Ministry of Natural Resources

Ministère des ressources naturelles

Ontario

Tuesday, July 29, 2025
MPSB-2025-LRIA-00001-WP-001

Township of Muskoka Lakes
1 Bailey Street
Port Carling, ON P0B 1J0

Dear Permittee,

RE: Work Permit MPSB-2025-LRIA-00001-WP-001

Enclosed is the subject work permit which authorizes you to **rehabilitate and enhance the existing concrete structure, including repairs to the north embankments, retaining walls, and powerhouse, as well as the construction of a concrete spillway integrated with the existing southern abutment**, at the location specified on the permit. Please familiarize yourself with the conditions of the work permit prior to undertaking the work. The contractor and the equipment operator must be provided with a copy of this work permit and be familiar with the conditions prior to proceeding with any work. A copy of the work permit must be available on site while the work is being conducted.

No in-water work is permitted between April 1st and May 31st. This authorization does not release you of the responsibility for obtaining any other permits that may be required under federal, provincial or municipal legislation. This includes any requirements under the *Endangered Species Act* which is now administered by the Ministry of Environment, Conservation, and Parks.

The *Ontario Heritage Act* regulates archaeological resources in Ontario. During the course of your project work, should you accidently discover archaeological artefacts, please stop all work, secure the site and contact the Ministry of Tourism, Culture and Sport, Archaeology Programs Unit, by email at Archaeology@ontario.ca, or by phone at 416-212-8886. Also, please notify the MNRF.

In accordance with the *Cemeteries Act*, R.S.O. 1990 c. C.4, should you accidently discover human remains during the course of your project work, you are required to stop all work, secure the site and notify the Ontario Provincial Police along with the MNRF.

You may contact **Laurel Gordon** by phone at **705-346-0009** or by email to Laurel.Gordon@ontario.ca if you have any further questions regarding this matter.

Sincerely,

Shannon Norton
District Supervisor, Bracebridge Minden Parry Sound District

Ministry of Natural Resources- /encl

Ontario

Ministry of Natural Resources
Ministère des ressources naturelles

Work Permit /
Permis de travail

Permit No./Permis No.
MPSB-2025-LRIA-00001-WP-001

This permit is issued under the authority and provisions of the following indicated Provincial Acts and their regulations and is subject to the limitations and provisions thereof and is also subject to the terms and conditions herein.
Ce permis est émis conformément aux dispositions des lois provinciales ci-après et des règlements y afférents et est sujet aux restrictions et dispositions de ce lois et règlements ainsi qu'aux conditions ci-énoncées.

[X] Lakes and Rivers Improvement Act/Loi sur l'aménagement des lacs et des rivières;

Note: The issuance of this permit does not relieve the applicant from the responsibility of acquiring any other agency, board, government, etc. approval as may be required nor does it relieve the permittee from the requirements of any other legislation.
Remarque : La délivrance d'un permis n'exonère pas le demandeur de l'obligation d'obtenir l'autorisation de tout autre organisme, commission, gouvernement, etc. qui pourrait être exigée, non plus qu'elle exempte le détenteur des dispositions des lois.

The Permit is issued to: Ce Permis est délivré à:

Name of Permittee/Nom du detenteur: The Corporation of the Township of Muskoka Lakes

Post Office Address/Adresse postale: 1 Bailey Street, Port Carling ON, P0B 1J0, CA

To conduct an operation from July 29, 2025, to and including the December 31, 2026

Pour effectuer des travaux du July 29, 2025 jusqu'au Décembre 31, 2026

at location/à l'emplacement: Lot 14, Concession A, Geographic Township of Medora, Township of Muskoka Lakes, Burgess Dam. PIN 481540635; PT LT 275 PL 26 MEDORA; PT BLK C PL 26 MEDORA

As per your application dated/conformément à la / Demande de permis en date du:

2025-06-27

For the purpose of / Aux fins de: Rehabilitation and improvement of the existing concrete structure, including repair of the north embankments, retaining walls, and powerhouse, as well as the construction of a concrete spillway integrated with the existing southern abutment.

Subject to the following conditions:/Et sous les conditions suivantes:

1. The Permittee shall keep this permit or a true copy thereof on the work permit area./ Le détenteur conservera ce permis ou une copie conforme sur les lieux des travaux.

2. The person in charge of the operation conducted under this permit shall produce and show this permit or the true copy kept on the work permit area to any officer whenever requested by the officer. /
Le responsable des travaux couverts par ce permis doit produire le permis ou sa copie conforme si un agent lui demande.

3. Other conditions as listed on the reverse side of this permit as well as those contained in Schedule(s) D attached.
Autres conditions énoncées au verso de ce permis ainsi que celles apparaissant aux annexes suivantes .

Place of Issue/Emis à: Parry Sound, Ontario	
Date/Date de déliverance: 2025-07-29	Signature of Issuing Officer/Signature du délivreur: R. Wakefield

Personal Information on this form is collected under the authority of Section 13 of the Public Lands Act, R.S.O. 1990, the Lakes and Rivers Improvement Act, R.S.O. 1990, and Regulation 975 as amended, and the information will be used for the purposes of the Act and Regulations. Questions about this information should be directed to the local NDMNRF office.
Les renseignements personnels exigés dans les présentes sont recueillies en vertu de la Loi sur l'aménagement des lacs et des rivières et du règlement 975 de l'Ontario tel que modifié. Ils seront utilisés selon les termes de la Loi et des règlements. Veuillez adresser toute question à ce sujet au bureau du DNMRNF. Une liste des bureaux du DNMRNF avec adresses et numéros de téléphone en français est disponible.

Conditions

It is agreed by the parties hereto that:

1) This Work Permit gives the permittee only the right to carry out work on the described site for the purpose specified in this permit and does not convey any right, title or interest in the land.

2) The permittee covenants to indemnify and forever save and keep harmless the Crown, its officers, servants and agents from and against any and all claims, demands, suits, actions, damages, loss, cost or expenses arising out of any injury to persons, including death, or loss or damage to property of others which may be or be alleged to be caused by or suffered as a result of or in any manner associated with the exercise of any right or privilege granted to the permittee by this Work Permit.

3) a) A permittee is an occupier under the Trespass to Property Act and the Occupier's Liability Act and shall take such care as in all circumstances of the case is reasonable to see that persons entering on the premises, and the property brought on the premises by these persons, are reasonably safe while on the premises. b) Any posting of signs or notices pursuant to the Trespass to Property Act and the Occupier's Liability Act, on the work permit area, shall be subject to prior approval of the issuing officer. The location and format of all signs and notices must be approved by an officer. c) The permittee agrees to remove all signs or notices on termination of the permit, or at the direction of the issuing officer. d) The permittee agrees to post any signs or notices as required or directed by an officer.

4) This Work Permit shall not be assigned or transferred.

5) The permittee may, with the approval of the District Manager, or will, at the District Manager's request, remove the improvements , property or other assets from the public lands and leave the site in a clean and safe condition, restored as much as possible to its original state except where the requirement to restore is waived in writing by the District Manager.

6) a) Upon termination of this permit, the permittee has no right to, or reasonable expectation of, the issuance of a new permit based on prior work on the land. b) The successive issuance of any permit or permits for work on the land described herein will not create any future rights or interests whatsoever in the land.

7) Violations of any of the conditions constitutes an offence.

Conditions

Les parties conviennent que:

1) Ce permis de travail autorise le détenteur à effectuer les travaux sur le terrain décrit aux fins énoncées dans ce permis. Il ne confère aucun droit, titre ou intérêt sur le terrain.

2) Le détenteur indemnisera et protègera la Couronne, ses agents, fonctionnaires et représentants de toute poursuite, demande, procès, dommages, perte ou coûts découlant de blessures, décès ou dommages matériels â autrui qui pourrait être causés ou infligés, ou présumer être causés ou infligés de quelque façon que ce soit, par l'exercice des droits ou privilèges accordés par ce permis à son détenteur.

3) a) Le détenteur est considéré comme un occupant aux termes de la Loi sur l'entrée sans autorisation et de la Loi sur la responsabilité des occupants et il doit prendre toute mesure qui, dans la situation, est considérée raisonnable afin que les personnes entrant sur les lieux, et les biens apportés par ces personnes, soient raisonnablement sécuritaires lorsqu'ils sont sur les lieux. b) Les avis ou panneaux exigés par la Loi sur l'entrée sans autorisation et la Loi sur la responsabilité des occupants et installés sur les lieux de travail couverts par le permis doivent être préalablement approuvés par le délivreur. L'emplacement et le format des affiches ou des avis doivent être approuvés par le délivreur. c) Le détenteur convient d'enlever ces avis ou panneaux conformément à la Loi sur l'entrée sans autorisation à l'expiration du permis ou sur l'ordre du délivreur. d) Le détenteur accepte de poser des affiches ou des avis à la demande du délivreur.

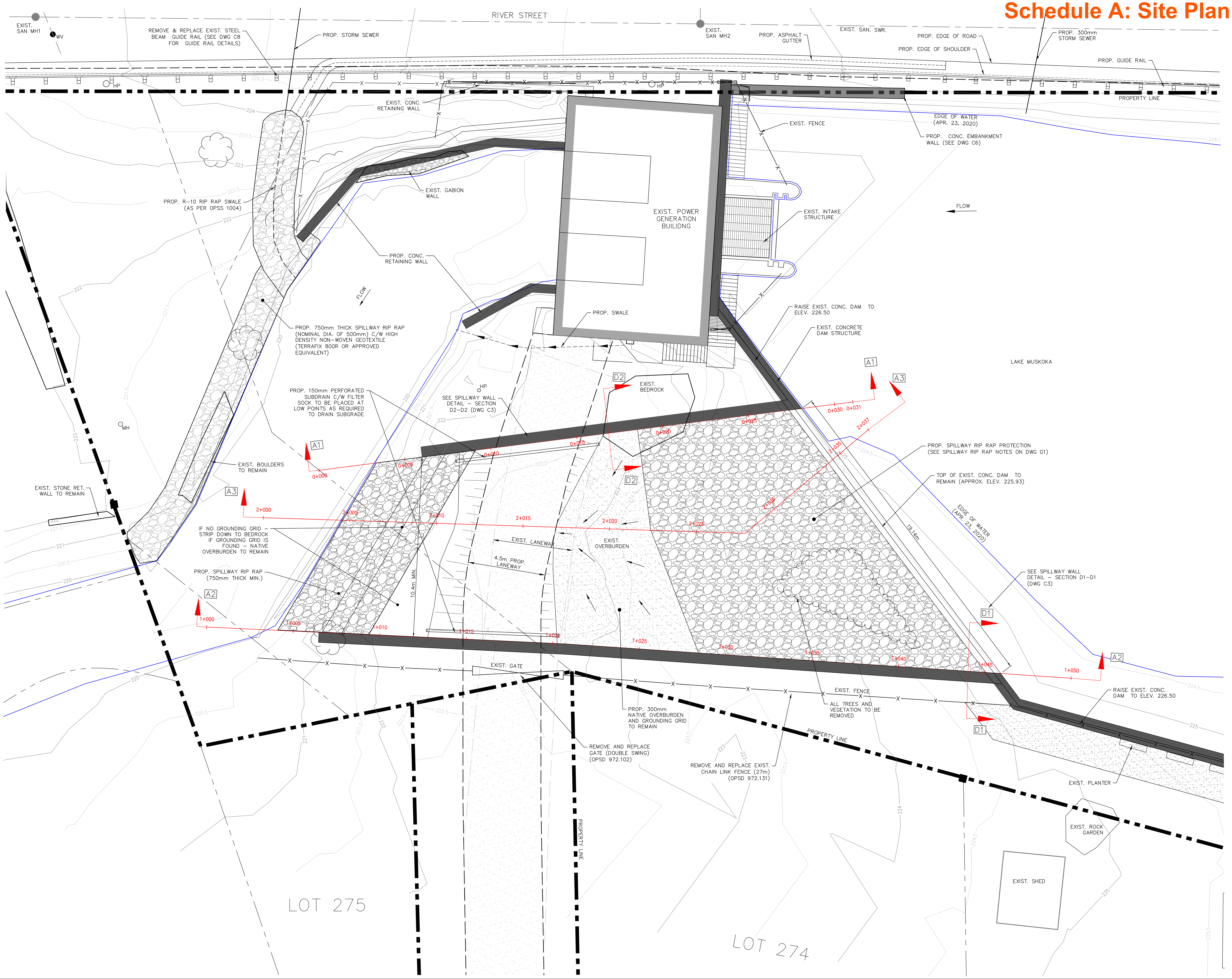
4) Ce permis ne peut être ni cédé ni transféré.

5) Le détenteur peut, sous réserve de l'approbation du chef de district, ou doit à sa demande, enlever les aménagements, les biens ou autres avoirs des terres publiques et laisser le site propre et sûr, restauré dans toute la mesure du possible à sa condition originale sauf s'il en est dispensé par écrite par le chef de district.

6) a) À l'expiration de ce permis, il sera décidé de délivrer un nouveau permis conformément aux règlements afférents à la Loi sur les terres publiques et le détenteur n'a aucun droit, ni ne peut raisonnablement s'attendre, à ce qu'un nouveau permis lui soit accordé uniquement parce que des travaux ont été effectués sur le site. b) La délivrance successive de permis d'effectuer des travaux sur le terrain décrit ici ne confère aucun droit ou intérêt futur sur ce terrain.

7) Les infractions à ces conditions sont punies par la Loi.

Schedule A: Site Plan 1/4



P:\2023\231236 – Burgess Dam Detailed Design\03 Drawings\CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg

KEY PLAN

ENGINEER'S SEAL:

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
16/05/2025	6	ISSUED FOR TENDER	DR	EG
18/07/2024	5	ISSUED FOR APPROVALS	DR	EG
05\06\2024	4	ISSUED FOR FINAL REVIEW	DR	EG
08/05/2024	3	ISSUED FOR CLIENT REVIEW	DR	EG
05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

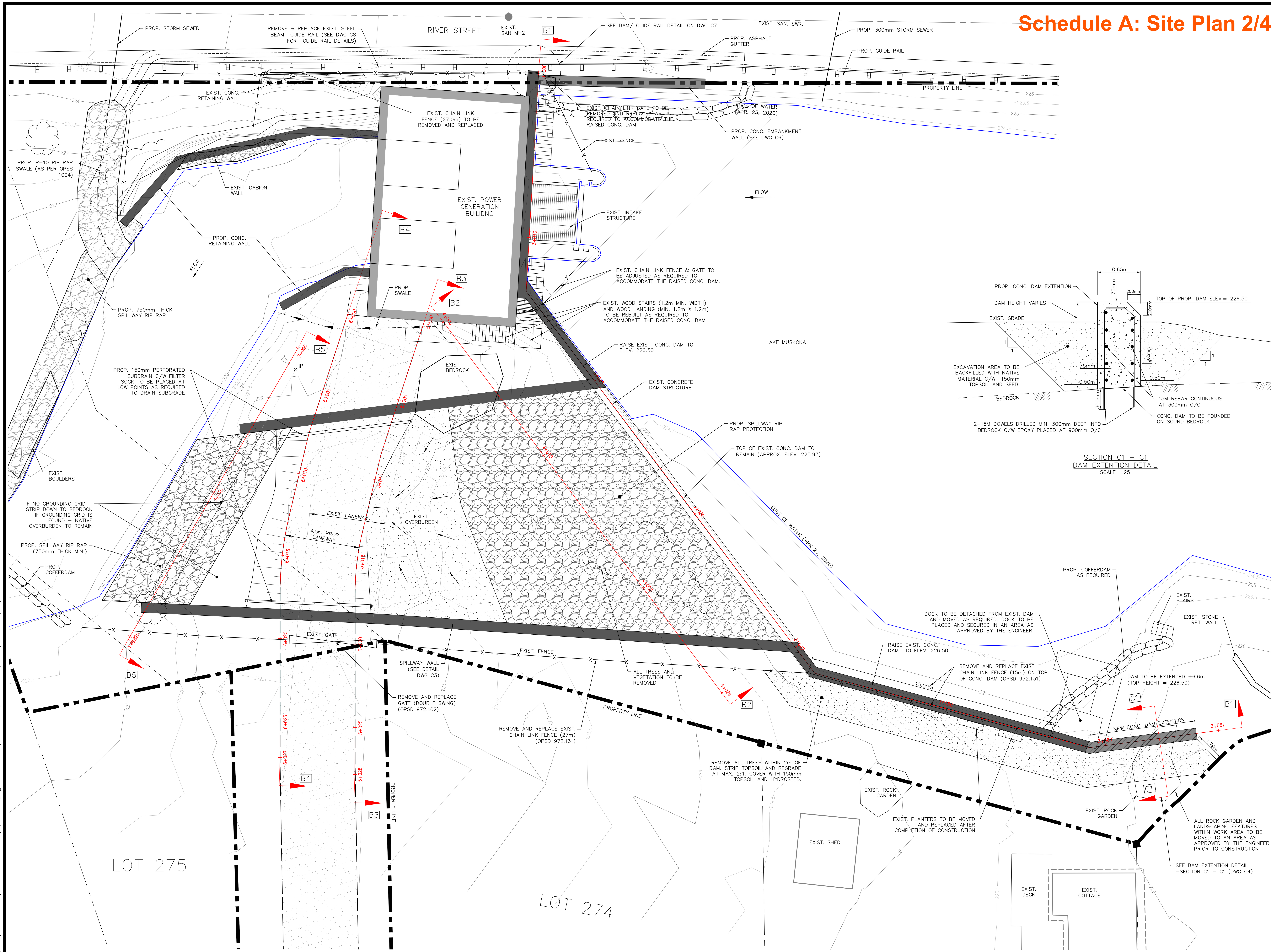
SPILLWAY PLAN

DRAWN	DESIGNED	CHECKED	APPROVED
DR	EG	EG	EG

SCALE	DATE
1 : 100	JUNE 25, 2025

PROJECT No.	REVISION	DRAWING
23-1236	7	C2

Schedule A: Site Plan 2/4



N

KEY PLAN

ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER E.K. GILES 100206670 JUNE 25, 2025 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER Y. LIANG 100145939 PROVINCE OF ONTARIO

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
16/05/2025	6	ISSUED FOR TENDER	DR	EG
18/07/2024	5	ISSUED FOR APPROVALS	DR	EG
05\06\2024	4	ISSUED FOR FINAL REVIEW	DR	EG
08/05/2024	3	ISSUED FOR CLIENT REVIEW	DR	EG
05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

SPILLWAY, DAM RAISE AND DAM EXTENSION PLAN

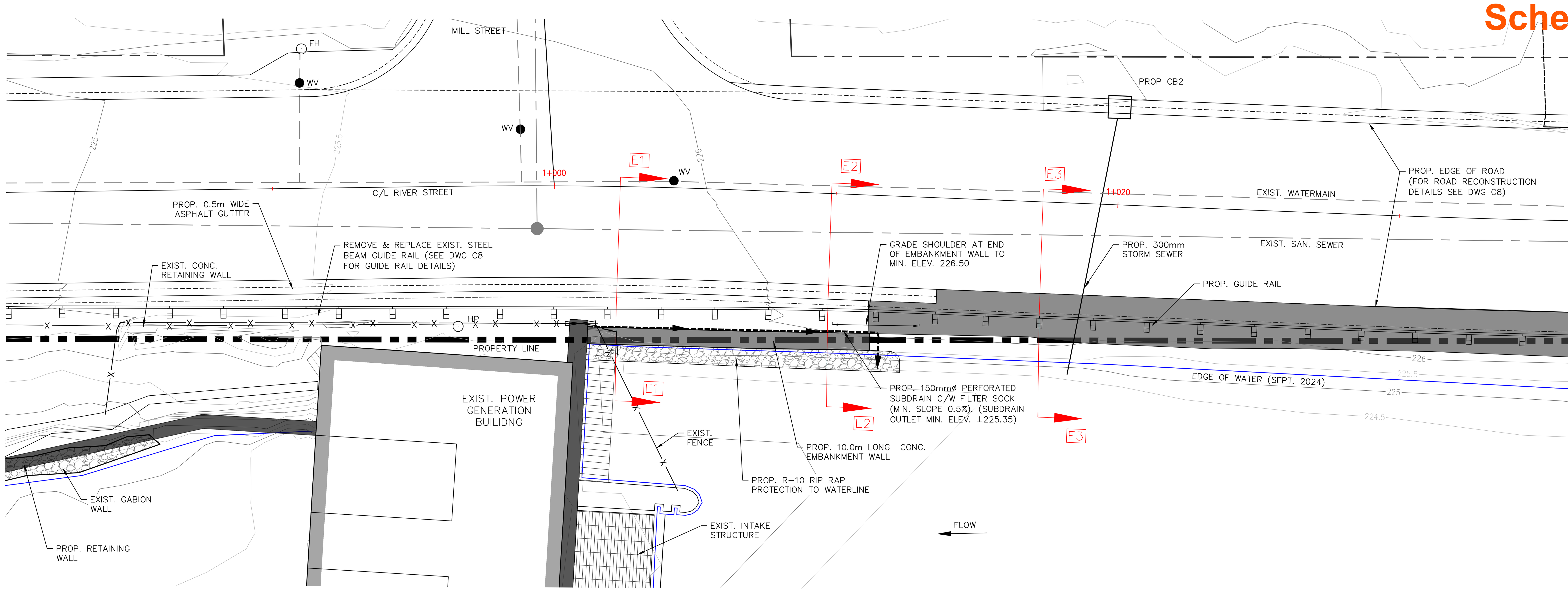
DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED

1 : 100	JUNE 25, 2025
SCALE	DATE

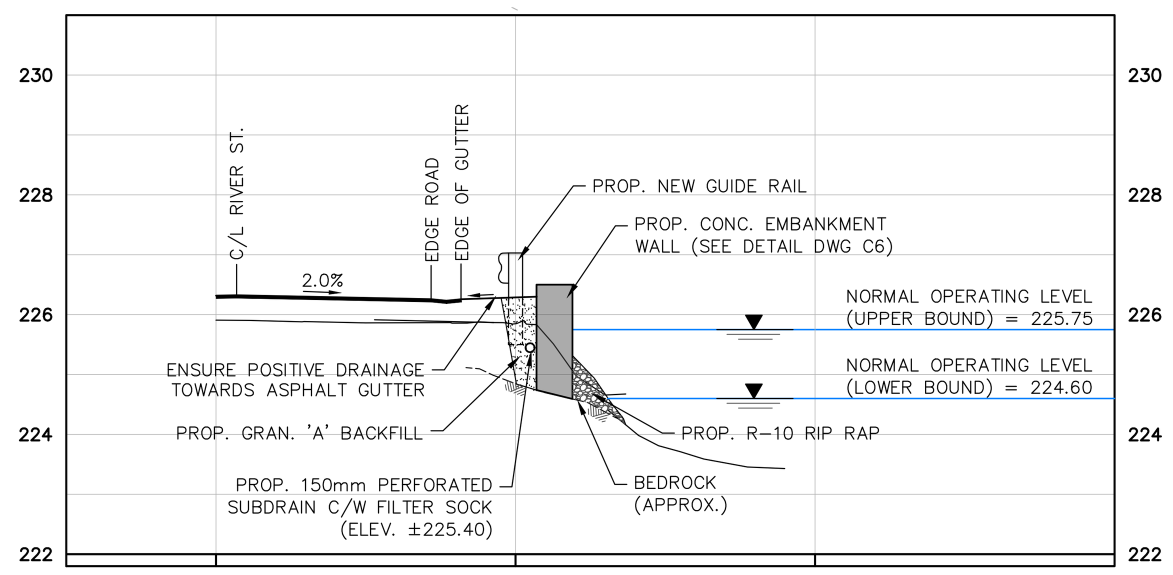
23-1236	7	C4
PROJECT No.	REVISION	DRAWING

P:\2023\231236 - Burgess Dam Detailed Design\03 Drawings\CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg

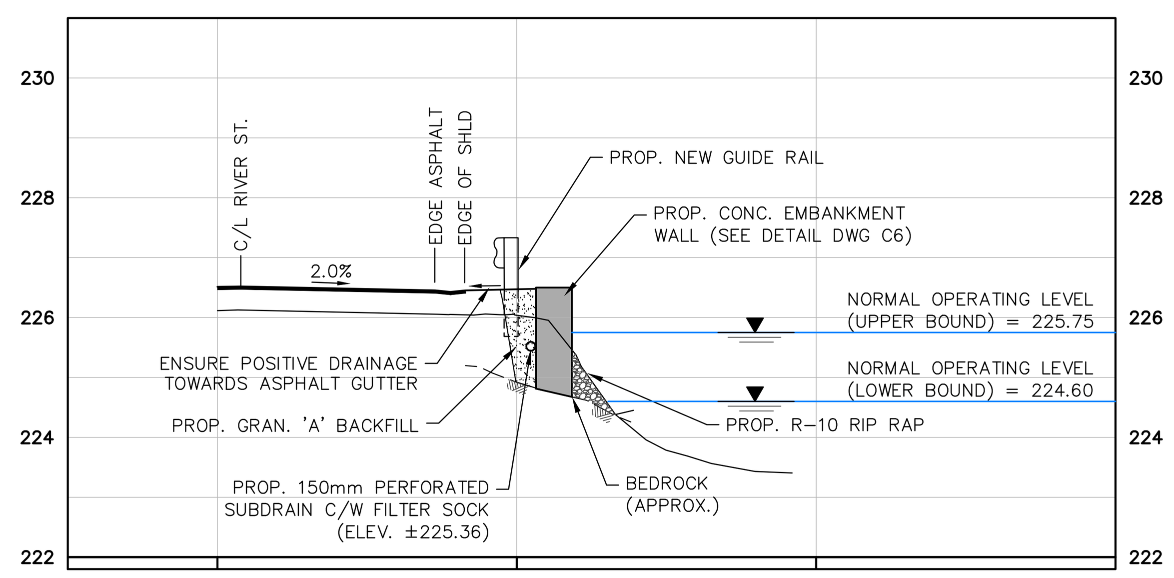
Schedule A: Site Plan 3/4



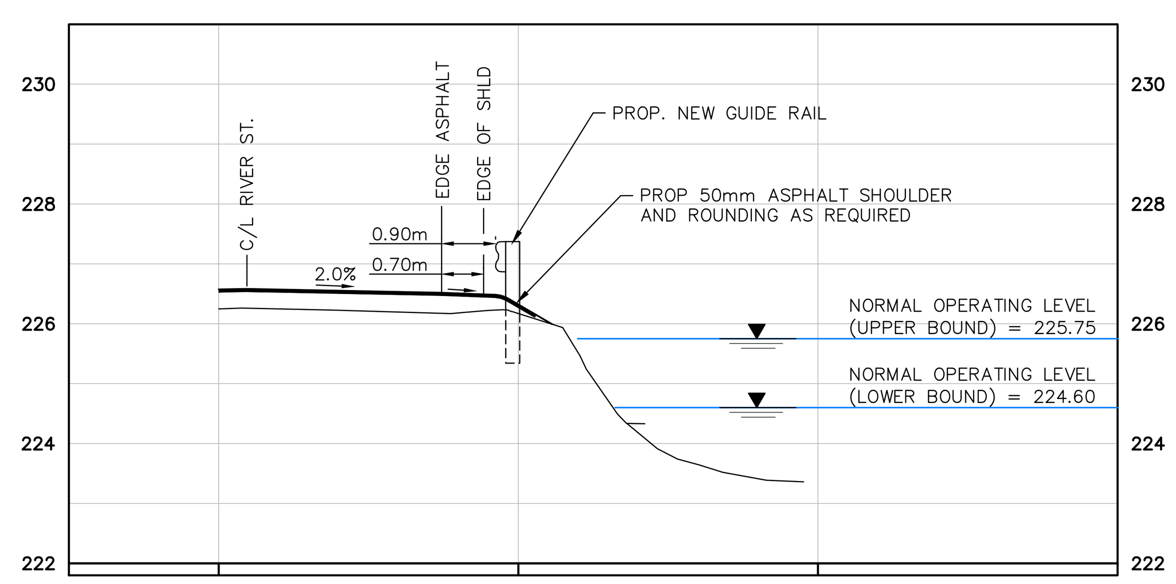
PLAN VIEW
SCALE 1:100



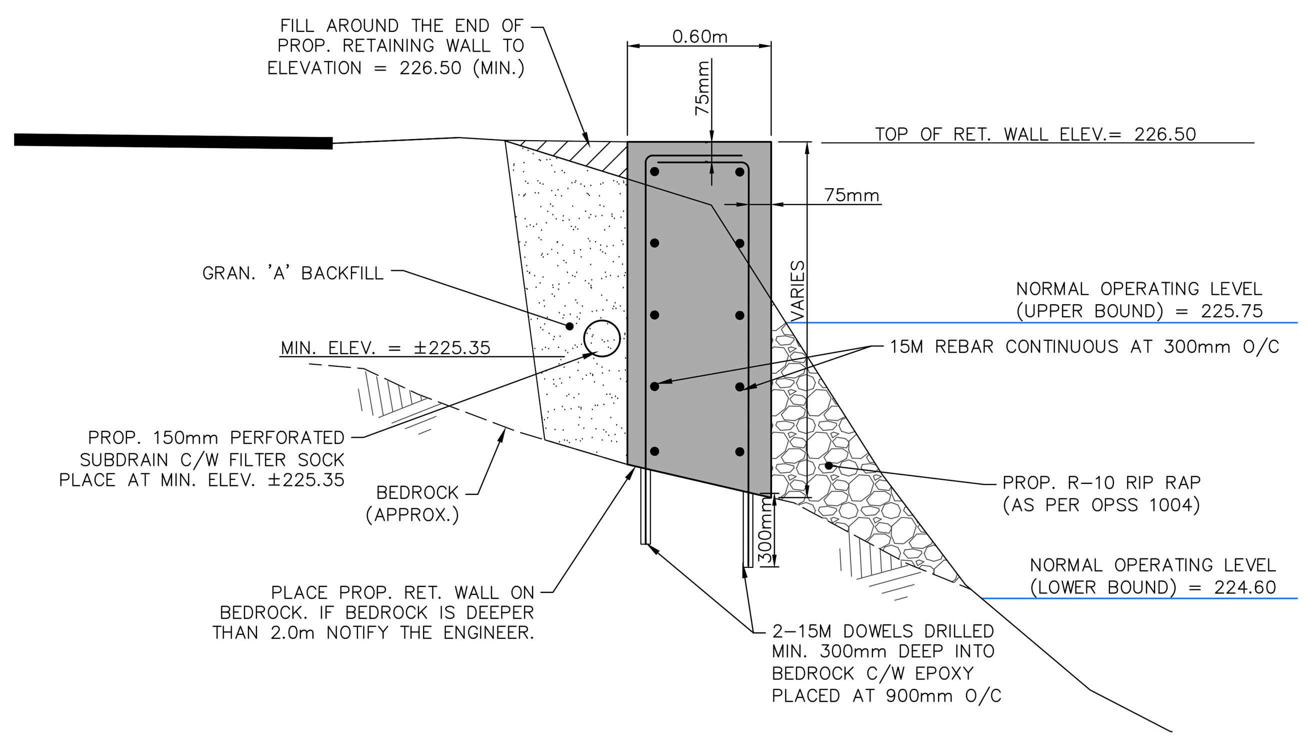
SECTION E1 – E1
SCALE 1:100



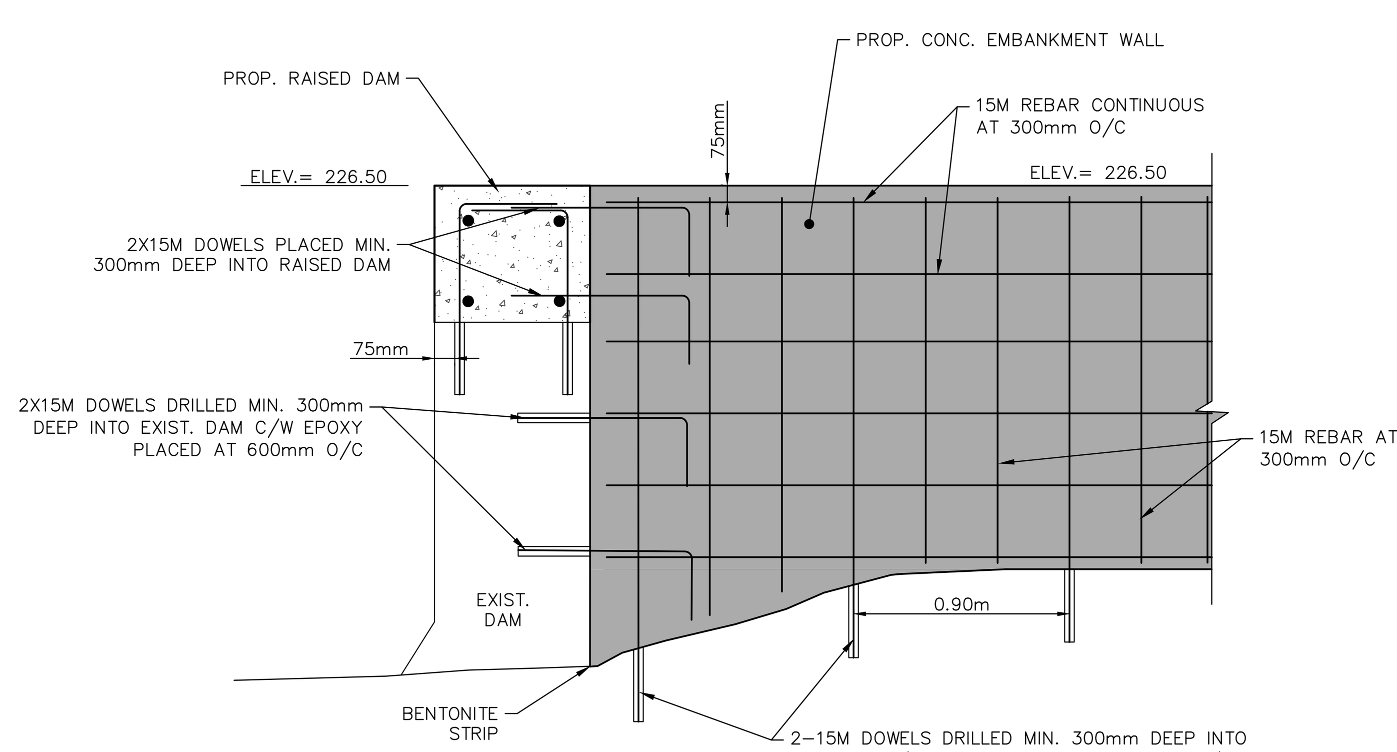
SECTION E2 – E2
SCALE 1:100



SECTION E3 – E3
SCALE 1:100



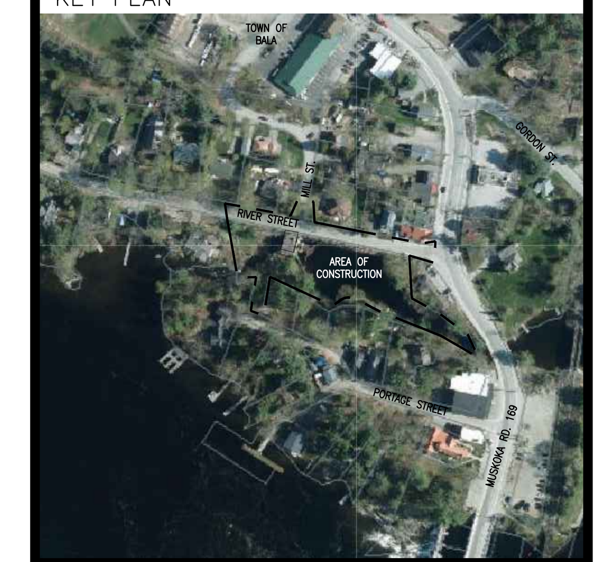
PROP. CONCRETE EMBANKMENT WALL ON NATIVE GROUND
SCALE 1:25



PROP. CONCRETE EMBANKMENT WALL CONNECTION TO EXIST. DAM
SCALE 1:25

N

KEY PLAN



ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER E.K. GILES 100206670 JUNE 25, 2025 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER Y. LIANG 100145939 2025-06-25 PROVINCE OF ONTARIO

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
16/05/2025	6	ISSUED FOR TENDER	DR	EG
18/07/2024	5	ISSUED FOR APPROVALS	DR	EG
05\06\2024	4	ISSUED FOR FINAL REVIEW	DR	EG
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05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

CONCRETE EMBANKMENT WALL

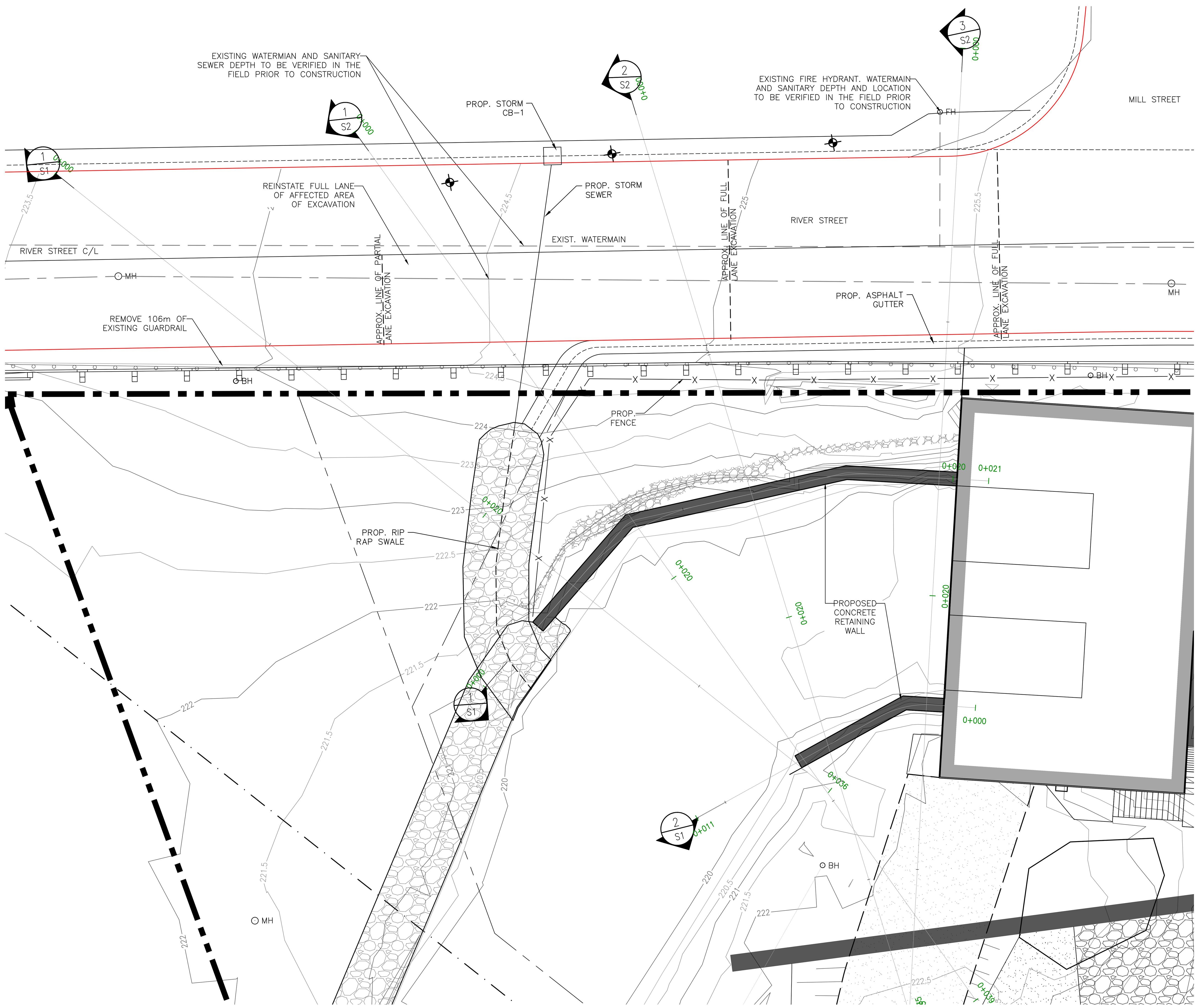
DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED

1 : 100	JUNE 25, 2025
SCALE	DATE

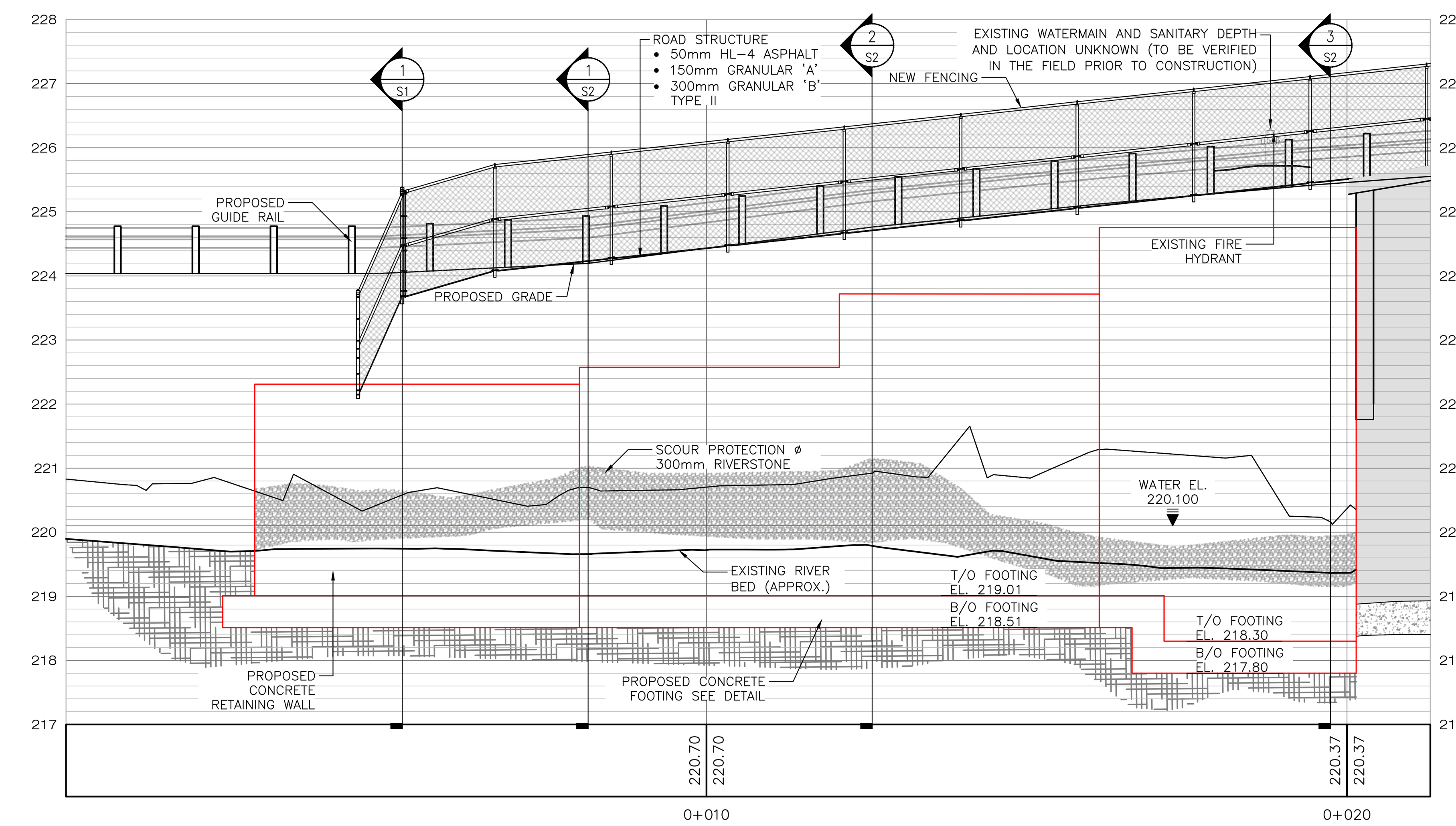
23-1236	7	C6
PROJECT No.	REVISION	DRAWING

P:\2023\231236 - Burgess Dam Detailed Design\03 Drawings\#CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg

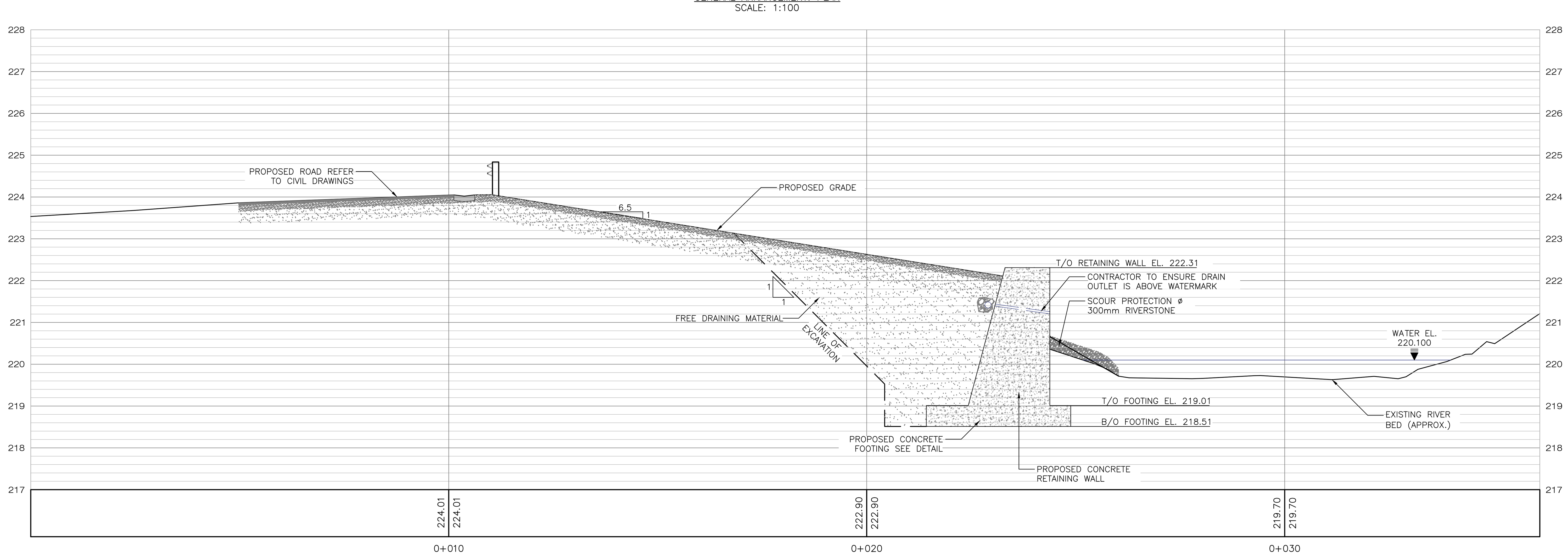
Schedule A: Site Plan 4/4



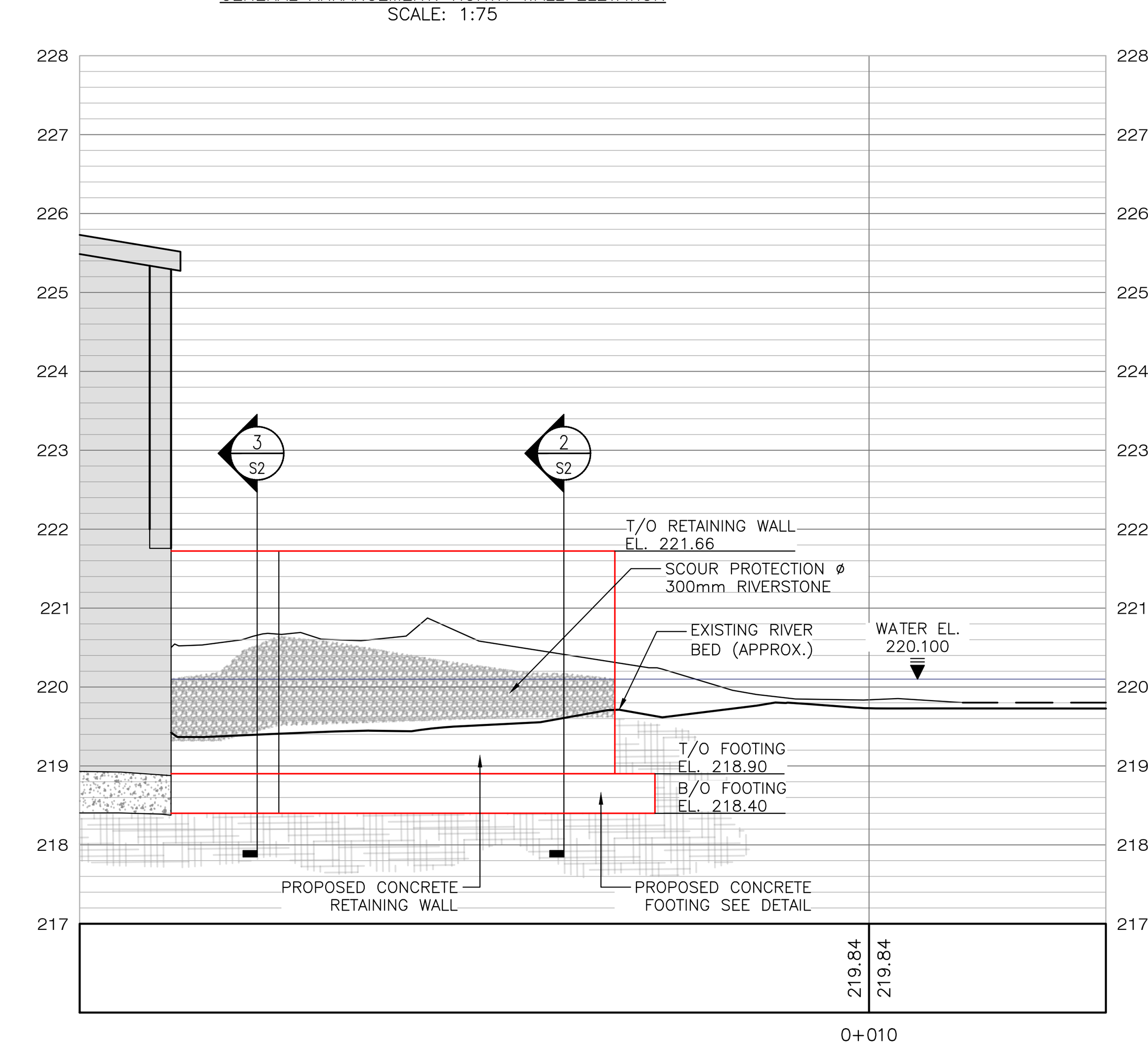
GENERAL ARRANGEMENT: PLAN
SCALE: 1:100



GENERAL ARRANGEMENT: NORTH WALL ELEVATION
SCALE: 1:75

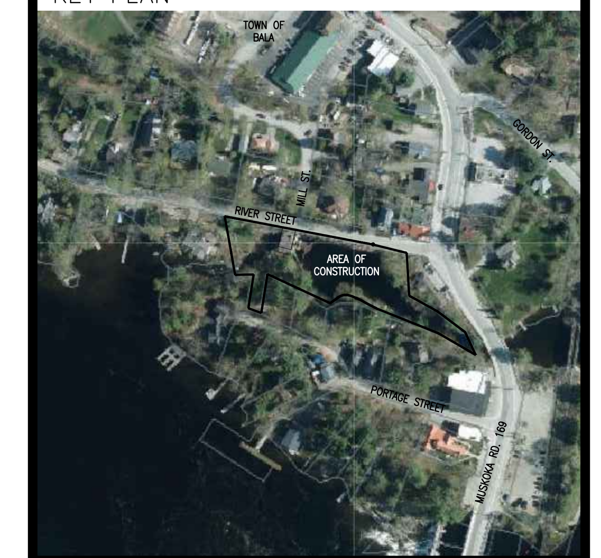


GENERAL ARRANGEMENT: EAST SIDE SECTION OF NORTH RETAINING WALL
SCALE 1:75



GENERAL ARRANGEMENT: SOUTH WALL ELEVATION
SCALE: 1:75

KEY PLAN



ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER
F.R. PALMAY
100162809
2025-Jun-27
PROVINCE OF ONTARIO

DATE (DAY/MTH/YR)	REV.	REVISION	BY	APP'D
26/06/2025	3	ISSUED FOR CONSTRUCTION	HD	FP
13/05/2025	2	ISSUED FOR TENDER	HD	FP
26/06/2024	1	ISSUED FOR FINAL REVIEW	HD	FP
09/05/2024	0	ISSUED FOR REVIEW	HD	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

GENERAL ARRANGEMENT, ELEVATIONS & RETAINING WALL DETAIL

DRAWN	DESIGNED	CHECKED	APPROVED
HD	FP	FP	FP

SCALE	DATE
AS NOTED	JUNE 26, 2025

PROJECT No.	REVISION	DRAWING
23-1236	3	S1

P:\2023\231236 - Burgess Dam Detailed Design\03.02 Drawings\03.02 Current\231236 - Burgess Dam - Retaining Wall - 2025-06-26.dwg

Schedule "B" Work Permit Conditions Report

Submission ID: MPSB-2025-LRIA-00001

Approval Number: MPSB-2025-LRIA-00001-WP-001

Proponent: The Corporation of the Township of Muskoka Lakes

- The extent of the project must front lands owned by the permit holder and in no way encroach upon neighbouring properties
- All work shall be carried out within the approved Work Permit Area (WPA) only. Any work outside the approved WPA will require separate approval or an amendment to this Work Permit.
- Wheeled or tracked machinery or equipment used in connection with the activity must be operated from dry land, on ice surface or operated from a barge or vessel, and must be stored on dry land or stored on a barge or vessel.
- Any material that results from the activity, including sediment, debris and aquatic vegetation, must be immediately disposed of on dry land and in a manner that prevents it from entering or re-entering the water body.

Ministry of
Natural Resources
Divisional Delivery Branch
Technical Services Section

Ministère des
Richesses naturelles

P.O. Box 7000, 300 Water Street
Peterborough, Ontario K9J 3C7

Telephone: (705) 761-0771 (cell)
Facsimile: (705) 755-3233

Ontario

July 7, 2025 MPSB-2025-LRIA-00001

MEMORANDUM TO:

Laurel Gordon
Bracebridge Minden Parry Sound District

SUBJECT: Application Under the Lakes and Rivers Improvement Act
Burgess 1 Dam Rehabilitation, Lake Muskoka
Part Lot 14, Conc. A, Township of Medora, Township of Muskoka Lakes

We have reviewed the plans and specifications associated with the above noted application and find them to be acceptable.

Attached, is our approval under Section 16(2) of the Lakes and Rivers Improvement Act including the Schedule 'F' Conditions.

Amber Langmuir, P.Eng.
Lead Project Engineer
Technical Services Section

Attachments

SCHEDULE 'F' CONDITIONS

SUBJECT: Application Under the Lakes and Rivers Improvement Act, for the Burgess 1 Dam Rehabilitation, Lake Muskoka, Part Lot 14, Conc. 4, Township of Medora, Township of Muskoka Lakes
Applicant/Owner: The Corporation of the Township of Muskoka Lakes
Consultant: Tulloch

The plans and specifications for the Burgess 1 Dam Rehabilitation, Lake Muskoka, part Lot 14, Conc.A, Township of Muskoka Lakes has been approved, under Sections 16(2) of the Lakes and Rivers Improvement Act subject to the following conditions:

1. This approval is given ONLY to the proposed works shown and/or described on the following documents prepared by the consultants, Tulloch:

    1.1 Application for a Work Permit – Part 1, from The Corporation of the Township of Muskoka Lakes c/o Tim Sopkowe, dated 2025/04/22

    1.2 Report titled "Burgess 1 Dam – Rehabilitation", dated June 2025 (Revision June 27, 2025), prepared by Tulloch, signed by K.J. Cheung, P.Eng., F.R.Palmay, P.Eng., E.K. Giles, P.Eng., and Y.Liang, P.Eng., including Appendices:

    - Issue For *Construction* Drawings:
        - Drawing C1, Existing Conditions & Removals, dated June 25, 2025, signed E.K. Giles, P.Eng.and Y.Liang, P.Eng.
        - Drawing C2, Spillway Plan, dated June 25, 2025, signed E.K. Giles, P.Eng.and Y.Liang, P.Eng.
        - Drawing C3, Spillway Sections and Details, dated June 25, 2025, signed E.K. Giles, P.Eng.and Y.Liang, P.Eng.
        - Drawing C4, Spillway, Dam Raise and Dam Extension Plan, dated June 25, signed E.K. Giles, P.Eng.and Y.Liang, P.Eng.
        - Drawing C5, Spillway, Dam Raise and Dam Extension Sections and Details, dated June 25, 2025, signed E.K. Giles, P.Eng.and Y.Liang, P.Eng.
        - Drawing C6, Concrete Embankment Wall, dated June 25, 2025, signed E.K. Giles, P.Eng.and Y.Liang, P.Eng.
        - Drawing C7, Laneway Grading and Details, dated June 25, 2025 (stamped May 16, 2025), signed E.K. Giles, P.Eng. and Y.Liang, P.Eng
        - Drawing C8 River Street Road Reconstruction Plan & Profile STA. 0+940-1+091, dated June 25, 2025, signed C.J. Stilwell, P.Eng.
        - Drawing E1, Sediment & Erosion Control Plan, dated June 25, 2025, signed E.K. Giles, P.Eng. and Y.Liang, P.Eng.

  - Drawing S1, General Arrangement, Elevations & Retaining Wall Detail, dated June 26, 2025, (stamped June 27, 2025), signed F.R. Palmay, P.Eng.
  - Drawing S2, Retaining Wall Sections, dated June 26, 2025, (stamped June 27, 2025), signed F.R. Palmay, P.Eng.
  - Drawing S3, Foundation Upgrades & Roof Framing Plans, dated June 26, 2025, (stamped June 27, 2025), signed F.R. Palmay, P.Eng.
  - Drawing S4, Foundation Upgrades & Roof Framing Details, dated June 26, 2025, (stamped June 27, 2025), signed F.R. Palmay, P.Eng.
  - Drawing S5, Removal Photos, dated June 26, 2025, (stamped June 27, 2025), signed F.R. Palmay, P.Eng.
  - Drawing G1, General Notes, dated June 25, 2025, signed E.K. Giles, P.Eng.and Y.Liang, P.Eng.
- Appendix D: Hazard Potential Classification Memo, individually dated April 9, 2025, prepared by Erik Giles, P.Eng., Georg Liang, P.Eng., Kelvin Cheung, P.Eng.
- Appendix F: Dam Stability Calculations, individually dated April 9, 2025
- Appendix G: Rock Parameters Memorandum, dated May 2025 as per Burgess 1 Dam – Rehabilitation Report.
- Appendix H: Retaining Wall Calculations, dated May 2025 as per Burgess 1 Dam – Rehabilitation Report.

2. Issued for Construction drawings must be submitted to the Ministry of Natural Resources for review and acceptance before work begins.

3. A Site Contractor or Person in Charge must be appointed and be submitted to the Ministry of Natural Resources before work begins.

4. The work shall be carried out during low flow periods, in accordance with the project schedule in the Application. There shall be no in-water works from April 1st to May 31st. Any works that may impact downstream fish areas spawning (located approximately 5-10m downstream of the dam) shall also follow this timing window.

5. Any changes to the design or construction of this project will require prior review and acceptance by the Ministry of Natural Resources. Any work outside of the approved Work Permit Area (WPA) will require separate approval or an amendment to this approval.

6. Erosion and sediment control techniques shall be employed to minimize sediment from surface activities and/or any release of sediment from the pond(s) or reservoir to downstream areas. Prior to any construction, all sediment and erosion controls (ie. Silt fences, rock check dams, coffer dams, etc.) must be in place and functioning effectively. If erosion and sediment control measures are ineffective or not in place, the Applicant

shall immediately notify the District Supervisor, **Parry Sound Work Centre**, **Shannon Norton at +1 (705) 706-3597** and act to ensure appropriate controls are installed and maintained.

7. The applicant shall not allow any deleterious material, (as defined within the Canada Fisheries Act) caused by his/her activity, to enter or re-enter the water body.

8. Prior to the commencement of any construction activities, the Contractor must submit Erosion and Sediment Control Plans, Dewatering Plans and Construction Phasing Plans to the Ministry of Natural Resources for review and acceptance. Any cofferdams proposed within these plans are subject to LRIA.

9. The applicant shall maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved. Immediately after construction, all disturbed surfaces shall be stabilized, sodded or seeded to guard against erosion.

10. The applicant shall not allow any deleterious substance, (as defined in the Canada Fisheries Act) caused by their activity, to enter or re-enter the water body.

11. All water discharge from pumps, etc., are to be directed through appropriate sedimentation control to prevent material from entering any water.

12. Prior to construction of any in-water work, the working area shall be sealed off to prevent entry of fish, and when sealed, fish found within the working area are to be removed and transferred immediately upstream or downstream of the working area. A Licence to Collect Fish for Scientific Purposes shall be required from the Parry Sound Work Centre for any fish transfers.

13. There shall be no changes to the maximum water flow of 4m3/s, generating capacity, flow intake or typical operating procedures as a result of the works.

14. All equipment and machinery shall be clean and free of aquatic invasive species prior to arriving on the project site.

15. The Owner/ applicant The Corporation of the Township of Muskoka Lakes, and their successors or assigns shall be responsible for periodic and regular inspection, maintenance, operation and repair of the approved works in accordance with the plans and specifications approval, to ensure structural integrity and functional performance.

16. The Applicant shall require that the construction of the aforementioned work be inspected by the design engineer, Tulloch, or their representative, as frequently as may be required during construction to ensure compliance with the plans and specifications and conditions of approval.

17. Upon completion of construction, the Applicant, The Corporation of the Township of Muskoka Lakes, shall, in writing, certify to the District Supervisor, **Parry Sound Work Centre**, that the work was completed in accordance with the approved plans. Where any part of the completed works differs from the approved plans, the Ministry may

request that the applicant identify aspects of the work which were modified and provide a set of as-constructed drawings.

18. The permit applies to the period of time from permit issuance until December 31,2026.

19. Approval under the Lakes and Rivers Improvement Act does not relieve the Applicant from compliance with the provisions of any other applicable Federal, Provincial, and/or Municipal Statutes, Regulations or By-Laws.

20. The issuance of this approval does not confer authorization to the applicant to enter or use the property of third parties without permission of the landowner(s).

21. The Applicant shall contact **the District Supervisor, Parry Sound Work Centre, Shannon Norton at +1 (705) 706-3597**, forty-eight hours prior to commencement of the work in order that inspections may be arranged.

Approved
Under Section 16(2)

Engineer Under the Act
Divisional Delivery Branch,
Technical Services Section, Peterborough

Ontario Ministry of Natural Resources and Forestry

Application for Work Permit Part 1

1. Applicant Information

Applicant (e. g., landowner, licencee, permittee, etc.) (Cannot be a subcontractor)

Last Name	First Name	Middle Initial
Tim	Sopkowe	

Business Telephone Number	Residence Telephone Number
705 765-3156 ext.	

Mailing Address

Unit Number	Street Number	Street Name	PO Box
	1	Bailey Street	129

City/Town	Province	Postal Code
Port Carling	ON	P0B 1J0

2. Site Contractor or Person in Charge

Last Name	First Name	Middle Initial
To be determined	To be determined	

Business Telephone Number	Residence Telephone Number	Radio Contact Available
ext.		☐ Yes ☐ No

Mailing Address

Unit Number	Street Number	Street Name	PO Box

City/Town	Province	Postal Code

3. Type of Work Proposed

Indicate and complete the appropriate additional part(s)

☐ Building Construction ☑ Work on Shorelands ☑ Work within a W...

4. Location of Work Permit Area

Township, Municipality, Basemap No. or Lot and Concession, Location, Subdi...
Bala, Ontario, District of Muskoka Lakes, 17U 609163 4985226

Other (i.e. Waterbody) describe
Lake Muskoka upstream and Moon River downstream

Camp Location
No camp required

5. Private Land

Private Lands of - Applicant
☑ Yes ☐ No ☐ Other (specify) Township of Muskoka L...

6. Effective Dates (s)

Start Date (yyyy/mm/dd)	Finish Date (yyyy/mm/dd)
2025/07/15	2026/03/31

7. Equipment Information

Equipment to be used (specify)
Turbidity curtain, silt fencing, excavator, half ton trucks, hand sh...

8. Signature

Personal Information on this form is collected under the authority of Section 13 o... as amended and Ontario Regulation 975 as amended, and the information will b... about this information should be directed to the local MNRF office. MNRF office ...
I/We hereby agree to rely solely upon the terms and conditions of the written wor... amendments to the written work permit must be approved in writing by MNRF.
I certify the information given in this application is true.

Signature of Applicant	Position
(signed)	Director of Operati...
Signature of Contractor (if applicable)	**Position**
Date Application Received in Office (yyyy/mm/dd)	

MINISTRY OF NATURAL RESOURCES

PLANS AND SPECIFICATIONS
APPROVED
UNDER THE LAKES AND RIVERS IMPROVEMENT ACT

ENGINEER UNDER THE ACT

DATE: July 7, 2025

APPROVAL No. MPSB-2025-LRIA-00001

Note: The issuance of this permit does not relieve the applicant from the responsibility of acquiring any other agency, board, government, or other approvals as may be required.
If an applicant requires a copy of this application, the applicant should retain copy prior to submitting.

A list of MNRF offices with addresses and telephone numbers.

Northwest Region

Regional Office	Address	Telephone Number
Northwest Regional Office – Thunder Bay	435 S. James St, Suite 221, P7E 6S8	807 475-1261
Atikokan	108 Saturn Avenue, P0T 1C0	807 597-6971
Dryden	479 Government Road (Hwy.17), Box 730, P8N 2Z4	807 223-3341
Fort Frances	922 Scott Street, P9A 1J4	807 274-5337
Geraldton	208 Beamish Avenue Box 640, P0T 1M0	807 854-1030
Ignace	Box 448, P0T 1T0	807 934-2233
Kenora	808 Robertson Street, Box 5080, P9N 3X9	807 468-2501
Nipigon	5 Wadsworth, Box 970, P0T 2J0	807 887-5000
Red Lake	227 Howey Street Box 5003, P0V 2M0	807 727-2253
Sioux Lookout	49 Prince Street, Box 309, P8T 1A6	807 737-1140
Thunder Bay	435 S. James St, Suite B001, P7E 6S8	807 475-1471

Northeast Region

Regional Office	Address	Telephone Number
Northeast Regional Office – South Porcupine	Ontario Government Complex Hwy 101, Postal Bag 3020, PON 1HO	05-235-1157
Blind River	62 Queen Avenue, P0R 1B0	705 356-2234
Chapleau	190 Cherry Street, P0M 1K0	705 864-1710
Cochrane	Cochrane District 2-4 Hwy. 11 South, PO Box 730, P0L 1C0	705 272-4365
Hearst	613 Front Street, Box 670, P0L 1N0	705-362-4346
Kapuskasing	Hwy 11 W., Box 2, P5N 2X8	705 335-6191
Kirkland Lake	Box 910, 10 Government Rd., P2N 3K4	705 568-3222
Manitouwadge	Box 309, P0T 2C0	807 826-3225
Moosonee	Revillion Road, Box 190, P0L 1Y0	705 336-2987
North Bay	3301 Trout Lake Road, P1A 4L7	705 475-5550
Sault Ste. Marie	64 Church Street, P6A 3H3	705 949-1231
Sudbury	3767 Hwy. 69 South, Suite 5, P3G 1E7	705 564-7823
Timmins	Ontario Government Complex, Hwy 101 East, Postal Bag 3090 South Porcupine, P0N 1H0	705 235-1300
Wawa	48 Mission Road, Box 1160, P0S 1K0	705 856-2396

Southern Region

Regional Office	Address	Telephone Number
Southern Regional Office – Peterborough	300 Water Street, 4th Floor, South Tower, K9J 3C7	705-755-2001
Aurora, Greater Toronto Area (GTA)	50 Bloomington Road, L4G 0L8	905 713-7400
Aylmer	615 John Street North, N5H 2S8	519 773-9241
Bancroft	106 Monck Street Box 500, K0L 1C0	613 332-3940
Bracebridge	1350 High Falls Road, P1L 1W9	705 645-8747
Guelph	1 Stone Road West, N1G 4Y2	519 826-4955
Kemptville	10 Campus Road, Postal Bag 2002, Concession Road, K0G 1J0	613 258-8204
Kingston	Ontario Government Building, Beachgrove Complex 51 Heakes Lane, K7M 9B1	613 531-5700
Midhurst (Huronia)	2284 Nursery Road, L0L 1X0	705 725-7500
Minden	Hwy. 35 By-pass, Box 820, K0M 2K0	705 286-1521
Niagara	Box 5000, 4890 Victoria Avenue North, L0R 2E0	905 562-4147
Owen Sound	1450 7th Ave. East, N4K 2Z1	519 376-3860
Parry Sound	7 Bay Street, P2A 1S4	705 746-4201
Pembroke	31 Riverside Drive, K8A 8R6	613 732-3661
Peterborough	300 Water Street, 1st Floor South Tower, K9J 3C7	705 755-2001

LOCH

| Biologists | Engineers

MINISTRY OF NATURAL RESOURCES

PLANS AND SPECIFICATIONS **APPROVED**

UNDER THE LAKES AND RIVERS IMPROVEMENT ACT

ENGINEER UNDER THE ACT

DATE: July 7, 2025

APPROVAL No. MPSB-2025-LRIA-00001

y of Natural Resources

s 1 Dam - Rehabilitation

nd Rivers Improvement Act Design Brief Report

ntario

H Document No. / Rev. 23-1236-2050-002 / Rev. 1

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for Use

LICENSED PROFESSIONAL ENGINEER K. J. CHEUNG 100562307 June 27, 2025 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER F. R. PALMAY 100162809 2025-Jun-27 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER E. K. GILES 100206670 JUN 27/2025 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER Y. LIANG 100145939 2025-06-27 PROVINCE OF ONTARIO

June 27, 2025	1	Issued for Use	E. Giles	G. Liang
May 16, 2025	0	Issued for Use	E. Giles	G. Liang
Date	**Rev.**	**Status**	**Prepared By**	**Approved By**

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TULLOCH

Planners | Surveyors | Biologists | Engineers

June 27, 2025
23-1236

Ontario Ministry of Natural Resources
Bracebridge Minden Parry Sound District
R.R.2., Highway 11 North at High Falls Road
Bracebridge, Ontario
P1L 1W9

Attention: Laurel Gordon | IRM Technical Specialist

Re: Burgess 1 Dam Rehabilitation Design Brief to Support Lakes and Rivers Improvement Act Permit Application

Dear Ms. Gordon,

Please find enclosed a summary report outlining the design intent and supporting calculations to support the Lakes and Rivers Improvement Act (LRIA) permitting for the rehabilitation of the Burgess 1 Dam structure located in Bala, Ontario, within the Township of Muskoka Lakes.

This report outlines the proposed rehabilitation efforts and proposed design upgrades to improve the safety of the aging Burgess Dam to allow for a more robust structure, including the addition of an emergency spillway, upgrade of the overflow and non-overflow dam sections, powerhouse structural rehabilitation, and upgrades to River Street including raising the road and upgrades to its bank slope retaining structure.

We trust the enclosed is adequate for your current needs. If there is anything further that we can assist with, please contact us at your convenience.

Sincerely,

Erik Giles, P.Eng.
Geotechnical Engineer

TULLOCH

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1. INTRODUCTION AND SCOPE

TULLOCH Engineering Inc. (TULLOCH) was retained by the Township of Muskoka Lakes (Township) to provide engineering services for the rehabilitation of the Burgess 1 Dam located in Bala, Ontario. The purpose of the rehabilitation is to help address deficiencies with the structure that were made clear during the flooding in the Muskoka area in the spring of 2019. At the time of the flooding, the dam experienced an overtopping event with significant uncontrolled release of water around both abutments of the structure. While the structural integrity of the dam remained intact, future significant flooding events could have a more consequential outcome. Further discussion on the history of the Dam and the recent activities that have led to the current rehabilitation design will be discussed further in Section 2.

The current scope of TULLOCH's work is to provide safety improvements to the dam by means of addressing structural deficiencies with the dam, powerhouse and associated retaining structures and also provide a more robust containment as well as the inclusion of an emergency spillway structure. This report will function as a summary of the planned activities and provide the design input regarding the intent, assumptions, rationale and calculations for consideration under the Lakes and Rivers Improvement Act (LRIA) permitting process. The Issued For Construction (IFC) drawings have been provided attached in Appendix A and should be read in conjunction with this report.

The Dam rehabilitation has been focused in four (4) main areas summarized below:

1. **Non-overflow Dam Section and Emergency Overflow Spillway:** Part of the existing Non-overflow dam section will be raised and extended to accommodate flood flows and prevent overtopping under the Inflow Design Flood (IDF) event. The remaining portion of the existing dam (Overflow Section) will be designed and upgraded as an emergency spillway to allow for a controlled release of water under the IDF event until the North and South Bala Falls Dams can stabilize water conditions per the existing Muskoka River Watershed Management Plan (MRWMP).

2. **Structural Rehabilitation of the Powerhouse:** Anchoring and grouting will be conducted in the powerhouse to pin the large the horizontal crack encountered in the Dam Safety Review (DSR) inspection for the powerhouse, the aging timber roof and steel support bracing will also be replaced and upgraded.

3. **Replacing North Slope Retaining Walls and Improving Erosion Control:** The aging gabion baskets and stacked boulders, as well as the cracked existing retaining wall on the north downstream slope of the site will be replaced with new cast in place retaining structures, upgrades to erosion protection will be added to the downstream tailrace/channel.

4. **River Street Raising:** River Street will be raised to create passive containment to prevent water from overflowing the north abutment of the dam during IDF flooding conditions and also to prevent water from building behind the new retaining structures. A small concrete embankment wall will transition the road raise along the north embankment of the dam.

2. BACKGROUND / HISTORY OF BURGESS 1 DAM AND DESIGN EFFORTS

The Burgess 1 Dam facility comprises a small two (2) turbine generating station, including a concrete powerhouse and gravity dam, which is located in Bala, Ontario, adjacent to the North and South Bala Falls Dams. Upstream of the dam is Bala Bay within Lake Muskoka, and downstream of the dam are the headwaters of the Moon River.

The Burgess 1 Dam facility was originally constructed in 1917 where operations were taken over by the Ontario Hydro Commission from their purchase of the dam and generating facility in 1929. The facility was purchased by the Township in 1963 and has since been leased to various power generating companies up to the present day. The dam consists of an approximately 59 m long concrete dam founded on bedrock with a maximum height of approximately 3 meters. A powerhouse has been built into the northern section of the dam and is currently in operation.

In the Spring of 2019, the Burgess 1 Dam experienced an overtopping event caused by flooding of the Muskoka watershed upstream of the facility that put the safety of the dam at risk. A Dam Safety Review (DSR) was commissioned in the Summer of 2019 by the Township to review the current state of the Burgess 1 Dam and determine any safety/structural issues with the dam facility as well as recommend proposed remediation/rehabilitation plans. The DSR determined safety concerns with respect to dam stability and capacity to withstand a similar flooding event. Conceptual designs for dam rehabilitation were completed at the conclusion of the DSR.

In 2020, the Township retained TULLOCH to perform a Municipal Class Environmental Assessment Schedule B Study (Class EA Study or EA) for the proposed improvements to the Burgess 1 Dam facility. The goal of the study was to evaluate and assess the various proposed alternative solutions to the problem statement generated for the project in a transparent manner while encouraging public and agency feedback for the project. The result of the EA process determined the preferred alternative solution was the rehabilitation of the dam and powerhouse structure. At the conclusion of the EA, the conceptual design from the DSR was advanced to the preliminary design stage based on the selected preferred solution.

Detailed Design of the structure was commenced in late 2023 and has since been completed. The IFC drawings attached to this report in Appendix A form the basis of the rehabilitation. This report will provide a summary of the design efforts for the LRIA permitting process for consideration and review from the Ministry of Natural Resources (MNR). This will include a brief summary of the current state of the dam and key DSR findings, design intent, and key elements of the dam. This report will also provide rationale and assumptions for the attached calculations associated with the design, which are referenced throughout the report.

3. CURRENT STATE

The following section will outline the current state of the dam and references key elements of the DSR Report attached in Appendix B. The dam and associate structure currently consist of three (3) main components, including the following:

- ±59 m long x 3 m high concrete gravity dam with a crest width of approximately 0.6 m. Fill has been placed against the downstream face of the dam to help prevent overturning and sliding.
- 9 x 14 m power single story two (2) bay powerhouse, which includes a turbine in each bay. One (1) turbine was replaced when the power generation of the dam was taken over by KRIS Power circa 2010 (current tenant). The other turbine appears to be one of the original Francis turbines installed when the powerhouse was built.
- 16 m long retaining wall connected to the north wall of the powerhouse, which supports River Street; below the wall, the embankment is supported by a series of gabion baskets and stacked boulders.
- Totten Sims Hubicki and Associates (TSHA) performed a review of the dam in 1986 and created a drawing set for the dam, which appears to be the only known drawings of the structure. Key dimensions are summarized in Table 3-1 below as taken from the DSR Report; the dimensions and main features were taken from the TSHA report and/or the Muskoka River Watershed Management Plan (Acres 2006).

Table 3-1: Summary of the In-situ Features of the Burgess 1 Dam

No.	Dam	Main Features	Reference
1	Non-overflow Dam Section	• Concrete Retaining Structure on Bedrock supported by D/S fill embankment.	• TSHA Structural Report, 1986 Drawing P-1 and P-2
2	Powerhouse Dam Section	• Concrete gravity dam and powerhouse are integrated into one structure and founded on the bedrock	• TSHA Structural Report, 1986 Drawing P-1 and P-2
4	Dam Crest Elevation (m)	• EL. 225.93 m (note due to the age of concrete this value somewhat fluctuates across the dam)	• TSHA Structural Report, 1986 Drawing P-1 and P-2
5	Maximum Dam Height (m)	• Max. 3 m (non-overflow section) • Max. 6 m (Powerhouse Section)	• TSHA, Structural Report 1986 Drawing P-1 and P-2
6	Crest Width (m)	• Approx. 0.6 m	• TSHA, 1986 Drawing P-1 and P-2
7	Dam Length (m)	• 59 m (total length of dam) • 14 m (Powerhouse Section)	• TSHA, 1986 Drawing P-1 and P-2
8	Spillway	• No Spillway	• MRWMP, 2006
9	Reservoir Levels	• NOL Range between 224.6 and 225.75 m • IDF El. The ac.49m	• MRWMP, 2006
10	Powerhouse	• 0.14MW, 2 Units • Max. flow rate 4m^3/s	• MRWMP, 2006

The 2019 DSR identified several deficiencies with respect to the existing dam and associated structures that the rehabilitation design intends to address. The main deficiencies are summarized below:

- The site inspection in 2019 indicated an approximate overtopping of 0.4 m over the existing dam crest. Significant washout of downstream fill and loss of water control around both the north and south abutment were noted. A diversion channel was dug behind the south abutment to prevent undermining of the dam during the flooding.
- The as-built dam crest at an elevation of EL. 225.93 m is not adequate to withstand the Inflow Design Flood (IDF) as published in the Muskoka River Dam Operation Manual, which identifies the Lake Muskoka 100-year water level of 226.49 m (taken as the IDF).

- Washout of fill caused by the loss of water control could lead to the dam becoming destabilized due to insufficient armouring. Stability issues of the non-overflow and powerhouse sections were noted in the DSR.

- There was no identifiable emergency spillway for the existing dam. The dam has a high risk potential of breach when subjected to uncontrolled overtopping/releasing water flow in the future.

- The powerhouse was noted to have a large horizontal crack running through the base of the concrete deck structure indicating the powerhouse may no longer be acting as a monolithic structure. In addition, undermining was also noted at the concrete deck foundation due to long-term outlet flow scouring during powerplant operation. Stability concerns were identified with the powerhouse in the DSR.

- Large cracks and poor drainage were noted in the existing retaining wall connected to the north wall of the powerhouse.

- The gabion baskets and stacked boulders are in poor condition and could lead to the destabilization of River Street.

The DSR recommended that remedial and/or rehabilitative actions be taken to address the above main deficiencies. The DSR Report was previously submitted to the MNR as part of the EA process; however, for reference, it is attached to this report in Appendix B. Furthermore, the Project File Report Associated with the EA is also attached in Appendix C of this report. It should be noted that the design calculations discussed and provided in subsequent attachments, including the IFC drawings in Appendix A, supersede those in the DSR and EA as they reflect the current intent of the design. The DSR and EA reports are provided for context and reference of the project through the design cycle.

4. REHABILITATION EFFORTS AND DESIGN INTENT OVERVIEW

The following sections will summarize the rehabilitation efforts and design intent to address the deficiencies in 2019 DSR while implementing the preferred solution selected during the 2020 EA study for the dam and associated structures.

