Pilot Study Assessment of

Increase in Lot Coverage in

Rurally Serviced Roadway Neighbourhoods (Community of Ancaster)

Prepared for:

City of Hamilton

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PILOT STUDY ASSESSMENT
of
INCREASE IN LOT COVERAGE IN RURALLY-SERVICED ROADWAY NEIGHBOURHOODS (COMMUNITY OF ANCASTER)

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EXECUTIVE SUMMARY

Background

The City of Hamilton has been observing development trends related to severances and redevelopment of lots in high-value “desirable” neighbourhoods, such as those found in the older sections of the Community of Ancaster. There has been an increase in the amount of redevelopment occurring on the larger lots in Ancaster. Lots are being created through severance applications, as well as the redevelopment of large infill homes on existing lots. Redevelopment in these areas is increasing the amount of overall impervious coverage, including:

- New and/or larger driveways;
- Walkways;
- Building footprints;
- Accessory buildings; and
- Pools, patios and decking areas.

The issue is particularly prevalent in those neighbourhoods which are rurally-serviced (i.e. ditches and driveway culverts versus curb/gutter and storm sewers). In those circumstances, where the amount of severance applications and infill development and related impervious coverage increases are significant, local catchment impervious coverage can increase resulting in higher peak flows and corresponding runoff volumes, and also potentially deliver additional contaminant load to environmentally sensitive receivers/systems, causing potential flooding, erosion, and environmental degradation.

In the Community of Ancaster, the Ancaster Zoning By-law 87-57 zones the lands identified in this study as Existing Residential “ER” Zone. Historically these areas did not have municipal servicing and therefore required large lots to provide on-site servicing (septic and wells). Municipal servicing has now been provided and the lands formerly required for on-site servicing can now be occupied by structures.

The ER Zone recognizes the existing large lots for single detached dwellings and establishes a Minimum Frontage of 18 metres, Minimum Lot Area of 695 square metres and a Maximum Lot Coverage of 35%. . A Maximum Lot Coverage of 35% only accounts for the portion of land occupied by buildings and structures (i.e. houses and accessory structures) and does not include other impervious areas such as driveways, walkways and patios.
Given the reduced requirements to provide on-site services, severances and infill development has now become more prevalent. In this regard, the City of Hamilton has commissioned this assessment to define the potential level of impact and associated opportunities for mitigation specific to stormwater management and related issues. This initiative has engaged multiple City departments including the Planning and Economic Development Department and Public Works.

Approach

As part of this investigation, a suitable location in the Community of Ancaster, currently serviced with a rural roadway drainage standard, has been identified to conduct a pilot study through

technical analyses (modelling) to determine the impact potential (specific to surface water runoff) due to varying levels of increased impervious coverage, resulting from infill development and lot severances. The evaluation has quantitatively assessed the change in runoff rate and volume indicating the impacts to performance. The study has also considered opportunities for mitigation at a high level.

A Site Reconnaissance was conducted to identify development and servicing trends across Ancaster to support the selection of candidate sites for study. Eight (8) neighbourhoods i(ref. Appendix B and C) were reviewed with City staff based on Property Assessment data provided by the City and also servicing approach/configuration.

In order to provide a perspective on the residential redevelopment in these areas f , other area municipalities were also contacted to determine if there are similar problems in those communities, and if so what are those municipalities doing about the matter.

To support the numerical impact assessment, analytical modelling of the Pilot Study area in the Community of Ancaster was conducted; this included model selection, parameterization, and associated assumptions and performance assessment.

The hydrologic modelling program PCSWMM was adopted for use in this study to develop a numerical model representative of the conditions present within the Pilot Study area.

Three (3) redevelopment scenarios have been considered in the assessment, which reflect increased impervious coverage due to the infill development of larger homes on existing lots or the creation and development of new lots by severance application. The existing amount of impervious area has been increased by 10%, 20%, and 30% for this modelling exercise

In addition, a fourth scenario was modelled to reflect the Maximum Lot Coverage of 35% permitted in the ER Zone. In this scenario the assumption was that all lots had a Lot Coverage of 35% reflecting buildings and structures, plus the existing level of driveways, walkways and patios. The drainage system performance has been evaluated based on four (4) design storm events: the 25 mm 4-hour Chicago storm, as well as the 2 year (53 mm in 24 hours), 5 year (72 mm in 24 hours), and 100 year (123 mm in 24 hours) SCS 24-hour storm events.

Results

The Pilot Study area has four (4) distinct outlets which were assessed for peak flows and runoff volumes for the five (5) scenarios including existing impervious coverage, , the three (3) redevelopment scenarios of varying levels of increasing impervious coverage and the ER Zone Maximum Lot Coverage of 35%. Table ES-1 provides an indication of the relative change in percent peak flow and runoff volume associated with the varying levels of lot coverage cited in this study.

Much of the existing Pilot Study area has a rural cross-section with roadside ditches on either side. Many of the driveway culverts within these ditches are sunk into the ground, adversely affecting their capacity and ability to convey flow, which does not meet the City’s level of service. The soils in the area are considered to be favorable for drainage (i.e. permeable).

Table ES-1: Percentage Increase of Peak Flows and Runoff Volumes vs. Existing Land Use																
Scenario and Design Event	Outlet 1				Outlet 2				Outlet 3				Outlet 4			
	Peak Flows		Runoff Volume		Peak Flows		Runoff Volume		Peak Flows		Runoff Volume		Peak Flows		Runoff Volume	
	(m^3/s)	% Increase	(ML)	% Increase	(m^3/s)	% Increase	(ML)	% Increase	(m^3/s)	% Increase	(ML)	% Increase	(m^3/s)	% Increase	(ML)	% Increase
25 mm Chicago 4 Hour																
Existing % imp	0.013	0	0.044	0	0.015	0	0.054	0	0.005	0	0.035	0	0.135	0	0.292	0
Existing +10% imp	0.018	38.5	0.079	79.5	0.021	40.0	0.084	55.6	0.007	40.0	0.059	68.6	0.180	33.3	0.394	34.9
Existing +20% imp	0.022	69.2	0.138	213.6	0.029	93.3	0.128	137.0	0.011	120.2	0.106	202.9	0.220	63.0	0.526	80.1
Existing +30% imp	0.027	107.7	0.207	370.5	0.041	173.3	0.196	263.0	0.019	280.0	0.165	371.4	0.260	92.6	0.707	142.1
ER Zone Maximum Lot Coverage 35%	0.019	46.2	0.087	97.7	0.022	46.7	0.109	101.9	0.005	0	0.056	60.0	0.188	39.3	0.419	43.5
2 year SCS 24 Hour (53 mm in 24 hours)																
Existing % imp	0.043	0	0.476	0	0.046	0	0.422	0	0.031	0	0.391	0	0.200	0	1.429	0
Existing +10% imp	0.062	44.2	0.583	22.5	0.065	41.3	0.543	28.7	0.045	45.2	0.491	25.6	0.266	33.0	1.778	24.4
Existing +20% imp	0.079	83.7	0.703	47.7	0.081	76.1	0.678	60.7	0.063	103.2	0.605	54.7	0.339	69.5	2.153	50.7
Existing +30% imp	0.100	132.6	0.840	76.5	0.118	156.5	0.839	98.8	0.093	200.0	0.740	89.3	0.428	114.0	2.570	79.8
ER Zone Maximum Lot Coverage 35%	0.062	44.2	0.599	25.8	0.065	41.3	0.607	43.8	0.038	22.6	0.460	17.6	0.274	37.0	1.884	31.8
5 year SCS 24 Hour (72 mm in 24 hours)																
Existing % imp	0.085	0	0.814	0	0.088	0	0.795	0	0.073	0	0.706	0	0.352	0	2.455	0
Existing +10% imp	0.122	43.5	0.969	19.0	0.145	64.8	0.963	21.1	0.109	49.3	0.853	20.8	0.449	27.6	2.916	18.8
Existing +20% imp	0.135	58.8	1.122	37.8	0.237	169.3	1.149	44.5	0.167	128.8	1.030	45.9	0.546	55.1	3.394	38.2
Existing +30% imp	0.141	65.9	1.300	59.7	0.334	279.5	1.361	71.2	0.237	224.7	1.250	77.1	0.629	78.7	3.907	59.1
ER Zone Maximum Lot Coverage 35%	0.125	47.1	0.990	21.6	0.183	108.0	1.049	31.9	0.097	32.9	0.816	15.6	0.465	32.1	3.056	24.5
100 year SCS 24 Hour (123 mm in 24 hours)																
Existing % imp	0.298	0	1.899	0	0.495	0	2.058	0	0.391	0	2.026	0	0.971	0	5.580	0
Existing +10% imp	0.367	23.2	2.138	12.6	0.596	20.4	2.336	13.5	0.552	41.2	2.372	17.1	1.038	6.9	6.233	11.7
Existing +20% imp	0.462	55.0	2.391	25.9	0.706	42.6	2.630	27.8	0.731	87.0	2.776	37.0	1.112	14.5	6.876	23.2
Existing +30% imp	0.563	88.9	2.663	40.2	0.809	63.4	2.947	43.2	0.986	152.2	3.246	60.2	1.176	21.1	7.523	34.8
ER Zone Maximum Lot Coverage 35%	0.363	21.8	2.166	14.1	0.625	26.3	2.465	19.8	0.542	38.6	2.330	15.0	1.083	11.5	6.439	15.4

Mitigation

In order to mitigate the potential impacts of increased impervious coverage from the future lot severances or infill development, Low Impact Development Best Management Practices (LID BMPs) can be designed and implemented to provide storage on individual lots to decrease the runoff peaks and volume. Based on the area’s residential land use bioswales would be a viable BMP to store the additional runoff volume. For this Pilot assessment, the most intense scenario (i.e. +30% imperviousness) has been evaluated for each storm event (excluding the infrequent 100 year event) at each outlet.

Based on this assessment, it is considered that on-lot infiltration-based BMPs would be practical for implementation in these settings and should be considered going-forward by City staff as part of its site plan and/or building permit process. It is suggested though that there would be merit in assessing local BMP performance using long-term data at a neighbourhood scale to improve and refine sizing beyond preliminary figures outlined in this assessment.

As noted, increased imperviousness without mitigation will lead to increased runoff rates and volumes which will degrade the performance of ditch systems in rurally-serviced neighbourhoods. On-lot BMPs such as rain gardens, soakaway beds, increased topsoil depth, and other storage infiltration-based technologies have the potential to off-site (mitigate) the impacts related to increase imperviousness. The sizing of these forms of on-lot BMPs needs to be carefully considered to take into account the potential for long-term loss of effectiveness due to clogging with fines, lack of maintenance, or even removal by landowners, since the BMPs are not in public control. Various municipal jurisdictions have therefore taken the approach to build in redundancy in the capacity of these BMPs through over-design, in essence assuming an area-wide loss in effectiveness over time.

Other Considerations

While localized flooding and standing water in ditches cause short-term impacts to area residents, increasing urban coverage in existing communities can also cause other longer term impacts to receiving systems as follows:

Erosion

Where open watercourses receive drainage from neighbourhoods experiencing increased lot coverage, peak flows and runoff volumes (in particular) would in the absence of any mitigation be expected to increase and so too would the erosion potential in the reaches. The amount of this increased risk would vary based on a number of factors including level of lot coverage increase and the sensitivity of the receiving system. Clearly this brings forward the need for holistic neighbourhood scale assessments to determine the need, level of risk, and best form of mitigation.

Water Quality

Urban contaminants typically wash off roadways and driveways, most commonly associated with vehicles and roadway maintenance, particularly in the winter/spring (salt/sand). Other urban contaminants include yard waste, pesticides/herbicides and airborne contaminants draining off rooftops. Notwithstanding, there have been good advances reducing pesticides and herbicides through local and provincial measures, and rooftop runoff is generally conceded to be substantially less contaminated than runoff from roadways/driveways, in terms of amount and toxicity.

Where impervious coverage increases (through severances and new infill development) roadway dimensions usually stay the same (except in extreme cases), while usage would be expected to increase (more homes would equate to more people and drivers). As such, it is anticipated that there would be some increase in contaminant loading, however it would be expected to be proportionately less than peak flows and runoff volume, hence overall likely less of a concern.

Urban drainage often discharges to natural systems including: creeks/watercourses, wetlands, slough forests, and lakes. The combined impacts of higher peaks and volumes, along with greater contaminant loading can degrade these natural systems affecting long-term health. Those natural features which are reliant on seasonal variations in water supply can also be detrimentally affected by too much water too frequently (can drown out less tolerant vegetation) and similarly even slight increases in contaminant load can over time, as noted, reduce the system’s ecological diversity.

Conclusions

Based on the technical assessment conducted for the rurally-serviced pilot area in the Community of Ancaster, the following can be concluded:

i) The Community of Ancaster has a number of areas which are serviced by rural and semi-rural drainage standards in older parts of the community with comparatively large lots versus current practices. Several of these areas are being redeveloped through severances of larger lots and/or tearing down smaller homes and replacing with ones of substantially larger footprints.

ii) The change in development trends for these residential areas has the potential to increase peak flows, runoff volumes, and contaminant loads, leading to reduced roadside ditch performance and degraded water quality.

iii) A set of area characteristics including topography, historical land use changes, and ditch condition was used to select a Pilot study area as the preferred site for the assessment.

iv) Numerical analyses of three (3) scenarios increasing the impervious area by10%, 20%, 30% and a fourth scenario evaluating the ER Zone Maximum Lot Coverage of 35%) has demonstrated that peak flows and runoff volumes could increase substantially with the relative amount depending on location, coverage, and size of event.

v) The existing ditch and driveway culvert system in the Pilot area performs reasonably well for the 25 mm and 2 year storm (53 mm in 24 hours) with only isolated locations exhibiting spill onto lawns during a 2 year event, largely attributable to driveway culvert grades and

maintenance condition. The 5 year (72 mm in 24 hours) performance is not as good with some areas spilling onto the roadway. The 100 year event (123 mm in 24 hours) exhibits widespread overtopping of roads, as expected, to effectively drain the study area, with increased lot coverage scenarios exacting the greatest impacts to the urbanized road sections.

vi) Increased impervious coverage reduces system performance increasing the number and severity of drainage deficiencies. This assessment has been based on peak flows and does not inherently consider runoff volumes which, due to increased lot coverage, would extend the period of inundation.

vii) While not directly assessed by this pilot study, both creek/ditch erosion and water quality are anticipated to be similarly affected by the increased impervious coverage, albeit water quality is likely to be the lesser of the two, given the limited amount of contaminant sources for expanded residential home coverage.

Recommendations

i) On-lot BMPs (including forms of LID) can be an effective means of mitigating the increased runoff (peaks and volumes) and should be considered for these circumstances; City staff should contemplate the design and implementation of these measures per the City’s Drainage Policy and the City’s Criteria and Guidelines for Stormwater Infrastructure Design as well as the following:

- Applicants must demonstrate that an adequate outlet is available with no impact to any downstream properties
- Should lot level controls (and suitable forms of LID) for SWM be proposed to mitigate increase runoff, the proposed infrastructure must be included in the appropriate Consent Agreement with securities and registered on title. This would include operation and maintenance responsibility.
- Overbuilding the BMPs (i.e. providing redundant storage) the amount of control to account for loss of effectiveness over time
- Use of less complex BMPs (i.e. increased topsoil depth)
- Requiring focussed site specific geotechnical investigations for each single lot development to establish groundwater levels and infiltration capability of native / local soils
- Avoid lowering rebuilt homes basement elevation due to potential to intercept more groundwater and promote more frequent discharge foundation water into ditches

ii) Where potential for redevelopment is significant the City should consider a detailed drainage assessment to confirm a suitable storm outlet and downstream impacts.

iii) Driveway culverts should be inspected as part of the City’s inspection activities for condition and build-up of sediment, and maintained accordingly; problem areas should be assessed more frequently

iv) Rebuilt rurally serviced roadways should consider subdrains for ditch systems

1.1 INTRODUCTION

1.2 Overview of Problem

The City of Hamilton is observing development trends related to severances and redevelopment of lots in high-value “desirable” neighbourhoods, such as those found in the older sections of the Community of Ancaster. These larger lots are in certain circumstances being severed creating multiple properties or having existing homes torn down and replaced by larger homes resulting in higher overall impervious coverage and additional driveway entrances needed to cross local drainage ditches servicing the neighbourhood. The issue is particularly prevalent in those neighbourhoods which are rurally-serviced (i.e. ditches and driveway culverts versus curb/gutter and storm sewers). In those circumstances, where the amount of severances and related increase in lot coverage is significant, local catchment impervious coverage can increase resulting in higher peak flows and corresponding runoff volumes, and also potentially deliver additional contaminant load to environmentally sensitive receivers/systems causing potential flooding, erosion, and environmental degradation. By way of definition for the purpose of this report, rebuilding homes on existing lots with larger dwellings or severing lots and forming two or more lots from a single lot, is considered a form of land use intensification through redevelopment, which has the effect of adding impervious coverage and associated impervious surfaces.

Many older communities have been redeveloping over time which is consistent with Municipal and contemporary Urban Planning Policy which promotes 40% of new development / growth within the existing urban boundary. Concurrently though, the City’s Public Works Department remains concerned about ensuring that any potential impacts of this form of redevelopment are effectively managed. In this regard, the City of Hamilton has commissioned an assessment of this matter based on supportable science, to define the potential level of impact and associated opportunities for mitigation. This initiative has engaged multiple City departments including the Planning and Economic Development Department, and Public Works.

1.3 Approach

Due to the potential breadth of the issue across the Community of Ancaster, it has been considered impractical to numerically assess all of the potential infill/redevelopment and severance locations where rural servicing exists. Rather, a suitable location in the community has been identified based on various criteria to serve as a pilot area for this study. An investigation of this type is also expected to inform City staff of the related impacts for not only those lands with potential in the Community of Ancaster, but also other parts of the City of Hamilton including Waterdown, and the older parts of Stoney Creek.

As part of this study, City staff has provided mapping depicting infill/redevelopment and severances in Ancaster, and defined high potential locations for redevelopment in the future.(ref. Figure)

Through this investigation, a “state of knowledge” within the industry regarding this matter has been secured to determine whether or not other Municipalities have this phenomenon occurring and how others are addressing the matter. In addition, through this study Amec Foster Wheeler has generally documented the evolution of stormwater management and building standards related to servicing and building footprints from the 1970’s to present.

1.4 Detailed Scope

As part of this investigation, a suitable location in the Community of Ancaster, currently serviced with a rural roadway drainage standard, has been identified to conduct a pilot study through technical analyses (modelling) to determine the impact potential due to varying levels of increased impervious coverage due to lot severances and infill development. The findings from the assessment of this ‘typical area’ will be used by City staff to provide opinions on the impact to the overall community. The evaluation quantitatively assesses the change in runoff rate and volume and from this establishes an indication of performance, while also providing a basis to qualitatively evaluate other factors such as: erosion, water quality, terrestrial, and aquatic ecology. The study has considered opportunities for mitigation at a high level.

The following outlines the respective tasks considered in this assessment.

Task 1: Scoping Meeting with City Staff

Task 2: Collect and Review Background Data

- Planning reports, local geotechnical data (in area of interest), Area Drainage Plans and reports
- Planning Policy
- plans of historical severances/rebuilds
- data related to potential redevelopment areas based on:
  - age of development
  - lot size
  - home size
- topographic mapping/servicing plans depicting existing building coverage and impervious areas

Task 3: Site Reconnaissance to locate potential candidate neighbourhood for pilot study; review state of repair including ditches and driveway culverts (See xx)

Task 4: Two-man Survey Team to confirm any critical grades

Task 5: Review trends in other communities; three (3) communities contacted to determine extent and action

Task 6: Meeting with Planning and Economic Development Department to discuss the issue and proposed assessment approach

Task 7: Evaluate suitable modelling platforms and develop locally discrete hydrologic model for pilot study; need to consider for:

- infiltration
- roadside ditch conveyance (and storage)
- sensitivity to imperviousness
- potential for LID BMPs assessment

Conduct analysis of three (3) scenarios of increasing imperviousness, and a scenario evaluating the impacts of the Maximum Lot Coverage of 35% as permitted by the ER Zone, and determine impacts to runoff (peaks and volume).

Task 8: Meeting with Public Works to review preliminary numerical findings

Task 9: Update assessment based on City staff input; evaluate additional impacts (qualitatively) based on broader factors including: erosion, water quality, natural environment; consider impact potential to balance of Community of Ancaster, along with professional opinion on transferability of approach and findings to other locations in Hamilton.

Task 10: Finalize report; prepare summary for presentation to Committee

2.0 BACKGROUND DATA/INFORMATION

Over the course of this Pilot Study, City staff has provided a number of data items and related information to support the investigation, including as follows:

Geotechnical Investigation GTR-1213 by Terraprobe. February 15, 2007;
The report provides a representation of soil and ground water conditions for the surrounding area, based on boreholes drilled along Ravina Crescent, Douglas Road, Rosemary Lane, and St. Margaret Road. This information has been used to determine soil type and class, as well as SCS Curve Numbers (CN values) for the hydrologic modelling.

Soil Map of Wentworth County – Soil Survey Report No. 32. Soil Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, 1967;
The soil map has been reviewed to provide additional information on soils in the study area.

Aerial Mapping of study area;
Received from the City of Hamilton June 18, 2014. The aerial file (.sid) provides information on existing land use and impervious coverage.

Topographic mapping;
Received from the City of Hamilton June 30, 2014. The contours file (.dwg) provides topographic information required for delineating drainage boundaries and related limits.

Field Survey conducted by AMEC on July 22, 2014;
Survey has been conducted to determine the geometry of the road and ditch sections for input into the hydrologic model, as driveway culverts. In some areas, survey data has been reviewed to verify catchment areas, determined from the topographic information provided by the City. The limits of areas surveyed has been provided on Drawing 4.

Plan and Profile drawings created by Giffels Associates Limited (Dated: May 2007) and the Regional Transportation Department of the Regional Municipality of Hamilton-Wentworth (Dated: July 1996) provided by the City of Hamilton on July 3, 2014;
The Plan and Profile drawings have provided information on the study area streets: Douglas Road, Rosemary Lane, St. Margaret Road, and Cameron Drive. The drawings reveal relevant underground infrastructure including storm sewers and catchbasins, and supplement the aforementioned survey with additional information on road grades and culverts.

Other information such as mapping and reporting has also been provided and has been referenced accordingly throughout this report including:

Number of severance applications in all communities and pilot area specifically (referred to in Section 4.3)
Amount of building permits issued in all communities and pilot area specifically (referred to in Section 4.3)

3.0 SITE RECONNAISSANCE/SELECTION OF CANDIDATE AREA

The objective of the Site Reconnaissance has been to identify development and servicing trends across Ancaster and use information from the field observations to support the selection of candidate sites for study. In advance of the site reconnaissance, City staff provided mapping depicting the servicing of several areas so that rurally-dominated serviced areas could be identified for the reconnaissance effort.

An analysis form (ref. Appendix C) was developed to support the inspection of the sites on May 2, 2014. A summary of the field inspection providing characterization was provided to City staff May 5, 2014, followed by an analysis of the eight (8) neighbourhoods based on Property Assessment data provided by the City May 23, 2014.

This information was subsequently provided to the City on May 29, 2014 and pursuant, the City reviewed these data and concluded that the impervious coverage data were of insufficient accuracy and suggested that the City’s parcel fabric be used instead. City staff then forwarded the City-wide shape files for these data June 16, 2014. Based on Amec Foster Wheeler’s review of this information for the eight (8) potential neighbourhoods, it was concluded that the information was also not of sufficient accuracy for this purpose as it did not reflect driveways, out buildings, or other impervious surfaces, and in fact in some cases the building outline/footprint was considered questionable. As such, it was suggested that for the assessment, home size would be advanced as the decision-making factor for the assessment, along with directly-measured impervious surfaces from the aerial mapping.

Table 3.1 summarizes the observations characterizing the various neighbourhoods (ref. Drawing 1 depicting subject areas).

**Table 3.1: Pilot Study-Assessment of Redevelopment Potential
Rurally-serviced Roadway Neighbourhoods, Ancaster
Neighbourhood Characterization**

Area ID	General Location/Name	Topography	Historical Redevelopment	Redevelopment Potential	Ditch Condition	Other
A	North-Ancaster Heights	Rolling	~ 10%	Moderate	Average	Neighbourhood Standard-Good +
B	North-Central – Tamarac	Mild	< 5%	Low – Moderate	Good	Noisy Less desirable
C	South-East – adjacent to HGCC	Mild to Moderate	10 – 15%	Moderate – Good	Good	Smaller Lots
C +	Towards Wilson Street St. Mathews	Mild to Moderate	20% +	Good	Good	
D	Nakoma (1960’s)	Flat	< 5%	Limited	Good	Smaller Lots Good Homes
E	Veteran Land Act Area	Flat / Mild	~ 10%	Moderate	Good	Smaller Lots Good Homes
F	West – Oak Hill Lothyian	Rolling / Steep	30%	High	Average – Good	
G	Central	Rolling / Steep	5 – 10%	Moderate – Good	Good	Higher Quality Homes

Supplemental analyses of available data were subsequently conducted for the eight (8) + sites providing a series of statistics used to support site selection (ref. Tables 3.2 and 3.3).

Table 3.2: Residential PropertyAssessment									
Area	A	B	C	C+	D	E	F	G	TOTAL
# of Residential Areas	188	157	351	339	292	232	191	114	1864
Average Size of Home (sqft)	1787	1396	1408	1305	1804	1938	2412	2114	1771
Maximum Size of Home (sqft)	5540	2527	4550	3193	4815	6762	5981	6298	6762
Minimum Size of Home (sqft)	870	1107	705	731	727	939	1044	976	705
Average Size of Lot (acre)	0.33	0.26	0.24	0.19	0.26	0.41	0.41	0.31	0.30
Maximum Size of Lot (acre)	0.95	0.47	0.79	0.66	0.74	2.42	1.98	0.86	2.42
Minimum Size of Lot (acre)	0.12	0.19	0.01	0.036	0.01	0.021	0.17	0.018	0.01
Average Age of Construction (yr)	1965	1963	1966	1963	1974	1972	1971	1973	1968

Table 3.3: Residential Property Assessment Notes		
Area A	No additional notes	
Area B	No additional notes	
Area C	Note: It should be noted that the condominium complex at 175 Fiddlers Green Rd was included in this assessment due to the fact that it provided sqft data.	Note: 9 properties that are included in an apartment complex were not included in this assessment due to the fact that data for their sqft was not available. These properties included units 1 through 9 at 306 Woodworth Drive.
Area C+	Note: The apartment complex at 150 Wilson St West was not included in this data assessment due to the fact that data associated with this location was incomplete and skewed the rest of the assessment.	Note: The housing complex at 210 Fiddlers Green Rd was included in this assessment due to the fact that if there are flooding events, each housing unit would be affected. However, the Average, Maximum, and Minimum size of lot calculations did not include the housing units at the 210 Fiddlers Green Rd housing complex.
Area D	Note: 98 Valleyview Dr did not contain any data for Lot size and was therefore removed for the Average Lot Size calculations.	
Area E	NOTE: the property at 196 Fallingbrook Dr does not have any data for Lot Size and was therefore not included in the assessment of Average Lot Size.	
Area F	No additional notes	
Area G	No additional notes	

Based on the foregoing, the following summarizes the results of the screening/selection process for the respective candidate sites for the pilot study:

1. Neighbourhood areas B and D screened from the assessment due to low redevelopment potential
2. Neighbourhoods A, F, and G are more rolling with steeper topography, hence will not demonstrate standing water issues to the same degree as others
3. The balance of the Neighbourhoods C, C+, and E are good with perhaps C+ (just north of C) being preferred due to the larger lots in this area.

As such, Area C+ (ref. Drawing 1) has been selected for study.

4.1 TRENDS

In order to provide a perspective on the issue of increased impervious coverage, Amec Foster Wheeler has, at the request of the City of Hamilton, reached out to other area municipalities to determine if there is in fact a similar problem in those communities, and if so what are those municipalities doing about the matter.

In addition, Amec Foster Wheeler has prepared a historical chronological summary of drainage servicing, stormwater management, and residential land use to offer a framework for general trends over time in Southern Ontario, largely based on observations, professional experience, and various literature.

4.2 Historical

There are a number of factors which have combined in parts of Hamilton contributing to the current issue including: age of development, type of drainage servicing standard, stormwater management and home/lot size. In order to bring these matters into some level of focus, Amec Foster Wheeler has prepared the following table as a guide to better understanding historical trends:

Table 4.1: Historical Trends

Era of Development	Servicing Standard for Drainage	Residential		Stormwater Management Type
		Lot Size	Home Size	
pre 1950’s	Predominantly rural	Large > 60 x 100’	Small < 1500 ft^2	None
1960’s	Mix of rural and urban	Large > 60 x 100’	Small-Medium < 1800 ft^2	None
1970’s	Predominantly urban	Medium-Large > 50 x 100’	Medium <2000 ft^2	Quantity
1980’s	Predominantly urban	Medium > 40 x 100’	Medium-Large < 2200 ft^2	Quantity
1990’s	Predominantly urban	Small > 35 x 100’	Large > 2500 ft^2	Quantity/Quality
2000’s	Predominantly urban	Mix of shallow-wide (New urbanism)	Large > 2500 ft^2	Quantity/Quality (LID BMPs)

Clearly the trends summarized in Table 4.1 represent an ever increasing lot coverage largely in response to planning directives (“Places to Grow”) and market forces, including the limited availability of land. As such, based on observed trends over the past 50 years +/- the average impervious cover on a detached single family residence has gone from about 30% impervious cover to 60% and greater.

4.3 Municipal

As noted, through part of this pilot investigation, Amec Foster Wheeler staff has contacted a number of local municipalities to determine if they are experiencing similar trends and if so what are they doing to manage the concerns/impacts. Amec Foster Wheeler staff reached out to three (3) municipalities, namely:

Municipality	Contact
• Mississauga	Muneef Ahmad, P.Eng.
• Oakville	Kristina Parker, P.Eng.
• Burlington	Cary Clark, P.Eng.

Over the course of the Pilot Study, the City of Mississauga provided a written response and a meeting was held with Town of Oakville staff; to-date the City of Burlington has not responded. The following, in brief, describes a summary of the information offered by the neighbouring municipalities.

Mississauga

Mississauga’s Site Plan Control By-law (ref. Appendix B), which covers desirable neighbourhoods closer to the Lake for example, has helped to ensure City staff has the opportunity to review development plans for all key City concerns. Issues related to the incremental change in lot coverage has been raised and City staff continues to examine each development case-by-case for opportunities where drainage can be directed to grassed areas in lieu of explicit LID BMPs, so at least flows can be managed to the best extent possible. Otherwise the City does not have a specific policy to address the issue from a development-standpoint, other than continuing to keep these concerns in mind when reviewing applications related to local issues.

There is also a Council directive (ref. Appendix B) to implement LID measures within City road right-of-ways to the best extent possible, subject to budget availability.

City staff also noted that where the Site Plan process may not cover all needs, it’s Building Permit process may be sufficiently robust to address the requirements to complement those elements not captured by Site Plan control.

Oakville

Amec Foster Wheeler staff met with Town staff to review this matter. Town staff noted that historically (from 1960’s to early 2000’s) the Town had a program to urbanize rurally-serviced neighbourhoods with the predominant focus of priority based on political and social needs. In recent years this informal program has stalled giving way to more neighbourhood-focussed Class EA’s which examine issues on a holistic scale providing opportunities for residents, stakeholders, and regulators to become engaged. Notwithstanding, there are a number of locations in Oakville, particularly in the desirable lakefront area, where redevelopment through severances and “tear downs” is very prevalent and issues of standing water and local flooding are widespread. Other related concerns are associated with larger homes and deeper basement bringing forward the

need particularly in areas of high groundwater, of extensive discharge of foundation drainage to the surface, further exacerbating ditch drainage/performance.

Town staff is currently reviewing alternatives and is considering a Town-wide integrated hydrologic/hydraulic assessment to define problems and consultatively establish solutions.

Burlington

<As of the time of writing, City of Burlington staff has not responded to the information request.>

4.4 Ancaster

As part of this Pilot Study, City of Hamilton staff collected data associated with approved severance applications and redevelopment throughout the Community including maps and addresses, for both areas serviced to a rural and urban drainage standard (ref. Figure 1). The Site Reconnaissance (ref. Appendix C) has also visually confirmed the extent to which sub-neighbourhoods are changing and coming under pressure to intensify. (Map should show the pilot area)

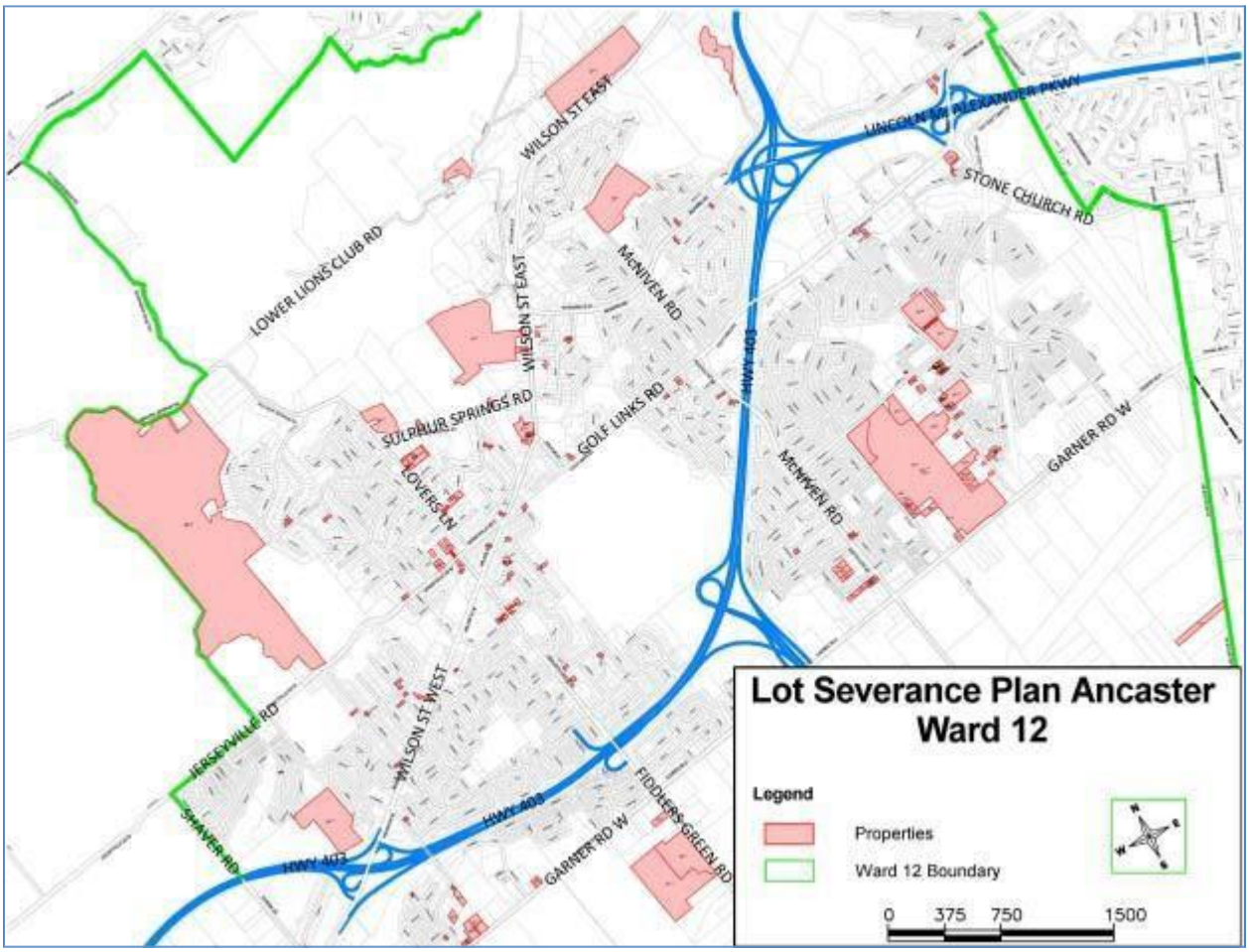

Figure 1: Plan of Properties with Lot Severances Plan Ancaster Ward 12

5.1 ANALYSIS/ASSESSMENT

This section outlines the details associated with the analytical modelling of the Pilot Study area in the Community of Ancaster, including model selection, parameterization, and associated assumptions and performance assessment.

5.2 Model Selection/Objectives

The hydrologic modelling program PCSWMM has been adopted for use in this study to develop a numerical model representative of the conditions present within the Pilot Study area. This program offers an interface in conjunction with the EPA-approved SWMM engine which integrates both hydrology and hydraulics. This model can be used to effectively consider aspects such as infiltration, impervious coverage, roadside ditch conveyance/storage, and also support the evaluation of potential Low Impact Development/Source Control BMP’s.

5.2 Model Parameterization

The various parameters relevant to the hydrology/hydraulics for existing conditions are summarized in Table 5.1 (ref. Drawing 2 for catchment plan).

Table 5.1: Parameterization Table – Existing Land Use							
Subcatchment	**Area (ha)**	**Width (m)**	**Flow Length (m)**	**Total Imperviousness (%)**	**Directly Connected Imperviousness (%)**	**CN Applied for Pervious Area**	**Depression Storage for Pervious Area**
S101.1	0.48	120.7	40.0	39	7.8	66.2	3.6
S101.2	0.99	247.0	40.0	37	7.4	65.3	3.7
S102.1	1.04	103.8	100.0	38	7.6	65.8	3.7
S102.2	0.26	200.0	13.0	39	7.8	66.2	3.6
S103	0.55	59.1	93.3	39	7.8	66.2	3.6
S104	0.52	37.5	140.0	37	7.4	65.3	3.7
S105	0.27	19.0	142.3	42	8.4	67.6	3.5
S201.1	0.71	137.1	51.5	36	7.2	64.9	3.8
S201.2	0.54	179.0	30.0	37	7.4	65.3	3.7
S202.1	0.82	90.2	90.5	47	9.4	69.9	3.3
S202.2	0.26	86.6	30.0	61	12.2	76.7	2.8
S203	0.32	34.0	94.2	35	7.0	64.5	3.8
S301.1	0.30	150.0	20.0	32	6.4	63.1	3.9
S301.2	0.50	167.3	30.0	33	6.6	63.6	3.9
S302.1	0.31	87.9	35.0	41	8.2	67.2	3.6
S302.2	0.18	136.9	13.5	38	7.6	65.8	3.7
S303.1	1.14	126.2	90.5	37	7.4	65.3	3.7
S303.2	0.64	212.5	30.0	39	7.8	66.2	3.6
S401.1	0.44	64.0	69.0	37	7.4	65.3	3.7
S401.2	0.08	54.2	15.5	36	7.2	64.9	3.8
S402.1	1.04	58.7	177.0	30	6.0	62.3	4
S402.2	0.20	133.5	15.0	37	7.4	65.3	3.7
S403.1	0.68	199.0	34.0	42	8.4	67.6	3.5
S403.2	0.47	223.2	21.0	50	10.0	71.3	3.2
S404.1	1.52	89.1	171.0	37	7.4	65.3	3.7
S404.2	0.24	75.4	31.6	44	8.8	68.5	3.5
S405.1	1.38	76.7	180.0	39	19.5	61.0	4.1
S405.2	0.29	145.5	20.0	50	25.0	65.3	3.7
S406.1	0.33	41.9	79.7	54	27.0	67.0	3.6
S406.2	2.17	144.6	150.0	38	19.0	60.7	4.1
S407	1.23	107.2	115.0	28	5.6	61.4	4.1

Note: SCS Soil Class assumed as AB with a CN of 50 throughout the study area.

