WMI & Associates Limited
119 Collier Street, Barrie, Ontario, L4M 1H5
P (705) 797-2027 F (705)797-2028

June 24, 2025

Duivenvoorden Haulage Limited
Aggregate Pit Expansion – Stormwater Management Brief
WMI File No.: 20-636
NVCA ID #: 42204

Duivenvoorden Haulage Ltd. is proposing to apply for a Class 'A' License (Category 3 – Pit Above Water) under the Aggregate Resources Act, for the expansion of an existing pit. The license would permit aggregate extraction to expand north onto the 437202 4th Line (Phases 1-3), Township of Melancthon property and include a strip of 437138 4th Line between the municipal right-of-way and the existing pit (Phase 1). The subject area for the pit expansion (licensed area) is 45 hectares (111.1 acres), with a proposed extraction area of 31.4 hectares (77.6 acres), and will be referred to as the "site" within the context of this brief.

As required by the Nottawasaga Valley Conservation Authority (NVCA) pre-consultation comments (dated June 23, 2020) and through continued correspondence with the NVCA (email dated Nov. 11, 2020 & comments letter dated Oct. 20, 2021) and Township peer review comments from R.J. Burnside & Associates Ltd. (letters dated April 12, 2022, August 22, 2024 and January 7, 2025), this brief has been prepared by WMI & Associates Limited in support of the proposed aggregate pit expansion from a stormwater management perspective.

The proposed aggregate pit expansion does not include an increase in impervious area as it is simply an extension of the sites existing earthworks operation.

Upon investigation of the existing drainage conditions associated with the site, it was determined that the subject lands has no stormwater outlet due to its existing topography. As indicated on the attached **Drainage Plan (FIG1)**, all contributing runoff from external lands enters from the west, north and east, with the majority of the runoff being generally concentrated at four (4) specific locations. All internal and external runoff in the existing condition ultimately concentrates and infiltrates into the native soils at either the low point located centrally within Phase 3A or within Phase 1 immediately east of the existing pit and adjacent to the 4th Line ROW. As indicated by Dufferin County's GIS mapping, aerial imagery clearly illustrates the low area (surfacing ponding visible) while Google Maps imagery taken at a different time shows the same area as being cropped, further suggesting that all contributing runoff ultimately infiltrates on-site.

The external runoff from the southwest runs into an existing wetland feature located at the southwest corner of 437202 4th Line prior to entering the proposed aggregate extraction area. Runoff from the wetland is only anticipated to discharge into the site upon the wetland surcharging, at which time the runoff will follow the site topography across the currently farmed lands to an existing depression within Phase 3A where it is infiltrated into the native soils. Prior to Phase 3A aggregate extraction, a cut-off swale will be constructed along the north limit of the wetland to intercept external drainage and direct it into the already extracted Phase 2 portion of the pit.

The external runoff from the north runs through a grass hollow (small valley feature) prior to reaching the sites north property boundary. From this location the external runoff is directed across the currently farmed lands to an existing depression within Phase 3A via the natural topography of these lands where it is infiltrated into the native soils. Prior to Phase 3A aggregate extraction, a temporary swale will convey external runoff south into the already extracted Phase 2 portion of the pit to allow for the extraction within Phase 3A. Once Phase 3A has been completed, the temporary swale will be removed and external runoff will be directed east from the downstream end of the proposed twin 900mmØ CSP culverts under the noise berm, into Phase 3A to allow for the extraction within Phase 3B.

A relatively small portion of the sites external drainage comes from the 4th Line right-of-way (ROW) at the northeast and southeast corners of the proposed pit expansion area. Two (2) distinct low points exist in the west ditch of the 4th Line along the site frontage that have potential to spill into the subject site. The northern low point ultimately drains west to the existing depression within Phase 3A. Prior to Phase 3A aggregate extraction, a cut-off swale will be constructed from the downstream end of the proposed 400mmØ CSP culvert under the noise berm, south into Phase 2 to allow for the extraction within Phase 3A. Upon completion of Phase 3A, the aforementioned cut-off swale can be removed and the contributing runoff to the culvert can discharge directly into Phase 3A.

The southern low point within the west ditch of the 4th Line in the existing condition will consist of hydraulic relief into the Phase 1 lands via a proposed 400mmØ CSP culvert under the noise berm. The discharge location of the culvert within the site is the first area proposed for aggregate extraction. In the interim localized ponding and infiltration will occur at the culvert outlet on-site due to the existing topography in this area. Once the first portion of Phase 1 has been extracted, external runoff will be directed west into the existing pit area where it will be infiltrated.

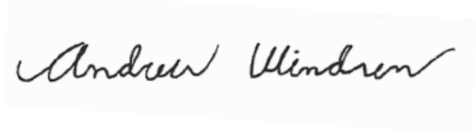
The stormwater drainage for the pit expansion will be managed to suit the proposed phasing as per the Operational Plan prepared by Innovative Planning Solutions (IPS), which details the aggregate extraction activities. The drainage through the site in the proposed condition will follow the contours of the pit floor with an elevation of 507 masl (meters above sea level) at the northwest corner to 497 masl at the east limit of the property. The proposed sequencing of the stormwater drainage and erosion and sediment controls shall be as follows:

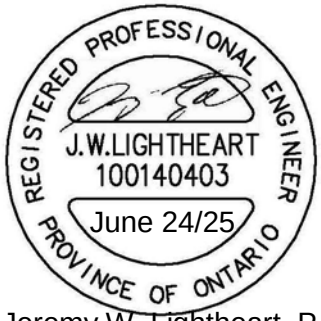
- Prior to any construction or pit expansion, silt fence is to be installed along the east limit of the existing wetland between the wetland and pit expansion Phases 1 & 2.
- Topsoil and overburden will be stripped from the site starting within Phase 1 and extending north as required, to construct the perimeter noise berms as detailed on the **Erosion & Sediment Control Plan (ESC)**.
- The removal of aggregate from Phases 1-2 (from the south towards the north) will generally direct the stormwater drainage to the previous phases / existing pit where it will minimize impacts to extraction operations and be temporarily stored within the property limits prior to being infiltrated as is in the existing condition.
- With the exception of the lowered/extracted areas of Phases 1 and 2, all internal and external drainage including excess runoff from the wetland, will flow into the existing depression located centrally within Phase 3A where it will be infiltrated as in the existing condition.
- Prior to construction of Phase 3A, three (3) cut-off swales will be constructed to re-direct external runoff from the west, north and east, into the previously extracted Phase 2 portion of the site. Refer to the **Erosion & Sediment Control Plan (ESC)** for details.
- Upon completion of Phase 3A, the cut-off swales for the northern and northeastern external drainage inlets will be removed and these areas will be directed into Phase 3A to allow for the aggregate extraction within Phase 3B.

Based on the above, we request that this Stormwater Management Brief be received by the NVCA and Township in support of the proposed expansion of DHL's existing aggregate pit located on the 4th Line in the Township of Melancthon.

Respectfully submitted,

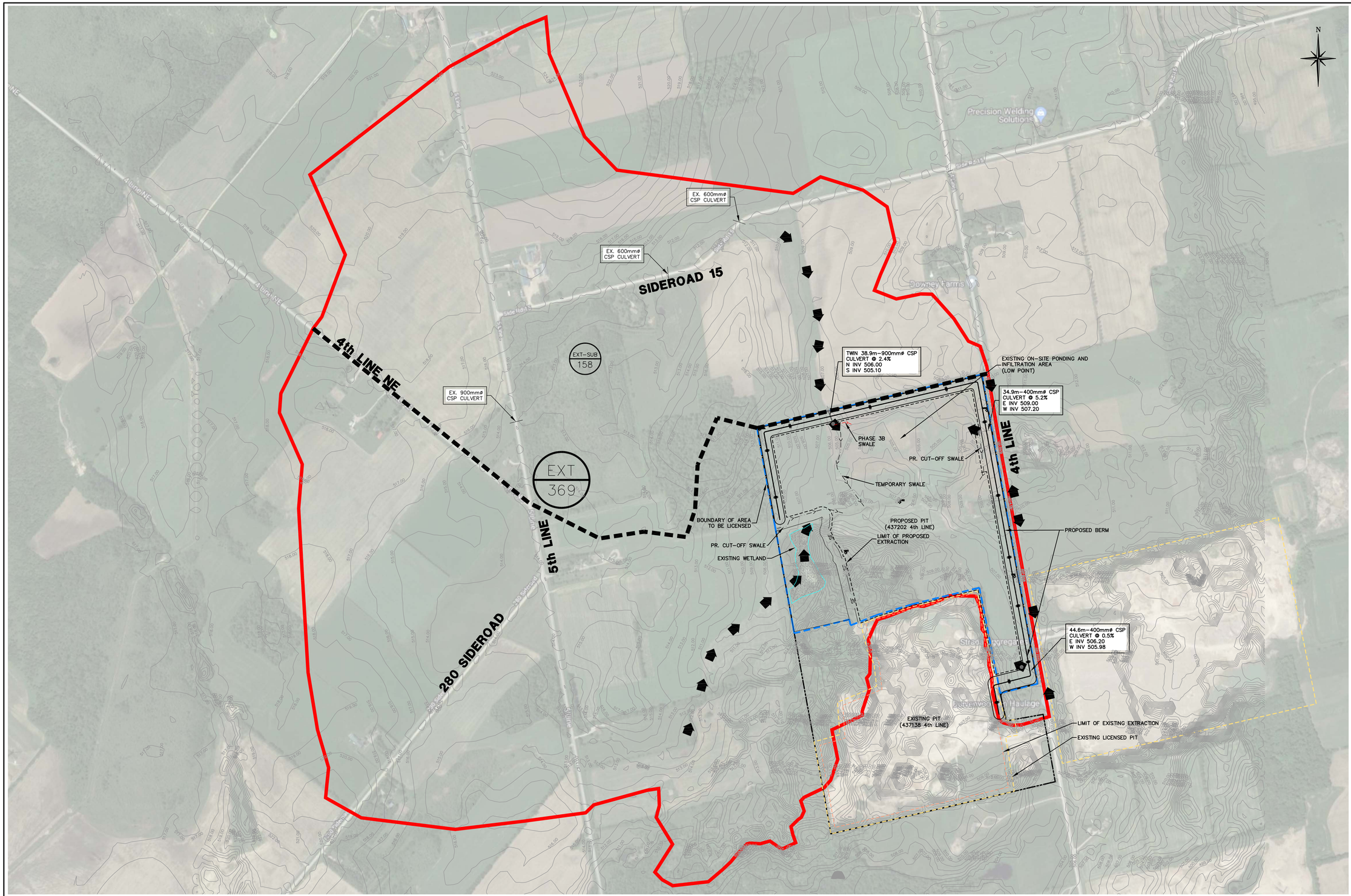
WMI & Associates Limited



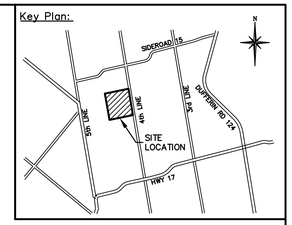


Andrew Windrem, C. Tech

Jeremy W. Lightheart, P. Eng.