It should be noted that in discussion with the Township, the turbine, head gates and other mechanical and electrical elements associated with the dam are considered outside of TULLOCH's scope. The intent with respect to rehabilitation is to leave the existing turbine equipment and generation capabilities intact with no changes to the installed generating capacity or flow intake. The 4 m^3/s allotted to the Burgess 1 Dam under the Muskoka River Watershed Management Plan will remain unchanged. As such, typical operational procedures of the dam will also remain unchanged. The intent behind the design elements is to address safety issues with the various elements of the structure and rehabilitate the site to provide a more robust flood response.

4.1. Concrete Dam Structure

4.1.1. Non-overflow Section

As indicated in the DSR and based on the flooding event of 2019, the freeboard on the dam was not sufficient to withstand the flood flows. Uncontrolled overflow and water releasing occurred during the 2019 flood event, which was very close to the 100-year flood event of Lake Muskoka. The 1/100-year flood was assigned to Burgess based on the selected Hazard Potential Classification (HPC) per the MNRF LRIA Technical Bulletin, which will be discussed in greater detail in Section 5.1 of this report. Given the 1/100-year flood level exceeded the existing dam crest, in order to prevent uncontrolled flooding, a portion of the dam crest towards both abutments will be raised to accommodate the 100-year event to an elevation of EL. 226.50 m. Initially a slightly conservative dam crest of EL. 226.6 m (i.e. higher freeboard) was considered in the design; however, in order for the River Street road raising to be feasible due to utility and property conflicts while still promoting flow through the emergency spillway, the final dam crest elevation of 226.5m was selected. This elevation will allow the dam to hold back the IDF while the emergency spillway is activated.

As a function of raising the non-overflow section of the dam to EL. 226.50, the southern abutment of the dam will be extended approximately 7.0 m to tie into bedrock at the new elevation. The new section will be dowelled into bedrock and built to a similar geometry as the original dam. This is shown in plan on Drawing C4 and in detail on Drawing C5 of the IFC drawings in Appendix A of this report.

The raised dam will include dowelling into the existing dam and raising the section with reinforced concrete by approximately 500 mm. The raise will also include the addition of a bentonite water stop. The proposed dam raise is shown in detail on Drawing C5 of the IFC drawings in Appendix A.

4.1.2. Emergency Overflow Spillway-Overflow Section

In order to safely pass the IDF at the dam site in a controlled manner, an emergency spillway has been added to the existing dam structure. The designed spillway consists of the following:

- Concrete overflow sill (existing concrete dam) with the crest elevation of approx EL. 225.93m
- Riprap Protected Spillway channel ranging 15-25m in width and a global slope of 8H:1V
- North and South Concrete Guide Walls sitting on the bedrock with anchor dowels
- Riprap protected chute zone at the end of spillway channel

Details on hydraulic calculations, including spillway rating curve, flow depth and velocity, rip rap sizing, flow energy dissipation and erosion/scouring protection, will be discussed in Sections 5.3 and 5.4 of this report, respectively. The spillway was incorporated into the design to safely convey the IDF while operating within the confines of the Burgess Dam site. It should be noted that the main flood flows will continue to be handled by the North and South Bala Falls Dams per the MRWMP. The emergency spillway at the Burgess Dam Site aims to achieve the following objectives:

- Safely pass/divert flood waters during extreme events (IDF) through the Burgess 1 Dam Property in a controlled manner.
- Divert floodwaters away from the powerhouse and to the tailrace downstream of the dam as efficiently as possible and mitigate risk to the powerhouse structure.
- Allow for continued access into the facility via the man and bay door on the south wall of the powerhouse to meet routine maintenance and operational requirements of the powerhouse.
- Prevent disturbance of the existing grounding grid to the extent possible. The grounding grid will be fed through the spillway training walls into the powerhouse where encountered.
- Maximize the spillway capacity based on the above constraints to allow for the emergency spillway to act as a stop gap until flood flows can be passed through the larger North and South Bala Falls Dams.

- Placement of sufficient erosion control to dissipate flow energy, reduce flow velocity and also prevent downstream fill erosion during activation.

As described above, the Emergency Spillway does not act as a traditional emergency spillway due to the size constraints of the Burgess 1 Dam site property and the significant catchment area upstream of the dam; the spillway cannot be constructed to be large enough to pass the flood flows of Lake Muskoka. Instead, per the MRWMP, the main flood flows will be required to be passed by the adjacent larger North and South Bala Falls dams. The purpose of the new emergency spillway at Burgess is to ensure water is channelled away from the dam abutments and powerhouse and act as a stop gap until the larger dams' spillways can be engaged. The spillway invert has been set at the original dam crest of EL 225.93 m so that water will flow preferentially through the spillway to the downstream tailrace area to avoid an uncontrolled release of water. Spillway details can be seen in plan view in Drawing C2 and in the sections and details in Drawing C3 of the IFC Drawings in Appendix A.

4.1.3. North Concrete Wall

A small concrete wall was also designed to act as a barrier at the low area surveyed between the River Street embankment and the north abutment of the dam. The wall will tie into the raised dam at the same elevation of EL. 226.50 m. Construction of the wall will help contain water in the upstream pond and act as a transition to where the road has been raised, and prevent flooding behind the proposed retaining walls and down River Street. This wall will be pinned to the shallow bedrock on site. Plan and Section views of the wall are shown on Drawing C6 of the IFC Drawings.

4.2. Structural Rehabilitation of the Powerhouse

4.2.1. Roof Replacement

The Burgess 1 Dam currently consists of an aging timber roof with polyethylene sheeting weighed by various debris as waterproofing. The roof will be replaced with a new timber roof incorporating access hatches over each turbine bay for future retrofitting as required. The roof will be supported by a series of interior steel braces, which will be discussed in the following sub-section. A plan view of the replaced roof can be seen in Drawing S3, and details and sections can be seen in Drawing S4 of the IFC drawing package in Appendix A.

4.2.2. Powerhouse Steel Bracing

The existing steel bracing, which was observed to be corroded will be replaced and help support the replaced roof. The steel bracing will consist of a series of columns placed on concrete pedestals to help mitigate future corrosion. Sections and details of the bracing can be found in Drawing S4 of the IFC drawing package in Appendix A.

4.2.3. Powerhouse Anchors and Grouting

During the DSR inspection it was noted that the piers of the powerhouse demonstrated erosion/undermining around the outflow bays of the structure. Furthermore, a large horizontal crack was noted through the base of the structure. In order to address these concerns and aid in the stability of the structure, a series of nine (9) DYWIDAG Anchors have been incorporated into the design to be drilled and grouted into the competent bedrock surface. Non-shrink grout will also be added to fill the voids below the bays. The proposed anchors are shown in Plan and section view in Drawings S3 and S4, respectively, in the IFC drawing package in Appendix A. Stability calculations with respect to the anchoring plan are discussed below in Section 6.

4.3. Retaining Walls

During the initial dam inspection as part of the DSR, the original northern retaining wall was observed to be significantly cracked; furthermore, the area directly downstream of the dam appeared to be retained by a series of stacked boulders and aging gabion baskets. The DSR identified a deficiency which was subsequently re-examined in the North Slope Investigation Report, which was appended to the original EA Project File Report attached in Appendix C (Shown in Appendix I of the EA originally submitted forming part of the Preliminary Design Memo). A survey was conducted, and a slope stability assessment was completed on the slope. Under current conditions, the north slope was found to have insufficient Factor of Safety between the gabions with respect to sliding.

Between the poor condition of the existing north retaining wall and marginally safe conditions of the aging gabion walls, it was determined that the retaining walls downstream of the dam should be replaced as part of the overall rehabilitation.

The retaining walls will consist of two (2) cast in place retaining walls on the north and south sides of the tail race of the dam. The north wall will replace the existing retaining wall and gabion baskets. The walls will act as both retaining structures but also as a training wall to prevent erosion of the north slope from operational flows during dam and powerhouse operations. The walls will be pinned to the bedrock surface. Plan, elevation and section views of the proposed walls can be seen in Drawings S1 and S2 of the IFC drawing package in Appendix A. Calculations for the retaining wall will be discussed further in Section 8 below.

4.4. River Street Raising

The final major element of the rehabilitation for the Burgess 1 Dam is the strategic raising of River Street. The southern embankment of River Street forms the north edge of the head pond for the dam. During the 2019 flooding event significant water flow was observed to flood across River Street and run down the road and behind the existing retaining structures. A survey of the road indicates that portions of the road are lower than the existing dam crest at approx EL. 225.93. Therefore, if the dam were raised without raising the road, water would preferentially overtop the road under IDF conditions. In order to solve this issue, it was discussed with the Township that either a long concrete water retaining wall would be required or the road could be raised. The preference of the Township was to create a more passive solution by raising River Street. This was agreed upon by TULLOCH to prevent further maintenance of concrete structures at the site in the future.

As such, River Street will be raised approximately 500 mm to match the height of the dam at EL. 226.50 m and be above the 100-year flood level of Lake Muskoka. Furthermore, drainage improvements such as the newly constructed swale and asphalt shoulders will help promote drainage away from the retaining walls and dam structure. Drawing C8 shows the proposed grade raise and typical sections for River Street in the IFC Drawings in Appendix A.

5. SPILLWAY HYDRAULIC CALCULATIONS

The following sections will outline the Hazard Potential Classification (HPC) selection for Burgess, IDF determination, and hydraulic calculations for the spillway structure which are shown on the IFC Drawings. Accompanying calculations sheets are referenced in the report body and attached to this report for reference. Each major component with respect to hydraulic calculations is summarized below.

5.1. Hazard Potential Classification

A desktop study was conducted as part of the scope for the Dam Safety Review to help determine the HPC of the dam per the MNRF LRIA Technical Bulletin for Classification and Inflow Design Flood Criteria.

The summary table provided in the DSR is presented below for both the normal operating (sunny day) and flooding failure conditions (rainy day). As shown below, the Dam would fit into the Overall Classification of Low per the criteria published in the Technical Bulletin.

Table 5-1: Burgess 1 Dam Classification Summary

Category	Burgess 1 Dam	
	Flood	Non-Flood
Incremental Loss of Life (LOL)	0	0
	Low	Low
Economic Damages	<$300,000	<$300,000
	Low	Low
Environmental	Low	Low
Cultural / Heritage	Low	Low
Governing Criteria	Economic / LOL	Economic / LOL
Overall Classification (HPC)	**LOW**	**LOW**

In summary, due to the relatively small size/head of the dam, in the event of failure, the main risk associated with failure would be the loss or damage of shoreline structures such as docks in the immediate upstream and downstream area of the dam. A supplementary letter requested by the MNR outlining the rationale for the selection of the criteria under each of the major HPC categories is attached to this report in Appendix D. It should be noted that detailed dam break analysis was not considered part of the scope of the DSR or subsequent design phases for the project.

5.2. Inflow Design Flood (IDF) Determination

Upon selection of the HPC, the IDF was chosen based on the LRIA Technical Bulletin – Classification and Inflow Design Flood Criteria. As shown in Table 2 within Section 3.2 of the bulletin, the IDF for a Low HPC dam is a 25-Year Flood to a 100-Year Flood. Given the recent flooding at Burgess, it was determined that for the purposes of conservative design, the 100-year flood be utilized, and best resembles the flooding witnessed in 2019.

TULLOCH reached out to the MNR during the DSR to determine the 100-year elevations for Lake Muskoka, which would represent the IDF for Burgess. The figure below shows the 2019 water levels, including the flooding, in comparison to the IDF value/100-year Flood value.

It should also be noted that an observed flood level of approximately 226.45m was noted based on a 400-450 mm overtopping of water over the dam at the time of flooding in 2019. Figure 5-1, shown below, was taken from the 2019 DSR Report, illustrating water levels at Burgess Dam Site.

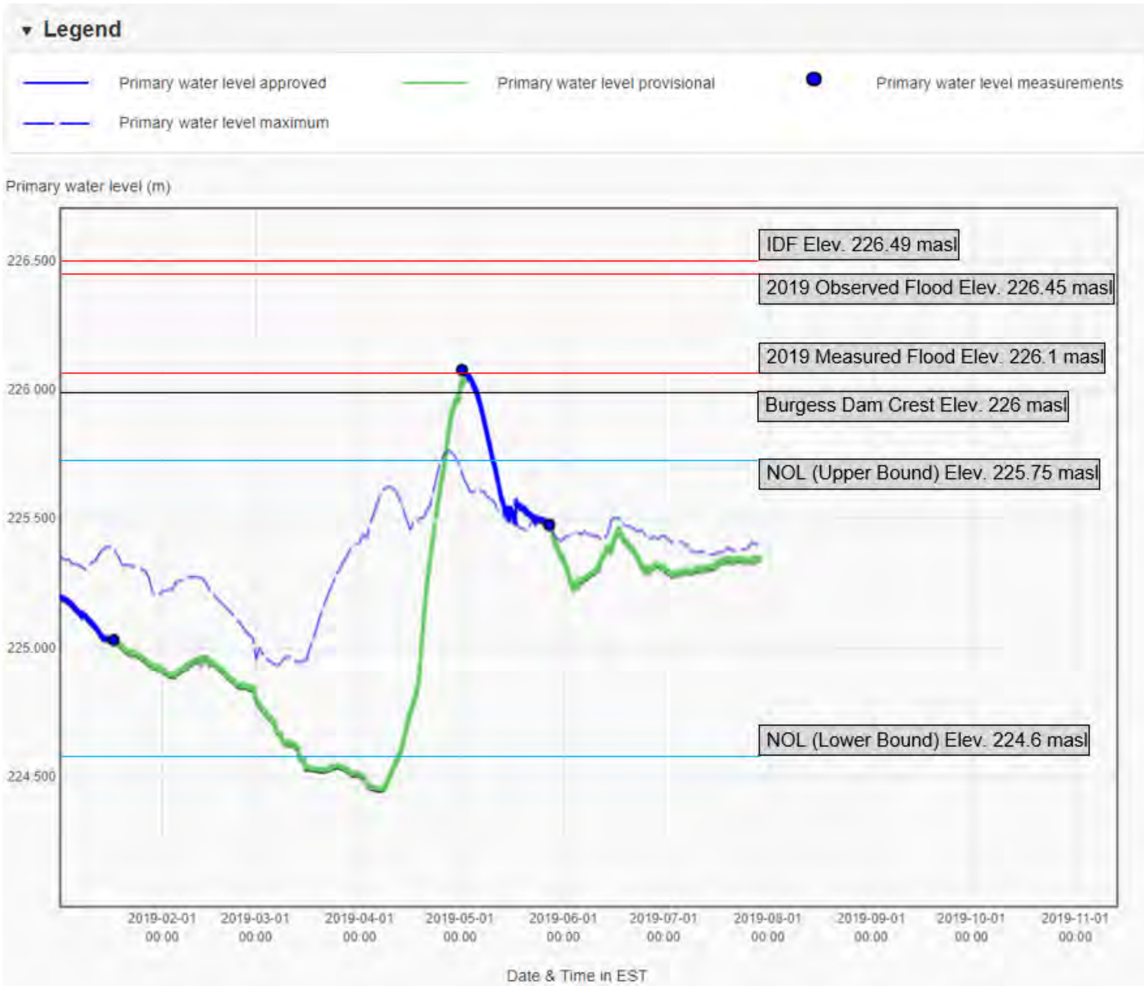

Figure 5-1: Burgess Dam 1 - 2019 Water Levels vs. NOL and IDF

As shown above, the selected IDF level relates to the 100-year Lake Muskoka (upstream water body) as provided directly by the MNR and selected as a conservative value for design. As discussed above in Section 4.0 the final non-overflow dam crest was selected to be EL. 226.50 m just above the IDF level to promote water flow through the spillway set at approx.. EL. 225.93 m, which corresponds to the original crest elevation of the existing dam.

5.3. Upstream Water Level Impact

As described in Section 4.0, the design intent for the rehabilitation for the Burgess 1 Dam is to undergo no change to the operational or generation capacity of the structure. As such, typical upstream and downstream water levels are expected to be maintained with no change in flow through the dam. The water allocation of 4m^{3}/s per the MRWMP will remain the same.

Under extreme flooding conditions (e.g. IDF), as the spillway invert has remained at the existing dam crest, water will begin to flow as before; however, it will be controlled and directed into the spillway channel and through to the tailrace, not randomly (uncontrolled) around the abutments as was experienced during the 2019 flooding event. Ultimate control of the flood flows will still continue to be managed by the North and South Bala Falls, which is the current operational procedure per the MRWMP. Further discussion on spillway sizing and anticipated water velocities is discussed below in Section 5.4.

5.4. Spillway Sizing and Flow Velocities

The Spillway sizing and geometry were assessed based on maximizing the spillway opening while channeling flow down the exposed bedrock tailrace downstream of the dam. Furthermore, the spillway channel walls were sized such that access to the powerhouse was maintained. The Hydraulic Calculations Spreadsheet attached in Appendix E of this report outlines the details of the hydraulic calculations for the spillway design. The following subsections summarize the methodologies and the results.

5.4.1. *Spillway IDF Flow*

The spillway was sized based on utilizing the givens outlined below:

- IDF Water Level = ELl. 226.49 m
- Dam Crest Elevation (Non-overflow) = EL. 226.50 m
- Spillway Sill Crest Elevation = EL. 225.93 m – this corresponds to the surveyed elevation of the lowest point of the original dam crest in the area of the spillway; due to the age of the structure, there is some minor variation across the crest.
- Spillway Bottom of Wall = EL. 224.25 m– Taken from the spillway cross section bedrock surface elevation. As shown in sections of the spillway in Drawing C3 Sections A1-A1 (Ch0+027.5) of the IFC drawings in Appendix A.
- Length of the weir crest used was 25m to determine a conservative flow rate Q.

The spillway flows were determined by using the Weir formula shown below in Equation 5-1

$$Q = C_w L H^{1.5} \qquad [Eqn\ 5-1]$$

Where

Q = Discharge over the Weir (m^3/s)

L = Length of Weir Crest (m)

H = Water head between Water Surface and Weir Crest (H_{max} = EL. 226.49 m – EL. 225.93 = 0.56 m, i.e. IDF water level – weir crest)

C_w = Weir coefficient taken as 1.84 for a sharp Crested Weir (Thin Overflow weir crest of 0.6m width for the dam)

From Equation 5-1, this maximum flow rate Q of 19.28 m^3/s was calculated. The spillway rating curve (Flow versus Water Elevation) is shown in the hydraulic calculations in Appendix E.

5.4.2. Spillway Channel Sizing and Flow Velocity

Spillway channel sizing was conducted specifically for the determination of the height of the training walls; furthermore, the approach below is also used to calculate flow velocity based on Manning's roughness for the rip rap. Equation 5-2, shown below, was used to determine the height of the water through the spillway channel with rip rap protection.

$$h = \left(\frac{nQ}{b\sqrt{S}}\right)^{\frac{3}{5}} \left(1 + \frac{2h}{b}\right)^{\frac{2}{5}} \qquad [Eqn\ 5-2]$$

Where

h = the normal water depth in the spillway (m)

n = Manning's Roughness Coefficient of rip rap taken as 0.045 (unitless)

S = Slope of Spillway taken at 0.125 based on a straight-line interpolation of the proposed spillway alignment and ground conditions. (unitless)

Q = Design Flow taken at 19.28 m3/s as described in Section 5.4.1 above

b = Width of the Spillway Taken as the minimum of 15 m of the spillway to determine the maximum flow velocity for conservative design through the spillway channel.

From Equation 5-2, an initial value of h is estimated and then the value is iterated until the equation is satisfied and the values agree. From the above, the depth of water in the spillway channel was determined to be 0.34 m.

A flow velocity can then be calculated using the water depth calculated above, multiplied by the width of the spillway channel; this area is then divided by the design Q of 19.28 m^3/s to achieve a flow velocity of 3.74 m/s. Full calculation sheets are presented in Appendix E.

The height of the spillway containment walls was then calculated to be 0.6 m, which allows for approximately 250 mm of freeboard. The maximum freeboard was selected to still maintain access to the powerhouse.

The flow velocity at the conclusion of the spillway channel chute was also calculated through riprap lined apron. The interstitial velocity through the rip rap at the end of the spillway was calculated using equation 5-3, shown below:

$$V_m = n_p \left(\frac{S_o g D_{50}}{K'}\right)^{1/2} \qquad [Eqn\ 5-3]$$

Where

Vm = interstitial velocity through rip rap (m/s)

np = Rip Rap Porosity taken as 0.46 for angular rip rap (Stephensen 1979)

g = Gravitational acceleration (9.81 m/s2)

K’ = Friction Factor – Taken as 4 for crushed rock

So = Slope of spillway taken at 0.125 (1V:8H) as discussed above.

D50 = Taken as 0.36 m as discussed in Section 5.5

The result is an interstitial velocity of 0.15 m/s, which translates to a velocity dissipation of approximately 96% from the initial velocity of 3.74 m/s above.

In summary, the spillway sizing has been maximized to the extent possible to allow for translation of the maximum flow safely through to the downstream tailrace during the IDF event based on the property constraints while still allowing access to the powerhouse. Water will flow over the overflow section, be slowed by the rip rap protected zone to the extent possible and be contained by the training wall anchored to the bedrock on either side of the spillway. The water will then be slowed again through the rip rap lined chute before approaching to the downstream creek. Erosion protection has also been added on the opposite bank to minimize the impact of high flows during activation. Detailed hydraulic calculations are shown in Appendix E of this report.

5.5. Rip Rap Sizing

The spillway rip rap sizing was completed utilizing the IDF flow and minimum 15 m width of the spillway channel for the purposes of conservative design. The rip rap was sized via a graphical method shown in Appendix E. A conservative slope of 25% was used to account for the steeper drop off near the end of the spillway channel. Furthermore, A small sensitivity analysis was conducted varying slope between 12.5% and 25%. This resulted in a rip rap D_{50} size changing between approximately 0.33 m and 0.37 m. Therefore, the rip rap size selected for the spillway channel was sized at a D_{50} of 0.37 m and a maximum size of 2 x D_{50} was used and rounded up to 750 mm. For the purposes of constructability, a tolerance of ± 50 mm was added to the drawing notes to allow for flexibility of the material selection. The thickness of the rip rap was based on the above sizing in the spillway channel, as shown in the IFC drawings attached in Appendix A of this report.

The above calculations were based on the maximum flows through the spillway channel; as such, for the purpose of conservative design, the same size and thickness of the rip rap will be used for erosion protection improvements on the opposite bank of the tail race as shown in Drawing C4 of the IFC Drawings in Appendix A.

Finally, a standard OPSS 1004 R-10 rip rap material will be used for the River Street drainage swale for erosion protection. The swale will be handling small amounts of flows from River Street to prevent water build up behind the proposed retaining walls. This erosion protection will not see flood flows and is designed to carry minor flows associated with localized run off from River Street. As such, a standard OPSS product has been selected.

6. DAM STABILITY ASSESSMENT

The following section will describe the stability calculations completed as part of the rehabilitation design of the dam structure. Stability calculations were completed for the three (3) main elements of the facility, including:

- Non-overflow section of the dam, Crest Elevation at EL. 226.5 m

- Overflow section of the dam, Crest Elevation at EL. 226.0 m (rounded from 225.93 m for purpose of calculation)
- Powerhouse Section of the Dam (section encompassing powerhouse and dam)

It should be noted that the calculations for the downstream cast in place retaining walls will be discussed below in Section 8 of this report.

The following subsections summarize the applied loading cases, assumptions and results for each of the above main segments of the dam for the proposed rehabilitation. Loading conditions were generally taken from the LRIA Technical Bulletin – Structural Design and Factors for Safety in which to check the dam.

6.1. Loading Cases and Assumptions

The stability calculations for the Burgess 1 Dam were based on four (4) main loading cases for the three (3) main dam segments. The loading cases discussed below were used from the LRIA Technical Bulletin, including:

- **Load Case 1:** Usual Load (summer) – Dead Load, Hydrostatic Load (Normal Operating Level), Sedimentation Load and Uplift
- **Load Case 2:** Unusual Load (Flood) – Dead Load; Hydrostatic Load (IDF Flood Level), Sedimentation Load, Uplift
- **Load Case 3:** Earthquake Load – Design Earthquake Load, Dead Loads, Hydrostatic Load (Normal Operating Water Level), Sedimentation Load, Uplift
- **Load Case 4:** Usual Load (winter) – Dead Load, Hydrostatic Load (Winter Operating Level), Ice Load, Sedimentation Load and Uplift

Per the Technical Bulletin, the unusual winter load and post-earthquake load were not included for the following reasons:

- Per the LRIA Technical Bulletin, unusual winter loading cases do not apply to existing low and moderate hazard potential classification concrete gravity dams, where operating conditions are not anticipated to change. As such, given the HPC of the Burgess Dam as being Low, and with the intent to not change operational capacity or processes this loading case was not included in the stability evaluation.

- Earthquake or post earthquake stability assessment does not need to be undertaken for existing dams that have a low or moderate hazard classification under a sunny day failure. As a function of conservative design checks, TULLOCH performed a stability check under earthquake loads. However, the PGA value in Bala is very low, and this loading condition was found not to govern. As such, post earthquake stability assessment was not considered for further evaluation.
- Water levels used for Case 3 and Case 4 were the NOWL and Winter Operating level respectively per the LRIA guideline. The NOWL was taken at El. 225.75 m and the upper the upper bound of the winter operating level based on available historic data of El. 225.6 masl was used for the purpose of conservative design calculations.

Stability calculations under the four (4) load cases are provided attached in Appendix F of this report. With respect to the calculations, Table 6-1 summarizes the parameters used for the provided analyses.

Table 6-1: Summary of Geotechnical Parameters Stability Calculation

No.	Type of Material	Cohesion, c' (kPa)	Internal Friction Angle, φ' (Degree)	Unit Weight, γ' (kN/m^3)
1	Dam Unreinforced Concrete	0	50	23.58
2	D/S Fill Material	0	35	19
3	Concrete-to-Bedrock Interface	290	40	20

The values provided are based on conservatively assumed values and engineering judgment. The concrete to bedrock interface cohesion was derived from the type of bedrock observed on site (granitic gneiss) and studies conducted under similar geological conditions. A memorandum explaining the in-depth rationale behind the concrete/rock interface parameters is provided in Appendix G.

Additional inputs and relevant assumptions for the attached calculations are presented below:

- Dimensions for the dam were taken from the historic drawings completed by Totten Sims Hubicki Associates and verified in the field during inspections. Where the drawings were insufficient, field measurements were taken.

- Operating water levels for the various load cases were taken from the Muskoka Watershed Management Plan specific to Burgess Dam.

- The design earthquake load was taken as a 1/500-year event per the LRIA Technical Bulletin for an HPC hazard of Low. The PGA value used is based on the site-specific National Building Code of Canada Values.

- Per the LRIA Technical Bulletin the Resultant method is employed as a check to ensure that the resultant forces are within the middle third of the dam surface being analyzed for usual load cases. For unusual loading cases, the resultant force can be outside the middle third of the dam cross-section but within the base of the dam. TULLOCH reviewed the resultant method as part of the factor of safety calculations presented in this report; however, the Burgess Dam is a thin (0.6m in width) water retaining structure compared to typical concrete gravity dams with a mass concrete geometry, which the sufficient FOS of the stability can be achieved by the self-weight (i.e. Gravity force) of the dam body. This, however, is not feasible based on the dimensions of Burgess. As such, without substantial build out to the dam, which would be neither economical nor reasonable, the resultant will fall outside the dam sections.

- Due to a lack of as-built information for the existing Burgess Dam, it is unknown whether the Burgess Dam was keyed into bedrock or anchored to bedrock during its construction back in 1917. Calculation of the location resultant force can not be completed without original as-built information.

- Finally, it was considered that the current rehabilitation design does not change the existing foundation condition of the dam, has minimal dam geometry upgrades (i.e. 0.5m raising for part of the dam) and has potential improvements to dam stability at the downstream side, including the addition of riprap and spillway concrete guide walls which will effectively locally buttress the dam section. As such, the location of the resultant forces will not be an issue based on our best engineering judgment.

6.2. Stability Results Summary

The proposed rehabilitation measures indicate that the dam will meet the required Factor of Safety based on the above inputs, assumptions and LRIA Technical Bulletin required minimums. Table 6-2, shown below, summarizes the stability results for each of the three (3) main dam segments under the above-mentioned loading conditions.

Table 6-2: Analyzed Cases and Applicable Stability Criteria

Case	Description	Water Level (m)	LRIA Minimum FOS (Sliding) Unbonded	FOS-Sliding	FOS-Overturning
Non-Overflow Dam Section					
1	Usual Load (Summer)	225.75	1.5	55.80	57.30
2	Unusual Load (Flood)	226.49	1.3	22.84	18.67
3	Earthquake Load (NOWL)	225.75	1.1	55.50	56.73
4	Usual Load (Winter)	225.6	1.5	5.83	4.60
Overflow Dam Section					
1	Usual Load (Summer)	225.75	1.5	46.53	33.08
2	Unusual Load (Flood)	226.49	1.3	9.53	10.78
3	Earthquake Load (NOWL)	225.75	1.1	23.16	33.17
4	Usual Load (Winter)	225.6	1.5	4.86	2.66
Powerhouse Section					
1	Usual Load (Summer)	225.75	1.5	1.5 (with 2 anchors)	2.04
2	Unusual Load (Flood)	226.49	1.3	1.3 (with 4 anchors)	1.67
3	Earthquake Load (NOWL)	225.75	1.1	1.12	1.74
4	Usual Load (Winter)	225.6	1.5	1.5 (with 9 anchors)	1.5 (with 9 anchors)

Furthermore, the governing section was found to be the powerhouse largely due to the large crack encountered through the base of the section. As such post tensioned anchors were required to meet FOS requirements under all but the seismic load case. Further discussion on the post tensioned anchors is provided below in Section 6.3. Detailed calculation sheets for all load cases shown above can be found in Appendix E.

6.3. Post Tensioned Anchors for Powerhouse

Post tensioned DYWIDAG anchors have been proposed for the rehabilitation of the powerhouse to achieve two (2) main purposes:

1) To pin the top and lower portion of the powerhouse together so it can act again as a monolithic structure.

2) Pin the entire powerhouse to the bedrock and increase the stability of the structure against rotation and sliding.

Without anchoring, as shown in the calculations under load cases 1 through 3 as described above in Table 6-2, the powerhouse was deemed marginally safe, and the LRIA minimum FOS was not met. This was largely due to the conservative assumption that only the concrete above the crack was acting to resist the dam from sliding and overturning. As such, the addition of anchors was required.

The number of calculated anchors was iterated through each load case until the maximum number was required under the Usual Ice Loading Case. A total of 8.3 anchors was theoretically required based on the calculation. Calculations for the anchors were based on pull out failure cones from mechanical anchors. In order to meet the most conservative case a total drill depth of 5.0 m was required through the concrete and into the competent bedrock. This total amount of anchors was rounded up to nine (9) to achieve the required FOS.

In order to achieve the required FOS under the LRIA requirements, nine (9) anchors will be installed through the powerhouse to allow for the rehabilitation of the structure and remediation of the crack. Detailed anchor requirement calculations are provided in the stability calculations in Appendix F.

During the initial phases of the detailed design phase, post tensioned anchors were also considered for the non-overflow and overflow sections of the dam; however, based on the age of the concrete and thin sections of the dam, it was believed there was/is a significant risk that post tensioning anchors on the thin wall section of the dam could cause cracking or material failure of the concrete. This, in turn, would be extremely difficult to remediate without replacing the dam and could also lead to potential failure during construction. As such, the installation of post tensioned anchors outside of the powerhouse was not considered further in the design.

7. STRUCTURAL REHABILITATION DISCUSSION

The following sections will detail additional rehabilitation measures for the powerhouse to improve upon the existing structure while maintaining the ability to generate power.

7.1. Roof Replacement

The roof consists of an aging wood framed structure; it is not clear when it was constructed; however, we know it post dates the original construction as it is framed with dimensional lumber, and some joists have been sistered. There is no record or documentation of roof replacement or rehabilitation, so we cannot determine the date of construction. The current roof water proofing consists of polyethylene sheeting over the exterior roof weighed down by various debris.

Given the poor condition of the existing roof, it will be replaced with a new wood framed structure supported by steel beams and bracing, outlined below in Section 7.2. The roof will consist of 2 x 12 wood joists spaced at 16” o.c. supported by a Steel W8 x 40 central beam. Two (2) access hatches will also be incorporated into the roof to access the turbines in the future, should additional retrofits, repairs or rehabilitation be required. Details on the proposed roof replacement can be seen on Drawing S4 and S5 of the IFC Drawings in Appendix A.

7.2. Steel Bracing and Concrete Pads

The existing steel bracing on the powerhouse was noted to be corroded at the connection to the floor of the powerhouse due to the regularly wet environment within the powerhouse. As such, the integrity of the bracing has been compromised and will require replacement. The proposed rehabilitation will address this by replacing the bracing with a series of W6x15 columns anchored to the powerhouse wall. The braces will be placed on reinforced concrete pedestals to prevent future corrosion and extend the design life of the bracing as part of the rehabilitation efforts. Steel bracing will also be added in the middle of the powerhouse to replace the aging mid span column in a similar fashion.

7.3. Powerhouse Grouting

During the inspection of the powerhouse, undermining and erosion were noted around the tailrace bays of the facility, likely caused by facility operation over time. The areas of erosion will be backfilled with non-shrink grout to rehabilitate the area and prevent further erosion/undermining. This work will be planned during the construction of the retaining walls when the downstream area is de-watered and the head gates have been closed for construction. Proposed grouting areas are shown in Drawings sheet S5 in the IFC Drawings. Actual areas will be determined when the area is de-watered and inspected.

7.4. Post Tensioned Anchors

Anchors will be added to the powerhouse, as discussed above in Section 6.3. The anchors will be drilled into competent bedrock, grouted and post tensioned. A total of nine (9) DYWIDAG Strand anchors are proposed for the rehabilitation as shown on Drawing sheet S4 and S5 of the IFC Drawings in Appendix A.

8. RETAINING WALL REPLACEMENT AND REHABILITATION

As discussed above in Section 4.3, one of the major components of the rehabilitation effort is to rehabilitate the downstream north slope of the dam. The existing concrete retaining wall is in poor condition with significant cracking, and the stacked boulders and gabion baskets are also in poor condition. As part of the rehabilitation efforts, the existing concrete wall, boulders, and stacked gabion baskets will be removed, and the area will be excavated to the competent shallow bedrock surface.

Cast in place concrete retaining walls will be pinned to the bedrock surface to act as both a retaining and training wall. The retaining walls will improve the stability of River Street and also enhance the erosion protection along the north bank that sees regular flows during the operation of the generating station. The maximum estimated height for the retaining wall will be approximately 6.95 m from the river bottom to the top of the wall, with a pinned base width of 3.0 m. Once cast, the walls will be backfilled with compacted free draining granular fill. A subdrain has also been installed behind each wall to promote drainage and prevent build up of hydrostatic pressures.

Stability calculations were completed on the wall with the following main assumptions and parameters shown below in Table 8-1

Table 8-1: Summary of Geotechnical Parameters Stability Calculation

No.	Type of Material	Cohesion, c' (kPa)	Internal Friction Angle, φ' (Degree)	Unit Weight, γ' (kN/m^3)
1	Dam Unreinforced Concrete	0	-	24
2	U/S Backfill	0	38	22

The critical section where the retaining wall will be highest was analyzed in sliding and rotational failure. A summary of the calculated safety factors is provided below. It should be noted that bearing failure for the wall was not considered, as the retaining wall will be supported on the competent bedrock surface.

Table 8-2: Retaining Wall Stability Analysis

Description	FOS Minimum Sliding	FOS Minimum Overturning	FOS-Sliding	FOS-Overturning
Retaining Wall – Critical Section	1.5	2.0	4.01	3.30

As shown above, the proposed retaining wall is considered safe at the critical section, with the Factor of Safety exceeding the typical minimum requirements. Detailed calculations regarding the wall stability and design calculations are provided attached to this report in Appendix H of this report.

9. EROSION AND SEDIMENT CONTROL

An erosion and sediment control plan has been developed for the rehabilitation efforts. The plan shown in the IFC Drawings on Drawing Sheet E1 in Appendix A of this report.

Generally, ESC measures on the plan include the following key measures:

- Siltation control via perimeter silt fencing installed per OPSD 219.130
- Turbidity curtains are to be placed along the upstream impacted areas at the north upstream head pond along River Street and at the southern dam abutment where the dam will be extended.
- Temporary coffer dams are also envisioned at the north embankment wall near the north abutment of the dam, southern dam extension, and at the downstream perimeter of the works within the tail race channel. Generally, the presence of shallow bedrock is anticipated, and if the work can be done during low water levels, significant coffer damming is not anticipated.
    - For the North abutment and southern extension, the lower bound normal operating level is approximately EL. 224.60 m, the inferred bedrock elevation will likely be above the water level at the time of construction. As such, extensive coffer damming is not anticipated.

- For the tail race section, in the summer months, when the head gates have been closed for dam maintenance, the tail race section has historically been observed to be dry to near dry. As such, significant coffer damming is not anticipated in the downstream tailrace.
- While temporary measures and construction schedule are the responsibility of the successful contractor, coffer dams consisting of polyethylene wrapped sandbags are anticipated (likely less than 1.0 m in height).

- If required for de-watering sediment traps via sediment control bags is anticipated to prevent sedimentation of the waterway during de-watering. De-watering is anticipated to be limited in scope for similar reasons that extensive coffer damming is not envisioned.
- No threshold value for sediment monitoring is proposed at this time, as no ongoing monitoring for turbidity will be undertaken downstream of the work site. The Contractor will monitor the work area, and any suspended sediment identified downstream will result in works temporarily stopping. At this point, ESC measures will be inspected, and additional isolation / ESC measures will be installed to prevent further downstream sediment transport. If the sediment release constitutes a spill, the MECP will be notified. Work will only commence once the work area is secured and stabilized, and the risk for further downstream sediment transport has been eliminated or mitigated.

9.1. Dewatering

De-watering is anticipated to be completed via small sump and pump operations at the Contractor’s discretion based on their de-watering plan, which will be submitted to the Township and TULLOCH prior to start of construction. De-watering plans will be submitted to the MNR for review prior to start up.

A water by-pass is not considered necessary for the rehabilitation directly at Burgess as upstream water can flow around the Burgess site via the North and South Bala Falls Dams, which effectively acts as a by-pass for the structure.

Finally, it should be noted that temporary works associated with construction, such as but not limited to temporary de-watering coffer damming and the like, is considered the successful contractor's responsibility. The necessary documentation and plans for temporary works shall be submitted to the Township and TULLOCH for review and submitted for approval from the MNR as part of the LRIA permitting process.

10. ENVIRONMENTAL IMPACT ASSESSMENT

As part of the EA process an Environmental Impact Assessment (EIA) was completed for the site. The EIA consisted of a desktop study and field visit to help determine potential environmental concerns, impacts and mitigation strategies for the proposed rehabilitation of the structure. The EIA report, which formed part of the EA Project File Report, was originally completed with the preliminary design of the structure in mind. An updated version reflecting the current proposed rehabilitation of the dam as presented in the IFC drawings is attached in Appendix I of this report.

11. CONSTRUCTION SCHEDULE

A preliminary construction schedule has been provided as part of this report. It should be noted that ultimately, the contractor will be responsible to provide a construction schedule in advance of the works to the Township and TULLOCH for review.

Given the above, the attached Gantt chart shows key tasks, milestones and estimated durations for the project and is attached in Appendix J. A proposed start date of July 7, 2025, has been established as a placeholder at the time of writing this report. However, if permitting and tendering can be conducted faster it is the intent of the project to begin as soon as practical in 2025.

12. DEPARTMENT OF FISHERIES AND OCEANS PERMITTING

The Department of Fisheries and Oceans (DFO) was engaged for permitting the proposed rehabilitation project. Upon review from the DFO biologists and team, the proposed construction, as presented in the IFC drawings has been accepted. The DFO has provided a letter outlining standard measures and mitigations, which was issued to the Township and will be shared with the selected contractor prior to conducting the work. This letter was issued on April 25, 2025, and is attached for review in Appendix K of this report, along with relevant correspondence with the DFO prior to issue of the letter.

13. SUMMARY AND CLOSURE

In conclusion, the proposed rehabilitation of the Burgess 1 Dam is required to help address deficiencies noted in the Dam Safety Review and to implement the preferred solution determined from the MEA Class Schedule B Environmental Assessment of rehabilitating the dam and powerhouse. The proposed rehabilitation will address the following key identified issues:

- Address freeboard and flood capabilities of the dam by raising the non-overflow section and creating an emergency spillway to allow for better management of flood flows.

- Extend the dam and raise River Street to prevent uncontrolled release of water during the Inflow Design Flood Event.
- Address structural and stability issues identified with the powerhouse.
- Rehabilitation of the downstream north slope area to improve stability, water management and erosion control.

The rehabilitation of Burgess will allow an often overlooked but critical piece of infrastructure within the Muskoka River Watershed to extend its life and to handle increasingly variable climatic conditions.

This report has been prepared by TULLOCH for the exclusive use of the Township of Muskoka Lakes and their authorized agents for submission to the Ministry of Natural Resources for permitting under the Lakes and Rivers Improvement Act. This report should be read in conjunction with the Notice to Reader attached in Appendix L of this report, which forms an integral part of this document.

We trust that the information in this report will be sufficient to allow for permitting to continue and allow this project to enter into tendering and construction. Should further elaboration be required for any portion of this project, we would be pleased to assist.

Prepared By:
Erik Giles P.Eng.
Geotechnical Engineer

Reviewed By:
George Liang, PhD., P.Eng.
Sr. Geotechnical Engineer

Frank Palmay P.Eng.
Structural Engineer

Kelvin Cheung P.Eng.
Geotechnical Engineer

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APPENDIX A

IFC DRAWINGS

TOWNSHIP OF MUSKOKA LAKES

LITTLE BURGESS GENERATING STATION

1 BAILEY STREET

PORT CARLING, ONTARIO

KEY PLAN
SCALE=1:1000

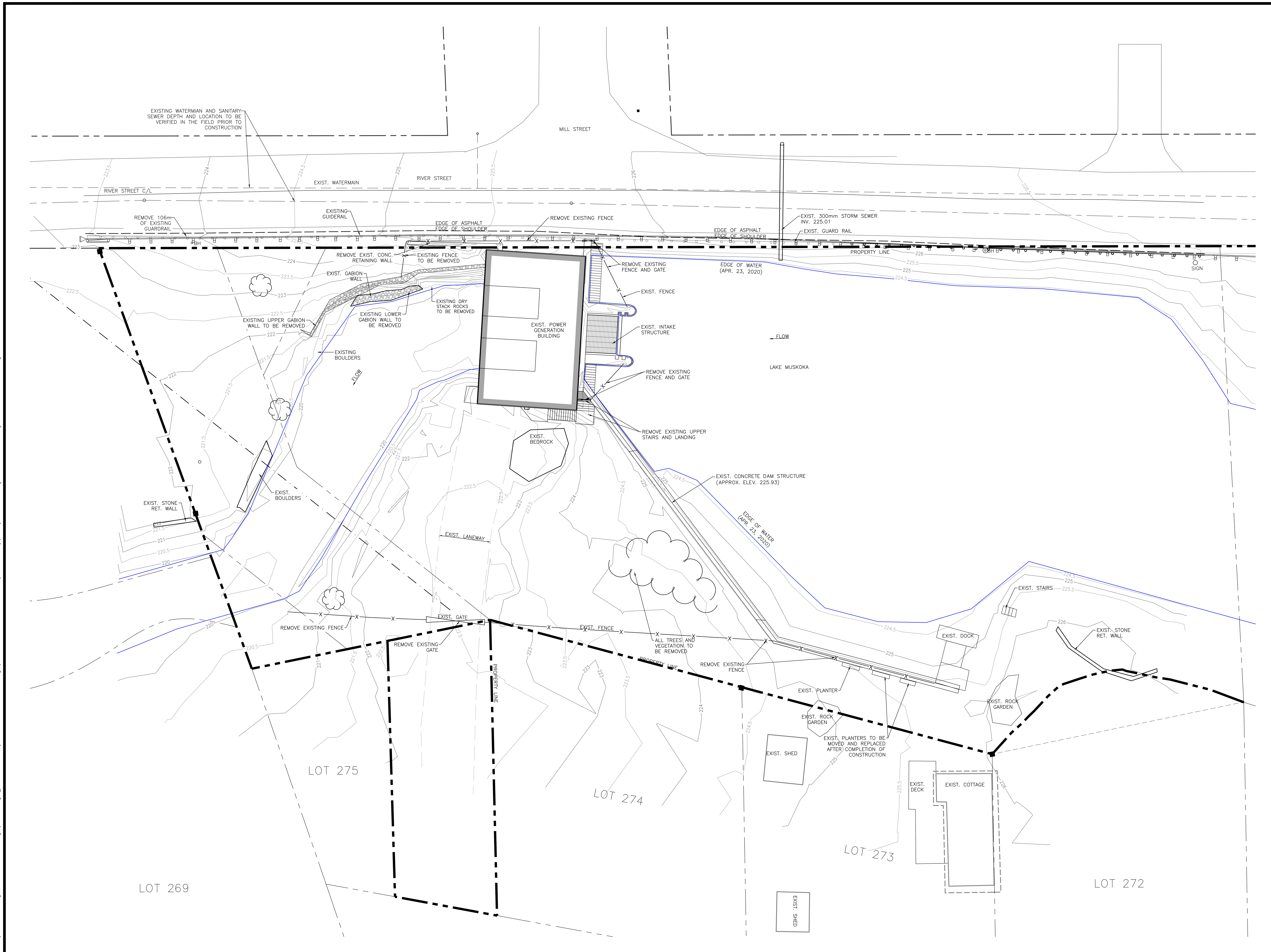
LIST OF DRAWINGS

No.	Rev.	DRAWING DESCRIPTION
C1	7	Existing Conditions & Removals
C2	7	Spillway Plan
C3	7	Spillway Sections & Details
C4	7	Spillway, Dam Raise & Dam Extension Plan
C5	7	Spillway, Dam Raise & Dam Extension Section & Details
C6	7	Concrete Embankment Wall
C7	7	Laneway Grading & Details
C8	7	River Street Road Reconstruction Plan & Profile Sta. 0+940 to 1+091
E1	7	Sediment & Erosion Control Plan
S1	3	General Arrangement, Elevations & Retaining Wall Detail
S2	3	Retaining Wall Sections
S3	3	Foundation Upgrades & Roof Framing Plans
S4	3	Foundation Upgrades & Roof Framing Details
S5	3	Removal Photos
G1	7	General Notes

TOWNSHIP OF MUSKOKA Lakes

TULLOCH

PROJECT No. 23-1236



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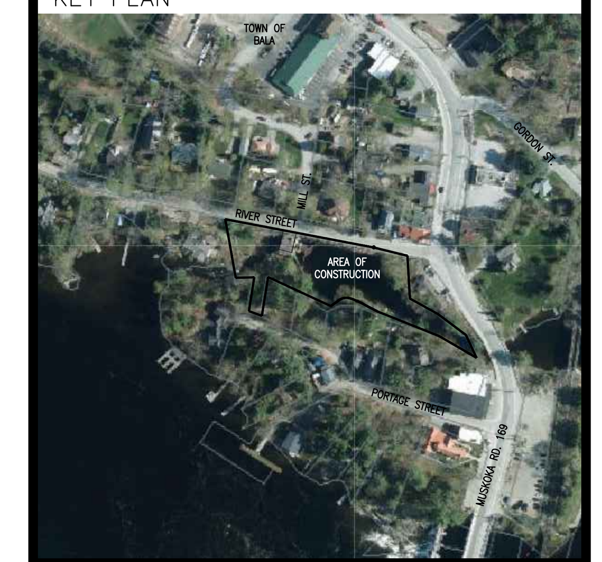
KEY PLAN



ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER E. K. GILES 100206670 JUNE 25, 2025 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER Y. LIANG 100145939 2025-06-25 PROVINCE OF ONTARIO

DATE (DAY/MTH/YR.)	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	HD	EG
16/05/2025	6	ISSUED FOR TENDER	HD	EG
06/26/2024	0	ISSUED FOR FINAL REVIEW	HD	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

EXISTING CONDITIONS & REMOVALS

HD	FP	FP	FP
DRAWN	DESIGNED	CHECKED	APPROVED

1:150	JUNE 25, 2025
SCALE	DATE

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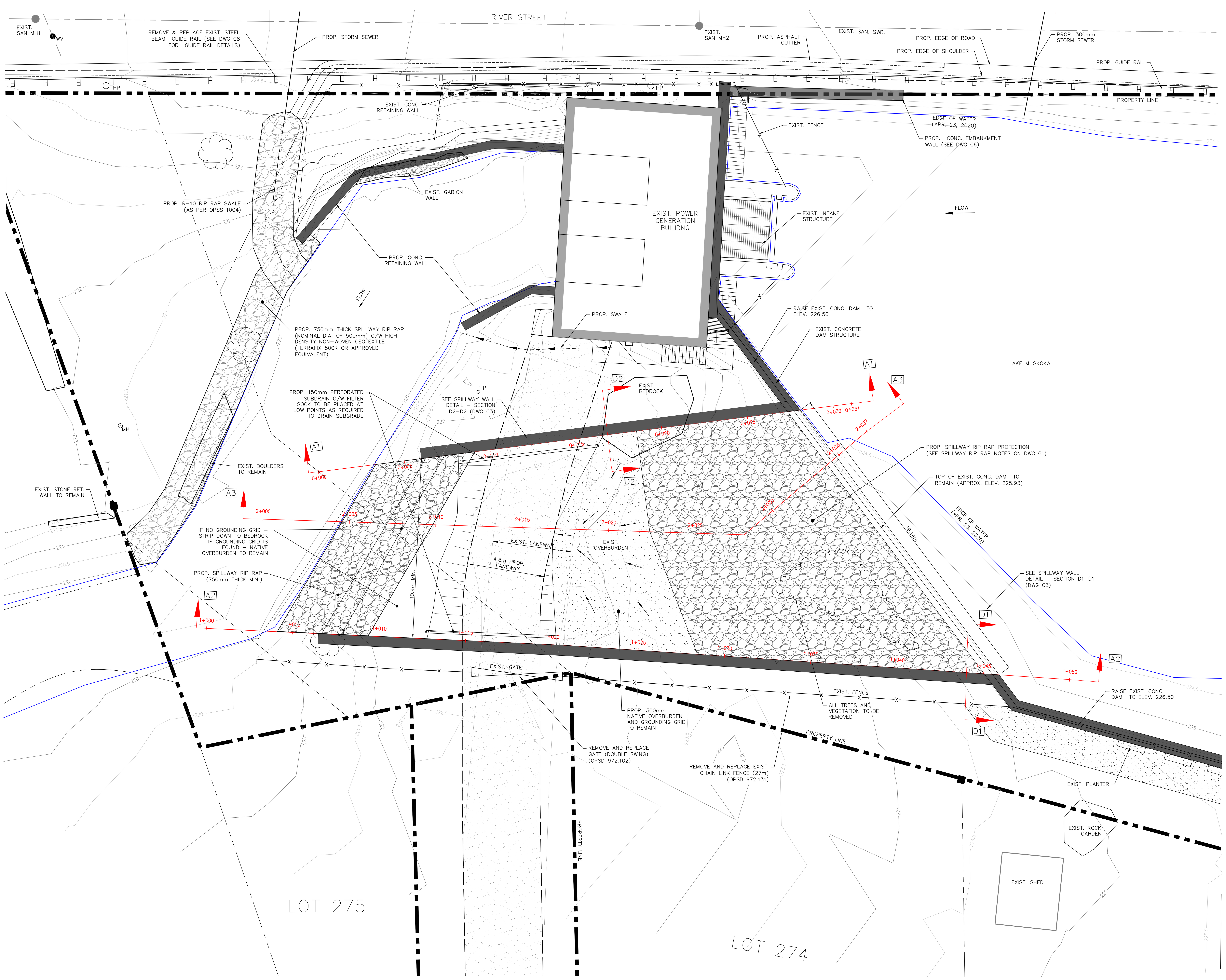
PROJECT No.	REVISION	DRAWING



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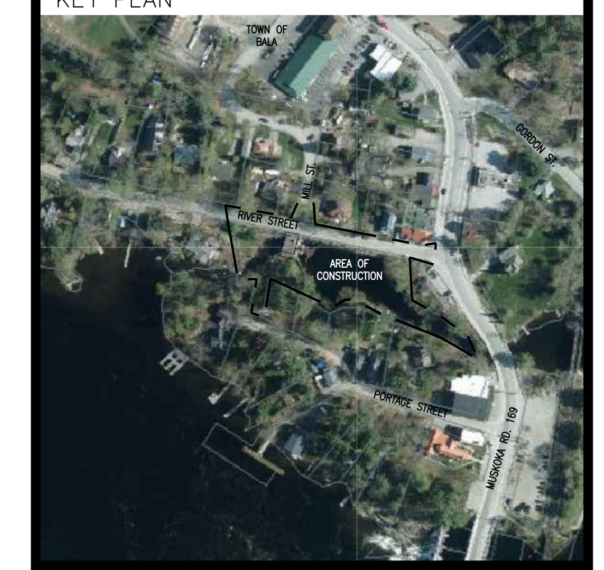

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05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

SPILLWAY PLAN

DRAWN	DESIGNED	CHECKED	APPROVED
DR	EG	EG	EG

SCALE	DATE
1 : 100	JUNE 25, 2025

PROJECT No.	REVISION	DRAWING
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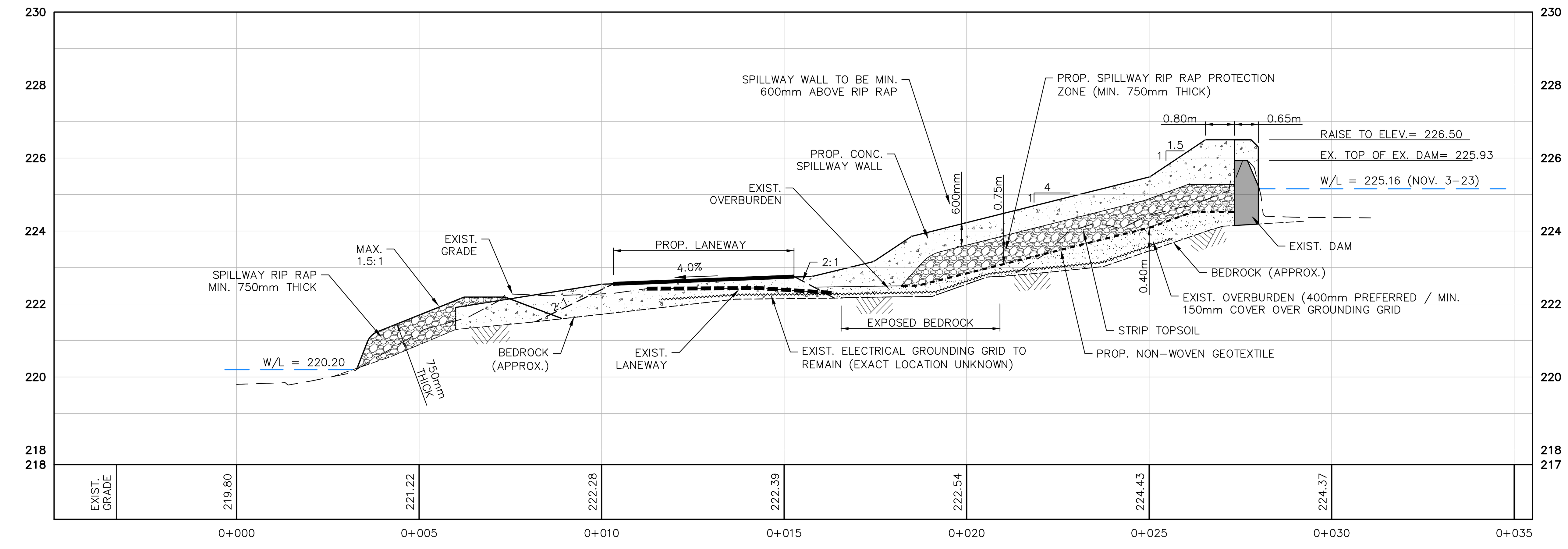

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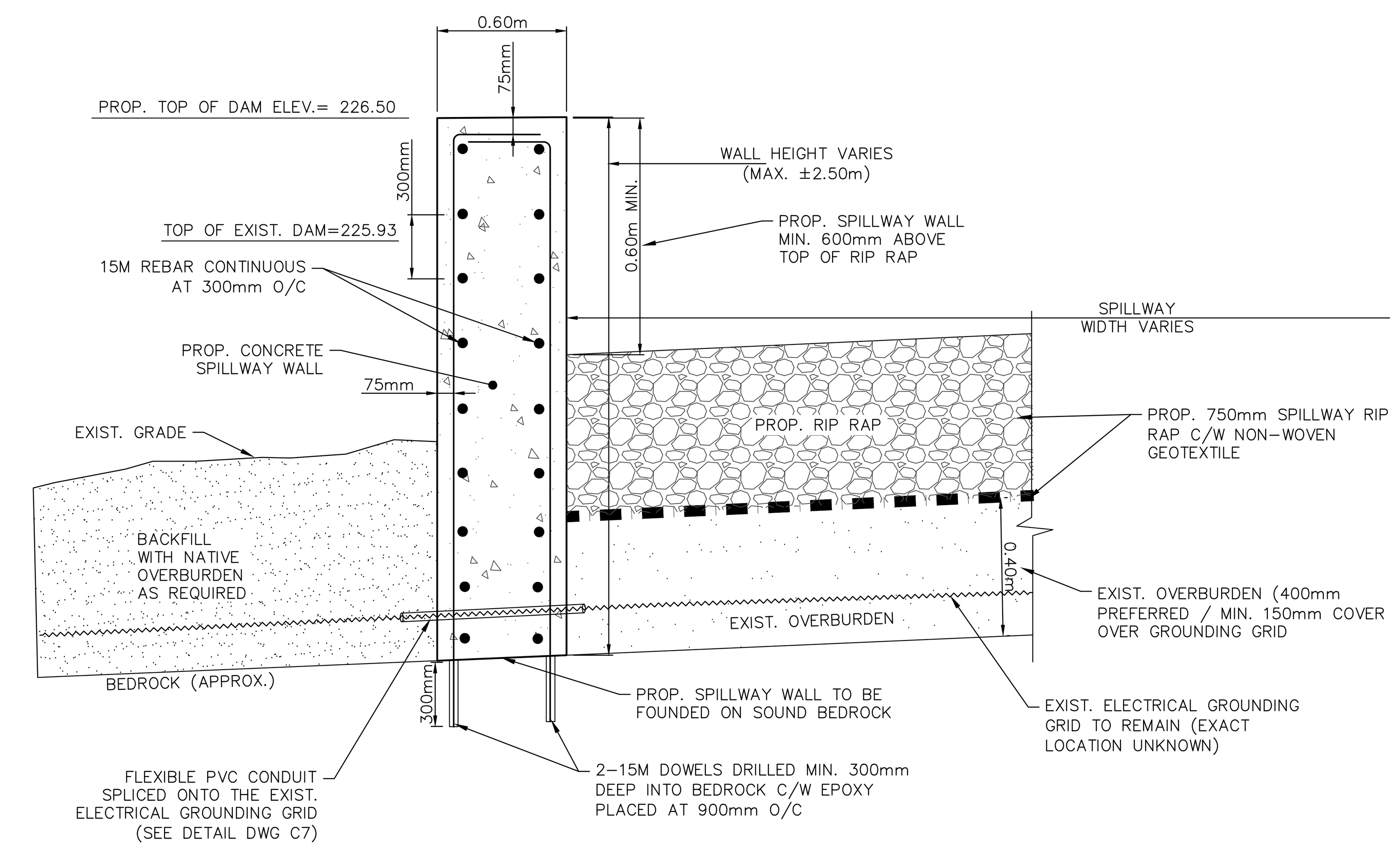

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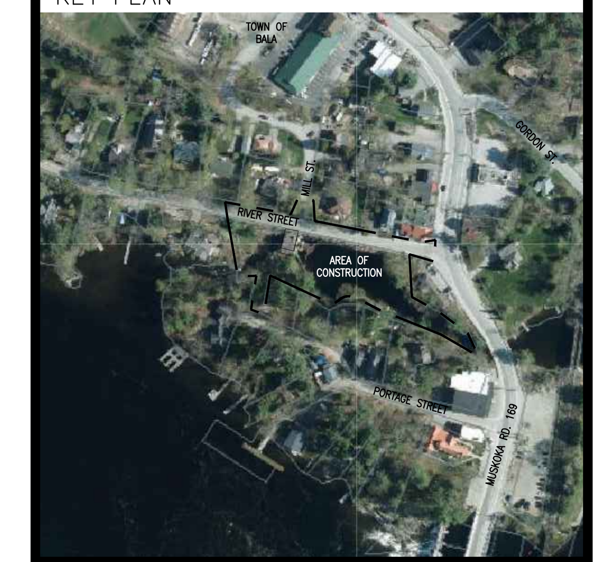
SPILLWAY WALL DETAIL
SCALE 1:25



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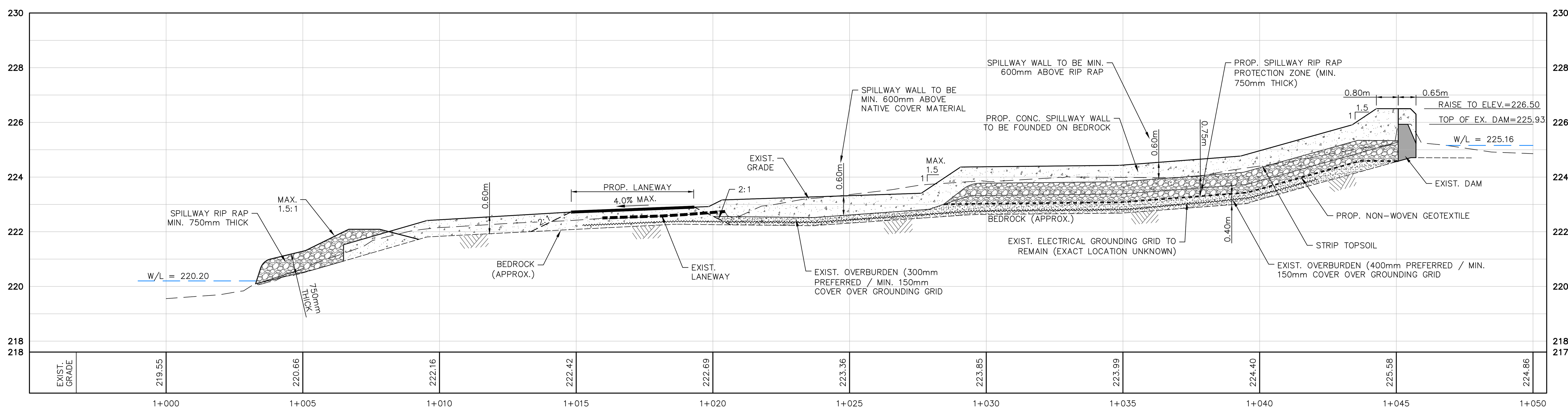

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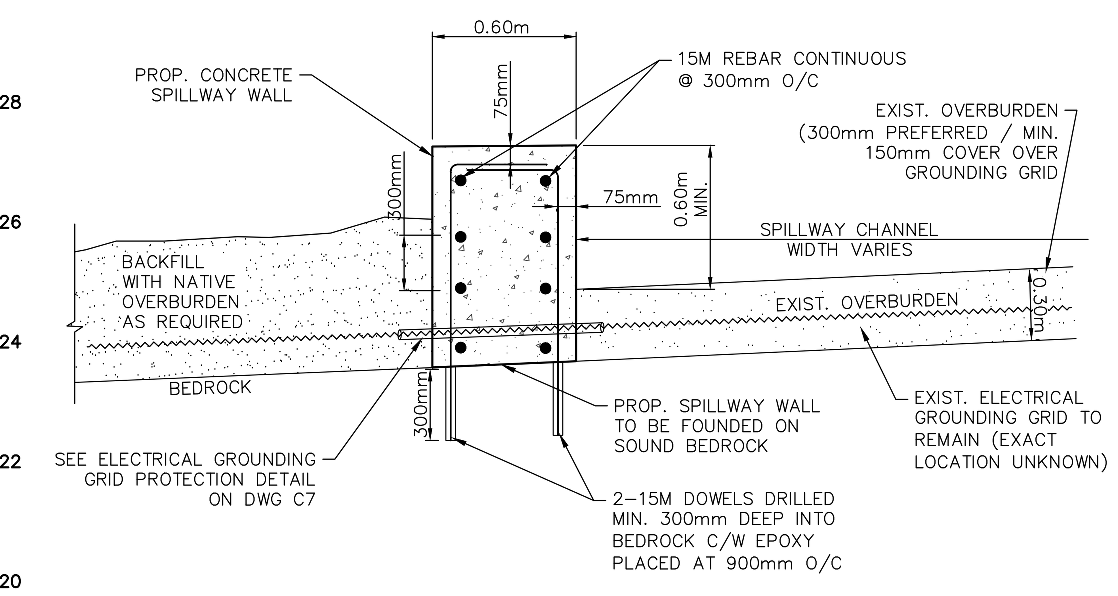

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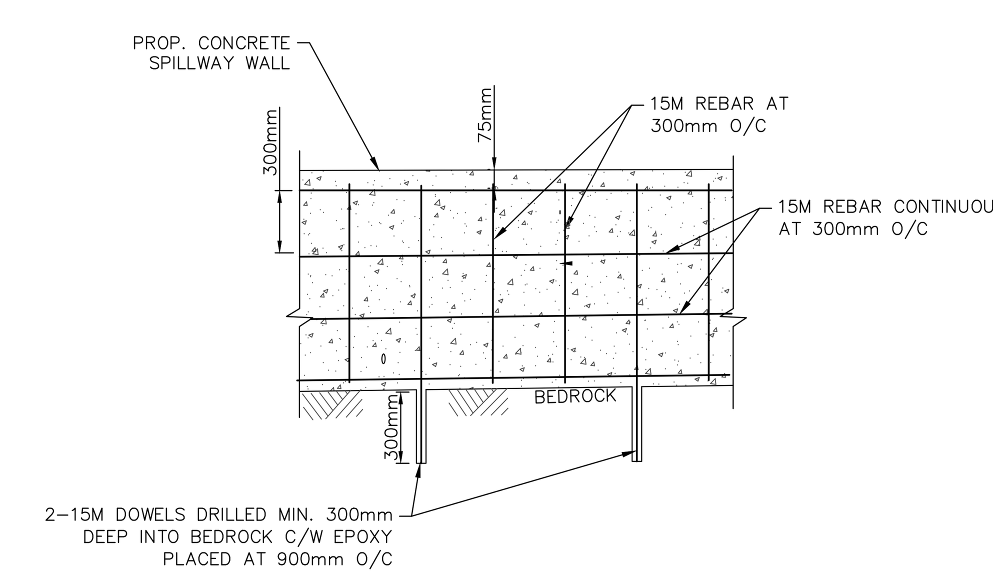
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario



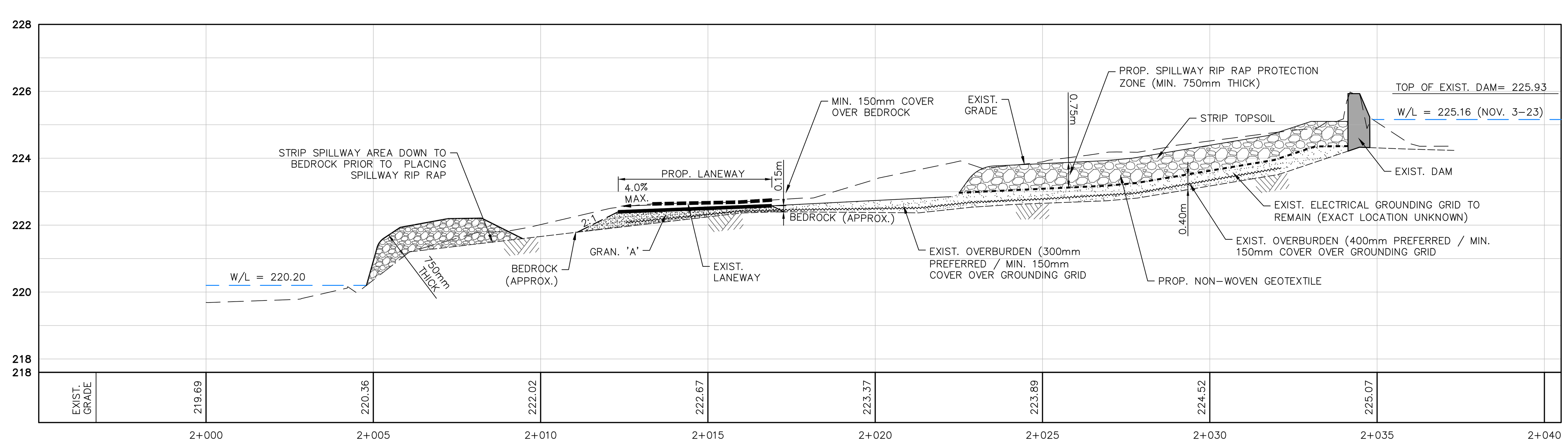
SPILLWAY WALL LONGITUDINAL VIEW
SCALE 1:25

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB



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DRAWING TITLE:

SPILLWAY SECTIONS AND DETAILS

DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED

1 : 100	JUNE 25, 2025
SCALE	DATE

23-1236	7	C3
PROJECT No.	REVISION	DRAWING

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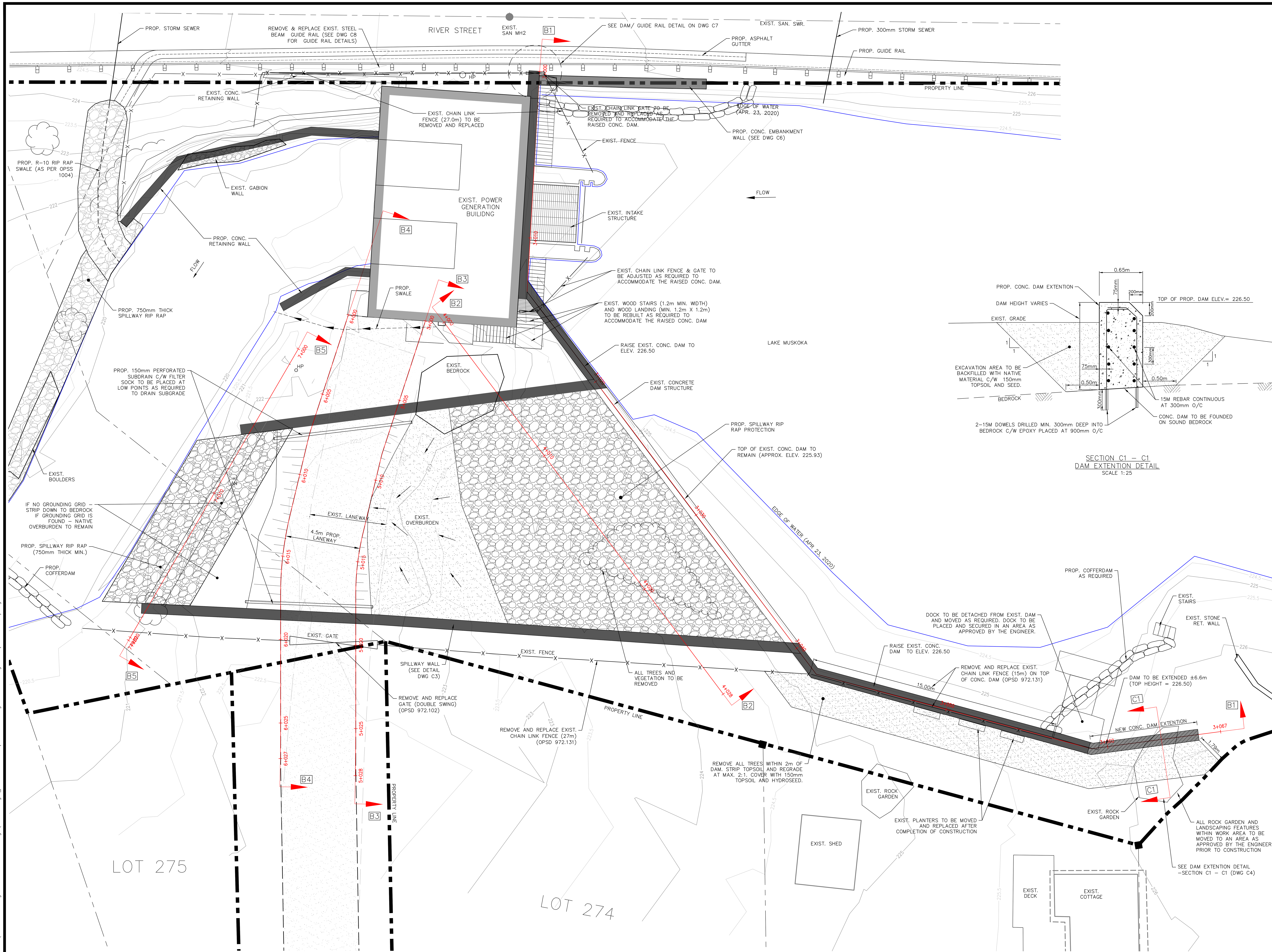

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KEY PLAN

ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER E.K. GILES 100206670 JUNE 25, 2025 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER Y. LIANG 100145939 2025-06-25 PROVINCE OF ONTARIO

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05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

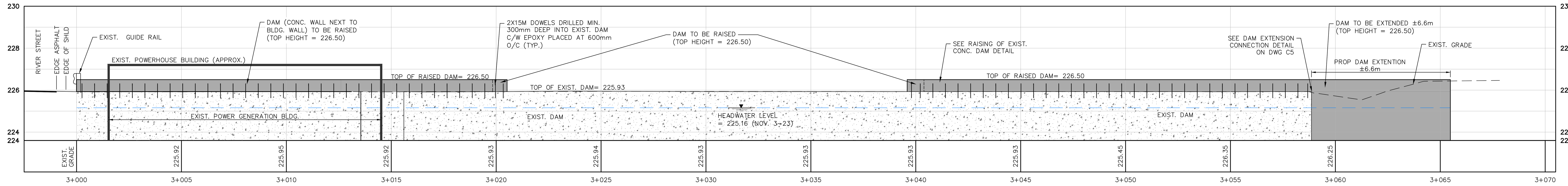
DRAWING TITLE:

SPILLWAY, DAM RAISE AND DAM EXTENSION PLAN

DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED

1 : 100	JUNE 25, 2025
SCALE	DATE

23-1236	7	C4
PROJECT No.	REVISION	DRAWING



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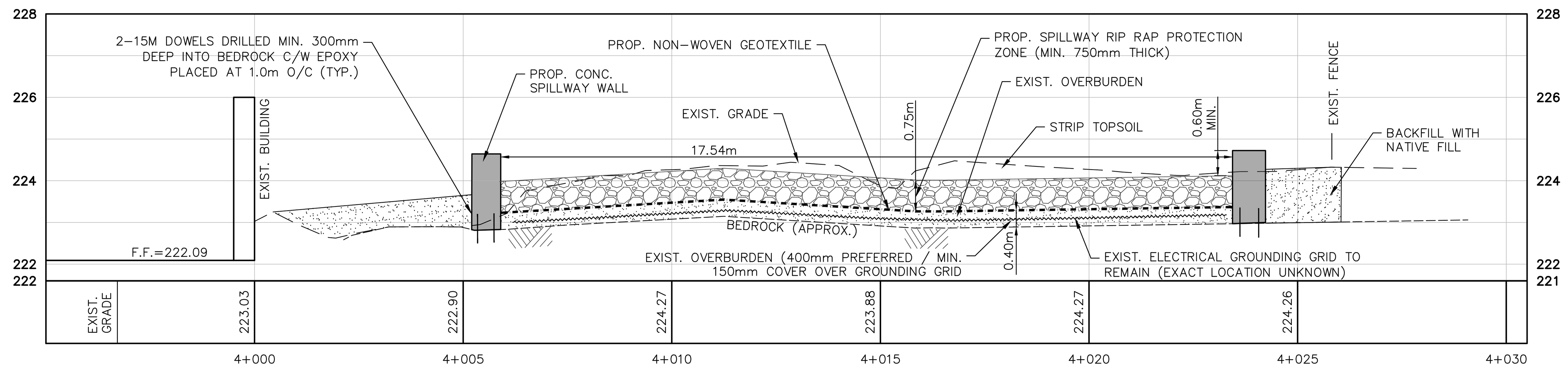

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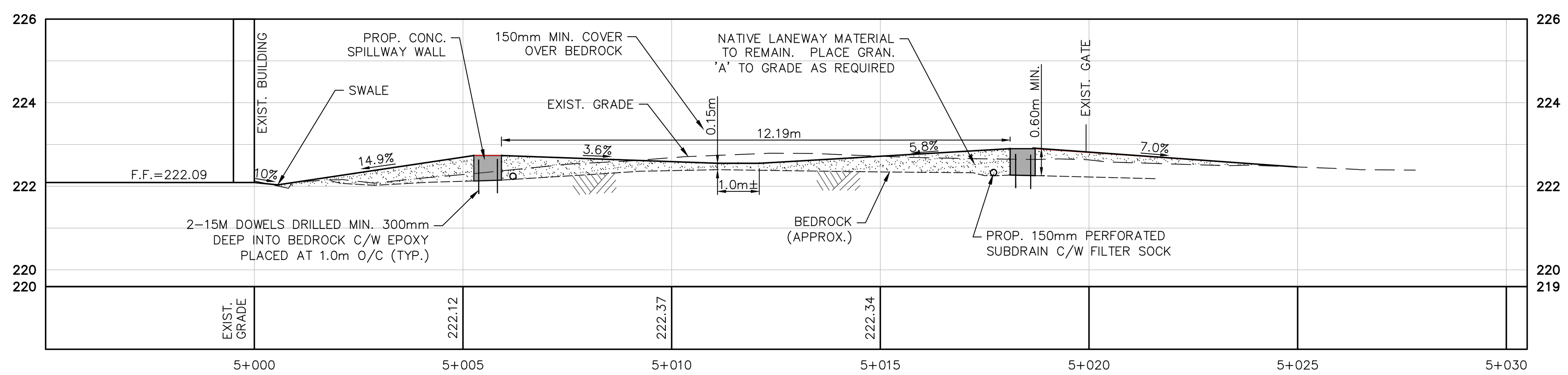

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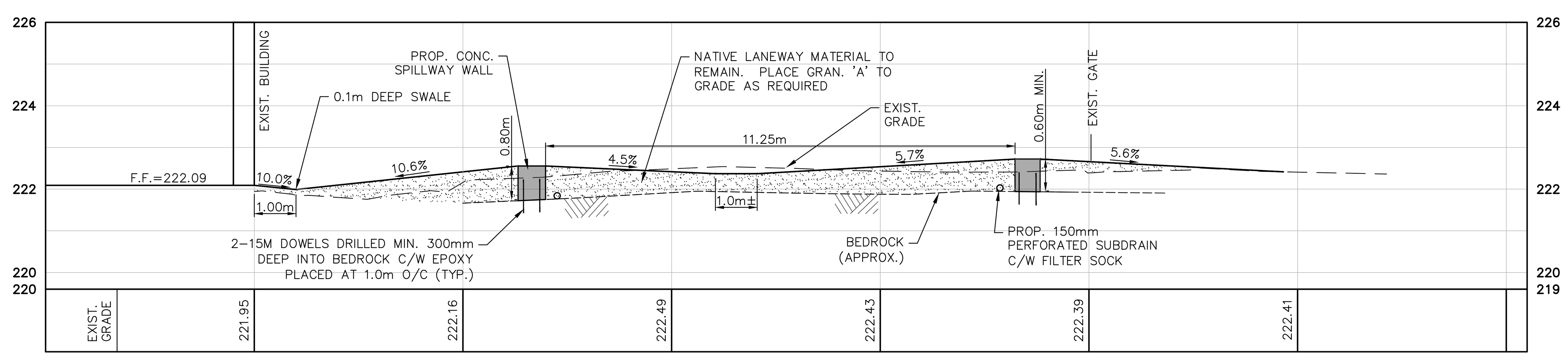