Table 5.2: Parameterization Table – Future Land Use													
Subcatchment	Area (ha)	Width (m)	Flow Length (m)	“Existing Configuration” Imperviousness (%)		“+10% Impervious” Imperviousness (%)		“+20% Impervious” Imperviousness (%)		“+30% Impervious” Imperviousness (%)		Approved Zoning Scenario Imperviousness (%)	
				Total	Directly Connected	Total	Directly Connected	Total	Directly Connected	Total	Directly Connected	Total	Directly Connected
S101.1	0.48	120.7	40.0	39	7.8	49	9.8	59	11.8	69	13.8	45	9.0
S101.2	0.99	247.0	40.0	37	7.4	47	9.4	57	11.4	67	13.4	46	9.2
S102.1	1.04	103.8	100.0	38	7.6	48	9.6	58	11.6	68	13.6	51	10.2
S102.2	0.26	200.0	13.0	39	7.8	49	9.8	59	11.8	69	13.8	39	7.8
S103	0.55	59.1	93.3	39	7.8	49	9.8	59	11.8	69	13.8	52	10.4
S104	0.52	37.5	140.0	37	7.4	47	9.4	57	11.4	67	13.4	50	10.0
S105	0.27	19.0	142.3	42	8.4	52	10.4	62	12.4	72	14.4	71	14.2
S201.1	0.71	137.1	51.5	36	7.2	46	9.2	56	11.2	66	13.2	49	9.8
S201.2	0.54	179.0	30.0	37	7.4	47	9.4	57	11.4	67	13.4	37	7.4
S202.1	0.82	90.2	90.5	47	9.4	57	11.4	67	13.4	77	15.4	64	12.8
S202.2	0.26	86.6	30.0	61	12.2	71	14.2	81	16.2	91	18.2	61	12.2
S203	0.32	34.0	94.2	35	7.0	45	9.0	55	11.0	65	13.0	83	16.6
S301.1	0.30	150.0	20.0	32	6.4	42	8.4	52	10.4	62	12.4	32	6.4
S301.2	0.50	167.3	30.0	33	6.6	43	8.6	53	10.6	63	12.6	33	6.6
S302.1	0.31	87.9	35.0	41	8.2	51	10.2	61	12.2	71	14.2	57	11.4
S302.2	0.18	136.9	13.5	38	7.6	48	9.6	58	11.6	68	13.6	38	7.6
S303.1	1.14	126.2	90.5	37	7.4	47	9.4	57	11.4	67	13.4	51	10.2
S303.2	0.64	212.5	30.0	39	7.8	49	9.8	59	11.8	69	13.8	39	7.8
S401.1	0.44	64.0	69.0	37	7.4	47	9.4	57	11.4	67	13.4	55	11.0
S401.2	0.08	54.2	15.5	36	7.2	46	9.2	56	11.2	66	13.2	36	7.2
S402.1	1.04	58.7	177.0	30	6.0	40	8.0	50	10.0	60	12.0	44	8.8
S402.2	0.20	133.5	15.0	37	7.4	47	9.4	57	11.4	67	13.4	37	7.4
S403.1	0.68	199.0	34.0	42	8.4	52	10.4	62	12.4	72	14.4	54	10.8
S403.2	0.47	223.2	21.0	50	10.0	60	12.0	70	14.0	80	16.0	50	10.0
S404.1	1.52	89.1	171.0	37	7.4	47	9.4	57	11.4	67	13.4	53	10.6
S404.2	0.24	75.4	31.6	44	8.8	54	10.8	64	12.8	74	14.8	47	9.4
S405.1	1.38	76.7	180.0	39	19.5	49	24.5	59	29.5	69	34.5	50	25.0
S405.2	0.29	145.5	20.0	50	25.0	60	30.0	70	35.0	80	40.0	50	25.0
S406.1	0.33	41.9	79.7	54	27.0	64	32.0	74	37.0	84	42.0	58	29.0
S406.2	2.17	144.6	150.0	38	19.0	48	24.0	58	29.0	68	34.0	52	26.0
S407	1.23	107.2	115.0	28	5.6	38	7.6	48	9.6	58	11.6	52	10.4

Note: SCS Soil Class assumed as AB with a CN of 50 throughout the study area.

The SCS Soil Class and the Base Curve Number (CN) for the Pervious Areas have been estimated based on the background information reviewed for this study. Past geotechnical investigations determined the soil composition in the area to be largely that of sandy silt, silty sand, sand, and gravel. These soils are generally of a particularly coarse particle size which would indicate a well-draining soil in the Pilot Study area. Soil Survey Report 32 classifies this area as Springvale Sandy Loam, a well-draining soil, which agrees well with the information provided in the aforementioned geotechnical investigation conducted by Terraprobe. Due to the likelihood of fill of a less favourable drainage property being introduced to the site during construction, a slightly more conservative SCS Soil Class of AB has been adopted. The CN value of 50 has been determined from the soil class in conjunction with a pervious land use of “Open Space/Lawns” having good grass coverage and in good condition.

Total Imperviousness and drainage area have been determined directly from the aerial mapping and topography provided by the City; the catchment area plan has been developed directly from this base information.

The PCSWMM methodology requires users to define both total and directly connected impervious fractions with the latter representative of the portion draining directly to the receiver/collector. For the Pilot Study area, the directly connected impervious area has been estimated to be 20% of the total imperviousness in rurally-serviced areas and 50% of the total imperviousness in urban (curb and gutter) areas. The rational for establishing these rates include: heavy siltation of roadside ditches impeding infiltration, and the inherent nature of an urban cross section directing flow towards concrete curbs and underground pipes.

The resultant SCS applied CN and Depression Storage values have been derived from the base CN values and the associated impervious coverage.

Other parameters relevant to the integrated hydrologic/hydraulic modelling include: watershed slope and Manning’s roughness coefficients. Based on field observations, these parameters have been considered consistent throughout, whereby a typical slope value of 2% has been used for the Pilot Study area as well as Manning’s values of 0.2 and 0.013 for pervious and impervious areas, respectively.

5.3 Redevelopment Scenarios

As noted, the total imperviousness for the existing land use condition has been derived from the aerial mapping provided by the City. Based on dialogue with City staff, three (3) scenarios have been assembled, which in essence reflect increased impervious coverage due to either the creation of new lots through severance applications or the development of larger homes on existing lots. The total imperviousness and corresponding directly connected proportion for each subcatchment has been increased by 10%, 20%, and 30% over the existing value to reflect possible redevelopment scenarios. (ref. Drawings 5a and 5b). In addition, A fourth scenario has assessed the impacts of a Lot Coverage of 35% as permitted in the ER Zoning. coverage (ref. Drawings 5c and 27). Selection of an appropriate rainfall distribution/duration for the impact assessment (hydrologic modelling) has been conducted by comparing a shorter duration storm with a comparably higher maximum intensity and lower rainfall depth (i.e. Chicago 6-hour) and a longer duration storm with a comparably higher rainfall depth and lower maximum intensity

(i.e. SCS 24-hour), and assessing based on the resultant peak flows and runoff volumes. For the majority of the storm events and redevelopment scenarios considered, the SCS 24-hour distribution produced higher (and therefore, more conservative) peak flows and runoff volumes than the Chicago 6-hour distribution at the outlet locations of the Pilot Study area. As a result, the drainage system has been evaluated based on four storm events: the 25 mm 4-hour Chicago storm, as well as the 2 year (53 mm in 24 hours), 5 year (72 mm in 24 hours), and 100 year(123 mm in 24 hours) SCS 24-hour storm events. Typically the serviceability of minor systems (ditches and storm sewers) is established on the basis of safe conveyance of a 2 to 10 year event. In addition, smaller storms (such as a 25 mm event) are often used as a performance metric for frequent events including stormwater management focused on water quality mitigation. City of Hamilton staff also has an interest in better understanding the potential impact of redevelopment on major events (i.e. 100 year storm) and as such supplemental investigations have been conducted for the major system.

Table 5.3: Peak Flows and Runoff Volumes								
Land Use Scenario Design Event	Outlet 1		Outlet 2		Outlet 3		Outlet 4	
	Peak Flows (m^3/s)	Runoff Volume (ML)	Peak Flows (m^3/s)	Runoff Volume (ML)	Peak Flows (m^3/s)	Runoff Volume (ML)	Peak Flows (m^3/s)	Runoff Volume (ML)
25 mm Chicago 4 Hour								
Existing % imp	0.013	0.044	0.015	0.054	0.005	0.035	0.135	0.292
Existing +10% imp	0.018	0.079	0.021	0.084	0.007	0.059	0.180	0.394
Existing +20% imp	0.022	0.138	0.029	0.128	0.011	0.106	0.220	0.526
Existing +30% imp	0.027	0.207	0.041	0.196	0.019	0.165	0.260	0.707
ER Zone Maximum Lot Coverage 35%	0.019	0.087	0.022	0.109	0.005	0.056	0.188	0.419
2 year SCS 24 Hour (53 mm in 24 hours)								
Existing % imp	0.043	0.476	0.046	0.422	0.031	0.391	0.200	1.429
Existing +10% imp	0.062	0.583	0.065	0.543	0.045	0.491	0.266	1.778
Existing +20% imp	0.079	0.703	0.081	0.678	0.063	0.605	0.339	2.153
Existing +30% imp	0.100	0.840	0.118	0.839	0.093	0.740	0.428	2.570
ER Zone Maximum Lot Coverage 35%	0.062	0.599	0.065	0.607	0.038	0.460	0.274	1.884
5 year SCS 24 Hour (72 mm in 24 hours)								
Existing % imp	0.085	0.814	0.088	0.795	0.073	0.706	0.352	2.455
Existing +10% imp	0.122	0.969	0.145	0.963	0.109	0.853	0.449	2.916
Existing +20% imp	0.135	1.122	0.237	1.149	0.167	1.030	0.546	3.394
Existing +30% imp	0.141	1.300	0.334	1.361	0.237	1.250	0.629	3.907
ER Zone Maximum Lot Coverage 35%	0.125	0.990	0.183	1.049	0.097	0.816	0.465	3.056
100 year SCS 24 Hour (123 mm in 24 hours)								
Existing % imp	0.298	1.899	0.495	2.058	0.391	2.026	0.971	5.580
Existing +10% imp	0.367	2.138	0.596	2.336	0.552	2.372	1.038	6.233
Existing +20% imp	0.462	2.391	0.706	2.630	0.731	2.776	1.112	6.876
Existing +30% imp	0.563	2.663	0.809	2.947	0.986	3.246	1.176	7.523
ER Zone Maximum Lot Coverage 35%	0.363	2.166	0.625	2.465	0.542	2.330	1.083	6.439

Table 5.4: Percentage Increase of Peak Flows and Runoff Volumes vs. Existing Land Use																
Scenario	Outlet 1				Outlet 2				Outlet 3				Outlet 4			
	Peak Flows		Runoff Volume		Peak Flows		Runoff Volume		Peak Flows		Runoff Volume		Peak Flows		Runoff Volume	
	(m^3/s)	% Increase	(ML)	% Increase	(m^3/s)	% Increase	(ML)	% Increase	(m^3/s)	% Increase	(ML)	% Increase	(m^3/s)	% Increase	(ML)	% Increase
25 mm Chicago 4 Hour																
Existing % imp	0.013	0	0.044	0	0.015	0	0.054	0	0.005	0	0.035	0	0.135	0	0.292	0
Existing +10% imp	0.018	38.5	0.079	79.5	0.021	40.0	0.084	55.6	0.007	40.0	0.059	68.6	0.180	33.3	0.394	34.9
Existing +20% imp	0.022	69.2	0.138	213.6	0.029	93.3	0.128	137.0	0.011	120.2	0.106	202.9	0.220	63.0	0.526	80.1
Existing +30% imp	0.027	107.7	0.207	370.5	0.041	173.3	0.196	263.0	0.019	280.0	0.165	371.4	0.260	92.6	0.707	142.1
ER Zone Maximum Lot Coverage 35%	0.019	46.2	0.087	97.7	0.022	46.7	0.109	101.9	0.005	0	0.056	60.0	0.188	39.3	0.419	43.5
2 year SCS 24 Hour (53 mm in 24 hours)																
Existing % imp	0.043	0	0.476	0	0.046	0	0.422	0	0.031	0	0.391	0	0.200	0	1.429	0
Existing +10% imp	0.062	44.2	0.583	22.5	0.065	41.3	0.543	28.7	0.045	45.2	0.491	25.6	0.266	33.0	1.778	24.4
Existing +20% imp	0.079	83.7	0.703	47.7	0.081	76.1	0.678	60.7	0.063	103.2	0.605	54.7	0.339	69.5	2.153	50.7
Existing +30% imp	0.100	132.6	0.840	76.5	0.118	156.5	0.839	98.8	0.093	200.0	0.740	89.3	0.428	114.0	2.570	79.8
ER Zone Maximum Lot Coverage 35%	0.062	44.2	0.599	25.8	0.065	41.3	0.607	43.8	0.038	22.6	0.460	17.6	0.274	37.0	1.884	31.8
5 year SCS 24 Hour (72 mm in 24 hours)																
Existing % imp	0.085	0	0.814	0	0.088	0	0.795	0	0.073	0	0.706	0	0.352	0	2.455	0
Existing +10% imp	0.122	43.5	0.969	19.0	0.145	64.8	0.963	21.1	0.109	49.3	0.853	20.8	0.449	27.6	2.916	18.8
Existing +20% imp	0.135	58.8	1.122	37.8	0.237	169.3	1.149	44.5	0.167	128.8	1.030	45.9	0.546	55.1	3.394	38.2
Existing +30% imp	0.141	65.9	1.300	59.7	0.334	279.5	1.361	71.2	0.237	224.7	1.250	77.1	0.629	78.7	3.907	59.1
ER Zone Maximum Lot Coverage 35%	0.125	47.1	0.990	21.6	0.183	108.0	1.049	31.9	0.097	32.9	0.816	15.6	0.465	32.1	3.056	24.5
100 year SCS 24 Hour (123 mm in 24 hours)																
Existing % imp	0.298	0	1.899	0	0.495	0	2.058	0	0.391	0	2.026	0	0.971	0	5.580	0
Existing +10% imp	0.367	23.2	2.138	12.6	0.596	20.4	2.336	13.5	0.552	41.2	2.372	17.1	1.038	6.9	6.233	11.7
Existing +20% imp	0.462	55.0	2.391	25.9	0.706	42.6	2.630	27.8	0.731	87.0	2.776	37.0	1.112	14.5	6.876	23.2
Existing +30% imp	0.563	88.9	2.663	40.2	0.809	63.4	2.947	43.2	0.986	152.2	3.246	60.2	1.176	21.1	7.523	34.8
ER Zone Maximum Lot Coverage 35%	0.363	21.8	2.166	14.1	0.625	26.3	2.465	19.8	0.542	38.6	2.330	15.0	1.083	11.5	6.439	15.4

5.4 Summary of Results

In reference to Drawing 2, it is evident that the Pilot Study area has four (4) distinct outlets; these have notionally been coded based on 100, 200, 300, and 400 series of catchments. Table 5.3 provides a summary of the peak flows and runoff volumes for the four (4) outlets for five (5) distinct scenarios including existing impervious coverage, , three (3) redevelopment scenarios of varying levels of increasing coverage and the Maximum Lot Coverage of 35% as permitted by the ER Zone. Table 5.4 provides an indication of the relative change in percent peak flow and runoff volume associated with the varying levels of redevelopment cited in this study.

5.5 Existing System Performance

Much of the existing Pilot Study area has a rural cross-section with roadside ditches on either side. Many of the driveway culverts within these ditches are sunk into the ground, adversely affecting their capacity and ability to convey flow. The north end of Rosemary Lane is urbanized and conveys flow to Outlet #4 via catchbasins and a storm sewer with a maximum diameter of 600 mm. As discussed previously, the soils in the area are considered to be favorable for drainage (i.e. permeable). The following provides a discussion of the results of the assessment for the existing configuration.

The 100-series subcatchments encompass much of Cameron Drive and a small part of St. Margaret Road. During the 25 mm storm event, only the most severely sunk culverts are anticipated to cause local backups, potentially above the top of ditch. The northwest quadrant of St. Margaret Road and Cameron Drive intersection would also have water ponding above the top of ditch and onto the adjacent lawn. During the 2 year storm event (53 mm in 24 hours), some of the more sunken culverts in the area are anticipated to backup and overtop the driveway. The northwest quadrant of St. Margaret Road and Cameron Drive intersection would continue to have water ponding above the top of ditch and runoff would spill south, over the road, towards the 200-series subcatchments. During the 5 year storm event (72 mm in 24 hours), water would further overtop the ditch and spill across the road near the outlet and the road-crossing 300 mm diameter CSP. Ditches around the outlet would also spill out of ditches onto adjacent lawns. During the 100 year storm event (123 mm in 24 hours), much of the area would experience full ditches spilling out onto adjacent lawns. Spill across the road would occur at locations indicated for the 2 and 5 year storms but to a greater degree, as well as spill on the eastern most portion of Cameron Drive heading to the west side of the road. The catchbasin draining this series of subcatchments would be inundated, causing spill across nearby side yards.

The 200-series subcatchments encompass part of St. Margaret Road. During the 25 mm storm event, there would be a possibility that some of the shallower ditches would overtop and spill onto adjacent lawns. During the 2 year storm event (53 mm in 24 hours), water would be received from catchment 104 via spill at the intersection of St. Margaret Road and Cameron Drive. Water would overtop multiple driveways and spill onto lawns, immediately west of the 400 mm diameter CSP road-crossing culvert. During the 5 year storm event (72 mm in 24 hours), water would further the road at the road-crossing culvert. Water would overtop ditches and spill onto lawns in much of area. During the 100 year storm event (123 mm in 24 hours), spill onto private property would worsen, in particular just upstream of the road-crossing culvert. The relief flow, spilling overtop the road, would provide the majority of the conveyance of flow from west to east and would be localized to the low area at the road-crossing culvert.

The 300-series subcatchments encompass a substantial portion of St. Margaret Road and part of Douglas Road. During the 25 mm storm event, sunken culverts would backup water with the possibility of minor spill over driveways on both Douglas Road and St. Margaret Road. Shallow ditches may overtop water onto adjacent lawns. During the 2 year storm event (53 mm in 24 hours), sunken culverts would backup, causing spill over driveways. Shallow ditches would overtop spilling onto adjacent lawns. The road-crossing 350 mm diameter CSP culvert at the intersection of St. Margaret Road and Douglas Road would be operating under pressure flow. During the 5 year storm event (72 mm in 24 hours), water would be expected to spill out of the ditches and onto adjacent lawns along much of St. Margaret Road and to a lesser extent on Douglas Road. During the 100 year storm event (123 mm in 24 hours), the road-crossing culvert would be unable to convey the entirety of the peak flows and flow would be expected to spill south and, to a lesser degree, east across the St. Margaret Road and Douglas Road intersection. A fraction of the flow within the east ditches on Rosemary Lane, north of the Rosemary Lane and Douglas Road intersection, is expected to continue east along Douglas Road through the 300-series subcatchments. Spill onto adjacent lawns would occur throughout the area, however the most severe flooding of private property is expected to be localized upstream of culverts and in the shallow ditches on the east side of St. Margaret Road. The 400-series subcatchments encompass part of Douglas Road and Rosemary Lane. During the 25 mm storm event, only culverts that are severely sunk (i.e. less than a quarter of the culvert is showing above ground) would be expected to backup, with the possibility of water spilling over the corresponding driveway. During the 2 year storm event (53 mm in 24 hours), driveway spill would be limited to only the most sunken driveway culverts. The roadside ditches are expected to be full of water at the intersection of Douglas Road and Rosemary Lane, causing the two road-crossing culverts to be full, as well. During the 5 year storm event (72 mm in 24 hours), several driveways would experience water spill over top. The urban section of road would be anticipated to have water crossing the centreline of road where longitudinal grades are shallower. During the 100 year storm event (123 mm in 24 hours), the urban section of road would experience increased depth of water crossing the centreline of road (i.e. approximately to the top of curb). Water will also spill across Rosemary Lane, just north of the Rosemary Lane and Douglas Road intersection. Partial flow reaching the northeast corner of the Rosemary Lane and Douglas Road intersection is anticipated to spill east along Douglas Road into the 300-series subcatchments.

For the purposes of the study, all of the runoff within the study area is assumed to have reached one of the four outlet points. It should be noted however that the headwaters on Rosemary Lane (i.e. predominantly subcatchment 406.2) are drained via catchbasins and conveyed via the storm sewer towards outlet 400, as the lot grades slope away from the road. For a major storm event (i.e. the 100 year storm event), it is expected that some of the flow may, in actuality, be directed north towards the rear yards and Brockhouse Park (corner of Fiddlers Green Road and Wilson Street East). Due to the relative size of the headwater area, all flow has been conservatively assumed to remain within the study area for the purpose of this assessment.

5.6 Assessment of Redevelopment Scenarios

For the four (4) redevelopment scenarios, the total imperviousness for each subcatchment has been increased by 10%, 20%, and 30% above the existing impervious coverage, as well as a Maximum Lot Coverage of 35% as per the ER Zone, (ref. Table 5.2). Other attributes of the Pilot Study area have been assumed to remain constant for this assessment. The following outlines anticipated impacts to performance as a result of the increases in impervious coverage (ref. Drawings 6 to 26 for representation of performance impacts).

As noted, the 100-series subcatchments encompass much of Cameron Drive and a small part of St. Margaret Road. During the 25 mm storm event, severely sunken culverts are anticipated to backup above the top of ditch much like for the existing land use, with higher chances of driveway spill occurring. As with the existing condition, ponding above the top of ditch would occur at the northwest quadrant of St. Margaret Road and Cameron Drive intersection, and with a 30% increase in impervious coverage, water would be anticipated to spill towards the 200-series subcatchments. During the 2 year storm event (53 mm in 24 hours), there would be spill across the intersection towards the 200-series subcatchments for the 10%, 20%, and approved zoning, as for the existing configuration. All redevelopment scenarios indicate that the road-crossing culvert would be operating under pressure flow. The cases of a Maximum permitted Lot Coverage of 35% and the increase of 10% to impervious areas, would see the ditches near the outlet as being full. An increase of 20% imperviousness, would have the ditches near the outlet spilling onto adjacent lawns. An increase of 30% imperviousness, would have the water overtop the ditch and spill across the road near the outlet and road-crossing culvert. During the 5 year storm event (72 mm in 24 hours), all redevelopment scenarios would spill across the road near the outlet, much like with the existing configuration, however the length of ditch spilling out onto adjacent lawns would increase with the increase in imperviousness. During the 100 year storm event (123 mm in 24 hours), flow begins to spill (~1 cm depth over crown) from the northwest corner to the east side of the St. Margaret Road and Cameron Drive intersection, under all redevelopment scenarios. At the same intersection, flow from the northwest corner spills to the southwest corner with an increase in depth of 1 cm or less for all redevelopment scenarios. Spill from the easternmost portion of Cameron Drive heading to the west side of the road would increase by ~1 cm for the 20% and 30% redevelopment scenarios and no change for the 10% and permitted Lot Coverage redevelopment. The change in depth of water over the road at the road-crossing culvert would be more substantial: 1 cm increase for the 10% and permitted Lot Coverage approved zoning scenarios, 2 to 3 cm for the 20% scenario, and 4 cm increase for the 30% scenario.

As noted, the 200-series subcatchments encompass part of St. Margaret Road. During the 25 mm storm event, multiple driveway culverts would be under pressure flow with some overtopping driveways. At 30% redevelopment coverage increase, water would be received from catchment 104 via spill at the intersection of St. Margaret Road and Cameron Drive. During the 2 year storm event (53 mm in 24 hours), additional water would be received from catchment 104 via spill at the intersection of St. Margaret Road and Cameron Drive, for 10%, 20%, and approved redevelopment, as with the existing configuration. Additional 10% coverage and the permitted Lot Coverage are much like the existing configuration where water would overtop multiple driveways and water would backup onto lawns in the ditch west of the road-crossing culvert (400 mm CSP). For 20% to 30%, the extent of the water backup onto lawns in the ditch west of

the road-crossing culvert (400 mm CSP) would occur noticeably further along the ditch, than with the existing configuration. Also, water would spill across the road at the culvert crossing and overtop ditches and onto lawns in much of the area. During the 5 year storm event (72 mm in 24 hours), all redevelopment scenarios indicate spill would occur over the road at the road-crossing culvert. Water would overtop ditches and onto lawns in much of the area. During the 100 year storm event (123 mm in 24 hours), the road crown in the area of the road-crossing culvert provides relief for the runoff in the west ditches. The depth of flow over the road is expected to increase in this area by approximately 1 cm for 10% intensification, 2 cm for 20% increase to impervious coverage and permitted Lot Coverage, and 3 cm for the 30% increase impervious coverage scenario.

The 300-series subcatchments encompass a substantial portion of St. Margaret Road and part of Douglas Road. During the 25 mm storm event, for all redevelopment scenarios considered, multiple sunken culverts backup with spill overtopping driveways. Ditches near some culverts appear full and may overtop onto lawns; other ditches would maintain capacity. During the 2 year storm event (53 mm in 24 hours), for the 10%, 20%, increase and approved coverage, sunken culverts would backup with spill overtopping driveways. Shallow ditches would spill onto adjacent lawns. Similar to the existing conditions, the 350 mm diameter CSP road-crossing culvert at the intersection of Douglas Road and St. Margaret Road would be operating under pressure flow. At 30% impervious coverage increase, water would overtop ditches and onto lawns along much of St. Margaret Road and to a lesser degree along Douglas Road. The 350 mm diameter CSP road-crossing culvert at the Douglas Road and St. Margaret Road intersection would spill over the top of the road to the downstream ditch. During the 5 year storm event (72 mm in 24 hours), the road-crossing culvert would also overtop for all redevelopment scenarios. Water would overtop ditches and spill onto lawns along much of the area. During the 100 year storm event (123 mm in 24 hours), flow crosses from the northwest corner to the east side and southwest corner of the St. Margaret Road and Douglas Road intersection. At this intersection, spill over the road crown would increase approximately 1 cm for 10% coverage increase, 1 to 2 cm for approved zoning coverage, 2 to 3 cm for 20% increased coverage, and 4 cm for 30% increased coverage. Just south of this intersection, on St. Margaret Road, spill occurs for the 20% and 30% increased impervious coverage, heading west to east at an approximate depth of 1 to 2 cm. Additionally, the 30% increased impervious coverage scenario would spill (approximately 2 cm deep) heading south across Douglas Road, approximately midway between Rosemary Lane and St. Margaret Road.

The 400-series subcatchments encompass part of Douglas Road and Rosemary Lane. During the 25 mm storm event, with an increase of 20% to 30% to impervious coverage, roadside ditches and road-crossing culverts would be expected to be full of water at the intersection of Douglas Road and Rosemary Lane. As well, the urban section of road would be anticipated to have water crossing the centreline of road. When the imperviousness increases by only 10% or to the permitted Lot Coverage, conditions are expected to be much like the existing configuration. During the 2 year storm event (53 mm in 24 hours), a lot with buildings occupying 35% of the lot and an increase of 10% imperviousness would result in issues similar to that of the existing configuration, with the addition of possible water crossing the centreline of road in the urbanized sections of Rosemary Lane. Increases of 20% to 30% to the existing impervious areas would result in several driveways being overtopped throughout the rurally-serviced areas. During the 5 year storm event (72 mm in 24 hours), for the Approved zoning scenario where a buildings

occupy 35% of a lot and the scenario of an additional 10% impervious coverage, pressure flow would start to take place in the mainline storm sewer located on Rosemary Lane. At 20% increased impervious coverage levels, pressure flow would be present in parts of the mainline storm sewer. At 30% increased coverage, pressure flow would be present throughout the mainline storm sewer. Also, at 20% to 30% increased impervious coverage levels, water would spill onto adjacent lawns and across the road, north of the Rosemary Lane and Douglas Road intersection. During the 100 year storm event (123 mm in 24 hours), Rosemary Lane experiences spill (heading west to east) over the road crown at certain points north of Douglas Road. Immediately north of the Rosemary Lane and Douglas Road intersection, the depth of water crossing the road increases by approximately 1 cm for 10% increased coverage and approved zoning redevelopment scenarios and 2 cm for 20% and 30% increased coverage. The urbanized portion of Rosemary Lane is expected to see a substantial increase in the depth of water crossing the road. For all redevelopment scenarios, flow is expected to be above the curb and on the lawn, with an approximate 3 to 4 cm increase for 10% increased impervious coverage, 4 to 5 cm for permitted Lot Coverage scenarios, 7 cm for 20% increased impervious coverage, and 10 cm for 30% increased impervious coverage at the most severe points. Assuming a 2% lot grade from back of curb to structure, the water level is not anticipated to reach any of the existing structures, however it is expected to span the width of the R.O.W. in the most extreme (i.e. 30% increased coverage) scenario. As mentioned in the “Existing System Performance” section of the report, this is stated with the understanding that all runoff from the headwaters in Subcatchment 406.2 is assumed to route through the study area.

The assessment of impacts has intentionally focused on more frequent storms specific to those events which would be expected to cause nuisance-type flooding and/or standing water in the roadside ditches serving these neighbourhoods. The roadside ditches under these frequent storms (25 mm depth, 2 year (53 mm in 24 hours) and 5 year (72 mm in 24 hours) would constitute the minor system and be expected to function frequently and efficiently much like storm sewers and catchbasins would in fully urbanized settings. For less frequent larger storms, the ditches would completely fill and overtop or spill onto the roadway, and in part to the ditch backslope on private property; this would constitute the major (overland) system. Due to the infrequent nature of these storms and the significant volume of water and related ground saturation, the impact of increased lot coverage on major system performance is comparatively less from a percentage basis. This result is not unexpected and is also generally corroborated by the results documented in this report which suggests a higher percentage change in peak flows for the smaller events (ref. Table 5.4). In rurally-serviced neighbourhoods, the major system is comprised of the ditches, driveway culverts, and the roadway. In order to keep this fully functional during large infrequent storms, it is important to ensure positive longitudinal gradients, as well as a cross-sectional area which at design gradients can convey at a minimum a 100 year flood. Safe conveyance to end receivers (creeks, rivers, lake) is also important without flooding private property.

5.7 Opportunities for Low Impact Development Best Management Practices (LID BMPs on-Lot)

In order to mitigate the potential impacts of increased impervious coverage from the anticipated redevelopment, LID BMPs can be designed and implemented to provide storage on individual lots to decrease the runoff peaks and volume. Based on the area land use, bioswales would be a viable BMPs to store the additional runoff volume. For this assessment, as an example only, the most intense scenario (i.e. +30% imperviousness) has been evaluated for each storm event (excluding the infrequent 100 year event) at each outlet. Target capture volumes required to reduce the runoff volume in the example +30% imperviousness scenario to the existing level of runoff volume have been established accordingly for information purposes only.

With an increase of 30% impervious coverage, the 100-series catchments would produce an additional 163 m^3, 364 m^3, and 486 m^3 respectively at the outlet for the 25 mm, 2 year (53 mm in 24 hours), and 5 year (72 mm in 24 hours) storms based on the modelled analysis. This area currently has 41 (+/-) lots. The infiltration-based BMPs would have an estimated porosity of approximately 0.437 and an average depth of 1.25 m. Assuming an approximate square-shaped bioswale, the resultant side width of each lot’s BMP would need to be 2.7 m, 4.0 m, and 4.7 m for the 25 mm, 2 year, and 5 year storms, respectively.

With an increase of 30% impervious coverage, the 200-series catchments would produce an additional 142 m^3, 417 m^3, and 566 m^3 respectively at the outlet for the 25 mm, 2 year (53 mm in 24 hours), and 5 year (72 mm in 24 hours) storms based on the modelled analysis. This area currently has 14 (+/-) lots. The infiltration-based BMPs would have an estimated porosity of approximately 0.437 and an average depth of 1.25 m. Assuming an approximate square-shaped bioswale, the resultant side width of each lot’s BMP would need to be 4.3 m, 7.4 m, and 8.6 m for the 25 mm, 2 year, and 5 year storms, respectively.

With an increase of 30% impervious coverage, the 300-series catchments would produce an additional 130 m^3, 349 m^3, and 544 m^3 respectively at the outlet for the 25 mm, 2 year (53 mm in 24 hours), and 5 year (72 mm in 24 hours) storms based on the modelled analysis. This area currently has 22 (+/-) lots. The infiltration-based BMPs would have an estimated porosity of approximately 0.437 and an average depth of 1.25 m. Assuming an approximate square-shaped bioswale, the resultant side width of each lot’s BMP would need to be 3.3 m, 5.4 m, and 6.7 m for the 25 mm, 2 year, and 5 year storms, respectively.

With an increase of 30% impervious coverage, the 400-series catchments would produce an additional 415 m^3, 1,141 m^3, and 1,452 m^3 respectively at the outlet for the 25 mm, 2 year (53 mm in 24 hours), and 5 year (72 mm in 24 hours) storms based on the modelled analysis. This area currently has 67 (+/-) lots. The infiltration-based BMPs would have an estimated porosity of approximately 0.437 and an average depth of 1.25 m. Assuming an approximate square-shaped bioswale, the resultant side width of each lot’s BMP would need to be 3.4 m, 5.6 m, and 6.3 m for the 25 mm, 2 year, and 5 year storms, respectively.

Based on this assessment, it is considered that on-lot infiltration-based BMPs would be practical for implementation in these settings and should be considered going-forward by City staff as part of its site plan and/or building permit process, similar to the City of Mississauga. It is suggested

though that there would be merit in assessing BMP performance using long-term continuous data to improve and refine sizing beyond preliminary figures outlined in this assessment.

As noted, increased impervious coverage without mitigation will lead to increased runoff rates and volumes which will degrade the performance of ditch systems in rurally-serviced neighbourhoods. On-lot BMPs such as rain gardens, soakaway beds, increased topsoil depth, and other storage infiltration-based technologies have the potential to off-set (mitigate) the impacts related to redevelopment. The sizing of these forms of on-lot BMPs needs to be carefully considered to take into account the potential for long-term loss of effectiveness due to clogging with fines, lack of maintenance, or even removal by landowners, since the BMPs are not in public control. Various municipal jurisdictions have therefore taken the approach to build in redundancy in the capacity of these BMPs through over design, in essence assuming an area-wide loss in effectiveness over time. Industry-based figures in this regard range broadly between 25% and 75%, and even 100% depending on the type of BMP. Clearly BMPs with less need for maintenance and “less working parts” like increased topsoil depth would have a lower requirement for redundant storage than say a rain garden or infiltration trench. It is therefore encouraging that the City remains open to a range of % over-build based on the preferred or chosen BMP.

In Kitchener Ontario, the City has taken on-lot BMPs a step further due to that Municipality’s reliance on groundwater-based drinking water. In Kitchener, on-lot BMPs are in some circumstances sited at the front property line and an easement is taken by the City attached to the road right-of-way so that it can, in the event the local landowner does not maintain the BMP to conduct its own maintenance. These BMPs have often been designed as subsurface infiltration chambers which, based on lot grading and rooftop plumbing, capture clean water which recharges the regional aquifer. The concept of an easement on private property for the purpose of possible municipal maintenance is not a new one to the City of Hamilton; the Meadowlands Plaza in Ancaster for instance has easements on oil and grit separators (OGS) so that if the Plaza owner does not maintain this infrastructure, the City has the right to enter the property and clean out/maintain the OGSs and charge back the service to the landowner.

Another consideration relates to the influence of climate change and how best to build resiliency into redeveloping neighbourhoods. Climate change is generally conceded to be modifying weather patterns resulting in more frequent and more intense storms. In rurally-serviced, redeveloping areas, as assessed in this Pilot Study, climate change would be expected to exacerbate the issue of ditch performance degradation leading to more frequent and worse instances of flooding and standing water. As such, the need for on-lot mitigation BMPs is strengthened as would be the requirement for sizing redundancy.

6.1 OTHER CONSIDERATIONS

Beyond the performance metrics outlined in Section 5 associated with peak flows and runoff volume in regards to hydraulic conveyance capacity, there are a number of complementary factors related to infill/redevelopment associated with drainage, which need to be considered by Municipalities, public, and regulators including:

- Erosion
- Water Quality
- Natural Environment

While localized flooding and standing water in ditches cause short-term impacts to area residents, increasing urban coverage in existing communities can also cause other longer term impacts to receiving systems as follows:

Erosion

Where open watercourses receive drainage from redeveloping neighbourhoods, peak flows and runoff volumes (in particular) would in the absence of any mitigation be expected to increase and so too would the erosion potential. The amount of this increased risk would vary based on a number of factors including level of redevelopment and the sensitivity of the receiving system. Clearly this brings forward the need for holistic neighbourhood scale assessments, as contemplated by Oakville, to determine the need, level of risk, and best form of mitigation.

Water Quality

Urban contaminants typically wash off roadways and driveways, most commonly associated with vehicles and roadway maintenance, particularly in the winter/spring (salt/sand). Other urban contaminants include yard waste, pesticides/herbicides and airborne contaminants draining off rooftops. Notwithstanding, there have been good advances reducing pesticides and herbicides through local and provincial measures, and rooftop runoff is generally conceded to be substantially less contaminated than runoff from roadways/driveways in terms of amount and toxicity.

For residential redevelopment roadway dimensions usually stay the same (except in extreme cases) while usage would be expected to increase (larger homes would equate to more people and drivers, while severances would directly add population to the communities). As such, it is anticipated that there would be some increase in contaminant loading, however it would be expected to be proportionately less than peak flows and runoff volume, hence overall likely less of a concern.

Natural Environment

As noted, urban drainage often discharges to natural systems including: creeks/watercourses, wetlands, slough forests, and lakes. The combined impacts of higher peaks and volumes, along with greater contaminant loading can degrade these natural systems affecting long-term health. Those natural features which are reliant on seasonal variations in water supply can be

detrimentally affected by too much water too frequently (can drown out less tolerant vegetation) and similarly even slight increases in contaminant load over time can, as noted, reduce the system’s ecological diversity. Notwithstanding, the assessments to define potential impacts to these natural systems would be highly complex, require multi-seasonal field data, and also involve numerous disciplines to appropriately establish an understanding of the risks and potential impacts involved.

7.0 CONCLUSIONS/RECOMMENDATIONS

Based on the technical assessment conducted for the rurally-serviced pilot area in the Community of Ancaster, the following can be concluded:

i) The Community of Ancaster has a number of areas which are serviced by rural and semi-rural drainage standards; many of these locations are in older parts of the community with comparatively large lots versus current practices.

ii) The majority of these areas in the Community of Ancaster are zoned Existing Residential “ER” Zone in the Ancaster Zoning By-law 87-57. All development must meet the requirements of this zone, specifically the Maximum Lot Coverage of 35% which refers to the portion of land occupied by buildings and structures (i.e. houses and accessory structures) and does not include impervious areas such as driveways, walkways and patios.

iii) Several of these areas are being redeveloped through severances of larger lots and/or tearing down smaller homes and replacing with ones of substantially larger footprints.

iv) There have been 38 Severances in Ancaster ER communities and 8 in the Pilot Area

v) There have been 337 Demolition and Building Permit applications in all Ancaster ER areas and 42 in the Pilot Area

vi) Redevelopment through one of the foregoing mechanisms has the potential to increase peak flows, runoff volumes, and contaminant loads, leading to reduced roadside ditch performance and degraded water quality.

vii) Based on a set of area characteristics including topography, historical redevelopment, and ditch condition, Area C+ was selected as the preferred site for the pilot assessment.

viii) A review of development eras from the 1950’s to present suggests a trend towards smaller lots with urban drainage systems (curb, gutter, sewers) and more comprehensive stormwater management including LID BMPs (at source).

ix) Three (3) area municipalities were contacted to determine if the trend toward redevelopment was prevalent in those communities and if so what if anything was being done to address the concerns.

