PRELIMINARY STORMWATER MANAGEMENT REPORT
& JACK CREEK FLOODLINE COMMENTARY
PILGRIM'S REST
PART LOTS 3 & 4, CONCESSION 11 (BURLEIGH)
TOWNSHIP OF NORTH KAWARTHA
COUNTY OF PETERBOROUGH

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INTRODUCTION

Dobri Engineering Ltd. has been retained to prepare a Preliminary Stormwater Management Report for the proposed re-development at Pilgrim's Rest Campground. The property is on Northey's Bay Road, approximately 1.5km west of County Road 6. The property is situated between Cheboutequion Drive on the west, Northey's Bay Road on the north, Jack Creek on the east and Stony Lake on the south.

The property to be re-developed is approximately 28.8 hectares in area. The campground is a seasonal resort having 86 fully serviced sites and 10 unserviced sites. A total of 30 single condominium lots are to be created. The new lots will occupy approximately 19 ha, leaving the remaining 9.8 ha in a natural state.

Drawing 15-511-POST illustrates the Post-Development conditions. The various drainage catchment area boundaries are noted. All stormwater runoff is directed towards Stony Lake and Jack Creek, and other small tributaries which discharge into Stony Lake. A minimum 15m buffer strip will be maintained adjacent all the noted water courses and the Lake.

STORMWATER MANAGEMENT

Any land development project will alter the runoff characteristics of the site. Normal stormwater management practice is to provide both stormwater quality and stormwater quantity controls for a land development project. The types of controls selected are dependent on the site conditions.

Stormwater quantity controls – Typically the peak post-development discharge rates can not exceed the peak pre-development discharge rates, ensuring that the development does not negatively impact downstream lands. This can be accomplished by constructing temporary surface storage facilities such as parking lot storage, building rooftop storage, or stormwater management ponds. Sub-surface storage in large structures or oversized pipes is also possible, but more costly.

Although stormwater quantity controls will not be required for this development, since it is adjacent Stony Lake, all swales/ditches must be designed to contain and convey runoff to the various drainage outlets.

Stormwater quality controls – The level of protection to be provided is determined by the sensitivity of the aquatic habitat which may be impacted by stormwater discharge. The 3 levels of protection are:

> 'Enhanced Protection', 80% suspended solids removal where habitat is very sensitive to sediment and siltation.
>
> 'Normal Protection', 70% suspended solids removal where conditions for enhanced protection don't exist.

'Basic Protection', 60% suspended solids removal where habitat is not sensitive to stormwater impacts.

An enhanced level of protection for permanent water quality control for this site is appropriate.

Temporary stormwater quality controls during construction typically include:

-the construction of temporary sediment control ponds (large sites)

-the installation of silt fences along property boundaries and around earth stockpiles

-the installation of rock check dams or straw bales within swales or drainage channels

-the installation of a mud-mat at the road entrance.

Permanent stormwater quality controls which are typically implemented are:

lot level controls	-reduce grade to promote infiltration -rear yard ponding areas or soak-away pits -infiltration trenches -grassed swales -pervious pipe systems -vegetated filter strips -stream & valley corridor buffer strips
end-of-pipe controls	-wet ponds -dry ponds -wetlands -infiltration basins

The topography, soil type, bedrock elevation, water table elevation and the catchment area are all factors which must be considered to decide on the appropriate stormwater control selected.

STORMWATER QUALITY ANALYSIS

The immediate effect that the development will have on the quality of stormwater runoff is directly associated with the construction activities. Prior to commencing construction, a light duty silt fence shall be installed along the buffer setbacks of lots 6-8, 9 & 13 and 16-20, as noted on the plan. During construction activities (roadway, earthworks) silt fence should be placed around any earth stockpiles and rock check dams and straw bales should be installed in swales and road ditches (along concentrated flow paths).

The above will provide erosion and sediment controls during construction. An inspection and maintenance schedule for the erosion and sedimentation measures should be established and strictly adhered to. All erosion and sedimentation measures should be installed in accordance with sections B and C of "Guidelines on Erosion and

Sedimentation Control for Urban Construction Sites", published by the Government of Ontario (MNR, MOE, MMA, MTO, Conservation Authorities, Municipal Engineers Association and the Urban Development Institute).

Once construction is complete and the vegetation is established, the temporary erosion controls installed can be removed.

Oakridge Environmental Limited (ORE) completed the Hydrogeological and Site Servicing Study for the development. The study found that soil cover on the bedrock ranges in depth from 0 to 1.4m throughout the site. The Appendix includes figures from the report for quick reference. The reader should refer to the final ORE report for the most up-to date figures.