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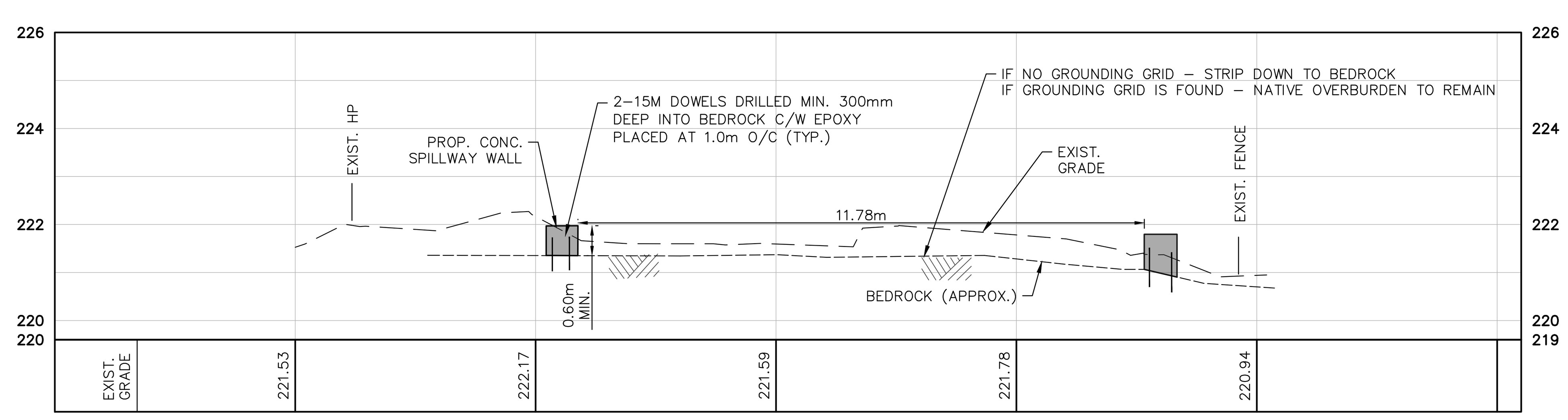

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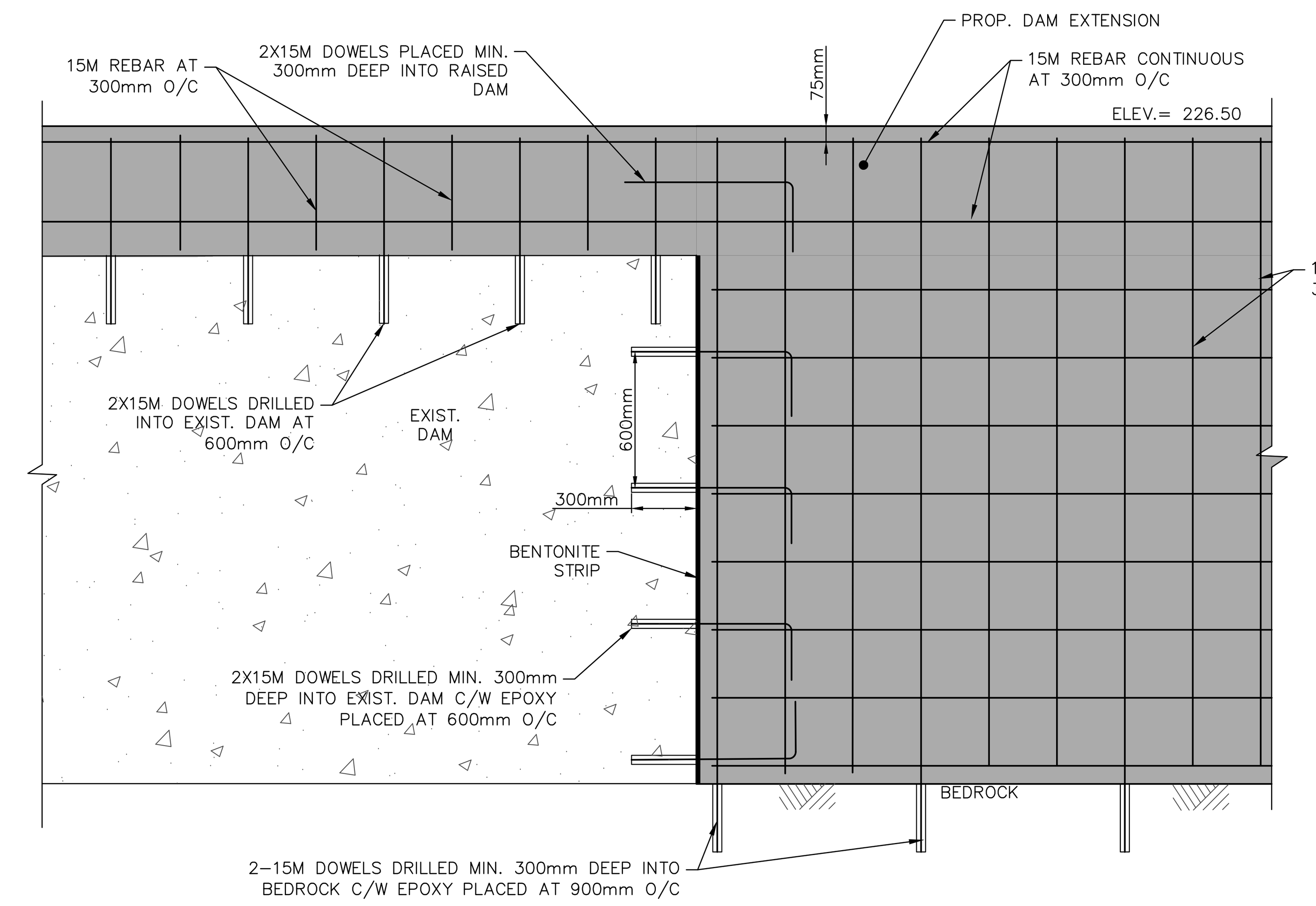
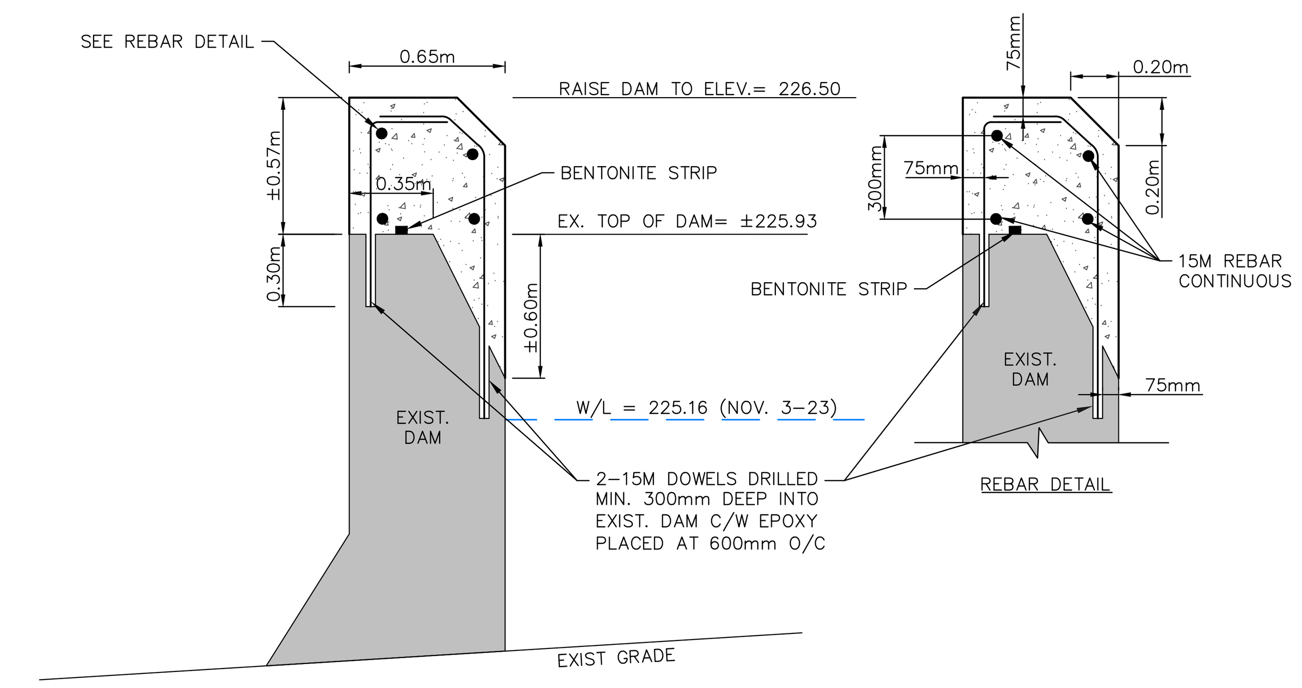
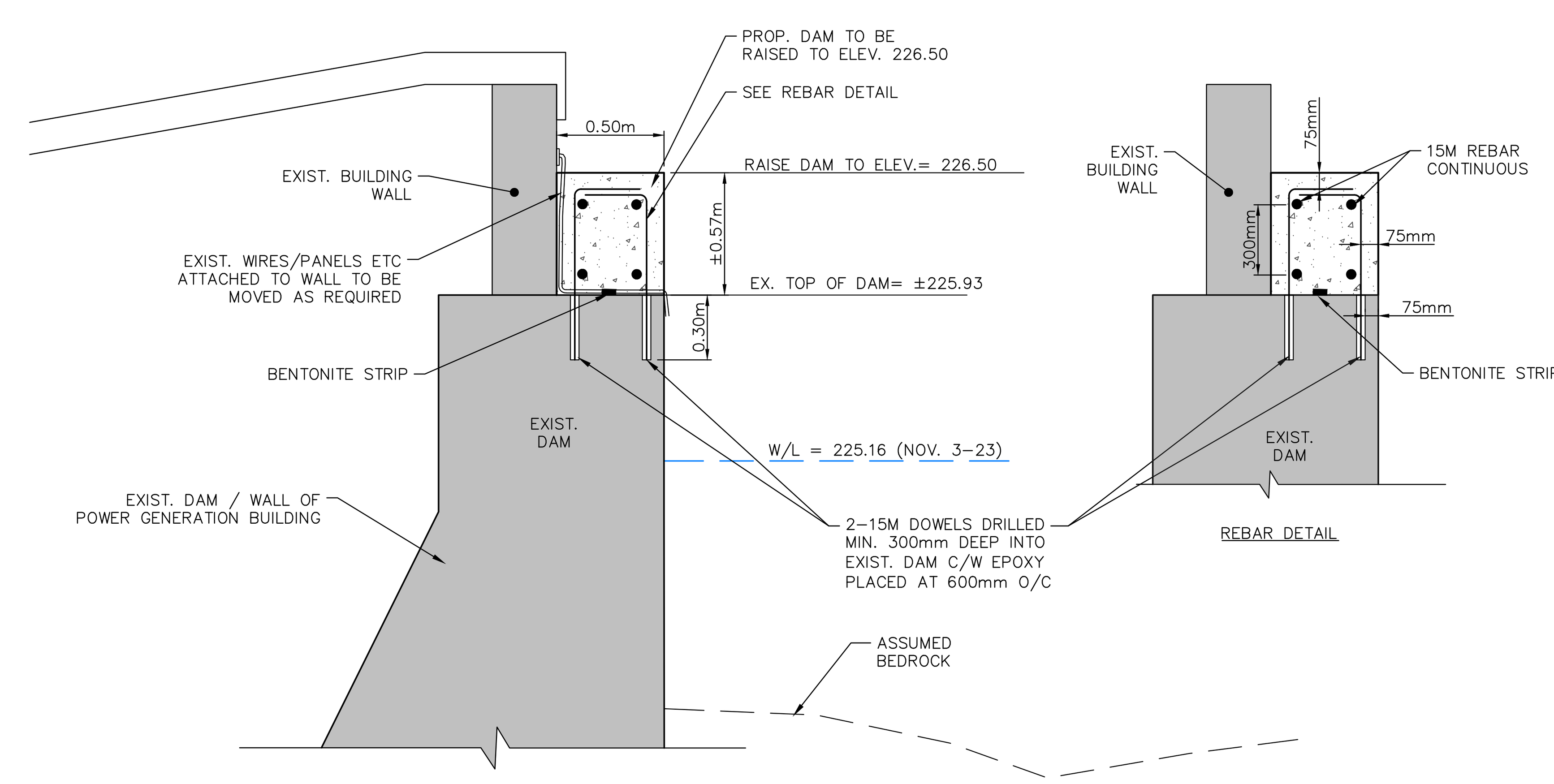


DAM EXTENSION CONNECTION TO EXIST. DAM DETAIL
SCALE 1:25



RAISING OF EXIST. CONC. DAM DETAIL
SCALE 1:25



RAISING OF EXIST. CONC. DAM AT BUILDING DETAIL
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KEY PLAN

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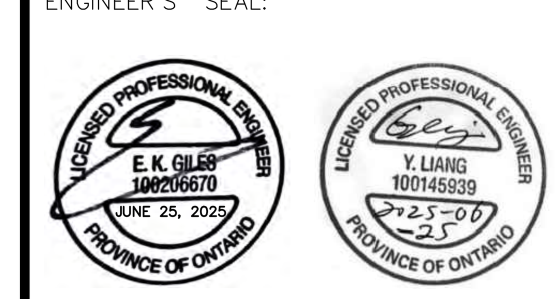

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28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

SPILLWAY, DAM RAISE AND DAM EXTENSION SECTIONS AND DETAILS

DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED

1 : 100	JUNE 25, 2025
SCALE	DATE

23-1236	7	C5
PROJECT No.	REVISION	DRAWING

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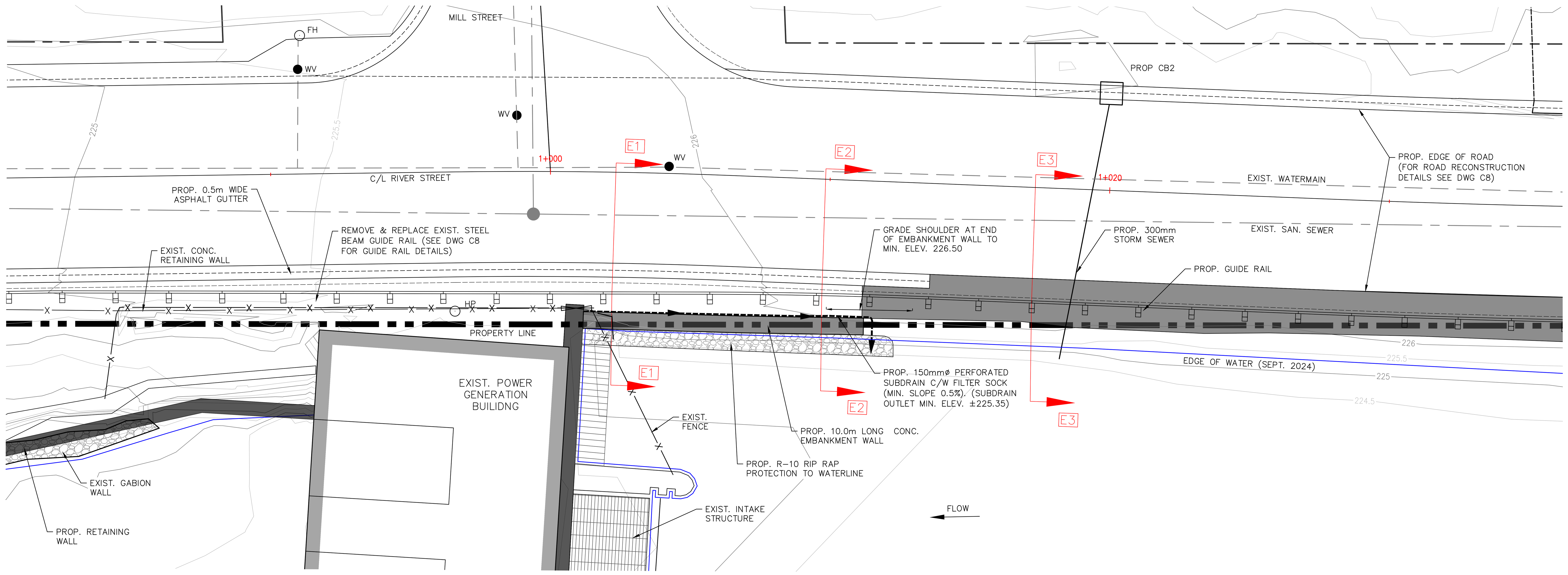
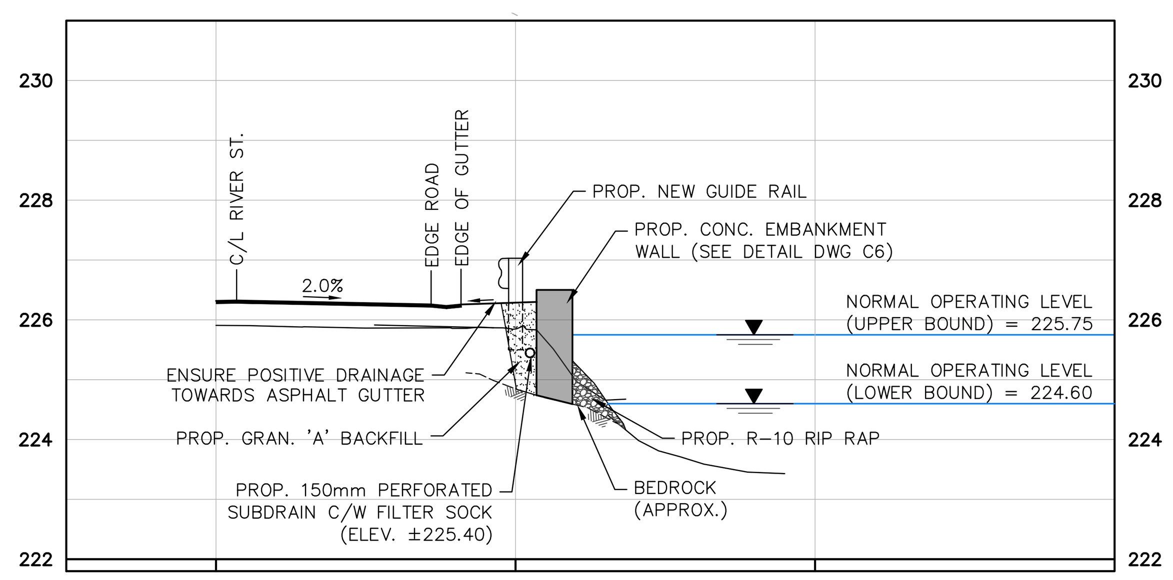


PLAN VIEW
SCALE 1:100



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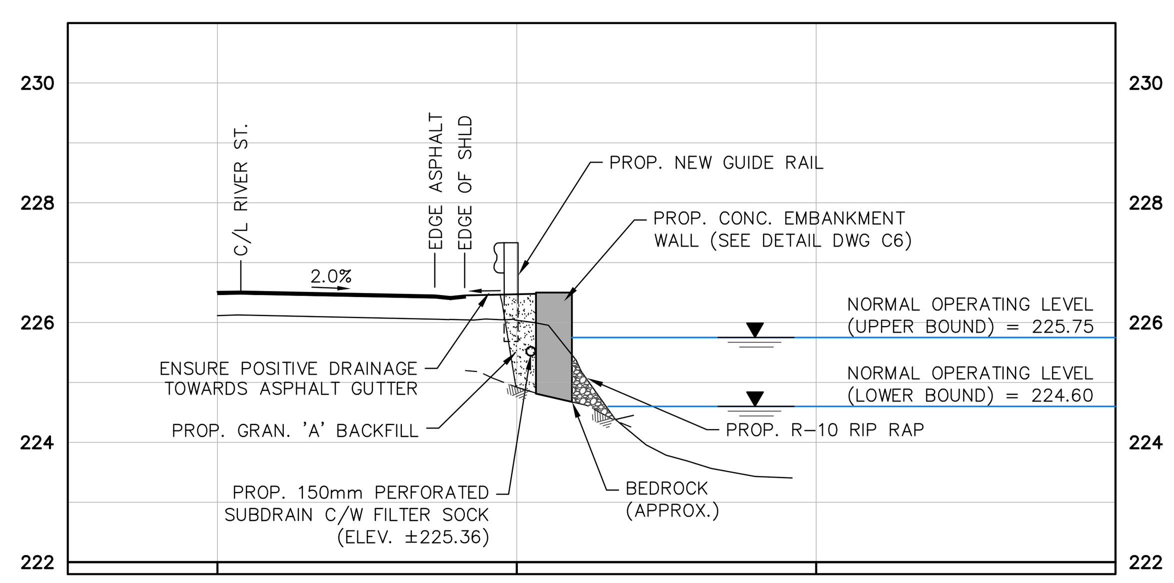

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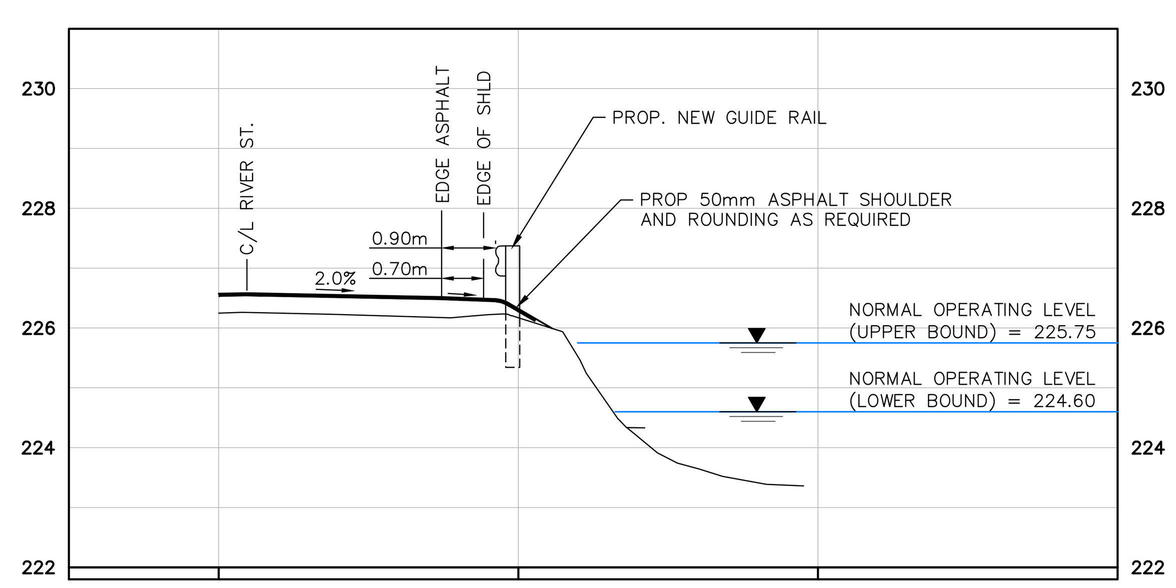

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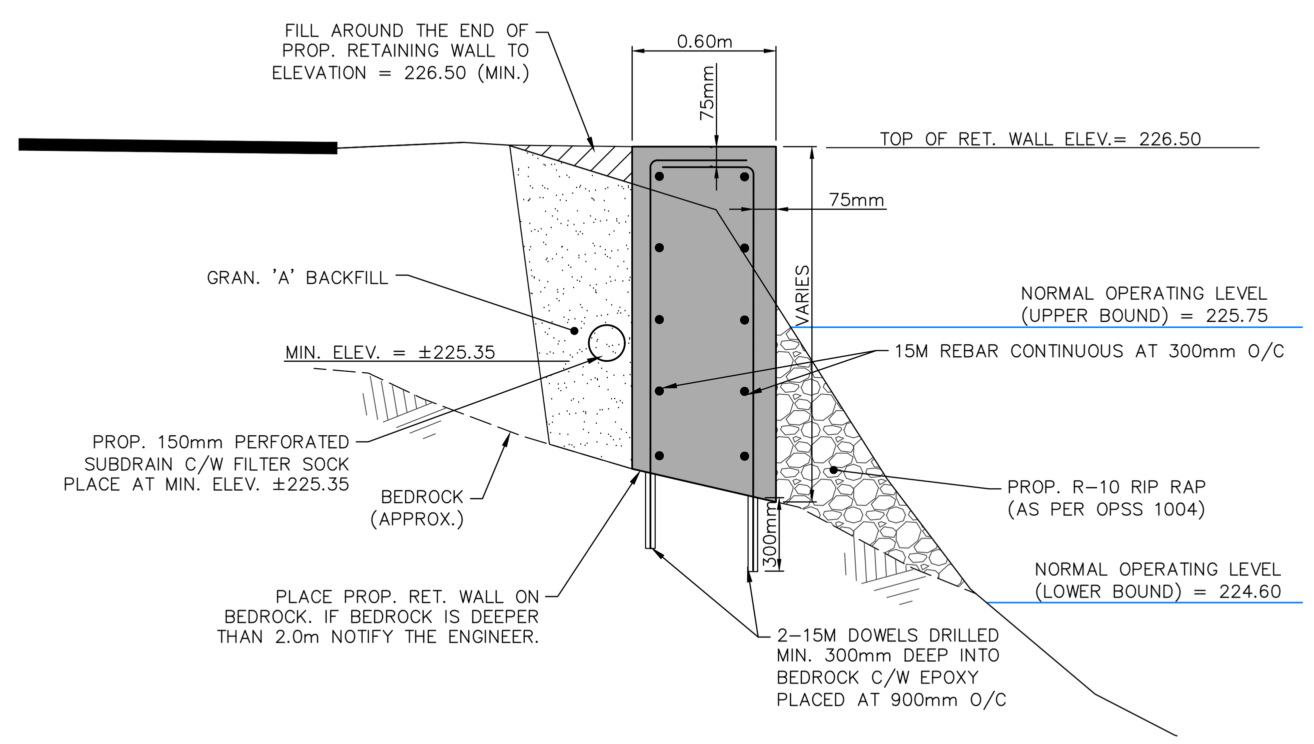

PROP. CONCRETE EMBANKMENT WALL ON NATIVE GROUND
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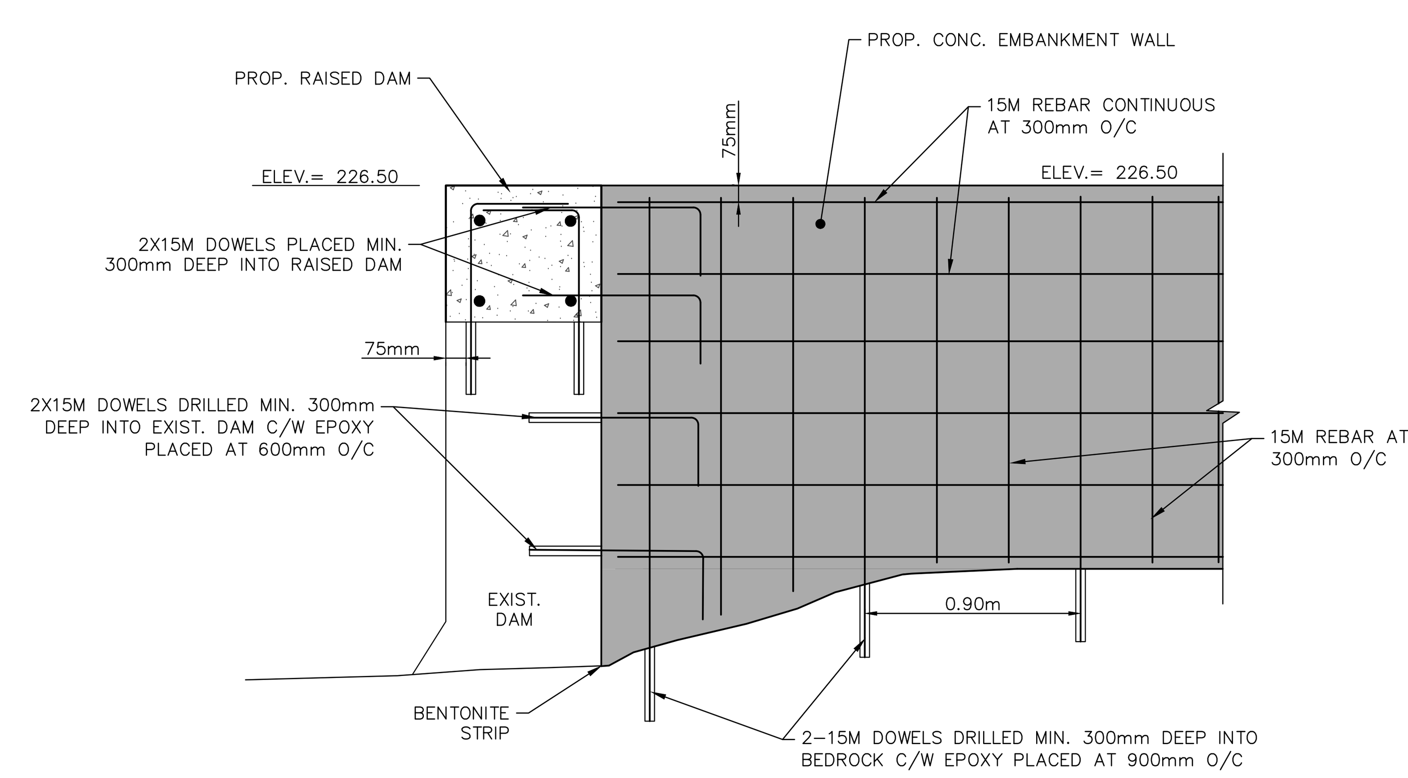

PROP. CONCRETE EMBANKMENT WALL CONNECTION TO EXIST. DAM
SCALE 1:25

P:\2023\231236 – Burgess Dam Detailed Design\03 Drawings\#CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg

KEY PLAN

ENGINEER'S SEAL:

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
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30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

CONCRETE EMBANKMENT WALL

DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED

1 : 100	JUNE 25, 2025
SCALE	DATE

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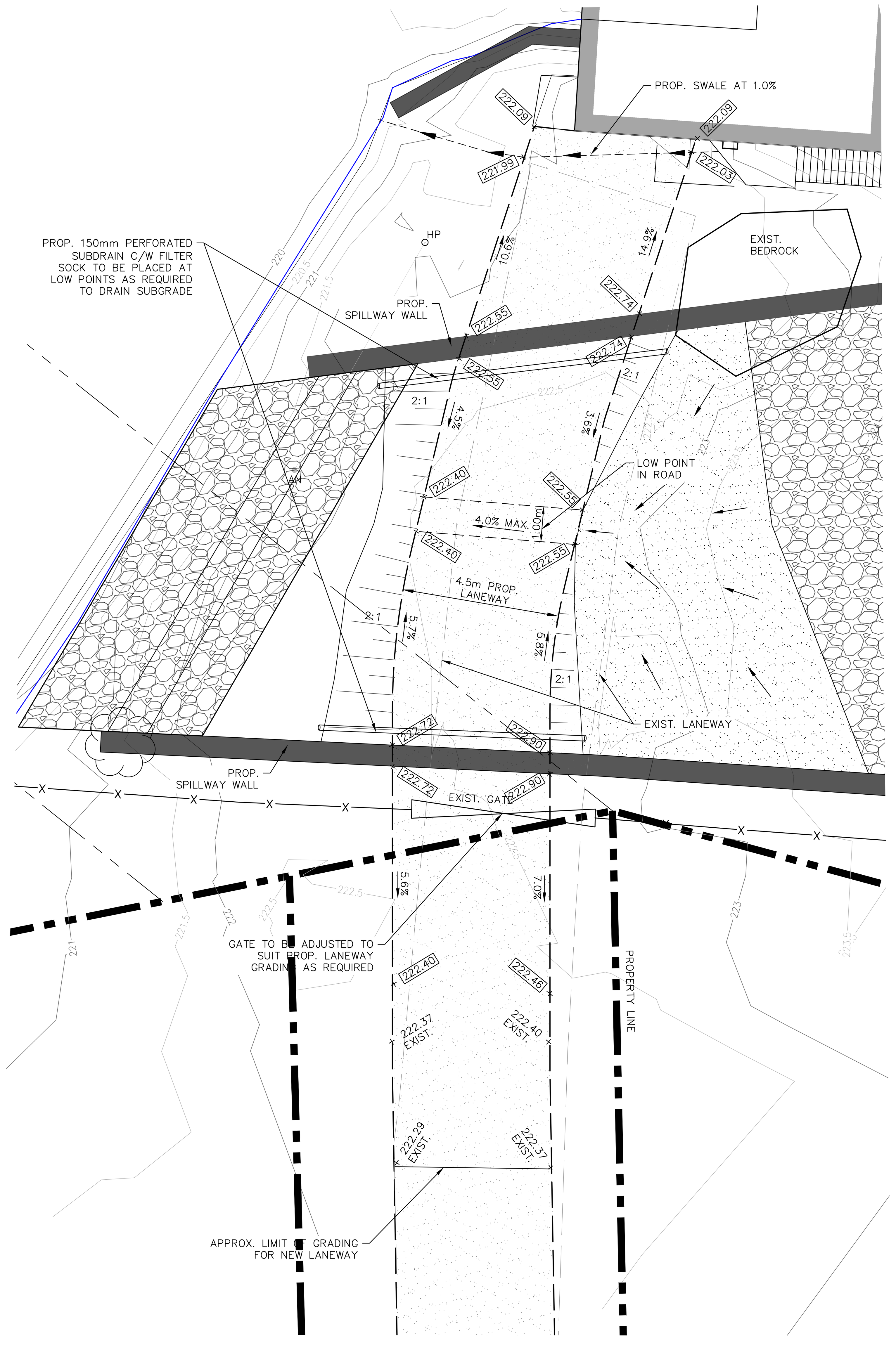
PROJECT No.	REVISION	DRAWING



LANEWAY GRADING AND DRAINAGE PLAN
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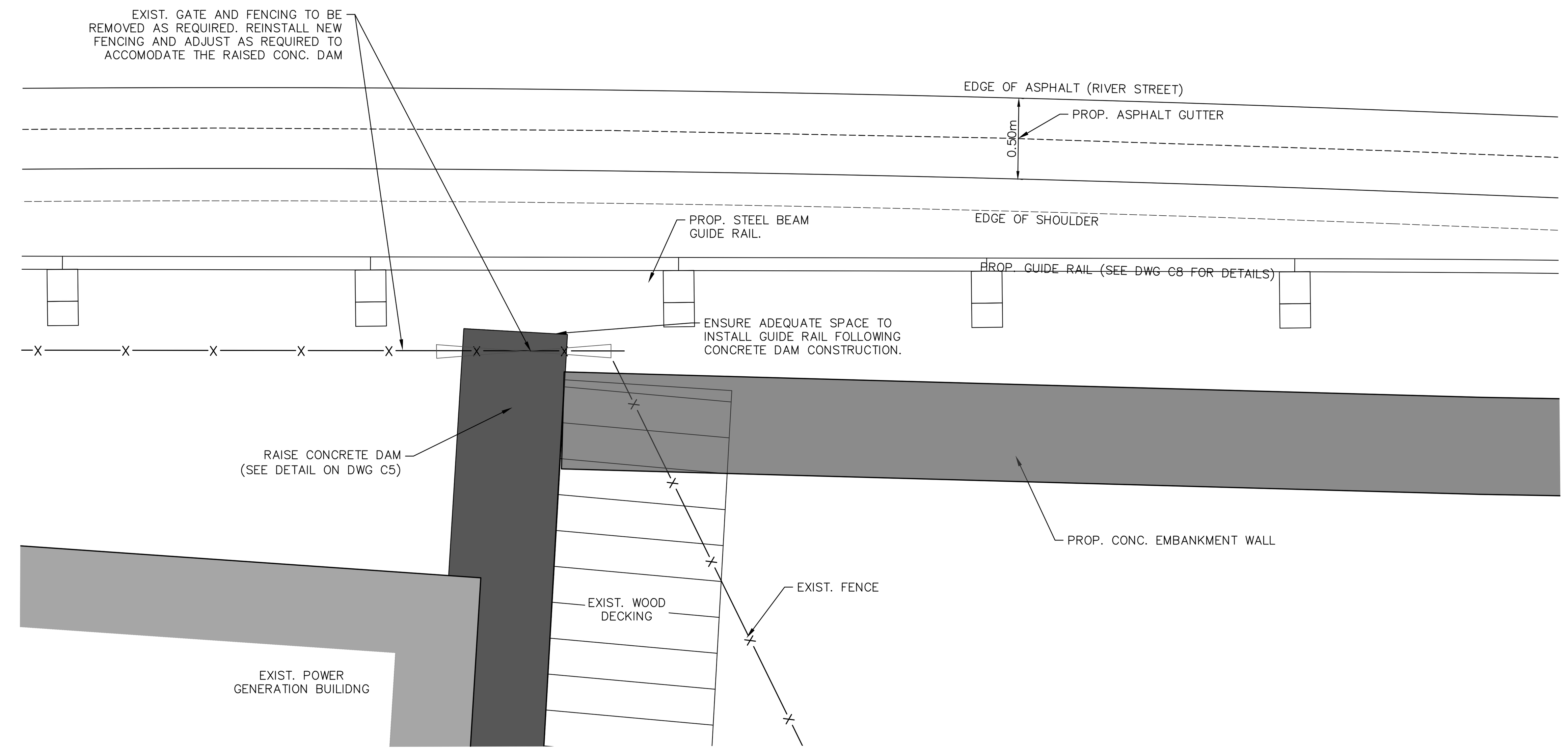

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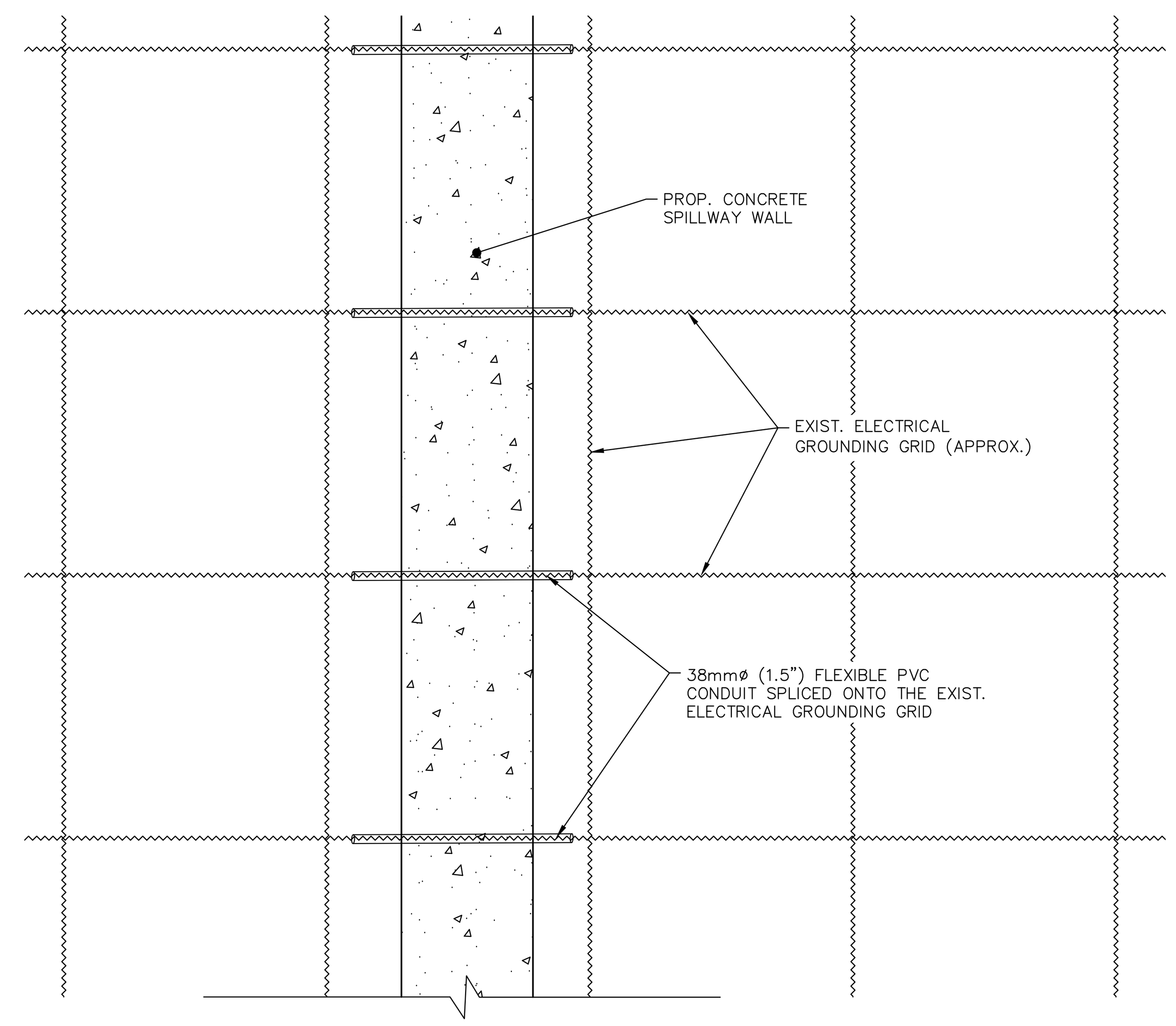

ELECTRICAL GROUNDING GRID PROTECTION
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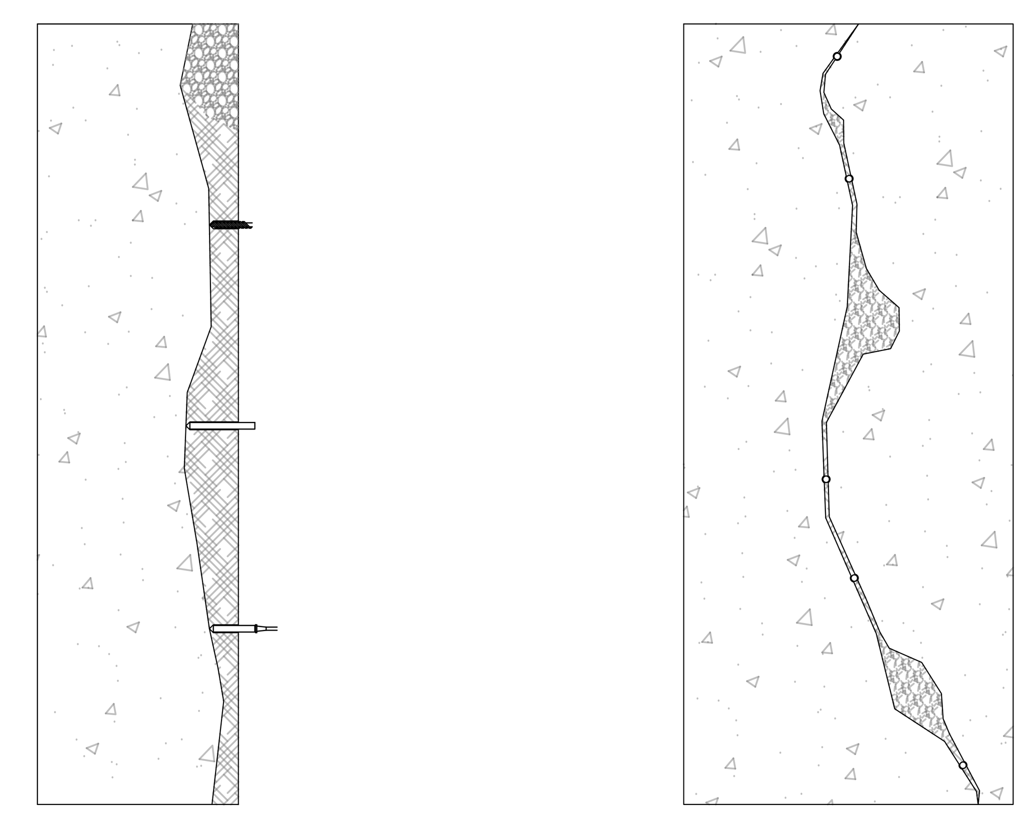
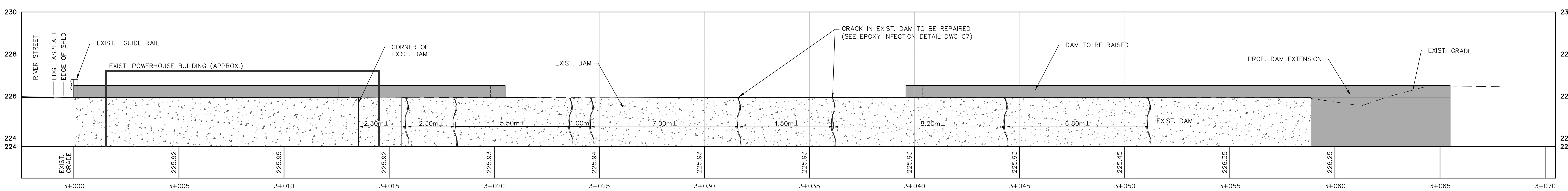


SIDE VIEW

FRONT VIEW

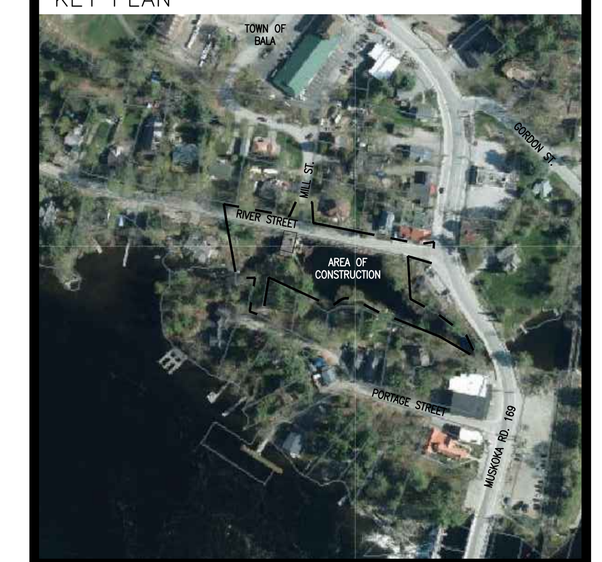
EPOXY INJECTION: CONCRETE CRACK REPAIR
N.T.S.



CRACK REPAIR LOCATIONS ON EXISTING DAM
SCALE 1:100

P:\2023\231236 – Burgess Dam Detailed Design\03 Drawings\CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg

KEY PLAN



ENGINEER'S SEAL:

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
16/05/2025	6	ISSUED FOR TENDER	DR	EG
18/07/2024	5	ISSUED FOR APPROVALS	DR	EG
05\06\2024	4	ISSUED FOR FINAL REVIEW	DR	EG
08/05/2024	3	ISSUED FOR CLIENT REVIEW	DR	EG
05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

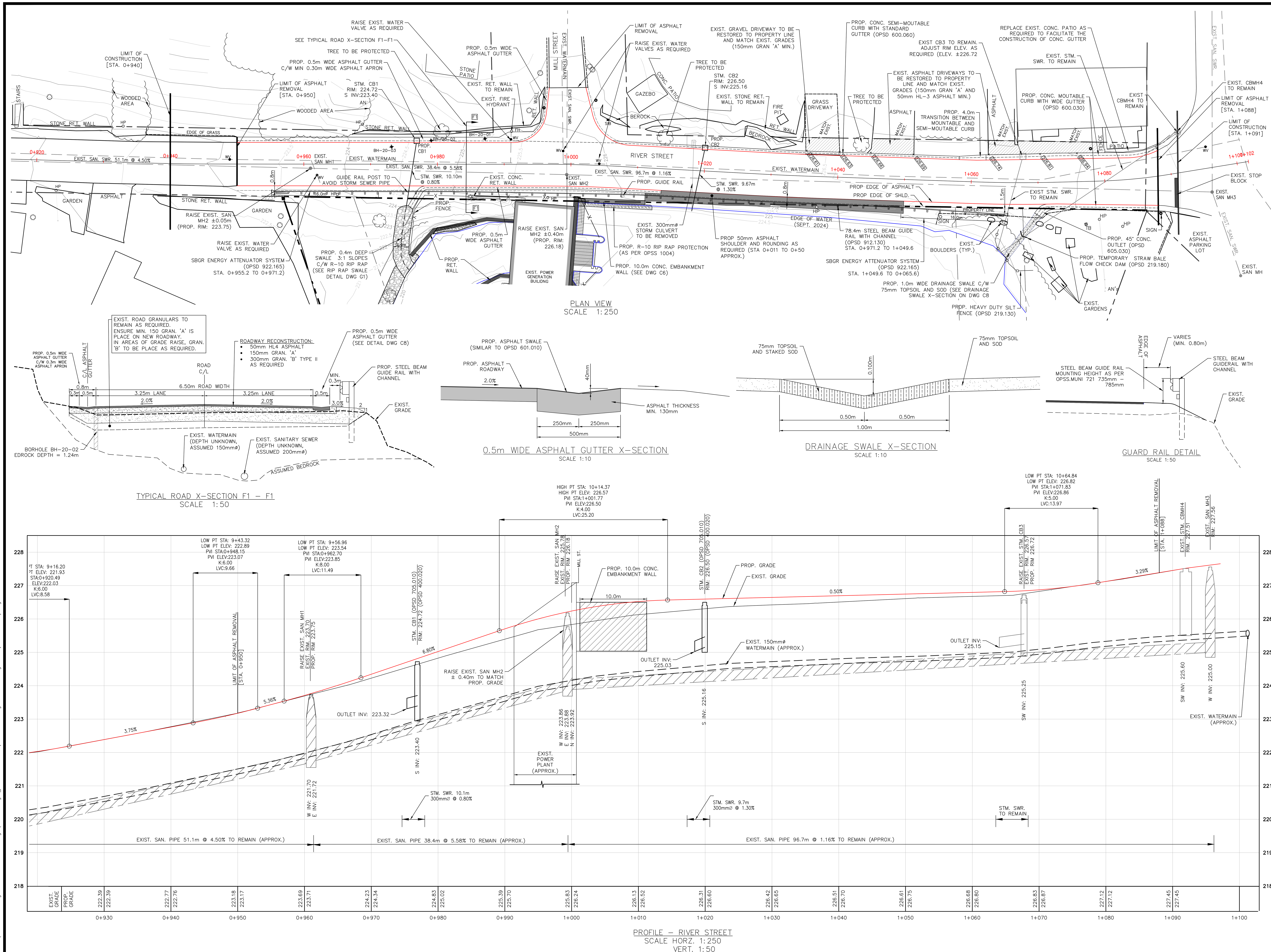
DRAWING TITLE:

LANEWAY GRADING AND DETAILS

DRAWN	DESIGNED	CHECKED	APPROVED
DR	EG	EG	EG

SCALE	DATE
AS SHOWN	JUNE 25, 2025

PROJECT No.	REVISION	DRAWING
23-1236	7	C7



KEY PLAN

ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER
JUNE 25, 2025
C. J. STILWELL
PROVINCE OF ONTARIO

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
16/05/2025	6	ISSUED FOR TENDER	DR	EG
18/07/2024	5	ISSUED FOR APPROVALS	DR	EG
05\06\2024	4	ISSUED FOR FINAL REVIEW	DR	EG
08/05/2024	3	ISSUED FOR CLIENT REVIEW	DR	EG
05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

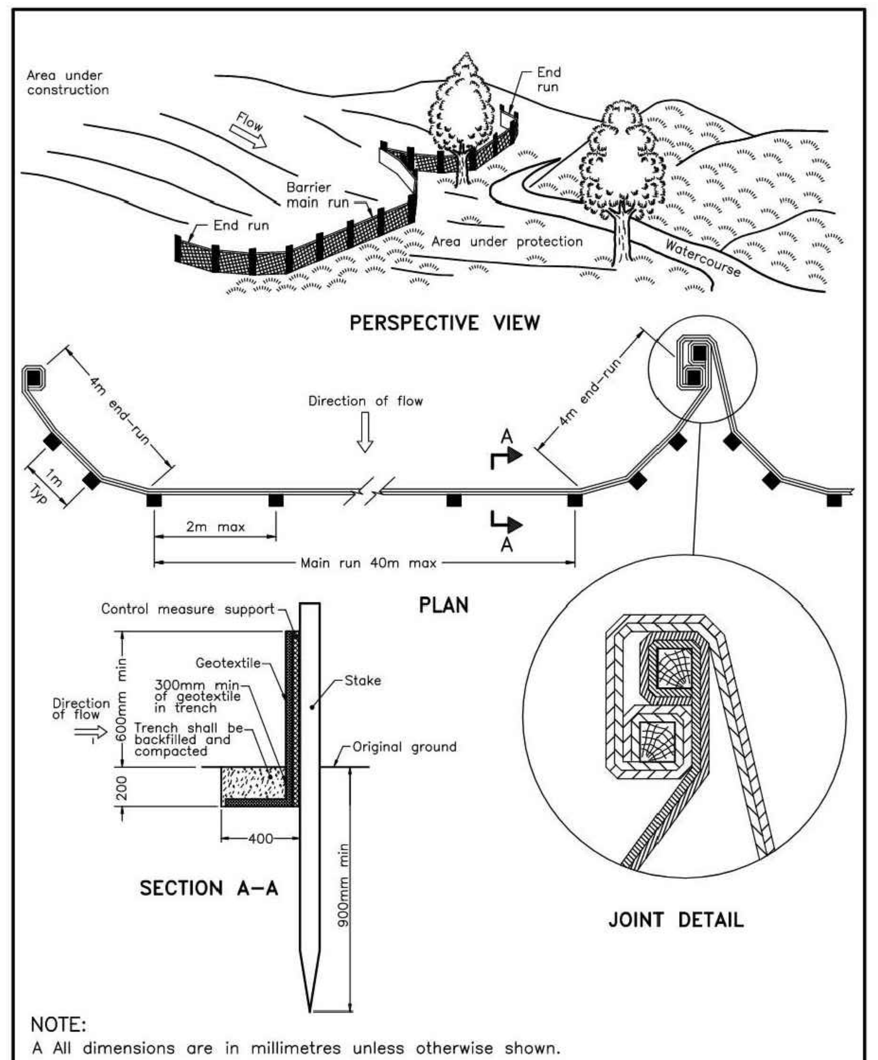
RIVER STREET ROAD RECONSTRUCTION PLAN & PROFILE STA. 0+940 TO 1+091

DR	DR	CS	EG
DRAWN	DESIGNED	CHECKED	APPROVED

AS SHOWN	JUNE 25, 2025
SCALE	DATE

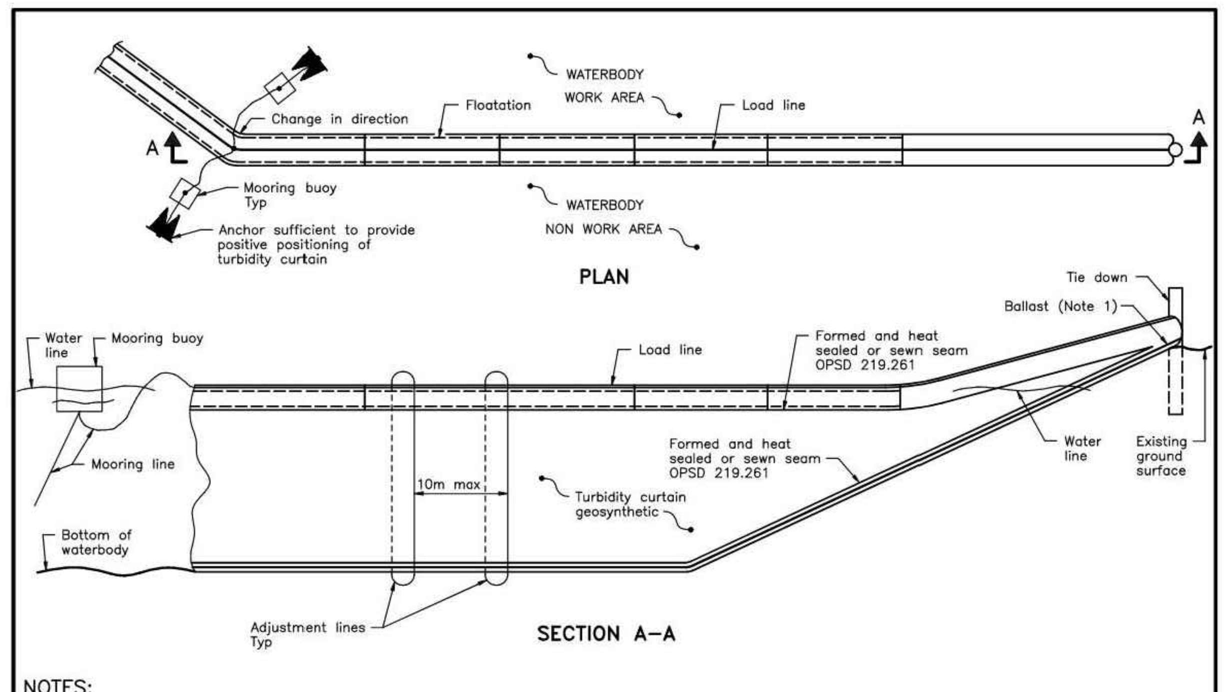
23-1236	7	C8
PROJECT No.	REVISION	DRAWING

P:\2023\231236 – Burgess Dam Detailed Design\03 Drawings\CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg



NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2021	Rev 3
HEAVY–DUTY SILT FENCE BARRIER	OPSD 219.130	



NOTES:
1 Additional ballast may be required depending on local conditions.
A All dimensions are in millimeters unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2022	Rev 3
TURBIDITY CURTAIN	OPSD 219.260	

CONSTRUCTION MITIGATION:

1. EROSION CONTROL STRUCTURES ARE TO BE MONITORED REGULARLY AND ANY DAMAGE REPAIRED IMMEDIATELY. SEDIMENT IS TO BE REMOVED WHEN ACCUMULATIONS BUILD UP INSIDE THE CONTROL FENCE.
2. ALL EROSION CONTROL STRUCTURES ARE TO REMAIN IN PLACE UNTIL ALL DISTURBED GROUND HAS BEEN RESTABLIZED EITHER BY GRAVEL OR RESTORATION OF VEGETATIVE GROUND COVER.
3. NO ALTERNATE METHODS OF EROSION PROTECTION SHALL BE PERMITTED UNLESS APPROVED BY THE ENGINEER AND THE TOWNSHIP OF MUSKOKA LAKES.
4. THE CONTRACTOR IS RESPONSIBLE FOR MUNICIPAL ROADWAY TO BE CLEARED OF ALL SEDIMENT TRACKED BY VEHICLES AT THE END OF EACH DAY.
5. THE CONTRACTOR IS RESPONSIBLE TO REMOVE ANY SEDIMENT THAT HAS TRACKED OFF SITE ONTO ADJACENT PROPERTY OWNED BY OTHERS. RESTORATION AND/OR MAINTENANCE TO ADJACENT PROPERTY MUST BE COMPLETED TO EQUAL OR BETTER CONDITION.
10. THE CONTRACTOR SHALL ISOLATE THE WORK AREA FROM THE WATER AND COMPLETE ALL WORK IN THE DRY.
11. ALL SEDIMENT CONTROL AND EROSION PROTECTION DEVICES ARE TO BE IN PLACE PRIOR TO THE COMMENCEMENT OF CONSTRUCTION AND SHALL BE MAINTAINED BY THE CONTRACTOR UNTIL CONSTRUCTION IS COMPLETE, SUBJECT TO APPROVAL BY THE CONTRACT ADMINISTRATOR.

SEDIMENT CONTROL AND ENVIRONMENTAL MANAGEMENT:

GENERAL:

1. IT IS THE CONTRACTOR'S RESPONSIBILITY FOR THE SEDIMENT CONTROL PLAN DURING CONSTRUCTION. THE CONTRACTOR SHALL PROVIDE FOR APPROVAL A CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP) FOR THE MANAGEMENT AND MITIGATION OF CONSTRUCTION IMPACTS, COMPLYING WITH THE REGULATORY REQUIREMENTS OUTLINED IN ALL PERMITS AND LICENSES PERTINENT TO THIS CONTRACT.
2. THE CONTRACTOR SHALL USE MATERIALS, CONSTRUCTION PRACTICES, MITIGATION TECHNIQUES AND MONITORING OF OPERATION AT MUSKOKA LAKE AND ADJACENT WATER CROSSING AT THE DAM SITE IN ORDER TO PREVENT HARMFUL ALTERATION, DISRUPTION OR DISTRACTION OF FISH HABITAT OR THE IMPAIRMENT OF WATER QUALITY.

SEDIMENT CONTROL:

1. THE CONTRACTOR SHALL PHASE THE CONSTRUCTION ACTIVITIES TO MINIMIZE THE SIZE OF THE DISTURBED AREA AND THE DURATION OF SOIL EXPOSURE. SEDIMENTATION CONTROL PLAN (SCP) BY CONTRACTOR MUST BE SUBMITTED FOR APPROVAL PRIOR TO CONSTRUCTION. THE SCP SHALL COVER THE ENTIRE CONSTRUCTION ACTIVITIES.
2. ALL EXCAVATIONS SHALL HAVE STABLE SIDE SLOPES TO PREVENT SLOPE FAILURE AND MINIMIZE EROSION. RUNOFF THROUGH THE WORKS AREA SHALL BE MINIMIZED BY PROVIDING BERMS, DITCHES AND OTHER DIVERSION MEASURES.
3. RUNOFF FROM THE WORK AREA INCLUDING ACCESS ROAD, LAYDOWN AREA, TEMPORARY EXCAVATION WASTE DISPOSAL AREA AT THE SITE SHALL BE CHANNELIZED AND CONTROLLED BY A VARIETY OF TECHNIQUES INCLUDING SILT TRAP, STRAW BALES, SILT FENCE, SEDIMENTATION POND, AND EARTH–FILL BERMS WITH GEOSYNTHETIC FILTER BEFORE DISCHARGING TO THE RECEIVING WATER COURSE.
4. IF DEWATERING IS REQUIRED, CONTRACTOR TO UTILIZE SEDIMENT CONTROL BAGS TO PREVENT SEDIMENT FROM ENTERING THE WATERWAY.

FUEL AND OIL SPILLS:

1. THE CONTRACTOR SHALL WORK IN ACCORDANCE WITH ALL ENVIRONMENT REGULATIONS AND THE TOWNSHIP POLICIES REGARDING SPILLS OF FUELS AND OILS DURING CONSTRUCTION.
2. CORROSIVE, TOXIC, FLAMMABLE OR OTHERWISE POLLUTING FLUIDS SHALL NOT BE DISCHARGED. SPILLS OF SUCH FLUIDS SHALL BE CONTAINED AND CLEANED UP IN ACCORDANCE WITH THE SPILL RESPONSE AND REPORTING PROCEDURES.
3. THE AREA AROUND FUEL STORAGE LOCATIONS THAT ARE SET UP ON SITE SHALL BE CONTAINED IN SUCH A WAY THAT THE CONTAINMENT WALLS (BERMS OR OTHERWISE) AND THE AREA CONTAINED WITHIN THE WALLS ARE IMPERMEABLE TO FUEL. THE STORAGE AREA WITHIN THE CONTAINMENT ZONE SHALL PROVIDE ADEQUATE STORAGE FOR THE MAXIMUM VOLUME OF FUEL TO BE STORED AT THAT LOCATION.
4. PORTABLE FUEL TANKS AND FUEL CANS SHALL NOT BE LEFT AT LOCATIONS NEAR A WATERCOURSE OF ANY KIND. ALL FUEL TANKS MUST BE DOUBLE WALLED, EQUIPPED WITH 360° VEHICLE PROTECTION, A SPILL KIT AND AN EMPTY 45–GAL DRUM FOR SPILL CONTAMINANTS MUST BE PROVIDED AT EACH TANK. A LIST OF EMERGENCY CONTACT NUMBERS FOR KEY PERSONNEL MUST BE PROVIDED TO THE SITE.

SEDIMENT & EROSION CONTROL STRATEGIES:

PRECONSTRUCTION SITE ACTIVITIES:

1. ALL MATERIALS AND EQUIPMENT USED FOR THE PURPOSE OF SITE PREPARATION AND PROJECT COMPLETION SHOULD BE OPERATED AND STORED IN A MANNER THAT PREVENTS ANY DELETERIOUS SUBSTANCE (e.g. PETROLEUM PRODUCTS, SILT. etc.) FROM ENTERING THE WATER. THE EQUIPMENT SHALL BE CLEANED OF ALL CONTAMINATES PRIOR TO BEING BROUGHT ON SITE.

ADMINISTRATIVE MEASURES

1. THE CONTRACTOR WILL BE IN CHARGE OF ON–SITE WORK AND IS RESPONSIBLE FOR THE IMPLEMENTATION OF THE ENVIRONMENT PROTECTION PLAN. MITIGATION MEASURES ARE TO BE INSTALLED IN ACCORDANCE WITH THE PROJECT DRAWINGS.
2. THE SITE SUPERVISOR WILL HOLD A MEETING OF ALL EQUIPMENT OPERATORS WORKING AT THE SITE TO MAKE THEM AWARE OF THE ENVIRONMENTAL CONCERNS AND MEASURES SET OUT IN THIS PLAN TO CONTROL SEDIMENT. EXISTING VEGETATION IS TO BE PROTECTED TO THE MAXIMUM EXTENT POSSIBLE.
3. TO THE MAXIMUM EXTENT POSSIBLE, NO SEDIMENTS SHALL ENTER THE WATER DURING ANY ASPECT OF THE WORK. SHORT TERM INTRODUCTION OF SEDIMENTS SHALL BE KEPT TO THE LOWEST PRACTICAL LEVEL AND THERE SHOULD BE NO LONG TERM SOURCES OF SEDIMENT FROM THE COMPLETED PROJECT.

SEDIMENT CONTROL MEASURES:

1. THE CONTRACTOR SHALL INSTALL SEDIMENT AND EROSION MEASURES PRIOR TO CONSTRUCTION AND MAINTAIN UNTIL THE WORK SITE IS STABILIZED TO PREVENT ENTRY OF SEDIMENT INTO THE WATER.

INSPECTION & MAINTENANCE:

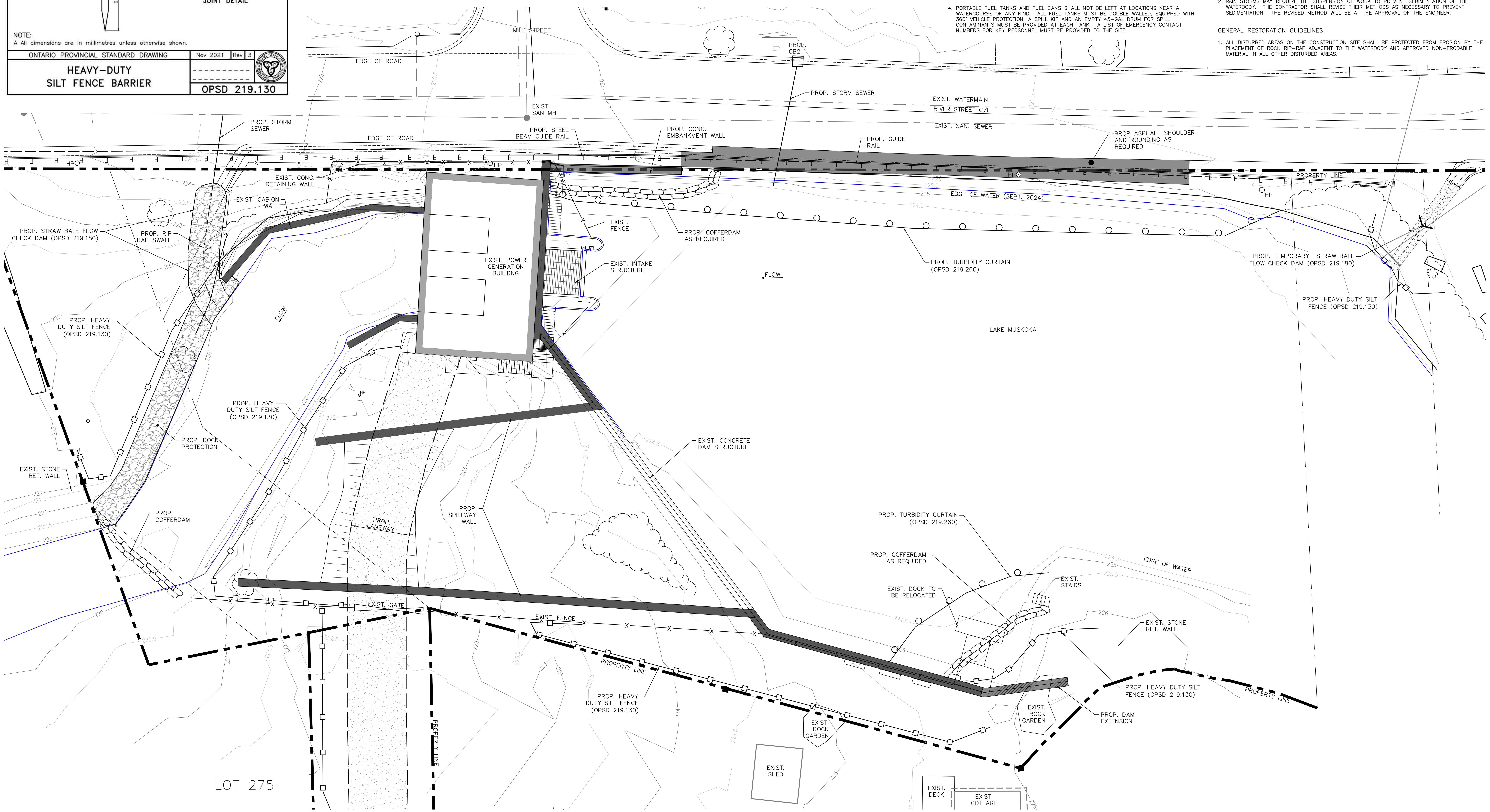
2. CONSTRUCTION OPERATIONS WILL BE UNDER THE DIRECTION OF THE SITE SUPERVISOR FOR THE CONTRACTOR AND INSPECTED BY THE SITE INSPECTOR FOR THE OWNER. ANY PROBLEMS OR CONCERNS WILL BE RESOLVED ON SITE WITH THE ENGINEER.
3. DOWNSTREAM AREA SHALL BE REGULARLY INSPECTED. IF SUSPENDED SEDIMENTS ARE NOTED WORK IS TO STOP IMMEDIATELY, ESC MEASURES AND CONDITIONS TO BE INSPECTED BY A QUALIFIED PROFESSIONAL. ADDITIONAL MEASURES AND ISOLATION SHALL BE INSTALLED PER INSPECTION RECOMMENDATIONS. IF A SEDIMENT RELEASE IS IDENTIFIED THE CONTRACTOR WILL TAKE IMMEDIATE ACTION TO CONTAIN AND/OR CLEAN THE SPILL. THE MECP SPILLS ACTION CENTRE SHALL BE CONTACTED IMMEDIATELY AT 1–800–268–6060.

CONTINGENCY PLANS:

1. THE CONTINGENCY PLANS WILL BE INITIATED AS CONDITIONS IN THE FIELD DICTATE.
2. RAIN STORMS MAY REQUIRE THE SUSPENSION OF WORK TO PREVENT SEDIMENTATION OF THE WATERBODY. THE CONTRACTOR SHALL REVISE THEIR METHODS AS NECESSARY TO PREVENT SEDIMENTATION. THE REVISED METHOD WILL BE AT THE APPROVAL OF THE ENGINEER.

GENERAL RESTORATION GUIDELINES:

1. ALL DISTURBED AREAS ON THE CONSTRUCTION SITE SHALL BE PROTECTED FROM EROSION BY THE PLACEMENT OF ROCK RIP–RAP ADJACENT TO THE WATERBODY AND APPROVED NON–ERODABLE MATERIAL IN ALL OTHER DISTURBED AREAS.



