



January 29, 2019

File: 35050-01/IOD-DIKE SAF

INFORMATION BULLETIN

To: Diking Authorities and professional engineers involved in the design process of dikes in British Columbia

Re: Update – Status of Seismic Design of Dikes in BC

The 2014 Seismic Design Guidelines for Dikes – 2nd Edition (“**the guidelines**”) apply to the design and construction of new and major upgrades to high consequence dikes in high seismic zones. Seismic assessments and designs should be consistent with these guidelines to obtain *Dike Maintenance Act* approval from the Ministry of Forests, Lands, Natural Resource Operations and Rural Development prior to construction.

Currently there are two projects that may impact the application of the guidelines: The Dike Consequence Classification (lead by the Province) and the Seismic Assessment and Geotechnical Investigation of Lower Mainland Dikes (lead by the Fraser Basin Council). The purpose of this bulletin is to provide clarity to professionals and diking authorities planning or undertaking design work on dikes while these projects are underway and prior to any new direction implemented by the Province. A short summary of each project and potential impacts to the seismic design or construction of dikes are provided below.

- **Dike Consequence Classification:** This project will result in the consequence classification of all dikes which are regulate under the *Dike Maintenance Act*. This project is anticipated to be completed in 2019. Impacts relating to seismic design may include:
 - Updating which dikes the guidelines are applicable to
 - Other, as developed through the Province’s implementation process
- **Seismic Assessment and Geotechnical Investigation of Lower Mainland Dikes:** This project aims to work with local governments to develop a program to increase the seismic resiliency of high consequence dikes in the Lower Mainland. This program includes geotechnical investigations and seismic assessment of existing dikes, as required for development of the program. The project is guided by an advisory group to ensure a robust program that considers both the economics of achieving seismic resilience and the need for flood protection after a significant seismic event. This project is anticipated to be completed in 2021. Impacts to seismic design may include:
 - Recommendations for updated seismic design criteria
 - Increased geotechnical information for existing dike alignments
 - New professional practice guidelines for professionals undertaking seismic design and construction of dikes
 - Recommendations for alternatives to meeting the guidelines
 - Others, as developed by the advisory group or through the Province’s implementation process



Until notified, all applicants for *Dike Maintenance Act* approvals are to continue to follow the 2014 Seismic Design Guidelines for Dikes – 2nd Edition, where the dike is considered a high consequence dike as defined in the guidelines or as determined by the Inspector or Deputy Inspector of Dikes. Applicants are strongly encouraged to contact their regional Deputy Inspector of Dikes to confirm the applicability of the guidelines to their project prior to undertaking detailed design or submitting applications to senior government funding programs for new dikes or major dike upgrades.

The following clarifications to the guidelines are presented and are to be followed where applicable:

1. **Section 7 – Definitions.** Addition of definition for Major dike upgrade: a major dike upgrade generally would be considered when a dike is to be raised by 0.5m or more on a significant portion of the dike segment, or as determined by the Inspector (as defined in the *Dike Maintenance Act*).
 - a. Note funding agreements administered by, or cost shared in part or in whole with the Province typically require the guidelines are met in full. The inability to meet the guidelines due to inadequate funding will not be considered by an Inspector as a reason to relax the guidelines, unless specifically negotiated prior to their funding application. Any negotiation prior to funding approval must still meet the criteria listed in Clarification 4 below.
2. **Section 13 – Performance Based Design Criteria.** Horizontal and vertical displacement for all three performance categories, as listed in Displacement Table 2 – Summary of Maximum Allowable Dike Crest Displacement Corresponding to Performance Categories, must be analysed and submitted.
 - a. If the analysis indicates maximum displacement is exceeded for ANY of the performance categories, an analysis of remediation measures to improve dike/ground performance needs to be submitted.
 - b. If the maximum displacement criteria cannot be met through any manner of dike/ ground improvement, this should be clearly documented, with indication of best performance achievable.
 - c. Note - Designs incorporating the dike into massive fills (i.e. “superdike” concept) must submit analysis to confirm the “superdike” retains its hydraulic integrity in each performance category.
3. **Section 13 – Performance Based Design Criteria.** “The designer shall independently confirm that the displaced configuration of the diking system would provide at least 0.3 m of post-earthquake freeboard above 1:10-yr return period water level to meet performance expectations.” This requirement is IN ADDITION to satisfactory meeting the displacement requirements of Table 2 in the same section. It is not to be viewed in isolation and meeting this alone does not satisfy the requirements of the guidelines (i.e. displacement criteria must be met for all three performance categories as well).
 - a. If the freeboard is not meet, then remediation must be applied to improve dike performance until met. Refer to Figures 8b-8d in the guidelines.
4. **Section 13 – Performance Based Design Criteria.** If a diking authority seeks a relaxation of the maximum displacement requirements AND ONLY IF there is sufficient 1:10 year return period flood freeboard post-earthquake, then the diking authority shall present the rationale as to why and shall include for sufficient details on the proposed alternate means of mitigating post-earthquake flood risk. A detailed plan should be included as to how and when the guidelines can be met in the future.

- a. Note the application **MUST** still include the analysis for all three performance categories and include the analysis of any dike/ground improvements required to meet the guidelines (if attainable).
 - b. If the applicants reason for relaxation is due to significant financial increase (i.e. an order of magnitude or more the cost of a non-seismic dike, or as agreed to by the Inspector), detailed cost estimates to undertake the various remediation methods explored to meet the guidelines must be included. This should also include for dike realignment, “superdike” concept, or mass fill of development site.
5. **Section 15 – Analysis Methods.** For determining displacements, the Newmark method must be used first for all Liquefaction Indices (unless authorized otherwise by the regional Deputy Inspector of Dikes). Where deemed appropriate by the qualified professional engineer (QP) or required in the guidelines or determined by the regional Deputy Inspector of Dikes, rigorous methods should then be used to compare against the Newmark analysis. Discrepancies in results between the simple and rigorous methods should be highlighted and discussed, with the recommended set of results explained sufficiently by the QP.

Regards,

A handwritten signature in black ink, appearing to read 'Mitchell Hahn', with a stylized, cursive script.

Mitchell Hahn, P.Eng.
Inspector of Dikes