Using infiltration as a means to provide stormwater quality control is not an option. Permanent stormwater quality controls can be provided by passive filtration measures. Utilizing grassed swales along lot lines and flow spreaders at outlets will provide runoff quality control, prior to discharge through the buffer areas.

STORMWATER QUANTITY ANALYSIS

An analysis for the surface water runoff is based on the following:

1. MTO Rainfall Data

MTO - Stoney Lake Area

	A	*B*
2-yr	*20.4*	*-0.692*
5-yr	*27.3*	*-0.692*
10-yr	*31.9*	*-0.692*
25-yr	*37.6*	*-0.692*
50-yr	*41.9*	*-0.692*
100-yr	*46.1*	*-0.692*

*Where r (mm/hr) =A*t^B*
And t is in hours

2. Timmons Storm
3. Rational Method $Q_p = 0.0028CIA$
4. Airport Formula Tc=(3.26(1.1-C)D^1/2)/S^1/3
5. MTO Drainage Manual
6. MOE – Stormwater Management Planning & Design Manual, 2003
7. MNR River and Stream Systems Erosion Hazard Limit Technical Guide
8. Construction Greater Golden Horseshoe Area Conservation Authorities - Erosion and Sedimentation Control Guideline for Urban
9. Credit Valley Conservation and Toronto and Region Conservation - Low-Impact Development Stormwater Management Planning and Design Guide

10. Municipal Engineering Standards
11. Runoff Coefficient of 0.05 for Jack Creek drainage basin
12. Runoff Coefficient of 0.20 for Pre-Development conditions, entire site
13. Runoff Coefficient of 0.30 for landscaped areas (Post-Development)
14. Runoff Coefficient of 0.95 for paved surface, concrete and building roof
15. Runoff Coefficient of 0.75 for gravel surface
16. Hydrogeological and Site Servicing Study completed by Oakridge Environmental Limited (ORE)
17. Ontario Base Mapping (OBM) of the area

POST-DEVELOPMENT CONDITIONS

Drawing 15-511-POST illustrates the proposed development, with the various Catchment areas. The drainage areas will be similar to Pre-Development conditions. The following table summarizes the catchment areas.

Catchment	Area (ha)	Comments
A1	0.33	Area at entrance roadway. Surface runoff generally directed north.
A2	1.23	Northern limit of development with surface runoff directed towards tributary to Jack Creek. Only a small portion of Lot 30 is within this catchment.
A3	4.77	Northeast area of development with surface runoff directed towards tributary to Jack Creek. Surface runoff from all or part of Lots 24 thru 30 are within this catchment.
A4	1.51	Northwest area of development with surface runoff directed towards Cheboutequion Drive. Some surface ponding on Lot 1. Lots 1,2 and part of lot 3 & 4 are included.
A5	5.78	Central western area with surface drainage to a channel conveying runoff in a general SW direction into Stony Lake. Surface runoff is from lots 3 thru 8.
A6	3.87	Central eastern area with surface runoff towards Jack Creek. Surface runoff is from all or part of Lots 9 thru 11, 13, 14, and 20 thru 28.
A7	5.07	Southern development area. Surface runoff is towards Jack Creek and Stony Lake. Surface runoff is from all or part of Lots 11, 12, and 14 thru 20.
Total	22.56	

B1	0.42	Extraneous area in SE corner of Northey's Bay Road and Cheboutequion Drive
B2	1.24	Extraneous area in SE corner of Northey's Bay Road and Cheboutequion Drive
B3	0.96	Extraneous area in SE corner of Northey's Bay Road and Cheboutequion Drive
Total	2.62	

The average runoff coefficient for the development area is calculated below, based on the following criteria.

Road length	865m
Road width	6m (considered paved for design flow calculations)
Road shoulder	1.5m
Driveway	6m wide and 10m long - each
House	230 sq.m (2500 sq. ft) - each

Surface	Area	C	A*C
Roadway (Paved)	6990	0.95	6640.5
Roadway (shoulder)	2595	0.75	1946.25
Building	6900	0.95	6555
Developed (grass)	232291	0.3	69687.3
Undeveloped	41600	0.2	8320
TOTAL	290376		93149.05

C 0.32

Note that the roadway is considered to be paved for design flow calculations, while it is intended to be gravel.