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KEY PLAN

ENGINEER'S SEAL:

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
16/05/2025	6	ISSUED FOR TENDER	DR	EG
18/07/2024	5	ISSUED FOR APPROVALS	DR	EG
05\06\2024	4	ISSUED FOR FINAL REVIEW	DR	EG
08/05/2024	3	ISSUED FOR CLIENT REVIEW	DR	EG
05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

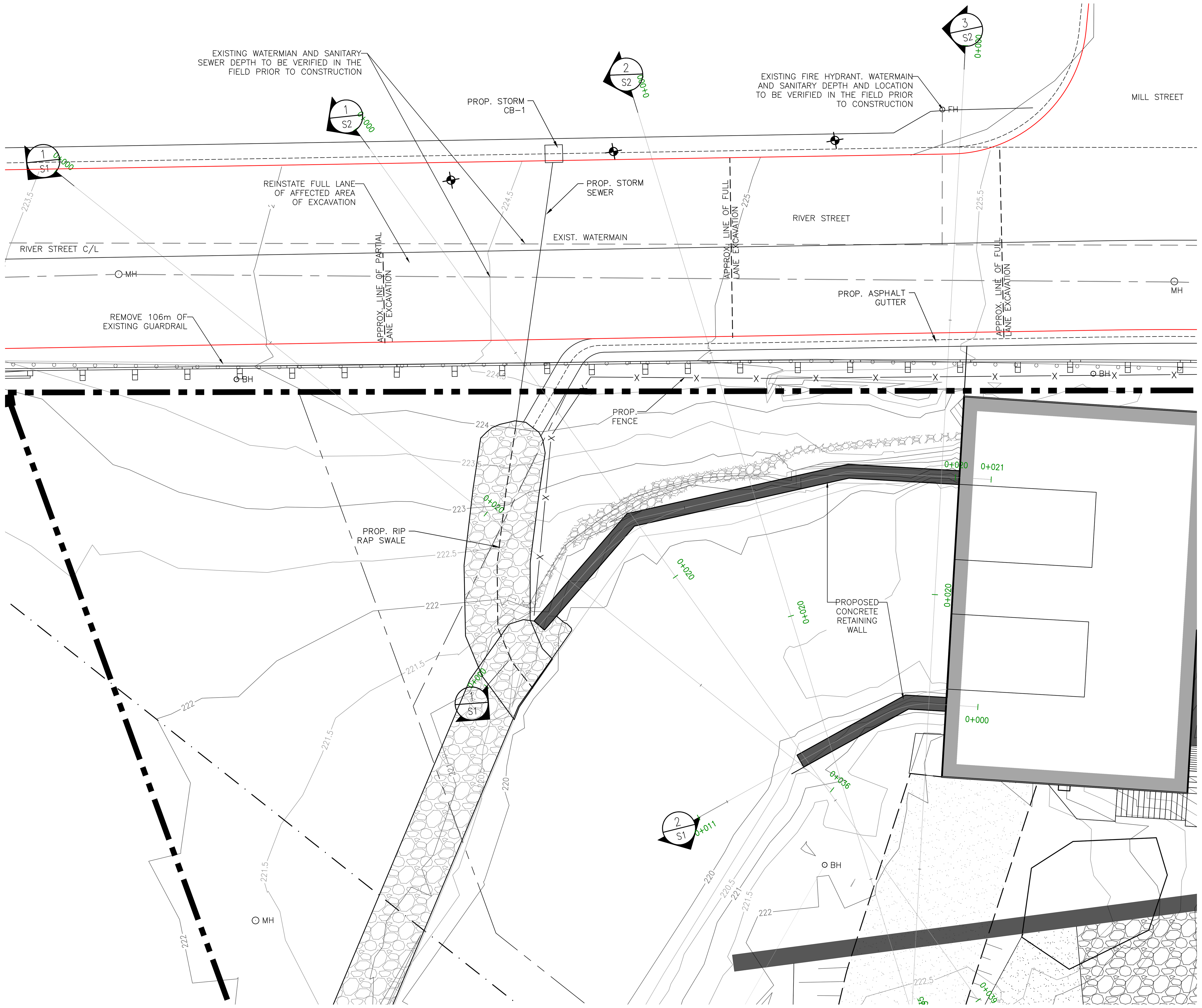
LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

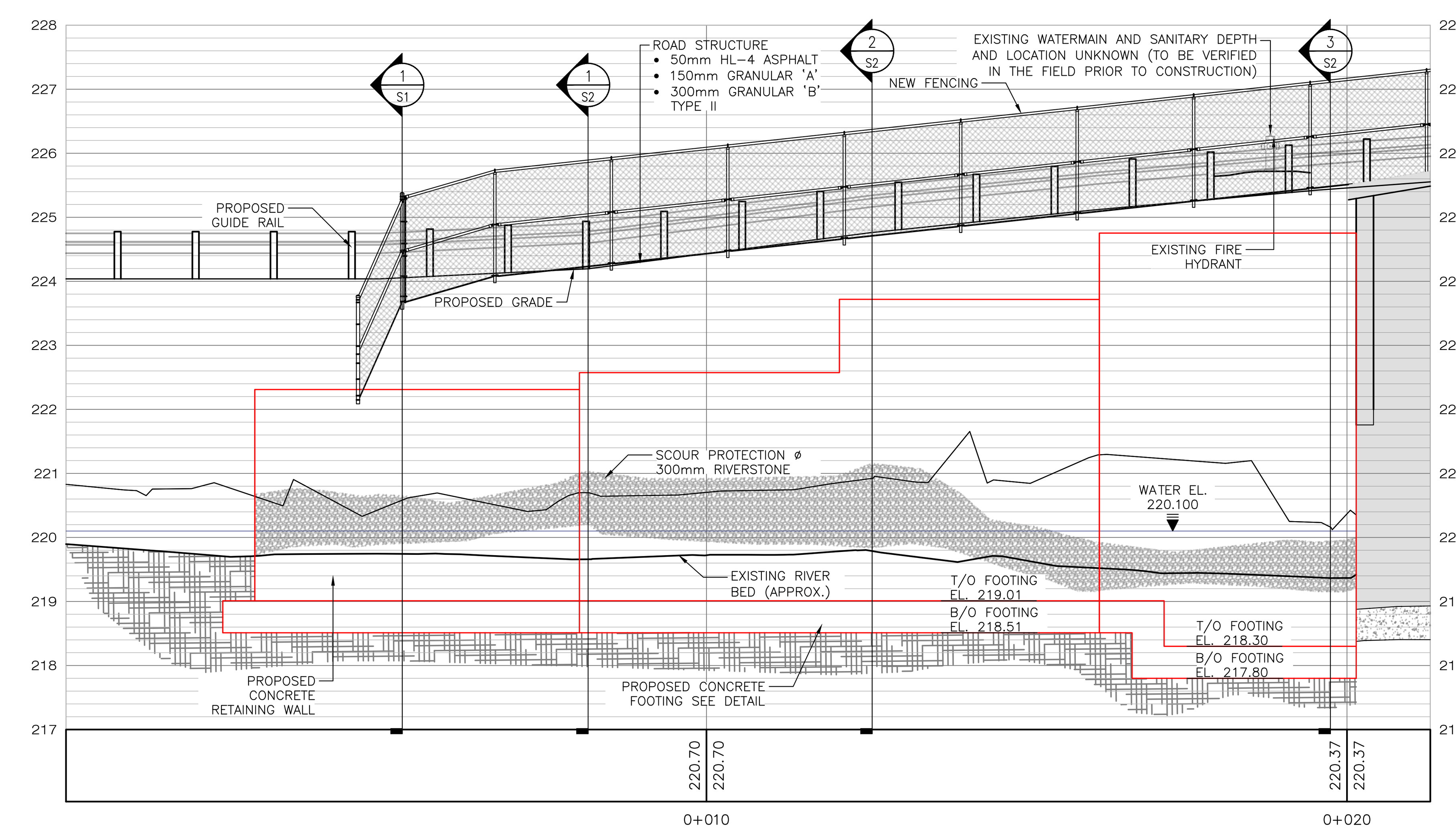
SEDIMENT & EROSION CONTROL PLAN

DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED
1 : 150		JUNE 25, 2025	
SCALE		DATE	
23-1236	7	E1	
PROJECT No.	REVISION	DRAWING	

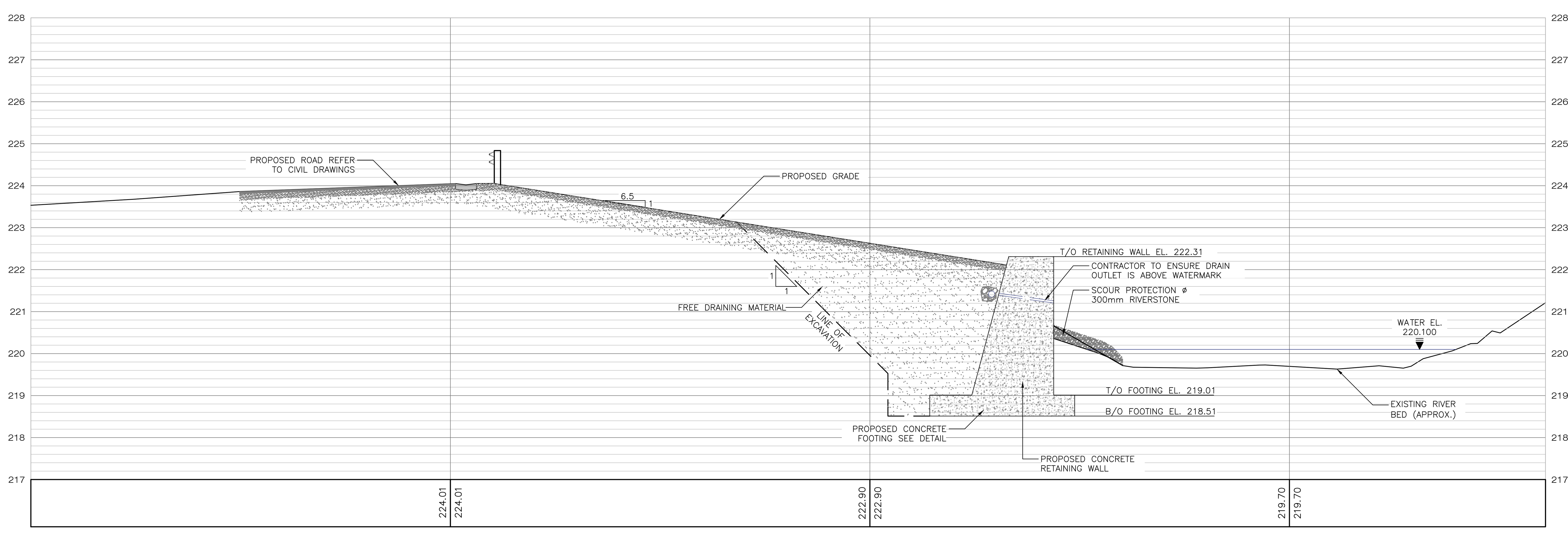
P:\2023\231236 – Burgess Dam Detailed Design\03 Drawings\CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg



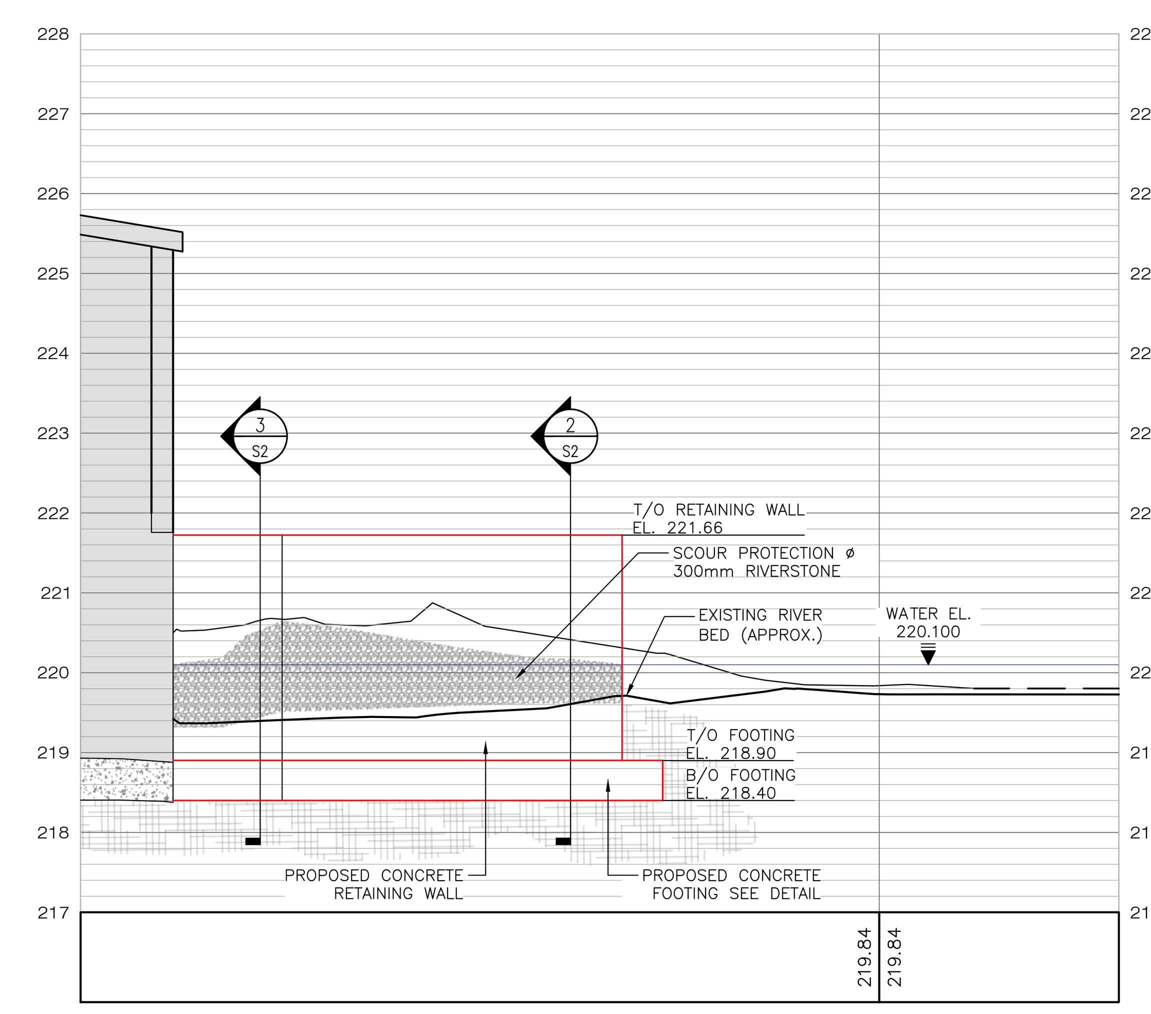
GENERAL ARRANGEMENT: PLAN
SCALE: 1:100



GENERAL ARRANGEMENT: NORTH WALL ELEVATION
SCALE: 1:75



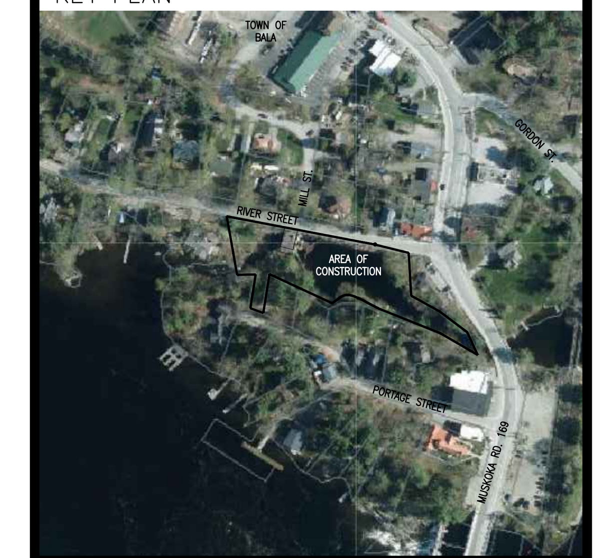
GENERAL ARRANGEMENT: EAST SIDE SECTION OF NORTH RETAINING WALL
SCALE 1:75



GENERAL ARRANGEMENT: SOUTH WALL ELEVATION
SCALE: 1:75

N

KEY PLAN



ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER
F.R. PALMAY
100162809
2025-Jun-27
PROVINCE OF ONTARIO

DATE (DAY/MTH/YR)	REV.	REVISION	BY	APP'D
26/06/2025	3	ISSUED FOR CONSTRUCTION	HD	FP
13/05/2025	2	ISSUED FOR TENDER	HD	FP
26/06/2024	1	ISSUED FOR FINAL REVIEW	HD	FP
09/05/2024	0	ISSUED FOR REVIEW	HD	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

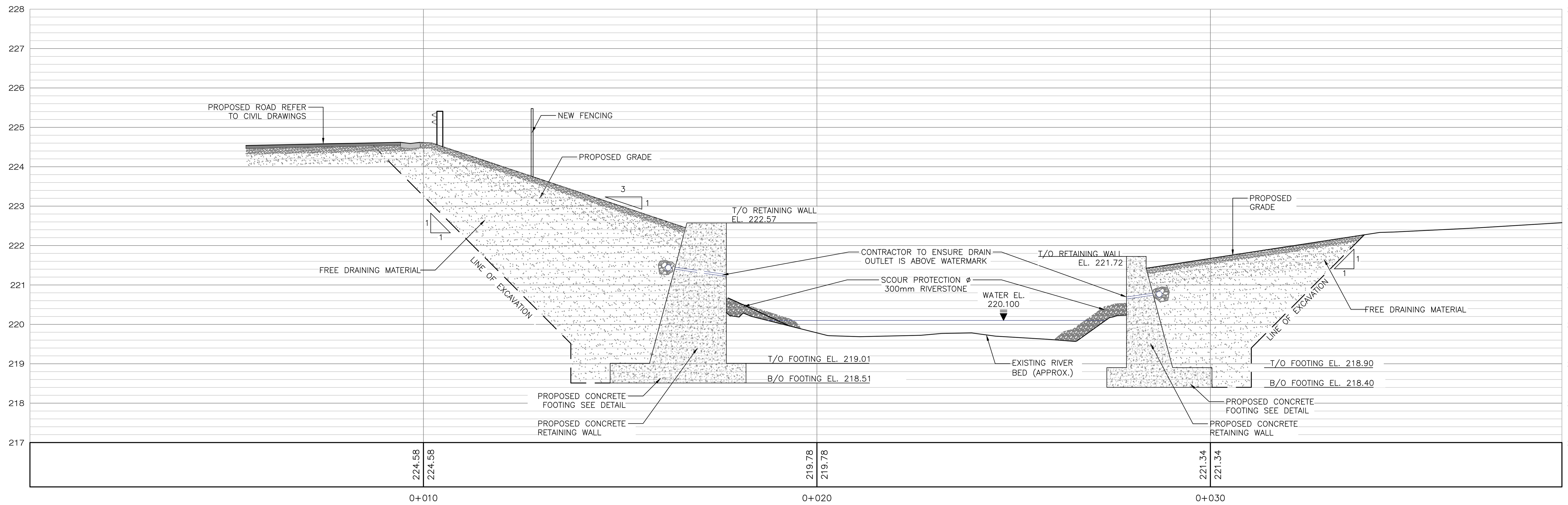
GENERAL ARRANGEMENT, ELEVATIONS & RETAINING WALL DETAIL

HD	FP	FP	FP
DRAWN	DESIGNED	CHECKED	APPROVED

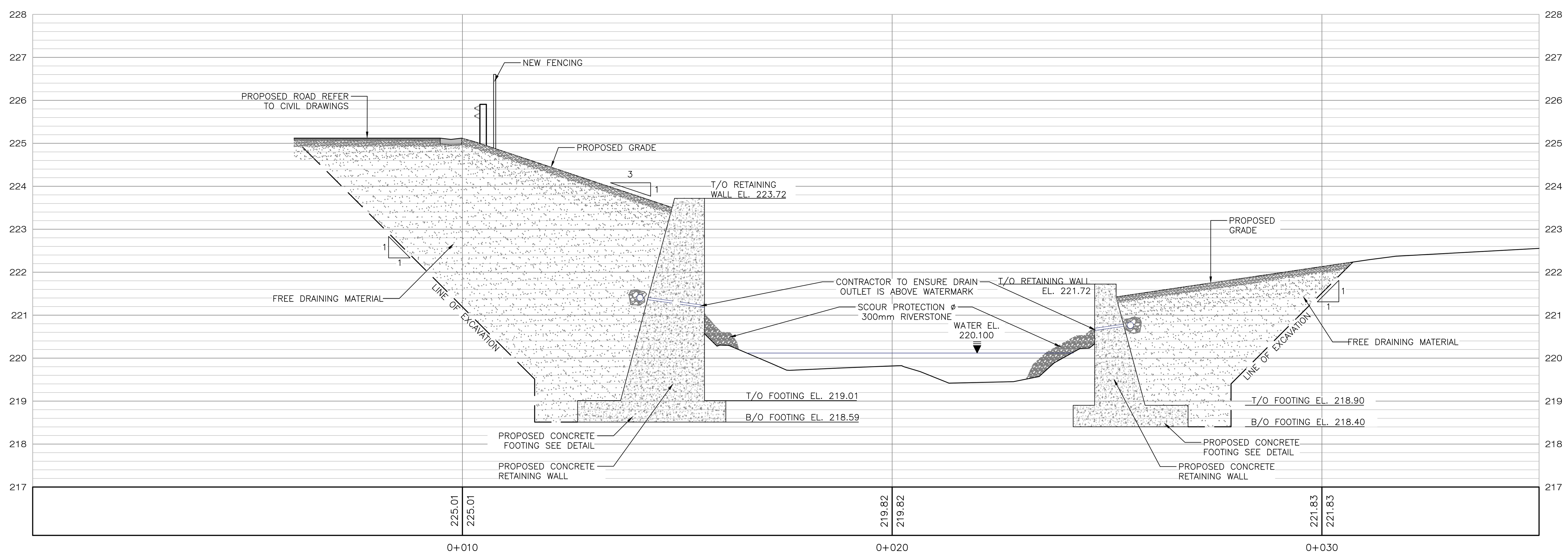
AS NOTED	JUNE 26, 2025
SCALE	DATE

23-1236	3	S1
PROJECT No.	REVISION	DRAWING

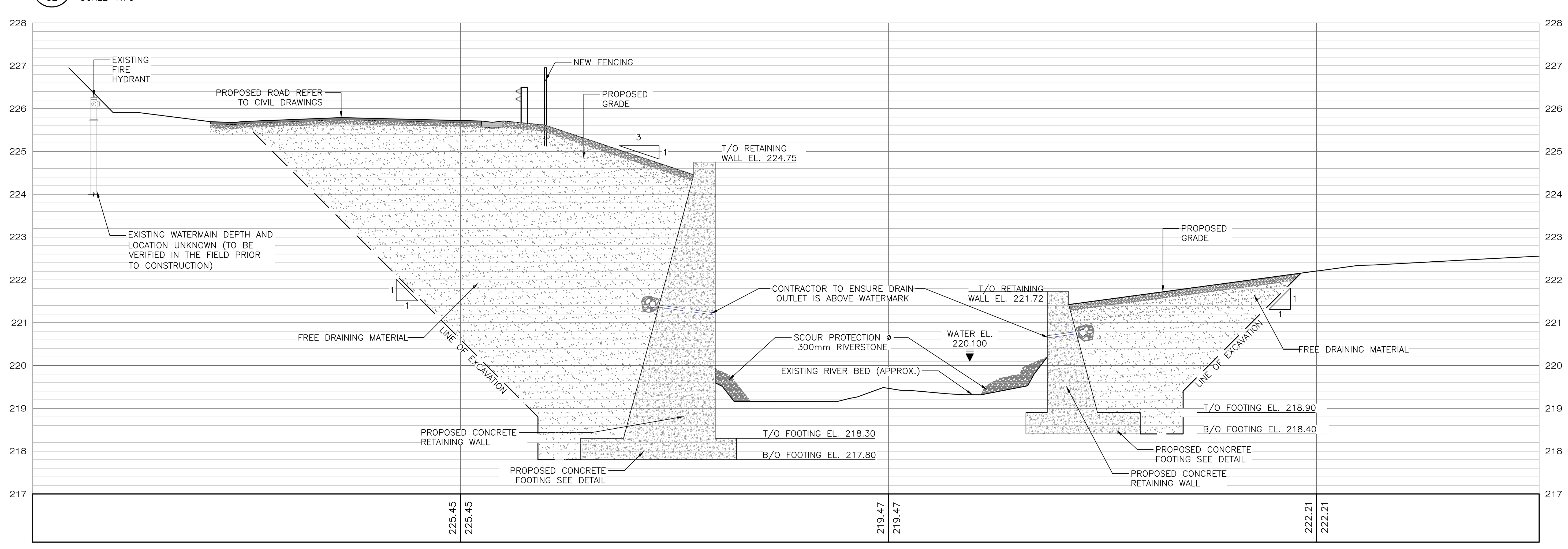
P:\2023\231236 - Burgess Dam Detailed Design\03.02 Current\231236 - Burgess Dam - Retaining Wall - 2025-06-26.dwg



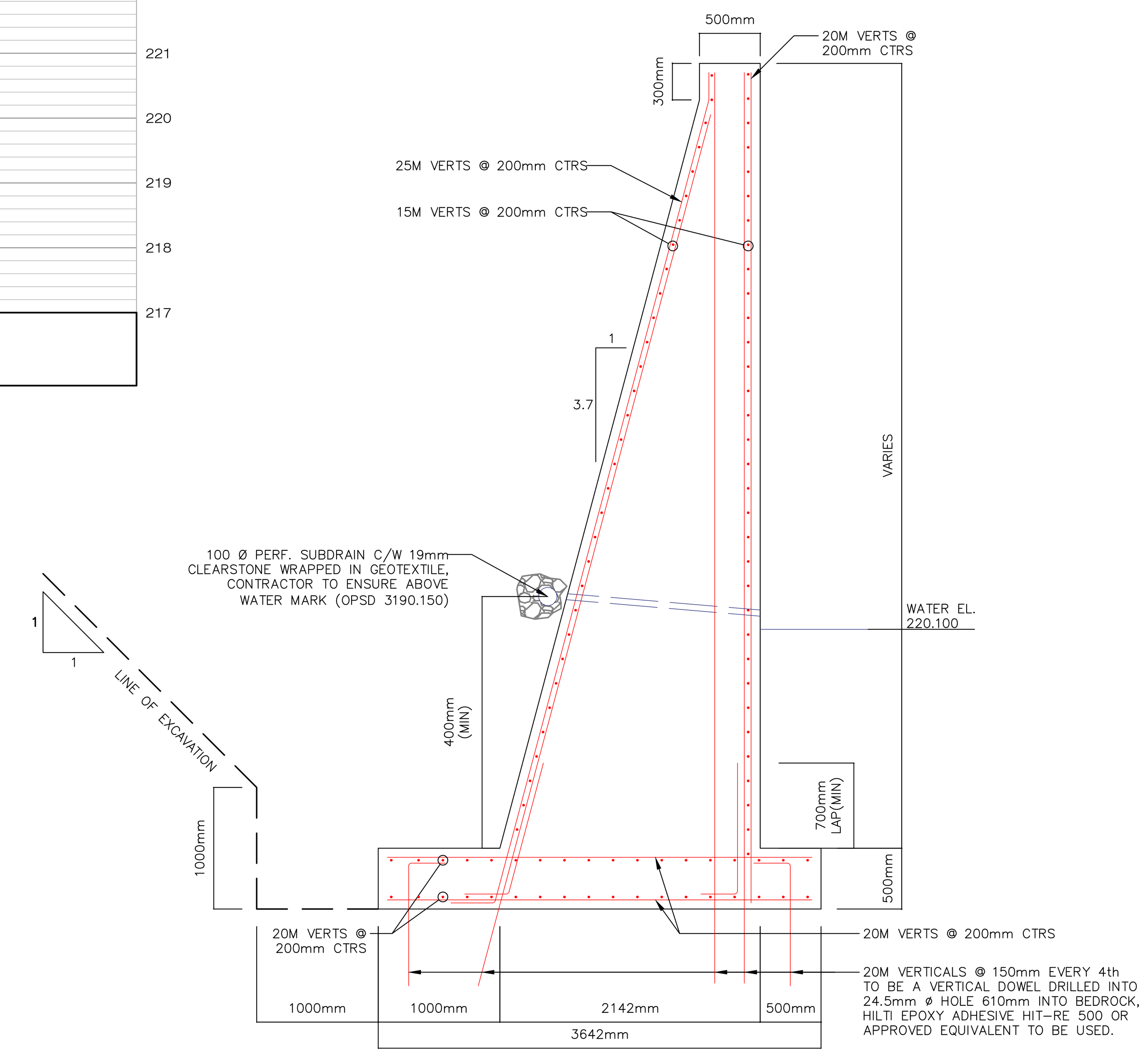
1 / S2 GENERAL ARRANGEMENT: MIDDLE SECTION OF NORTH WALL AND EAST SECTION OF SOUTH RETAINING WALL
SCALE 1:75



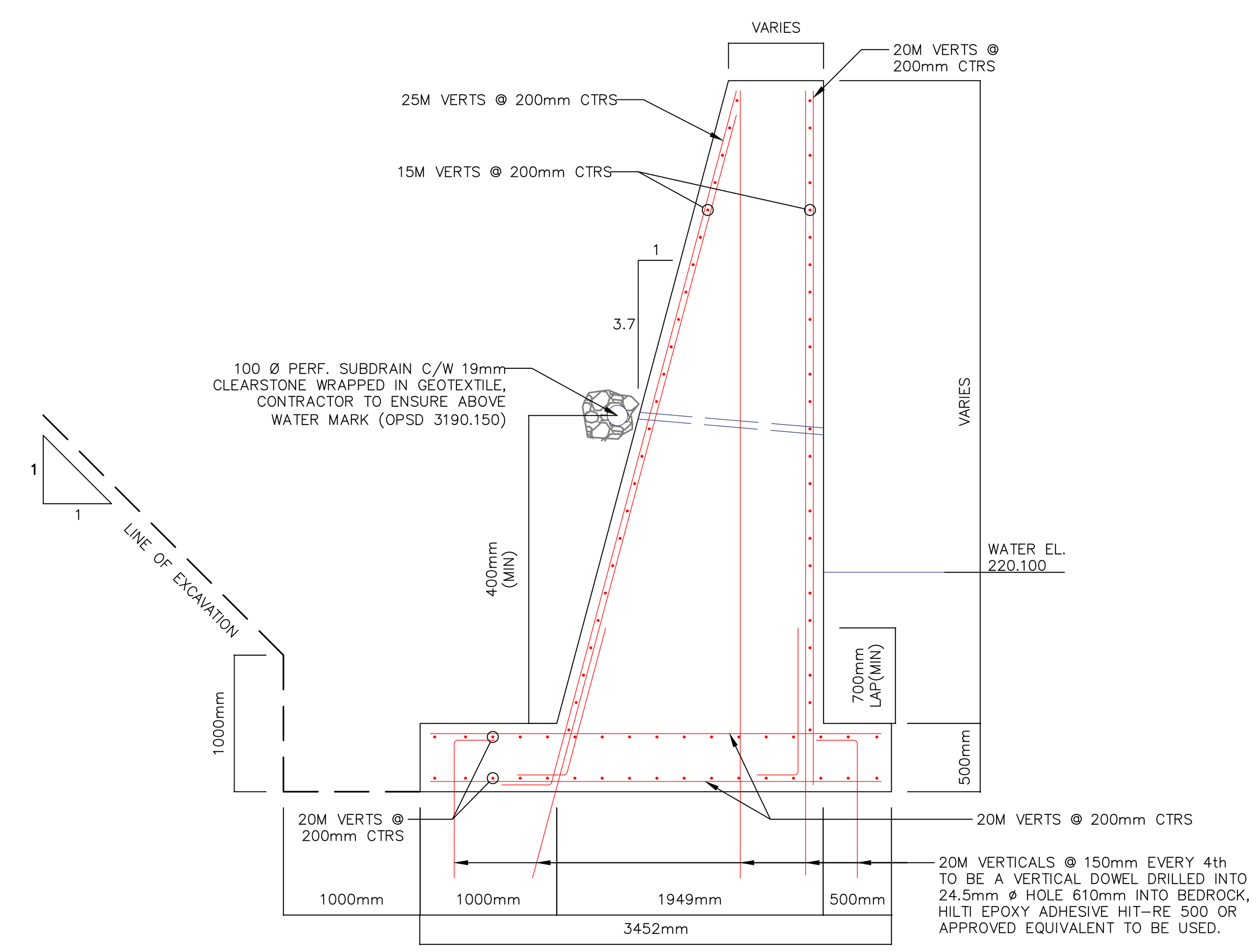
2 / S2 GENERAL ARRANGEMENT: MIDDLE SECTION OF NORTH AND SOUTH RETAINING WALL
SCALE 1:75



3 / S2 GENERAL ARRANGEMENT: WEST SECTION OF NORTH AND SOUTH RETAINING WALL
SCALE 1:75



TYPICAL SECTION OF NORTH RETAINING WALL
SCALE: 1:40



TYPICAL MIDDLE SECTION OF NORTH RETAINING WALL
SCALE: 1:40

KEY PLAN

ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER
F. R. PALMAY
100162809
2025-Jun-27
PROVINCE OF ONTARIO

DATE (DAY/MTH/YR)	REV.	REVISION	BY	APP'D
26/06/2025	3	ISSUED FOR CONSTRUCTION	HD	FP
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26/06/2024	1	ISSUED FOR FINAL REVIEW	HD	FP
09/05/2024	0	ISSUED FOR CLIENT REVIEW	HD	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

RETAINING WALL SECTIONS

DRAWN	DESIGNED	CHECKED	APPROVED
HD	FP	FP	FP

SCALE	DATE
AS NOTED	JUNE 26, 2025

PROJECT No.	REVISION	DRAWING
23-1236	3	S2

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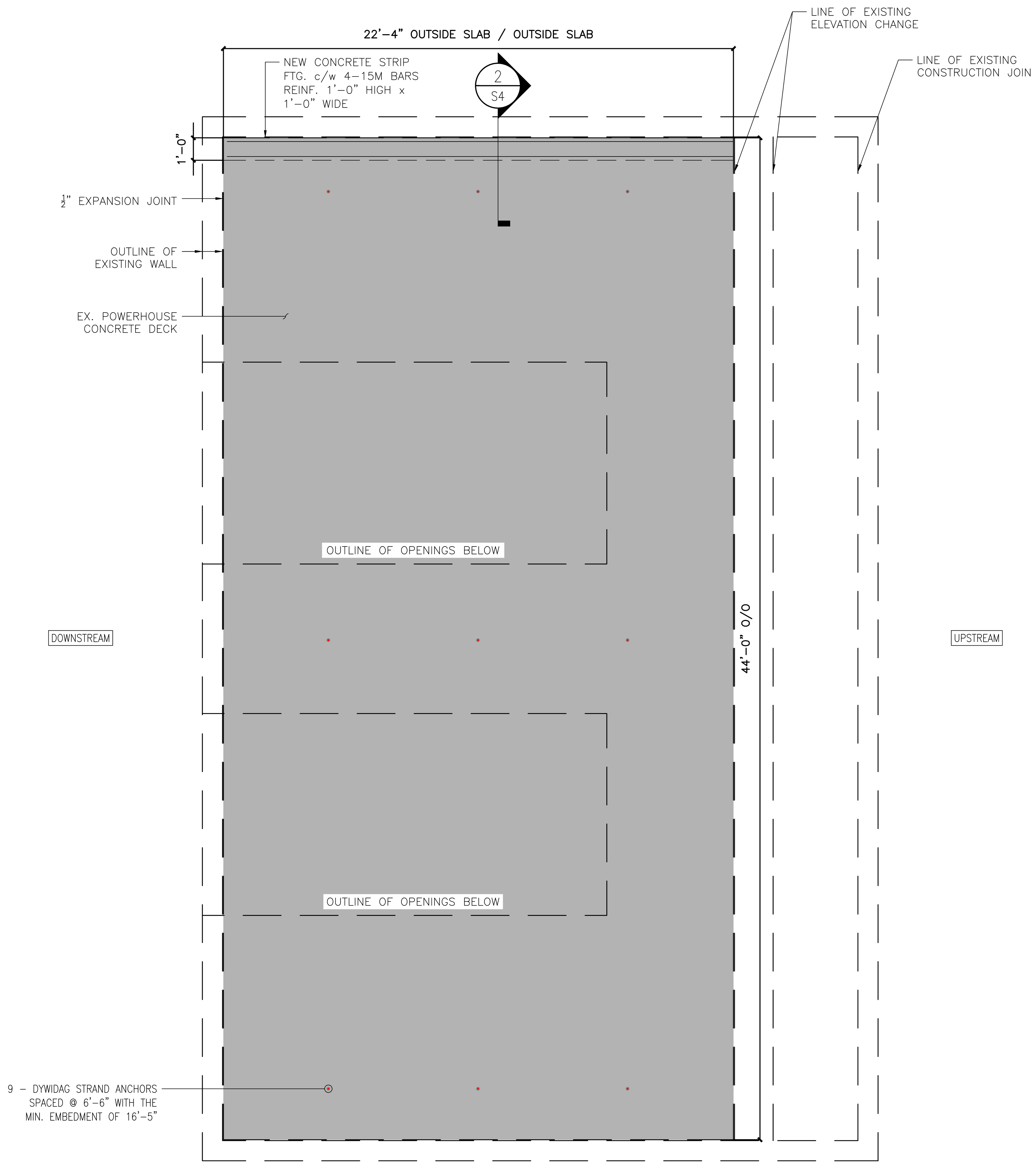
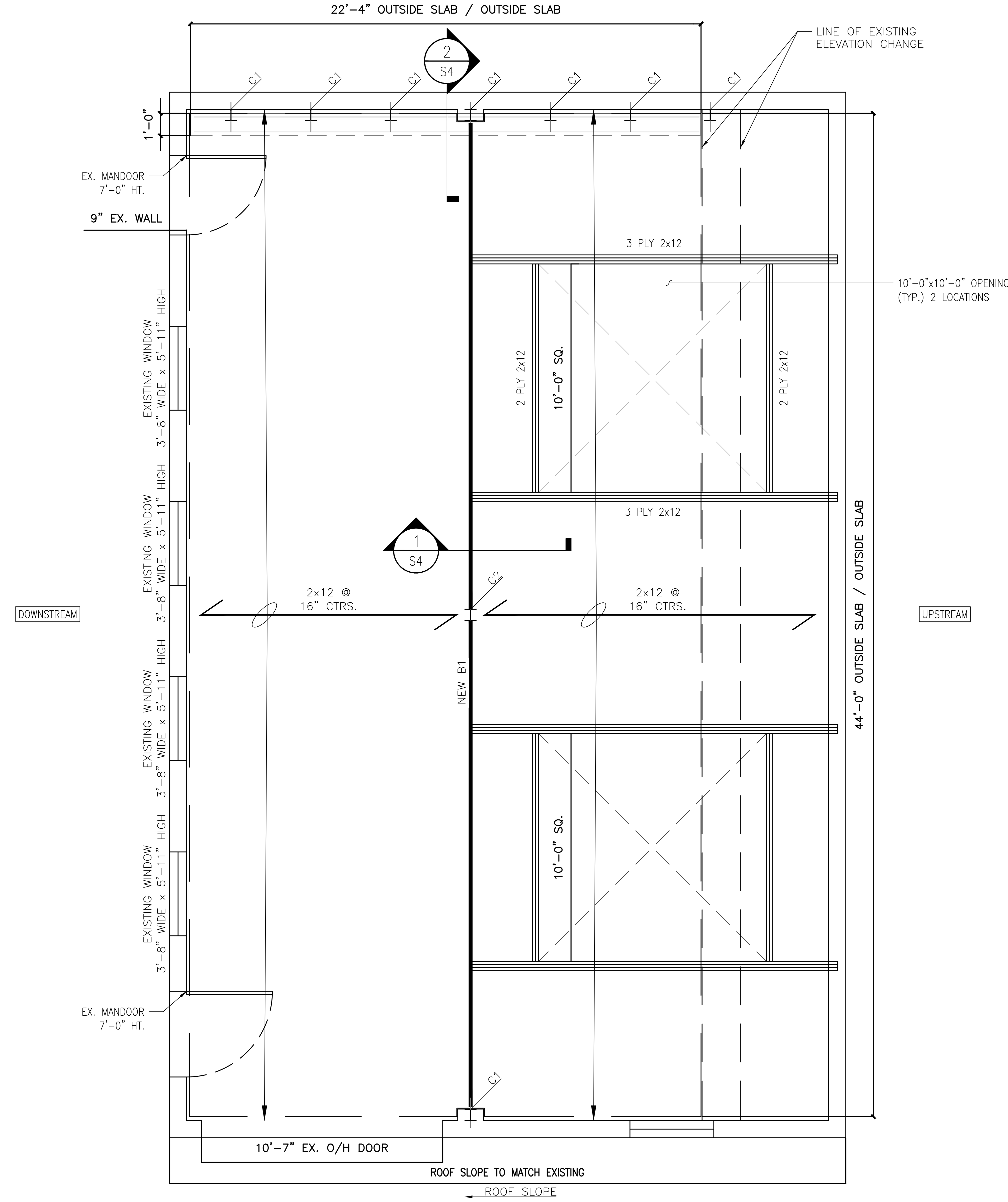


FOUNDATION PLAN: PROPOSED POWER HOUSE CONCRETE DECK UPGRADES
SCALE: 1:50



PROPOSED ROOF FRAMING PLAN
SCALE: 1:50

BEAM SCHEDULE

I	B1 = NEW W8x40 WITH CONTINUOUS NAILER PLATE

COLUMN SCHEDULE

C1	C1 = NEW W6x15 WITH 10"x10"x ⅜" BASE PLATE TO BE ANCHORED TO EXISTING WALL.
C2	C2 = NEW W6x15 WITH 10"x10"x ⅜" BASE PLATE.

N

KEY PLAN

ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER
F. R. PALMAY
100162809
2025-Jun-27
PROVINCE OF ONTARIO

DATE (DAY/MON/YR)	REV.	REVISION	BY	APP'D
26/06/2025	3	ISSUED FOR CONSTRUCTION	HD	FP
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CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

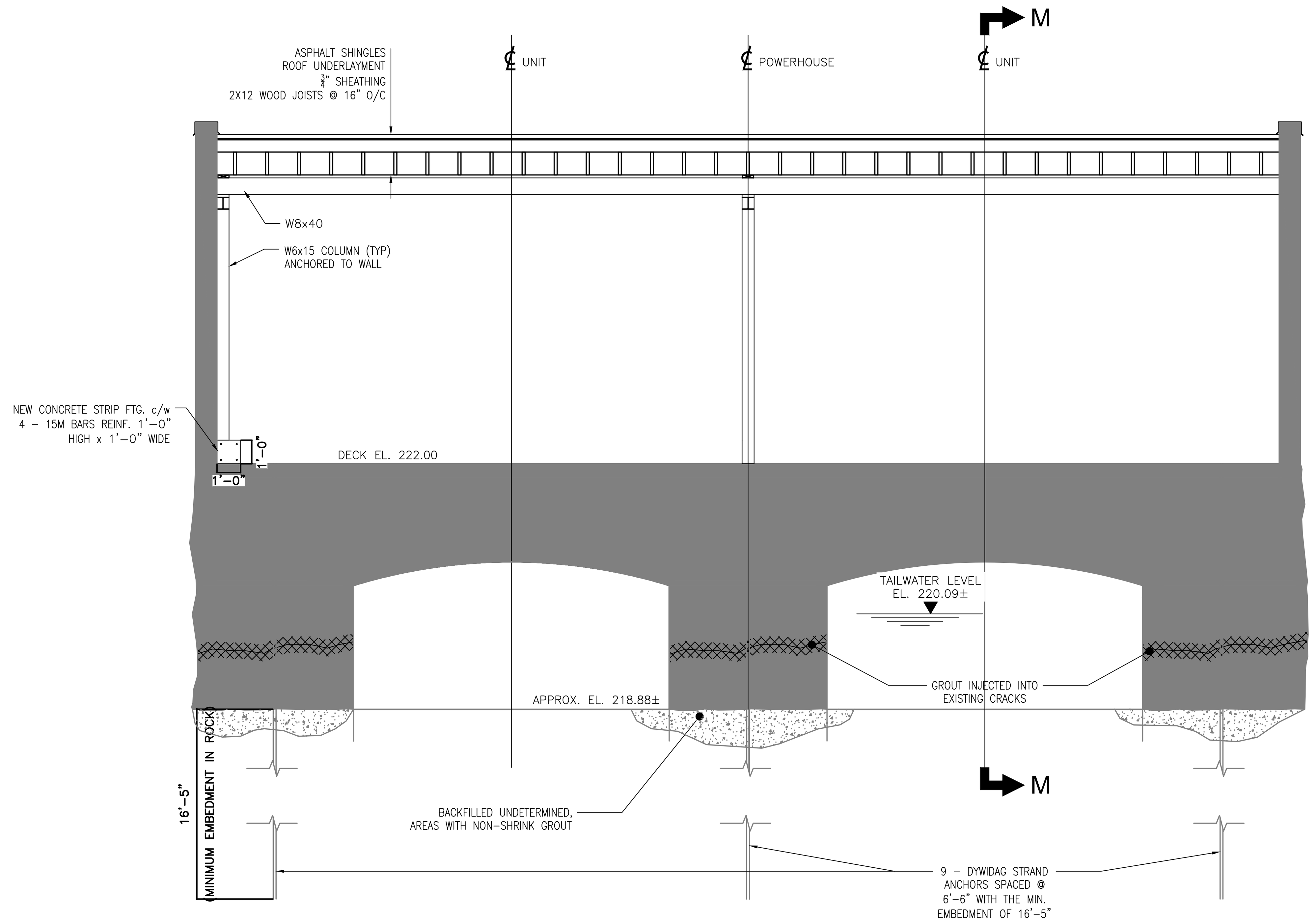
FOUNDATION UPGRADES & ROOF FRAMING PLANS

HD	FP	FP	FP
DRAWN	DESIGNED	CHECKED	APPROVED

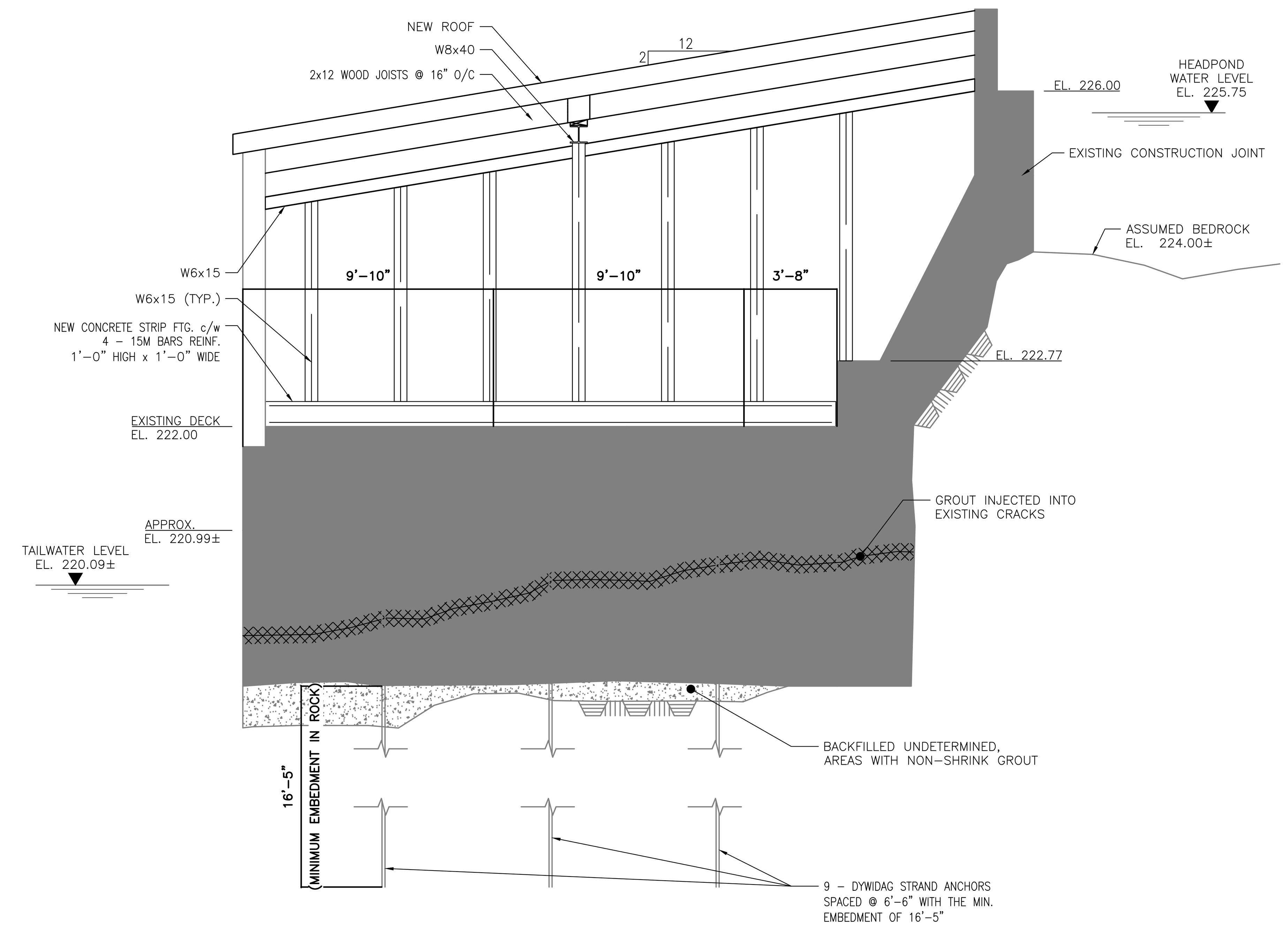
AS NOTED	JUNE 26, 2025
SCALE	DATE

23-1236	3	S3
PROJECT No.	REVISION	DRAWING

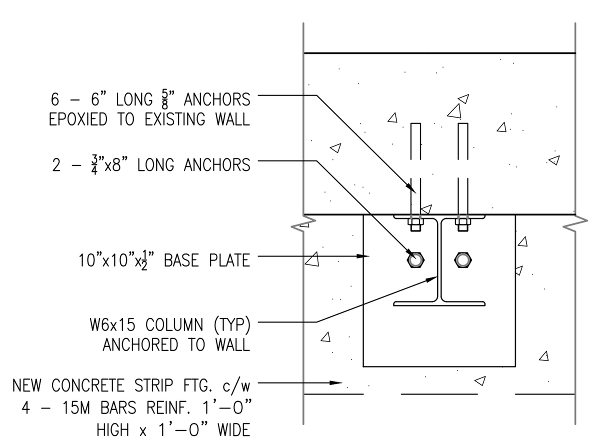
P:\2023\231236 - Burgess Dam Detailed Design\03.02 Current\03 Drawings\231236 - Burgess Dam - Power House - 2025-05-13.dwg



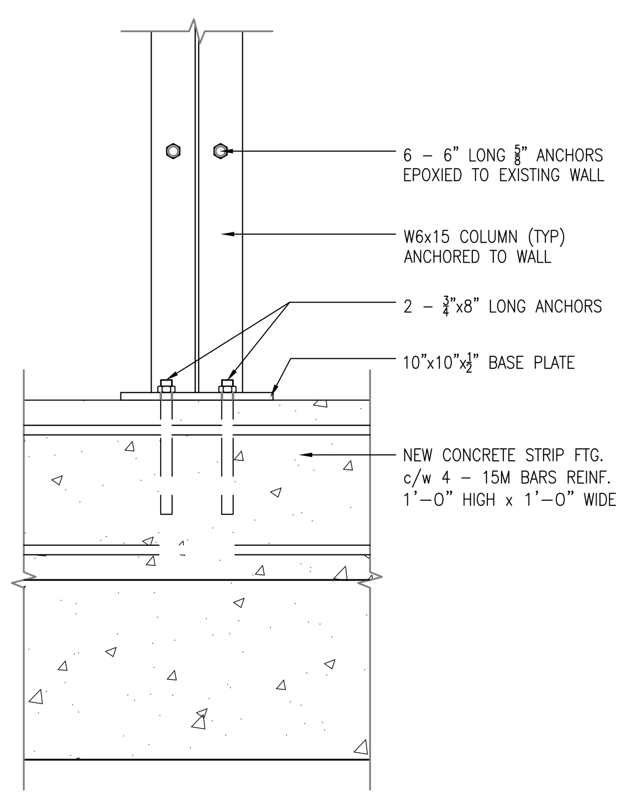
DOWNSTREAM FACE SECTION OF PROPOSED POWER HOUSE STRUCTURE ASSEMBLY
SCALE: 1:50



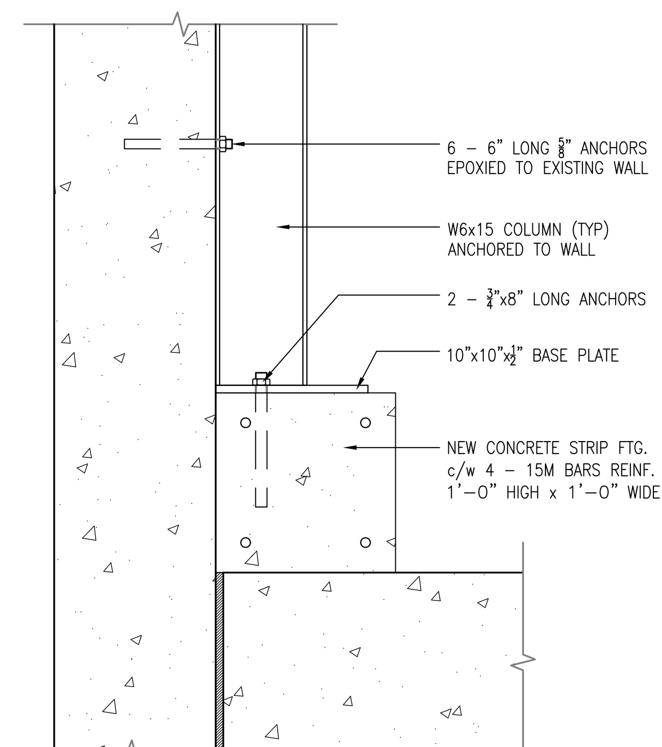
SECTION M-M: SIDE SECTION OF PROPOSED ROOF ASSEMBLY AND NEW WALL ASSEMBLY
SCALE: 1:50



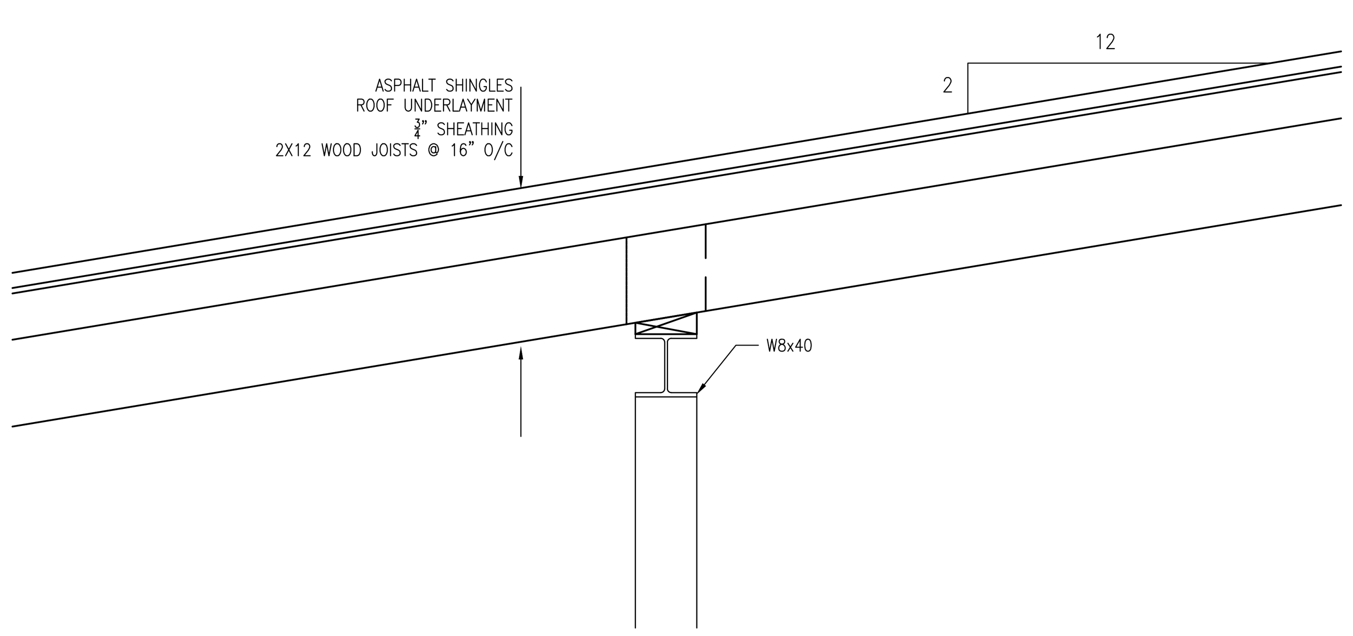
BASE PLATE AND ANCHOR DETAILS : DETAIL A1
SCALE: 1:10



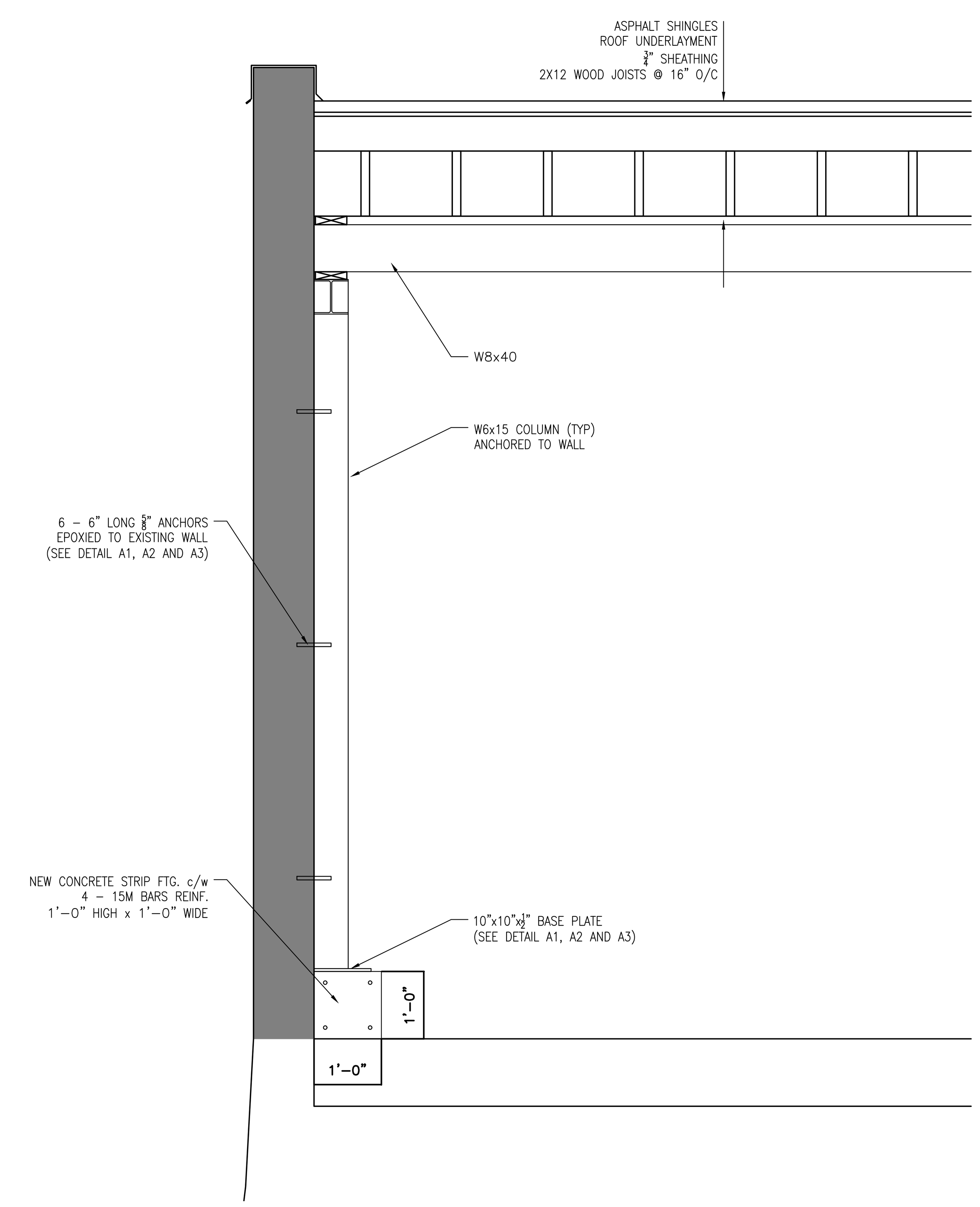
BASE PLATE AND ANCHOR DETAILS : DETAIL A2
SCALE: 1:10



BASE PLATE AND ANCHOR DETAILS : DETAIL A3
SCALE: 1:10



1 / S4 ROOF ASSEMBLY: DETAILS
SCALE 1:20



2 / S4 ROOF ASSEMBLY AND NEW CONCRETE STRIP FOOTING: DETAIL
SCALE 1:20

N

KEY PLAN

ENGINEER'S SEAL:

LICENSED PROFESSIONAL ENGINEER
F. R. PALMAY
100162809
2025-Jun-27
PROVINCE OF ONTARIO

DATE (DAY/MTH/YR)	REV.	REVISION	BY	APP'D
26/06/2025	3	ISSUED FOR CONSTRUCTION	HD	FP
13/05/2025	2	ISSUED FOR TENDER	HD	FP
20/06/2024	1	ISSUED FOR REVIEW	HD	FP
09/05/2024	0	ISSUED FOR REVIEW	HD	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

FOUNDATION UPGRADES AND ROOF FRAMING DETAILS

HD	FP	FP	FP
DRAWN	DESIGNED	CHECKED	APPROVED

AS NOTED	JUNE 26, 2025
SCALE	DATE

23-1236	3	S4
PROJECT No.	REVISION	DRAWING

P:\2023\231236 - Burgess Dam Detailed Design\03.02 Current\231236 - Burgess Dam - Power House - 2025-05-13.dwg

PHOTO 1
DOWNSTREAM SIDE
WEST ELEVATION LOOKING EAST

REMOVE EX. WOOD BEAM

REMOVE EX. WOOD
COLUMN AND BRACING

PHOTO 2
EXISTING BEAM AND ROOF STRUCTURE

REMOVE EX. WOOD BEAM

PHOTO 3
EXISTING BEAM AND ROOF STRUCTURE

REMOVE EX. WOOD BEAM

REMOVE ALL EX. WOOD JOISTS AND DECK PLANKING.

PHOTO 4
EXISTING BEAM AND ROOF STRUCTURE

REMOVE ALL EX. WOOD BRACING

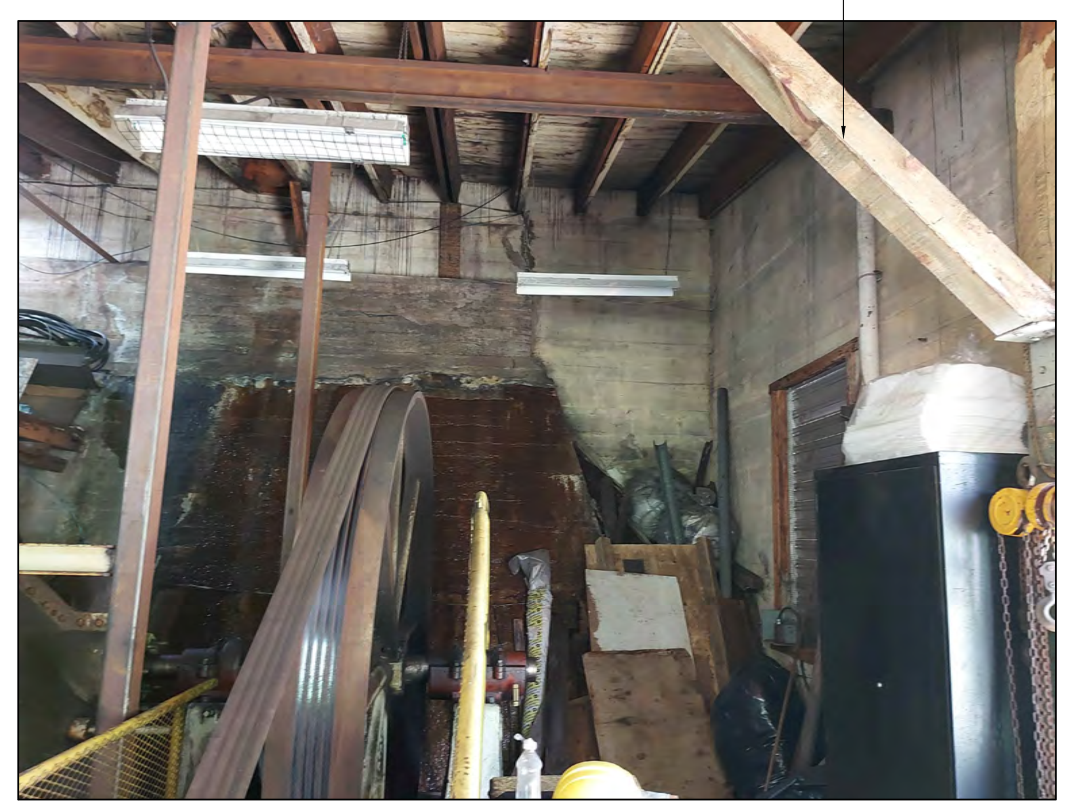


PHOTO 5
EXISTING BEAM AND ROOF STRUCTURE

PHOTO 6
EXISTING STEEL COLUMN BASE – NORTH WALL

PHOTO 7
EXISTING STEELWORK – NORTH WALL

PHOTO 8
EXISTING STEELWORK – NORTH WALL

REMOVAL NOTES

1. REMOVE EXISTING WOOD FRAMED ROOF STRUCTURE AND REPLACE WITH NEW.
2. REMOVE EXISTING WOOD TIMBER CENTRE BEAM AND EX. WOOD COLUMNS AND REPLACE WITH NEW STEEL.
3. REMOVE ALL EXISTING STEEL COLUMNS ON NORTH WALL AND REPLACE WITH NEW.

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REMOVAL PHOTOS

HD	FP	FP	FP
DRAWN	DESIGNED	CHECKED	APPROVED

AS NOTED	JUNE 26, 2025
SCALE	DATE

23-1236	3	S5
PROJECT No.	REVISION	DRAWING

P:\2023\231236 – Burgess Dam Detailed Design\03 Drawings\03.02 Current\231236 – Burgess Dam – Power House – 2025-05-13.dwg

P:\2023\231236 – Burgess Dam Detailed Design\03 Drawings\#CIVIL DRAWINGS\23-1236-Burgess Dam Design-IFC (June 25-25).dwg

GENERAL NOTES (CIVIL):

1. DO NOT SCALE DRAWINGS.
2. ALL STANDARDS ARE TO BE IN ACCORDANCE WITH CURRENT ONTARIO PROVINCIAL STANDARD DRAWINGS (OPSD), ONTARIO PROVINCIAL STANDARD SPECIFICATIONS (OPSS) AND ONTARIO BUILDING CODE (LATEST EDITION), UNLESS OTHERWISE NOTED.
3. NOTIFY ALL UTILITIES AND MUNICIPAL AUTHORITIES 72 HOURS PRIOR TO COMMENCEMENT OF CONSTRUCTION. UTILITY PERSONNEL TO BE ON SITE WHEN EXCAVATING ADJACENT TO UNDERGROUND UTILITIES. SUPPORT UTILITIES IN ACCORDANCE WITH THE DIRECTIONS AND GUIDELINES OF THE IMPACTED UTILITY.
4. THE LOCATION OF UTILITIES AND SERVICES SHOWN ON DRAWINGS IS APPROXIMATE AND MAY BE INCOMPLETE. CONFIRM EXACT LOCATION OF UTILITIES WITH MINISTRY, MUNICIPALITY OR UTILITIES. THE CONTRACTOR IS RESPONSIBLE TO DETERMINE LOCATIONS OF ALL UTILITIES PRIOR TO CONSTRUCTION AND WILL BE RESPONSIBLE FOR PROTECTING AGAINST DAMAGE. THE CONTRACTOR ASSUMES ALL LIABILITY FOR DAMAGE TO UTILITY AND ROAD WORKS.
5. COMPLY WITH THE REQUIREMENTS OF THE DISTRICT MUNICIPALITY OF MUSKOKA IN REGARD TO TRAFFIC FLOW ON MUNICIPAL STREETS. ALL NECESSARY TRAFFIC CONTROL AND SIGNAGE IS TO BE IN ACCORDANCE WITH MTO BOOK 7 REQUIREMENTS.
6. DESIGN DRAWINGS ARE TO BE READ IN CONJUNCTION WITH SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.
7. ALL DIMENSIONS ARE IN METERS, EXCEPT PIPE DIAMETERS, WHICH ARE IN MILLIMETERS, UNLESS SPECIFIED OTHERWISE.
8. THE CONTRACTOR IS RESPONSIBLE FOR ALL DETAILED LAYOUT WORK.
9. ALL SILTATION AND EROSION CONTROL MEASURES ARE TO BE IN PLACE PRIOR TO CONSTRUCTION AND SHALL REMAIN IN PLACE UNTIL THE DISTURBED AREAS ARE REINSTALLED TO THE EXISTING CONDITION IS BETTER.
10. THE CONTRACTOR IS RESPONSIBLE FOR ALL DE-WATERING AND WATER MANAGEMENT DURING CONSTRUCTION.
11. LATEST APPROVED DRAWINGS TO BE USED FOR CONSTRUCTION AND ALL DISCREPANCIES REPORTED TO THE ENGINEER.
12. TYPICAL DESIGN DETAILS SHOWN ON THE DRAWINGS SHALL GOVERN THE WORK. IF DETAILS ON OTHER DRAWINGS CONFLICT THE MOST STRINGENT SHALL GOVERN.
13. ALL INSTALLATIONS AND CONSTRUCTION TO BE COMPLETED TO THE SATISFACTION OF THE ENGINEER AND THE TOWNSHIP OF MUSKOKA LAKES IN ACCORDANCE WITH THE CONTRACT DOCUMETNS
14. COMPLETE ALL EXCAVATIONS AND FOUNDATION WORK IN ACCORDANCE WITH THE OCCUPATIONAL HEALTH & SAFETY ACT (LATEST EDITION).
15. RESTORATION OF ALL DISTURBED AREAS SHALL BE 75mm TOPSOIL AND SEED MIX UNLESS NOTED OTHERWISE.
16. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, DETAILS, AND ELEVATIONS OF THE EXISTING STRUCTURE THAT ARE RELEVANT TO THE WORK SHOWN ON THE DRAWING PRIOR TO THE COMMENCEMENT OF THE WORK. ANY DISCREPANCIES SHALL BE REPORTED TO THE CONTRACT ADMINISTRATOR AND THE PROPOSED ADJUSTMENT OF THE WORK REQUIRED TO MATCH THE EXISTING STRUCTURE SHALL BE SUBMITTED FOR APPROVAL.
17. CONTRACTOR ASSUMES ALL RESPONSIBILITY OF DESIGN, ERECTION AND REMOVAL OF TEMPORARY WORKS.
18. FORMWORK SHALL CONFORM TO THE REQUIREMENTS OF THE LATEST EDITION OF CSA A23.1.
19. DESIGN OF FORMWORK IS THE CONTRACTOR'S RESPONSIBILITY.
20. CONTRACTOR TO PROVIDE TEMPORARY BRACING, SUPPORTS AND/OR OTHER INSTALLATIONS NECESSARY TO MAINTAIN PLUMBNESS, TRUE, ALIGNMENT AND STABILITY OF THE STRUCTURE AND ALL OF ITS PARTS THROUGHOUT ALL ERECTION STAGES.
21. IT IS THE ULTIMATE RESPONSIBILITY OF THE CONTRACTOR/OWNER TO ENSURE THAT ALL REQUIRED PERMITS AND APPROVALS ARE OBTAINED & POSTED PRIOR TO PROCEEDING WITH CONSTRUCTION. THESE PERMITS/APPROVALS MAY INCLUDE (BUT ARE NOT NECESSARILY LIMITED TO):
    - MUNICIPAL BUILDING DEPARTMENT PERMIT TO CONSTRUCT (MULTIPLE PERMITS MAY BE REQUIRED)
    - GOVERNMENTAL REGULATORS (CDA/MNRF)
    - ELECTRICAL SAFETY AUTHORITY (ESA) PERMIT

FOUNDATION PREPARATION:

GENERAL:

1. THIS SPECIFICATION COVERS WORK ITEMS REQUIRED FOR CLEARING/ GRUBBING, STRIPPING, EXCAVATION AND FOUNDATION PREPARATION PRIOR TO PLACEMENT OF EMBANKMENT FILL MATERIALS AND CONSTRUCTION OF THE RELATED APPURTENANT STRUCTURES INCLUDING SPILLWAY, ACCESS ROADS, LAYDOWN AREA AND TEMPORARY DISPOSAL AREA ETC.

WATER MANAGEMENT:

1. THE EXISTING DAM CAN BE THE UPSTREAM COFFERDAM DURING REHABILITATION CONSTRUCTION. THE FOUNDATION PREPARATION FOR THE DOWNSTREAM WORK AREA WILL RESULT IN SOME SEEPAGE FROM UPSTREAM (THE EXISTING DAM FOUNDATION). THE SEEPAGE RATE IS CONSIDERED TO BE MANAGEABLE BY SUMPS AND PUMPS DURING CONSTRUCTION. IT IS THE CONTRACTOR'S RESPONSIBILITY FOR WATER MANAGEMENT DURING CONSTRUCTION.
2. SOME SEEPAGE AND /OR RUN-OFF WATER MAYBE ENCOUNTERED FROM SURROUND AREAS AT THE SITE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTROL OF RUN-OFF STORM EVENT DURING CONSTRUCTION.
3. THE CONTRACTOR'S PROPOSED WATER MANAGEMENT PLAN SHALL BE SUBMITTED TO THE CLIENT'S APPROVAL.

FOUNDATION PREPARATION:

CLEARING AND GRUBBING:

1. THE WORK TO BE DONE UNDER THIS ITEM COMPRISES THE SUPPLY OF ALL LABOUR, PLANT AND MATERIAL, AND THE PERFORMANCE OF ALL WORK NECESSARY FOR CLEARING AND GRUBBING THE CONSTRUCTION AREA, AS SHOWN ON THE DESIGN DRAWINGS.
2. CLEARING AND GRUBBING SHALL CONSIST OF CUTTING AND DISPOSING OF ALL TREES, HEDGES, SHRUBS ALIVE OR DEAD, DEBRIS AND ALL OTHER PERISHABLE MATERIALS, INCLUDING FALLEN TREES AND LOGS WHICH MAY BE VISIBLE ON THE SURFACE OF THE GROUND WITHIN THE CONSTRUCTION AREA. ALL TREES, HEDGES, AND SHRUBS SHALL BE CUT OFF AT THE NATURAL GROUND SURFACE IN ALL AREAS OF THE CONSTRUCTION AS SHOWN ON THE DESIGN DRAWINGS.
3. THE CONTRACTOR SHALL GIVE THE CLIENT OR ITS REPRESENTATIVE AT LEAST THREE (3) DAYS NOTICE OF INTENT TO CLEAR AREAS. THE LIMITS OF CLEARING AS APPROVED BY THE CLIENT OR ITS REPRESENTATIVE AND AS SPECIFIED HEREIN SHALL BE STRICTLY ADHERED TO.
4. REMOVE ALL CLEARED MATERIAL FROM THE SITE AND DISPOSED OF IN A MANNER ACCEPTABLE TO THE CLIENT OR ITS REPRESENTATIVE.
5. THE WORK SHALL BE CARRIED OUT STRICTLY IN ACCORDANCE WITH THE ENVIRONMENTAL ASSESSMENT PERMIT ISSUED FOR THE PROJECT. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING AND COMPLYING WITH ANY AND ALL PERMITS ASSOCIATE WITH CLEARING, GRUBBING AND PERMANENT DISPOSAL OF MATERIALS.
6. CLEARING, GRUBBING AND STRIPPING SHALL BE COMPLETED PRIOR TO THE START OF EARTHWORKS AND SHALL BE AT A MINIMUM DISTANCE OF FIVE (5) METERS FROM FILL PLACEMENT. CONTRACTOR CAN ONLY PROCEED WITH FILL PLACEMENT AFTER RECEIVING WRITTEN APPROVAL FROM THE CLIENT OR ITS REPRESENTATIVE.

STRIPPING, EXCAVATION AND STOCKPILING:

1. THE WORK SHALL COMPRISE THE SUPPLY OF ALL LABOUR AND PLANT, AND THE PERFORMANCE OF ALL WORK NECESSARY FOR THE STRIPPING, EXCAVATION AND STOCKPILING FOR SUBSEQUENT REUSE OR DISPOSING OF STRIPPED AND EXCAVATED MATERIALS FROM THE CONSTRUCTION AREA OF THE DAM, ACCESS ROAD AND LAYDOWN AREA ETC.
2. IT IS THE CONTRACTOR'S RESPONSIBILITY TO COORDINATE WITH THE CLIENT FOR CLEARANCE OF ANY BURIED UTILITIES, EXITING GROUND GRID AND INSTRUMENTATION AT THE DAM SITE. BURIED UTILITIES, GROUNDING GRID AND INSTRUMENTATION SHALL BE PROTECTED OR REMOVED WITHOUT DAMAGE BEFORE STRIPPING AND EXCAVATION ACTIVITY. NO STRIPPING OF ANY AREA SHALL START WITHOUT PRIOR WRITTEN APPROVAL FROM THE CLIENT OR ITS REPRESENTATIVE.
3. THE STRIPPING AND EXCAVATED MATERIALS AT THE EXISTING DAM SITE SHALL NOT BE REUSED FOR ENGINEERED DAM FILL MATERIALS. THE MATERIAL MAY NEED TO BE DISCARDED AT THE CLIENT OR ITS REPRESENTATIVE'S DISCRETION. THE STRIPPED MATERIAL NOT SUITABLE FOR RE-USE SHALL BE DISPOSED OF BY THE CONTRACTOR OFF SITE AND DISPOSED OF IN A MANNER ACCEPTABLE TO THE CLIENT OR ITS REPRESENTATIVE.
4. THE EXCAVATED MATERIALS FROM THE EXISTING DAM SITE AS PER DESIGN SHALL BE TEMPORARILY STOCKPILED AT THE DAM SITE APPROVED BY THE CLIENT OR ITS REPRESENTATIVE. STOCKPILES SHALL BE SLOPED SUFFICIENTLY FOR STABILITY. STOCKPILED MATERIALS SHALL BE PROTECTED WITHOUT CONTAMINATION AND EROSION.

GRANULAR FILL PLACEMENT AND COMPACTION:

GENERAL:

1. THIS SPECIFICATION DESCRIBES THE REQUIREMENTS FOR PLACEMENT AND COMPACTION OF GRANULAR FILL MATERIALS INCLUDING ROCKFILL/RIP RAP FOR EMBANKMENT DAM BUTTRESS, SPILLWAY, AND CREEK BANK EROSION PROTECTION CONSTRUCTION AS PER DESIGN DRAWINGS.

MATERIAL CODES AND TEST STANDARDS:

2. THE GRANULAR FILL MATERIALS SHALL FOLLOW THE ASTM STANDARDS INCLUDING:

ASTM	DESCRIPTION
ASTM D75	METHODS FOR SAMPLING AGGREGATES
ASTM D422	METHOD FOR PARTICLE SIZE ANALYSIS
ASTM D698	TEST METHOD FOR MOISTURE-DENSITY RELATIONS OF SOILS AND SOIL AGGREGATE MIXTURES USING 4.4LB. (2.5 KG) RAMMER AND 305mm (12") DROP
ASTM D854	TEST METHOD FOR SPECIFIC GRAVITY OF SOILS
ASTM D1140	TEST METHOD FOR AMOUNT OF MATERIALS IN SOILS FINER THAN THE NO. 200 SIEVE
ASTM D2216	METHOD FOR LABORATORY DETERMINATION OF WATER (MOISTURE) OF SOIL, ROCK AND SOIL-AGGREGATE MIXTURES
ASTM D2922	TEST METHODS FOR DENSITY OF SOIL AND SOIL-AGGREGATE IN PLACE BY NUCLEAR METHODS (SHALLOW DEPTH)
ASTM D3017	TEST METHODS FOR MOISTURE CONTENT OF SOIL AND SOIL-AGGREGATE IN PLACE BY NUCLEAR METHODS (SHALLOW DEPTH)
ASTM D5519	STANDARD TEST METHOD FOR PARTICLE SIZE ANALYSIS OF NATURAL AND MAN-MADE RIP RAP MATERIALS
ASTM D7263	STANDARD TEST METHODS FOR LABORATORY DETERMINATION OF DENSITY (UNIT WEIGHT) OF SOIL SPECIMENS

DIMENSIONAL TOLERANCES:

1. DIMENSIONS SHALL NOT BE LESS THAN THOSE SPECIFIED AND FINAL SLOPES SHALL NOT BE STEEPER THAN THOSE INDICATED ON THE DESIGN DRAWINGS. UNLESS OTHERWISE SHOWN ON THE DRAWINGS, THE ACCEPTABLE DIMENSIONAL TOLERANCES FOR THE FILL PLACEMENT SHALL BE THE FOLLOWING:
    - LEVEL TOLERANCE: +/- 0.1m
    - HORIZONTAL TOLERANCE +/- 0.3m
2. SHOULD ANY ERRORS IN SETTING OUT THE WORKS OCCUR, SUCH ERRORS SHALL BE CORRECTED AND ANY NECESSARY ADJUSTMENT TO PREVIOUSLY PLACED FILL MATERIALS RESULTING FROM SUCH ERRORS SHALL BE MADE GOOD TO THE SATISFACTION OF THE ENGINEER AT THE SITE PRIOR TO FURTHER PLACEMENT OF FILL MATERIALS AT NO COST TO THE CLIENT.

GRANULAR FILL MATERIALS:

1. THE GRANULAR FILL MATERIALS FOR THE WORK AS PER DESIGN DRAWING SHALL BE:
    - ROCKFILL
    - RIP RAP
    - FREE DRAINING GRANULAR FILL AS NOTED ON DESIGN DRAWINGS
2. THE GRANULAR FILL MATERIALS SHALL CONSIST OF NATURALLY OCCURRING (AS SPECIFIED HERE), OR CRUSHED, CLEAN, SOUND, MINERAL PARTICLES, NON-PLASTIC, FREE FROM ROOTS AND TOPSOIL OR OTHER DEBRIS. MATERIALS CONTAINING QUANTITIES OF ORGANIC MATTER, FLAT OR ELONGATED PARTICLES, DELETERIOUS MATERIAL SHALL NOT BE USED FOR GRANULAR FILL MATERIALS.
3. MATERIAL PLACED WHICH DOES NOT MEET THE SPECIFIED GRADATION REQUIREMENTS SHALL BE REMOVED, BLENDED OR OTHERWISE REWORKED TO PRODUCE A MATERIAL WHICH DOES.
4. OVERSIZED PARTICLES SHALL BE REMOVED, EITHER AT THE SOURCE OR DURING PLACEMENT OR BOTH. WHERE REDUCED LIFT THICKNESSES ARE REQUIRED, PARTICLES LARGER THAN 2/3 OF THE REDUCED LIFT THICKNESS SHALL BE REMOVED PRIOR TO COMPACTION.
5. THE GRANULAR FILL MATERIALS SHOULD BE NON-METAL LEACHING AND ARD POTENTIAL MATERIALS.
    - ROCKFILL

ROCKFILL MATERIAL FOR EMBANKMENT FILL SHALL BE FROM CRUSHED ROCK SPALLS IN ACCORDANCE WITH THE FOLLOWING GRADATIONS:

SIEVE SIZES (US STANDARD SIZE)	GRAIN SIZE (mm)	% PASSING
12"	300	100
6"	240	85
3"	150	50
1-1/2"	80	15

- SPILLWAY RIP RAP

RIP RAP MATERIAL FOR EMBANKMENT AND SPILLWAY EROSION PROTECTION SHALL BE WELL GRADED SIZES OF HARD STRONG DURABLE, DENSE, AND HIGH-QUALITY ROCK FRAGMENTS. THE FRAGMENTS SHALL BE GENERALLY CUBIC IN SHAPE WITH THE LARGEST DIMENSION NOT MORE THAN TWICE THE SMALLEST. THE RIP RAP SHALL MEET THE FOLLOWING CRITERIA:

- MAXIMUM SIZE (D_{MAX}): 750 mm (±50mm)
- MEDIAN SIZE (D_{50}): 370 mm
- MINIMUM SIZE (D_{MIN}): 180 mm (±50mm)

GRANULAR FILL PLACEMENT AND COMPACTION:

- GENERAL

1. THE WORK TO BE DONE SHALL COMPRISE THE SUPPLY OF ALL LABOUR, PLANT AND MATERIAL, AND THE PERFORMANCE OF ALL WORK NECESSARY FOR SUPPLYING, PLACING AND COMPACTING GRANULAR FILL MATERIALS, AS SHOWN ON THE DESIGN DRAWINGS.
2. GRANULAR FILL MATERIALS SHALL BE PLACED TO THE LINES AND GRADES SHOWN ON THE DRAWINGS AND AS REQUIRED BY THE ENGINEER BASED ON SPECIFIC SITE CONDITIONS.
3. PLACING AND SPREADING OF GRANULAR FILL MATERIAL IN ACCORDANCE WITH THESE SPECIFICATIONS SHALL BE PERFORMED IN SUCH A MANNER AS TO AVOID SEGREGATION OF SIZES AND TO OBTAIN A HOMOGENEOUS MASS.
4. THE SELECTION OF COMPACTION EQUIPMENT SHALL BE SUBJECT TO THE APPROVAL OF ENGINEER AND TO CONTINUING SATISFACTORY PERFORMANCE.
5. NATIVE MATERIAL, SUITABLE FOR BACKFILL, SHALL BE COMPACTED TO 98% STANDARD PROCTOR MAXIMUM DRY DENSITY.
6. GRANULAR MATERIAL, USED FOR BACKFILL, AND EMBEDMENT SHALL BE PLACED IN LAYERS 200mm IN DEPTH MAXIMUM AND COMPACTED TO 100% STANDARD PROCTOR MAXIMUM DRY DENSITY UNLESS OTHERWISE NOTED.
7. WHERE NECESSARY TO ACHIEVE THE SPECIFIED COMPACTION, WATER SHALL BE APPLIED BY CONTROLLED SPRINKLING TO THE GRANULAR FILL MATERIALS IN AMOUNTS AS APPROVED BY THE ENGINEER.
8. THE STOCKPILING OF GRANULAR FILL MATERIAL WILL BE INSPECTED AND APPROVED BY ENGINEER, AT APPROVED LOCATIONS, PROVIDED THAT CONTRACTOR EXERCISES EVERY PRECAUTION NECESSARY AND BEST PRACTICES TO PREVENT SEGREGATION OF PARTICLE SIZES. THE STOCKPILED MATERIAL SHALL MEET THE GRADATION REQUIREMENTS SPECIFIED ABOVE.
9. GRANULAR FILL MATERIAL SHALL NOT BE CONTAMINATED BY MIXING WITH OTHER MATERIALS. FILL MATERIALS WHICH HAVE BECOME CONTAMINATED SHALL BE REMOVED AND REPLACED AT NO ADDITIONAL COST TO THE CLIENT.
10. GRANULAR FILL MATERIALS SHALL BE PLACED, SPREAD AND COMPACTED IN A DIRECTION PARALLEL TO THE AXIS OF THE DAM EXCEPT AS OTHERWISE PERMITTED BY ENGINEER BASED ON THE SPECIFIC SITE CONDITION.
11. THE CONTRACTOR MAY USE AN ALTERNATIVE TYPE OF ROLLER OR EQUIPMENT FOR COMPACTION PROVIDED THAT THE PERFORMANCE OF SUCH EQUIPMENT IS DEMONSTRATED TO PRODUCE THE COMPACTION SPECIFIED TO MEET THE REQUIREMENT OF THE SPECIFICATION.
12. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR THE QUALITY OF WORK IN ACCORDANCE WITH THESE SPECIFICATIONS. ENGINEER WILL CARRY OUT QUALITY CONTROL TESTING OF CONTRACTOR'S OPERATIONS, AND CONTRACTOR SHALL COOPERATE IN EVERY WAY TO ENSURE THAT TESTS CAN BE PERFORMED AT ALL LOCATIONS AND TIMES AS REQUIRED BY THE ENGINEER. THE CONTRACTOR SHALL VARY THE METHOD OF PLACING AND COMPACTION IN ORDER TO MEET THE REQUIREMENTS OF THESE SPECIFICATIONS AS DETERMINED BY TESTING AND AS ACCEPTED BY THE ENGINEER.
13. THE CONTRACTOR SHALL SUBMIT TO THE ENGINEER THE SOURCE OF ALL THE REQUIRED GRANULAR FILL MATERIALS SPECIFIED IN THE DESIGN DRAWING AND ASSOCIATE TESTING DATA RESULTS WITHIN 7 DAYS OF AWARD OF CONTRACT. ADDITIONAL TESTING OF THE MATERIAL MAY BE REQUIRED BY THE ENGINEER DURING THE WORK TO DEMONSTRATE CONFORMANCE TO THE SPECIFIED GRADATIONS.

- ROCKFILL

1. EACH LAYER OF ROCKFILL MATERIAL SHALL BE COMPACTED BY NOT LESS THAN FOUR COMPLETE PASSES OF THE VIBRATORY ROLLER EQUIPMENT. VIBRATORY ROLLER SHALL HAVE A SMOOTH STEEL DRUM, EQUIPPED WITH CLEANING DEVICES, EITHER PULLED OR SELF-PROPELLED. COMPACTOR SHALL HAVE A STATIC WEIGHT OF 10 TONNES ON THE AXIS OF THE DRUM. THE VIBRATION FREQUENCY OF THE VIBRATORY ROLLER DURING OPERATION SHALL BE BETWEEN 20HZ AND 35HZ AND THE COMPACTION (CENTRIFUGAL) FORCE DEVELOPED BY THE ROLLER AT 30 HZ SHALL NOT BE LESS THAN 19 T. THE POWER OF THE ENGINE DRIVING THE VIBRATORY ROLLER SHALL BE SUFFICIENT TO MAINTAIN THE SPECIFIED FREQUENCY AND CENTRIFUGAL FORCE UNDER THE MOST ADVERSE CONDITIONS WHICH MAY BE ENCOUNTERED DURING COMPACTION OF THE FILL.
2. THE VIBRATORY ROLLER SHALL MAINTAIN A MINIMUM DISTANCE OF 1.5m FROM THE EXISTING CONCRETE DAM FOR COMPACTION. ROCKFILL MATERIAL AROUND THE EXISTING CONCRETE DAM SHALL BE LAID IN 300mm LAYERS AND SHALL BE COMPACTED WITH HAND COMPACTORS TO 98% SPMDD.
3. ROCKFILL MATERIAL UNDER WATER SHALL BE PLACED WITH MECHANICAL EQUIPMENT AND COMPACTED UNDER WATER WITH THE BACK OF EXCAVATOR BUCKET SO THAT NO DEFORMATION CAN BE OBSERVED. EACH LAYER OF ROCKFILL MATERIAL UNDER WATER SHALL NOT BE MORE THAN 250mm THICK BEFORE COMPACTION.
4. IF REQUIRED BY THE ENGINEER, CONTRACTOR SHALL VARY THE NUMBER OF PASSES OF COMPACTION EQUIPMENT FROM THE MINIMUM FOUR COMPLETE PASSES SPECIFIED, IN ORDER TO ACHIEVE THE SPECIFIED DENSITY.

