Hamilton Conservation Authority

A Healthy Watershed for Everyone

Board of Directors To Sit As Hearing Board

Thursday, May 9, 2024 at 6:00 p.m.
Section 28 Hearing Re: 820 Sulphur Springs Road, Ancaster, Permit Application No. A/F,C/24/05

Hamilton Conservation Authority is now conducting meetings in a hybrid format via an in-person and WebEx platform.

All hybrid meetings can be viewed live on HCA's You Tube Channel: https://www.youtube.com/user/HamiltonConservation

1. **Call to Order** – Brad Clark

2. **Declarations of Conflict of Interest**

3. **Notice of Hearing**

   3.1 Notice of Hearing_820 Sulphur Springs Rd Page 1

   3.2 Section 28 Hearing Guidelines, Hearing Procedures (Appendix B) Page 3

4. **Motion to sit as a Section 28 Hearing**

5. **Chair's Opening Remarks**

6. **Presentation by Hamilton Conservation Authority Staff and Applicant**

   6.1. Introduction of applicant/agent by HCA Staff

   6.2. HCA Staff Report re: 820 Sulphur Springs Rd, Ancaster, Permit No. A/F,C/24/05 Page 5

   6.3. Presentation by Applicant

      6.3.1. Applicant's Presentation Page 23

6.4. Questions from applicant and/or applicant's counsel to HCA staff

6.5. Questions from HCA staff and/or staff counsel to applicant

6.6. Questions from Hearing Board to HCA staff and/or applicant

7. Hearing Board to move In Camera

8. Hearing Board to reconvene in public forum

9. Chair to advise of Hearing Board's decision

10. Adjournment

April 12, 2024 File: A/F,C/24/05

BY EMAIL

Anthony Quinn
c/o AQ Holdings
P.O. Box 199
Millgrove, ON L0R 1V0

Dear Mr. Quinn:

RE: NOTICE OF HEARING
Hearing under Section 28.1(5) of the *Conservation Authorities Act* for an Application by Anthony Quinn c/o AQ Holdings for Development in a Regulated Area of Sulphur Creek at 820 Sulphur Springs Road, City of Hamilton (Ancaster)

This letter serves to inform you that the application by Anthony Quinn (c/o AQ Holdings), received January 19, 2024, for development in a regulated area of Sulphur Creek at 820 Sulphur Springs Road will be considered by the Board of Directors at the meeting scheduled for:

6:00 p.m. on May 9, 2024

At the offices of the Hamilton Conservation Authority at:

838 Mineral Springs Road, Ancaster, ON

This is a Hearing under Section 28.1(5) of the *Conservation Authorities Act*. Please note that Authority staff is recommending **refusal** of the application on the basis that the development does not meet the requirements of the development Regulation under the *Conservation Authorities Act.* A copy of the staff report outlining staff's reasons for recommending refusal is included with this notice. Also attached is a copy of the HCA's Hearing Guidelines.

You are invited to speak in support of your application and submit supporting written material for the Hearing. You will be allotted approximately 20 minutes to speak at the Hearing. You may be represented by legal Counsel or have advisors present information to the Board of Directors. If you intend to appear, please contact Mike Stone, Acting Director, Watershed Management Services, to confirm attendees. Any written material you intend to present or rely on will be required to be submitted by April 26, 2024, to enable the Board members time to review the material along with the staff report.

This Hearing is governed by the provisions of the *Statutory Powers Procedure Act*. Under the Act, a witness is automatically afforded a protection that is similar to the protection of the *Ontario Evidence Act*. This means that the evidence that a witness gives may not be used in subsequent civil proceedings or in the prosecutions against the witness under a Provincial Statute. It does not relieve the witness of the obligation of this oath since matters of perjury are not affected by the automatic affording of the protection. The significance is that the legislation is Provincial and cannot affect Federal matters. If a witness requires protection of the *Canada Evidence Act*, that protection must be obtained in the usual manner.

The Ontario Statute requires the tribunal to draw this matter to the attention of the witness as this tribunal has no knowledge of the effect of any evidence that a witness may give.

If you do not attend at this Hearing, the Board of Directors of the Hamilton Conservation Authority may proceed in your absence, and you will not be entitled to any further notice of proceedings.

Please contact the undersigned at ext. 133 at this office if you have any questions regarding this matter.

Yours truly,

Mike Stone MCIP, RPP
Acting Director, Watershed Management Services

Enclosures: Hamilton Conservation Authority Hearing Guidelines
Hamilton Conservation Authority Hearing Report

APPENDIX B

Hearing Procedures

1. Motion to sit as Hearing Board.
2. Roll Call followed by the Chairperson's opening remarks. For electronic hearings, the Chairperson shall ensure that all parties and the Hearing Board are able to clearly hear one another and any witnesses throughout the hearing.
3. Staff will introduce to the Hearing Board the applicant/owner, his/her agent and others wishing to speak.
4. Staff will indicate the nature and location of the subject application and the conclusions.
5. Staff will present the staff report included in the Authority/Executive Committee agenda.
6. The applicant and/or their agent will present their material
7. Staff and/or the conservation authority's agent may question the applicant and/or their agent if reasonably required for a full and fair disclosure of matters presented at the Hearing.[1]
8. The applicant and/or their agent may question the conservation authority staff and/or their agent if reasonably required for full and fair disclosure of matters presented at the Hearing.[2]
9. The Hearing Board will question, if necessary, both the staff and the applicant/agent.
10. The Hearing Board will move into closed session for deliberation. For electronic meetings, the Hearing Board will separate from other participants for deliberation.
11. Members of the Hearing Board will move and second a motion.
12. A motion will be carried which will culminate in the decision.
13. The Hearing Board will move out of closed session. For electronic meetings, the Hearing Board will reconvene with other hearing participants.
14. The Chairperson or Acting Chairperson will advise the owner/applicant of the Hearing Board decision, including providing the Board's reasons for the decision for approval or refusal.
15. If decision is "to refuse" or "approve with conditions", the Chairperson or Acting Chairperson shall notify the owner/applicant of his/her right to appeal the decision to the Ontario Land Tribunal within 30 days of receipt of the reasons for the decision.
16. Motion to move out of Hearing Board and sit as the Board of Directors.

[1, 2] As per the *Statutory Powers Procedure Act* a tribunal may reasonably limit further examination or cross-examination of a witness where it is satisfied that the examination or cross-examination has been sufficient to disclose fully and fairly all matters relevant to the issues in the proceeding.

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Hearing Report

TO:	**Board of Directors**
FROM:	**Lisa Burnside, Chief Administrative Officer (CAO)**
RECOMMENDED BY:	**Mike Stone, MCIP, RPP, Acting Director, Watershed Management Services**
PREPARED BY:	**Cathy Plosz, MCIP, RPP, Senior Planner, Watershed Management Services**
REVIEWED BY:	**T. Scott Peck, MCIP, RPP, Deputy Chief Administrative Officer**
DATE:	**May 9, 2024**
RE:	**Hearing under Section 28.1(5) of the *Conservation Authorities Act* for an Application by Anthony Quinn c/o AQ Holdings for Development in a Regulated Area of Sulphur Creek at 820 Sulphur Springs Road, City of Hamilton (Ancaster) – Permit Application No. A/F,C/24/05.**

STAFF RECOMMENDATION

THAT HCA staff recommends to the Board of Directors:

THAT the Board of Directors refuse the application made by Anthony Quinn (c/o AQ Holdings) for repair work on a former residential dwelling in a regulated area of Sulphur Creek at 820 Sulphur Springs Road, City of Hamilton (Ancaster) as the proposal does not meet the requirements of the development Regulation under the *Conservation Authorities Act*.

BACKGROUND

Site Description

The subject site at 820 Sulphur Springs Road is a 23.12 ha (57.13 ac) vacant property, located west of Sulphur Springs Road and south of the Hamilton-Brantford rail trail. The property is within the Niagara Escarpment Plan Area of the Greenbelt Plan, and sits within the Sulphur Creek subwatershed and Sulphur Creek valley system. A tributary of Sulphur Creek traverses the southern portion of the subject property (Attachment A) and flows easterly through a culvert under Sulphur Springs Road.

The City's Rural Hamilton Official Plan (RHOP) has identified Core Areas of the Natural Heritage System on the property, including the Dundas Valley Environmentally Significant Area, Significant Woodland, unevaluated wetlands and a stream. A provincially significant Life Science Area of Natural and Scientific Interest (ANSI) is located east of Sulphur Springs Road, adjacent to the site. An Environmental Impact Statement (EIS) was prepared and confirmed five types of Significant Wildlife Habitat on site. The property is zoned P6, Conservation/Hazard Land, in the City of Hamilton's Comprehensive Zoning By-law. The site is designated as Escarpment Natural Area and Escarpment Protection Area under the Niagara Escarpment Plan.

The property contains a former two-storey single dwelling, which is thought to have been constructed sometime in the mid-1800s. The residence has not been occupied for many years, and in 2019 suffered significant damage resulting from a fire. The former residence is listed in the City's inventory of heritage buildings, but has no official status or protection through inclusion on the Municipal Heritage Registry or designation under the *Ontario Heritage Act.*

The entire property is regulated pursuant to the *Conservation Authorities Act* and *Ontario Regulation 41/*24 due to the presence of Sulphur Creek and its associated apparent (confined) valley, wetlands, and associated flooding and erosion hazards.

The Proposal

The proposal is for repair work to preserve the integrity of the remains of a former two-storey 128 sq. m (1,377.8 sq ft) single dwelling. The permit application is to recognize work already completed, and to allow for additional repair work.

Work already completed includes stone masonry repairs on the walls of the structure, the construction of a new cedar roof and chimney, and the addition of eaves and downspouts. The application also proposes additional repair work to preserve the integrity of the building, including finishing the roof, eaves and downspouts, waterproofing, siding, windows and doors, masonry repair, foundation insulation, repairing existing stairs leading to the basement, and general site clean-up.

The subject proposal is part of a larger development plan for the property, which is the subject of a Niagara Escarpment Commission (NEC) development permit application and includes the construction of a two-storey, 1100 sq. m. (11,840 sq. ft.) single dwelling, with a new driveway, septic system, well, and detached garage, and the conversion of the former residence to an accessory structure for storage purposes.

The site plan and elevation drawings provided in support of the proposal and permit application are attached to this report (Attachment B).

Application Review to Date

On July 5, 2021, HCA was copied on an email from Mr. Ed Fothergill, Fothergill Planning & Development Inc., to the Niagara Escarpment Commission (NEC) advising of his intention to submit a development permit application to the NEC on behalf of his client (Mr. Anthony Quinn) to allow for the construction of a new house and repair of the remains of a former residential dwelling at 820 Sulphur Springs Road. The email acknowledged flooding issues at the property and attached a floodplain analysis report that had been prepared in this regard, and requested NEC, City of Hamilton and HCA review of the information to facilitate their planned NEC development permit application.

On August 18, 2021, HCA staff provided its review comments on the floodplain analysis, noting the existing driveway to the property and former residence is affected by significant flooding from the Regional (regulatory) storm event and that safe access to the property is not available, and that as such, HCA would not support a proposal for redevelopment of the property.

On January 24, 2022, HCA received an email from Mr. Fothergill noting their intention to submit an HCA permit application for the proposed development. The permit application submission was received via email on January 27, 2022. HCA responded on January 28, 2022 noting staff had met with the NEC to review the proposal and that HCA cannot issue a permit under its Regulation until the required development permit under the Niagara Escarpment Planning and Development Act has been issued, and that as such HCA would not be processing the submitted permit application.

On June 10, 2022, HCA was circulated a Request for Comment from the NEC for a proposed development permit to construct a new single dwelling, garage, septic system, driveway and well, and to convert the former dwelling to an accessory structure.

On July 29, 2022, HCA provided comments to the NEC recommending refusal of the application given the property is affected by flooding and does not have safe access, that the proposed development is located within the Sulphur Creek confined valley system and it had not been demonstrated that the development was located beyond hazard limits, and that the potential environmental impacts of the development had not been adequately addressed.

The NEC development permit application review is still on-going, and there have been a number of resubmissions by the applicant to try and address NEC, HCA and City of Hamilton comments and concerns. HCA continues to have concerns as noted above, and has advised the applicant on a number of occasions the proposed development does not comply with HCA's policies and that HCA staff would not be able to support an HCA permit for the development. There has been no NEC decision regarding the NEC development permit application to date, and as noted, an HCA permit application cannot be processed until the NEC decision is made.

Notwithstanding the above, in April 2023 HCA staff observed potential development activity at the former residence on the subject property. HCA staff sent a Caution Letter to the property owner on May 10, 2023, noting its observations and that any development would require an HCA permit. HCA requested a site visit to confirm if work that may have required a permit had been completed.

On June 13, 2023, HCA staff attended a site visit with the owner and his planning agent. During the site visit, staff observed that restoration work had been completed on the former residence, including masonry repairs and construction of a new cedar roof and chimney. HCA also observed two gravel piles along the driveway, a concrete pad at the front of the structure, a chain link fence around the structure, construction debris (steel beams and concrete), a backhoe, two dumpsters, and exposed soil and rock piles near the top of bank of Sulphur Creek. While on site, the owner stated that work was complete and no further work was planned until they had received the required NEC development permit.

On June 22, 2023, the HCA sent a follow up letter to the Caution Notice and related site visit. HCA staff advised they did not intend to pursue the matter further given there did not appear to be any disturbance or filling in the floodplain and that flooding and erosion hazards had not been impacted by the work, and that the owner had indicated that no further work was proposed until they received their NEC development permit. The follow up letter also indicated that any further development or site alteration would require a permit, and that for any development to proceed it would have to be demonstrated that safe access to the site was available.

On July 5, 2023, the owner's planning agent contacted the HCA to advise that notwithstanding their earlier commitment to wait for receipt of the NEC development permit before undertaking any further work, that the owner intended to undertake further restorative work. It was noted this work was needed to prepare the building for winter, and would include finishing the roof, flashing, eaves/downspouts, waterproofing, siding, windows, doors, masonry repair and insulation below grade, repair of existing stairs leading to basement, and general clean up. In reviewing, HCA staff advised the owner to contact the NEC, to obtain a written response that either approves a NEC permit for the proposed work or provides clearance that an NEC permit is not required (i.e. the work is exempt), as HCA cannot issue a permit until NEC requirements are met.

On September 6, 2023, the City of Hamilton Building Department issued an order to comply for the work completed on the former residence without a building permit. The City was also in the process of reviewing a separate building permit submission for the proposed additional weatherproofing work.

After contacting the NEC, the owner was notified on November 10, 2023 that the proposed external repairs on the heritage building were exempt from requiring a NEC development permit, and that the NEC did not consider the proposed repairs to the heritage structure to be related to the active NEC application. After receiving the NEC response, the owner's legal counsel, Ms. Marcia Oliver, with Bennett Construction Group, contacted the HCA for direction on how to proceed, given HCA approval/clearance was required before a building permit could be issued.

On November 15, 2023, HCA responded that the repair work (completed and proposed) represents new development under its Regulation, and that since HCA policies do not permit development in a confined creek valley system and there is no safe access to the site, HCA staff is not able to issue a permit for the repair work. HCA also advised that it will be considering if further action may be required under its Regulation in relation to the work completed without a permit.

On November 24, 2023, HCA received an email from the applicant's counsel advising the applicant intended to apply for an HCA permit to complete the repair work on the existing building and requesting clarification regarding the applicable regulation and policies and details regarding the permit and appeal process.

On December 5, 2023, the property owner emailed HCA to advise he intended to proceed with the repair work without delay. HCA responded noting the proposed work would require an HCA permit, and that work completed without a permit would constitute a violation of HCA's regulation. Given HCA's policies would not support a permit, HCA was consulting with its legal counsel and would provide further direction on how to proceed.

On December 22, 2023, the HCA provided a letter in response to the applicant's counsel's email of November 24, 2023. The HCA letter noted applications for the completed and proposed work could be submitted and that HCA would process these in the normal manner. The letter provided clarification on the regulations and applicable policies, and describing the permit submission requirements and permit review and hearing process.

On January 17, 2024 the owner's planning agent confirmed that the owner intended to submit a permit application for the proposed work. The permit application was received electronically on January 19, 2024.

On January 30, 2024, HCA staff notified the applicant that additional information was required to deem the permit application complete. HCA staff also advised that the application could not be supported by staff, since the proposal did not conform to policy, and that the application would therefore need to be considered by the HCA Board of Directors at a Hearing.

The requested additional information in support of the permit application was received on January 31 and February 6, 2024. On February 2, 2024, HCA provided further comments to the applicant's counsel regarding Hearing process and timelines, and requesting the applicant confirm their preferred date for Hearing either in March or May. HCA staff undertook a site visit on February 7, 2024 to confirm scope of work completed and proposed. The applicant and newly retained counsel, Mr. Raj Kehar, with WeirFoulds LLP, were in attendance for the site visit.

On February 12, 2024, Mr. Kehar sent an email confirming their preference to proceed with a Hearing in May, rather than as originally proposed in March. HCA staff responded on February 13 confirming a Hearing could proceed on May 9, 2024.

In accordance with *Conservation Authority Act Hearing Guidelines* (MNRF October 2005, amended 2018, 2020 and 2021) and the *Hamilton Region Conservation Authority Administrative By-law* (HCA, October 5, 2023), HCA provided the Notice of Hearing to the applicant, as well as a copy of this Hearing Report, which outlines HCA staff's analysis of the application and reasons for recommending refusal, on Friday, April 12, 2024.

STAFF COMMENT

HCA has a mandate to ensure that people and property are protected from impacts associated with natural hazards. The Province has delegated the authority for implementing the provincial interest in natural hazards to Conservation Authorities. In evaluating the subject application, HCA staff must ensure that HCA policies regarding development and hazardous lands, which are informed by Provincial direction and policy, are considered and met. The summary of key provincial policies below provides important background and context, and is followed by a description of the HCA hazard policies and legislative requirements that are applicable to the subject application.

Provincial Policy

The Provincial Policy Statement (PPS) provides policy direction on matters of provincial interest related to land use planning and development. The PPS provides a policy framework for allowing appropriate development, while protecting resources of provincial interest, conserving the natural and built environment, and ensuring public health and safety.

With respect to natural hazards, the PPS states that development shall generally be directed to areas outside of hazardous lands, including hazardous lands adjacent to river and stream systems which are impacted by flooding hazards and/or erosion hazards (PPS 3.1.1). Notwithstanding these restrictions, development may be permitted in those portions of hazardous lands where the effects and risks to public safety are minor and can be mitigated in accordance with provincial standards, and new hazards are not created or existing hazards aggravated, and no adverse environmental impacts will result (PPS 3.1.7).

HCA Policy

According to Section 28(1) of the *Conservation Authorities Act,* no person shall undertake development activity in a regulated area without permission from the HCA. Under Section 28.1 of the *Conservation Authorities Act,* HCA may issue a permit for development activity in a regulated area if, in its opinion, the activity is not likely to affect the control of flooding, erosion, dynamic beaches or unstable soil or bedrock, or create conditions or circumstances that, in the event of a natural hazard, might jeopardize the health or safety of persons or result in the damage or destruction of property.

Development activity is defined broadly under the *Conservation Authorities Act*, and includes the construction or reconstruction of a building or structure of any kind, and any change to a building or structure that would have the effect of altering the use or potential use of the building or structure.

HCA's *Planning & Regulation Policies and Guidelines*, as approved by the HCA Board of Directors in October 2011, were developed to implement the development regulations and requirements of the *Conservation Authorities Act*, as well as provincial natural hazard policies under the PPS. HCA applies these policies to its review of planning and regulation proposals. HCA policies generally do not permit development within a confined creek valley system or where a site does not have safe access.

On April 4, 2024, the HCA Board of Directors endorsed the adoption of *Interim Policy Guidelines for the Administration and Implementation of Ontario Regulation 41/24 (Prohibited Activities, Exemptions and Permits)*. These guidelines were developed by Conservation Ontario to provide CAs with interim direction to support the implementation of the new regulations, while existing CA policy documents are reviewed and updated as may be necessary. The guidelines provide that existing CA policies should continue to be considered and applied, with appropriate consideration given to the newly proclaimed sections of the *Conservation Authorities Act* and *Ontario Regulation 41/24*, and that where discrepancies exist between the legislation, existing CA policies and the interim guidelines, that the provisions of the text of the legislation and regulation will prevail.

The following provides a summary of the key policies and requirements of HCA's Planning & Regulation Policies and Guidelines, as they apply to the subject application.

2. 1. 2. Erosion Hazard Limits

Erosion hazards mean the loss of land, due to human or natural process, that pose a threat to life and property. The erosion hazard limit for river and stream systems is determined by using the 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), and includes allowances for toe erosion, slope stability, and access during emergencies.

Generally, development should not occur on or on top of valley walls because the long-term stability of the slope, and therefore public health and safety, cannot be guaranteed. Development should be set back from the top of valley walls far enough to avoid increases in loading forces on the top of the slope, changes in drainage patterns that would compromise slope stability or exacerbate erosion of the slope face, and loss of stabilizing vegetation on the slope face.

Confined systems are those where the watercourse is located within a valley corridor, either with or without a flood plain, and is confined by valley walls. Figure 1 illustrates how the erosion hazard limit is defined for a confined valley system.

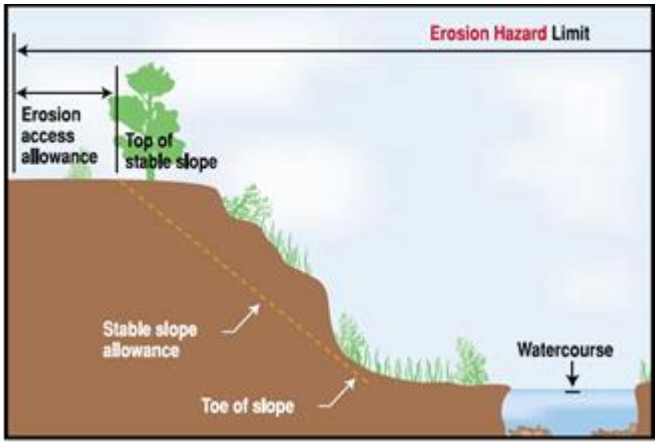


Figure 1: Erosion Hazard Limit for a Confined System

The subject property is located within the Sulphur Creek confined valley system (Attachment A).

2. 1. 2. 3 Development

Any development and/or site alteration within the jurisdiction of the Authority and within the erosion hazard limit and/or in, on or adjacent to valleylands must be in accordance with the following policies and guidelines and must be to the satisfaction of the Authority.

a. Development activities and uses on natural valley slopes will generally be prohibited. At its discretion, however, the Authority may permit the following uses:

i. Passive recreation and associated structures (e.g. staircases);

ii. Structures associated with erosion and sediment control; and

iii. Any other relevant or appropriate use and/or development as deemed satisfactory by the Authority.

d. Any development proposals adjacent to valleylands must be located outside of the erosion hazard limit and incorporate a vegetation protective zone appropriate for the features associated with that valley.

2. 1. 1 Flooding Hazard Limit

The Hamilton Conservation Authority manages flood plain lands at the Regulatory Flood level of the Regional Storm (Hurricane Hazel) with the exception of those numbered watercourses in the Stoney Creek area that have undergone a criteria reduction in the Regulatory Flood level to the 100 year flood event and the Special Policy Areas (SPAs) in Dundas. The Conservation Authority manages these lands as one zone areas with the exception of the Dundas SPAs, which utilize the floodway and flood fringe management approach, and are treated as two zone areas.

One zone areas are those where the Conservation Authority prohibits all development or site alteration within the boundaries of the Regulatory Flood level. This is the most effective way of minimizing threats to public health or safety or property damage. The one zone concept is the preferred approach for the management of flooding hazards within river and stream systems as it provides the most cost-effective means of minimizing potential threats to life and risks of property damage and social disruption. Where the one zone concept is applied, the entire flood plain or the entire flooding hazard limit defines the floodway (Figure 2).

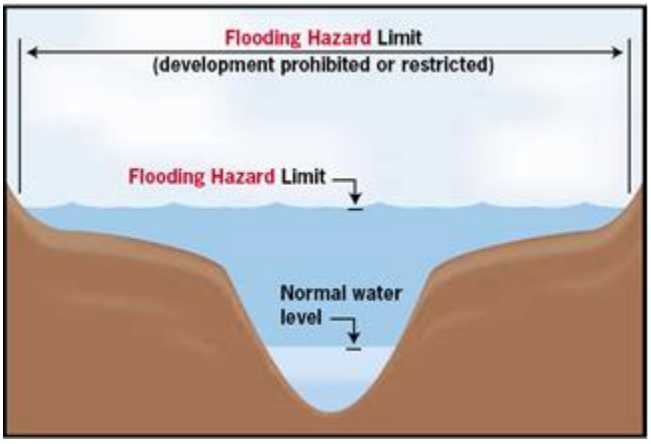


Figure 2: Flooding Hazard Limit for One Zone Concept

2. 1. 1. 3. 1 Development

Any development and/or site alteration within the jurisdiction of the Authority and within the flooding hazard limit for one zone areas must be in accordance with the following policies and guidelines and must be to the satisfaction of the Authority.

2. 1. 1. 3. 1. 1 Additions and Replacement Structures

l. Replacement structures must be constructed and located such that vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies.

8. 1. 1 Safe Access

a. Safe ingress and egress for pedestrians and vehicles must be such that the depth is less than 0.3 m (1 ft) and the velocity is no greater than 1.7 m/s (5.5 ft/s).

Application Assessment

The property at 820 Sulphur Springs Road is located in a confined (apparent) valley system associated with Sulphur Creek. The former residence has been repaired and restored, and is proposed to be an accessory structure as part of a larger development proposal for the property which continues to be under review by the NEC. The owner has completed work without the necessary approvals to advance their development proposal, and has now submitted an application for a HCA permit to recognize the work already done and for completing further restoration.

The entire property is within the limits of a natural confined valley system associated with Sulphur Creek. The former residence is located within the valley and its associated erosion hazard limit (Figure 1). As outlined above, HCA's *Policies and Guidelines* generally do not permit development within the limits of a confined valley system.

While the former residence is located outside the floodplain, the existing driveway to the structure is within the flooding hazard limits for the 100-year and Regional (regulatory) storms. The floodplain modelling completed by the engineering consultant (S. Llewellyn & Associates, June 2021, and updated November 8, 2023), confirmed that the driveway access from the municipal road to the subject site is affected by flood depths that do not meet HCA's Policies and Guidelines or provincial standards for safe access set out in the "Technical Guide - River and Stream Systems: Flooding Hazard Limit" (Ministry of Natural Resources, 2002). These policies and guidelines set out that in order for safe access to be provided for pedestrians and vehicles, that flood depths should be less than 0.3 m (1 ft) and velocities less than 1.7 m/s (5.5 ft/s).

The Technical Memorandum from S. Llewellyn and Associates (November 8, 2023) included a 2D floodplain analysis for the property which showed that the existing driveway can be flooded to a depth of 6.3 m (20.7 ft) at Sulphur Springs Road during a regulatory (Regional) storm event. Under these significant flood depths, safe access to the property would not be available for pedestrians, vehicles or emergency services.

In considering the applicable regulations and policies, it is HCA staff's opinion that the conditions under which a permit can be issued under the *Conservation Authorities Act* are not met for the proposed development activity. In particular, staff note that given safe access to the property is not available, the proposed development activity would create conditions or circumstances that, in the event of a regulatory flood, might jeopardize the health or safety of persons, which is contrary to the conditions for issuance of a permit under Section 28.1(b) of the *Conservation Authorities Act*.

The Gilmor Case

In support of staff's assessment of the application and the importance of safety considerations, it is noted the Court of Appeal for Ontario has upheld the importance and appropriateness of considering public safety and safe access when determining if a permit may be issued for development in areas subject to flooding hazards. In a 2017 decision by the Court of Appeal regarding the matter of *Gilmor v. Nottawasaga Valley Conservation Authority* (the 'Gilmor case'), the court concluded that the Conservation Authority's, and subsequently the Mining and Land Commissioner's, consideration of public safety and the absence of safe access was appropriate in determining a permit could not be issued for the development proposed in that case. The Court of Appeal upheld the Commissioner's decision and denied the development permit. There are similarities between the subject proposal and the Gilmor case, in that in the Gilmor case a new house was proposed outside of the floodplain, but there was no safe access to the house from the municipal road. In the Gilmor case, flood depths at the driveway/road were approximately 1 m (3 ft), considerably less than the flood depths at the subject property at 820 Sulphur Springs Road which exceed 6 m (20 ft).

STRATEGIC PLAN LINKAGE

HCA's Strategic Plan 2019 – 2023 outlines its major strategic priority areas and related initiatives for advancing HCA's Vision to provide a healthy watershed for everyone. HCA implements a wide variety of programs to fulfill this mandate, including programs to manage water resources and protect people and property from natural hazards. Administration of development regulations under the *Conservation Authorities* contributes to the achievement of these program objectives and HCA's Strategic Plan more generally.

AGENCY COMMENTS

None.

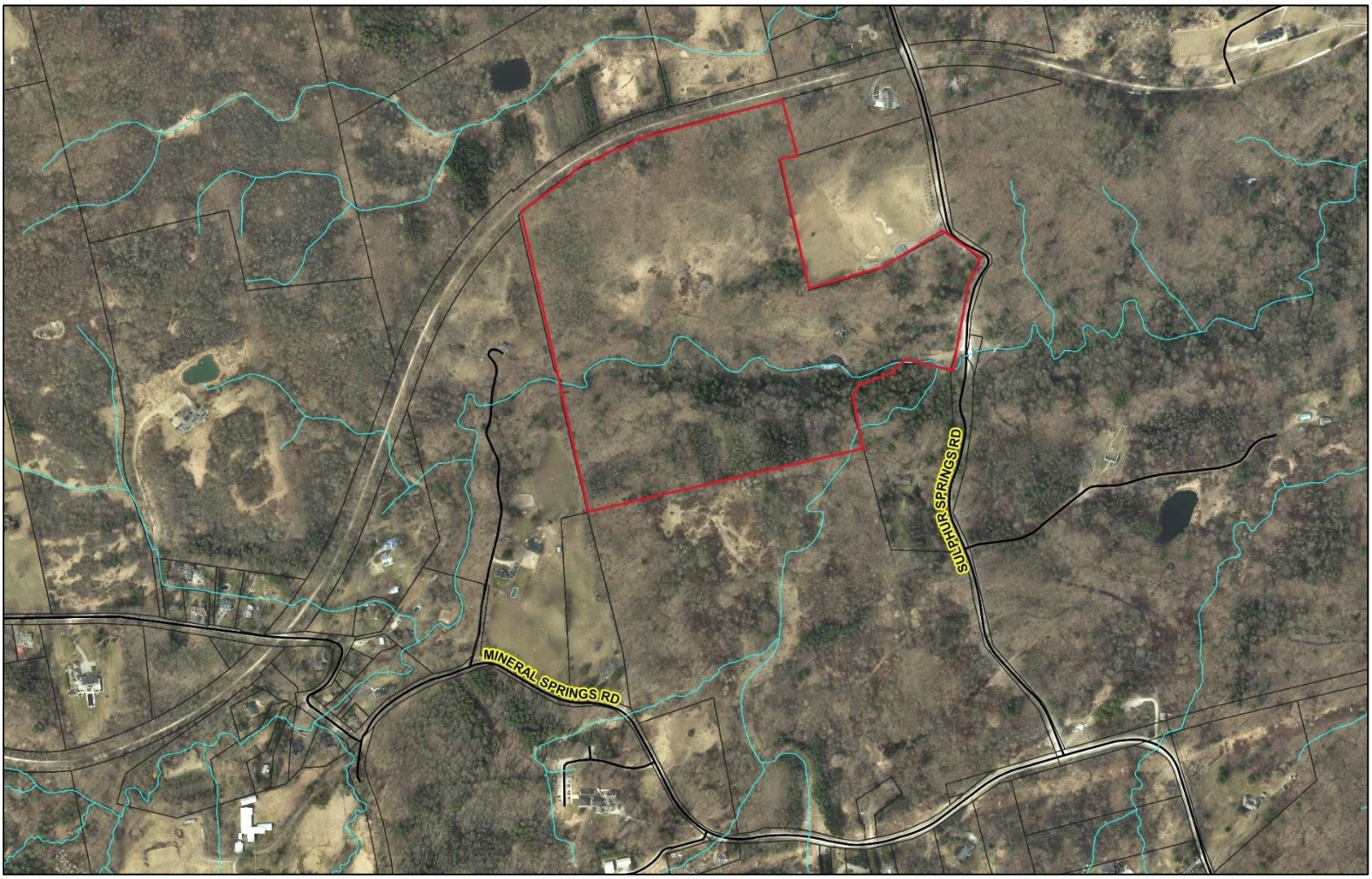
CONCLUSION

The subject application proposes development activity within the Sulphur Creek confined valley system and its associated erosion hazard limit. The existing driveway does not allow safe access to the property during a regulatory flood. Provincial and HCA policies take a preventative approach to addressing the potential risks and impacts associated with natural hazards by generally directing development to areas outside of hazardous lands. It is HCA staff's opinion the policy framework outlined in HCA's *Planning and Regulation Policies and Guidelines (October, 2011)* does not support the proposed development.

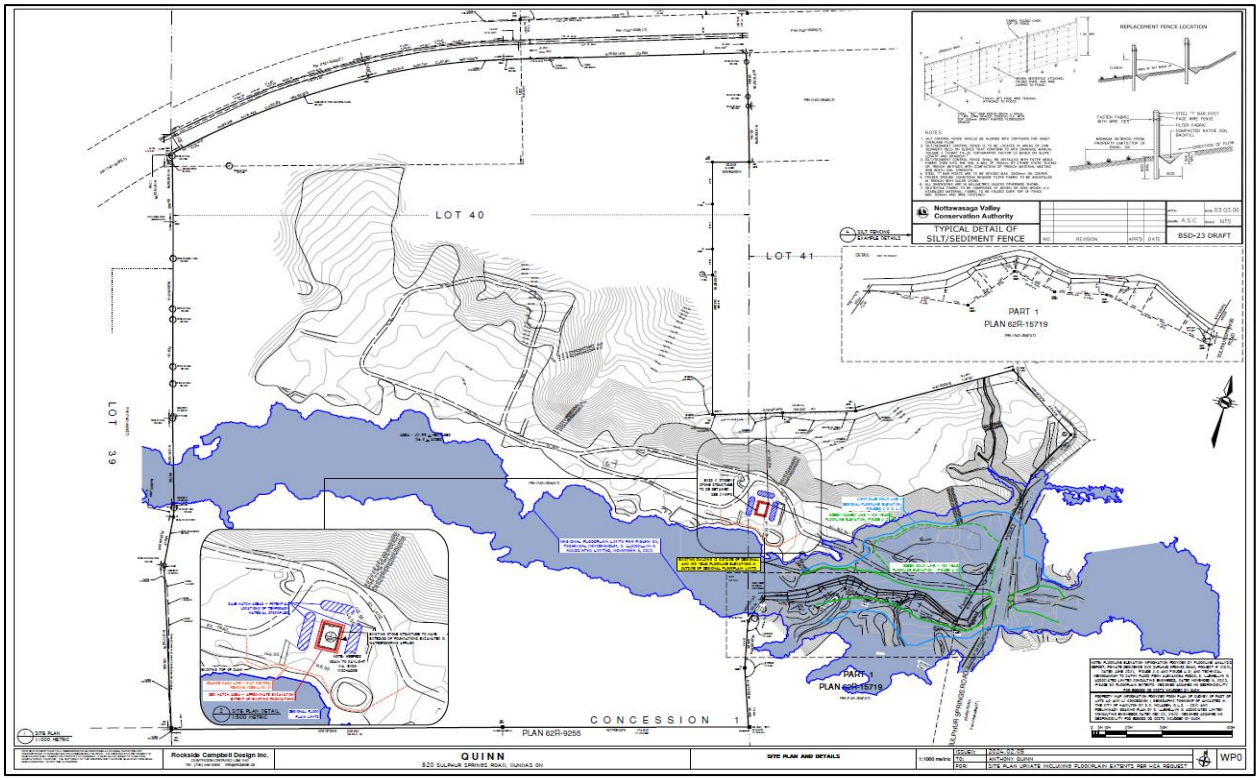
On this basis, the proposed development does not meet the conditions under which HCA may issue a permit under the *Conservation Authorities Act*. As such, it is the recommendation of HCA staff that the application be refused.

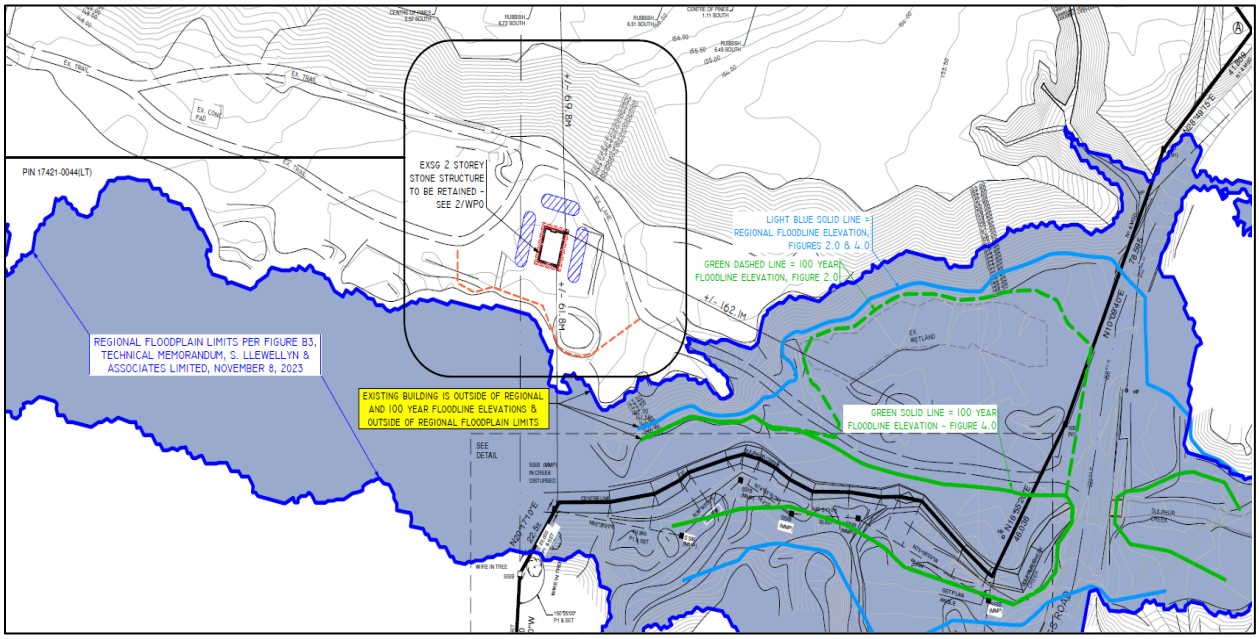
Attachment A – Site Location

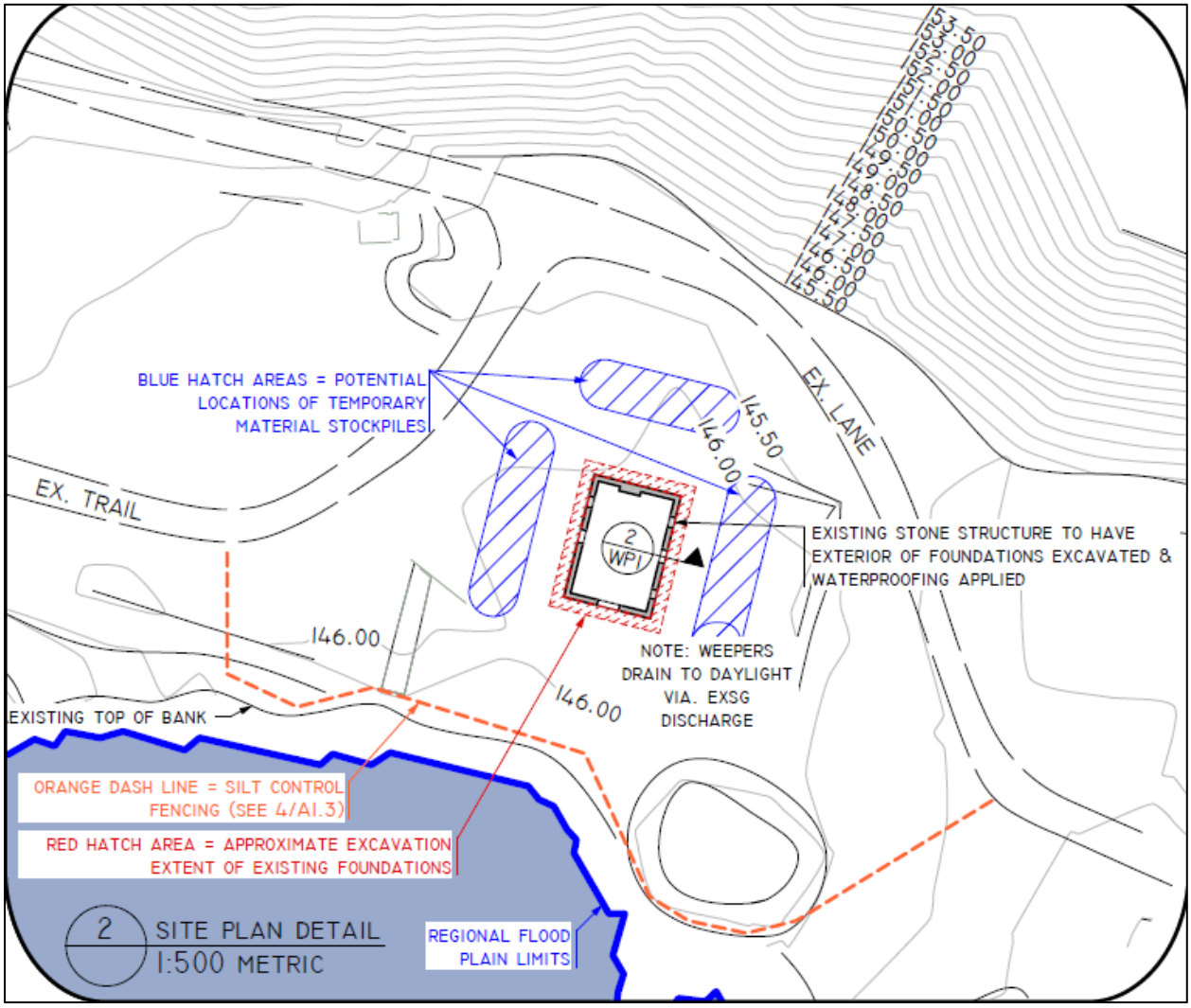
820 Sulphur Springs Road, City of Hamilton



Attachment B – Development Proposal






BLUE HATCH AREAS = POTENTIAL LOCATIONS OF TEMPORARY MATERIAL STOCKPILES
EX. TRAIL
EX. LANE
145.50
146.00
2 WP
EXISTING STONE STRUCTURE TO HAVE EXTERIOR OF FOUNDATIONS EXCAVATED & WATERPROOFING APPLIED
NOTE: WEEPERS DRAIN TO DAYLIGHT VIA. EXSG DISCHARGE
146.00
146.00
EXISTING TOP OF BANK
ORANGE DASH LINE = SILT CONTROL FENCING (SEE 4/A1.3)
RED HATCH AREA = APPROXIMATE EXCAVATION EXTENT OF EXISTING FOUNDATIONS
2 SITE PLAN DETAIL
1:500 METRIC
REGIONAL FLOOD PLAIN LIMITS

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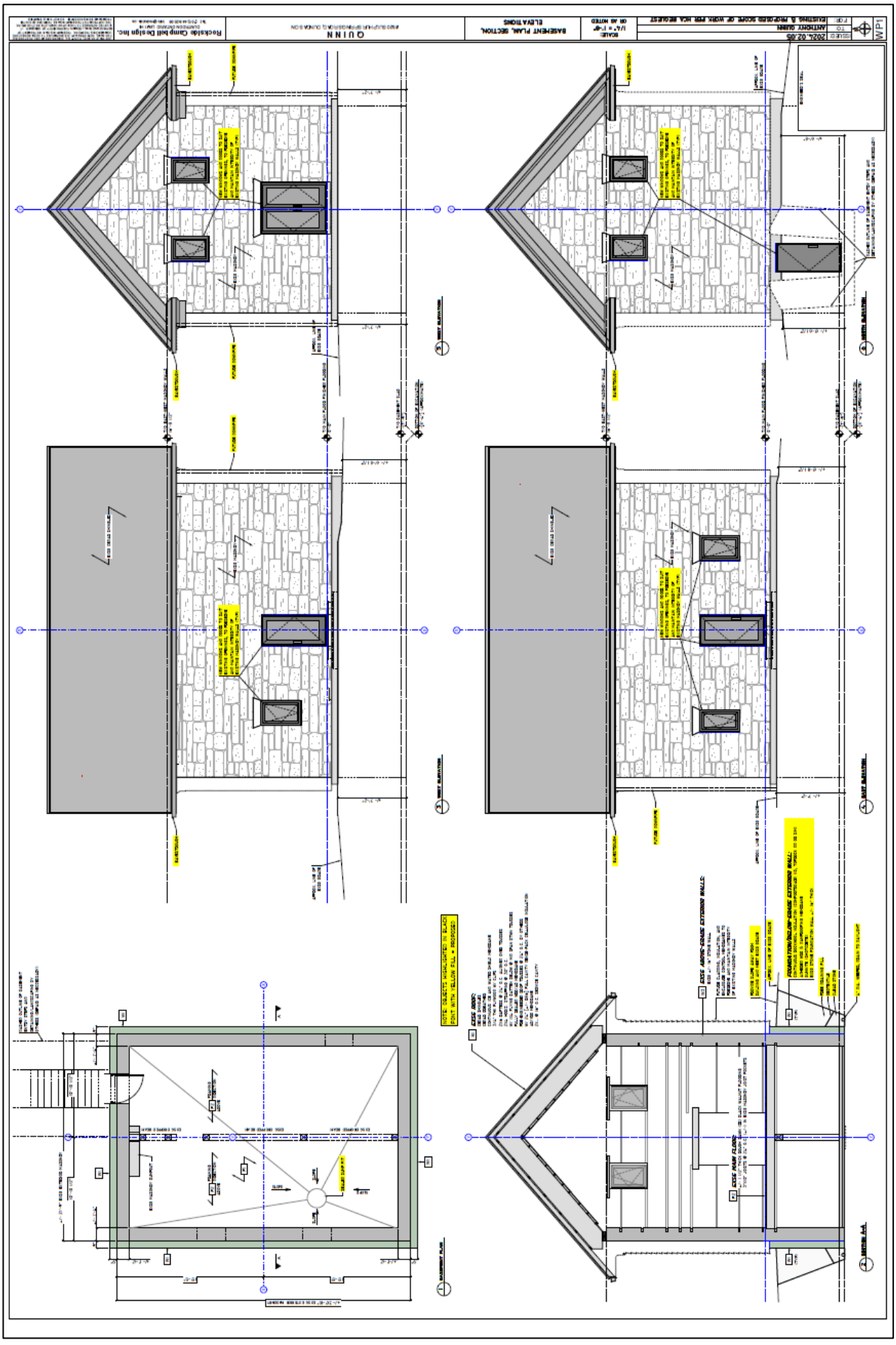

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Board of Directors Hearing
May 9, 2024

820 Sulphur Springs Road, Ancaster, ON

HCA File: A/F. C/24/05

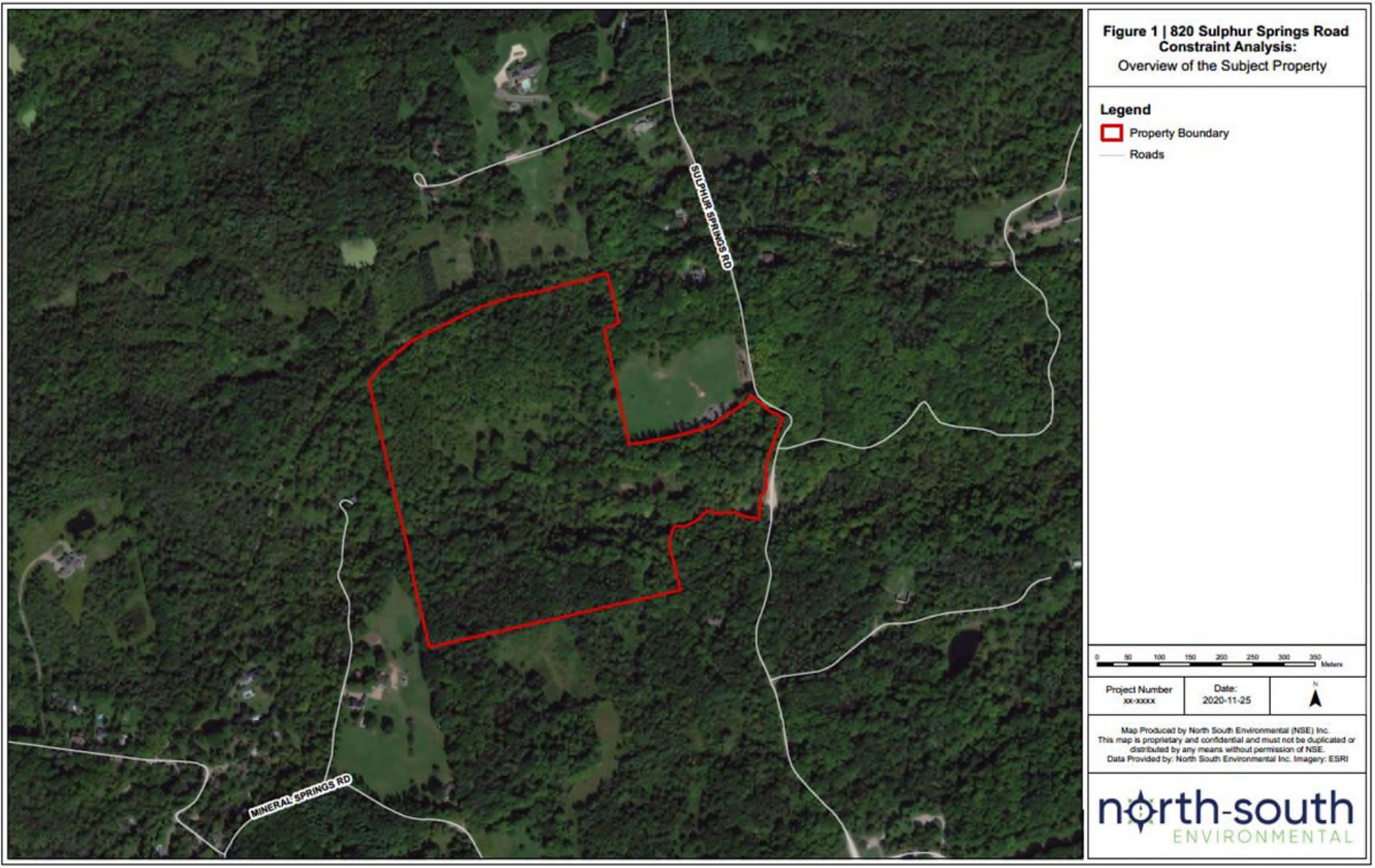


Figure 1 | 820 Sulphur Springs Road Constraint Analysis:
Overview of the Subject Property

Legend

- Property Boundary
- Roads

0 50 100 150 200 250 300 350 Meters

Project Number	Date:	N
xx-xxxx	2020-11-25	

Map Produced by North South Environmental (NSE) Inc.
This map is proprietary and confidential and must not be duplicated or distributed by any means without permission of NSE.
Data Provided by: North South Environmental Inc. Imagery: ESRI

north-south ENVIRONMENTAL

LOT 40

LOT 41

LOT 39

PROPOSED RESIDENCE

PROPOSED GARAGE

PROPOSED SEPTIC

AREA - 22.99 ± HECTARES
56.8 ± ACRES

DRIPLINE

SITE Z: 15M SETBACK FROM DRIPLINE = PROPOSED BUILDING DEVELOPMENT AREA
(AREA 15M AWAY FROM DRIPLINE = +/- 2.42ha)

SITE Z: 15M SETBACK FROM DRIPLINE

PROPOSED SINGLE FAMILY RESIDENCE
(1STOREY MAX 500 SM GROUND FLOOR AREA GFA & 11M)
(EXAMPLE BUILDING SHOWN FOR ILLUSTRATIVE PURPOSES ONLY)

PROPOSED BASEMENT TUNNEL
(1STOREY MAX 500 SM GROUND FLOOR AREA GFA & 11M)
(EXAMPLE FOOTPRINT SHOWN FOR ILLUSTRATIVE PURPOSES ONLY)

PROPOSED DETACHED GARAGE
(1STOREY MAX 150 SM GROUND FLOOR AREA GFA & 11M)
(EXAMPLE BUILDING FOOTPRINT SHOWN FOR ILLUSTRATIVE PURPOSES ONLY)

SITE Z: DRIPLINE
LIMIT OF WOODLAND AS FLAGGED AND TIED IN ON SEPTEMBER 8, 2021
(APROX 17M NORTH-SOUTH & 20M EAST-WEST
ISOMAP)

SITE Z: EXSG TRAILS REUTILIZED AS DRIVEWAY

SITE Z: PROPOSED SEPTIC
(LOCATION AND SIZE TO BE CONFIRMED)

15M SEPTIC SETBACK LINE

MATCH INTO EX. GRADES MAX 3:1 (TYP.)

RUBBISH 0.57 WEST

RUBBISH 0.51 SOUTH

RUBBISH 0.49 SOUTH

RUBBISH 0.46 SOUTH

CENTRE OF RAILS 0.50 SOUTH

CENTRE OF RAILS 1.10 SOUTH

RUBBISH 0.49 SOUTH

EXISTING TOP OF BANK

EXISTING

PROPOSED

REGIONAL FLOODPLAIN LIMITS PER FIGURE B3, TECHNICAL MEMORANDUM, S. LLEWELLYN & ASSOCIATES LIMITED, NOVEMBER 8, 2023

NOTE: ALL PROPOSED WORKS ARE OUTSIDE OF REGIONAL AND 100 YEAR FLOODLINE ELEVATIONS & OUTSIDE OF REGIONAL FLOODPLAIN LIMITS

LIGHT BLUE SOLID LINE = REGIONAL FLOODLINE ELEVATION, FIGURES 2.0 & 4.0

GREEN DASHED LINE = 100 YEAR FLOODLINE ELEVATION, FIGURE 2.0

GREEN SOLID LINE = 100 YEAR FLOODLINE ELEVATION - FIGURE 4.0

+/- 162.1M

+/- 148.69M

BLUE HATCH AREAS = POTENTIAL LOCATIONS OF TEMPORARY MATERIAL STOCKPILES

EX. TRAIL

EX. LANE

145.50

146.00

146.00

146.00

EXISTING STONE STRUCTURE TO HAVE EXTERIOR OF FOUNDATIONS EXCAVATED & WATERPROOFING APPLIED

NOTE: WEEPERS DRAIN TO DAYLIGHT VIA. EXSG DISCHARGE

ORANGE DASH LINE = SILT CONTROL FENCING (SEE 4/A1.3)

RED HATCH AREA = APPROXIMATE EXCAVATION EXTENT OF EXISTING FOUNDATIONS

2 SITE PLAN DETAIL
1:500 METRIC

OUTLINE OF FORMER PATIO

OUTLINE OF FORMER PORCH

FOOTPRINT OF PREVIOUS ADDITIONS TO STONE STRUCTURE
+/- 89.1 SM GFA (GROUND FLOOR AREA),
+/- 121.8SM TFA (TOTAL FLOOR AREA)

+/- 11.72M SETBACK

EXSG 2 STOREY STONE STRUCTURE
TO BE STABILIZED AND RETAINED AS ACCESSORY BUILDING
63.6SM GFA
127.2SM TFA

+/- 7.72M SETBACK

+/- 4.66M SETBACK

3 SITE PLAN EXCERPT - EXSG STONE STRUCTURE
1:500

1 SITE PLAN
1:1000 METRIC

PART 1
PLAN 62R-15719
PIN 17421-0047(LT)

PLAN 62R-9255

CONCESSION 1

SULPHUR SPRINGS ROAD (GIVEN ROAD)

PIN 17421-0026(LT)

PIN 17421-0023(LT)

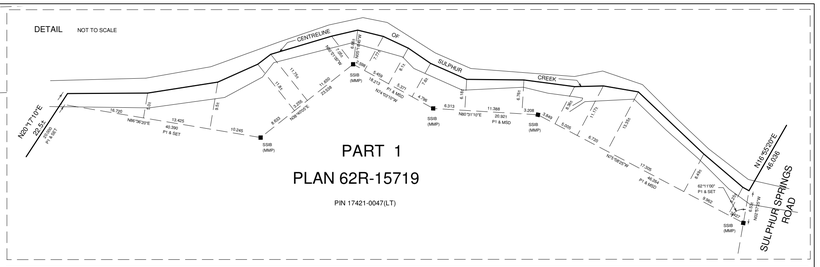
PIN 17421-0042(LT)

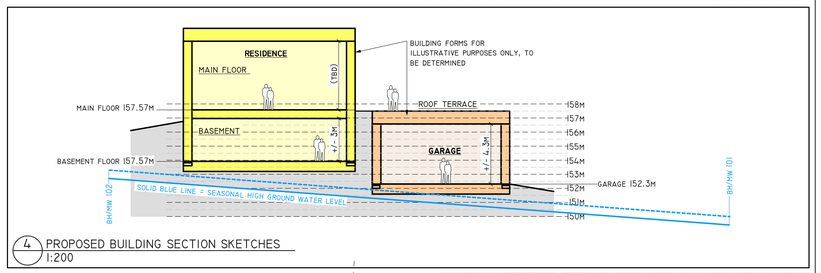
PIN 17421-0043(LT)

PIN 17421-0044(LT)

PIN 17421-0056(LT)

DETAIL NOT TO SCALE





4 PROPOSED BUILDING SECTION SKETCHES
1:200

5 SITE MAP
1:5000

NOTE: FLOODLINE ELEVATION INFORMATION PROVIDED BY FLOODLINE ANALYSIS REPORT, PRIVATE RESIDENCE 820 SULPHUR SPRINGS ROAD, PROJECT # 21031, DATED JUNE 2021, FIGURE 2.0 AND FIGURE 4.0, AND TECHNICAL MEMORANDUM TO CATHY PLOSZ FROM ALEXANDRA PORCO, S. LLEWELLYN & ASSOCIATES LIMITED CONSULTING ENGINEERS, DATED NOVEMBER 8, 2023, FIGURE B3 FLOODPLAIN EXTENTS. DESIGNER ASSUMES NO RESPONSIBILITY FOR ERRORS OR COSTS INCURRED BY SUCH.

PROPERTY MAP INFORMATION PROVIDED FROM PLAN OF SURVEY OF PART OF LOTS 40 AND 41 CONCESSION 1 GEOGRAPHIC TOWNSHIP OF ANCASTER IN THE CITY OF HAMILTON BY S.D. MCLAREN, O.L.S. - 2021 AND PRELIMINARY GRADING PLAN BY S. LLEWELLYN & ASSOCIATES LIMITED CONSULTING ENGINEERS DATED DEC 22, 2022. DESIGNER ASSUMES NO RESPONSIBILITY FOR ERRORS OR COSTS INCURRED BY SUCH.

0 5M 10M 25M 50M 100M

CONTRACTOR MUST VERIFY ALL DIMENSIONS AND BE RESPONSIBLE FOR SAME, REPORTING ANY DISCREPANCIES TO DESIGNER BEFORE COMMENCING THE WORK. THE DRAWING IS AN INSTRUMENT OF SERVICE AND SHALL REMAIN THE PROPERTY OF DESIGNER. IT MUST BE RETURNED TO THEM UPON COMPLETION OF THE WORK. THE COPYRIGHT OF THIS DRAWING AND THE WORK EXECUTED FROM SAME BEING RESERVED. DO NOT SCALE DRAWING.

Rockside Campbell Design Inc.
DUNTROON ONTARIO L0M 1H0
Tel: (705) 446-2506 info@rockside.ca

QUINN
820 SULPHUR SPRINGS ROAD, DUNDAS ON

SITE PLAN AND DETAILS

1:1000 metric

ISSUED:	2024.04.05
TO:	QUINN, FOTHERGILL, SPITALE, ABASS, KING, COLOSIMO, OLIVER, KEHAR
FOR:	SUBMISSION PURPOSES

A1

Chronology of Events

DATE	EVENT
August 2019	Fire occurs at 820 Sulphur Springs Road
November 23, 2020	Applicant purchases 820 Sulphur Springs Road
January 27, 2022	Original Permit application submitted to HCA for repairs
January 28, 2022	HCA advises that NEC permit is required first
April 21, 2022	Application made to NEC
November 10, 2023	NEC correspondence indicating that the repair work is not development and therefore no Permit is required
November 15, 2023	HCA correspondence indicating that the repair work is development
January 23, 2024	Applicant submitted Application for Development Permit
January 30, 2024	Application for Development Permit is refused

Pre-damage condition

Post-damage condition, during repairs

Post-damage condition, during repairs

Post-damage condition, during repairs

Current condition, April 23, 2024

Current condition, April 23, 2024

HCA Planning & Regulations Policies and Guidelines

Definition of Development:

A. As it pertains to the Conservation Authorities Act, means:

a. The construction, reconstruction, erection or placing of a *building* or structure of any kind;

b. Any change to a *building* or structure that would have the effect of altering the use or potential use of the *building* or structure, increasing the size of the *building* or structure or increasing the number of *dwelling units* in the *building* or structure;

c. Site grading; or

d. The temporary or permanent placing, dumping or removal of any material originating on the site or elsewhere.

B. As it pertains to the Planning Act, Provincial Policy Statement, and Greenbelt Plan means the creation of a new lot, a change in land use, or the construction of *buildings* and structures, requiring approval under the Planning Act, but does not include:

a. Activities that create or maintain infrastructure authorized under an environmental assessment process; or

b. Works subject to the Drainage Act. (*PPS).*

R.R.O. 1990, Reg. 828: Development within the Development Control Area

5. The following classes of development, if listed as permitted uses under the land use policies established in the Niagara Escarpment Plan and not in conflict with a development permit issued under the Act, are exempt from the requirement of obtaining a development permit:

4.1 The maintenance or repair of the exterior of a building or structure that does not change the use of the building or structure.

HCA Planning & Regulations Policies and Guidelines

Replacement Structure:

means the restoration of a building or structure to its original form (i.e. same dimensions, square footage and building footprint).

HCA Planning & Regulations Policies and Guidelines

Replacement Structure in Flooding Hazard Limit:

- Permitted use under section 2.1.1.1;

2. 1. 1. 3. 1. 1 Additions and Replacement Structures

Additions and *replacements* of the structures listed in Policies 2.1.1.1 and 2.1.1.3.1 will be permitted in one zone areas provided they meet the following conditions to the satisfaction of the *Authority.*

e. *Replacement structures* shall be restored to their original form (i.e. same dimensions, square footage, and *building* footprint), provided they were not destroyed by flooding.

l. *Replacement structures* must be constructed and located such that vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies.

HCA Planning & Regulations Policies and Guidelines

Replacement Structure in Erosion Hazard Limit:

2. 1. 2. 3. 1 Additions and Replacement Structures

a. *Additions* to existing structures may be permitted provided that they are located outside of the *erosion hazard* limits.

b. Any proposed *addition* or *replacement structure* may be subject to a geotechnical report at the expense of the proponent if the *Authority* deems it to be necessary (Appendix I).

c. When necessary the *addition,* renovation, basement or *replacement structure* will be subject to the *floodproofing* requirements of *Authority* staff and as determined by Section 8.1, and its sub-policies.

d. *Replacement structures* shall be restored to their original form (i.e. same dimensions, square footage, and footprint).

e. Locating *replacement structures* or *additions* on a portion of the property where the *erosion hazards* are the least significant must be examined in the case of all proposals and applied wherever possible. An *addition* will only be permitted within the *erosion hazard* limit if it can be shown that the structure cannot reasonably be located elsewhere on the property and the *addition* does not encroach any further into the *erosion hazard* limit than the existing structure.

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HAMILTON CONSERVATION AUTHORITY

HEARING UNDER SECTION 28.1(5) OF THE CONSERVATION AUTHORITIES ACT

820 SULPHUR SPRINGS ROAD

A/F, C/24/05

Anthony Quinn and Anthony Quinn Holdings Inc.

DOCUMENT BOOK

May 9, 2024

WEIRFOULDS LLP
Barristers & Solicitors
201 – 1320 Cornwall Road
Oakville, ON L6J 7W5

Raj Kehar
Tel: 416-947-5051
rkehar@weirfoulds.com

Solicitor for Anthony Quinn

I N D E X

TAB	DOCUMENT
1.	Conservation Authorities Act, R.S.O. 1990, c. C.27 (excerpts)
2.	Ontario Regulation 41/24: Prohibited Activities, Exemptions and Permits
3.	Ontario Regulation 828/90: Designation of Area of Development Control
4.	Provincial Policy Statement, 2020 (excerpts)
5.	MNR Technical Guide – River and Stream Systems: Flooding Hazard Limit (2002)
6.	MNR Technical Guide – River and Stream Systems: Erosion Hazard Limit (2002)
7.	HCA Planning & Regulation Policies and Guidelines (October 2011)
8.	Application to HCA for Approval of Work to Existing Structure (January 23, 2024)
9.	HCA Staff Hearing Report for May 9, 2024 Hearing
10.	Site Plan dated April 5, 2024

TAB 1

Ontario

Français

Conservation Authorities Act

R.S.O. 1990, CHAPTER C.27

Consolidation Period: From April 1, 2024 to the e-Laws currency date.

Last amendment: 2022, c. 21, Sched. 2, s. 1-15.

Legislative History: [+]

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PART I
PURPOSE AND INTERPRETATION

Purpose

0.1 The purpose of this Act is to provide for the organization and delivery of programs and services that further the conservation, restoration, development and management of natural resources in watersheds in Ontario. 2017, c. 23, Sched. 4, s. 1.

Section Amendments with date in force (d/m/y) [+]

Definitions

1 In this Act,

"advisory board" means an advisory board appointed by an authority; ("conseil consultatif")

"authority" means a conservation authority established by or under this Act or a predecessor of this Act; ("office")

"executive committee" means the executive committee appointed by an authority; ("comité de direction")

"land" includes buildings and any estate, term, easement, right or interest in, to, over or affecting land; ("bien-fonds")

"Minister" means the Minister of Natural Resources and Forestry or such other member of the Executive Council as may be assigned the administration of this Act under the *Executive Council Act*; ("ministre")

"municipality" means a local municipality, and includes a band under the *Indian Act* (Canada) that is permitted to control, manage and expend its revenue money under section 69 of that Act; ("municipalité")

"operating expenses" include,

(a) salaries, per diems and travel expenses of employees and members of an authority,

(b) rent and other office costs,

(c) program expenses,

(d) costs that are related to the operation or maintenance of a project, but not including the project's capital costs, and

(e) such other costs as may be prescribed by regulation; ("dépenses d'exploitation")

"participating municipality" means a municipality that is designated by or under this Act as a participating municipality; ("municipalité participante")

"project" means a work undertaken by an authority for the furtherance of its objects; ("projet")

"watershed" means an area drained by a river and its tributaries. ("bassin hydrographique") R.S.O. 1990, c. C.27, s. 1; 1996, c. 1, Sched. M, s. 40; 1998, c. 18, Sched. I, s. 1; 2002, c. 17, Sched. F, Table; 2017, c. 23, Sched. 4, s. 2; 2019, c. 9, Sched. 2, s. 1; 2022, c. 21, Sched. 2, s.1.

Section Amendments with date in force (d/m/y) [+]

Existing aboriginal or treaty rights

1.1 For greater certainty, nothing in this Act shall be construed so as to abrogate or derogate from the protection provided for the existing aboriginal and treaty rights of the aboriginal peoples of Canada as recognized and affirmed in section 35 of the *Constitution Act, 1982*. 2020, c. 36, Sched. 6, s. 1.

Section Amendments with date in force (d/m/y) [+]

PART II
ESTABLISHMENT OF CONSERVATION AUTHORITIES

Meeting to establish authority for watershed

2 (1) Where the councils of any two or more municipalities situate either wholly or partly within a watershed by resolution request the Minister to call a meeting for the establishment of an authority for the watershed or any defined part thereof, the Minister shall fix a time and place for such a meeting and shall forthwith notify the council of every municipality either wholly or partly within the watershed or part thereof. R.S.O. 1990, c. C.27, s. 2 (1).

Representatives at meeting

(2) The council of each municipality may appoint representatives to attend the meeting in the following numbers:

1. Where the population is 1,000,000 or more, seven representatives.

1.1 Where the population is 500,000 or more but less than 1,000,000, six representatives.

1.2 Where the population is 250,000 or more but less than 500,000, five representatives.

2. Where the population is 100,000 or more but less than 250,000, four representatives.

3. Where the population is 50,000 or more but less than 100,000, three representatives.

4. Where the population is 10,000 or more but less than 50,000, two representatives.

5. Where the population is less than 10,000, one representative. R.S.O. 1990, c. C.27, s. 2 (2); 2001, c. 9, Sched. K, s. 1 (1).

Authority of representatives

(3) The representatives so appointed have authority to vote and generally act on behalf of their respective municipalities at the meeting. R.S.O. 1990, c. C.27, s. 2 (3).

Quorum

(4) At any meeting called under this section, a quorum consists of two-thirds of the representatives that the municipalities notified are entitled to appoint. R.S.O. 1990, c. C.27, s. 2 (4); 2017, c. 23, Sched. 4, s. 4.

Section Amendments with date in force (d/m/y) [+]

Establishment, jurisdiction and initial financing
Establishment and jurisdiction of authority

3 (1) Upon receipt by the Minister of a resolution passed at a meeting held under section 2 and at which a quorum was present by not less than two-thirds of the representatives present thereat requesting the establishment of an authority, the Lieutenant Governor in Council may establish a conservation authority and designate the municipalities that are the participating municipalities and the area over which the authority has jurisdiction. R.S.O. 1990, c. C.27, s. 3 (1); 2017, c. 23, Sched. 4, s. 5 (1).

Where only part of municipality in watershed

(2) Where a municipality is only partly within the watershed, the Lieutenant Governor in Council may include the whole or that part of the municipality in the area over which the authority has jurisdiction. R.S.O. 1990, c. C.27, s. 3 (2).

Name of authority

(3) The name of each authority shall be determined by the Lieutenant Governor in Council and shall conclude with the words "conservation authority" in English and shall include the words "office de protection de la nature" in French. R.S.O. 1990, c. C.27, s. 3 (3).

Corporate body

(4) Every authority is a body corporate. R.S.O. 1990, c. C.27, s. 3 (4).

Borrowing power

(5) Every authority may, for its purposes, borrow on the promissory note of the authority such money as may be required until payment to the authority of any grants and of sums to be paid to the authority by the participating municipalities. R.S.O. 1990, c. C.27, s. 3 (5); 2017, c. 23, Sched. 4, s. 5 (2).

Section Amendments with date in force (d/m/y) [+]

Upper-tier municipalities
Regional municipalities to act in place of local municipalities

4 (1) An upper-tier municipality that was established as a regional municipality before the day subsection 6 (1) of Schedule 4 to the *Building Better Communities and Conserving Watersheds Act, 2017* comes into force,

(a) shall act in the place of the local municipalities within the regional municipality for the purpose of appointing representatives to attend a meeting for the establishment or enlargement of a conservation authority or the amalgamation of conservation authorities and for the purpose may appoint representatives in the numbers to which the local municipalities would otherwise have been entitled; and

(b) shall be a participating municipality in the place of such of the local municipalities within the regional municipality as are wholly or partly within the area under the jurisdiction of a conservation authority and shall appoint to each such authority the number of members to which the local municipalities would otherwise have been entitled as participating municipalities. R.S.O. 1990, c. C.27, s. 4 (1); 2017, c. 23, Sched. 4, s. 6 (1).

(2) REPEALED: 2017, c. 23, Sched. 4, s. 6 (2).

Section Amendments with date in force (d/m/y) [+]

Toronto and Region Conservation Authority

5 (1) The Metropolitan Toronto and Region Conservation Authority is continued under the name Toronto and Region Conservation Authority in English and Office de protection de la nature de Toronto et de la région in French, and has jurisdiction in all matters provided for in this Act over the area under its jurisdiction on December 31, 1990, as it may be altered under this Act. 1997, c. 26, Sched.

(2) Repealed: 2001, c. 9, Sched. K, s. 1 (2).

Section Amendments with date in force (d/m/y) [+]

PART VI
REGULATION OF AREAS OVER WHICH AUTHORITIES HAVE JURISDICTION

Prohibited activities re watercourses, wetlands, etc.

28 (1) No person shall carry on the following activities, or permit another person to carry on the following activities, in the area of jurisdiction of an authority:

1. Activities to straighten, change, divert or interfere in any way with the existing channel of a river, creek, stream or watercourse or to change or interfere in any way with a wetland.
2. Development activities in areas that are within the authority's area of jurisdiction and are,

    i. hazardous lands,

    ii. wetlands,

    iii. river or stream valleys the limits of which shall be determined in accordance with the regulations,

    iv. areas that are adjacent or close to the shoreline of the Great Lakes-St. Lawrence River System or to an inland lake and that may be affected by flooding, erosion or dynamic beach hazards, such areas to be further determined or specified in accordance with the regulations, or

    v. other areas in which development should be prohibited or regulated, as may be determined by the regulations. 2017, c. 23, Sched. 4, s. 25; 2022, c. 21, Sched. 2, s. 7 (1).

Exception, aggregates

(2) The prohibitions in subsection (1) do not apply to an activity approved under the *Aggregate Resources Act* after December 18, 1998, the date the *Red Tape Reduction Act, 1998* received Royal Assent. 2017, c. 23, Sched. 4, s. 25.

Same, prescribed activities

(3) The prohibitions in subsection (1) do not apply to an activity or a type of activity that is prescribed by regulation and is carried out in accordance with the regulations. 2017, c. 23, Sched. 4, s. 25.

Same, prescribed areas

(4) The prohibitions in subsection (1) do not apply to any activity described in that subsection if it is carried out,

(a) in an area that is within an authority's area of jurisdiction and specified in the regulations; and

(b) in accordance with any conditions specified in the regulations. 2017, c. 23, Sched. 4, s. 25.

Same, *Planning Act*

(4.1) Subject to subsection (4.2), the prohibitions in subsection (1) do not apply to an activity within a municipality prescribed by the regulations if,

(a) the activity is part of development authorized under the *Planning Act*; and

(b) such conditions and restrictions as may be prescribed for obtaining the exception and on carrying out the activity are satisfied. 2022, c. 21, Sched. 2, s. 7 (2).

Same
(4.2) If a regulation prescribes activities, areas of municipalities or types of authorizations under the *Planning Act* for the purposes of this subsection, or prescribes any other conditions or restrictions relating to an exception under subsection (4.1), the exception applies only in respect of such activities, areas and authorizations and subject to such conditions and restrictions. 2022, c. 21, Sched. 2, s. 7 (2).

Definitions
(5) In this section,

"development activity" means a development activity as defined by regulation; ("activité d'aménagement")

"hazardous land" means hazardous land as defined by regulation; ("terrain dangereux")

"watercourse" means a watercourse as defined by regulation; ("cours d'eau")

"wetland" means a wetland as defined by regulation. ("terre marécageuse") 2017, c. 23, Sched. 4, s. 25.

Section Amendments with date in force (d/m/y) [+]

28.0.1 REPEALED: 2020, c. 36, Sched. 6, s. 15 (2).

Section Amendments with date in force (d/m/y) [+]

Permits
28.1 (1) An authority may issue a permit to a person to engage in an activity specified in the permit that would otherwise be prohibited by section 28, if, in the opinion of the authority,

(a) the activity is not likely to affect the control of flooding, erosion, dynamic beaches or unstable soil or bedrock;

(b) the activity is not likely to create conditions or circumstances that, in the event of a natural hazard, might jeopardize the health or safety of persons or result in the damage or destruction of property; and

(c) any other requirements that may be prescribed by the regulations are met. 2017, c. 23, Sched. 4, s. 25; 2022, c. 21, Sched. 2, s. 9 (1).

Application for permit
(2) A person who wishes to engage in an activity that is prohibited under section 28 in an area situated in the jurisdiction of an authority may apply to the authority for a permit under this section. 2017, c. 23, Sched. 4, s. 25.

Same
(3) An application for a permit shall be made in accordance with the regulations and include such information as is required by regulation. 2017, c. 23, Sched. 4, s. 25.

Conditions
(4) Subject to subsection (5), an authority may issue a permit with or without conditions. 2017, c. 23, Sched. 4, s. 25.

Hearing
(5) An authority shall not refuse an application for a permit or attach conditions to a permit unless the applicant for the permit has been given an opportunity to be heard by the authority. 2017, c. 23, Sched. 4, s. 25.

Renewable energy projects
(6) In the case of an application for a permit to engage in development related to a renewable energy project as defined in subsection 2 (1) of the *Electricity Act, 1998*,

(a) the authority shall not refuse the permit unless it is of the opinion that it is necessary to do so to control flooding, erosion, dynamic beaches or unstable soil or bedrock; and

(b) despite subsection (4), the authority shall not attach conditions to the permit unless the conditions relate to controlling flooding, erosion, dynamic beaches or unstable soil or bedrock. 2017, c. 23, Sched. 4, s. 25; 2018, c. 16, s. 3 (2); 2022, c. 21, Sched. 2, s. 9 (2).

Reasons for decision

(7) If the authority, after holding a hearing, refuses a permit or issues the permit subject to conditions, the authority shall give the applicant written reasons for the decision. 2017, c. 23, Sched. 4, s. 25.

Request for Minister's review

(8) Subject to the regulations, where the authority refuses a permit or imposes any conditions on a permit to which the applicant objects, the applicant may, within 15 days of receiving reasons for the authority's decision, submit a request to the Minister for the Minister to review the authority's decision. 2020, c. 36, Sched. 6, s. 16 (2).

Reply by Minister

(9) Within 30 days after receiving a request under subsection (8), the Minister shall reply to the request and indicate in writing to the applicant and the authority whether or not the Minister intends to conduct a review of the authority's decision. Failure on the part of the Minister to reply to a request within the 30 day period is deemed to be an indication that the Minister does not intend to review the authority's decision. 2020, c. 36, Sched. 6, s. 16 (2).

Same

(10) If a reply given under subsection (9) indicates that the Minister intends to conduct a review, the Minister may in the reply require the applicant and the authority to provide the Minister with such information as the Minister considers necessary to conduct the review. 2020, c. 36, Sched. 6, s. 16 (2).

Information

(11) The applicant and the authority shall submit to the Minister such information as was specified in the reply given under subsection (9) within the time period specified in the reply. 2020, c. 36, Sched. 6, s. 16 (2).

Publication of notice of review

(12) The Minister shall publish on the Environmental Registry notice of the Minister's intention to review a decision made by an authority and shall do so within 30 days of giving a reply to that effect under subsection (9). 2020, c. 36, Sched. 6, s. 16 (2).

No hearing required

(13) The Minister is not required to hold a hearing while conducting a review of an authority's decision. 2020, c. 36, Sched. 6, s. 16 (2).

Conferring with persons, etc.

(14) Before making a decision with respect to a review, the Minister may confer with any person or body that the Minister considers may have an interest in the review. 2020, c. 36, Sched. 6, s. 16 (2).

Minister's decision

(15) After conducting a review of an authority's decision, the Minister may confirm or vary the authority's decision or make any decision that the Minister considers appropriate, including issuing the permit subject to conditions. 2020, c. 36, Sched. 6, s. 16 (2).

Same

(16) The Minister shall base any decision under subsection (15) on the criteria set out in clauses (1) (a), (b) and (c). 2020, c. 36, Sched. 6, s. 16 (2).

Reasons

(17) If, upon conducting a review of an authority's decision, the Minister decides to refuse to issue a permit or to issue a permit subject to conditions, the Minister shall give the applicant and the authority written reasons for the decision. 2020, c. 36, Sched. 6, s. 16 (2).

Copy to authority
(18) If the Minister issues a permit under subsection (15), the Minister shall give a copy of the permit to the authority within five days after the permit is issued. 2020, c. 36, Sched. 6, s. 16 (2).

Decision final
(19) A decision made by the Minister under subsection (15) is final. 2020, c. 36, Sched. 6, s. 16 (2).

Appeal to Tribunal
(20) Within 90 days after receiving the reasons for the authority's decision under subsection (7), the applicant may appeal the authority's decision to the Ontario Land Tribunal, subject to subsection (21). 2020, c. 36, Sched. 6, s. 16 (2); 2021, c. 4, Sched. 6, s. 39 (13).

Exception
(21) An applicant who submitted a request under subsection (8) for the Minister to conduct a review of an authority's decision shall not appeal the decision to the Ontario Land Tribunal under subsection (20) unless,

(a) the Minister's reply under subsection (9) indicated that the Minister refused to conduct the review; or

(b) 30 days have elapsed following the day the applicant submitted the request for a Minister's review and the Minister has not made a reply under subsection (9). 2020, c. 36, Sched. 6, s. 16 (2); 2021, c. 4, Sched. 6, s. 39 (13).

Appeal, no decision by authority
(22) If an application for a permit is made to the authority and the application complies with subsection (3), and if the authority fails to give the applicant notice of a decision with respect to the application within 90 days after the application is made, the applicant may appeal the application directly to the Ontario Land Tribunal. 2020, c. 36, Sched. 6, s. 16 (2); 2021, c. 4, Sched. 6, s. 39 (13); 2022, c. 21, Sched. 2, s. 9 (3).

Appeal, no decision by Minister
(23) If the Minister indicates in a reply given under subsection (9) that the Minister intends to review an authority's decision and the Minister fails to make a decision within 90 days of giving the reply, the applicant may, within the next 30 days, appeal the authority's decision directly to the Ontario Land Tribunal. 2020, c. 36, Sched. 6, s. 16 (2); 2021, c. 4, Sched. 6, s. 39 (13).

Notice of Appeal
(24) A notice of an appeal under subsection (20), (22) or (23) shall be sent to the Ontario Land Tribunal and to the authority by registered mail. 2020, c. 36, Sched. 6, s. 16 (2); 2021, c. 4, Sched. 6, s. 39 (13).

Hearing by Tribunal
(25) The Ontario Land Tribunal shall fix a date for a hearing of an appeal under subsection (20), (22) or (23), give notice to all interested parties and give all necessary direction for the hearing. 2020, c. 36, Sched. 6, s. 16 (2); 2021, c. 4, Sched. 6, s. 39 (13).

Powers of the Tribunal
(26) The Ontario Land Tribunal has authority to take evidence, to refuse the permit or to order the authority to issue the permit, with or without conditions. 2020, c. 36, Sched. 6, s. 16 (2); 2021, c. 4, Sched. 6, s. 39 (13).

Section Amendments with date in force (d/m/y) [+]

Permits issued by Minister
Minister's order
28.1.1 (1) Despite subsection 28.1 (1) and subject to the regulations, the Minister may, by order,

(a) direct an authority not to issue a permit to a person who wishes to engage in a specified activity that, without the permit, would be prohibited under section 28 in the area of jurisdiction of the authority; or

(b) direct the authorities that are specified in the order not to issue permits to persons who may wish to engage in a type or class of activity described in the order that, without the permit, would be prohibited under section 28 and to continue to refrain from doing so for such period as may be specified in the order. 2020, c. 36, Sched. 6, s. 17.

Minister's power

(2) If an order is made under subsection (1), the Minister has the power to issue a permit to engage in any activity described in the order that would otherwise be prohibited under section 28 if, in the Minister's opinion, the criteria described in clauses 28.1 (1) (a), (b) and (c) are satisfied. 2020, c. 36, Sched. 6, s. 17.

Same

(3) An order made under clause (1) (a) may be made either before or after an application for a permit has been submitted to the relevant authority. 2020, c. 36, Sched. 6, s. 17.

Same

(4) An order made under clause (1) (b) may provide that it applies to activities even if applications for permits have been submitted to the relevant authorities and decisions with respect to the applications are currently pending. 2020, c. 36, Sched. 6, s. 17.

Notice of order

(5) Notice of an order made under subsection (1) shall be,

(a) given to every authority that is directed by the order not to issue one or more permits;

(b) given to any person who submitted an application for the permits in question before the order was made where the application is still pending; and

(c) posted on the Environmental Registry within 30 days of being made. 2020, c. 36, Sched. 6, s. 17.

Information forwarded to Minister

(6) If an application for a permit to engage in an activity is submitted to an authority under section 28.1 before the day an order is made under this section directing the authority to not issue such a permit,

(a) the authority shall forward to the Minister all documents and information relating to the application that were submitted by the applicant and shall do so within the time period set out in the order, if any; and

(b) the applicant shall forward to the Minister such further information as the Minister may specify in the order and shall do so within the time period set out in the order, if any. 2020, c. 36, Sched. 6, s. 17.

Application to Minister

(7) If an order is made under this section that prevents an authority from issuing a permit to engage in an activity in circumstances where an application for such a permit has not yet been submitted to the authority but may be submitted in the future,

(a) any person who wishes to engage in the activity shall submit to the Minister,

(i) an application for a permit to do so that includes such information as may be specified in the regulation,

(ii) a fee in the same amount as the fee that the person would have paid to the authority had the application been submitted to the authority, and

(iii) any information that the Minister believes is necessary to make a determination with respect to the issuance of the permit and that may be specified in the order; and

(b) if the authority receives an application for such a permit after the day the order is made, the authority shall direct the applicant to submit the application in accordance with clause (a). 2020, c. 36, Sched. 6, s. 17.

Conferring with persons, etc.
(8) Before making a decision with respect to an application for a permit, the Minister may confer with any person or body that the Minister considers may have an interest in the application. 2020, c. 36, Sched. 6, s. 17.

Conditions
(9) The Minister may issue a permit subject to such conditions as the Minister determines are appropriate. 2020, c. 36, Sched. 6, s. 17.

Reasons
(10) If the Minister refuses a permit or issues a permit subject to conditions, the Minister shall give the applicant written reasons for the decision and shall provide a copy of the reasons to the relevant authority. 2020, c. 36, Sched. 6, s. 17.

Copy to authority
(11) If the Minister issues a permit under this section, the Minister shall give a copy of the permit to the authority that has jurisdiction over the watershed for which the permit is valid within five days after the permit is issued. 2020, c. 36, Sched. 6, s. 17.

Decision final
(12) A decision made by the Minister with respect to an application for a permit is final. 2020, c. 36, Sched. 6, s. 17.

Appeal
(13) If an application for a permit is made or forwarded to the Minister under this section and the application complies with the requirements of subsection 28.1 (3) or clause (7) (a) of this section, as the case may be, and if the Minister fails to give the applicant notice of a decision with respect to the application within 90 days after the application is made, the applicant may appeal the application directly to the Ontario Land Tribunal. 2020, c. 36, Sched. 6, s. 17; 2021, c. 4, Sched. 6, s. 39 (14).

Same
(14) Subsections 28.1 (24), (25) and (26) apply with necessary modifications to an appeal to the Ontario Land Tribunal made under subsection (13). 2020, c. 36, Sched. 6, s. 17; 2021, c. 4, Sched. 6, s. 39 (14).

Section Amendments with date in force (d/m/y) [+]

Mandatory permits, zoning orders
28.1.2 (1) This section applies to any application submitted to an authority under section 28.1 for a permit to carry out a development project in the authority's area of jurisdiction if,

(a) an order has been made by the Minister of Municipal Affairs and Housing under section 34.1 or 47 of the *Planning Act* authorizing the development project under that Act;

(b) the lands in the authority's area of jurisdiction on which the development project is to be carried out are not located in the Greenbelt Area designated under section 2 of the *Greenbelt Act, 2005*; and

(c) such other requirements as may be prescribed are satisfied. 2020, c. 36, Sched. 6, s. 17; 2022, c. 21, Sched. 2, s. 10 (1).

Definition
(2) In this section,

"development project" means development activity as defined in subsection 28 (5) or any other act or activity that, without a permit issued under this section or section 28.1, would be prohibited under section 28. 2020, c. 36, Sched. 6, s. 17; 2022, c. 21, Sched. 2, s. 10 (2).

Permit to be issued
(3) Subject to the regulations, an authority that receives an application for a permit to carry out a development project in the authority's area of jurisdiction shall issue the permit if all of the requirements in clauses (1) (a), (b) and (c) are satisfied. 2020, c. 36, Sched. 6, s. 17.

Same

(4) For greater certainty, an authority shall not refuse to issue a permit to carry out a development project under subsection (3) despite,

(a) the prohibitions in subsection 28 (1) and the fact that the development project may not meet the criteria for issuing a permit under subsection 28.1 (1); and

(b) anything in subsection 3 (5) of the *Planning Act*. 2020, c. 36, Sched. 6, s. 17.

Conditions prescribed by regulations

(5) A permit granted under this section is subject to such conditions as may be prescribed. 2020, c. 36, Sched. 6, s. 17; 2022, c. 21, Sched. 2, s. 10 (3).

Conditions specified by authority

(6) Subject to subsection (7), an authority may attach conditions to the permit, including conditions to mitigate,

(a) any effects the development project is likely to have on the control of flooding, erosion, dynamic beaches or unstable soil or bedrock;

(b) any conditions or circumstances created by the development project that, in the event of a natural hazard, might jeopardize the health or safety of persons or result in the damage or destruction of property; or

(c) any other matters that may be prescribed by regulation. 2020, c. 36, Sched. 6, s. 17; 2022, c. 21, Sched. 2, s. 10 (4).

Hearing

(7) An authority shall not attach conditions to a permit unless the applicant for the permit has been given an opportunity to be heard by the authority. 2020, c. 36, Sched. 6, s. 17.

Reasons for conditions

(8) If, after holding a hearing, an authority issues a permit subject to conditions, the authority shall give the permit holder written reasons for deciding to attach the conditions. 2020, c. 36, Sched. 6, s. 17.

Request for Minister's review

(9) A permit holder who objects to any conditions attached to the permit by an authority may, within 15 days of the reasons being given under subsection (8), submit a request to the Minister for the Minister to review the conditions, subject to the regulations. 2022, c. 21, Sched. 2, s. 10 (5).

Minister's review

(10) Subsections 28.1 (9) to (14) apply with necessary modifications to a Minister's review conducted pursuant to a request made under subsection (9). 2020, c. 36, Sched. 6, s. 17.

Minister's decision

(11) After conducting a review of an authority's decision, the Minister may confirm or vary the conditions attached by the authority to a permit, including removing conditions or requiring that such additional conditions be attached to the permit as the Minister considers appropriate. 2020, c. 36, Sched. 6, s. 17; 2022, c. 21, Sched. 2, s. 10 (6).

Same

(12) In making a decision under subsection (11), the Minister shall consider,

(a) effects the development project is likely to have on the control of flooding, erosion, dynamic beaches or unstable soil or bedrock;

(b) conditions or circumstances created by the development project that, in the event of a natural hazard, might jeopardize the health or safety of persons or result in the damage or destruction of property; or

(c) any other matters as may be prescribed by the regulations. 2020, c. 36, Sched. 6, s. 17; 2022, c. 21, Sched. 2, s. 10 (7).

Decision final
(13) A decision made by the Minister under subsection (11) is final. 2020, c. 36, Sched. 6, s. 17.

Appeal
(14) A permit holder who objects to any conditions attached to the permit by an authority may, within 90 days of the reasons being given under subsection (8), appeal to the Ontario Land Tribunal to review the conditions if,

(a) the permit holder has not submitted a request under subsection (9) to the Minister to review the conditions; or

(b) the permit holder has submitted a request to the Minister to review the conditions under subsection (9) and,

(i) 30 days have elapsed following the day the permit holder submitted the request and the Minister did not make a reply in accordance with subsection 28.1 (9), or

(ii) the Minister made a reply in accordance with subsection 28.1 (9) indicating that the Minister refused to conduct the review. 2020, c. 36, Sched. 6, s. 17; 2021, c. 4, Sched. 6, s. 39 (14); 2022, c. 21, Sched. 2, s. 10 (8).

Same
(15) If the Minister indicates in a reply given in accordance with subsection 28.1 (9) that the Minister intends to review an authority's decision and the Minister fails to make a decision within 90 days of giving the reply, the permit holder may, within the next 30 days, appeal the conditions attached by the authority directly to the Ontario Land Tribunal. 2020, c. 36, Sched. 6, s. 17; 2021, c. 4, Sched. 6, s. 39 (14); 2022, c. 21, Sched. 2, s. 10 (9).

Same
(16) Subsections 28.1 (24), (25) and (26) apply with necessary modifications to an appeal made under subsection (14) or (15). 2020, c. 36, Sched. 6, s. 17.

Agreement
(17) An authority that issues a permit to carry out a development project under this section shall enter into an agreement with respect to the development project with the permit holder and the authority and the permit holder may add a municipality or such other person or entity as they consider appropriate as parties to the agreement. 2020, c. 36, Sched. 6, s. 17.

Content of agreement
(18) An agreement under subsection (17) shall set out actions or requirements that the permit holder must complete or satisfy in order to compensate for ecological impacts and any other impacts that may result from the development project. 2020, c. 36, Sched. 6, s. 17.

Limitation on development
(19) No person shall begin a development project until an agreement required under subsection (17) has been entered into. 2020, c. 36, Sched. 6, s. 17.

Same
(19.1) If a regulation made under subsection 40 (4) provides that a development project may begin prior to entering into an agreement under subsection (17), but an agreement is not entered into by the date identified in the regulation, no person shall carry out the development project until such time the agreement is entered into. 2022, c. 21, Sched. 2, s. 10 (10).

Conflict
(20) If the conditions attached to a permit issued under this section conflict with the terms of an order made under section 34.1 or 47 of the *Planning Act*, the terms of the order shall prevail. 2022, c. 21, Sched. 2, s. 10 (11).

Section Amendments with date in force (d/m/y) [+]

Period of validity
28.2 A permit shall be valid for a period to be determined in accordance with the regulations. 2017, c. 23, Sched. 4, s. 25.

Section Amendments with date in force (d/m/y) [+]

Cancellation of permits

28.3 (1) An authority may cancel a permit issued under section 28.1 or 28.1.1 if it is of the opinion that the conditions of the permit have not been met or that the circumstances that are prescribed by regulation exist. 2017, c. 23, Sched. 4, s. 25; 2020, c. 36, Sched. 6, s. 18 (1).

Notice

(2) Before cancelling a permit, an authority shall give a notice of intent to cancel to the permit holder indicating that the permit will be cancelled on a date specified in the notice unless the holder requests a hearing under subsection (3). 2017, c. 23, Sched. 4, s. 25.

Request for hearing

(3) Within 15 days of receiving a notice of intent to cancel a permit from the authority, the permit holder may submit a written request for a hearing to the authority. 2017, c. 23, Sched. 4, s. 25.

Hearing

(4) The authority shall set a date for the hearing and hold the hearing within a reasonable time after receiving a request for a hearing. 2017, c. 23, Sched. 4, s. 25.

Power

(5) After a hearing, the authority may confirm, rescind or vary the decision to cancel a permit. 2017, c. 23, Sched. 4, s. 25.

Appeal

(6) If the authority confirms the cancellation of a permit or makes another order under subsection (5) to which the permit holder objects, the permit holder may, within 90 days of receiving notice of the authority's decision, appeal the decision to the Ontario Land Tribunal. 2020, c. 36, Sched. 6, s. 18 (2); 2021, c. 4, Sched. 6, s. 39 (15).

Same

(7) A notice of an appeal under subsection (6) shall be sent to the Ontario Land Tribunal and to the authority by registered mail. 2020, c. 36, Sched. 6, s. 18 (2); 2021, c. 4, Sched. 6, s. 39 (15).

Hearing

(8) The Ontario Land Tribunal shall fix a date for a hearing of an appeal under subsection (6), give notice to all interested parties and give all necessary direction for the hearing. 2020, c. 36, Sched. 6, s. 18 (2); 2021, c. 4, Sched. 6, s. 39 (15).

Powers of the Tribunal

(9) The Ontario Land Tribunal has authority to take evidence, to confirm, rescind or vary the decision to cancel the permit, with or without conditions. 2020, c. 36, Sched. 6, s. 18 (2); 2021, c. 4, Sched. 6, s. 39 (15).

Section Amendments with date in force (d/m/y) [+]

Delegation of power

28.4 An authority may delegate any of its powers relating to the issuance or cancellation of permits under this Act or the regulations, or to the holding of hearings in relation to the permits, to the authority's executive committee or to any other person or body, subject to any limitations or requirements that may be prescribed by regulation. 2017, c. 23, Sched. 4, s. 25.

Section Amendments with date in force (d/m/y) [+]

Regulations: activities affecting natural resources

28.5 (1) The Lieutenant Governor in Council may make regulations with respect to activities that may impact the conservation, restoration, development or management of natural resources and that may be carried out in the areas of jurisdiction of authorities, including regulations,

(a) identifying activities that have or may have an impact on the conservation, restoration, development or management of natural resources for the purposes of the regulation;

(b) regulating those activities;

(c) prohibiting those activities or requiring that a person obtain a permit from the relevant authority to engage in the activities in the authority's area of jurisdiction. 2017, c. 23, Sched. 4, s. 26.

Same

(2) A regulation under clause (1) (c) that requires that a person obtain a permit from the relevant authority to engage in an activity described in subsection (1) may,

(a) provide for applications to be made to an authority for the permit and specify the manner, content and form of the application;

(b) provide for the issuance, expiration, renewal and cancellation of a permit;

(c) require hearings in relation to any matter referred to in clauses (a) and (b) and specify the person before whom, or the body before which, the matter shall be heard, provide for notices and other procedural matters relating to the hearing and provide for an appeal from any decision. 2017, c. 23, Sched. 4, s. 26.

Same

(3) A regulation made under this section may be limited in its application to one or more authorities or activities. 2017, c. 23, Sched. 4, s. 26.

Section Amendments with date in force (d/m/y) [+]

Regulations: public use of authority's property

29 (1) The Minister may make regulations with respect to land and other property owned by authorities including regulations,

(a) regulating and governing the use by the public of the lands and the works, vehicles, boats, services and things of the authority;

(b) providing for the protection and preservation from damage of the property of the authority;

(c) prescribing fees for the occupation and use of lands and works, vehicles, boats, recreational facilities and services;

(d) prescribing permits designating privileges in connection with use of the lands or any part thereof and prescribing fees for permits;

(e) regulating and governing vehicular and pedestrian traffic and prohibiting the use of any class of vehicle or classes of vehicles;

(f) prohibiting or regulating and governing the erection, posting up or other display of notices, signs, sign boards and other advertising devices;

(g) prescribing terms and conditions under which horses, dogs and other animals may be allowed on the lands or any part thereof;

(h) subject to the *Forest Fires Prevention Act* and the regulations made thereunder, prohibiting or regulating and governing the use, setting and extinguishment of fires. R.S.O. 1990, c. C.27, s. 29 (1); 1998, c. 18, Sched. I, s. 13 (1); 2017, c. 23, Sched. 4, s. 27 (1).

(1.1), (1.2) REPEALED: 2017, c. 23, Sched. 4, s. 27 (2).

Same

(2) A regulation made under this section may be limited in its application to one or more authorities. 2017, c. 23, Sched. 4, s. 27 (2).

Section Amendments with date in force (d/m/y) [+]

30 REPEALED: 2017, c. 23, Sched. 4, s. 28.

Section Amendments with date in force (d/m/y) [+]

PART VII
ENFORCEMENT AND OFFENCES

Appointment of officers

30.1 An authority may appoint officers for the purposes of ensuring compliance with this Act and the regulations. 2017, c. 23, Sched. 4, s. 29.

Section Amendments with date in force (d/m/y) [+]

Entry without warrant, permit application

30.2 (1) An officer appointed by an authority under section 30.1 may enter any land situated in the authority's area of jurisdiction, without a warrant and without the consent of the owner or occupier, if,

(a) an application has been submitted under section 28.1 or 28.1.1 for a permit to engage in an activity with respect to the land;

(b) the entry is for the purpose of determining whether to issue a permit; and

(c) the officer has given reasonable notice of the entry to the owner or occupier of the property. 2020, c. 36, Sched. 6, s. 19 (1).

Entry without warrant, compliance

(1.1) An officer appointed by an authority under section 30.1 may enter any land situated in the authority's area of jurisdiction, without a warrant and without the consent of the owner or occupier, if,

(a) the entry is for the purpose of ensuring compliance with subsection 28 (1), 28.1.2 (19) or 28.1.2 (19.1), with a regulation made under section 28.5 or with the conditions of a permit issued under section 28.1, 28.1.1 or 28.1.2 or issued under a regulation made under clause 28.5 (1) (c);

(b) the officer has reasonable grounds to believe that a contravention of a provision of the Act or a regulation referred to in clause (a) or of a condition of a permit referred to in clause (a) is causing or is likely to cause significant damage and,

(i) the damage affects or is likely to affect the control of flooding, erosion, dynamic beaches or unstable soil or bedrock, or

(ii) in the event of a natural hazard, the damage will or is likely to create conditions or circumstances that might jeopardize the health and safety of persons or result in damage or destruction of property; and

(c) the officer has reasonable grounds to believe that the entry is required to prevent or reduce the effects or risks described in clause (b). 2020, c. 36, Sched. 6, s. 19 (1); 2022, c. 21, Sched. 2, s. 11.

No entry to buildings

(2) The power to enter land under subsection (1) or (1.1) does not authorize the entry into a dwelling or other building situated on the land. 2017, c. 23, Sched. 4, s. 29; 2020, c. 36, Sched. 6, s. 19 (2).

Time of entry

(3) The power to enter land under subsection (1) or (1.1) may be exercised at any reasonable time. 2017, c. 23, Sched. 4, s. 29; 2020, c. 36, Sched. 6, s. 19 (2).

Power upon entry

(4) An officer who enters land under subsection (1) or (1.1) may do any of the following things:

1. Inspect any thing that is relevant to the inspection.

2. Conduct any tests, take any measurements, take any specimens or samples, set up any equipment and make any photographic or other records that may be relevant to the inspection.

3. Ask any questions that are relevant to the inspection to the occupant of the land. 2017, c. 23, Sched. 4, s. 29; 2020, c. 36, Sched. 6, s. 19 (2).

No use of force

(5) Subsection (1) or (1.1) does not authorize the use of force. 2017, c. 23, Sched. 4, s. 29; 2020, c. 36, Sched. 6, s. 19 (2).

Experts, etc.

(6) An officer who enters land under this section may be accompanied and assisted by any person with such knowledge, skills or expertise as may be required for the purposes of the inspection. 2017, c. 23, Sched. 4, s. 29.

Section Amendments with date in force (d/m/y) [+]

Searches

Search with warrant

30.3 (1) An officer may obtain a search warrant under Part VIII of the *Provincial Offences Act* in respect of an offence under this Act. 2017, c. 23, Sched. 4, s. 29.

Assistance

(2) The search warrant may authorize any person specified in the warrant to accompany and assist the officer in the execution of the warrant. 2017, c. 23, Sched. 4, s. 29.

Search without warrant

(3) If an officer has reasonable grounds to believe that there is something on land that will afford evidence of an offence under this Act but that the time required to obtain a warrant would lead to the loss, removal or destruction of the evidence, the officer may, without warrant, enter and search the land. 2017, c. 23, Sched. 4, s. 29.

No entry to buildings

(4) The power to enter land under subsection (3) does not authorize the entry into a dwelling or other building situated on the land. 2017, c. 23, Sched. 4, s. 29.

Section Amendments with date in force (d/m/y) [+]

Stop order

30.4 (1) An officer appointed under section 30.1 may make an order requiring a person to stop engaging in or not to engage in an activity if the officer has reasonable grounds to believe that,

(a) the person has engaged in, is engaging in or is about to engage in the activity and, as a result, is contravening or will contravene,

(i) subsection 28 (1), 28.1.2 (19) or 28.1.2 (19.1) or a regulation made under section 28.5, or

(ii) the conditions of a permit issued under section 28.1, 28.1.1 or 28.1.2 or issued under a regulation made under clause 28.5 (1) (c);

(b) the activity has caused, is causing or is likely to cause significant damage and,

(i) the damage affects or is likely to affect the control of flooding, erosion, dynamic beaches or unstable soil or bedrock, or

(ii) in the event of a natural hazard, the damage will or is likely to create conditions or circumstances that might jeopardize the health and safety of persons or result in damage or destruction of property; and

(c) the order will prevent or reduce the damage described in clause (b). 2020, c. 36, Sched. 6, s. 20 (1); 2022, c. 21, Sched. 2, s. 12.

Information to be included in the order
(2) The order shall,

(a) specify the provision that the officer believes is being or is about to be contravened;

(b) briefly describe the nature of the contravention and its location;

(c) briefly describe the nature of the damage being caused or likely to be caused by the activity; and

(d) state that a hearing on the order may be requested in accordance with this section. 2020, c. 36, Sched. 6, s. 20 (1).

Service of order
(3) An order under this section shall be served personally or by registered mail addressed to the person against whom the order is made at the person's last known address. 2017, c. 23, Sched. 4, s. 29.

Registered mail
(4) An order served by registered mail shall be deemed to have been served on the fifth day after the day of mailing, unless the person served establishes that the person did not, acting in good faith, through absence, accident, illness or other cause beyond the person's control, receive the order until a later date. 2017, c. 23, Sched. 4, s. 29.

Effective date
(5) An order under this section takes effect when it is served, or at such later time as is specified in the order. 2017, c. 23, Sched. 4, s. 29.

Right to hearing
(6) A person who is served with an order under this section may request a hearing before the authority or, if the authority so directs, before the authority's executive committee by mailing or delivering to the authority, within 30 days after service of the order, a written request for a hearing that includes a statement of the reasons for requesting the hearing. 2017, c. 23, Sched. 4, s. 29.

Powers of authority
(7) After holding a hearing, the authority or executive committee, as the case may be, shall,

(a) confirm the order;

(b) amend the order; or

(c) remove the order, with or without conditions. 2017, c. 23, Sched. 4, s. 29.

Reasons for decision
(8) The authority or executive committee, as the case may be, shall give the person who requested the hearing written reasons for the decision. 2017, c. 23, Sched. 4, s. 29.

Appeal
(9) Within 30 days after receiving the reasons in subsection (8), the person who requested the hearing may appeal to the Minister or to a body prescribed by the regulations and, after reviewing the submissions, the Minister or the prescribed body may,

(a) confirm the order;

(b) amend the order; or

(c) remove the order, with or without conditions. 2017, c. 23, Sched. 4, s. 29; 2020, c. 36, Sched. 6, s. 20 (2).

Section Amendments with date in force (d/m/y) [+]

Offences
30.5 (1) Every person is guilty of an offence if the person contravenes,

(a) subsection 28 (1), 28.1.2 (19) or 28.1.2 (19.1);

(b) a regulation respecting activities permitted under subsection 28 (3), (4) or (4.1) or a regulation made under section 28.5;

(c) the conditions of a permit that was issued under section 28.1, 28.1.1 or 28.1.2 or under a regulation made under clause 28.5 (1) (c); or

(d) a stop order issued under section 30.4. 2020, c. 36, Sched. 6, s. 21; 2022, c. 21, Sched. 2, s. 13.

Penalty

(2) A person who commits an offence under subsection (1) is liable on conviction,

(a) in the case of an individual,

(i) to a fine of not more than $50,000 or to a term of imprisonment of not more than three months, or to both, and

(ii) to an additional fine of not more than $10,000 for each day or part of a day on which the offence occurs or continues; and

(b) in the case of a corporation,

(i) to a fine of not more than $1,000,000, and

(ii) to an additional fine of not more than $200,000 for each day or part of a day on which the offence occurs or continues. 2017, c. 23, Sched. 4, s. 29.

Monetary benefit

(3) Despite the maximum fines set out in clauses (2) (a) and (b), a court that convicts a person of an offence under clause (1) (a) or (b) may increase the fine it imposes on the person by an amount equal to the amount of the monetary benefit that was acquired by the person, or that accrued to the person, as a result of the commission of the offence. 2017, c. 23, Sched. 4, s. 29.

Contravening s. 29 regulations

(4) Every person who contravenes a regulation made under section 29 is guilty of an offence and on conviction is liable to a fine of not more than $1,000. 2017, c. 23, Sched. 4, s. 29.

Obstruction of officer

(5) Every person who prevents or obstructs an officer from entering land under section 30.2 or 30.3 is guilty of an offence and on conviction is liable to a fine of not more than $10,000. 2017, c. 23, Sched. 4, s. 29.

Section Amendments with date in force (d/m/y) [+]

Limitation period

30.6 A proceeding shall not be commenced with respect to an offence under subsection 30.5 (1), (4) or (5) more than two years after the day on which the offence first comes to the attention of an officer appointed under section 30.1. 2017, c. 23, Sched. 4, s. 29.

Section Amendments with date in force (d/m/y) [+]

Rehabilitation orders

30.7 (1) In addition to any other remedy or penalty provided by law, the court, upon convicting a person of an offence under clause 30.5 (1) (a) or (b), may order the convicted person to,

(a) remove, at the convicted person’s expense, any development within such reasonable time as the court orders; and

(b) take such actions as the court directs, within the time the court may specify, to repair or rehabilitate the damage that results from or is in any way connected to the commission of the offence. 2017, c. 23, Sched. 4, s. 29.

Non-compliance with order

(2) If a person does not comply with an order made under subsection (1), the authority having jurisdiction may arrange for any removal, repair or rehabilitation that was required of a person under subsection (1) to be carried out. 2017, c. 23, Sched. 4, s. 29.

Liability for certain costs

(3) The person to whom an order is made under subsection (1) is liable for the cost of any removal, repair or rehabilitation arranged by an authority under subsection (2), and the amount is recoverable by the authority by action in a court of competent jurisdiction. 2017, c. 23, Sched. 4, s. 29.

Section Amendments with date in force (d/m/y) [+]

PART VIII
MATTERS RELATING TO LAND AND WATER USE

31 REPEALED: 2020, c. 36, Sched. 6, s. 22.

Section Amendments with date in force (d/m/y) [+]

Restrictions on projects

Crown land affected

32 (1) Where any land required for the carrying out of a project or a part thereof is Crown land, a plan and description of the land prepared and signed by an Ontario land surveyor and signed by the chair or vice-chair of the authority shall be deposited with the Minister, and the project or the part thereof shall not be proceeded with until the authority has received the approval in writing of the Minister. R.S.O. 1990, c. C.27, s. 32 (1).

Interference with public work

(2) Where a project or a part thereof may interfere with a public work of Ontario, the authority shall file with the Minister of Infrastructure a plan and description of the project or a part thereof together with a statement of the interference with the public work that may occur and a statement of the manner in which the authority proposes to remedy the interference, and the project or the part thereof shall not be proceeded with until the authority has received the approval in writing of the Minister of Infrastructure. R.S.O. 1990, c. C.27, s. 32 (2); 1998, c. 15, Sched. E, s. 3 (3); 2011, c. 9, Sched. 27, s. 22.

Interference with highway

(3) Where a project or a part thereof will interfere with a public road or highway, the authority shall file with the Minister of Transportation a plan and description of the project or a part thereof together with a statement of the interference with the public road or highway that will occur and a statement of the manner in which the authority proposes to remedy the interference, and the project or the part thereof shall not be proceeded with until the authority has received the approval in writing of the Minister of Transportation. R.S.O. 1990, c. C.27, s. 32 (3).

Costs, how to be borne

(4) The cost of rebuilding any road, highway, bridge, public work or any part thereof and the cost of any other work that any of the Ministers of the Crown may require to be done under this section shall be borne by the authority, except where an agreement providing for payment thereof in some other manner has been entered into with the Crown in right of Ontario. R.S.O. 1990, c. C.27, s. 32 (4); 1998, c. 15, Sched. E, s. 3 (4).

Section Amendments with date in force (d/m/y) [+]

Assessment of lands of authority

33 (1) Land vested in an authority, except works erected by an authority for the purposes of a project, is taxable for municipal purposes by levy under section 312 of the *Municipal Act, 2001* or section 277 of the *City of Toronto Act, 2006*, as the case may be, upon the assessment and classification of such land determined in each year by the Municipal Property Assessment Corporation and the land shall be assessed under the *Assessment Act* as if the works erected by the authority on the land had not been erected. 1997, c. 5, s. 64 (1); 1997, c. 43, Sched. G, s. 19; 2001, c. 8, s. 203; 2002, c. 17, Sched. F, Table; 2006, c. 32, Sched. C, s. 8.

TAB 2

Ontario

Français

ONTARIO REGULATION 41/24

made under the

CONSERVATION AUTHORITIES ACT

Made: December 5, 2023
Filed: February 16, 2024
Published on e-Laws: February 16, 2024
Published in The Ontario Gazette: March 2, 2024

PROHIBITED ACTIVITIES, EXEMPTIONS AND PERMITS

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Definitions

1. (1) In section 28 of the Act and in this Regulation,

"development activity" means,

(a) the construction, reconstruction, erection or placing of a building or structure of any kind,

(b) any change to a building or structure that would have the effect of altering the use or potential use of the building or structure, increasing the size of the building or structure or increasing the number of dwelling units in the building or structure,

(c) site grading, or

(d) the temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere; ("activité d'aménagement")

"hazardous land" means land that could be unsafe for development because of naturally occurring processes associated with flooding, erosion, dynamic beaches or unstable soil or bedrock; ("terrain dangereux")

"watercourse" means a defined channel, having a bed and banks or sides, in which a flow of water regularly or continuously occurs; ("cours d'eau")

"wetland" means land that,

(a) is seasonally or permanently covered by shallow water or has a water table close to or at its surface,

(b) directly contributes to the hydrological function of a watershed through connection with a surface watercourse,

(c) has hydric soils, the formation of which have been caused by the presence of abundant water, and

(d) has vegetation dominated by hydrophytic plants or water tolerant plants, the dominance of which have been favoured by the presence of abundant water. ("terre marécageuse")

(2) The definition of "wetland" in subsection (1) does not include periodically soaked or wet land used for agricultural purposes which no longer exhibits a wetland characteristic referred to in clause (c) or (d) of that definition.

Prohibited activities, subparagraph 2 iii of s. 28 (1) of the Act

2. (1) For the purposes of subparagraph 2 iii of subsection 28 (1) of the Act, river or stream valleys include river or stream valleys that have depressional features associated with a river or stream, whether or not they contain a watercourse, the limits of which are determined as follows:

1. Where the river or stream valley is apparent and has stable slopes, the valley extends from the stable top of the bank, plus 15 metres, to a similar point on the opposite side.
2. Where the river or stream valley is apparent and has unstable slopes, the valley extends from the predicted long term stable slope projected from the existing stable slope or, if the toe of the slope is unstable, from the predicted location of the toe of the slope as a result of stream erosion over a projected 100-year period, plus 15 metres, to a similar point on the opposite side.
3. Where the river or stream valley is not apparent, the valley extends,
    (i) to the furthest of the following distances:
        A. the distance from a point outside the edge of the maximum extent of the flood plain under the applicable flood event standard to a similar point on the opposite side, and

        B. the distance from the predicted meander belt of a watercourse, expanded as required to convey the flood flows under the applicable flood event standard to a similar point on the opposite side, and

    (ii) an additional 15-metre allowance on each side, except in areas within the jurisdiction of the Niagara Peninsula Conservation Authority.

(2) For the purposes of subparagraph 2 iv of subsection 28 (1) of the Act, areas adjacent or close to the shoreline of the Great Lakes-St. Lawrence River System or to inland lakes that may be affected by flooding, erosion or dynamic beach hazards include,

(a) the area starting from the furthest offshore extent of the authority's boundary to the furthest of the following distances:

(i) the 100-year flood level, plus the appropriate allowance for wave uprush, and, if necessary, for other water-related hazards, including ship-generated waves, ice piling and ice jamming, except in respect of Wanapitei Lake in the Nickel District Conservation Authority, the applicable flood event standard for that lake being the one set out in item 1 of Table 16 of Schedule 1,

(ii) the predicted long-term stable slope projected from the existing stable toe of the slope or from the predicted location of the toe of the slope as that location may have shifted as a result of shoreline erosion over a 100-year period, and

(iii) where a dynamic beach is associated with the waterfront lands, an allowance of 30 metres inland to accommodate dynamic beach movement, except in the areas within the jurisdictions of the Mattagami Region Conservation Authority, the Nickle District Conservation Authority and the North Bay-Mattawa Conservation Authority where the allowance is 15 metres inland; and

(b) the area that is an additional 15 metres allowance inland from the area described in clause (a).

(3) For the purposes of subparagraph 2 v of subsection 28 (1) of the Act, other areas in which development activities are prohibited are the areas within an authority's area of jurisdiction that are within 30 metres of a wetland.

Applicable Flood Event Standards

3. The applicable flood event standards with respect to an authority, for the purposes of paragraph 3 of subsection 2 (1) and to determine the maximum susceptibility to flooding of lands or areas in the area of jurisdiction of an authority are the standards specified in Schedule 1 as those standards are described in Schedule 2.

Maps of regulated areas

4. (1) An authority shall develop maps depicting the areas within the authority's area of jurisdiction where development activities are prohibited under paragraph 2 of subsection 28 (1) of the Act which shall be filed at the head office of the authority and made available to the public on the authority's website, and by any other means that the authority considers advisable.

(2) At least once annually, the authority shall,

(a) review the maps referred to in subsection (1) and determine if updates to the maps are required;

(b) make and file such updates to the maps at its head office if required; and

(c) make the updated maps available to the public on its website and by any other means it considers advisable.

(3) Where new information or analysis becomes available that may result in significant updates to the areas where development activities are prohibited under paragraph 2 of subsection 28 (1) of the Act, including enlargements or reductions to such areas, the authority shall ensure that stakeholders, municipalities and the public are notified of the proposed changes in any manner that the authority considers advisable, including making any relevant information or studies available online at least 30 days prior to an authority meeting during which the proposed changes are on the agenda.

(4) Where significant changes to the areas where development activities are prohibited have been made in accordance with subsection (3), the authority shall promptly update the maps described in subsection (1).

(5) For greater certainty, in case of a conflict regarding the boundaries of the areas where development activities are prohibited under paragraph 2 of subsection 28 (1) of the Act, the description of those areas in that paragraph and in section 2 of this Regulation prevail over the depiction of the areas in the maps referred to in subsection (1) of this section.

Exceptions

5. Paragraph 2 of subsection 28 (1) of the Act does not apply to,

(a) the construction, reconstruction, erection or placement of,

(i) a seasonal or floating dock that,

(A) is 10 square metres or less,

(B) does not require permanent support structures, and

(C) can be removed in the event of flooding,

(ii) a rail, chain-link or panelled fence with a minimum of 75 millimetres of width between panels, that is not within a wetland or watercourse,

(iii) agricultural in-field erosion control structures that are not within and that do not have any outlet of water directed or connected to a watercourse, wetland or river or stream valley,

(iv) a non-habitable accessory building or structure that,

(A) is incidental or subordinate to the principal building or structure,

(B) is 15 square metres or less, and

(C) is not within a wetland or watercourse, or

(v) an unenclosed detached deck or patio that is 15 square metres or less, is not placed within a watercourse or wetland and does not utilize any method of cantilevering;

(b) the installation of new tile drains that are not within a wetland or watercourse, within 30 metres of a wetland or within 15 metres of a watercourse, and that have an outlet of water that is not directed or connected to a watercourse, wetland or river or stream valley, or the maintenance or repair of existing tile drains;

(c) the installation, maintenance or repair of a pond for watering livestock that is not connected to or within a watercourse or wetland, within 15 metres of a wetland or a watercourse, and where no excavated material is deposited within an area where subsection 28 (1) of the Act applies;

(d) the maintenance or repair of a driveway or private lane that is outside of a wetland or the maintenance or repair of a public road, provided that the driveway or road is not extended or widened and the elevation, bedding materials and existing culverts are not altered;

(e) the maintenance or repair of municipal drains as described in, and conducted in accordance with the mitigation requirements set out in the Drainage Act and the Conservation Authorities Act Protocol, approved by the Minister and available on a government of Ontario website, as it may be amended from time to time; and

(f) the reconstruction of a non-habitable garage with no basement, if the reconstruction does not exceed the existing footprint of the garage and does not allow for a change in the potential use of the garage to create a habitable space.

Pre-submission consultation

6. (1) Prior to submitting an application for a permit under section 28.1 of the Act, an authority and the applicant may engage in pre-submission consultation for the purposes of confirming the requirements of a complete application to obtain a permit for the activity in question, which may include,

(a) requests by the authority to the applicant for,

(i) initial information on the proposed activity such as a description of the project and any associated plans, or

(ii) details about the property upon which the activities are proposed to be carried out, including copies of plans, maps or surveys; or

(b) meetings between the authority and the applicant prior to the submission of an application, including any site visits to the property where the activities are proposed to be carried out.

(2) If the applicant requests a pre-submission consultation under subsection (1), the authority is required to engage in the pre-submission consultation.

Application for permit

7. (1) An application for a permit under section 28.1 of the Act shall be submitted to an authority and shall include,

(a) a plan of the area showing the type and location of the proposed development activity or a plan of the area showing plan view and cross-section details of an activity to straighten, change, divert or interfere with the existing channel of a river, creek, stream or watercourse, or change or interfere with a wetland;

(b) the proposed use of any buildings and structures following completion of the development activity or a statement of the purpose of an activity to straighten, change, divert or interfere with the existing channel of a river, creek, stream or watercourse or to change or interfere with a wetland;

(c) the start and completion dates of the development activity or other activity;

(d) a description of the methods to be used in carrying out an activity to straighten, change, divert or interfere with the existing channel of a river, creek, stream or watercourse, or change or interfere with a wetland;

(e) the elevations of existing buildings, if any, and grades and the proposed elevations of any buildings and grades after the development activity or other activity;

(f) drainage details before and after the development activity or other activity;

(g) a complete description of any type of fill proposed to be placed or dumped;

(h) a confirmation of authorization for the proposed development activity or other activity given by the owner of the subject property, if the applicant is not the owner; and

(i) any other technical information, studies or plans that the authority requests including information requested during pre-submission consultations between the authority and the applicant.

(2) Upon receipt of the information required under subsection (1) and payment by the applicant of the fee charged by the authority under subsection 21.2 (4) of the Act, the authority shall notify the applicant in writing, within 21 days, whether or not the application complies with subsection 28.1 (3) of the Act and is deemed to be a complete application.

(3) If the authority notifies an applicant under subsection (2) that the application is complete, the authority shall not require new studies, technical information or plans under clause (1) (i) from the applicant to make a determination on the application, unless agreed to by the authority and the applicant. For greater certainty, the authority may ask the applicant for clarification or further details regarding any matter related to the application.

Request for review

8. (1) An applicant may request a review by the authority if,

(a) the applicant has not received a notice from the authority within 21 days in accordance with subsection 7 (2);

(b) the applicant disagrees with the authority's determination that the application for a permit is incomplete; or

(c) the applicant is of the view that a request by the authority for other information, studies or plans under clause 7 (1) (i) is not reasonable.

(2) A review requested by an applicant under subsection (1) shall be completed by the authority no later than 30 days after it is requested and the authority shall, as the case may be,

(a) confirm that the application meets the requirements of subsection 7 (1) and is complete or provide reasons why the application is incomplete; or

(b) provide reasons why a request for other information, studies or plans under clause 7 (1) (i) is reasonable or withdraw the request for all or some of the information, studies or plans.

Conditions of permits

9. (1) An authority may attach conditions on a permit issued under section 28.1 of the Act only if, in the opinion of the authority, the conditions,

(a) assist in preventing or mitigating any effects on the control of flooding, erosion, dynamic beaches or unstable soil or bedrock;

(b) assist in preventing or mitigating any effects on human health or safety or any damage or destruction of property in the event of a natural hazard; or

(c) support the administration or implementation of the permit, including conditions related to reporting, notification, monitoring and compliance with the permit.

(2) In addition to the conditions referred to in subsection (1), the Lake Simcoe Region Conservation Authority may attach conditions to a permit that relate to designated policies and other policies in the Lake Simcoe Protection Plan that apply to the issuance of the permit.

Lake Simcoe Protection requirements

10. For the purpose of clause 28.1 (1) (c) of the Act, a decision to issue a permit within the area of jurisdiction of the Lake Simcoe Region Conservation Authority shall,

(a) conform with any designated policies in the Lake Simcoe Protection Plan that apply to the issuance of the permit; and

(b) have regard to any other policies in the Lake Simcoe Protection Plan that apply to the issuance of the permit.

Period of validity of permits and extensions

11. (1) The maximum period of validity of a permit issued under sections 28.1, 28.1.1 and 28.1.2 of the Act, including any extension, is 60 months.

(2) If a permit is issued for less than the maximum period of validity, the holder of a permit may, at least 60 days before the expiry of the permit, submit an application for an extension of the permit to,

(a) the authority that issued the permit, in the case of permits issued under section 28.1 or 28.1.2 of the Act; or

(b) the Minister, in the case of permits issued under section 28.1.1 of the Act.

(3) An authority or the Minister, as the case may be, may approve an extension of the period of validity of a permit that was issued for a period of less than 60 months but the total period of validity of the permit, including the extension, shall not exceed 60 months.

(4) If an authority intends to refuse a request for an extension, the authority shall give notice of intent to refuse to the holder of the permit, indicating that the extension will be refused unless the holder requests a hearing under subsection (5).

(5) Within 15 days of receiving a notice of intent to refuse a request for an extension, the holder of the permit may submit a written request for a hearing to the authority.

(6) If a request for hearing is submitted under subsection (5), the authority shall hold the hearing within a reasonable time, and shall give the holder at least five days notice of the date of the hearing.

(7) After holding a hearing under subsection (6), the authority may,

(a) confirm the refusal of the extension; or

(b) grant an extension for such period of time as it deems appropriate, as long as the total period of validity of the permit does not exceed the applicable maximum period specified in subsection (1).

Policy and procedure documents re permits

12. Each authority shall develop policy and procedure documents with respect to permit applications and reviews that, at a minimum, include the following:

1. Additional details regarding the pre-submission consultation process described in section 6 as well as additional details related to complete permit application requirements.
2. Procedures respecting the process for a review under section 8.

3. Standard timelines for the authority to make a decision on permit applications following a notification that an application is complete under subsection 7 (2), as the authority determines advisable.
4. Any other policies and procedures, as the authority considers advisable, for the purpose of administering the issuance of permits under Part VI of the Act.
5. A process for the periodic review and updating of the authority's policy and procedure documents, including procedures for consulting with stakeholders and the public during the review and update process, as the authority considers advisable.

Commencement

13. This Regulation comes into force on the later of the day subsection 25 (2) of Schedule 6 to the *Protect, Support and Recover from COVID-19 Act (Budget Measures), 2020* comes into force and the day this Regulation is filed.

SCHEDULE 1
FLOOD EVENT STANDARDS

1. For the following conservation authorities, the applicable flood event standards are those specified in Table 1 below:

1. Ausable Bayfield Conservation Authority.
2. Catfish Creek Conservation Authority.
3. Credit Valley Conservation Authority.
4. Ganaraska Region Conservation Authority.
5. Grand River Conservation Authority.
6. Halton Region Conservation Authority.
7. Kettle Creek Conservation Authority.
8. Maitland Valley Conservation Authority.
9. Saugeen Valley Conservation Authority.
10. Toronto and Region Conservation Authority.

TABLE 1

Item	Areas	Applicable Flood Event Standards
1.	All areas	The Hurricane Hazel Flood Event Standard, the 100 Year Flood Event Standard and the 100-year flood level plus wave uprush

2. For the following conservation authorities, the applicable flood event standards are those specified in Table 2 below:

1. Cataraqui Region Conservation Authority.
2. Long Point Region Conservation Authority.
3. Quinte Region Conservation Authority.
4. Raisin Region Conservation Authority.
5. South Nation River Conservation Authority.

TABLE 2

Item	Areas	Applicable Flood Event Standards

1.	All areas	The 100 Year Flood Event Standard and the 100-year flood level plus wave uprush

3. For the following conservation authorities, the applicable flood event standards are those specified in Table 3 below:

1. Mississippi Valley Conservation Authority.
2. Rideau Valley Conservation Authority.

TABLE 3

Item	Areas	Applicable Flood Event Standards
1.	All areas	The 100 Year Flood Event Standard

4. For the following conservation authorities, the applicable flood event standards are those specified in Table 4 below:

1. Mattagami Region Conservation Authority.
2. Nottawasaga Valley Conservation Authority.
3. Sault Ste. Marie Region Conservation Authority.

TABLE 4

Item	Areas	Applicable Flood Event Standards
1.	All areas	The 100 Year Flood Event Standard, the Timmins Flood Event Standard, and the 100-year flood level plus wave uprush

5. For the Crowe Valley Conservation Authority, the applicable flood event standards are those specified in Table 5 below:

TABLE 5

Item	Areas	Applicable Flood Event Standards
1.	All areas	The 100 Year Flood Event Standard, the Timmins Flood Event Standard, the Hurricane Hazel Flood Event Standard and the 100-year flood level

6. For the Kawartha Region Conservation Authority, the applicable flood event standards are those specified in Table 6 below:

TABLE 6

Item	Areas	Applicable Flood Event Standards
1.	All areas	The 100 Year Flood Event Standard and the Timmins Flood Event Standard

7. For the Central Lake Ontario Conservation Authority, the applicable flood event standards are those specified in Table 7 below:

TABLE 7

Item	Areas	Applicable Flood Event Standards
1.	Pringle Creek and Darlington	The 100 Year Flood Event Standard
2.	Lake Ontario in the Great Lakes-St. Lawrence River System	The 100-year flood level plus wave uprush
3.	All other areas	The Hurricane Hazel Flood Event Standard

8. For the Essex Region Conservation Authority, the applicable flood event standards are those specified in Table 8 below:

TABLE 8

Item	Areas	Applicable Flood Event Standards
1.	The main branch and the east branch (Silver Creek) of the Ruscom River, and its tributaries within the Town of Lakeshore and the Town of Kingsville and the main and north branch of Canard River in the Town of LaSalle, Concessions I and II, and on the main branch of the Canard River in the Town of Amherstburg, Concessions I, II, III and IV	The March 1985 Flood Event Standard

2.	All other areas	The 100 Year Flood Event Standard

9. For the Grey Sauble Conservation Authority, the applicable flood event standards are those specified in Table 9 below:

TABLE 9

Item	Areas	Applicable Flood Event Standards
1.	The Sauble River Watershed	The 100 Year Flood Event Standard
2.	Lake Huron and Georgian Bay in the Great Lakes-St. Lawrence River System	The 100-year flood level plus wave uprush
3.	All other watersheds	The Timmins Flood Event Standard

10. For the Hamilton Region Conservation Authority, the applicable flood event standards are those specified in Table 10 below:

TABLE 10

Item	Areas	Applicable Flood Event Standards
1.	Watercourses WCO, WCI, WC2, 3, 4, 5.0, 5.1, 6.0, 6.1, 6.2, 6.3, 6.4, 7.0, 7.1, 7.2, 7.3, 8.0, 9.0, 10.0, 10.1, 10.2, 11.0 and 12.0 as indicated on Map Figure 1 of Project 98040-A, Stoney Creek, Stormwater Management Assessment, prepared by Philips Engineering and located at the Hamilton Region Conservation Authority head office and Hamilton Harbour in the Great Lakes-St. Lawrence River System	The 100-year flood level

2.	Lake Ontario in the Great Lakes-St. Lawrence River System	The 100-year flood level plus wave uprush
3.	All other areas	The Hurricane Hazel Flood Event Standard

11. For the Lake Simcoe Region Conservation Authority, the applicable flood event standards are those specified in Table 11 below:

TABLE 11

Item	Areas	Applicable Flood Event Standards
1.	Bunker's Creek and Sophia Creek	The 100 Year Flood Event Standard
2.	Talbot River and the Trent-Severn waterway	The Timmins Flood Event Standard
3.	Lake Simcoe	The 100-year flood level plus wave uprush
4.	All other areas	The Hurricane Hazel Flood Event Standard

12. For the Lakehead Region Conservation Authority, the applicable flood event standards are those specified in Table 12 below:

TABLE 12

Item	Areas	Applicable Flood Event Standards
1.	The main channel of the Kaministiquia River	The 100 Year Flood Event
2.	Lake Superior in the Great Lakes-St. Lawrence River System	The 100-year flood level plus wave uprush
3.	All other areas	Timmins Flood Event Standard

13. For the Lower Thames Valley Conservation Authority, the applicable flood event standards are those specified in Table 13 below:

TABLE 13

Item	Areas	Applicable Flood Event Standards
1.	All areas	The 1937 Regulatory Flood Event Standard and the 100-year flood level plus wave uprush

14. For the Lower Trent Region Conservation Authority, the applicable flood event standards are those specified in Table 14 below:

TABLE 14

Item	Areas	Applicable Flood Event Standards
1.	The main channels of Rice Lake and Trent River	The rainfall, snowmelt, or a combination of rainfall and snowmelt, that would produce the water surface elevations above Canadian Geodetic Datum described in Table 1 of Schedule 3
2.	Lake Ontario in the Great Lakes-St. Lawrence River System	The 100-year flood level plus wave uprush
3.	All other areas	The Timmins Flood Event Standard

15. For the Niagara Peninsula Conservation Authority, the applicable flood event standards are those specified in Table 15 below:

TABLE 15

Item	Areas	Applicable Flood Event Standards
1.	The watersheds associated with Shriner’s Creek, Ten Mile Creek and Beaverdam Creek (including Tributary W-6-5) in the City of Niagara Falls	The Hurricane Hazel Flood Event Standard

2.	Lake Ontario and Lake Erie in the Great Lakes-St. Lawrence River System	The 100-year flood level plus wave uprush
3.	All other areas	The 100 Year Flood Event Standard

16. For the Nickel District Conservation Authority, the applicable flood event standards are those specified in Table 16 below:

TABLE 16

Item	Areas	Applicable Flood Event Standards
1.	Wanapitei Lake	The maximum flood allowance elevation of 267.95 metres Canadian Geodetic Datum (in accordance with Ontario Power Generation's Licence of Occupation Agreement #6168)
2.	All other areas	The Timmins Flood Event Standard and the 100 Year Flood Event Standard

17. For the North Bay-Mattawa Conservation Authority, the applicable flood event standards are those specified in Table 17 below:

TABLE 17

Item	Areas	Applicable Flood Event Standards
1.	Chippewa Creek and its tributaries below the North Bay Escarpment, Parks Creek, the Mattawa River in the Town of Mattawa and the La Vase River	The 100 Year Flood Event Standard
2.	Lake Nipissing	100-year flood level plus wave uprush
3.	All other areas	The Timmins Flood Event Standard

18. For the Otonabee Region Conservation Authority, the applicable flood event standards are those specified in Table 18 below:

TABLE 18

Item	Areas	Applicable Flood Event Standards
1.	Rice Lake, Stony Lake, Clear Lake, Lovesick Lake, Deer Bay, Buckhorn Lake, Chemong Lake, Pigeon Lake, Katchiwanooka Lake and Lower Buckhorn Lake	The rainfall, snowmelt, or a combination of rainfall and snowmelt, that would produce the water surface elevations above Canadian Geodetic Datum described in Table 2 of Schedule 3.
2.	All other areas	The Timmins Flood Event Standard

19. For the St. Clair Region Conservation Authority, the applicable flood event standards are those specified in Table 19 below:

TABLE 19

Item	Areas	Applicable Flood Event Standards
1.	Perch Creek	The 100 Year Flood Event Standard
2.	Lake Huron, Lake St. Clair and St. Clair River in the Great Lakes-St. Lawrence River System	The 100-year flood level plus wave uprush
3.	All other areas	The Hurricane Hazel Flood Event Standard

20. For the Upper Thames Region Conservation Authority, the applicable flood event standards are those specified in Table 20 below:

TABLE 20

Item	Areas	Applicable Flood Event Standards
1.	All areas	The 1937 Flood Event Standard

SCHEDULE 2
DESCRIPTION OF STANDARDS

1. The Hurricane Hazel Flood Event Standard means a storm that produces over a 48-hour period,

(a) in a drainage area of 25 square kilometres or less, rainfall that has the distribution set out in Table 1; or

(b) in a drainage area of more than 25 square kilometres, rainfall such that the number of millimetres of rain referred to in each case in Table 1 is modified by the percentage amount shown in Column 2 of Table 2 opposite the corresponding size of the drainage area set out Column 1 of Table 2.

TABLE 1

73 millimetres of rain in the first 36 hours
6 millimetres of rain in the 37th hour
4 millimetres of rain in the 38th hour
6 millimetres of rain in the 39th hour
13 millimetres of rain in the 40th hour
17 millimetres of rain in the 41st hour
13 millimetres of rain in the 42nd hour
23 millimetres of rain in the 43rd hour
13 millimetres of rain in the 44th hour
13 millimetres of rain in the 45th hour
53 millimetres of rain in the 46th hour
38 millimetres of rain in the 47th hour
13 millimetres of rain in the 48th hour

TABLE 2

Column 1 Drainage Area (square kilometres)	Column 2 Percentage
26 to 45 both inclusive	99.2
46 to 65 both inclusive	98.2
66 to 90 both inclusive	97.1
91 to 115 both inclusive	96.3
116 to 140 both inclusive	95.4
141 to 165 both inclusive	94.8
166 to 195 both inclusive	94.2
196 to 220 both inclusive	93.5
221 to 245 both inclusive	92.7
246 to 270 both inclusive	92.0
271 to 450 both inclusive	89.4
451 to 575 both inclusive	86.7
576 to 700 both inclusive	84.0
701 to 850 both inclusive	82.4

851 to 1000 both inclusive	80.8
1001 to 1200 both inclusive	79.3
1201 to 1500 both inclusive	76.6
1501 to 1700 both inclusive	74.4
1701 to 2000 both inclusive	73.3
2001 to 2200 both inclusive	71.7
2201 to 2500 both inclusive	70.2
2501 to 2700 both inclusive	69.0
2701 to 4500 both inclusive	64.4
4501 to 6000 both inclusive	61.4
6001 to 7000 both inclusive	58.9
7001 to 8000 both inclusive	57.4

2. The Timmins Flood Event Standard means a storm that produces over a 12-hour period,

(a) in a drainage area of 25 square kilometres or less, rainfall that has the distribution set out in Table 3; or

(b) in a drainage area of more than 25 square kilometres, rainfall such that the number of millimetres of rain referred to in each case in Table 3 is modified by the percentage amount shown in Column 2 of Table 4 opposite the corresponding size of the drainage area set out in Column 1 of Table 4.

TABLE 3

15 mm of rain in the 1st hour
20 mm of rain in the 2nd hour
10 mm of rain in the 3rd hour
3 mm of rain in the 4th hour
5 mm of rain in the 5th hour
20 mm of rain in the 6th hour
43 mm of rain in the 7th hour
20 mm of rain in the 8th hour
23 mm of rain in the 9th hour
13 mm of rain in the 10th hour
13 mm of rain in the 11th hour
8 mm of rain in the 12th hour

TABLE 4

Column 1 Drainage Area (km^2)	Column 2 Percentage
26 to 50 both inclusive	97
51 to 75 both inclusive	94

76 to 100 both inclusive	90
101 to 150 both inclusive	87
151 to 200 both inclusive	84
201 to 250 both inclusive	82
251 to 375 both inclusive	79
376 to 500 both inclusive	76
501 to 750 both inclusive	74
751 to 1000 both inclusive	70
1001 to 1250 both inclusive	68
1251 to 1500 both inclusive	66
1501 to 1800 both inclusive	65
1801 to 2100 both inclusive	64
2101 to 2300 both inclusive	63
2301 to 2600 both inclusive	62
2601 to 3900 both inclusive	58
3901 to 5200 both inclusive	56
5201 to 6500 both inclusive	53
6501 to 8000 both inclusive	50

3. The 100 Year Flood Event Standard means rainfall, snowmelt, or a combination of rainfall and snowmelt, producing at any location in a river, creek, stream or watercourse a peak flow that has a probability of occurrence of one per cent during any given year.

4. The 100-year flood level means the peak instantaneous still water level plus an allowance for wave uprush and other water-related hazards for inland lakes and the Great Lakes-St. Lawrence River System that has a probability of occurrence of one per cent during any given year.

5. The March 1985 Flood Event Standard means the flood levels observed, surveyed and mapped, and located at the Essex Region Conservation Authority head office, along portions of the relevant prescribed watercourses that exceeded the 100 Year Flood Event Standard.

6. The 1937 Flood Event Standard means the historical observed 1937 flood on the Thames River. This event is equivalent to the combination of events that caused the flood event on the Thames River in April of 1937. The 1937 flood event is estimated to be equivalent to a 1 in 250-year return flood.

7. The 1937 Regulatory Flood Event Standard means the historical observed 1937 flood on the Thames River. This event is equivalent to a flow of 1,540 cubic metres per second (cms) commencing at Delaware and proportionately reducing until 1,160 cms at Thamesville and 1,125 cms at Chatham. The 1937 flood event is estimated to be equivalent to a 1 in 250-year return flood.

SCHEDULE 3
WATER SURFACE ELEVATIONS

1. The water surface elevations above Canadian Geodetic Datum applicable to Item 1 in Table 14 of Schedule 1 are shown in Table 1.

TABLE 1

LOWER TRENT REGION CONSERVATION AUTHORITY

Location	Water Surface Elevation
Rice Lake	187.9 metres
Trent River below Dam #1 (Trenton)	77.2 metres
Trent River below Dam #2 (Sidney)	81.3 metres
Trent River below Dam #3 (Glen Miller)	87.7 metres
Trent River below Dam #4 (Batawa)	95.7 metres
Trent River below Dam #5 (Trent)	101.7 metres
Trent River below Dam #6 (Frankford)	107.9 metres
Trent River below Dam #7 (Glen Ross)	113.5 metres
Trent River below Dam #8 (Meyers)	117.9 metres
Trent River below Dam #9 (Hagues Reach)	128.1 metres
Trent River below Dam # 10 (Ranney Falls)	143.4 metres
Trent River below Dam #11 (Campbellford)	148.3 metres
Trent River below Dam #12 (Crowe Bay)	154.3 metres
Trent River below Dam #13 (Healy Falls)	175.5 metres
Trent River below Dam #14 (Hastings)	186.7 metres

2. The water surface elevations above Canadian Geodetic Datum applicable to Item 1 in Table 18 of Schedule 1 are shown in Table 2.

TABLE 2

OTONABEE REGION CONSERVATION AUTHORITY

Water Body	Water Surface Elevation
Rice Lake	187.90 metres
Stony Lake	235.95 metres
Clear Lake	235.95 metres
Lovesick Lake	242.16 metres

Deer Bay	244.31 metres
Buckhorn Lake	247.12 metres
Chemong Lake	247.12 metres
Pigeon Lake	247.12 metres
Katchiwanooka Lake	233.68 metres
Lower Buckhorn Lake	244.31 metres

Made by:
Pris par :

Le ministre des Richesses naturelles et des Forêts,

GRAYDON SMITH

Minister of Natural Resources and Forestry

Date made: December 5, 2023
Pris le : 5 décembre 2023

Français

TAB 3

Ontario

Niagara Escarpment Planning and Development Act
Loi sur la planification et l'aménagement de l'escarpement du Niagara

R.R.O. 1990, REGULATION 828

DEVELOPMENT WITHIN THE DEVELOPMENT CONTROL AREA

Consolidation Period: From January 1, 2013 to the e-Laws currency date.

Last amendment: 423/12.

Legislative History: [+]

This Regulation is made in English only.

Interpretation

1. (1) In this Regulation,

"dwelling" means a building or part thereof, designed for use by one household and which has for the exclusive use of the household,

(a) one or more habitable rooms,

(b) separate kitchen facilities,

(c) separate sanitary facilities, and

(d) a private entrance from outside the building or from a common area within the building,

but does not include a mobile home;

"front wall" means the wall of a building or structure that is located nearest to the front lot line;

"front yard" means a yard extending across the full width of a lot on which a building or structure is situate, and extending from the front lot line to the part of the building or structure that is nearest to the front lot line;

"general agricultural development" means a class of development whereby land, buildings or structures are used for the purpose of forestry, cultivation of trees and nursery stock, maple sugar harvesting, field crops, fruit farming, market gardening, dairying, animal husbandry, poultry raising, beekeeping, the operation of glass or plastic covered greenhouses, and such uses as are customarily and normally related to agriculture, but does not include,

(a) special agricultural development, or

(b) the construction of an equestrian racetrack or sand ring or any class of development whereby land, buildings or structures are used for the purpose of an equestrian event or a horseback riding school;

"good forestry practices" means the proper implementation of harvest, renewal and maintenance activities known to be appropriate for the forest and environmental conditions under which they are being applied and that minimize detriments to forest values including significant ecosystems, important fish and wildlife habitat, soil and water quality and quantity, forest productivity and health and the aesthetics and recreational opportunities of the landscape;

"group home" means a residence that is licensed or funded by a public agency for the accommodation of three to 10 persons, exclusive of staff, living under supervision in a single housekeeping unit and who, by reason of their emotional, mental, social or physical condition or legal status, need a group living arrangement for their well being;

"household" means one or more persons living as a single housekeeping unit in one dwelling or in a group home;

"lot" means a parcel of land,

(a) described in a deed or other document legally capable of conveying an interest in land, or

(b) shown as a lot or block on a registered plan of subdivision;

"lot area" means the horizontal area within the boundary lines of a lot;

"mobile home" means a vehicle that is,

(a) designed to be pulled or propelled by a motor vehicle, and

(b) used for human habitation;

"professional forester" means a person who holds a certificate of registration under the *Professional Foresters Act, 2000*;

"rear yard" means a yard extended across the full width of a lot upon which a building or structure is situate and from the rear lot line to the part of the building or structure that is nearest to the rear lot line;

"road" means a highway that is,

(a) under the jurisdiction of the Province of Ontario or a municipality, or

(b) a road within a registered plan of subdivision;

"seasonal" means operated for six months or less in a calendar year;

"side yard" means a yard extending from the front yard to the rear yard of a lot upon which a building or structure is situate and from the side lot line to the part of the building or structure that is nearest to the side lot line;

"single dwelling" means a separate building containing only one dwelling;

"special agricultural development" means a class of development whereby land, buildings or structures are used for the purpose of intensive livestock, poultry, cattle or other farm operations and includes use as a piggery, a turkey, game bird or chicken farm or hatchery, a fur farm, a mushroom farm, an animal kennel, a farm for the keeping or display of exotic animals, an aquaculture facility and a feed lot area or manure storage area;

"tree" means a woody plant that,

(a) has reached a height of 4.5 metres or belongs to a species that has an average height of at least 4.5 metres at physiological maturity, and

(b) has a stem diameter of more than 10.2 centimetres when measured from the outside bark at a point 1.3 metres above the ground;

"wind machine" means an engine-driven fan that is used for protecting horticultural crops from damage due to cold air and frost;

"yard" means the area on a lot unoccupied by a building or structure. R.R.O. 1990, Reg. 828, s. 1; O. Reg. 658/92, s. 1; O. Reg. 190/93, s. 1; O. Reg. 48/99, s. 1 (1-4); O. Reg. 423/12, s. 1.

(2) In this Regulation,

(a) a lot that abuts on a road or a body of water is considered to have a front lot line on each lot line that abuts on the road or the water; and

(b) a corner lot is considered to have two front lot lines.

(3) For the purposes of this Regulation, something is accessory to another thing if it is normally incidental or subordinate to the other thing, but a dwelling or other structure that is used for human habitation shall be deemed not to be accessory to anything. O. Reg. 48/99, s. 1 (5).

2. This Regulation applies to the areas of land within the Niagara Escarpment Planning Area that is designated under Regulation 826 of the Revised Regulations of Ontario, 1990 (Designation of Area of Development Control) made under the Act as an area of development control. R.R.O. 1990, Reg. 828, s. 2.

3. Zoning by-laws and the Minister's orders made under section 47 of the *Planning Act* have no effect in the area of development control designated under Regulation 826 of the Revised Regulations of Ontario, 1990 (Designation of Area of Development Control) made under the Act. O. Reg. 48/99, s. 2.

4. An application for a development permit shall be on a form provided by the Commission. O. Reg. 48/99, s. 2.

5. The following classes of development, if listed as permitted uses under the land use policies established in the Niagara Escarpment Plan and not in conflict with a development permit issued under the Act, are exempt from the requirement of obtaining a development permit:

1. The maintenance or repair of land, buildings or structures damaged, without any human intervention, by fire, lightning, unusually severe weather, storms, floods or other natural causes.
2. The reconstruction of land, buildings or structures damaged or destroyed, without any human intervention, by fire, lightning, unusually severe weather, storms, floods or other natural causes, if the reconstruction,
    i. is on the same site where the damage or destruction occurred,
    ii. does not change the use on the site,
    iii. in the case of a building or structure, results in a building or structure that occupies an area that is not more than that occupied by the original or is of a height that is no greater than that of the original, and
    iv. is started within two years after the damage or destruction occurred.
3. The maintenance, repair, reconstruction or demolition of land, buildings or structures that is required by an order or other instrument issued under an Act by a public authority for the purpose of ensuring public safety or health.

3.1 The environmental remediation of land, buildings or structures that is required by an order or other instrument issued under an Act by a public authority.

4. The maintenance, repair, reconstruction or improvement of the interior of a building or structure that does not change the use of the building or structure.

4.1 The maintenance or repair of the exterior of a building or structure that does not change the use of the building or structure.

4.2 The maintenance, repair, construction or improvement of a building or structure for fire safety and fire exits and barrier free access.

4.3 The maintenance, repair or renewal of highways or municipal roads if the maintenance, repair or renewal does not,
    i. open an unopened road allowance,
    ii. expand the width of the road,
    iii. change the road from a seasonal to a year round road,
    iv. change the surface of the road from gravel to pavement, or
    v. require road cuts and contour changes.

4.4 The maintenance, repair or cleaning of drainage ditches and swales along highways and municipal roads, including the replacement of culverts associated with driveway lanes and entrances onto municipal roads and highways.

4.5 The maintenance or repair of slopes and retaining walls within the road allowance of highways and municipal roads.

4.6 The maintenance or repair of rock faces or cliffs associated with road cuts, including the mechanical scaling of rock cliffs within the road allowance required for safety purposes.

4.7 The maintenance or repair of rock faces or cliffs associated with hydroelectric facilities, including the mechanical scaling of rock cliffs required for safety purposes.

5. The construction, erection, installation, maintenance, repair or renewal of sidewalks, curbs, gutters, street signs and street lights on municipal roads and highways and the maintenance and renewal of driveway lanes and entrances onto municipal roads and highways.

6. The maintenance, repair or renewal of sewers, mains, pipes, cables, including fiber optic cables, wire or other apparatus connected with public utilities, including equipment shelters and lockers, and the breaking open of any municipal road or highway or other land for this purpose.

6.1 The construction or installation of sewers, mains, pipes, cables, including fiber optic cables, wire or other apparatus connected with public utilities, including equipment shelters and lockers, in an area designated as an Urban Area in the Niagara Escarpment Plan.

7. Subject to paragraphs 8, 9, 9.1, 9.2, 10, 11, 13, 13.1, 13.2, 13.3, 20 and 31, general agricultural development.

8. The following classes of development for the purposes of general agricultural development:

i. The cultivation of soil, including the picking and removal of field rocks and stones, but not including the stripping, removal or stockpiling of topsoil, earth, rock, sand, gravel or other aggregate material, the addition of fill or the construction of a berm.

ii. The digging or drilling of a well.

iii. The installation of a farm tile drain.

iv. The installation or operation of a water irrigation system that does not include the construction of a pond or the alteration of a stream or watercourse.

v. The repair, maintenance and cleaning of farm drains.

vi. The spreading of manure and similar farm waste and processed municipal bio-solids in accordance with the *Nutrient Management Act, 2002* and the *Clean Water Act, 2006*.

9. The construction of a building, structure or facility accessory to general agricultural development, other than a dwelling or pond if, on completion of the development, all the following conditions are met:

i. The area of the lot on which the construction occurred is at least 20 hectares.

ii. The side yard depth of the lot on which the construction occurred is at least 15 metres.

iii. The rear yard depth of the lot on which the construction occurred is at least 15 metres.

iv. The building, structure or facility is at least 90 metres from the centre line of an abutting open public road.

v. In the case of an equestrian facility or horse barn, the structure is not greater in size than 450 square metres, not greater in height than 10 metres to the roof peak and does not contain a dwelling.

vi. The building, structure or facility meets the setback requirements calculated under the minimum distance separation formulae as defined in the Niagara Escarpment Plan.

vii. The lot is not identified as an Agricultural Purposes Only Lot in the Niagara Escarpment Plan.

9.1 The conversion and use of agricultural buildings, structures and facilities from one type of livestock, animal husbandry or poultry farming to another on a lot with an area of at least 20 hectares, if the minimum distance separation formulae as defined in the Niagara Escarpment Plan are met and such conversion and use is in accordance with the *Nutrient Management Act, 2002* and the *Clean Water Act, 2006*.

9.2 The installation of a wind machine if the structure is set back 25 metres from any lot line and 125 metres from the nearest dwelling on another lot.

10. A dug farm pond accessory to general agricultural development if, on completion of the development, all the following conditions are met:

i. The pond is not located within the Escarpment Natural Area of the Niagara Escarpment Plan nor within a wetland as defined by the Niagara Escarpment Plan.

ii. The pond does not need construction of a dam or berm and is not located on a stream or watercourse.

iii. The surface area of the pond is located at least 30 metres from the nearest lot line and from any septic system or well.

iv. The surface area of the pond is not greater than 150 square metres.

v. The area of the lot is at least 20 hectares.

vi. The dredged material is used for landscaping immediately around the pond site and rehabilitated with vegetation.

vii. The pond does not require the use of water from a well.

11. The installation of a portable, seasonal farm produce stand or market structure accessory to general agricultural development, other than a food service vehicle, if, on completion of the installation, all the following conditions are met:

i. The total surface area covered by the stand or structure does not exceed 28 square metres.

ii. The setback of the stand or structure from the front lot line is at least 7.5 metres.

iii. The items for sale at the stand or structure are limited to produce grown by or products made from produce grown by the owner or operator of the lot on which the stand or structure is situated.

iv. The stand or structure is removed during the portion of the season when it is not in operation.

11.1 The extension of a single dwelling if, on completion of the extension, the height of the extension does not exceed the height of the original dwelling, the total surface area occupied by the extension does not exceed 93 square metres and the dimensions of the extension are such that either,

i. the yard depth of the lot on which the extension occurred meets the following conditions:

A. the side yard depth is at least 4.5 metres,

B. the rear yard depth is at least 7.5 metres, and

C. the front yard depth is at least 15 metres, or

ii. if the yard depth of the lot on which the single dwelling is situated was less than the yard depth described in sub-paragraph i before the extension was begun, the yard depth of the lot, determined in relation to the extension alone, meets the conditions described in subparagraph i.

11.2 A change to the height or pitch of a roof of a single dwelling, or of a building or structure that is accessory to a single dwelling, for the purpose of maintenance, repair or renewal if,

i. the total floor area of the dwelling, building or structure is not increased,

ii. the height of the dwelling, building or structure is not increased by more than 2.5 metres, and

iii. one of the following conditions is met:

A. In the case of a dwelling, building or structure that before the change had a roof line of 7.5 metres or less in height, the height of the roofline of the dwelling, building or structure after the change does not exceed 7.5 metres.

B. In the case of a dwelling, building or structure that before the change had a roof line of more than 7.5 metres in height, the height of the roof line of the dwelling, building or structure after the change does not exceed the height of the highest part of the roof line as it was before the change.

11.3 The construction or extension of buildings or structures accessory to single dwellings, if all the following conditions are met on the completion of the construction or extension:

i. No accessory building or structure or any part thereof lies between the front lot line and the wall of the dwelling nearest to it, unless the accessory building or structure has a front yard setback of at least 15 metres.

ii. No accessory building or structure or any part thereof is less than one metre from any side or rear lot line.

iii. The total area covered by all accessory buildings and structures does not exceed 5 per cent of the lot area, or 72 square metres, whichever is the lesser.

iv. No accessory building or structure exceeds a height of 4.5 metres.

12. The planting and cultivation of trees or nursery stock.

13. Subject to any applicable municipal by-law or regulation made under any Act that regulates the cutting of trees, the cutting, destruction, removal, pruning, relocation or transplantation of trees on a lot, if the trees are cut, destroyed, removed, pruned, relocated or transplanted for any of the following purposes or reasons:

i. as part of the normal operation of a Christmas tree farm, nursery or orchard,

ii. because the trees constitute a safety hazard,

iii. because the trees are dead or diseased or have been damaged by natural causes and not by human intervention,

iv. for the maintenance of oil and gas pipelines, distribution lines and corridors,

v. for the maintenance of electric power distribution lines and corridors,

vi. for the connection, repair and maintenance of public utilities to approved buildings and structures,

vii. for the maintenance of open public roads and road allowances immediately adjacent to them,

viii. for the maintenance of existing recreational trails,

ix. for personal use by the owner of the lot on which the trees to be cut, destroyed, removed or pruned are situated, if no sale occurs of the trees or any wood products created from the cutting, destruction, removal or pruning of the trees,

x. for controlling exotic pests and diseases through programs authorized or undertaken by public authorities having jurisdiction to prescribe such control,

xi. for forest fire control or controlled burning through programs authorized or undertaken by public authorities having jurisdiction to prescribe such control.

