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The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study: Raw Water

ENGINEERING FEASIBILITY DESIGN REPORT

WRITE UP 3: SITE INVESTIGATION FOR THE POSITIONING OF GAUGING WEIRS

FINAL

OCTOBER 2014

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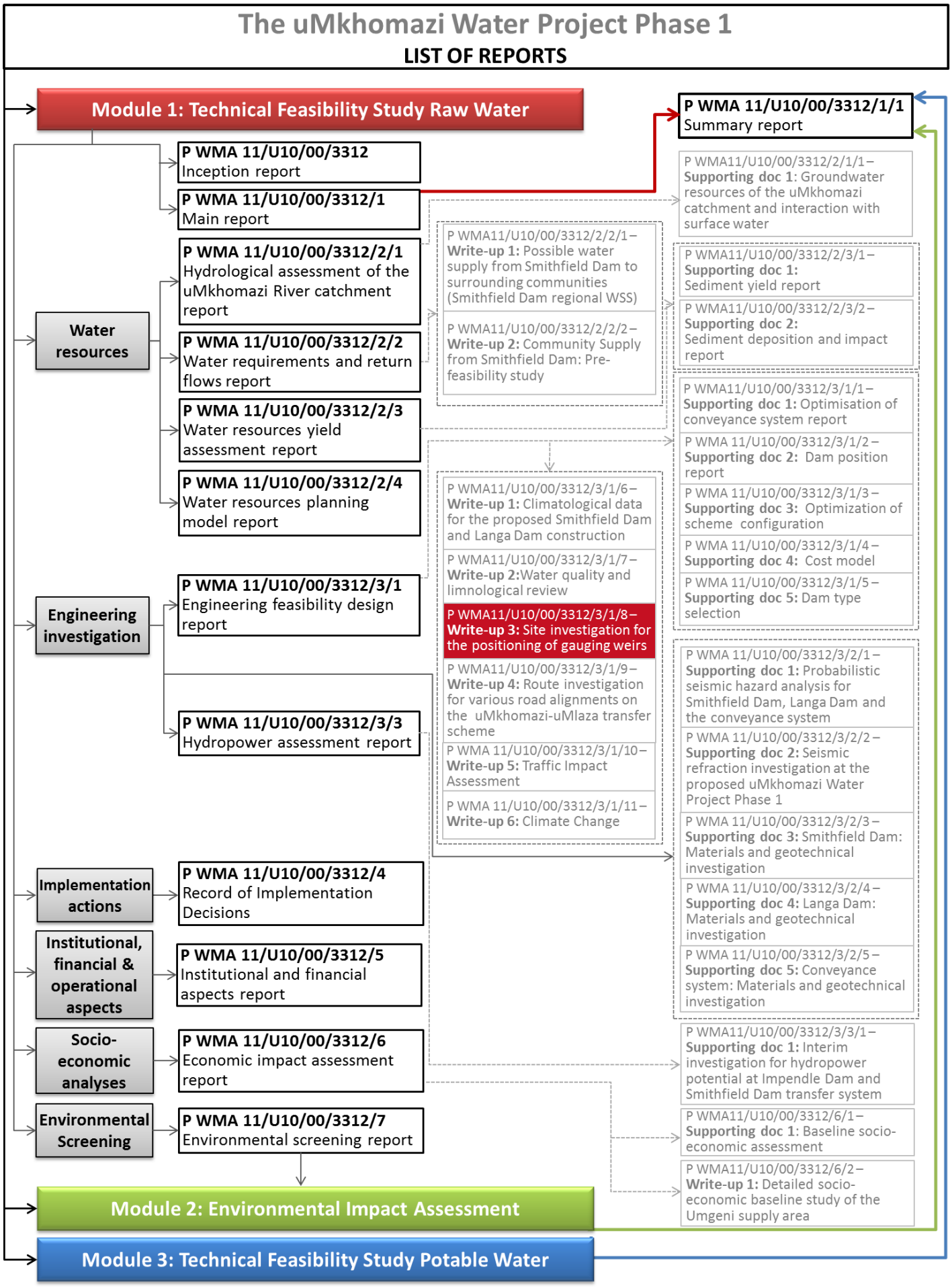
PREAMBLE

In June 2014, two years after the commencement of the uMkhomazi Water Project Phase 1 Feasibility Study, a new Department of Water and Sanitation was formed by Cabinet, including the formerly known Department of Water Affairs.

