ESP assignments. The UIU includes the use of the Inspection Unit mounted on a truck, the bucket operator, a driver who operates as the backup bucket operator, traffic control signs specific to the operation of the UIU and the sequencer (note all other traffic control measures shall be supplied and maintained by the ESP). When available, there will be no cost for these personnel and equipment, however, the ESP shall be responsible for the arrangements and cost of the transportation of the Sequencer. Note: A minimum 500 kg and 50mm ball towing package is required for the sequencer.

Bucket capacity of the UIU is typically restricted to the bucket operator and one inspector plus tools. The ESP will be responsible for supplying their own full body harness and lanyards. Bucket evacuation and fall protection training is required, certificates to be provided by the ESP.

The UIU units are typically available from Monday through Thursday of each week for 10 hours each day, except for statutory holidays, etc. The UIU may operate to temperatures of approximately -20°C, however operating below -10°C will require authorization from MIT. The UIU may not be operated during wind speeds greater than 55 KPH unless authorized by MIT. For UIU work on high volume routes such as the Perimeter Highway, there shall be no disruptions to traffic prior to 9 am and after 3 pm, i.e. rush hour traffic.

The ESP shall arrange scheduling of the UIU through the MIT Project Manager. The UIU may not be available for all assignments and its availability shall be confirmed and reserved during the preparation of the proposal or quote. The UIU is used by MIT for emergencies within the Province and may be required during the time scheduled for use by the ESP. Where ESP activities cannot be reasonably rescheduled to accommodate the emergency use of the UIU, consideration may be given to an extension of time to the completion date.

### 1.9.2 USE OF ALL TERRAIN VEHICLES (ATV'S) FOR ENGINEERING ACTIVITIES

MIT, in recognition of the substantial cost savings that can be made through the use of ATV's for engineering activities (e.g. field surveys), will allow ATV's to operate on the highway right-of way under special authorization. ESP's should make their request to MIT for this special authorization. The following conditions will apply:

- ATV's cannot work on the highway finished pavement surface (shoulder to shoulder).
- ATV's can cross highway surfaces, but must follow existing legislation (unnecessary highway crossing must be avoided).
- The registered owner(s) of the ATV must ensure that ATV operators are trained and fully qualified to operate ATV's. A valid operator's license of a class higher than a learner's permit shall be obtained by an ATV operator prior to doing work in the right-of-way.
- The use of ATV's must be restricted to daylight hours only.
- All employees on the ATV's must wear fluorescent safety vests. These employees must also wear protective headwear that has been approved by one of the following organizations:
  - Canadian Standards Association (CSA)
  - American National Standards Institute (ANSI)
  - British Standards Association
- ATV's must be licensed, insured, and equipped as defined in the existing legislation.
- If unique safety hazards are identified, MIT reserves the right to refuse the use of ATV's for survey activities.
- The Work Area where the ATV's are to be used should be limited to 3 kilometres in length. This is particularly important if the work zone is to be "signed". Unless surveyors (not ATV's - see the first point) are actually working on the road surface, the need for warning signs is minimal.
- MIT will require that the ATV users develop a safe work procedure for this specific operation. If several ESP's will be involved in this type of operation, a joint safe work procedure could be developed to accomplish the work.
- The use of rotating amber light attached to a pole mounted on the ATV machine will also be required.

## **SECTION 2 – INSPECTION, PRELIMINARY DESIGN AND ENVIRONMENTAL APPLICATIONS**

### **2.1 INSPECTION AND DETAILED CONDITION SURVEYS**

#### **2.1.1 GENERAL**

Structure inspections associated with the design process may range from general structure inspections (Level 1) to a Detailed Condition Survey (Level 3). The inspection may be a small part of an Engineering Services Assignment for structure rehabilitation or be the primary deliverable in an assignment for annual structure inspections. All information gathered at site visits shall be prepared and filed in the form of a Level 1, 2 or 3 Inspection Report. The inspections shall be carried out according to MIT standards, the reports prepared according to MIT Standards and practises and filed as stand alone documents in the MIT hard and electronic filing systems.

#### **2.1.2 WORKPLACE AND PUBLIC SAFETY**

All inspections shall be in accordance with Workplace Safety and Health requirements as per Section 1.6 and provide for the safety of the travelling public as per Section 1.7.

Where inspections are undertaken of railway structures or highway structures over or adjacent to rail lines the ESP shall abide by the following:

- CN's "Safety Guidelines for Contractors" (latest edition),
- CPR's "Minimum Safety Requirements for Contractors Working on Railway Property" (latest edition).

#### **2.1.3 INSPECTION PERSONNEL**

Where inspections are intended to generate a formal Level 2 Inspection Report, or are undertaken as part of a formal Level 3 Inspection (e.g. Detailed Condition Survey), the inspections shall be managed under the direction of a Professional Engineer registered in Manitoba with at least 10 years experience (of which at least 5 years is in structure inspections) with demonstrated experience in large scale inspection projects. This person shall be on site directing all aspects of the investigation throughout the entire period of the inspection.

#### **2.1.4 INSPECTION REQUIREMENTS**

Level 2 inspections shall be conducted in accordance with the Ministry of Ontario Structure Inspection Manual (OSIM), latest edition.

Material Condition Surveys for timber and steel, and Underwater Inspections (classified as Level 3 inspections) shall be carried out according to OSIM, latest edition.

Detailed Condition Surveys (DCS) classified as Level 3 Inspections shall be carried out in accordance with the Ministry of Ontario Structure Rehabilitation Manual (OSRM), latest edition, and the following shall apply:

- A Professional Engineer registered in Manitoba with at least 10 years experience (of which at least 5 years is in structure inspections) shall be on site directing all aspects of the investigation.
- OSRM guidelines on the type of testing and applicable standards, testing frequency and reporting format shall be followed.
- Field and laboratory testing shall be by the ESP.
- The ESP shall:
  - liaise with the appropriate utilities and local authorities in order to avoid damage to the structure or utilities and ensure the work is carried out in a safe manner
  - repair all areas damaged by destructive testing

- Other than as directed in the Project Terms of Reference (TOR), all components of the DCS shall be considered by the ESP and only those deemed necessary to the assignment by the ESP shall be undertaken. The rationale for selection shall be provided to MIT.

### **2.1.5 CONDITION ASSESSMENT**

For a Condition Assessment, the overall condition will be described by the results of the following special investigations:

- Level 3 inspections,
- strength evaluation,
- settlement/movement monitoring, and
- functionality review.

The Project TOR will identify which of the investigations shall be included for any particular Assessment. The remaining service life of the structure will be determined and management plans with costs established. Material condition surveys typically form part of the Level 3 inspections and the data collected will be further used to design any rehabilitation works and aid in contract quantity determination during the Detailed Design Phase.

Where Condition Assessments are undertaken, a separate report shall be prepared for each Level 3 inspection. All reports shall be submitted to the MIT's Project Manager in hard and electronic copy for filing in the Water Control & Structures filing system.

The Condition Assessment Report shall include the following (inspection reports appended to the Report):

- a summary of the overall bridge condition,
- a summary of the results from the strength evaluation,
- a review of settlements and movements,
- a summary of the functionality review,
- identification of emergent or urgent works,
- identification of maintenance works, and
- preliminary recommendations for a Structure Management Plan.

The Structure Management Plan can only comment on the deficiencies noted from the functionality review and in the inspections undertaken. The plan may include recommendations that further study be undertaken during preliminary design where a Traffic Study Analysis, System Planning, Highway Geometric Requirements, Hydrology, Geotechnical and Environmental Considerations may be considered in establishing the management strategy.

## **2.2 PRELIMINARY DESIGN PHASE**

### **2.2.1 GENERAL**

The preliminary design for the replacement or rehabilitation of structures and culverts includes input from several civil engineering disciplines and may be an iterative process until an efficient solution is developed that meets all of the project criteria. The preliminary design defines all aspects of the bridge replacement or rehabilitation works that are required. The preliminary design phase includes:

- assembly and/or review of survey and project information,
- geotechnical investigation,
- bridge condition assessment,
- geometric design,
- hazard protection,
- hydrotechnical design,
- site location,
- environmental determinations,



- consideration of traffic control,
- identification of constructability issues,
- construction staging,
- structure selection,
- determination of rehabilitation works,
- development of optimized concepts for advancement to structural design, and
- life cycle cost analysis of options.

The preliminary design identifies:

- location of the structure,
- geometric design of the roadway over the structure,
- structure type,
- required hydraulic opening or clearance diagram under the structure,
- foundation type,
- important superstructure details (e.g. girder types and depths, riding surface, deck details, sidewalks, barriers, etc.) or rehabilitation works,
- hazard protection,
- preliminary details of traffic control plans,
- constructability issues,
- estimates of the project cost
- preliminary project schedule, and
- construction staging.

During the preliminary design all major stakeholders are consulted and their issues addressed and sufficient information is gathered to make environmental applications.

### **2.2.2 PRELIMINARY DESIGN REQUIREMENTS**

The ESP shall abide by and conduct the work in accordance with the following design codes, standards, guidelines, requirements, policies and manuals:

- Design of highway structures shall be in accordance with: American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specification (latest edition), plus interims.
- Design of railway bridge structures shall be in accordance with: American Railway Engineering and Maintenance Association (AREMA) “Manual for Railway Engineering” (latest edition). AREMA shall be used as a reference when designing structures over railways.
- The ESP shall also abide by the following appropriate corporate guidelines and requirements when designing railway structures, or highway structures above rail lines:
  - CN’s “Guidelines for Design of Railway Structures” (latest edition).
  - CN’s “Safety Guidelines for Contractors” (latest edition).
  - CPR’s “Requirements for the Design of Steel and Concrete Bridges Carrying Railway Traffic in Canada” (latest edition), and
  - CPR’s “Minimum Safety Requirements for Contractors Working on Railway Property” (latest edition).
- MIT’s “ESP Engagement and Administration Manual” (latest Edition)
- MIT’s “CADD Standards Manual” (latest edition).
- MIT’s “Contract Administration and Construction Inspection Manual” (latest edition).
- MIT’s “Standard Construction Specifications” for bridges and roads (latest edition).
- AASHTO Roadside Design Guide (Latest Edition).
- Transportation Association of Canada (TAC) “Geometric Design Guide for Canadian Roads”.
- MIT’s “Manitoba Work Zone Traffic Control Manual – Provincial Roads and Provincial Trunk Highways” (latest edition).
- Manitoba Workplace Safety and Health Act and Regulations (latest edition).

- Canadian Standards Association (CSA).
- American Standard Testing Methods (ASTM).

### 2.2.3 INFORMATION ASSEMBLY AND REVIEW

In addition to the information indicated in section 1.5.2, the following information should be assembled and reviewed in the preparation of the Preliminary Design:

- Bridge Survey: the bridge survey is generally prepared by MIT unless noted otherwise in the project TOR. All surveys prepared by MIT or the ESP shall be prepared in accordance with the "Manual for CAICE Bridge Surveys". A copy of this manual can be provided to the ESP upon request. A bridge survey may not be required for all projects; bridge rehabilitation may not require a bridge survey unless approach roadworks and/or an evaluation of overpass geometries are requested and are considered as part of the assignment. In these cases a limited bridge survey may be required and will be specified in the Project TOR. The ESP should review the survey information available and indicate any additional information they require to complete the assignment as part of their proposal. **Note:** Currently Microstation Geopac Survey is being used to prepare all bridge surveys and the Manual for CAICE Bridge Surveys is currently being revised to incorporate the use of Geopac Survey.
- Geotechnical information: any available soils information will be provided as indicated in Section 1.5.2. The ESP should review the available geotechnical information available and indicate any additional information they require to complete the assignment as part of their proposal.
- Preliminary hydrology may be available for the site. The ESP should review the available hydrological information available, indicate any additional information that may be required to complete the assignment and include procurement of the information as part of their proposal. The hydrological information assembled should include, but not necessarily be limited to:
  - o Historical streamflow data
  - o Review of historical highwater levels at the site, from the bridge survey or discussions with local residents or agencies
  - o Ice thickness and ice loading characteristics
  - o Erosion, scour or sedimentation
  - o River morphology
  - o Debris characteristics
  - o Groundwater and artesian conditions
  - o Identification of local hydraulic structures that influence the site
  - o Identification of surface water and soils conditions that may affect the durability of buried or submerged steel structures
- Inspection reports (Level 1, 2 and 3): The ESP should review the inspection information available and indicate any additional information that may be required to complete the assignment as part of their proposal. The ESP shall make themselves familiar with all aspects of the structure and the site in order to complete the assignment. The ESP shall undertake any inspections they deem necessary to complete the assignment and identify those in their proposal.
- The ESP shall review the Geometric Design Criteria (GDC) report for the highway in the vicinity of the structure. The GDC may not be available and may be under development concurrently with the preliminary design of the structure. In that event, the ESP will be required to co-ordinate with and provide information to MIT's Regional and Planning and Design Branches in the development of the GDC.
- For railway structures or highway structures over railways, the ESP shall obtain the clearance requirements from the affected Railway Agency.
- The ESP shall review the roadway profile over the structure provided by MIT. The roadway profile may be influenced by the depth of structure, the design hydraulic opening of the bridge or the clearance diagrams for highway or railway overpasses and the ESP shall co-ordinate with MIT in the determination of the final roadway profile.
- The ESP may be required to co-ordinate with the MIT Traffic Engineering Branch and the local Regional office in the development of the appropriate hazard protection. Both offices should be contacted for their site specific requirements.
- The ESP shall assemble information necessary for the preparation of the Environmental submission. Refer to Section 2.3.

- Identify utility requirements.
- Identify any land requirements.
- Identify project stakeholders and obtain their project requirements.
- Review available maintenance records for the site.
- Long-term management plans for the bridge, overpass or highway(s) in the vicinity of the site.

## **2.2.4 HYDRO-TECHNICAL DESIGN GUIDELINES**

### **2.2.4.1 General Requirements**

The Hydraulic Design will include, but not necessarily be limited to, the following work:

- Determine the final hydrology of the site.
- Determine the required hydraulic opening based on the final recommended structure and any temporary works, listing the appropriate Design HWL and the associated flow through the structures.
- Protect all foundations against erosion for the applicable hydraulic design event.
- Identify any temporary and permanent erosion control requirements for the site.
- Identify river training works and co-ordinate with any bank stabilization requirements.
- Determine the ice thickness and any special ice loading requirements for the final structure.

The following items shall be reviewed with MIT prior to starting the hydraulic design:

- Maximum backwater effects
- Culvert hydraulic design requirements (i.e. head loss through culverts, submergence restrictions, etc)
- The hydraulic design requirements when fish passage is a requirement of the Environmental submission.

### **2.2.4.2 Hydrologic Design Requirements**

MIT recognizes Manitoba Water Stewardship (MWS) as the Provincial authority responsible for the development and application of all hydrologic analysis methodologies undertaken within the Province. As such, MIT relies upon the experience and expertise of MWS for the hydrologic design of highway and water control infrastructure. The following are MIT's hydrologic requirements for design purposes and are to be undertaken in accordance with MWS's current methods of analysis. Any deviation from these methods must receive approval from MWS before MIT will accept it in the design process.

MIT expects the ESP will undertake any additional field work (above and beyond that provided by MIT) to ensure that enough information is available to be able to assess all of the requirements below. Field work will include, but not be limited to, collection of topographical information, investigation of site conditions (ice / debris problems, artesian flows, high water levels, etc), and any other information the ESP may deem necessary to provide a thorough and complete analysis of the study area.

#### **2.2.4.2.1 Permanent Works Design Discharge**

Unless noted otherwise in the Project TOR, there are three design discharges to determine for permanent works: the design flood discharge, the fish passage discharge and the navigation design discharge.

##### **The design flood discharge:**

The design flood discharge will be in accordance with the design flood event defined below:

1. Historical flood event from gauge records or as recorded by MWS staff;
2. Flood event based upon the following return periods:
  - Provincial roads: generally designed for a flood event with a 3% frequency return period.
  - Provincial Trunk Highways: generally designed for a flood event with a 2% frequency return period.

The ESP will determine the above two values and review with MIT prior to defining the design flood event for the design flood discharge at the structure.

**Fish passage design discharge:**

The fish passage design discharge currently accepted by the Department of Fisheries and Oceans (DFO) is the 10% occurrence of the 3 day delay flow.

**Navigation design discharge:**

This is the design discharge used to determine navigable clearances. Currently, Transport Canada (TC) utilizes the average annual flood. However, as this may be dependent on location, the ESP shall confirm the discharge frequency to be used with TC.

**2.2.4.2.2 Temporary Works Design Discharge**

The sizing of shoofly detour drainage works are typically designed for flood events with a 5% or 10% frequency return period for the months that construction is expected to occur. The design of the temporary works must ensure that the risk to temporary works, construction site, staff, adjacent property, persons, infrastructure etc, is minimized. The ESP shall recommend an appropriate frequency return period for the flood event to MIT prior to commencing design work.

It should be noted that if temporary works are to remain in place throughout the fisheries timing windows and the navigation season, the temporary work will be designed to satisfy DFO and Transport Canada requirements. The ESP is responsible for confirming this with the regulators.

Temporary shoofly detours shall be designed to be located on the upstream side of the site.

**2.2.4.2.3 Hydraulic Design Guidelines for Bridge Structures**

- A minimum clearance of 0.3m is required from the underside of girders to the design flood water level. The design flood water level will be water level associated with the design flood event described in Section 2.2.4.2.1.
- Ice thickness, pan size and depth of ice flow shall be considered when assessing the minimum clearance requirements. This information will also be provided to the structural engineer so as to ensure that ice loads are taken into account when designing the structure.
- Head loss shall not exceed 0.2 m;
- Navigable clearances as required by Transport Canada shall be provided;
- Average channel velocities through the bridge opening shall not exceed 1.5 m/s; and
- Adequate erosion protection, immediately under the bridge and extending beyond the bridge (both upstream and downstream) shall be provided to prevent erosion to ensure the stability of the bridge and approach roadways.

**2.2.4.2.4 Hydraulic Design Guidelines for Culvert Structures**

- A minimum clearance of 0.2m shall be maintained between the soffit or obvert of the culvert and the design flood water level for the entire length of the culvert. The design flood water level will be the water level associated with the design flood event described in Section 2.2.4.2.1.
- Head loss shall not exceed 0.3m;
- Navigable clearances as required by Transport Canada shall be provided;
- At the 3dQ10 event, the culvert structure shall meet all of the Department of Fisheries and Oceans' (DFO) requirements (embedment, velocities, etc);

- Adequate erosion protection, both upstream and downstream of the culvert structure shall be provided. This includes protection around the inlet and outlet of the culvert to a minimum height equal to the top of the culvert, and protection of roadway fills as required.
- The culvert shall be designed to resist any and all uplift (buoyant) forces.