The road will not be designed with open ditches/swales, but rather with surface runoff via sheet flow across the roadway. The runoff will continue via sheet flow across the lots and along the side yard swales. Where necessary, shallow drainage swales will be constructed along the rear yard and discharged through flow spreaders and through the natural vegetated lands before entering Stony Lake, all as noted on the plan. There is no intent to construct any ditches/swales through the buffer area, and concentrate flows to convey runoff into the Lake. The Appendix includes pages from the MOE Manual for quick reference.

The grassed swales are to maintain flows <0.15 cms and velocity <0.5 m/s in order to provide quality control. Assuming a drainage area of 1ha, the peak flow during the 5-yr and 100-yr storm events is calculated at 0.08 cms and 0.14 cms respectively (t=10 min or 0.167 hrs). Using the open channel flow equation (1m flat bottom, n=0.09, 3:1 side slopes), at a 3% swale slope, the 100-yr flow of 0.14 cms will be conveyed at a velocity of 0.5 m/s and a depth of 0.18m. The 5-yr flow of 0.08 cms will be conveyed at a velocity of 0.42 m/s and a depth of 0.14m.

The weir equation can be used to design the flow spreader.

Weir Equation $Q=1.67*L*H^{1.5}$

Where Q= flow (cms)
L= length of weir (m)
H= depth of flow (m)

Using a 10m long weir, and a flow of 0.14 cms, the depth of flow over the weir will be 42mm. The final design for swales and flow spreaders will be determined at the detailed design stage.

JACK CREEK

The water flow through Jack Creek has been estimated for the 100-yr storm event, and is presented in Appendix B. Based on these calculations, the rear lot areas of a few of the lots may be flooded, while conveying stormwater runoff to the Lake. Surface water runoff will be conveyed through existing channels and the homes will be located on higher ground, outside these potential flooded areas.

CONCLUSIONS & RECOMMENDATIONS

Standard Stormwater Management practices can be implemented to provide quality control for this proposed development. Based on this preliminary evaluation, we make the following conclusions and recommendations:

1. Contractor to follow good housekeeping practices (ie: fueling and cleaning of equipment is not to be carried out near swales and ditches).
2. A silt fence barrier should be installed around the perimeter of all material stockpiles. The stockpiles should be seeded to establish a temporary vegetative cover if necessary.
3. Temporary stormwater quality controls will include the installation of a light duty silt fence as noted.
4. An inspection and maintenance schedule of all erosion and sedimentation measures should be established and adhered to. General maintenance requirements are presented in the Appendix.
5. Permanent water quality protection (enhanced level) will be provided by passive filtration measures (grassed swales, flow spreaders, natural vegetated buffer).
6. The Island is to remain undisturbed.
7. During the 100-yr storm event water flow through Jack Creek will potentially flood the rear areas of a few of the lots as noted in Appendix B. The homes will be located outside these areas and on higher ground and thus will not be impacted.

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APPENDIX A

LOT AREA SUMMARY (sq.m)

1	4382
2	5573
3	5089
4	5525
5	5505
6	6595
7	5590
8	5065
9	5752
10	5014
11	5088
12	5338
13	5228
14	5016
15	5265
16	4566
17	4411
18	4580
19	4722
20	4633
21	4968
22	5077
23	5505
24	5694
25	5058
26	4930
27	4328
28	5364
29	4998
30	5262
OTHER	33197

TOTAL SITE APPROXIMATE 28.8ha

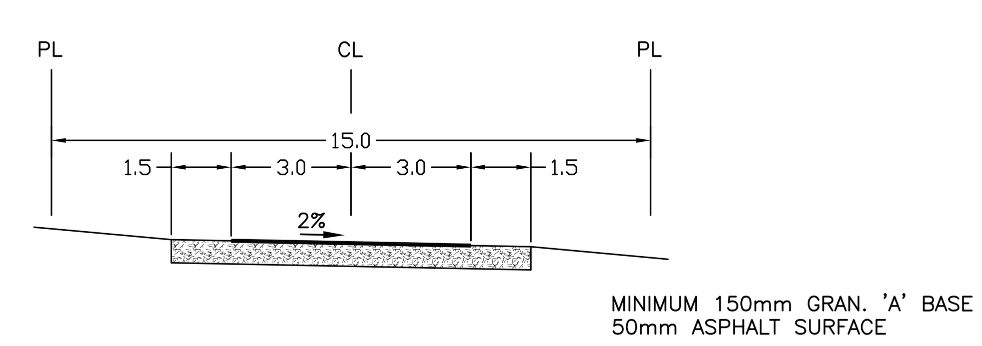
DRAINAGE AREA SUMMARY (sq.m)

