Report to:

BOARD OF SUNSET POINT CAMP

SUNSET POINT CAMP Storm Water Management & Overland Drainage Report

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SUNSET POINT CAMP
STORM WATER MANAGEMENT & OVERLAND DRAINAGE REPORT

SEPTEMBER 2008

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REVISION HISTORY

REV. NO	ISSUE DATE	PREPARED BY AND DATE	REVIEWED BY AND DATE	APPROVED BY AND DATE	DESCRIPTION OF REVISION

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1.0 INTRODUCTION & STUDY AREA

The Summer Village of Sunset Point required the Board of Sunset Point Camp to commission the preparation of portions of an Area Structure Plan (ASP) to assess the current and future needs of this community. As part of the Area Structure Plan, Wardrop Engineering Inc. has prepared this report, entitled "Sunset Point Camp Storm Water Management & Overland Drainage Report." This report has been prepared based on current survey data and existing CAD drawings of the camp as well as the future development plans for the village. The main objectives of this report are to:

- present a plan showing the existing storm water management facilities, topography, and flow paths
- provide detailed pre and post development storm water run-off calculations based on existing conditions and future development plans
- provide recommendations for onsite storm water storage to manage increased runoff from future development

The Sunset Point Camp is located approximately 60km west of Edmonton, and occupies an area of 37 hectares as shown within the site boundary on Plans 2 to 5.

Study area boundaries are as follows:

- Lac Ste Anne to the West
- 54th Avenue (Bay St.) to the North
- East side of abandoned rail line Right of Way to the East
- Existing development off 49A Avenue to the South

The land occupied by the camp is a low relief till plain on the eastern shore of Lac Ste. Anne. The terrain slopes generally westward from the Eastern boundary of the study area at an elevation of between 735m and 738m, and surface runoff drains to the Lake at elevation 723m. There is a 6m hill adjacent to the current RV parking area. The site is approximately 1/3 forested land consisting mainly of Poplar and Spruce with heavy ground cover, and 2/3 mixed development including cottage lots, RV parking, and open grassed areas. The Site is underlain by moderately well drained Chernozomic soils above sandy yellow clays and gravels.

All drainage from the site is directed to Lac Ste. Anne. The site is however, divided by Sunset Drive, which isolates the larger 33.5 ha parcel from the receiving body. Storm water flows from this area are directed under Sunset Drive through various culverts along its length. The 3.5 ha parcel adjacent to the lake has no observed drainage structures, and drains overland to the lake.

Future development plans include expansions to the Centre (hotel style building), RV Park and the developed cottage lot area See Plan 2. The cottage lots will be developed on existing forested land, while the RV parking will expand eastward requiring extensive re-grading of the existing hill.

2.0 METHODOLOGY

A GPS survey of the area was conducted to pick up local topography and locate existing storm water management features. The survey data was augmented by a documented visual survey following summer storm events. This aided in identifying flow paths and trapped lows. The results of this survey were integrated into the existing ASP CAD drawing.

Hydrologic analysis was carried out in accordance with the City of Edmonton and Alberta Environmental Protection Stormwater Management Design Guidelines using the XP-SWMM computer model to simulate a single event rainfall / runoff. The 1 in 100 and 1 in 5 year, 4 hour design storms were supplied by the City of Edmonton, and represent a modified Chicago rainfall distribution pattern. The micro climate near Lac St Anne will vary somewhat from that of Edmonton. The modelling based on nearest available data is adequate for general analysis. Structural configurations, of culvert sizes for example, have been tweaked to local experience in the past and can be in the future also.

Drainage sub-catchments were determined based on current survey data. For the purpose of runoff volume generation, land uses were determined using aerial photographs. Representative sample blocks within each sub-catchment were analyzed to determine the per cent that is impervious for each land use. These values were then extended to each sub-catchment based on the % land use observed. See appendix A for land use and % impervious calculations. Infiltration, roughness and storage values as well as infiltration capacity were selected based on industry standards. These values were assigned given the predominant land use of each sub-catchment. See Table 2.1.

Table 2.1 – Infiltration parameters

Forest	Impervious	Pervious			
Depression Storage (mm)	0.6	10	f_0 =	51	mm/hr
Manning's 'n'	0.018	0.3	f_∞ =	7	mm/hr
Zero Detention (%)	25		α =	0.00115	
Field	Impervious	Pervious			
Depression Storage (mm)	0.6	10	f_0 =	25	mm/hr
Manning's 'n'	0.018	0.25	f_∞ =	7	mm/hr
Zero Detention (%)	25		α =	0.00115	
Residential	Impervious	Pervious			
Depression Storage (mm)	0.6	10	f_0 =	38	mm/hr
Manning's 'n'	0.018	0.25	f_∞ =	7	mm/hr
Zero Detention (%)	25		α =	0.00115	

The existing drainage network was modeled to a level of detail appropriate to its level of development and the survey data. Sub-catchments range in size from 0.3ha in the most developed areas to 13ha in undeveloped areas with no planned development. To analyze the impact of future development on storm water discharge, the indicated development areas were modified to represent the new land uses. The 100 year design storm was used to analyze the major storm drainage system, and for the calculation of post development flows to determine storage volumes required to limit runoff to pre-development levels. The 5 year design storm was used to analyze the existing minor drainage system.

Figure 1: This photo, taken after several days of constant rain at Sunset Point Camp, illustrates close to the ideal practice for green camp water management. Gravel roads (and paths) with a good crown provide a relatively dry and permeable travel surface while forcing the water to pond near the grass. This water helps keep the site green and the fire hazard low. Infiltration and evaporation can dry the site surface in one sunny day. The camp is pleasant and useable. Maintenance requires occasional reshaping or addition of gravel to keep roads and paths dry.

3.0 STORM DRAINAGE DESIGN

3.1 EXISTING DRAINAGE

The existing drainage system for Sunset Point Camp is shown in Plan 3. It is comprised of open ditches and culverts. This system conveys the total runoff from the site to Lac Ste. Anne. The ditches are grass lined and appear to be well maintained. The culverts are corrugated Steel Pipe (CSP) and range in size from 300mm to 600mm. 600mm CSP culverts have been used at the crossings under Sunset Drive. Most of the culverts appear to be in good repair; however the 300mm culvert at the main camp entrance appears to be almost completely buried at its upstream end. Land drainage through the forested sections appears to be directed along natural drainage courses. There are no permanent water bodies or dedicated storage facilities on site, although the grading of the site allows for temporary ponding in numerous locations. The existing road network is primarily compacted gravel road constructed on grade, and appears to have little impact on the overland drainage routes. See Plan 4 for delineation of the existing catchments. The drainage areas and imperviousness ratios used in the modelling are summarized in Table 3.1.1. The imperviousness ratios were calculated for each catchment as a weighted average for the type of the land use.

Table 3.1.1
Incremental Land Use Areas - Existing

Point	Area	% Impervious
1	1.90	15.3
2	1.53	26.9
2.1	2.70	30.2
2.1.1	0.30	25.0
2.2	1.00	19.6
2.3	1.30	12.4
3	1.90	26.8
3.1	12.90	0.0
3.2	6.90	0.0
3.2.1	3.10	21.6
3.2.1.1	0.60	34.5
4	0.70	16.4

3.2 POST DEVELOPMENT DRAINAGE

The storm drainage system for the future development of the site has been designed based on an extension of the current ditch and culvert system. The storm sewer system was designed to accommodate flows generated by a storm with an approximate 5 year return period through the culverts, while the 100 year event flows are allowed to overtop onsite roads, but not Sunset drive. Since the majority of the drainage network is open ditch, there is no change between the major and minor flow paths. Due to an increase in imperviousness in the future development plans, storm water detention facilities will be required to maintain pre-development release rates. The greatest impact to post-development flows occurs at Culvert 3. This is due to the clearing of 2.8 ha of forest to create new cottage lots as well as the expansion of the RV parking area. There is also some impact to Culvert 4 due to the RV park expansion. These detention facilities were sized based on the ultimate development plan.

The general design concept is shown in Plan 5. It is characterized by:

- The existing ditch and culvert drainage system will be extended to accommodate the expansion to the RV Park. This will require an extension of the ditch and the installation of a 300mm CSP culvert at the entrance to the expanded area.
- The runoff entering Culvert 3.1.1 will be directed to a stormwater management facility.
- The dry pond will be located in the naturally low area upstream of Culvert 3. This pond has been sized to collect the 100 year post-development flow and release it at pre-development rates
- The discharge from this pond will be released to the ditch along Sunset Drive where it will enter Culvert 3 and drain to Lac Ste. Anne. Any depth over 0.5m filling the relatively flat ditch during an extreme event will also exit to the lake via culvert 2 that is 230m north of culvert 3.
- Expansion of the RV park will also slightly increase the discharge to Culvert 4. Since the area is currently a hill and will require re-grading for future use, the increase in release rate is only marginal, and can be accommodated by storage in the ditch leading to culvert 4.

The drainage areas and imperviousness ratios used in the modelling of the ultimate development plan are summarized in Table 3.2.1. The imperviousness ratios were calculated for each catchment as a weighted average for the type of the land use.

Table 3.2.1
Incremental Land Use Areas - Future Stage 2

Point	Area	% Impervious
1	1.90	15.3
2	1.53	26.9
2.1	2.70	30.2
2.1.1	0.30	25.0
2.2	1.00	19.6
2.3	1.30	12.4
3	4.70	28.7
3.1	10.10	1.8
3.2	6.90	0.0
3.2.1	3.10	21.6
3.2.1.1	0.60	45.0
4	0.70	24.1

4.0 RESULTS SUMMARY

The results of the storm drainage calculations are summarized in the tables below. The outflow hydrographs and velocity profiles are included in Appendix B.