#### **2.2.4.2.5 General Design Considerations**

Bridge structure openings on watercourses shall be sized and protected so that over the Design service life of the structure they do not:

- Cause an unacceptable level of flooding on neighboring flood sensitive lands and developments;
- Cause any flooding of the highway road surface;
- Have a negative impact on local channel stability; and
- Cause erosion affecting the stability of the bridge structure or roadway fills.
- Cause erosion affecting the stability or aesthetics of adjacent public, private or commercial property.

The ESP shall carryout all hydraulic analyses required to ensure that the hydraulic impact from downstream structures and natural occurrences are taken into account in the analysis and design of any structure being investigated and/or proposed for construction.

The ESP shall assess the hydraulic and hydrologic impacts of the proposed structure relative to the existing conditions so as to ensure that the hydraulic and hydrologic status quo is maintained. Where the status quo cannot be maintained, or the conditions listed above cannot be prevented, the ESP shall quantify the hydraulic and hydrologic impacts to the upstream and downstream waterway, floodplain, property and infrastructure and report immediately to MIT. The impacts of the proposed structures shall be clearly identified and documented in a report. The report shall also contain cost estimates for mitigation of these impacts. No further design work shall occur until MIT permits this change in writing.

The ESP shall take into account the hydraulic capacity of the receiving downstream waterway and infrastructure and clearly indicate any impact(s) the proposed structure may have on such infrastructure

#### **2.2.4.3 Considerations for Rehabilitation**

The hydraulic design for structures proposed for rehabilitation, may be limited to a review to ensure that the existing hydraulic design is performing well and there is no danger of overtopping the bridge or the substructures are not in danger if being undermined. Where the bridge replacement is contrasted against rehabilitation, the hydraulic design must be fully completed in order to accurately compare and contrast the two management strategies. The TOR will provide direction as to the scope of options considered for rehabilitation preliminary design.

##### **2.2.4.3.1 Hydrologic and Hydraulic Design Submissions**

The ESP will be required to submit the following information to MIT and MWS for review and approval.

1. A Hydrologic and Hydraulic Design Report (sealed by a Professional Engineer registered in Manitoba) with the design report including (as appendices) copies of all information used in the analysis and generation of the report (field information, output from hydraulic model, etc.); and
2. HEC-RAS models of the proposed drainage works.

#### **2.2.5 GEOTECHNICAL DESIGN**

The Geotechnical Design will include, but not necessarily be limited to, the following work:

- Identify and perform any soil or hydro-geotechnical investigations required to complete the preliminary design work indicated in Section 2.2.1
- Selection of foundation system

- Detailed design of foundation capacity providing pile/caisson capacities or design bearing pressures for spread footings.
- Pile installation details:
  - o Driving requirements
  - o Pile tip protection requirements
  - o Design Details for any downdrag effects
  - o Cleanout details for pipe piles
- Caisson Installation details:
  - o Identify specialized construction requirements (ie: hard drilling, water conditions, sleeving requirements)
  - o Identify inspection requirements and design inspection process (ie: visual examination of rock socketed caissons)
- Identify any further investigation that may be required to proof the soil or rock profile for detailed design.
- Identify areas of instability and perform the preliminary design of soil stabilization solutions that are applicable to the proposed structure. Co-ordinate with any river training and roadway works.

The geotechnical design of the foundations for structures proposed for rehabilitation may be limited to a review to ensure that the existing foundations have adequate capacity to support the existing and proposed loads on the foundations. The identification of areas of instability and the preliminary design of soil stabilization solutions shall apply to rehabilitation projects. Where the structure replacement is contrasted against rehabilitation, the geotechnical design must be fully completed in order to accurately compare and contrast the two management strategies. The Project TOR will provide direction as to the scope of options considered for rehabilitation preliminary design.

## **2.2.6 NEW STRUCTURE/REHABILITATION PLAN DESIGN AND SELECTION**

The following requirements apply to the preliminary design unless noted otherwise in the Project TOR:

- Section 3 – Detailed Design of Bridge and Roadway Structures shall apply to the development of all alternatives and in particular to the following details:
  - o Super and substructure systems
  - o Foundations
  - o Geometries
  - o Bridge rail and hazard protection
  - o Retaining walls
  - o Durability requirements
- Consideration shall be given to selecting structures and rehabilitation works that minimize the effect to the environment and navigability.
- Structures shall be designed to provide temporary and permanent erosion protection during construction and for the long-term performance of the structure. The provisions of Section 2.3 shall apply.
- Significant constructability issues, such as: equipment access for foundation installation or girder erection, type and installation of coffer dams, water control for excavations, materials availability and construction staging for traffic control shall be considered in the preliminary design. The recommended preliminary design alternative must have addressed all significant construction issues identified.
- The functional design of any roadworks associated with the rehabilitated or replacement structure shall be completed.
- Plans to maintain traffic control during construction shall be developed for all replacement or rehabilitation options developed. Preliminary designs of detours shall be developed. The minimum traffic requirements during rehabilitation or replacement shall be identified in the Project TOR.
- Alternatives for replacement structures shall be developed based on many factors, including but not limited to: design hydraulic opening, roadway profile, foundation requirements, constructability and traffic staging issues and capital and life cycle cost.

- Alternatives for structure rehabilitations shall be developed based on many factors, including but not limited to: roadway profile, bridge width from the GDC requirements, extent of superstructure deterioration, superstructure load carrying capacity, design service life, long-range management plan for the site, hazard protection and bridge rail requirements, construction staging and traffic control and capital and life cycle cost.
- Bridge rehabilitation projects shall consider the following alternatives as a minimum unless the TOR indicates otherwise:
  - Minimal, or “Do-nothing” alternative
  - Partial depth or full depth deck repair alternatives. Bridge rehabilitations shall provide the bridge width provided by HPD based on the current GDC. Where the requirements of the GDC appear cost prohibitive, alternate proposals to maximize the geometric functionality of the bridge shall be developed for consideration by MIT.
  - Bridge replacement option. A general unit price for replacement of the bridge may be used as the lower cost envelop for cost comparisons where bridge replacement is not likely. If bridge replacement appears to be a competitive alternative, more refined investigation of the scope of the bridge replacement works including hydraulic and geotechnical design shall be undertaken.
- Evaluation of rehabilitation and replacement options shall consider:
  - the functionality of the bridge in each option with respect to:
    - Hydraulic design
    - Foundation capacity
    - Existing vertical and horizontal geometric design
    - Bridge rail
    - Hazard protection
  - Load carrying capacity of the structure replacement or rehabilitation
  - Constructability issues
  - Traffic control
  - Capital Cost
  - Life Cycle Cost
  - Project schedule
- Develop preliminary interim cost estimates (Class “C”) for the various rehabilitation and replacement alternatives, including work at the approach road works (if necessary).
- Develop the following schedules:
  - Project schedules that illustrates the major project milestones including:
    - Completion of Preliminary Design
    - Detailed Design phase
    - Tendering and award phase
    - Construction phase
  - Construction schedule that illustrates the timing of all major contracts and major items of work, construction staging and materials procurement.
- A recommendation shall be made following evaluation of the replacement or rehabilitation alternatives.
- Following the completion of the preliminary design and acceptance of a recommended alternative for replacement or rehabilitation, the ESP shall prepare the final environmental application supporting documents and information as detailed in Section 2.3. The ESP shall provide clarification or additional supporting information in response to questions from the Regulating Authority regarding the Environmental submission.
- Prepare necessary submissions for any other outstanding permits, authorizations and licenses that may be required.

### **2.2.7 TRAFFIC ACCOMMODATION AND STAGING**

During the preliminary design phase, the ESP shall be responsible for identifying and remedying situations that will require special traffic accommodation procedures to be implemented. These situations could involve construction and removal of shoofly detour, major utility relocations; need to accommodate high traffic volumes, major grade line changes, lane closures, etc.

Where detours or traffic control is required, the method of detour shall be determined and finalised (route detour, shoofly, staged construction, Acrow bridge, etc) and preliminary details of the proposed detour provided. The traffic control and staging plan shall be developed in sufficient detail to ensure its viability and documented for use in detailed design. Where construction staging and traffic control is complex, this task may require significant effort and detail.

### **2.2.8 STAKEHOLDER INPUT**

The ESP shall discuss the proposed alternatives with stakeholders as required to facilitate input and feedback. The ESP shall formulate a public participation strategy where required. Any strategy not detailed in the project Terms of Reference requires prior approval of MIT.

### **2.2.9 DELIVERABLES**

The primary deliverable for the Preliminary Design is the Preliminary Design Report, including the supporting documentation and information for the Environmental submission.

The Preliminary Design Report would;

- describe the work undertaken by the ESP,
- summarize any inspections or Detailed Condition Surveys as they apply to the preliminary design,
- summarize the hydraulic and geotechnical designs,
- identify alternatives for rehabilitation and replacement options that were considered,
- summarize the life cycle cost analysis for each of the options,
- provide an evaluation of the options and the final recommendation for rehabilitation or replacement.
- include Class “C” cost estimates and schedules for the recommended rehabilitation or replacement alternative.
- As a minimum, the following details shall be provided for the recommended alternative:
  - Structure location and alignment
  - Structure length, number of spans
  - Hydraulic opening and hydraulic design details, or details of clearance boxes with clear zones defined
  - Channel alignment, river training works as well as short and long term erosion protection details
  - Details of superstructure continuity and fixity details at substructure units
  - Riding surface
  - Deck thickness and durability requirements
  - Girder/Superstructure system – type, spacing, depth, etc.
  - Bridge rail
  - Substructure types
  - Foundation details
  - Roadway profile, approach details and extent of works
  - Hazard protection
  - Drainage details
  - Embankment details – height, front/side slope requirements, slope stability requirements
  - Retaining wall locations and protection
  - Culvert types, lengths and dimensions

## **2.3 ENVIRONMENTAL APPLICATIONS**

### **2.3.1 GOVERNMENT REQUIREMENTS**



### **2.3.1.1 Federal Government**

Federal Departments, such as Fisheries and Oceans (DFO) and Transport Canada, have the mandate for ensuring that projects, in which the Federal Government has a decision making responsibility or fiduciary duty, are appropriately handled with respect to environmental considerations.

Specific attention is paid to watercourses, wetlands and migratory bird habitat.

### **2.3.1.2 Provincial Departments**

Provincial Departments have the mandate for regulating surface disturbances on private and Provincial Crown Land and all water throughout the Province.

## **2.3.2 ROLES AND RESPONSIBILITIES**

### **2.3.2.1 MIT**

MIT is responsible for assembling and submitting all Environmental Applications to the following regulatory bodies and obtaining the necessary permits, authorizations and licenses that may be applicable to the project:

- Manitoba Conservation
- Transport Canada
- Federal Department of Fisheries and Oceans (DFO)

The submission to the various approving bodies in the federal and provincial governments on behalf of MIT is the responsibility of:

Kimber Osiowy  
Manager of Environmental Services  
Highway Planning and Design  
Winnipeg, Manitoba, R3C 3H8  
Tel: (204) 945-2369

### **2.3.2.2 ESP**

The ESP shall comply with all current environmental legislation and is responsible for the following:

- Prepare environmental drawing(s) and all other supporting documentation for the Environmental Application(s), as required, for permits, authorization and license compliance, such as Federal Department of Fisheries and Oceans (DFO), Navigable Waters and others, including any site investigations, mitigation strategies and compensation measures that may be required,
- Prepare supporting documentation for any other outstanding permits, authorizations and licenses that are required, including any site investigations that may be required, and
- Review Best Management Practices and confirm design requirements for erosion control and protection.

As part of preparing the supporting documentation for the Environmental Application(s), the ESP shall conduct an Environmental Risk Assessment and identify any permanent and temporary measures required to protect the environment. The ESP shall prepare the Erosion Control and Sedimentation Plan, discuss it with MIT and it will be incorporated into the contract bid items and Special Provisions, if necessary.

The following is a list of generic items that may be identified in the Environmental Risk Assessment:

- A list of Permits/Authorizations that will be required and special conditions/restrictions that may be imposed by each.
- Mitigation plans for each site.
- Compensation plans for each site.

- Temporary works for construction access and demolition operations by the Contractor and potential impact to the watercourse and navigation.
- A plan for erosion and sediment control during and after construction, including a schedule for winterizing sites if necessary, and for monitoring success of erosion control measures.
- A watercourse protection plan, if required, by the Contractor.
- Appropriate disposal of hazardous waste by the Contractor.
- If surplus soil is anticipated, a description of how it will be handled by the Contractor.
- Hazardous materials storage plan by the Contractor.
- Equipment fueling and liquids management plan by the Contractor.
- Laydown and staging area(s) revegetation plan by the Contractor.

The ESP shall ensure that all Acts, Regulations, Environmental Protection Guidelines and any other documents that pertain to environmental matters are complied with during the preliminary design stage of the project. The ESP shall become familiar with these documents and keep up-to-date with them.

It is **MANDATORY** that environmental issues are considered and dealt with through all stages of the project, especially at the preliminary design stage when the environmental applications are made. The requirements for the supporting documentation shall be reviewed at the Project Initialization Meeting with MIT's Project Manager. Discussion on environmental issues throughout the assignment shall be undertaken with both MIT's Project Manager and the Manager of Environmental Services.

There are differing information requirements imposed by the regulatory agencies for the various stages of a project. The full details of the requirements should be confirmed by the Manager of Environmental Services.

If required, contact with the appropriate Federal and Provincial Government Departments (Fisheries & Oceans Canada, Transport Canada, Environment Canada, Manitoba Conservation) on behalf of MIT shall be professional and consistent to ensure that all environmental requirements are followed.

All drawings submitted as supporting documentation for the environmental application must contain sufficient information and be submitted in the format and quantity specified for the regulatory agencies to make informed decisions. The ESP shall ensure that all supporting documentation, for which they are responsible, are prepared and submitted to MIT's Project Manager who will direct them to the Manager of Environmental Services. The Manager of Environmental Services will then prepare the Environmental Application forms and submit the package to the appropriate regulatory agency responsible for approving the application. The information collection required in support of these documents shall be commenced well in advance of the submission date.

It should be noted that it may take a considerable period of time before any permit, approval or authorization for environmentally sensitive areas is issued. The ESP's shall familiarize themselves with regulatory requirements and timing needed to process applications. The ESP shall ensure that any supporting documentation is completed in a timely manner and submitted to MIT's Project Manager as soon as possible.

Following receipt of approvals, copies of all Environmental Approvals, Permits, Authorizations and other associated documents shall be included on the drawings and in the tender documents. Where the environmental documents indicate specialized work to be performed by the Contractor, the Special Provisions shall describe the work required, and the method of payment. Where the environmental documents indicate conditions that are beyond the scope of the Contractor's Work, the excluded conditions shall be clearly indicated on the drawings and in the Special Provisions.

### **2.3.3 CONTAMINATED SITES**

If, during the course of any investigations or work, the ESP believes or has a reason to believe that any property may be contaminated by hydrocarbons or any other hazardous substance, the ESP must

immediately report the contamination to Manitoba Environment, MIT's Project Manager and the Manager of Environmental Services. Further direction will be given to the ESP at that time.

#### **2.3.4 REPORTING REQUIREMENTS**

Copies of all environmental drawing(s) and all other supporting documentation for the Environmental Application(s) and correspondence pertaining to the Environmental Licensing process must be submitted as part of the Preliminary Design Report to MIT's Project Manager with a copy to the Manager of Environmental Services.

## **SECTION 3 – DETAILED DESIGN OF BRIDGE STRUCTURES AND ROADWAY STRUCTURES**

### **3.1 INTRODUCTION**

This Section covers general design requirements applicable to bridge structures and roadway structures (i.e. overhead sign structures, retaining walls, etc.) in the project. Any additional project specific design requirements will be included in the Terms of Reference.

Typical design details (Detail No. DD-xx) referenced in this manual are available on the MIT website. The ESP shall make every effort to use these typical design details where at all possible.

### **3.2 GENERAL**

Detailed design requirements for all bridge structures, roadway structures and other appurtenances are generally specified in this Section and address the areas of design, safety, functionality/serviceability, durability/maintainability and aesthetics. If a requirement is not specified in this Section, the requirement shall be set to a standard generally being met on new bridge structures and roadway structures of similar type on the Provincial highway system.

Bridge structures must be designed to be structurally and operationally safe in terms of accommodation of traffic, operations, inspection and maintenance activities for the entire duration of the service life.

All designs shall incorporate the appropriate selection of design concepts and code provisions, design details, specifications, materials and construction methods and techniques.

### **3.3 RESPONSIBILITY FOR DESIGN**

The Design Engineer is responsible for the design of the elements of the Project including, but not limited to: geotechnical investigations, hydro-geological and hydro-technical design, environmental considerations for permits, topographic surveys, in-stream watercourse surveys, approvals and permits, (other than Department of Fisheries and Oceans and Transport Canada), other field investigations and technical analysis required to complete the designs in a professional and competent manner while following good engineering practices.

The Design Engineer shall be responsible for completing the structural, hydraulic and geotechnical design for bridges and other structures (e.g. culverts, overpasses, underpasses, roadway structures, appurtenances) as detailed in this Section. All engineered Drawings shall be produced in accordance with MIT's CADD Standards Manual.

#### **3.3.1 PROJECT DESIGN BRIEF**

The Design Engineer shall prepare a Project Design Brief for the structure(s) prior to commencement of detailed design. This document lists key points and design assumptions prior to any detailed design work. The purpose of the document is to ensure that the Design Engineer, major stakeholders (i.e. railway companies, if applicable) and the Department agree on the main design assumptions, before the design progresses to detailed work.

### **3.4 AESTHETICS**

The Design Engineer is advised that the Department supports and encourages the inclusion of cost effective features to improve the overall bridge structures and roadway structures aesthetics.

The Design Engineer shall develop and incorporate in its design an aesthetic theme throughout the Project that shall complement the surrounding environment and generally be compatible with similar features and structures located in the general vicinity. If additional aesthetics are required, they will be indicated in the Terms of Reference.

Any proposed aesthetic features shall take into consideration routine and long-term maintenance costs and not lead to potential maintenance and rehabilitation problems in the future.

Proposed twin bridge structures shall be aesthetically the same and constructed of the same material type. Twin bridge structures are structures spanning a common opening and close enough to be located on the same bridge approach fills or within a single right of way. Twin bridge structures shall have the same headslopes and openings.

Bridge headslopes are typically incapable of supporting vegetation due to the shadow created by the bridge structure. On railway overpass and grade separation bridge structures, the bridge headslope shall be covered with cast in place reinforced concrete slope protection that prevents erosion and enhances the appearance of the headslopes.

All electrical and communications wiring for the Project shall be underground or embedded, with the exception of under bridge lighting on substructure units of grade separation structures, which shall be surface mounted.

