HYDROLOGICAL BASELINE STUDY

ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED DROERIVIER SOLAR FACILITY

PORTION 55 OF FARM 168 STEENROTSFONTEIN
AND A PORTION OF
PORTION 10 OF FARM 170 WELTEVREDE, BEAUFORT WEST

FOR
DROERIVIER SOLAR POWER PLANT (PTY) LTD

SEPTEMBER 2014

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**TABLE OF CONTENTS**

1. Introduction
2. Project Description
3. Declaration
4. Scope
5. Assumptions and Limitations
6. Legislative Requirements
7. Method of Assessment
   7.1 Desktop Study
   7.2 Field/Site Investigation
8. Results and Findings
   8.1 Baseline State/Ecological Characteristics of the Site
   8.2 Climate
   8.3 Geology and Soils
   8.4 Geo-Hydrology
   8.5 Wetland Assessment
   8.6 Hydrology
   8.7 Constraints
      8.7.1 Watercourses
      8.7.2 Buffer Zones
         8.7.2.1 Gamka River
         8.7.2.2 Site Watercourse Buffers
      8.7.3 Slope and roughness of Terrain
9. Recommendations
10. Conclusion
11. References
12. Annexures
    Annexure A: Locality Plan
    Annexure B: 1:50 000 Topographical Map (extract 3222BC)
    Annexure C: 1:10 000 NFEPA Plan
    Annexure D: DROE-1 (A0) Assessment Outcomes (Watercourses, Buffer Zones and Development Area Extents)
    Annexure E: DROE-2 (A3) Watercourses and Buffer Zones
    Annexure F: DROE-3 (A3) Development Area Extents
1. Introduction

PWCE was appointed by Droërivier Solar Power Plant (Pty) Ltd, via the Environmental Assessment Practitioner (EAP), Cape Environmental Assessment Practitioners (Pty) Ltd, to undertake a specialist hydrological assessment, as part of the environmental assessment and authorization process, for a new solar facility on portion 55 of farm 168 Steenrotsfontein and a portion of portion 10 of farm 170 Weltevreden, Beaufort West to be known as Droërivier Solar Facility. (Refer Locality Plan attached as Appendix A)

This hydrological assessment shall have the following components:

1) A Baseline Study to inform the Scoping Reports for the Solar Facility
2) An Impact Assessment for the Solar Facility
3) An Impact Assessment to inform the Basic Assessment Report (BAR) for an associated powerline.
4) A Field Investigation to inform the above reports and assessments

The following document is the Baseline Study and it shall be used to assess the most suitable locality for the facility, in particular, the limits of the Photovoltaic (PV) panel arrays relative to the Stormwater runoff features, such as channels and rivers, which occur due to the natural topography of the site. It will also be used to assess the constraints associated with a possible powerline from the facility across the Gamka River.

2. Project Description

The Applicant intends to develop a Photovoltaic (PV) solar facility with a maximum generation capacity of 75MW (megawatts) AC (alternating current). This facility shall consist of fixed tilt, single and double-axis tracking PV panel arrays, covering and approximate area of 225ha, which will convert solar energy from the sun (Direct Current DC = >90MW) into electricity (Alternating Current AC = 75MW) to be fed into the national Eskom grid, at the nearby existing Eskom Droërivier Substation.

Associated infrastructure shall include the following:

- An overhead 132kV transmission line of approximately 3km in length, which will align parallel to one of the two existing transmission lines already crossing the study site, to link the facility to the nearby Eskom Droërivier Substation, just north of the Gamka River;
- An on-site Switching/Sub-station;
- Auxiliary buildings (Control Centre, Administration offices, Security etc;
- A network of inverters, transformers, and underground cabling;
- Access road off the N12 and internal road network to and around the PV panels;
- Perimeter security fencing;
- Rainwater tanks.
The proposed concept and layout details, including the associated structures and infrastructure (roads, grid connections etc), will be informed and adjusted by inputs and feedback gathered from the specialists, project team, key stakeholders and the public during the environmental process.

3. Declaration

In accordance with the requirements of Section 32(3)(b) of the Environmental Impact Assessment Regulations, 2010, I, the undersigned, declare that I am an independent Consultant appointed by AE-AMD (Pty) Ltd (on behalf of the IPP: Droërivier Solar Power Plant (Pty) Ltd.), with no business, financial, personal or other interest in this application and that the findings of this report are based on my own objective opinions.