Table 4.1
Culvert Analysis

	5yr		100yr					
	EXISTING		EXISTING		FUTURE 1		FUTURE 2	
CULVERT	Q (m3/s)	STATE	Q (m3/s)	STATE	Q (m3/s)	STATE	Q (m3/s)	STATE
1	0.050	25%	0.144	40%	0.144	40%	0.144	40%
2	0.209	50%	0.463	90%	0.463	90%	0.463	90%
2.1	0.155	50%	0.347	90%	0.347	90%	0.347	90%
2.1.1	0.014	40%	0.052	75%	0.052	75%	0.052	75%
2.2	0.037	25%	0.109	30%	0.109	30%	0.109	30%
2.3	0.114	70%	0.315	SC†	0.303	SC†	0.298	SC†
3	0.063	35%	0.436	70%	0.491	75%	0.515	SC
3.2.1	0.123	50%	0.393	70%	0.393	70%	0.380	70%
3.2.1.1	0.039	50%	0.089	90%	0.089	SC	0.079*	SC
4	0.023		0.144	70%	0.144	70%	0.160	75%
3.2.1.1.1			FUTURE STAGE 2, 5 YR		0.036	30%	0.105	SC

* New storage created in Stage 2
SC surcharge condition
† Based on unrestricted developent flow

Surcharging was observed at various locations throughout the system, but overtopping of roadways was not observed.

Table 4.2
Ditch Flows

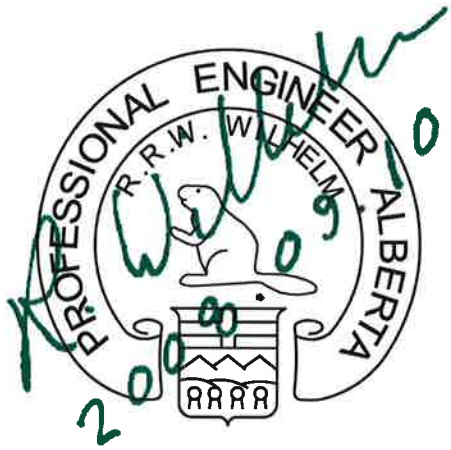
DITCH	5yr EXISTING v (m/s)	100yr EXISTING v (m/s)	100yr FUTURE 1 v (m/s)	100yr FUTURE 2 v (m/s)
1	0.196	0.277	0.277	0.277
2	0.522	0.606	0.606	0.606
3	0.070	0.081	0.081	0.081
Link 25	0.083	0.103	0.122	0.116
4	0.001	0.053	0.037	0.060
5	0.500	0.800	0.800	0.800
6	0.273	0.400	0.400	0.400
7	0.360	0.323	0.323	0.360
d new	FUTURE STAGE 2, 5 YR		0.460	0.460

Table 4.3
Storage Volumes

Storage Node	Max. Pre-development Flow (m3/s)	Max. Post-development Flow Stage 1 (m3/s)	Storage Volume (m3)	Max. Post-development Flow Stage 2 (m3/s)	Storage Volume (m3)
C3	0.434	0.522	385	0.534	480
C4	0.144	0.144	0	0.16	5

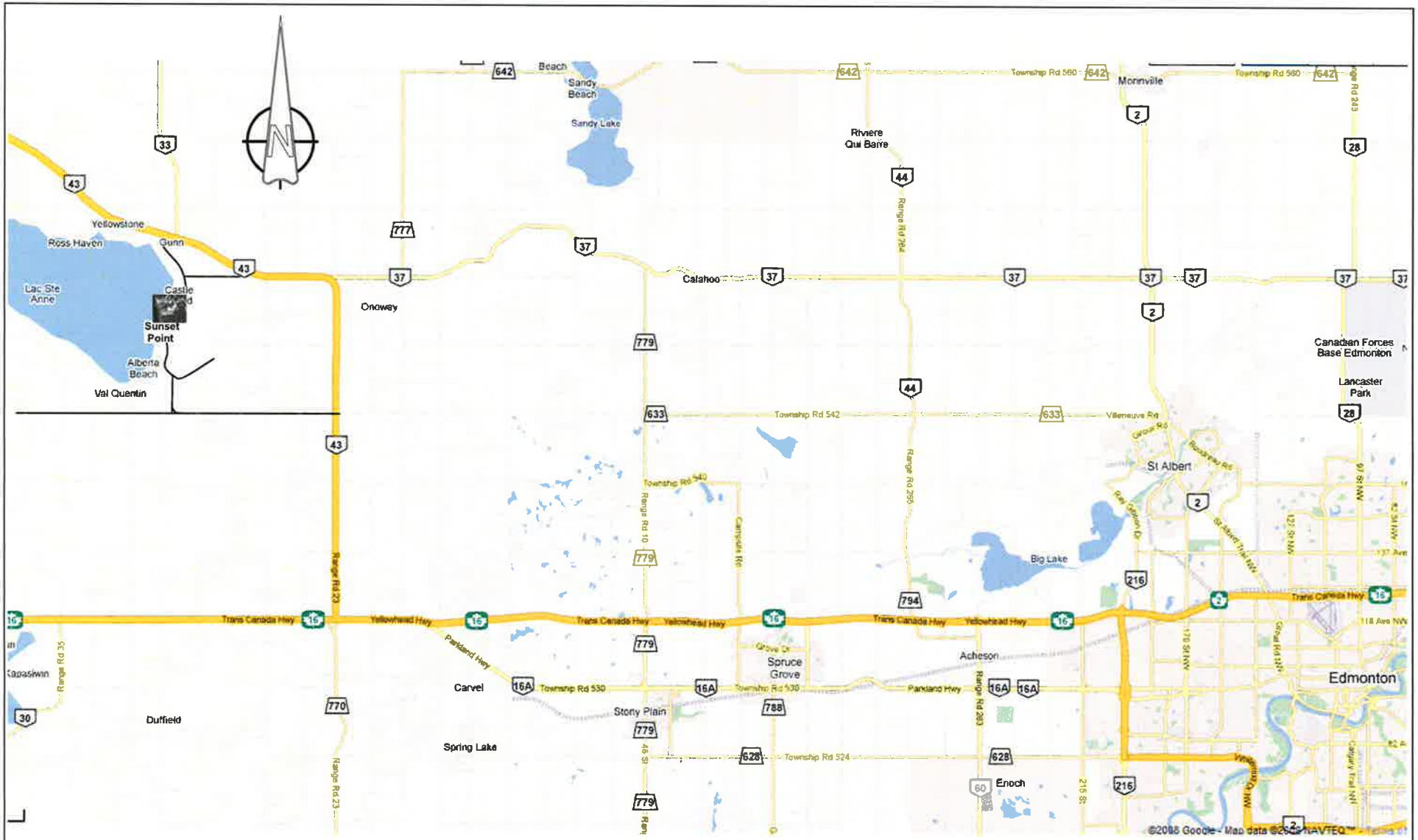
5.0 CONCLUSIONS

1. The proposed drainage plan conforms to the Stormwater Management Guidelines for the province of Alberta 1999.
2. The discharge from the study area into the culverts under Sunset Drive does not cause overtopping of the driving surface during the 100 year event.
3. A dry bottom detention pond with an estimated volume of 480m^3 will be required to attenuate flows from the proposed expansion of the cottage lot area and the RV park. A detailed design of this facility is required prior to development.
4. Increased post-development flows draining to the north require a small amount of storage (5m^3) in order to maintain pre-development release rates. This volume can be accommodated through onsite storage in the RV park area.
5. The culvert under the east main entrance road should be repaired to allow proper operation of the drainage system.



PERMIT TO PRACTICE
WARDROP ENGINEERING INC.
Signature A. Wilhelm
Date Sep 10 08
PERMIT NUMBER: P 0940
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

PLANS 1 TO 5



NO.	DESCRIPTION	DATE	ISSUED BY
0	Final Report Issue	8/9/8	R. Wilhelm

REVISIONS/ISSUE

WARDROP | Engineering Inc.

CLIENT
SUNSET POINT CAMP

DRAWING DESCRIPTION
Site Location
PROPOSED DRAINAGE SYSTEM

DESIGNED BY:	PJ	DRAWN BY:	JA	DRAWING NO.	REV.
CHECKED BY:		DATE:	08.07.24	PLAN 1	0

NO.	DESCRIPTION	DATE	ISSUED BY
0	Final Report Issue	8/9/8	R.Wilhelm

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WARDROP | Engineering Inc.

CLIENT
SUNSET POINT CAMP

DRAWING DESCRIPTION
DEVELOPMENT PLAN
LOTS – EXISTING AND FUTURE

DESIGNED BY:	PJ	DRAWN BY:	RW	DRAWING NO.	REV.
CHECKED BY:		DATE:	08.07.24	PLAN 2	0

NO.	DESCRIPTION	DATE	ISSUED BY
0	Final Report Issue	8/9/8	R. Wilhelm

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WARDROP | Engineering Inc.

CLIENT
SUNSET POINT CAMP

DRAWING DESCRIPTION
DEVELOPMENT PLAN
EXISTING DRAINAGE SYSTEM

DESIGNED BY:	PJ	DRAWN BY:	RW	DRAWING NO.	REV.
CHECKED BY:		DATE:	08.07.24	PLAN 3	0

NO.	DESCRIPTION	DATE	ISSUED BY
0	Final Report Issue	8/9/8	R. Wilhelm

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WARDROP | Engineering Inc.

CLIENT
SUNSET POINT CAMP

DRAWING DESCRIPTION
DEVELOPMENT PLAN
EXISTING CATCHMENT AREAS

DESIGNED BY:	PJ	DRAWN BY:	RW	DRAWING NO.	REV.
CHECKED BY:		DATE:	08.07.24	PLAN 4	0

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0	Final Report Issue	8/9/8	R. Wilhelm

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WARDROP | Engineering Inc.