### **3.5 PROVISIONS FOR FUTURE STAGES**

During detailed design of the bridge structures and roadway structures, the Design Engineer shall be cognizant of the requirement for future expansion through the addition of lanes or other elements as detailed in the Terms of Reference. When required, the initial design and construction must feasibly allow for future economical expansion through addition of lanes and other elements.

Vertical grade lines shall be set so that all vertical clearance requirements are met after any anticipated bridge structure widening and/or lengthening or roadway rehabilitation/widening has occurred.

In order to simplify future repairs and rehabilitations, new and rehabilitated superstructures with 4 or more lanes shall be designed as 2 separate superstructures, or designed such that the superstructures can be disconnected without the loss of load-carrying capacity. Further, PPCCG and PPCBG bridge structures with two or more lanes of traffic in each direction shall be laterally post-tensioned one half of the bridge width at a time. This requirement provides for future bridge rehabilitation and detouring of traffic and eliminates the need to reduce the load carrying capacity during construction.

### **3.6 DURABILITY**

Unless noted otherwise in the Terms of Reference, bridge structures shall be designed for a service life of 75 years, with the exception of the deck, barriers and sidewalks, which shall have a minimum service life of 50 years. The design shall recognize the need for ease of replacement of components whose service life is expected to be less than the design service life and the provision of access for inspection and maintenance. The level of maintenance, rehabilitation and/or repair required during the service life of the bridge structures shall be consistent with or better than that generally anticipated to be required for other bridge structures of similar age and type on the Provincial highway system.

The Department's standard system for protecting a bridge deck for "Major Bridge Structures" from deterioration of reinforcement due to deicing salts and freeze-thaw damage of the concrete consists of:

- High performance concrete (HPC),
- Corrosion-resistant reinforcement, and

- Substantial clear cover on the reinforcement.

This standard bridge deck protection system shall be used unless otherwise specified in RFQ/RFP Terms of Reference. HPC is defined as concrete meeting the requirements of CSA A23.1 Class C-1 with macro-fibres.

The number of deck joints shall be kept to a minimum and bridge superstructures shall be continuous for live load over the piers where practical. The design shall also include provision to capture and manage deck drainage such that it does not come into contact with concrete and steel surfaces of other bridge components.

HPC shall be used for all bridge decks, curbs, sidewalks, medians, traffic barriers, concrete overlays and any other bridge components that will come into direct contact with de-icing salts.

An approved Type 1c silane sealer shall be applied to all concrete surfaces which are susceptible to deterioration by water and de-icing salts.

The minimum clear cover for lateral stressing strands in pre-cast concrete box and channel girders shall be 45 mm ( $\pm 5$  mm).

Corrosion resistant reinforcement shall be used in the following locations unless otherwise specified in the Terms of Reference:

- Both layers of reinforcement in cast-in-place concrete bridge decks,
- Stirrups projecting from precast girders into deck slab,
- Reinforcement in curbs and barriers (abutments and superstructure),
- Reinforcement within 150 mm of the top of abutment backwalls and diaphragms,
- Reinforcement in wingwalls within 150 mm of the top of the concrete deck surface, and
- Reinforcing dowels that connect the approach slab to the abutment backwall.

Uncoated black reinforcing steel will not be accepted as a substitute.

### **3.7 HYDRO-TECHNICAL**

For proposed bridge structures over watercourses, including bridge size culverts (1.8 meter diameter or larger), MIT will evaluate the ESP's hydro-technical design using MIT's current "Hydro-technical Design Guidelines" in Section 2.2.4.

### **3.8 DESIGN CODES AND STANDARDS**

#### **3.8.1 HIGHWAY STRUCTURES**

The design and detail of all bridge structures and structural components shall conform to the requirements set forth in the latest edition, including the interim update(s), of the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications as modified and amended by this manual. CAN/CSA-S6-06 Canadian Highway Bridge Design Code (CHBDC) is also specified for the detailed design of specific components as described in further detail in this Section.

All welding shall be detailed in accordance to the standards and requirements of the AASHTO/AWS D1.5M/D1.5: 2002 Bridge Welding Code.

Single load path structures are not allowed. Slab and girder bridge structures (with the exception of trapezoidal structural steel box girder structures) shall have a minimum of: four girder lines for single lane

structures, five girder lines for two lane structures and seven girder lines for three and four lane structures.

Department standard design details shall be utilized for all design work and Drawings where appropriate. International System of Units, SI (metric), shall also be used in all design work and Drawings.

### 3.8.2 RAILWAY UNDERPASS/OVERPASS DESIGN CRITERIA

For railway overpass and underpass design, the Design Engineer shall meet the requirements of the American Railway Engineering and Maintenance Association (AREMA) "Manual for Railway Engineering" (latest edition).

The Design Engineer shall also abide by the following appropriate corporate guidelines and requirements when designing railway underpass and overpass structures:

- CN's "Guidelines for Design of Railway Structures" (latest edition),
- CN's "Safety Guidelines for Contractors" (latest edition),
- CP Rail's "Requirements for the Design of Steel and Concrete Bridges Carrying Railway Traffic in Canada" (latest edition),
- CP Rail's "Minimum Safety Requirements for Contractors Working on Railway Property" (latest edition), and
- Transport Canada's "Standards Respecting Railway Clearances", May 14, 1992 (or latest edition).

### 3.9 STANDARD HIGHWAY STRUCTURE TYPES

All bridge structures constructed in the Province of Manitoba are classified into two groups: "Major Bridge Structures" and "Minor Bridge Structures". In general, "Major Bridge Structures" are located on Provincial Trunk Highways (PTH) and "Minor Bridge Structures" are located on Provincial Roads (PR). Standard "Major Bridge Structures" that are constructed on PTH roadways include: channel, box, I- and NU-girder concrete bridges; reinforced concrete culverts and steel girder bridges. Standard "Minor Bridge Structures" that are constructed on PR roadways are limited to channel girder bridges (PPCC bridges) and steel culverts. The structures described below are typical structures constructed by MIT. The ESP shall employ these typical structures where at all possible.

#### 3.9.1 "MAJOR BRIDGE STRUCTURES"

"Major Bridge Structures" shall have the following characteristics:

- a) Constructed over major river crossing (bridge) or overpass/underpass structure on highway or railway,
- b) Crash tested guardrail system,
- c) Cast-in-place concrete curb and/or sidewalk,
- d) Constructed on PTH roadways,
- e) Located on PR's that allow RTAC loading with a forecasted 20 year Average Daily Truck Traffic (ADTT) greater than 60 in one direction,
- f) Drainage system requirement,
- g) Durability considerations, and
- h) A design life of 75 years.

The Department uses three types of standard prestressed concrete girders: Precast Prestressed Concrete Box Girders (PPCBG), Precast Prestressed Concrete Channel Girders (PPCCG) and Precast Prestressed Concrete I-Girders (PPCIG). These are the most common "Major Bridge Structures" types used. Advantages of these precast prestressed concrete girders include: low initial and future maintenance costs and high quality, factory-produced products. Structural steel girder bridges are another type of "Major Bridge Structures" and are considered in most cases; but, are typically more cost

effective for long spans and special locations such as the Red River crossings. It has been found that in Southern and Central Manitoba prestressed concrete girder bridges with shorter span lengths are more economical to construct on a life cycle cost basis than steel girder bridges.

Where any of the above "Major Bridge Structures" are required to have more than one span, the resulting multi-span structure shall be designed as a continuous structure, provided that geotechnical conditions allow. Bridge structures made continuous eliminate durability problems associated with deck joints over the piers.

Concrete NU girders (Nebraska University) may also be used. The NU girders, initially developed by Nebraska University's Construction Systems Technology Department, allow concrete bridge structures to have longer spans and shallower structural depth. Concrete NU girders also optimize weight and length with slender cross-sections.

### 3.9.1.1 Girders - General

- a) Overhead clearance signs shall be provided on all bridge structures at the locations of underpassing roadways and shall be attached to the upstream traffic fascia curb.
- b) For connecting diaphragms in exterior girders, no connection components shall be visible on the exterior surface of the girders.

### 3.9.1.2 Precast-Prestressed Concrete Girders

- a) Appropriate allowance for prestress (pre-tension and post-tension) shortening, shrinkage and creep shall be included in the fabricated length of the girders.
- b) Stirrup projections from the top of the precast girder into the deck shall meet all code requirements for lap splicing with vertical stirrups, and anchorage requirements for developing full composite action.
- c) When projection of stirrups is less than 40 mm above the underside of the bottom mat of deck bars, additional hat shaped extension bars or other means shall be provided to tie the slab and the deck haunch together to ensure the deck and girders act compositely.
- d) Longitudinal deck bars shall be detailed with a bar centered directly over the girder webs and the remaining bars spaced evenly between girder lines.
- e) Horizontal interface shear design for composite action shall satisfy the requirements from CAN/CSA-S6-06 or AASHTO LRFD Bridge Design Specifications, whichever is more stringent.
- f) Additional vertical stirrups and closed ties for crack control at pretension girder ends shall be provided.
- g) For NU Girders and other "I" shaped girders, all girder ends shall have cast-in shoe plates anchored into the girders.
- h) For NU Girders, four bonded prestressing strands shall be incorporated in the top flange to assist in controlling stresses due to transportation and deck construction.
- i) For NU Girders and other "I" shaped girders used for overpass/underpass structures, additional reinforced cast in place concrete diaphragms shall be provided over the centerline of all lanes and railway tracks below. These diaphragms shall be minimum 300 mm wide and shall extend from the bottom of girder and be integral with the deck above, for the full width of the bridge.

#### 3.9.1.2.1 Precast Prestressed Concrete Box Girders (PPCBG)

Standard span lengths for box girders from centre line of bearing to centre line of bearing range from 10 m to 34 m. The cross-sections of a standard 1 200 mm wide PPCBG girder for standard heights are shown in Detail No. DD-01. Typical details of a standard 1200 mm deep PPCBG girder are shown in Detail No. DD-02. Standard depths of box girders are: 700 mm, 800 mm, 900 mm, 1 000 mm, and 1 100 mm. Standard bridge roadway widths, dimensioned out-to-out of girders, range from 8.4 m to 13.2 m at 1.2 m increments. The cross-section of a standard PPCBG bridge structure is shown in Detail No. DD-03.



PPCBG girders are selected for site conditions where superstructure depth is restricted such as overpasses or areas of High Water Level (HWL), where it is not possible or cost-effective to raise the grade.

As shown in Detail No. DD-04, box girders are arranged adjacent to each other and laterally post-tensioned to permit load sharing and distribution of the live load. The advantages of a precast prestressed concrete box girder bridge structure are high torsional resistance and excellent span to depth ratio.

Particular attention shall be given to the exterior girders of a PPCBG bridge structure to allow deck drain holes between the strands of the bottom slab. This type of girder is not allowed for skew angles greater than 30 degrees.

#### **3.9.1.2.2 Precast Prestressed Concrete Channel Girders (PPCCG)**

The cross-section of a standard PPCCG girder for standard heights is shown in Detail No. DD-05. Detail No. DD-06 shows the standard cross-section detail of an 800 mm deep PPCCG girder. As shown in Detail No. DD-07, standard span lengths for channel girders from centre line of bearing to center line of bearing range from 10 m to 22.5 m. Standard bridge roadway widths, dimensioned out-to-out of girders, range from 8.4 m to 13.2 m at 1.2 m increments. The cross-section of a standard PPCCG bridge structure is shown in Detail No. DD-08.

PPCCG girders are less costly to fabricate than box girders and are often suitable for short span bridges with shallow depth structures. The Department will not allow channel girders for overpass structures as they are vulnerable to vehicle impact from below.

As shown in Detail No. DD-09, channel girders are also arranged adjacent to each other and laterally post-tensioned to provide load sharing and distribution of the live load. This type of girder is not allowed for skew angles greater than 30 degrees.

#### **3.9.1.2.3 Precast Prestressed Concrete I-Girders (PPCIG)**

Cross-sections of standard PPCIG girders are shown in Detail No. DD-10. Standard span lengths for I-girders, measured from centre line of bearing to centre line of bearing, range from 10 m to 30 m. The cross-section of a standard PPCIG bridge structure is shown in Detail No. DD-11.

PPCIG bridge structures are durable, economical and advantageous where the depth of the superstructure is not limited by other factors. They are also ideal for skew angles greater than 30 degrees.

#### **3.9.1.2.4 Ends of Prestressing Strands**

A minimum 3 mm coat of thixotropic epoxy shall be applied to the ends of precast prestressed concrete girders in accordance with the Manufacturer's instructions when the ends are not to be embedded in concrete.

#### **3.9.1.2.5 Dowels For PPCCG and PPCBG Bridge Structures**

- Dowel Holes (Fixed)  
To be filled with non-shrink grout with minimum compressive strength of 35 MPa at 24 hours.
- Dowel Holes (Expansion)  
To be void and ensure there is a space at top of the dowel for vertical movement.

### 3.9.1.2.6 Shear Keys for PPCCG and PPCBG Bridge Structures

Shear keys between adjacent channel and box girders shall be filled with a non-shrink grout having a minimum compressive strength of 35 MPa at 24 hours.

### 3.9.1.2.7 Structural Steel Girders

Welded steel plate girders shall be designed to meet the following requirements:

- a) Vertical stiffeners and girder ends shall be square to the girder flanges. Abutment detailing dimensions shall account for the effects of girder end tilt.
- b) Stiffened plate girder webs shall in no case have intermediate transverse stiffeners spaced at greater than 1.5 times the girder depth.
- c) All welded steel girders, regardless of span, shall be cambered for 100% of dead load deflection and roadway grade line profile.
- d) All bearing stiffeners shall be "fit to bear bottom" and "fit only top", and then fillet welded to both top and bottom flanges.
- e) For long bridges with large expansion movements, the use of multiple bearing stiffeners shall be considered.
- f) Location of jacking stiffeners shall be based on estimated jack sizes required for bearing replacement, plus sufficient clearance to the edge of the abutment seat or pier cap.
- g) Diaphragm connector plates and intermediate stiffeners at stress reversal locations shall be welded to both top and bottom flanges. Intermediate stiffeners, other than at stress reversal locations, shall be welded to the compression flange only, and cut short of the tension flange with web gap meeting the requirement of the Design Code.
- h) Corners of stiffener plates projecting past the outside edge of flange plates shall be coped 45°.
- i) No intersecting welds are allowed. Horizontal stiffeners on the same side of the web as vertical stiffeners shall be terminated a minimum 6 mm from intersecting vertical stiffener welds.
- j) All weld ends shall terminate 10 mm from the edge or end of plates.
- k) Gusset plates for attachment of horizontal lateral bracing shall be bolted and not welded to girders.
- l) Changes in girder flange widths shall be tapered at a taper of 2 (longitudinal):1 (transverse).

Structural steel girders are used where span lengths or site conditions preclude the efficient use of precast prestressed concrete girders. Structural steel girders are also well suited to complex geometries and long spans. Member types are either rolled steel girders or plate girders. Rolled steel girders (commonly known as W-sections) are produced at the steel mill. Plate girders are typically built up from steel plates with the webs and flanges welded together to create an I cross-section. Structural steel box girders may also be considered for very long spans and curved roadways. Standard structural steel box girder cross-sections are trapezoidal shape with the webs sloped equally out from the bottom flange. The two webs are normally the same depth. Bearing stiffeners, intermediate stiffeners and connection stiffeners are welded to the web/flange as necessary.

All structural steel members in contact with and supporting the concrete deck shall be designed for composite action. Stud type shear connectors shall be used for composite action construction. Channel type shear connectors shall not be used on any new structural steel bridges due to their poor fatigue performance in the negative moment zone of continuous steel bridges.

### 3.9.1.2.8 Limits for Girder Transportation – Weights and Dimensions

Girders that require transportation by truck on the highway system should be sized in order that the following limits are not exceeded, if possible:

Length	47.5 m out to out, including truck
Width	4.4 m
Weight	62.5 tonnes including truck (GVW for RTAC routes)

If particular girders are close to these limits or if a larger girder size is required, the Design Engineer shall inquire with the heavy haul industry to determine if suitable hauling equipment is available and the necessary permits can be obtained. If the limiting constraints described above cannot be met, the Design Engineer shall take into consideration all loading and haul conditions in the detailed design of the particular girder and shall verify that the girder of a particular length and weight can be transported to the structure site, including negotiating tight corners and switchbacks and complying with allowable loading on the route and posted load limits for structures en route, if applicable.

To meet the limiting constraints above, steel girders are typically a maximum length of 41.5 m or weight of 43,500 kg and prestressed concrete girders are a maximum length of 39 m or weight of 43,500 kg. Girder weights shall be calculated using concrete densities of 2650 kg/m<sup>3</sup> for I-Girders and 2720 kg/m<sup>3</sup> for box girders to provide allowance for spread of formwork and higher reinforcing steel densities.

#### **3.9.1.2.9 Jacking**

Bridge structures shall be designed with provisions for jacking during future maintenance operations, and the proposed locations for jacking shall be indicated on the Drawings.

#### **3.9.1.3 Fall Protection Anchor Points**

Bridge girders shall be designed with provisions for anchoring fall protection safety devices that would be used during construction and future condition inspections and maintenance operations.

### **3.9.2 STANDARD “MINOR BRIDGE STRUCTURES”**

“Minor Bridge Structures” shall have the following characteristics:

- a) Constructed on PR roadways, main market roads and RM roads (for water control sites),
- b) Guardrail system (bolted on to the exterior girders) without curbs,
- c) Forecasted 20 year Average Daily Truck Traffic (ADTT) is less than 60 in one direction, and
- d) There is no load sharing between PPCC girders due to bolted lateral connection between adjacent girders.

#### **3.9.2.1 Precast Prestressed Concrete Channel (PPCC)**

The two standard girder lengths for PPCC out-to-out of girders are 8 m and 12 m long. The standard span lengths of these PR type channel girders are 7.8 m and 11.8 m from center line of bearing to center line of bearing. Girder length and cross-sections for a standard 12 m long PPCC are shown in Detail No. DD-12. Standard roadway widths, dimensioned out-to-out of girders, range from 8.4 m to 13.2 m at 1.2 m increments. The cross-section of a standard PPCC bridge structure is shown in Detail No. DD-13.

## **3.10 LOADS AND LOAD DISTRIBUTION**

### **3.10.1 VEHICULAR LIVE LOAD**

Design vehicular live loading shall be as defined in the AASHTO LRFD Bridge Design Specifications (Design Code). As a minimum, the design load shall consist of the following live loads as shown in Detail No. DD-14 (whichever governs):

- a) Modified AASHTO MSS 22.5 (HSS 25) Truck
- b) AASHTO MS 27 (HS 30) Lane Load
- c) AASHTO LRFD HL-93 Loadings

**Note:** In some circumstances Modified AASHTO MSS27 (HSS30) Design Truck Loading or specialized overload vehicles may be specified by the Department for specific projects in the Terms of Reference.