Key Plan:



Legend:

- CATCHMENT IDENTIFICATION (0)
- CATCHMENT AREA (HA) (0.00)
- CONCENTRATED EXTERNAL FLOW
- LIMITS OF CATCHMENT AREA
- LIMITS OF SUB-CATCHMENT AREA
- BOUNDARY OF AREA TO BE LICENSED
- LIMIT OF PROPOSED EXTRACTION
- EXISTING LICENSED PIT
- LIMIT OF EXISTING EXTRACTION
- PROPERTY LINE

DRAWING REFERENCE NOTES:

1. BASE MAPPING AND TOPOGRAPHIC INFORMATION FROM DIGITAL OBM AND AIR PHOTO ANALYSIS PROVIDED BY GOOGLE EARTH 2018 EUROPA TECHNOLOGIES
2. SHELBURNE PIT EXPANSION LANDS TOPOGRAPHIC INFORMATION PREPARED BY DHL DATED APRIL 8, 2025.
3. EXTERNAL TO THE SITE, THE DEM TOPOGRAPHIC SURVEY WAS USED. INTERNAL TO THE SITE, THE DHL TOPOGRAPHIC SURVEY WAS USED. THE DEM SURFACE WAS RAISED BY 1.24m TO ALIGN WITH THE DHL TOPOGRAPHIC SURVEY.
4. PROPERTY BOUNDARY PREPARED BY RODNEY GREYER, OLS, DATED JANUARY 20, 2019.
5. OPERATIONAL PLAN PREPARED BY IPS DATED JUNE 2025.

CAUTION
CONTRACTOR TO DETERMINE LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.

Notes:

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REGISTERED PROFESSIONAL ENGINEER
J.W.LIGHTHEART
100140403
JUN. 24, 2025
PROVINCE OF ONTARIO

No.	Issue / Revision	Date
1	1ST SUBMISSION	DEC. 15, 2020
2	2ND SUBMISSION – NVCA COMMENTS	MAY 24, 2024
3	THIRD SUBMISSION	OCT. 18, 2024
4	FOURTH SUBMISSION	JUNE 24, 2025

DHL PIT

DRAINAGE PLAN

Client:
Duivenvoorden Haulage Ltd.
3425 9th Line
Innisfil, Ontario
L9S 3Z6

WMI & Associates Limited
119 Collier Street
Barrie, Ontario
L4M 1H5
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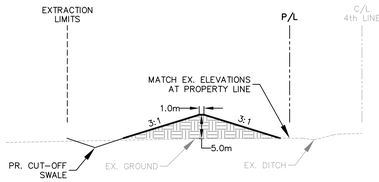
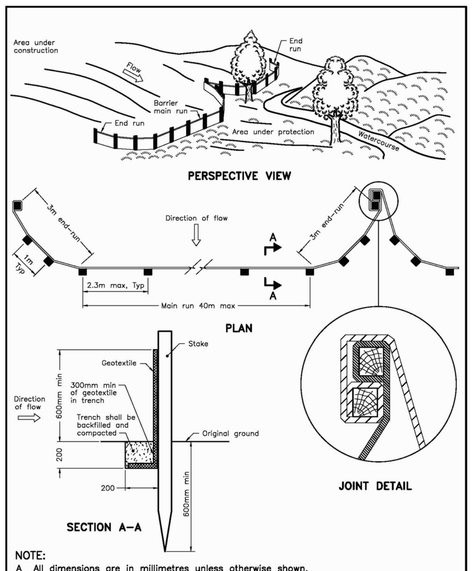
Drawn By	Checked By	Drawing No.
AW	JWL	FIG1
Scale 1:5000	Project No. 20-636	

Z:\Projects\2020\20-636\CAD\WMI\Issue_No2\250522_Base.dwg, FIG1, 6/24/2025 2:21:26 PM



