TECHNICAL MEMORANDUM

DATE January 5, 2017 **PROJECT No.** 1411250045/14000

TO Andrew Evers
Ministry of Environment and Climate Change

FROM Alan Hull, Paul Smolkin

CONSIDERATION OF DAVID WILLIAMS' REVISED BEDROCK GEOLOGY MAP AND LANDFILL PERFORMANCE AT THE PROPOSED CRRRC SITE

In his letter of June 21, 2016, David Williams (the retired Ontario Geological Survey (OGS) geologist who had mapped the geology used to prepare the published OGS bedrock geology maps in the area of the CRRRC) indicated that he would update the 1:50,000 scale Russell and Ottawa map sheets to modify the location of his previously inferred fault extending beneath the site of the proposed CRRRC. His modifications would consider the additional information and interpretation provided by Golder, which was not available to Mr. Williams when he produced his maps in 1985 and his 1991 report.

On December 20, 2016 Golder received from Mr. Williams his revised interpretation of the bedrock geology within the area of the Ottawa and Russell map sheets. His revised mapping is attached. As per his June 21, 2016 letter, the inferred fault previously shown as passing through the CRRRC site has been shifted northward approximately 2.2 km. This revised inferred fault was considered in the Golder memorandum of September 12, 2016, which provided further evaluation of potential effects of earthquake shaking on the proposed CRRRC landfill component.

Mr. Williams recently received revised map sheets also present an inferred "new" fault trace trending approximately east-west, with an inferred trace located about 700 m south of the south limit of the proposed CRRRC landfill component. As discussed in Golder's September 12, 2016 memorandum, in our opinion there is no surface or subsurface evidence for the east-west striking faults shown on the previous or recently revised maps prepared by Mr. Williams north of the Gloucester Fault. Nonetheless, Golder has now considered whether the shaking associated with an extreme, low probability earthquake along a fault that Mr. Williams now infers is located 700 m south of the landfill can be expected to produce a significantly different landfill response than an inferred fault 2.2 km north of the landfill footprint, as analysed in our September 12, 2016 memorandum.

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Our analysis is as follows:

1) Mr. Williams infers two faults within the bedrock—one about 2.2 km to the north and one about 700 m to the south of the proposed CRRRC landfill component. These faults were not included in his 1991 interpretation, but his underlying geological model remains unchanged. Mr. Williams' interpretations assume that the major geological units within the bedrock formations are unconformably fault-bounded.

2) The new inferred faults (and other 1991 inferred faults) are Williams' interpretation that the sedimentary bedrock north of the Gloucester fault is located within a structural basin developed by displacement on a series of south-dipping normal faults, with no displacement greater than about 50 m. Golder considers that none of these faults are related to the present-day tectonic regime, show no evidence for surface rupture in the Holocene (last 11,700 years) and are, therefore, inactive using the fault activity framework of landfill regulations from British Columbia and the United States.

3) The new faults inferred by Mr. Williams do not extend under the footprint of the proposed CRRRC site and, therefore, do not pose a potential surface fault rupture hazard to the CRRRC site.

4) In his June 21, 2016 letter describing his then revised interpretation, Mr. Williams included the fault 2.2 km to the north of the CRRRC landfill component. Golder's interpretation of the bedrock geology does not support the existence (or Holocene activity) of this fault. Golder nevertheless modeled the potential effects of very strong earthquake ground shaking associated with an **M**7+ earthquake generated on this inferred fault 2.2 km from the CRRRC landfill component, as reported in our September 12, 2016 memorandum. The proposed landfill was found to experience very strong shaking and relatively significant displacement during the postulated **M**7+ earthquake. However, the predicted displacements of the landfill did not result in dislocation of waste beyond the CRRRC site; and it was concluded that post-earthquake repairs could be readily made to continue safe operation of the CRRRC facility. Golder's conclusions were supported by the observed experience of landfill performance during strong earthquake shaking in the western USA, as reported in our September 12, 2016 memorandum.

5) Golder considers that the uncertainties associated with estimating near-field earthquake ground motions measured in past earthquakes indicate that the earthquake strong ground motions within about 5 km of earthquake epicenter or fault rupture are likely very similar. The strength of earthquake shaking and landfill displacement at sites in the near-field (i.e., within about 5 km) are influenced more by the earthquake magnitude and local site conditions than the distance to the earthquake epicenter and/or causative fault (assuming the same earthquake magnitude). That is, the earthquake shaking can reasonably be expected to be similar for an earthquake generated on a fault 2.2 km from the CRRRC landfill component and from an earthquake generated 700 m from the landfill component.