CLIENT
SUNSET POINT CAMP

DRAWING DESCRIPTION
DEVELOPMENT PLAN
PROPOSED DRAINAGE SYSTEM

DESIGNED BY: PJ	DRAWN BY: RW	DRAWING NO.	REV.
CHECKED BY:	DATE: 08.07.24	PLAN 5	0

APPENDIX A

Incremental Land Use Areas - Existing

1

Land Use	Area
Grass	0.86
Trees	0.71
Gravel Road	0.22
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	0.11
No runoff	
Area	1.90
C'	0.28
% Impervious	15.3

2

Land Use	Area
Grass	0.08
Trees	0.41
Gravel Road	
Cottage lots - treed	0.96
Cottage lots - non treed	
RV parking	
Impervious	0.08
No runoff	
Area	1.53
C'	0.37
% Impervious	26.9

2.1

Land Use	Area
Grass	0.07
Trees	0.95
Gravel Road	0.37
Cottage lots - treed	1.24
Cottage lots - non treed	
RV parking	
Impervious	0.07
No runoff	
Area	2.70
C'	0.37
% Impervious	30.2

2.1.1

Land Use	Area
Grass	0.22
Trees	
Gravel Road	0.01
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	0.07
No runoff	
Area	0.30
C'	0.39
% Impervious	25.0

2.2

Land Use	Area
Grass	
Trees	0.53
Gravel Road	0.09
Cottage lots - treed	0.1
Cottage lots - non treed	0.28
RV parking	
Impervious	
No runoff	
Area	1.00
C'	0.30
% Impervious	19.6

Culvert 2.3

Land Use	Area
Grass	0.4
Trees	0.47
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	0.38
RV parking	
Impervious	0.05
No runoff	
Area	1.30
C'	0.28
% Impervious	12.4

Incremental Land Use Areas - Existing

3

Land Use	Area
Grass	
Trees	0.2
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	1.7
RV parking	
Impervious	
No runoff	
Area	1.90
C'	0.41
% Impervious	26.8

3.1

Land Use	Area
Grass	
Trees	12.9
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	
No runoff	
Area	12.90
C'	0.15
% Impervious	0.0

3.2

Land Use	Area
Grass	2
Trees	4.7
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	
No runoff	0.2
Area	6.90
C'	0.16
% Impervious	0.0

3.2.1

Land Use	Area
Grass	0.45
Trees	1.33
Gravel Road	0.15
Cottage lots - treed	0.2
Cottage lots - non treed	
RV parking	0.9
Impervious	0.07
No runoff	
Area	3.10
C'	0.28
% Impervious	21.6

3.2.1.1

Land Use	Area
Grass	0.09
Trees	0.05
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	0.46
Impervious	
No runoff	
Area	0.60
C'	0.33
% Impervious	34.5

4

Land Use	Area
Grass	0.1
Trees	0.36
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	0.12
RV parking	0.07
Impervious	0.05
No runoff	
Area	0.70
C'	0.29
% Impervious	16.4

Incremental Land Use Areas - Future Stage 1

Culvert 1

Land Use	Area
Grass	0.86
Trees	0.71
Gravel Road	0.22
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	0.11
No runoff	
Area	1.90
C'	0.28
% Impervious	15.3

Culvert 2

Land Use	Area
Grass	0.08
Trees	0.41
Gravel Road	
Cottage lots - treed	0.96
Cottage lots - non treed	
RV parking	
Impervious	0.08
No runoff	
Area	1.53
C'	0.37
% Impervious	26.9

Culvert 2.1

Land Use	Area
Grass	0.07
Trees	0.95
Gravel Road	0.37
Cottage lots - treed	1.24
Cottage lots - non treed	
RV parking	
Impervious	0.07
No runoff	
Area	2.70
C'	0.37
% Impervious	30.2

Culvert 2.1.1

Land Use	Area
Grass	0.22
Trees	
Gravel Road	0.01
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	0.07
No runoff	
Area	0.30
C'	0.39
% Impervious	25.0

Culvert 2.2

Land Use	Area
Grass	
Trees	0.53
Gravel Road	0.09
Cottage lots - treed	0.1
Cottage lots - non treed	0.28
RV parking	
Impervious	
No runoff	
Area	1.00
C'	0.30
% Impervious	19.6

Culvert 2.3

Land Use	Area
Grass	0.4
Trees	0.47
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	0.38
RV parking	
Impervious	0.05
No runoff	
Area	1.30
C'	0.28
% Impervious	12.4

Incremental Land Use Areas - Future Stage 1

Culvert 3

Land Use	Area
Grass	
Trees	0.2
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	4.5
RV parking	
Impervious	
No runoff	
Area	4.70
C'	0.42
% Impervious	28.7

3.1

Land Use	Area
Grass	
Trees	10.1
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	
No runoff	
Area	10.10
C'	0.15
% Impervious	0.0

3.2

Land Use	Area
Grass	2
Trees	4.7
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	
No runoff	0.2
Area	6.90
C'	0.16
% Impervious	0.0

Culvert 3.2.1

Land Use	Area
Grass	0.45
Trees	1.33
Gravel Road	0.15
Cottage lots - treed	0.2
Cottage lots - non treed	
RV parking	0.9
Impervious	0.07
No runoff	
Area	3.10
C'	0.28
% Impervious	21.6

Culvert 3.2.1.1

Land Use	Area
Grass	0.09
Trees	0.05
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	0.46
Impervious	
No runoff	
Area	0.60
C'	0.33
% Impervious	34.5

Culvert 4

Land Use	Area
Grass	0.1
Trees	0.36
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	0.12
RV parking	0.07
Impervious	0.05
No runoff	
Area	0.70
C'	0.29
% Impervious	16.4

Incremental Land Use Areas - Future Stage 2

1

Land Use	Area
Grass	0.86
Trees	0.71
Gravel Road	0.22
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	0.11
No runoff	
Area	1.90
C'	0.28
% Impervious	15.3

2

Land Use	Area
Grass	0.08
Trees	0.41
Gravel Road	
Cottage lots - treed	0.96
Cottage lots - non treed	
RV parking	
Impervious	0.08
No runoff	
Area	1.53
C'	0.37
% Impervious	26.9

2.1

Land Use	Area
Grass	0.07
Trees	0.95
Gravel Road	0.37
Cottage lots - treed	1.24
Cottage lots - non treed	
RV parking	
Impervious	0.07
No runoff	
Area	2.70
C'	0.37
% Impervious	30.2

2.1.1

Land Use	Area
Grass	0.22
Trees	
Gravel Road	0.01
Cottage lots - treed	
Cottage lots - non treed	
RV parking	
Impervious	0.07
No runoff	
Area	0.30
C'	0.39
% Impervious	25.0

2.2

Land Use	Area
Grass	
Trees	0.53
Gravel Road	0.09
Cottage lots - treed	0.1
Cottage lots - non treed	0.28
RV parking	
Impervious	
No runoff	
Area	1.00
C'	0.30
% Impervious	19.6

2.3

Land Use	Area
Grass	0.4
Trees	0.47
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	0.38
RV parking	
Impervious	0.05
No runoff	
Area	1.30
C'	0.28
% Impervious	12.4

Incremental Land Use Areas - Future Stage 2

3

Land Use	Area
Grass	
Trees	0.2
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	4.5
RV parking	
Impervious	
No runoff	
Area	4.70
C'	0.42
% Impervious	28.7

3.1

Land Use	Area
Grass	0.1
Trees	9.59
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	0.41
Impervious	
No runoff	
Area	10.10
C'	0.16
% Impervious	1.8

3.2

Land Use	Area
Grass	2
Trees	4.1
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	0.6
Impervious	
No runoff	0.2
Area	6.90
C'	0.18
% Impervious	3.9

3.2.1

Land Use	Area
Grass	0.45
Trees	1.33
Gravel Road	0.15
Cottage lots - treed	0.2
Cottage lots - non treed	
RV parking	0.9
Impervious	0.07
No runoff	
Area	3.10
C'	0.28
% Impervious	21.6

3.2.1.1

Land Use	Area
Grass	
Trees	
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	0.6
Impervious	
No runoff	
Area	0.60
C'	0.38
% Impervious	45.0

3.2.1.1.1

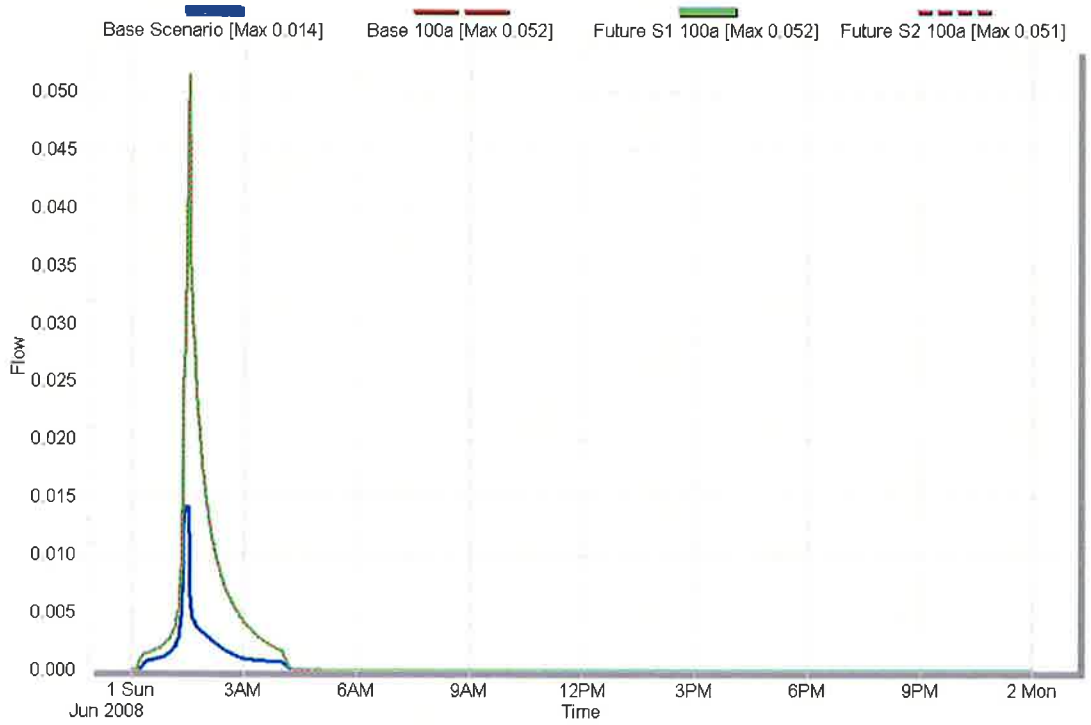
Land Use	Area
Grass	
Trees	
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	
RV parking	0.42
Impervious	
No runoff	
Area	0.42
C'	0.38
% Impervious	45.0