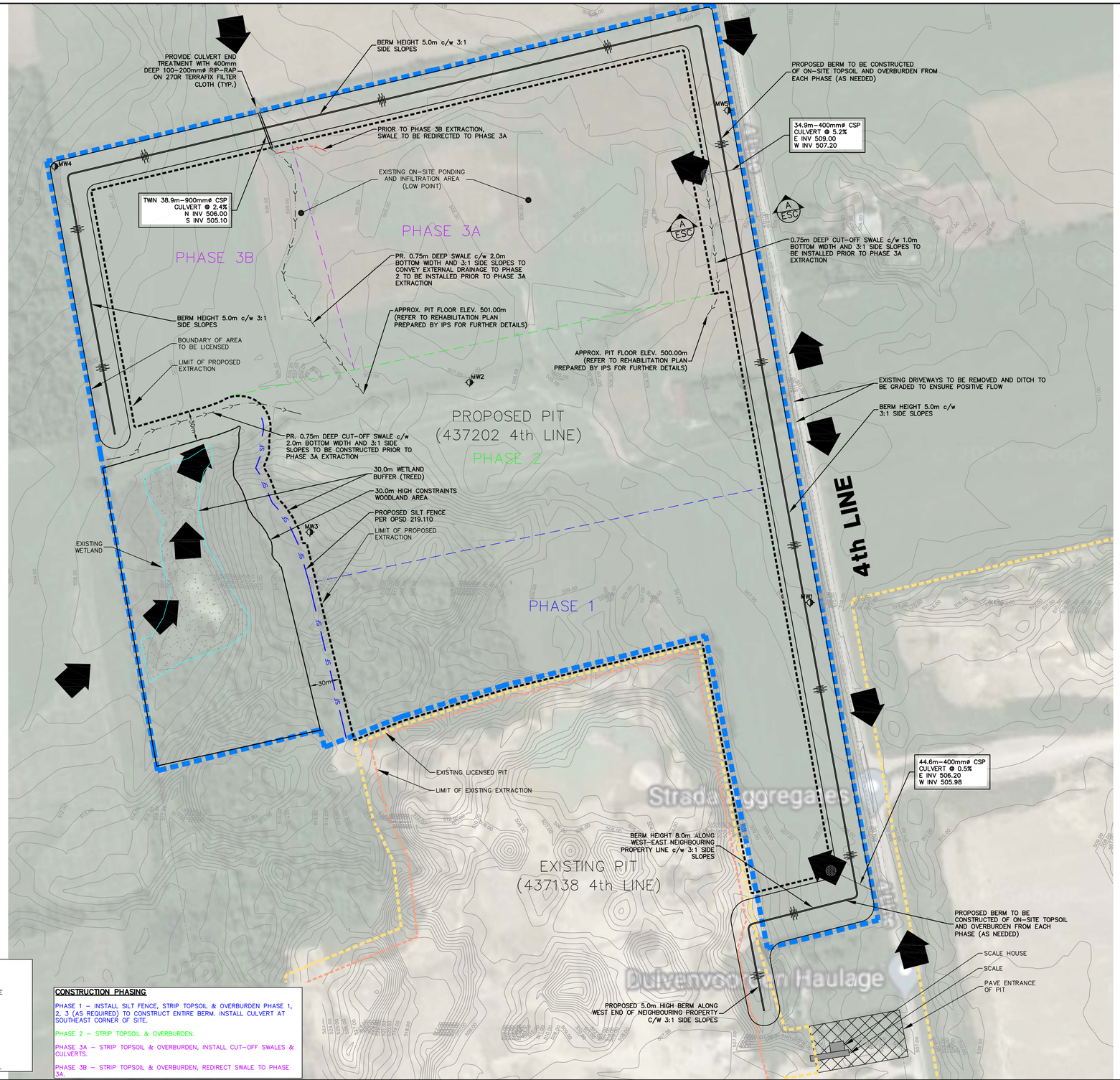
CROSS SECTION A–A: TYPICAL 5.0m HIGH BERM

N.T.S.



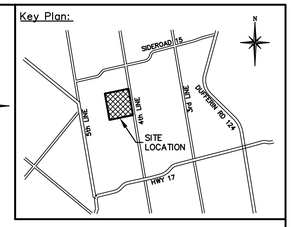
NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2021	Rev 3
LIGHT–DUTY SILT FENCE BARRIER		OPSD 219.110



N

Key Plan:



EXISTING FEATURES (EX)

- EX STD IRON BAR
- EX IRON BAR
- EX UTILITY POLE
- EX BELL PED
- EX HYDRO TRANSFORMER
- EX WS — EX WATER SERVICE
- EX HYD — EX FIRE HYD.
- NS — EX ST NAME SIGN
- SS — EX STOP SIGN
- 123.45 — EX ELEVATION
- EX FENCE
- EX U/G GASMAIN
- EX U/G BELL
- EX U/G HYDRO
- EX WV — EX WATERMAIN & VALVE
- EX 00mmø SAN @ 0.0% — EX SAN SEWER & MH
- EX 00mmø STM @ 0.0% — EX STM SEWER & MH

PROPOSED FEATURES (PR)

- NS — PR STREET NAME SIGN
- SS — PR STOP SIGN
- SF SF — PR SILT FENCE
- PR STREET LIGHT
- PR HYDRO TRANSFORMER
- W — PR WATER SERVICE
- S — PR SANITARY SERVICE
- ST — PR STORM SERVICE
- 00mmø W/M — PR WATERMAIN
- PR FIRE HYDRANT
- PR WATER VALVE
- 0m–00mmø SAN @ 0.0% — PR SANITARY SEWER
- MH A — PR SANITARY MANHOLE
- 0m–00mmø STM @ 0.0% — PR STORM SEWER
- CBMH 1 — PR CATCHBASIN MANHOLE
- MH 1 — PR MANHOLE
- CB 1A — PR CATCHBASIN
- PR SWALE
- 000.00 — PR ELEVATION
- (000.00) — PR MATCH EXISTING ELEVATION (INTERPOLATED)
- 000.00TC — PR TOP OF CURB ELEVATION
- 000.00EP — PR EDGE OF PAVEMENT ELEVATION
- PR STEEP SLOPE
- CONCENTRATED EXTERNAL FLOW
- BOUNDARY OF AREA TO BE LICENSED
- LIMIT OF PROPOSED EXTRACTION
- HIGH CONSTRAINS WOODLAND AREA
- EXISTING LICENSED PIT
- LIMIT OF EXISTING EXTRACTION
- PROPERTY LINE
- MW1 — MONITORING WELL

