

STORMWATER MANAGEMENT REPORT

***On Proposed development of the Soventix Unilever 3.2MWp
Solar Photo-Voltaic (PV) Plant for Erven 757 & 758 of
Boksburg East Extension 19 (part of the remainder of portion
127 of the farm Vogelfontein 84-IR)***

***City of Ekurhuleni Metropolitan Municipality, Gauteng
Province.***

A . D . A

c o n s u l t i n g e n g i n e e r s

29th March 2022

STORMWATER MANAGEMENT REPORT

FOR

Proposed development of the Soventix Unilever 3.2MWp Solar Photo-Voltaic (PV) Plant.

On erven 757 & 758 of Boksburg East Extension 19 (part of the remainder of portion 127 of the farm Vogelfontein 84-IR)

CONTENTS

1	INTRODUCTION & BACKGROUND
2	HYDROLOGY
3	RAINFALL
4	MODELING
5	PEAK OUTFLOWS & ATTACHED HYDRO GRAPHS
6	RESULTS
7	ATTENUATION
8	RECOMMENDATIONS
9	ANNEXURES

1. INTRODUCTION

This report is compiled to address the internal storm water management for the proposed solar farm development. We will be seeking your (Ekurhuleni stormwater department) approval of this report so that we may continue with the SDP submissions and the submission of construction drawings to the various departments.

2. PROPERTY BACKGROUND

The following comments will give a more in detail description of the property and the make-up of what is current and what will be proposed for the property.

- The proposed development will be a solar farm which will service UNILVER SA INDUSTRIAL FACTORY located south of the proposed development.
- Properties that have been included on the proposal of the SUN-PANEL farm are as follows
 - Erf 757, remainder of portion 127 & 108 of the Farm Volgenfontein No. 84-IR
- The above-mentioned properties will hence forth be referred to as the proposed property.
- Die proposed properties will have a total area of 16.2Ha, of that total area only 24% or 4ha of the properties will be part of construction for the sun-panel erections.
- The proposed property is currently covered with medium plant growth and grass fields with large gums trees spaced close to each other.
- The existing ground surface falls from the south easterly corner 1634.00 to the North-western corner 1625.00 of the proposed property with low points in the centre of the property at an average gradient of 1.34 % fall.
- The proposals in the Ecoleges Environmental consultant screening reports (SOLAR PV-ALT 1-3) have all been accommodated in this Stormwater management report.
- Taking the previous comment into consideration, which ever area is approved for the sun panels to be erected the works to be done in this area will still accommodate and control the stormwater as per HydroCad simulation and calculations.
- The property does not have any existing formal storm water lines or infrastructure.
- A municipal stormwater culvert 800x800 is available and is situated on the Northern boundary of the of the property which will serve as the outlet for the proposed development.
- The culvert mentioned in above statement currently services the proposed property stormwater run-off as well as the higher lying property Ceoco (Portion 1 of Erf 725, Erf 755 & Erf 756 EXT 1, BOKSBURG EAST
- These properties stormwater contribution will be included in our stormwater analysis and calculations.
- All the stormwater that is currently entering the site from neighbouring properties & other surrounding areas will be included into the stormwater analysis and calculations
- Stormwater accumulated from property Unilever & DHL (Re of portion 277) that is currently entering the proposed sun panel development area is flowing into an open earth channel whose stormwater is connecting to the exiting stormwater channel .
- The stormwater Unilever & DHL (Re of Portion 277) will not be controlled in the sun panel area development attenuation pond but merely be kept in its current state.

3. HYDROLOGY

Rainfall estimation in this report has been based on the Rational method as per “Urban Stormwater Management in SA – Stedelike Vloedwater Beheer in SA - Pretoria 1983”.

Calculations based on PC based Design Flood Estimates for Small Catchments in Southern Africa, by RE Schulze, EJ Schmidt and JC Smithers.

4. Rainfall

A triangular storm and a MAP (mean annual precipitation) between 600-900 mm has been used.. Please see attached Annexure B that shows the rational method of each area that was determined for storm water runoff.

The 1 in 5, 1 in 25 and 1 in 50 storms events were simulated in the storm water run-off model. These storm durations were selected as they provide the peak outflow. The storm intensities for the 1 in 5, 1 in 25 and 1 in 50 return periods are as follows for the pre-development & post-development scenario.

5. Modelling

The computer modelling was carried out using Hydrocad version 9.1 computer software written by Applied Microcomputer Systems of the USA. Hydrocad is a Computer Aided Design system for modelling the hydrology and hydraulics of stormwater runoff. It is based largely on the hydrology techniques developed by the Soil Conservation Service (SCS/NRCS), combined with other hydrology and hydraulics calculations. For a given rainfall event, these techniques are used to generate hydrographs throughout a watershed.

Additional areas have been included in the stormwater calculation as these areas' stormwater is currently being discharged into our proposed development property as well as into the exiting stormwater Culvert.

Modelling was carried out for the following events.

- 1 in 5-year event with the pre & post development of the area
- 1 in 25-year event with the pre & post development of the area
- 1 in 50-year event with the pre & post development of the area
- 1 in 50-year event with the post development of the area (CEOCO HIGHER LYING PROPERTY)

Hydrograph Input Data:

Description	Average Factor	
Sun Panel Pre development site:	C2	0.230
Sun Panel Post developed Site:	C2	0.328
Ceoco Contributing area Post development Site:	C2	0.625

6. Peak Outflows: Attached Hydrograph

The following table was compiled and simplified for your convenience from the information obtained in the Rational method sheets and the Hydro Cad Analyses sheets. The notes below will indicate the contributing areas that have been included in the hydro calculations as to provide a complete and comprehensive breakdown of the total stormwater accumulated on site that is discharged into the existing concrete culvert outlet.

Additional Notes:

AREA 1 (SUN PANEL AREA)

- Properties that have been included on the Proposed development of the Soventix Unilever 3.2MWp Solar Photo-Voltaic (PV) Plant, on erven 757 & 758 of Boksburg East Extension 19 (part of the remainder of portion 127 of the farm Vogelfontein 84-IR)

AREA 2 (UNILEVER & DHL)

- Unilever & DHL (Remainder of Portion 277) is a higher lying area that a portion of its stormwater is currently flowing into the proposed sun panel area that has been included in the hydro calculations.

AREA 3 (CEOCO)

- Ceoco is also a higher lying area, Portion 1 of Erf 725, Erf 755 & Erf 756 EXT 1, BOKSBURG EAST this existing property has an attenuation pond, and its outflow also contributes to the exiting concrete culvert. This outflow contribution has also been included Separately at section 8(attenuation pond) of the report. Only the 1: 50-year Post development contribution from this property has been included in the calculation below.

Table 6.1: Proposed Development Area Storm water

Event	Areas	Pre-development (ℓ/s)	Post-development (ℓ/s)	Volume Stored (Post development) (m ³)
1 in 5-year event	AREA 1 (SUN PANEL AREA)	700,2	1033,0	1258,8
1 in 5-year event	AREA 2(Unilever & DHL)	360,1	349,5	NA
1 in 25-year event	AREA 1 (SUN PANEL AREA)	1092,5	1647,2	3224,6
1 in 25-year event	AREA 2(Unilever & DHL)	549,2	557,0	NA
1 in 50-year event	AREA 1 (SUN PANEL AREA)	1334,1	2014,0	3789,3
1 in 50-year event	AREA 2(Unilever & DHL)	670,6	680,1	NA
1 in 50-year event	AREA 3 (CEOCO)	NA	3208,6	3813,2

7. Results

The maximum peak flows for the 1 in 5, 1 in 25 and 1 in 50-year return periods for the existing scenario is estimated as shown on attached drawing. Please refer to the attached Annexure for the calculation, drawings and results for information.

8. Attenuation

The Ekurhuleni Stormwater department (EM) requires on-site attenuation structures/ponds to be constructed for all new developments. These structures are to be designed to attenuate both the 1:5 and 1:25 year storms but our calculations does show we will be able to accommodate the 1 in 50 year storm.

Table 8.1 Attenuation Channel & Attenuation Pond Characteristics

Retention Type (Attenuation pond)	Catchment Area (m ²)	Pond Dimensions (m)	Storage (m ³)	Outflow contribution (m ³ /s)
Total Storage Volume Needed 1 in 5 year event Post Development				
AREA 1	162 000	NA	3840	0,5654
AREA 2	30 000	NA	NA	0,3493
AREA 3	117 970	NA	4000	0,1580
Total contribution 1-3				1,0727
Total Storage Volume Needed 1 in 25 year event post Development				
AREA 1	162 000	NA	3840	0,6977
AREA 2	30 000	NA	NA	0,5570
AREA 3	117 970	NA	4000	0,2545
Total contribution 1-3				1,5092
Total Storage Volume Needed for 1 in 50 year event Post Development				
AREA 1	162 000	40m x 40m x 2,4m	3840	1,2768
AREA 2	30 000	NA	NA	0,681
AREA 3 (Existing)	117 970	50m x40m x2 m	4000	0,643
Total all areas 1-3, stormwater contributions (m³/s) 1 in 50 Year storm-event				2,6015
Concrete Culvert 800x 800 Maximum Capacity (m³/s)				2,4105
Concrete culvert system under pressure (m³/s) 1 in 50 Year storm-event				-0,191

9. Recommendations

- As indicated on Table 8.1 the following statements can be assumed.
 - it is shown that the existing 0.8m x 0.8m Concrete culvert has a maximum capacity of 2,4105m³/s to where areas 1-3 stormwater water is currently being discharged into.
 - The existing culvert has adequate capacity to take the stormwater discharge from the areas for a 1 in 5 year & 1 in 25 year storm event.
 - In the 1 in 50 year storm event the system can be seen to be under pressure by 0,191m³/s but this is only applicable to where the storm is at its most aggressive.
- As indicated on the attached Sketches , it is shown that the proposed property coverage area will be as follows.
 - ✓ 24% or 4ha of the area will be covered by the solar panels which is 1,2m x 0,9m.
 - ✓ The surface below the solar panels will be covered by Planted & cut grass that will maintained on a regular basis.
 - ✓ The sun panel, channels and attenuation pond will be the only areas to received works and the stormwater calculations will include the entire property as indicated on the attached annexure
 - ✓ The remaining 76% of the property will remain as is with regards to the plant growth except for the areas where we propose the open grassed lined channels, and the attenuation pond are to be built.
 - ✓ The area where the sun panels will be constructed will be dependent on the comments or approval of this report and the environmental report.
- Attenuation is required for the proposed development.
- A municipal stormwater culvert 800x800 is available and is situated on the Northern boundary of the of the property.
- The culvert mentioned in above statement currently services the proposed property stormwater run-off as- well as the property Area 3 "Ceoco" ERF 725, EXT 1, BOKSBURG EAST located above the proposed development which has an attenuation facility controlling the outflow of stormwater.
- The sections where paving blocks are to be inserted will be shaped with a minimum gradient of 1,5% to the centre of each row solar panel and be diverted in a northern direction.
- The stormwater that is directed by the sloped soil will then connect to open earth channel which will be connected to the attenuation pond.
- The stormwater from the attenuation pond will then be connected to the existing 800mm x 800mm municipal storm culvert which runs below Transnet railway line and connects to the municipal stormwater system.
- Stormwater accumulated from property Area 2 ((Unilever & DHL (Re of portion 277))that is currently entering the proposed sun panel development is also connecting to the exiting stormwater concrete culvert.
- The stormwater from Re of Portion 277 (Area 2) will not be controlled in the sun panel area development attenuation pond but merely be kept in its current state.

PLEASE REFER TO ATTACHED ANNEXURES FOR ANY FURTHER DETAILS WHICH IS UNCLEAR.

10. ANNEXURES

A) LAYOUT PLAN DRAWING

- Internal storm water management layout drawing (all contributing areas)
- Proposed Site Layout (SOLAR PANEL LAYOUT)

B) DATA INPUT ANALYSIS (rational method)
Pre & Post development developing area.

C) HYDRO CAD MODELLING
1 in 5 years development
1 in 25 years post development.
1 in 50 years post development.
1 in 50 years post development (Area 3) Ceoco

D) ENVIROMENTAL SCREENING REPORT (PROPOSED AREAS)

ANNEXURE A



2ND AREA
UNILEVER SUN PANEL

Existing AREA 3 SW connection

AREA 3 (CEOCO)

Legend

- Central Edible Oils
- Polygon Measure
- ROAD CONSTRUCTION AREA
- St Dominic's Catholic School for?
- Unilever Gates

Proposed Attenuation pond

PROPOSED UNILEVER SUN-PANEL AREA.

Existing open earth channel (AREA2)

AREA 2 (Unilever & DHL)

St Dominics Rd

St Dominic's Catholic School for...

Central Edible Oils

Unilever Gates







Figure 3. Alternative development sites for the proposed Unilever solar PV facility. Alternative 1 poses the lowest impact based on high-level analyses.

AGRICULTURE THEME				
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	Land capability evaluation values of 11 – 15; all irrigated land; horticulture and viticulture; demarcated high value agricultural areas with a priority rating of A and/or B. These areas are potentially unsuitable for development owing to: <ul style="list-style-type: none"> - high agricultural value & preservation importance; - high production capability; - high capital investment made; or - unique agricultural land attributes. 	Land capability evaluation values of 8 - 10 including all cultivated areas including sugar cane areas and demarcated high value agricultural areas with a priority rating of C and/or D. High sensitivity areas are still preservation worthy since they include land with an agricultural production potential and suitability for specific crops.	Land capability evaluation values of 6 – 7. Medium sensitivity areas are likely to be very marginal arable land.	Land capability evaluation values of 1 – 5. Low sensitivity areas are likely to be non-arable land and is therefore land onto which most development should be steered.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

ANNEXURE B

Project Name :UNILEVER SUN PANEL SMP

Project Number :AH RE/ Pft 127/ 189/108

Date Compiled11 March 2022

Storm Water Calculations and Assumptions - Pre Development

1. Colour Code

= Blocks to be filled in by Engineer with information from Project

Description :

= Blocks to be filled in by Engineer from information obtained in tables and Calculations below.

2. Gradient of Site

Height Diverence (m)

Length of Site (km)

1635

580

1625

1,72%

3. Area of Site

162000

m²

0,16

km²

4. C

Downflow Factor to be chosen by Engineer from table shown below

0,23

Ch

Cd

Cp

C2

0,03

0,16

0,04

0

Description	Classification	Rural C _r				Urban C _u			
		Average Yearly Rainfall (mm)				Description	Factor		
		600	600 - 900	900 +					
Area and Gradient (Ch)	Swamp and Pans < 3 %	0,01	0,03	0,05	Grass Lawns				
	Flat Areas 3 - 10 %	0,06	0,08	0,11	Sandy Flat < 2 %	0,05 - 0,10			
	Hills 10 - 30 %	0,12	0,16	0,2	Sandy Steep > 7 %	0,15 - 0,20			
	Steep Area > 30 %	0,22	0,26	0,3	Heavy Ground Flat < 2 %	0,13 - 0,17			
Permeable (Cd)	Very Permeable	0,03	0,04	0,05	Heavy Ground Steep > 7 %	0,25 - 0,35			
	Permeable	0,06	0,08	0,1	Residential Areas				
	Average Permeable	0,12	0,16	0,2	Houses	0,30 - 0,50			
	Un - Permeable	0,21	0,26	0,3	Flats	0,50 - 0,70			
Plantgrowth (Cp)	Thich Plantgrowth	0,03	0,04	0,05	Commercial				
	Light Plantgrowth	0,07	0,11	0,15	Light Commercial	0,50 - 0,80			
	Grassfields	0,17	0,21	0,25	Heavy Commercial	0,60 - 0,90			
	No Plant Growth	0,26	0,28	0,3	Businesses				
Retemperiod (Years)		100	50	20	10	5	2	Midtown	0,70 - 0,95
								Urban	0,50 - 0,70
Adjustment Factor (F _j)		1,00	0,95	0,90	0,85	0,80	0,75	Streets	0,70 - 0,95
								Maximum Flood	1

5. Rainfall Concentration Time Calculation (T_c) :

Concentration Time for Overland Flow

0,604

x

r

x

L

S^{0,5}

0,487

T_c

0,604

x

0,8

x

0,58

0,08

0,487

1,40

Hours

84,27

Min

Concentration Time for Water Channel

(0,87

x

L²

1000

x

S_{gen}

0,385

H_{0,85L}

-

H_{0,10L}

1000

x

0,75

L

0,01

T_c

0,24

Hours

r

=

Induction Coefficient

Clean Compacted Ground with no rocks

=

0,1

Paved Areas

=

0,02

Sparse Grass over rough Terrein

=

0,3

Moderate Grass Coverage

=

0,4

Thick Grass Coverage

=

0,8

6. Depth of the Rainfall for specific Returnperiods (mm) to be obtained from the Fig 3.6 point 11 as shown below.

Retemperiod (Years)	Depth of Rainfall (mm)
2	32
5	57
10	66
20	82
50	98
100	118

7. Q

C

x

I

x

A (Area of Site km²)

x

Adjustment Factor

3,6

Maximum Flow for Specific Retemperiods (Q)				
Retem Period	Rainfall Intensity		Q (Peak Flow m³/s)	
	Overland Flow	Channel Flow	Overland Flow	Channel Flow
2	22,78	131,49	0,18	1,02
5	40,58	234,21	0,34	1,94
10	46,99	271,19	0,41	2,39
20	58,38	336,93	0,54	3,14
50	69,77	402,68	0,69	3,96
100	84,01	484,86	0,87	1,00

The figure contains three related graphs for rainfall analysis:

- Top Left Graph:** A log-log plot of Rainfall Intensity (mm/hr) versus Duration (hours). It includes multiple curves for different Return Periods (years) ranging from 2 to 100. A red line indicates a specific design storm event.
- Top Right Graph:** A log-log plot of Rainfall Depth (mm) versus Duration (hours). It shows curves for different Return Periods (years) ranging from 2 to 100. A red line indicates a specific design storm event.
- Bottom Graph:** A semi-log plot of Rainfall Depth (mm) versus Average annual rainfall (mm). It shows data points for Summer rains, Winter rains, and Rains throughout the year, along with a fitted curve.

Percentage coverage	C-value	Conversion
0	0	0
0	0	0

1. Colour Code = Blocks to be filled in by Engineer with information from Project
Description : = Blocks to be filled in by Engineer from information obtained in tables and Calculations below.
2. Gradient of Site = $\frac{\text{Height Difference (m)}}{\text{Length of Site (km)}} = \frac{\text{Highest Point (m)} - \text{Lowest Point (m)}}{0.746} = \frac{1635 - 1625}{746} = 1.34\%$
3. Area of Site = 162000 m² = 0.16 km²
4. C = Downflow Factor to be chosen by Engineer from table shown below = 0.3275
- = $\frac{C_1}{C_2} = \frac{0}{0.3275} = 0$

		Rural C ₁					Urban C ₂		
Description	Classification	Average Yearly Rainfall (mm)			Joburg :		750	Description	Factor
		600	600 - 900	900 +					
Area and Gradient (Ch)	Swamp and Pans	< 3 %	0.01	0.03	0.03	0.05		Grass Lawns	
	Flat Areas	3 - 10 %	0.06	0.08	0.11		Sandy Flat	< 2 %	0.05 - 0.
	Hills	10 - 30 %	0.12	0.16	0.2		Sandy Steep	> 7 %	0.15 - 0.
	Steep Area	> 30 %	0.22	0.26	0.3		Heavy Ground Flat	< 2 %	0.13 - 0.
Permeable (Cd)	Very Permeable		0.03	0.04	0.05		Heavy Ground Steep	> 7 %	0.25 - 0.
	Permeable		0.06	0.08	0.1		Residential Areas		
	Average Permeable		0.12	0.16	0.2		Houses		0.30 - 0.
	Un - Permeable		0.21	0.26	0.3		Flats		0.50 - 0.
Plantgrowth (Cp)	Thick Plantgrowth		0.03	0.04	0.05		Commercial		
	Light Plantgrowth		0.07	0.11	0.15		Light Commercial		0.50 - 0.
	Grassfields		0.17	0.21	0.25		Heavy Commercial		0.60 - 0.
	No Plant Growth		0.26	0.28	0.3		Businesses		
Returnperiod (Years)		100	50	20	10	5	2	Midtown	0.70 - 0.
								Urban	0.50 - 0.
Adjustment Factor (F _i)		1.00	0.95	0.90	0.85	0.80	0.75	Streets	0.70 - 0.
								Maximum Flood	1

Percentage cover	C-value	Conversion
75	0.17	0.1275
25	0.8	0.2
0	0.8	0

5. Rainfall Concentration Time Calculation (T_c) :
- Concentration Time for Overland Flow = 0.604 x $\frac{f}{S^{0.5}} \times L$ = 0.467
- T_c = 0.604 x 0.6 x 0.746 = 0.267
- = 1.30 Hours
- Concentration Time for Water Channel = $\frac{(0.87 \times L)^2}{1000 \times S_{\text{sum}}}$ = 0.385
- S_{sum} = $\frac{H_{0.85} - H_{0.15}}{1000 \times 0.75 L}$
- = 0.01
- T_c = 0.30 Hours
6. Depth of the Rainfall for specific Returnperiods (mm) to be obtained from the Fig 3.6 point 11 as shown below

Returnperiod (Years)	Depth of Rainfall (mm)
2	23
5	50
10	63
20	80
50	96
100	110

7. Q = $\frac{C}{3.6} \times I \times A$ (Area of Site km²) x Adjustment Factor

Return Period	Maximum Flow for Specific Returnperiods (Q)			
	Overland Flow	Channel Flow	Overland Flow	Channel Flow
2	17.66	77.86	0.20	0.86
5	38.39	169.25	0.45	2.00
10	48.38	213.26	0.61	2.67
20	61.43	270.80	0.81	3.59
50	73.71	324.96	1.03	4.55
100	84.46	372.35	1.24	5.49

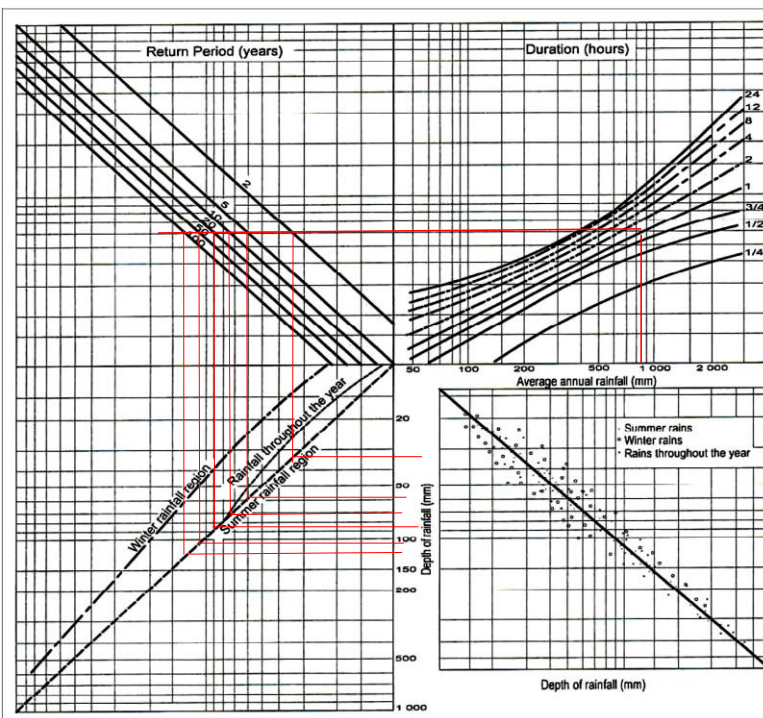


Figure 3.6: Depth-Duration-Return period diagram of point rainfall

Storm Water Calculations and Assumptions - Pre Development

1. Colour Code
Description :
- = Blocks to be filled in by Engineer with information from Project
 = Blocks to be filled in by Engineer from information obtained in tables and Calculations below.
2. Gradiënt of Site = $\frac{\text{Height Diverence (m)}}{\text{Length of Site (km)}}$ = $\frac{\text{Highest Point (m)} - \text{Lowest Point (m)}}{580}$ = $\frac{1634 - 1623}{580}$ = 1,90%
3. Area of Site = 71774 m² = 0,07 km²
4. C = Downflow Factor to be chosen by Engineer from table shown below = 0,23
= $\frac{C_1}{C_2}$
= Ch + Cd + Cp + 0
= 0,03 + 0,16 + 0,04 + 0

Rural C ₁							Urban C ₂		
Description	Classification	Average Yearly Rainfall (mm)		Jo'burg :		750	Description	Factor	
		600	600 - 900	900 +					
Area and Gradient (Ch)	Swamp and Pans < 3 %	0,01	0,03	0,05			Grass Lawns		
	Flat Area's 3 - 10 %	0,06	0,08	0,11			Sandy Flat < 2 %	0.05 - 0.10	
	Hill's 10 - 30 %	0,12	0,16	0,2			Sandy Steep > 7 %	0.15 - 0.20	
	Steep Area > 30 %	0,22	0,26	0,3			Heavy Ground Flat < 2 %	0.13 - 0.17	
Permeable (Cd)	Very Permeable	0,03	0,04	0,05			Heavy Ground Steep > 7 %	0.25 - 0.35	
	Permeable	0,06	0,08	0,1			Residential Areas		
	Average Permeable	0,12	0,16	0,2			Houses	0.30 - 0.50	
	Un - Permeable	0,21	0,26	0,3			Flats	0.50 - 0.70	
Plantgrowth (Cp)	Thich Plantgrowth	0,03	0,04	0,05			Commercial		
	Light Plantgrowth	0,07	0,11	0,15			Light Commercial	0.50 - 0.80	
	Grassfields	0,17	0,21	0,25			Heavy Commercial	0.60 - 0.90	
	No Plant Growth	0,26	0,28	0,3			Businesses		
Reternperiod (Years)		100	50	20	10	5	2	Midtown	0.70 - 0.95
								Urban	0.50 - 0.70
Adjustment Factor (F _i)		1,00	0,95	0.90	0,85	0,80	0,75	Streets	0.70 - 0.95
								Maximum Flood	1