13.1 The non-commercial cutting, destruction, removal, pruning, relocation or transplanting of trees on a lot that is not greater than 0.8 hectares in area, if,

i. the cutting, destruction, removal, pruning, relocation or transplanting is carried out in accordance with good forestry practices, and

ii. there is a municipal by-law governing the cutting, destruction, removal, pruning, relocation or transplanting and all operations are carried out in accordance with the by-law.

13.2 Subject to any municipal by-law that regulates the cutting of trees, the cutting, destruction, removal, pruning, relocating or transplanting, in accordance with good forestry practices, of not more than 10 per cent of the trees within a 10-year period on a lot that is greater than 0.8 hectares in area, if, in the case of an Area of Natural Scientific Interest (Life Science) that is in public ownership, the trees are cut, destroyed, removed, pruned, relocated or transplanted only where it is necessary to maintain the values for which the area was acquired, for emergency access, where existing agreements are in effect, or to implement uses permitted in approved Park and Open Space Plans that are not in conflict with the Niagara Escarpment Plan.

13.3 The cutting, destruction, removal, pruning, relocating or transplanting of more than 10 per cent of the trees within a 10-year period on a lot that is greater than 0.8 hectares in area, if the trees are cut, destroyed, removed, pruned, relocated or transplanted in accordance with,

i. the *Crown Forest Sustainability Act, 1994*, the *Forestry Act*, the *Conservation Authorities Act* or a by-law made under the *Municipal Act, 2001*, and, in the case of an Area of Natural Scientific Interest (Life Science) that is in public ownership, the trees are cut, destroyed, removed, pruned, relocated or transplanted only where it is necessary to maintain the values for which the area was acquired, for emergency access, where existing agreements are in effect or to implement uses permitted in approved Park and Open Space Plans that are not in conflict with the Niagara Escarpment Plan, or

ii. a forest management plan, including tree cutting prescriptions, recommended by the Ministry of Natural Resources, a conservation authority or a professional forester, that,

A. uses tree cutting and management methods designed to minimize adverse effects on the natural environment, including surface drainage and groundwater,

B. minimizes disruption of habitats for plants and animal species occurring in the area,

C. retains the diversity of native tree species and other plant and animal species,

D. aims over the long term to maintain and enhance the quality and productivity of the forest site,

E. minimizes cutting and tree management within highly sensitive areas such as steep slopes, unstable soils, stream valleys, wetlands and areas of significant groundwater recharge and discharge,

F. includes natural regeneration or rehabilitation through reforestation where necessary, and

G. in the case of an Area of Natural Scientific Interest (Life Science) that is in public ownership, permits tree cutting only where it is necessary to maintain the values for which the area was acquired, for emergency access, where existing agreements are in effect or to implement uses permitted in approved Park and Open Space Plans that are not in conflict with the Niagara Escarpment Plan.

14. The maintenance, repair, replacement or decommissioning of a private sewage disposal system that services only the lot on which it is located.

15. The digging or drilling of a well or the installation of a cistern for the purpose of supplying potable water for a single dwelling.

16. The construction of an outdoor swimming pool, spa or hot tub accessory to a single dwelling, including an associated deck, pump, filter or heater, if all the following conditions are met on the completion of the development:

    i. The water area of the swimming pool, spa or hot tub is at least 2.5 metres from the nearest lot line.

    ii. Any associated pump, filter or heater is at least one metre from the nearest lot line.

    iii. The maximum water area is 93 square metres in the case of a swimming pool and 13 square metres in the case of a spa or hot tub.

    iv. Municipal swimming pool, spa or hot tub fencing and safety requirements are met.

    v. If the swimming pool, spa or hot tub is located on a lot containing part of the Escarpment brow as defined in the Niagara Escarpment Plan in which the brow is formed by a rock cliff, the water area of the swimming pool, spa or hot tub is set back at least 10 metres from the location of the brow on the lot.

17. The maintenance of lands, buildings and structures under the jurisdiction of a conservation authority, the establishment of hiking or cross-country ski trails and the erection of signs for the purposes of property identification or interpretative or recreational information on lands owned by a conservation authority.

18. The installation of electric power distribution lines, operating at a nominal voltage not exceeding 50 kilovolts by,

    i. burying the lines underground, or

    ii. using poles not exceeding a height of 18.9 metres to carry them if the distribution lines are,

        A. located on or immediately adjacent to public road allowances, or

        B. located on easements for such distribution lines contained in a registered plan of subdivision or condominium.

18.1 The installation of electric power distribution lines of any voltage if they are added to and carried on existing poles, towers or similar structures that were approved and intended for this purpose.

19. The production of aggregate from land that was licensed for a pit or quarry on June 10, 1975 under the *Pits and Quarries Control Act, 1971* and that has been licensed for a pit or quarry continuously since that date under the *Aggregate Resources Act* or a predecessor of the *Aggregate Resources Act*, including the removal and stockpiling of overburden, the construction of berms and the blasting, excavation, crushing, washing, stockpiling and hauling of aggregate from the licensed site, but not including,

i. dewatering, the taking of water or the discharge of water or sewage, unless the dewatering, taking or discharge was authorized under a permit or approval obtained under the *Ontario Water Resources Act* before Ontario Regulation 469/96 came into force,

ii. the construction of a building, structure or facility, other than a berm,

iii. any activity related to the production of aggregate that was excavated elsewhere, or

iv. any activity related to an asphalt or concrete batch plant or a brick or cement block manufacturing plant.

19.1 The recycling and reprocessing of materials originally produced from aggregate as defined under the Niagara Escarpment Plan within an area licensed for a pit or quarry in the area identified for extraction on the site plans approved under the *Aggregate Resources Act* if the following conditions are met:

i. The recycling and reprocessing use shall be incidental and subordinate to the mineral resource extraction operation licensed pursuant to the *Aggregate Resources Act* and shall not continue after extraction of on-site aggregate materials is complete.

ii. The appropriate amendments to the site plans under the *Aggregate Resources Act* have been obtained from the Ministry of Natural Resources and the site plan shows the recycling location as a separate specific delineated area.

iii. The recycling and reprocessing use shall be operated by the licensee or for the licensee in accordance with the licence and site plans under the *Aggregate Resources Act*.

iv. All waste materials not used in recycling and reprocessing, including steel and rebar shall be removed from the site and not permanently stored or stockpiled.

v. Recyclable asphalt materials will not be stockpiled within 30 metres of any natural or artificial water body or pond or within 2 metres of the surface of the established water table.

vi. The recycling and reprocessing use is limited to crushing, washing, processing, stockpiling, blending and hauling the materials to and from the licensed site but does not include activities specified in subparagraph 19 iv.

vii. The recycled and reprocessed materials shall not be used in the site rehabilitation, berming or screening of the pit or quarry.

viii. Any required permits, approvals, certificates and similar authorizations for the recycling and reprocessing use have been obtained from the Ministry of the Environment.

19.2 The demolition or removal of all or part of any building or structure within an area licensed for a pit or quarry so that extraction can occur within the area identified for extraction on the site plans approved under the *Aggregate Resources Act*, subject to any terms and conditions that apply to such buildings and structures on the licence or the site plan.

20. The demolition of all or part of a dwelling, a building or structure accessory to a dwelling or a building or structure accessory to general agricultural development, if all the following conditions are met:

i. The dwelling, building or structure or the part to be demolished has a total floor space not exceeding 93 square metres.

ii. The dwelling, building or structure or the part to be demolished,

A. is not designated under the *Ontario Heritage Act* as being of historic or architectural value or interest,

B. is not intended to be designated under the *Ontario Heritage Act* as being of historic or architectural value or interest, according to a notice of intention to designate published under that Act, and

C. is not otherwise recognized under any Act or any municipal by-law as being historically or architecturally significant.

iii. The site on which the demolition occurs is levelled and covered with topsoil of sufficient depth to support the growth of vegetation.

iv. Any waste material resulting from the demolition is reused on the site or removed and disposed of at a waste disposal site approved to receive that kind of waste under the *Environmental Protection Act* or the *Environmental Assessment Act*.

21. The construction of a patio, porch, deck or verandah as an extension to a single dwelling if, on the completion of the construction, all the following conditions are met:

i. The total surface area covered by the patio, deck, porch or verandah does not exceed 56 square metres.

ii. The side yard depth of the lot on which the construction occurred is at least one metre.

iii. The rear yard depth of the lot on which the construction occurred is at least 7.5 metres.

iv. The front yard depth of the lot on which the construction occurred is at least 10 metres.

v. If the dwelling is located on a lot that contains part of the Escarpment brow as defined in the Niagara Escarpment Plan in which the brow is formed by a rock cliff, the patio, porch, deck or verandah is set back at least 10 metres from the location of the brow on the lot.

22. The repair, replacement, decommissioning or maintenance of an existing underground fuel tank.

23. The construction or installation for a single dwelling of an air conditioner, heat pump, chimney, flag pole or television or radio receiving antenna that is located at least one metre from the nearest lot line. However, the installation of a satellite dish is not exempted under this paragraph.

23.1 The construction or installation on a lot of entrance gates or decorative pillars associated with driveway lanes and entrances onto municipal roads and highways.

24. The excavation of land, including the boring of holes, for one of the following temporary purposes:

i. Testing for aggregate in the Escarpment Rural Area of the Niagara Escarpment Plan.

ii. Soil testing.

iii. Test drilling for the supply of water.

iv. Archaeological exploration, survey or field work carried out in accordance with the *Ontario Heritage Act* or a federal statute.

v. Surveys or field work undertaken for the purpose of environmental monitoring, research or inventory.

24.1 The installation of permanent boreholes for the purpose of monitoring dam safety at hydroelectric facilities.

25. The construction or installation for a single dwelling of a satellite dish that is not more than one metre in diameter and that is located at least one metre from the nearest lot line.

26. The construction or installation of a satellite dish more than one metre in diameter for a single dwelling if, on the completion of the construction or installation, all the following conditions are met:

    i. The area of the lot on which the single dwelling is situated is at least 0.4 hectares.

    ii. Only one satellite dish is located on the lot.

    iii. The satellite dish is not located in the front yard.

    iv. The height of the satellite dish above the ground, including the pole, does not exceed 4.5 metres.

    v. The side yard depth measured from the closest point of the satellite dish to the side lot line is at least 4.5 metres.

    vi. The rear yard depth measured from the closest point of the satellite dish to the rear lot line is at least 4.5 metres.

27. The construction or installation of a portable storage compound, works yard or trailer used in or incidental to the construction of federal, provincial or municipal public works if the compound, yard or trailer does not house an asphalt plant or facility and is not used as a dwelling. The compound, yard or trailer must be removed within one year after its construction or installation or when the public works is completed, whichever is earlier.
28. The construction or installation of a portable tool shed, scaffold, trailer or other building or structure used in or incidental to approved development if the shed, scaffold, trailer or other building or structure is not used as a dwelling and is located on the same lot as the approved development. The shed, scaffold, trailer, building or structure must be removed within one year after its construction or installation or when the development is completed, whichever is earlier.
29. Small scale recycling depots for paper, glass, plastic, wood, metal or cardboard established by a municipality to serve the local community if the area of the depot does not exceed 74 square metres.
30. The maintenance of land, buildings and structures for the Bruce Trail by the Bruce Trail Conservancy and the establishment of the Bruce Trail by the Bruce Trail Conservancy on land owned or managed by agreement with the Bruce Trail Conservancy.
31. The repair or maintenance of an existing dug pond, if all the following conditions are met:

    i. The pond is not located within the Escarpment Natural Area of the Niagara Escarpment Plan.

    ii. The original surface area and depth is not increased.

    iii. The pond does not require the construction or reconstruction of a dam or berm and is not located on a stream or watercourse.

    iv. The dredged material is used for landscaping immediately around the pond site and rehabilitated with vegetation.

32. The construction of an outdoor tennis court and associated fencing accessory to a single dwelling, if all the following conditions are met on the completion of the development:

    i. The surface area of the tennis court is at least 10 metres from the nearest lot line.

    ii. The maximum surface area of the tennis court is 650 square metres.

    iii. Municipal fencing and lighting requirements are met.

33. The construction or removal of school classroom portables accessory to an existing educational facility on property owned by a school board, college or university.

33.1 The establishment, placement or removal of a portable recreational trailer or vehicle on an existing site within a seasonal campground or trailer park, and, if the trailer or vehicle is allowed to remain on the site year round, the construction of the following facilities associated with the trailer or vehicle and located at least 15 metres from the nearest lot line to the campground or trailer park:

i. An addition that does not exceed 45 square metres in area and is equal to or less than the height of the existing trailer or vehicle.

ii. A patio, deck or covered porch that does not exceed 56 square metres in area.

iii. An accessory building that does not exceed 40 square metres in area.

34. The erection or removal of a temporary special event tent, if all the following conditions are met:

i. The tent is situated on a lot for not more than 30 days in any calendar year.

ii. The tent does not require servicing facilities or the construction of a permanent foundation.

iii. The tent does not result in a change in use of the land upon which it is situated.

35. The installation, construction or repair of the following signs and structures:

i. Traffic, caution, directional and emergency street number signs erected by or on behalf of any government agency.

ii. Election signs.

iii. No trespassing or warning signs.

iv. Temporary public information signs erected by or on behalf of any government agency.

v. Temporary real estate signs that do not exceed one square metre in area.

vi. Mail boxes.

vii. Children’s outdoor playground equipment.

viii. A children’s school bus weather shelter or enclosure that is adjacent to a municipal road or highway and not larger than 4 square metres.

ix. A garbage enclosure or storage area that is not larger than 9 square metres.

x. A retaining wall installed for landscaping, decorative or aesthetic purposes that has a maximum height of 1 metre.

xi. A fence that has a maximum height of 2.4 metres, a brick or stone wall that has a maximum height of 1.2 metres, or a fence or wall that is permitted by a municipal by-law governing the erection of fencing or walls, but does not include fencing, stone walls or sound barriers for animal kennels and veterinary clinics.

xii. Unlit signage, plaques or cairns identifying a site or feature as being of cultural local, provincial or national value or interest or of historical significance.

xiii. A temporary and portable sign or banner within an area designated as a Minor Urban Centre or Urban Area in the Niagara Escarpment Plan, if the sign is subject to a permit from the municipality having jurisdiction.

xiv. A temporary hunting blind.

36. Subject to any municipal by-law governing signage, the erection of one sign advertising the sale of farm produce if all of the following conditions are met:

i. The sign is not more than 122 centimetres by 122 centimetres in size.

ii. The sign has a posted height from the existing grade of not more than 244 centimetres to the top of the sign.

iii. The sign is not lighted.

iv. The sign is erected on the lot on which the produce is offered for sale.

v. The owner of the sign also owns or rents the lot on which the sign is located.

vi. The owner of the sign also owns or rents the lot on which the produce being offered for sale was grown.

vii. The sign is erected and displayed only during the growing season in which the produce being offered for sale is harvested and available for sale.

37. The construction and installation of flush mounted solar panels and solar water heating systems on the roof of any building or structure.

38. The installation, construction or repair of a ground source heat pump, if on completion all of the following conditions are met:

i. The ground source heat pump does not require the removal of trees or the addition of fill or earth.

ii. The ground source heat pump does not require the construction of a pond or the alteration of an existing pond, stream or watercourse.

39. Water taking or discharge associated with a permitted use if,

i. the water taking or discharge is authorized under an emergency order or other similar instrument issued by the Ministry of the Environment under the authority of an Act for the purpose of ensuring public safety, environmental protection or health, or

ii. all of the following conditions are met:

A. The water taking or discharge was originally authorized by a Development Permit issued under the Act.

B. A Permit to Take Water previously authorized by a Development Permit is being renewed by the Ministry of the Environment for the same purpose at the same maximum rates of water taking.

C. An environmental compliance approval for water discharge authorized by a Development Permit is being renewed by the Ministry of the Environment for the same purpose at the same rates of discharge.

D. The water taking or discharge does not require the construction or installation of additional infrastructure or apparatus.

40. The drilling of wells for a municipal water supply that serves the population of the municipality.

41. The construction and installation of buildings, structures, facilities and related undertakings identified in a Park and Open Space Plan as defined in the Niagara Escarpment Plan for a park or open space area listed in Appendix 1 of the Niagara Escarpment Plan if,

    i. The plan has been approved by the Niagara Escarpment Commission and Ministry of Natural Resources under Part 3 of the Niagara Escarpment Plan after the coming into force of Ontario Regulation 423/12.

    ii. The plan has specifically identified and detailed the buildings, structures, facilities and related undertakings that are to be exempted under this section.

    iii. The construction and installation of the buildings, structures, facilities and related undertakings occurs within 5 years of the approval of the master plan under subparagraph i. R.R.O. 1990, Reg. 828, s. 5; O. Reg. 658/92, s. 2; O. Reg. 469/96, s. 1; O. Reg. 48/99, s. 3; O. Reg. 423/12, s. 2.

SCHEDULE 1 REVOKED: O. REG. 48/99, S. 4.

FORM 1 REVOKED: O. REG. 48/99, S. 5.

TAB 4

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Provincial Policy Statement, 2020

Under the *Planning Act*

Ontario

PROVINCIAL POLICY STATEMENT, 2020

Approved by the Lieutenant Governor in Council, Order in Council No. 229/2020

This Provincial Policy Statement was issued under section 3 of the *Planning Act* and came into effect May 1, 2020. It replaces the Provincial Policy Statement issued April 30, 2014.

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Part I: Preamble

The Provincial Policy Statement provides policy direction on matters of provincial interest related to land use planning and development. As a key part of Ontario's policy-led planning system, the Provincial Policy Statement sets the policy foundation for regulating the development and use of land. It also supports the provincial goal to enhance the quality of life for all Ontarians.

The Provincial Policy Statement provides for appropriate development while protecting resources of provincial interest, public health and safety, and the quality of the natural and built environment. The Provincial Policy Statement supports improved land use planning and management, which contributes to a more effective and efficient land use planning system.

The policies of the Provincial Policy Statement may be complemented by provincial plans or by locally-generated policies regarding matters of municipal interest. Provincial plans and municipal official plans provide a framework for comprehensive, integrated, place-based and long-term planning that supports and integrates the principles of strong communities, a clean and healthy environment and economic growth, for the long term.

Municipal official plans are the most important vehicle for implementation of this Provincial Policy Statement and for achieving comprehensive, integrated and long-term planning. Official plans shall identify provincial interests and set out appropriate land use designations and policies.

Official plans should also coordinate cross-boundary matters to complement the actions of other planning authorities and promote mutually beneficial solutions. Official plans shall provide clear, reasonable and attainable policies to protect provincial interests and direct development to suitable areas. In order to protect provincial interests, planning authorities shall keep their official plans up-to-date with this Provincial Policy Statement.

Zoning and development permit by-laws are also important for implementation of this Provincial Policy Statement. Planning authorities shall keep their zoning and development permit by-laws up-to-date with their official plans and this Provincial Policy Statement.

Land use planning is only one of the tools for implementing provincial interests. A wide range of legislation, regulations, policies and programs may apply to decisions with respect to *Planning Act* applications and affect planning matters, and assist in implementing these interests.

Within the Great Lakes – St. Lawrence River Basin, there may be circumstances where planning authorities should consider agreements related to the protection or restoration of the Great Lakes – St. Lawrence River Basin. Examples of these agreements include Great Lakes agreements between Ontario and Canada, between Ontario and Quebec and the Great Lakes States of the United States of America, and between Canada and the United States of America.

Part II: Legislative Authority

The Provincial Policy Statement is issued under the authority of section 3 of the *Planning Act* and came into effect on May 1, 2020.

In respect of the exercise of any authority that affects a planning matter, section 3 of the *Planning Act* requires that decisions affecting planning matters "shall be consistent with" policy statements issued under the Act.

Comments, submissions or advice that affect a planning matter that are provided by the council of a municipality, a local board, a planning board, a minister or ministry, board, commission or agency of the government "shall be consistent with" this Provincial Policy Statement.

Part III: How to Read the Provincial Policy Statement

The provincial policy-led planning system recognizes and addresses the complex inter-relationships among environmental, economic and social factors in land use planning. The Provincial Policy Statement supports a comprehensive, integrated and long-term approach to planning, and recognizes linkages among policy areas.

Read the Entire Provincial Policy Statement

The Provincial Policy Statement is more than a set of individual policies. It is to be read in its entirety and the relevant policies are to be applied to each situation. When more than one policy is relevant, a decision-maker should consider all of the relevant policies to understand how they work together. The language of each policy, including the Implementation and Interpretation policies, will assist decision-makers in understanding how the policies are to be implemented.

While specific policies sometimes refer to other policies for ease of use, these cross-references do not take away from the need to read the Provincial Policy Statement as a whole.

There is no implied priority in the order in which the policies appear.

Consider Specific Policy Language

When applying the Provincial Policy Statement it is important to consider the specific language of the policies. Each policy provides direction on how it is to be implemented, how it is situated within the broader Provincial Policy Statement, and how it relates to other policies.

Some policies set out positive directives, such as "settlement areas shall be the focus of growth and development." Other policies set out limitations and prohibitions, such as "development and site alteration shall not be permitted." Other policies use enabling or supportive language, such as "should," "promote" and "encourage."

The choice of language is intended to distinguish between the types of policies and the nature of implementation. There is some discretion when applying a policy with enabling or supportive language in contrast to a policy with a directive, limitation or prohibition.

Geographic Scale of Policies

The Provincial Policy Statement recognizes the diversity of Ontario and that local context is important. Policies are outcome-oriented, and some policies provide flexibility in their implementation provided that provincial interests are upheld.

While the Provincial Policy Statement is to be read as a whole, not all policies will be applicable to every site, feature or area. The Provincial Policy Statement applies at a range of geographic scales.

Some of the policies refer to specific areas or features and can only be applied where these features or areas exist. Other policies refer to planning objectives that need to be considered in the context of the municipality or planning area as a whole, and are not necessarily applicable to a specific site or development proposal.

Policies Represent Minimum Standards

The policies of the Provincial Policy Statement represent minimum standards.

Within the framework of the provincial policy-led planning system, planning authorities and decision-makers may go beyond these minimum standards to address matters of importance to a specific community, unless doing so would conflict with any policy of the Provincial Policy Statement.

Defined Terms and Meanings

Except for references to legislation which are italicized, other italicized terms in the Provincial Policy Statement are defined in the Definitions section. For non-italicized terms, the normal meaning of the word applies. Terms may be italicized only in specific policies; for these terms, the defined meaning applies where they are italicized and the normal meaning applies where they are not italicized. Defined terms in the Definitions section are intended to capture both singular and plural forms of these terms in the policies.

Guidance Material

Guidance material and technical criteria may be issued from time to time to assist planning authorities and decision-makers with implementing the policies of the Provincial Policy Statement. Information, technical criteria and approaches outlined in guidance material are meant to support but not add to or detract from the policies of the Provincial Policy Statement.

Relationship with Provincial Plans

The Provincial Policy Statement provides overall policy directions on matters of provincial interest related to land use planning and development in Ontario, and applies province-wide, except where this policy statement or another provincial plan provides otherwise.

Provincial plans, such as the Greenbelt Plan, A Place to Grow: Growth Plan for the Greater Golden Horseshoe and the Growth Plan for Northern Ontario, build upon the policy foundation provided by the Provincial Policy Statement. They provide additional land use planning policies to address issues facing specific geographic areas in Ontario.

Provincial plans are to be read in conjunction with the Provincial Policy Statement. They take precedence over the policies of the Provincial Policy Statement to the extent of any conflict, except where the relevant legislation provides otherwise.

Where the policies of provincial plans address the same, similar, related, or overlapping matters as the policies of the Provincial Policy Statement, applying the more specific policies of the provincial plan satisfies the more general requirements of the Provincial Policy Statement. In contrast, where matters addressed in the Provincial Policy Statement do not overlap with policies in provincial plans, the policies in the Provincial Policy Statement must be independently satisfied.

Land use planning decisions made by municipalities, planning boards, the Province, or a commission or agency of the government must be consistent with the Provincial Policy Statement. Where provincial plans are in effect, planning decisions must conform or not conflict with them, as the case may be.

Part IV: Vision for Ontario's Land Use Planning System

The long-term prosperity and social well-being of Ontario depends upon planning for strong, sustainable and resilient communities for people of all ages, a clean and healthy environment, and a strong and competitive economy.

Ontario is a vast province with diverse urban, rural and northern communities which may face different challenges related to diversity in population, economic activity, pace of growth and physical and natural conditions. Some areas face challenges related to maintaining population and diversifying their economy, while other areas face challenges related to accommodating and managing the development and population growth which is occurring, while protecting important resources and the quality of the natural environment.

The Province's rich cultural diversity is one of its distinctive and defining features. Indigenous communities have a unique relationship with the land and its resources, which continues to shape the history and economy of the Province today. Ontario recognizes the unique role Indigenous communities have in land use planning and development, and the contribution of Indigenous communities' perspectives and traditional knowledge to land use planning decisions. The Province recognizes the importance of consulting with Aboriginal communities on planning matters that may affect their section 35 Aboriginal or treaty rights. Planning authorities are encouraged to build constructive, cooperative relationships through meaningful engagement with Indigenous communities to facilitate knowledge-sharing in land use planning processes and inform decision-making.

The Provincial Policy Statement focuses growth and development within urban and rural settlement areas while supporting the viability of rural areas. It recognizes that the wise management of land use change may involve directing, promoting or sustaining development. Land use must be carefully managed to accommodate appropriate development to meet the full range of current and future needs, while achieving efficient development patterns and avoiding significant or sensitive resources and areas which may pose a risk to public health and safety. Planning authorities are encouraged to permit and facilitate a range of housing options, including new development as well as residential intensification, to respond to current and future needs.

Efficient development patterns optimize the use of land, resources and public investment in infrastructure and public service facilities. These land use patterns promote a mix of housing, including affordable housing, employment, recreation, parks and open spaces, and transportation choices that increase the use of active transportation and transit before other modes of travel. They support the financial well-being of the Province and municipalities over the long term, and minimize the undesirable effects of development, including impacts on air, water and other resources. They also permit better adaptation and response to the impacts of a changing climate, which will vary from region to region.

Strong, liveable and healthy communities promote and enhance human health and social well-being, are economically and environmentally sound, and are resilient to climate change.

The Province's natural heritage resources, water resources, including the Great Lakes, agricultural resources, mineral resources, and cultural heritage and archaeological resources provide important environmental, economic and social benefits. The wise use and management of these resources over the long term is a key provincial interest. The Province must ensure that its resources are managed in a sustainable way to conserve biodiversity, protect essential ecological processes and public health and safety, provide for the production of food and fibre, minimize environmental and social impacts, provide for recreational opportunities (e.g. fishing, hunting and hiking) and meet its long-term needs.

It is equally important to protect the overall health and safety of the population, including preparing for the impacts of a changing climate. The Provincial Policy Statement directs development away from areas of natural and human-made hazards. This preventative approach supports provincial and municipal financial well-being over the long term, protects public health and safety, and minimizes cost, risk and social disruption.

Taking action to conserve land and resources avoids the need for costly remedial measures to correct problems and supports economic and environmental principles.

Strong communities, a clean and healthy environment and a strong economy are inextricably linked. Long-term prosperity, human and environmental health and social well-being should take precedence over short-term considerations.

The fundamental principles set out in the Provincial Policy Statement apply throughout Ontario. To support our collective well-being, now and in the future, all land use must be well managed.

3.0 Protecting Public Health and Safety

Ontario's long-term prosperity, environmental health and social well-being depend on reducing the potential for public cost or risk to Ontario's residents from natural or human-made hazards.

Development shall be directed away from areas of natural or human-made hazards where there is an unacceptable risk to public health or safety or of property damage, and not create new or aggravate existing hazards.

Mitigating potential risk to public health or safety or of property damage from natural hazards, including the risks that may be associated with the impacts of a changing climate, will require the Province, planning authorities, and conservation authorities to work together.

Accordingly:

3.1 Natural Hazards

3.1.1 Development shall generally be directed, in accordance with guidance developed by the Province (as amended from time to time), to areas outside of:

a) *hazardous lands* adjacent to the shorelines of the *Great Lakes - St. Lawrence River System* and *large inland lakes* which are impacted by *flooding hazards*, *erosion hazards* and/or *dynamic beach hazards*;
b) *hazardous lands* adjacent to *river*, *stream and small inland lake systems* which are impacted by *flooding hazards* and/or *erosion hazards*; and
c) *hazardous sites.*

3.1.2 *Development* and *site alteration* shall not be permitted within:

a) the *dynamic beach hazard*;
b) *defined portions of the flooding hazard along connecting channels* (the St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers);
c) areas that would be rendered inaccessible to people and vehicles during times of *flooding hazards*, *erosion hazards* and/or *dynamic beach hazards*, unless it has been demonstrated that the site has safe access appropriate for the nature of the *development* and the natural hazard; and
d) a *floodway* regardless of whether the area of inundation contains high points of land not subject to flooding.

3.1.3 Planning authorities shall prepare for the *impacts of a changing climate* that may increase the risk associated with natural hazards.

3.1.4 Despite policy 3.1.2, *development* and *site alteration* may be permitted in certain areas associated with the *flooding hazard* along *river*, *stream and small inland lake systems*:

a) in those exceptional situations where a *Special Policy Area* has been approved. The designation of a *Special Policy Area*, and any change or modification to the official plan policies, land use designations or boundaries applying to *Special Policy Area* lands, must be approved by the Ministers of Municipal Affairs and Housing and Natural Resources and Forestry prior to the approval authority approving such changes or modifications; or
b) where the *development* is limited to uses which by their nature must locate within the *floodway*, including flood and/or erosion control works or minor additions or passive non-structural uses which do not affect flood flows.

3.1.5 *Development* shall not be permitted to locate in *hazardous lands* and *hazardous sites* where the use is:

a) an *institutional use* including hospitals, long-term care homes, retirement homes, pre-schools, school nurseries, day cares and schools;
b) an *essential emergency service* such as that provided by fire, police and ambulance stations and electrical substations; or
c) uses associated with the disposal, manufacture, treatment or storage of *hazardous substances*.

3.1.6 Where the *two zone concept* for *flood plains* is applied, *development* and *site alteration* may be permitted in the *flood fringe*, subject to appropriate floodproofing to the *flooding hazard* elevation or another *flooding hazard* standard approved by the Minister of Natural Resources and Forestry.

3.1.7 Further to policy 3.1.6, and except as prohibited in policies 3.1.2 and 3.1.5, *development* and *site alteration* may be permitted in those portions of *hazardous lands* and *hazardous sites* where the effects and risk to public safety are minor, could be mitigated in accordance with provincial standards, and where all of the following are demonstrated and achieved:

a) *development* and *site alteration* is carried out in accordance with *floodproofing standards*, *protection works standards*, and *access standards*;
b) vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies;
c) new hazards are not created and existing hazards are not aggravated; and
d) no adverse environmental impacts will result.

3.1.8 *Development* shall generally be directed to areas outside of lands that are unsafe for *development* due to the presence of *hazardous forest types for wildland fire*.

Development may however be permitted in lands with *hazardous forest types for wildland fire* where the risk is mitigated in accordance with *wildland fire assessment and mitigation standards.*

3.2 Human-Made Hazards

3.2.1 Development on, abutting or adjacent to lands affected by *mine hazards*; *oil*, *gas and salt hazards*; or former *mineral mining operations*, *mineral aggregate operations* or *petroleum resource operations* may be permitted only if rehabilitation or other measures to address and mitigate known or suspected hazards are under way or have been completed.

3.2.2 Sites with contaminants in land or water shall be assessed and remediated as necessary prior to any activity on the site associated with the proposed use such that there will be no *adverse effects*.

3.2.3 Planning authorities should support, where feasible, on-site and local re-use of excess soil through planning and development approvals while protecting human health and the environment.

6.0 Definitions

Access standards: means methods or procedures to ensure safe vehicular and pedestrian movement, and access for the maintenance and repair of protection works, during times of *flooding hazards*, *erosion hazards* and/or *other water-related hazards*.

Active transportation: means human-powered travel, including but not limited to, walking, cycling, inline skating and travel with the use of mobility aids, including motorized wheelchairs and other power-assisted devices moving at a comparable speed.

Adjacent lands: means

a) for the purposes of policy 1.6.8.3, those lands contiguous to existing or planned corridors and transportation facilities where *development* would have a negative impact on the corridor or facility. The extent of the *adjacent lands* may be recommended in guidelines developed by the Province or based on municipal approaches that achieve the same objectives;
b) for the purposes of policy 2.1.8, those lands contiguous to a specific *natural heritage feature or area* where it is likely that *development* or *site alteration* would have a *negative impact* on the feature or area. The extent of the *adjacent lands* may be recommended by the Province or based on municipal approaches which achieve the same objectives;
c) for the purposes of policies 2.4.2.2 and 2.5.2.5, those lands contiguous to lands on the surface of known *petroleum resources*, *mineral deposits*, or *deposits of mineral aggregate resources* where it is likely that *development* would constrain future access to the resources. The extent of the *adjacent lands* may be recommended by the Province; and
d) for the purposes of policy 2.6.3, those lands contiguous to a *protected heritage property* or as otherwise defined in the municipal official plan.

Adverse effects: as defined in the *Environmental Protection Act*, means one or more of:

a) impairment of the quality of the natural environment for any use that can be made of it;
b) injury or damage to property or plant or animal life;
c) harm or material discomfort to any person;
d) an adverse effect on the health of any person;
e) impairment of the safety of any person;
f) rendering any property or plant or animal life unfit for human use;
g) loss of enjoyment of normal use of property; and
h) interference with normal conduct of business.

Affordable: means

a) in the case of ownership housing, the least expensive of:
    1. housing for which the purchase price results in annual accommodation costs which do not exceed 30 percent of gross annual household income for *low and moderate income households*; or
    2. housing for which the purchase price is at least 10 percent below the average purchase price of a resale unit in the *regional market area*;
b) in the case of rental housing, the least expensive of:
    1. a unit for which the rent does not exceed 30 percent of gross annual household income for *low and moderate income households*; or
    2. a unit for which the rent is at or below the average market rent of a unit in the *regional market area*.

Agricultural condition: means

a) in regard to *specialty crop areas*, a condition in which substantially the same areas and same average soil capability for agriculture are restored, the same range and productivity of specialty crops common in the area can be achieved, and, where

applicable, the microclimate on which the site and surrounding area may be dependent for specialty crop production will be maintained or restored; and

b) in regard to *prime agricultural land* outside of *specialty crop areas*, a condition in which substantially the same areas and same average soil capability for agriculture are restored.

Agricultural System: A system comprised of a group of inter-connected elements that collectively create a viable, thriving agricultural sector. It has two components:

a) An agricultural land base comprised of *prime agricultural areas*, including *specialty crop areas*, and *rural lands* that together create a continuous productive land base for agriculture; and
b) An *agri-food network* which includes *infrastructure*, services, and assets important to the viability of the agri-food sector.

Agricultural uses: means the growing of crops, including nursery, biomass, and horticultural crops; raising of livestock; raising of other animals for food, fur or fibre, including poultry and fish; aquaculture; apiaries; agro-forestry; maple syrup production; and associated on-farm buildings and structures, including, but not limited to livestock facilities, manure storages, value-retaining facilities, and accommodation for full-time farm labour when the size and nature of the operation requires additional employment.

Agri-food network: Within the *agricultural system*, a network that includes elements important to the viability of the agri-food sector such as regional *infrastructure* and transportation networks; on-farm buildings and infrastructure; agricultural services, farm markets, distributors, and primary processing; and vibrant, agriculture-supportive communities.

Agri-tourism uses: means those farm-related tourism uses, including limited accommodation such as a bed and breakfast, that promote the enjoyment, education or activities related to the farm operation.

Agriculture-related uses: means those farm-related commercial and farm-related industrial uses that are directly related to farm operations in the area, support agriculture, benefit from being in close proximity to farm operations, and provide direct products and/or services to farm operations as a primary activity.

Airports: means all Ontario airports, including designated lands for future airports, with Noise Exposure Forecast (NEF)/Noise Exposure Projection (NEP) mapping.

Alternative energy system: means a system that uses sources of energy or energy conversion processes to produce power, heat and/or cooling that significantly reduces the amount of harmful emissions to the environment (air, earth and water) when compared to conventional energy systems.

Archaeological resources: includes artifacts, archaeological sites, marine archaeological sites, as defined under the *Ontario Heritage Act*. The identification and evaluation of such resources are based upon archaeological fieldwork undertaken in accordance with the *Ontario Heritage Act*.

Areas of archaeological potential: means areas with the likelihood to contain *archaeological resources*. Criteria to identify archaeological potential are established by the Province. The *Ontario Heritage Act* requires archaeological potential to be confirmed by a licensed archaeologist.

Areas of mineral potential: means areas favourable to the discovery of *mineral deposits* due to geology, the presence of known *mineral deposits* or other technical evidence.

Areas of natural and scientific interest (ANSI): means areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education.

Brownfield sites: means undeveloped or previously developed properties that may be

contaminated. They are usually, but not exclusively, former industrial or commercial properties that may be underutilized, derelict or vacant.

Built heritage resource: means a building, structure, monument, installation or any manufactured or constructed part or remnant that contributes to a property's cultural heritage value or interest as identified by a community, including an Indigenous community. *Built heritage resources* are located on property that may be designated under Parts IV or V of the *Ontario Heritage Act*, or that may be included on local, provincial, federal and/or international registers.

Coastal wetland: means

a) any *wetland* that is located on one of the Great Lakes or their connecting channels (Lake St. Clair, St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers); or
b) any other *wetland* that is on a tributary to any of the above-specified water bodies and lies, either wholly or in part, downstream of a line located 2 kilometres upstream of the 1:100 year floodline (plus wave run-up) of the large water body to which the tributary is connected.

Comprehensive rehabilitation: means rehabilitation of land from which *mineral aggregate resources* have been extracted that is coordinated and complementary, to the extent possible, with the rehabilitation of other sites in an area where there is a high concentration of *mineral aggregate operations*.

Comprehensive review: means

a) for the purposes of policies 1.1.3.8, 1.1.3.9 and 1.3.2.4, an official plan review which is initiated by a planning authority, or an official plan amendment which is initiated or adopted by a planning authority, which:
    1. is based on a review of population and employment projections and which reflect projections and allocations by upper-tier municipalities and *provincial plans*, where applicable; considers alternative directions for growth or development; and determines how best to accommodate the development while protecting provincial interests;
    2. utilizes opportunities to accommodate projected growth or development through *intensification* and *redevelopment*; and considers physical constraints to accommodating the proposed development within existing *settlement area* boundaries;
    3. is integrated with planning for *infrastructure* and *public service facilities*, and considers financial viability over the life cycle of these assets, which may be demonstrated through asset management planning;
    4. confirms sufficient water quality, quantity and assimilative capacity of receiving water are available to accommodate the proposed development;
    5. confirms that sewage and water services can be provided in accordance with policy 1.6.6; and
    6. considers cross-jurisdictional issues.
b) for the purposes of policy 1.1.6, means a review undertaken by a planning authority or comparable body which:
    1. addresses long-term population projections, *infrastructure* requirements and related matters;
    2. confirms that the lands to be developed do not comprise *specialty crop areas* in accordance with policy 2.3.2; and
    3. considers cross-jurisdictional issues.

In undertaking a *comprehensive review* the level of detail of the assessment should correspond with the complexity and scale of the settlement boundary or development proposal.

Conserved: means the identification, protection, management and use of *built heritage resources, cultural heritage landscapes* and *archaeological resources* in a manner that ensures their cultural heritage value or interest is retained. This may be achieved by the implementation of recommendations set out in a conservation plan, archaeological assessment, and/or heritage impact assessment that has been approved, accepted or adopted by the relevant planning authority and/or decision-

maker. Mitigative measures and/or alternative development approaches can be included in these plans and assessments.

Cultural heritage landscape: means a defined geographical area that may have been modified by human activity and is identified as having cultural heritage value or interest by a community, including an Indigenous community. The area may include features such as buildings, structures, spaces, views, archaeological sites or natural elements that are valued together for their interrelationship, meaning or association. *Cultural heritage landscapes* may be properties that have been determined to have cultural heritage value or interest under the *Ontario Heritage Act*, or have been included on federal and/or international registers, and/or protected through official plan, zoning by-law, or other land use planning mechanisms.

Defined portions of the flooding hazard along connecting channels: means those areas which are critical to the conveyance of the flows associated with the *one hundred year flood level* along the St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers, where *development* or *site alteration* will create *flooding hazards*, cause updrift and/or downdrift impacts and/or cause adverse environmental impacts.

Deposits of mineral aggregate resources: means an area of identified *mineral aggregate resources*, as delineated in Aggregate Resource Inventory Papers or comprehensive studies prepared using evaluation procedures established by the Province for surficial and bedrock resources, as amended from time to time, that has a sufficient quantity and quality to warrant present or future extraction.

Designated and available: means lands designated in the official plan for urban residential use. For municipalities where more detailed official plan policies (e.g. secondary plans) are required before development applications can be considered for approval, only lands that have commenced the more detailed planning process are considered to be *designated and available* for the purposes of this definition.

Designated growth areas: means lands within *settlement areas* designated in an official plan for growth over the long-term planning horizon provided in policy 1.1.2, but which have not yet been fully developed. *Designated growth areas* include lands which are *designated and available* for residential growth in accordance with policy 1.4.1(a), as well as lands required for employment and other uses.

Designated vulnerable area: means areas defined as vulnerable, in accordance with provincial standards, by virtue of their importance as a drinking water source.

Development: means the creation of a new lot, a change in land use, or the construction of buildings and structures requiring approval under the *Planning Act*, but does not include:

a) activities that create or maintain *infrastructure* authorized under an environmental assessment process;
b) works subject to the *Drainage Act*; or
c) for the purposes of policy 2.1.4(a), underground or surface mining of *minerals* or advanced exploration on mining lands in *significant areas of mineral potential* in Ecoregion 5E, where advanced exploration has the same meaning as under the *Mining Act*. Instead, those matters shall be subject to policy 2.1.5(a).

Dynamic beach hazard: means areas of inherently unstable accumulations of shoreline sediments along the *Great Lakes - St. Lawrence River System* and *large inland lakes*, as identified by provincial standards, as amended from time to time. The *dynamic beach hazard* limit consists of the *flooding hazard* limit plus a dynamic beach allowance.

Ecological function: means the natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions.

Employment area: means those areas designated in an official plan for clusters of business and economic activities including, but not limited to, manufacturing, warehousing, offices, and associated retail and ancillary facilities.

Endangered species: means a species that is classified as "Endangered Species" on the Species at Risk in Ontario List, as updated and amended from time to time.

Erosion hazard: means the loss of land, due to human or natural processes, that poses a threat to life and property. The *erosion hazard* limit is determined using considerations that include the 100 year erosion rate (the average annual rate of recession extended over a one hundred year time span), an allowance for slope stability, and an erosion/erosion access allowance.

Essential emergency service: means services which would be impaired during an emergency as a result of flooding, the failure of floodproofing measures and/or protection works, and/or erosion.

Fish: means fish, which as defined in the *Fisheries Act*, includes fish, shellfish, crustaceans, and marine animals, at all stages of their life cycles.

Fish habitat: as defined in the *Fisheries Act*, means spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas on which *fish* depend directly or indirectly in order to carry out their life processes.

Flood fringe: for *river*, *stream and small inland lake systems*, means the outer portion of the *flood plain* between the *floodway* and the *flooding hazard* limit. Depths and velocities of flooding are generally less severe in the flood fringe than those experienced in the *floodway*.

Flood plain: for *river*, *stream and small inland lake systems*, means the area, usually low lands adjoining a watercourse, which has been or may be subject to *flooding hazards*.

Flooding hazard: means the inundation, under the conditions specified below, of areas adjacent to a shoreline or a river or stream system and not ordinarily covered by water:

a) along the shorelines of the *Great Lakes - St. Lawrence River System* and *large inland lakes*, the *flooding hazard* limit is based on the *one hundred year flood level* plus an allowance for *wave uprush* and *other water-related hazards*;
b) along *river*, *stream and small inland lake systems*, the *flooding hazard* limit is the greater of:
    1. the flood resulting from the rainfall actually experienced during a major storm such as the Hurricane Hazel storm (1954) or the Timmins storm (1961), transposed over a specific watershed and combined with the local conditions, where evidence suggests that the storm event could have potentially occurred over watersheds in the general area;
    2. the *one hundred year flood*; and
    3. a flood which is greater than 1. or 2. which was actually experienced in a particular watershed or portion thereof as a result of ice jams and which has been approved as the standard for that specific area by the Minister of Natural Resources and Forestry;

    except where the use of the *one hundred year flood* or the actually experienced event has been approved by the Minister of Natural Resources and Forestry as the standard for a specific watershed (where the past history of flooding supports the lowering of the standard).

Floodproofing standard: means the combination of measures incorporated into the basic design and/or construction of buildings, structures, or properties to reduce or eliminate *flooding hazards*, *wave uprush* and *other water-related hazards* along the shorelines of the *Great Lakes - St. Lawrence River System* and *large inland lakes*, and *flooding hazards* along *river*, *stream and small inland lake systems*.

Floodway: for *river*, *stream and small inland lake systems*, means the portion of the *flood*

plain where *development* and *site alteration* would cause a danger to public health and safety or property damage.

Where the one zone concept is applied, the *floodway* is the entire contiguous *flood plain*.

Where the *two zone concept* is applied, the *floodway* is the contiguous inner portion of the *flood plain*, representing that area required for the safe passage of flood flow and/or that area where flood depths and/or velocities are considered to be such that they pose a potential threat to life and/or property damage. Where the *two zone concept* applies, the outer portion of the *flood plain* is called the *flood fringe*.

Freight-supportive: in regard to land use patterns, means transportation systems and facilities that facilitate the movement of goods. This includes policies or programs intended to support efficient freight movement through the planning, design and operation of land use and transportation systems. Approaches may be recommended in guidelines developed by the Province or based on municipal approaches that achieve the same objectives.

Great Lakes - St. Lawrence River System: means the major water system consisting of Lakes Superior, Huron, St. Clair, Erie and Ontario and their connecting channels, and the St. Lawrence River within the boundaries of the Province of Ontario.

Green infrastructure: means natural and human-made elements that provide ecological and hydrological functions and processes. *Green infrastructure* can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs.

Ground water feature: means water-related features in the earth's subsurface, including recharge/discharge areas, water tables, aquifers and unsaturated zones that can be defined by surface and subsurface hydrogeologic investigations.

Habitat of endangered species and threatened species: means habitat within the meaning of Section 2 of the *Endangered Species Act, 2007*.

Hazardous forest types for wildland fire: means forest types assessed as being associated with the risk of high to extreme wildland fire using risk assessment tools established by the Ontario Ministry of Natural Resources and Forestry, as amended from time to time.

Hazardous lands: means property or lands that could be unsafe for development due to naturally occurring processes. Along the shorelines of the *Great Lakes - St. Lawrence River System*, this means the land, including that covered by water, between the international boundary, where applicable, and the furthest landward limit of the *flooding hazard*, *erosion hazard* or *dynamic beach hazard* limits. Along the shorelines of *large inland lakes*, this means the land, including that covered by water, between a defined offshore distance or depth and the furthest landward limit of the *flooding hazard*, *erosion hazard* or *dynamic beach hazard* limits. Along *river*, *stream and small inland lake systems*, this means the land, including that covered by water, to the furthest landward limit of the *flooding hazard* or *erosion hazard* limits.

Hazardous sites: means property or lands that could be unsafe for *development* and *site alteration* due to naturally occurring hazards. These may include unstable soils (sensitive marine clays [leda], organic soils) or unstable bedrock (karst topography).

Hazardous substances: means substances which, individually, or in combination with other substances, are normally considered to pose a danger to public health, safety and the environment. These substances generally include a wide array of materials that are toxic, ignitable, corrosive, reactive, radioactive or pathological.

Heritage attributes: means the principal features or elements that contribute to a *protected heritage property*'s cultural heritage value or interest, and may include the

property's built, constructed, or manufactured elements, as well as natural landforms, vegetation, water features, and its visual setting (e.g. significant views or vistas to or from a *protected heritage property*).

High quality: means primary and secondary sand and gravel resources and bedrock resources as defined in the Aggregate Resource Inventory Papers (ARIP).

Housing options: means a range of housing types such as, but not limited to single-detached, semi-detached, rowhouses, townhouses, stacked townhouses, multiplexes, additional residential units, tiny homes, multi-residential buildings. The term can also refer to a variety of housing arrangements and forms such as, but not limited to life lease housing, co-ownership housing, co-operative housing, community land trusts, land lease community homes, *affordable* housing, housing for people with *special needs*, and housing related to employment, institutional or educational uses.

Hydrologic function: means the functions of the hydrological cycle that include the occurrence, circulation, distribution and chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things.

Impacts of a changing climate: means the present and future consequences from changes in weather patterns at local and regional levels including extreme weather events and increased climate variability.

Individual on-site sewage services: means sewage systems, as defined in O. Reg. 332/12 under the *Building Code Act*, *1992*, that are owned, operated and managed by the owner of the property upon which the system is located.

Individual on-site water services: means individual, autonomous water supply systems that are owned, operated and managed by the owner of the property upon which the system is located.

Infrastructure: means physical structures (facilities and corridors) that form the foundation for development. *Infrastructure* includes: sewage and water systems, septage treatment systems, stormwater management systems, waste management systems, electricity generation facilities, electricity transmission and distribution systems, communications/telecommunications, transit and transportation corridors and facilities, oil and gas pipelines and associated facilities.

Institutional use: for the purposes of policy 3.1.5, means land uses where there is a threat to the safe evacuation of vulnerable populations such as older persons, persons with disabilities, and those who are sick or young, during an emergency as a result of flooding, failure of floodproofing measures or protection works, or erosion.

Intensification: means the development of a property, site or area at a higher density than currently exists through:

a) *redevelopment*, including the reuse of *brownfield sites*;
b) the development of vacant and/or underutilized lots within previously developed areas;
c) infill development; and
d) the expansion or conversion of existing buildings.

Large inland lakes: means those waterbodies having a surface area of equal to or greater than 100 square kilometres where there is not a measurable or predictable response to a single runoff event.

Legal or technical reasons: means severances for purposes such as easements, corrections of deeds, quit claims, and minor boundary adjustments, which do not result in the creation of a new lot.

Low and moderate income households: means

a) in the case of ownership housing, households with incomes in the lowest 60 percent of the income distribution for the *regional market area*; or

b) in the case of rental housing, households with incomes in the lowest 60 percent of the income distribution for renter households for the *regional market area*.

Major facilities: means facilities which may require separation from *sensitive land uses*, including but not limited to airports, manufacturing uses, transportation infrastructure and corridors, *rail facilities*, *marine facilities*, sewage treatment facilities, *waste management systems*, oil and gas pipelines, industries, energy generation facilities and transmission systems, and resource extraction activities.

Major goods movement facilities and corridors: means transportation facilities and corridors associated with the inter- and intra-provincial movement of goods. Examples include: inter-modal facilities, ports, *airports, rail facilities*, truck terminals, freight corridors, freight facilities, and haul routes and primary transportation corridors used for the movement of goods. Approaches that are *freight-supportive* may be recommended in guidelines developed by the Province or based on municipal approaches that achieve the same objectives.

Marine facilities: means ferries, harbours, ports, ferry terminals, canals and associated uses, including designated lands for future *marine facilities*.

Mine hazard: means any feature of a mine as defined under the *Mining Act*, or any related disturbance of the ground that has not been rehabilitated.

Minerals: means metallic minerals and non-metallic minerals as herein defined, but does not include *mineral aggregate resources* or *petroleum resources*.

Metallic minerals means those minerals from which metals (e.g. copper, nickel, gold) are derived.

Non-metallic minerals means those minerals that are of value for intrinsic properties of the minerals themselves and not as a source of metal. They are generally synonymous with industrial minerals (e.g. asbestos, graphite, kyanite, mica, nepheline syenite, salt, talc, and wollastonite).

Mineral aggregate operation: means
a) lands under license or permit, other than for *wayside pits and quarries*, issued in accordance with the *Aggregate Resources Act*;
b) for lands not designated under the *Aggregate Resources Act*, established pits and quarries that are not in contravention of municipal zoning by-laws and including adjacent land under agreement with or owned by the operator, to permit continuation of the operation; and
c) associated facilities used in extraction, transport, beneficiation, processing or recycling of *mineral aggregate resources* and derived products such as asphalt and concrete, or the production of secondary related products.

Mineral aggregate resources: means gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock or other material prescribed under the *Aggregate Resources Act* suitable for construction, industrial, manufacturing and maintenance purposes but does not include metallic ores, asbestos, graphite, kyanite, mica, nepheline syenite, salt, talc, wollastonite, mine tailings or other material prescribed under the *Mining Act*.

Mineral aggregate resource conservation: means
a) the recovery and recycling of manufactured materials derived from mineral aggregates (e.g. glass, porcelain, brick, concrete, asphalt, slag, etc.), for re-use in construction, manufacturing, industrial or maintenance projects as a substitute for new mineral aggregates; and
b) the wise use of mineral aggregates including utilization or extraction of on-site *mineral aggregate resources* prior to development occurring.

Mineral deposits: means areas of identified *minerals* that have sufficient quantity and quality based on specific geological evidence to warrant present or future extraction.

Mineral mining operation: means mining operations and associated facilities, or, past producing mines with remaining mineral development potential that have not been permanently rehabilitated to another use.

Minimum distance separation formulae: means formulae and guidelines developed by the Province, as amended from time to time, to separate uses so as to reduce incompatibility concerns about odour from livestock facilities.

Multimodal transportation system: means a transportation system which may include several forms of transportation such as automobiles, walking, trucks, cycling, buses, rapid transit, rail (such as commuter and freight), air and marine.

Municipal sewage services: means a sewage works within the meaning of section 1 of the *Ontario Water Resources Act* that is owned or operated by a municipality, including centralized and decentralized systems.

Municipal water services: means a municipal drinking-water system within the meaning of section 2 of the *Safe Drinking Water Act*, *2002*, including centralized and decentralized systems.

Natural heritage features and areas: means features and areas, including *significant wetlands*, *significant coastal wetlands*, other *coastal wetlands* in Ecoregions 5E, 6E and 7E, *fish habitat*, *significant woodlands* and *significant valleylands* in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River), *habitat of endangered species and threatened species*, *significant wildlife habitat*, and *significant areas of natural and scientific interest*, which are important for their environmental and social values as a legacy of the natural landscapes of an area.

Natural heritage system: means a system made up of *natural heritage features and areas*, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include *natural heritage features and areas*, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecological functions to continue. The Province has a recommended approach for identifying *natural heritage systems*, but municipal approaches that achieve or exceed the same objective may also be used.

Negative impacts: means

a) in regard to policy 1.6.6.4 and 1.6.6.5, potential risks to human health and safety and degradation to the *quality and quantity of water*, *sensitive surface water features* and *sensitive ground water features*, and their related *hydrologic functions*, due to single, multiple or successive *development*. *Negative impacts* should be assessed through environmental studies including hydrogeological or water quality impact assessments, in accordance with provincial standards;
b) in regard to policy 2.2, degradation to the *quality and quantity of water*, *sensitive surface water features* and *sensitive ground water features*, and their related *hydrologic functions*, due to single, multiple or successive *development* or *site alteration* activities;
c) in regard to *fish habitat*, any permanent alteration to, or destruction of *fish habitat*, except where, in conjunction with the appropriate authorities, it has been authorized under the *Fisheries Act*; and
d) in regard to other *natural heritage features and areas*, degradation that threatens the health and integrity of the natural features or *ecological functions* for which an area is identified due to single, multiple or successive *development* or *site alteration* activities.

Normal farm practices: means a practice, as defined in the *Farming and Food Production Protection Act*, *1998*, that is conducted in a manner consistent with proper and acceptable customs and standards as established and followed by similar agricultural operations under similar circumstances; or makes use of innovative technology in a manner consistent with proper advanced farm management practices. Normal farm practices shall be consistent with the *Nutrient Management Act*, *2002* and regulations made under that Act.

Oil, gas and salt hazards: means any feature of a well or work as defined under the *Oil*, *Gas and Salt Resources Act*, or any related disturbance of the ground that has not been rehabilitated.

On-farm diversified uses: means uses that are secondary to the principal agricultural use of the property, and are limited in area. *On-farm diversified uses* include, but are not limited to, home occupations, home industries, *agri-tourism uses*, and uses that produce value-added agricultural products. Ground-mounted solar facilities are permitted in *prime agricultural areas,* including *specialty crop areas,* only as *on-farm diversified uses.*

One hundred year flood: for *river, stream and small inland lake systems*, means that flood, based on an analysis of precipitation, snow melt, or a combination thereof, having a return period of 100 years on average, or having a 1% chance of occurring or being exceeded in any given year.

One hundred year flood level: means

a) for the shorelines of the Great Lakes, the peak instantaneous stillwater level, resulting from combinations of mean monthly lake levels and wind setups, which has a 1% chance of being equalled or exceeded in any given year;
b) in the connecting channels (St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers), the peak instantaneous stillwater level which has a 1% chance of being equalled or exceeded in any given year; and
c) for large inland lakes, lake levels and wind setups that have a 1% chance of being equalled or exceeded in any given year, except that, where sufficient water level records do not exist, the one hundred year flood level is based on the highest known water level and wind setups.

Other water-related hazards: means water-associated phenomena other than *flooding hazards* and *wave uprush* which act on shorelines. This includes, but is not limited to ship-generated waves, ice piling and ice jamming.

Partial services: means

a) *municipal sewage services* or *private communal sewage services* combined with *individual on-site water services*; or
b) *municipal water services* or *private communal water services* combined with *individual on-site sewage services*.

Petroleum resource operations: means oil, gas and salt wells and associated facilities and other drilling operations, oil field fluid disposal wells and associated facilities, and wells and facilities for the underground storage of natural gas and other hydrocarbons.

Petroleum resources: means oil, gas, and salt (extracted by solution mining method) and formation water resources which have been identified through exploration and verified by preliminary drilling or other forms of investigation. This may include sites of former operations where resources are still present or former sites that may be converted to underground storage for natural gas or other hydrocarbons.

Planned corridors: means corridors or future corridors which are required to meet projected needs, and are identified through *provincial plans*, preferred alignment(s) determined through the *Environmental Assessment Act* process, or identified through planning studies where the Ontario Ministry of Transportation, Metrolinx, Ontario Ministry of Energy, Northern Development and Mines or Independent Electricity System Operator (IESO) or any successor to those ministries or entities is actively pursuing the identification of a corridor.

Approaches for the protection of *planned corridors* may be recommended in guidelines developed by the Province.

Portable asphalt plant: means a facility

a) with equipment designed to heat and dry aggregate and to mix aggregate with bituminous asphalt to produce asphalt paving material, and includes stockpiling and storage of bulk materials used in the process; and
b) which is not of permanent construction, but which is to be dismantled at the completion of the construction project.

Portable concrete plant: means a building or structure

a) with equipment designed to mix cementing materials, aggregate, water and admixtures to produce concrete, and includes stockpiling and storage of bulk materials used in the process; and
b) which is not of permanent construction, but which is designed to be dismantled at the completion of the construction project.

Prime agricultural area: means areas where *prime agricultural lands* predominate. This includes areas of *prime agricultural lands* and associated Canada Land Inventory Class 4 through 7 lands, and additional areas where there is a local concentration of farms which exhibit characteristics of ongoing agriculture. *Prime agricultural areas* may be identified by the Ontario Ministry of Agriculture and Food using guidelines developed by the Province as amended from time to time. A *prime agricultural area* may also be identified through an alternative agricultural land evaluation system approved by the Province.

Prime agricultural land: means *specialty crop areas* and/or Canada Land Inventory Class 1, 2, and 3 lands, as amended from time to time, in this order of priority for protection.

Private communal sewage services: means a sewage works within the meaning of section 1 of the *Ontario Water Resources Act* that serves six or more lots or private residences and is not owned by a municipality.

Private communal water services: means a non-municipal drinking-water system within the meaning of section 2 of the *Safe Drinking Water Act*, *2002* that serves six or more lots or private residences.

Protected heritage property: means property designated under Parts IV, V or VI of the *Ontario Heritage Act*; property subject to a heritage conservation easement under Parts II or IV of the *Ontario Heritage Act*; property identified by the Province and prescribed public bodies as provincial heritage property under the Standards and Guidelines for Conservation of Provincial Heritage Properties; property protected under federal legislation, and UNESCO World Heritage Sites.

Protection works standards: means the combination of non-structural or structural works and allowances for slope stability and flooding/erosion to reduce the damage caused by *flooding hazards*, *erosion hazards* and *other water-related hazards*, and to allow access for their maintenance and repair.

Provincial and federal requirements: means

a) in regard to policy 2.1.6, legislation and policies administered by the federal or provincial governments for the purpose of fisheries protection (including *fish* and *fish habitat*), and related, scientifically established standards such as water quality criteria for protecting lake trout populations; and
b) in regard to policy 2.1.7, legislation and policies administered by the provincial government or federal government, where applicable, for the purpose of protecting species at risk and their habitat.

Provincial plan: means a provincial plan within the meaning of section 1 of the *Planning Act*.

Public service facilities: means land, buildings and structures for the provision of programs and services provided or subsidized by a government or other body, such as social assistance, recreation, police and fire protection, health and educational programs, long-term care services, and cultural services.

Public service facilities do not include *infrastructure*.

Quality and quantity of water: is measured by indicators associated with hydrologic function such as minimum base flow, depth to water table, aquifer pressure, oxygen levels, suspended solids, temperature, bacteria, nutrients and hazardous contaminants, and hydrologic regime.

Rail facilities: means rail corridors, rail sidings, train stations, inter-modal facilities, rail yards and associated uses, including designated lands for future *rail facilities*.

Recreation: means leisure time activity undertaken in built or natural settings for purposes of physical activity, health benefits, sport participation and skill development, personal enjoyment, positive social interaction and the achievement of human potential.

Redevelopment: means the creation of new units, uses or lots on previously developed land in existing communities, including *brownfield sites*.

Regional market area: refers to an area that has a high degree of social and economic interaction. The upper or single-tier municipality, or planning area, will normally serve as the *regional market area*. However, where a *regional market area* extends significantly beyond these boundaries, then the *regional market area* may be based on the larger market area. Where *regional market areas* are very large and sparsely populated, a smaller area, if defined in an official plan, may be utilized.

Renewable energy source: means an energy source that is renewed by natural processes and includes wind, water, biomass, biogas, biofuel, solar energy, geothermal energy and tidal forces.

Renewable energy system: means a system that generates electricity, heat and/or cooling from a *renewable energy source.*

Reserve sewage system capacity: means design or planned capacity in a centralized waste water treatment facility which is not yet committed to existing or approved development. For the purposes of policy 1.6.6.6, reserve capacity for *private communal sewage services* and *individual on-site sewage services* is considered sufficient if the hauled sewage from the development can be treated and land-applied on agricultural land under the *Nutrient Management Act*, or disposed of at sites approved under the *Environmental Protection Act* or the *Ontario Water Resources Act*, but not by land-applying untreated, hauled sewage.

Reserve water system capacity: means design or planned capacity in a centralized water treatment facility which is not yet committed to existing or approved development.

Residence surplus to a farming operation: means an existing habitable farm residence that is rendered surplus as a result of farm consolidation (the acquisition of additional farm parcels to be operated as one farm operation).

Residential intensification: means intensification of a property, site or area which results in a net increase in residential units or accommodation and includes:

a) redevelopment, including the redevelopment of *brownfield sites*;
b) the development of vacant or underutilized lots within previously developed areas;
c) infill development;
d) development and introduction of new *housing options* within previously developed areas;
e) the conversion or expansion of existing industrial, commercial and institutional buildings for residential use; and
f) the conversion or expansion of existing residential buildings to create new residential units or accommodation, including accessory apartments, additional residential units, rooming houses, and other *housing options*.

River, stream and small inland lake systems: means all watercourses, rivers, streams, and

small inland lakes or waterbodies that have a measurable or predictable response to a single runoff event.

Rural areas: means a system of lands within municipalities that may include rural *settlement areas*, *rural lands*, *prime agricultural areas*, natural heritage features and areas, and resource areas.

Rural lands: means lands which are located outside *settlement areas* and which are outside *prime agricultural areas*.

Sensitive: in regard to *surface water features* and *ground water features*, means areas that are particularly susceptible to impacts from activities or events including, but not limited to, water withdrawals, and additions of pollutants.

Sensitive land uses: means buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more *adverse effects* from contaminant discharges generated by a nearby *major facility*. *Sensitive land uses* may be a part of the natural or built environment. Examples may include, but are not limited to: residences, day care centres, and educational and health facilities.

Settlement areas: means urban areas and rural settlement areas within municipalities (such as cities, towns, villages and hamlets) that are:

a) built-up areas where development is concentrated and which have a mix of land uses; and
b) lands which have been designated in an official plan for development over the long-term planning horizon provided for in policy 1.1.2. In cases where land in *designated growth areas* is not available, the *settlement area* may be no larger than the area where development is concentrated.

Sewage and water services: includes *municipal sewage services* and *municipal water services*, *private communal sewage services* and *private communal water services*, *individual on-site sewage services* and *individual on-site water services*, and *partial services*.

Significant: means

a) in regard to *wetlands*, *coastal wetlands* and *areas of natural and scientific interest*, an area identified as provincially significant by the Ontario Ministry of Natural Resources and Forestry using evaluation procedures established by the Province, as amended from time to time;
b) in regard to *woodlands*, an area which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history. These are to be identified using criteria established by the Ontario Ministry of Natural Resources and Forestry;
c) in regard to other features and areas in policy 2.1, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or *natural heritage system*;
d) in regard to *mineral* potential, an area identified as provincially significant through evaluation procedures developed by the Province, as amended from time to time, such as the Provincially Significant Mineral Potential Index; and
e) in regard to cultural heritage and archaeology, resources that have been determined to have cultural heritage value or interest. Processes and criteria for determining cultural heritage value or interest are established by the Province under the authority of the *Ontario Heritage Act*.

Criteria for determining significance for the resources identified in sections (c)-(d) are recommended by the Province, but municipal approaches that achieve or exceed the same objective may also be used.

While some significant resources may already be identified and inventoried by official sources,

the significance of others can only be determined after evaluation.

Site alteration: means activities, such as grading, excavation and the placement of fill that would change the landform and natural vegetative characteristics of a site.

For the purposes of policy 2.1.4(a), *site alteration* does not include underground or surface mining of *minerals* or advanced exploration on mining lands in *significant areas of mineral potential* in Ecoregion 5E, where advanced exploration has the same meaning as in the *Mining Act*. Instead, those matters shall be subject to policy 2.1.5(a).

Special needs: means any housing, including dedicated facilities, in whole or in part, that is used by people who have specific needs beyond economic needs, including but not limited to, needs such as mobility requirements or support functions required for daily living. Examples of *special needs* housing may include, but are not limited to long-term care homes, adaptable and accessible housing, and housing for persons with disabilities such as physical, sensory or mental health disabilities, and housing for older persons.

Special Policy Area: means an area within a community that has historically existed in the *flood plain* and where site-specific policies, approved by both the Ministers of Natural Resources and Forestry and Municipal Affairs and Housing, are intended to provide for the continued viability of existing uses (which are generally on a small scale) and address the significant social and economic hardships to the community that would result from strict adherence to provincial policies concerning *development*. The criteria and procedures for approval are established by the Province.

A *Special Policy Area* is not intended to allow for new or intensified *development* and *site alteration*, if a community has feasible opportunities for *development* outside the *flood plain*.

Specialty crop area: means areas designated using guidelines developed by the Province, as amended from time to time. In these areas, specialty crops are predominantly grown such as tender fruits (peaches, cherries, plums), grapes, other fruit crops, vegetable crops, greenhouse crops, and crops from agriculturally developed organic soil, usually resulting from:

a) soils that have suitability to produce specialty crops, or lands that are subject to special climatic conditions, or a combination of both;
b) farmers skilled in the production of specialty crops; and
c) a long-term investment of capital in areas such as crops, drainage, infrastructure and related facilities and services to produce, store, or process specialty crops.

Surface water feature: means water-related features on the earth's surface, including headwaters, rivers, stream channels, inland lakes, seepage areas, recharge/discharge areas, springs, wetlands, and associated riparian lands that can be defined by their soil moisture, soil type, vegetation or topographic characteristics.

Threatened species: means a species that is classified as "Threatened Species" on the Species at Risk in Ontario List, as updated and amended from time to time.

Transit-supportive: in regard to land use patterns, means development that makes transit viable, optimizes investments in transit infrastructure, and improves the quality of the experience of using transit. It often refers to compact, mixed-use development that has a high level of employment and residential densities, including air rights development, in proximity to transit stations, corridors and associated elements within the *transportation system*. Approaches may be recommended in guidelines developed by the Province or based on municipal approaches that achieve the same objectives.

Transportation demand management: means a set of strategies that result in more efficient use of the *transportation system* by influencing travel behaviour by mode, time of day,

frequency, trip length, regulation, route, or cost.

Transportation system: means a system consisting of facilities, corridors and rights-of-way for the movement of people and goods, and associated transportation facilities including transit stops and stations, sidewalks, cycle lanes, bus lanes, high occupancy vehicle lanes, *rail facilities*, parking facilities, park'n'ride lots, service centres, rest stops, vehicle inspection stations, inter-modal facilities, harbours, *airports*, *marine facilities*, ferries, canals and associated facilities such as storage and maintenance.

Two zone concept: means an approach to *flood plain* management where the *flood plain* is differentiated in two parts: the *floodway* and the *flood fringe*.

Valleylands: means a natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year.

Vulnerable: means surface and/or ground water that can be easily changed or impacted.

Waste management system: means sites and facilities to accommodate solid waste from one or more municipalities and includes recycling facilities, transfer stations, processing sites and disposal sites.

Watershed: means an area that is drained by a river and its tributaries.

Wave uprush: means the rush of water up onto a shoreline or structure following the breaking of a wave; the limit of wave uprush is the point of furthest landward rush of water onto the shoreline.

Wayside pits and quarries: means a temporary pit or quarry opened and used by or for a public authority solely for the purpose of a particular project or contract of road construction and not located on the road right-of-way.

Wetlands: means lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens.

Periodically soaked or wet lands being used for agricultural purposes which no longer exhibit wetland characteristics are not considered to be wetlands for the purposes of this definition.

Wildland fire assessment and mitigation standards: means the combination of risk assessment tools and environmentally appropriate mitigation measures identified by the Ontario Ministry of Natural Resources and Forestry to be incorporated into the design, construction and/or modification of buildings, structures, properties and/or communities to reduce the risk to public safety, infrastructure and property from wildland fire.

Wildlife habitat: means areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual or life cycle; and areas which are important to migratory or non-migratory species.

Woodlands: means treed areas that provide environmental and economic benefits to both the private landowner and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of wildlife habitat, outdoor recreational opportunities, and the sustainable harvest of a wide range of woodland products. *Woodlands* include treed areas, woodlots or forested areas and vary in their level of significance at the local, regional and provincial levels. *Woodlands* may be delineated according to the *Forestry Act* definition or the Province's Ecological Land Classification system definition for "forest".

TAB 5

Ontario

Technical Guide

River & Stream Systems: Flooding Hazard Limit

Ontario Ministry of Natural Resources
Water Resources Section
300 W ater Street, 5 th Floor, South Tower, P.O. Box 7000
Peterborough, Ontario K9J 8M5

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Acknowledgements

The Technical Guide, River and Stream Systems; Flooding Hazard Limit updates the 1986 Flood Plain Management in Ontario Technical Guidelines, Ontario Ministry of Natural Resources (OMNR) and supports the Natural Hazard Policies of the Provincial Policy Statement of the *Planning Act*. Ivan Lorant of Dillon Consulting Ltd. updated the Technical Guide, River and Stream Systems; Flooding Hazard Limit, under the direction and guidance provided by a steering committee of OMNR Water Resources staff of the Lands and Waters Branch, including:

Ala Boyd (Chair)
Pearl McKeen
Les Pataky
Don Greer
John Ding
Ron McGirr

The original 1986 Flood Plain Management in Ontario Technical Guidelines were prepared by the Conservation Authorities and Water Management Branch, Ministry of Natural Resources, under the supervision of G.S. Sardesai. The principal writer was Ivan Lorant, P.Eng., Chief Water Resources Engineer, M.M. Dillon Ltd. Guidance during preparation of the guidelines was provided by a steering committee comprised of:

Ivan Lorant (Chairman)	M.M. Dillon Ltd.
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Dr. A. Smith	Conservation Authority
C. Mather	Conservation Authority
R. Wigle	MacLaren Plansearch
H.Belore	Cumming-Cockburn & Associates Ltd.

During the preparation of the guidelines and during subsequent review, input was also received from a number of individuals and agencies including provincial ministries, conservation authorities, Consulting Engineers of Ontario and various specialists, particularly:

Dr. E. Watt
Dr. P. Wisner
Dr. T. Dickinson
Proctor & Redfern Ltd. (Mr. A, Perks)
A. Robinson & Associates Ltd. (Mr. A. Robinson)
Mr. S. Baltaos
Dr. L. Gerard
Dr. N. Kouwen
Mr. D. Calkins
Paragon Engineering Ltd. (Mr. J. Gorrie)
S.A. Kirchhefer Ltd. (Mr. S. Kirchhefer).

All contributions, present and past are gratefully acknowledged.

For information concerning the Natural Hazards Policies or the Technical Guide, River and Stream Systems; Flooding Hazard Limit, please contact the Water Resources Section of the Lands and Waters Branch, Ministry of Natural Resources, in Peterborough, Ontario at (705) 755-1222.

A. Preface

A new efficient and effective land use planning process was introduced in Ontario to replace the complex planning system used in the past and to ensure the environmental, economic and social well-being of the people of Ontario.

The 1997 Provincial Policy Statement issued under the authority of Section 3 of the Planning Act provides policy direction on matters of Provincial interests related to land use planning and development. According to the Planning Act, planning authorities "shall have regard to" policy statements issued under the Act. One important principle behind the Policy statement to achieve long-term economic prosperity, environmental health and social well-being is the reduction of public cost and risk to Ontario's residents by directing development away from areas where there is risk to public health or safety or risk of property damage. Accordingly, the Province of Ontario adopted policies under Public Health and Safety policy areas addressing natural and human-made hazards. Part of the new approach empowers municipalities in protecting the environment and streamlining an ecosystem based planning process.

Flood plain studies form an important part of watershed management and planning. Proper planning requires the balancing of a wide range of public and private interests. Ecosystem based planning within a watershed or a sub-watershed, involves an up-front evaluation of numerous, and often competing, land use and natural resources interests. It provides a means of examining and developing planning strategies that balance local as well as community-based needs. Through ecosystem based planning processes, environmental concerns such as flood and erosion hazard lands can be identified and incorporated into the land use planing process.

The Ministry of Natural Resources (MNR) through its refocussed water management program will ensure that the program is effectively aligned with the Ministry's vision of sustainable development and its mission to achieve ecological sustainability. MNR objectives to achieve ecological sustainability include the continuation of Provincial programs for the protection of life and property from flooding and other water-related hazards, and the provision of direction and input through policy, information and science support.

The Provincial government's role in the planning and management of flood risk areas is to protect society, including all levels of government, from being forced to bear unreasonable social and economic burdens due to unwise individual choices.

The Province sets minimum standards to ensure that these risks and costs to society are reduced. There are instances where local conditions dictate that the minimum standards may not be sufficient and a higher standard may be more appropriate. The Province has empowered municipalities to assume responsibilities for the management of flood risk areas, the associated liability and the risk relative to planning for new land uses in and around these areas. The municipality making these decisions should ensure that flood plain management studies are undertaken by a Professional Engineer and resulting flood lines, flood proofing standards are examined and approved by a Professional Engineer using accepted engineering principles.

The management of flood susceptible lands involves a combination of three main program components:

i) Prevention, by land use planning and regulation of development;
ii) Protection, by applying structural and non-structural measures and acquisition; and
iii) Emergency response, by flood forecasting/warning and flood/erosion disaster relief.

Over the long-term prevention is the preferred method for the management of flood plain lands.

The Ministry of Natural Resources, as a participant in the Province of Ontario's planning reform initiatives, is responsible for providing policy leadership and directions specific to natural hazards, including flood hazards along river and stream systems within the Province. This Rivers and Streams Technical Guide: Flooding Hazard Limit document has been prepared to assist in the understanding of the latest Provincial Policy Statement and to describe approaches which have been determined to be consistent with the new policies. The enclosed document is based on the 1996 Provincial Policy Statement and it updates the original 1986 Flood Plain Management in Ontario, Technical Guideline publication. It incorporates the previously released Provincial Flood Plain Planning Policy Statement Implementation Guidelines, (1988), new technology and findings of additional studies in the field of flood plain investigations and court decisions.

This guide serves in an advisory role and is not intended to introduce any changes from the Policy Statement. Instead, it should be read in conjunction with the Provincial Policy Statement as well as other flood related implementation guides.

In preparing the Rivers and Streams Technical Guide, the Ministry intends to document standardized approaches to manage flood susceptible lands across the Province. Designers and review agency staff will find the Guide helpful in their work as it is based on a standard methodology. The material presented will go a long way to avoid and/or reduce the duplica-

tion in flood plain calculations and, as a result, should represent a cost saving for flood plain management projects. Also, the Guide will assist in the approval process and in explaining, or if necessary defending, the methodology when challenged.

The past practice of rapid conveyance of floodwaters away from urban and rural areas has affected our natural watercourses. River valleys and stream corridors are constantly adjusting to natural and human induced processes. In addition to providing hydraulic conveyance to flows, these corridors perform other hydrological functions, such as the discharge and recharge of groundwater, and the erosion, transport and deposition of sediment. Channels lined with hard surfaces have been constructed to carry the floodwaters, replacing the natural streams and valleys. These changes in the river systems have resulted in a loss of fishery and wildlife habitat, and deterioration of water quality and aesthetic features associated with natural streams. The recent changes in Provincial policies and raised environmental concerns have resulted in changes to our approach to watershed management, and have forced us to regard channels as important multi-functional links within our ecosystem.

This document describes, in general terms, an important component of watershed management; it presents the hydrologic and hydraulic work needed to conduct flood plain analyses. It is not intended to be a list of mandatory instructions on technical methodologies to be rigidly applied in all circumstances, rather, it serves to assist technical staff experienced in water resources in the selection of the most appropriate computational method and flexible implementation measures, provided the decisions made are consistent with the latest Provincial Policy Statement. The Guide cannot replace good engineering and environmental judgement in adopting the most appropriate procedures required to achieve the amount of detail and effort involved, and in determining the practical degree of accuracy achievable when adopting a flood related study program.

The following seven steps outline the proposed flood plain study tasks to be followed, indicating the relevant Technical Guide chapters which provide more detailed descriptions on the recommended procedures.

Step 1.Select flood plain standard (Chapter B)

- Identify study area on Figure B-1 to determine Zone and corresponding flood standard
- Select flood standard from: Historical Storm (Hazel, Timmins), 100 year flood, or a historical storm observed in the area provided it exceeds the 100 year flood

Step 2.Review data requirements, methods of hydrologic and hydraulic calculations (Chapter C)

- Data requirement: streamflows, water levels, meteorological and physiographic data
- Flood magnitudes: flood frequency analysis for 100 year floods, or hydrologic modelling of flood from a specified meteorological event, (see Chapters D and E)
- Hydraulic modelling, type of flow, cross-section data, roughness, bridge and culvert losses, plotting (see Chapters F and G)
- Select mapping (for detailed specification see Chapter J)

Step 3.Select hydrologic modelling parameters (Chapter D)

- Select rainfall input to modelling of flood standard: Hazel, Timmins, 100 year storm depth, duration, distribution, snowmelt
- Select soil data
- Select land use

Step 4.Select methods of computing flows (Chapter E)

- Hydrologic models: single and continuous models
- Computational procedures: snowmelts, infiltration, soil moisture account, base flow, watershed routing
- Recommended model selection
- Model calibration

Step 5.Select method of computing water levels for open water conditions, (Chapter F)

- Recommended models
- Flood routing
- Reservoir routing
- Effect of lakes and reservoirs
- Waterway crossings and encroachments
- Model calibration and sensitivity

Step 6.Compute ice jam levels, where appropriate, (Chapter G)

- Determine the need to compute ice jam levels for the site
- Select ice jam computational method
- Estimate frequency of ice jams

Step 7.Prepare technical report, (Chapter H)

The last two chapters describe:

- **Implementation and agency roles (Chapter I)** and
- **Survey and mapping specification, (Chapter J)**.

The six Appendices which provide information are listed below:

Appendix 1	Bibliography
Appendix 2	Glossary
Appendix 3	Application to change the flood standard
Appendix 4	Application of the two zone concept
Appendix 5	Special Policy Areas, factors to be considered
Appendix 6	**Floodproofing**.

1. BACKGROUND

The Provincial government's role in the planning and management of flood risk areas is to protect society, including all levels of government, from being forced to bear unreasonable social and economic burdens due to unwise individual choices. The management of flood susceptible lands involves the combination of three main program components: i) prevention, by land use planning and regulation of development, ii) protection, by applying structural and non-structural measures, and acquisition, and iii) emergency response, by flood forecasting/warning and flood/erosion disaster relief. Over the long term, prevention is the preferred method for the management of flood plain lands.

The Provincial Policy Statement (May 1996) issued under the authority of the Planning Act provides policy direction on matters of provincial interest related to land use planning and development. According to the Provincial Policy Statement, the Province's long-term economic prosperity, environmental health and social well-being depend on reducing the potential for public cost and risk to Ontario's residents by directing development away from areas where there is a risk to public health and safety or a risk of property damage. The policy on public health and safety states that development will generally be diverted to areas outside of hazardous lands adjacent to river and stream systems which are impacted by flooding and/or erosion hazards.

The guiding Principles behind the Provincial Policy Statement are as follows:

- Proper flood plain management requires flood/erosion hazards to be simultaneously recognized and addressed in a manner that is integrated with land use planning and maintains environmental ecosystem integrity;
- Effective flood plain management can only occur on a watershed basis with due consideration given to development effects and associated environmental impacts;
- Local conditions vary along the flood plain and, accordingly, must be taken into account in the planning and managing of flood plains;
- New development which is susceptible to flood/erosion hazards or which will cause or aggravate flood/erosion hazards to existing and approved uses, or which will cause adverse environmental impacts must not be permitted to occur unless the flood/erosion hazards and environmental impacts have been addressed; and
- Flood plain management and land use planning are distinct yet related activities that require overall co-ordination on the part of municipalities, Conservation Authorities, the Ministry of Natural Resources and Ministry of Municipal Affairs and Housing.

The following sections describe the flood plain policies and standards to be used for delineating flood hazard lands across the Province.

2. PROVINCIAL NATURAL HAZARD POLICIES

2.1 Natural Hazard Policies

The Provincial Policy Statement on Public Health and Safety describes the Natural Hazards policies (Provincial Policy Statement, Section 3.1) relating to flood plains as follows:

Policy 3.1.1 Development will generally be directed to areas outside of:

a) hazardous lands adjacent to shorelines of the Great lakes - St. Lawrence River System and large inland lakes which are impacted by flooding, erosion, and/or dynamic beach hazards;
b) hazardous lands adjacent to river and stream systems which are impacted by flooding and/or erosion hazards; and
c) hazardous sites

Policy 3.1.2 Development and site alterations will not be permitted within:

a) defined portions of dynamic beach;
b) defined portions of the one hundred year flood level along connecting channels (the St. Mary's, St. Clair, Detroit, Niagara and St. Lawrence Rivers); and
c) defined floodways (except in those exceptional situations where a Special Policy Area has been approved).

Policy 3.1.3 Except as provided in policy 3.1.2, development and site alteration may be permitted in hazardous lands and hazardous sites, provided that all of the following can be achieved:

a) the hazards can be safely addressed, and the development and site alteration is carried out in accordance with established standards and procedures;
b) new hazards are not created and existing hazards are not aggravated;
c) no adverse environmental impacts will result;
d) vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies; and
e) the development does not include institutional uses, essential emergency services of the disposal, manufacture, treatment or storage of hazardous substances.

2.2 Provincial Interests - Flooding Hazards

The overall interests and expectations of the Province of Ontario in flood plain management along river and stream systems are described here:

- All land use planning and resource management bodies within the Province will have regard to the implications of their actions respecting the creation of new or aggravation of existing flood plain management problems;

- Municipalities and planning boards will recognize the flood and erosion susceptibility and environmental integrity of flood plains at the various stages of the land use planning process for which they have jurisdiction; and

- Municipalities and planning boards will direct new development to areas outside of the flood and erosion hazard areas.

2.3 Flood Standards for River Systems

Flooding hazards means the inundation, under the conditions specified below, of areas adjacent to a river system (that are not ordinarily covered by water). The flooding hazard limit is the greater of:

i) the flood resulting from a rainfall actually experienced during a major storm such as the Hurricane Hazel storm (1954) or the Timmins storm (1961), transposed over a specific watershed and combined with the local conditions, where evidence suggests that the storm event could have potentially occurred over watersheds in the general area;

ii) the one hundred year flood; or

iii) a flood which is greater than i) or ii) which was actually experienced on a particular watershed or portion thereof, for example as a result of ice jams and which has been approved as the standard for that specific area by the Minister of Natural Resources; and

The exception is where the use of the 100 year flood or actually experienced event as the flood standard for a specific watershed, even though it does not exceed the Hazel or Timmins event, has been approved by the Minister of Natural Resources, (where past history of flooding supports the lowering of the standard).

For those watersheds with a flood standard greater than the minimum acceptable for the area (see Figure B-1), the option exists for municipalities and planning boards to apply to the Minister of Natural Resources, in accordance with procedures established, to change the standard, subject to the following overriding conditions.

(a) Changes to the existing flood standard will only be considered with the support of a significant majority of municipalities and/or planning boards within the watershed, in consultation with the local Conservation Authority or Ministry of Natural Resources, where Conservation Authorities do not exist; and

(b) The lowering of the existing flood standard where the past history of flooding reveals that a higher level is more appropriate will not be considered.

The method of applying to change the flood plain standards are described in Appendix 3.

Where flooding is experienced in excess of the existing flood standard, the Minister of Natural Resources may require the flood standard to be modified to reflect the observed flood event. The 100 year flood is the minimum acceptable flood standard for flood plain delineation.

2.4 Flood Hazard Limits for Lakes < 100 sq. km.

The basic principles of defining flood standards along lakes are similar to the principles adopted for rivers. However, there are additional factors, such as the effect of wind, which have to be considered when selecting standards for Lake Levels.

Smaller lakes, less than 100 km^2 in size may or may not respond to a single runoff event. Similarly riverine lakes and large rivers (i.e., Ottawa River) which, due to their size and fetch (>3 km), may be subject to wind set up, generating water levels higher than the flood standard selected for the river.

The standard for defining the flood plain along small lakes and large rivers is the same standard used for rivers (Hazel-Centred, Timmins-Centred, maximum observed or 100-year, whichever is applicable) plus an appropriate allowance for wind setup. The wind setup is to be calculated on the basis of mean wind speed and applicable maximum effective fetch. The computed wind setup will then apply along the entire lake shore. Where the maximum effective fetch is less than 3 km, the lake can be treated as an integral component of the river system, therefore the flood standard will be the same as that applied to the river system.

2.5 Official Plan Flooding Hazard Limit Policies

Municipalities and planning boards should show or describe flood plain lands in their official plans and incorporate policies to address new development consistent with the policy statement.

Municipalities and planning boards, in consultation with the local Conservation Authority or Ministry of Natural Resources, where no Conservation Authority exists, should include in their official plans:

(a) policies where by uses permitted in flood plains are cognizant of flood susceptibility and flood risk;

(b) policies whereby no new buildings or structures are permitted which are susceptible to flood related damages or will cause adverse impacts to existing upstream or downstream development or lands;

(c) policies addressing additions or alterations to existing buildings or structures and replacement of buildings or structures located in flood plains; and

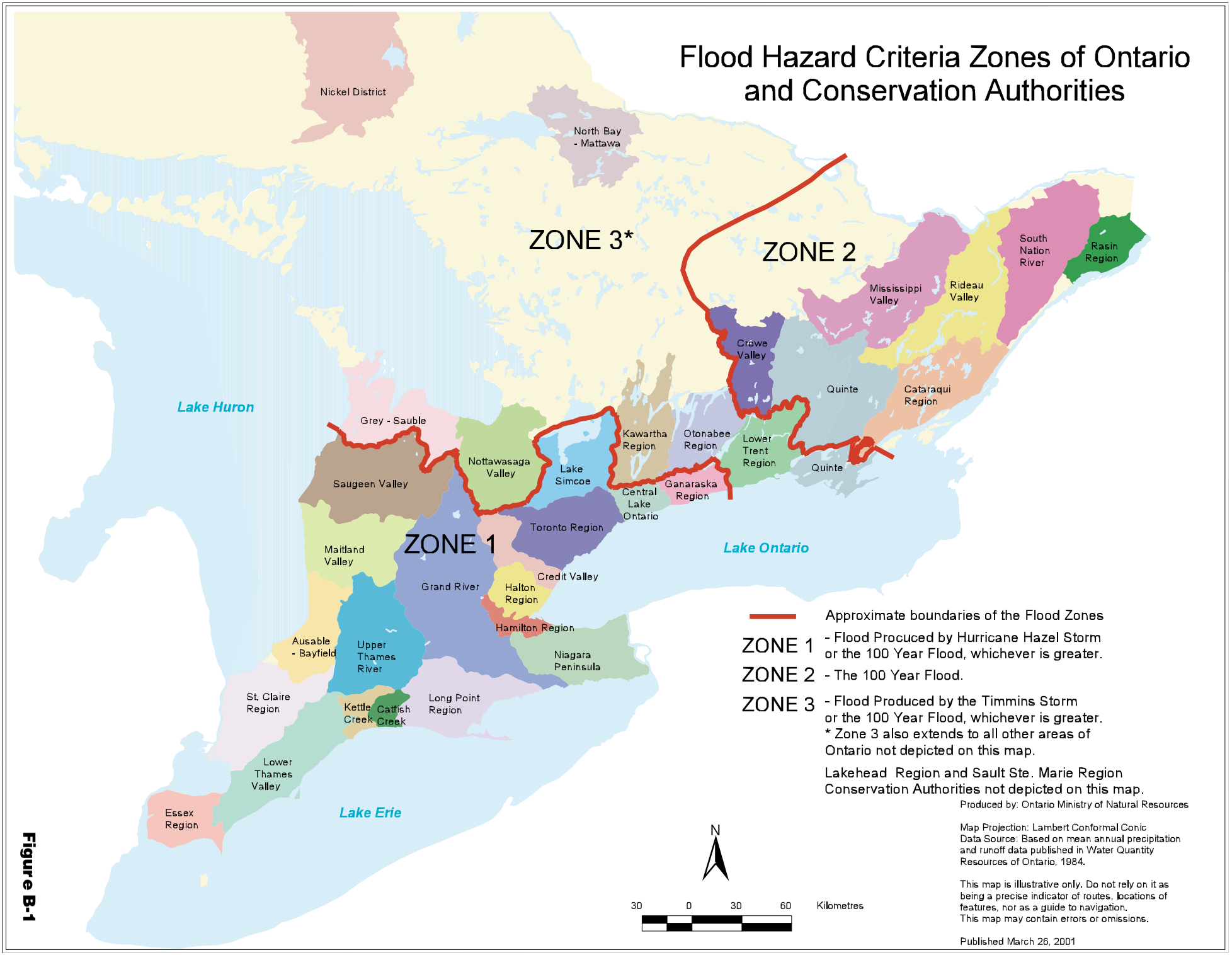

Flood Hazard Criteria Zones of Ontario
and Conservation Authorities
Nickel District
North Bay
- Mattawa
ZONE 3*
ZONE 2
ZONE 1
Lake Huron
Lake Ontario
Lake Erie
Grey - Sauble
Saugeen Valley
Nottawasaga
Valley
Lake
Simcoe
Kawartha
Region
Otonabee
Region
Lower
Trent
Region
Quinte
Central
Lake
Ontario
Ganaraska
Region
Toronto Region
Maitland
Valley
Grand River
Halton
Region
Credit Valley
Hamilton Region
Niagara
Peninsula
Ausable
- Bayfield
Upper
Thames
River
St. Claire
Region
Kettle
Creek
Catfish
Creek
Long Point
Region
Lower
Thames
Valley
Essex
Region
Crowe
Valley
Mississippi
Valley
Rideau
Valley
South
Nation
River
Rasin
Region
Cataraqui
Region
Approximate boundaries of the Flood Zones
ZONE 1 - Flood Procuced by Hurricane Hazel Storm or the 100 Year Flood, whichever is greater.
ZONE 2 - The 100 Year Flood.
ZONE 3 - Flood Produced by the Timmins Storm or the 100 Year Flood, whichever is greater.
* Zone 3 also extends to all other areas of Ontario not depicted on this map.
Lakehead Region and Sault Ste. Marie Region Conservation Authorities not depicted on this map.
N
30 0 30 60 Kilometres
Produced by: Ontario Ministry of Natural Resources
Map Projection: Lambert Conformal Conic
Data Source: Based on mean annual precipitation and runoff data published in Water Quantity Resources of Ontario, 1984.
This map is illustrative only. Do not rely on it as being a precise indicator of routes, locations of features, nor as a guide to navigation.
This map may contain errors or omissions.
Published March 26, 2001

Figure B-1

(d) policies addressing such public and private works that must located in flood plains by nature of their use.

Municipalities and planning boards should identify in their official plans, the planning controls required to give effect to the flood plain policies of the Province. Where no official plan exists, the zoning document affecting the area should contain provisions to reflect this policy statement.

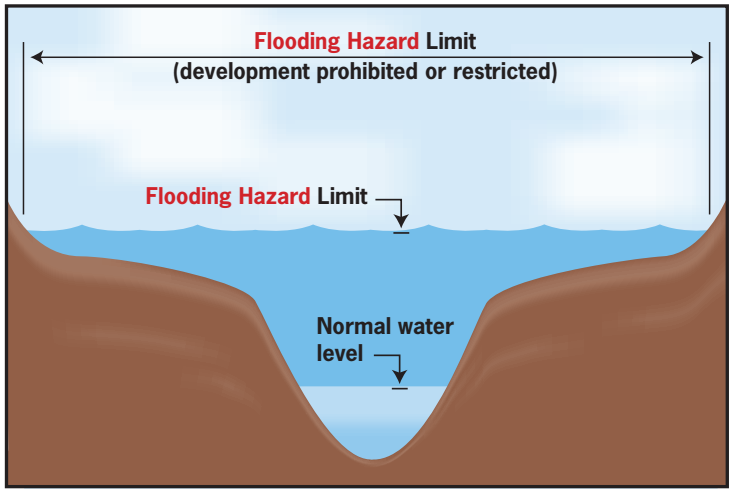
2.6 One Zone Concept

Generally, the flood plain will consist of one zone, defined by the selected flood standard (see Figure B-1). New development in the flood plain is to be prohibited or restricted. Where the one zone concept is applied:

i) Municipalities and planning boards should include policies in their official plans that explain the intent of the one zone concept;

ii) The flood plain should be appropriately zoned in conformity with the official plan designation to reflect its prohibitive or restrictive use; and

iii) The entire flood plain should be treated as the floodway.



(NOT TO SCALE)

Figure B-2 - One Zone Floodplain Concept

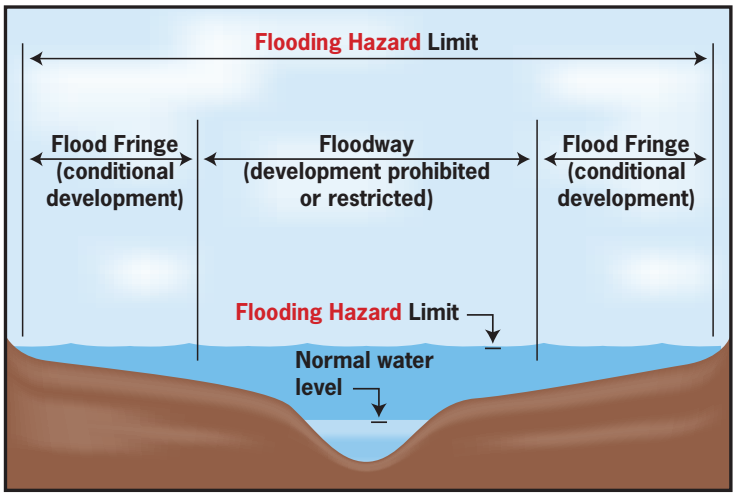
2.7 Two Zone Concept.

The two zone concept recognizes the fact that the flood plain can often be divided into two zones: the floodway, where the majority of the flow is conveyed and flood fringes which exist on both sides of the floodway.

Where the two zone concept is applied, the floodway is the inner portion of the flood plain, representing that area required for the safe passage of flood flow and/or that area where flood depth and/or velocities are considered to be such that they pose a potential threat to life and/or property damage.

Floodway for a river system means the portion of the flood plain where development and site alteration would cause a danger to public health and safety or property damage. Uses which by their nature must be located within the floodway, such as flood and/or erosion control works, or where appropriate, minor additions or passive, non-structural uses which do not affect flood flows may be permitted. New development in the floodway is to be prohibited or restricted.

For outer portions of flood plains that could potentially be safely developed with no adverse impacts, the Conservation Authorities in Ontario, or where no Conservation Authorities exist, the Ministry of Natural Resources, in co-operation with the watershed municipalities, have the option of selective application of the two zone (floodway - flood fringe) concept (see Figure B-2).



(NOT TO SCALE)

Figure B-3 - Two Zone Floodway - Floodfringe concept

The extent of the floodway is to be determined based on local watershed conditions, such as critical flood depth and velocity, existing and proposed development, and the potential for upstream or downstream impacts. Generally, flow depth in excess of 1 m and/or flow velocities above 1 m/s can create significant hazards for developments.

The two zone approach adopted in 1982 used the magnitude of flood as the design criteria to identify the floodway and flood fringe areas. The Floodway was based on the 100 year flood, while the flood fringe was based on the Hazel or Timmins flood. The benefits of this approach was that the 100 year flood represents a sufficiently extreme event to identify a portion of the river that carries the majority of the flow, and it is relatively easy to identify the limits of the floodway. However, in some instances it resulted in a narrow strip of flood fringe land, and it did not reflect the actual risks involved in filling the flood fringe areas.

The present practice, introduced in 1988 for the selection of the floodway and flood fringe areas, replaced the rigid 100 year criterion with a more flexible approach based on the critical flood depth and velocity values. It recognizes the fact that the impact of encroachment caused by filling and/or development in a flood fringe area can result in:

- increases in upstream flood levels
- increases in downstream flows
- increases in downstream velocities
- change in the timing of flows.

This present approach appears to be more equitable than the rigid flood frequency criterion, however, it is vulnerable to political interference. Instead of a frequency criterion, a hydraulic criterion is introduced with consideration to the upstream and downstream impacts on the existing and proposed developments.

A rigorous approach based on the present hydraulic criterion to identify the floodway and flood fringe boundary was developed by Moin and Shaw (1989) using the DWOPER model. Multiple regression equations are used to undertake a sensitivity analysis to tests the changes in flood levels, flows and velocities caused by various degrees of flood fringe encroachment. The method is based on equations which relate the topographic features and degree of encroachment to the hydraulic changes in the flood plain. Generally, five different levels of encroachment are modelled for at least three different flows ranging from a 25 year to the Hazel or Timmins floods. The final selection is based on the proposed development scenario with the least upstream and downstream impacts. New development that may be permitted in the flood fringe should be protected to the level of the flood standard.

Where the two zone concept is proposed to be applied or is considered to be a plausible option, municipalities should include policies in their official plans that explain the intent of the two zone concept and the potential developability of the flood fringe versus the floodway.

Where the two-zone concept is applied, the flood fringe should be zoned in conformity with the official plan designation, and the flood hazards and requirements for floodproofing be recognized in the zoning document. The floodway should be appropriately zoned to reflect its prohibitive or restrictive use.

The factors to be considered and the application procedures for a two zone designation are presented in Appendix 4.

2.8 Special Policy Area Concept

Special Policy area means an area within a community that has historically existed in the flood plain where site specific policies apply, approved by the Ministries of Natural Resources and Municipal Affairs and Housing, which are intended to address the significant social and economic hardships to the community that would result from strict adherence to provincial policies concerning development.

Where strict adherence to one and two zone policies is not feasible, the concept of special policy area status is recognized as a possible option for flood prone communities or portions thereof. Municipalities may apply for special policy area status, in accordance with established procedures, and controlled development may be permitted once such status is obtained.

Municipalities should delineate special policy areas in their official plans and include policies indicating the circumstances under which new development may be permitted and identifying the minimum acceptable level of protection required for new development.

Factors to be considered and the application procedures for a Special Policy area designation are presented in Appendix 5.

2.9 Access and Floodproofing

Any new development permitted in the flood plain, in accordance with the policy statement, should be protected by acceptable floodproofing actions or measures. However, the new development does not include institutional uses or essential emergency services (e.g. police, fire) or disposal, manufacture, treatment or storage of hazardous substances. Where such uses are pre-existing, a higher floodproofing standard should be considered.

Ingress/egress for new buildings be such that vehicular and pedestrian movement is not prevented during times of flooding. The potential for risk to life along the flood hazard lands are the highest during storm events. Access involving both ingress and egress should be addressed prior to approval developments near flood hazard lands. Ingress and egress to and from the development should be such that movement of people and vehicles are not be prevented during high floods. The highest priorities for access to emergency vehicles should be given to police, ambulance and fire services, especially where evacuation is a distinct possibility in areas surrounded by flooding. All local agencies involved in local emergencies should be consulted regarding the adequacy of access.

A more detailed description on floodproofing methods are presented in Appendix 6.

2.10 Public Safety

Notwithstanding the above flood plain policies, new development will not be permitted to locate in the flood plain where the use is:

- associated with the manufacture, storage, disposal and/or consumption of hazardous substances or the treatment, collection and disposal of sewage, which would pose an unacceptable threat to public safety if they were to escape their normal containment/use as a result of flooding or failure of floodproofing measures;
- associated with institutional services, such as hospitals, nursing homes and schools, which would pose a significant threat to the safety of the inhabitants (i.e., the sick, the elderly, the disabled or the young), if involved in an emergency evacuation situation as a result of flooding or failure of floodproofing measures; and
- associated with services such as those provided by fire, police and ambulance stations and electrical sub-stations, which would be impaired during a flood emergency as a result of flooding or failure of floodproofing measures.

Where new development identified in Public Safety Policy is not considered to pose an unacceptable risk to public safety, a higher level of flood protection and/or additional floodproofing precautions above the flood standard level, may still be required due to the sensitive nature of the development.

3. DEFINITIONS OF THE FLOODING HAZARD STANDARDS

3.1 Introduction

The group of flood standards referred to in the Natural Hazard Policy is the basis by which flood plains are delineated. It is designed to accomplish the main objectives of flood plain management: to prevent loss of life and to minimize property damage and social disruption.

There are three types of flood events used in defining the flood standard: i) Synthetic storms developed from the two large historical events (Hurricane Hazel and Timmins storm), ii) Observed and documented historical events (if larger than the 100 year event), and iii) Statistically derived 100 year events.

The magnitude of the flood which defines the flood plain limits in a particular area of the Province is largely dependent upon the susceptibility of that area to tropical or thunderstorms, rainfall, snowfall or a combination of these meteorological events. Figure B-1 shows the areas of the Province, subdivided into three zones.

3.2 Selecting the Flood Standards

The applicable flood standards for each of the three zones are described below.

Zone 1

For all watersheds within Zone 1 the flooding hazard limit is the greater of:

i) the flood resulting from a rainfall actually experienced during Hurricane Hazel storm (1954), transposed and centred over the watershed and combined with the local conditions;

ii) the one hundred year flood; or

iii) a flood which is greater than i) or ii) which was actually experienced on a particular watershed or portion thereof, for example as a result of ice jams and which has been approved as the standard for that specific area by the Minister of Natural Resources.

Alternatively, if approved by the Minister of Natural Resources, the 100 year flood level could replace the Hazel criterion, if no observed floods (see iii) exceeded the 100 year flood level in the watershed.

Zone 2

For all watersheds within Zone 2 the flood standard is the 100 year flood level if there are no records of observed and documented flood levels exceeding this criterion within the same watershed.

However, where recorded and documented flood levels are found in the same watershed within Zone 2 which exceeded the computed 100 year flood levels, the use of the 100 year criterion should be reviewed. As a guide, it is suggested that if the observed event is at least 0.1 m higher than the computed 100 year event, and the watershed characteristics have not changed since the historical observation, then the historical event should be considered for the flood plain standard.

Zone 3

For all watersheds within Zone 3 the flooding hazard limit is the greater of:

i) the flood resulting from a rainfall actually experienced during Timmins storm (1961), transposed and centred over the watershed and combined with the local conditions;

ii) the one hundred year flood; or

iii) a flood which is greater than i) or ii) which was actually experienced on a particular watershed or portion thereof, for example as a result of ice jams and which has been approved as the standard for that specific area by the Minister of Natural Resources.

Hazel and Timmins events have been extensively analyzed and the hourly distribution and areal reduction factors for different drainage areas have been developed for each storm (Chapter D). The resulting storms can be transposed within their respective zones to the watershed in question.

3.3 Historical Storms

The extreme total rainfall produced by Hurricane Hazel in 1954 in Southern Ontario, which is used as a flood standard, is not the highest observed event on record; the Hazel event was exceeded by the Harrow (Essex) storm in July 1989. Over a small area of 10 km^2, the centre of the storm produced 450 mm of rain in 30 hours, which is far in excess of the 285 mm rain produced by the 48 hour Hazel storm. Despite this, the Harrow storm resulted in no fatalities and it created only relatively small amount of flood damages compared to Hazel. For storm areas 1,000 km^2 or larger, the Hazel storm still dominates. Therefore, although the extreme Harrow storm is not used as a flood plain standard in the Essex county area, developers and designers of hydraulic structures should be cognizant of the potential effects if such a storm would occur in the Essex region.

Information on observed floods can come from surveyed high water marks, reliable reports, photographs or data publications. The event could be caused by rainfall, with or without snowmelt, which could be extended for the entire watershed. While the transposition of the Hazel and Timmins storms within their zones has been found to be valid, the transposition of observed historical events may not be valid. Therefore, a historical event should be used within the watershed where the observation has taken place. Where evidence suggests that the flood event could have potentially occurred over an adjacent watershed, the observed event can be transposed to the adjacent watershed. If the event was caused by an ice jam, the event cannot be extended within or transposed to an adjacent watershed. The investigation of an observed historical event requires a careful assessment before it can replace the 100 year criterion. When considering the use of a past historic event as a flood standard, it is important to consider the changes in watershed characteristics which took place since the observed event. A calibrated hydrological computer model should be used to estimate the flood events for watershed and land use characteristics selected for the flood plain mapping study.

For very small areas (generally <1 km^2) usually forming part of the headwaters of a stream characterized, due to short times of concentration, the 100 year flood event can exceed the Hazel flood. In such a case, the 100 year standard should be used for defining the flood plain for the headwaters. Consequently, for large watersheds more than one flood standard may apply; 100 year flood for the small headwaters area and the Hazel or Timmins storm for the rest of the watershed. However, there are also large watersheds where the 100 year flood is greater than the Timmins flood.

TABLE B-1
DESIGN RETURN PERIOD IN YEARS (T)
FOR DIFFERENT DESIGN LIFE AND RISK VALUES

Risk (r)	Design Life in Years (L)	
	50	100
1%	4977	9953
10%	475	950
22%	200	400
25%	174	348
39%	100	200
50%	73	145
64%	50	100

Figure B-1
Examples of risk value and cor responding design criterion for the two most fr equently used design life categories ar e presented in this table.

Applying the Flood Standards

When applying flood standards, the Flooding Hazard Limit (or the "Regulatory Flood Line") is the **greater of** the regional storm, the 100-year, a documented maximum observed flood event including ice jams. Flood elevations greater than those generated by the noted standardsmay be approved by the Minister of Natural Resources on an individual basis. Reductions in the flood standards may also be approved by the Minister after receiving documented support of the majority of municipalities in the watershed. Appendix 3, Application to Change the Flood Standard Within A Watershed outlines the process for approvals.

3.4 Return Period Floods.

Hazel and Timmins storms represent extreme storm events within their respective regions. A comparison of these extreme events with other observed historical rainfall values showed that neither storm fitted the historical rainfall data distribution. Hence no statistical analysis could be carried out to establish the return periods for Hazel or Timmins. The only conclusion derived from the analysis is the fact that each of the two storms was in excess of the computed 100-year storm. When calculating risk of flood damages based on Hazel and Timmins storms, the designer should assume a return period in excess of 100-year, (i.e., 200 years or more).

The use of predicted return period storm and return period flood require careful interpretation. For example, a 100-year flood does not mean that flood conditions will occur only once every 100 years, but that flood conditions will occur on average once every 100 years, and that during any one year, there is a 1% probability of occurrence. Although the return period has been used widely as a risk criterion, it has grave disadvantages unless it is translated in terms of other criteria. Given a particular return period, it is not at all clear what risk is being undertaken in a specified engineering operation.

In order to provide the complete picture, three components are required to describe the design criterion:

1. Design return period (T)
2. Design life (L)
3. Risk of being equalled during design life (r)

These three are related by the equation:

$$r = 1 - (1 - \frac{1}{T})^{L}$$

The table clearly demonstrates the magnitude of risk that the 100 year flood could be exceeded within a 50 or 100 year design life of a project. A 100 year design return period would provide a 39% risk of being equalled or exceeded for an expected project life of 50 years, and a 64% risk for an expected project life of 100 years.

Even a 1000 year return period flood has a 5% risk of being equalled or exceeded in a 50 year period. Risk in practice cannot be eliminated, it can only be reduced to an acceptable level.

4. SPECIAL FLOOD HAZARD CONDITIONS

4.1 Flood Hazard Standards Downstream of a Control Structure

4.1.1 Dams

Dams and dykes can reduce flood risk downstream or behind a dyke, but they do not eliminate the risk. The purpose of a dam or a dyke is to protect existing development, but not to free up additional land and allow for new development.

A number of flow management approaches concerning dams and downstream flood hazards are available: 1) Use reduced regulated flow, 2) Use unregulated flow and 3) Use flow resulting from failure.

Reduced peak flows based on the operation of the dam is not always in the public interest, since funds to maintain and replace the structure in the future cannot be assured. Also, projected flood peak attenuation may not be achieved as a result of ice, debris or sediment accumulation that affect storage, operating problems that alter discharge capacity, or floods that vary from the design event in terms of timing, volume and hydrograph shape. The use of peak flows resulting from a dam failure is the most conservative option, and the recommended option where public safety is the issue. The preferred approach is the use of unregulated flow to identify flood hazard limits downstream of a dam.

Various types and designs of flood control dams exist. Some are passive in that there is no means of controlling discharge (i.e., earthen dams); some have basic means of control such as stop logs, and while others have electrically operated flood gates with full-time operators. Many dams are considered multi-purpose; providing recreational use, irrigation or flow augmentation in addition to flood control. Flood control dams are normally designed to control to the flood standard, although others control to higher levels (i.e., maximum probable).

It must be remembered that the function of a flood control dam is to hold back upstream flood waters. Whatever the type or design of dam, these structures are not a floodproofing option for downstream developments. Through construction, design and operational errors, and deterioration of the structure, dams cannot be completely relied upon and new construction in flood hazard areas should not be permitted through reliance on control works. Similarly, stormwater management facilities should not be relied upon in the establishment of flood hazard limits. It is suggested that dam break analysis be undertaken, specifically downstream of major impoundments/dykes to determine the flood hazard.

The local Conservation Authority, or the Ministry of Natural Resources where no Conservation Authority exists, will have to be consulted as to their treatment of flood control dams within their overall approach to flood plain management.

For additional details concerning dam management in the Ontario, please consult the *Lakes and Rivers Improvement Act.*

4.1.2 Dykes and Flood Walls

Where a dyke has been properly designed and constructed to the flood standard, and a suitable maintenance program is in place, the area behind the dyke can be considered as flood fringe. As such, new development would still be required to be floodproofed to the flood standard. The floodway would be considered to be contained within the dyke area. If new development in the flood fringe cannot be floodproofed to the flood standard, then special policy area status may be requested, subject to the appropriate requirements.

As a precaution, certain areas immediately behind a dyke may be considered too hazardous for any use or certain types of uses if failure of the dyke was ever to occur. Also, the area immediately behind the dyke may be required for maintenance purposes.

The establishment of no development or limited development zones behind a dyke will be dependent on local conditions (i.e., flood depth and velocity) and local approaches to flood plain management. Construction of these flood control structures may result in an increase in flood levels at the site and along downstream reaches of the river. Dykes and flood walls protect existing areas located behind, but do not provide additional flood benefits.

Dykes and flood walls are not regarded as permanent flood control structures and the land behind the dykes and flood walls should continue to require protection to the revised (increased) flood standard.

4.2 Bridges and Culverts -

Bridges and culverts are primarily designed based on economic consideration. Roadway crossings are not intended to act as dams although the design often has to accommodate temporary ponding behind the structure. This could increase the flood plain limits upstream and reduce the flood peaks; hence, the flood hazard downstream may be reduced to some extent. When the structure is enlarged or removed, the temporary backwater ponding is reduced or eliminated, thereby potentially changing both the upstream and downstream flood lines. It is recommended, that the upstream flood line should make allowance for the backwater effects caused by the structure. Where this assumption results in unacceptable conditions the culvert should be replaced, or alternatively, where feasible, the two zone concept should be introduced. Under the two zone concept minor filling would be permitted in shallow areas, provided the filling would create no adverse flooding or environmental impacts upstream or downstream.

Downstream of the culvert or bridge, the natural flood line should be used for delineating the flood hazard, making no allowance for the temporary upstream ponding.

4.3 Confluence of Lakes, Rivers and Streams

In rivers flowing into large lakes (Figure B-4), where the high water conditions at the confluence are generated by two independent flood events, the flood standard should be based on the higher of:

i) mean annual flood level in the river and/or stream and the flood hazard limit in the connecting channel, (See The Great Lakes - St. Lawrence River System and Large Inland Lakes Technical Guide.)

ii) the flood hazard limit (Hurricane Hazel, Timmins Storms, observed or the 100 year event) in the mean monthly levels in the connecting channel or lake.

Where the high water conditions at the junction of lake and river are caused by the same type of flood, such as in small lakes (less than 100 km^2) or riverine lakes with an effective fetch less than 3 km, the river and the corresponding lake levels cannot be assumed to be caused by independent events. In such a case, the flood standard at the junction should be based on flood standard of the lake and river.

4.4 Confluence of Rivers

Rivers flowing into a large receiving watercourse, such as the connecting channels which convey flows between Lakes Superior, Huron, St. Clair, Erie and Ontario, also require an analysis of the respective flood levels. Where the high water conditions at the junction of the two rivers are generated by two independent flood events, the flood standard should be based on the higher of:

i) mean annual flood level in the smaller river and the flood standard (Hazel, Timmins, observed or 100 year event) in the connecting channel; or

ii) flood standard (Hazel, Timmins, observed or 100 year event) in the smaller river and mean annual flood levels in the connecting channels.

Where the high water conditions at the junction of two rivers are caused by the same event, the flood standard is applied to both.

4.5 Floodproofing of Buildings

Ontario Building Code applies to all new buildings in the Province. It is administered by the Ministry of Municipal Affairs and Housing and is implemented by the Chief Building Officials appointed by local municipalities.

Any floodproofing measure must conform with Part 4, Design of the Building Code, which describes types and designs of construction materials and the design requirements to minimize the hazards caused by a potential structural failure. The Code indicates where dynamic loading may apply, what the allowable loads or bearing pressures are and where hydrostatic uplift applies. Also, the floodproofing must conform with Part 9, Housing and Small Buildings, which describes the detailed requirements for the construction of houses (three stories high or less). This section details waterproofing, surface and subsurface drainage.

4.6 Stormwater Management Ponds

Stormwater management facilities may not be used to provide any reduction in flood flows.

5. DESIGN STANDARDS FOR DAMS

Floods and flood levels described in the previous section are used to define flood plain limits and to protect new developments along rivers and lakes.

The design criteria for sizing water control structures may differ from the flood plain standard. The factors which most influence the selection of the design criterion are the risks of loss of life and of property damage, the consequences of using lower criteria and economic considerations.

Dams and Reservoirs are frequently used to retard and store flood runoff during high flows, in order to protect the downstream environment. The Ministry of Natural Resources requires Ontario dams to safely accommodate the minimum inflows shown on Table B-2. The magnitude of design flood depends on the size of the structure, storage volume and the hazard caused by a potential dam failure due to floods in excess of design capacity (see Table B-2). The top of dam elevation must include a freeboard above the computed design flood elevation.

TABLE B-2 CLASSIFICATION CRITERIA AND INFLOW DESIGN FLOODS FOR DAMS

HAZARD POTENTIAL	SIZE OF DAM		
	SMALL	**INTERMEDIATE**	**LARGE**
	Height / **Storage**	**Height** / **Storage**	**Height** / **Storage**
	< 7.5m or < 25 ft. / < 100 x 10^3 cu.m or < 80 ac-ft	7.5 to 15m or 25 to 50 ft. / 100 x 10^3 to 1000 x 10^3 cu.m or 80 to 800 ac-ft	> 15m or > 50 ft. / > 1000 x 10^3 cu.m or > 800 ac-ft
Damage to dam only	25-year return period flood to 50-year return period flood	50-year return period flood to 100-year return period flood	100-year return period flood to Regional Flood**
LOW **Property Damage** / **Loss of Life** — Minimal to agriculture,other dams or structures not for human habitation. None to residential, commercial, industrial or land to be developed within 20 years. / None	25-year return period flood to 50-year return period flood	100-year return period flood to Regional Flood**	Regional Flood** to Probable Maximum Flood
SIGNIFICANT **Property Damage** / **Loss of Life** — Appreciable to agriculture , operations other dams or residential, commercial, industrial development or land to be developed within 20 years.* / None expected	100-year return period flood to Regional Flood**	Regional Flood** to Probable Maximum Flood	Probable Maximum Flood
HIGH **Property Damage** / **Loss of Life** — Extensive to agricultural operations, other dams or residential, commercial, or industrial development / One or more	Regional Flood** to Probable Maximum Flood	Probable Maximum Flood	Probable Maximum Flood

* where any land to be affected is developed for residential, commercial or industrial use or is to be developed within 20 years use Regional Flood or greater

** Regional Flood: (see section 2.3 Flood Standards for River Systems and Figure B-1 Flood Hazard Criteria Zones of Ontario

Table B-2 taken from Guidelines and Criteria for Location and Plans and Specifications Approvals, Lakes and Rivers Improvement Act, 1977, Ontario Ministry of Natural Resources

6. DESIGN STANDARDS FOR STRUCTURES

Waterway openings for culverts, bridge crossings and other drainage facilities for provincial highways should be designed in accordance with the pertinent policies and guidelines established by the Ministry of Transportation. Commonly used flood frequencies for sizing bridges, culverts, storm drainage systems and related stream channels are shown in Table B-3. Municipal and private stream crossings should also be designed to similar criteria.

TABLE B-3
DESIGN FLOOD FOR ROAD CROSSINGS

Road Classification	DESIGN FLOODS	
	Total span up to 6.0 m.	Total span over 6.0 m.
Freeway, Urban Arterial	50 Year	100 Year
Rural Arterial Collector Road Local (paved)	25 Year	50 year
Local (unpaved) Resource Access Road	10 Year	25 year
Temporary Detours	1 to 5 year	1 to 10 year

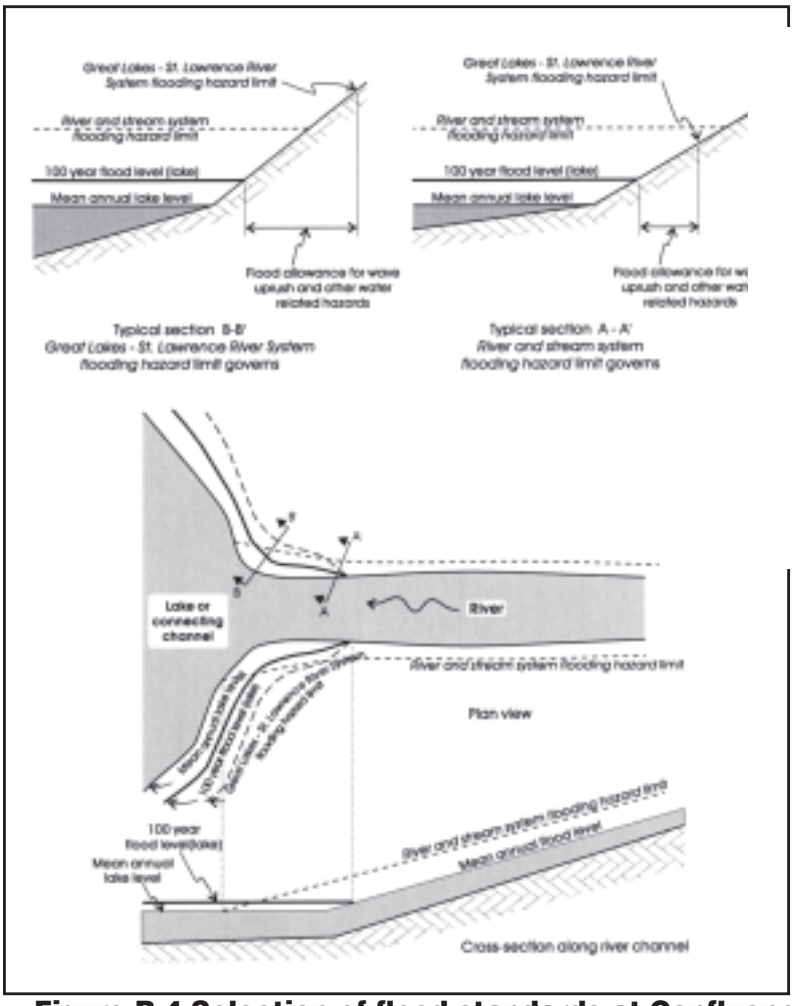


Figure B-4 Selection of flood standards at Confluence of Lakes, Rivers and Streams

C - HYDROLOGIC AND HYDRAULIC PROCEDURES

1. FLOODS

1.1 General

The criteria to be used to define limits of flood hazards across Ontario are described in Chapter B. This Chapter describes the general hydrologic and hydraulic procedures recommended for flood plain delineation in Ontario. A brief description is provided on data requirements, flood flow calculations and water level analysis. Basically, the criteria refer to floods based on probability (100 year) or on a specified meteorological event. Detailed descriptions on specific methods of computing flood flows and water levels in Ontario are given in Chapters D to G.

1.2 Floods Based on Exceedance Probability of Occurrence

A flood based on probability must be determined by a frequency analysis of recorded flood peaks or, where such information is inadequate, through a regional flood frequency analysis. The analysis should produce the best estimate for the required exceedance probability of occurrence.

1.3 Flood Produced by a Specified Meteorological Event

This type of flood is that produced by determining either the effects of a large storm over the basin or the runoff from a specified combination of snowmelt and precipitation. A specific probability is not attached to such a flood; for example, the peak flow resulting from the 100 year storm is not necessarily the 100 year flood. Whether or not the 100 year storm and the resulting flood have the same exceedance probability of occurrence depends on the antecedent moisture condition of a watershed when the storm event occurs.

Examples of floods produced by a specific meteorological event are Hurricane Hazel and the Timmins storm.

1.4 Observed Floods

Observed floods greater than the 100 year flood level may be used to define the flood risk area. Observed floods may be the result of precipitation, snowmelt, ice jams, other such causes, or any combination thereof. Observed floods must meet acceptable documentation standards as outlined in Section B.

Observed floods are useful in illustrating to the general public the severity and extent of the flood selected for the flood plain definition. The limits of the observed flood should be shown on the mapping for comparison, even if they are not the selected flood.

2. DATA REQUIRED

To determine the peak flows of the floods to be mapped and their corresponding water surface elevations, it is necessary to obtain a considerable amount of data from numerous sources. It will not be necessary to collect all of the following data for each specific case. The requirements will vary depending upon the types of flood to be mapped, the methodology to be used and the location. Much of the information will be common to all cases.

2.1 Streamflow Records

The first and most important data required are any streamflow records that may exist for the watercourse in question and any tributaries involved. If a regional flood frequency analysis is to be carried out, records must be collected for other streams in the same meteorological region. The main source of such data is the Water Survey of Canada, but records may also be available from other organizations such as provincial agencies (i.e. MNR, MOE, etc.), conservation authorities and power companies. Data should be obtained from every available source and thoroughly reviewed for accuracy. To ensure that the most up-to-date records are obtained for published hydrometric stations, data should be retrieved directly from the latest version of HYDAT CD-ROM rather than from annual publications.

For a flood frequency analysis, an annual maxima series will generally be required. Although a record of instantaneous peaks is desirable, in many cases mean daily flows will be the only available data. Should either partial duration series or joint probability analysis be required, it will then be necessary to obtain records for more than just the highest peak flow in each year (i.e., several high peaks throughout the year). Where instantaneous data is not available, daily data must be adjusted to reflect instantaneous values

To enable routing of a flood from a gauging station to another location downstream, sufficient data must be obtained to define the complete flood hydrograph.

2.2 Historical Floods

Historical flood refers to an event that occurred either prior to records being kept on a river or stream, or floods that are greater than the minimum 100 year flood but have occurred since records have been kept. There are many cases where reasonable estimates can be made of the magnitude of an historical flood from information on high water marks. Such information may be found in newspaper files and public archives.

If the historical flood was unusually large and a good estimate of its magnitude can be made, the information can be used in a flood frequency analysis leading to increased confidence in the estimate of the flood used for flood plain definition.

When documenting historical floods, two or more sources of information should be cross-referenced to augment the reliability of the flood estimate.

2.3 Specified Meteorological Event

In Zones 1 and 3, as defined in the Provincial Policy Statement, the flood standards are based on specified meteorological events. The rainfall volumes and their time distributions for the Hurricane Hazel and the Timmins regional storms are defined in Chapter B.

If a flood is to be based on another specified input, relevant data on snowmelt and precipitation
rates must also be collected.

2.4 Stage-Discharge Relationships

Once the peak flow discharge of the flood event is determined, the next step is to develop a stage -discharge relationship within a reach and to convert the discharge to a water surface elevation. If the water surface elevation is to be determined at a different location upstream where no stage - discharge curve is available, or at a series of points along a stream, then the discharge must be converted to a water surface profile. This procedure normally entails backwater computations based on a known or downstream water surface elevation. In this regard, a stage-discharge relationship can be used to determine the starting water surface elevation for the calculation of the water surface profile, and to calibrate the backwater calculation model at the same intermediate or upstream location. If a stream gauge is available at the location, this is achieved by using the stage-discharge or rating curve for the gauging station.

When converting a discharge to water surface elevations, it is important to note that smaller floods usually fall within the range of existing discharge measurements and can be converted to stages with a fair amount of confidence. This of course is only true if measurements are taken at a stable section where the curve remains constant with respect to time. At unstable sections, the curve changes with physical changes in the stream channel and considerable judgement and experience regarding the site are necessary to use the curve. Judgement is also required in the extrapolation of stage-discharge curves that will be necessary for floods of large magnitude. A small error in extending a curve can lead to sizeable errors in estimating the stage corresponding to a large discharge. Therefore, such estimates are best made by personnel who are both experienced in this type of work and have a good knowledge of the location. This is usually done for gauging stations maintained by Environment Canada staff of the appropriate District Office.

For control points where no gauging station exists, it will be necessary to develop a stage-discharge relationship. This entails a considerable amount of field work to survey the cross-section and take discharge measurements over a range of stream flows. It is not adequate to measure discharge only at times of low flow, which is the optimum time for surveying cross-sections, but it is also essential to take measurements during medium and high flows.

In most parts of Ontario, where flood flows normally occur in the spring, this would entail taking measurements over a period of several months to establish a reasonable range of the rating curve. Streamflow measurements should be as accurate as possible; this can be achieved by following the procedures described in the “Hydrometric Field Manual - Measurement of River Discharge”, published by the Water Resources Branch, Canada Department of the Environment.

2.5 Hydraulic Coefficients

To determine the water surface profile along the reach of a stream corresponding to a given discharge, it is usually necessary to undertake backwater computations. These computations normally work in a stepwise manner, determining the water surface elevations at various points along the reach. The important variables to be considered are the hydraulic coefficients which affect the flow within each segment of the reach. Many of these coefficients are well established for all types of structures, such as bridge piers and weirs, and can be found in texts on hydraulics. The most important, however, is the roughness coefficient, Manning’s “n”, which has considerable influence on hydraulic computations. Although there are guidelines available for estimating this coefficient, considerable experience is necessary to determine realistic values. The coefficient must be estimated for the stream channel and the overbank area inundated by the various flood events. It should be noted that in many backwater programs the coefficient used also takes into account such things as bend and eddy losses. The combination of these is often referred to as Manning’s “n” for the sake of simplicity.

As Manning’s “n” is an important parameter in backwater calculations and is not a value that can be directly measured, it is

worthwhile expending some effort in obtaining a good estimate. This can best be achieved using known water levels and the corresponding peak flow at various points along a reach for a past flood. As the effects of channel beds on the roughness coefficient are not the same for high and low flows, it is not sufficient just to obtain water levels when the flow is low; levels during higher flows are also necessary to determine how the roughness coefficient varies. In general, the value of the roughness coefficient decreases as the depth of flow increases.

2.6 Elevations of High Water Marks

Accurate readings of high water marks of past flood events are very useful in backwater calculations. However, obtaining reliable readings is often difficult due to the passage of the time between the flood and the collecting of data.

The best way to obtain this data is by the use of crest-stage gauges at various locations along a reach. They are inexpensive, simple to install and maintain, and provide an accurate elevation of high water. The installation of crest-stage gauges would be worthwhile even if the passage of only one flood peak was recorded, but obviously more data would be an improvement. It is recommended, therefore, that crest-stage gauges should be installed at various points along a reach to be mapped if it is likely that a flood peak will pass during the course of the investigation.

There may be cases where such gauges have been installed and maintained by various agencies, such as Environment Canada, and, if available, this information should be collected.

High water marks can also be collected by direct survey at the time of passage of a flood peak. This is usually achieved by pegging or otherwise marking the water level at various locations at or near peak discharge. If the stage is fairly constant and the distances to be travelled are small, a good indication of the true high water mark can be obtained. The elevations of the pegs or marks can be determined by field survey at a later date, although they should be revisited soon after the flood to find indications of the actual high water mark. It is rarely known when the actual peak is occurring but, if pegs were placed close to the peak, they should serve as a good guide to locating marks of the maximum stage.

Other sources of information on past floods are newspaper files and public archives where documented examples of maximum water surface elevations can often be found.

2.7 Aerial Photographs

In several cases where large floods have occurred in the last few years, aerial photography programs have been undertaken to delineate the inundated area. This information can be very valuable for mapping purposes as it gives a true indication of the flood line for a given event.

If the stream is gauged and the discharge is known at the time of photography, the information can serve as a check on water levels, roughness coefficients, etc. Also, if a large recorded flood that is to be mapped has been photographed, much of the work in estimating the extent of flooding is eliminated.

2.8 Cross-Section

In order to determine the water surface profile of a given flood discharge, it is usually necessary to perform a backwater analysis along the reach of the stream or streams considered. For this purpose, it is necessary to obtain information on the geometry of the channel and its flood plain which is accomplished by surveying cross-sections at various locations. Cross-sections can also be obtained from 1:2000 or larger scale topographic maps, by photogrammetric methods, and from digital terrain models where available.

Cross-sections are required at all representative locations throughout the channel reach. Such locations are where changes occur in slope, cross-sectional area or channel roughness; locations where levees begin and end; and at bridges and other channel restrictions. Where an abrupt change occurs, several cross-sections should be used to describe the change regardless of the distance between them.

It is impossible to specify the interval at which cross-sections should be surveyed, but two points should be kept in mind. First, sufficient sections should be obtained to adequately define the river geometry and second, the interval between them should be such that the assumption of gradually varied flow within a section should be reasonably valid.

Surveyed cross-sections must include the entire flood plain of the main channel and any tributaries that are likely to experience backwater effects. Sufficient points should be established to accurately define the geometry of the cross-sections and they must be tied in horizontally to permanent structures and vertically to established bench marks.

2.9 Regulated Flows

If the stream under consideration is subject to a significant artificial regulation by dams, diversions, etc., that have significant effects on peak flows, it is necessary to obtain data on the effect of such regulation to enable a conversion of streamflows to natural conditions prior to undertaking a flood frequency analysis.

2.10 Meteorologic and Physiographic Data

These types of data will be necessary for two areas of study, regional flood frequency analysis and hydrologic modelling.

The actual variables required depend upon their relative significance or the information necessary to calibrate a hydrologic model.

For regional flood frequency analysis, the following factors are commonly considered, but may not all be significant: drainage area, area of lakes and swamps, basin slope, channel slope and channel length, as well as mean annual runoff, precipitation and snowfall. Other variables may also be of significance depending upon the region, its topography and climate.

For hydrologic modelling purposes, many of the above variables are used as well as information on soil types, forest cover, groundwater, land use, infiltration rates and soil moisture conditions. To operate a model, a great deal of meteorologic data is required including rainfall, temperature and snowfall records, radiation data, snowmelt coefficients and lapse rates. The data required vary widely depending on the model used. The best test of the model's validity can be measured by how well the model estimates compare to the recorded flows for flood events that are similar in magnitude. Otherwise, the calibrated model parameters may have to be adjusted to allow for possible non-linear effect of watershed response in a manner similar to the adjustment of Manning's "n" value described in Section 2.5 above.

Other methods under development rely on meteorological and topographic data to estimate flood hydrographs. Radar rainfall data can be used with appropriate hydrological models for estimating flood hydrographs. These models can integrate real time radar and rain gauge data, streamflow/reservoir release data where applicable, and watershed characteristics to estimate flows. Current research to improve these models and increased radar and meteorological data availability will eventually provide accurate, year-round flow estimates which in some instances could replace hydrometric data.

The use of remote sensing to obtain hydrologic or water level information also presents potential opportunities. Satellites which monitor the earth surface can determine the extent of water bodies or flooding, type of land cover, snow depth, soil moisture and river ice will soon be able to estimate flood conditions for every satellite pass. As the satellite information will only be available at daily intervals at best, this method would be more applicable for large and remote watersheds. At present the level of accuracy and the cost prohibits the use of remote sensing data to estimate flows for flood plain mapping purposes.

2.11 Lake Levels

A problem arises when a stream discharges into a large lake with a backwater effect. For a given flood flow in the stream, there is a wide range of possible lake levels that would be coincident. It is necessary to obtain lake level data in such cases to enable a reasonable judgement or assumption to be made. Decisions on the backwater effect must be based on the variability of water levels and the probable timing of the flood which will define the limits of the flood plain.

3. FLOOD MAGNITUDES

The two main steps in the mapping of a flood plain are: (1) to determine the flood criteria and the corresponding flood flow; and (2) to delineate the area inundated by the flood flow. Whether the selected flood is based on a flood frequency analysis or the resultant runoff of a specified meteorologic input, there is considerable investigation necessary to develop a reasonable estimate. This is the main part of the hydrologic investigation required and should be carried out using the best techniques available. A high standard of analysis along with good engineering judgement will be required to obtain realistic results, which can be defended when legally challenged.

3.1 Flood Frequency Analysis

In some cases, the floods to be mapped will be determined by frequency analysis. While it may be difficult to specify some of the aspects of flood frequency analysis, there are some rules that must be followed.

(a) Conversion of Regulated Flows to Natural Conditions

In flood frequency analysis of peak flows, the initial assumption is made that floods are random and independent events that can be described by a particular probability distribution. If a stream is regulated sufficiently to affect the resulting peak flows, then they are no longer random and independent events; a probability distribution which assumes randomness and independence is not applicable. The first step in undertaking a frequency analysis is to determine the influence of regulation on the streamflows. If necessary, the conversion of regulated streamflows to natural conditions is achieved by removing the effect of dams and diversions.

Given adequate data such as diversion flows, reservoir stages, outflows and stage-storage curves, it is possible to convert flows to natural conditions by reverse reservoir routing. If such data are not available, the problem becomes more difficult. Records are generally available for major installations, which are the most likely to affect peak flows, but there may not be data available for smaller projects. It may be necessary to estimate their effect by various empirical formulas depending on the type of installation.

If regulations were significant and their effects have not been removed, the results from single station flood flow analysis are applicable only to the watercourse between the control structure and the next major confluence with other tributaries. They should not be included in regional flood flow frequency analysis.

(b) Non-Stationary Record

When records of historical peak flows are used for a frequency analysis, it is assumed that all the data are samples from a single population. This implies that

conditions in the watershed have remained unchanged during the period of record. In some cases, considerable change in a basin over the years will affect the flood regime. Forestry operations, urbanization, agricultural drainage and irrigation can have a considerable effect on streamflows. If this effect is significant, it is necessary to assess the changes that have occurred with time in order to develop a stationary record for analysis.

(c) Extension of Streamflow Records

It has been the practice in the past, particularly when undertaking a regional flood frequency analysis, to extend the records of flood flows at short-term stations by correlation with adjacent streams. Generally, this has been used to make a more accurate assessment of the plotting positions of the recorded floods when graphical techniques are used to define a frequency curve. Such a procedure is not used with statistical techniques and should normally be avoided.

The only case where extending a streamflow record can be justified is where the stream has a short period of record and there is not enough data available to carry out a regional analysis. In such a case, the record can be extended based on a larger sample at an adjacent stream or on meteorological data in order to estimate the desired flood event.

(d) Single Station Flood Frequency Analysis

A single station flood frequency analysis for the stream in question will be adequate only if the record is long and reliable. If the record is not of sufficient length to calculate an extreme event, such as a 100 year flood, (i.e., 30 to 40 years) or there is some doubt of its reliability, a regional flood frequency analysis should be carried out, in which case several single station analyses are combined.

The first step in a frequency analysis is to obtain the available data and assess its reliability. Whenever possible, instantaneous peak flows should be analyzed rather than mean daily values. Where the data is not available, mean daily values have to be converted to instantaneous. The record should be checked for the possibility of ice or log jams which may cause an increase in stage which would lead to an erroneous discharge value.

Once the record has been assessed and is judged to be reliable, a frequency analysis of annual peak flows must be carried out. There are various theoretical probability distributions that can be used for this purpose, those commonly used include: (1) Extreme Value Distribution (Gumbel 1); (2) Lognormal Distribution; (3) Three-Parameter Lognormal Distribution; and (4) Log Pearson Type 3 Distribution. The computer program Consolidated Frequency Analysis CFA version 3.1 developed by Environment Canada is a user friendly interactive flood frequency analysis program which is capable of analyzing streamflow data using all the probability distributions mentioned above.

The preferred method of estimating distribution parameters is that of maximum likelihood, since minimum variance estimates are obtained. If no maximum likelihood solution can be found, the method of moments should be used. Computed or graphical estimates based on empirical plotting of positions should be avoided.

It is often difficult to determine which distribution best describes a given data sample. There are various significance tests available, but with the small sample sizes usually found in hydrology, they are of little value. Although graphical estimates should not be used alone, it is always worthwhile to plot the data and the computed frequency curve to give a visual indication to confirm it is the best fit. This can be used in conjunction with other factors such as a comparison of sample and distribution statistics, the variances of the estimates and, where applicable, the confidence limits.

Documented computer programs are available for statistical computation. These and other programs can be used to compute the parameters, statistics, frequency curves and standard error of estimate for the four distributions mentioned above. The inclusion of a plot routine and a guide to the interpretation of output provides the user with all the pertinent information necessary for choosing the most suitable distribution.

In Ontario, the preferred distribution is found in previous studies to be the three-parameter lognormal. When the skew of an annual flood series is negative, the 3-parameter lognormal has no solution. In this case and for regional flood frequency analysis, the skew is assumed to be zero, ie., the 2-parameter lognormal is used instead, as discussed in Subsection (e) below.

Another factor which should be considered is the possibility of including an historical flood in the analysis. If a good estimate can be obtained of a large flood which occurred prior to records being maintained on a stream, it should be taken into account in the flood frequency analysis. For this purpose, the value of the historical flood and its year of occurrence must be known, as well as the fact that it was the largest flood between that year and the start of the recorded series. In such a case, all available information on a stream can be used in the analysis to give the best estimate of the frequency curve. At the present time, this type of analysis can only be carried out using the Extreme Value Distribution with parameters estimated by maximum likelihood. A documented computer program of this analysis is available from the Engineering Division of the Water Planning and Management Branch, Environment Canada. An admittedly limited amount of testing shows that, although the inclusion of an historical flood may not have a significant effect on the frequency curve, it does reduce the variance of the estimate, thus increasing the reliability of the curve.

As was stated earlier, it is usually good practice to plot the observed peaks at empirical plotting positions and the computed frequency curve on the relevant probability paper to gain a visual impression of the frequency curve. In some cases, a broken line effect is indicated which is not described by any theoretical distribution. If this occurs, the data must be thoroughly examined to

establish the cause of the non-homogeneity of the sample. There are several possible reasons for this such as moving of a gauging station, change in regulation patterns, urbanization or other changes in watershed characteristics which should be considered prior to analysis. It is also possible that the sample may be biased by the inclusion of several rare events within a short time period. It is most likely, however, that the explanation for the broken line effect will be that peak flows were caused by two or more flood-generating mechanisms. In this case, the flood series contains samples from more than one population and should be treated as such.

(e) Regional Flood Frequency Analysis

A flood frequency regime based on the analysis of data from a single station may not accurately represent the regional characteristics. A regional flood frequency analysis tends to overcome this problem by including data samples from several stations within a hydrologically similar region. Recently, OMNR updated the Regional Flood Frequency Analysis, with data up to 1997. A program that will calculate the 1:100 yr to 1:20 yr flows for unguaged watersheds has been produced and is available from the Water Resources Section, MNR.

This type of analysis should be used when the record for the stream in question is short or unreliable and in cases where there is some doubt of the validity of the single station frequency curve. In cases where there is little or nor data for the stream, the only solution is a regional analysis; it should also be used when a stream is gauged at some distance from the reach to be mapped.

The first problem in carrying out a regional analysis is to determine the extent of the homogeneous region. This must be based initially on knowledge of meteorological and physiographic conditions so that all streams used would appear to have similar runoff characteristics. For each stream in the region with sufficient length of record (at least 10 years), a single station frequency analysis is carried out, taking into account all the factors described earlier. Obviously the same probability distribution must be used in all cases, so one must be chosen that is applicable to the region. It is common to use a two-parameter distribution for regional analysis as the necessity for estimating a regional coefficient of skew is avoided; however, a three-parameter distribution should be used if indicated by the single station analyses.

At this point, a technique must be chosen to develop regional characteristics from the single station frequency curves. There are three methods that are commonly used.

(i) Index Flood Method:

For each of the stations used in the analysis, a dimensionless frequency curve is developed by plotting floods of various return periods as ratios of the mean annual flood. The mean used should be that of the distribution rather than the sample mean. A check on the homogeneity of the region can be made using a test such as that described by Dalrymple (1968). It should be noted that the confidence limits derived in the Dalrymple study were developed for the Extreme Value Distribution; if other distributions are used applicable limits must be computed.

Once it is established that all streams are within a homogeneous region, a dimensionless regional flood frequency curve can be developed. For each of several return periods, the median of the individual ratios to the mean annual flood is determined. These median values, when plotted on the appropriate probability paper, define the dimensionless regional flood frequency curve.

The final step entails developing and verifying an equation to estimate the mean annual flood for any stream within the region. Multiple regression analysis or an envelope curve is used to develop a relation between the mean annual flood and various physiographic and climatic parameters. In the original Index Flood Method, the mean annual flood was related to the drainage area only. When additional variables such as mean annual runoff, channel slope, basin slope, areas of lakes and swamps and soil characteristics are considered, it becomes a modified index flood method.

The Regional Flood Frequency Analysis using the Index Flood method prepared by Moin and Shaw (1985) presented in the previous Flood Plain Management Technical Guideline document will require updating to include post -1983 data before using it for flood plain analysis. The same applies to the Regional Frequency Study based on the regression method. This was prepared by Cumming Cockburn and Associates Ltd in 1985, and the results were incorporated in the previous Flood Plain Management Technical Guideline document.

(ii) Estimating Floods of Various Return Periods:

A second technique is to estimate floods of specified return periods, including the mean annual flood, directly by multiple regression analysis. The independent variables chosen are similar to those used to estimate the mean annual flood, but a series of relationships is developed; one for each of selected return periods. The dependent variables used in the analysis are floods of the selected return periods.

Since the same meteorological and physiographical data sets are used by both the modified index flood and multiple regression analysis methods, the flood estimates for various return periods are expected to be similar.

(iii) Estimating Distribution Parameters:

Multiple regression techniques can also be used to estimate regional values of the parameters of a probability distribution. The relevant parameters are first derived for each of the individual stations in the region, then regression equations are developed to estimate them for ungauged streams. These are generally done for the purposes of selecting the best distribution or delineating a homogeneous region.

(f) Transfer of Location

In many cases there will be no gauge on a stream at the

location where mapping of the flood plain is required. If there is no gauge on the stream at all, or the gauge is far from the desired location, regional techniques must be used to estimate flood magnitudes. If a stream is gauged sufficiently close to the required point, a transfer of flows by streamflow routing or simpler techniques can be achieved.

Streamflow routing should be used if there is significant storage between the gauging station and the required control point. Routing can be carried out either prior to or after the frequency analysis. In the first case, recorded flood hydrographs are routed to the desired location, then a frequency analysis is carried out on the routed peak discharges. In the latter case first a frequency analysis is carried out, then the estimated flood is routed through the system. It becomes necessary to develop a complete flood hydrograph for this purpose rather than only estimating a peak discharge.

(g) Change to Natural Conditions

As previously mentioned, streamflows that include the effect of artificial regulation need to be converted to natural conditions prior to undertaking a frequency analysis. Once an estimate has been made of the natural flood magnitude, it is necessary to reconvert the flow back to regulated conditions. As well, the data used for the original conversion will be necessary to determine and document probable operating procedures of the installations under conditions of the flood selected for defining the flood plain.

3.2 Runoff Simulation From a Specified Meteorologic Event

In the event that the flood plain definition is to be based on a specified input rather than on frequency analysis, it becomes necessary to convert the input data into discharge values. The first part of the process is to determine the likely meteorologic event. Among the two likely inputs are an historical regional storm (the Hurricane Hazel or the Timmins Storm) and a combination of snowmelt and precipitation.

The Hazel and Timmins storms are defined in the Flood Plain Policy and summarized in Chapter B. If the specified input is to be a combination of snowmelt and precipitation, it is necessary to document the rates and areal extent of each, and to justify the specified values. It should be shown that such a combination is realistic by comparison with recorded meteorological data in the region.

The second major part of the process is the conversion of the precipitation/snowmelt input to basin runoff, and runoff to river discharge at the location required. This involves the use of a hydrologic model of the watershed of which there are many types currently available. Most of these models are adequate for the region in which they were developed and for the size of the watershed they were designed to handle. Applying them to different regions and larger or smaller watersheds than recommended is not always successful, therefore, great care should be taken when choosing a model. Watershed models can vary from those based on a triangular unit hydrograph to those that attempt to describe every aspect of the hydrologic cycle. In general, it is preferable to use the simplest model, ie., having a minimum number of parameters, that is adequate to simulate observed discharges over a range of storm events. In many of the more complex systems, enormous amounts of data are required apart from the basic physiographic and meteorological characteristics. Data on evaporation, soil moisture, infiltration rates, groundwater storage, etc., are not available in many cases and so the model parameters must be estimated. Thus, it is common that the majority of the parameters are estimated rather than measured which leads to a low level of confidence in the results.

Any model applied to a particular watershed should take into account the factors which have a major influence on the runoff characteristics. It should have the capacity to adequately describe the main physiographic aspects of a watershed as well as the effects of channel and lake storage and groundwater influence. Furthermore, the model should have the ability to incorporate those types of artificial regulation that may exist in the basin under study.

As the major meteorological input to a model in this case may be a particular documented storm, it should be able to operate on a time scale that will both analyze the precipitation data and synthesize discharges at such intervals as are relevant for the watershed. For large basins, computations on a daily basis will generally suffice; for small basins, however, the time interval may be very small. Also of concern is the type of input to be analyzed. If it is a storm that can only occur in summer or fall, no provision for snowmelt is required. If, however, the input is a specified combination of snowmelt and precipitation, a model must be chosen that can take both into account. The best test of a watershed model lies in its ability to adequately reproduce recorded flows from storms similar in magnitude to that of the selected flood. It is not adequate for the purposes of the flood risk mapping program to blindly apply any model to a watershed without adequate testing for both calibration and verification of the model parameters. Generally, hydrologic models are calibrated for a basin by successive attempts at reproducing recorded data while varying those parameters that are not fixed until an adequate reconstitution is developed. This procedure is followed for several historical events so that model calibration is not based on a single sample. If sufficient records exist on the stream, several recorded discharges should be run, independent of the calibration runs, to verify the model. If there are no records on the stream in question, the model must be calibrated and tested on a similar adjacent watershed where the variable parameters can be assumed to match those of the basin under study.

It is known that the runoff characteristics of a watershed can vary widely depending upon the quantity and intensity of precipitation, and the antecedent conditions, (ie., the non-linear watershed response). If the synthesis of stream flows is to be based on the largest storm of record in a particular region, the calibration of model parameters should be attempted using other large storms rather than lesser events. Also, the antecedent conditions assumed should match those in effect prior

to the occurrence of the historical storm.

If a combination of snowmelt and precipitation is specified, model parameters relevant to snowmelt should initially be estimated from rainfall-free events. Similarly, estimates of rainfall-runoff parameters should be based on events free from snowmelt. Calibration and verification of the model should then be finalized using recorded discharges caused by both elements.

Stream flow simulation consists of the derivation of a discharge by transforming a meteorological input into a hydrological output. The simulation methods generally characterize the drainage basin of three separate types of storage elements: watershed, lake/reservoir and channel considered either in series or in parallel. The watershed storage input is represented by rain or snowmelt. Abstraction from gross water input will produce the runoff portion of the channel inflow. The total channel inflow includes a baseflow component. The channel storage is computed from channel routing representing a reach of the river, with input at the upstream end and the local inflows along the reach. The outputs are the downstream discharge. Reservoir/lake storage is computed using river inflow as input; the output represents the storage and outflow. The routing involves computation of the hydrograph modification as the water flows through the storage elements, decreasing and delaying peak flows, and therefore, extending the flow duration of the hydrograph.

Reservoir/lake routing transforms stream flow (peak or hydrograph) by its passage through the reservoir/lake.

Compared to the statistical estimates of peak flows, and corresponding standard error of estimates, errors in estimates obtained from the streamflow simulation are not calculated. Streamflow simulation to establish floodplain limits depends on the use of computer models, that represent mathematically the complex physical process inherent in flood generation. Thorough understanding of the flood characteristics of the river and the watershed and the calibration/verification of the model is essential to derive credible results.

Infiltration in frozen grounds is generally assumed to be zero in modelling. This assumption is only valid for conditions when the ground is frozen solid.

When flood flows and levels are computed for different land use scenarios (such as existing and future development conditions), abstractions should be computed separately for lands likely to be affected by different land use scenarios.

A more detailed discussion of the flood computation is presented in Chapter E. However, the purpose of Chapter E is not to list all available models for streamflow simulation, but to illustrate the models used by most modellers, and those which were reviewed and found to be acceptable by the Ministry of Natural Resources.

4. HYDRAULIC ANALYSIS

Once the magnitude of a flood to be mapped has been determined by one of the methods previously described, the next step involves converting the streamflow to a water surface elevation at a given location, generally downstream of the reach to be mapped, and computing the water surface profile for the reach.

To determine the stage corresponding to a large flood discharge, it is necessary to extend the stage-discharge curve. As mentioned earlier, for gauging stations maintained by the federal government, preferably, this should be carried out by staff of the appropriate District Office of the Water Survey of Canada. For control points where no gauging station exists, the stage-discharge curve developed for the site must be extended. There are several methods for this that can be found in various texts, but particular care must be taken when overbank flow is involved, which will nearly always be the case when mapping a flood plain.

Computation of water surfaces profiles from a given downstream starting point usually involves the use of backwater analysis. Such analysis is very tedious for manual calculation and therefore is generally achieved by using a computer program. There are several reliable backwater programs available and the choice of a particular system can depend on many factors. One should be used that has been well tested and applied successfully to many different conditions. It should have the capability to incorporate those conditions that will be met in the reach under study. As a guide, the following points should be taken into consideration when selecting a program to compute water surface profiles.

4.1 Type of Flow

Most programs available are for steady, gradually varying flow only, using the standard step method of computation. As well, many of these programs were developed for subcritical flow although some can handle supercritical conditions.

4.2 Cross-Sections

A computer program should be able to incorporate cross-sections of any shape and should have the capability to subdivide the sections to enable separate analysis of the channel and overbank regions. The number of sub-divisions should be adequate to reflect the varying hydraulic characteristics of the entire cross-section up to the limits of the flood plain. It may also be advantageous to have the ability to interpolate between specified cross-sections where velocity changes are rapid.

The program should also be able to account for skewed cross-sections which is necessary where bridge crossings are not perpendicular to the channel.

4.3 Critical Depth

Critical depth should be computed at each cross-section to ensure that the water surface stays on the correct side of critical (sub or super critical) and that hydraulic jumps or drawdowns are accounted for as the flow state changes in a downstream direction from supercritical to subcritical or vice versa. This is necessary as some programs continue calculations assuming subcritical flow regardless of the critical depth. Minimum specific energy should be used to calculate critical depth, rather than a simplified approach.

If the flow depth crosses critical, some programs simply assume critical depth is reached at the next section whereas others interpolate between cross-sections to obtain a more accurate location.

4.4 Velocity Distribution

The velocity of flow is not uniform for a cross-section and necessitates the subdivision of the section into elements of approximately equal velocity. From these elements, a weighted velocity head can be computed for the section, the accuracy of which increases with the number of elements.

4.5 Roughness

It is very important in a backwater analysis that the friction losses be computed as accurately as possible. The program should enable specification of several values of Manning's "n" for each cross-section as well as for different reach lengths between cross-sections if required. The ability to change roughness coefficients by a given ratio is useful for testing the sensitivity of the water surface profile to the roughness values.

4.6 Use of High Water Marks

It is an advantage for a program to have the ability to use known high water marks to calculate the roughness coefficients. In this case, only preliminary estimates are needed to initialize the program rather than specifying inflexible roughness coefficients which can lead to considerable errors in the water surface profile.

4.7 Plotting Routines

The inclusion of routines for plotting profiles and cross-sections in the program has the advantage of simplifying the editing of input data and verifying assumptions, as well as providing an output that can be easily understood and directly included in a technical report. For analysis purposes, routines using a high speed printer are more flexible and provide faster turnaround than those using mechanical plotting devices. However, for documentation purposes, a good quality plotter should be used.

4.8 Bridge Losses

Any program used must normally include provisions for computing bridge losses under three possible conditions. The first is a low flow condition when the water surface is below the bottom chord of the bridge. The second is that a pressure flow condition that exists when the surface is above the bottom chord, and the third is a combination of weir and pressure flow when the bridge is overtopped. No allowance should be made for potential scour of the stream bed during a flood in the assessment of hydraulic losses.

4.9 Culvert Losses

If the backwater analysis is carried out on a small stream that flows through culverts, the capability to compute culvert losses is required in the program. In most cases, where the flood is considerably larger than the design discharge for a culvert, the conditions would be similar to that of a bridge under a combination of weir and pressure flow. No allowance should be made for potential scour of the stream bed during a flood in the assessment of hydraulic losses.

4.10 Split Channel Flow

This type of flow occurs when the discharge is separated into two or more channels by the presence of islands within the flood plain. In this situation it is necessary to determine the proper division of the flow in each of the channels and the corresponding water surface elevations.

4.11 Other Factors

There are several other factors that should be considered in the selection of a program for computing water surface profiles. It should be fully documented so that the methodology and the algorithms can be followed, assumptions verified, and changes made where necessary. It is essential that the user fully understands the program rather than treating it as "black box". It may be necessary to add routines for special circumstances that may exist in a particular reach, but are not provided for in the original package.