- RIP RAP

1. RIP RAP SHALL BE PLACED BY SUITABLE MECHANICAL EQUIPMENT SO THAT INTERMIXING OF ADJOINING ROCKFILL AND RIP RAP DOES NOT OCCUR DURING PLACING AND SO THAT MINIMUM BREAKAGE OF ROCK FRAGMENTS OCCURS.
2. RIP RAP NEED NOT BE COMPACTED BUT PLACED CAREFULLY IN SUCH A MANNER THAT LARGER ROCK FRAGMENTS ARE UNIFORMLY DISTRIBUTED AND SMALLER ROCK FRAGMENTS FILL VOIDS BETWEEN LARGER PIECES. HAND PLACING SHALL BE REQUIRED TO THE EXTENT NECESSARY TO SECURE RESULTS SPECIFIED ABOVE. THE SPECIFIED ROCK SIZES AND GRADING APPLY TO RIP RAP IN-PLACE.

CONCRETE CAST-IN-PLACE AND REPAIR:

GENERAL:

THE CONCRETE CAST-IN-PLACE AND REPAIR WORK FOR THIS PROJECT MAINLY CONSISTS OF:

1. REMOVING THE CONCRETE STRUCTURE AS SHOWN AND DESCRIBED ON THE DRAWINGS AND IN THIS SPECIFICATION.
2. PREPARING THE SURFACE FOR THE CONCRETE CAST-IN-PLACE AS SHOWN ON THE DRAWINGS, INCLUDING ABRASIVE CLEANING, CLEANING OF EXISTING REINFORCEMENT, AND APPLYING BONDING AGENT TO THE SURFACE.
3. SUPPLYING MATERIALS AND THE MIXING AND PLACING OF CONCRETE AS SHOWN AND DESCRIBED ON THE DRAWINGS AND IN THIS SPECIFICATION INCLUDING VIBRATING, FINISHING, AND CURING.
4. SUPPLYING, FABRICATING, CONSTRUCTING, MAINTAINING AND REMOVING TEMPORARY WORKS, INCLUDING FALSEWORK AND FORMWORK.
5. THE QUALITY CONTROL (QC) TESTING OF ALL CONCRETE MIX MATERIALS.

REFERENCES AND STANDARDS:

1. CSA A23.1/A23.2, CONCRETE MATERIALS AND METHODS OF CONCRETE CONSTRUCTION/METHODS OF TEST AND STANDARD PRACTICES FOR CONCRETE.
2. CAN/CSA A3001, CEMENTITIOUS MATERIALS FOR USE IN CONCRETE.
3. INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI) TECHNICAL GUIDELINE NO. 310.1R, GUIDE FOR SURFACE.
4. PREPARATION FOR THE REPAIR OF DETERIORATED CONCRETE RESULTING FROM REINFORCING STEEL CORROSION.
5. CAN/CSA G30.18, BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT.
6. ACI 117, STANDARD TOLERANCES FOR CONCRETE CONSTRUCTION AND MATERIALS.
7. REINFORCING STEEL INSTITUTE OF CANADA, (RSIC), MANUAL OF STANDARD PRACTICE.
8. GUIDE TO CONCRETE REPAIR (2ND EDITION). U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION. AUGUST 2015.

CONCRETE REMOVAL:

1. ALL AREAS OF THE EXISTING CONCRETE TO BE REMOVED WILL BE MARKED BY THE CONTRACTOR AS SHOWN ON DRAWINGS. THE CONCRETE REMOVAL AREAS SHALL BE CONFIRMED AND APPROVED BY THE ENGINEER BEFORE PROCESSING.
2. THE CONTRACTOR SHALL REMOVE THE EXISTING CONCRETE AS THE DIMENSIONS SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE ENGINEER. ANY DAMAGE CAUSED BY THE CONTRACTOR TO ANY PORTION OF THE STRUCTURE NOT INTENDED FOR THE REMOVAL SHALL BE REPAIRED/RECOVERED BY THE CONTRACTOR, AT THE CONTRACTOR'S EXPENSE, TO THE SATISFACTION OF THE ENGINEER.
3. THE CONTRACTOR SHALL EXERCISE CAUTION AND TAKE CARE NOT TO DAMAGE ANY EXISTING DAM, POWERHOUSE, ROAD, AND EARTH RETAINING STRUCTURE, INTENDED TO REMAIN IN PLACE.

CONCRETE CAST-IN-PLACE:

1. CONCRETE MIX DESIGN SHALL BE AS FOLLOWS UNLESS NOTED OTHERWISE:
    - MINIMUM 28-DAY COMPRESSIVE STRENGTH – 30 MPA, CLASS F1.
    - CEMENTITIOUS MATERIAL: TYPE GU WITH UP TO 30% FLY ASH.
    - MAXIMUM WATER/CEMENT RATIO BY WEIGHT: 0.45
    - SLUMP: 75mm +- 25mm (BEFORE ADDITION OF SUPERPLASTICIZER).
    - AGGREGATE: 20mm MAX. NOMINAL SIZE.
    - AIR CONTENT AS PER CSA A23.1
    - EXECUTION ACCORDING TO CSA A23.1, LATEST EDITION.
    - CURING ACCORDING TO CSA A23.1, LATEST EDITION.
2. ALL CONCRETE SHALL MEET THE REQUIREMENTS OF CSA A23.1 AND A23.2 STANDARDS, LATEST EDITION.
3. AGGREGATES SHALL BE TESTED FOR ALKALI REACTIVITY AS PER CSA A23.1 AND A23.2 AND APPROVED BY THE ENGINEER.
4. BACK-FILLING AGAINST CAST-IN-PLACE CONCRETE WALLS SHALL NOT COMMENCE UNTIL CONCRETE IN THE WALL HAS ACHIEVED DESIGN STRENGTH.

GEOTEXTILE:

GENERAL:

GEOTEXTILE WILL BE USED TO:

- PROVIDE EROSION CONTROL FOR OVERFLOW ROCKFILL/RIP RAP FILL OF DOWNSTREAM SPILLWAY CHANNEL AND/OR THE AREA SUBJECT TO FLOW/RUN OFF EROSION AND OR SCOUR DURING DAM OPERATION.
- INTERFACE BETWEEN THE ROCKFILL/RIP RAP AND EXCAVATED NATIVE SOIL FOR THE CREEK BANK EROSION PROTECTION.
- SEPARATE AND PREVENT MIXING OF MATERIALS OF DIFFERENT GRADING AS REQUIRED IN THE DESIGN DRAWING

APPLICABLE CODES AND STANDARDS:

THE FOLLOWING CODES AND STANDARDS APPLY FOR THE USE OF GEOTEXTILES:

1. ASTM D 4354 PRACTICE FOR SAMPLING OF GEOSYNTHETICS FOR TESTING.
2. ASTM D 4355 TEST METHOD FOR DETERIORATION OF GEOTEXTILES FROM EXPOSURE TO ULTRAVIOLET LIGHT AND WATER (XENON-ARC TYPE APPARATUS).
3. ASTM D 4491-99A, STANDARD TEST METHODS FOR WATER PERMEABILITY FOR GEOTEXTILES BY PERMITTIVITY.
4. ASTM D 4595-86 (2001), STANDARD TEST METHOD FOR TENSILE PROPERTIES OF GEOTEXTILES BY THE WIDE-WIDTH STRIP METHOD.
5. ASTM D 4632 TEST METHOD FOR GRAB BREAKING LOAD AND ELONGATION OF GEOTEXTILES.
6. ASTM 4716-01, TEST METHOD FOR DETERMINING THE (IN-PLANE) FLOW RATE PER UNIT WIDTH AND HYDRAULIC TRANSMISSIVITY OF A GEOSYNTHETIC USING A CONSTANT HEAD.
7. ASTM D 4751-99A, STANDARD TEST METHOD FOR DETERMINING APPARENT OPENING SIZE OF A GEOTEXTILE.
8. ASTM D4759, PRACTICE FOR DETERMINING THE SPECIFICATION CONFORMANCE OF GEOSYNTHETICS.
9. ASTM D4833, TEST METHOD FOR INDEX PUNCTURE RESISTANCE OF GEOTEXTILES, GEOMEMBRANES AND RELATED PRODUCTS.
10. ASTM D4873, GUIDE FOR IDENTIFICATION, STORAGE, AND HANDLING OF GEOTEXTILES.
11. ASTM D4884, STANDARD TEST METHOD FOR STRENGTH OF SEWN OR THERMALLY BONDED SEAMS OF GEOTEXTILES.
12. ASTM D5261, TEST METHOD FOR MEASURING MASS PER UNIT AREA OF GEOTEXTILES.
13. ASTM D5321, STANDARD TEST METHOD FOR DETERMINING THE COEFFICIENT OF SOIL AND GEOSYNTHETIC OR GEOSYNTHETIC AND GEOSYNTHETIC FRICTION BY THE DIRECT SHEAR METHOD.
14. GRI STANDARD GT12(A) (EDITORIAL CHANGES), GEOSYNTHETIC RESEARCH INSTITUTE. DECEMBER 19, 2012.

SHIPPING, STORAGE, AND HANDLING:

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SHIPPING, STORAGE, AND HANDLING OF GEOTEXTILE, AS PER THE ASTM, AND AS WELL AS ANY RELATED COSTS, INCIDENTAL OR OTHERWISE, INCLUDED IN THE INSTALLATION PRICE.
2. THE GEOTEXTILE SHALL ADHERE TO THE LABELLING REQUIREMENTS OF ASTM D 4873 AND SHIPPING, HANDLING AND STORAGE SHALL ADHERE TO ASTM D 4873.

MATERIAL TYPE:

1. THE GEOTEXTILE SHALL BE OF NON-WOVEN SYNTHETIC FIBER, SUPPLIED IN ROLLS:
    - MINIMUM WIDTH OF 4.6m;
    - MINIMUM LENGTH OF 91m; AND
    - COMPOSED OF MINIMUM 85% BY MASS OF POLYPROPYLENE WITH INHIBITORS ADDED TO BASE PLASTIC TO RESIST DETERIORATION BY ULTRA-VIOLET AND HEAT EXPOSURE FOR 60 DAYS.
2. PHYSICAL PROPERTIES OF THE GEOTEXTILE SHALL INCLUDE:

PHYSICAL PROPERTY	VALUE	UNIT	ASTM
NOMINAL THICKNESS	4.1	mm	ASTM D 5199
MASS PER UNIT AREA	540	G/m2	ASTM D 5261
TENSILE STRENGTH	1.64	KN	ASTM D 4632
ELONGATION AT BREAK	50%	–	ASTM D 4632
TRAPEZOIDAL TEAR STRENGTH	0.64	KN	ASTM D 4533
PUNCTURE STRENGTH	1.0	KN	ASTM D 4833
MINIMUM MULLEN BURST	5170	KPA	–
UV RESISTANCE	MINIMUM 70%	–	ASTM D4355
APPARENT OPENING SIZE	0.2	mm	ASTM D 4751
MINIMUM WATER FLOW RATE	2,000	L/MIN/m^2	ASTM D 4491
PERMITTIVITY	0.7	S^{-1}	ASTM D 4491

3. MATERIAL ACCEPTANCE SHALL ADHERE TO ASTM D 4759.

GEOTEXTILE PLACEMENT:

1. PLACE GEOTEXTILE ON APPROVED SUBGRADE, FOLLOWING THE REQUIRED EXCAVATION AND STRIPPING, SITE PREPARATION FOR GEOTEXTILE INSTALLATION AND SMOOTH-ROLLING THE PREPARED SUBGRADE SURFACE.
2. PLACE GEOTEXTILE SMOOTH AND FREE OF TENSION STRESS, FOLDS, WRINKLES AND CREASES.
3. GEOTEXTILE PLACED ON SLOPES SHALL BE STARTED FROM THE TOE TO THE UPPER EXTENT OF THE SLOPE.
4. THE GEOTEXTILE SHALL BE JOINED BY OVERLAPS, THE MINIMUM OVERLAP BEING 500mm.
5. ANY DAMAGED GEOTEXTILE SHALL BE PROMPTLY REPLACED OR REPAIRED TO THE APPROVAL OF THE ENGINEER AT THE SITE.
6. PROTECT PLACED GEOTEXTILE FROM DISPLACEMENT, DAMAGE OR DETERIORATION BEFORE, DURING AND AFTER PLACEMENT OF MATERIAL LAYERS.

STRUCTURAL STEEL:

1. STRUCTURAL STEEL SHALL CONFORM TO CAN/CSA-S19.
2. STRUCTURAL STEEL SHALL BE NEW G40.21 350W MATERIAL UNLESS NOTED OTHERWISE.
3. HOLLOW STRUCTURAL SECTIONS SHALL BE ASTM A500 GRADE C OR G40.21 350W MATERIAL UNLESS NOTED OTHERWISE
4. ANGLES CHANNELS AND PLATES TO BE G40-.21-300W MATERIAL UNLESS NOTED OTHERWISE.
5. WELDING TO CSA W59 WELDED STEEL CONSTRUCTION, LATEST EDITION.
6. FABRICATOR SHALL BE CERTIFIED ACCORDING TO CSA STANDARD W47.1 DIVISION 1 OR 2, LATEST EDITION.
7. ALL BOLTED CONNECTIONS TO BE BEARING TYPE. THE BOLTS SHALL BE BROUGHT TO TO A SNUG TIGHT CONDITION AS DEFINED BY CAN/CSA S16.1.
8. MEMBERS SHALL BE CONNECTED FOR THE FORCES INDICATED. WHERE THESE FORCES ARE NOT SHOWN, COMPRESSION AND TENSION SHOULD BE CONNECTED FOR 50% OF THE EFFECTIVE STRENGTH OF THAT MEMBER AND BEAMS CONNECTED FOR THE FULL UNIFORM CAPACITY FOR THAT SPAN.
9. SPLICES SHALL BE DESIGNED TO DEVELOP THE FULL CAPACITY OF THAT MEMBER AT THE POINT OF SPLICE. MEMBERS SHALL NOT BE SPLICED AT THE MAXIMUM STRESS POINTS. NO SPLICE IS TO BE MADE UNLESS SHOWN ON THE DRAWINGS OR REVIEWED AND APPROVED BY THE CONSULTANT.
10. PROVIDE WELDED STIFFENERS PLATES ON BOTH SIDES OF BEAMS AT POINTS OF CONCENTRATED LOADS INCLUDING BEAMS SUPPORTING COLUMNS OR RUNNING OVER THE TOP OF COLUMNS.
11. ANCHOR BOLTS TO ASTM A307, UNLESS NOTED OTHERWISE.
12. GROUT (NON-SHRINK) UNDER BEARING PLATES SHALL BE M-BED BY STERNSON LTD. OR APPROVED EQUAL.
13. NO DRILLING OR CUTTING AFTER FABRICATION OF STRUCTURAL STEEL UNLESS APPROVED BY THE ENGINEER.
14. ALL FIELD WELDED CONNECTIONS TO BE INSPECTED BY FABRICATION CONTRACTOR.
15. PROVIDE WEEP HOLES IN ALL HSS STRUCTURAL.

MATERIAL TESTING AND INSPECTIONS:

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ENGAGING THE SERVICES OF A CERTIFIED TESTING AND INSPECTION COMPANY TO COMPLETE:
    - COMPACTION TESTING ON ALL INSTALLED GRANULAR MATERIAL.
    - TESTING OF ALL PLACED CONCRETE/CEMENTITIOUS GROUT
    - IN ACCORDANCE WITH CAN/CSA-A23.2-14.
    - ROCK ANCHOR PULL TEST.
    - ALL OTHER QUALITY CONTROL REQUIREMENTS AS OUTLINED IN OPS SPECIFICATIONS.

POSTED TENSIONED ANCHOR DOWEL:

GENERAL:

1. THE WORK TO BE DONE SHALL COMPRISE THE SUPPLY OF ALL LABOUR, PLANT AND MATERIAL, AND THE PERFORMANCE OF ALL WORK NECESSARY FOR SUPPLYING, DRILLING, INSTALLATION, AND GROUTING, POST-TENSIONING TO THE DESIGN LOAD FOR THE ANCHOR DOWELS, AS SHOWN ON THE DESIGN DRAWINGS.

ROCK DOWEL INSTALLATION:

1. ALL ROCK DOWEL LOCATIONS AND ORIENTATIONS SHALL BE COORDINATED WITH THE ENGINEER PRIOR TO DRILLING. BORE HOLES DRILLED WITHOUT PRIOR APPROVAL FROM THE ENGINEER MAY BE REJECTED AT THE DISCRETION OF THE ENGINEER. REJECTED BORE HOLES SHALL BE FILLED WITH GROUT AND NEW HOLES SHALL BE DRILLED AT THE CONTRACTOR'S EXPENSE.
2. THE LOCATES FOR DRILLING SHALL BE CLEAR OF BURIED UTILITIES. IT IS THE CONTRACTOR'S RESPONSIBILITY TO THE CLEARANCE OF THE DRILLING AREA.
3. UNLESS OTHERWISE SPECIFIED AND APPROVED IN WRITING BY THE ENGINEER, ALL BORE HOLES SHALL BE DRILLED USING A LOW IMPACT ROTARY DRILL TO PREVENT DAMAGE TO THE EXISTING DAM CONCRETE STRUCTURE. AIR POWERED DRILLS ARE NOT ALLOWED TO PREVENT DAMAGE TO THE EXISTING CONCRETE STRUCTURE. ANY DAMAGE SHALL BE REPORTED TO THE ENGINEER FOR CORRECTIVE. CORRECTIVE ACTION AS SPECIFIED BY THE ENGINEER WILL BE COMPLETED AT THE CONTRACTOR'S EXPENSE.
4. ALL BORE HOLES SHALL BE CLEANED OUT USING COMPRESSED AIR PRIOR TO INSERTING THE REINFORCING DOWEL. THE ENGINEER RESERVES THE RIGHT TO WITNESS THE CLEANING PROCESS AND INSERTION OF DOWELS. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IN ADVANCE OF CLEANING AND INSERTION OF DOWELS SO THAT DEPTH AND CLEANLINESS OF THE DRILLED HOLES CAN BE CONFIRMED. DOWELS GROUTED WITHOUT INSPECTION SHALL BE REJECTED AND REPLACED AT NO ADDITIONAL COST TO THE CLIENT.
5. ALL ROCK DOWELS SHALL BE GROUTED IN THE PRESENCE OF THE ENGINEER. GROUTING PERFORMED WITHOUT THE ENGINEER PRESENT SHALL BE REJECTED AND THE ROCK DOWELS REPLACED AT THE CONTRACTOR'S EXPENSE.
6. ALL ROCK DOWELS SHALL BE CENTERED IN THE DRILLED HOLE USING CENTRALIZERS. CONTRACTOR SHALL ADJUST CENTRALIZER SIZE ACCORDING TO DRILLED HOLE DIAMETER IF NECESSARY. ANY ROCK DOWEL NOT CENTERED SHALL BE REJECTED AND REPLACED AT THE CONTRACTOR'S EXPENSE. ANCHORS OR DOWELS SHALL NOT DEVIATE MORE THAN 8% OF THE DRILLED DIAMETER FROM THE CENTER OF THE HOLE. ALL DOWELS SHALL BE APPROVED PRIOR TO INSERTION OF CEMENT GROUT PLUG.
7. THE CONTRACTOR SHALL KEEP THE AREA CLEAN DURING GROUTING. ANY SPILLED GROUT SHALL BE CLEANED IMMEDIATELY AT NO ADDITIONAL COST TO THE CLIENT.
8. SURFACE GROUT SHALL BE SCULPTED AND STAINED TO MATCH EXISTING SURROUNDING COLOR, TEXTURE, AND SHAPE CONDITIONS.
9. ROCK DOWEL MATERIAL, DIAMETER AND EMBEDMENT SHALL BE AS SPECIFIED ON THE DESIGN DRAWING. EMBEDMENT LENGTH SHALL BE THE ACTUAL LENGTH OF BAR SET BENEATH THE EXISTING CONCRETE SURFACE AND ENCASED INTO GROUT. THE CONTRACTOR SHALL ADJUST THE DRILL DEPTH TO MEET THE REQUIRED MINIMUM EMBEDMENT LENGTHS AND ACCOUNT FOR TOP/BOTTOM CLEARANCE AND/OR GROUT PLUG.

CONCRETE NOTES:

1. CONCRETE IS SPECIFIED USING ALTERNATIVE NUMBER OF CSA A23.1 TABLE 2 AS FOLLOWS:

TABLE 1:

PARAMETER	EXTERIOR SLAB
EXPOSED CLASS (TABLE 1)	C-2
AIR CONTENT CATEGORY (TABLE 4)	1
MAX. W/C RATION (TABLE 2)	0.5
CURING TYPE (TABLE 2)	2
MIN. COMPRESSIVE STRENGTH	32MPa

2. AT LEAST TWO (2) WEEKS PRIOR TO THE PLACEMENT OF CONCRETE THE CONTRACTOR SHALL SUBMIT THE FOLLOWING TO THE ENGINEER FOR REVIEW:
    - A VALID 'CERTIFICATE OF READY MIXED CONCRETE PRODUCTION FACILITIES' OR A VALID 'CERTIFICATE OF MOBILE MIX CONCRETE PRODUCTION FACILITIES' AS ISSUED BY THE 'READY MIXED CONCRETE ASSOCIATION OF ONTARIO' TO THE PLANT BEING USED.
    - A COMPLETED 'CONCRETE MIXED DESIGN SUBMISSION FORM'
    - A QUALITY PLAN THAT DESIGNATES A SPECIFIED SLUMP OR SOME OTHER MEASURE OF WORKMANSHIP.
    - TEST RESULTS TO SHOW COMPLIANCE WITH CSA A23.1.
    - AIR VOID SYSTEM OF HARDENED CONCRETE.
    - STATISTICAL STRENGTH TEST ANALYSIS TO CONFIRM THE STRENGTH LEVEL FOR EACH CLASS OF CONCRETE INCLUDING THE EXPECTED 7/28 DAY STRENGTH RATIO
3. FABRICATION AND PLACEMENT OF REINFORCING STEEL TO BE IN ACCORDANCE WITH CSA A23.1 AND THE REINFORCING STEEL INSTITUTE OF CANADA'S 'REINFORCING STEEL MANUAL OF STANDARD PRACTICE'.
4. REINFORCING STEEL SHALL BE DEFORMED BARS CONFORMING TO CSA G30.18 M92, Fy=400 MPa (GRADE 400)
5. CONCRETE SHALL NOT BE POURED UNTIL REBAR HAS BEEN INSPECTED BY THE ENGINEER.
6. WHERE REBARS JOIN AT CORNERS PROVIDE CORNER BARS FOR LAPS.
7. CONCRETE COVER FOR REINFORCING STEEL AS PER TABLE 17 OF CSA A23.1
    - ALL CONCRETE CAST AGAINST EARTH 75mm (3")
    - ALL CONCRETE CAST IN FORMS BUT EXPOSED TO EARTH OR WEATHER 50mm (2")
    - BARS 20M AND SMALLER IN WALLS AND SLABS 32mm (1 1/4")
    - CONCRETE NOT EXPOSED TO EARTH AND WEATHER 25mm (1") OR 1.5 NOMINAL BAR DIAMETER
8. ALL REINFORCING BARS SHALL BE ACCURATELY PLACED AND ADEQUATELY SUPPORTED BY PRECAST CONCRETE, ADDITIONAL BARS, STIRRUPS, TIES OR APPROVED CHAIRS AGAINST DISPLACEMENT.
9. CONTINUOUS AND TEMPERATURE REINFORCING BARS SPLICES TO BE LAPPED 40 BAR DIAMETERS OR A MINIMUM OF 300mm (12") AT SPLICES AND CORNERS, UNLESS OTHERWISE SHOWN ON SECTION OR TYPICAL DETAILS. LAP CONTINUOUS TOP BARS AT CENTRE BETWEEN SUPPORTS AND CONTINUOUS BOTTOM BARS AT SUPPORTS. AS REQUIRED, TERMINATE CONTINUOUS BARS AT NON CONTINUOUS ENDS WITH STANDARD HOOKS.
10. CONSTRUCTION JOINTS: SLAB CONSTRUCTION JOINTS MAY BE MADE ONLY AT APPROVED LOCATIONS SHOWN OR AS DIRECTED BY THE ENGINEER.

CONCRETE ANCHORS:

1. ALL CONCRETE ANCHORS TO BE HILTI HAS ROD HOT DIPPED GALVANIZED (DIAMETER AS NOTED ON DRAWINGS).
2. ALL CONCRETE ANCHORS TO BE COMPLETE WITH HOT DIPPED GALVANIZED FLAT WASHERS, NUTS, LOCK NUTS, ETC. AS SPECIFIED ON THE DRAWINGS.
3. ALL EPOXY ADHESIVE SHALL BE HILTI HIT-HY 200/HIT ICE.
4. INSTALL AS PER MANUFACTURER'S SPECIFICATIONS.

CEMENTITIOUS GROUT:

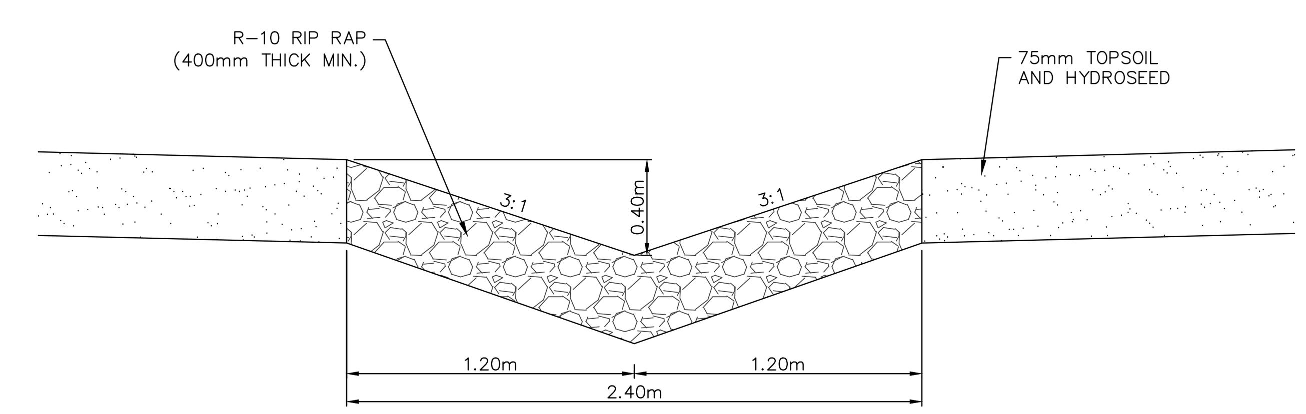
1. CEMENTITIOUS GROUT FOR ROCK DOWELS TO BE SIKAGROUT 212.
2. CEMENTITIOUS GROUT UNDER BASE PLATES TO BE SIKAGROUT 212.

ROCK DOWELS:

1. ROCK DOWELS TO BE:
    - 25M – POWER HOUSE STABILIZATION
    - 20M – RETAINING WALL
    - 15M – SPILLWAY WALL, DAM RAISING, DAN EXTENSION AND RETAINING WALL #2

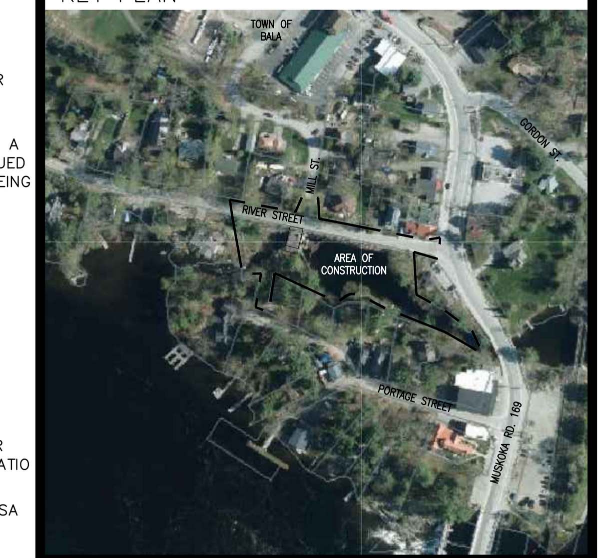
ALL DOWELS TO CONFORM TO CSA G30.18 M92, Fy=400 MPa (GRADE 400)

2. ALL DRILLED HOLES FOR ROCK DOWELS SHALL BE 25mm GREATER THAN THE DOWEL DIAMETER.



RIP RAP DRAINAGE SWALE X-SECTION
SCALE 1:50

KEY PLAN



ENGINEER'S SEAL:

DATE	REV.	REVISION	BY	APP'D
25/06/2025	7	ISSUED FOR CONSTRUCTION	DR	EG
16/05/2025	6	ISSUED FOR TENDER	DR	EG
18/07/2024	5	ISSUED FOR APPROVALS	DR	EG
05\06\2024	4	ISSUED FOR FINAL REVIEW	DR	EG
08/05/2024	3	ISSUED FOR CLIENT REVIEW	DR	EG
05/04/2024	2	ISSUED FOR CLIENT REVIEW	DR	EG
28/03/2024	1	ISSUED FOR CLIENT REVIEW	DR	EG/FP
30/09/2022	0	ISSUED FOR CLIENT REVIEW	BWJ	FP

CLIENT:

Township of Muskoka Lakes
1 Bailey Street, P.O. Box 129
Port Carling, Ontario

CONSULTANT:

TULLOCH

PROJECT TITLE:

LITTLE BURGESS GENERATING STATION REHAB

DRAWING TITLE:

GENERAL NOTES

DR	EG	EG	EG
DRAWN	DESIGNED	CHECKED	APPROVED

AS SHOWN	JUNE 25, 2025
SCALE	DATE

23-1236	7	G1
PROJECT No.	REVISION	DRAWING

APPENDIX B

DSR REPORT

DAM SAFETY REVIEW
BURGESS 1 DAM

for

Township of Muskoka Lakes

September 6, 2019

TULLOCH Project No.: 19-1493

2019-09-06	0	Issued for Use	E. Giles	F. Palmay	G. Liang
2019-08-14	A	Issue for Draft	E. Giles	F. Palmay	G. Liang
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**
TULLOCH					

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LIST OF ACCRONYMS

CDA	Canadian Dam Association
DSD	Dam Safety Deficiency
DSI	Dam Safety Inspection
D/S	Downstream Side of Dam
EPRP	Emergency Preparedness and Response Plan
EWL	Existing Water Level
FOS	Factor of Safety
HPC	Hazard Potential Classification
HWL	Headwater Level
ICC	Incremental Consequence Category
IDF	Inflow Design Flood
IEL&D	Incremental Economic Loss and Damage
ILOL	Incremental Loss of Life
NOL	Normal Operating Water Level
MDE	Maximum Design Earthquake
MNRF	Ontario Ministry of Natural Resources and Forestry
PAR	Population at Risk
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RFP	Request for Proposal
SFI	Scope for Improvement
U/S	Upstream Side of Dam

EXECUTIVE SUMMARY

ES-1 OVERVIEW

This report presents the results of a Dam Safety Review (DSR), performed by TULLOCH Engineering (TULLOCH) for the Burgess 1 Dam structure associated with the powerhouse at Bala, Muskoka, Ontario. The DSR was triggered by an overtopping event in the spring of 2019.

The DSR included a site visit On July 4th, 2019 by Frank Palmay, P. Eng. and Erik Giles, P. Eng., where existing conditions of the structure were observed and recorded along with site measurements. This report summarizes the results of the DSR and has been prepared according to CDA (2007, 2014) and MNRF (2011) guidelines.

Based on this DSR, the Burgess 1 Dam is in "poor to fair safe condition". However, some deficiencies and non-conformances were identified as summarized in Tables ES-1 and ES-2, respectively. The following summarizes the DSR findings.

E-2 HYDROTECHNICAL ASSESSMENT

The following is a summary of the hydrotechnical assessment of the Burgess 1 Dam based on the available information provided in MRWMP.

- The Inflow Design Flood at the MNRF Bala Dams was established as the 100 years event with a maximum lake of El. 226.5m. The identical IDF (1/100yrs) with a water level of El. 226.5 m applies to Burgess 1 Dam;
- The Normal Operating Level (NOL) is also defined by Bala North and South dam. The NOL is in the range of El. 224.6 m to El. 225.75 m (Acres, 2006).
- Based on document review, the existing dam crest elevation is at El. 226 m (to be confirmed by survey). TULLOCH recommended that the reservoir level upstream of the Burgess 1 Dam should be kept within the operating levels as per the MRWMP of El. 225.75 m (upper bound) in order to ensure a minimum freeboard of 0.25 m during operation.
- The current dam does not have enough freeboard to store the IDF at present. Design measures for proper management of overflows should be developed for IDF event.
- The reservoir water level was at about El. 225.3 m at the time of TULLOCH's dam safety inspection (DSI) conducted July 4th, 2019. This level is inferred to be the normal operating water level (NOL) of the facility.

- Based on the incremental consequences of dam failure during the IDF and sunny day breach (i.e. non-flood) conditions, the Burgess 1 Dam is classified as having a LOW HPC according to both MNRF and CDA guidelines.

E-3 GEOTECHNICAL STABILITY

The following table summarizes the results of the calculated factor of safety for the existing Burgess 1 Dam section under various loading conditions compared to the MNRF required minimum FOS.

Table ES-1: Calculated FOS for Stability of Burgess Dam Structures

Dam	Case[1]	Water Level (m)	FOS-Sliding	FOS - Overturning	Required FOS – Sliding/Overturning
Non-overflow Dam Section	Static Loading with NOL	El. 225.75	2.7	1.4	1.5 / 2.0
	Pseudo-static α=0.01g and NOL	El. 225.75	2.7	1.4	1.1 /1.1
	Static Loading with IDF	El. 226.49	2.3	1.1	1.3 / 1.3
Powerhouse Dam Section	Static Loading with NOL	El. 225.75	1.2	1.0	1.5 / 2.0
	Pseudo-static α=0.01g and NOL	El. 225.75	1.2	1.0	1.1 / 1.1
	Static Loading with IDF	El. 226.49	1.1	1.0	1.3 / 1.3

Note: 1- NOL is the Normal Operating Level

Based on the geotechnical stability assessment, Repair or mitigation measures have to be developed for both the non-overflow dam section and powerhouse dam section to improve the FOSs to meet the criteria.

E-4 DAM MANAGEMENT AND PUBLIC SAFETY CONCLUSIONS

Based on the site inspection it was determined that there are a number of concerns towards public safety that need to be addressed such as upgrading and adding signage on the site, repairing and extending broken fencing, burying exposed ground wires and the creation of a Public Safety Plan. Further details can be found in table ES.2.

E-5 SUMMARY TABLES

Tables ES-2 and ES-3 summarize the recommended remedial actions to address the observed deficiencies and non-conformances at the Burgess 1 Dam site.

Table ES.1: Dam Safety Recommendations

Dam Structure	Issue	Category	Recommended Action	Recommended Schedule
Non-overflow dam section	**Moderate to significant washouts along the dam toe area caused from 2019 flooding** The FOS of the concrete dam section depends on the remaining fill material on the d/s toe area for the post-overflow event in 2019 flooding. Significant washout /scouring was observed along the downstream toe area with a scoring depth in excess of 1.0 - 1.5 m. The observed lake level in 2019 spring was about El. 226.45 m, is comparable to an IDF event for the Bala Falls Dams. Under the current site condition, the calculated FOSs against sliding and overturning are inadequate and do not meet required minimums.	Deficiency	Replace/reinstate the d/s fill material with rockfill/rip rap erosion protection to improve the FOS to meet the criteria	Spring/Summer 2020 High Priority
	No emergency spillway	Deficiency	A spillway option or the alternative overflow control options should be designed and constructed to pass the IDF conditions during a flood event.	Within 5 years
	Inadequate water level monitoring program	Deficiency	Install permanent water level gauges and / or other reliable monitoring measures tied to the Bala North and South Dams and monitor the water level regularly.	Spring/Summer 2020

Dam Structure	Issue	Category	Recommended Action	Recommended Schedule
Powerhouse Dam Section	**The powerhouse structure is in poor condition.** The dam and powerhouse are integrated into one structure. Large diagonal cracks observed in the concrete foundation slab likely caused by undermining from long-term scouring during powerhouse operation have compromised the load path of the structure and have limited the slabs ability to uphold the structure. In its current state the FOS of the powerhouse does not meet required minimums. The current site condition, the calculated FOSs against sliding and over-turning for the powerhouse dam section are inadequate to meet the required minimum FOSs.	Deficiency	Repair or mitigation measures must be developed for the powerhouse dam section (including the foundation treatment) to improve the FOS to meet required minimums.	Fall 2020 High Priority
	Powerhouse operation Under current condition, the powerhouse needs to cease operation to prevent further scouring and undermining of the foundation which are causing stability issue of the powerhouse.	Deficiency	Stop the units running or extend the tailrace pipeline to a safe distance d/s.	Spring/Summer 2020

Table ES.2: Maintenance and Surveillance Recommendations

Dam Structure	Deficiency or Non-Conformance	Category	Recommended Action	Recommended Schedule
Non-Overflow and Powerhouse dam Section	**Lack of record drawings**	Non-conformance	Compile the following records and keep them on file for Dam Safety Purposes: • Existing dam as-built drawings and design reports • As-built records for dam modifications/repairs.	Within 2 years after completion of the dam upgrade.
	OMS document	Non-conformance	Develop an OMS Manual for the facility. The normal operating water level and maximum operating water level should be defined in the OMS.	Within 1 year after completion of the detail design of the dam upgrade.
	Emergency Preparedness and Response Plan (EPRP)	Non-conformance	Develop an EPRP	Within 1 year after completion of the detail design of the dam upgrade.
	A survey of the dam structures and associate facilities	Non-conformance	A survey of the existing dam structures should be conducted for the design of dam structure upgrade to meet the CDA and MNRF guidelines	Complete by end of 2019
	Dense vegetation present at the dam site	Non-conformance	The vegetation should be removed within 3-5 m footprint of the selected option for the dam upgrade	Prior to the construction of the dam upgrade.
	Grouting or concrete patching the cracks in the existing dam sections	Non-conformance	Grouting or concrete patching is recommended to repair the existing cracks in the dam.	Complete by Spring/Summer 2020

Dam Structure	Deficiency or Non-Conformance	Category	Recommended Action	Recommended Schedule
Non-Overflow and Powerhouse dam Section (con't)	**There is no signage at the dam sites, upstream from or downstream from the dams, or at the access points**	Non-conformance	Safety and warning signage should be posted at both entrances to the site. Signage should be installed on the dams indicating hazards, including presence of deep water in the lake approaching to the dam, required PPE, hazards of working at or around dam and signage at the discharge facilities indicating unexpected release of flows or fast-moving water. Signage should be posted upstream and downstream of facility to warn the public of fast-moving water and the presence of the dam	Complete by Spring/ summer 2020
	Public Safety Plan (PSP)	Non-conformance	A Public Safety Plan (PSP) should be drafted to address the safety issues and ensure they are properly managed, and controls are properly maintained.	Complete by Spring 2020
	The existing boom line is in a poor condition	Non-conformance	Upgrade the boom line and adjust the safety distance to the powerhouse inlet; Regular maintenance is recommended.	Complete by Spring / Summer 2020
	Exposed grounding wire along site	Non-conformance	Backfill all exposed wires	Complete ASAP High Priority
	The existing fence / gate to constrain the public access to the dam site	Non-conformance	Upgrade the fence / gate to constrain the public access to the dam site without permits. Regular maintenance is recommended.	Complete by Spring / Summer 2020

Dam Structure	Deficiency or Non-Conformance	Category	Recommended Action	Recommended Schedule
River Street Concrete Retaining Wall and Embankment	**River Street Concrete Retaining Wall is in a fair safe condition**	Non-conformance	Retaining wall drainage efficiency upgrade design and construction are recommended; survey and geotechnical investigation and assessment are required.	Prior to the construction of the dam upgrade.
	River Street Embankment with Gabion Wall is in poor condition The embankment to the west of the retaining wall was in poor to fair safe condition during 2019 DSI. There exists a potential slope failure risk for River Street adjacent to the tailrace of the dam.	Non-conformance	A slope stability evaluation of the embankment along River Street is recommended. Detailed geotechnical investigation and assessment are strongly recommended.	Complete by Spring / Summer 2020

1. INTRODUCTION

1.1 Purpose and Objectives

TULLOCH Engineering Ltd. (TULLOCH) was retained by the Township of Muskoka Lakes (the Township) to carry out a Dam Safety Review (DSR) for the Burgess 1 Dam structures in Bala, Ontario within the District of Muskoka. Appendix A shows the site the location.

A DSR is an independent and systematic review and evaluation of the design, construction, maintenance, operation, and management systems affecting dam safety. For this DSR, the Burgess 1 Dam and associate structures were assessed in accordance with the Canadian Dam Association (CDA) Dam Safety Guidelines (2007, 2014) and Ontario Ministry of Natural Resources (MNR) Best Management Practices and Technical Bulletins (2011). Prior to this report, a formal DSR has not been carried out for the Burgess 1 Dam structures.

The overall objective of the DSR is to provide the Township with an independent and comprehensive assessment of the adequacy of the current Burgess 1 Dam facility to meet or exceed the applicable dam safety requirements. This review is intended to identify and categorize all dam safety issues that require remedial attention. Further, the issues identified are prioritized in Table ES-1 to ES-2 to assist the Township in setting priorities and developing an action plan to deal with the safety related deficiencies identified for the Burgess 1 Dam.

The scope of the work for the DSR was detailed in the TULLOCH Proposal dated May 31st, 2019 (Proposal #19-0001-179). The process commenced with The Township providing historical documents relating to the project to TULLOCH for review. Next, a DSI was performed by TULLOCH engineers accompanied by Mr. Steve Dursley a representative of KRIS Renewable Power the current lease and operator of the facility on July 4th, 2019. The DSI was limited to the civil/geotechnical, hydrotechnical and structural aspects of the facilities. Following the site inspections, a detailed DSR was completed including:

- Background data review
- Key/critical findings and preliminary recommendations
- Geotechnical, Structural and Hydrotechnical assessments
- Preliminary study for the mitigation/repair options
- Conclusion and recommendations
- DSR Report

Th following sections provide details of the DSR completed for the Burgess 1 Dam Structures. A Key Location Plan for the site can be found in Appendix A.

2. BACKGROUND INFORMATION

2.1 Document Review

The DSR process began with a review of available background information. The following documents were reviewed and formed the basis of this DSR.

- MRWMP Final Plan Report by Acres international, dated 2006
- Bala – Small Hydro Development Burgess Dam Site – Report on Proposals for Development by Totten Sims Hubicki Associates, not dated (circa 1987)
- Township of Muskoka Lakes Small Hydro Development Bala Tender Documents by Totten Sims Hubicki Associates, dated 1987
- Structural Report Bala Dam and Power Building Township of Muskoka Lakes by Totten Sims Hubicki Associates, dated 1986
- A Proposal for Historic Site Development of The Bala Power Generating Facility by Integrated Resource Group, dated 1984
- Feasibility Study for The Restoration of the Bala Power Generation Station by Integrated Resource Group, (not dated circa. 1984)

2.2 General Site Layout

The Burgess 1 Dam mainly consists of the following structures:

- Concrete dam structure (Water Retaining structure, Non-overflow dam section);
- Concrete dam with downstream (d/s) powerhouse structure;
- River Street Retaining Wall and Embankment;
- Other ancillary structures including the access road, fence, gates, tailrace and walkways.

A key location plan can be seen in Appendix A which shows the Burgess 1 Dam general site layout.

2.3 Organization and Responsibilities

Originally the dam was built by J.W. and A.M. Burgess between 1917 and 1922 and the dam/generating station was purchase by the Ontario Hydro Commission in 1929. Burgess 1 Dam was owned and operated by Ontario Hydro from 1929 to 1957 and was then sold to the Township in 1963 who currently owns the facility.

Based on Township records the facility was largely unused for a long period of time until it was partially refurbished and leased to Marsh Power in 1988 for the purpose of power generation until

1999. The facility was then leased to Algonquin Power (Fund) Canada Inc. and operated by Algonquin Power Systems Inc. until 2011. Upon expiry of the lease KRIS Renewable Power Ltd (KRIS). Began to lease and operate the generating station. The current Lease started in August of 2012 and expires in 2022. KRIS currently operates the facility employs a part time care and maintenance operator who works e at the facility to run the generating station, remove debris from the headwaters/spillway inlet and generally maintain the property. KRIS has also partially upgraded the facility by adding new metal sluicegates and a new turbine on the north inlet of the headwaters.

2.4 Burgess 1 Dam Facilities

The Burgess 1 Dam was built and began operation in 1917. The facility consists of a 59 ± meter long concrete dam founded on bedrock with a maximum height of approximately 3 meters. Fill has been placed on the downstream face of the dam to provide resistance against the overturning and sliding of the structure. The powerhouse is approximately 9 m x 14 m in dimension including the turbine, generator and associated electrical equipment. Finally, a 16 m long retaining wall connected to the north wall of the powerhouse supports River St immediately to the north of the facility. The tail race is armored with gabion baskets sitting atop a historic boulder rock wall on the north bank of the facility. The dam and powerhouse are integrated into one structure, which is situated in a constructed channel on the existing bedrock. Table 2-1 below summarizes the main features of the dam structures on site:

Table 2-1: Summary of the In-situ Features of the Burgess 1 Dam

No.	Dam	Main Features	Reference
1	Non-overflow Dam Section	Concrete Retaining Structure on Bedrock supported by d/s fill embankment.	• TSHA Structural Report, 1986 Drawing P-1 and P-2
2	Powerhouse Dam Section	Concrete gravity dam and powerhouse are integrated into one structure and founded on the bedrock	• TSHA Structural Report, 1986 Drawing P-1 and P-2
4	Dam Crest Elevation (m)	• El. 226.0 m	• TSHA Structural Report, 1986 Drawing P-1 and P-2
5	Maximum Dam Height (m)	• Max. 3 m (non-overflow section) • Max. 6 m (Powerhouse Section)	• TSHA, Structural Report 1986 Drawing P-1 and P-2
6	Crest Width (m)	• Approx. 0.6 m	• TSHA, 1986 Drawing P-1 and P-2
7	Dam Length (m)	• 59 m (total length of dam) • 14m (Powerhouse Section)	• TSHA, 1986 Drawing P-1 and P-2

No.	Dam	Main Features	Reference
8	Spillway	• No Spillway	• MRWMP, 2006
9	Reservoir Levels	• NOL Range between 224.6 and 225.75 m • IDF El. 226.49m	• MRWMP, 2006
10	Powerhouse	• 0.14MW, 2 Units • Max. flow rate 4m^3/s	• MRWMP, 2006

For further information/details of the features of the Burgess 1 Dam, relevant historic drawings/site plans can be viewed in Appendix F. The aforementioned plans along with field measurements formed the bases for the modelling and the figures presented in this report. It is strongly recommended that a detailed survey of the site be undertaken to verify dimensions and elevations.

3. SITE CONDITIONS

3.1 Site Surficial Geology

Based on review of Bedrock Geology and Surficial Geology of Southern Ontario mapping as published by the Ontario Geological Society (OGS), the site surficial geology is comprised of Canadian Shield with formations of Precambrian Bedrock typical within the Muskoka region. The bedrock on site was located close to ground surface and comprised of typical geologic formations for the Bala area including hard and smooth pink to grey migmatitic rocks as well as quartzofeldspathic gneisses (OGS 2019). The Burgess 1 Dam is located at the lower section of the Muskoka river watershed near the bottom of Lake Muskoka where regional topography is typically mapped as low local relief varying from plains to undulating hummocky conditions (Acres 2006). Overburden in the Bala area is typically sandy and shallow in depth with thick organic deposits found in low lying wetland areas. Overburden observed on site was typically shallow and sandy in nature.

3.2 Site Seismicity

The site seismicity is based on the 2015 National Building Code seismic peak ground acceleration (PGA). Based on the DSR, the Burgess 1 Dam has been classified as a dam structure with LOW flood and earthquake hazards, indicating the return period of the design earthquake to be 1/100 according to CDA Guidelines (2013 Edition). Accordingly, the PGA seismic coefficient for the dam sites has a 40% probability of exceedance in 50 years corresponding to a return period of 1 in 100 years, based on the 2015 National Building Code. Appendix B shows the PGA data obtained from the 2015 National Building Code Seismic Hazard Calculation Index which is specific to the site. This corresponds to a PGS value of 0.01.

3.3 Site Hydrology

Located on the lower tier of the Muskoka Watershed, the Burgess 1 Dam generating facility along with the North and South Bala Falls Dams hold back most of the water collected from the Muskoka River Watershed sharing a drainage area of 4683 km^2 and a lake surface area of 120 km^2 (Acres 2006) . Generally, flood events for the watershed occur in two basic types, a spring freshet from melted snow along with increased precipitation and major storm events.

The Burgess Dam is largely controlled by the larger North and South Bala Falls Dams located ~ 300m south of the facility which typically handles the flood flow through the watershed. Water from the Burgess Dam flows south west into the Moon and Musquash Rivers eventually into Georgian Bay. The majority of the watershed meets in Bala forming a bottle neck that must handle significant flows during flooding conditions from the majority of the watershed. Recorded river flow data at the Bala Reach of the Muskoka river indicate a long-term average stream flow of approximately 76.7 m^3/s (Acres 2006).

The allocated maximum flow to the Burgess Generating Station is 4 m^3/s and there is no spilling capacity. As a result, all flood flows passing from Lake Muskoka are routed through the North and South Bala Dams. The facility has two turbine units and is rated at 0.14 MW. Power is generated at the facility only when Lake Muskoka water levels are within an acceptable range.

4. DAM SAFETY GUIDELINES

This DSR was executed in accordance with the following guidelines from both the MNRF (2011) and Canadian Dam Association (2007, 2011, 2013):

- The Ontario MNRF Guidelines including Ontario Ministry of Natural Resources and Forestry Lakes and Rivers Improvement Act Administrative (LRIA) Guide (dated August 2011),
- Associated Technical Bulletins and Best Management Practices.
- Canadian Dam Association, 2007 Dam Safety Guidelines, including 2013 Revisions.
- Canadian Dam Association, Guidelines for Public Safety Around Dams, 2011.

Dam classification and design criteria for the DSR are based on the MNRF (2011) Hazard Potential Classification (HPC) system, the CDA (2007) dam classification category and associate Inflow Design Flood (IDF) and Earthquake Hazards. Appendix C includes the dam classification and criteria used in this study from the CDA and MNRF guidelines.

5. DSR PROCEDURES

5.1 DSI and Interviews

A DSI in support of the DSR were carried out on July 4th, 2019 by Mr. Frank Palmay, P.Eng. and Mr. Erik Giles, P.Eng. of TULLOCH Engineering. The DSI personnel were accompanied by Mr. Steve Dursley, who was a KRIS representative. The inspected areas included the Burgess 1 Dam structures, powerhouse and associate equipment, u/s reservoir, the downstream tailrace, River Street retaining wall structures and the surrounding areas.

The details of the DSI field report and findings are in Appendix D and the previously issued Key Findings Memorandum can be found in Appendix E.

5.2 DSR Assessments

The following technical assessments were carried out in support of this DSR:

- Hydrotechnical assessment to determine the Hazard Potential Classification (HPC) and Inflow Design Flood (IDF) for the structures
- Geotechnical assessment to evaluate the stability of the existing dam under various loading conditions
- Development of a preliminary options for Dam mitigation/repair including baseline cost estimation
- DSR report

6. DAM SAFETY INSPECTIONS

6.1 General

The site inspections at the Burgess 1 Dam were completed on July 4th, 2019, based on the following sequence:

- The site DSI was undertaken with an emphasis on the nature, extent and condition of the contained material(s), reservoir levels, upstream (U/S) and downstream (D/S) areas and abutment contacts, the geotechnical environment, and included the flow discharge facilities as well as the structural condition of the existing powerhouse structure and retaining wall attached to the dam;
- Walk-arounds and visual inspections at the dam site included observations of components such as dam crests, U/S and D/S slopes, abutments, toe areas, and a record of relevant details indicative of the stability and potential risk of instability of the structures. The recorded information includes facility name, height of structure, approximate slope gradients, activity status and physical condition (i.e. visible depressions, cracking,

deformation, surface erosion, freeboard, signs of past flooding, overtopping, internal erosion, piping, sand boils etc.);

- Inspections of the appurtenant structures were done to assess their condition, functionality and adequacy;
- Inspection forms were completed for each of the significant structures, including the gathering of other relevant information such as GPS data (georeferenced using UTM co-ordinates), digital photographs of all pertinent features, and area characterization (refer to Appendices D and E);
- Where background information was not available, the dimensions of the structures were estimated with a measuring tape or by pacing;
- No underwater inspections were proposed nor were any inspections of high steep slopes carried out when accessibility was limited.
- Assessment was based on exposed physical condition only and did not include destructive testing of any element of the structure. No samples were collected and therefore no laboratory analysis of the concrete or soils was conducted.

The objective of the inspections was to identify and address any deficiency findings and recommend associated mitigation measures. The key points of the findings for the facility are summarized below. As noted above, the field inspection checklist for the dam facility is included in Appendix D of this report. Recommendations with respect to the findings in the report are presented in Sections 9.0 through 11.0.

6.2 Access, Safety and Security

Access to the site was via Portage Street located south of the main downtown area of the Town of Bala. The dam was built adjacent to River Street and there are both full year and seasonal residents located on both Portage and River Streets. The main access to the dam is through a locked entrance gate from Portage Street, with a second locked man gate that exits onto River Street. A Chain-link fence runs across the south side of the property and connect to the south abutment of the dam. A small length of chain-link fence also ties into the guardrails west of the River Street retaining wall. However, the fencing located to the south of the dam has fallen into disrepair and needs to be replaced. Furthermore, the man gate and locking system to the River Street entrance along the north side of the powerhouse also should be upgraded. Fencing should be extended along the dam crest to prevent boaters from accessing the facility from the headwaters.

No significant signage is present along the facility either at the headwaters or tailrace locations. A small faded sign warning of moving water is located overtop of the sluicegates however it is difficult to read and should be replaced. There is no signage posted on either gate. For the purpose of public safety warning signs should be posted in all aforementioned locations.

The sluice gate of the dam appeared to be outfitted with warning lights however they were not in use or tested during the DSI, visual and auditory warnings should be implemented if not already and tested frequently to ensure they are in good working order.

The boom-line for the dam is comprised of historic timbers which are half sunken and the setback distance is too close to the dam. The line is poorly visible from the headwaters of the dam and does not provide an ample barrier for the public. The boom line should be upgraded to modern standards and setback further from the dam.

6.3 Observations

Generally, the dam structure was found to be in fair condition considering the age of the structure. However, the powerhouse section of the dam is in poor overall condition from both a structural and dam safety perspective and will require remediation due to the presence of failed or failing structural members and a large transverse crack through the floor slab of the dam. Furthermore, significant washout of the downstream fill from another future flooding event has the potential to cause the structure to fail. As such there are dam safety issues associated with this site that will require remediation. Detailed observations for the DSI can be found in Table 1 of the Key Findings memo issued on July 24, 2019 which can be found in Appendix E. Preliminary recommendations were also made in this document but have since been refined and will be addressed below in Section 11.0.

7. HYDROTECHNICAL ASSESSMENT

7.1 Methodology

A hydrotechnical assessment was carried out mainly based on literature data review and desktop study. As described in the preceding sections, the Burgess 1 Dam facility is currently rated at 0.14 MW, operates when Lake Muskoka water levels are within an acceptable range. The facility has no spill capacity as upstream water level control is provided by the Bala North and Bala South dams. The hydrotechnical assessment mainly consist of the following steps:

- Compile the lake levels taken from Environment Canada hydrometric data measured from the nearest upstream station near the inflow of the Bala dams (Station ID:02EB015);
- Compile the operating lake levels of the Burgess dam as outlines in the MRWMP (2006);
- Determine the IDF for Burgess dam based on available data;
- Determine the Hazard Potential Classification (HPC) based on the MNRF and CDA criteria;
- Assess if the existing Burgess Dam has adequate freeboard for IDF event.

7.2 Water Levels

Figure 7-1 shown below illustrates the water levels at Burgess 1 Dam Site in 2019 and compares it to critical water levels associated with the structure according to the MRWMP. Table 7-1 summarizes the critical water levels. Summarizing:

- The maximum measured water level in 2019 during the flood event was at El. 226.1m at Gauge Station 02EB015, which occurred on May 1st, 2019;
- The IDF value provided by the MNRF and illustrated in the Muskoka River Dam Operation Manual for both the Bala Falls Dams is 226.49 masl and corresponds to the 100-year flooding event. The observed maximum water level at Burgess 1 Dam during overtopping in 2019 spring was at approximate El. 226.45m, which is very close the IDF (1/100yrs return) level of El. 226.49m;
- The facility has no spill capacity as upstream water level control is provided by the Bala North and South Falls Dams. Based on their proximity and virtually parallel positioning along the watershed it has been determined that the design IDF for the Bala South and North Dams is the most appropriate value for use at the Burgess 1 Dam location.
- The existing Burgess 1 Dam crest is at El. 226 m. During the determined IDF event water levels are above the dam crest by 0.39 m. Therefore, it can be determined that the Burgess dam does not have sufficient freeboard nor was the existing facility designed to handle IDF in its current state.

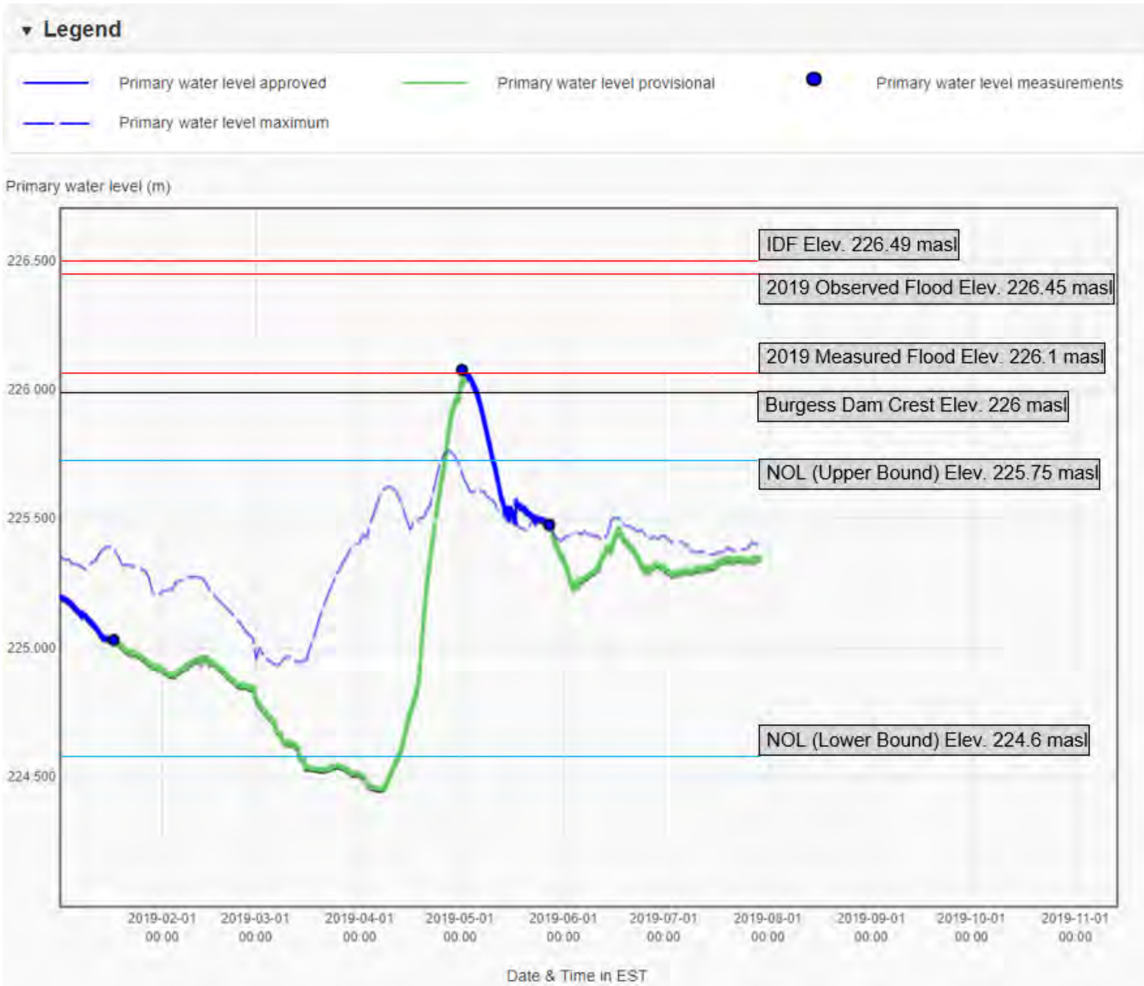

Figure 7-1: Burgess Dam 1 - 2019 Water Levels vs. NOL and IDF

Table 7-1: Water Levels Associated with Burgess 1 Dam

Parameter	Elevation (masl)
Burgess Dam Crest Elevation (to be confirmed by survey data)	226.00
2019 Flooding Measured Maximum Level at nearest Gauge Station 02EB015	226.10
2019 Observed Flooding level at the dam site	226.45
NOL Burgess Dam 1 (Upper Bound)	225.75
NOL Burgess Dam 1 (Lower Bound)	224.60
IDF – 100-year Lake Muskoka Flood Level	226.49

7.3 Hazard Potential Classification (HPC)

Table 7-2 summarizes the hazard potential classification (HPC) based on MNRF guideline (as provided in Appendix C). Given the above criteria, the HPC of the Burgess 1 Dam is LOW.

Table 7-2: Burgess 1 Dam Classification Summary

Category	Burgess 1 Dam	
	Flood	Non-Flood
Incremental Loss of Life (LOL)	0	0
	Low	Low
Economic Damages	<$300,000	<$300,000
	Low	Low
Environmental	Low	Low
Cultural / Heritage	Low	Low
Governing Criteria	Economic / LOL	Economic / LOL
Overall Classification (HPC)	**LOW**	**LOW**

8. GEOTECHNICAL ASSESSMENT

As part of the DSR, the stability analyses for the existing dam sections were carried out to assess the Factor of Safety (FOS) for both Non-overflow and powerhouse dam section under various loading conditions. The following sections summarize the geotechnical assessment.

8.1 Criteria

Table 8-1 summarizes the analyzed cases, u/s water levels and the applicable stability criteria based on CDA and MNRF Guidelines.

Table 8-1: Analyzed Cases and Applicable Stability Criteria

Case	Description	Water Level (m)	FOS-Sliding	FOS-Overturning
1	Static Loading NOL	El. 225.75	1.5	2.0
2	Seismic Loading with NOL	El. 225.75	1.1	1.1
3	Static Loading with IDF	El. 226.49	1.3	1.3

8.2 Methodology

The FOS calculation for stability analysis of the dam sections involved the following Equations:

FOS against sliding failure:

$$FOS = \frac{\sum Resisting\ Froce}{\sum Driving\ Force} \quad [8\text{-}1]$$

FOS against overturning failure:

$$FOS = \frac{\sum Resisting\ Moment}{\sum Driving\ Moment} \quad [8\text{-}2]$$

FOS against bearing Failure

$$FOS = \frac{q_{allowable}}{q_{maximum}} \quad [8\text{-}3]$$

Bearing failure for the facility was calculated for both sections and found to have an FOS greater than 3.0 using a conservative allowable bedrock capacity of 1 MPa. Considering that the facility has a short dam height and is founded on bedrock it was determined that the focus of the analysis will be on failure against sliding and overturning.

Therefore, the FOS against foundation bearing failure is considered to be sufficient and no further calculation is included in the geotechnical assessment. Table 8-1 summarizes the geotechnical parameters used in the stability calculation.

Table 8-2: Summary of Geotechnical Parameters Stability Calculation[1]

No.	Type of Material	Cohesion, c' (kPa)	Internal Friction Angle,φ' (Degree)	Unit Weight, γ' (kN/m^3)
1	Dam Unreinforced Concrete	0	50	24
2	D/S Fill Material	0	35	19
3	Concrete-to-Bedrock Interface[1]	0	45	20

Note: [1]-Geotechnical parameters are assumed for the DSR based on TULLOCH's engineering experience.

8.3 Stability - Seismic Event

Based on Section 7, the Burgess 1 Dam has been classified as a LOW HPC rating, indicating that the return period of the design earthquake is 1/100 according to CDA Guidelines (2013 Edition). The following site-specific PGA has been used to perform pseudo-static stability analysis of these dams:

- For 1/100-year return period, the PGA for the site is 0.01 g, corresponding to a Class 'C' site classification. Appendix C shows the PGA data obtained from the 2015 National Building Code Seismic Hazard Calculation.

- For pseudo-static analysis, the horizontal PGA value was multiplied by 2/3 giving 0.7(0.01g) = 0.007 g. Considering the shallow bedrock present at dam site, two thirds of the horizontal PGA on bedrock is considered to replicate the sustained ground motion. Correspondingly, a ground acceleration of 0.005 g was applied for the pseudo-static seismic assessment of the dam structures at this site.

8.4 Results

Table 8-3 summarizes the results of the stability analysis calculations. The results are discussed in the following sections of this report. Figures 8-1 and 8-2 show representative sections of the dam that were analyzed which are show below.

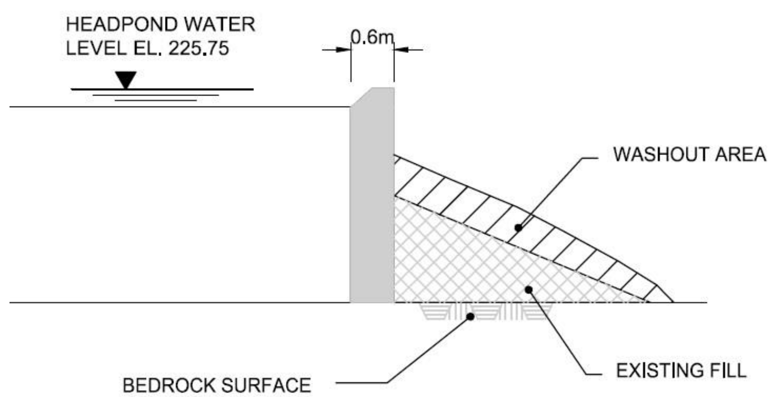

Figure 8-1: Typical Non-overflow Dam Section for Stability Analysis

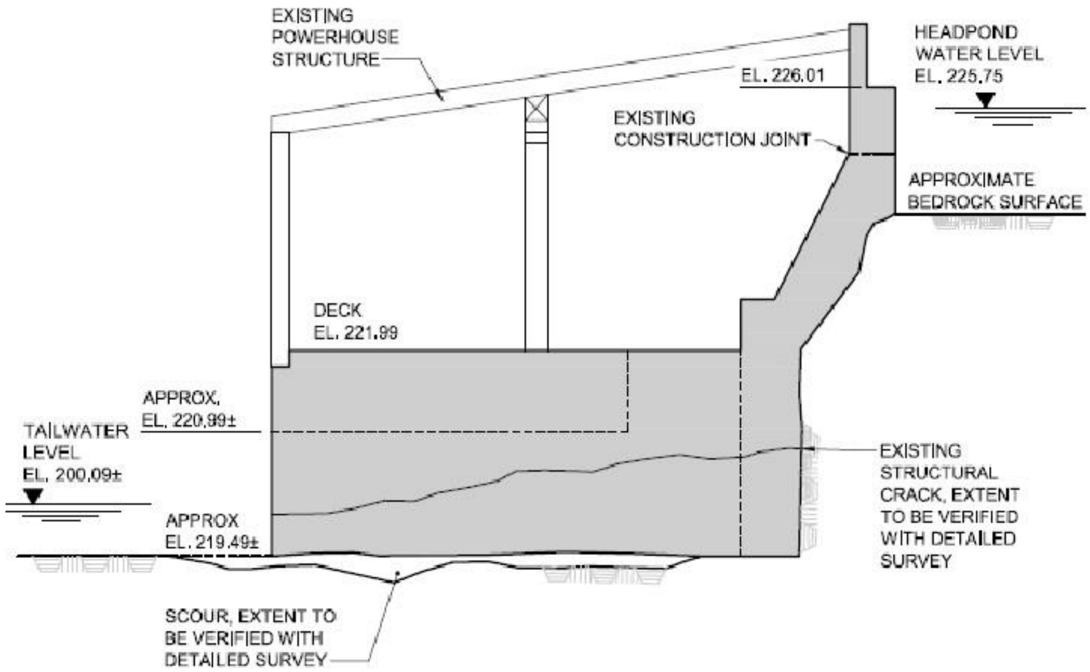

Figure 8-2: Typical Powerhouse Dam Section for Stability Analysis

Factor of Safety calculation results are summarized below for the various loading conditions under each section mentioned above:

Non-overflow Dam Section

- Under static loading condition with NOL at El. 225.75 m, the calculated FOS against sliding is 2.7, which meets the required minimum FOS of 1.5; The calculated FOS against overturning is 1.4, which does not meet the required minimum FOS of 2.0.
- Under seismic loading condition with NOL at El. 225.75 m, the calculated FOSs against sliding and overturning are 2.7 and 1.4, respectively. The calculated FOSs meet the required minimum FOSs of 1.1. Due to a short dam height and low PGA value at the site, the seismic loading has a negligible impact on the stability of Burgess dam.
- Under static loading condition incorporating the IDF water level, the calculated FOS against sliding is 2.3, which meets the required minimum FOS of 1.3; The calculated FOS against overturning is 1.1, which does not meet the required minimum FOS of 1.3.

Powerhouse Dam Section

- Under static loading condition with NOL at El. 225.75 m, the calculated FOS against sliding is 1.2, which does not meet the required minimum FOS of 1.5; The calculated FOS against overturning is 1.0, which does not meet the required minimum FOS of 2.0.
- Under seismic loading condition with NOL at El. 225.75 m, the calculated FOS against sliding is 1.2, which meet the required minimum FOS of 1.1; the calculated FOS against overturning is 1.0, which does not meet the required minimum FOS of 1.1. Due to a short dam height and low PGA value at the site, the seismic loading has a negligible impact on the stability of Burgess dam.
- Under static loading condition incorporating the IDF water level, the calculated FOS against sliding is 1.1, which meets the required minimum FOS of 1.3; The calculated FOS against overturning is 1.0, which does not meet the required minimum FOS of 1.3.

Based on the geotechnical stability assessment, Repair or mitigation measures must be developed for both the non-overflow dam section and powerhouse dam section to improve the FOS to meet the minimum acceptable criteria.

Table 8-3: Calculated FOS for Stability of Burgess Dam Structures

Dam	Case	Water Level (m)	FOS-Sliding	FOS - Overturning
Non-overflow Dam Section	Static Loading with NOL	El. 225.75	2.7	1.4
	Pseudo-static α=0.005g and NOL	El. 225.75	2.7	1.4
	Static Loading with IDF	El. 226.49	2.3	1.1
Powerhouse Dam Section	Static Loading with NOL	El. 225.75	1.2	1.0
	Pseudo-static α=0.005g and NOL	El. 225.75	1.2	1.0
	Static Loading with IDF	El. 226.49	1.1	1.0

8.5 River Street Concrete Wall and Embankment

Based on site inspection, the concrete retaining wall along River Street is in a Fair condition. The presence of the vertical cracks in the wall encountered during the DSI indicated drainage efficiency of the retaining wall may not be adequate. The inadequate drainage likely caused water pressures to build up behind the retaining wall. This could be alleviated by implementing better drainage and water management through and around the wall. Preliminary recommendations will be discussed further in Section 11.0.

The Embankment along River Street downstream of the site is very steep and appears to be eroding at the toe where there are newer gabion baskets placed on a historic boulder/stone wall.

There is a concern for the slope failure of the embankment due to the erosion/ scour caused by water flows during power generation activity. The slope stability evaluation of the embankment along the River Street is not included in the scope of this DSR, however, a detailed geotechnical investigation and assessment are strongly recommended.

9. DAM MANAGEMENT CRITERIA

9.1 Operation, Maintenance, and Surveillance

It is our understanding that there is currently no OMS Manual for the Burgess 1 Dam facility. However, Operating levels for all control dams in the Muskoka watershed can be found in the Muskoka River Dam Operation Manual. The manual does not provide the necessary detail for the site-specific operation, maintenance and surveillance for the Burgess 1 Dam site. Therefore, it is TULLOCH's recommendation that an OMS manual be drafted for the Burgess 1 Dam.

9.2 Emergency Preparedness and Response Plan

There is no formal Emergency Preparedness and Response Plan for the dam in the event of failure. The Muskoka River Dam Operating Manual describes typical operating levels but does not describe issues relating to a response of a failure/emergency event.

It is recommended that an Emergency Preparedness and Response Plan be prepared for the facilities now that a DSR has been completed for the site which should include the anticipated effects of a dam failure under the selected IDF.

10. PUBLIC SAFETY

10.1 Review

The Burgess 1 Dam main access gate is located off Portage Street and is typically locked when site personnel are not present. The man gate located on the south bank of River Street is poorly secured with a thin chain and padlock, although it is kept locked upgrades to the gate would improve security. Fencing around the property is damaged in some places and could allow for access to the general public. Although not generally accessible a cottager has also built a dock on the south abutment of the dam. The site is generally inaccessible by foot, but it is possible to access the site by boat or by walking up the tailrace due to poor signage and an inadequate boom line. There is no signage for the Burgess 1 Dam warning the public of the dangers associated with active hydro generation except for one badly faded poorly sized sign located on the top of the sluicegate. The boom line for the dam is poorly visible, dated, and does not have appropriate clearance from the dam.

10.2 Recommendations

- Signage should be added for the Headwaters and Tailrace of the facility indicating danger and the unexpected release of flows/fast moving water

- The faded sign should be replaced on the dam
- Fencing should be expanded along the dam crest and repaired where broken
- The dock on the south abutment should be removed
- The north access gate should be repaired, and the locking system upgraded

11. MITIGATION RECOMMENDATIONS

Recommended mitigation measures are outlined below for the Non-overflow, Powerhouse and River Street Retaining Wall sections of the Burgess 1 Dam site. TULLOCH has provided improvement options for each section of the structure with a brief discussion on each option. It should be noted that these recommendations are at a conceptual level and quantities/cost estimations need to be verified with a detailed survey of the property. Conceptual figures of the facility upgrades can be seen in Appendix G.

11.1 Non-Overflow Dam Section

11.1.1 Option N1 – Downstream Rip Rap Placement and Toe Berm

Option N1 is to reinstate the fill of the existing dam by replacing rockfill/ rip rap over a non-woven geotextile for erosion protection d/s of the existing dam site. Fill should be replaced in washout section and then covered with a geotextile. The addition of rip rap will provide added erosion protection in the event of overtopping to avoid excessive washout of fill similar to the 2019 event. In order to collect overflow water during flooding events a toe-berm could be constructed along the downstream property line to channel water down to the in-situ river channel. A similar berm would be constructed along the south wall of the powerhouse to keep flows away from the building foundation. Figures 19-1493-C-01 and 02 in Appendix G show the conceptual design for Option N1. Highlights of the N1 design include:

- Downstream; clear and strip organics as required;
- Reinstate washed-out sections of downstream fill
- Place Non-woven geotextile and rip rap (500mm thick); grade back toward the tailrace for erosion protection;
- build toe berms along the existing property line and the south wall of the powerhouse to manage and divert the overflow (if it occurs) toward the river;
- Extend the existing dam to the south end to accommodate toe berm and flow management (about 8m in length);
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;

11.1.2 Option N2 – Partial Dam Raise and Emergency Spillway

Option N2 is to partially raise sections of the Non-overflow area of the dam and install and emergency spillway to control overflow during flooding events.

The spillway invert could be kept at the current dam crest elevation and the remainder of the dam would subsequently be raised 0.5m to meet the minimum freeboard criteria during the operation of the spillway during a flood event. The final spillway invert elevation and grade as well as the dam raise will need to be determined based on a detailed survey and hydrotechnical assessment. Figures 19-1493-C-04 and 05 in Appendix G show the conceptual design for Option N2. Highlights of the N2 design include:

- Downstream; clear and strip organics as required;
- Partially raise the dam 0.5 m for the dam section about 20 m in length south of the proposed spillway invert and 6 m in length north of the invert;
- Build an emergency spillway channel with rip rap placed a minimum of 500 mm thick over non-woven geotextile with a total approximate width of about 18m through the middle of Non-overflow section of the dam;
- The spillway should be angled such that water is directed into the existing tailrace and away from the River Street embankment;
- Re-instate the fill south of the spillway that has been washed away during the flooding event and tie into the spillway;
- Extend the existing dam abutment south to accommodate a higher elevation (about 8m in length);
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;

11.2 Powerhouse Dam Section

11.2.1 Option P1 –Demolish Powerhouse and Replace with New Dam

Given the relatively poor condition of the existing powerhouse, Option P1 is to demolish the existing powerhouse dam section and build a new replacement concrete dam section upstream of the existing powerhouse. Figures 19-1493-C-08 and C-10 in Appendix G show the existing condition of the section and a conceptual design for Option P1. Highlights of the P1 design include:

- Installation of u/s and d/s cofferdams;
- Removal of the old dam section and associate powerhouse structures;

- Construction of a new concrete gravity dam (about 2.5m high) on excavated bedrock for water retention (i.e. to maintain the lake level); the new dam section will be tied into the existing non-overflow section.
- Removal of cofferdams after construction is complete.

11.2.2 Option P2 – Powerhouse Refurbishment and Reinforcement

It may be advantageous to keep the powerhouse section of the dam intact given its historic value and the potentially prohibitive cost of decommissioning and deconstruction. Furthermore, the possibility of continued power generation may be appealing to the Township. As such, given that the current FOS of the existing powerhouse dam section is marginally stable a refurbishment of the facility is possible to meet current standards. Option P2 entails the structural reinforcement of the existing building as well as to remediate and reinforce the dam section and foundation of the powerhouse. Figure 19-1493-C-09 in Appendix G shows the conceptual design for Option P2. The highlights of Option P2 include:

- Fill the scour areas (i.e. undermined holes) in the foundation the powerhouse with mass pour concrete;
- Grout the cracks developed in the existing concrete piers;
- Reinforce the powerhouse structures with 9 rock anchors (Φ35mm, 8m long) to be installed to a minimum depth of 6 m into the bedrock; Grout the existing crack through the foundation once bolts are installed;
- Repair/Replace the Roof;
- Add shear struts and additional structural bracing in the powerhouse building;
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;
- Extend the existing tailrace pipes for the turbine units d/s to keep them a safer distance away from the powerhouse to avoid scour and undermining of the foundation.

11.3 River Street Concrete Retaining Wall

Based on review of site photos and field findings, the following mitigation actions should be considered to improve the performance of the existing concrete retaining wall structure:

- Install a drainage ditch u/s of the retaining wall to divert the surficial run-off water from River Street;
- Drill drainage holes and install drainage pipes along the base of the existing concrete retaining wall;

It should be noted that all options described above are conceptual in nature. Verification of design elements, dimensions and quantities and associated costs will require topographical survey, geotechnical investigation and further geotechnical/structural analysis to move towards detailed design.

11.4 Cost Estimation

Preliminary costs and material quantities were estimated based on historical design drawings (seen in Appendix F) provided by the Township and an assumed ground profile. Table 11-1 shows a summary of the cost estimation for the options discussed above. It should be noted that the costing and quantities are considered preliminary for the purpose to help select a preferred option for detailed design. Costs and quantities should be verified with a detailed ground survey and confirmed with further geotechnical and structural analysis. Tables H-1 through H-4 in Appendix F show the details of the preliminary cost estimation for each option discussed above.

Table 11-1 Summary of the Preliminary Cost Estimates (FEL1 Level)

Area	Option	Cost Estimation ($)
Non-overflow Dam Section	N1	$ 171,535.00
	N2	$ 227,570.00
Powerhouse Dam Section and River Street Concrete Retaining Wall	P1	$ 1,884,400.00
	P2	$ 535,150.00

11.5 Preliminary Remediation Recommendations

Based on the assessment above, the following option combinations are feasible considering both technical and economic aspects, including:

- Option N1 and Option P2 (total cost: $ 706,685.00)
- Option N2 and Option P2 (total cost: $ 762,720.00)

TULLOCH recommends Option N2 and P2 for the proposed remediation of the facility the decision was made given the following considerations:

- Although the total cost for Option N2 / P2 is about 8% higher than Option N1/P2 combination, Option N2 will allow the dam to handle large flows more predictably and ensure that water flow is controlled and directed down the tailrace.
- By channeling the water down a dedicated spillway there is less likelihood of irregular erosion and scour and the risk of property damage is significantly reduced, as well it will reduce the likelihood of large flows against the River Street embankment.