ROW	15895
A1	3303
A2	12291
A3	47705
A4	15061
A5	57825
A6	38717
A7	50689

TOTAL LOTS 1-30 154,220

TOTAL LENGTH OF ROAD 865m

B1	4177
B2	12436
B3	9633



TYPICAL ROAD SECTION
NTS

CONTOURS TAKEN FROM OBM MAPPING

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PILGRIM'S REST
POST-DEVELOPMENT PLAN
PART LOTS 3 & 4, CONC. 11 (BURLEIGH)
TOWNSHIP OF NORTH KAWARTHA

SCALE: 1:1500	DATE: JUNE 21/17	BY: BD
	DWG. NO.: 15-511-POST	

MAINTENANCE

Reference: Storm water Management Planning and Design Manual, March 2003, MOE

The proposed Stromwater Management Facilities will require periodic inspections and maintenance.

Typical maintenance practices for swales are outlined below:

A. Inspections

Inspections of the SWMP will indicate whether maintenance is required or not. Inspections should be made of SWMP's after every significant storm during the first two years of operation to ensure that the SWMP is functioning properly. It is anticipated that this will translate into an average of four inspections per year.

After this initial period, when the SWMP operation has been confirmed, annual inspections may suffice.

Points of regular inspection would be as follows:

Swales

1. Is the grass/vegetation dead? (This will indicate the need to re-vegetate the swale).

2. Is there erosion downstream of the swale? Sod eroded area. There may be a need to provide further erosion control (rip rap, plant stakings) to prevent the re-occurrence of erosion.

3. Is there standing water in the swale? Swale to be cleaned and possibly re-graded.

B. Grass Cutting

Frequency

Grass cutting is one maintenance activity which is solely undertaken to enhance the aesthetics, or "perceived aesthetics" of the facility. Generally, it is recommended that grass cutting be eliminated around SWMPs. No grass cutting will enhance water quality and provide additional safety benefits for wet facilities. Grass cutting should be done as infrequently as possible, recognizing the aesthetic concerns of nearby residents.

Methods

Grass cutting is fairly straightforward for most SWMPs. Grass cutting around wet facilities should ensure that the grass is not cut to the edge of the permanent pool. In addition grass cutting should be done parallel to the shoreline (as a safety precaution) with grass clippings being ejected upland (to reduce the potential for organic loadings to the pond).

C. Weed Control

Frequency

It is anticipated that weed control may have to be done once every year. Weeds are generally defined as any kind of vegetation which is unwanted in a particular area. In terms of SWMPs, weeds are generally non-native species which tend to decrease the bio-diversity of the planting strategy that was implemented. For example, purple loosestrife would be considered a weed because it is a non-native species which tends to "out compete" other more sensitive species and create mono-culture planting environments. Dominant species such as purple loosestrife and cattails are generally classified as undesirable species from this perspective.

Methods

Weeding should be done by hand to prevent the destruction of surrounding vegetation. The use of herbicides and insecticides should be prohibited near SWMPs since they create water quality problems. The use of fertilizer should also be limited to minimize the nutrient loadings to the downstream receiving waters.

D. Sediment Removal

Frequency

The frequency of sediment removal depends on many factors:

- Upstream land use and level of imperviousness
- Active and permanent pool storage
- Upstream development activities (i.e. effectiveness of sediment and erosion control activities)
- SWMP type
- Private practices (i.e. sanding)

Methods

The methods for sediment removal depend on the type of SWMP implemented. The following section describes sediment removal techniques.

Grass Swales

Visual inspection and the aesthetic attributes of swales will indicate the need for maintenance. In areas which receive road runoff, discoloration of the soils or the build-up of a ‘crust’ may indicate the need for mulch (to maintain infiltration properties).

E. Trash Removal

Trash removal is an integral part of SWMP maintenance. Generally there will be a need to undertake a “spring cleanup” with respect to trash removal for all surface SWMPs. Trash removal is then preformed as required based on the observations of trash build-up during the regular inspections.

Design Guidance

Swale Cross-section

Grassed swales can be effective SWMPs for pollutant removal if designed properly. The water quality benefits associated with grassed swales depend on the contact area between the water and the swale and the swale slope. Deep narrow swales are less effective for pollutant removal compared to shallow wide swales. Given typical urban swale dimensions (0.75 m bottom width, 2.5:1 side slopes and 0.5 m depth), the contributing drainage area is generally limited to ≤ 2 ha (to maintain flow ≤ 0.15 m^3/s and velocity ≤ 0.5 m/s). Table 4.5 indicates drainage area restrictions for various degrees of imperviousness, based on the assumptions given regarding channel cross-section, slope and cover. The swales evaluated in Table 4.5 are indicative of swales servicing an urban subdivision and not a transportation corridor.

