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Cato Ridge Development

1:50 and 1:100 Flood Lines Study

Assmang

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1 Introduction

1.1 Purpose of Study

Assmang and the Cato Ridge Development Company (CRDC) are two of the major land owners in Cato Ridge. The company, collectively referred to as Assmang, has received several offers to purchase and develop the land.

The pre-feasibility flood line determination is only one aspect of an in-depth study of the area. The purpose of the Flood Lines Study is to indicate the extent of the 1:50 and 1:100-year flood lines in the Cato Ridge Development area and possible impact on future infrastructure. This in turn will enable Assmang to make informed decisions on whether to sell or develop their properties.

This report will consist of three main sections addressing the following:

- Topographical information,
- Hydrological modelling methodology,
- Model output.

1.2 Locality

Cato Ridge is situated between Pietermaritzburg and Durban in eThekwini in South Africa. It is about 50km north-west of Durban and 30km south-east of Pietermaritzburg.

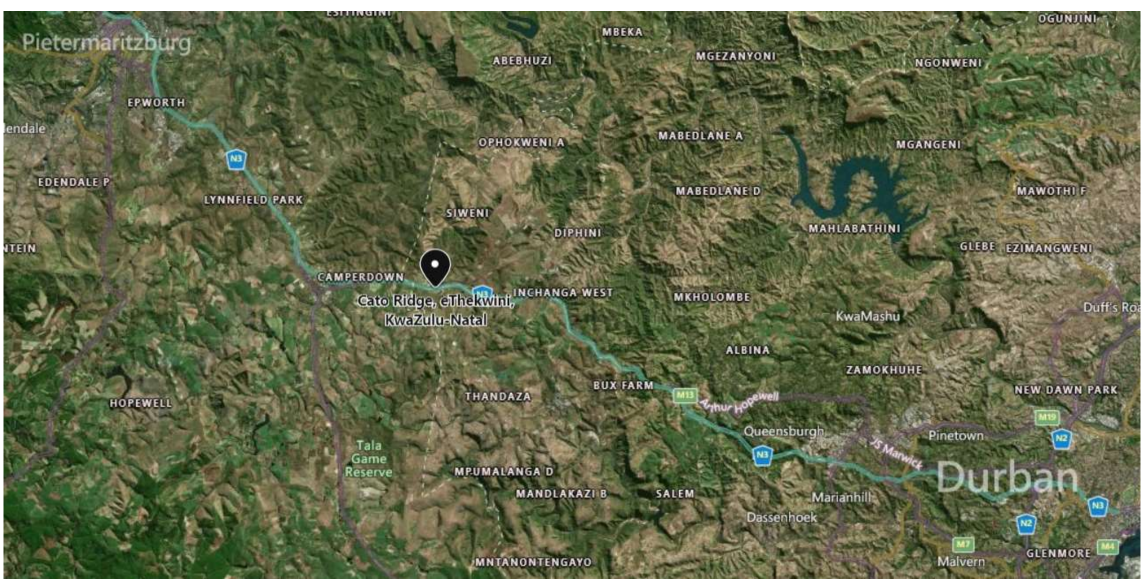

Figure 1: Locality of Cato Ridge

1.3 Study Area

The Cato Ridge study area consists of a natural high point north of the N3, where the new developments are proposed, with steep hills sloping away from the higher centre. The slopes are more even south of the N3 where the flood line design was done. Runoff from the area will be calculated using the Coastal rainfall intensity equation. The area high point is approximately 800 above means sea level and sloping downwards from there.

The boundary of the Cato Ridge development and study area can be seen in the figure below.

Figure 2: Cato Ridge study area

1.4 Objectives

The objectives are as follows:

- To indicate the extent of 1:50 and 1:100-year flood lines in the Cato Ridge area.
- To avoid flooding of any existing and future infrastructure.
- To document all assumptions and findings regarding the hydraulic modelling.

2 Topographical Information

The Arial topography and 5m contours utilised in the hydrological study were sourced from the client, however, additional information from external sources were obtained to verify if the area received were sufficient for catchment area determination for the low-lying areas of interest. The figure below shows the 5m contours and the location of the streams chosen for the flood line study.