PM Wium  Pr.Eng  BSc.Eng (Civil) UCT, MSAICE, MIMESA

Field of Expertise: Civil Engineering, Hydrology, Sustainable Stormwater Systems
4. Scope

Specific Objectives of this Study are:

- Overview of existing state / conditions of the proposed solar site;
- Identifying development constraints, in particular watercourses;
- Recommending buffers to watercourses;
- Identifying suitable development areas and best practice options;
- Recommending mitigating measures to minimize development impacts at planning stage.

5. Assumptions and limitations

- This study is limited to a Hydrological Assessment. If at a later stage there is a need for further specialist studies these could include:
  
  i. Wetland Assessment
  ii. Geo-Hydrological Assessment
  iii. Geological Assessment

- No hydraulic flows or flood lines have been established. These may be required during the Impact Assessment to quantify impacts.
- No water quality assessment included in this study.
- No hydrological modeling of the site undertaken.
- No risk analysis of the sensitivity of the watercourses and rivers has been undertaken.

6. Legislative Requirements

National

- National Environmental Management Act (Act 107 of 1998) and associated regulations as amended in June 2010
- Disaster Management Act (Act 57 of 2002)
- National Environmental Management Biodiversity Act (Act 10 of 2004)

Provincial

- Western Cape Planning and Development Act (Act 7 of 1999)
7. Method of Assessment

7.1 Desktop Study

A desktop study was compiled using relevant information from:

Maps:
- 1 : 50 000 Topographical Map of Beaufort West (No. 3222BC)
- 1 : 6 000 000 Geological Map of South Africa
- Google Earth

Documents and Data received from the EAP as part of the Terms of Reference:
- Proposed EIA Study Area (Google Map)
- Locality Plan
- 1 : 250 000 Topographical Map (extract)
- 1 : 50 000 Topographical Map (extract)
- Vegetation and Ecosystem Status Map
- Critical Biodiversity Area Map
- National Freshwater Ecosystem Priority Area (NFEPA)
- National Protected Areas Expansion Strategy (NPAES)

Relevant documents and information available on Internet
- Various Documents, Data, Reports and Guidelines

7.2 Field/Site Investigation

- Visit site to obtain an overview of site features, proximity to existing roads, electrical substation and powerlines, Gamka River, location of existing river crossings.
- Map exact location of existing 'watercourses' using a hand held GPS.
- Measure width of watercourses.
- Take photographs at each waypoint and cross-reference in field notes.
- Identify geology of the area to obtain an overview of bedrock and soil types and features and their impact on planning and construction of the facility.
- Investigate groundwater indicators and estimate geo-hydrological conditions.
- Investigate wetland indicators and characteristics.
- Identify mitigating measures that would be required of development interfacing with the natural/existing conditions.
The site was visited on the 3rd, 4th and 5th of September 2014. The entire site was traversed by 4 x 4 vehicle and by foot, mapping all hydrological features.

(Refer PWCE drawing DROE-4 showing the routes traversed and the waypoints logged.

Not attached but available if required)

8. Results and Findings

8.1 Baseline State/Ecology Characteristics of the site

The site is typical of the Karoo landscape with generally flat topography, rock strewn, sparsely vegetated, open plains. The Gamka River, well established and fairly large, traverses the site, slightly to the north of the proposed facility site and south of the existing Droërivier Eskom Sub-station. Most of the land falls northwards towards this river, with fairly gentle slopes. There is a portion of the site that falls towards the west, meeting the Gamka River lower down its course.

Two existing powerlines traverse the property from south to north, crossing the Gamka River on their way to the existing Droërivier sub-station.

The farm is currently used for stock grazing and the only farm buildings or infrastructure are on the north side of and adjacent to the Gamka River, close to the western side of the property. There appears to be only one borehole in operation on the south side of the river, which is located strategically central to the property. It is powered by a small solar panel and according to the Owner, the yields are very small, in the order of 200l/hr. There are two concrete reservoirs situated there and a small plastic tank feeding a water trough.

It would appear that the land is extremely rocky and inhospitable and no irrigation farming has taken place in the past. There are numerous outcrops of rock and exposed bedrock in places, with very little soil cover and typically, sparse grass tuft vegetation, with thorn trees lining the lower reaches where water runoff concentrates. The Gamka River appears as a mature, well established watercourse with well established vegetation.