(a) Floodway

In addition to the points mentioned above, most of which will be common to all streams investigated, there are two other important items that may have to be considered in some parts of Ontario. The first of these items is the delineation of the floodway on the flood risk maps. Under the option of two-zone concept, as described in Chapter B, a floodway has to be separated from flood fringes of a flood plain. The floodway in this case is defined as the stream channel and that part of the flood plain required to convey the majority of the flood. Being

that the floodway is smaller in area than the flood risk zone, there must be an increase in water surface elevation. Therefore, the maximum increase will have to be specified when defining the floodway. At first glance this concept appears to offer no advantages as it increases the area of the flood plain. However, in cases where the floodway is designated, some development will be permitted within the designated flood fringe area. Where warranted, this can lead to improved use of the land within the flood plain and may provide an incentive for the development of floodproofing techniques.

Should it be necessary to delineate a floodway, a program must be selected that has the capability to carry out the necessary calculations. Normally trial limits of the floodway would be specified, based on the geometry of the channel and the flood plain, and a trial-and-error technique used to adjust the floodway width until the increase in water surface elevations is maintained within the specified maximum.

(b) Ice Jams

The second problem that is encountered in some parts of Ontario is an increase in water levels caused by ice or log jams. Such an increase can be considerable, leading to more widespread flooding than would be experienced with a flood of much larger magnitude without the jam occurring. Ice jams generally occur at a specific location, where there is a constriction in the channel, either natural or artificial. It would be normal, therefore, to survey a cross-section at that point, which would enable a backwater program to take account of such an event. Should flooding in the entire reach to be mapped be the result of an ice jam, the backwater computations are started at the location of the jam. If the jam occurs within the reach the procedure must be split into two parts. Downstream of the jam, the normal procedure will be followed for the specified flood. At the location of the jam, a new initial water surface elevation must be specified to compute the profile for the upstream reach. Thus, it is a fairly simple matter to account for ice jams in the hydraulic analysis, if the stage resulting from the jam can be determined.

Estimating the effects of such jams on a flood of a given magnitude is not a simple problem. The research carried out in this field is considerable and new techniques are being developed. Estimates should be based on the past history of jams at the particular location, taking any relevant facts into account. It may be possible to develop estimates for the resulting water level directly on a probability basis or by adding the stage effect of a jam to that resulting from a flood of a given probability. It is probable that this type of decision will be made prior to the commencement of an investigation.

4.12 Dykes

Area behind a dyke is regarded as fringe area if dykes are high enough to provide protection against the flood standard for the area and development in this area is subject to flood proofing requirements to flood standard, unless designated as a Special Policy Area. A special problem arises where dykes have been constructed in the flood plain for protective purposes. If the dykes are too low and would be overtopped by the flood standard selected for flood plain definition, the land behind the dykes would be in the flood plain and, therefore, within the flood risk area. If the dykes are of sufficient height to contain the flood standard, the dykes would normally delineate the extent of inundation. This does not apply in cases where the dykes are not structurally inadequate and would fail under large floods.

A structural assessment of dykes would not normally be considered as part of the investigation but would probably be specified prior to the commencement of any hydraulic analysis.

4.13 Spills

In case of ill-defined channels or top of banks combined with high flows, flood levels can overtop the banks and spill overland. Frequently, this spill will move into another watershed or join the same watercourse at a distance downstream.

The effect of spills moving into another watershed should be assessed to determine the potential flood risks. Alternative measures should be investigated to prevent the spill moving into the adjacent watershed. If the amount of spill is relatively small, less than 10% of the peak flow, the flood plain mapping for the watercourse should be based on the original flow, without any deduction for the spill. For larger spills, allowance for the reduced flow should only be made where the review of alternatives proves that the spill cannot be prevented, either because there are no feasible alternatives or the costs, when compared to the potential benefits, are too high.

Where the spill re-joins the watercourse further downstream, the route of the spill should be examined to determine the potential harmful effects of overland flow. No reduction should be made for the spill in the downstream flood plain computations.

D. FLOW COMPUTATION DATA REQUIREMENTS

1. RAINFALL ANALYSIS

1.1 Introduction

The following discussion is a collection and presentation of design storms and distributions applicable to hydrologic studies within Canada, particularly Ontario, and is intended to assist the user in simulating runoff from precipitation. It does not attempt to select a universal or standard distribution of storms. Rather, it attempts to present and compare storms and distributions so that the user may select the one which is the most suitable for the study.

Apart from the storms used for computing floods (generally the Hazel, Timmins and 100-year storms), information is also provided on Probable Maximum and frequently occurring storms and distributions.

The storms and distributions have been grouped into three categories. The first, **Historical**, includes recorded events, while the second, **Return Period**, includes storm distributions and rainfall depth of a specific frequency or return period. The last group, **Probable Maximum**, considers the largest theoretical rainfall possible.

Until its recent reorganization, Atmospheric Environmental Services (AES) of Environment Canada provided the atmospheric data and analyses across the country. In this Guide all data and analyses prepared in the past by AES is referred to under the old name, as AES. For any new information the user should contact Environment Canada Ontario Region office.

Under the three categories mentioned above, the following storms and distributions are discussed:

Historical	·	Hurricane Hazel
	·	Timmins
Return Period	·	A.E.S - 1 Hour
		- 12 Hour Snowmelt
Probable Maximum	·	Small Dams.

The following characteristics will be used to describe each of the above storms.

- total precipitation
- duration
- temporal distribution
- time step
- areal reduction.

The purpose of using a storm in the computation of floods is to generate simulated runoff for a specific event. A number of storms and rainfall distributions have been developed and are used to generate simulated runoff.

If the failure of a structure could result in the loss of life (see Table B-4), then the use of a Probable Maximum Rainfall is recommended.

To compute the extent of flood plain, one may use either of the two Historical storms described under the flood plain standards or a return period storm depending on the zone the watershed is located in. In the case of the Hazel or Timmins storms, the particular storm to be used is specified according to the zone. In other cases, the user is left with the decision to select the storm and the distribution. Figure D-1 presents a decision diagram to assist the user in the selection process.

A summary of storms used in the past in Ontario are presented in Table D-1. The variation in the duration of the storms is from 1 hour to 30 days. Many of the computed intensity-duration-frequency values do not compare very well with the published AES data, as indicated in the table. In such cases, with the exception of Hazel or Timmins, storms of different durations may have to be applied, if applicable, in order to obtain the maximum peak flow rate for the selected frequency event.

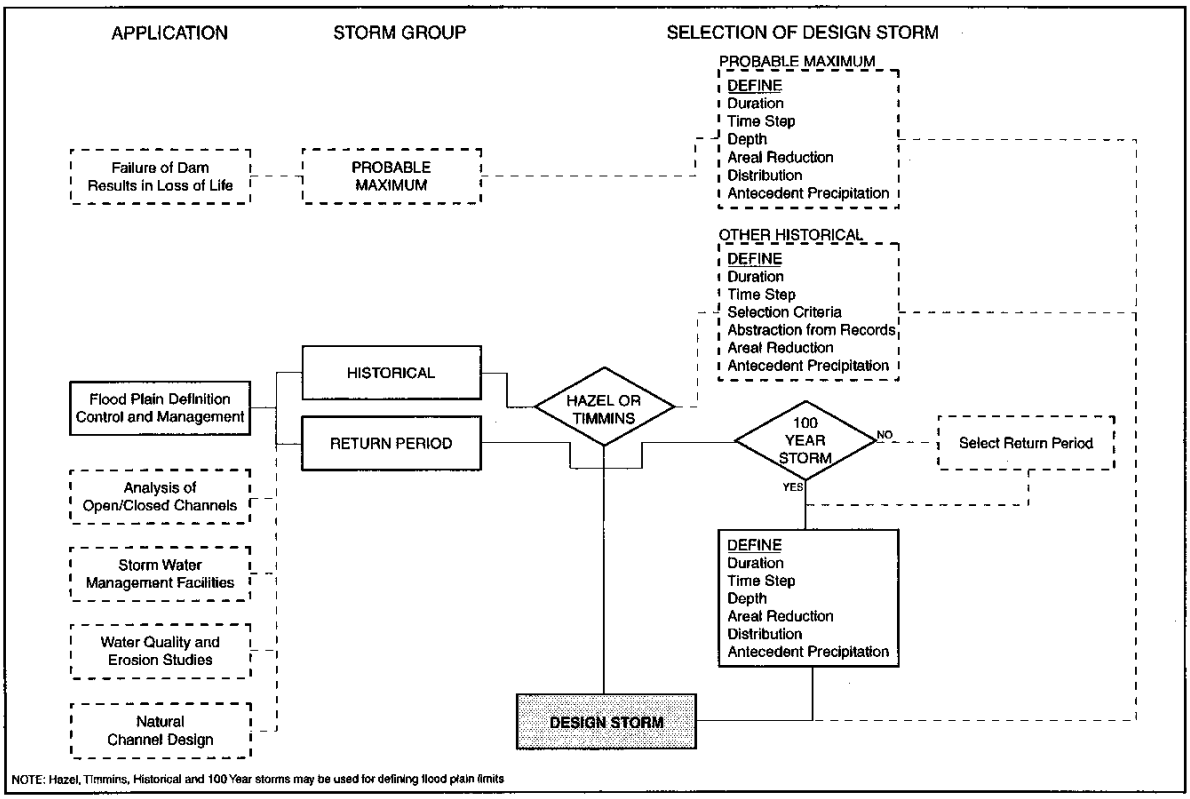


Figure D-1: Design Storm Selection

TABLE D-1
COMPARISON OF STORMS USED FOR
FLOOD PLAIN AND PROBABLE MAXIMUM PRECIPITATION COMPUTATION

	Duration	Time Interval	Comparison with IDF Curves	Degree of Difficulty		Antecedent Precipitation	Areal Reduction
				To Determine	To Apply		
1. Historical							
Hurricane Hazel	12 hour	1 hour	Poor	Low	Low	Recorded	Recorded
Timmins	12 hour	1 hour	Poor	Low	Low	Recorded	Recorded
Severe Single Event	User Defined	User Defined	Poor	High	Low	Recorded	Recorded
Series of Single Events	User Defined	User Defined	Poor	High	High	Recorded	Recorded
2. Return Period							
Small Dams	6 hour	1 hour	Poor	Low	Low	User Assigned	User Assigned
Huff	Variable	Variable	Poor	Low	High	User Assigned	User Assigned
Keifer & Chu	Variable	Variable	Good	Medium	Low	User Assigned	User Assigned
S.C.S. Type II	24 Hour	15 min	Fair	Low	Low	User Assigned	User Assigned
	12 hour	15 min	Fair	Low	Low	User Assigned	User Assigned
	6 hour	15 min	Fair	Low	Low	User Assigned	User Assigned
A.E.S. - 1 Hour	1 hour	5 min	Poor	Low	Low	User Assigned	User Assigned
A.E.S. - 12 Hour	12 hour	1 hour	Poor	Low	Low	User Assigned	User Assigned
Snowmelt	1-30 days	1 day	Good	Medium	Low	User Assigned	User Assigned
3. Probable Maximum							
Small Dams	6 hour	1 hour	Poor	Low	Low	User Assigned	User Assigned
HEC	48 hour	6 hour	Poor	Low	Low	User Assigned	User Assigned
Emergency Spillway	36 hour	1 hour	Poor	Low	Low	User Assigned	User Assigned
Bruce	6-48 hours	6 or 12 hour	Poor	Low	Low	User Assigned	User Assigned

Table D-1

1.2 Historical Storms

Two of the floods suitable for flood plain delineation are based on historical storms called "Hurricane Hazel" and "Timmins", both of which are described below.

Hurricane Hazel

Hurricane Hazel was adopted by the Ministry of Natural Resources as the storm for watersheds located within Zone 1 in the area delineated in Figure B-1. Although the path of Hurricane Hazel was located to the west of Toronto, studies have indicated that it could have occurred anywhere within the delineated area.

The 12-hour design storm (Table D-2) was developed from rainfall gauge data located at Snelgrove, just north of Brampton. The storm is to be applied to watersheds with areas less than 25 km^2 as indicated in the Table.

For larger basins, the rainfall amounts listed in Table D-2 are to be modified by the reduction factor percentages shown for different drainage areas in Table D-3. These factors should be based on an equivalent circular area. In the case of an elongated watershed, the isohyetal technique should be applied to determine the rainfall input for the runoff simulation.

A hyetograph and a dimensionless storm distribution curve of the 12-hour design storm (36th and 48th hours) are shown in Figure D-2.

From the records, curves were produced for the 6, 12, 24, 36, and 48 hour portion of Hurricane Hazel for a range of drainage areas, as illustrated on Figure D-3, which incorporate the areal reduction effect.

Timmins

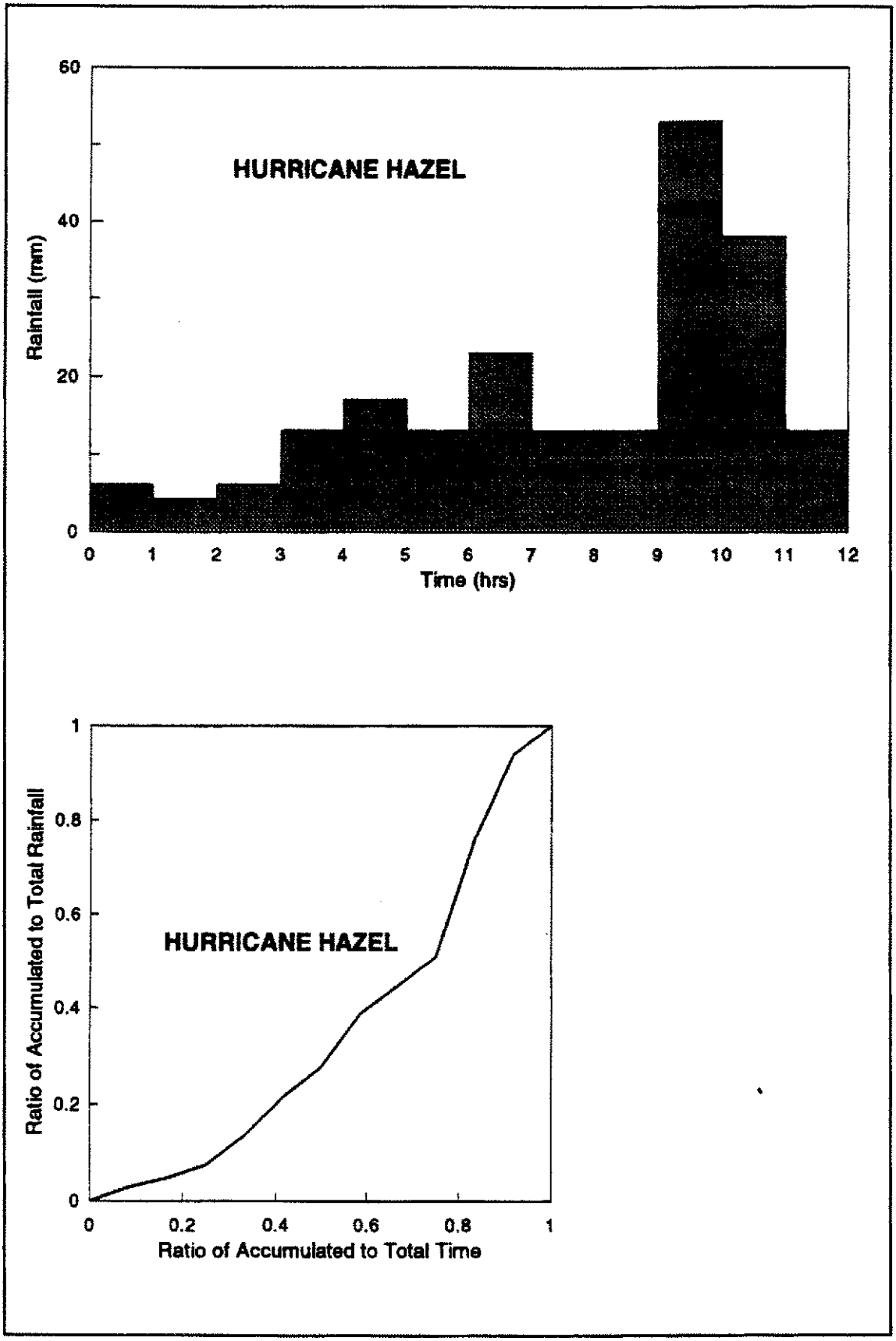
"Timmins" is the name applied to the summer storm which occurred over Timmins, Ontario on September 1, 1961. The event is described by McMullen in Circular 37456 published by the Meteorological Branch of the Department of Transport. The storm created severe property damage and resulted in loss of life on the banks of Town Creek.

The 12 hour design storm (Table D-4 and Figure D-4) was developed from information assembled from several gauges located in Timmins. It was adopted by the Ministry of Natural Resources, as the Storm to produce the flood standard for watersheds less than 25 km^2 in size within Zone 3 delineated in Figure B-1. Similar to the Hazel storm, an areal reduction is applied to the Timmins point rainfall, for drainage areas larger than 25 km^2 based on the 24 hour isohyets as shown in Table D-5.

1.3 Return Period Storms

The second group of storms used for flood plain definition are the return period storms. In absence of adequate streamflow records, rainfall data is used to synthesize stream flows. Rainfall records are more frequently available and have longer duration than stream flow records. Although a precipitation gauge can only provide information for a small area, the general characteristics of precipitation usually vary in a regular manner. Once the rainfall information is determined, there are several techniques available to convert it into an estimate of flow.

Figure D-2: Hurricane Hazel Storm Hyetograph and Dimensionless Distribution



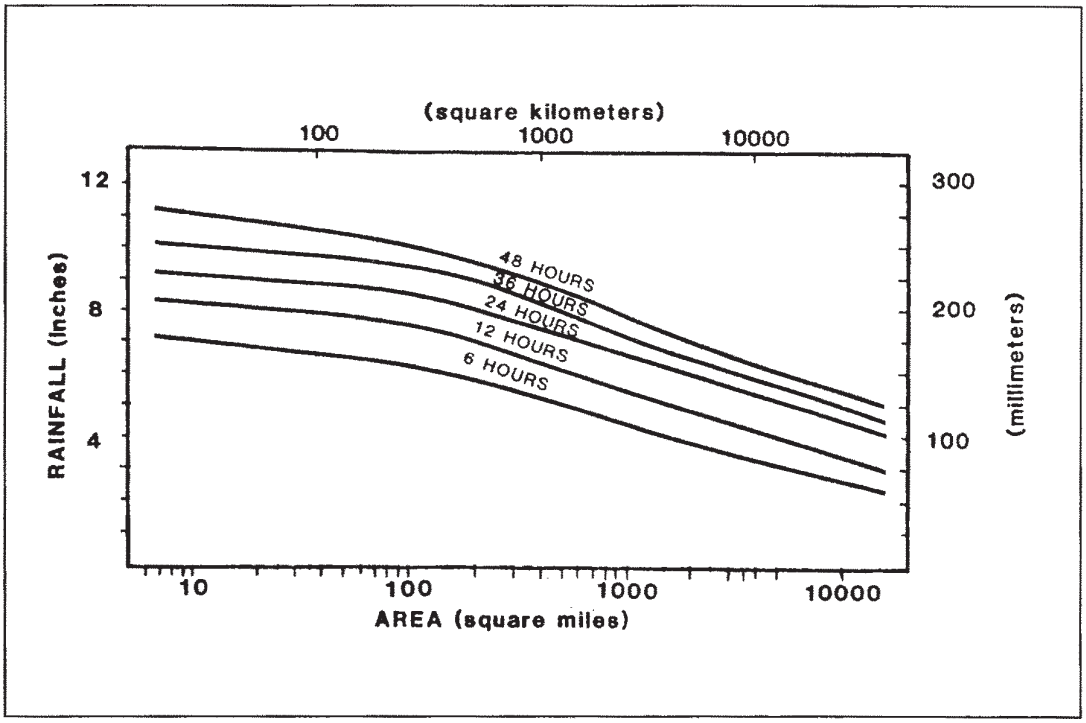


Figure D-3: Hurricane Hazel Areal Reduction

Figure D-3: Hurricane Hazel Area Reduction

TABLE D-2
HURRICANE HAZEL RAINFALL DEPTHS

	Depth		Percent of Last 12 hours
	mm	inches	
First 36 hours	73	2.90	-
37th hour	6	.25	3
38th hour	4	.17	2
39th hour	6	.25	3
40th hour	13	.50	6
41st hour	17	.66	8
42nd hour	13	.50	6
43rd hour	23	.91	11
44th hour	13	.50	6
45th hour	13	.50	6
46th hour	53	2.08	25
47th hour	38	1.49	18
48th hour	13	.50	6
TOTAL	285	11.21	100

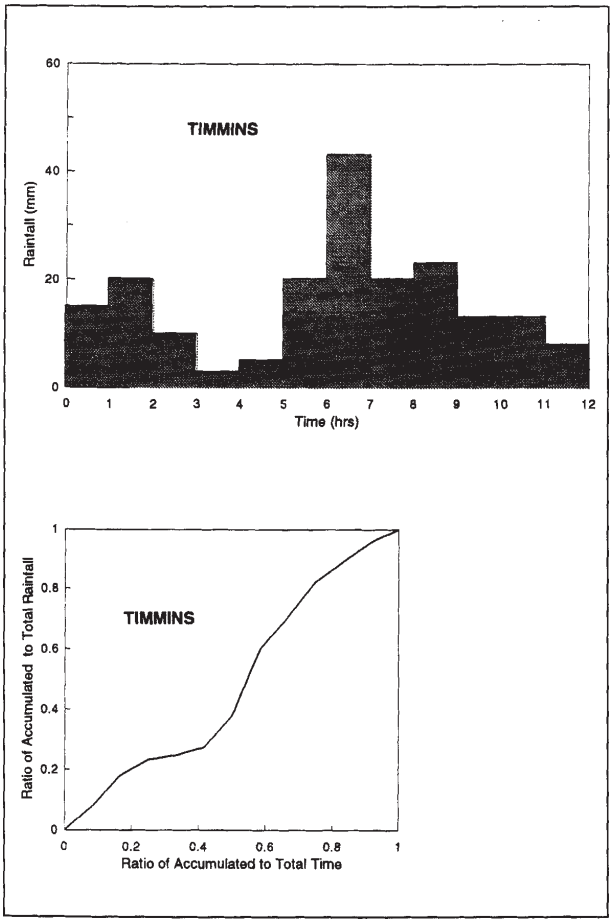


Figure D-4 Timmins Storm Hyetograph and Dimensionless distribution

TABLE D-3 HURRICANE HAZEL - AREAL REDUCTION	
Area (km^2)	**Reduction Factor Percentage**
0 to 25	100.0 (no reduction)
26 to 45	99.2
46 to 65	98.2
66 to 90	97.1
91 to 115	96.3
116 to 140	95.4
141 to 165	94.8
166 to 195	94.2
196 to 220	93.5
221 to 245	92.7
246 to 270	92.0
271 to 450	89.4
451 to 575	86.7
576 to 700	84.0
701 to 850	82.4
851 to 1000	80.8
1001 to 1200	79.3
1201 to 1500	76.6
1501 to 1700	74.4
1701 to 2000	73.3
2001 to 2200	71.7
2201 to 2500	70.2
2501 to 2700	69.0
2701 to 4500	64.4
4501 to 6000	61.4
6001 to 7000	58.9
7001 to 8000	57.4

Note: Reduction factor to be multiplied by the rainfall depth for watersheds larger than 25 km^2.

TABLE D-4 TIMMINS - RAINFALL DEPTHS			
	Depth		Percent of Last 12 hours
	mm	inches	
1st	15	0.6	8
2nd	20	0.8	10
3rd	10	0.4	6
4th	3	0.1	1
5th	5	0.2	3
6th	20	0.8	10
7th	43	1.7	23
8th	20	0.8	10
9th	23	0.9	12
10th	13	0.5	6
11th	13	0.5	7
12th	8	0.3	4
TOTAL	193	7.6	

TABLE D-5 TIMMINS - AREAL REDUCTION	
Area (km^2)	Reduction Factor Percentage
0 to 25	100.0 (no reduction)
26 to 50	97
51 to 75	94
76 to 100	90
101 to 150	87
151 to 200	84
201 to 250	82
251 to 375	79
376 to 500	76
501 to 750	74
751 to 1000	70
1001 to 1250	68
1251 to 1500	66
1501 to 1800	65
1801 to 2100	64
2101 to 2300	63
2301 to 2600	62
2601 to 3900	58
3901 to 5200	56
5201 to 6500	53
6501 to 8000	50

Note: Reduction factor to be multiplied by the rainfall.

Figure D-5A: 24 Hour Duration Mean Annual Extreme Rainfall

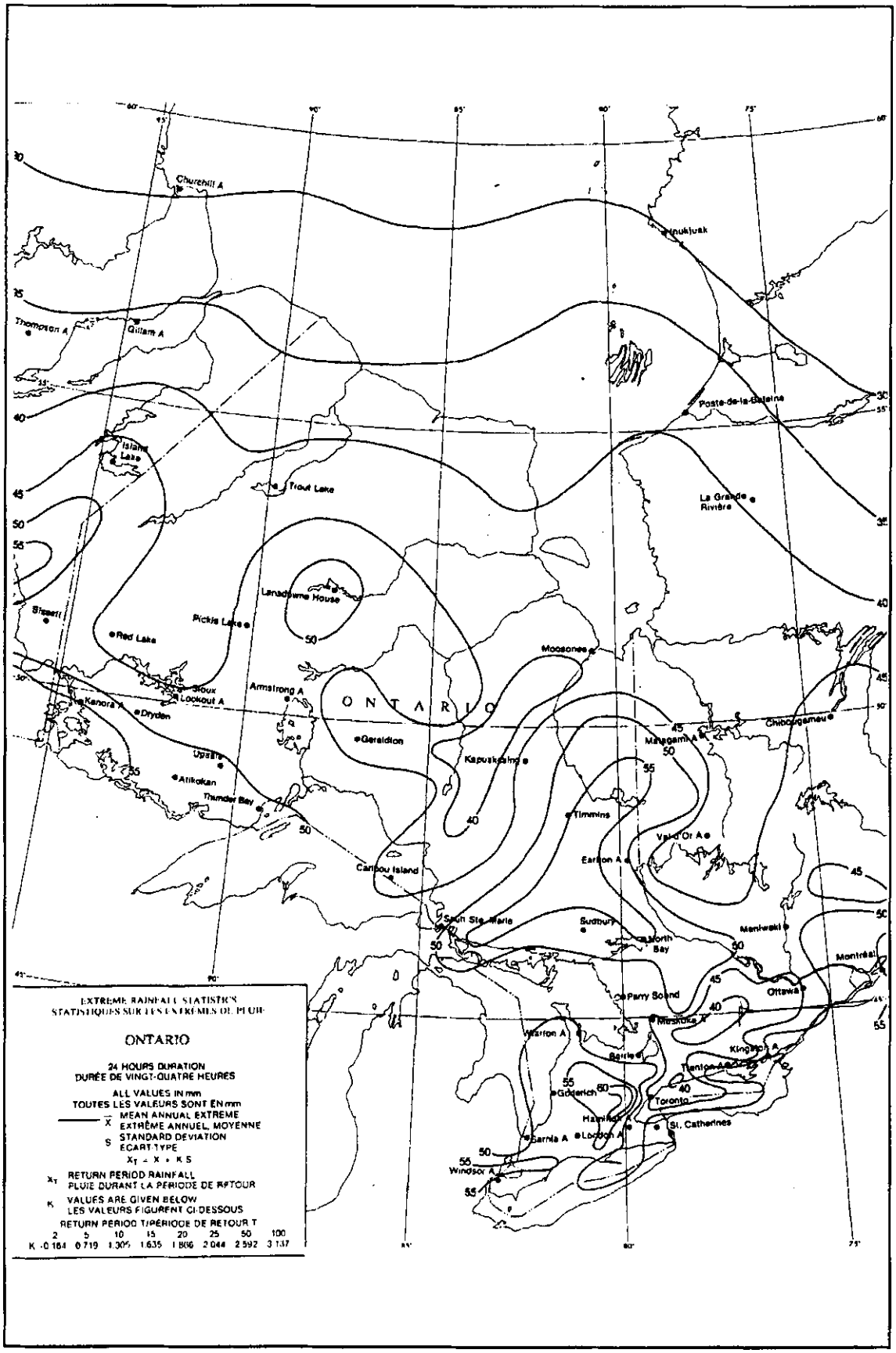
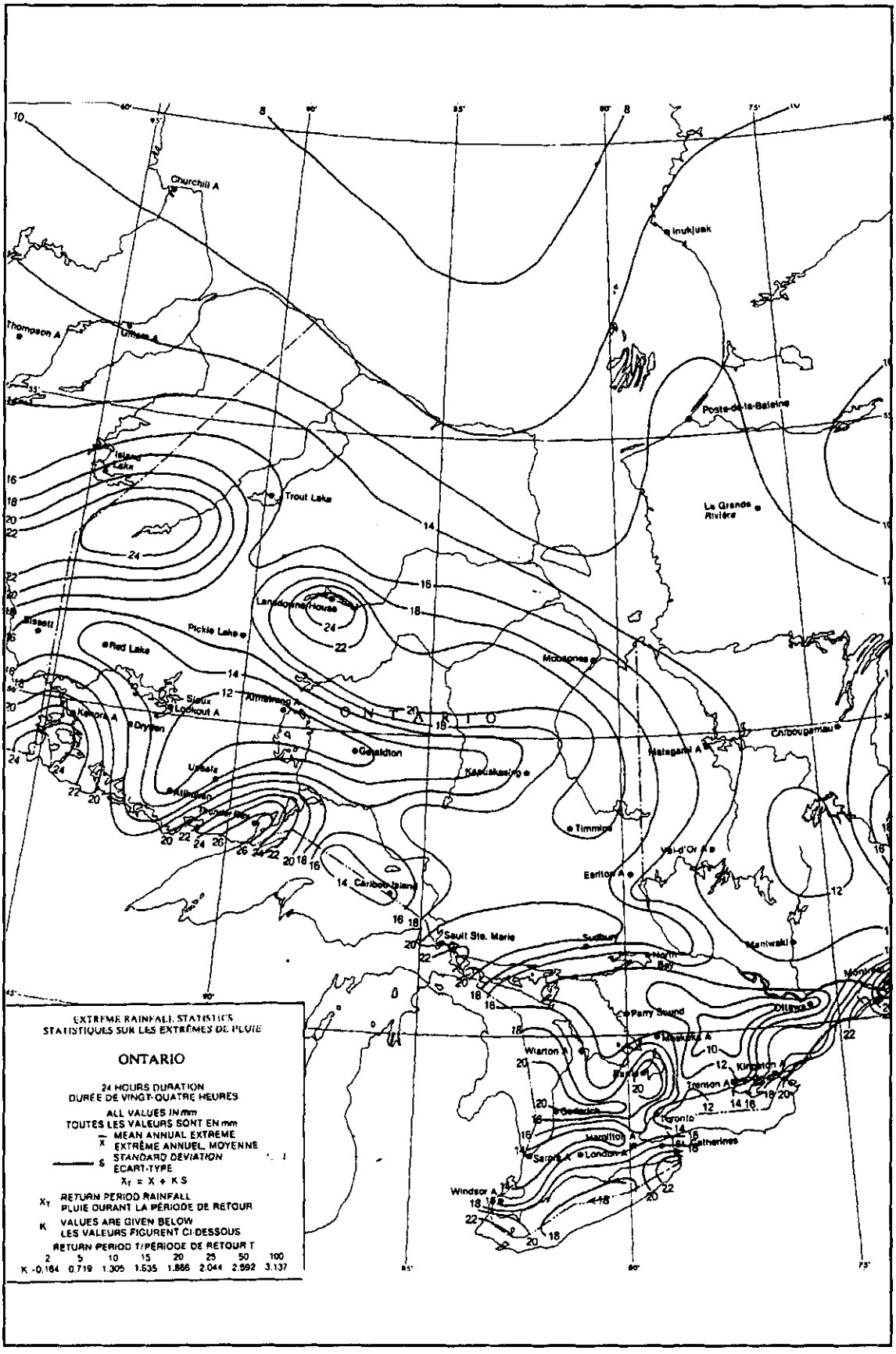


Figure D-5B: 24 Hour Duration Rainfall Standard Deviation



Intensity-duration-frequency curves prepared by AES are available from Environment Canada Ontario Region office for recording rain gauges with more than ten years of record. These gauges provide information on point rainfall. The point extreme rainfall statistics for individual recording precipitation gauges are periodically updated and are also available from Environment Canada Ontario Region office.

When computing flows from a given return period rainfall, the commonly made assumption is that rainfall of a given frequency produces streamflows of the same frequency. However, a rainfall event is made up of many components, each with a unique return period, therefore in practice it is not possible to have the same return period of each of the components. A second reason why this assumption may not be true in many cases is due to the variability of the antecedent moisture conditions.

There are two types of design storms: single event and continuous simulation. The single event can be based on an historical storm or a synthetic storm based on a statistical analysis of recorded data.

The second approach to the rainfall/runoff analysis is the use of continuous simulation. Instead of the assumption of a return period for a single event, the continuous simulation approach is based on the input of long-term precipitation data. The simulation of numerous events will allow a statistical analysis of the simulated flows, and thus derive an estimate of the return period for the runoff event.

The two most important selections the user has to make to define a return period storm are: rainfall duration and depth.

Rainfall Duration

The duration of the required storm varies with the type of analysis. Generally, storm durations should reflect watershed characteristics, and should be equal to the time of concentration of the watershed. Large watershed or small watershed with storage facilities may require the use of long duration storms such as 12 or 24 hours.

Smaller watersheds without storage facilities, such as a typical urban watershed, may require a 1 to 3 hour duration storm for rainfall-runoff simulation. If in doubt, several storm durations should be tried.

Similarly, the time step should be carefully selected in the computation. Small urban area studies may require 5 to 10 minute time steps. Any further reduction such as a 1 or 2 minute time step may result in unrealistic high flows when used with some of the design storm distribution, such as the Chicago method. Large watersheds and long duration storms such as a 24 hour storm, may be analyzed with hourly time steps.

Selection of Rainfall Depth

For Location Near a Gauge

In Canada, the source of most precipitation data is Environment Canada. More than 60 Environment Canada recording rainfall gauges are in operation in Ontario and provide continuous data on duration and intensity of events. In most cases, there will be at least one such station data available for rainfall-runoff simulation at or near the project to estimate flows. The user should obtain the most recent intensity-duration-frequency curves and tables for the relevant station(s).

Intensity-duration-frequency curves were traditionally the most widely-used form of meteorological data, especially in urban drainage design, because of the dominant role of the Rational Method.

Most designs are based on maximum values drawn from records of complete annual rainfall. There are situations, however, where runoff from winter rainfall on frozen ground, coupled with snowmelt, may exceed runoff from annual maximum rainfall.

Intensity-duration-frequency curves are calculated on data recorded during several independent storms. As an example, the highest depth of rainfall recorded for a 5 and a 10 min. period may have occurred during different storms. The largest rainfall intensity value for each duration for each year of record is used by Environment Canada to prepare intensity-duration-frequency curves.

It should be noted that extrapolation of frequency curves for return periods greater than twice the length of record will result in increased inaccuracies.

Remote from a Gauge

For areas where no such recording gauges are available, information on rainfall for selected duration and for different return period events presented in Rainfall Frequency Atlas for Canada (Hogg and Carr, 1985) should be used.. The publication contains maps describing extreme rainfall events. The regional maps of both the mean and standard deviation of annual extremes of rainfall are provided for the following durations: 5, 10, 15, 30, 60 minutes and 2, 6, 12 and 24 hours. The 24 hour duration mean annual extremes and the corresponding standard deviation are presented on Figures D-5A and D-5B as examples from the Atlas.

Areal Reduction

In contrast to the Hazel and Timmins storms, which have known areal distributions, return period storms require the computation of areal reduction factors.

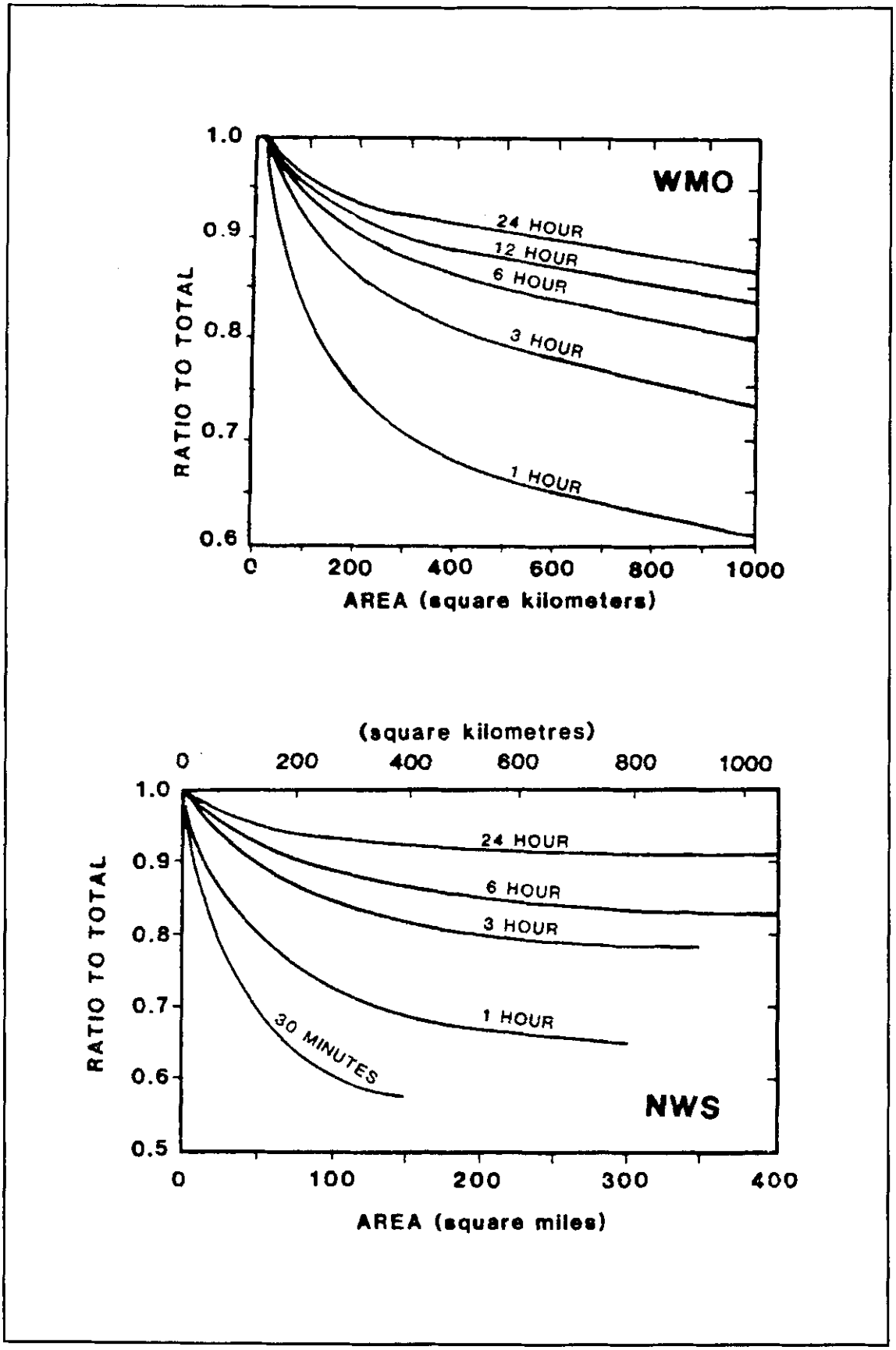
Intensity-duration-frequency curves describe the variation of point rainfall with time for a given frequency. The curves do not include an adjustment for the variation with area. Examples of two common methods of adjustment are shown in Figure D-6. The first method is used by the World Meteorological Organization and the second by the U.S. National Weather Service for non-historical storms.

The adjustment in rainfall depth for a particular point of interest can be calculated by either of the two methods. The two approaches can be used for the upstream drainage area or with the assumption of a circular area, using the longest length of the watershed as a diameter. A few examples of the circular area-watershed length relationship are shown in the following table.

Watershed Length (km)	**Circular Area (km^2)**
1	0.8
5	19.6
5.6	25.0
10.0	78.5

Generally, for studies undertaken in Ontario, no reduction to point rainfall is used for areas under 25 km^2.

Figure D-6: Areal Reduction Curves



Either method is acceptable to reduce point rainfall, especially for a large area; however, the WMO curves give a ratio of 1.0 for areas of less than 25 km^2, which is more realistic than the NWS curves which will converge at 0 area for a ratio of 1.0.

When analyzing thunderstorm type rainfall in urban areas, storm distribution becomes an important factor. Variation in rainfall intensity over small areas, such as 5 km^2, can be significant. Unfortunately, due to lack of rainfall data, no guidelines are available on storm distribution within small urban areas.

Storm Distributions

A number of historical, return period and Probable Maximum Rainfall distributions are available for the designer. Table D-6 summarizes the distributions recommended for the various storms by different agencies.

For the Hazel and Timmins storms, the distribution is provided by the Ministry of Natural Resources. For Return Period storms, the temporal distribution of the rainfall will determine the peak intensity and time to peak. The most commonly used temporal distributions are: a) those based on Ontario and Canadian data, such as the AES distribution and HYDROTEK design storms, or b) those developed in the U.S., such as the Chicago or the SCS distribution.

a) Canadian Storm Distributions

Atmospheric Environment Services staff undertook an investigation on the variability of the time distribution of rainfall in storms across Canada. Data from almost 2,000 extreme events were used to develop regional time-probability distributions for the 1 and 12 hour storms.

Examples of the 12 hour rain distribution curves produced by A.E.S. for southern and northern Ontario are shown on Figure D-7.

The designer has to exercise caution when selecting rainfall distribution from the enclosed graphs. For example, the selection of a 10% curve would result in an advanced pattern of excess rainfall, as the early portion of the rain contains a large percent of the total precipitation. This distribution will have a significant effect in the runoff computation, as the high losses during the initial part of the high intensity storm will result in relatively low runoff. At the other extreme, the selection of the 90% curve will provide a delayed pattern resulting in high rainfall values at the end of the storm. Such a distribution will produce higher runoff as the losses are usually lower at the tail end of the storm.

The use of the 50% curve can give misleading flow results, as the intensity during the storm would be fairly uniform, which contradicts observed distribution data. It is suggested that the user should analyze local storms to establish appropriate distributions. Where no such data are available, the 30% curve is suggested for use.

A more detailed analysis of 1 hour storms presented below suggests that the peak occurs within the first half of the storm event.

The 1 hour urban design storm (HYDROTEK, 1985) is also based on A.E.S. rainfall data. The design storm distribution is described by two parameters which can be applied in conjunction with the total rainfall values published with the intensity-duration-frequency data. The model assumes a linear rise and an exponential decay for the rainfall intensity during the storm. Parameter "a" defines the time of peak intensity, and "K" is a dimensionless exponential decay coefficient, as shown in Figure D-8.

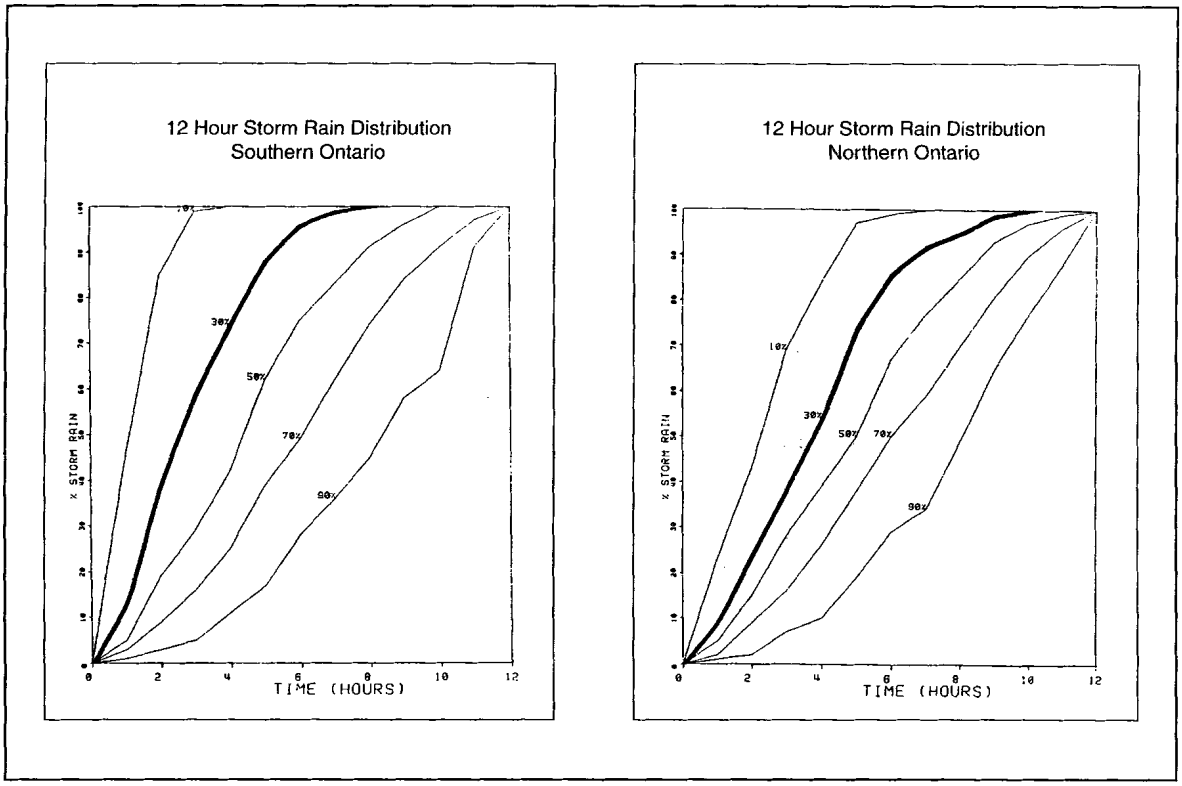


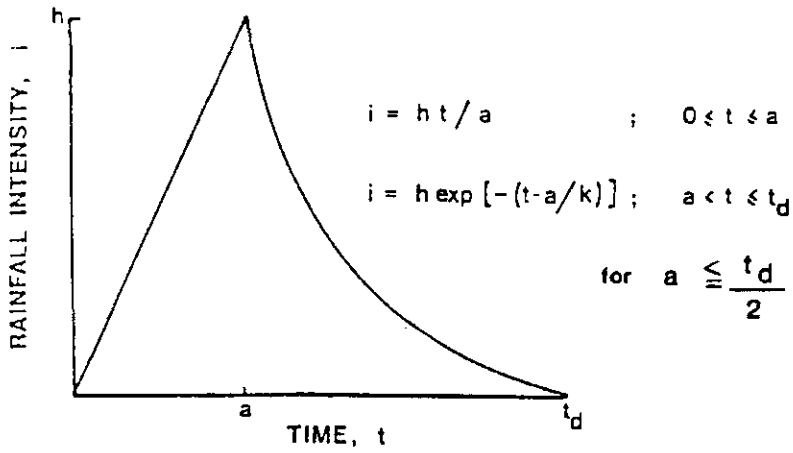
Figure D-7: 12 Hour Storm Distribution

TABLE D-6
RAINFALL DISTRIBUTIONS (PERCENT)

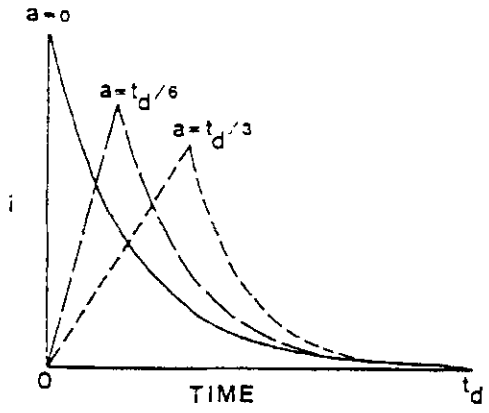
Type	Reference	Storm Duration	HOURS											
			1	2	3	4	5	6	7	8	9	10	11	12
Probable Maximum Storm	Small Dams	6 Hour	8	9	11	49	15	8	-	-	-	-	-	-
HAZEL	Ministry of Natural Resources	12 Hour	3	2	3	6	8	6	11	6	6	25	18	6
TIMMINS	Ministry of Natural Resources	12 Hour	8	10	6	1	3	10	23	10	12	6	7	4
Return Period Storms	SCS II	24 Hour 2 Hour Increment	2	3	3	4	6	48	16	6	4	3	3	2
	AES, 30% Southern Ontario	12 Hour	15	25	22	14	12	8	9	1	0	0	0	0
	AES, 30% Northern Ontario	12 hour	8	17	15	14	18	14	6	3	3	1	1	0
	AES, 70% Southern Ontario	12 hour	3	5	7	10	14	10	12	11	9	9	5	5
	AES, 70% Northern Ontario	12 Hour	3	5	7	10	13	12	8	10	11	11	5	5

Note: A.E.S. 30% distributions represent 70% of all storms for which the accumulated hourly rainfall was equal or less than shown. Consequently, only 30% of the storms had higher accumulated rainfall.

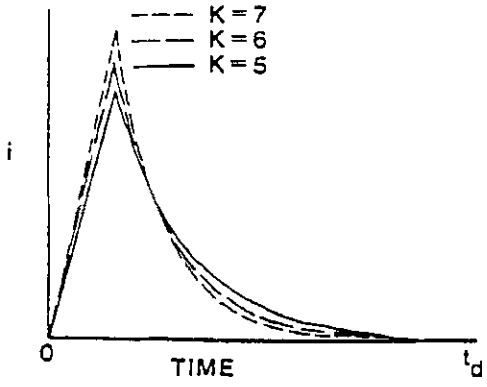
Figure D-8: 1 Hour Urban Design Storm



Definition sketch of urban design storm



Variation of design storm shape with a



Variation of design storm shape with K

Results of the storm distribution analysis for Ontario are presented in Table D-7. The regional K value for the Province is 7, and the individual "a" values for the 12 stations analyzed range from 21 to 28 minutes. Similar analysis can be carried out for other stations data by the user. Alternatively, the two parameters K=7 and a=25 minutes can be used with rainfall values obtained from intensity-duration-frequency data.

The above model has not yet been tested for longer duration storms.

TABLE D-7
ONTARIO VALUES FOR PARAMETER "a" (minutes)

Ear Falls	28
Central Patricia	23
Thunder Bay	25
Rayner	27
White River	27
Timmins	24
Sudbury	21
Windsor	27
St. Thomas	24
Toronto	21
Kingston	27
Ottawa	26

At present no appropriate storm distributions are available for any other duration, except the 1 and 12 hour storms. When the designer is faced with the task of establishing a design storm distribution for any other duration, historical rainfall data for the relevant gauge(s) should be analyzed to determine the appropriate distribution.

A simplified approach used in the HYDROTEK method involves a dimensionless duration and percent of storm plot, for the 1 hour and 12 hour A.E.S. storm distribution curves, for any of the 10%, 30%, 50% and 70% criteria.

Where the dimensionless plots for the two different duration storms are similar, the designer can estimate any duration storm distribution between 1 and 12 hours. However, this is an approximate method and should not be used without verifying the distribution with historical data.

b) Keifer and Chu (Chicago) Distribution

The main advantage of this method, published first in 1957, is that the design storm is created from the intensity-duration-frequency curve. Therefore, results will fit the published IDF curve.

The method requires the computation of the time to peak and the ratio of the time before or after the peak, divided by the storm duration. This ratio can only be derived from existing rainfall records. The method involves calculating the mean values of mass antecedent rainfall and the mean location of the peaks for various rainfall durations for a series of excessive rainfall events.

c) SCS Type II Distribution

The original distribution derived by its author was based on a 24-hour storm. Subsequently, the 6 and 12 hour distributions were obtained by selecting the increments within the central 6 and 12 hour periods of the original 24 hour storm.

Prior to the development of distributions for Canada and Ontario by AES and HYDROTEK, the Chicago and SCS distributions were widely used in Ontario. More recent comparisons of the Chicago and SCS distributions with Ontario data found that for Ontario applications, the AES and the HYDROTEK distributions give more realistic results.

1.4 Probable Maximum Rainfall

The Probable Maximum Rainfall is the largest precipitation event that can be reasonably expected to occur over a selected basin. It is based on a rational consideration of the chance of simultaneous occurrence of the maximum of the various elements which contribute to the event.

The storm is used to calculate flow rates for the design of spillway structures and other hydraulic structures, where failure could result in the loss of life.

The estimate of the Probable Maximum Rainfall as presented in the Design of Small Dams (US Department of Interior Bureau of Reclamation, (1987) is based on analyses which consists of:

- determining the areal and time distribution of large storms;
- maximizing the observed storms by increasing their values to their physical upper limit and;
- considering the transposition of these storms.

Although the work presented specified the mainland United States, it did however overlap into areas of Southern Ontario and the Maritimes. J.P. Bruce (1957) found after a preliminary investigation, that the overlap was a result of a geographical extrapolation, but the meteorological conditions peculiar to Southern Ontario were not considered.

Figure D-9 presents generalized Probable Maximum Precipitation (PMP) estimates for Ontario, based on a series of PMP studies undertaken by Dillon (1987) and can be used to provide preliminary estimates of PMP's ranging from 6 to 96 hour duration.

1.5 Snowmelt and Winter Precipitation

The previous chapters have discussed total rainfall and rainfall distributions. A review of Canadian flow records will reveal that many basins generate annual peak flow rates and volumes during the spring period, usually as a result of snowmelt and rainfall. Past experience has indicated difficul-

ties in selecting design parameters to calculate accurate estimates of snowmelt. This section discusses simplified snowmelt modelling procedures for determining annual maximum snowmelt plus rainfall values. For other methods, the reader is referred to the Ministry of Natural Resources, Snow Hydrology Studies, Phases I, II and III. (McLaren Plansearch 1984)

Five sets of snowmelt plus rainfall frequency values were developed by AES for Canada using the degree day method. Two of these prepared for Ontario are presented in Table D-8. A more detailed description can be found in Extreme Value Estimates of Snowmelt (Louise and Hogg, 1980) and in the Hydrology of Floods in Canada (National Research Council of Canada, 1989).

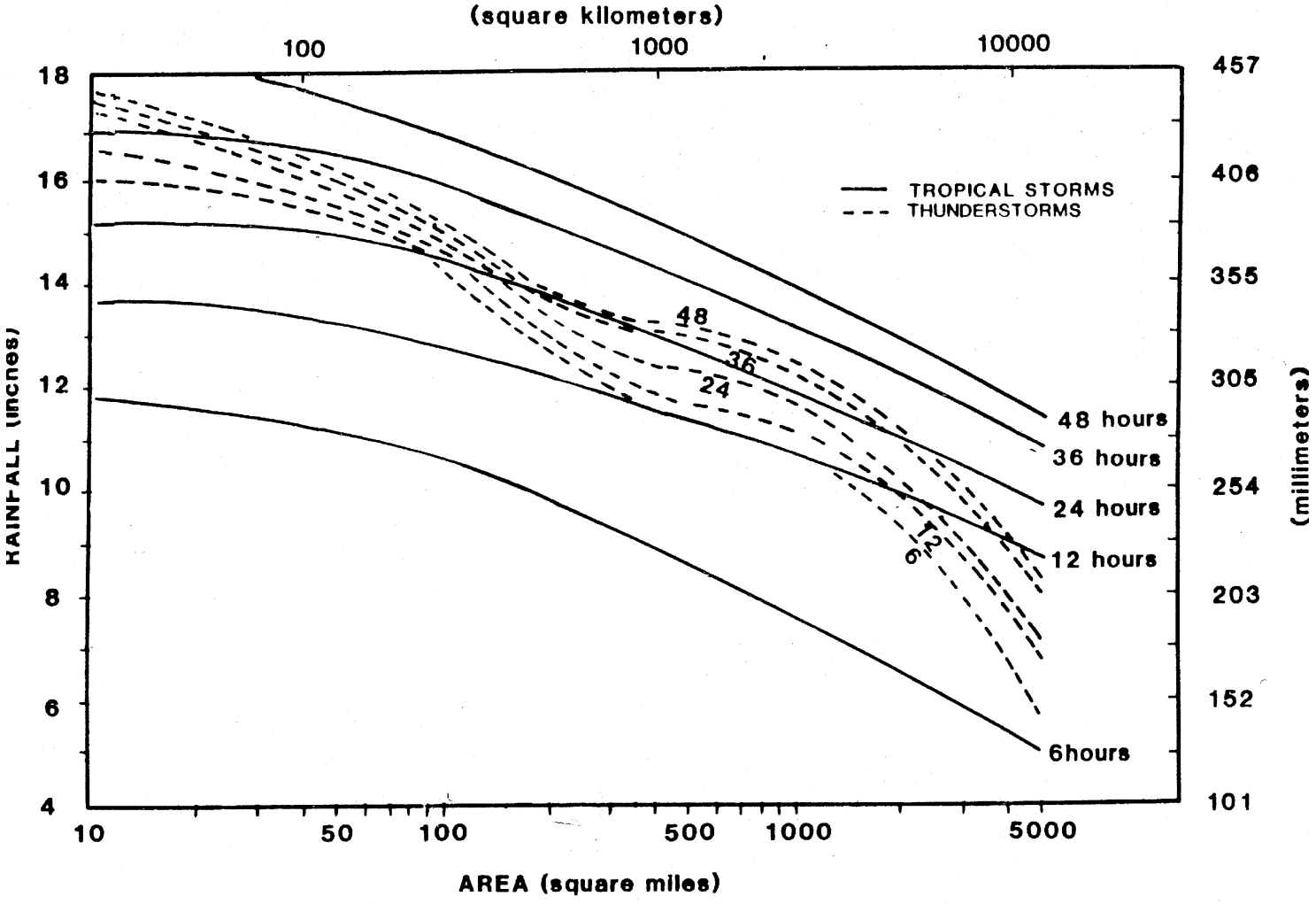


FIGURE D-9
PROBABLE MAXIMUM
SOUTHERN ONTARIO RAINFALL VALUES
BY J.P. BRUCE

TABLE D-8
AES SNOWMELT EQUATIONS

Model 4 - Southern Ontario

$SM\ 4 = 0.91\ T_{max}$

SM 4 = mm/day

T_{max} = maximum daily air temperatures (C)

Model 5 - Southern Ontario

$SM\ 5 = 3.66\ T_m$

SM 5 = mm/day

T_m = mean daily air temperature, (C)

Environment Canada can provide snowmelt plus rainfall frequency values for AES stations for durations of 1 to 30 days and return periods up to 100-years. These daily values can be converted to shorter durations, such as hourly precipitation, and used as input in the precipitation/runoff simulation process, especially in cases where it exceeds the summer rainfall values.

The input data used in the analysis and in the calculation of the snowmelt estimates are daily maximum and minimum temperatures, daily rainfall total and daily depth of fresh snow measurements by ruler. A snow density of 0.1 was assumed to convert snow depth into its water equivalent.

Snowmelt models use an Algorithm that is based upon synthetic snowpacks which are accumulated according to the daily snowfall measurements and depleted according to the snowmelt as determined by the individual model. The Algorithm ceases to operate when the synthetic snowpack is reduced to zero. Daily rainfall is added to the daily snowmelt as calculated by each model and the maxima of maximum series for the different durations.

Calibration of the equation selected from Table D-8 using single station or regional frequency estimates should be carried out wherever feasible.

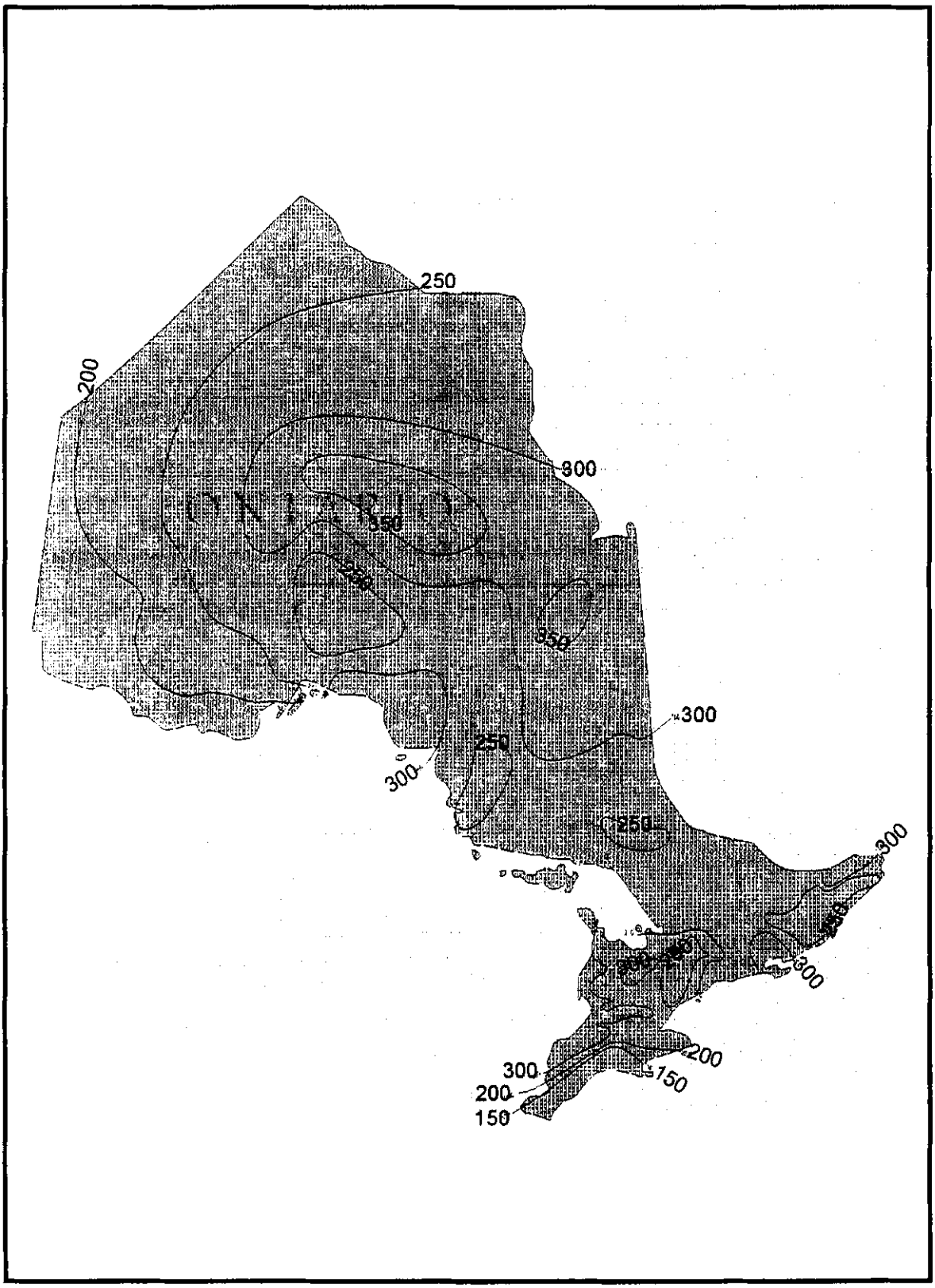
The extreme precipitation data, upon which the Environment Canada intensity-duration-frequency curves are based, is derived from storms that occur mainly in the summer or fall, which represents rainfall that falls on pervious surfaces that permit infiltration and thereby reduce runoff. In the winter months, rainfall is less intense, but may fall on frozen ground that prevents infiltration, and may be supplemented by snowmelt runoff. At present no separate winter rainfall intensity-frequency-duration curves are available. It is hoped Environment Canada will provide such data in the future.

As part of the series of snow hydrology studies undertaken by MNR, Dillon (1994) prepared a comprehensive study of 195 Ontario snow gauges. The study provides estimates of maximum snow water equivalent for a range of 2 to 100 year return periods. (See example on Figure D-10).

Differences in rainfall and rainfall/snowmelt events affect the amount of runoff generated, due to the seasonal differences in rainfall losses. The excess rain for undeveloped land can be significantly higher during the winter and early spring than during the summer. Runoff coefficients for undeveloped land could be 3 to 4 times higher during the winter compared to the summer conditions.

In urban areas, the differences in runoff between the two seasons is less significant. However, the long duration events, required for the design of storage facilities, may show that rain plus snowmelt in urban areas could generate runoff in excess of the runoff caused by summer events.

Figure D-10: 100 Year Snowpack Water Equivalent Mapping



Note: Measurements are in Millimeters

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D 2. SOIL DATA

Soil type and texture can strongly influence the runoff characteristics of a basin. A considerable amount of published data is available on Ontario soils and their runoff characteristics. The list presented in Table D-11 summarizes reports and maps released by the Ontario Centre for Soil Resource Evaluation on soils for Southern and Northern Ontario.

In hydrologic calculations, according to the system developed by the U.S. Soil Conservation Service, soils may be classified into four hydrologic soil groups, A, B, C and D, on the basis of their texture and drainage condition. Descriptions of the four groups, modified slightly by the staff of the MTO to suit Ontario conditions (MTO Drainage Manual) are as follows.

A High infiltration and transmission rates when thoroughly wet, i.e. deep, well-drained to excessively-drained sands and gravels. These soils have a very low runoff potential.

B Moderate infiltration and transmission rates when thoroughly wet, i.e. open textured loam, moderately deep to deep.

C Slow infiltration and transmission rates when thoroughly wet, i.e. clay loams with a high swelling potential.

D Very slow infiltration and transmission rates when thoroughly wet, i.e. clay loams with a high swelling potential. These soils have the highest runoff potential.

It should be noted that the classification depends not only on the texture of soils, but also on the presence or absence of impeding layers and/or high water tables. According to the SCS criteria, soils with a layer that impedes downward movement of water are classified as Group C and soils with a permanent high water table are classified as Group D.

In Ontario some important soils have been found to lie between the main groups given above, and have therefore been interpolated as AB, BC or CD as appropriate.

The four main hydrologic soil groups (A, B, C and D) and the three interpolated ones (AB, BC and CD) were identified by MTO for various soils and are identified in various publications such as:

1. General Soil Types.
2. Surficial Geology Maps.
3. Land Classification Maps.
4. Soil Associations in Southern Ontario.

A detailed identification of hydrologic soil groups for principal soil types are shown in the MTO Drainage Manual, Chapter H.

Field verification of soil types selected from maps and reports are an important part of the data preparation, it should be done before the runoff computation phase.

3. LAND USE

The land use types within a watershed may be determined from maps and/or aerial photo analysis. Where the runoff analysis requires the computation of agricultural farming practices, Census of Canada data may be used to estimate the extent of crop, pasture or wooded area. Tables extracted from the Census of Canada data are available in the MTO Drainage Manual, Chapter H. Land uses may be grouped according to similar hydrologic characteristics.

Crop — areas under cultivation, including summer fallow; also improved land such as farm lanes and yards.

Pasture — seeded and natural pasture and other unimproved farmland.

Woodland — farm woodlots, bush, forested areas and cutover land reverting to forest.

Large areas of urbanization should be measured from maps or air photos, but roads, scattered houses and other relatively small non-agricultural areas can be included as part of the agricultural area in all but the smallest basins. Future extent of urbanization should be extracted from Official Plans or other Municipal land use planning documents and the planning horizon should preferably extend 20 years into the future.

Variations in types of woodland should normally be ignored. Small clearings and cut-over land can be included in the wooded areas.

Where stormwater management facilities, existing or future, can affect the magnitude and/or timing of the flows, the cumulative effects of these structures should be incorporated in the flood plain studies.

Table D-9: Ontario Soil Surveys

SUMMARY OF SOIL SURVEY COVERAGE

County Area NTS Reference	Report No.	Date	Scale	No. of Maps	Available From	Information Slope	Information Data
Brant	55	In prep.	1:25 000	4	IC	S	D
Bruce	16	1954	1:63 360[2]	2	IC	G1	L
Chapleau–Foleyet (41–O, 42B)	61	1986	1:250 000	2	IC	G2	N
Dufferin	38	1953	1:63 360	1	IC	S	L
Dundas[3]	14	1952	1:63 000	1	IC	G1	L
Durham	9	1946	1:126 720	1	IC	G1	L
Elgin	63	1993	1:50 000	3	IC	S	D
Essex	11	1949	1:63 360	1	IC	G2	L
Fort Frances–Rainy River (52C, 52D)[1]	51	1986 1986	1:250 000 1:50 000	1 5	IC IC	N S	NA NA
Frontenac	39	1963	1:63 360	2	IC	G2	L
Glengarry	24	1957	1:63 360	1	IC	G2	L
Gogama (41P)[1]	59	1987 1987	1:250 000 1:50 000	1 2	IC IC	N S	NA NA
Grenville[3]	12	1949	1:63 360	1	IC	G2	L
Grey	17	1954	1:63 360	2	IC	G2	L
Haldimand–Norfolk	57	1984 1985	1:25 000 1:100 000	13 1	IC IC	S N	D NA
Halton	43	1971	1:63 360	1	IC	S	L
Hastings	27	1962	1:63 360	3	IC	G2	L
Huron	13	1952	1:63 360	2	IC	G2	L
Kenora–Dryden–Pointe du Bois (52E, 52F, 52L)[1]	52	1988	1:50 000	4	IC	S	NA
Kent	64	In prep.	1:50 000	3	OCSRE	S	D
Lambton	22	1957	1:63 360	1	IC	G2	L
Lanark	40	1967	1:63 360	2	IC	S	L
Leeds	41	1968	1:63 360	2	IC	S	L
Lennox–Addington	36	1961	1:63 360	2	IC	G2	L
Manitoulin Islands[3]	26	1959	1:63 360	2	IC	G2	L
Middlesex	56	1992	1:50 000	3	IC	S	D
Niagara	60	1989 1989	1:25 000 1:100 000	7 1	IC IC	S N	D NA
North Bay (31L)[1]	54	1987 1987	1:250 000 1:50 000	1 7	IC IC	N S	NA NA
Northumberland	42	1976	1:63 360	1	IC	S	L
Ontario	23	1956	1:63 360	2	IC	G2	N
Ottawa–Carleton	58	1987	1:50 000	3	IC	S	D
Ottawa–Urban Fringe	47	1977	1:25 000	3	IC	S	D
Oxford	28	1961	1:63 360	1	IC	G2	L
Parry Sound[1]	31	1962	1:126 720	1	IC	G2	L
Peel	18	1953	1:63 360	1	IC	G2	L
Perth	15	1952	1:63 360	1	IC	G2	L
Peterborough	45	1981	1:63 360	2	IC	S	L

(Continued)

SUMMARY — Continued

County Area NTS Reference	Report No.	Date	Scale	No. of Maps	Available From	Information Slope	Information Data
Prince Edward	10	1948	1:63 360	1	IC	G2	L
Pukaskwa National Park[1]	53	1985	1:100 000	1	IC	S	NA
Renfrew	37	1963	1:63 360	4	IC	G2	L
Russell–Prescott	33	1962	1:63 360	2	IC	G2	L
Simcoe	29	1962	1:63 360	2	IC	G2	L
Soil Landscapes of Canada, Ontario–South		1989	1:1 000 000	1	IC NSDB	S	L
Soil Landscapes of Canada, Ontario–North		In prep.	1:1 000 000	1	NSDB	S	L
Stormont[3]	20	1954	1:63 360	1	IC	G2	L
Sudbury (41–I)[1]	49	1983 1983	1:250 000 1:50 000	1 10	IC IC	N S	NA NA
Thunder Bay (52A)[1]	48	1981 1981	1:250 000 1:50 000	1 8	IC IC	N S	NA NA
Timmins–Noranda–Rouyn (42A, 32D)[1]	46	1979 1979	1:250 000 1:50 000	1 6	IC IC	N S	NA NA
Victoria[3]	25	1957	1:100 000[4]	1	IC	G2	L
Ville-Marie (Ont. section)	OP 90–2	1990 1990	1:250 000 1:50 000	1 8	OCSRE OCSRE	N S	NA L
Waterloo	44	1971 1971	1:20 800 1:100 000	45 1	IC IC	S N	D NA
Wellington[3]	35	1962	1:63 360	2	IC	S	L
Wentworth	32	1965	1:63 360	1	IC	S	L
York	19	1955	1:63 360	1	IC	G2	N

[1]No report prepared;
[2]Originally printed at a scale of 1:95 040 but reprinted at a scale of 1:63 360;
[3]Report available, maps out of print;
[4]Originally printed at a scale of 1:63 360 but reprinted at a scale of 1:100 000

Symbols used in the brochure

NA - Not Applicable; no report prepared
N - Not included; general soil descriptions only
S - Specific slope information for map units; shown on map symbol
G1 - General slope information; slope values given in report
G2 - General slope information; no slope values given
D - Detailed analytical data for most soils in the report
L - Limited analytical data available in the report

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The National Soil DataBase contains computerized versions of many of the soil maps indicated in this brochure. These coverages are designed for use in a Geographic Information System. For further information regarding database contents, format, and availability, please contact your local CLBRR Land Resource Unit, or the

Canadian Soil Information System (CanSIS)
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Fax: (613) 995-7283

E. METHODS OF COMPUTING FLOOD FLOWS

1. INTRODUCTION

Hazel, Timmins, or the 100 year criteria require multi-stage computations to determine the water levels and the extent of flood plain, as shown below. Where the criteria is based on an observed flood, these computations are not required.

The first stage involves the computation of the magnitude of flood standard to be used for delineating the flood plain. The second stage involves the computation of the corresponding flood level, and the final stage in the process of defining the flood plain in a watershed involves the delineation of floodlines on maps.

Table E-1 summarizes the alternative methods available to compute floods and water levels.

The Hazel, Timmins or 100 year floods can be calculated from flow data or from meteorological input, by using hydrological models or statistical calculations. The corresponding water levels can be computed from the floods by hydraulic models. The only exception is the rare occasion when the 100-year water level to be determined coincides with the location where long-term flood level data are available. In such a case, if the future watershed conditions will be similar to the conditions reflected in the historical data, a frequency analysis of water levels could establish the 100-year water level.

The engineer or modeller may have to compute flood and water levels with return periods other than the 100-year flood for the design and economic appraisal of flood, stormwater management and erosion control works. The seven different alternative methods listed under the 100-year flood on Table E-1 can be used for computing various return period floods.

Numerous flow computation procedures were reviewed to identify their appropriateness for Ontario conditions. Three criteria were used for the selection of flow estimating procedures: accuracy, consistency and cost-effectiveness.

Accuracy was based on the comparison of flood frequency estimates obtained from the selected procedures, with flood frequency estimates determined from suitable streamflow records at selected test sites.

Consistency identified the ease of reproducing similar results by different users at the site based on the same procedures.

Cost-effectiveness was an indication of effort required to compute flows compared to the study requirements.

Generally, floods and corresponding floodlines can be calculated from peak flows or from flood hydrographs. Each of these two approaches has a number of alternative methods available to compute the flood. Table E-2 lists the methods described in this document.

Before the appropriate method of computation is selected, the designer should establish the need to compute peak flow or a complete hydrograph. The following guide will assist in the selection process.

TABLE E-1
ALTERNATIVE METHODS OF FLOOD AND WATER LEVEL CALCULATIONS

Criteria	Data Used for Flow Calculation	Flow Simulation Model	Computed Flood	Water Level Computation	Flood Level
HAZEL	Hazel Storm	Rainfall-runoff	Hazel flood	Hydraulic model	Hazel flood level
TIMMINS	Timmins Storm	Rainfall-runoff	Timmins flood	Hydraulic model	Timmins flood level
OBSERVED FLOOD	Recorded Storm flow or level	Rainfall/snowmelt-runoff or Frequency analysis	Observed flood	Hydraulic model	Observed flood level
100 YEAR FLOOD	Single site flow records	Single station frequency analysis	100-year flood	Hydraulic model	100-year flood level
	Regional flow records	Regional frequency analysis	100-year flood	Hydraulic model	100-year flood level
	Combined single site and regional flow records	Frequency analysis	100-year flood	Hydraulic model	100-year flood level
	Series of historical storms	Rainfall/snowmelt - runoff and frequency analysis	100-year flood	Hydraulic model	100-year flood level
	Continuous meteorological (precipitation, temperature) records	Rainfall/snowmelt - runoff and frequency analysis	100-year flood	Hydraulic model	100-year flood level
	100-year design storm	Rainfall/snowmelt - runoff	100-year flood	Hydraulic model	100-year flood level
	Water level records	-	-	Frequency analysis of levels	100-year flood level

TABLE E-2
COMPUTATION OF DIFFERENT CRITERIA FLOODS

PEAK FLOWS		HYDROGRAPH	
Recommended Method for Design	**Alternative Methods for Planning or Checking**	**Single Event Storm**	**Series of Storms**
. Single station flood frequency analysis	. Regional regression equations	. Storm simulation, frequency of flow assumed to be same as frequency of storm	. Series of large storms or continuous precipitation simulation, followed by frequency analysis of annual maximum flows
. Regional flood frequency analysis	. Index Flood method		
. Combined Individual and Regional Analysis	. Watershed Classification (MTO)		

Notes:

Hydrograph methods are recommended if:

- watershed is outside the range of regional regression applicability.
- watershed has different land uses than the regression equations which were based on rural land use conditions;
- watershed is regulated;
- Hazel or Timmins flood computation is required;
- remedial measures or watershed requirements warrant it.

Hydrograph simulation by computer analysis is required normally where:

i) Watersheds for which the required parameters of the regional frequency relationships fall outside the range of applicability, i.e. for small or urban watersheds, (50 km^2);

ii) Watersheds which have undergone or are expected to undergo land use changes which make the regional frequency relationships developed from a database of rural watersheds inapplicable. This will generally be as a result of urbanization but may also be related to major changes in agricultural practices;

iii) Watersheds which are subject to significant regulation effects due to manipulation of storage or flow within the drainage area;

iv) Watersheds for which the criteria remain the Hazel or Timmins flood as currently defined; and

v) Where different watershed management options are to be tested.

Peak flow calculations are relatively easy to perform where long-term reliable streamflow records are available which reflect the present and future land use conditions, (for a description of the Ontario Hydrometric Network see report by Dillon, (1996). Unfortunately, such individual station frequency analysis results would only be applicable at the gauging station locations. Otherwise, where no flow data is available, regional data can be used to compute peak flows. A combination of the single station and regional flow analysis is recommended where only short-term data is available. Where the single station data cover less than a 10 year period, the records should not be used in the frequency analysis.

Where no gauging station data are available for analysis, a regional frequency study should be undertaken to determine the peak flow. For planning studies or for checking previously computed flows, three peak flow computation methods developed for Ontario conditions are presented in Table E-2; (i) Regional Frequency analysis, (ii) Index Flood method, and (iii) Watershed classification method, developed by the Ministry of Transportation, Ontario.

The Regional Frequency analysis for Ontario, originally undertaken in 1986 by Cumming Cockburn Ltd for the first Flood Plain Management Technical Guideline document, was based on pre-1986 streamflow data and therefore will require updating to incorporate the more recent streamflow data. Similarly, the Index Flood method report prepared by Moin and Shaw (1985), reproduced in the first addition of the Technical Guideline document, will require an update to reflect the present data base. The third method, based on Watershed Classification, is being currently updated by MTO and should be available in early 1997.

The above methods should not be used in urban watersheds, or for Hazel, Timmins and Historical flood computations.

Table E-3 summarizes the recommendations on the use of single station data and regional frequency analyses for (primary) instantaneous and (secondary) mean daily peak flows.

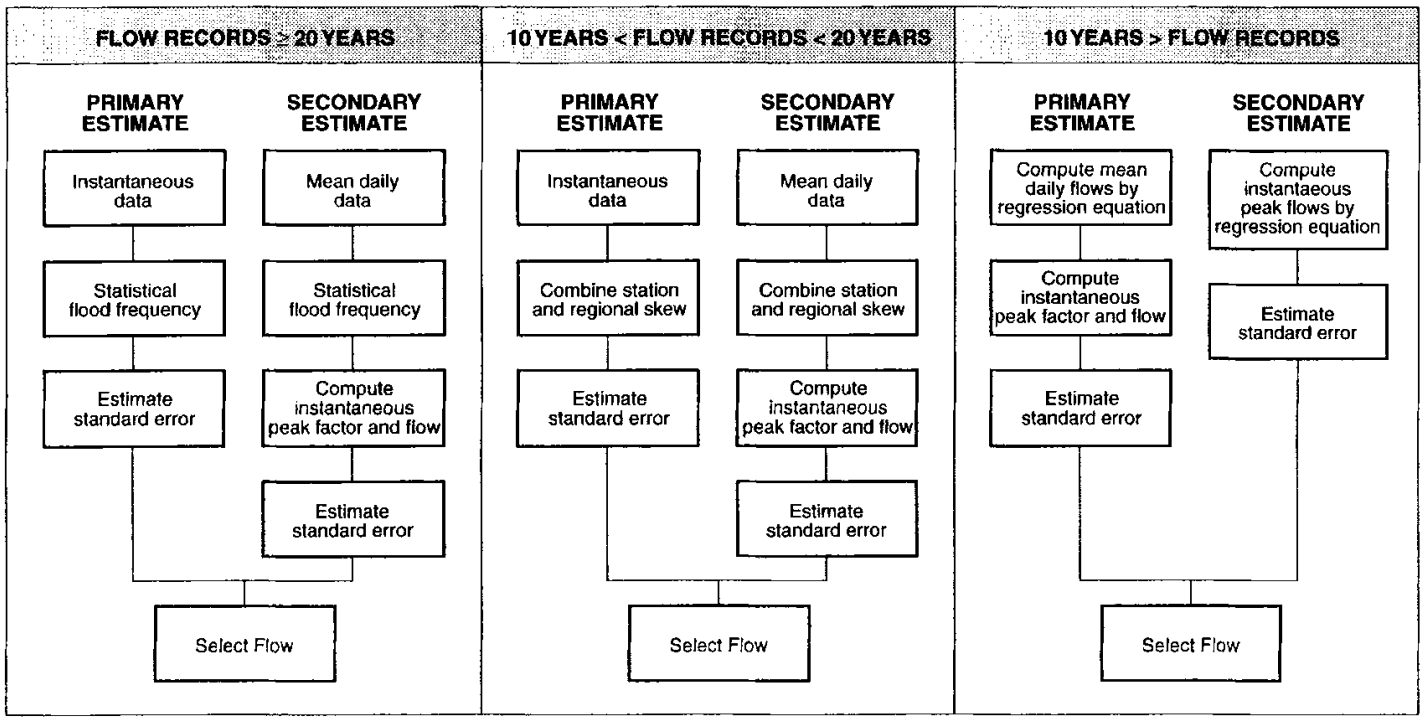
Where the user has the choice of computing the flows by hydrograph and the peak flow methods, the computer model results should be checked by comparing the results with flows

obtained from Regression, Index Flood or Watershed Classification methods. Normally, the results should be within one standard error. However, as indicated, the Regression and Index Flood methods presented in the first edition of the Technical Guideline document are out of date and unless these methods are updated, the comparison would not be valid.

When computing the peak flow with the three methods listed for checking results, the outcome could show a wide range of flows. Particular attention should also be given to those situations where parameters of the regional frequency relationship fall near the limits of range and applicability.

Hydrograph simulation by computer analysis should be carried out to compare with the results obtained from Regional Frequency Analysis. The designer should use the standard error computation and considerable amount of judgement before selecting the return period peak design flow.

Results of a single station flood frequency analysis may be used to calibrate the computer model.



NOTE: Compare standard error of estimate for each technique and use engineering judgement to select peak flow. Intantaneous peak flow data are preferred where available and are used for primary peak flow estimates. Secondary estimates are based on mean daily data used in conjunction with ratios of instantaneous and mean daily peaks.

Table E-3: Summary of 100 Year Primary and Secondary Flood Peak Computation

2. HYDROLOGIC MODELS

2.1 Types of Hydrologic Models

Hydrologic modelling is an important tool for estimating flow hydrographs, including peak discharges, for flood plain management where statistical techniques based on regional analysis of flow records are inappropriate.

A hydrologic model can be used to estimate the:

- response of the physical system to rainfall and/or snowmelt;
- frequency distribution of high flows;
- attenuating effects of storage elements such as channel routing and reservoirs; and
- effect of changes to the watershed.

The following summary provides guidance on how to select a hydrologic model for a flood plain mapping application.

There are two main approaches to mathematical modelling. The first is to design a deterministic (or parameter) model whose response is equivalent to the physical system. This may be either through a model that uses semi-empirical equations that describe the rainfall/snowmelt-runoff process; or one that uses a series of processes of the system. The second major approach to simulation is to determine the statistical parameters describing the response of the system, and to use these statistics to generate a record which is statistically indistinguishable from the measured record. This is called stochastic simulation.

For the most part, the models used in relation to flood plain mapping are of the first type, namely deterministic models. Hence, the remainder of this section will be restricted to the discussion and documentation of models of this type.

Within the class of deterministic models, there are a number of model types which can be identified. The differences between these types are important since they affect the selection of a particular model for a particular situation. The most significant distinctions which can be made are:

- continuous event versus single event;
- lumped versus distributed; and
- rural versus urban.

Continuous Event Models

Continuous simulation models allow the synthesis of long sequences of streamflow data based upon long-term records of meteorological conditions in the modelled watershed.

In general, they operate by maintaining a continuous account of various important hydrologic conditions in the watershed. These conditions include interception, depression, and soil moisture storages, ground water storage, channel storage, and snow pack conditions. The components of the hydrologic cycle are represented within such models to varying degrees of detail. These components react to a given watershed input, (e.g. precipitation, depending upon the current status of the system), to produce an estimate of the resulting streamflow. If the model is well calibrated and verified, the resulting time series of streamflows can be used as a substitute for observed flow records. Using these results, a flood frequency analysis could then be performed using the annual maxima peak extracted for each year.

Many single event models use startup conditions and then run for a period limited by their application or the number of times steps it takes to fill their internal arrays. In recent years, some single event models have been made continuous by the use of 'carry-over' files. The technique used is to retain the conditions for the end of the one run of the model in a temporary file, then use this file as the startup conditions for the next run of the model. One such model, the APIC model (API Continuous model) was developed by Walter T. Sittner of the U.S. Weather Bureau in 1969. MacLaren Plansearch calibrated it for some watersheds in Ontario for the Streamflow Forecast Centre (MacLaren Plansearch, 1982). Also a continuous version of GAWSER (Ghate and Whiteley, 1982) was developed by Harold Schroeter for the MNR Engineering Branch. Both of these models use carryover files for continuous mode. The GAWSER model is much more complex than the APIC model and as a result, also requires seasonalization of the parameters in order to run in continuous mode. Many of the parameters used in complex deterministic models vary throughout the year. Therefore, files have been developed to assist with startup of these models at any time during the year. These files are also required for running GAWSER in continuous mode.

There are several advantages to this technique. The continuous model needs only one startup calculation. It is easier to run it continuously through the next event than to attempt to ascertain the correct startup parameters and then adjust them for the next event. It is easier to calibrate these models when accurate continuous data is available because it is easier to run them for a continuous period concentrating on calibration of the parameter rather than continue trying to get the startup correct. If the model drifts one can change any of the temporary file and restart the model from that file concentrating on the drift and not the startup parameters. This technique was a natural development from attempts to convey startup conditions from one event to the next.

In practice, the state-of-the-art of modelling requires that caution be exercised in taking this approach.

Single Event Models

Single event models share many features with continuous models in that the hydrologic cycle is represented by various model components. However, no attempt is made to track watershed conditions continuously in time. For such a model, the initial moisture storage, snowpack conditions, etc., must

be obtained by some external means prior to each runoff event of interest. In some situations, this can be carried out effectively based upon observed data; in other cases, an arbitrary selection of initial conditions may be necessary.

Single event models can be used to generate a hydrograph associated with an observed storm event, or from a synthetic design storm. In the latter case, rainfall statistics recorded at a meteorologic station are used to construct a rainfall event which is then input to the model. Generally, this type of single event modelling assumes that there is no alternative of the rainfall statistics during the transformation of rainfall to runoff (i.e., 100 year rainfall yields a 100 year peak flow).

Multi-event simulation can be carried out with single event models. It consists of the simulation of a series of storms, each with its own antecedent moisture conditions followed by a frequency analysis of resulting flows. This method avoids the use of a design storm and has been tested on watercourses in the Metropolitan Toronto area.

Lumped and Distributed Models

The terms lumped versus distributed describe the degree to which the application of a particular model requires the averaging of watershed characteristics over its area. A number of models are purely lumped models, for example STORM (U.S. Corps of Engineers, 1976, 1977), using average values of parameters such as maximum infiltration rate across the entire watershed. Other models, for example the HYMO-based model (Williams and Hann, 1973), are distributed in the sense that they permit the discretization of a watershed into a number of subareas. Flows from individual subareas are combined and routed through the stream channel network to obtain flows at downstream points. However, within an individual subarea, the parameters are lumped representations of the area. The most truly distributed models are those which allow discretization of an individual subarea with simulation of the rate of precipitation falling within each discrete block. Such models have been used in research studies, but have not to date been applied in practice.

Over the last decade, super computers have been used for parallel programming where many identical computations can be performed simultaneously. Using this computing power on small scale input data, such as radar, distributed weather information, or satellite information and combining this with small scale watershed parameters and antecedent conditions would result in a highly distributed model. Streamflow calculations from a very large number of segments of a watershed would be routed overland and through the ground into the streams. The anticipation is that using smaller and smaller pieces of the watershed to perform the calculations would produce a highly distributed model and allow for increased accuracy in both the timing and quantity of water moving through the watershed. The accuracy of the input data for these models continues to be a major stumbling block.

Currently there is a focus on applying these techniques to microcomputers and using them where there is insufficient streamflow data to justify other models.

Urban and Rural Models

The earliest computerized hydrologic models, for example the Stanford Watershed Model IV (Crawford and Linsley, 1966), were developed for use in rural watersheds in various watershed planning and design studies. In urban areas, the Rational Method was generally applied for estimating design flows for drainage projects. However, with the heightened awareness of the environmental impact of storm and combined sewer discharges, a new set of models specifically designed for use in urban watersheds have been developed. These models, such as the EPA Storm Water Management Model (SWMM) (Huber et al., 1982), provide detailed information on urban runoff for use in studies relating to the control of storm runoff. This has, however, led to the creation of two distinct sets of models: one for rural watersheds and another for urban areas. The use of a "rural" model in an urban area and vice versa has sometimes led to erroneous results. In flood plain mapping projects, there is frequently an urban component associated with the hydrology of the areas of interest. This often means that it is necessary to utilize an urban hydrologic model to analyze part or all of the subject watershed.

Urban models, such as SWMM, should not be used without testing in a rural area since default values and runoff response simulations are often not representative of rural conditions. Generally, urban models should simulate separately runoff from pervious and impervious areas, averaging can lead to significant errors in runoff volume.

The precipitation/runoff models can simulate the flows associated with existing urban development as a prerequisite to developing remedial strategies (particularly related to sewer overflows). With an increasing emphasis on controlling flows from new developments, these models were adopted to estimate post-development flows. However, a number of these models were generally unsuitable for estimating flows from rural areas and hence, the existing rural models were used for "pre-development" cases. Unfortunately, many of these models are based upon different computational procedures. It is, therefore, very difficult to determine to what extent changes predicted by this approach are the result of different modelling techniques rather than real differences caused by land use changes. This problem of incompatibility of different models has been recognized within recent years and such an approach is not recommended if at all avoidable.

The intermediate approach of utilizing a "single" model which contains separate components to simulate the urban and rural areas appear to reflect the current state-of-the-art. As an example, the INTEROTTHYMO-89 (Wisner and Choon-Eng, 1984) and MIDUSS (Smith and Falcone, 1984) models contain two distinct unit hydrographs for use in urban and rural areas. The urban component uses a single linear reservoir with a storage delay constant defined in terms of watershed characteristics. Model use indicates that 200 ha may represent the upper limit of urban subwatershed application, due to the increasing significance of runoff lag effects. The rural component uses an n-linear reservoirs conceptualization first suggested by Nash in 1957 in his paper on instantaneous unit hydrograph. GAWSER (Whiteley and Gate, 1977) model has also added an urban algorithm to simulate urban land use.

While impacts of urbanization are clearly visible and relatively well understood, the effects of rural land use changes are generally more subtle and the subject of diverse opinion. Although there are many ways in which changes may occur, the following have been identified in past studies to be of some importance:

- installation of agricultural drainage to improve productivity of existing agricultural lands and to bring new "drained" areas into production;
- modifications of crop types and cropping practices; and
- deforestation or reforestation.

Modelling of agricultural drainage such as municipal or tile drains, can be carried out in one of several ways, including:

- empirical adjustments or watershed model parameters based upon literature and experience;
- field scale modelling of tile-drainage using a model such as DRAINMOD. These field-scale effects can then be projected to a watershed scale by modifying the parameters of a watershed model;
- modelling the modifications to municipal drains using a channel routing component of a watershed model; and
- using a watershed model such as GAWSER which has a specific component designed to simulate the effect of agricultural drainage.

Modelling potential impacts of cropping practices on watershed response would ideally be carried out using a physically based model in which specific areas would be modelled with the appropriate characteristics. However, given the empirical nature of current models and computation techniques, the most that can be achieved is a judicious modification of model parameters based on experience and literature sources. In the case of a relatively complex model, such as HSP-F, parameters related to overland flow length, slope roughness, infiltration and soil moisture storage can be modified to reflect altered practices. In the case of a simpler model such as INTERHYMO-89, based on the S.C.S. runoff method, the average Curve Number (CN) can be recomputed to reflect a different make-up of land use.

Forested Watershed Modelling

Forest cover reduces the yield from a watershed, thus resulting in lower annual streamflow and decreased ground water recharge.

Although evapotranspiration rates and soil water moisture storage are reportedly diminished during the growing season by the removal of wooded areas, summer streamflow rates are usually only marginally greater. The most significant increase in watershed yield following forest clear cutting is experienced during the spring snowmelt season with incremental runoff volumes reportedly approaching 30 percent of annual yield.

It appears that flow is higher from cutover forest land during the growing season, with an average response difference of between 10 and 200% being possible. The effect of the removal of cover on peak flows will vary depending on the soil disturbance, intensity and duration of the storm event and the treatment of the land after forest removal. Larger infiltration and soil storage capacities commonly found in forests are known to eliminate overland flow. These forest processes are particularly important during small storm events. During severe rainfalls, forest discharges to stream channels via subsurface flow can be significant.

Forest cover may either increase or decrease individual flood peaks caused by snowmelt or rainfall plus snowmelt events. Although wooded areas will prolong snow cover during the spring period, the most rapid snowmelt of the year may be late in the season when high temperatures and radiation occurs. If combined with rainfall, forest cover can be a liability rather than a flood control asset. Maintaining dissimilar land uses over a watershed now appears to be the accepted practice of desynchronizing snowmelt related peak flows and thereby reducing flood potential throughout the snowmelt season.

The most suitable models for examining impacts of forest cover on flood peaks would appear to be those such as HSP-F and the National Weather Service Model which contain specific parameters related to forest cover. These parameters act as controls on the snowmelt and evaporation processes and can be varied directly in accordance with anticipated changes. Other factors such as changes in wind speed from open to forested areas, changes in surface storages and infiltration rates between forested and open lands must also be correctly modelled.

2.2 Computational Procedures Used in Models

A description of the computational techniques in general use is given below. It is intended that this will assist the user in better understanding the individual models listed. In addition, it should also assist in assessing new models which will inevitably be developed in the future.

Most methods of computing runoff from rainfall and/or snowmelt using a deterministic model involve two processes: the computation of the volume of rainfall/snowmelt contributing to river flow from each storm, and the distribution of this volume with respect to time.

In the determination of runoff volume, most models currently used utilize the "classic" concept of "Hortonian" overland flow. In general, this consists of the separation of input rainfall or snowmelt into a surface or direct runoff component and a subsurface component which may or may not contribute to streamflow within the period of interest. The separation is usually controlled by determining the infiltration capacity of the surface of the watershed at the time of the input. If the rate of input exceeds the infiltration capacity, surface runoff occurs: if not, then all input is absorbed into the ground. The infiltration capacity is generally dependent upon the level of

soil moisture prior to the event of interest. Many models maintain an account of the soil moisture status by budgeting inputs from infiltration versus losses from evapotranspiration and deep percolation. In continuous simulation models, a ground water component is frequently linked to the deep percolation loss, which, in turn, controls baseflow between events.

The estimated runoff volume is generally subject to some form of watershed routing to represent the lag time and attenuation found in most watersheds. In more complex models, channel routing and reservoir routing may also be included.

It should be noted that this "classic" concept of the genesis of streamflow has been widely questioned in the past. An alternative is the so-called variable source area concept, which explains that surface runoff is generated by the "non-Hortonian" or saturated overland flow, due to the rising of water table in the (wet) areas immediately adjacent to the stream channels. However, most of the currently utilized hydrologic models employ this "classic" concept in one form or another.

Snowmelt

A study of snowmelt modelling by MacLaren Plansearch (1984) sponsored by the Conservation Authorities and Water Management Branch indicated that the following three models are the most commonly used in current hydrologic practice:

i) Energy balance models which characterize some or all aspects of the heat balance of a snowpack but utilize approximate formulae to model the snowmelt process. This approach is adopted in several operational models such as HSP-F, (Johanson et al., 1980) and (Anderson and Nichols, 1984), SSARR (U.S. Corps of Engineers, 1972) , and HEC-1 (U.S. Corps of Engineers, 1981). The equations used are generally based on the U.S. Army Corps of Engineers' 1956 Snow Hydrology Study.

Additional empirical equations are used to define the extent of areal snow cover, the storage and delay of water in the snowpack, and any heat deficit which may arise.

ii) Index models which identify snowmelt processes explicitly, but without the use of extensive meteorological input data. An example of this type of model is NWSRFS (Watt and Associates, 1979).

iii) Temperature index models in which air temperature is used as an indicator of snowmelt.

In some cases, additional factors such as variation in snow cover area are included in the equation. Models which incorporate such an approach are QUALHYMO (Rowney and Wisner, 1984a), USDAHL-74 (Holtan et al., 1975), and the UBC model (Quick and Pipes, 1977).

iv) GAWSER contains a snowmelt routine that considers what happens to the snow as it melts, and it reflects the observations that as the snow leaves the centre of a field significant amounts remain in the edges.

Infiltration

The following infiltration methods are considered to be acceptable in hydrologic modelling:

i) Horton's equation;
ii) S.C.S. Curve Number Procedure;
iii) Holtan Infiltration Equation; and
iv) Green-Ampt Infiltration Equation.

Soil Moisture Accounting

Soil moisture is generally modelled by the use of moisture storage reservoirs. A variety of formulations have been utilized ranging from a simple one reservoir system of total subsurface moisture to a complex four reservoir system. Several models utilize the S.C.S. (1972) Curve Number procedure for the calculation of runoff volumes which is based upon external information such as antecedent soil moisture indices. In single event models, it is necessary to initialize whatever index of soil moisture is used based upon external information. In the case of continuous simulation models, an account of moisture conditions is maintained. This is achieved by balancing inputs from infiltration against losses due to direct outflow to the channel system, evaporation to the atmosphere and percolation to deeper soil moisture zones.

Groundwater Storage/Baseflow

Baseflow or groundwater response is generally not considered to be an important factor in determining the peak flows, which are of interest in flood plain mapping studies. There is, however, considerable evidence that rapid subsurface response can generate a large proportion of flows for certain watersheds. However, the current generation of models, particularly single-event models, would have limited abilities in reproducing such responses. In general, groundwater response can be modelled as a linear storage reservoir.

Watershed Routing

A great deal of research effort has been expended in refining this aspect of hydrologic modelling. Hence many different methodologies have been proposed. The most frequently used techniques are:

- the Unit Hydrograph method (both linear and non-linear);
- the Kinematic Wave method;
- the Time-Area Curve method.

2.3 Recommended Model Selection

At the present time, there is no universal model that can be generally recommended for all applications. Therefore, each user must consider several alternatives in deciding what model is best for a given application.

A variety of procedures have been presented in the literature for use in model selection. A general framework for model selection consists of the following steps:

1. Define the problem and specify the hydrologic information required to make flood plain management decisions.

2. Identify the available models and determine:
   - if watershed characteristics represented by model parameters govern watershed response in the intended application; and
   - if watershed and hydrometeorologic data required by models are available.

3. Specify the required performance of the hydrologic model:
   - the accuracy of the flow estimates; and
   - time frame available to obtain required hydrologic information.

4. Estimate the data preparation and computation costs for each model and compare to budget limits.

5. Rate candidate models and select.

Elaborate model evaluation is often not practical or possible due to a lack of published information on the accuracy of computational procedures. A preliminary screening of available hydrologic models was therefore carried out during the preparation of this Guide. The list of models selected which are conceptually sound and have demonstrated an ability to reliably estimate peak rates of streamflow in Ontario watercourses, are shown in Table E-4. The hydrologic features of the models are presented in Table E-5. These models are non-proprietary and may be obtained from the sources identified in the documentation for distribution fees ranging up to approximately $1,500.

Many of the models listed in the two tables are also described in the Provincial Urban Drainage Design Guidelines. These models, HYMO, INTERHYMO-89, VUH HYMO, SWMM, OTTSWMM, STORM, are also recommended to calculate major and minor system flows required for urban drainage studies.

TABLE E-4
LIST OF HYDROLOGIC MODELS

Class Model	Name of Model	Comment
Continuous Simulation	HSP-F HWSRFS (Stanford Version) NWSRFS (Sacramento Version) SSARR USDAHL-74 GAWSER QUALHYMO TUNIS	- complex continuous models - simplified continuous model
Single Event, Rural Areas	GAWSER HYMO VUH-HYMO HEC-1 FLOOD2 INTERHYMO-89 MIDUSS	- generally for use in rural watersheds
Single Event, Urban Areas	DDSWMM (formerly OTTSWMM) SWMM STORM INTERHYMO-89 MIDUSS	- generally for use in urban subareas

New Models

It is expected that new models or recoded existing models will continue to appear on a regular basis for many years. The new models, based on acceptable or new procedures, will require approval by the Ministry of Natural Resources before application.

When a modeller proposes a new model or an improved procedure for use with an existing model, the procedure should first be tested on well documented demonstration watersheds. These special test watersheds and data sheets should be maintained by the Ministry of Natural Resources. In addition, the proposed procedures should be submitted for publication in a technical journal by the author so that his or her contribution to the state-of-the-art can be scrutinized by peers. These technical journals include CSCE, ASCE, Water Resources Research, Canadian Water Resources Journal, Journal of Hydrology, etc. A thesis or a paper presented at a conference is not considered to be a published paper. Only when the superiority of the new procedure is clearly established, will the Ministry consider its use on flood plain mapping projects. The final decision should be made by the Ministry's staff, or by an appointed outside specialist.

Consultation with hydrology and hydraulic specialists of other Ministries is encouraged during the review procedures.

The Ministry will consider acceptance for general use only those models which have been demonstrated to be superior to some of the currently accepted models. The advantages and disadvantages of the candidate models will be evaluated from both theoretical and practical points of view. In general, only non-proprietary models will be considered for acceptance by the Ministry.

2.4 Model Calibration

Calibration of hydrologic and hydraulic models is an important part of the flood plain investigation. Frequently, lack of adequate data to calibrate and verify the model or lack of funding and expertise is used as an excuse to avoid calibration and validation of the models.

Calibration of the models involves the adjustment of model parameters to reduce the differences between observed and simulated events. If there are no observed events available for calibration/verification, the uncertainty of parameter values can be reduced if the model is calibrated on a hydrologically similar watershed. The verification of a model is equally important, as this procedure will assess how the calibrated model predicts a set of events not used for calibration. Generally, the more complex a simulation model, the more data and expertise that is required; this will invariably result in a more expensive study, with results that are not necessarily more accurate.

In general, it is not feasible to directly estimate all model parameters from the physically measurable characteristics of the watershed. It is, therefore, necessary to calibrate and verify a model for each particular application. From a calibration viewpoint it may save time to select a model with the fewest parameters. However, the selection of a model that has been calibrated on a similar watershed could assist in the calibration.

Selection of data for calibration should reflect the intended use of the model. If the model is to be used exclusively to estimate flood flows of high return periods then the calibration data set should be biased towards such events.

TABLE E-5
HYDROLOGIC MODEL SELECTION MATRIX

APPLICATIONS	MODELS												
	Flood2	HEC-1	HYMO	HSPF	NWSRFS Stanford	NWSRFS Sacramento	INTERHYMO-89	SWMM/DD SWMM	STORM	SSARR	USDAHL-74	VUH-HYMO	QUALHYMO
Processes to be Simulated													
Precipitation	●	●	●	●	●	●	●	●	●	●	●	●	●
Snowmelt		●		●	●	●		●	●	●	●	●	●
Infiltration	●	●	●	●	●	●		●	●	●	●	●	●
Evapotranspiration				●	●	●		◦	●	●	●		●
Surface Runoff	●	●	●	●	●	●	●	●	●	●	●	●	●
Subsurface Flow		●		●	●	●				●	●		●
Data Availability													
Precipitation	●	●	●	●	●	●	●	●	●	●	●	●	●
Temperature	●	●		●	●	●		◦	●	●	●	●	●
Other Met. Variables		◦		●						◦	E	◦	
Flow Records	●	●	●	●	●	●	●	◦	◦	●	●	●	●
Design Criteria													
Frequency Based				●	●	●		●	●	●	●		●
Historical Event	●	●	●		●		●	●				●	●
Design Rainfall	●	●	●				●	●				●	●
Land Use													
Rural	●	●	●	●	●	●	●		●	●	●	●	●
Urban				●			●	●	●				●
Agricultural													
Drainage Courses													
Significant Reservoir Storage	●	●	●	●			●	●		●		●	●
Watercourse Routing	●	●	●	●	●	●	●	●		●		●	●
Complex Models				●	●	●		●		●			

Note: ◦ = Optional
E = Pan Evaporation

If on the other hand the entire annual flow cycle must be simulated, then a broad range of flows must be included (i.e. wet, average and dry years). As a rough guideline, for continuous simulation models a minimum of five years of calibration data and five years of independent verification data would be appropriate. For a single event model, five events of significant magnitude is recommended, this will prove invaluable for testing the accuracy of the calibration and should not be over looked.

Model parameters can be obtained by either measurement from physical data, computation from available records of flow or selection based upon previous experience. The accuracy of flow records is largely dependent on rating curves at gauge sites; every effort should, therefore, be made to investigate the degree of error which may be inherent in rating curves due to the type of control section or the flow range. When calibrating for high water elevation during spring breakup, it is important to consider ice conditions that can cause false high flow readings in the rating tables.

Certain parameters such as drainage area, channel slopes and impervious fraction of the watershed can be measured directly from topographic mapping or other sources, such as a GIS data bank.

Other type of parameters which must be initialized are those which can be estimated from available records. This would include baseflow recession constants, direct runoff unit hydrograph parameters, areal reduction factors applicable to rainfall and degree-day coefficients for snowmelt calculations. This group of parameters would be subject to optimization in the calibration process, but would be expected to vary within a relatively narrow range in a suitable model of the given watershed.

The final group of parameters is that for which it is difficult to find a direct physical interpretation and which must be estimated based upon general experience, or experience from using the particular model on another watershed. This would include parameters such as maximum soil moisture deficit, factors to modify potential evaporation to actual evaporation, factors to adjust convection melt estimates to field conditions, interflow recession constant, average infiltration rates, etc. A fairly wide range of fluctuation of these values during calibration would be anticipated. Final values which are consistent with watershed characteristics would increase the users confidence in the suitability of the model for the intended application.

F. WATER LEVEL COMPUTATIONS - OPEN WATER

1. GENERAL

This chapter outlines and compares hydraulic analysis and modelling techniques that are suitable for application to a wide variety of Ontario rivers to estimate water levels. These techniques generally find their application in flood plain management, flood control, and preliminary engineering and design projects. Where discharge or streamflow may be assumed to be constant over a period of interest, a set of steady, nonuniform flow computations, generally known as "Backwater" computations, can be applied. On the other hand, where the discharge varies with time due to a rapidly changing runoff, or due to complex channel/storage interactions, unsteady non-uniform flow computations, known as "flood routing" computations, are necessary to depict the changes in discharge, depth and velocity.

2. BACKWATER PROFILES

In most cases, steady flow conditions can be assumed along a particular length of watercourse or river. The water surface profile computations may be based on the solution of the one-dimensional energy equations for gradually varied flow (the Bernoulli equation).

The Standard Step Method is the most commonly used method in computing water surface profiles under the above conditions. The calculations are made by successive approximation as follows. For subcritical flow conditions, the calculations begin with a known water surface elevation at the start of a reach (or downstream boundary). A water surface elevation is then estimated for the end of the reach, and energy losses are calculated. The resulting water surface elevation is then computed by adding the calculated losses to the known water surface elevation at the start of the reach. If there is a significant difference between the estimated and computed elevations, a new estimate is made and the computation repeated. When the difference between these estimated and computed elevations is less than some allowable error (about 1 or 2 mm), the computed elevation is accepted and computations are advanced to the next cross section.

In the case where the backwater computations are to begin at another river, the initial water level should be selected according to the respective travel times of both watercourses. For example, if the peak of the flood hydrograph on the study river occurs at an elapsed time of 16 hours, then the initial water level on the downstream river at the confluence would correspond to the same time on its own flood hydrograph, developed from the storm centred on its own watershed. Depending upon the relative times to peak of both rivers, the initial water level may occur before or after the peak elevation occurs on the downstream river.

Basic data required for calculating water surface profiles are discharge, starting water surface elevation, cross section geometry, roughness coefficients, and occasionally other types of energy loss coefficients. to determine the flow, the Manning formula for open channels is commonly used, and physical geometry is expressed in terms of a plan of channel alignment, cross section coordinates, and distances between cross sections. Detailed surveys are needed to establish the boundary geometry at bridges, and photographs of the structure are desirable.

In all cases, field measurements of cross sections, discharges, and water surface profiles of actual floods are necessary to verify the accuracy of calculated profiles. This procedure requires measurements of recorded flow and water surface elevations to calibrate the hydraulic roughness coefficient (Manning's n) associated with the friction losses occurring along a study reach. When bridges and other constrictions are encountered, contraction and expansion losses are frequently more predominant than friction losses and must also be verified by field measurement. In this situation, expansion and concentration coefficients will be calibrated using the recorded water levels upstream and downstream of the bridge.

3. FLOOD ROUTING

In some cases, the problem cannot be reduced to a steady flow assumption because of rapidly varying inflows or tributary flows, the effects of significant channel storage, or complex interactions between channel flow and adjacent flood plain areas. Under these conditions, the flow is considered to be unsteady, and the process of computing the movement of a flood wave through a channel is called "flood routing'.

Hydrologic routing is the term used to describe flood routing in which only the equation of continuity is employed. The form of the continuity equation used in hydrologic routing procedures states that for a given time interval (dt), the difference between the inflow to a reach (I) and the outflow from a reach (O) must equal the change in storage (dS), within the reach, expressed by:

$$I - O = dS/dt$$

When the continuity equation alone is used as the mathematical model of unsteady flow, the model becomes linear, in contrast to the fact that the flow is mathematically non-linear. Thus, the success of this model depends upon the extent to which the prototype flow is non-linear. The steadier the flood flow, the better the results of the hydrologic routing model. Linear mathematical models of river flow based on continuity alone do not take into account the upstream travel of waves, such as those produced at junctions, dams, or irregularities in channel cross section.

The simplest application of the continuity equation is obtained by assuming storage to be a function of outflow alone, (i.e., S = KO or O = (1/K)S). While applicable for reservoir routing, these methods generally are among the least exact of those which utilize only the continuity equation. Probably the most widely used hydrologic routing method is the Muskingum method. This method assumes storage to be a linear function of both inflow and outflow, so that

$$S = K [XI + (1-X)O] \text{ or } O = (1/K)S - x(ds/dt)$$

Where "x" and "K" are empirical constants which are found by trial and error for a reach. The coefficient x is considered to be related to the conveyance of a reach, while "K" represents the time of propagation of a given discharge along a reach.

Although hydrologic routing is comparatively easier than other techniques, it has several disadvantages. A large amount of data is required for evaluation of coefficients, and the applicability of the coefficients beyond the range of calibration is doubtful. Also, backwater is not included, and the solution is heavily dependent on the time and distance increments used in the computational procedures.

The hydrologic or storage routing methods are generally included in watershed simulation models to route or move an upstream hydrograph along a river to a downstream location, such as a reservoir, a confluence or a flood damage centre. When the "routed" hydrograph is combined with the "local" hydrograph representing the contribution of flows only between the upstream and downstream ends, a "total" hydrograph is obtained which represents the contribution of flows from all the areas upstream.

Hydraulic routing describes those methods in which both the continuity and momentum equations are employed to route flood waves in a river.

When lateral inflow is ignored in the momentum equation, it becomes equivalent to a rating curve for steady uniform flow, since the friction slope is equal to the bed slope. This approximation results in the kinematic wave method of routing. The kinematic wave method is considered superior to hydrologic routing methods since the degree of over-simplification is reduced and thus, the degree of uncertainty between model results and prototype behaviour is reduced.

Storage effects due to channel irregularities or off-channel storage may produce subsidence of the flood wave which is not predicted by the kinematic wave theory. Since kinematic waves are defined in terms of continuity considerations, they can therefore only travel downstream, thus backwater effects are ignored.

Dynamic routing models include some or all of the terms in the momentum equation which have been ignored in the kinematic wave models. These models may be one or two dimensional. Dynamic routing models possess the capacity of simulating upstream movement of a flood wave, (i.e., backwater effects) are included. However, solution of the full equations, especially in two dimensions, is more difficult than the previously described simplified forms. Dynamic models may also be simplified; for example, the spatial derivatives of velocity in the momentum equation are often deleted, as the inclusion of these terms adds little to the computation. For a slowly rising flood the effect of these terms is minimal and, therefore, their removal may be justified.

4.CHOOSING A HYDRAULIC MODELLING TECHNIQUE

Recognizing the different types of flood routing methods, the choice of a suitable modelling technique for a particular river can be very important. Generally, there are two major factors affecting the choice: namely the type of information required from the method and the data available about the geometry of the natural river and previous floods.

The results from a flood routing study will, of course, be dictated by the nature of the overall project. For example, if a building is being constructed on the flood plain that does not significantly affect the flood characteristics of the river, the engineer will be concerned with the peak level of a flood hydrograph at the construction site. He may also be interested in how long the flood will be above a certain level, in which case he will need to know the shape of the stage hydrograph.

Similar information with respect to flood discharge hydrographs will be required when designing a spillway for a reservoir. Here the engineer may be concerned principally with the rising part of the discharge hydrograph and with its shape near the peak. If, however, alterations are being proposed, such as a flood damage reduction scheme, then a knowledge of peak levels and discharges from floods, and possibly the associated hydrographs, will be necessary at the improvement sites and downstream.

When general flow and water level information is required at selected sections which are far apart (i.e., 20 times the width of the flood plain or more), then a routing method, utilizing simplified mathematical calculations combined with a coarse model of the river valley is usually sufficient, rather than a detailed model of the river channel, flood plain and valley wall. However, when more detailed information on flooding is required along the river, including water levels and mean velocities, then a more complicated numerical model may be required.

Another important aspect of the information obtained from a flood routing method is the accuracy of the results. This accuracy will, of course, be a function of the accuracy of the data and the method itself. Apart from the accuracy of the input data, the errors in the results will depend principally on the suitability of the basic equations to describe the phenomenon of flood propagation. In general, it is the errors arising from the unsuitability of terms in the basic equations which are the most difficult to eliminate. Numerical analyses are sufficiently well advanced that errors generated by the solution techniques, including finite difference schemes for the equations, boundary conditions and data handling techniques are not a significant problem.

The amount and quality of data from a natural river, both for the geometry of the channel and flood plain, and for previous

flood discharges and levels, is another significant factor in the choice of a flood routing method. Fortunately, it is usually possible to obtain general information on a river from topographic maps. This information will, for instance, include the length of a reach, the slope of the channel, and the plan area of the flood plain. It is still necessary, however, to know something about the speed of flood peaks along the reach, and the corresponding peak discharges, particularly if water inundates the flood plain. If this information is of poor quality, then nothing is gained by using a flood routing method more complicated than a simple storage method.

Fortunately, many rivers have at least one gauging station which can be used to produce hydrographs from previous floods for calibration. The usefulness of recorded water level information will increase if gauges are located within sites that have the potential to be flooded and possibly experience high damages, especially those that may require flood control works. However, it is common for the error in the calculated discharges to be more than 20% of the actual discharge, particularly for high flows. This large error is due to the difficulties in extrapolating the rating curve for flow over an adjacent flood plain. If there is no gauging station available, either a gauging station has to be built or discharge hydrographs for previous floods have to be derived at the upstream section of the reach from some hydrologic model.

If a detailed numerical model is to be developed, the amount of calibration data increases with the amount of detail required. Such data can be expensive to obtain and depends, in the case of a flood plain study, on the occurrence of appropriate floods during the course of the investigation. It should also be remembered that if the parameters for a given method have been determined for a particular range of floods, then the use of the method with the same parameters for larger floods can introduce errors.

There are numerous computer models available for backwater and flood routing computations. These models have been developed over the years based upon the previously described methods, and all have been tested and calibrated on real streams. A brief overview of several different hydraulic models with different capabilities and levels of complexity are presented in Table F-1.

Having regard to the foregoing discussion, the choice of model should be based upon the available data and information on the river, and the desired amount and quality of estimates. Additional factors that might be considered include:

- level of complexity (data input and interpretation of results)
- flexibility
- experience of user
- ease of calibration
- raining requirements.

Obviously, no model satisfies all requirements; a general rule should be to select the simplest model that provides the necessary information.

Table F.1: Hydraulic Model Selection Matrix

	TYPE OF FLOW						HYDRAULIC EQUATIONS				RESULTS										INPUT DATA													MISC.			SENSITIVITY				COST			USAGE							
	Gradually varied flow	Steady	Unsteady	One-dimensional	Sub-critical flow	Super-critical flow	Energy Equation	Manning's equation	St. Venant's equation	Continuity	Water surface profile	Velocity profile	Bridge structure	Flow hydrograph	Water elevation hydrograph	Sediment Transport	Flow distributions	Spill	Ice	Cross-section geometry	Bridge geometry	Weir and diversions	Flow and flow regime	Flow hydrograph	Water elevation hydrograph	Initial water elevation	Manning's "n"	Loss coefficients	Lateral inflows	Tributary profile	Multiple profile	Automatic calibration	Manning's "n"	Loss coefficients	t	n	Low Medium	Medium	High	Applied in Ontario	Widely Applied	Documentation	Program support	Required training	Low Ease of Use	Medium Ease of Use	High Ease of Use
Standard Step Method	•	•		•	•	•	•	•			•	•								•			•			•	•					•	•			•					•						
Direct Step Method	•	•		•	•	•	•	•			•	•								•			•			•	•					•	•			•				•	•			•		
Transform Curve Method	•	•		•	•		•				•	•								•			•			•	•					•	•			•			•		•	•	•		•	
WSP2	•	•		•	•		•	•			•	•	•				•			•	•		•			•	•	•		•		•	•				•				•	•	•		•	
HEC-2/HEC-RAS	•	•		•	•	•	•	•			•	•	•				•		•	•	•		•			•	•	•	•	•	•	•	•				•		•	•	•	•	•		•	•
USGS	•	•			•		•	•			•	•	•							•	•	•	•			•	•	•		•		•	•				•				•	•	•		•	
SHP	•	•	•	•	•		•	•	•	•	•	•								•				•		•	•	•					•		•	•					•	•	•		•	
FLOW ID	•	•	•	•	•	•		•	•	•	•	•		•	•				•	•		•		•	•	•	•		•				•		•		•		•	•		•	•	•			•
EXTRAN	•	•	•	•	•	•		•	•	•	•	•		•	•				•	•		•		•	•	•	•		•				•		•		•		•	•		•	•	•			•
FLDWAV[1]	•	•	•	•	•	•		•	•	•	•	•	•	•	•				•	•		•	•	•	•	•	•	•	•	•		•	•	•	•		•		•	•		•	•	•			•
HEC-GVF	•	•	•	•	•	•		•	•	•	•	•		•	•				•	•			•	•	•	•	•		•				•		•			•		•	•		•	•	•			
MOBED	•	•	•	•	•	•		•	•	•	•	•		•	•	•		•		•		•	•	•	•	•	•		•				•		•		•		•	•		•	•	•			•
FERNS	•	•	•	•	•	•	•		•	•	•									•	•	•				•			•	•		•					•							•		
FLOW I-D +	•	•	•	•	•	•	•		•	•	•	•														•			•	•														•		•
WSPRO	•	•		•	•	•	•	•			•	•	•				•			•	•					•	•		•	•	•	•	•				•				•	•	•		•	
SMS[2]	•	•	•	•	•	•	•		•	•	•	•	•			•	•			•	•	•		•	•	•				•	•					•					•	•	•			•
UNET	•	•	•	•	•	•		•	•	•	•	•	•				•			•	•	•			•	•				•	•		•				•					•	•	•		•	

1 formerly DAMBREAK and DWOPER

2 includes RAMZ, FESWMS and SEDZD interfaces

\+ to be confirmed

Computer models continue to be refined and developed. In addition, a simplified manual approach based, say, on the Standard Step method, may be preferable in some cases to the use of a complex computer model. A simplified approach allows a much closer scrutiny of input data, closer involvement of the engineer in the computations, and more direct application of experience and judgement. Table F-1 represents a decision matrix designed to summarize the applicability of typical models. Ultimately, the selection of the appropriate model must be left to the judgement of the individual professional. Any model based upon the principles discussed in this chapter, and which can be calibrated and verified by the user, is an acceptable choice.

5. RESERVOIR ROUTING

Reservoirs, lakes and onstream storage facilities affect both the flows and water levels along a river system. Hydrologic models may be employed to estimate the effect of reservoirs on streamflows, and subsequently the hydraulics can be computed with the revised flood flows. Alternatively, the physical properties of the reservoir can be incorporated directly into a hydraulic flood routing model of the river. More frequently, it is necessary to establish a starting water level at a lake for a backwater computation, or a local floodline around a lake. In such cases, a process of reservoir routing may be applied, in the absence of direct water level recordings.

The most commonly used method of routing through a reservoir is the Storage-Indication method, also known as the modified Puls method or level-pool routing. This is a hydrologic routing method by which a flood hydrograph routed through a reservoir is both delayed and attenuated as it enters and spreads over the reservoir surface. Water stored in the reservoir is then discharged gradually through flow control devices such as gates, orifices and overflow spillways.

Storage-Indication method is also used by some hydrologic models such as INTERHYMO 89, GAWSER and QUALHYMO in their respective reservoir routing routines.

In floodline mapping studies, the analysis of flow-frequency relationships require the conversion of regulated flows to de-regulated or natural flows. If the streamflows under consideration are subject to artificial regulation by dams or diversions, which have significant impacts on peak flows, it is necessary to estimate the effect of such regulation to enable a conversion of streamflows to natural conditions prior to undertaking a flood frequency analysis. When the degree of flow regulation is not negligible, results from single-station flood frequency analyses can not be used in a regional analysis unless the observed flood flows have first been converted to their natural state. Otherwise, the regional regression equations would under-estimate the flood magnitude at ungauged watersheds.

For reservoirs, records of outflows, stage and stage-storage curves are required, and for diversions, the quantity diverted into or out of the system. Rule curves or operating procedures must also be obtained to enable a reconversion from regulated conditions to a natural flood estimate. It may be necessary, if an installation was made within a period of record, to collect data on the times of installation, cut-off, and reservoir-filling, etc.

Given adequate data, such as diversion flows, reservoir stages, outflows and stage-storage curves, it is a simple if tedious task to convert flows to natural conditions. The regulated flows may then be converted to natural flows by a simple ratio equal to the degree of regulation determined. Once the flows are de-regulated, a normal flood frequency analysis can be carried out. Comparison of streamflow records before and after reservoir construction can also be used to estimate the overall effect of regulation.

6. EFFECT OF LAKES AND RESERVOIRS

Lakes and reservoirs act to attenuate flood flows in a watershed, therefore, the storage and outflow characteristics of major lakes and reservoirs must be taken into account in the hydrologic analysis. The resulting design runoff should then be used for establishing required water surface elevations.

A lake also represents a discontinuity in the flood profile along a river that must sometimes be separately accounted for in the hydraulic computations. Therefore, the estimation of maximum lake or reservoir levels is a necessary component of many flood studies. These water levels may be used for:

- initial water levels for commencing backwater computations;
- direct plotting of floodlines around lake or reservoir perimeters; and
- estimating flood levels at watercourse inlets or outlets.

Where sufficient records exist, water levels corresponding to specified return intervals may be estimated by statistical means. Maximum instantaneous water levels may be fitted to extreme-value probability distributions similar to the method used in flood frequency studies.

Joint probabilities due to spring flood water elevations and wind set-up may also be estimated from available records. The HYDSTAT computer program, available from the Ministry of Natural Resources, estimates the joint probability of two related events from observed data.

If a significant amount of regulation exists in a lake, it will be necessary to carry out detailed design flood routing computations through the lake or reservoir, according to appropriate seasonal gate settings and rule curves. In most cases, short interval time steps (1 hour or so) will be needed in order to define the maximum levels reached under various floods. Most hydrologic models provide the means to perform these computations.

Water levels for the Great Lakes were published by the MNR Conservation Authorities and Water Management Branch in 1989. The report lists flood levels determined by calculating the probability of all possible combinations of monthly mean lake levels and wind setups which could result in a peak instantaneous water level having a total probability of being equalled or exceeded of 1% in any year.

7. WATERWAY CROSSINGS AND ENCROACHMENTS

Bridges, culverts, weirs, and embankments create local head losses and rapidly varied flow conditions; these also represent discontinuities in the flood profile and must be treated separately. Energy losses may be due to local contraction and expansion of the flow approaching and leaving the structure, as well as to friction loss through the structure itself.

In relatively simple cases, such as where a hand calculator Standard Step method is being applied, these losses can be independently estimated and entered into the computations. The coefficient for expansion losses is a function of the change in velocity head between cross sections and is adequately discussed in most textbooks. Bridge losses may be estimated from observations and measurements, or by use of an empirical equation, such as the Yarnell formula. These losses are then added to the total energy at the bridge section, and computations proceed to the next upstream cross section.

In most cases, however, a computer model such as the HEC-2 or the more recent HEC-RAS will be applied for backwater analysis. Special routines are included in many of these models to directly handle the losses due to bridges and culverts, based upon the size, geometry, and configuration of these structures.

It is usually sufficient to include only those bridges and waterway crossings that would significantly affect the waterway. Based upon field inspection, maps and air photo interpretation, many small walkways, trestles, and at-grade roadways may be neglected, depending upon the magnitude of the design flow. All culvert embankments, however, should be carefully considered.

Waterway encroachments, due to urban developments, roadway embankments and structures, may also significantly affect flood plain hydraulics. Some computer models include special routines for this purpose, but the most common approach is to modify the channel cross section to reflect the encroached section, and re-compute the flood profile. The encroachment area may affect one or several cross sections. Where numerous buildings have been constructed at-grade, but no actual filling of the flood plain has occurred, the engineer may choose to modify the cross section and vary the flood plain roughness coefficient to represent the encroachment.

It is a current policy of the Ministry of Natural Resources to base flood profile computations, for flood hazard mapping purposes, upon existing structural and hydraulic conditions along the river. Where a structure may be replaced in future, or upon inspection of preliminary hydraulic results, a structure may prove to be unstable or breach on overtopping in such cases, additional hydraulic analyses of the resulting downstream flood wave should be carried out.

8. MODEL CALIBRATION

Having selected an appropriate computer model and set it up to represent a particular reach of river, it is essential that a process of model calibration and testing be carried out. It is likely that errors due to data uncertainties will be greater than computational errors. Since much of the input data (including Manning's 'n', loss coefficients, reach selection) depends upon hydraulic engineering experience and judgement, the model should be compared against observed flows and water levels in the study reach.

Model calibration refers to the process of adjusting the appropriate coefficients and parameters so that the model will replicate an observed flood event as closely as possible. Ideally, sufficient flood records will be available so that the "split-sample" technique may be employed, in which the model is calibrated against one set of flood levels, and verified against a different set.

The following general procedures are suitable for calibration of most hydraulic river models:

- Suitable streamflow and water level measurements are collected by field survey along the watercourse.
- The sensitive hydraulic model parameters are identified and estimated in order to simulate the documented flood event. Normally, these would include Manning's 'n', expansion and contraction coefficients, and peak flows, but may be extended to include starting water levels, cross section data, and the presence of ice, sedimentation, and other debris.
- The parameters are varied as required, through a process of iteration, until a satisfactory comparison between computed and measured water levels is obtained.
- The model is then verified by comparing computed and measured water levels for a flood event not used in the calibration process.

By this means, a satisfactory computer model can usually be established. If this is not the case, the engineer should examine the study reach for significant factors not included in the model (such as ice blockage), or reconsider the choice of hydraulic model itself.

Water levels for calibration purposes must usually be measured in the field, but several sources of useful data may be present including historic high water levels which may be obtained from landowners, residents and local officials.

Flows and water levels may be obtained from stream gauging stations operating in the study area. Environment Canada, Ontario, the Ministries of Natural Resources and Environment and Energy, Conservation Authorities, and various private agencies may operate suitable gauges in the area. If more than one gauge happens to exist along the study reach, water surface profile information on many floods can be obtained.

Maximum water levels may also be obtained by surveying high water marks in the field after the passage of a flood. In many cases, these marks persist for several weeks after the event, from which a reasonably accurate profile can be surveyed. Measurements along both banks should be obtained and compared, in this case. Flow estimates may be available from an upstream or downstream gauge, and adjusted to the reach of interest.

A field monitoring program may be carried out to directly measure water levels during the passage of the flood. Simple crest water level gauges can be installed at intervals along the study reach and read after the flood. Flow records may be made in the field using the Slope-Area method, but it is usually more practical to resort to a nearby stream gauge on the same river.

In setting up such a monitoring program, gauge durability, convenient access, vandalism, and hydraulically unobstructed location should be borne in mind.

9. TESTING AND SENSITIVITY

The purpose of model testing and sensitivity analysis is to assess the impact of variations or uncertainties in the various calibrated model parameters on flood profiles. The relative importance of the variables is determined by changing one variable, within prescribed limits, and conducting simulations with all other variables held constant. The following parameters are usually considered.

- peak flood discharge;
- channel and flood plain roughness;
- expansion and contraction coefficients;
- starting water levels, tidal conditions, or control gate operations;
- channel configuration, including the spacing, location, and definition of cross sections;
- ice-jamming and debris blockage; and
- sedimentation and sand bars.

Peak discharge and roughness are usually found to be the most sensitive parameters. However, in particular cases, one or more of these other variables may prove to be significant, in which case additional consideration should be given to the field monitoring, calibration, and delineation of the ultimate floodlines.

G. WATER LEVEL COMPUTATIONS - ICE JAMS

1. INTRODUCTION

The potential for ice jam flooding is present in Southern Ontario during the three month period between freeze-up in late December and break-up in late March. In Northern Ontario, this period usually extends over a five month period beginning in late November. During these periods, flooding may result from accumulations of frazil slush, or fragmented sheet ice or both.

Many ice jam prone areas have been identified in Ontario. In many cases, the ice jam flood levels have exceeded 100-year open-water flood levels, even when combined with relatively frequent (5 years) floods. The majority of problems have arisen from ice jams during break-up. In some cases, frazil ice blockages, culvert icing, and aufeis (flow on top of the ice) accumulations have resulted in flooding.

Ice accumulations may be formed by ice pieces drifting slowly downstream and coming to rest against the front of an existing cover. If the surface velocity is sufficiently low, these pieces abut against each other without overturning or otherwise being carried beneath the cover. A thin fragmented ice field is thereby formed and the front progresses upstream at a rate dictated by the supply of ice.

At slightly higher velocities, the incoming ice may be entrained at the front of the accumulation and pass beneath the cover and deposit downstream. The incoming ice may also be entrained and stack at the front of the accumulation causing the cover to progress upstream. This depends upon the size and quality of ice reaching the front of the accumulation.

If the ice is entrained into the flow and passes beneath the cover it will deposit in low velocity areas, generally progressing in a downstream direction. On large rivers, the frazil slush has been documented to deposit along the thalweg of the channel. Hanging dams often form as the result of frazil deposition.

The thickening of the ice cover front by ice floes underturning and accumulating by stacking, or packing, etc. is often referred to as hydraulic thickening. The cover progresses upstream at the prescribed thickness, and no further thickening occurs. In this case, the internal forces are sufficiently balanced by the shear at the banks.

Overall, these processes of entrainment, deposition and hydraulic thickening progressively form an ice accumulation which is thicker than that of the individual pieces forming it, and this increases the resistance to flow and raises water levels.

The shear force of the water flowing beneath the accumulation and the cover weight acting in the direction of the slope of the surface increase as the accumulation grows upstream. These forces are transferred through the accumulation to the river banks or to the original obstruction. If the thickness of the cover is not sufficient to sustain these forces, the cover will thicken by internal collapse or “shoves”. This thickening process continues within the accumulation until the forces acting on it are sustained by shear at the banks. At that time, no additional load is transferred to the downstream obstruction/accumulation and the thickness of the accumulation reaches a maximum which is called the equilibrium thickness. This process continues as the cover advances upstream, with the thickness varying from reach-to-reach in response to the governing forces. The thickness and roughness of this type of accumulation can be quite substantial and are shown in the walls of fragment ice floes (shear walls) left along the river banks after the release or melt of an ice jam event.

This idealized description of the hydraulic and structural factors may often be seen during the regular accumulation of frazil slush or floes during cover formation. Once the accumulation freezes to form a solid cover, the water levels are higher than the open water case for equivalent flows because of the addition of the surface boundary and the displacement effect of the ice.

During the break-up, a regular accumulation and upstream progression of an ice accumulation which commonly occurs during freeze-up is highly variable, and the process is typically more violent and unpredictable. Irregular blocks of ice and large pieces of sheet ice are swept along with the current to collide with other stationary pieces, crushing them into smaller fragments. Small blockages form and release to affect a general downstream movement of a mass of ice debris. This mass may eventually come to a halt after considerable crushing, abrasion, breaking and piling to form a jam such as that shown in Figure G-1. During this period of time the pack remains unconsolidated.

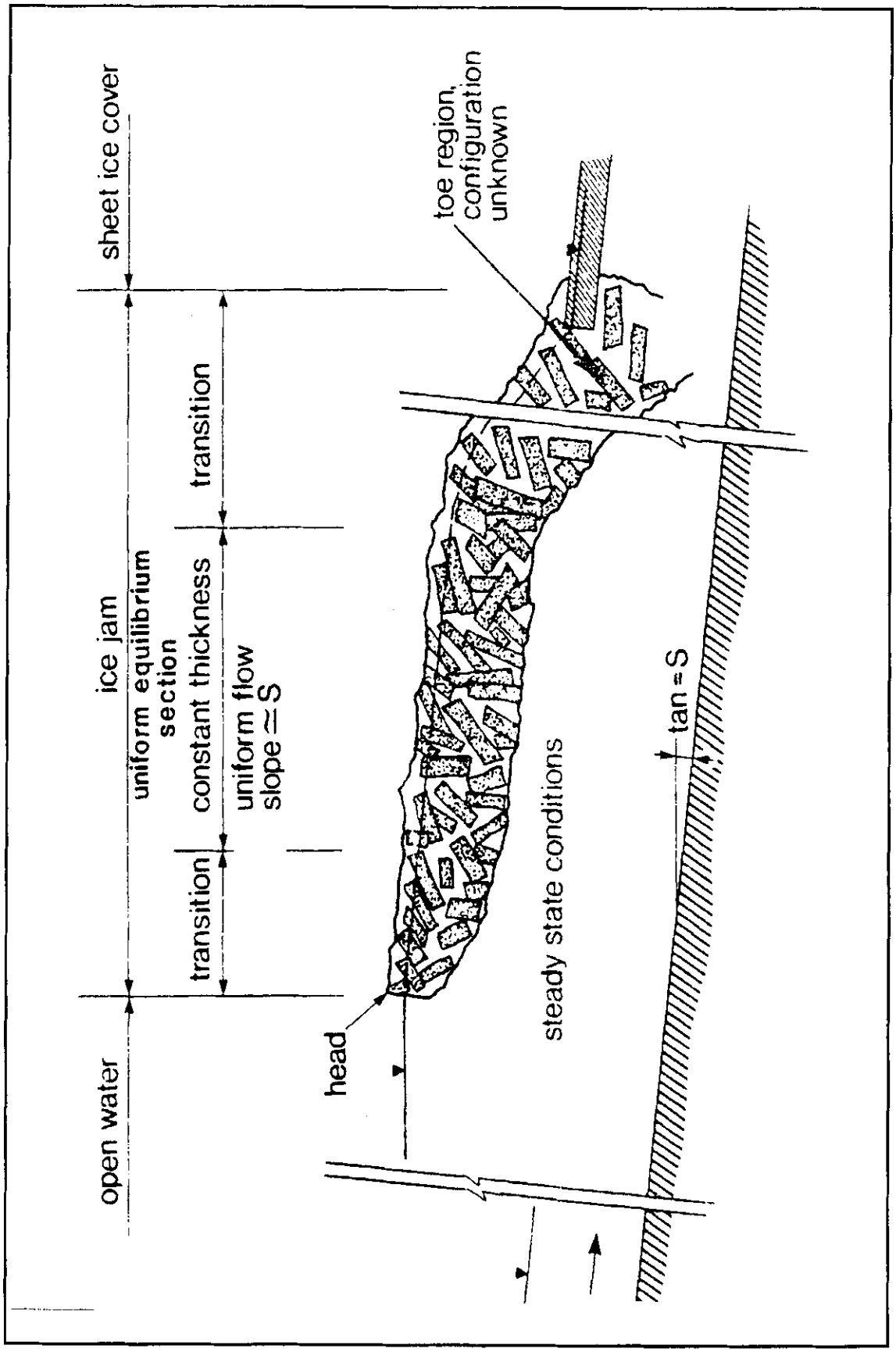
Some contact with the bed (grounding) is common for a short section near the toe of the jam. In a grounded or “dry” ice jam, this blockage extends to the bottom across the full width of the channel. The flow obstruction is almost complete and exceptionally high water levels can result with the majority of flow occurring in the flood plain. In a “floating” ice-jam, which seems to be the most common type of jam, it is not unusual for a short section near the toe to be grounded across part of the channel width. Save for this short section near the toe, however, the jam is floating and a relatively unobstructed flow path is maintained beneath its full length.

Barring significant grounding or surges resulting from ice jam re-formation, it has been shown that the highest flood stage which can be caused by floating ice jams occurs within the equilibrium section of the jam.

The upstream edge of a stationary ice sheet (shown in Figure G-1) is the most common site for the formation of break-up ice jams. In ice jam years, this sheet may be more resistant to movement because of bed or bank attachment or thickness, or simply unaffected by the wave of water released by the breakup of upstream jams. In non-jamming years, the cover may melt in place or be significantly weakened by thermal decay, or simply be carried away with the passage of water and ice from upstream. This simple break-up process without significant jamming is typical for the Province.

Although initiation of an ice jam commonly occurs at a stationary ice cover, other possible sites where the stationery ice exists include bends, narrows, islands, bridge piers, bars, and slope transitions. At any of these sites, the downstream movement of the break-up ice may stall and form an ice jam.

Figure G-1: Schematic Illustration of an Equilibrium Ice Jam



Reproduced from *"River Ice Jams: Theory, Case Studies, Applications"* S. Beltaos, 1983

2. ICE JAM COMPUTATIONS

Break-up ice jams between the transitions at the head and toe will attain a constant thickness (equilibrium thickness). Uniform flow will exist in this section, and the depth is the maximum depth that can be caused by a floating ice jam.

The forces acting on ice jams have been evaluated by a number of investigators to determine the equilibrium thickness. Based on this evaluation, two types of accumulation, termed "narrow" and "wide", have been identified in the literature.

In the "narrow" case, the internal stresses acting within the jam decrease in the downstream direction. No thickening by shoves takes place and the thickness is governed by hydrodynamic constraints at the head of the jam. This narrow condition is very unlikely in break-up ice jams but is common during the freeze-up process.

In the "wide" case, the final thickness of the ice-jam is governed by the flow shear stress and fragment strength considerations. The internal stresses increase in the downstream direction in response to upstream forces (e.g. shear on the bottom and cover weight component) and reach a maximum value equal to the compressive strength of the jam within a few river widths from the head of the jam.

The accumulation thickness of the floating ice jam at this location prevails throughout the equilibrium reach of the jam. As mentioned above, the depth is a maximum in this reach and the accumulation thickness is given by;

$$\mu\rho_i[1-s_i]gt^2 + 2Ct = B\,[\tau_i + P_i g t S_w]$$

where:

μ = internal frictional resistance coefficient

ρ = density of ice

s_i = Pi/P = specific gravity of ice 0.917 gm/cm^3

g = gravitational acceleration (9.8 m/sec^2)

t = ice-jam equilibrium thickness (m)

C = cohesion of the ice cover = 0 at breakup

τ_i = shear stress of water acting on the jam
$= \rho g R_i S_w$

S_w = slope of the water surface gradient (m/m)

R_i = hydraulic radius beneath the ice cover (m)

B = width of the equilibrium accumulation
(channel width at bottom accumulation)

A number of methods have been advanced to calculate the ice jam stage within the equilibrium reach of these "wide" channel jams. In general, it is assumed that:

1. The break-up ice jam is a floating, granular mass and is formed with no cohesion between the ice pieces.

2. Flow conditions are reasonably steady in the reach of interest.

3. The channel geometry can be adequately described by its average geometry (mean width, depth and roughness), and that flow depth and jam thickness do not vary across the equilibrium accumulation.

4. By-pass channels or low banks with wide flood plains are not present to interrupt stage increases by providing a form of relief through spillage.

The following analytical models are all based on the same "wide" channel assumption and governed equations. The only variation in the models is in the representation of channel roughness.

Beltaos - "Detailed" Approach

Beltaos describes both a detailed analysis and a simplified one which may be sufficient for many engineering calculations. To make clear the nature of the simplifications made in the latter approach, the detailed method will be described first.

In the detailed approach, the channel section is initially taken to be divided into upper and lower subsections, with flow in the upper section controlled by the average shear stress on the underside of the jam, and in the bottom sections by shear stress on the river bed.

The computation begins with an assumed value of break-up ice jam thickness and proceeds to evaluate the hydraulic radius for the ice-controlled section.

The roughness of the bottom of the jam is then computed using equations derived from the author's study of observed thickness and roughness measurements (employing caution in situations of large relative roughness). This roughness is combined with that of the bed to determine the hydraulic radius of the bed-controlled section (Rb) and the composite Darcy resistance coefficient (fo). The depth (h) beneath the jam is:

$$h = Ri + Rb$$

and the ice-jam stage (hj) is:

$$hj = h + 0.917t$$

The discharge for this condition is based on the bottom width of the ice accumulation (W) using:

$$Q = Wh([4/fo]\ ghS)^{1/2}$$

The procedure is repeated for several other values sufficient to define a curve of thickness vs. discharge, as shown in the example in Figure G-3.

The basic procedure assumes that the width of the accumulation W does not change with stage, but an iterative approach may be used to account for limited variations of W.

Beltaos "Simplified" Approach

The calculation of break-up ice jam stage may be conducted quickly by using this approach. In the simplified method, it is further assumed that the internal frictional resistance (() and ice jam resistance factors (Fo and Fi) do not vary from site to site.

The maximum possible depth for the stage of a floating ice jam at break-up is estimated from the dimensionless functions shown in Figure G-2. These functions are based on data from ice observations at a number of sites across the nation, including the Thames and Grand Rivers in Ontario. The upper graph plots the data and the bottom graph plots the monotonic function derived from the data.

The dimensionless depth and discharge are each based on the average bottom width of the ice accumulation, slope and unit discharge (B, So and q). The peak ice jam stage for a given discharge is computed by (a) calculating (, (b) finding a corresponding from Figure G-2, and (c) calculating the ice-effected depth from:

$$Hj = SoB$$

Through this analytical approach, an upper envelope of peak break-up stages (such as shown in Figure G-3) can be computed for a range of flows at a site which is assumed to be in the equilibrium portion of an ice jam. The upper envelope shown in Figure G-3 generally exceeds the observed stages as it should. Also shown on Figure G-3 are the results of a "detailed" modelling approach.

The detailed approach allows for more account to be taken of the variations in the parameters involved than does the simplified approach (e.g. channel width variations), but more assumptions are made to obtain this detail.

Overall, the "detailed" approach to determine the upper envelope of ice jam stage appears to provide a more reasonable approximation of observed stages than the "simplified" approach in the few example cases in which the two have been applied. In the simplified approach, however, the author notes that special constraints such as low flood plains and bypass channels must be determined from careful field inspections and used to modify the calculations along the lines used by Gerard and Calkins (see below).

Calkins

The ice jam equilibrium thickness equation has also been used by this author in an approach which is generally the same as Beltaos. However, a limiting discharge concept is included in his formulation for the main channel of rivers having significant overbank spillage into the flood plain. The maximum flow in the channel in these situations (and the maximum ice jam thickness) is defined as that which will raise the stage sufficiently to carry oncoming ice pieces into the floodway. At that point the channel ice jam will no longer thicken by shoves.

Not all flood plains provide complete flow relief of this sort, and oncoming ice may also be confined to the main channel without entering the flood plain. In addition, flow partitioning for the flood plain and channel may be necessary outside of the model to compute the final stage once overbank flooding occurs. Hence, it is a useful concept if applied with caution and supported by field reconnaissance evidence.

Figure G-2: Dimensionless Depth Versus Dimensionless Discharge: River Ice Jams in Equilibrium

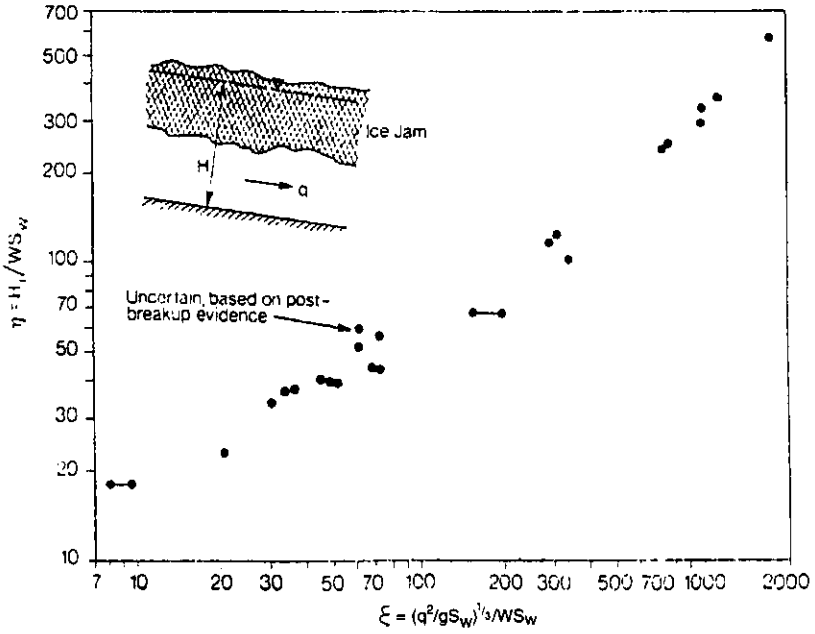


FIG (a) DIMENSIONLESS DEPTH vs. DIMENSIONLESS DISCHARGE FOR RIVER ICE JAMS IN EQUILIBRIUM (Data)

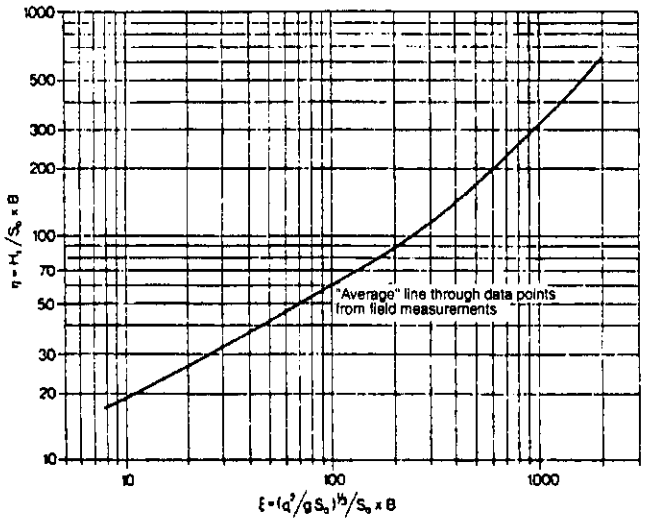
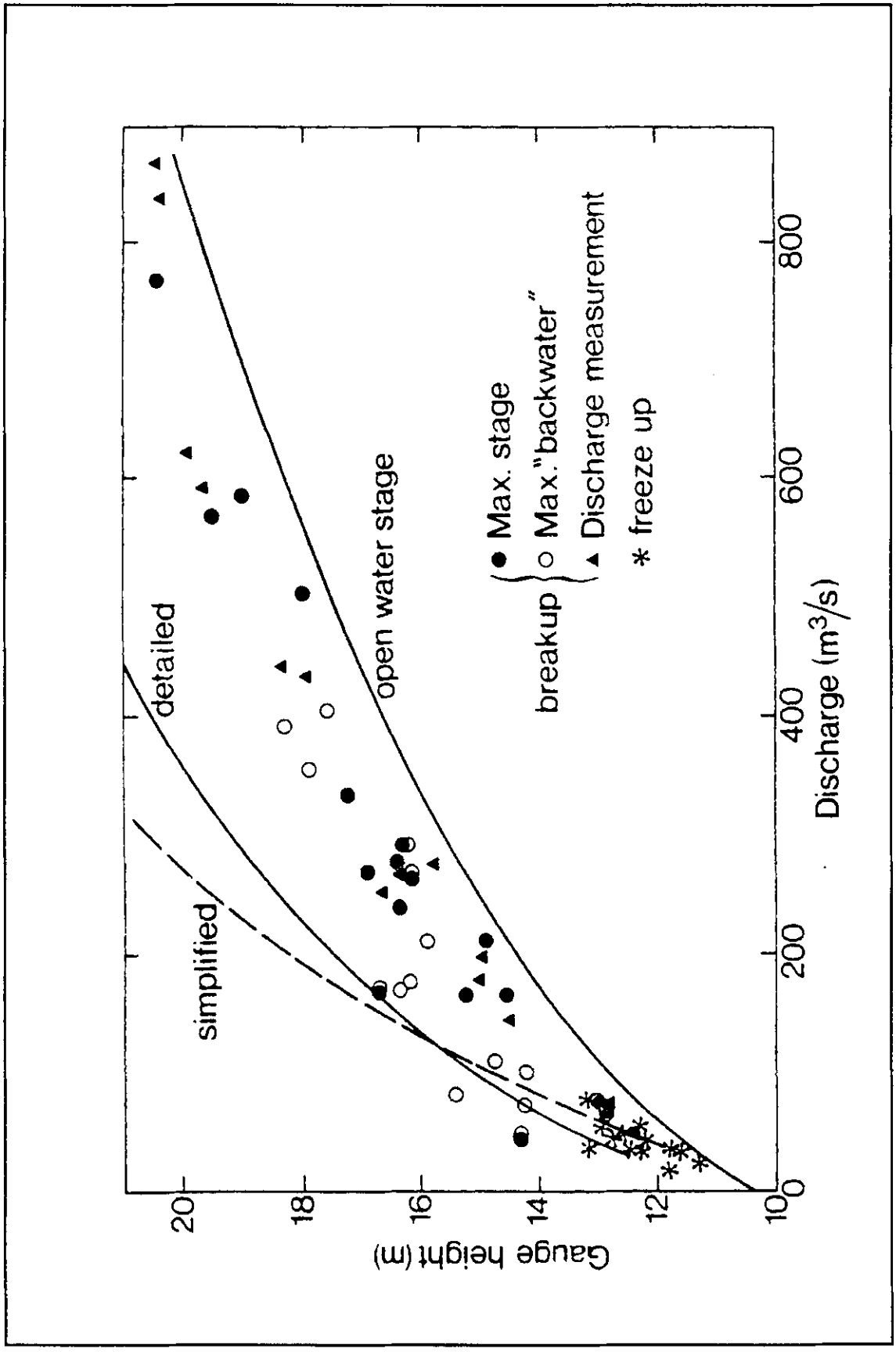


FIG.(b) DIMENSIONLESS WATER DEPTH DUE TO AN EQUILIBRIUM, FLOATING, WIDE CHANNEL JAM vs. DIMENSIONLESS DISCHARGE

Reproduced from *"Lecture Notes on Ice Jams"* S. Beltaos, 1984

Figure G-3: Freeze Up and Break Up Stages Versus Discharges; Thames River at Thamesville Ontario



Reproduced from *"River Ice Jams: Theory, Case Studies and Applications"* S. Beltaos, 1983

Gerard

The approach advanced by Gerard is similar to Beltaos "detailed" approach, except in the roughness formulation. In his approach, the absolute hydraulic roughness is employed in developing the depth of flow beneath the ice jam instead of friction factors or Manning's 'n'.

The approach is based on reach averaged geometry and culminates in a stage-discharge relationship. Trends for possible leakage spill to the flood plain must be evaluated outside of the model, and the author cautions that deep channels are required to obtain reasonable results when using this method for very rough ice covers.

HEC-2 (Ice Option)

The Hydrologic Engineering Centre has modified the HEC-2 backwater model to account for the presence of floating ice covers. Program modifications take into account the reduction in flow area, increased wetted perimeter and roughness caused by an ice cover. The program assumes steady state conditions, a stationary cover, and a floating cohesionless jam at break-up for computation of ice cover stability.

For determining ice jam water levels, the user must provide:

- ice thickness;
- Manning's roughness coefficient for the ice cover;
- specific gravity of the ice;
- the discharge; and
- information on the downstream control.

The ice thickness is assumed constant between each cross section and is estimated by the user. For equilibrium ice jam situations, it is appropriate to calculate the thickness for representative sections from the equation presented earlier in this chapter.

The ice cover roughness must also be stipulated by the user. Manning's 'n' values are reported in the literature to range from 0.01 to 0.04 for single layer ice sheets and from 0.05 to over 0.1 for ice jam situations. The range is quite broad but again can be specified for a given condition using other analytical means (e.g. Beltaos "Detailed").

Information on the downstream control or starting water level is also a critical input parameter for HEC-2. In an ice-jam situation, the downstream control is the blockage itself about which little is usually known. In cases where the control elevation is well defined (e.g. the crest of a dam) the process is relatively straightforward. In most cases, however, the starting water level must be generated by other analytical means.

Overall, the model requires the user to derive and input all of the ice parameters in an ice jam situation. Where downstream conditions, stage observations and ice thickness measurements are known or accurately estimated, the model appears to provide reasonable simulations of ice-effect profiles.

The HEC-2 ice option becomes extremely flexible in determining the stage when the flow discharge and ice jam thickness causes water to flow onto the flood plain. Using one of the techniques to determine reach averaged ice jam thickness at or near bankfull conditions, these thicknesses can then be used as input to HEC-2 to evaluate the conditions when flood plain flow occurs.

RIVJAM MODEL

A numerical model RIVJAM (Beltaos 1996) was developed at the National Water Research Institute as a tool for studying the configuration of ice jams and the water levels caused by river ice jams under a variety of conditions. The model computes longitudinal profiles of the ice jams in natural streams and the resultant water levels. Steady state conditions and one-dimensionality are assumed, which means that the flow and the jam configuration do not change with time; the jam thickness is assumed to be uniform across the river, though it may vary longitudinally.

RIVJAM solves two differential equations with two unknowns, jam thickness and water depth. The output of the model consists of the longitudinal variations of the jam thickness, flow depth and water level. The concept of flow through the voids of the jam is incorporated in the model. Past application of the model included determination of the safe height of a proposed bridge, comparison of different dyking schemes to alleviate ice-jam damages, assessment of the channelization, dredging and erection of ice retention structures, and changes to the regime of a river caused by climate changes and river regulation.

3. SUMMARY OF ICE JAM COMPUTATION METHODS

The following methods are suggested for consideration:

- Beltaos - "Simplified"
- Beltaos - "Detailed"
- Gerard
- Calkins
- HEC-2 Ice Option
- RIVJAM

The Beltaos "Simplified" approach provides the simplest method for quickly evaluating the range of possible ice-effect levels. One of the other detailed approaches, however, would appear more appropriate if studies continue beyond a simple, reconnaissance stage.

There are also a variety of limits which can be evaluated to estimate an upper bound on the maximum ice-effect stage. For example, in instances where wide flood plains provide considerable relief through "leakage", the approach of Calkins can be used for establishing maximum ice jam thickness and flow in the main channel.

The HEC-2 ice option is a useful tool when flood plain flows are significant for showing reach-wide ice effects but it requires important input parameters to be derived from other analytical models or surveys (i.e., ice jam thickness and a good reconnaissance survey to determine relief channels, etc.). Similarly, the RIVJAM can assist in the study of water levels during ice jam conditions, however, at the time of the writing this Guide the model was still under testing and the user's manual was only available in a draft form.