In order to maintain consistent reporting, all reports emanating from Module 1 of the study will be published under the Department of Water Affairs name.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BKS	Legacy BKS (Pty) Ltd, now AECOM SA (Pty) Ltd
DM	District Municipality
D:NWRP	Directorate: National Water Resource Planning
DWA	Department of Water Affairs
EWR	Ecological Water Requirements
FSL	Full Supply Level
IFR	Instream Flow Requirements
KZN	KwaZulu-Natal
LM	Local Municipality
MAR	Mean Annual Run-off
MMA	Mogoba Maphuthi and Associates
MMTS	Mooi Mgeni Transfer Scheme
RSA	Republic of South Africa
uMWP	uMkhomazi Water Project
uMWP-1	uMkhomazi Water Project – Phase 1
uMWP-2	uMkhomazi Water Project – Phase 2

LIST OF UNITS

m	metre
km	kilometre
m^3	cubic metre

1 INTRODUCTION

The Department of Water Affairs appointed **BKS (Pty) Ltd** in association with three sub-consultants **Africa Geo-Environmental Services, MM&A and Urban-Econ** with effect from 1 December 2011 to undertake the **uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study Raw Water** study.

On 1 November 2012, BKS (Pty) Ltd was acquired by **AECOM Technology Corporation**. As a result of the change in name and ownership of the company during the study period, all the final study reports will be published under the AECOM name.

In 2010, the Department of Arts and Culture published a list of name changes in the Government Gazette (GG No 33584, 1 October 2010). In this list, the Mkomazi River's name was changed to the **uMkhomazi River***. The published spelling will thus be used throughout this technical feasibility study.*

1.1 BACKGROUND TO THE PROJECT

The current water resources of the Mgeni system are insufficient to meet the long-term water requirements of the system. The Mgeni System is the main water source that supplies about five million people and industries in the eThekwini Municipality, uMgungundlovu District Municipality (DM) and Msunduzi Local Municipality (LM), all of which comprise the economic powerhouse of the KwaZulu-Natal Province.

The Mgeni System comprises the Midmar, Albert Falls, Nagle and Inanda Dams in KwaZulu-Natal, a water transfer scheme from the Mooi River and the newly constructed Spring Grove Dam. The current system (Midmar, Albert Falls, Nagle and Inanda Dams and the MMTS-1) has a stochastic yield of 334 million m³/annum (measured at Inanda Dam) at a 99% assurance of supply. The short-term augmentation measure, Phase 2 of the Mooi Mgeni Transfer Scheme (MMTS-2), currently being implemented with the construction of Spring Grove Dam, will increase water supply from the Mgeni system by 60 million m³/year. However, this will not be sufficient to meet the long-term water requirements of the system.

Pre-feasibility investigations indicated that Phase 1 of the uMkhomazi Water Project (uMWP-1), which entails the transfer of water from the undeveloped uMkhomazi River to the existing Mgeni system, is the scheme most likely to fulfil this requirement. The uMkhomazi River is the third-largest river in KwaZulu-Natal in terms of mean annual runoff (MAR).

Eight alternative schemes were initially identified as possible alternatives, and the Impendle and Smithfield scheme configurations have emerged as suitable for further investigation. The pre-feasibility investigation, concluded in 1998, recommended that the Smithfield scheme be taken to a detailed feasibility-level investigation as its transfer conveyances would be independent of the existing Mgeni System, thus reducing the risk of limited or non-supply to eThekwini and some areas of Pietermaritzburg, and providing a back-up to the Mgeni System.

The ***Mkomazi-Mgeni Transfer Pre-feasibility Study*** concluded that the first phase of the uMWP would comprise a new dam at Smithfield on the uMkhomazi River near Richmond, a multi-level intake tower and pump station, a water transfer pipeline/tunnel to a balancing dam at Baynesfield or a similar in-stream dam, a water treatment works at Baynesfield in the uMlaza River valley and a gravity pipeline to the Umgeni bulk distribution reservoir system, below the reservoir at Umlaas Road. From here, water will be distributed under gravity to eThekwini and possibly low-lying areas of Pietermaritzburg. Phase two of the uMWP may be implemented when needed, and could comprise the construction of a large dam at Impendle further upstream on the uMkhomazi River to release water to the downstream Smithfield Dam. Together, these developments have been identified as having a 99% assured stochastic yield of about 388 million m³/year.