There is very little erosion apparent over the property, due in part to the low rainfall and in part to the rocky terrain. The terrain undulates mildly creating valleys and ridges, some larger than others. Stormwater channels are clearly visible in all larger valleys. The site has the appearance of an undisturbed, natural environment, except for the powerlines and a localized borrow pit located close to the N12, with very little impact or modification from previous uses.
General view of site (looking North)

General view of site (looking East)
8.2 Climate

Beaufort West is located in the arid north-eastern region of the Great Karoo, experiencing typical extremes of temperature; summer highs of >40°C and winter lows of <-5°C. Summer rains occur mainly in Autumn (March). It has a Mean Annual Precipitation (MAP) of 234.5mm.

Typically, the sparse rainfall falls with a fairly high intensity, encountering generally hard terrain and often causing so called ‘flash flooding’.

8.3 Geology and soils

The site is underlain by bedrock of the lower Abrahamskraal Formation (1500m – 2000m thick) and upper Teekloof Formation (+-1400m thick) of the Beaufort Group.

This overlies the Ecca Group and Dwyka Formation, which make up the Karoo SuperGroup and were formed towards the end of the Permian Age, +-250 million years ago.

The Beaufort Group consists of alternating mudstone and sandstone beds, with dark grey shale exposed in places.
One location on site showed dolerite intrusions in a river bed, but these are generally located to the north of the site, closer to the escarpment.

Bedrock is close to the surface and foundations of the panel arrays will have to take this into account.

The soils on the site have been produced by rock weathering (typically, Mispah and Glenrosa forms, but these were not investigated).

Very little soil cover occurs on the rocky sandstone outcrops, but in the flatter plains and lower slopes, a silty sand was apparent (exposed in aardvark holes).

The majority of the channels that had been formed, showed weathered grey shale in their bottoms. Typically, the flash flooding, which would be prevalent on this site, would be initially severe enough to lift and transport the shale and deposit it out of suspension when flatter grades are reached.

This was considered to be / used as a clear indicator of a ‘defined channel’.

Grey shale channel bed
8.4 Geo-Hydrology

No geo-hydrological features were apparent on the surface of this site. No springs, seeps, or even wetter areas inside the borrow pit, gave any indication that there was any groundwater close to the soil surface.

There is an existing borehole water point, consisting of two concrete reservoirs and a plastic tank, powered by a small solar panel, situated at approximately the centre of the property. It feeds a drinking trough. However, no assessment of borehole function or chemical composition was carried out and therefore no verification of the Owners comment on the yield could be made. Typically, groundwater would be trapped in lenses within the rock (sandstone) layers approximately 100 to 200m below ground.

From evidence of the borehole water being suitable for animal consumption, it is likely that this water will be suitable for construction (concrete mixing).

The impact of this development on the groundwater would be limited to spillage from the construction and operational phases, which can be mitigated against with a comprehensive ‘environmental management plan’.

It should be noted that it is likely that further boreholes would be required. This would trigger a Water Use Licence Application in terms of the National Water Act and would have to be timeously applied for from the Department of Water Affairs.

8.5 Wetland Assessment

No wetland characteristics were visible on the property, except for the immediate area in and around the Gamka River. No investigation was however carried out on the site by the author.

It would appear however that due to the shallow presence of bedrock, the low rainfall and the short duration of storms, the water does not stay in the channels long enough to result in the formation of hydromorphic soils.

It may be important to engage the services of a wetland /freshwater specialist for the Impact Assessment portion of this process, in order to identify the impacts that the development might have on the Gamka River watercourse.
8.6 Hydrology

There are signs of ephemeral water flow throughout the site. This is indicative of a site where virtually all the Stormwater runoff is on the surface. Infiltration through the sub-strata however does occur, but the permeability of these layers is low (estimated at 1 x 10^-7 m/s) and occurs largely through cracks and fissures.

Due to the flatness of the terrain, sheet flow pre-dominates and only after a certain time concentrates enough to give rise to ‘channel’ flow. In all the larger valleys there is an obvious and defined channel, made up of a sandy/gravel bottom devoid of vegetation, with varying heights of banks.

In any storm, which is usually not of long duration or of high intensity, the runoff would accumulate slowly by meandering through the vegetation and rocks, until it accumulates and concentrates. At this point, a channel is formed, increasing in width as it meanders towards the Gamka River.