Table 4.5: Grassed Swale Drainage Area Guidelines*

% Imperviousness	Maximum Drainage Area (ha)
35	2.0
75	1.5
90	1.0

**Based on the following assumptions: trapezoidal channel, grassed lined (n = 0.035), slope of drainage area = 2%, 2.5:1 side slopes, 0.75 m bottom width, 0.5% channel slope, max. allowable Q = 0.15 m^3/s, max. allowable V = 0.5 m/s.*

Grassed swales are most effective for stormwater treatment when depth of flow is minimized, bottom width is maximized (≥ 0.75 m) and channel slope is minimized (e.g., ≤ 1%). Grassed swales with a slope up to 4% can be used for water quality purposes, but effectiveness diminishes as velocity increases. Grass should be allowed to grow higher than 75 mm to enhance the filtration of suspended solids.

Flow Velocity

As a general guideline, grassed swales designed for water quality enhancement should be designed to convey the peak flow from a 4 hour 25 mm Chicago storm with a velocity ≤ 0.5 m/s. This guideline results in a requirement for wide, flat swales for larger drainage areas.

All grass swales must be evaluated under major system and minor system events to ensure that the swale can convey these storms effectively.

Ditch and Culvert Servicing

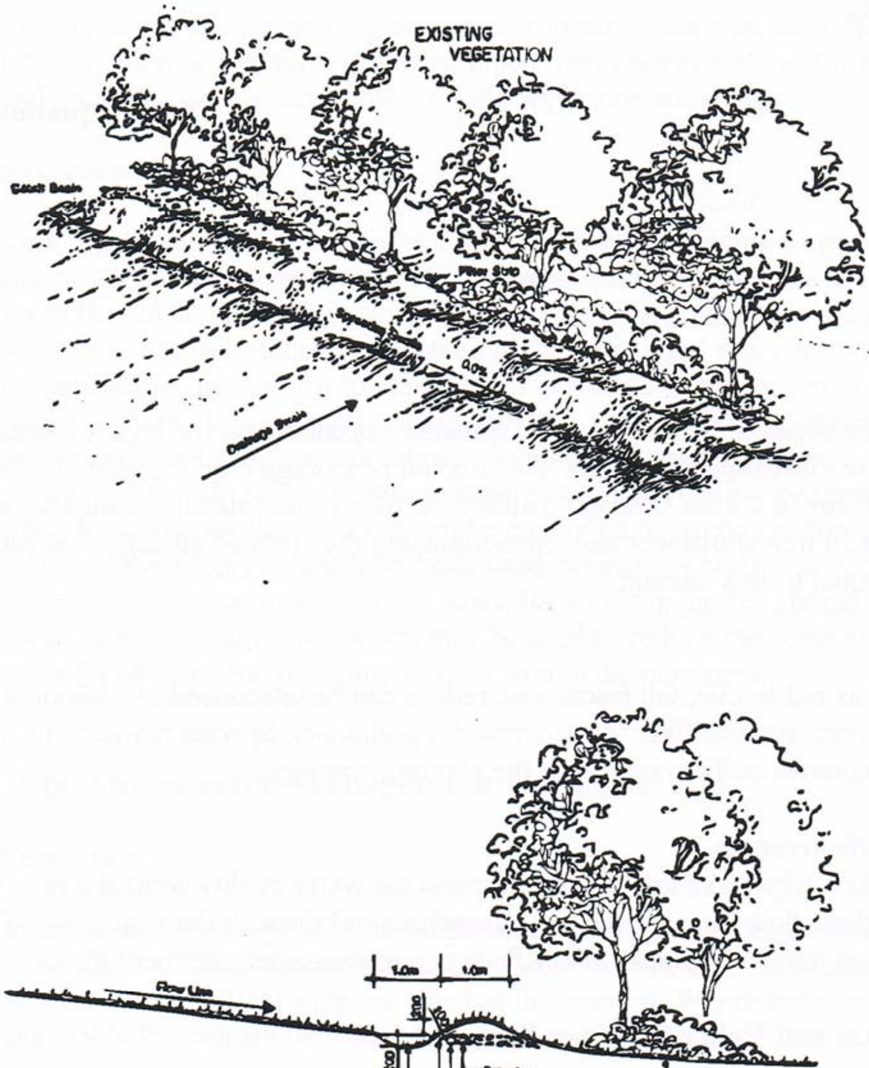
Ditch and culvert servicing is viable for lots which will accommodate swale lengths ≥ the culvert length underneath the driveway (not just the driveway pavement width). The swale length should also be ≥ 5 m for aesthetic and maintenance purposes. This is generally achievable for small lots (9 m) with single driveways or larger lots (15 m) with double driveways.