The Design Engineer shall confirm design loading requirements as part of the Project Design Brief prior to the start of detailed design.

Dynamic load allowance factor shall be applied to the live load in accordance with AASHTO LRFD 3.6.2 to increase the effects of the live load.

### **3.10.2 LIVE LOAD DISTRIBUTION FACTORS**

In accordance with AASHTO LRFD 4.6.2.2, the approximate method of analysis shall be used to determine the lateral live load distribution to individual girders for standard bridge structures. Lateral live load distribution factors are dependant on a number of characteristics specific to each bridge design and include: type of deck and girders, number of design lanes loaded, whether the girder is an interior or exterior girder, span length, transverse girder spacing, stiffness of the girder, and connectivity between girders. There are specific ranges of applicability for the use of the approximate method of analysis. Extending the application of the approximate method of analysis beyond the limits of applicability must be approved by the Department.

### **3.10.3 DEAD LOAD**

Dead load is the gravity load due to self-weight of structural and non-structural elements. Dead load shall be categorized as: weight of pre-fabricated elements, cast-in-place concrete members, wearing surface and miscellaneous weight such as railing, concrete barriers, utilities and signage.

For girders, the dead load of the deck is distributed to each girder based on their respective tributary widths. Superimposed dead loads, such as wearing surface, railing, barriers and medians, conduit loads shall be distributed equally to all girder lines. Sign structures, cantilevered sidewalks and utilities whose loads acts entirely outside the exterior girder shall be assumed to be carried by the exterior girders.

Densities specified for a number of materials in AASHTO LRFD Table 3.5.1-1 or computed specific product densities shall be used.

### **3.10.4 VEHICLE COLLISION LOADS FOR SUBSTRUCTURE UNITS**

Substructure units on the highway network shall be designed for the vehicle collision loads as specified in the Design Code.

## **3.11 GEOMETRY**

- Girder span lengths shall be dimensioned from centerline of bearing to centerline of bearing of the bottom flange.
- Bridge structure lengths shall be measured inside face to inside face of abutment backwall.
- Girder lengths for "Major Bridge Structures" shall be measured out to out of the bottom flange.
- Roadway cross-fall of 2% shall be provided on all "Major Bridge Structures", except on super-elevated roadways. The roadway cross-slope for all "Minor Bridge Structures" shall be 1.5%.
- Bridge structures with skew angles less than 5 degrees shall be made square.
- Bridge structures with skew angles greater than 5 degrees shall be constructed with skew angles in 5 degrees increments, if possible.
- One-way longitudinal slope of 0.35% minimum is required for "Major Bridge Structures" where road geometry is suitable. A vertical curve may be allowed for longer structures.
- Where jointless construction is not specified in multi-span "Major Bridge Structures", a minimum of 100 mm clearance between ends of girders shall be provided. Similarly, a minimum 100 mm space shall be provided between the ends of girders and inside face of abutment backwall.

- Centreline Final Pavement stations and elevations shall be shown over centerline at each substructure unit and at the inside face of abutment backwalls. Station and elevation shall be given to the nearest millimeter.
- Pile layouts shall be referenced to the points established where centerline roadway and inside face of abutment backwall/centerline pier intersect.
- Substructure units shall be numbered in the direction of increasing roadway chainage; i.e., abutment no. 1 (SU 1) occurs at the lower chainage location and the numbering increases from there.
- Girder deflection and camber:

#### Steel Girders

Steel girders shall be cambered for 100% of dead load effects to suit final road way geometry. Factors that are to be considered include: dead load of girder, dead load of deck slab, superimposed dead load (ex. wearing surface, curbs and bridgerail) and final grade line. Data shall be presented on a camber diagram that shows overall camber along with net camber values for individual girder segments.

#### Precast Girders (Channel and Box Girders)

Forms for precast girders are adjusted to maintain a level top surface prior to deck casting by allowing a sag to be built into the girder to compensate for camber resulting from prestressing/post-tensioning forces. The required sag shall be presented on the Drawings.

The deflection data used in calculating the sag shall be presented on the Drawings: dead load of girder, camber due to prestressing/post-tensioning forces, dead load of cast-in-place deck slab (if used), superimposed dead load (ex. wearing surface, curbs and bridgerail) and final grade line.

- Clearances for Grade Separation Structures:

#### Roadway

Calculated critical clearances shall be shown on the General Layout Drawing for all grade separation structures. The minimum required vertical clearance for a grade separation structure is as specified by TAC, but shall not be less than 5.4 meters for overpasses on PTH and PR roadways.

#### Railway

The detailed design shall meet the critical clearances as specified by the respective railway company with consideration given to the following:

- For each degree of curvature of the track, the horizontal clearance shall be increased by 50 mm each side of the track.
- Crash walls shall be provided for any structures with substructure components within 7.65 m of any track unless specified otherwise by the respective railway company.
- Continuous drainage over the structure is preferred, but in no case shall deck drains be closer than 6 m to the tracks, unless in a closed system. Careful consideration shall be given to drainage adjacent to the track and approval for the proposed drainage system shall be obtained from the respective railway company prior to construction.

The Design Engineer shall design a roadway grade line that optimizes the location and length of the bridge structure. Where practical, bridge structures shall be located on tangent horizontal alignments.

Bridge decks shall have a maximum grade of 3% or as stated in the TOR. Bridge structures shall not be located on spiral curves.

For deck drainage purposes, the Department considers a minimum grade of 0.35% to be desirable. However, the Department recognizes that grade line constraints for grade separation structures may require crest curves that result in portions of the bridge deck having a grade of less than 0.35%. Where practical, the crests of crest curves shall be located off of or at one end of the bridge opening.

The bridge roadway width between inside face of curbs shall meet the requirements in the Terms of Reference. If the bridge width is not specified in the TOR, the ESP will be required to make an application for bridge width. A copy of the form is included in Appendix A. The tops of sidewalks, curbs and medians shall slope 1% towards the roadway. The tops of abutment seats and pier caps shall have a wash slope of 1% to a minimum of 5 mm difference in elevations from front to back.

Top of bridge headslope fill widths shall be a minimum of the out-to-out bridge end width plus 2 meters. Taper rate from headslope fill width to approach roadway fill width shall be 30:1 or flatter. Corner transitions between headslope and sideslope shall use an elliptical curve at the toe of the slope.

Bridge structure support locations (e.g. piers, abutments, retaining walls) shall allow all required sight distances to be met.

The minimum vertical clearance for any sign structures over the roadway shall be a minimum of 6.0 meters.

### 3.12 MATERIALS

Manitoba Infrastructure and Transportation, Water Control and Structures maintains a pre-approved list of bridge materials and products. The Design Engineer shall obtain a copy of the “Approved Products List” and become familiar with it.

#### 3.12.1 CONCRETE

Standard weight aggregates shall be used for all concrete production. Portland cement type 10 (GU) shall be used for all normal exposure conditions. Portland cement type 50 (HS) (sulphate-resistant) shall be specified for site conditions subject to sulphate attack. Concrete exposure class shall be specified in accordance with the requirements of CAN/CSA A23.1, “Concrete Materials and Methods of Concrete Construction”, Table 11 and Table 14, respectively.

It should be noted that the relative degree of sulphate attack is severe for the following municipalities of the Province of Manitoba. (Source: Manitoba Building Code).

Brokenhead	Hanover	Rockwood	Springfield
DeSalaberry	MacDonald	Rosser	Tache
Cartier	Montcalm	St. Andrews	West St. Paul
East St. Paul	Morris	Ste. Anne	Winnipeg
Emerson	Rhineland	St. Clements	
Franklin	Ritchot	St. Francis Xavier	

The minimum 28-day compressive strength of concrete and class of exposure for different structural components shall be as follows unless approved otherwise by the Department.

Description	Strength	Class of Exposure
Pier shafts, pier tops and abutments (headwalls, wingwalls, backwalls, and retaining walls)	35 MPa	C - 1
Diaphragms, approach slabs, and transition slabs	35 MPa*	C - 1
Deck, curbs, sidewalks and traffic barriers	45 MPa	C - 1
Cast-in-place piles, pile caps, and spread footings	35 MPa	S - 1
Precast concrete girders	$f_{ci} = 30$ MPa $f'_c = 40$ MPa	C - 1
Precast NU concrete girders	$f_{ci} = 37.5$ MPa $f'_c = 55$ MPa	C - 1
Grout to fill shear keys	35 MPa @ 24 hrs	C - 1
Cast-in-place concrete culverts and all other miscellaneous concrete	35 MPa	C - 1

\*Structural design may require compressive strengths for diaphragms that are greater than 35 MPa.

### 3.12.2 CONCRETE REINFORCEMENT

- Reinforcing steel shall conform to the requirements of CAN/CSA-G30.18-M92, Grade 400W.
- All reinforcing steel shall be deformed.
- Epoxy coated reinforcing steel is not allowed for use.
- Either stainless steel clad, galvanized or MMFX-2 microcomposite steel shall be used for superstructure concrete, including bridge decks, curbs, sidewalks and barriers.
- Stainless steel can be used for exposed sides of barriers and curbs.
- Glass Fiber Reinforced Polymer (GFRP) can be used for bridge decks.
- Minimum lap for reinforcing steel bars: 15M = 550 mm, 20M = 670 mm and 25M = 860 mm unless design requirements dictate otherwise.

### 3.12.3 STRUCTURAL STEEL

- Structural steel shall conform to the following requirements:

Welded steel girders and all materials welded to girders	CSA G40.21-M-Grade 350WT
Bearing materials and bracing material bolted to girders	CSA G40.21-M-Grade 300WT
Miscellaneous steel, including deck joints	CSA G40.21-M-Grade 300W
Bolts	A325 or A325M
Charpy V-Notch Testing	CSA G40.21-M-Grade 350WT
- HSS tubing and W shape guardrail posts shall conform to CAN/CSA-G40.21-M92, Grade 350W.
- Weathering steel shall not be used unless approved by the Department.
- As a minimum, all structural steel (including girders, diaphragms, stiffeners, jacking beams, etc.) shall be protected by a coating system meeting the requirements of the Manitoba Infrastructure and Transportation, Water Control and Structures "Specifications for Coating Structural Steel".

### 3.12.4 BEARINGS

Bearing types allowed for new construction include:

- Steel reinforced elastomeric bearing pads with or without stainless steel and Teflon sliding surfaces,

- Pot bearings, and
- Spherical bearings.

**NOTE:** Steel reinforced elastomeric bearing pads shall be used whenever possible. The Design Engineer shall confirm design loading requirements as part of the Project Design Brief prior to the start of detailed design and provide justification for the selection of bearing type, including cost, availability and other factors.

Steel Reinforced Elastomeric Bearing Pads:

- Expansion bearings shall have PTFE bonded to top of elastomeric pad with stainless steel on mating surface. Stainless steel sliding surfaces shall conform to ASTM A 167 Type 304 or A 240M Type 304. The roughness of the contact surface, measured in accordance with CSA Standard B95, shall not be greater than 0.25  $\mu\text{m}$  arithmetic average for plane surfaces and 0.40  $\mu\text{m}$  RMS for curved surfaces. Stainless steel mating surface shall have a minimum thickness of 1.5 mm when the maximum dimension of the surface is less than or equal to 300 mm, and at least 3.0 mm when the maximum dimension is larger than 300 mm. The stainless steel plate shall be wider than the elastomeric pad by at least 10 mm on each side.
- Elastomeric pads shall be restrained by means of keeper bars on the bearing seat.
- Elastomeric material shall satisfy the requirements of AASHTO Low-temperature Elastomer Grade 4 or 5 as defined in Section 18 of the AASHTO LRFD Bridge Construction Specifications, latest edition. Unconfined sheet PTFE may be bonded to an elastomeric bearing with a Shore A durometer hardness of 60.
- Elastomeric bearing pads on skewed bridges are to be orientated perpendicular to the longitudinal girder axis.
- Polytetrafluoroethylene Polymer (PTFE) resin for use in sliding surfaces shall be unfilled, flat sheets made from virgin material and shall conform to ASTM Standard D4894 or D4895. The PTFE layer shall be at least 2 mm thick after compression.
- Internal steel plates for laminated bearing shall be rolled mild steel with minimum yield strength of 230 MPa
- All structural steel shall conform to the requirements of CSA Standard G40.21-M, Grade 300W.
- All exposed surfaces of the steel plate shall be zinc metallized. Surfaces to be metallized shall be blast cleaned in accordance with SSPC-SP5, "White Metal Blast Cleaning". All bearings shall be grouted in prior to casting deck concrete. Bearings pads shall be designed for all rotations that take place after the bearings are grouted.
- For expansion bearings, the elastomeric cover for the uppermost steel shim shall not be greater than 5 mm.
- Un-lubricated PTFE shall be specified.
- Elastomeric pads shall be restrained from walking out by means of 6 mm high corner keeper bars welded to the top of the base plate. The 6 mm height is to limit girder raising/jacking for future removal and replacement of bearing pads.
- Shim plates, if required, shall be stainless steel.

Pot Bearings:

- Pot bearings are used where laminated elastomeric bearings are not capable of carrying the required load.
- Rotational allowance shall satisfy the requirements defined in Section 14.4.2 of the AASHTO LRFD Bridge Design Specifications, latest edition.
- Pot bearings shall be installed on a level base plate or galvanized steel shim stacks, and grouted in prior to casting deck concrete. The bearings shall be designed for all rotations that take place before and after grouting, plus a minimum fabrication and construction tolerance allowance of 0.01 radian.
- Pot bearing components shall be metalized or galvanized and shall be attached to galvanized plates by bolting.



General:

- a) Bearings are to be level in the direction of movement.
- b) Expansion bearings shall have a 'temperature setting' table or graph provided on the Drawings.
- c) Expansion bearings shall provide a factored movement of 1.20 times the theoretical movement in accordance with Table 3.4.1-2, AASHTO LRFD Bridge Design Specifications, latest edition, but not less than 25 mm, beyond theoretical travel. All bearings shall be designed to allow sufficient travel in the bearing components for all conditions of translation and rotation from temperature change, longitudinal gradient, movements associated with the effects of creep, shrinkage, construction methodology/loading, rotation under live load and additional movement due to foundation conditions (if anticipated).
- d) The tabulation of permanent vertical load, total vertical load and bearing pressures at serviceability limit states design shall be shown on the Drawing for each bearing.
- e) Bearing and girder designs shall take into consideration the future need to jack girders to permit repair, maintenance and replacement of bearings.
- f) Where it is necessary to adjust the relative location of the bearing top plate with respect to the bottom plate during installation, the bearings shall be designed and installed so they are centered at 0° C.
- g) Base plates shall be hot-dip galvanized or metalized.
- h) For precast girders, sole plates shall be hot-dip-galvanized or metalized, and field welded to galvanized shoe plates cast into the girders. All damaged galvanizing shall be repaired by metalizing.
- i) Attachment by welding shall be in the longitudinal direction along the edge of the girder. Transverse welding requires underhand welding and shall not be permitted. Transverse ends shall be sealed with Sikaflex 1a or an approved caulking material.
- j) Bearing contact face preparation:
  - Steel plates in contact shall be machined to a surface finish of 3.2 µm and a flatness tolerance of 0.001 x bearing dimension. Contact surfaces with elastomeric pad and grout or cast-in-place concrete do not require machining. Where required, machining shall be performed prior to hot-dip galvanizing. Where the galvanizing process may cause distortion, metalizing shall be used.
  - Galvanized surfaces shall be isolated from black steel by painting with two coats of epoxy mastic paint.
- k) Galvanized surfaces in contact with concrete or cementitious grout shall have the contact surfaces protected by a barrier coating.
- l) Uplift bearings shall not be used.
- m) Bridges and bearings shall be designed and detailed to allow for bearing replacement. Typical bearing replacement includes simultaneously jacking all girder lines to avoid damage to the deck, diaphragms and deck joint components. Locations for future jacking shall be shown on the Drawings and shall be based on estimated jack and distribution plate sizes.
- n) Shear transfer mechanisms required to transfer permanent horizontal loads between the superstructure and substructure shall have stainless steel on Teflon sliding surfaces, if required to accommodate superstructure expansion/contraction.

### 3.12.5 PRESTRESSING STRANDS

- Prestressing steel strands shall conform to the requirements of ASTM standard A416M, "*Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete*" specifications.
- Strands shall be either harped and/or de-bonded to reduce the tensile stresses at the ends of girders.
- Information to be indicated on the Drawings shall include: ultimate tensile strength of the strands, jacking force per strand, number of strands, centre of gravity of strands, strand diameter, debonding location and location of harp point(s).
- 12.7 mm diameter, uncoated seven wire low relaxation (LR) strand shall be used. Larger diameter strands may be used upon approval of the Department.
- Minimum ultimate strength,  $f_{pu} = 1860$  MPa/strand shall be used.

- Maximum applied jacking force shall be,  $f'_s = 137.7$  kN/strand.

### 3.12.6 LATERAL POST-TENSIONING STRANDS

- As shown in Design No. DD-04 and DD-09, PPCBG and PPCCG bridge structures shall be post-tensioned transversely with high strength prestressing strands. The number of ducts and location of these transverse strands shall be determined based on the anticipated method of lateral load distribution, depth of girder, span length of girders and skew angle of the bridge structure. It should be noted that the PCI Bridge Manual recommends the use of an upper and a lower duct in each girder to provide beam action where lateral post-tensioning is utilized for lateral load distribution. As a minimum, two-12.7 mm diameter strands shall be used in each duct.
- Lateral post-tensioning strand shall be a minimum of 12.7 mm in diameter.
- Jacking force,  $f'_s = 93.45$  kN/strand, and the minimum ultimate strength,  $f_{pu} = 1860$  MPa shall be used.

### 3.12.7 DECK PROTECTION AND WEARING SURFACE

The Department's standard system for protecting a bridge deck for "Major Bridge Structures" from deterioration of reinforcement due to deicing salts and freeze-thaw damage to concrete consists of:

- High performance concrete (HPC),
- Corrosion-resistant reinforcement, and
- Substantial clear cover on the reinforcement.

In cases where the Department specifies in the Terms of Reference that a bituminous wearing surface will be allowed, a hot-poured rubberized asphalt waterproofing membrane is required below the bituminous wearing surface. The hot-poured rubberized asphalt waterproofing membrane shall meet the requirements of the CAN/CGSB-37.50. The bituminous wearing surface and hot-poured rubberized asphalt waterproofing membrane shall have a total thickness of 90 mm: consisting of a 4 mm hot poured rubberized asphalt membrane + 6 mm protection board + two 40 mm lifts of Class B bituminous pavement. For PPCCG and PPCBG bridge structures, a 300 mm wide strip of reinforcing sheet shall be placed over the shear keys within the 4 mm layer of hot poured rubberized asphalt membrane.