It would also appear that the storm events and associated stormwater run-off / flows are short and sharp, being able to suspend fine gravel (shale), transport it and deposit it once the grade on the channel has flattened. These gravel bottomed channels with defined banks were a clear indicator of the transition from the diffuse flows associated with sheet flow to the concentrated flows associated with channel flow. They became the clear indicator of when a ‘drainage path’ became a ‘watercourse’.

Start of a gravel channel
8.7 Constraints

The Hydrological constraints on the extent of development on this site are largely set by the physical location of the watercourses and the buffers that are recommended around them. This includes the Gamka River, which is a recognized National Freshwater Ecosystem Priority Area (NFEPA).

There were other types of constraints that were noticed and captured at the time of the site inspection and have been added to the spatial layout of the development area extent as supplementary information. These include the steep slopes of a number of ‘ridges’ or banks, the roughness of some of the terrain and the two existing electrical servitude areas, which currently protect the existing overhead powerlines traversing the site.

8.7.1 Watercourses

The National Water Act (Act 36 of 1998), (NWA), which is the primary statute providing the legal basis for water management in South Africa, requires authorization for certain activities / uses.

These are contained in Section 21 and the following particular uses are relevant to this site and in particular to defining the extents of the development area:

21 (c) impeding or diverting the flow of water in a watercourse
21 (i) altering the bed, banks, course or characteristics of a watercourse.

“Impeding the flow” means the temporary or permanent obstruction or hindrance to the flow of water in a watercourse by a structure built either fully or partially in or across a watercourse.

“diverting the flow” means a temporary or permanent structure causing the flow of water to be rerouted in a watercourse for any purpose.

“altering the bed, banks, course or characteristics” – means any change affecting the resource quality within the riparian habitat or 1:100 year floodline, whichever is the greater distance.

Defining a watercourse and applying suitable buffers to protect these resources and restricting development to exclude these
buffers, would negate the need for authorization. This is a desired outcome of this study.

The National Water Act defines a ‘watercourse’ as:

(a) a river or spring;
(b) a natural channel or depression in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which water flows; and
(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse as defined by the National Water Act, 1998 (Act 36 of 1998)

and a reference to a watercourse includes, where relevant, its bed and banks (corrected by Correction Notice 2 of 10 Dec 2010, GN No.R 1159)

The application of this on this project was the desired outcome of the site visit undertaken in September 2014.

Apart from the Gamka River, which is an obvious river and ‘watercourse’, the definitions (a), (c) and (d) were not encountered or apply on this site. The site was completely dry and arid, with no visible water.

(b) A natural channel or depression in which water flows regularly or intermittently, is therefore the issue that needs interpretation.

The NWA does not define a channel. Various definitions were consulted and all have a common interpretation:

- It is (well) defined
- It has a bed in which water flows
- It has sides or the channel is a ‘hollow’, implying a bed and sides (banks).

On site, it was clearly apparent that runoff initially collects by meandering through the grass tufts and rocks as sheet flow, the extent of which is determined by the topography, it’s grade and bed condition.
Meandering sheet flow

At a certain point, this flow concentrates into a natural route and forms a 'channel'. These are defined, have a bed and, initially no sides, but which become deeper and more defined with maturity.

Mature channel
A clear indicator of a defined channel was the bed condition, repeatedly consisting of loose weathered dark grey shale.

These defined channels, are, in my opinion, the start of ‘watercourses’ and have been used in this report as the constraint, with buffer, to define the edge of the development extent.

The location of these watercourses is recorded spatially on Drawing DROE-3 attached as Annexure 4.

### 8.7.2 Buffer Zones

Buffer zones generally protect the ecology of a water resource and vary in size in accordance with the sensitivity of the water resource and the risk the development imposes directly on it.

Buffer zones have been established for the watercourses on this property:

- To protect them as water resources;
- To establish a zone into which the development must not encroach;
- To alleviate the need for Authorization in terms of the NWA and ‘water use’;
- To protect the solar panel array supports from flood scour; and
- To protect bank edges and the small rivulets joining the main stream.

The buffer zones proposed take into consideration the hydrological parameters of each specific watercourse.

It corresponds approximately with where the 100yr floodline should rise to in a severe storm scenario. Although no calculations have been carried out as yet, the size of the channel is a good indication of the size of the catchment and quantity of water that could be expected.