In brief, both Oakville and Mississauga responded noting that the problem is evident however no formal process is yet in-place to address the impact. That said, it appears with the awareness of the situation, municipal staff is working towards opportunities to reduce impacts by way of informal treatment, involvement of Building Departments, and neighbourhood focussed Class EA’s.

x) Numerical analyses of three (3) scenarios of 10%, 20%, 30% increased imperviousness and a fourth scenario analysing impact of a Maximum Lot Coverage of 35 as permitted by

the ER Zone has demonstrated that peak flows and runoff volumes increase substantially with the relative amount depending on location, coverage, and size of event.

xi) The existing ditch and driveway culvert system in the Pilot area performs reasonably well for the 25 mm and 2 year storm (53 mm in 24 hours) with only isolated locations exhibiting spill onto lawns during a 2 year event, largely attributable to driveway culvert grades and maintenance condition. The 5 year (72 mm in 24 hours) performance is not as good with some areas spilling onto the roadway. The 100 year event (123 mm in 24 hours) exhibits widespread overtopping of roads, as expected, to effectively drain the study area, with redevelopment exacting the greatest impacts to the urbanized road sections.

xii) As expected, the increase in impervious area reduces system performance, increasing the number and severity of drainage deficiencies. This assessment has been based on peak flows and does not inherently consider runoff volumes which, due to redevelopment, would extend the period of inundation.

xiii) While not directly assessed by this pilot study, both creek/ditch erosion and water quality are anticipated to be similarly affected by the redevelopment, albeit water quality is likely to be the lesser of the two, given the limited amount of contaminant sources for expanded residential home coverage.

Recommendations

v) On-lot BMPs (including forms of LID) can be an effective means of mitigating the increased runoff (peaks and volumes) and should be considered for these circumstances; City staff should contemplate the design and implementation of these measures per the City’s Drainage Policy and the City’s Criteria and Guidelines for Stormwater Infrastructure Design as well as the following:

- Applicants must demonstrate that an adequate outlet is available with no impact to any downstream properties
- Should lot level controls (and suitable forms of LID) for SWM be proposed to mitigate increase runoff, the proposed infrastructure must be included in the appropriate Consent Agreement with securities and registered on title. This would include operation and maintenance responsibility.
- Overbuilding the BMPs (i.e. providing redundant storage) the amount of control to account for loss of effectiveness over time
- Use of less complex BMPs (i.e. increased topsoil depth)
- Requiring focussed site specific geotechnical investigations for each single lot development to establish groundwater levels and infiltration capability of native / local soils
- Avoid lowering rebuilt homes basement elevation due to potential to intercept more groundwater and promote more frequent discharge foundation water into ditches

vi) Where potential for redevelopment is significant the City should consider a detailed drainage assessment to confirm a suitable storm outlet and downstream impacts.

vii) Driveway culverts should be inspected as part of the City’s inspection activities for condition and build-up of sediment, and maintained accordingly; problem areas should be assessed more frequently

viii) Rebuilt rurally serviced roadways should consider subdrains for ditch systems

Respectfully submitted,

Amec Foster Wheeler Environment & Infrastructure
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Principal Consultant

Per: Matthew Kuyntjes, B.Eng.
Project Engineer

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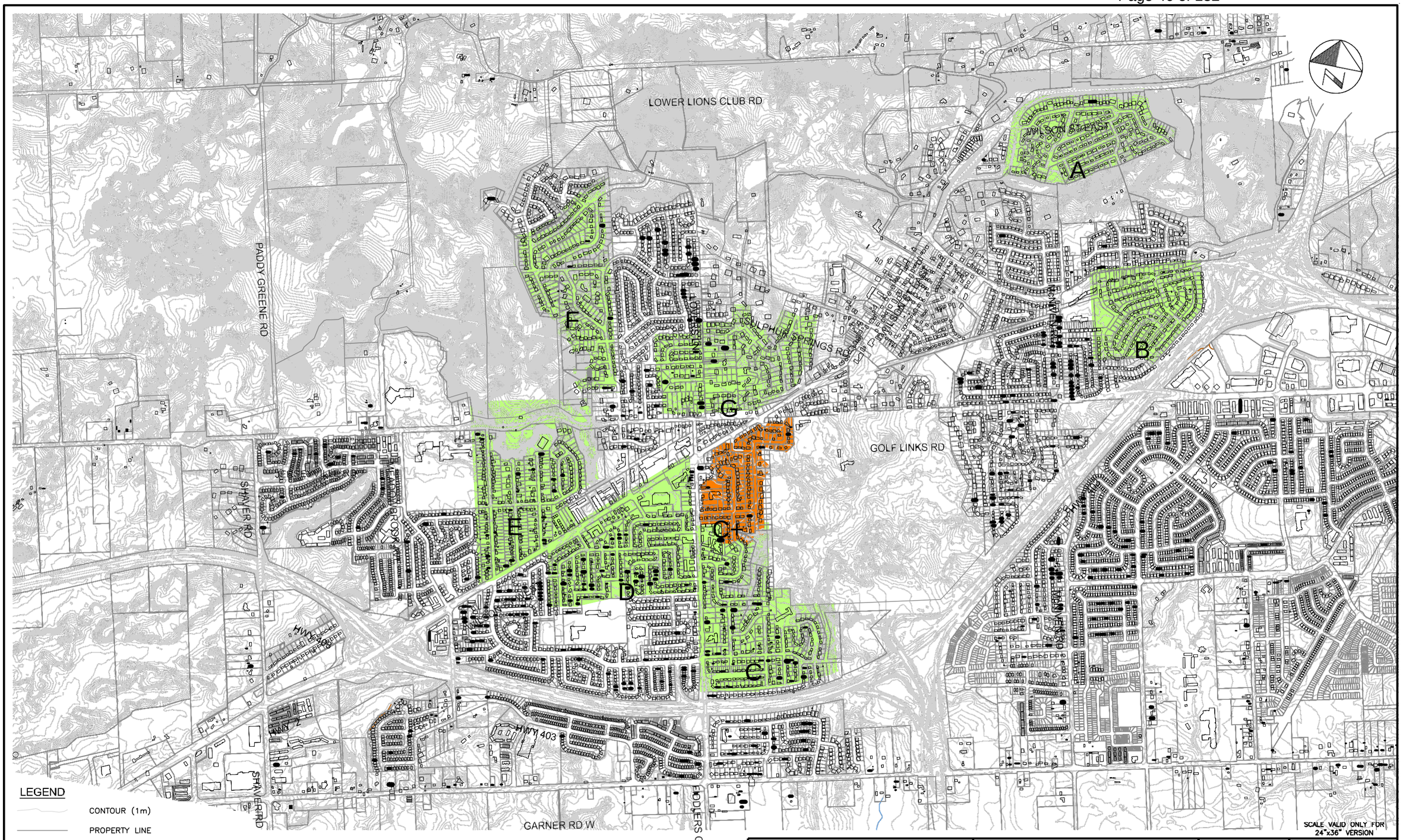
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CONTOUR (1m)
PROPERTY LINE
BUILDING
SELECTED CANDIDATE AREA
NON-SELECTED CANDIDATE AREA
SCALE VALID ONLY FOR 24"x36" VERSION
COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
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CANDIDATE
RURALLY-SERVICED
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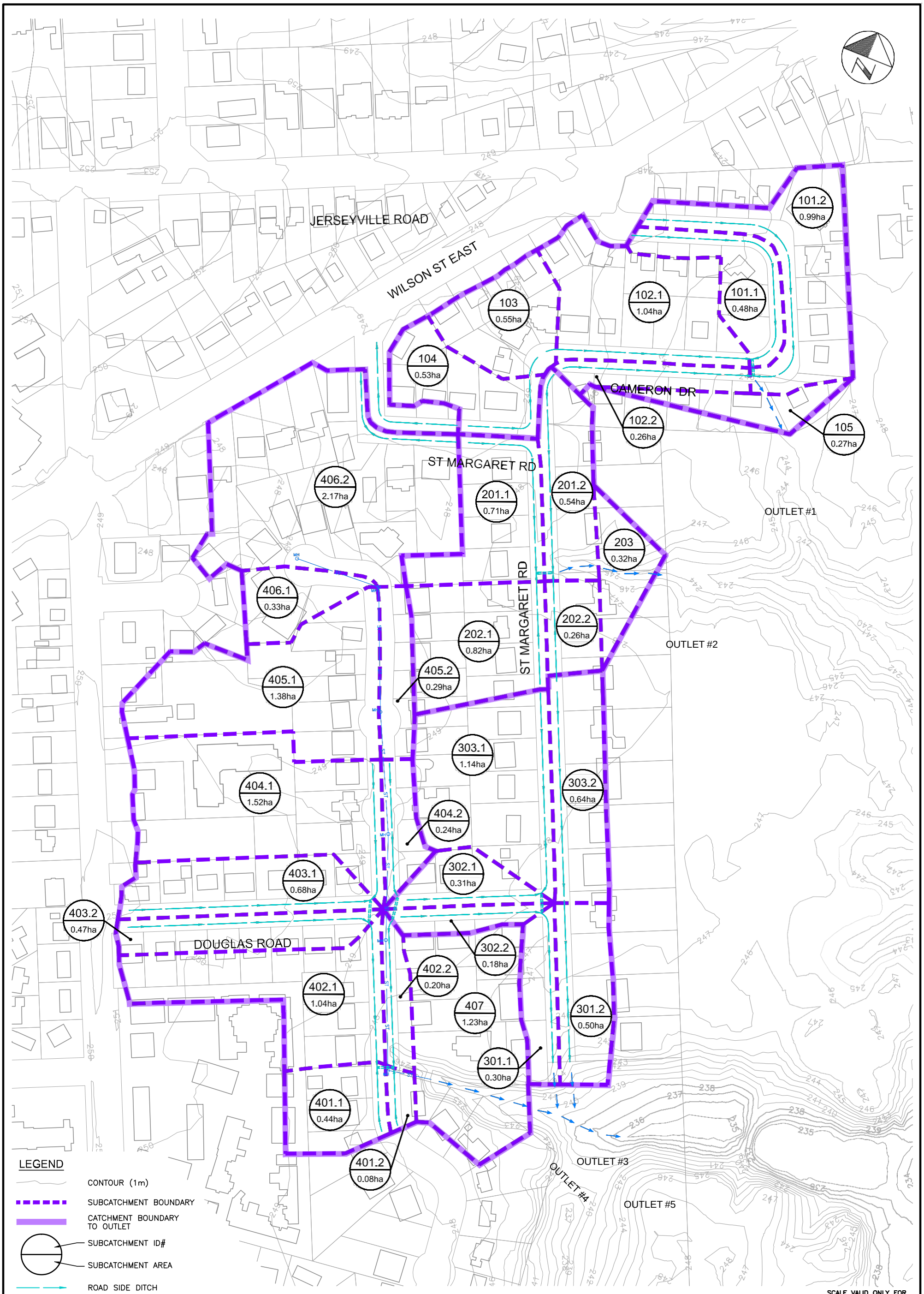

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

SUB-CATCHMENT BOUNDARY PLAN

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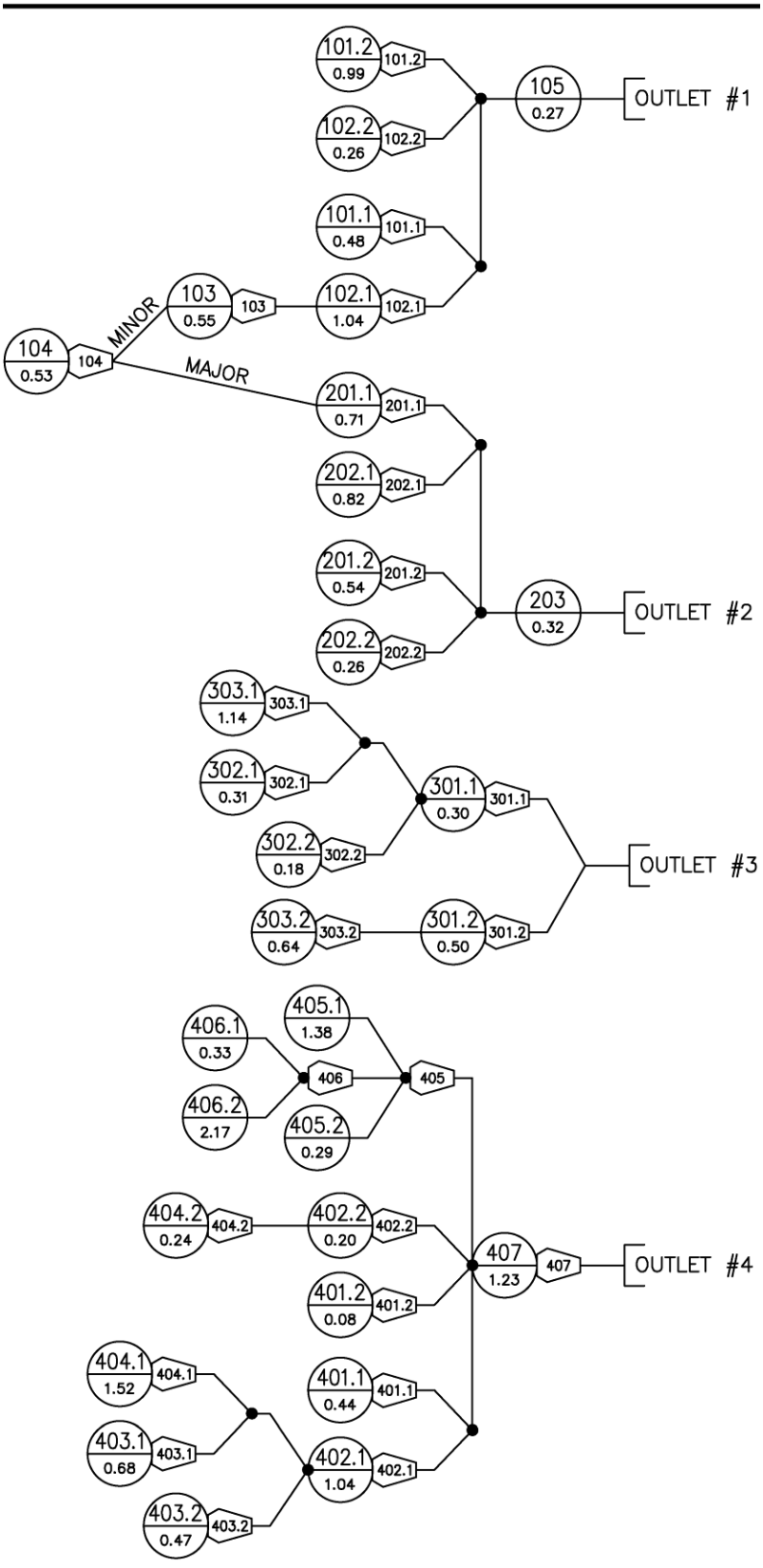
Last Saved by:richard.bartolo
Last Saved: 2015-01-14



LEGEND

101 / 1.47 — SUBCATCHMENT ID# / SUBCATCHMENT AREA

CHANNEL ROUTING ELEMENT AND REFERENCE NUMBER

• FLOW NODE

COMMUNITY OF ANCASTER

PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS

CITY OF HAMILTON

EXISTING CONDITIONS MODEL SCHEMATIC

amec:u

NOT TO SCALE

Consultant File No. TP114049

Drawing No. 3

Plotted By: Last Saved By: P:\Work\TP

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- SURVEYED AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- STORM SEWER
- STORM SEWER MANHOLE

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

SURVEY LOCATION PLAN

amec

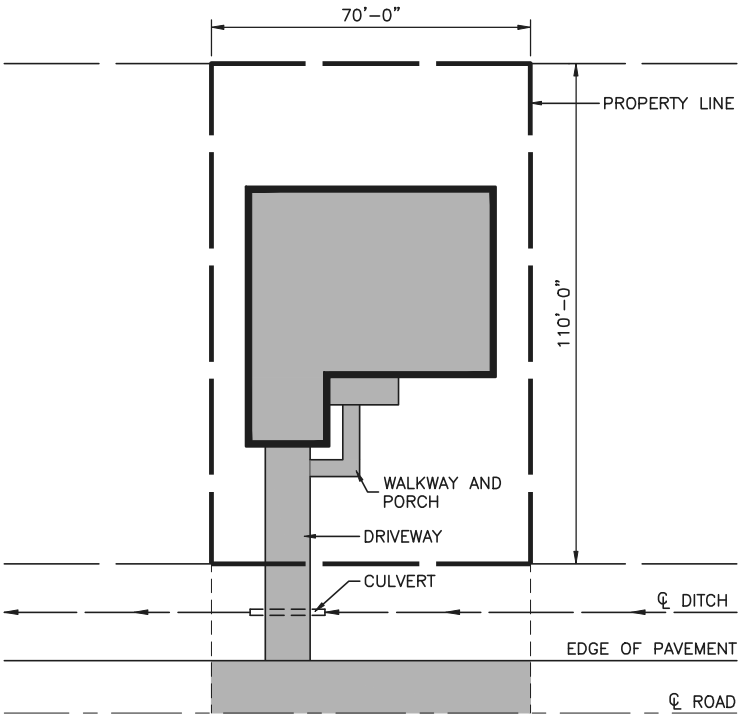
Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

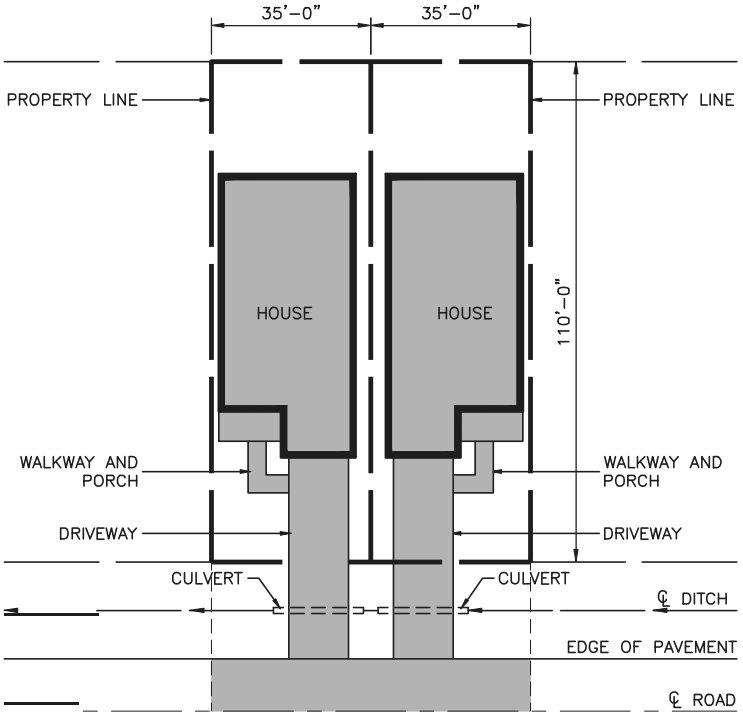
Drawing No.
4

Saved: 2015-03-04 By: richard.bartolo
Plotted: 2015-03-04 By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg4 SurveyLocation.dwg

EXISTING CONDITIONS



BUILDING LOT COVERAGE IS ±24.2%, WHILE TOTAL IMPERVIOUSNESS ASSUMED FOR MODELLING (BUILDING, DRIVEWAY, WALKWAY, PORCH AND HALF THE ROAD) IS ±38%



BUILDING LOT COVERAGE IS ±34.8%, WHILE TOTAL IMPERVIOUSNESS ASSUMED FOR MODELLING (BUILDING, DRIVEWAY, WALKWAY, PORCH AND HALF THE ROAD) IS ±57.5%

NOTE:
LOT COVERAGE ONLY ACCOUNTS FOR THE PORTION OF THE LOT OCCUPIED BY BUILDINGS AND STRUCTURES (ie. HOUSE AND ACCESSORY STRUCTURES) AND DOES NOT INCLUDE IMPERVIOUS AREAS SUCH AS THE DRIVEWAYS, WALKWAYS AND PATIOS.

LEGEND

IMPERVIOUS AREA

SCALE VALID ONLY FOR LETTER VERSION

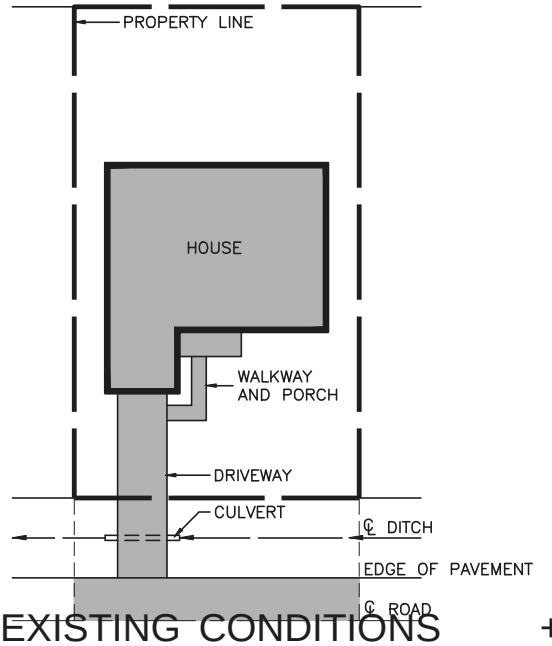
Plotted: 2016-06-30
Last Saved: 2016-06-30 By: richard.bartolo
Saved: By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\2016-06 (LotUpd)\Dwg5a LotSevExample.dwg

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

TYPICAL LOT
SEVERANCE SCHEMATIC

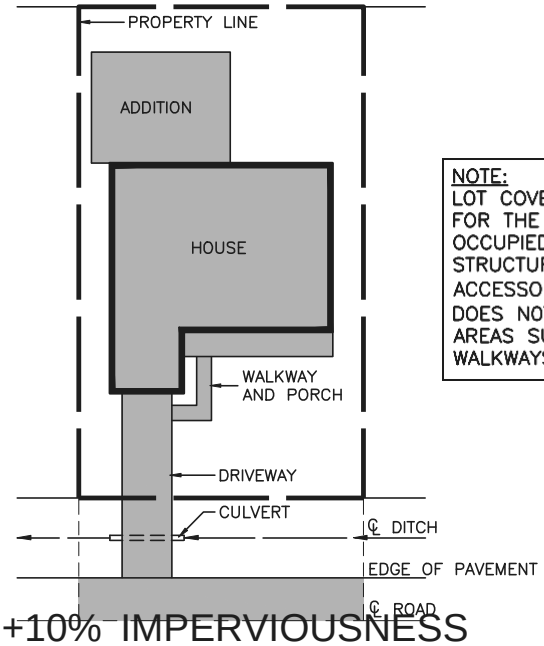
amec

Scale 1:500
0 2.5 5 10
Consultant File No.
TP114049
Drawing No.
5a



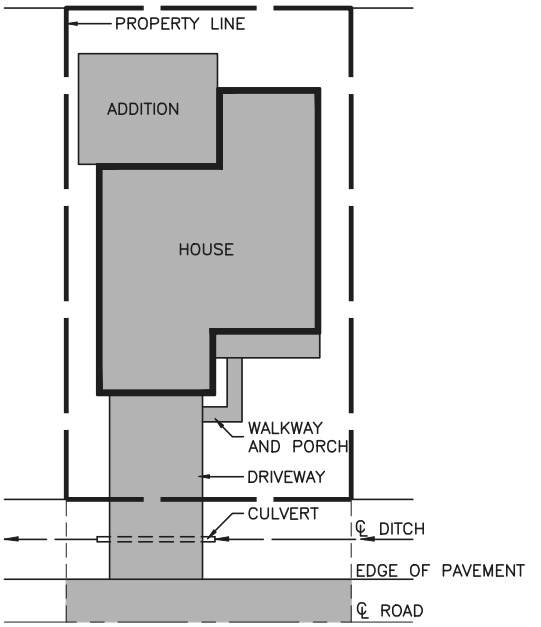
EXISTING CONDITIONS

BUILDING LOT COVERAGE IS ±24.2%, WHILE TOTAL IMPERVIOUSNESS ASSUMED FOR MODELLING (BUILDING, DRIVEWAY, WALKWAY, PORCH AND HALF THE ROAD) IS ±38%



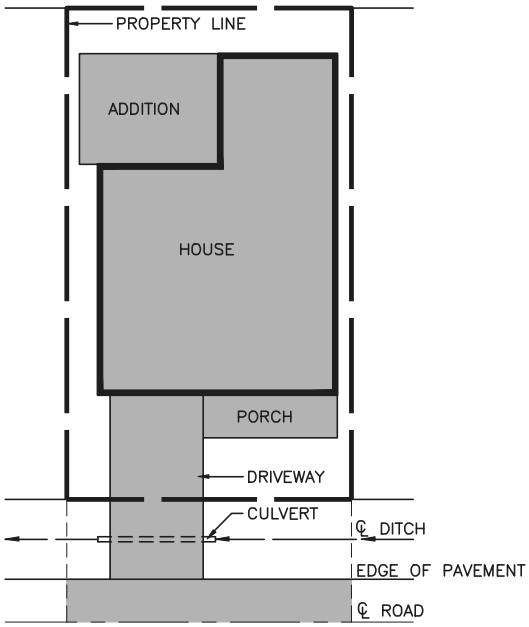
+10% IMPERVIOUSNESS

BUILDING LOT COVERAGE IS ±32.9%, WHILE TOTAL IMPERVIOUSNESS ASSUMED FOR MODELLING (BUILDING, DRIVEWAY, WALKWAY, PORCH AND HALF THE ROAD) IS ±48%



+20% IMPERVIOUSNESS

BUILDING LOT COVERAGE IS ±38.9%, WHILE TOTAL IMPERVIOUSNESS ASSUMED FOR MODELLING (BUILDING, DRIVEWAY, WALKWAY, PORCH AND HALF THE ROAD) IS ±58%



+30% IMPERVIOUSNESS

BUILDING LOT COVERAGE IS ±47.9%, WHILE TOTAL IMPERVIOUSNESS ASSUMED FOR MODELLING (BUILDING, DRIVEWAY, WALKWAY, PORCH AND HALF THE ROAD) IS ±68%

NOTE:
LOT COVERAGE ONLY ACCOUNTS FOR THE PORTION OF THE LOT OCCUPIED BY BUILDINGS AND STRUCTURES (ie. HOUSE AND ACCESSORY STRUCTURES) AND DOES NOT INCLUDE IMPERVIOUS AREAS SUCH AS THE DRIVEWAYS, WALKWAYS AND PATIOS.

LEGEND

IMPERVIOUS AREA

SCALE VALID ONLY FOR LETTER VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

IMPERVIOUS AREA
COMPARISON SCHEMATIC

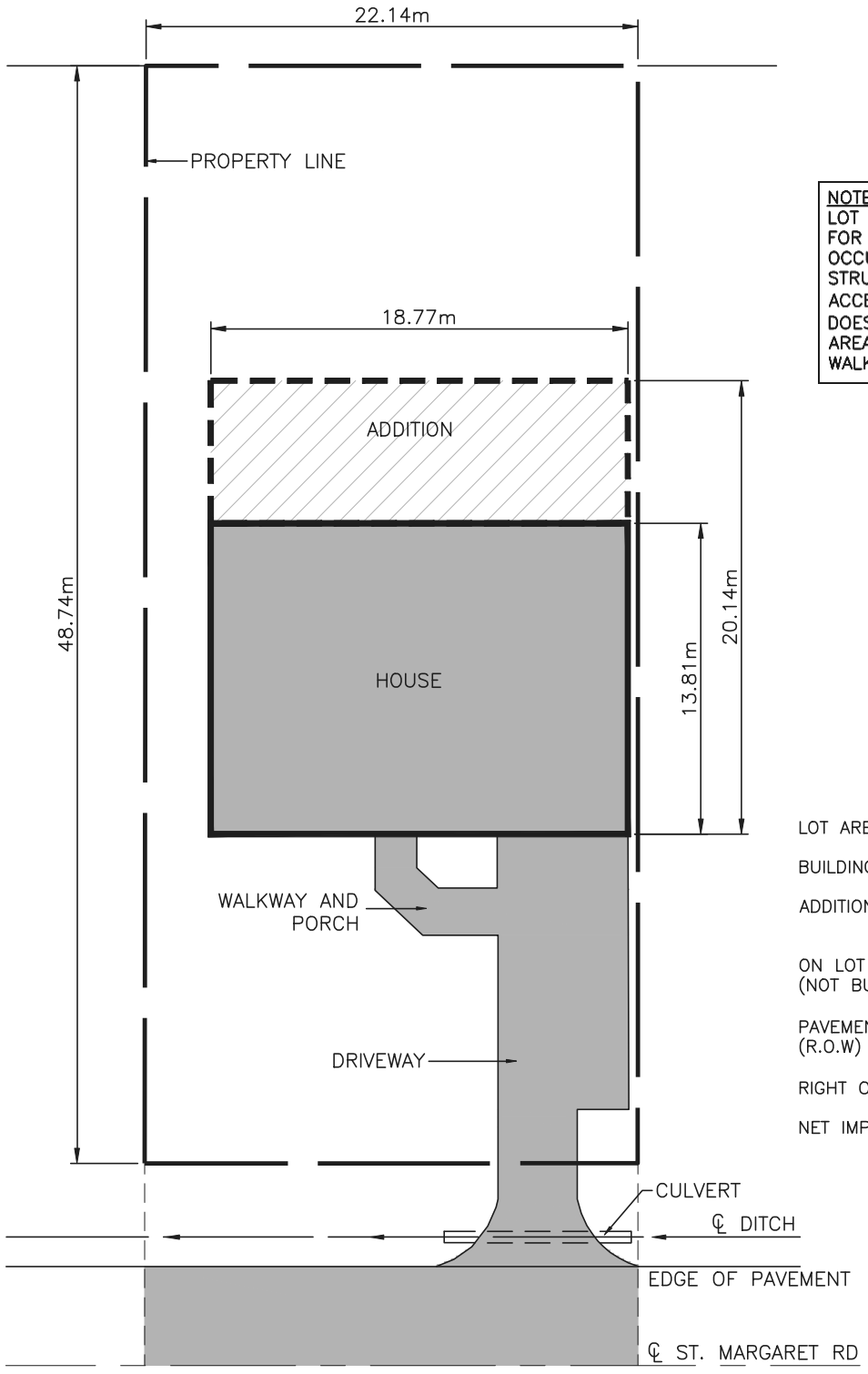
amec

Scale 1:600
0 3 6 12

Consultant File No.
TP114049

Drawing No.
5b

Plotted: 2016-06-30
Last Saved: 2016-06-30
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\2016-06 (LotUpd)\Dwg5b AreaExamples.dwg



NOTE:
LOT COVERAGE ONLY ACCOUNTS FOR THE PORTION OF THE LOT OCCUPIED BY BUILDINGS AND STRUCTURES (ie. HOUSE AND ACCESSORY STRUCTURES) AND DOES NOT INCLUDE IMPERVIOUS AREAS SUCH AS THE DRIVEWAYS, WALKWAYS AND PATIOS.

LOT AREA:	1080.0m²
BUILDING AREA:	259.2m²
ADDITION AREA:	118.8m²
ON LOT HARD SURFACE: (NOT BUILDING)	94.7m²
PAVEMENT AREA: (R.O.W)	119.2m²
RIGHT OF WAY AREA:	199.5m²
NET IMPERVIOUSNESS:	46.3%

EXISTING CONDITIONS: ~24% BUILDING COVERAGE (eg only)
(APPROVED ZONING INTENSIFICATION: 35% BUILDING COVERAGE)

LEGEND
IMPERVIOUS AREA

SCALE VALID ONLY FOR LETTER VERSION

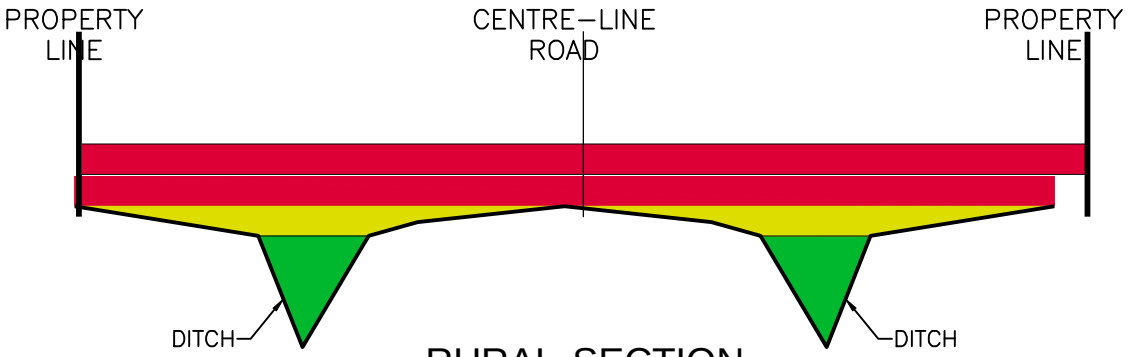
COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

APPROVED ZONING SCENARIO

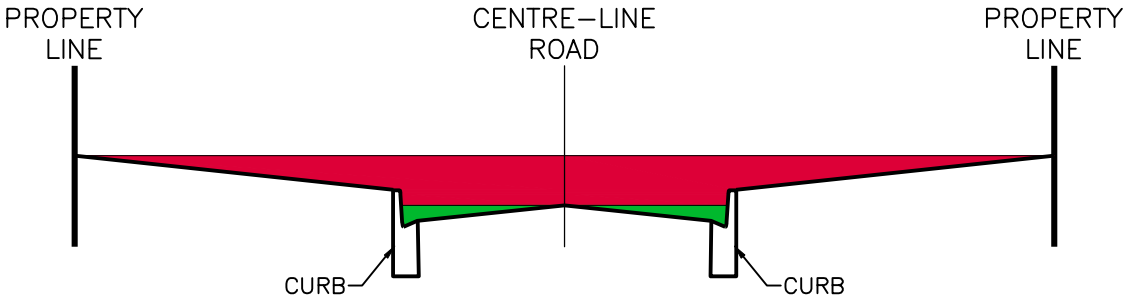
amec

Scale 1:250
0 1 2 4
Consultant File No.
TP114049
Drawing No.
5c

Plotted: 2016-07-20
Last Saved: 2016-06-30
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\2016-06 (LotUpd)\Dwg5c AreaExamples.dwg



RURAL SECTION



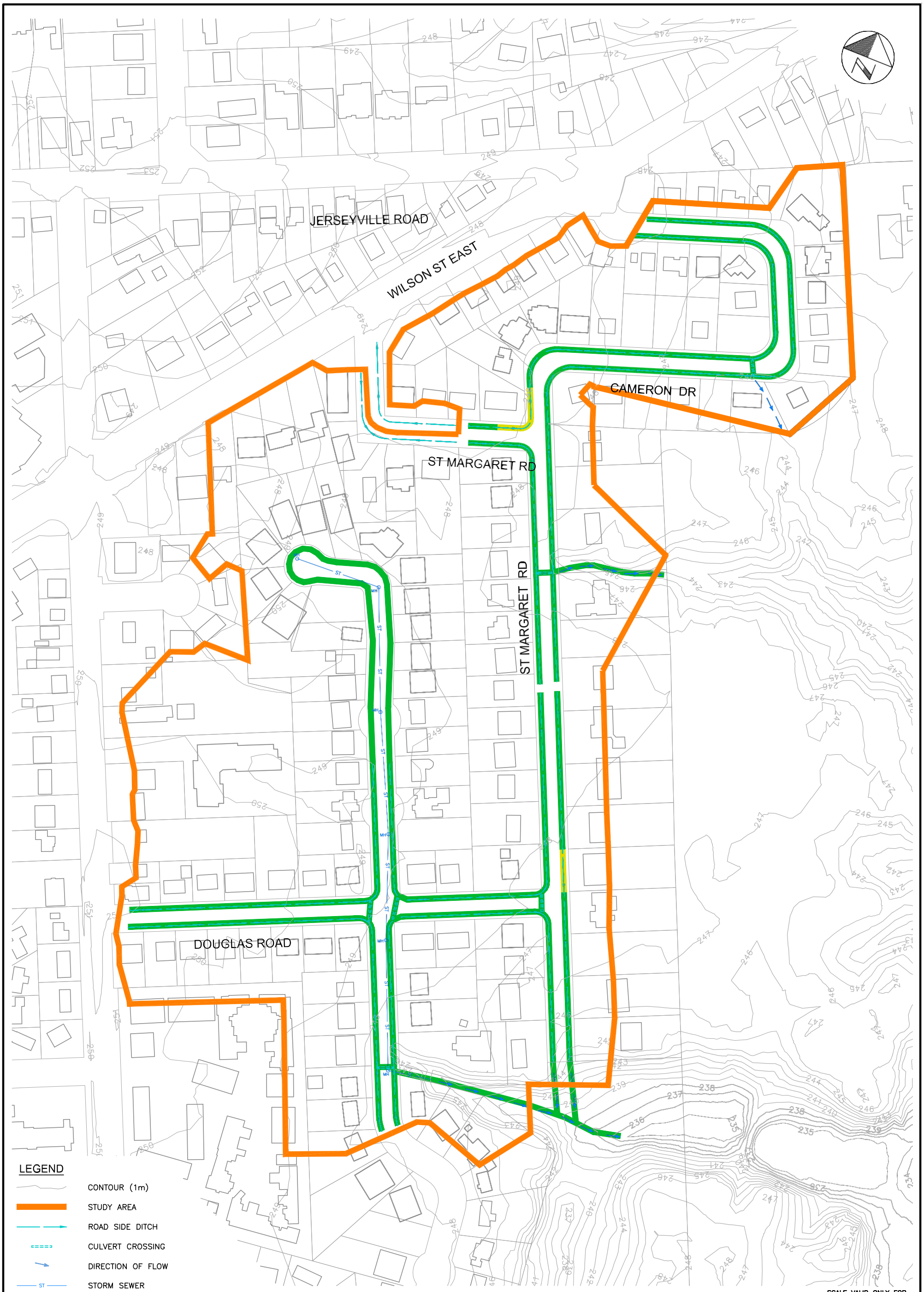
URBAN SECTION

(ROSEMARY LANE ONLY)

NOTE:
THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWINGS #7 TO #26

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON	SCHEMATIC OF FLOODING CONDITIONS PERTAINING TO 25mm, 2 YEAR AND 5 YEAR STORMEVENTS	amec	Scale: NOT TO SCALE Consultant File No.: TP114049 Drawing No.: 6

Plotted: 2015-01-15 Plotted By: richard.bartolo
Last Saved: 2015-01-14 Last Saved By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg6 FloodSchematic.dwg



SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
EXISTING CONFIGURATION
25mm STORM EVENT

amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
7

Saved: 2015-Jan-14 By: richard.bartolo Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg7 25mmPerfImpExs.dwg
Plotted: 2015-Jan-14 By: richard.bartolo

JERSEYVILLE ROAD

WILSON ST EAST

CAMERON DR

ST MARGARET RD

ST MARGARET RD

DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON

PERFORMANCE IMPACT PLAN +10% IMPERVIOUSNESS 25mm STORM EVENT

amec

Scale 1:1250 (0 10 20 40)

Consultant File No. TP114049

Drawing No. 8

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
+20% IMPERVIOUSNESS
25mm STORM EVENT