- Based on the cost estimates and constructability for the powerhouse dam section, it may be more advantageous to leave the powerhouse in place. Option P1 (i.e. Removal of the powerhouse and replaced by a new dam) is the most expensive option and would present considerable difficulties in construction. In addition, due to the historic significance of the structure it may be advantageous to maintain a refurbished structure.

Ultimately the decision on the future of the Burgess 1 Dam facility will be up to the Township and TULLOCH would be pleased to offer any further services towards the rehabilitation of this structure.

12. CLOSURE

This DSR report has been prepared by TULLOCH for the exclusive use of the Township of Muskoka Lakes and their authorized agents for the evaluation of the performance and safety of the Burgess 1 Dam located in Bala, Ontario.

We trust that the information in this report will be sufficient to allow the Township of Muskoka Lakes to better understand the risks associated with the Burgess 1 Dam Facility and provide a clear path forward towards rehabilitation of the structure. Should further elaboration be required for any portion of this project, we would be pleased to assist.

George Liang, Ph.D., P.Eng.
Senior Geotechnical Engineer

Erik Giles., P.Eng.
Geotechnical Engineer

Frank Palmay P.Eng.
Structural Design Engineer, Project Manager

REFERENCES

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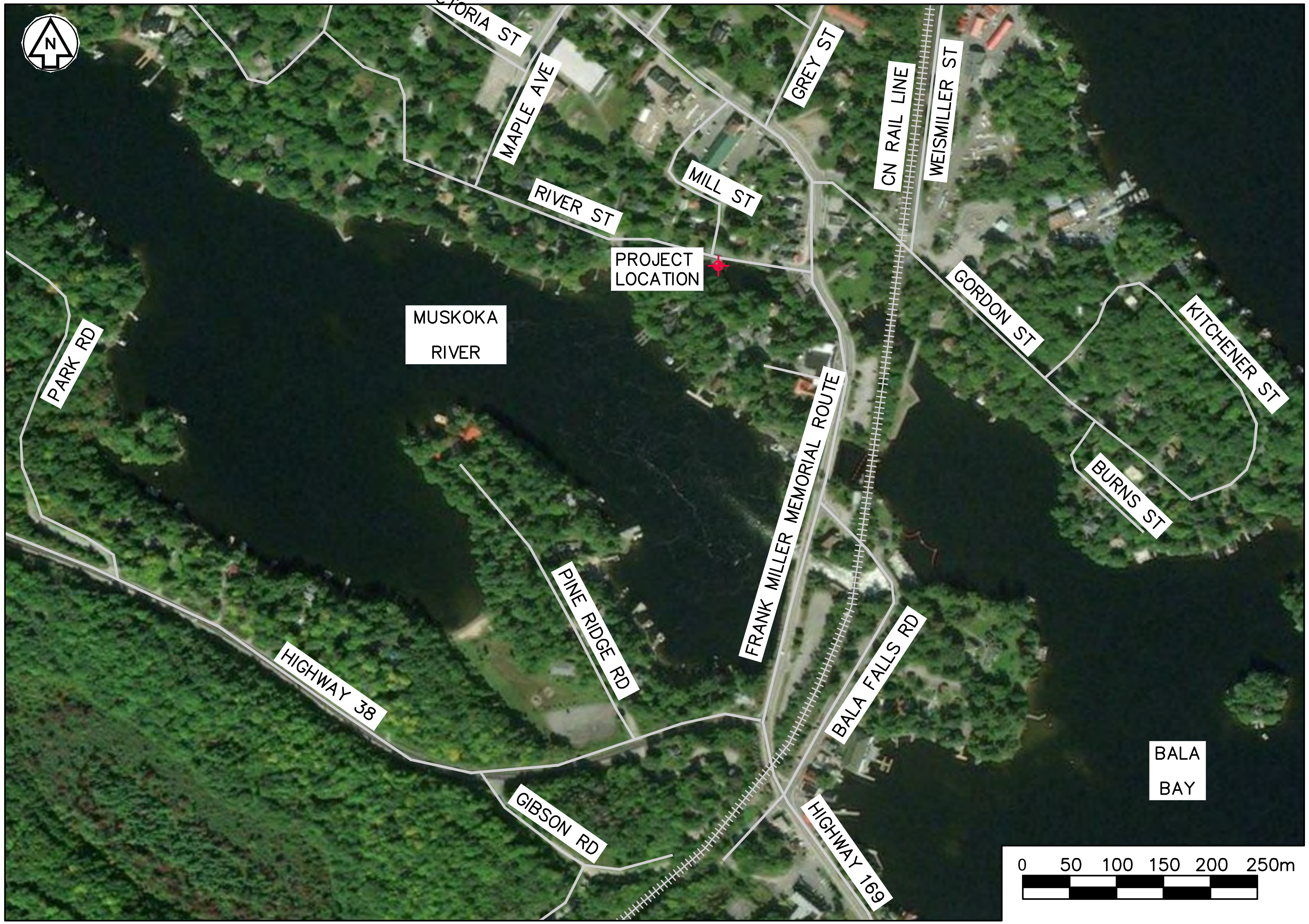
Totten Sims Hubicki Associates. (circa 1987). Bala – Small Hydro Development Burgess Dam Site.

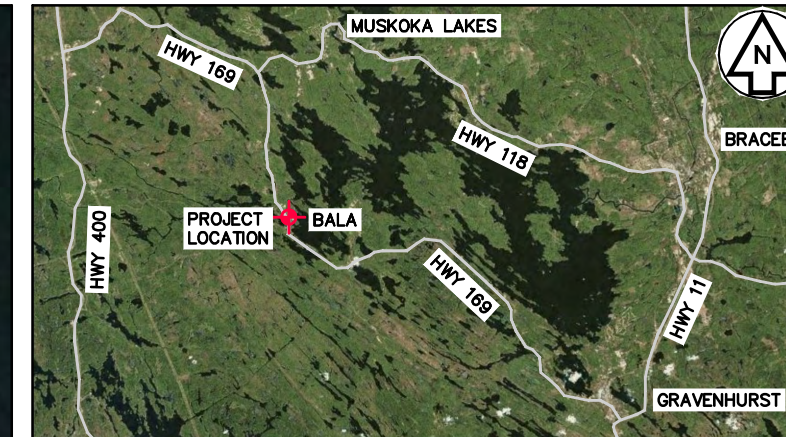
APPENDIX A

KEY LOCATION PLAN



PLAN - BALA, ONTARIO

N.T.S.



PROJECT LOCATION

N.T.S

No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	KK	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING: PROJECT LOCATION KEY PLAN

CLIENT: TOWNSHIP OF MUSKOKA LAKES

PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT

DRAWN BY: K. KORTEKAAS
CHECKED BY: E. GILES
DESIGNED BY: G. LIANG
APPROVED BY: G. LIANG
SCALE: AS NOTED
DATE: 2019-08-07
DRAWING No. 19-1493-C-00
REVISION No. A

H:\2019\ENGINEERING\191493 - Bala Dam Safety Review_DRAWINGS\191493-C-00.dwg

APPENDIX B

NBCC SEISMIC HAZARD VALUES

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.015N 79.616W

2019-08-13 17:41 UT

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.078	0.049	0.032	0.011
Sa (0.1)	0.109	0.071	0.048	0.018
Sa (0.2)	0.109	0.074	0.051	0.020
Sa (0.3)	0.095	0.065	0.045	0.018
Sa (0.5)	0.080	0.054	0.037	0.014
Sa (1.0)	0.049	0.033	0.022	0.007
Sa (2.0)	0.026	0.016	0.011	0.003
Sa (5.0)	0.006	0.004	0.002	0.001
Sa (10.0)	0.003	0.002	0.001	0.000
PGA (g)	0.064	0.041	0.028	0.010
PGV (m/s)	0.067	0.042	0.027	0.008

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

APPENDIX C

CDA AND MNRF TECHNICAL RESOURCES

1. DAM CLASSIFICATION AND DESIGN CRITERIA

According to the Technical Bulletin of the MNRF Guidelines, dams are classified us the following classification system which is based on four classification categories that define incremental losses due to dam failure based on increasing level of magnitude. Similarly, the CDA has five classification categories. Tables 1.1 and 1.2 outline the 2011 MNRF and the 2013 CDA criteria for determining the classification for individual dams. Table 1.3 and Table 1.4 identify the range of based on MNRF and CDA criteria.

Table 1.1: Dam Classification based on CDA Guidelines (2013)

Dam Class	Population at Risk [1]	Incremental Losses		
		Loss of Life [2]	Environmental and cultural values	Infrastructure and economics
LOW	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
SIGNIFICANT	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
HIGH	Permanent	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
VERY HIGH	Permanent	100 or fewer	Significant loss or deterioration of critical fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
EXTREME	Permanent	More than 100	Major loss of critical fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

Note 1: Definitions for population at risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).
Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

Note 2: Implications for loss of life:

Unspecified – the appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Table 1.2: Hazard Potential Classification based on MNRF Guidelines (2011)

	Hazard Categories – Incremental Losses[1]			
Hazard Potential	**Life Safety[2]**	**Property Losses[3]**	**Environmental Losses**	**Cultural – Built Heritage Losses**
LOW	No potential loss of life.	Minimal damage to property with estimated losses not to exceed $300,000.	Minimal loss of fish and/or wildlife habitat with high capability of natural restoration resulting in a very low likelihood of negatively affecting the status of the population.	Reversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act.
MODERATE	No potential loss of life.	Moderate damage with estimated losses not to exceed $3 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or structures not for human habitation, infrastructure and services including local roads and railway lines. The inundation zone is typically undeveloped or predominantly rural or agricultural, or it is managed so that the land usage is for transient activities such as with day-use facilities. Minimal damage to residential, commercial, and industrial areas, or land identified as designated growth areas as shown in official plans.	Moderate loss or deterioration of fish and/or wildlife habitat with moderate capability of natural restoration resulting in a low likelihood of negatively affecting the status of the population.	Irreversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act. Reversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or nationally recognized heritage sites.
HIGH	Potential loss of life of 1-10 persons	Appreciable damage with estimated losses not to exceed $30 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or residential, commercial, industrial areas, infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services includes regional roads, railway lines, or municipal water and wastewater treatment facilities and publicly-owned utilities.	Appreciable loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/ or wildlife habitat with reasonable likelihood of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered, or reversible damage to the habitat of that species.	Irreversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or damage to nationally recognized heritage sites.
VERY HIGH	Potential loss of life of 11 or more persons.	Extensive damage, estimated losses in excess of $30 million, to buildings, agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, infrastructure and services. Typically includes destruction of, or extensive damage to, large residential, institutional, concentrated commercial and industrial areas and major infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services includes highways, railway lines or municipal water and wastewater treatment facilities and publicly-owned utilities.	Extensive loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/ or wildlife habitat with very little or no feasibility of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a viable portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered or irreversible damage to the habitat of that species.	

Notes:

1. Incremental losses are those losses resulting from dam failure above those which would occur under the same conditions (flood, earthquake or other event) with the dam in place but without failure of the dam.
2. Life safety. Refer to Technical Guide – River and Streams Systems: Flooding Hazard Limits, Ontario Ministry of Natural Resources, 2002, for definition of 2 x 2 rule. The 2 x 2 rule defines that people would be at risk if the product of the velocity and the depth exceeded 0.37 square meters per second or if velocity exceeds 1.7 meters per second or if depth of water exceeds 0.8 meters. For dam failures under flood conditions the potential for loss of life is assessed based on permanent dwellings (including habitable buildings and trailer parks) only. For dam failures under normal (sunny day) conditions the potential for loss of life is assessed based on both permanent dwellings (including habitable dwellings, trailer parks and seasonal campgrounds) and transient persons.
3. Property losses refer to all direct losses to third parties; they do not include losses to the owner, such as loss of the dam, or revenue. The dollar losses, where identified, are indexed to Statistics Canada values Year 2000.
4. An HPC must be developed under both flood and normal (sunny day) conditions.
5. Evaluation of the hazard potential is based on both present land use and on anticipated development as outlined in the pertinent official planning documents (e.g. Official Plan). In the absence of an approved Official Plan the HPC should be based on expected development within the foreseeable future. Under the Provincial Policy Statement, '*designated growth areas*' means lands within *settlement areas* designated in an official plan for growth over the long-term planning horizon (specifies normal time horizon of up to 20 years), but which have not yet been fully developed. *Designated growth areas* include lands which are *designated and available* for residential growth in accordance with the policy, as well as lands required for employment and other uses (Italicized terms as defined in the PPS, 2005).
6. Where several dams are situated along the same watercourse, consideration must be given to the cascade effect of failures when classifying the structures, such that if failure of an upstream dam could contribute to failure of a downstream dam, then the HPC of the upstream dam must be the same as or greater than that of the downstream structure.
7. The HPC is determined by the highest potential consequences, whether life safety, property losses, environmental losses, or cultural-built heritage losses.

Table 1.1: Range of Minimum Inflow Design Floods

<table>
<tr><th rowspan="2">Hazard Potential Classification (HPC)</th><th colspan="4">Range of Minimum Inflow Design Floods [1]</th></tr>
<tr><th colspan="2">Life Safety [3]</th><th>Property and Environment</th><th>Cultural – Built Heritage</th></tr>
<tr><td>LOW</td><td colspan="4">25 year Flood to 100 year Flood</td></tr>
<tr><td>MODERATE</td><td colspan="4">100 year Flood to 1000 year Flood or Regulatory Flood whichever is greater</td></tr>
<tr><td>HIGH</td><td>1-10</td><td>1/3 between the 1000 Year Flood and the PMF</td><td>1000 Year Flood or Regulatory Flood, whichever is greater, to 1/3 between the 1000 Year Flood and the PMF</td><td>1000 Year flood or Regulatory Flood, whichever is greater</td></tr>
<tr><td rowspan="2">VERY HIGH</td><td>11-100</td><td>2/3 between the 1000 Year Flood and the PMF</td><td rowspan="2">1/3 between the 1000 Year Flood and the PMF to the PMF</td><td rowspan="2"></td></tr>
<tr><td>Greater than 100</td><td>PMF</td></tr>
</table>

Notes

1. The selection of the IDF within the range of flows provided should be commensurate with the hazard potential losses within the HPC Table. The degree of study required to define the hazard potential losses of dam failure will vary with the extent of existing and potential downstream development and the type of dam (size and shape of breach and breach time formation).
2. As an alternative to using the table the IDF can also be determined by an incremental analysis. Incremental analysis is a series of scenarios for various increasing flows, both with and without dam failure that is used to determine where there is no longer any significant additional threat to loss of life, property, environment and cultural – built heritage to select the appropriate IDF.
3. Where there is a potential for loss of life the IDF may be reduced provided that a minimum of 12 hours advanced warning time is available from the time of dam failure until the arrival of the inundation wave, provided that property, environment, or cultural – built heritage losses do not prescribe a higher IDF.

Table 1.2: Floods and Earthquake Hazards, Standard-Based Assessments (CDA)

Dam Class	Annual Exceedance Probability – Floods[1]	Annual Exceedance Probability – Earthquakes[4]
LOW	1/100 year	1/100
SIGNIFICANT	Between 1/100 and 1/1000 year[2]	Between 1/100 and 1/1000
HIGH	1/3 between 1/1000 and PMF[3]	1/2475[5]
VERY HIGH	2/3 between 1/1000 and PMF[3]	½ between 1/2475[5] and 1/10,000 or MCE[3]
EXTREME	PMF[3]	1/10,000 or MCE[3]

Notes
1. Simple extrapolation of flood statistics beyond 10^{-3} AEP is not acceptable.
2. As an alternative to using the table the IDF can also be determined by an incremental analysis. Incremental analysis is a series of Selected on basis of incremental flood analysis, exposure, and consequences of failure.
3. PMF and MCE have no associated AEP.
4. Mean values of the estimated range in AEP levels for earthquakes should be used. The earthquake(s) with the AEP as defined in this table is then input as the contributory earthquake(s) to develop Earthquake Design ground Motion (EDGM) parameters as described in Section 6.5 of the CDA Guidelines.
5. This level has been selected for consistency with seismic design levels given in the National Building Code of Canada.

APPENDIX D

DSI FIELD INSPECTION REPORT

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FIELD INSPECTION REPORT

Site Identification:	Burgess Dam
Structure Identification:	Burgess Dam
Location:	Bala, Ontario
Inspection Date:	04-07-2019
Inspection Time:	09:10
Inspected By:	E. Giles, F. Palmay
Accompanied By:	Steve Dursley
Inspection Type:	Dam Safety Assessment

Atmospheric Conditions

Inspection Day:	Clear
Temp:	27
Previous Week:	26 - 32
Temp Range:	26-32
Current Pond Level:	Unknown
Current Freeboard:	0.7 m

Dam Structure

1.1 Surface Cracking, Displacement, etc.	Yes
Comments	Cracks apparent on concrete upstream and downstream surface, ranging from hairline tonarrow expected with age of dam, efflouressence observed on cracks. Some cracks evidence of historic repairs
1.2 Concrete Deterioration, Spalling, etc.	No
Comments	Minor to moderate Spalling on concrete on dam and along u/s face of Dam, small delaminated section ~ 1.0m long on dam crest
1.3 Evidence of Scouring	Yes
Comments	Scouring evident typical of age of structure, the worst section observed was along south side of powerhouse on the dwonstream face of the dam where significant deterioration was observed.

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1.4 Evidence of Seepage	Yes
Comments	Seepage along d/s face at south edge of power station, as well as ~ 10m downstream of the dam near the joint between section DC/CB. Significant was observed at east wall of powerstation/downstream face of dam. In discussion with operator, seepage had improved since applying cold patch repairs to upstream and
1.5 Unusual or Special conditions	Yes
Comments	Powerhouse still in operation, original roof with bracing, joists failing, corrosion of bracing observed particulalry on the floor
1.6 Undesirable Vegetation, Debris, etc. at toes	Yes
Comments	Significant vegetation along downstream toe including trees/stumps, debris from flooding, and significant washouts were observed caused by the flooding.

View of downstream dam face, note concrete degradation on cold joint

View of upstream face, note broken fence and vegetation build up along downstream toe of dam

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Seepage observed along downstream face of dam built into powerhouse

Abutments

2.1 Surface Cracking, sinkholes, etc. — No

Comments — Minor cracking and deterioration evident typical with age of structure, good contact at abutment observed

2.2 Evidence of Settlement, movement, etc. — No

Comments — No evidence of movement on the dam

2.3 Gap, Leakages, etc. at Contact. — No

Comments — South abutment contact observed to be good some cracks visible expected with age of structure

2.4 Evidence of Repairs — Yes

Comments — Evidence of repair on larger cracks of dam, cold patch concrete placed over large cracks plus cracks were also filled upstream near the generating station dring low water levels. Cold patch placed thorughout powerhouse on downstream face of dam to curtail seepage

2.5 Unusual or Special Conditions. — Yes

Comments — There is a dock built into the south abutmentand of the dam by a local cottager. The north abutment is buillt into river street and terminates at the road shoulder guard rail.

South abutment of dam, note dock built into dam crest at tie-in, good contact

North abutment of dam, concrete ends at guard rail at embankment of Riiver Street, good contact observed

Historically repaired crack with cold patch concrete on downstream face of dam near south abutment

Pond Level and Perimeter

3.1 Concerns with pond level. Yes

Comments Minimal freeboard observed with approximately 0.7m, measured at time of inspection. Based on discussion with operator the dam was close to overtopping during the flooding events of 2013 and overtopped for the first time 2019.

3.2 Concerns with pond perimeter	Yes
Comments	Risk of property damage from overtopping, the retaining wall on the north side of the powerhouse was observed to be cracked through the wall and moving, steep embankment observed on north side of tail race holding up River Street
3.3 Other concerns with pond area	Yes
Comments	River Street berm at north edge of the pond with low freeboard (<1.0 m) poor/insufficient erosion protection

View of pond and sluicegate, note road embankment on pond, insufficient erosion protection

Area of washout where water was spilling over the dam and down to tail race, site of temporary ditch excavated to channel water away from properties

Upstream pond note ~0.7m of free board at time of site visit

4. Other Unusual Conditions Comments

Yes

The embankment north of the dam and located west of the powerhouse is eroded and very steep, washout in 2019 observed at toe of concrete retaining wall. Rock fill wa splaced back in the area of the washout by the township

Steep embankment on north side of dam, photo taken downstream at tailrace note retaining wall

Large crack through retaining wall, note movement of wall

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	Large transverse crack running through powerhouse foundation, hole in wall at outlet of power house with significant seepage of ~ 2.0 L/s, possible outlet of historic box drain
5. Instrumentation	No
Comments	Water level is monitored just inside of the sluice gate to detect debris build up at spillway entrance, remnants of staff guge observed.

Spillway, Discharge Structure, Etc.

6.1 Concern for Discharge Control Structure	Yes
Comments	There is no emergency spillway for the dam and properties on both sides of the dam were effected during flooding of 2019.
6.2 Concern for Adequacy & Reliability of Emergency	Yes
Comments	See comments 6.1 there is no emergency spillway for this facility
7. Environmental Concerns	Yes
Comments	According to Steve Dursley downstream of the dam in the tail raace fish can spawning is observed

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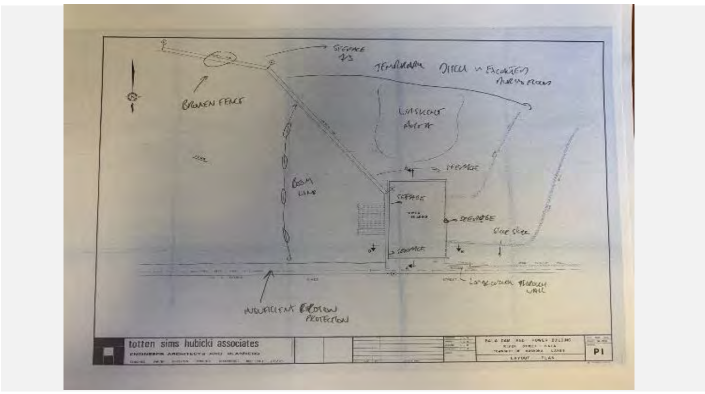
8. Safety Concerns	Yes
Comments	Poor guarding for turbine/ moivng parts wtihin the power house, broken fence on dam crest, expose grounding wire, washouts/debris and uneven ground caused from flooding
Signature:	

General Dam Information

Structure Type:	Concrete hydro electric dam
Spillway:	Sluice gate leading to two turbines, no emergency spillway
Foundation:	Bedrock
Crest Elev. (Current):	226.93
Abutments:	Concrete on bedrock
Max Height (Current):	~6m
Crest Length:	~59.2 m
Decants & Outlets:	Sluicegate into two turbines, outlet in two openings at generating station
Catchment Area:	Unknown
Normal Pond Elev:	224.6 - 225.61 (Bala Falls Dam)
Fetch Length & Direction:	~140 m
Max/Min OWL:	225.75 (Bala Falls Dam)
Construction History:	Built in 1917, minor rehabilitations through the years, Large rocks added to tail race to prevent erosion of properties downstream, Upgrade to south turbine in late 80s by Marsh Power and upgrade of north turbine and sluicegate in 2010s by current leasor KRIS power. Property owned by Township of Muskoka Lakes, leased to Kris Power, currently actively generating power
Last DSIs:	Unknown
Additional Notes:	



Site sketch with notes

APPENDIX E

KEY FINDINGS MEMORANDUM

M E M O R A N D U M

Date: Wednesday, July 24, 2019

To: Ken Becking

CC: George Liang; Sean Hinchberger

From: Erik Giles; Frank Palmay

Re: KEY / CRITICAL FINDINGS FOR BURGESS 1 DAM IN BALA, ONTARIO

1. DATE

- July 4th, 2019

2. PERSONNEL AT SITE

- KRIS Power: Steve Dursley (Care and Maintenance Operator)
- TULLOCH: Frank Palmay (P.Eng.), Erik Giles (P. Eng.)

3. SUMMARY OF THE KEY/CRITICAL FINDINGS

The dam safety inspection (DSI) for the Burgess 1 Dam took place on the morning of July 4th, 2019. Steve Dursley (KRIS Power) met the TULLOCH team on site and permitted entrance to the facility. The inspected structures included the following:

- Concrete dam structure (Water Retaining structure, Non-overflow dam section);
- Concrete dam with downstream (d/s) powerhouse structure;
- River Road Retaining Wall and Embankment;
- Downstream erosion and scouring conditions during 2019 flooding;
- Upstream (u/s) reservoir (within 500m approaching to the Burgess 1 Dam);
- Other ancillary structures including the access road, fence, gates, tailrace and walkways etc. where accessible.

Table 1 summarizes the key/critical findings during the site inspection. The detailed field inspection checklist and comments including selected photographs are presented in Appendix A.

Section 4 presents the discussion based on the key findings and the preliminary engineering assessment; Section 5 summarizes the three preliminary recommendations for remediation with respect to the scope of work.

Table 1: Key/Critical Findings During the DSI

Site	Site Segment	Observation Criteria	Key/Critical Findings
Burgess 1 Dam	Concrete Dam (Water Retaining Structure, Non-overflow section)	Structural	• Cracking in dam – hairline to narrow, no to minimal movement based on observation; • Sections of delamination on dam crest; • Evidence of historic crack repairs with cold patch concrete; • Concrete degradation observed with moderate spalling – worst section south of powerhouse near tie-in with powerhouse walls; • Minor to moderate pitting and scour observed along structure and on visible sections of u/s face of dam, expected given age of structure.
		Geotechnical	**General** • Abutment contacts sound at each end of the dam; o South abutment has a dock built on top of it by a cottager o North abutment ties into River Street • Moderate to significant washouts along the dam toe area caused from flooding; • Freeboard at time of inspection was ~0.7m from dam crest; • Significant vegetation builds up on d/s toe of dam including large trees ~ 0.3m in diameter, evidence of historic vegetation clearing i.e. stumps; • Debris from flooding piled on and around dam section.
			Seepage • Minor seepage observed ~ 15m d/s of the dam near the access gate, ponded water visible; • No evidence of boils or piping beneath the dam section; • Cold patch concrete has been placed on the d/s and u/s sections of dam to reduce the seepage/leakage since KRIS power has taken up the operation of the dam facility, this has reduced the seepage/leakage according to Mr. Dursley.

Site	Site Segment	Observation Criteria	Key/Critical Findings
			<u>Geotechnical Stability</u> • Moderate to significant washouts were observed caused by flood waters at the d/s of the concrete dam, a ~ 1.0m depth of the d/s toe fill material along the concrete dam have been washed away; a ~ 2.0m depth of the d/s fill materials have been eroded/washed out at the south end of the powerhouse section. The erosion of the d/s toe fill materials may cause dam stability issue; • Upstream slope/River Road embankment has insufficient erosion protection/armouring; • Based on visual inspection, the concrete dam and the powerhouse section have not experienced obvious moving or shifting at the time of DSI.
			<u>Water Control/Spillway</u> • There is no emergency spillway for this facility, a temporary trench was excavated to channel flood waters during the 2019 flooding event and diverted the water to the south of the property near the access gate and down into the tailrace area; • A new sluicegate was installed by KRIS power.
			<u>Instrumentation</u> • There is no monitoring program or instrumentation installed for the lake levels at the dam site, remnants of a staff gauge were observed on the outlet of the powerhouse • KRIS power does monitor water levels at the sluicegate invert to determine if blockages are accumulating, this data was not available on site.

Site	Site Segment	Observation Criteria	Key/Critical Findings
	Powerhouse Section	Structural	• Roof of powerhouse is overstressed; joists are cracking at midspan; • Roof of powerhouse is not watertight and has polyethylene vapor barrier placed overtop, this is trapping moisture and not allowing the roof to dry out, likely causing accelerated deterioration of members; • Steel frame installed in powerhouse is corroding at the bottom as a result of continued exposure to standing water, significant section loss noted; • Carpenter ants or termites present (observed sawdust in powerhouse); • Diagonal cracks in powerhouse indicating foundation of structure may be compromised; • Water leaking through rear wall of powerhouse; • Efflorescence present on walls and floor slab of powerhouse indicating seepage is passing through concrete.
		Geotechnical	• Generally moderate seepage observed along the d/s of the powerhouse dam section, a significant seepage was observed at south and north ends of powerhouse. In conversation with Steve Dursley, the seepage is relatively unchanging throughout the course of the year in 2019. And remains in a steady state; • Large hole ~ 0.2m in diameter leaking a significant amount of water ~ 2.0 l/s, this has been a known issue, and has remained unchanged. This may be the outlet to a historic box drainage system installed in the dam, again indicating a steady state condition; • Moderate seepage observed along downstream toe concentrating outside of south end of powerhouse, likely through worn section of dam; • Transverse crack through powerhouse as noted above indicate potential foundation failure and reduced capacity of floor slab to act as ballast for the gravity dam section.

Site	Site Segment	Observation Criteria	Key/Critical Findings
Other Associated Infrastructure	River Road Retaining Wall and Embankment	Structural	• Undermining of stone retaining wall supporting River Street; • Crack in cast in place wall supporting River street and portion of wall now leaning away from the road indicating movement;
		Geotechnical	• Embankment along River Street upstream of the Burgess Dam is very steep and appears to be eroding at the toe where there are newer gabion baskets placed on a historic boulder/stone wall. There is a concern for the slope failure of the embankment due to the erosion/ scour caused by the water flows. The slope stability evaluation of the embankment along the River Street is not included in the scope of this DSR. Detailed geotechnical investigation and assessment are strongly recommended; • Evidence of slope movement based on guardrail; • Sediment build-up observed within tail race due to washout material.
Burgess 1 Dam Site	Dam Site	Public Safety	• Inadequate/ no signage for safety warning at the u/s dam for the potential hazards of the vortex/swirl caused by the running flow during operation of the powerhouse; • Inadequate boom line, poorly visible and half sunken logs; the boom line is in a poor condition and the distance to the inlet of the powerhouse is inadequate; • Broken fencing on dam crest allows for access from public, lack of physical barriers along dam crest to prevent access; • Inadequate gating/locking system, easily accessed.

4. DISCUSSION

The following sections discuss the key findings and preliminary structural / geotechnical assessment for the Burgess 1 Dam.

4.1 Structural

Based on the DSI, it is believed that the roof of the powerhouse has failed in several locations. Broken roof joists were noted in several locations with failure along the midspan of the beams. The joists had been reinforced in the past; however, the current bracing is providing inadequate support for snow loads as detailed in the Ontario Building Code. Furthermore, the roof membrane has failed and has been temporarily repaired with polyethylene vapor barrier weighted on the roof with various cobbles and debris. The vapor barrier is currently trapping condensation and moisture on the roof which is expediting deterioration.

It was also noted during the inspection that there had been previous attempts to rehabilitate the structure by evidence of a steel frame constructed on the interior of the powerhouse, however, moisture present along the base of the columns as a resultant of the seepage has left the bracing with severe corrosion, which significantly reduces the structural capacity of the steel frame.

Finally, a large/wide crack along the powerhouse foundation walls was observed running through the entire structure. The cause of this may have been a result of losing the foundation material over time below the walls during the powerhouse operation, which may have caused the foundation to drop, or excessive pressure brought on from the hydrostatic forces acting on the dam. This large crack also poses a risk to the stability of the dam which will be discussed in Section 4.2.

Based on the above evidence, major rehabilitation or replacement of the building would be required.

4.2 Geotechnical

4.2.1 General Dam Conditions

Inspection of the concrete dam indicated that the concrete wall of the dam area was generally in a fair condition. Seepage was noted at various areas under the dam sections, however, there was no indication of boiling or piping through the dam foundation and the observed seepage rate was relatively stable. Significant seepage was observed in the powerhouse, however, the amount of the seepage was reported to remain steady in recent years.

Generally, the condition of the concrete was found to be expected with the age of the structure, some hairline to narrow cracks were observed in the dam with a small section of delamination at the crest on the southern side. Areas of scour / erosion were observed particularly around the south side of the powerhouse where aggregate was observed. Evidence of historic repairs with cold patch concrete were evident along some sections of the dam including the powerhouse dam section. The contacts at both abutments for the powerhouse dam sections were generally in a good condition with no evidence of seepage. However, a large crack observed under the powerhouse floor slab (discussed in Section 4.1) indicated that the d/s support for the concrete gravity dam (i.e. the powerhouse dam section) has been compromised.

4.2.2 Factor of Safety for Dam Stability

Based on the review of the available documents and drawings provided by the Client, it is understood that the as-built concrete dam (non-overflow section) was constructed on the in-situ bedrock and supported by the downstream fill placed against the dam; at the powerhouse section, the d/s powerhouse structure with a massive concrete floor slab are likely to work together with the concrete gravity dam structure to take the loads. The typical dam sections are included in Appendix B.

Preliminary stability calculations were carried out for both non-overflow concrete dam section and the powerhouse dam section (see Appendix B). Table 4-1 is a summary of the preliminary results of the calculated factor of safety for the dam under current condition.

Table 4-1: Summary of the Calculated FOS (Static)[1]

Dam Section	Maximum Height (m)	Calculated FOS		Required Min FOS
Non-overflow Section	3	Against Sliding	2.2 to 2.4	1.5
		Against Overturning	1.2 to 1.4	2.0
Powerhouse Dam Section	6	Against Sliding	2.4-3.3	1.5
		Against Overturning	1.6-1.9	2.0

Note:[1-] The water level is assumed to be 30cm below the dam crest.

Based on Table 4-1, it can be seen that:

- For non-overflow dam section, the calculated FOS is depending on the remaining fill material at d/s toe area for the post-overflow event in 2019 flooding. Significant washout /scouring was observed along the downstream toe area with a scoring depth in excess of 1.0 - 1.5 m. Under the current site condition, the calculated FOS against sliding is in the range of 2.2 to 2.4, which meet the required minimum required FOS of

1.5; The calculated FOS against overturning is in the range of 1.2 to 1.4, which does not meet the required FOS of 2.0. Repair or mitigation measures have to be developed for the non-overflow dam section to improve the FOS to meet the criteria;

- For the powerhouse dam section, a large longitudinal crack that was observed through the floor slab/foundation of the dam during DSI. The presence of the crack likely indicated that both the dam section and the powerhouse structure worked together carrying loading. Under the current site condition, the calculated FOS against sliding is in the range of 2.4 to 3.3, which meet the required minimum FOS of 1.5; The calculated FOS against overturning is in the range of 1.6 to 1.9, which does not meet the required FOS of 2.0. Repair or mitigation measures need to be developed for the powerhouse dam section to improve the FOS to meet the criteria.
- For the powerhouse dam section, caution should be taken if/when the powerhouse is considered to be removed. If the powerhouse is to stay intact it is recommended that the floor slab be repaired by anchoring the two pieces together and seating the anchors into bedrock to ensure that the slab can act as one unit. Furthermore, to achieve an acceptable safety factor the slab should be anchored into the bedrock to prevent overturning or sliding. Further geotechnical investigation and engineering assessment may be required.

4.2.3 Overflow Water Management

There is no emergency spillway installed at the dam site to manage the overflow. The overflow water was largely reported to the south side of the dam near the right abutment and was then channeled down to the tailrace through a temporary trench during 2019 overtopping event. Significant scour and washout for the downstream fill materials were caused by the random overflow. Furthermore, the current dam is at risk of failure due to the severe erosion/scouring at the downstream toe area. To improve the dam safety condition, replacement of the d/s fill material, the overflow water management facility and the d/s erosion protection measures should be developed.

4.2.4 Vegetation Control

Significant vegetation was observed on the downstream edge of the dam with large trees growing directly downstream of the dam. Vegetation should be removed within 3 – 5 m of the footprint of the selected repair/mitigation option.

5. PRELIMINARY RECOMMENDATIONS

The following sections briefly discuss the preliminary recommendations for the rehabilitation of the Burgess 1 Dam facilities. The preliminary recommendations are based on the consideration of the following factors:

- The key findings of 2019 DSI and dam safety;

- Preliminary structural / geotechnical assessment;
- Impact on the environmental and permitting for the construction at the dam site;
- Technical and economic feasibility and constructability;

Several preliminary options for the rehabilitation of the Burgess 1 Dam facilities are evaluated at an FEL 1 level (i.e. preliminary design). However, for the purpose of this Memoranda, three (3) primary feasible options will be briefly discussed. The further engineering assessment of the feasible rehabilitation options are in progress, the final recommended option will be presented in the DSR report.

5.1 Option #1 Re-instate downstream Fill and add Erosion Protection

The objective of the Option #1 is to reinstate the FOS of the existing dam by replacing d/s fill material and manage the overflow by re-grading the d/s slope associate with rockfill/ riprap for erosion protection. A small toe berm is required to divert the overflow (if it occurs). Option #1 mainly consists of the following (see Appendix B-Option #1):

- Downstream vegetation removal as required;
- Strip the top organic soil as required;
- Replace the d/s fill materials to reinstate the FOS of the dam;
- Regrade the d/s fill materials and build a toe berm to manage and divert the overflow (if it occurs) toward d/s main river; The finish grade should be generally higher grade at the North side and progressively lower to the south side approaching the d/s river channel;
- Add appropriate rockfill/riprap for erosion protection if overtopping occurs;
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;
- At the powerhouse the slab should be repaired and anchored to the bedrock, or if the powerhouse is to be decommissioned then fill could be placed over-top of the slab to compensate for the compromised slab.

5.2 Option #2 Partially Dam Crest Raise without Spillway

The objective of the Option #2 is to partially raise the dam on both left and right abutment sides and direct the overflow (if occur) through the middle existing dam section toward the d/s river channel. Option #2 mainly consists of the following (See Appendix B-Option 2):

- Downstream vegetation removal as required;
- Strip the top organic soil as required;

- Partially raise the dam crest on the north and south dam sections; the middle section of the existing dam will be maintained to pass and divert the overflow to the d/s river channel;
- Replace the d/s fill materials to reinstate the FOS of the dam;
- For the area between the middle dam section and the d/s existing river channel, regrade the d/s fill and add appropriate rockfill/riprap for erosion protection to divert the overflow (if occur)
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;
- At the powerhouse the slab should be repaired and anchored to the bedrock, or if the powerhouse is to be decommissioned then fill could be placed over-top of the slab to compensate for the compromised slab.

5.3 Option #3 Dam Crest Raise plus Spillway Construction

The objective of the Option #3 is to raise the entire dam and install an emergency spillway to manage and control any overflow for flood event.

The installation of a spillway to the Burgess Dam facility would be highly advantageous. In the flood event, the overflow would be safely controlled and channeled to d/s river channel that would not affect the u/s lake operation level and the existing d/s facilities/ properties. Given that the overtopping occurred along the south section of the dam, the proposed spillway location would be at the south side of the dam, which has the shortest distance to the existing river channel. Furthermore, based on the topography of the site the most direct route to connect back to the tailrace would be along the southern edge of the property south of the existing water course. This would avoid unnecessary flows running against the River Street embankment. The spillway invert could be kept at the current dam crest elevation and the remainder of the dam could be raised minimally to meet the minimum freeboard criteria during the operation of the spillway in the flood event. The final spillway invert elevation and dam raise will be determined based on the hydrotechnical assessment. Option # 3 mainly consists of the following (see Appendix B-Option 3):

- Downstream vegetation removal as required;
- Strip the top organic soil as required;
- Raise the dam crest as per design;
- Install the emergency spillway as per design (e.g. Geomembrane Lined Rockfill Channel);
- Replace the d/s fill materials to reinstate the FOS of the dam;
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;

- At the powerhouse the slab should be repaired and anchored to the bedrock, or if the powerhouse is to be decommissioned then fill could be placed over-top of the slab to compensate for the compromised slab.

For all three options, appropriate topographical survey of the existing dam and surrounding area is required.

5.4 River Street Embankment and Retaining Wall

Visual inspection of the retaining wall and downstream embankment of River Street indicates that there is significant risk posed to the road.

River street currently sits on an embankment at an approximate 2H:1V on which the toe is supported by a more recent gabion basket retaining wall sitting on a historic boulder retaining wall. There is also a concrete retaining wall that abuts the south side of River Street and connects to the north wall of the powerhouse. A large crack through the retaining wall was observed and a large section of the wall has failed and has shown signs of movement.

There was also evidence of washout at the toe of the retaining wall. If a flood event were to occur again, and water were to make its way along the toe of the River Street embankment, there is a significant risk of a slope failure which could result in loss of the road and surrounding property damage. The existing concrete retaining wall is in a poor condition and should be replaced.

The embankment to the west of the wall should be better reinforced including the addition of erosion/scour protection to prevent future washout and slope instability. While this is not considered a direct risk to the dam, the observations on site deemed it necessary to be brought to the Township's attention as there exists a risk to River Street adjacent to the tailrace of the dam. The slope stability evaluation of the embankment along the River Street is not included in the scope of this DSR. Detailed geotechnical investigation and assessment are strongly recommended.

5.5 Public Safety and Access

The following summarize the recommendations regarding the public safety and access based on the DSI, including:

- A Public Safety Plan (PSP) should be drafted to address these issues and ensure they are properly managed.
- Install adequate safety signage at the dam site for warning of flow, deep water, the potential hazards of the vortex/swirl etc.
- Upgrade the boom line and adjust the safety distance to the powerhouse inlet;
- Upgrade the fence / gate to constrain the public access to the dam site without permits;

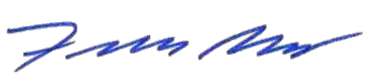
- The sluicegate of the dam appeared to have overhead flashing lights, however, they were not able to be tested during the site visit. Visual and audio warnings if not installed should be implemented and tested regularly to ensure that during startup/operation adequate warning can be given to members of the public.
- Grounding wire is currently exposed due to the washout. Exposed wire should be backfilled as soon as possible as this poses a significant hazard currently on the site. Furthermore, debris that has washed up on and over the dam crest should be removed.
- The south abutment currently has a dock from the neighboring resident built on the dam crest which should be removed.

6. CLOSURE

We hope that this draft memo helps frame the critical issues and proposed remediations for the Burgess 1 Dam facility. The detailed dam safety assessment is in progress and the final results will be presented in the final DSR report. If you have any questions, please feel free to reach out to the undersigned.

Sincerely,

Erik Giles, P.Eng
Geotechnical Engineer

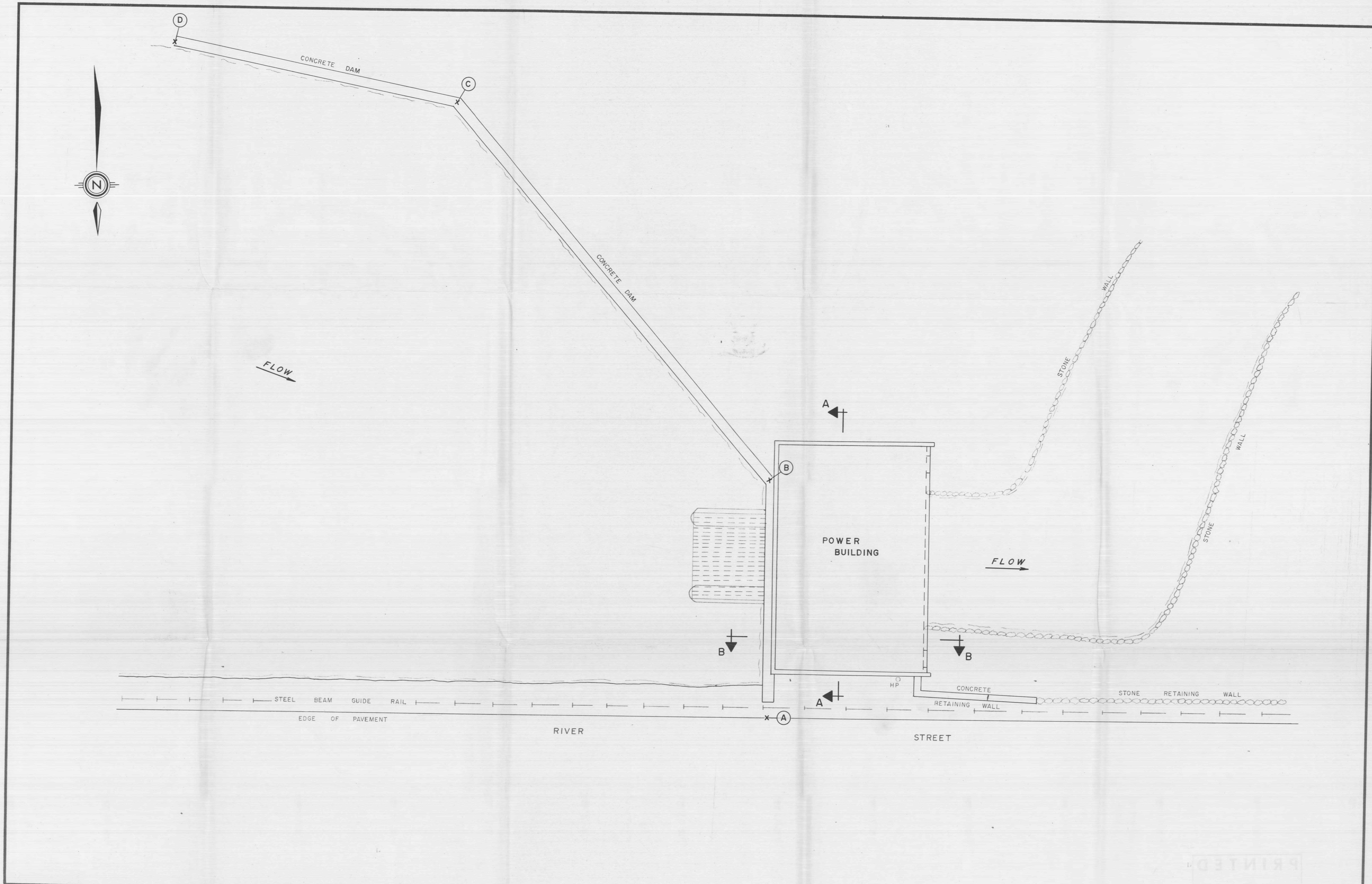


Frank Palmay P.Eng
Structural Design Engineer

Attachment(s)/Enclosure: Field Inspection Reports

APPENDIX F

HISTORIC SITE PLANS



totten sims hubicki associates

ENGINEERS ARCHITECTS AND PLANNERS

COBOURG WHITBY KINGSTON TORONTO BRACEBRIDGE BROCKVILLE OTTAWA

No.	DATE	BY	REVISIONS

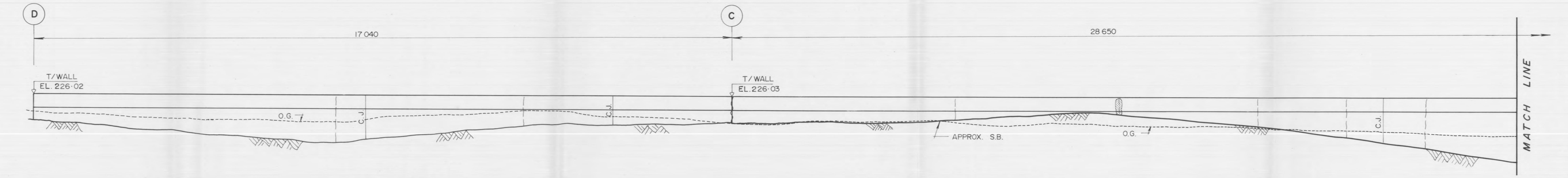
DESIGNED: D. L. B.
DRAWN: R. G. W.
CHECKED: D. L. B.
APPROVED: G. L. A.
SCALE: 1:100

BALA DAM AND POWER BUILDING
RIVER STREET - BALA
TOWNSHIP OF MUSKOKA LAKES

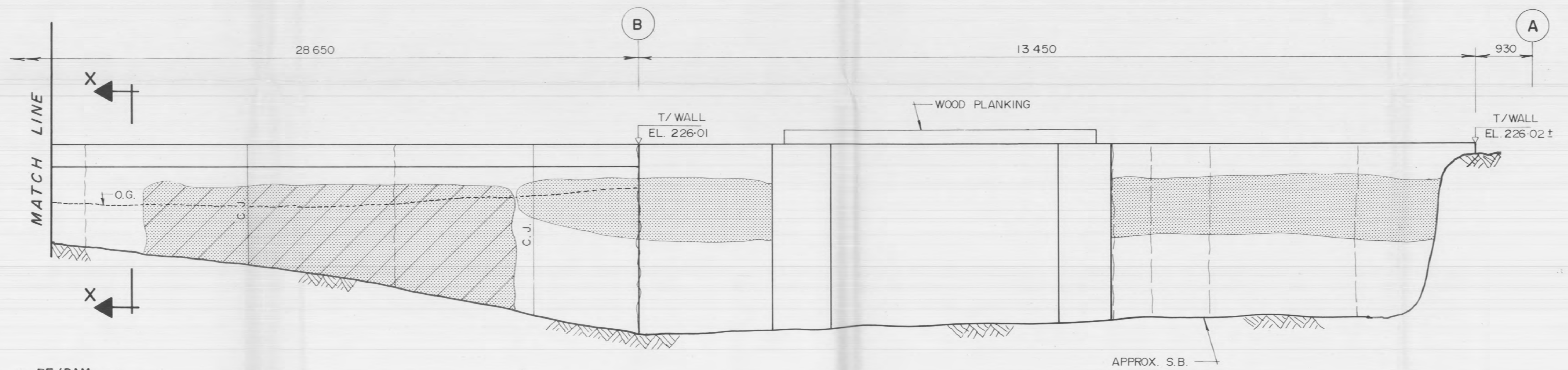
LAYOUT PLAN

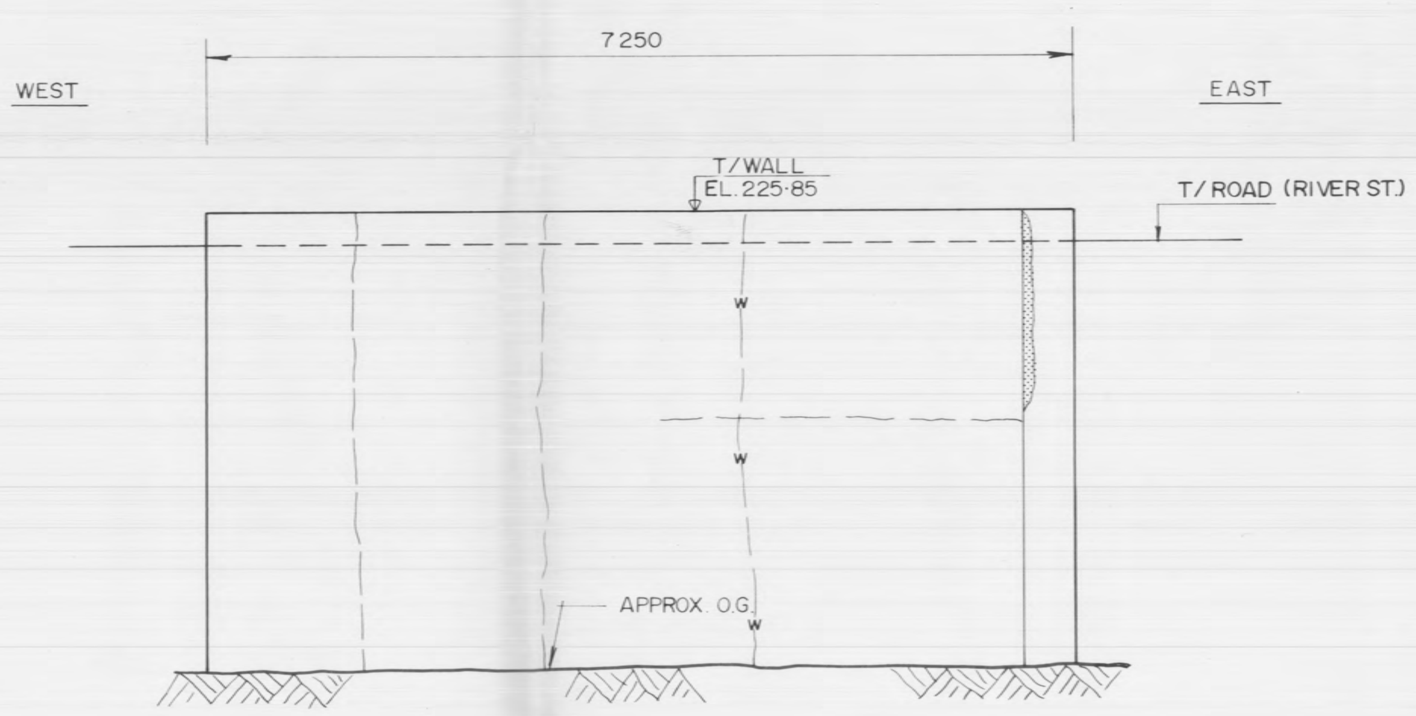
DATE: AUG., 1986
PROJECT: 36-7058
DRAWING: P1

TRANSTEX 15 250-4-79

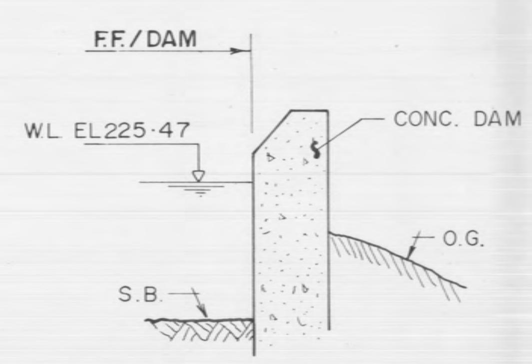


ELEVATION – CONCRETE DAM





ELEVATION – CONCRETE RETAINING WALL

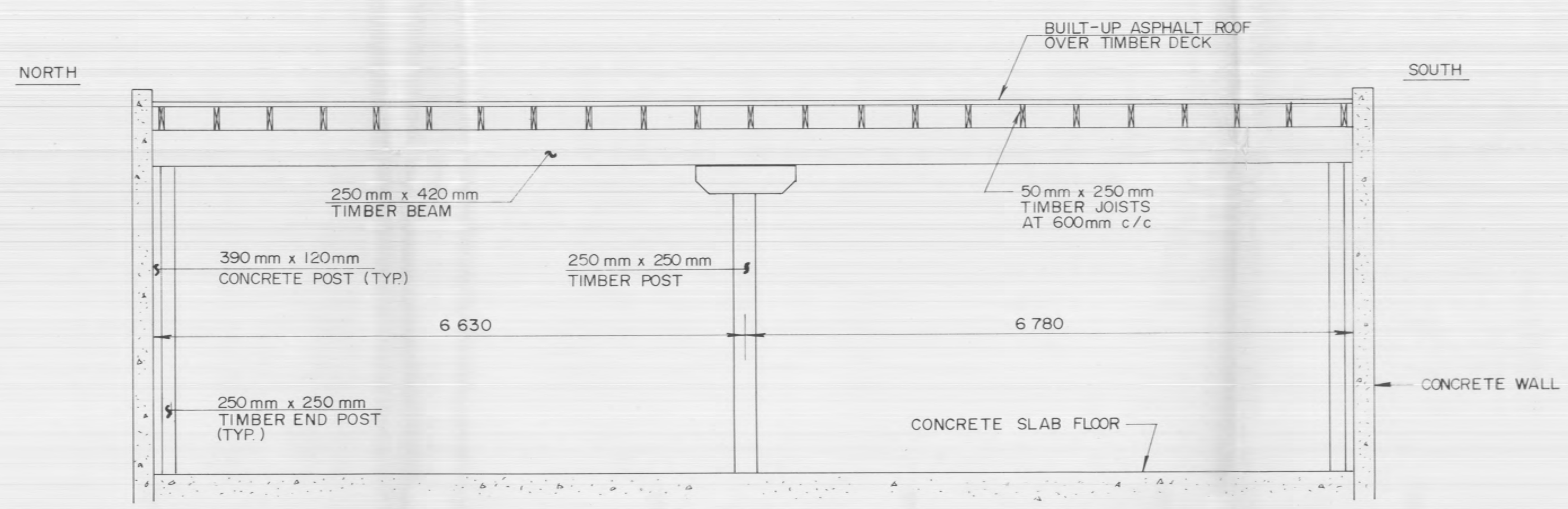


SECTION X-X

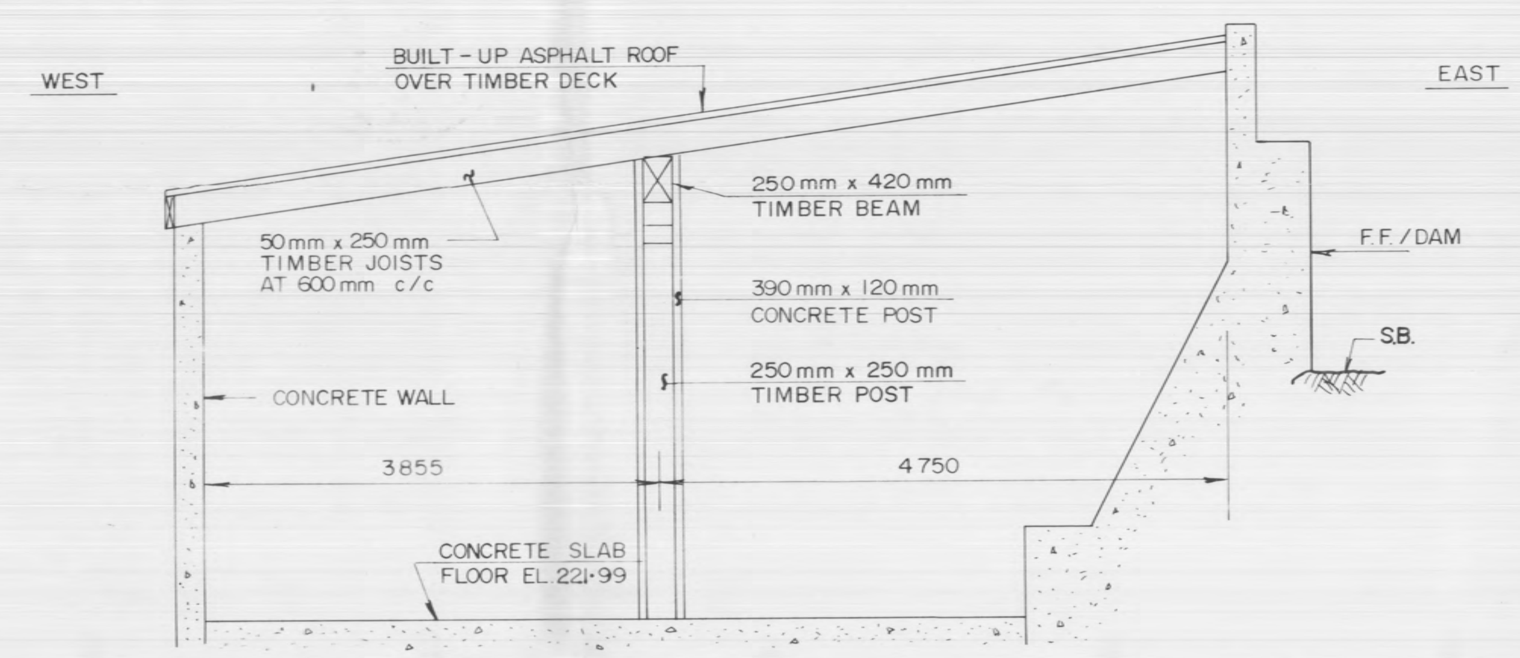
ELEVATION – CONCRETE DAM

LEGEND

- DENOTES MINOR CRACK
- DENOTES WIDE CRACK
- DENOTES SPALLED AREA
- DENOTES MINOR SPALLED AREA
- DENOTES ORIGINAL GROUND (O.G.)



SECTION A – A



SECTION B – B

POWER BUILDING

PRINTED

totten sims hubicki associates

ENGINEERS ARCHITECTS AND PLANNERS

COBOURG WHITBY KINGSTON TORONTO BRACEBRIDGE BROCKVILLE OTTAWA

No.	DATE	BY	REVISIONS

DESIGNED: D. L. B.
DRAWN: R. G. W.
CHECKED: D. L. B.
APPROVED: G. L. A.
SCALE: 1 : 50 UNLESS NOTED

BALA DAM AND POWER BUILDING
RIVER STREET – BALA
TOWNSHIP OF MUSKOKA LAKES

SECTIONS & ELEVATIONS

DATE: AUG. 1986
PROJECT: 36-7058
DRAWING: P2

DATE	AMBIENT NOISE LEVEL MEASUREMENT STATIONS (dB)						
	1	2	3	4	5	6	
FEB. 3, 1988	46	39	52.5	41	46	56.5	
MAR. 22, 1988	42	36	44	36	38	40	
MAR. 24 1988	40	38	48	39	38	40	
APR. 5, 1988	46	42	45	45	43	56	
APR. 8, 1988	52	40	50	42	40	43	WINDY
MAY 10, 1988	52	44	62	50	54	57	WINDY
MAY 30, 1988	55	48	65	53	52	49	
JUL. 11, 1988	52	50	60	50	52	48	
JUL. 26, 1988	53	48	58	50	53	54	
AUG. 3, 1988	50	40	72	48	54	55	WINDY REDUCED DIVERSION
SEP. 7, 1988	55	42	48	50	53	50	

EXISTING SITE PLAN

RESTORATION
BY
MARSH HYDROPOWER LTD.

PORT COLBORNE ONTARIO

NO.	DESCRIPTION	DATE	APP'D
A	PROPERTY LINES CHANGED	23SEPT88	F.M.N.

REVISION

DRAWN BY G.K.
DESIGNED BY B.R.
CHECKED BY F.N.
APPROVED BY
DATE FEB. 1988
SCALE 1:250

Cumming Cockburn Limited
Consulting Engineers and Planners

TOWNSHIP OF
MUSKOKA LAKES

CLERK – ADMINISTRATOR

BALA ONTARIO

LITTLE BURGESS
GENERATING STATION

BALA ONTARIO

EXISTING SITE PLAN

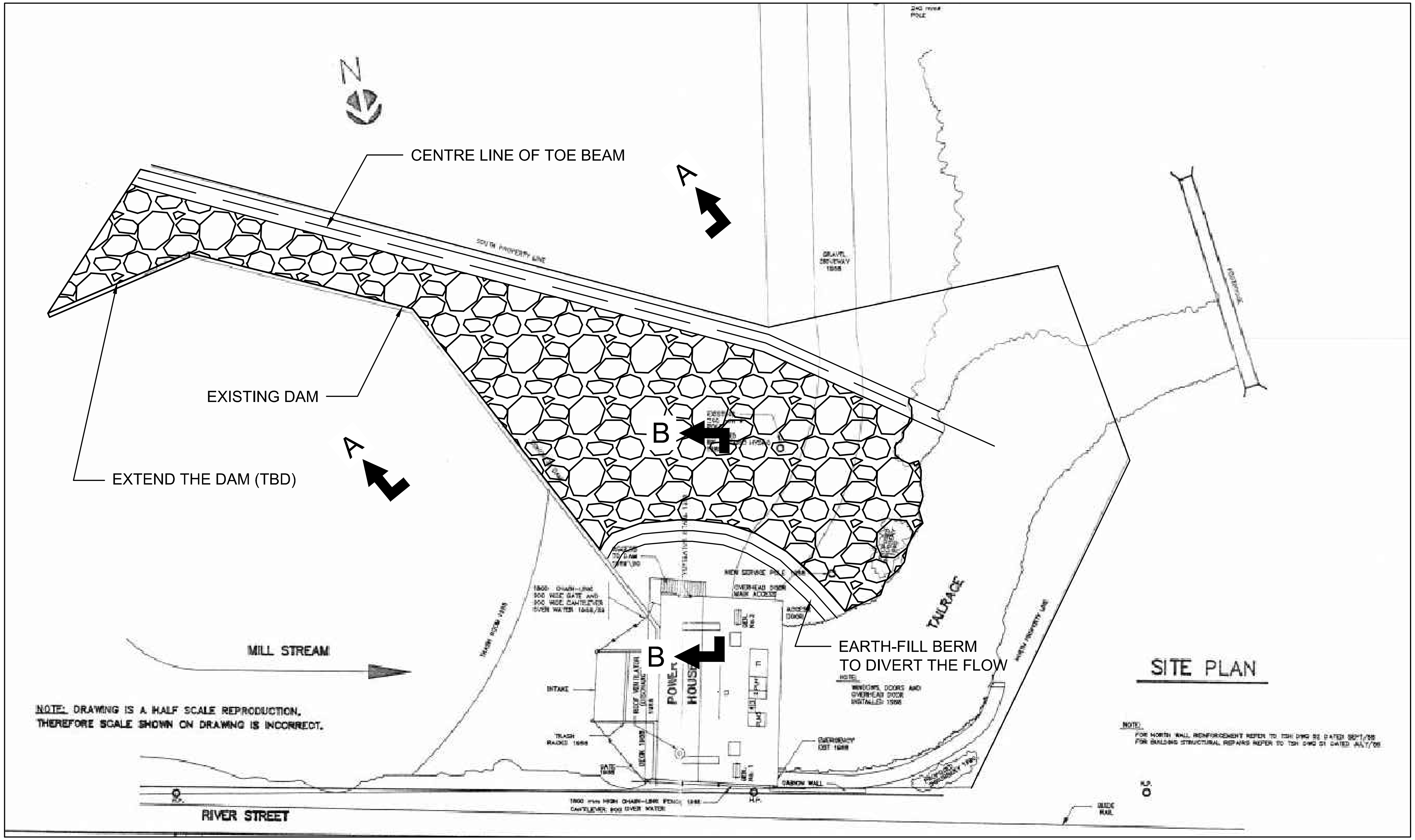
DRAWING NO. 4383–S1

REV. A

4383 BALA PLOT SCALE 1:0.25 BALA1.DWG

APPENDIX G

REMEDIATION OPTIONS FIGURES



PLAN
N.T.S

No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	MA	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

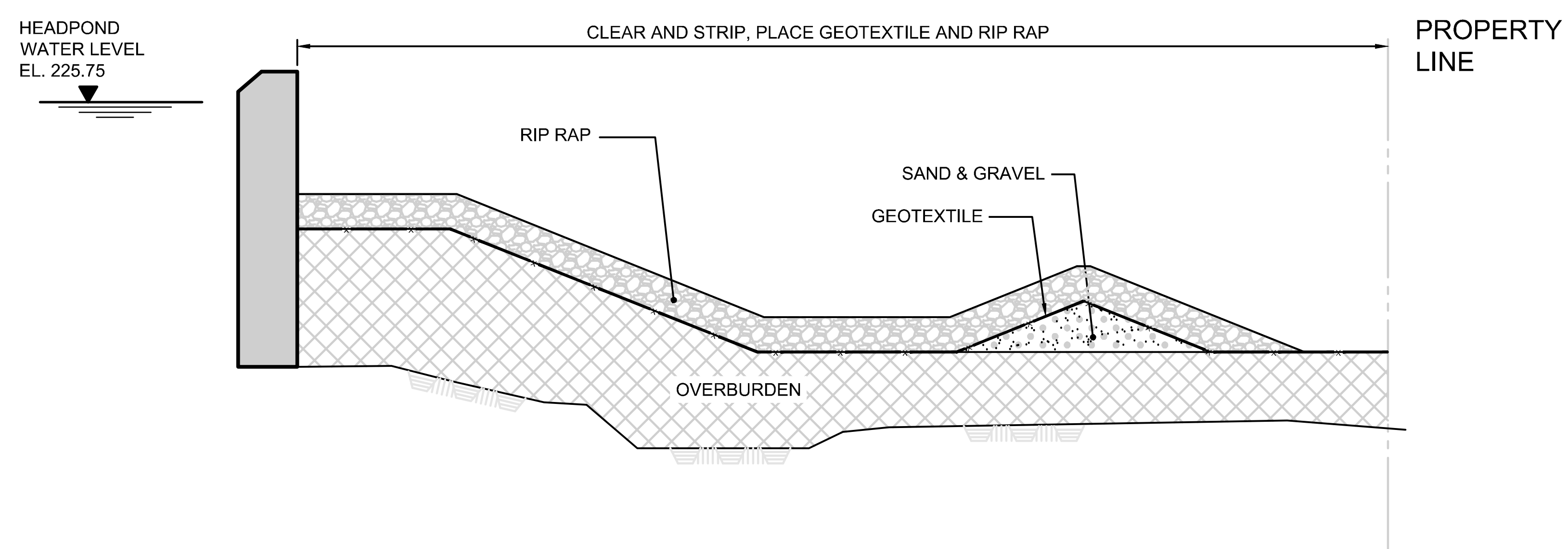
DRAWING: NON-OVERFLOW DAM SECTION OPTION N1 UPGRADED DOWNSTREAM FILL WITH TOE BERM - PLAN

CLIENT: TOWNSHIP OF MUSKOKA LAKES

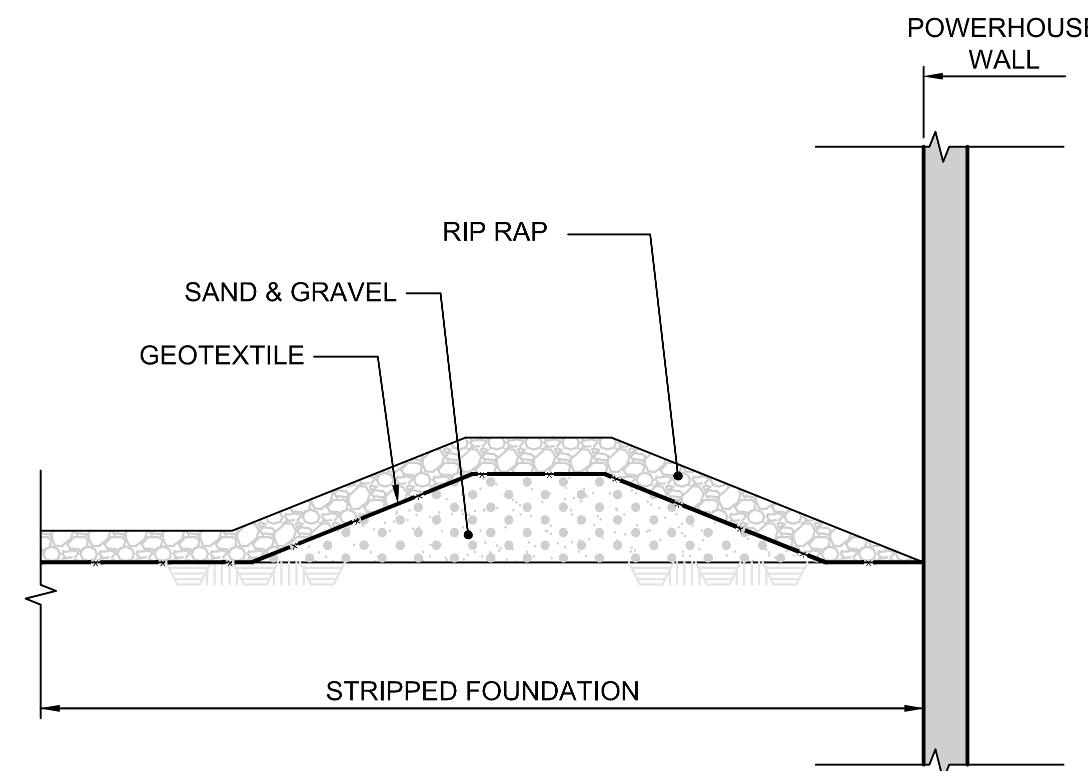
PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT

DRAWN BY:	CHECKED BY:	DESIGNED BY:
K. KORTEKAAS	E. GILES	G. LIANG
APPROVED BY: G. LIANG	SCALE: AS NOTED	DATE: 2019-08-07
DRAWING No.: 19-1493-C-01		REVISION No.: A

H:\2019\ENGINEERING\191493 - Bala Dam Safety Review_DRAWINGS\191493-C-01 through C-02.dwg



SECTION A-A
N.T.S



SECTION B-B
N.T.S

No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	KK	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING:	CLIENT: / PROJECT:	DRAWN BY:	CHECKED BY:	DESIGNED BY:
NON-OVERFLOW DAM SECTION OPTION N1 UPGRADED DOWNSTREAM FILL WITH TOE BERM - SECTIONS	CLIENT: TOWNSHIP OF MUSKOKA LAKES	K. KORTEKAAS	E. GILES	G. LIANG
	PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT	APPROVED BY: G. LIANG	SCALE: AS NOTED	DATE: 2019-08-07
		DRAWING No. 19-1493-C-02		REVISION No. A

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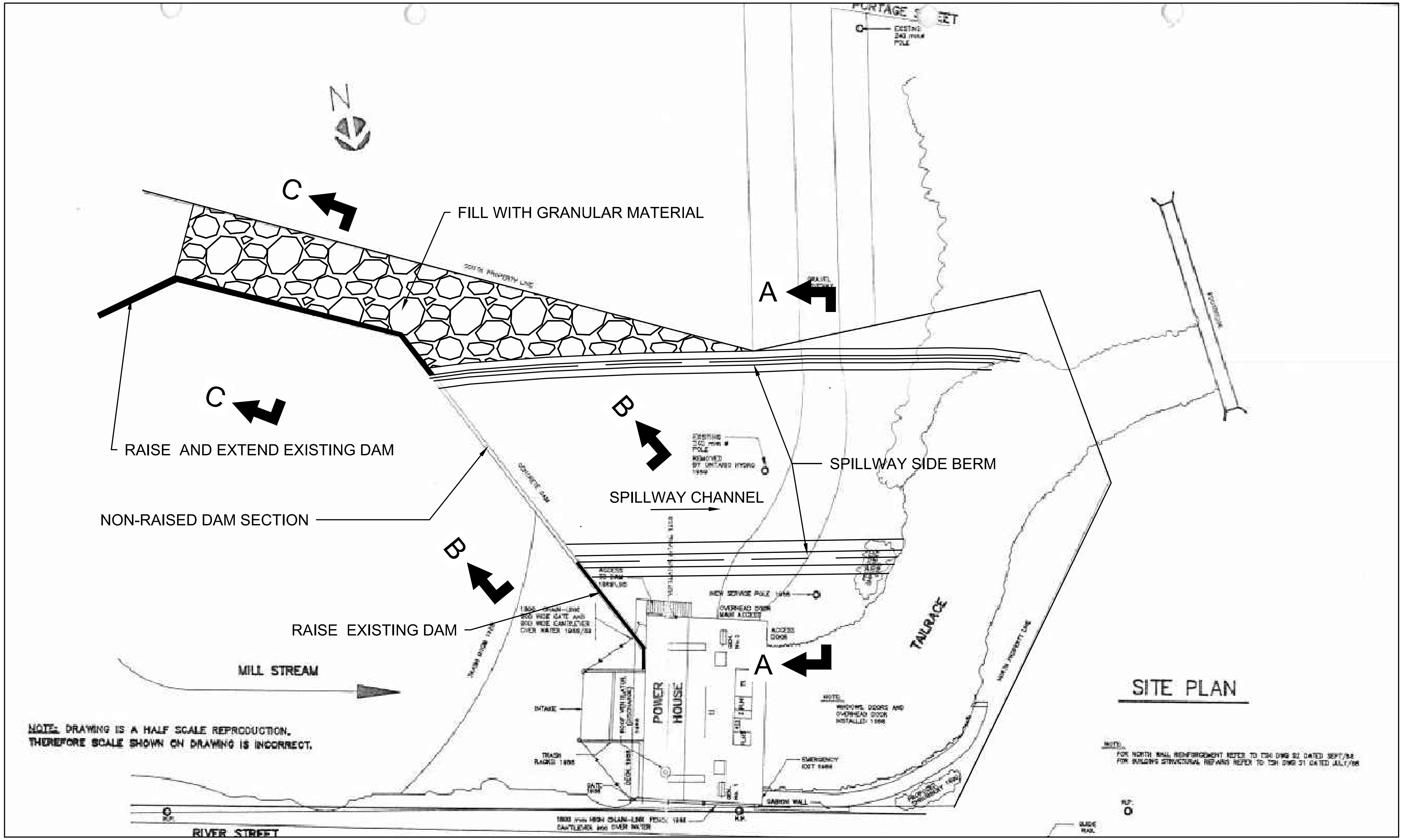

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No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	MA	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING: NON-OVERFLOW DAM SECTION OPTION N2 UPGRADED DOWNSTREAM FILL WITH SPILLWAY -PLAN

CLIENT: TOWNSHIP OF MUSKOKA LAKES

PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT

DRAWN BY:	CHECKED BY:	DESIGNED BY:
K. KORTEKAAS	E. GILES	G. LIANG
APPROVED BY: G. LIANG	SCALE: AS NOTED	DATE: 2019-08-07
DRAWING No.: 19-1493-C-04		REVISION No.: A

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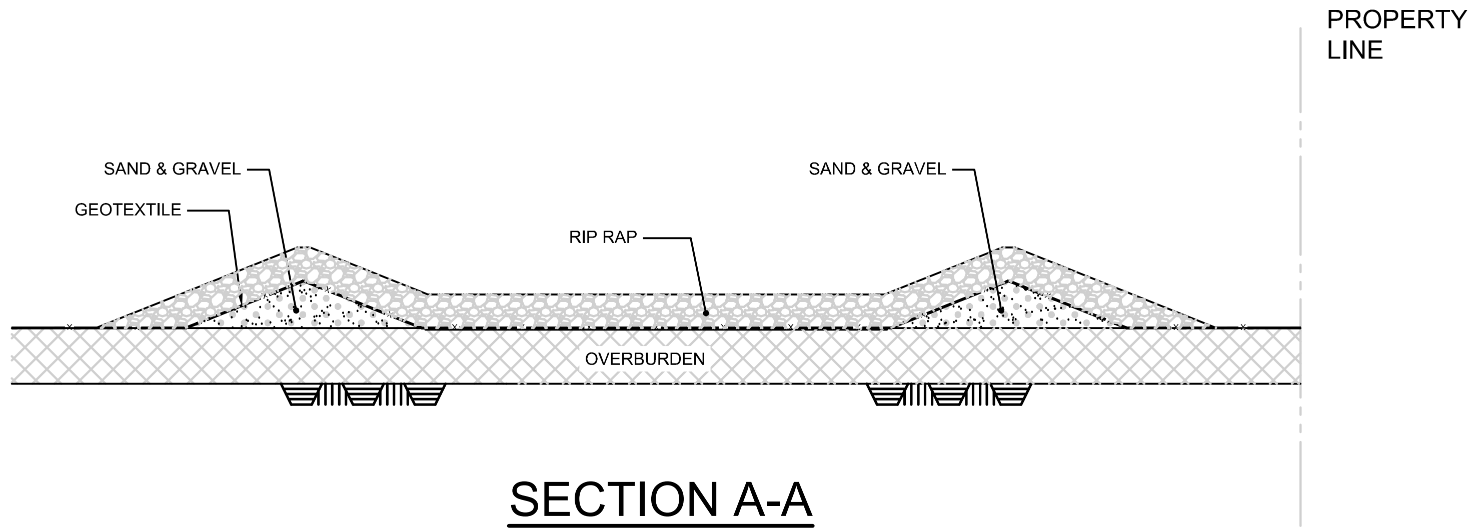

SECTION A-A

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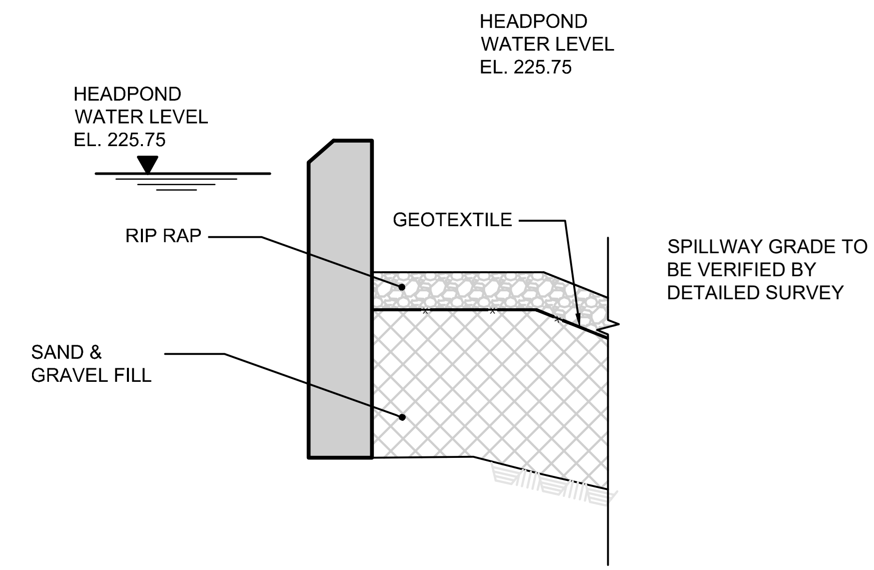