GENERAL NOTES:

1. ENTRANCE SHALL BE PAVED PRIOR TO UNDERTAKING ANY SITE ALTERATION ACTIVITIES.
2. EROSION CONTROL WORKS TO BE INSPECTED REGULARLY AFTER EVERY RAINFALL AND REPAIRED/REPLACED AS REQUIRED BY THE ENGINEER.
3. ALL DISTURBED AREAS TO BE RESTORED USING TOPSOIL AND SEED IMMEDIATELY UPON ESTABLISHING FINAL ELEVATIONS.
4. ALL AREAS WHICH REMAIN UNDISTURBED FOR MORE THAN 30 DAYS SHALL BE STABILIZED.
5. EROSION CONTROL WORKS TO BE MAINTAINED UNTIL THE SITE HAS STABILIZED AND REMOVAL IS DIRECTED BY THE ENGINEER.
6. SILT FENCE IS TO BE CONSTRUCTED/INSTALLED AS PER THE PHASING PLAN SHOWN ON THIS DRAWING.
7. ROUTINE INSPECTIONS OF THE SEDIMENT AND EROSION CONTROL STRUCTURES ARE REQUIRED DURING THE CONSTRUCTION PHASE.

CONSTRUCTION PHASING

PHASE 1 – INSTALL SILT FENCE, STRIP TOPSOIL & OVERBURDEN PHASE 1, 2, 3 (AS REQUIRED) TO CONSTRUCT ENTIRE BERM. INSTALL CULVERT AT SOUTHEAST CORNER OF SITE.

PHASE 2 – STRIP TOPSOIL & OVERBURDEN.

PHASE 3A – STRIP TOPSOIL & OVERBURDEN, INSTALL CUT–OFF SWALES & CULVERTS.

PHASE 3B – STRIP TOPSOIL & OVERBURDEN, REDIRECT SWALE TO PHASE 3A.

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REGISTERED PROFESSIONAL ENGINEER
J.W.LIGHTHEART
100140403
JUN. 24, 2025
PROVINCE OF ONTARIO

No.	Issue / Revision	Date
1	2ND SUBMISSION – NVCA COMMENTS	MAY 24, 2024
2	THIRD SUBMISSION	OCT. 18, 2024
3	FOURTH SUBMISSION	JUNE 24, 2025

DHL PIT

EROSION & SEDIMENT CONTROL PLAN

Client:
Duivenvoorden Haulage Ltd.
3425 9th Line
Innisfil, Ontario
L9S 3Z6

WMI & Associates Limited
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Ph 705-797-2027
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Drawn By	Checked By	Drawing No.
AW	JWL	ESC
Scale 1:2000	Project No. 20–636	

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4th LINE

PROPOSED BERM TO BE CONSTRUCTED OF ON-SITE TOPSOIL AND OVERBURDEN FROM EACH PHASE (AS NEEDED)

0.75m DEEP CUT-OFF SWALE c/w 1.0m BOTTOM WIDTH AND 3:1 SIDE SLOPES TO BE INSTALLED PRIOR TO PHASE 3A EXTRACTION

EXISTING DRIVEWAYS TO BE REMOVED AND DITCH TO BE GRADED TO ENSURE POSITIVE FLOW

BERM HEIGHT 5.0m c/w 3:1 SIDE SLOPES

EX. DRIVEWAY

PROPOSED BERM TO BE CONSTRUCTED OF ON-SITE TOPSOIL AND OVERBURDEN FROM EACH PHASE (AS NEEDED)

EX. CENTRELINE OF ROAD
EX. EDGE OF PAVEMENT
EX. EDGE OF SHOULDER
EX. C/L OF DITCH
EX. TOP OF SLOPE

MW3
MW1

34.9m-400mmø CSP CULVERT @ 5.2%
E INV 509.00
W INV 507.20

PROPOSED EXTRACTION LIMITS

44.6m-400mmø CSP CULVERT @ 0.5%
E INV 506.20
W INV 505.98

BERM HEIGHT 8.0m ALONG WEST-EAST NEIGHBOURING PROPERTY LINE c/w 3:1 SIDE SLOPES

PROPOSED PIT
(437202 4th LINE)