Overall, however, it must be noted that the above-described methods for determining ice jam flood stages have not been refined to the same extent as have models for open-water flood situations. There is still considerable ongoing discussion in the literature as to the merits of each modelling approach and, at present, no approach is clearly 'better' than another. There are still uncertainties and limitations to be resolved, and the assessment should always be based on careful analysis of historical information and detailed site inspection.

It is also worthy of note that the methods for estimating ice jam water levels have not been tested in a wide range of applications in Ontario, although evidence from other jurisdictions indicates that the simulation results can be reasonable. From the Ontario results, it can be shown that they can certainly be applied to establish upper bounds on the ice jam phenomenon, with correspondence with historical evidence resulting from site observations. Such observations may indicate the potential for some overbank spillage, and hence that the equilibrium depth cannot be reached at those sites.

In general, it is quite possible that many of the observed ice-effect stages at a site may not have been caused by ice jams in equilibrium. For example, the historical levels may have arisen from;

a) flood peaks from the break-up of an upstream jam (attenuated effects or surge effects);

b) the backwater from a distant downstream ice jam;

c) evolving ice jams which release before building to their maximum flood depth at equilibrium;

d) ice jams which cannot be sustained beyond a given flow rate (i.e. an ice clearing discharge discussed by Beltaos);

e) ice jams which result in spillage over dykes or banks into the flood plain; or

f) ice jams which have their development limited by a limited supply of ice from upstream.

These conditions and their effect on water levels can be taken into account by careful field inspection, data review and analysis, and by some of the analytical models outlined above.

The importance of accurate historical and field data from the area of interest cannot be overstated. The ice jam water levels are local phenomena which result from site-specific conditions (i.e., a constriction). Unlike hydrologic data which can often be transposed from site to site or generated by regional analyses, the ice jam flood level data at one site have been shown to be completely different at another site even on the same river, and are not amenable to such transposition.

4. STAGE-FREQUENCY OF ICE JAM FLOOD LEVELS

The frequency of ice jam flood levels can currently be estimated on the basis of historical information or by using analytical modelling procedures. The former may prove suitable where there is a long record of reliable ice stage estimates and the latter where there are few. Wherever possible, historical data should be used to check the results of analytically based approaches and vice versa for the historical approaches.

4.1 Historically Based Estimates

A number of historical flood level observations will usually be found in the review of historical data at sites which have experienced ice jam flooding. The most recent flood will likely be reasonably well documented, as will those floods which occurred in the last five to ten years. There will be substantially less information on lesser floods or those occurring in the more distant past, but in view of the local nature of ice jam floods and the general paucity of data, it is important to include these events as well.

An approach which makes full use of all the historical observations in a probability analysis for ice jam flooding has been developed by Gerard and Karpuk. The methodology is as follows:

1. Draw together a complete history of ice jam flood stages from all possible sources (i.e., surveys, environmental evidence, interviews, etc.) and relate them to a reference stage, such as the zero discharge stage.

2. Examine topographic mapping, field surveys, air photography, etc. to identify the exact site to which the data applies and features of the area which could affect ice jam flood levels (i.e., relief channels).

3. Establish a perception stage for each data source. This is the stage below which each source of data would not likely have provided information on the maximum ice related stage, (for example, this could be close to bank-full stage for local residents, or be the minimum gauge reading which could be recorded by hydrometric instruments).

4. Organize the information to display the stages identified from each source and their perception stages.

5. Establish a record length, rank and confidence limit associated with each flood stage. A summary diagram which gives the lowest perception stage for each year of record to be used in the analysis can assist in this evaluation. The record length is the sum of all years having perception levels which do not exceed the given flood level. The rank of each flood level is determined by comparing that level to others in the group with a perception stage equal to or lower than the peak itself.

This process may give the same rank for several peaks and different record lengths for different peaks.

6. Determine the cumulative probability for the maximum break-up stages, employing a plotting position formula and fitting a cumulative distribution curve to the data. This fitted curve may follow one of the standard statistical distributions, but more likely than not, it won't. This is because the ice-related stages are likely to be near the upper bound of possible flood levels from ice jamming and are quite likely limited to a maximum stage by physical constraints at the site (i.e., flood plain spill, diversion).

An example of this method is shown on Figure G-4, which indicates that this approach leads directly to a probability distribution of ice jam flood stages without a requirement to simulate ice jam configurations, flood levels or winter flows. This would be an advantage at sites where severe grounding or aufeis accumulations have been identified as the cause of flooding problems. It requires that a reasonable number of years of observed levels be available at a floodprone site and that the ice regime has been reasonably stationary in the past, as the ice regime will change if there has been a significant change in the flow regime. Given that these constraints are met, it provides a probability distribution which is consistent with other approaches for estimating ice stage frequency.

This approach requires the modeller to conduct a very careful examination of ice jam flood stages and the flood prone area. It cannot be completed without on-site investigation and interviews - both of which provide necessary insight and valuable supporting details which might otherwise be missed in a "desk-top" study.

The same methodology applies to sites which have a long record of gauged water levels through the break-up period. At such sites, it may be possible to replace significant portions of the more qualitative information derived from other sources with the gauged data, or employ the monitored information to validate perception stage information. Overall, such records may reduce the data acquisition phase, but, as mentioned above, should not replace the essential requirement for the modeller to evaluate the physical characteristics of the site and their implications on ice-effect stages.

4.2 Deterministic Estimates

Certain rivers and streams in Ontario have been or will be significantly modified by channelization, dyking, reservoir construction or ice retention works. As a result, the ice regime will not be statistically stationary and deterministic estimates rather than historically based ones will be required to estimate ice jam stages. Such estimates may also be desirable to augment the historical base, or to provide a second estimate of design levels.

The analytical models described in the previous pages provide ice jam stage estimates as a function of streamflow. This flow data (unlike ice stage data) can be transposed to ice jam sites

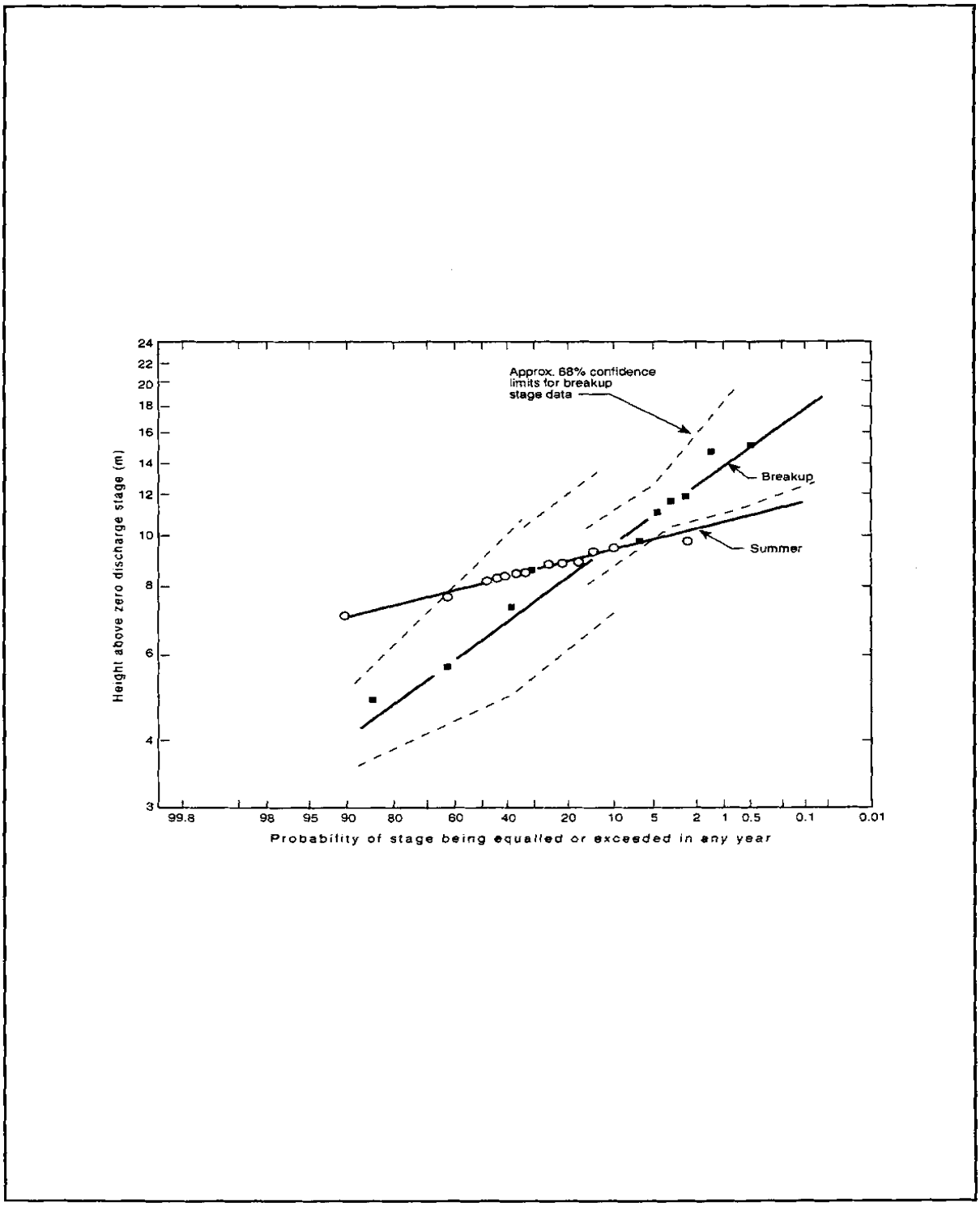
from non-jam areas and can be used to develop a probability distribution of ice jam stage.

The methodology for conducting this work has been outlined by several authors, most notable Gerard and Calkins. The procedure can be used with one or more of the analytical models outlined earlier and is as follows:

1. Develop stage discharge curves for ice-effected conditions. This includes the stage effect of a solid ice cover (a lower bound on ice stage) and open water conditions, as well as the equilibrium ice jam stage (an upper bound on ice stage) calculated by using the analytical approaches described previously.

2. Evaluate stage and discharge limits associated with each ice cover condition and incorporate the results in the stage-discharge curves taking into account the following notes:

Figure G-4: Probability Distribution of Annual Maximum Ice - Effect Stage and Open Water Stage



Reproduced from *"Probability Analysis of Historical Flood Data"* R. Gerard and E.W. Karpuk

- in river reaches with wide flood plains, environmental evidence (i.e., ice abrasion scars), as well as analytical estimates (Calkins), will indicate an approximate upper limit defined by leakage or overflow;

- if information is available from gauge or other records, site observations or local observers, an estimate of the range of stages or discharges associated with the solid ice cover prior to the break-up ice run should be made; and

- the volume of ice required to develop an ice jam of sufficient length and thickness may also limit the stage (Calkins).

3. Derive an estimate of the maximum streamflow (observed, transposed or simulated) at the site during ice-effected periods for an extended number of years.

4. For the limited number of years for which historical ice stage data is available, derive stages from the synthetic rating curves and compare the observed stages to the synthesized stages and adjust the synthesized curve (or establish a compromise) if necessary. The degree of compromise should be based on the quality of the historical data.

5. For each year, determine the maximum solid ice cover stage (from the stage-discharge curve for solid ice conditions) using the maximum ice-effect flow estimate. Similarly, determine the maximum ice jam stage (from the ice jam stage-discharge curve) using the maximum flow during the break-up period.

6. Rank the stage for each of these two sequences for the period of study and determine the cumulative probability distribution for each sequence.

   For discharges greater than the estimated breakup/ice-run discharge, the ice jam stage distribution will be an upper bound on the true ice-related stage distribution in that it assumes the site is affected by an equilibrium jam each year. The solid ice stage provides a lower bound in that it assumes no jams form each year. If, for example, the peak discharge in a year is less than the breakup/ice-run discharge then there will only be a solid ice cover stage assigned to that year. This assumes it to have been a year in which the ice effectively melted in place.

7. Estimate the frequency of ice jam formation in the vicinity of the site from available historical information, and use this to deduce a final compromise probability distribution between the upper and lower bounds described above using the relation:

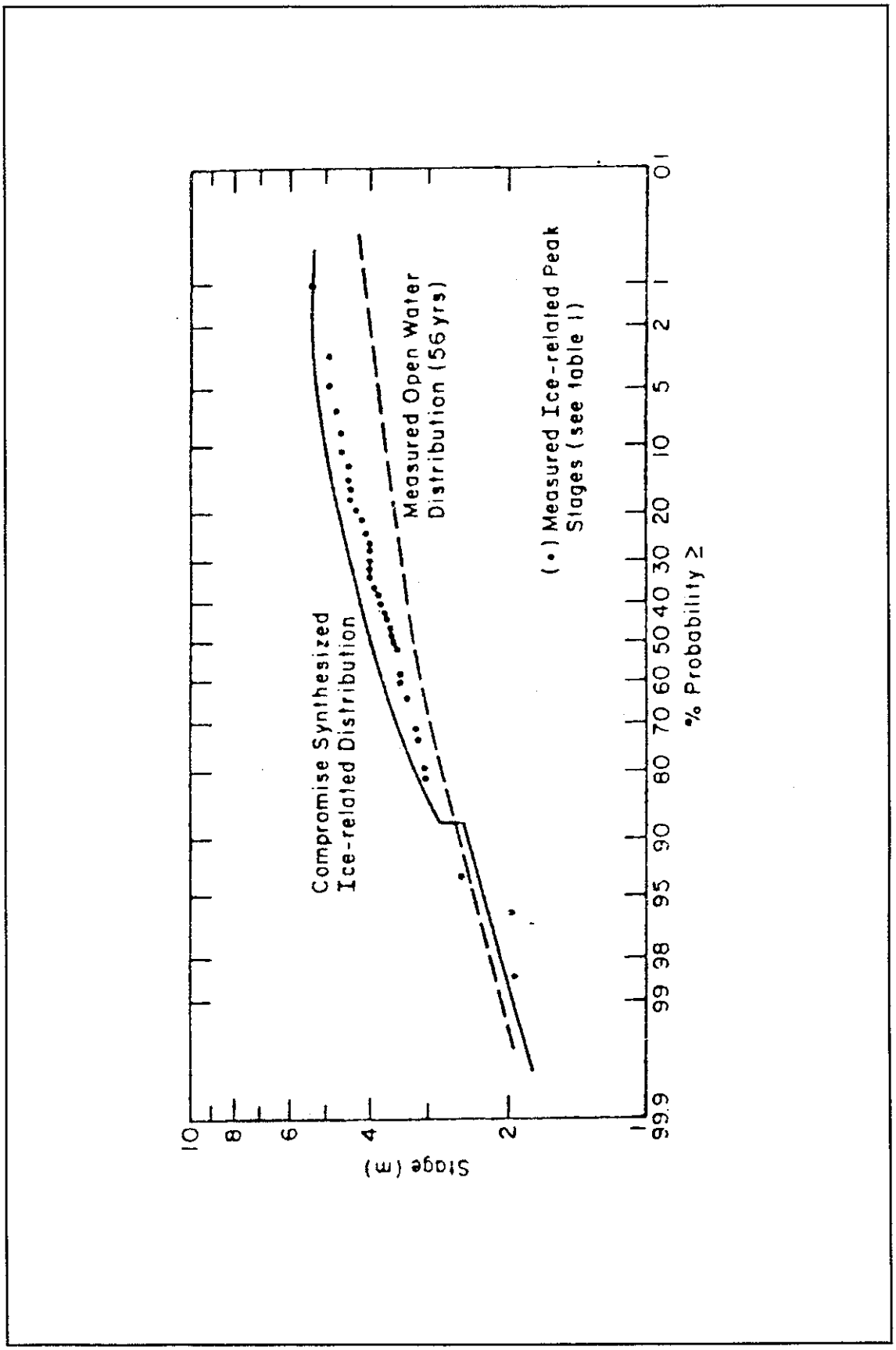
$$P = Pj + Pc$$

where 'P' is the probability of a stage being equalled or exceeded by ice effects, 'Pj' is the probability of a stage being equalled or exceeded by an ice jam, and 'Pc' is the probability of the stage being exceeded by a solid ice cover stage.

The final product of this work will be a stage probability distribution such as shown by the solid curve in Figure G-5. Also shown in the Figure, are actual ice-related stages measured at the site during 37 ice jam events in the 58 years of record. The agreement is quite good and demonstrates that this analytically-based deterministic approach can be used with some confidence.

As in the historical approach, this technique requires the modeller to evaluate the physical characteristics of the site (and their implications on ice-effect stages) and draw together important information from interviews and environmental evidence at the site.

Figure G-5: Comparison of Synthesized and Measured Ice - Related Stage Probability Distributions



Reproduced from *"Ice Related Flood Frequency Analysis"* R. Gerard and D.J. Calkins, 1984

4.3 Annual Flood Stage Probability Distribution

The overall annual stage probability distribution is required for delineating the extent of flood plains in the Province, for estimating average annual flood damages or for determining the location/elevation of structures to be located outside the frequent effects of high water levels.

If the interest is simply in design stages such as the above, the open-water and ice-related stage-frequency distributions can be directly combined as with other mixed populations. As the two distributions are reasonably independent:

$$P_A = P_I + P_O - P_I P_O$$

Where:

P_A = the probability that a flood stage will be equalled or exceeded by either ice-related flooding or open-water flooding

P_I = the probability of the ice-related flood exceeding the given stage

P_O = the probability of open-water floods exceeding that stage

An alternative to combining the separate distributions to derive an annual curve is to choose the peak stage (ice-related or open-water) for each year for which information is available for both. The annual distribution can then be plotted directly. However, for years without both open water and ice-related data, useful information from a limited database is wasted.

If the evaluation also involves assessment of flood damages which differ significantly between open-water seasons and ice seasons, it is important that damage probability curves be developed from each stage distribution and then combined as above to determine the annual damage probability curve.

5. PROCEDURE FOR ESTIMATING THE FREQUENCY OF ICE-EFFECT STAGES

Figure G-6 presents a summary flow chart of the general procedure for estimating the frequency of break-up ice jam stages.

The first decision in the procedure follows a preliminary field reconnaissance and data review, and is based on historical flooding at the site of interest. If none of the past flooding is a result of ice jams, then ice-related levels need not be considered. If ice jamming has caused high levels, the following steps are required.

Collection of relevant data is one of the most important elements in the evaluation of ice-related stages. The type of information required/available from the site is important and this key research is best undertaken by the engineer who will eventually complete any subsequent modelling or estimating of stage-probability relationships.

Detailed river geometry is as important in the ice analyses as it is in open-water flood assessments. Information from on-site investigations may suggest that surveys be extended to higher elevations than for open water cases, for example, or include surveys of high level diversions. If such cross section data are not available, additional field surveys may be needed (or proposed surveys for open-water studies may require some extension). An ice reconnaissance survey is appropriate as well.

Once the field data is assembled, reviewed and prepared in a reference report, the frequency of significant ice jams at the site can be estimated for subsequent use. This work is followed by several decision steps to determine which approach may or may not be used for estimating the frequency of ice jam levels.

If there is a long history of ice-jam flood stage observations and the ice regime has been statistically stationary during the period of these observations (and will remain so for the foreseeable future), it is possible to go directly to the Historically Based approach for estimating the frequency of ice-jam stages (Gerard and Karpuk). If these qualifications are not met, an analytical procedure leading to a Deterministic Approach is required. This latter approach may also be used for stationary regimes with a long history of data (as shown on the flow chart by an optional arrow) to derive the best compromise estimates for upper and lower bounds on ice stage.

The study may only require a preliminary estimate of the ice jam stage-probability relationship. If there is some reliable data and the ice/river regime is statistically stationary, then the Historically Based approach may be used for this estimate.

The Deterministic Approach is used where there is limited ice-stage data or the river regime is statistically non-stationary (or will be in the near future). The analytical modelling procedures involved require measured or synthetically derived discharge data for the ice-related period, and it may be convenient to begin to assemble or generate the data at this point. The next step is to develop ice-related stage discharge curves and determine the best approach to this work. An evaluation

providing very rapid development of ice-stage relationships for the site may be adequate. If so, the Beltaos "Simplified" method is appropriate.

If a detailed evaluation is deemed necessary (to account for channel width variations, for example) the Beltaos "Detailed" or similar detailed approaches would be appropriate.

At this juncture, the above developed relationships must be adjusted on the basis of field evidence and historical data (which may indicate flood plain spillage, diversion flow, or other influences setting physical limits on the stage reached by ice-related flooding).

The adjusted stage discharge relationships are converted into frequency relationships using the discharge data assembled earlier; these are then converted into probabilistic relationships using the estimated frequency of significant ice jams developed from historical data or societal sources.

Overall, these procedures give a deterministic estimate of the ice jam stage-probability distribution paralleling that of the Historically Based approach. These relationships may then be combined with open-water flood stage probability to determine an annual probability distribution of peak stage, or used in separate flood damage analyses if seasonal flood damages are significantly different. Alternatively, an ice-related design flood level may be taken directly from the ice-related stage probability relationship.

In relative terms, the inclusion of an ice-related analysis with an open-water assessment will require a greater level of effort than an open-water assessment alone. A portion of this additional effort is taken up by the key requirement for collection and detailed study of environmental/societal ice data from the site. The remainder is taken up by the analysis approach. The Historically Based approach is the most rapid because the analytical modelling procedures of the Deterministic approach are not required. Similarly, the 'Simplified" analytical method by Beltaos requires less effort than the "Detailed" approaches to develop a basic stage-discharge relationship for the site.

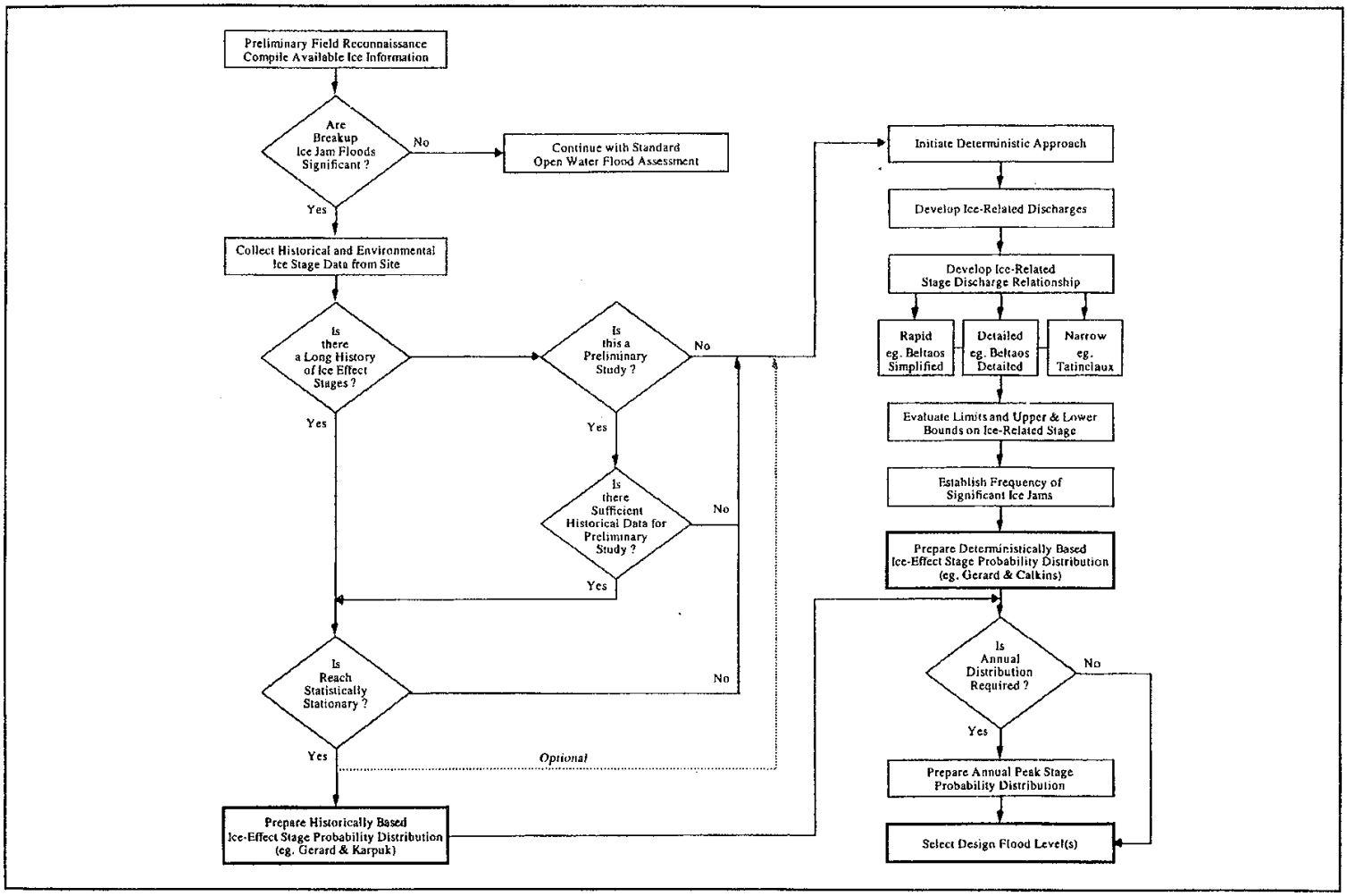


Figure G-6: Procedure for Estimating the Frequency of Breakup Ice Jam Stages

6. DATA COLLECTION FOR ICE-EFFECT LEVELS

Field observations and historical information on ice-related floods are required for forecasting potential ice problems, completing ice management studies, modelling ice processes and conducting stage frequency analysis of ice related flood levels. Some of the data needs for the latter are collected as standard procedure for open-water flood assessments, but many of the data needs for ice studies are additional to current requirements.

River Geometry

Cross sections and profiles required for open-water analyses are also one of the key requirements for assessing factors which control ice levels. For ice studies, physical survey requirements include:

- sufficient cross sections to adequately describe the reach averaged geometry and any atypical features - all tied to a reference datum. A reach length in the range of 20 times the width may be sufficient to adequately define the geometry;
- bed and water level profiles extending upstream and downstream of the site - particularly if ice jams in these areas are the cause of problems at the site; and
- identification of overbank spill areas or diversions, or obstructions to such diversions in the likely ice jam reach.

Detailed GIS topographic mapping is a definite asset, particularly if there is a possibility of spills or diversions around the ice jam site. With the extensive use of GIS, many software packages have effective tools for calculating where water will go when an ice jam is introduced. As ice jam stages may be several metres above even the 100-year open-water level, it is worthwhile including these high levels in establishing the vertical limits of the field survey program.

Historical Flood Level Data

As ice jams are reach specific phenomena, historical flood level information is needed from the specific reach under study. This data may be obtained from environmental evidence or other sources. Information from the latter includes recorded data in:

- diaries, logs, letters, journals, local and regional records, archives, conservation reports, and previous studies;
- photograph albums, television news records, video coverage;
- aerial and LANDSAT imagery; and
- stream gauge records (staff, crest or flow) and Water Survey of Canada ice condition notes.

Valuable data also resides with streamside residents, public works officials and government agencies. From interviews with these observers important data can be derived on:

- ice jam locations;
- ice-related flood levels and extent;
- dates, frequency and the relative timing or sequence of events during ice-related floods;
- velocity, depth, ice thickness and dimensions;
- antecedent and post-jamming conditions upstream and downstream;
- water level stages perceived to be indicative of developing problems.

The location and effect of ice jamming may vary from location to location within even a short study reach and hence it is useful to interview a number of people within the study area. Information provided by each should be carefully screened to ensure that flood levels described by each can be identified with a specific location.

Environmental evidence of historical ice-effect flood levels is given by:

- ice scars or abrasion marks (on trees, structures, drainage outlets), or by large scale vegetation damage;
- disturbed bank material or ridges caused by ice push.

Scars on trees may be dated by tree ring analysis to provide the year as well as the elevation of the flood, and the profile of ice scar levels derived along the study reach gives substantial information for use in analytical projections.

Ice Monitoring

Ice observations at freeze-up, break-up and mid-winter provide valuable insight into the processes that may shape the break-up regime during ice jam years. In most years, such observation will not coincide with significant ice jam flooding since such floods are generally infrequent. Nevertheless, establishing a regular program will assist in interpreting cause-effect relationships in ice jam years and provide an understanding of ice processes in the reach and quantitative stage data for use in stage frequency analysis.

The level of effort involved in an annual monitoring program will depend on the site, the nature and significance of the ice problem, the frequency of significant floods and budget constraints. At a minimum, field observation which will be useful for projecting ice-related stages should be taken over a long reach upstream and downstream of the site of interest and should include:

- stage measurements at freeze-up and break-up;
- freeze-up and break-up dates;
- descriptive observations at break-up (sequences, jam locations, thickness and strength);
- photographic record of ice conditions (surface texture, anomalies).

At some sites, the general understanding of ice processes might be aided by:

- periodic stage measurements from freeze-up to post break-up;
- periodic ice thickness and thickness cross section surveys;
- records of open water areas, leads;
- stage-discharge measurements; and
- additional photographic surveys.

Also, it may be advantageous at some locations to:

- install new level gauges; and
- establish bench marks to assist in level monitoring in ice jam years.

If ice jamming does occur, as much quantitative work as can be conducted with the manpower resources at hand will be invaluable for later study. Particular focal points are;

- water surface profile along the jam;
- nature of the ice comprising the jam;
- location of the ice jam (toe) affecting the site and cause of the jam;
- evolution of the ice jam;
- flow estimates (channel, overbanks, in diversions);
- complete photographic coverage (from ground and air);
- time record of observations; location of upstream or downstream jams; and
- reconstruction of break-up sequence that led to the jam.

Post-jam observations and data collection can also provide highly valuable information:

- associated meteorological conditions;
- floe thickness along river banks, ice strength (qualitative);
- shear wall thickness, location, elevation; and
- high water mark elevations along the jam.

The final and most important result of this work is a summary document drawing all the observations together. It has proven most beneficial to prepare such a report immediately after the observations are completed, so that recent recollections can be recorded while they are still fresh in the observers mind.

7. CONCLUSIONS

It is evident from the above discussions that a substantial commitment is required to develop ice-related frequency distributions which can be employed with reasonable confidence. The approaches require:

- detailed site reconnaissance;
- collection of historical and environmental data; and
- careful evaluation of ice data.

Although some of this work is an additional requirement, much of it can be efficiently combined with that which is undertaken for more standard open-water flood studies.

At sites which lack a reasonably long term history of ice observation, or for which changes have or will be made to the stream and/or streamflow, it will be necessary to:

- generate peak winter streamflow data; and
- prepare ice-related stage-discharge curves.

Given that only limited experience has been gained in such assessments in Ontario, and that the ice-related site information and modelling approaches are not yet as refined as for open-water cases, it will likely be several years before this process is as streamlined as today's open water assessments. However, since techniques for assessing ice jam flood levels are available and are well documented, and ice-related flooding is significant in many rivers in the Province, it should not be long before these techniques are put to good use by consultants and regulatory agencies alike.

1. TECHNICAL REPORT

An important step towards meeting the goals of flood plain management is the completion of flood plain studies, which will provide communities and approval agencies with the necessary data base of clearly presented technical information. The following description summarizes the technical information required by approving agencies. Technical staff involved in the review process may periodically need advice on modelling or statistical analysis. Such expertise may be available with private consultants and academics.

Upon completion of the hydrologic and hydraulic investigations, and prior to the compilation of the flood risk maps, a draft technical report will be submitted to the Flood Plain Study Technical Review Committee. The report should present the studies in sufficient detail that specialists in this field can determine the adequacy of the work and its conformance to the procedures outlined in this document. A review of the draft report will be undertaken at this stage and then, subject to the acceptance of the work described in it, the flood risk maps will be compiled. The technical report is not intended for wide distribution; a brochure summarizing the significant points will be prepared and made available to the public.

The draft submission should include the following material:

1.0 Introduction

Include a brief statement on the purpose of the study and a summary of past flooding problems. Any past flood plain studies and mapping should also be briefly referenced.

2.0 Study Area

Describe study scope and identify study limits on small scale maps. Communities affected and any existing structural and non-structural flood protection and emergency measures should be presented. List future land use plans, and any proposed flood control or prevention measures.

Describe the area to be mapped, the watercourse and its tributaries, watershed characteristics, climatic conditions and flood-generating mechanism.

3.0 Hydrological Analyses

Flood Standard

Describe the flood standard to be used for rivers and lakes, and any past recorded flood events within or in adjacent watersheds. If a Two Zone or Special Policy Area scenario is considered as an alternative to the one zone concept, provide detailed description of the alternative and any limitation on the increase in water levels.

Data

All the data used in the investigation, whether measured or estimated, should be fully described.

The source of the data should be given and background information must be provided for any assumed values to enable an assessment of their validity. Tables, maps and graphs should be used to illustrate data such as streamflow records, historical storms, stage-discharge relationships, cross-sections, and surveyed profiles. Reproductions of relevant aerial photographs should also be presented.

Flood Computations - Flood Frequency Analysis

Describe streamflow and rainfall groups and records. Information relevant to the conversion of regulated streamflows to natural conditions and the stationary nature of the data series should be fully described. If the effects are not sufficiently large to warrant adjustments to the data, this should be explained with quantitative estimates of their significance at the point in question.

For a single station frequency analysis, the data used should be shown and the choice of probability distribution and method of parameter estimation explained. Frequency curves with plotted data points and computed confidence limits are essential. When the flood standard is based on the 100-year flood, the expected probability adjustment should be shown as well. If an historical flood is included in the analysis, the techniques used must be explained and the effects of its inclusion on the frequency curve and the variance of the estimate should be shown. Should a joint probability analysis be required, all relevant information including basic assumptions should be described.

For a regional flood frequency analysis, the extent of the region and streams included must be described along with the records used at each station. The single station analysis should be covered as above and, depending on the method of regionalization used, homogeneity tests, variables used in multiple variable regression analysis and their statistical significance, regression equations, correlation coefficients, and standard errors of estimate must be described.

Should a transfer of location of the estimated flood be required, the method and the underlying assumptions must be explained. Reconversion of natural flood estimates to regulated conditions should be described when appropriate along with an explanation of the operating procedures assumed and the basis for the assumptions.

Flood Computations - Rainfall/Runoff Modelling

The input in this case must be fully documented and any storm transposition and change in orientation explained. A brief description of the hydrologic model employed must be included, outlining the basic methodology and assumptions, and the history of its previous use. The data required to operate the model, both measured and estimated, should be shown with a background explanation for the estimated values.

Calibration and Validation

Describe the method of calibration and validation, the events used, and errors. Compare computed flows with flows obtained from other analyses, such as the MTO, Regional Frequency or for small areas, the Rational Method.

Presentation of Flows

Present flows in tabular form for different events and locations. Compare results with previous estimates and recorded events.

4.0 Hydraulic Analyses

Describe topography of the flood plain and the methods used for taking cross-sections. Provide a summary of structures, dimensions and photos. For the river system describe the roughness coefficients and starting water levels used.

Describe river crossings with significant storage effects.

Extrapolation of stage-discharge curves should be shown with an explanation of the methods employed. A description of the backwater program should include a brief explanation of each aspect of its operation that is significant to the particular stream. It should be clear which coefficients were estimated and which were obtained by direct or indirect measurement. Plots of all cross-sections must be shown, as well as water surface profiles for the entire reach for each of the flood events considered.

If the floodway is delineated, the specified increase in the water levels should be explained and the limits of the floodway shown on the cross-section plots. The water surface profile computed for the floodway condition must also be included. In cases where ice or log jams are taken into account, a complete description of the techniques used should be given.

For lakes wind setup and wave estimates should be presented.

A summary of the backwater computation should be provided, listing water levels for different flows and locations. Previous backwater analyses and observed past flood levels should be incorporated in the summary.

Calibrate the backwater model, or in absence of historical observed flood observations, undertake a sensitivity analysis to test the changes in water levels caused by changes in roughness coefficients.

Spill areas should be identified and the effect of spill should be commented on.

5.0 Flood Line Delineation

Describe mapping used, date of aerial photos, scale, contour intervals, accuracy and checking. Explain the method used to plot flood lines. Where the study included the floodway and flood fringe zones, describe each and the effect of encroachment on the flood plain. Similarly, describe the effect of dykes or dams on the flood lines.

6.0 Other Studies

Should special cases arise that necessitate the use of procedures outside the scope of this document, a complete description of the techniques used must be given. It should not be necessary for the reviewer to search through a list of references to fully understand the investigation; the report should stand as a self-explanatory document to personnel who are experienced in this field of study.

7.0 References

8.0 Exhibits

- location maps to identify study area;
- land use and soil maps;
- identification of historically flooded areas;
- identification of location of major structures, bridge data sheets;
- historical photos, if available;
- tables and hydrographs to provide summary of discharges, elevations and mean velocities with a cross section reference;
- flood frequency curves;
- where the two zone application was used, computed width, depth and velocities across the flood fringe areas at both sides of the section; and
- computer plot of flood profile.

9.0 Appendices

Input data and output summary should be presented in Appendices.

I. IMPLEMENTATION OF FLOOD PLAIN POLICIES AND MAPPING

The different agencies and their roles and mandates are summarized below.

The position of the Province is that all public agencies exercising their planning authority shall have regard for the Provincial Policy Statement issued under Section 3 of the Planning Act as amended by Bill 20. Those policy statements address matters of Provincial interests including flooding and erosion hazards.

To assist public agencies in fulfilling this agreement, the Province identified the Ministry of Natural Resources to develop a technical guide for the calculation and mapping of flood and erosion limits of hazard lands.

As lead ministry responsible for administration of the provincial flood plain management program, the Ministry of Natural Resources is responsible for providing technical support for the implementation of the policy. This includes the responsibility for the development of a Technical Guide to provide direction on the definition of flood and erosion standards.

The Conservation Authorities or the Ministry of Natural Resources, where Conservation Authorities do not exist, will refer to the applicable flood plain mapping (approved under the Canada/Ontario Flood Damage reduction Program or successors thereto), for assistance and direction related to the implementation of the flood plain policies in the Provincial Policy Statement.

The Conservation Authorities will administer the provisions of the Conservation Authorities Act R.S.O 1990, and Fill, Construction and Alteration to Waterways regulations passed pursuant to Section 28(1) of the Act, or successors thereto, to assist in the implementation of this policy statement.

The Ministry of Natural Resources will administer the provision of the Lakes and Rivers Improvement Act, R.S.O, 1990, the Public Lands Act, R.S.O. 1990 and the Federal Fisheries Act or successors thereto, to assist in the implementation of this policy statement.

The Ministry of Natural Resources, in conjunction with Environment Canada will continue to administer the remainder of the Canada-Ontario Flood Damage Reduction Program through the Conservation Authorities and the municipalities. This includes the pursuance of flood and erosion hazard mapping and studies, and the preparation of information maps generated to the general public depicting flood and erosion susceptible lands. Once the program is completed, the Ministry of Natural Resources and Conservation Authorities will provide administrative and advisory roles to municipalities undertaking flood plain mapping studies.

Flood plain mapping

The flood standards to be used for delineating flood plains are described in the Provincial Policy Statement, (see Chapter B).

Methodologies for carrying out the hydrologic and hydraulic calculations and the preparing of base mapping for a flood plain analysis are outlined in this Technical Guide.

The flood plain mapping document will require approval from the local municipality and from the Conservation Authority, or where no Conservation Authorities exist, from the Ministry of Natural Resources.

Municipal Plan input and review

The Ministry of Natural Resources through the Ministry of Municipal Affairs and Housing, in cooperation with the Conservation Authorities, will administer the Natural Hazards Policies in the Provincial Policy Statement, as well advise and explain its content and application to municipalities.

The Ministry of Municipal Affairs and Housing and municipalities with delegated approval from the Minister will ensure that municipal planning documents subject to their review will have regard to the Natural Hazards Policies.

Municipalities, with input from Conservation Authorities, or the Ministry of Natural Resources where no Conservation Authorities exist, will put in place planning controls necessary to implement the Natural Hazards Policies in Official Plans.

The Conservation Authorities, or the Ministry of Natural Resources where no Conservation Authorities exist, are responsible for plan review related to natural hazard management. In this regard they will:

- Make available any existing mapping, flood and erosion data and studies and provide technical assistance to any government body or planning authority, in particular municipalities and planning boards, and assist municipalities and planning boards to incorporate the intent of the Policy Statement for the management of hazard lands susceptible to flood, erosion and other water related hazards into land use planning process and appropriate planning documents.

- Provide comments to approval agencies on proposed planning actions that may have implications for the management of hazards lands susceptible to flood or erosion and other water related hazards.

- Make representations or provide technical expertise to the Ontario Municipal Board or other appeal bodies, where a matter related to the Policy Statement may be an issue.

- Consult with ministries, public agencies, boards, authorities and municipalities on matters pertaining to the management of lands susceptible to flood, erosion or other water related hazards as may be appropriate.

- Inform and educate the general public on the principles and practices of flood and erosion hazard lands and provide information on the characteristics and consequences of flood, erosion and other water related hazards in flood plains.

The Ministry of Natural Resources in co-operation with the Ministry of Municipal Affairs and Housing will undertake periodic research programs to investigate and update planning implementation and natural hazard management techniques. The same Ministries, in cooperation with Conservation Authorities, will administer the flooding and erosion hazard policies, as well as advise and explain its contents and application to municipalities, planning boards, and other agencies.

The intent of the Natural Hazards Policies should be reflected in a municipality's Official Plan. Flooding and erosion are naturally occurring processes influenced by local watershed conditions. When addressing these physical processes from an ecosystem perspective, the local physical and ecological processes may need to be retained in an undisturbed state to the greatest extent possible, and possibly enhanced to sustain the overall health of the watershed ecosystem.

The order of preference in addressing the natural hazard concerns are prevention, protection and emergency measures. Frequently, a combination of the options will provide the most effective solutions to address the public safety and health issues. Effective hazard management can only occur on a comprehensive watershed basis. Therefore, site specific development activities should be evaluated on an overall watershed or jurisdictional base.

There is continuing research work being undertaken on the effect of developments on our ecological systems. Once a new approach has been field tested and proven to be effective in reducing or eliminating adverse effects on our environment and it is shown to provide a cost effective solution, the information will be disseminated by MNR and MOEE to all involved in land use planning, design and approval of developments and watershed management.

Benefits of flood plain and natural hazard policies

The favourable benefit-cost ratio produced by the ongoing flood plain mapping and zoning program was demonstrated by the very successful Canada-Ontario Flood Damage Reduction Program (FDRP). The program attempted to avoid the use of structural methods of flood control which subsidize those who develop in the flood plain. Instead, the beneficial effect of flood plain zoning and restriction of development in the flood plain resulted in significant reduction in the costs associated with flooding. This was done by drawing and publicising detailed flood plain maps. Potential and current landowners were expected to use this information to avoid or modify flood plain developments. This information was also useful to local authorities in planning and zoning decisions.

Although the FDRP program has been phased out, the continuation of flood plain and hazard land management (mapping and strict control of development along flood risk areas) will ensure that the benefits of the program will continue.

Past experience in flood plain management in Ontario identified three categories of benefits closely related to flood plain mapping:

- reduced flood damages;
- administrative and social benefits; and
- environmental, ecological and sustainable development benefits.

Keeping development out of flood risk areas will obviously reduce the risk of lives and property damages.
Flood plain management results in a number of administrative and social benefits as well, that include: the production of detailed flood line mapping which yield strengthened official plans and/or zoning by-laws that improve the precision of regulation, expediting the processing of permit applications, facilitating decision-making and enhancement of the defensibility of planning decisions. Finally, it provides a precise delineation of flood lands to identify and market the development potential of lands outside the risk areas.

The environmental benefits of flood plain designation include: 1) the maintenance of wetland areas for hydrologic and flood stage reduction purposes, 2) the preservation of environmentally sensitive areas, including provincially and regionally significant plant and animal species.

SUMMARY OF IMPLEMENTATION OF FLOOD PLAIN POLICIES

ACT	PURPOSE	IMPLEMENTATION
Planning Act	Enabling legislation	Land use planning decisions by Municipalities, local boards, planning boards, government agencies, committees
Official Plans	Provide background information Delineate flood and erosion hazard areas with supporting policies Identify development requirements Outline implementation policies to address flooding	Implementation by municipalities
Zoning By-Laws (in conformity with Official Plans)	Prohibiting erection of building or structure on lands subject to flooding or erosion	Implementation by municipalities through development control
Plan of Subdivision and Land severance	Lot/Block creation to delineate areas subject to flooding and erosion	Implementation by municipalities
Site plan control	Identification of landscape and buffer requirements	Implementation by municipalities
The Conservation Authorities Act	Administrative: to study watershed, to control the flow of surface water in order to prevent floods Regulatory: Make regulations prohibiting or regulating or requiring the permission of the Conservation Authority for the changing, diverting or interfering with existing water bodies Prohibiting or regulating or requiring the permission of the Conservation Authority for the construction of any building or structure, or placing or dumping of fill of any kind in flood hazard land . This mandate does not include the control of land use	Responsibilities for implementation with CA's, where they exist, and MNR where they do not.
Lakes and Rivers Improvement Act	Mandate: Provides MNR powers for the use of waters of Ontario and to regulate improvements to them	Application to MNR offices, and other agencies to be contacted MOE, Conservation Authority, MTO if affected Approval of project location, plans and specifications
Public Lands Act	Sale and disposal of public lands and forests, including lands covered by water or lands seasonally inundated by water	Administered by MNR
Building Code	No special provision for flood susceptibility, only indication where dynamic loading conditions apply. Also, for buildings three storeys or less and with area less than 557 square meters describes waterproofing, surface and subsurface drainage.	Ontario Building Code administered by Ministry of Housing. Under the Municipal Act municipalities can pass building by-laws which are not more restrictive nor lenient than the Building Code.
Building permits	Issuance of Building Permits	Issued by Chief Building Official, may require approval from Conservation Authority and MNR
Federal legislation		
Canada Water Act		
National Flood Damage Reduction	Canada-Ontario flood plain mapping	Federal-Provincial (MNR) program – local management of designated flood risk areas.

J. SURVEYS AND MAPPING

UNDER REVIEW

APPENDIX 1 : BIBLIOGRAPHY

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APPENDIX - 2 - GLOSSARY

Adverse Effects

As defined in the *Environmental Protection Act*, means one or more of:

- impairment of the quality of the natural environment for any use that can be made of it;
- injury or damage to property or plant and animal life;
- harm or material discomfort to any person;
- an adverse effect on the health of any person;
- impairment of the safety of any person;
- rendering any property or plant or animal life unfit for use by humans;
- loss of enjoyment of normal use of property; and
- interference with normal conduct of business.

Areas of Natural and Scientific Interest (ANSI)

Means areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study, or education.

Cultural Heritage Landscape

Means a defined geographical area of heritage significance which has been modified by human activities. Such an area is valued by a community; and is of significance to the understanding of the history of a people or place.

Design Flood

The flood which controls the design of a specific flood related project, i.e. dam, diversion, bank protection, etc.

Development

Means the creation of a new lot, a change in land use, or the construction of buildings and structures, requiring approval under the *Planning Act*; but does not include activities that create or maintain infrastructure authorized under an environmental assessment process; or works subject to the *Drainage Act*.

Ecological Functions

Means the natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions.

Erosion Hazards

Means the loss of land, due to human or natural processes, that poses a threat to life and property. The erosion hazard limit is determined using the 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), an allowance for slope stability, and an erosion allowance.

Essential Emergency Services

Means services such as those provided by fire, police and ambulance stations and electrical substations, which would be impaired during an emergency as a result of flooding, the failure of floodproofing measures and/or protection works, and/or erosion.

Established Standards and Procedures

Means the following:

Floodproofing standard, which means the combination of measures incorporated into the basic design and/or construction of buildings, structures, or properties to reduce or eliminate flooding, wave uprush and other water related hazards along the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes, and flooding along river and stream systems.

Fetch

Length of water surface exposed to wind.

Fish Habitat

Means the spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes.

Flood Fringe

Means the outer portion of the flood plain between the floodway and the flooding hazard limit. Depth and velocities of flooding are generally less severe in the flood fringe than those experienced in the floodway. The flood fringe is the area where development and site alteration may be permitted, subject to appropriate floodproofing to the flooding hazard elevation or another flooding hazard standard approved by the Ministry of Natural Resources.

Flood Plain

Flood plain of a river system means the area, usually low lands adjoining a watercourse, which has been or may be subject to flooding hazards.

Flood Standard

Flood used to define flooding hazard along rivers and stream systems.

Floodway (for river and stream systems)

Means the portion of the flood plain where development (other than uses which by their nature must be located within the floodway, flood and/or erosion control works, or where appropriate, minor additions or passive, non-structural uses which do not affect flood flows) and site alteration would cause a danger to public health and safety or property damage.

Where the one zone concept is applied, the floodway is the entire flood plain.

Where the two zone concept is applied, the floodway is the inner portion of the flood plain, representing that area required for the safe passage of flood flow and/or that area where flood depths and/or velocities are considered to be such that they pose a potential thread to life and/or property damage. Where the two zone concept applies, the outer portion of the flood plain is called the flood fringe.

Great Lakes - St. Lawrence River System:

Means the major water system consisting of Lakes Superior, Huron, St. Clair, Erie and Ontario and their connecting channels, and the St. Lawrence River within the boundaries of the Province of Ontario.

Hazardous Lands

Means property or lands that could be unsafe for development due to naturally occurring processes. Along the shorelines of the Great Lakes - St. Lawrence River System, this means the land, including that covered by water, between the international boundary, where applicable, and the furthest landward limit of the flooding, erosion or dynamic beach hazard limits. Along the shorelines of large inland lakes, this means the land, including that covered by water, between a defined offshore distance or depth and the furthest landward limit of the flooding, erosion or dynamic beach hazard limits. Along river and stream systems, this means the land, including that covered by water, to the furthest landward limit of the flooding or erosion hazard limits.

Hazardous Sites

Means property or lands that could be unsafe for development and site alteration due to naturally occurring hazards. These may include unstable soils (sensitive marine clays [lead], organic soils) or unstable bedrock (karst topography).

Hazardous Substances

Means substances which, individually, or in combination with other substances, are normally considered to pose a danger to public health, safety and the environment. These substances generally include a wide array of materials that are toxic, ignitable, corrosive, reactive, radioactive or pathological.

Large Inland Lakes

Means those waterbodies having a surface area of equal to or greater than 100 square kilometres where there is not a measurable or predictable response to a single runoff event.

Maximum Probable Flood

The largest flood that can reasonably be expected to occur at a selected point. It is based on rational consideration of the chance of simultaneous occurrence of the maximum of the various elements which contribute to the flood.

Natural Heritage Features and Areas

Means features and areas, such as significant wetlands, fish habitat, significant woodlands south and east of the Canadian Shield, significant valleylands south and east of the Canadian Shield, significant portions of the habitat of endangered and threatened species, significant wildlife habitat and significant areas of natural and scientific interest, which are important for their environmental and social values as a legacy of the natural landscapes of an area.

Negative Impacts

Means:

a) in regard to fish habitat, the harmful alteration, disruption or destruction of fish habitat, except where it has been authorized under the *Fisheries Act*, using the guiding principle of no net loss of productive capacity;

b) in regard to other natural heritage features and areas, the loss of the natural features or ecological functions for which an area is identified.

One Hundred Year Flood (for river and stream systems)

Means that flood, based on an analysis of precipitation, snow melt, or a combination thereof, having a return period of 100 years on average, or having a 1% chance of occurring or being exceeded in any given year.

One Hundred Year Flood Level

Means:

- For the shorelines of the Great Lakes, the peak instantaneous stillwater level, resulting from combinations of mean monthly lake levels and wind setups, which has a 1% chance of being equalled or exceeded in any given year.

- In the connecting channels (St. Mary's, St. Clair, Detroit, Niagara and St. Lawrence Rivers), the peak instantaneous stillwater level which has a 1% chance of being equalled or exceeded in any given year.

- For large inland lakes, lake levels and wind setups that have a 1% chance of being equalled or exceeded in any given year, except that, where sufficient water level records do not exist, the one hundred year flood level is based on the highest known water level and wind setups.

- For rivers and streams, water leves caused by the 100 year return period flood, resulting in a 1% chance of occurring or being exceeded in any year.

One Hundred Year Precipitation

Precipitation, which on the average is expected to be equalled or exceeded once every 100 years. The chance of occurring in any one year is 1%.

Normally, the data is based on extrapolation of recorded events, as none of the Ontario rainfall stations have 100 years of record.

Other Related Hazards

Means water-associated phenomena other than flooding and wave uprush which act on shorelines. This includes, but is not limited to ice, ice piling and ice jamming.

Prime Agricultural Area

Means an area where prime agricultural land predominates. Prime agricultural areas may also be identified through an alternative agricultural land evaluation system approved by the province.

Prime Agricultural Land

Means lands that includes specialty crop lands and/or Canada Land inventory Classes 1, 2 and 3 soils, in this order of priority for protection.

Public Service Facilities

Means land, buildings and structures for the provision of public services, but does not include infrastructure.

Public Services

Means programs and services provided or subsidized by a government or other public body. Examples include social assistance, recreation, police and fire protection, health and educational programs, and cultural services.

Quality and Quantity (of water)

Is measured by indicators such as minimum base flow, oxygen levels, suspended solids, temperature, bacteria, nutrients, hazardous contaminants, and hydrologic regime.

Residential Infilling

Means the creation of a residential lot between two existing non-farm residences which are on separated lots of a similar size and which are situated on the same side of a road and are not more than 100 metres apart.

River and Stream Systems

Means all watercourses, rivers, streams, and small inland lakes or waterbodies that have a measurable or predictable response to a single runoff event.

Rural Areas

Means lands in the rural area which are not prime agricultural areas.

Sensitive Land Uses

Means buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more adverse effects from contaminant discharges generated by a nearby major facility. Sensitive land uses may be a part of the natural or built environment. Examples include: residences, day care centres, and educational and health facilities.

Significant

Means:

- In regard to wetlands and areas of natural and scientific interest, an area identified as provincially significant by the Ministry of Natural Resources using evaluation procedures established by the province, as amended from time to time.

- In regard to other features and areas, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system. Criteria for determining significance may be recommended by the Province, but municipal approaches that achieve the same objective may also be used.

- In regard to other matters, important in terms of amount, content, representation or effect.

Site Alteration

Means activities, such as fill, grading and excavation, that would change the landform and natural vegetative characteristics of a site.

Special Policy Area

Means an area within a community that has historically existed in the flood plain and where site specific policies, approved by the Ministers of Natural Resources and Municipal Affairs and Housing, are intended to address the significant social and economic hardships to the community that would result from strict adherence to provincial policies concerning development.

Thalweg

Line connecting the deepest points along a stream channel.

Valleylands

Means a natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year.

APPENDIX 3 - APPLICATION TO CHANGE THE FLOOD STANDARD WITHIN A WATERSHED

For those watersheds with a flood standard greater than the provincial minimum acceptable standard of the 100 year flood, the option exists for municipalities and planning boards to apply to the Minister of Natural Resources, in accordance with the following procedures, to change the standard, subject to the following overriding conditions:[1]

- Changes to the existing flood standard will only be considered with the support of a significant majority of municipalities and/or planning boards within the watershed, in consultation with the local Conservation Authority or Ministry of Natural Resources, where Conservation Authorities do not exist; and

- the lowering of the existing flood standard where the past history of flooding reveals a higher level is more appropriate will not be considered.

It is recognized that complete information may not be available when a municipality comes forward with a request to change the flood standard. It is suggested, however, that reasonable information be provided to assess the impacts of the change.

Conservation Authorities and Ministry of Natural Resources Regional Offices, where Conservation Authorities do not exist, will be responsible for co-ordinating requests for changes.

To facilitate requests for changes in the flood standard, the following sequence will be followed:

(1) Responsibilities of the Initiating Municipality

- When considering requesting a change in the flood standard, the initiating municipality will first provide a suitable forum for public input for which prior notice is given to the general public.

A request made to the Minister of Natural Resources to consider a change will be in the form of a council endorsed resolution. The resolution, accompanied by documentation on the prior notification and opportunities for public input, will be forwarded to the Minister of Natural Resources together with an explanation as to the reasons for the request. The Minister may wish to seek clarification or additional information from the initiating municipality.

(2) Ministry's Action

- Main office of the Ministry of Natural Resources will inform the appropriate Conservation Authority or Ministry of Natural Resources Regional Office, where no Conservation Authorities exist, and the Ministry of Municipal Affairs and Housing, of the request for a change.

(3) Co-ordination/Technical Input by the Conservation Authority or Ministry of Natural Resources

- The Conservation Authority or Ministry of Natural Resources Regional office will provide written notification to each municipality within the watershed. Municipalities will include upper tier (i.e. regions, counties, etc.) and lower tier (i.e. cities, townships, etc.), whether situated totally or partially within the watershed. The transmittal letter will:

. identify that the Conservation Authority or Ministry of Natural Resources Regional office is acting in a co-ordinating role on behalf of the Minister of Natural Resources;

. identify that a request to change the flood standard has been made and include the actual resolution passed by the initiating municipality;

. request that all municipalities make their views known (whether for or against) in the form of a council endorsed resolution;

. identify that the resolutions are to be directed to the Minister of Natural Resources but forwarded to the local Conservation Authority or Ministry of Natural Resources Regional office for compilation;

. request that documentation of the public notification and the opportunities afforded for the public representation also be provided and forwarded in conjunction with the council endorsed resolution;

. identify that the comments of the Conservation Authority or Ministry of Natural Resources Regional office will be forwarded to each municipality in the near future;

. identify that a change in the flood standard may result in changes to municipal planning documents (i.e. official plan, zoning by-laws, etc.) and that the municipality may wish to contact the Ministry of Municipal Affairs and Housing in this regard;

- Under separate cover, the Conservation Authority or Ministry of Natural Resources Regional office will provide comments to the municipalities regarding the water management implications, if any, of a change in the flood standard. Comments may include specific information on:

. past history of flooding;
. time required to pass flood flows;
. extent and rate of urbanization;
. changes required to give effect to a change in the flood standard;
. funding implications;
. etc..

(4) Responsibilities of the Responding Municipalities

- In considering the request of the initiating municipality to change the flood standard for the watershed, each municipality will provide opportunities for public input for which prior notice is given to the general public.

(5) Additional Opportunity for Public Input

- If after a municipality has finalized its position through a council endorsed resolution, members of the public still wish to make their views known, they may do so directly to the Minister of Natural Resources.

(6) Minister's Decision

• Once obtained, the Conservation Authority or Ministry of Natural Resources Regional office will forward all municipal resolutions, including documentation of public notices and opportunities provided for public input, and its own comments to the Minister of Natural Resources and copies of the submission will be sent to each watershed municipality for information purposes.

• In considering a request to change the flood standard, the main office of the Ministry of Natural Resources will consult the Ministry of Municipal Affairs and Housing and may request the comments and opinions of any other groups and/or individuals, as deemed appropriate.

• Upon making a decision, the Minister of Natural Resources will directly inform, in writing, all watershed municipalities, the local Conservation Authority or Ministry of Natural Resources Regional Office, and the Ministry of Municipal Affairs and Housing.

(7) Communication Plan

• Upon formal approval of a change in the flood standard, the watershed municipalities, in conjunction with the local Conservation Authority or Ministry of Natural Resources Regional office, will jointly prepare a communication plan to inform:

. the general public
. interest groups/associations
. other appropriate public agencies
. consultants (i.e. planning, engineering, architectural, etc.)
. developers/builders
. others

The communication plan will also highlight the major water management changes to municipal planning documents that may be required as a result of the change in the flood standard.

1 For territories without municipal organization, planning boards, where they exist, will assume the responsibilities identified for "municipalities" within the context of this process. For territories without municipal organizations that do not have planning boards, requests to change the regulatory flood standard will be made directly to the Minister of Natural Resources by interested parties.

APPENDIX –4 APPLICATION OF THE TWO-ZONE CONCEPT FACTORS TO BE CONSIDERED

Evaluation of the following factors will assist in assessing the suitability of applying the two-zone concept.

(1) Frequency of flooding

Caution should be exercised in applying the two-zone concept for chronic problem areas. While development in such areas could adequately be floodproofed, maintenance and upkeep would continuously be required to ensure floodproofing measures and local services remain effective.

(2) Physical Characteristics of the Valley

Steepness of valley slopes, instability of banks and poor soil conditions in flood fringe areas can physically render the flood fringe unsuitable for development. Adopting the two-zone concept would show more promise for areas with a flat overbank and shallow flow. Topography varies, so evaluation is necessary on a local basis in determining suitability.

(3) Local Need

Suitability of flood fringe areas for development can be influenced by municipal planning considerations including availability of developable land elsewhere in the municipality. In urban areas where land values are high and pressure for development is usually the greatest, the concept shows promise. Lot sizes are usually larger in rural areas, and it is generally possible to locate development outside the flood plain. Therefore, proposed application of the two-zone concept in rural/agricultural areas will require detailed rationale/justification.

(4) Impacts of Proposed Development

Encroachment within the flood fringe area usually results in an increase in flood levels. The extent of potential increases will be dependent on a number of factors in watershed characteristics and the degree to which the two-zone concept is to be applied. As a result, it may be necessary to recalculate for the flood standard the flood levels for floodproofing purposes and identify and assess the upstream and downstream impacts where the two-zone concept is being considered. This is particularly true where the two-zone concept is to be applied over extensive areas.

(a) Flood Levels at the Site and Upstream

Filling and construction within the flood fringe area reduces the cross-sectional area of the waterway, so the corresponding flood level increases at the site and immediately upstream. This increase in the flood level can be estimated with reasonable accuracy and normally does not require major engineering studies.

(b) Flood Levels Downstream

General encroachment within the flood fringe area reduces the storage capacity of the flood plain and results in an increase in flood flows and the flood levels along the downstream reaches of the river. If undertaken during the initial flood plain mapping process, the revised levels can be computed without major additional expense. Where flood plain mapping was undertaken several years earlier and the data base utilized in preparing the maps is not readily available, the calculation of the revised flood levels may require major engineering studies at substantial cost.

(5) Feasibility of Floodproofing

One of the major factors in determining if a flood fringe area is suitable for development is the feasibility and cost of floodproofing.

(6) Constraints to the Provision of Services

Flood fringe areas are low-lying and it is often difficult and expensive to provide necessary services (watermains, sewers, drainage works, etc.) to serve the developments. Drainage systems should provide protection against the flood standard and it may be difficult to provide outlets above the level of flood standard. In these situations, it may be necessary to provide pumping facilities which would result in some additional expense in new developments.

(7) Ingress/Egress

Major accessways to development potentially located in the flood fringe must be examined. It is not acceptable to have development isolated during the flood conditions because roads and escape routes are not passable.

(8) Changes in Land Use

Land use is a key factor considered in flood plain studies and the calculation of flood lines. Proposed development, not anticipated in these calculations, could create increased flood risks and thus reduce the effectiveness of flood plain management programs.

It is therefore imperative that municipalities discuss proposed changes in land use with the local Conservation Authority or Ministry of Natural Resources, where one does not exist.

(9) Administrative Capability

The feasibility of the two-zone concept requires the examination of a number of factors and implementation requires assurance that various conditions are complied with. Therefore, staff availability and expertise must also be considered.

As well, certain planning tools (e.g. zoning, site plan control, subdivision control) are required to effectively implement the necessary land use controls. Where such tools are not available, e.g. areas without municipal organization, application of the two-zone concept is not a viable option unless supported by detailed methods of implementation.

It is not mandatory that a municipal official plan contain floodway - flood fringe policies prior to utilizing the two-zone concept. It is certainly intended that the municipal documents ultimately outline the basis for utilizing the two-zone concept and the areas of the municipality where it would apply. However, some municipalities in conjunction with the Conservation Authority

(Fill, Construction and Alteration to Waterways Regulation) or the Ministry of Natural Resources, may have already been utilizing the two-zone concept. In this regard, it is not the intent of the Provincial Flood Plain Policy that the water management options be applied retroactively, to municipal planning documents.

During the preparation of an official plan update or a major official plan amendment affecting flood plain areas, the municipality in conjunction with the Conservation Authority or Ministry of Natural Resources, should include policies addressing:

. existing areas of the municipality utilizing the two-zone concept and/or;

. a framework for analyzing potential areas of two-zone application, including both land use considerations and technical flood plain information and,

. the inter-relationship between the official plan, zoning by-law and the Conservation Authority's Fill, Construction and Alteration to Waterways Regulation.

The Regional Engineer of the Ministry of Natural Resources shall be involved in decision making regarding potential application of a two-zone concept.

APPENDIX 5 : SPECIAL POLICY AREAS -

A – REQUIRED CONSIDERATIONS

Special Policy Area application ONLY applies to River and Stream Systems and inland lakes that are less than 100 square kilometres in size and hydrologically respond to a single meteorological event. They do not apply to hazardous lands adjacent to Great Lakes – St. Lawrence River System and large inland lakes.

Only the Minister of Natural Resources and the Minister of Municipal Affairs and Housing have the authority to approve Special Policy Areas in Ontario. Since Special Policy Areas place the province at a greater degree of risk, this function CANNOT be delegated to municipalities or other planning bodies.

In determining whether or not an area potentially qualifies for special policy area status, the factors to be considered can be grouped into two major categories — community related and technical.

(1) Community Related

The characteristics of the community itself are important considerations in identifying eligibility for special policy area status. To potentially qualify, an area should:

. have a municipal commitment to area maintenance;
. be an area designated in the official plan for continued growth;
. have significant investment in infrastructure, i.e. services;
. limited opportunities for development elsewhere.

(a) Municipal Commitment

To qualify for special policy area status a municipality must have a commitment, reflected in its official plan policies, to the continued upkeep of the area, such as an active program to revitalize.

(b) Designated Growth Centre

To qualify for special policy area status, a community must be recognized as a centre for urban growth and development. This would be reflected in planning documents - regional municipality, county, joint planning area or local municipality plan. This criterion attempts to ensure there is a desire and commitment to further development on the community's part.

(c) Infrastructure Investment

A further measure of commitment to continued growth is the extent of investment in community infrastructure. Practical indicators include the extent of servicing that exists, i.e. water and sewage.

(d) Limited Alternatives

A community with feasible alternatives for expansion or redevelopment outside the flood plain area would not necessarily qualify for special policy area status.

(2) Technical Criteria

To determine if a community qualifies for special policy area status, various technical criteria relating to the flood hazard must also be considered:

- Appropriateness of other flood plain management measures, i.e. remedial works, two-zone approach.
- Depth of flooding and velocity of flow.
- Frequency of flooding.
- Feasibility of floodproofing measures.
- Upstream and downstream effects.
- Frequency of ice jams and other obstructions.
- Berms and flood walls.
- Reduced flood standard.

(a) Appropriateness of Other Measures

In order to contemplate eligibility for special policy status, other measures such as remedial works and the two-one approach must be proven to be unworkable.

In situations where remedial measures to permanently reduce flood levels may not be implemented in the immediate future, a special policy area might be considered as a water management option, until the remedial measures have been completed.

(b) Flow Characteristics

The depth of flooding and velocity of flow within a flood plain will have a bearing on the extent and location of a special policy area. No matter how strong the arguments relating to other criteria, an area susceptible to severe flooding may not be appropriate for special consideration.

(c) Frequency of Flooding

The frequency of flooding relative to the depth and velocity criteria also determines if special policy area status is appropriate. Potential special policy areas will be individually evaluated relative to flood frequency, both past and future.

(d) Floodproofing Measures

The feasibility of floodproofing new development, in general, within the special policy area must be examined. Based on flood characteristics, local conditions and type of land use proposed, alternative floodproofing measures can be examined as to their individual feasibility and desirability. Key in examining alternative floodproofing measures is the level of flood protection that can be afforded.

(e) Upstream and Downstream Effects

The effects on upstream and downstream areas caused by increased development in the flood plain must be taken into account. Normally, this is determined through the watershed planning process of the Conservation Authority or other special water management studies. These effects may be only minor in some instances. In others, because of the land use patterns and topography, the effects, though significant, may be acceptable. To determine upstream and downstream effects, all special policy area proposals will be evaluated on a case-by-case basis.

(f) Frequency of Ice Jams

Ice jams are a natural phenomena caused by topographic, hydraulic and meteorological factors. Resultant flooding has long been a problem and must be considered in the decision-making process regarding development in a flood plain.

It is almost impossible to predict in advance whether an ice jam will form or if any resultant flooding will occur and to what extent it will occur.

With ice generated floods, river flows are generally much below a flood standard (winter conditions), but due to ice constriction, levels may rise above the flood standard. Due to the unpredictable nature of ice jams, a conservative approach to development is needed where ice jams are known to have caused problems.

(g) Berms and Flood Walls

Where a berm or flood wall has been properly designed to the flood standard and constructed, and a suitable maintenance program is in place, the floodway would be considered to be contained within the berm or flood wall area. The area behind the berm or flood wall can be considered flood fringe. As such, a new development would be required to be floodproofed to the flood standard. If new development cannot be floodproofed to the flood standard, then special policy area status may be requested.

If there are any openings in the berm or flood wall (e.g. road crossings, watercourse confluence, etc.) which would require human intervention to complete the dyke during an impending flood through sand bagging, placing of stop logs etc., the berm or flood wall shall not be considered to contain the floodway.

The establishment of no or limited development zones behind a berm or flood wall will be dependent on local conditions (e.g. flood depth and velocity) and local approaches to flood plain management. As a precaution, certain areas immediately behind a berm or flood wall may be considered too hazardous for any or certain types of uses, if through ice jams, debris jams etc., failure of the berm or flood wall was ever to occur.

(h) Reduced Flood Standards

For watersheds where reduced flood standards levels have received approval by the Minister of Natural Resources in accordance with the provisions of Appendix "A", the options still exists for a municipality to apply for preliminary approval in principle for Special Policy Area status. However, if for example, the new flood standard for a watershed is the 100 year event and a floodway has been defined using the product of depth and velocity, it may be difficult to provide justification for the two-zone concept being too stringent.

Existing Special Policy Area policies may require revision once a reduced flood standard has been approved by the Minister or alternatively, the need for a special policy area may or may no longer exist.

(i) Evaluation

All criteria must be balanced against one another and a decision reached as to whether the community will qualify for special policy area status. The weighting of these factors will depend on the complexity and relative nature of the criteria. Before such weighing is undertaken, as much factual data as possible should be assembled.

(3) Types of Special Policy Areas

Each special policy area is unique, but there are two identifiable types:

(a) special policy areas where floodproofing to the flood standard is not provided; and

(b) special policy areas where development is proposed in the floodway.

Both types of special policy areas run counter to basic concepts within the provincial policy statement, namely; new development within the flood plain should be protected from flooding to the level of the flood standard and new development within the floodway, the more hazardous portion of the flood plain, should be prohibited or restricted to non-structural uses such as open space.

Therefore, great care must be exercised in proposing and approving special policy areas as susceptibility to flooding and damage are much greater in such areas.

B - PROCEDURES FOR APPROVAL

Procedures for seeking approval of a special policy area designation will generally consist of three phases:

Phase

Phase I identification of need and preliminary approval in principle;
Phase II(a) data collection and preparation of draft official plan policies;
Phase II(b) review and formal approval of official plan policies;
Phase III implementation and review/update.

(1) Phase I - Identification of Need and Preliminary Approval as Special Policy Area

(a) Request for Special Policy Area Status

Phase I (preliminary approval in principle) is designed to establish special policy area status in principle, and to lay the framework for further technical evaluation. It will prevent unnecessary expenditures prior to the approval agencies' acceptance of the request as being consistent with the principles of flood plain management. This phase will also identify the nature and extent of further studies necessary to accurately evaluate the limits and/or scope of the special policy area.

A special policy area is a flood plain planning option based on water management principles. It is necessary to consider policies for all land uses within the special policy area as policy decisions regarding one land use may adversely affect or limit the alternatives for other land use policies. Separate special policy area proposals for each land use within an overall special policy area is not appropriate.

It must be noted, approval in principle does not signify final approval of the proposed designated, nor is it an assurance the special policy area will be approved. The latter will depend largely on the conclusions and results under Phase II(a).

The initial request for special policy area status, having regard to the criteria outlined, must come from the municipality. The municipality should be satisfied it meets the criteria and that it has suitable expertise and financial capability to deal with the establishment of a special policy area. The request for special policy area status should be accompanied by a brief report addressing the criteria for special policy area eligibility. In this regard, the municipality should contact the local Conservation Authority where one exists, as an initial step to determine the type of flood related information that may exist. The Conservation Authority or Ministry of Natural Resources shall also provide detailed flood related information in report form indicating the rationale and justification why the provisions of the two-zone concept are too onerous.

The municipality should then approach the Ministry of Municipal Affairs and Housing, the local Conservation Authority and the Ministry of Natural Resources to obtain approval in principle of its request for special policy area status. Until it has been notified of approval in principle, the municipality should not proceed with any additional studies.

(b) Provincial Review of Municipal Request for Approval in Principle

The Ministry of Municipal Affairs and Housing will co-ordinate the review of material prepared by the municipality to decide whether it meets the criteria and if acceptance in principle can be given. Where the municipality seeking approval in principle for special policy area status is within a 'delegated' regional municipality, the region will be involved in the review. Regional municipal representatives may co-ordinate the review of all materials relating to a special policy area designation once the municipality has been given approval in principle and direction has been provided as to the additional studies required to support an approval of a specific special policy area.

If more information is required, the municipality will be advised what is required in support of its request for approval in principle and the agencies will reconsider the application when the additional material is available.

(c) Approval in Principle to Consider Special Policy Area Status

The municipality will receive written approval in principle jointly issued by representatives of the Ministries of Municipal Affairs and Housing, Natural Resources and, where one exists, the local Conservation Authority.

Upon acceptance in principle, the municipality will be advised regarding detailed studies required to support development of official plan policies for the special policy area.

(d) Refusal of Approval in Principle for Special Policy Area Status

If a municipality is ineligible under the criteria outlined, it will be notified and given reasons.

(2) Phase II(a) - Data Collection and Preparation of Draft Official Plan Policies

A municipality granted approval in principle for consideration of special policy area status, will be expected to collect appropriate data according to the approval in principle letter, and to produce policies meeting the guideline requirements. While data collection is the responsibility of the municipality requesting special policy area status, provincial agencies will assist as much as possible in providing information and in endeavouring to provide the municipality with guidance, technical advice, etc. A working group may be established to liaise with the municipality and monitor the study progress.

The municipality should carry out the following steps under the guidance of the working group composed of representatives of the Ministry of Natural Resources, the local Conservation Authority, the Ministry of Municipal Affairs and Housing, and possibly other Ministries such as the Ministry of the Environment and Energy and the Ministry of Northern Development and Mines. Municipal representation should include both planning and engineering staff. If there is a regional municipality, its representative should also be included.

(a) Municipal Data Collection

Before policies are developed, the municipality should collect data and demonstrate adequate consideration of alternatives. This stage should be monitored by the working group who will provide technical assistance to the municipality as needed and wherever possible.

(b) Evaluation of Alternatives

The municipality should consider alternative approaches to handling the problems of the floodprone area including upstream and downstream effects of the alternatives.

(c) Policy Formation

Once the data collection is completed, the municipality can prepare proposed policies. The policies should include and be supported by, but not necessarily limited to, the following information which shall be subject to the approval of the Conservation Authority, where one exists and the Ministries of Municipal Affairs and Housing and Natural Resources:

- An introductory statement containing an explanation of provincial policy, a brief description of the area proposed for a special policy area, and a justification for the proposal (including an evaluation of risk factors involved in permitting development in the flood plain).

- The boundaries of the special policy area shall extend to the appropriate floodlines on each side of the watercourse (if appropriate) and be closed at both the upstream and downstream limits. The policies will then address all land uses, additions, renovations and replacements within these boundaries.

- The flood levels must be defined by floodplain mapping studies for the area(a) under consideration. Such studies should consider both pre and post-development situations.

- The minimum acceptable level of protection (floodproofing) for development within the special policy area.[1]

- The land use policies and designations for the proposed special policy area.

- Detailed implementation policies identifying the mechanisms (i.e. zoning, site plan control) and means to be applied to ensure flood susceptibility and floodproofing are addressed by new development.

- Policies for new buildings, additions, renovations, infilling and replacements within the proposed special policy area.

- The roles of council, Conservation Authority(ies) and

the Ministries of Municipal Affairs and Housing, Natural Resources and any other appropriate agency with respect to the circulation and review of development proposals including subdivision plans, consents, minor variances, and building permits.

- The delineation of the boundaries of the special policy area, as an overlay, on the land use schedule.

- An appendix which includes background reports and studies supporting the policies proposed.

The municipality in preparing an appendix to its official plan document would include background papers addressing the special policy area guidelines and how the draft official plan policies reflect them. It would outline various alternatives considered and studies carried out to support the proposed policies. Exceptions to the provincial policy statement on flood plain planning are considered on their own merits, and the Province will want to ensure there is a clear outline of the basis of these exceptions for the benefit of the public and others.

Agreement to the general policy proposals should be given in writing by representatives of Ministries of Municipal Affairs and Housing, Natural Resources and the local Conservation Authority, preferably before any public meeting, so as to avoid raising false expectations.

(3) Phase II(b) - Review and Formal Approval of Official Plan Policies

Processing the documentation for review and approval would comply with the requirements of the Planning Act, and the standard procedures established by the Ministry of Municipal Affairs and Housing for the review of all official plans and amendments would be followed.

(a) Public Involvement

The municipality has a responsibility to involve the public in considering proposed policies as they will form a component of the official plan. The municipality may request technical backup and support from the provincial ministries for presentation purposes at any public meetings.

(b) Review of Draft Official Plan Policies

Following public meetings, the official plan policies, including appendix material, should be finalized in draft form by the municipality and copies forwarded to the Ministry of Municipal Affairs and Housing, whose responsibility is to co-ordinate a response from the provincial agencies and the local Conservation Authority on all draft documents. This response should be received by the municipality within 30 days or other agreed to period. If necessary, meetings may be held to discuss the response.

(c) Municipal Adoption

Based on comments received, the municipality would make appropriate modifications and formally adopt the official plan policies.

(d) Conservation Authority Adoption

The special policy area provisions will determine the basis by which a Conservation Authority will administer applications pursuant to their Fill, Construction and Alteration to Waterways Regulation. Therefore, the agreed upon policies require a resolution of acceptance by either the Executive Committee or the Full Authority, whichever has been vested with the decision-making authority.

(e) Formal Submission for Approval

Once finalized at the local level, the municipality would then submit the policies to the Ministry of Municipal Affairs and Housing for approval, unless a regional municipality has the authority to receive them.

As the draft official plan policies request approval for special policy area status, they will also be forwarded to the appropriate Regional Office of the Ministry of Natural Resources to initiate the approval process by the Minister of Natural Resources. The Minister would then inform the Minister of Municipal Affairs and Housing of his/her support or objection to the official plan policies.

In all other respects, normal official plan policy circulation and approval procedures would be followed, as specified under the Planning Act, or by the Ministry of Municipal Affairs and Housing.

(4) Phase III - Implementation and Review/Update

(a) Implementation

The official plan/official plan amendment policies for a special policy area are implemented by a municipality and the Ministry of Natural Resources outside the area of Conservation Authority jurisdiction through the zoning by-law process.

The policies developed for the special policy area will have no legislative basis for enforcement under the Planning Act unless they are addressed in the zoning by-law. It is therefore important that close ongoing liaison among the agencies that developed the policies, be maintained after the approval of the official plan/official plan amendment to ensure that the proposed zoning by-law provisions adequately address all of the special policy area policies.

Ideally, the alternative implementation mechanisms will have been previously discussed or outlined in the implementation section of the official plan/official plan amendment. However, if additional information is required or unforeseen problems arise at the time the implementing zoning by-law is being prepared, it may be necessary to reconvene the special policy area technical committee. As a minimum, the implementing zoning by-law should be circulated in draft form to the agencies represented on the technical committee prior to public meetings and/or prior to the bylaw receiving three readings by council.

Special policy area policies are also implemented by Conservation Authorities where they exist, through the issuance of permits under Section 28(1) of the Conservation Authorities Act where such regulations have been adopted. It is therefore important to establish and maintain a close working relationship between the Conservation Authority and the municipality to ensure that any necessary approvals under the Planning Act and the Conservation Authorities Act are coordinated and mutually supportive.

(b) Review and Update

As flood plain information/works or reduced flood standards are approved and/or completed the Special Policy Area policies should be reviewed by the respective participants and the municipal documents amended as necessary.

Where no changes to the Special Policy Area policies, land use designations or boundaries are necessary and the policies/schedules are being transferred to another municipal document, further approvals of the Minister of Natural Resources are not required.

1 A minimum acceptable level of protection for Special Policy areas has not been included in the Guide due to the extent of variation in flood plain characteristics which exists province-wide. However, the 100 year flood has been used almost exclusively as the minimum acceptable flood standard and the CMHC lending policy is also based on this level. (See Section 5.4, Federal Legislation.) SPAs which include a minimum acceptable level of protection which is less than the 100 year flood will require substantial justification. In this regard it should not be interpreted as either the flood standard or the 100 year flood elevation. In all situations as much of floodproofing as possible should be incorporated in the policies.

APPENDIX 6 : FLOODPROOFING

INTRODUCTION

Floodproofing is defined as a combination of structural changes and/or adjustments incorporated into the basic design and/or construction or alteration of individual buildings, structures or properties subject to flooding so as to reduce or eliminate flood damages. It is acknowledged that this term is somewhat misleading, since total protection from flood damage cannot always be assured. However, if applied effectively, floodproofing can play a significant role in comprehensive flood plain management.

Floodproofing is generally most appropriate in situations where moderate flooding with low velocity and short duration is experienced and where traditional structural flood protection, such as dams and channels are not considered to be feasible. Although measures can be applied to both existing and new developments, it is usually impractical, expensive and extremely difficult to flood proof existing buildings.

Since floodproofing is best incorporated into the initial planning and design stages, new development has the greatest potential for permanent structural adjustment. In general, floodproofing can be applied most economically and effectively in the design of new buildings in developing areas. It can also be applied to infilling situations and proposed additions in developed areas. However, as well as providing adequate flood protection, new development within developed areas will have to take into account special considerations such as the aesthetic blend with neighbouring properties.

Floodproofing, whether wet or dry should be no lower than the 1:100 year flood level. The only exceptions are in cases where an addition is proposed to an existing structure or there is one remaining infilling lot in a neighbourhood. In these instances, the floodproofing level should be no lower than the first floor levels of the existing structure or the adjacent structures.

TYPES OF FLOODPROOFING

All floodproofing measures can be described as active or passive and providing wet or dry protection.

Active vs Passive

Active floodproofing requires some action, i.e. closing watertight doors or sandbagging for the measure to be effective. Advance flood warning is almost always required in order to make the flood protection operational.

Passive floodproofing measures are defined as those that are in place and do not require flood warning or any other action to put the flood protection into effect. These include construction of development at or above the flood standard, or the use of continuous berms or floodwalls.

Dry vs Wet Protection

The object of dry floodproofing is to keep a development and its contents completely dry. Such can be carried out by elevating the development above the level of the flood standard or by designing walls to be watertight and installing watertight doors and seals to withstand the forces of flood waters. The benefit of elevated floodproofing is that it is passive and advance warning of an impending flood is not required. Temporary watertight closures, on the other hand, are considered to be active floodproofing usually requiring advance warning for operation.

Wet floodproofing is undertaken in expectation of possible flooding. Its use is generally limited to certain specific non-residential/non-habitable structures (e.g. arena, stadium, parking garage), but many of the techniques of wet floodproofing can be used with certain dry floodproofing approaches. The intent of wet floodproofing is to maintain structural integrity by avoiding external unbalanced forces from acting on buildings during and after a flood, to reduce flood damage to contents, and to reduce the cost of post flood clean up. As such, wet floodproofing requires that the interior space below the level of the flood standard remain unfinished, be non-habitable, and be free of service units and panels, thereby ensuring minimal damage. Also, this space must not be used for storage of immovable or hazardous materials that are buoyant, flammable, explosive or toxic. Furthermore, access ways into and from a wet floodproofed building must allow for safe pedestrian movement.

For new development, dry floodproofing above the level of the flood standard can generally be economically and easily achieved in the design and early construction phase. However, dry floodproofing of structures which will have portions below the level of the flood standard will require additional special design attention so that the structure will resist all loads including hydrostatic pressures.

TECHNICAL CONSIDERATIONS

Once flood waters enter a development, the risk of loss of life and flood damage will be determined by the location of the habitable portion of the buildings. The habitable portion of a structure is defined as living space intended for use by the occupant with the key concern being overnight occupancy. This includes buildings used for residential, commercial, recreational, and institutional purposes. In considering appropriate floodproofing measures, the habitable portion of the building should be designed to eliminate or minimize the risk of flood damage and loss of life.

As a rule, damages increase rapidly with the depth of flooding. Major structural damage occurs when a structure is weakened, totally collapses or is displaced. Damage to contents, such as finishes, trimwork, furniture, appliances, equipment and storage materials, also represents a substantial portion of the total loss. In addition, it is difficult to assign a dollar value to compensate for human suffering caused by a flood.

Thus, protection to at least the level of the flood standard is significant in reducing human suffering and property damage. In selecting between wet or dry flood protection, consideration must be given to the type of development, need for floodproofing and cost effectiveness. Further, selection of active or passive measures will depend on location of the habitable portion of the development below or above the level of the flood standard, local flood warning, and accessways.

As well, all mechanical and electrical systems should be designed and installed so that the heating, lighting, ventilation, air conditioning and other sys-

tems are not vulnerable to flood damage during the flood standard. Where flooding could interrupt key power supplies, it may be necessary to provide stand-by or backup systems, with power and controls located above the level of the flood standard.

In order to determine the most appropriate floodproofing measure, the full extent of the flood hazard must be evaluated. This section outlines technical considerations which can assist in determining the most suitable floodproofing measure.

(1) Flooding as a Threat to Life

Hazard to life is linked to the frequency of flooding, and to depth of flood waters and the velocity of flow in the floodplain. Depth increases buoyancy and velocity increases instability, so that each of depth and velocity should be studied independently or as a combined function.

(a) Depth

Any person in the midst of a flooded area will be acted upon by a buoyant force equal to the weight of water displaced by that person. The volume of displaced water and this force increases with depth until neutral equilibrium is reached and the person begins to float.

Average adults and teenage children remain stable when standing in flood depths up to about 1.37 m (4.5 ft.). The average school child 6 - 10 years old would float at about 1.1 m (3.5 ft.), although smaller, younger children in this range would float at a depth of about 0.98 m (3.2 ft.).

Hence, in terms of depth and individuals who could be present in the floodplain during a flood:

- depths in excess of about 0.98 m (3.2 ft.) would be sufficient to float young school children;
- a depth of about 1.37 m (4.5 ft.) is the threshold of stability for teenage children and most adults.

(b) Velocity

Moving water in the floodplain exerts a lateral force resulting from momentum thrust of the flood flow. This force acts to displace objects in a downstream direction. The shear force of friction of a person on the wet surface of the floodplain resists this force. However, even relatively low velocities of flow in the floodplain can pose possible flood hazards.

The force exerted by various flow velocities can be developed for different age and size groups, but because its effect is tied to depth, a better appreciation of velocity effects can be gained by looking at both depth and velocity in combination.

(c) Combination of Depth and Velocity

As a guide for personnel involved in stream flow/depth monitoring, the simple "3 x 3 rule" was developed in the U.S. based on 3 ft depth and 3 ft/s velocity values. The rule suggests that people would be at risk if the product (multiple) of the velocity and the depth exceeded 0.8 m^2/s (9 $ft.^2/s$).

The Water Survey of Canada has the same rule of thumb and its Hydrometric Field Manual (1981) states, "a general rule of thumb which has been used in the past is arrived at through the product of the depth and velocity. Generally speaking, if the bed is firm and provides good footing, the product of these two factors should be slightly less than 1 m^2/s, or roughly 9 $ft.^2/s$".

It should be noted that this rule of thumb applies to trained professionals whose regular work accustoms them to the dynamic forces of river flows, buoyant forces from partial submergence and recognition of potential hazards, e.g. rocks, depressions, etc. They also enter the stream with equipment which will assist them in maintaining stability, e.g. tag line, wading rod, strap-on cleats for greater stability.

It is considered highly unlikely that such equipment would be available to most occupants of floodproofed buildings in the flood plain. It seems equally unlikely that these occupants would have the same level of experience as water survey staff in dealing with high depths, current speeds, unsteady footing, or cold weather/water conditions.

As a result, it is likely that the simple rule of 3 x 3 product (1 m^2/s or 9 $ft.^2/s$) represents an upper limit for adult male occupants in the flood plain and that it would be reasonable to consider something lower as being more representative of a safe upper limit for most flood plain occupants.

As noted earlier, any person on foot during a flood may be subject to a number of forces in the floodplain. Excluding impact by ice and/or other debris, these forces include:

- an upward buoyant force, equal to the weight of the fluid displaced;
- a lateral force exerted by the moving water (linear momentum);
- unbalanced hydrostatic forces.

Resisting these forces are:

- the shear force of friction acting through the weight of the person standing on a wet surface in the floodplain.

Figure 6-1 provides a graphical representation of depth and velocity hazards in the flood plain to show the limits of stability. Unit weights of 976, 1464 and 1952 kg/m^2 (200,300 and 400 $lb/ft.^2$) are used. Adults of average size would fall into the range between 976 -1952 kg/m^2 (200 - 400 $lb/ft.^2$) but young children would more appropriately fall into a range of 732 - 1464 kg/m^2 (150 - 300 $lb/ft.^2$). Only 7% of Ontario's population is within the 6 - 10 year age range, i.e. young children (Statistics Canada, 1981).

The coefficient of friction between foot apparel and wet grass, gravel, bare soils, pavements or other wet surfaces under flood conditions is not well known. A standard table of friction coefficients suggests that friction factors in the order of 0.3 to 0.6 could be characteristics of the ratio of the force to body weight required to initiate movement over unlubricated, dry surfaces. It is assumed that a lower friction factor range would be representative of the same state for a person standing on wet grass or pavement under flood conditions. The sensitivity of the stability calculation to friction factors of 0.15 and 0.3 is shown on Figure 6-1.

Any flood plain situation giving velocity and depth conditions lower than the appropriate curve for that individual is one where that person would be in a stable condition in the flood plain. Conditions of velocity or depth exceeding the appropriate stability curve would be unstable conditions for the same individual.

It is also appropriate to note that this analysis is based on a person standing still in the flood plain. Once a person begins to move to install floodproofing measures or leave the flood-prone area, stability is reduced further.

Figure 6-2 presents the same chart with overlays of different "product rules" (products of depth x velocity in m and m/s (ft. and ft./s). The 3 x 3, 3 x 2 and 2 x 2 rules are shown on the figure with the use of 0.3 friction factor to represent wet conditions. The cross hatched area defines a region of depth and velocity combinations which are stable, low risk combinations for most individuals likely to be present in the floodplain during a flood.

The 3 x 3 line encloses a large area of depth and velocity conditions which would lead to instability for most individuals. The 3 x 2 line represents a general average, but it too encompasses areas of instability for many individuals.

The 2 x 2 line excludes most of the unstable conditions for most individuals and would appear adequate at first glance. However, the 2 x 2 rule also has limitations as shown on the graph. At low velocity but depths greater than 0.9 - 1.2 m (3 - 4 ft.), most individuals would become buoyant. Similarly, in areas where flood plain depths may be less than 0.3 m (1 ft.) but where velocities exceed 1.5 - 1.8 m/s (5 - 6 ft./s) encountered on roadways or bridge crossings, for example, stability conditions would be exceeded and some individuals would be swept off their feet.

Although no product rule exactly defines this region, a reasonable approximation of the low risk area can be made with a product rule that includes some constraints on the domain of depth and velocity. For example, a product depth and velocity less than or equal to 0.4 m^2/s (4 $ft.^2/s$) defines the low risk area providing that depth does not exceed 0.8 m (2.6 ft.) and that the velocity does not exceed 1.7 m/s (5.5 ft/s). By contrast, in a situation where the depth and velocity are 1.1 m (3.5 ft.) and 0.3 m/s (1 ft./s) respectively, the product is less than 0.4 m^2/s (4 $ft.^2/s$) but the depth limit is exceeded. Hence, these conditions define a high risk area for some individuals.

It is evident that this approximate classification is somewhat conservative; but until further research is undertaken, it provides a reasonable factor of safety for all individuals - young and old - who may be present in the floodplain.

(2) Duration of Flood

The duration of a flood or the length of time a river overflows its banks, reaches its crest and recedes to within its banks depends on the efficiency of the river to transport the flood waters. Since the size of the watershed, time of concentration and duration of a flood affects the type of impact and pressure on the development, floodproofing measures must be designed to withstand these forces for the required period of time.

(3) Rate of Rise and Fall

The rate of rise and fall of a flood to and from its crest can affect the type and extent of floodproofing. For example, where the rise and fall are very sudden, there may not be time to implement active floodproofing measures, such as watertight seals and doors and thus these approaches would be deemed unacceptable. The rate should also be considered in investigations of slope stability for certain types of soils where a quick drawdown of flood waters may pose problems.

(4) Flood Warning System

The availability of advance warning can play an important role in determining the most appropriate measure. Where active floodproofing procedures are contemplated, lead time for implementation of appropriate protective measures and devices must be related to the amount of advance warning.

(5) Structural Integrity

When buildings and structures are surrounded by flood waters, they cause unbalanced pressures and loadings on all wetted surfaces, which increase rapidly with depth. Unbalanced pressures can cause structural and sub-structural damages which can completely collapse or displace the development. In order to design the most appropriate floodproofing measures, it is important to determine the effect of stresses on the proposed building.

The stresses imposed on a building are due to hydrostatic, hydrodynamic and impact loadings, depending on its location. Hydrostatic loads are developed by water that is either still or moving at a low velocity. These loads may be defined as acting vertically downward (i.e., on floors), or vertically upward (i.e., uplift), or laterally when acting horizontally on walls. Hydrodynamic loads results from the flow of water against or around a structure at moderate or higher velocities. These loads are directly dependent on the velocity of flow, and can also adversely affect the floodproofing measures by causing erosion and scour. Impact loads are caused by water-borne objectives, debris and ice. Their effects become greater and more crucial as the velocity and weight of objects increase. Impact loads are difficult to predict and define accurately. However, a reasonable allowance can be made with the knowledge of the conditions of the site.

(a) Superstructures (Above Ground)

Hydrostatic Loading Effects

Until the mid-1970s, it was assumed that standard design and construction practices - without modification - would be adequate to ensure that floodproofing by closures and seals could be conducted to moderate depth/hydrostatic loading without threatening the structural integrity of the above ground/superstructure of most buildings. However, various research by the U.S. Corps of Engineers over the years, has suggested otherwise.

Studies on structures of conventional design have determined that:

- brick veneer, frame structures (such as a typical home) would resist hydrostatic loading up to about 0.8 m (2.5 ft.) without damage;

- concrete block structures with limited or no reinforcement (such as the small warehouse building) displayed similar resistance characteristics and would not be damaged by hydrostatic loading up to 0.8 m (2.5 ft.). Above this at 0.9 and 1.2 (3 and 4 ft.) depths deflection and cracking became significant;

- solid brick structures responded in a similar manner. Tests with these also included end and side walls and walls with and without door openings. Walls with ceiling joists (with and without door openings) were found adequate to resist loadings to about 0.8 m (2.5 ft.). Walls with ceiling joists provide much stronger, but failed explosively when 2 x 4 supports were snapped;

- poured concrete walls were not tested, but from experience with other structural designs it was presumed that conventional design techniques would prove adequate against hydrostatic loads to at least 0.9 (3 ft.).

Therefore, 0.8 m (2.5 ft.) would appear to be the upper limit of effective flood depth (static plus equivalent hydrodynamic head) which can be resisted by conventionally designed structures without affecting structural integrity.

Studies on structural integrity during flow conditions have also given an appreciation of the permeability of conventional structures, in that:

· brick structures of conventional design begin to leak almost immediately and badly, when in contact with flood waters;

· concrete block structures of conventional design also leak badly at a rate that exceeds that of brick structures.

Tests also conducted to determine if materials or surface coatings would enhance water tightness found:

· no clear sealants (e.g. epoxy) were completely effective;

· no asphaltic material was completely effective;

· embedded roofing felts with polyethylene sheeting laid between a second brick course were found effective - but exceptionally stringent quality control of workmanship was required (particularly at joints);

· flood shields/bulkheads also presented difficulties and were for the most part ineffective unless designed especially with gaskets, smooth surfaces and locking bolts;

· certain thick, non-tear materials can be used as external "wrappings" to effectively seal buildings against infiltration. These are very special materials and fall into the category of "active" measures vs "passive", permanent measures.

In summary then:

· conventional designs are not water resistant/waterproof for even low depths of flooding;

· new structures should be designed from scratch for complete water tightness (or if not completely watertight must incorporate an internal system to collect and remove water seepage);

· new structures using conventional designs can be made watertight (without re-design) but the only proven approach so far uses external "wrapping".

Erosion

Flow velocities which will cause erosion of grass covered slopes or erosion around foundations are difficult to determine. Factors such as type of cover, slope and soil conditions must be taken into account. For most common situations, the range lies between 0.8 m/s and 1.2 m/s (2.5 ft/s and 4 ft/s) for easily eroded soils and 1.1 m/s to 1.5 m/s (3.5 ft./s to 5 ft./s) for more erosion resistant soils.

Impact Loading and Debris Accumulation

This aspect of structural integrity has not been studied in the field because it is practically impossible to establish velocity/depth limits associated with loadings caused by debris accumulation and the impact of floating objects on the flood plain. The nature of debris accumulations and size and shape of floatables simply varies too significantly.

Ice, debris and other floating materials can result in significant impact loading on buildings within the flood plain or increase the loads on buildings as a result of blockage. Although these loads are difficult to estimate a reasonable allowance must be made in design. Sites where the potential for such loading is high should simply be avoided or buildings should be designed/landscaped to intercept/deflect materials before the building is affected.

In cases where floodproofing is achieved by elevation on columns or piles, the clearing space between the columns or piles should measure perpendicular to the general direction of flood flow and should be adequately designed to minimize possible debris blockage. The open space created below the level of the flood standard should remain essentially free of more buoyant or hazardous materials.

(b) Substructures/Basements (Below Ground)

Based on normal (conventional) construction methods, any hydrostatic head in excess of 0.2 m (0.7 ft.) may result in damage to basement floors (i.e. the upward force of groundwater on the basement floor).

Even where the basement of a single storey brick or masonry structure has been structurally reinforced and/or made watertight, structural integrity or buoyancy may pose problems when groundwater (saturated soil) levels are 1.2 - 1.5 m (4 - 5 ft.) above the level of the basement floor. Much depends on the duration of the flooding, type of soil and the presence/effectiveness of the drainage system.

(6) Vehicular Access

Little or no information exists in the literature regarding ingress/egress criteria for vehicles.

The question of safety for the passage of vehicles can be subdivided into:

· flood depth and velocity considerations affecting egress of private vehicles from floodproofed areas;

· flood depth and velocity affecting access of private and emergency vehicles to floodproofed areas.

(a) Private Vehicles

In general, water contact is one critical issue in terms of its effect on the ignition/electrical system and the exhaust system. In the former, the distributor and/or spark plugs are the main items of concerns and those which are typical problem areas for most motorists.

Private vehicles come in all shapes and sizes and it is practically impossible to identify "typical" vehicles for assessing the elevation of key electrical components from the road surface. It appears likely that a depth of about 0.4 m - 0.6 m (1.5 - 2 ft.) would be sufficient to reach the distributor or plugs of most private vehicles. They would fail to start at this depth and hence vehicular egress will be halted. Cars may start at lower depths but then "splash" from driving on wet pavement or from the radiator fan would become a concern.

The issue of the exhaust system and the effect that flooding can play on engine back pressures/expulsion of exhaust gases appears to be the controlling factor. Difficulty would probably be experienced in starting most vehicles if the vehicle is standing in water at a depth that covers the muffler. The vehicle may start and continue to run if it is quickly removed from the water but if remains at that depth, there is a strong possibility that it will fail soon after.

Again, it is practically impossible to generalize this depth but

for most family automobiles something in the range of about 0.3 m - 0.4 m (1 - 1.5 ft.) would be the maximum depth of flooding before potential egress problems would result.

A hazard diagram such as Figure 2 may also be derived to evaluate the significance of flood velocity (and depth) on vehicles. Such a diagram would indicate that a "typical" North American car would not be significantly affected by velocities up to about 4.5 m/s (15 ft./s) or more at flood depths at less than 0.3 m (1 ft.). At running board depth or slightly above 0.3 m (1 ft.) the maximum velocity for stability drops to about 3 m/s (10 ft./s) and at about 0.4 m (1.5 ft.) depth an average vehicle may be displaced by velocities as low as 0.3 - 0.6 m/s (1 - 2 ft./s), with smaller vehicles becoming buoyant.

(b) Emergency Vehicles

Emergency vehicles operate under the same constraints relating to the electrical/exhaust system. Most police vehicles and ambulances would be limited by exhaust considerations, although emergency vans are better equipped to avoid splash problems since the key electrical components are higher above the road surface.

Diesel fire vehicles with top exhausts appear best suited for flood conditions. Their road clearance is high and it is suggested that 0.9 m - 1.2 m (3 - 4 ft.) of flood depth would not present a problem. These vehicles are about 10 times heavier than most automobiles and hence are resistant to displacement by higher velocity flood flows. Operations at velocities in excess of 4.5 m (15 ft./s) would probably not pose a problem when these vehicles are moving over a good/non-eroding base.

(7) Portable or Mobile Buildings and Structures

A portable or mobile building is one that is not permanently tied or anchored to a foundation and can be transported by means of a hauler. Portable or mobile buildings can be located on individual sites or in a park or subdivision. They can be used for temporary purposes, such as for construction crews or as full-time residences/seasonal homes with overnight occupancy.

When located in flood plains, portable or mobile buildings are highly susceptible to flood damage. Since they are not affixed to a permanent foundation, flood waters may easily sweep such buildings off their sites. Without advance warning, residents can be entrapped in the building. In addition, portable or mobile buildings can increase the flood hazard as they collide with other structures or block bridge openings or culverts. Despite this, portable or mobile buildings often are located in flood plains because:

- flood plain land acquisition costs may be lower;
- swamp conditions and higher water table which prevail in flood plain areas may preclude construction of permanent homes with basements; and
- potential recreational access by locating close to the water's edge.

Ideally, portable or mobile buildings should not be located in the flood plain. However, when located in the flood fringe, they should be properly floodproofed to the flood standard, in order to prevent flotation, collapse and lateral movement. Due to the inherent hazard of remaining in a mobile building during a flood, contingency plans indicating escape routes and alternative vehicular accessways should be prepared.

Where the portable or mobile building is on site temporarily, it may not be feasible to meet all the requirements for floodproofing. In such cases, temporary location of portable and mobile buildings in the flood fringe may be considered where the time frame is very short and sufficient flood warning would allow the structure to be hauled away in advance of the flood.

(8) Floodproofing Complexity

The complexity of floodproofing techniques (and to a degree the cost) is best related to depth and type of floodproofing considered.

(a) Closures and Seals

It appears that external walls can be floodproofed by closures and seals to a flood depth of about 0.8 m (2.5 ft.). Beyond this depth, structural integrity is threatened and special reinforcing or revised designs (with poured concrete walls for example) are required.

Dry floodproofing to this depth can be completed with the use of impervious external "wrappings". These contingency wrappings are anchored beneath the ground surface along the foundation and rolled upward and hung into place along the walls of building prior to flooding. Equivalent dry floodproofing using internal sealants, doubled walls, etc. with flood shields at openings is more complex, expensive and uncertain as to effectiveness.

Basements can be closed and sealed to levels of about 1.2 - 1.5 m (4 - 5 ft.) above the floor slab with poured concrete designs employing additional reinforcement and special attention to monolithic construction. Beyond this level, the procedure becomes complicated as buoyancy/uplift must be addressed through anchors and/or added wall and slab thickness.

Overall, closures and seals is fraught with possible problems and is considerably more complicated than other floodproofing approaches.

(b) Elevated structures

Structures on Fill

Floodproofing on fill is generally considered for slab on grade construction. It is not a complex procedure and conventional building techniques are employed once the pad is down. The principal concern is fill compaction which must usually be done in 0.2 - 0.3 m (0.5 - 1 ft.) lifts. Beyond 0.6 - 0.9 m (2 - 3 ft.). however, pad sizes increase, compaction requirements become more important and an engineer or soils consultant should be employed for design review and inspection. Increased elevation may also lead to requirements for pad sizes in excess of lot size and, hence, additional requirements for erosion protection, etc.

Houses with conventional basements can also be placed in fill to elevate the first floor to a level about 2.1 - 2.4 m (7 - 8 ft.) above grade (i.e. the basement is founded on grade and the basement walls are surrounded by fill). At 1.2 - 1.5 m (4 - 5 ft.) above grade, the procedure is complicated by the need for wall and slab reinforcement, and anchors to prevent buoyancy.

Elevation on Columns, Piles, Piers and Extended Foundation Walls

Elevated structures using these techniques must be designed with consideration for debris loading, orientation of supports, effective submergence on foundation soil conditions and anchorage, bracing and connection details, availability of mechanical equipment, etc. In most instances, an

engineer should be consulted to ensure that the possible effects of flooding are considered in the design. There are more factors to consider than conventional house construction on fill and, hence, these approaches could be considered more complex.

The majority of elevated buildings use posts for support (steel or timber). Installation becomes more complex at lengths in the range of 3.6 - 4.8 m (12 - 16 ft.) since machinery is needed for installation. A range of 3 - 3.6 m (10 - 12 Ft.) seems typical for most homes which use extended posts.

Mechanically-driven piles are reported to be the best solution if severe erosion is anticipated. Pile driving equipment and skilled operators are at a premium and, because of the initial expense, this technique may be too complex/unnecessary for flood depths less than 1.5 - 1.8 m (5 - 6 ft.)

Piers/columns are generally constructed with brick, concrete block or poured concrete. The common elevation range for each of these approaches is as follows, beyond which increasing complexity is assumed:

- 0.4 - 1.8 m (1.5 - 6 ft.) for brick piers;
- 0.4 - 2.4 m 91.5 - 8 ft.) for reinforced concrete masonry piers;
- 0.4 - 3.6 m (1.5 - 12 ft.) (or more) for poured in place, reinforced concrete piers.

Extended foundation walls make a relatively simple and effective foundation for elevated structures but again must be designed with consideration for loads and pressures anticipated in the flood plain.

Berms and Floodwalls

Berms (or levees) and floodwalls used for floodproofing are low structures built around single homes or individual industrial complexes. Property design is more complex since material and construction practices must be closely monitored, they must be regularly maintained (in the case of berms), and they usually require adequate pumping facilities to handle interior drainage and seepage. Both berms and floodwalls usually have some opening for access and consideration must be given to closure.

In many instances, berms and floodwalls should be designed by qualified professional engineers.

Intentionally Flooding a Building (Wet Floodproofing)

Intentionally flooding a building for the purpose of balancing internal and external pressures so as to maintain structural integrity is in itself not complex. To ensure minimal damage and quick clean up, a number of conditions have been placed on the use of wet floodproofing by agencies such as Canada Mortgage and Housing Corporation. Requirements include:

· at least two openable windows located on opposite sides of the building;

· tops of window sills to be not less than 150 mm below grade (to allow flood water into the basement);

· basements to remain unfurnished and contain non-habitable space only;

· mechanical and electrical equipment, heating units and duct work to be located above the flood standard;

· sump pump required;

While wet floodproofing may be designed and provided for in a building, there is no guarantee over time that the requirements will be maintained. In particular, it is difficult to control the “finishing off” of basements which would then result in damages when wet floodproofing measures were put into effect. Therefore, while wet floodproofing may appear desirable initially, the ability to ensure the principles and requirements of wet floodproofing are maintained in the future must also be considered.

TAB 6

Ontario

Technical Guide

River & Stream Systems: Erosion Hazard Limit

Ontario Ministry of Natural Resources
Water Resources Section
300 Water Street, 5th Floor, South Tower, P.O. Box 7000
Peterborough, Ontario K9J 8M5

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This document has been prepared by Terraprobe Limited and Aqua Solutions for the Ontario Ministry of Natural Resources, Water Resources Section in support of the Natural Hazards Policies (3.1) of Provincial Policy Statement of the Planning Act (1997). Contact information is as follows:

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Acknowledgements

Many individuals contributed significant time and effort towards the preparation of this document. The contributions of Judy Sullivan - Aqua Solutions, Mike Tanos - Terraprobe Limited and Ala Boyd and Pearl McKeen of the Ontario Ministry of Natural Resources are gratefully acknowledged.

In addition this document could not have been completed without the generous contributions of the following individuals.

Robert Newbury, Newbury Hydraulics
Robbin Sotir, Robbin B. Sotir & Associates

Selected figures were reproduced from:

Newbury, R. & Gaboury, M., Stream Analysis and Fish Habitat Design: A Field Manual. 1993, and
R.B. Sotir presentation notes. This material used by permission of Newbury Hydraulics Ltd. and R. Sotir & Associates.

Introduction

The 1996 Provincial Policy Statement issued under the authority of Section 3 of the Planning Act provides policy direction on matters of Provincial interests related to land use planning and development. According to the Planning Act, planning authorities "shall have regard to" policy statements issued under the Act. One important principle behind the policy statement to achieve long-term economic prosperity, environmental health and social well-being is the reduction of public cost and risk to Ontario's residents by directing development away from areas where there is risk to public health or safety or risk of property damage. Accordingly, the Province of Ontario issued policies under Public Health and Safety policy areas addressing natural and human-made hazards. The new planning approach also empowers municipalities to promote efficient, cost-effective development and land use patterns through the use of coordinated approaches when dealing with issues which cross municipal boundaries including ecosystem and watershed related issues, shoreline and riverine hazards.

Figure 1 - Slope Slide Caused By River Erosion

Natural hazard studies form an important part of watershed management and planning. Proper planning requires the balancing of a wide range of public and private interests. Ecosystem based planning within a watershed or a sub-watershed, involves an up-front evaluation of numerous, and sometimes competing, land use and natural resources interests. It provides a means of examining and developing planning strategies that balance local as well as community-based needs. Through ecosystem based planning processes, environmental and social concerns such as flood and erosion hazard lands can be identified and incorporated into the land use planing process.

The Ministry of Natural Resources (MNR) is the lead administrative Ministry having overall Government responsibility for natural hazard policies and programs (flooding, erosion, etc.). The Provincial Policy Statement (PPS) of the Planning Act outlines areas of provincial interest respecting natural hazard policies (Section 3.1).

Provincial reforms have streamlined municipal planning into a "one-window" process. Municipal planning decisions are guided by the policy direction in the Provincial Policy Statement, as opposed to comment and input received from individual ministries. MNR is a signatory of the Provincial One Window Protocol and assists the Ministry of Municipal Affairs and Housing in the achievement of Provincial One Window Vision. Municipalities are delegated with authority to address areas of provincial interest in their planning documents. The Ministry of Natural Resources (MNR) through its water management program will ensure that the program is effectively aligned with the Ministry's vision of sustainable development and its mission to achieve ecological sustainability. MNR's objectives to achieve ecological sustainability include the continuation of Provincial programs for the protection of life and property from flooding and other water-related hazards, and the provision of direction and input through policy, information and science support.

The Provincial government's role in the planning and management of flood risk areas is to protect society, including all levels of government, from being forced to bear unreasonable social and economic burdens due to unwise individual choices.

The Province sets minimum standards to ensure that these risks and costs to society are reduced. There are instances where local conditions dictate that the minimum standards may not be sufficient and a higher standard may be more appropriate. The Province has empowered municipalities to assume responsibilities for the management of natural hazards, the associated liability and the risk relative to planning for new land uses in and around these areas. The municipality making these decisions should ensure that natural hazards studies are undertaken by accredited professionals such as a Professional Engineer.

The Technical Guide - Rivers and Streams: Erosion Hazard Limit document has been prepared to assist in the understanding of the latest Provincial Policy Statement and to describe approaches which have been determined to be consistent with the new policies. The enclosed document is based on the 1996 Provincial Policy Statement and it updates previous documents (i.e. Natural Hazards Training Manual) which address riverine erosion hazards.

This guide serves in an advisory role and is not intended to introduce any changes from the Policy Statement. Instead, it should be read in conjunction with the Provincial Policy Statement as well as other natural hazards related technical and implementation guides.

The primary purpose of the Rivers and Streams Technical Guide Erosion Hazard Limit***, is to provide a consistent and standardized procedure for the identification and management of riverine erosion hazards in the Province of Ontario.*** Designers and review agency staff will find the Guide helpful in their work as it is based on a standard and relatively simplistic methodology, intended to be applied to two generalized landform systems through which river and stream systems flow; confined and unconfined systems.

This document describes, in general terms, an important component of watershed management; it presents the hydraulic work as well as soil and slope stability analyses needed to conduct riverine erosion studies to determine appropriate management strategies. It is not intended to be a list of mandatory instructions on technical methodologies to be rigidly applied in all circumstances. Instead, the Guide serves to assist technical staff experienced in natural hazards management to select the most appropriate methods and flexible implementation measures in the identification of riverine erosion lands. The Guide cannot replace good engineering, scientific and environmental judgement in adopting the most appropriate procedures required when undertaking and adopting a local or watershed-based erosion and slope stability related study program.

The Rivers and Streams Technical Guide Erosion Hazard Limit is composed of the following six sections:

Section 1: Introduction
Section 2: description of the physical features and processes
Section 3: application of the Provincial Policy, definitions of *erosion hazard* limits and associated “allowances” based on a simplified landform system
Section 4: description of the study, site and field investigation information
Section 5: direction on how to address the hazards within a watershed context
Section 6: introduction to environmentally sound hazard management approaches

The meteorological (rainfall) and physical process and factors which impact upon watersheds and the nature of their interactions with the surficial materials and local geology are extremely complex and the subject of many current ongoing scientific investigations. River and stream systems undergo continuous changes in form and configuration as a result of natural processes such as erosion, transport and deposition of sediment and varying hydraulic conditions. The primary agents are water flow rates and natural channel gradients. The degree of impact that the erosive forces have is dependent on the relative strength of the materials that comprise the channel bed and banks. Land use change and alteration to the watersheds hydrologic cycle may accelerate impacts. Numerous other physical, biological and human induced processes also impact river and stream systems and continue to influence the characteristics of the constantly evolving watershed. The interactions amongst these processes and their inter-relationships need to be understood, assessed and integrated as part of any implementation option or strategy aimed toward sound management of watershed ecosystems and hazard lands.

To address in part, the importance of some of these processes, their inter-relationships and impacts on river and stream systems the following documents should be consulted:

- Adaptive Management of Stream Corridors in Ontario (2001, In press)
- Technical Guide River and Stream Systems Flooding Hazard Limit, MNR (2001)
- Geotechnical Principles for Stable Slopes, MNR (1998)
- Stormwater Management Practices Planning and Design Manual, MOE (2001 - in press)
- Stream Corridor Restoration: Principles, Processes and Practices, USDA (1998)
- Stream Assessment Protocol, MNR (2001)

For more detailed technical information, the reader is urged to consult the bibiography which includes a number of references on hydraulics, geomorphology and river engineering.

2.0 Erosion Process

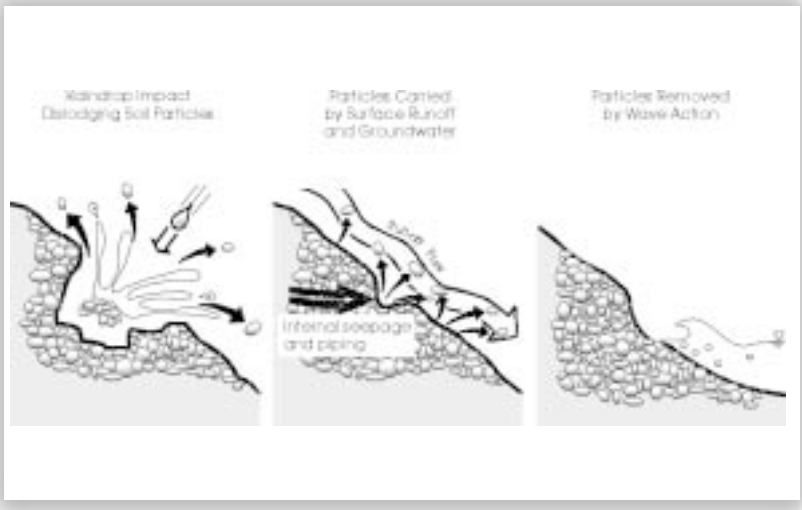


Figure 2 - Water Action on Soil

Erosion and slope instability are two different processes which are often associated together. The erosion process affects the soil surface at the particle level, by gradually dislodging and removing (transporting) the soil particles from the parent mass (Figure 2).
Slope instability consists of the sudden movement or sliding of a large mass of soil over a failure plane. Slope instability is not restricted to the removal of the surface particles. It consists of the sudden movement or sliding of a large mass of soil over a failure plane. (See figure 3)

The following examples indicate the erosion process not slope instability. Slope instability will be addressed further on in Section 2.4.5 of this document.

Water movement is often the agent (see Figure 5) commonly occurring in one of the following manners;
- channel bed and bank erosion by watercourse flow
- slope toe erosion by watercourse flow coincident with slope
- internal seepage, springs, piping near or over the bank, flooding
- surface runoff, gully erosion, sheet and rill erosion near and over the bank by surface drainage (upland areas) into the watercourse.

Figure 7 - Bank Erosion due to deflected flow debris

Other processes such as wind and frost may assist in the weathering or dislodging and transport of soil particles. Streams also widen their channels in several ways;

- bank erosion due to lateral corrasion during flood flows,
- bank erosion due to deflected flow from debris (tree trunks, boulders, dumping, slumps), and
- impinging of a meander belt against valley slopes.

Figure 3 - Slope Instability

Figure 4 - River Erosion

Figure 5 - Gully Erosion of Slope

Figure 6 - Rill Erosion of Slope

2.1 PHYSIOGRAPHY

GEOMORPHOLOGY - GLACIAL DEPOSITS AND LANDFORMS

The surface features of Ontario have been shaped by Quaternary Period glaciation which also produced the Great Lakes. The section on The Formation of Streams from AMSC[1] should be reviewed.

The Quaternary Period began about 1.8 million years ago and has been subdivided as follows.

Pleistocene Epoch OR "the Great Ice Age"	1.8 million years before present	time of growth and decay of several continental-scale ice sheets
	115,000 years ago	beginning of Wisconsinan glaciation
	20,000 years ago	Laurentide Ice Sheet covers Ontario
		end of Wisconsinan glaciation
Holocene Epoch	10,000 years before present	post-glacial times
	present	

Large sheets of ice (estimated at to 1 km thick) advanced and retreated over the bedrock surface which was carved and scoured. Clay, silt, sand, and gravel were deposited. What remained were the Canadian Shield of Precambrian bedrock, and Quaternary glacial deposits. The glacial deposits had an average depth of 30 to 60 metres.

The most widespread glacial deposit was "till". Till describes "sediment that has been transported and deposited by or from glacier ice, with little or no sorting by water" (Dreimanis, 1982). Till is typically massive in structure, without stratification or lamination. Till is often compact or over-consolidated due to the pressures exerted by the glacier ice mass.

In addition to till sheets, there were also glaciofluvial deposits (sand and gravel), and glaciolacustrine deposits (clays, silts, sands), and post-glacial deposits of alluvium or peat.

The glacier ice movements also caused landform features including:

a) fluted (grooved) till plains;
b) drumlinized till plains;
c) hummocky (or ribbed or washboard) ground moraine;
d) crag-and-tail features;
e) eskers, spillways, kames, kettles.

Drumlins are oval-shaped hills composed of till or stratified sediments. The nature of the glacial deposits (dense or hard soil, landform features) can have significant influence on the natural drainage characteristics and patterns that develop.

The numerous sequences of glacier ice advance and retreat were accompanied by the drainage of vast quantities of meltwater and the formation of streams, rivers, and lakes. For further information, see the section on Glacial History, The Formation of Streams, AMSC[2]. As glaciation left southern Ontario, the landscape was covered mostly by coniferous forests (pines and spruce). These features are indicated on the following (figure 8 and 9). The Quaternary Geology for Southern Ontario.

After the glacier retreat, the Ontario landscape was subjected to erosion and the cutting of river valleys as the result of surface run-off and drainage. Locally the glacial deposits have been modified by this erosion. Soil materials are often referred to as 'overburden' or unconsolidated materials. Bedrock is encountered beneath the soil materials, and is generally strong and consolidated, see the section on Surficial Material & Landforms, AMSC[3].

Most of southern Ontario is underlain by sedimentary rocks such as shale and limestone. Central and northern Ontario is predominantly underlain by igneous and metamorphic rocks such as granite and gneiss. The Bedrock Geology of Ontario is shown on the following maps, Map 2 A & B (figure 10). Further details can be found in the section on Bedrock Geology, AMSC and the document "Geotechnical Principles For Stable Slopes", April 1998.

Figures 8 and 9 : Quarternary Geology For Southern Ontario

Figure 10: Bedrock Geology of Ontario

1 Work in Progress: Adaptive Management of Stream Corridors in Ontario, 2000
2 Work in Progress: Adaptive Management of Stream Corridors in Ontario, 2000
3 Ibid

Figure 11 - Confined system

Figure 12 - Confined system

Figure 13 - Confined system

Geologic constraints on rivers (valley walls, bedrock sills, terrain) can affect their channel shape and pattern, and susceptibility to erosion. Valley systems can include alluvial deposits, flood plains, and terraces. Most rivers are not "alluvial rivers" since they do not flow on self-deposited sediments, but rather across terrain that has been formed or altered by glacial processes.

For the purpose of addressing erosion and slope stability hazards in river and stream systems, the following general landform types have been selected;

a) Confined watercourse is within a valley corridor with or without a floodplain, confined by the valley walls,

b) Unconfined watercourse is not within a valley corridor, but relatively flat to gently rolling plains, and is not confined,

Figure 14 - Unconfined system

The **confined** river valley or stream system is one in which the physical presence of a valley corridor containing a river or stream channel (may or may not contain flowing water) is visibly detectable from the surrounding landscape by either field investigations, aerial photograph and/or map interpretation. The location of the river or stream channel may be located at the base or toe of the valley slope, in close proximity to the valley slope toe (less than 15 m) or removed from the valley slope toe (15 m or more).

Figure 15 - Unconfined system

An **unconfined** river valley or stream system is one in which a river or steam is present but there is no discernible valley slope that can be detected from the surrounding landscape by either field investigations, aerial photography and/or map interpretation. For the most part, unconfined systems are usually located within the headwater areas of drainage basins and in fairly flat terrain. The river or stream channels contain either perennial (year round) or ephemeral (seasonal or intermittent) flow and may range in channel configuration from seepage and natural springs to detectable channels.

2.2 SOIL COMPOSITION AND PROPERTIES

Soil has properties that can be unique to each site and quite variable, so that a subsurface investigation of soil stratigraphy and strength properties should be considered at every site where the slopes are high and steep (i.e., higher than 2 m and steeper than 3 to 1, horiz. to vert.) or where there are issues of public safety or property value.

Soil slopes and river banks can be composed of a single soil type (referred to as 'massive' or homogeneous) or, of many soil layers (stratified) with different strength properties. Similarly a wide variety of ground water and seepage conditions may occur, ranging from dry conditions to several distinct ground water flow systems within the same slope.

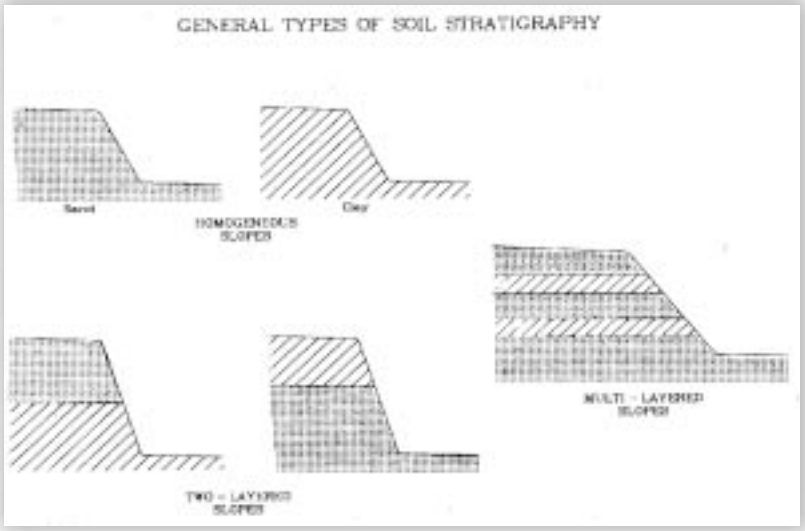


Figure 16 - Layered Soil Stratigraphy

Much of Ontario has been subjected to the Wisconsinan glaciation (about 12,000 years ago) when thick glaciers advanced and retreated across the land. This period created the soil deposits , surface features, and drainage patterns of much of southern Ontario (refer to Chapman and Putnam, 1984; Physiography of Southern Ontario). The most common glacial deposits found in Ontario are noted below;

Figure 17 - Layered Soil Stratigraphy

- **glacial till** is a heterogeneous mixture of many particle sizes ranging from clay to boulders (clayey silt, sandy silt, silt and sand); transported and laid down near the base of a glacier; typically consolidated and competent; non-sorted and non-stratified; 'till' is a Scottish word describing a stony clay; sometimes referred to as 'boulder clay'
- glaciofluvial **outwash sands and gravels** (alluvium) were deposited by drainage of ice meltwater, often well-sorted and stratified.
- **glaciolacustrine clays and silts** (laminated or varved) deposited in bottoms of glacier lakes and ponds; fine-grained.
- **glacial marine sediment** (Leda clays) clay-rich, flocculated structure, sensitive,
- **ice-contact stratified drift** (kames, eskers, kettles) modified by meltwater during or after deposition; may have considerable sorting and stratification, as well as large range of sizes, chaotic structure, and inclusions of till.
- **eolian deposits** of sand dunes, sand sheets, and loess.

After the glacier retreat, the Ontario landscape was subjected to erosion and the cutting of river valleys as the result of surface run-off and drainage. Locally the glacial deposits have been modified by this erosion. Land development activities such as cutting and filling (earth-moving) and drainage may also result in significant changes to soil and ground water conditions.

A soil mass is composed of individual soil particles in which there are void spaces between the particles, filled by either air or water. In engineering terms, soil is defined as "unconsolidated material composed of discrete solid particles". There is a large variety in distribution of the particle sizes and shapes in soils, ranging from granular soils such as gravel or sand, to clay soils or mixtures thereof. Soil descriptions are based on the "gradation" or distribution of particle sizes (by weight) for the following general types;

Table 2.0 - Soil Particle Sizes

Soil Type	Range of Particle Size (equivalent diameter)	Texture	Notes
gravel	2 to 60 mm	coarse	grape-, pea like; cobbles 60 to 200 mm, grapefruit-like
sand	0.06 to 2.0 mm	gritty	particles visible by eye, salt-, sugar-like, gritty feel
silt	0.002 to 0.06 mm	smooth	powder-like, grains not visible to eye, cannot roll thread
clay	< 0.002 mm	silky	smears, can roll thread, like play-dough

Coarse grained soils can be readily recognized in the field by visual examination (by eye) and direct measurement of soil particle sizes (by tape measure). A "rapid sedimentation test"

can also be helpful. Place soil in a tall bottle of water, shake, then place bottle upright and allow the suspended soil particles to sediment. Sand sizes and coarser will have settled to the bottom after about 1 minute.

The sense of touch (tactile examination) can be used to distinguish between sand, silt, and clay. Sand has a gritty, sharp feel. Silt has a rough feel and clay has a smooth, greasy feel. Clay sticks to your fingers and dries slowly. Silt dries fairly quickly and can be dusted off the fingers easily (slight stain residue left).

Silty soil can also be identified with the "dilatancy test". A wet pat of soil is shaken or tapped in the palm of the hand. If there is a high silt content in the soil, it will exhibit dilatancy and will show free water on the surface. This water will disappear when the soil pat is squeezed.

Figure 18 - Dilatancy Test

The "shine test" can be used to determine the presence of clay. A lump of slightly moist soil is cut using a knife blade. The cut soil surface will appear either shiny (indicating a significant clay content and high plasticity) or dull (indicating a low clay content and low plasticity).

In addition to the grain size distribution, soils are also identified or classified on the basis of various other "index properties" such as "density, water content, and plasticity".

Soils containing significant amounts of clay and silt are termed "cohesive". These soils can stick together in a cohesive mass or clump. The individual particles are generally not distinguishable by the unaided eye (too fine). These soils are termed "plastic" as they can be moulded in a cohesive mass or shape when moist. A measure of the "plasticity" can be obtained with a laboratory Atterberg Limits test.

The very fine individual clay particles are plate-shaped or flake-shaped and can be arranged in a "flocculated" condition similar to a house of cards or, in a "dispersed" condition with aligned orientation of the particles.

For further information on the soil properties of cohesionless and cohesive soils, see Appendix 1, Appendix 2 and the document "Geotechnical Principles for Stable Slopes", 1998.

The erosion rates and properties of bedrock can vary from a hard granite, to limestone, to a very soft shale as indicated below.

The properties of shale can vary greatly depending on its durability. Long-term stable slope angles of 8° to near vertical have been observed. Most natural slopes of shale have weathered to a stable inclination (usually not steep unless interbedded with more resistant rocks) and stability becomes an issue only for excavations or highway cuts. For highway cuts in shale slopes, it is quite common to see design slope inclinations of about 1 to 1 (horiz. to vert.) to about 1.5 to 1 (horiz. to vert.).

As previously discussed, potential natural hazards in river and stream valley systems are typically related to either or both; toe or bank erosion by water flow, and slope instability and slope slides or failures.

The following soil classifications or categories have been chosen for use in evaluating slope toe or bank erosion resistance to river and stream flows;

1. **Hard Bedrock (i.e., granite)**.

2. **Soft Bedrock (e.g., shale, limestone), or Cobbles, or Boulders**.

3. **Stiff/Hard Cohesive Soil (e.g., clays, clayey silt), or** Coarse Granular (e.g., gravels, sandy gravel), or **Glacial Till.**

4. **Soft/Firm Cohesive Soil, or** Fine Granular (e.g., sand, silt), or Fill.

(see illustration below)

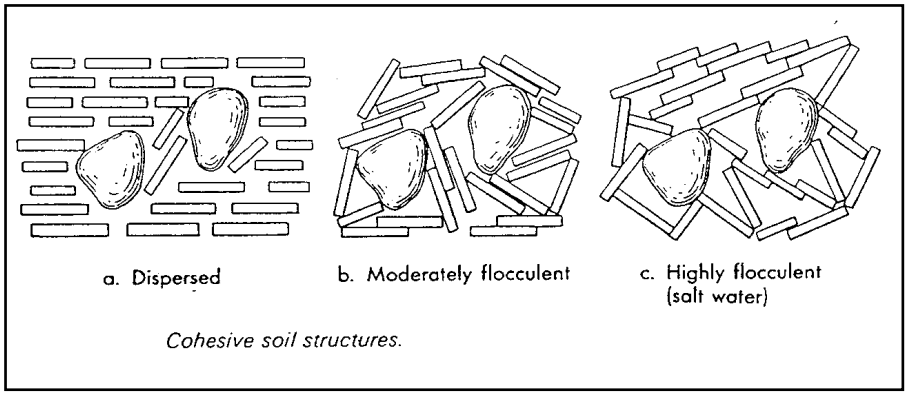


Figure 19 - Flocculated Particle Arrangement

Figure 20 - Soft Bedrock - Limestone

Figure 24 - Soft Bedrock Shale

Figure 21 - Soft Shale Slope

Figure 26 - Stiff/Hard Cohesive - Clayey Sill

Figure 22 - Hard Bedrock - Granite

Figure 26 - Coarse Granular - Gravel

Figure 23 - Soft/Firm Cohesive

Figure 27 - Fine Granular - Sand

2.3 PHYSICAL FEATURES AND PROCESSES

Most of the drainage features in Ontario, were formed as a result of very large surface runoff following Pleistocene glaciation some 10,000 to 12,000 years ago. River valleys and stream corridor systems are by nature dynamic, constantly changing landforms due to the erosive forces of flowing water and the relative stability of surrounding bank sand slopes. The spring season usually experiences fierce fluvial action (snow meltwater, rains, ice jams, flooding). The degree and frequency with which morphological (physical) change will occur in these drainage systems depends on the interaction of a number of interrelated factors including hydraulic flow, storm frequencies, channel configuration, sediment load in the system, and the stability of the banks, bed and adjacent slopes. A summary of the fundamental processes of river and stream systems can be found in the section on Stream Corridors: Form, Function & Processes of the AMSC[5] report.

Man-made changes to the watershed, have also affected water courses and their equilibrium of hydrology and hydraulics. These result in ground loss or movement, and the creation of hazardous conditions that pose a threat to human lives and cause property damages. Millions of dollars are spent annually in attempts to remedy erosion and slope stability problems of varying degrees of risk to life and property.

Even with the installation of remedial measures (i.e., assumed to address the erosion hazard), the natural forces of erosion and water flow rates may prove to be such that the remedial measures may only offer a temporary solution or a very limited measure of protection.

Figure 32 - Manmade Hazard Damages - Collapsed Wall

River and stream systems are part of larger overall drainage watersheds, and the river and stream mechanics are linked to the watershed processes. The natural importance of rivers and stream systems in providing physical, biological, and chemical support functions for sustaining ecosystems (including that of humans) is well established. These support functions are strongly associated with the physical processes of discharge (flow), erosion, deposition and transport that are inherent in any fluvial system. Given that ecological sustainability is based on the dynamic nature of these systems, it is essential that their physical processes (i.e., flow dynamics) be allowed to function in a natural state. Erosion is dependent on a number of processes as well as the composition and morphology of the watershed.

Figure 28 - River Processes - Erosion

Figure 29 - River Processes - Ice

Figure 30 - Wind Erosion Damages on Soft Sand

Figure 31 - Manmade Hazard Damages

2.3.1 Scope, Scale & Spacial Extent

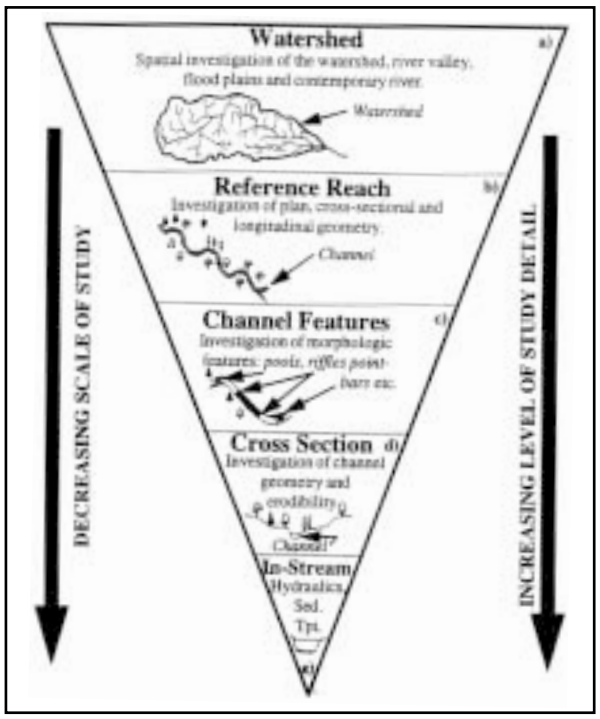


Figure 33 - Scales of Investigation (MNR)

The river and stream systems function on a watershed/subwatershed basis, it is for this reason that it is extremely important to determine the extent of the scope, scale and spacial extent of the site that it effects. The river systems study area is likely much larger than the site itself. Rivers and streams are integrated flowing systems that create and maintain habitats within the structure of their flow as well as on and beyond their wetted boundaries. The effects from the site may not only be felt up or downstream but also well outside the areas that maintain the flows along the valley or stream corridor.

In order to determine the scope, scale and spacial extent required in an investigation for a particular site, it is important to recognize the major differences in information requirements associated with these variables. A discussion on the effect and role of scale is presented in the AMSC[6]. It is helpful to outline the general range of possible levels of investigation. The following list illustrates four general levels and is presented from work prepared by MNR, 1994 fig. 33 and Newbury, 1993 fig. 34. The MNR ranges are described according to the level of investigation required depending on the geographic scale of the application and its related hydrology and flow network. In Newbury's work, within the watershed the flow habitats are nested within one another at smaller and smaller scales. These habitat scales coincide with the levels presented by MNR.

Level 1: Watershed or Channel Segment

This involves the investigation of the stream system in the context of its watershed. The overall stream and valley system network and linkages to the adjacent table lands are considered. The size and geometry (width, depth, slope) of stream segments within the overall watershed are determined using such things as flows from the tributary drainage areas, ground water recharge and discharge areas should also be identified.

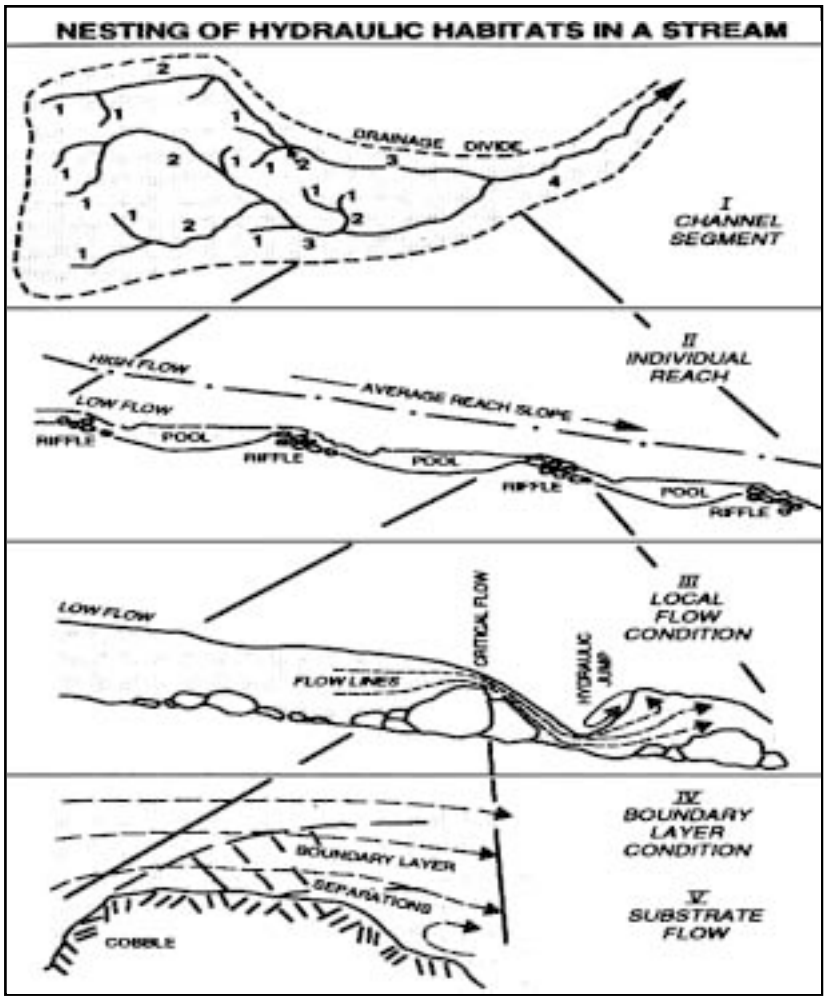


Figure 34 - (Newbury, 1993) - Nesting of Smaller Levels of Stream Habitats

Level 2: **Individual Reach**

Reaches may be distinguished within a segment with characteristic riffles, pools, substrates, and channel patterns. This will also include identification of boundary conditions such as the flow regime from an upstream area or sediment loads.

Level 3: **Cross Section of Reach**

A specific cross sectional area within a section of the reach is defined. The local flow conditions within a specific section of the reach can be determined.

Level 4: **Site**

The specific, localized features and issues are identified at this level. Newbury's fourth level considers the boundary layer habitat of an individual benthic organism located within the local flow structure. It may be characterized by direct and analogous measurements. Newbury extends this level by introducing a further level which can not be observed directly but can be implied from measurement of the local piezometric gradient and the conductance of the streambed deposits.

The following figure indicates the levels and how they relate to the nesting of smaller and smaller levels of stream habitats.

2.3.2 River and Stream Classifications

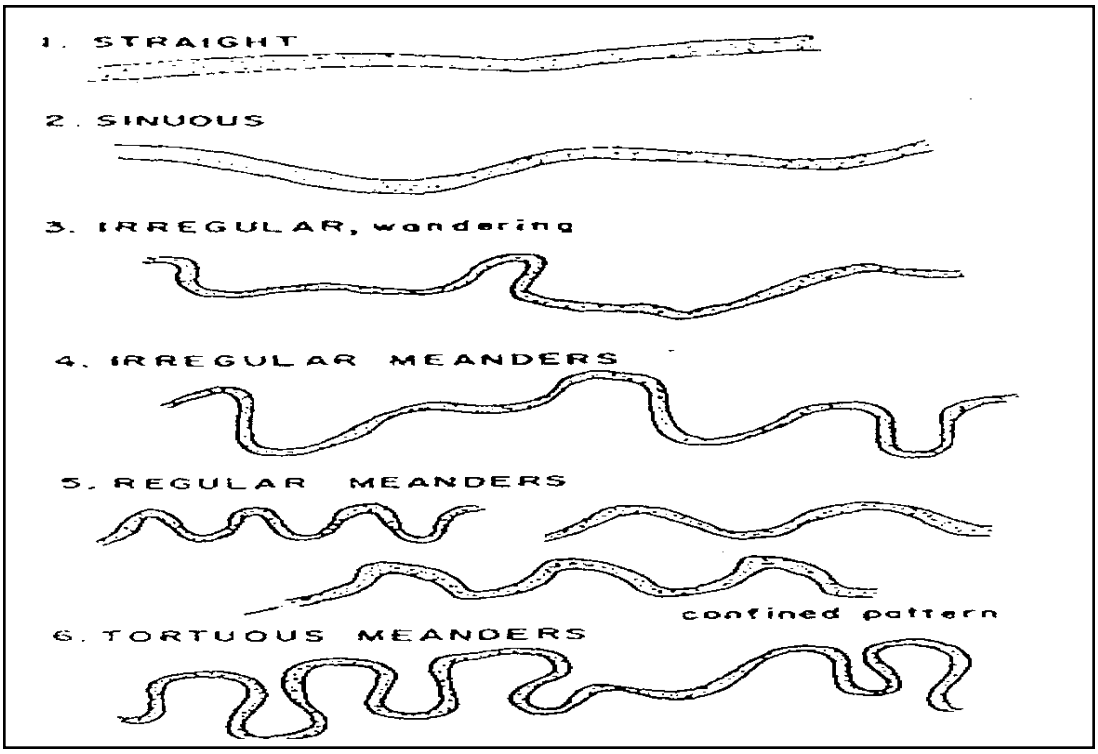


Figure 35 - River Patterns

Classification systems allow comparison of river features and behaviour, based on similar characteristics.
The complexity of the interaction of the above variables in ravines, river valleys, and stream corridor environments results in a wide array of drainage and stream/river types and patterns (Leopold et al, 1964).

There are a variety of classification systems available. A discussion on the various systems and their attributes is provided in a section of the AMSC[7] report.

2.3.3 Flow Regime

The flow component of river and stream systems plays a significant roll in the determination of the channel form. The "flow regime" defines the amount, intensity, duration, magnitude, and frequency of a precipitation event. This can encompass valley, floodplain, riparian, baseflow and bankfull flows. Refer to chapters 2 and 4 of the AMSC document for further details on the various flow regimes and the following figure.

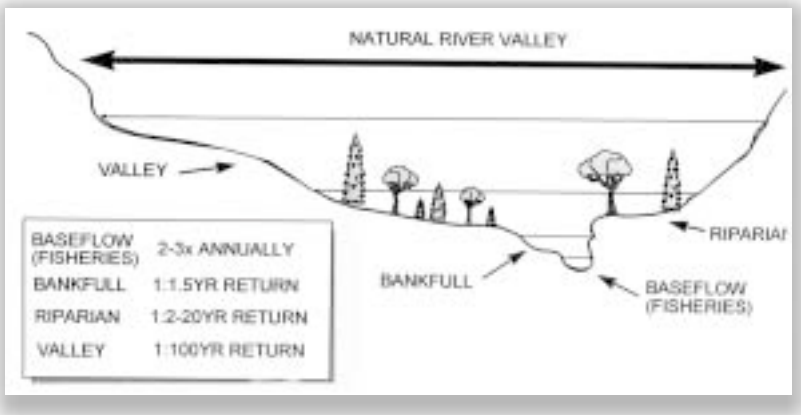
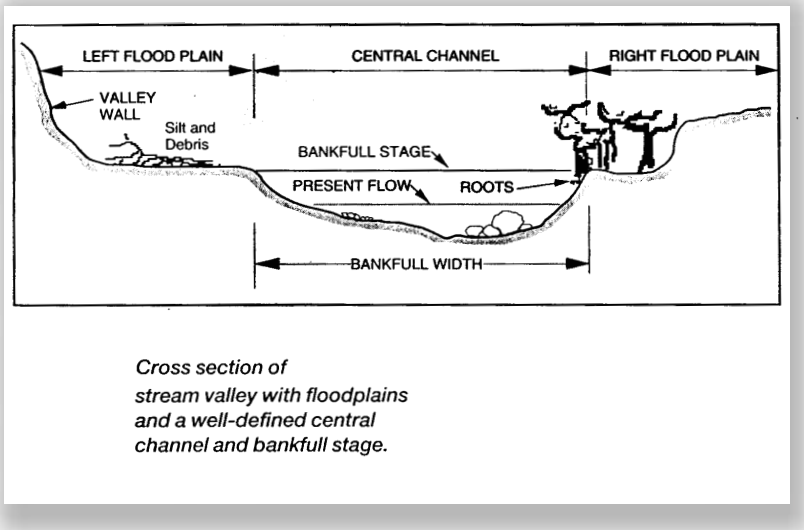


Figure 36 - Stages of Flow

2.3.3.1 Bankfull Conditions

The bankfull conditions are important in determining the erosion hazards for river and stream systems. For confined and unconfined systems the erosion hazard guide indicates the bankfull width can be used to determine the erosion allowance and the "meander belt allowance (20 x bankfull width).' If information on the Flooding Hazard Limit is not available or if the proponent prefers to determine the erosion hazard allowance by using the meander belt analysis then a detailed study may be conducted for the particular stream or river.

Numerous technical sources have indicated that the bankfull discharge is the event that determines channel morphology or change. The "channel-forming discharge" or the bankfull width can be identified in the field by scour lines, vegetation changes, or recent sediment. Bankfull channel width is commonly determined through either field investigations or through aerial photograph interpretation. (See Section 3.3 for



Cross section of stream valley with floodplains and a well-defined central channel and bankfull stage.

Figure 37 - Stream Valley Cross-section

Figure 38 - Bankfull Conditions

Figure 39 - Bankfull Conditions

further information). It can also be estimated on the basis of hydrologic analysis of storm flow levels for bankfull conditions.

The regularly recurring bankfull flood maintains the central channel or channels and may be used as the channel characteristic or maintenance flow in relationships that describe the width, depth, and bed materials in sample reaches. In many basins, a strong correlation exists between the bankfull discharge and the tributary drainage area. As indicated in Figure # 40, the relationship may be used to compare the runoff characteristics of different basins. The dashed lines in Figure 40 bracket the range of relationships for streams with high and low runoff regimes in the United States (Newbury, 1994).

Establishing the natural channel geometry relationships for a stream is an important step in understanding the stream's behaviour and characteristics. The drainage area the channel geometry measurements may be linked to the channel pattern and profile. If structures in these areas are required, they can be used to dimension stream rehabilitation works that mimic natural conditions. Even a preliminary estimate of the hydraulic geometry based on an abbreviated field survey in which only the bankfull width and depth are measured will provide useful guidelines. (Newbury 1994) The following graphs (Figures 41 to 42) was produced by plotting data from Ontario streams on top of existing data from the United States and Canada.

For further details and plots, please see Section 3.1.1, A procedure entitled "Stream Assessment Protocol for Ontario", 1998 included a procedure for determining the bankfull characteristics in the field. It is a very useful tool for application of the bankfull width.

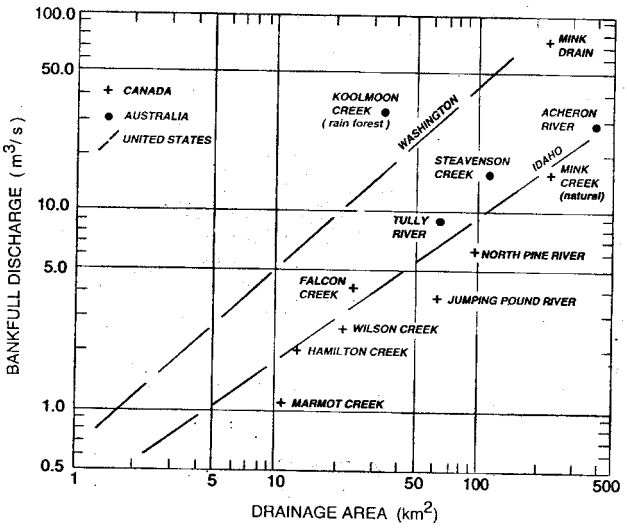


Figure 40 - Bankfull Discharge vs Drainage (Newbury, 1994)

ALL DATA

	Watercourse	DRAINAGE AREA (km2)	BANKFULL DEPTH (m)	BANKFULL WIDTH (m)	BANKFULL DISCHARGE cu.m/s	STREAM CLASS
ANNABEL DATA						
1	BEAR CREEK BELOW BRIGDEN	533.0	2.38	25.67	27.94	C6
2	BEAVERTON RIVER NEAR BEAVERTON	282.0	0.94	27.60	42.40	C4
3	BIG CREEK NEAR DELHI	362.0	1.42	18.20	29.73	F4
4	BLACK CREEK BELOW ACTON	18.9	0.61	4.36	2.27	E4
5	BOWMANVILLE CREEK NEAR ELMIRA	104.0	0.60	15.80	18.40	C3
6	BURNLEY CREEK ABOVE WARKWORTH	71.2	0.68	17.30	16.35	C4
7	CANAGAGIGUE CREEK NEAR ELMIRA	82.3	0.74	27.63	26.23	C4
8	COLD CREEK AT ORLAND	159.0	1.22	22.34	19.21	C4
9	COPELAND CREEK NEAR PENETANGUISHENI	26.9	0.52	8.40	3.61	C5
10	CREDIT RIVER AT BRIMSTONE	22.5	0.81	12.70	18.25	B3
11	CREDIT RIVER NEAR CATARACT	205.0	0.84	17.80	17.48	C4
12	CREDIT RIVER - ERIN BRANCH ABOVE ERIN	32.3	0.59	9.60	3.29	C5
13	WEST CREDIT RIVER ABOVE THE FORKS OF	96.0	0.46	10.40	9.64	B3
14	CREDIT RIVER NEAR ORANGEVILLE	62.2	0.80	9.90	6.72	C5
15	EAST HUMBER RIVER AT KING CREEK	94.8	1.38	7.70	13.70	E4
16	EELS CREEK BELOW APSLEY	241.0	0.74	15.40	21.68	B1
17	ERAMOSA RIVER ABOVE GUELPH	236.0	0.60	27.40	17.80	C3
18	FAREWELL CREEK AT OSHAWA	58.5	0.54	19.20	8.74	C4
19	GANARASKA RIVER NEAR DALE	262.0	1.30	27.60	49.87	C4
20	GANARASKA RIVER NEAR OSACA	67.3	0.93	11.30	14.26	E4
21	HOG CREEK NEAR VICTORIA HARBOUR	65.2	0.91	10.20	14.15	E4
22	HORNER CREEK NEAR INNERKIP	108.0	1.37	8.50	15.28	E5
23	HUMBER RIVER NEAR PALGRAVE	117.0	0.84	15.20	12.60	C4
24	IRVINE CREEK ABOVE SALEM	215.0	0.66	32.60	53.84	C1
25	IRVINE CREEK AT ELORA	215.0	1.22	16.50	53.84	F2
26	IRVINE CREEK AT SALEM	215.0	0.98	15.60	53.84	F1
27	MAITLAND RIVER AVOVE WINGHAM	528.0	1.80	43.60	96.40	C3
28	MAITLAND RIVER NEAR HARRISTON	112.0	0.74	26.50	24.67	C4
29	McKENZIE RIVER NEAR CALEDONIA	171.0	0.57	22.30	15.29	C5
30	NOTTAWASAGA RIVER AT HOCKLEY	172.9	0.92	14.30	20.00	C3
31	NOTTAWASAGA RIVER NEAR BAXTER	1180.0	1.99	39.00	98..73	C5
32	PEFFERLAW BROOK NEAR UDORA	332.0	0.76	22.60	18.45	C4
33	PINE RIVER NEAR EVERETTE	195.0	0.83	11.50	14.50	F4
34	PINE RIVER NEAR KILGORIE	75.0	0.65	12.30	9.97	B3
35	REDHILL CREEK BELOW ALBION FALLS	23.5	0.88	14.50	18.16	B3
36	SAUGEEN RIVER ABOVE DURHAM	329.0	0.92	41.70	73.50	C3
37	SILVER CREEK AT NORVAL (ROGERS CREEK	127.0	0.64	18.80	12.92	B4
38	SIXTEEN MILE CREEK BELOW HILTON FALLS	34.5	0.68	14.90	16.79	B3
39	SWAN CREEK NEAR ELORA	34.0	0.78	5.20	7.62	E4
40	SYNDENHAM RIVER AT ALVINSTON	730.0	1.79	48.70	84.90	C1
41	TROUT CREEK NEAR FAIRVIEW	36.0	1.14	8.60	16.93	F4
42	TWELVE MILE CREEK BELOW DECEW FALLS	63.5	1.27	8.60	19.25	A3
43	TWENTY MILE CREEK ABOVE BALLS FALLS	293.0	1.10	31.50	66.94	C1
44	TWENTY MILE CREEK BELOW BALLS FALLS	293.0	1.98	15.20	66.94	A2
45	WILLOW CREEK ABOVE LITTLE LAKE	94.8	1.57	13.70	22.65	E5
46	WILLOW CREEK AT MIDHURST	127.0	0.78	15.70	10.98	C4
47	WILMOT CREEK NEAR NEWCASTLE	82.6	0.90	13.71	18.00	C5
NEWBURY DATA						
48	DON RIVER	3.1	0.30	1.80		
49	DON RIVER	3.4	0.27	2.20		
50	DON RIVER	19.0	0.46	4.20		
51	DON RIVER	57.9	0.55	8.30		
52	DON RIVER	98.3	0.60	10.70		
53	DON RIVER	125.5	0.65	10.10		

Figure 41 - Ontario River Data List

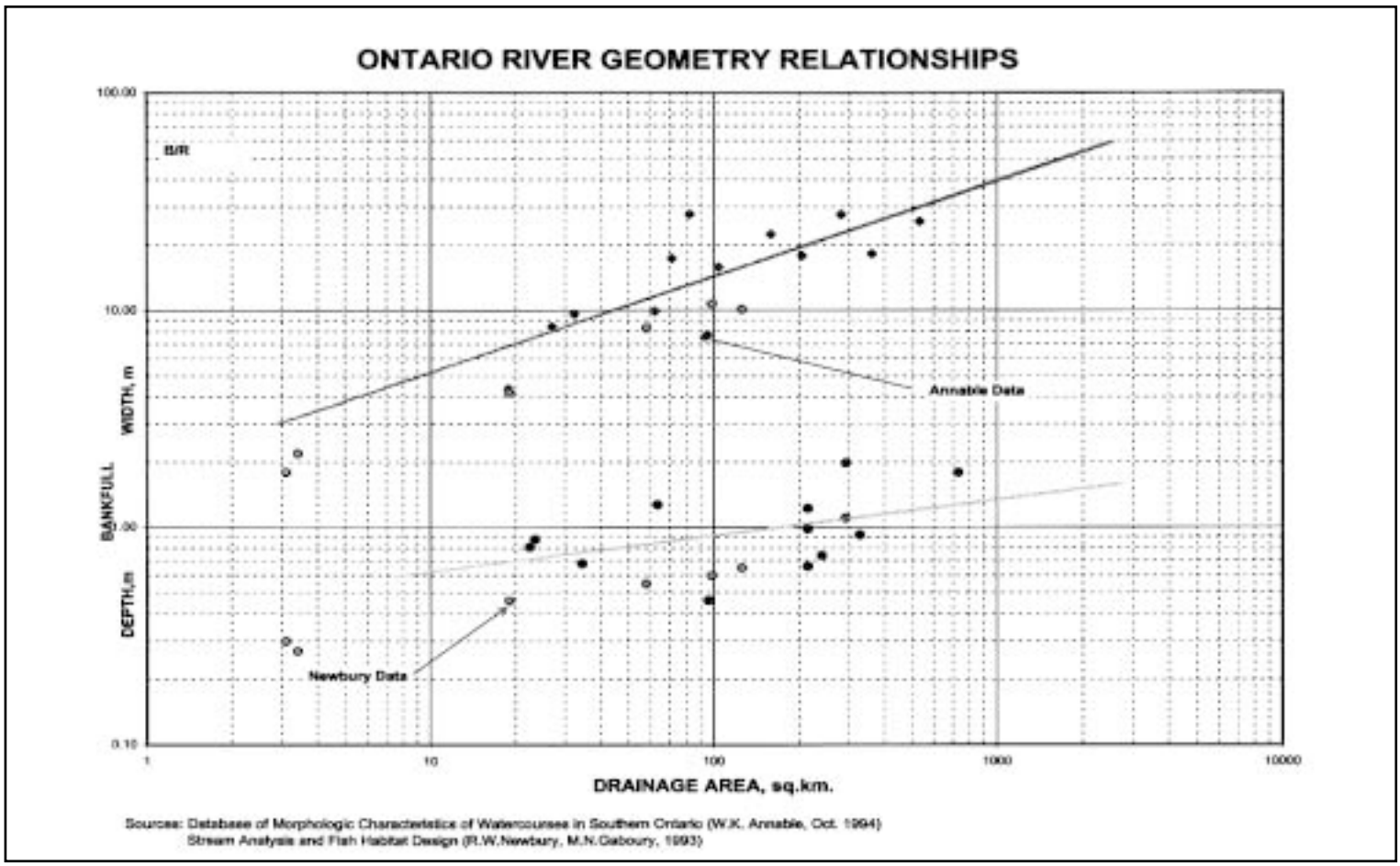


Figure 42 - Ontario River All Data - Chart 1

2.4 Sediment Regime

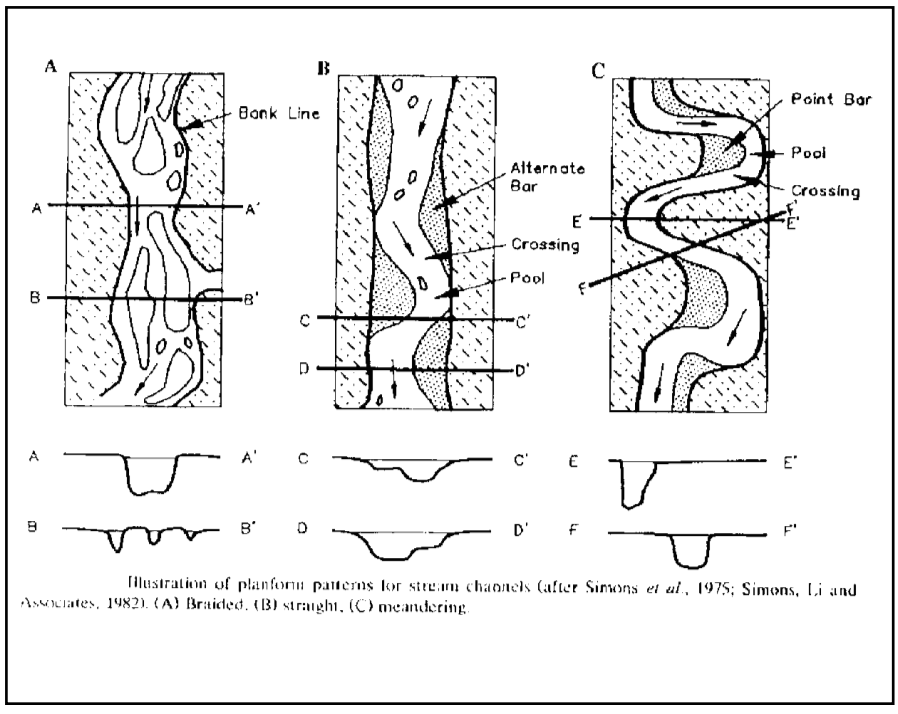


Figure 43 - Plan View River Patterns

The pattern (plan view) of rivers has been classified as "braided, straight, or meandering", or some combination of all three (Leopold and Wolman, 1957). If the channel walls and bed are alluvial (cohesionless sediments), the natural river shape tends to be sinuous and not straight.