An allowable alternative system can be used with a total thickness of 60 mm: consisting of two 3 mm layers of hot poured rubberized asphalt membrane + 2 mm reinforcing sheet + 2 mm protection sheet + a single 50 mm lift of Class B bituminous pavement. For PPCCG and PPCBG bridge structures, a 300 mm wide strip of reinforcing sheet shall be placed over the shear keys within the two 3 mm layers of hot poured rubberized asphalt membrane.

Bituminous Wearing Surface - MIT "Class B" bituminous pavement shall be used.

For PPCCG and PPCBG bridges:

- A reinforced high-performance concrete overlay may be specified for lateral load distribution. The minimum thickness of any overlay shall be 150 mm.
- The riding surface may be:
  - Reinforced high-performance concrete overlay
  - Bituminous (with waterproofing membrane) over:
    - Reinforced high-performance concrete overlay
    - PPGBG or PPCCG girders

Standard PPCC bridges require only the bituminous wearing surface without the hot-poured rubberized asphalt waterproofing membrane.

## 3.13 CLEAR CONCRETE COVER TO REINFORCING STEEL

Adequate clear concrete cover shall be provided for prestressing and reinforcing steel as per section 5.12.3 of the AASHTO LRFD specifications or CHBDC CAN/CSA-S6-06, whichever governs. As a minimum, the following clear concrete cover for prestressing and reinforcing steel shall be provided:

Steel in concrete subject to normal exposure	50 mm
Steel in concrete cast in contact with soil (no form)	75 mm
Steel in cast-in-place concrete decks with waterproofing & wearing surface	
Top layer	50 mm
Bottom layer	50 mm
Steel in cast-in-place concrete decks without waterproofing	
Top layer	75 mm
Bottom layer	50 mm
Steel adjacent to front face of concrete curb/barrier wall	100 mm
Precast prestressed concrete hexagonal piles	50 mm
Concrete approach slabs	50 mm
Precast prestressed concrete girders	25 mm

### 3.14 SHEAR KEYS

Shear keys between adjacent precast concrete box and channel girders shall be filled with non-shrink grout. The grout shall have a minimum compressive strength of 35 MPa at 24 hrs. As shown in Detail No. DD-04 and DD-09, the shear key at the centerline of roadway shall be grouted, and the grout allowed to cure, prior to lateral post-tensioning with a non-shrink, non-extended grout. The remaining shear keys shall be grouted after the lateral post-tensioning operation is performed and ducts filled with a non-shrink grout. In situations where a girder is located along the centerline of the bridge, the two shear keys adjacent to the centerline of roadway shall require grouting (and curing) prior to lateral post-tensioning with a non-shrink, non-extended grout.

### 3.15 DIAPHRAGMS

- PPCCG and PPCBG bridge structures ranging in span lengths from 10 m to 15 m shall have end diaphragms and one intermediate diaphragm located at mid-span (as a minimum). Diaphragms for PPCCGs are shown in Detail No. DD-07.
- Span lengths in excess of 17.5 m (for all girder types) shall have a minimum of two intermediate diaphragms in addition to the end diaphragms.
- Intermediate diaphragms are required in bridge structures with girder and deck slab superstructures unless their omission is agreed to in advance and in writing by the Department. Intermediate diaphragms in bridge structures with steel girder and deck slab superstructures shall have a maximum spacing of 8.0 m. Intermediate diaphragms in bridge structures with precast concrete girder and deck slab superstructures shall have a maximum spacing of 13.0 m unless noted otherwise.
- All diaphragms for PPCCGs and PPCBGs shall extend the same depth as the girder.
- As shown in Detail No. DD-11, diaphragms for PPCIGs shall extend to the bottom of the web (as a minimum).
- Diaphragms shall be placed parallel to the direction of skew.
- For jointless deck design, pier diaphragms shall be continuous cast-in-place concrete diaphragms and shall be either pinned or permit free expansion. Minimum separation between girders ends shall be 150 mm with grouted tendons only, and 300mm with bent strands or hooked rebar. For pier diaphragms with a pinned or expansion connection to the pier, girders ends shall be supported on double reinforced elastomeric pads.
- Minimum age for girders before field cast continuity shall be 30 days. Girder design and detailing shall consider the effects of differential camber between girders, such as in haunch height variations

and diaphragm connectors. Girder design strength shall be based on the nominal girder depth assuming the minimum haunch height.

- Intermediate diaphragms for steel or precast girders 1200 mm deep or shallower, shall be channel or W shape of at least 1/3 and preferably 1/2 the girder depth. For girders deeper than 1200 mm, full depth X or K bracing with top and bottom horizontals shall be provided.
- Intermediate diaphragms and girders shall be designed for construction loads during deck concrete placement in accordance with the Design Code. Specifically, diaphragms, exterior steel and precast girders carrying deck overhangs shall be checked to ensure sufficient strength and stability to handle concentrated loads from deck finishing machines, work bridges, moveable deck hoarding, suspended working platforms, fog misting equipment, and loads from temporary walkways outside the edge of the deck slab. Loads assumed for such design shall be based on realistic estimates for each bridge structure and shall be shown on the Drawings.

### 3.16 SUPERSTRUCTURE CONCRETE

#### 3.16.1 CAST-IN-PLACE CONCRETE BRIDGE DECKS

The AASHTO LRFD Specifications include two methods of concrete deck design. One method (S4.6.2.1) is called the approximate method of deck design and it is typically referred to as the equivalent strip method. The other method (S9.7.2) is called the Empirical Design Method. The Empirical Design Method is based on laboratory testing of concrete deck slabs. This testing indicated that the loads on the deck are transmitted to the supporting components mainly through arching action in the deck, not through shears and moments as assumed by traditional design. Furthermore, the Empirical Design Method requires less reinforcement in the interior portions of the bridge deck than the approximate method. However, the overhang region needs to be designed for vehicular collision with the railing system and for dead and live loads acting on the deck. Concrete bridge decks shall be designed in accordance with the Empirical Design Methodology, where code conditions apply.

The minimum thickness of a concrete bridge deck without the wearing surface shall be 200 mm thick. Variable depth haunches at the girder shall be provided to maintain the deck concrete thickness between girders. Haunches may be positive (above top of girder) or negative (below top of girder).

Prestressed concrete girder bridge structures shall be designed for composite action such that both the concrete deck and the girder respond to the load as a unit. The composite action is accomplished by extending reinforcing stirrups from the top of the girders into the deck.

Concrete deck on steel girders shall also be designed to act compositely with the girders. Composite action design significantly stiffens the steel girders. The composite action is accomplished by the use of properly designed shear stud connectors welded onto the top flange of the girders.

Depending on specific site conditions, the following types of deck reinforcement can be used: stainless steel clad, galvanized, MMFX-2 microcomposite steel, or Glass Fiber Reinforced Polymers (GFRP). The Design Engineer shall confirm the type of deck reinforcement as part of the Project Design Brief prior to the start of detailed design. For skewed bridges, the reinforcement shall be detailed such that the transverse bars are parallel to the skew angle. All bridge deck reinforcement shall be 15 mm or larger in diameter.

For a GFRP reinforced concrete deck only, the Department will allow the deck slab to be designed to meet the requirements of Section 8.18.4 and Section 16.7.1 and 16.7.2 of CAN/CSA-S6 (latest edition), except that clause 8.18.4.1 (b) is amended to limit girder spacing to slab depth ratio of 15.0. Use of this method requires composite action between the deck slab and girder over the entire girder length.

Precast deck panels (partial and full-depth) are not allowed without written approval from the Department.

Stay-in-place deck soffit formwork is not allowed.

### 3.16.2 CURBS, BARRIERS AND SIDEWALKS

Concrete curbs and barriers shall have crack control joints at a maximum spacing of 3 meters (centered between bridge rail posts where applicable). Longitudinal reinforcing in the curbs shall be discontinuous at the joints. Load transfer dowels shall be provided across the joints in barriers and the barrier shall be designed as end panels for the entire length of the structure. Control joints shall extend down to the top of the concrete deck and shall be caulked prior to application of deck waterproofing membrane.

Sidewalks shall have a curb projecting 100 mm above the finished top of the sidewalk along the outside edge. Sidewalks shall be higher than the adjacent road surface and drain through slots in the traffic separation barrier onto the roadway surface.

The clear sidewalk width shall be a maximum of 2.5 meters.

The following set-back requirements or protective measures shall be followed when attachments, such as signs, lamp posts, sign structure support columns, piers of adjacent bridges, etc. are on top of or close behind bridge or retaining wall barriers.

Applicable roadside barrier standard	Set-back or other treatment
TL 2	305mm minimum
TL 3	610mm minimum
TL 4	For lamp posts and sign structure columns, provide PL2 combination barrier. If a PL3 bridgerail is required by the Bridge Design Code the overall height of the standard PL3 barrier shall be increased to 1370 by increasing the height of the concrete base. A set-back of 610 mm is required behind the top rail. For piers of adjacent bridges, a 3,000 mm minimum set-back is required.

Light standards shall be mounted on top of the curb or concrete barrier at locations close to the centerline of piers to avoid excessive vibration from traffic.

### 3.17 DECK JOINTS

- Deck joints shall be designed to accommodate movement and provide a watertight seal for the bridge deck.
- “Minor Bridge Structures” do not require deck joints.
- “Major Bridge Structures” require strip seals and/or modular expansion joints. Only approved strip seals shall be used.
- Strip seals are used for expansion and fixed joint locations. Minimum joint gap of 60 mm or Manufacturer’s recommendation, whichever is larger, is to be maintained by stop movement bars to facilitate future seal replacements. The Design Engineer shall note that this is often larger than the minimum gap indicated on Manufacturer's brochures, which provide gap widths suitable for first installation only.
- For strip seal type deck joints with skew angles within the range of 20° to 45°, snow plow guard plates shall be investigated.
- Modular expansion joints shall be used when strip seals cannot provide adequate movement capability.
- Compression seal joints are not allowed for use.
- If joints are not desired at the ends of a bridge structure and geotechnical considerations permit, integral or semi integral abutments should be used.

- Wherever practical, expansion and/or fixed joints shall be avoided or placed in the approach pavement away from the end of the superstructure.
- The Design Engineer shall use standard Department details, and include all site specific details, dimensions, temperature setting tables, etc. on the Drawings.
- Deck joints on steel girder superstructures are to be erected by bolting to the girders. Bolted connections shall utilize slotted holes to provide adjustment in vertical, lateral, and longitudinal directions.
- Deck joints on concrete girder superstructures or abutments shall be erected on adjustable supports by projecting dowels with threaded couplers for elevation adjustment.
- The use of link slabs is not permitted.
- Adequate access within curbs and barriers shall be provided for maintenance and repair work to joints.
- Steel cover plates shall be used over joints in curbs, sidewalks and barrier walls. These plates shall be fastened with two rows of countersunk bolts. The sidewalk plates shall have a non-slip coating applied.
- Deck joints shall be recessed 5 mm below riding surfaces and 8 mm behind the vertical traffic faces of curbs, sidewalks, medians and barriers. The free ends of any cover plates shall be pointed away from the direction of oncoming traffic.

### 3.18 DECK DRAINAGE

It is important to provide a good deck drainage system on all “Major Bridge Structures” primarily for traffic safety reasons, but also to prevent structural deterioration from water ponding and inadequate drainage.

- Drains shall be placed so that splash onto the substructure units does not occur.
- For overpasses, drains shall not be placed over the roadway or railroad tracks.
- Deck drains are required on bridge structures where the road grade is relatively flat. The Design Engineer shall use typical MIT details. The deck drains shall be spaced such that during a 1 in 20 year rain event, the water does not exceed the storage along the curb and accumulate in the travel lane.
- Bridge decks with waterproofing membranes shall have provisions made along the gutter lines to allow for the drainage of water that penetrates the asphaltic wearing surface.
- Drains required for the deck and sidewalks shall drain vertically downward and extend beyond the bottom of the girders by 300 mm except at locations where ice damage may be expected where the drains shall be 100 mm below the underside of girders.
- The opening for all roadway drains and downspouts shall be a minimum of 200 mm as per AASHTO LRFD requirements for bridge decks subjected to freezing conditions.
- Drainage at the ends of the abutments shall be directed into catch basins. The catch basins shall discharge through a buried CSP to the toe of the embankment onto a grouted rip-rap spill pad.

### 3.19 CONCRETE CURBS

- The cross-section of a typical cast-in-place concrete curb used on all “Major Bridge Structures” is shown in Detail No. DD-15. The Design Engineer shall use typical MIT details, where at all possible.
- The outside face of curb shall be offset from the outside face of the girder to allow for a water drip groove and clean line.
- Curb widths shall range from 550 - 600 mm.
- Depth of curb shall be a minimum of 300 mm from top of cast-in-place deck (if present) or top of PPCBG and PPCCG (if deck is not present). This depth accommodates an 85 mm asphalt wearing surface.

### 3.20 PRECAST CONCRETE BARRIERS

- The cross-section of a typical precast concrete traffic barrier is shown in Detail No. DD-16.
- Precast concrete barriers are used to separate traffic and protect vehicular and pedestrian traffic as a temporary measure during construction.
- Precast concrete barriers can be placed in the median and shoulder.
- Precast concrete barriers are not permitted for permanent installations.

### 3.21 RAILINGS

With the exception of culverts, all “Major Bridge Structures” shall be designed with a crash tested railing system. The railing system shall meet the minimum loading requirements of Test Level 4 (TL-4) as defined by the National Cooperative Highway Research Program (NCHRP) Report 350: “*Recommended Procedures for the Safety Performance Evaluation of Highway Features*”.

Deck slabs shall be designed in accordance with AASHTO LRFD Bridge Design Specification (latest edition).

#### a) Traffic - Bridge Rail Standards for New Construction

A multiple Performance Level approach has been adopted by AASHTO LRFD Bridge Design Specification to suit the different traffic and geometric conditions at typical bridge structure sites. The traffic conditions and crash testing requirements for Test Levels TL-1 to TL-6 are defined in Section 13 of the AASHTO design specification. The Department has adopted the following traffic barrier details as standards:

1. The F-shape concrete barrier may be used when there is a preference for architectural reasons, mainly around urban areas. A height of 850 mm has been chosen for the concrete barrier which includes a 50 mm allowance for a future overlay. Typical details are available in Detail No. DD-23, DD-24, and DD-26.

Panel lengths shall be identical, where possible. The maximum difference in adjacent panel lengths should not exceed 750 mm. All panels shall be designed as end panels with dowel reinforcing crossing the control joints. If TL-5 or TL-6 barriers are required, the front face shall have a similar shape to the TL-4 barrier with the exception of the overall height, where possible (see Detail No. DD-25 and DD-27). TL-5 and TL-6 barriers and their details shall require prior approval by the Department.

2. The TL-4 open tube rail (Alaska railing) is the most preferred design for the following considerations:
  - a) Reduced snow accumulation and drifting, and safer traffic operation. Reduced snow removal effort.
  - b) See through visibility.
  - c) Shrinkage cracking of concrete barriers has been a recurring problem with no apparent solution. These cracks often result in increased maintenance.
3. The TL-2 Thrie Beam with curb design is for use on culverts at grade with approach slabs, to avoid transitioning between different bridgerail types within a short length. In this case, the Thrie Beam from the approach transitions is carried along the full length of the structure.

Hazard protection shall be designed as per AASHTO LRFD and the Roadside Design Guide in order to protect errant vehicles from the ends of bridge and culverts and all other hazards

associated with bridge and roadway structures. Note that each bridgerail system described above design comes with specific approach guardrail transitions.

It is the Design Engineer's responsibility to ensure that the bridgerail type chosen is appropriate for the site specific Test Level requirements according to AASHTO LRFD Bridge Design Specifications. The Design Engineer is also responsible for designing bridge deck and curb reinforcement to ensure that the bridgerail anchorages can be fully developed, and do not become the weak link in the system.

b) Pedestrian:

The Design Engineer shall use typical Department details, and include all site specific details, dimensions, temperature setting tables, etc. on the Drawings. The pedestrian railing shall be designed for use at the outside of sidewalks, and used only when there is a traffic railing/barrier located on the traffic side of the sidewalk. Maximum panel length is 3000 mm and panel lengths should be in multiples of 150 mm.

When a vehicular bridge includes a sidewalk, an F shaped concrete barrier shall be provided between the sidewalk and the roadway.

c) Layout:

All dimensions for bridgerail layouts are to be given on centerline of bridgerail anchor bolts.

Bridgerail expansion joints shall be provided at all deck joint locations. For long bridges, additional expansion joints shall be provided at a maximum spacing of 45 meters.

Bridgerail expansion joints shall be sleeved and the Design Engineer shall use typical MIT details. The Design Engineer shall ensure that the bridge deck expansion gap closes before the bridgerail expansion gap.

Approach guardrail located at bridges with semi-integral abutments shall be designed to accommodate expansion and contraction with minimal long-term maintenance.

Steel bridge railing for bridges with curve radii of 600m or less shall be fabricated curved.

### 3.22 APPROACH SLABS

Approach slabs provide a smooth transition between the bridge deck and the approach roadway pavement. The approach slab helps to reduce the bump that can be created when the approach fill settles at the end of the bridge structure. Settlement of approach fills typically consists of a compression of the embankment material and a consolidation of the underlying natural foundation soils. The overall magnitude of these two components can be substantial, resulting in a bump felt by motorists driving on to the bridge structure or away from the bridge structure (or the abutment diaphragm for semi-integral abutments).

Department standards require that an approach slab be fixed to the abutment backwalls (or the abutment diaphragm for semi-integral abutments) and constructed at both ends of all "Major Bridge Structures".

"Minor Bridge Structures" constructed on a PR roadway usually have low volumes of high-speed truck traffic and do not require approach slabs. However, the approach roadways shall be paved a minimum of 50 m long past each end of the PPCC bridge.

The approach slabs on all "Major Bridge Structures" shall be cast-in-place reinforced structural concrete and meet the following criteria:



- Extend a minimum of 7 000 mm long (measured parallel to centerline of roadway) beyond both ends of the bridge structure.
- Width of the approach slab shall be the same as the bridge roadway width.
- Minimum concrete compressive strength – 35 MPa
- Minimum 250 mm thick
- Standard longitudinal reinforcing (placed parallel to centerline of roadway):
  - Top Slab                      15M bars @ 300 mm
  - Bottom Slab                 20M bars @ 120 mm
- Standard transverse reinforcing (placed parallel to backwall):
  - Top Slab                      15M bars @ 450 mm
  - Bottom Slab                 20M bars @ 350 mm
- Slab overlay: 75 mm of compacted asphaltic wearing surface, waterproofing membrane is not required.
- Low density Styrofoam or flexcell, 25 mm x 100 mm, is detailed in a keyway on the outer edge of the backwall for the full width of the bridge structure.
- The transverse reinforcing for the top mat is detailed with a discontinuity along centerline of roadway.
- Standard joint details shall be included along centerline of roadway, around the perimeter of the slab and between the abutment blockout.

