Stormwater Management Report

Romney Wind Development
Township of Chatham-Kent and Town of Lakeshore
Project #SWW187418

Prepared for:

Wood Power & Process
700 – 202 Winston Park Drive, Oakville, ON

10/11/2018

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10/11/2018

Nayereh Azad
Senior Civil Engineer
Wood Power & Process
700 – 202 Winston Park Drive
Oakville, ON

RE: Romney Wind Development Stormwater Management Report

Dear Madam,

We are pleased to provide you with this Stormwater Management Report, which provides the supporting stormwater management (SWM) analyses for the proposed Romney Wind Development in the Township of Chatham-Kent and the Town of Lakeshore. Specifically, this SWM report addresses the proposed construction of the Operations & Maintenance building, as well as the substation location, and the proposed maintenance access roads for the wind turbines.

We trust the report adequately addresses the requirements of this project. Please do not hesitate to contact the undersigned should you require additional information.

Sincerely,

Wood Environment & Infrastructure Solutions

Prepared by:

Per: Matthew Senior, M.A.Sc., P.Eng.
Senior Water Resources Engineer

Prepared by:

Per: Priyantha Hunukumbura, Ph.D., E.I.T.
Water Resources Analyst

Reviewed by:

Per: Peter Nimmrichter, M.Eng., P.Eng., IRP
Associate Water Resources Engineer

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1.0 Introduction

Wood Enviornment & Infrastructure Solutions, a division of Wood Canada Limited (Wood EIS), has been retained by Wood Power & Process (Wood PNP) to provide water resources engineering services to prepare a stormwater management (SWM) report related to the Romney Wind Development located in the Municipality of Chatham-Kent and the Town of Lakeshore (ref Figure 1.1). The extents of the proposed wind farm development have been provided in Figure 1.2.

Based on a review of the overall proposed development, this report has been prepared primarily for two (2) specific components of the development which would be expected to result in changes in stormwater runoff regime under proposed conditions. These two components arethe Operations & Maintenance (O&M) Building (located within the Municipality of Chatham-Kent), and the Substation (located within the Town of Lakeshore). Both sites lie within the jurisdiction of the Lower Thames River Conservation Authority (LTRCA). The focus of the current report is on these two (2) sites only.

It should also be noted that minor gravel access roads have been proposed for the wind turbine locations themselves. The hydrologic impacts of these additional changes have been reviewed further as part of Section 3 of this report.

The current report has been prepared to assess potential changes in runoff associated with the proposed development (i.e. runoff volume and peak flow, water quality) and develop necessary mitigation and management strategies accordingly.

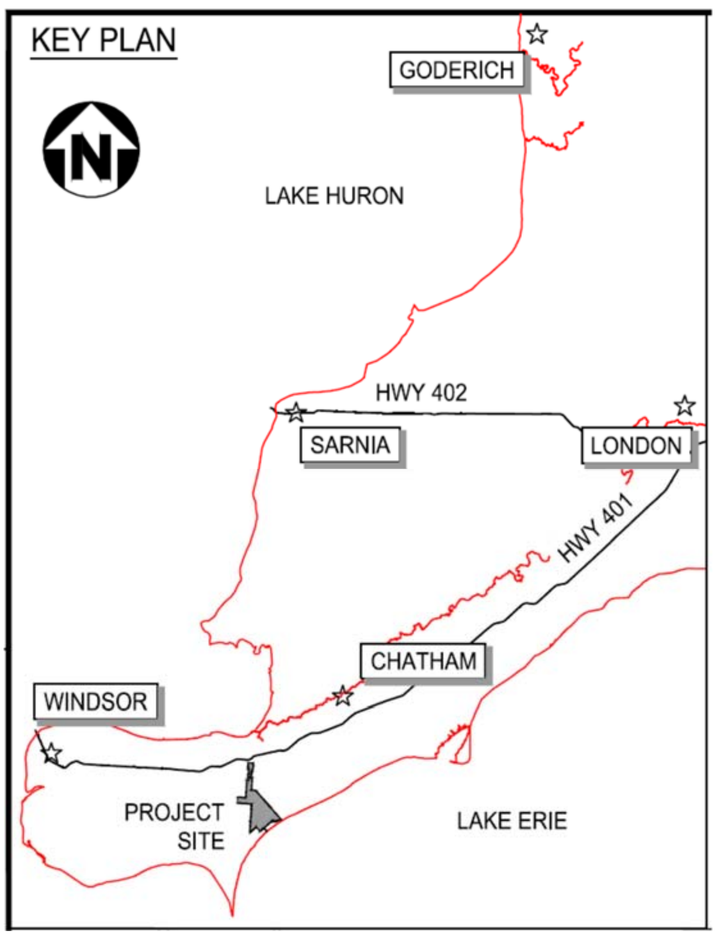


Figure 1.1: Site Location

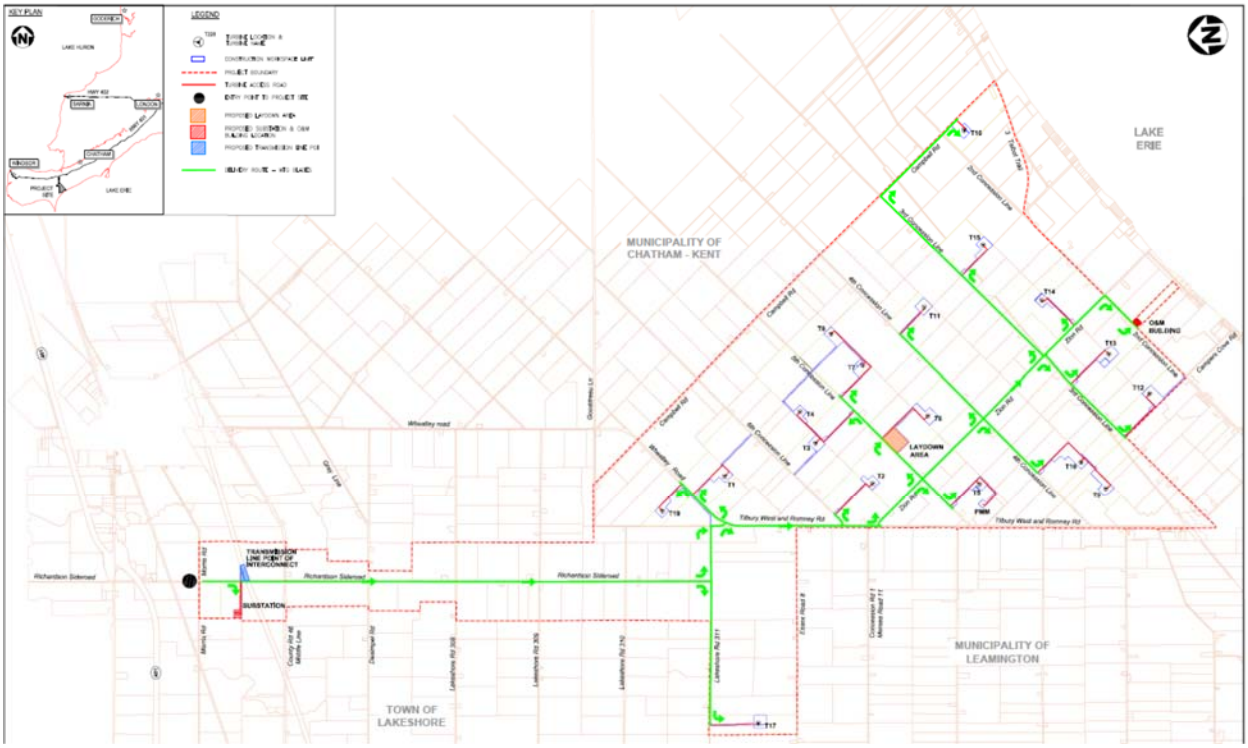


Figure 1.2: Extents of Proposed Wind Farm Development

2.0 Site Description

2.1 Existing Conditions

2.1.1 Operations & Maintenance Building

The site of the proposed Operations & Maintenance (O&M) Building is located within the Municipality of Chatham-Kent, along the south side of Highway 3 (Talbot Trail) between Zion Road and Campers Cove Road, close to the Lake Erie shoreline. Under current conditions, the site is rural in nature, and is used for agricultural purposes. The site is directly adjacent to a single private residence. Under existing conditions, an external area of 0.66 ha drains through the site from the north-east, as well as a portion of the residential site to the south-west (0.12 ha); refer to Figure 2.3. Overall, the area drains in a south-westerly direction, and is tributary to the Yellow Creek watershed, which drains southerly to Lake Erie. Based on information provided by the Lower Thames River Conservation Authority (LTRCA), no portion of the site is regulated. As well, no municipal drains are located within the vicinity of the proposed building.

2.1.2 Substation

The site of the proposed substation is located within the Town of Lakeshore, along the west side of Richardson Side Road, between Middle Road (County Road 46) and Morris Road (Concession Road 5). The site is completely rural in nature, and is used for agricultural purposes. Under existing conditions, a 4.77 ha portion of land from west of Richardson Side Road drains through the primary area of interest (refer to Figure 2.5). The area generally drains in a westerly direction, and is tributary to the Big Creek watershed, which drains in a northerly direction towards Lake St. Clair. Based on information provided by the LTRCA, no portion of the site is regulated. Based on information provided by the Town of Lakeshore, a Municipal Drain is located on an east-west alignment parallel to the site boundary. Based on topographic data, no surface drainage feature is present in this location, as such the municipal drain is assumed to be a sub-surface pipe.

2.2 Proposed Conditions

2.2.1 Operations & Maintenance Building

Under proposed conditions, a 0.40 ha section of the overall property will be developed for the Operations & Maintenance building, as presented in Figure 2.1. As evident from Figure 2.1, the majority of the site will be converted to a hard-packed gravel surface. An operations and maintenance building (18.3m x 18.3m, or about 335 m^2) is proposed, along with a small oil shed structure (42 m^2). A grassed/landscaped area would also be included around the majority of the site perimeter, and directly south of the proposed operations and maintenance building. In order to re-direct external area flows, a swale will be required around the site perimeter. Overall site drainage under proposed conditions would mimic existing condition flow paths, and is presented in Figure 2.4; further hydrologic analyses are presented in subsequent sections of this report.

2.2.2 Substation

Under proposed conditions, a 0.35 ha section of the property will be developed for the substation, part of an overall 1.26 ha area (refer to Figure 2.6). This does not include the proposed 5 m gravel roadway itself (some 0.22 ha). The proposed site layout is presented in Figure 2.2. As evident from Figure 2.2., the majority of the development will be around the substation itself, some 500 m ±west of Richardson Side Road. The substation itself is understood to be placed on large diameter stone to ensure rapid drainage and limit any potential ponding, given the implications to the electrical equipment. The access road itself is also understood to consist of hard-packed gravel. In order to re-direct external area flows between Richardson

Side Road and the site itself, a swale will be required, as indicated on Figure 2.6, and discussed further in subsequent sections of the report. The existing Municipal Drain indicated on available mapping (sub-surface pipe) would remain unchanged and unaffected under proposed conditions; no new connections to the drain would be made, and no grading or surface operations would be expected to impact the function of the drain.