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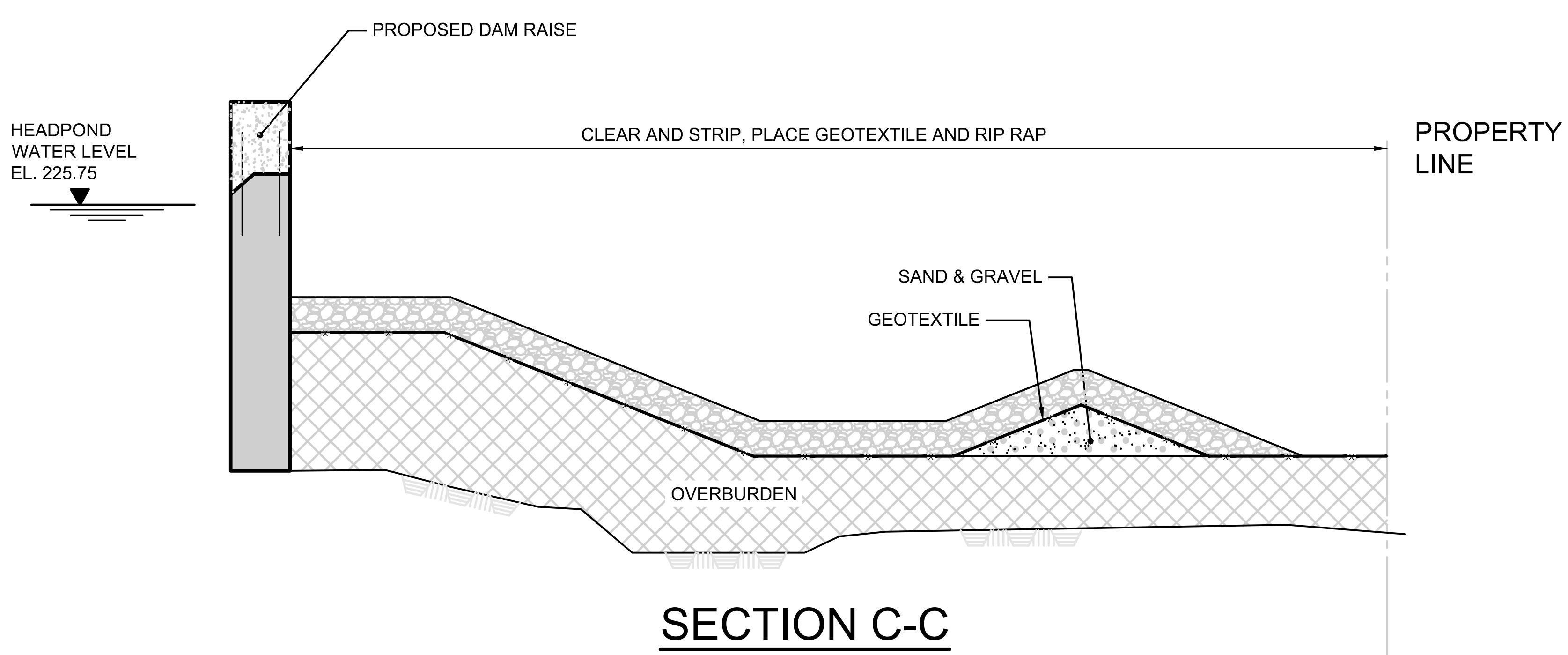

SECTION C-C

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No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	KK	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING: NON-OVERFLOW DAM SECTION OPTION N2 UPGRADED DOWNSTREAM FILL WITH SPILLWAY - SECTIONS	CLIENT: TOWNSHIP OF MUSKOKA LAKES	DRAWN BY: K. KORTEKAAS	CHECKED BY: E. GILES	DESIGNED BY: G. LIANG
	PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT	APPROVED BY: G. LIANG	SCALE: AS NOTED	DATE: 2019-08-07
		DRAWING No. 19-1493-C-05		REVISION No. A

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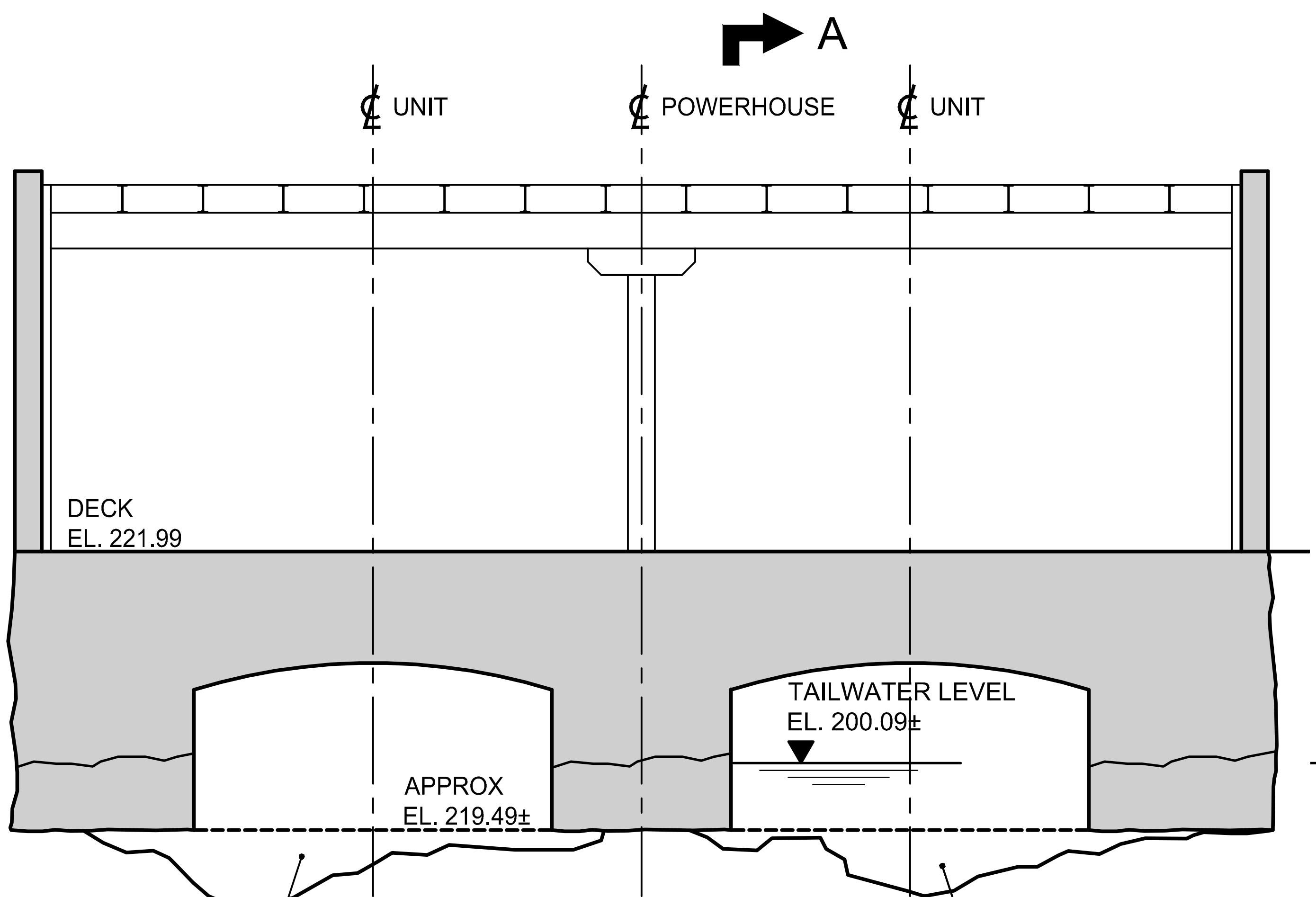

PROFILE
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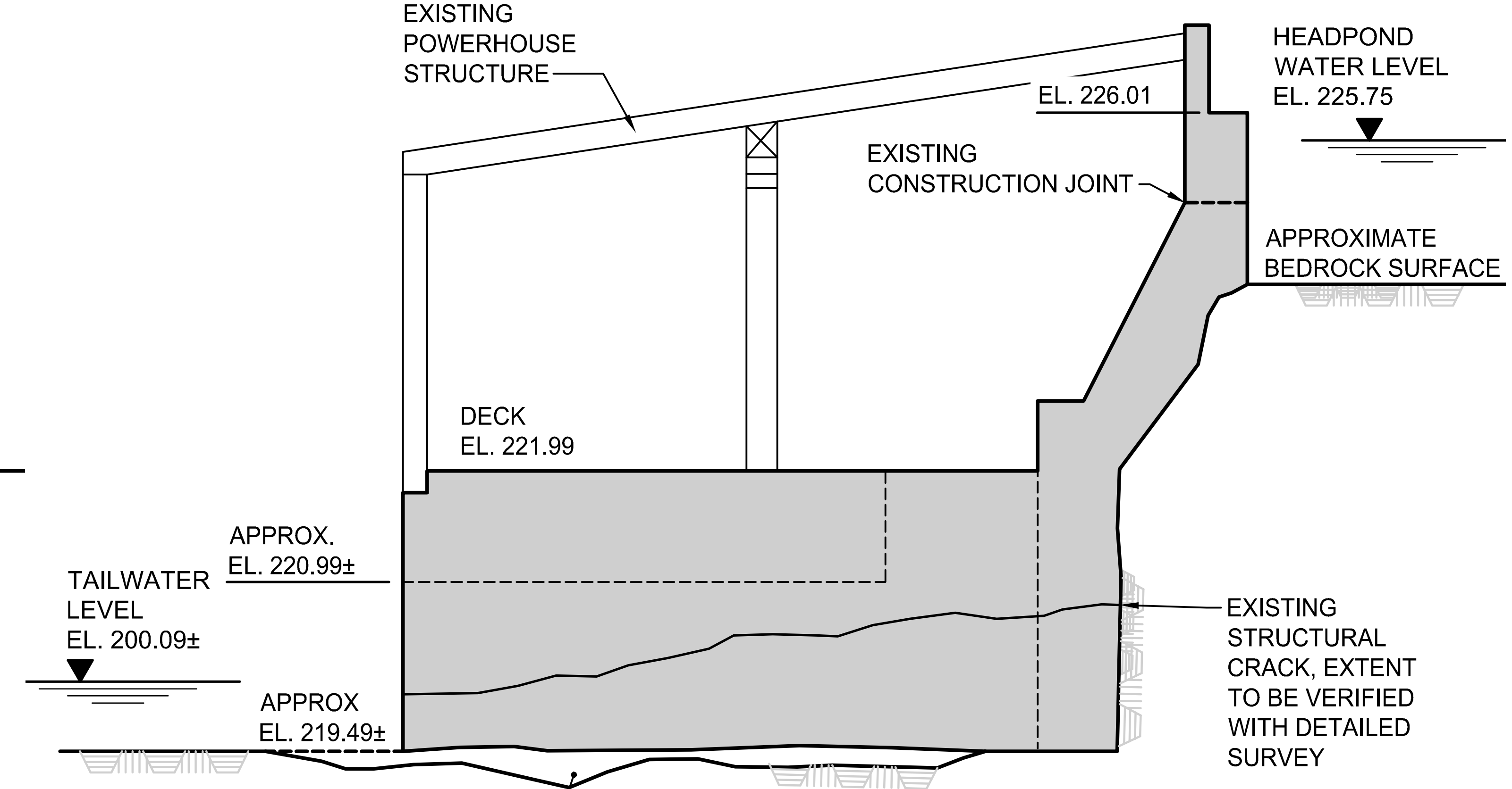

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N.T.S

No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	KK	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING: POWERHOUSE REMEDIATION EXISTING CONDITIONS PROFILE AND SECTION	CLIENT: TOWNSHIP OF MUSKOKA LAKES	DRAWN BY: K. KORTEKAAS	CHECKED BY: E. GILES	DESIGNED BY: G. LIANG
	PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT	APPROVED BY: G. LIANG	SCALE: AS NOTED	DATE: 2019-08-07
		DRAWING No. 19-1493-C-08		REVISION No. A

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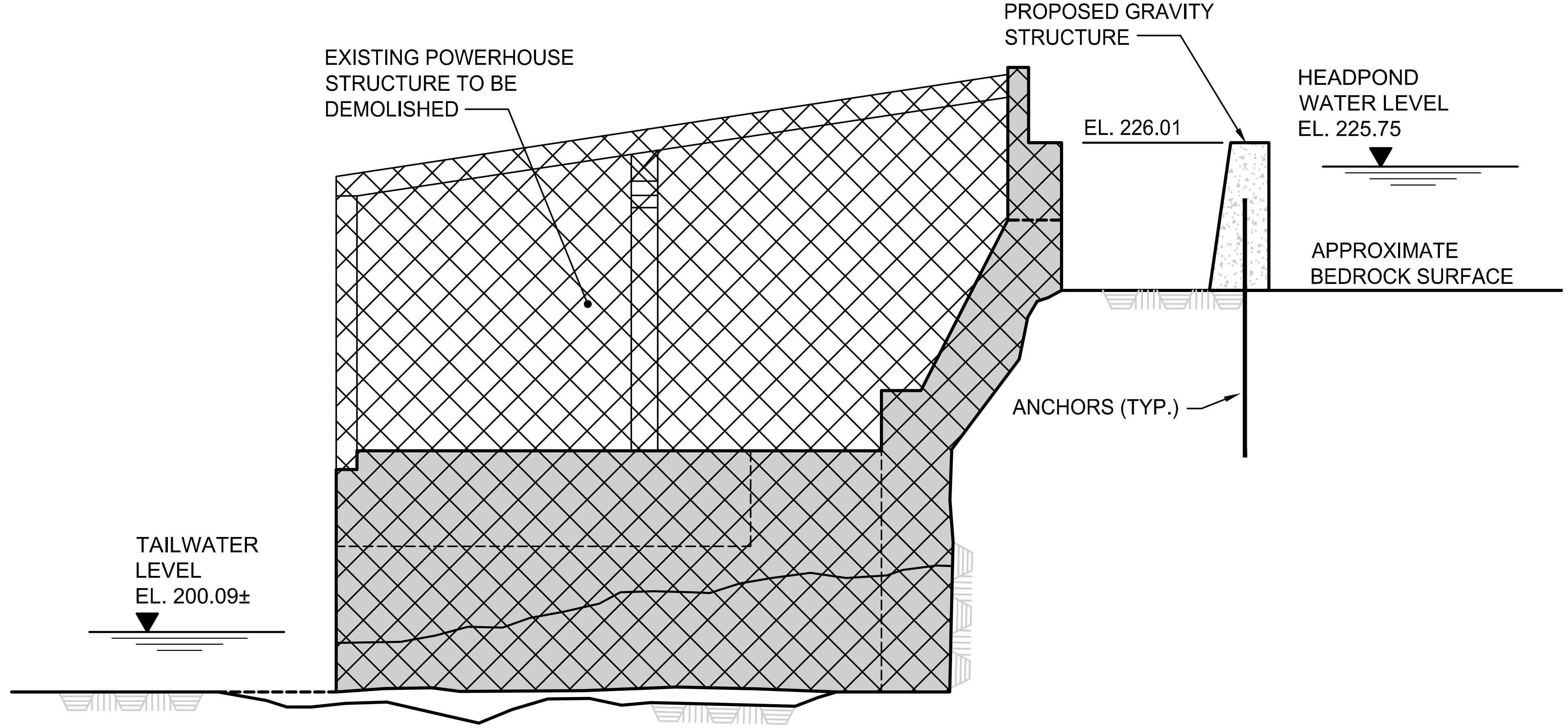

SECTION A-A

N.T.S

No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	KK	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING: POWERHOUSE REMEDIATION OPTION P1 POWERHOUSE REMOVAL SECTION	CLIENT: TOWNSHIP OF MUSKOKA LAKES	PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT
DRAWN BY: K. KORTEKAAS	CHECKED BY: E. GILES	DESIGNED BY: G. LIANG
APPROVED BY: G. LIANG	SCALE: AS NOTED	DATE: 2019-08-07
DRAWING No. 19-1493-C-10	REVISION No. A	

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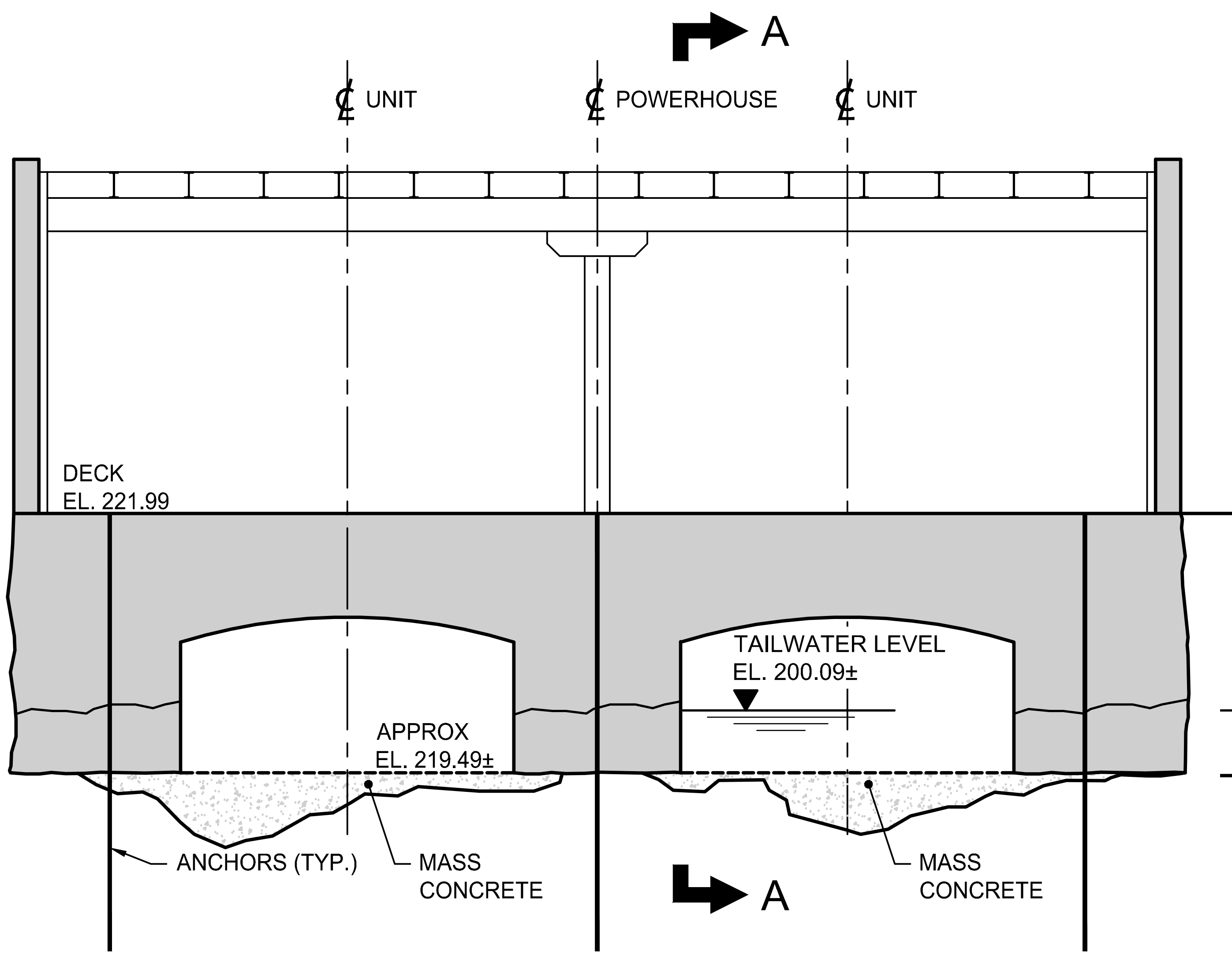

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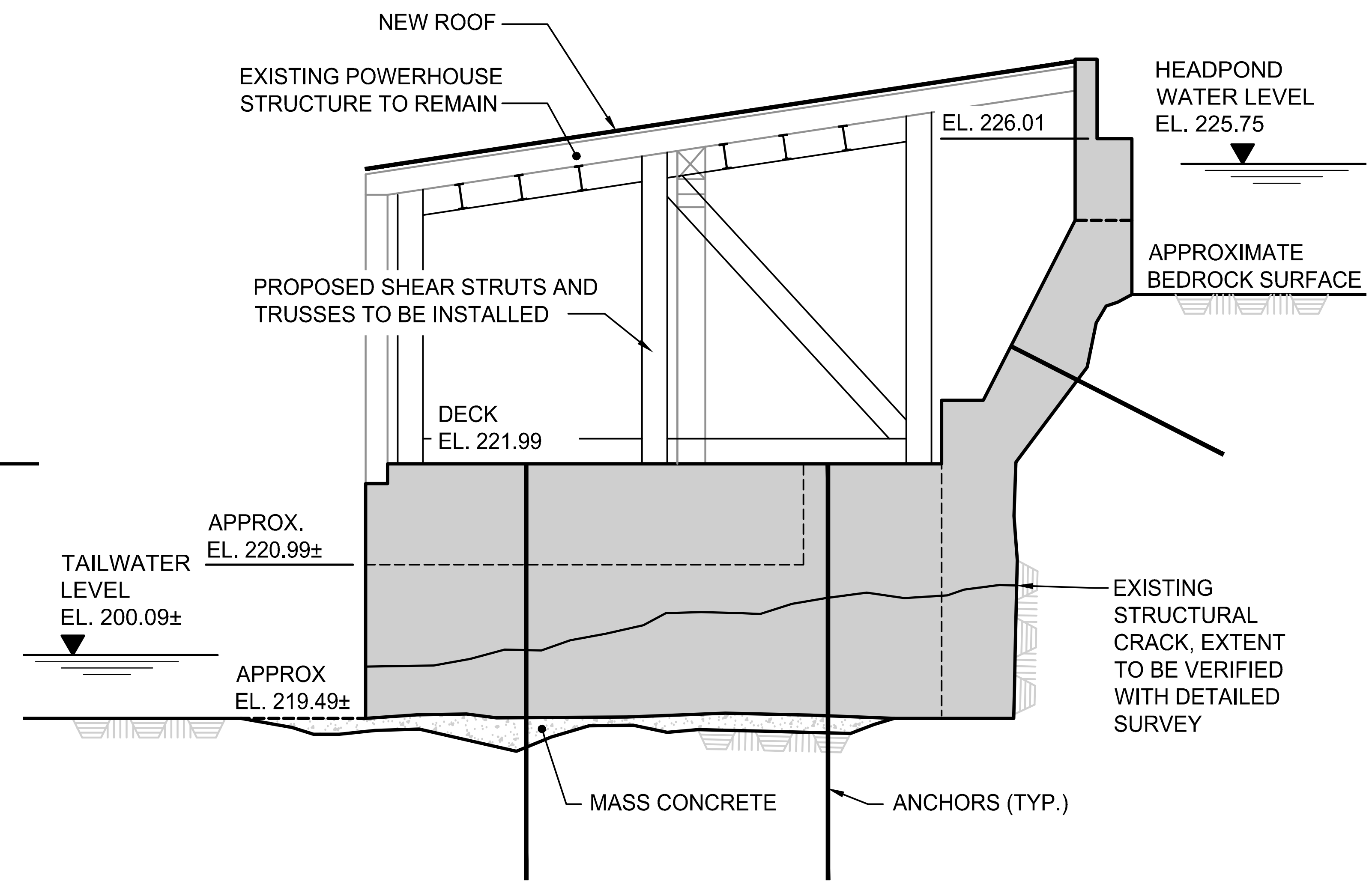

SECTION A-A
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No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	KK	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING: POWERHOUSE REMEDIATION OPTION P2 POWERHOUSE REFURBISHMENT SECTION

CLIENT: TOWNSHIP OF MUSKOKA LAKES

PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT

DRAWN BY:	CHECKED BY:	DESIGNED BY:
K. KORTEKAAS	E. GILES	G. LIANG
APPROVED BY:	SCALE:	DATE:
G. LIANG	AS NOTED	2019-08-07

DRAWING No.: 19-1493-C-09

REVISION No.: A

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APPENDIX H

PRELIMINARY COST TABLES

Table H-1: Burgess 1 Dam Repair
Cost Estimate - Option N1: Downstream Rip Rap Placement and Toe Berm

August, 2019

Item	Description	Estimated Quantity	Unit	Unit Price ($/Unit)	Total ($)
1	**Dam Rehabilitation**				
1.1	Stripping	900	m2	$15.00	$13,500
1.2	Sand and Gravel	150	m3	$50.00	$7,500
1.3	Riprap/rockfill	330	m3	$75.00	$24,750
1.4	Geotextile	825	m2	$7.00	$5,775
1.5	Concrete (dam extension to the south end)	6	m3	$1,000.00	$6,000
1.6	Grouting existing dam cracks	40	LS	$50,000.00	$50,000
1.7	Anchor Φ25, 1m @ spacing 2m for dam raise	10	LS	$5,000.00	$5,000
2	**Construction Access Road**	1	LS	$10,000.00	$10,000
	Subtotal				$122,525
Contingencies					
		40%			**$49,010**
	Subtotal Contingencies				**$49,010**
	Total Estimated Construction Cost				**$171,535**

Exclusions:
- Third Party Construction Quality Assurance (CQA)
- Environmental, Engineering, Administration & Site Inspection
- Land acquisition
- Financing / IDC
- Owner's costs
- Bonding and Insurance

Table H-2: Burgess 1 Dam Repair
Cost Estimate - Option N2: Partial Dam Raise and Emergency Spillway

August, 2019

Item	Description	Estimated Quantity	Unit	Unit Price ($/Unit)	Total ($)
1	**Dam Rehabilitation**				
1.1	Stripping	1,500	m2	$15.00	$22,500
1.2	Sand and Gravel	550	m3	$50.00	$27,500
1.3	Riprap/rockfill	250	m3	$75.00	$18,750
1.4	Geotextile	675	m2	$7.00	$5,000
1.5	Concrete (dam extension to the south end and partial raise 0.5m)	14	m3	$1,000.00	$13,800
1.6	Grouting existing dam cracks	40	LS	$50,000.00	$50,000
1.7	Anchor Φ25, 1m @ spacing 2m for dam raise	35	LS	$15,000.00	$15,000
2	**Construction Access Road**	1	LS	$10,000.00	$10,000
	Subtotal				162,550
Contingencies					
		40%			**$65,020**
	Subtotal Contingencies				**$65,020**
	Total Estimated Construction Cost				**$227,570**

Exclusions:

-Third Party Construction Quality Assurance (CQA)
- Environmental, Engineering, Administration & Site Inspection
- Land acquisition
- Financing / IDC
- Owner's costs
- Bonding and Insurance

Table H-3: Burgess 1 Dam Repair
Cost Estimate - Option P1: Demolish Powerhouse and Replace with New Dam

August, 2019

Item	Description	Estimated Quantity	Unit	Unit Price ($/Unit)	Total ($)
1	**Powerhouse Removal**				
1.1	D/s and u/s Coffer Dam	1,000	m2	$500.00	$500,000
1.2	Removal of Powerhouse/Decommisioning	1	L.S	$150,000.00	$150,000
1.3	Removal of the old dam concrete (dam section)	130	m3	$1,000.00	$130,000
2	**Build New Dam Section**				
2.1	New concrete dam section (ONLY, No powerhouse)	55	m3	$10,000.00	$550,000
3	**Construction Access Road**	1	LS	$10,000.00	$10,000
4	**Right Bank Concrete Retaining wall**				
4.1	Drill Drainage holes	1	LS	$5,000.00	$5,000
4.2	Excavate Drainage Ditch	1	LS	$1,000.00	$1,000
4.3	Granular Material lined Ditch	25	m3	$50.00	$1,250
	Subtotal				1,346,000
Contingencies					
		40%			**$538,400**
	Subtotal Contingencies				**$538,400**
	Total Estimated Construction Cost				**$1,884,400**

Exclusions:

-Third Party Construction Quality Assurance (CQA)
- Environmental, Engineering, Administration & Site Inspection
- Land acquisition
- Financing / IDC
- Owner's costs
- Bonding and Insurance

Table H-4: Burgess 1 Dam Repair

Cost Estimate - Powerhouse Option P2: Powerhouse Refurbishment and Reinforcement

August, 2019

Item	Description	Estimated Quantity	Unit	Unit Price ($/Unit)	Total ($)
1	**Powerhouse Retrofit**				
1.1	Mass Concrete to fill the undermine area of the powerhouse foundation	30	m3	$2,500.00	$75,000
1.2	Foundation Grouting	36	LS	$50,000.00	$50,000
1.3	Anchorage the existing concrete slab to bedrock,Φ36mm, 8m long with 6m in rock	1	LS	$50,000.00	$50,000
1.4	New powerhouse roof	1	LS	$100,000.00	$100,000
1.5	Additional frame and column for powerhouse structure	1	LS	$50,000.00	$50,000
1.6	Dam Crack grouting repair	40	m2	$1,000.00	$40,000
2	**Construction Access Road**	1	LS	$10,000.00	$10,000
3	**Right Bank Concrete Retaining wall**				
3.1	Drill Drainage holes	1	LS	$5,000.00	$5,000
3.2	Excavate Drainage Ditch	1	LS	$1,000.00	$1,000
3.3	Granular Material lined Ditch	25	m3	$50.00	$1,250
	Subtotal				$382,250
Contingencies					
		40%			**$152,900**
	Subtotal Contingencies				**$152,900**
	Total Estimated Construction Cost				**$535,150**

Exclusions:

-Third Party Construction Quality Assurance (CQA)
- Environmental, Engineering, Administration & Site Inspection
- Land acquisition
- Financing / IDC
- Owner's costs
- Bonding and Insurance

APPENDIX I

NOTICE TO READER

NOTICE TO READER

This report has been prepared by TULLOCH Engineering Ltd. ('TULLOCH') for the sole and exclusive use of the Township of Muskoka Lakes. (the 'Client') to provide analysis with respect to the safety and preliminary remediation of the Burgess 1 Dam located in the Town of Bala, Ontario between Portage and River Street on Bala Bay, (The Site) This report pertains to the above referenced project and site, only, and shall not be used for any other purpose, or provided to, relied upon or used by any third party without the express written consent of TULLOCH.

If this report was prepared to support regulatory compliance, then the Client may authorize its use by the Regulatory Agency as an approved user provided this report is marked "Issued for Use" by TULLOCH, is stamped by a licenced Engineer, and is relevant to the specific project for which a review is being done.

TULLOCH has prepared this report with the degree of care, skill and diligence normally provided by engineers in the performance of comparable services for projects of similar nature subject to the time limits and physical constraints applicable to this work. No other warranty expressed or implied is made. This report contains opinions, conclusions and recommendations made by TULLOCH using professional judgment and reasonable care for the purpose of foundation engineering for the Development. Use of or reliance on this report by the Client is subject to the following conditions:

a) the report being read in the context of and subject to the terms of the Engineering Services Agreement for the Work (see Proposal #19-0001-179), including any methodologies, procedures, techniques, assumptions and other relevant terms or conditions specified or agreed therein;

b) the report being read in its entirety. TULLOCH is not responsible for the use of portions of the report without reference to the entire report;

c) the conditions of the site may change over time or may have already changed due to natural forces or human intervention, and TULLOCH takes no responsibility for the impact that such changes may have on the accuracy or validity of the observations, conclusions and recommendations set out in this report;

d) the report is based on information made available to TULLOCH by the Client or by certain third parties; and unless stated otherwise in the Engineering Services Agreement for the Work, TULLOCH has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith.

APPENDIX C

ENVIRONMENTAL ASSESSMENT PROJECT FILE REPORT

Township of Muskoka Lakes

Burgess Dam Class EA

Bala, ON

Project File Report (PFR)

TULLOCH Document No. / Rev. 20-1051-20-2050-0003 / Rev. 1

November 17, 2022

Issued for Use

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1	1	Township of Muskoka Lakes
1	1	TULLOCH Engineering
0	1	MECP Project Review Unit, Environmental Assessments and Permissions Branch
0	1	MNRF Parry Sound District
0	1	MHSTCI Toronto Heritage Planner

Revision Log

Revision #	Revised By	Date	Issue/ Revision Description
1	E.G./C.S.	November 17, 2022	Re-issued for Public Review
0	E.G./C.S.	January 24, 2022	PFR Executive Summary Issued for Public Review
A	E.G./C.S.	December 21, 2021	Draft for Township Review

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List of Appendices

EXECUTIVE SUMMARY

The Township of Muskoka Lakes (the Township) is considering rehabilitation and/or improvement of the Burgess 1 Dam facility which comprises a small two (2) turbine generating station including a concrete powerhouse and concrete gravity dam which is located in Bala, Ontario adjacent to the North and South Bala Falls Dams. Upstream of the dam is Bala Bay within Lake Muskoka and downstream of the dam is the headwaters of the Moon River.

The Burgess 1 Dam facility was originally constructed in 1917 where operations were taken over by the Ontario Hydro Commission from their purchase of the dam and generating facility in 1929. The facility was purchased by the Township of Muskoka Lakes in 1963 and has since been leased to various power generating companies up to present day. The dam consists of an approximately 59 m long concrete dam founded on bedrock with a maximum height of approximately 3 meters. A powerhouse has been built into the northern section of the dam which is currently in operation.

In the Spring of 2019, the Burgess 1 Dam experienced an overtopping event caused by flooding of the Muskoka watershed upstream of the facility that put the safety of the dam at risk. A Dam Safety Review (DSR) was commissioned in the Summer of 2019 to review the current state of the Burgess 1 Dam and determine any safety/structural issues with the dam facility as well as recommend proposed remediation/rehabilitation plans. The DSR determined safety concerns with respect to dam stability and capacity to withstand a similar event in the future. Recommendations were made to replace or rehabilitate the existing facility to handle higher future water levels.

TULLOCH was retained by the Township to complete a Municipal Class Environmental Assessment Schedule B Study (Class EA Study or EA) for the proposed improvements to the Burgess 1 Dam facility. The goal of the study was to evaluate and assess the various proposed alternative solutions to the problem statement generated for the project in a transparent manner while encouraging public and agency feedback for the project. This report documents the findings of the EA for the proposed improvements and includes a number of appendices that make up the varying components of the study. The assessment was undertaken starting in February of 2020.

Public and agency consultation was completed throughout the study. Due to the restrictions surrounding public gatherings imposed by the COVID-19 pandemic an online presentation (PIC) was completed and posted on the Engage Muskoka Lakes website owned and operated by the Township. In addition to the PIC a notice of project mail out in July 2020 was conducted to various stakeholders for the project include members of the public, first nations groups and regulating bodies. Public and agency feedback was solicited either via email or direct correspondence through the survey on the Engage Muskoka Lakes webpage. A FAQ page was also posted and updated regularly on the website to incorporate questions commonly received from the survey and/or email inquiries with respect to the project.

As part of the Class EA procedure a Problem/Opportunity Statement was generated for the study to identify the need for the EA. The statement was approved by the Township and is shown below:

> *In the Spring of 2019, the Burgess 1 Dam experienced an overtopping event caused by flooding of the Muskoka watershed upstream of the facility that put the dam at risk. A Dam Safety Review conducted in the Summer of 2019 determined safety concerns with respect to dam stability and capacity to withstand a similar event. Failure of the Burgess 1 Dam would result in significant loss of water control upstream affecting Lake Muskoka and its residents., furthermore, failure of the dam could result in property damage and risk to public safety downstream of the facility along the Moon River. The Township of Muskoka Lakes is considering replacement of rehabilitation of the Burgess 1 Dam*

Based on the above Problem Statement, four (4) alternative solutions were proposed to the Township and stakeholders for evaluation to address the recommendations made within the DSR.

Option 1 – Do Nothing

Option 2 – Rehabilitation of the Dam and Removal of the Power Generation Equipment

Option 3 - Rehabilitation of the Dam and Powerhouse

Option 4 - Replacement of the Facility

On October 13th, 2021, TULLOCH presented the results of the various attached studies and public input for the EA study to the Township of Muskoka Lakes Council as well as our recommendation for selection of the preferred alternative solution.

The results of the Class EA study including public and stakeholder feedback, and Township Council preference, indicates that **Option 3 – Rehabilitation of the Dam and Powerhouse is the Preferred Alternative** and should be chosen as the desired path forward to address the safety concerns provided by the DSR conducted in 2019.

1. PROJECT BACKGROUND AND PREVIOUS STUDIES

The Burgess 1 Dam facility comprises a small two (2) turbine generating station including a concrete powerhouse and concrete gravity dam, located in Bala, Ontario. The facility is located adjacent to the North and South Bala Falls Dams directly to the north of the larger facilities as shown below in Figure 1. Upstream of the dam is Bala Bay within Lake Muskoka and downstream of the dam is the headwaters of the Moon River. The dam was originally constructed in 1917. Operations were taken over by the Ontario Hydro Commission from their purchase of the dam and generating facility in 1929. The facility was purchased by the Township of Muskoka Lakes in 1963 and has since been leased to various power generating companies up to present day. The dam consists of two main elements, first, an approximately 59 m long concrete dam founded on bedrock with a maximum height of approximately 3 meters. Second, a powerhouse was built directly into the downstream side of the northern abutment/section of the dam. The powerhouse currently has two (2) turbines that currently generate power. Retrofits to the structure have occurred over the years including partial upgrades to the power generation equipment as well as various structural bracing of the existing powerhouse. The most recent renovations included the addition of a new turbine, head gate and electrical equipment. A 16 m long concrete gravity retaining wall is connected to the north wall of the powerhouse which supports River St. immediately to the North of the structure. Figure 1 shown below shows the location of the Burgess Dam facility.

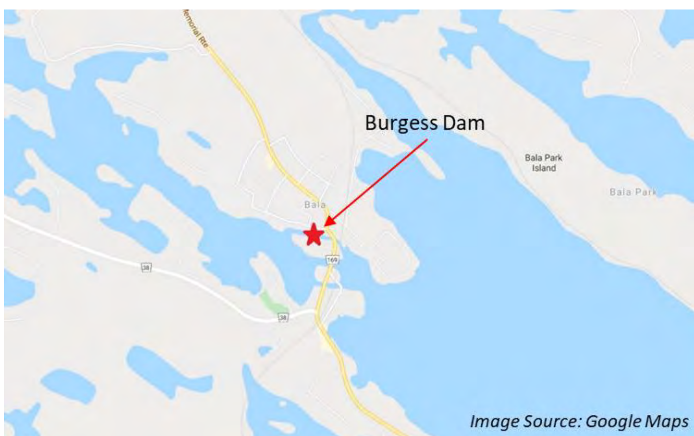

Figure 1: Burges Dam Location

The need for an Environmental Assessment of the Burgess 1 Dam facility was directly linked to the flooding experienced in the Muskoka region in 2019. Due to high water levels associated with the floods in the spring of 2019, the Burgess 1 Dam experienced an overtopping event caused by flooding of the Muskoka watershed upstream of the facility that put the safety of the dam at risk. Water was observed to breach the structure causing downstream washout of the facility grounds in addition to water being released in an uncontrolled manner on either abutment of the dam.

Due to the nature of the overtopping event caused by the flooding and the possibility of future flooding posing a safety risk to the dam, a Dam Safety Review (DSR) was commissioned in the Summer of 2019 to review the current state of the Burgess 1 Dam and determine any safety/structural issues with the dam facility as well as recommend proposed remediation / rehabilitation plans.

The DSR determined safety concerns with respect to dam stability and capacity to withstand a similar event in the future. Recommendations were made to replace or rehabilitate the existing facility to handle higher future water levels. The DSR conducted by TULLOCH Engineering Inc (TULLOCH) was issued in September of 2019 is found in Appendix B and was also posted for public review on the Township's Engage Muskoka Lakes Web Page as part of the public consultation initiatives for this study. Key findings from the Dam Safety Review are summarized below:

- Non-Overflow Structure/Retaining Wall
  - Moderate to significant washouts were found to occur due to the flooding events which impact the stability of the dam including inadequate factor of safety associated with the structure with respect to the non-overflow structure
  - No emergency spillway or overflow water control options were in place to prevent an uncontrolled release of the structure during flooding conditions
  - The gabion wall retaining river street was found to be in poor condition.
- Powerhouse Structure
  - The powerhouse was generally found to be in poor condition with large diagonal cracks observed in the concrete foundation slab. The powerhouse roof was found to be in poor condition
  - The operation of the powerhouse appears to be undermining the structure which may be leading to the cracking and/or deterioration.

As a result of the Dam safety review, it was determined that the current state of the Burgess 1 Facility was generally deficient and would require rehabilitation to withstand future flooding events as well as to improve the overall safety of the structure to modern design codes.

The Township of Muskoka Lakes (the Township) initiated a Municipal Class Environmental Assessment Schedule B Study (Class EA Study or EA) to study and evaluate alternative solutions for improvements to the Burgess 1 Dam facility to address safety concerns identified in the 2019 Dam Safety Review (DSR). A problem and Opportunity Statement was generated with proposed alternative solutions that are discussed in the following section.

2. CLASS ENVIRONMENTAL ASSESSMENT PROCESS

Municipal infrastructure projects are required to meet the requirements of the Ontario Environmental Assessment (EA) Act. The Municipal Class EA (October 2000, as amended in 2007/2011/2015) applies to a group or “class” of municipal projects which occur frequently, and which have relatively minor and predictable impacts. These projects are approved under the EA Act, as long as they are planned, designed and constructed according to the requirements of the Class EA document.

The specific requirements of the Class EA for a particular project depend on the type of project, its complexity and the significance of environmental impacts. To assist proponents in determining the status of projects, four categories of projects are identified in the Municipal Class EA document, including Schedule “A”, “A+”, “B” and “C” projects.

2.1. Schedule A

These projects are limited in scale, have minimal adverse environmental effects, and typically consist of normal maintenance and operational activities. These projects are considered pre-approved and may proceed without following the full Class EA planning process.

2.2. Schedule A+

These projects are also limited in scale, have minimal adverse environmental effects, and are considered pre-approved, but there is a requirement for public notification prior to construction or implementation of the project. The purpose of the notification is to inform the public of projects occurring in their local area. Although the public is informed of the project, there is no appeal mechanism to the Ministry of the Environment and Climate Change (MOECC); any concerns raised can be addressed at the municipal council level. There is no defined cost limit for a Schedule A or A+ project.

2.3. Schedule B

These projects have the potential for some adverse environmental effects, thus requiring a screening process involving mandatory contact with directly affected public and relevant review agencies. If all concerns can be adequately addressed, the project may proceed. These projects generally include improvements and minor expansions to existing facilities. The construction cost limit for a Schedule ‘B’ project of this type is less than $2.7 million. There is an appeal mechanism to the MOECC. If all public and agency comments and issues are resolved during the public review period, the project may proceed.

2.4. Schedule C

These projects have potential for significant environmental effects and are subject to the full planning and documentation procedures specified in the Class EA document. All five phases of the Class EA process must be completed including Phase 3 (Alternative Design Concepts for Preferred Solution) and a Phase 4 (Environmental Study Report). The Environmental Study Report is submitted for review by the public and relevant review agencies. If all public and agency comments and issues are resolved during the public review period, the project may proceed. These projects generally include construction of new facilities or major expansions to existing facilities. The construction cost limit for Schedule C projects of this type is greater than $2.7 million.

2.5. Selected Schedule

Based on the above, the Burgess 1 Dam project was completed as a Phase 2, Schedule B activity under the Municipal Class EA process due to the need for improvements to the existing facility where there are potential for adverse environmental effects. As noted in the MEA Class EA document, the divisions between schedules are often not distinct, and the proponent is responsible for customizing it to reflect the complexities and needs identified. It is documented here that the Class EA process was followed for each bridge including consultation with stakeholders throughout each step of the process

3. PROBLEM/OPPORTUNITY STATEMENT

As part of the Class EA procedure a Problem/Opportunity Statement was generated for the study with consultation from the Township to present to the various stakeholders for the project as well as to determine the need for the EA process. The statement was approved by the Township and is shown below:

> *In the Spring of 2019, the Burgess 1 Dam experienced an overtopping event caused by flooding of the Muskoka watershed upstream of the facility that put the dam at risk. A Dam Safety Review conducted in the Summer of 2019 determined safety concerns with respect to dam stability and capacity to withstand a similar event. Failure of the Burgess 1 Dam would result in significant loss of water control upstream affecting Lake Muskoka and its residents., furthermore, failure of the dam could result in property damage and risk to public safety downstream of the facility along the Moon River. The Township of Muskoka Lakes is considering replacement of rehabilitation of the Burgess 1 Dam*.

The above statement was included in the Notice of Project that was sent out in the initial mail out to various stake holders for the project. The Notice identified the Burgess area as well as introduced the engage Muskoka lakes landing page for stakeholders to follow updates on the project as it developed. Finally, the problem/opportunity statement and proposed alternative solutions were included in the correspondence to help guide the decision-making process and solicit public and agency feedback. A copy of the Notice of Project is attached to this report and can be found in Appendix A. The alternative solutions and the decision-making process for selecting the preferred alternative solution is discussed in more detail in Section 4 of this report.

4. DESCIPTION OF THE STUDY AREA ENVIRONMENT

As part of the EA, a series of assessments were completed to address potential impacts of the proposed project on the environment. These assessments were used to evaluate the alternatives and select the Preferred Alternative Solution for the study. This included viewing the project through various lenses including cultural/archaeological, environmental, as well as a condition assessment of the turbine equipment within the generating station. Each study is summarized below in the following sub-sections.

4.1. Archeological Assessment and Cultural Heritage Evaluation

A Stage 1 Archaeological Assessment and Cultural Heritage Evaluation were conducted by Horizon Archaeology Inc. to support the requirements of the EA with respect to the heritage value associated with the Burgess 1 Dam facility. The Archaeological Assessment of the area found no archaeological potential, with no further archaeological concerns. The Cultural Heritage Evaluation found that the Burgess Dam should be added to the Ontario Heritage Act Register, and the structure’s façade or shell should be preserved if possible. Further, the original turbine still housed within the structure should be preserved, preferably in place or somewhere which might share its history. Both reports completed by Horizon can be found in Appendix C.

4.2. Environmental Impact Assessment

An Environmental Impact Assessment of existing conditions found at the Burgess Dam facility was conducted by TULLOCH which provides environmental impacts and context for the proposed alternative solutions listed below. The Environmental Impact Assessment found that clearing of vegetation, and replacement or refurbishment of the dam and powerhouse should occur outside of the General Nesting Period. While no evidence of roosting bats, or migratory bird nests on the structure were found, all active bird nests and roosting bats should be avoided. Potential habitat for Barn Swallow, a species at risk, exists within the project area. In-water work will be required for replacement and refurbishment options, with longer work times for dam replacement increasing the chance of sediment transfer downstream and impacts to fish. Further, excavation required for dam replacement is more likely to result in changes to sensitive fish spawning habitat upstream and downstream of the dam, as a result in-water work if required should be minimized and MNRF in-water timing windows should be followed. The Environmental Impact Assessment can be found in Appendix D.

4.3. Turbine Condition Assessment

Norcan Hydraulic Turbine Inc. was contracted by TULLOCH to perform a site assessment of the current conditions and operational characteristics of the power generating equipment found at the facility. The goal of this study was to determine the current state of the mechanical and electrical equipment of the facility to aide in determine if there was a need for replacement or costs associated with replacement and/or maintenance of the rehabilitated facility. The site assessment found that original Francis turbine may have surpassed it manufacturer's life expectancy with repairs completed in the past to maintain generation capability, and the retrofitted axial flow machine appeared to be in good condition from a surface assessment. No evaluation of the existing machine performance was possible at time of site assessment as the turbine was not in operation. The report provides a preliminary assessment for the possibility for continued power generation with rehabilitation or replacement of the turbine equipment in the facility. Ultimately the study found that reinvestment into the generating station could remain an economically viable option. The site assessment report can be found in Appendix E.

5. ASSESSMENT OF ALTERNATIVE SOLUTIONS

5.1. Alternative Solutions

Based on the Problem Statement, four (4) alternative solutions were proposed to the Township and stakeholders for evaluation to address the recommendations made within the DSR. They are summarized below:

5.1.1. Option 1 – Do Nothing

As required by the Class EA process, the "Do Nothing" alternative solution was considered and includes completing minimal maintenance on the dam structure. Under this alternative the status quo would be maintained, and the dam would continue to function as it has in the past. This solution was not recommended as it does not address the fundamental safety issues addressed in the DSR.

5.1.2. Option 2 – Rehabilitation of the Dam and Removal of the Power Generation Equipment

This alternative solution would involve repairing the deficiencies of the dam and reducing the risk of overtopping and/or failure of the facility in the future. Rehabilitation of the dam structure along with additional works to increase the safety of the dam which could extend its design life and reduce the risk to public safety and the upstream water levels in Lake Muskoka. Based on the findings of the DSR, the powerhouse section of the dam was identified as requiring the most effort to retrofit and rehabilitate and it may be considered preferable to decommission and remove the power generation system altogether. The powerhouse structure which is considered integral to the dam would be decommissioned to the maximum extent possible and a passive water retaining dam would take the place of the hydro generation facility and enter a care and maintenance state.

The dam would then receive regular inspection and maintenance as required to ensure proper function.

5.1.3. Option 3 - Rehabilitation of the Dam and Powerhouse

Similar to Option 2, the dam would be rehabilitated to address the safety and stability concerns discussed in the DSR. However, under this alternative solution the powerhouse section would also be rehabilitated along with the power generation equipment. Active generation would continue as before with upgraded equipment. The non-overflow section of the dam would be rehabilitated in a similar fashion as Option 2 to extend the life of the dam and increase the safety and stability of the structure. However, for Option 3 the powerhouse would remain intact and would be upgraded including the mechanical and electrical equipment to meet modern design codes. This option would allow for the continued operation of the Burgess 1 Dam facility for power generation into the future. The intent at this time would be for the overall output of the facility to remain the same without increased capacity due to the water allotments dedicated to burgess for power generation purposes.

5.1.4. Option 4 - Replacement of the Facility

The current age of the Burgess 1 Dam facility is in excess of 100 years (constructed in 1917), the infrastructure has exceeded its design life in its current state. This alternative solution would involve the construction of a new dam facility with or without power generation capabilities. Construction of a new dam would likely be targeted in a similar footprint of the existing dam and would likely involve temporary dam structures while the existing dam could be deconstructed, and construction of a new facility would take its place using modern design methodology. Replacement of the dam may provide a longer design life than repairs and rehabilitation of the facility and may require less continued care and maintenance in the future.

5.2. Evaluation of Alternative Solutions

The four alternative solutions were assessed using a weighted evaluation matrix. The evaluation criteria included Public Input/Social Environment, Cultural Heritage, Natural Environment, Public Safety, Economic Impact, and Physical Environment. Criteria were ranked for each option from 1 to 4 using information available in the various assessments completed as part of the EA, as well as based on public feedback including the results of the survey published on the Engage Muskoka Lakes webpage. In the ranking system options ranked with the value of 4 had the highest positive impact for each criteria. Total scoring was calculated for each option by summation of the product of weight and rank for each of the evaluation criteria. The weighted evaluation matrix used to determine the preferred alternative solution is shown below in Table 5-1.

Table 5-1: Weighted Evaluation Matrix for Burgess Dam EA Alternatives

Evaluation Criteria	Weight	Option 1: Do Nothing	Option 2: Rehab Dam Remove Power	Option 3: Rehab Dam & Powerhouse	Option 4: Replacement
Public Input/Social Environment	15	1	2	4	3
Cultural Heritage	10	2	3	4	1
Natural Environment	15	4	2	3	1
Public Safety	30	1	3	2	4
Economic Impact	20	4	3	2	1
Physical Environment	10	1	3	4	2
TOTAL	**100**	**215**	**270**	**285**	**230**

5.3. Preferred Solution

Based on the results of the weighted evaluation matrix it was determined that **Option 3 – Rehabilitation of the Dam and Powerhouse is the Preferred Alternative.** This option should be selected and implemented to address the safety concerns provided by the DSR conducted in 2019. It should be noted that Option 3 was found to be in alignment with the majority of the public and stakeholder feedback in addition to the Township Council.

5.3.1. Estimated Costs for the Preferred Solution

Preliminary costing for Option 3 was completed, with an estimated $2,599,680.00 required to complete the rehabilitation and upgrades to the structure which will prevent future adverse effects to the environment. The cost estimate is provided in Appendix J. The estimated cost is less than $2.7 million and thus does not surpass the construction cost limit for Schedule B projects, confirming that the selected schedule is appropriate for the Burgess 1 Dam. It should be noted that the costing excludes third party construction quality assurance, site inspection, land acquisition, financing, owner costs, and bonding and insurance.

6. FOLLOW-UP COMMITMENTS

As a result of the EA the Township has begun the design process associated with the rehabilitation of the structure. A preliminary design is currently being conducted by TULLOCH to further the design of the Conceptual options proposed in the DSR in the spirit of the preferred alternative solution discussed above in Section 4.2. Upon completion of the Preliminary design a Detailed Design process including issuing of an IFC drawing packages should be conducted. Once completed appropriate permitting through applicable agencies will be required prior to tendering and beginning the work.

The required follow-up commitment for the Burgess 1 Dam structures is a review of the Hazard Potential Classification (HPC) of the Dam every 10 years as required by the LRIA given the HPC classification of Low. Further, any significant change affecting the dam area triggers a DSR or appropriate investigations. Significant changes include, but are not limited to, discovery of unusual conditions, new dams on the river system, new developments downstream of the dam, new knowledge of safety analysis, new standards of safety and extreme hydrologic or seismic events. Furthermore, it is recommended that annual Dam Safety Inspections be completed by a qualified engineer on the facility as a best management practice for the structure, particularly until the rehabilitation can be completed. In addition to annual Dam Safety Inspection, to regular documented inspections by the Township or the current Tennant is recommended given the age of the structure.

7. PUBLIC CONSULATION PROCESS

Public and agency consultation was completed throughout the study. Due to the restrictions surrounding public gatherings imposed by the COVID-19 pandemic an online presentation (PIC) was completed and posted on the Engage Muskoka Lakes website owned and operated by the Township as well as a notice of project mail out in July 2020. In addition to the presentation posted on-line a survey was created to engage and solicit feedback from members of the public which was discussed in the presentation and posted to the webpage.

Public and agency feedback was solicited either via email or direct correspondence through the survey on the Engage Muskoka Lakes webpage. Public feedback solicitation included businesses, residents, and other addresses within a 250 m radius of the dam, and Indigenous communities including Beausoleil First Nation, Chippewas of Georgina Island, Chippewas of Rama First Nation, Wahta Mohawks, Moose Deer Point First Nation, Metis Nation of Ontario, Wasauksing First Nation, Shawanaga First Nation, and Metis Nation of Ontario Lands. Many responses were received from Bala residents, and one response was received from an Indigenous community. Consultation with agencies included the MECP, MNDMNRF, Transport Canada, MTCS and others. An FAQ page was also posted and updated regularly on the website to incorporate questions commonly received from the survey and/or email inquiries with respect to the project to allow for transparent dialogue and honest feedback.

General comments during public consultation included a desire to rehabilitate and continue power generation if economically responsible, a general support for green energy, and expectation that safety related issues of the dam would be resolved was also a common theme. The presentation, results and response to the PIC, public and stakeholder survey, and the most up-to-date FAQ page is provided in Appendix F. All public and agency correspondence received throughout the execution of the EA are provided in Appendix G. It should be noted that personal information and names of the correspondents in all emails within the project file and associated appendix have been redacted to respect the privacy of those involved in the study. As discussed in the above section generally the public consensus was in general alignment with the recommended preferred alternative solution of rehabilitating the dam and maintaining power generation.

Finally, upon conclusion of the public consultation program, On October 13th, 2021, TULLOCH presented the results of the various studies and public input for the EA study to the Township of

Muskoka Lakes Council as well as the recommendation for selection of the preferred alternative solution. This was generally agreed upon by council members and the preferred alternative solution recommendation was supported. A copy of the slide deck for the presentation is provided in Appendix H.

8. PRELIMINARY DESIGN FOR PREFERRED ALTERNATIVE SOLUTION

Upon acceptance of the preferred alternative solution a preliminary design was completed by TULLOCH through the fall of 2022 for the civil and structural rehabilitation of the Burgess 1 Dam. A design brief memo outlining the proposed rehabilitation and design of the structure is provided in Appendix I which can then be furthered in the Detailed Design phase for the project. The design brief memo includes preliminary design drawings and the cost estimate referenced in section 5.3.1.

9. NOTICE OF STUDY COMPLETION AND PROVISION OF PROJECT FILES FOR PUBLIC REVIEW

The completion of this Project File Report (PFR) and filing of the Notice of Study Completion concludes the Class EA process for this project. The PFR is made available to the public for review upon request for thirty (30) calendar days. If concerns regarding the project cannot be resolved in discussion with the Township of Muskoka Lakes, a person or party may request that the Minister of the Environment and Climate Change make an order for the project to comply with Part II of the Environmental Assessment Act (referred to as a Part II Order), which requires an Individual Environmental Assessment. Requests must be received by the Minister within the 30-day review period. If no new or outstanding concerns are brought forward during the review period, the Township may complete detailed design and construction of the project.

10. CLOSURE

The findings of the Municipal Class Environmental Assessment (EA) Study for the improvement of the Burgess 1 Dam located in Bala, Ontario have been prepared by TULLOCH Engineering in consultation with the Township of Muskoka Lakes.

Under the Schedule 'B' Class EA, the project can proceed from Phase 2 (alternative Solutions to Phase 5 (implementation of the Class EA process). Design and construction can follow completion of this study. Phase 3 (alternative Design Concepts for Preferred Solution) and Phase 4 (Environmental Study Report) are not required for Schedule B projects.

We trust that the information in this report will be sufficient to allow the Township to proceed with the project. Should further elaboration be required for any portion of this project, we would be pleased to assist.

Sincerely,

Erik Giles P. Eng.
TULLOCH Engineering Inc.

Chris Stilwell P.Eng.
TULLOCH Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
E. K. GILES
100206670
NOV 17/2022
PROVINCE OF ONTARIO

APPENDIX A

Notice of Project and Problem and Solution Statement

Notice of Public Information Centre
Municipal Class Environmental Assessment Study
Burgess 1 Dam

The Study:

The Township of Muskoka Lakes has initiated a Class Environmental Assessment (EA) Study for the replacement or rehabilitation of the Burgess 1 Dam facility located in Bala, Ontario. (see map)

The Process:

A key component of the study is consultation with interested stakeholders (public and review agencies). Please visit:

www.engagemuskokalakes.ca

At the above link, a presentation will be made available regarding the Class Environmental Assessment process, the proposed works, possible alternative solutions and the identification and mitigation of any adverse impacts as a result of the project. After viewing the presentation there will be a section for comments and questions. Upon completion of the study, a Project File will be prepared for public review and comment. Subject to comments received and the receipt of necessary approvals, The Township intends to proceed with the detailed planning and design of the preferred solution. The Township wants to ensure that anyone interested in this study has the opportunity to get involved and provide feedback and input prior to design and implementation. To allow for the continuation of the study, the feedback period will end on September 9th 2020.

Alternatively:

If you are unable to view the presentation or do not have access to the Township of Muskoka Lakes website, you may request a hard copy form of the presentation to be sent via mail to your address along with a comment card to mail back to the Township. If you require a mailed copy or would like more information. please contact:

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20-1051
December 20, 2021

Township of Muskoka Lakes
1 Bailey Street
Port Carling, ON
P0B 1J0

Attention: Ken Becking

CC: Tim Sopkowe, Chris Stilwell

Re: Burgess Dam Schedule B EA – Problem Statement and Alternative Solutions

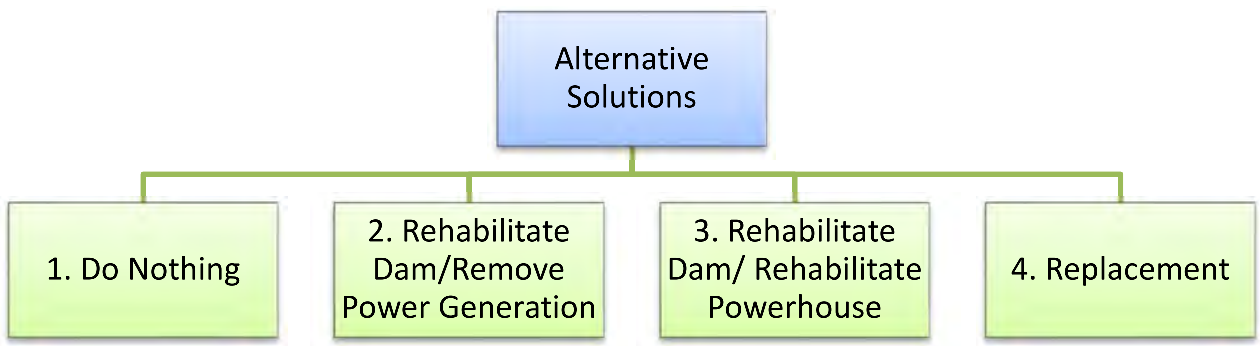
Please find below the problem and opportunity statement as well as potential alternative solutions in preparation for the Burgess 1 Dam Schedule B EA for your review. The purpose of this letter is to clearly define the problem regarding the aging infrastructure and briefly detail alternate solutions at a high level to commence Phase 1 of the EA.

Problem Statement

The Burgess 1 Dam located in Bala, Ontario was originally constructed in 1917 where operations were taken over by the Ontario Hydro Commission from their purchase of the dam and generating facility in 1929. The facility was purchased by the Township of Muskoka Lakes in 1963 and has been leased to various power generating companies up to present day. The dam consists of an approximately 59 m long concrete dam founded on bedrock with a maximum height of 3 meters. A powerhouse has been built into the northern section of the dam which is currently in operation. In the spring of 2019, the Burgess 1 Dam experienced an overtopping event caused by flooding of the Muskoka watershed upstream of the facility that put the dam at risk. A Dam Safety Review (DSR) conducted in the summer of 2019 determined safety concerns with respect to dam stability and capacity to withstand a similar event. Failure of the Burgess 1 Dam would result in significant loss of water control upstream affecting Lake Muskoka and its residents, furthermore, failure of the dam could result in property damage and risk to public safety downstream of the facility along the Moon River. The Township of Muskoka Lakes (The Township) is considering replacement or rehabilitation of the Burgess 1 Dam.

Alternative Solutions

The Township has determined it is important to engage the public in the decision making process and has decided to follow the Class EA process for Municipal Projects. Alternative solutions have been identified and will be reviewed through the Municipal Engineer's Class Environmental Assessment (Class EA) process. The outcome of the Class EA will be to select a preferred solution based on input from stakeholders including the Township and the public. The following flow chart indicates the proposed alternative solutions to the problem statement outlined above. The options below are based on recommendations from the Dam Safety Review and discussion with the Township. Each solution will be briefly described below.



1. Do Nothing

This option would involve doing-nothing and leaving the dam and powerhouse as-is in the current condition after the overtopping event in spring of 2019. Safety issues with respect to stability of the dam and state of the powerhouse would not be addressed to ensure the dam is in a safe condition for use.

2. Rehabilitation of the Dam and Removal of the Power Generation

Rehabilitate the dam with the goal of repairing deficiencies and reducing the risk of overtopping and/or failure of the facility in the future. Rehabilitation of the dam structure along with additional works to increase the safety of the dam could extend its design life and reduce the risk to public safety and upstream water levels in Lake Muskoka. Based on the findings of the Dam Safety Review it was shown that the powerhouse section of the dam was identified as requiring the most effort to retrofit and rehabilitate it may be considered preferable to decommission and remove the power generation system altogether. The powerhouse structure is an integral part of the dam and cannot be removed in its entirety. The powerhouse would be decommissioned to the maximum extent possible and the dam would then enter a care and maintenance state and act as a water control dam requiring inspection and as-needed maintenance.

3. Rehabilitation of the Dam and Powerhouse

This alternative solution is similar to the previous solution with the exception that the powerhouse section would also be rehabilitated along with the power generation equipment. Active generation would continue. The non-overflow section of the dam would be rehabilitated in a similar fashion as Option 3 to extend the life of the dam and increase the safety and stability of the structure. However, it is possible and may be preferable to keep the powerhouse intact. Rehabilitation would entail completing work necessary to meet modern design codes and address the stability issues raised in the 2019 Dam Safety Review. This option would allow for continued operation of the Burgess 1 Dam facility for power generation.

4. Replacement

Based on the current condition and age of Burgess Dam 1 (constructed in 1917), the current infrastructure has exceeded its design life in its current state. Repairs and rehabilitation of the facility may not extend the life of the dam to an acceptable level and would require continued care and maintenance even in a state of closure. This alternative involves the construction of a new dam facility with or without a power generating facility. This would likely involve the construction of a temporary dam while the existing dam was deconstructed and the construction of a new facility in its place using modern design methodology.

The above Problem Statement and Alternative Solutions have been prepared by TULLOCH Engineering in consultation with the Township of Muskoka lakes and will be used as the basis for the Schedule B EA for the Burgess 1 Dam facility.

Sincerely,

Erik Giles P. Eng.
TULLOCH ENGINEERING INC.

APPENDIX B

Burgess DSR Report

TULLOCH
ENGINEERING

DAM SAFETY REVIEW
BURGESS 1 DAM

for

Township of Muskoka Lakes



September 6, 2019

TULLOCH Project No.: 19-1493

2019-09-06	0	Issued for Use	E. Giles	F. Palmay	G. Liang
2019-08-14	A	Issue for Draft	E. Giles	F. Palmay	G. Liang
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**
TULLOCH					

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CDA	Canadian Dam Association
DSD	Dam Safety Deficiency
DSI	Dam Safety Inspection
D/S	Downstream Side of Dam
EPRP	Emergency Preparedness and Response Plan
EWL	Existing Water Level
FOS	Factor of Safety
HPC	Hazard Potential Classification
HWL	Headwater Level
ICC	Incremental Consequence Category
IDF	Inflow Design Flood
IEL&D	Incremental Economic Loss and Damage
ILOL	Incremental Loss of Life
NOL	Normal Operating Water Level
MDE	Maximum Design Earthquake
MNRF	Ontario Ministry of Natural Resources and Forestry
PAR	Population at Risk
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RFP	Request for Proposal
SFI	Scope for Improvement
U/S	Upstream Side of Dam

EXECUTIVE SUMMARY

ES-1 OVERVIEW

This report presents the results of a Dam Safety Review (DSR), performed by TULLOCH Engineering (TULLOCH) for the Burgess 1 Dam structure associated with the powerhouse at Bala, Muskoka, Ontario. The DSR was triggered by an overtopping event in the spring of 2019.

The DSR included a site visit On July 4th, 2019 by Frank Palmay, P. Eng. and Erik Giles, P. Eng., where existing conditions of the structure were observed and recorded along with site measurements. This report summarizes the results of the DSR and has been prepared according to CDA (2007, 2014) and MNRF (2011) guidelines.

Based on this DSR, the Burgess 1 Dam is in "poor to fair safe condition". However, some deficiencies and non-conformances were identified as summarized in Tables ES-1 and ES-2, respectively. The following summarizes the DSR findings.

E-2 HYDROTECHNICAL ASSESSMENT

The following is a summary of the hydrotechnical assessment of the Burgess 1 Dam based on the available information provided in MRWMP.

- The Inflow Design Flood at the MNRF Bala Dams was established as the 100 years event with a maximum lake of El. 226.5m. The identical IDF (1/100yrs) with a water level of El. 226.5 m applies to Burgess 1 Dam;
- The Normal Operating Level (NOL) is also defined by Bala North and South dam. The NOL is in the range of El. 224.6 m to El. 225.75 m (Acres, 2006).
- Based on document review, the existing dam crest elevation is at El. 226 m (to be confirmed by survey). TULLOCH recommended that the reservoir level upstream of the Burgess 1 Dam should be kept within the operating levels as per the MRWMP of El. 225.75 m (upper bound) in order to ensure a minimum freeboard of 0.25 m during operation.
- The current dam does not have enough freeboard to store the IDF at present. Design measures for proper management of overflows should be developed for IDF event.
- The reservoir water level was at about El. 225.3 m at the time of TULLOCH's dam safety inspection (DSI) conducted July 4th, 2019. This level is inferred to be the normal operating water level (NOL) of the facility.

- Based on the incremental consequences of dam failure during the IDF and sunny day breach (i.e. non-flood) conditions, the Burgess 1 Dam is classified as having a LOW HPC according to both MNRF and CDA guidelines.

E-3 GEOTECHNICAL STABILITY

The following table summarizes the results of the calculated factor of safety for the existing Burgess 1 Dam section under various loading conditions compared to the MNRF required minimum FOS.

Table ES-1: Calculated FOS for Stability of Burgess Dam Structures

Dam	Case[1]	Water Level (m)	FOS-Sliding	FOS - Overturning	Required FOS – Sliding/Overturning
Non-overflow Dam Section	Static Loading with NOL	El. 225.75	2.7	1.4	1.5 / 2.0
	Pseudo-static α=0.01g and NOL	El. 225.75	2.7	1.4	1.1 /1.1
	Static Loading with IDF	El. 226.49	2.3	1.1	1.3 / 1.3
Powerhouse Dam Section	Static Loading with NOL	El. 225.75	1.2	1.0	1.5 / 2.0
	Pseudo-static α=0.01g and NOL	El. 225.75	1.2	1.0	1.1 / 1.1
	Static Loading with IDF	El. 226.49	1.1	1.0	1.3 / 1.3

Note: [1-] NOL is the Normal Operating Level

Based on the geotechnical stability assessment, Repair or mitigation measures have to be developed for both the non-overflow dam section and powerhouse dam section to improve the FOSs to meet the criteria.

E-4 DAM MANAGEMENT AND PUBLIC SAFETY CONCLUSIONS

Based on the site inspection it was determined that there are a number of concerns towards public safety that need to be addressed such as upgrading and adding signage on the site, repairing and extending broken fencing, burying exposed ground wires and the creation of a Public Safety Plan. Further details can be found in table ES.2.

E-5 SUMMARY TABLES

Tables ES-2 and ES-3 summarize the recommended remedial actions to address the observed deficiencies and non-conformances at the Burgess 1 Dam site.

Table ES.1: Dam Safety Recommendations

Dam Structure	Issue	Category	Recommended Action	Recommended Schedule
Non-overflow dam section	**Moderate to significant washouts along the dam toe area caused from 2019 flooding** The FOS of the concrete dam section depends on the remaining fill material on the d/s toe area for the post-overflow event in 2019 flooding. Significant washout /scouring was observed along the downstream toe area with a scoring depth in excess of 1.0 - 1.5 m. The observed lake level in 2019 spring was about El. 226.45 m, is comparable to an IDF event for the Bala Falls Dams. Under the current site condition, the calculated FOSs against sliding and overturning are inadequate and do not meet required minimums.	Deficiency	Replace/reinstate the d/s fill material with rockfill/rip rap erosion protection to improve the FOS to meet the criteria	Spring/Summer 2020 High Priority
	No emergency spillway	Deficiency	A spillway option or the alternative overflow control options should be designed and constructed to pass the IDF conditions during a flood event.	Within 5 years
	Inadequate water level monitoring program	Deficiency	Install permanent water level gauges and / or other reliable monitoring measures tied to the Bala North and South Dams and monitor the water level regularly.	Spring/Summer 2020

Dam Structure	Issue	Category	Recommended Action	Recommended Schedule
Powerhouse Dam Section	**The powerhouse structure is in poor condition.** The dam and powerhouse are integrated into one structure. Large diagonal cracks observed in the concrete foundation slab likely caused by undermining from long-term scouring during powerhouse operation have compromised the load path of the structure and have limited the slabs ability to uphold the structure. In its current state the FOS of the powerhouse does not meet required minimums. The current site condition, the calculated FOSs against sliding and over-turning for the powerhouse dam section are inadequate to meet the required minimum FOSs.	Deficiency	Repair or mitigation measures must be developed for the powerhouse dam section (including the foundation treatment) to improve the FOS to meet required minimums.	Fall 2020 High Priority
	Powerhouse operation Under current condition, the powerhouse needs to cease operation to prevent further scouring and undermining of the foundation which are causing stability issue of the powerhouse.	Deficiency	Stop the units running or extend the tailrace pipeline to a safe distance d/s.	Spring/Summer 2020

Table ES.2: Maintenance and Surveillance Recommendations

Dam Structure	Deficiency or Non-Conformance	Category	Recommended Action	Recommended Schedule
Non-Overflow and Powerhouse dam Section	**Lack of record drawings**	Non-conformance	Compile the following records and keep them on file for Dam Safety Purposes: • Existing dam as-built drawings and design reports • As-built records for dam modifications/repairs.	Within 2 years after completion of the dam upgrade.
	OMS document	Non-conformance	Develop an OMS Manual for the facility. The normal operating water level and maximum operating water level should be defined in the OMS.	Within 1 year after completion of the detail design of the dam upgrade.
	Emergency Preparedness and Response Plan (EPRP)	Non-conformance	Develop an EPRP	Within 1 year after completion of the detail design of the dam upgrade.
	A survey of the dam structures and associate facilities	Non-conformance	A survey of the existing dam structures should be conducted for the design of dam structure upgrade to meet the CDA and MNRF guidelines	Complete by end of 2019
	Dense vegetation present at the dam site	Non-conformance	The vegetation should be removed within 3-5 m footprint of the selected option for the dam upgrade	Prior to the construction of the dam upgrade.
	Grouting or concrete patching the cracks in the existing dam sections	Non-conformance	Grouting or concrete patching is recommended to repair the existing cracks in the dam.	Complete by Spring/Summer 2020

Dam Structure	Deficiency or Non-Conformance	Category	Recommended Action	Recommended Schedule
Non-Overflow and Powerhouse dam Section (con't)	**There is no signage at the dam sites, upstream from or downstream from the dams, or at the access points**	Non-conformance	Safety and warning signage should be posted at both entrances to the site. Signage should be installed on the dams indicating hazards, including presence of deep water in the lake approaching to the dam, required PPE, hazards of working at or around dam and signage at the discharge facilities indicating unexpected release of flows or fast-moving water. Signage should be posted upstream and downstream of facility to warn the public of fast-moving water and the presence of the dam	Complete by Spring/ summer 2020
	Public Safety Plan (PSP)	Non-conformance	A Public Safety Plan (PSP) should be drafted to address the safety issues and ensure they are properly managed, and controls are properly maintained.	Complete by Spring 2020
	The existing boom line is in a poor condition	Non-conformance	Upgrade the boom line and adjust the safety distance to the powerhouse inlet; Regular maintenance is recommended.	Complete by Spring / Summer 2020
	Exposed grounding wire along site	Non-conformance	Backfill all exposed wires	Complete ASAP High Priority
	The existing fence / gate to constrain the public access to the dam site	Non-conformance	Upgrade the fence / gate to constrain the public access to the dam site without permits. Regular maintenance is recommended.	Complete by Spring / Summer 2020

Dam Structure	Deficiency or Non-Conformance	Category	Recommended Action	Recommended Schedule
River Street Concrete Retaining Wall and Embankment	**River Street Concrete Retaining Wall is in a fair safe condition**	Non-conformance	Retaining wall drainage efficiency upgrade design and construction are recommended; survey and geotechnical investigation and assessment are required.	Prior to the construction of the dam upgrade.
	River Street Embankment with Gabion Wall is in poor condition The embankment to the west of the retaining wall was in poor to fair safe condition during 2019 DSI. There exists a potential slope failure risk for River Street adjacent to the tailrace of the dam.	Non-conformance	A slope stability evaluation of the embankment along River Street is recommended. Detailed geotechnical investigation and assessment are strongly recommended.	Complete by Spring / Summer 2020

1. INTRODUCTION

1.1 Purpose and Objectives

TULLOCH Engineering Ltd. (TULLOCH) was retained by the Township of Muskoka Lakes (the Township) to carry out a Dam Safety Review (DSR) for the Burgess 1 Dam structures in Bala, Ontario within the District of Muskoka. Appendix A shows the site the location.

A DSR is an independent and systematic review and evaluation of the design, construction, maintenance, operation, and management systems affecting dam safety. For this DSR, the Burgess 1 Dam and associate structures were assessed in accordance with the Canadian Dam Association (CDA) Dam Safety Guidelines (2007, 2014) and Ontario Ministry of Natural Resources (MNR) Best Management Practices and Technical Bulletins (2011). Prior to this report, a formal DSR has not been carried out for the Burgess 1 Dam structures.

The overall objective of the DSR is to provide the Township with an independent and comprehensive assessment of the adequacy of the current Burgess 1 Dam facility to meet or exceed the applicable dam safety requirements. This review is intended to identify and categorize all dam safety issues that require remedial attention. Further, the issues identified are prioritized in Table ES-1 to ES-2 to assist the Township in setting priorities and developing an action plan to deal with the safety related deficiencies identified for the Burgess 1 Dam.

The scope of the work for the DSR was detailed in the TULLOCH Proposal dated May 31st, 2019 (Proposal #19-0001-179). The process commenced with The Township providing historical documents relating to the project to TULLOCH for review. Next, a DSI was performed by TULLOCH engineers accompanied by Mr. Steve Dursley a representative of KRIS Renewable Power the current lease and operator of the facility on July 4th, 2019. The DSI was limited to the civil/geotechnical, hydrotechnical and structural aspects of the facilities. Following the site inspections, a detailed DSR was completed including:

- Background data review
- Key/critical findings and preliminary recommendations
- Geotechnical, Structural and Hydrotechnical assessments
- Preliminary study for the mitigation/repair options
- Conclusion and recommendations
- DSR Report

Th following sections provide details of the DSR completed for the Burgess 1 Dam Structures. A Key Location Plan for the site can be found in Appendix A.

2. BACKGROUND INFORMATION

2.1 Document Review

The DSR process began with a review of available background information. The following documents were reviewed and formed the basis of this DSR.

- MRWMP Final Plan Report by Acres international, dated 2006
- Bala – Small Hydro Development Burgess Dam Site – Report on Proposals for Development by Totten Sims Hubicki Associates, not dated (circa 1987)
- Township of Muskoka Lakes Small Hydro Development Bala Tender Documents by Totten Sims Hubicki Associates, dated 1987
- Structural Report Bala Dam and Power Building Township of Muskoka Lakes by Totten Sims Hubicki Associates, dated 1986
- A Proposal for Historic Site Development of The Bala Power Generating Facility by Integrated Resource Group, dated 1984
- Feasibility Study for The Restoration of the Bala Power Generation Station by Integrated Resource Group, (not dated circa. 1984)

2.2 General Site Layout

The Burgess 1 Dam mainly consists of the following structures:

- Concrete dam structure (Water Retaining structure, Non-overflow dam section);
- Concrete dam with downstream (d/s) powerhouse structure;
- River Street Retaining Wall and Embankment;
- Other ancillary structures including the access road, fence, gates, tailrace and walkways.

A key location plan can be seen in Appendix A which shows the Burgess 1 Dam general site layout.

2.3 Organization and Responsibilities

Originally the dam was built by J.W. and A.M. Burgess between 1917 and 1922 and the dam/generating station was purchase by the Ontario Hydro Commission in 1929. Burgess 1 Dam was owned and operated by Ontario Hydro from 1929 to 1957 and was then sold to the Township in 1963 who currently owns the facility.

Based on Township records the facility was largely unused for a long period of time until it was partially refurbished and leased to Marsh Power in 1988 for the purpose of power generation until

1999. The facility was then leased to Algonquin Power (Fund) Canada Inc. and operated by Algonquin Power Systems Inc. until 2011. Upon expiry of the lease KRIS Renewable Power Ltd (KRIS). Began to lease and operate the generating station. The current Lease started in August of 2012 and expires in 2022. KRIS currently operates the facility employs a part time care and maintenance operator who works e at the facility to run the generating station, remove debris from the headwaters/spillway inlet and generally maintain the property. KRIS has also partially upgraded the facility by adding new metal sluicegates and a new turbine on the north inlet of the headwaters.

2.4 Burgess 1 Dam Facilities

The Burgess 1 Dam was built and began operation in 1917. The facility consists of a 59 ± meter long concrete dam founded on bedrock with a maximum height of approximately 3 meters. Fill has been placed on the downstream face of the dam to provide resistance against the overturning and sliding of the structure. The powerhouse is approximately 9 m x 14 m in dimension including the turbine, generator and associated electrical equipment. Finally, a 16 m long retaining wall connected to the north wall of the powerhouse supports River St immediately to the north of the facility. The tail race is armored with gabion baskets sitting atop a historic boulder rock wall on the north bank of the facility. The dam and powerhouse are integrated into one structure, which is situated in a constructed channel on the existing bedrock. Table 2-1 below summarizes the main features of the dam structures on site:

Table 2-1: Summary of the In-situ Features of the Burgess 1 Dam

No.	Dam	Main Features	Reference
1	Non-overflow Dam Section	Concrete Retaining Structure on Bedrock supported by d/s fill embankment.	• TSHA Structural Report, 1986 Drawing P-1 and P-2
2	Powerhouse Dam Section	Concrete gravity dam and powerhouse are integrated into one structure and founded on the bedrock	• TSHA Structural Report, 1986 Drawing P-1 and P-2
4	Dam Crest Elevation (m)	• El. 226.0 m	• TSHA Structural Report, 1986 Drawing P-1 and P-2
5	Maximum Dam Height (m)	• Max. 3 m (non-overflow section) • Max. 6 m (Powerhouse Section)	• TSHA, Structural Report 1986 Drawing P-1 and P-2
6	Crest Width (m)	• Approx. 0.6 m	• TSHA, 1986 Drawing P-1 and P-2
7	Dam Length (m)	• 59 m (total length of dam) • 14m (Powerhouse Section)	• TSHA, 1986 Drawing P-1 and P-2

No.	Dam	Main Features	Reference
8	Spillway	• No Spillway	• MRWMP, 2006
9	Reservoir Levels	• NOL Range between 224.6 and 225.75 m • IDF El. 226.49m	• MRWMP, 2006
10	Powerhouse	• 0.14MW, 2 Units • Max. flow rate 4m^3/s	• MRWMP, 2006

For further information/details of the features of the Burgess 1 Dam, relevant historic drawings/site plans can be viewed in Appendix F. The aforementioned plans along with field measurements formed the bases for the modelling and the figures presented in this report. It is strongly recommended that a detailed survey of the site be undertaken to verify dimensions and elevations.