See Typical Cadd Details for standard approach slab drawings.

### 3.23 UTILITY ACCOMMODATION

The Design Engineer shall make provision for accommodation of utilities on any new bridge structure(s) as required by utility companies. Present and future utility requirements (telephone, hydro, cable and others) as identified by the utility companies shall be accommodated. Gas lines are not allowed on bridge structures.

The utility ducts shall be placed within the bridge curbs/barriers and shall be extended beyond the ends of the abutment wingwalls and terminated behind the roadway approach guardrail. Utility ducts shall not be placed within the bridge deck or attached to the bridge girders, unless authorized by Manitoba Infrastructure and Transportation.

Additional conduits, weatherproof boxes, and anchor bolts for light poles are required in situations where lighting is to be provided on the bridge structure or on the adjacent approaches. Project specific lighting requirements will be specified by the Department in the Terms of Reference. Conduit sizes and locations of boxes and light fixtures will, in most instances, be provided by the utility company.

Pull pits shall be provided as deemed necessary by the utility companies.

Notwithstanding the above, it is the opinion of the Department that in the long term utilities that are attached to the exterior of a bridge structure will invariably become a problem through vandalism or when major maintenance of the structure is required. It is the Department's strong preference that whenever practical utility plants are not attached to a bridge structure and an alternative means of crossing an obstruction be actively pursued by the utility companies. However, if other options are not reasonably available, and a utility company still wishes to pursue a request to attach a plant to an existing bridge structure, the following conditions must be met:

- Complete details of the proposed attachment must be submitted to the Department for review, and written approval must be given by the Department prior to the commencement of the installation under consideration.

- In the event that a utility plant is no longer required, the owner of the utility plant shall advise the Department, arrange for the plant to be removed, and restore the structure to its original condition prior to the installation of the plant (where practical). Any required restoration work shall be completed to the satisfaction of the Department.

### 3.24 FOUNDATIONS/GEOTECHNICAL

The proper design of bridge structure foundations requires thorough knowledge of the subsurface profile at the particular bridge structure site. Site investigation such as boring, in-situ testing, sampling, laboratory testing and analysis of all geotechnical data shall be performed in order for the appropriate foundation type to be chosen and designed.

Foundations are divided into two basic types: shallow foundation where spread footings are utilized and deep foundation where piles are driven deep into the ground.

Standard deep foundations used to support new “Major Bridge Structures” include: precast prestressed concrete hexagonal piles, steel HP piles, steel pipe piles (concrete filled) and caissons (including rock socketted). Pile foundations shall not be designed using the results of PDA testing.

Applied factored loads and factored pile resistances for abutment and pile bent or pier piles shall be shown in the “Design Data” on the “Cover Sheet” Drawing.

#### 3.24.1 GENERAL

The Designer shall consider the following design practices as they relate to the geotechnical performance of the bridge elements:

- a) Bridge and culvert designs shall accommodate all short-term and long-term settlements.
- b) If continuous deck structures are to be used, the bridge shall be designed for applicable short term and long term differential settlements. A minimum differential settlement of 10 mm shall be used.
- c) Foundations shall be such that the underside of footings or pile caps are a minimum of 1.8 metres below grade (anticipated frost penetration) for piers and 0.5m for perched abutments.
- d) Backfill around and on top of excavations shall be accomplished with clay or a fine granular to avoid “bath-tub” effects of backfilling with a coarse granular surrounded by clay.
- e) Slope paving shall be “keyed in” to the underlying soil to mitigate translation of the paving.

#### 3.24.2 GENERAL – PILES

- (a) All welded pile splices whose tensile or flexural capacity is deemed to be critical to the structural integrity of the bridge structure (for example with integral bridges), shall be identified as tension splice welds on the Drawings. All welds will require testing using non-destructive testing techniques. The following note shall be included on the Drawings:

“ALL OF THE PILE SPLICE WELDS THAT ARE REQUIRED WITHIN THE TOP “X” METRES OF THE PILE ARE TENSION SPLICE WELDS”

- (b) Full length piles shall be provided wherever possible to avoid field splicing.
- (c) Steel piles for “Major Bridge Structures” designed to be exposed shall be metalized to a minimum of one metre below grade or stream bed. All damaged metalizing shall be repaired on-site with a cold applied metalizing compound.

#### 3.24.3 PRECAST PRESTRESSED CONCRETE HEXAGONAL PILES

Cross-sections of typical precast prestressed concrete hexagonal piles are shown in Detail No. DD-17. As shown in Detail No. DD-17, precast concrete piles come in three standard diameters: 305 mm, 356 mm and 406 mm. A typical detail for a precast prestressed concrete hexagonal pile splice is shown in Detail No. DD-18.

Precast concrete piles are considered non-corrosive, but can be damaged by direct chemical attack. Sulphate resistant portland cement type 50 (HS) shall be used to fabricate all precast concrete piles.

#### **3.24.4 STEEL HP PILES**

Steel HP piles are ideal if the piles need to be driven into the bedrock or to refusal. Steel HP piles are rolled steel and are available in standard sizes. The standard HP piles sizes used by MIT are HP250 x 85 and HP310 x 110. Steel HP piles are typically used for any depth because splicing is relatively simple and it is performed by full penetration butt-welding. HP310 x 110 steel piles shall be used for all "Major Bridge Structures".

The typical detail for HP-pile splice is shown in Detail No. DD-18. Welding shall conform to applicable standard specifications. Mechanical splices of HP piles are not permitted.

Driving tips added to steel HP piles shall be specified only when it is recommended due to foundation and geotechnical requirements. The Department typically uses Hard-Bit Point model HP-77750-B, and the standard detail for pile driving tip is shown in Detail No. DD18. The Design Engineer shall attempt to use this detail where it is suitable.

#### **3.24.5 STEEL PIPE PILES**

Circular steel pipe piles can also be used for "Major Bridge Structures" foundations. The standard sizes of the pipe piles used are: 324 mm, 356 mm and 406 mm diameters. Depending on the geotechnical design requirements, the Design Engineer shall specify the grade and pipe wall thickness of the steel pipe pile. Only steel pipe piles filled with cast-in-place concrete shall be specified. The cast-in-place concrete shall include reinforcement steel. Driving tips are welded to the bottom of the steel pipe piles for ease of penetration in soil containing boulders. Splicing of pipe piles shall be accomplished through full penetration butt-welding. Standard details of the steel pipe pile splice and driving tip are shown in Detail No. DD-18.

#### **3.24.6 STEEL HP PILES FOR PPCC BRIDGES**

Steel HP piles shall be used for all PPCC bridges unless there are geotechnical concerns that prohibit their use. The following HP pile sizes shall be used wherever possible. Structural analysis/design by the Design Engineer is required if other sections of HP pile are chosen.

- End bents for 8 m girder length: HP250 x 85
- End bents for 12 m girder length: HP310 x 110
- Intermediate bents for all girder length: HP310 x 110
- Wingwalls for all girder lengths: HP250 x 85

It should be noted that the maximum intermediate bent pile height (i.e. top of pile to ground level) above the ground line is 4.5 m. Any pile bent height greater than 4.5 m requires a site specific structural design by the Design Engineer.

### **3.25 ABUTMENTS**

An abutment is a reinforced concrete structure that supports the ends of a bridge span, provides lateral support for approach roadway fill, and supports the approach roadway and approach slab.

The standard type of abutment used by the Department is the stub abutment. Stub abutments are located at or near the top of approach fills, with a backwall depth sufficient to accommodate the superstructure depth and bearings which sit on the bearing seat. A stub abutment is built on a minimum of two rows of pile foundation, and the bridge seat acts as a pile cap. Examples of stub abutments for PPCIG, PPCCG and PPCBG bridge structures are shown in Detail No. DD-19. The design and details of site specific abutments will depend upon the bridge geometry, subsurface profile and surrounding topography.

If geotechnical considerations permit, an integral abutment may be considered for new "Major Bridge Structures". An integral abutment has lower construction cost and superior long-term performance. Integral abutment design also eliminates the need to use expansion joints in the bridge deck.

Bridge plaques meeting the Department's requirements shall be attached to all bridge abutments.

### 3.25.1 INTEGRAL ABUTMENTS

Integral abutments (includes fully integral and semi-integral abutments) shall be designed to meet the following requirements (for guidance see the Alberta (ATU) Bridge Structures Design Criteria, "Appendix A -Guidelines for Design of Integral Abutments"):

- a) Integral abutments may be used for steel girder bridges less than or equal to 75m in length and for concrete girder bridges less than or equal to 100m in length.
- b) The effects of skew and potential for twisting of superstructure on plan shall be analyzed and accounted for, especially for skew greater than 20°.
- c) The amount of structure and earth that have to move with the abutment during thermal movement of the superstructure shall be minimized. Abutment seat heights shall not be greater than 1.2m and wing wall length shall not be greater than 8m.
- d) All the abutments negative bending moments will be present in the girders due to rotational restraints provided by the abutments as well as by rotational restraints provided by adjacent less heavily loaded girders with smaller end rotations. These negative bending moments shall be considered in the design.
- e) For fully integral abutments the abutment foundation shall be a single row of H-piles oriented for weak axis bending unless otherwise accepted by the Department. For large movements, piles can be installed in permanent steel casings. The casings shall be filled with Styrofoam pellets. Steel casings shall be designed to last the same life as the bridge, and an appropriate sacrificial corrosion thickness or galvanizing shall be provided. The H-piles shall be embedded a minimum of 2 pile widths into the abutment seat.
- f) The approach slab shall extend 0.5m longer than the wingwalls such that the cycle control joint is located beyond the ends of the wingwalls.
- g) Installation of expansion foam material behind integral abutments for the purpose of relieving earth pressures is not permitted.
- h) Integral approach slabs shall not be designed to move longitudinally in and out between stationary and parallel non-integral wingwalls.
- i) Two layers of polyethylene sheet or fabric shall be provided under the approach slab to minimize frictional forces due to horizontal movement. The connection between the approach slab and the superstructure shall be designed to resist these forces.

### 3.25.2 ABUTMENT DRAINAGE

Any water that accumulates behind the abutment backwalls and wingwalls shall be drained to prevent settlement of the embankment or failure of the wingwalls. This is accomplished by providing footing drains. Granular backfill behind the backwall and wingwalls shall be specified to allow the water to drain into the footing drains. A 200 mm diameter perforated Corrugated Steel Pipe (CSP), 1.6 mm thick, shall be installed behind the footing. The CSP drainpipe shall be hot dip galvanized and wrapped in a geotextile sleeve. A typical CSP abutment drainage system is shown in Detail No. DD-20.

### 3.25.3 SUBSTRUCTURE UNITS (ABUTMENTS AND PIERS)

- a) All substructure units (i.e. abutments and piers), except for piles and slope protection, shall have a minimum concrete strength of 35 MPa and the concrete shall meet the requirements of CSA A23.1 Class S-1.
- b) Hammerhead piers shall have a minimum thickness of 1 meter with a maximum cantilever length of 3 meters.
- c) Piers shall have a minimum of three columns and shall have a minimum cross-section area of 2.8 m<sup>2</sup> for each column or the columns shall be linked together with a strut extending from the top of the foundation to 1.4 m above the adjacent ground between the two columns.
- d) Ends of pier caps and pier shafts shall either be circular or chamfered (minimum 300 x 300 mm).

### 3.26 APPROACH FILL

The selection of representative “characteristic” geotechnical parameters used to determine foundation capacity shall be based on the results of appropriate field and laboratory investigations and shall represent the Design Engineer’s “best” estimate of the likely values of the parameters, taking into account all the factors that may have influence on the soil properties, in accordance with the Canadian Foundation Engineering Manual, 4<sup>th</sup> Edition, 2006, Chapter 8.5.

Fill material in the approaches to the bridge structure shall be of select quality. Silt material specified as “ML” or “MH” material (in accordance with the Modified Unified Soil Classification System) shall not be used in the design and construction of the bridge headslopes and approach fills, nor in the roadway embankments. The global stability of bridge headslopes and approach fills, including the effects of retaining walls, shall be designed for a minimum long-term factor of safety of 1.5 and a short-term factor of safety of 1.3.

The design of the bridge approach fills and retaining walls shall account for stability, long-term settlements and wall deformations. Stability analyses shall be carried out to determine that head slopes and retaining walls have acceptable short term and long term stability in order to prevent failure or excessive deformation. Deformations of embankment and walls (including settlement and lateral movements) shall be determined using appropriate deformation analyses, with representative soil parameters derived from site specific geotechnical investigations and local experience. The expected range of embankment and wall displacements including settlement and lateral movements shall be taken into account in the design of the bridge structure and shall provide for acceptable structural and aesthetic performance of the embankments and walls. Any differential settlement between the bridge structure and approach fills shall not cause a deviation in final bridge structure riding surface of more than 1% from the roadway design grade.

### 3.27 SLOPE PAVEMENT

Slope pavement shall be provided for all overpass and underpass structures on the headslopes. Cast-in-place reinforced concrete shall be used to provide slope protection and aesthetics. The concrete shall be reinforced with 10M bars only. The use of Welded Wire Fabric (WWF) reinforcement is not permitted. Slope pavement shall be founded on a minimum 200 mm thick granular fill base with geotextile. The limits of this base shall be shown on the Drawings.

Precast concrete blocks are not allowed.

### 3.28 BURIED STRUCTURES

Buried structures are typically used for relatively short span waterway crossings on both PTH and PR roadways if such a structure is found to be hydraulically adequate for a particular site.

Acceptable buried structures on the PTH network include:

- Cast-in-place reinforced concrete box culvert,
- Precast concrete box culvert post-tensioned, and
- Round Precast Concrete Pipe culvert.

Acceptable buried structures constructed on the PR network include:

- Structural Plate Corrugated Steel Pipe (SPCSP) culvert, and
- Corrugated Steel Pipe (CSP) culvert.

Unacceptable buried structures on the PTH network include, but are not limited to the following:

- Precast concrete arch systems
- Steel plate arch systems

Box culverts that are constructed of cast-in-place or precast concrete may have single or multiple cell openings.

In some instances, hydrological, geotechnical, roadway geometry, safety requirements or other factors may require that PTH style buried structures be built on a PR roadway.

Conventional open trench excavation and backfill, hydraulic jacking and tunneling or combination of both may be used to install round precast concrete pipe culverts. Conventional installation is open trench excavation where a relatively narrow trench is excavated in undisturbed soil and back filled with granular material. Hydraulic jacking and tunneling is an ideal installation methodology for high roadway embankments where a culvert is advanced through the embankment by means of jacking while simultaneously excavating from inside the culvert opening for the culvert to pass through. The tunnel shall closely fit the outside shape of the culvert and allow no greater than 50 mm spacing between the culvert and the tunnel.

Design charts for round precast concrete pipe culverts and round Structural Plate Corrugated Steel Pipe (SPCSP) culverts are shown in Detail No. DD-21 and DD-22, respectively. It should be noted that these design charts are applicable for open trench installation only and are not applicable to hydraulic jacking and tunneling installation methodology. These charts do not relieve the Design Engineer's responsibility for the structural design of the culverts.

For concrete culverts other than cast-in-place concrete, the size selection shall be coordinated with the Manufacturer to be consistent with standard sizes that are readily available.

### **3.29 OVERHEAD SIGN AND LIGHTING STRUCTURES**

Overhead and cantilevered sign structures and high mast lighting structures with a height greater than 20 m shall be designed in accordance with the requirements of AASHTO "*Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*" (the "AASHTO Standard Overhead Sign Specs"), latest edition plus interims and the following additional criteria:

Equation 3-1 of AASHTO Standard Overhead Sign Specs, Clause 3.8.1 shall be modified as follows:

$$P_z = 2.7qKzCd$$

where  $q$  shall be taken from *CAN/CSA S6-06*, Table A3.1.7 for a return period of 50 years;

- The design ice thickness for ice accretion shall be the value given in *CAN/CSA S6-06*, Figure A3.1.4;
- For the design of all cantilevered sign structures, the Fatigue Importance Factors in Table 11-1 of the AASHTO Standard Overhead Sign Specs shall be based on Fatigue Category I. The deflection for cantilevered sign structures, as specified in Clause 11.8 of the AASHTO Standard Overhead Sign Specs shall not exceed 200 mm;
- Stresses for anchor bolts shall be limited to  $0.50 F_{pu}$  applied to the root tensile stress area at the Group Load Combination I, II and III. Stress range for Group IV shall be in accordance with Section 11 of the AASHTO Standard Overhead Sign Specs. The design shall allow for the failure of one anchor at any one location for each pile foundation. After such failure, the remaining anchors shall still be capable of meeting the above design requirements;
- Anchor bolts shall be pre-tensioned to  $0.70 F_{pu}$ ;
- Design sign panel area shall be taken as the largest of:
  - Initial state sign panels;
  - Future sign panel requirements and,
  - Area of  $3.5 \text{ m}^2 \times 60\%$  of horizontal span length, placed in any position along the span;
- Sign structures shall have a permanent vertical camber of  $L + 200$  where L is the span of the horizontal arm of the sign structure;
- The tops of the concrete foundations shall project from 700 mm to 850 mm above the adjacent ground surface on the traffic side. The exposed portion of the concrete foundation shall be of circular cross-section; and
- The minimum vertical clearance below the sign panels shall be 6.0 meters.

### 3.30 RETAINING WALL STRUCTURES

Non-mechanically stabilized earth retaining walls shall be designed in accordance with the provisions of *CAN/CSA-S6-06*.

The use of pile supported retaining structures (e.g. concrete cantilever retaining structures on piles) as retaining structures at bridge location (as defined below) will be permitted.

Reinforced soil slopes steeper than 45 degrees shall also be considered as retaining walls. The following retaining wall systems and abutment wall types are not typically used by MIT:

- Mechanically stabilized earth (MSE) walls with dry cast concrete block facings;
- Metal bin walls;
- Steel sheet pile walls; and
- Walls with wire facings.

The use of these types of retaining walls shall be discussed with MIT for site specific projects and will require approval from MIT.

Adequate drainage (internal and external) shall be provided for all walls.

Mechanically Stabilized Earth (MSE) Walls shall be designed to the more severe requirements of *CAN/CSA-S6-06* and the AASHTO LRFD Bridge Design, 4<sup>th</sup> Edition, 2007, except that global stability shall be designed in accordance with Section 300-24: Foundations/Geotechnical. The design life of all MSE components shall be 100 years.

Abutments on top of MSE walls shall be supported on piles.

The height of retaining walls shall be limited to 6 meters for highway interchange and overpass structures and 8 meters for railway underpasses without approval by MIT. The height of wall shall be measured from the top of the wall to the top of pavement or rail in front of the wall.