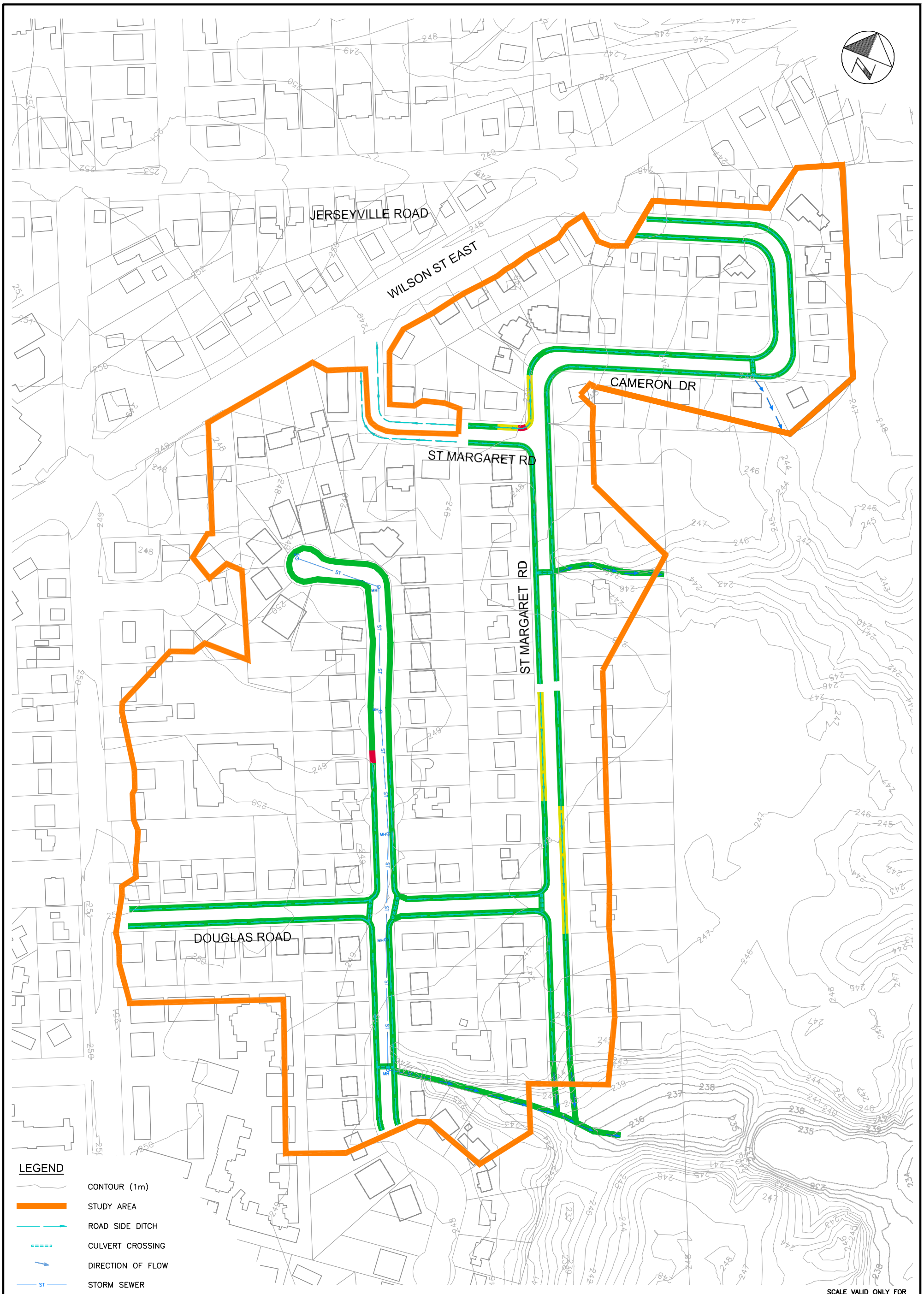
amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
9

Saved: 2015-03-04 By: richard.bartolo Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg9 25mmPerfImp20.dwg



SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
+30% IMPERVIOUSNESS
25mm STORM EVENT

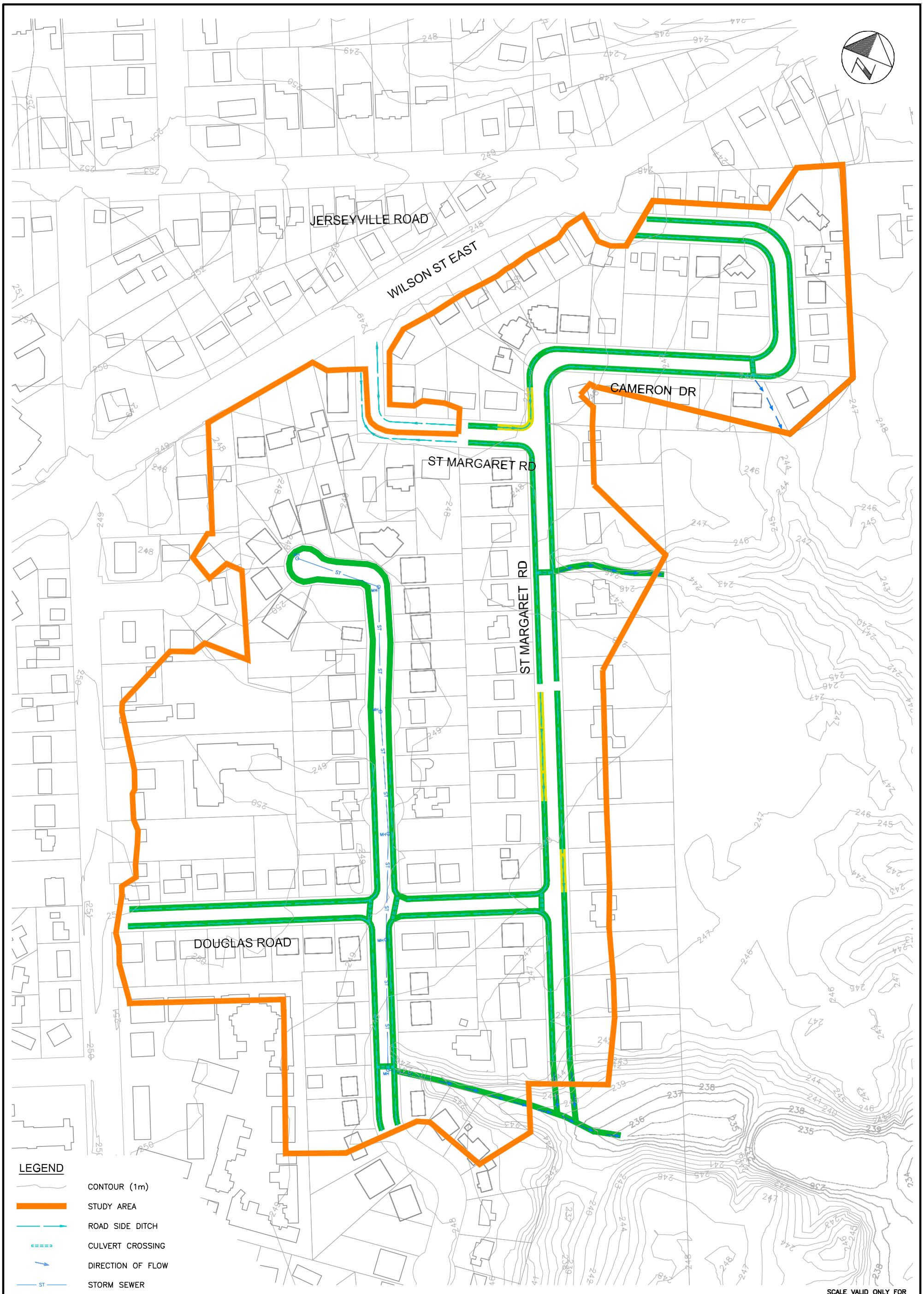
amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
10

Saved: 2015-Sep-15 By: richard.bartolo
Plotted: 2015-Sep-15 By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg10 25mmPerfImp30.dwg



SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON	PERFORMANCE IMPACT PLAN APPROVED ZONING CONFIGURATION 25mm STORM EVENT	amec	Scale 1:1250 (0 10 20 40) Consultant File No. TP114049 Drawing No. 11

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN EXISTING CONFIGURATION 2 YEAR STORM EVENT

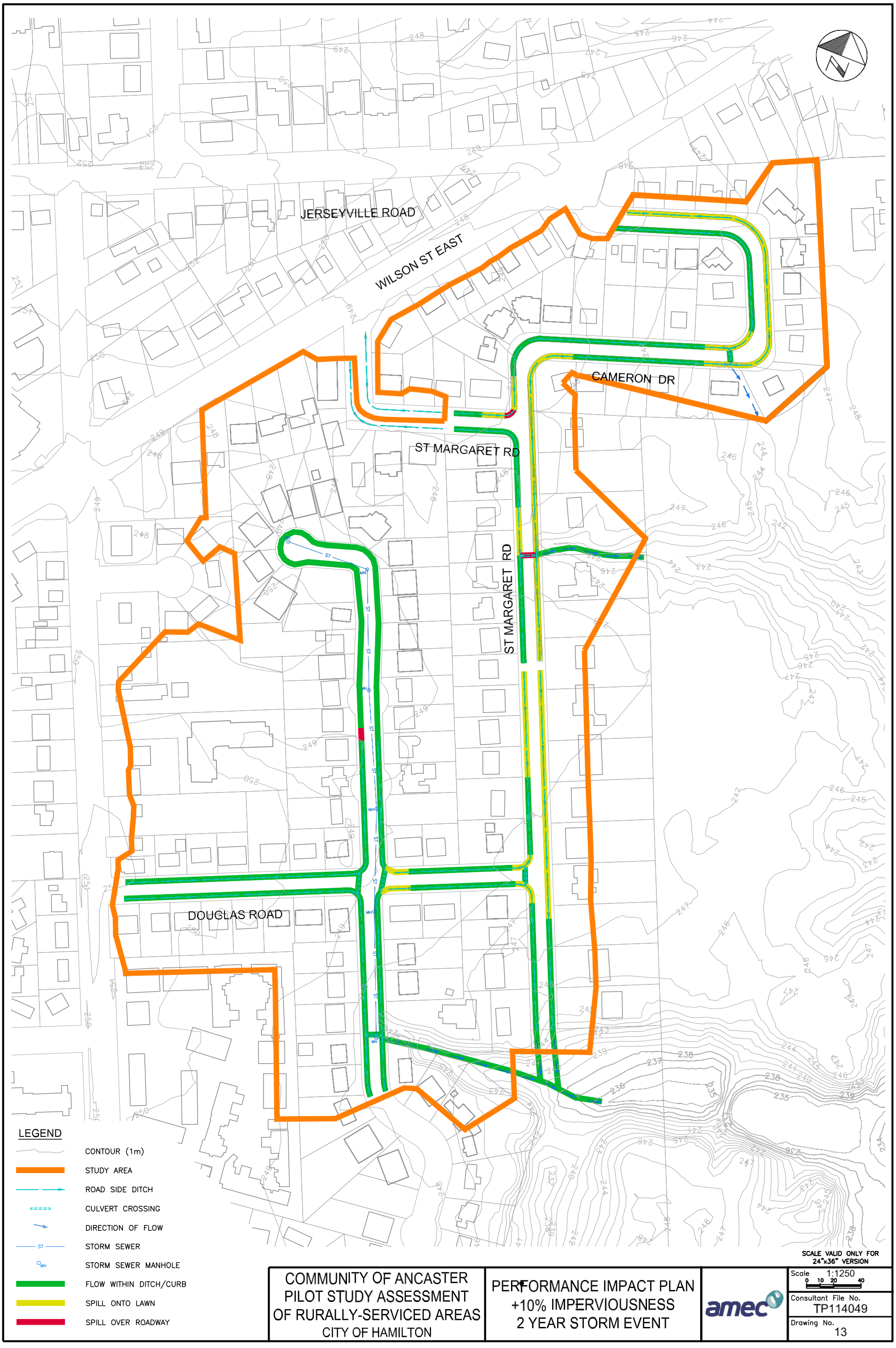
amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
12

Last Saved: 2015-01-14 Last Saved By: richard.bartolo Plotted: 2015-01-15 Plotted By: richard.bartolo Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg12 2yrPerfImpExs.dwg



SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
+10% IMPERVIOUSNESS
2 YEAR STORM EVENT

amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
13

Saved: 2015-03-04 By: richard.bartolo
Plotted: 2015-03-04 By: richard.bartolo
Last Updated By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg13 2yrPerfImp10.dwg

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
+20% IMPERVIOUSNESS
2 YEAR STORM EVENT

amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 14

Saved: 2015-01-14 Saved By: richard.bartolo
Plotted: 2015-01-15 Plotted By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg14 2yrPerfImp20.dwg

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
+30% IMPERVIOUSNESS
2 YEAR STORM EVENT

amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 15

Saved: 2015-03-04 By: richard.bartolo
Plotted: 2015-03-04 By: richard.bartolo
Last Edited By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg15 2yrPerfImp30.dwg

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
APPROVED ZONING
CONFIGURATION
2 YEAR STORM EVENT

amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
16

Saved: 2015-01-15 Saved By: richard.bartolo
Plotted: 2015-01-15 Plotted By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg16 2yrPerfImpApp.dwg

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
EXISTING CONFIGURATION
5 YEAR STORM EVENT

amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
17

Saved: 2015-01-15 By: richard.bartolo Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg17 5yrPerfImpExs.dwg
Plotted: 2015-01-15 By: richard.bartolo

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN +10% IMPERVIOUSNESS 5 YEAR STORM EVENT

amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 18

Saved: 2015-03-04 By: richard.bartolo
Plotted: 2015-03-04 By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg18 5yrPerfImp10.dwg

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
+20% IMPERVIOUSNESS
5 YEAR STORM EVENT

amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 19

Saved: 2015-03-04 By: richard.bartolo
Plotted: 2015-03-04 By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg19 5yrPerfImp20.dwg

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON

PERFORMANCE IMPACT PLAN +30% IMPERVIOUSNESS 5 YEAR STORM EVENT

amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 20

Saved: 2015-03-04 By: richard.bartolo
Plotted: 2015-03-04 By: richard.bartolo
Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg20 5yrPerfImp30.dwg

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- FLOW WITHIN DITCH/CURB
- SPILL ONTO LAWN
- SPILL OVER ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

PERFORMANCE IMPACT PLAN
APPROVED ZONING
CONFIGURATION
5 YEAR STORM EVENT

amec

Scale 1:1250
0 10 20 40

Consultant File No.
TP114049

Drawing No.
21

Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg21 5yrPerfImpApp.dwg
Saved: 2015-01-15 Last richard.bartlett Saved By:
Plotted: 2015-01-15 richard.bartlett
Updated By:

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- NO OVERTOP
- > 0cm – 5cm DEPTH OF OVERTOPPING
- > 5cm – 15cm DEPTH OF OVERTOPPING

NOTE: DEPTHS AND LOCATIONS OF SPILL ARE APPROXIMATE

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON

PERFORMANCE IMPACT PLAN EXISTING CONFIGURATION 100 YEAR STORM EVENT

amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 22

Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg22 100yrPerflimpExs.dwg
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Plotted: 2015-01-15 Plotted By: richard.bartolo

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- NO OVERTOP
- > 0cm – 5cm DEPTH OF OVERTOPPING
- > 5cm – 15cm DEPTH OF OVERTOPPING

NOTE: DEPTHS AND LOCATIONS OF SPILL ARE APPROXIMATE

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON

PERFORMANCE IMPACT PLAN +10% IMPERVIOUSNESS 100 YEAR STORM EVENT

amec

Scale 1:1250
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Consultant File No.
TP114049

Drawing No.
23

Saved: 2015-03-16 By: richard.bartolo Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg23 100yrPerfImp10.dwg
Plotted: 2015-03-16 By: richard.bartolo

JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- NO OVERTOP
- > 0cm – 5cm DEPTH OF OVERTOPPING
- > 5cm – 15cm DEPTH OF OVERTOPPING

NOTE: DEPTHS AND LOCATIONS OF SPILL ARE APPROXIMATE

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON

PERFORMANCE IMPACT PLAN +20% IMPERVIOUSNESS 100 YEAR STORM EVENT

amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 24

Saved: 2015-03-16 By: richard.bartolo
Printed: 2015-03-16 By: richard.bartolo
Last Updated By: richard.bartolo
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JERSEYVILLE ROAD
WILSON ST EAST
CAMERON DR
ST MARGARET RD
ST MARGARET RD
DOUGLAS ROAD

LEGEND

- CONTOUR (1m)
- STUDY AREA
- ROAD SIDE DITCH
- CULVERT CROSSING
- DIRECTION OF FLOW
- ST — STORM SEWER
- O_{MH} — STORM SEWER MANHOLE
- NO OVERTOP
- > 0cm – 5cm DEPTH OF OVERTOPPING
- > 5cm – 15cm DEPTH OF OVERTOPPING

NOTE: DEPTHS AND LOCATIONS OF SPILL ARE APPROXIMATE

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON

PERFORMANCE IMPACT PLAN +30% IMPERVIOUSNESS 100 YEAR STORM EVENT

amec

Scale 1:1250
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Consultant File No.
TP114049

Drawing No.
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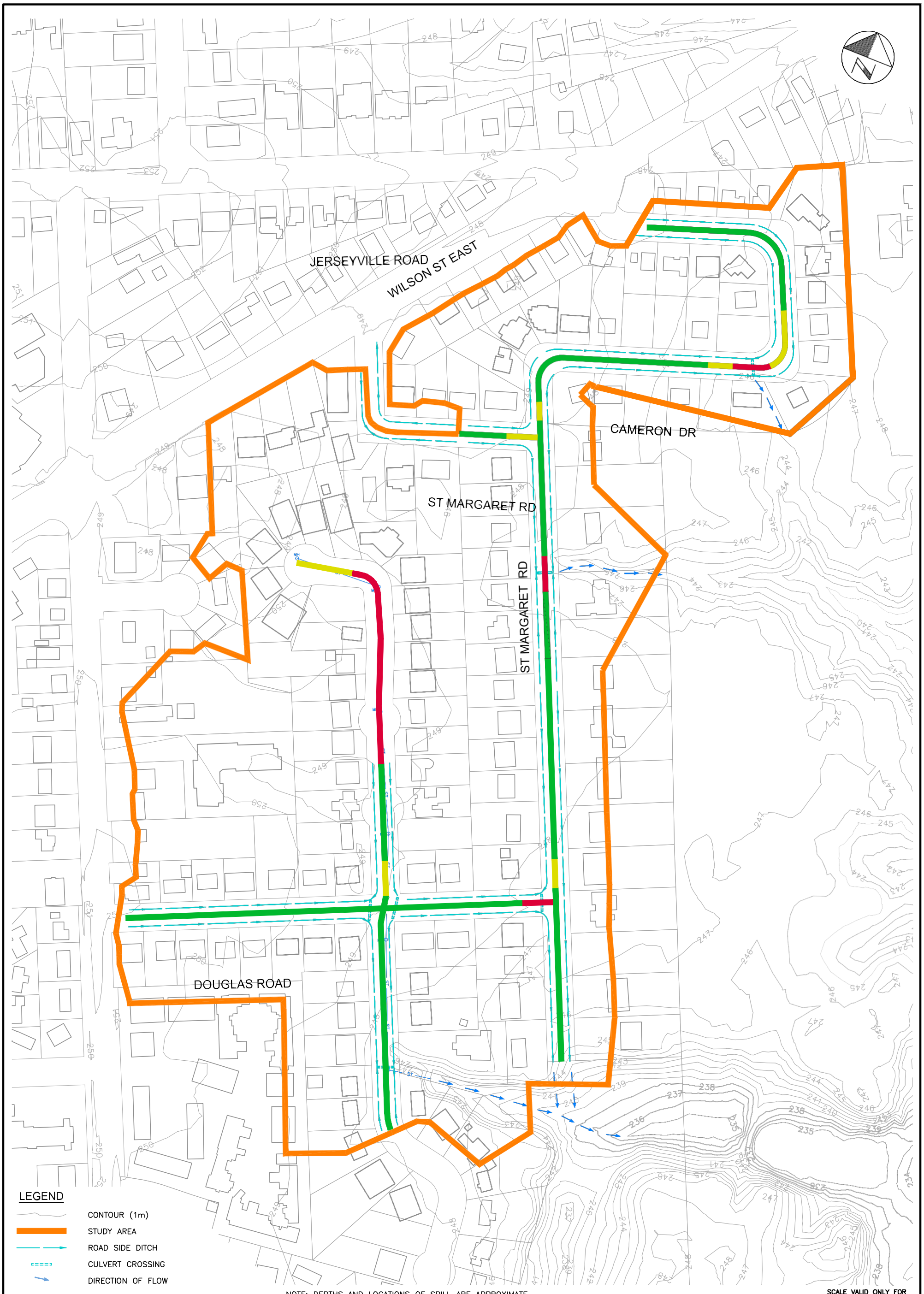


NOTE: DEPTHS AND LOCATIONS OF SPILL ARE APPROXIMATE

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER PILOT STUDY ASSESSMENT OF RURALLY-SERVICED AREAS CITY OF HAMILTON	PERFORMANCE IMPACT PLAN APPROVED ZONING CONFIGURATION 100 YEAR STORM EVENT	amec	Scale 1:1250 (0 10 20 40) Consultant File No. TP114049 Drawing No. 26

Last Saved: 2015-01-15 Plotted: richard.bartolo Plotted By: 2015-01-15 richard.bartolo

WILSON ST EAST

ST MARGARET RD

CAMERON DR

JERSEYVILLE ROAD

OUTLET #1

OUTLET #2

OUTLET #3

OUTLET #4

OUTLET #5

101.2 0.99ha
101.1 0.48ha
102.1 1.04ha
103 0.55ha
104 0.53ha
102.2 0.26ha
105 0.27ha
406.2 2.17ha
201.1 0.71ha
201.2 0.54ha
203 0.32ha
406.1 0.33ha
202.1 0.82ha
202.2 0.26ha
405.2 0.29ha
405.1 1.38ha
303.1 1.14ha
303.2 0.64ha
404.1 1.52ha
404.2 0.24ha
403.1 0.68ha
302.1 0.31ha
403.2 0.47ha
302.2 0.18ha
402.2 0.20ha
402.1 1.04ha
407 1.23ha
301.2 0.50ha
301.1 0.30ha
401.1 0.44ha
401.2 0.08ha

LEGEND

- CONTOUR (1m)
- SUBCATCHMENT BOUNDARY
- CATCHMENT BOUNDARY TO OUTLET
- SUBCATCHMENT ID#
- SUBCATCHMENT AREA
- ROAD SIDE DITCH
- 7 / 1.25 CULVERT CROSSING
- DIRECTION OF FLOW
- ST STORM SEWER
- MH STORM SEWER MANHOLE

IMPERVIOUS COVERAGE INCREASE OF:

- NO CHANGE
- 1%–10%
- 11%–20%
- 21%–30%
- OVER 30%

SCALE VALID ONLY FOR 24"x36" VERSION

COMMUNITY OF ANCASTER
PILOT STUDY ASSESSMENT
OF RURALLY-SERVICED AREAS
CITY OF HAMILTON

RANGE OF SUB-CATCHMENT
PERCENTAGE CHANGE IN
IMPERVIOUSNESS AS PER
CURRENT ZONING

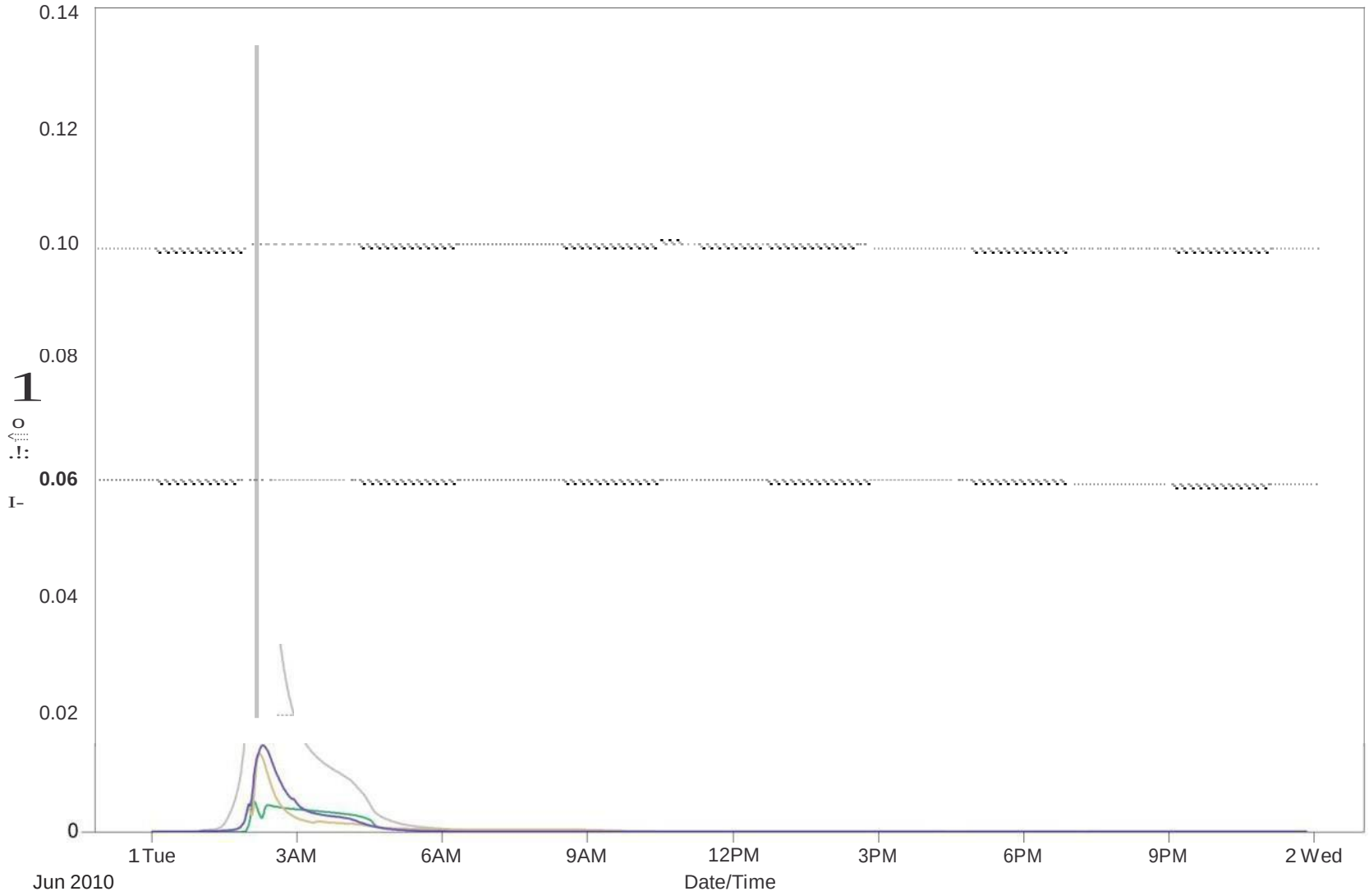
amec

Scale 1:1250 (0 10 20 40)
Consultant File No. TP114049
Drawing No. 27

Path: P:\Work\TP114049\water\dwg\Jan2015\Dwg2ImpervChange.dwg
Plotted By: richard.bartolo
Plotted: 2015-01-15
By:richard.bartolo
Saved: 2015-01-15