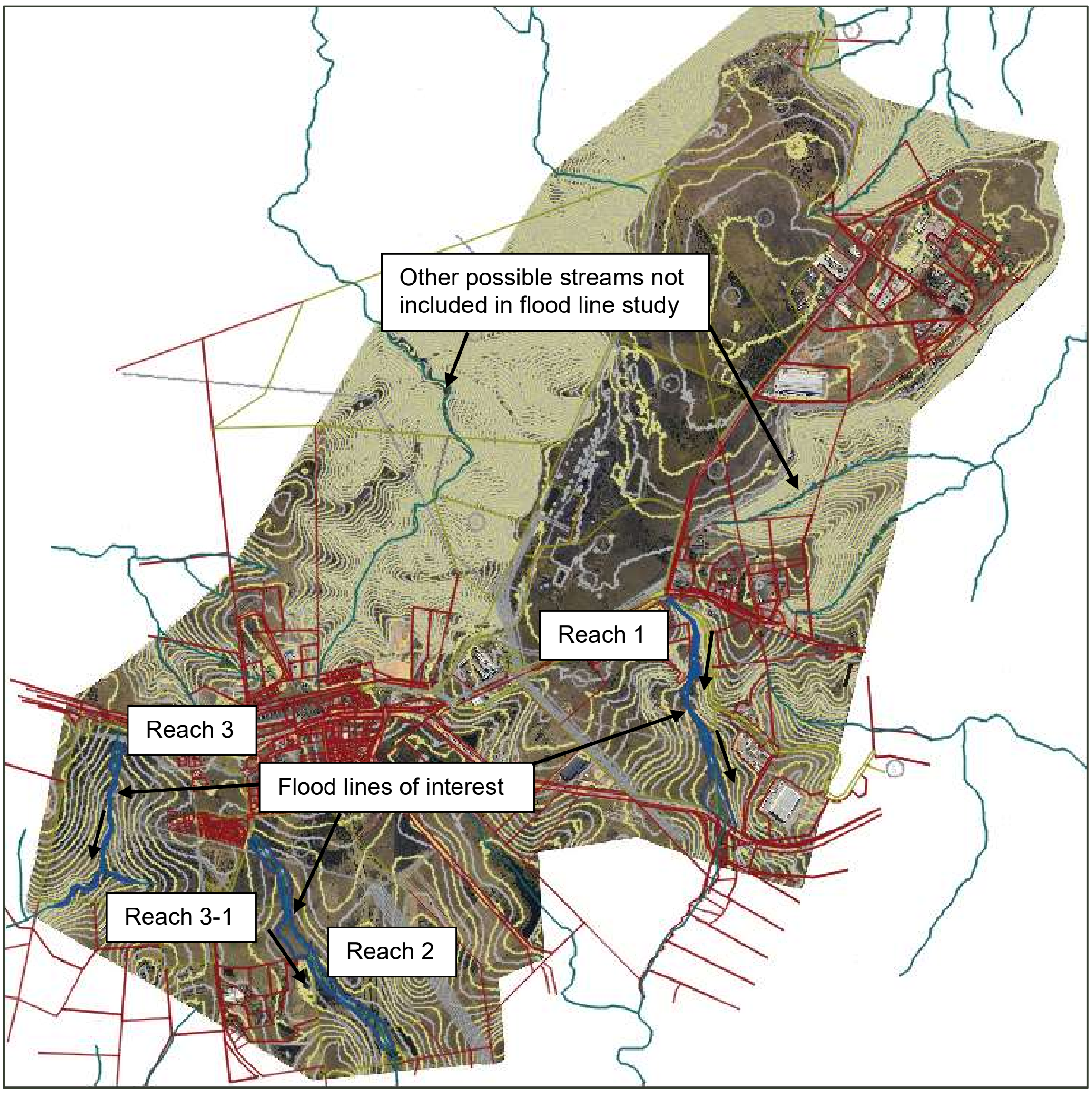

Figure 3: 5m Contours layout of study area

3 Hydrological modelling Methodology

3.1 Introduction

This section deals with the principles of the determining flood lines for identified flood prone areas which may inherit possible risk.

The flood lines were complied with the objective of the study as of utmost importance. These flood lines should not be used, without prior verification, for any purpose other than the intended purpose. Specific assumptions were made to meet the objectives of the study.