Lateral wall displacements due to internal mechanically stabilized earth wall deformations, if applicable, and due to movements of the wall foundation shall not result in the top of the wall leaning outwards relative to the bottom of the wall during the life of the structure. Any structural elements supported on the walls, such as abutments, abutment deck joints, abutment bearings and barriers, shall be designed to accommodate any movements resulting from lateral wall displacements. Lateral wall displacements shall also not exceed 50 mm at any part of the wall.

When MSE walls are used at bridge structures, they shall be considered an integral part of the bridge structure and shall be designed and detailed to interact with the rest of the bridge structure (i.e. abutment piles, seat wingwalls, barriers, backwalls, diaphragms, and approach slabs) in a manner that will provide adequate structural capacity and long-term durability. All MSE walls at bridge structures shall use steel reinforcements.

Retaining walls with traffic running parallel to the top of the wall shall have rigid bridge barriers meeting, as a minimum, the Performance Level 2 requirements of CAN/CSA-S6-06 Section 12. The retaining wall shall be designed to fully resist the barrier loads applied to the barrier. Safety handrails shall be mounted along the tops of all other retaining walls.

MSE wall panels and concrete fascia shall be supported by compacted backfill without voids or equivalent on the back (non-exposed). MSE wall panels shall be precast concrete panels topped with a concrete coping (cast-in-place or pre-cast). The concrete coping shall be HPC and shall have a smooth top with no steps or abrupt changes in height. Precast concrete panels shall be HPC and shall have a minimum thickness of 140 mm. The minimum cover to the reinforcing steel shall be 50 mm. Differential settlements of the precast panel walls shall not exceed the limits shown in Table C11.10.4.1 of the AASHTO LRFD Bridge Design Specifications, 4<sup>th</sup> Edition.

Obstructions such as piles and associated casings, or casings for future pile installations in the soil reinforcement zone of MSE walls, shall be accommodated with appropriate arrangement of soil reinforcing around such obstructions. Splaying of soil reinforcement shall not exceed 20° from the perpendicular to the facing panel.

Precast concrete panels for MSE walls shall be designed to accommodate a differential settlement of 100 mm in 10 metres of length along the wall. The joint gaps between adjacent panels shall be designed to be 20 mm nominal. Joints between panels shall have a lip and recess (ship lap) configuration so that joint material is protected and overall aesthetics are enhanced.

Special corner units shall be used for MSE walls when the interior angle between adjacent panels is 130° or less.

For stepped leveling pads for MSE walls, the maximum elevation difference between adjacent steps shall not exceed 750mm. The minimum length of each stepped section shall be 2250 mm.

Where staged construction is required and large differential settlement is expected between stages, appropriately located full height vertical slip joints shall be provided.

For MSE retaining wall abutments, the MSE wingwalls shall be flared away from the overpassing roadway so that they clear the abutment wingwalls or run generally parallel to the underpassing roadway. The ends of wingwalls running generally parallel to the underpassing roadway shall be flared back in accordance with the Flare Rate Table in Section H5.4.2 of the Roadside Design Guide and buried into the ground.



Proper drainage, with a drainage swale on top and weeping tile near the bottom, is required. Highway and bridge surface drainage shall be controlled and channeled away from the back of the walls and mechanically stabilized earth mass. The weeping tile drains shall consist of 150 mm diameter PVC complete with filter sock and shall be located near the front and back bottom corners of the mechanically stabilized earth mass. The weeping tile drains shall be day-lighted or connected for positive drainage.

Dry cast concrete block walls are not permitted.

When closed style abutments are used, the designer shall provide one of the following from the face of the abutment breastwall/cap/backwall:

- i) A clearance box of 2.8m high to allow the use of an under-bridge crane basket, or
- ii) A clearance box of 1.8 high and 1.2m wide, complete with guardrail and tie-off points for inspector access.

### 3.31 QUANTITIES

The following list of items and associated units shall be used when preparing quantities. Quantities shall be listed on the Drawings in numerical order.

Material	Unit
Concrete	m <sup>3</sup>
Reinforcing Steel	kg or tonnes
Piling (all types)	m
Structural Steel	kg
Miscellaneous Metal	kg
Hot Poured Rubberized Asphalt Waterproofing	m <sup>2</sup>
Bituminous Pavement	tonnes or m <sup>3</sup>
Stone Rip-Rap	m <sup>3</sup>
Granular backfill	m <sup>3</sup>
Girders (all types)	each

*Table 1: List of Quantities*

Piling, concrete, and stone rip-rap require a separate quantity for each size or type used.

Individual quantity estimate tables shall be shown on the applicable Drawings for the abutments, piers (if applicable), and deck.

Structural steel mass for steel girder bridges shall be calculated accurately and the mass shown on the "General Notes" area of the girder Drawings. Mass includes girders, diaphragms, stiffener splice plates and any brackets. The mass of bolts, nuts, and washers is not included and considered incidental to the work.

All quantities, with the exception of slope protection and stone rip-rap, shall be calculated and shown to the nearest whole number. Slope protection and stone rip-rap quantities shall be computed and shown to the nearest 10 units.

### 3.32 EROSION CONTROL

All temporary and permanent erosion control measures associated with the final structure and the interim construction stages shall be designed. The provisions of Section 2.3 shall apply.

The limits of the disturbed areas shall be identified on the Drawings as well as all construction staging.

### 3.33 CADD DRAWINGS

Computer Aided Design and Drafting (CADD) shall be used to prepare all structure engineered Drawings. The Department has adopted MicroStation<sup>®</sup> from the Bentley Systems Incorporated as its standard CADD software package.

Drawings shall be prepared in accordance with MIT's CADD Standards Manual utilizing typical Department details (where applicable).

### 3.34 DESIGN REVIEW

For each specific site, milestone meetings (to be held at initiation, 75% and 90% completion) and a final design review meeting (98% completion) shall be attended by the Design Engineer, the Department and representatives of major stakeholders. The Design Engineer shall submit five Drawing sets to the Department for each milestone meeting two weeks in advance of the meeting.

### 3.35 DETAILED DESIGN REPORT

At the conclusion of the detailed design for a specific bridge structure, the Design Engineer shall submit the following documentation as part of the Detailed Design Report:

- Project Design Brief
- Design notes by the Design Engineer (for record purposes only)
- Design notes by the Engineer conducting the independent design check (for record purposes only)
- Hydrotechnical Report
- Hydrogeological Report
- Geotechnical Report, including the global stability of bridge structure headslopes and retaining walls
- Information provided to support the following:
  - *Canada Transportation Act* ("CTA") applications
  - *Navigable Waters Protection Act* ("NWPA") drawings and permit applications
  - Department of Fisheries and Oceans ("DFO") applications
- Construction and material specifications not contained in MIT standard construction specifications
- Notes and correspondence with the Department
- Correspondence with any stakeholders
- Correspondence with any utility companies
- Minutes of Meetings
- Any other outstanding applications, approvals for licenses or permits, etc., required to carry out the work that were not obtained during the preliminary/functional design phase
- One set of issued for construction drawings prepared as indicated in the CADD Standards Manual.
- As-built drawings or record drawings shall be provided in assignments that include either Advisory Services During Construction or Contract Administration. Where these services are included in separate assignments, they shall be supplied separate from the Detailed Design report. As-built or record drawings shall be prepared according to the instructions in the CADD Standards Manual.
- Design Exception(s).

## **SECTION 4 - TENDER PREPARATION**

### **4.1 CONSTRUCTION TENDER PACKAGE**

#### **4.1.1 GENERAL**

The Construction Tender Package is one of the key deliverables of the detailed design phase. The accuracy and relevance of the information provided is critical to the bidding process and provides the framework for the contract administration and construction inspection phase of the project.

The ESP shall undertake an independent check of all submissions in accordance with Section 1.5.4 of this manual. A Construction Tender Package shall be submitted by the ESP to the MIT Project Manager. This formal submission shall be accompanied by a signed covering letter from the ESP and shall include: tender documents, Drawings, "A" cost estimate (i.e. "Engineer's Estimate") and Amendment(s) as detailed below.

MIT recognizes that the current tendering process is very comprehensive. MIT may suggest, in the Terms of Reference, alternative tendering/construction processes that will result in economy to the overall project. Similarly, the ESP is encouraged to suggest alternative tendering/construction processes that can be expected to result in lower overall project costs and do not impose undue risk on either the Contractor or MIT.

MIT will be responsible for advertising and opening of all tenders, awarding of all contracts and preparing the tabulation of tenders.

#### **4.1.2 CONSTRUCTION TENDER PACKAGE SUBMISSION REQUIREMENTS**

There are five main components to the Construction Tender Package submission: the covering letter, tender documents, Drawings, "A" cost estimate (i.e. "Engineer's Estimate") and Amendment(s).

##### **4.1.2.1 Covering Letter**

The covering letter may be submitted in electronic or printed form. The letter shall contain the following information:

- The name, address and telephone number and signature of the ESP;
- The name, title, telephone number, email address of the designer/contact person responsible for the preparation of the Construction Tender Package;
- The formal description of the project, tender number, highway/control section number, location of a railway structure within a rail line subdivision, and the structure site number;
- A list of all enclosures;
- The status of all environmental licenses and permits (e.g. DFO and Navigable Waters Authorizations), if applicable;
- Identification of the individual/company that performed the independent check;
- If the "A" cost estimate varies from the most recent "B" cost estimate by more than 15% (either greater or less), the ESP shall provide a rationale for the variance; and
- A list of all Design Exceptions with the corresponding MIT approvals.

##### **4.1.2.2 Tender Documents**

The tender documents shall be submitted in electronic format and in accordance with the following:

- The tender document shall be prepared in Microsoft Word format. Electronic conversion from other programs into Microsoft Word is NOT acceptable;
- All tender documents shall be created using MIT's tender document shell;

- The ESP shall provide bid item descriptions, bid item codes, quantity and cost estimates in MIT's standard format and nomenclature;
- Whenever possible, the tender document shall utilize standard MIT's Standard Construction Specifications and Special Provisions;
- Any non-typical Special Provisions, shall be created in a format consistent with MIT's Standard Construction Specifications;
- All licenses, permits, authorizations, or scanned images to be incorporated in the tender document shall be scanned using the following settings:
  - Save image in Adobe Acrobat (\*.pdf) format
  - Resolution: 300 dpi
  - Image type: line art
  - All scanned images shall be legible in the printed and electronic form
- All tender documents shall include a "Location Plan".
- The engineer of record shall authenticate the last page of the special provisions.

The format of the tender documents is as follows:

- Title Page
- General Description of Work
- Work Schedule
- Bid Page
- List of Standard Construction Specifications and other documents forming part and parcel of the tender
- Instructions to Bidder
- Special Provisions
- Environmental permits, licenses, approvals, authorizations
- Location Plan

If new bid item descriptions and bid item codes need to be created as a result of non-typical Special Provisions that are required for a specific project, the ESP shall inform the MIT Project Manager immediately in order for the appropriate administrative work to be completed prior to tendering.

#### 4.1.2.3 Drawings

All Drawings shall be exclusively computer generated in MIT's standard Drawing size for all structure projects (24" x 36") and in accordance with the MIT CADD Standards Manual. Some tenders may require oversize Drawings that are intended to form part of the tender documents. Oversize Drawings are described as Drawings larger than 24" x 36". These Drawings may be required due to the size or detail of a project and are occasionally needed for interchanges, complex intersections, etc. Whenever possible the ESP shall attempt to use standard size Drawings in lieu of oversized Drawings.

Submission requirements for scaled Drawings include:

- Tender Drawings shall be identified with "Issued for Construction" in the revision box and intended for the purpose of tendering & construction.
- The ESP shall submit one set of authenticated mylars to MIT with the tender documents.
- The ESP may scan the reference Drawings and provide the Drawings in Adobe Acrobat (\*.pdf) format. If the ESP elects to provide the reference Drawings in electronic format, each Drawing shall be either expanded or reduced to fit on a standard 24" x 36" size.

A much more detailed description of the Drawing requirements is included in MIT's CADD Standards Manual.

#### 4.1.2.4 “Engineer’s Estimate”

The “Engineer’s Estimate” shall be submitted in electronic and hard copy format and in accordance with the following:

- “A” cost estimate for all bid items at the time of tendering.
- The cost estimate will include bid items, Extra Work allowance, contract administration and construction inspection, utility, materials, quality control and quality assurance testing, traffic control and other relevant Project Costs.
- For projects with different types of work, separate cost estimates shall be provided for each component of the work (i.e. bridge work, approach road works, etc.).
- All cost estimates shall be provided in electronic form on MIT’s bid page and in printed format.
- The engineer of record shall authenticate the hard copy of the engineer’s estimate.

#### 4.1.2.5 Amendments

Amendments are revisions to the tender documents that are issued to all bidders during the tender period. Although any number of sources may identify the need for an Amendment; the ESP is responsible for providing any Amendment information to MIT a minimum of 3 days prior to the tender closing date.

Typically, the ESP shall notify the MIT Project Manager, as soon it becomes apparent that changes to the tender documents are required. Where feasible, the Amendment(s) shall be submitted to MIT on the same working day that the need is identified. If an Amendment is submitted to MIT less than three working days prior to the scheduled close of tenders, the closing date will be extended by MIT to allow all bidders the opportunity to evaluate the Amendment.

The Amendment submission shall be in Microsoft Word electronic format and in MIT’s standard form. If the Amendment includes revised drawings, the Drawings shall be provided in accordance with Section 4.1.2.3.

If the Amendment will result in a change to the estimated cost of the project, the ESP shall provide a revised “Engineer’s Estimate” with the Amendment submission.

## 4.2 CONSTRUCTION SPECIFICATIONS AND SPECIAL PROVISIONS

Whenever possible, ESP’s shall utilize MIT’s Standard Construction Specifications rather than creating new Special Provisions. When new Special Provisions are created, they shall be accepted by MIT.

If it is necessary for the ESP to develop a new Special Provision, the ESP shall ensure the Special Provision is created in a format that is consistent with the Standard Construction Specifications. It is important that any new Special Provision has been reviewed by MIT to ensure that there is no conflict with any other Standard Construction Specifications or standard Special Provisions.

## 4.3 LOCAL CONTENT CLAUSE

MIT’s practice is to use local labour, equipment and material resource supply (through mutual agreement with the local organizations) when undertaking construction work within certain areas of the province. The ESP should ascertain if the project is within these areas and then incorporate the current MIT policy in these matters into the tender documents. ESP’s should contact the MIT Project Manager for the latest information in this regard.

## 4.4 MATERIALS FOR STRUCTURES

The ESP shall prepare a material list for each project site itemizing all structural materials to be incorporated during construction.

Typically, the supply of materials will be either the responsibility of MIT or the Contractor as part of the construction contract. In the instance where material supply is by MIT, the ESP shall co-ordinate the purchase of materials with MIT within the time frames outlined below.

The following timelines define the time required to order various materials supplied by MIT for the projects. These timelines include: review of tender drawings, preparation of purchase order, tendering period (usually one week), fabrication and delivery.

Please note that the timelines listed below are general in nature, and are to be used as a guide only. The ESP is responsible for verifying current availability for all materials.

Approach Guardrail Components	4 months
Bearings	4 months
Bridge Iron	3 months
Concrete Piles:	4 months
CSP and SPCSP Culverts	3 to 4 months (depending on size & quantity)
Expansion joints (including seals):	4 months
Glued Laminated Timber Stringers	4 months
Miscellaneous Metal	4 months
Miscellaneous Lumber/Timber	4 months
Miscellaneous Materials	4 months
Piles Tips:	3 months
Pipe Piles:	6 months
Precast Concrete Box and Channel Girders	3 to 4 months (depending on quantity)
Precast Concrete NU and I Girders	3 to 4 months (depending on quantity)
Precast Concrete Pipe	3 to 4 months (depending on size & quantity)
Reinforcing Steel:	4 months
Steel H-piles:	6 months
Structural Steel	6 months

**Note:** In specific instances, delivery of steel H-piles has taken up to 8 months due to availability of steel and dates of mill steel runs.

#### 4.5 REPORTING REQUIREMENTS

Unless otherwise agreed by the Project Manager, the ESP shall submit the “*draft*” Construction Tender Package to MIT a minimum of 6 weeks prior to the “Construction Tender Package Submission Date” as stated in the Terms of Reference.

Following the technical review and acceptance of the tender documents by MIT, the ESP shall submit the “*final*” Construction Tender Package to the Project Manager a minimum of 2 weeks prior to the “Construction Tender Package Submission Date”.

## **PRE-TENDER CHECKLIST**

### **SITE SPECIFIC ISSUES**

#### **General**

- Landowner requests/agreements with MIT from land acquisition process
- Work by Others (MTS, MB Hydro, MIT staff)
- Co-ordination with Others (if required)
- Details for other MIT contracts within the project limits and anticipated timelines
- For structures in urban settings, is there a requirement for special features or architectural details?
- Survey control (completed by MIT)
- Local content clause
- Environmental approvals have been received

#### **Utility Issues**

- Existing utility ducts on structures (are they asbestos lined?)
- Existing utility plant shown on Drawings, including manholes, that have to be removed by Contractor or special precautions (i.e steel plating / hydroexcavation /minimum distances for working) of existing plant required during construction

#### **Access**

- Access to site for general construction activities
- Is there a requirement for “right in/right” out at access roads
- Identify responsibilities for construction, maintenance and removal of access roads, if more than 1 prime contractor on adjacent sites
- Access to site for girders

#### **Traffic Accommodation**

- Shoofly detour - traffic control requirements
- Traffic Staging Plan(s) during construction
- Permanent signage requirements
- Overhead sign structures (existing and/or new)
- Traffic signals (temporary and/or permanent)
- Illumination of bridge and road works during construction
- Approach Guardrail (temporary and/or permanent)
- Precast concrete barriers or triton barriers required
- Pavement marking

### Temporary Works and Laydown/Staging Areas

- Are there any specific requirements for Contractor's temporary works (i.e. work bridges, working platforms, access berms, demolition platforms)
- Laydown and staging areas with appropriate access

### Workplace Health and Safety Issues

- "Prime Contractor" issues if adjacent to another contract at the same time within the overall project limits

### Environmental Issues

- Environmental issues that impact the Contractor's work and permits/authorizations have been obtained
- Site drainage issues on temporary basis during construction
- Special requirements from permits/authorizations that impact the Contractor's work

### Geotechnical and Hydrogeological Issues

- Borrow locations for embankment construction and test hole information on Drawings
- Sand drains or PVD's
- Co-ordination with installation and removal of performance monitoring instrumentation
- Confirm and identify locations of existing geotechnical / hydrogeological instrumentation and that the Contractor needs to work around this instrumentation or remove if acceptable to MIT
- Confirm (if required) and include condition assessment program for existing foundations
- Specific requirements and timelines imposed on the Contractor as a result of newly constructed embankment settlement and possible instability from imposed construction loading
- PDA testing during pile installation
- Include test hole location plan and test hole logs
- Reference Geotechnical Report and availability for review

### Railway Bridges

- Temporary crossings of the track and approval of CN or CP for these crossings
- Flagging requirements
- Co-ordination with CN and CP for track tie-ins and salvage of existing ties and ballast
- Required permits have been obtained



## **SECTION 5 - TRAFFIC MANAGEMENT PLANS**

### **5.1 INTRODUCTION**

When activities such as bridge or road construction, utility relocation, geotechnical/groundwater investigations, inspections, or surveying are performed on or adjacent to public roadways in Manitoba, the person(s) performing the work must make suitable provisions to safely accommodate the traveling public.