APPENDIX A

PCSWMM INPUT/OUTPUT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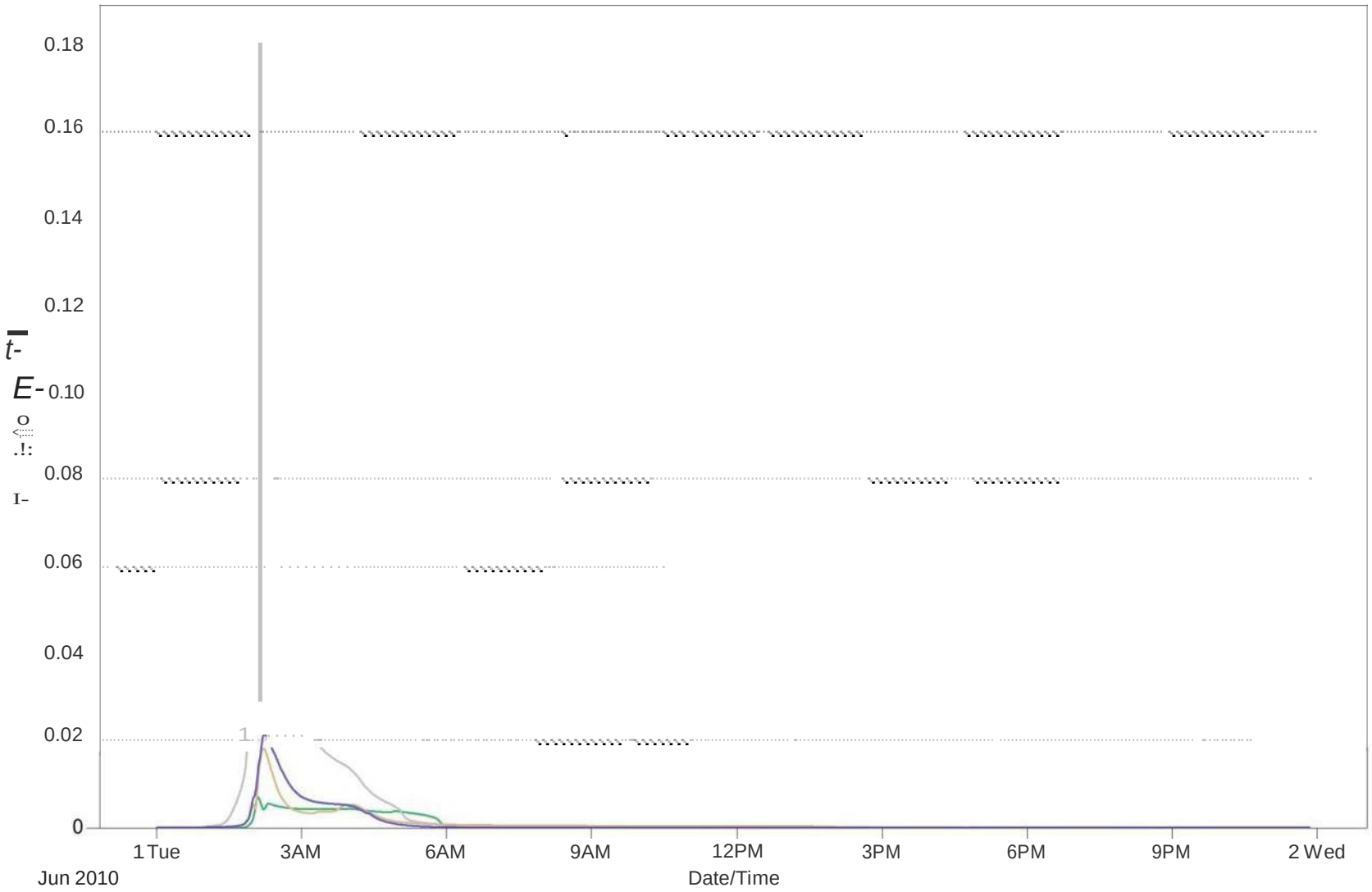
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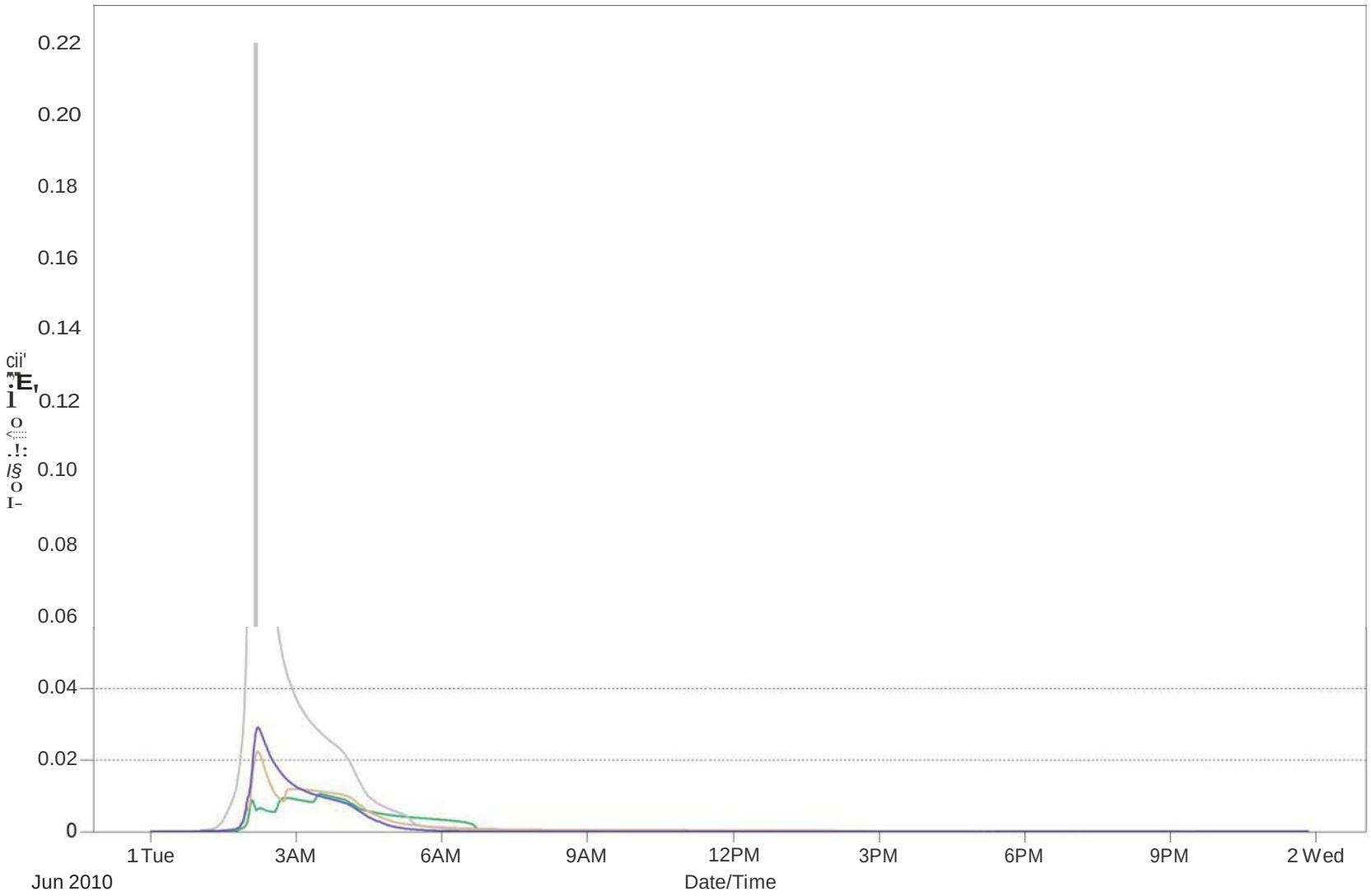
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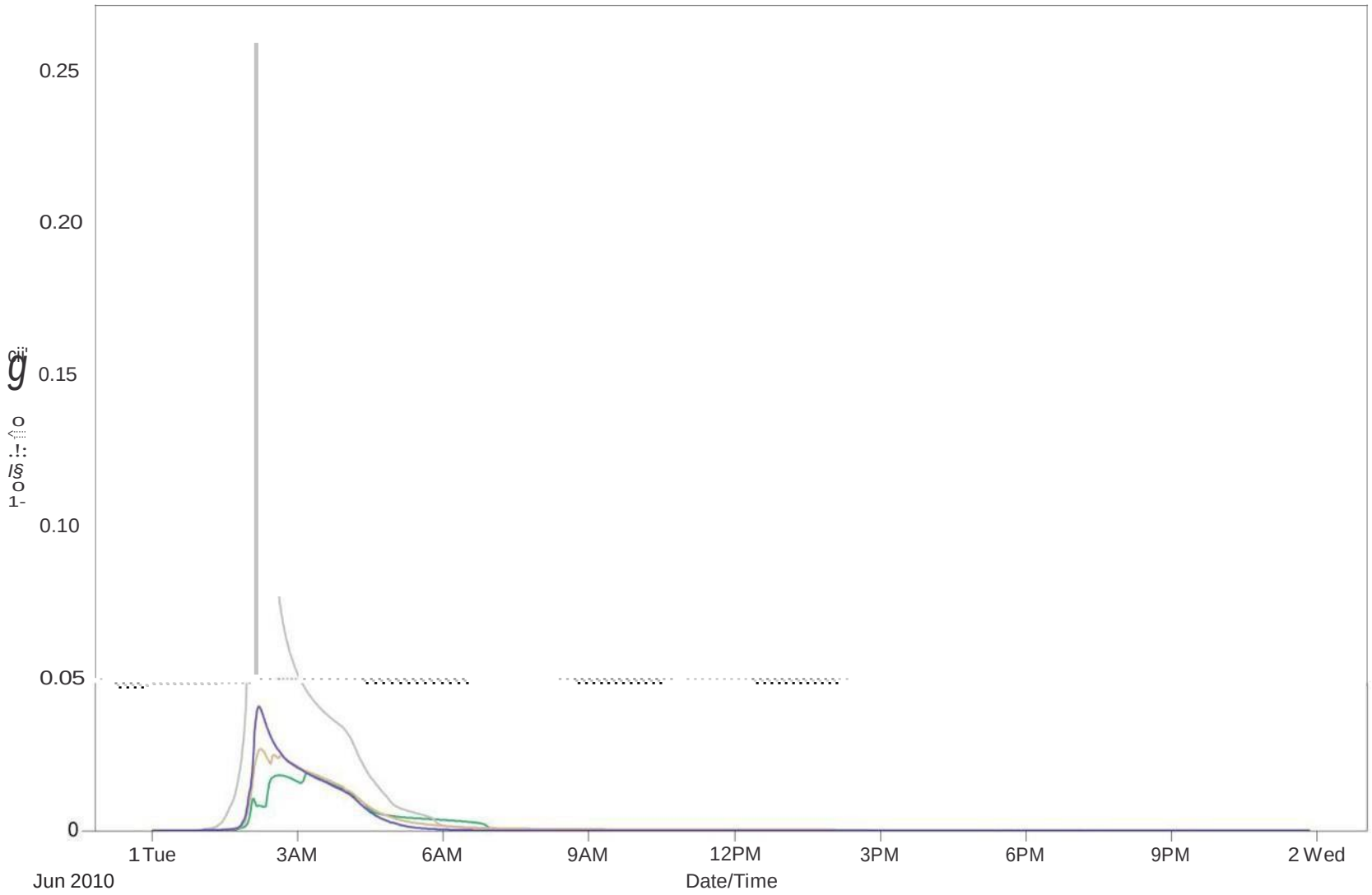
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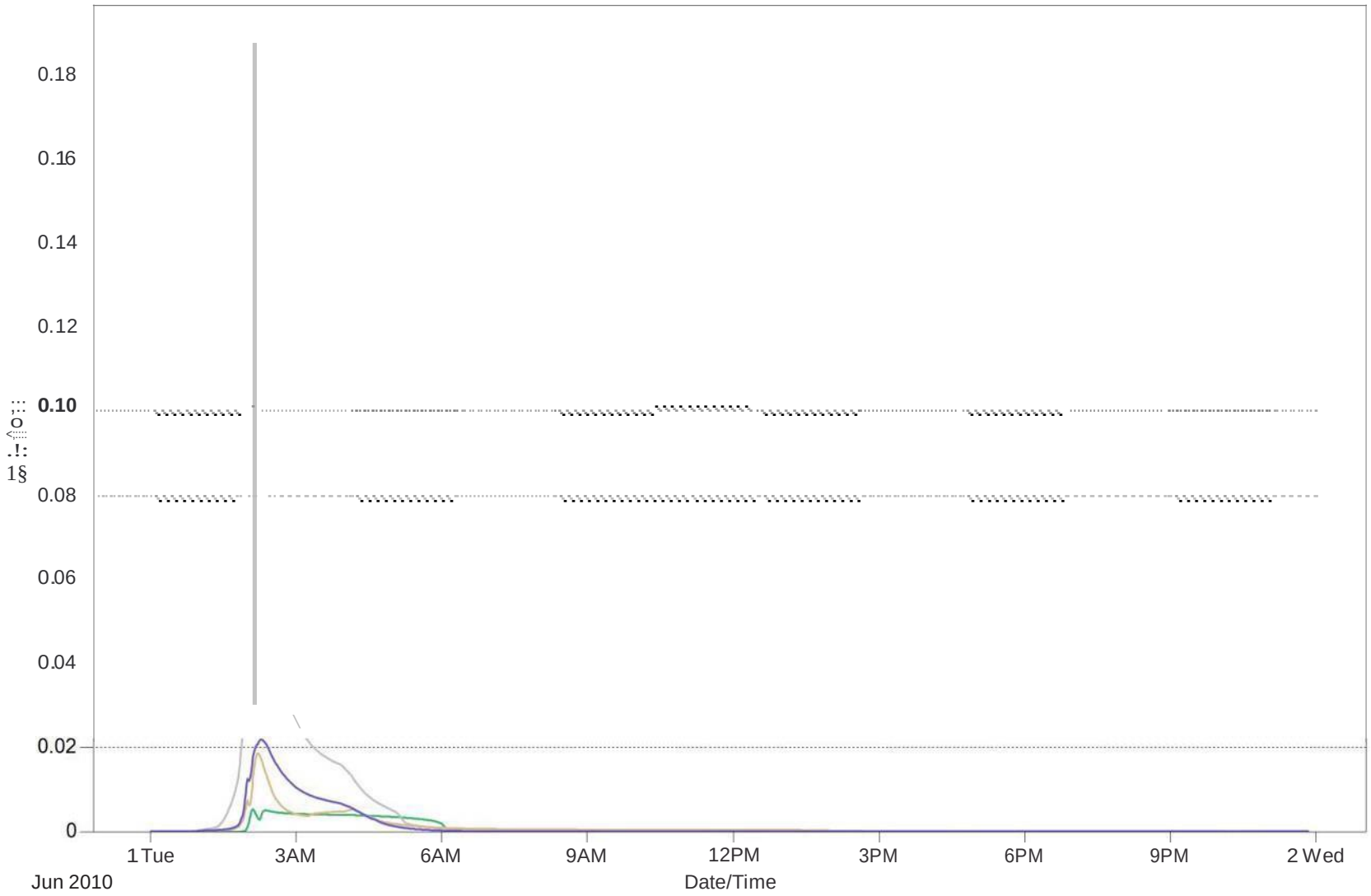
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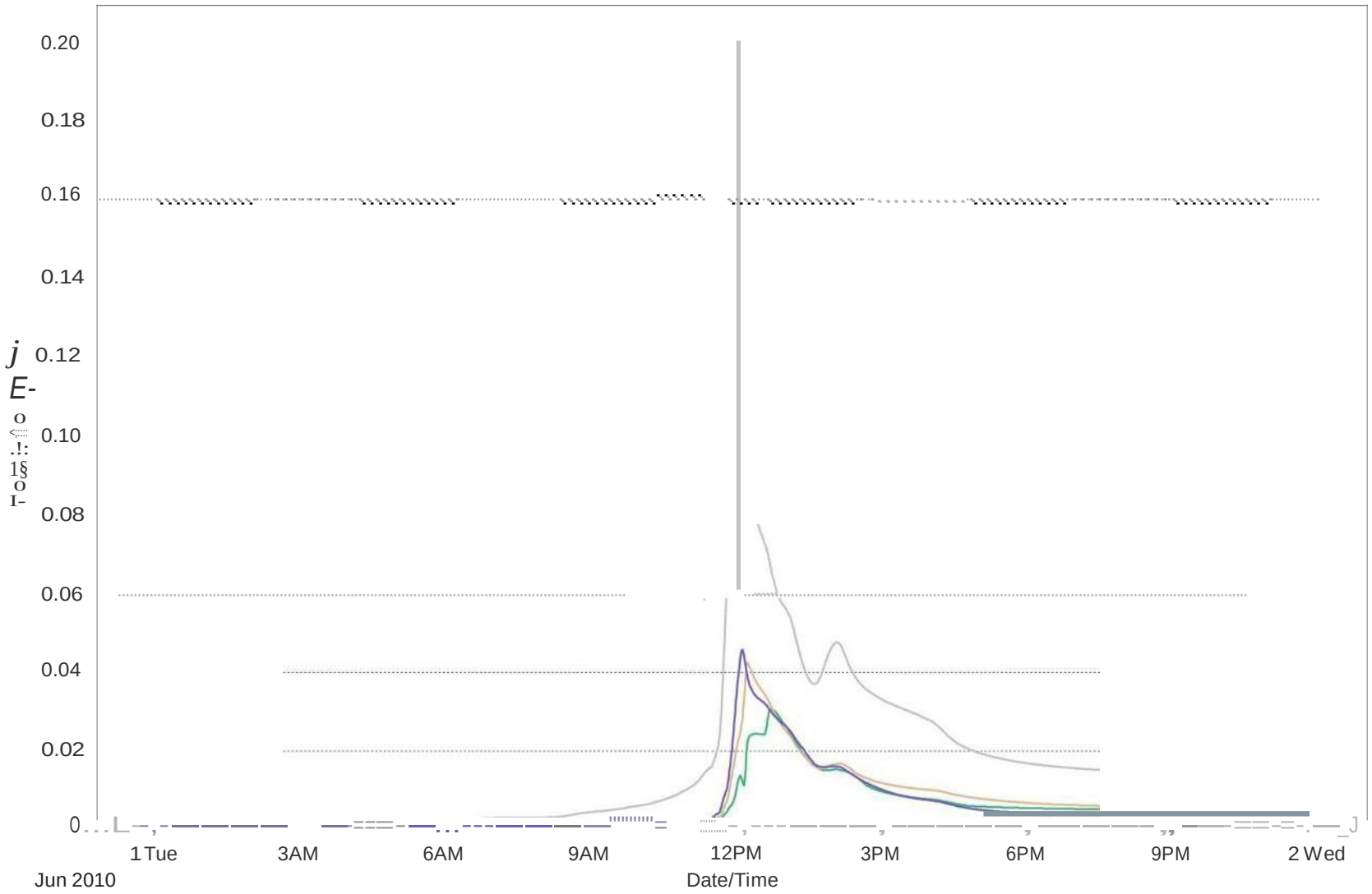
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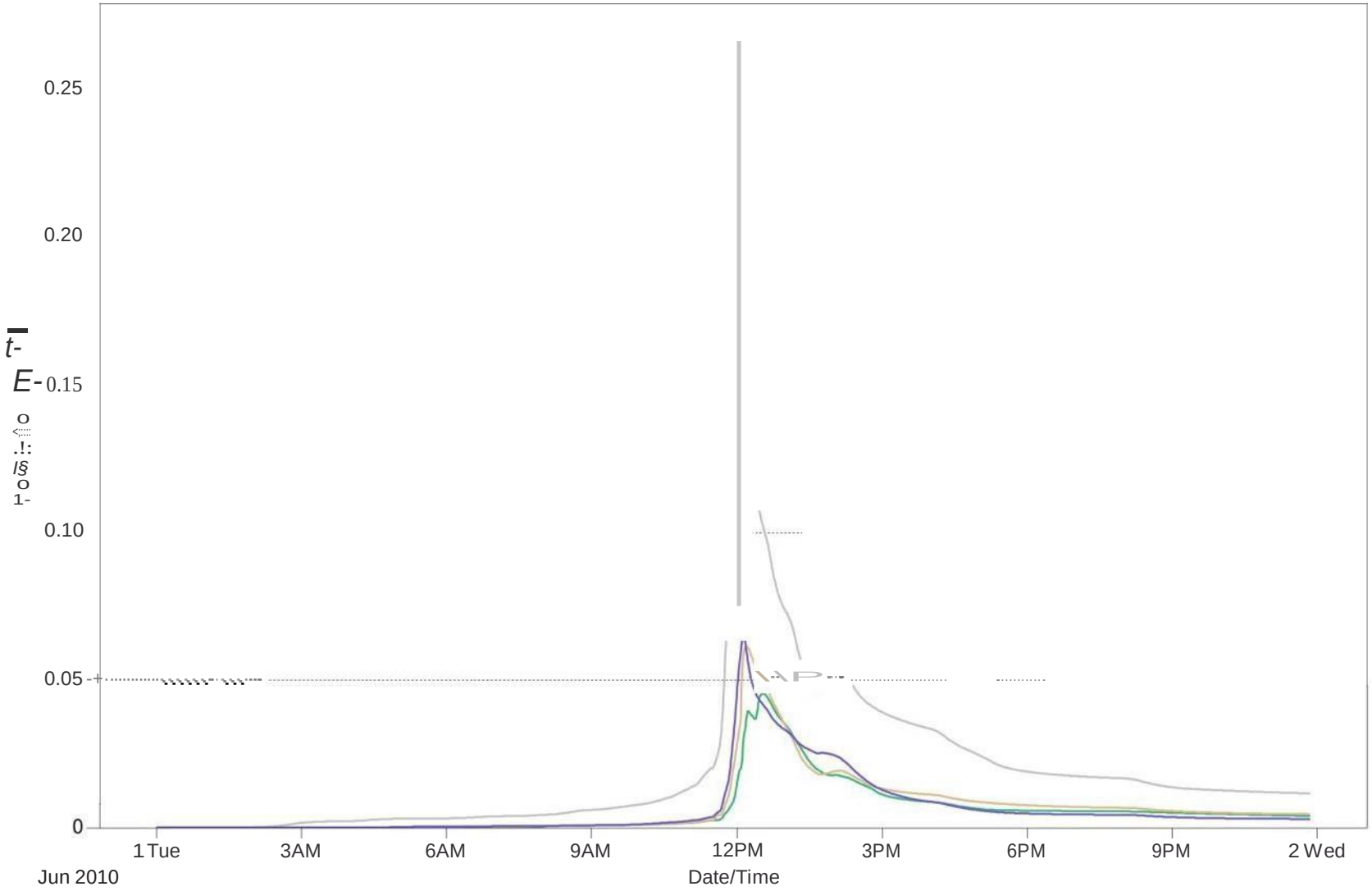
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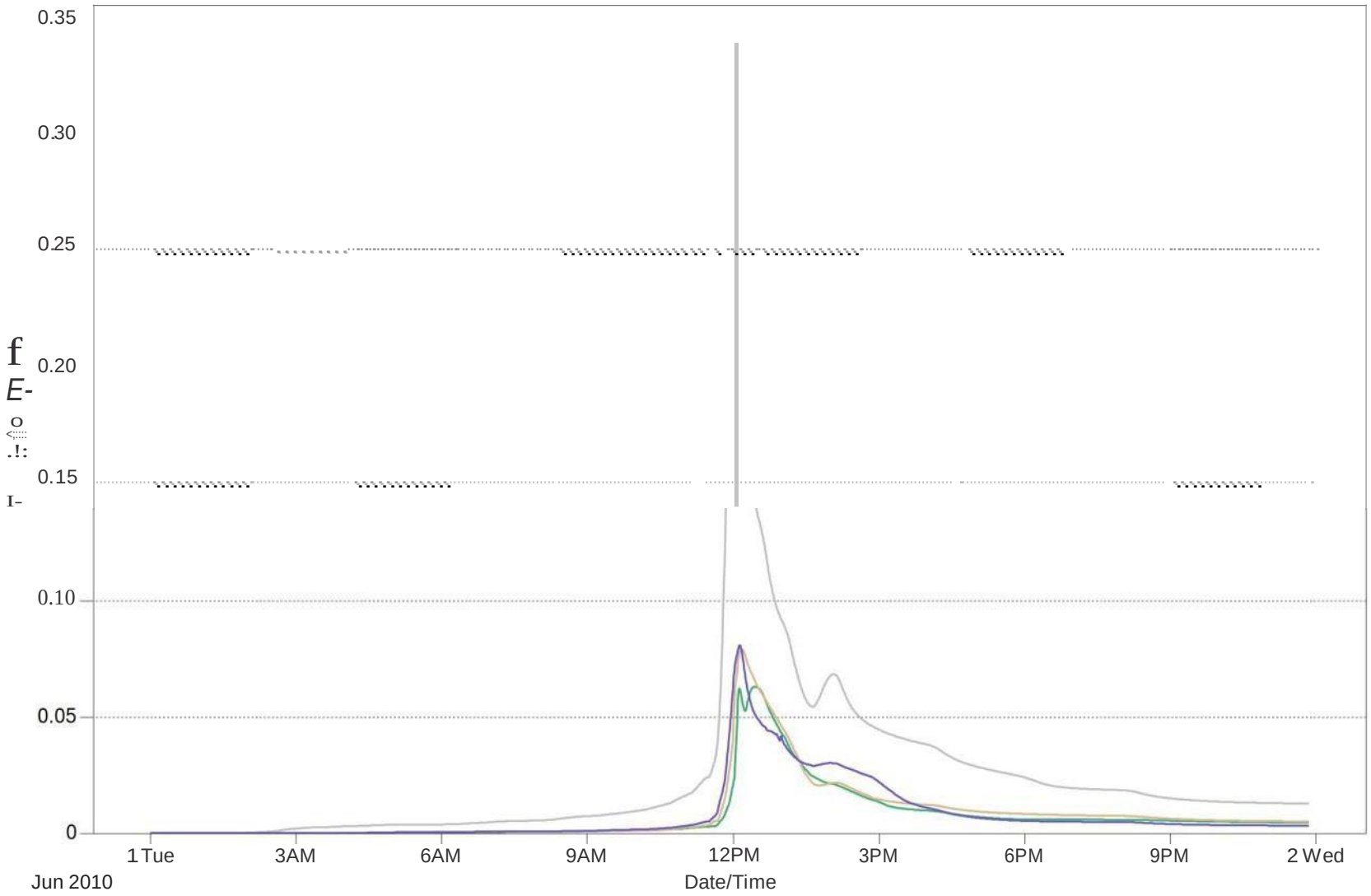
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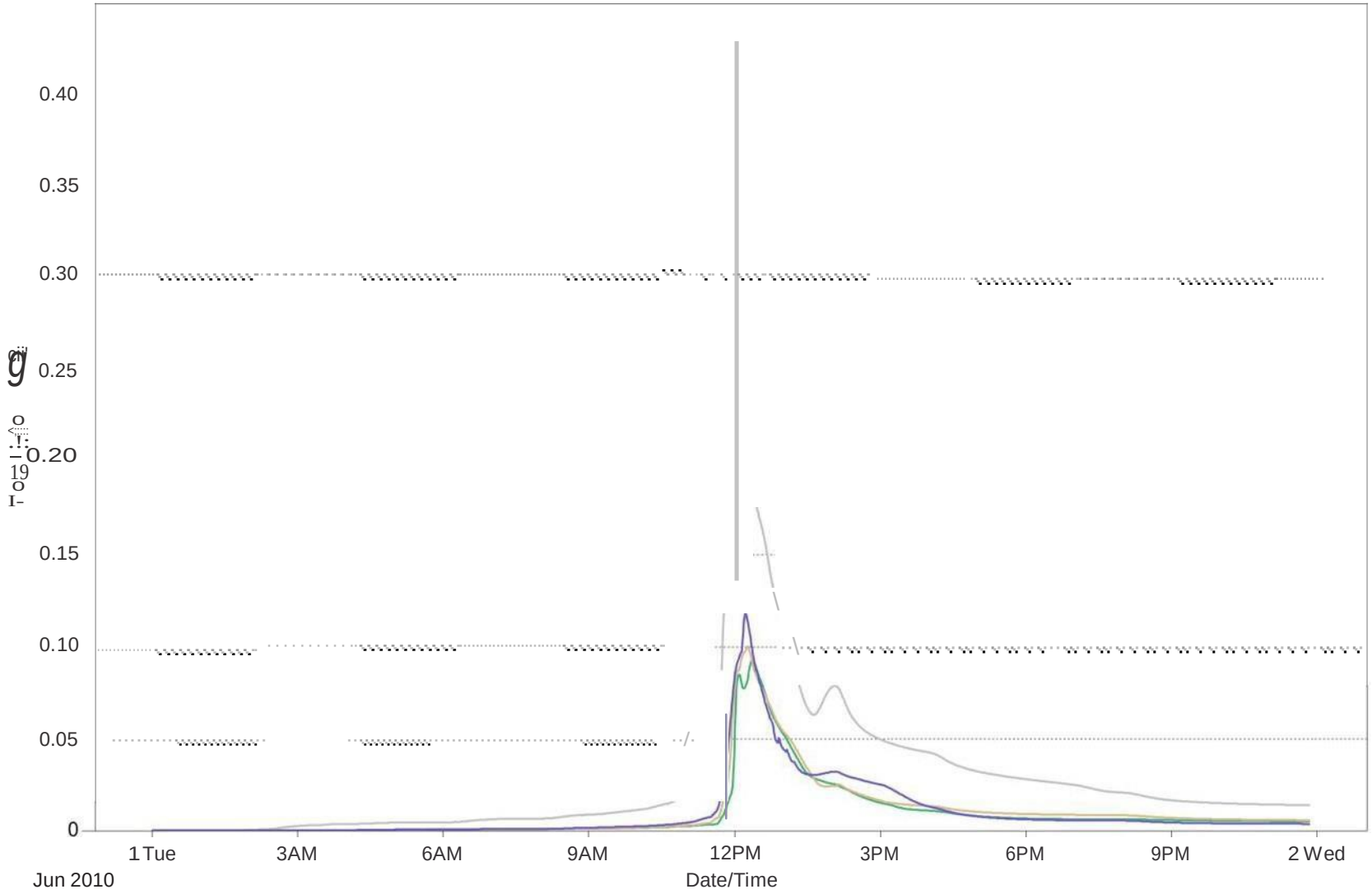
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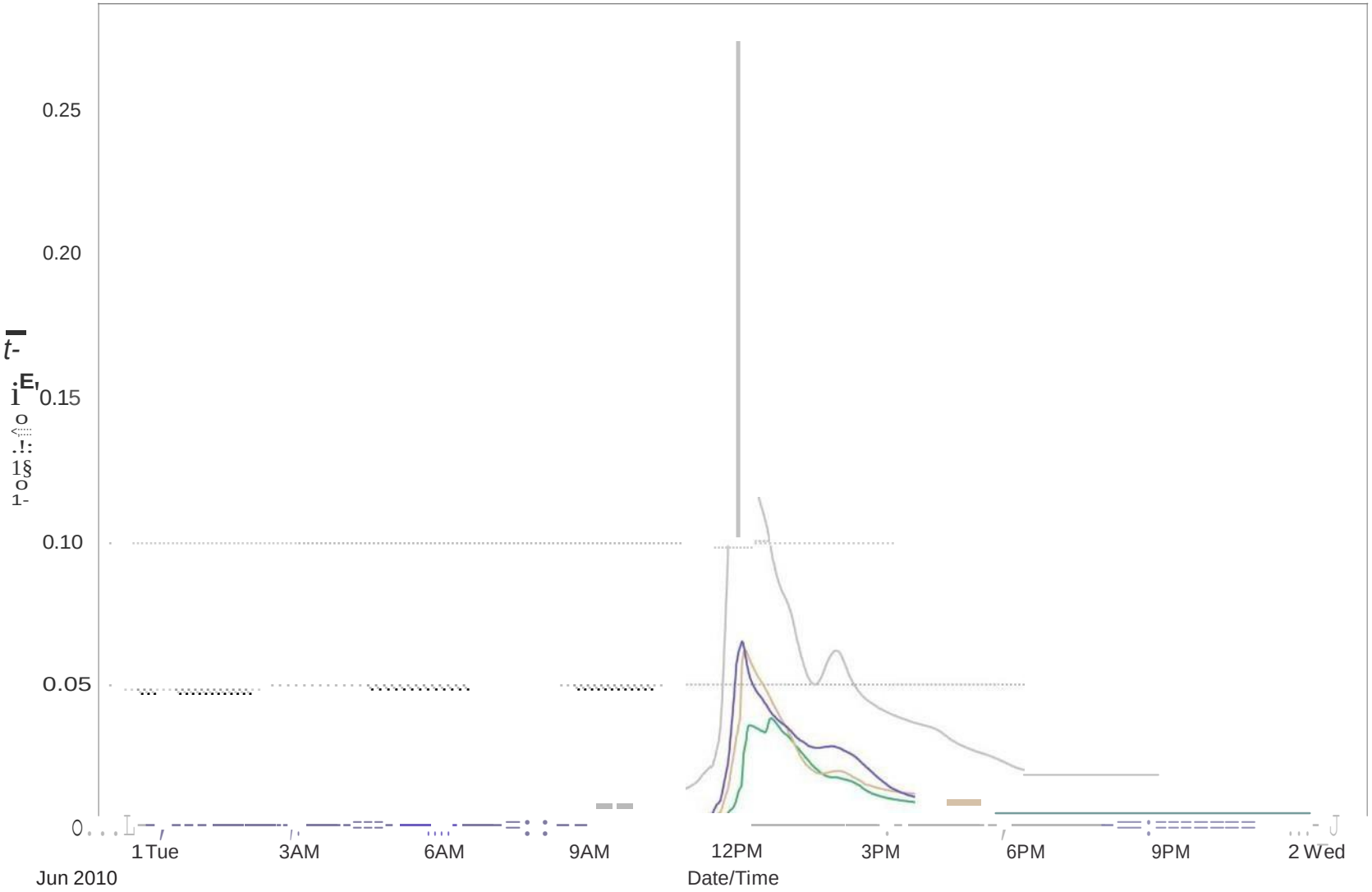
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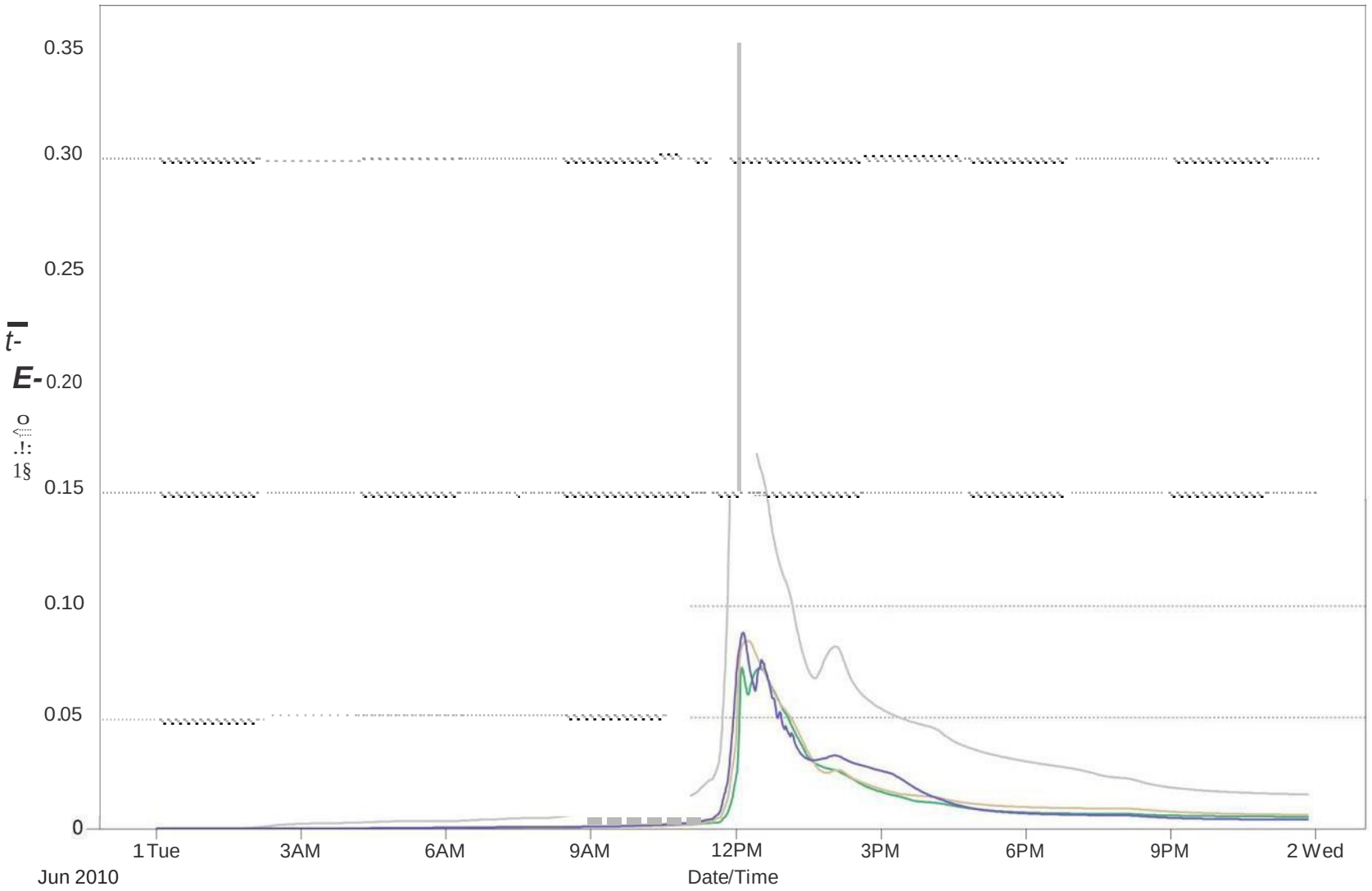
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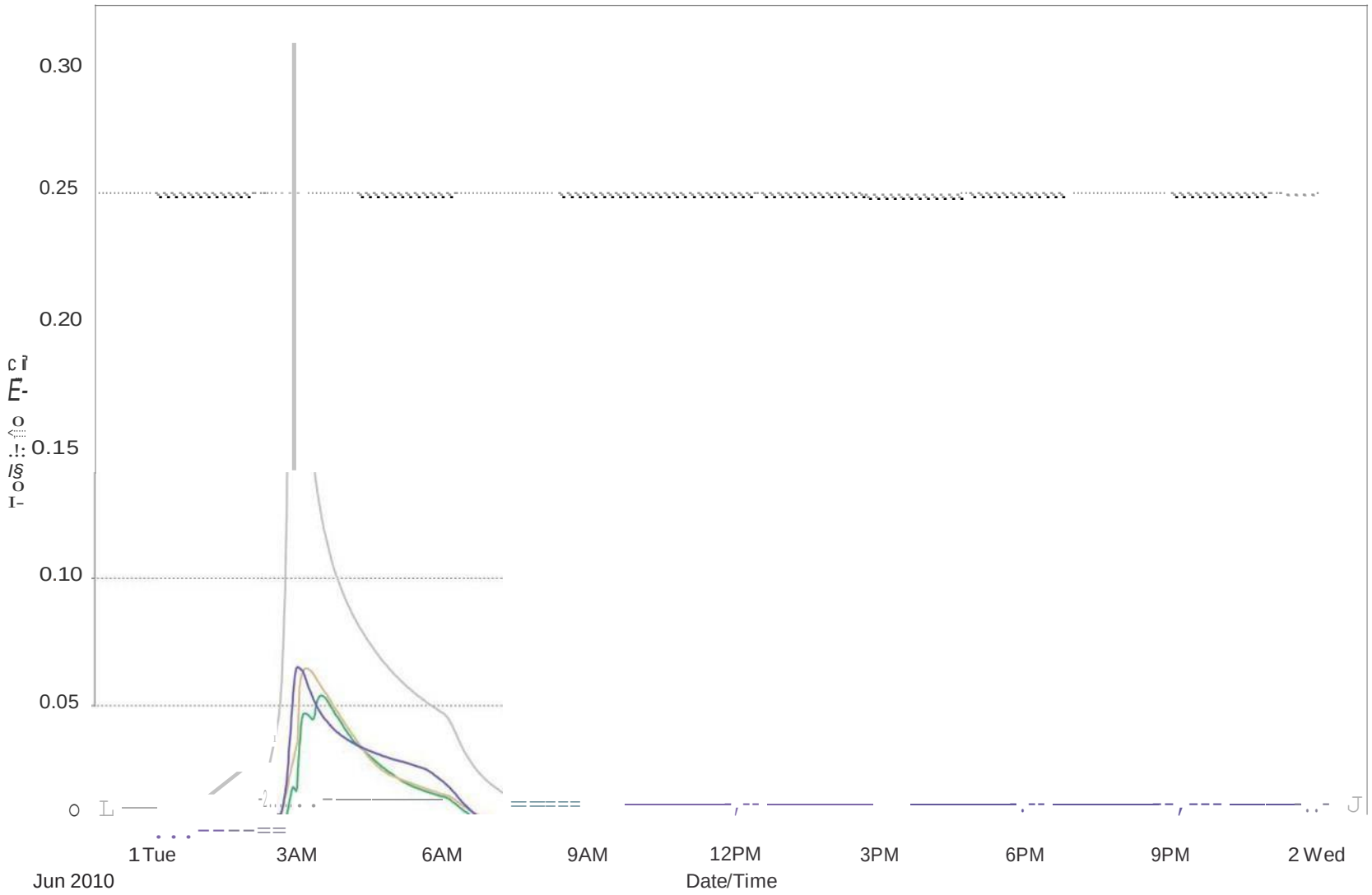
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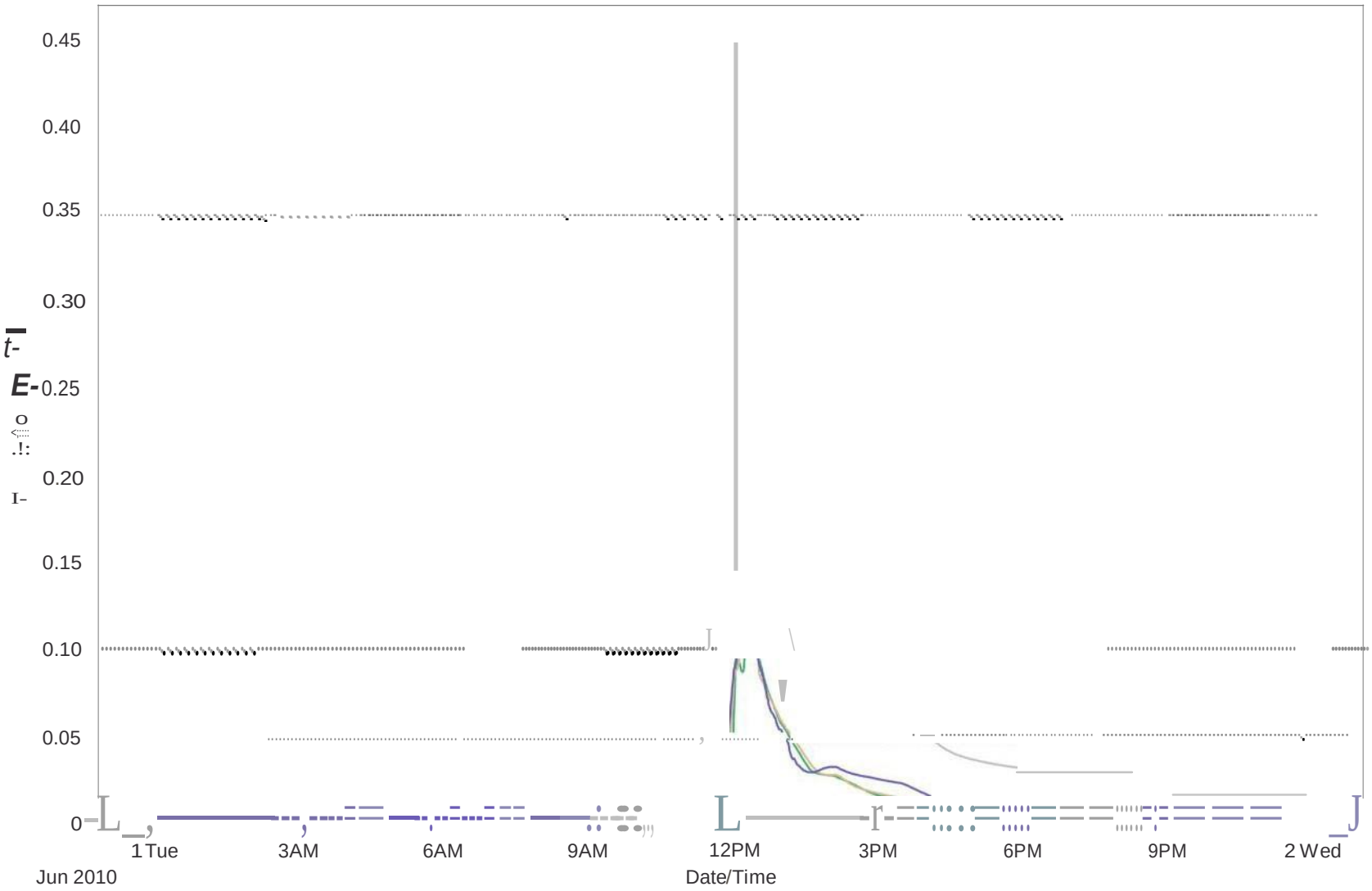
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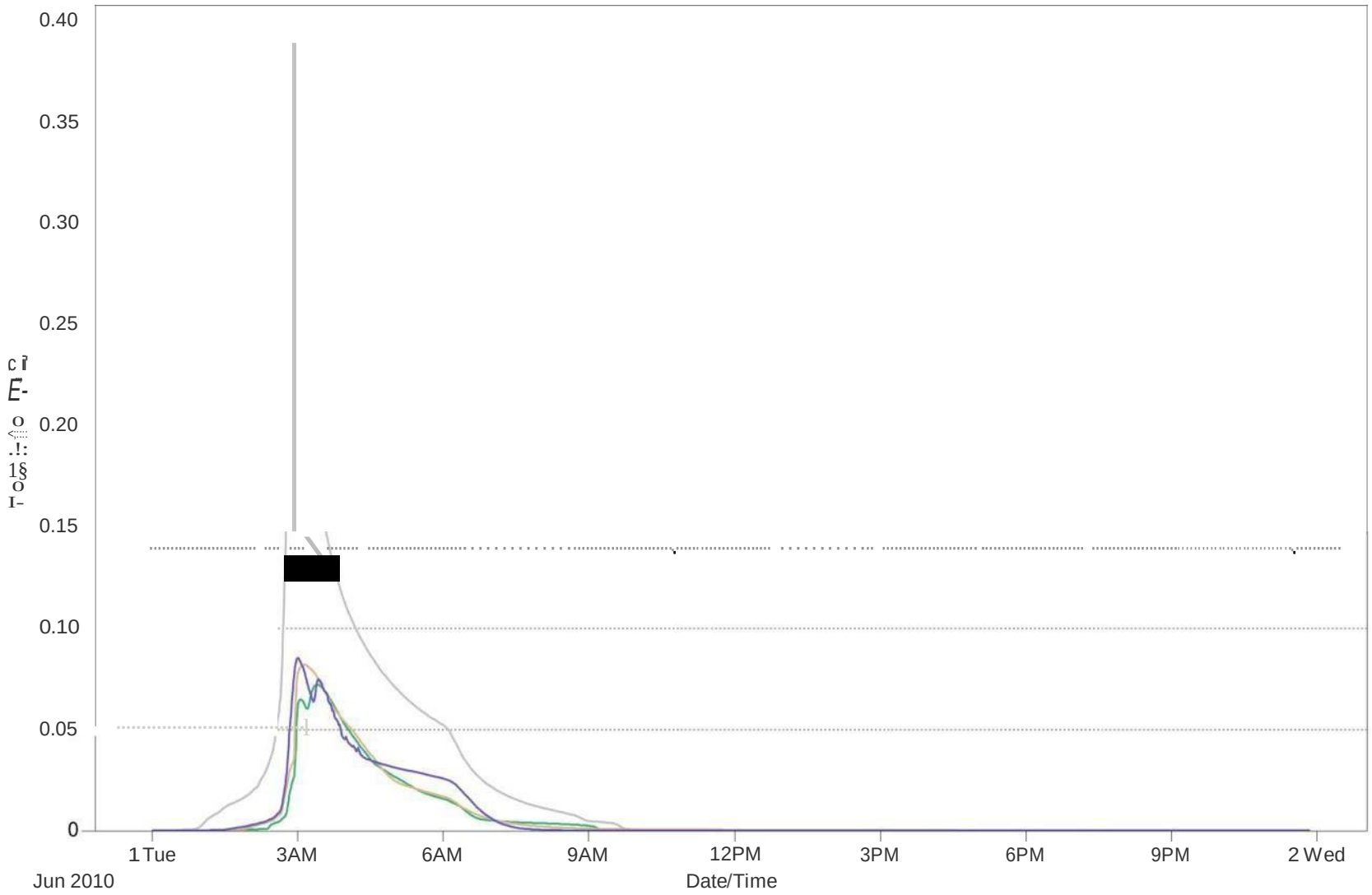
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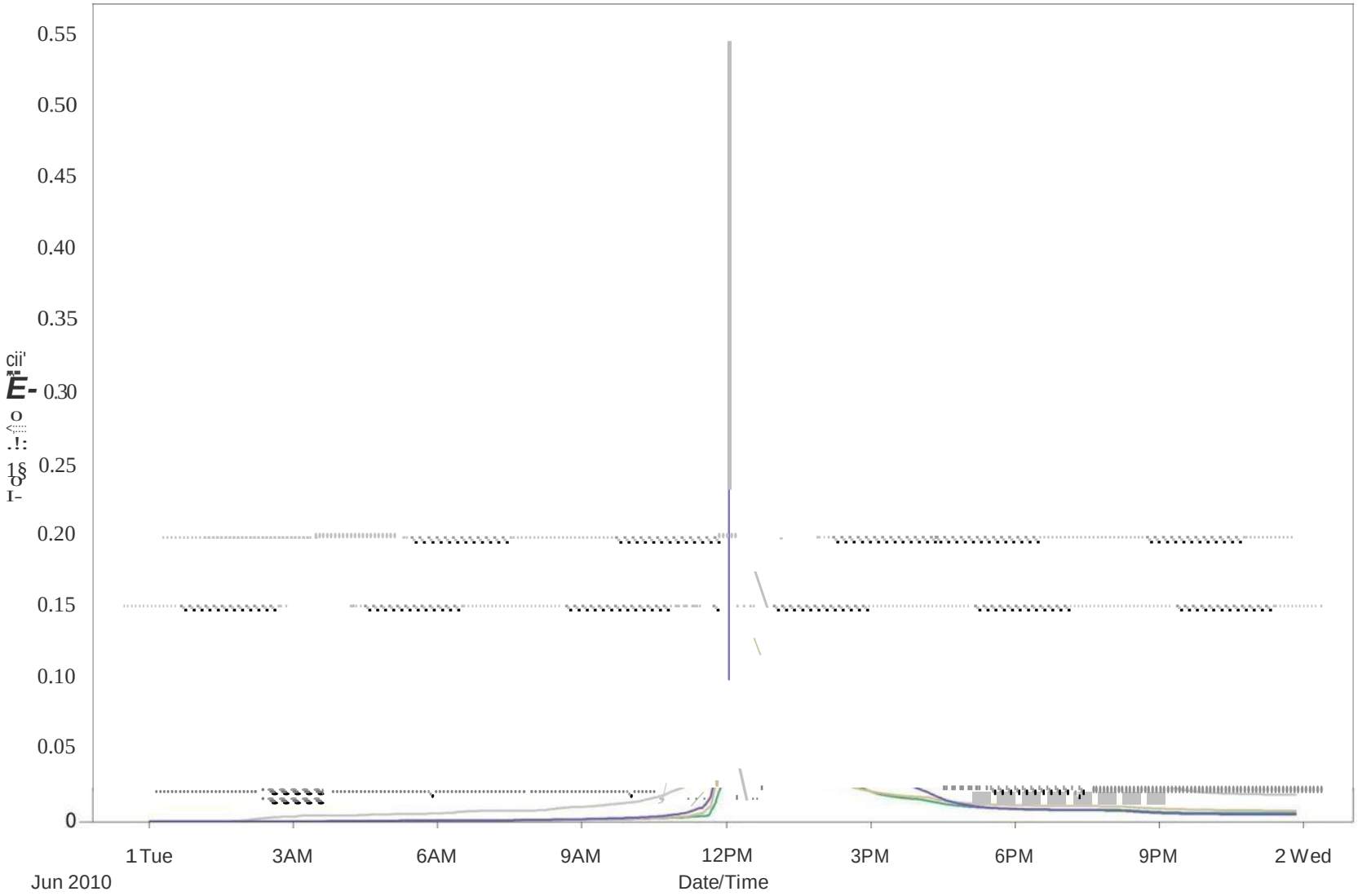
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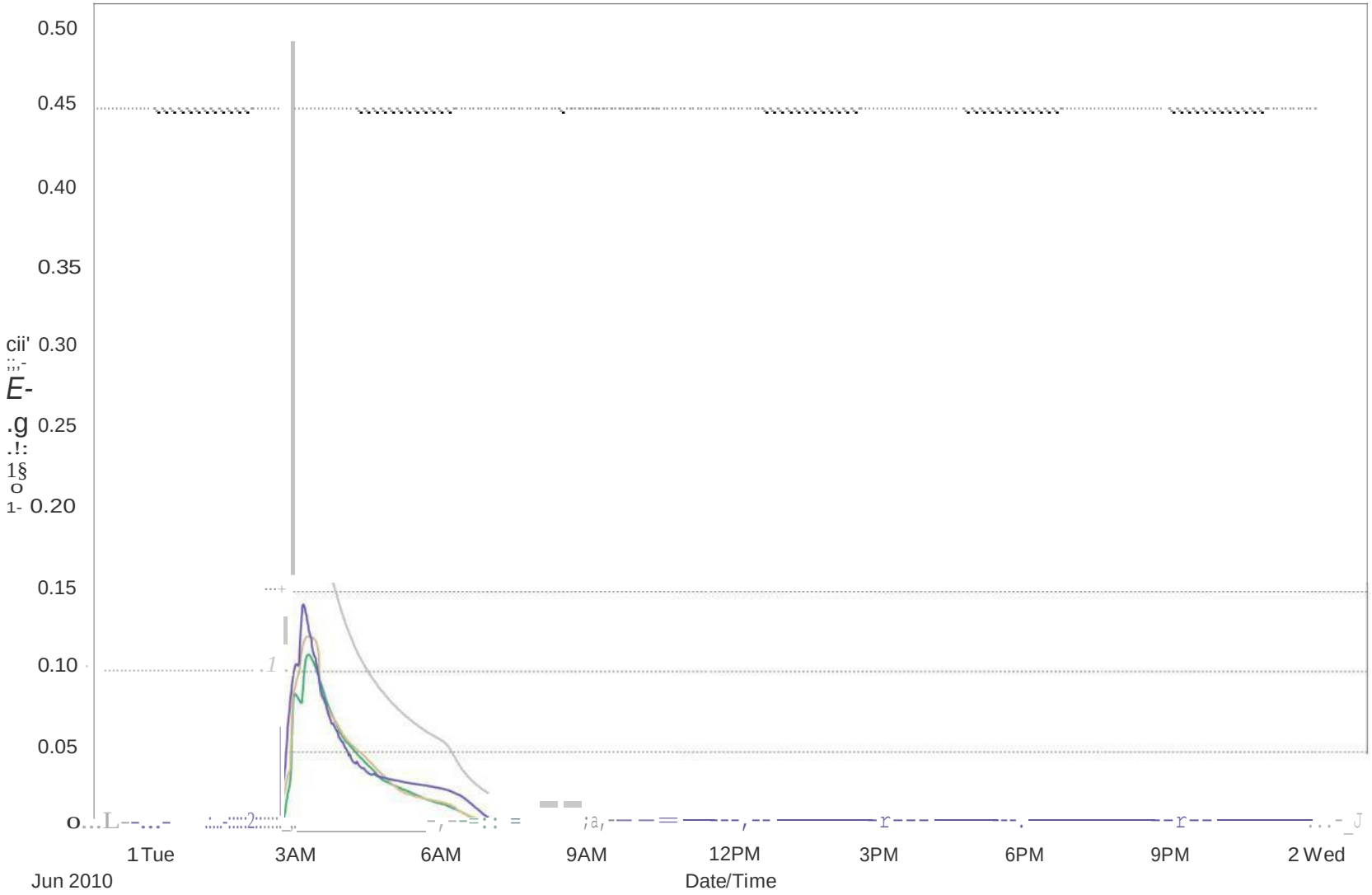