A "double containment system" is also proposed for the substation site to address spill containment risk. This is discussed further in Section 5.

Figure 2.1: Proposed O&M Building Layout

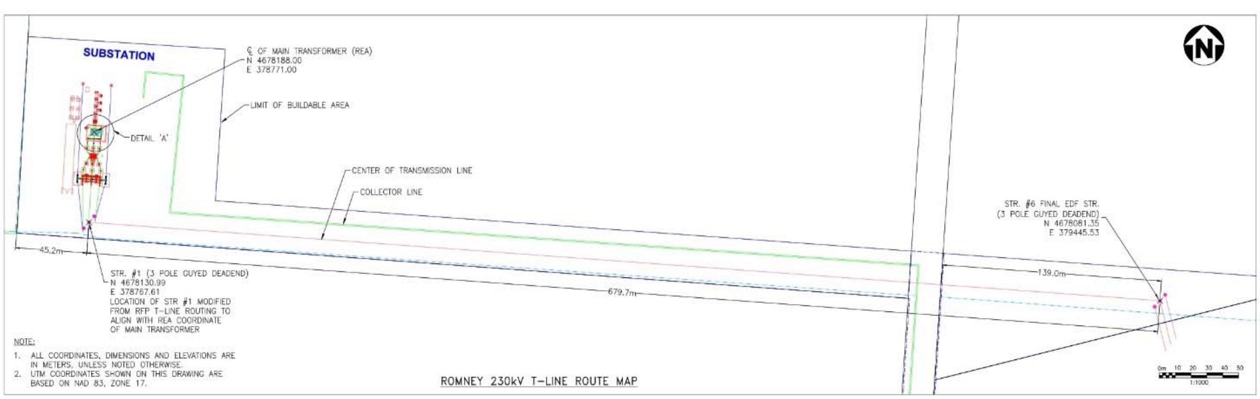
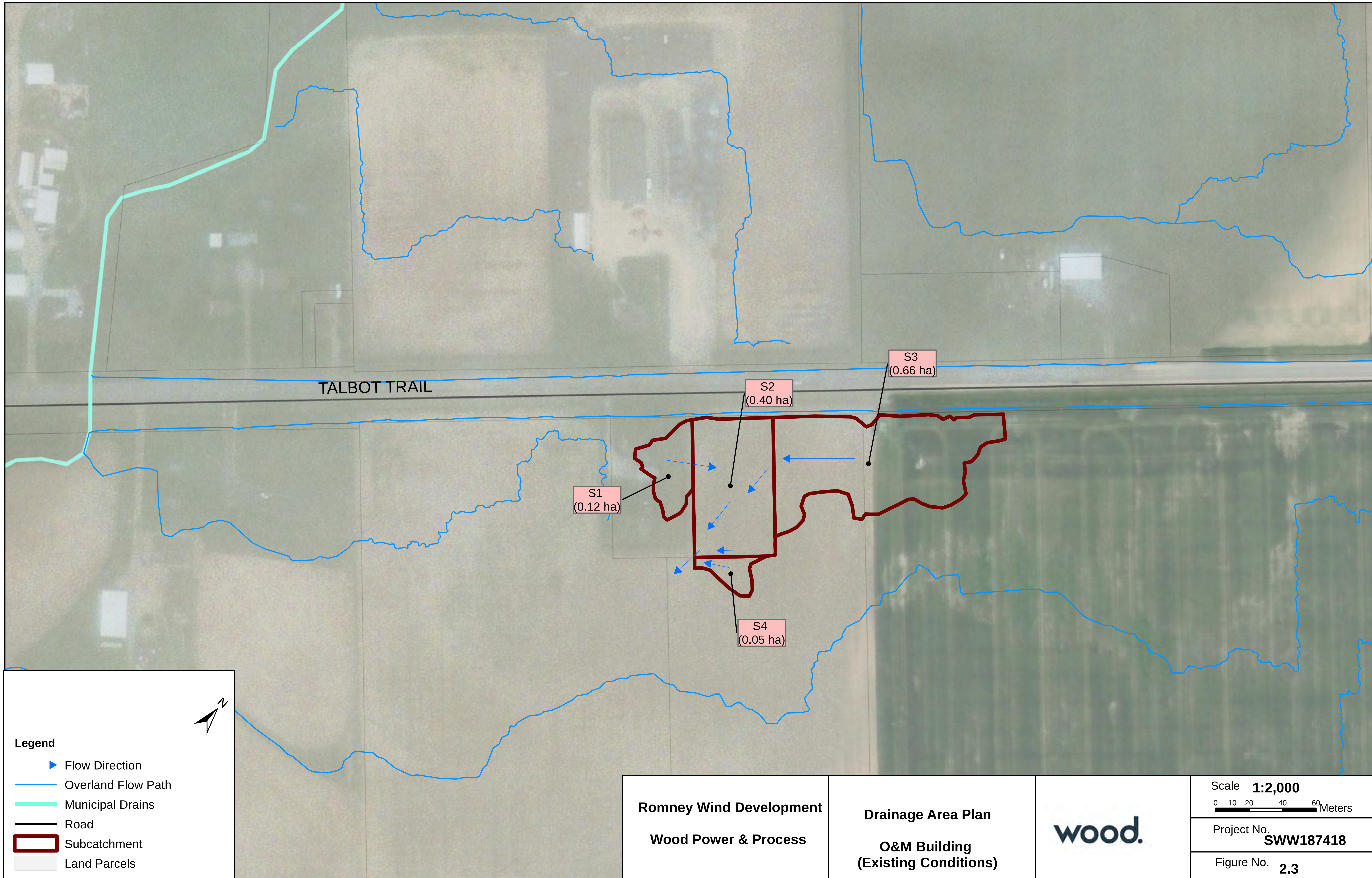


Figure 2.2: Proposed Substation Layout



Romney Wind Development

Wood Power & Process

Drainage Area Plan

O&M Building (Existing Conditions)

wood.

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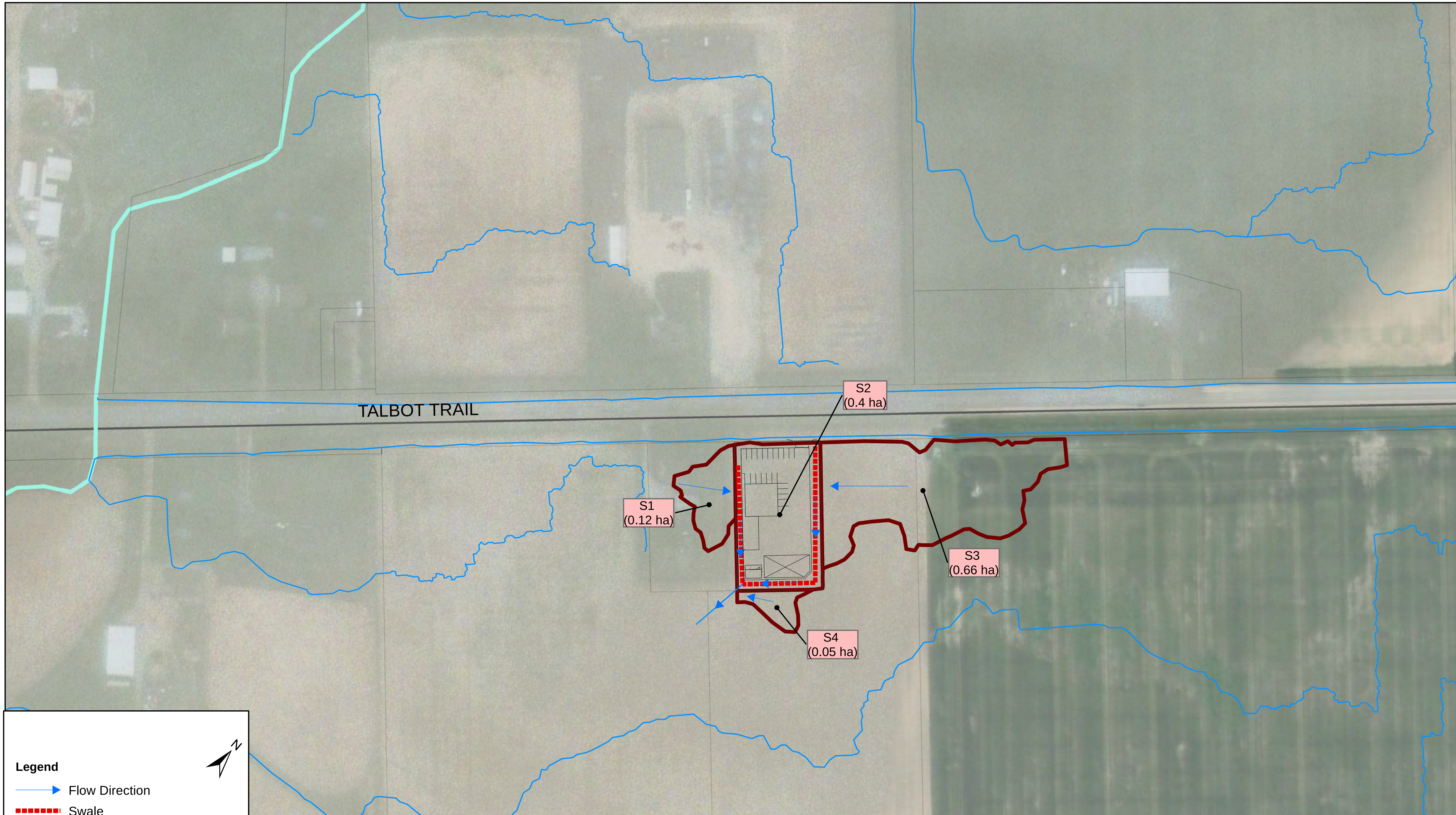
Figure No. **2.3**



Romney Wind Development

Wood Power & Process

Drainage Area Plan

O&M Building (Future Conditions)