Various flood lines were created to give the client an idea what the water level changes would be for different flood scenarios. The scenarios investigated and represented in this design are:

- Existing conditions – 1:50 and 1:100-year flood line with Rational Method and compared with Alternative Rational Method.
- Future conditions, assuming the new development comprises 50% of the area – 1:100-year flood line with Rational Method and compared with Alternative Rational Method.
- Future flood conditions including an additional 15% for climate change circumstances – 1:100-year flood line with Rational Method and compared with Alternative Rational Method.
- 1:50 and 1:100-year flood line using the Standard Design Flood Method. This method uses a different design approach than Rational Method and usually gives a very high run-off in comparison to other methods. This check ensures we have the worst-case flood line boundary.

Once we have more information regarding the new development, the area characteristics can be adjusted, and a more accurate flood line can be determined if needed. However, the client can make informed decisions, regarding their properties, based on what is given in this report.

3.2 Hydrology Parameters

The nearest rainfall station is Camperdown rain gauge (0240077P) which was taken out of the TR102, the South African Storm Rainfall tables from the department of Environment Affairs.

Rainfall data indicates a MAP of 738mm but a rounded-up number of 750 mm was used for the calculations.

Table 1: Rainfall Data from TR102 in mm

RI	1:2	1:5	1:10	1:20	1:50	1:100	1:200
1 Day	49	72	90	112	147	178	215
2 Day	62	91	114	142	186	226	275
3 Day	70	102	129	160	209	255	309
7 Day	91	127	156	188	237	281	332

3.3 Existing Water Courses

For the flood lines analyses, most of the tributaries were derived from aerial photos and surveyed information. Figure 3 above indicates the position and direction of the water courses. The existing conditions for the study area can be divided into approximately 85% Rural areas and 15% Urban areas. However, future possible development would increase the run-off ultimately increasing the water level of the flood lines as run-off factors will be influenced by new development. Other aspects such as climate change can also have an impact on the water levels and will be considered in the study.

The Rural area can be defined as sparse grass to medium cover grass over a rough surface with tropical plant life, typical to the coast and eThekwini, in the watercourses. The streams drain in a south-eastern direction. Three separate streams were identified as part of the study as shown in Figure 3.

3.4 Flood Lines Delineation Procedures

The tributaries considered in modelling floods are the centrelines and cross-sections of the streams. The attributes for the centrelines were defined horizontally and vertically. The horizontal plane was defined using aerial photos and the vertical aspects from survey information showing the centre line levels of the streams.

After creating alignments for the three tributaries, sample lines or cross sections were defined. The watersheds and control points were identified by means of survey and aerial photos.

These findings were then used to determine other relevant input parameters required to complete the flood line model in HEC-RAS.

3.5 Cross Sections and Parameters

3.5.1 Sections Delineation

The criteria for the cross sections delineation are as follows:

- Cross sections are drawn perpendicular to the flow of the water.
- Where the stream centre line curves in the horizontal direction, the cross sections should never overlap.
- Cross sections should be spaced sufficiently close to one another to ensure that the geometry of the stream can be well defined in the hydraulic model.
- Cross sections should be sufficiently wide to cover the stream banks

3.5.2 Stream Cross sections

Cross sections were drawn and were interpolated closely in areas with bends in the stream and further apart at straight stream profile. Figure 4 below shows a typical stream cross section generated in Hec-Ras.