6) Golder concludes that in the highly improbable event of a major earthquake along the newly inferred fault 700 m south of the CRRRC landfill, the landfill would experience very similar earthquake shaking and induced landfill displacements as an earthquake generated on the inferred fault located 2.2 km north of the CRRRC landfill. As set out in our September 12, 2016 memorandum, our analysis showed that the proposed CRRRC landfill would be damaged by this shaking, but the waste would remain on the site and the damage to the landfill would be readily remediable.

AH/PAS/sg
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Attachment: D. Williams Bedrock Geology Map Sheets, revised December 2016

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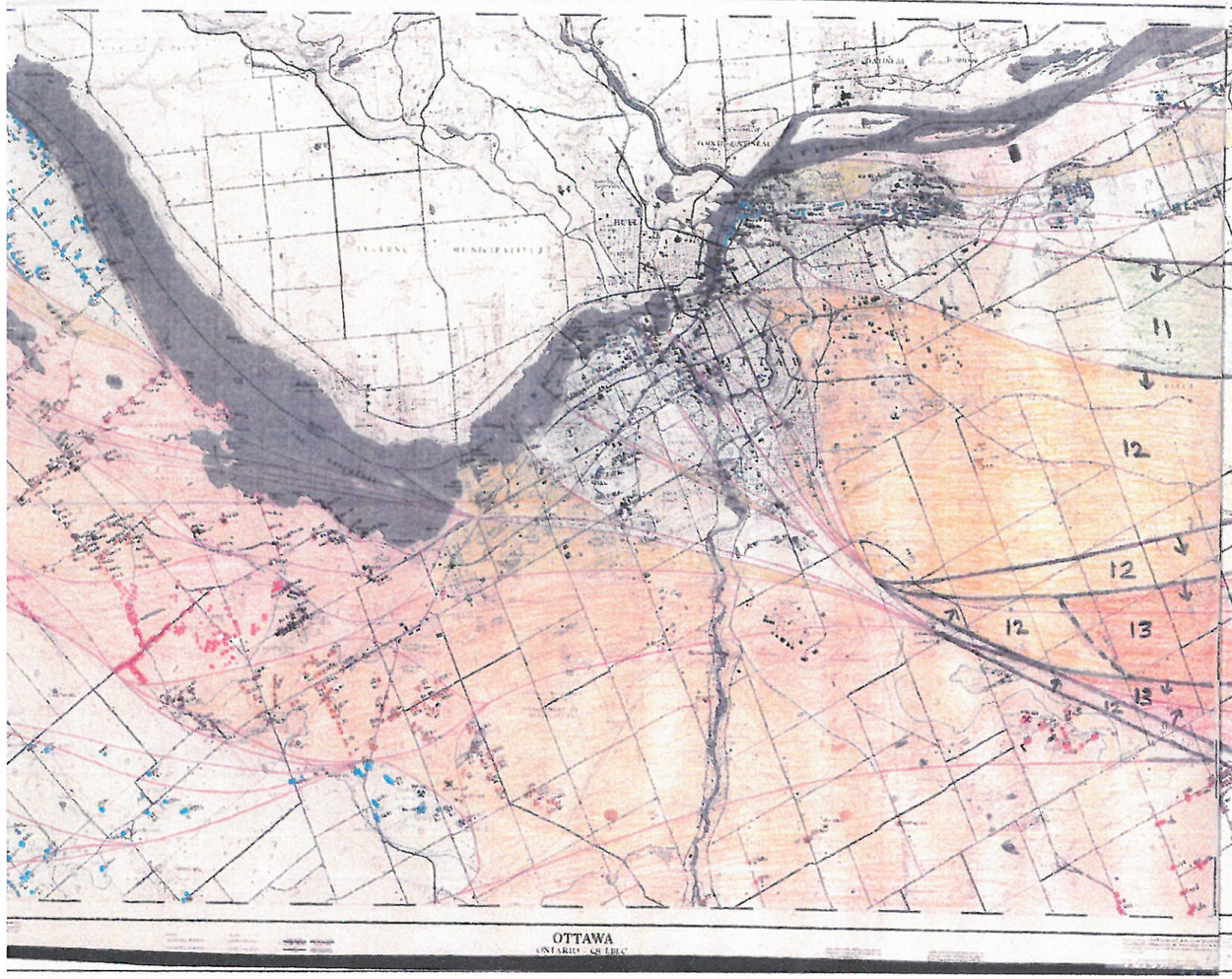