Percentage coverage	C-value	Converction
0	0,35	0
0	0,3	0
0	0,95	0
		0

5. Rainfall Concentration Time Calculation (T_c) :
- Concentration Time for Overland Flow = 0,604 x $\frac{r \times L}{S^{0.5}}$ ^{0,467}
- T_c = 0,604 x 0,8 x 0,58 ^{0,467}
= 1,37 Hours 82,42 Min
- Concentration Time for Water Channel = $\frac{(0.87 \times L)^2}{1000 \times S_{gem}}$ ^{0,385}
- S_{gem} = $\frac{H_{0.85L} - H_{0.10L}}{1000 \times 0.75 L}$
= 0,011
- T_c = 0,23 Hours
- r = Induction Coffeciënt

Clean Compacted Ground with no rocks = 0,1

Paved Areas = 0,02

Sparse Grass over rough Terrein = 0,3

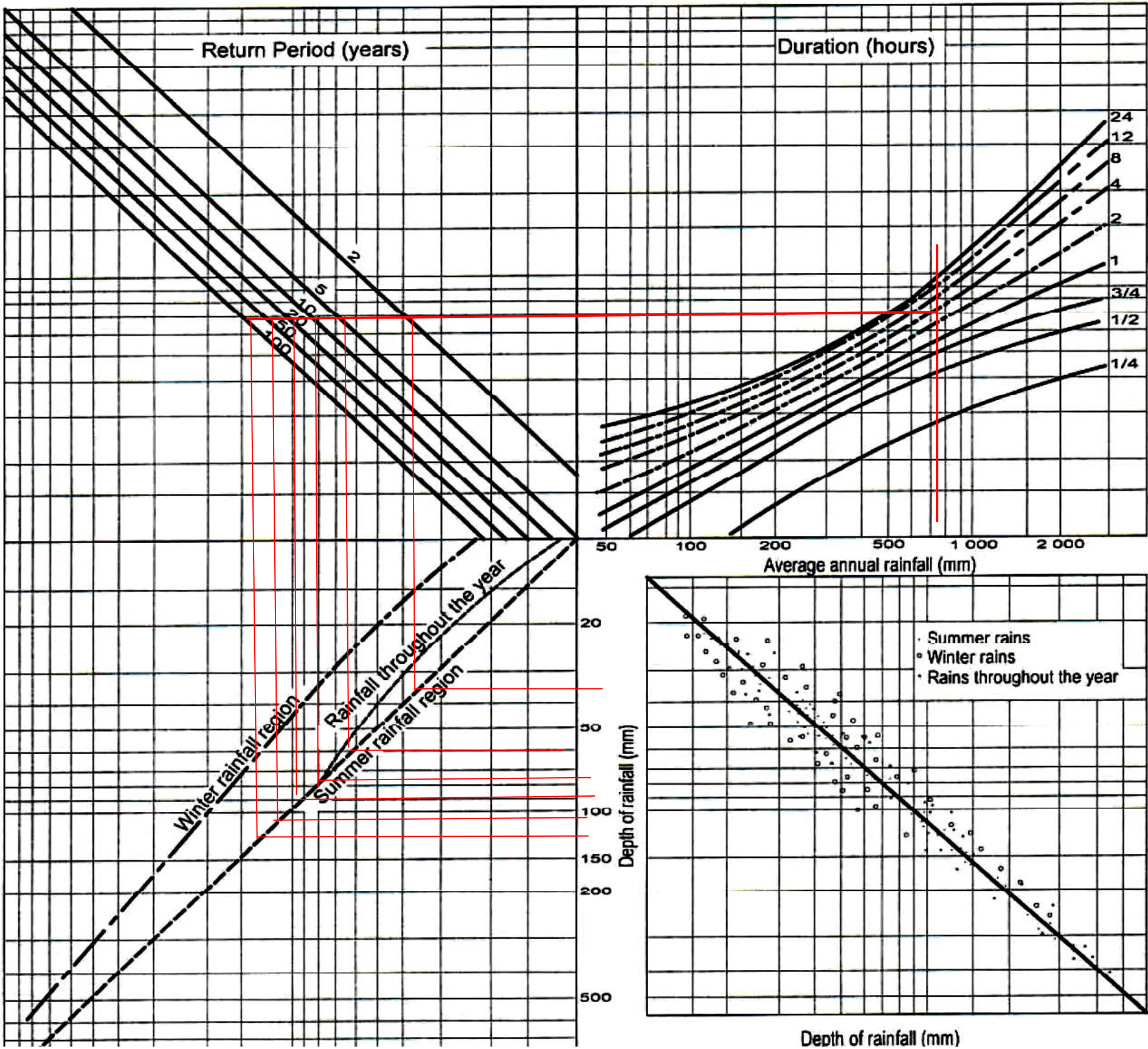
Moderate Grass Coverage = 0,4

Thick Grass Coverage = 0,8

6. Depth of the Rainfall for specific Returnperiods (mm) to be obtained from the Fig 3.6 point 11 as shown below.
- | Reternperiod (Years) | Depth of Rainfall (mm) |
|----------------------|------------------------|
| 2 | 38 |
| 5 | 61 |
| 10 | 79 |
| 20 | 93 |
| 50 | 115 |
| 100 | 130 |

7. Q = $\frac{C \times I \times A \text{ (Area of Site km}^2\text{)}}{3,6}$ x Adjustment Factor

Maximum Flow for Specific Reternperiods (Q)				
Retern Period	Rainfall Intencity		Q (Peak Flow m³/s)	
	Overland Flow	Channel Flow	Overland Flow	Channel Flow
2	27,66	161,98	0,10	0,56
5	44,41	260,01	0,16	0,95
10	57,51	336,74	0,22	1,31
20	67,70	396,41	0,28	1,64
50	83,72	490,19	0,36	2,14
100	94,64	554,13	0,43	1,00



Project Name :UNILEVER SUN PANEL SMP(DHL & UNILEVER CONTRIBUTE)

Project Number :RE/ Ptt 277

Date Compiled11 March 2022

Storm Water Calculations and Assumptions - POST Development

1. Colour Code
Description :

= Blocks to be filled in by Engineer with information from Project
 = Blocks to be filled in by Engineer from information obtained in tables and Calculations below.

2. Gradient of Site

Height Diverence (m)

Length of Site (km)

Highest Point (m)

-

Lowest Point (m)

=

1630

-

1625

=

300

=

1,67%

3. Area of Site

=

30000

m²

=

0,03

km²

4. C

=

Downflow Factor to be chosen by Engineer from table shown below

=

0,625

=

Ch

+

Cd

+

Cp

+

C2

=

0

+

0

+

0

+

0,625

Description	Classification	Rural C ₁				Urban C ₂			
		Average Yearly Rainfall (mm)				Description	Factor		
		600	600 - 900	900 +					
Area and Gradient (Ch)	Swamp and Pans < 3 %	0,01	0,03	0,05	Grass Lawns				
	Flat Areas 3 - 10 %	0,06	0,08	0,11	Sandy Flat < 2 %	0,05 - 0,10			
	Hills 10 - 30 %	0,12	0,16	0,2	Sandy Steep > 7 %	0,15 - 0,20			
	Steep Area > 30 %	0,22	0,26	0,3	Heavy Ground Flat < 2 %	0,13 - 0,17			
Permeable (Cd)	Very Permeable	0,03	0,04	0,05	Heavy Ground Steep > 7 %	0,25 - 0,35			
	Permeable	0,06	0,08	0,1	Residential Areas				
	Average Permeable	0,12	0,16	0,2	Houses	0,30 - 0,50			
	Un - Permeable	0,21	0,26	0,3	Flats	0,50 - 0,70			
Plantgrowth (Cp)	Thich Plantgrowth	0,03	0,04	0,05	Commercial				
	Light Plantgrowth	0,07	0,11	0,15	Light Commercial	0,50 - 0,80			
	Grassfields	0,17	0,21	0,25	Heavy Commercial	0,60 - 0,90			
	No Plant Growth	0,26	0,28	0,3	Businesses				
Returnperiod (Years)		100	50	20	10	5	2	Midtown	0,70 - 0,95
Adjustment Factor (F ₃)		1,00	0,95	0,90	0,85	0,80	0,75	Urban	0,50 - 0,70
								Streets	0,70 - 0,95
								Maximum Flood	1

Percentage coverage	C-value	Conversion
0	0	0
0	0	0
0,6	75	0,45
0,7	25	0,175
		0,625

5. Rainfall Concentration Time Calculation (T_c) :

Concentration Time for Overland Flow

=

0,604

x

r

x

L

S^{0,5}

0,487

T_c

=

0,604

x

0,02

x

0,3

0,04

0,487

=

0,25

Hours

15,17

Min

Concentration Time for Water Channel

=

(0,87

x

L²

1000

x

S_{gen}

0,385

S_{gen}

=

H_{0,85L}

-

H_{0,10L}

1000

x

0,75

L

=

0,005

T_c

=

0,19

Hours

6. Depth of the Rainfall for specific Returnperiods (mm) to be obtained from the Fig 3.6 point 11 as shown below.

Returnperiod (Years)	Depth of Rainfall (mm)
2	10
5	25
10	32
20	39
50	48
100	57

r	=	Induction Coefficient
Clean Compacted Ground with no rocks	=	0,1
Paved Areas	=	0,02
Sparse Grass over rough Terrein	=	0,3
Moderate Grass Coverage	=	0,4
Thick Grass Coverage	=	0,8

7. Q

=

C

x

I

x

A (Area of Site km²)

x

Adjustment Factor

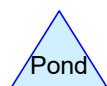
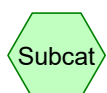
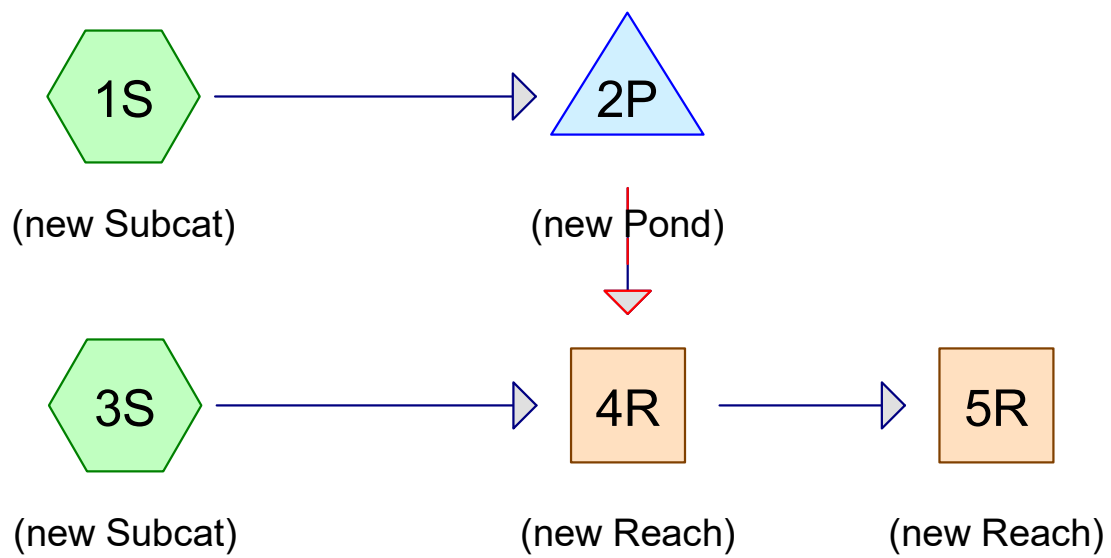
3,6

Maximum Flow for Specific Returnperiods (Q)				
Return Period	Rainfall Intensity		Q (Peak Flow m³/s)	
	Overland Flow	Channel Flow	Overland Flow	Channel Flow
2	39,55	52,27	0,15	0,20
5	98,88	130,69	0,41	0,54
10	126,57	167,28	0,56	0,74
20	154,26	203,87	0,72	0,96
50	189,86	250,92	0,94	1,24
100	225,45	297,96	1,17	1,00

The figure contains two main charts and a smaller inset chart.

- Top Chart:** A log-log plot showing Rainfall Intensity (mm/hr) on the y-axis (ranging from 1 to 200) versus Duration (hours) on the x-axis (ranging from 0.1 to 200). Multiple curves are plotted for different Return Periods (years): 2, 5, 10, 20, 50, and 100. The curves show that for a given duration, the rainfall intensity increases with the return period.
- Bottom Chart:** A log-log plot showing Depth of rainfall (mm) on the y-axis (ranging from 10 to 500) versus Duration (hours) on the x-axis (ranging from 0.1 to 200). This chart also shows curves for different Return Periods (2, 5, 10, 20, 50, 100 years).
- Inset Chart:** A scatter plot showing Depth of rainfall (mm) on the y-axis (ranging from 10 to 500) versus Average annual rainfall (mm) on the x-axis (ranging from 50 to 2000). It includes data points for Summer rains, Winter rains, and Rains throughout the year, along with a trend line.

ANNEXURE C



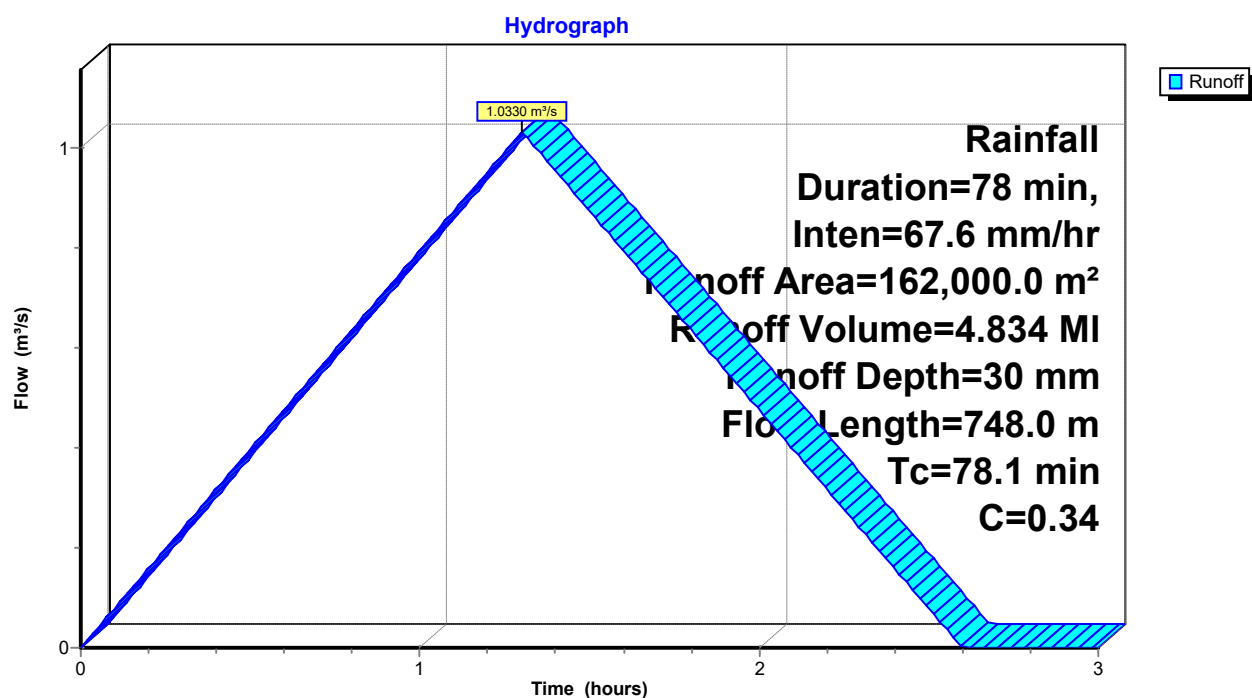
Summary for Subcatchment 1S: (new Subcat)

Runoff = 1.0330 m³/s @ 1.30 hrs, Volume= 4.834 MI, Depth= 30 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Rainfall Duration=78 min, Inten=67.6 mm/hr

Area (m ²)	C	Description
162,000.0	0.34	
162,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
78.1	748.0		0.16		Direct Entry,

Subcatchment 1S: (new Subcat)

Summary for Subcatchment 3S: (new Subcat)

Runoff = 0.3493 m³/s @ 0.26 hrs, Volume= 1.635 MI, Depth= 54 mm

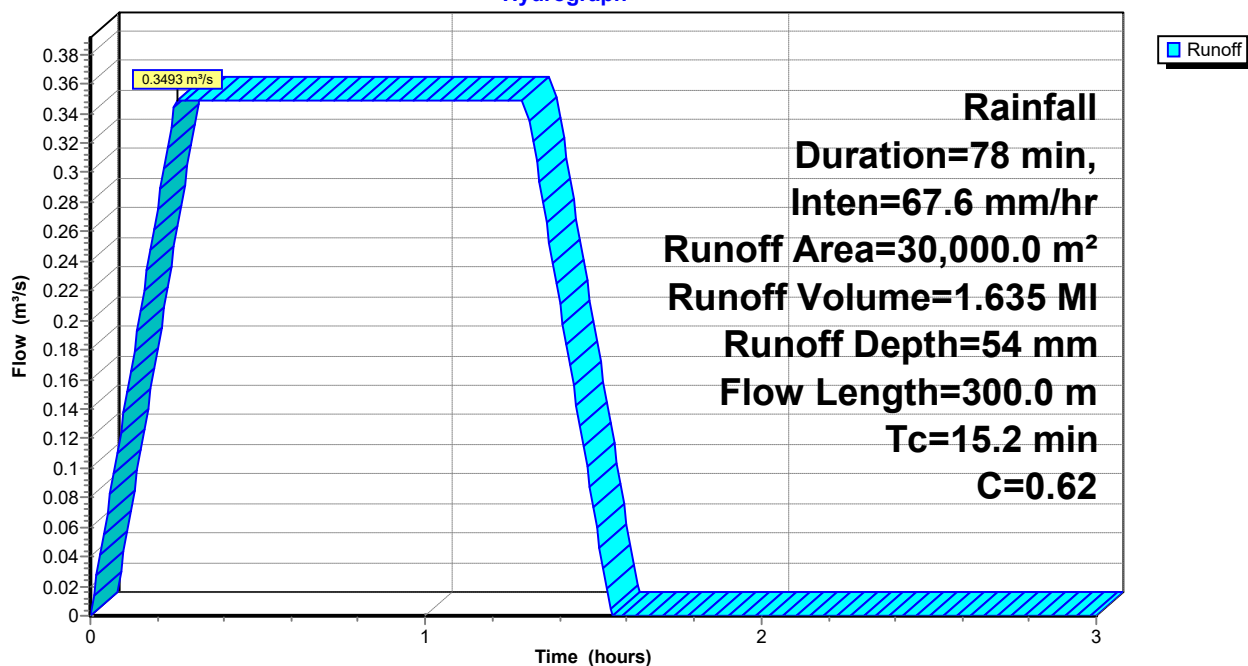
Runoff by Rational method, Rise/Fall=1.0/1.0 xT_c, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Rainfall Duration=78 min, Inten=67.6 mm/hr

Area (m ²)	C	Description
30,000.0	0.62	
30,000.0		100.00% Pervious Area

T _c (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
15.2	300.0		0.33		Direct Entry,

Subcatchment 3S: (new Subcat)

Hydrograph



Summary for Reach 4R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 34 mm
 Inflow = 0.8749 m³/s @ 1.30 hrs, Volume= 6.466 MI
 Outflow = 0.8676 m³/s @ 1.37 hrs, Volume= 6.356 MI, Atten= 1%, Lag= 4.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.90 m/s, Min. Travel Time= 3.7 min
 Avg. Velocity = 0.79 m/s, Avg. Travel Time= 4.2 min

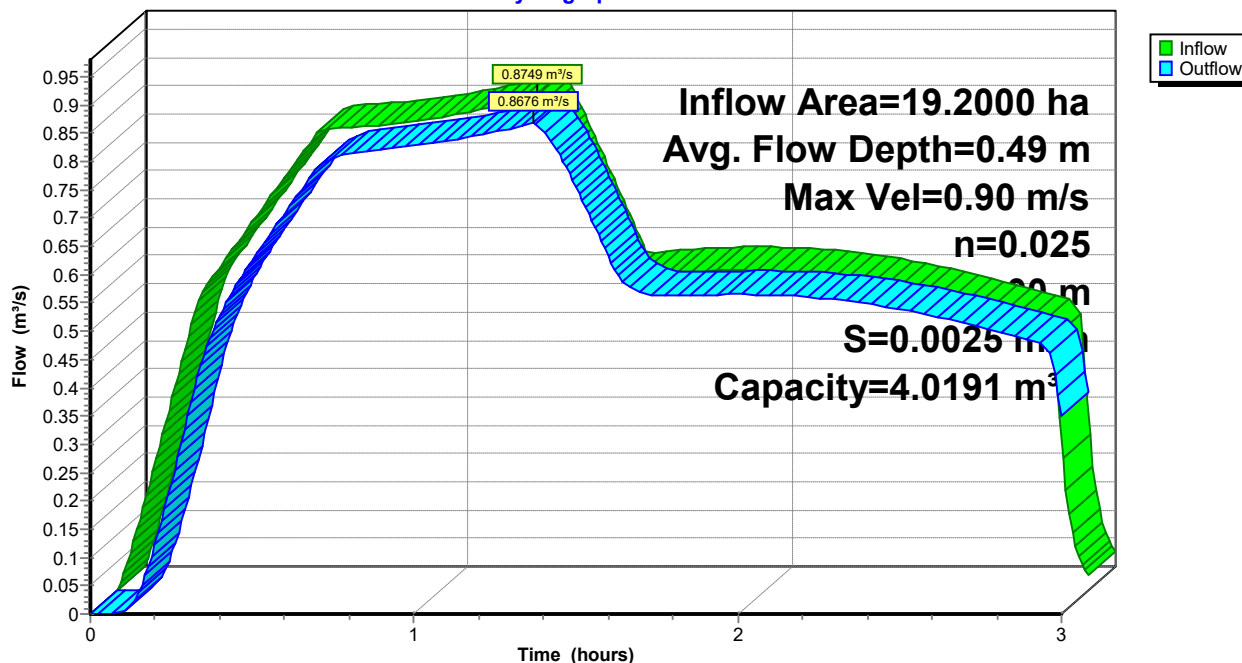
Peak Storage= 192.5 m³ @ 1.31 hrs
 Average Depth at Peak Storage= 0.49 m, Surface Width= 2.95 m
 Bank-Full Depth= 1.00 m Flow Area= 3.00 m², Capacity= 4.0191 m³/s

1.00 m x 1.00 m deep channel, n= 0.025 Earth, clean & straight
 Side Slope Z-value= 2.0 m/m Top Width= 5.00 m
 Length= 200.00 m Slope= 0.0025 m/m
 Inlet Invert= 1,624.000 m, Outlet Invert= 1,623.500 m



Reach 4R: (new Reach)

Hydrograph



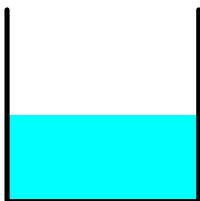
Summary for Reach 5R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 33 mm
 Inflow = 0.8676 m³/s @ 1.37 hrs, Volume= 6.356 MI
 Outflow = 0.8674 m³/s @ 1.37 hrs, Volume= 6.350 MI, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 3.00 m/s, Min. Travel Time= 0.1 min
 Avg. Velocity = 2.65 m/s, Avg. Travel Time= 0.2 min

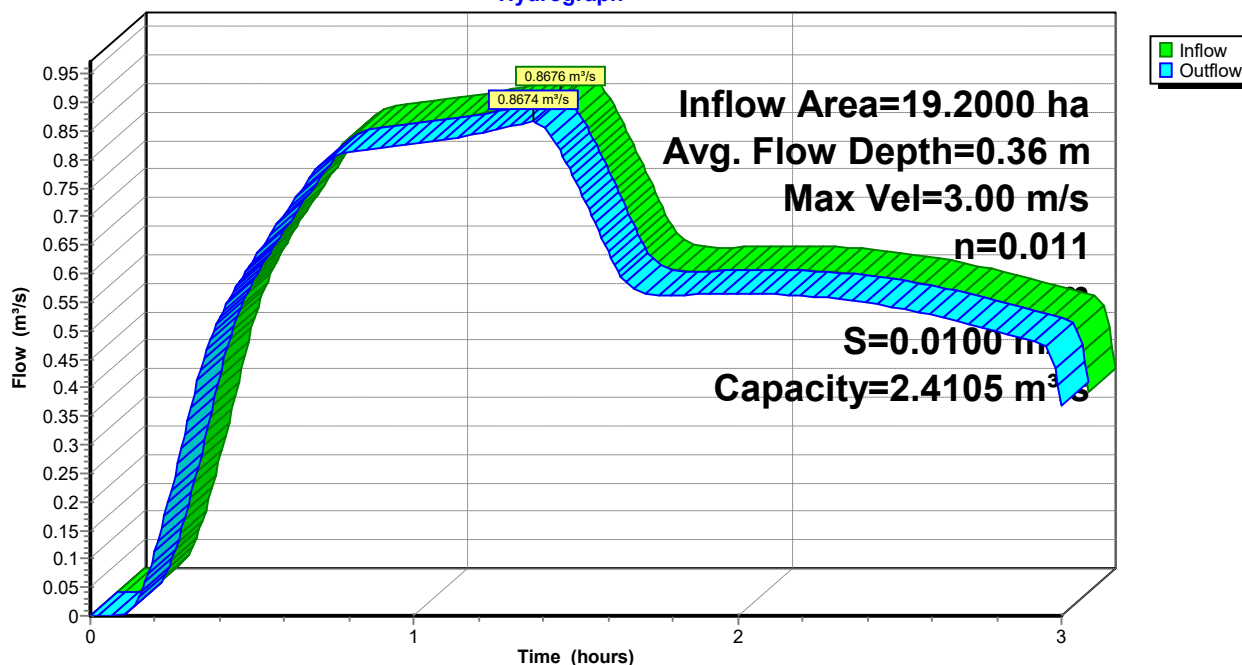
Peak Storage= 7.2 m³ @ 1.37 hrs
 Average Depth at Peak Storage= 0.36 m, Surface Width= 0.80 m
 Bank-Full Depth= 0.80 m Flow Area= 0.64 m², Capacity= 2.4105 m³/s