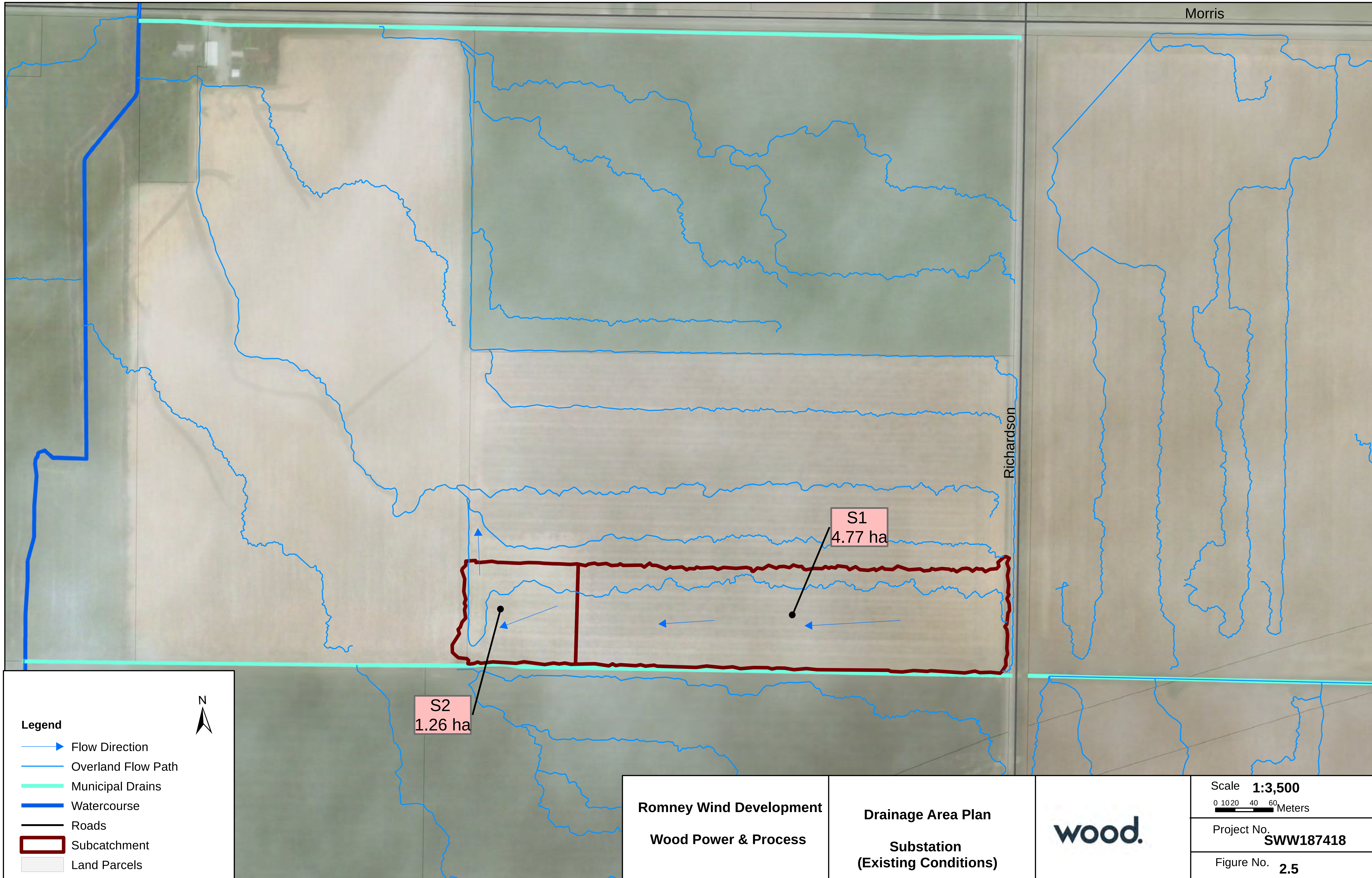
wood.

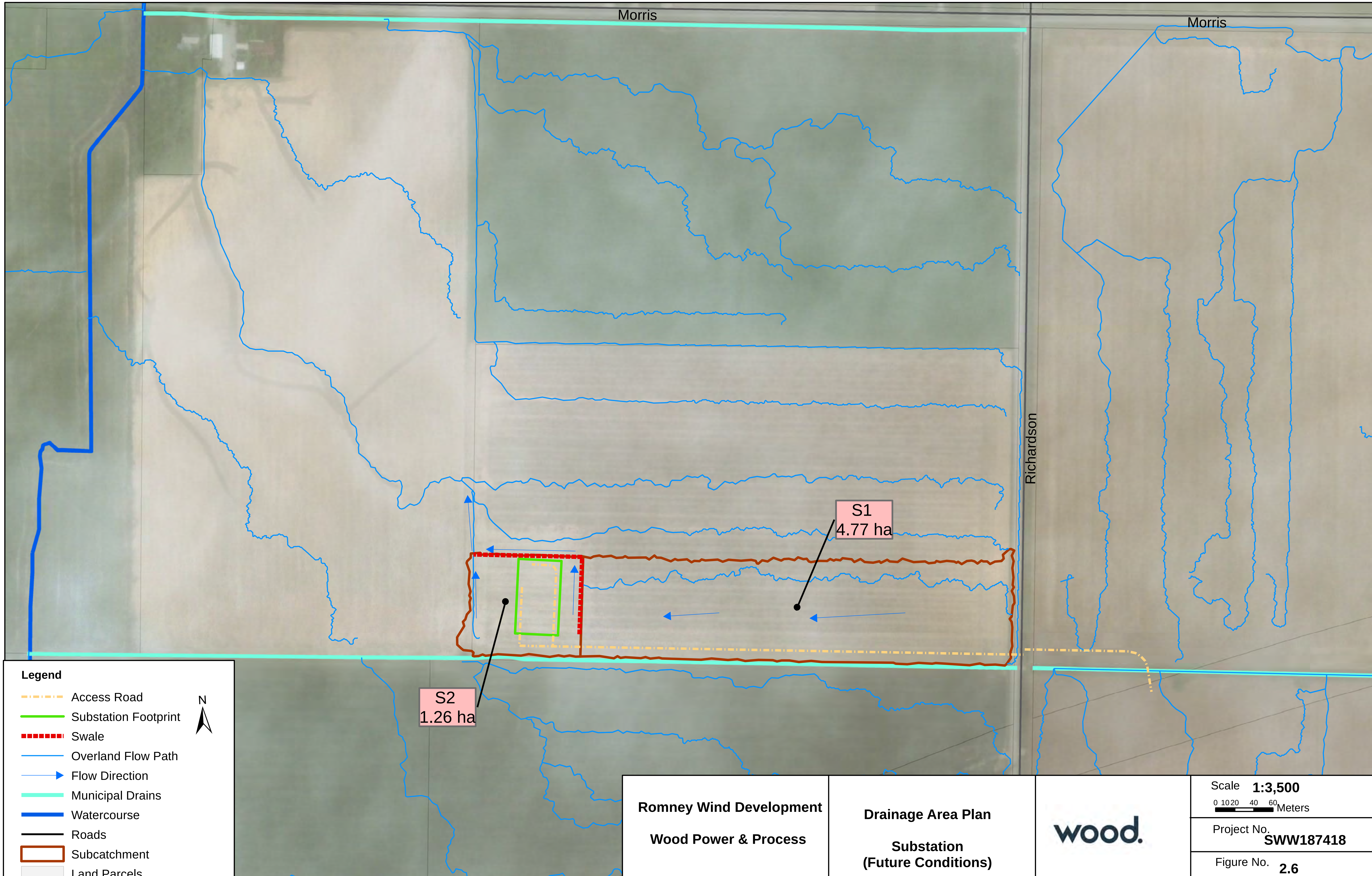
Scale **1:2,000**

0 10 20 40 60 Meters

Project No. **SWW187418**

Figure No. **2.4**


Morris
Richardson
S1
4.77 ha
S2
1.26 ha
N
Legend
Flow Direction
Overland Flow Path
Municipal Drains
Watercourse
Roads
Subcatchment
Land Parcels
Romney Wind Development
Wood Power & Process
Drainage Area Plan
Substation
(Existing Conditions)
wood.
Scale 1:3,500
0 10 20 40 60 Meters
Project No. SWW187418
Figure No. 2.5


Morris
Morris
Richardson
S1
4.77 ha
S2
1.26 ha
Legend
Access Road
Substation Footprint
Swale
Overland Flow Path
Flow Direction
Municipal Drains
Watercourse
Roads
Subcatchment
Land Parcels
N
Romney Wind Development
Wood Power & Process
Drainage Area Plan
Substation
(Future Conditions)
wood.
Scale 1:3,500
0 10 20 40 60 Meters
Project No. SWW187418
Figure No. 2.6

3.0 Hydrologic Modelling

3.1 Model Selection

In order to evaluate the site for stormwater management, it has been necessary to conduct hydrologic modelling, to develop storm response hydrographs and associated peak flows under both existing and proposed conditions.

PCSWMM has been employed for the current assessment. PCSWMM is a graphical user interface and pre-processor for the well-known US EPA-SWMM model. It is a combined hydrologic/hydraulic model which is capable of assessing complex hydraulic conditions, including dual drainage (minor/major system) and surcharge and reverse flow. A copy of all completed PCSWMM modelling has been included in Appendix A, along with all hydrologic model parameters.

3.2 Design Storms

As part of the hydrologic modelling process, rainfall input is required. Based on the rural nature of the site, the closest available source of local intensity-duration-frequency (IDF) rainfall statistics has been reviewed. The closest available gauge with long term data is Environment Canada's Point Pelee CS station (gauge 613P001), which has 22 years of available data (1975 – 2004, including a gap between 1994-2001). As the closest available source of rainfall data, this gauge has been applied for the current assessment. A copy of the IDF data has been included in Appendix A.

Based on a brief modelling sensitivity analysis, it has been determined that the SCS 6-hour design storm distribution yields the most conservative peak flow results, and has been applied for the current assessment. The SCS design storm distributions have been widely applied throughout Southern Ontario, and the 6-hour distribution in particular typically yields the highest peak flows, as is the case here. Based on the IDF data for the site, 6-hour design storm rainfall depths range from 42.5 mm (2-year storm) to 111.11 mm (100-year storm).

3.3 Modelling Parameters

In order to determine appropriate infiltration parameters, a characterization of on-site soils is required. Based on available Ontario Soils Mapping for this area (Chatham Kent – O&M Building, and Essex County – Substation site), the area consists of heavy, highly impermeable clays (Kelvin Clay for the O&M Building and Brookston Clay for the Substation), with an associated hydrologic SCS Classification of "D". As such, an SCS Classification of "D" for the site soils is considered appropriate in both cases.

Infiltration and runoff parameters have been based on the foregoing soil classification assumption, different land uses evident within the drainage area in question, and typical literature values. Values applied for the current assessment are summarized in Table 3.1.

Table 3.1: Assumed Runoff Parameters for Different Land Use Types

Land Use	US SCS CN (AMC-II)	Initial Abstraction (mm)
Forest	79	7
Agricultural	80 (80-94)	5
Grass	80	5
Gravel	91	2
Rooftop	98	1

As per Table 3.1, it is noted that for agricultural areas, such as row crops, legumes, or rotation meadow, Curve Number values may vary from 80 up to 94, depending on the time of year and hydrologic condition (i.e. degree of vegetation coverage, tilling, etc.). Given that gravel surfaces would be expected to have a Curve Number of 91, it is possible that in some cases, the proposed development (which largely consists of gravel surfaces) could in fact slightly reduce runoff potential. Notwithstanding, in order to provide a more standard comparison between pre-development and post-development conditions, agricultural areas have been assumed to have a lower, more permeable Curve Number of 80, which is consistent with that for grassed areas.

Infiltration modelling has applied the SCS Curve Number method, based on area-weighing and the standard values presented in Table 3.1. Initial abstractions have also been calculated based on areally-weighting the assumed values presented in Table 3.1.

There is only a small percentage of impervious areas under both existing and proposed conditions for both sites, corresponding to rooftop areas. These areas have been modelled within PCSWMM as impervious areas accordingly, using the PERVIOUS route command, which routes the impervious flows across the pervious land segment. This is considered appropriate under both existing and proposed conditions, and representative of actual drainage (i.e. roof drains discharge to the pervious ground surface).

Other hydrologic parameters, such as length and slope, have generally been directly measured from the available mapping. Overall site topography is very flat, as such a slope of 0.1% has been generally assumed, based on measurements from available digital elevation model (DEM) data.