4

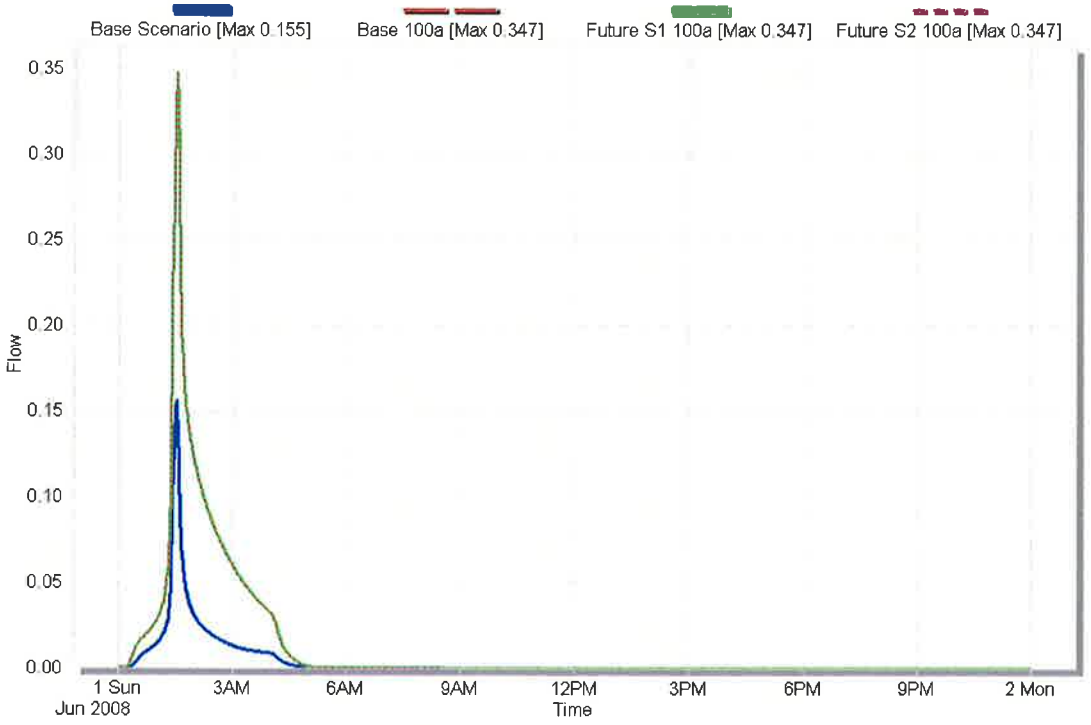
Land Use	Area
Grass	0.1
Trees	0.24
Gravel Road	
Cottage lots - treed	
Cottage lots - non treed	0.12
RV parking	0.19
Impervious	0.05
No runoff	
Area	0.70
C'	0.33
% Impervious	24.1