0.80 m x 0.80 m deep channel, n= 0.011
 Length= 25.00 m Slope= 0.0100 m/m
 Inlet Invert= 1,623.500 m, Outlet Invert= 1,623.250 m



Reach 5R: (new Reach)

Hydrograph



Summary for Pond 2P: (new Pond)

Inflow Area = 16.2000 ha, 0.00% Impervious, Inflow Depth = 30 mm
 Inflow = 1.0330 m³/s @ 1.30 hrs, Volume= 4.834 MI
 Outflow = 0.5654 m³/s @ 1.89 hrs, Volume= 4.831 MI, Atten= 45%, Lag= 35.3 min
 Primary = 0.5654 m³/s @ 1.89 hrs, Volume= 4.831 MI
 Secondary = 0.0000 m³/s @ 0.00 hrs, Volume= 0.000 MI

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Peak Elev= 1,624.504 m @ 1.89 hrs Surf.Area= 2,500.0 m² Storage= 1,258.8 m³

Plug-Flow detention time= 21.0 min calculated for 4.831 MI (100% of inflow)
 Center-of-Mass det. time= 20.9 min (98.9 - 78.0)

Volume	Invert	Avail.Storage	Storage Description
#1 1,624.000 m		6,250.0 m ³	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
1,624.000	2,500.0	0.0	0.0
1,626.500	2,500.0	6,250.0	6,250.0

Device	Routing	Invert	Outlet Devices
#1	Primary	1,623.000 m	470 mm Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Secondary	1,625.300 m	Custom Weir/Orifice, Cv= 1.45 (C= 1.81) Head (meters) 0.000 0.395 Width (meters) 3.00 3.00

Primary OutFlow Max=0.5654 m³/s @ 1.89 hrs HW=1,624.504 m (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.5654 m³/s @ 3.26 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 0.00 hrs HW=1,624.000 m (Free Discharge)
 ↑2=Custom Weir/Orifice (Controls 0.0000 m³/s)

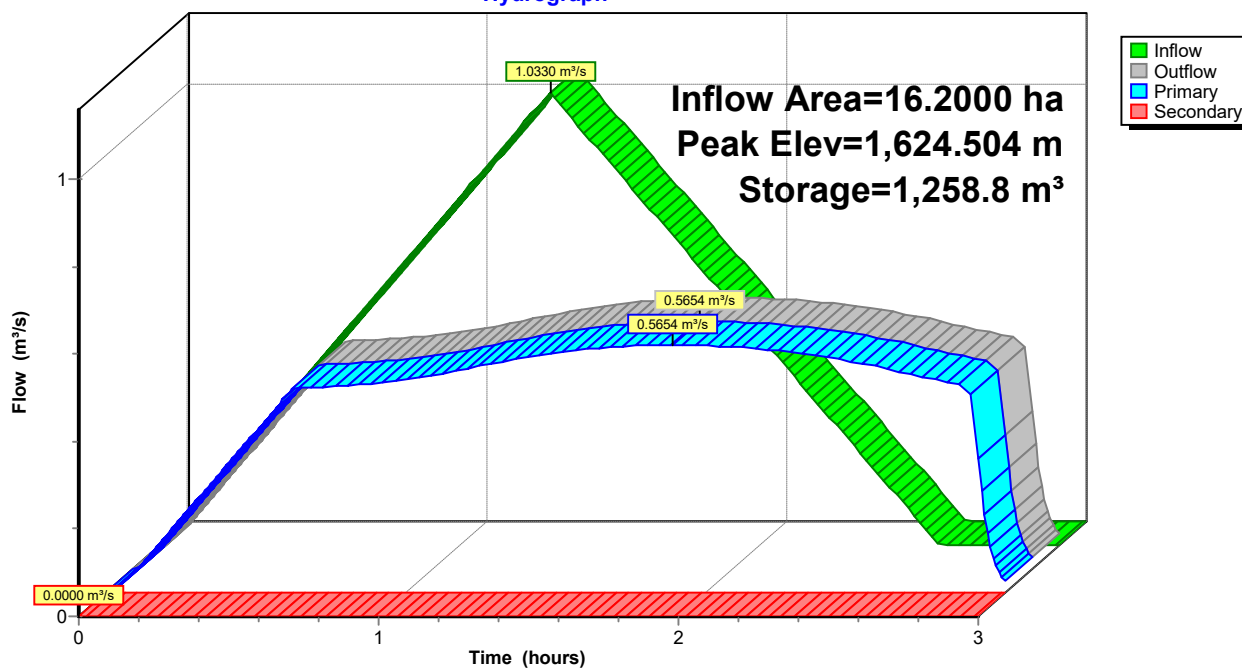
Pond 2P: (new Pond)**Hydrograph**

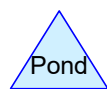
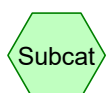
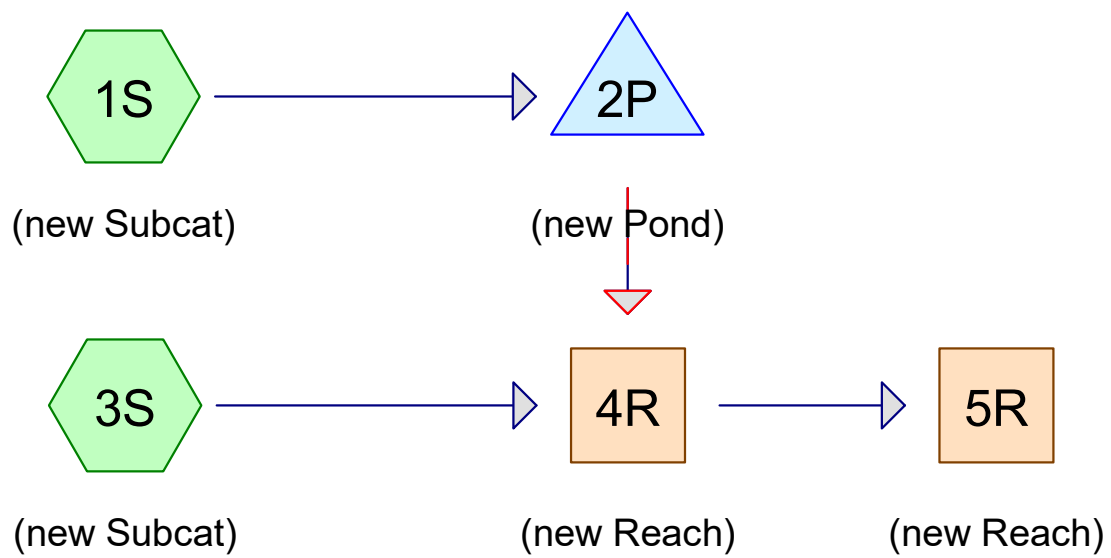
TABLE OF CONTENTS

Project Reports

- 1 Routing Diagram

Current Event

- 2 Subcat 1S: (new Subcat)
- 3 Subcat 3S: (new Subcat)
- 4 Reach 4R: (new Reach)
- 5 Reach 5R: (new Reach)
- 6 Pond 2P: (new Pond)



Summary for Subcatchment 1S: (new Subcat)

Runoff = 0.7002 m³/s @ 1.37 hrs, Volume= 3.452 MI, Depth= 21 mm

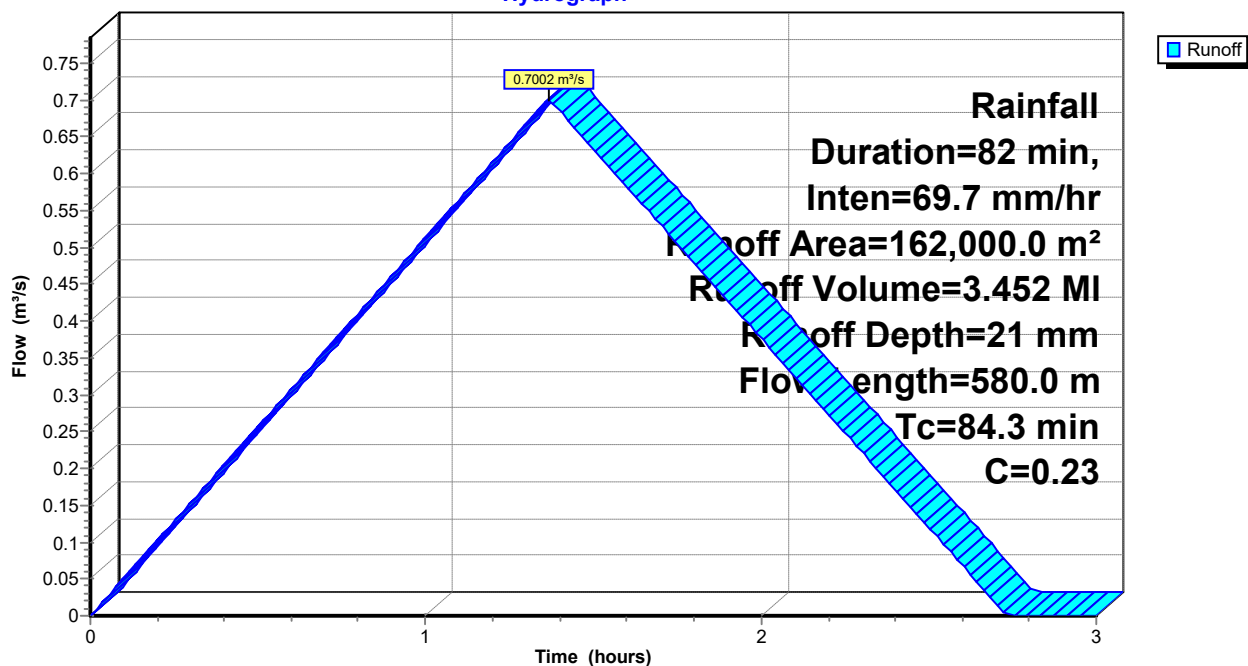
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Rainfall Duration=82 min, Inten=69.7 mm/hr

Area (m ²)	C	Description
162,000.0	0.23	
162,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
84.3	580.0		0.11		Direct Entry,

Subcatchment 1S: (new Subcat)

Hydrograph



Summary for Subcatchment 3S: (new Subcat)

Runoff = 0.3601 m³/s @ 0.26 hrs, Volume= 1.772 MI, Depth= 59 mm

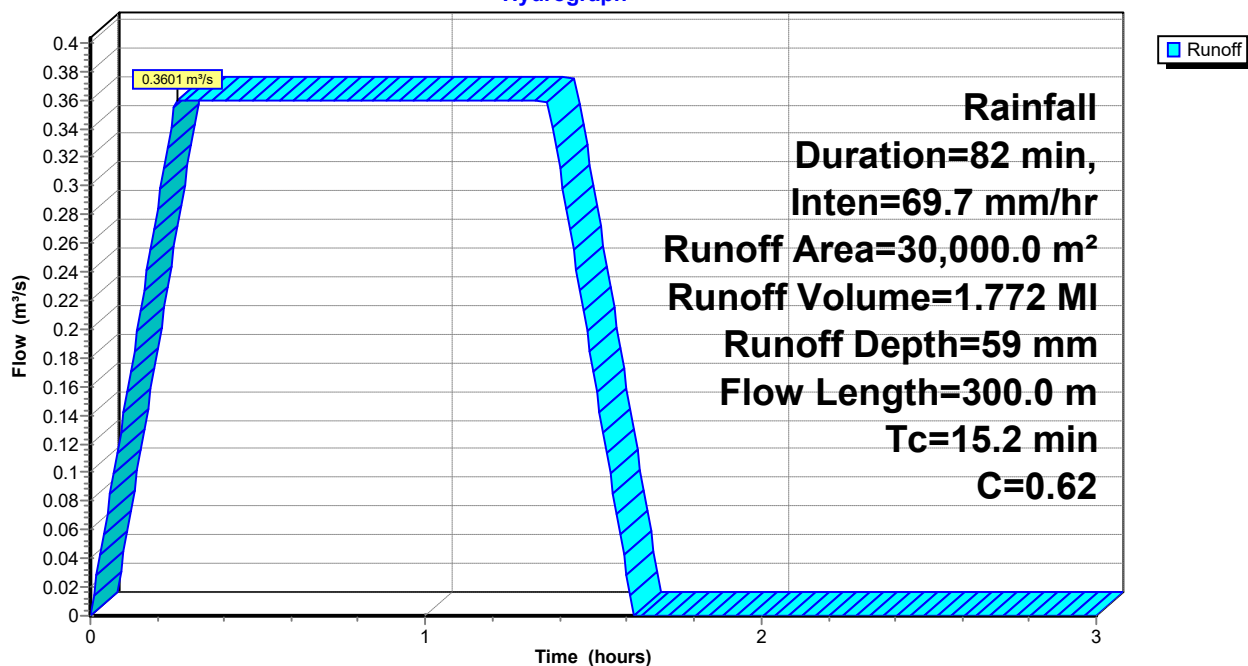
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Rainfall Duration=82 min, Inten=69.7 mm/hr

Area (m ²)	C	Description
30,000.0	0.62	
30,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
15.2	300.0		0.33		Direct Entry,

Subcatchment 3S: (new Subcat)

Hydrograph



Summary for Reach 4R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth = 27 mm
 Inflow = 0.8432 m³/s @ 1.36 hrs, Volume= 5.224 MI
 Outflow = 0.8402 m³/s @ 1.43 hrs, Volume= 5.214 MI, Atten= 0%, Lag= 4.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.89 m/s, Min. Travel Time= 3.7 min
 Avg. Velocity = 0.72 m/s, Avg. Travel Time= 4.7 min

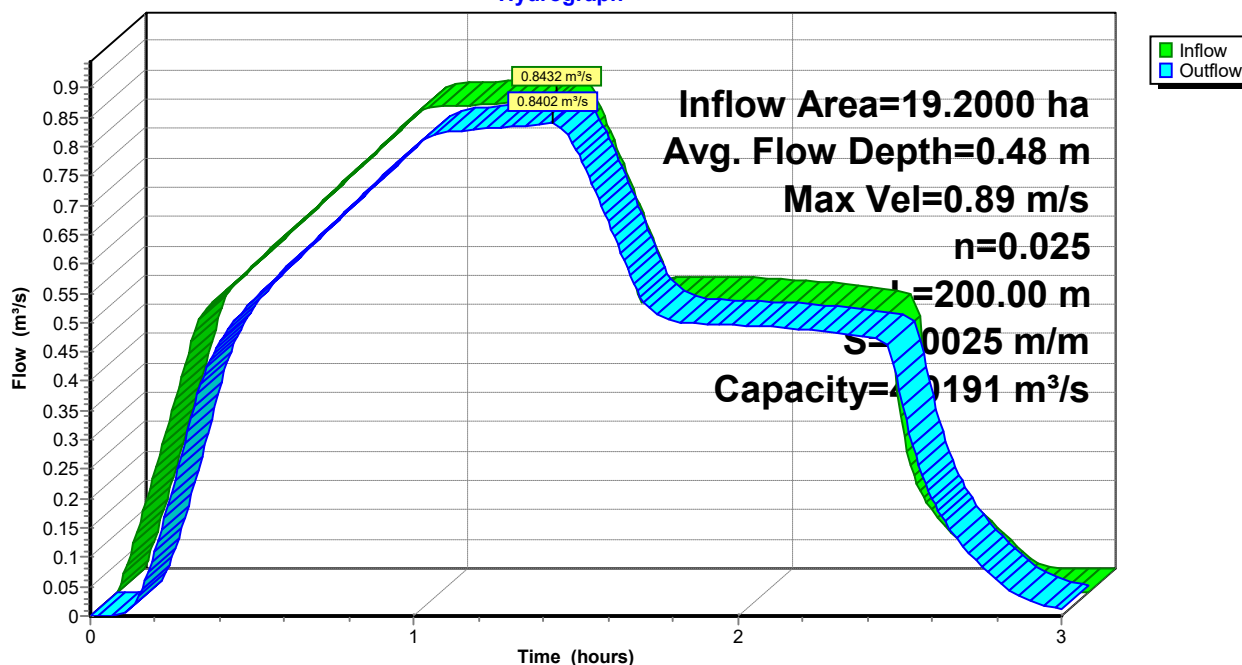
Peak Storage= 188.0 m³ @ 1.37 hrs
 Average Depth at Peak Storage= 0.48 m, Surface Width= 2.92 m
 Bank-Full Depth= 1.00 m Flow Area= 3.00 m², Capacity= 4.0191 m³/s

1.00 m x 1.00 m deep channel, n= 0.025 Earth, clean & straight
 Side Slope Z-value= 2.0 m/m Top Width= 5.00 m
 Length= 200.00 m Slope= 0.0025 m/m
 Inlet Invert= 1,624.000 m, Outlet Invert= 1,623.500 m



Reach 4R: (new Reach)

Hydrograph



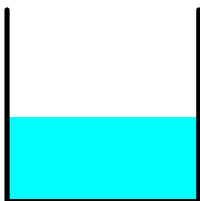
Summary for Reach 5R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 27 mm
 Inflow = 0.8402 m³/s @ 1.43 hrs, Volume= 5.214 MI
 Outflow = 0.8400 m³/s @ 1.43 hrs, Volume= 5.214 MI, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 2.98 m/s, Min. Travel Time= 0.1 min
 Avg. Velocity = 2.40 m/s, Avg. Travel Time= 0.2 min

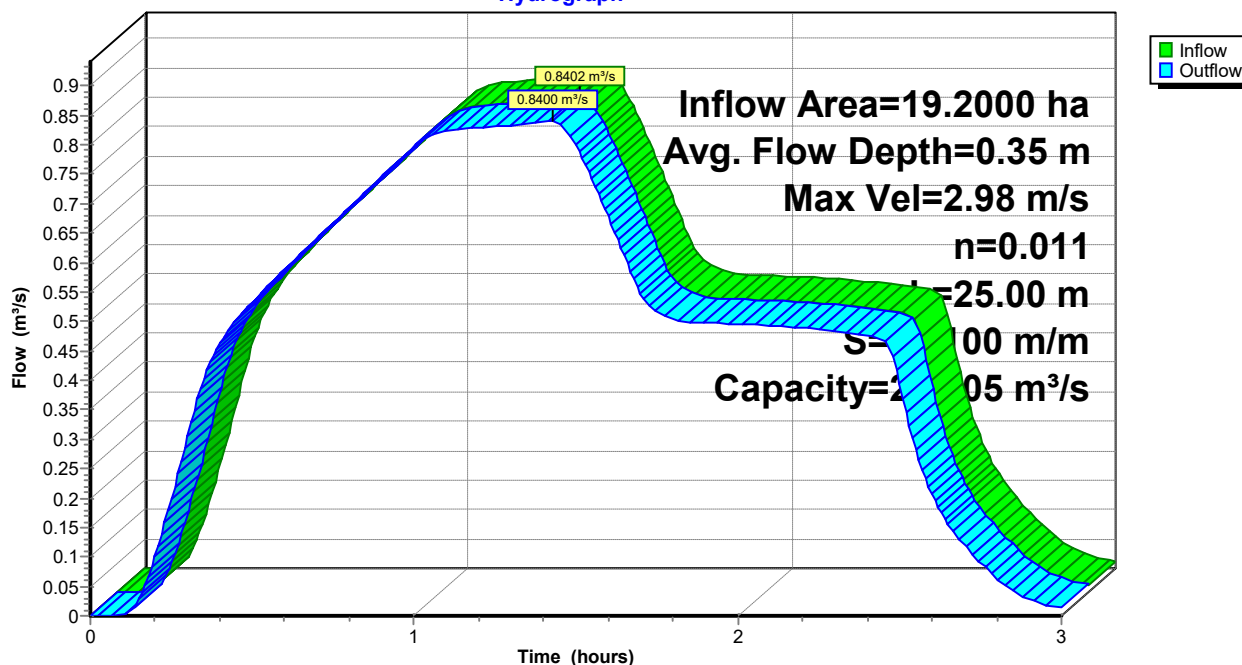
Peak Storage= 7.1 m³ @ 1.43 hrs
 Average Depth at Peak Storage= 0.35 m, Surface Width= 0.80 m
 Bank-Full Depth= 0.80 m Flow Area= 0.64 m², Capacity= 2.4105 m³/s

0.80 m x 0.80 m deep channel, n= 0.011
 Length= 25.00 m Slope= 0.0100 m/m
 Inlet Invert= 1,623.500 m, Outlet Invert= 1,623.250 m



Reach 5R: (new Reach)

Hydrograph



Summary for Pond 2P: (new Pond)

Inflow Area = 16.2000 ha, 0.00% Impervious, Inflow Depth = 21 mm
 Inflow = 0.7002 m³/s @ 1.37 hrs, Volume= 3.452 MI
 Outflow = 0.4966 m³/s @ 1.77 hrs, Volume= 3.452 MI, Atten= 29%, Lag= 23.9 min
 Primary = 0.4966 m³/s @ 1.77 hrs, Volume= 3.452 MI
 Secondary = 0.0000 m³/s @ 0.00 hrs, Volume= 0.000 MI

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Peak Elev= 1,624.160 m @ 1.77 hrs Surf.Area= 2,500.0 m² Storage= 399.4 m³

Plug-Flow detention time= 7.1 min calculated for 3.452 MI (100% of inflow)
 Center-of-Mass det. time= 7.1 min (89.1 - 82.0)

Volume	Invert	Avail.Storage	Storage Description
#1 1,624.000 m	6,250.0 m³	Custom Stage Data (Prismatic) Listed below (Recalc)	

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
1,624.000	2,500.0	0.0	0.0
1,626.500	2,500.0	6,250.0	6,250.0

Device	Routing	Invert	Outlet Devices
#1	Primary	1,623.000 m	470 mm Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Secondary	1,625.300 m	Custom Weir/Orifice, Cv= 1.45 (C= 1.81) Head (meters) 0.000 0.395 Width (meters) 3.00 3.00

Primary OutFlow Max=0.4966 m³/s @ 1.77 hrs HW=1,624.160 m (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.4966 m³/s @ 2.86 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 0.00 hrs HW=1,624.000 m (Free Discharge)
 ↑2=Custom Weir/Orifice (Controls 0.0000 m³/s)

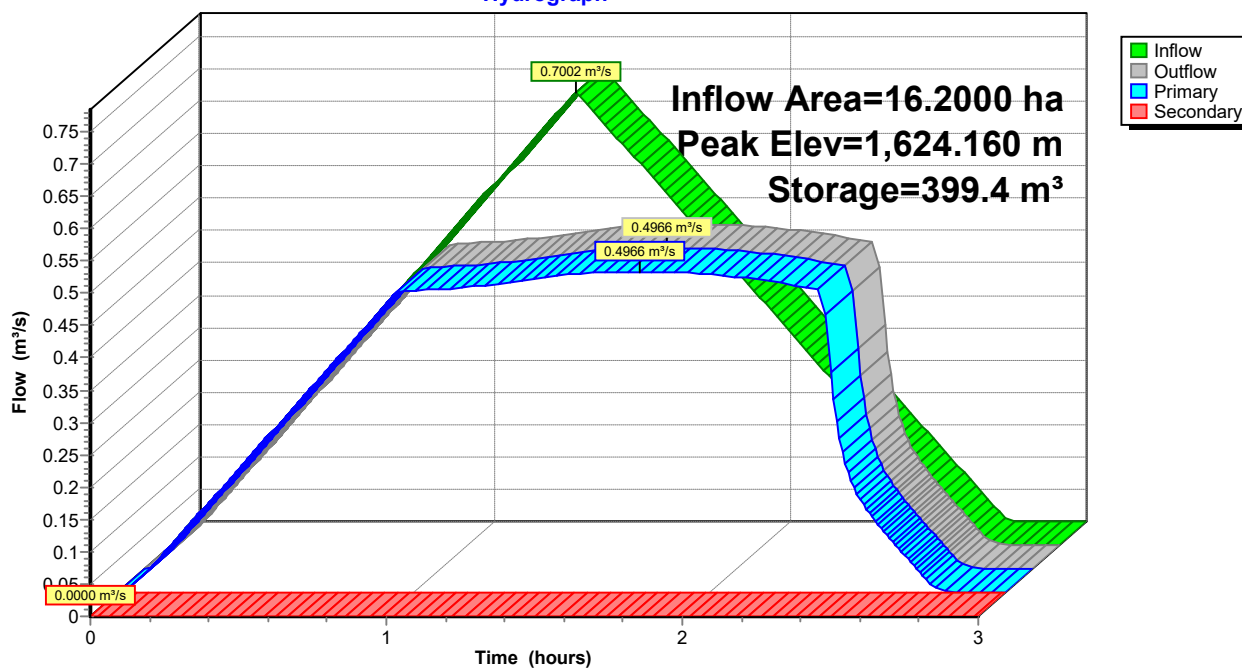
Pond 2P: (new Pond)**Hydrograph**

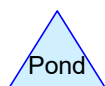
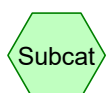
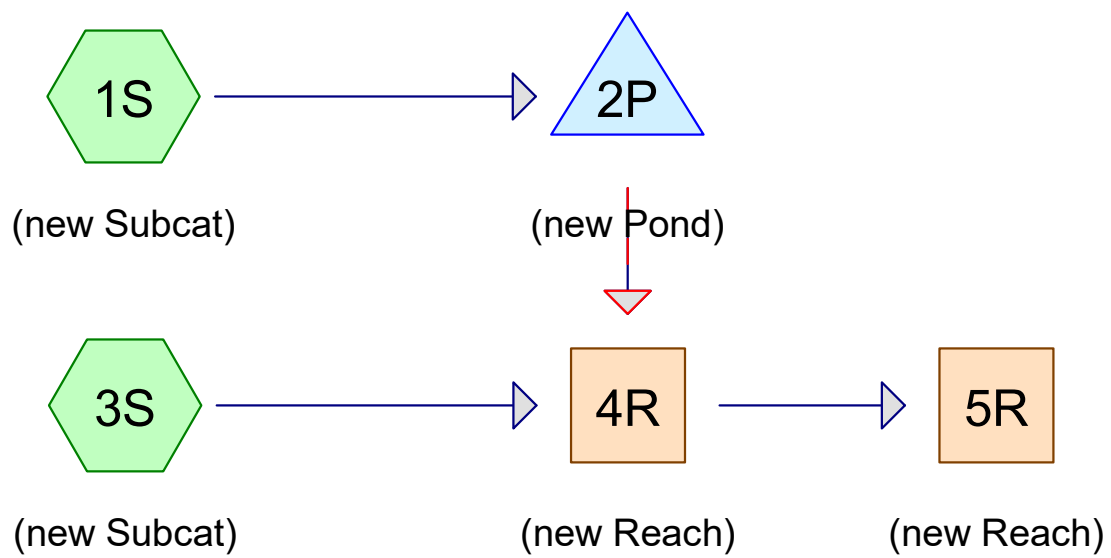
TABLE OF CONTENTS