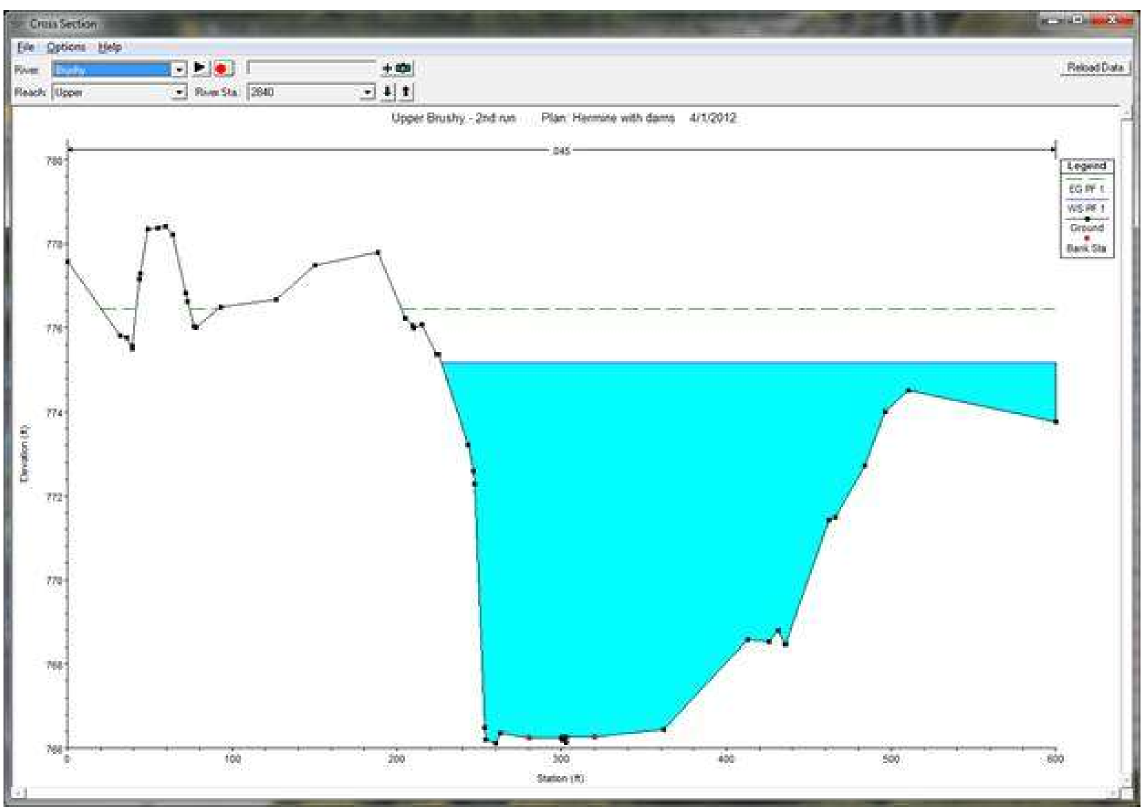

Figure 4: Typical cross section

3.5.3 Coefficients and Parameters Representing Losses

The total volume of rainfall does not result in run-off. A certain volume is retained in the catchment either as ponds or as infiltration. The rate at which water infiltrates into the ground changes over time as soil becomes saturated. This alters the run-off rate during a storm event continuously and does not only affect run-off volumes but also run-off peaks. These loses are incorporated into the flood line models by means of factors considered during run-off calculations and certain factors and coefficients used.

3.5.4 Stream Parameters

The following parameters were used for the simulation:

Table 2: Input Parameters

Parameter	Value	Motivation
Manning ‘n’	0.03 (main channel)	Clean, winding, some pools and shoals and some weeds and stones
	0.04 (floodplains)	Scattered bush, heavy weeds
Boundary Conditions	Normal depth (downstream)	Worst case boundary condition
	Normal depth (upstream)	Worst case boundary condition
Flow regime	Mixed	To include possible control points

4 Model Output

The Cato Ridge catchment areas and flows in m³/s are shown in the table below. The flows were obtained using various methods as applied in the Utility Program for Drainage (SANRAL Drainage Manual).

Table 3: Reach 1 - Hydrological information

REACH 1 (3.762 km²)						
CALCULATION METHOD	**Rational Method**		**Alternative Rational Method**		**SDF**	
FLOODLINES	**1:50**	**1:100**	**1:50**	**1:100**	**1:50**	**1:100**
Existing conditions	23.91	30.47	22.74	27.16	69.25	89.17
Future Conditions: 50% developed area	28.76	35.99	27.35	32.08	69.25	89.17
Future Conditions with additional 15% for Climate Change	33.07	41.39	31.45	36.89	69.25	89.17

Table 4: Reach 2 - Hydrological information

REACH 2 (25.040 km²)						
CALCULATION METHOD	**Rational Method**		**Alternative Rational Method**		**SDF**	
FLOODLINES	**1:50**	**1:1008.5**	**1:50**	**1:100**	**1:50**	**1:100**
Existing conditions	29.3	37.3	27.5	32.8	79.2	102.0
Future Conditions: 50% developed area	35.2	44.0	33.0	38.7	79.2	102.0
Future Conditions with additional 15% for Climate Change	40.5	50.6	38.0	44.5	79.2	102.0