Subcatchment length is a key parameter within PCSWMM, as it is used to represent sheet flow/overland flow, and accounts for the expected degree of attenuation (i.e. it is a surrogate for time of concentration or time to peak used in unit hydrograph methodologies). As noted, subcatchment length has been directly measured, where possible, based on the expected length of sheet flow. For those few subcatchments where a drainage channel is more well defined (such as a ditch), the subcatchment length has been defined using generally accepted relationships between channel length and flow path length, such as the Proctor & Redfern method (Proctor and Redfern, Ltd. And MacLaren, J.F. Ltd, 1976, "Stormwater Management Model Study – Vol 1". Research Rep. No. 7, Canada-Ontario Research Program, Environmental Protection Service, Ottawa), which indicated that the subcatchment width (width of the kinematic wave plane) should be 1.7 times the channel length. Thus subcatchment length is equal to the drainage area divided by 1.7 times the channel length.

3.4 Modelling Results (Existing Conditions)

3.4.1 Operations & Maintenance Building

The drainage systems of the Operations and Maintenance (O&M) Building under existing conditions have been simulated using the methodology described in Section 3.3, and as per the land use described in Section 2.1.1 (ref. Figure 2.3). Simulated peak flows for the 2 through 100 year storm events are presented in Table 3.2.

The simulated peak flows presented in Table 3.2 will serve as basis for evaluating the expected change in peak flows under proposed conditions, as described and assessed in Section 3.5.1.

Table 3.2: Simulated Peak Flows for O&M Site – Existing Conditions (SCS 6-Hour Design Storm)							
Location	Drainage Area (ha)	Simulated Peak Flow (m³/s) for Return Period (Years)					
		2	5	10	25	50	100
S1	0.12	0.001	0.004	0.008	0.013	0.017	0.021
S2	0.40	0.004	0.014	0.024	0.040	0.053	0.067
S3	0.66	0.006	0.020	0.035	0.058	0.078	0.100
S4	0.05	0.001	0.002	0.004	0.007	0.009	0.011
All	1.23	0.013	0.040	0.070	0.117	0.157	0.200
Note: Due to the very small computed flows, the peak flows have been documented above to three decimal places as a means of illustrating computed changes from pre-development to post-development. This level of detail is provided for information purposes only and should not be construed as an indication of the accuracy of the simulation model computations.							

3.4.2 Substation

The existing conditions substation site drainage systems have been simulated using the methodology described in Section 3.3, and as per the land use described in Section 2.1.2 (ref. Figure 2.4). Simulated peak flows for the 2 through 100 year storm events are presented in Table 3.3.

The simulated peak flows presented in Table 3.3 will serve as basis for evaluating the expected change in peak flows under proposed conditions, as described and assessed in Section 3.5.2.

Table 3.3: Simulated Peak Flows for Substation – Existing Conditions (SCS 6-Hour Design Storm)							
Location	Drainage Area (ha)	Simulated Peak Flow (m³/s) for Return Period (Years)					
		2	5	10	25	50	100
S1	4.77	0.029	0.089	0.143	0.237	0.327	0.427
S2	1.26	0.007	0.020	0.033	0.051	0.070	0.092
All	6.03	0.035	0.109	0.176	0.287	0.395	0.516
Note: Due to the very small computed flows, the peak flows have been documented above to three decimal places as a means of illustrating computed changes from pre-development to post-development. This level of detail is provided for information purposes only and should not be construed as an indication of the accuracy of the simulation model computations.							

3.5 Modelling Results (Proposed Conditions)

3.5.1 Operations & Maintenance Building

The proposed conditions drainage systems of the Operations and Maintenance (O&M) Building have been simulated using the methodology described in Section 3.3, and as per the land use described in Section 2.2.1 (ref. Figure 2.5). Simulated peak flows for the 2 through 100 year storm events are presented in Table 3.4, along with the calculated change in peak flows as compared to the results presented in Table 3.2.

Table 3.4: Simulated Peak Flows for O&M Site – Proposed Conditions (SCS 6-Hour Design Storm)							
Location	Drainage Area (ha)	Simulated Peak Flow (m^3/s) for Return Period (Years)					
		2	5	10	25	50	100
S1	0.12	0.001	0.004	0.008	0.013	0.017	0.021
S2	0.40	0.013	0.031	0.046	0.066	0.082	0.098
S3	0.66	0.006	0.020	0.035	0.058	0.078	0.100
S4	0.05	0.001	0.002	0.004	0.007	0.009	0.011
All	1.23	0.018	0.052	0.082	0.127	0.165	0.206
Location	Drainage Area (ha)	Comparison of Proposed to Existing Conditions Peak Flows (m^3/s)					
		2	5	10	25	50	100
S1	0	0	0	0	0	0	0
S2	0	+0.009	+0.017	+0.022	+0.026	+0.029	+0.031
S3	0	0	0	0	0	0	0
S4	0	0	0	0	0	0	0
All	0	+0.005	+0.012	+0.012	+0.010	+0.008	+0.006
Note: Due to the very small computed flows, the peak flows have been documented above to three decimal places as a means of illustrating computed changes from pre-development to post-development. This level of detail is provided for information purposes only and should not be construed as an indication of the accuracy of the simulation model computations.							

The simulated results indicate a marginal increase in peak flows for subcatchment S2 (the O&M site) for all storm events (between 9 and 31 L/s), as would be expected given the conversion to a predominantly gravel surface. The simulated modelling results indicate that the overall increase in flow is reduced at the outlet of all drainage areas however, to increases of between 5 and 12 L/s which are considered to be minor and negligible. This is considered attributable to the flow attenuation and routing impacts of the two proposed swales, which would drain the site itself as well as external areas. The swales would have a relatively low overall slope, which contributes to the simulated flow attenuation. As noted previously, the preceding analyses also assume that the external agricultural lands have a similar runoff potential to grassed areas, which depending on the season and hydrologic condition of these areas, may not in fact be the case. Based on the preceding, no further on-site quantity controls are considered warranted for the O&M Building site.

3.5.2 Substation

The proposed conditions drainage systems of the substation site have been simulated using the methodology described in Section 3.3, and as per the land use described in Section 2.2.2 (ref. Figure 2.6). Simulated peak flows for the 2 through 100 year storm events are presented in Table 3.5, along with the calculated change in peak flows as compared to the results presented in Table 3.3.

Table 3.5: Simulated Peak Flows for Substation – Proposed Conditions (SCS 6-Hour Design Storm)							
Location	Drainage Area (ha)	Simulated Peak Flow (m^3/s) for Return Period (Years)					
		2	5	10	25	50	100
S1	4.77	0.030	0.093	0.147	0.245	0.336	0.438
S2	1.26	0.010	0.028	0.042	0.067	0.089	0.114
All	6.03	0.040	0.115	0.186	0.292	0.388	0.498
Location	Drainage Area (ha)	Comparison of Proposed to Existing Conditions Peak Flows (m^3/s)					
		2	5	10	25	50	100
S1	0	+0.001	+0.004	+0.004	+0.008	+0.009	+0.011
S2	0	+0.003	+0.008	+0.009	+0.016	+0.019	+0.022
All	0	+0.005	+0.006	+0.010	+0.005	-0.007	-0.018
Note: Due to the very small computed flows, the peak flows have been documented above to three decimal places as a means of illustrating computed changes from pre-development to post-development. This level of detail is provided for information purposes only and should not be construed as an indication of the accuracy of the simulation model computations.							

The simulated results indicate marginal increases in peak flows for both subcatchment S1 (which contains the proposed gravel access road) and subcatchment S2 (the substation site) for all storm events (between 1 and 22 L/s, depending on the storm event, with higher differences for less frequent, more formative storm events). Similar to the simulated results for the O&M building site, the results at the model outlet indicate that these simulated increases in flow are generally negated at the outlet of all drainage areas (increase of 10 L/s to a simulated decrease of 18 L/s). This is again considered attributable to the flow attenuation and routing impacts of the proposed swale, which would drain the larger external drainage area (S1). The swale would again have a relatively low overall slope (consistent with the general site topography), which contributes to the simulated flow attenuation. As noted previously, the preceding analyses also assume that the external agricultural lands have a similar runoff potential to grassed areas, which depending on the season and hydrologic condition of these areas, may not in fact be the case. Further, the stone and aggregate placed around the substation has been modeled as a hard-packed gravel surface, however in reality, would be expected to have minimal if any direct runoff potential given the larger pore space. Based on the preceding, no further on-site quantity controls are considered warranted for the substation site.

In addition to the preceding, the 24-hour, 50-year storm volume has been simulated for the substation site itself (S2), using the SCS Type-II Design Storm (118.1 mm of rainfall, based on the Point Pelee IDF data). This value is required to support the design of the double containment collection system, discussed further in Section 5.2. Based on the current modelling, the runoff volume in this case is 985 m^3. This value is however likely conservative, as the transformer pit itself is somewhat smaller than the total boundary of subcatchment S2, and surface areas could be graded away accordingly. Thus, storage volumes could be calculated based on the actual area of the pit and directly draining area, and the previously noted 118.1 mm of rainfall, assuming full capture.

3.5.3 Wind Turbine Access Roads

The various proposed wind turbines to be constructed as part of the overall development will require access roads. It is understood that these access roads will be consistent with the access road proposed for the substation, namely gravel surfaced roadways, generally 5 m +\- in width to allow for periodic access for maintenance and repairs post-construction.

Based on the hydrologic modelling effort for the primary two sites (O&M Building and Substation) described in the previous sections, the hydrologic impacts of a conversion of agricultural land to gravel surface for these access roads (particularly given the nominal area involved) is also considered to be negligible. As discussed in Section 3.3, in some cases depending on the type of agricultural application and time of year, the runoff potential (as represented by the US SCS Curve Number) from the existing area may in fact be higher than under proposed conditions (gravel). Detailed hydrologic modelling of these sites is therefore not considered warranted, as no observable difference in surface runoff potential due to the construction of these access roads would be expected.

4.0 Hydraulic Assessment

4.1 Operations & Maintenance Building

As noted in previous sections, two (2) different swales have been recommended to convey flows from external drainage areas around the proposed O&M building site. This includes a western swale (subcatchment S1), and an eastern swale (subcatchments S3 and S5). Sizing calculations for the swales have been provided in Appendix A, based on Manning's equation for open channel (non-pressurized flow). The swale profile has been estimated based on matching existing surface grades at both the upstream and downstream limits (0.1 to 0.2%), and an assumed relatively shallow flow conveyance depth (0.3 m). Based on these calculations, and the simulated 100-year flow rates from Section 3.4, both swales should have a minimum bottom width of 1.0 m, and 3H:1V side slopes, resulting in a top width of approximately 2.8 m. If possible, it is recommended that a wider and deeper swale be constructed, to provide an additional measure of freeboard. The swales should be seeded following construction with a low maintenance seed mix; shorter grasses are generally preferred to avoid high density vegetation which could block flow conveyance.