Project Reports

- 1 Routing Diagram

Current Event

- 2 Subcat 1S: (new Subcat)
- 3 Subcat 3S: (new Subcat)
- 4 Reach 4R: (new Reach)
- 5 Reach 5R: (new Reach)
- 6 Pond 2P: (new Pond)



Summary for Subcatchment 1S: (new Subcat)

Runoff = 1.6472 m³/s @ 1.30 hrs, Volume= 7.709 MI, Depth= 48 mm

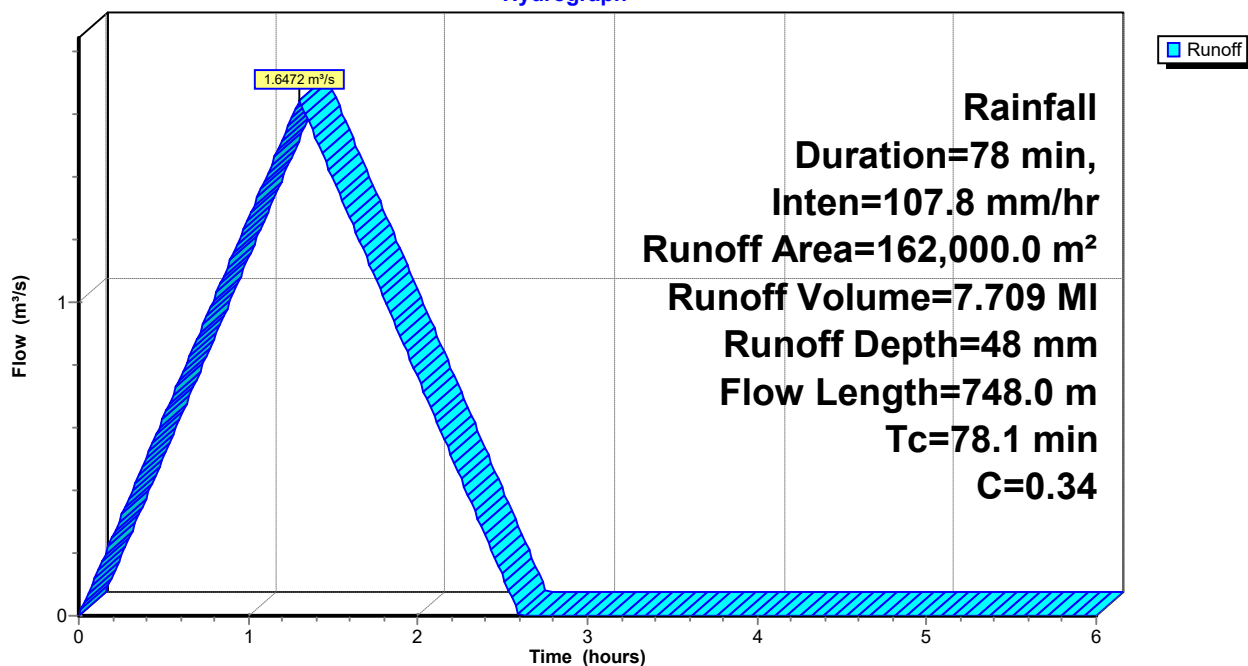
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
 Rainfall Duration=78 min, Inten=107.8 mm/hr

Area (m ²)	C	Description
162,000.0	0.34	
162,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
78.1	748.0		0.16		Direct Entry,

Subcatchment 1S: (new Subcat)

Hydrograph



Summary for Subcatchment 3S: (new Subcat)

Runoff = 0.5570 m³/s @ 0.26 hrs, Volume= 2.607 MI, Depth= 87 mm

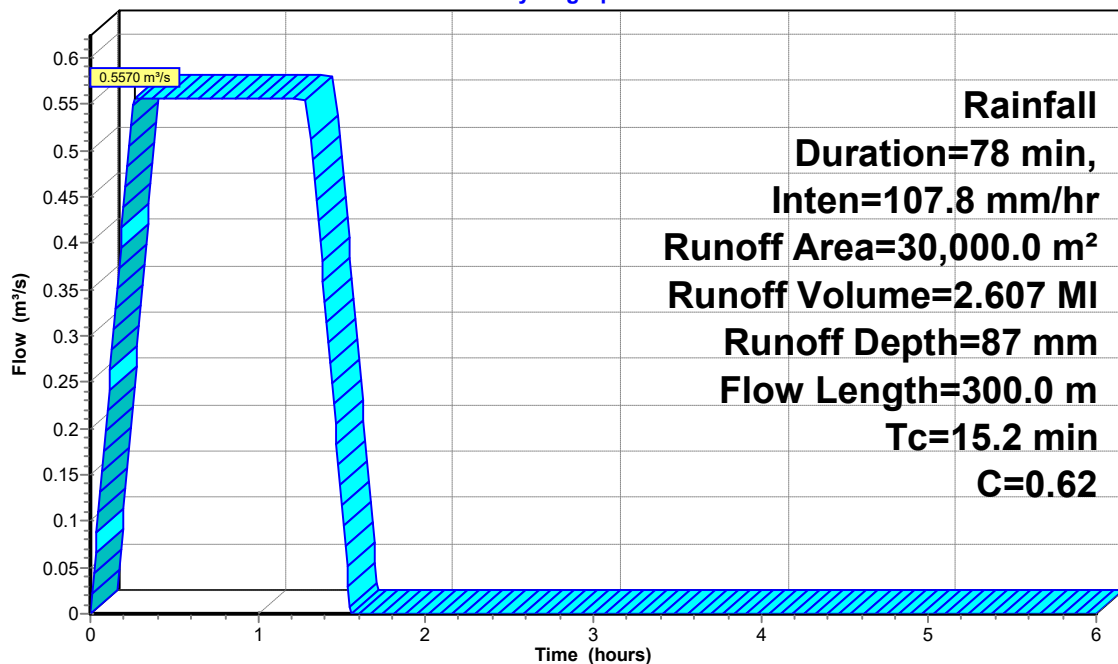
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Rainfall Duration=78 min, Inten=107.8 mm/hr

Area (m ²)	C	Description
30,000.0	0.62	
30,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
15.2	300.0		0.33		Direct Entry,

Subcatchment 3S: (new Subcat)

Hydrograph



Summary for Reach 4R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth = 54 mm
 Inflow = 1.1680 m³/s @ 1.30 hrs, Volume= 10.316 MI
 Outflow = 1.1558 m³/s @ 1.36 hrs, Volume= 10.315 MI, Atten= 1%, Lag= 3.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.97 m/s, Min. Travel Time= 3.4 min
 Avg. Velocity = 0.60 m/s, Avg. Travel Time= 5.5 min

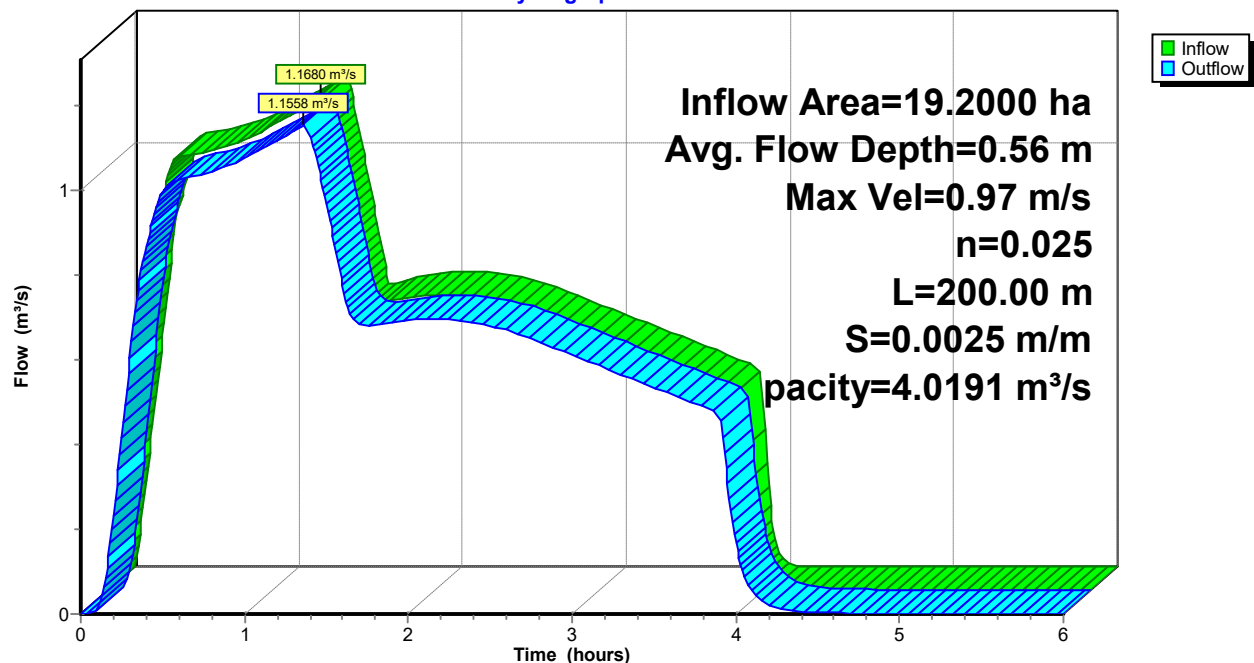
Peak Storage= 237.8 m³ @ 1.31 hrs
 Average Depth at Peak Storage= 0.56 m, Surface Width= 3.24 m
 Bank-Full Depth= 1.00 m Flow Area= 3.00 m², Capacity= 4.0191 m³/s

1.00 m x 1.00 m deep channel, n= 0.025 Earth, clean & straight
 Side Slope Z-value= 2.0 m/m Top Width= 5.00 m
 Length= 200.00 m Slope= 0.0025 m/m
 Inlet Invert= 1,624.000 m, Outlet Invert= 1,623.500 m



Reach 4R: (new Reach)

Hydrograph



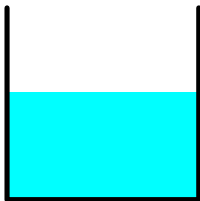
Summary for Reach 5R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 54 mm
 Inflow = 1.1558 m³/s @ 1.36 hrs, Volume= 10.315 MI
 Outflow = 1.1556 m³/s @ 1.37 hrs, Volume= 10.315 MI, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
 Max. Velocity= 3.22 m/s, Min. Travel Time= 0.1 min
 Avg. Velocity = 2.01 m/s, Avg. Travel Time= 0.2 min

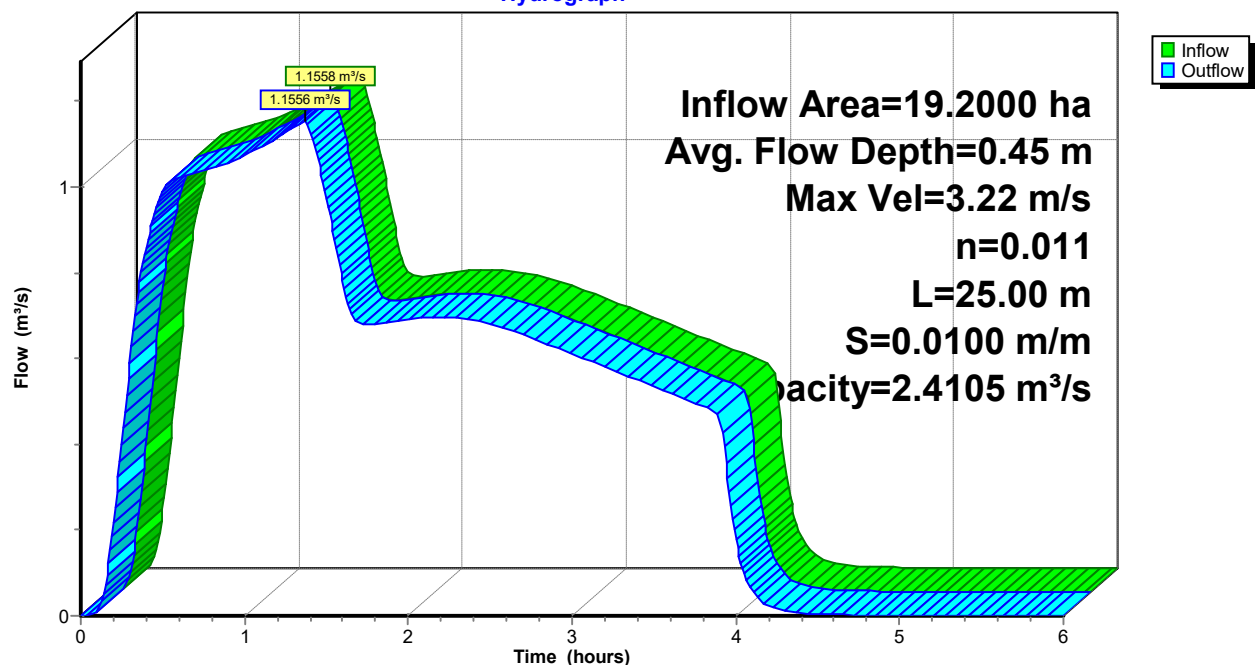
Peak Storage= 9.0 m³ @ 1.36 hrs
 Average Depth at Peak Storage= 0.45 m, Surface Width= 0.80 m
 Bank-Full Depth= 0.80 m Flow Area= 0.64 m², Capacity= 2.4105 m³/s

0.80 m x 0.80 m deep channel, n= 0.011
 Length= 25.00 m Slope= 0.0100 m/m
 Inlet Invert= 1,623.500 m, Outlet Invert= 1,623.250 m



Reach 5R: (new Reach)

Hydrograph



Summary for Pond 2P: (new Pond)

Inflow Area = 16.2000 ha, 0.00% Impervious, Inflow Depth = 48 mm
 Inflow = 1.6472 m³/s @ 1.30 hrs, Volume= 7.709 MI
 Outflow = 0.6977 m³/s @ 2.05 hrs, Volume= 7.709 MI, Atten= 58%, Lag= 45.0 min
 Primary = 0.6977 m³/s @ 2.05 hrs, Volume= 7.709 MI
 Secondary = 0.0000 m³/s @ 0.00 hrs, Volume= 0.000 MI

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
 Peak Elev= 1,625.290 m @ 2.05 hrs Surf.Area= 2,500.0 m² Storage= 3,224.6 m³

Plug-Flow detention time= 45.9 min calculated for 7.696 MI (100% of inflow)
 Center-of-Mass det. time= 46.0 min (124.0 - 78.0)

Volume	Invert	Avail.Storage	Storage Description
#1 1,624.000 m	6,250.0 m ³	Custom Stage Data (Prismatic) Listed below (Recalc)	

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
1,624.000	2,500.0	0.0	0.0
1,626.500	2,500.0	6,250.0	6,250.0

Device	Routing	Invert	Outlet Devices
#1	Primary	1,623.000 m	470 mm Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Secondary	1,625.300 m	Custom Weir/Orifice, Cv= 1.45 (C= 1.81) Head (meters) 0.000 0.395 Width (meters) 3.00 3.00

Primary OutFlow Max=0.6977 m³/s @ 2.05 hrs HW=1,625.290 m (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.6977 m³/s @ 4.02 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 0.00 hrs HW=1,624.000 m (Free Discharge)
 ↑2=Custom Weir/Orifice (Controls 0.0000 m³/s)

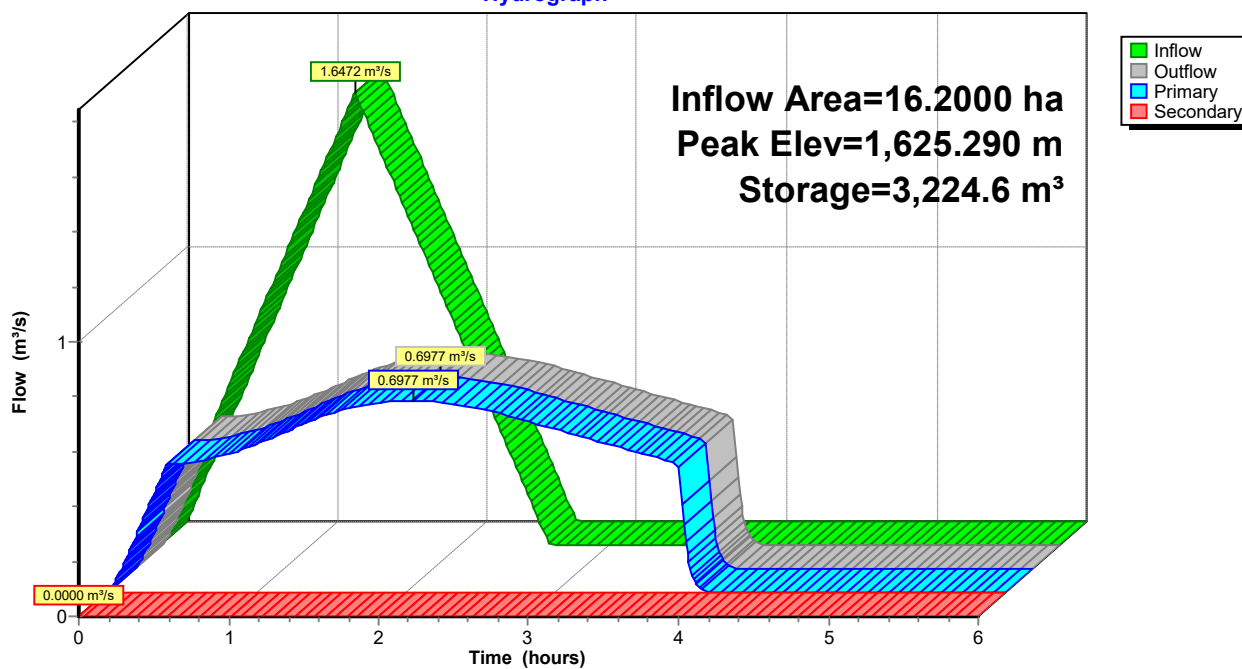
Pond 2P: (new Pond)**Hydrograph**

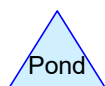
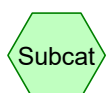
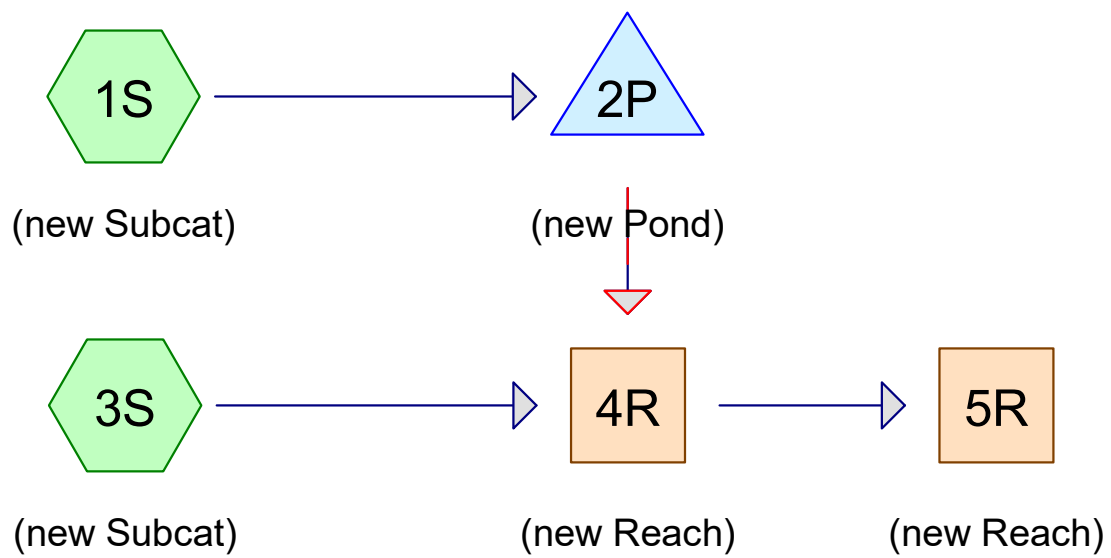
TABLE OF CONTENTS

Project Reports

- 1 Routing Diagram

Current Event

- 2 Subcat 1S: (new Subcat)
- 3 Subcat 3S: (new Subcat)
- 4 Reach 4R: (new Reach)
- 5 Reach 5R: (new Reach)
- 6 Pond 2P: (new Pond)



1 in 25 year pre

Prepared by HP

HydroCAD® 10.10-4a s/n 06378 © 2020 HydroCAD Software Solutions LLC

Rainfall Duration=82 min, Inten=106.3 mm/hr

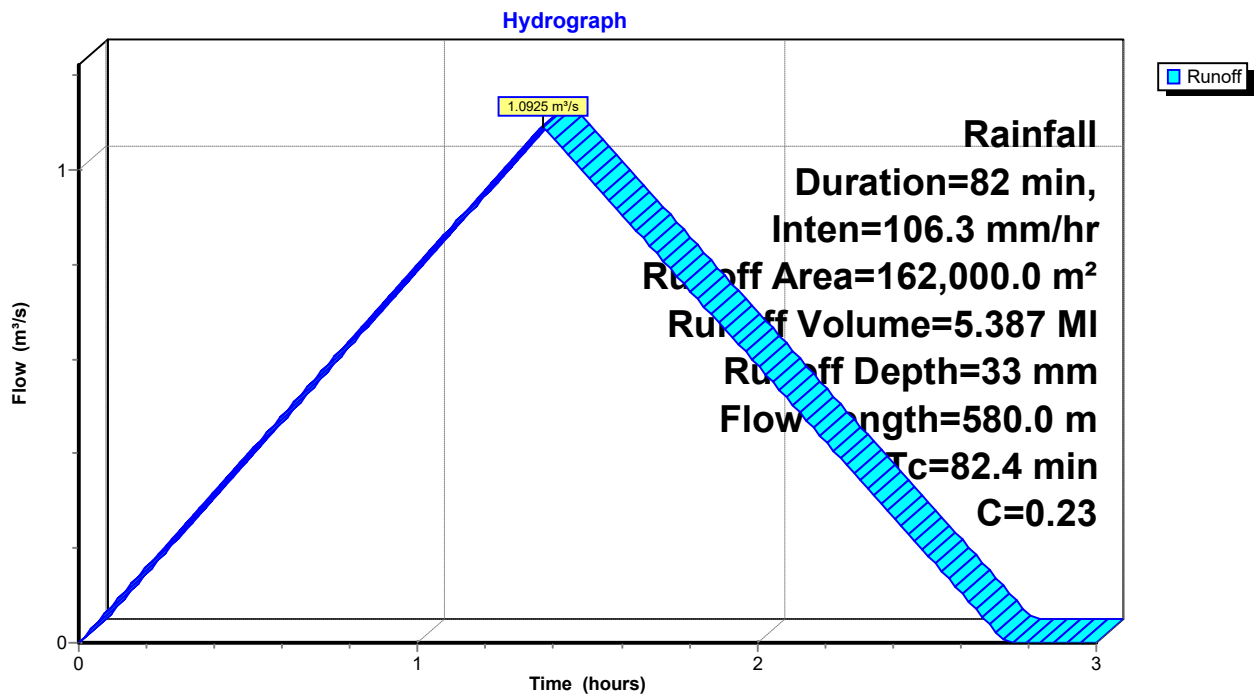
Printed 2022/03/23

Page 2

Summary for Subcatchment 1S: (new Subcat)Runoff = 1.0925 m³/s @ 1.37 hrs, Volume= 5.387 MI, Depth= 33 mmRunoff by Rational method, Rise/Fall=1.0/1.0 xT_c, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Rainfall Duration=82 min, Inten=106.3 mm/hr

Area (m ²)	C	Description
162,000.0	0.23	
162,000.0		100.00% Pervious Area

T _c (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
82.4	580.0		0.12		Direct Entry,