Table 5: Reach 3 - Hydrological information

REACH 3 (2.710 km²)						
CALCULATION METHOD	**Rational Method**		**Alternative Rational Method**		**SDF**	
FLOODLINES	**1:50**	**1:100**	**1:50**	**1:100**	**1:50**	**1:100**
Existing conditions	18.6	23.7	17.9	21.3	56.7	73.0
Future Conditions: 50% developed area	22.3	27.9	21.5	25.2	56.7	73.0
Future Conditions with additional 15% for Climate Change	25.6	32.1	24.7	29.0	56.7	73.0

Table 6: Reach 3-1 - Hydrological information

REACH 3-1 (0.624 km²)						
CALCULATION METHOD	**Rational Method**		**Alternative Rational Method**		**SDF**	
FLOODLINES	**1:50**	**1:100**	**1:50**	**1:100**	**1:50**	**1:100**
Existing conditions	6.7	8.5	7.0	8.4	26.2	33.8
Future Conditions: 50% developed area	8.0	10.0	8.5	9.9	26.2	33.8
Future Conditions with additional 15% for Climate Change	9.2	11.5	9.8	11.4	26.2	33.8

Refer to Appendix A for the catchment delineation of each reach. Areas falling outside of the

The Hec-Ras output is a comprehensive set of results and the results of the flood lines can be seen in Appendix B. No existing infrastructure is affected by the flood lines.

Recommendations

5 Conclusion

This report documented all the assumptions and findings regarding calculated hydrology and the hydraulic calculations performed for the determination of the 1:50 and 1:100-year flood lines in the Cato Ridge Development area. The flood extents are clearly shown in the drawing provided in Appendix B.

It should be noted that stream centre lines are not always well defined; the identification of the canal section of a stream is more relevant.

These flood lines should not be used, without prior verification, for any purpose other than the intended purpose. Specific assumptions were made to meet the objectives of the study.

The flood lines can indicate the risks to the existing and future development.

SIGNED ____________________RUAN GILAU (Pr Tech Eng.):