A discussion on sediment loads and channel thresholds can be found in the section on Form, Function and Processes in (AMSC, 1999).

Meandering channels are S-shaped and serpentine. Within the channel width is a narrow deep section termed the "***thalweg***." Along the channel, the position of the thalweg shifts in a sinuous shape. The deepest part of the channel is located in a "pool" at the apex of the meander. A shallow "riffle" often occurs in the straight sections between meanders.

The degree of **sinuosity** (index) is the ratio of the channel length, to the length of the meander belt axis. Studies on channel meanders (Schumm and Khan, 1972) found that sinuosity increased with increasing channel gradient, to a threshold gradient beyond which the channel pattern changes from meandering to braided (Figure 45) (Lane 1957).

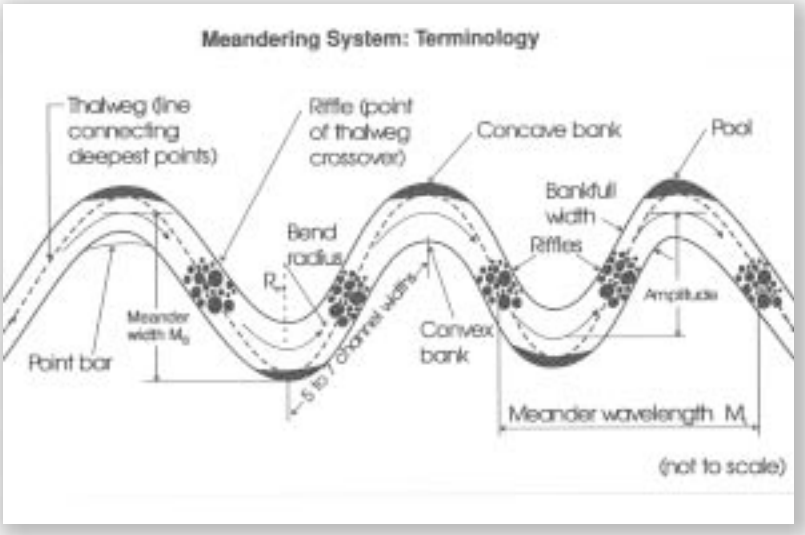


Figure 44 - Meandering Systems

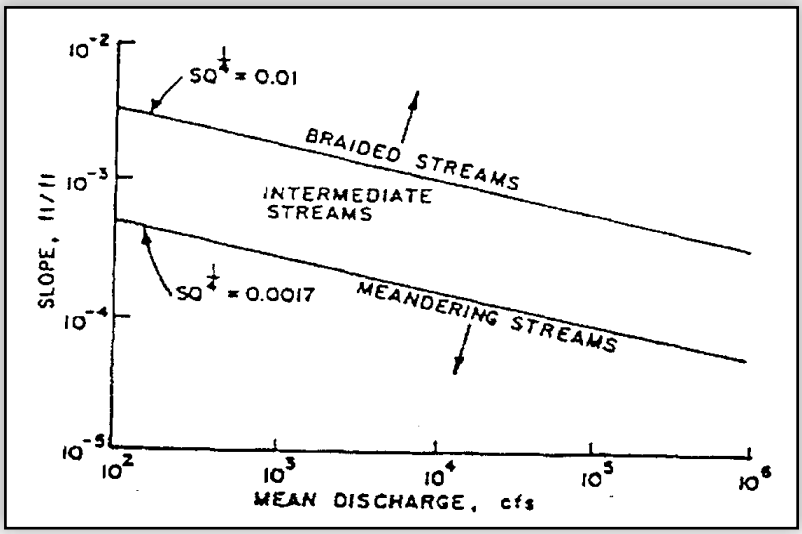


Figure 45 - Threshold River Gradients

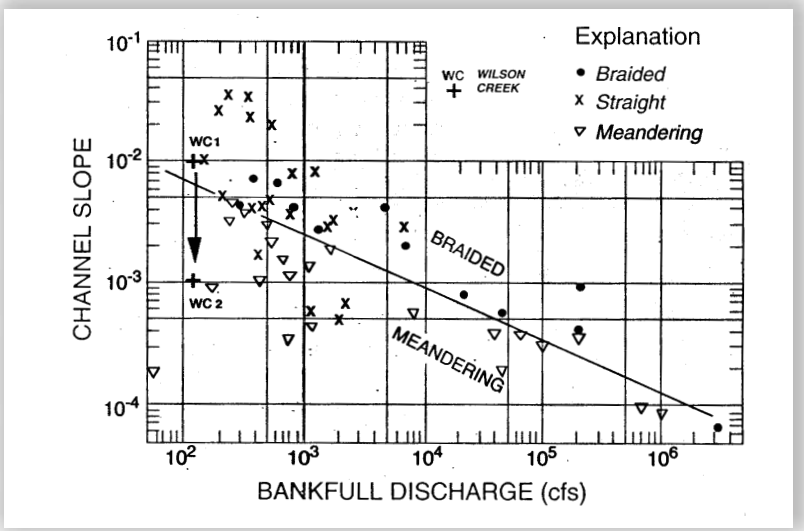


Figure 46 - Bankfull Discharge & Channel Pattern (from Newbury, 1994)

Stream patterns are seldom uniform throughout a drainage basin. For example, in streams with steep reaches and low-gradient lower reaches, the channel often shifts from a straight or braided pattern to a meandering pattern. A relationship between the reach slope, bankfull discharge, and channel pattern has been observed by Leopold and Wolman (1957) as shown in Figure 46 . The figure also illustrates two sample reaches where there is a shift in pattern from straight to meandering pattern (Newbury 1994).

Studies on watercourse channel profiles (Schumm, 1960) found the following affect of sediment load on width to depth ratio.

Sediment Type	Width to Depth Ratio
clay and silt	small
sand	large

In any fluvial system, the resultant "morphology" or change of the channel is a result of the dynamic balance of energy (flowing or discharge of water) and the resistance of material comprising the channel perimeter (Morisawa, 1985). As such, the channel form (e.g., shape, size, configuration) is governed by its need to carry sediment load (bed, suspended and dissolved) using the availability of water flows (discharge). A change in any of the variables (discharge, load, resistance) will result in a change in the channel form. One result of this change may be a shifting of the watercourse channel causing a meander and new channel orientation to form.

Several empirical relationships have been derived to describe river or stream morphology, referred to as "regime" equations (Leopold et al, 1964). For a list of some of these empirical relationships refer to Appendix 2. These describe relationships between the discharge flow and the river shape and dimensions. It has been accepted that channel shapes and patterns are formed mainly by the "bankfull discharge". Often flood events in Ontario are produced by snow melt which may be accompanied by rainfall. Natural watercourses experience frequent changes in flow rates and sediment loads.

Relationship observed between slope, bankfull discharge, and channel pattern (Leopold and Wolman 1957).

2.4.1 Sinuosity

Figure 47 - Meandering Systems

Figure 48 - Meandering River System

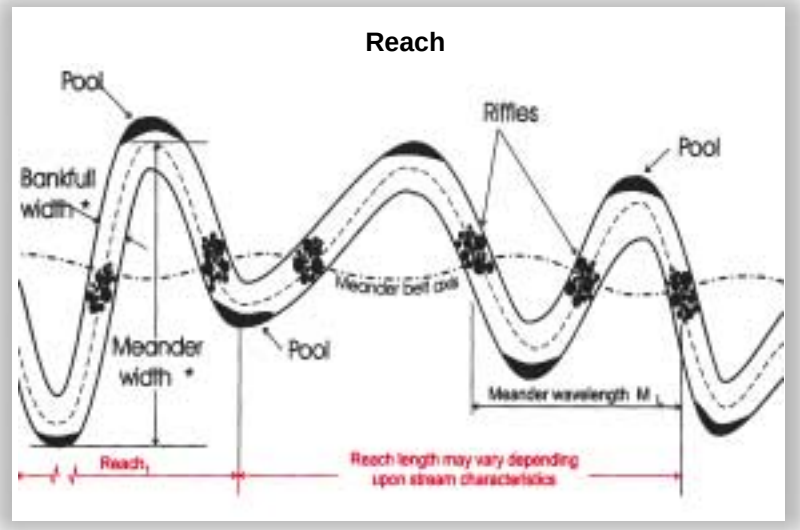


Figure 49 - "Reach", a length of channel over which channel characteristics are stable or similar.

Unconfined ravines, river valleys and stream corridor systems tend to be predominately located within relatively flat terrain. They normally contain perennial (year round) or ephemeral (intermittent) flows which may have a tendency to constantly shift or meander (laterally and downstream) in response to the continuous changes associated with the natural influence of discharge and load. The maximum extent, or area of provincial interest that a water channel migrates is termed "meander belt allowance". The term "meander belt" is derived from terminology used to describe meandering systems.

Watercourses have a natural tendency to "sinuosity" in the lower reaches where bed downcutting is reduced. "Meandering" refers to the tortuous shape of the channel in plan view. The sinuous bends develop to a size governed by the bed and bank materials, and by the bankfull discharge. Changes in the bankfull discharge can result in changes in the size of the sinuous bends. A limit to the width of the meander can be caused by the development of "chutes" (short channels formed during high flows) across the inner bank sediments. The "Sinuosity Index" (SI) is used to describe the degree of meandering and is the ratio of the channel length to the downvalley distance. The Sinuousity Index can range from less than 1.05 to more than 1.5. 1.5 is appropriate for many streams and is a measure of the "wiggliness" or "tortuosity" of a watercourse. Meandering channels have an SI of 1.5 or more and are more common to cohesive bed and bank soil materials. The typical bankfull velocity of a meandering stream is between 1 and 3 metres per second.

2.4.2 Reach

A meandering system is comprised of a series of interconnected reaches. A "reach" is defined as a length of channel over which the channel characteristics are stable or similar. The extent of a reach depends on the geometry and dynamics of the channel. It is often measured in multiples of channel width, meander wavelengths, or riffle-pool sequences. Measurements should be taken over a length sufficient to establish the stable characteristics of the channel. All geomorphological features and types of aquatic habitat should be proportionally represented in the section of the stream being assessed, and at least two of each of the major features of the section should be represented. Measurements of channel characteristics within a reach should be carried out so that the range of conditions within the reach can be specified (MNR, 1994).

Similar biological characteristics can also be measured to assist in determining the reach. Frissell et al. , 1986 suggest that habitats follow the same organization as the branching network of the stream reaches, implying that sample reaches for habitat surveys may be selected on the basis of stream segment order numbers or position in the drainage network.

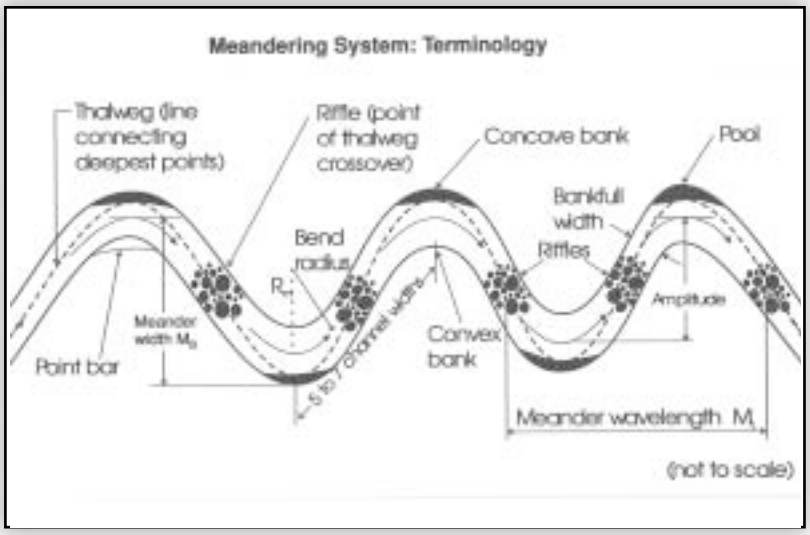


Figure 50 - Thalweg

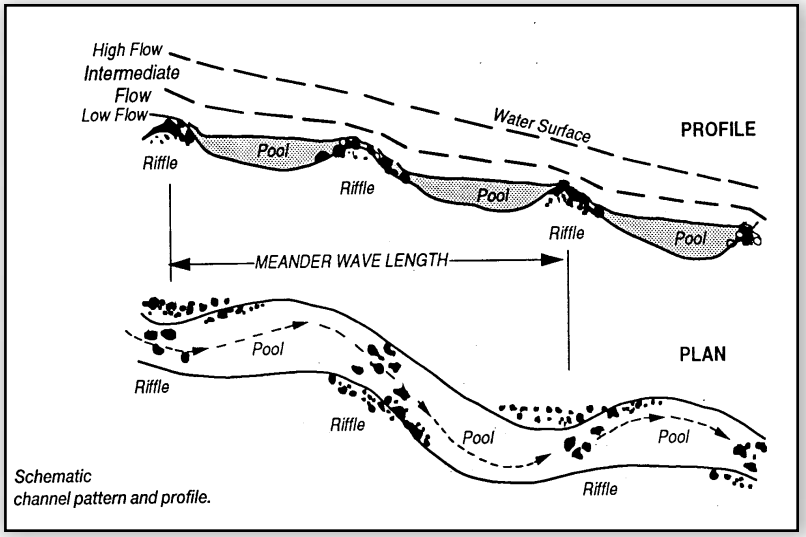


Figure 51 - Riffles and Pools (Newbury, 1993)

Figure 52 - Riffle

Meandering channels are often S-shaped and serpentine. Within the channel width is a narrow deep section termed the "thalweg". Along the channel, the position of the thalweg is the path traced by the flow that follows the deepest part of the channel, it shifts in a sinuous shape along the river or stream.

2.4.3 Riffles & Pools

Most natural channels comprise a series of riffles, made up of high points composed of coarser sediment, and pools or step-pools made up of low points with finer bed particles. The pool and riffle profile creates the diverse hydraulic habitat conditions that are required in rivers and streams with healthy habitats. At low flows, riffles have turbulent, shallow flow that aids to increase the stream's dissolved oxygen content, and are the most productive areas for generating food and acting as spawning grounds. The deepest part of the channel is located in a "pool" at the apex of the meander. The pools are resting and rearing habitat for fish. A shallow 'riffle" often occurs in the straight sections between meanders. Some natural systems, such as very steep gradient streams or ephemeral streams do not exhibit pool and riffle formations.

Pools and riffles are characteristic of meandering streams. The riffle, pool sequence occurs in intervals on average that occur 6 times the bankfull width. Upstream from the accumulations, a shallow pool is formed and downstream from the crest of the accumulation, a local increase in slope causes the flow to accelerate, forming a riffle of rapids. Under low discharge conditions, the pool and riffle profile stores water in the channel and re-aerates the flow. The effect of the pool and riffle forms are less apparent under flood conditions, although high discharges are required to scour the pools and maintain the riffle form. A further description of riffles and pools can be found in the 'Natural Channel Systems An Approach to Management and Design' MNR 1994.

The overall longitudinal profile of a stream in erodible materials is generally concave. However, with a stream segment the profile is broken into a series of smaller steps that form pools and riffles under low flow conditions as shown in Figure # 51. This naturally stepped profile forms a vertical wave form that has been observed for all channel patterns. In straight channels, the length of the pool or distance between riffles is equal to the straight line distance between the riffles that occur at points of inflection in a meandering channel.

Often the same pool and riffle profiles will develop in a stream which has been channelized in spite of their uniformly constructed gradients. The strong tendency for natural streams to follow meandering paths and to form pool and riffle profiles suggests that straightened and uniformly channelized rivers with erodible beds can only be maintained by repeated reconstruction. (Newbury, 1994)

2.4.4 Channel stability and Tractive Force

Figure 53 - Point Bars & Pools

Figure 54 - Riffle - Pool Example

Flowing water can cause surface erosion of the bank or channel. This river or stream bank erosion is often a cause of slope instability. Erosion occurring at the slope toe, acts to steepen the slope locally, and removes slope support by undercutting. The erosion can be a result of increased flow velocities from climatic events such as heavy rains or snowmelt. The magnitude or rate of erosion can be quite variable over the course of a year dependent on the volume, velocity, frequency and duration of the flows through the river or stream corridor. A heavy rainfall or rapid snow melt event may increase the potential magnitude or rate of erosion as a result of a measurable increase in water flows (discharge) into and through the river valley and stream corridors.

The most potential for erosion is by the watercourse flow itself and this is directly related to the flow velocity and its shearing force or tractive force. Tractive force is the shear stress resulting from watercourse flow and acting on the stream bed or bank materials. Bank erosion (and toe erosion) is often highly variable and episodic, usually associated with flood flows. The level or rate of toe erosion in this instance, is a function of the amount, duration, and frequencies of water flowing through the system.

The movement of coarse sediments by rolling and bouncing along the channel bed has been studied by many researchers concerned with stable channel design. Erosion occurs when the velocity of the flow acting on a channel bed or bank are greater than the resistive forces of the local material. Channel bends are exposed to velocities of higher flow than are straight channels. High shear stress zones can develop along both the concave and convex parts of the channel.

The materials can consist of non-cohesive materials (e.g., sands and gravels) or cohesive (e.g., clay) materials. The movement of the non-cohesive particles depends on the shape, size, or density of the particles, or on their relative position. Since the cohesive soils have a cohesive bond between particles, the movement not only depends on the same criteria as previously mentioned for the non-cohesive but also on the resisting force created by the cohesive bond. Generally the cohesive soils are more resistant than the non-cohesive soils to erosion.

Two general approaches are available to estimate flows that will prevent erosion: an empirical method of estimating safe velocities, or theoretical methods of computing tractive force. The empirical method of estimating the velocities can be very difficult as the velocities can be extremely variable in a river or stream system. They should only be estimated by someone who has extensive experience in the area.

The shear force caused by the water is called the tractive force. The shear stress exerted by the flow on individual particles just at the point at which they begin to move (incipient motion) has been measured in laboratory flumes but only observed indirectly in canals and natural channels. In research studies, shear stress on the surface of the streambed or on an individual particle on: the bed is determined by measuring the adjacent velocity profile with miniature current meters.

In canal and stream studies, a more general measure of shear stress, the “tractive force”, is used to characterize the average shear stress in a reach. In the following relationship, the tractive force in Kg/m2 of the streambed may be determined from two simple field measurements, the average slope of the water surface in the reach and the depth of flow.

Where = 1,000 x *d* x *s*

= tractive force of flow (kg/m2)
and (x 9.8 for Newtons/m2)
d = depth of flow (m)
s = slope of water surface

The tractive force can be related to the size of material at incipient motion as shown in Figure 55.

The field observations and recommended design guidelines were compiled by Lane (1955) for a wide range of canals and river channels. The data are widely scattered for several reasons, for example; smooth channels with cohesive bed materials (clays and fine silts) tolerate high shear stresses until they start to erode and then become highly mobile, coarser silt and sand bed streams form ripples and dunes that move along the streambed, and gravel and cobble bed streams may develop an erosion resistant "paving" of cemented or closely packed bed material. However, for non-cohesive bed materials greater than 1 cm in diameter (fine gravel), the relationship is less scattered and may be approximated as:

Tractive force (kg/m2) = incipient diameter (cm)

Flat shale gravels and cobbles have been observed to move at approximately half of the tractive force required for an equivalent rounded particle (Magalhaes and Chau 1983).

Bed stability:

The degree of stability of a stream channel may be estimated using the bed paving material sample and reach slope observations from the field. For coarse non-cohesive bed paving materials, the mean diameter at incipient motion may be determined for different depths of flow using Lane's general relationship. The percent of the bed materials that lie above or below this value may be determined from the cumulative frequency of mean bed material size plot. (Newbury 1994).

Studies have found that a soil mass can sustain water flow without erosion of soil particles, up to a "limiting" or "critical" or "competent flow velocity" beyond which the tractive force becomes sufficient to dislodge and transport (erode) soil particles from the soil mass.

The following table (Lane, 1955) shows allowable flow velocities and tractive force for several types of bed and bank materials. The values are **for aged stable channels.**

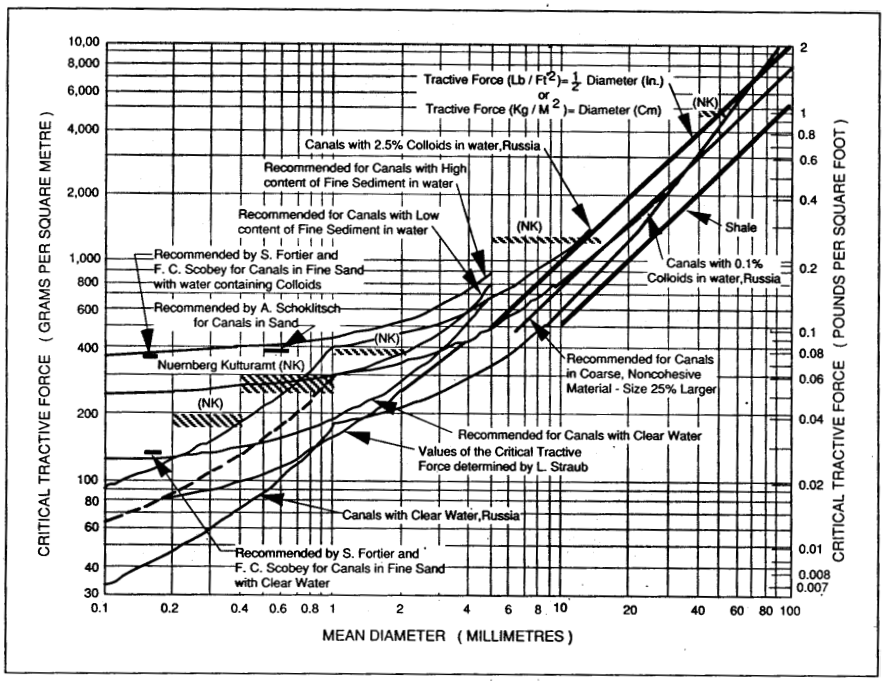


Figure 55 - Tractive Forces

Table 2.1 - Allowable Flow Velocity and Tractive Force, Aged Channels

Material	CLEAR WATER Velocity (fps)	Tractive Force (psf)	SUSPENDED SILTS Tractive Force (psf)	Velocity (fps)
Fine Sand	1.5	0.027	2.50	0.075
Sandy Silt	1.75	0.037	2.50	0.075
Silty Clay	2	0.048	3.00	0.110
Silt	2	0.048	3.50	0.150
Firm Clay	2.5	0.075	3.50	0.150
Stiff Clay	3.75	0.260	5.00	0.460
Shale, Hardpan	6	0.670	6.00	0.670
Fine Gravel	2.5	0.075	5.00	0.320
Coarse Gravel	4	0.300	6.00	0.670
Cobbles, Shingles	5	0.910	5.50	1.100

For newly constructed channels, the following values have been suggested,

For high flow velocities, **rip rap** has been commonly used to protect against erosion. Rough angular shaped rock can interlock and resist over turning, better than smooth, rounded stone. Environmental considerations must be addressed when designing any structure when considering the type of material to be installed.

For the purposes of the application of the provincial policy the tractive force may be calculated to determine whether or not the existing materials are stable and whether 'active' erosion is occurring. If 'active' erosion is occurring then the left hand side of Table 3 from Section 3 should be applied when determining which erosion allowance is appropriate.

Table 2.3 - Permissible Flow Velocity, New Channels

Material	PERMISSIBLE VELOCITIES (fps) Bare Channel			
Vegetation	Poor	Fair	Good	
Sand, Silt	1.5	1.5	3	4
Sandy Clay	2	2.5	4	5
Silty Clay	2	2.5	3	4
Clay	2.5	3	4	5

2.4.4.1 Proximity of Watercourse to Valley Wall

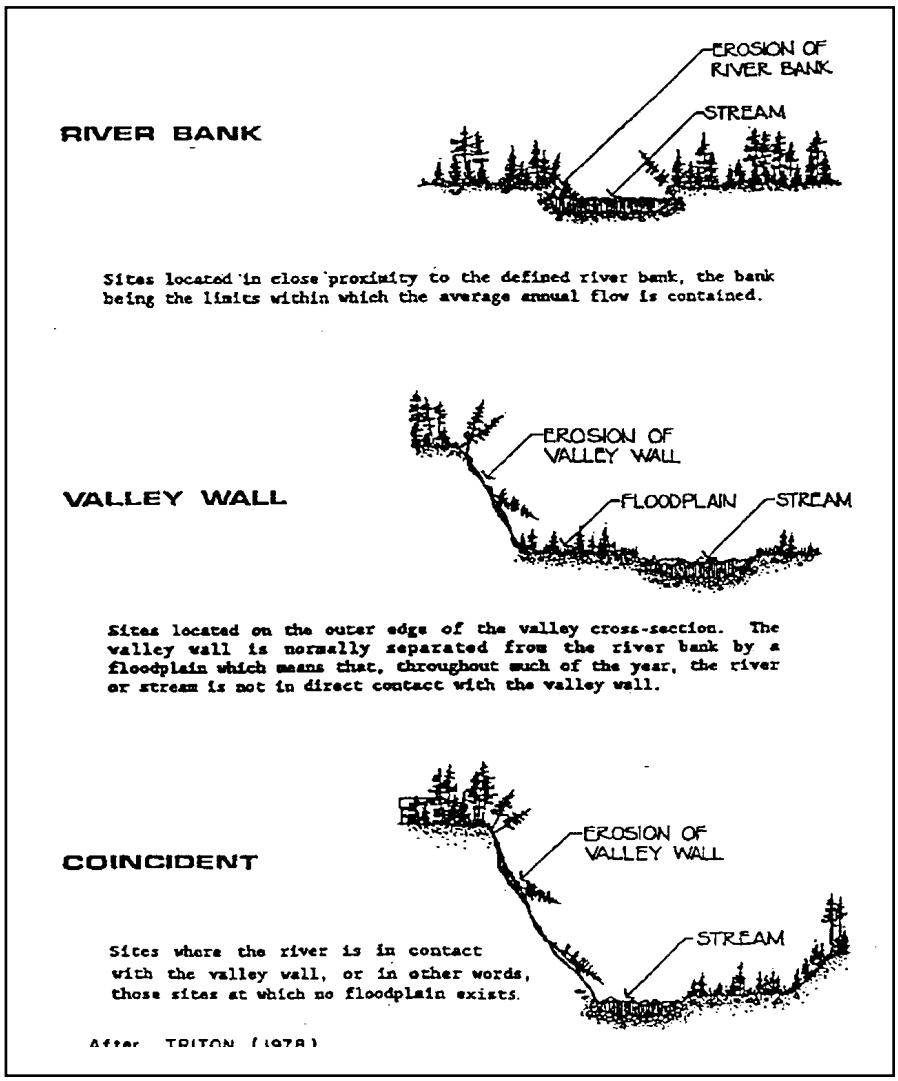


Figure 56 - River Valley Profiles

Many rivers and streams flow in valleys that exert some degree of lateral (e.g., slopes) or vertical (e.g., bedrock) control over the river. Valleys often contain a flood plain within which the river flows. Some watercourses do not have confined valley slopes. Alluvial channels adjust their shape, gradient, and dimensions according to the discharge flow and sediment load.

If the river or stream channel is in close proximity or abuts the valley slope wall, the erosive forces of the flowing water will cause a local steepening and then undercutting of the valley wall. The degree or severity of this erosive action and its hazard or risk, are dependent on many factors including,
•the soil composition and strength
•the proximity and exposure of the slope to the water flow
•the discharge volume, rate, flow velocity, frequency, duration, sediment load.

The hazard of slope toe erosion is also a function of the proximity of the river or stream channel to a valley wall. Locations where there are changes in watercourse flow directions, such as the outside bends of rivers or channels, are particularly susceptible to slope toe erosion. This is due to the distribution of the flow velocity and the tractive force along the channel bed and bank.

The proximity of the river or valley wall to the watercourse is addressed in the policy through the application of the erosion allowance. If the river or valley wall is less than 15 m from the watercourse then Table 3 recommends an appropriate minimum setback depending on the particular soils at the site.

2.4.4.2 Internal Seepage (Ground Water)

Water seepage or ground water levels can also affect slope stability since they affect the soil strength. Piping on a slope face can be related to springs or seepage where soil erosion occurs in water bearing sands and slopes. As ground water emits from a soil slope in the form of springs, erosion of soil particles can occur and the loss of ground.

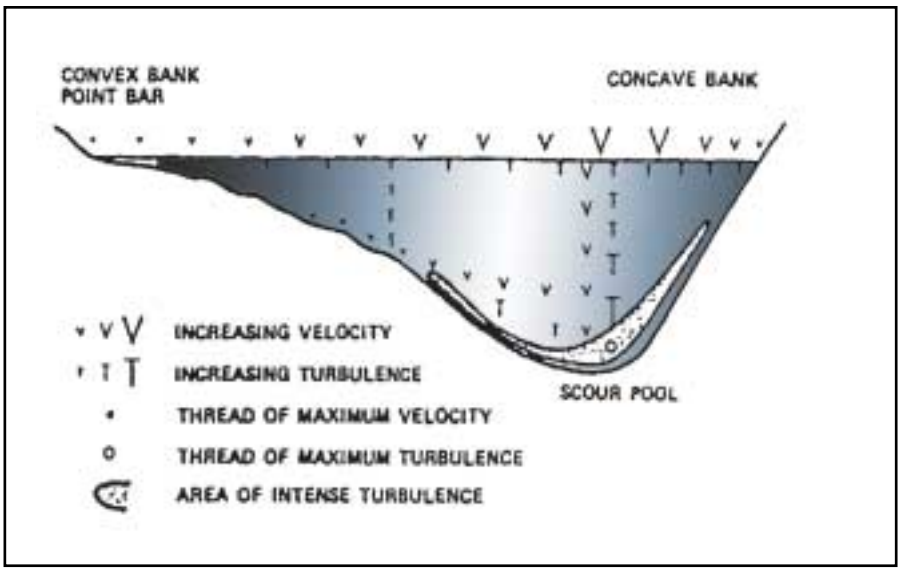


Figure 57 - Flow Velocity Distribution

Figure 58 - Piping

Figure 59 - Piping - Close up

Figure 60 - Piping Hole

Overall, water is generally regarded as the most significant cause or initiator of slope failures. As such, any hydrologic change to either surface or ground water drainage patterns can pose a direct impact on slope stability. Beyond the lubricant influence of ground water within a slope, the accumulation of ground water combined with the natural action of gravity and the overall weight of the ground water itself, will lead to a reduction in slope stability.

Figure 61 - Groundwater and Internal Drainage

Gully development typically starts at the slope toe and progresses up the slope face to the slope crest and into the table land. It also can be initiated inland by natural drainage

Figure 62 - Gully Erosion

Figure 63 - Gully Erosion

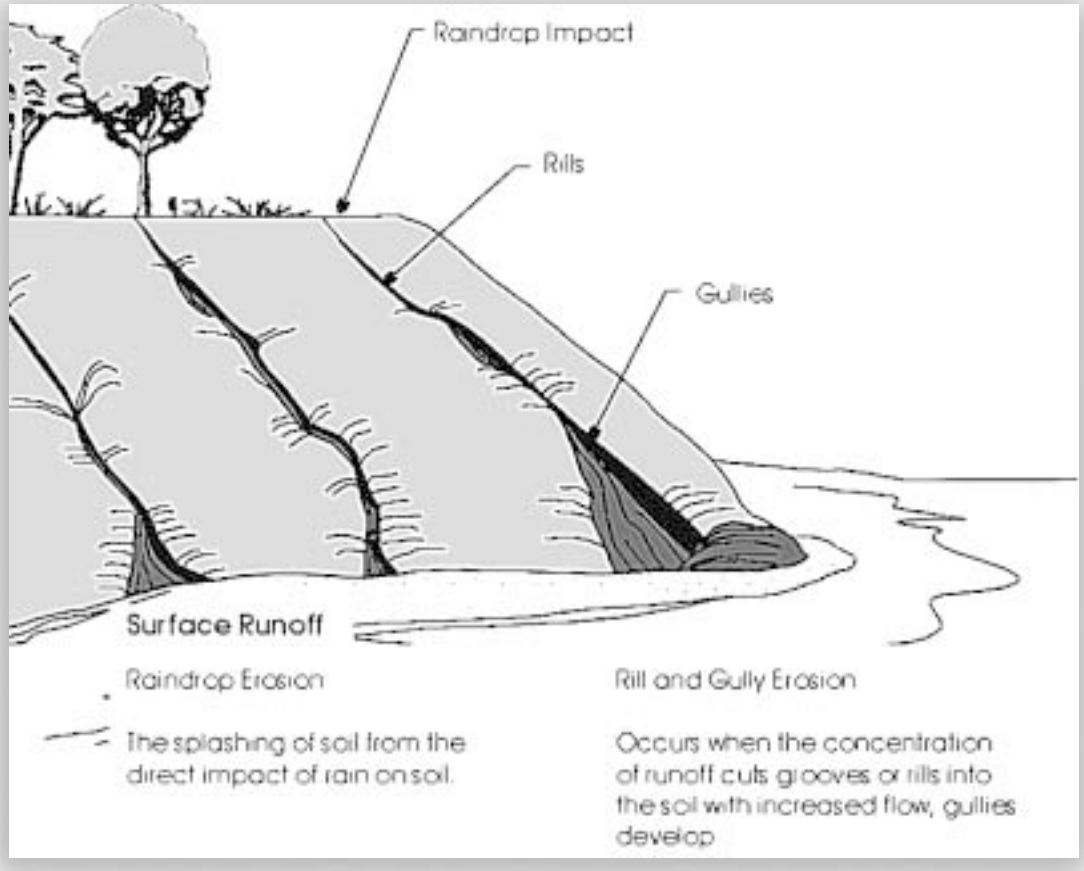
processes or by manmade drainage features such as storm sewer outfalls, ditches, farm field tiles, and the like.
The typical gully erosion process is summarized as follows;

1.sufficient run-off drainage to disrupt natural vegetation cover,
2.establishment of a drainage channel and start of downcutting,
3.channel banks steepen by continuing base erosion, until slope failure,
4.gully widens with slow slides, and debris interrupts downcutting,
5.cycle of downcutting and slumping is repeated after debris is washed away downcutting resumes,
6.gully can mature once stable gradient is achieved by drainage flows.

Erosion of the gully base followed by slumping of the side-slopes, will result in the gully slope crest receding and the loss of table land. The erodibility is influenced predominantly by the nature of the soil, and by the slope gradient (Steepness). Strongly bonded 'cohesive' soils (i.e., clays, clayey silts, tills) are generally less erodible than 'cohesionless' soils (i.e., sands, silts).

2.4.4.3 Surface Runoff

Surface runoff from rainfall or snowmelt can cause soil particles to be broken up and dislodged. The dislodged soil particles can then be transported away by water flowing over the ground surface. Rill erosion can develop when shallow flow concentrates in low spots and cuts tiny channels often only a few inches deep.



As flow increases, surface drainage can become concentrated and erosion may go unchecked, and gullies can develop. Depending on the level of concentrated flows and erosion, extremely large gullies can develop. The gully erosion process is attributed to 2 actions;

a)downcutting of the gully base by swiftly flowing water,
b)slumping or failure of the gully banks (this causes the gully to become wider).

Figure 64 - Rill and Gully Erosion

2.4.4.4 Stream Bank Cover and Vegetation

Stream bank cover increases bank stability and provides shade to the river or stream system. The shade provided by the vegetation is extremely important biologically providing a protective canopy for the river or stream and moderating the energy input into the stream by influencing the stream temperature and primary productivity. Vegetation is even more critical for smaller streams as the impacts vegetation have on the stability of the stream are greatly increased.

A vegetation cover on a slope is the primary defence against soil erosion and is very important to long term erosion protection. As indicated on Figure 65 to 66, vegetation protects against surface erosion and shallow translational slope slides by;

a)by holding, binding, or reinforcing the soil with a root system,
b)removing water from the soil by uptake and transpiration,
c)reducing run-off flow velocity,
d)by reducing frost penetration,
e)by the buttressing or reinforcing action of large tree roots

By reducing surface erosion, the likelihood of shallow instability is also decreased.

Vegetation also improves the visual aesthetics of a shoreline slope and is a vital part of the ecosystem.

Slope stability can also be decreased by the removal of stabilizing vegetation. This may be of particular importance where the removal of the smaller and more numerous tree roots, may also remove the binding strength and anchoring or reinforcement that roots provide. For further information on vegetation and its impacts please see the "Geotechnical Principles for Stable Slopes" and AMSC[8].

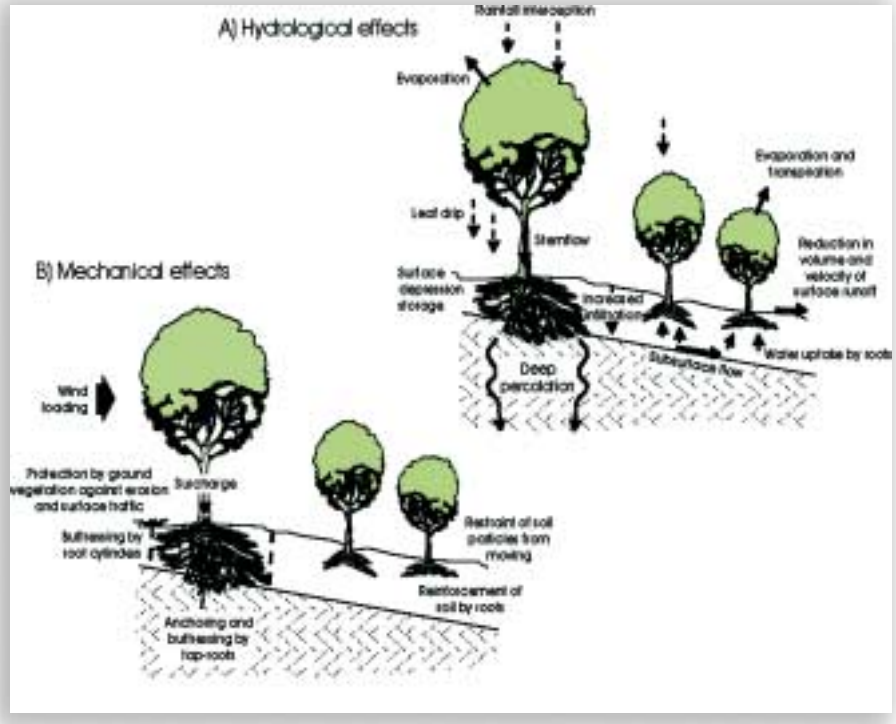


Figure 65 - Effects of Vegetation

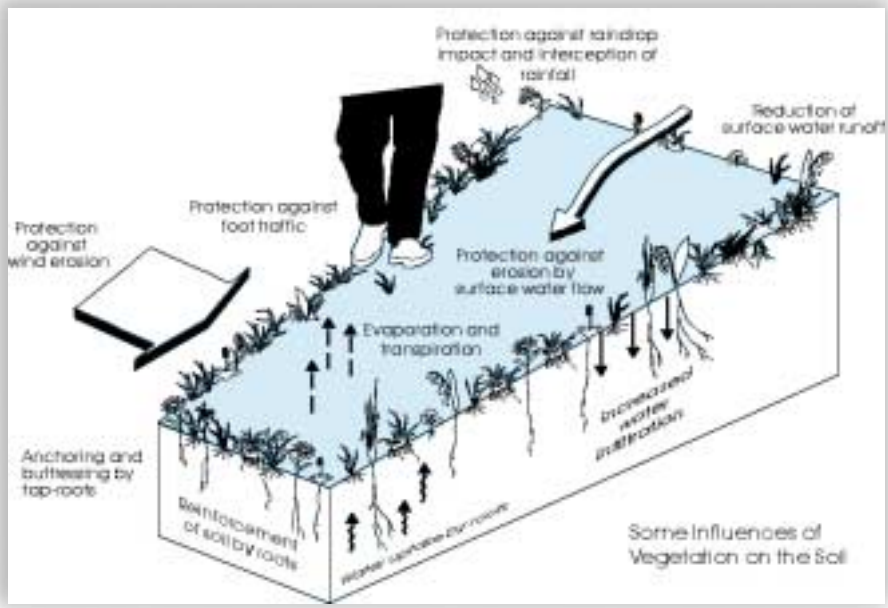


Figure 66 - Effects of Vegetation

Figure 68 - Vegetated Slopes

Figure 67 - Surface Erosion

2.4.5 Slope Failure or Instability Processes

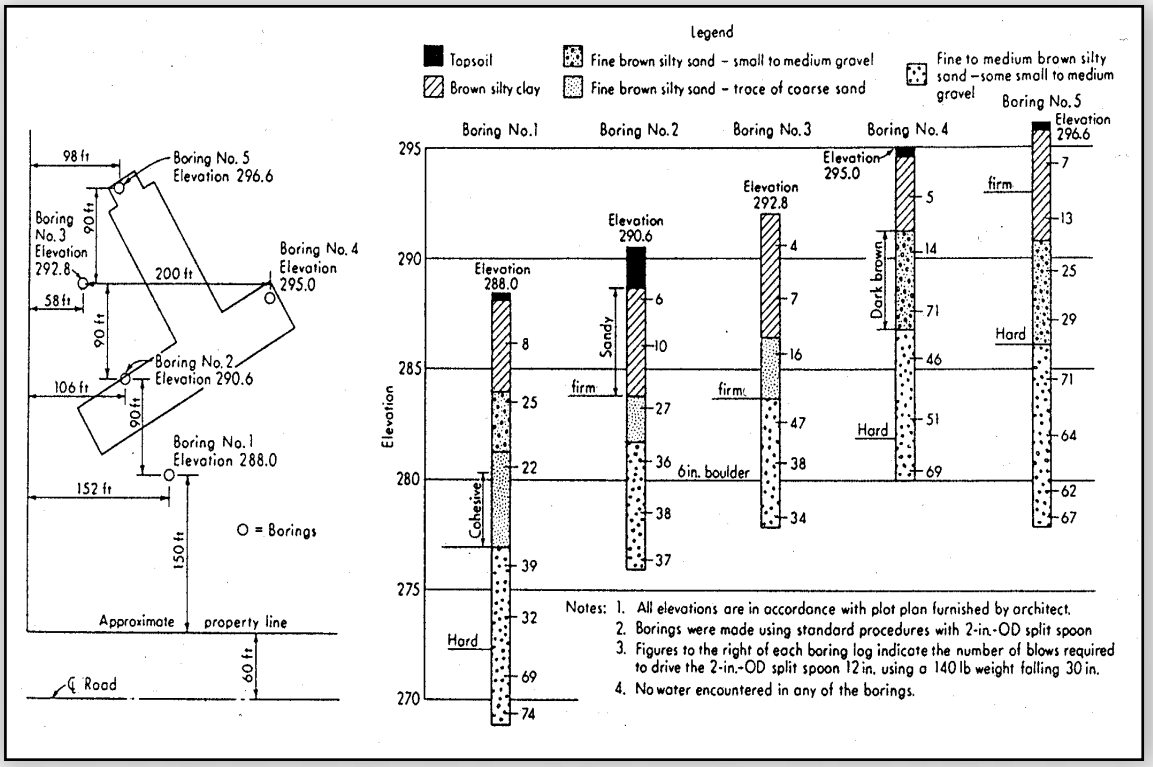


Figure 69 - Slope steepness and failures

Slope failures (i.e., instability) consist of the sudden movement or sliding of a large mass of soil over a failure plane. Slope movement or instability can occur in many ways but is generally the result of;

- changes in slope configurations, such as steepness or inclination
- increases in loading on or near the slope, such as structures or filling
- changes in ground water conditions or drainage of the soil (i.e., heavy rainfall or spring melt, drainage blocked by filling, or broken watermains)
- loss of vegetation cover and root systems
- erosion of the slope toe.

Slopes are by their very nature, subject to movements and failure, whether it is large and deep-seated failure or a shallow and local failure. Failures within both these categories can occur rapidly under adverse conditions, causing immediate and disastrous damage to structures within the failure area. It can also take decades to develop to such a magnitude that movements pose a danger to structures located within or near the zone of failure. Permitting development along or in close proximity to slopes must take in account the potential for slope failure however, development should be located outside the hazard limit whenever possible. The following section briefly discusses some slope stability principles for detailed information on this subject please refer to the document "Geotechnical Principles For Stable Slopes", 1998.

Slopes comprised either in part or wholly of sensitive marine clay are prone to slope failure, which in the case of flow slides and earth flows, can involve many hectares of land. A large earth flow that occurred in sensitive marine clay on the east bank of the South Nation River at Lemieux, Ontario on June 20, 1993 involved an area of about 17 hectares and retrogressed about 680 m into the land. Borehole information indicated that a zone of soft, sensitive marine clay was underlying a stiff cap or crust consisting of laminated marine-estuarine sands and deltaic silts and sands. The landslide mechanism involved the fluidization of much of the landslide mass and subsidence, translation, and rotation of soils forming the cap or crust. The flow most likely occurred as a result of extrusion of the soft sensitive clay layer, due to an increase in the water table level. For further details on Sensitive Marine Clays please refer to the document " Technical Guide for Hazardous Sites ", 1997.

Slope failure or instability involves the sudden movement or sliding of a large mass of soil over a "failure plane" (also called slip plane). Slope movements or failures tend to occur rapidly, when compared to erosion processes. The movement often leaves a "scarp" at the top of the slope and slumped ground below.

The principle driving force in slope instability, is gravity. Therefore, the slope inclination or steepness, has the greatest effect on stability. Steep slopes are most susceptible or vulnerable to failure, if there are minor changes in the other important variables (loading, undercutting, wet weather). Flatter slopes tend to be affected less by changes in these other variables.

2.4.5.1 Slope Failure Types

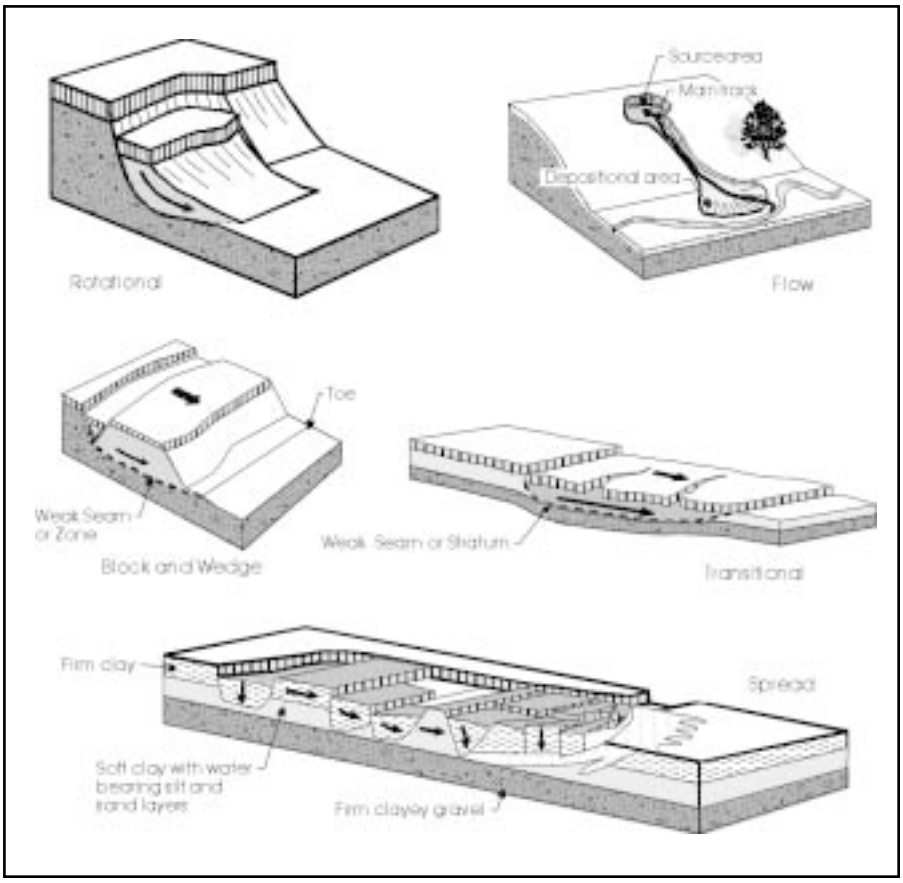


Figure 70 - Slope Failure Types

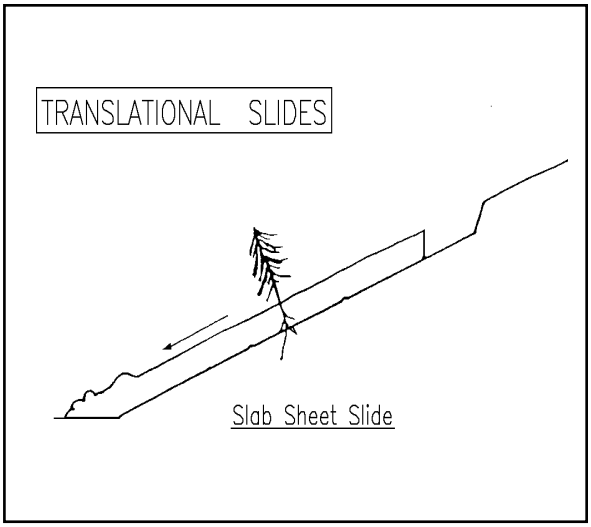


Figure 71 - Translational Failures

Slope movements are generally classified by a combination of the geometry and the nature of the failure. For details on all the various slope slide classifications see "Geotechnical Principles for Stable Slopes" 1994 by Terraprobe. For the purpose of this document, the four main classes of slope movement are as follows;

1)translational or surficial sliding,
2)rotational failures,
3)retrogressive failures,
4)flow slides or earth flows.

The mechanism of erosion at the slope toe can initiate any of these types of failures.

Translational Failures

- generally associated with a planar or sheet (non-circular) failure surface,
- typically occurs in granular soils (i.e., sands, silts), on relatively steep slopes where a thin soil layer slides,
- can occur on slopes composed of any soil type if the failure surface is influenced by the presence of discontinuities within the slope (i.e., bedding planes, faults, weak layers, fissures).

The failure surface can be deep depending on the location of the discontinuity.

Rotational Failures

- generally occur in relatively uniform soil conditions (i.e., few soil layers)
- typically involve movement along a curved or circular (concave upwards) failure plane; leaves an exposed back-scarp and the shifted soil mass rises at the slope toe,
- failure may be shallow or deep depending on the subsurface conditions, soil strength, and ground water,
- prevalent in fine grained soils (clays, silts).

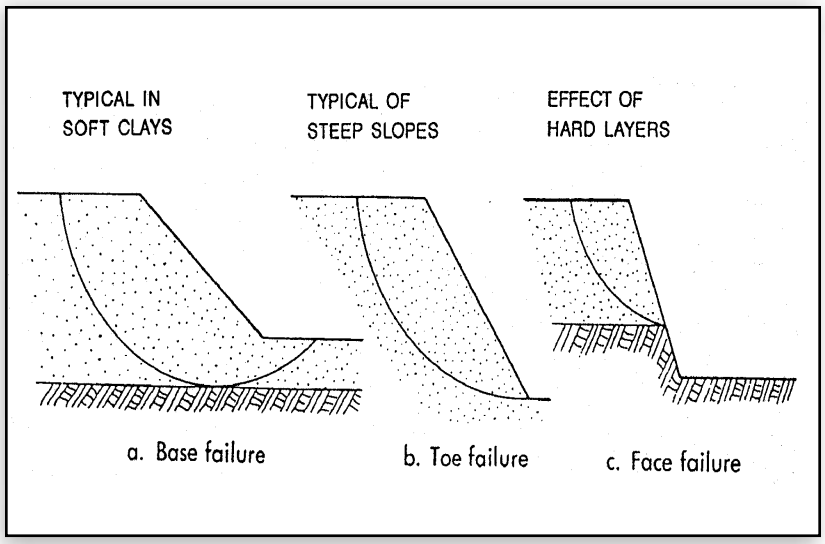


Figure 72 - Face Failures

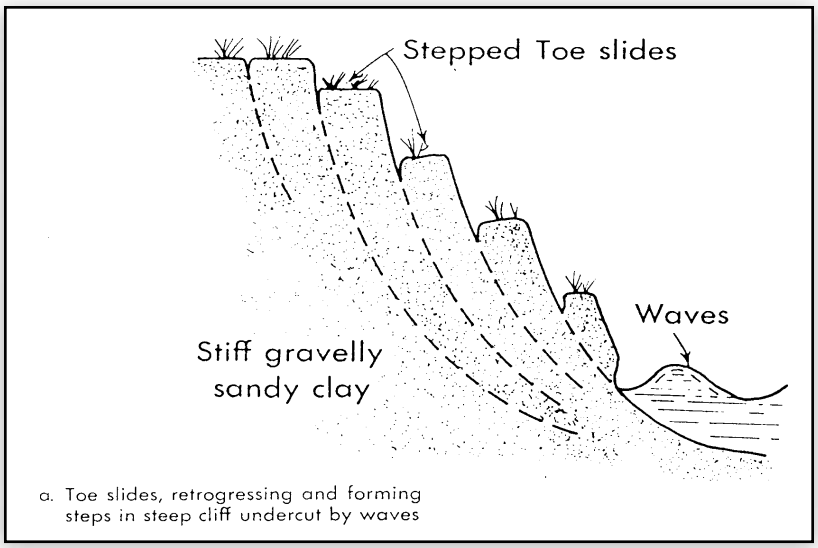


Figure 73 - Retrogressive Rotational Failures

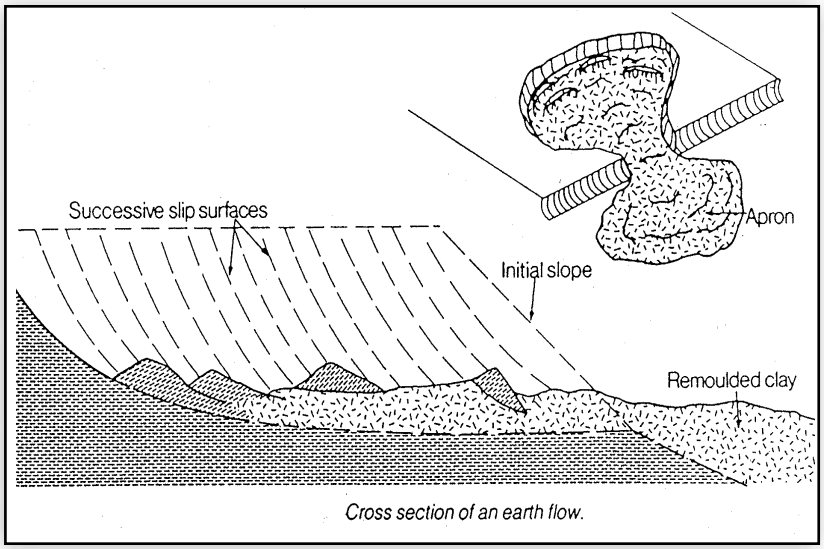


Figure 74 - Flow Slides Failure Mechanism

Retrogressive Failures

- initiated by a single simple rotational or translational failure, but successive slippages continue to occur within the slope due to a combination of slope geometry and disturbance of the clay soils composing the slope,
- occur in slopes composed wholly or partly of clay,
- characterized by the presence of remnants of the failed slices, a number of back-scarps along the slope face and an apron of failure debris at the slope toe,
- failure by successive rotational slippages can continue for large distances (retrogressive flow slides).

Earth Flows

- initiated by a single slide at the slope toe,
- initially similar to retrogressive failures, but movement of the soil mass continues over a larger area,
- studies are still ongoing to investigate the movement principles in earth flows (susceptible environments, and distance of retrogression),
- Tavenas et al (1982) have proposed the following four criteria to evaluate potential for earth flow occurrence (based on slope geometry prior and during failure, and on soil strength and remould ability),

1)the slope must be unstable; slope height and soil strength suitable for initial failure,
2)successive failure back-scarps must be unstable; again related to slope height and soil strength,
3)the slide debris must be able to flow; a combination of low remoulded strength (< 1 kPa) and high liquidity index (> 1.2),
4)the slide debris must continue to flow out of the failure scar without causing a blockage; there must be sufficient potential energy within the failing slope mass to cause remoulding and allow outflow of the slide debris (liquid limit of 40 % or more).

Further details on this can be found in the Technical Guide for Hazardous Sites, (Leda Clays) 1997.

Figure 75 - Retrogressive Slides

Figure 76 - Flow Slide

Figure 77 - Tension Cracks

Figure 78 - Failure Scarp

Figure 79 - Bank Failure

2.4.5.2 Indicators of Instability

There are several general indicators of slope stability, including slope inclination, soil types, groundwater levels, and other slope features such as tension cracks.

Immediately before a translational or rotational slide occurs, “tension cracks” may develop parallel and close to the slope crest.

The slope surface after a slide often display “tension cracks” above the slide and, a distinct “scarp” at the “head” or “crown” where the sliding mass has separated from the slope. A bulging soil mass is often found at the “toe” of the slide.

Slope failures tend to be self-stabilizing in that the slope configuration becomes flatter and more stable. This assumes that the slumped soil is not removed by toe erosion.

Evidence of past slope slides may include:

a)bare slope areas (no vegetation);
b)tree trunks which are bent or bowed, or dead trees whose roots may have been damaged by slope movements;
c)scarps and tension cracks;
d)irregular slope surface such as slumped soil masses, or humps.
e)See the list on the following Figure.

It is important to note that in some steep slope areas, bent or bowed tree trunks are not necessarily caused by slope movements (though they often do). The curved tree trunks may be due to initial root development and twisting or bowing growth in response to reaching for moving sunlight and adjacent tree canopies.

Examination of historical air photographs, surveys, and discussions with local residents can be important in detecting the extent or presence of past slides.

2.4.5.3 Human Activities

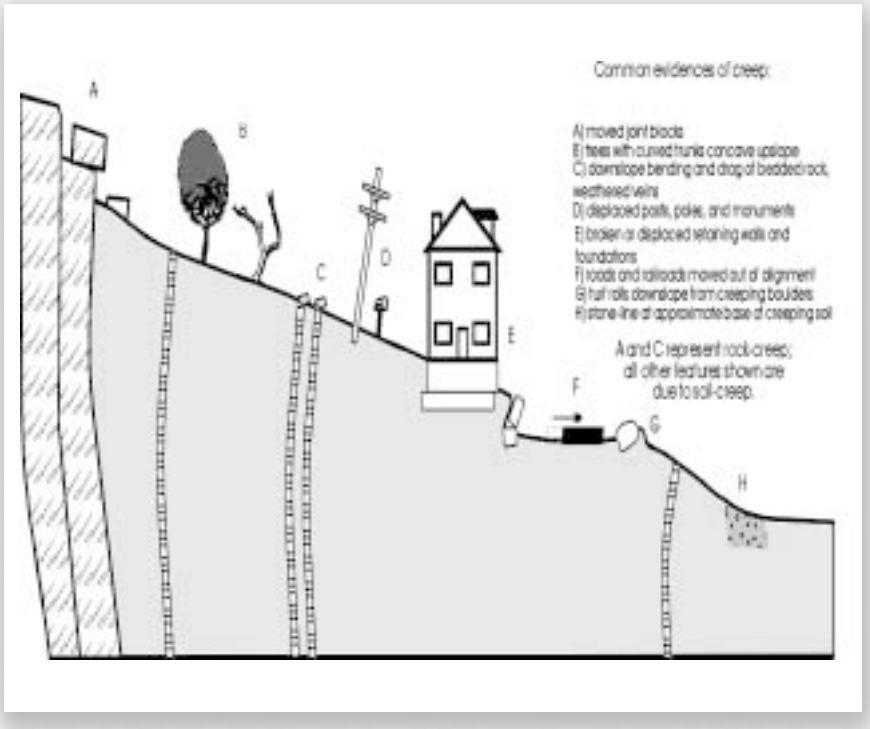


Figure 80 - Indicators of Instability

A number of human activities can aggravate or create slope instability. These include indiscriminate discharge or leakage of water from swimming pools, septic systems, storm runoff control ponds, and drains, as well as agricultural tile drainage systems. Changes in the topography, by cut and fill earth moving or land grading, can also alter the strength of any soil strata or add weight to the entire slope. The construction of buildings or protection works on or near these slopes can further weaken the slope which in turn may contribute to an increased instability in the future.

With the activities of urbanization and land development; fill placement near slope crests, construction of retaining walls near slopes, and excavations into slopes, may alter the slope stability. Filling is a common practice in most urban areas as people try to reclaim more usable flat tableland along existing slope crests. Fill placement often occurs in an uncontrolled manner (sometimes over an extended period of time) and may result in an unstable fill mass which eventually experiences movements. Slides within fill materials placed randomly and not engineered, can be quite unpredictable and extensive. The resulting instability may occur through the fill materials only or, through both fill and underlying native soil.

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Filling on slopes can be carried out in a safe and stable manner with suitable control works, drainage measures included in the design and precautions taken during construction. The fill works must be designed and construction supervised under the responsibility of a qualified geotechnical engineer.

Figure 81 - Bent Guardrail Due to Failure Below Water Line

Figure 82 - Scarps, Slumped Soil Masses

Hazardous Lands: River and Stream Systems (Policy 3.1.1 (b)

By definition, *river and stream systems* includes all watercourses, rivers, streams and small inland lakes (i.e., lakes having a surface area of less than 100 square kilometres that have a measurable and predictable response to a single runoff event).

River and stream systems are by nature dynamic, constantly changing landforms due mainly to the erosive forces of flowing water and the relative stability of surrounding slopes. The degree and frequency with which the morphological or physical change will occur in these systems depends on the interaction of a number of interrelated factors including hydraulic flow, channel configuration, sediment load in the system, and the stability of the banks, bed and adjacent slopes.

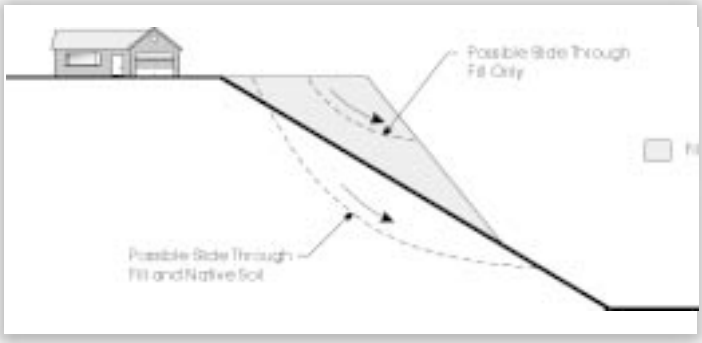


Figure 84 - Filling On Slopes

The *natural* importance of *river and stream systems* in providing physical, biological and chemical support functions for sustaining ecosystems, including that of humans, is indisputable. These functions are strongly associated with the physical processes of discharge (i.e., flow), erosion, deposition and transport that are inherent in any river and stream system. Given that ecological sustainability is based on the dynamic nature of these systems, it is essential that their physical processes (e.g., flow dynamics) be allowed to function in as natural a state as possible.

It is, however, the constant shaping and re-shaping of the *river and stream systems* by the physical processes associated with flooding, erosion and slope stability that result in the creation of hazardous conditions that pose a threat to human lives and cause property damages. Millions of dollars are spent annually in attempts to remedy flooding and erosion problems which pose a risk to life and property.

Defining the "area of provincial interest" within *river and stream systems* should first involve an understanding of the interrelationships between all of the physical processes acting on and influencing a particular system. These physical processes result from the interaction of numerous variables that comprise a watershed and/or river and stream system. These include, but are not limited to:

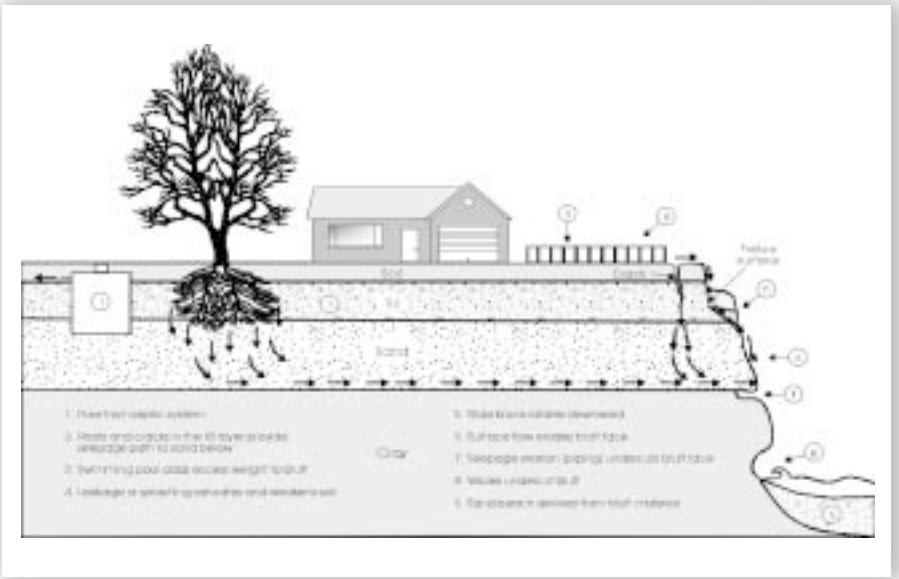


Figure 83 - Human Activities:Discharage of Water on Slope, Leakage of Pools

Figure 85 - Installation of Geomatting

Figure 86 - Drainage Designed by Geotechnical Engineer

Figure 87 - Repaired Slope, Filled Slope Designed by Geotechnical Engineer

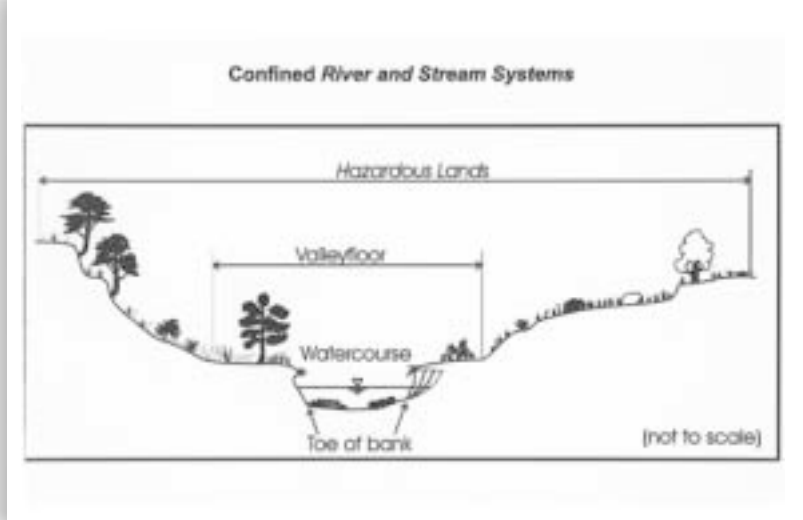


Figure 88 - Confined River and Stream System

Figure 89 - Confined River and Stream System

Figure 90 - Confined River and Stream System

- geology (e.g. , topography, lithology);
- climate (e. g. , precipitation including rain/snow, temperature, wind);
- soil properties (e. g. , structure, type, density, porosity);
- vegetation types (e. g. , grasses, shrubs, trees, density/depth of root systems);
- hydrologic & hydraulic conditions (e. g. , fluvial system);
- discharge (i. e. , volume per unit time)
- low flow, peak discharge, bank full discharge, ephemeral or perennial flow
- channel configuration
- width vs. depth, slope, roughness, composition of the bed/bank material, pattern (e. g., braided, meandering, straight)
- sediment load
- bedload, suspended load, dissolved load
- hydraulic conditions (e. g. , slopes); and
- ground water regime (e. g. , flow)
- soil drainage (e. g. , porosity)
- overland flow, through flow, saturation flow
- slope stability
- height
- inclination
- loading
- proximity to flowing water (e. g. , potential for toe erosion)
- water content
- land use and human impact

The complexity of the interaction of these variables in various *river and stream systems* results in a wide array of drainage and stream/river types (Leopold et al, 1964; Gregory and Walling 1974; Morisawa, 1985).

For *hazardous lands* associated with *river and stream systems* (Policy 3.1.1(b)), the numerous combinations of physical landforms have been simplified into two basic types:

•**confined system**;
•**unconfined system**.

Confined *river and stream systems* are ones in which the physical presence of a valley corridor containing a river or stream channel, which may or may not contain flowing water, is visibly discernible (i.e., valley walls are clearly definable) from the surrounding landscape by either field investigations, aerial photography and/or map interpretation. The location of the river or stream channel may be located at the base of the valley slope, in close proximity to the valley slope (i.e., within 15 m) or removed from the valley slope (i.e., a distance greater than 15 m) (see Figures 88-90).

Unconfined *river and stream systems* are ones in which a river or stream is present but there is no discernible valley slope or bank that can be detected from the surrounding landscape by either field investigations, aerial photography and/or map interpretation. For the most part, unconfined systems are found in fairly flat or gently rolling landscapes and can be located within the headwater areas of drainage basins. The river or stream channels contain either perennial (i.e., year round) or ephemeral (i.e., seasonal or intermittent) flow and may range in channel configuration from seepage and natural springs to detectable channels (see Figure 91-93).

Figure 92 - Unconfined System

Figure 93 - Unconfined System

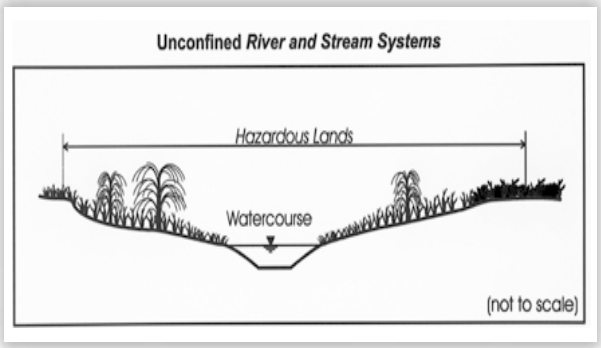


Figure 91 - Unconfined River and Stream System

Erosion Hazards

The three main forces that shape and re-shape *river and stream systems* are the natural processes of erosion, flooding (i.e., water flow), and slope stability. Erosion and slope stability are two natural processes which are quite different in nature yet often linked together. Erosion is essentially the continual loss of earth material (i.e., soil or sediment) over time as a result of the influence of water or wind. Slope stability, usually described in terms of the potential for slope failure, refers to a mass movement of earth material, or soil, sliding down a bank or slope face as a result of a single event in time.

By definition, the *erosion hazards* limit, depending on the type of *river and stream system* involved, should be based on the combined influence of:

- toe erosion allowance
- stable slope allowance
- ***flooding hazard*** **limit** or **meander belt allowance**
- erosion access allowance

River and Stream Systems Landform Classification

	Confined	Unconfined
Watercourse Profile		
Typical Geologic Setting	Valley corridors	Glaciated plains, flat to gently rolling

Hazard Allowances	Confined	Unconfined
Stable Slope	Yes	No
Toe Erosion	Yes	No
Meander Belt	No	Yes
Access Allowance	Yes	Yes

Figure 94 - Landform Classification

Based on the type of *river and stream system* landform (i.e., confined, unconfined), Figure 94 provides guidance on which combinations of these factors (hazard allowances) should be used in defining the *erosion hazards* limit.

Defining the *erosion hazards* limit for the two basic types of *river and stream systems* landforms should be based on the following approaches:

Confined systems (see Figures 95a and 95b)

toe erosion allowance* (from Table 2; OR 100 times the average annual recession rate of the toe) **OR** as determined by a study using accepted geotechnical and engineering principles

+ allowance for stable slope 3:1 (h:v) minimum **OR** as determined by a study using accepted geotechnical principles

+ erosion access allowance 6 metres **OR** as determined by a study using accepted scientific, geotechnical and engineering principles

* Note:

.*where the soil type is not known, Table 3 recommends the use of a 15 m toe erosion allowance; and*

.*when using average annual recession rates to determine the toe erosion allowance a minimum of 25 years of reliable information is recommended.*

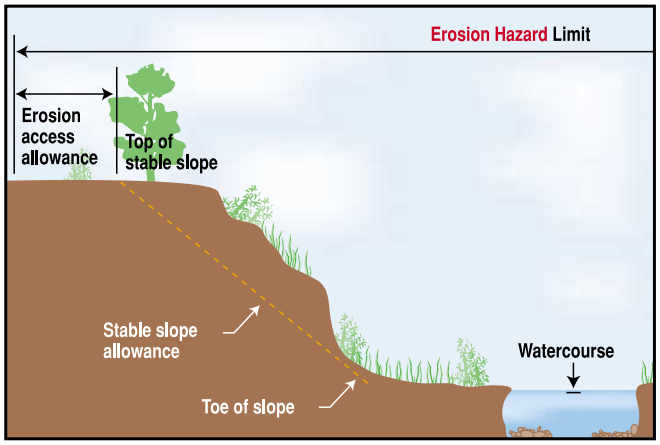


Figure 95 a Confined System, Erosion hazard limit where toe of valley slope is located more than 15 metres from the watercourse

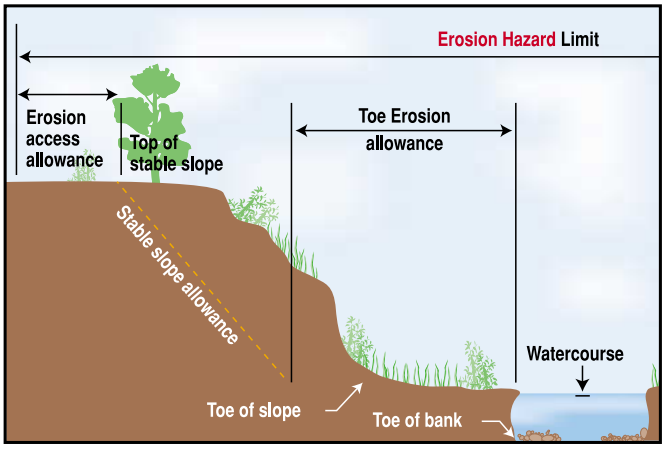
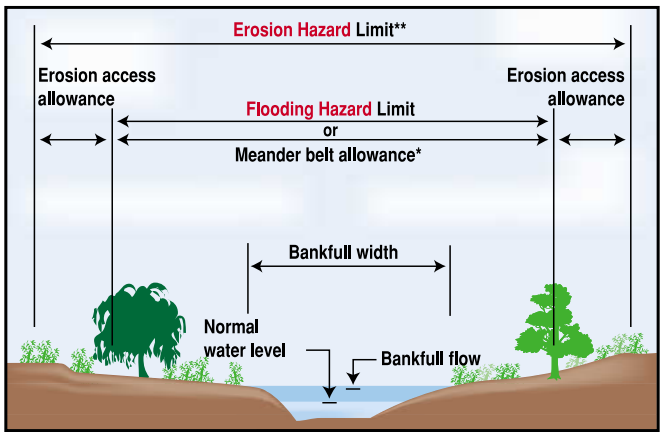


Figure 95 b Confined System, Erosion hazard limit where toe of valley slope is located less than 15 metres from the watercourse

Unconfined systems (see Figure 96)

an allowance for the *flooding hazard* limit OR meander belt allowance 20 times the bankfull channel width centred over the meander belt axis **OR** as determined by a study using accepted engineering principles

+ erosion access allowance 6 metres **OR** as determined by a study using accepted scientific, geotechnical and engineering principles



(NOT TO SCALE)

* The bankfull channel width with the largest amplitude meander in the reach is used to determine Meander Belt Width.

** Erosion access allowance is also added to the flooding hazard limit, when known, to define the erosion hazard limit.

Figure 96 Erosion Hazard Limit

The following subsections clarify how each of these components for defining *erosion hazards* should be determined and where flexibility may be provided to undertake studies to address unique, local situations (e.g., where the approach(es) may be considered excessive or insufficient to define the area of provincial interest). Where studies using accepted scientific, geotechnical and/or engineering principles were used to determine the landward limit of the *erosion hazards* are approved by the municipality, they should be applied only within the area studied.

3.1 TOE EROSION ALLOWANCE

The flow of water through *river and stream systems* can cause erosion of the surface or exposed face of the bank or channel. The magnitude or rate of erosion can be quite variable over the time dependent on the volume, velocity and duration of the flows. For example, a heavy rainfall or rapid snowmelt event may increase the potential magnitude or rate of erosion as a result of a measurable increase in water flows or discharge into and through the *river and stream systems*. Areas which are particularly susceptible to erosion are those banks or valleys slopes on the outside of meanders or bends of the river or stream.

Erosion is also the result of the gradual and continuous removal of soil material through other processes which are not always easily discernible. For example, wind and ice action on a river bank or channel results in the weathering, dislodging and transport of soil particles. This constant, yet often slow removal, ultimately can lead to the undercutting and instability of an adjacent slope. The level or rate of toe erosion, in this instance, is a function of the amount of water flowing through the system, the presence, duration and force of the wind, and the varying influence of ice and other water related forces (e.g., ground water seepage, and piping).

The rate of erosion is also a function of the proximity of the river or stream channel to a valley wall or bank face. If the river or stream channel is in close proximity or abuts the valley wall the erosive forces of the flowing water will cause a steepening and then undercutting of the valley wall. The degree or severity of this erosive action is dependent on the soil composition (e.g., determines the strength or susceptibility of the slope) and the proximity and exposure of the slope to the channel or water flows.

The **toe erosion allowance** or recession of the toe of the slope, which is normally applied only to confined systems and may be determined in one of four ways:

•use of the **average annual recession rate** applies only to confined and terrain-dependent systems consisting of cohesive materials. A minimum 25 years of record or data is required to provide a measure of reliability when determining average annual recession rate extended over a 100 year planning horizon. Data sources could include survey information, aerial photographs and through field monitoring and measurement using equipment having sufficient precision and accuracy to provide a reliable indication of recession.

•use of a **15 metre toe erosion allowance** measured inland horizontally and perpendicular to the toe of the watercourse slope (Figure 97) where the valley floor is less than or equal to 15 metres (i.e., distance between the watercourse and the base of the valley wall). The proximity of the watercourse to the base of the valley wall can be determined from aerial photography or site investigations.

•**toe erosion allowance based on soil types and hydraulic processes** based on visual observations or analytical studies and where the valley floor is less than or equal to 15 metres (i.e., distance between the watercourse and the base of the valley wall). Use of this option is guided by the information outlined in Table 3.

•use of a study using accepted geotechnical and engineering principles and based on a minimum of 25 years of record or data.

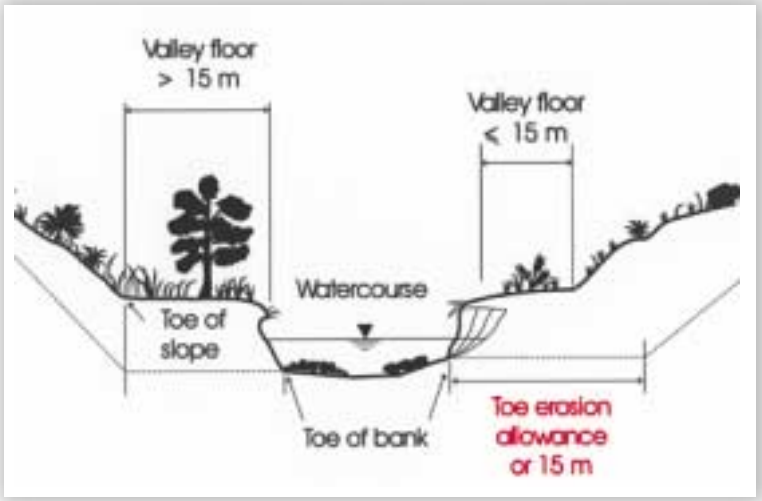


Figure 97 - 15 metre Toe Erosion Allowance

The first two options are straightforward and can be applied directly. Where the third option outlined above is selected (i.e., use of Table 3), there are a number of steps involved in determining the toe erosion allowance for a given location.

STEP 1:**The native soil structure or composition of the site should be confirmed**.

The native soil structure or composition of the site should be confirmed either through a site visit or previously generated information (e.g., borehole, auger hole or test pits). Select one of four general material types (i.e., hard rock; soft rock, cobbles and boulders; stiff/hard cohesive soils, coarse granular and/or tills; or soft/firm cohesive soil and/or fine granular) from Table 3.

For a further description and photo's of the general material types (i.e., hard rock, soft rock, cobbles and boulders; stiff/hard cohesive soils, coarse granular and/or tills; or soft/firm cohesive soil and/or fine granular) refer to Section 2.2 of this document.

Table 3: Determination of Toe Erosion Allowance

MINIMUM TOE EROSION ALLOWANCE - River Within 15 m of Slope Toe*

Type of Material Native Soil Structure	**Evidence** of Active Erosion** **OR** Bankfull Flow Velocity > Competent Flow Velocity***	**No evidence** of Active Erosion** **OR** Bankfull Flow Velocity <Competent Flow Velocity***		
	RANGE OF SUGGESTED TOE **EROSION ALLOWANCES**	Bankfull Width		
		< 5m	5-30m	> 30m
1.Hard Rock (granite) *	0 - 2 m	0 m	0 m	1 m
2.Soft Rock (shale, limestone) Cobbles, Boulders *	2 - 5 m	0 m	1 m	2 m
3.Stiff/Hard Cohesive Soil (clays, clay silt), Coarse Granular (gravels) Tills *	5 - 8 m	1 m	2 m	4 m
4.Soft/Firm Cohesive Soil, loose granular, (sand, silt) Fill *	8 - 15 m	1-2 m	5 m	7 m

*Where a combination of different native soil structures occurs, the greater or largest range of applicable toe erosion allowances for the materials found at the site should be applied

****Active Erosion** is defined as: bank material is exposed directly to stream flow under normal or flood flow conditions where undercutting, oversteepening, slumping of a bank or down stream sediment loading is occurring. An area may have erosion but there may not be evidence of 'active erosion' either as a result of well rooted vegetation or as a result of a condition of net sediment deposition. The area may still suffer erosion at some point in the future as a result of shifting of the channel. The toe erosion allowances presented in the right half of Table 3 are suggested for sites with this condition. See Step 3.

*****Competent Flow Velocity** is the flow velocity that the bed material in the stream can support without resulting in erosion or scour. For *bankfull width* and *bankfull flow velocity*, see Section 3.1.2.

Where there is evidence of high variability in soil composition, the soil composition is not known, and/or evidence of high erosion activity, the 15 metre toe erosion allowance should be applied.

STEP 2: Determine whether or not there is evidence of active erosion OR if the bankfull velocity is greater than the competent flow velocity.

Visible on-site evidence of active erosion may include a bare or vegetation-free river or stream bank which is directly exposed to water flows, and where undercutting, over-steepening, slumping of the bank or high downstream sediment loading is occurring. Slumping, scars, and bare stream banks that are not directly exposed to river flows are slope stability issues and should not be considered as evidence of "active erosion".

If field investigations determine that active erosion is occurring and as long as the soils at the site can be identified, it may not be necessary to determine the bankfull or competent flow velocities at the site. The Toe Erosion Allowances from Table 3 can be applied directly without any further calculations.

Figure 98 - Determine Evidence of 'Active'

Figure 99 - Example of 'Active' Bank Erosion

However, if field observations are not undertaken and it is unknown whether active erosion is occurring at the site, then it may be necessary to determine the bankfull or competent flow velocities at the site.

Determination of whether the bankfull velocity is greater than the competent flow velocity can be confirmed through site investigations or the calculation of flow velocities (i.e., determined through the use of hydrologic studies involving an assessment of flow data and flow model calculations).

Using Table 3 will require some definitions which are presented at the bottom of the chart. One of the key components is the determination of the bankfull velocity and bankfull width.

Figure 100 - Example of 'Active' Erosion (Slumping)

3.1.1 Determination of Bankfull Characteristics

The bankfull flow is the maximum flow within a channel before spilling onto its floodplain. As the flow and energy per cross-sectional area is at its maximum at bankfull conditions, this flow performs the most work upon the channel boundary and has also been shown to be the most effective flow for transporting sediment.

Several definitions have been developed and are valid but lead to some confusion. These definitions include terms such as "channel defining flow", effective discharge, mean annual flood and dominant discharge. They all have slightly different meanings and can actually be the equivalent of bankfull flow.

A field procedure for determining bankfull width was developed by MNR as part of the "Stream Assessment Protocol for Ontario", 1998. This document and field assessment can be followed to obtain the bankfull width.

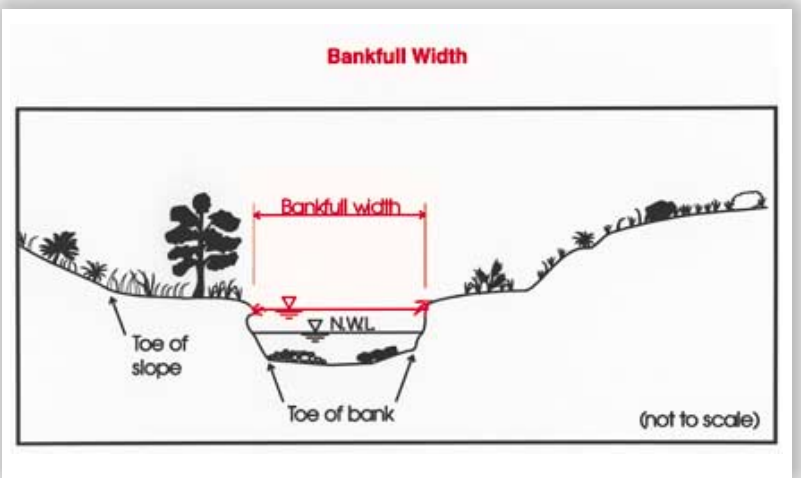


Figure 101 - Bankfull Width

Figure 102 - Examples of rivers at bankfull conditions

Physical indicators such as;

•a change in vegetation type; i.e., the lower limit of growth for perennial species (willow, alder, dogwood);
•a change in slope along the river bank;
•a change in the soil particle size of the bank;
•undercuts (erosion) in the bank;
•stain lines along the bank, or the lower limit of lichens on boulders;

are just some of the general indicators which can be helpful in identifying the bankfull width in the field. Refer to Section 2.3.3.1 for a bankfull discussion.

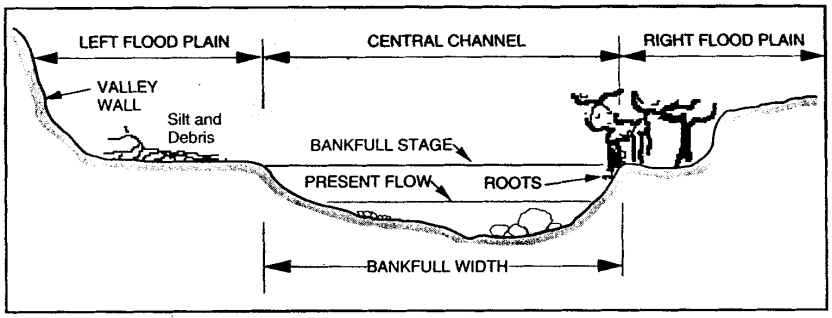
In the absence of field collected bankfull width data, the following charts (figures 104 - 107) may be used, provided they are used by qualified experts applying "accepted scientific and engineering principles".

The list of watercourses that were studied and measured in the field came from a study, "Database of Morphologic Characteristics of Watercourses in Southern Ontario", August, 1996 by W.K. Annable. Data was collected at 47 sites in larger systems, non-urbanized watersheds in Southern Ontario. It is very important to note that the data which was collected is only applicable to non-urbanized streams and rivers.

The detailed survey information for each of the first 47 sites is available in the above report and the "Morphologic Relationships of Rural Watercourses in Southern Ontario and Selected Field Methods in Fluvial Geomorphology", August, 1996, by W.K. Annable.

If the drainage area is known for a site and the particular river system is on the list, the bankfull characteristics are provided. There may also be a river in a particular area that mimics one of the surveyed systems (i.e., same soil conditions, strata, hydraulics, gradient, etc.), then the information may be used with caution and the expertise to help interpret or predict bankfull conditions at the similar location.

Figure 105 is a plot of Newbury's data with all the 47 sites from the Annable study with the addition of 6 sites from the Don River. Figure 106 is a plot of the Newbury sites and all the Alluvial sites where the bedrock sites were taken out. Figure 107 indicates all the bedrock sites and Newbury's sites. This data may also be used to determine the "meander belt allowance" in the following sections.



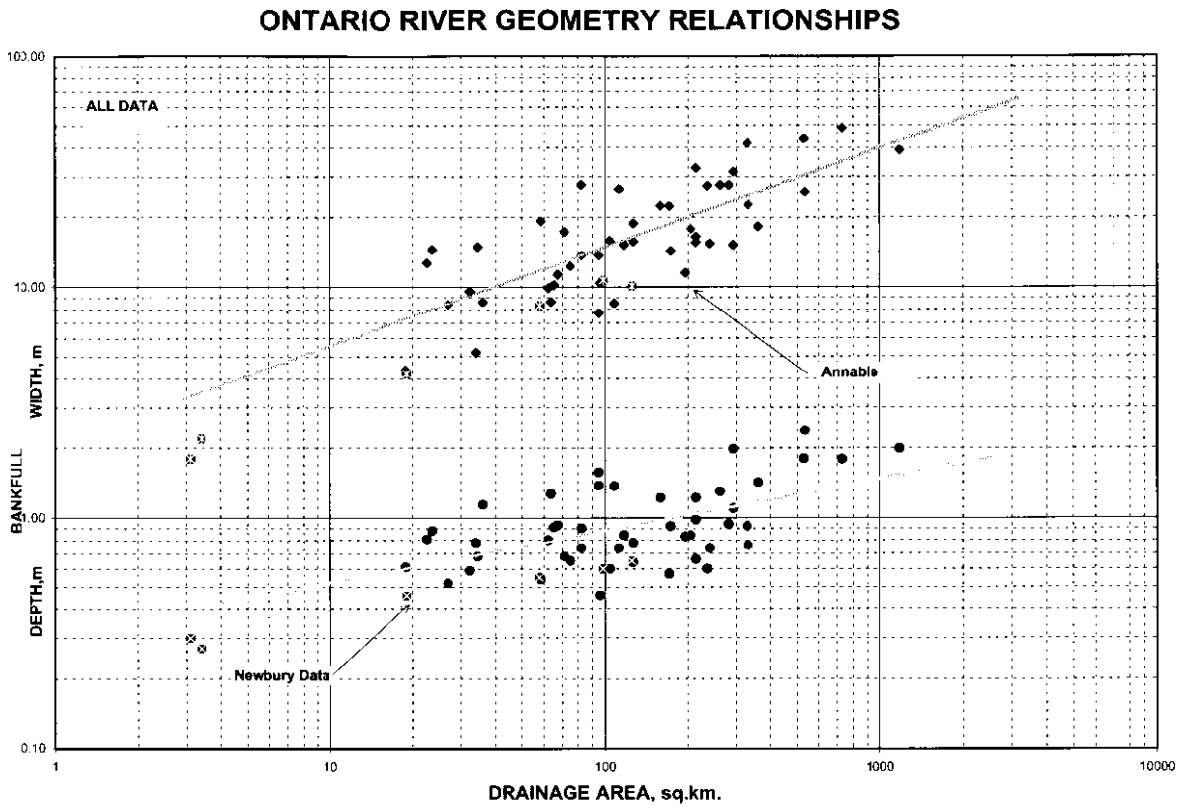
Cross section of stream valley with floodplains and a well-defined central channel and bankfull stage.

Figure 103 - Bankfull Stage

ALL DATA

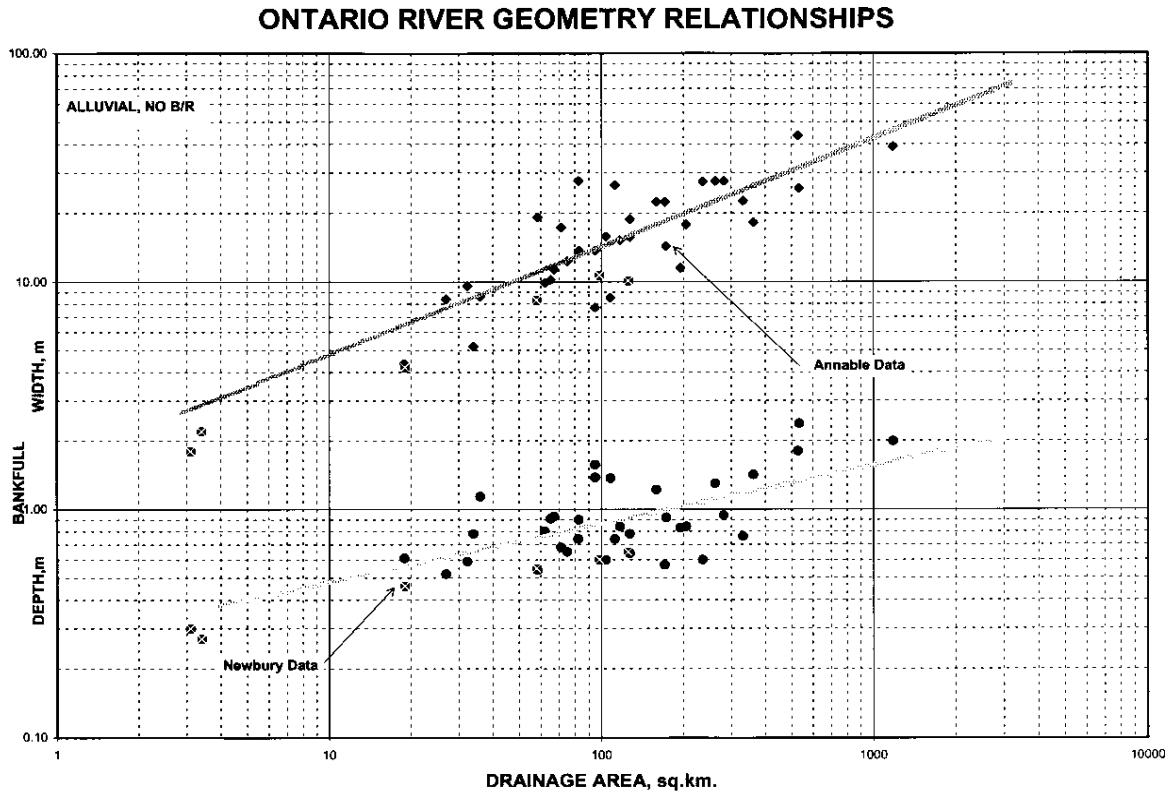
	Watercourse	DRAINAGE AREA (km2)	BANKFULL DEPTH (m)	BANKFULL WIDTH (m)	BANKFULL DISCHARGE cu.m/s	STREAM CLASS
ANNABEL DATA						
1	BEAR CREEK BELOW BRIGDEN	533.0	2.38	25.67	27.94	C6
2	BEAVERTON RIVER NEAR BEAVERTON	282.0	0.94	27.60	42.40	C4
3	BIG CREEK NEAR DELHI	362.0	1.42	18.20	29.73	F4
4	BLACK CREEK BELOW ACTON	18.9	0.61	4.36	2.27	E4
5	BOWMANVILLE CREEK NEAR ELMIRA	104.0	0.60	15.80	18.40	C3
6	BURNLEY CREEK ABOVE WARKWORTH	71.2	0.68	17.30	16.35	C4
7	CANAGAGIGUE CREEK NEAR ELMIRA	82.3	0.74	27.63	26.23	C4
8	COLD CREEK AT ORLAND	159.0	1.22	22.34	19.21	C4
9	COPELAND CREEK NEAR PENETANGUISHENI	26.9	0.52	8.40	3.61	C5
10	CREDIT RIVER AT BRIMSTONE	22.5	0.81	12.70	18.25	B3
11	CREDIT RIVER NEAR CATARACT	205.0	0.84	17.80	17.48	C4
12	CREDIT RIVER - ERIN BRANCH ABOVE ERIN	32.3	0.59	9.60	3.29	C5
13	WEST CREDIT RIVER ABOVE THE FORKS OF	96.0	0.46	10.40	9.64	B3
14	CREDIT RIVER NEAR ORANGEVILLE	62.2	0.80	9.90	6.72	C5
15	EAST HUMBER RIVER AT KING CREEK	94.8	1.38	7.70	13.70	E4
16	EELS CREEK BELOW APSLEY	241.0	0.74	15.40	21.68	B1
17	ERAMOSA RIVER ABOVE GUELPH	236.0	0.60	27.40	17.80	C3
18	FAREWELL CREEK AT OSHAWA	58.5	0.54	19.20	8.74	C4
19	GANARASKA RIVER NEAR DALE	262.0	1.30	27.60	49.87	C4
20	GANARASKA RIVER NEAR OSACA	67.3	0.93	11.30	14.26	E4
21	HOG CREEK NEAR VICTORIA HARBOUR	65.2	0.91	10.20	14.15	E4
22	HORNER CREEK NEAR INNERKIP	108.0	1.37	8.50	15.28	E5
23	HUMBER RIVER NEAR PALGRAVE	117.0	0.84	15.20	12.60	C4
24	IRVINE CREEK ABOVE SALEM	215.0	0.66	32.60	53.84	C1
25	IRVINE CREEK AT ELORA	215.0	1.22	16.50	53.84	F2
26	IRVINE CREEK AT SALEM	215.0	0.98	15.60	53.84	F1
27	MAITLAND RIVER AVOVE WINGHAM	528.0	1.80	43.60	96.40	C3
28	MAITLAND RIVER NEAR HARRISTON	112.0	0.74	26.50	24.67	C4
29	McKENZIE RIVER NEAR CALEDONIA	171.0	0.57	22.30	15.29	C5
30	NOTTAWASAGA RIVER AT HOCKLEY	172.9	0.92	14.30	20.00	C3
31	NOTTAWASAGA RIVER NEAR BAXTER	1180.0	1.99	39.00	98..73	C5
32	PEFFERLAW BROOK NEAR UDORA	332.0	0.76	22.60	18.45	C4
33	PINE RIVER NEAR EVERETTE	195.0	0.83	11.50	14.50	F4
34	PINE RIVER NEAR KILGORIE	75.0	0.65	12.30	9.97	B3
35	REDHILL CREEK BELOW ALBION FALLS	23.5	0.88	14.50	18.16	B3
36	SAUGEEN RIVER ABOVE DURHAM	329.0	0.92	41.70	73.50	C3
37	SILVER CREEK AT NORVAL (ROGERS CREEK	127.0	0.64	18.80	12.92	B4
38	SIXTEEN MILE CREEK BELOW HILTON FALLS	34.5	0.68	14.90	16.79	B3
39	SWAN CREEK NEAR ELORA	34.0	0.78	5.20	7.62	E4
40	SYNDENHAM RIVER AT ALVINSTON	730.0	1.79	48.70	84.90	C1
41	TROUT CREEK NEAR FAIRVIEW	36.0	1.14	8.60	16.93	F4
42	TWELVE MILE CREEK BELOW DECEW FALLS	63.5	1.27	8.60	19.25	A3
43	TWENTY MILE CREEK ABOVE BALLS FALLS	293.0	1.10	31.50	66.94	C1
44	TWENTY MILE CREEK BELOW BALLS FALLS	293.0	1.98	15.20	66.94	A2
45	WILLOW CREEK ABOVE LITTLE LAKE	94.8	1.57	13.70	22.65	E5
46	WILLOW CREEK AT MIDHURST	127.0	0.78	15.70	10.98	C4
47	WILMOT CREEK NEAR NEWCASTLE	82.6	0.90	13.71	18.00	C5
NEWBURY DATA						
48	DON RIVER	3.1	0.30	1.80		
49	DON RIVER	3.4	0.27	2.20		
50	DON RIVER	19.0	0.46	4.20		
51	DON RIVER	57.9	0.55	8.30		
52	DON RIVER	98.3	0.60	10.70		
53	DON RIVER	125.5	0.65	10.10		

Figure 104 - Ontario River Geometry Relationships List



Sources: Database of Morphologic Characteristics of Watercourses in Southern Ontario (W.K. Annable, Oct. 1994)
Stream Analysis and Fish Habitat Design (R.W.Newbury, M.N.Gaboury, 1993)

Figure 105 - Ontario River All Data Chart 1



Sources: Database of Morphologic Characteristics of Watercourses in Southern Ontario (W.K. Annable, Oct. 1994)
Stream Analysis and Fish Habitat Design (R.W.Newbury, M.N.Gaboury, 1993)

Figure 106 - Ontario River , Alluvial Sites

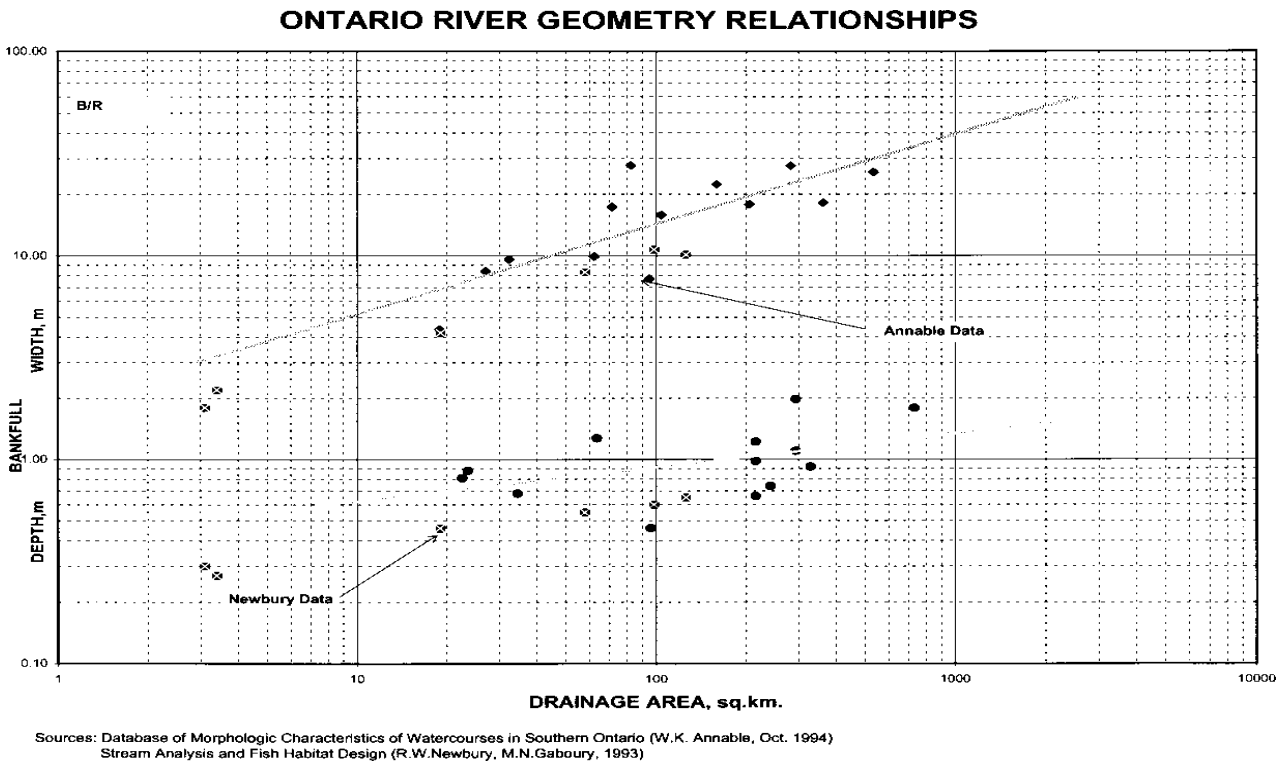


Figure 107 - Ontario River Data, Bedrock Sites

3.1.2 Competent Flow Velocity

For active erosion to take place, the flow velocity must increase and exceed the "competent" or "critical" velocity associated with the bed and bank material. Furthermore, the amount of erosion is then dependent on the frequency and duration of the erosive flow velocities.

Empirical methods have been used to assess the potential for vertical scour or erosion in rivers, for the purpose of **bridge foundation design (Ontario Highway Bridge Design Code, 1991)**. The OHBDC compiled numerous field data and case studies from Ontario, concerning scour and erosion. The **"competent mean velocity"** has been related to soil type or grain size (river bed and bank), for various depths of flow (regime) based on **bankfull discharge conditions**. This represents the minimum flow velocity which can cause active erosion based on the soil bed or bank materials.

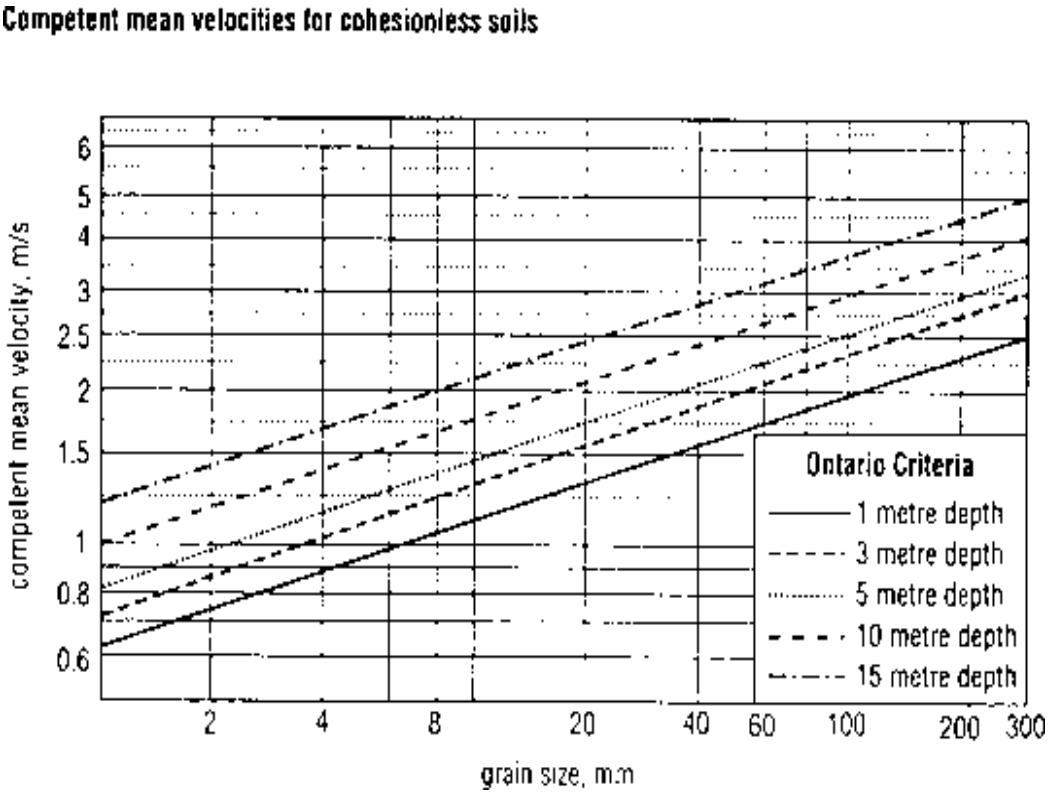


Figure 108 - Competent Mean Velocities for Cohesionless Soils

Competent mean velocities for cohesive soils

Depth of Flow (metres)	Competent Mean Velocity (in metres / second) Soil Scourability		
	High	Medium	Low
1.0	0.5	0.9	1.6
1.5	0.6	1.0	1.8
3.0	0.6	1.2	2.0
6.0	0.7	1.3	2.3
15.0	0.8	1.5	2.6

NOTES:

1. *Competent velocities should be based on local experience whenever possible, taking into account saturation and weathering of the soil.*
2. *It is not advisable to relate the tabulated values to soil property indices because of the strong effect of saturation and weathering on the scourability of many cohesive soils. However, the following tentative relationship to soil consistency is offered as a rough guide.*
   - *High scourability — very soft to soft clays.*
   - *Medium scourability — firm to stiff clays.*
   - *Low scourability — stiff to hard clays; some glacial tills.*
3. *Soil consistency can be judged by the following field test applied with the soil at or near its natural water content [36].*
   - *Very soft — easily penetrated several centimetres by fist.*
   - *Soft — easily penetrated several centimetres by thumb.*
   - *Firm — moderate effort required to penetrate several centimetres.*
   - *Stiff — readily indented but penetrated only by great effort.*
   - *Very Stiff — readily indented by thumb nail*
   - *Hard — indented with difficulty by thumb nail.*

Figure 109 - Competent Mean Velocities for Cohesive Soils

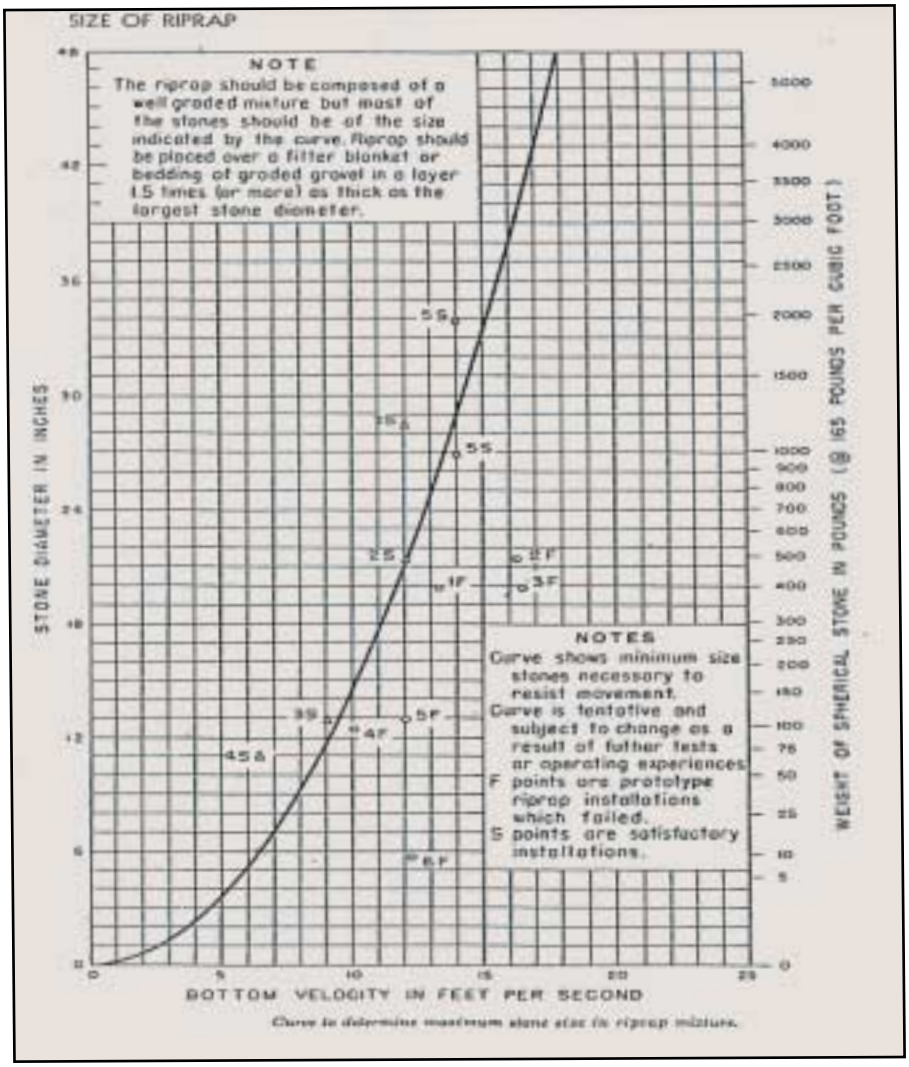


Figure 110 - Competent Flow Velocity of Rip Rap

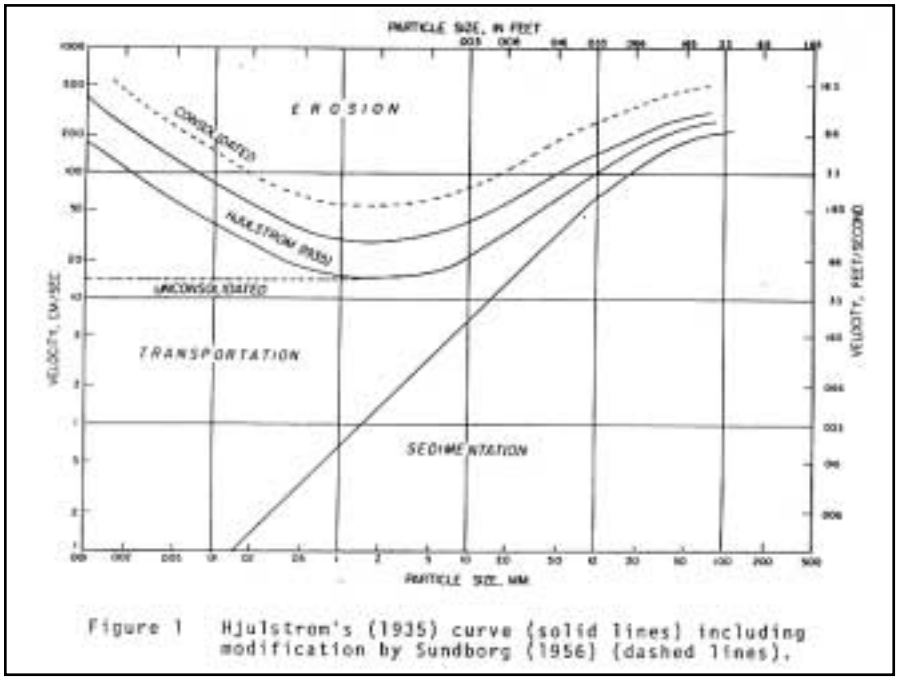


Figure 1 Hjulstrom's (1935) curve (solid lines) including modification by Sundborg (1956) (dashed lines).

Figure 111 - Modified Hjulstrom Curve (1935, 1994)

In very general terms, the flow velocity needed to cause "active erosion" is lowest for sand size particles, as shown on the **Hjulstrom Curve** (1935).fig 111. This graphical representation offers a simple description of flow velocity and particle size, in terms of **erosion, transportation, and deposition.**

STEP 3:Active Erosion has been Confirmed or the bankfull velocity is greater than the competent flow velocity

Figure 112 - Active Erosion

Figure 113 - No 'Active Erosion

Where active erosion is confirmed (see Figures 112) **OR** the bankfull velocity is greater than the competent flow velocity, and the native soil structure or composition is known, Table 3 provides the range of toe erosion allowance that should applied (e.g., for soft/firm cohesive soils (# 4, left column) the toe erosion allowance should be within the range of 8-15 metres).

STEP 4: No active erosion or bankfull velocity is less than the competent flow velocity

Where there is no evidence of active erosion (see Figure 113, 114) **OR** the bankfull velocity is less than the competent flow velocity, water depths should be used to determine the toe erosion allowance (e.g., from Table 3, the area of stiff/hard cohesive soils (#3) and a bankfull width of 5 to 30 metres would result in the selection of a toe erosion allowance of 2 metres).

Where the use of any of the first four options suggests that the identified toe erosion allowance may be excessive or not sufficient enough to reflect location conditions, mechanisms should be incorporated into the planning process providing the flexibility to undertake a study using accepted geotechnical and engineering principles and a minimum of 25 years of record or data to determine the toe erosion allowance. Where the municipality or planning board approves the study using accepted geotechnical and engineering principles, the geotechnical/engineering toe erosion allowance should be applied only in the area studied.

In some locations studies of toe erosion allowances may have already been undertaken by local agencies. These allowances are generally unique to specific watersheds or regions and are usually based on the subsoil and ground water conditions characteristic of the area. Where local studies have been undertaken using accepted geotechnical and engineering principles they may be used to determine the toe erosion allowances for the area studied.

Figure 114 - No 'Active Erosion'

3.2 STABLE SLOPE ALLOWANCE

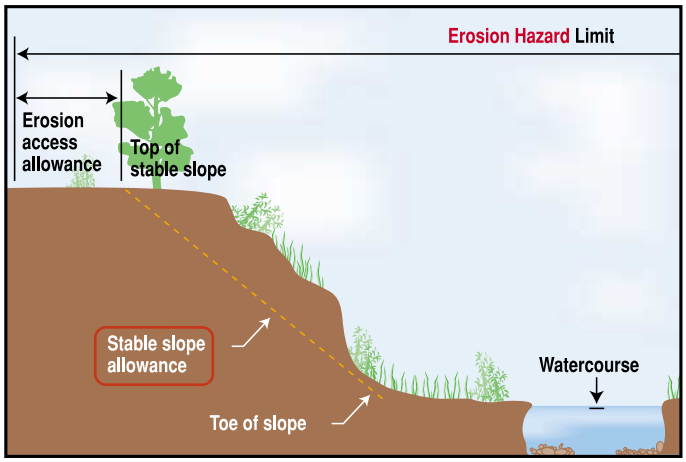


Figure 115 a - Stable Slope Allowance
(toe of valley slope >15m from watercourse)

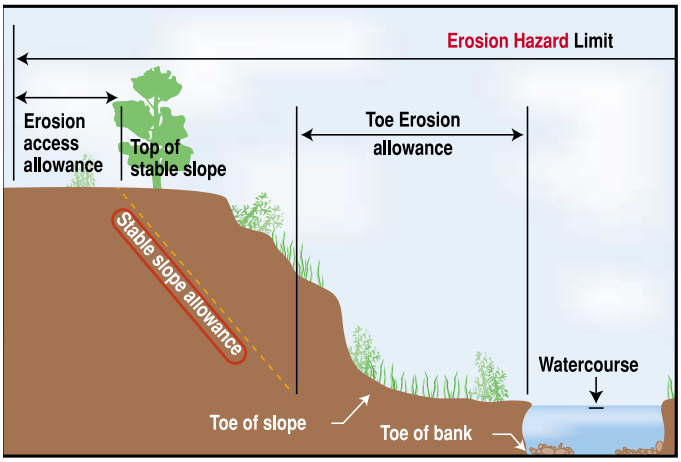


Figure 115 b - Stable Slope Allowance
(toe of valley slope ≤15m from watercourse)

The **stable slope allowance** is an important component of the e*rosion hazard* limit for **confined** r*iver and stream systems.*

The stability or instability of slopes is governed by the interrelationships between a number of variables associated with surface and subsurface conditions. These include, but are not limited to, soil composition, slope steepness or inclination, water content and movement through and over the slope, load or pressures on the slope, and the presence or proximity of flowing water. Slope movement or instability can occur in many ways. The most common causes of slope movement include:

• changes in slope configuration (e.g., steepness, inclination);
• increases in loading on a slope (e.g., placement of buildings, structures or fill at or near the crest of the slope);
• changes in surface/subsurface drainage of the soil resulting in higher levels of flows and erosive action or higher water pressures (e.g., heavy rainfall, blocked drainage); and
• loss or removal of stabilizing vegetation (e.g., weakening of the soil structure with the removal of the surface cover and root systems).

Naturally occurring erosion processes can also play an integral role in affecting the stability of a slope. This is particularly true where flowing water is involved (e.g., surface runoff over the slope, seepage zones associated with throughflow and ground water flow). Examples of the effects of flowing water on slope stability include, but are not limited to:

• slope failure caused by erosion at the toe of the slope as evidenced by the undercutting and steepening of the slope by river or stream flows or wave action at the base of the slope;
• saturation and resultant weakening of the strength of the soil structure (e.g., slope face) related to water seepage or the presence of ground water flow; and
• "piping", associated with springs or seepage areas, on the slope face which may cause erosion to occur in the weaker layer of soil (e.g., sand) overlying a less permeable soil type (e.g., clay).

Generally, development should not occur on or on top of valley walls because the long-term stability of the slope, and therefore public health and safety, cannot be guaranteed. Development should be set back from the top of valley walls far enough to avoid increases in loading forces on the top of the slope, changes in drainage patterns that would compromise slope stability or exacerbate erosion of the slope face, and loss of stabilizing vegetation on the slope face.

Where the valley wall is over-steepened or subject to active toe erosion, development should be set farther back from the top of the valley wall so that the development will also be safe from erosion and slope failure in the long term. This is likely the case when the slope is steeper than the suggested stable slope allowance (3 horizontal to 1 vertical distance) or when the toe of the slope is within 15 metres of the river or stream bank.

The determination and use of a **stable slope allowance** should apply only to confined systems to locate the top of stable slope and subsequently, the **erosion access allowance** (see section 3.4). By definition, unconfined systems do not have discernible valley or channel slopes and as such, do not usually have significant slope stability concerns.

The **stable slope allowance** means:

• Where the toe of the valley slope is located less than 15 metres from the river or stream bank, a horizontal allowance measured farther landward from the toe erosion allowance (i.e. horizontal and perpendicular from the toe of the watercourse) equivalent to at least 3.0 times the height of the slope. (see figure 115b)
• Where the toe of the valley slope is located more than 15 metres from the river or stream bank, a horizontal allowance measured from the toe of the valley slope equivalent to 3.0 times the height of the slope (see figure 115a)
OR
A stable slope allowance determined by a study using accepted geotechnical principles.

Where municipalities and planning boards determine that the 3:1 (h:v) stable slope allowance is excessive or not sufficient enough, mechanisms should be incorporated into the planning process providing the flexibility to undertake a study using accepted geotechnical principles to determine the stable slope allowance and the top of the stable slope.

Where studies using accepted geotechnical principles are approved by the municipalities or planning boards, the engineered stable slope allowance should be applied only in the area studied. For further recommendations on what specifically should be addressed by these studies please refer to Chapter 4, Mapping and Studies and Geotechnical Principles for Stable Slopes, 1998 report.

3.3 FLOODING HAZARD LIMIT ALLOWANCE AND MEANDER BELT ALLOWANCE

In determining the *erosion hazard* limit of **unconfined** *river and stream systems*, either the flood hazard limit or the meander belt allowance are applied along with the **erosion access allowance** (see section 3.4).

Approaches to determine the extent of flooding, or the *flooding hazard* limit are outlined in the Technical Guide - River and Streams Systems, Flooding Hazard Limit and are based on either storm centred events (i.e. Hurricane Hazel, Timmins Storm) or a flood frequency based event (i.e. 100-year flood), or an observed event.

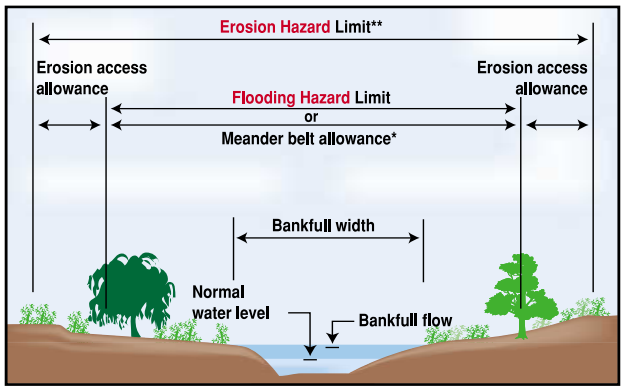
The general intent of defining the *flooding hazard* limit or meander belt allowance of unconfined river and stream systems is to ensure that the flow of water and its associated natural processes, including erosion, are maintained.

As unconfined systems are generally found within relatively flat terrains it is important to recognize that natural hazards associated with these fluvial systems may extend well beyond the immediate channel under conditions such as heavy or rapid runoff or spring snowmelt. During these times of increased flows, water flow may overtop banks of channels, create new channels and/or cause flooding and erosion.

Where the *flooding hazard* limit plus the erosion access allowance is used to determine the *erosion hazard* limit, the existence and availability of applicable data normally limits its use to drainage basins of greater than 125 hectares.

•Meander Belt Allowance

In any fluvial system, the morphology or change of the channel is a result of the dynamic balance of energy (e.g., flow or discharge of water) and the resistance of material comprising the channel perimeter (Morisawa 1985). As such, the channel form (e.g., shape, size, configuration) is governed by its need to carry sediment load (e.g., bed, suspended and dissolved) using the availability of water flows or discharge. A change in any of the variables (e.g., discharge, load, resistance) will result in a change in the channel form. One result of this change may be a shifting of the watercourse channel causing a change in the meander or channel orientation or form.



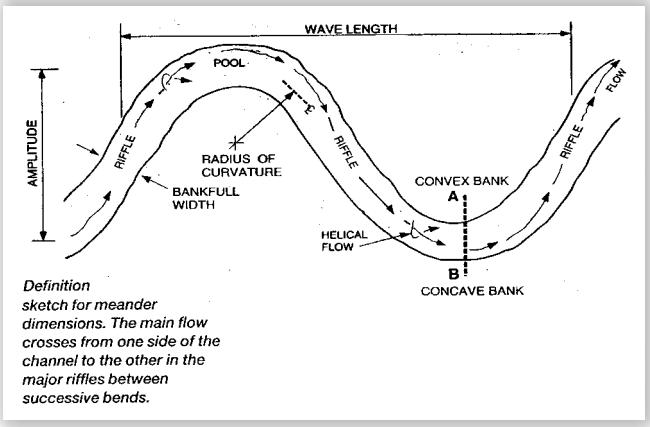
(NOT TO SCALE)

* The bankfull channel width with the largest amplitude meander in the reach is used to determine Meander Belt Width.

** Erosion access allowance is also added to the flooding hazard limit, when known, to define the erosion hazard limit.

Figure 116 - Flooding Hazard Limit for Unconfined Systems

Figure 117 - unconfined System



Definition sketch for meander dimensions. The main flow crosses from one side of the channel to the other in the major riffles between successive bends.

Figure 118 - River Terminology

Unconfined *river and stream systems* are located within relatively flat terrain. They normally contain perennial (i.e., year round) or ephemeral (i.e.,seasonal or intermittent) flows which have a tendency to constantly shift or meander (i.e., laterally and downstream) in response to the continuous changes associated with the natural influence of discharge and load.

The term **meander belt allowance**, for the purposes of defining the "area of provincial interest", is essentially the maximum extent that a water channel migrates. The term meander belt is derived from terminology used to describe meandering systems such as amplitude, wavelength, bend radius, bankfull width, point bars, pools, riffles and concave and convex banks.

A meandering system is comprised of a series of interconnected reaches. A reach is defined as a length of channel over which the channel characteristics are stable or similar. See Chapter 2 for a further description of reach. For each reach, the meander belt can conceptually be centred on a line or axis drawn through the middle of the meanders or riffle zones, a line that essentially divides each of the meanders in half (Figure 119).

Bankfull width can be established. Please see the previous Section 3.1.1 - Determination of Bankfull Characteristics.

Numerous technical sources have indicated that the bankfull discharge is the main type of flow that determines channel morphology or change. As such, the width of the meander belt is derived from an analysis of the bankfull channel width of the largest amplitude meander in the reach. Bankfull channel width may be determined through either field investigations or through aerial photograph interpretation. Based on available data and information the **meander belt allowance** should be defined as **20 times the bankfull channel width of the reach** and centred on the meander belt axis (Figure 120).

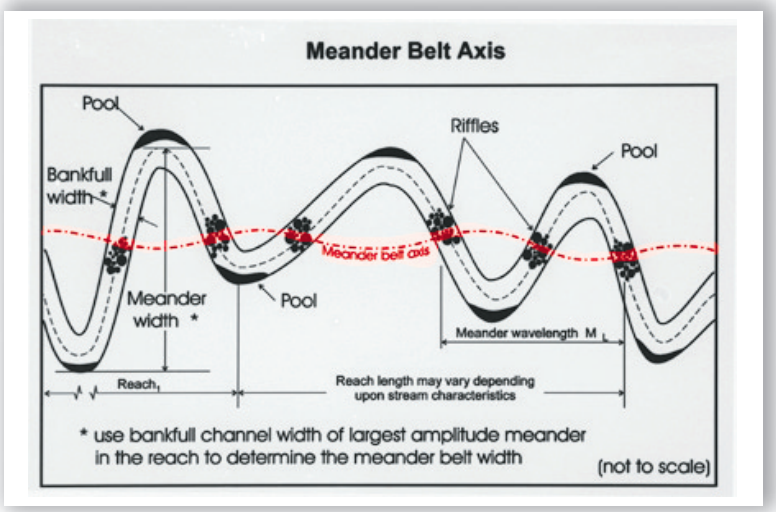


Figure 119 - Meander Belt Axis and Reach

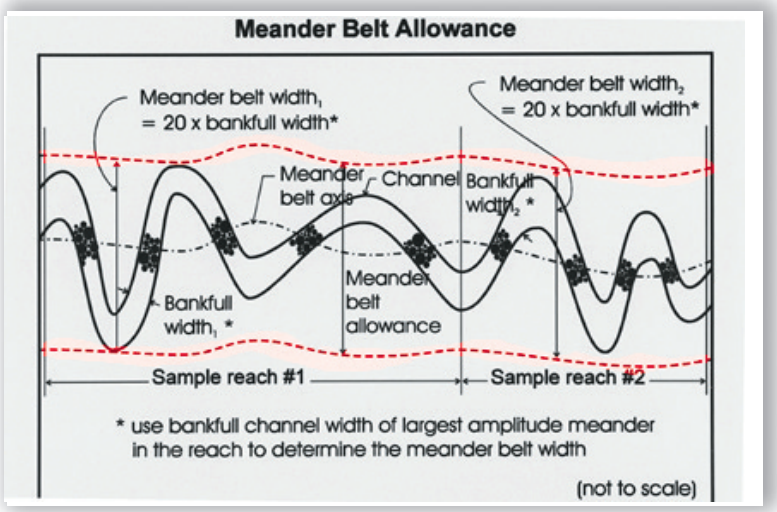


Figure 120- Meander Belt Allowance

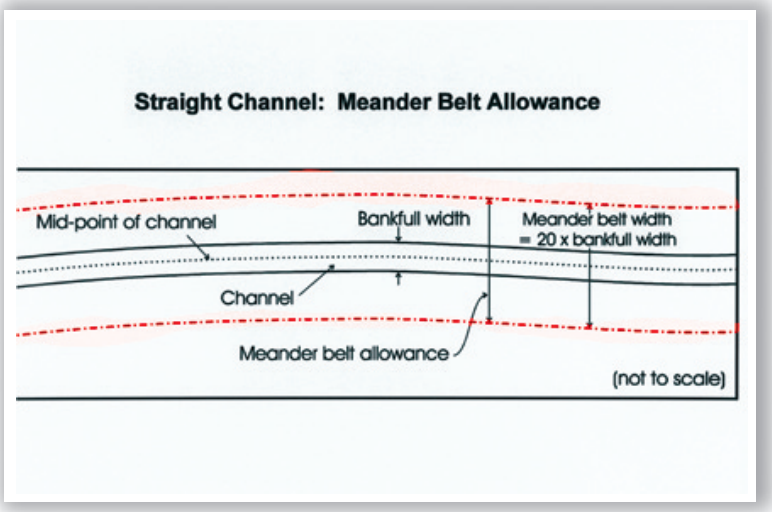


Figure 121 - Straight Channel

For those reaches where the channel appears to be straight (Figure 121), numerous factors combine to influence the size, shape and location of the meanders or the channel. For example, the "straightness" of the channel may result from the channel bed being located in a less erosive soil structure. Over time, flows within the channel bed may expose a more erosive soil structure and the channel may again begin to form meanders. When applying the meander belt allowance of 20 times the bankfull channel width for a reach that appears to be relatively straight, the meander belt should be centred on the mid-line of the channel.

Combining all of the calculated meander belt widths for each reach together along the entire length of channel will provide the overall meander belt allowance for the unconfined system.

Where municipalities and planning boards determine that 20 times the bankfull channel width of the reach is excessive or not sufficient enough in determining the meander belt allowance, mechanisms should be incorporated into the planning process providing the flexibility to undertake a study using accepted scientific, and engineering principles to determine the meander belt allowance. This flexibility may not be warranted or desired where a more precise definition of the meander belt allowance or *erosion hazard* limit is not necessary, where there is sufficient area within the development lot to site any proposed development outside of the *erosion hazard* limit (i.e., meander belt allowance plus the erosion access allowance), where development pressure is low and alternative development sites exist, or where the staff, administrative and financial resources within the municipality may preclude the ability of the municipality to support such studies. For those situations where a study is used to determine the "meander belt allowance", the study should be undertaken using "accepted engineering principles". For further recommendations on what should be addressed by these studies please refer to Chapter 4 - Field and Site Investigation.

Some studies of meander belt allowances have already been undertaken by local agencies. These allowances are generally unique to specific watersheds or regions. Where local studies have been undertaken using accepted engineering principles they may be used to determine the meander belt allowance for the area studied.

3.4 EROSION ACCESS ALLOWANCE

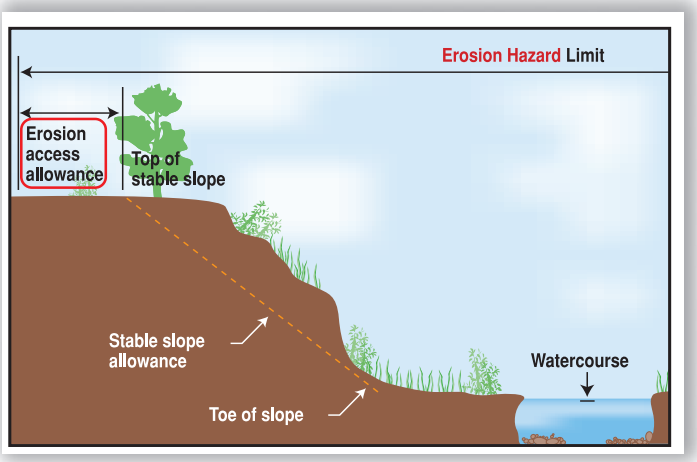


Figure 122 - Erosion Access Allowance: Confined Systems

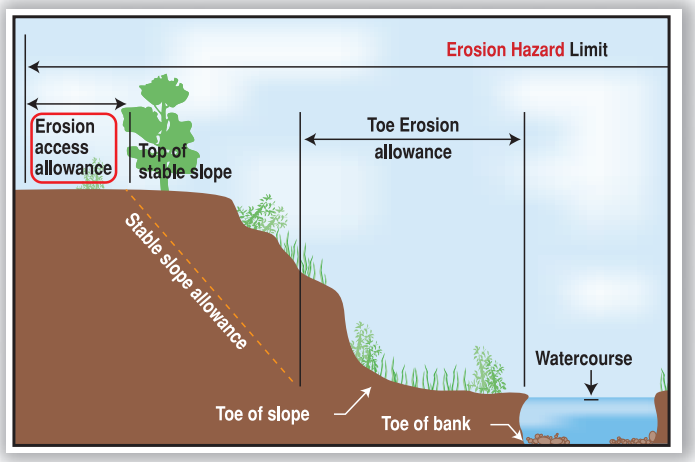


Figure 123 - Erosion Access Allowance: Unconfined Systems

Figure 124 - Erosion Access Allowance

The erosion access allowance is the last component used to determine the landward limit of the *erosion hazards* and should be applied within all confined, unconfined and terrain-dependent *river and stream systems*.

Three main principles support the inclusion of the erosion access allowance:

- providing for emergency access to erosion prone areas;
- providing for construction access for regular maintenance and access to the site in the event of an erosion event or failure of a structure; and
- providing protection against unforeseen or predicted external conditions which could have an adverse effect on the natural conditions or processes acting on or within an erosion prone area of provincial interest.

Study results using available data and information suggests that the **erosion access allowance** for *river and stream systems* should be **6 metres** (see Figures 122 and 123).

Where municipalities and planning boards determine that the suggested 6 metre erosion access allowance is excessive or not sufficient enough to provide the required public safety and site access, mechanisms should be incorporated into the planning process providing the flexibility to undertake a study using accepted scientific, geotechnical and engineering principles to determine the erosion access allowance. This flexibility may not be warranted or desired where a more precise definition of the erosion access allowance is not necessary, where there is sufficient area within the development lot to site any proposed development outside of the *erosion hazard* limit, where development pressure is low and alternative development sites exist, or where the staff, administrative and financial resources within the municipality may preclude the ability of the municipality to support such studies.

For those situations where a study is used to determine the "erosion access allowance", the study should be undertaken using "accepted scientific, geotechnical and engineering principles". Where studies using accepted scientific, geotechnical and engineering principles are approved by the municipality or planning boards, they should be applied only in the area studied.

Some studies of erosion access allowances have already been undertaken by local agencies. These allowances are generally unique to specific watersheds or regions. Where local studies have been undertaken using accepted scientific, geotechnical and engineering principles they may be used to determine the erosion access allowances for the area studied.

4.0 SITE INVESTIGATION AND STUDIES

If the proponent has decided that the generic setbacks are not appropriate for their purposes and would like to do a detailed study, then the following section will outline the procedure which should be followed.

The initial investigation for the site should be carried out by first carrying out the Step process outlined in the AMSC[9] in Ontario document. The following key questions should be answered as part of the initial erosion study:

- Where is the channel in its process of evolution?
- What is the disturbance?
- What future disturbances are likely to occur?
- What are the channel dynamics today?
- What is the streams response to the disturbance?
- What is the ultimate configuration of the channel?

This procedure will determine the potential future channel configuration and therefore assist in determining what areas are potentially safe to develop on or which areas are in danger of erosion in the future. The details of what is required in order to address each of these questions can be found in the AMSC[10] document. Additional investigations are the erosion, meandering and geotechnical investigations. These will assess the scale, nature, and extent of the natural erosion and slope stability process at the site and are covered under Section 4 of this document. The geotechnical procedure determines the surface, subsurface conditions (e.g., soil, rock, groundwater) and their potential for future slope instability. The erosion and meandering refers to the natural ongoing process in the river and stream system.

4.1 GENERAL INVESTIGATION FOR CONFINED AND UNCONFINED SYSTEMS

A site and field investigation may be carried out to assess the potential requirements for the confined or unconfined system (i.e., meander belt allowance, toe erosion allowance, stable slope allowance, and/or erosion access allowance). Depending on the landform type confined or unconfined, the type of study will vary significantly.

4.1.1 Site Investigation

The "site investigation" should involve a review of available records and a site visit to permit review of the type, scale and extent of the site hazard, the consequent risk to life, property and structure.

4.1.2 Review of Mapping

Regional geology should be considered at the outset of any slope stability investigation, along with any records of past slope instability situations. MNR geological mapping (bedrock geology and bedrock topography or drift thickness, Quaternary geology and MOE water well records) is available for many areas of the province, including most urbanized centres. Other sources include the Ministry of Development and Mines, and the Geologic Survey of Canada.

Many urbanized areas have had topographic mapping prepared from air photography interpretation and this is often available from the Engineering or Public Works Department in the municipal level government offices. The mapping should preferably be at a scale of 1:500 or 1:1000 in order to show sufficient detail of the slope profile.

These government offices sometimes also possess records of historical air photographs which may document conditions of erosion, slope instability, land development, or land filling. The Metropolitan Toronto Archives has such air photographs for the Toronto-centred area which are available from 1947 on almost an annual basis. These air photographs are at a scale of about 1:4800. Conservation Authorities also have files which document past reports of slope failures or erosion.

4.1.3 Review of Aerial Photographs

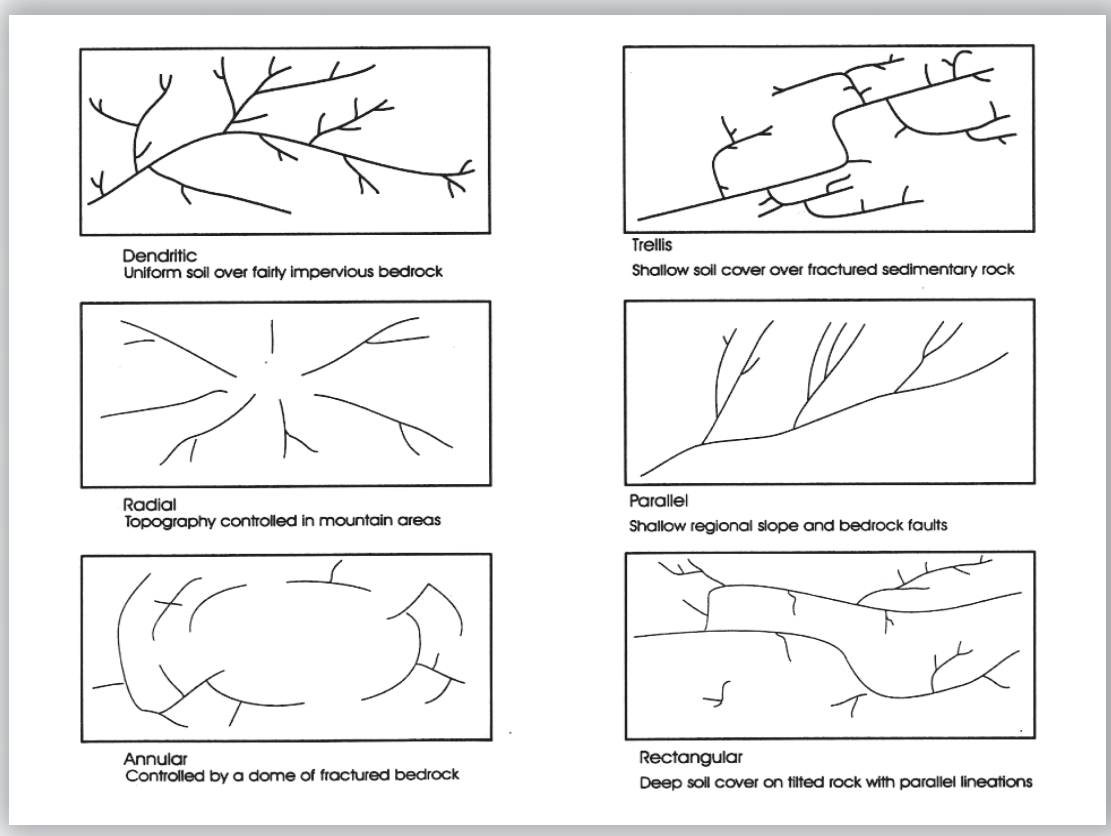


Figure 125 - Basic Drainage patterns (Mitchell, R.J., 1983)

An important aerial photographic element is soil tone that can indicate moisture condition on the ground. A dark tone of soil generally indicates a high moisture condition on the ground (i.e., high ground water level). The sharpness of the tonal boundary between dark and light tone of soils, aids in determination of soil type. Well-drained coarse-textured soils show distinct tonal boundaries, while poorly drained fine-textured soils show irregular unclear tonal boundaries. Vegetation pattern is connected with soil moisture conditions and reflects local and regional climatic conditions. Typically a small difference in soil moisture condition is detected by a corresponding change in vegetation conditions on the ground.

The following features (discernible on aerial photographs) are typical of landslide or landslide-susceptible terrain (Rib, H.T. and Liang, T.);

Air photos provide detailed geological and topographic information over a relatively large area (watershed, subwatershed, reach and site scales) and are used to detect conditions that are difficult to observe/evaluate from a surface investigation (i.e., previous landslides, river meandering, landforms, drainage patterns). The elements evaluated by air photo interpretation include topographic features, drainage, erosion, soil tones, and vegetation.

The density and pattern of drainage channels in a given area, directly reflect the nature of the underlying soil and rock. Drainage patterns are better developed within the relatively impervious soils which promote surface runoff. For example, a closely spaced drainage system denotes relatively impervious materials; a tree-like drainage pattern develops in flat lying beds and relatively uniform materials; a parallel stream pattern indicates the presence of a regional slope. The basic patterns and their relationship to soils and bedrock are shown on Figure 125.

- land masses undercut by streams,
- steep slopes having large masses of loose soils,
- sharp line of break at the scarp and/or tension cracks,
- hummocky surface of the sliding mass below the scarp,
- unnatural topography, such as spoon-shaped depressions in the terrain,
- seepage zones,
- closely spaced drainage channels,
- accumulation of debris in drainage channels or valleys,
- distinctive change in vegetation and tone, indicative of changes in soil moisture,
- inclined trees, displaced fences, distress to roadway.

Details of aerial photographic terrain evaluation are contained in Transportation Research Board Special Report No.176, “Landslides, Analysis and Control”, 1978.

4.3 Confined Systems : Determination of Toe Erosion and Slope Stability Issues

Toe Erosion Rates:

Toe erosion rates are best determined through long term measurements. Site measurements may not always be available for the site and aerial photography may be the best source of information. A minimum of 25 years of data is recommended for erosion assessment rates.

Slope Stability Requirements:
The following section describes the reasoning and basis for a suggested method of site evaluation to assist in determining the level of geotechnical investigation required to assess slope stability. In all cases, the responsibility for providing the geotechnical investigation is that of the proponent who might be a land developer, a pit operator, or a government agency. Part of the proposed development may be located close to a slope crest and there may be concerns about risks of ground loss in the event of a slope slide.

The level of geotechnical investigation required to determine the stability of a slope involves an understanding of:

- the physical and hydrological site conditions; and
- the type of development or land-use proposed,

which may be put at risk.

4.3.1 Site Investigation

Slope stability analysis and the calculation of Factors of Safety, requires certain basic information that can be determined in several manners or can be estimated with reasonable accuracy;

a)the slope configuration; height and inclination or shape. These can be estimated visually, or determined from topographic mapping, or measured by on-site survey of slope cross-sections (profiles).

b)the subsurface conditions within the slope; soil stratigraphy (types and layering), soil strengths (density and shear strength), groundwater levels. These can be determined in a general manner by visual inspection of exposed soil on the slope, or on the basis of geologic mapping. More specific information can be obtained by drilling boreholes (unlimited depth), or digging test pits (max. depth 3 to 5 m), or hand auger holes (max. 1 to 2 m depth).

c)any external loadings to the slope; structures, traffic, earthquakes,

d)site drainage and erosion conditions; surface run-off, ditches, channels, seepage, creeks, rivers, lakes,

e)vegetation cover.

The decision to use simple investigation (based on site inspection only) versus a detailed investigation (including boreholes, surveys or mapping) depends mostly on:

•the slope height; and
•the consequence of slope failure on the adjacent land-use.

4.3.2 Tools: Slope Inspection Record and Slope Rating Chart

A site inspection is always required when assessing slope stability, which produces an extensive basis of factual information for relatively little cost. The following tools are useful when assessing any site. The recommended procedure is to fill in the Slope Inspection Record and then the Slope Rating Chart.

a)Slope Inspection Record

The completion of the **Slope Inspection Record** (Table 4.1) from a field investigation is very important because it establishes vital factual information on the slope height, slope inclination, exposed soil stratigraphy (if visible), vegetation cover, structures near the slope, and other important features which are relied on by the stability analysis in attempting to model or simulate the actual forces and strength resistance conditions at a site. A photographic record (still or video) should also be taken of the site slope conditions.

•File No.
record date and time of inspection, including weather conditions and visibility, site accessibility

•Site Location
describe site location with respect to major roads or regional features; provide sketch

•Watershed
record name of watershed site is located in

•Property Ownership
obtain name and address of property owner, and legal description for property; describe current land-use of site and adjacent properties

•Slope Data
record vertical height of slope from toe to crest; describe slope inclination (horiz. to vert. or angle from horizontal) and shape (also provide sketch at end of report and take photographs), whether slope angle is uniform or composite

•Slope Drainage
describe locations and amounts of any seepage on the slope face or near the slope crest or toe; note location of any 'piping' if occurring, also provide sketch at end of report and take photographs

•Slope Soil Stratigraphy
where visible or exposed, describe soil stratigraphy (location, thickness, colour of soil layers) and soil types (sand, clay, rock) if possible, also show on sketch and take photographs

•Water Course Features
indicate location and proximity of any nearby drainage features or water bodies (marshy ground, swale, channel, gully, springs, stream, creek, river, pond, bay, lake), show on sketch

•Vegetation Cover
describe location, amount, and types of vegetation cover on the slope (crest, face, toe) and on adjacent properties; show sketches, take photographs; grasses, weeds, shrubs, saplings, trees

•Structures
describe location, types, and size of any man-made structures on the slope face or near the slope crest or slope toe; show on sketches, take photographs; buildings, retaining walls, fences, roads, stairs, decks, towers, bridges, buried utilities

•Erosion Features
describe location, types, and size of any erosion features on the slope face or near the slope crest or slope toe; show on sketches, take photographs; bare exposed soil, rills, gully, toe erosion, scour, undercutting, piping

•Slope Slide Features
describe location, types, and size of any past slope movements on the slope face or near the slope crest or slope toe; show on sketches, take photographs; tension cracks, scarps, slumps, bulges, ridges, bent tree trunks or stands of dead trees

•Comments
record any other general observations

•Plan View Sketch
show locations of slope crest, toe, structures, vegetation, stratigraphy, seepage, erosion, water course features

•Profile Sketch
show slope height, inclination, and shape

The Site Inspection Record (see next page) can be taken out to the site and has the following components to be recorded about the site. Further description is found in Chapter 7 of the Geotechnical Principles for Stable Slopes, 1998 report.

TABLE 4.1 - Slope Inspection Record

1. FILE NAME / NO.
INSPECTION DATE (DDMMYY):
WEATHER (circle):
• sunny • partly cloudy • cloudy
• calm • breeze • windy
• clear • fog • rain • snow
• cold • cool • warm • hot
estimated air temperature:
INSPECTED BY (name):

2. SITE LOCATION (describe main roads, features)

SKETCH

3. WATERSHED

4. PROPERTY OWNERSHIP (name, address, phone):

LEGAL DESCRIPTION
Lot
Concession
Township
County

CURRENT LAND USE (circle and describe)
• vacant -field, bush, woods, forest, wilderness, tundra,

• passive -recreational parks, golf courses, non-habitable structures, buried utilities, swimming pools,

• active -habitable structures, residential, commercial, industrial, warehousing and storage,

• infra-structure or public use - stadiums, hospitals,
schools, bridges, high voltage power lines, waste management sites,

5. SLOPE DATA

HEIGHT • 3 - 6 m • 6 - 10 m • 10 - 15 m • 15 - 20 m
• 20 - 25 m • 25 - 30 m • > 30 m
estimated height (m):

INCLINATION AND SHAPE

• 4:1 or flatter 25 % 14°	• up to 3:1 33 % 18 °	• up to 2:1 50 % 26 °
• up to 1:1 100 % 45°	• up to :1 200 % 63 °	• steeper than :1 > 63 °

6. SLOPE DRAINAGE (describe)

TOP

FACE

BOTTOM

7. SLOPE SOIL STRATIGRAPHY (describe, positions, thicknesses, types) TOP FACE BOTTOM
8. WATER COURSE FEATURES (circle and describe) SWALE, CHANNEL GULLY STREAM, CREEK, RIVER POND, BAY, LAKE SPRINGS MARSHY GROUND
9. VEGETATION COVER(grasses, weeds, shrubs, saplings, trees) TOP FACE BOTTOM
10. STRUCTURES(buildings, walls, fences, sewers, roads, stairs, decks, towers,) TOP FACE BOTTOM
11. EROSION FEATURES(scour, undercutting, bare areas, piping, rills, gully) TOP FACE BOTTOM
12. SLOPE SLIDE FEATURES(tension cracks, scarps, slumps, bulges, grabens, ridges, bent trees) TOP FACE BOTTOM
13. PLAN SKETCH OF SLOPE
14. PROFILE SKETCH OF SLOPE

Slope Stability Rating Chart To Determine The Level of Investigation Required

To assist in determining the suggested level of investigation required, a "Slope Stability Rating Chart" is provided (Table 4.2). This Rating Chart can used by either those reviewing proposals or by a proponent, however a site visit is required to complete the Chart. The Rating Chart must be completed for all slope assessments and be retained by the reviewer. The Rating Chart has 7 components that together provide a reasonable assessment of the slope stability. Some calibration may be required of the values in the chart, on the basis of extensive experience with its use. The 7 components are;

1. Slope Inclination

• The angle from the horizontal of the slope face, measured from the toe to the crest. If the slope is comprised of several different inclinations, provide details on each. Estimate visually, or use hand inclinometer to measure approximate inclination, or survey (also refer to available mapping).

2. Soil Stratigraphy

• Soil layering and soil types composing the slope. Confirm if visible in bare exposed areas. Refer to previous nearby boreholes or well established local geology. If several soil layers are present, provide details on each.

3. Seepage from Slope Face

• The quantity and location of groundwater on the slope face. Visually inspect slope for surface seepage (springs, streams, creeks).

4. Slope Height

• Measurement of the vertical height between the toe (bottom) and the crest (top) of the slope. Estimate visually, or measure by surveying, or refer to available mapping.

5. Vegetation Cover on Slope Face

• Indication of the type and extent of vegetation cover (trees, grass).

6. Table Land Drainage and Gullies

• Indication of surface infiltration and run-off over the slope face, which may cause a potential for surface erosion. Describe whether table land drains towards slope and whether drainage/erosion features are present.

7. Previous Landslide History

• Indicates past instability. Visually inspect slope for evidence or indicators of past instability (scarps, tension cracks, slumped ground, bent or bowed or dead trees, leaning structures such as walls etc.).

Toe Erosion

. Recognizes the presence of and potential for continued slope instability. Toe erosion must be addressed prior to solving slope instability.

The Rating Chart provides a general indication of the stability of a slope. Based on this chart, the level of investigation required, can be assessed. The chart is a guideline or tool only. In all cases, the consequences of slope failure must be carefully considered and may be an over-riding factor. The chart is not intended as a replacement to the judgement of experienced and qualified geotechnical engineers. The chart was prepared, to help in assessing the level of geotechnical investigation which would be appropriate for the site conditions. The Slope Rating Chart was based on important slope stability factors; slope inclination, soil stratigraphy, seepage, slope height, vegetation, drainage, and previous land slide activity.