Equally, although no “riparian habitat” was visible on site, any such riparian habitat is likely also to be related to the size of the channel and for the purposes of this hydrological report can be deemed to be captured sufficiently by the buffers proposed.

#### 8.7.2.1 Gamka River

The Gamka River, which traverses the site from east to west, is a National Freshwater Ecosystem Priority Area (NFEPA) river. As such, it should be assessed by a Freshwater Specialist as part of the Environmental Impact Assessment to classify the attributes of
its ecosystem and define the level of protection needed as a sensitive water resource.

This will define the buffer that is required either side of its banks.

According to the NFEPA Implementation Manual (WRC Report No. 1801/1/11-August 2011) a buffer of 100m from top of bank should be imposed, with refinement once an assessment has been carried out.

This has been shown on Drawing DROE-1 attached as Annexure D.

### 8.7.2.2 Site Watercourse Buffers

There is no legislation regarding required buffers around a watercourse in the NWA. The Act refers only to a 32m zone within which a development requires authorization in terms of water use. Our recommendation in this regard is addressed later but hydrologically the following buffers are recommended:

The drainage paths identified on site fall into four categories, established to simplify the imposing of appropriate buffers.

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<th>Table 8.7.2.2</th>
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<tbody>
<tr>
<td><strong>Type</strong></td>
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<tr>
<td>A Sheet flow</td>
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<tr>
<td>B Defined channel</td>
</tr>
<tr>
<td>C Defined channel</td>
</tr>
<tr>
<td>D Defined channel</td>
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</tbody>
</table>
Channel Type A  No Buffer

- Sheet flow
- No discernable channel
- No banks and no bed
- Slight historical flow indicators less than 1m wide
- Usually part of a whole area of such paths
- Not defined as a watercourse and no buffer required
Channel Type B  Buffer 10m from centerline

- Concentrated flows
- Defined channel
- Nil to slight banks
- Distinct bed less than 2m wide
- Buffer 10m from centerline

Channel Type B
Channel Type C  Buffer 10m from bank edge

• Concentrated flows
• Defined channel
• Banks 100mm to 500mm
• Distinct bed 2-5m wide
• Exposed bedrock in places
• Buffer 10m from bank edge
Channel Type D  Buffer 32m from bank edge

- Dry river bed
- Banks 200mm to 1000mm
- Shale and course sand bed
- Thorn trees and other sparse vegetation
- Buffer 32m from bank edge

The watercourses and buffer zones are shown spatially on drawing DROE-2 attached as Annexure E.
8.7.3 Slope and roughness of Terrain

In some instances there are slopes and very rough terrain on which it will be impossible to build arrays even though these arrays are self contained on separate foundations.

These areas have been identified and have been excluded from the development area.

They are shown on drawing DROE-1 attached as Annexure D.

9. Recommendations

9.1 Hydrologically, the development of this site as a solar energy facility should try as much as possible to retain the existing features and natural topography, without modification. A significant design parameter would be to not encroach into the existing drainage paths, watercourses and buffer zones.

This parameter is in line with the desired outcome of minimizing impact on water resources and the obtaining of authorization in terms of the NWA for ‘water use’ within a watercourse.

9.2 In terms of this report, we have recommended certain buffers to protect the watercourses, and in some instances, these are less than the 32m encroachment limit referred to in the National Environmental Management Act (Act 107 of 1998) (NEMA) triggering an environmental authorization.

NWA Authorization will be needed but we recommend that the authorization take the form of Section 22 (3):

‘A responsible authority may dispense with the requirement for a licence for water use if it is satisfied that the purpose of this Act will be met by the grant of a licence, permit or other authorization under any other law.’

In other words, if the process of assessment under the NEMA, grants an environmental authorization after a thorough process that includes an acceptance of reduced buffer zones, when appropriate, then a Letter from the Minister, being the responsible authority, shall suffice.

9.3 The Gamka River is a NFEPA river and as such needs to be assessed by a Freshwater Specialist to establish the impacts of the solar facility development. One of the outcomes of this assessment should be the establishment of a suitable ecological buffer. We recommend that this Specialist to appointed for the Impact Assessment phase of the environmental process in terms of NEMA.
9.4 Also, because the Gamka River is a NFEPA river, located within an existing Critical Biodiversity Area (CPA), we strongly recommend that an Integrated Water Use Licence (IWUL), which in our opinion, will definitely be required, be applied for as soon as possible to cover the construction of the parallel transmission line and pylons required to connect to the Droerivier Eskom Substation.