DATE __14 October 2019___ON BEHALF OF AURECON

Appendix A – Catchment Delineation

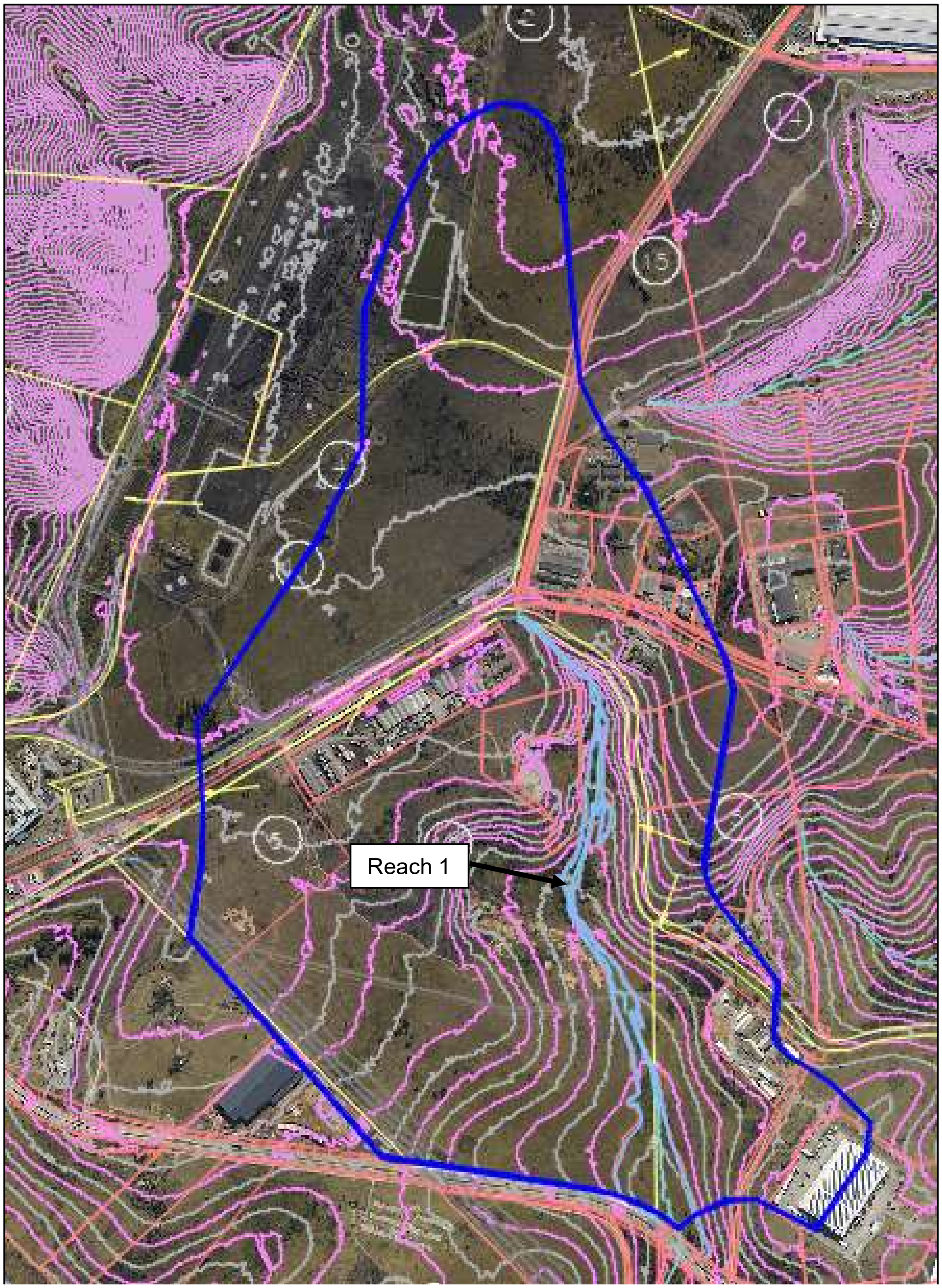

Figure 5: Reach 1 - Catchment area

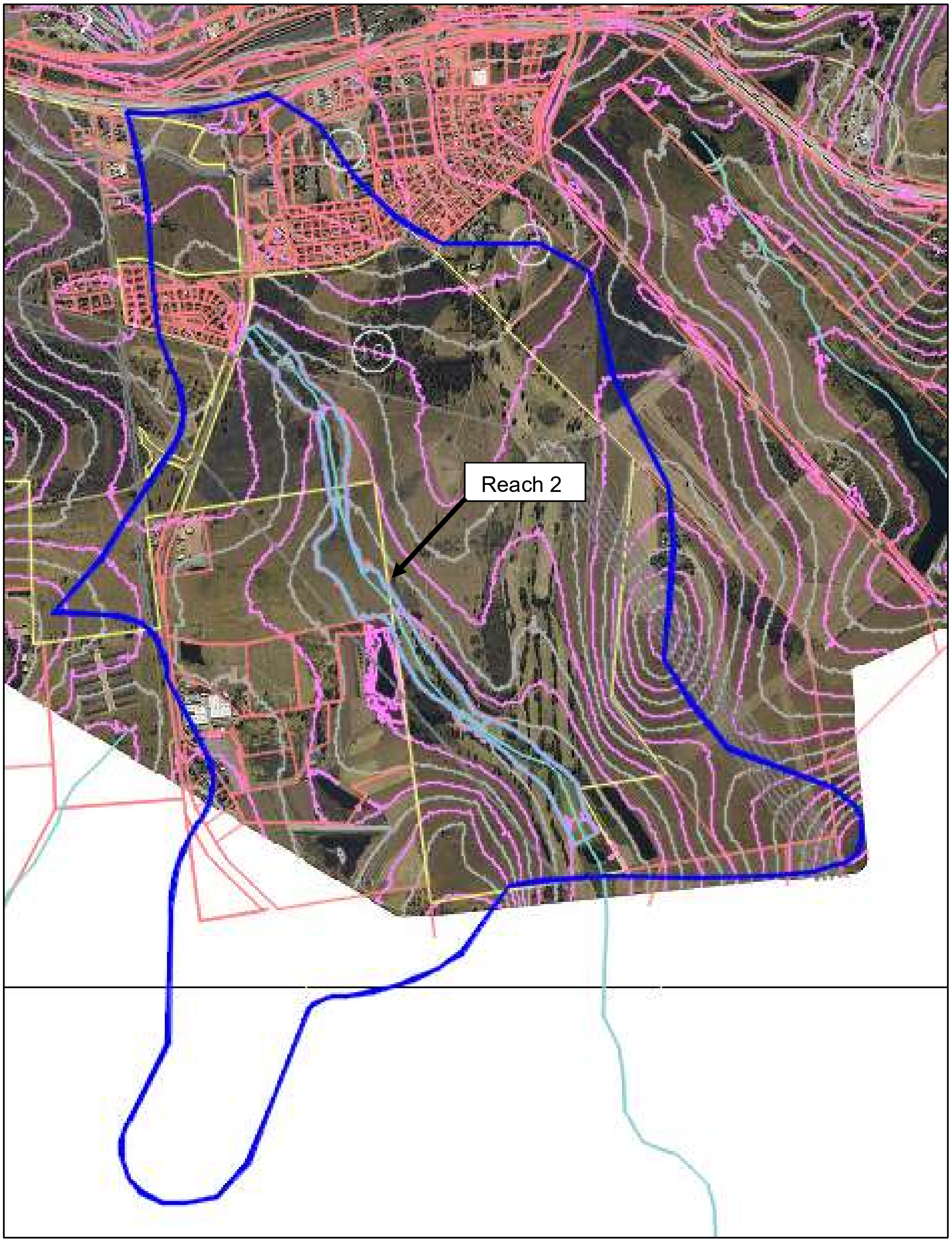

Figure 6: Reach 2 - Catchment area

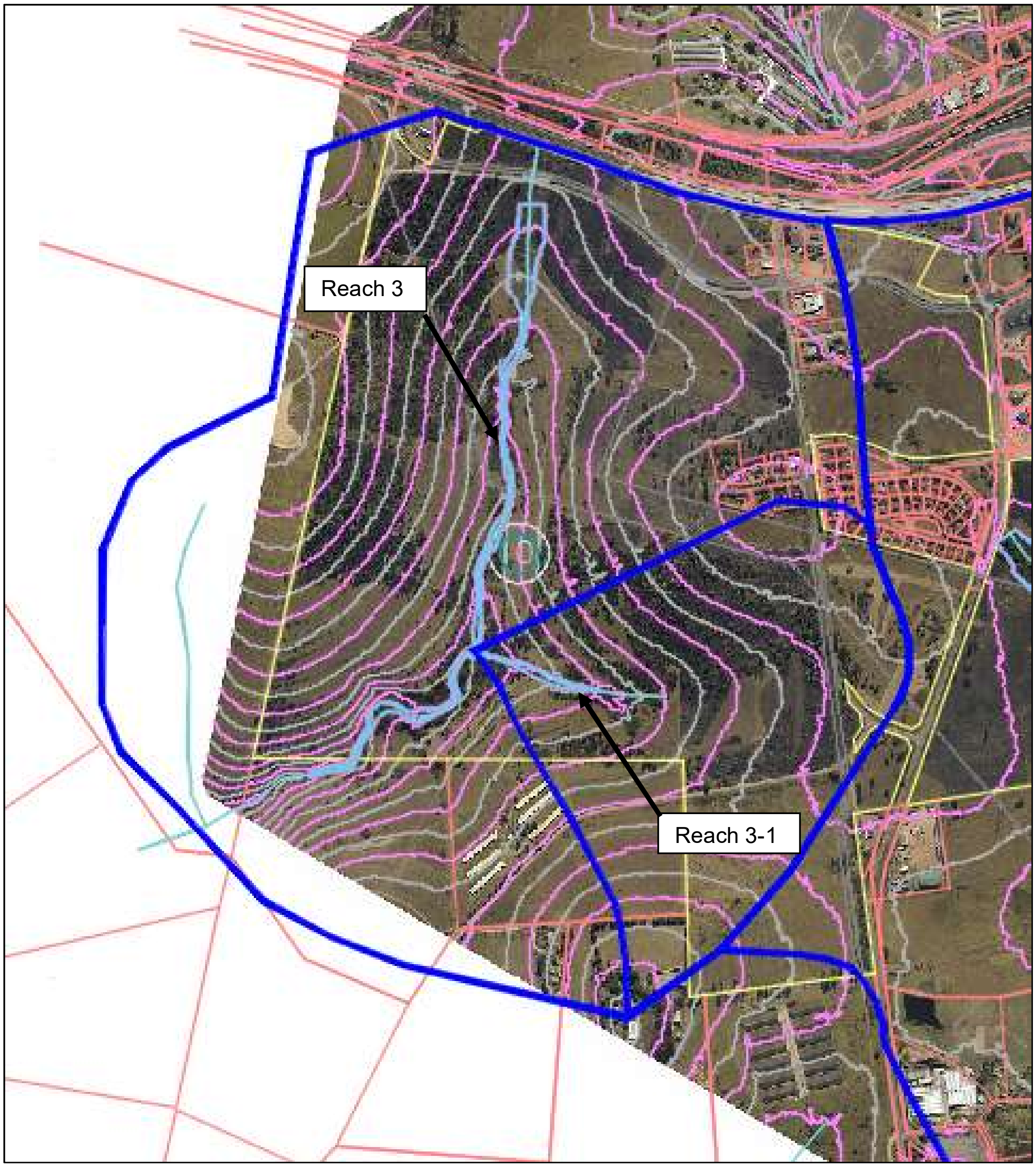

Figure 7: Reach 3 and 3-1 Catchment area

Appendix B – 1:50 and 1:100-Y floodlines

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LEGEND

LINE	DESCRIPTION
	1:50 YEAR FLOOD LINE - EXISTING
	1:100 YEAR FLOOD LINE - EXISTING
	1:100 YEAR FLOOD LINE - WITH 50% DEVELOPED AREA
	1:100 YEAR FLOOD LINE - CLIMATE CHANGE ADDITION
	1:100 YEAR FLOOD LINE - STANDARD DESIGN FLOOD METHOD
	CATO RIDGE STREAMS

CLIENT