The chart is used by circling the rating value of the most appropriate descriptions for the key factor observed on the slope, based on visual inspection. The circled values are totalled at the bottom, and the total value is used as a guide to determine the appropriate level of investigation, from a choice of 3 levels listed at the bottom of the chart. Further details on use of the chart are provided in "Geotechnical Principles for Stable Slopes", 1998.

TABLE 4.2 - SLOPE STABILITY RATING CHART

Site Location: File No.
Property Owner: Inspection Date:
Inspected By: Weather:

1.	**SLOPE INCLINATION**		
	degrees	**horiz. : vert.**	
a)	18 or less	3 : 1 or flatter	0
b)	18 - 26	2 : 1 to more than 3 : 1	6
c)	more than 26	steeper than 2 : 1	16
2.	**SOIL STRATIGRAPHY**		
a)	Shale, Limestone, Granite (Bedrock)		0
b)	Sand, Gravel		6
c)	Glacial Till		9
d)	Clay, Silt		12
e)	Fill		16
f)	Leda Clay		24
3.	**SEEPAGE FROM SLOPE FACE**		
a)	None or Near bottom only		0
b)	Near mid-slope only		6
c)	Near crest only or, From several levels		12
4.	**SLOPE HEIGHT**		
a)	2 m or less		0
b)	2.1 to 5 m		2
c)	5.1 to 10 m		4
d)	more than 10 m		8
5.	**VEGETATION COVER ON SLOPE FACE**		
a)	Well vegetated; heavy shrubs or forested with mature trees		0
b)	Light vegetation; Mostly grass, weeds, occasional trees, shrubs		4
c)	No vegetation, bare		8
6.	**TABLE LAND DRAINAGE**		
a)	Table land flat, no apparent drainage over slope		0
b)	Minor drainage over slope, no active erosion		2
c)	Drainage over slope, active erosion, gullies		4
7.	**PROXIMITY OF WATERCOURSE TO SLOPE TOE**		
a)	15 metres or more from slope toe		0
b)	Less than 15 metres from slope toe		6
8.	**PREVIOUS LANDSLIDE ACTIVITY**		
a)	No		0
b)	Yes		6

SLOPE INSTABILITY RATING VALUES INVESTIGATION RATING SUMMARY **TOTAL**

SUMMARY OF RATING VALUES AND RESULTING INVESTIGATION REQUIREMENTS

1. Low potential	< 24	Site inspection only, confirmation, report letter.
2. Slight potential	25-35	Site inspection and surveying, preliminary study, detailed report.
3. Moderate potential	> 35	Boreholes, piezometers, lab tests, surveying, detailed report.

NOTES:
a) Choose only one from each category; compare total rating value with above requirements.
b)If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe; the potential for toe erosion and undercutting should be evaluated in detail and, protection provided if required.

The Rating Chart identifies 3 levels of stability and associated investigation requirements. The three levels are:

1. Stable / Site Inspection Only
A rating of 24 or less, suggests stable slope conditions,

- no toe erosion,
- good vegetation cover
- no evidence of past instability
- no structures within (slope height) of the crest

and that no further investigation (beyond visual inspection) is needed. This should be simply confirmed through a visual site inspection and estimate of the slope configuration and slope stratigraphy and drainage (i.e. no measurements). Confirmation of the slope stability should be provided in the form of a letter (signed and sealed with A.P.E.O. stamp) from an experienced and qualified geotechnical engineer. The letter should include a summary of the site inspection observations which could be recorded on a Slope Inspection Form (see enclosed) and should clearly identify;

- slope height and inclination,
- vegetation cover on slope face,
- toe erosion, or surface erosion on slope,
- structures near slope crest or on slope,
- drainage features near slope crest, on slope face, or near slope toe.

2. Slight Potential / Site Inspection, Preliminary Study
A rating between 25-35 suggests the presence of several surface features that could create an unstable slope situation. The stability of the slope should be confirmed through a visual site inspection only, without boreholes. In addition to recording the visual observations outlined in the section above, some direct measurements of site features are required.

The slope height and inclination should be determined either with a hand inclinometer, or by 'breaking slope', or from mapping, or by surveying. As well, more information about the soil stratigraphy of the slope, should be obtained (without drilling boreholes) based on either previous or nearby subsurface investigations, or geologic mapping, or hand augering or test pits to determine shallow depth soil type(s). Measurements should be taken (by hand tape or surveying) of the locations of structures relative to the crest, and other features such as vegetation, past slide features (tension cracks, scarps, slumps, bulges, ridges), and erosion features. If available, historical air photographs should be examined for evidence of any past instability over the long-term. Confirmation of the slope stability should be provided in the form of a detailed report (signed and sealed with A.P.E.O. stamp) from an experienced and qualified geotechnical engineer.

This report will include:

- Slope Inspection Record (Appendix)
- a Site Plan and a Slope Profile indicating the positions of the various measurements taken on site (slope crest, slope toe, location of structures relative to crest, drainage features, erosion features, vegetation cover, indicators of past instability or movements)
- photographs of the site and slope conditions
- a discussion of the site inspection and measurements taken, review of previous information
- preliminary engineering analysis of slope stability (i.e., calculation of Factor of Safety) based on the above information and measurements, but utilizing conservative soil strength parameters and groundwater conditions since boreholes were not carried out.

3. Moderate Potential / Borehole Investigation
A rating of more than 35 suggests a moderate potential for instability. This may result if the slope is either steep, high and/or has several features that could create an unstable slope situation. The stability of the slope should be assessed more precisely through topographic survey of slope configuration and boreholes for slope stratigraphy and penetration resistance tests. Piezometers must be installed in the boreholes and measurements must be taken for groundwater levels. Laboratory testing on the borehole samples must be conducted to measure Basic Index Properties (water contents, unit weights, grain size distribution, Atterberg Limits) described in Appendix D, or other properties as required.

A detailed engineering stability analysis must be conducted to determine if the Factor of Safety for the original slope conditions equals or exceeds a design minimum Factor of Safety. The analysis should be based on the information obtained from the site survey and the borehole information. Historical data such as air photographs should also be reviewed. Confirmation of the slope stability or instability (and the stable slope inclination) should be provided in the form of a detailed report (signed and sealed with A.P.E.O. stamp) from an experienced and qualified geotechnical engineer. This

report will include:

- Slope Inspection Record (Appendix)
- a Site Plan and a Slope Profile indicating the positions of the various measurements taken on site (slope crest, slope toe, location of structures relative to crest, drainage features, erosion features, vegetation cover, indicators of past instability or movements)
- photographs of the site and slope conditions
- a discussion of the site inspection and measurements taken, review of previous information
- borehole logs and piezometer monitoring data
- laboratory test results (water contents, unit weights, grain size distribution, Atterberg Limits)
- the results of the detailed engineering Stability Analysis (Factors of Safety, failure surfaces, assumed slope data), stabilization alternatives, long-term stable slope inclination.

Where the local geology is well known (exposed stratigraphy or nearby boreholes), the requirement for numbers or depths of boreholes should be reviewed and possibly reduced.

Costs for the various Levels of Biotechnical Investigation

If a site slope is higher than 2 m and steeper than 3 to 1 (horiz. to vert.), an assessment of slope stability is warranted. Three basic levels of investigation have been identified, to be used in evaluating slope stability of sites. The Slope Rating Chart above is an aid to determine the appropriate level of investigation for a site, based on the physical features of the site slopes which are important to slope stability (height, inclination, groundwater, etc.).

The results of carrying out a Level 1 or Level 2 investigation may be that a Level 3 investigation is required. In general terms, the levels of investigation have been chosen on a basic premise that low height or gentle slopes can be analyzed sufficiently by general or observational methods, and that as slopes become higher and steeper more rigorous and intensive methods are required. The amount of field investigation increases with each level as follows:

Level 1	- site visit and inspection by engineer;
Level 2	- site visit and inspection, mapping and site survey/measurements of physical features;
Level 3	- site visit/inspection, mapping/surveying, borehole drilling.

For purposes of comparison only, the approximate engineering fees (2000 $Cdn.) for evaluating a single house lot on a slope site is estimated as follows;

Level 1	$ 500 - 1,500
Level 2	$ 2,000 - 4,500
Level 3	$ 5,000 - 12,000 and up.

Some complex site conditions may result in higher costs for investigation than indicated above.

4.3.3 Slope Stability Engineering Analysis

The engineering analysis of slope stability should be conducted with a recognized method (Bishop's, Janbu, Morgenstern-Price, Spencer, Sarma) in accordance with guidelines provided in "Geotechnical Principles for Stable Slopes", 1998. The geotechnical report should provide details on the analysis method, the model basis and all assumptions made, and the extent of calculations with an overall summary. Both in the report text and on suitable figures or drawings the following basic information and discussion should be provided:

a) slope height, slope inclination,
b) location of structures near slope,
c) assessment of erosion risks,
d) soil stratigraphy and strength,
e) ground water conditions and drainage,
f) vegetation cover and species,
g) Factor of Safety calculations,
h) potential causes of instability,
I) alternative slope stabilization methods, and comparison of benefits,
j) discussion of erosion on or near the site; locations, extent, severity, rates, suitable protection alternatives
k) discussion of potential impacts on surrounding properties
l) if required, discussion of cost-benefit analysis of stabilization measures including
- 'do nothing'
- partial stabilization
- full stabilization

m) long-term stable slope crest position and inclination, based on engineering analysis.

4.3.3.1 Design Minimum Factors of Safety

A table of recommended minimum Factors of Safety for design, has been prepared by reviewing the current practice in different areas around the world. The common range of minimum Factor of Safety for design is 1.2 to 1.5.

The recommended minimum Factors of Safety have been prepared on the basis of land-use above or below the slope. This table recognizes the consequences or risks to land-use or life by the occurrence of a slope slide. In general, the recommended minimum Factor of Safety for design, increases as the land-use intensifies or as publicly-owned resources and utilities become at risk.

Table 4.3

	LAND-USES	DESIGN MINIMUM FACTOR OF SAFETY
A	**PASSIVE**; no buildings near slope; farm field, bush, forest, timberland, woods, wasteland, badlands, tundra	1.10
B	**LIGHT**; no habitable structures near slope; recreational parks, golf courses, buried small utilities, tile beds, barns, garages, swimming pools, sheds, satellite dishes, dog houses	1.20 to 1.30
C	**ACTIVE**; habitable or occupied structures near slope; residential, commercial, and industrial buildings, retaining walls, storage/warehousing of non-hazardous substances	1.30 to 1.50
D	**INFRASTRUCTURE and PUBLIC USE**; public use structures or buildings (i.e., hospitals, schools, stadiums), cemeteries, bridges, high voltage power transmission lines, towers, storage/warehousing of hazardous materials, waste management areas	1.40 to 1.50

4.3.4 Field Investigation

If there is insufficient existing topographic mapping on a site (at 1:500 scale or better), then detailed topographic surveying will be necessary to establish positions of surface features (slope crest, toe, structures and fences, vegetation and trees, drainage or seepage, scarps, ridges), as well as to measure slope profile (cross-section) or configuration (inclination). The plan should also show the locations of boreholes, auger holes, or test pits. The profile should show the soil stratigraphy (see enclosed examples).

The subsurface conditions of the slope should be investigated with boreholes and piezometers, to accurately establish the soil types, soil stratigraphy, soil relative density or consistency, ground water levels, and obtain soil samples. Boreholes are more suitable for investigation than test pits, because excavated test pits are limited by the equipment to maximum depths of 3 to 5 m. Conventional boreholes can be drilled to depths of 30 m or more.
One or two boreholes may be sufficient for many small and simple sites, while many boreholes may be required for larger sites or complex site conditions. For example, boreholes for other engineering projects are often spaced as follows:

Road Pavements and Sewers	50 to 150 m
Buildings	15 to 30 m.

For uniform slope conditions, a reasonable maximum spacing of boreholes along the slope crest would be about 100 m (a closer spacing may be necessary for complex sites).

Generally the ground conditions should be established for the full height of the slope. Some judgement can be used where previous information is available, or where rock or other competent material is found at a shallower depth.

There are several methods of advancing boreholes,

- hand augers
- wash boring
- rotary auger (continuous flight)
  - solid stem
  - hollow stem.

The borehole is usually advanced by continuous flight solid-stem augers which are extracted at each depth interval to permit the insertion of a sampling device or test apparatus. These solid-stem augers typically result in borehole sizes of about 125 mm diameter. Hollow-stem augers (continuous flight) do not require extraction at depth intervals because a central hollow core serves as a casing to support the borehole. Sampling and testing equipment can be inserted through the augers to the bottom of the borehole. In very deep boreholes, the torque required to turn the augers may not be available and other means of borehole advancement are required.

Another standard method of advancing boreholes (through very slow) is "wash boring" which involves the insertion of pipe casing to support the hole and the use of a chopping bit on drill rods to dislodge the soil at the bottom of the borehole. Water is pumped under pressure through the drill rods and chopping bit to wash out the dislodged soil. The casing is driven to the bottom successively as required.

Portable tripod equipment can be used in difficult access areas (i.e., on slope face), to advance boreholes to moderate depths such as 5 to 10 m. This is very slow work.

Boreholes can also be drilled off-shore in standing water (lake, river, pond, bay) with the aid of a barge or platform to carry the drilling equipment.

Shallow hand auger holes can also be carried out (1 m depths) on steep slopes or in difficult access areas, but these are of limited value due to the shallow depth.

The most common test in the borehole is the Standard Penetration Test (S.P.T.) which consists of driving a standard split-spoon sampler (50 mm diameter, 600 mm long) into the bottom of the borehole with a falling weight of 67 kg dropping over a height of 0.75 m.

In soft cohesive soils, thin-walled Shelby tubes are used for the extraction of relatively undisturbed samples. The field vane apparatus is also used in soft, cohesive soils, in order to obtain shear strength values of the soil. The field vane consists of a vane-like device on the end of drill rods, which is inserted into the soil at the borehole bottom and then turned at the ground surface. The torque required to turn the vane is measured. The measured torque can be related to undrained shear strength based on the shape and size of the field vane.

Other types of penetration resistance testing can be carried out (dynamic cone, static cone) and these are summarized on the following table (ref. Cdn.Fdn.Man.),

For further information on the type of available testing, see Appendix 4, Borehole Test Methods.

Ground water conditions are often measured by standpipe piezometers consisting of hollow plastic pipe or tubing (10 to 50 mm diameter), which are installed in the boreholes on completion of drilling. Monitoring of ground water levels is conducted after borehole drilling.

The most common standpipe installation consists of small diameter tubing which extends down to a filtered porous (or perforated) tip that is surrounded with granular material (sand or fine gravel). Ground water is allowed to enter the standpipe through the filtered porous or perforated tip, and to rise to its static hydrostatic or piezometric level inside the piezometer tubing or piping. The ground water level inside the tubing can be measured by lowering a calibrated coaxial cable with low electrical current (or other device) down to the water level.

4.3.5 Laboratory Testing

In the geotechnical laboratory, the soil samples should all be subject to tactile examination by an experienced engineer who confirms the field descriptions on the borehole log, and who selects representative samples for detailed testing. There are several common laboratory tests to establish index properties of soils. The behaviour of soils types are often estimated on the basis of their measured index properties.

The most common laboratory tests and their recommended testing frequency for samples are:

A. Water contents, all samples
   B. Atterberg Limits, cohesive strata
   C. Grain size distribution, all strata
   D. Soil unit weight, as required
   E. Specific gravity, as required
   F. Direct shear test, sand strata, as required
   G. Triaxial compression test, cohesive strata, as required.

The Bore Hole testing methods are summarized on the following Table 4.4.

TABLE 4.4 - Borehole Test Methods					
Type of Test	Type of Soil Best For	Not For		Properties Obtainable	Remarks References
1.Standard Penetration Test	Sand	Clay	Qualitative evaluation of compactness; comparison of subsoil stratification.	(See Section 4.5.1.1)	1) CSA A119.1 2) ASTM D1586 3) Fletcher (1965) 4) Peck et al (1963) 5) Tavenas (1971) 6) ISSMFE (1977)
2. Dynamic Cone Test	Sand and Gravel Sand	Clay	Qualitative evaluation of compactness; comparison of subsoil stratification.		1) ISSMFE (1977)
3. Static Cone Test	Sand		Continuous evaluation of density and strength of sands and gravel; undrained shear strength in clays.	Test is best suited for design of piles in sand. Tests in clay only reliable with vane tests.	1) Sanglerat (1972) 2) Schmertmann 1970) 3) Ladanyi & Eden (1969) 4) ISSMFE (1977)
4. Plate Bearing Test	Sand		Modulus of subgrade reaction. Ultimate bearing capacity.	Strictly applicable in uniform deposits. Size effects must be considered in other cases.	
5. Vane Test	Clay	Silt Sand Gravel	Undrained shear strength c_u.	Test should be used with care particularly in fissured, varved and highly plastic clays.	1) ASTM D 2573 2) Bjerrum (1972) 3) Aas (1965) 4) Lo (1972) 5) Schmertmann 1975) 6) Lemasson (1976)
6. Pressure - meter Test	Soft rock Sand	-	Ultimate bearing capacity and compressibility	(See Section 4.5.1.3)	1) Menard (1965) 2) Eisenstein (1973) 3) Tavenas (1971) 4) Baguelin 1978)
7. Permeability Test	Sand and Gravel	Clay	Evaluation of co-efficient of permeability	Variable head tests in BH's have limited accuracy. Results reliable to one order of magnitude obtained only from long term large scale pumping tests.	1) Hvorslev (1949) 2) NAVFAC DM7 3) Sherard

4.4 UNCONFINED SYSTEMS -

RECOMMENDED STUDY ISSUES TO BE ADDRESSED

For those situations where a study is used to determine the "meander belt allowance", the study should be undertaken using "accepted engineering and scientific principles". These studies usually involve a range of study areas such as geomorphology, engineering, ecology, biology. The variables involved in the study include some of the following but are not limited to:

- discharge regimes;
- slope, sinuosity, width-to-depth ratios, particle size of sediment in river/stream beds and banks, stream entrenchment ratios, and landform feature/stability class;
- drainage areas and patterns of the system;
- determination of the meander pattern (e.g., amplitude, radius of curvature, meander length, concave and convex banks, spacing of pool and riffle zones, and the presence or remnant meanders or oxbow lakes);
- bedload, suspended load and dissolved loads;
- channel roughness and shear stress required to move sediment loads;
- bankfull discharge and channel determination; and
- potential for lateral or downstream migration of the meander belt allowance.

A study of the river system characteristics may be required in order to determine the meander belt allowance. For further details on how a complete study encompassing all of the appropriate disciplines please review in detail the 9 step process outlined in AMSC[11]. This report outlines the various engineering, geomorphology and biology technical requirements when conducting a study. The bankfull characteristics are critical for determination of the meander belt. The procedure outlined in Chapter 3 of this document should be referenced when conducting any study.

4.4.1 Field Investigation

Within each of the reaches identified in the initial studies of the drainage basin, a field study should be undertaken to measure the stream geometry, flood capacity, and characteristics. The observations may also be used to determine the hydraulic characteristics of preferred habitats. Biological sampling may be carried out at the same time.

There are various methods available to carry out field investigations ensuring all of the required information is taken at the site. Depending on the desired outcome and criteria, different information and data may be collected.

There is no standard field sheet available which covers all aspects of the full set of geomorphology, engineering and biological information requirements so we have included sample sheets in Appendix 3 which focus on these areas. The first set of field sheets in Appendix 3A which have been provided are from Newbury & Gaboury, 1994, Stream Analysis and Fish Habitat. These sheets are the ones which focus on collecting the required engineering criteria. The next data field sheets in Appendix 3B are from J. Parish, 1999 of Parish Geomorphic with an emphasis on the fluvial geomorphology aspects. A very thorough assessment protocol was developed by MNR, 1998 entitled, "Stream Assessment Protocol for Ontario". This documents a detailed procedure which assesses the fish habitat suitability in Ontario streams. The protocol is designed to improve the repeatability (precision) of stream habitat assessments at a practical level. Objective data are collected in the field which then become a baseline for all future interpretations. The field sheets can be found in Appendix 3.

4.4.2 Recommended Analysis

The study procedure in the AMSC[12] document for the channel should be followed and the engineering, geomorphology and biology aspects should be analyzed as indicated. A question which needs to be answered in order to determine the meander belt width is what will the ultimate configuration of the channel be in the future? Once this has been addressed, then considerations can be made as to where, and what type, if any, of development can be considered at the particular site in question.

Determination of the bankfull width can be referred to Section 3.1.1 of this document. If the proponent determines that the recommended 20 times bankfull is not appropriate for their location, they must then provide the appropriate information, an analysis of the meander belt width which can be determined through accepted scientific and engineering study. In 1998, the "TRCA Meander Belt Width Delineation Procedure" was developed for the TRCA and may be a useful reference

when assessing the meander belt width. The reference has been included for your information. This document discusses a method in determining the meander belt width. It suggests more than one method be used when attempting to predict the width. "Therefore, by developing only one belt width delineation procedure that is applicable for a range of flow regimes and floodplain settings, only a crude approximation of the actual belt width can be obtained. By examining various features of a floodplain, properties of both the floodplain and valley materials, and by understanding the flow regime of a river, a general belt width delineation procedure can be modified to yield reliable estimates of the belt width for any given river.", [Page 9, TRCA Meander Belt Width Delineation Procedure, 1998][13]. This document explains the difficulty and importance of attaining good data for site analysis, and presents some practical methods for delineating the meander belt width.

A field procedure and protocol for assessing river characteristics (and fish habitat) which includes determining the bankfull width has been developed by MNR. This procedure is entitled "Stream Assessment Protocol for Ontario, 1998" and was designed to improve the precision and repeatability of stream assessments at a practical level.

5.0 ADDRESSING THE HAZARD

5.1 Introduction

Human responses to erosion concerns have primarily involved the construction of various forms of protection works. Unfortunately, these responses have often included works which were not designed within the appropriate context (e.g., watershed, subwatershed, reach, site). The works were usually designed with only the particular site in mind and more often than not incompatible with neighbouring installations, physical and biological processes. These works were often installed in an ad hoc fashion and largely ignored watershed processes and the resulting environmental impacts.

For certain *development* and *site alteration* to be permitted within *hazardous lands*, the Policy 3.1.3 states that all of the following requirements must be fulfilled:

- the hazards can be safely addressed, and the *development* and *site alteration* is carried out in accordance with *established standards and procedures* (Policy 3.1.3(a));
- new hazards are not created and existing hazards are not aggravated (Policy 3.1.3(b));
- no adverse environmental impacts will result (Policy 3.1.3(c));
- vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies (Policy 3.1.3(d)); and
- the *development* does not include *institutional uses* or *essential emergency services* or the disposal, manufacture, treatment or storage of *hazardous substances* (Policy 3.1.3(e)).

In ensuring that these requirements are met, the intent of this Technical Guide is to provide direction on how to "address the hazards". This includes assessing whether or not protection works for *development* and *site alteration* within the *hazardous lands* interest appropriately address the *erosion hazards* on-site. This outlines considerations that help determine the ultimate success of protection works including, but not limited to, hazards typically associated with the various types of structures. This is accomplished by identifying the potential impacts of protection works on the physical environmental processes.

5.2 Policies

Erosion is a natural phenomena evident on many watershed systems. This phenomena, or natural process, only becomes a problem, or hazard, when development is located in close proximity to the hazard. This Technical Guide has discussed the characteristics of this process and the delineation and mapping of *hazardous lands* adjacent to river and stream systems which are impacted by the *erosion hazards*. This chapter builds on this information and examines the watershed management approaches that may enable the *erosion hazard* to be safely and appropriately addressed in an environmentally sound manner.

In Ontario, addressing the *erosion hazard* has typically involved one or more of three watershed management approaches: prevention, protection works (non-structural or structural) and emergency response. Prevention is essentially the orderly planning of land use and the regulation of *development* and *site alteration* along watersheds subject to *erosion hazards* (i.e., generally directing *development* and *site alteration* to areas outside of *hazardous lands* as stated in Policy 3.1.1(a)).

By definition, *development*

"means the creation of a new lot, a change in land use, or the construction of buildings and structures, requiring approval under the Planning Act; but does not include activities that create or maintain *infrastructure* authorized under an environmental assessment process; or works subject to the Drainage Act." (Provincial Policy Statement, 1996)

Site alteration means activities, such as fill, grading and excavation, that would change the landform and natural vegetative characteristics of a site." (Provincial Policy Statement, 1996)

Prevention approaches are the preferred approach for management of the *riverine* hazards as they reduce or minimize hazard losses by modifying the loss potential (e.g., hazard allowances and property acquisition).

Protection, as an alternative to prevention, involves non-structural and structural protection works which are essentially engineered methods for protecting *development* and *site alteration* located within the erosion susceptible areas. Some non-structural protection approaches are; relocation, bluff measures or soil bioengineering techniques. Some structural protection approaches which include but are not limited to the following; biotechnical stabilization methods, natural channel design techniques, revetments. These protection works may help to reduce the hazard losses by modifying the *erosion hazards* in the river or stream system. One must recognize that any changes to the natural physical process will have an impact on the biological and ecological processes and functions within the system.

While prevention is clearly the preferred choice for management, protection works are not to be considered as inherently negative. In a number of locations and situations, erosion protection works are necessary and may be the only realistic option. For example, protection works may be necessary at hazard prone areas where a large investment has already been made in the existing development, at parks in highly urbanized areas where recreational space is very limited, or in areas of very significant historical or social importance. In cases like these, it may be appropriate to proceed with protection works if the impacts that result from the works can be identified and mitigated or compensated.

Proper protection works, in combination with the appropriate allowances to address the stable slope and *erosion hazards* (i.e., *established standards and procedures*, Policy 3.1.3(a)), may provide sufficient "protection" to warrant consideration of *development* and *site alteration* within the limit of the *erosion hazard*. With the exception of the situations noted later (i.e., Policies 3.1.2(a) and (b)), *development* and *site alteration* may be permitted within the least hazardous portions of the *hazardous lands* provided that all of the following can be achieved:

- the hazards can be safely addressed, and the *development* and *site alteration* is carried out in accordance with *established standards and procedures* (Policy 3.1.3(a));
- new hazards are not created and existing hazards are not aggravated (Policy 3.1.3(b));
- no adverse environmental impacts will result (Policy 3.1.3(c));
- vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies (Policy 3.1.3(d)); and
- the *development* does not include *institutional uses* or *essential emergency services* or the disposal, manufacture, treatment or storage of *hazardous substances* (Policy 3.1.3(e)).

The inclusion of these requirements is intended to provide flexibility to recognize local conditions. When applying this flexibility, care must be taken to ensure that the magnitude or degree of risk(s) is clearly understood, and that the potential or feasibility for *development* and *site alteration* to safely locate within certain portions of the *hazardous lands* is sound, reasonable and can be implemented in accordance with the *established standards and procedures*. Care must also be taken to ensure that the interests and intent of other policies addressing the same riverine areas are not compromised. Where all of these conditions cannot be fulfilled, the *development* and *site alteration* is to be directed to areas outside the *hazardous lands*.

The intent of these conditions (i.e., Policy 3.1.3 (a) to (e)) is to promote public safety and to minimize risks to life, property damage, adverse environmental impacts and social disruption. Ecological, geomorphological and socio-economic elements are concentrated along the riverine system and are uniquely defined by their interactions within the environment. A delicate, dynamic balance exists between these elements, a balance which can easily be altered or upset. It is imperative that any protection works consider both the immediate and the broader ecological, geomorphological and socio-economic contexts, as no part of the system operates independently of any other part. The proponent should also consider whether or not the protection works are justified from a benefit-cost perspective and are in keeping with any objectives for public access, recreation and aesthetics.

There are areas where protection works may be inappropriate and unacceptable as they would not meet all of the requirements of Policy 3.1.3. These areas may include, but are not limited to: locations where the active erosion of the site provides an essential sediment source downstream and imperative to maintaining the geomorphological processes; sites where the proposed protection works would result in unacceptable environmental impacts (e.g., adjacent wetland or fish habitat is significantly impacted); areas where the protection works create or aggravate hazards at upstream/downstream properties (e.g., structures trapping or deflecting sediment transport resulting in a significantly reduced quantity of sediment at adjacent properties thus increasing *erosion hazards*).

Although the policies governing natural hazards do provide the flexibility for municipalities and planning boards to consider *development* and *site alteration* within the least hazardous portions of the *hazardous lands*, care must be taken to ensure that *development* and *site alteration* are not permitted within those areas identified in Policy 3.1.2, namely:

- institutional uses;
- essential emergency services
- disposal, manufacturing, treatment or storage of hazardous substances.

When applying Policy 3.1.3, a number of complicating planning issues may arise. For example, municipalities and planning boards may need to develop strategies to deal with existing lots of record, *residential infilling*, *residential intensifica-*

tion, or with additions and alterations to existing development. In some municipalities, development applications involving structures or buildings which by the nature of their use are normally located in close proximity to or within the water (e.g., weirs, utilities, etc.) may also require a more detailed evaluation. In each of these cases, consultation with the local Conservation Authority and the Ministry of Natural Resources may assist municipalities and planning boards in determining the potential risks associated with the various municipal land use planning strategies that may be under consideration or applied. In all of these situations, regardless of the planning issue being evaluated, the overall intent of the Policy, to minimize the potential risk to life and property, is to be preserved.

5.2.1 Established Standards and Procedures

Where the potential for environmentally sound development to safely occur does exist, the *development* and *site alteration* should be carried out in accordance with the *established standards and procedures* (Policy 3.1.3(a)) that apply. *Established standards and procedures* means the following:

- "**Protection works standard**, which means the combination of non-structural or structural works and allowances for slope stability and erosion to reduce the damages caused by *erosion* and to allow access for their maintenance and repair."

- "**Access standard**, which means a method or procedure to ensure safe vehicular and pedestrian movement, and access for the maintenance and repair of protection works, during times of *erosion*."

It must be recognized that there are no guarantees that protection works will offer protection for the 100 year planning horizon. In fact, protection works installed to address erosion hazards typically have a design life of only 25 to 50 years. This is due to limitations in current knowledge of the natural processes and their interaction with structures, the limited durability of structures and materials in the environment, the natural erosional sediment processes, possible inadequate quality control during design and construction, and insufficient maintenance.

Protection Works Standard

In addressing the natural hazards (i.e., *flooding* and/or *erosion hazards*, including unstable slopes), so as to considered development within the least hazardous portions of the *hazardous lands* for *river and stream systems*, the following *protection works standards* should be applied:

- for **confined systems**

protection works (non-structural, structural)	+	**toe erosion allowance*** (from Table 3 OR 100 times the average annual recession rate of the toe) **OR** a study using accepted geotechnical and engineering principles	+	**allowance for stable slope** 3:1 (h:v) **OR** as determined by a study using accepted geotechnical principles	+	**erosion access allowance** 6 metres **OR** as determined by a study using accepted scientific, geotechnical and engineering principles

* Note: *where the soil type is not known, Table 3 recommends the use of a 15 m toe erosion allowance; and when using average annual recession rates to determine the toe erosion allowance a minimum of 25 years of reliable information is recommended.*

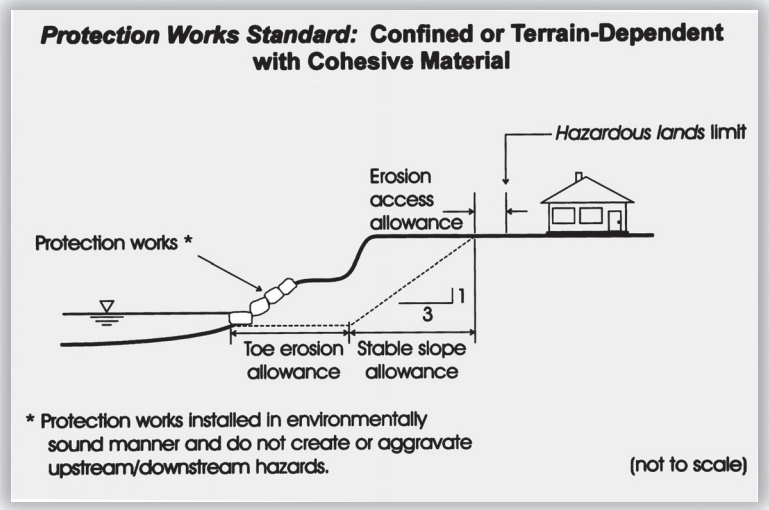
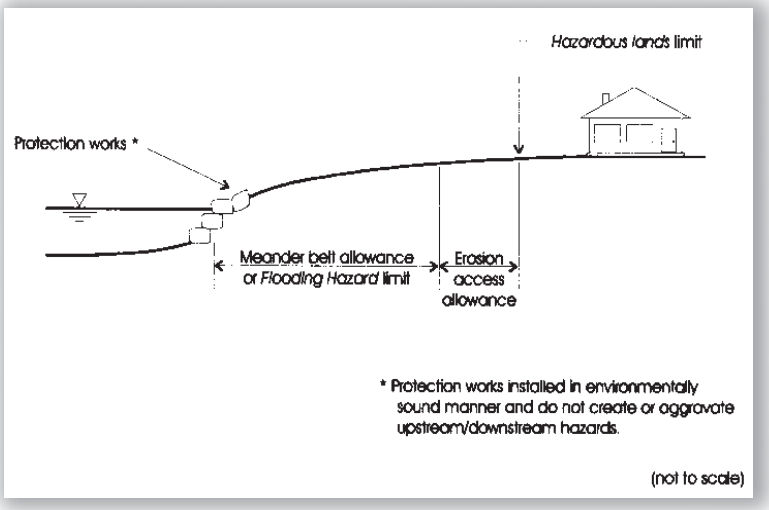


Figure 126 - Protection Works Standard: Confined Systems

Figure 127- Protection Works for Confined System (example)



128 - Protection Works Standard : Unconfined Systems

Where the *protection works standard* is deemed too excessive or insufficient to address the severity of the natural hazards impacting on a particular site, mechanisms should be incorporated into the planning process providing the flexibility to undertake a study using accepted scientific, geotechnical and engineering principles to determine the *protection works standard*.

Where the municipality or planning board approves the study (studies) using accepted geotechnical, scientific and/or engineering principles, where applicable and appropriate, to determine the toe erosion, meander belt, stable slope and/or erosion access allowances, the *protection works standard* should then consist of the protection works plus the approved allowances and applied only in the area studied.

Access to the development in times of erosion emergencies is necessary for safety. Access to the protection works is also required for maintenance and repairs.

• for **UNconfined systems**

protection works (non-structural, structural works)	+	**allowance for the *flooding hazard* limit OR meander belt allowance** 20 times the bankfull channel width centred over the meander belt axis **OR** as determined by a study using accepted engineering principles	+	**erosion access allowance** 6 metres **OR** as determined by a study using accepted scientific, geotechnical and engineering principles

5.3 WATERSHED MANAGEMENT APPROACHES FOR ADDRESSING THE HAZARDS

Ensuring that the hazards can safely be addressed, as required by Policy 3.1.3(a), essentially means that any measures or actions intended to minimize or reduce the *erosion* must not place the safety of people or property and developments at risk. This section provides an overview of the various watershed management approaches that may be considered to address *erosion hazards*.

It is extremely important to note that before any watershed management approaches are considered the process outlined in the AMSC[14] in Ontario should be part of the evaluation process and should be followed when undertaking any site assessment.

There is a wide variety of watershed management approaches and they can be classified or grouped in many ways according to different criteria. For the purpose of this Technical Guide, the management approaches have been classified as being either a prevention or a protection approach.

5.3.1 Prevention

Prevention is the orderly planning of land use and the regulation of development in erosion susceptible areas. Prevention approaches reduce hazard losses by modifying the loss potential they are hazard allowances and property acquisition. It is better to manage a functional natural river and stream system than to design a new one. Siting new urban developments adequately away from the watercourse to ensure the continuation of a functional floodplain and stream system, will in most cases achieve public safety and environmental objectives. Prevention is the preferred approach when making decisions on watershed management alternatives although it may not always be possible.

5.3.2 Non-structural protection works

Protection approaches are engineered methods for protecting development located within the erosion susceptible areas and they reduce hazard losses by modifying the erosion hazards along the river and stream system. Protection approaches can be further classified as non-structural or structural. **Non-structural protection works** are activities that do not involve the construction or placement of significant additional structures or material along or in the river or stream system. Non-structural protection works include: relocation and some soil bioengineering techniques.

5.3.2. Relocation

Relocation is an effective means of mitigating erosion hazards by moving the building or service (e.g., roadway, utility) to a different site further inland or to a more landward location within the existing site. Relocation often proves to be less costly than protection, especially in areas of high to severe erosion. It is an effective practice to mitigating erosion hazards. Virtually any structure can be relocated but whether or not the cost of relocating is justified depends on several factors. The major limitations are the size and construction style of the building (and therefore the actual feasibility of moving) and the availability of a site for relocation. The actual moving costs for a typical single family dwelling can often be quite feasible in comparison to the costs of providing adequate, effective, environmentally sound works. Generally the width and height of the house are the limiting factors. The width must be less than the clearance along the roadways (i.e., between trees, hydro poles) and the height lower than the overhead clearance (i.e., under overhead wires, bridges). Houses with slab foundations, concrete block walls, extensive brick or stone work, or large unusual shapes are often impractical to move. The greatest costs associated with relocation may be acquiring an additional parcel of land if setbacks do not permit relocation on the same property. When a building or service is relocated it should be placed landward of the hazardous lands.

5.3.2.2 Soil Bioengineering Techniques

Soil bioengineering is the utilization of vegetation through live construction. Live construction entails the use of conventional planting's alone (e.g., grasses and shrubs).

For the purposes of this policy non-structural protection works defines soil bioengineering techniques as those which use vegetation to control surface drainage, runoff and/or groundwater flow. Soil bioengineering techniques may also involve regrading of the slope but only if a minor amount of

material used, if a significant amount of material is used then the works would be considered structural protection works. Other sources of water which need to be controlled and not allowed to discharge freely down the face of the slope are; lawn sprinkling, swimming pool drainage and leaks, and possibly septic systems. In a high flow river or stream system, soil bioengineering techniques are insufficient to address the 'active' erosion which is occurring but can be used to address the surface erosion problems. In order to address the 'active' erosion structural measures may need to be added resulting in what is referred to as biotechnical stabilization techniques. It is important to note however, that in very low or intermittent flow zone soil bioengineering techniques may be appropriate to address the surface erosion problems. The following section outlines some examples of non-structural methods including some soil bioengineering techniques. For details on soil bioengineering techniques refer to Biotechnical and Soil Bioengineering, A Practical Guide for Erosion Control, 1996.

Soil bioengineering refers to the use of living plant materials to also protect against erosion (brush layering or contour wattling). These approaches are most effective as surface erosion protection and are not very effective for improving overall stability against deep rotational slides or slides which extend deeper than the root reinforcement. As erosion protection, biotechnical slope protection approaches may be more appropriate stabilization measures. They may require less site access and disturbance to install.

Vegetation by itself is vulnerable to frost action, trampling, and moisture or nutrient deficiencies. Further, it does not address the hazards of slope instability or toe erosion.

Empirically it has been found that a **2 to 1 inclination** (26°) is the **steepest upon which vegetation can be established and maintained satisfactory**. However a slightly flatter inclination of **3 to 1** (17°) is required to achieve **maximum vegetative stability**. Steeper inclinations cannot be suitably stabilized by vegetation alone and additional reinforcing or support is required.

5.3.3 Structural Protection

Structural protection works involve the construction and/or placement of significant additional structures and/or materials along the river or stream system. Some structural protection approaches which include but are not limited to the following; biotechnical stabilization methods, natural channel design techniques, revetments. Table 5 presents a summary and schematic view of the primary types of stabilization measures.

5.3.3.1 Natural Channel - Riffle, Pool Sequence Design Techniques

Natural channel (i.e., riffle, pool sequence) designs should be considered as the first alternative to structural protection works. Successful designs must re-create many natural conditions encompassing hydraulics, fluvial processes and aquatic requirements. The key is to mimic the natural geometry and materials of the stream. Inherent in these types of designs is that some level of instability will be anticipated and knowledge of the desired ecosystem is applied in the design. In contrast, the "hard engineered" channels are designed to be stable with fixed geometries, usually built in concrete or lined with protective materials, and for the single purpose of efficient water conductance. [Pg. 196 "Exploration and rehabilitation of hydraulic habitats in streams using principles of fluvial behaviour", Robert Newbury, Marc Gaboury, Freshwater Biology (1993) 29, Pg. 195-210.][15]

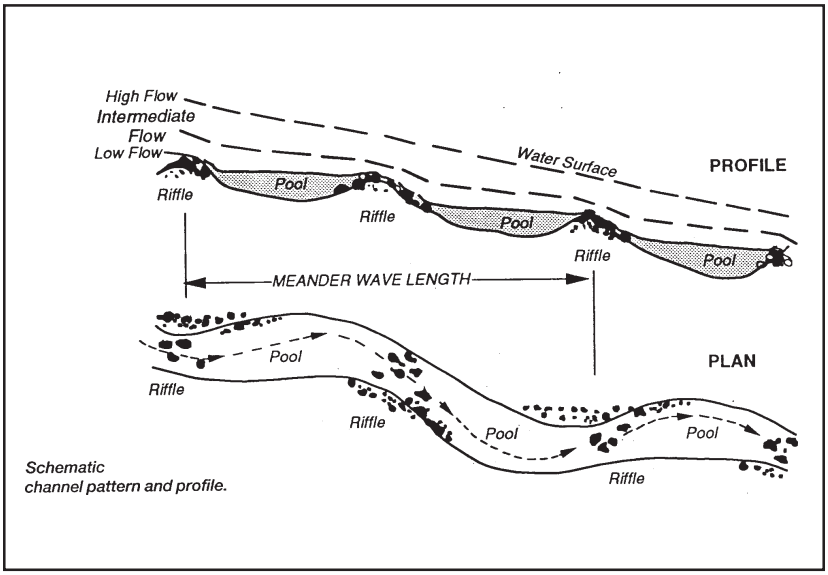


Figure 129 - Riffle and Pools (Newbury, 1993)

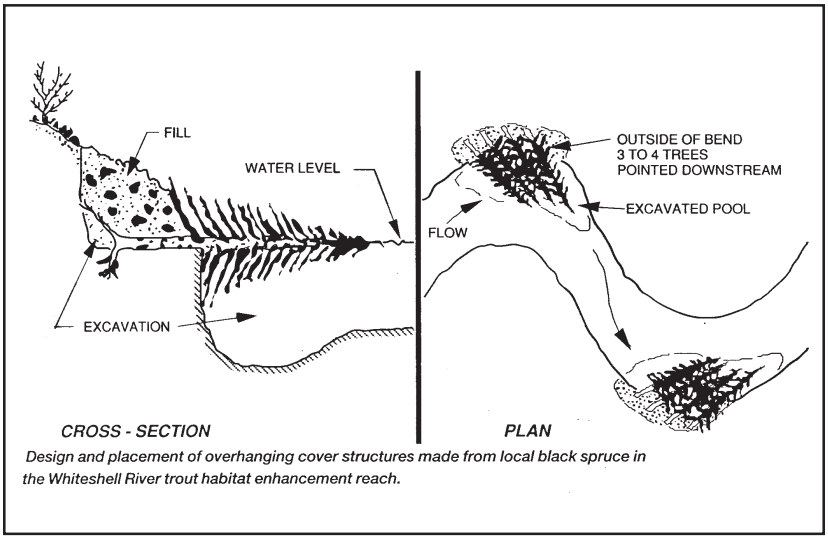


Figure 130 - Log Anchors (Newbury, 1993)

Figure 131 - Back/side channels

Figure 132 -Riffle Design

Included in these types of designs are often the log-anchors as seen in Figure 135 and back and side channel areas which may be important in addressing the overall biological needs depending on the ecosystems. For detailed information and the procedure to be followed to carry out these designs, please refer to Newbury & Gaboury, “Stream Analysis and Fish Habitat Design”, 1993.

Figure 133 -Installation of Log Crib

Figure 134 - Log Crib Works

5.3.3.2 Biotechnical Stabilization Techniques

Structural works such as biotechnical stabilization techniques and natural channel designs (e.g., vegetated mesh and grids, vegetated crib, rip rap, armour stone and tiered walls) although they significantly impact the existing system, if designed properly can often provide an opportunity to enhance environmental conditions.

If vegetation is used in combination with structural elements then the works are referred to as structural and called biotechnical stabilization techniques. The term biotechnical is used to describe methods which consist of both structural and vegetative elements working together in an integrated manner (e.g., brush layering, vegetated crib, rip rap or armour stone walls). The vegetation plays an important functional roll that will vary depending on the structural elements involved.

For further details on the application of biotechnical techniques please refer to the following: Appendix 4 and (Grey and Sotir) Biotechnical and Soil Bioengineering Slope Stabilization, A Practical Guide for Erosion Control, 1996.

5.4 Application of Approaches for Addressing the Hazard

The following chart lists the main river and stream management practices that may be appropriate to address the hazards at a given site. The individual application will depend on the different processes governing the erosion at the particular site. The chart does not endorse a particular type of management practice, it only provides an initial indication of whether or not a particular approach may be appropriate for addressing the various types of hazards on site.

The site should be thoroughly assessed following the procedure outlined in theAMSC[16] in Ontario document. Natural channel, riffle, pool design, soil bioengineering, biotechnical stabilization alternatives should all be fully evaluated. A complete assessment and identification of the potential impacts the selected practices will have on the natural river or stream processes should be followed. The identification of the impacts are then evaluated with respect to creating or aggravating any upstream/downstream impacts. As well, the impacts must be examined to ensure the selected practice is environmentally sound. An appraisal of the impacts on the fisheries and terrestrial wildlife habitat should be carried out. It is possible that the initially selected practice is appropriate for addressing the hazard on-site, but that it does NOT meet the other equally important requirements:

1 new or existing hazards can not be created and/or aggravated;
2 no updrift/downdrift impacts result; and
3 the practice must be environmentally sound.

See the procedure outlined in Chapter 6 of this document, Environmentally Sound Management which outlines these requirements.

5.4.1 Procedure

The chart indicates the management practice that may be appropriate to address the hazard. The management practices are grouped under the categories: **prevention, non-structural protection** and **structural protection**.

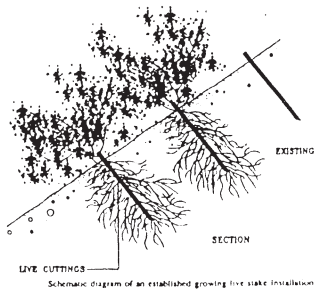
The use of the chart then requires that you identify the type of hazard you are addressing (i.e., river toe erosion, slope instability or surface erosion). The check marks indicate the type of hazard which is being addressed and which management method is the most appropriate for addressing that specific hazard. The following rating has been used:

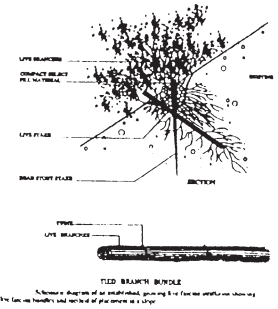
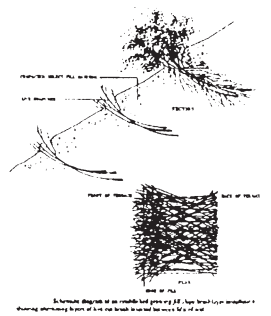
✔✔✔ - Recommended to address the hazards
✔✔ - Generally will address the hazards
✔ - May be considered but may not provide the proper level of protection to address the hazards.
✖ - Will not address the hazard

The proponent should still address the concerns outlined in Section 5.4 and carry out the procedure outlined in the AMSC[17] document.

16 Work in Progress: Adaptive Management of Stream Corridors in Ontario, 2000
17 Work in Progress: Adaptive Management of Stream Corridors in Ontario, 2000

Table 5 - Methods for Addressing Hazards - Provention and Protection Measures

	EROSION MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY			NOTES	SKETCH
			Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides	Surface Runoff		
PREVENTION	1. Prevention	Hazard Allowance Set-backs; stay away from the potential problems	✔✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	requires no work in river, stream or on slope	
	2. Relocation	Move building or service (e.g., utility or roadway)	✔✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	requires no work in river, stream or slope	
SOIL BIOENGINEERING NON-STRUCTURAL	3. Live Staking	insertion of live plant cuttings in rows or clusters (willow stakes, ½ to 1 m long)			✔		✔✔	suitable for repair of small shallow earth slumps, gullies	 Schematic diagram of an established growing live stake installation

	EROSION MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY		Surface Runoff	NOTES	SKETCH
			Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides			
SOIL BIOENGINEERING NON-STRUCTURAL	4. Live Fascines, Contour Wattling	bundles of rootable plant stems and branches (willow, dogwood, alder) buried in shallow trenches across slopes and anchored with wood stakes, 1 to 2 m spacing			✔✔		✔✔✔	suitable for control of surface runoff erosion and shallow slides, cut slopes, embankments, max. Steepness 1½ to 1, improves drainage	
	5. Brush Layering, Branch Packing	layers of live cut branches (up to 3½ m long, sticking out and criss-crossed) buried across a slope, rows every 1 to 2 m (willow, dogwood, alder)			✔✔✔		✔✔✔	best suited where slope fill is added; protects against surface erosion and shallow slides, improves drainage, max. Steepness 1½ to 1	

Legend:

✔✔✔ Recommended to address hazards

✔✔ Generally will address hazards

✔ May be considered but may not provide proper level of protection to address hazard

▲ does not address environmental concerns

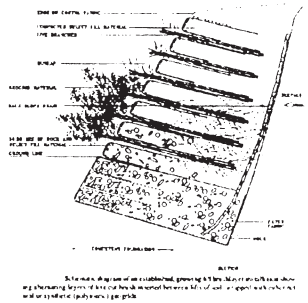
Notes:

1) Filter cloth & drainage design is not indicated on the drawings, but MUST be included in the design of any protection works.

2) The Adaptive Management Evaluation Approach should be followed as part of the design procedure.

3) Tables are not intended to be inclusive of all structural techniques available. The tables are general in nature and are intended to serve as a guide. They are not exhaustive and site-specific conditions may differ.

Table 5 - Methods for Addressing Hazards - Provention and Protection Measures

	EROSION MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY		Surface Runoff	NOTES	SKETCH
			Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides			
SOIL BIOENGINEERING NON-STRUCTURAL	6. Vegetated Mesh and Grids	plant brush layers and plastic mesh/grid layers back into slope; provide reinforcing	✔✔	✔✔	✔✔✔			suitable for very steep slopes; effective against periodic scour, improves drainage, max. Steepness 1 to 1	

Legend:

✔✔✔ Recommended to address hazards

✔✔ Generally will address hazards

✔ May be considered but may not provide proper level of protection to address hazard

▲ does not address environmental concerns

Notes:

1) Filter cloth & drainage design is not indicated on the drawings, but MUST be included in the design of any protection works.

2) The Adaptive Management Evaluation Approach should be followed as part of the design procedure.

3) Tables are not intended to be inclusive of all structural techniques available. The tables are general in nature and are intended to serve as a guide. They are not exhaustive a[illegible]te-specific conditions may differ.

Table 5 - Methods for Addressing Haz Provention and Protection Measures

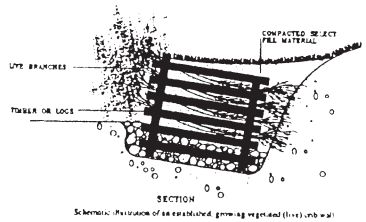
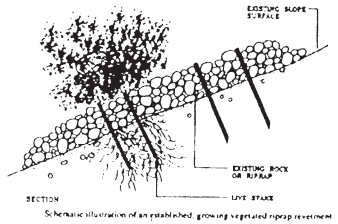
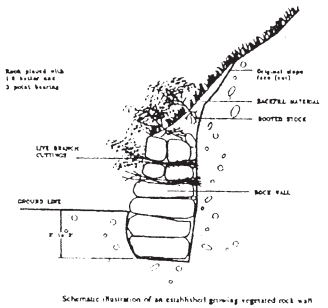
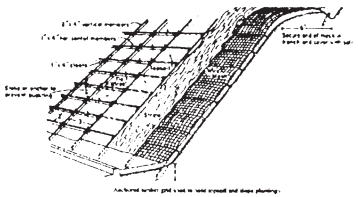
	EROSION MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY		Surface Runoff	NOTES	SKETCH
			Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides			
BIOTECHNICAL STABILIZATION STRUCTURAL	7. Natural Channel Assessment and Design	channel designed with variations of Riffle/Pool sequence	✔✔✔	✔✔✔	✔✔✔		✔✔✔	requires work in river, stream or slope, effective on erosion. When vegetation is used in combination with harder materials, shallow slides and surface runoff is addressed.	
	8. Vegetated Crib Walls	near-vertical retaining wall formed by box of stacked timbers filled with earth and layers of live branch cuttings	✔✔✔	✔✔✔	✔✔✔			effective as a toe wall on slopes, and against scour, near-vertical wall, max. Height 2 m	
	9. Vegetated Rip Rap	(joint planting) live willow cuttings inserted through rip rap	✔✔✔	✔✔	✔		✔✔✔	flexible, suitable for repair of localized slump areas, along stream banks, max. Steepness 1½ to 1	

Table 5 - Methods for Addressing Hazards - Provention and Protection Measures

	EROSION MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY			NOTES	SKETCH
			Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides	Surface Runoff		
BIOTECHNICAL STABILIZATION STRUCTURAL	10. Vegetated Rock Walls, Crib Walls	live branch cuttings inserted into openings of rock breast wall and crib wall	✔✔✔	✔✔✔	✔✔✔			effective as low toe walls, protects against scour, max. Height 2 to 3 m	
	11. Vegetated Cellular Grids	lattice-like array anchored to slope and planted in openings	✔✔✔	✔✔	✔		✔✔✔	flexible, permits vegetation on steep slopes up to 1 to 1, requires little fill * this option may address toe and meander erosion if scour protection such as rip rap is added to the toe of the structure	
	12. Vegetated Tiered Walls	series of short stepped walls with plantings on the benches			✔✔✔	✔✔		suitable for high slopes, max. Height 1½ m per bench this option may address toe and meander erosion if scour protection such as armour stone or rip rap is added to toe of structure	

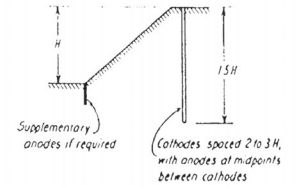
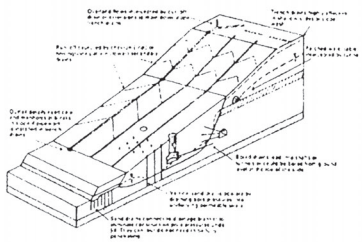
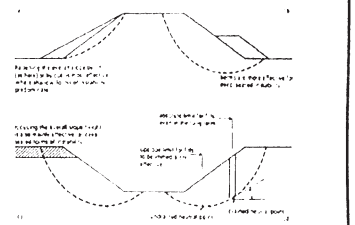
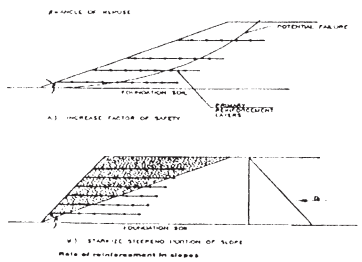
	ON MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY		Surface Runoff	NOTES	SKETCH
			Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides			
INERT CONSTRUCTION STRUCTURAL	13. Improve Ground Properties	Grouting, electro-osmosis			✔✔	✔✔✔		dependant on soil properties	 One arrangement of electrodes suitable for stabilizing slope by electro-osmosis.
	14. Reduce External Loads on Slope	Move traffic, remove fill			✔✔	✔✔			
	15. Improve Slope Drainage	Gravel trenches, sand wicks, deep wells			✔✔✔	✔✔		effective where water levels influence stability	

Table 5 - Methods for Addressing Hazards - Provention and Protection Measures

	EROSION MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY			NOTES	SKETCH
			Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides	Surface Runoff		
INERT CONSTRUCTION STRUCTURAL	16. Alter Slope Geometry (cut/fill, height, inclination)	Reduce inclination, lower height, provide toe berm			✔✔✔	✔✔✔		Major earthworks	
	17. Ground Anchors / Reinforcement	Metal cables drilled and grouted, plastic geogrid layers			✔	✔✔✔		Corrosion risk, not flexible	

Legend:

✔✔✔ Recommended to address hazards

✔✔ Generally will address hazards

✔ May be considered but may not provide proper level of protection to address hazard

▲ does not address environmental concerns

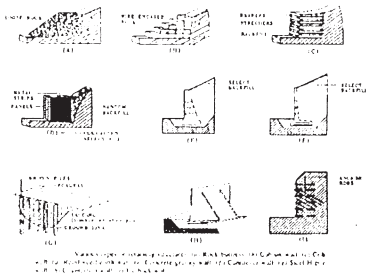
Notes:

1) Filter cloth & drainage design is not indicated on the drawings, but MUST be included in the design of any protection works.

2) The Adaptive Management Evaluation Approach should be followed as part of the design procedure.

3) Tables are not intended to be inclusive of all structural techniques available. The tables are general in nature and are intended to serve as a guide. They are not exhaustive a[illegible]ite-specific conditions may differ.

Table 5 - Methods for Addressing Ha Provention and Protection Measures

EROSION MANAGEMENT	DESCRIPTION	RIVER FLOW EROSION		SLOPE INSTABILITY		Surface Runoff	NOTES	SKETCH
		Toe Erosion	Meander Erosion	Shallow Slides	Deep Slides			
18. Retaining Walls / Structures; crib walls, but does not address environmental concerns.	Stacked Blocks, Concrete, Reinforced Backfill, Soldier Piles & Lagging	✔✔▲	✔✔▲	✔✔▲	✔		Cantilever walls feasible up to 9 m height, Counterfort walls suitable for heights more than 8 m	

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Notes:

1) Filter cloth & drainage design is not indicated on the drawings, but MUST be included in the design of any protection works.

2) The Adaptive Management Evaluation Approach should be followed as part of the design procedure.

3) Tables are not intended to be inclusive of all structural techniques available. The tables are general in nature and are intended to serve as a guide. They are not exhaustive and site-specific conditions may differ.

5.4.2 Monitor and Adjust Design

The evaluation phase of the project is often omitted from the overall process and budget. It is the only way to determine whether or not a project has been successful. The evaluation of the project depends on information which was gathered and gained from the monitoring. This information is used to measure or correct project performance, as well as to improve the knowledge base and technology for future projects.

Monitoring is needed to ensure that the project has met it's objectives and does not fail. A great deal of information now exists for the creation of effective monitoring programs. The following references outline many of the specific considerations for monitoring. These references come from initiatives such as the Ministry of Natural Resources guide, Stream Corridors, Adaptive Management In Progress, U.S. Department of Agriculture's Stream Corridor Restoration Handbook.

The specific goals of the project should be considered in order to determine whether the project was a success. The goals may vary depending on the habitat, aesthetics, uses, economics or stability issues. The fundamental elements of a monitoring program should be established at the onset of the project where measurable goals are outlined and baseline data is collected.

Measurable goals for example could set out that fish production in a dredging area be maintained after the project is completed. This would require that the baseline information be conducted to gain a knowledge of existing levels of production. It would also require an indicator of success such as a specific level of production or fishing success that can be measured after construction. The same would apply to a goal of improved bank stability, which requires knowledge of existing stability, migration or erosion rates (baseline), as well as some measurable indicator of success (bank erosion rate, cross sectional dynamics, etc.).

Stakeholders and proponents should ask at the initiation of the project how they will know if the project worked. One of the most important considerations is how to distinguish between change in the stream resulting from the project and a change resulting from activities elsewhere in the natural system.

Typical Monitoring Measures

The following factors may require consideration to ensure that the correct indicators are measured, practical and economically sound methods are used:

- duration and frequency of monitoring;
- relevance of parameters measured to the type of monitoring and goals;
- spatial extent and number of samples;
- technical expertise and need for ease of measurement, observation, understanding;
- repeatability and consistency;
- data management and reporting requirements;
- required level of scientific certainty and validity (level of detail, uncertainty in the project technology);
- clarity in baseline data (helps determine monitoring effort to detect a change)
- technical expertise of group carrying out monitoring;
- distinction between project changes and other natural processes which change in the physical system.

A major consideration in establishing a monitoring program is the timing and scale of project effects that must be measured. Will project effects be measured "before and after" at one location, or compared to reference sites or both? Monitoring should cover an appropriate sized area over which various project objectives should be achieved. There may be a lag period before project effects are measurable. The number of samples should reflect the degree of confidence desired in the data. Various monitoring parameters may be more susceptible to seasonal, annual patterns or activities.

In any proposed works, the systems should continue to be monitored and adjusted as outlined in "AMSC" and the "1998, U.S. Department of Agriculture's Stream Corridor Restoration Handbook".

6.0 ENVIRONMENTALLY SOUND MANAGEMENT WITHIN THE EROSION HAZARD: PHYSICAL AND ECOLOGICAL IMPACTS FOR RIVER AND STREAM SYSTEMS

Increasing pressure to develop along river and stream systems susceptible to flooding and erosion hazards has resulted in detrimental impacts to the shore and aquatic ecosystem. Effective river and stream systems management requires that implementing agencies manage not only the erosion hazards but that there also be a recognition and understanding of the potential impacts of any such actions on the river and stream systems environment or ecosystem and the mandates and objectives of other resource management programs (fisheries, wetlands, wildlife).

The purpose of Section 6 is to provide direction in considering the river and stream system environment. Through understanding the function and susceptibility of various river and stream system ecosystems to disturbance, the potential impacts that may occur as a result of proposed development or remedial works can be identified, and methods of reducing these impacts through design changes or mitigation measures can be implemented.

Environmentally sound management refers to principles, methods and procedures involved in addressing all of the issues that are part of the protection, management and enhancement of the river and stream system ecosystem. This includes but is not limited to the following; geology, geomorphology, hydrogeology, ecology, biology, landscape architect, natural heritage, planning, geotechnical, hydrology and hydraulics. We will introduce some methods associated with undertaking of hazard management in an environmentally sound manner when considering development proposals within the *hazardous lands* but have not attempted to cover all of the respective disciplines. The social and natural heritage issues are of equal importance but policies regarding this issues should be referred to directly. The application of the methods and procedures which are associated with the various disciplines and how they are applied in the study of river and stream system processes are outlined in detail in the AMSC[18] in Ontario, 1998. This document provides a procedure which should be followed when ever any type of protection works or study is being considered within the river or stream system. (see figure 135).

This procedure is designed to aid decision-makers in evaluating an area, or particular location, within an area of provincial interest and in ensuring that consideration is given to both the physical and ecological influences and impacts when selecting which, if any, natural hazard management response (e.g., prevention, non-structural protection works or structural protection works) would provide the "best management practice" given local site conditions. This includes:

- **Identify Hazards;**
- **Identify Development Proposed Within the Hazardous Lands or Hazardous Sites;**
- **Identify Appropriate Hazard Management Response;**
- **Determine Potential Impacts to Physical Processes and Characteristics;**
- **Assess Off-Site Physical Impacts;**
- **Assess Biological or Environmental Impacts; and**
- **Mitigate Minor Impacts of Preferred Hazard Management Response.**

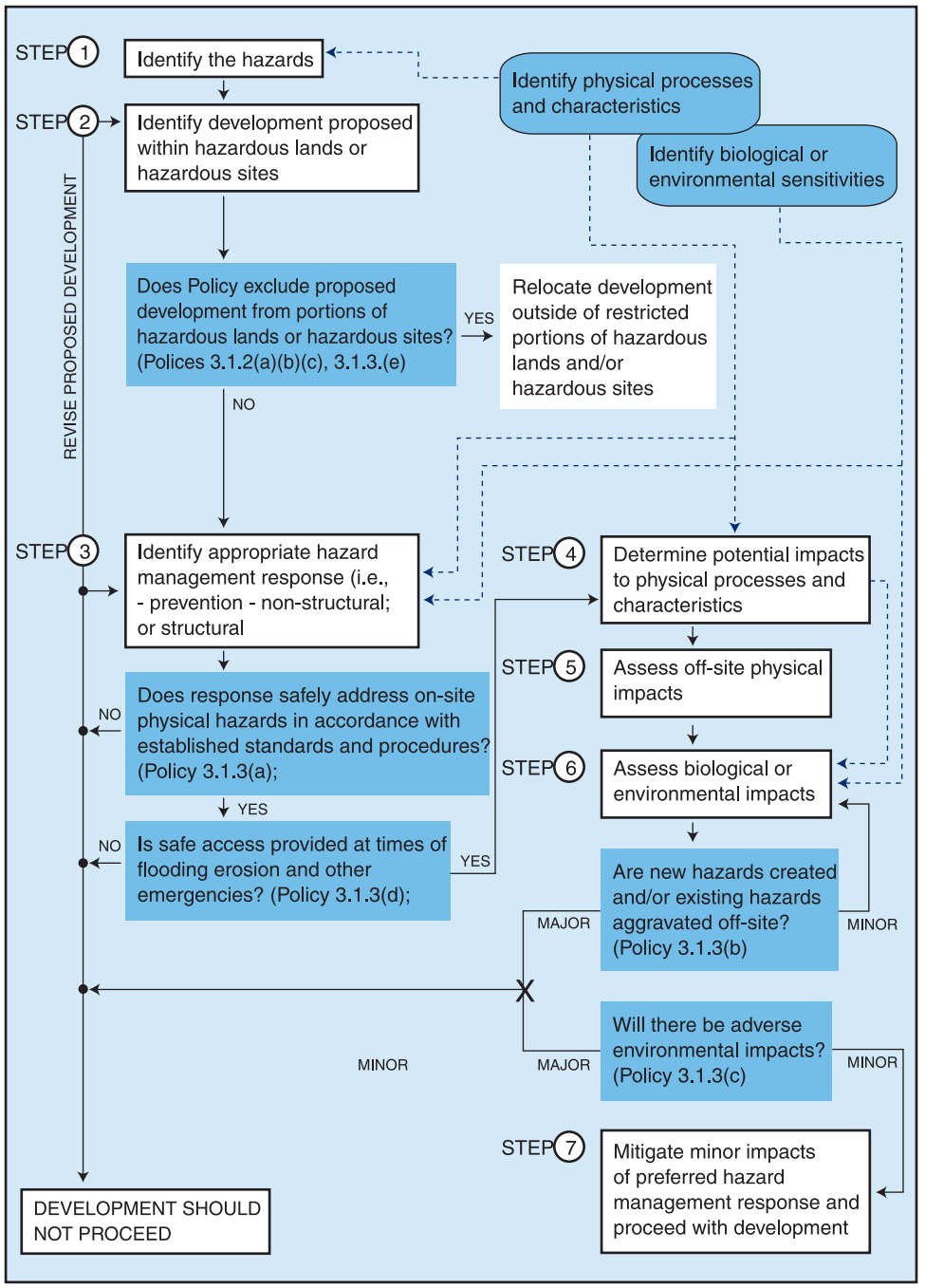


Figure 135 - Addressing the Hazards: 7 Step Procedure

The following procedure focuses on some basic questions and issues that must be addressed in any development decision-making process. It is recognized that some natural hazards may be more complex than others. As such the level of evaluation will be site specific and directly proportional to such factors as the size, severity, and type of risks and the potential physical, environmental and biological impacts that may result.

An excellent summary of specific potential drainage impacts and causes as a result of drainage alterations has been prepared by the Ontario Ministry of Transportation, Chapter 2 Developing Drainage Objectives and Criteria, Drainage Management Manual 1997. Many of the applications in this manual are directly applicable to the river and stream systems. Summary charts have been included in Appendix 3 of this document for your information.

6.1 Identify Hazards

The Policy identifies *hazardous lands* adjacent to *river and stream systems* which are impacted by *flooding* and/or *erosion hazards*; and *hazardous sites*. The first step is to identify, or delineate, these four areas of provincial interest. If the standard allowances are not used to delineate the erosion hazards, this step may require a study to assess the existing processes within and beyond the specific site. A further level of understanding of the physical and ecological processes and how they fit into the overall watershed/subwatershed characteristics will be necessary. Reference should be made to the AMSC[19] and the recommended procedure followed.

6.2 Identify Development Proposed Within the Hazardous Lands

Except for certain restrictions (i.e., Policy 3.1.3), the Policy has the flexibility to permit *development* and *site alterations* to be located within the least hazardous portion of the *hazardous lands* and/or *hazardous sites*. The second step is to identify the size and nature of the development that is proposed within the *hazardous lands* and/or *hazardous sites*. The characteristics of the proposed development activity, or the resulting land use, can influence the type of hazard management response to be applied. For example, a high-density residential development will obviously require a greater degree of protection from hazards than non-habitable buildings. Development can generally be grouped into three major categories:

- multi-lot, large lot and large scale development;
- residential or habitable infilling, redevelopment, replacement, major additions/alterations, minor additions/alterations; and
- non-habitable buildings and structures.

Policy 3.1.2 does not permit *development* and *site alterations* within *defined portions of the dynamic beach*, *defined portions of the one hundred year flood level along connecting channels*, and a *floodway*. Also, Policy 3.1.3(e) excludes *institutional uses* or *essential emergency services* or the disposal, manufacture, treatment or storage of *hazardous substances* from the areas of provincial interest. Such uses should not be permitted within these areas and should be directed to areas outside the *hazardous lands* and/or *hazardous sites*.

6.3 Identify Appropriate Hazard Management Response

As discussed in Section 5, where development is to be considered within any of the four areas of provincial interest, the development must fulfil all of the *established standards and procedures* respecting:

- protection works; and
- access.

This involves an assessment of whether or not the selected hazard management response (i.e., prevention, non-structural or structural protection works) is required or considered to be appropriate, will it fulfil each of these standards and will it safely address the on-site physical hazards. This will require an extensive level of understanding of the physical processes and characteristics of the site.

If it is determined that these standards are not fulfilled, or if the proposed hazard management response does not in fact safely "address the on-site physical hazards" (e.g., erosion) (Policy 3.1.3(a)) or if safe ingress and egress is not provided at times of flooding, erosion and other emergencies (Policy 3.1.3(d)), then an alternative hazard management response should be selected and/or the proposed development revised.

6.4 Determine Potential Impacts to Physical Processes and Characteristics

In any application that requires some type of protection works should be evaluated within the appropriate context of the watershed. It is important to consider the appropriate scale to address the key issues as well as to understand how the stream and valley system functions and the impacts the works will have on the management of the system. One of the primary issues when considering protection works to address natural hazards is the need to assess the impacts of the selected protection works on the area's physical processes and characteristics.

Although a particular hazard management response may appropriately address the local or on-site erosion hazard(s), the physical characteristics of the protection works (e.g., structural form and slope, size of material, permeability, etc.), the methods used in construction, the methods of maintenance, and the post-design life measures may individually and/or collectively affect the characteristics and physical processes of a given location. The "affects" or impacts may in turn cause harm to the ecosystem and pose physical risk or harm by increasing or exacerbating hazards on surrounding properties.

The potential influences and impacts of the proposed hazard management response to the physical processes and characteristics must be identified. This will require a sufficient level of understanding of the physical processes and characteristics.

In addition to understanding and addressing the type and magnitude of impacts on the physical processes and characteristics on-site, consideration it is extremely important to also consider the spatial extent of the physical impacts in order to be able to assess the impacts off-site (e.g., how far upstream/downstream the physical impact is determined to extend). Evaluation of the spatial extent (e.g., watershed, subwatershed, reach, site) of the physical impacts is dependent on such factors as the type, design, configuration and sometimes the timing of the installation of protection works. The resultant impact(s) on the physical processes is also dependent on the physical characteristics of the area in which the works are being installed. For example, is the native soil structure highly susceptible to disturbance, is the area exposed, is it partially sheltered, and what is the magnitude and duration of the forces (e.g., wind, waves, flood flows)? A general discussion outlining the scope, scale, and spacial extent concerns which should be addressed when evaluating the potential impacts has been provided in Section 2.3.1 of this document. A further discussion of this topic is provided in the "AMSC[20]".

Effective ecosystem and natural hazards management requires implementing agencies to manage not only the physical hazards (e.g., flooding, erosion, dynamic beaches, unstable soils, unstable bedrock), but to recognize and understand the potential impacts of any such actions on the local environment or ecosystem. Further reference to the AMSC[21] document outlines many of the biological, ecological and geomorphic impacts and concerns which should also be addressed.

6.5 Assessing Spacial Extent (Off-Site Physical) Impacts

Beyond the consideration of the range, magnitude and consequences of protection works on on-site physical processes and characteristics, one must also give consideration to the potential range, magnitude and consequences of the same protection works on off-site locations or surrounding properties (e.g., updrift/ downdrift river and stream system properties, upstream/downstream riverine properties).

Evaluations of potential physical impacts are often described in terms of **major** or **minor impacts**. For the purposes of this document, clarification and consistency, the following definitions specific to natural hazards will apply:

- **Minor physical impacts** are defined as being of short-duration, where the impact can be mitigated through alterations in design or the selection of an alternative form of protection work, where the impact can be addressed by a change in the timing of construction, where there is likely to be a high rate of recovery, and where there is a low potential for spin-off effects.
- **Major physical impacts** are defined as having long-term and permanent adverse impact on the on-site/off-site physical characteristics and/or processes, where the impact(s) cannot be mitigated through changes in design and/or timing, and where there is a high potential for spin-offs direct and/or indirect effects.

Where major off-site physical impacts result, the development is considered to not be fulfilling the conditions of the applicable policy (e.g., Policy 3.1.3(b), development is to not aggravate existing hazards, create new hazards). Where new hazards are created and/or existing hazards aggravated, one of three options should be implemented:

- an alternative method of "addressing the hazard" must be considered; or
- the development should be revised; or
- the development should not be permitted.

Where minor physical impacts are identified, a determination of whether this impact(s) can be further reduced using another form of protection works or an alteration to the design, installation method or timing should be considered.

6.6 Assess Biological and Environmental Impacts

The environmentally sound management of a particular location requires an understanding not only of the physical processes impacted by various protection works, but also of the effects that these physical processes, and any changes to them, have on the ecosystem. The more complex or diverse the physical characteristics and processes that are shaping and reshaping the development site, the more diverse the range of habitat types for plant and animal species. Although examination and understanding of these diversities, therefore, will help to ensure that potential adverse environmental impacts are addressed and minimized.

The gradual encroachment of development on sensitive ecosystems have in the past resulted in impacts which were frequently overlooked until it was too costly, practical or late to remedy or recover affected habitats. It is essential, therefore, in any decision-making process to ensure that environmental concerns are considered as an integral part of managing a particular location, and not as an isolated study component to be addressed at a later or last stage of the process. For environmental concerns to be duly recognized and properly evaluated and addressed, they must be considered at all stages of the land use planning process, from the formulation of alternative development strategies to the plan implementation and post-development monitoring stage.

To carry out a complete evaluation, it will necessary to identify the environmental sensitivities associated with a particular development site and to develop an understanding and recognition of their importance to the ecosystem as a whole. As well, it will be necessary to have as input, an understanding of the potential physical impacts and their spatial extent. An evaluation of how the biological, terrestrial, ecological elements and processes are impacted by the introduction of the development and any associated non-structural or structural works that may be proposed should be undertaken.

Habitat, in general, is the combination of living and non-living things which provide a particular species with the resources it needs to complete its life cycle. These may include soil, water, air, rocks, rain, heat and the other plants and animals which provide the food needed for survival. Maintaining a diversity of habitats is essential to accommodating the needs of many species and to ensuring the continued diversity of wild life. The term "wild life", as defined in the Wild Life Strategy for Ontario (1991), includes all wild animals, birds, reptiles, amphibians, fish, invertebrates, as well as, plants, algae, bacteria, and other wild organisms. All species have different habitats, which collectively influence each other and function together as an ecological system or ecosystem.

When assessing the environmental sensitivities within natural hazard areas, one must also fully recognize that the use, existence and management of wild life species are not restricted to these "areas of provincial interest". As such, any decisions made relative to natural hazards should also consult the broader resource planning and management interests of the implementing agencies normally identified in ecosystem-based resource management plans (e.g., watershed, subwatershed management plans).

The biological component of the ecosystem encompasses all wild life and the habitat that supports it. Every wild life species has its own habitat requirements, which can change depending on the stage of its life cycle, the season or even the hour of the day. Areas involving water are particularly important in terms of wild life habitat. For example, areas surrounding wetlands, ponds, rivers and lakes are used by more wild life species than any other habitat type.

An analysis of the significance of the various biological elements of the ecosystem and their susceptibility to disturbance from the placement or design of various protection works is often very difficult due to the interconnections and linkages between these elements.

When evaluating the potential impacts of any proposed activities, one may undertake an assessment of the function and significance of the habitat, and secondly, an assessment on the susceptibility of the habitat to disturbance.

The function and significance of a habitat includes the interrelationships between it and other components of the ecosystem, the general importance of the habitat type in terms of its economic or social value, and its intrinsic values in providing habitat for endangered species. Discussions on the susceptibility of a habitat normally relate to the response of a particular habitat to stress or to changes being placed on it. In general, habitats that can withstand this stress, or which can adapt or recover quickly are considered to have a low susceptibility to disturbance. Conversely, where stress or change to the ecosystem can result in permanent or irreversible changes to the diversity and number of habitats and associated wild life species, such habitats are considered to have a high susceptibility to disturbance.

When discussing potential options for addressing natural hazards, earlier components of this document identified three general categories of management approaches:

- prevention
- non-structural
- structural

Prevention techniques such as the siting of buildings landward of the natural hazard limits and property acquisition and with some non-structural protection works such as building relocation measures normally do not require major alterations or disturbance to the local environments within areas of natural hazards. Where these measures are undertaken with minimal disturbance, the environmental impacts and potential for long-term disturbance to sensitive habitats with these measures may be considered to be negligible.

Conversely, there are some **non-structural** approaches to addressing natural hazards such as soil bioengineering techniques, (e.g., live staking, live facines, contour wattling, brush layering, branch packing) are often used to address a common problem of surface runoff erosion. These techniques often require that some alteration of the local environment is undertaken. See Summary Table 5 and Appendix 4 for examples.

Structural works such as biotechnical stabilization techniques and natural channel designs (e.g., vegetated mesh and grids, vegetated crib, rip rap, armour stone and tiered walls) although they significantly impact the existing system, if designed properly can often provide an opportunity to enhance environmental conditions. See Summary Table 5 and Appendix 4 for examples.

Although the magnitude of the impact is often directly proportional to the level of intrusion and disturbance, these measures may add new stressors and impacts on susceptible habitats but they may also provide an opportunity to improve conditions.

Of the three general categories of protection works, structural protection works have the potential to cause the greatest magnitude and range of spatial and temporal environmental impacts depending on the susceptibility of the biological communities and their associated habitats to disturbance.

The relative significance of the ecological impacts associated with various protection works may include the evaluation of some of the following criteria:

- importance
- spatial extent
- duration of effect
- recovery
- mitigation
- cumulative effects

6.6.1 Importance

This addresses the significance or the value attached to the potentially affected area as a result of such factors as its location, uniqueness or importance for wild life and society.

For example, there are many areas along river and stream systems that have been identified as having high value or significance due to the special functions or habitats which they provided to a diverse range of wild life. These include endangered species habitat, spawning areas, Areas of Natural and Scientific Interest, provincially and locally significant watersheds, Environmentally Significant Areas, and areas deemed to be of Natural Heritage. As such, these areas should be given special consideration and attention in planning for a protection works structure.

6.6.2 Spatial Extent and Scale

The environmental impacts associated with various protection works can occur within the immediate site or in the vicinity of the works (e.g., reach, upstream/downstream for riverine sites) and/or at a further distance from the site area (e.g., watershed, subwatershed).

Impacts in the immediate vicinity of the protection works can result from both large-scale (e.g., construction of an erosion structure) and small-scale activities (e.g., clearing of vegetation for access).

For example, typical on-site environmental impacts of protection works or related development activities may include but are not limited to:

- placement of fill material which covers aquatic plants and bottom substrates;
- changes to nearshore substrates on which fish species may spawn (e.g., cobbles);
- alteration of water levels in periodically flooded areas which may restrict spawning areas and waterfowl habitat;
- removal or clearing of river and stream system vegetation which provides shade, bank stabilization and habitat for wild life; and
- removal of material from the nearshore such as boulders, cobbles, and stumps affect fish feeding grounds by reducing the potential habitat for food organisms (prey species).

A few typical off-site environmental impacts for river and stream system areas may include:

- release of sediments into the water column;
- release of sediments upland, downland or inland of the site, disturbing terrestrial habitat, food supplies;
- disruption to the corridor from either noise or physical impacts affecting migration patterns of certain species;
- changes in sediment supply and alongshore sediment transport either increasing or decreasing erosion in the system; and
- change to substrates covering aquatic plants, bottom substrates, and plants.

Rarely are there environmental impacts which are limited to the immediate site of the activity or disturbance. For this reason, careful consideration and evaluation of on-site and off-site impacts must be addressed in any development decision-making process.

6.6.3 Duration of Effect

Evaluation of this criteria addresses the length of time associated with the activity and its possible environmental impacts. Such impacts are normally identified in terms of their short-term or long-term duration.

There are three key temporal phases associated with protection works:

- construction-related activities;
- operation and function of the protection works during its design life; and
- post-design life.

Short-term environmental impacts are generally associated with construction activities and may often be avoided through alterations and/or modifications in project design or through changes in construction practices (e.g., fencing of the access route to the site to minimize surrounding disturbance, use of silt screens/fencing).

Long-term environmental impacts are generally the result of the project design and occur following construction. For example, the direct loss of a fish spawning bed by the placement of a structure in the river and stream system would be considered a long-term impact.

During the post-design life phase, when the structure has failed or is no longer functioning as designed, environmental impacts may be more difficult to predict. Generally, however, these impacts will likely occur on-site and off-site in areas surrounding the development site.

6.6.4 Recovery

The susceptibility of habitat and its ability to recover following a stress placed on it must be considered. For example, the re-establishment of a small area of river and stream system vegetation when a construction road is no longer required, may be quick to recover and may require little input. Conversely, other environmental impacts, such as those associated with the alteration of a drainage pattern to a wetland may be irreversible.

6.6.5 Mitigation

The use of standard mitigation measures or practices are normally required to alleviate or reduce the environmental impacts associated with a particular development activity. Mitigation measures can be employed during the construction phase or in the actual design stage of a particular structure or activity to reduce associated environmental impacts.

When standard mitigation measures will not substantially reduce environmental impacts (e.g., loss of habitat will occur), compensation for the displaced habitat may be considered and/or required. As an example, compensation plans associated with the potential destruction of fish habitat must be approved by the Federal Department of Fisheries and Oceans.

6.6.6 Cumulative Impacts

Although the environmental impacts associated with a single development activity may be considered to be small or minimal, the addition of this impact to all others being placed on an already stressed ecosystem may have the cumulative impact of causing serious and potentially irreversible degradation. Careful consideration of the cumulative impact of any and all development activities should be assessed and determined through ongoing consultation with all agencies having an interest in the ecosystem.

For the purposes of this document the evaluation of these criteria has been based on the resultant major or minor biological impacts:

- **minor biological** are those which can be mitigated, that is, the proposed structure or or environmental activity will cause impacts which can be mitigated through changes in impacts the design and/or timing of the activity. Confining impacts to what is considered a minor level (as opposed to a major level impact) is contingent on having an impact of short duration, the availability of mitigation practices, a high rate of recovery, and a low potential for spin-off effects.

- **major biological** occur when the structure or activity has significant long-term **or environmental** permanent adverse environmental impacts on the net productivity of the **impacts** habitat on-site or off-site. A major impact can occur when the impact is of long-term duration, the rate of recovery of the habitat is low, there is a high potential for spin-off or indirect effects and/or the area affected is considered to be critical habitat.

The relative importance of each of these criteria and the rigour with which they are evaluated may vary with each project. As a standard evaluation procedure, implementing agencies should consider the type and size of the project, scope of the works and the sensitivity of the location when deciding on the level of study that is to determine whether or not the development is being undertaken in an environmentally sound manner. The procedure outlined in the AMSC[22] should be followed when conducting any type of study or assessment of potential protection works. Where the development cannot be undertaken in an environmentally sound manner (e.g., adverse environmental impacts result) alternative works should be considered or the development should not be permitted.

6.7 Mitigate Minor Impacts of Preferred Hazard Management Response

The proposed *development* and *site alteration* may proceed provided it meets all the requirements of Policies 3.1.2 and 3.1.2, as outlined in the above steps and any minor impacts are mitigated by alterations to the design and/or to the timing and method of installation. Please review Section 5.4.2 Monitoring and Adjust Design of this document and the AMSC [23] document for further details.

TAB 7

PLANNING &REGULATION POLICIES AND GUIDELINES

October 2011

Approved by the Board of Directors: October 6, 2011

authorities for plans of subdivision will circulate the proposals to the *HCA* for comment in order that matters concerning land conservation and resource management may be addressed.

Conservation Authority concerns are to be addressed on a site-specific basis and should be reflective of the natural features of the area in question. Concerns regarding the management of *flood plains* and natural hazard lands should be reviewed by *HCA* engineering staff, and those pertaining to *wildlife habitat*, *Environmentally Significant Areas* or other *natural heritage features and areas*, by *HCA* staff ecologists.

If the *Authority* has concerns regarding the proposal they may either:

- Propose revisions to the existing plan; or
- Suggest that the Plan is premature as further studies are required; or
- Clearly indicate that the *Authority* is unable to support the Plan due to its lack of conformity with *PPS* policies.

1. 6. 7 Site Plan Controls

Site plans detail the specifics of the *development* proposed for a parcel of land. The conditions set out in a site plan are applied over and above those detailed in zoning By-laws. Generally speaking, site plan controls are used to ensure that: *developments* are built and maintained in a manner that has been agreed on by the approval granting body, proposed *developments* meet certain standards of quality and appearance, there is safe and easy access for pedestrians and vehicles, there is adequate parking, landscaping and drainage, and that nearby properties are protected from incompatible *development*.

1. 6. 8 Conservation Authorities Act Section 28 Permitting

Pursuant to Section 28 of the CA Act, under Ontario Regulation 97/04 "Content of Conservation Authority Regulations under Subsection 28 (1) of the Act: "Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses" (Content Regulation), each *CA* has developed individual regulations approved by the Minister that identify and regulate certain activities in and adjacent to *watercourses* (including *valleylands*), *wetlands*, shorelines of inland lakes and *hazardous lands*. In general, permissions (permits) may be granted where, in the opinion of the *CA*, the control of flooding, erosion, dynamic beaches, *pollution* or the *conservation of land* is not impacted.

An application for a CA Act S. 28 permission (permit) is made, usually by the landowner or an agent on behalf of a landowner or an infrastructure manager and owner such as a Municipal Corporation. Information required to support an application is outlined in the Appendices section of the document.

1. 6. 8. 1 Pre-consultation on Permission (Permit) Applications

Pre-consultation is encouraged to provide clarity and direction, to facilitate receipt of complete applications and to streamline the permit application review and decision making process. To meet these objectives, depending on the scale and scope of the project, pre-consultation may include staff from the following parties: *HCA*, the municipality (for example, planning and engineering staff), the applicant, consultants, the developer and owner, and may be supplemented by staff from provincial ministries, Parks Canada and any other appropriate government agencies; and may occur concurrently with Planning Act pre-consultation.

2 Natural Hazards

Within the jurisdiction of the Hamilton Conservation Authority (*HCA*) there are three major natural hazards that are regulated pursuant to the *HCA* Regulation 161/06 under Ontario Regulation 97/04 (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation). *River and stream systems*, shorelines, and *hazardous sites* are of public interest and can pose a risk to property and human safety by causing flooding, slope failure, and unexpected collapsing of the land. The following sections outline policies and guidelines for regulating *development* and *site alteration* and for providing planning advice to our municipalities within the limit of these *hazardous lands*.

When reviewing *development* proposals within these *hazardous lands*, *Authority* staff will refer to the River and Stream Systems: Flooding Hazard Limit Technical Guide found in Adaptive Management of Stream Corridors in Ontario (*MNR* & Watershed Science Centre, 2001), and any amendments, updates, or revisions thereto. Where a discrepancy exists between this policy document and the *MNR* Technical Guides, the latter document will prevail. Each *development* proposal should utilize *Best Management Practices* (*BMPs*) and should provide all opportunities for protection and rehabilitation of natural features and their *ecological functions*.

The policies and guidelines contained within this document should not be read in isolation of one another. Rather, they should be read concurrently and in their entirety and the appropriate range of policies and guidelines should be applied to each situation. In the case where more than one policy applies to a situation, the more restrictive policy will apply.

2. 1 River and Stream Systems

Flooding and *erosion hazards* put people at risk, can cause extensive damages to property and infrastructure, and cause social and economic disruption to the communities that are affected. *River and stream systems* can be affected by severe flooding events or *valley slope* failures along shorelines.

Over the years there have been thousands of flood events in Ontario with varying impacts on lands, property, and human populations. By managing flood prone lands proactively, in conjunction with appropriate protective and emergency response measures, it is possible to mitigate many of the damaging effects of river and stream flooding.

The Provincial Policy Statement recognizes unacceptable risks associated with such events, and has required municipalities to address hazard lands (which include *valleyland* systems and flood and erosion prone lands along riverine systems) in their Official Plan (*OP*) processes. Much of the responsibility for such areas has subsequently been delegated to the Conservation Authorities, who have the required technical and professional expertise for managing such lands.

Development within the Regulation limit of the *Authority's* jurisdiction is governed by the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (*HCA* Regulation 161/06 under Ontario Regulation 97/04).

The hazard limit of *river and stream systems* is delineated by the Ontario Ministry of Natural Resources (*MNR*) standards and criteria and consists of both *flooding hazards* and *erosion hazards* along the shoreline. These standards and criteria are provided in Appendix C.

2. 1. 1 Flooding Hazard Limit

The Hamilton Conservation Authority manages *flood plain* lands at the *Regulatory Flood* level of the Regional Storm (*Hurricane Hazel*) with the exception of those numbered *watercourses* in the Stoney Creek area that have undergone a criteria reduction in the *Regulatory Flood* level to the *100 year flood* event and the *Special Policy Areas* (*SPAs*) in Dundas. The Conservation Authority manages these lands as one zone areas with the exception of the Dundas *SPAs*, which utilize the *floodway* and *flood fringe* management approach, and are treated as two zone areas.

As they currently exist, the Dundas *SPAs* were created in 1999 as the result of an Official Plan amendment, which amalgamated and officially designated a wider range of *SPAs*. There are now four officially recognized *SPAs* within the former municipality of Dundas, which are regulated through a set of policies separate from those used for the Hamilton Conservation Authority's one zone areas. The policies for the former Town of Dundas *SPAs* are provided in Section 2.1.1.4.1 within this document.

2. 1. 1. 1 Permitted Uses in the Flood Plain

- Agriculture or open space/recreational uses that do not require permanent, closed structures or any major alteration of the landscape;
- Flood, erosion and sediment control structures;
- Gardens, nurseries and *open arboretums*;
- Other non-structural uses such as forestry and wildlife management;
- *Replacement structures* or minor *additions* to existing structures;
- Municipal infrastructure such as water treatment facilities/wastewater discharge/water intakes, pumping stations, etc. that must be located in the *flood plain* as determined through the Class *EA* process; and
- Any other relevant or appropriate use and/or *development* as deemed satisfactory by the *Authority*.

2. 1. 1. 2 Prohibited Uses in the Flood Plain

- Institutional uses associated with hospitals, nursing homes, pre-school, school nurseries, day care and schools, where there is a threat to the safe evacuation of the sick, the elderly, persons with disabilities or the young during an emergency as a result of flooding, failure of *floodproofing* measures or protection works, or erosion;
- An essential emergency service such as that provided by fire, police and ambulance stations and electrical substations, which would be impaired during an emergency as a result of flooding, the failure of *floodproofing* measures and/or protection works, and/or erosion;
- Uses associated with the disposal, manufacture, treatment or storage of *hazardous substances*; and
- Any other use and/or *development* as deemed unsatisfactory by the *Authority*.

2. 1. 1. 3 One Zone Areas

One zone areas are those where the Conservation Authority prohibits all *development* or *site alteration* within the boundaries of the *Regulatory Flood* level. This is the most effective way of minimizing threats to public health or safety or property damage. The *one zone concept* is the preferred approach for the management of *flooding hazards* within *river and stream systems* as it provides the most cost-effective means of minimizing potential threats to life and risks of property damage and social disruption. Where the *one zone concept* is applied, the entire *flood plain* or the entire *flooding hazard* limit defines the *floodway* (Figure 3).

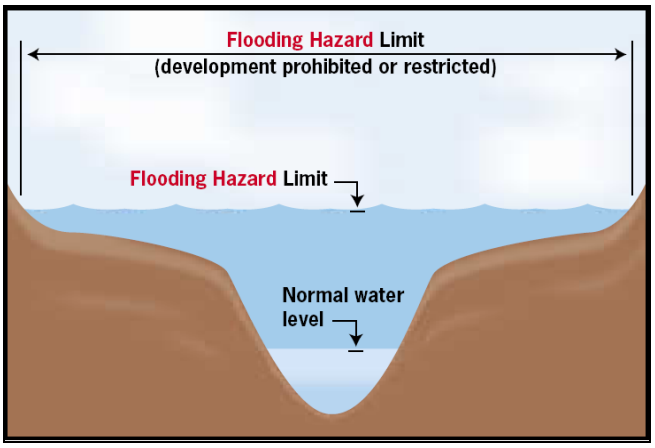


Figure 3: Flooding Hazard Limit for One Zone Concept

2. 1. 1. 3. 1 Development

Any *development* and/or *site alteration* within the jurisdiction of the *Authority* and within the *flooding hazard* limit for one zone areas must be in accordance with the following policies and guidelines and must be to the satisfaction of the *Authority*.

a. With the exception of those uses outlined in Section 2.1.1.1, and under the provisions of these *development* policies and sub-policies, *development* within the *flood plain* will be prohibited in all one zone areas.

b. In spill areas, *development* may be permitted in areas where flooding depths are less than or equal to 0.3 m and/or flooding velocities are less than or equal to 0.3 m/sec. Supporting calculations to assess onsite and offsite flood elevation impacts may be required. Only *developments* with no net impacts on flood elevations will be considered. *Dry floodproofing* measures with a 0.3 m freeboard above the *Regulatory Flood* elevations will be required.

c. Interior renovations to any *building* or structure that do not alter the use or potential use, do not increase the size, and do not increase the number of *dwelling units* of that *building* or structure will only require a letter of permission from the *Authority* pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04.

d. *Development* and/or *site alteration* that is within the Regulation limit but outside of hazard limits generally will only require a letter of permission from the *Authority* pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04.

2. 1. 1. 3. 1. 1 Additions and Replacement Structures

Additions and *replacements* of the structures listed in Policies 2.1.1.1 and 2.1.1.3.1 will be permitted in one zone areas provided they meet the following conditions to the satisfaction of the *Authority*.

a. Applications for the reconstruction of structures that have been destroyed or extensively damaged by flooding and that would be subject to the same level of risk will not be supported by the *Authority*.

b. In no instance shall an *addition* or renovation be more flood vulnerable than the existing structure, nor shall the flood vulnerability of the existing structure be increased as a result of the *addition*.

c. A minor *addition*, including the basement area, shall be less than 50% of the *original ground floor area* and does not increase the number of *dwelling units* of the existing structure. Minor *additions* may be permitted in the *flood plain* subject to the following conditions:
   i. Where *Authority* staff deem it to be necessary, the proponent shall be required to complete a hydraulic analysis at their own expense;
   ii. Proposed *additions* may not cause a new or aggravate an existing hazard;
   iii. Minor *additions* to an existing *building* should incorporate *floodproofing* measures to the extent and level possible, based on site-specific conditions. At a minimum, the *addition* should not be more flood vulnerable than the existing structure, in that no openings on the *addition* are to be below the elevation of existing openings;
   iv. Wherever possible, minor *additions* should be constructed 0.3 m (1 foot) above the level of the *Regulatory Flood*;
   v. Minor *additions* will only be permitted where existing flood depths do not exceed 0.8 m and the velocity does not exceed 1.7 m/sec;
   vi. Vehicles and people must have a way of safely entering and existing the area during times of flooding, erosion and other emergencies;
   vii. New basements will be permitted as part of an *addition* only if the existing main structure already has a basement. Crawl spaces will not be considered a basement area; and
   viii. Subsequent requests for *additions* which will result in the cumulative exceedance of the maximum permitted allowance, as based on the *original ground floor area*, shall not be permitted.

d. A major *addition* shall exceed or be equal to 50% of the *original ground floor area* of the existing structure. Major *additions* shall not be permitted in the *flood plain* in one zone areas with the exception of those provisions detailed in Section 2.1.1.3.1.

e. *Replacement structures* shall be restored to their original form (i.e. same dimensions, square footage, and *building* footprint), provided they were not destroyed by flooding.

f. Locating *replacement structures* or *additions* on a portion of the property where the *flooding hazard* is the least significant must be examined in the case of all proposals and applied wherever possible.

g. *Replacement structures* will require that *dry passive floodproofing* to the level of the *Regulatory Flood* be implemented to the fullest extent possible. In no case shall the proposed *development* be more flood susceptible than the previous structure.

h. The finished floor/lowest opening of any *replacement structure* is to be constructed 0.3 m (1 foot) above the level of the *Regulatory Flood*, if possible.

i. Any walls or floor space located below the level of the *Regulatory Flood* must be capable of withstanding the hydrostatic pressures of elevated water tables. Proposals that intend to utilize such measures will require professionally engineered and approved plans.

j. Wherever possible, all electrical panels and outlets should be located 0.3 m above the level of the *Regulatory Flood*. Where this is not reasonable, electrical equipment must be located no lower than the level of the *Regulatory Flood* and be *floodproofed* to the greatest extent possible.

k. The existing stage/storage of the *Regulatory Flood plain* must be maintained.

l. *Replacement structures* must be constructed and located such that vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies.

2. 1. 1. 3. 1. 2 Accessory Structures

Accessory structures shall be permitted within the *flood plain* provided that they meet the following conditions to the satisfaction of the *Authority*:

a. *Accessory structures* less than 10 m^2 (108 sq. ft.) will not require a permit pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04, however the *Authority* requires a minimum 6 m *erosion access allowance*, where possible, from the *top of slope* or the *toe of slope* and/or a 15 m setback from the channel bank of any *watercourse* is maintained. *Accessory structures* greater than or equal to 10 m^2 will require a permit. Any proposed *accessory structure* that is greater than or equal to 28 m^2 (300 sq. ft.) in size must meet the requirements of Section 2.1.1.3.1.

b. *Accessory structures*, greater than 10 m^2 (108 sq. ft.) but less than 28 m^2 (300 sq. ft.) in size, will generally not be permitted within the *flood plain*, subject to the following:
   i. *Accessory structures* will only be permitted within the *flood plain* if it can be demonstrated to the satisfaction of the *Authority* that the structure cannot reasonably be located elsewhere on the property;
   ii. The *accessory structure* must not increase the *Regulatory Flood* elevation. Such determinations are to be made by a professional engineer, and must be to the satisfaction of the *Authority*; and
   iii. *Accessory structures* must be *wet floodproofed* to the level of the *Regulatory Flood* when erected in the *flood plain*.

c. Above-ground swimming pools shall not be permitted in the *flood plain*.

d. In-ground swimming pools may be permitted provided that all *fill* is removed from the *flood plain*.

e. In providing a permit for an *accessory structure*, *Authority* staff will ensure that the applicant is aware that all other zoning By-laws and municipal building requirements must also be met prior to the erection of the structure.

2. 1. 1. 3. 1. 3 Fencing

a. Fencing projects will not be required to secure a permit.

2. 1. 1. 4 Two Zone Areas

The *two zone concept* identifies the *floodway* and *flood fringe* (Figure 4). The *floodway* refers to that portion of the *flood plain* where *development* and *site alteration* would cause a threat to public health and safety and property damage. In other words it is that portion of the *flood plain* required for the safe passage of flood flow and/or that area where flood depths and/or velocities are considered to be such that they pose a potential threat to life and property damage. The *flood fringe* is the portion of the *flood plain* where *development* may be permitted subject to certain policies and procedures. Some factors to take into account when determining the more hazardous areas of *flood plains* include depth of water, velocity of flow, combined depth and velocity, vehicle access and structural integrity (*MNR* & Watershed Science Centre, 2001).

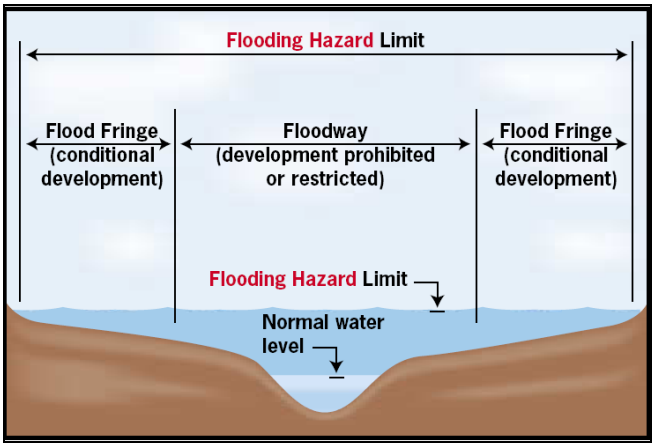


Figure 4: Flooding Hazard Limit for Two Zone Concept

2. 1. 1. 4. 1 Special Policy Areas

Due to historical *development* in the now former Town of Dundas, the *HCA* and the Town underwent a technical assessment and Official Plan (*OP*) consolidation in October of 2000. This had the effect of creating four designated *Special Policy Areas* (*SPAs*) within the former Town of Dundas and these lands are managed as two zone areas. In instances where *Authority* staff receive applications for *development* within the *SPAs* of the Spencer Creek *watershed* for *hazardous lands* surrounding the Spencer, Sydenham, and Anne Creeks they will refer to the following policies.

Any *development* and/or *site alteration* within the jurisdiction of the *Authority* and within the former Town of Dundas *Special Policy Areas* (*SPAs*) must be in accordance with the following policies and guidelines and must be to the satisfaction of the *Authority*.

a. When considering *development* within *SPAs* in the former Town of Dundas, *Authority* staff will refer to, and require conformity to, *SPA* policies within the former Town of Dundas' *OP*, dated October 27 2000, or any amendments, updates, or revisions thereto (see Appendix H). At such a time that the new City of Hamilton's *OP SPA* policies are in effect, *Authority* staff will refer to, and require conformity to, the City of Hamilton's *OP SPA* policies or any amendments, updates, or revisions thereto.

b. All *floodproofing* measures noted in the *SPAs* policies will be in accordance with Section 8.1, of this document, and its sub-sections.

c. Where the former Town of Dundas *OP*, dated October 27 2000, refers to Ontario Regulation 151/90 (Fill, Construction and Alteration to Waterways), *HCA* Regulation 161/06 under Ontario Regulation 97/04 will prevail.

d. The Conservation Hazard Lands designations in respect to *SPA* 2, noted within the former Town of Dundas *OP*, dated October 27 2000, will be found within Appendix H. At such a time that the new City of Hamilton's *OP* Conservation Hazard Land policies are in effect, *Authority* staff will refer to the City of Hamilton's *OP* Conservation Hazard Land policies or any amendments, updates, or revisions thereto.

e. Where *additions* and *replacement* structures are noted in respect to *SPA* 3, Section 2.1.1.3.1.1, of this document, will be utilized.

2. 1. 1. 5 Cut and Fill Operations

Cut and *fill* is a technique that is used to balance flood storage losses resulting from the placement of *fill* within a *flood plain*. This is achieved by removing a volume of earth at the appropriate elevation and location to offset areas within the *flood plain* to be filled. The suitability of cut and *fill* operations is extremely site-specific.

It should be recognized that in conducting a cut and *fill*, additional flood free lands are not obtained. A cut and *fill* will only serve to transfer floodwaters from one area to another as a result of the manipulation of the land's contours. In reviewing applications that will require cut and *fill*, the following policies will be applicable.

2. 1. 1. 5. 1 General Policies

The *Authority* does not encourage cut and *fill* operations as this type of *development* alters the existing contours of the *flood plain* which can lead to potential safety risks to both property and life. Any proposals that involve cut and *fill* operations within the jurisdiction of the *Authority* and within the *flooding hazard* limit must be in accordance with the following policies and guidelines and must be to the satisfaction of the *Authority*.

a. The preservation of *valleylands* and natural vegetation must be taken into account in all proposed cut and *fill* operations.

b. The amount of *fill* removed (cut) must be equal to or greater than the volume of *fill* proposed for placement within the *flood plain*.

c. All excess *fill* material removed (cut), as part of this operation, shall be required to be moved to an area that is outside of the *flood plain*.

d. Cut and *fill* must be balanced in 0.3 m (1 foot) increments.

e. No *negative impacts* on the hydraulic conveyance capabilities of the *watercourse* will be permitted.

f. Depending on the location of the proposed works, a geotechnical evaluation may be required in order to ensure the long-term stability of the works (Appendix I).

g. A cut and *fill* plan must be submitted and meet all requirements of Appendix J.

2. 1. 1. 5. 2 Hydraulic Analysis Requirements

In order to ensure that there is no significant impact on upstream or downstream flooding and erosion potential, a hydraulic analysis will be required for existing and proposed conditions. HEC-RAS is a backwater model developed by the US Army Corps of Engineers and is most widely used in *flood plain* management. Accordingly, it is the only model discussed in this document.

At a minimum, this analysis shall be required to submit the following information:

a. When generating a flood line the following information is required:
   i. Explanation of how the starting water level was determined;
   ii. A description of how/where flow values utilized in the model were determined;
   iii. A topographic map showing cross-sections and flood lines; and
   iv. Hard copy and electronic files of the input and output for existing and proposed conditions and Edit 2 results.

2. 1. 1. 6 Flood Plain Dedication

a. *Flood plain* lands will only be accepted through dedication in accordance with the *Authority's* lands acquisition policy.

2. 1. 2 Erosion Hazard Limit

Erosion hazards mean the loss of land, due to human or natural process, that pose a threat to life and property. The *erosion hazard* limit for *river and stream systems* is determined by using the 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), and includes allowances for toe erosion, slope stability, and access during emergencies. The *erosion hazard* component of *river and stream systems* is intended to address both, erosion potential of the actual river and stream bank, as well as erosion or potential slope stability issues related to valley walls through which rivers flow. The application of the *erosion hazard* limit will depend on whether the *watercourse* flows through a well defined valley system and is confined within a valley corridor or whether it flows through landscapes that are relatively flat, and is not confined or bounded by valley walls.

Generally, *development* should not occur on or on top of valley walls because the long-term stability of the slope, and therefore public health and safety, cannot be guaranteed. *Development* should be set back from the top of valley walls far enough to avoid increases in loading forces on the top of the slope, changes in drainage patterns that would compromise slope stability or exacerbate erosion of the slope face, and loss of stabilizing vegetation on the slope face.

In order to determine what the *erosion hazard* limit for *river and stream systems*, the following components must be taken into consideration. These components would be utilized to a varying degree depending on whether the stream system is *confined* or *unconfined*. If the stream system was considered a *confined system* then one would consider if the slope is stable or unstable. Not all of these components would be utilized for one *river or stream system*.

The following defines how the *erosion hazard* limit was established for *HCA* Regulation 161/06 under Ontario Regulation 97/04:

a. *Toe erosion allowance*, determined using one of the following methods:
   i. The average annual recession rate as based on 25 yrs worth of accumulated erosion data over a 100 year planning horizon; or
   ii. Up to a 15 m *toe erosion allowance* measured inland horizontally and perpendicular to the toe of the *watercourse* slope where the distance between the *watercourse* and the base of the valley wall is $\leq$ 15 m; or
   iii. Based on a valid study, which is based on 25 yrs worth of accumulated erosion data; or
   iv. An analysis based on soil types and hydraulic processes or analytical studies, where the *watercourse* is $\leq$ 15 m from the base of the valley wall. Table 1 details the minimum *toe erosion allowances* for specific soil types. If valid studies indicate that allowances should be greater than those indicated within the table, the greater of the two will be utilized;

b. A *stable slope allowance* of 3(H):1(V) or as determined by a valid study;

c. A *meander belt allowance*; and

d. An *erosion access allowance*. The *Authority* requires a minimum 6 m *erosion access allowance* is utilized, where possible. If the width of the allowance is determined to be insufficient, then *Authority* staff may require that a wider allowance be established.

Type of material Native Soil Structure	Evidence of active erosion or where the bankfull flow velocity is greater than competent flow velocity	No evidence of active erosion		
		bankfull width		
		<5m	5-30m	>30m
Hard rock (e.g. granite)	0-2m	0m	0m	1m
Soft rock (shale, limestone), cobbles, boulders	2-5m	0m	1m	2m
Clays, clay-silt, gravels	5-8m	1m	2m	4m
Sand, silt	8-15m	1-2m	5m	7m

Table 1: Minimum toe erosion allowance - where river is within 15 m of slope toe

2. 1. 2. 1 Erosion Hazard Limit for Confined Systems

Confined systems are those where the *watercourse* is located within a valley corridor, either with or without a *flood plain*, and is confined by valley walls. The *watercourse* may be located at the toe of the *valley slope*, in close proximity to the toe of the *valley slope* (less than 15 m), or removed from the toe of the *valley slope* (more than 15 m). The *watercourse* can contain perennial, intermittent or ephemeral flows and may range in channel configuration, from seepage and natural springs to detectable channels.

The following defines how the *erosion hazard* limit for *confined systems* was established for *HCA* Regulation 161/06 under Ontario Regulation 97/04:

a. The *erosion hazard* limit for *confined river and stream systems* shall be the greater of (Figure 5 & Figure 6):
   i. The *toe erosion allowance* (as outlined in Section 2.1.2). *Toe erosion allowance* is only considered for *watercourses* located less than 15 m from the *toe of slope*;
   ii. A *stable slope allowance* (3:1) or as determined by a valid study*;* and
   iii. An *erosion access allowance* of 6 m, where possible, or as determined by a valid study.

   OR

   i. As determined by a valid study which takes into consideration all of the above criteria.

b. The *Authority* may, where it is deemed necessary, require the proponent to submit a geotechnical evaluation in order to determine the safety and potential impacts of the proposed *development* (see Appendix I).

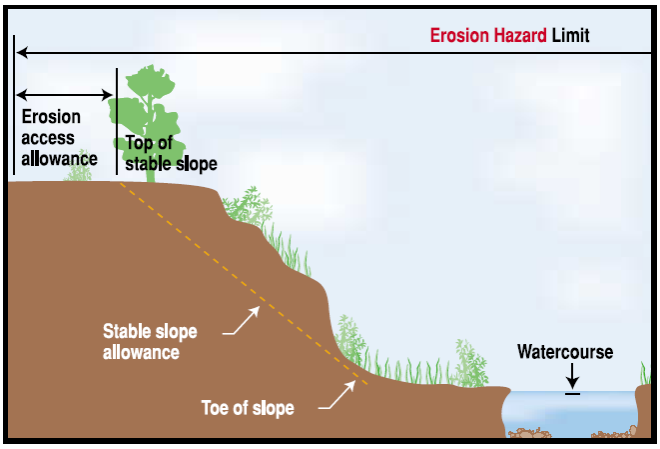


Figure 5: Erosion Hazard Limit for a Confined System (where toe of slope is more than 15 m from watercourse)

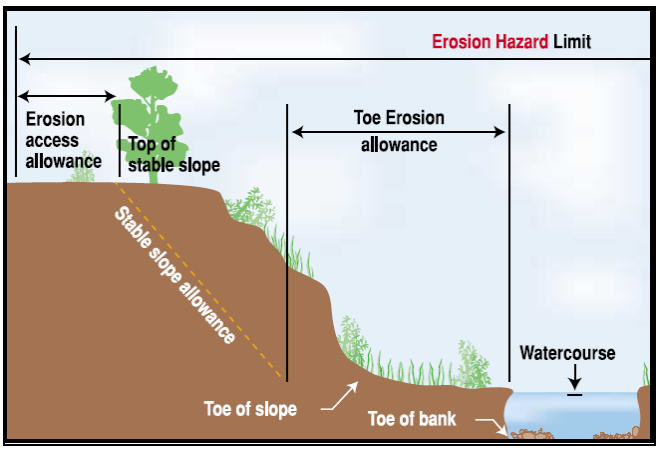


Figure 6: Erosion Hazard Limit for a Confined System (where toe of slope is less than 15 m from watercourse)

2. 1. 2. 1. 1 Stable Slopes

Section 2.1.2.1 and Section 2.1.2.3, and their sub-sections, shall apply to stable slopes in addition to the following policies and guidelines.

a. A slope which, through a surface inspection, **does not** reveal evidence of any of the following:
   i. Bare slope areas, e.g. no vegetation;
   ii. Outward tilting of trees;
   iii. Toe erosion at the base of the slope;
   iv. The addition of *fill*;
   v. An easily erodable soil type;
   vi. Slumping, gullying or other visible erosion processes; or
   vii. An angle greater than 3(H):1(V),

   Shall be subject to the application of the following policies:

1. The physical *top of slope* is to be established through a site visit by *Authority* staff and, where appropriate, in consultation with municipal staff.

2. When measuring *top of slope* the *Authority* recommends that *disconnected features* be included on a case by case basis. These cases shall be reviewed by *Authority* staff in conjunction with the appropriate municipal authorities.

3. The *Authority* requires a minimum 6 m *erosion access allowance*, where possible, from the *Authority* approved physical *top of slope* for any *development* and/or *site alteration*. This includes swimming pools, sub-surface sewage disposal systems and the placement of *fill*. Wherever possible existing vegetation should be maintained in the setback areas.

4. The *Authority* requires that any *development* and/or *site alteration* maintains a minimum 6.0 m *erosion access allowance*, where possible, from the *Authority* approved *toe of slope*.

5. The *Authority* will require that an appropriate limit of construction fence is erected a minimum of 3 m from the top of stable slope, and maintained during construction to discourage dumping of *fill* material and disturbance of the vegetation on the *valley slope*.

2. 1. 2. 1. 2 Unstable Slopes

Policies 2.1.2.1 and 2.1.2.3, and its sub-policies, shall apply to unstable slopes in addition to the following policies and guidelines.

a. A slope which, through a surface inspection, **does** reveal evidence of any of the following;
   i. Bare slope areas, e.g. no vegetation;
   ii. Outward tilting of trees;
   iii. Toe erosion at the base of the slope;
   iv. The addition of *fill*;
   v. An easily erodable soil type;
   vi. Slumping, gullying or other visible erosion processes; or
   vii. An angle greater than 3(H):1(V),

   Shall be subject to the application of the following policies:

   1. In all instances where the stability of the bank is questionable the *Authority* will require the proponent to submit a geotechnical report undertaken by a qualified professional (Appendix I). This is required in order to assess the appropriate *erosion hazard* limit and setback from an unstable slope as well as the slope stability, as they relate to the specific *development* proposal. Reports should also provide recommendations for approaches to stabilizing the slope if necessary.

2. At minimum, all reports must include:
    A. The nature and property of soils;
    B. Information regarding average annual recession rate;
    C. *Toe erosion allowance*, where a stream is less than 15 m from the *toe of slope* and not in a meander belt; and
    D. The allowance for a stable slope.

3. The *Authority* requires a minimum 6 m *erosion access allowance*, where possible, from the *stable slope allowance* and from the *Authority* approved *toe of slope* for any *development* and/or *site alteration*.

2. 1. 2. 2 Erosion Hazard Limit for Unconfined Systems

Unconfined systems are those systems where the *watercourse* is not located within a valley corridor with discernable slopes, but relatively flat to gently rolling plains and is not confined by valley walls. The *watercourse* can contain perennial, intermittent or ephemeral flows and may range in channel configuration, from seepage and natural springs to detectable channels.

The following defines how the *erosion hazard* limit for *unconfined systems* was established for *HCA* Regulation 161/06 under Ontario Regulation 97/04:

a. The *erosion hazard* limit for *unconfined river and stream systems* shall be the greater of (Figure 7):
    i. The *flooding hazard* limit; or
    ii. The *meander belt allowance*; or
    iii. As determined by a valid study; plus
    iv. An *erosion access allowance* of 6 m, where possible, or as determined by a valid study.

b. The *Authority* may, where it is deemed necessary, require the proponent to submit a geotechnical evaluation in order to determine the safety and potential impacts of the proposed *development* (see Appendix I).

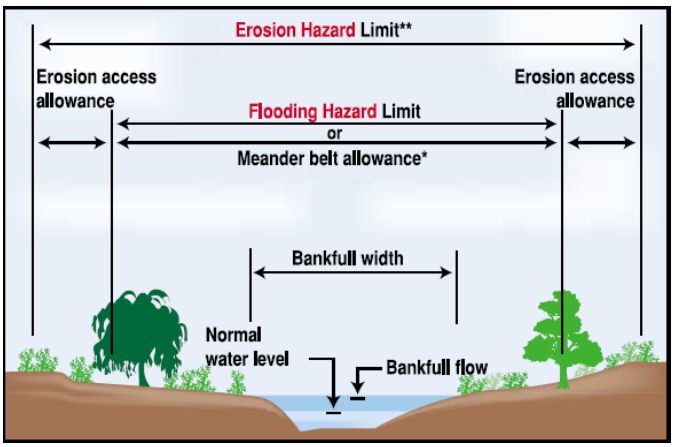


Figure 7: Erosion Hazard Limit for an Unconfined System
** the bankfull channel width with the largest amplitude meander in the reach is used to determine the meander belt width*
*** the erosion access allowance is also added to the flooding hazard limit, when known, to define the erosion hazard limit*

2. 1. 2. 2. 1 Meander Belt Allowance

The width of a meander belt can be determined by analyzing the bankfull channel width of the largest amplitude meander. The *meander belt allowance* is defined as 20 times the bankfull channel width of the reach and centred on the meander belt axis (Figure 8). When determining the meander belt for relatively straight reaches, the meander belt should be centred on the mid-line of the channel.

Section 2.1.2.3 shall apply to the *meander belt allowance* in addition to the following policies and guidelines.

a. Any *development* and/or *site alteration* proposal which is within the *meander belt allowance* must be supported by a valid engineering study and/or an Environmental Impact Statement (*EIS*).

b. *Buildings* and structures located within the *meander belt allowance*, other than those destroyed by erosion or flooding, will be permitted to be replaced or relocated within the *meander belt allowance* provided the *buildings* or structures are of the same size and use, contain the same number of *dwelling units* and where the works will not increase the risk to life or damage to properties as a result of erosion.

c. Locating the *building* or structure on a portion of the property where the *flooding hazard* and/or *erosion hazard* is the least significant must be examined in the case of all proposals and applied wherever possible.

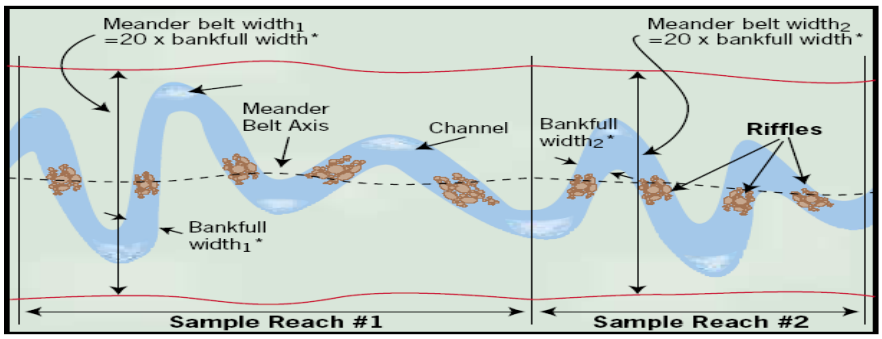


Figure 8: Meander Belt
** use bankfull channel width of largest amplitude meander in the reach to determine the meander belt width*

2. 1. 2. 3 Development

Any *development* and/or *site alteration* within the jurisdiction of the *Authority* and within the *erosion hazard* limit and/or in, on or adjacent to *valleylands* must be in accordance with the following policies and guidelines and must be to the satisfaction of the *Authority*.

a. *Development* activities and uses on natural *valley slopes* will generally be prohibited. At its discretion, however, the *Authority* may permit the following uses:
    i. Passive recreation and associated structures (e.g. staircases);
    ii. Structures associated with erosion and sediment control; and
    iii. Any other relevant or appropriate use and/or *development* as deemed satisfactory by the *Authority*.

b. *Development* is not permitted in *significant valleylands* unless it can be demonstrated through the submission of an *EIS* that there will be no *negative impacts* on the natural features or the *ecological functions* for which the area is identified.

c. *Development* will not be permitted on lands adjacent to *significant valleylands* (50 m from the boundary of the *valleyland*) unless the *ecological function* of the *adjacent lands* has been evaluated and it has been demonstrated through the submission of an *EIS* that there will be no *negative impacts* on the natural features or on their *ecological functions*.

d. Any *development* proposals adjacent to *valleylands* must be located outside of the *erosion hazard* limit and incorporate a *vegetation protective zone* appropriate for the features associated with that valley.

e. Increased fragmentation of ownership within *valleylands* and riverine systems will be discouraged by the *Authority*. Possible occurrences of fragmentation should be monitored through the plan review process.

f. The *Authority* will encourage the municipality to designate all *valleylands* in their Official Plans in a manner that recognizes their inherent environmental characteristics and limitations to *development* and to zone *valleylands* within appropriate open space zoning.

g. Where new lots are created near *valleylands* the *Authority* will encourage their creation outside of the hazard land limits.

h. The *Authority* requires that a minimum *erosion access allowance* of 6 m wide be incorporated into the *development* proposal, where possible, and that the *erosion access allowance* permit access from a municipal roadway to and along the *top of slope* for regular maintenance purposed and/or to repair protection works. Side yard access allowances may be shared between adjacent landowners provided that the shared easement is registered on title.

i. The proponent shall be required to demonstrate to the satisfaction of the *Authority* that the proposed *development* includes the presence of a *building* envelope that incorporates all relevant setbacks from the natural features of the property and conforms to all applicable zoning By-law requirements.

j. The *Authority* will encourage the re-establishment of native and locally appropriate vegetation on disturbed *valley slopes* in order to minimize soil erosion both during and after construction. Where *Authority* staff deem it to be necessary, the proponent will be required to submit a vegetation plan based on those guidelines established in Section 10.1 of this document.

k. The *Authority* will encourage overland drainage to be directed away from *valley slopes* when reviewing *development* proposals on existing lots of record and newly created lots, in areas adjacent to valley systems.

l. Where *fill* placements, grade modifications or other *development* activities are proposed within or adjacent to *valleyland* areas, those guidelines established in Section 5.1 (Fill Placement and Grade Modifications) and Section 9.1 (Erosion and Sediment Control Standards) of this document shall be applied wherever appropriate.

m. Interior renovations to any *building* or structure that do not alter the use or potential use, do not increase the size, and do not increase the number of *dwelling units* of that *building* or structure will only require a letter of permission from the *Authority* pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04.

n. *Development* and/or *site alteration* that is within the Regulation limit but outside of hazard limits generally will only require a letter of permission from the *Authority* pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04.

2. 1. 2. 3. 1 Additions and Replacement Structures

a. *Additions* to existing structures may be permitted provided that they are located outside of the *erosion hazard* limits**.**

b. Any proposed *addition* or *replacement structure* may be subject to a geotechnical report at the expense of the proponent if the *Authority* deems it to be necessary (Appendix I).

c. When necessary the *addition*, renovation, basement or *replacement structure* will be subject to the *floodproofing* requirements of *Authority* staff and as determined by Section 8.1, and its sub-policies.

d. *Replacement structures* shall be restored to their original form (i.e. same dimensions, square footage, and footprint).

e. Locating *replacement structures* or *additions* on a portion of the property where the *erosion hazards* are the least significant must be examined in the case of all proposals and applied wherever possible. An *addition* will only be permitted within the *erosion hazard* limit if it can be shown that the structure cannot reasonably be located elsewhere on the property and the *addition* does not encroach any further into the *erosion hazard* limit than the existing structure.

2. 1. 2. 3. 2 Accessory Structures

a. *Accessory structures* less than 10 m^2 (108 sq. ft.) will not require a permit pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04, but the *Authority* requires a minimum 6 m *erosion access allowance*, where possible, from the *top of slope* or the *toe of slope* and/or a 15 m setback from the channel bank of any *watercourse* is maintained. *Accessory structures* greater than or equal to 10 m^2 will require a permit. Any proposed *accessory structure* that is greater than or equal to 28 m^2 (300 sq. ft.) in size must meet the requirements of Section 2.1.2.3

b. *Accessory structures*, greater than 10 m^2 (108 sq. ft.) but less than 28 m^2 (300 sq. ft.) in size, will generally not be permitted within the *erosion hazard* limits, subject to the following:

i. That any proposed *accessory structure* will only be permitted if it can be demonstrated to the satisfaction of the *Authority* that the structure cannot reasonably be located elsewhere on the property;
ii. That any proposed *accessory structure* may be subject to a geotechnical study conducted at the expense of the proponent if the *Authority* deems it to be necessary (Appendix I); and
iii. That a geotechnical study noted in (ii) above is to the satisfaction of the *Authority*.

2. 1. 3 Alterations to Watercourses

Any *alteration to a watercourse* within the jurisdiction of the *Authority* must be in accordance with the following policies and guidelines and must be to the satisfaction of the *Authority*.

a. The *Authority* shall encourage municipalities to place restrictive zoning on *watercourse vegetation protective zones*.

b. Any *alterations to a watercourse* shall be designed in accordance with natural channel design principles, as outlined in Adaptive Management of Stream Corridors in Ontario (*MNR* & Watershed Science Centre, 2001), to the maximum extent possible and where applicable.

c. *Alterations to a watercourse* will be evaluated on an individual basis, having consideration for the following:
   i. No *negative impacts* on the natural features or on the *ecological functions*, including *fish* and wildlife requirements as set out by other federal, provincial or municipal legislation/plans/technical guidelines and a *net environmental benefit* is achieved;
   ii. Maintenance of the natural topography of the *watercourse* system, flood conveyance and flood storage;
   iii. No adverse impacts upstream and/or downstream of the proposed works in respect to fluvial geomorphological processes, storage capacity of the *flood plain*, *flood plain* elevations, flood frequency, erosion rates or erosion frequency along either side of the *watercourse*;
   iv. No adverse impacts on *ground water features* and recharge/discharge;
   v. Geotechnical issues are addressed to the satisfaction of the *Authority*; and
   vi. Adequate erosion and sediment control measures are incorporated and utilized during the construction phase.

d. An *alteration to a watercourse* shall only be permitted with prior written approval of the *Authority*. An exception is made for activities conducted pursuant to the Drainage Act, where the *Authority* has an opportunity to work in cooperation with member municipalities and other approval agencies (including Fisheries and Oceans Canada – *DFO*) to consider and mitigate the environmental impacts of drain maintenance and new drainage proposals.

e. Notwithstanding Policy 2.1.3 (d), bridges and other major structures proposed on municipal drains will require prior written approval from the *Authority*.

f. The *quality and quantity of water* within *watercourses* shall be protected, improved or restored by minimizing potential *negative impacts* including cross-jurisdictional and cross-*watershed* impacts.

g. The *Authority* generally does not support proposals to realign or re-channelize natural *watercourses*. The proposal may be considered if the alteration provides flood relief, erosion control, *fish habitat*, and/or environmental enhancement to the *Authority's* satisfaction. Approvals from other agencies may be required.

h. The *Authority* will require an undisturbed *vegetation protective zone* running consistently along both sides of all *watercourses*. A reduction in the *vegetation protective zone* will not be considered for *development* and/or *site alteration* proposals. Exceptions may be considered for *additions*, *replacement structures* and *accessory structures*, where locating *buildings* and/or structures outside of the *vegetation protective zone* is not viable. The *vegetation protective zone* is to be measured perpendicularly outward from each of the two edges of the bankfull width with the following provisions.

NOTE: *Authority* staff will use thermal regimes documented at the time these policies were approved by the Board of Directors. In all cases, the methods of Stoneman, C.L. and Jones, M.L. (1996) will be utilized to determine the thermal regime of a *watercourse*.

i. A minimum 15 m (49 ft.) *vegetation protective zone* for all warmwater *watercourses* (30 m total);
ii. A minimum 30 m (98 ft.) *vegetation protective zone* for all coldwater or marginally coldwater (coolwater) *watercourses* (60 m total). Where *watercourses* have not been studied as to thermal regimes or *fish* population, the 30 m *vegetation protective zone* is required;
iii. Greater *vegetation protective zones* may be required in some areas as a result of sensitive soil conditions (e.g. high permeability, shallow soil depths, steep slopes, or extensive organics, etc.) and/or in the habitat of *endangered* or *threatened species*;
iv. The *vegetation protective zone* may be required to be enhanced as determined by the *Authority*;
v. The *vegetation protective zone* for a meandering stream shall be the greater of either the *meander belt allowance* or the required *vegetation protective zone* for warmwater, marginally coldwater, or coldwater *watercourses*;
vi. *Best Management Practices* (*BMPs*) should be used where the *vegetation protective zone* is interrupted to allow *watercourse* crossings, as permitted in Section. 2.1.3. An interruption should occur only where it is proven to be least intrusive; and
vii. Trails and paths may be allowed in the *vegetation protective zone* provided that:
    1. The trail or path is located outside of *erosion hazard*, except for crossings;
    2. The trail or path should not come closer than 4 m to the edge of a *watercourse*, except for crossings, unless it has been demonstrated through the completion of an Environmental Impact Statement (*EIS*) that there will be no *negative impacts* on the natural features or on their *ecological functions*;
    3. The trail or path does not impede the natural function of *valleylands*;
    4. Permeable surfacing is recommended for trail or path construction; and
    5. There is a compensating *vegetation protective zone* allowance added to the width of the *vegetation protective zone*.

i. The *Authority* will consider *watercourse* crossings with the following provisions:
    i. That the crossings are proposed to be located in areas of least environmental impact;
    ii. An erosion and sediment control plan (Section 9.1) be submitted for approval;
    iii. A site restoration plan be submitted for approval;
    iv. The number of crossings be kept to a minimum;
    v. Crossings should be perpendicular to the *watercourse*;

vi. Crossings, especially any culvert crossings, should not be placed where the stream meanders, and the crossing must be constructed such that low flow conditions are maintained within the crossing;

vii. The *Authority* encourages that culverts be open-bottomed or embedded a minimum of 20% in order to maintain *fish* passage. Where closed-bottom culverts are used, natural substrate parent to the *watercourse* should be placed within the culvert, and the hydraulic capacity of these culverts must consider this requirement. All culvert installations must be appropriately sized such that flows will permit the passage of all *fish* species inhabiting the affected *watercourse*.

viii. The *Authority* requires the use of crossing methods with the least impact on the *watercourse* and maintains the character of the stream bed and banks, where possible (e.g. spanning bridges/structures, open-bottom culverts); and

ix. In rural/agricultural areas, low-level crossings may be considered to allow controlled cattle crossing between pasture lands only where necessary. Low-level crossings for farm or other machinery will not be supported. The permission of low-level crossings will be subject to provisions (i) through (viii) above.

2. 2 Lake Ontario Shoreline

Areas that lie along the Lake Ontario shoreline, including Hamilton Harbour, may be subject to *flooding hazards*, *wave action* and *other water-related hazards*, *erosion hazards* or *dynamic beach hazards*. In considering *development* applications for lands located in such areas, it is important to consider and account for the landward limits of such hazards in order to mitigate, to the greatest extent possible, the potential effects of these hazards on property and human safety. By incorporating hazard limits into *development* considerations, the *Authority* is able to conserve and protect what are often fragile and sensitive ecosystems.

The Provincial Policy Statement recognizes unacceptable risks associated with such events, and has required municipalities to address hazard lands (which include flood and erosion prone lands along shoreline systems, and dynamic beach processes) in their Official Plan (*OP*) policies. Much of the responsibility for such areas has subsequently been delegated to the Conservation Authorities, who have the required technical and professional expertise for managing such lands.

Development within the Regulation limit of the *Authority's* jurisdiction is governed by the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (*HCA* Regulation 161/06 under Ontario Regulation 97/04).

The hazard limit of the *Great Lakes-St. Lawrence River System* is delineated by the Ontario Ministry of Natural Resources (*MNR*) standards and criteria and consists of *flooding hazards*, *erosion hazards*, and *dynamic beach hazards* along the shoreline. The *HCA* Regulation limit for this natural hazard is the furthest landward extent of the aggregate of the *flooding hazard* limit plus the *erosion hazard* limit plus the *dynamic beach hazard* plus 15 m inland.

2. 2. 1 Shoreline Hazard Limits

The following limits will apply in all instances unless it can be shown to the satisfaction of the *Authority* and through valid engineering studies (by a qualified professional), at the expense of the proponent, that other allowance limits will maintain the integrity of the feature in question. The need for greater hazard land limits may be demonstrated through the completion of these studies. The shoreline hazard limit is the furthest landward extent of the aggregate of the *flooding hazard* limit plus the *erosion hazard* limit plus the *dynamic beach hazard* limit.

2. 2. 1. 1 Flooding Hazard Limits

Where *Authority* staff consider proposed *developments* and/or *site alterations* in or on the areas adjacent or close to the shoreline of Lake Ontario, *flooding hazard* land limits will apply (e.g. Figure 9).

a. *Flooding hazards* are based on the combined influence of:
   i. The *100 year flood level*;
   ii. The extent of *wave action*;
   iii. The extent of *other water-related hazards*; and
   iv. The existence or absence of shoreline protection works.

b. For the Lake Ontario shoreline, excluding Hamilton Harbour, the *flooding hazard* limit has been determined to be 78.5 m IGLD 1955 (International Great Lakes Datum). This elevation includes the *100 year flood level* (76.0 m IGLD) plus the *wave action* and *other water-related hazards* (2.5 m) [Great Lakes-St. Lawrence River System and Large Inland Lakes Technical Guides (*MNR* & Watershed Science Centre, 2001) and Lake Ontario Waterfront Study, Stoney Creek (F.J. Reinders and Assoc. and Conroy Dowson Planning Consultants Inc., March 1980)].

c. For Hamilton Harbour shoreline, the *flooding hazard* limit has been determined to be 77.5 m IGLD 1955 which includes the *100 year flood level* (76.0 m IGLD***)*** plus the *wave action* and *other water-related hazards* (1.5 m) [Great Lakes-St. Lawrence River System and Large Inland Lakes Technical Guides (*MNR* & Watershed Science Centre, 2001), Lake Ontario Waterfront Study, Stoney Creek (F.J. Reinders and Assoc. and Conroy Dowson Planning Consultants Inc., March 1980), and West Harbour Waterfront Recreation Master Plan: Phase 1 Technical Report (City of Hamilton, October 2006)].

d. A valid engineering study, undertaken by a qualified coastal engineer and at the expense of the proponent, may be undertaken or may be required to be undertaken, in areas where the exact extent of the *flooding hazard* limit needs to be verified. The need for greater hazard land limits may be demonstrated through the completion of this study.

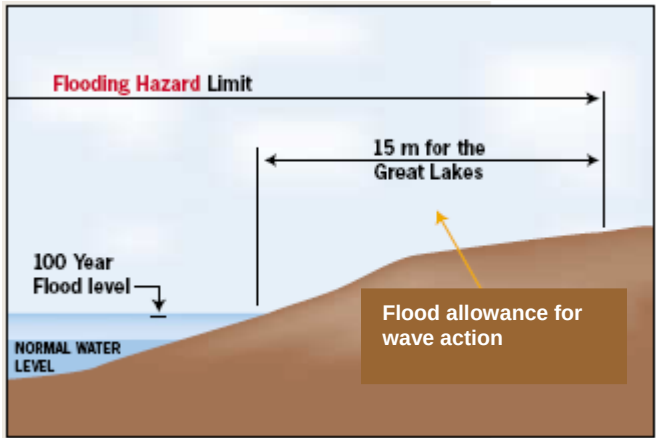


Figure 9: Flooding Hazard Limit for Lake Ontario

2. 2. 1. 1. 1 Wave Action

The Ministry of Natural Resources discuss *wave action* in Understanding Natural Hazards: Introductory Guide (2001). The following is taken from that guide.

> Along shorelines subject to *wave action*, winds can drive water farther inland, beyond the *100 year flood level* limit. Planning authorities must add the area covered by *wave uprush* to the area covered by the *100 year flood*.
>
> Along irregular shorelines, or where there are docks, protection structures or other structures, planners also have to take into account the effect of waves hitting vertical surfaces and sending spray inland. They also have to calculate the area affected when particularly strong waves overtop breakwalls, bluffs or other shoreline structures that act as barriers.

Planning authorities also have to take into account other water-related factors that can magnify flood destruction. They include these and other influences: ship generated waves, ice piling, and ice jamming.

In some areas, *wave uprush* may overtop banks or protection works and the water may collect, or pond, beyond the *100 year flood level*, thereby causing a long-term *flooding hazard*. Given the variety in protection works and naturally occurring shoreline banks that could contribute to ponding, no one suggested approach is useful. In this situation, planning authorities should undertake studies to determine the flood allowance for *wave uprush* and *other water-related hazards*.

All proposals for *development* along the Lake Ontario shoreline shall be subject to an allowance for *wave action* and *other water-related hazards*.

2. 2. 1. 2 Erosion Hazard Limits

Where *Authority* staff consider *development* proposals and/or *site alterations* in or on the areas adjacent or close to the Lake Ontario shoreline the *erosion hazard* limit shall be applicable (e.g. Figure 10).

a. *Erosion hazards* are based on a combined influence of:
   i. *Stable slope allowance* of 3(H):1(V);
   ii. A 30 m *toe erosion allowance* (measured from *stable slope allowance*); and
   iii. The existence or absence of shoreline protection works.

b. A valid engineering study, undertaken by a qualified coastal engineer and at the expense of the proponent, may be undertaken or may be required to be undertaken, in areas where the exact extent of the *erosion hazard* limit needs to be verified. The need for greater hazard land limits may be demonstrated through the completion of this study.

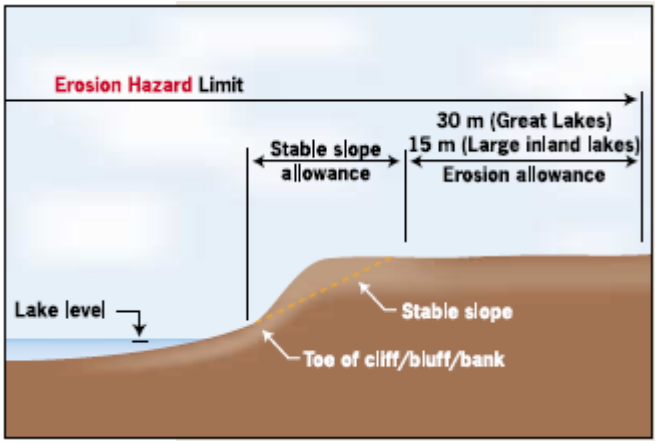


Figure 10: Erosion Hazard Limit for Lake Ontario

2. 2. 1. 3 Dynamic Beach Hazard Limits

To define a dynamic beach, the first step is to know the location of the *flooding hazard* limit. In dynamic beach areas, elevations can change quite dramatically from season to season and year to year due to build up and erosion of sand, cobbles, and other beach deposits. When elevations change, so does the location of the *flooding hazard* limit. This is an especially important consideration, because in times of low lake levels, the near shore areas that have been submerged under normal or high lake levels are now exposed, subjected to accretion and erosion processes. It may seem that the landward extent of the dynamic beach has changed, thereby introducing potential for *development* or expansion of existing *development*. Historic information about the farthest landward extent of flooding will be an important consideration for good long-term management of *dynamic beach hazards* (*MNR*, 2001).

Where *Authority* staff consider that proposed *developments* might impact on a dynamic beach system, the following *dynamic beach hazard* limit shall apply (Figure 11).

a. The *dynamic beach hazard* limit is determined by:
   i. The *flooding hazard* limit (*100 year flood level* plus an allowance for *wave action* and *other water-related hazards*); plus
   ii. A 30 m dynamic beach allowance.

b. A valid engineering study, undertaken by a qualified coastal engineer and at the expense of the proponent, may be undertaken or may be required to be undertaken, in areas where the exact extent of the *erosion hazard* limit needs to be verified. The need for greater hazard land limits may be demonstrated through the completion of this study.

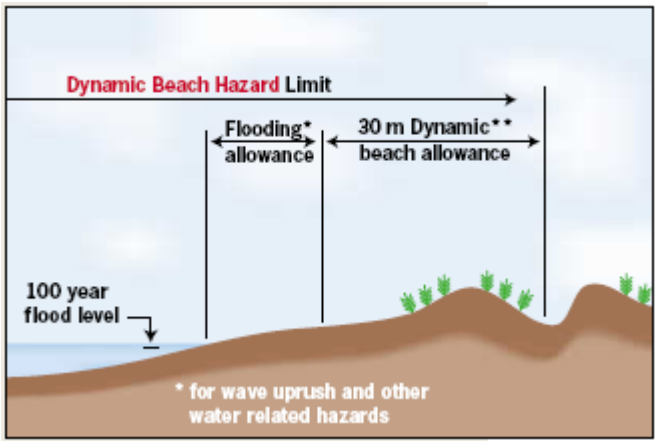


Figure 11: Dynamic Beach Hazard Limit for Lake Ontario
(*** is not applicable*)

2. 2. 2 Development

Any *development* and/or *site alteration* within the jurisdiction of the *Authority* and in, on or adjacent to the areas of shorelines must be in accordance with the following policies and guidelines and must be to the satisfaction of the *Authority*.

a. *Development* and/or *site alteration* will not be permitted in or on the areas within the *dynamic beach hazard*.

b. The *Authority* will generally direct *development* to occur outside of *hazardous lands* adjacent to the Lake Ontario shoreline that are impacted by flooding and/or erosion, unless the following conditions are met:
    i. The *ecological function* of areas adjacent or close to the shoreline have been evaluated and it has been demonstrated through the submission of an *EIS* that there will be no *negative impacts* on natural features or their *ecological functions*;
    ii. The hazards can be safely addressed, and the *development* and/or *site alteration* is carried out in accordance with *floodproofing* standards, *protection works standards*, and *access standards*;
    iii. Vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies;
    iv. New hazards are not created and existing hazards are not aggravated; and
    v. No adverse environmental impacts will result.

c. *Development* and/or *site alteration* will not be permitted in or on *hazardous lands* where the use is:
    i. An institutional use associated with hospitals, nursing homes, pre-school, school nurseries, day care and schools, where there is a threat to the safe evacuation of the sick, the elderly, persons with disabilities or the young during an emergency as a result of flooding, failure of *floodproofing* measures or protection works, or erosion;
    ii. An essential emergency service such as that provided by fire, police and ambulance stations and electrical substations, which would be impaired during an emergency as a result of flooding, the failure of *floodproofing* measures and/or protection works, and/or erosion;
    iii. Uses associated with the disposal, manufacture, treatment or storage of *hazardous substances*; or
    iv. Any other use and/or *development* as deemed unsatisfactory by the *Authority*.

d. *Development* and/or *site alteration* that will be susceptible to flood damage or is likely to increase flood damages to existing *developments*/uses will be prohibited.

e. Any proposed *development* will be subject to appropriate *floodproofing* standards (Section 8.1, including its sub-sections), erosion and sediment control measures (Section 9.1), and/or vegetation plans (Section 10.1) and as determined to be necessary by the *Authority*.

f. Wherever possible the municipality will be encouraged to obtain public access, shore strip dedication, easement, or right-of-way to the waterfront when multiple residential, commercial, industrial or recreational *development* occurs. These lands will provide linkages between and among *natural heritage features and areas, surface water features, ground water features* and *hydrologic functions*, and aid in maintaining the diversity and connectivity of natural features in an area and the long-term *ecological functions* and biodiversity of these natural systems. *Authority* staff will encourage the union of these sections of open space so as to form an almost continuous public shore.

g. The *Authority* will encourage shoreline protection works that incorporate an ecosystem approach and natural shoreline processes. Shoreline protection works must meet the requirements of Section 2.2.2.1.

h. Interior renovations to any *building* or structure that do not alter the use or potential use, do not increase the size, and do not increase the number of *dwelling units* of that *building* or structure will only require a letter of permission from the *Authority* pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04.

i. *Development* and/or *site alteration* that is within the Regulation limit but outside of hazard limits generally will only require a letter of permission from the *Authority* pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04.

2. 2. 2. 1 Shoreline Protection Works

a. Where shoreline protection works are proposed the applicant must meet the following requirements:
   i. The purpose of the proposed works must be clearly defined;
   ii. Shoreline works must be designed for the *100 year flood level*, *wave uprush*, and according to accepted scientific coastal engineering principles, where viable;
   iii. The works must be designed and/or approved by a professional engineer with experience and qualifications in coastal engineering;
   iv. Slope stability must be assessed by a professional engineer with experience and qualifications in coastal/geotechnical engineering;
   v. The ownership of land, where the protection works are proposed, must be clearly established by the applicant;
   vi. The design and installation of protection works must allow for access to and along the protection works for appropriate equipment and machinery for regular maintenance purposes and/or to repair the protection works should failure occur;
   vii. The works will not aggravate existing hazards and/or create new hazards at updrift/downdrift properties;
   viii. In areas of existing *development*, protection works should be coordinated with adjacent properties, where possible; and
   ix. The *Authority* requires that the protection works incorporate a minimum *erosion access allowance* of 6 m, where possible, and that the *erosion access allowance* permit access from a municipal roadway to and along the shoreline protection works for regular maintenance purposes and/or to repair the protection works, where possible. Side yard access allowances may be shared between adjacent landowners provided that the shared easement is registered on title.

b. The *Authority* will generally not support shoreline protection works that:
    i. Do not consider natural coastal processes;
    ii. Are not effective against long-term erosion;
    iii. Do not preserve cobble/shingle beaches;
    iv. Do not protect/regenerate aquatic and terrestrial habitat;
    v. Encroach on *fish habitat* (in accordance with the *Authority's* agreement with Fisheries and Oceans Canada – *DFO*); and
    vi. Negatively impact neighbouring shorelines.

    In addition, determination of a stable slope (where required) shall be at the loss of the proponent's land, not *fish habitat*. If *fish habitat* loss occurs, compensation for the loss of habitat may be required under the direction of a Fisheries Act authorization.

c. The *Authority* will notify and encourage shoreline property owners with existing protection works on their properties of the importance of regular maintenance of these structures to ensure long-term protection.

d. Where shoreline protection works exist, the *Authority* may request that the integrity of that protection works be assessed by a qualified coastal engineer, at the expense of the proponent, and any recommendations for improvement be incorporated into the *development* proposal.

e. Groynes generally will not be permitted within *hazardous lands* along the Lake Ontario shoreline.

f. The *MNR* will be consulted for all shoreline works to determine if there are Crown interests and if any permits are required.

2. 2. 2. 2 Additions and Replacement Structures

a. *Additions* to structures existing within the shoreline hazard limits will not be permitted, unless the proposed *addition* meets Policy 2.2.2 (b) and Policy 2.2.2.1 (a). Additionally, adequate side and rear yard access for regular maintenance purposes and/or to repair the protection works is required.

b. *Additions* may be permitted on existing structures outside of the shoreline hazard limits, but within the regulated area.

c. The viability of locating *replacement structures* or *additions* on a portion of the property where the shoreline hazards are the least significant must be examined in the case of all proposals and applied wherever possible. *Replacement structures* can only be rebuilt within the shoreline hazard limits if the structure is adequately protected from the shoreline hazards through the installation of shoreline protection works as per Section 2.2.2.1.

2. 2. 2. 3 Accessory/Minor Structures

a. Minor or *accessory structures* will not be permitted within shoreline hazard limits, unless that structure is adequately protected from the shoreline hazards.

b. *Accessory structures* less than 10 m^2 (108 sq. ft.) will not require a permit pursuant to *HCA* Regulation 161/06 under Ontario Regulation 97/04. *Accessory structures* greater than or equal to 10 m^2 will require a permit. Any proposed *accessory structure* that is greater than or equal to 28 m^2 (300 sq. ft.) in size must meet the requirements of Section 2.2.2.

2. 2. 2. 4 Swimming Pools

a. Swimming pools will not be permitted within the shoreline hazard limits, unless adequate shoreline protection works are installed as per Section 2.2.2.1.

2. 3 Hazardous Sites

Areas that exhibit karstic features are classified as *hazardous sites*. Karsts are landforms that have a unique drainage network, with the majority of this network being located beneath the surface. Karst topography includes features such as *sinkpoints*, caves, *sinkholes*, fissures, and springs, and is found in areas along and above the Niagara Escarpment. These *hazardous sites* may be subject to erosional collapse, flooding, and water quality issues. In considering *development* applications for lands located in such areas it is important to consider and account for the landward limits of such hazards in order to mitigate, to the greatest extent possible, the potential effects of these hazards on property and human safety. Although the main regulatory issue is public safety and property damage, the *Authority* is also concerned with conserving and protecting the sensitive ecosystems that may be influenced by *development*.

The Provincial Policy Statement recognizes unacceptable risks associated with such areas, and has required municipalities to address *hazardous sites* in their Official Plan (*OP*) processes. Much of the responsibility for such areas has subsequently been delegated to the Conservation Authorities, who have the required technical and professional expertise for managing such lands.

Development within the Regulation limit of the *Authority's* jurisdiction is governed by the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (*HCA* Regulation 161/06 under Ontario Regulation 97/04).

Unlike *river and stream systems* or the Lake Ontario shoreline, *hazardous sites* do not have one formula for defining a hazardous area associated with karst formations; therefore the hazard must be defined on a site-specific basis.

In the *watershed* of the Hamilton Conservation Authority, there exists the Eramosa Karst *Area of Natural and Scientific Interest* (*ANSI*) as determined through a Ministry of Natural Resources investigation and report dated April 2003. This *ANSI* is located in the former City of Stoney Creek, is 195.7 hectares in size, and is considered a provincially *significant* earth science *ANSI*. It contains numerous diverse karstic features, including dry valleys, overflow sinks, sinking streams and a post glacial stream cave of significant length – the Nexus Cave.

The April 2003 provincial report provides guidance to decision-makers on how best to manage the Eramosa Karst and recommends certain technical studies that need to be undertaken as part of *development* within the karst and its three main sub-areas – Developed Area, Core Area, and Feeder Area.

Sixty (60) hectares of the Core and Buffer areas of the Eramosa Karst are in public ownership and will remain in public ownership in order to preserve its geomorphology and the hydrological function of the karst.

2. 3. 1 Development

Any *development* and/or *site alteration* within the jurisdiction of the *Authority* and within *hazardous sites* (identified or not) must be in accordance with the following policies and guidelines and must be to the satisfaction of the *Authority*.

a. *Development* within and adjacent to the Eramosa Karst *ANSI* shall be in conformity with the policies outlined in Section 2.3.1 of this document and shall also be in conformity with the recommendations contained within the April 2003 Ministry of Natural Resources report entitled, "Earth Science Inventory and Evaluation of the Eramosa Karst Areas of Natural and Scientific Interest".

b. The limit of the any *hazardous site* will be established in the field in conjunction with the *Authority* staff and a qualified professional. If proponent is other than the landowner, then permission must be received from landowner before staking limit of the *hazardous site*.

c. *Development* and/or *site alteration* shall generally be directed to areas outside of *hazardous sites*.

d. *Development* and/or *site alteration* shall not be permitted:
   i. In or on the areas that are *hazardous sites*;
   ii. In or on the areas that are adjacent to *hazardous sites*;
   iii. Within a setback distance of 50 m from the boundary a *hazardous site*,

   Unless in the opinion of the *Authority*, it has been demonstrated (through the submission of an *EIS*) that there will be no *negative impacts* on natural features or their *ecological functions*, including but not limited to, the control of flooding, erosion, *pollution*, or the *conservation of land*.

e. *Development* and/or *site alteration* shall not be permitted to locate in *hazardous sites* where the use is, but not limited to:
   i. An institutional use associated with hospitals, nursing homes, pre-school, school nurseries, day care and schools, where there is a threat to the safe evacuation of the sick, the elderly, persons with disabilities or the young during an emergency as a result of flooding, failure of *floodproofing* measures or protection works, or erosion;
   ii. An essential emergency service as that provided by fire, police and ambulance stations and electrical substations, which would be impaired during an emergency as a result of flooding, the failure of *floodproofing* measures and/or protection works, and/or erosion;
   iii. Uses associated with the disposal, manufacture, treatment or storage of *hazardous substances*; and
   iv. Any other use and/or *development* as deemed unsatisfactory by the *Authority*.

f. *Development* and/or *site alteration* may be permitted in those portions of *hazardous sites* where the effects and risk to public safety are minor so as to be managed or mitigated in accordance with provincial standards, as determined by the demonstration and achievement of all of the following:
    i. *Development* and/or *site alteration* is carried out in accordance with *floodproofing* standards, *protection works standards*, and *access standards*;
    ii. Vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies;
    iii. New hazards are not created and existing hazards are not aggravated; and
    iv. No adverse environmental impacts will result.

g. *Development* and/or *site alteration* will only be considered in or on areas that are *hazardous sites* if the following concerns are addressed to the satisfaction of the *Authority*:
    i. Stormwater drainage;
    ii. Utilities;
    iii. Groundwater contamination;
    iv. Flooding; and
    v. Protection of unique features and dynamic processes that cause formation of karst.

h. *Development* and/or *site alteration* shall not be permitted within a setback distance of 50 m from any karst feature, unless the uses are:
    i. Fences, signs, roads and drainage structures that do not obstruct surface or groundwater flows;
    ii. Trails and other passive recreation facilities, excluding *buildings*;
    iii. Agricultural uses excluding *buildings* and structures;
    iv. Properly designed and maintained stormwater management facilities;
    v. Utility lines that do not obstruct surface or subsurface flows;
    vi. Conservation uses excluding *buildings* or structures;
    vii. Forestry uses excluding *buildings* or structures; and
    viii. Any other relevant or appropriate use and/or *development* as deemed satisfactory by the *Authority*.

i. Surface water run-off shall be controlled such that it could not interfere with the ecological and hydrogeological function of any *hazardous site* and:
    i. Non-point source *pollution* load of nutrients and sediment shall not exceed the pre-*development* load; and
    ii. Surface water run-off shall not directly enter a *sinkhole* or closed depression unless that is the natural drainage pattern. Drainage plans shall be designed to route surface water run-off through vegetative filters or other filtration measures before it enters such features.

j. Site plans associated with *development* and/or *site alteration* shall provide for a stable vegetative cover on areas not occupied or covered by the *building* footprint, access, parking, loading or storage areas.

k. Stormwater management ponds shall not be located within depressions or areas containing *sinkholes*. Stormwater management ponds shall be designed with impervious materials to prevent groundwater *pollution*.

l. Utility installations shall be designed to prevent potential subsidence and/or karst-forming processes.

m. Water wells shall be installed as far away as viable from a *sinkhole*. The *Authority* may require an assessment of the draw down impact of the well on the water table and may decline approval where the draw down has the potential to destabilize the karst topography.

n. All permitted land uses which involve above ground storage tanks shall make provision for secondary containment.

o. A monitoring program may be required by the *Authority* to measure the potential impacts of any *development*.

p. The *Authority* will encourage local municipalities to zone lands to restrict land use activities which may have a *negative impact* on the groundwater resource.

q. The *Authority* will encourage local municipalities to identify *hazardous sites* through municipal planning documents (e.g. Official Plans, Zoning By-Laws, neighbourhood plans, and sub-*watershed* plans) and to develop conservation policies for these areas and the lands adjacent to them.

r. All land uses within *hazardous sites* shall be subject to a site plan, as deemed necessary by the *Authority*, to illustrate mitigation and remedial measures, proper siting and containment of storage facilities, lot grading and drainage, and site design plans.

s. The *Authority* will encourage *Best Management Practices* (*BMPs*) for *development* and/or *site alteration* in *hazardous sites* or in those *watershed* areas that directly drain into the *hazardous sites*.

8 Floodproofing Standards

The term *floodproofing* is used to describe the combination of measures that are incorporated into the basic design and/or construction or alteration of individual *buildings*, structures or properties so as to reduce the impacts of flood related damages. *Floodproofing* alleviates damages to *buildings* and structures and therefore reduces the risk to public safety and property. The purpose of these planning guidelines is to provide direction when *floodproofing* is required, therefore the following policies will apply to all proposed *developments*, where applicable.

The policies and guidelines contained within this document should not be read in isolation of one another. Rather, they should be read concurrently and in their entirety and the appropriate range of policies and guidelines should be applied to each situation. In the case where more than one policy applies to a situation, the more restrictive policy will apply.

8. 1 General Policies

Any *development* within the jurisdiction of the *Authority* and within any and all *flooding hazards* (i.e. rivers and streams, shorelines, karst areas) must be in accordance with the following policies and guidelines, where applicable, and must be to the satisfaction of the *Authority*.

a. *Floodproofing* is dependent on the following characteristics of a flood. These criteria will be taken into consideration when deciding *floodproofing* on a site-specific basis:
    i. The combination of depth and velocity of the flood waters;
    ii. The duration of the flood;
    iii. The rate of rise and fall of the flood waters; and
    iv. The type of flood warning system in place.

b. All mechanical and electrical systems must be designed and installed so that the heating, lighting, ventilation, air conditioning and other systems are not vulnerable to flood damage during the flood standard. Where flooding could interrupt key power supplies, it may be necessary to provide stand-by or backup systems, with power and controls located above the level of the flood standard.