The DWA aims to have this scheme implemented by 2022.

1.2 STUDY AREA

The study focus and key objective is related to the feasibility investigation of the Smithfield Dam and related raw water conveyance infrastructure. However, this is a multi-disciplinary project with the study area defined as the uMkhomazi River catchment, stretching to the north to include the uMngeni River catchment (see **Figure 1.1**). The various tasks have specific focus area, defined as:

- Water Resources: uMkhomazi and Mgeni River catchments;

- Water requirements: Water users in the Mgeni System and the uMkhomazi River catchment;
- Engineering investigations: Proposed dams at Impendle (only for costing purposes) and Smithfield, and the raw water conveyance infrastructure corridor between Smithfield Dam and the Water Treatment Plant of Umgeni Water;
- Environmental screening as input for the Environmental Impact Assessment; and
- Socio-economic impact assessment: Regional, provincial (KwaZulu-Natal (KZN)) and national.

1.3 OBJECTIVE, SCOPE AND ORGANISATION OF THE STUDY

According to the Terms of Reference (November 2010), the objective of the study project is to undertake a feasibility study to finalise the planning of the proposed uMkhomazi Water Project (uMWP) at a very detailed level for the scheme to be accurately compared with other possible alternatives and be ready for implementation (detailed design and construction) on completion of the study.

The feasibility study has been divided into the following modules, which will run concurrently:

- Module 1: Technical Feasibility Raw Water (DWA) (*defined below*);
- Module 2: Environmental Impact Assessment (DWA); and
- Module 3: Technical Feasibility Potable Water (Umgeni Water) (*ranging from the Water Treatment Plant to the tie-in point with the eThekwini distribution system*).

This module, the raw water technical feasibility study, considers water resources aspects, engineering investigations and project planning and scheduling and implementation tasks, as well as an environmental screening and assessment of socio-economic impacts of the proposed project.

Some specific objectives for this study, recommended in the Mkomazi-Mgeni Transfer Scheme Pre-feasibility are listed below:

- Smithfield Dam (Phase 1) to be investigated to a detailed feasibility level;
- Investigate the availability of water from Impendle Dam (Phase 2) as a future resource to release to Smithfield Dam, and refine the phasing of the selected schemes;

- Optimise the conveyance system between Smithfield Dam and the proposed Baynesfield Water Treatment Plant;
- Undertake a water resources assessment of the uMkhomazi River catchment, including water availability to the lower uMkhomazi;
- Evaluate the use of Baynesfield Dam as a balancing dam; and
- Investigate the social and economic impact of the uMWP.

The raw water feasibility study constitutes Module 1 (of three modules) of this overall study that is being undertaken in close collaboration with the DWA, Umgeni Water and the Professional Services Providers (PSPs) of the other modules.

1.4 BACKGROUND TO THIS REPORT

In order to achieve the objectives of the study, as stated above, gauging weirs were required on the river system to measure the total flow of the river at various strategic locations. Flow measurement is important downstream of dams to measure total dam releases and spills, as well as in open river sections to ensure sufficient water flows through the downstream river reaches.

After discussions with Dr Pieter Wessels (DWA) three potential locations for gauging weirs were identified. Dr Wessels also provided recommended sites at each of these locations based on a desktop study of the area. Three weirs are to be constructed to measure the flow of the river at the following locations:

a) Location 1

This site will be below the proposed Impendle Dam. The weir at location 1 will be used to determine the ***inflow*** to the proposed Smithfield Dam for operational purposes (i.e. timing & magnitude of EWR releases and accounting for incremental flows when making releases from Impendle Dam). This gauging station will replace the existing station which will be inundated by the construction of Smithfield Dam.

b) Location 2

This site is situated below the proposed Smithfield Dam and is to be constructed to determine the ***discharges (i.e. spills and releases)*** from Smithfield Dam for application in the dam balance.

c) Location 3

The third gauging weir will be constructed further downstream, near Hella Hella, with the intent being to determine the ***runoff from the incremental catchment*** downstream of Smithfield Dam to account for this in determining the magnitude of EWR releases from Smithfield Dam.