4.2 Substation

As noted in previous sections, a bypass swale is necessary for the substation site in order to convey flows from external drainage areas around the proposed substation site. The external drainage area in this case (S1) is more sizeable (4.77 ha) than for the O&M Building site, and would necessitate a comparably larger swale dimension. Sizing calculations for the swale has been provided in Appendix A, based on Manning's equation for open channel (non-pressurized flow). The swale profile has been estimated based on matching existing surface grades at both the upstream and downstream limits (approximately 0.1%), and an assumed relatively shallow flow conveyance depth (0.3 m). Based on these calculations, and the simulated 100-year flow rates from Section 3.4, the swale should have a minimum bottom width of 5 m, and 3H:1V side slopes, resulting in a top width of approximately 6.8 m. If possible, it is recommended that a wider and deeper swale be constructed, to provide an additional measure of freeboard. The swale should be seeded following construction with a low maintenance seed mix; shorter grasses are generally preferred to avoid high density vegetation which could block flow conveyance.

4.3 Wind Turbine Access Roads

Based on the assessment/review outlined in Section 3.5.3, no hydrologic modelling is considered necessary for the wind turbine access roads, as no observable difference in surface runoff potential due to the creation of the gravel roadway surfaces would be expected. Notwithstanding, as part of the grading design, existing topography for the proposed access roads should be reviewed to confirm whether or not any existing watercourses or drainage features are accommodated and conveyed appropriately across the roadway, through the implementation of bypass swales and/or culverts as required.

5.0 Stormwater Quality

5.1 General Approach

Typically, the primary driver of negative stormwater quality impacts in development is the implementation of paved surfaces, particularly those subject to vehicular traffic. Paved surfaces tend to accumulate sediment and suspended solids, and along with this particulate matter related contaminants such as heavy metals. These contaminants are then washed off during rainfall events into stormwater collection systems, and ultimately into receivers. Stormwater quality management measures are then required to treat this increased contaminant loading.

No paving is proposed as part of the planned development at either the O&M building or substation sites, nor are the proposed access roads to the wind turbines proposed to be paved. As such, contaminant loadings are expected to be more comparable to pre-development conditions than paved type surfaces. In all cases, hard-packed gravel is proposed for the majoirty of the site, however even such gravel surfaces would still promote infiltration and limit the buildup, and washoff of contaminants. Further, discharge from these gravel surfaces would either be directed to grassed/vegetated swales along the perimeter or existing agricultural land, which would further promote infiltration and settling of any generated sediment.

As a further measure for on-site quality control at the two primary sites (O&M Site and Substation), it is recommended the vegetated buffers and filter strips be implemented around the perimeter of the development areas, including around the edges of the proposed grassed swale systems. These measures would further promote filtration and capture of any potential sedimentation and contaminants of concern.

Based on the preceding, stormwater quality is not expected to be a major concern, given the lack of paving and promotion of infiltration, through gravel surfaces, adjacent vegetated/grassed swales and agriculatural land, and for the two (2) primary sites, vegetated buffers and filter strips. No additional stormwater quality controls are considered warranted in this case for any of the proposed development locations.

5.2 Substation – Transformer Containment

A "double containment system" is proposed for the transformer within the substation site. A general outline of this system is as follows, and is consistent with the approved approach employed at similar sites by Wood Power & Process:

- A "double containment system" will be implemented for the transformer at the station. In addition to "first stage" of containment, namely the transformer enclosure (Conserver, Tank, etcetera), a "second Stage" of containment will be in the form of transformer containment pit system.
- The spill containment facility serving the transformer substation shall have a minimum volume equal to the volume of transformer oil and lubricants plus the volume equivalent to providing a minimum 24-hour duration, 50-year return storm capacity for the stormwater drainage area around the transformer under normal operating conditions (985 m^3, or calculated using the 50-year rainfall of 118.1 mm). The containment area shall have:
    - o an impervious floor with walls typically consisting of reinforced concrete or impervious plastic liners, sloped toward an outlet oil control device, allowing for a freeboard of 0.25 metres terminating approximately 0.30 metres above grade to prevent external stormwater flows from entering the facility. The facility shall have a minimum of 300 mm layer of crushed stone (19mm to 38mm in diameter) within, all as needed in accordance to site specific conditions. and final design parameters; or

  - a permeable floor with impervious plastic walls and around the transformer pad; equipped with subsurface drainage with a minimum 50mm diameter drain installed on a sand layer sloped toward an outlet for sample collection purposes; designed with an oil absorbent material on floor and walls and allowing for a freeboard of 0.25 metres terminating approximately 0.30 metres above grade to prevent external stormwater flows from entering the facility. The facility's berm shall be designed as needed in accordance to site specific conditions and 'the facility shall have a minimum 300mm layer of crushed stones (19mm to 38mm in diameter) on top of the system, as needed in accordance to site specific conditions and final design parameters.

- The spill containment facility shall be equipped with an oil detection system, it also shall have a minimum of two (2) PVC pipes (or equivalent material) 50mm diameter to allow for visual inspection of water accumulation. One pipe must be installed half way from the transformer pad to vehicle access route.
- Drainage from the transformer pit would be removed by either manually or automatically operating a sump pump to discharge the liquid. In either case, an oil/grease sensor would be mounted on the pump to detect any oil/grease in the liquid. The operators of the facility shall implement a REA monitoring program for oil detection. If no oil/grease is detected in the liquid, discharge would be via the stormwater collection system and a clean stormwater outlet from the containment facility.

6.0 Erosion and Sediment Control and Operations and Maintenance

6.1 Erosion and Sediment Control during Construction

Erosion and Sediment Controls must be implemented during construction in order to prevent the off-site movement of sediment, and to avoid filling and contaminating proposed stormwater management features, particularly proposed swales. Measures that should be implemented during construction include, but are not limited to:

- Establishing sediment control fence along the site perimeter, particularly the downstream side;
- Implementing rock check dams or straw bale check dams at the overall site outlet;
- Ensuring bare surfaces are re-seeded as quickly as possible following construction, and ideally undertaking construction during warm-weather periods when germination and growth of seeding would be expected; and
- Ensure regular inspection and maintenance of all erosion and sediment controls throughout the construction period.

6.2 Long Term Operations and Maintenance

All infrastructure, including stormwater management measures, will require periodic maintenance to ensure continued function and proper operation. Limited SWM controls are proposed for the current site, given the relatively minimal associated change in the site. Notwithstanding, a series of vegetated/grassed swales and vegetated buffers/filter strips have been proposed as part of the current SWM strategy for both sites. Typical operations and maintenance activities for these features include:

- Annual inspection of SWM measures
  - Condition of the vegetation (minimal growth that may lead to erosion, or excessive growth that may lead to decreased conveyance capacity);
  - Signs of erosion; and
  - Signs of sedimentation (confirmation that the originally designed conveyance depths and widths remain available).
- Maintaining a log book of inspection observations and corrective actions as required

7.0 Summary and Conclusions

A SWM assessment has been completed for the O&M Building and Substation sites, both components of the proposed Romney Wind Development. The current SWM assessment has focused on impacts and control measures for two (2) primary sites, namely the Operations and Maintenance Building, and the Substation site. Based on an assessment of the hydrologic change associated with the various gravel access roads necessary for individual wind turbine installations, little to no deviation from the current runoff regime would be expected. As part of the grading design for the roadways, existing low points (watercourses or drainage features) should be confirmed to ensure adequate conveyance (swale and/or culvert) as required.

Hydrologic modelling has been completed to assess the simulated changes in runoff (peak flows) under proposed conditions (as compared to existing conditions) at both of the preceding sites. The results indicate that simulated changes are negligible in both cases, given the overall minor changes in land use and lack of impermeable surfaces (other than roof areas for the O&M site, which would discharge to the pervious ground surface). Some flow attenuation would be provided by the proposed flow bypass swales, which would be used to direct external flows around both development sites. Based on the preceding analysis, no quantity controls are considered necessary or warranted.

Further to the preceding, given the lack of paved surfaces in any proposed development location, stormwater quality impacts are not expected to be a concern. Gravel and grassed areas will continue to promote infiltration and minimize sediment and contaminant build-up and wash-off, as is expected for urbanized paved surfaces. For the two (2) primary sites (O&M Site and Substation) the previously proposed grassed/vegetated swales will further serve to settle and infiltrate stormwater, reducing any contaminant concerns. Further, vegetated buffers and filter strips should be considered around the site perimeter for the two (2) sites, and adjacent to conveyance swales, in order to further attenuate and filter stormwater.

A “double containment” system will be implemented for the transformer at the substation site, based on the previously approved design and methods employed by Wood Power & Process at other similar sites.

Recommended Erosion and Sediment controls for the construction period have been provided as part of the current reporting, along with long term recommendations for operations and maintenance activities. These activities should focus on periodic inspections and repairs to areas showing signs of erosion, minimal or excessive vegetation growth, or excess sedimentation.

Appendix A:

Calculations and Modelling Files

idf_v2-3_2014_12_21_613_ON_613P001_POINT_PELEE_CS.txt
Environment Canada/Environnement Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2014/12/21

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POINT PELEE CS ON 613P001
(composite)
Latitude: 41 57'N Longitude: 82 31'W Elevation/Altitude: 176 m

Years/Années : 1975 - 2004 # Years/Années : 22

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Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1975	7.9	14.0	14.7	15.5	31.0	34.3	34.3	34.3	45.5
1976	9.1	13.2	17.0	20.8	22.4	32.3	37.8	48.3	49.3
1977	10.2	17.3	22.9	34.5	51.6	51.6	53.6	53.6	53.6
1978	4.6	9.1	11.4	16.0	16.0	21.2	23.9	34.5	37.0
1979	8.1	12.1	15.2	16.6	16.8	16.8	26.1	49.2	58.6
1980	11.7	17.8	18.8	25.7	35.0	37.3	41.6	41.8	70.9
1981	8.6	13.8	15.8	18.8	22.1	22.7	29.8	34.4	50.9
1982	13.4	18.8	24.9	33.8	34.7	35.9	35.9	36.4	36.4
1983	8.5	11.3	15.0	21.6	28.1	32.5	37.5	44.6	54.8
1984	12.5	17.2	18.7	19.9	22.2	25.7	29.4	33.0	33.0
1985	9.9	12.4	17.0	19.9	19.9	21.7	29.6	29.8	29.9
1986	7.4	9.9	13.3	21.9	24.0	37.7	48.2	48.4	51.0
1987	10.5	15.2	18.8	18.8	29.6	38.0	73.1	81.1	91.4
1988	7.7	9.6	10.6	13.4	15.6	18.8	29.5	37.0	40.0
1989	14.3	20.4	30.6	51.0	63.2	85.8	102.5	110.5	113.6
1990	12.2	14.1	16.7	23.3	36.7	50.5	77.9	106.3	106.4
1991	8.6	14.9	15.4	18.0	21.2	26.4	40.1	57.0	58.8
1992	6.9	9.4	12.5	22.2	36.5	55.0	75.7	83.4	85.8
1993	14.3	20.4	21.0	21.2	21.2	24.3	26.1	31.4	38.2
2002	17.6	22.4	23.2	23.4	23.4	30.2	41.8	49.0	51.6
2003	7.6	8.6	9.6	12.6	15.6	20.8	49.4	56.0	56.0
2004	13.0	19.2	23.6	41.8	61.0	63.4	65.4	65.4	72.6
# Yrs. Années	22	22	22	22	22	22	22	22	22
Mean Moyenne	10.2	14.6	17.6	23.2	29.4	35.6	45.9	53.0	58.4
Std. Dev. Écart-type	3.1	4.1	5.2	9.3	13.7	16.8	20.8	23.2	23.0
Skew. Dissymétrie	0.56	0.22	0.70	1.73	1.38	1.51	1.29	1.40	1.12
Kurtosis	3.39	2.34	3.75	6.19	4.59	5.76	4.43	4.56	3.93