8. 1. 1 Safe Access

a. Safe ingress and egress for pedestrians and vehicles must be such that the depth is less than 0.3 m (1 ft) and the velocity is no greater than 1.7 m/s (5.5 ft/s).

8. 1. 2 Additions and Replacement Structures

a. *Replacement* residential/habitable structures will require *dry passive floodproofing* to the level of the *Regulatory Flood* plus a freeboard of 0.3 m (1 ft) wherever possible.

b. Minor *additions* to an existing *building* are the only *developments* that shall be permitted to be *floodproofed* to less than the *Regulatory Flood* level. In all instances they should incorporate *floodproofing* measures to the extent and level possible, based on site-specific conditions. At a minimum, the *addition* should not be more flood vulnerable than the existing structure, in that no openings on the *addition* are to be below the elevation of existing openings.

8. 1. 3 Dry Floodproofing

a. The use of *dry active floodproofing* measures will only be accepted in instances where it is not possible and/or practical to utilize *dry passive* approaches.

b. When reviewing *dry passive floodproofing* designs, *Authority* staff shall ensure that adequate use of *fill*, columns or design modifications are used in order to ensure that openings in *buildings* or structures will be elevated above the level of the *Regulatory Flood*, plus a freeboard of 0.3 m (1 foot), where possible.

c. Where *Authority* staff determine that it is not viable or practical to use *dry passive floodproofing* measures, *dry active* measures may be explored and utilized. In reviewing such approaches, staff shall ensure that the use of water tight doors, seals, berms/floodwalls or other similar measures to prevent water from entering openings below the *Regulatory Flood* level are adequately and appropriately incorporated into the design.

d. All *dry floodproofing* designs must be prepared and certified by a qualified engineer.

e. Wherever possible, *dry floodproofing* measures should be passive rather than active.

8. 1. 4 Wet Floodproofing

a. *Wet floodproofing* shall only be considered for structures that are non-residential or non-habitable.

b. *Wet floodproofing* shall be to the level of the *Regulatory Flood* plus a freeboard of 0.3 m. (1 foot), where possible.

c. When reviewing *wet floodproofing* measures *Authority* staff shall ensure that appropriate use is made of materials, methods and design measures such that structural integrity may be maintained in the event of a flood, and that water damage will be minimized to the greatest extent possible.

d. When reviewing *wet floodproofing* measures *Authority* staff shall ensure that designs have included two openings below the level of the *Regulatory Flood* in order that water is able to freely enter and exit the structure.

e. If deemed necessary, the *Authority* may require that *wet floodproofing* designs be prepared and submitted by a qualified engineer.

13 Definitions

100 year flood: means rainfall or snowmelt, or a combination of rainfall and snowmelt producing at any location in a river, creek, stream or *watercourse*, a peak flow that has a probability of occurrence of one per cent during any given year. The quantity and distribution of this storm is defined by the Conservation Authority and is used as the storm centred event for regulatory purposes for *watercourses* WCO, WCI, WC2, 3,4,5.0, 5.1, 6.0, 6.1, 6.2, 6.3, 6.4, 7.0, 7.1, 7.2, 7.3, 8.0, 9.0, 10.0, 10.1, 10.2, 11.0 and 12.0 as indicated on Map Figure 1 of Project 98040-A, Stoney Creek, Stormwater Management Assessment, prepared by Philips Engineering and located at the *Authority* Administrative office in Ancaster, Ontario, to which *watercourses* the 100 year flood event applies. [*PPS* & *HCA* Reg. 161/06]

100 year flood level: means, for the shorelines of Lake Ontario in the *Great Lakes-St. Lawrence River System*, the peak instantaneous still water level plus an allowance for *wave action* and *other water-related hazards* that has a probability of occurrence of one per cent during any given year. [*HCA* Reg. 161/06]

AOC: means Area of Concern.

Access standards: means methods or procedures to ensure safe vehicular and pedestrian movement, and access for the maintenance and repair of protection works, during times of *flooding hazards*, *erosion hazards* and/or *other water-related hazards*. [*PPS*]

Accessory structure: means a secondary, freestanding, non-habitable *building* or structure on the same lot as the main *building* to which it is subordinate, devoted exclusively to a use naturally and normally incidental to the main use of the premises. Examples of such structures include decks, tool sheds, pools, pool houses, and gazebos. Above ground swimming pools are not considered to be an accessory structure.

Addition: means any construction occurring on an existing structure that serves to increase the total area of that *building*. The *Authority* categorizes additions according to the following guidelines:

a. **Minor**: means any addition less than 50% of the *original ground floor area* of the existing structure, which does not increase the number of *dwelling units*, as existed on October 6, 2005.
b. **Major**: means any addition greater than or equal to 50% of the *original ground floor area* of the existing structure as existed on October 6, 2005.

Adjacent lands: means those lands contiguous to a specific *natural heritage feature or area*, where it is likely that *development* or *site alteration* would have a *negative impact* on the feature or area. The extent of the adjacent lands may be recommended by the Province or based on municipal approaches which achieve the same objectives. The extent of adjacent lands is based on information on the effectiveness of setbacks, landforms and sustainable natural vegetation in preventing or mitigating any *negative impacts* that might be expected to occur adjacent to a feature or area. Adjacent lands are not synonymous with *vegetation protective zone* / *buffer* areas, nor are they necessarily no-*development* zones. [*PPS* & *MNR* Natural Heritage Reference Manual]

Alteration to a watercourse: means straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream or *watercourse*. Examples of an alteration include, but are not limited to: channelizations, full or partial diversions, retaining walls, revetments, bridges, culverts, pipeline crossings, docks, erosion protection measures, and construction of storm sewer outlets.

ANSI: see *area of natural and scientific interest*.

Area of interference: means the area located outside of the *wetland* that could impact the *wetland* if *development* were to be permitted.

Area of Natural and Scientific Interest (ANSI): means an area of land and/or water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education. ANSI's are identified using evaluation procedures established by the Province, as amended from time to time. [*PPS*]

Authority: means the Hamilton Conservation Authority.

Best Management Practices (BMPs): means methods, facilities and structures which are designed to protect or improve the environment and *natural heritage features* from the effects of land *development* activities. BMPs can include, but are not limited to, land use restrictions, source control of pollutants, stormwater management ponds, grassed swales, underground storage facilities, woodlot management, soil erosion control, crop rotation, tree windbreaks and natural fencerows.

Buffer: see *vegetation protective zone.*

BMP: see *best management practices.*

Building: means something that is built; a structure of any kind.

CA: means Conservation Authority.

CO: means Conservation Ontario.

COSEWIC: means the Committee on the Status of Endangered Wildlife in Canada.

COSSARO: means the Committee on the Status of Species at Risk in Ontario.

Coastal wetland: means

a. any *wetland* that is located on one of the Great Lakes or their connecting channels (Lake St. Clair, St. Mary's, St. Clair, Detroit, Niagara and St. Lawrence Rivers); or
b. any other *wetland* that is on a tributary to any of the above-specified water bodies and lies, either wholly or in part, downstream of a line located 2 kms upstream of the 1:100 year floodline (plus wave run-up) of the large water body to which the tributary is connected. [*PPS*]

Confined system: means a system wherein the *watercourse* is located within a valley corridor, either with or without a *flood plain*, and is confined by valley walls. The *watercourse* can be located at the toe of the *valley slope*, in close proximity to the toe of the *valley slope* (less than 15 m), or removed from the toe of the *valley slope* (more than 15 m). The *watercourse* can contain perennial, intermittent or ephemeral flows and may range in channel configuration, from seepage and natural springs to detectable channels.

Conservation of land: means the protection, preservation, management, or restoration of land (including the physical and biological resources and processes) from loss, damage, or neglect.

Critical Habitat: those *fish habitats* which have high productive capacity, are rare, highly sensitive to *development*, or have a critical role in sustaining fisheries (e.g., spawning and nursery areas for some species, and ground water discharge areas). The *Authority* requires that a minimum *vegetation protective zone* / *buffer* of 30 m be maintained on both sides of a *watercourse* that has been identified as Critical Habitat, although this may be adjusted upwards if indicated appropriate through fisheries assessments. Critical Habitat corresponds with the older *MNR* classification for Type 1 *watercourses*. Also see *Important* and *Marginal Habitat*.

DFO: means Fisheries and Oceans Canada.

Designated vulnerable area: means areas defined as *vulnerable*, in accordance with provincial standards, by virtue of their importance as a drinking water source that may be impacted by activities or events. [*PPS*]

Development:

A. As it pertains to the Conservation Authorities Act, means:
   a. The construction, reconstruction, erection or placing of a *building* or structure of any kind;
   b. Any change to a *building* or structure that would have the effect of altering the use or potential use of the *building* or structure, increasing the size of the *building* or structure or increasing the number of *dwelling units* in the *building* or structure;
   c. Site grading; or
   d. The temporary or permanent placing, dumping or removal of any material originating on the site or elsewhere.

B. As it pertains to the Planning Act, Provincial Policy Statement, and Greenbelt Plan means the creation of a new lot, a change in land use, or the construction of *buildings* and structures, requiring approval under the Planning Act, but does not include:
   a. Activities that create or maintain infrastructure authorized under an environmental assessment process; or
   b. Works subject to the Drainage Act. (*PPS*).

Disconnected features: means those features that have, as a result of *development* or natural processes, become disconnected from the feature with which they were originally associated. An example of a disconnected feature is a section of *valley slope* that has been disconnected from the primary slope as a result of road construction.

Dry floodproofing: means *floodproofing* where the objective is to keep a *development* or structure and its contents completely dry during a flood event. There are two basic techniques to dry floodproofing:

a. Dry passive *floodproofing* includes the use of *fill*, columns or design modifications to elevate openings in the structure at or above the level of the *Regulatory Flood*. These measures do not require flood warning or any other action to put the flood protection into effect.
b. Dry active *floodproofing* utilizes techniques such as water tight doors, seals, berms/floodwalls to prevent water from entering openings below the level of the *Regulatory Flood*. Advance flood warning is almost always required in order to make the flood protection operational (i.e. closing of water tight doors, installation of waterproof protective coverings over windows, etc.). [Flood Plain Planning Policy Statement]

Dwelling unit: means one or more habitable rooms, occupied or capable of being occupied as an independent and separate housekeeping establishment, in which separate kitchen and sanitary facilities are provided for the exclusive use of the occupants. [Planning Act]

Dynamic beach hazard: means areas of inherently unstable accumulations of shoreline sediments along the *Great Lakes-St. Lawrence River System* and *large inland lakes*, as identified by provincial standards, as amended from time to time. The dynamic beach hazard limit consists of the *flooding hazard* limit plus a dynamic beach allowance. [*PPS*]

EA: means Environmental Assessment.

EC: means Environment Canada.

EIS: means Environmental Impact Statement.

EO: see *element occurrence.*

ESA: see *environmentally significant area*.

Ecological function: means the natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions. [*PPS*]

Endangered species: means a wildlife species that is facing imminent *extirpation* or *extinction*. These species are listed or categorized as an "Endangered Species" on the Ontario Ministry of Natural Resources' official species at risk list, as updated and amended from time to time. [*PPS* & *EC*]

Element occurrence (EO): A term used by conservation data centres and NatureServe that refers to an occurrence of an element of biodiversity on the landscape; an area of land and/or water on/in which an element (e.g. species or ecological community) is or was present. An EO has a conservation value for the element: it is a location important to the conservation of the species or community. For a species, an EO is generally the habitat occupied by a local population. What constitutes an occurrence varies among species. Breeding colonies, breeding *ponds*, denning sites and hibernacula are general examples of different types of animal EOs. For an ecological community, an EO may be the area containing a patch of that community type.

Environmentally Significant Area (ESA): means a natural area that has been identified as being significant and worthy of protection based on three criteria: ecology, hydrology and geology.

Erosion access allowance: is an *access standard* that is needed to ensure there is a big enough safety zone for people and vehicles to enter and exit an area during an emergency, and/or for maintenance purposes, such as a slope failure or flooding. The *Authority* requires that the minimum erosion access allowance is 6 m, where possible. [*MNR*, 2001]

Erosion hazard: means the loss of land, due to human or natural processes, that poses a threat to life and/or property. The erosion hazard limit is determined using considerations that include the 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), an allowance for slope stability and an erosion/*erosion access allowance*. This includes erosion due to karst-forming processes. [*PPS*]

Extinction: refers to a species and indicates that it no longer exists. [*EC*]

Extirpation: refers to a wildlife species and indicates that it no longer exists in the wild in Canada, but exists elsewhere. [*EC*]

Fill: means earth, sand, gravel, rubble, garbage or any other material whether similar to or different from any of the aforementioned materials, whether originating on the site or elsewhere, used or capable of being used to raise, lower or in any way affect the existing contours of the ground.

Fish: means fish, which as defined in S.2 of the Fisheries Act, c. F-14, as amended, includes fish, shellfish, crustaceans, and marine animals, at all stages of their life cycles. [*PPS*]

Fish habitat: as defined in the Fisheries Act, C. F-14, means the spawning grounds and nursery, rearing, food supply and migration areas on which *fish* depend directly or indirectly, in order to carry out their life processes. [*PPS*]

Flooding hazard: means the inundation, under the conditions specified below, of areas adjacent to a shoreline or a *river or stream system* and not ordinarily covered by water:

a. Along the shorelines of the *Great Lakes-St. Lawrence River System* and *large inland lakes*, the flooding hazard limit is based on the *100 year flood level* plus an allowance for *wave action* and *other water-related hazards*.
b. Along *river and stream systems*, the flooding hazard limit is the greater of:
    i. The flood resulting from the rainfall actually experienced during a major storm such as the *Hurricane Hazel* Storm (1954), transposed over a specific *watershed* and combined with the local conditions, where evidence suggests that the storm event could have potentially occurred over *watershed* in the general area;
    ii. The *100 year flood*; or
    iii. A flood which is greater than (i) or (ii) which was actually experienced in a particular *watershed* or portion thereof as a result of ice jams and which has been approved as the standard for that specific area by the Minister of Natural Resources,

    Except where the use of the *100 year flood* or the actually experienced event has been approved by the Minister of Natural Resources as the standard for a specific *watershed* (where the history of past flooding supports the lowering of the standard). [*PPS*]

Floodproofing (also see *Wet* and *Dry floodproofing*): means the combination of structural and non-structural *additions*, changes or adjustments incorporated into the basic design and/or construction of *buildings*, structures, or properties to reduce or eliminate flood damage to real estate, improved real property, water and sanitary facilities, structures or their contents.

Flood fringe: means the outer portion of the *flood plain* between the *floodway* and the *flooding hazard* limit. In the case of the Dundas *Special Policy Areas*, the flood fringe is defined as the balance of those lands located between the *floodway* and the furthest limit of the Regional Storm (*Hurricane Hazel*).

Flood plain: means the area, usually low lands adjoining a *watercourse*, which has been or may be subject to *flooding hazards*.

Floodway: means the channel of a *watercourse* and that inner portion of the *flood plain* where flood depths and velocities are generally higher than those experienced in the *flood fringe*. The floodway represents that area required for the safe passage of flood flow and/or that area where flood depths and/or velocities are considered to be such that they pose a potential threat to life and/or property damage. In the case of the Dundas *Special Policy Areas* the floodway is defined as the *flood plain* resulting from the 100 year storm, with the *flood fringe* being the balance of the *Regional Flood plain*.

Great Lakes-St. Lawrence River System: means the major water system consisting of Lakes Superior, Huron, St. Clair, Erie and Ontario and their connecting channels, and the St. Lawrence River within the boundaries of the Province of Ontario. [*PPS*]

Ground water feature: refers to water-related features in the earth's subsurface, including recharge/discharge areas, water tables, aquifers and unsaturated zones that can be defined by surface and subsurface hydrogeologic investigations. [*PPS*]

HADD: means the harmful alteration, disruption or destruction of *fish habitat*, as defined under the Fisheries Act.

HCA: means the Hamilton Conservation Authority.

Hazardous lands: means property or lands that could be unsafe for *development* due to naturally occurring processes. Along the shorelines of the *Great Lakes-St. Lawrence River System*, this means the land, including that covered by water, between the international boundary, where applicable, and the furthest landward limit of the *flooding hazard*, *erosion hazard* or *dynamic beach hazard* limits. Along the shorelines of *large inland lakes*, this means the land, including that covered by water, between a defined offshore distance or depth and the furthest landward limit of the *flooding hazard*, *erosion hazard* or *dynamic beach hazard* limits. Along river and stream and small inland lake systems, this means the land, including that covered by water, to the furthest landward limit of the *flooding hazard* or *erosion hazard* limits. Hazardous lands also include *hazardous sites*. [*PPS*]

Hazardous sites: means property or lands that could be unsafe for *development* and *site alteration* due to naturally occurring hazards. These may include unstable soils (organic soils) or unstable bedrock (karst topography). Karst topography can include, but is not limited to features such as: *sinkpoints*, caves, *sinkholes*, fissures, and springs. [*PPS*]

Hazardous substance: means substances which, individually, or in combination with other substances, are normally considered to pose a danger to public health, safety and the environment. These substances generally include a wide array of materials that are toxic, ignitable, corrosive, reactive, radioactive or pathological. [*PPS*]

Hurricane Hazel: means a storm occurring in October 1954 in Southern Ontario, whose quantity and distribution is defined in Ontario Regulation 161/06, under Regulation 97/04 and which is used as the riverine flood event standard to all *watersheds* in the jurisdiction of the *HCA* with the exception of the numbered *watercourses* in the former City of Stoney Creek.

Hydrologic function: means the functions of the hydrological cycle that include the occurrence, circulation, distribution and chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things. [*PPS*]

Important Habitat: means those *fish habitats* which are moderately sensitive to *development* and, although important to the *fish* population, are not considered critical (e.g. feeding areas, open water habitats of lakes). The *Authority* requires that a minimum *vegetation protective zone* / *buffer* of 15 m be maintained on both sides of a *watercourse* that has been identified as Important Habitat. Important Habitat corresponds with the older *MNR* classification for Type 2 *watercourses*. Also see *Critical* and *Marginal Habitat*.

Interference with Wetlands: means any *development* and / or *site alteration* within a *wetland's area of interference*.

LRIA: means Lakes and Rivers Improvement Act.

Large Inland Lakes: means those water bodies having a surface area equal to or greater than 100 km^2 where there is not a measurable or predictable response to a single runoff event.

MMAH: means the Ontario Ministry of Municipal Affairs and Housing.

MNR: means Ontario Ministry of Natural Resources.

MOU: means Memorandum of Understanding.

Marginal Habitat: means those *fish habitats* which have low productive capacity or are highly degraded, and do not currently contribute directly to *fish* productivity. They often have the potential to be improved significantly (e.g. a portion of a waterbody, such as a channelized stream, that has been highly altered physically). The *Authority* requires that a minimum *vegetation protective zone* / *buffer* of 15 m be maintained on both sides of a *watercourse* that has been identified as Marginal Habitat. Marginal Habitat corresponds with the older *MNR* classification for Type 3 *watercourses*. Also see *Critical* and *Important Habitat*.

Meander belt allowance: means the setback that keeps *development* from being affected by river and stream meandering (this includes allowance for the 100 year erosion rate). [*MNR*, 2001]

NEC: means Niagara Escarpment Commission.

NEP: means Niagara Escarpment Plan.

Natural Areas Inventory (NAI): refers to an extensive biological review of all the significant natural areas in the former Regional Municipality of Hamilton-Wentworth (now the City of Hamilton). The resulting documents contain detailed descriptions of each natural area and its significant features including:

- A complete listing of the flora and fauna of each natural area;
- An annotated listing of plants, reptiles, amphibians, butterflies, *fish*, nesting birds and mammals of this Region;
- A detailed description of the geology, soils and hydrology of the Region;
- *Watershed* summaries of all the stream systems;
- Mapped locations of rare species; and
- A technical library backing up all of the database and report information.

Natural heritage features or areas: means features and areas, including *significant wetlands*, *significant coastal wetlands*, *fish habitat*, *significant woodlands*, *significant valleylands*, *significant* habitat of *endangered species* and *threatened species*, *significant wildlife habitat*, and *significant Areas of Natural and Scientific Interest*, which are important for their environmental and social values as a legacy of the natural landscape of an area. [*PPS*]

Natural heritage system: means a system made up of *natural heritage features and areas*, linked by natural corridors which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. These systems can include lands that have been restored and areas with the potential to be restored to a natural state. [*PPS*]

Negative impacts: means

a. In regard to water, the degradation to the *quality and quantity of water*, *sensitive surface water features* and *sensitive ground water features*, and their related *hydrologic functions*, due to single, multiple or successive *development* or *site alteration* activities;
b. In regard to *fish habitat*, the harmful alteration, disruption or destruction (*HADD*) of *fish habitat*, except where, in conjunction with the appropriate authorities, it has been authorized under the Fisheries Act, using the guiding principle of no net loss of productive capacity; and
c. In regard to other *natural heritage features and areas*, the degradation that threatens the health and integrity of the natural features or *ecological functions* for which an area is identified due to single, multiple or successive *development* or *site alteration* activities. [*PPS*]

OMB: means Ontario Municipal Board.

OP: means Official Plan.

One zone concept: means the approach whereby the entire *flood plain*, as defined by the *Regulatory Flood*, is treated as one unit, and all *development* is prohibited or restricted.

Open arboretum: means a plot of land or facility where trees and shrubs are cultivated for scientific, educational, and/or ornamental purposes and which does not require any closed structures.

Original ground floor area: means the habitable ground floor area of a *building* as existed on October 6, 2005.

Other water-related hazard: means water-associated phenomena other than *flooding hazards* and *wave action* which act on shorelines. This includes, but is not limited to ship-generated waves, ice piling and ice jamming. [*PPS*]

PBWP: means Parkway Belt West Plan.

PPS: means Provincial Policy Statement, 2005, or any amendments, updates, or revisions thereto.

PSW: see Provincially *Significant Wetland*.

Pond: means a body of water usually smaller than a lake, encircled by vegetation, and generally shallow enough for sunlight to reach the bottom. Rooted plants can grow in any spot within the pond creating a habitat for various forms of animal life.

- **In-stream pond (a.k.a. on-line):** a pond that has been constructed by digging out or dredging an area within an existing *watercourse* or by damming a *watercourse*.

Pollution: means any deleterious physical substance or other contaminant that has the potential to be generated by *development* in an area. [O. Reg. 97/04]

Protection works standards: means the combination of non-structural or structural works and allowances for slope stability and flooding/erosion to reduce the damage caused by *flooding hazards*, *erosion hazards* and *other water-related hazards*, and to allow access for their maintenance and repair. [*PPS*]

Provincial and federal requirements: means legislation and policies administer by the federal or provincial governments for the purposed of the protection of *fish* and *fish habitat*, and related, scientifically established standards such as water quality criteria for protecting lake trout populations. [*PPS*]

Quality and quantity of water: is measured by indicators such as minimum base flow, depth to water table, aquifer pressure, oxygen levels, suspended solids, temperature, bacteria, nutrients and hazardous contaminants, and hydrologic regime. [*PPS*]

RAP: means Remedial Action Plan.

Regional Flood: means the rainfall event and soil conditions existing during *Hurricane Hazel*, transposed over a specific *watershed* and combined with local conditions.

Regulatory Flood: means the applicable flood or storm standard utilized to determine the maximum susceptibility to flooding of lands or areas within the *watersheds* in the jurisdiction of the *Authority*. The flood event standards used to define the regulatory flood within the *Authority's* jurisdiction are: *Hurricane Hazel*, the *100 Year Flood*, and the *100 Year Flood Level* plus *wave action* and *other water-related hazards*.

Replacement structure: means the restoration of a *building* or structure to its original form (i.e. same dimensions, square footage and *building* footprint).

River, stream and small inland lake systems: means all *watercourses*, rivers, streams, and small inland lakes or waterbodies that have a measurable or predictable response to a single runoff event. [*PPS*]

SARA: means the Species at Risk Act.

SARO: means Species at Risk in Ontario.

SPA: see *Special Policy Area*.

SWM: means stormwater management.

Sensitive: in regard to *surface water features* and *ground water features*, means areas that are particularly susceptible to impacts from activities or events including, but not limited to, water withdrawals, and additions of pollutants. [*PPS*]

Significant: means

a. In regard to *wetlands*, *coastal wetlands* and *Areas of Natural and Scientific Interest*, and area identified as Provincially Significant by the *MNR* using evaluation procedures established by the Province, as amended from time to time;
b. In regard to the habitat of *endangered species* and *threatened species*, means the habitat, as approved by the *MNR*, that is necessary for the maintenance, survival, and/or the recovery of naturally occurring or reintroduced populations of *endangered species* or *threatened species*, and where those areas of occurrence are occupied or habitually occupied by the species during all or any part(s) of its life cycle;
c. In regard to *woodlands*, an area which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history; and
d. In regard to *valleylands* and *wildlife habitat*, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or *natural heritage system*. [*PPS*]

Sinkhole: means a topographically closed depression, commonly circular or oval in plain view; commonly referred to as dolines. [*MNR*, 2003]

Sinkpoint: means the point where a stream sinks underground into a conduit. [*MNR*, 2003]

Site Alteration: means activities, such grading, excavation and the placement of *fill* that would change the landform and natural vegetative characteristics of a site. [*PPS*]

Special Policy Area (SPA): means an area within a community that has historically existed in the *flood plain* and where site-specific policies, approved by both the Ministers of Natural Resources and Municipal Affairs and Housing, are intended to provide for the continued viability of existing uses (which are generally on a small scale) and address the significant social and economic hardships to the community that would result from strict adherence to provincial policies concerning *development*. The criteria and procedures for approval are established by the Province. A Special Policy Area is not intended to allow for new or intensified *development* and *site alteration*, if a community has viable opportunities for *development* outside the *flood plain*. [*PPS*]

Stable slope allowance: means the setback that ensures safety if slumping or slope failure occur. Refers to the suggested angle of stability for a slope is 3:1 (horizontal: vertical) or approximately 18 degrees. The stable slope allowance is a horizontal allowance measured landward from the *toe of slope* that is relative to the height of the slope. [*MNR*, 2001]

Surface water feature: refers to water-related features on the earth's surface, including headwaters, rivers, stream channels, inland lakes, seepage areas, recharge/discharge areas, springs, *wetlands*, *sinkholes*, and associated riparian lands that can be defined by their soil moisture, soil type, vegetation or topographic characteristics. [*PPS*]

Threatened species: means a wildlife species that is likely to become an *endangered species* if nothing is done to reverse the factors leading to its *extirpation* or *extinction*. These species are listed or categorized as a "Threatened Species" on the Ontario Ministry of Natural Resources' official species at risk list, as updated and amended from time to time. [*PPS* & *EC*]

Toe erosion allowance: means the setback that ensures safety if the toe of the slope adjacent to the river or stream erodes and weakens the bank, increasing the risk of slumping. (*MNR*, 2001)

Toe of slope (a.k.a. base of slope): means the point of the slope where the downward inclination of the land levels off or the upward inclination of the land begins.

Top of slope (a.k.a. crest of slope, top of bank): means the point of the slope where the downward inclination of the land begins or the upward inclination of the land levels off.

Two zone concept: means the approach whereby certain areas of the *flood plain* are considered to be less hazardous than others such that *development* potentially could safely occur. The *flood fringe* defines that portion of the *flood plain* where *development* may be permitted, subject to appropriate *floodproofing*. The *floodway* defines that portion of the *flood plain* wherein *development* is prohibited or restricted. These technical studies need to be approved by the province prior to implementation of the two zone concept.

Unconfined system: means a system wherein the *watercourse* is not located within a valley corridor with discernible slopes, but relatively flat to gently rolling plains and is not confined by valley walls. The *watercourse* can contain perennial, intermittent or ephemeral flows and may range in channel configuration, from seepage and natural springs to detectable channels.

Valley Slope: refers to the area between *top of slope* and *toe of slope*.

Valleylands: means a natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year. [*PPS*]

Vegetation Protective Zone (Buffer): means permanent zones of natural self-sustaining native vegetation that border natural features (e.g. streams, *wetlands*, woodlots, shorelines) and are established to protect natural areas from the impacts of *development* or *site alteration*. The width of the vegetation protection zone is to be of sufficient size to protect the feature and its functions from the impacts of the proposed change and associated activities that will occur before, during and after construction, and where possible, restore or enhance the feature and/or its function. [Greenbelt Plan, 2005]

Vulnerable: means surface and groundwater that can be easily changed or impacted by activities or events, either by virtue of their vicinity to such activities or events or by permissive pathways between such activities and the surface and/or groundwater. [*PPS*]

Watercourse: means an identifiable depression in the ground in which a flow of water regularly or continuously occurs. Where the thermal regime of a watercourse is in question (i.e. whether the watercourse is classified as warmwater, coolwater, or coldwater) the methods of Stoneman, C.L. and Jones, M.L. (1996) will be utilized.

Watershed: means an area that is drained by a river and its tributaries.

Wave action: means the combination of *wave uprush*, *wave setup*, and *wave overtopping*. [*MNR*, 2001]

Wave overtopping: essentially occurs when the height of the natural shoreline, or of the protection work, above the stillwater level is less than the limit of uprush. As a result, waves overtopping the protection work can cause flooding of the onshore and can threaten the structural stability of protection works. [*MNR*, 2001]

Wave setup: means the mean increase in water level caused by the onshore transport of water due to waves breaking at the shoreline. [*MNR*, 2001]

Wave uprush: means the rush of water up onto a shoreline or structure following the breaking of a wave; the limit of wave uprush is the point of furthest landward rush of water onto the shoreline. [*MNR*, 2001]

Wet floodproofing: means *floodproofing* that involves designing a structure using materials, methods and design measures that maintain structural integrity by avoiding external unbalanced forces from acting on *buildings* during and after a flood, to reduce flood damage to contents, and to reduce the cost of post flood clean up. *Buildings* or structures are designed so as to intentionally allow flood waters to enter and exit. These *floodproofing* measures require that the interior space below the level of the *Regulatory Flood* remain unfinished, be non-habitable, and be free of service units and panels. [Flood Plain Planning Policy Statement]

Wetlands: means lands that:

a. Are seasonally or permanently covered by shallow water or has a water table close to or at its surface;
b. Directly contribute to the hydrological function of a *watershed* through connection with a surface *watercourse*;
c. Have hydric soils, the formation of which has been caused by the presence of abundant water; and
d. Have vegetation dominated by hydrophytic plants or water tolerant plants, the dominance of which has been favoured by the presence of abundant water,

But does not include periodically soaked or wet land that is used for agricultural purposes and no longer exhibits a wetland characteristic referred to in clause (c) or (d). The four major types of wetlands are swamps, marshes, bogs and fens. [O. Reg. 97/04]

Wildlife habitat: means areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual or life cycle and areas which are important to migratory or non-migratory species. [*PPS*]

Woodlands: means treed areas that provide environmental, social and economic benefits to both the private landowners and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of *wildlife habitat*, outdoor recreational opportunities, and the sustainable harvest of a wide range of woodland products. Woodlands include treed areas, woodlots or forested areas and vary in their level of significance at the local, regional and provincial levels. [*PPS*]

TAB 8

FPD

FOTHERGILL PLANNING & DEVELOPMENT INC.

62 DAFFODIL CRES. • HAMILTON, ON L9K 1E1 • PHONE: (905) 577-1077 • FAX: (905) 546-0545 • E-MAIL: edf@nas.net

January 23, 2024

Mr. Scott Peck
Deputy CAO/Director, Watershed Management Services
Hamilton Conservation Authority
838 Mineral Springs Rd.
Ancaster, Ontario, L9G 4X1

Dear Mr. Peck:

Re: Application for Development Permit
Maintenance of Heritage Building
820 Sulphur Springs Road – Mr. Anthony Quinn

Please accept this correspondence together with supporting material to allow for the issuance of a Permit to address work already undertaken, which permit is necessary to comply with an Order to Comply issued by the City of Hamilton's Building Department and to allow for repair work to preserve the integrity of a former dwelling unit which has heritage significance and is intended to be used for storage purposes. Some of the work is also needed to meet City of Hamilton Property Standards requirements.

Attached with the application, please find enclosed the following:

1. Completed application form
2. Topographic Plan of entire property.
3. Planning Report dated December, 2023 prepared by Fothergill Planning and Development Inc.
4. Heritage Report dated November 17, 2021 from City of Hamilton.
5. Floodplain Analysis Report dated June 2021 prepared by S. Llewellyn & Associates Ltd.
6. Floodplain Analysis Report dated November 8, 2023, prepared by S. Llewellyn & Associates Ltd.
7. Correspondence from Scott Peck, Hamilton Conservation Authority, dated January 28, 2022 noting that HCA will not be processing permit application.
8. Correspondence from Jim Campbell to Cathy Plosz dated July 17, 2023 with an outline of details for the repairs.

9. Correspondence from Andrew Winters to Cathy Plosz dated July 18, 2023 regarding floodplain line.

10. Correspondence from Andrew Winters to Cathy Plosz dated July 20, 2023, with site plan to illustrate some of the repairs and mitigation measures to be employed during the work .

11. Correspondence from Cathy Plosz to Jim Campbell dated July 20, 2023 noting that NEC approval is required prior to any other planning approvals.

12. Correspondence from Cathy Plosz to Andrew Winters dated July 26, 2023 noting that the owner must either receive a permit from the Niagara Escarpment Commission or clearance that an NEC permit is not required.

13. Notice of Order to Comply from City of Hamilton dated September 6, 2023.

14. Building Permit Application Review Letter from City of Hamilton dated October 19, 2023 noting that approval is required from Hamilton Conservation Authority.

15. Correspondence from Andrej Obradovic dated November 10, 2023, stating that an NEC Permit is not required for the repairs of the building.

16. Correspondence from Mike Stone dated November 15, 2023 noting that the work completed and proposed represents new development, but that HCA is not able to issue a permit(s).

17. Correspondence from Mike Stone dated December 22, 2023 noting that Development Permit required for Building Permit to issue, along with Fee required to be paid.

We enclose the fee of **$9,298.21** as set out in Mr. Stone's correspondence of January 17, 2024. Should there be additional amounts required please advise.

We look forward to the issuance of the permit as soon as possible.

Thank you very much.

Sincerely,

FOTHERGILL PLANNING AND DEVELOPMENT INC.

E.J. Fothergill, MCIP, RPP
President

cc. Anthony Quinn, Michael Colosimo, Alexandra Porco, Jim Campbell, Andrew Winters

PLANNING REPORT

Application for Permit – Hamilton Conservation Authority

Mr. Anthony Quinn
820 Sulphur Springs Road
City of Hamilton

Date: January, 2024

Prepared for: Anthony Quinn

Prepared by: Fothergill Planning and Development Inc.

1.0 Introduction

This application is for repair work that is designed to preserve the integrity of an existing building on the property which has been deemed to have historical significance. The building, which was once a single-family residential dwelling, has been damaged by fire.

2.0 Outline of Repairs

In order to protect the building, certain repair measures are required. Work on the site completed so far includes masonry repairs and a new roof.

Additional repair work that is required to preserve the integrity of the building includes: finishing the roof, eaves, downspouts, waterproofing, siding, replacement of windows doors in existing/original openings (to further secure building in accordance with Property Standards), masonry repair, insulation of foundation and repair of existing stairs leading to the basement, and general clean-up.

Details of the conservation mitigation efforts to be employed while the work is on-going, along with a proposed grading plan and cross section showing proposed excavation were submitted on a site plan presented to the Conservation Authority through an email dated July 20, 2023 from Andrew Winters (see attachment 10). Specifically, the following information was indicated on the site plan:

- location of proposed silt fence
- proposed silt fence example detail
- location of potential, temporary material stockpiles
- note that the weeping tile will drain to daylight via an existing discharge

- proposed grading plan
- cross section and plan showing the proposed excavation around the existing stone building
- topographic information

3.0 Historical Perspective

A Permit to initiate this work was prepared and submitted to the Conservation Authority on January 27, 2022. The Permit also included the construction of a new dwelling unit and improvements to the existing driveway. Upon submission of the application, we were advised on January 28, 2022 that the Conservation Authority is not permitted to issue a permit for the intended work and that this approval process has to proceed by way of an application for a Development Permit from the Niagara Escarpment Commission and subject to that process, the HCA can consider the permit application.

On April 21, 2022, an application was made to the Niagara Escarpment Commission for the construction of a new dwelling, improvements to the existing driveway, and the rehabilitation of the former residential dwelling that had been damaged. That application continues to be reviewed and processed by the Niagara Escarpment Commission.

Correspondence dated November 10, 2023 from the Niagara Escarpment Commission indicated that the repair work that had been completed and contemplated repair work for the building did not meet the definition of "development" within the Niagara Escarpment Plan, and therefore a Niagara Escarpment Permit was not required.

However, correspondence from Mr. Stone dated November 15, 2023 and December 22, 2023 noted that the work completed and proposed for the building represents "development" as defined under the regulations of the Hamilton Conservation Authority.

4.0 Planning Review

These repairs are intended to protect the structural integrity of the building which is compromised by weather. The installation of the window and doors, which will replace the current hoarding, is necessary to secure the building as required by Property Standards. It is imperative that the work to complete the restorative process be completed as quickly as possible. The owner was required to register the property with the City of Hamilton as a vacant building and must pay an annual fee to the City. The City of Hamilton also routinely sends a by-law officer to the City to inspect the building.

The repairs do not result in any enlargement of the footprint or the size of the building. As a result, there is no expansion of the use. As noted in the Heritage Report attached with this application, there is both local and Provincial interest in preserving a structure considered to have heritage value. This application will help to achieve those important public interest objectives.

It is understood that the two major concerns of the mandate of the Hamilton Conservation Authority are to prevent flood hazards and erosion hazards. The proposal does not affect either of these conditions.

The repairs do not create, nor are they subject to, an erosion hazard or affect stable banks.

The building itself is outside of the regulated floodplain area. This is confirmed by the two reports prepared by S. Llewellyn & Associates which delineate the limits of the floodplain. Both reports are included with this submission. Please see Attachments 5 & 6.

While the existing driveway is located within the Regional storm limits, 2 proposals for improvements the driveway have been submitted: 1. To raise the existing driveway; or 2. Re-locate the existing driveway. Both options have been proposed in the context of the NEC Application that has been submitted with respect to the overall development of the site (new home, garage etc).

Outside of these considerations, I am not aware of any policy or regulation that would prevent the issuance of a permit for repair work on the existing building.

We note however that in this instance only temporary access is required for a short period of time to allow for the repairs to be completed. The building and the property will continue to remain vacant.

We look forward to the issuance of the permit as soon as possible.

Respectfully Submitted,

E.J. Fothergill, MCIP, RPP
President

ATTACHMENT 1

Application Form

Hamilton Conservation Authority
A Healthy Watershed for Everyone

P.O. Box 81067
838 Mineral Springs Road
Ancaster, ON L9G 4X1
P: (905) 525-2181
W: https://conservationhamilton.ca/

Darren Kenny, Watershed Officer
Darren.Kenny@conservationhamilton.ca x 131
OR
Elizabeth Reimer, Watershed Officer
EReimer@conservationhamilton.ca x 165

Permit Application Form – Ontario Regulation 161/06 Hamilton Conservation Authority (HCA) Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses

OWNERSHIP DETAILS

(PLEASE PRINT)

Owner's Name: ANTHONY QUINN c/o AQ HOLDINGS

Mailing Address: PO BOX 199 City / Town: MILLGROVE Postal Code L0R 1V0

Phone – Business: ( ) 416-464-6099 Residence: ( ) _____ FAX: ( ) _____

E-Mail AQuinn@BennettGroup.ca

Applicant / Agent Name: ED FOTHERGILL OF FOTHERGILL PLANNING & DEVELOPMENT

Mailing Address: 62 DAFFODIL CRESCENT City / Town: ANCASTER Postal Code L9K 1E1

Phone – Business: ( ) 905-577-1077 Residence: ( ) _____ FAX: ( ) _____

E-Mail edf@nas.net

Note: If the application is prepared by someone other than the landowner, then a Letter of Authorization or a copy of the Offer to Purchase must be submitted with the application. A Landowner Authorization form is attached, if needed.

LOCATION DETAILS

Location of Property

Lot _____ Concession _____ Plan Lot _____ Registered Plan No. _____

Municipal Street Address (if applicable)
820 SULPHUR SPRINGS ROAD

City: HAMILTON Town / Township: _____

Existing Use of Property DAMAGED REMAINS OF FORMER DWELLING Proposed Use of Property STORAGE

Have you confirmed with the City of Hamilton Planning Department that the proper zoning is in place to permit the proposed development? Yes ☑ No ☐

DESCRIPTION OF PROPOSED WORK

☐ Erect a new structure
☐ Place or remove fill material
☐ Alter an existing watercourse or shoreline
☑ OTHER (Please specify) REPAIR WORK
☐ Alter, add to, or remove an existing structure
☐ Construct a pond
☐ Install a septic system

Fee Received _____ Method of Payment _____
P.O.# (Municipal App.) _____

INSTRUCTIONS

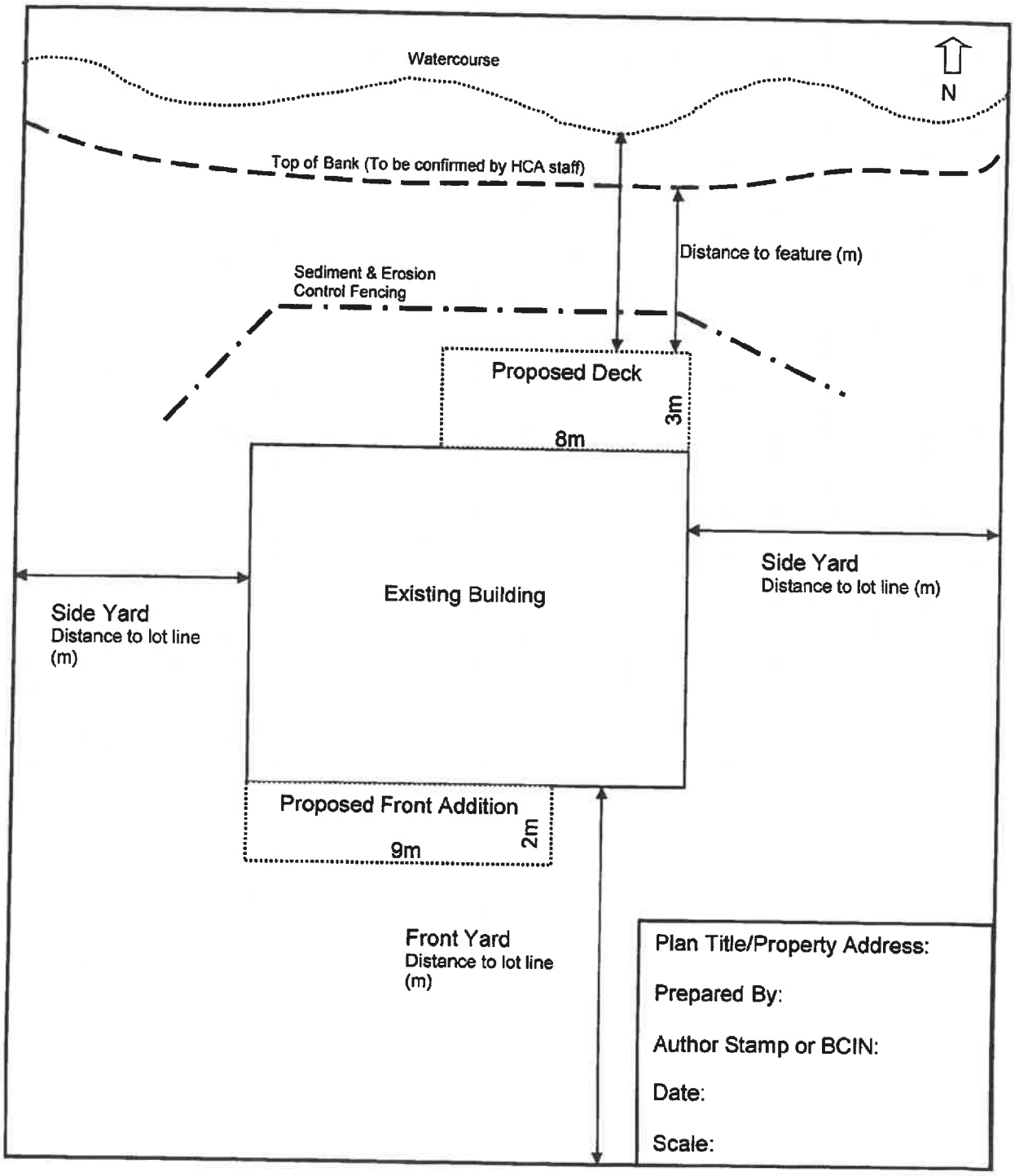
It is highly recommended that the applicant consult with HCA staff prior to submitting a Permit application. Pre-consultation ensures that all required information accompanies the subject application. In the absence of pre-consultation with HCA staff, the following information must be included for an application to be deemed complete:

- Payment of Required Application Fee
- Location Map showing nearest roads/intersections
- Legal Survey of Property (where available)
- Statement of purpose of the project (including proposed start and finish dates)
- 2 sets of folded plan(s)/drawing(s) for initial review (4 copies of final plans) illustrating existing site conditions and proposed development/site alteration including:
    - Date, author and scale
    - Property boundaries
    - Location of natural hazard/heritage features
    - Dimensions and locations of all existing and proposed structures or alterations to structures (including distances to property boundaries and natural features)
        - This includes but is not limited to septic systems, parking lots, exterior site uses and facilities
    - Drainage details before and after development. Should grade changes be required to implement the proposal, dimensions and locations of existing and proposed grades including cross-sections details must be submitted, as well as the signature and stamp of a qualified Professional Engineer. This plan should include type and volume of fill required. This may include proposed landscaping works.
    - Extent of disturbed area, staging of equipment and fill stockpiling locations
    - Location of tree protection fencing (if applicable)
    - Location of erosion and sediment control measures
    - House floor and elevation plans (if applicable). Must include stamp or BCIN.

NOTE: ALL PLANS LARGER THAN 11 X 17 MUST BE FOLDED. ROLLED DRAWINGS WILL NOT BE ACCEPTED

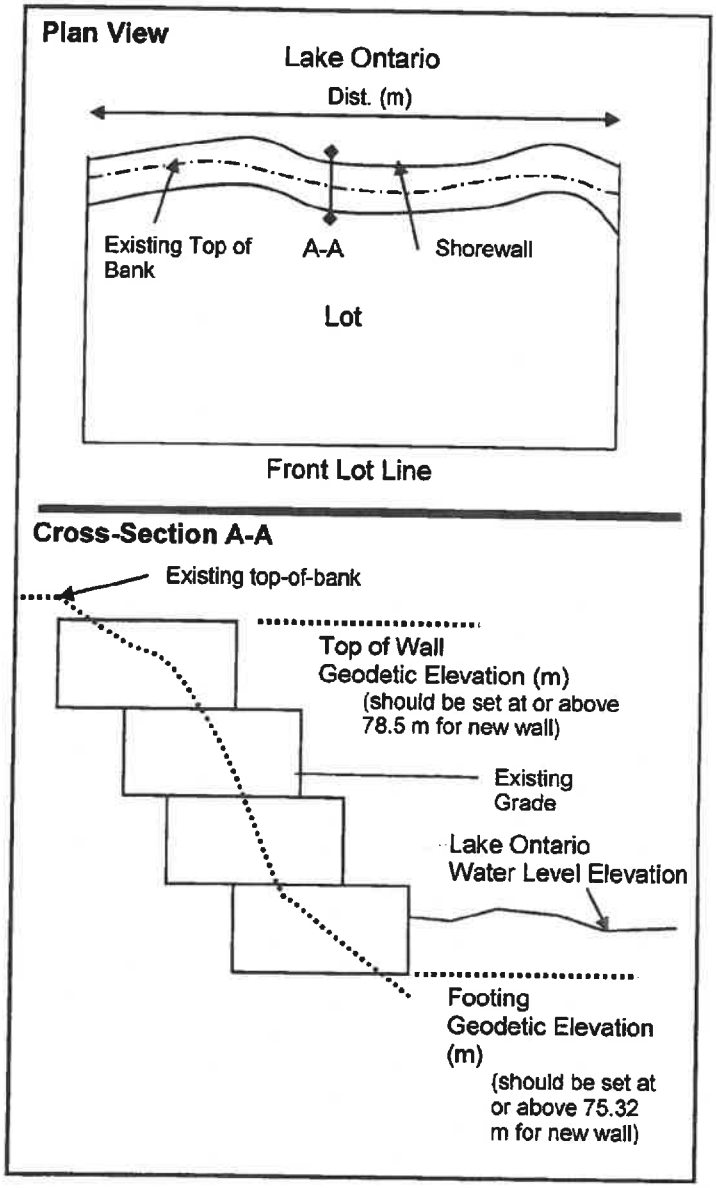
Sample Site Plan

(see INSTRUCTIONS page of Application form or Application Requirements Checklist if provided for details)



Sample Shorewall Site Plan

(see INSTRUCTIONS page of Application form or Application Requirements Checklist if provided for details)



Final Shoreline Wall Plan must include:

- ☐ Both plan view and cross-sectional drawings. Cross-section location should be shown on plan view (A-A).
- ☐ Information on type of wall/repair proposed.
- ☐ Information on how new wall or repair will be tied into existing shoreline protection on adjacent properties.
- ☐ Elevation of the top of the wall, footing and Lake Ontario water level.
- ☐ Weight/size/type of material for new wall or repair.
- ☐ Length of shoreline to be protected.
- ☐ Information on type/amount of backfill if proposed.
- ☐ Location of proposed wall in relation to existing grade and top-of-bank
- ☐ Information on location and size of any additional structures proposed.
- ☐ Drawing scale should be provided

* Note:

All shorewall projects (new and repairs) must be supported by a qualified coastal engineer. Contact the HCA to determine the extent of the supporting information required.

Please provide additional details related to proposed work, describing materials and methods to be used and purpose of project. If you require additional space, please attach a separate page.

SEE ATTACHED MATERIAL.

Proposed Commencement Date of Work: NOW

Proposed Completion Date of Work: LATE 2023

The personal information on this form is collected under the authority of the Conservation Authorities Act, R.S.O. 1990, c27 as amended. The personal information will be used for the purposes of administering Ontario Regulation 161/06 - HCA Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses Regulation. Specifically the information will be used to:

- **Evaluate the development proposal for conformity with HCA and Provincial policies**
- **Liaise with other regulatory agencies having jurisdiction**
- **Report to the HCA Board of Directors for information**

This information will become part of the public record and is available to the general public. Questions about the collection of personal information should be directed to HCA Watershed Officer Darren Kenny (Ext. 131) or by mail at 838 Mineral Springs Road PO Box 81067, Ancaster, ON, L9G 4X1.

I/We ANTHONY QUINN **declare that the information submitted**
(Please Print)
as part of this application is correct to the best of my knowledge and I/we agree to abide by the Ontario Regulation 161/06 - HCA Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses Regulation. I/We acknowledge that this application and supporting documentation will be considered as public documents and available to the public on request. I/We also give permission to the Hamilton Conservation Authority staff to inspect the subject property in conjunction with this application. "I/We acknowledge and agree that any permit issued pursuant to this application may be revoked if it is issued on the basis of false, inaccurate, or misleading information."

Signature: _____ **Date:** January 18, 2024

PERMIT APPLICATION INFORMATION

As required under Ontario Regulation 161/06 - HCA Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses Regulation

Upon receipt of an application, HCA staff will provide notification in writing within 21 days stating whether or not the application is complete. If the application is deemed incomplete, a list of any outstanding information will be provided.

Once the application is deemed complete, HCA staff will complete a detailed review of the application within thirty (30) days for minor applications and ninety (90) days for major applications.

Your submitted application will be assessed to determine whether the proposed works will affect the control of flooding, erosion, pollution, dynamic beach, or the conservation of land in accordance with HCA policies and programs.

If the application conforms to HCA policy and programs, a permit will be issued by Hamilton Conservation Authority staff and may be subject to the fulfillment of specific conditions. Permits issued by the Hamilton Conservation Authority are non-transferable and do not constitute an exemption from obtaining any other agency approvals (i.e. Municipal Offices, Ministry of Natural Resources and Forestry, Niagara Escarpment Commission, etc). Permits are valid for a two (2) year period.

Note: A compliance inspection may be completed by Hamilton Conservation Authority staff up to one year after the expiry of the permit.

If the application does not conform to Authority policy and staff are recommending refusal of the application, the Authority Board of Directors will convene as a Hearing Board to hear the arguments for and against the application. You will be notified as to a hearing date to which you or your agent should attend. Upon hearing the presentations made by Authority staff and the applicant/agent, the Authority Board of Directors will decide to approve or refuse the application.

If the application is refused by the Authority Board of Directors, the applicant will be notified in writing. The applicant, within thirty (30) days of notification, may appeal the decision of the Authority Board of Directors to the Mining and Lands Tribunal who may dismiss or grant the appeal.

LANDOWNER AUTHORIZATION

For Subject Property:

Lot _____, Concession _____] [Plan Lot _____ Registered Plan No. _____

Street Address: 820 SULPHUR SPRINGS ROAD

Municipality: HAMILTON

If this application is to be submitted by a solicitor or agent on behalf of the owner(s), this Landowner Authorization must be completed and signed by the owner(s). If the owner is a Corporation acting without agent or solicitor, the application must be signed by an officer of the Corporation and the Corporation's seal (if any) must be affixed.

NOTE TO THE OWNER(S):

IF THE APPLICATION IS TO BE PREPARED BY A SOLICITOR OR AGENT, AUTHORIZATION SHOULD NOT BE GIVEN UNTIL THE APPLICATION AND ITS ATTACHMENTS HAVE BEEN EXAMINED AND APPROVED BY YOU, THE OWNER(S).

I/WE ANTHONY QUINN

(PRINT FULL NAME OF OWNER(S))

HEREBY AUTHORIZE

ED FOTHERGILL OF FOTHERGILL PLANNING & DEVELOPMENT INC.

(PRINT FULL NAME OF SOLICITOR OR AGENT)

TO SUBMIT THE ENCLOSED APPLICATION TO THE HAMILTON CONSERVATION AUTHORITY (HCA), AND TO APPEAR ON MY BEHALF AT ANY HEARINGS(S) OF THE APPLICATION AND TO PROVIDE ANY INFORMATION OR MATERIAL REQUIRED BY THE HCA RELEVANT TO THE APPLICATION FOR PURPOSES OF OBTAINING A PERMIT FOR DEVELOPMENT, INTERFERENCE WITH WETLANDS, AND ALTERATIONS TO SHORELINES AND WATERCOURSES IN ACCORDANCE WITH THE REQUIREMENTS OF ONTARIO REGULATION 161/06 - HCA DEVELOPMENT, INTERFERENCE WITH WETLANDS, AND ALTERATIONS TO SHORELINES AND WATERCOURSES REGULATION.

DATED AT THE City OF Hamilton,
CITY/TOWN

THIS 18th DAY OF January 20 24

ANTHONY QUINN

(PRINT FULL NAME OF OWNER(S))

SIGNATURE OF OWNER(S)

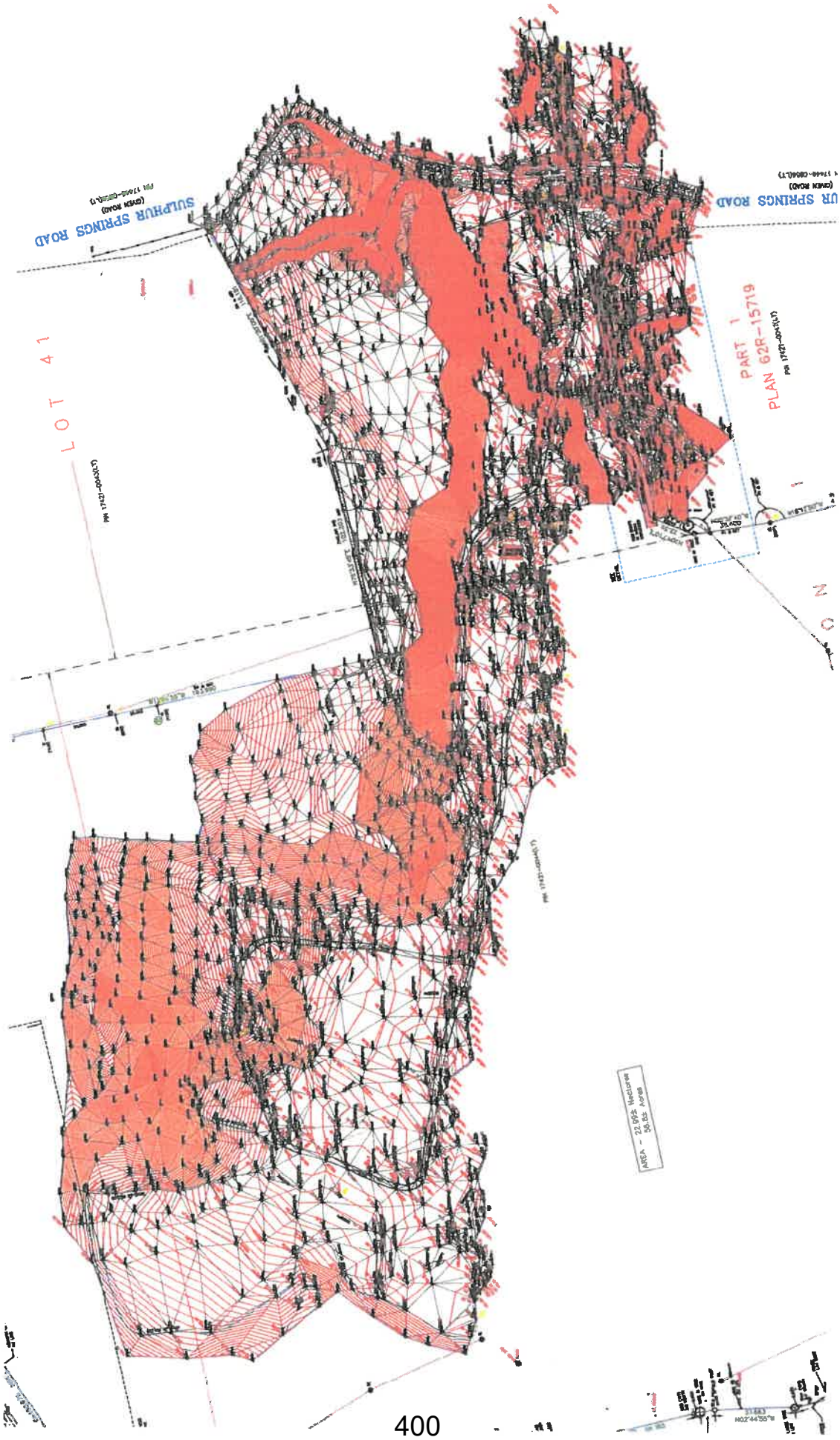
Owner's Mailing Address: PO BOX 199

MILLGROVE, ON L0R 1V0

8

ATTACHMENT 2

Topographic Survey


SULPHUR SPRINGS ROAD
(OWEN ROAD)
SULPHUR SPRINGS ROAD
LOT 41
PART 1
PLAN 62R-15719
AREA - 22.995 Hectares
56.83 Acres

ATTACHMENT 3

Planning Report dated December 2023

PLANNING REPORT

Application for Permit – Hamilton Conservation Authority

Mr. Anthony Quinn
820 Sulphur Springs Road
City of Hamilton

Date: December, 2023

Prepared for: Anthony Quinn

Prepared by: Fothergill Planning and Development Inc.

1.0 Introduction

This application is for repair work that is designed to preserve the integrity of an existing building on the property which has been deemed to have historical significance. The building, which was once a single-family residential dwelling, has been damaged by fire.

2.0 Outline of Repairs

In order to protect the building, certain repair measures are required. Work on the site completed so far includes mason repairs and a new roof.

Additional work that is required to preserve the integrity of the building includes installation of silt fencing along the south side of the activities noted, finishing the roof, eaves, downspouts, waterproofing, siding, windows, doors, mason repair, and installation below grade, repair of existing stairs leading to the basement, and general clean-up.

Details of the repair work were presented to the Conservation Authority through an email dated July 20, 2023 from Andrew Winters.

3.0 Historical Perspective

A Permit to initiate this work was prepared and submitted to the Conservation Authority on January 27, 2022. The Permit also included the construction of a new dwelling unit and improvements to the existing driveway. Upon submission of the application, we were advised on January 28, 2022 that the Conservation Authority is

not permitted to issue a permit for the intended work and that this approval process has to proceed by way of an application for a Development Permit from the Niagara Escarpment Commission and subject to that process, the HCA can consider the permit application.

On April 21, 2022, an application was made to the Niagara Escarpment Commission for the construction of a new dwelling, improvements to the existing driveway, and the rehabilitation of the former residential dwelling that had been damaged. That application continues to be reviewed and processed by the Niagara Escarpment Commission.

Correspondence dated November 10, 2023 from the Niagara Escarpment Commission indicated that the repair work that was being undertaken and contemplated for the building did not meet the definition of development within the Niagara Escarpment Plan, and therefore a Niagara Escarpment Permit was not required.

Correspondence from Mr. Stone dated November 15, 2023, noted that the work completed and proposed for the building represents development under the regulations of the Hamilton Conservation Authority. Because of the location of the building, he noted that HCA is not able to issue a permit(s) for the work completed or proposed.

4.0 Planning Review

The repairs do not result in any enlargement of the footprint or the size of the building. As a result, there is no expansion of the use. As noted in the Heritage Report attached with this application, there is both local and Provincial interest in preserving a structure considered to have heritage value. This application will help to achieve those important public interest objectives.

It is understood that the two major concerns of the mandate of the Hamilton Conservation Authority are to prevent flood hazards and erosion hazards. The proposal does not affect either of these conditions.

The repairs and the building itself is outside of the regulated floodplain area. This is confirmed by the two reports prepared by S. Llewellyn & Associates which delineate the limits of the floodplain. Both reports are included with this submission.

The repairs do not create, nor are they subject to, an erosion hazard or affect stable banks.

Outside of these two considerations, I am not aware of any policy or regulation that would prevent the issuance of a permit for repair work on the existing building, within a confined valley system.

Since the repairs are intended to protect the structure from inclement weather, it is imperative that the work to complete the restorative process be completed as quickly as possible.

We look forward to the issuance of the permit as soon as possible.

Respectfully Submitted,

E.J. Fothergill, MCIP, RPP
President

ATTACHMENT 4

Heritage Report - City of Hamilton

Ed Fothergill

From: Lee, Julian <Julian.Lee@hamilton.ca>
Sent: November 17, 2021 1:41 PM
To: Ed Fothergill
Subject: RE: Heritage Inventory
Attachments: Sulphur Springs Rd_820 (Farewell House).pdf

Hi Ed,

Thanks for your response. 820 Sulphur Springs Road is listed in the City of Hamilton's Inventory of Heritage Buildings and has been identified as having cultural heritage value or interest. I've included some more information below regarding what it means to be on the Inventory.

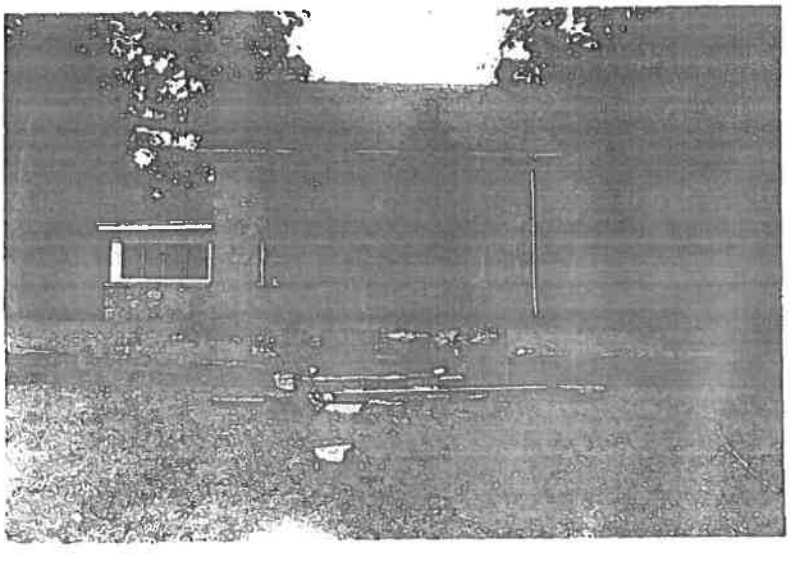
Regarding impacts to properties on the Inventory, while the City encourages the retention and reuse of existing historic structures, there are no legal restrictions or Heritage Permit requirements for inventoried properties. If demolition or redevelopment were to be proposed and any Planning Act applications were required, such as Site Plan, Minor Variance, Severance, etc., there may be a requirement to have a Cultural Heritage Impact Assessment prepared by a qualified Heritage Consultant.

I've also attached a LACAC report from the City's heritage filing that you may find interesting. Please feel free to reach out if you have any further questions.

Thank you,
Julian

Julian Lee
Assistant Cultural Heritage Planner
Development Planning, Heritage and Design
Planning and Economic Development
City of Hamilton
71 Main Street West, 5th Floor
Hamilton, ON L8P 4Y5

THE FAREWELL HOUSE
820 Sulphur Srings Road



L.A.C.A.C '85

FAREWELL

820 Sulphur Springs Rd.

Introduction

The house is located on Lot 40 Concession 1, at 820 Sulphur Springs Rd. The total area of the property consists of 55 acres. Historically, the Farewell's property is significant due to its ties with the Hermitage, located closeby on Mineral Springs Rd. The property is presently being used as a summer home by Mr. Farewell and his wife. The house is surrounded by open space and trees, outlining the property. In addition, the Sulphur Creek cuts through the property. Thus, the property is very picturesque.

History

The deed of the land was issued to David Cummings in 1798 by the King of England; King George III. However, this name was not recorded in the registry land titles as the initial purchaser of the Crown Patent. Conversely, the name Israel Dawdy had been recorded as being the grantee and thus, the person who had purchased the land from the Crown initially. The discrepancy of land holders could have been due to the fact that at this early date the registration of the initial land holder might not have been recorded. In Ancaster's Heritage, the book suggests that some of the first Crown Patents were not registered by the first owners, but rather were registered by a second purchaser who later registered the land from the Crown. Therefore, it can be assumed that Israel Dawdy was the purchaser and thus, responsible for clearing and developing the land. David Cummings, according to 'Ancaster's Heritage' was probably a resident of Upper Canada and was issued a loyalist grant under the second proclamation. Therefore, David Cummings could be considered as an absentee landholder.

In conversation with Mr. Farewell it was said that one of the men convicted of high treason at the trial of the 'Bloody Assize' during the War of 1812 had owned the property. His name was Adam Chrysler. After he was hung, the land was confiscated and given over to the Crown Land by the Commission of Traitor's Estates. This information, however, was never enter in the land titles, probably due to the fact that no traitors were ever entered in land titles.

George Leith was another owner of this property. He was noted for his role in building the Hermitage in 1855. This land is part of the Hermitage Estates encompassing 400 acres of property. The Farewell's property is presently under private ownership and is no longer under the Hermitage Estates. George Leith also was involved in some of the political decisions as a council member of Ancaster Township.

In conclusion, this property is historically valuable due to its connections with the Hermitage Estates and its architectural value.

Architecture

The Farewell house remains somewhat of a mystery concerning the construction date, builder and use, due to the rough use of materials, and the complementary yet contrasting incorporation of styles.

When the house was built, the neighbourhood was agricultural land yet there was one mill on the Sulphur Creek that was never operative. This mill was probably built sometime between 1790 and 1820. The property owner at this time was Isreal Dowdy who was one of the original 15 shareholders in the Union Mill Co. The mill was a frame structure which was used in the 1880's as a warehouse and eventually torn down in 1930. Mr. Dowdy however was not the builder of the present house as he is listed as living elsewhere at this time. There was also another structure on the property according to Mr. Farewell. The remains of walls of small bricks with window openings was found in the grass behind the present house. This earlier structure could have been the home of John Frazer who owned the land from 1848-55. John Frazer or the later owner George Leith are more likely the builders of the present house however, which is styled in stone after the Georgian fashion. Stone was also a favourite building of the Scotch immigrants.

Upper Canada Georgain is based upon symmetry, simple massing and plain classical details with a strong American influence. Other features of this style include the blocky stone massing, end chimneys that are built in the wall and a balanced composition of good porportions. This porportioning included a rectangular facade with steep roof whose ends have a moulded raking cornice and short returning eaves, and built in stone 1½ or 2 storeys high. This house however would be a 'poor man's Georgian' home as the front facade has 3 bays instead of 5 and there is no central hallway. In this sense however it proves a good example of the Ontario vernacular workman's house in stone with a direct and natural use of materials and additive compositions over the

years. These houses were essentially simplified folk expressions of eighteenth century American classical architecture.

The term vernacular implies the common touch; use of common sense by the local artesian in good building practise - originally from Latin meaning 'a native of uncertain origin'.

That the house is 'styled' after the Georgian design is evident however there is no evidence to prove the house was built during 1785-1812 when this style was prevalent. It will be presumed then that the house was built during the Neo-Classic era 1830-60 from which some of the features of the house are taken. This style still incorporates symmetry in design, returned eave, and the vernacular touch like the Georgian style, however there is a greater influx of Classical detailing in this style. The use of a pediment style arch above the door is a classical design yet its use as a doorway embellishment originated in the Georgian period. The double hung 6/6 windows with larger panes are also Neo-Classic.

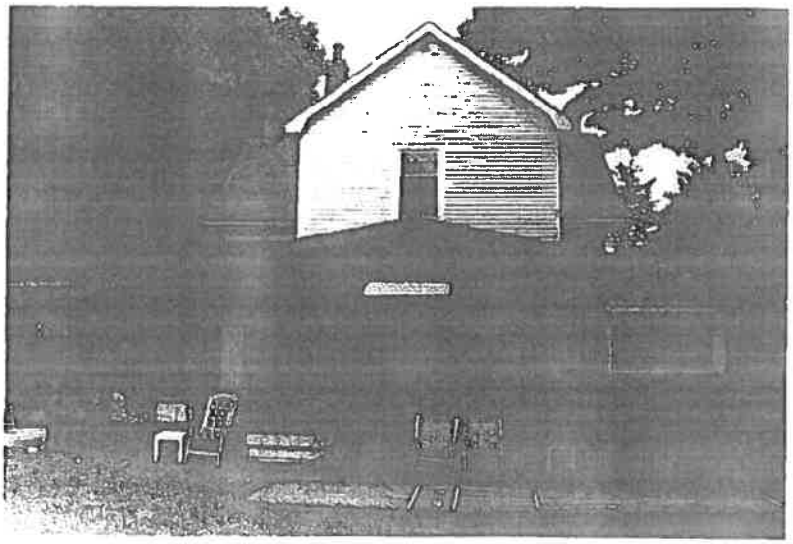
The house is constructed of rough cut stone with thick mortar . The left side of the main facade has the stone laid in coarses whereas the right side of the entrance is uncoarsed. It could be that this side of the house was built by a less skilled craftsman i.e. an apprentice. The framing members were rafters, pegged or nailed in place. Walls of stone are generally 2-3 ft. thick with the mortar in between based on lime. The interior wall is plastered over. There is some evidence of craftsmanship in the rough quoins on the corner edges.

The front (east) facade of the house contains the relatively newer 1/1 double hung windows, although the window openings are quite small. The windows of the south end wall of the main block of the house are 2/2 and like the older 6/6 windows of the north end wall, have a 14" interior window seat beneath them.

The interior plan is quite simple as it is presently with no central hallway yet there is a central hall on the upper floor that is original. Mr. Farewell was not aware of any

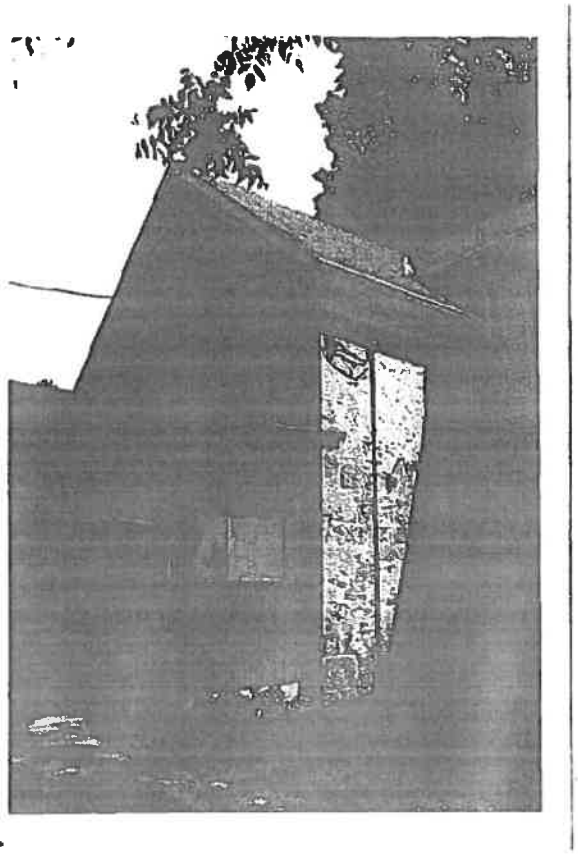
alterations other than the wall removed in the living room; for a central hall plan, 2 walls would have had to have been removed from this area. The main floor plan as it exists reinforces the theory that this was a workman's house and later a butter churning house. The front door opens into the living room which was originally the living room with the kitchen to the left of the front door. In this kitchen was a large stove that heated the house as well as provide cooking facilities. Behind this stove was (and still remains) the stair to the second floor which rises from a small 90 degree turn at the bottom, against the original exterior back wall to the second floor bedrooms. The stairs to the basement are found beneath this stair and is entered from the back of the house. Upstairs the bedrooms are presently two large rooms but was originally divided into four smaller rooms. At the back end of the hall is the addition which contains a bedroom and bathroom which lie above the dining room and kitchen. The floor board are 6-8" wide and of pine.

From the evidence presented it is difficult to date the house, however the most probable date of construction would be between 1830-60 making the builder John Frazer or George Leith. If built by George Leith it was probably the home of his foreman or right hand man who worked to clear the land and farm it.



The Farewell house from the back showing all of the additions about the main house. Note the pair of original chimneys and the fascia & frieze under the eaves.

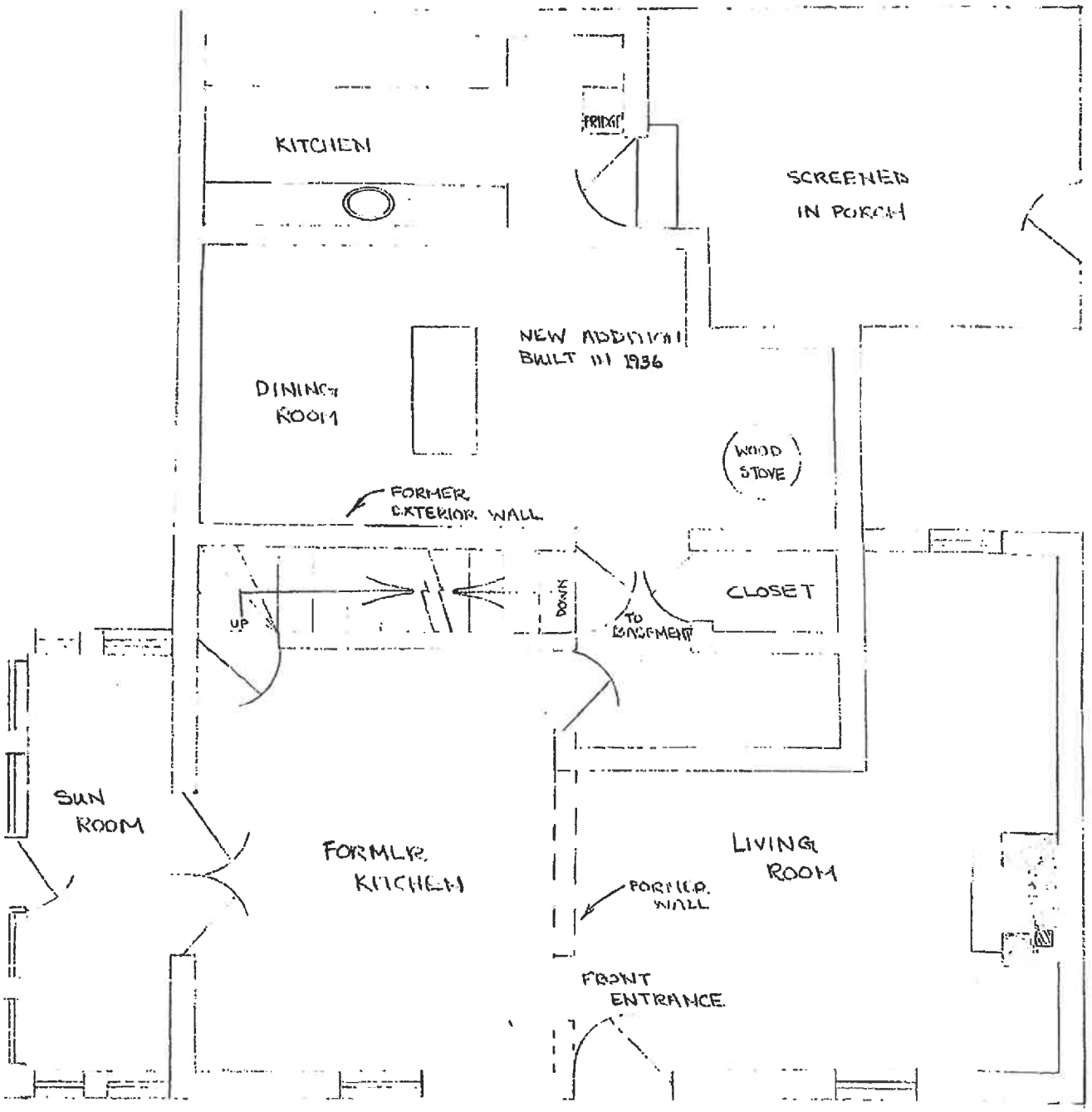
A detail of the supporting bracket of the peaked hood over the front door. Note the plain fascia of this hood which matches the main roof.



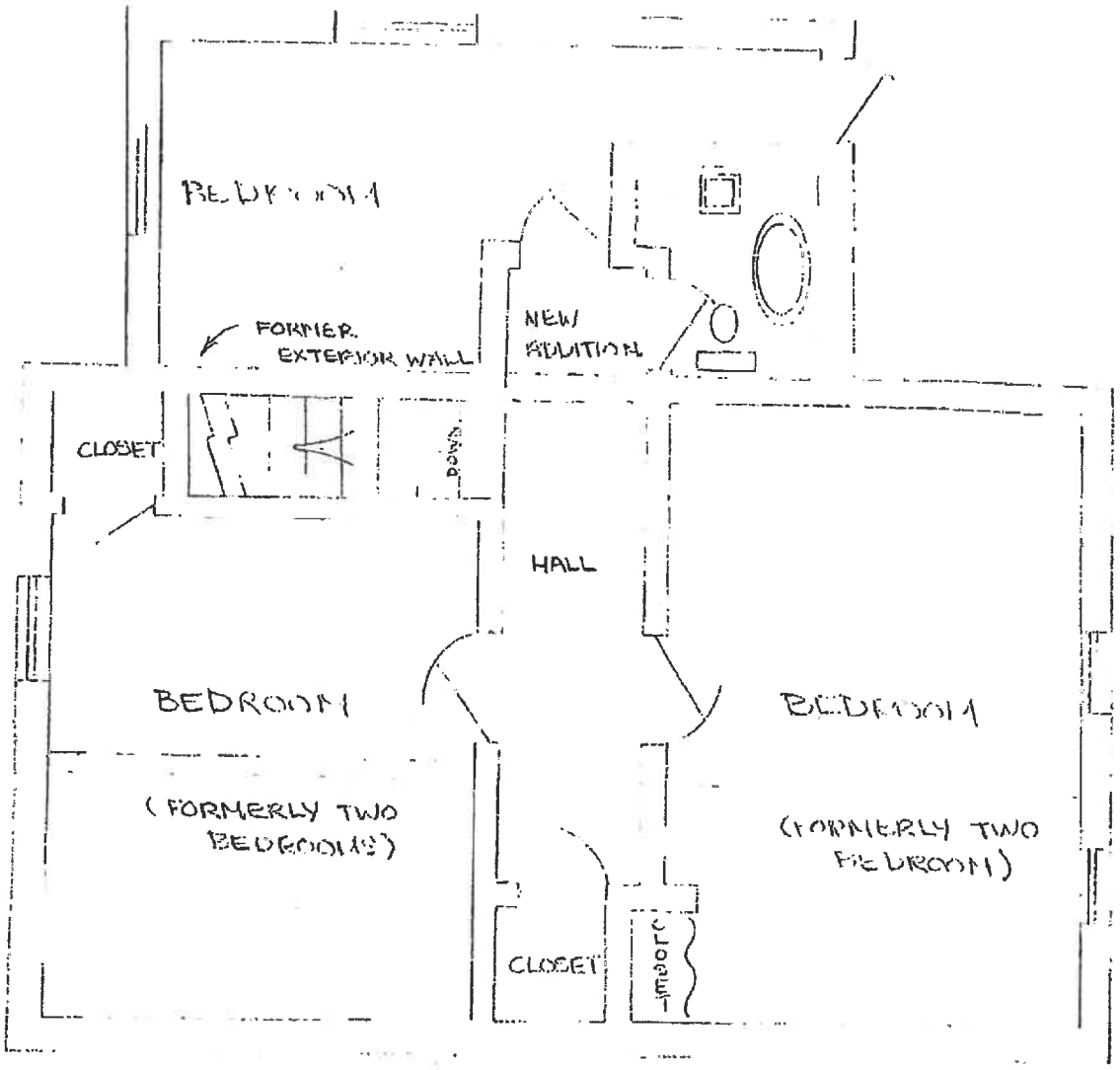
The southeast corner of the house showing the present side garage, second and first storey rear additions. Note the Neo-Classic returned eaves and rough stone voussoirs over the windows. The black line on this end wall suggests an earlier porch.

FAREWELL

MAIN FLOOR

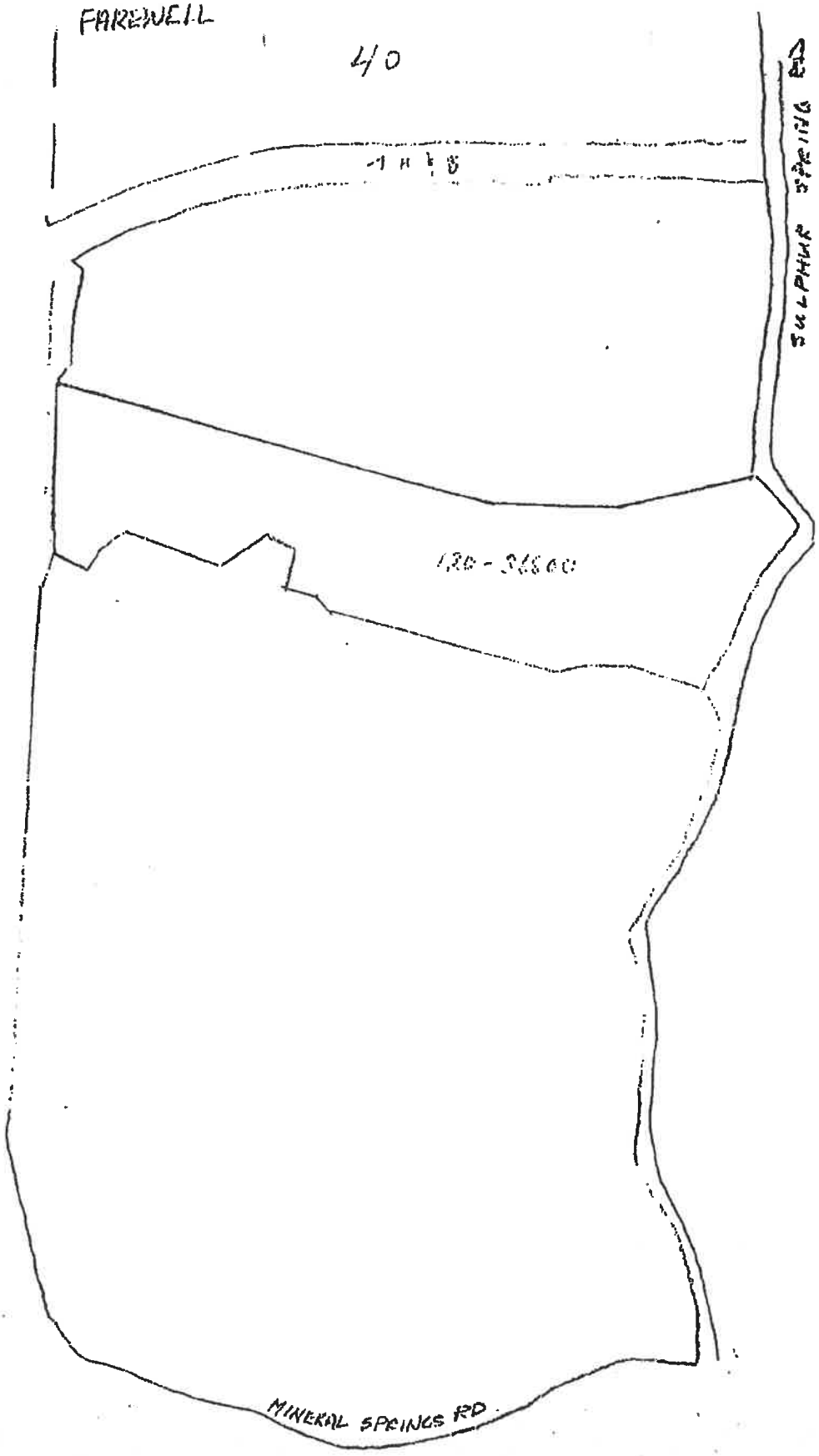


SECOND FLOOR



CON. 1 LOT # 40

Instrument	Date of Instrument	Registration Date	Grantor	Grantee	Consideration	Land & Remarks
B&S			The Crown	Israel Dawdy		W½ of S½ = 50 a
B&S	April 7/1847	Oct. 3/1850	Israel Dawdy	John Sutherland	£ 150	N½ of S½ = 50 a
B&S	July 11/1848	Oct. 3/1850	John Sutherland et al	Anne Frazer, the wife of	£ 200	N½ of S½ = 50 a
				John Stewart Frazer		
B&S	April 28/1854	May 10/1854	John Stewart Frazer	Catharine Urquhart	£ 80	N½ of S½ = 50 a
B&S	April 7/1855	June 19/1855	Donald C. Urquhart	George Leith	£ 500	" " "
B&S	April 11/1871	Nov 29/1871	George Leith	Richard L. Gard	$ 3750	" " "
B&S	July 4/1872	July 5/1872	Richard L. Gard	John Harvey	£ 5000	" " "
Conc/ Grant	June 24/1926	July 23/1926	James H. Woodley Edna M.	James M. Farewell	$5,000	" " "
			Exors of William Woodley			
Grant	Jan. 11/1955	July 18/1962	Eva M. A. Farewell	Madelyn Morris	1.00 val con	Pt. E½ 100 a
			personally & as Extrs. of James			
			M. Farewell M. Morris			
			& M. R. Farewell			
Grant	Aug 11/1966	Aug 31/1966	Madelyn Morris	Marvin R Farewell	1.00 val con	Pt. = 19.08 ac going W= lots 40
						at centre line of week dist 4,072'0
						S. of S.A. Governors Rd then along centre
						of week.


FAREWELL
4/0
SULPHUR SPRINGS RD
120 - 345 ac
MINERAL SPRINGS RD

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Interview with present owner. (see title page)

ATTACHMENT 5

Floodline Analysis Report

June 2021

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Floodline Analysis Report

Private Residence

820 Sulphur Springs Road

City of Hamilton

June 2021

Project# 21031

3228 South Service Road, Suite 105, East Wing, Burlington, Ontario, L7N 3H8
Tel. (905) 631-6978 info@sla.on.ca

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APPENDICES

Appendix A – Background Information ..... Encl.
Appendix B – Existing Conditions HEC-RAS ..... Encl.
Appendix C – Proposed Conditions HEC-RAS ..... Encl.

1.0 INTRODUCTION AND BACKGROUND

1.1 Overview

S. Llewellyn & Associates Limited was retained by the property owner to review the existing floodline elevations within the property with respect to potential ingress/egress issues. The property has an area of approximately 23 ha and is located on the west side of Sulphur Springs Road. Sulphur Creek traverses the south limit of the property draining via an existing box culvert under Sulphur Springs Road (see Figure 1.0 for location plan). The property is largely a vacant lot covered with trees, shrub and some wetland features. A farmhouse was located on the property at the top of the hill, that has since burned down. The proponent proposes to construct a new single-family residence within the property setback from Sulphur Springs road on the high table lands. Access to the future residence and the property in general is via an existing driveway from Sulphur Springs drive that runs parallel to Sulphur Creek. The existing driveway is little more than a worn pathway approximately 2 m to 3 m wide.

The proponent proposes to construct a single-family residence on the north side of the watercourse, in an elevated portion of the property. This will necessitate improvements to the site access to provide safe ingress/egress.

1.2 Background Information

The following sources were consulted in the preparation of this report:

Ref. 1: *City of Hamilton Interactive Mapping Tool - https://map.hamilton.ca/*

Ref. 2: *The Hamilton Conservation Authority – Regulated Areas Map Tool*

Ref. 3: *Spencer Creek Watershed Hydrology Study* (MacLaren Plansearch / Lavalin, January 1990)

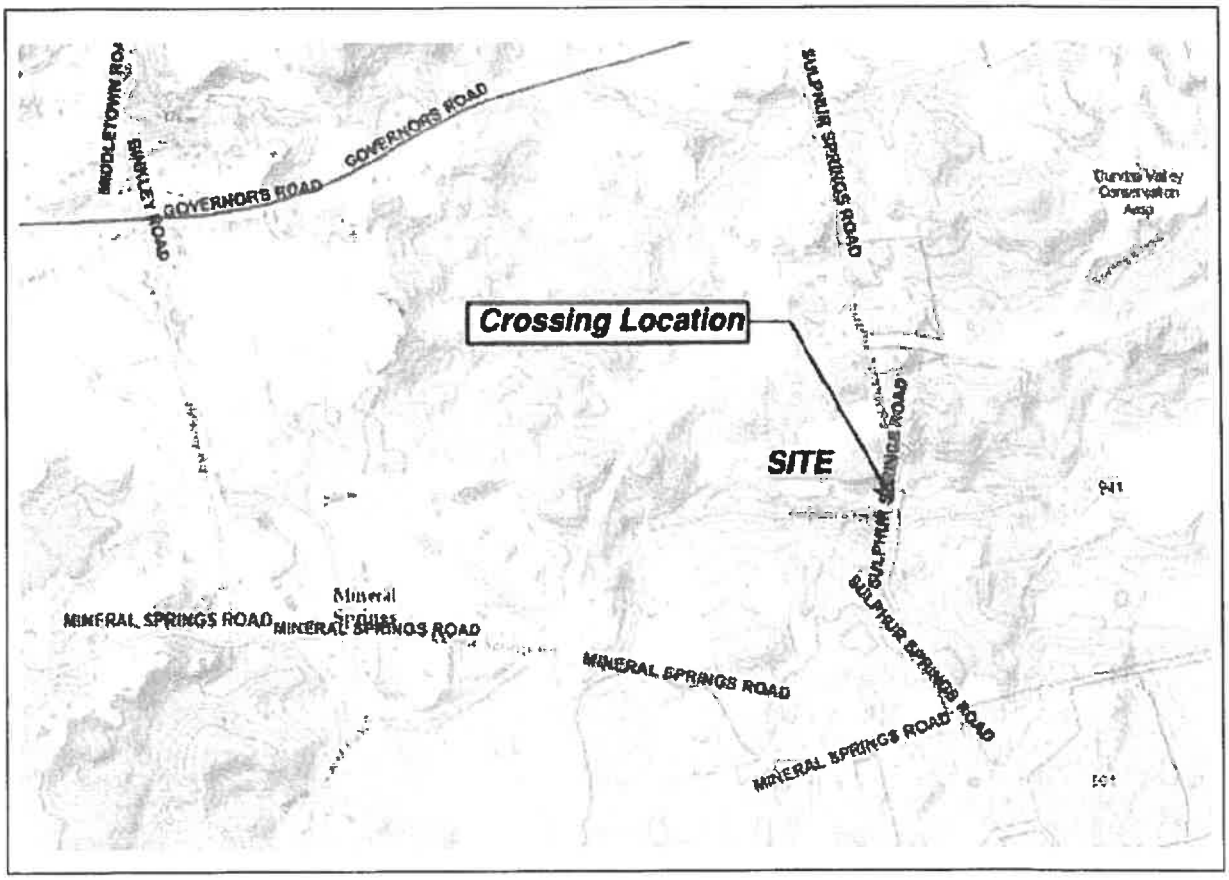


Figure 1.0 – Location Plan

2.0 EXISTING CONDITIONS AND HYDRUALIC MODEL SETUP

2.1 HEC-RAS Modeling Setup and Existing Cross-Section Information

No existing hydraulic modeling was available for the watercourse. A topographical survey was undertaken which included a section of the existing watercourse on the west side of Sulphur Springs Road as well as a section downstream (east) of Sulphur Springs Road. Sixteen (16) existing condition cross-sections (12 upstream of Sulphur Springs Road and 4 downstream) through the watercourse were extracted from the topographic surface model and coded into the U.S. Army Corp. of Engineers HEC-RAS program. See Figure 2.0 for cross-section locations. Figure 2.0 also shows the alignment of the existing access into the site. The existing access is situated at-grade. Sulphur Creek crossing under Sulphur Springs Road via an existing concrete box culvert with dimensions of 12.7mL x 3.8mW x 1.55mH.

2.2 Watercourse Flows

Flows for the HEC-RAS model were extracted from the *Spencer Creek Watershed Hydrology Study* (Ref. 3). Flows generated from catchments 355, 356, 357 and part of 358 drain through the existing watercourse and through the existing culvert crossing. Table 2.1 summarizes the flows applied to the upstream cross-section No. 210.15. Figure 3.0 shows the drainage boundaries for the culvert crossing and Appendix A provides the background flow information from the source document along with a summary worksheet.

Table 2.1 – Flow Rates Applied to HEC-RAS Model

Cross-Section	Development Scenario	Peak Flow (m^3/s)						
		2-Yr	5-Yr	10-Yr	20-Yr	50-Yr	100-Yr	Reg.
210.15	Existing & Proposed	4.61	7.02	8.81	10.36	12.62	14.39	95.14

2.3 Boundary Conditions

No known downstream boundary conditions are available for this watercourse. As such, the downstream boundary condition was set at "Normal Depth" with a slope channel slope of 0.5% within the HEC-RAS model for all storm events.

3.0 PROPOSED CONDITIONS

3.1 Proposed Conditions Cross-Section Information

The proposed conditions model is largely the same as the existing conditions model except for adjustments to account for a proposed driveway elevation above the 100-year water surface. See Section 4.2 for additional details regarding the proposed model.

Watercourse flows and boundary conditions remained unchanged in the proposed conditions model.

4.0 ANALYSIS RESULTS

4.1 Existing Conditions

The existing conditions HEC-RAS analysis results and cross-sections are provided in Appendix B. The analysis results show that there is no overtopping of Sulphur Springs Road for the 2-year to 100-year events (inclusive). However, during the Regional Storm event the depth of flow overtopping the road can be in excess of 1 m. The existing access/path is generally overtopped during all storm events with the exception of the cross-sections located nearest Sulphur Springs Road where the access path is marginally higher than the 2-year to 10-year floodline elevations depending the cross-section. Figure 3.0 shows the extents of the existing conditions 100-year and Regional Storm floodlines.

4.2 Proposed Conditions

As indicated earlier, under existing conditions, the access/path into the site is overtopped by floodwaters for virtually all storm events. In order to provide safe ingress/egress into the development for both the future residents and emergency services, it is proposed to construct a driveway that will be located above the 100-year water surface thereby permitting safe access between the future residence and Sulphur Springs Road during a 100-year storm event. At this time a 6 m wide driveway is proposed which satisfies OBC fire access requirements. An additional 0.5m of either side has also been assumed for gabion baskets or armour stone walls to support the raised driveway; alternatively, slopes can be used to transition back to existing grade.

The proposed driveway is elevation above the existing ground by 0.3 m to 0.9 m from Sulphur Springs Road to where the grade can be matched. Raising the driveway effectively creates a levee parallel to the watercourse that cuts off access to the outside left overbank area for backwater. The top of the proposed road was modelled as a levee to replicate the proposed conditions. The levees are indicated on the cross-sections in Appendix C. To utilize the left overbank area, equalization culverts were added at two locations near the downstream end of the driveway to allow flow across the proposed driveway. The culverts consist of two (2) - 300mm diameter BOSS 2000 HDPE culverts and four (4) – 600mm diameter BOSS 2000 HPDE culverts. See Figure 4.0 for location of culvert crossings.

The most conservative scenario would be to assume that there were no equalization culverts and the left overbank would be limited based on the driveway acting as a levee. This condition (with no equalization pipes) was modeled due to its simplicity. Table 4.1 provides a comparison between the existing conditions model and the proposed conditions model assuming no equalization flow/storage.

The analysis results indicate the following:

- There is no change in the Regional Event floodline elevations between existing and proposed.
- Under proposed condition, an increase in floodline elevations for various storm events occurs at cross-sections 135.33, 120.19 and 105.25. The increase in flood elevation ranges from 0.01 m to 0.17m (1 to 17 cm).
- No increase in flood elevation occurs off the property in the downstream or upstream direction.

Although flood elevations increase under proposed conditions, the cross-sections where they occur are internal cross-sections where they can be easily accommodated by the deep valley form. Moreover, the model results were based on the assumption of no equalization pipes. With the additional of the culverts crossing the driveway, it is expected that the water surface elevation would be reduced to the existing condition levels and volume becomes utilized in the left overbank area.

Table 4.1 - Comparision of Existing & Proposed Water Surface Elevations					
			Existing	Proposed (No equlization)	Difference in Elev.
River Sta	Profile	Q Total	W.S. Elev	W.S. Elev	Proposed - Existing
		(m3/s)	(m)	(m)	(m)
210.15	2-YR	4.61	138.45	138.45	0
210.15	5-YR	7.02	138.58	138.58	0
210.15	10-YR	8.81	138.66	138.66	0
210.15	20-YR	10.36	138.73	138.73	0
210.15	50-YR	12.62	138.81	138.81	0
210.15	100-YR	14.39	138.88	138.88	0
210.15	REG	95.14	140.23	140.23	0
195.21	2-YR	4.61	138.35	138.35	0
195.21	5-YR	7.02	138.48	138.48	0
195.21	10-YR	8.81	138.57	138.57	0
195.21	20-YR	10.36	138.64	138.64	0
195.21	50-YR	12.62	138.72	138.72	0
195.21	100-YR	14.39	138.79	138.79	0
195.21	REG	95.14	140.11	140.11	0
180.39	2-YR	4.61	138.19	138.19	0
180.39	5-YR	7.02	138.33	138.33	0
180.39	10-YR	8.81	138.42	138.42	0
180.39	20-YR	10.36	138.49	138.49	0
180.39	50-YR	12.62	138.58	138.58	0
180.39	100-YR	14.39	138.64	138.64	0
180.39	REG	95.14	139.92	139.92	0
165.22	2-YR	4.61	138.11	138.11	0
165.22	5-YR	7.02	138.25	138.25	0
165.22	10-YR	8.81	138.34	138.34	0
165.22	20-YR	10.36	138.41	138.41	0
165.22	50-YR	12.62	138.5	138.5	0
165.22	100-YR	14.39	138.56	138.56	0
165.22	REG	95.14	139.68	139.68	0
150.13	2-YR	4.61	137.82	137.82	0
150.13	5-YR	7.02	137.95	137.95	0
150.13	10-YR	8.81	138.02	138.02	0
150.13	20-YR	10.36	138.08	138.08	0
150.13	50-YR	12.62	138.15	138.15	0
150.13	100-YR	14.39	138.21	138.21	0
150.13	REG	95.14	139.39	139.39	0
135.33	2-YR	4.61	137.78	137.81	***0.03***
135.33	5-YR	7.02	137.85	137.94	***0.09***
135.33	10-YR	8.81	137.89	138.01	***0.12***
135.33	20-YR	10.36	137.93	138.07	***0.14***
135.33	50-YR	12.62	137.98	138.15	***0.17***
135.33	100-YR	14.39	138.05	138.2	***0.15***
135.33	REG	95.14	139.6	139.6	0
120.19	2-YR	4.61	137.74	137.75	***0.01***
120.19	5-YR	7.02	137.8	137.88	***0.08***
120.19	10-YR	8.81	137.84	137.95	***0.11***
120.19	20-YR	10.36	137.88	138	***0.12***
120.19	50-YR	12.62	137.92	138.08	***0.16***
120.19	100-YR	14.39	138.01	138.12	***0.11***
120.19	REG	95.14	139.59	139.59	0
105.25	2-YR	4.61	137.48	137.47	-0.01
105.25	5-YR	7.02	137.66	137.65	-0.01
105.25	10-YR	8.81	137.69	137.71	***0.02***
105.25	20-YR	10.36	137.71	137.75	***0.04***
105.25	50-YR	12.62	137.82	137.8	-0.02
105.25	100-YR	14.39	137.95	137.92	-0.03
105.25	REG	95.14	139.57	139.57	0
90.05	2-YR	4.61	136.96	136.96	0
90.05	5-YR	7.02	137.2	137.2	0
90.05	10-YR	8.81	137.37	137.37	0

Red indicates proposed elevations greater than existing

Table 4.1 - Comparision of Existing & Proposed Water Surface Elevations					
River Sta	Profile	Q Total (m3/s)	Existing W.S. Elev (m)	Proposed (No equlization) W.S. Elev (m)	Difference in Elev. Proposed - Existing (m)
90.05	20-YR	10.36	137.52	137.52	0
90.05	50-YR	12.62	137.75	137.74	-0.01
90.05	100-YR	14.39	137.91	137.89	-0.02
90.05	REG	95.14	139.54	139.54	0
80.11	2-YR	4.61	136.96	136.96	0
80.11	5-YR	7.02	137.21	137.21	0
80.11	10-YR	8.81	137.38	137.38	0
80.11	20-YR	10.36	137.53	137.53	0
80.11	50-YR	12.62	137.74	137.74	0
80.11	100-YR	14.39	137.9	137.89	-0.01
80.11	REG	95.14	139.52	139.52	0
72.14	2-YR	4.61	136.85	136.85	0
72.14	5-YR	7.02	137.12	137.12	0
72.14	10-YR	8.81	137.31	137.31	0
72.14	20-YR	10.36	137.47	137.47	0
72.14	50-YR	12.62	137.68	137.68	0
72.14	100-YR	14.39	137.85	137.85	0
72.14	REG	95.14	139.48	139.48	0
64.16	2-YR	4.61	136.75	136.75	0
64.16	5-YR	7.02	137	137	0
64.16	10-YR	8.81	137.18	137.18	0
64.16	20-YR	10.36	137.32	137.32	0
64.16	50-YR	12.62	137.52	137.52	0
64.16	100-YR	14.39	137.68	137.68	0
64.16	REG	95.14	139.36	139.36	0
57.5		Culvert			
49.4	2-YR	4.61	136.61	136.61	0
49.4	5-YR	7.02	136.75	136.75	0
49.4	10-YR	8.81	136.83	136.83	0
49.4	20-YR	10.36	136.89	136.89	0
49.4	50-YR	12.62	136.97	136.97	0
49.4	100-YR	14.39	137.01	137.01	0
49.4	REG	95.14	139.03	139.03	0
41.14	2-YR	4.61	136.56	136.56	0
41.14	5-YR	7.02	136.7	136.7	0
41.14	10-YR	8.81	136.79	136.79	0
41.14	20-YR	10.36	136.87	136.87	0
41.14	50-YR	12.62	136.97	136.97	0
41.14	100-YR	14.39	137.03	137.03	0
41.14	REG	95.14	138.19	138.19	0
26.28	2-YR	4.61	136.39	136.39	0
26.28	5-YR	7.02	136.48	136.48	0
26.28	10-YR	8.81	136.53	136.53	0
26.28	20-YR	10.36	136.57	136.57	0
26.28	50-YR	12.62	136.62	136.62	0
26.28	100-YR	14.39	136.68	136.68	0
26.28	REG	95.14	137.81	137.81	0
11.26	2-YR	4.61	136.06	136.06	0
11.26	5-YR	7.02	136.12	136.12	0
11.26	10-YR	8.81	136.16	136.16	0
11.26	20-YR	10.36	136.19	136.19	0
11.26	50-YR	12.62	136.24	136.24	0
11.26	100-YR	14.39	136.27	136.27	0
11.26	REG	95.14	137.14	137.14	0

5.0 CONCLUSIONS AND RECOMMENDATIONS

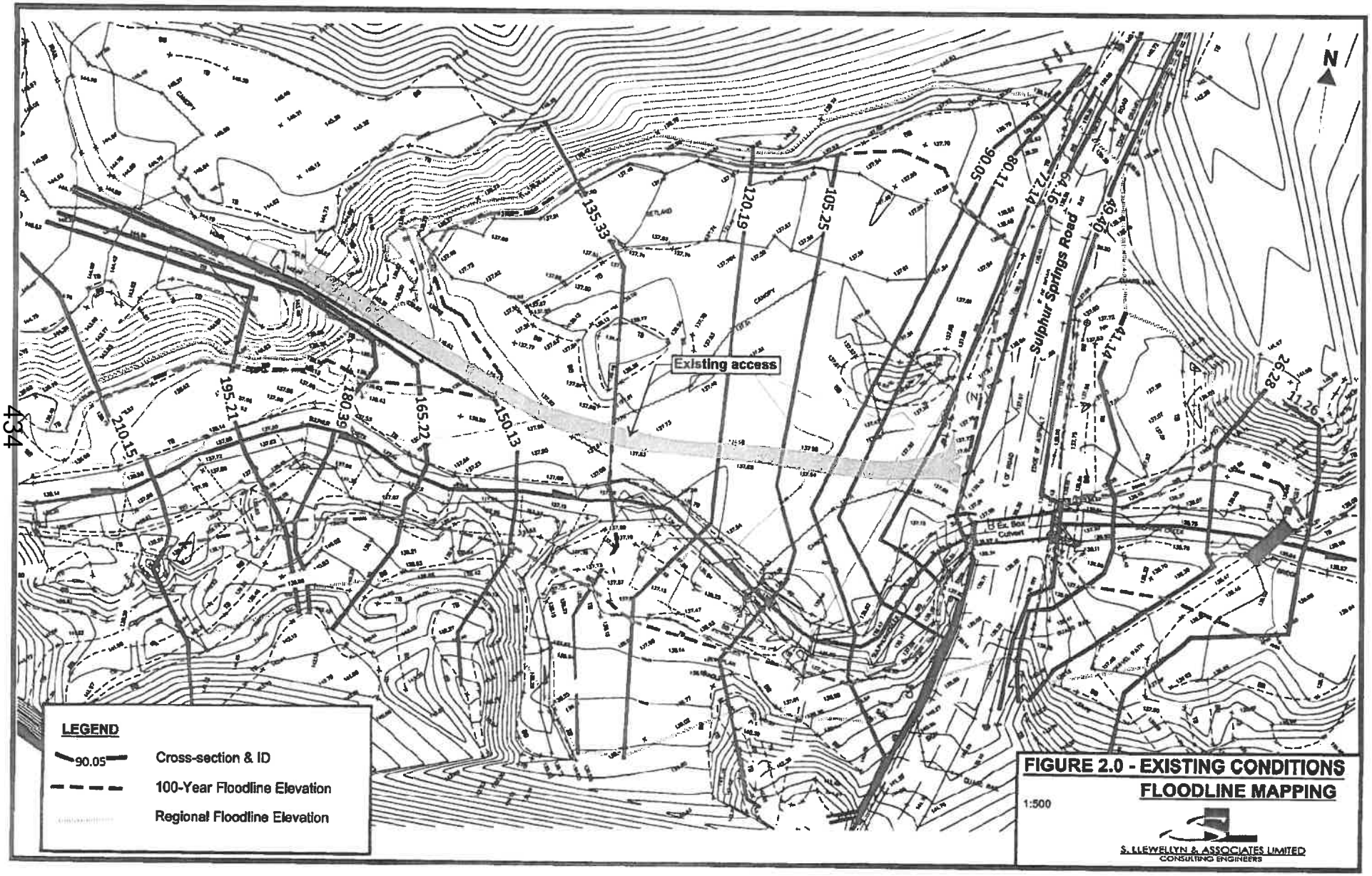
Based on the information provided herein, it is concluded that a proposed driveway can be constructed through the property providing safe ingress and egress during the 100-year storm event without adversely impacting flooding in the area.

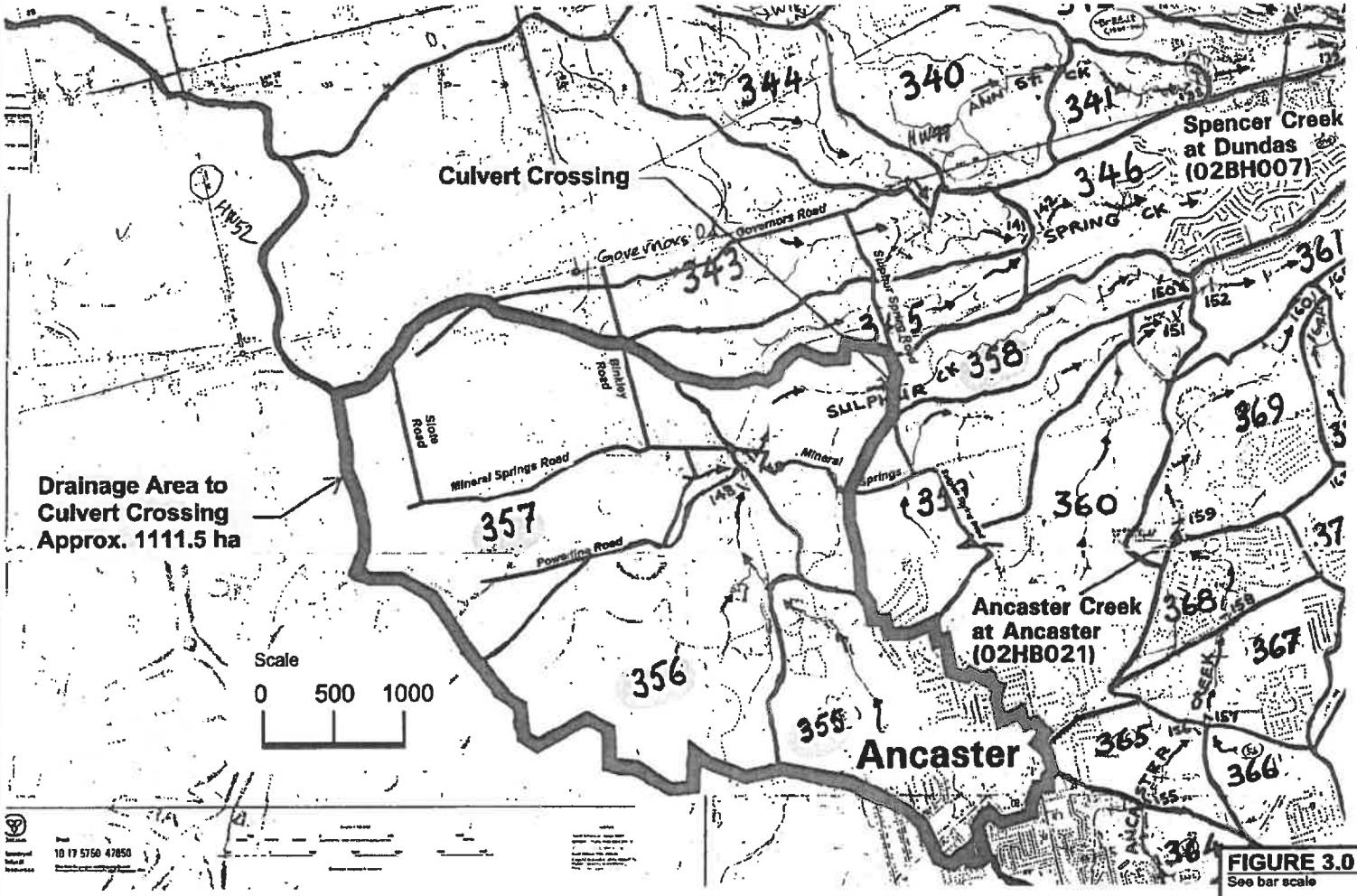
It is recommended that this report be used as the basis for the final construction drawings for the road grading and culvert installation which will include grading, culvert installation details and sediment and erosion control.

We trust the information enclosed is satisfactory. Should you have any questions please do not hesitate to contact our office.

S. Llewellyn & Associates Limited.

John Oreskovic, P. Eng.


N
Existing access
Sulphur Springs Road
135.33
120.19
105.25
90.05
80.11
72.14
64.16
49.40
41.14
26.28
11.26
210.15
195.21
180.39
165.22
150.13
Ex. Box Culvert
LEGEND
90.05 Cross-section & ID
100-Year Floodline Elevation
Regional Floodline Elevation
FIGURE 2.0 - EXISTING CONDITIONS
FLOODLINE MAPPING
1:500
S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS



Source
Spencer Creek/Cootes Paradise Basin Watershed Map

N

FIGURE 3.0 - DRAINAGE AREA
See bar scale

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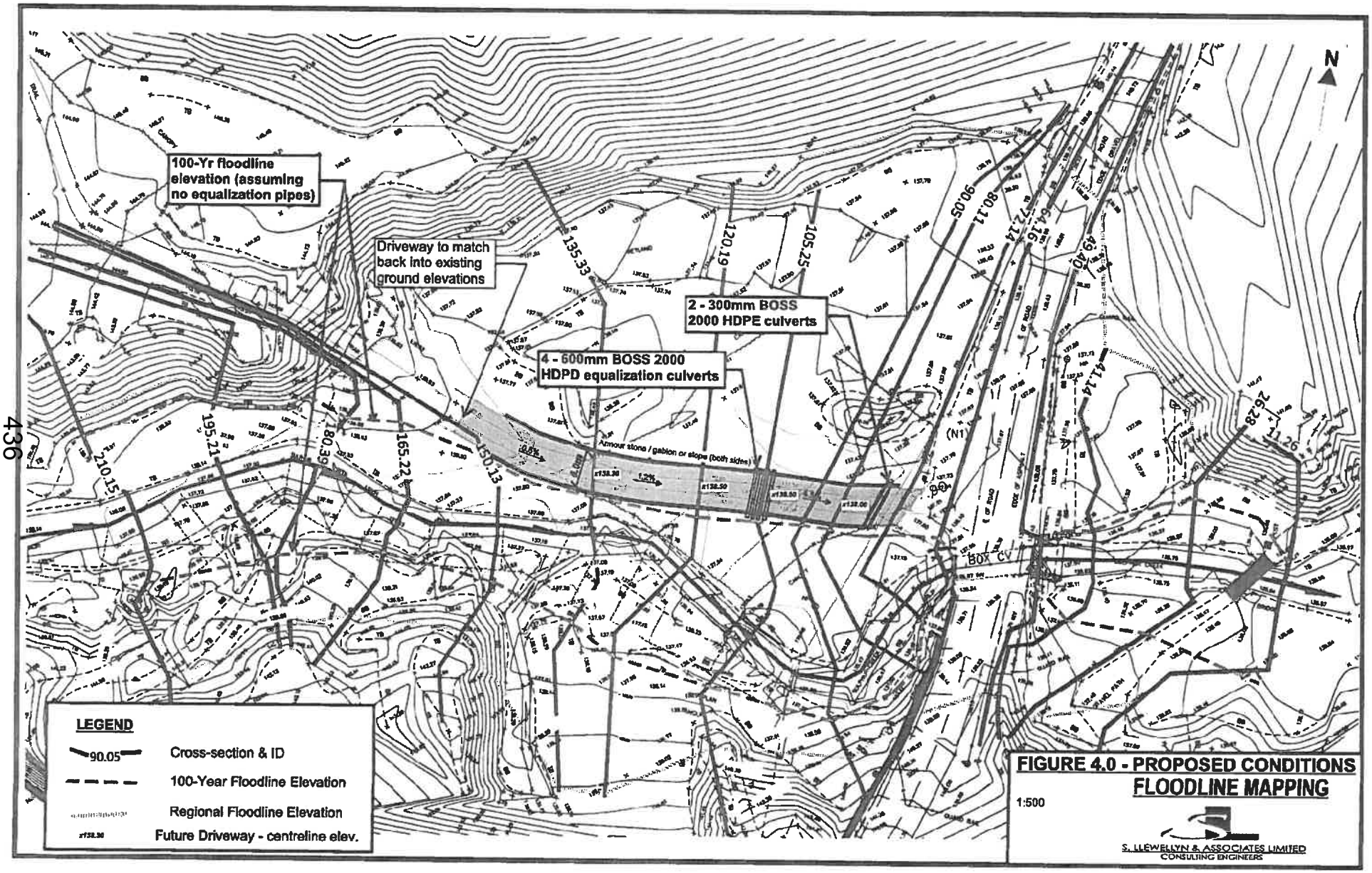
435


100-Yr floodline elevation (assuming no equalization pipes)
Driveway to match back into existing ground elevations
2 - 300mm BOSS 2000 HDPE culverts
4 - 600mm BOSS 2000 HDPD equalization culverts
Armour stone / gabion or slope (both sides)
N
LEGEND
90.05 Cross-section & ID
100-Year Floodline Elevation
Regional Floodline Elevation
Future Driveway - centreline elev.
FIGURE 4.0 - PROPOSED CONDITIONS
FLOODLINE MAPPING
1:500
S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

APPENDIX A

BACKGROUND INFORMATION

Total Flows at Culvert Crossing

Catchment	Area (ha)	2	5	10	20	50	100	Regional
355	232	2.00	2.64	3.02	3.35	3.76	4.05	
356	306	0.92	1.54	2.00	2.48	3.14	3.67	
357	443.5	1.25	2.12	2.76	3.42	4.34	5.08	
358 *	130	0.44	0.72	1.03	1.11	1.38	1.59	
Total -->	**1111.5**	**4.61**	**7.02**	**8.81**	**10.36**	**12.62**	**14.39**	**95.14**

* Subbasin 358 has a total area of 230ha, but only 130ha (56.5%) is upstream of the culvert crossing

Flow extracted from Spencer Creek Watershed Hydrology Study (see Appendices)

For Regional Storm

Regional Flow to node 153 (outlet for catchment 361) = 154.4 cms

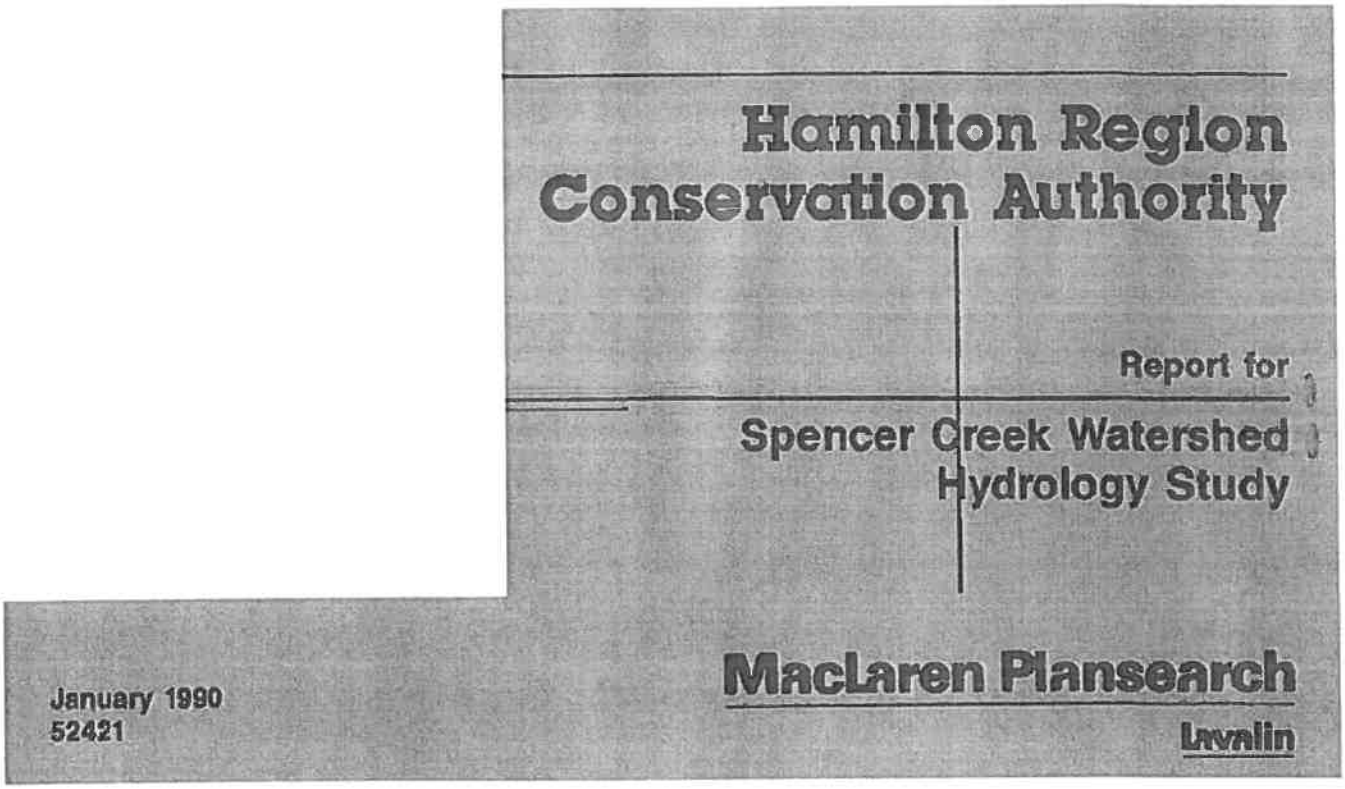
Areas draining to node 153 are:

Catchment	Area (ha)
355	232.0
356	306.0
357	443.5
358	230.0
359	262.5
360	215.7
361	114.0
	1803.7

Area draining to culvert crossing = 1111.5 ha

Regional Flow at culvert crossing = (1111.5 / 1803.7) x 154.4cms = **95.14 cms**

Selected information from:



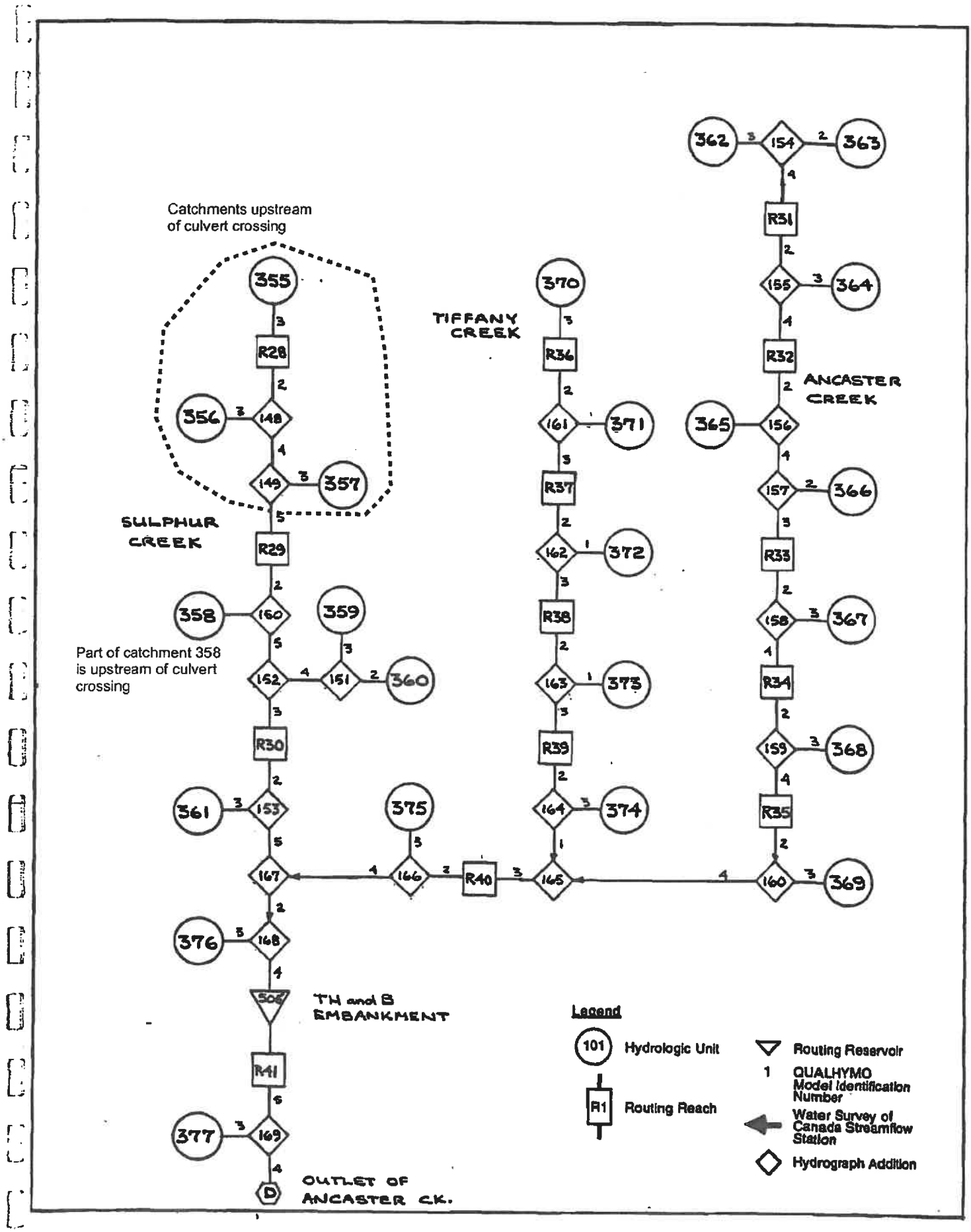

Catchments upstream of culvert crossing
355
R28
356
148
149
357
SULPHUR CREEK
R29
358
160
359
Part of catchment 358 is upstream of culvert crossing
152
151
360
R30
361
153
375
167
166
R40
376
168
506
TH and B EMBANKMENT
R41
377
169
OUTLET OF ANCASTER CK.
TIFFANY CREEK
370
R36
161
371
R37
162
372
R38
163
373
R39
164
374
165
362
154
363
R31
155
364
R32
ANCASTER CREEK
365
156
R33
157
366
R34
158
367
R35
159
368
160
369
Legend
101 Hydrologic Unit
R1 Routing Reach
Routing Reservoir
1 QUALHYMO Model Identification Number
Water Survey of Canada Streamflow Station
Hydrograph Addition

Table 3-3(a) (cont'd) (Future Conditions) Pg 2 of 3

Sub-Basin No.	Area (ha)	Imp. Area (ha)	Imp. Area %	Perv. Area (ha)	Weighted CN (AMC II)
326	410.0	-	-	410.0	67.4
327	177.4	-	-	177.4	79.3
328	374.9	-	-	374.9	70.4
329	199.7	8.2	4.11	191.5	71.9
330	925.9	1.0	0.11	924.9	69.0
331	486.2	4.7	0.97	481.5	65.0
332	434.3	97.3	22.40	337.0	77.4
333	92.8	25.2	27.16	67.6	86.3
334	122.5	46.3	37.80	76.2	90.0
335	234.9	-	-	234.9	68.3
336	860.3	55.3	6.42	673.5	73.2
337	53.3	-	-	53.3	73.9
338	129.0	47.4	36.74	81.6	87.1
339	84.2	25.7	30.52	62.3	87.5
340	236.5	50.2	21.22	207.3	82.0
341	57.8	38.7	66.96	56.1	94.7
342	100.4	77.4	77.09	78.5	96.3
343	739.6	12.8	1.73	727.6	70.2
344	164.5	12.0	7.29	160.3	75.4
345	115.2	-	-	115.2	70.3
346	293.5	77.4	26.37	218.2	87.6
347	357.0	-	-	357.0	74.5
348	107.5	44.8	41.70	66.1	84.1
349	696.0	20.2	2.90	675.8	68.2
350	202.8	73.1	36.04	168.4	87.4
351	516.5	106.1	20.54	508.0	82.7
352	217.9	10.9	5.00	207.0	78.6
353	136.2	2.4	1.76	133.8	70.8
354	250.5	23.80	9.50	228.7	71.8
355	232.0	56.0	24.10	182.5	75.4
356	306.0	-	-	306.0	63.4
357	443.5	1.2	0.27	442.3	64.7

All basins located upstream of culvert crossing

Note: only approx. 130ha (56.5%) of basin 358 is located upstream of the culvert crossing

Table 3-3(a) (cont'd) (Future Conditions)

Sub-Basin No.	Area (ha)	Imp. Area (ha)	Imp. Area %	Perv. Area (ha)	Weighted CN (AMC II)
358	230.0	2.7	1.17	227.3	66.1
359	262.5	75.6	28.80	262.5	82.1
360	215.7	16.4	7.603	201.3	73.2
361	114.0	16.2	14.21	97.8	77.5
362	243.3	5.3	2.18	238.0	64.6
363	113.5	8.7	7.67	104.8	68.2
364	151.5	52.4	34.59	107.7	82.7
365	73.5	6.2	8.44	67.3	77.5
366	71.0	16.7	23.52	59.3	80.9
367	106.0	35.2	33.21	106.0	85.5
368	77.5	33.2	42.84	44.3	89.6
369	145.0	31.2	21.52	120.2	78.7
370	434.5	79.6	18.32	413.5	78.1
371	212.0	93.8	44.24	209.4	88.3
372	124.0	60.1	48.47	124.0	88.8
373	117.0	33.4	28.55	85.8	83.1
374	21.5	3.3	15.35	18.2	96.5
375	130.0	5.2	4.00	124.8	68.8
376	196.0	28.8	14.69	172.0	81.4
377	115.5	29.4	25.46	86.1	80.7
378	83.5	14.8	17.73	68.7	88.7
379	266.6	49.4	18.53	217.2	82.1
380	208.5	-	-	208.5	57.6
381	359.0	25.6	7.13	333.4	72.1
382	408.0	396.8	47.25	173.2	99.7
383	194.5	93.3	47.97	101.2	92.6
384	132.5	57.4	43.32	75.1	92.6
385	569.0	143.4	25.20	444.4	88.9
386	365.8	138.3	37.81	227.5	90.7
387	738.5	318.0	43.06	420.5	91.2
388	170.0	62.5	36.77	108.0	91.8
389	551.5	230.2	41.74	321.3	92.4

Table 3-13

SPENCER CREEK - FUTURE LAND USE CONDITIONS *

FLOOD FREQUENCY RESULTS FOR MAIN BRANCH
OF SPENCER CREEK - SELECTED LOCATIONS

Instantaneous Flood Flow for Various Return Periods (m^3/s)

Location	Description	1 in 2	1 in 5	1 in 10	1 in 20	1 in 50	1 in 100 Year
Spencer Creek Main Branch							
501	outlet of Valens Dam	1.37	1.97	2.31	2.63	3.00	3.27
502	outlet of Beverly Swamp	4.01	5.46	6.69	8.06	10.10	11.90
126	below W. Spencer Creek	16.70	22.00	25.60	29.10	33.70	37.30
129	inflow to Christie Dam	19.70	26.30	30.20	33.80	38.20	41.30
135	upstream CNR Embankment	23.60	31.80	36.90	41.60	47.60	52.00
146	below Spring Creek conf.	31.90	45.60	55.30	65.00	78.20	88.50
170	below Ancaster Creek	49.30	70.90	83.30	94.30	107.00	116.00
187	inflow at RBG	87.60	123.00	145.00	165.00	191.00	209.00
Spencer Creek Tributaries							
133	outlet of Logies Creek	2.90	4.06	4.91	5.76	6.94	7.88
139	outlet Ann Street Creek	4.06	5.65	7.26	9.52	14.00	19.00
143	outlet of Spring Creek	5.25	9.65	13.30	17.30	23.30	28.40
145	outlet of Sydenham Creek	2.11	3.77	5.10	6.54	8.54	10.40
153	outlet of Sulphur Creek	7.35	10.60	13.10	16.00	20.10	23.60
164	outlet of Tiffany Creek	5.22	9.66	13.60	18.20	25.30	31.70
169	outlet of Ancaster Creek	18.80	29.00	36.90	45.10	56.30	65.20
176	outlet of Borer's Creek	7.51	14.00	19.40	25.40	34.40	42.10
184	outlet of Chedoke Creek	25.20	41.10	50.20	57.40	64.50	68.60

* future land use without regulation by Christie Dam, TH&B and CNR embankments.
Please refer to Technical Appendix for more detailed values of discharge.

TABLE 3-14

HURRICANE HAZEL FLOOD FLOW SUMMARY

Hydrograph Unit, Area or Addition[1]		Description	Hurricane Hazel Flow[2] Present (m^3/s)
Spencer Creek Main Branch			
Rt.	501	outlet of Valens Dam	34.5
Rt.	502	outlet of Beverly Swamp	112.0
Add	126	confluence with W. Spencer Ck	305.3
Add	129	inflow to Christie Dam	344.2
Add	135	upstream of CNR Embankment	387.3
Add	146	confluence with Spring Creek	439.3
Add	170	just below Ancaster Creek Conf.	620.7
Add	187	total inflow at RBG/Cootes	878.8
Spencer Creek Tributaries			
Add	133	outlet of Area 336/Logies Creek	58.4
Add	139	outlet of Area 342/Ann St. Creek	36.6
Add	143	outlet of Spring Creek	83.2
Add	145	outlet of Area 348/Sydenham Creek	28.0
Add	153	outlet of Area 361/Sulphur Creek	154.4
Add	164	outlet of Area 374/Tiffany Creek	45.4
Add	169	outflow of Ancaster Ck. at Spencer confluence	283.3
Add	176	outlet of Borer's Creek	101.7
Add	184	Coronation Park/Chedoke Creek	201.0

1 Refer to foldout map (PLATE 1) for location references

2 Flood flows excluding Christie Dam, TH&B and CNR embankments

RETURN PERIOD DESIGN FLOWS (FATMAB) DISTRIBUTION

FLOW POINT	2	5	10	20	50	100		C.S.	C.K.
331	1.09	1.49	1.96	2.68	4.28	6.27	wakeby	0.511	7.140
332	3.32	4.06	4.91	6.15	8.72	11.70	wakeby	0.528	6.965
333	0.93	1.01	1.19	1.36	1.57	1.72	3pln	-0.036	3.163
334	1.47	1.91	2.18	2.42	2.71	2.92	3pln	0.014	3.270
335	0.58	0.84	1.03	1.24	1.54	1.79	3pln	-0.020	3.230
336	2.33	3.17	3.96	4.91	6.50	7.99	wakeby	0.187	4.999
337	0.28	0.50	0.61	0.69	0.76	0.80	wakeby	-0.153	2.574
338	1.53	2.00	2.28	2.53	2.83	3.05	3pln	0.012	3.223
339	0.97	1.36	1.71	2.27	3.52	5.12	wakeby	-0.196	5.373
340	1.77	2.85	3.65	4.49	5.67	6.62	3pln	0.062	4.278
341	0.79	1.38	1.82	2.29	2.95	3.49	3pln	0.048	4.410
342	1.59	2.30	3.07	3.97	5.89	8.03	wakeby	0.119	4.818
343	2.80	4.64	6.27	7.97	10.40	12.30	3pln	-0.021	3.239
344	0.83	1.48	1.98	2.49	3.21	3.80	3pln	0.001	3.591
345	0.56	0.99	1.29	1.60	2.01	2.33	3pln	-0.120	2.979
346	2.29	3.33	4.36	5.69	8.02	10.40	wakeby	0.090	4.455
347	1.27	2.35	3.22	4.17	5.56	6.73	3pln	-0.047	3.650
348	1.21	1.69	2.20	2.97	4.68	6.79	wakeby	0.259	5.775
349	2.00	3.61	4.86	6.18	8.06	9.61	3pln	-0.017	3.816
350	1.81	2.59	3.50	4.85	7.71	11.10	wakeby	0.432	6.503
351	2.74	4.03	5.45	7.56	12.00	17.20	wakeby	-0.237	5.399
352	0.92	1.69	2.28	2.91	3.81	4.55	3pln	-0.026	3.834
353	0.75	1.13	1.51	2.10	3.38	4.44	wakeby	0.255	5.100
354	1.12	2.18	3.06	4.03	5.49	6.75	3pln	0.063	4.435
355	2.00	2.64	3.02	3.35	3.76	4.05	3pln	-0.009	3.547
356	0.92	1.54	2.00	2.48	3.14	3.67	3pln	-0.092	3.123
357	1.25	2.12	2.76	3.42	4.34	5.08	3pln	-0.099	3.116
358	0.78	1.28	1.62	1.97	2.44	2.81	3pln	-0.050	3.312
359	2.09	2.85	3.32	3.76	4.30	4.71	3pln	-0.091	2.575
360	0.95	1.46	1.81	2.14	2.59	2.93	3pln	0.020	3.788
361	0.95	1.27	1.47	1.66	1.90	2.07	3pln	0.009	3.952
362	0.69	1.30	1.72	2.13	2.67	3.07	wakeby	-0.219	2.683
363	0.44	0.87	1.13	1.35	1.58	1.73	wakeby	-0.398	2.443
364	1.18	2.22	3.12	4.13	5.67	7.00	wakeby	-0.051	3.476
365	0.36	0.75	0.98	1.16	1.35	1.46	wakeby	-0.495	2.477
366	0.55	0.98	1.32	1.69	2.22	2.66	wakeby	-0.055	3.410
367	0.74	1.45	2.10	2.86	4.08	5.17	3pln	-0.077	3.445
368	0.80	1.48	2.08	2.76	3.82	4.76	3pln	-0.038	3.534
369	1.07	1.91	2.64	3.47	4.73	5.83	3pln	-0.041	3.463
370	1.72	3.38	4.96	6.89	10.60	12.90	3pln	-0.115	3.254
371	1.61	2.39	5.17	7.41	11.20	14.80	3pln	-0.162	3.235
372	1.05	2.13	3.16	4.41	6.47	8.38	3pln	-0.106	3.371
373	0.96	1.71	2.35	3.07	4.17	5.11	3pln	-0.055	3.401
374	0.33	0.62	0.87	1.14	1.55	1.91	3pln	-0.081	3.369
375	0.48	1.03	1.48	1.94	2.60	3.15	wakeby	-0.423	2.775
376	1.35	2.47	3.46	4.61	6.40	7.99	3pln	-0.038	3.556
377	0.87	1.50	2.02	2.59	3.44	4.17	3pln	-0.039	3.469
378	0.74	1.25	1.65	2.07	2.69	3.19	3pln	0.105	4.761
379	1.73	3.14	4.42	5.90	8.24	10.30	3pln	-0.126	3.238
380	0.73	1.41	1.97	2.57	3.47	4.23	3pln	-0.100	3.529
381	1.44	2.91	4.16	5.57	7.70	9.36	3pln	-0.010	4.034
382	7.62	12.80	16.80	20.90	26.70	31.40	3pln	-0.129	2.916
383	2.28	3.56	4.45	5.34	6.54	7.47	3pln	-0.166	2.495
384	1.59	2.51	3.01	3.38	3.74	3.94	wakeby	-0.141	2.490

RETURN PERIOD DESIGN FLOWS DISTRIBUTION

FLOW POINT	2	5	10	20	50	100		C.S.	C.K.
385	5.07	8.44	10.40	12.00	13.60	14.50	wakeby	-0.305	2.345
386	3.91	6.32	7.63	8.62	9.57	10.10	wakeby	-0.226	2.307
387	7.55	12.40	15.30	17.60	20.00	21.40	wakeby	-0.223	2.482
388	2.05	3.24	3.86	4.31	4.73	4.94	wakeby	-0.147	2.348
389	5.99	9.69	12.10	13.80	15.50	16.50	wakeby	-0.250	2.369
501	1.37	1.97	2.31	2.63	3.00	3.27	3pln	0.030	3.541
502	4.01	5.46	6.69	8.06	10.10	11.90	3pln	0.050	3.523
506	53.60	75.80	88.50	99.60	113.00	122.00	3pln	-0.055	2.289

Subcatchment Flows

APPENDIX B

EXISTING CONDITIONS HEC-RAS

Existing Conditions

HEC-RAS Plan: 20 River: Sulphur Creek Reach: Sulphur Creek

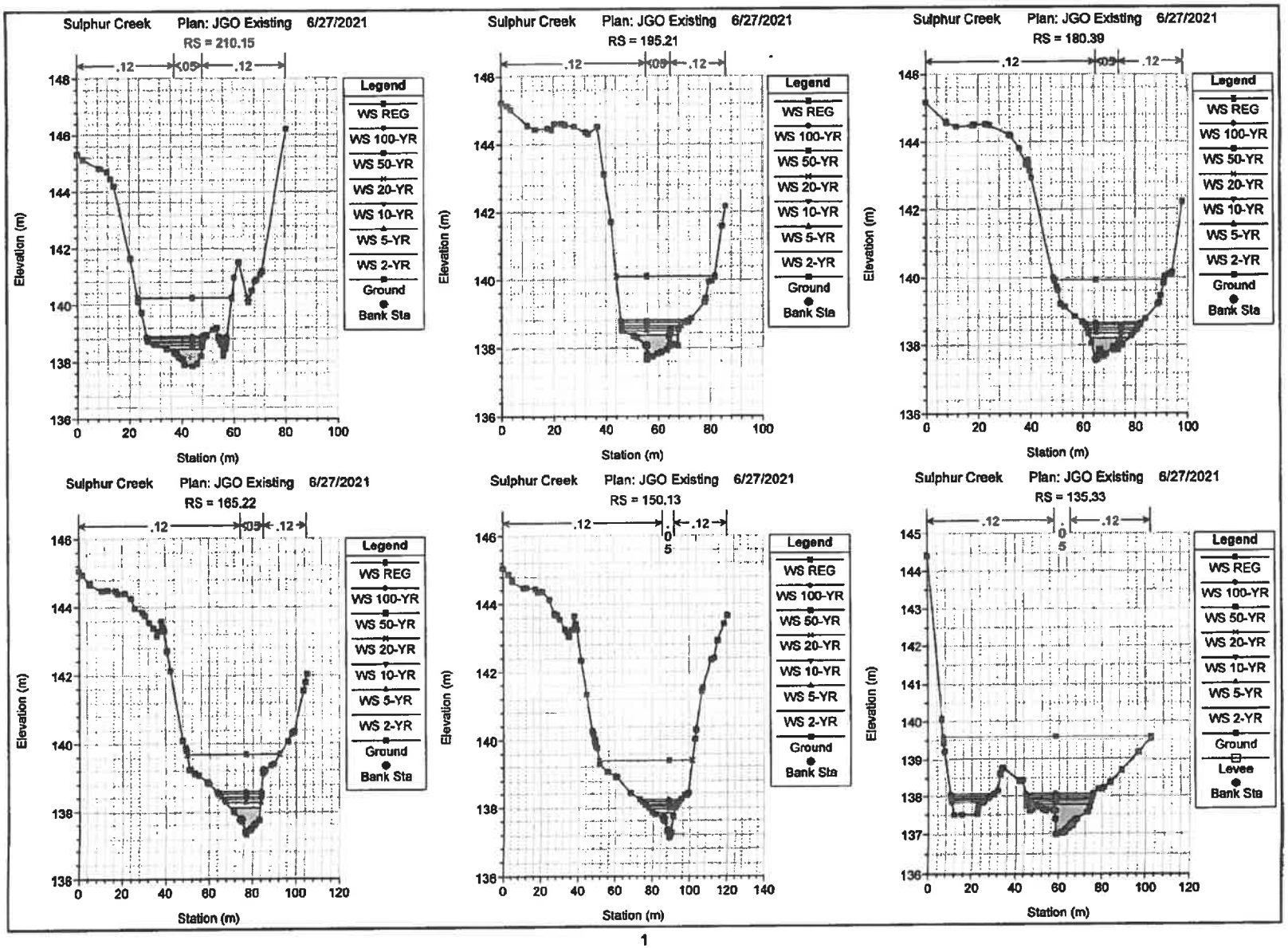
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Sulphur Creek	210.15	2-YR	4.61	137.84	138.45		138.50	0.007976	1.02	4.82	14.87	0.49
Sulphur Creek	210.15	5-YR	7.02	137.84	138.58		138.65	0.007573	1.16	7.03	19.14	0.50
Sulphur Creek	210.15	10-YR	8.81	137.84	138.66		138.74	0.007405	1.25	8.68	21.69	0.50
Sulphur Creek	210.15	20-YR	10.36	137.84	138.73		138.81	0.007232	1.31	10.18	23.97	0.50
Sulphur Creek	210.15	50-YR	12.62	137.84	138.81		138.90	0.006932	1.38	12.29	24.61	0.50
Sulphur Creek	210.15	100-YR	14.39	137.84	138.88		138.97	0.006695	1.42	13.88	25.52	0.50
Sulphur Creek	210.15	REG	95.14	137.84	140.23		140.52	0.007089	2.79	58.41	36.95	0.60
Sulphur Creek	195.21	2-YR	4.61	137.66	138.35		138.40	0.006104	0.95	5.96	17.08	0.43
Sulphur Creek	195.21	5-YR	7.02	137.66	138.48		138.54	0.006375	1.10	8.49	21.42	0.45
Sulphur Creek	195.21	10-YR	8.81	137.66	138.57		138.63	0.006282	1.18	10.33	21.79	0.45
Sulphur Creek	195.21	20-YR	10.36	137.66	138.64		138.70	0.006234	1.25	11.81	22.93	0.46
Sulphur Creek	195.21	50-YR	12.62	137.66	138.72		138.80	0.006112	1.33	13.91	24.46	0.46
Sulphur Creek	195.21	100-YR	14.39	137.66	138.79		138.87	0.005979	1.38	15.58	26.31	0.46
Sulphur Creek	195.21	REG	95.14	137.66	140.11		140.40	0.008111	2.92	58.61	37.81	0.63
Sulphur Creek	180.39	2-YR	4.61	137.58	138.19		138.26	0.013485	1.23	4.46	14.25	0.63
Sulphur Creek	180.39	5-YR	7.02	137.58	138.33		138.42	0.010834	1.35	6.64	16.95	0.59
Sulphur Creek	180.39	10-YR	8.81	137.58	138.42		138.51	0.009887	1.43	8.20	18.50	0.58
Sulphur Creek	180.39	20-YR	10.36	137.58	138.49		138.59	0.009332	1.49	9.51	19.56	0.57
Sulphur Creek	180.39	50-YR	12.62	137.58	138.58		138.69	0.008814	1.57	11.35	20.87	0.57
Sulphur Creek	180.39	100-YR	14.39	137.58	138.64		138.76	0.008574	1.64	12.72	22.24	0.57
Sulphur Creek	180.39	REG	95.14	137.58	139.92		140.27	0.009612	3.21	57.96	42.11	0.70
Sulphur Creek	165.22	2-YR	4.61	137.31	138.11		138.15	0.004360	0.89	5.91	13.92	0.38
Sulphur Creek	165.22	5-YR	7.02	137.31	138.25		138.30	0.004880	1.05	8.04	16.01	0.40
Sulphur Creek	165.22	10-YR	8.81	137.31	138.34		138.40	0.004884	1.16	9.51	17.30	0.42
Sulphur Creek	165.22	20-YR	10.36	137.31	138.41		138.48	0.005027	1.23	10.74	18.32	0.43
Sulphur Creek	165.22	50-YR	12.62	137.31	138.50		138.58	0.005223	1.33	12.46	19.84	0.44
Sulphur Creek	165.22	100-YR	14.39	137.31	138.56		138.65	0.005390	1.40	13.73	20.59	0.46
Sulphur Creek	165.22	REG	95.14	137.31	139.68		140.10	0.012212	3.31	49.57	42.74	0.76
Sulphur Creek	150.13	2-YR	4.61	137.09	137.82	137.82	138.00	0.029324	1.89	2.78	10.86	0.93
Sulphur Creek	150.13	5-YR	7.02	137.09	137.95	137.95	138.15	0.025930	2.05	4.47	13.81	0.91
Sulphur Creek	150.13	10-YR	8.81	137.09	138.02	138.02	138.24	0.025642	2.18	5.53	15.29	0.92
Sulphur Creek	150.13	20-YR	10.36	137.09	138.08	138.08	138.32	0.025270	2.30	6.40	16.86	0.92
Sulphur Creek	150.13	50-YR	12.62	137.09	138.15	138.15	138.41	0.024355	2.43	7.77	19.41	0.92
Sulphur Creek	150.13	100-YR	14.39	137.09	138.21	138.21	138.48	0.023652	2.52	8.90	21.69	0.92
Sulphur Creek	150.13	REG	95.14	137.09	139.39	139.39	139.87	0.018208	4.12	53.84	50.18	0.94
Sulphur Creek	135.33	2-YR	4.61	136.98	137.78	137.42	137.80	0.002408	0.75	9.66	28.30	0.29
Sulphur Creek	135.33	5-YR	7.02	136.98	137.85	137.53	137.88	0.002960	0.89	15.69	43.40	0.32
Sulphur Creek	135.33	10-YR	8.81	136.98	137.89	137.61	137.93	0.003519	1.01	17.85	45.21	0.35
Sulphur Creek	135.33	20-YR	10.36	136.98	137.93	137.67	137.97	0.003958	1.10	19.58	46.60	0.38
Sulphur Creek	135.33	50-YR	12.62	136.98	137.96	137.74	138.03	0.004588	1.23	21.83	48.36	0.41
Sulphur Creek	135.33	100-YR	14.39	136.98	138.05	137.79	138.10	0.004215	1.24	25.34	50.89	0.40
Sulphur Creek	135.33	REG	95.14	136.98	139.60	138.60	139.65	0.002199	1.68	148.23	95.56	0.34
Sulphur Creek	120.19	2-YR	4.61	136.63	137.74	137.38	137.76	0.002288	0.79	18.39	73.03	0.28
Sulphur Creek	120.19	5-YR	7.02	136.63	137.80	137.53	137.83	0.003338	0.99	20.40	73.24	0.34
Sulphur Creek	120.19	10-YR	8.81	136.63	137.84	137.61	137.86	0.003726	1.08	23.66	73.42	0.36
Sulphur Creek	120.19	20-YR	10.36	136.63	137.88	137.74	137.91	0.004011	1.16	26.21	73.63	0.38
Sulphur Creek	120.19	50-YR	12.62	136.63	137.92	137.78	137.96	0.004470	1.25	29.35	73.88	0.40
Sulphur Creek	120.19	100-YR	14.39	136.63	138.01	137.80	138.04	0.003429	1.16	35.79	74.40	0.36
Sulphur Creek	120.19	REG	95.14	136.63	139.59	138.35	139.62	0.001648	1.46	171.26	98.06	0.29
Sulphur Creek	105.25	2-YR	4.61	136.48	137.48	137.48	137.66	0.029888	1.95	3.03	14.17	0.81
Sulphur Creek	105.25	5-YR	7.02	136.48	137.56	137.56	137.73	0.014753	1.51	12.20	58.69	0.58
Sulphur Creek	105.25	10-YR	8.81	136.48	137.69	137.69	137.77	0.016791	1.64	14.34	70.08	0.62
Sulphur Creek	105.25	20-YR	10.36	136.48	137.71	137.71	137.79	0.018555	1.74	15.91	70.36	0.65
Sulphur Creek	105.25	50-YR	12.62	136.48	137.82	137.74	137.86	0.010461	1.37	23.64	71.63	0.49
Sulphur Creek	105.25	100-YR	14.39	136.48	137.95	137.76	137.97	0.005319	1.04	33.23	72.73	0.35
Sulphur Creek	105.25	REG	95.14	136.48	139.57	138.19	139.59	0.001771	1.14	166.71	87.97	0.23
Sulphur Creek	90.05	2-YR	4.61	136.22	136.96	136.88	137.09	0.021369	1.63	2.83	6.01	0.76
Sulphur Creek	90.05	5-YR	7.02	136.22	137.20	137.01	137.33	0.013697	1.59	4.43	7.23	0.64
Sulphur Creek	90.05	10-YR	8.81	136.22	137.37	137.10	137.48	0.009516	1.52	6.99	22.60	0.55
Sulphur Creek	90.05	20-YR	10.36	136.22	137.52	137.17	137.61	0.006397	1.38	12.35	48.30	0.46
Sulphur Creek	90.05	50-YR	12.62	136.22	137.75	137.31	137.78	0.002780	1.03	27.49	72.61	0.31
Sulphur Creek	90.05	100-YR	14.39	136.22	137.91	137.41	137.93	0.001685	0.86	39.16	73.81	0.25
Sulphur Creek	90.05	REG	95.14	136.22	139.54	138.23	139.57	0.001068	1.18	194.91	107.80	0.23
Sulphur Creek	80.11	2-YR	4.61	135.84	136.96		136.99	0.003241	0.82	5.61	5.78	0.33
Sulphur Creek	80.11	5-YR	7.02	135.84	137.21		137.25	0.002660	0.88	8.57	17.83	0.31
Sulphur Creek	80.11	10-YR	8.81	135.84	137.38		137.42	0.002174	0.88	12.84	35.43	0.29
Sulphur Creek	80.11	20-YR	10.36	135.84	137.53		137.56	0.001691	0.84	18.79	43.25	0.26
Sulphur Creek	80.11	50-YR	12.62	135.84	137.74		137.76	0.001121	0.76	30.72	66.03	0.21