Winter Operation

Swale systems which receive road runoff may have their infiltration capacity diminished over time, as salt effects on soil structure and clogging occur. Swale systems need to be maintained

Figure 4.16 illustrates a typical level spreader design. A small berm is used as the level spreader. It creates a damming effect, preventing stormwater from entering the vegetation until the water level exceeds the height of the spreader. A perforated pipe (100 mm diameter) is installed in the spreader berm to ensure that any water which is trapped behind the berm after a storm can be drained. The perforated pipe should be wrapped in a filter sock to ensure that native material does not infiltrate the pipe.

Figure 4.16: Typical Filter Strip



APPENDIX B
JACK CREEK

JACK CREEK

The Jack Creek Watershed area of 14,775 ha is noted on the accompanying plan taken from MNR mapping. Flow records for Jack Creek were not available.

Drawing 15-511-Jack Creek illustrates the Creek through the property, from Stoney Lake to the Bridge on Northey's Bay Road. Two cross-sections across the Creek are also noted on the plan.

The open channel flow equation was used to calculate the flows.

V=(R^2/3)*(S^1/2)/N, and Q=V*A

Where V= velocity m/s

R= wetted perimeter

S= channel slope (0.4%)

N= Manning's n (0.035 rock)

A= cross-sectional area (cu.m)

Q= flow (cms)

The narrowest channel closest to the proposed lots is at Cross-Section 1, abutting Lot 20. The flow of 61.26 cms would be conveyed through this channel at an estimated water elevation of 241.0m. The lot grade is above this elevation and flooding will not occur.

At Cross-Section 2 approximately 200m upstream, the channel is substantially wider and the flow of 63.7 cms would be conveyed through the channel at an estimated water elevation of 239.1m. This is lower than the downstream water level. The maximum water level at Cross-Section 2 is at 241.0 (same as at Cross-Section 1) prior to spilling over through the existing drainage channel at the rear of lots 6 – 9 and lot 13. The rear area of lots 22 and 23 will be partially flooded if this occurs, however the proposed buildings and sewage systems will be located outside the potential flooded area.

Flooding along Jack Creek during the major storm event, will not impact the proposed development.

The peak flow through Jack Creek can be conservatively estimated using the following criteria.

Runoff coefficient C= 0.10

L = 9500m (Measured from mapping)

S = 1.0% (average estimated slope)

Tc=(3.26(1.1-C)L^1/2)/S^1/3 (where C < 0.4) Airport formula

Calculated Tc = 317.7 minutes

Calculate I (rainfall intensity) using MTO IDF data, and the peak flow using the Rational Method.

$Q_p = 0.0028CIA$

Where Q_p = peak discharge (cms)

C = Runoff coefficient

I = rainfall intensity

A = drainage area (ha)

MTO - Stoney Lake (at site)

	A	*B*
2-yr	*20.4*	*-0.692*
5-yr	*27.3*	*-0.692*
10-yr	*31.9*	*-0.692*
25-yr	*37.6*	*-0.692*
50-yr	*41.9*	*-0.692*
100-yr	*46.1*	*-0.692*