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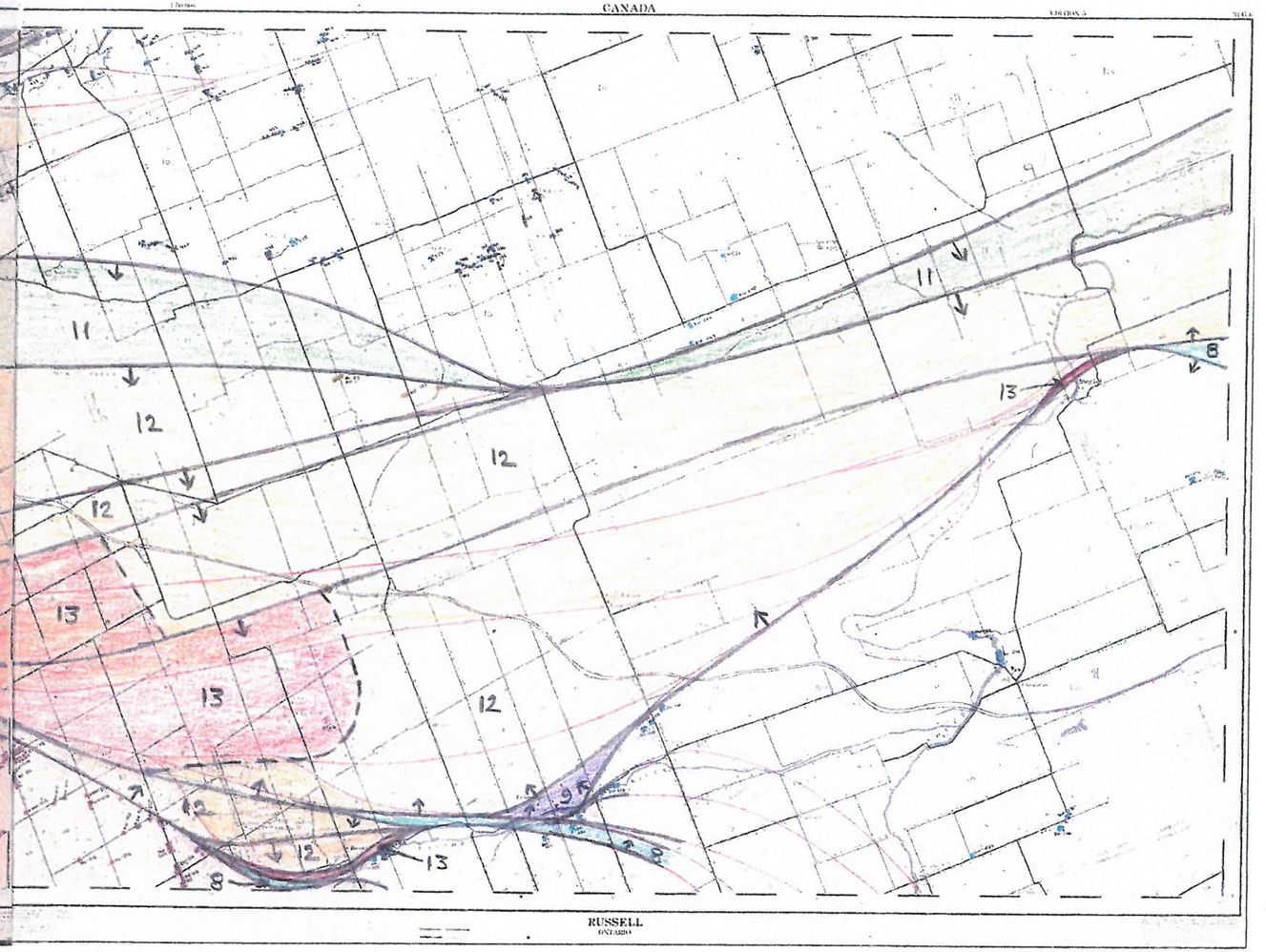

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