APPENDIX B

Conduit C 2.1.1 from Node7 to Node8

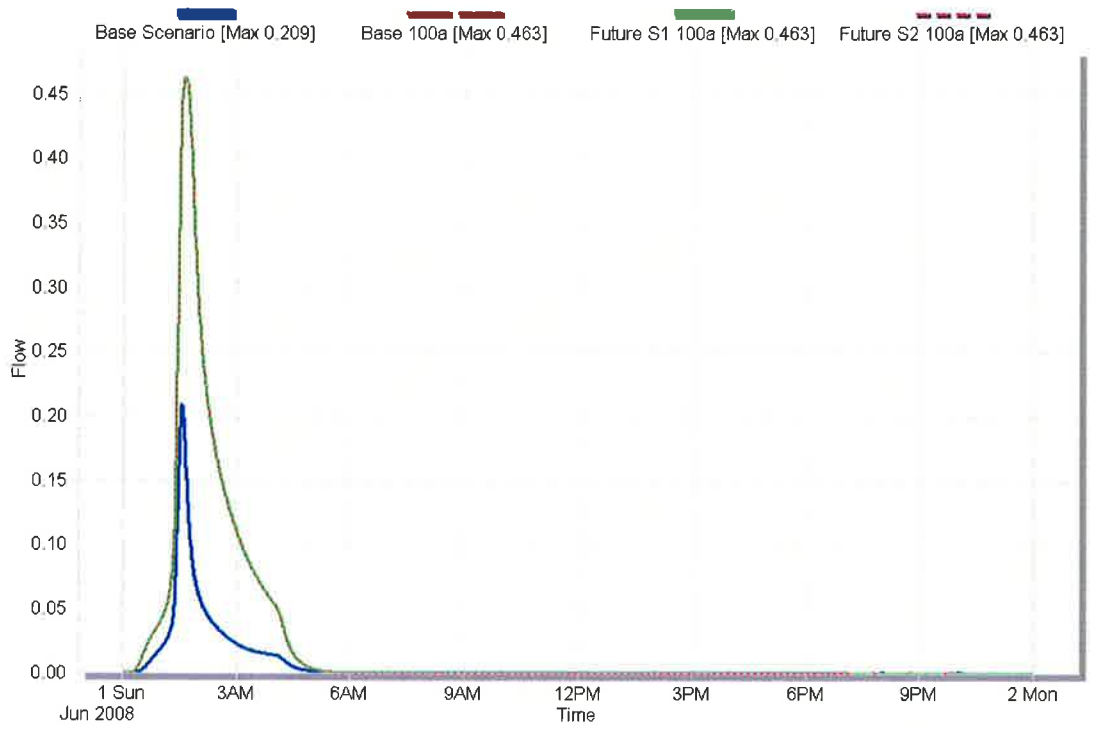


Conduit C 2.1 from Node9 to Node10

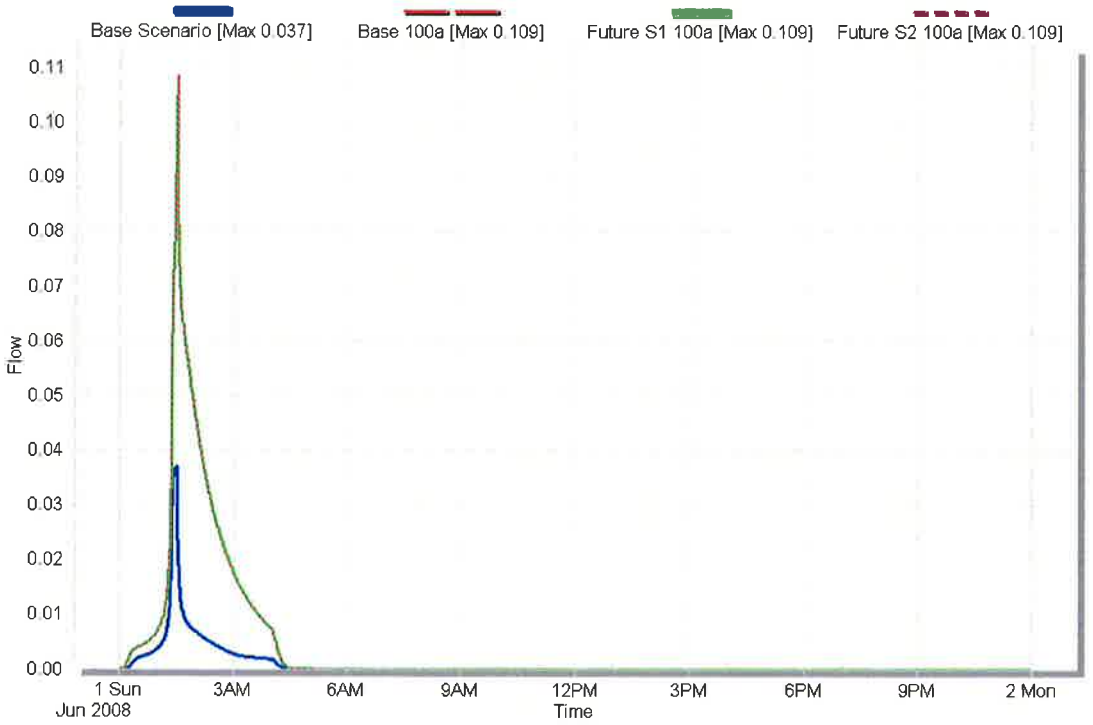


Appendix B

Conduit C 2 from Node3 to Node4

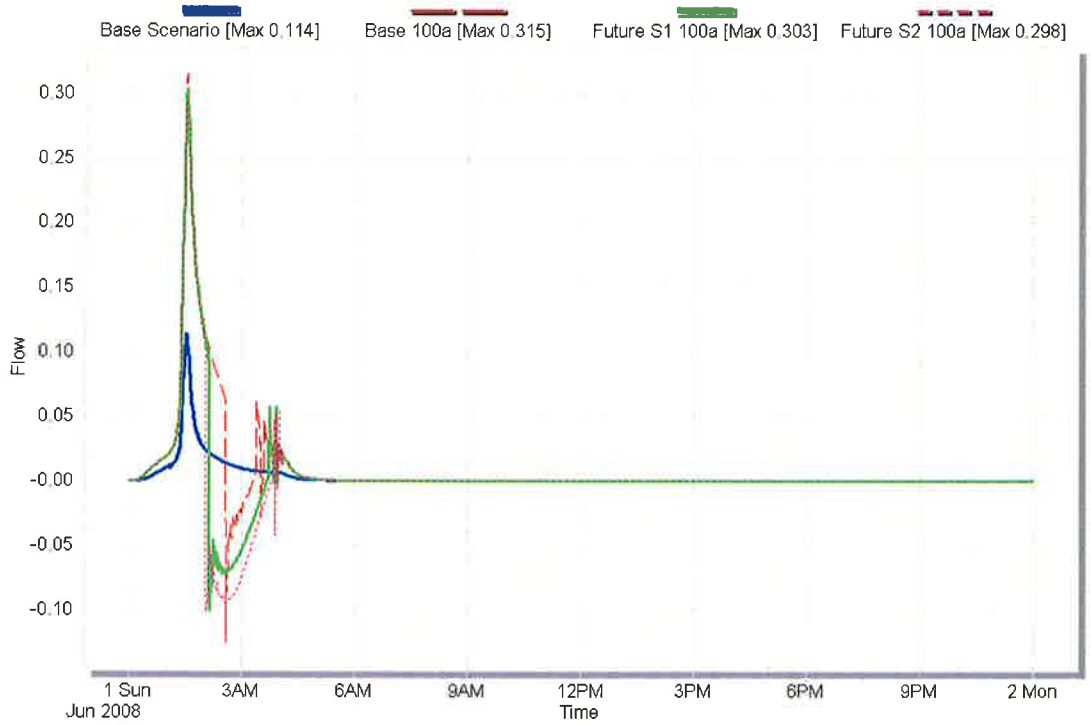


Conduit C 2.2 from Node19 to Node17



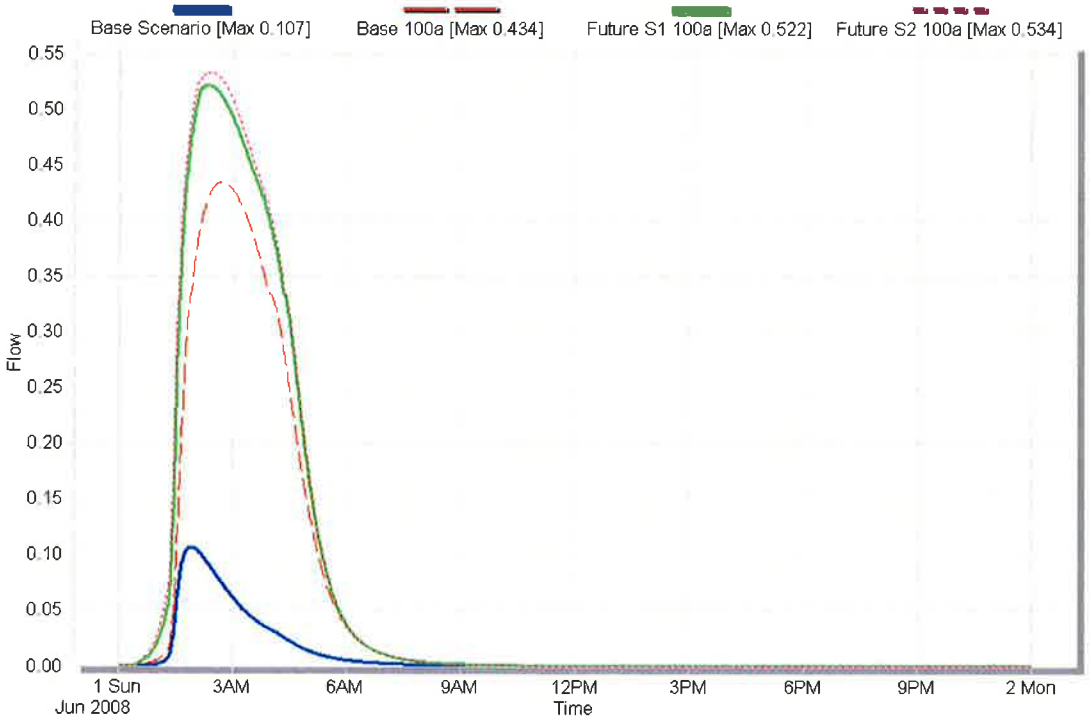
Appendix B

Conduit C 2.3 from Node17 to Node18