3. SITE CONDITIONS

3.1 Site Surficial Geology

Based on review of Bedrock Geology and Surficial Geology of Southern Ontario mapping as published by the Ontario Geological Society (OGS), the site surficial geology is comprised of Canadian Shield with formations of Precambrian Bedrock typical within the Muskoka region. The bedrock on site was located close to ground surface and comprised of typical geologic formations for the Bala area including hard and smooth pink to grey migmatitic rocks as well as quartzofeldspathic gneisses (OGS 2019). The Burgess 1 Dam is located at the lower section of the Muskoka river watershed near the bottom of Lake Muskoka where regional topography is typically mapped as low local relief varying from plains to undulating hummocky conditions (Acres 2006). Overburden in the Bala area is typically sandy and shallow in depth with thick organic deposits found in low lying wetland areas. Overburden observed on site was typically shallow and sandy in nature.

3.2 Site Seismicity

The site seismicity is based on the 2015 National Building Code seismic peak ground acceleration (PGA). Based on the DSR, the Burgess 1 Dam has been classified as a dam structure with LOW flood and earthquake hazards, indicating the return period of the design earthquake to be 1/100 according to CDA Guidelines (2013 Edition). Accordingly, the PGA seismic coefficient for the dam sites has a 40% probability of exceedance in 50 years corresponding to a return period of 1 in 100 years, based on the 2015 National Building Code. Appendix B shows the PGA data obtained from the 2015 National Building Code Seismic Hazard Calculation Index which is specific to the site. This corresponds to a PGS value of 0.01.

3.3 Site Hydrology

Located on the lower tier of the Muskoka Watershed, the Burgess 1 Dam generating facility along with the North and South Bala Falls Dams hold back most of the water collected from the Muskoka River Watershed sharing a drainage area of 4683 km^2 and a lake surface area of 120 km^2 (Acres 2006) . Generally, flood events for the watershed occur in two basic types, a spring freshet from melted snow along with increased precipitation and major storm events.

The Burgess Dam is largely controlled by the larger North and South Bala Falls Dams located ~ 300m south of the facility which typically handles the flood flow through the watershed. Water from the Burgess Dam flows south west into the Moon and Musquash Rivers eventually into Georgian Bay. The majority of the watershed meets in Bala forming a bottle neck that must handle significant flows during flooding conditions from the majority of the watershed. Recorded river flow data at the Bala Reach of the Muskoka river indicate a long-term average stream flow of approximately 76.7 m^3/s (Acres 2006).

The allocated maximum flow to the Burgess Generating Station is 4 m^3/s and there is no spilling capacity. As a result, all flood flows passing from Lake Muskoka are routed through the North and South Bala Dams. The facility has two turbine units and is rated at 0.14 MW. Power is generated at the facility only when Lake Muskoka water levels are within an acceptable range.

4. DAM SAFETY GUIDELINES

This DSR was executed in accordance with the following guidelines from both the MNRF (2011) and Canadian Dam Association (2007, 2011, 2013):

- The Ontario MNRF Guidelines including Ontario Ministry of Natural Resources and Forestry Lakes and Rivers Improvement Act Administrative (LRIA) Guide (dated August 2011),
- Associated Technical Bulletins and Best Management Practices.
- Canadian Dam Association, 2007 Dam Safety Guidelines, including 2013 Revisions.
- Canadian Dam Association, Guidelines for Public Safety Around Dams, 2011.

Dam classification and design criteria for the DSR are based on the MNRF (2011) Hazard Potential Classification (HPC) system, the CDA (2007) dam classification category and associate Inflow Design Flood (IDF) and Earthquake Hazards. Appendix C includes the dam classification and criteria used in this study from the CDA and MNRF guidelines.

5. DSR PROCEDURES

5.1 DSI and Interviews

A DSI in support of the DSR were carried out on July 4th, 2019 by Mr. Frank Palmay, P.Eng. and Mr. Erik Giles, P.Eng. of TULLOCH Engineering. The DSI personnel were accompanied by Mr. Steve Dursley, who was a KRIS representative. The inspected areas included the Burgess 1 Dam structures, powerhouse and associate equipment, u/s reservoir, the downstream tailrace, River Street retaining wall structures and the surrounding areas.

The details of the DSI field report and findings are in Appendix D and the previously issued Key Findings Memorandum can be found in Appendix E.

5.2 DSR Assessments

The following technical assessments were carried out in support of this DSR:

- Hydrotechnical assessment to determine the Hazard Potential Classification (HPC) and Inflow Design Flood (IDF) for the structures
- Geotechnical assessment to evaluate the stability of the existing dam under various loading conditions
- Development of a preliminary options for Dam mitigation/repair including baseline cost estimation
- DSR report

6. DAM SAFETY INSPECTIONS

6.1 General

The site inspections at the Burgess 1 Dam were completed on July 4th, 2019, based on the following sequence:

- The site DSI was undertaken with an emphasis on the nature, extent and condition of the contained material(s), reservoir levels, upstream (U/S) and downstream (D/S) areas and abutment contacts, the geotechnical environment, and included the flow discharge facilities as well as the structural condition of the existing powerhouse structure and retaining wall attached to the dam;
- Walk-arounds and visual inspections at the dam site included observations of components such as dam crests, U/S and D/S slopes, abutments, toe areas, and a record of relevant details indicative of the stability and potential risk of instability of the structures. The recorded information includes facility name, height of structure, approximate slope gradients, activity status and physical condition (i.e. visible depressions, cracking,

deformation, surface erosion, freeboard, signs of past flooding, overtopping, internal erosion, piping, sand boils etc.);

- Inspections of the appurtenant structures were done to assess their condition, functionality and adequacy;
- Inspection forms were completed for each of the significant structures, including the gathering of other relevant information such as GPS data (georeferenced using UTM co-ordinates), digital photographs of all pertinent features, and area characterization (refer to Appendices D and E);
- Where background information was not available, the dimensions of the structures were estimated with a measuring tape or by pacing;
- No underwater inspections were proposed nor were any inspections of high steep slopes carried out when accessibility was limited.
- Assessment was based on exposed physical condition only and did not include destructive testing of any element of the structure. No samples were collected and therefore no laboratory analysis of the concrete or soils was conducted.

The objective of the inspections was to identify and address any deficiency findings and recommend associated mitigation measures. The key points of the findings for the facility are summarized below. As noted above, the field inspection checklist for the dam facility is included in Appendix D of this report. Recommendations with respect to the findings in the report are presented in Sections 9.0 through 11.0.

6.2 Access, Safety and Security

Access to the site was via Portage Street located south of the main downtown area of the Town of Bala. The dam was built adjacent to River Street and there are both full year and seasonal residents located on both Portage and River Streets. The main access to the dam is through a locked entrance gate from Portage Street, with a second locked man gate that exits onto River Street. A Chain-link fence runs across the south side of the property and connect to the south abutment of the dam. A small length of chain-link fence also ties into the guardrails west of the River Street retaining wall. However, the fencing located to the south of the dam has fallen into disrepair and needs to be replaced. Furthermore, the man gate and locking system to the River Street entrance along the north side of the powerhouse also should be upgraded. Fencing should be extended along the dam crest to prevent boaters from accessing the facility from the headwaters.

No significant signage is present along the facility either at the headwaters or tailrace locations. A small faded sign warning of moving water is located overtop of the sluicegates however it is difficult to read and should be replaced. There is no signage posted on either gate. For the purpose of public safety warning signs should be posted in all aforementioned locations.

The sluice gate of the dam appeared to be outfitted with warning lights however they were not in use or tested during the DSI, visual and auditory warnings should be implemented if not already and tested frequently to ensure they are in good working order.

The boom-line for the dam is comprised of historic timbers which are half sunken and the setback distance is too close to the dam. The line is poorly visible from the headwaters of the dam and does not provide an ample barrier for the public. The boom line should be upgraded to modern standards and setback further from the dam.

6.3 Observations

Generally, the dam structure was found to be in fair condition considering the age of the structure. However, the powerhouse section of the dam is in poor overall condition from both a structural and dam safety perspective and will require remediation due to the presence of failed or failing structural members and a large transverse crack through the floor slab of the dam. Furthermore, significant washout of the downstream fill from another future flooding event has the potential to cause the structure to fail. As such there are dam safety issues associated with this site that will require remediation. Detailed observations for the DSI can be found in Table 1 of the Key Findings memo issued on July 24, 2019 which can be found in Appendix E. Preliminary recommendations were also made in this document but have since been refined and will be addressed below in Section 11.0.

7. HYDROTECHNICAL ASSESSMENT

7.1 Methodology

A hydrotechnical assessment was carried out mainly based on literature data review and desktop study. As described in the preceding sections, the Burgess 1 Dam facility is currently rated at 0.14 MW, operates when Lake Muskoka water levels are within an acceptable range. The facility has no spill capacity as upstream water level control is provided by the Bala North and Bala South dams. The hydrotechnical assessment mainly consist of the following steps:

- Compile the lake levels taken from Environment Canada hydrometric data measured from the nearest upstream station near the inflow of the Bala dams (Station ID:02EB015);
- Compile the operating lake levels of the Burgess dam as outlines in the MRWMP (2006);
- Determine the IDF for Burgess dam based on available data;
- Determine the Hazard Potential Classification (HPC) based on the MNRF and CDA criteria;
- Assess if the existing Burgess Dam has adequate freeboard for IDF event.

7.2 Water Levels

Figure 7-1 shown below illustrates the water levels at Burgess 1 Dam Site in 2019 and compares it to critical water levels associated with the structure according to the MRWMP. Table 7-1 summarizes the critical water levels. Summarizing:

- The maximum measured water level in 2019 during the flood event was at El. 226.1m at Gauge Station 02EB015, which occurred on May 1st, 2019;
- The IDF value provided by the MNRF and illustrated in the Muskoka River Dam Operation Manual for both the Bala Falls Dams is 226.49 masl and corresponds to the 100-year flooding event. The observed maximum water level at Burgess 1 Dam during overtopping in 2019 spring was at approximate El. 226.45m, which is very close the IDF (1/100yrs return) level of El. 226.49m;
- The facility has no spill capacity as upstream water level control is provided by the Bala North and South Falls Dams. Based on their proximity and virtually parallel positioning along the watershed it has been determined that the design IDF for the Bala South and North Dams is the most appropriate value for use at the Burgess 1 Dam location.
- The existing Burgess 1 Dam crest is at El. 226 m. During the determined IDF event water levels are above the dam crest by 0.39 m. Therefore, it can be determined that the Burgess dam does not have sufficient freeboard nor was the existing facility designed to handle IDF in its current state.

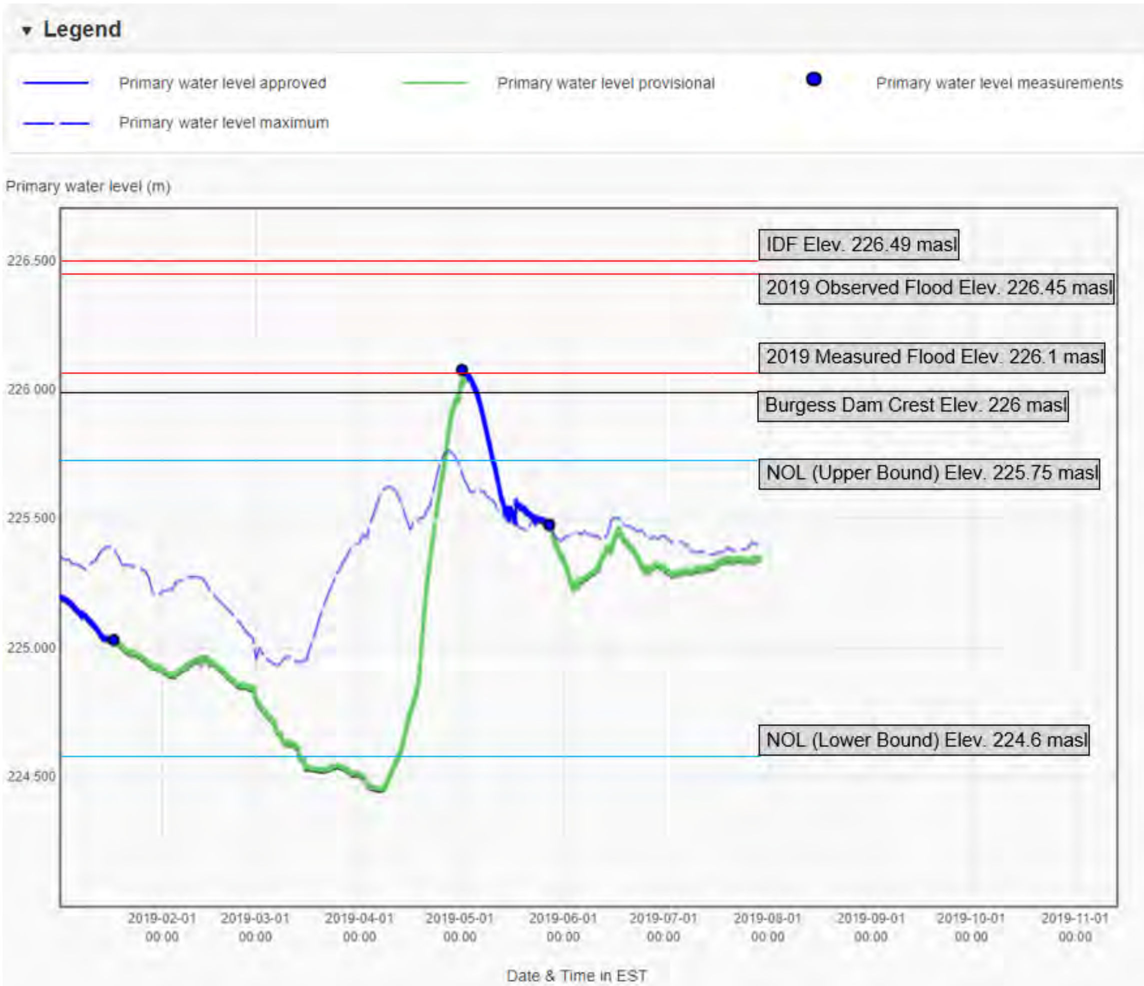

Figure 7-1: Burgess Dam 1 - 2019 Water Levels vs. NOL and IDF

Table 7-1: Water Levels Associated with Burgess 1 Dam

Parameter	Elevation (masl)
Burgess Dam Crest Elevation (to be confirmed by survey data)	226.00
2019 Flooding Measured Maximum Level at nearest Gauge Station 02EB015	226.10
2019 Observed Flooding level at the dam site	226.45
NOL Burgess Dam 1 (Upper Bound)	225.75
NOL Burgess Dam 1 (Lower Bound)	224.60
IDF – 100-year Lake Muskoka Flood Level	226.49

7.3 Hazard Potential Classification (HPC)

Table 7-2 summarizes the hazard potential classification (HPC) based on MNRF guideline (as provided in Appendix C). Given the above criteria, the HPC of the Burgess 1 Dam is LOW.

Table 7-2: Burgess 1 Dam Classification Summary

Category	Burgess 1 Dam	
	Flood	Non-Flood
Incremental Loss of Life (LOL)	0	0
	Low	Low
Economic Damages	<$300,000	<$300,000
	Low	Low
Environmental	Low	Low
Cultural / Heritage	Low	Low
Governing Criteria	Economic / LOL	Economic / LOL
Overall Classification (HPC)	**LOW**	**LOW**

8. GEOTECHNICAL ASSESSMENT

As part of the DSR, the stability analyses for the existing dam sections were carried out to assess the Factor of Safety (FOS) for both Non-overflow and powerhouse dam section under various loading conditions. The following sections summarize the geotechnical assessment.

8.1 Criteria

Table 8-1 summarizes the analyzed cases, u/s water levels and the applicable stability criteria based on CDA and MNRF Guidelines.

Table 8-1: Analyzed Cases and Applicable Stability Criteria

Case	Description	Water Level (m)	FOS-Sliding	FOS-Overturning
1	Static Loading NOL	El. 225.75	1.5	2.0
2	Seismic Loading with NOL	El. 225.75	1.1	1.1
3	Static Loading with IDF	El. 226.49	1.3	1.3

8.2 Methodology

The FOS calculation for stability analysis of the dam sections involved the following Equations:

FOS against sliding failure:

$$FOS = \frac{\sum Resisting\ Froce}{\sum Driving\ Force} \qquad [8\text{-}1]$$

FOS against overturning failure:

$$FOS = \frac{\sum Resisting\ Moment}{\sum Driving\ Moment} \qquad [8\text{-}2]$$

FOS against bearing Failure

$$FOS = \frac{q_{allowable}}{q_{maximum}} \qquad [8\text{-}3]$$

Bearing failure for the facility was calculated for both sections and found to have an FOS greater than 3.0 using a conservative allowable bedrock capacity of 1 MPa. Considering that the facility has a short dam height and is founded on bedrock it was determined that the focus of the analysis will be on failure against sliding and overturning.

Therefore, the FOS against foundation bearing failure is considered to be sufficient and no further calculation is included in the geotechnical assessment. Table 8-1 summarizes the geotechnical parameters used in the stability calculation.

Table 8-2: Summary of Geotechnical Parameters Stability Calculation[1]

No.	Type of Material	Cohesion, c' (kPa)	Internal Friction Angle, φ' (Degree)	Unit Weight, γ' (kN/m^3)
1	Dam Unreinforced Concrete	0	50	24
2	D/S Fill Material	0	35	19
3	Concrete-to-Bedrock Interface[1]	0	45	20

Note: [1]-Geotechnical parameters are assumed for the DSR based on TULLOCH's engineering experience.

8.3 Stability - Seismic Event

Based on Section 7, the Burgess 1 Dam has been classified as a LOW HPC rating, indicating that the return period of the design earthquake is 1/100 according to CDA Guidelines (2013 Edition). The following site-specific PGA has been used to perform pseudo-static stability analysis of these dams:

- For 1/100-year return period, the PGA for the site is 0.01 g, corresponding to a Class 'C' site classification. Appendix C shows the PGA data obtained from the 2015 National Building Code Seismic Hazard Calculation.

- For pseudo-static analysis, the horizontal PGA value was multiplied by 2/3 giving 0.7(0.01g) = 0.007 g. Considering the shallow bedrock present at dam site, two thirds of the horizontal PGA on bedrock is considered to replicate the sustained ground motion. Correspondingly, a ground acceleration of 0.005 g was applied for the pseudo-static seismic assessment of the dam structures at this site.

8.4 Results

Table 8-3 summarizes the results of the stability analysis calculations. The results are discussed in the following sections of this report. Figures 8-1 and 8-2 show representative sections of the dam that were analyzed which are show below.

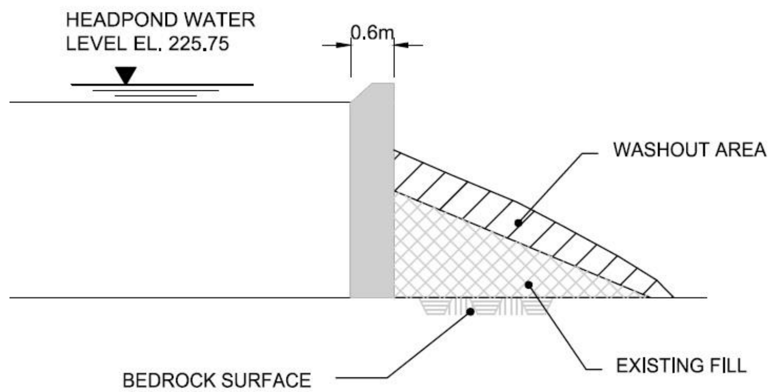

Figure 8-1: Typical Non-overflow Dam Section for Stability Analysis

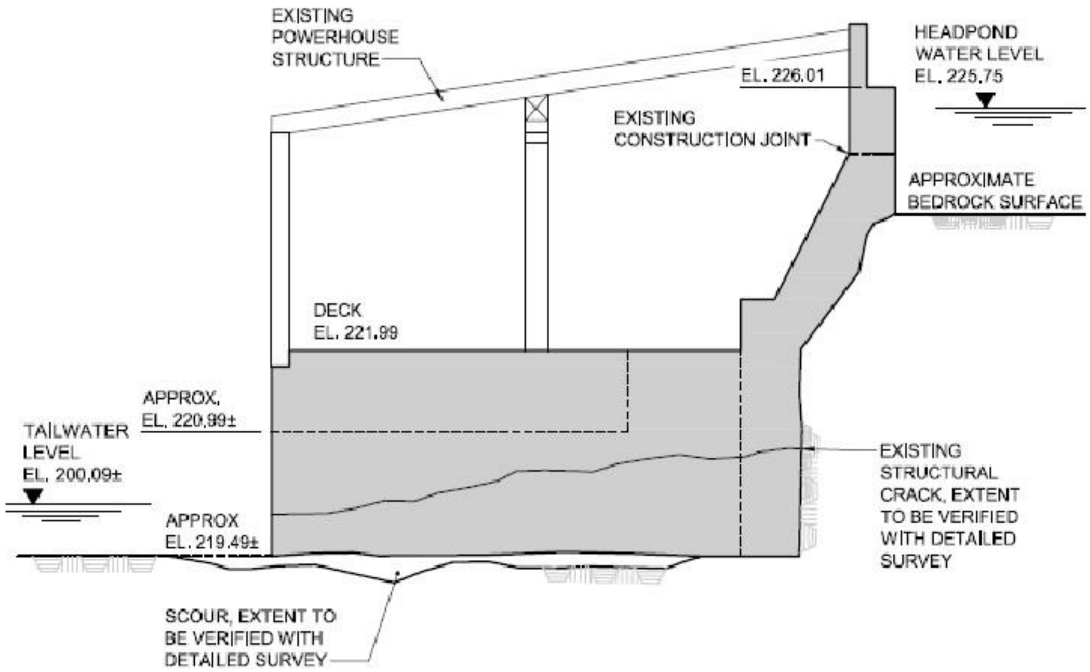

Figure 8-2: Typical Powerhouse Dam Section for Stability Analysis

Factor of Safety calculation results are summarized below for the various loading conditions under each section mentioned above:

Non-overflow Dam Section

- Under static loading condition with NOL at El. 225.75 m, the calculated FOS against sliding is 2.7, which meets the required minimum FOS of 1.5; The calculated FOS against overturning is 1.4, which does not meet the required minimum FOS of 2.0.
- Under seismic loading condition with NOL at El. 225.75 m, the calculated FOSs against sliding and overturning are 2.7 and 1.4, respectively. The calculated FOSs meet the required minimum FOSs of 1.1. Due to a short dam height and low PGA value at the site, the seismic loading has a negligible impact on the stability of Burgess dam.
- Under static loading condition incorporating the IDF water level, the calculated FOS against sliding is 2.3, which meets the required minimum FOS of 1.3; The calculated FOS against overturning is 1.1, which does not meet the required minimum FOS of 1.3.

Powerhouse Dam Section

- Under static loading condition with NOL at El. 225.75 m, the calculated FOS against sliding is 1.2, which does not meet the required minimum FOS of 1.5; The calculated FOS against overturning is 1.0, which does not meet the required minimum FOS of 2.0.
- Under seismic loading condition with NOL at El. 225.75 m, the calculated FOS against sliding is 1.2, which meet the required minimum FOS of 1.1; the calculated FOS against overturning is 1.0, which does not meet the required minimum FOS of 1.1. Due to a short dam height and low PGA value at the site, the seismic loading has a negligible impact on the stability of Burgess dam.
- Under static loading condition incorporating the IDF water level, the calculated FOS against sliding is 1.1, which meets the required minimum FOS of 1.3; The calculated FOS against overturning is 1.0, which does not meet the required minimum FOS of 1.3.

Based on the geotechnical stability assessment, Repair or mitigation measures must be developed for both the non-overflow dam section and powerhouse dam section to improve the FOS to meet the minimum acceptable criteria.

Table 8-3: Calculated FOS for Stability of Burgess Dam Structures

Dam	Case	Water Level (m)	FOS-Sliding	FOS - Overturning
Non-overflow Dam Section	Static Loading with NOL	El. 225.75	2.7	1.4
	Pseudo-static α=0.005g and NOL	El. 225.75	2.7	1.4
	Static Loading with IDF	El. 226.49	2.3	1.1
Powerhouse Dam Section	Static Loading with NOL	El. 225.75	1.2	1.0
	Pseudo-static α=0.005g and NOL	El. 225.75	1.2	1.0
	Static Loading with IDF	El. 226.49	1.1	1.0

8.5 River Street Concrete Wall and Embankment

Based on site inspection, the concrete retaining wall along River Street is in a Fair condition. The presence of the vertical cracks in the wall encountered during the DSI indicated drainage efficiency of the retaining wall may not be adequate. The inadequate drainage likely caused water pressures to build up behind the retaining wall. This could be alleviated by implementing better drainage and water management through and around the wall. Preliminary recommendations will be discussed further in Section 11.0.

The Embankment along River Street downstream of the site is very steep and appears to be eroding at the toe where there are newer gabion baskets placed on a historic boulder/stone wall.

There is a concern for the slope failure of the embankment due to the erosion/ scour caused by water flows during power generation activity. The slope stability evaluation of the embankment along the River Street is not included in the scope of this DSR, however, a detailed geotechnical investigation and assessment are strongly recommended.

9. DAM MANAGEMENT CRITERIA

9.1 Operation, Maintenance, and Surveillance

It is our understanding that there is currently no OMS Manual for the Burgess 1 Dam facility. However, Operating levels for all control dams in the Muskoka watershed can be found in the Muskoka River Dam Operation Manual. The manual does not provide the necessary detail for the site-specific operation, maintenance and surveillance for the Burgess 1 Dam site. Therefore, it is TULLOCH's recommendation that an OMS manual be drafted for the Burgess 1 Dam.

9.2 Emergency Preparedness and Response Plan

There is no formal Emergency Preparedness and Response Plan for the dam in the event of failure. The Muskoka River Dam Operating Manual describes typical operating levels but does not describe issues relating to a response of a failure/emergency event.

It is recommended that an Emergency Preparedness and Response Plan be prepared for the facilities now that a DSR has been completed for the site which should include the anticipated effects of a dam failure under the selected IDF.

10. PUBLIC SAFETY

10.1 Review

The Burgess 1 Dam main access gate is located off Portage Street and is typically locked when site personnel are not present. The man gate located on the south bank of River Street is poorly secured with a thin chain and padlock, although it is kept locked upgrades to the gate would improve security. Fencing around the property is damaged in some places and could allow for access to the general public. Although not generally accessible a cottager has also built a dock on the south abutment of the dam. The site is generally inaccessible by foot, but it is possible to access the site by boat or by walking up the tailrace due to poor signage and an inadequate boom line. There is no signage for the Burgess 1 Dam warning the public of the dangers associated with active hydro generation except for one badly faded poorly sized sign located on the top of the sluicegate. The boom line for the dam is poorly visible, dated, and does not have appropriate clearance from the dam.

10.2 Recommendations

- Signage should be added for the Headwaters and Tailrace of the facility indicating danger and the unexpected release of flows/fast moving water

- The faded sign should be replaced on the dam
- Fencing should be expanded along the dam crest and repaired where broken
- The dock on the south abutment should be removed
- The north access gate should be repaired, and the locking system upgraded

11. MITIGATION RECOMMENDATIONS

Recommended mitigation measures are outlined below for the Non-overflow, Powerhouse and River Street Retaining Wall sections of the Burgess 1 Dam site. TULLOCH has provided improvement options for each section of the structure with a brief discussion on each option. It should be noted that these recommendations are at a conceptual level and quantities/cost estimations need to be verified with a detailed survey of the property. Conceptual figures of the facility upgrades can be seen in Appendix G.

11.1 Non-Overflow Dam Section

11.1.1 Option N1 – Downstream Rip Rap Placement and Toe Berm

Option N1 is to reinstate the fill of the existing dam by replacing rockfill/ rip rap over a non-woven geotextile for erosion protection d/s of the existing dam site. Fill should be replaced in washout section and then covered with a geotextile. The addition of rip rap will provide added erosion protection in the event of overtopping to avoid excessive washout of fill similar to the 2019 event. In order to collect overflow water during flooding events a toe-berm could be constructed along the downstream property line to channel water down to the in-situ river channel. A similar berm would be constructed along the south wall of the powerhouse to keep flows away from the building foundation. Figures 19-1493-C-01 and 02 in Appendix G show the conceptual design for Option N1. Highlights of the N1 design include:

- Downstream; clear and strip organics as required;
- Reinstate washed-out sections of downstream fill
- Place Non-woven geotextile and rip rap (500mm thick); grade back toward the tailrace for erosion protection;
- build toe berms along the existing property line and the south wall of the powerhouse to manage and divert the overflow (if it occurs) toward the river;
- Extend the existing dam to the south end to accommodate toe berm and flow management (about 8m in length);
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;

11.1.2 Option N2 – Partial Dam Raise and Emergency Spillway

Option N2 is to partially raise sections of the Non-overflow area of the dam and install and emergency spillway to control overflow during flooding events.

The spillway invert could be kept at the current dam crest elevation and the remainder of the dam would subsequently be raised 0.5m to meet the minimum freeboard criteria during the operation of the spillway during a flood event. The final spillway invert elevation and grade as well as the dam raise will need to be determined based on a detailed survey and hydrotechnical assessment. Figures 19-1493-C-04 and 05 in Appendix G show the conceptual design for Option N2. Highlights of the N2 design include:

- Downstream; clear and strip organics as required;
- Partially raise the dam 0.5 m for the dam section about 20 m in length south of the proposed spillway invert and 6 m in length north of the invert;
- Build an emergency spillway channel with rip rap placed a minimum of 500 mm thick over non-woven geotextile with a total approximate width of about 18m through the middle of Non-overflow section of the dam;
- The spillway should be angled such that water is directed into the existing tailrace and away from the River Street embankment;
- Re-instate the fill south of the spillway that has been washed away during the flooding event and tie into the spillway;
- Extend the existing dam abutment south to accommodate a higher elevation (about 8m in length);
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;

11.2 Powerhouse Dam Section

11.2.1 Option P1 –Demolish Powerhouse and Replace with New Dam

Given the relatively poor condition of the existing powerhouse, Option P1 is to demolish the existing powerhouse dam section and build a new replacement concrete dam section upstream of the existing powerhouse. Figures 19-1493-C-08 and C-10 in Appendix G show the existing condition of the section and a conceptual design for Option P1. Highlights of the P1 design include:

- Installation of u/s and d/s cofferdams;
- Removal of the old dam section and associate powerhouse structures;

- Construction of a new concrete gravity dam (about 2.5m high) on excavated bedrock for water retention (i.e. to maintain the lake level); the new dam section will be tied into the existing non-overflow section.

- Removal of cofferdams after construction is complete.

11.2.2 Option P2 – Powerhouse Refurbishment and Reinforcement

It may be advantageous to keep the powerhouse section of the dam intact given its historic value and the potentially prohibitive cost of decommissioning and deconstruction. Furthermore, the possibility of continued power generation may be appealing to the Township. As such, given that the current FOS of the existing powerhouse dam section is marginally stable a refurbishment of the facility is possible to meet current standards. Option P2 entails the structural reinforcement of the existing building as well as to remediate and reinforce the dam section and foundation of the powerhouse. Figure 19-1493-C-09 in Appendix G shows the conceptual design for Option P2. The highlights of Option P2 include:

- Fill the scour areas (i.e. undermined holes) in the foundation the powerhouse with mass pour concrete;

- Grout the cracks developed in the existing concrete piers;

- Reinforce the powerhouse structures with 9 rock anchors (Φ35mm, 8m long) to be installed to a minimum depth of 6 m into the bedrock; Grout the existing crack through the foundation once bolts are installed;

- Repair/Replace the Roof;

- Add shear struts and additional structural bracing in the powerhouse building;

- Grouting or concrete patching the cracks in the existing dam to limit the leakage;

- Extend the existing tailrace pipes for the turbine units d/s to keep them a safer distance away from the powerhouse to avoid scour and undermining of the foundation.

11.3 River Street Concrete Retaining Wall

Based on review of site photos and field findings, the following mitigation actions should be considered to improve the performance of the existing concrete retaining wall structure:

- Install a drainage ditch u/s of the retaining wall to divert the surficial run-off water from River Street;

- Drill drainage holes and install drainage pipes along the base of the existing concrete retaining wall;

It should be noted that all options described above are conceptual in nature. Verification of design elements, dimensions and quantities and associated costs will require topographical survey, geotechnical investigation and further geotechnical/structural analysis to move towards detailed design.

11.4 Cost Estimation

Preliminary costs and material quantities were estimated based on historical design drawings (seen in Appendix F) provided by the Township and an assumed ground profile. Table 11-1 shows a summary of the cost estimation for the options discussed above. It should be noted that the costing and quantities are considered preliminary for the purpose to help select a preferred option for detailed design. Costs and quantities should be verified with a detailed ground survey and confirmed with further geotechnical and structural analysis. Tables H-1 through H-4 in Appendix F show the details of the preliminary cost estimation for each option discussed above.

Table 11-1 Summary of the Preliminary Cost Estimates (FEL1 Level)

Area	Option	Cost Estimation ($)
Non-overflow Dam Section	N1	$ 171,535.00
	N2	$ 227,570.00
Powerhouse Dam Section and River Street Concrete Retaining Wall	P1	$ 1,884,400.00
	P2	$ 535,150.00

11.5 Preliminary Remediation Recommendations

Based on the assessment above, the following option combinations are feasible considering both technical and economic aspects, including:

- Option N1 and Option P2 (total cost: $ 706,685.00)
- Option N2 and Option P2 (total cost: $ 762,720.00)

TULLOCH recommends Option N2 and P2 for the proposed remediation of the facility the decision was made given the following considerations:

- Although the total cost for Option N2 / P2 is about 8% higher than Option N1/P2 combination, Option N2 will allow the dam to handle large flows more predictably and ensure that water flow is controlled and directed down the tailrace.
- By channeling the water down a dedicated spillway there is less likelihood of irregular erosion and scour and the risk of property damage is significantly reduced, as well it will reduce the likelihood of large flows against the River Street embankment.

- Based on the cost estimates and constructability for the powerhouse dam section, it may be more advantageous to leave the powerhouse in place. Option P1 (i.e. Removal of the powerhouse and replaced by a new dam) is the most expensive option and would present considerable difficulties in construction. In addition, due to the historic significance of the structure it may be advantageous to maintain a refurbished structure.

Ultimately the decision on the future of the Burgess 1 Dam facility will be up to the Township and TULLOCH would be pleased to offer any further services towards the rehabilitation of this structure.

12. CLOSURE

This DSR report has been prepared by TULLOCH for the exclusive use of the Township of Muskoka Lakes and their authorized agents for the evaluation of the performance and safety of the Burgess 1 Dam located in Bala, Ontario.

We trust that the information in this report will be sufficient to allow the Township of Muskoka Lakes to better understand the risks associated with the Burgess 1 Dam Facility and provide a clear path forward towards rehabilitation of the structure. Should further elaboration be required for any portion of this project, we would be pleased to assist.

George Liang, Ph.D., P.Eng.
Senior Geotechnical Engineer

Erik Giles., P.Eng.
Geotechnical Engineer

Frank Palmay P.Eng.
Structural Design Engineer, Project Manager

REFERENCES

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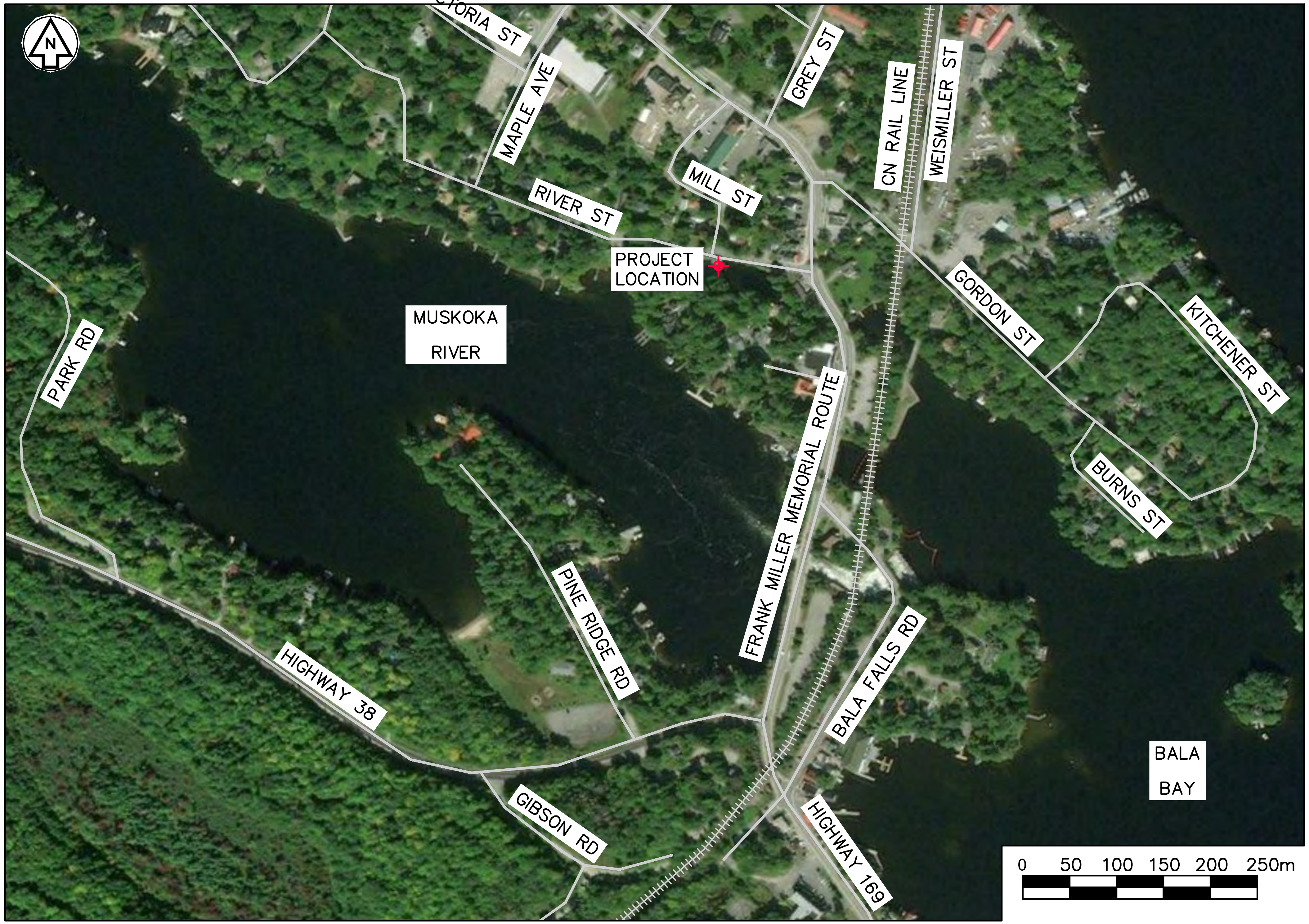
Totten Sims Hubicki Associates. (circa 1987). Bala – Small Hydro Development Burgess Dam Site.

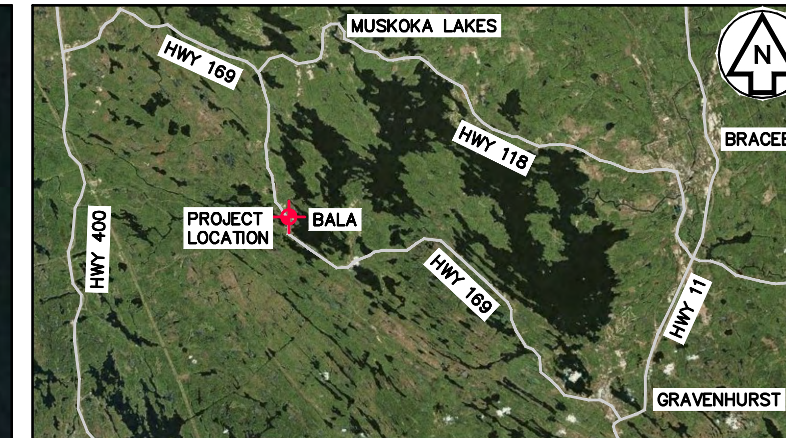
APPENDIX A

KEY LOCATION PLAN



PLAN - BALA, ONTARIO

N.T.S.



PROJECT LOCATION

N.T.S

No.	DATE	BY	ISSUES / REVISIONS
A	2019-08-13	KK	ISSUED DRAFT FOR CLIENT REVIEW

TULLOCH ENGINEERING

DRAWING: PROJECT LOCATION KEY PLAN

CLIENT: TOWNSHIP OF MUSKOKA LAKES

PROJECT: BURGESS DAM 1 DAM SAFETY ASSESSMENT

DRAWN BY:	CHECKED BY:	DESIGNED BY:
K. KORTEKAAS	E. GILES	G. LIANG
APPROVED BY: G. LIANG	SCALE: AS NOTED	DATE: 2019-08-07

DRAWING No. 19-1493-C-00

REVISION No. A

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APPENDIX B

NBCC SEISMIC HAZARD VALUES

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.015N 79.616W

2019-08-13 17:41 UT

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.078	0.049	0.032	0.011
Sa (0.1)	0.109	0.071	0.048	0.018
Sa (0.2)	0.109	0.074	0.051	0.020
Sa (0.3)	0.095	0.065	0.045	0.018
Sa (0.5)	0.080	0.054	0.037	0.014
Sa (1.0)	0.049	0.033	0.022	0.007
Sa (2.0)	0.026	0.016	0.011	0.003
Sa (5.0)	0.006	0.004	0.002	0.001
Sa (10.0)	0.003	0.002	0.001	0.000
PGA (g)	0.064	0.041	0.028	0.010
PGV (m/s)	0.067	0.042	0.027	0.008

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Natural Resources Canada   Ressources naturelles Canada

Canada

APPENDIX C

CDA AND MNRF TECHNICAL RESOURCES

1. DAM CLASSIFICATION AND DESIGN CRITERIA

According to the Technical Bulletin of the MNRF Guidelines, dams are classified us the following classification system which is based on four classification categories that define incremental losses due to dam failure based on increasing level of magnitude. Similarly, the CDA has five classification categories. Tables 1.1 and 1.2 outline the 2011 MNRF and the 2013 CDA criteria for determining the classification for individual dams. Table 1.3 and Table 1.4 identify the range of based on MNRF and CDA criteria.

Table 1.1: Dam Classification based on CDA Guidelines (2013)

Dam Class	Population at Risk [1]	Incremental Losses		
		Loss of Life [2]	Environmental and cultural values	Infrastructure and economics
LOW	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
SIGNIFICANT	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
HIGH	Permanent	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
VERY HIGH	Permanent	100 or fewer	Significant loss or deterioration of critical fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
EXTREME	Permanent	More than 100	Major loss of critical fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

Note 1: Definitions for population at risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).
Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

Note 2: Implications for loss of life:

Unspecified – the appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Table 1.2: Hazard Potential Classification based on MNRF Guidelines (2011)

	Hazard Categories – Incremental Losses[1]			
Hazard Potential	**Life Safety[2]**	**Property Losses[3]**	**Environmental Losses**	**Cultural – Built Heritage Losses**
LOW	No potential loss of life.	Minimal damage to property with estimated losses not to exceed $300,000.	Minimal loss of fish and/or wildlife habitat with high capability of natural restoration resulting in a very low likelihood of negatively affecting the status of the population.	Reversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act.
MODERATE	No potential loss of life.	Moderate damage with estimated losses not to exceed $3 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or structures not for human habitation, infrastructure and services including local roads and railway lines. The inundation zone is typically undeveloped or predominantly rural or agricultural, or it is managed so that the land usage is for transient activities such as with day-use facilities. Minimal damage to residential, commercial, and industrial areas, or land identified as designated growth areas as shown in official plans.	Moderate loss or deterioration of fish and/or wildlife habitat with moderate capability of natural restoration resulting in a low likelihood of negatively affecting the status of the population.	Irreversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act. Reversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or nationally recognized heritage sites.
HIGH	Potential loss of life of 1-10 persons	Appreciable damage with estimated losses not to exceed $30 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or residential, commercial, industrial areas, infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services includes regional roads, railway lines, or municipal water and wastewater treatment facilities and publicly-owned utilities.	Appreciable loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/ or wildlife habitat with reasonable likelihood of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered, or reversible damage to the habitat of that species.	Irreversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or damage to nationally recognized heritage sites.
VERY HIGH	Potential loss of life of 11 or more persons.	Extensive damage, estimated losses in excess of $30 million, to buildings, agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, infrastructure and services. Typically includes destruction of, or extensive damage to, large residential, institutional, concentrated commercial and industrial areas and major infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services includes highways, railway lines or municipal water and wastewater treatment facilities and publicly-owned utilities.	Extensive loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/ or wildlife habitat with very little or no feasibility of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a viable portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered or irreversible damage to the habitat of that species.	

Notes:

1. Incremental losses are those losses resulting from dam failure above those which would occur under the same conditions (flood, earthquake or other event) with the dam in place but without failure of the dam.
2. Life safety. Refer to Technical Guide – River and Streams Systems: Flooding Hazard Limits, Ontario Ministry of Natural Resources, 2002, for definition of 2 x 2 rule. The 2 x 2 rule defines that people would be at risk if the product of the velocity and the depth exceeded 0.37 square meters per second or if velocity exceeds 1.7 meters per second or if depth of water exceeds 0.8 meters. For dam failures under flood conditions the potential for loss of life is assessed based on permanent dwellings (including habitable buildings and trailer parks) only. For dam failures under normal (sunny day) conditions the potential for loss of life is assessed based on both permanent dwellings (including habitable dwellings, trailer parks and seasonal campgrounds) and transient persons.
3. Property losses refer to all direct losses to third parties; they do not include losses to the owner, such as loss of the dam, or revenue. The dollar losses, where identified, are indexed to Statistics Canada values Year 2000.
4. An HPC must be developed under both flood and normal (sunny day) conditions.
5. Evaluation of the hazard potential is based on both present land use and on anticipated development as outlined in the pertinent official planning documents (e.g. Official Plan). In the absence of an approved Official Plan the HPC should be based on expected development within the foreseeable future. Under the Provincial Policy Statement, '*designated growth areas*' means lands within *settlement areas* designated in an official plan for growth over the long-term planning horizon (specifies normal time horizon of up to 20 years), but which have not yet been fully developed. *Designated growth areas* include lands which are *designated and available* for residential growth in accordance with the policy, as well as lands required for employment and other uses (Italicized terms as defined in the PPS, 2005).
6. Where several dams are situated along the same watercourse, consideration must be given to the cascade effect of failures when classifying the structures, such that if failure of an upstream dam could contribute to failure of a downstream dam, then the HPC of the upstream dam must be the same as or greater than that of the downstream structure.
7. The HPC is determined by the highest potential consequences, whether life safety, property losses, environmental losses, or cultural-built heritage losses.

Table 1.1: Range of Minimum Inflow Design Floods

Hazard Potential Classification (HPC)	Range of Minimum Inflow Design Floods [1]			
	Life Safety [3]		Property and Environment	Cultural – Built Heritage
LOW	25 year Flood to 100 year Flood			
MODERATE	100 year Flood to 1000 year Flood or Regulatory Flood whichever is greater			
HIGH	1-10	1/3 between the 1000 Year Flood and the PMF	1000 Year Flood or Regulatory Flood, whichever is greater, to 1/3 between the 1000 Year Flood and the PMF	1000 Year flood or Regulatory Flood, whichever is greater
VERY HIGH	11-100	2/3 between the 1000 Year Flood and the PMF	1/3 between the 1000 Year Flood and the PMF to the PMF	
	Greater than 100	PMF		

Notes

1. The selection of the IDF within the range of flows provided should be commensurate with the hazard potential losses within the HPC Table. The degree of study required to define the hazard potential losses of dam failure will vary with the extent of existing and potential downstream development and the type of dam (size and shape of breach and breach time formation).
2. As an alternative to using the table the IDF can also be determined by an incremental analysis. Incremental analysis is a series of scenarios for various increasing flows, both with and without dam failure that is used to determine where there is no longer any significant additional threat to loss of life, property, environment and cultural – built heritage to select the appropriate IDF.
3. Where there is a potential for loss of life the IDF may be reduced provided that a minimum of 12 hours advanced warning time is available from the time of dam failure until the arrival of the inundation wave, provided that property, environment, or cultural – built heritage losses do not prescribe a higher IDF.

Table 1.2: Floods and Earthquake Hazards, Standard-Based Assessments (CDA)

Dam Class	Annual Exceedance Probability – Floods[1]	Annual Exceedance Probability – Earthquakes[4]
LOW	1/100 year	1/100
SIGNIFICANT	Between 1/100 and 1/1000 year[2]	Between 1/100 and 1/1000
HIGH	1/3 between 1/1000 and PMF[3]	1/2475[5]
VERY HIGH	2/3 between 1/1000 and PMF[3]	½ between 1/2475[5] and 1/10,000 or MCE[3]
EXTREME	PMF[3]	1/10,000 or MCE[3]

Notes
1. Simple extrapolation of flood statistics beyond 10^{-3} AEP is not acceptable.
2. As an alternative to using the table the IDF can also be determined by an incremental analysis. Incremental analysis is a series of Selected on basis of incremental flood analysis, exposure, and consequences of failure.
3. PMF and MCE have no associated AEP.
4. Mean values of the estimated range in AEP levels for earthquakes should be used. The earthquake(s) with the AEP as defined in this table is then input as the contributory earthquake(s) to develop Earthquake Design ground Motion (EDGM) parameters as described in Section 6.5 of the CDA Guidelines.
5. This level has been selected for consistency with seismic design levels given in the National Building Code of Canada.

APPENDIX D

DSI FIELD INSPECTION REPORT

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FIELD INSPECTION REPORT

Site Identification:	Burgess Dam
Structure Identification:	Burgess Dam
Location:	Bala, Ontario
Inspection Date:	04-07-2019
Inspection Time:	09:10
Inspected By:	E. Giles, F. Palmay
Accompanied By:	Steve Dursley
Inspection Type:	Dam Safety Assessment

Atmospheric Conditions

Inspection Day:	Clear
Temp:	27
Previous Week:	26 - 32
Temp Range:	26-32
Current Pond Level:	Unknown
Current Freeboard:	0.7 m

Dam Structure

1.1 Surface Cracking, Displacement, etc.	Yes
Comments	Cracks apparent on concrete upstream and downstream surface, ranging from hairline tonarrow expected with age of dam, efflouressence observed on cracks. Some cracks evidence of historic repairs
1.2 Concrete Deterioration, Spalling, etc.	No
Comments	Minor to moderate Spalling on concrete on dam and along u/s face of Dam, small delaminated section ~ 1.0m long on dam crest
1.3 Evidence of Scouring	Yes
Comments	Scouring evident typical of age of structure, the worst section observed was along south side of powerhouse on the dwonstream face of the dam where significant deterioration was observed.

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1.4 Evidence of Seepage	Yes
Comments	Seepage along d/s face at south edge of power station, as well as ~ 10m downstream of the dam near the joint between section DC/CB. Significant was observed at east wall of powerstation/downstream face of dam. In discussion with operator, seepage had improved since applying cold patch repairs to upstream and
1.5 Unusual or Special conditions	Yes
Comments	Powerhouse still in operation, original roof with bracing, joists failing, corrosion of bracing observed particulalry on the floor
1.6 Undesirable Vegetation, Debris, etc. at toes	Yes
Comments	Significant vegetation along downstream toe including trees/stumps, debris from flooding, and significant washouts were observed caused by the flooding.

View of downstream dam face, note concrete degradation on cold joint

View of upstream face, note broken fence and vegetation build up along downstream toe of dam

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Seepage observed along downstream face of dam built into powerhouse

Abutments

2.1 Surface Cracking, sinkholes, etc.	No
Comments	Minor cracking and deterioration evident typical with age of structure, good contact at abutment observed
2.2 Evidence of Settlement, movement, etc.	No
Comments	No evidence of movement on the dam
2.3 Gap, Leakages, etc. at Contact.	No
Comments	South abutment contact observed to be good some cracks visible expected with age of structure
2.4 Evidence of Repairs	Yes
Comments	Evidence of repair on larger cracks of dam, cold patch concrete placed over large cracks plus cracks were also filled upstream near the generating station dring low water levels. Cold patch placed thorughout powerhouse on downstream face of dam to curtail seepage
2.5 Unusual or Special Conditions.	Yes
Comments	There is a dock built into the south abutmentand of

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the dam by a local cottager. The north abutment is buillt into river street and terminates at the road shoulder guard rail.

South abutment of dam, note dock built into dam crest at tie-in, good contact

North abutment of dam, concrete ends at guard rail at embankment of Riiver Street, good contact observed

Historically repaired crack with cold patch concrete on downstream face of dam near south abutment

Pond Level and Perimeter

3.1 Concerns with pond level.	Yes
Comments	Minimal freeboard observed with approximately 0.7m,

measured at time of inspection. Based on discussion with operator the dam was close to overtopping during the flooding events of 2013 and overtopped for the first time 2019.

3.2 Concerns with pond perimeter

Yes

Comments

Risk of property damage from overtopping, the retaining wall on the north side of the powerhouse was observed to be cracked through the wall and moving, steep embankment observed on north side of tail race holding up River Street

3.3 Other concerns with pond area

Yes

Comments

River Street berm at north edge of the pond with low freeboard (<1.0 m) poor/insufficient erosion protection

View of pond and sluicegate, note road embankment on pond, insufficient erosion protection

Area of washout where water was spilling over the dam and down to tail race, site of temporary ditch excavated to channel water away from properties

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Upstream pond note ~0.7m of free board at time of site visit

4. Other Unusual Conditions

Yes

Comments

The embankment north of the dam and located west of the powerhouse is eroded and very steep, washout in 2019 observed at toe of concrete retaining wall. Rock fill wa splaced back in the area of the washout by the township

Steep embankment on north side of dam, photo taken downstream at tailrace note retaining wall

Large crack through retaining wall, note movement of wall

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Large transverse crack running through powerhouse foundation, hole in wall at outlet of power house with significant seepage of ~ 2.0 L/s, possible outlet of historic box drain

5. Instrumentation	No
Comments	Water level is monitored just inside of the sluice gate to detect debris build up at spillway entrance, remnants of staff guge observed.

Spillway, Discharge Structure, Etc.

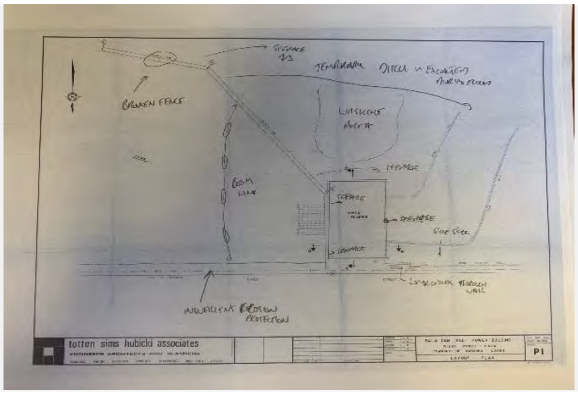
6.1 Concern for Discharge Control Structure	Yes
Comments	There is no emergency spillway for the dam and properties on both sides of the dam were effected during flooding of 2019.
6.2 Concern for Adequacy & Reliability of Emergency	Yes
Comments	See comments 6.1 there is no emergency spillway for this facility
7. Environmental Concerns	Yes
Comments	According to Steve Dursley downstream of the dam in the tail raace fish can spawning is observed

TULLOCH ENGINEERING

8. Safety Concerns	Yes
Comments	Poor guarding for turbine/ moivng parts wtihin the power house, broken fence on dam crest, expose grounding wire, washouts/debris and uneven ground caused from flooding
Signature:	

General Dam Information

Structure Type:	Concrete hydro electric dam
Spillway:	Sluice gate leading to two turbines, no emergency spillway
Foundation:	Bedrock
Crest Elev. (Current):	226.93
Abutments:	Concrete on bedrock
Max Height (Current):	~6m
Crest Length:	~59.2 m
Decants & Outlets:	Sluicegate into two turbines, outlet in two openings at generating station
Catchment Area:	Unknown
Normal Pond Elev:	224.6 - 225.61 (Bala Falls Dam)
Fetch Length & Direction:	~140 m
Max/Min OWL:	225.75 (Bala Falls Dam)
Construction History:	Built in 1917, minor rehabilitations through the years, Large rocks added to tail race to prevent erosion of properties downstream, Upgrade to south turbine in late 80s by Marsh Power and upgrade of north turbine and sluicegate in 2010s by current leasor KRIS power. Property owned by Township of Muskoka Lakes, leased to Kris Power, currently actively generating power
Last DSIs:	Unknown
Additional Notes:	



Site sketch with notes

APPENDIX E

KEY FINDINGS MEMORANDUM

M E M O R A N D U M

Date: **Wednesday, July 24, 2019**

To: Ken Becking

CC: George Liang; Sean Hinchberger

From: Erik Giles; Frank Palmay

Re: **KEY / CRITICAL FINDINGS FOR BURGESS 1 DAM IN BALA, ONTARIO**

1. DATE

- July 4th, 2019

2. PERSONNEL AT SITE

- KRIS Power: Steve Dursley (Care and Maintenance Operator)
- TULLOCH: Frank Palmay (P.Eng.), Erik Giles (P. Eng.)

3. SUMMARY OF THE KEY/CRITICAL FINDINGS

The dam safety inspection (DSI) for the Burgess 1 Dam took place on the morning of July 4th, 2019. Steve Dursley (KRIS Power) met the TULLOCH team on site and permitted entrance to the facility. The inspected structures included the following:

- Concrete dam structure (Water Retaining structure, Non-overflow dam section);
- Concrete dam with downstream (d/s) powerhouse structure;
- River Road Retaining Wall and Embankment;
- Downstream erosion and scouring conditions during 2019 flooding;
- Upstream (u/s) reservoir (within 500m approaching to the Burgess 1 Dam);
- Other ancillary structures including the access road, fence, gates, tailrace and walkways etc. where accessible.

Table 1 summarizes the key/critical findings during the site inspection. The detailed field inspection checklist and comments including selected photographs are presented in Appendix A.

Section 4 presents the discussion based on the key findings and the preliminary engineering assessment; Section 5 summarizes the three preliminary recommendations for remediation with respect to the scope of work.

Table 1: Key/Critical Findings During the DSI

Site	Site Segment	Observation Criteria	Key/Critical Findings
Burgess 1 Dam	Concrete Dam (Water Retaining Structure, Non-overflow section)	Structural	• Cracking in dam – hairline to narrow, no to minimal movement based on observation; • Sections of delamination on dam crest; • Evidence of historic crack repairs with cold patch concrete; • Concrete degradation observed with moderate spalling – worst section south of powerhouse near tie-in with powerhouse walls; • Minor to moderate pitting and scour observed along structure and on visible sections of u/s face of dam, expected given age of structure.
		Geotechnical	**General** • Abutment contacts sound at each end of the dam; o South abutment has a dock built on top of it by a cottager o North abutment ties into River Street • Moderate to significant washouts along the dam toe area caused from flooding; • Freeboard at time of inspection was ~0.7m from dam crest; • Significant vegetation builds up on d/s toe of dam including large trees ~ 0.3m in diameter, evidence of historic vegetation clearing i.e. stumps; • Debris from flooding piled on and around dam section.
			Seepage • Minor seepage observed ~ 15m d/s of the dam near the access gate, ponded water visible; • No evidence of boils or piping beneath the dam section; • Cold patch concrete has been placed on the d/s and u/s sections of dam to reduce the seepage/leakage since KRIS power has taken up the operation of the dam facility, this has reduced the seepage/leakage according to Mr. Dursley.

Site	Site Segment	Observation Criteria	Key/Critical Findings
			<u>Geotechnical Stability</u> • Moderate to significant washouts were observed caused by flood waters at the d/s of the concrete dam, a ~ 1.0m depth of the d/s toe fill material along the concrete dam have been washed away; a ~ 2.0m depth of the d/s fill materials have been eroded/washed out at the south end of the powerhouse section. The erosion of the d/s toe fill materials may cause dam stability issue; • Upstream slope/River Road embankment has insufficient erosion protection/armouring; • Based on visual inspection, the concrete dam and the powerhouse section have not experienced obvious moving or shifting at the time of DSI.
			<u>Water Control/Spillway</u> • There is no emergency spillway for this facility, a temporary trench was excavated to channel flood waters during the 2019 flooding event and diverted the water to the south of the property near the access gate and down into the tailrace area; • A new sluicegate was installed by KRIS power.
			<u>Instrumentation</u> • There is no monitoring program or instrumentation installed for the lake levels at the dam site, remnants of a staff gauge were observed on the outlet of the powerhouse • KRIS power does monitor water levels at the sluicegate invert to determine if blockages are accumulating, this data was not available on site.

Site	Site Segment	Observation Criteria	Key/Critical Findings
	Powerhouse Section	Structural	• Roof of powerhouse is overstressed; joists are cracking at midspan; • Roof of powerhouse is not watertight and has polyethylene vapor barrier placed overtop, this is trapping moisture and not allowing the roof to dry out, likely causing accelerated deterioration of members; • Steel frame installed in powerhouse is corroding at the bottom as a result of continued exposure to standing water, significant section loss noted; • Carpenter ants or termites present (observed sawdust in powerhouse); • Diagonal cracks in powerhouse indicating foundation of structure may be compromised; • Water leaking through rear wall of powerhouse; • Efflorescence present on walls and floor slab of powerhouse indicating seepage is passing through concrete.
		Geotechnical	• Generally moderate seepage observed along the d/s of the powerhouse dam section, a significant seepage was observed at south and north ends of powerhouse. In conversation with Steve Dursley, the seepage is relatively unchanging throughout the course of the year in 2019. And remains in a steady state; • Large hole ~ 0.2m in diameter leaking a significant amount of water ~ 2.0 l/s, this has been a known issue, and has remained unchanged. This may be the outlet to a historic box drainage system installed in the dam, again indicating a steady state condition; • Moderate seepage observed along downstream toe concentrating outside of south end of powerhouse, likely through worn section of dam; • Transverse crack through powerhouse as noted above indicate potential foundation failure and reduced capacity of floor slab to act as ballast for the gravity dam section.

Site	Site Segment	Observation Criteria	Key/Critical Findings
Other Associated Infrastructure	River Road Retaining Wall and Embankment	Structural	• Undermining of stone retaining wall supporting River Street; • Crack in cast in place wall supporting River street and portion of wall now leaning away from the road indicating movement;
		Geotechnical	• Embankment along River Street upstream of the Burgess Dam is very steep and appears to be eroding at the toe where there are newer gabion baskets placed on a historic boulder/stone wall. There is a concern for the slope failure of the embankment due to the erosion/ scour caused by the water flows. The slope stability evaluation of the embankment along the River Street is not included in the scope of this DSR. Detailed geotechnical investigation and assessment are strongly recommended; • Evidence of slope movement based on guardrail; • Sediment build-up observed within tail race due to washout material.
Burgess 1 Dam Site	Dam Site	Public Safety	• Inadequate/ no signage for safety warning at the u/s dam for the potential hazards of the vortex/swirl caused by the running flow during operation of the powerhouse; • Inadequate boom line, poorly visible and half sunken logs; the boom line is in a poor condition and the distance to the inlet of the powerhouse is inadequate; • Broken fencing on dam crest allows for access from public, lack of physical barriers along dam crest to prevent access; • Inadequate gating/locking system, easily accessed.

4. DISCUSSION

The following sections discuss the key findings and preliminary structural / geotechnical assessment for the Burgess 1 Dam.

4.1 Structural

Based on the DSI, it is believed that the roof of the powerhouse has failed in several locations. Broken roof joists were noted in several locations with failure along the midspan of the beams. The joists had been reinforced in the past; however, the current bracing is providing inadequate support for snow loads as detailed in the Ontario Building Code. Furthermore, the roof membrane has failed and has been temporarily repaired with polyethylene vapor barrier weighted on the roof with various cobbles and debris. The vapor barrier is currently trapping condensation and moisture on the roof which is expediting deterioration.

It was also noted during the inspection that there had been previous attempts to rehabilitate the structure by evidence of a steel frame constructed on the interior of the powerhouse, however, moisture present along the base of the columns as a resultant of the seepage has left the bracing with severe corrosion, which significantly reduces the structural capacity of the steel frame.

Finally, a large/wide crack along the powerhouse foundation walls was observed running through the entire structure. The cause of this may have been a result of losing the foundation material over time below the walls during the powerhouse operation, which may have caused the foundation to drop, or excessive pressure brought on from the hydrostatic forces acting on the dam. This large crack also poses a risk to the stability of the dam which will be discussed in Section 4.2.

Based on the above evidence, major rehabilitation or replacement of the building would be required.

4.2 Geotechnical

4.2.1 General Dam Conditions

Inspection of the concrete dam indicated that the concrete wall of the dam area was generally in a fair condition. Seepage was noted at various areas under the dam sections, however, there was no indication of boiling or piping through the dam foundation and the observed seepage rate was relatively stable. Significant seepage was observed in the powerhouse, however, the amount of the seepage was reported to remain steady in recent years.

Generally, the condition of the concrete was found to be expected with the age of the structure, some hairline to narrow cracks were observed in the dam with a small section of delamination at the crest on the southern side. Areas of scour / erosion were observed particularly around the south side of the powerhouse where aggregate was observed. Evidence of historic repairs with cold patch concrete were evident along some sections of the dam including the powerhouse dam section. The contacts at both abutments for the powerhouse dam sections were generally in a good condition with no evidence of seepage. However, a large crack observed under the powerhouse floor slab (discussed in Section 4.1) indicated that the d/s support for the concrete gravity dam (i.e. the powerhouse dam section) has been compromised.

4.2.2 Factor of Safety for Dam Stability

Based on the review of the available documents and drawings provided by the Client, it is understood that the as-built concrete dam (non-overflow section) was constructed on the in-situ bedrock and supported by the downstream fill placed against the dam; at the powerhouse section, the d/s powerhouse structure with a massive concrete floor slab are likely to work together with the concrete gravity dam structure to take the loads. The typical dam sections are included in Appendix B.

Preliminary stability calculations were carried out for both non-overflow concrete dam section and the powerhouse dam section (see Appendix B). Table 4-1 is a summary of the preliminary results of the calculated factor of safety for the dam under current condition.

Table 4-1: Summary of the Calculated FOS (Static)[1]

Dam Section	Maximum Height (m)	Calculated FOS		Required Min FOS
Non-overflow Section	3	Against Sliding	2.2 to 2.4	1.5
		Against Overturning	1.2 to 1.4	2.0
Powerhouse Dam Section	6	Against Sliding	2.4-3.3	1.5
		Against Overturning	1.6-1.9	2.0

Note:[1-] The water level is assumed to be 30cm below the dam crest.

Based on Table 4-1, it can be seen that:

- For non-overflow dam section, the calculated FOS is depending on the remaining fill material at d/s toe area for the post-overflow event in 2019 flooding. Significant washout /scouring was observed along the downstream toe area with a scoring depth in excess of 1.0 - 1.5 m. Under the current site condition, the calculated FOS against sliding is in the range of 2.2 to 2.4, which meet the required minimum required FOS of

1.5; The calculated FOS against overturning is in the range of 1.2 to 1.4, which does not meet the required FOS of 2.0. Repair or mitigation measures have to be developed for the non-overflow dam section to improve the FOS to meet the criteria;

- For the powerhouse dam section, a large longitudinal crack that was observed through the floor slab/foundation of the dam during DSI. The presence of the crack likely indicated that both the dam section and the powerhouse structure worked together carrying loading. Under the current site condition, the calculated FOS against sliding is in the range of 2.4 to 3.3, which meet the required minimum FOS of 1.5; The calculated FOS against overturning is in the range of 1.6 to 1.9, which does not meet the required FOS of 2.0. Repair or mitigation measures need to be developed for the powerhouse dam section to improve the FOS to meet the criteria.
- For the powerhouse dam section, caution should be taken if/when the powerhouse is considered to be removed. If the powerhouse is to stay intact it is recommended that the floor slab be repaired by anchoring the two pieces together and seating the anchors into bedrock to ensure that the slab can act as one unit. Furthermore, to achieve an acceptable safety factor the slab should be anchored into the bedrock to prevent overturning or sliding. Further geotechnical investigation and engineering assessment may be required.

4.2.3 Overflow Water Management

There is no emergency spillway installed at the dam site to manage the overflow. The overflow water was largely reported to the south side of the dam near the right abutment and was then channeled down to the tailrace through a temporary trench during 2019 overtopping event. Significant scour and washout for the downstream fill materials were caused by the random overflow. Furthermore, the current dam is at risk of failure due to the severe erosion/scouring at the downstream toe area. To improve the dam safety condition, replacement of the d/s fill material, the overflow water management facility and the d/s erosion protection measures should be developed.

4.2.4 Vegetation Control

Significant vegetation was observed on the downstream edge of the dam with large trees growing directly downstream of the dam. Vegetation should be removed within 3 – 5 m of the footprint of the selected repair/mitigation option.

5. PRELIMINARY RECOMMENDATIONS

The following sections briefly discuss the preliminary recommendations for the rehabilitation of the Burgess 1 Dam facilities. The preliminary recommendations are based on the consideration of the following factors:

- The key findings of 2019 DSI and dam safety;

- Preliminary structural / geotechnical assessment;
- Impact on the environmental and permitting for the construction at the dam site;
- Technical and economic feasibility and constructability;

Several preliminary options for the rehabilitation of the Burgess 1 Dam facilities are evaluated at an FEL 1 level (i.e. preliminary design). However, for the purpose of this Memoranda, three (3) primary feasible options will be briefly discussed. The further engineering assessment of the feasible rehabilitation options are in progress, the final recommended option will be presented in the DSR report.

5.1 Option #1 Re-instate downstream Fill and add Erosion Protection

The objective of the Option #1 is to reinstate the FOS of the existing dam by replacing d/s fill material and manage the overflow by re-grading the d/s slope associate with rockfill/ riprap for erosion protection. A small toe berm is required to divert the overflow (if it occurs). Option #1 mainly consists of the following (see Appendix B-Option #1):

- Downstream vegetation removal as required;
- Strip the top organic soil as required;
- Replace the d/s fill materials to reinstate the FOS of the dam;
- Regrade the d/s fill materials and build a toe berm to manage and divert the overflow (if it occurs) toward d/s main river; The finish grade should be generally higher grade at the North side and progressively lower to the south side approaching the d/s river channel;
- Add appropriate rockfill/riprap for erosion protection if overtopping occurs;
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;
- At the powerhouse the slab should be repaired and anchored to the bedrock, or if the powerhouse is to be decommissioned then fill could be placed over-top of the slab to compensate for the compromised slab.

5.2 Option #2 Partially Dam Crest Raise without Spillway

The objective of the Option #2 is to partially raise the dam on both left and right abutment sides and direct the overflow (if occur) through the middle existing dam section toward the d/s river channel. Option #2 mainly consists of the following (See Appendix B-Option 2):

- Downstream vegetation removal as required;
- Strip the top organic soil as required;

- Partially raise the dam crest on the north and south dam sections; the middle section of the existing dam will be maintained to pass and divert the overflow to the d/s river channel;
- Replace the d/s fill materials to reinstate the FOS of the dam;
- For the area between the middle dam section and the d/s existing river channel, regrade the d/s fill and add appropriate rockfill/riprap for erosion protection to divert the overflow (if occur)
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;
- At the powerhouse the slab should be repaired and anchored to the bedrock, or if the powerhouse is to be decommissioned then fill could be placed over-top of the slab to compensate for the compromised slab.

5.3 Option #3 Dam Crest Raise plus Spillway Construction

The objective of the Option #3 is to raise the entire dam and install an emergency spillway to manage and control any overflow for flood event.

The installation of a spillway to the Burgess Dam facility would be highly advantageous. In the flood event, the overflow would be safely controlled and channeled to d/s river channel that would not affect the u/s lake operation level and the existing d/s facilities/ properties. Given that the overtopping occurred along the south section of the dam, the proposed spillway location would be at the south side of the dam, which has the shortest distance to the existing river channel. Furthermore, based on the topography of the site the most direct route to connect back to the tailrace would be along the southern edge of the property south of the existing water course. This would avoid unnecessary flows running against the River Street embankment. The spillway invert could be kept at the current dam crest elevation and the remainder of the dam could be raised minimally to meet the minimum freeboard criteria during the operation of the spillway in the flood event. The final spillway invert elevation and dam raise will be determined based on the hydrotechnical assessment. Option # 3 mainly consists of the following (see Appendix B-Option 3):

- Downstream vegetation removal as required;
- Strip the top organic soil as required;
- Raise the dam crest as per design;
- Install the emergency spillway as per design (e.g. Geomembrane Lined Rockfill Channel);
- Replace the d/s fill materials to reinstate the FOS of the dam;
- Grouting or concrete patching the cracks in the existing dam to limit the leakage;

- At the powerhouse the slab should be repaired and anchored to the bedrock, or if the powerhouse is to be decommissioned then fill could be placed over-top of the slab to compensate for the compromised slab.

For all three options, appropriate topographical survey of the existing dam and surrounding area is required.

5.4 River Street Embankment and Retaining Wall

Visual inspection of the retaining wall and downstream embankment of River Street indicates that there is significant risk posed to the road.

River street currently sits on an embankment at an approximate 2H:1V on which the toe is supported by a more recent gabion basket retaining wall sitting on a historic boulder retaining wall. There is also a concrete retaining wall that abuts the south side of River Street and connects to the north wall of the powerhouse. A large crack through the retaining wall was observed and a large section of the wall has failed and has shown signs of movement.

There was also evidence of washout at the toe of the retaining wall. If a flood event were to occur again, and water were to make its way along the toe of the River Street embankment, there is a significant risk of a slope failure which could result in loss of the road and surrounding property damage. The existing concrete retaining wall is in a poor condition and should be replaced.

The embankment to the west of the wall should be better reinforced including the addition of erosion/scour protection to prevent future washout and slope instability. While this is not considered a direct risk to the dam, the observations on site deemed it necessary to be brought to the Township's attention as there exists a risk to River Street adjacent to the tailrace of the dam. The slope stability evaluation of the embankment along the River Street is not included in the scope of this DSR. Detailed geotechnical investigation and assessment are strongly recommended.

5.5 Public Safety and Access

The following summarize the recommendations regarding the public safety and access based on the DSI, including:

- A Public Safety Plan (PSP) should be drafted to address these issues and ensure they are properly managed.
- Install adequate safety signage at the dam site for warning of flow, deep water, the potential hazards of the vortex/swirl etc.
- Upgrade the boom line and adjust the safety distance to the powerhouse inlet;
- Upgrade the fence / gate to constrain the public access to the dam site without permits;

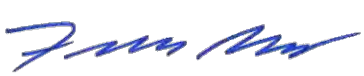
- The sluicegate of the dam appeared to have overhead flashing lights, however, they were not able to be tested during the site visit. Visual and audio warnings if not installed should be implemented and tested regularly to ensure that during startup/operation adequate warning can be given to members of the public.
- Grounding wire is currently exposed due to the washout. Exposed wire should be backfilled as soon as possible as this poses a significant hazard currently on the site. Furthermore, debris that has washed up on and over the dam crest should be removed.
- The south abutment currently has a dock from the neighboring resident built on the dam crest which should be removed.

6. CLOSURE

We hope that this draft memo helps frame the critical issues and proposed remediations for the Burgess 1 Dam facility. The detailed dam safety assessment is in progress and the final results will be presented in the final DSR report. If you have any questions, please feel free to reach out to the undersigned.

Sincerely,

Erik Giles, P.Eng
Geotechnical Engineer

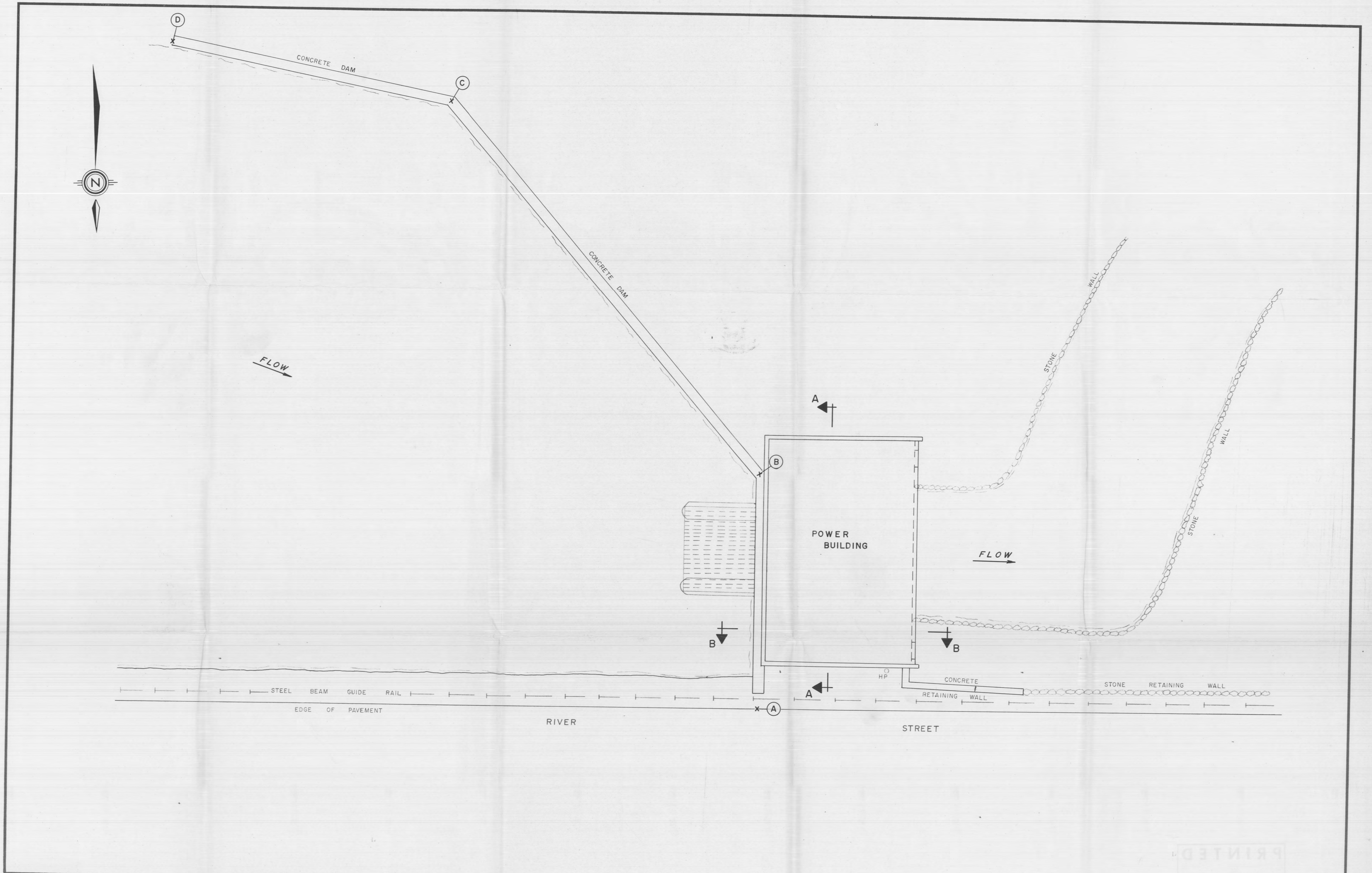


Frank Palmay P.Eng
Structural Design Engineer

Attachment(s)/Enclosure: Field Inspection Reports

APPENDIX F

HISTORIC SITE PLANS



totten sims hubicki associates

ENGINEERS ARCHITECTS AND PLANNERS

COBOURG WHITBY KINGSTON TORONTO BRACEBRIDGE BROCKVILLE OTTAWA

No.	DATE	BY	REVISIONS

DESIGNED:	D. L. B.
DRAWN:	R. G. W.
CHECKED:	D. L. B.
APPROVED:	G. L. A.
SCALE:	1:100

BALA DAM AND POWER BUILDING
RIVER STREET - BALA
TOWNSHIP OF MUSKOKA LAKES

LAYOUT PLAN

DATE: AUG., 1986
PROJECT: 36-7058
DRAWING: P1