REV	DATE	REVISION DETAILS	APPROVED
A	11.10.18	ISSUED FOR INFORMATION	

SCALE: 1:3000 SIZE: A0

FOR INFORMATION

DRAWN: J. FORD

CHECKED: I. GREYLING

REVIEWED: R. GILAU

APPROVED

DATE

PROJECT

CATO RIDGE DEVELOPMENT

TITLE

STOMRWATER FLOODLINES LAYOUT
SHEET 2 OF 4

DRAWING NUMBER

505788 - 0000 - DRG - SW - 0101 - A

LEGEND

LINE	DESCRIPTION
	1:50 YEAR FLOOD LINE - EXISTING
	1:100 YEAR FLOOD LINE - EXISTING
	1:100 YEAR FLOOD LINE - WITH 50% DEVELOPED AREA
	1:100 YEAR FLOOD LINE - CLIMATE CHANGE ADDITION
	1:100 YEAR FLOOD LINE - STANDARD DESIGN FLOOD METHOD
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REV	DATE	REVISION DETAILS	APPROVED
A	11.10.18	ISSUED FOR INFORMATION	

SCALE: 1:3000 | SIZE: A0

FOR INFORMATION

DRAWN: J. FORD
DESIGNED: I. GREYLING
REVIEWED: R. GILAU

APPROVED / DATE

PROJECT
CATO RIDGE DEVELOPMENT

TITLE
STOMRWATER FLOODLINES LAYOUT
SHEET 3 OF 4

DRAWING NUMBER
505788 - 0000 - DRG - SW - 0102 - A

LEGEND

LINE	DESCRIPTION
	1:50 YEAR FLOOD LINE - EXISTING
	1:100 YEAR FLOOD LINE - EXISTING
	1:100 YEAR FLOOD LINE - WITH 30% DEVELOPED AREA
	1:100 YEAR FLOOD LINE - CLIMATE CHANGE ADDITION
	1:100 YEAR FLOOD LINE - STANDARD DESIGN FLOOD METHOD
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SCALE	SIZE
1:3000	A0

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STOMRWATER FLOODLINES LAYOUT
SHEET 4 OF 4

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