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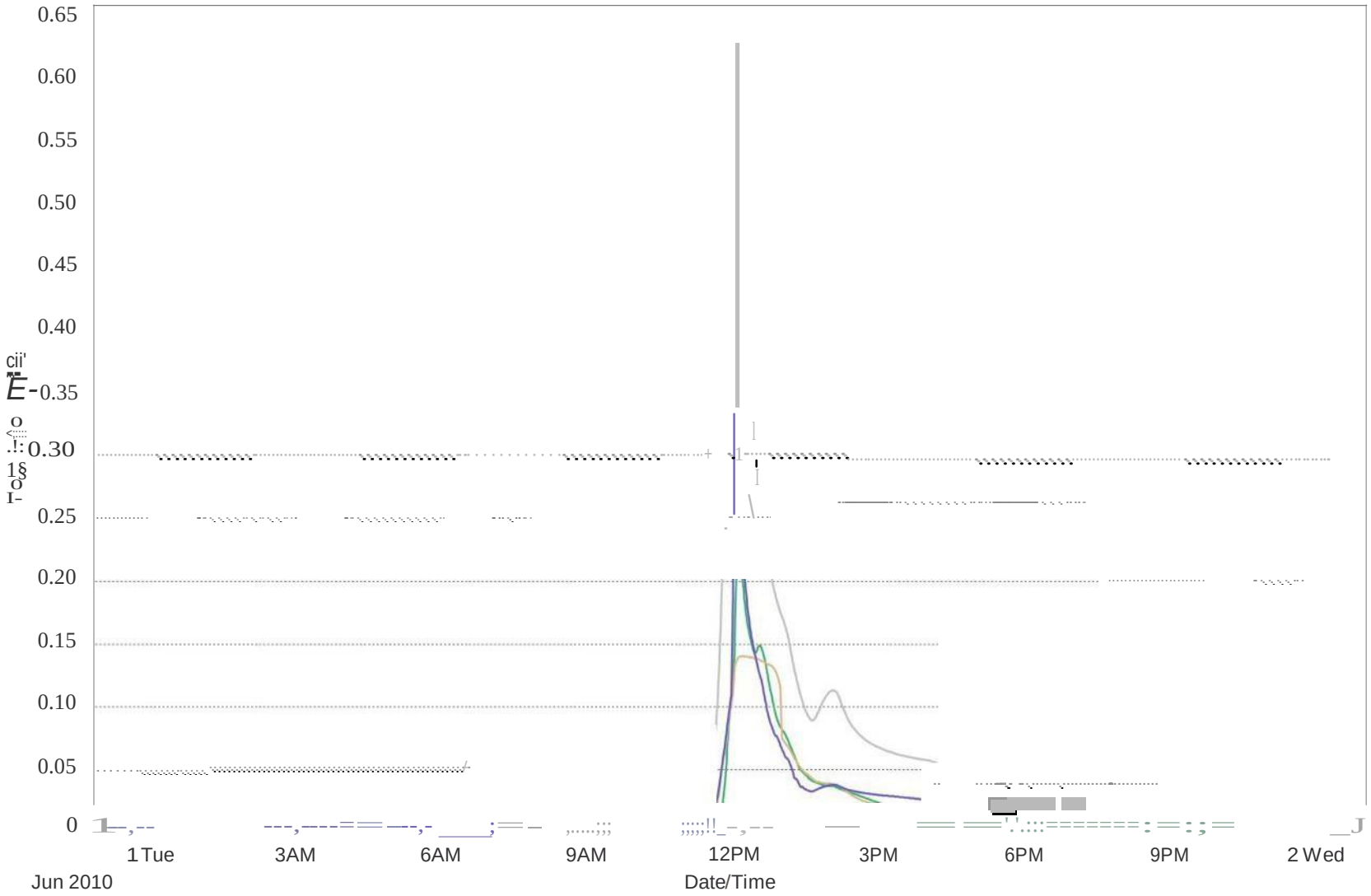
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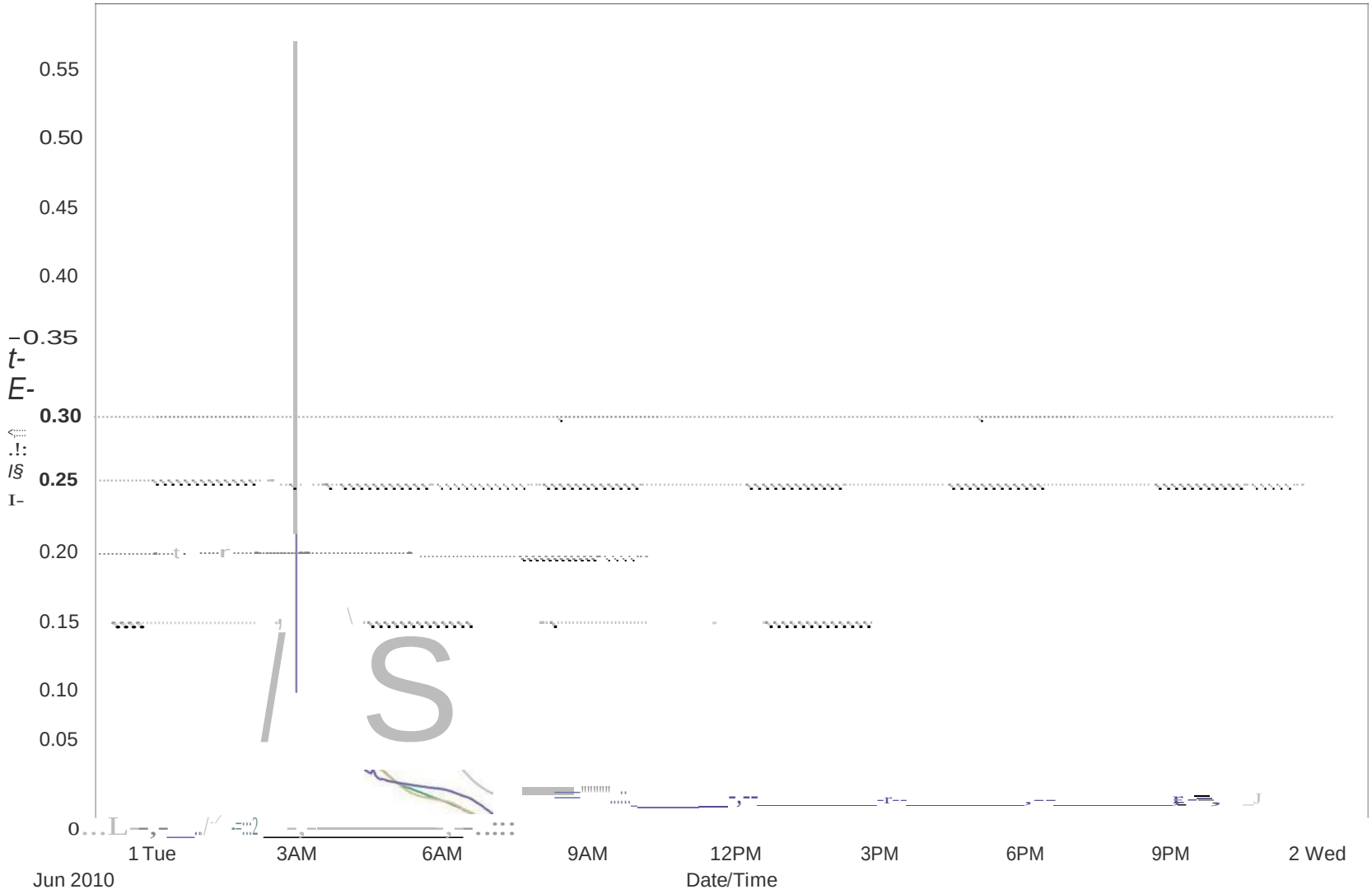
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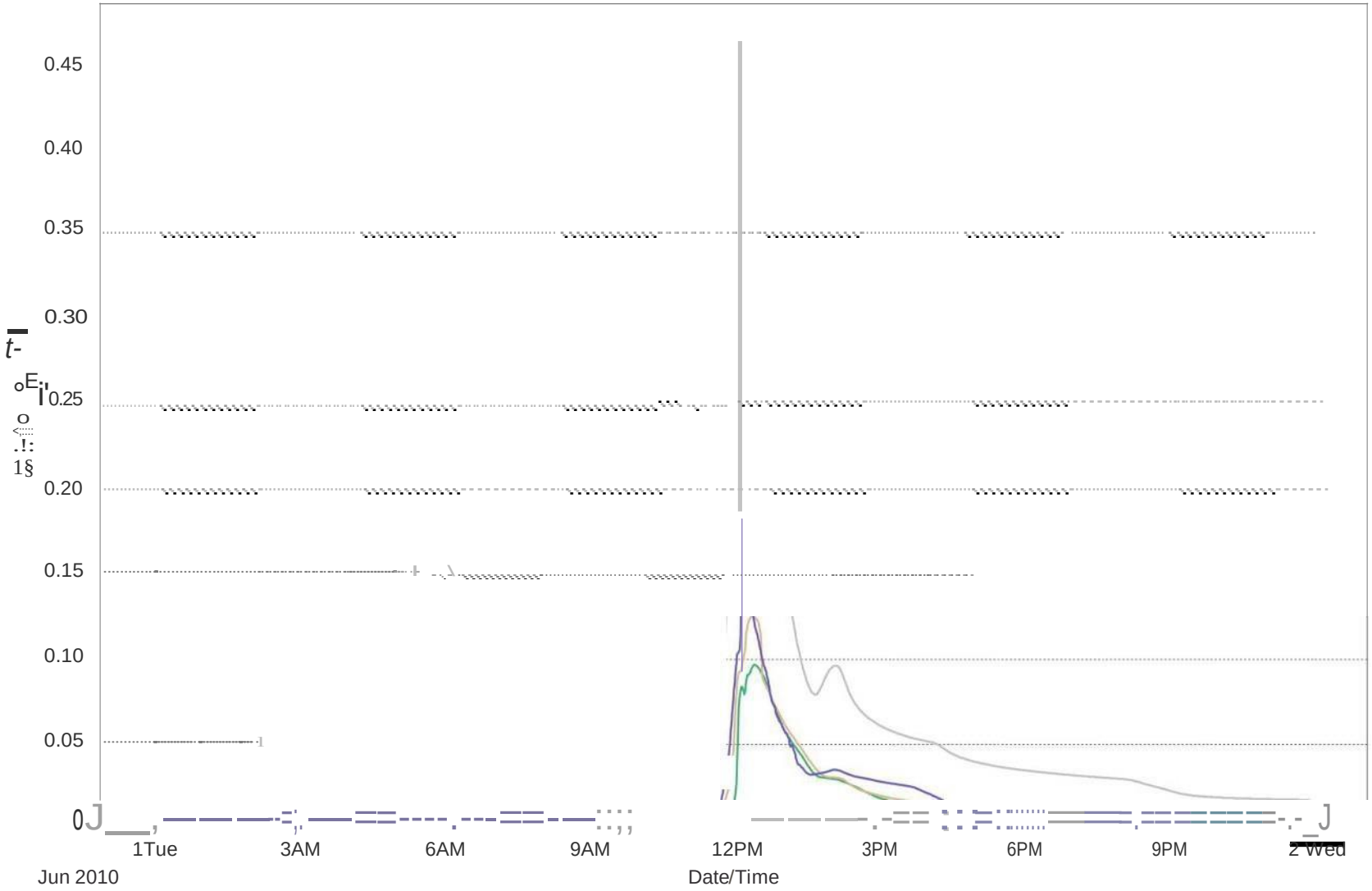
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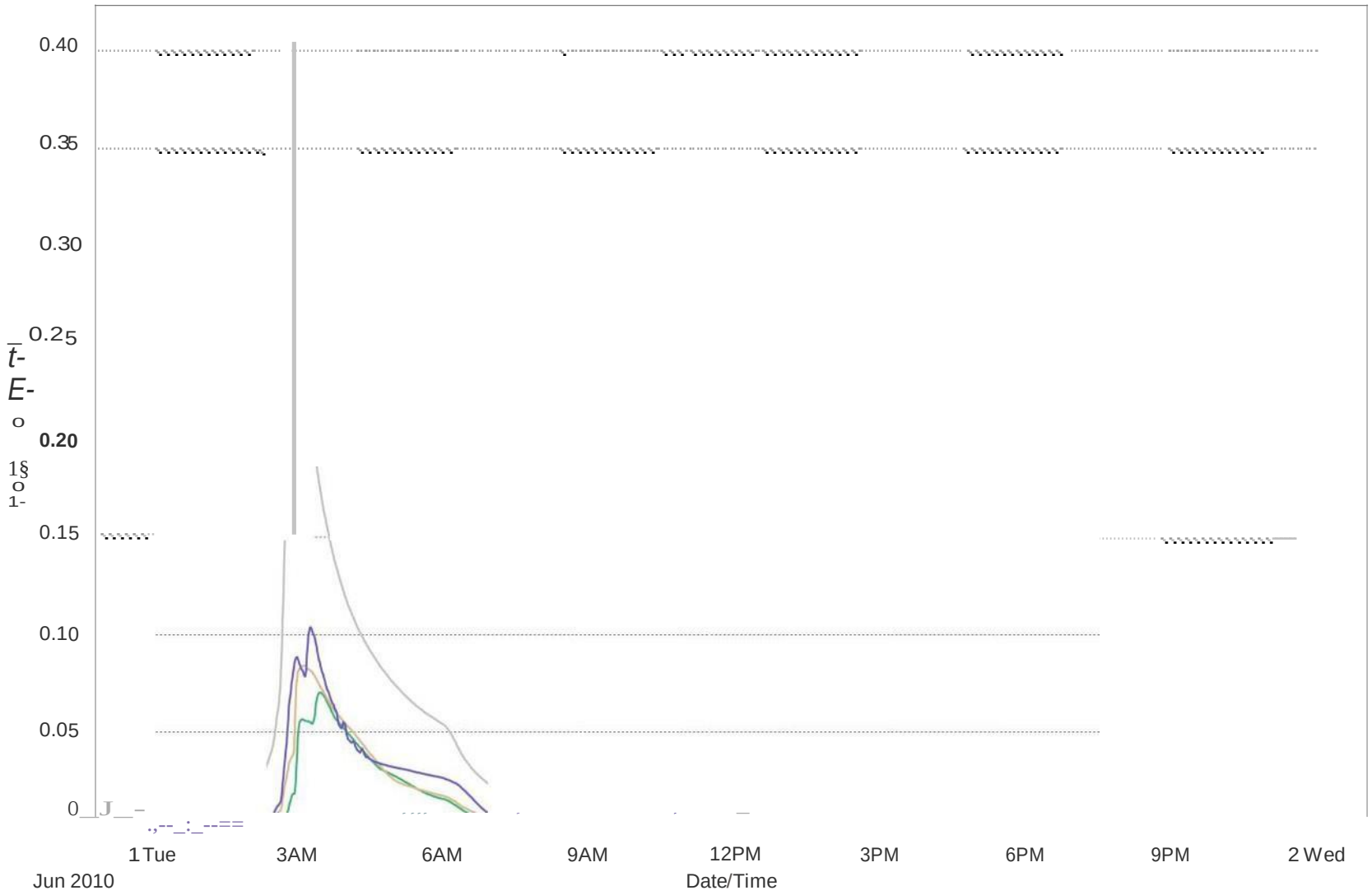
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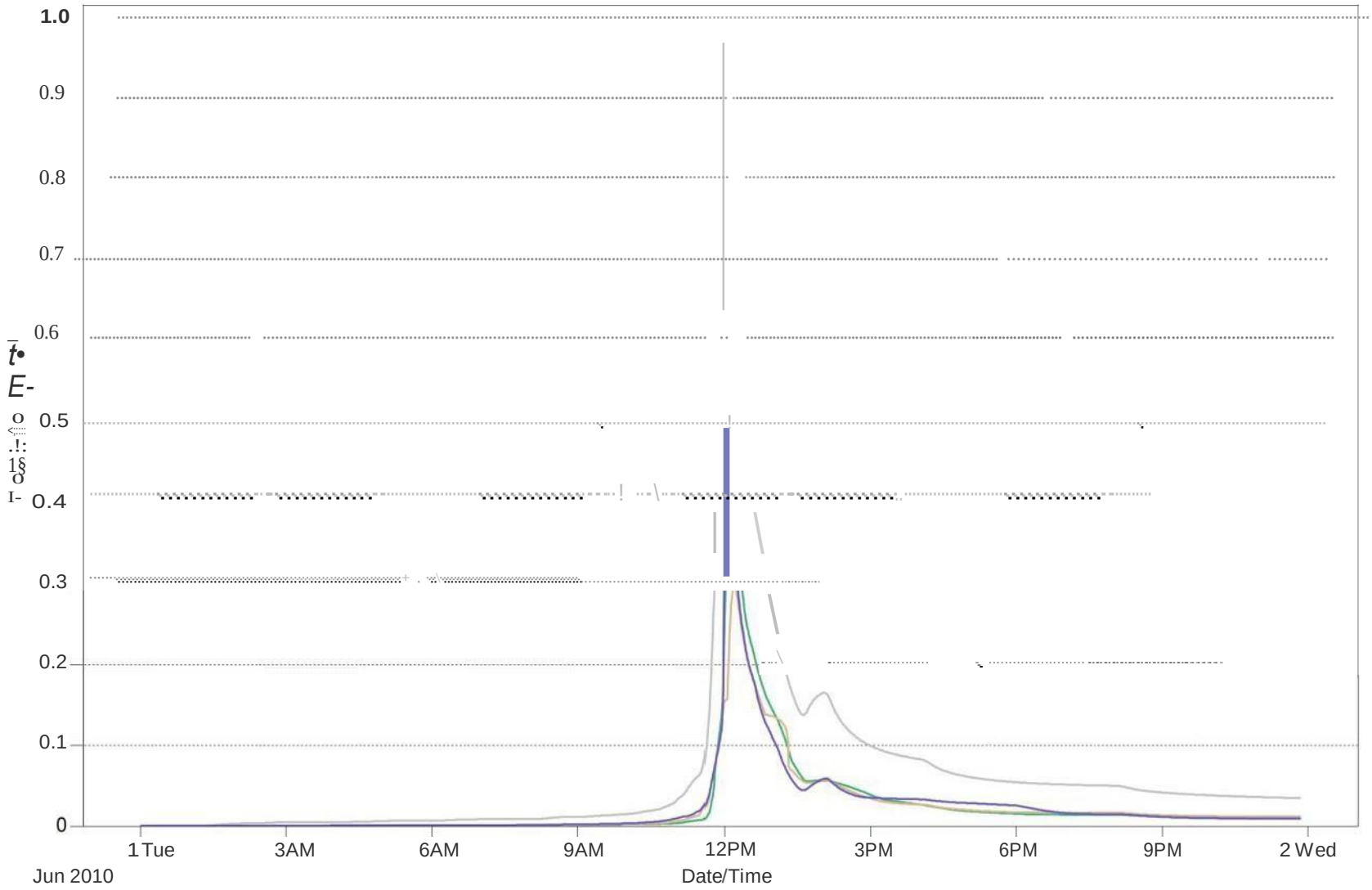
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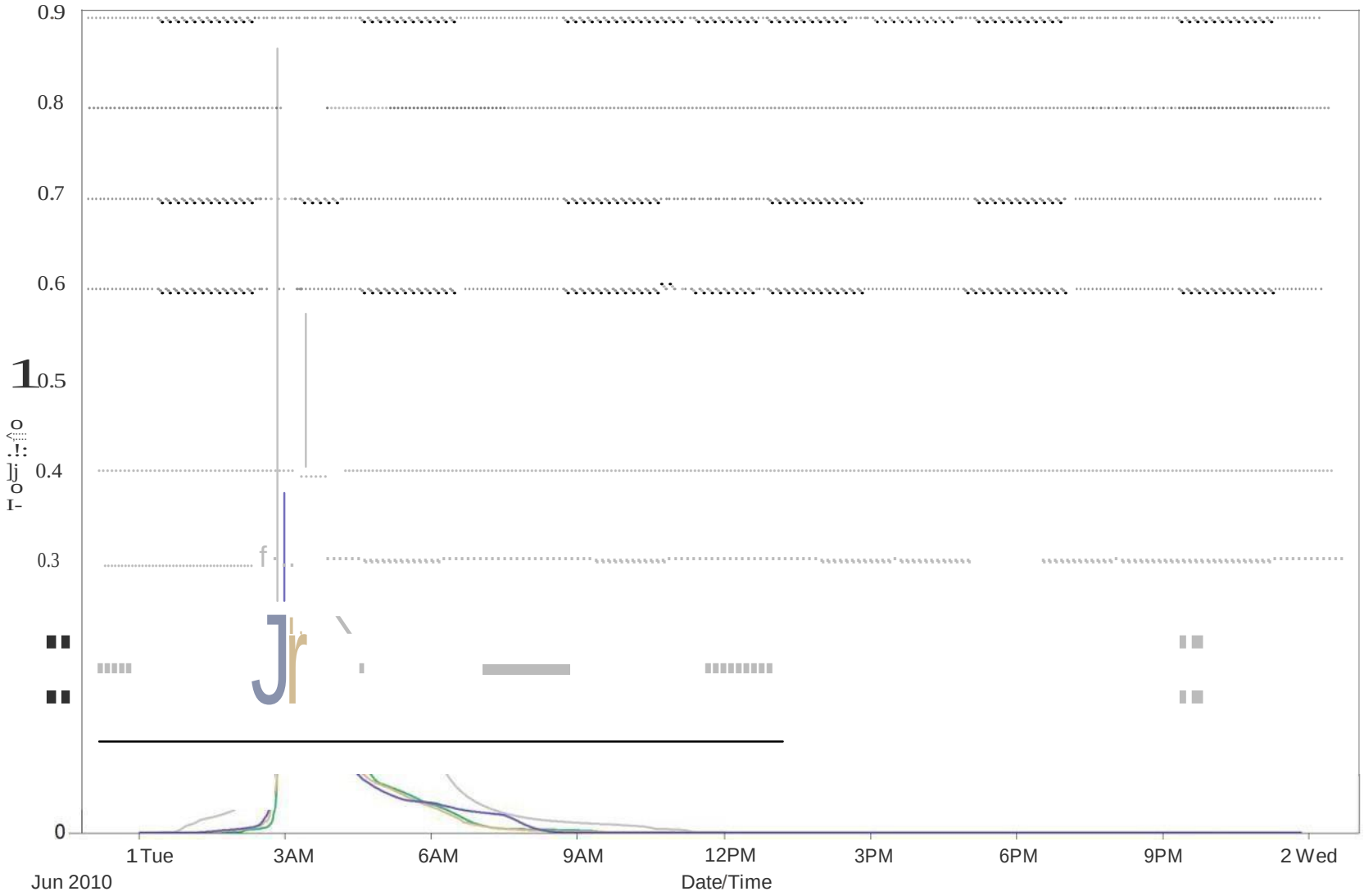
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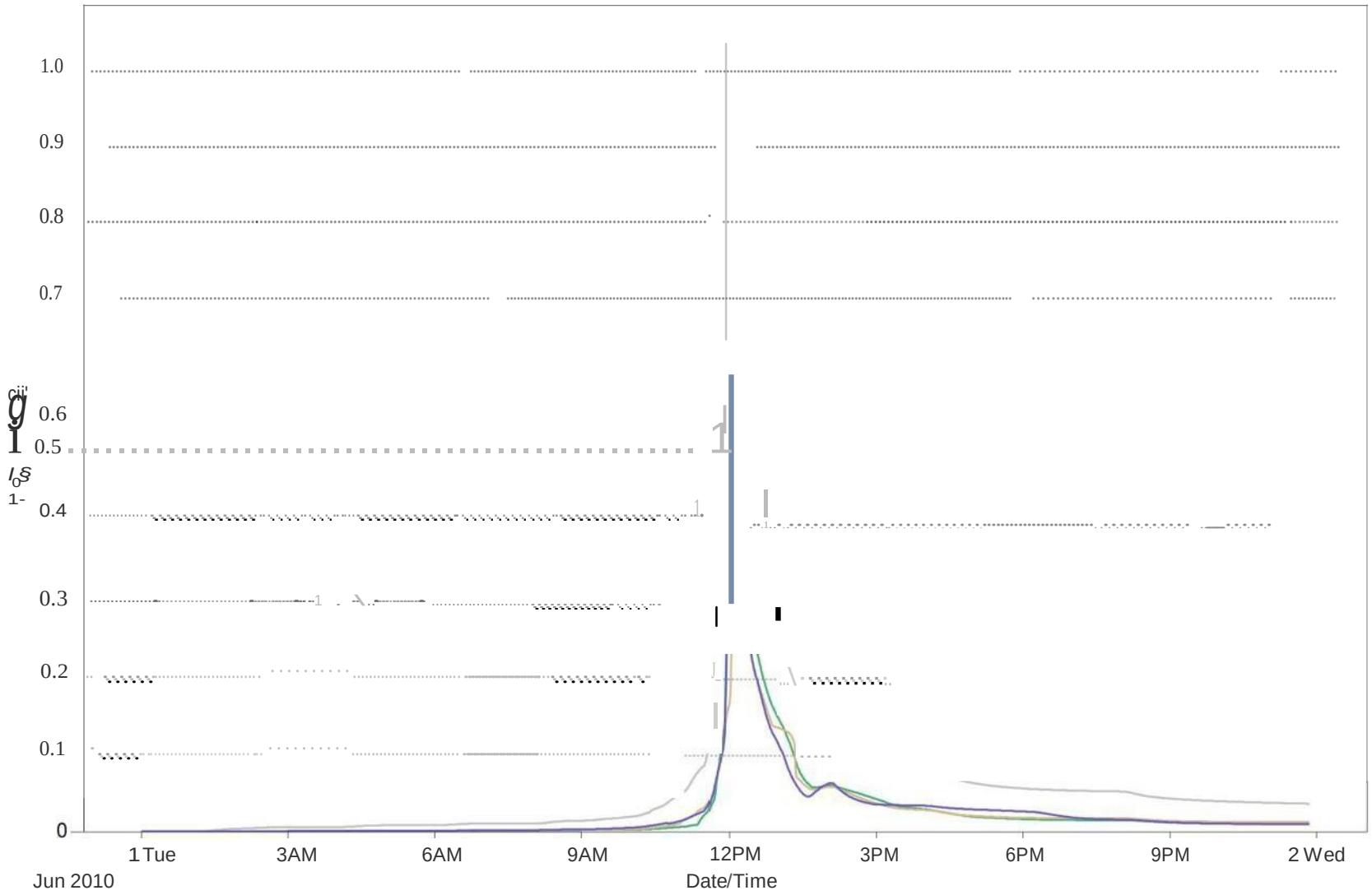
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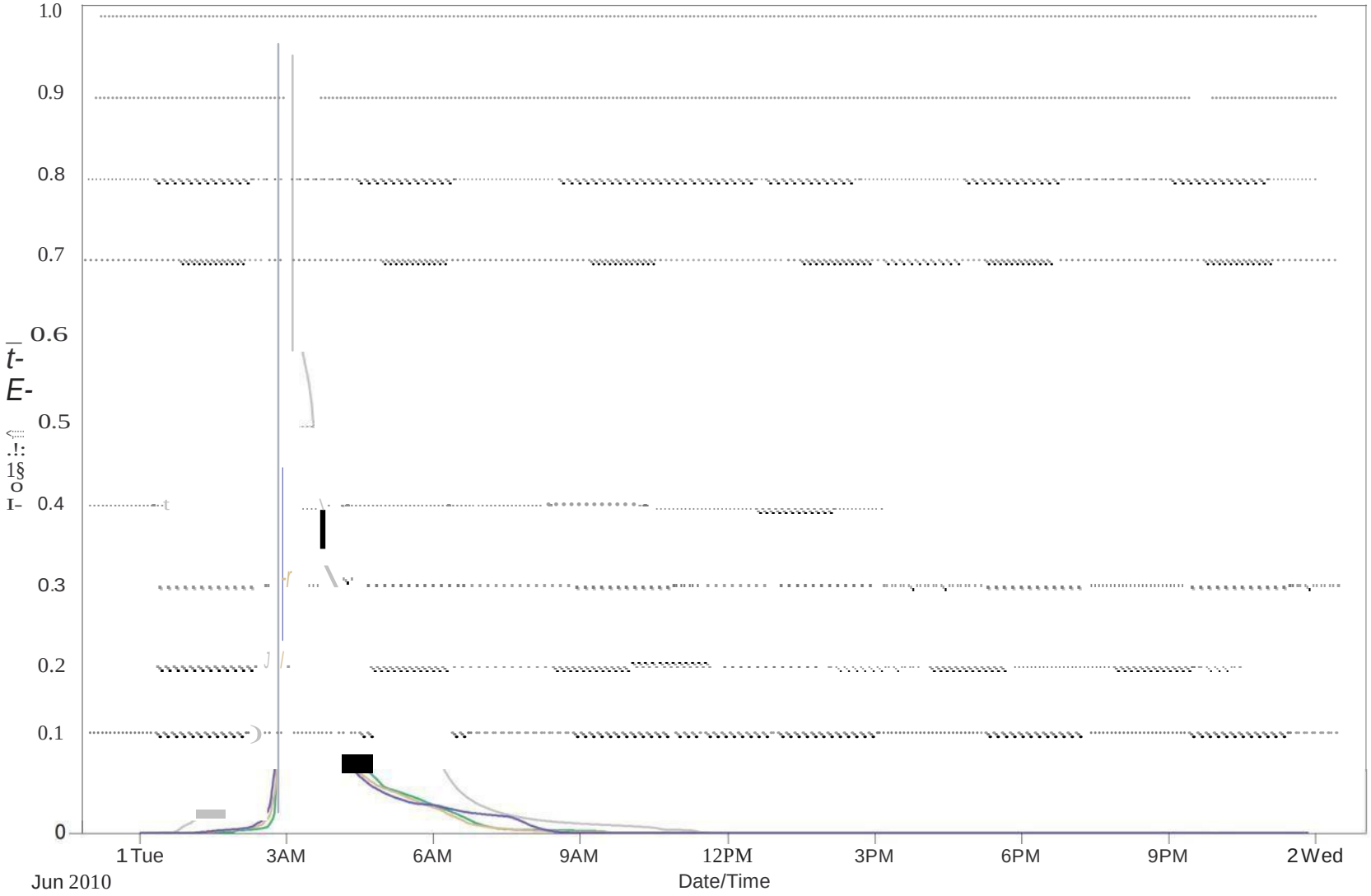
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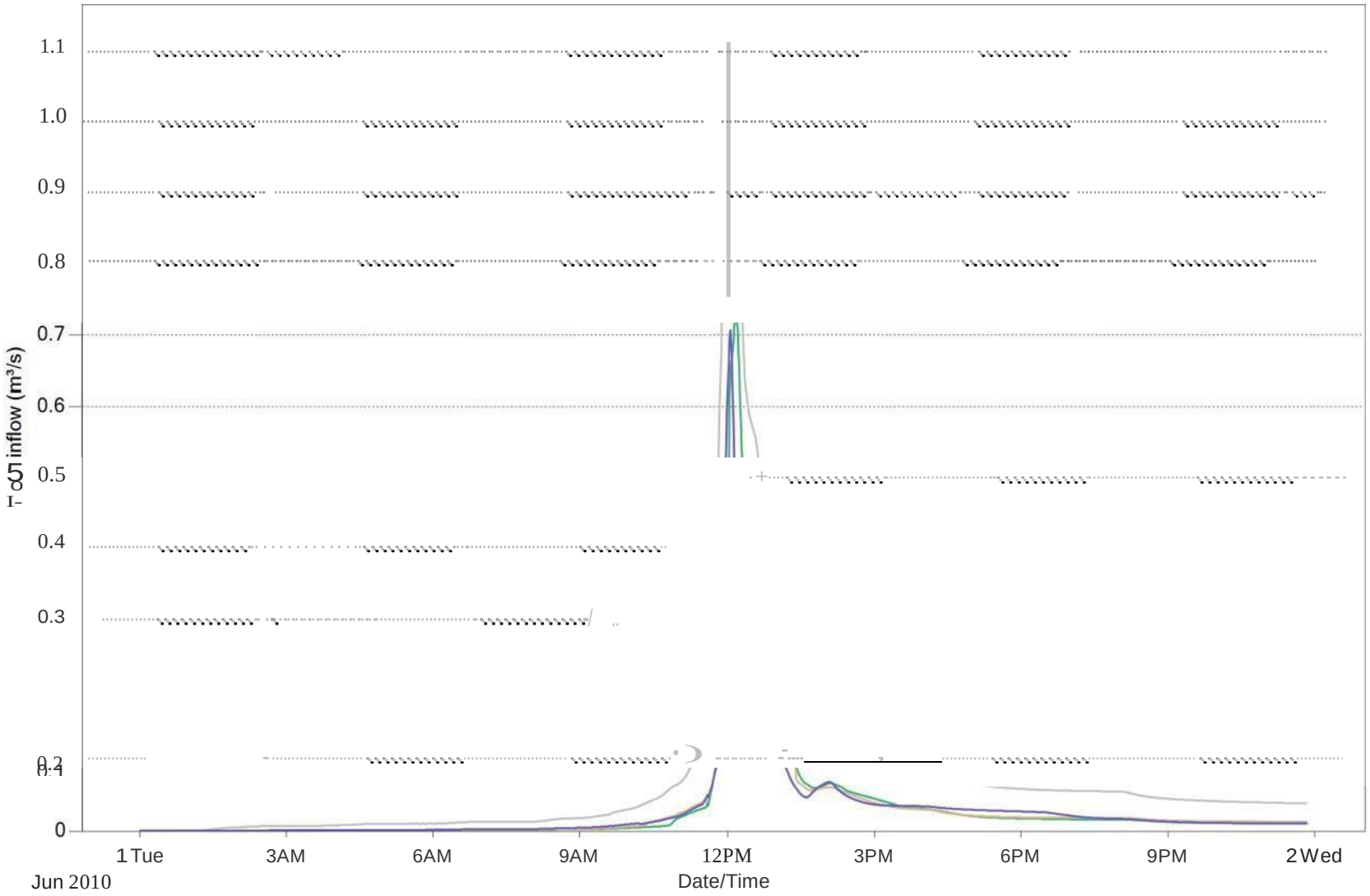
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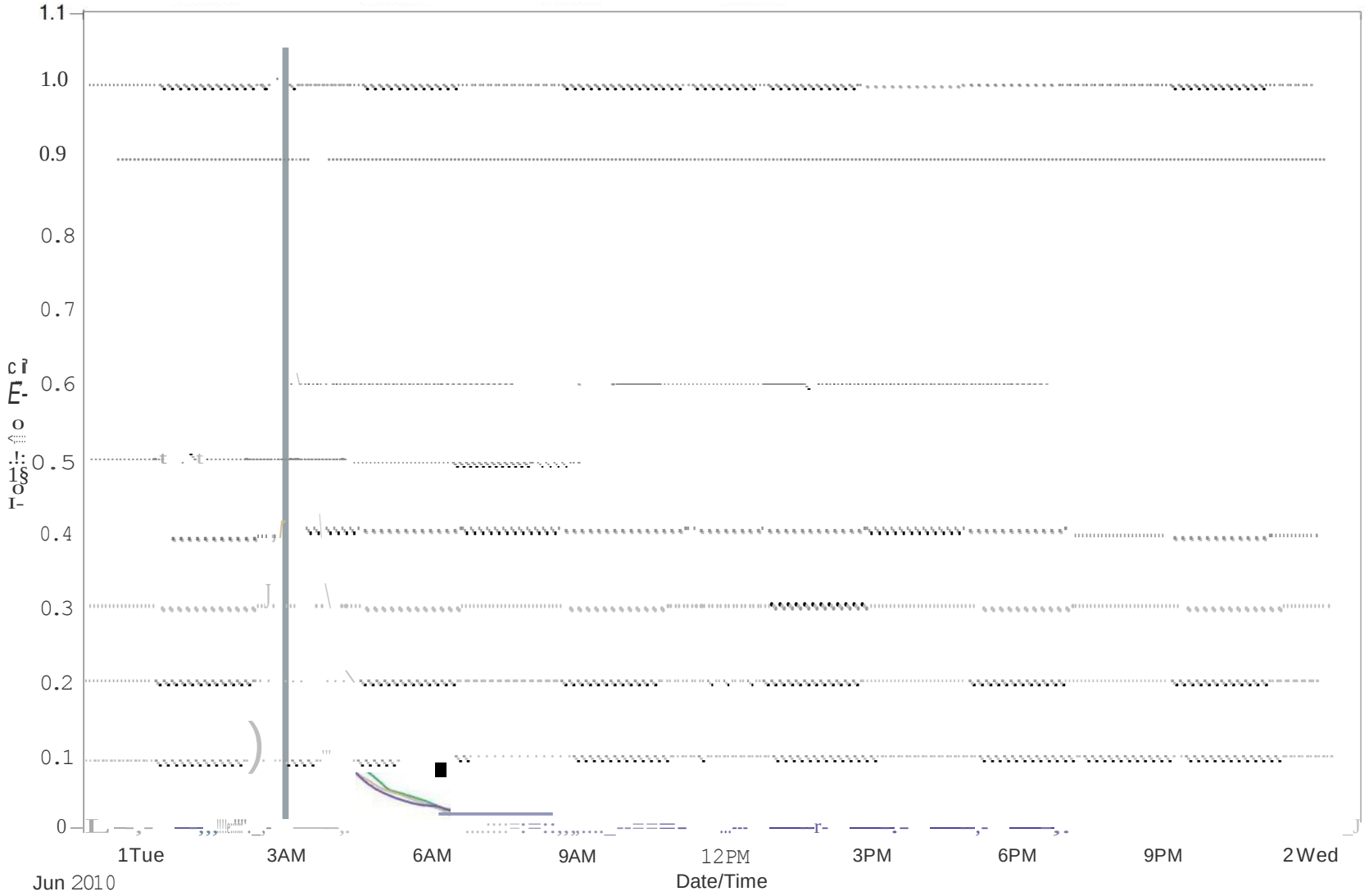
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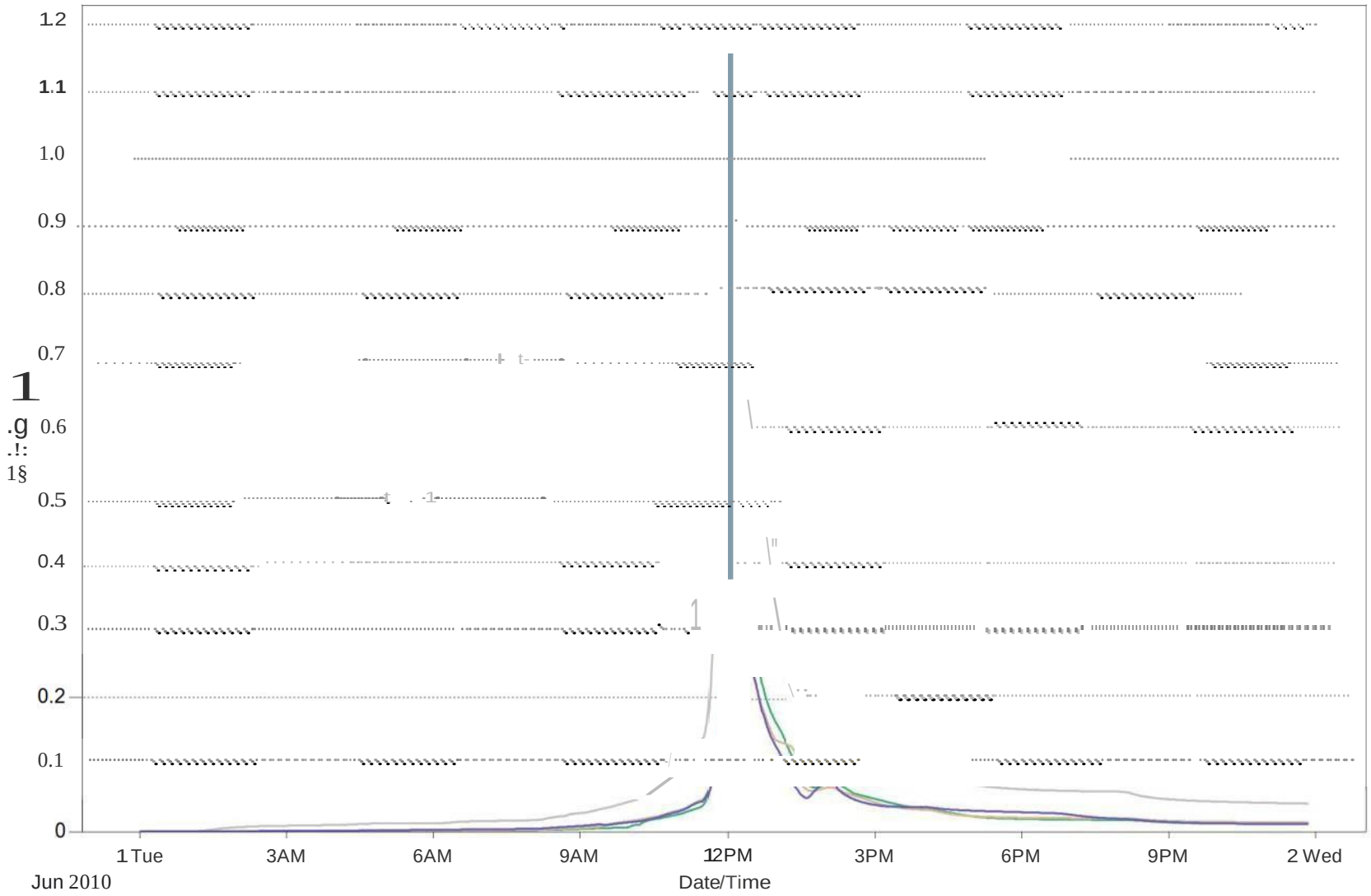
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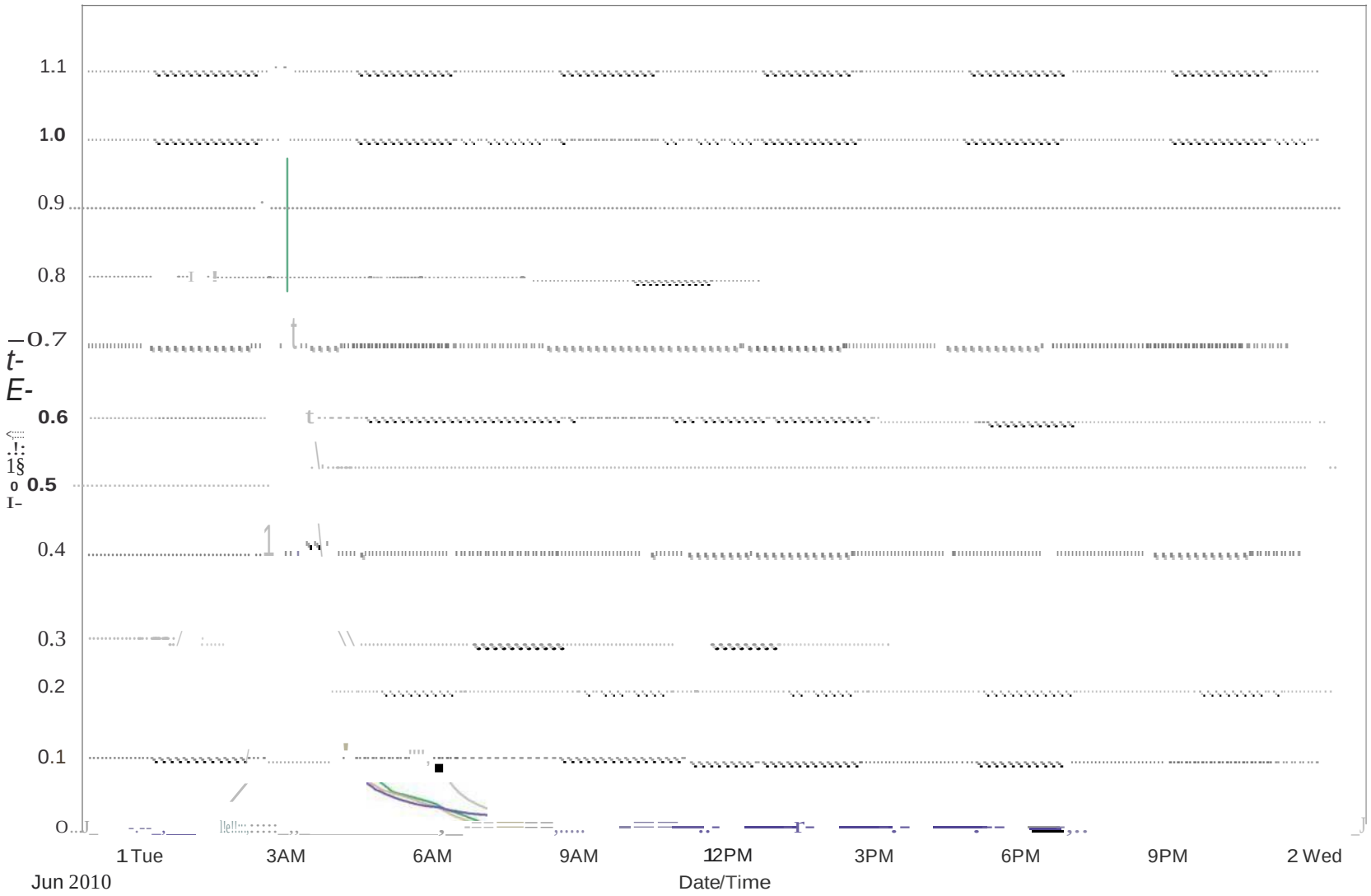
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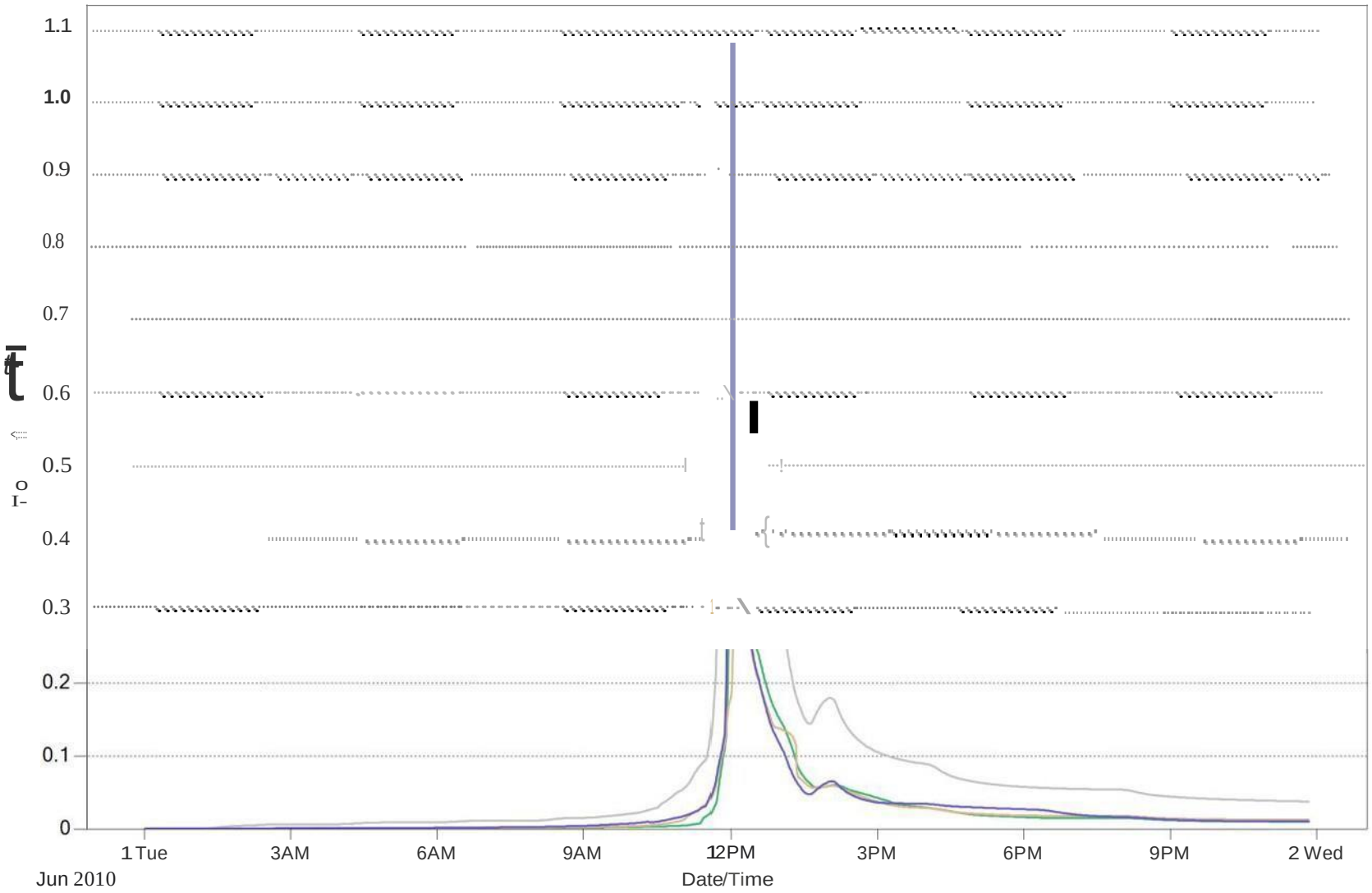
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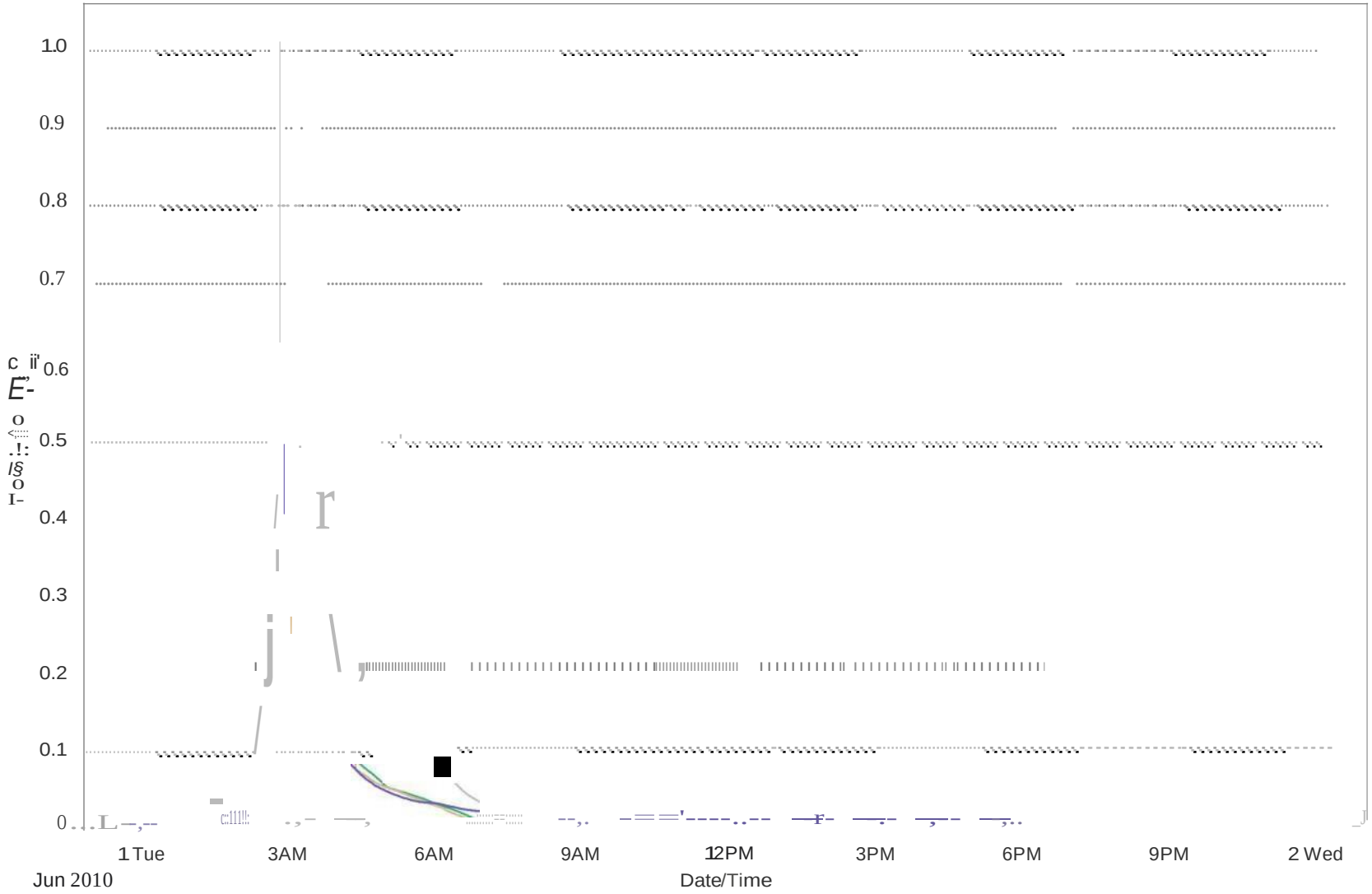
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APPENDIX B