PHASE 3A

PHASE 2

PHASE 1

BERM HEIGHT 5.0m c/w 3:1 SIDE SLOPES

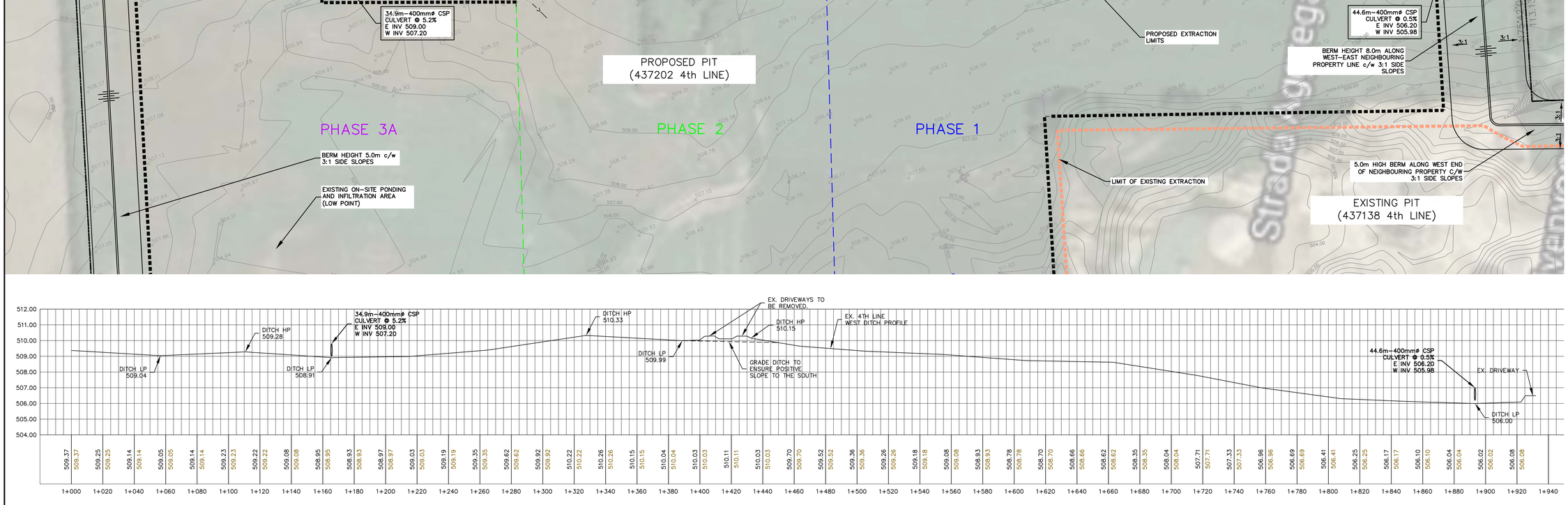
EXISTING ON-SITE PONDING AND INFILTRATION AREA (LOW POINT)

LIMIT OF EXISTING EXTRACTION

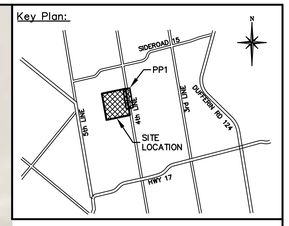
5.0m HIGH BERM ALONG WEST END OF NEIGHBOURING PROPERTY C/W 3:1 SIDE SLOPES

EXISTING PIT
(437138 4th LINE)

N10°11'40"W
1715.10



Key Plan:



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- EX WATER SERVICE
- EX FIRE HYD.
- EX ST NAME SIGN
- EX STOP SIGN
- EX ELEVATION
- EX FENCE
- EX U/G GASMAIN
- EX U/G BELL
- EX U/G HYDRO
- EX WATERMAIN & VALVE
- EX SAN SEWER & MH
- EX STM SEWER & MH

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- PR WATERMAIN
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- PR SANITARY MANHOLE
- PR STORM SEWER
- PR CATCHBASIN MANHOLE
- PR MANHOLE
- PR CATCHBASIN
- PR SWALE
- PR ELEVATION
- PR MATCH EXISTING ELEVATION (INTERPOLATED)
- PR TOP OF CURB ELEVATION
- PR EDGE OF PAVEMENT ELEVATION
- PR STEEP SLOPE
- CONCENTRATED EXTERNAL FLOW
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- LIMIT OF PROPOSED EXTRACTION
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- LIMIT OF EXISTING EXTRACTION
- PROPERTY LINE
- MONITORING WELL

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PHASE 3A – STRIP TOPSOIL & OVERBURDEN, INSTALL CUT-OFF SWALES & CULVERTS.

PHASE 3B – STRIP TOPSOIL & OVERBURDEN, REDIRECT SWALE TO PHASE 3A.

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No.	Issue / Revision	Date
1	FOURTH SUBMISSION	JUNE 24, 2025

DHL PIT

4th LINE DITCH
PLAN & PROFILE
STA 1+000 TO 1+923

Client:
Duivenvoorden Haulage Ltd.
3425 9th Line
Innisfil, Ontario
L9S 3Z6

WMI & Associates Limited
119 Collier Street
Barrie, Ontario
L4M 1H5
Ph 705-797-2027
www.wmiengineering.ca

Drawn By	Checked By	Drawing No.
AW	JWL	PP1
Scale H-1:1250 V-1:125	Project No. 20-636	

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RUNOFF COEFFICIENT CALCULATIONS
"C" SPREADSHEET

Date: 27-May-25 **Project No.:** 20-636

Project: DHL Pit **Prepared By:** AW

RUNOFF COEFFICIENT NUMBERS

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade	0.22	0.35	0.55
	5 - 10% grade	0.3	0.45	0.6
	10 - 30% grade	0.4	0.65	0.7
Pasture Land	0 - 5% grade	0.1	0.28	0.4
	5 - 10% grade	0.15	0.35	0.45
	10 - 30% grade	0.22	0.4	0.55
Woodlot or Cutover	0 - 5% grade	0.08	0.25	0.35
	5 - 10% grade	0.12	0.3	0.42
	10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands		0.05	0.05	0.05
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	0.95	0.95	0.95
Gravel	(not used for proposed parking or storage areas)	0.4	0.5	0.6
Residential	Single Family	0.3	0.4	0.5
	Multiple (i.e. semi, townhouse, apartment, etc.)	0.5	0.6	0.7
Industrial	Light	0.55	0.65	0.75
	Heavy	0.65	0.75	0.85
Commercial		0.6	0.7	0.8
Unimproved Areas		0.1	0.2	0.3
Lawn	< 2% grade	0.05	0.11	0.17
	2 - 7% grade	0.1	0.16	0.22
	> 7% grade	0.15	0.25	0.35