9.5 We recommend that the top of the banks of the Gamka River be established under a separate brief, as it will more than likely entail the calculation of the 1 in 100 yr return period floodline. The northern bank is at the moment undefined, being more part of the floodplain than a distinct bank.

9.6 We recommend that a Specialist Geo-Hydrologist be appointed to assess the abstraction of water from further boreholes, which may be required. The current boreholes do not appear to have sufficient yield for the construction phase of the development and possibly even for the operational phase, and thus other / alternative sources of water should be investigated.

9.7 We also recommend that a Specialist Geologist be appointed to assess the founding conditions for the development, in order to recommend that most viable method of founding the solar panel arrays.

9.8 Design Considerations and Mitigating Measures

- Due to the presence of shallow bedrock, lay down areas and platforms for buildings should be located on flat terrain utilizing fill rather than cut;
- Equally, infrastructure, cable routes, pipework etc. should be designed to be placed in the deeper soil areas;
- Consideration should be given to above ground cabling and concrete base construction to minimize excavation into the bedrock;
- These above-ground foundations and cableways must be aligned / designed in such a manner that they do not obstruct sheet flows of stormwater run-off.
- Consideration should be given to constructing the foundations for the solar panel arrays, as well as some of the other similar foundations, as cast in-situ drilled mini-piles rather than conventional bases. It will be a quicker, cheaper option, it will reduce the amount of blasting, rock excavation, the amount of spoil and the amount of concrete required.
- One of the requirements of development adjacent to a NFEPA river is that the post-development runoff into the receiving waters should not exceed the pre-development runoff. One way to do this is to implement attenuation at source on the site. Infield Rainwater Harvesting (IRWH) can be implemented at each of the arrays to attenuate the increased runoff from the panels in small coffers.
created with excess material from the foundation excavations. This can be developed at design stage.

- Stormwater management must be addressed at design stage and mitigating measures should be designed into the proposal to minimize impacts on downstream receiving waters and watercourses. Erosion protection, minimizing concentrated flows, limiting the development footprint, minimizing and planning vegetation clearing, limiting traffic around site, are some of the measures that can be implemented. These recommendations will be better defined with input from the various specialists and stakeholders during the EIR phase of the environmental process and included in the Environmental Management Programme (EMP).

9.9 No-go option

Due to the natural condition of the site (little erosion or modification) and accepting that there will be enough mitigating measures put in place during the development of the site to minimize the impact of the development on the receiving waters, no obvious benefit was noted or existing function protected, if the site was conserved from development as a solar facility. The impacts on the riverine system, hydrologically, will remain minimal.

10. Conclusion

If the existing natural hydrological features of the site can be kept largely unmodified, a development use of a Solar Facility for this property is considered acceptable.

By their nature, the development footprint of such a solar facility is surprisingly small and hydrologically, if this footprint could be kept outside of the features (outside the buffer zones), the functionality of the natural systems would remain intact.

Runoff co-efficients would remain similar, due to the array support spacing and the little increase in runoff concentration, due to the panels themselves and the development of the relatively few structures, could be mitigated against.

The impact on the NFEPA river, the Gamka, can be minimized, keeping in line with the principles of such a protected area, which is to keep the integrity and state of the river intact, post-development.
11. References


11.3 City of Cape Town: Roads and Stormwater Department: Catchment, Stormwater and River Management Branch: ‘Floodplain and River Corridor Management Policy’ (May 2001)


12. Annexures

Annexure A: Locality Plan

Annexure B: 1 : 50 000 Topographical Map (extract 3222BC)

Annexure C: 1 : 50 000 NFEPA Plan

Annexure D: DROE-1 (A0) Assessment Outcomes (Watercourses, Buffer Zones and Development Area Extents)

Annexure E: DROE-2 (A3) Watercourses and Buffer Zones

Annexure F: DROE-3 (A3) Development Area Extents
WATERCOURSES LESS THAN 2m WIDE
10m BUFFER ON CENTRELINE

WATERCOURSES 2-5m WIDE
15m BUFFER FROM BANK EDGE

WATERCOURSES GREATER THAN 5m WIDE
32m BUFFER FROM BANK EDGE
DEVELOPMENT CONSTRAINTS AREA = 367.4Ha