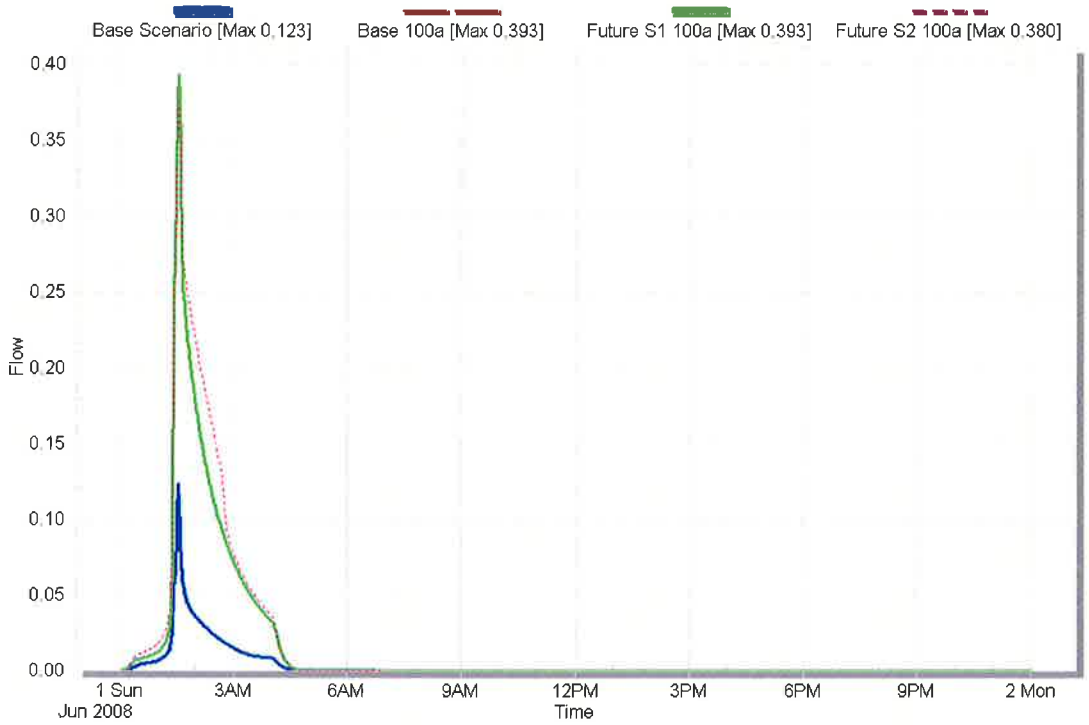


Conduit C 2.3 based on unrestricted development

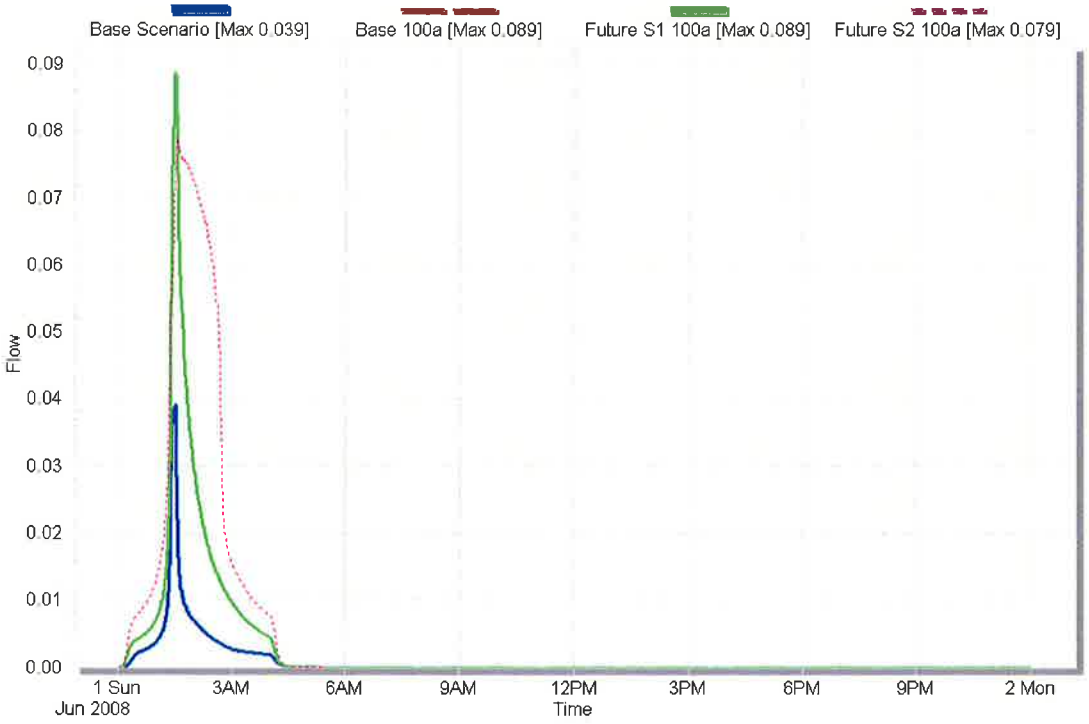
Conduit C 3 from Node1 to Node2



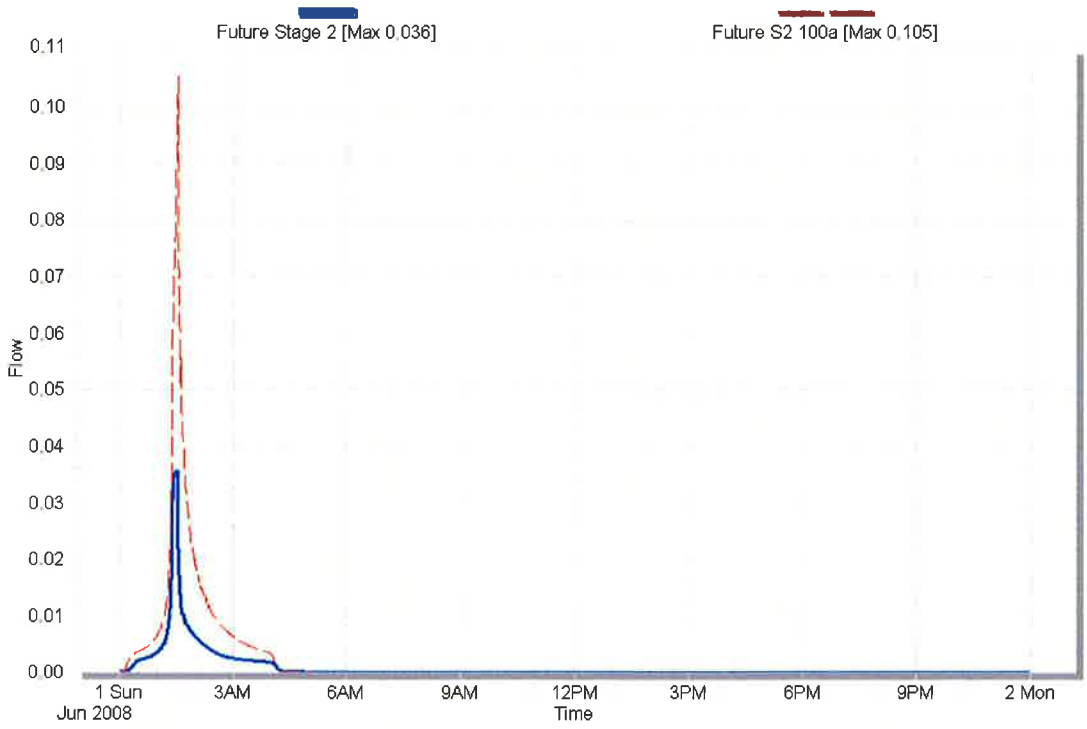
Conduit C 3.1 from Node12 to Node11



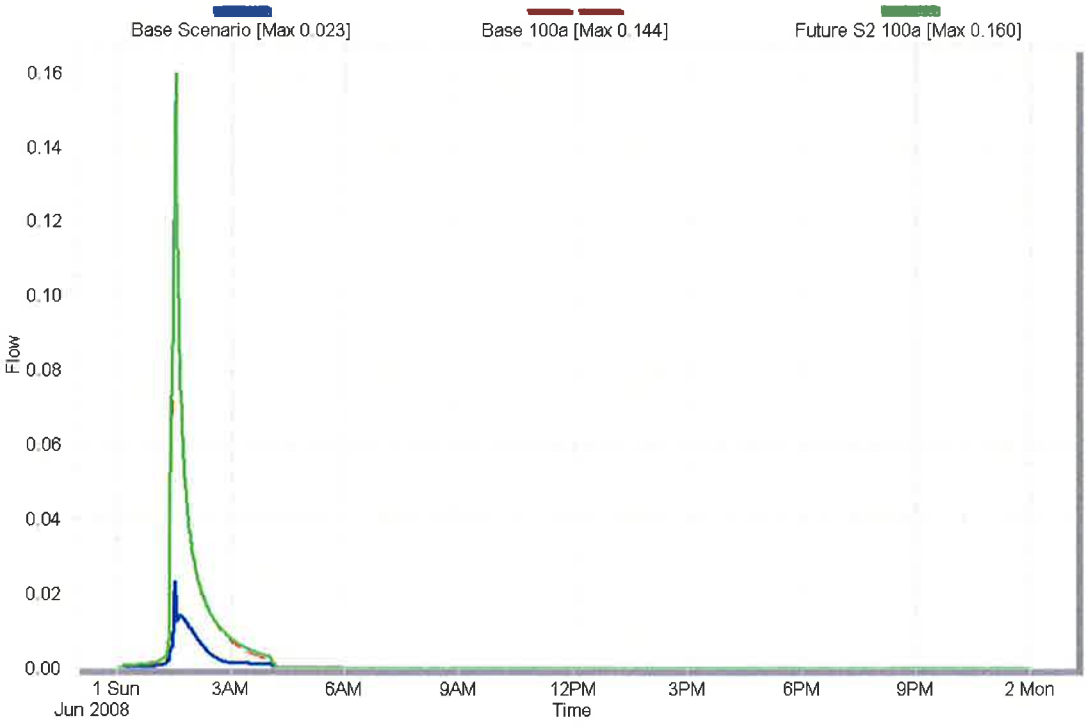
Conduit C 3.1.1 from Node14 to Node13



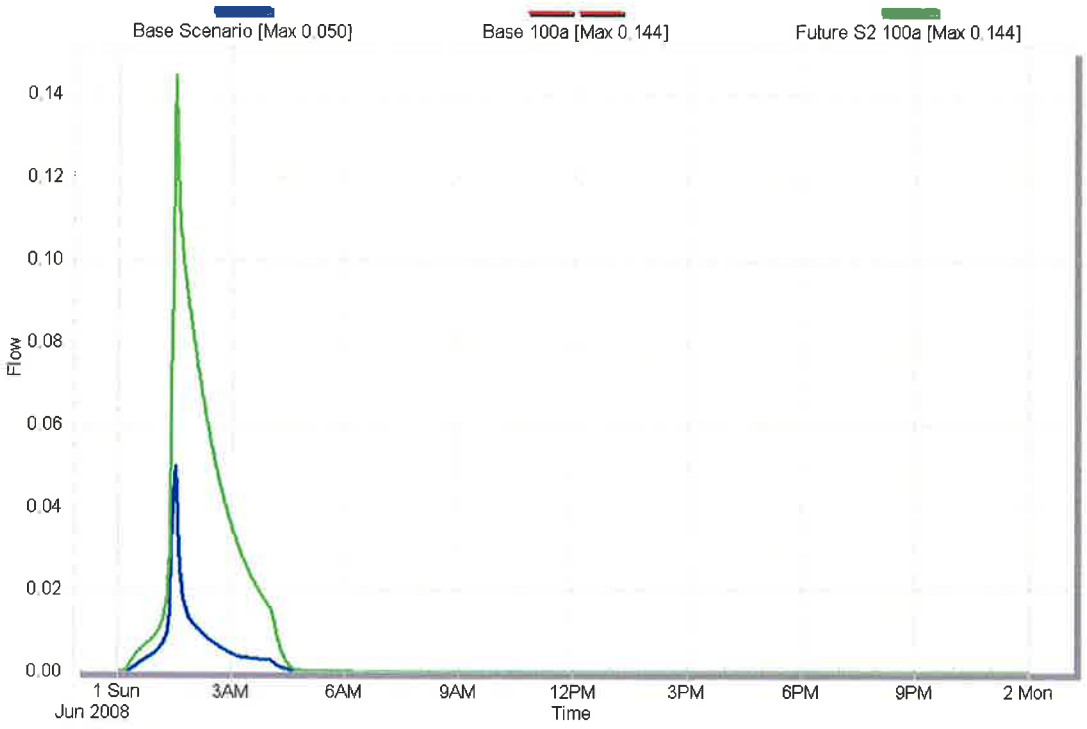