Ref: Runoff Coefficient Numbers - Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual", MTO. (1997)

<<< **Elements Requiring Input Information**

EXT-SUB CATCHMENT

Land Cover		Hydrologic Soil Groups		
		A-AB	B-BC	C-D
Cultivated Land	0 - 5% grade	64.9		
	5 - 10% grade	64.9		
	10 - 30% grade			
Pasture Land	0 - 5% grade			
	5 - 10% grade			
	10 - 30% grade			
Woodlot or Cutover	0 - 5% grade	26.6		
	5 - 10% grade			
	10 - 30% grade			
Lakes and Wetlands				
Impervious Area	(i.e. buildings, roads, parking lot, etc.)	1.7		
Gravel	(not used for proposed parking or storage areas)			
Residential	Single Family			
	Multiple (i.e. semi, townhouse, apartment, etc.)			
Industrial	Light			
	Heavy			
Commercial				
Unimproved Areas				
Lawn	< 2% grade			
	2 - 7% grade			
	> 7% grade			

Total Area (ha) = 158.0 **Runoff Coefficient, C =** **0.24**

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TIME OF CONCENTRATION & TIME TO PEAK CALCULATIONS
T_C & T_P SPREADSHEET

Date: 27-May-25 **Project No.:** 20-636

Project: DHL Pit **Prepared By:** AW

OVERLAND SHEET FLOW TIME OF CONCENTRATION (T_C) CALCULATION, $T_{C, OVER}$

The Runoff Coefficient 'C' governs which Time of Concentration Formula is used: C > 0.40 Bransby Williams Formula
C <= 0.40 Airport Formula (FAA Equation)
Ref: MTO, Drainage Management Manual, pg 28, Ch. 8, 1997

<<< **Elements Requiring Input Information**

Catchment I.D.	Area (ha)	h_1 (m)	h_2 (m)	Length (m)	Runoff Coefficient	h_{DELTA} (m)	Slope (%)
EXT-SUB	158	525	505.5	2942	0.24	19.5	0.7

$T_{C, OVER}$ (min.)	
Airport Formula	Bransby Williams Formula
174.2	

Airport Formula (FAA Equation)

$$T_{C, OVER} = \frac{3.26\ (1.1-C)\ (L)^{0.5}}{(S)^{0.33}} \quad \text{(min.)}$$

where, C = Runoff Coefficient
L = Length of Overland Flow Path, (m)
S = Avg. Slope of Overland Flow Path, (%)

Bransby Williams Formula

$$T_{C, OVER} = \frac{0.057\ (L)}{(S)^{0.2}\ (A)^{0.1}} \quad \text{(min.)}$$

where, L = Length of Overland Flow Path, (m)
S = Avg. Slope of Overland Flow Path, (%)
A = Catchment Area, (ha)

CHANNELIZED FLOW TIME OF CONCENTRATION (T_C) CALCULATION, $T_{C, CHAN}$

Refer to separate sheet attached for the calculation of the Velocity values (i.e. Flow Master Output, Manning's Channel Spreadsheet, etc.).

Catchment I.D.	Length (m)	Velocity (m/s)	$T_{C, CHAN}$ (min.)

$$T_{C, CHAN} = \frac{L}{V} \quad \text{(min.)}$$

where, L = Length of Channel, (m)
V = Flow Velocity in Channel, (m/s)

PIPED FLOW TIME OF CONCENTRATION (T_C) CALCULATION, $T_{C, PIPE}$

Refer to separate sheet attached for the calculation of the Velocity values (i.e. Culvert Master Output, Manning's Pipe Spreadsheet, etc.).

Catchment I.D.	Length (m)	Velocity (m/s)	$T_{C, PIPE}$ (min.)

$$T_{C, PIPE} = \frac{L}{V} \quad \text{(min.)}$$

where, L = Length of Pipe, (m)
V = Flow Velocity in Pipe, (m/s)

TOTAL TIME OF CONCENTRATION (T_C) AND TIME TO PEAK (T_P) CALCULATION, $T_{C, TOTAL}$, $T_{P, TOTAL}$

The Total Time of Concentration and Time to Peak values consist of a combination of the Overland, Channel and/or Pipe travel times.

Catchment I.D.	$T_{C, OVER}$ (min.)	$T_{C, CHAN}$ (min.)	$T_{C, PIPE}$ (min.)

$T_{C, TOTAL}$ (min.)	$T_{P, TOTAL}$ (min.)	$T_{P, TOTAL}$ (min.)

$$T_{C, TOTAL} = T_{C, OVER} + T_{C, CHAN} + T_{C, PIPE} \quad \text{(min.)}$$

$$T_{P, TOTAL} = 0.67 \times T_{C, TOTAL} \quad \text{(min.)}$$

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RATIONAL METHOD CALCULATIONS

Date: 27-May-25 **Project No.:** 20-636

Project: DHL Pit **Prepared By:** AW

<<< **Elements Requiring Input Information**

Rainfall Intensity-Duration-Frequency Coefficients from: MTO IDF Curve Lookup

2-year		5-year		10-year		25-year		50-year		100-year	
A =	22.8	A =	30.1	A =	35.0	A =	41.1	A =	45.7	A =	50.2
B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699	B =	-0.699

Rational Method Formula

$$Q = \frac{C \times I \times A}{360} \quad (m^3/s)$$

where, C = Runoff Coefficient
I = Rainfall Intensity, (mm/hr)
A = Drainage Area, (ha)

Rainfall Intensity Equation (2-100 year storm events)

$$I_{2\text{-}100} = A \times (T_C / 60)^B \quad (mm/hr)$$

where, A = Rainfall IDF Coefficient
B = Rainfall IDF Coefficient
T_C = Time of Concentration, (min)

Runoff Coefficient Equations
Based on MTO Drainage Manual (1984), page BD-4

2-year	C_2 =	C
5-year	C_5 =	C
10-year	C_{10} =	C
25-year	C_{25} =	1.10 x C
50-year	C_{50} =	1.20 x C
100-year	C_{100} =	1.25 x C

For storms having a return period of more than 10 years, the Runoff Coefficient, C, will be increased as indicated above, up to a maximum value of 1.