Subcatchment 1S: (new Subcat)

Summary for Subcatchment 3S: (new Subcat)

Runoff = 0.5492 m³/s @ 0.26 hrs, Volume= 2.702 MI, Depth= 90 mm

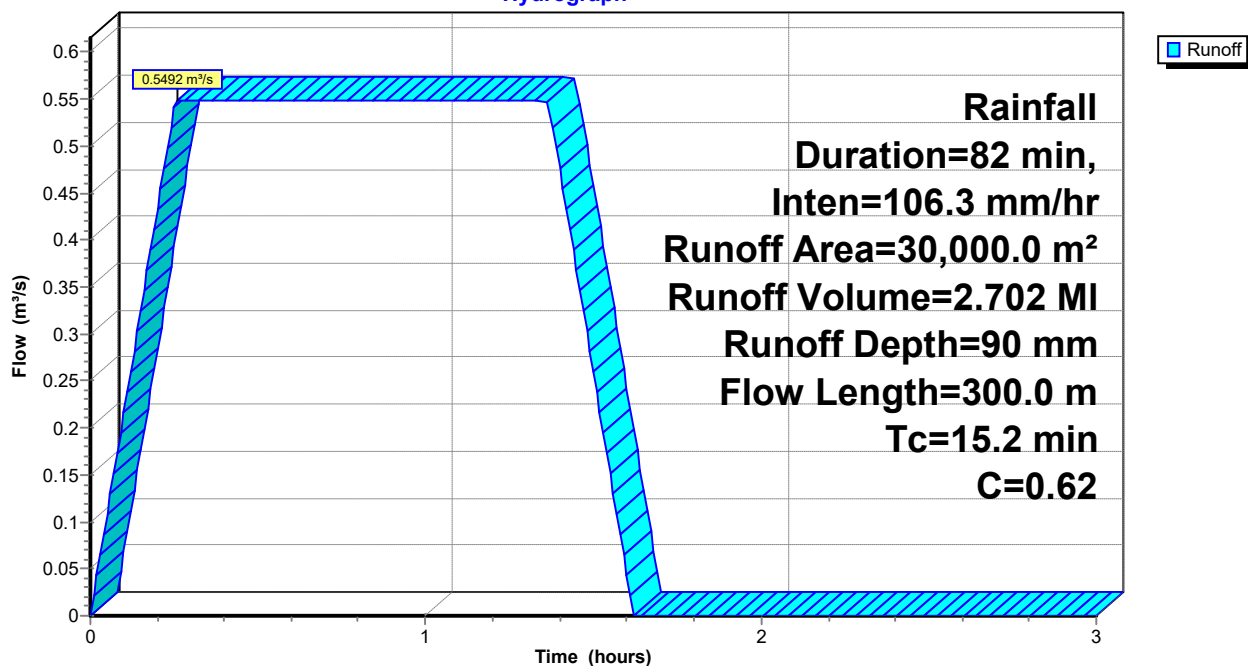
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Rainfall Duration=82 min, Inten=106.3 mm/hr

Area (m ²)	C	Description
30,000.0	0.62	
30,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
15.2	300.0		0.33		Direct Entry,

Subcatchment 3S: (new Subcat)

Hydrograph



Summary for Reach 4R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 41 mm
 Inflow = 1.0845 m³/s @ 1.36 hrs, Volume= 7.800 MI
 Outflow = 1.0783 m³/s @ 1.43 hrs, Volume= 7.568 MI, Atten= 1%, Lag= 4.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.95 m/s, Min. Travel Time= 3.5 min
 Avg. Velocity = 0.83 m/s, Avg. Travel Time= 4.0 min

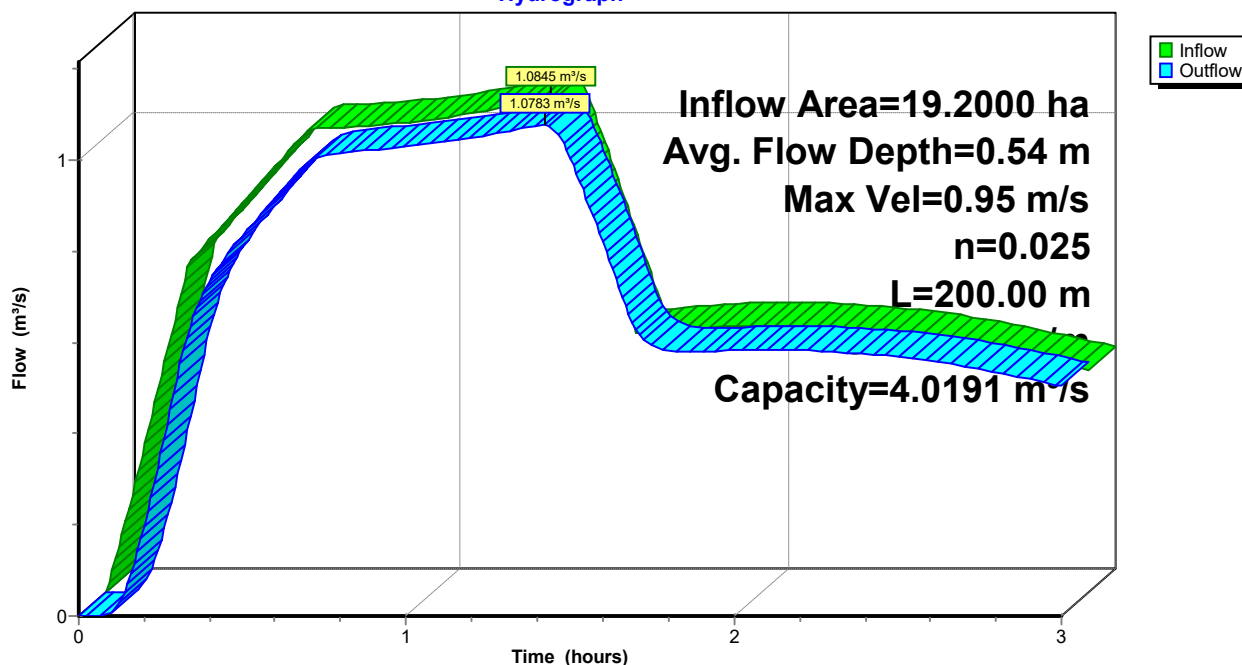
Peak Storage= 225.9 m³ @ 1.37 hrs
 Average Depth at Peak Storage= 0.54 m, Surface Width= 3.17 m
 Bank-Full Depth= 1.00 m Flow Area= 3.00 m², Capacity= 4.0191 m³/s

1.00 m x 1.00 m deep channel, n= 0.025 Earth, clean & straight
 Side Slope Z-value= 2.0 m/m Top Width= 5.00 m
 Length= 200.00 m Slope= 0.0025 m/m
 Inlet Invert= 1,624.000 m, Outlet Invert= 1,623.500 m



Reach 4R: (new Reach)

Hydrograph



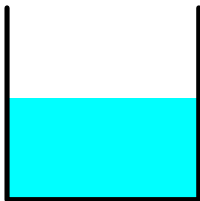
Summary for Reach 5R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 39 mm
 Inflow = 1.0783 m³/s @ 1.43 hrs, Volume= 7.568 MI
 Outflow = 1.0780 m³/s @ 1.43 hrs, Volume= 7.559 MI, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 3.17 m/s, Min. Travel Time= 0.1 min
 Avg. Velocity = 2.77 m/s, Avg. Travel Time= 0.2 min

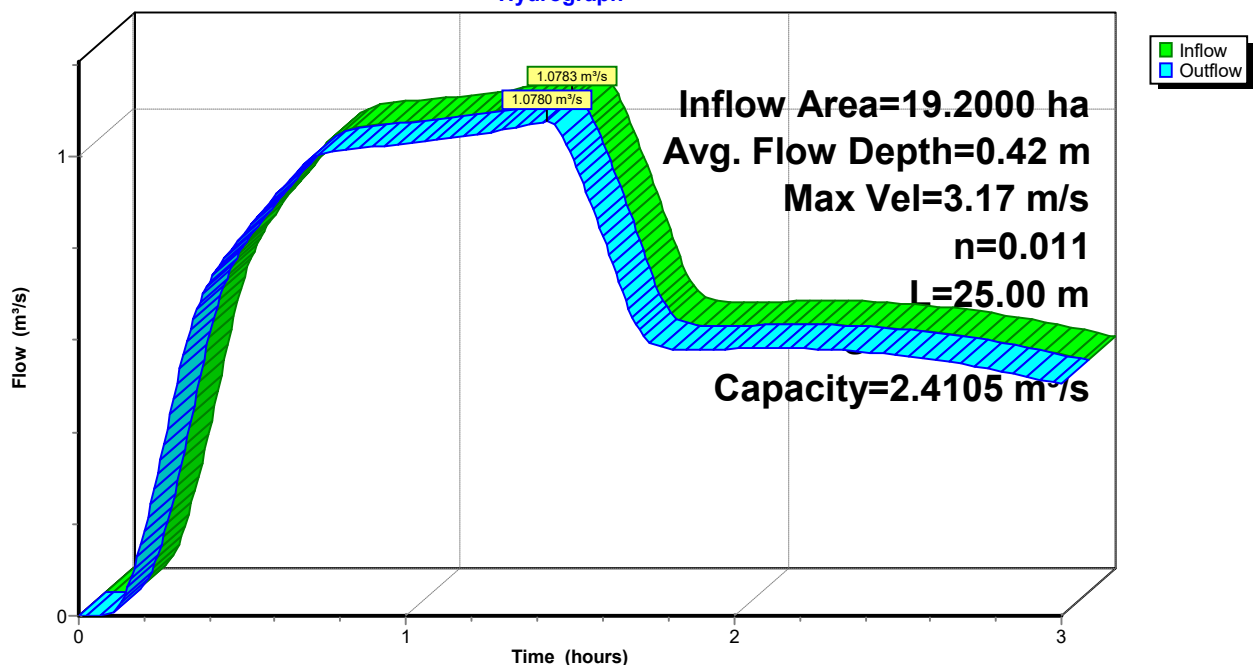
Peak Storage= 8.5 m³ @ 1.43 hrs
 Average Depth at Peak Storage= 0.42 m, Surface Width= 0.80 m
 Bank-Full Depth= 0.80 m Flow Area= 0.64 m², Capacity= 2.4105 m³/s

0.80 m x 0.80 m deep channel, n= 0.011
 Length= 25.00 m Slope= 0.0100 m/m
 Inlet Invert= 1,623.500 m, Outlet Invert= 1,623.250 m



Reach 5R: (new Reach)

Hydrograph



Summary for Pond 2P: (new Pond)

Inflow Area = 16.2000 ha, 0.00% Impervious, Inflow Depth = 33 mm
 Inflow = 1.0925 m³/s @ 1.37 hrs, Volume= 5.387 MI
 Outflow = 0.5834 m³/s @ 2.01 hrs, Volume= 5.098 MI, Atten= 47%, Lag= 38.3 min
 Primary = 0.5834 m³/s @ 2.01 hrs, Volume= 5.098 MI
 Secondary = 0.0000 m³/s @ 0.00 hrs, Volume= 0.000 MI

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Peak Elev= 1,624.601 m @ 2.01 hrs Surf.Area= 2,500.0 m² Storage= 1,501.8 m³

Plug-Flow detention time= 23.6 min calculated for 5.098 MI (95% of inflow)
 Center-of-Mass det. time= 20.0 min (102.0 - 82.0)

Volume	Invert	Avail.Storage	Storage Description
#1 1,624.000 m		6,250.0 m ³	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
1,624.000	2,500.0	0.0	0.0
1,626.500	2,500.0	6,250.0	6,250.0

Device	Routing	Invert	Outlet Devices
#1	Primary	1,623.000 m	470 mm Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Secondary	1,625.300 m	Custom Weir/Orifice, Cv= 1.45 (C= 1.81) Head (meters) 0.000 0.395 Width (meters) 3.00 3.00

Primary OutFlow Max=0.5834 m³/s @ 2.01 hrs HW=1,624.601 m (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.5834 m³/s @ 3.36 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 0.00 hrs HW=1,624.000 m (Free Discharge)
 ↑2=Custom Weir/Orifice (Controls 0.0000 m³/s)

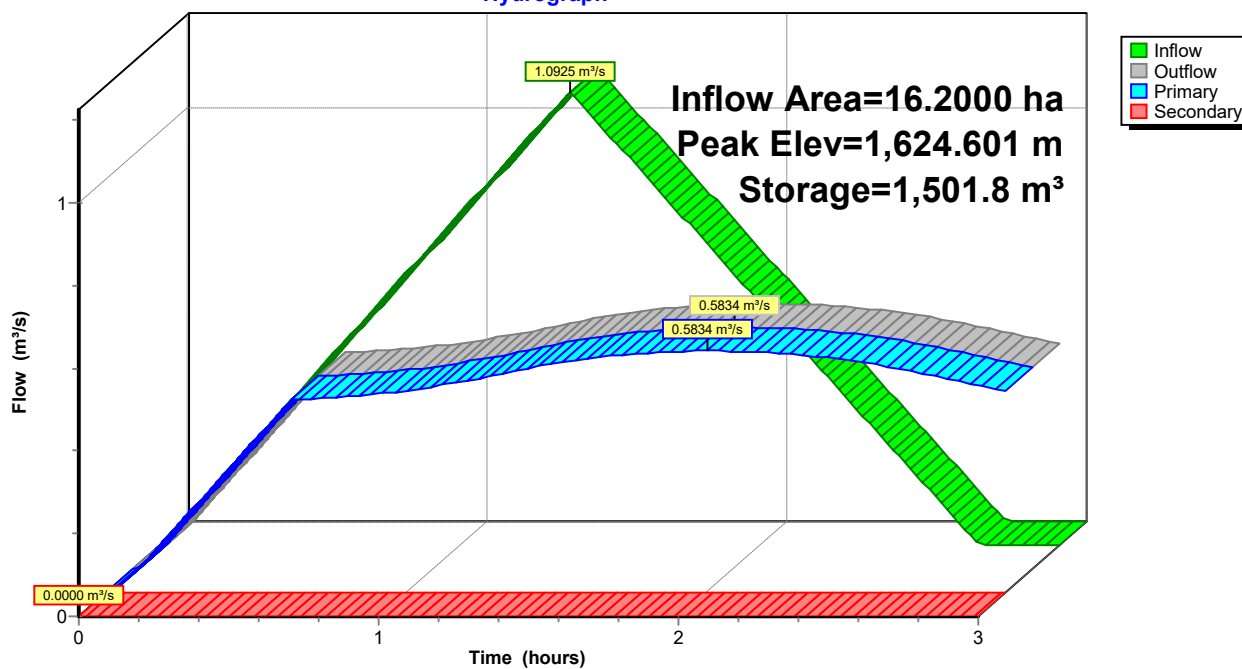
Pond 2P: (new Pond)**Hydrograph**

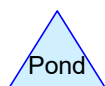
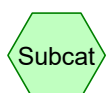
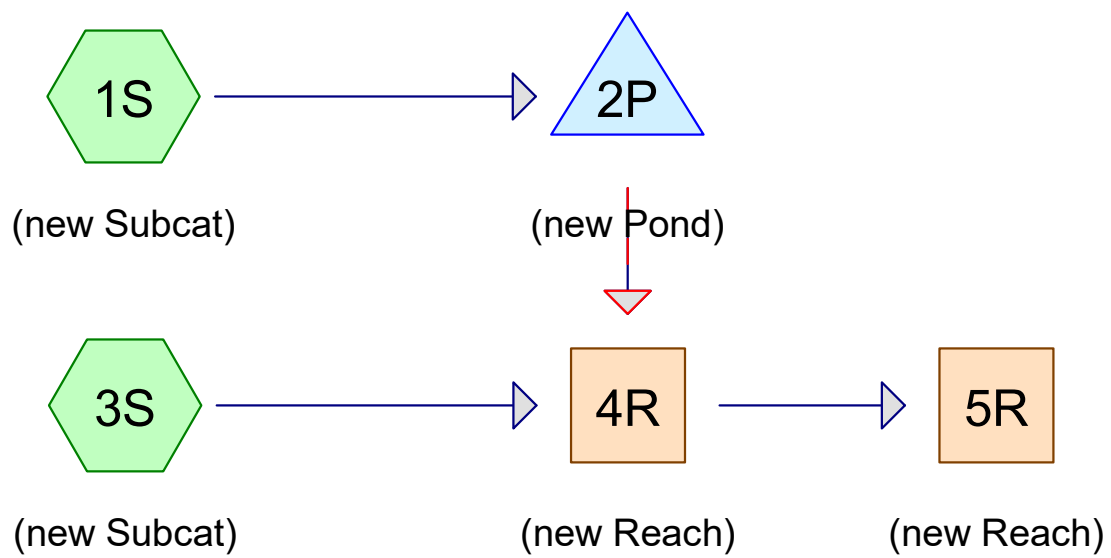
TABLE OF CONTENTS

Project Reports

- 1 Routing Diagram

Current Event

- 2 Subcat 1S: (new Subcat)
- 3 Subcat 3S: (new Subcat)
- 4 Reach 4R: (new Reach)
- 5 Reach 5R: (new Reach)
- 6 Pond 2P: (new Pond)



1 in 50 year post

Prepared by HP

HydroCAD® 10.10-4a s/n 06378 © 2020 HydroCAD Software Solutions LLC

Rainfall Duration=78 min, Inten=131.8 mm/hr

Printed 2022/03/23

Page 2

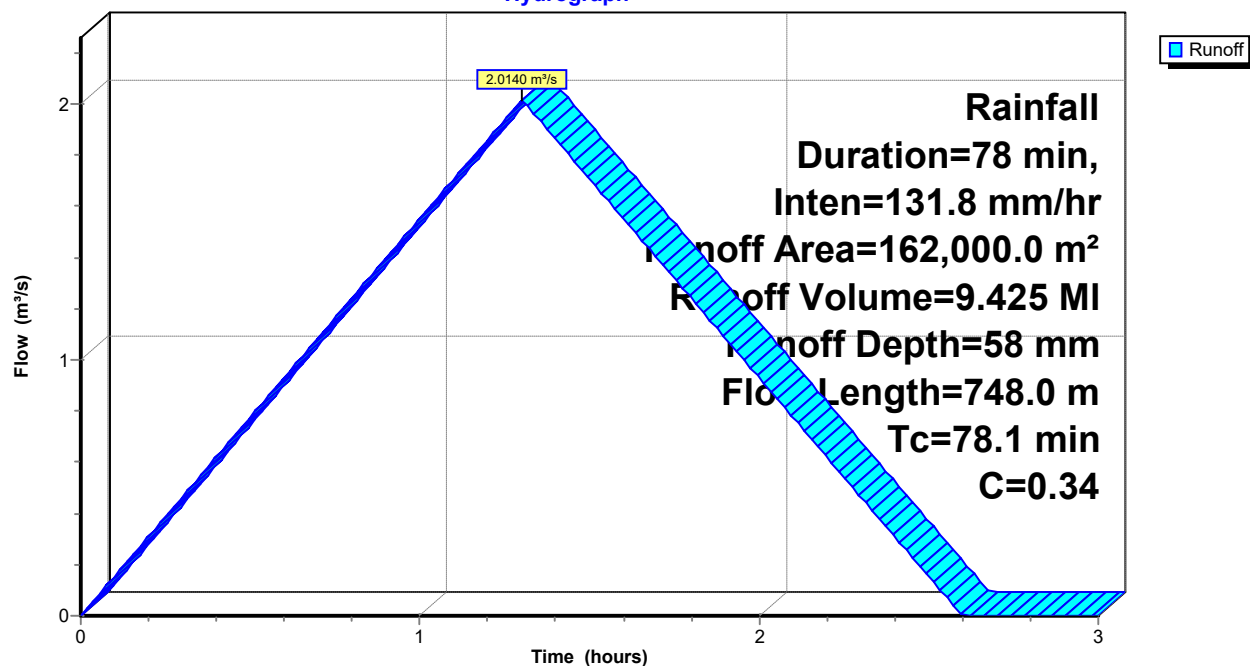
Summary for Subcatchment 1S: (new Subcat)Runoff = 2.0140 m³/s @ 1.30 hrs, Volume= 9.425 MI, Depth= 58 mmRunoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Rainfall Duration=78 min, Inten=131.8 mm/hr

Area (m ²)	C	Description
162,000.0	0.34	
162,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
78.1	748.0		0.16		Direct Entry,

Subcatchment 1S: (new Subcat)

Hydrograph



Summary for Subcatchment 3S: (new Subcat)

Runoff = 0.6810 m³/s @ 0.26 hrs, Volume= 3.187 MI, Depth= 106 mm

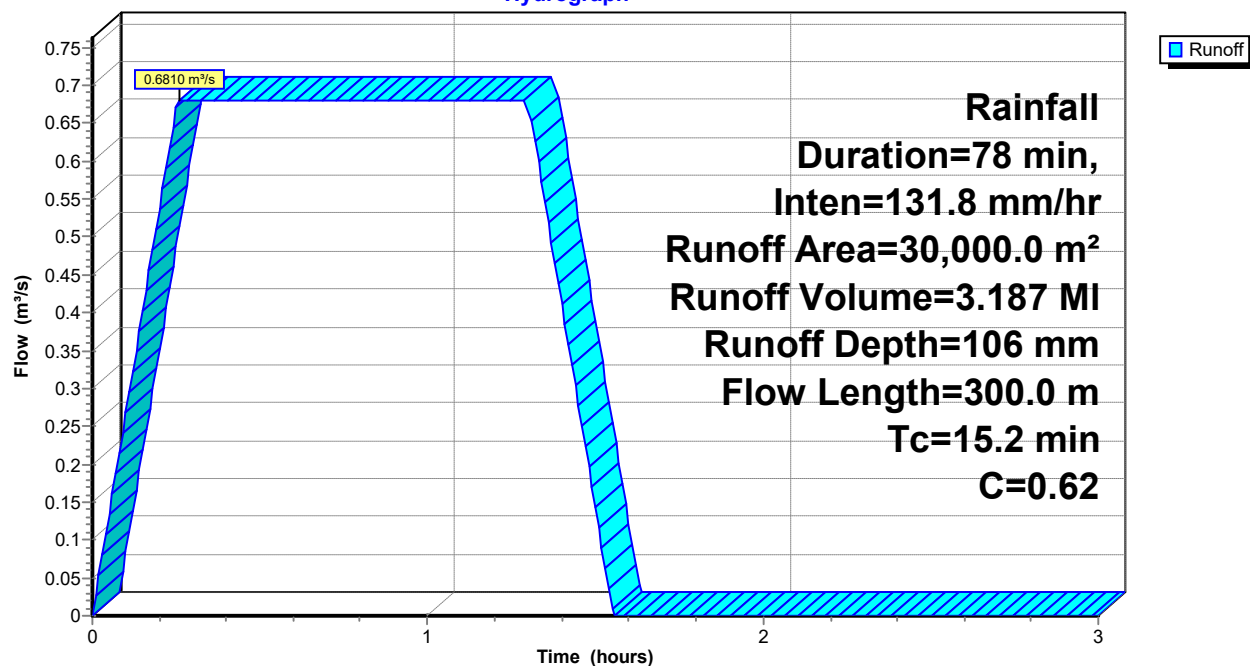
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Rainfall Duration=78 min, Inten=131.8 mm/hr

Area (m ²)	C	Description
30,000.0	0.62	
30,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
15.2	300.0		0.33		Direct Entry,

Subcatchment 3S: (new Subcat)

Hydrograph



Summary for Reach 4R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 56 mm
 Inflow = 1.3409 m³/s @ 1.30 hrs, Volume= 10.664 MI
 Outflow = 1.3264 m³/s @ 1.36 hrs, Volume= 10.388 MI, Atten= 1%, Lag= 3.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.01 m/s, Min. Travel Time= 3.3 min
 Avg. Velocity = 0.91 m/s, Avg. Travel Time= 3.7 min

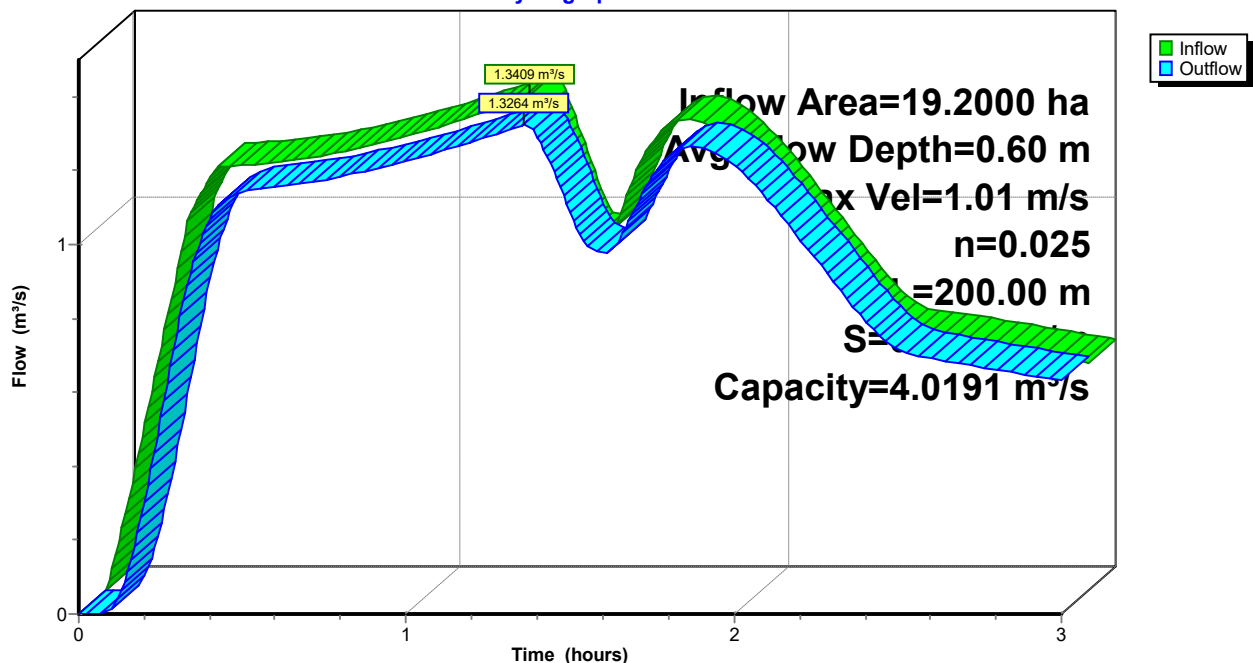
Peak Storage= 263.3 m³ @ 1.31 hrs
 Average Depth at Peak Storage= 0.60 m, Surface Width= 3.40 m
 Bank-Full Depth= 1.00 m Flow Area= 3.00 m², Capacity= 4.0191 m³/s