RELATED INFORMATION

SITE PLAN CONTROL BY-LAW

THE CORPORATION OF THE CITY OF MISSISSAUGA

BY-LAW NO. 0293-2006

NOTE:

This is an "OFFICE CONSOLIDATION" of By-law No. 0293-2006. City of Mississauga Site Plan Control By-law, approved by City Council 2006 July 05. and came into force and effect, 2006 July 05, and incorporating all amendments made to the said By-law.

For accurate reference, the "ORIGINAL" individual By-laws should be consulted. Copies of "ORIGINAL" By-laws are available at the Corporate Services Department, Office of the City Clerk (3rd Floor Facade, City Hall), Copies of the "OFFICE CONSOLIDATION" are available from the Planning and Building Department, Strategic Planning and Business Services Division (3rd Floor, West Wing, City Hall).

The number in bracket and italic, eg. *(1234-2006)*, at the end of a section, subsection, paragraph, subparagraph, etc., is the number of the By-law amending By-law No. 0293-2006 that implemented or amended that section, subsection, paragraph, subparagraph, etc.

Date of updates to the "Office Consolidation" and latest By-law in force:

Amending By-law No.	Amends	Enacted and Passed	In Force
0060-1007	Section 5(l)	Feb 28 2007	Feb 28 2007
0162-2007	Section 5(a)	Apr 25 2007	Apr 25 2007
0238-2007	Repeals and Replaces Sections 4(c), (d), 5(a),(b),(d),(e),(h),(m) Adds Section 5(o)	Jun 20 2007	Jun 20 2007

SITE PLAN CONTROL BY-LAW

THE CORPORATION OF THE CITY OF MISSISSAUGA

BY-LAW NO. 0293-2006

A By-law to provide for Site Plan Control in the City of Mississauga
and to repeal By-law 1127-85, as amended, and By-law 314-89.

WHEREAS section 41 of the *Planning Ac/,* R.S.O. 1990, c. P 13, as amended, permits the Council of a municipality to designate the whole or any part of the municipality as a Site Plan Control Area, where in the Official Plan the area is shown or described as a proposed Site Plan Control Area;

AND WHEREAS section 5.3.6 of the Official Plan for the City of Mississauga (Mississauga Plan) designates all lands in the City of Mississauga as a Site Plan Control Area;

AND WHEREAS subsection 41 (11) of the *Planning Ac/,* R.S.O 1990, c P.13, as amended, refers to section 427 of the *Municipal Acl 2001,* S.O. 2001, c.25, as amended, which pennits a municipality to direct or require that a matter or thing be done at the person's expense and may recover the costs by action of doing said thing or matter from the person directed or required to do it;

NOW THEREFORE the Council of the Corporation of the City of Mississauga ENACTS as follows:

1. For the purposes of this By-law:

   (a) "CITY" means the Corporation of the City of Mississauga;

   (b) "COMMISSIONER" means the Commissioner of the Planning and Building Department, including his or her designate as identified by the Commissioner in writing from time lo time;

   (c) "COUNCIL" means the Council of The Corporation of the City of Mississauga;

   (d) "DEVELOPMENT" has the same meaning as in subsection 41(1) of the *Planning Act,* R.S.O. 1990, c.P.13, as amended;

   (e) "OWNER" means any owner ofland as identified in the records of the proper Land Registry Office or Land Titles Office and includes a purchaser under a valid Agreement of Purchase and Sale, and the authorized agent of any such purchaser or owner of land;

   (f) "REDEVELOPMENT" means the removal of buildings or structures from land and the construction or erection of other buildings or structures thereon and "REDEVELOP" has a corresponding meaning;

   (g) "SITE PLAN" means those plans and/or drawings as contemplated by subsection 41 (4) of the *Planning Act,* R.S O 1990, c P.13 , as amended;

   (h) "SITE PLAN UNDERTAKING" means an agreement as contemplated by subsection 41 (7)(c) of the *Planning Act,* R.S 0. 1990, c P.13, as amended, regarding matters pertaining to the development or redevelopment of a property subject to site plan control, and which may appear in the form of a document called a Site Plan Undertaking or as a Site Plan Development Agreement, as approved by the Commissioner, and signed by both tl1e owner and the Commissioner;

   (i) "SITE WORKS" means all of those requirements made by the Commissioner as identified on a site plan for land which is to be developed or redeveloped, drawn to a suitable scale and showing thereon the following:

      (i) the location, size and design of all matters provided forunder subsections 41(4), (7) and (8) of the *Planning Ac/,* R.S.O. 1990, c.P.13, as amended;

      (ii) the dimensions and area of land and the boundary lines of all lots that comprise the land, certified by or taken from a drawing prepared by an Ontario Land Surveyor;

      (iii) buildings and structures which are to remain on the land and all setback measurements related thereto;

      (iv) landscaping works, including location, size and description of all hedges, trees, shmbs and other landscaping, and detailed tree replacement and tree planting infonnation; and,

      (v) such other data as may be required by the Commissioner consistent with the provisions of the *Planning Act,* R.S.O. 1990, c.P.13, as amended .

2. All the lands within the municipal boundaries ofthe City are hereby designated as a Site Plan Control Area, and no person shall undertake development on the lands without the approval of a site plan by Council

3. Council hereby delegales 10 lhe Commissioner the power; and aulhority conferred upon lhe Counci I under sec1ion 41 of the *Planning Act*, R.S.O. 1990, c.P 13, as amended, except the authority lo define any class of or classes of development that may be undertaken without the approval of a site plan.

4. Section 2 of this By-law shall not apply to the following classes of development

(a) Detached dwellings having direcl frontage on a public road;

(b) Semi-detached dwellings having direct frontage on a public road;

(c) Lands with an Employmenl zone; *(0238-2007)*

(d) All developmenl on lands zoned "RM5-45" and "RM5-46". *(0238-2007)*

5. Notwithslanding section 4 of this By-law, section 2 of this By-Jaw shall apply to the following classes of developmenl:

(a) All developmenl and redevelopment on lands zoned "Rl-29", "R2-32", "R2-33", "R2-35", "R3-54", "R3-60", "R4-14", "R4-57", "R9-l", "RM2-48", "U-4", "0-9", "D-6", "D-7", "C5-19"; *(0162-2007), (0238-2007)*

(b) All development or redevelopment on lands used for the office of a resident physician, dentisl, drugless practitioner or heallh professional in a detached dwelling; *(0238-2007)*

(c) All development or redevelopment on lands with the municipal address 1355 Aerowood Road;

(d) All buildings and structures on lands zoned "U"(Ulility) having a floor area greater lhan 10m^2;*(0238-2007)*

(e) All development or redevelopment on lands with an Employment zone which abut the roads shown on Schedules "l" and "2" attached to this By-Jaw; *(0238-2007)*

(f) All development or redevelopmenl on the lands shown on Schedule "3" attached to lhis By-law;

(g) All developmenl or redevelopmenl on the lands shown on Schedule "4" attached lo this By-law;

(h) All development or redevelopment on lands zoned for detached dwellings on the lands shown on Schedule "5" attached to this By-Jaw; *(0238-2007)*

(i) All developmenl or redevelopment on lhe lands shown on Schedule "6" attached lo this By-Jaw;

(j) All development or redevelopmenl on the lands shown on Schedule "7" (lands fronling, flanking and/or abutting Mississauga Road), attached to this By-Jaw;

(k) All development or redevelopment on the lands shown on Schedule "8" (the Port Credit Heritage Conservation District) attached to this By-law;

(l) All developmenl or redevelopment on the lands shown on Schedule "9" attached to this By-law;

(m) All development or redevelopment on lands zoned:

(i) Employment which are within 60 m of lands zoned residential and not otherwise subject to site plan control through other sections of this By-law; *(0238-2007)*

(ii) Employment which abul lands zoned greenbelt, open space and parkway belt ; *(0238-2007)*

(iii) "D" (Developmenl) which are used for a non-residenlial use; and *(0238-2007)*

(iv) "RM7", wilh the exceplion of delached and semi-delached dwellings; *(0238-2007)*

(n) All development or redevelopment of the lands shown on Schedule "lO" attached to this By-Jaw. *(0080-2007)*

(o) All power generating facilities. *(0238-2007)*

6. The Commissioner may require thal securities be posted by the owner, in such amount as lhe Commissioner deems necessary and appropriate, to ensure lhe provision and maintenance of the site works as shown on an approved site plan. Securities are to be submitted in a form deemed acceplable lo the Commissioner.

7. The Commissioner may require an owner to provide and execute a site plan undertaking to ensure compliance wilh the conditions lo provide, maintain or complete lhe site works as required by the Commissioner.

8. If an owner is in defaull of carrying out sile works by failing to comply with the conditions to provide, main lain or complete the site works as required by the Commissioner, !hen the City, ils authorized agenls, servants or employees may enter upon the owner's land or into the owner's structures with reasonable nolice to complele the site works at the owner's expense.

9. The City may recover any costs incurred by the City, including interest and administration expenses, to provide, maintain or complete site works by deducting from or drawing upon securities that have been provided to the City by the owner. If there are no securities, or if the amount of securities held by the City are not sufficient to cover the costs incurred by the City, then without limiting the City's remedies the costs incurred by the City which can not be reimbursed or recovered from securities will be added to the tax roll of the property that is the subject of the site works and will be collected in the same manner as taxes.

I0. The Commissioner is hereby delegated the authority to detennine and directthe appropriate action to be taken in the administration of this By-law, including any remedial action to be taken where an owner defaults in the carrying out of the site works

11. Should a court of competent jurisdiction declare any section or part of a section of this By-law invalid, it is the stated intention of Council that the remainder of this By-law shall continue in force unless the court makes an order to the contrary.

12. (a) By-law 1127-85, and amending By-Jaws 171-86, 267-86, 996-86, 1042-86, 1099-86, 16-87, 865-87, 214-88, 66-89, 112-89, 191-89, 257-89, 268-89, 319-89, 437-89, 487-89, 543-89, 622-89, 100-90, 120-90, 188-90, 443-90, 489-90, 11-91, 24-91, 83-91, 188-91, 332-91, 464-91, 126-92, 311-92, 361-92, 462-92, 552-92, 554-92, 286-94, 370-95, 268-96, 401-96, 164-97, 533-97, 628-97, 630-97, 58-98, 410-98, 424-98, 512-98, 23-99, 54-99, 158-99, 363-99, 369-99, 479-99, 0095-2000, 0333-2000, 0349-2000, 0405-2000, 0492-2000, 0577-2000, 0584-2000, 0073-2001, 0183-2001, 0288-2001, 0314-2001, 0347-2001, 0406-2001, 0486-2001, 0504-2001, 0015-2002, 0452-2002, 0086-2003, 0364-2003, 0476-2003, 0229-2004, 0275-2004, 0338-2005, 0054-2006 are hereby repealed .

(b) By-law 314-89 is hereby repealed.

ENACTED and PASSED this 5th day of July 2006

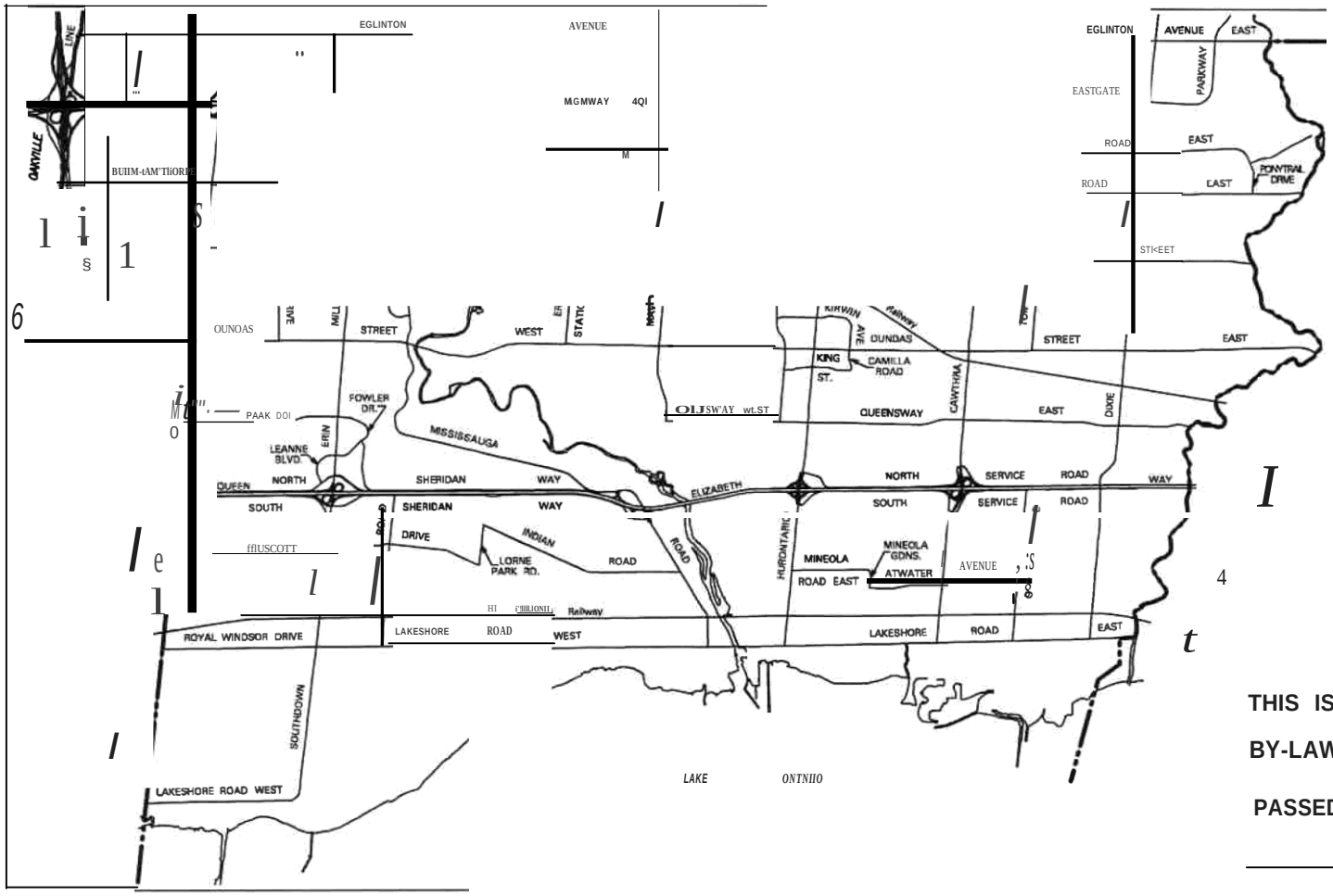
"HAZEL McCALLION"

MAYOR

"CRYSTAL GREER"

CLERK

K:\fLAN\I)CK: MJ\JNTENANCE\ZONING BY-LAW\Consolidalions\Curr.:nl\B\"-law 0293-2006- Sile Plan Conlrol - All doc



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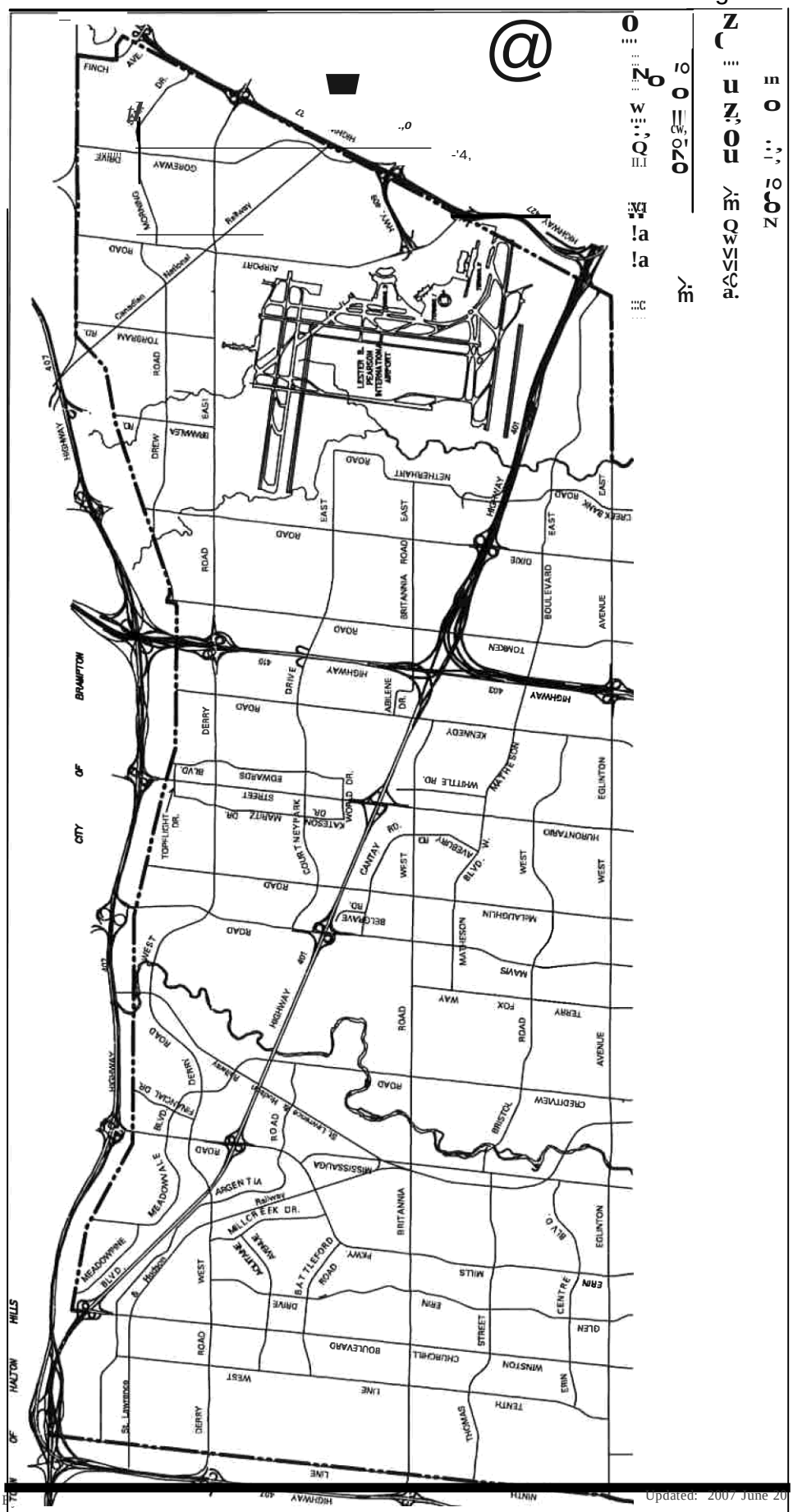
BY-LAW 0293-2006
PASSED BY COUNCIL ON
2006 JULY 05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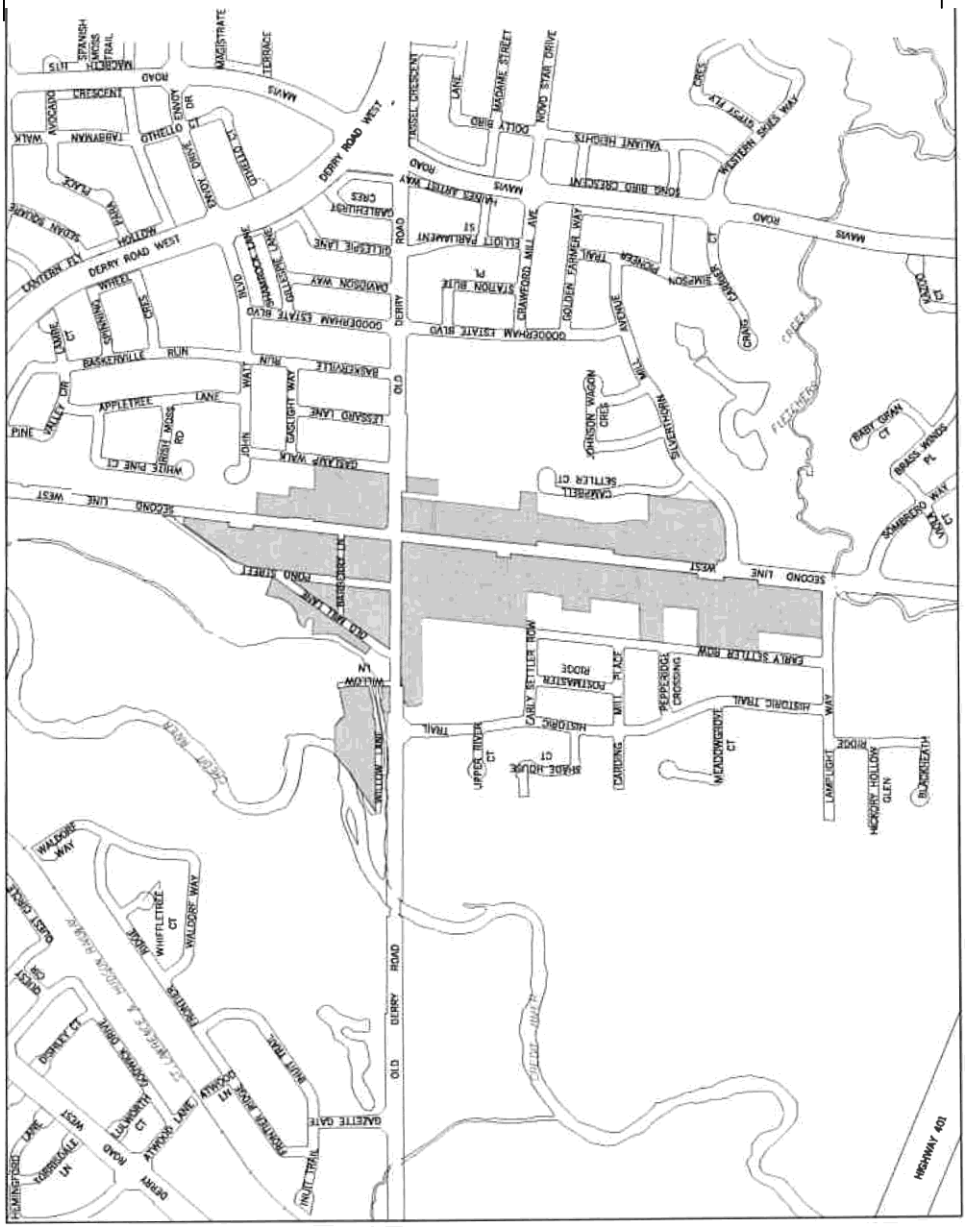
HIGHWAY 27
HWY. 400
HIGHWAY 427
GOREWAY DRIVE
GOREWAY ROAD
Railway
AIRPORT ROAD
Canadian National
TORBRAM RD.
HIGHWAY 407
DREW RD.
EAST
LESTER B. PEARSON INTERNATIONAL AIRPORT
401
NETHERHART ROAD
CREEK BANK ROAD
DIXIE BOULEVARD
BRITANNIA ROAD
TOMKEN AVENUE
HIGHWAY 410
DRIVE
ABLENE DR.
HIGHWAY 403
DERRY ROAD
KENNEDY
WINSTON CHURCHILL BLVD.
EDWARDS BLVD.
STREET
MATHESON BLVD. E.
EGLINTON
MATTLE RD.
WORLD DR.
MAPLEVIEW DR.
CATESON DR.
COURT NEYPARK DR.
TOPLIGHT DR.
CANTAY RD.
AVEBURY RD.
HURONTARIO
WEST
BELGRAVE RD.
MELALGHLIN
MATHESON BLVD. E.
MAVIS ROAD
FOX WAY
TERRY ROAD
AVENUE
CREDITVIEW
BRISTOL ROAD
ARGENTIA ROAD
Railway
MILLER CREEK DR.
MISSISSAUGA ROAD
FIELDMOUNT DR.
BLVD.
MEADOWVALE
MEADOWPINE BLVD.
St. Lawrence & Hudson
KESTREL DRIVE
BATTLEFORD ROAD
MILLS
ERIN CENTRE BLVD.
GLEN ERIN
BOULEVARD
CHURCHILL
WINSTON
ERIN
TENTH LINE
THOMAS
ST. LAWRENCE
DERRY
WEST
LINE
CITY OF BRAMPTON
HALTON HILLS
HIGHWAY 407
NINTH LINE