*-99.9 Indicates Missing Data/Données manquantes

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Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	9.7	12.4	14.2	16.5	18.2	19.9	22
10 min	13.9	17.6	20.0	23.0	25.3	27.5	22
15 min	16.7	21.3	24.3	28.1	31.0	33.8	22
30 min	21.7	29.9	35.4	42.3	47.4	52.5	22
1 h	27.2	39.3	47.4	57.5	65.1	72.5	22
2 h	32.8	47.7	57.5	70.0	79.2	88.4	22
6 h	42.5	60.8	73.0	88.4	99.8	111.1	22
12 h	49.2	69.7	83.2	100.3	113.1	125.7	22
24 h	54.6	75.0	88.5	105.5	118.1	130.7	22

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	116.4	149.2	170.8	198.2	218.6	238.7	22
	+/- 14.2	+/- 23.9	+/- 32.3	+/- 43.6	+/- 52.2	+/- 60.8	22
10 min	83.5	105.4	119.9	138.2	151.7	165.2	22
	+/- 9.5	+/- 16.0	+/- 21.6	+/- 29.1	+/- 34.8	+/- 40.6	22
15 min	66.9	85.2	97.3	112.5	123.8	135.1	22
	+/- 7.9	+/- 13.3	+/- 18.0	+/- 24.3	+/- 29.1	+/- 33.9	22
30 min	43.4	59.9	70.8	84.6	94.8	105.0	22
	+/- 7.2	+/- 12.1	+/- 16.3	+/- 22.0	+/- 26.3	+/- 30.6	22
1 h	27.2	39.3	47.4	57.5	65.1	72.5	22
	+/- 5.3	+/- 8.9	+/- 12.0	+/- 16.2	+/- 19.3	+/- 22.5	22
2 h	16.4	23.8	28.8	35.0	39.6	44.2	22
	+/- 3.2	+/- 5.4	+/- 7.3	+/- 9.9	+/- 11.8	+/- 13.8	22
6 h	7.1	10.1	12.2	14.7	16.6	18.5	22
	+/- 1.3	+/- 2.2	+/- 3.0	+/- 4.1	+/- 4.9	+/- 5.7	22
12 h	4.1	5.8	6.9	8.4	9.4	10.5	22
	+/- 0.7	+/- 1.2	+/- 1.7	+/- 2.3	+/- 2.7	+/- 3.2	22
24 h	2.3	3.1	3.7	4.4	4.9	5.4	22
	+/- 0.4	+/- 0.6	+/- 0.8	+/- 1.1	+/- 1.4	+/- 1.6	22

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

****

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	40.8	53.5	62.0	72.6	80.5	88.4

Std. Dev. /Écart-type (RR)	40.3	50.8	57.8	66.7	73.3	79.8
Std. Error/Erreur-type	9.0	12.8	15.4	18.7	21.1	23.6
Coefficient (A)	24.3	33.1	38.8	46.1	51.5	56.8
Exponent/Exposant (B)	-0.704	-0.684	-0.675	-0.667	-0.663	-0.660
Mean % Error/% erreur moyenne	8.3	10.9	12.3	13.6	14.3	14.9

6 HOUR SCS DESIGN STORM (IDF DATA FROM POINT PELEE CS 613P001)

Total Depth		42.5	60.8	73	88.4	99.8	111.1

	***Time Ending**	***% Inc**	**Depth/Increment**					
			2	**5**	**10**	**25**	**50**	**100**
	0	0	0					
30	0.5	0.02	0.85	1.216	1.46	1.768	1.996	2.222
60	1	0.03	1.275	1.824	2.19	2.652	2.994	3.333
90	1.5	0.03	1.275	1.824	2.19	2.652	2.994	3.333
120	2	0.05	2.125	3.04	3.65	4.42	4.99	5.555
150	2.5	0.06	2.55	3.648	4.38	5.304	5.988	6.666
165	2.75	0.15	6.375	9.12	10.95	13.26	14.97	16.665
180	3	0.39	16.575	23.712	28.47	34.476	38.922	43.329
210	3.5	0.11	4.675	6.688	8.03	9.724	10.978	12.221
240	4	0.05	2.125	3.04	3.65	4.42	4.99	5.555
270	4.5	0.04	1.7	2.432	2.92	3.536	3.992	4.444
300	5	0.03	1.275	1.824	2.19	2.652	2.994	3.333
360	6	0.04	1.7	2.432	2.92	3.536	3.992	4.444

* ref Design Chart 1.05 MTO Drainage Manutal

	Intensity (mm/hr)					
Time Step	2	5	10	25	50	100
10	1.70	2.43	2.92	3.54	3.99	4.44
20	1.70	2.43	2.92	3.54	3.99	4.44
30	1.70	2.43	2.92	3.54	3.99	4.44
40	2.55	3.65	4.38	5.30	5.99	6.67
50	2.55	3.65	4.38	5.30	5.99	6.67
60	2.55	3.65	4.38	5.30	5.99	6.67
70	2.55	3.65	4.38	5.30	5.99	6.67
80	2.55	3.65	4.38	5.30	5.99	6.67
90	2.55	3.65	4.38	5.30	5.99	6.67
100	4.25	6.08	7.30	8.84	9.98	11.11
110	4.25	6.08	7.30	8.84	9.98	11.11
120	4.25	6.08	7.30	8.84	9.98	11.11
130	5.10	7.30	8.76	10.61	11.98	13.33
140	5.10	7.30	8.76	10.61	11.98	13.33
150	5.10	7.30	8.76	10.61	11.98	13.33
160	25.50	36.48	43.80	53.04	59.88	66.66
170	45.90	65.66	78.84	95.47	107.78	119.99
180	66.30	94.85	113.88	137.90	155.69	173.32
190	9.35	13.38	16.06	19.45	21.96	24.44
200	9.35	13.38	16.06	19.45	21.96	24.44
210	9.35	13.38	16.06	19.45	21.96	24.44
220	4.25	6.08	7.30	8.84	9.98	11.11
230	4.25	6.08	7.30	8.84	9.98	11.11
240	4.25	6.08	7.30	8.84	9.98	11.11
250	3.40	4.86	5.84	7.07	7.98	8.89
260	3.40	4.86	5.84	7.07	7.98	8.89
270	3.40	4.86	5.84	7.07	7.98	8.89
280	2.55	3.65	4.38	5.30	5.99	6.67
290	2.55	3.65	4.38	5.30	5.99	6.67
300	2.55	3.65	4.38	5.30	5.99	6.67
310	1.70	2.43	2.92	3.54	3.99	4.44
320	1.70	2.43	2.92	3.54	3.99	4.44
330	1.70	2.43	2.92	3.54	3.99	4.44
340	1.70	2.43	2.92	3.54	3.99	4.44
350	1.70	2.43	2.92	3.54	3.99	4.44
360	1.70	2.43	2.92	3.54	3.99	4.44

TABLE A1 - BASE HYDROLOGIC PARAMETERIZATION (O&M BUILDING)

Land Use	CN (AMC-II)	Initial Abstraction (mm)
Forest	79	7
Row Crops	80	5
Grass	80	5
Gravel	91	2
Rooftop/Paved	98	1

TABLE A2 - CALCULATION OF SCS CURVE NUMBER AND IMPERVIOUSNESS (O&M BUILDING)

Land Use	Sub	Total Area (ha)	Forest (ha)	Row Crops (ha)	Grass (ha)	Gravel (ha)	Rooftop/Paved - Disconnected (ha)	Rooftop/Paved/Open Water - Connected (ha)	Imperviousness (%)	CN Pervious Area (AMC-II)	IA Pervious Area (mm)
Existing	S1	0.12	0.00	0.12	0.0000	0.00	0.0019	0.000	1.5%	80.0	5.0
	S2	0.40	0.00	0.40	0.0000	0.00	0.0000	0.000	0.0%	80.0	5.0
	S3	0.66	0.00	0.66	0.0000	0.00	0.0000	0.000	0.0%	80.0	5.0
	S4	0.05	0.00	0.00	0.0528	0.00	0.0000	0.000	0.0%	80.0	5.0
Proposed	S1	0.12	0.00	0.12	0.0000	0.00	0.0000	0.000	0.0%	80.0	5.0
	S2	0.40	0.04	0.00	0.0213	0.33	0.0070	0.000	1.7%	89.2	2.7
	S3	0.66	0.00	0.66	0.0000	0.00	0.0000	0.000	0.0%	80.0	5.0
	S4	0.05	0.00	0.00	0.0488	0.00	0.0040	0.000	0.0%	80.0	5.0

TABLE A3 - CALCULATION OF OVERLAND FLOW LENGTH AND SLOPE (O&M BUILDING)

Land Use	Sub	Total Area (ha)	Slope (%)	Channel Length (m)	Calculated Overland Flow Length (m)	Applied Overland Flow Length (m)
Existing	S1	0.12	0.10	27	27	30
	S2	0.40	0.10	81	29	30
	S3	0.66	0.10	114	34	35
	S4	0.05	0.10	24	13	20
Proposed	S1	0.12	0.10	27	27	30
	S2	0.40	0.10	81	29	30
	S3	0.66	0.10	114	34	35
	S4	0.05	0.10	24	13	20

TABLE A4 - BASE HYDROLOGIC PARAMETERIZATION (SUBSTATION)

Land Use	CN (AMC-II)	Initial Abstraction (mm)
Forest	79	7
Row Crops	80	5
Grass	80	5
Gravel	91	2
Rooftop/Paved	98	1

TABLE A5 - CALCULATION OF SCS CURVE NUMBER AND IMPERVIOUSNESS (SUBSTATION)

Land Use	Sub	Total Area (ha)	Forest (ha)	Row Crops (ha)	Grass (ha)	Gravel (ha)	Rooftop/Paved - Disconnected (ha)	Rooftop/Paved/Open Water - Connected (ha)	Imperviousness (%)	CN Pervious Area (AMC-II)	IA Pervious Area (mm)
Existing	S1	4.77	0.00	4.77	0.0000	0.00	0.0000	0.000	0.0%	80.0	5.0
	S2	1.26	0.00	1.26	0.0000	0.00	0.0000	0.000	0.0%	80.0	5.0
Proposed	S1	4.77	0.00	4.55	0.0000	0.22	0.0000	0.000	0.0%	80.5	4.9
	S2	1.26	0.00	0.79	0.0000	0.47	0.0000	0.000	0.0%	84.1	3.9

TABLE A6 - CALCULATION OF OVERLAND FLOW LENGTH AND SLOPE (SUBSTATION)

Land Use	Sub	Total Area (ha)	Slope (%)	Channel Length (m)	Calculated Overland Flow Length (m)	Applied Overland Flow Length (m)
Existing	S1	4.77	0.10	420	67	70
	S2	1.26	0.10	85	87	90
Proposed	S1	4.77	0.10	420	67	70
	S2	1.26	0.10	85	87	90