1.00 m x 1.00 m deep channel, n= 0.025 Earth, clean & straight
 Side Slope Z-value= 2.0 m/m Top Width= 5.00 m
 Length= 200.00 m Slope= 0.0025 m/m
 Inlet Invert= 1,624.000 m, Outlet Invert= 1,623.500 m



Reach 4R: (new Reach)

Hydrograph



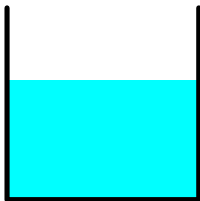
Summary for Reach 5R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 54 mm
 Inflow = 1.3264 m³/s @ 1.36 hrs, Volume= 10.388 MI
 Outflow = 1.3259 m³/s @ 1.36 hrs, Volume= 10.378 MI, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 3.33 m/s, Min. Travel Time= 0.1 min
 Avg. Velocity = 3.02 m/s, Avg. Travel Time= 0.1 min

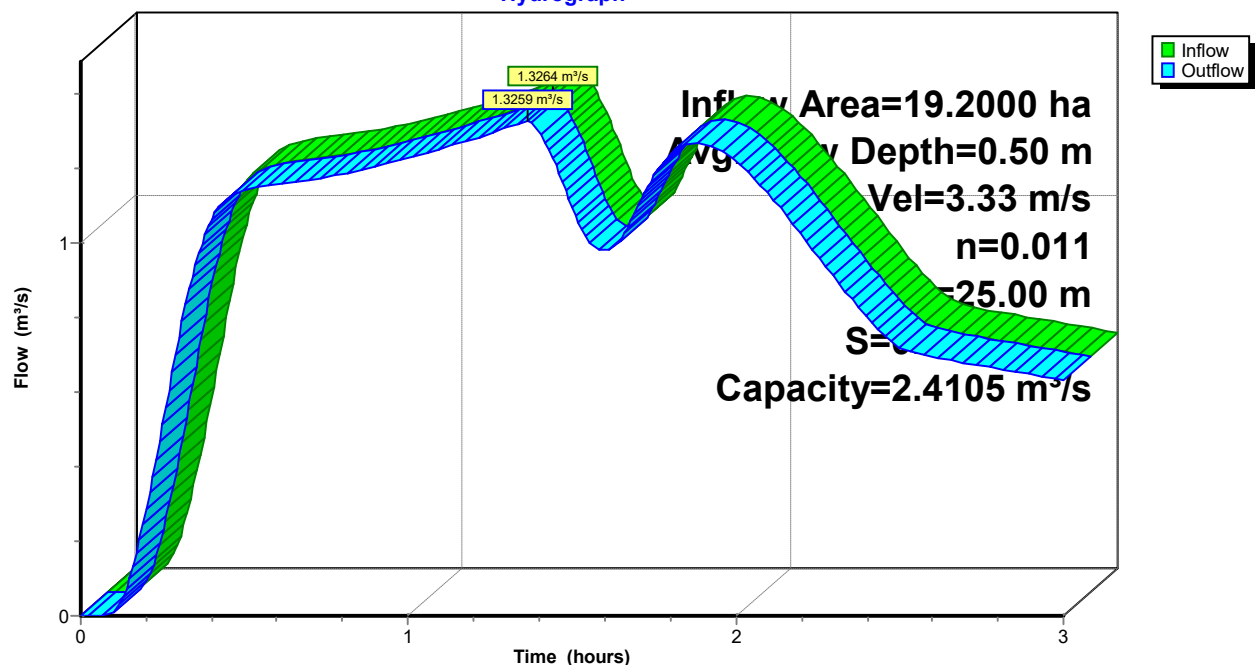
Peak Storage= 10.0 m³ @ 1.36 hrs
 Average Depth at Peak Storage= 0.50 m, Surface Width= 0.80 m
 Bank-Full Depth= 0.80 m Flow Area= 0.64 m², Capacity= 2.4105 m³/s

0.80 m x 0.80 m deep channel, n= 0.011
 Length= 25.00 m Slope= 0.0100 m/m
 Inlet Invert= 1,623.500 m, Outlet Invert= 1,623.250 m



Reach 5R: (new Reach)

Hydrograph



Summary for Pond 2P: (new Pond)

Inflow Area = 16.2000 ha, 0.00% Impervious, Inflow Depth = 58 mm
 Inflow = 2.0140 m³/s @ 1.30 hrs, Volume= 9.425 MI
 Outflow = 1.2768 m³/s @ 1.78 hrs, Volume= 7.477 MI, Atten= 37%, Lag= 28.6 min
 Primary = 0.7313 m³/s @ 1.78 hrs, Volume= 6.392 MI
 Secondary = 0.5455 m³/s @ 1.78 hrs, Volume= 1.084 MI

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Peak Elev= 1,625.516 m @ 1.78 hrs Surf.Area= 2,500.0 m² Storage= 3,789.3 m³

Plug-Flow detention time= 36.2 min calculated for 7.477 MI (79% of inflow)
 Center-of-Mass det. time= 24.6 min (102.6 - 78.0)

Volume	Invert	Avail.Storage	Storage Description
#1 1,624.000 m	6,250.0 m ³	Custom Stage Data (Prismatic) Listed below (Recalc)	

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
1,624.000	2,500.0	0.0	0.0
1,626.500	2,500.0	6,250.0	6,250.0

Device	Routing	Invert	Outlet Devices
#1	Primary	1,623.000 m	470 mm Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Secondary	1,625.300 m	Custom Weir/Orifice, Cv= 1.45 (C= 1.81) Head (meters) 0.000 0.395 Width (meters) 3.00 3.00

Primary OutFlow Max=0.7313 m³/s @ 1.78 hrs HW=1,625.516 m (Free Discharge)
 ↑1=Orifice/Grate (Orifice Controls 0.7313 m³/s @ 4.22 m/s)

Secondary OutFlow Max=0.5448 m³/s @ 1.78 hrs HW=1,625.516 m (Free Discharge)
 ↑2=Custom Weir/Orifice (Weir Controls 0.5448 m³/s @ 0.84 m/s)

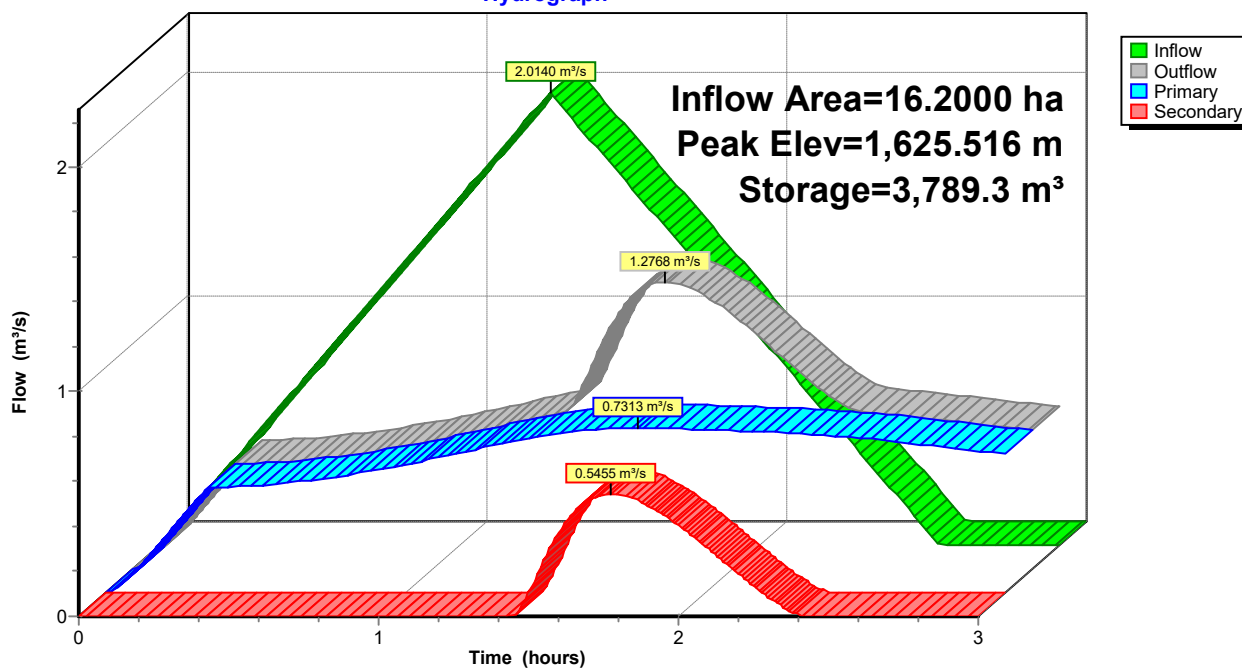
Pond 2P: (new Pond)**Hydrograph**

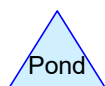
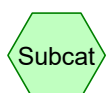
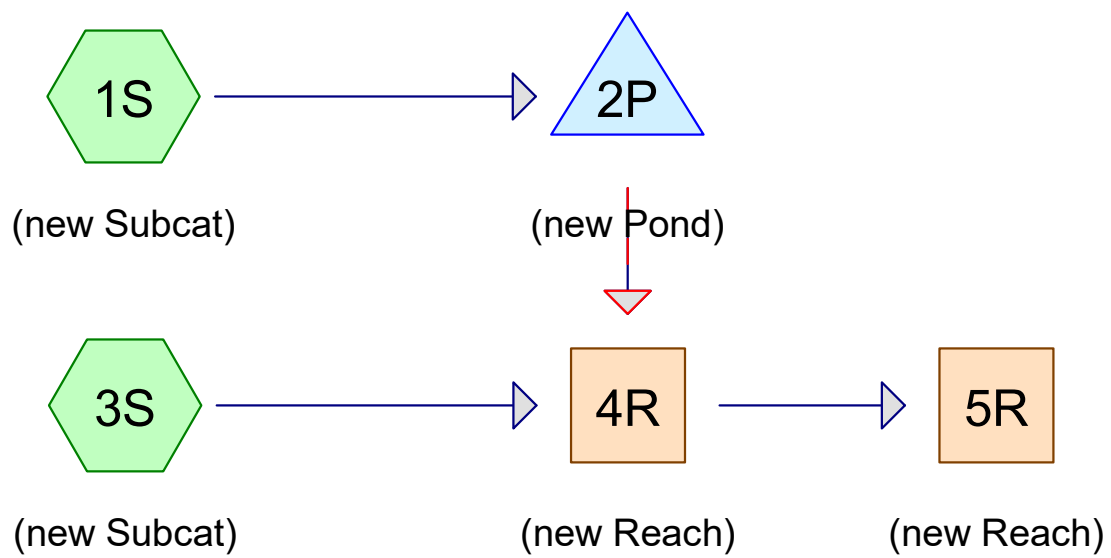
TABLE OF CONTENTS

Project Reports

- 1 Routing Diagram

Current Event

- 2 Subcat 1S: (new Subcat)
- 3 Subcat 3S: (new Subcat)
- 4 Reach 4R: (new Reach)
- 5 Reach 5R: (new Reach)
- 6 Pond 2P: (new Pond)



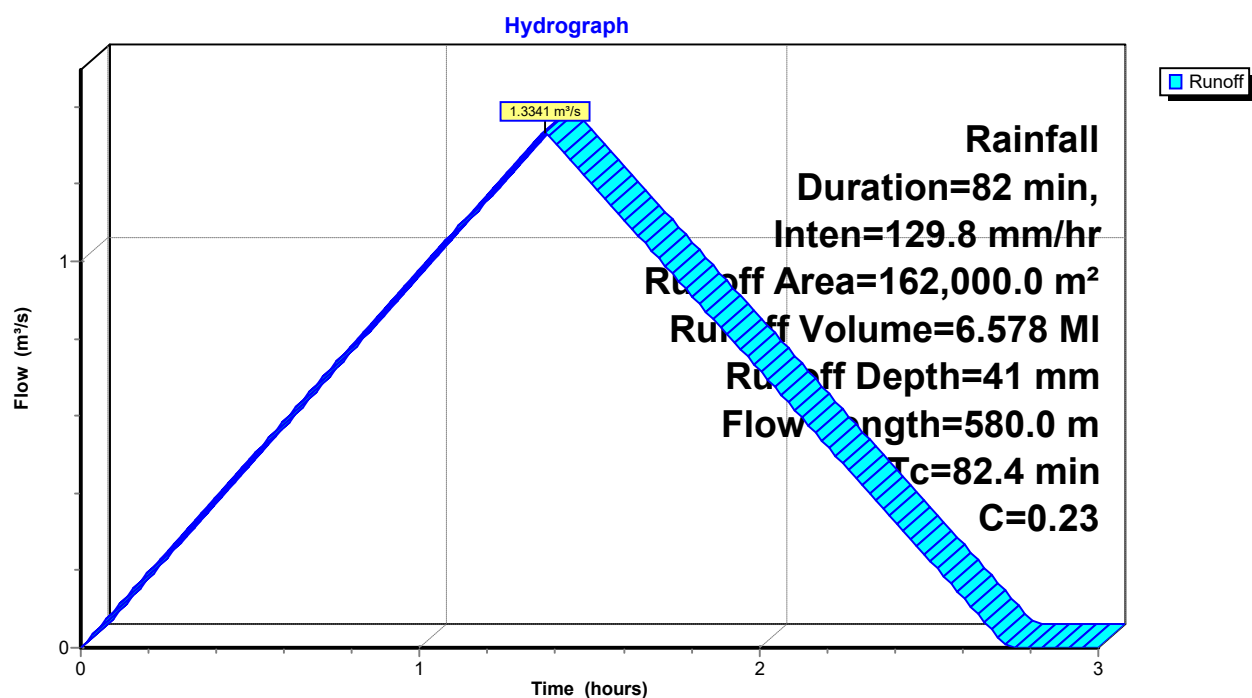
Summary for Subcatchment 1S: (new Subcat)

Runoff = 1.3341 m³/s @ 1.37 hrs, Volume= 6.578 MI, Depth= 41 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xT_c, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Rainfall Duration=82 min, Inten=129.8 mm/hr

Area (m ²)	C	Description
162,000.0	0.23	
162,000.0		100.00% Pervious Area

T _c (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
82.4	580.0		0.12		Direct Entry,

Subcatchment 1S: (new Subcat)

Summary for Subcatchment 3S: (new Subcat)

Runoff = 0.6706 m³/s @ 0.26 hrs, Volume= 3.299 MI, Depth= 110 mm

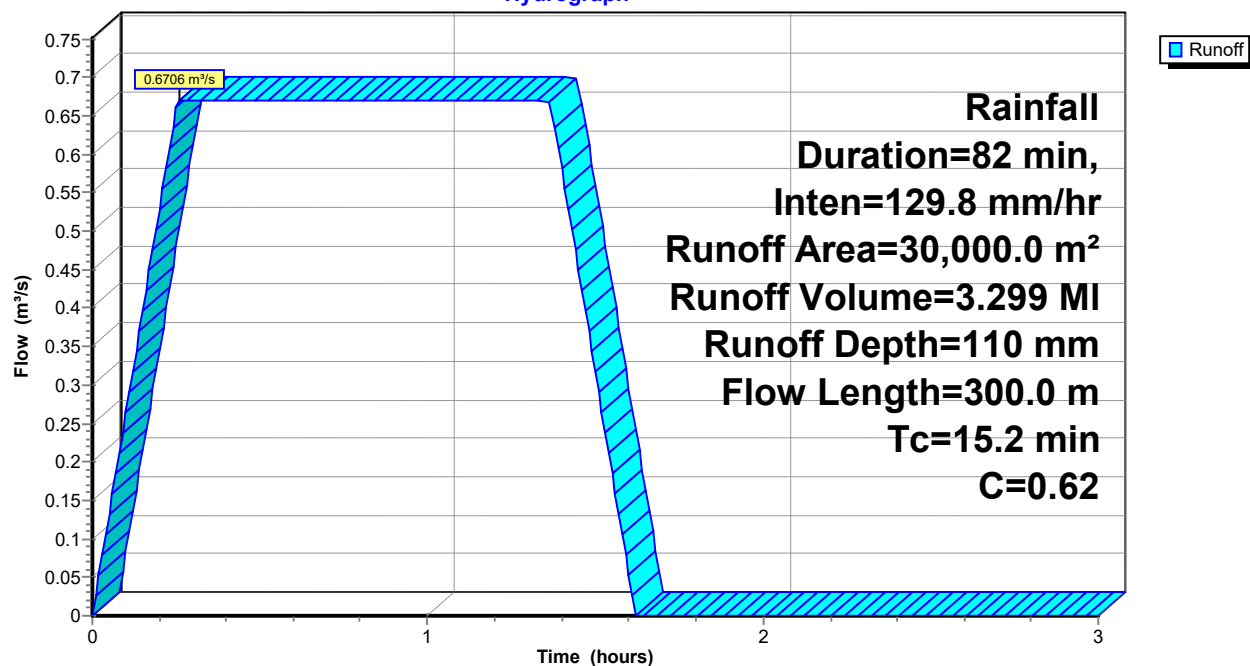
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Rainfall Duration=82 min, Inten=129.8 mm/hr

Area (m ²)	C	Description
30,000.0	0.62	
30,000.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
15.2	300.0		0.33		Direct Entry,

Subcatchment 3S: (new Subcat)

Hydrograph



Summary for Reach 4R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 46 mm
 Inflow = 1.2407 m³/s @ 1.36 hrs, Volume= 8.854 MI
 Outflow = 1.2326 m³/s @ 1.42 hrs, Volume= 8.602 MI, Atten= 1%, Lag= 4.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.99 m/s, Min. Travel Time= 3.4 min
 Avg. Velocity = 0.86 m/s, Avg. Travel Time= 3.9 min

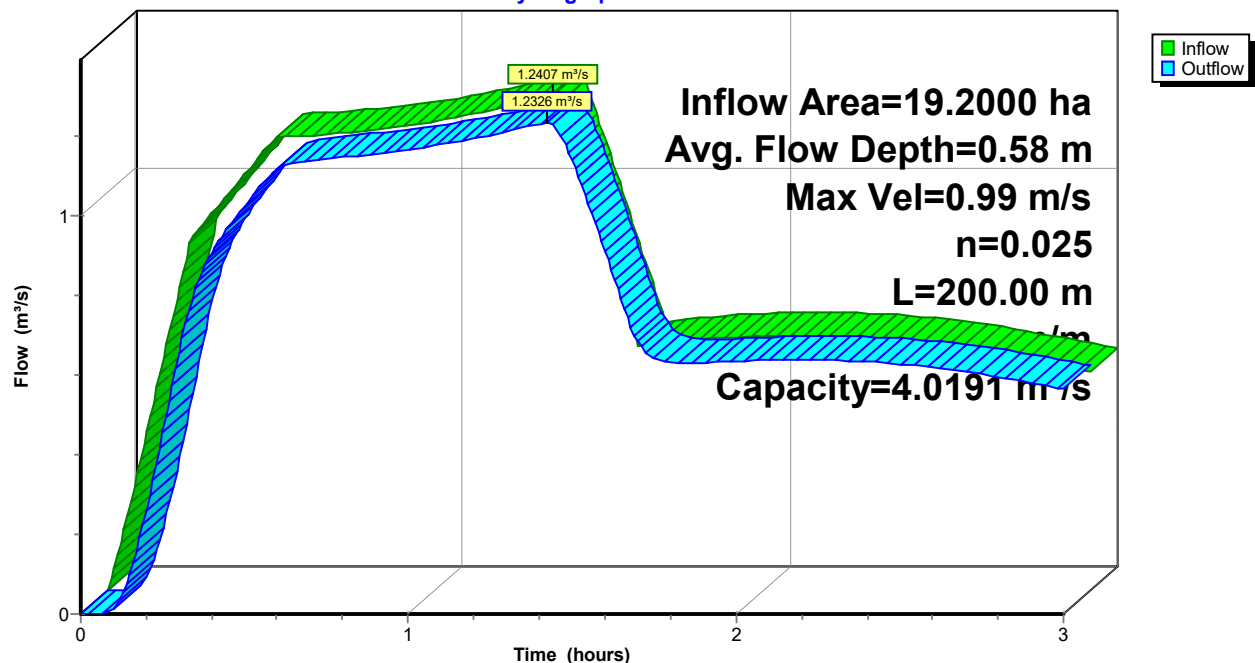
Peak Storage= 249.4 m³ @ 1.37 hrs
 Average Depth at Peak Storage= 0.58 m, Surface Width= 3.31 m
 Bank-Full Depth= 1.00 m Flow Area= 3.00 m², Capacity= 4.0191 m³/s

1.00 m x 1.00 m deep channel, n= 0.025 Earth, clean & straight
 Side Slope Z-value= 2.0 m/m Top Width= 5.00 m
 Length= 200.00 m Slope= 0.0025 m/m
 Inlet Invert= 1,624.000 m, Outlet Invert= 1,623.500 m



Reach 4R: (new Reach)

Hydrograph



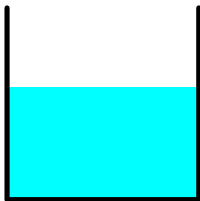
Summary for Reach 5R: (new Reach)

Inflow Area = 19.2000 ha, 0.00% Impervious, Inflow Depth > 45 mm
 Inflow = 1.2326 m³/s @ 1.42 hrs, Volume= 8.602 MI
 Outflow = 1.2326 m³/s @ 1.43 hrs, Volume= 8.593 MI, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 3.27 m/s, Min. Travel Time= 0.1 min
 Avg. Velocity = 2.86 m/s, Avg. Travel Time= 0.1 min

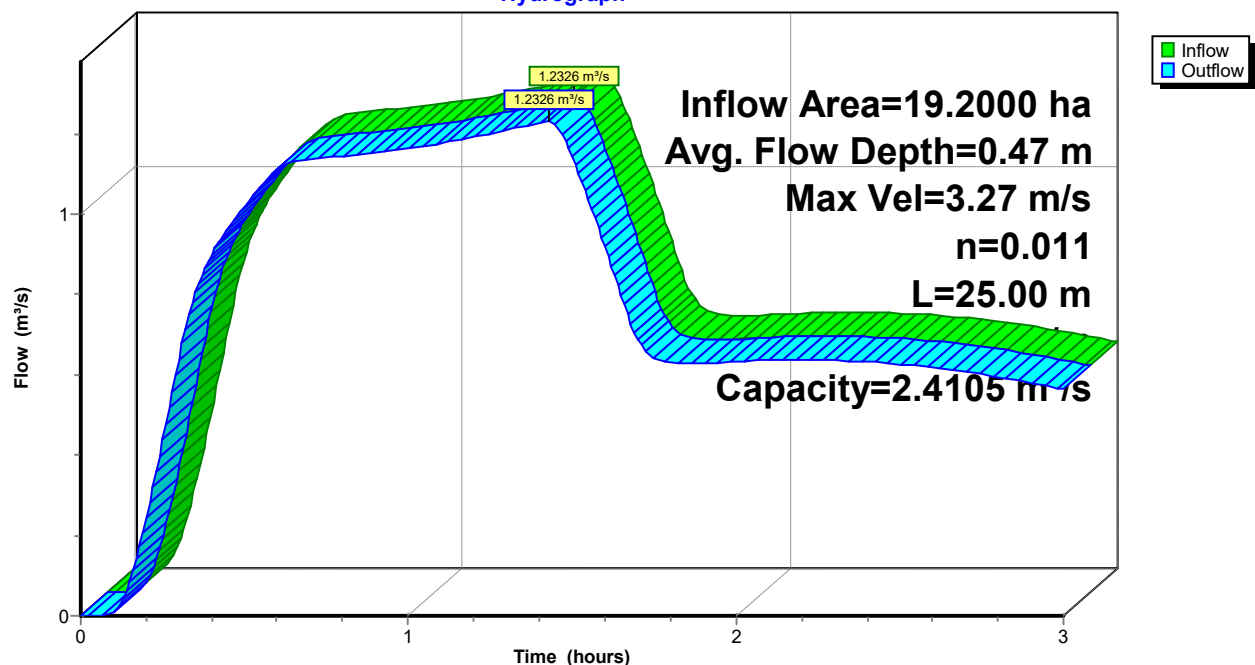
Peak Storage= 9.4 m³ @ 1.43 hrs
 Average Depth at Peak Storage= 0.47 m, Surface Width= 0.80 m
 Bank-Full Depth= 0.80 m Flow Area= 0.64 m², Capacity= 2.4105 m³/s

0.80 m x 0.80 m deep channel, n= 0.011
 Length= 25.00 m Slope= 0.0100 m/m
 Inlet Invert= 1,623.500 m, Outlet Invert= 1,623.250 m



Reach 5R: (new Reach)

Hydrograph



Summary for Pond 2P: (new Pond)