Conduit c new from Node71 to Node72



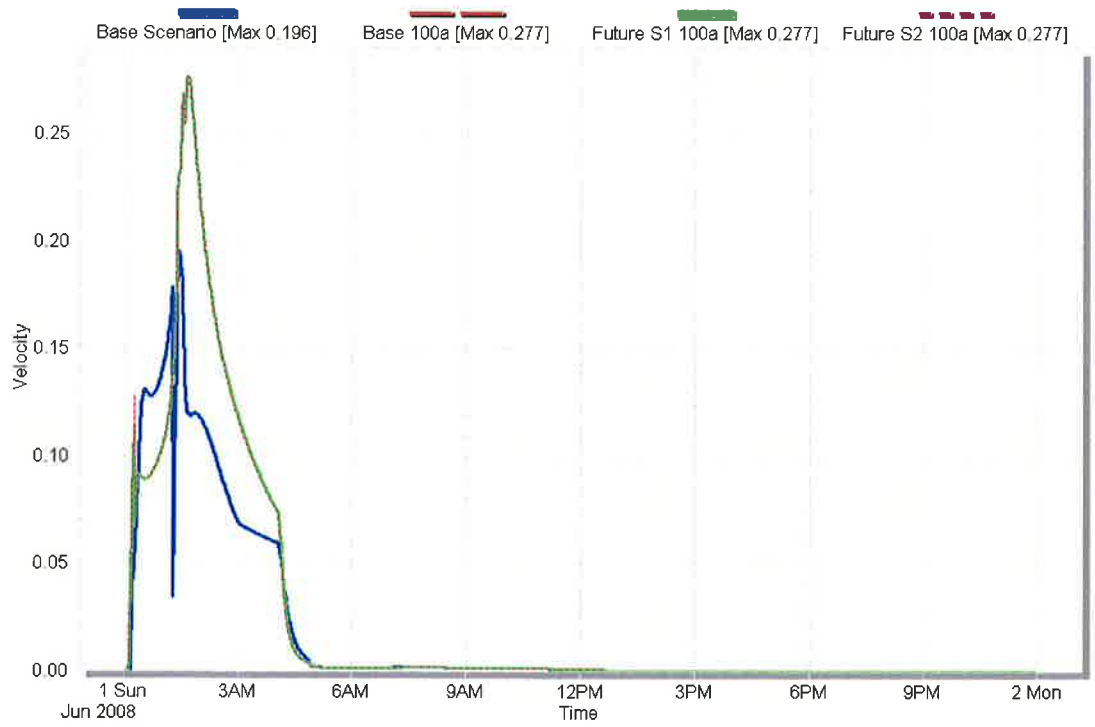
Conduit C 4 from Node15 to Node16



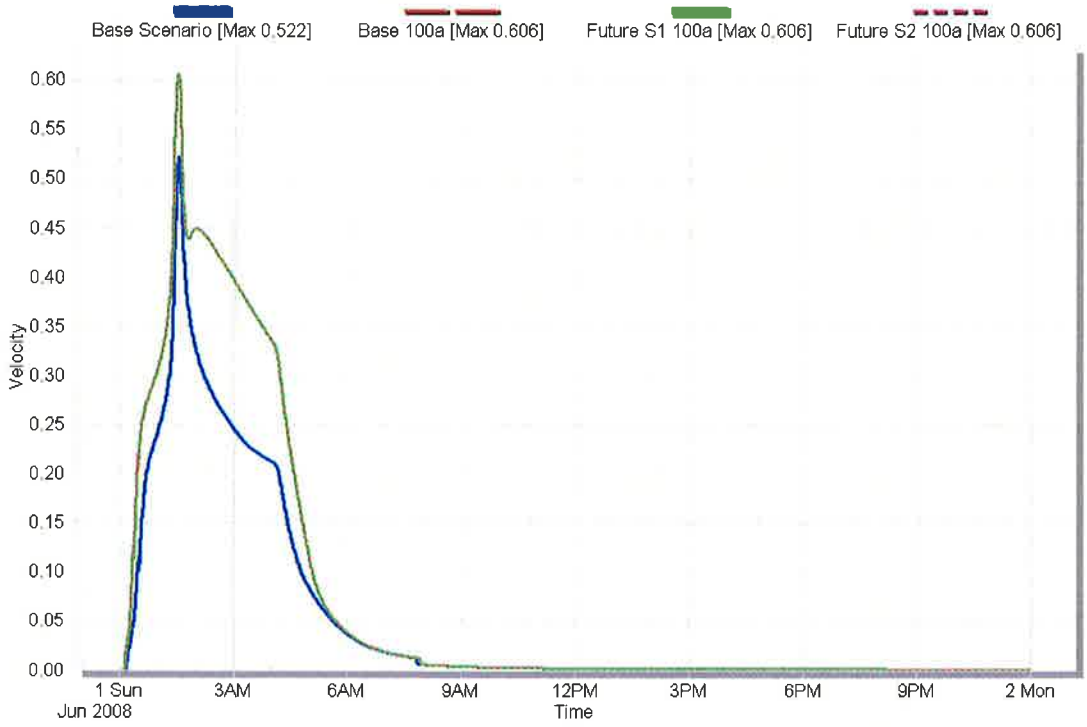
Conduit C 1 from Node5 to Node6



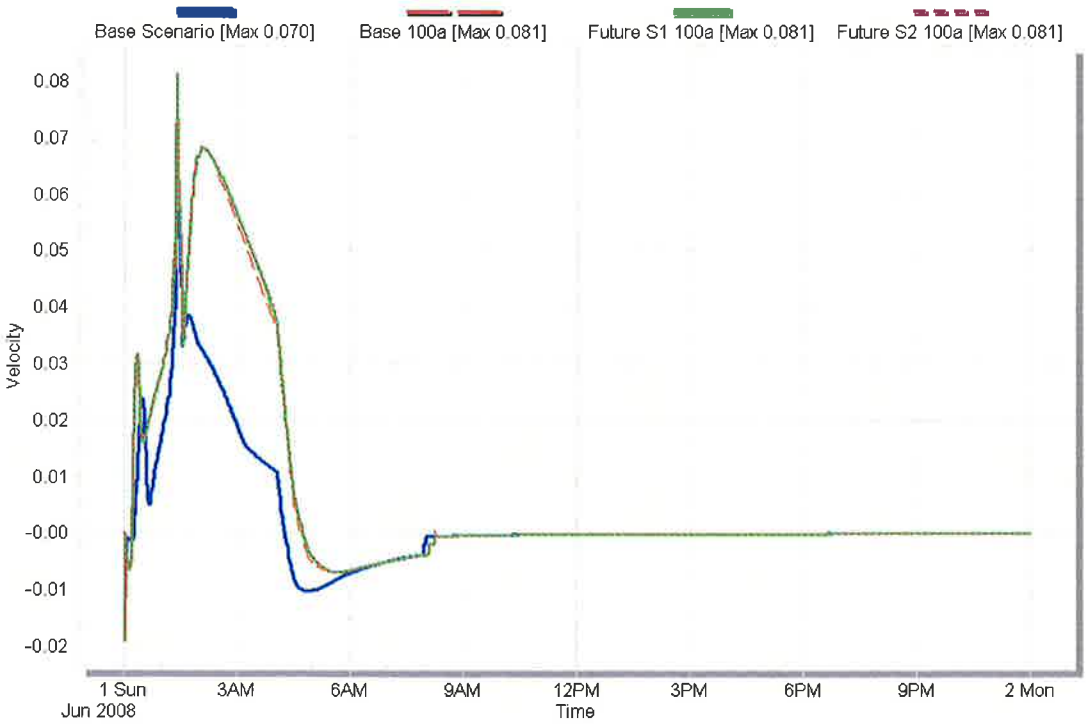
Conduit ditch1 from Node8 to Node9



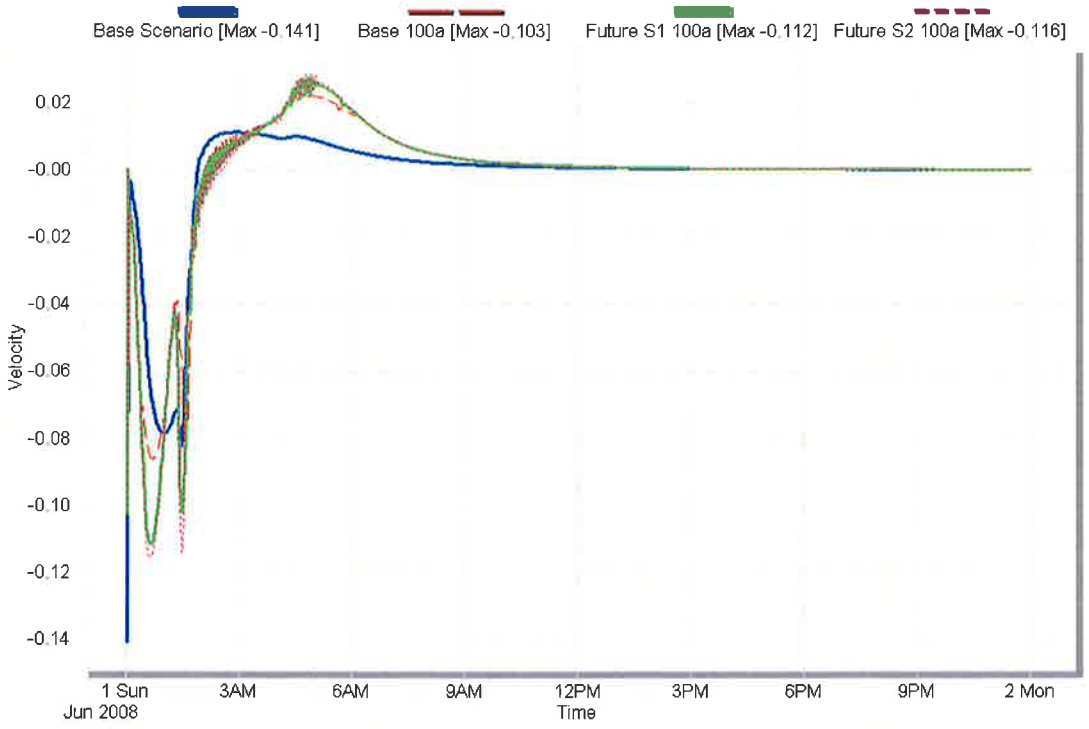
Conduit ditch2 from Node10 to Node3



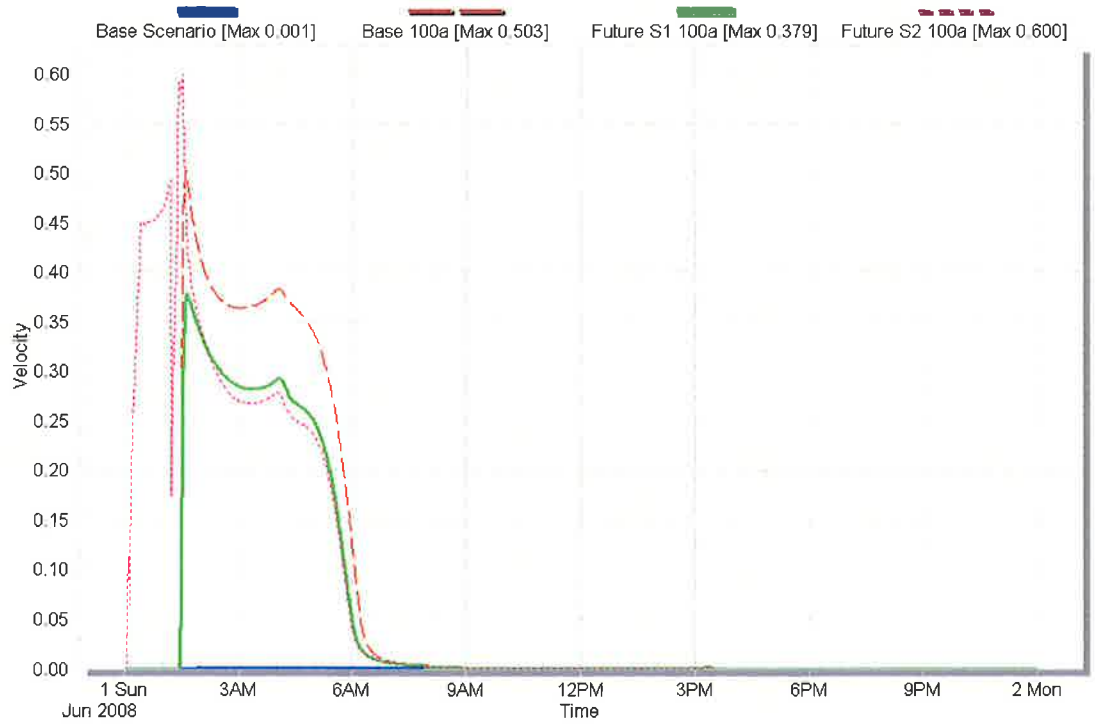