Existing Conditions

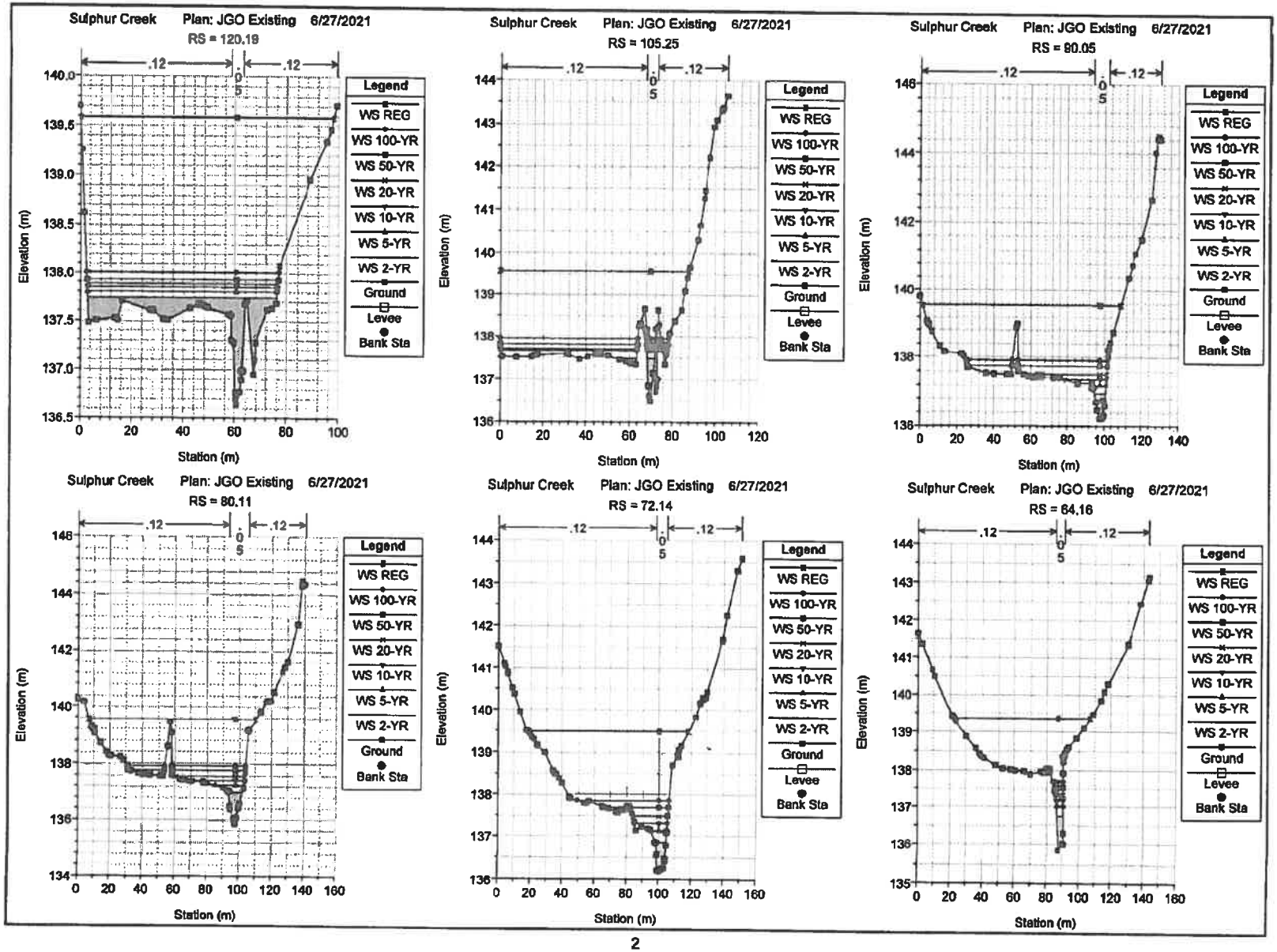
HEC-RAS Plan: 20 River: Sulphur Creek Reach: Sulphur Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Sulphur Creek	80.11	100-YR	14.39	135.84	137.90		137.92	0.000825	0.69	41.50	68.92	0.19
Sulphur Creek	80.11	REG	95.14	135.84	139.52		139.56	0.000984	1.17	183.69	103.33	0.22
Sulphur Creek	72.14	2-YR	4.61	136.20	136.85	136.69	136.94	0.012289	1.38	3.34	6.47	0.61
Sulphur Creek	72.14	5-YR	7.02	136.20	137.12	136.82	137.21	0.007179	1.35	5.55	9.79	0.50
Sulphur Creek	72.14	10-YR	8.81	136.20	137.31	136.91	137.39	0.005035	1.31	8.65	20.37	0.43
Sulphur Creek	72.14	20-YR	10.36	136.20	137.47	136.98	137.54	0.003678	1.24	12.01	21.62	0.38
Sulphur Creek	72.14	50-YR	12.62	136.20	137.68	137.08	137.75	0.002898	1.24	17.49	39.81	0.34
Sulphur Creek	72.14	100-YR	14.39	136.20	137.85	137.15	137.90	0.002170	1.16	25.41	57.09	0.30
Sulphur Creek	72.14	REG	95.14	136.20	139.48	138.44	139.54	0.001784	1.73	151.27	99.63	0.31
Sulphur Creek	64.16	2-YR	4.61	135.83	136.75	136.46	136.85	0.010294	1.44	3.21	4.25	0.53
Sulphur Creek	64.16	5-YR	7.02	135.83	137.00	136.84	137.14	0.010123	1.62	4.34	4.51	0.53
Sulphur Creek	64.16	10-YR	8.81	135.83	137.18	136.75	137.33	0.009901	1.71	5.14	4.68	0.52
Sulphur Creek	64.16	20-YR	10.36	135.83	137.32	136.84	137.48	0.009692	1.78	5.82	4.82	0.52
Sulphur Creek	64.16	50-YR	12.62	135.83	137.52	136.97	137.70	0.009231	1.85	6.84	5.50	0.51
Sulphur Creek	64.16	100-YR	14.39	135.83	137.68	137.06	137.86	0.008585	1.89	7.74	6.20	0.49
Sulphur Creek	64.16	REG	95.14	135.83	139.36	138.92	139.51	0.006276	2.51	95.08	84.35	0.46
Sulphur Creek	57.5		Culvert									
Sulphur Creek	49.4	2-YR	4.61	135.78	136.61		136.69	0.005235	1.24	3.85	5.04	0.44
Sulphur Creek	49.4	5-YR	7.02	135.78	136.75		136.88	0.007172	1.61	4.56	5.14	0.53
Sulphur Creek	49.4	10-YR	8.81	135.78	136.83		137.01	0.008492	1.86	4.99	5.20	0.58
Sulphur Creek	49.4	20-YR	10.36	135.78	136.89		137.11	0.009641	2.06	5.32	5.24	0.63
Sulphur Creek	49.4	50-YR	12.62	135.78	136.97		137.25	0.011447	2.34	5.71	5.30	0.69
Sulphur Creek	49.4	100-YR	14.39	135.78	137.01		137.35	0.013379	2.59	5.91	5.33	0.75
Sulphur Creek	49.4	REG	95.14	135.78	139.03	139.03	139.50	0.008117	3.88	74.76	79.86	0.69
Sulphur Creek	41.14	2-YR	4.61	135.81	136.56		136.63	0.007851	1.19	3.94	7.93	0.50
Sulphur Creek	41.14	5-YR	7.02	135.81	136.70		136.81	0.009165	1.44	5.15	9.82	0.56
Sulphur Creek	41.14	10-YR	8.81	135.81	136.79		136.92	0.009823	1.58	6.14	11.81	0.59
Sulphur Creek	41.14	20-YR	10.36	135.81	136.87		137.00	0.010123	1.67	7.09	13.75	0.60
Sulphur Creek	41.14	50-YR	12.62	135.81	136.97		137.12	0.010091	1.76	8.62	16.27	0.61
Sulphur Creek	41.14	100-YR	14.39	135.81	137.03		137.20	0.010452	1.84	9.59	16.85	0.62
Sulphur Creek	41.14	REG	95.14	135.81	138.19	138.19	138.68	0.015344	3.69	49.97	51.71	0.86
Sulphur Creek	26.28	2-YR	4.61	135.75	136.39	136.26	136.48	0.013084	1.35	3.88	10.53	0.64
Sulphur Creek	26.28	5-YR	7.02	135.75	136.48	136.39	136.62	0.015932	1.71	4.85	12.24	0.74
Sulphur Creek	26.28	10-YR	8.81	135.75	136.53	136.47	136.71	0.019687	1.95	5.46	13.02	0.81
Sulphur Creek	26.28	20-YR	10.36	135.75	136.57	136.53	136.78	0.021836	2.14	5.96	13.63	0.86
Sulphur Creek	26.28	50-YR	12.62	135.75	136.62	136.62	136.89	0.024064	2.37	6.77	15.21	0.92
Sulphur Creek	26.28	100-YR	14.39	135.75	136.68	136.68	136.95	0.022602	2.44	7.77	19.09	0.90
Sulphur Creek	26.28	REG	95.14	135.75	137.81	137.81	138.32	0.018490	4.08	50.64	47.76	0.95
Sulphur Creek	11.26	2-YR	4.61	135.84	136.06	136.06	136.15	0.044364	1.36	3.51	20.49	1.01
Sulphur Creek	11.26	5-YR	7.02	135.84	136.12	136.12	136.24	0.040763	1.55	4.78	21.70	1.01
Sulphur Creek	11.26	10-YR	8.81	135.84	136.16	136.16	136.30	0.037972	1.66	5.66	22.55	1.00
Sulphur Creek	11.26	20-YR	10.36	135.84	136.19	136.19	136.34	0.036874	1.74	6.38	23.20	1.00
Sulphur Creek	11.26	50-YR	12.62	135.84	136.24	136.24	136.41	0.035312	1.85	7.41	24.09	1.00
Sulphur Creek	11.26	100-YR	14.39	135.84	136.27	136.27	136.45	0.033943	1.92	8.22	24.78	1.00
Sulphur Creek	11.26	REG	95.14	135.84	137.14	137.14	137.60	0.020832	3.28	41.76	46.18	0.95

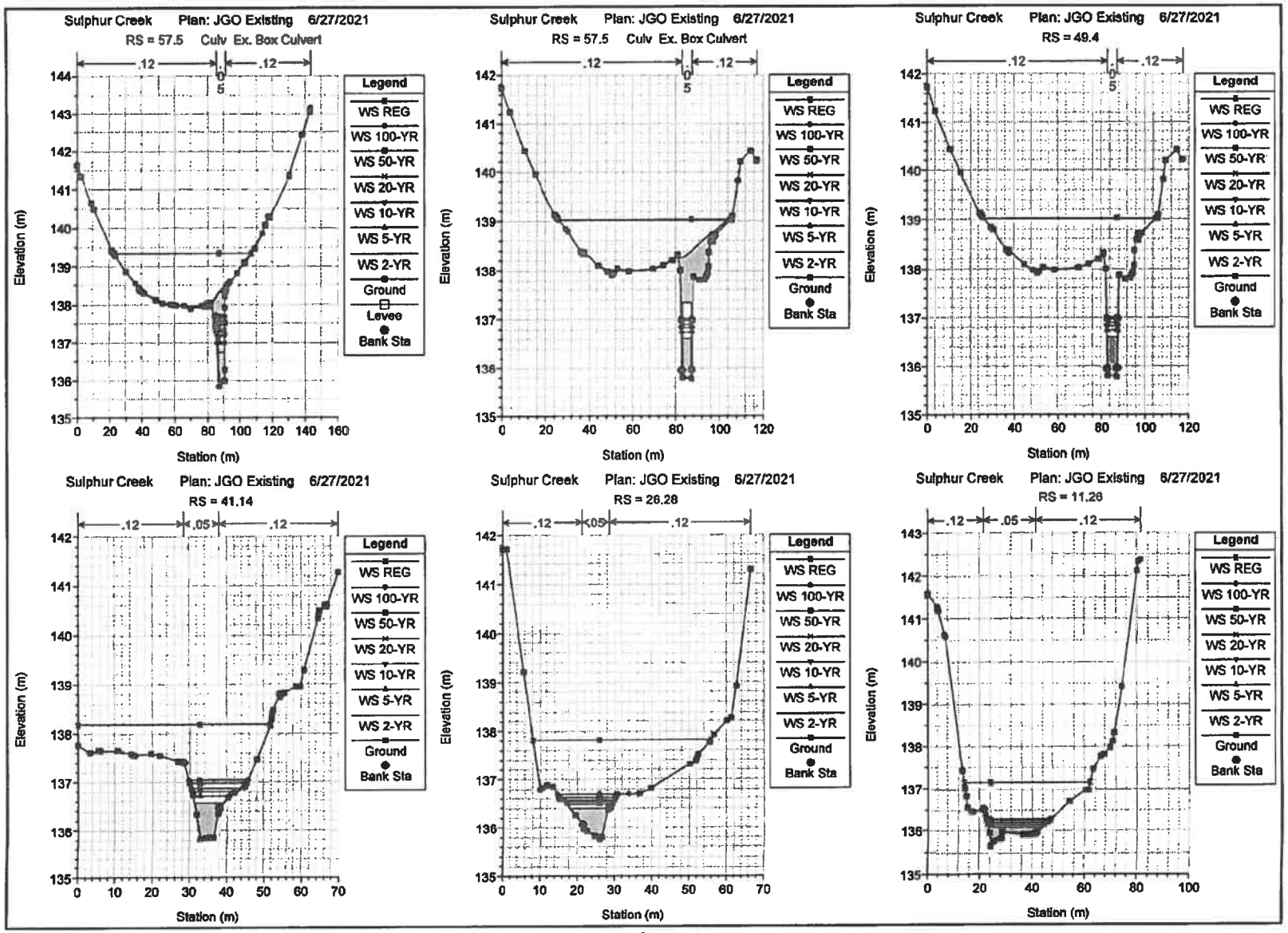
Existing Conditions Cross-Sections



Existing Conditions Cross-Sections



Existing Conditions Cross-Sections



APPENDIX C

PROPOSED CONDITIONS HEC-RAS

PROPOSED CONDITIONS (No Equalization Pipes)

HEC-RAS Plan: 21 River: Sulphur Creek Reach: Sulphur Creek

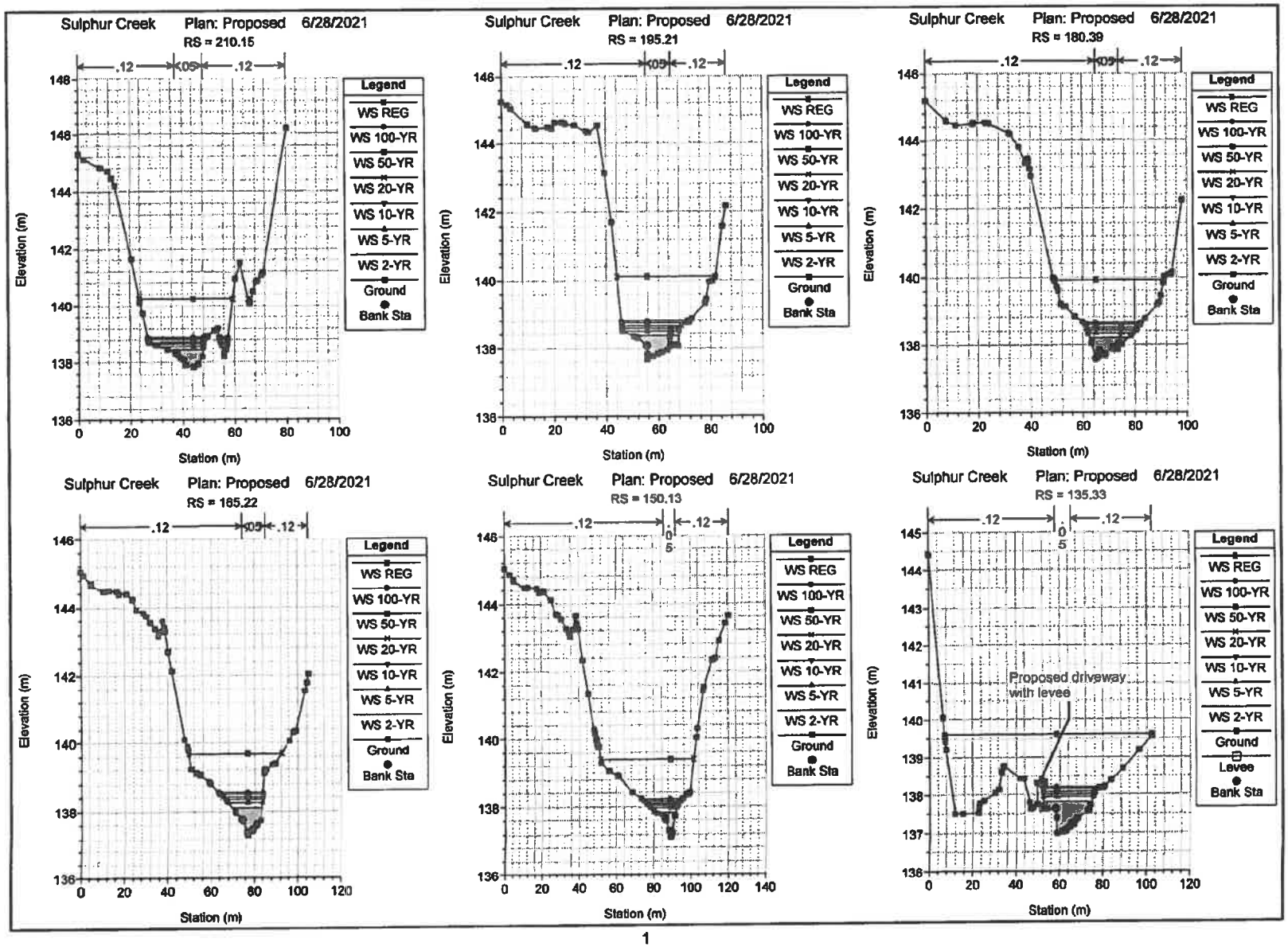
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Sulphur Creek	210.15	2-YR	4.61	137.84	138.45		138.50	0.007976	1.02	4.82	14.87	0.49
Sulphur Creek	210.15	5-YR	7.02	137.84	138.56		138.65	0.007573	1.16	7.03	19.14	0.50
Sulphur Creek	210.15	10-YR	8.81	137.84	138.65		138.74	0.007405	1.25	8.69	21.69	0.50
Sulphur Creek	210.15	20-YR	10.36	137.84	138.73		138.81	0.007232	1.31	10.18	23.97	0.50
Sulphur Creek	210.15	50-YR	12.62	137.84	138.81		138.90	0.006932	1.38	12.29	24.61	0.50
Sulphur Creek	210.15	100-YR	14.39	137.84	138.88		138.97	0.006695	1.42	13.66	25.52	0.50
Sulphur Creek	210.15	REG	95.14	137.84	140.23		140.52	0.007089	2.79	58.41	36.95	0.60
Sulphur Creek	195.21	2-YR	4.61	137.66	138.35		138.40	0.006104	0.95	5.96	17.08	0.43
Sulphur Creek	195.21	5-YR	7.02	137.66	138.46		138.54	0.006375	1.10	8.49	21.42	0.45
Sulphur Creek	195.21	10-YR	8.81	137.66	138.57		138.63	0.006282	1.18	10.33	21.79	0.45
Sulphur Creek	195.21	20-YR	10.36	137.66	138.64		138.70	0.006234	1.25	11.81	22.93	0.46
Sulphur Creek	195.21	50-YR	12.62	137.66	138.72		138.80	0.006112	1.33	13.91	24.46	0.46
Sulphur Creek	195.21	100-YR	14.39	137.66	138.79		138.87	0.005979	1.38	15.58	26.31	0.46
Sulphur Creek	195.21	REG	95.14	137.66	140.11		140.40	0.008111	2.92	58.61	37.81	0.63
Sulphur Creek	180.39	2-YR	4.61	137.58	138.19		138.26	0.013486	1.23	4.46	14.25	0.63
Sulphur Creek	180.39	5-YR	7.02	137.58	138.33		138.42	0.010834	1.35	6.84	16.95	0.59
Sulphur Creek	180.39	10-YR	8.81	137.58	138.42		138.51	0.009887	1.43	8.20	18.50	0.58
Sulphur Creek	180.39	20-YR	10.36	137.58	138.49		138.59	0.009332	1.49	9.51	19.56	0.57
Sulphur Creek	180.39	50-YR	12.62	137.58	138.58		138.69	0.008814	1.57	11.35	20.87	0.57
Sulphur Creek	180.39	100-YR	14.39	137.58	138.64		138.76	0.008674	1.64	12.72	22.24	0.57
Sulphur Creek	180.39	REG	95.14	137.58	139.92		140.27	0.009612	3.21	57.96	42.11	0.70
Sulphur Creek	165.22	2-YR	4.61	137.31	138.11		138.15	0.004360	0.89	5.91	13.92	0.38
Sulphur Creek	165.22	5-YR	7.02	137.31	138.25		138.30	0.004680	1.05	8.04	16.01	0.40
Sulphur Creek	165.22	10-YR	8.81	137.31	138.34		138.40	0.004864	1.16	9.51	17.30	0.42
Sulphur Creek	165.22	20-YR	10.36	137.31	138.41		138.48	0.005027	1.23	10.74	18.32	0.43
Sulphur Creek	165.22	50-YR	12.62	137.31	138.50		138.58	0.005223	1.33	12.46	19.64	0.44
Sulphur Creek	165.22	100-YR	14.39	137.31	138.56		138.65	0.005390	1.40	13.73	20.59	0.46
Sulphur Creek	165.22	REG	95.14	137.31	139.88		140.10	0.012212	3.31	49.57	42.74	0.76
Sulphur Creek	150.13	2-YR	4.61	137.09	137.82	137.82	138.00	0.029324	1.89	2.76	10.86	0.93
Sulphur Creek	150.13	5-YR	7.02	137.09	137.95	137.95	138.15	0.025830	2.05	4.47	13.81	0.91
Sulphur Creek	150.13	10-YR	8.81	137.09	138.02	138.02	138.24	0.025842	2.18	5.53	15.28	0.92
Sulphur Creek	150.13	20-YR	10.36	137.09	138.08	138.08	138.32	0.025270	2.30	6.40	16.86	0.92
Sulphur Creek	150.13	50-YR	12.62	137.09	138.15	138.15	138.41	0.024355	2.43	7.77	19.41	0.92
Sulphur Creek	150.13	100-YR	14.39	137.09	138.21	138.21	138.48	0.023652	2.52	8.90	21.59	0.92
Sulphur Creek	150.13	REG	95.14	137.09	139.39	139.39	139.87	0.018208	4.12	53.84	50.18	0.94
Sulphur Creek	135.33	2-YR	4.61	136.98	137.81	137.42	137.83	0.002072	0.72	9.76	22.20	0.27
Sulphur Creek	135.33	5-YR	7.02	136.98	137.94	137.53	137.97	0.002515	0.88	12.68	22.99	0.30
Sulphur Creek	135.33	10-YR	8.81	136.98	138.01	137.60	138.05	0.002824	0.99	14.48	23.42	0.33
Sulphur Creek	135.33	20-YR	10.36	136.98	138.07	137.67	138.12	0.003082	1.07	15.88	23.95	0.34
Sulphur Creek	135.33	50-YR	12.62	136.98	138.15	137.73	138.21	0.003456	1.20	17.78	25.26	0.37
Sulphur Creek	135.33	100-YR	14.39	136.98	138.22	137.78	138.25	0.002270	1.01	33.18	58.71	0.30
Sulphur Creek	135.33	REG	95.14	136.98	139.60	138.64	139.66	0.002303	1.72	144.99	65.56	0.35
Sulphur Creek	120.19	2-YR	4.61	136.63	137.75	137.36	137.79	0.003251	0.95	9.44	28.58	0.33
Sulphur Creek	120.19	5-YR	7.02	136.63	137.88	137.53	137.92	0.003769	1.12	12.98	28.95	0.36
Sulphur Creek	120.19	10-YR	8.81	136.63	137.95	137.61	138.00	0.004154	1.23	15.08	29.26	0.39
Sulphur Creek	120.19	20-YR	10.36	136.63	138.00	137.75	138.06	0.004442	1.32	16.73	29.54	0.40
Sulphur Creek	120.19	50-YR	12.62	136.63	138.08	137.81	138.14	0.004824	1.43	18.91	29.92	0.43
Sulphur Creek	120.19	100-YR	14.39	136.63	138.12	137.85	138.20	0.005289	1.54	20.27	30.52	0.45
Sulphur Creek	120.19	REG	95.14	136.63	139.59	138.37	139.62	0.001700	1.46	170.35	98.08	0.29
Sulphur Creek	105.25	2-YR	4.61	136.48	137.47	137.47	137.66	0.030202	1.96	3.00	14.05	0.82
Sulphur Creek	105.25	5-YR	7.02	136.48	137.65	137.65	137.80	0.023446	1.90	6.45	23.28	0.73
Sulphur Creek	105.25	10-YR	8.81	136.48	137.71	137.71	137.85	0.025003	2.02	7.87	23.87	0.75
Sulphur Creek	105.25	20-YR	10.36	136.48	137.75	137.75	137.92	0.026927	2.13	8.86	24.27	0.79
Sulphur Creek	105.25	50-YR	12.62	136.48	137.80	137.80	137.99	0.029518	2.29	10.13	24.73	0.82
Sulphur Creek	105.25	100-YR	14.39	136.48	137.92	137.84	138.05	0.020692	2.03	13.08	25.69	0.69
Sulphur Creek	105.25	REG	95.14	136.48	139.57	138.22	139.59	0.001841	1.18	165.46	87.98	0.24
Sulphur Creek	90.05	2-YR	4.61	136.22	136.96	136.88	137.09	0.021369	1.63	2.83	6.01	0.76
Sulphur Creek	90.05	5-YR	7.02	136.22	137.20	137.01	137.33	0.013596	1.59	4.43	7.23	0.64
Sulphur Creek	90.05	10-YR	8.81	136.22	137.37	137.11	137.48	0.009532	1.52	6.98	22.58	0.55
Sulphur Creek	90.05	20-YR	10.36	136.22	137.52	137.17	137.61	0.006398	1.38	11.47	32.34	0.46
Sulphur Creek	90.05	50-YR	12.62	136.22	137.74	137.31	137.78	0.003637	1.17	18.54	32.64	0.36
Sulphur Creek	90.05	100-YR	14.39	136.22	137.89	137.41	137.94	0.002650	1.07	23.86	32.85	0.31
Sulphur Creek	90.05	REG	95.14	136.22	139.54	138.14	139.57	0.001109	1.21	193.13	107.80	0.23
Sulphur Creek	80.11	2-YR	4.61	135.84	136.96	136.53	136.99	0.003241	0.82	5.61	8.78	0.33
Sulphur Creek	80.11	5-YR	7.02	135.84	137.21	136.67	137.25	0.002660	0.85	8.57	17.63	0.31
Sulphur Creek	80.11	10-YR	8.81	135.84	137.38	136.75	137.42	0.002144	0.88	12.88	30.56	0.29
Sulphur Creek	80.11	20-YR	10.36	135.84	137.53	136.82	137.58	0.001704	0.85	17.34	30.75	0.26
Sulphur Creek	80.11	50-YR	12.62	135.84	137.74	136.91	137.78	0.001263	0.80	23.78	31.02	0.23

PROPOSED CONDITIONS (No Equalization Pipes)

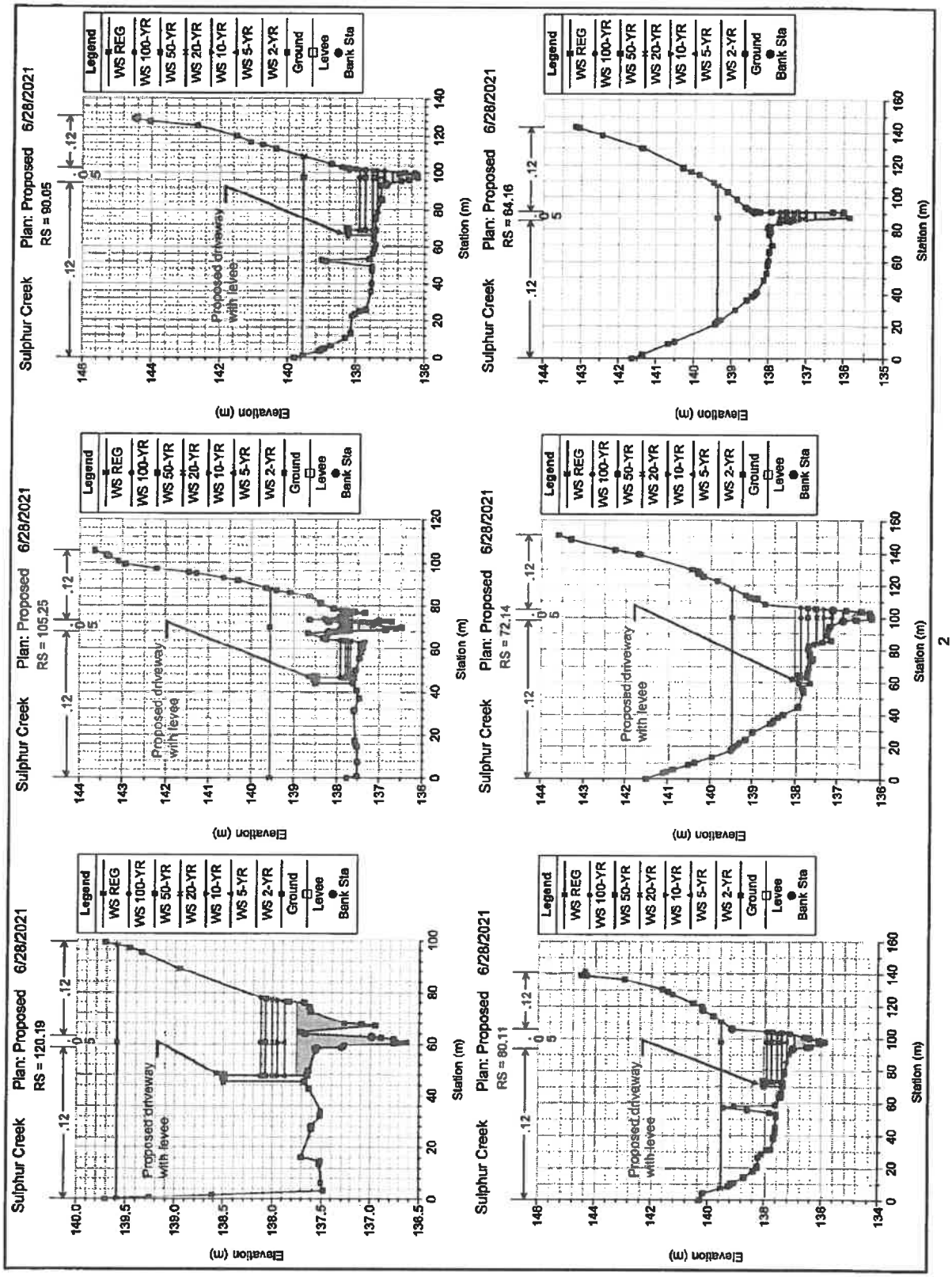
HEC-RAS Plan: 21 River: Sulphur Creek Reach: Sulphur Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Sulphur Creek	80.11	100-YR	14.39	135.84	137.89	136.97	137.92	0.001054	0.78	28.56	31.22	0.21
Sulphur Creek	80.11	REG	95.14	135.84	139.52	138.19	139.56	0.001023	1.18	181.70	103.31	0.23
Sulphur Creek	72.14	2-YR	4.61	136.20	136.85	136.69	136.94	0.012289	1.38	3.34	6.47	0.61
Sulphur Creek	72.14	5-YR	7.02	136.20	137.12	136.82	137.21	0.007179	1.35	5.55	9.79	0.50
Sulphur Creek	72.14	10-YR	8.81	136.20	137.31	136.91	137.39	0.005035	1.31	8.65	20.37	0.43
Sulphur Creek	72.14	20-YR	10.36	136.20	137.47	136.98	137.54	0.003678	1.24	12.01	21.82	0.38
Sulphur Creek	72.14	50-YR	12.62	136.20	137.68	137.08	137.75	0.002898	1.24	17.49	39.61	0.34
Sulphur Creek	72.14	100-YR	14.39	136.20	137.85	137.15	137.90	0.002028	1.13	24.88	43.06	0.28
Sulphur Creek	72.14	REG	95.14	136.20	139.48	138.45	139.54	0.001827	1.75	150.26	99.55	0.32
Sulphur Creek	64.16	2-YR	4.61	135.83	136.75	136.46	136.85	0.010294	1.44	3.21	4.25	0.63
Sulphur Creek	64.16	5-YR	7.02	135.83	137.00	136.63	137.14	0.010123	1.62	4.34	4.51	0.63
Sulphur Creek	64.16	10-YR	8.81	135.83	137.18	136.75	137.33	0.009801	1.71	5.14	4.68	0.62
Sulphur Creek	64.16	20-YR	10.36	135.83	137.32	136.84	137.48	0.009692	1.78	5.82	4.82	0.62
Sulphur Creek	64.16	50-YR	12.62	135.83	137.52	136.96	137.70	0.009231	1.85	6.84	5.50	0.61
Sulphur Creek	64.16	100-YR	14.39	135.83	137.68	137.05	137.86	0.008585	1.89	7.74	6.20	0.49
Sulphur Creek	64.16	REG	95.14	135.83	139.36	138.92	139.51	0.006276	2.51	95.08	84.35	0.46
Sulphur Creek	57.5		Culvert									
Sulphur Creek	49.4	2-YR	4.61	135.78	136.61		136.69	0.005235	1.24	3.85	5.04	0.44
Sulphur Creek	49.4	5-YR	7.02	135.78	136.75		136.88	0.007172	1.61	4.56	5.14	0.53
Sulphur Creek	49.4	10-YR	8.81	135.78	136.83		137.01	0.008492	1.86	4.99	5.20	0.58
Sulphur Creek	49.4	20-YR	10.36	135.78	136.89		137.11	0.009641	2.06	5.32	5.24	0.63
Sulphur Creek	49.4	50-YR	12.62	135.78	136.97		137.25	0.011447	2.34	5.71	5.30	0.69
Sulphur Creek	49.4	100-YR	14.39	135.78	137.01		137.35	0.013379	2.59	5.91	5.33	0.75
Sulphur Creek	49.4	REG	95.14	135.78	139.03	139.03	139.50	0.008117	3.88	74.76	79.86	0.69
Sulphur Creek	41.14	2-YR	4.61	135.81	136.56		136.63	0.007851	1.19	3.94	7.93	0.50
Sulphur Creek	41.14	5-YR	7.02	135.81	136.70		136.81	0.009155	1.44	5.15	9.82	0.56
Sulphur Creek	41.14	10-YR	8.81	135.81	136.79		136.92	0.009823	1.58	6.14	11.81	0.59
Sulphur Creek	41.14	20-YR	10.36	135.81	136.87		137.00	0.010123	1.67	7.09	13.75	0.60
Sulphur Creek	41.14	50-YR	12.62	135.81	136.97		137.12	0.010091	1.76	8.62	15.27	0.61
Sulphur Creek	41.14	100-YR	14.39	135.81	137.03		137.20	0.010452	1.84	9.59	15.85	0.62
Sulphur Creek	41.14	REG	95.14	135.81	138.19	138.19	138.69	0.015344	3.69	49.97	51.71	0.86
Sulphur Creek	28.28	2-YR	4.61	135.75	136.39	136.26	136.46	0.013084	1.35	3.86	10.53	0.64
Sulphur Creek	28.28	5-YR	7.02	135.75	136.48	136.39	136.62	0.016932	1.71	4.85	12.24	0.74
Sulphur Creek	28.28	10-YR	8.81	135.75	136.53	136.47	136.71	0.019687	1.95	5.46	13.02	0.81
Sulphur Creek	28.28	20-YR	10.36	135.75	136.57	136.53	136.78	0.021836	2.14	5.96	13.63	0.88
Sulphur Creek	28.28	50-YR	12.62	135.75	136.62	136.62	136.89	0.024084	2.37	6.77	15.21	0.92
Sulphur Creek	28.28	100-YR	14.39	135.75	136.68	136.68	136.96	0.022602	2.44	7.77	19.09	0.90
Sulphur Creek	28.28	REG	95.14	135.75	137.81	137.81	138.32	0.018490	4.08	50.64	47.76	0.95
Sulphur Creek	11.26	2-YR	4.61	135.84	136.06	136.06	136.15	0.044364	1.38	3.51	20.49	1.01
Sulphur Creek	11.26	5-YR	7.02	135.84	136.12	136.12	136.24	0.040763	1.55	4.78	21.70	1.01
Sulphur Creek	11.26	10-YR	8.81	135.84	136.16	136.16	136.30	0.037972	1.68	5.66	22.55	1.00
Sulphur Creek	11.26	20-YR	10.36	135.84	136.19	136.19	136.34	0.036874	1.74	6.38	23.20	1.00
Sulphur Creek	11.26	50-YR	12.62	135.84	136.24	136.24	136.41	0.035312	1.85	7.41	24.09	1.00
Sulphur Creek	11.26	100-YR	14.39	135.84	136.27	136.27	136.45	0.033943	1.92	8.22	24.78	1.00
Sulphur Creek	11.26	REG	95.14	135.84	137.14	137.14	137.50	0.020832	3.28	41.76	48.19	0.95

Proposed Conditions Cross-Sections



Proposed Conditions Cross-Sections



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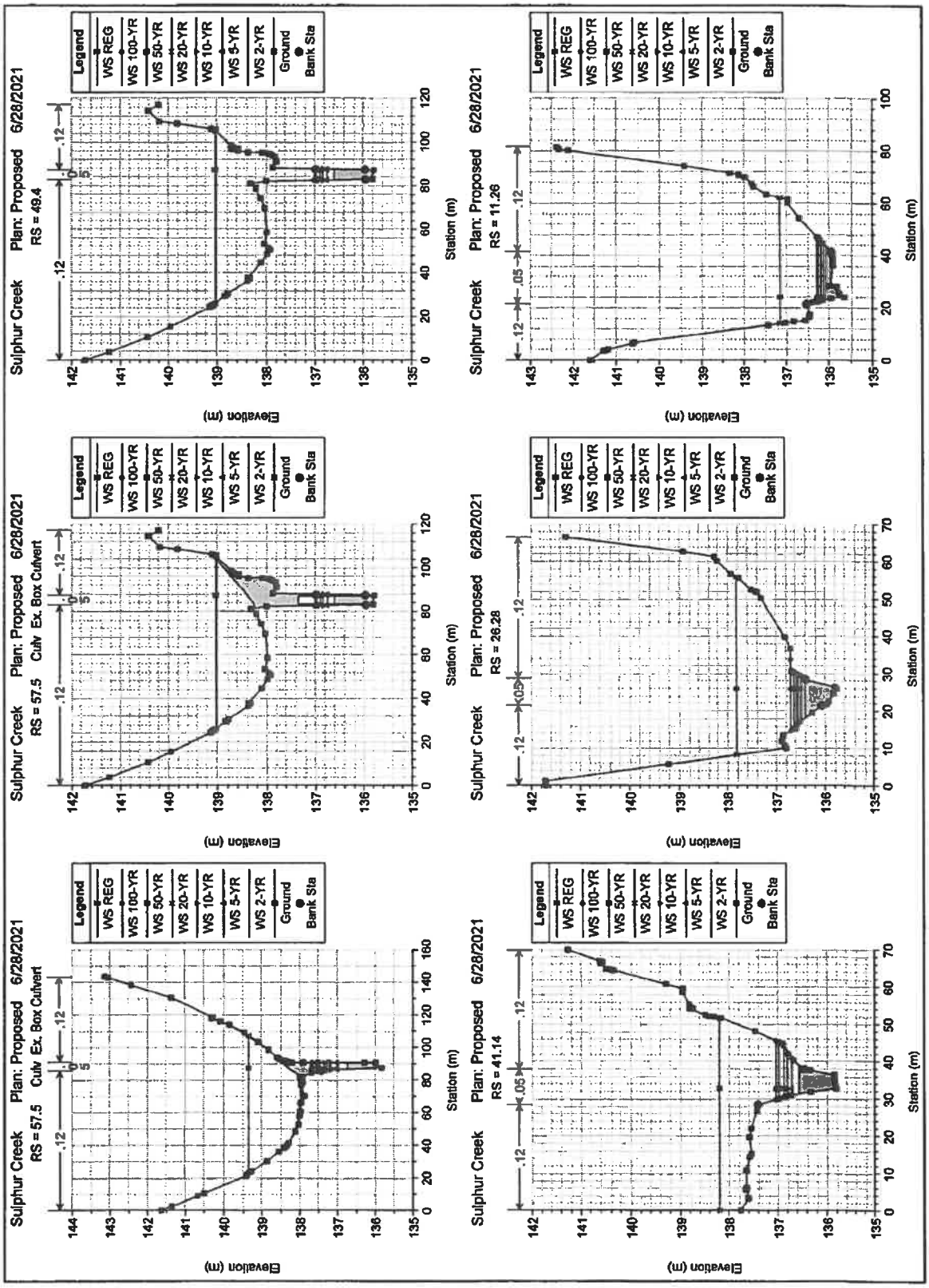
Proposed Conditions Cross-Sections



3

ATTACHMENT 6

Floodplain Analysis Memorandum

November 8, 2023

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM

To:	Cathy Plosz, Senior Planner Watershed Management Services	**From:**	Alexandra Porco
		Date:	November 8, 2023
Project:	820 Sulphur Springs Road Hamilton, ON	**Pages:**	5 + Appendices A & B
		Job #:	21031
Re:	Floodplain Analysis for Area Along Proposed Development		

1. Introduction

S. Llewellyn and Associates was retained by the property owner to review the existing floodplain elevations adjacent to the proposed site in support of the development of a single-family residence. The 23ha site is located on the west side of Sulphur Springs Road, in the City of Hamilton. Sulphur Springs Creek and the associated floodplain is located south of the proposed development. Refer to **Figure 1** for the location plan.

The purpose of this memo is to document the methodology and results from the floodplain analysis and demonstrate how the proposed site development can meet the criteria of Hamilton Conservation Authority (HCA) as it pertains to the Floodplain Regulation.

2. Background

The following information was used in the preparation of this memo:

Ref. 1: Spencer Creek Watershed Hydrology Study (MacLaren Plansearch / Lavalin, January 1990)

Ref. 2: River & Stream Systems: Flood Hazard Limit Technical Guide (Ontario Ministry of Natural Resources, 2002)

Ref. 3: LiDAR data provided by Hamilton Conservation Authority through the Government Open License.

Ref. 4: Topographic survey prepared by A.T. McLauren Limited.

3. Methodology

The subject site is located within Zone 1 of *Figure B-1: Flood Hazard Criteria Zones of Ontario and Conservation Authorities* within the River & Stream Systems Technical Guide (Ref. 2). Sites within Zone 1 are to consider the greater of the flood produced by Hurricane Hazel Storm (Regional Storm) or the 100-year storm.

The floodplain analysis assessment included the following tasks:

- Request terrain data (LiDAR DEM) from HCA for use within a 2D model and confirm the vertical datum (CGVD2013) to that of the topographic survey (CGVD1928).
- Complete a 2D Quasi-Steady State flow analysis for the Creek under existing conditions for the 100-year and Regional storm events according to River and Stream Systems: Flooding Hazard Limit Technical Guide (Ref. 2).

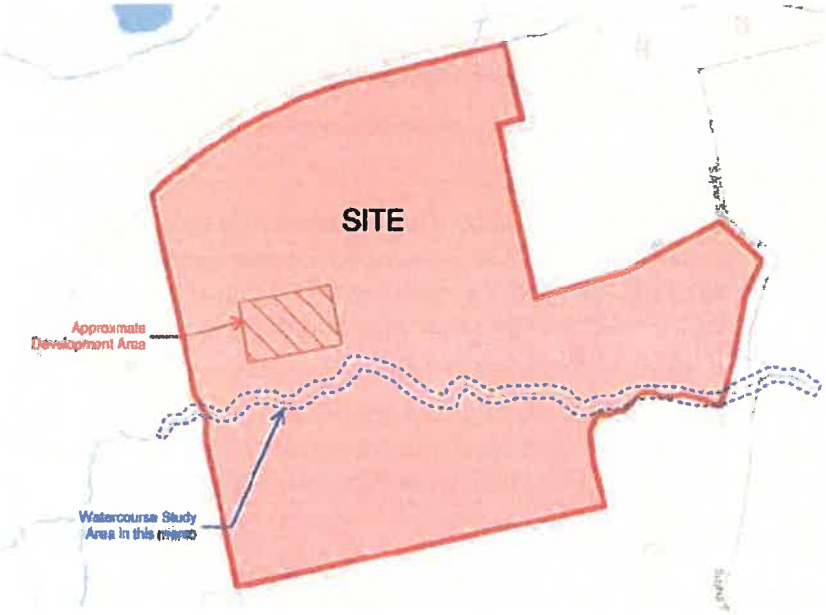


Figure 1 – Location Plan

4. Hydraulic Modeling Information

4.1. Flow Rates

Flows for the model were taken from the Spencer Creek Watershed Hydrology Study (Ref. 3). Flows generated from Catchments 355, 356, 357 and part of 358 drain through the existing watercourse and through the existing culvert crossing at Sulphur Springs Road. **Table 4.1** summarizes the flows applied to the 2D flow area within the model.

Table 4.1 – Steady Flow Rates

Storm Event	Flow Rate (m^3/s)
100-year	14.39
Regional	95.14

4.2. Review of LiDAR Data

The LiDAR data received by HCA was compared with 5 surveyed data points across varying surface types. It is noted that the LiDAR data has a vertical datum of CVGD2013 and the topographic survey has a vertical datum of CVGD1982. Based on this, it is expected that the LiDAR data points will be approximately 0.4m lower than the surveyed data points. **Table 4.2** shows the comparison of the points, along with the difference in vertical elevation and **Figure A1** in the Appendix shows the location from which the points were taken.

Table 4.2 – Data Point Comparison

Point Number	LiDAR Elevation (m)	Topographic Survey Elevation (m)	Difference in Elevation (m)
1	136.07	136.47	0.40
2	137.98	138.38	0.40
3	136.06	136.47	0.41
4	136.68	137.06	0.38
5	138.26	138.65	0.39

4.3. Geometry

A 2D geometry was created for the existing conditions. The 2D mesh was constructed covering the length of the Creek (approximately 845m upstream and 210m downstream of the culvert at Sulphur Springs Road), extending outwards to the high points on site.

The geometry has a 2m directional mesh applied for the primary channel area and Sulphur Springs Road. A conservative manning's 'n' of 0.045 has been applied across the entirety of the mesh and building areas have been modeled as obstructions with approximate locations taken from Google Maps. The culvert at Sulphur Springs Road has been created in the mesh. The culvert data was taken from the LiDAR data provided by HCA (Ref.3) and was cross-referenced with the topographic survey prepared by A.T. McLaren Limited (Ref.4) to confirm accuracy.

4.4. Inputs

The 100-year and Regional peak flow rates of 14.39m^3/s and 95.14m^3/s were used to create quasi-steady state hydrographs which increase from 0m^3/s to the peak flow in 3 hours and then are constant at the peak flow for the remainder of the time. These hydrographs, seen in **Figure 2**, were used to model the flow through the 2D HEC-RAS model in order to delineate the existing floodplain elevation/location for the 100-year and Regional storm events.

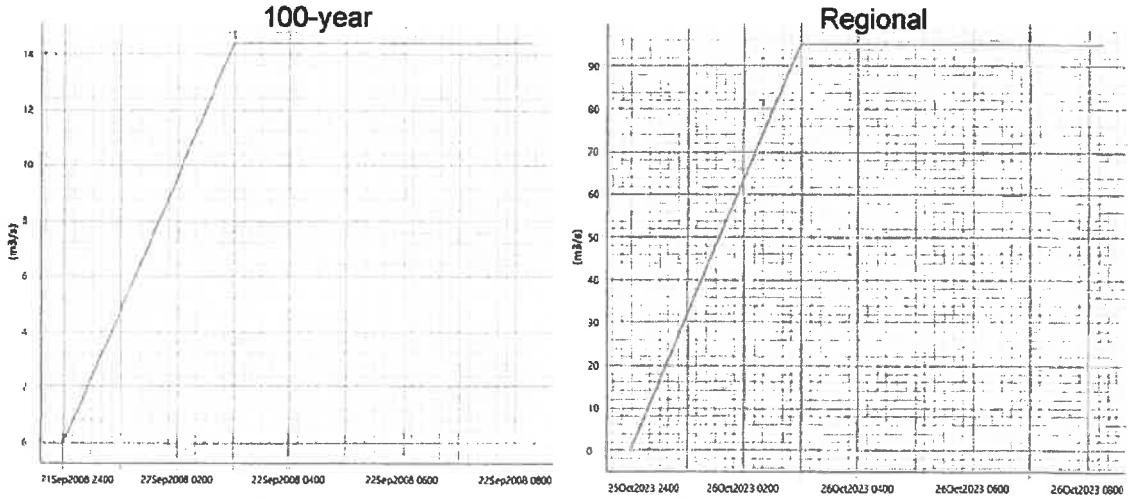


Figure 2 – Quasi-Steady State Input Flow Hydrographs

4.5. Analysis Results

Based on the results provided in RAS Mapper, the floodplain spans the width of the creek, into a relatively flat portion of land adjacent to the top of bank. The Regional storm event extends further towards the adjacent bottom of slope south of the proposed development area. The floodplain elevations (in CGVD2013) range from 149.30m to 137.50m for the 100-year storm event and 150.60m to 143.80m for the Regional storm event, moving west to east to the upstream end of the Sulphur Springs Road culvert. The floodplain elevation adjacent to the proposed location of the single-family residence is 142.90m and 144.15m for the 100-year and Regional storm events, respectively (refer to **Figures B1** and **B2** in Appendix B).

5. Discussions

The results show the Regional storm to be the worst case scenario with a floodplain elevation of 144.15m adjacent to the proposed location of the single-family residence. The existing grades within the proposed area of development (in CGVD2013) range from 148.00 to 158.00m and are outside of the floodplain area (refer to **Figure B3**).

5.1. Conclusions and Recommendations

Based on the results of the HEC-RAS model, it is concluded that the former dwelling, proposed dwelling and proposed driveway are outside of the regulated floodplain area and will not have a negative impact on the surrounding properties.

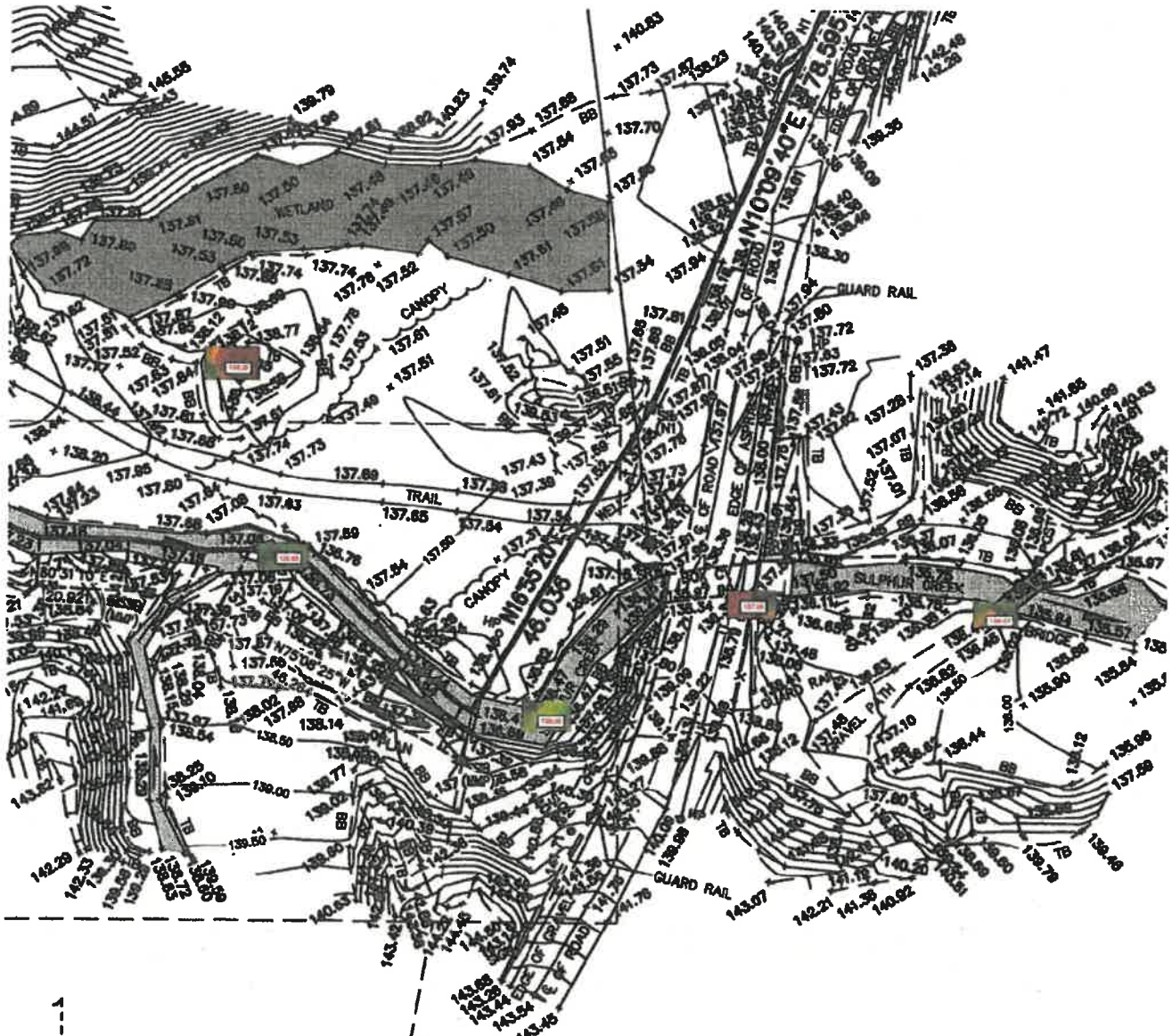
We trust the information enclosed is satisfactory. Should you have any questions please do not hesitate to contact our office.

S. Llewellyn & Associates Limited.

Alexandra Porco, P. Eng.

APPENDIX A

DATA POINT COMPARISON INFORMATION



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-15719

7(LT)

FIGURE A1

TOPO & LiDAR POINT COMPARISON

SCALE: NTS

PROJECT: 820 Sulphur Springs Road
PROJECT No.: 21031

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS
Tel. (905) 631-6978
Website: www.sla.on.ca
email: info@sla.on.ca
3228 South Service Road, Suite #105 East Wing, Burlington, Ont., L7N 3H8

APPENDIX B

RAS MAPPER OUTPUT – SCENARIO 1

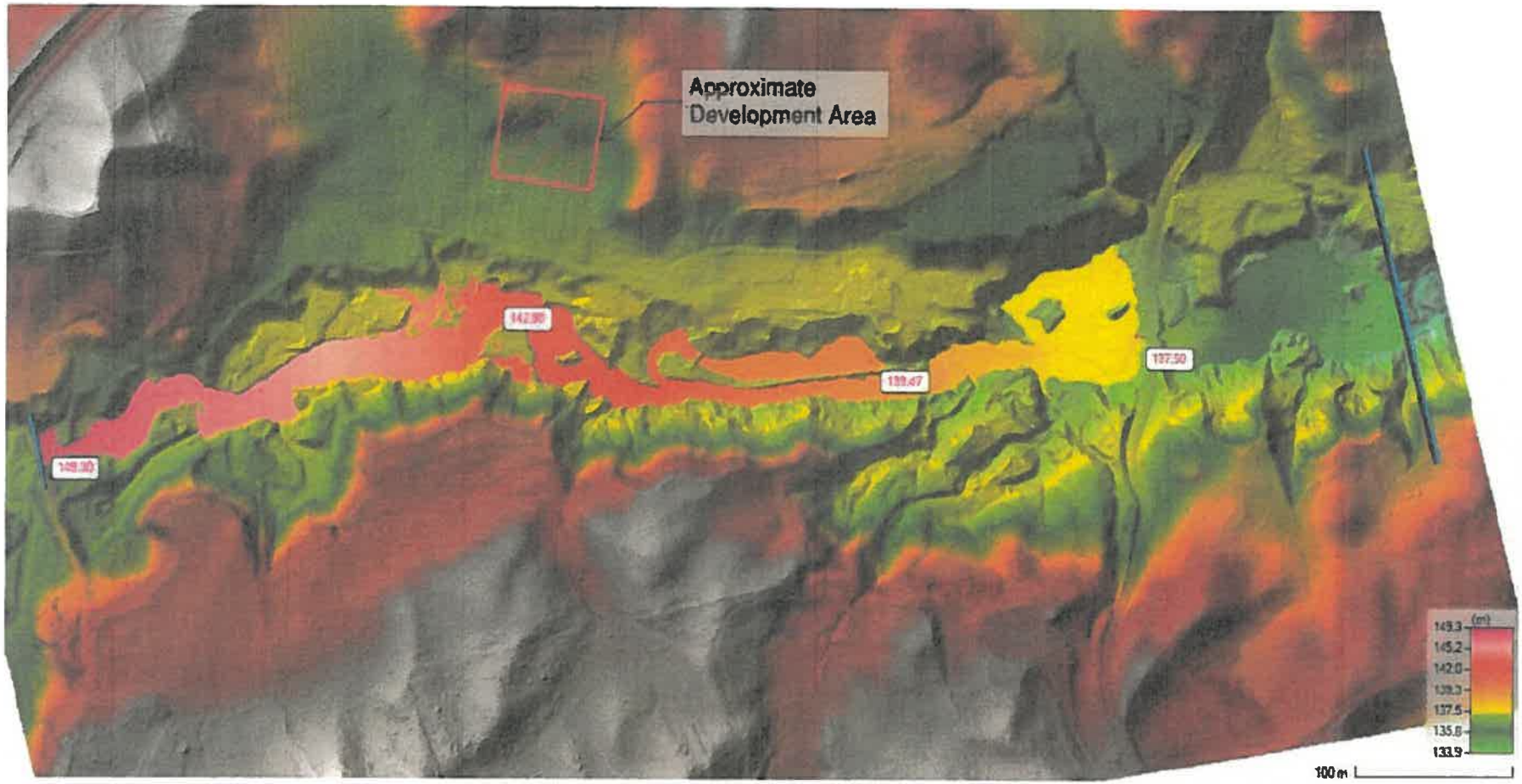


Figure B1 - Ex. Floodplain Elevation (Quasi-Steady State) for 100-Year Storm Event

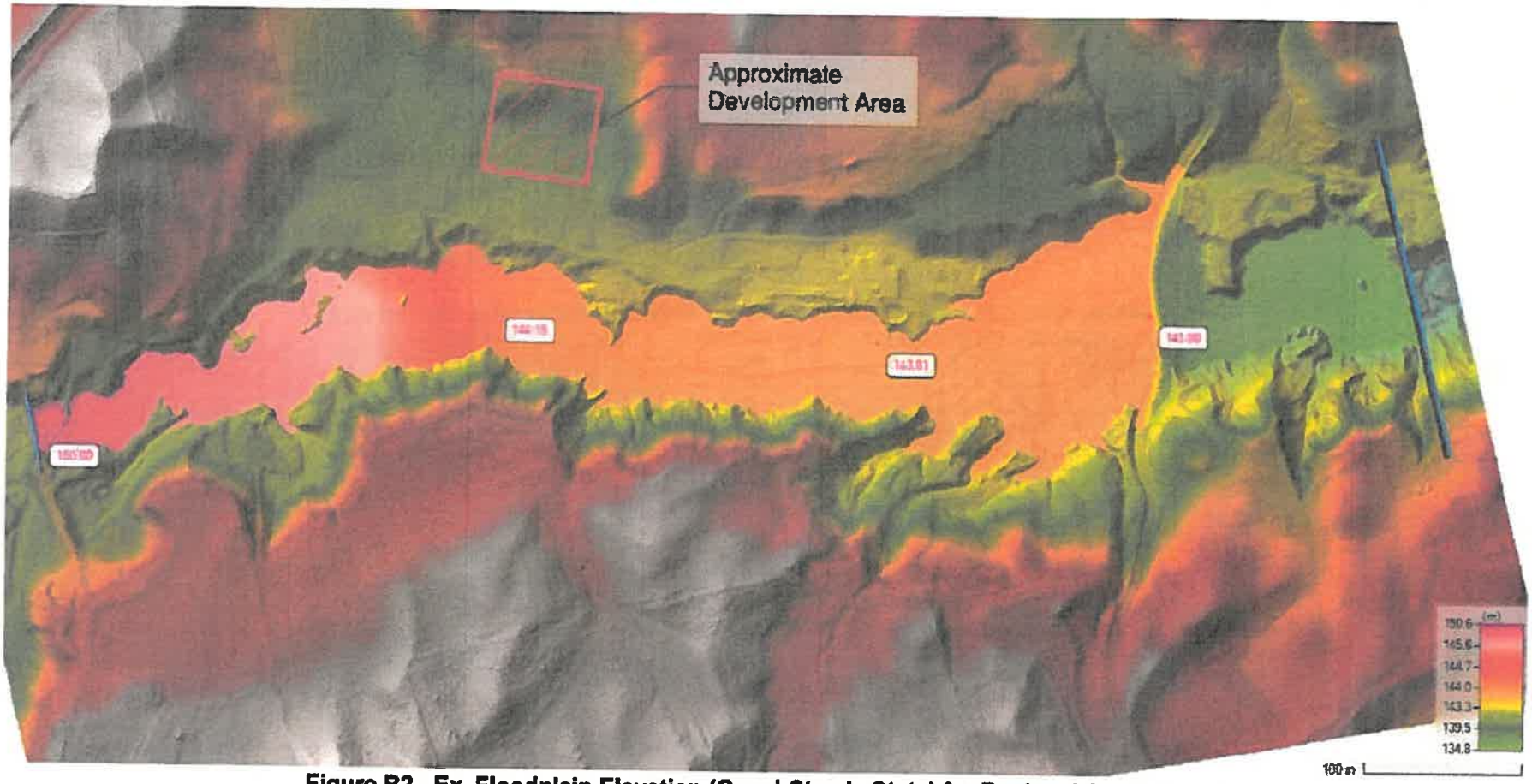
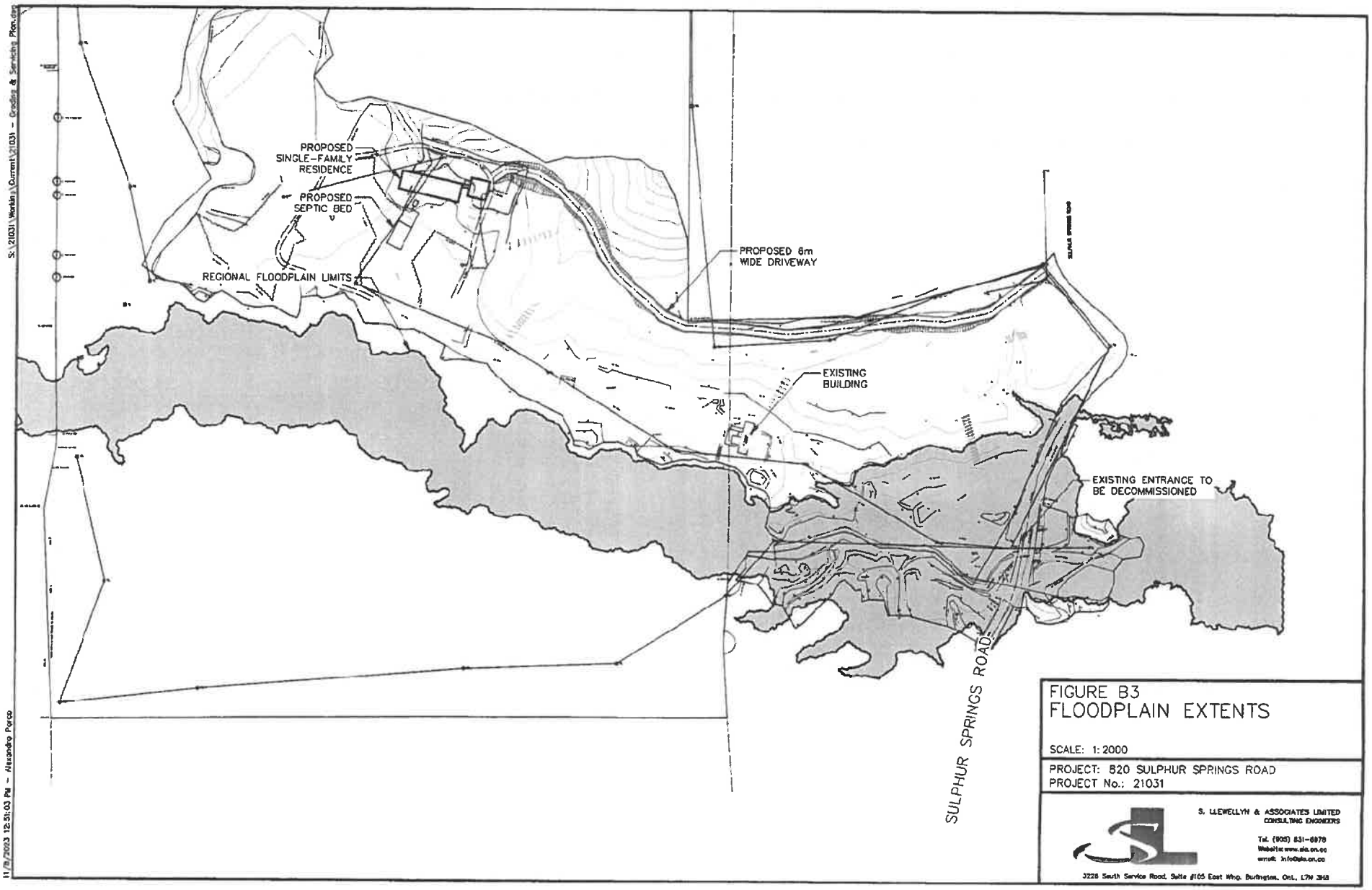


Figure B2 - Ex. Floodplain Elevation (Quasi-Steady State) for Regional Storm Event


PROPOSED SINGLE-FAMILY RESIDENCE
PROPOSED SEPTIC BED
REGIONAL FLOODPLAIN LIMITS
PROPOSED 6m WIDE DRIVEWAY
EXISTING BUILDING
EXISTING ENTRANCE TO BE DECOMMISSIONED
SULPHUR SPRINGS ROAD
FIGURE B3
FLOODPLAIN EXTENTS
SCALE: 1:2000
PROJECT: 820 SULPHUR SPRINGS ROAD
PROJECT No.: 21031
S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS
3228 South Service Road, Suite #105 East Wing, Burlington, Ont., L7N 3H8

ATTACHMENT 7

Correspondence from Conservation Hamilton

Dated January 28, 2022

Ed Fothergill

From:	Scott Peck <Scott.Peck@conservationhamilton.ca>
Sent:	January 28, 2022 11:48 AM
To:	Ed Fothergill
Cc:	'Anthony Quinn'; 'John Oreskovic'; 'Sal Spitale'; 'Izabela van Amelsvoort'
Subject:	RE: Application for Development Permit - 820 Sulphur Springs Road

Ed, I have had a meeting with NEC staff. I offer the following.

Section 24(3) of the Niagara Escarpment Planning and Development Act states the following:

(3) No building permit, work order, certificate or licence that relates to development shall be issued, and no approval, consent, permission or other decision that is authorized or required by an Act and that relates to development shall be made, in respect of any land, building or structure within an area of development control, unless the development is exempt under the regulations or,

(a) a development permit relating to the land, building or structure has been issued under this Act; and

(b) the building permit, work order, certificate, licence, approval, consent, permission or decision is consistent with the development permit. 1999, c. 12, Sched. N, s. 4 (9).

As such, the HCA is not permitted to issue a permit or approval under the CA Act for your proposal. Given the above, we will not be processing the application submitted.

As discussed with NEC staff, the proposal should be considered first by the NEC to address their requirements. Subject to that process, the HCA can consider your permit application under our act as required.

Thank you,

T. Scott Peck, B.A., DPA, MCIP, RPP, CMMIII
Deputy Chief Administrative Officer/
Director, Watershed Planning & Engineering
Hamilton Conservation Authority
Phone: 905-525-2181, Ext. 130

The contents of this e-mail and any attachments are intended for the named recipient(s). This e-mail may contain information that is privileged and confidential. If you have received this message in error or are not the named recipient(s), please notify the sender and permanently delete this message without reviewing, copying, forwarding, disclosing or otherwise using it or any part of it in any form whatsoever.

ATTACHMENT 8

Correspondence from Jim Campbell dated

July 17, 2023

Ed Fothergill

From: Jim Campbell <jim@rockside.ca>
Sent: July 17, 2023 3:40 PM
To: Cathy.Plosz@conservationhamilton.ca
Cc: Anthony Quinn; Andrew Winters; Ed Fothergill
Subject: 820 Sulphur Springs Road - Protection of Existing Building

Hello Cathy:

My client and friend Anthony Quinn updated me a few minutes ago to the conversation you and he had and the objectives for creating a site plan focusing in on the existing old stone building that has additional information:

- location of proposed silt fence,
- location of material stockpiles,
- any other erosion control measures,
- outlets for weeping tile,
- proposed grading plan,
- and a cross-section and/or plan showing the proposed excavation around the existing old stone building.

Please let me know if there is any other information that is required for this drawing.

As well, we thought it could be of interest to map onto the drawing the line of the designated flood plane. I have tried to locate that on the HCA website but am having trouble obtaining it – can you please send me either a pdf or a link showing where this line would be for the front portion of 820 Sulphur Springs Road?

Thanks,
Jim

James Campbell, M.Arch.
Rockside Campbell Design Inc.
705-446-2506
www.rockside.ca

ATTACHMENT 9

Correspondence from Andrew Winters

dated July 18, 2023

Ed Fothergill

From: Andrew Winters <andrew@rockside.ca>
Sent: July 18, 2023 1:31 PM
To: Cathy.Plosz@conservationhamilton.ca
Cc: Anthony Quinn; Ed Fothergill; Jim Campbell
Subject: RE: 820 Sulphur Springs Road - Protection of Existing Building

Good afternoon Cathy,

This is a follow-up to my voicemail a moment ago – do you have a pdf or link showing the line of the designated flood plane for the front portion of 820 sulphur springs road?

We wish to send the requested information as outlined in Jim's email below to you in short order.

Thank you,

Andrew Winters, M.Arch
Rockside Campbell Design Inc.
705-446-2506 (work)
705-828-4905 (cell)
www.rockside.ca

From: Jim Campbell <jim@rockside.ca>
Sent: Monday, July 17, 2023 3:40 PM
To: Cathy.Plosz@conservationhamilton.ca
Cc: Anthony Quinn <aquinn@bennettgroup.ca>; Andrew Winters <andrew@rockside.ca>; Ed Fothergill <edf@nas.net>
Subject: 820 Sulphur Springs Road - Protection of Existing Building

Hello Cathy:

My client and friend Anthony Quinn updated me a few minutes ago to the conversation you and he had and the objectives for creating a site plan focusing in on the existing old stone building that has additional information:

- location of proposed silt fence,
- location of material stockpiles,
- any other erosion control measures,
- outlets for weeping tile,
- proposed grading plan,
- and a cross-section and/or plan showing the proposed excavation around the existing old stone building.

Please let me know if there is any other information that is required for this drawing.

As well, we thought it could be of interest to map onto the drawing the line of the designated flood plane. I have tried to locate that on the HCA website but am having trouble obtaining it – can you please send me either a pdf or a link showing where this line would be for the front portion of 820 Sulphur Springs Road?

Thanks,
Jim

James Campbell, M.Arch.

ATTACHMENT 10

Correspondence from Andrew Winters
regarding Site Plan - July 2023

Ed Fothergill

From: Andrew Winters <andrew@rockside.ca>
Sent: July 20, 2023 11:08 AM
To: Cathy.Plosz@conservationhamilton.ca
Cc: Anthony Quinn; Jim Campbell; Ed Fothergill; Andrej.Obradovic@ontario.ca; Melissa.Kiddie@hamilton.ca; Morgan.Gowans@hamilton.ca
Subject: 820 Sulphur Springs Road - Protection of Existing Building
Attachments: 2023.07.19 QAOSH A1 OSH Site Plan A1.3.pdf

Good Morning Cathy,

As requested, please find attached a site plan for 820 Sulphur Springs Road which indicates:

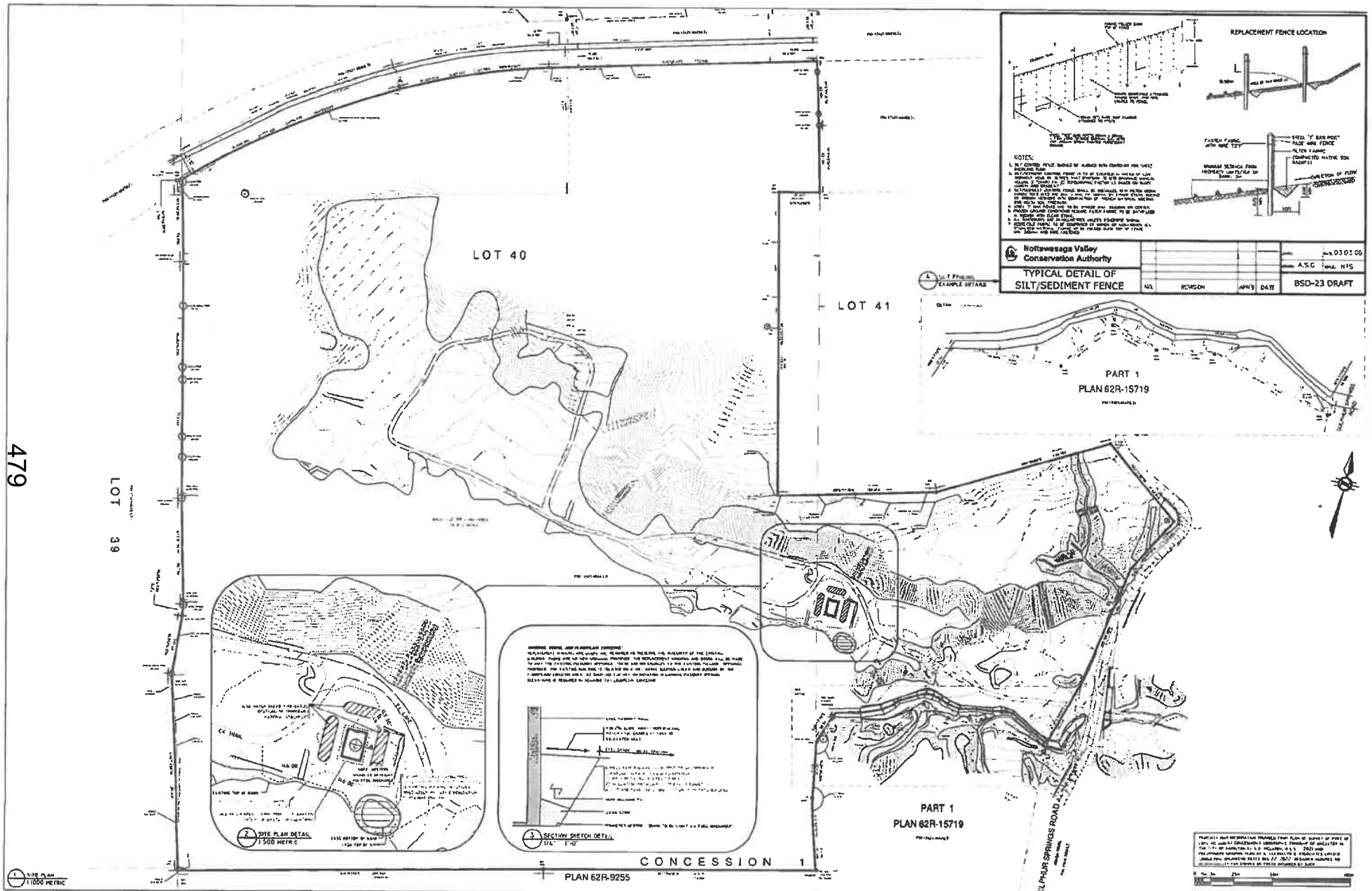
- location of proposed silt fence
- proposed silt fence example detail
- location of potential, temporary material stockpiles
- note that the weeping tile will drain to daylight via an existing discharge
- proposed grading plan
- cross section and plan showing the proposed excavation around the existing stone building
- topographic information

This is to protect the existing building, as outlined in previous correspondence from Ed Fothergill.

Please let us know if you require anything further.

Thank you,

Andrew Winters, M.Arch
Rockside Campbell Design Inc.
705-446-2506 (work)
705-828-4905 (cell)
www.rockside.ca


479
LOT 40
LOT 41
LOT 39
CONCESSION 1
PLAN 62R-9255
PART 1
PLAN 62R-15719
PART 1
PLAN 62R-15719
SULPHUR SPRINGS ROAD
REPLACEMENT FENCE LOCATION
NOTES:
Nottawasaga Valley Conservation Authority
TYPICAL DETAIL OF SILT/SEDIMENT FENCE
BSD-23 DRAFT
SITE PLAN DETAIL
1:500 METRIC
SECTION SKETCH DETAIL
1/4" = 1'-0"
SITE PLAN
1:1000 METRIC
Rockside Campbell Design Inc.
QUINN
820 SULPHUR SPRINGS ROAD, BURDAS ON
SITE PLAN AND DETAILS
1:1000 Metric
ANTHONY QUINN
OLD STONE HOUSE
A1.3

ATTACHMENT 11

Correspondence from Cathy Plosz

dated July 20, 2023

Ed Fothergill

From: Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>
Sent: July 20, 2023 9:35 AM
To: Jim Campbell
Cc: Anthony Quinn; Andrew Winters; Ed Fothergill; 'Obradovic, Andrej (NDMNRF)'; Kiddie, Melissa
Subject: RE: 820 Sulphur Springs Road - Protection of Existing Building

Hi Jim,
To assist with accurate floodplain delineation, please overlay the proposed site plan on a topographic survey, so that we have existing elevations. I believe that your client has a topographic survey/elevations from the previous study (G25 Geotechnical Investigation) that can be used.

In addition to what you list below, you can include any surveyed features (e.g. existing driveway, concrete pad, tree canopy, etc) and dimensions from these features, to help orient the location of the work proposed on site.

Please note that once staff review the site plan, we may ask for additional information and clarification.

Finally, I have copied the City and NEC, to keep them in the loop, since approvals may be required from NEC and the City. NEC approval is required prior to any other planning approvals.

Let me know if you have any questions.

Cathy

From: Jim Campbell <jim@rockside.ca>
Sent: July 17, 2023 3:40 PM
To: Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>
Cc: Anthony Quinn <aquinn@bennettgroup.ca>; Andrew Winters <andrew@rockside.ca>; Ed Fothergill <edf@nas.net>
Subject: 820 Sulphur Springs Road - Protection of Existing Building

Hello Cathy:

My client and friend Anthony Quinn updated me a few minutes ago to the conversation you and he had and the objectives for creating a site plan focusing in on the existing old stone building that has additional information:

- location of proposed silt fence,
- location of material stockpiles,
- any other erosion control measures,
- outlets for weeping tile,
- proposed grading plan,
- and a cross-section and/or plan showing the proposed excavation around the existing old stone building.

Please let me know if there is any other information that is required for this drawing.

As well, we thought it could be of interest to map onto the drawing the line of the designated flood plane. I have tried to locate that on the HCA website but am having trouble obtaining it – can you please send me either a pdf or a link showing where this line would be for the front portion of 820 Sulphur Springs Road?

Thanks,

ATTACHMENT 12

Correspondence from Cathy Plosz

dated July 26, 2023

Ed Fothergill

From: Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>
Sent: July 26, 2023 9:59 AM
To: Andrew Winters
Cc: Anthony Quinn; Jim Campbell; Ed Fothergill; Andrej.Obradovic@ontario.ca; Melissa.Kiddie@hamilton.ca; Morgan.Gowans@hamilton.ca
Subject: RE: 820 Sulphur Springs Road - Protection of Existing Building

Hi Andrew
Thank-you for sending the updated site plan and floodplain information.

As I noted in my telephone discussion with Mr. Quinn, since the site is within the development control area of the Niagara Escarpment Plan, HCA staff require a written response from Niagara Escarpment Commission (NEC) staff that either approves a NEC permit for the proposed works or provides clearance that an NEC permit is not required. Therefore, before HCA can respond to this proposal, I would direct the landowner back to the NEC.

Thank-you.

Cathy Plosz
Senior Planner
Hamilton Conservation Authority
838 Mineral Springs Road, P.O. Box 81067
Ancaster, ON L9G 4X1
Phone: 905-525-2181 Ext. 132
Email: cplosz@conservationhamilton.ca

Hamilton Conservation Authority

A Healthy Watershed for Everyone

The contents of this e-mail and any attachments are intended for the named recipient(s). This e-mail may contain information that is privileged and confidential. If you have received this message in error or are not the named recipient(s), please notify the sender and permanently delete this message without reviewing, copying, forwarding, disclosing or otherwise using it or any part of it in any form whatsoever.

From: Andrew Winters <andrew@rockside.ca>
Sent: July 21, 2023 12:07 PM
To: Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>
Cc: 'Anthony Quinn' <aquinn@bennettgroup.ca>; Jim Campbell <jim@rockside.ca>; Ed Fothergill <edf@nas.net>; Andrej.Obradovic@ontario.ca; Melissa.Kiddie@hamilton.ca; Morgan.Gowans@hamilton.ca
Subject: RE: 820 Sulphur Springs Road - Protection of Existing Building

ATTACHMENT 13

Order to Comply – City of Hamilton

dated September 6, 2023

Hamilton

PLANNING AND ECONOMIC DEVELOPMENT DEPARTMENT
Building Division
71 Main Street West
Hamilton, Ontario, Canada, L8P 4Y5
Phone: 905.546.2720 Fax: 905.546.2764
www.hamilton.ca

Order to Comply

Pursuant to Subsection 12(2) of the *Building Code Act, 1992*

Order Number. 23-138375-00 EN

Date Order Issued:
September 06, 2023
Application/Permit Number:
n/a

Address to which Order applies:
820 SULPHUR SPRINGS ROAD, ANCASTER

Order issued to:

ANTHONY QUINN HOLDINGS INC.
117 MELVILLE STREET
DUNDAS, ON L9H 2A6

The inspection on or about August 29, 2023 at the above-referenced address found the following contravention(s) of the Building Code or the *Building Code Act, 1992*.

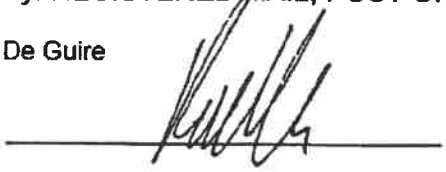
You are hereby ordered to correct the contraventions itemized below IMMEDIATELY.

Item	Reference	Description and location	Required action and compliance date
1.	Subsection 8. – (1) of the Building Code Act, 1992	Construction at the above address has commenced without the required permit being issued by the Chief Building Official, namely RENOVATION TO THE EXTERIOR WALLS AND ROOF OF AN EXISTING STRUCTURE.	Obtain a permit for all construction at the above address.

Order issued by: REGISTERED MAIL, POST ON SITE.

Name: Randy De Guire

BCIN: 26259

Signature: 

Telephone No.:905.546.2424 ext. 6774
Randy.DeGuire@Hamilton.ca

Note:

- It is illegal to obstruct the visibility of a posted Order. It is also illegal to remove a posted Order unless authorized by an inspector or Registered Code Agency. [*Building Code Act,1992* s. 20]
- An Order may be appealed to the Superior Court of Justice. [*Building Code Act, 1992* s. 25]. It may also be appealed to the Building Code Commission concerning the sufficiency of compliance with the technical requirements of the Building Code. [*Building Code Act, 1992* s. 24]
- Failure to comply with this Order could result in a Stop Work Order. [*Building Code Act, 1992* s. 14]
- Failure to comply with this Order is an offence which could result in a fine. [*Building Code Act, 1992* s.36]
- No construction affected by this Order is to be covered until inspected and approved. [*Building Code Act, 1992* s.13]

ATTACHMENT 14

Building Permit Application Review Letter

dated October 19, 2023

PLANNING AND ECONOMIC DEVELOPMENT DEPARTMENT
Building Division
71 Main Street West – 3rd Floor
Hamilton, Ontario, Canada, L8P 4Y5
Phone: 905.546.2720 Fax: 905.546.2764
www.hamilton.ca

Hamilton

October 19, 2023

IAN VAN OSCH

2694 RIVER RD.
HALDIMAND, ON N0A 1E0

RE: 820 SULPHUR SPRINGS . ANCASTER
Building Permit Application Number 23-306727-00 R9
Building Permit Application Review Letter

The following item(s) are required to be addressed prior to further review of the above-noted building permit application:

Item	Administrative	Reference
A1.	The property is located within the Hamilton Conservation Authority, prior approval is required. Contact the Hamilton Conservation Authority at permits@conservationhamilton.ca for further information.	

Note: Responding information will only be reviewed if provided in a single comprehensive submission complete with an itemized covering letter. Incomplete submissions will be subject to additional fees.

All documents shall be signed by the applicable required design professional(s). When revised drawings are submitted provide two (2) copies sealed and signed by the design professional(s).

Please be advised that should revised drawings be received that do not address the above-noted issues, there may be additional plan review fees owing in the amount of $170.00 per hour of review time.

If you require further information, please contact Ainsley Cannon at (905) 546-2424 ext. 4082 or Ainsley.cannon@hamilton.ca

Ainsley Cannon
Plan Examiner / Permit Application Specialist

For Director, Building Division

ATTACHMENT 15

Correspondence from Andre Obradovic, NEC

dated November 10, 2023

Ed Fothergill

From: Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>
Sent: November 10, 2023 4:08 PM
To: Marcia Oliver; Mike Stone; Cathy Plosz; Kiddie, Melissa
Cc: Scott Peck; Ed Fothergill; Anthony Quinn; randy.deguire@hamilton.ca; Catarino, Jennifer
Subject: RE: 820 Sulphur Springs Road - Building Permits

Hello Marcia,

I have reviewed your letter dated October 31, 2023. The subject property is located within the Niagara Escarpment Plan (NEP) area and area of Development Control (DC). As such, any proposed development including, a change in use or the repair, reconstruction or erection of a structure, requires written permission from the Niagara Escarpment Commission (NEC) in the form of a development permit unless the proposed development is considered exempt. NEC staff are of the opinion that the external repairs to the heritage structure are exempt from requiring a NEC development permit. Section 5.4.1 of Ontario Regulation 828/90 exempts the maintenance or repair of the exterior of a building or structure that does not change the use of the building or structure. NEC staff do not consider the repairs as a change in use. The repairs are proposed to maintain and conserve the structural integrity of the heritage structure. A change in use of this structure is proposed under NEC development permit application (W/R/2022-2023/054) which is currently being processed. The proposed repairs to the heritage structure are not related to the active NEC application. Considering that the proposal meets Section 5.4.1 of Ontario Regulation 828/90, an NEC development permit is not required for the proposed repairs.

Feel free to reach out to me if you have any questions.

Best,

Andrej Obradovic
Senior Planner | Niagara Escarpment Commission
232 Guelph Street, Georgetown, Ontario, L7G 4B1
289-924-1166 | www.escarpment.org

Niagara Escarpment Commission
An agency of the Government of Ontario

As part of providing accessible customer service, please let me know if you have any accommodation needs or require communication supports or alternate formats.

The NEC offices are now open to the public in a limited capacity. In order to ensure a safe and secure environment for staff and clients, the NEC **requires** that you make an appointment to meet with staff in person. Alternatively, the NEC will continue to provide services via telephone and email. Updates can be found on our website: https://escarpment.org/appointments

ATTACHMENT 16

Correspondence from Mike Stone, Conservation Hamilton
dated November 15, 2023

Ed Fothergill

From: Mike Stone <Mike.Stone@conservationhamilton.ca>
Sent: November 15, 2023 5:18 PM
To: Marcia Oliver
Cc: Ed Fothergill; Anthony Quinn; randy.deguire@hamilton.ca; Catarino, Jennifer; Kiddie, Melissa; Obradovic, Andrej (MNRF); Cathy Plosz; Scott Peck
Subject: RE: 820 Sulphur Springs Road - Building Permits 3rd Follow UP

Good afternoon Marcia,

Thank you for your patience as we have continued to consider this matter.

The work completed and proposed for the subject structure represents new development under HCA's regulation. HCA's policies do not permit development in a confined creek valley system and where a site does not have safe access. As such, HCA is not able to issue a permit(s) for the work completed or proposed.

Notwithstanding our June 22, 2023 Caution Notice follow-up letter, HCA will be giving further consideration as to what further action may be required under our regulation given the work completed without a permit.

HCA staff are available to meet to discuss these comments further if you feel that may be helpful.

Kind regards,
Mike

Mike Stone MA, MCIP, RPP | Manager, Watershed Planning, Stewardship & Ecological Services | Hamilton Conservation Authority
838 Mineral Springs Road, P.O. Box 81067, Ancaster (Hamilton), Ontario L9G 4X1
T: 905.525.2181 ext. 133 | E: mike.stone@conservationhamilton.ca | W: www.conservationhamilton.ca

From: Marcia Oliver <moliver@BennettGroup.ca> **Sent:** November 15, 2023 1:20 PM **To:** Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Scott Peck <Scott.Peck@conservationhamilton.ca>
Cc: Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>
Subject: RE: 820 Sulphur Springs Road - Building Permits 3rd Follow UP

Good Afternoon, Scott, Mike and Cathy

I am addressing this email to all of you in the hope that one of you might reply.

As you know, we submitted all material requested by Cathy back in July. We assume that material was reviewed by HCA, as no further request for information has been made by HCA to date. Further, as you also know we were directed to seek approval from NEC as a first step and to that end, NEC and HCA had a meeting last week; and, as you are aware NEC has advised us that no Development Permit from NEC is required in relation to the proposed work on the existing building. On Friday

Hamilton Conservation Authority
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last, and on Monday I sent emails to Mike's attention requesting HCA provide us with direction on next steps, including its position regarding the Building Permits (current application for exterior work and application to be submitted for work already done) and to date, I have no response.

Respectfully, I am at a loss to understand the delay and would ask for the courtesy of a reply.

Best regards,

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca

From: Marcia Oliver
Sent: Monday, November 13, 2023 1:02 PM
To: Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <aquinn@BennettGroup.ca>; randy.deguire@hamilton.ca; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>
Subject: RE: 820 Sulphur Springs Road - Building Permits

Hi Mike

Please see my questions below regarding next steps as related to obtaining the building permits. If a call will assist to expedite the next steps in the process, I am happy to make myself available.

I look forward to hearing from you as soon as possible.

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca

From: Marcia Oliver <moliver@BennettGroup.ca> **Sent:** Friday, November 10, 2023 4:22 PM **To:** Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>
Subject: Re: 820 Sulphur Springs Road - Building Permits

Andrej,

Thank you for this. Your prompt response is greatly appreciated.

@'Mike Stone' @Cathy.Plosz@conservationhamilton.ca, would you please advise us if HCA requires any further steps to be taken before the building permits can be issued, or does this end the required review, and will you be providing us with a letter/email for the benefit of the building department.

Many thanks and have a good weekend,

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

From: Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca> **Sent:** Friday, November 10, 2023 4:08:15 PM
To: Marcia Oliver <moliver@BennettGroup.ca>; Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca <randy.deguire@hamilton.ca>; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>
Subject: RE: 820 Sulphur Springs Road - Building Permits

Hello Marcia,

I have reviewed your letter dated October 31, 2023. The subject property is located within the Niagara Escarpment Plan (NEP) area and area of Development Control (DC). As such, any proposed development including, a change in use or the repair, reconstruction or erection of a structure, requires written permission from the Niagara Escarpment Commission (NEC) in the form of a development permit unless the proposed development is considered exempt. NEC staff are of the opinion that the external repairs to the heritage structure are exempt from requiring a NEC development permit. Section 5.4.1 of Ontario Regulation 828/90 exempts the maintenance or repair of the exterior of a building or structure that does not change the use of the building or structure. NEC staff do not consider the repairs as a change in use. The repairs are proposed to maintain and conserve the structural integrity of the heritage structure. A change in use of this structure is proposed under NEC development permit application (W/R/2022-2023/054) which is currently being processed. The proposed repairs to the heritage structure are not related to the active NEC application. Considering that the proposal meets Section 5.4.1 of Ontario Regulation 828/90, an NEC development permit is not required for the proposed repairs.

Feel free to reach out to me if you have any questions.

Best,

Andrej Obradovic
Senior Planner | Niagara Escarpment Commission
232 Guelph Street, Georgetown, Ontario, L7G 4B1
289-924-1166 | www.escarpment.org

From: Marcia Oliver <moliver@BennettGroup.ca> **Sent:** November 8, 2023 9:37 AM

To: Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: Re: 820 Sulphur Springs Road - Building Permits

Thanks Mike.

Regarding your last comment, despite what Mr. Quinn did, he is now trying to comply and I would caution you and anyone else involved in this process not to exercise their discretion in any retaliatory fashion, in light of past non compliance.

I look forward to hearing from you soon.

Best regards

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

From: Mike Stone <Mike.Stone@conservationhamilton.ca> **Sent:** Wednesday, November 8, 2023 9:29:11 AM **To:** Marcia Oliver <moliver@BennettGroup.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca <Andrej.Obradovic@ontario.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca <randy.deguire@hamilton.ca>
Subject: RE: 820 Sulphur Springs Road - Building Permits

Good morning Marcia,

HCA, City and NEC staff are meeting tomorrow for a discussion. In the interim, I can advise that with respect to your question no. 1, the general process is that the NEC issues their permit first, followed by HCA, and then City Building.

While I appreciate your last comment regarding timing and building integrity, I would note that we are presently in this position given that work on the former residence was initiated at Mr. Quinn's discretion and without having the required approvals in place.

I expect the agencies will be able to provide further comment after our discussion tomorrow.

Regards,
Mike

Mike Stone MA, MCIP, RPP | Manager, Watershed Planning, Stewardship & Ecological Services | Hamilton Conservation Authority
838 Mineral Springs Road, P.O. Box 81067, Ancaster (Hamilton), Ontario L9G 4X1
T: 905.525.2181 ext. 133 | E: mike.stone@conservationhamilton.ca | W: www.conservationhamilton.ca

From: Marcia Oliver <moliver@BennettGroup.ca> **Sent:** November 7, 2023 2:53 PM **To:** Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca> **Cc:** Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: 820 Sulphur Springs Road - Building Permits

Hi Mike

Just following up again.

While you sort things out as between NCA, HCA and COH, I would think, at the very least it would be possible for you to tell me: 1. Which authority needs to provide approval for the Building Permit to issue; and 2. Whether the information we provided to both HCA and copied to NEC in July of 2023 is sufficient to make the decision as to the issuance of the building permit. I suspect this is not the first time any of any of these authorities have dealt with this scenario and I would have thought that the process would be known and easy to provide us with.

Again, I reiterate that time is of the essence to get this work done. Without this exterior work the structural integrity of the building may be compromised.

Many thanks

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca

From: Marcia Oliver <moliver@BennettGroup.ca> **Sent:** Thursday, November 2, 2023 5:00 PM
To: Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: Re: Possible Spam 820 Sulphur Springs Road - Building Permits

Hi Mike

Thank you for your response. As you can appreciate time is of the essence as the colder weather is upon us. To properly protect the structure, the exterior work needs to proceed as soon as possible.

We would ask that whatever review is required, by whomever proceed on an expedited basis.

Many thanks for your anticipated cooperation,

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

From: Mike Stone <Mike.Stone@conservationhamilton.ca> **Sent:** Thursday, November 2, 2023 4:55:03 PM
To: Marcia Oliver <moliver@BennettGroup.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca <Andrej.Obradovic@ontario.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca <randy.deguire@hamilton.ca>
Subject: RE: Possible Spam 820 Sulphur Springs Road - Building Permits

You don't often get email from mike.stone@conservationhamilton.ca. Learn why this is important

Hello Marcia,

HCA is continuing to review your letter of October 31 and is not in a position to provide you with any comments at this time and your requested response date of November 2. Once we have had the opportunity to review and speak with City and NEC staff as may be required we will respond. I hope to be able to have comments for you over the next week or two.

Regards,

Mike Stone MA, MCIP, RPP | Manager, Watershed Planning, Stewardship & Ecological Services | Hamilton Conservation Authority
838 Mineral Springs Road, P.O. Box 81067, Ancaster (Hamilton), Ontario L9G 4X1
T: 905.525.2181 ext. 133 | E: mike.stone@conservationhamilton.ca | W: www.conservationhamilton.ca

From: Marcia Oliver <moliver@BennettGroup.ca> **Sent:** October 31, 2023 12:05 PM **To:** Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Mike Stone <mike.stone@conservationhamilton.ca>; Scott Peck <scott.peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: Possible Spam 820 Sulphur Springs Road - Building Permits

Good Afternoon

Please find attached my letter of today's date, along with the attachments referred to therein.

We look forward to hearing from you on or before Thursday November 2, 2023.

Yours truly,
Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

From: Marcia Oliver <moliver@BennettGroup.ca>
Sent: October 31, 2023 12:05 PM
To: Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Mike Stone <mike.stone@conservationhamilton.ca>; Scott Peck <scott.peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: Possible Spam 820 Sulphur Springs Road - Building Permits

Good Afternoon

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We look forward to hearing from you on or before Thursday November 2, 2023.

Yours truly,
Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
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From: Marcia Oliver <moliver@BennettGroup.ca>
Sent: November 7, 2023 2:53 PM
To: Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: 820 Sulphur Springs Road - Building Permits

Hi Mike

Just following up again.

While you sort things out as between NCA, HCA and COH, I would think, at the very least it would be possible for you to tell me: 1. Which authority needs to provide approval for the Building Permit to issue; and 2. Whether the information we provided to both HCA and copied to NEC in July of 2023 is sufficient to make the decision as to the issuance of the building permit. I suspect this is not the first time any of any of these authorities have dealt with this scenario and I would have thought that the process would be known and easy to provide us with.

Again, I reiterate that time is of the essence to get this work done. Without this exterior work the structural integrity of the building may be compromised.

Many thanks

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

Please consider the environment before printing. Thank you !

From: Marcia Oliver <moliver@BennettGroup.ca>
Sent: Thursday, November 2, 2023 5:00 PM
To: Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Andrej.Obradovic@ontario.ca; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: Re: Possible Spam 820 Sulphur Springs Road - Building Permits

Hi Mike

application. Considering that the proposal meets Section 5.4.1 of Ontario Regulation 828/90, an NEC development permit is not required for the proposed repairs.

Feel free to reach out to me if you have any questions.

Best,

Andrej Obradovic
Senior Planner | Niagara Escarpment Commission
232 Guelph Street, Georgetown, Ontario, L7G 4B1
289-924-1166 | www.escarpment.org

Niagara Escarpment Commission
An agency of the Government of Ontario

As part of providing accessible customer service, please let me know if you have any accommodation needs or require communication supports or alternate formats.

The NEC offices are now open to the public in a limited capacity. In order to ensure a safe and secure environment for staff and clients, the NEC **requires** that you make an appointment to meet with staff in person. Alternatively, the NEC will continue to provide services via telephone and email. Updates can be found on our website: https://escarpment.org/appointments

From: Marcia Oliver <moliver@BennettGroup.ca>
Sent: November 8, 2023 9:37 AM
To: Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Toman, Charlie <Charlie.Toman@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca
Subject: Re: 820 Sulphur Springs Road - Building Permits

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Thanks Mike.

Regarding your last comment, despite what Mr. Quinn did, he is now trying to comply and I would caution you and anyone else involved in this process not to exercise their discretion in any retaliatory fashion, in light of past non compliance.

I look forward to hearing from you soon.

Best regards

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

Please consider the environment before printing. Thank you !

From: Marcia Oliver
Sent: Monday, November 13, 2023 1:02 PM
To: Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Mike Stone <Mike.Stone@conservationhamilton.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>
Cc: Scott Peck <Scott.Peck@conservationhamilton.ca>; Ed Fothergill <edf@nas.net>; Anthony Quinn <aquinn@BennettGroup.ca>; randy.deguire@hamilton.ca; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>
Subject: RE: 820 Sulphur Springs Road - Building Permits

Hi Mike

Please see my questions below regarding next steps as related to obtaining the building permits. If a call will assist to expedite the next steps in the process, I am happy to make myself available.

I look forward to hearing from you as soon as possible.

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

Please consider the environment before printing. Thank you !

From: Marcia Oliver <moliver@BennettGroup.ca>
Sent: Friday, November 10, 2023 4:22 PM

1. Given your email of November 15, 2023, is HCA's determination therein - that it will not provide a permit or permission for such works – in effect a final decision of our client's forthcoming application?
2. When you refer to "HCA's regulation", are you are referencing O. Reg 161/06 made under the Conservation Authorities Act? If it is this or another Regulation, please specify same and what section(s) are relied upon in reaching the conclusions communicated to our client on November 15, 2023.
3. When you reference HCA's policies, which specific policies and sections thereof is HCA relying upon?
4. Please provide us with the evidence and rational HCA relies in rendering its decision to not permit or provide permission for the requested works.
5. Finally, please advise whether there is any other process or steps our client should be taking, and what appeal process should be utilized in order to challenge the subject decision of HCA.

Time is, as we have noted, of the essence for two reasons: the exterior work needs to be completed as soon as possible to avoid any damage to the structure of the building; and if any relevant appeal process you advise us of requires the filing of an appeal within a specified time frame, we want to ensure we meet that deadline. Accordingly, as noted above your reply is requested on or before Tuesday, November 28, 2023.

Many thanks for your attention to this matter

Best regards,
Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

Please consider the environment before printing. Thank you !

From: Mike Stone <Mike.Stone@conservationhamilton.ca>
Sent: Wednesday, November 15, 2023 5:18 PM
To: Marcia Oliver <moliver@BennettGroup.ca>
Cc: Ed Fothergill <edf@nas.net>; Anthony Quinn <AQuinn@BennettGroup.ca>; randy.deguire@hamilton.ca; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Scott Peck <Scott.Peck@conservationhamilton.ca>
Subject: RE: 820 Sulphur Springs Road - Building Permits 3rd Follow UP

Good afternoon Marcia,

Thank you for your patience as we have continued to consider this matter.

The work completed and proposed for the subject structure represents new development under HCA's regulation. HCA's policies do not permit development in a confined creek valley system and

Many thanks

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

From: Marcia Oliver
Sent: Friday, December 1, 2023 3:18:37 PM
To: Mike Stone <Mike.Stone@conservationhamilton.ca>
Cc: Ed Fothergill <edf@nas.net>; Anthony Quinn <aquinn@BennettGroup.ca>; randy.deguire@hamilton.ca <randy.deguire@hamilton.ca>; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Scott Peck <Scott.Peck@conservationhamilton.ca>
Subject: RE: 820 Sulphur Springs Road - 23.11.24 Oliver Response to Stone Email of November 15, 2023

Hi Mike

Thank you for your email below.

As you already know, time is of the essence if we are to complete the exterior work before winter sets in; and as you also know, if the exterior work is not completed soon, the structural integrity of the building will most likely be compromised over the winter.

It would be appreciated if you could provide us with some time frame as to when we might expect your response.

I look forward to hearing from you as soon as possible.

Many thanks,

Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

Please consider the environment before printing. Thank you !

ATTACHMENT 17

Correspondence from Mike Stone, Conservation Hamilton
dated December 22, 2023

Ed Fothergill

From: edf@nas.net on behalf of Mike Stone <Mike.Stone@conservationhamilton.ca>
Sent: December 22, 2023 1:00 PM
To: Ed Fothergill
Subject: RE: 820 Sulphur Springs Road - 23.11.24 Oliver Response to Stone Email of November 15, 2023
Attachments: HCA 23-12-22 Response to M.Oliver Email of 23-11-24.pdf

Hello Marcia,

Please see attached.

HCA staff can be available in January to review these comments further if that would be of assistance.

Regards,
Mike

Mike Stone MA, MCIP, RPP | Manager, Watershed Planning, Stewardship & Ecological Services | Hamilton Conservation Authority
838 Mineral Springs Road, P.O. Box 81067, Ancaster (Hamilton), Ontario L9G 4X1
T: 905.525.2181 ext. 133 | E: mike.stone@conservationhamilton.ca | W: www.conservationhamilton.ca

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From: Marcia Oliver <moliver@BennettGroup.ca>
Sent: December 22, 2023 11:21 AM
To: Mike Stone <Mike.Stone@conservationhamilton.ca>
Cc: Ed Fothergill <edf@nas.net>; randy.deguire@hamilton.ca; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Scott Peck <Scott.Peck@conservationhamilton.ca>; Anthony Quinn <AQuinn@BennettGroup.ca>
Subject: Re: 820 Sulphur Springs Road - 23.11.24 Oliver Response to Stone Email of November 15, 2023

Hamilton Conservation Authority
A Healthy Watershed for Everyone

Hi Mike

Looking forward to receipt of your response today.

All the best of the Season !

Marcia

Marcia J. Oliver, LL.B

General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
E: moliver@bennettgroup.ca
W: https://www.bennettgroup.ca

From: Mike Stone <Mike.Stone@conservationhamilton.ca>
Sent: Tuesday, December 19, 2023 4:59:59 PM
To: Marcia Oliver <moliver@BennettGroup.ca>
Cc: Ed Fothergill <edf@nas.net>; randy.deguire@hamilton.ca <randy.deguire@hamilton.ca>; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Scott Peck <Scott.Peck@conservationhamilton.ca>; Anthony Quinn <AQuinn@BennettGroup.ca>
Subject: RE: 820 Sulphur Springs Road - 23.11.24 Oliver Response to Stone Email of November 15, 2023

Good afternoon Marcia,

I met with our counsel this afternoon and expect to have some reply comments to you by the end of the week to address your November 24 email/questions.

Regards,
Mike

From: Marcia Oliver <moliver@BennettGroup.ca>
Sent: December 19, 2023 10:55 AM
To: Mike Stone <Mike.Stone@conservationhamilton.ca>
Cc: Ed Fothergill <edf@nas.net>; randy.deguire@hamilton.ca; Catarino, Jennifer <Jennifer.Catarino@hamilton.ca>; Kiddie, Melissa <Melissa.Kiddie@hamilton.ca>; Obradovic, Andrej (MNRF) <Andrej.Obradovic@ontario.ca>; Cathy Plosz <Cathy.Plosz@conservationhamilton.ca>; Scott Peck <Scott.Peck@conservationhamilton.ca>; Anthony Quinn <AQuinn@BennettGroup.ca>
Subject: RE: 820 Sulphur Springs Road - 23.11.24 Oliver Response to Stone Email of November 15, 2023
Importance: High

Good morning, Mike.

Just following up with you regarding your note below. When can we expect your response ?

Many thanks,
Marcia

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West, Millgrove, Ontario ON L0R 1V0
T: 905.689.7242 F: 905.689.7289 C: 519.719.2824
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Hamilton Conservation Authority

A Healthy Watershed for Everyone

BY EMAIL

December 22, 2023

Marcia J. Oliver, LL.B
General Counsel, V.P. Legal Services & Indigenous Relations
Bennett Construction Group
524-6th Concession Road West
Millgrove, ON L0R 1V0

Dear Ms. Oliver,

Re: 820 Sulphur Springs Road - 23.11.24 Oliver Response to Stone Email of 23.11.15

On November 24, 2023, you sent an email to HCA advising that, further to HCA's email of November 15, 2023, you intend to make a formal application to HCA for a permit to complete weather proofing works on the existing structure, but that prior to doing so you were seeking clarification on a number of matters, as set out in items 1 to 5 in your email. In response to your email, HCA provides the following comments for your consideration. Our comments are organized under items 1 to 5 as outlined in your November 24 email.

1. **Given your email of November 15, 2023, is HCA's determination therein - that it will not provide a permit or permission for such works – in effect a final decision of our client's forthcoming application?**

No, HCA's November 15 comments do not represent a final decision or formal denial, as no permit application has been received and such a denial can only be made by the HCA Board of Directors. You are entitled to submit applications for permission for the completed and proposed works, which HCA will process in the usual manner. Where a development proposal does not comply with HCA policies and a permission (permit) can not be issued at the staff level, applicants have the opportunity to appear and make submissions before the HCA Board of Directors to have their application further considered. The Hearing Board may refuse the application or approve the application, with or without conditions.

2. **When you refer to "HCA's regulation", are you are referencing O. Reg 161/06 made under the Conservation Authorities Act? If it is this or another Regulation, please specify same and what section(s) are relied upon in reaching the conclusions communicated to our client on November 15, 2023.**

Yes, the regulation referenced in HCA's November 15 email is *O. Reg 161/06* (*HCA's Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses*) made under the *Conservation Authorities Act* ("Regulation").

Section 2(1) of the Regulation outlines that no person shall undertake development or permit another person to undertake development in or on the areas within the jurisdiction of the Authority (i.e. a regulated area). Section 3(1) of the Regulation outlines that an Authority may grant permission for development in a regulated area if, in its opinion, the control of flooding, erosion, dynamic beaches, pollution or the conservation of land will not be affected by the development. Section 28(12) of the *Conservation Authorities Act* outlines that permission required under a regulation shall not be refused or granted subject to conditions unless the person requesting the permission has been given the opportunity to require a hearing before the Authority.

HCA staff refer to HCA Board of Directors' approved Planning & Regulation Policies and Guidelines ("*Policies and Guidelines*") to determine if a development may impact the considerations outlined in Section 3(1) of the Regulation. From time to time, the HCA staff will also refer to other applicable public policies.

Links to the Regulation, the *Conservation Authorities Act,* and HCA's *Policies and Guidelines* are included below:

https://www.ontario.ca/laws/regulation/060161

https://www.ontario.ca/laws/statute/90c27#BK47

https://conservationhamilton.ca/images/PDFs/Planning/PlanReqPolicyGuidewAppendices.pdf.

3. When you reference HCA's policies, which specific policies and sections thereof is HCA relying upon?

As noted in HCA's email of November 15, the work completed and proposed for the subject structure represents new development under HCA's Regulation. What constitutes *development* is defined under Section 28(25) of the *Conservation Authorities Act*. HCA's *Policies and Guidelines* do not permit development within erosion hazard limits or natural features associated with a confined creek valley system or where a site does not have safe access. Please refer to Section 2.1 and 8.1 of HCA's *Policies and Guidelines*.

HCA staff's full assessment of the past and proposed development's conformity with the *Policies and Guidelines* and Regulation will be provided upon review of any permit application submission and in any Staff Report created in preparation of a hearing before the HCA's Board of Directors.

4. **Please provide us with the evidence and rational HCA relies in rendering its decision to not permit or provide permission for the requested works.**

The past and proposed development's conformity with the *Policies and Guidelines* and Regulation will be provided upon review of any permit application submission and in any Staff Report created in preparation of a hearing before the HCA's Board of Directors.

On a strictly preliminary basis, we can advise that the subject structure for which development work is proposed is located within the limits of the Sulphur Creek confined valley system. As noted above, HCA's *Policies and Guidelines* do not permit development within the limits of a confined valley system. As well, based on the floodplain modelling completed by the engineering consultant (S. Llewellyn & Associates, June 2021), it is confirmed the driveway access from the municipal road to the subject site is affected by flood depths that do not meet HCA's *Policies and Guidelines* or provincial standards for safe access set out in the Technical Guide - River and Stream Systems: Flooding Hazard Limit (Ministry of Natural Resources, 2002).

5. **Finally, please advise whether there is any other process or steps our client should be taking, and what appeal process should be utilized in order to challenge the subject decision of HCA.**

As noted above, you are entitled to submit applications for permission for the completed and proposed works, which HCA will process in the usual manner. As part of your application, you will be required to submit a full description of the work completed and proposed, along with a site plan, grading plan and elevation drawings illustrating the works, as well as any supporting technical studies you are relying on in support of the works (e.g. floodplain assessment). A site visit will also be required to confirm work completed and proposed.

Based on our current understanding of the work completed and proposed, the applications would be considered as a major development permit with technical studies, with a violation surcharge for work completed without a permit. Under HCA's 2023 fee schedule, the fee for a major development permit with technical studies and a violation surcharge would be $9,298.21 (major development permit with technical studies $4702 + 75% violation surcharge + HST). We would accept this fee for both applications in this case. This fee is required to be submitted with the permit applications in order for the applications to be deemed complete.

Upon review of any permit application, if it is determined that the development does not conform with HCA *Policies and Guidelines* and any other applicable provincial policies and, therefore, HCA staff cannot support/issue the permit, you will be entitled to a hearing under Section 28(12) of the *Conservation Authorities Act* where HCA's Board of Directors will make the final decision on the request for permission for development.

You will have the opportunity to make written and oral submissions before any decision is made by HCA's Board of Directors, The Board may deny or approve the application, with or without conditions. If the Board denies the application (or approves it subject to conditions), you will have the opportunity to appeal the decision to the Ontario Land Tribunal.

Finally, we would reiterate that any development within an area regulated by the HCA without its prior written permission constitutes a violation of the Regulation and is considered an offence under Section 28(16) of the *Conservation Authorities Act* and, on conviction, an offender can be found liable to a fine of not more than $10,000 or to a term of imprisonment of not more than three months.

Notwithstanding any permit application you may make and any decision regarding that application, HCA retains the authority to take further action as may be permitted under the Regulation and the *Conservation Authorities Act* for any work completed without a permit.

We hope that this information will be of assistance to you in considering whether to proceed with a formal permit application. HCA staff are available to discuss these comments further if you have additional questions.

Sincerely,

Mike Stone, MA, RPP, MCIP
Acting Director, Watershed Management Services

TAB 9

Hearing Report

TO:	**Board of Directors**
FROM:	**Lisa Burnside, Chief Administrative Officer (CAO)**
RECOMMENDED BY:	**Mike Stone, MCIP, RPP, Acting Director, Watershed Management Services**
PREPARED BY:	**Cathy Plosz, MCIP, RPP, Senior Planner, Watershed Management Services**
REVIEWED BY:	**T. Scott Peck, MCIP, RPP, Deputy Chief Administrative Officer**
DATE:	**May 9, 2024**
RE:	**Hearing under Section 28.1(5) of the *Conservation Authorities Act* for an Application by Anthony Quinn c/o AQ Holdings for Development in a Regulated Area of Sulphur Creek at 820 Sulphur Springs Road, City of Hamilton (Ancaster) – Permit Application No. A/F,C/24/05.**

STAFF RECOMMENDATION

THAT HCA staff recommends to the Board of Directors:

THAT the Board of Directors refuse the application made by Anthony Quinn (c/o AQ Holdings) for repair work on a former residential dwelling in a regulated area of Sulphur Creek at 820 Sulphur Springs Road, City of Hamilton (Ancaster) as the proposal does not meet the requirements of the development Regulation under the *Conservation Authorities Act*.

BACKGROUND

Site Description

The subject site at 820 Sulphur Springs Road is a 23.12 ha (57.13 ac) vacant property, located west of Sulphur Springs Road and south of the Hamilton-Brantford rail trail. The property is within the Niagara Escarpment Plan Area of the Greenbelt Plan, and sits within the Sulphur Creek subwatershed and Sulphur Creek valley system. A tributary of Sulphur Creek traverses the southern portion of the subject property (Attachment A) and flows easterly through a culvert under Sulphur Springs Road.

The City's Rural Hamilton Official Plan (RHOP) has identified Core Areas of the Natural Heritage System on the property, including the Dundas Valley Environmentally Significant Area, Significant Woodland, unevaluated wetlands and a stream. A provincially significant Life Science Area of Natural and Scientific Interest (ANSI) is located east of Sulphur Springs Road, adjacent to the site. An Environmental Impact Statement (EIS) was prepared and confirmed five types of Significant Wildlife Habitat on site. The property is zoned P6, Conservation/Hazard Land, in the City of Hamilton's Comprehensive Zoning By-law. The site is designated as Escarpment Natural Area and Escarpment Protection Area under the Niagara Escarpment Plan.

The property contains a former two-storey single dwelling, which is thought to have been constructed sometime in the mid-1800s. The residence has not been occupied for many years, and in 2019 suffered significant damage resulting from a fire. The former residence is listed in the City's inventory of heritage buildings, but has no official status or protection through inclusion on the Municipal Heritage Registry or designation under the *Ontario Heritage Act.*

The entire property is regulated pursuant to the *Conservation Authorities Act* and *Ontario Regulation 41/*24 due to the presence of Sulphur Creek and its associated apparent (confined) valley, wetlands, and associated flooding and erosion hazards.

The Proposal

The proposal is for repair work to preserve the integrity of the remains of a former two-storey 128 sq. m (1,377.8 sq ft) single dwelling. The permit application is to recognize work already completed, and to allow for additional repair work.

Work already completed includes stone masonry repairs on the walls of the structure, the construction of a new cedar roof and chimney, and the addition of eaves and downspouts. The application also proposes additional repair work to preserve the integrity of the building, including finishing the roof, eaves and downspouts, waterproofing, siding, windows and doors, masonry repair, foundation insulation, repairing existing stairs leading to the basement, and general site clean-up.

The subject proposal is part of a larger development plan for the property, which is the subject of a Niagara Escarpment Commission (NEC) development permit application and includes the construction of a two-storey, 1100 sq. m. (11,840 sq. ft.) single dwelling, with a new driveway, septic system, well, and detached garage, and the conversion of the former residence to an accessory structure for storage purposes.

The site plan and elevation drawings provided in support of the proposal and permit application are attached to this report (Attachment B).

Application Review to Date

On July 5, 2021, HCA was copied on an email from Mr. Ed Fothergill, Fothergill Planning & Development Inc., to the Niagara Escarpment Commission (NEC) advising of his intention to submit a development permit application to the NEC on behalf of his client (Mr. Anthony Quinn) to allow for the construction of a new house and repair of the remains of a former residential dwelling at 820 Sulphur Springs Road. The email acknowledged flooding issues at the property and attached a floodplain analysis report that had been prepared in this regard, and requested NEC, City of Hamilton and HCA review of the information to facilitate their planned NEC development permit application.

On August 18, 2021, HCA staff provided its review comments on the floodplain analysis, noting the existing driveway to the property and former residence is affected by significant flooding from the Regional (regulatory) storm event and that safe access to the property is not available, and that as such, HCA would not support a proposal for redevelopment of the property.

On January 24, 2022, HCA received an email from Mr. Fothergill noting their intention to submit an HCA permit application for the proposed development. The permit application submission was received via email on January 27, 2022. HCA responded on January 28, 2022 noting staff had met with the NEC to review the proposal and that HCA cannot issue a permit under its Regulation until the required development permit under the Niagara Escarpment Planning and Development Act has been issued, and that as such HCA would not be processing the submitted permit application.

On June 10, 2022, HCA was circulated a Request for Comment from the NEC for a proposed development permit to construct a new single dwelling, garage, septic system, driveway and well, and to convert the former dwelling to an accessory structure.

On July 29, 2022, HCA provided comments to the NEC recommending refusal of the application given the property is affected by flooding and does not have safe access, that the proposed development is located within the Sulphur Creek confined valley system and it had not been demonstrated that the development was located beyond hazard limits, and that the potential environmental impacts of the development had not been adequately addressed.

The NEC development permit application review is still on-going, and there have been a number of resubmissions by the applicant to try and address NEC, HCA and City of Hamilton comments and concerns. HCA continues to have concerns as noted above, and has advised the applicant on a number of occasions the proposed development does not comply with HCA's policies and that HCA staff would not be able to support an HCA permit for the development. There has been no NEC decision regarding the NEC development permit application to date, and as noted, an HCA permit application cannot be processed until the NEC decision is made.

Notwithstanding the above, in April 2023 HCA staff observed potential development activity at the former residence on the subject property. HCA staff sent a Caution Letter to the property owner on May 10, 2023, noting its observations and that any development would require an HCA permit. HCA requested a site visit to confirm if work that may have required a permit had been completed.

On June 13, 2023, HCA staff attended a site visit with the owner and his planning agent. During the site visit, staff observed that restoration work had been completed on the former residence, including masonry repairs and construction of a new cedar roof and chimney. HCA also observed two gravel piles along the driveway, a concrete pad at the front of the structure, a chain link fence around the structure, construction debris (steel beams and concrete), a backhoe, two dumpsters, and exposed soil and rock piles near the top of bank of Sulphur Creek. While on site, the owner stated that work was complete and no further work was planned until they had received the required NEC development permit.

On June 22, 2023, the HCA sent a follow up letter to the Caution Notice and related site visit. HCA staff advised they did not intend to pursue the matter further given there did not appear to be any disturbance or filling in the floodplain and that flooding and erosion hazards had not been impacted by the work, and that the owner had indicated that no further work was proposed until they received their NEC development permit. The follow up letter also indicated that any further development or site alteration would require a permit, and that for any development to proceed it would have to be demonstrated that safe access to the site was available.

On July 5, 2023, the owner's planning agent contacted the HCA to advise that notwithstanding their earlier commitment to wait for receipt of the NEC development permit before undertaking any further work, that the owner intended to undertake further restorative work. It was noted this work was needed to prepare the building for winter, and would include finishing the roof, flashing, eaves/downspouts, waterproofing, siding, windows, doors, masonry repair and insulation below grade, repair of existing stairs leading to basement, and general clean up. In reviewing, HCA staff advised the owner to contact the NEC, to obtain a written response that either approves a NEC permit for the proposed work or provides clearance that an NEC permit is not required (i.e. the work is exempt), as HCA cannot issue a permit until NEC requirements are met.

On September 6, 2023, the City of Hamilton Building Department issued an order to comply for the work completed on the former residence without a building permit. The City was also in the process of reviewing a separate building permit submission for the proposed additional weatherproofing work.

After contacting the NEC, the owner was notified on November 10, 2023 that the proposed external repairs on the heritage building were exempt from requiring a NEC development permit, and that the NEC did not consider the proposed repairs to the heritage structure to be related to the active NEC application. After receiving the NEC response, the owner's legal counsel, Ms. Marcia Oliver, with Bennett Construction Group, contacted the HCA for direction on how to proceed, given HCA approval/clearance was required before a building permit could be issued.

On November 15, 2023, HCA responded that the repair work (completed and proposed) represents new development under its Regulation, and that since HCA policies do not permit development in a confined creek valley system and there is no safe access to the site, HCA staff is not able to issue a permit for the repair work. HCA also advised that it will be considering if further action may be required under its Regulation in relation to the work completed without a permit.

On November 24, 2023, HCA received an email from the applicant's counsel advising the applicant intended to apply for an HCA permit to complete the repair work on the existing building and requesting clarification regarding the applicable regulation and policies and details regarding the permit and appeal process.

On December 5, 2023, the property owner emailed HCA to advise he intended to proceed with the repair work without delay. HCA responded noting the proposed work would require an HCA permit, and that work completed without a permit would constitute a violation of HCA's regulation. Given HCA's policies would not support a permit, HCA was consulting with its legal counsel and would provide further direction on how to proceed.

On December 22, 2023, the HCA provided a letter in response to the applicant's counsel's email of November 24, 2023. The HCA letter noted applications for the completed and proposed work could be submitted and that HCA would process these in the normal manner. The letter provided clarification on the regulations and applicable policies, and describing the permit submission requirements and permit review and hearing process.

On January 17, 2024 the owner's planning agent confirmed that the owner intended to submit a permit application for the proposed work. The permit application was received electronically on January 19, 2024.

On January 30, 2024, HCA staff notified the applicant that additional information was required to deem the permit application complete. HCA staff also advised that the application could not be supported by staff, since the proposal did not conform to policy, and that the application would therefore need to be considered by the HCA Board of Directors at a Hearing.

The requested additional information in support of the permit application was received on January 31 and February 6, 2024. On February 2, 2024, HCA provided further comments to the applicant's counsel regarding Hearing process and timelines, and requesting the applicant confirm their preferred date for Hearing either in March or May. HCA staff undertook a site visit on February 7, 2024 to confirm scope of work completed and proposed. The applicant and newly retained counsel, Mr. Raj Kehar, with WeirFoulds LLP, were in attendance for the site visit.

On February 12, 2024, Mr. Kehar sent an email confirming their preference to proceed with a Hearing in May, rather than as originally proposed in March. HCA staff responded on February 13 confirming a Hearing could proceed on May 9, 2024.

In accordance with *Conservation Authority Act Hearing Guidelines* (MNRF October 2005, amended 2018, 2020 and 2021) and the *Hamilton Region Conservation Authority Administrative By-law* (HCA, October 5, 2023), HCA provided the Notice of Hearing to the applicant, as well as a copy of this Hearing Report, which outlines HCA staff's analysis of the application and reasons for recommending refusal, on Friday, April 12, 2024.

STAFF COMMENT

HCA has a mandate to ensure that people and property are protected from impacts associated with natural hazards. The Province has delegated the authority for implementing the provincial interest in natural hazards to Conservation Authorities. In evaluating the subject application, HCA staff must ensure that HCA policies regarding development and hazardous lands, which are informed by Provincial direction and policy, are considered and met. The summary of key provincial policies below provides important background and context, and is followed by a description of the HCA hazard policies and legislative requirements that are applicable to the subject application.

Provincial Policy

The Provincial Policy Statement (PPS) provides policy direction on matters of provincial interest related to land use planning and development. The PPS provides a policy framework for allowing appropriate development, while protecting resources of provincial interest, conserving the natural and built environment, and ensuring public health and safety.

With respect to natural hazards, the PPS states that development shall generally be directed to areas outside of hazardous lands, including hazardous lands adjacent to river and stream systems which are impacted by flooding hazards and/or erosion hazards (PPS 3.1.1). Notwithstanding these restrictions, development may be permitted in those portions of hazardous lands where the effects and risks to public safety are minor and can be mitigated in accordance with provincial standards, and new hazards are not created or existing hazards aggravated, and no adverse environmental impacts will result (PPS 3.1.7).

HCA Policy

According to Section 28(1) of the *Conservation Authorities Act,* no person shall undertake development activity in a regulated area without permission from the HCA. Under Section 28.1 of the *Conservation Authorities Act,* HCA may issue a permit for development activity in a regulated area if, in its opinion, the activity is not likely to affect the control of flooding, erosion, dynamic beaches or unstable soil or bedrock, or create conditions or circumstances that, in the event of a natural hazard, might jeopardize the health or safety of persons or result in the damage or destruction of property.

Development activity is defined broadly under the *Conservation Authorities Act*, and includes the construction or reconstruction of a building or structure of any kind, and any change to a building or structure that would have the effect of altering the use or potential use of the building or structure.

HCA's *Planning & Regulation Policies and Guidelines*, as approved by the HCA Board of Directors in October 2011, were developed to implement the development regulations and requirements of the *Conservation Authorities Act*, as well as provincial natural hazard policies under the PPS. HCA applies these policies to its review of planning and regulation proposals. HCA policies generally do not permit development within a confined creek valley system or where a site does not have safe access.

On April 4, 2024, the HCA Board of Directors endorsed the adoption of *Interim Policy Guidelines for the Administration and Implementation of Ontario Regulation 41/24 (Prohibited Activities, Exemptions and Permits)*. These guidelines were developed by Conservation Ontario to provide CAs with interim direction to support the implementation of the new regulations, while existing CA policy documents are reviewed and updated as may be necessary. The guidelines provide that existing CA policies should continue to be considered and applied, with appropriate consideration given to the newly proclaimed sections of the *Conservation Authorities Act* and *Ontario Regulation 41/24*, and that where discrepancies exist between the legislation, existing CA policies and the interim guidelines, that the provisions of the text of the legislation and regulation will prevail.

The following provides a summary of the key policies and requirements of HCA's Planning & Regulation Policies and Guidelines, as they apply to the subject application.

2. 1. 2. Erosion Hazard Limits

Erosion hazards mean the loss of land, due to human or natural process, that pose a threat to life and property. The erosion hazard limit for river and stream systems is determined by using the 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), and includes allowances for toe erosion, slope stability, and access during emergencies.

Generally, development should not occur on or on top of valley walls because the long-term stability of the slope, and therefore public health and safety, cannot be guaranteed. Development should be set back from the top of valley walls far enough to avoid increases in loading forces on the top of the slope, changes in drainage patterns that would compromise slope stability or exacerbate erosion of the slope face, and loss of stabilizing vegetation on the slope face.

Confined systems are those where the watercourse is located within a valley corridor, either with or without a flood plain, and is confined by valley walls. Figure 1 illustrates how the erosion hazard limit is defined for a confined valley system.

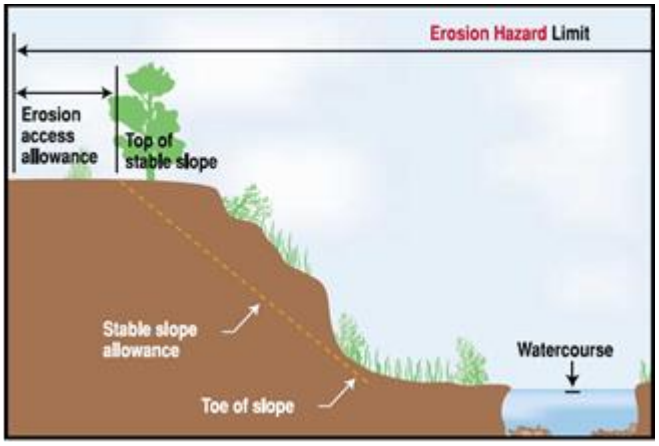


Figure 1: Erosion Hazard Limit for a Confined System

The subject property is located within the Sulphur Creek confined valley system (Attachment A).

2. 1. 2. 3 Development

Any development and/or site alteration within the jurisdiction of the Authority and within the erosion hazard limit and/or in, on or adjacent to valleylands must be in accordance with the following policies and guidelines and must be to the satisfaction of the Authority.

a. Development activities and uses on natural valley slopes will generally be prohibited. At its discretion, however, the Authority may permit the following uses:

i. Passive recreation and associated structures (e.g. staircases);

ii. Structures associated with erosion and sediment control; and

iii. Any other relevant or appropriate use and/or development as deemed satisfactory by the Authority.

d. Any development proposals adjacent to valleylands must be located outside of the erosion hazard limit and incorporate a vegetation protective zone appropriate for the features associated with that valley.

2. 1. 1 Flooding Hazard Limit

The Hamilton Conservation Authority manages flood plain lands at the Regulatory Flood level of the Regional Storm (Hurricane Hazel) with the exception of those numbered watercourses in the Stoney Creek area that have undergone a criteria reduction in the Regulatory Flood level to the 100 year flood event and the Special Policy Areas (SPAs) in Dundas. The Conservation Authority manages these lands as one zone areas with the exception of the Dundas SPAs, which utilize the floodway and flood fringe management approach, and are treated as two zone areas.

One zone areas are those where the Conservation Authority prohibits all development or site alteration within the boundaries of the Regulatory Flood level. This is the most effective way of minimizing threats to public health or safety or property damage. The one zone concept is the preferred approach for the management of flooding hazards within river and stream systems as it provides the most cost-effective means of minimizing potential threats to life and risks of property damage and social disruption. Where the one zone concept is applied, the entire flood plain or the entire flooding hazard limit defines the floodway (Figure 2).

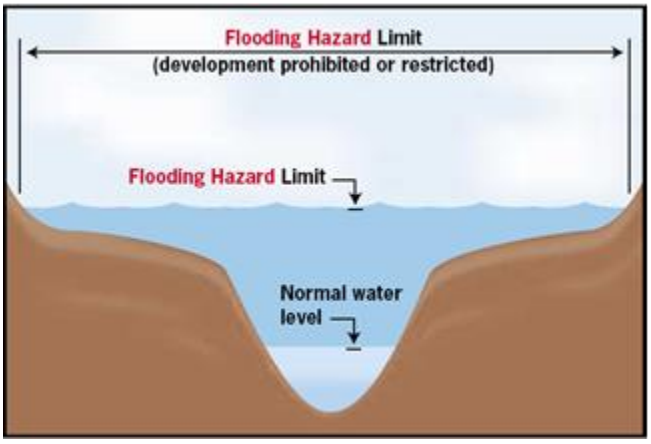


Figure 2: Flooding Hazard Limit for One Zone Concept

2. 1. 1. 3. 1 Development

Any development and/or site alteration within the jurisdiction of the Authority and within the flooding hazard limit for one zone areas must be in accordance with the following policies and guidelines and must be to the satisfaction of the Authority.

2. 1. 1. 3. 1. 1 Additions and Replacement Structures

l. Replacement structures must be constructed and located such that vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies.

8. 1. 1 Safe Access

a. Safe ingress and egress for pedestrians and vehicles must be such that the depth is less than 0.3 m (1 ft) and the velocity is no greater than 1.7 m/s (5.5 ft/s).

Application Assessment

The property at 820 Sulphur Springs Road is located in a confined (apparent) valley system associated with Sulphur Creek. The former residence has been repaired and restored, and is proposed to be an accessory structure as part of a larger development proposal for the property which continues to be under review by the NEC. The owner has completed work without the necessary approvals to advance their development proposal, and has now submitted an application for a HCA permit to recognize the work already done and for completing further restoration.

The entire property is within the limits of a natural confined valley system associated with Sulphur Creek. The former residence is located within the valley and its associated erosion hazard limit (Figure 1). As outlined above, HCA's *Policies and Guidelines* generally do not permit development within the limits of a confined valley system.

While the former residence is located outside the floodplain, the existing driveway to the structure is within the flooding hazard limits for the 100-year and Regional (regulatory) storms. The floodplain modelling completed by the engineering consultant (S. Llewellyn & Associates, June 2021, and updated November 8, 2023), confirmed that the driveway access from the municipal road to the subject site is affected by flood depths that do not meet HCA's Policies and Guidelines or provincial standards for safe access set out in the "Technical Guide - River and Stream Systems: Flooding Hazard Limit" (Ministry of Natural Resources, 2002). These policies and guidelines set out that in order for safe access to be provided for pedestrians and vehicles, that flood depths should be less than 0.3 m (1 ft) and velocities less than 1.7 m/s (5.5 ft/s).

The Technical Memorandum from S. Llewellyn and Associates (November 8, 2023) included a 2D floodplain analysis for the property which showed that the existing driveway can be flooded to a depth of 6.3 m (20.7 ft) at Sulphur Springs Road during a regulatory (Regional) storm event. Under these significant flood depths, safe access to the property would not be available for pedestrians, vehicles or emergency services.

In considering the applicable regulations and policies, it is HCA staff's opinion that the conditions under which a permit can be issued under the *Conservation Authorities Act* are not met for the proposed development activity. In particular, staff note that given safe access to the property is not available, the proposed development activity would create conditions or circumstances that, in the event of a regulatory flood, might jeopardize the health or safety of persons, which is contrary to the conditions for issuance of a permit under Section 28.1(b) of the *Conservation Authorities Act*.

The Gilmor Case

In support of staff's assessment of the application and the importance of safety considerations, it is noted the Court of Appeal for Ontario has upheld the importance and appropriateness of considering public safety and safe access when determining if a permit may be issued for development in areas subject to flooding hazards. In a 2017 decision by the Court of Appeal regarding the matter of *Gilmor v. Nottawasaga Valley Conservation Authority* (the 'Gilmor case'), the court concluded that the Conservation Authority's, and subsequently the Mining and Land Commissioner's, consideration of public safety and the absence of safe access was appropriate in determining a permit could not be issued for the development proposed in that case. The Court of Appeal upheld the Commissioner's decision and denied the development permit. There are similarities between the subject proposal and the Gilmor case, in that in the Gilmor case a new house was proposed outside of the floodplain, but there was no safe access to the house from the municipal road. In the Gilmor case, flood depths at the driveway/road were approximately 1 m (3 ft), considerably less than the flood depths at the subject property at 820 Sulphur Springs Road which exceed 6 m (20 ft).

STRATEGIC PLAN LINKAGE

HCA's Strategic Plan 2019 – 2023 outlines its major strategic priority areas and related initiatives for advancing HCA's Vision to provide a healthy watershed for everyone. HCA implements a wide variety of programs to fulfill this mandate, including programs to manage water resources and protect people and property from natural hazards. Administration of development regulations under the *Conservation Authorities* contributes to the achievement of these program objectives and HCA's Strategic Plan more generally.

AGENCY COMMENTS

None.

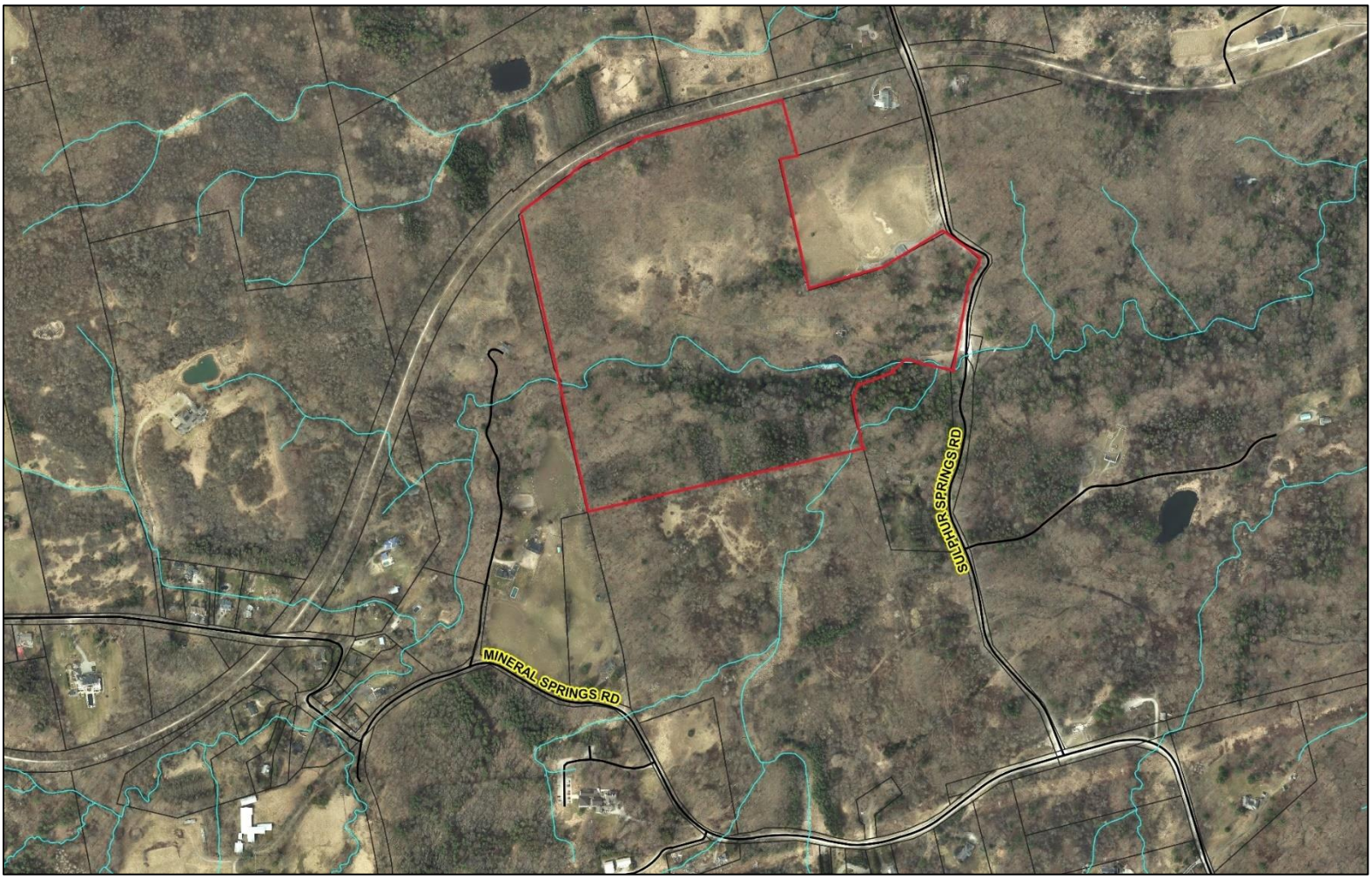
CONCLUSION

The subject application proposes development activity within the Sulphur Creek confined valley system and its associated erosion hazard limit. The existing driveway does not allow safe access to the property during a regulatory flood. Provincial and HCA policies take a preventative approach to addressing the potential risks and impacts associated with natural hazards by generally directing development to areas outside of hazardous lands. It is HCA staff's opinion the policy framework outlined in HCA's *Planning and Regulation Policies and Guidelines (October, 2011)* does not support the proposed development.

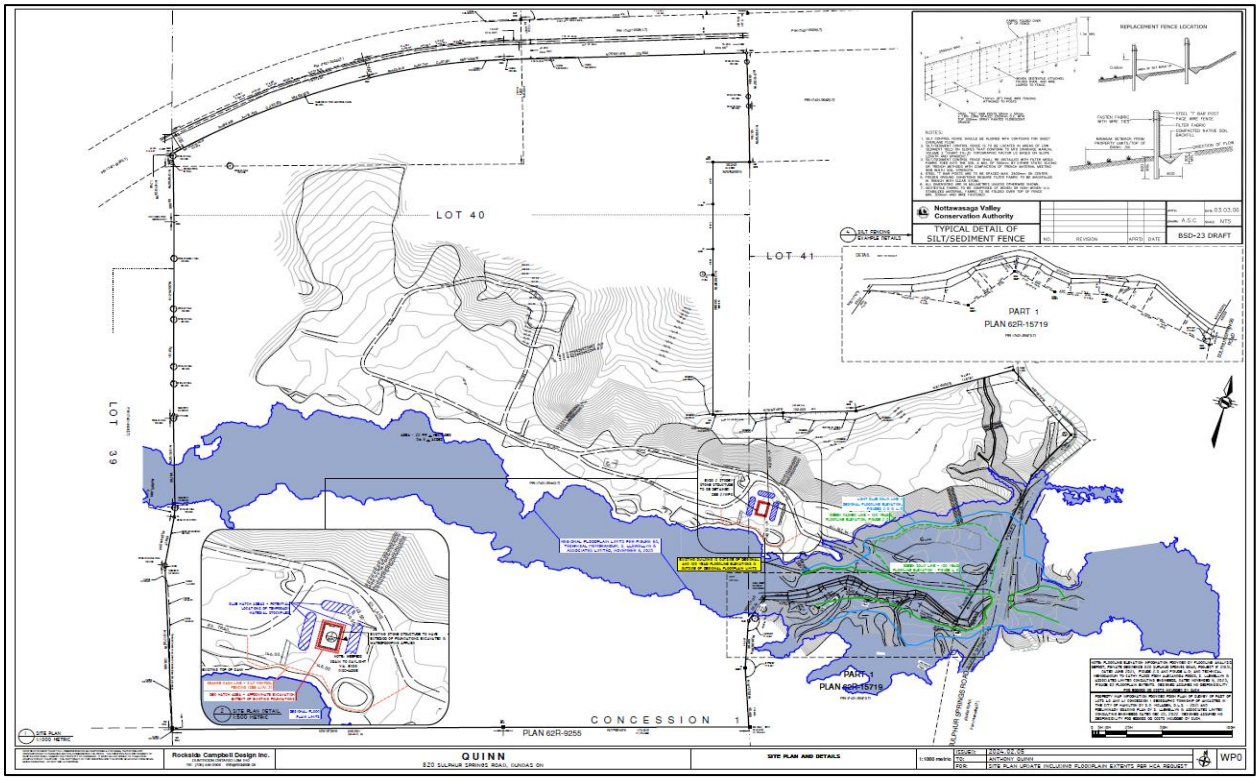
On this basis, the proposed development does not meet the conditions under which HCA may issue a permit under the *Conservation Authorities Act*. As such, it is the recommendation of HCA staff that the application be refused.

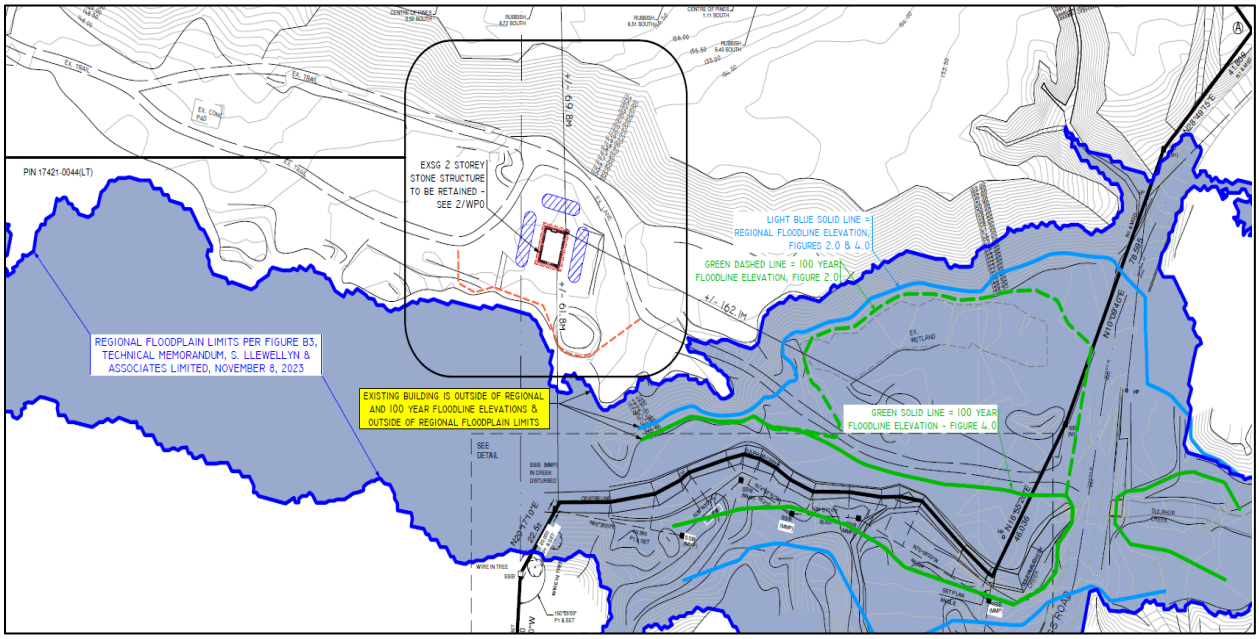
Attachment A – Site Location

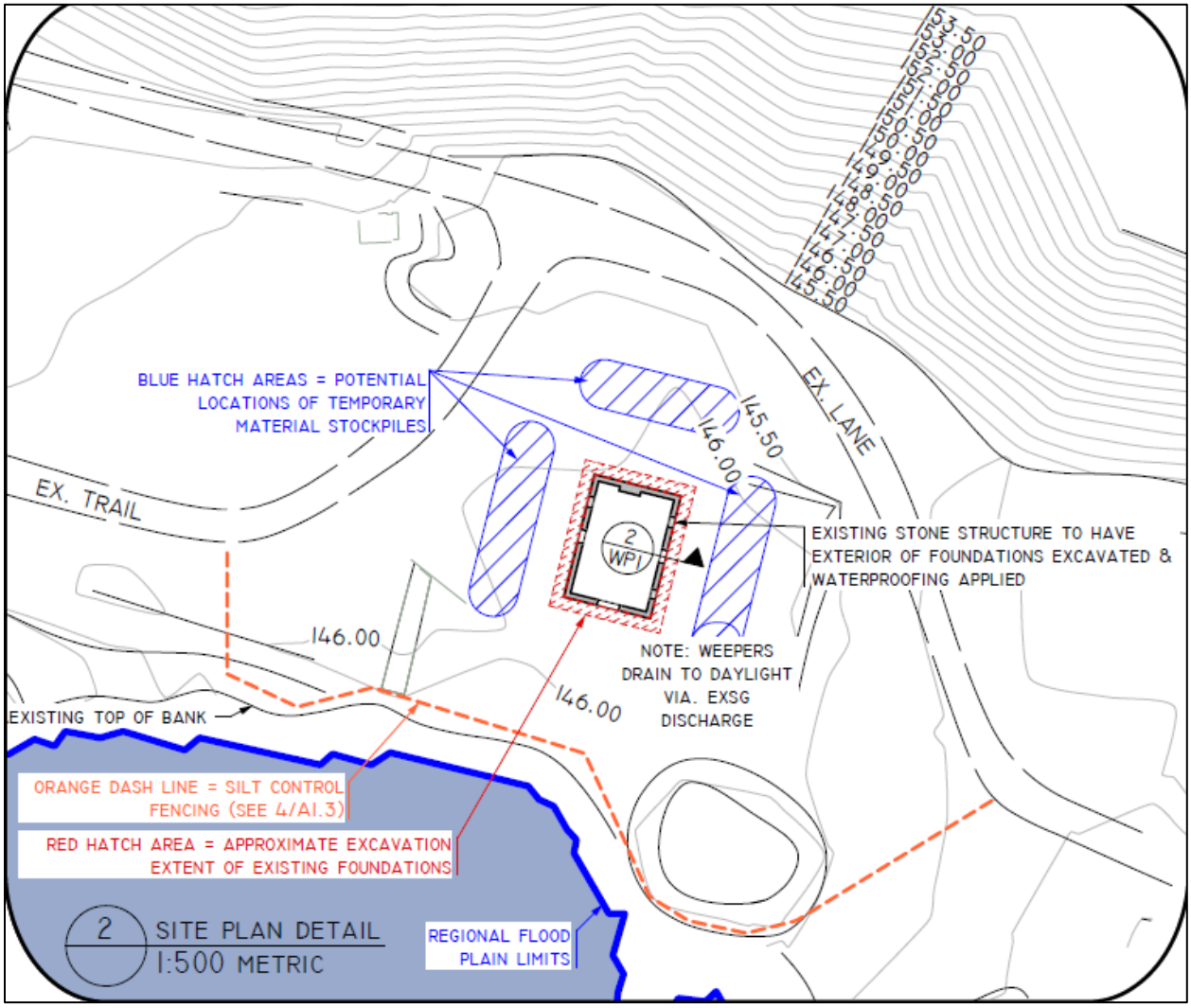
820 Sulphur Springs Road, City of Hamilton

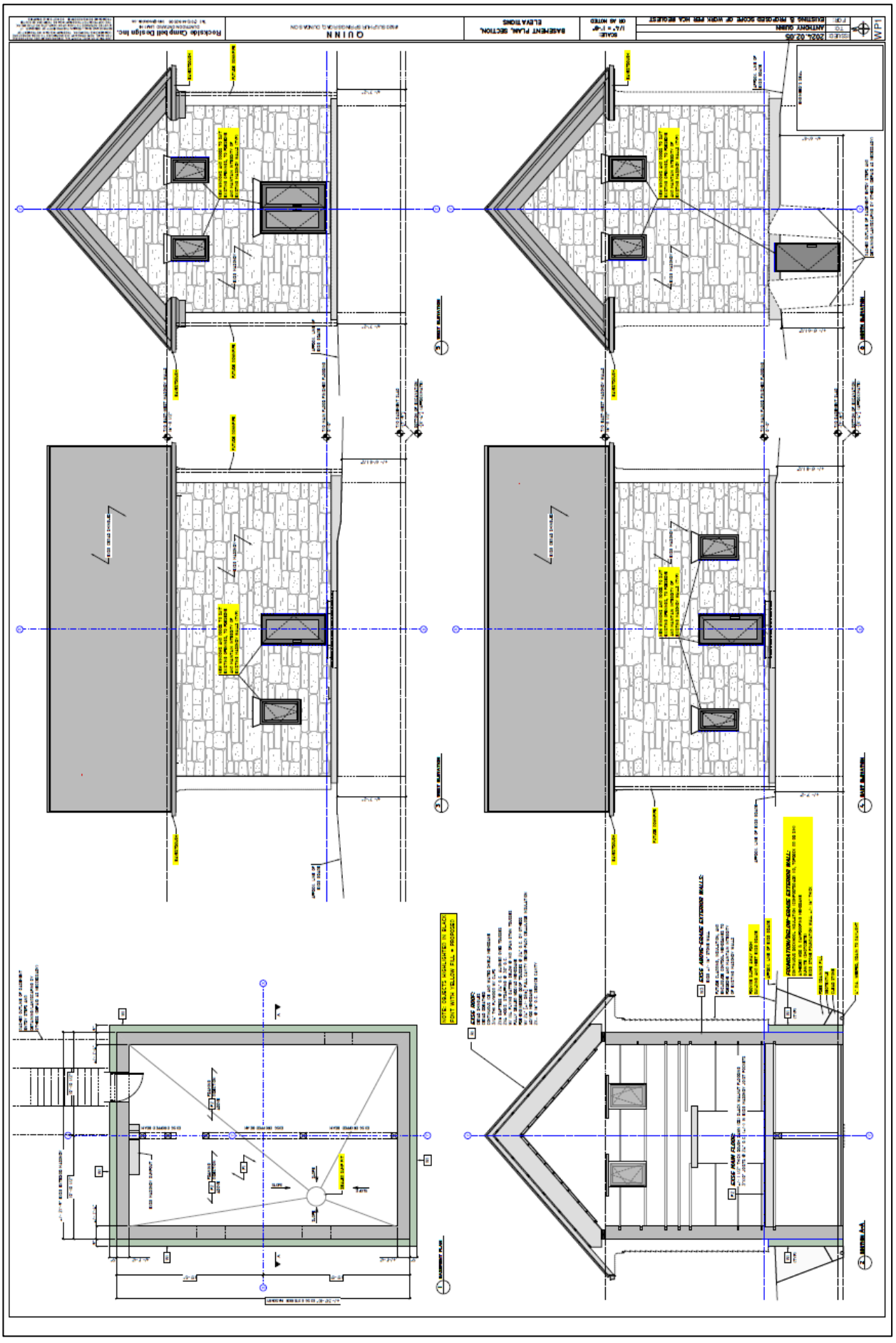


Attachment B – Development Proposal






BLUE HATCH AREAS = POTENTIAL LOCATIONS OF TEMPORARY MATERIAL STOCKPILES
EX. TRAIL
EX. LANE
145.50
146.00
2 WP
EXISTING STONE STRUCTURE TO HAVE EXTERIOR OF FOUNDATIONS EXCAVATED & WATERPROOFING APPLIED
NOTE: WEEPERS DRAIN TO DAYLIGHT VIA. EXSG DISCHARGE
146.00
146.00
EXISTING TOP OF BANK
ORANGE DASH LINE = SILT CONTROL FENCING (SEE 4/A1.3)
RED HATCH AREA = APPROXIMATE EXCAVATION EXTENT OF EXISTING FOUNDATIONS
2 SITE PLAN DETAIL
1:500 METRIC
REGIONAL FLOOD PLAIN LIMITS



TAB 10

LOT 40

LOT 41

LOT 39

PROPOSED RESIDENCE

PROPOSED GARAGE

PROPOSED SEPTIC

AREA - 22.99 ± HECTARES
56.8 ± ACRES

DRIPLINE

SITE Z: 15M SETBACK FROM DRIPLINE = PROPOSED BUILDING DEVELOPMENT AREA
(AREA 15M AWAY FROM DRIPLINE = +/- 2.07ha)

SITE Z: 15M SETBACK FROM DRIPLINE

PROPOSED SINGLE FAMILY RESIDENCE
(1STOREY MAX 555 SM GROUND FLOOR AREA (GFA & TFA))
(EXAMPLE BUILDING SHOWN FOR ILLUSTRATIVE PURPOSES ONLY)

PROPOSED BASEMENT TUNNEL
(1STOREY MAX 555 SM GROUND FLOOR AREA (GFA & TFA))
(EXAMPLE FOOTPRINT SHOWN FOR ILLUSTRATIVE PURPOSES ONLY)

PROPOSED DETACHED GARAGE
(1STOREY MAX 555 SM GROUND FLOOR AREA (GFA & TFA))
(EXAMPLE BUILDING FOOTPRINT SHOWN FOR ILLUSTRATIVE PURPOSES ONLY)

SITE Z: DRIPLINE
LIMIT OF WOODLAND AS FLAGGED AND TIED-IN ON SEPTEMBER 8, 2021
APPROX 17M NORTH-SOUTH X 202M EAST-WEST
(3,634m²)

SITE Z: EXSG TRAILS REUTILIZED AS DRIVEWAY

SITE Z: PROPOSED SEPTIC
(LOCATION AND SIZE TO BE CONFIRMED)

15M SEPTIC SETBACK LINE

MATCH INTO EX. GRADES MAX 3:1 (TYP.)

RUBBISH 0.57 WEST

RUBBISH 0.51 SOUTH

RUBBISH 0.49 SOUTH

RUBBISH 0.46 SOUTH

RUBBISH 0.49 SOUTH

CENTRE OF PINES 1:1 SOUTH

CENTRE OF PINES 1:1 SOUTH

EXISTING TOP OF BANK

EX. TRAIL

EX. LANE

REGIONAL FLOODPLAIN LIMITS PER FIGURE B3, TECHNICAL MEMORANDUM, S. LLEWELLYN & ASSOCIATES LIMITED, NOVEMBER 8, 2023

NOTE: ALL PROPOSED WORKS ARE OUTSIDE OF REGIONAL AND 100 YEAR FLOODLINE ELEVATIONS & OUTSIDE OF REGIONAL FLOODPLAIN LIMITS

LIGHT BLUE SOLID LINE = REGIONAL FLOODLINE ELEVATION, FIGURES 2.0 & 4.0

GREEN DASHED LINE = 100 YEAR FLOODLINE ELEVATION, FIGURE 2.0

GREEN SOLID LINE = 100 YEAR FLOODLINE ELEVATION - FIGURE 4.0

BLUE HATCH AREAS = POTENTIAL LOCATIONS OF TEMPORARY MATERIAL STOCKPILES

EXISTING STONE STRUCTURE TO HAVE EXTERIOR OF FOUNDATIONS EXCAVATED & WATERPROOFING APPLIED

NOTE: WEEPERS DRAIN TO DAYLIGHT VIA. EXSG DISCHARGE

ORANGE DASH LINE = SILT CONTROL FENCING (SEE 4/A1.3)

RED HATCH AREA = APPROXIMATE EXCAVATION EXTENT OF EXISTING FOUNDATIONS

REGIONAL FLOOD PLAIN LIMITS

OUTLINE OF FORMER PATIO

OUTLINE OF FORMER PORCH

FOOTPRINT OF PREVIOUS ADDITIONS TO STONE STRUCTURE
+/- 89.1 SM GFA (GROUND FLOOR AREA),
+/- 121.8SM TFA (TOTAL FLOOR AREA)

+/- 11.72M SETBACK

EXSG 2 STOREY STONE STRUCTURE
TO BE STABILIZED AND RETAINED AS ACCESSORY BUILDING
63.6SM GFA
127.2SM TFA

+/- 7.72M SETBACK

+/- 4.66M SETBACK

PART 1
PLAN 62R-15719
PIN 17421-0047(LT)

PLAN 62R-9255

CONCESSION 1

SULPHUR SPRINGS ROAD

PIN 17421-0043(LT)

PIN 17421-0042(LT)

PIN 17421-0044(LT)

PIN 17421-0023(LT)

PIN 17421-0028(LT)

PIN 17421-0025(LT)

PIN 17421-0026(LT)

PIN 17421-0027(LT)

PIN 17421-0029(LT)

PIN 17421-0030(LT)

PIN 17421-0031(LT)

PIN 17421-0032(LT)

PIN 17421-0033(LT)

PIN 17421-0034(LT)

PIN 17421-0035(LT)

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PIN 17421-0041(LT)

PIN 17421-0045(LT)

PIN 17421-0046(LT)

PIN 17421-0048(LT)

PIN 17421-0049(LT)

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PIN 17421-0057(LT)

PIN 17421-0058(LT)

PIN 17421-0059(LT)

PIN 17421-0060(LT)

PIN 17421-0061(LT)

PIN 17421-0062(LT)

PIN 17421-0063(LT)

PIN 17421-0064(LT)

PIN 17421-0065(LT)

PIN 17421-0066(LT)

PIN 17421-0067(LT)

PIN