Inflow Area = 16.2000 ha, 0.00% Impervious, Inflow Depth = 41 mm
 Inflow = 1.3341 m³/s @ 1.37 hrs, Volume= 6.578 MI
 Outflow = 0.6382 m³/s @ 2.08 hrs, Volume= 5.555 MI, Atten= 52%, Lag= 42.8 min
 Primary = 0.6382 m³/s @ 2.08 hrs, Volume= 5.555 MI
 Secondary = 0.0000 m³/s @ 0.00 hrs, Volume= 0.000 MI

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs

Peak Elev= 1,624.916 m @ 2.08 hrs Surf.Area= 2,500.0 m² Storage= 2,289.0 m³

Plug-Flow detention time= 29.7 min calculated for 5.537 MI (84% of inflow)

Center-of-Mass det. time= 20.3 min (102.3 - 82.0)

Volume	Invert	Avail.Storage	Storage Description
#1 1,624.000 m		6,250.0 m ³	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
1,624.000	2,500.0	0.0	0.0
1,626.500	2,500.0	6,250.0	6,250.0

Device	Routing	Invert	Outlet Devices
#1	Primary	1,623.000 m	470 mm Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Secondary	1,625.300 m	Custom Weir/Orifice, Cv= 1.45 (C= 1.81) Head (meters) 0.000 0.395 Width (meters) 3.00 3.00

Primary OutFlow Max=0.6382 m³/s @ 2.08 hrs HW=1,624.916 m (Free Discharge)

↑**1=Orifice/Grate** (Orifice Controls 0.6382 m³/s @ 3.68 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 0.00 hrs HW=1,624.000 m (Free Discharge)

↑**2=Custom Weir/Orifice** (Controls 0.0000 m³/s)

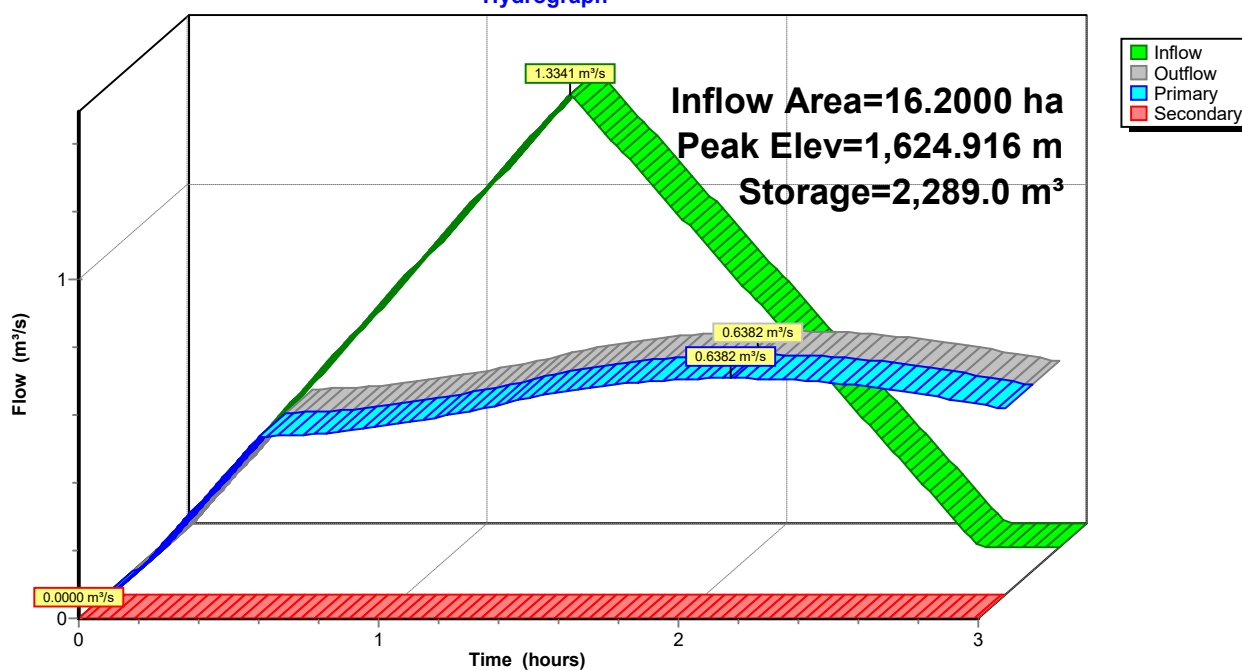
Pond 2P: (new Pond)**Hydrograph**

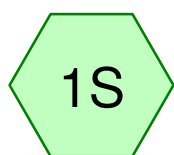
TABLE OF CONTENTS

Project Reports

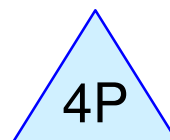
- 1 Routing Diagram

Current Event

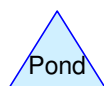
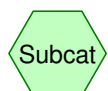
- 2 Subcat 1S: (new Subcat)
- 3 Subcat 3S: (new Subcat)
- 4 Reach 4R: (new Reach)
- 5 Reach 5R: (new Reach)
- 6 Pond 2P: (new Pond)



Area 1



(new Pond)



Routing Diagram for 1 in 50 year post dev

Prepared by {enter your company name here}, Printed 2018/03/29
HydroCAD® 10.00-20 s/n 06378 © 2017 HydroCAD Software Solutions LLC

1 in 50 year post dev

Rainfall Duration=23 min, Inten=134.1 mm/hr

Prepared by {enter your company name here}

Printed 2018/03/29

HydroCAD® 10.00-20 s/n 06378 © 2017 HydroCAD Software Solutions LLC

Page 2

Summary for Subcatchment 1S: Area 1Runoff = 3.2086 m³/s @ 0.38 hrs, Volume= 4,426.9 m³, Depth= 38 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

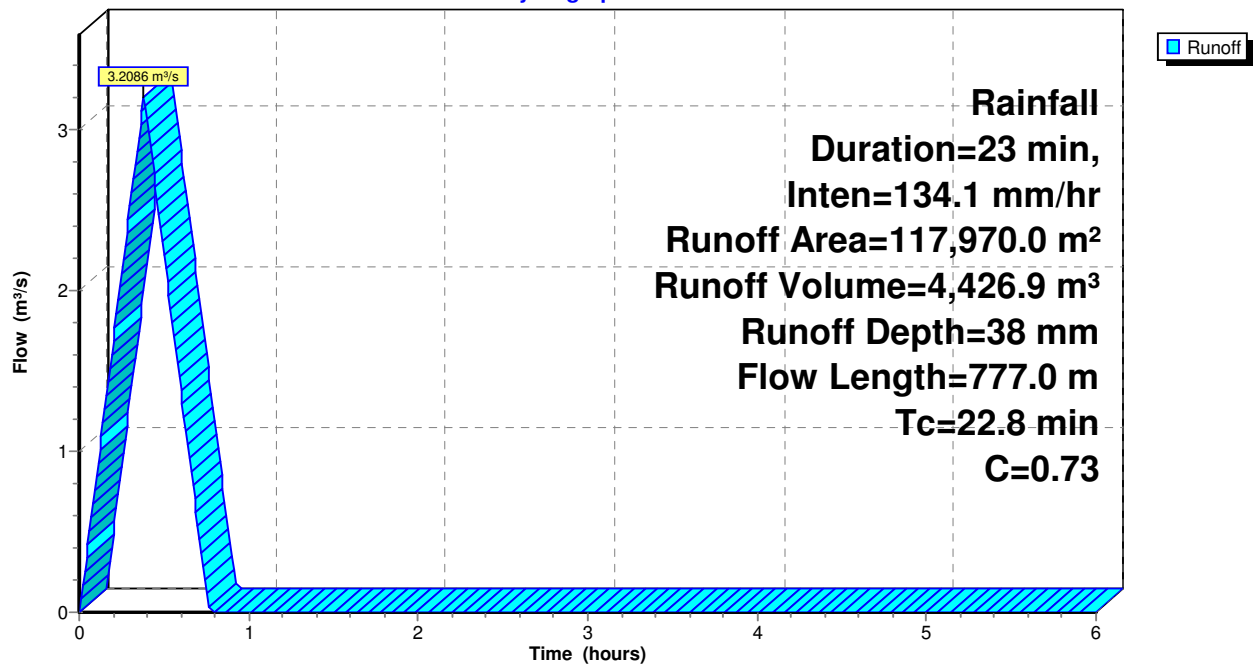
Rainfall Duration=23 min, Inten=134.1 mm/hr

Area (m ²)	C	Description
117,970.0	0.73	
117,970.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m ³ /s)	Description
22.8	777.0		0.57		Direct Entry,

Subcatchment 1S: Area 1

Hydrograph



Summary for Pond 4P: (new Pond)

Inflow Area = 117,970.0 m², 0.00% Impervious, Inflow Depth = 38 mm
 Inflow = 3.2086 m³/s @ 0.38 hrs, Volume= 4,426.9 m³
 Outflow = 0.6437 m³/s @ 0.69 hrs, Volume= 4,078.0 m³, Atten= 80%, Lag= 18.4 min
 Primary = 0.2734 m³/s @ 0.69 hrs, Volume= 3,789.9 m³
 Secondary = 0.3703 m³/s @ 0.69 hrs, Volume= 288.1 m³

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Peak Elev= 2.118 m @ 0.69 hrs Surf.Area= 1,800.0 m² Storage= 3,813.2 m³

Plug-Flow detention time= 127.3 min calculated for 4,078.0 m³ (92% of inflow)

Center-of-Mass det. time= 125.8 min (148.7 - 22.9)

Volume	Invert	Avail.Storage	Storage Description
#1	0.000 m	4,140.0 m ³	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
0.000	1,800.0	0.0	0.0
2.300	1,800.0	4,140.0	4,140.0

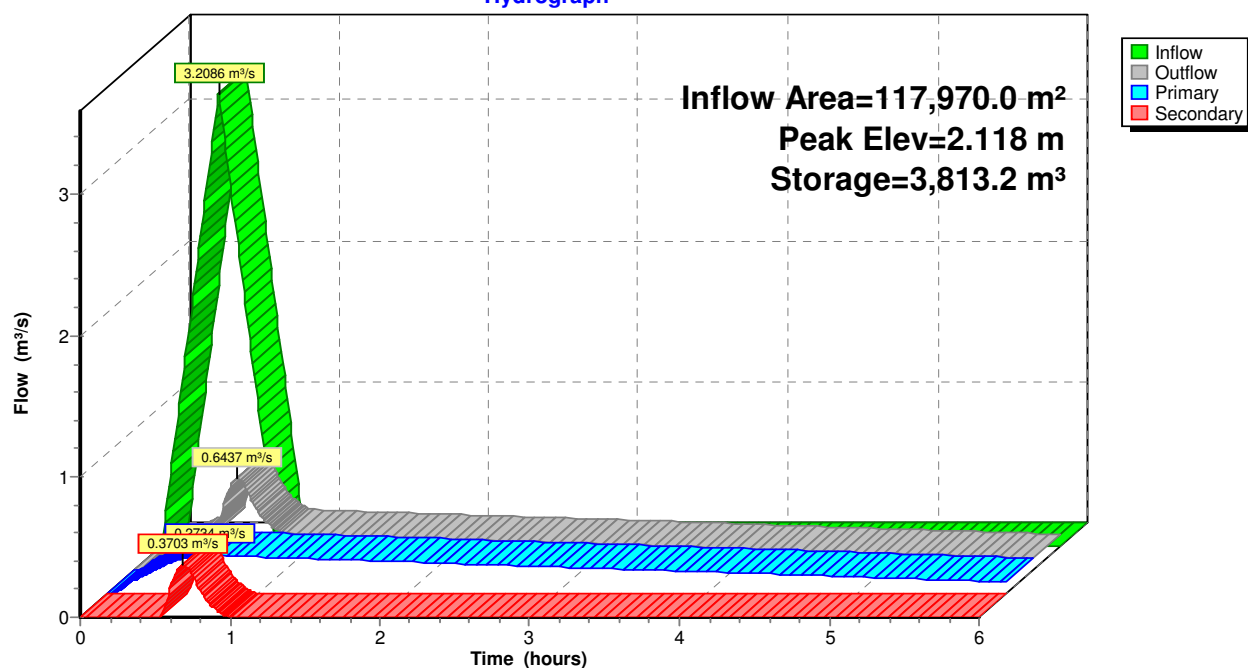
Device	Routing	Invert	Outlet Devices
#1	Primary	0.000 m	300 mm Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Secondary	1.900 m	Custom Weir/Orifice, Cv= 1.45 (C= 1.81) Head (meters) 0.000 0.300 Width (meters) 2.00 2.00

Primary OutFlow Max=0.2734 m³/s @ 0.69 hrs HW=2.118 m (Free Discharge)

↑**1=Orifice/Grate** (Orifice Controls 0.2734 m³/s @ 3.87 m/s)

Secondary OutFlow Max=0.3697 m³/s @ 0.69 hrs HW=2.118 m (Free Discharge)

↑**2=Custom Weir/Orifice** (Weir Controls 0.3697 m³/s @ 0.85 m/s)

Pond 4P: (new Pond)**Hydrograph**

ANNEXURE D

Applicant: Soventix SA (Pty) Ltd	Date: 19 May 2021
Address: Firgrove Business Park, Somerset West	
Email: jp.devilliers@soventix.com	
Tel: 021 852-7333	

PROJECT TITLE

Proposed construction of a 3.6MWp Solar Photovoltaic Plant on a 3.8ha site at the Unilever Boksburg factory.

Property description	<i>Enter Farm name, portion, number and registration division or Erf number etc.)</i>
	erf 757 & 758 Boksburg East, portions 127 & 189 of Vogelfontein
	84, City of Ekurhuleni Metropolitan Municipality.

Site co-ordinates

Indicate the position of the activity using the latitude and longitude of the centre point of the preferred site alternative. The co-ordinates must be in degrees, minutes and seconds using the Hartebeesthoek94 WGS84 co-ordinate system.

Latitude (S):
Longitude (E):

26°


13'

3.10"

28°

15'

57.17"

Desktop Findings		Site Confirmation	
Current land use zoning			
<i>Enter description from municipal town planning department:</i> <ul style="list-style-type: none"> Outstanding. 		Confirm	
		Dispute	
What is the observed land use on site: Open space			
Photograph (include photo no. from camera or phone, indicate cardinal direction the camera is facing & if possible, a GPS co-ordinate)/ description: 			
Photo 1. 360° photo of the proposed development footprint.			
Sensitive geographical features (i.e., wetlands, dongas, ridges, steep gradient, shallow bedrock, sodic sites, etc.)			

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.

Enter description and distances of sensitive geographical features observed using satellite imagery:

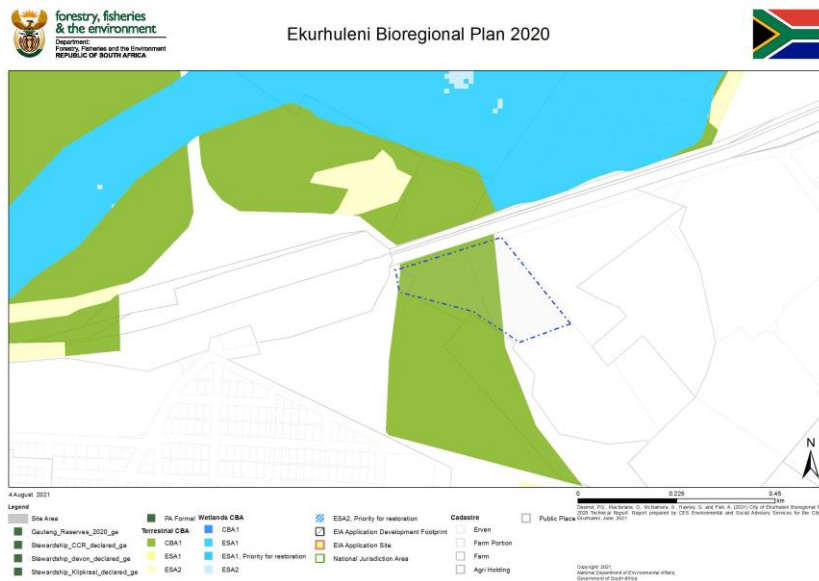


Figure 1. Area coloured “Green” is an Identified Geographic Area (CBA) according to Ekurhuleni Bioregional Plan (2020). A portion of the proposed footprint falls within the CBA.

Confirm

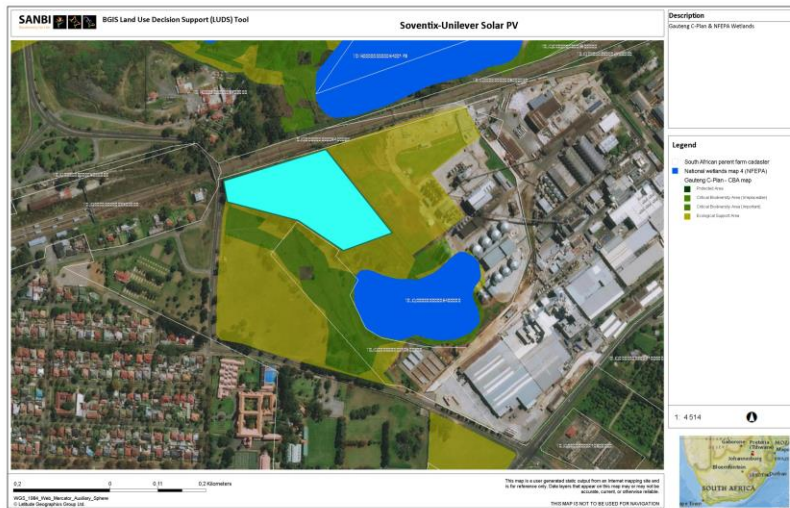


Figure 2. Proposed footprint in relation to Gauteng C-Plan Identified Geographic Areas: 1. ESA (Light-Green) and 2. CBA (Dark-Green). A delineated NFEPA wetland is also in close proximity.

Dispute

If not observed, motivate:

N/A.

Photograph (include photo no. from camera or phone, indicate cardinal direction the camera is facing & if possible, a GPS co-ordinate)/**description**:

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.



Photo 2. 360° photo of the adjacent NFEPA wetland.

Other Sensitive Elements (i.e., boreholes, SCC, limited cover material, etc.):

Description: Rand Water Services

Latitude (S):			Longitude (E):		
26°	13'	04.49"	28°	15'	58.14"

Photograph (include photo no. from camera or phone, indicate cardinal direction the camera is facing & if possible, a GPS co-ordinate)/**description**:



Photos 3 & 4. Existing Rand Water services and servitude crossing the proposed footprint (scour valve and cathodic protection, respectively).

Description: Eskom overhead powerline.

Latitude (S):			Longitude (E):		
°	'	"	°	'	"

Photograph (include photo no. from camera or phone, indicate cardinal direction the camera is facing & if possible, a GPS co-ordinate)/**description**:

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.



Photo 5. Existing overhead powerlines crossing the site.

Description: Old structures of potential heritage significance.

Latitude (S):			Longitude (E):		
°	'	"	°	'	"

Photograph (include photo no. from camera or phone, indicate cardinal direction the camera is facing & if possible, a GPS co-ordinate)/**description**:



Photos 6 & 7. Dismantled infrastructure just outside the proposed footprint (palisade wall in the background indicates the boundary of the development footprint) indicates some unknown historical activities in the area.

Description: Municipal stormwater channel.

Latitude (S):			Longitude (E):		
°	'	"	°	'	"

Photograph (include photo no. from camera or phone, indicate cardinal direction the camera is facing & if possible, a GPS co-ordinate)/**description**:

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.



Photo 8. Existing stormwater channel largely located outside the proposed footprint which may influence access to site.

Notes:



Enter a description of any noteworthy observations regarding the geographical, physical, biological, social, economic, heritage and cultural sensitivity of a site.

Vegetation is largely Kikuyu grass and Eucalyptus sp. trees, with limited indigenous grass & tree species. Several of the Eucalyptus trees have beehives mounted on them which presumably is part of either a commercial or community-based honey production system. Several existing services are located in and around the proposed footprint including a Rand Water pipeline and associated infrastructure, Eskom overhead powerline and municipal stormwater channel. The proposed site is bordered by a railway line (North), secondary roads, Kruger Street to the West and St. Dominics Street to the South and the Unilever facility to the East.

Two adjacent alternative sites were considered, one contains an NFEPA wetland and the other is open parkland largely containing indigenous vegetation and close to the residential area and school (St. Dominic's).

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.

										
Assessment	Agricultural Agro-Ecosystem Specialist Assessment			Agricultural Compliance Statement						
Description & Exemption(s)	An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being of “medium” or “low” sensitivity for agricultural resources must submit an Agricultural Compliance Statement .									
Enter Environmental Sensitivity Features from the Screening Report	<table border="1"> <thead> <tr> <th>Sensitivity</th> <th>Feature(s)</th> </tr> </thead> <tbody> <tr> <td>Medium</td> <td>Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate</td> </tr> </tbody> </table>						Sensitivity	Feature(s)	Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate
Sensitivity	Feature(s)									
Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate									
Desktop Findings (<i>enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans</i>): The proposed development falls within an industrial and historic mining area surrounded by residential. No active agricultural activities are evident.										
Motivation for Sensitivity Rating (<i>incl. actual rating if different from the Screening Tool</i>): A medium sensitivity is supported.										
Photograph (<i>include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate</i>): 										
Photo 9. View of the preferred footprint in a northerly direction.										

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

ANIMAL SPECIES THEME				
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW
<p>Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.</p>	<p>1. Critical habitat for range-restricted species (species with a geographically restricted area of distribution) of conservation concern, that have a global range of less than 10 km². 2. SCC listed on the IUCN Red List of Threatened Species or on South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria or listed as Nationally Rare. 3. Species aggregations that represent ≥1% of the global population size of a species, over a season, and during one or more key stages of its life cycle. 4. The number of mature individuals that ranks the site among the largest 10 aggregations known for the species.</p> <p>These areas are irreplaceable for SCC.</p> <div><input type="checkbox"/></div>	<p>1. Confirmed habitat for SCC. 2. SCC, listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable, according to the IUCN Red List 3.1. Categories and Criteria and under the national category of Rare.</p> <p>These areas are unsuitable for development due to a very likely impact on SCC.</p> <div><input checked="" type="checkbox"/></div>	<p>1. Suspected habitat for SCC based either on historical records (prior to 2002) or being a natural area included in a habitat suitability model for this species. 2. SCC listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria and under the national category of Rare.</p> <div><input type="checkbox"/></div>	<p>1. Areas where no natural habitat remains. 2. Natural areas where there is no suspected occurrence of SCC.</p> <div><input type="checkbox"/></div>
Assessment	Terrestrial Animal Species Specialist Assessment		Terrestrial Animal Species Specialist Assessment	Terrestrial Animal Species Compliance Statement
Description & Exemption(s)	An applicant intending to undertake an activity identified in the scope of this protocol, on a site identified by the screening tool as being of “very high” or “high” sensitivity for terrestrial animal species must submit a			

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

	<p>Terrestrial Animal Species Specialist Assessment Report.</p> <p>Where the information gathered from the site sensitivity verification differs from the screening tool designation of “very high” or “high”, for terrestrial animal species sensitivity and it is found to be of a “low” sensitivity, then a Terrestrial Animal Species Compliance Statement must be submitted.</p>																
<p>Enter Environmental Sensitivity Features from the Screening Report.</p>	<table border="1"> <thead> <tr> <th>Sensitivity</th><th>Feature(s)</th></tr> </thead> <tbody> <tr> <td>High</td><td>Aves-Tyto capensis</td></tr> <tr> <td>Medium</td><td>Invertebrate-Clonia uvarovi</td></tr> <tr> <td>Medium</td><td>Insecta-Aloeides dentatis dentatis</td></tr> <tr> <td>Medium</td><td>Insecta-Lepidochrysops procera</td></tr> <tr> <td>Medium</td><td>Mammalia-Chrysospalax villosus</td></tr> <tr> <td>Medium</td><td>Mammalia-Crocidura maquassiensis</td></tr> <tr> <td>Medium</td><td>Mammalia-Hydricotis maculicollis</td></tr> </tbody> </table>	Sensitivity	Feature(s)	High	Aves-Tyto capensis	Medium	Invertebrate-Clonia uvarovi	Medium	Insecta-Aloeides dentatis dentatis	Medium	Insecta-Lepidochrysops procera	Medium	Mammalia-Chrysospalax villosus	Medium	Mammalia-Crocidura maquassiensis	Medium	Mammalia-Hydricotis maculicollis
Sensitivity	Feature(s)																
High	Aves-Tyto capensis																
Medium	Invertebrate-Clonia uvarovi																
Medium	Insecta-Aloeides dentatis dentatis																
Medium	Insecta-Lepidochrysops procera																
Medium	Mammalia-Chrysospalax villosus																
Medium	Mammalia-Crocidura maquassiensis																
Medium	Mammalia-Hydricotis maculicollis																
<p>Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans):</p> <p>Tyto capensis (African grass-owl)</p> <p>Generally prefers marshes and vleis with patches of tall rank grass, weeds or sedges, but it may also occupy fynbos, renosterveld and thorn scrub close to water. Largely resident, although it moves away if there is a fire or if a temporarily flooded habitat dries up. Mainly eats rodents, foraging nocturnally by flying low over the ground, twisting its head in order to locate by sight and sound. Once prey is located it dives to the ground and picks it up with its talons, feeding on the ground or on a nearby perch. Vulnerable in South Africa, largely caused by habitat degradation through ploughing, grazing, draining and burning (http://www.biodiversityexplorer.info/birds/tytonidae/tyto_capensis.htm).</p> <p>Clonia uvarovi (Uvarov's Clonia)</p> <p>The threat status of Uvarov's Clonia is Vulnerable under criterion B1. Its extent of occurrence is relatively small (~5,000 km²), it has only been recorded in five locations, and the area, extent and quality of its habitat are expected to be in decline due to grazing pressure, cultivation, urban development, invasive alien plants and climate change. Furthermore, this species is not known to occur in any protected areas. This species inhabits tall woodland savannah. This species occurs in tall, woodland savannah in areas which are under intensive grazing pressure by livestock and wildlife, cultivation with non-timber crops, urban development, and invasion by alien plant species such as Lantana spp., bugweed and other non-native weed species. Furthermore, climate change is already causing increasingly frequent extreme weather events in these regions, which is liable to drastically effect the distribution of grasses, the katydid's food plant (http://speciesstatus.sanbi.org/assessment/last-assessment/4333/).</p> <p>Aloeides dentatis dentatis</p> <p>Endemic to Gauteng Province in South Africa, along and adjacent to the Witwatersrand and Suikerbosrand mountain ranges near Heidelberg eastwards to around Delmas. There are less than 1 500 individuals in the population with each of the six subpopulations having less than 250 individuals. There has been an intensification of threats due to continued urbanization. Inappropriate burning regimes and a decline in quality of habitat in and near residential areas has increased the threat. The population is severely fragmented. The taxon thus qualifies globally under the IUCN criteria as Endangered under criteria B and C</p>																	

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

(<http://speciesstatus.sanbi.org/assessment/last-assessment/200/>).