All of the proposed weir locations are shown in **Figure 1.2**.

Following discussions with Dr Wessels a site investigation was scheduled and this report documents the findings of that investigation.

1.5 SCOPE OF THIS REPORT

This report presents the details regarding the positioning of the proposed gauging weirs for the uMWP. After visiting potential sites on 30th and 31st January 2014, the locations for the gauging weirs were determined.

The report gives details of each of these locations and the possible sites for gauging weirs within them. The discussion on the sites includes the reasons for choosing that site, the potential drawbacks of each of the sites and the recommended specific position for construction of the weirs.

Topographical surveys of the three areas have been conducted and the results of these are to be used in the feasibility design of the weirs and do not form a part of this report.

A full geotechnical investigation has not as of yet been conducted on the three gauging weir locations, this will be done during the detailed design phase of the weirs. For each of the sites visited some comment has been made on the visible surface materials, however, these comments might be overridden by the insight gained from geotechnical investigation.

The use of telemetry at the weirs will be investigated further during the design phase and does not form a part of this report.

Figure 1.1: Locality map of the uMWP study area

1.6 LOCATION OF POTENTIAL SITES

Three gauging weir positions were identified from the site investigation. These were, as indicated in **Figure 1.2**, (1) downstream of Impendle Dam, (2) downstream of Smithfield Dam and (3) near Hella Hella.

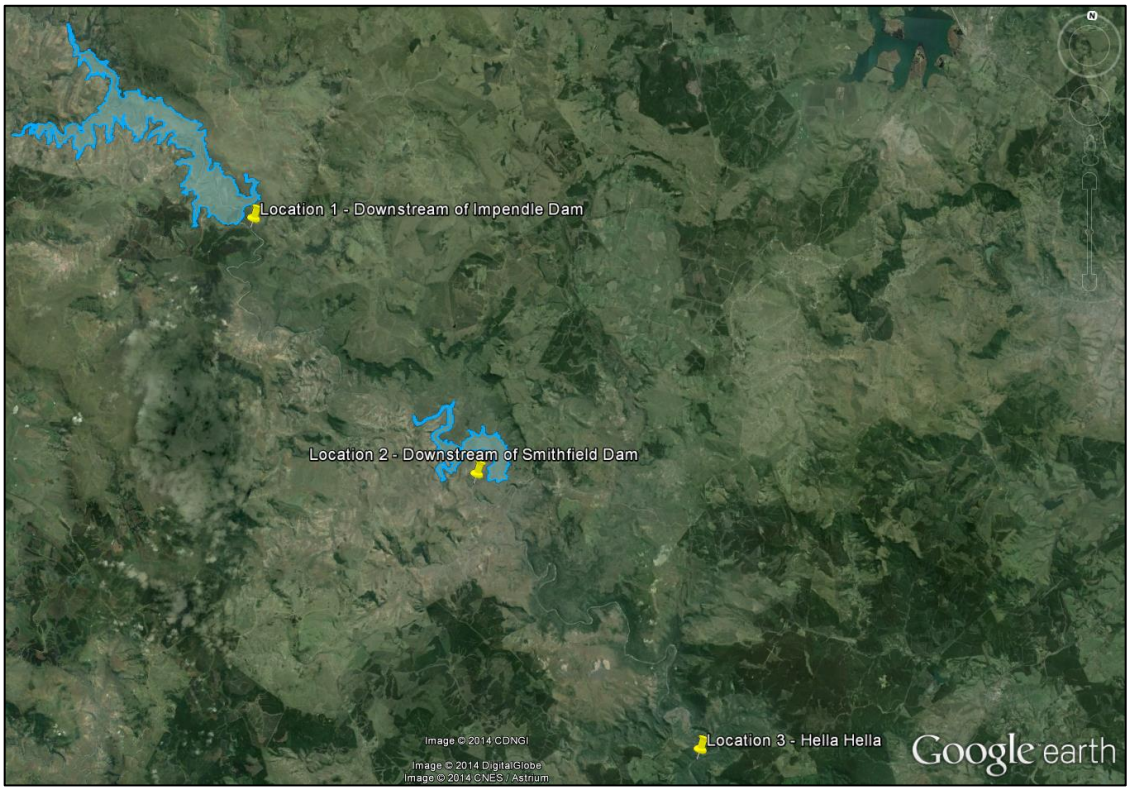

Figure 1.2 Proposed locations of gauging weirs

1.6.1 Choosing of suitable sites

When selecting a site for a gauging weir the most important aspects to consider, as presented in the *Manual for the planning design and operation of river gauging stations (Van Heerden, et al., 1986)*, are as follows:

- good foundation conditions;
- steep slope downstream from the site and a gradual to flat slope upstream;
- a bend in the river, upstream and downstream, must be avoided to facilitate straight flowlines over the weir (approach channel should be 4 to 5 times the channel width at design capacity);
- additional streams or tributaries entering the river system upstream of the weir are undesirable as these distort the flow readings;
- the river banks must be stable; and

- easy access to the site is advisable.

During the selection of the sites at each of the three locations it was preferable to have the site which would allow for the least amount of disturbance of the natural environment - both during construction as well as after. Thus, sites with existing roads and sites which would not require extensive bush clearing were preferred. Ultimately, however, the measuring of flows is the primary reason for the weirs and, within reason, optimal flow reading conditions should be prioritised.

2 LOCATION 1 – DOWNSTREAM OF IMPENDLE DAM

2.1 DETAILS

Three potential sites within the first 1.5 km immediately downstream of the proposed Impendle Dam were investigated. However, one of these was discarded as there was a stream flowing directly onto the site (indicated in **Figure 2.1**) which would have made construction at this site very difficult as well as impacting on the natural environment surrounding the stream. Thus, the other two sites with coordinates 29°39'8.92"S; 29°46'29.65"E and 29°39'23.79"S; 29°46'48.66"E, respectively, are discussed in detail and the preferred site identified in this section. **Figure 2.1**, included below, shows the location of the two sites to be discussed in the following text as well as showing the full supply level (FSL) of Impendle Dam, in blue.

Figure 2.1 Potential sites downstream of Impendle Dam showing stream flowing into river from the left bank

2.2 SITE 1

2.2.1 Access

Ease of access to the site is an important factor to take into consideration when selecting a site. The access roads will be used heavily during construction as equipment, materials and machinery are transported to and from the site. It is also linked closely to the overall impact that the construction of the weir would have on the environment, as if there is an existing road no extra clearing of virgin landscape would be required.

When visiting site 1 of location 1 it was found that there were existing access roads to the site. These were good quality dirt roads and ran through the Sappi plantation located on the right side of the uMkhomazi River. One of these roads is situated approximately 100 m from the river along the bottom end of the plantation, as shown in **Figure 2.1**, at coordinates 29°39'10.94"S 29°46'25.53"E. This road would require upgrading before construction could take place, but would not require a complete overhaul. Additional roads would need to be constructed down the bank to the riverside.

Access to the left bank would be more difficult as the existing roads, which service a small number of dwellings (**Figure 2.1**), are approximately 650 m from the river at coordinates 29°39'07.64"S 29°47'06.04"E and the conditions of these roads are unknown. Either extensions to the existing road would be required or a temporary bridge should be constructed from the right hand side so as to provide access across the uMkhomazi River. Construction would need to be completed during the low-rainfall winter months.

2.2.2 River characteristics

Figure 2.2 shows the site as viewed from the right bank downstream of where the weir would be constructed. At the site the river is about 30 m wide and has a flat section upstream of approximately 140 m leading up to the rocks and aerated water, as seen in **Figure 2.2**. The aerated water is usually an indication that there is an increase in the slope of the river bed, which would assist in avoiding submergence of the weir.

There is, however, a bend in the river, as seen at the top of **Figure 2.2**, prior to the 140 m straight section and this could possibly impact on the streamlines and

velocity distribution across the channel. The guideline given by *Van Heerden, et al. (1986)* states that the approach channel should be 4 to 5 times the channel width at design capacity, thus, the 140 m straight pool should be sufficient.

Figure 2.2 Downstream of Impendle – Site 1 control section taken from the right bank

2.2.3 Local Site Conditions

Figure 2.3 indicates a substantial amount of exposed rock at the start of the rapids and on the side banks of the river. Thus, it is assumed that there would be good foundation material available at this point in the river.