The purpose of this document is to provide information and guidance to the ESPs retained by MIT so that the accommodation of traffic is handled in a consistent, safe and effective manner. This document identifies the primary roles and responsibilities of all parties involved for public safety through construction zones, provides guidelines for the use of various Traffic Control Devices (TCD's) and outlines general considerations for the development of an effective Traffic Management Plan.

The contents of this document are not intended to modify or supersede any provisions of MIT's Standard Construction Specifications. In the event of a discrepancy between this document and the MIT's Standard Construction Specifications, the requirements of the MIT's Standard Construction Specifications are to be met.

Typical drawings for temporary construction signing are included in MIT's "Work Zone Traffic Control Manual for Provincial Roads and Highways" available at:

[www.gov.mb.ca/MIT/contracts/workzone/index.html](http://www.gov.mb.ca/MIT/contracts/workzone/index.html)

### **5.2 PRIMARY RESPONSIBILITIES**

To ensure traffic accommodation is handled in a consistent, safe and effective manner, it is critical that all parties to MIT's contracts carry out their respective responsibilities concerning traffic accommodation.

#### **5.2.1 ESP**

The following are the ESP's primary responsibilities for traffic accommodation, when designing a MIT project:

##### **Survey and Geotechnical/Groundwater Investigations:**

When an ESP performs work such as inspections, surveys or geotechnical/groundwater investigations within the highway right-of-way, the ESP is responsible for the necessary Traffic Control Devices in accordance with the Work Zone Traffic Control Manual.

##### **Design:**

- Develop a Traffic Management Plan and submit it as part of the Tender Submission Package for review by MIT prior to tendering.
- Identify in the Special Provisions of a tender, any unique situations that will require special traffic accommodation measures (eg. limiting the length of the Work Zone, requirement for pilot vehicles, requirement for flagpersons, right-in/right-out access, etc.).
- Where applicable, the ESP shall confirm requirements for overhead illumination for the Work Area (other than flagperson stations) with MIT and include any requirements in the Special Provisions for the tender.
- Provide suitable traffic accommodation for any of the ESP's activities and coordinate the positioning of the ESP's Traffic Control Devices with the Contractor and/or Utility Company when necessary.

## 5.2.2 MIT

MIT establishes construction requirements for traffic control and Drawings and ensures that public safety is a high priority on MIT construction contracts.

## 5.3 TRAFFIC CONTROL DEVICES (TCD'S)

### 5.3.1 GENERAL

To accommodate traffic safely and effectively in Work Zones, the use of Traffic Control Devices (TCD's) must achieve the following:

#### 5.3.1.1 Awareness and Identification

- Advise road users of the type of activity they will encounter.
- Divert traffic from its normal path when necessary.
- Advise road users when it is safe to resume normal speed.

#### 5.3.1.2 Protection

- Protect road users and workers from collisions by providing adequate warning and/or a barrier. Where access to a road is being denied to the public, a minimum of 1 barricade (that crosses the entire width of the lane) for each lane shall be used.

#### 5.3.1.3 Changes in Traffic Speeds

- Generally at locations where the Work results in a change to the existing road conditions (i.e. lane transitions, reduced lane widths, detours), creates obstructions or requires the presence of workers/equipment in or adjacent to the normal path of travel, a reduced speed zone is warranted. Speeds shall be appropriate for accommodating traffic safely through or around the Work Zone with a minimum of inconvenience. All proposed changes to the speed limits within the project limits must be approved by MIT, specifically the Director of Traffic Engineering.
- The "Maximum 60 km/h When Passing Workers" sign is to be used when workers are on or adjacent to the roadway surface.

#### 5.3.1.4 Lane Delineation

- Provide adequate transitions for the speed and volume of the traffic travelling through the Work Zone.

### 5.3.2 TEMPORARY SIGNING

#### 5.3.2.1 General

Temporary signing is necessary to safely accommodate traffic through the Work Zone. The various types of temporary signing generally used includes: temporary warning signs, temporary regulatory signs and information signs. Temporary signs must conform to the Specifications for shape, color, reflectivity and size, and be approved for use in Manitoba.

The type, configuration and number of temporary signs required for the Work Zone may vary depending on the nature of the activity and site conditions.

The following factors should be considered when establishing temporary signing:

- Changes to the Work Zone which temporarily or permanently affect signing requirements (covering or removing unnecessary signs, adding additional signs or moving signs).
- Positioning of the signs relative to the travel lane (distance from and height above the travel lane).

- Visibility of the signs (sight distance, vegetation, parked equipment, darkness, dust, etc., which may reduce effectiveness of the signs).
- Signing is required for both sides (in same direction) on multi-lane divided highways.
- Positioning of signs relative to the Work Area.
- Sign spacing. Higher speeds require longer spacing between signs. Refer to the Work Zone Traffic Control Manual for the site specific case.

Once all necessary temporary signs are in place and traffic is passing through the Work Zone, it is extremely important to monitor the Work Zone on a regular basis to ensure that:

- The signing is performing as intended.
- Maintenance of signs is completed in a timely fashion. (replacing damaged or stolen signs, repositioning signs, cleaning signs, re-erecting fallen signs, etc.)
- The signing continues to reflect and address the current site conditions.

### 5.3.2.2 Temporary Warning Signs

Temporary warning signs are used to notify road users of specific hazards that may be encountered in the Work Area. If road users are properly alerted to the changing conditions, they can react in sufficient time to pass safely through the Work Zone.

Some examples of temporary warning signs are:

- Flag person Ahead
- Survey Crew
- Pavement Drop-off

### 5.3.2.3 Temporary Regulatory Signs

Temporary regulatory signs are used to direct road users in the Work Zone. Regulatory signs impose legal obligations on all traffic. For example, temporary intersections or intersections having temporarily altered traffic patterns, may require stop signs.

Some examples of temporary regulatory signs are:

- Two-Way Traffic
- Do Not Pass
- Maximum Speed Ahead
- Maximum Speed When Passing Workers

### 5.3.2.4 Information (Guide) Signs

In certain situations, it may be desirable to use information signs to supplement the warning and regulatory signs. For example, detour guide signs and route markers may be used to advise and direct traffic to alternate routes, even though the Work Area is not closed to traffic. There are also special information signs relating to certain types of activities.

### 5.3.2.5 Installation of Temporary Signs

Temporary signs must be erected such that the face of the sign is clearly visible to oncoming traffic. On 2-lane undivided highways, the signs must be located on the right hand side of the road. On multilane divided highways, signs must be located on both sides of the road (i.e. in the shoulder and median).

For construction projects, the “Construction Area” sign shall be mounted on a post and shall be positioned at the start of the Work Zone, normally in conjunction with the gateway assemblies.

All other temporary signs may be mounted on posts or on portable stands. Generally, posts are used on Long Duration projects where the Work Area is stationary. The use of portable stands is better suited for situations where the Work Area is mobile or where the duration of work is relatively short.

The position of all signs relative to the roadway surface must conform with the Specifications. The posts and portable stands on which the signs are installed and any objects used to stabilize the portable stands must not present a hazard to traffic. (e.g. Posts stands and weights used to stabilize TCD's must be "industry standard").

In situations where it is necessary to make specific temporary signs more prominent, attaching flags may be appropriate.

### 5.3.3 DELINEATORS

Delineators are used to outline lane transitions and indicate the intended path for road users passing through the Work Area. Effective delineation can be achieved through the use of chevrons, plastic drums, traffic cones (including tubular delineators) or other similar devices. Delineators are not to be used without the appropriate advance warning signage.

To be effective, delineators must be reflectorized and the proper size.

Typical situations where delineators are used:

- Lane closure
- Lane closure tapers
- Shoulder closure tapers
- Downstream tapers
- To separate opposing lanes of traffic
- To identify temporary hazardous conditions (vertical cuts on roadway shoulders, etc.)
- Detours

### 5.3.4 SEQUENTIAL ARROWBOARDS

In certain situations for lane closures on multi-lane highways, sequential arrowboards are used. Arrowboards must always be used in conjunction with other TCD's.

Sequential Arrowboards are very effective for:

- Providing traffic with positive guidance for passing to the left or right of the work area.
- Encouraging traffic to leave the closed lane well in advance of the work area.
- Providing additional advance warning.
- Sequential Arrowboards must not be used on highways with "opposing" traffic.

### 5.3.5 OVERHEAD ILLUMINATION

Activities within the Work Zone often create conditions on or near the travel lane that are particularly hazardous at night when the road user's visibility is reduced. It is often necessary to supplement the reflectorized signs, barriers and channelizing devices with overhead lighting.

Special attention must be taken to ensure that overhead lighting does not "blind" the road users.

### 5.3.6 SPECIALIZED TRAFFIC CONTROL DEVICES

There are several other TCD's that can be used to supplement standard traffic control measures. These devices are generally used in unique situations or for specific activities (e.g. extremely high traffic volumes, etc.).

Examples of Specialized Traffic Control Devices are:

- Electronic Message Boards
- Rumble Strips (Rope or Mat Type)
- Special information signs developed for unique projects
- Pilot vehicles

## **5.4 TRAFFIC ACCOMMODATION**

### **5.4.1 GENERAL CONSIDERATIONS**

In addition to providing safe passage for traffic through the Work Zone, effective traffic accommodation involves minimizing inconvenience to traffic. To ensure traffic moves effectively through the Work Zone, it is critical that the Traffic Control Devices (TCD's) used to advise, warn and direct traffic are appropriate for the site conditions. Any TCD's that are not required must be removed or covered immediately.

In all cases, any required TCD's, flagpersons and detours must be in place prior to the commencement of the work. In addition, the required minimum lane width must be maintained at all times.

### **5.4.2 FLAGPERSONS**

In situations where the sole use of TCD's does not provide sufficient warning or direction to traffic, the use of flagpersons may be required. The proper use of flagpersons to control and direct the flow of traffic can mitigate problems inherent in congested Work Areas and in Work Areas involving reduced lane widths and lane closures. When traffic queues occur, additional flagpersons and/or repositioning of the "Flagperson Ahead" sign may be necessary. All flagpersons must be certified in accordance with the requirements outlined in MIT's Work Zone Traffic Control Manual.

### **5.4.3 DETOURS**

In situations where it is necessary to close the entire roadway, a detour must be provided. The scheduling, location and use of a detour requires prior approval of MIT and/or other jurisdictions.

Where the conditions dictate that construction of a detour is necessary, the ESP shall design the detour in accordance with MIT standard design details and the Work Zone Traffic Control Manual.

### **5.4.4 LONG DURATION PROJECTS**

Generally, Long Duration projects involve activities such as the construction of a new road or bridge. These projects may have a duration of anywhere from one or two years. The work generally requires the use of a large fleet of heavy equipment working in relatively long Work Zones, on and adjacent to the travel lanes.

Due to the varying duration, site conditions and the complexity of these types of projects, a unique Traffic Management Plan is required in each instance. When developing a Traffic Management Plan for a Long Duration project, the following additional factors must be considered:

- Type of activity (mobile versus stationary).
- Other work planned adjacent to or within the project limits.
- Railway crossings.
- Maintaining traffic control during periods of inactivity (off-hours, downtime, seasonal shutdown, etc.).

### **5.4.5 SHORT DURATION PROJECTS**

Typically, a Short Duration project is a project that does not require an overnight traffic disruption.

Short Duration projects generally involve activities such as geotechnical/groundwater investigations on existing roadway surfaces or to perform survey measurements within the highway right-of-way. Short Duration projects may have mobile or stationary Work Areas and may involve work on the highway travel lanes, the highway shoulders, in the highway right-of-way and on or around drainage facilities.

#### **5.4.6 TEMPORARY SPEED REDUCTIONS**

When work is performed within the highway right-of-way, the Manitoba Department of Infrastructure and Transportation, has the authority, under the Highway Traffic Act, to authorize temporary speed reductions in the Work Zones.

#### **5.4.7 CO-ORDINATION OF ACTIVITIES**

On construction projects, it is not uncommon to have the Contractor, ESP, and/or Utility Company simultaneously performing work within the Contractor's Work Zone. In these situations, it is important that traffic accommodation is a coordinated effort between all parties and that the positioning of Traffic Control Devices required for each activity is established prior to commencement of the work.

### **5.5 TRAFFIC MANAGEMENT PLAN**

#### **5.5.1 GENERAL**

When activities are performed on or adjacent to the roadway that disrupts the normal flow of traffic, a Traffic Management Plan is required. A Traffic Management Plan consists of Drawings and written procedures that address the traffic accommodation issues relevant to the specific activity being performed. To be effective, the Traffic Management Plan must provide road users with adequate warning of the activity being performed, protection for workers and equipment within the Work Area and allow traffic to pass safely through the Work Zone.

For work performed by a Contractor on a MIT construction contract, the Traffic Management Plan shall be developed by the ESP and included in the tender package.

Prior to tendering, the ESP shall submit the Traffic Management Plan to the MIT Project Manager along with the Tender Submission Package for review by MIT. The intent would be for the ESP to develop the Traffic Management Plan in consultation with MIT, and submit the Traffic Management Plan in sufficient time to allow the MIT to evaluate the suitability of the proposed strategy.

For "non-planned" activities or emergency situations, it may not be practical to develop a site specific Traffic Management Plan. For these cases, typical or generic strategy(s) described in the Work Zone Traffic Control Manual, may be used. These "generic" strategies must also be in place prior to commencement of the work.

When work is performed by an ESP, it may not be practical to develop a site specific Traffic Management Plan. For these cases, typical or generic strategy(s) described in the Work Zone Traffic Control Manual, may be used. These "generic" strategies must also be in place prior to commencement of the work.

To achieve consistency in the accommodation of traffic on MIT projects, the guidelines and Drawings contained in the Work Zone Traffic Control Manual must always be considered when developing a Traffic Management Plan.

The Work Zone Traffic Control Manual contains minimum standards for typical conditions. However, the actual requirements for traffic accommodation at the Work Zone may vary depending on the

complexity of the work activity, traffic volumes, traffic speeds, night time conditions, highway geometrics and other site specific conditions.

### 5.5.2 GENERAL CONSIDERATIONS WHEN DEVELOPING

The objective of a Traffic Management Plan is to safely accommodate both the road users passing through the Work Zone and the workers performing activities within the Work Zone. The complexity of the Traffic Management Plan will vary depending upon a number of factors including traffic volumes and the nature of the activity being performed. Typically, traffic accommodation measures required for Long Duration projects will be more elaborate than those for Short Duration projects.

Regardless of the nature of the activity, the following factors should be considered when developing the Traffic Management Plan:

- Duration of work.
- Traffic volumes (AADT, ASDT, peak hours, statutory holidays, special events and recreation traffic, etc.).
- Class of roadway (capacity, level of service, etc.).
- Available sight distance.
- Intersecting roadways.
- Grade line (steep hills create stopping problem).
- Type of roadway surface (gravel or paved).
- The use of only those Traffic Control Devices which are necessary to clearly warn, advise and control the traffic.
- The provision of a buffer between traffic and workers whenever possible.
- Workplace Safety and Health legislation pertaining to clothing, hardhats, etc., to be worn by workers.
- Devices used to delineate the travel lanes must be appropriate for the intended purpose. Such devices must be visible to traffic and positioned and spaced in a manner which will optimize their effectiveness.
- Stabilizing Traffic Control Devices with appropriate weights when necessary.
- Closing only those lanes necessary to divert traffic around workers and/or equipment.
- The use of flags to increase the visibility or prominence of signs.
- The use of flagpersons for traffic control.
- The effect of restricted traffic flow on “upstream” conditions (traffic congestion, etc.).
- Avoid scheduling operations during hours of peak traffic volumes.
- The requirements as illustrated in MIT’s Work Zone Traffic Control Manual pertaining to the use and location of tapers and transitions.
- Weather conditions (dust, rain or snow).
- Site specific safety issues.

### 5.5.3 ESTABLISHING THE TRAFFIC MANAGEMENT PLAN

It is extremely important that all parties, including the Contractor, have a clear understanding of how traffic will be accommodated before work commences. This information must be detailed in the Traffic Management Plan.

The Traffic Management Plan must contain Drawings detailing the configuration of temporary signing and any other Traffic Control Devices which will be used to accommodate traffic. For typical situations, the Drawings contained in the Work Zone Traffic Control Manual may be used. For non-typical situations, site specific or activity specific Drawings must be developed by the ESP.

The Traffic Management Plan must also document procedures which will be used to address specific issues such as:

- Installing, relocating and removing Traffic Control Devices.
- Accommodating wide or long vehicles.

- Accommodating vehicles around fresh tack coat.
- Staged installation, implementation and removal of the Traffic Control Devices.
- Night time and other periods of inactivity.
- Use of detours.
- Accommodating emergency vehicles.
- The use of non-typical lane widths.
- The on-site designate responsible for traffic accommodation.
- Any non-typical situations not covered by the Drawings.

It is critical that all parties are in agreement on the procedures, signing configurations, and Traffic Control Devices to be used for the accommodation of traffic prior to commencement of the work. Once work commences, changes can be made as conditions dictate. Any change made to the Traffic Management Plan including the reasons or circumstances necessitating the change must be documented in writing.



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**APPENDIX A**

**SAMPLE BRIDGE ROADWAY WIDTH FORM**

**DATE:**

**TO:** Heinz Lausmann, P.Eng.  
Senior Highway Planning Engineer  
Highway Planning and Design  
1420 - 215 Garry Street  
Winnipeg, MB R3C 3P3

**FROM:**

**PHONE:**

**FAX:**

**E-Mail:**

**SUBJECT: Request for Clear Roadway Width on Structure**

Bridge Site No.:

Region:

PTH or PR:

Name of Waterway, Railway or Road:

Structure Location (legal description):

Existing Structure:

- a) Type:
- b) Length:
- c) Roadway Width:
- d) Year Built:

Proposed Structure

- a) Type:
- b) Length:
- c) Rail Height:

The approximate top of the rail height above roadway surface for a typical installation is as follows:

- i. 850 mm for a Standard 2 Tube Steel PTH Type Bridge Rail, or
- ii. 765 mm for a PR/PPCC Type Bridge Rail

Rail Heights will vary from those shown if sidewalks or other special conditions are present.

Attachments:

- a) Municipal map showing structure location:
- b) Prints of bridge survey information:

Special features, if any

  

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Attachment

c: Bridges & Structures