DERRY ROAD WEST
SECOND LINE WEST
OLD DERRY ROAD
MAVIS ROAD
GOODERHAM ESTATE BLVD
HIGHWAY 403

SITE PLAN CONTROL AREA

CITY OF MISSISSAUGA

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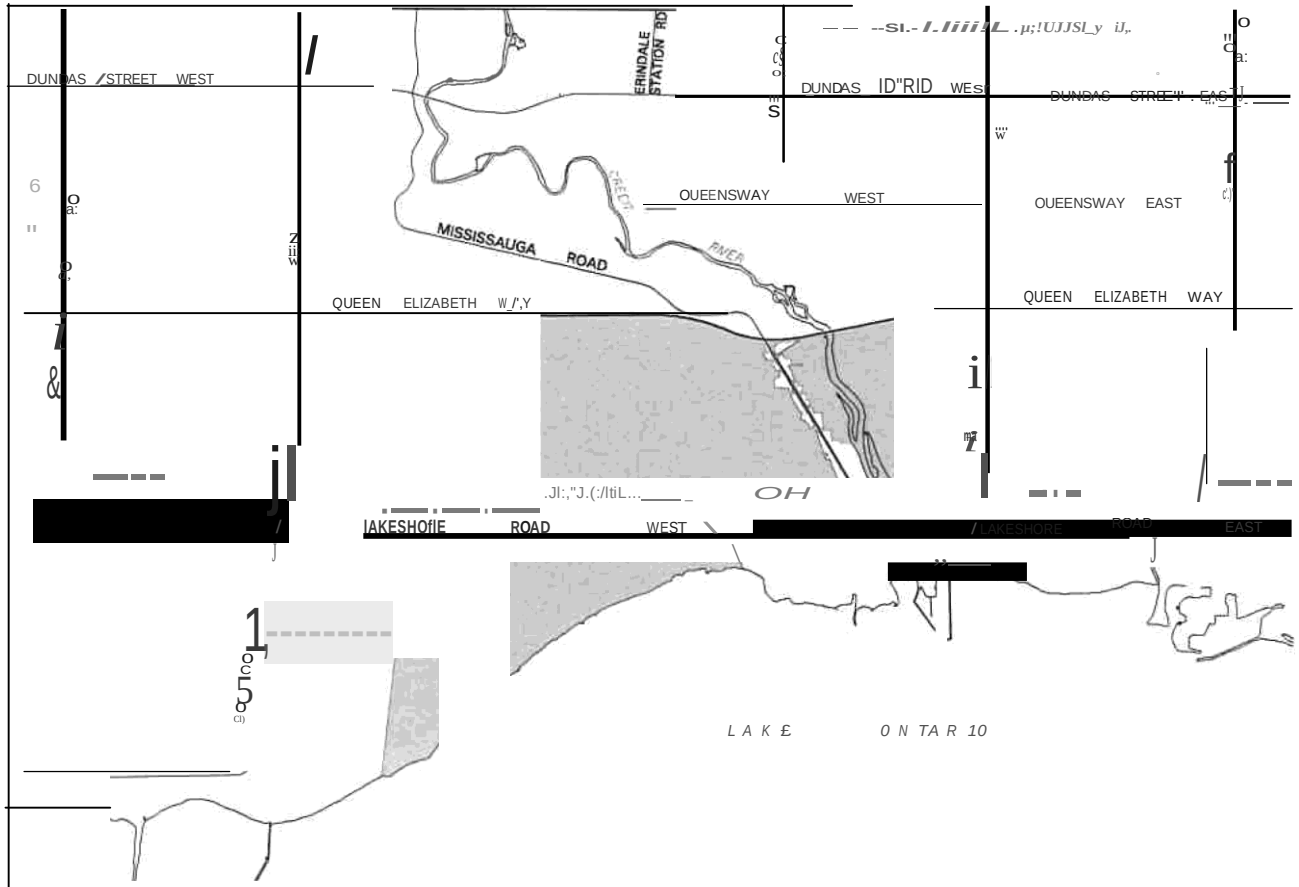
BY-LAW 0293-2006

PASSED BY COUNCIL ON

2006 JULY 05



f?7l SITE PLAN CONTROL AREA

CITY OF MISSISSAUGA

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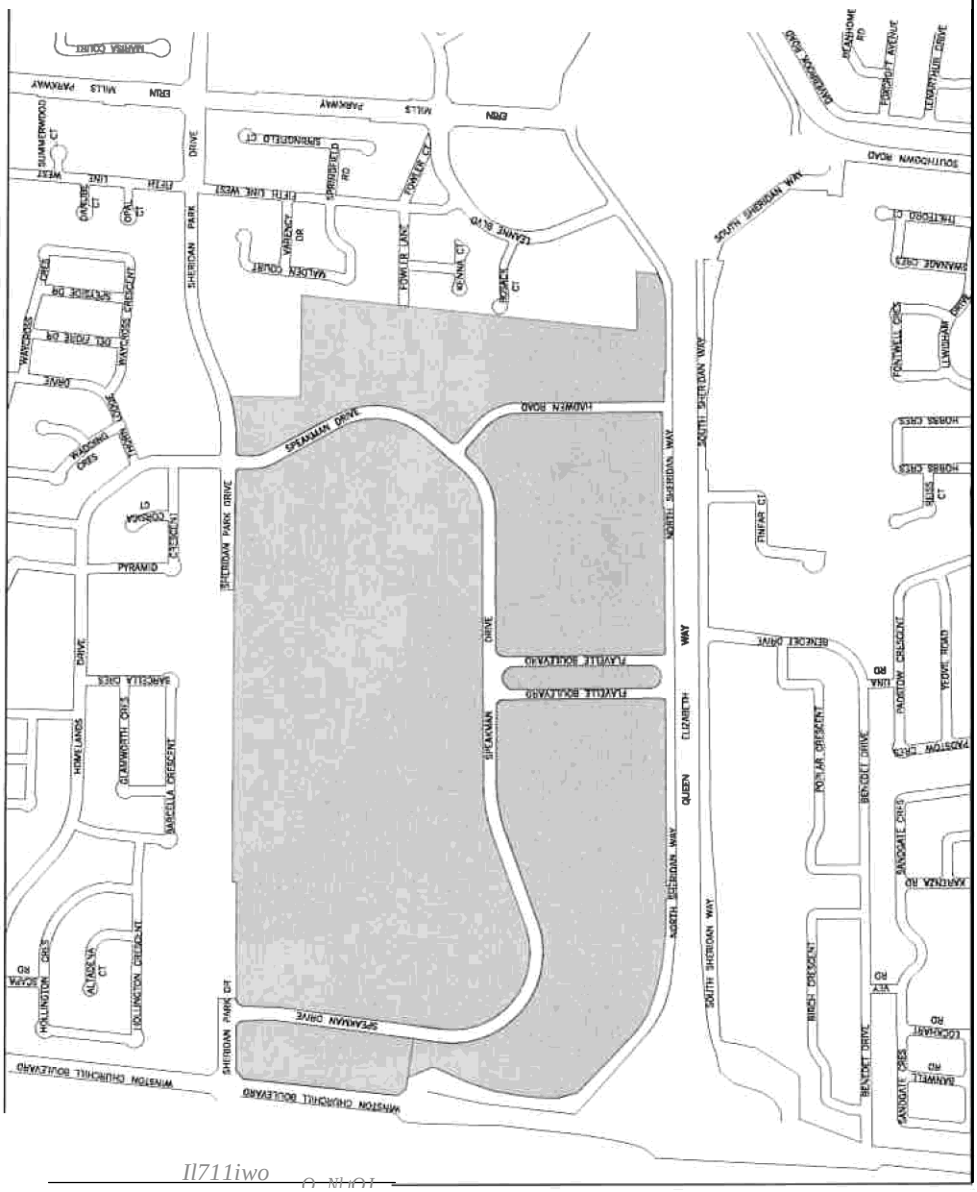
PASSED BY COUNCIL ON 2006 JULY 05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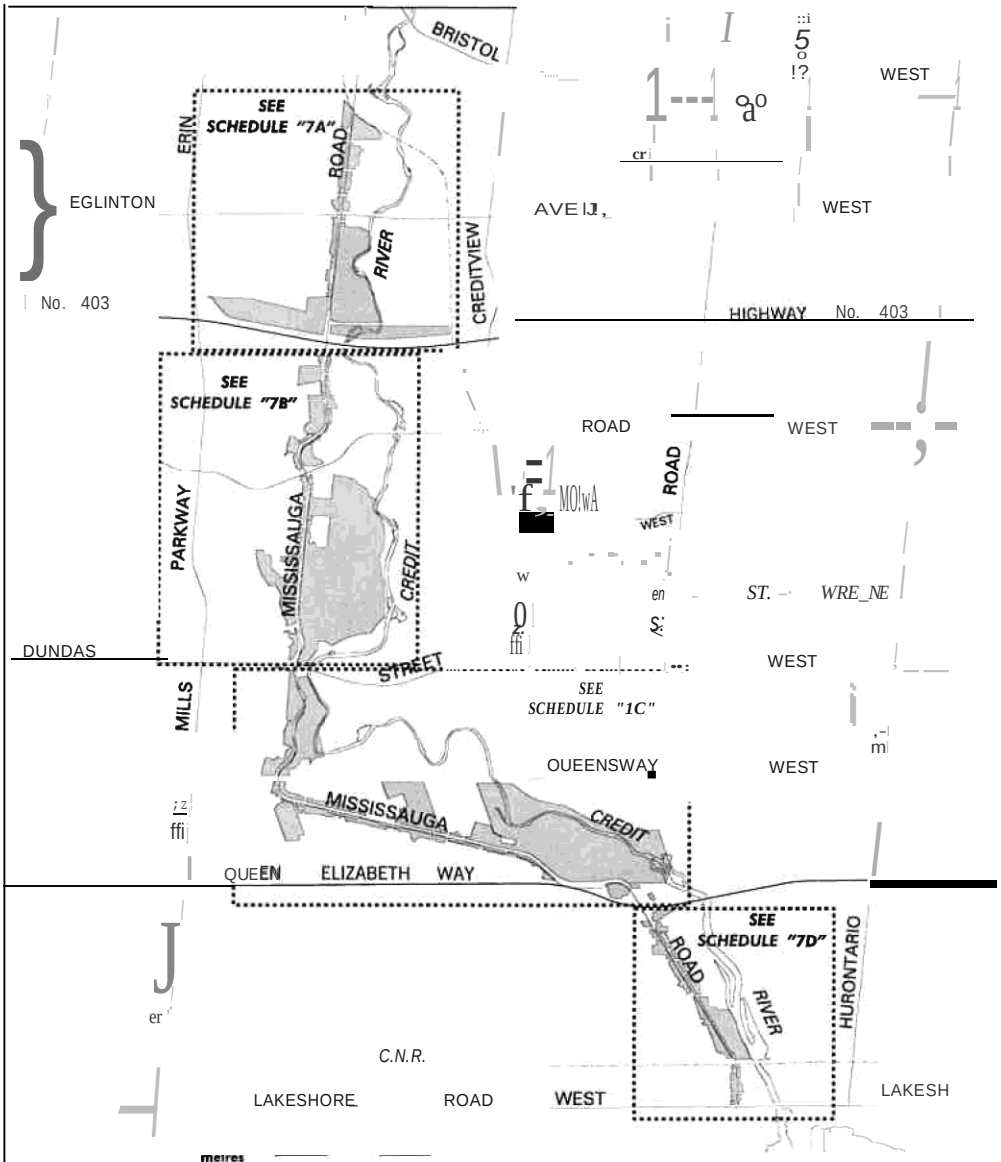
HADWEN ROAD
SHERIDAN PARK DRIVE
NORTH SHERIDAN WAY
SOUTH SHERIDAN WAY
QUEEN ELIZABETH WAY
FLAVILLE BOULEVARD
WINSTON CHURCHILL BOULEVARD
SOUTHDOWN ROAD
BENTLEY DRIVE
PYRAMID



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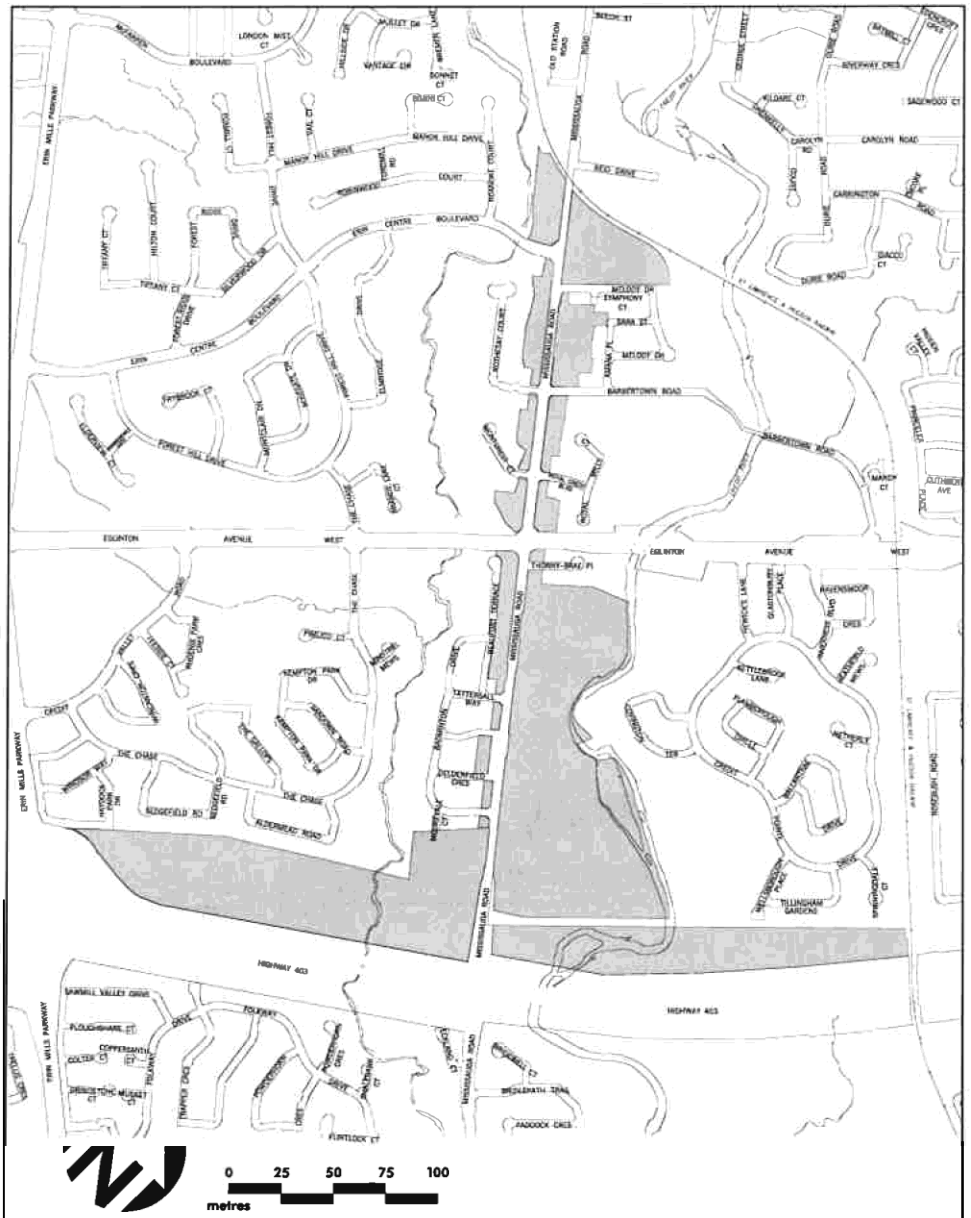
PASSED BY COUNCIL ON 2006 JULY 05

CITY OF MISSISSAUGA



SITE PLAN CONTROL AREA

THIS IS SCHEDULE "7A" TO BY-LAW 0293-2006

PASSED BY COUNCIL ON 2006 JULY 05

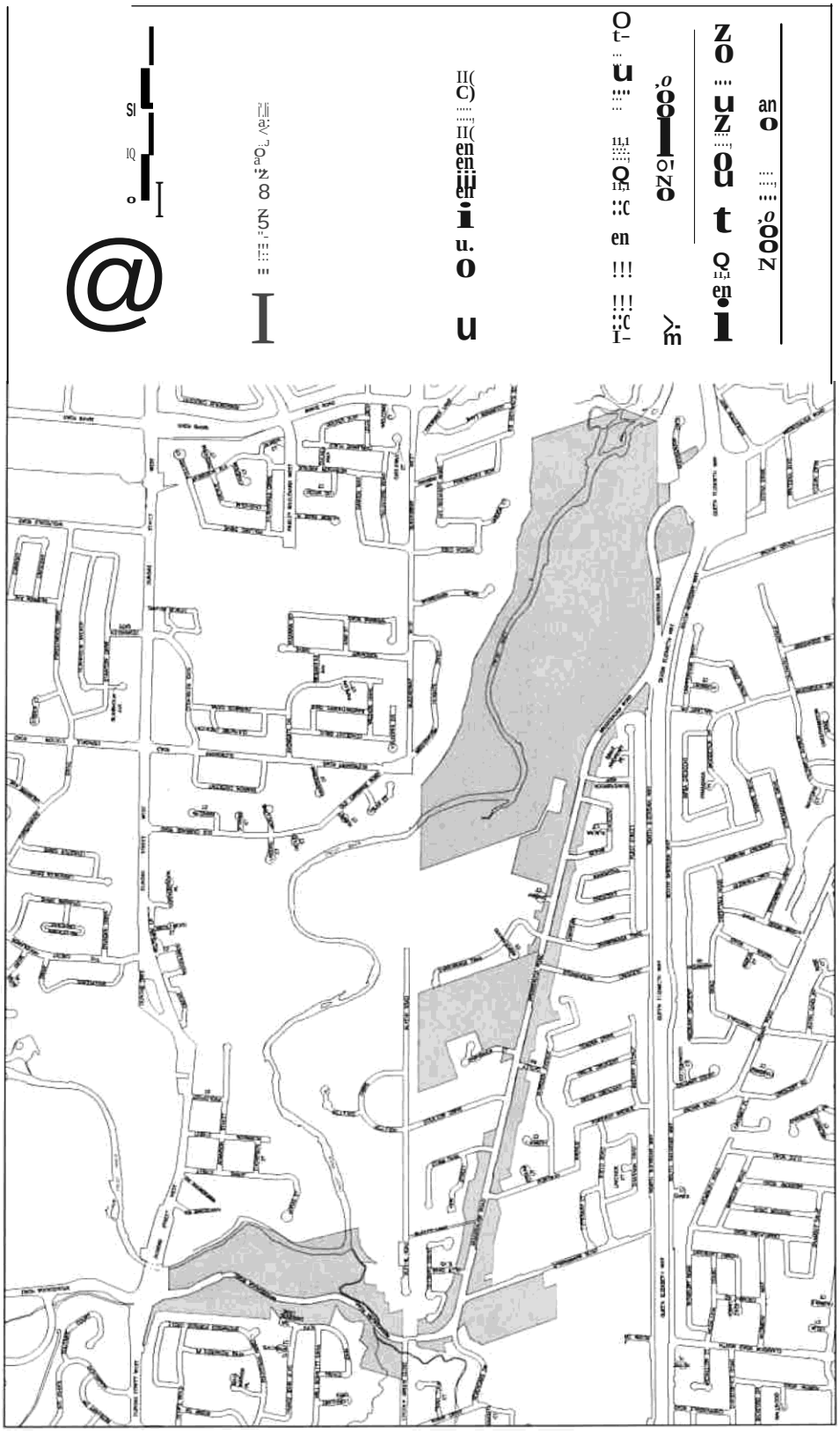
CITY OF MISSISSAUGA

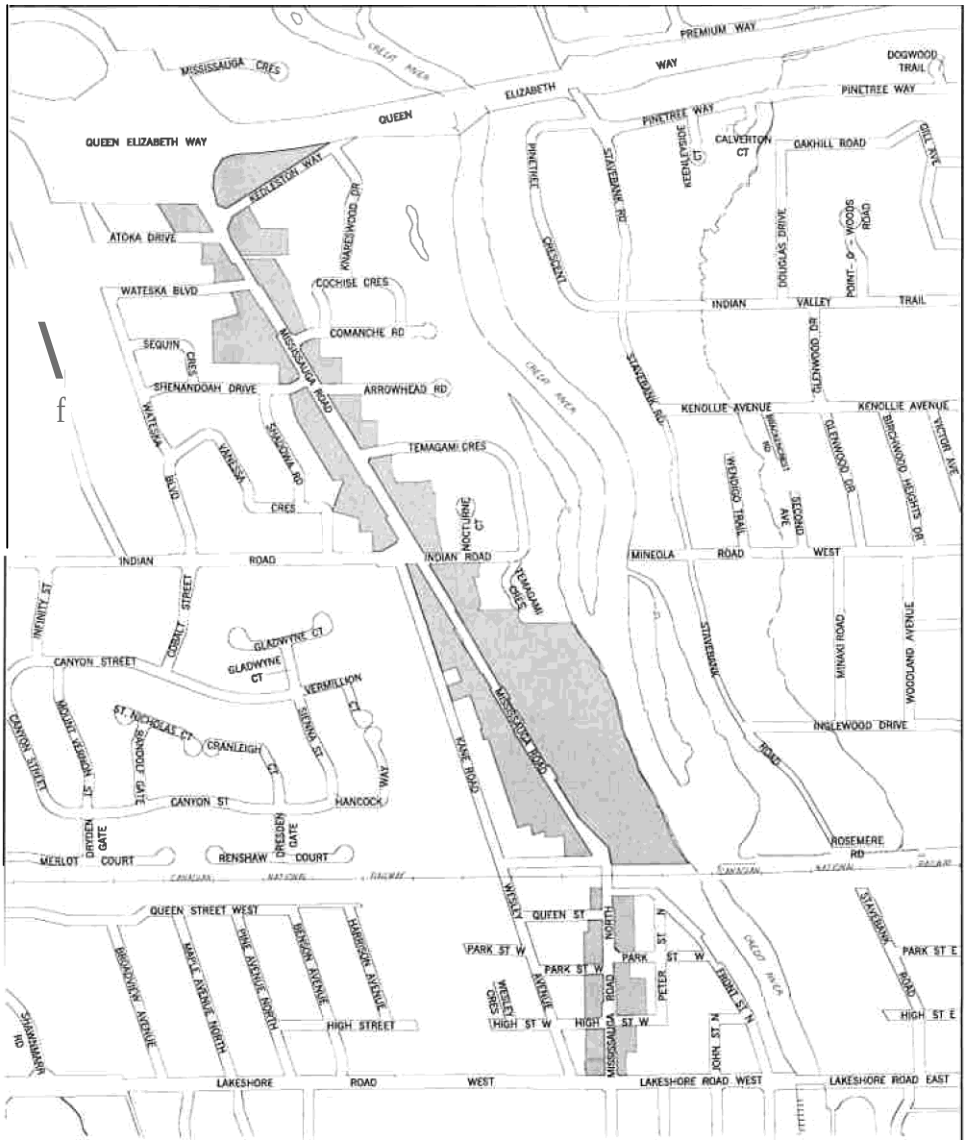
— SITE PLAN CONTROL AREA

THIS IS SCHEDULE "7B" TO BY-LAW 0293-2006

PASSED BY COUNCIL ON 2006 JULY 05

CITY OF MISSISSAUGA





– SITE PLAN CONTROL AREA

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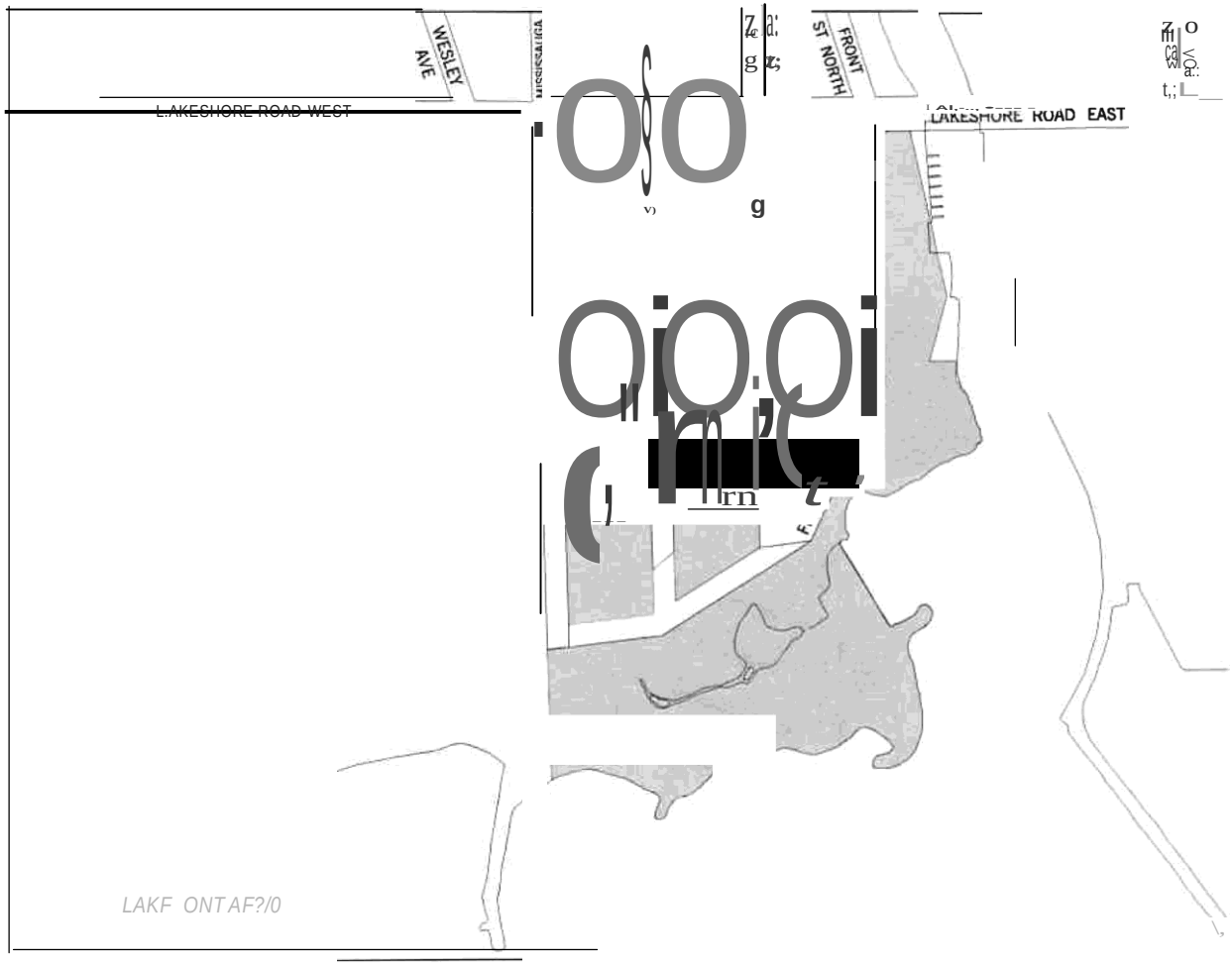
PASSED BY COUNCIL ON 2006 JULY 05

CITY OF MISSISSAUGA



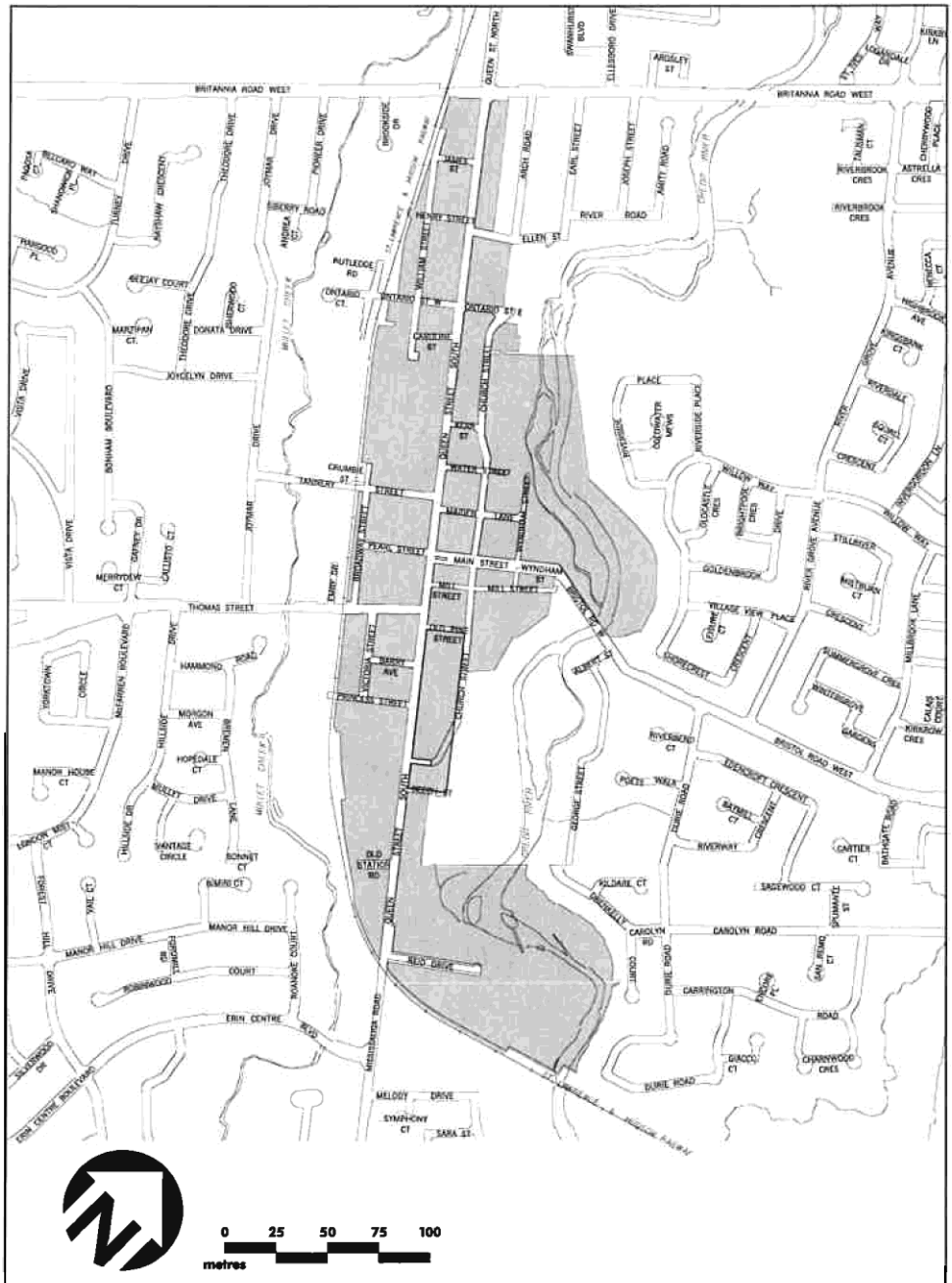
CITY OF MISSISSAUGA

THIS IS SCHEDULE "8" TO

BY-LAW 0293-2006

PASSED BY COUNCIL ON

2006 JULY 05



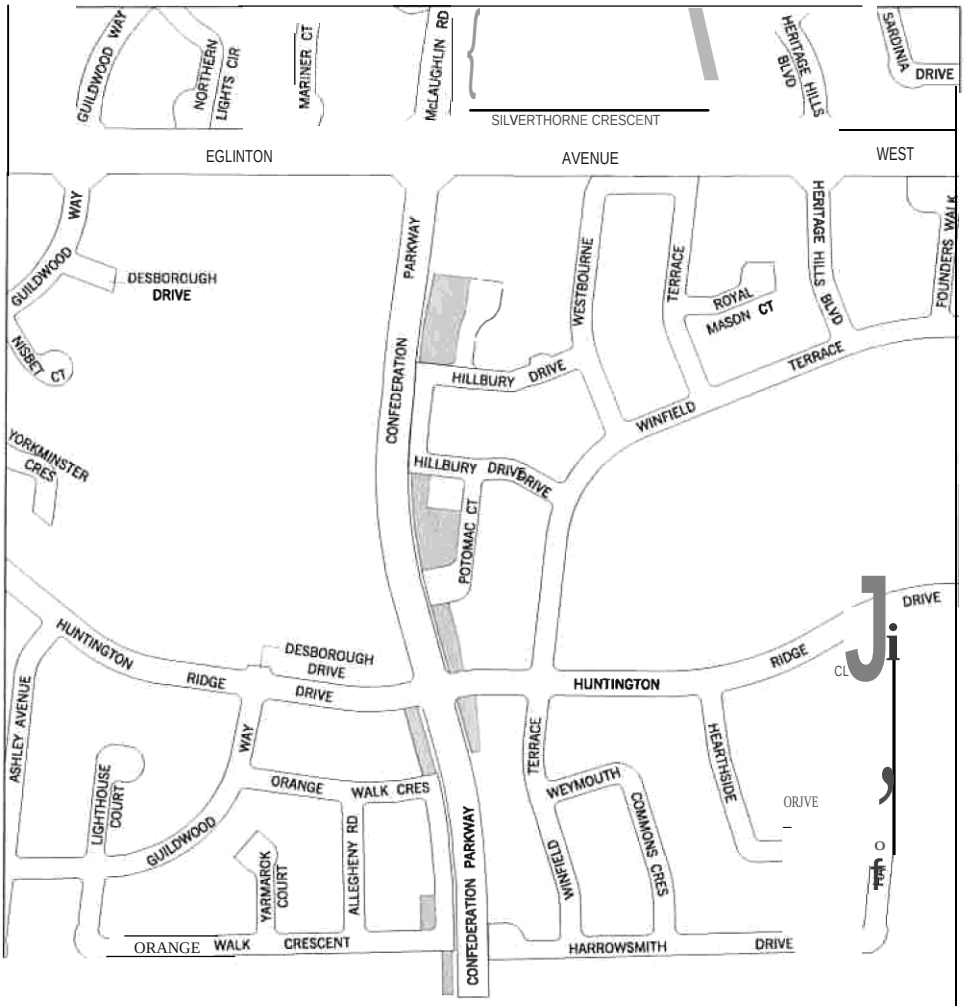
— SITE PLAN CONTROL AREA

THIS IS SCHEDULE "9" TO BY-LAW 0293-2006

PASSED BY COUNCIL ON 2006 JULY 05

CITY OF MISSISSAUGA

Schedule "10" to By-law 0293-2006 *(0080-2007)*



HIGHWAY 403

0 metres 100

SITE PLAN CONTROL AREA

THIS IS SCHEDULE "10" TO BY-LAW 0293-2006

AS ENACTED BY BY-LAW 0080-2007

PASSED BY COUNCIL ON 2007 FEBRUARY 28

CITY OF MISSISSAUGA

MISSISSAU

RESOLUTION 0046-2014
adopted by the Council of
The Corporation of the City of Mississauga
at its meeting on March 5, 2014

0046-2014 Moved by: Pat Mullin Seconded by: Chris Fonseca

WHEREAS stormwater management is an increasingly topical issue in light of recent local and national extreme weather events;

AND WHEREAS low impact development (LID) is a stormwater management approach that encompasses a suite of innovative techniques, sustainable technologies and green infrastructure that can infiltrate, store, evaporate and/or detain stormwater runoff;

AND WHEREAS the suite of LID techniques suitable for road rights-of-way includes a range of measures such as bio-retention facilities, rain gardens, swales, permeable pavement and prefabricated modules;

AND WHEREAS the use of LID techniques is consistent with the CONNECT and LIVING GREEN pillars of the City's Strategic Plan;

AND WHEREAS the City's Living Green Master Plan endorses the use of LID techniques for City projects;

AND WHEREAS the City has successfully implemented a number of LID installations as part of City facility capital projects;

AND WHEREAS the City has successfully implemented two LID projects within and adjacent to existing road rights-of-ways and design is underway for a third project;

AND WHEREAS Credit Valley Conservation has measured the performance of the Elm Drive LID installation during the July 8, 2013 storm and found that it delayed peak stormwater flows by 40 minutes and reduced runoff volume by 30%;

AND WHEREAS the City's road capital programs provide an opportunity to include LID installations where appropriate;

AND WHEREAS Transportation and Works Department staff currently review the road capital programs to identify LID opportunities as part of the regular work process, but are limited by budget and resources from implementing LID on a broad scale;

NOW THEREFORE BE IT RESOLVED THAT:

As part of the annual business planning and budget process, the Transportation and Works Department be directed to report on the technical and cost feasibility of LID opportunities associated with the recommended road capital programs for the following year, where such installations would provide optimal value and particularly in areas of Mississauga that have experienced flooding.

Carried

APPENDIX C

PHOTOGRAPHIC RECONNAISSANCE

PILOT STUDY ASSESSMENT OF DEVELOPMENT INTENSIFICATION – ANCASTER

Area: _____

General Location: _____

Outline of Grades and Physical Characteristics: _____

_____

_____

Condition of Ditches (Debris, sediment, signs of maintenance, ponded water etc.):

_____

_____

_____

Potential for Intensification: _____

_____

_____

Signs of past redevelopment/intensification: _____

_____

_____

Outlet Location and type (to woodlot; sewer; watercourse other – natural systems?)

_____

_____

_____

Other observations: _____

_____

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01 05 2014 09:47


01 05 2014 10:32


01 05 2014 08:51


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