*Where I (mm/hr) =A*t^B and t is in hours*

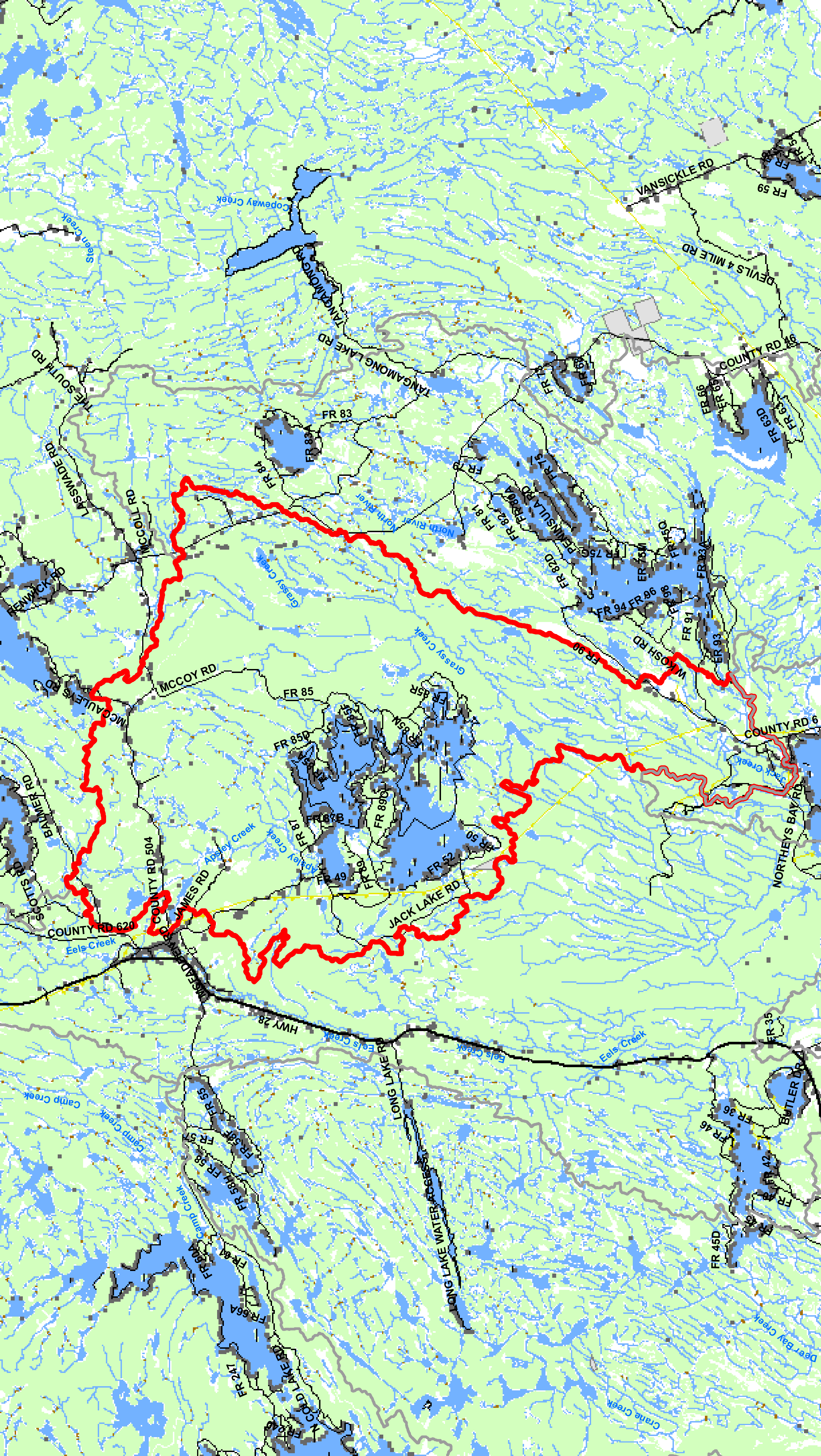
For the 100-yr storm event I= 14.5 mm/hr and the peak discharge is 60.2 cms.