Conduit ditch 3 from Node17 to Node3



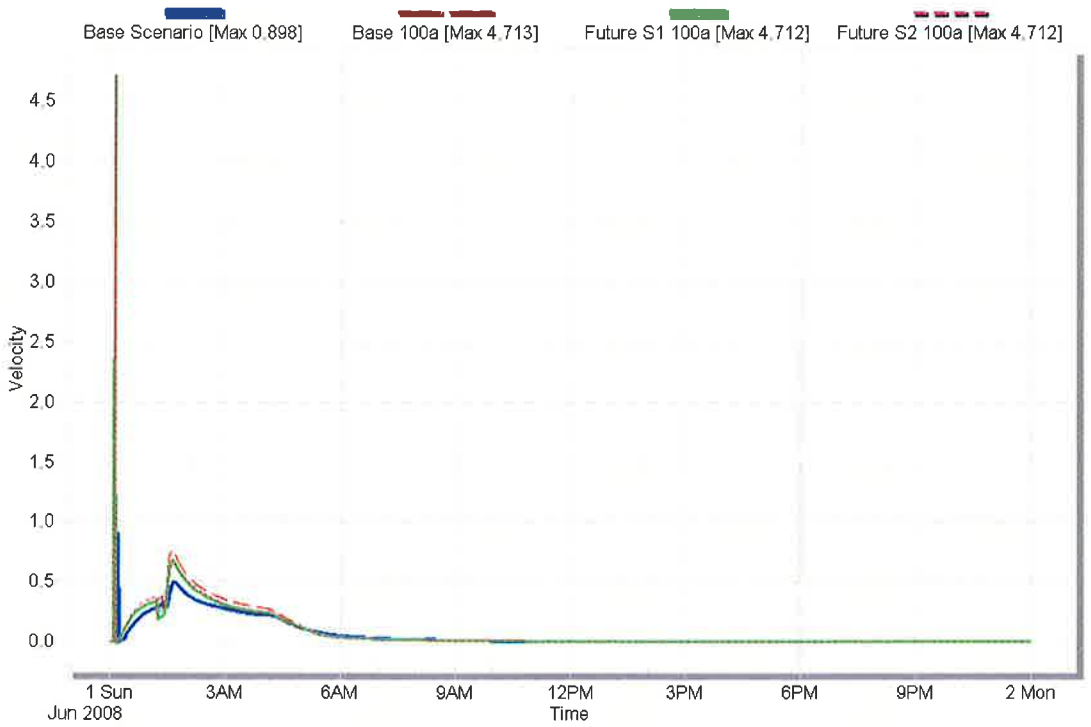
Conduit Link25 from Node1 to Node18



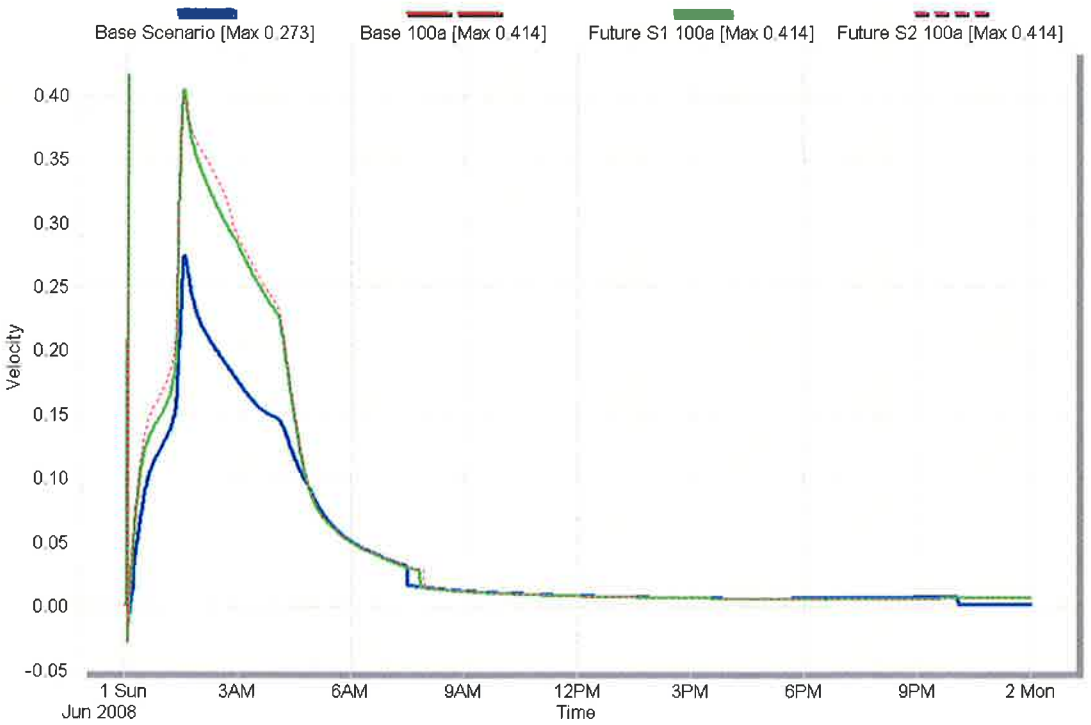
Conduit ditch 4 from Node64 to Node1



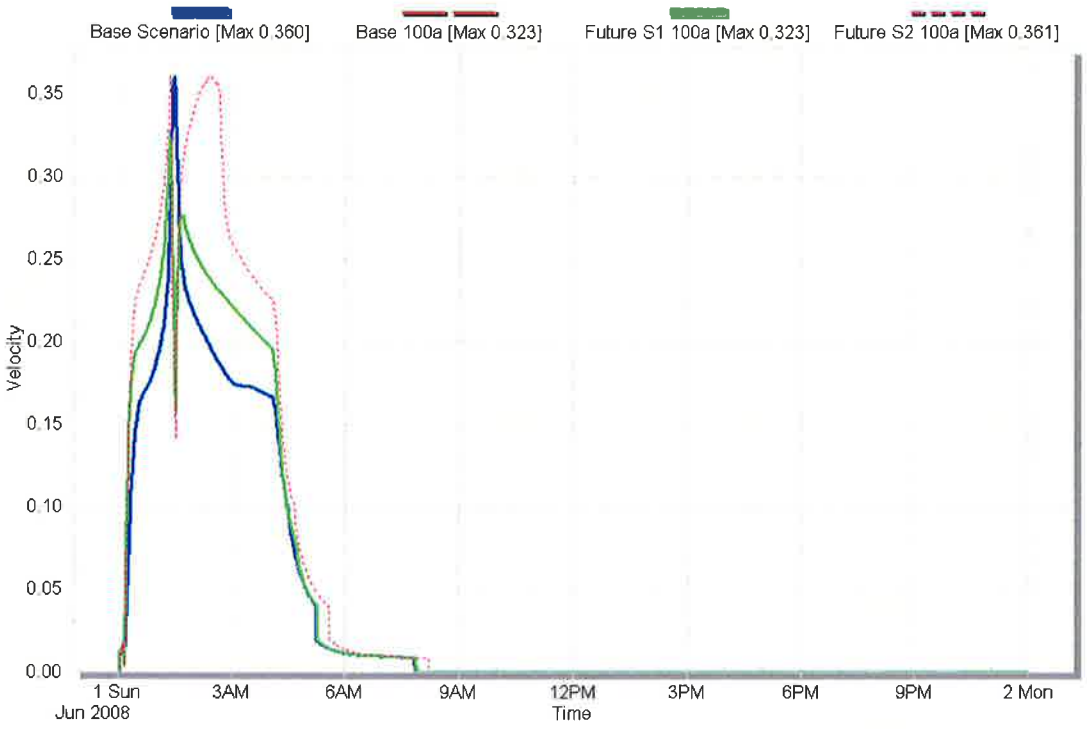
Conduit ditch 5 from Node59 to Node1



Conduit ditch 6 from Node11 to Node59



Conduit ditch 7 from Node13 to Node12



Conduit d new from Node72 to Node14