Lepidochrysops procera

Endemic to the Gauteng, KwaZulu-Natal, Mpumalanga, North West and Eastern Cape provinces in South Africa, from Kokstad in the south to Komatipoort in the north-east and Potchefstroom in the west. Much of the habitat containing the Highveld populations of *Lepidochrysops procera* is under pressure from residential development and overgrazing by cattle. The taxon is a rare habitat specialist with relatively few known locations, several of which are under some degree of threat. The taxon thus qualifies globally under the IUCN criteria as Least Concern and is nationally classified as Rare (Habitat Specialist). Rocky areas in grassland (and grassy areas in savanna), where its larval host plant, *Ocimum obovatum*, occurs. The early stages are unrecorded, but the presence of the host ant (probably a *Camponotus* species) will be an additional requisite

(<http://speciesstatus.sanbi.org/assessment/last-assessment/292/>).

Chrysospalax villosus (Rough-haired golden moles)

Rough-haired golden moles can only survive in a narrow niche. They live in densely vegetated grasslands, meadows, and edges of marshes. They live in light, sandy soil, and are not found in heavy soils, such as mud or clay. Some rough-haired golden moles have been recorded around the edges of golf courses and suburban gardens. (Bronner, 2013; "Chrysospalax villosus", 2013; Skinner, 2005). Rough-haired golden moles are threatened by urbanization, mining, and agricultural practices. They are losing their habitat due to these industrial practices as well as overgrazing by agricultural animals

(https://animaldiversity.org/accounts/Chrysospalax_villosus/).

Crocidura maquassiensis (Maquassie musk shrew)

This is a rare species endemic to South Africa, Swaziland and Zimbabwe, existing in moist grassland habitats in the Savannah and Grassland biomes. Although it has a wide inferred extent of occurrence (284,735 km²), it appears to be patchily distributed. We use wetlands as a proxy for suitable habitat and calculate the amount of natural habitat remaining within buffer strips around wetlands (32 m buffer strip) as the inferred area of occupancy (AOO). We suspect that these habitat patches are severely fragmented as shrews have a poor dispersal ability, and continuing rates of urban and rural expansion (highest rates are 15% and 9%, respectively, in Limpopo Province) may have increased overgrazing and water abstraction, which may reduce the suitability of patches and the corridors between them. Thus we list this species, under a precautionary purview, as Vulnerable B2ab(ii,iii,iv) because, although the AOO estimate varies widely, not all suitable habitat will be occupied.

Key interventions include protected area expansion of moist grassland and riverine woodland habitats, as well as providing incentives for landowners to sustain natural vegetation around wetlands and keep livestock or wildlife at ecological carrying capacity

(<http://speciesstatus.sanbi.org/taxa/detail/1995/>).

Hydrictis maculicollis (Spotted-necked otter)

These otters are aquatic and require permanent and continuous waterways. They live in dens, which are found near these sources of water. The spotted-necked otters are in decline due to changes in their environment and human interference. One problem is the increased use of nylon fishing nets, in which the otters get tangled in and die. Erosion of soil near the source of the rivers is also a threat. Fish-farmers and fur-trappers are also playing a part in the decline of the spotted-necked otter

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

(https://animaldiversity.org/accounts/Hydriectis_maculicollis/).

Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool):

Certain of the identified Species of Conservation Concern (SCC) listed in the Screening Report will not find suitable habitat within the preferred development footprint (Alternative 1). However, the appointed specialist will need to specifically verify presence/absence on site. Adjacent sites, with more natural vegetation and wetland may be better suited to support the identified SCC.


Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate):



Photo 10. Vegetation characteristic of Alternative 3 likely better suited to support some of the identified SCC due to it retaining more natural untransformed qualities.

PLANT SPECIES THEME				
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	<p>1. Critical habitat for range-restricted species (species with a geographically restricted area of distribution) of conservation concern, that have a global range of less than 10 km².</p> <p>2. SCC listed on the IUCN Red List of Threatened Species</p>	<p>1. Confirmed habitat for SCC.</p> <p>2. SCC, listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable, according the IUCN Red List 3.1. Categories and</p>	<p>1. Suspected habitat for SCC based either on historical records (prior to 2002) or being a natural area included in a habitat suitability model.</p> <p>2. SCC listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically</p>	<p>1. Areas where no natural habitat remains.</p> <p>2. Natural areas where there is no suspected occurrence of SCC.</p>

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

	<p>or on South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria or listed as Nationally Rare.</p> <p>3. Species aggregations that represent $\geq 1\%$ of the global population size of a species, over a season, and during one or more key stages of its life cycle.</p> <p>4. The number of mature individuals that ranks the site among the largest 10 aggregations known for the species.</p> <p>These areas are irreplaceable for SCC.</p> <div></div>	<p>Criteria and under the national category of Rare.</p> <p>These areas are unsuitable for development due to a very likely impact on SCC.</p> <div></div>	<p>Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria and under the national category of Rare.</p> <div></div>	<div></div>								
Assessment	Terrestrial Plant Species Specialist Assessment	Terrestrial Plant Species Specialist Assessment	Terrestrial Plant Species Compliance Statement									
Description & Exemption(s)	<p>An applicant intending to undertake an activity on a site identified by the screening tool as being of "medium sensitivity" for terrestrial plant species must submit either a Terrestrial Plant Species Specialist Assessment Report or a Terrestrial Plant Species Compliance Statement, depending on the outcome of a site inspection.</p>											
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1"> <thead> <tr> <th>Sensitivity</th><th>Feature(s)</th></tr> </thead> <tbody> <tr> <td>Medium</td><td>Sensitive species 1252</td></tr> <tr> <td>Medium</td><td>Khadia beswickii</td></tr> <tr> <td>Medium</td><td>Sensitive species 691</td></tr> </tbody> </table>				Sensitivity	Feature(s)	Medium	Sensitive species 1252	Medium	Khadia beswickii	Medium	Sensitive species 691
Sensitivity	Feature(s)											
Medium	Sensitive species 1252											
Medium	Khadia beswickii											
Medium	Sensitive species 691											
<p>Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans):</p> <p>Khadia beswickii</p> <p>South African endemic. 10 known locations are declining due to habitat loss to urban and infrastructure development, alien plant invasion, mining and collecting for the specialist succulent horticultural trade. Occurs on open shallow soil over rocks in grassland</p>												

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

(<http://redlist.sanbi.org/species.php?species=83-2>).

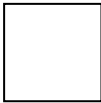

Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool):

Alternative 1 (preferred footprint) is very little indigenous vegetation intact and has been overtaken with alien grass and tree species. This site should be reduced to a “Low” sensitivity. The adjacent alternatives support a larger percentage of naturally occurring plant species.

Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate):




Photo 11. Vegetation characteristic of Alternative 1 overrun with alien grass and tree species.

AQUATIC BIODIVERSITY THEME		
Sensitivity Rating	VERY HIGH	LOW
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	- for aquatic biodiversity features. 	- for aquatic biodiversity features. 
Assessment	Aquatic Biodiversity Specialist Assessment	Aquatic Biodiversity Compliance Statement


MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.

Description & Exemption(s)	An applicant intending to undertake an activity identified in the scope of this protocol on a site identified on the screening tool as being of “ low sensitivity ” for aquatic biodiversity, must submit an Aquatic Biodiversity Compliance Statement .					
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1"> <tr> <td>Sensitivity</td><td>Feature(s)</td></tr> <tr> <td>Low</td><td>Low Sensitivity</td></tr> </table>		Sensitivity	Feature(s)	Low	Low Sensitivity
Sensitivity	Feature(s)					
Low	Low Sensitivity					
Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans): No aquatic environments were evident on site other than the NFEPA wetland which will not be affected by the development.						
Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool): A Low sensitivity is supported.						
Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate): 						
Photo 12. NFEPA wetland located adjacent to preferred footprint on Alternative 2.						

TERRESTRIAL BIODIVERSITY THEME		
Sensitivity Rating	VERY HIGH	LOW
Enter Environmental Sensitivity	- for terrestrial biodiversity features.	- for terrestrial biodiversity features.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc.,)
 Reg: 2006/023163/23

Rating from the Screening Report by ticking the applicable box.								
Assessment	Terrestrial Biodiversity Specialist Assessment	Terrestrial Biodiversity Compliance Statement						
Description & Exemption(s)	An applicant intending to undertake an activity identified in the scope of this protocol, on a site identified on the screening tool as being of “ very high sensitivity ” for terrestrial biodiversity, must submit a Terrestrial Biodiversity Specialist Assessment .							
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1"> <thead> <tr> <th>Sensitivity</th> <th>Feature(s)</th> </tr> </thead> <tbody> <tr> <td>Very High</td> <td>Ecological Support Area</td> </tr> <tr> <td>Very High</td> <td>Vulnerable ecosystem</td> </tr> </tbody> </table>		Sensitivity	Feature(s)	Very High	Ecological Support Area	Very High	Vulnerable ecosystem
Sensitivity	Feature(s)							
Very High	Ecological Support Area							
Very High	Vulnerable ecosystem							
Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans): Portions of the preferred footprint falls within a CBA according to the Ekurhuleni Bioregional Plan, as well as an ESA according to the Gauteng C-Plan and a Vulnerable Ecosystem.								
Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool): The current sensitivity rating is supported.								
Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate):								

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.



Photo 13. Biodiversity low as a consequence of dominant alien vegetation and boundaries to species movement including perimeter wall, railway line and roads.


DEFENCE THEME								
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW				
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	high likelihood for negative impacts on the defence installation. In-depth assessment of the potential impacts and mitigation measures are likely to be required before development can be considered in these areas. <input type="checkbox"/>	potential for negative impacts on the defence installation that can potentially be mitigated. Further assessment may be required to investigate potential impacts and mitigation measures. <input type="checkbox"/>	low potential for negative impacts on the defence installation, and if there are impacts there is a high likelihood of mitigation. Further assessment of the potential impacts may not be required. <input type="checkbox"/>	No negative impacts on the defence installation are expected in low sensitivity areas. It is unlikely for further assessment and mitigation measures to be required. <input checked="" type="checkbox"/>				
Assessment	Defence Compliance Statement			No requirement identified.				
Exemption(s)	None.							
Enter Environmental Sensitivity Features from	<table border="1"> <thead> <tr> <th>Sensitivity</th> <th>Feature(s)</th> </tr> </thead> <tbody> <tr> <td>Low</td> <td>Low Sensitivity</td> </tr> </tbody> </table>				Sensitivity	Feature(s)	Low	Low Sensitivity
Sensitivity	Feature(s)							
Low	Low Sensitivity							

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

the Screening Report.	
Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans):	
None.	
Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool):	
Current sensitivity rating supported.	
Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate):	
None.	


CIVIL AVIATION THEME				
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	high likelihood for negative impacts on the civil aviation installation. In-depth assessment of the potential impacts and mitigation measures are likely to be required before development can be considered in these areas. <input type="checkbox"/>	potential for negative impacts on the civil aviation installation that can potentially be mitigated. Further assessment may be required to investigate potential impacts and mitigation measures. <input type="checkbox"/>	low potential for negative impacts on the civil aviation installation, and if there are impacts there is a high likelihood of mitigation. Further assessment of the potential impacts may not be required. <input checked="" type="checkbox"/>	No negative impacts on the civil aviation installation are expected in low sensitivity areas. It is unlikely for further assessment and mitigation measures to be required. <input type="checkbox"/>
Assessment	Civil Aviation Compliance Statement			No requirement identified.
Exemption(s)	None.			
Enter Environmental Sensitivity Features from the Screening Report.	<div>Medium</div> <div>Within 8 km of other civil aviation aerodrome</div>			
Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans):				
The site is within 8km of OR Tambo International Airport.				
Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool):				
A medium civil aviation sensitivity rating is supported.				
Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate):				
None.				

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME										
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW						
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						
Assessment	Specialist Assessment	Specialist Assessment	Specialist Assessment or Compliance Statement	Compliance Statement						
	The required level of assessment must be based on the findings of the site sensitivity verification and must comply with Appendix 6 of the EIA Regulations.									
Exemption(s)	None.									
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1"> <thead> <tr> <th>Sensitivity</th> <th>Feature(s)</th> </tr> </thead> <tbody> <tr> <td>Very High</td> <td>Within 5km of a Grade I Heritage site</td> </tr> <tr> <td>Very High</td> <td>Within 2km of a Grade II Heritage site</td> </tr> </tbody> </table>				Sensitivity	Feature(s)	Very High	Within 5km of a Grade I Heritage site	Very High	Within 2km of a Grade II Heritage site
Sensitivity	Feature(s)									
Very High	Within 5km of a Grade I Heritage site									
Very High	Within 2km of a Grade II Heritage site									
<p>Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans):</p> <p>The National Heritage Resources Act (1999) lists activities under Section 38 entitled "Heritage resources management" which need to be reported to SAHRA and possibly investigated and assessed including: (c) any development or other activity which will change the character of a site— (i) exceeding 5 000 m² in extent; or</p> <p>Additionally, Section 36 addressed graves and burial grounds which may be exposed during excavation activities.</p>										
<p>Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool):</p> <p>A Medium sensitivity is motivated with the associated Heritage Impact Specialist Assessment to assess if the proposed solar PV facility will affect any heritage resources or grave sites.</p>										
<p>Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate):</p> <p>See photos 6 & 7.</p>										


PALEONTOLOGY THEME				
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Assessment	Specialist Assessment	Specialist Assessment	Specialist Assessment or Compliance Statement	Compliance Statement				
	The required level of assessment must be based on the findings of the site sensitivity verification and must comply with Appendix 6 of the EIA Regulations.							
Description & Exemption(s)	None.							
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1"> <tr> <th>Sensitivity</th> <th>Feature(s)</th> </tr> <tr> <td>Very High</td> <td>Features with a Very High paleontological sensitivity</td> </tr> </table>				Sensitivity	Feature(s)	Very High	Features with a Very High paleontological sensitivity
Sensitivity	Feature(s)							
Very High	Features with a Very High paleontological sensitivity							
Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans): The National Heritage Resources Act (1999) lists activities under Section 35 entitled "Archaeology, palaeontology and meteorites ". Sub-section (3) & (4) requires any person who discovers a palaeontology artefact to notify SAHRA after which the artefact/s may not be moved without a permit.								
Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool): A Medium sensitivity is supported with the associated Specialist Impact Assessment to assess if the proposed project is likely to affect any palaeontology resources.								
Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate): None.								

AVIAN THEME				
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	1. Critical habitat for range-restricted species (species with a geographically restricted area of distribution) of conservation concern, that have a global range of less than 10 km ² .	1. Confirmed habitat for SCC. 2. SCC, listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable,	1. Suspected habitat for SCC based either on historical records (prior to 2002) or being a natural area included in a habitat suitability model for this species. 2. SCC listed on the IUCN Red List of	1. Areas where no natural habitat remains. 2. Natural areas where there is no suspected occurrence of SCC.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

	<p>2. SCC listed on the IUCN Red List of Threatened Species or on South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria or listed as Nationally Rare.</p> <p>3. Species aggregations that represent $\geq 1\%$ of the global population size of a species, over a season, and during one or more key stages of its life cycle.</p> <p>4. The number of mature individuals that ranks the site among the largest 10 aggregations known for the species.</p> <p>These areas are irreplaceable for SCC.</p> <div style="border: 1px solid black; width: 50px; height: 50px; margin: 0 auto;"></div>	<p>according the IUCN Red List 3.1. Categories and Criteria and under the national category of Rare.</p> <p>These areas are unsuitable for development due to a very likely impact on SCC.</p> <div style="border: 1px solid black; width: 50px; height: 50px; margin: 0 auto; text-align: center;">  </div>	<p>Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria and under the national category of Rare.</p> <div style="border: 1px solid black; width: 50px; height: 50px; margin: 0 auto;"></div>	<div style="border: 1px solid black; width: 50px; height: 50px; margin: 0 auto;"></div>						
Assessment	Terrestrial Animal Species Specialist Assessment	Terrestrial Animal Species Specialist Assessment	Terrestrial Animal Species Compliance Statement							
Description & Exemption(s)	<p>An applicant intending to undertake an activity identified in the scope of this protocol, on a site identified by the screening tool as being of “very high” or “high” sensitivity for terrestrial animal species must submit a Terrestrial Animal Species Specialist Assessment Report.</p> <p>Where the information gathered from the site sensitivity verification differs from the screening tool designation of “very high” or “high”, for terrestrial animal species sensitivity and it is found to be of a “low” sensitivity, then a Terrestrial Animal Species Compliance Statement must be submitted.</p>									
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">Sensitivity</th><th>Feature(s)</th></tr> </thead> <tbody> <tr> <td>High</td><td>Within 500 m of a river</td></tr> <tr> <td>High</td><td>Within 500 m of a wetland</td></tr> </tbody> </table>				Sensitivity	Feature(s)	High	Within 500 m of a river	High	Within 500 m of a wetland
Sensitivity	Feature(s)									
High	Within 500 m of a river									
High	Within 500 m of a wetland									
Desktop Findings (<i>enter description of findings from comparing/overlaying the Screening</i>										

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

Tools spatial imagery of the theme with satellite imagery and other spatial plans):

The site is within 500m of a wetland. The apparent river was not witnessed.

Motivation for Sensitivity Rating (*incl. actual rating if different from the Screening Tool*):

A “**low sensitivity**” is motivated as habitat riparian and wetland habitat requirements fall outside the preferred footprint, and the height of the infrastructure poses a low-risk for bird strikes.

Photograph (*include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate*):




Photo 14. Spring-type wetland present on Alternative 3 in close proximity to road and Unilever factory.

BATS THEME				
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	1. Critical habitat for range-restricted species (species with a geographically restricted area of distribution) of conservation concern, that have a global range of less than 10 km ² . 2. SCC listed on the IUCN Red List of Threatened Species	1. Confirmed habitat for SCC. 2. SCC, listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable, according the IUCN Red List 3.1. Categories and	1. Suspected habitat for SCC based either on historical records (prior to 2002) or being a natural area included in a habitat suitability model for this species. 2. SCC listed on the IUCN Red List of Threatened Species or South Africa's National Red List	1. Areas where no natural habitat remains. 2. Natural areas where there is no suspected occurrence of SCC.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.

	<p>or on South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria or listed as Nationally Rare.</p> <p>3. Species aggregations that represent $\geq 1\%$ of the global population size of a species, over a season, and during one or more key stages of its life cycle.</p> <p>4. The number of mature individuals that ranks the site among the largest 10 aggregations known for the species.</p> <p>These areas are irreplaceable for SCC.</p>	<p>Criteria and under the national category of Rare.</p> <p>These areas are unsuitable for development due to a very likely impact on SCC.</p>	<p>website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria and under the national category of Rare.</p>					
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Assessment	Terrestrial Animal Species Specialist Assessment	Terrestrial Animal Species Specialist Assessment	Terrestrial Animal Species Compliance Statement					
Description & Exemption(s)	An applicant intending to undertake an activity identified in the scope of this protocol, on a site identified by the screening tool as being of "low" sensitivity for terrestrial animal species must submit a Terrestrial Animal Species Compliance Statement must be submitted.							
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1"> <thead> <tr> <th>Sensitivity</th><th>Feature(s)</th></tr> </thead> <tbody> <tr> <td>Low</td><td>Low sensitivity</td></tr> </tbody> </table>				Sensitivity	Feature(s)	Low	Low sensitivity
Sensitivity	Feature(s)							
Low	Low sensitivity							
Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans): None.								
Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool): A "low sensitivity" is supported.								
Photograph (include photo no. from phone or camera, indicate cardinal direction the								

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

camera is facing and if possible, a GPS co-ordinate):

None.

LANDSCAPE (SOLAR) THEME																
Sensitivity Rating	VERY HIGH	HIGH	MEDIUM	LOW												
Enter Environmental Sensitivity Rating from the Screening Report by ticking the applicable box.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>												
Assessment	Specialist Assessment	Specialist Assessment	Specialist Assessment or Compliance Statement	Compliance Statement												
	The required level of assessment must be based on the findings of the site sensitivity verification and must comply with Appendix 6 of the EIA Regulations.															
Exemption(s)	None.															
Enter Environmental Sensitivity Features from the Screening Report.	<table border="1"> <thead> <tr> <th>Sensitivity</th> <th>Feature(s)</th> </tr> </thead> <tbody> <tr> <td>High</td> <td>Between 500 and 1000 m of a town or village</td> </tr> <tr> <td>Medium</td> <td>Between a and 2 km of a town or village</td> </tr> <tr> <td>Medium</td> <td>Between 2 and 3 km of a game farm</td> </tr> <tr> <td>Medium</td> <td>Between 3 and 5 km of a nature reserve</td> </tr> <tr> <td>Very High</td> <td>Within 500 m of a town or village</td> </tr> </tbody> </table>				Sensitivity	Feature(s)	High	Between 500 and 1000 m of a town or village	Medium	Between a and 2 km of a town or village	Medium	Between 2 and 3 km of a game farm	Medium	Between 3 and 5 km of a nature reserve	Very High	Within 500 m of a town or village
Sensitivity	Feature(s)															
High	Between 500 and 1000 m of a town or village															
Medium	Between a and 2 km of a town or village															
Medium	Between 2 and 3 km of a game farm															
Medium	Between 3 and 5 km of a nature reserve															
Very High	Within 500 m of a town or village															

Desktop Findings (enter description of findings from comparing/overlaying the Screening Tools spatial imagery of the theme with satellite imagery and other spatial plans):

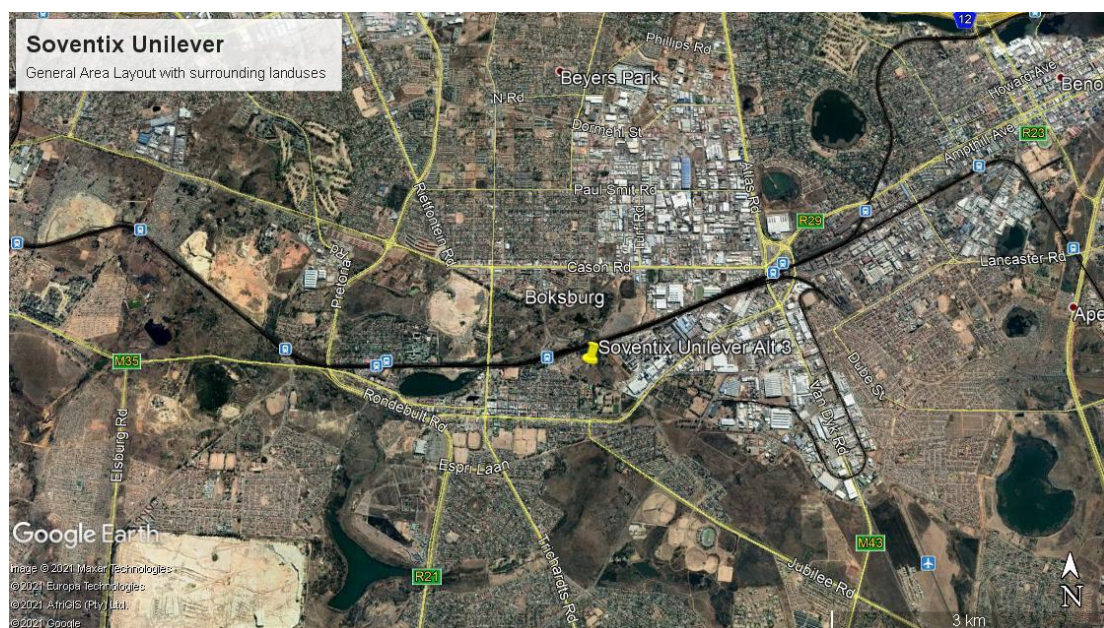


Figure 5. The proposed site is surrounded by industry, mining and residential.

Motivation for Sensitivity Rating (incl. actual rating if different from the Screening Tool):

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

A **high sensitivity** is supported, and a Visual Impact Assessment and Glint & Glare assessment must be undertaken.

Photograph (include photo no. from phone or camera, indicate cardinal direction the camera is facing and if possible, a GPS co-ordinate):



Photo 15. Area directly adjacent to Unilever factory on NFEPA wetland with a view to some of the surrounding land uses.

MEMBERS: J.A. Bowers (M Tech, Pr.Sci.Nat.) & S.D. MacGregor (M.Sc., Pr.Sci.Nat.)
Reg: 2006/023163/23

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by copyright law.