For comparison purposes, use

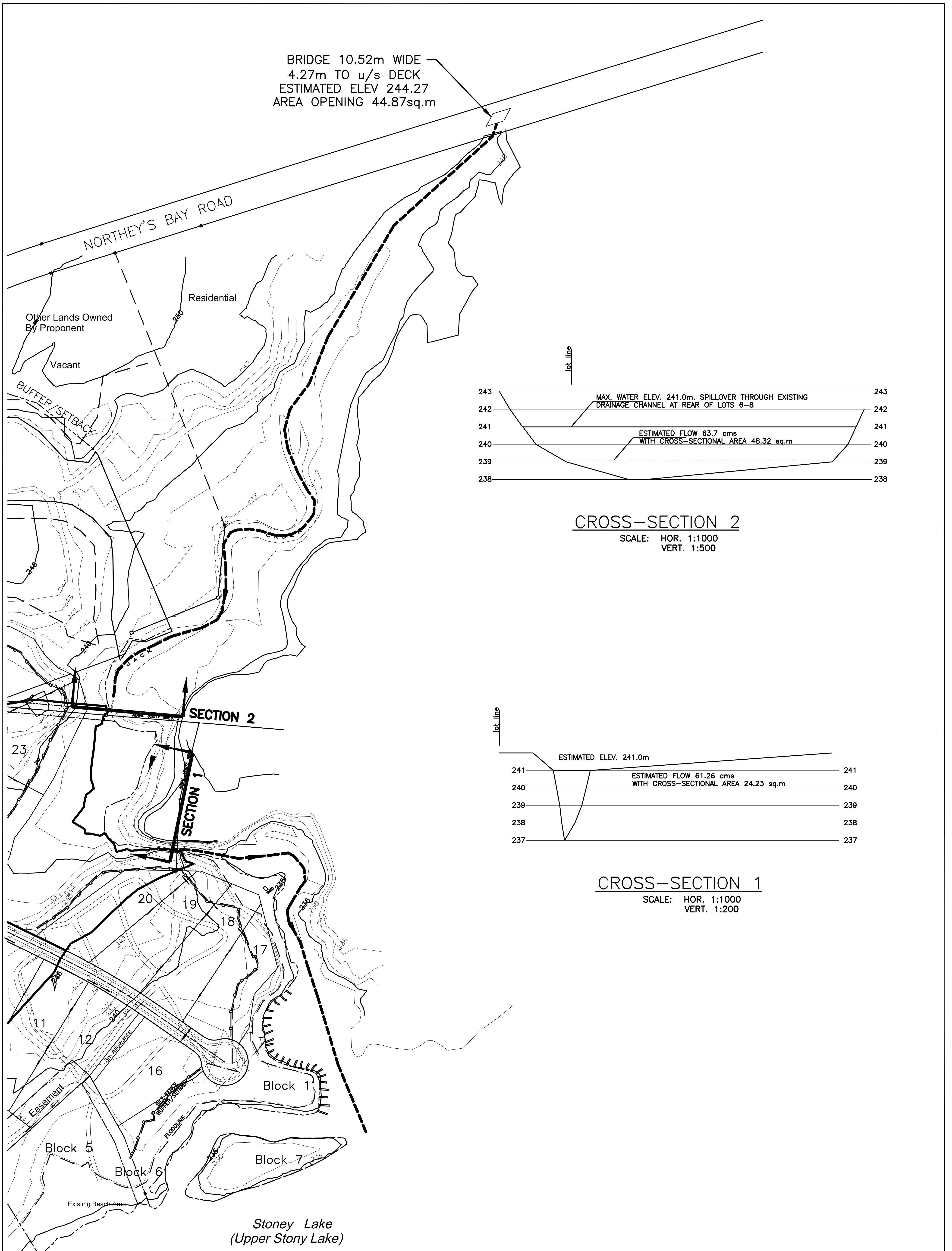
MTO - Jack Lake

	A	*B*
2-yr	*21.5*	*-0.699*
5-yr	*28.6*	*-0.699*
10-yr	*33.2*	*-0.699*
25-yr	*39*	*-0.699*
50-yr	*43.3*	*-0.699*
100-yr	*47.6*	*-0.699*

For the 100-yr storm event I= 14.8 mm/hr and the peak discharge is 61.4 cms. The estimated peak flow using the MTO IDF data at both locations is similar.



VANSICKLE RD
FR 59
DEVILS 4 MILE RD
Copeway Creek
Steen Creek
TANGAMONG RD
TANGAMONG LAKE RD
COUNTY RD 46
FR 83
FR 83A
FR 84
FR 79
FR 73
FR 66
FR 63D
THE SOUTH RD
LASSWADE RD
MCCOLL RD
North River
FR 81
FR 82
FR 80A
PENINSULA RD
FR 75
FR 75G
FR 82D
FR 75M
FR 75Q
FR 94
FR 96
FR 93
FR 91
FR 90
Grassy Creek
RENWICK RD
MCAULEYS RD
MCCOY RD
FR 85
FR 85D
FR 85R
FR 85N
COUNTY RD 6
NORTHEYS BAY RD
BALMER RD
SCOTTS RD
COUNTY RD 504
Apsley Creek
FR 87
FR 87B
FR 89
FR 49
FR 52
FR 50
JAMES RD
JACK LAKE RD
COUNTY RD 620
Eels Creek
HWY 28
LONG LAKE RD
LONG LAKE WATER ACCESS
Camp Creek
FR 55
FR 57
FR 58
FR 58H
FR 64
FR 66A
FR 247
N COLD LAKE RD
FR 35
BUTLER DR
FR 36
FR 46
FR 42
FR 45D
Deer Bay Creek
Crane Creek



CONTOURS TAKEN FROM OBM MAPPING

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PILGRIM'S REST
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