Rainfall Intensity Equation (25mm storm event)
Based on the MOE SWMP Manual (2003), Eq'n 4.9

$$I_{25mm} = (43 \times C) + 5.9 \quad (mm/hr)$$

where, C = Runoff Coefficient

Catchment I.D.	A (ha)	T_C (min.)	C	Q_{25mm} (m^3/s)	Q_2 (m^3/s)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{25} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)
EXT-SUB	158.0	174.2	0.24	1.709	1.140	1.505	1.750	2.261	2.742	3.138

Z:\Projects\2020\20-636\Design\Storm\Issue#4\[3-250527_Rational_Method_Calcs(A,B).xlsx]Rational Method

Culvert Calculator Report
Twin 900mm North Berm Culvert

Comments: The twin 900mm diameter culvert is sized to convey the 100-year design storm event from the contributing drainage area (3.138m3/s).

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	508.00	m	Headwater Depth/Height	1.66	
Computed Headwater Elev	507.52	m	Discharge	3.1380	m³/s
Inlet Control HW Elev.	507.52	m	Tailwater Elevation	505.10	m
Outlet Control HW Elev.	507.46	m	Control Type	Inlet Control	

Grades					
Upstream Invert	506.00	m	Downstream Invert	505.10	m
Length	38.90	m	Constructed Slope	0.023136	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.74	m
Slope Type	Mild		Normal Depth	0.76	m
Flow Regime	Subcritical		Critical Depth	0.74	m
Velocity Downstream	2.77	m/s	Critical Slope	0.024319	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	507.46	m	Upstream Velocity Head	0.37	m
Ke	0.90		Entrance Loss	0.33	m

Inlet Control Properties					
Inlet Control HW Elev.	507.52	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	1.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
400mm East Berm Culvert

Comments: The maximum flow the 400mm diameter culvert will convey before the runoff spills the southern high point within the 4th Line ditch is 0.298m3/s.

The maximum headwater elevation of 510.33m is the southern high point within the 4th Line ditch.

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	510.33	m	Headwater Depth/Height	3.27	
Computed Headwater Elev	510.33	m	Discharge	0.2979	m³/s
Inlet Control HW Elev.	510.17	m	Tailwater Elevation	507.20	m
Outlet Control HW Elev.	510.33	m	Control Type	Outlet Control	

Grades					
Upstream Invert	509.00	m	Downstream Invert	507.20	m
Length	34.90	m	Constructed Slope	0.051576	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.38	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.38	m
Velocity Downstream	2.38	m/s	Critical Slope	0.055555	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.41	m
Section Size	400 mm		Rise	0.41	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	510.33	m	Upstream Velocity Head	0.27	m
Ke	0.90		Entrance Loss	0.24	m

Inlet Control Properties					
Inlet Control HW Elev.	510.17	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.1	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Worksheet for Temporary Phase 3A Swale

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	1.00	%
Left Side Slope	3.0	H:V
Right Side Slope	3.0	H:V
Bottom Width	2.00	m
Discharge	3.138	m³/s

Results

Normal Depth	0.57	m
Flow Area	2.11	m²
Wetted Perimeter	5.60	m
Hydraulic Radius	0.38	m
Top Width	5.41	m
Critical Depth	0.49	m
Critical Slope	1.79	%
Velocity	1.49	m/s
Velocity Head	0.11	m
Specific Energy	0.68	m
Froude Number	0.76	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.57	m
Critical Depth	0.49	m
Channel Slope	1.00	%

Worksheet for Temporary Phase 3A Swale

GVF Output Data

Critical Slope	1.79	%

Messages

Notes

The proposed temporary swale has been designed to convey the 100-year design storm event from the contributing external drainage area (3.138m3/s).

Worksheet for Phase 3A Cut-off Swale

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	1.00	%
Left Side Slope	3.0	H:V
Right Side Slope	3.0	H:V
Bottom Width	1.00	m
Discharge	0.298	m³/s

Results

Normal Depth	0.22	m
Flow Area	0.37	m²
Wetted Perimeter	2.39	m
Hydraulic Radius	0.15	m
Top Width	2.32	m
Critical Depth	0.17	m
Critical Slope	2.46	%
Velocity	0.82	m/s
Velocity Head	0.03	m
Specific Energy	0.25	m
Froude Number	0.66	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.22	m
Critical Depth	0.17	m
Channel Slope	1.00	%

Worksheet for Phase 3A Cut-off Swale

GVF Output Data

Critical Slope	2.46	%

Messages

Notes

The 0.75m deep cut-off swale has been designed to convey the maximum flow conveyed through the upstream 400mm diameter culvert (0.298m3/s)