EXISTING CONDITIONS - SUBSTATION

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 2
Number of nodes 1
Number of links 0
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
POINTPELEE	6hr_SCSII_100Y	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
S1	4.77	681.10	0.00	0.1000	POINTPELEE	OF1
S2	1.26	140.53	0.00	0.1000	POINTPELEE	OF1

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
OF1	OUTFALL	179.03	0.00	0.0	

****
Transect Summary
****

Transect OverlandFlow
Area:

0.0007	0.0026	0.0059	0.0105	0.0165
0.0234	0.0309	0.0390	0.0478	0.0571
0.0671	0.0777	0.0889	0.1007	0.1132
0.1262	0.1399	0.1542	0.1691	0.1846
0.2006	0.2171	0.2339	0.2511	0.2687
0.2867	0.3051	0.3239	0.3431	0.3626

```
            0.3827     0.4035     0.4249     0.4470     0.4698
            0.4936     0.5190     0.5459     0.5744     0.6044
            0.6400     0.6765     0.7138     0.7521     0.7912
            0.8312     0.8721     0.9138     0.9565     1.0000
Hrad:
            0.0220     0.0440     0.0660     0.0880     0.1101
            0.1428     0.1739     0.2036     0.2323     0.2601
            0.2873     0.3138     0.3399     0.3656     0.3909
            0.4159     0.4406     0.4651     0.4895     0.5136
            0.5445     0.5751     0.6052     0.6350     0.6644
            0.6935     0.7223     0.7508     0.7790     0.8070
            0.8243     0.8419     0.8597     0.8778     0.8961
            0.9135     0.9292     0.9436     0.9571     0.8318
            0.8581     0.8843     0.9102     0.9360     0.9616
            0.9869     1.0121     1.0372     1.0620     1.0000
Width:
            0.0300     0.0600     0.0900     0.1200     0.1500
            0.1640     0.1780     0.1920     0.2060     0.2200
            0.2340     0.2480     0.2620     0.2760     0.2900
            0.3040     0.3180     0.3320     0.3460     0.3600
            0.3690     0.3780     0.3870     0.3960     0.4050
            0.4140     0.4230     0.4320     0.4410     0.4500
            0.4650     0.4800     0.4950     0.5100     0.5250
            0.5600     0.5950     0.6300     0.6650     0.8000
            0.8200     0.8400     0.8600     0.8800     0.9000
            0.9200     0.9400     0.9600     0.9800     1.0000


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Starting Date ............ 12/01/2016 00:00:00
Ending Date .............. 12/01/2016 12:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.670       111.100
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.264        43.842
Surface Runoff ...........         0.367        60.772
Final Storage ............         0.040         6.558
Continuity Error (%) .....        -0.065
```

************************* Flow Routing Continuity *************************	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.367	3.666
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.367	3.666
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
S1	111.10	0.00	0.00	43.84	60.99	2.91	0.43	0.549
S2	111.10	0.00	0.00	43.84	59.94	0.76	0.09	0.540

Analysis begun on: Thu Oct 04 22:49:01 2018
Analysis ended on: Thu Oct 04 22:49:01 2018
Total elapsed time: < 1 sec

PROPOSED CONDITIONS - SUBSTATION SITE

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 2
Number of nodes 3
Number of links 2
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
POINTPELEE	6hr_SCSII_100Y	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
S1	4.77	681.10	0.00	0.1000	POINTPELEE	J2
S2	1.26	140.53	0.00	0.1000	POINTPELEE	OF1

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	179.25	0.50	0.0	
J2	JUNCTION	179.15	0.50	0.0	
OF1	OUTFALL	179.03	0.50	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	J1	J2	CONDUIT	80.9	0.1236	0.0350
C2	J2	OF1	CONDUIT	113.8	0.1055	0.0350

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	TRAPEZOIDAL	0.50	3.25	0.40	8.00	1	1.77
C2	TRAPEZOIDAL	0.50	3.25	0.40	8.00	1	1.63

****
Transect Summary
****

Transect OverlandFlow

Area:

0.0007	0.0026	0.0059	0.0105	0.0165
0.0234	0.0309	0.0390	0.0478	0.0571
0.0671	0.0777	0.0889	0.1007	0.1132
0.1262	0.1399	0.1542	0.1691	0.1846
0.2006	0.2171	0.2339	0.2511	0.2687
0.2867	0.3051	0.3239	0.3431	0.3626
0.3827	0.4035	0.4249	0.4470	0.4698
0.4936	0.5190	0.5459	0.5744	0.6044
0.6400	0.6765	0.7138	0.7521	0.7912
0.8312	0.8721	0.9138	0.9565	1.0000

Hrad:

0.0220	0.0440	0.0660	0.0880	0.1101
0.1428	0.1739	0.2036	0.2323	0.2601
0.2873	0.3138	0.3399	0.3656	0.3909
0.4159	0.4406	0.4651	0.4895	0.5136
0.5445	0.5751	0.6052	0.6350	0.6644
0.6935	0.7223	0.7508	0.7790	0.8070
0.8243	0.8419	0.8597	0.8778	0.8961
0.9135	0.9292	0.9436	0.9571	0.8318
0.8581	0.8843	0.9102	0.9360	0.9616
0.9869	1.0121	1.0372	1.0620	1.0000

Width:

0.0300	0.0600	0.0900	0.1200	0.1500
0.1640	0.1780	0.1920	0.2060	0.2200
0.2340	0.2480	0.2620	0.2760	0.2900
0.3040	0.3180	0.3320	0.3460	0.3600
0.3690	0.3780	0.3870	0.3960	0.4050
0.4140	0.4230	0.4320	0.4410	0.4500
0.4650	0.4800	0.4950	0.5100	0.5250
0.5600	0.5950	0.6300	0.6650	0.8000
0.8200	0.8400	0.8600	0.8800	0.9000
0.9200	0.9400	0.9600	0.9800	1.0000

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****

Flow Units .... CMS

```
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ 12/01/2016 00:00:00
Ending Date .............. 12/01/2016 12:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.670       111.100
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.250        41.430
Surface Runoff ...........         0.382        63.316
Final Storage ............         0.039         6.429
Continuity Error (%) .....        -0.067


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.382         3.819
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.381         3.809
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.001         0.011
Continuity Error (%) .....        -0.023


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.
```

****
Routing Time Step Summary
****

Minimum Time Step :	4.50 sec
Average Time Step :	5.00 sec
Maximum Time Step :	5.00 sec
Percent in Steady State :	0.00
Average Iterations per Step :	2.00
Percent Not Converging :	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
S1	111.10	0.00	0.00	42.90	61.96	2.95	0.44	0.558
S2	111.10	0.00	0.00	35.90	68.42	0.87	0.11	0.616

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.02	0.16	179.41	0 03:23	0.16
J2	JUNCTION	0.08	0.26	179.41	0 03:22	0.26
OF1	OUTFALL	0.02	0.08	179.11	0 03:22	0.08

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent

----

J1	JUNCTION	0.000	0.071	0	03:09	0	0.0374	0.685
J2	JUNCTION	0.438	0.438	0	03:10	2.95	2.99	0.321
OF1	OUTFALL	0.114	0.498	0	03:21	0.865	3.81	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	80.81	0.109	0.498	3.809
System	80.81	0.109	0.498	3.809

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.071	0 03:09	0.10	0.04	0.42
C2	CONDUIT	0.393	0 03:22	0.41	0.24	0.35

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	---------- Fraction of Time in Flow Class ---------- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.22	0.04	0.00	0.75	0.00	0.00	0.00	0.45	0.00
C2	1.00	0.22	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Thu Oct 04 22:49:17 2018
Analysis ended on: Thu Oct 04 22:49:17 2018
Total elapsed time: < 1 sec

EXISTING CONDITIONS - O&M SITE

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 4
Number of nodes 2
Number of links 1
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
POINTPELEE	6hr_SCSII_100Y	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
S1	0.12	41.20	1.50	0.1000	POINTPELEE	J4
S2	0.40	133.40	0.00	0.1000	POINTPELEE	J4
S3	0.66	188.74	0.00	0.1000	POINTPELEE	J4
S4	0.05	26.40	0.00	0.1000	POINTPELEE	J4

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J4	JUNCTION	185.05	0.30	0.0	
OF1	OUTFALL	185.01	0.21	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness

```
  C1                J4                OF1               CONDUIT            27.3    0.1282
0.0450
```

```
  ********************
  Cross Section Summary
  ********************
```

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	OverlandFlow	0.21	7.12	0.14	51.55	1	1.51

```
  ****************
  Transect Summary
  ****************
```

Transect OverlandFlow

Area:

0.0001	0.0005	0.0011	0.0021	0.0045
0.0083	0.0131	0.0201	0.0282	0.0369
0.0467	0.0578	0.0698	0.0828	0.0974
0.1141	0.1325	0.1517	0.1714	0.1918
0.2128	0.2351	0.2589	0.2831	0.3076
0.3323	0.3573	0.3824	0.4077	0.4331
0.4592	0.4857	0.5125	0.5395	0.5667
0.5942	0.6219	0.6498	0.6779	0.7061
0.7345	0.7631	0.7919	0.8210	0.8504
0.8799	0.9096	0.9396	0.9697	1.0000

Hrad:

0.0152	0.0305	0.0457	0.0576	0.0585
0.0666	0.0837	0.0856	0.1029	0.1264
0.1471	0.1584	0.1808	0.1972	0.2189
0.2077	0.2146	0.2424	0.2695	0.2958
0.3202	0.3425	0.3339	0.3622	0.3902
0.4180	0.4460	0.4741	0.5020	0.5298
0.5533	0.5801	0.6065	0.6328	0.6589
0.6849	0.7108	0.7372	0.7635	0.7897
0.8143	0.8374	0.8604	0.8833	0.9081
0.9328	0.9574	0.9820	1.0064	1.0000

Width:

0.0081	0.0163	0.0244	0.0518	0.1028
0.1465	0.1668	0.2559	0.2749	0.3013
0.3434	0.3836	0.4053	0.4516	0.5155
0.5769	0.6267	0.6383	0.6580	0.6777
0.7118	0.7575	0.7921	0.8004	0.8092
0.8181	0.8236	0.8284	0.8331	0.8430
0.8686	0.8761	0.8838	0.8916	0.8993
0.9071	0.9146	0.9196	0.9247	0.9297
0.9364	0.9445	0.9527	0.9608	0.9674
0.9739	0.9804	0.9870	0.9935	1.0000

```
  *********************************************************
  NOTE: The summary statistics displayed in this report are
  based on results found at every computational time step,
  not just on results from each reporting time step.
  *********************************************************
```

```
  ****************
  Analysis Options
  ****************
```

```
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ 12/01/2016 00:10:00
Ending Date .............. 12/02/2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.137       111.100
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.058        46.898
Surface Runoff ...........         0.078        63.073
Final Storage ............         0.002         1.257
Continuity Error (%) .....        -0.115


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.078         0.780
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.078         0.780
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.004


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.
```

****
Routing Time Step Summary
****

Minimum Time Step	:	3.50 sec
Average Time Step	:	5.00 sec
Maximum Time Step	:	5.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
S1	111.10	0.00	0.00	46.13	63.86	0.08	0.02	0.575
S2	111.10	0.00	0.00	46.84	63.13	0.25	0.07	0.568
S3	111.10	0.00	0.00	47.13	62.83	0.42	0.10	0.566
S4	111.10	0.00	0.00	46.25	63.79	0.03	0.01	0.574

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J4	JUNCTION	0.01	0.10	185.15	0 03:02	0.10
OF1	OUTFALL	0.01	0.10	185.11	0 03:02	0.10

****
Node Inflow Summary
****

	Maximum Lateral Inflow	Maximum Total Inflow	Time of Max Occurrence	Lateral Inflow Volume	Total Inflow Volume	Flow Balance

Node	Type	CMS	CMS	days hr:min	10^6 ltr	10^6 ltr	Error Percent
J4	JUNCTION	0.200	0.200	0 03:00	0.78	0.78	-0.004
OF1	OUTFALL	0.000	0.186	0 03:02	0	0.78	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	34.91	0.026	0.186	0.780
System	34.91	0.026	0.186	0.780

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CHANNEL	0.186	0 03:02	0.10	0.12	0.46

****
Flow Classification Summary
****

	Adjusted	---------- Fraction of Time in Flow Class ----------								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.10	0.00	0.00	0.90	0.00	0.00	0.00	0.45	0.00

```
*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Thu Oct 04 22:28:21 2018
Analysis ended on:  Thu Oct 04 22:28:21 2018
Total elapsed time: < 1 sec
```

FUTURE CONDITIONS - O&M SITE

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 4
Number of nodes 6
Number of links 5
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
POINTPELEE	6hr_SCSII_100Y	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
S1	0.12	41.20	1.50	0.1000	POINTPELEE	J6
S2	0.40	133.40	1.70	0.1000	POINTPELEE	J4
S3	0.66	188.74	0.00	0.1000	POINTPELEE	J5
S4	0.05	26.40	0.00	0.1000	POINTPELEE	J3

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J2	JUNCTION	185.30	0.30	0.0	
J3	JUNCTION	185.14	0.30	0.0	
J4	JUNCTION	185.05	0.30	0.0	
J5	JUNCTION	185.23	0.30	0.0	
J6	JUNCTION	185.17	0.30	0.0	
OF1	OUTFALL	185.01	0.21	0.0	

****
Link Summary
****

Name From Node To Node Type Length %Slope Roughness

```
---------------------------------------------------------------------------------------------
---
  C1               J4               OF1              CONDUIT              34.6    0.1010
0.0450
  C2               J6               J4               CONDUIT              67.1    0.1789
0.0450
  C2_1             J2               J5               CONDUIT              28.1    0.2595
0.0350
  C2_2             J5               J3               CONDUIT              48.8    0.1843
0.0350
  C3               J3               J4               CONDUIT              40.9    0.2125
0.0350
```

```
  *********************
  Cross Section Summary
  *********************
                                        Full     Full     Hyd.     Max.   No. of     Full
  Conduit          Shape               Depth     Area     Rad.    Width  Barrels     Flow
  ---------------------------------------------------------------------------------------
  C1               OverlandSection      0.21     7.12     0.14    51.55        1     1.34
  C2               TRAPEZOIDAL          0.30     0.42     0.18     2.30        1     0.12
  C2_1             TRAPEZOIDAL          0.30     0.87     0.22     3.80        1     0.47
  C2_2             TRAPEZOIDAL          0.30     0.87     0.22     3.80        1     0.39
  C3               TRAPEZOIDAL          0.30     0.87     0.22     3.80        1     0.42
```

```
  ****************
  Transect Summary
  ****************

  Transect OverlandSection
  Area:
             0.0001     0.0005     0.0011     0.0021     0.0045
             0.0083     0.0131     0.0201     0.0282     0.0369
             0.0467     0.0578     0.0698     0.0828     0.0974
             0.1141     0.1325     0.1517     0.1714     0.1918
             0.2128     0.2351     0.2589     0.2831     0.3076
             0.3323     0.3573     0.3824     0.4077     0.4331
             0.4592     0.4857     0.5125     0.5395     0.5667
             0.5942     0.6219     0.6498     0.6779     0.7061
             0.7345     0.7631     0.7919     0.8210     0.8504
             0.8799     0.9096     0.9396     0.9697     1.0000
  Hrad:
             0.0152     0.0305     0.0457     0.0576     0.0585
             0.0666     0.0837     0.0856     0.1029     0.1264
             0.1471     0.1584     0.1808     0.1972     0.2189
             0.2077     0.2146     0.2424     0.2695     0.2958
             0.3202     0.3425     0.3339     0.3622     0.3902
             0.4180     0.4460     0.4741     0.5020     0.5298
             0.5533     0.5801     0.6065     0.6328     0.6589
             0.6849     0.7108     0.7372     0.7635     0.7897
             0.8143     0.8374     0.8604     0.8833     0.9081
             0.9328     0.9574     0.9820     1.0064     1.0000
  Width:
             0.0081     0.0163     0.0244     0.0518     0.1028
             0.1465     0.1668     0.2559     0.2749     0.3013
             0.3434     0.3836     0.4053     0.4516     0.5155
             0.5769     0.6267     0.6383     0.6580     0.6777
             0.7118     0.7575     0.7921     0.8004     0.8092
             0.8181     0.8236     0.8284     0.8331     0.8430
```

0.8686	0.8761	0.8838	0.8916	0.8993
0.9071	0.9146	0.9196	0.9247	0.9297
0.9364	0.9445	0.9527	0.9608	0.9674
0.9739	0.9804	0.9870	0.9935	1.0000

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ 12/01/2016 00:10:00
Ending Date .............. 12/02/2016 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m

**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.137       111.100
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.050        40.394
Surface Runoff ...........         0.086        69.589
Final Storage ............         0.002         1.251
Continuity Error (%) .....        -0.121

**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.086         0.861
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.086         0.861
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
```

Final Stored Volume 0.000 0.000
Continuity Error (%) 0.000

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	3.50 sec
Average Time Step	:	5.00 sec
Maximum Time Step	:	5.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
S1	111.10	0.00	0.00	46.13	63.86	0.08	0.02	0.575
S2	111.10	0.00	0.00	26.73	83.27	0.33	0.10	0.750
S3	111.10	0.00	0.00	47.13	62.83	0.42	0.10	0.566
S4	111.10	0.00	0.00	46.25	63.79	0.03	0.01	0.574

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J2	JUNCTION	0.00	0.06	185.36	0 03:02	0.06

J3	JUNCTION	0.01	0.14	185.28	0	03:04	0.14
J4	JUNCTION	0.02	0.10	185.15	0	03:05	0.10
J5	JUNCTION	0.01	0.14	185.36	0	03:02	0.14
J6	JUNCTION	0.01	0.13	185.30	0	03:03	0.13
OF1	OUTFALL	0.02	0.10	185.12	0	03:05	0.10

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J2	JUNCTION	0.000	0.004	0 02:57	0	0.0021	0.391
J3	JUNCTION	0.011	0.104	0 03:02	0.0337	0.449	0.034
J4	JUNCTION	0.098	0.206	0 03:02	0.333	0.861	0.019
J5	JUNCTION	0.100	0.100	0 03:00	0.415	0.417	-0.033
J6	JUNCTION	0.021	0.021	0 03:00	0.0789	0.0789	-0.036
OF1	OUTFALL	0.000	0.199	0 03:05	0	0.861	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	51.41	0.020	0.199	0.861

System	51.41	0.020	0.199	0.861

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CHANNEL	0.199	0 03:05	0.10	0.15	0.48
C2	CONDUIT	0.019	0 03:03	0.20	0.16	0.39
C2_1	CONDUIT	0.004	0 02:57	0.03	0.01	0.33
C2_2	CONDUIT	0.094	0 03:02	0.29	0.24	0.46
C3	CONDUIT	0.101	0 03:04	0.35	0.24	0.41

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.07	0.00	0.00	0.93	0.00	0.00	0.00	0.05	0.00
C2	1.00	0.07	0.04	0.00	0.90	0.00	0.00	0.00	0.86	0.00
C2_1	1.00	0.12	0.66	0.00	0.22	0.00	0.00	0.00	0.84	0.00
C2_2	1.00	0.10	0.01	0.00	0.88	0.00	0.00	0.00	0.87	0.00
C3	1.00	0.07	0.04	0.00	0.89	0.00	0.00	0.00	0.84	0.00

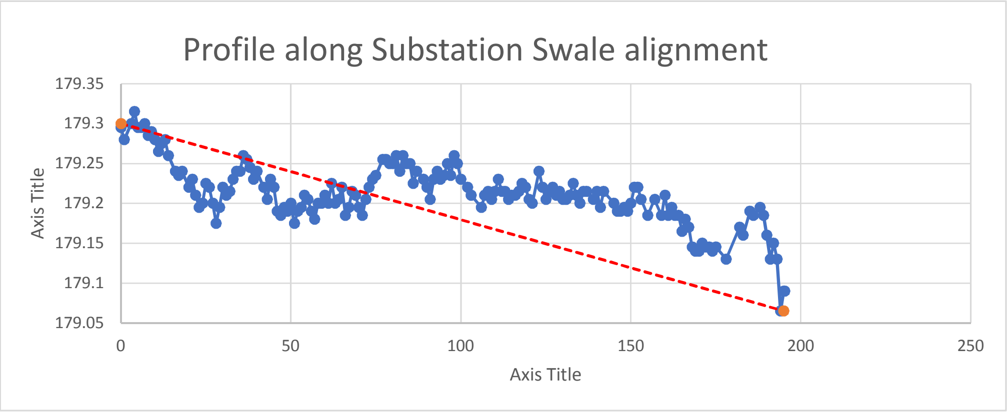
****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Thu Oct 04 22:52:23 2018
Analysis ended on: Thu Oct 04 22:52:23 2018
Total elapsed time: < 1 sec

SWALE CAPACITY CALCULATIONS - SUBSTATION

Swale Capacity (West)	
Side slopes (H_V m/m)=	3
Slope	0.12%
Mannings n =	0.035
Length - L (m) =	120
water Depth -D (m) =	0.3
Bottom Width (m) =	5
Top Width (m) =	6.8
A =	1.77
R =	0.26
Qcap =	0.71
100y Flow from Modelling	0.5



SWALE CAPACITY CALCULATIONS - O&M BUILDING

Swale Capacity (West)	
Side slopes (H_V m/m)=	3
Slope	0.17%
Mannings n =	0.035
Length - L (m) =	70
water Depth -D (m) =	0.3
Bottom Width (m) =	1
Top Width (m) =	2.8
A =	0.57
R =	0.19673
Q =	0.23
100Y Flow from modelling	0.02

Swale Capacity (East)	
Side slopes (H_V m/m)=	3
Slope	0.10%
Mannings n =	0.035
Length - L (m) =	120
water Depth -D (m) =	0.3
Bottom Width (m) =	1
Top Width (m) =	2.8
A =	0.57
R =	0.19673
Q =	0.178
100Y Flow from modelling	0.101