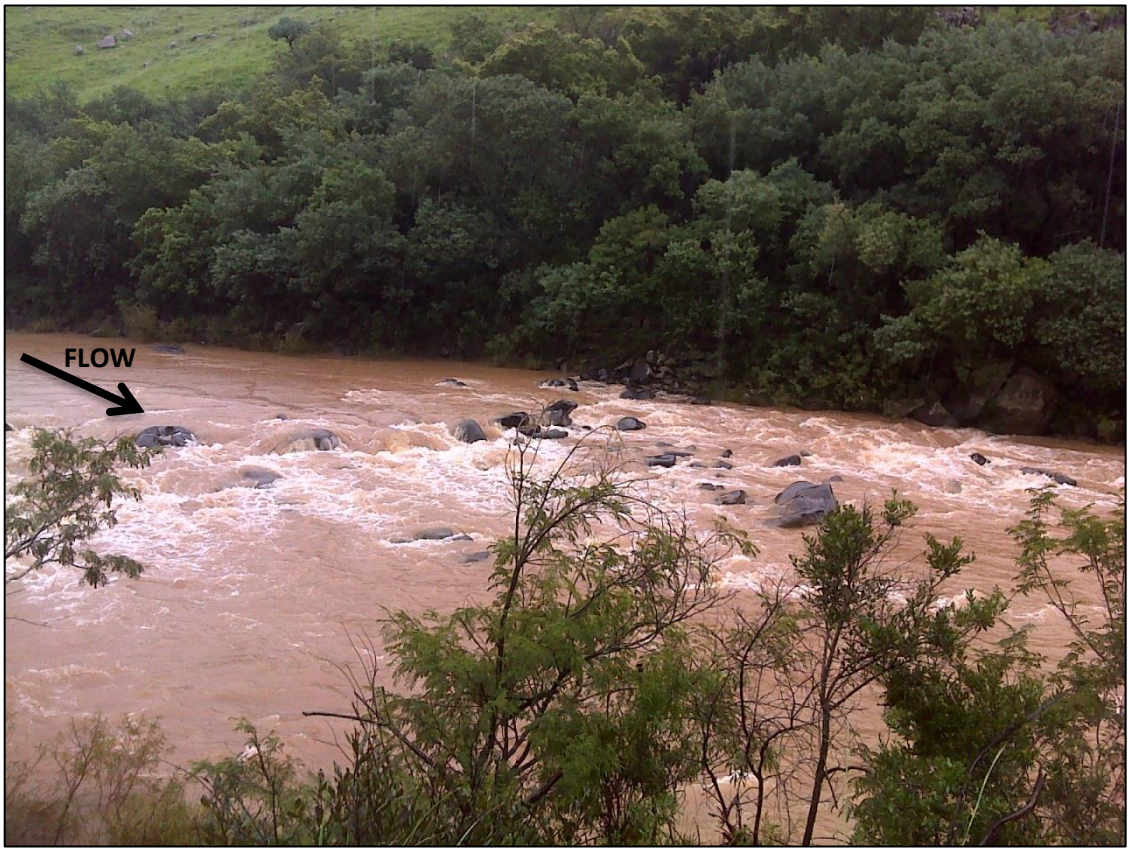

Figure 2.3 Downstream of Impendle – Site 1 showing exposed rock, rapids and an increase in the slope of the river bed from the right bank

2.3 SITE 2

2.3.1 Access

The accessibility of the second site is the same as that of the first with existing access roads on the right bank found at 29°39'10.94"S 29°46'25.53"E approximately 100 m from the uMkhomazi River. Access roads on the left bank are further from the river and untested, these roads can be found at coordinates 29°39'07.64"S 29°47'06.04"E.

2.3.2 River Characteristics

Figure 2.4 shows the site as viewed from the right river bank, the site was found to be approximately 30 m wide. There is a straight section of river from a control section, which would be inundated, approximately 130 m long leading up to the proposed site. The river is also straight for approximately 350 m prior to that control point. After the proposed position of the weir the river does increase in slope which would assist with avoiding submergence of the weir.

Figure 2.5 shows the view upstream the river from the proposed site 2. This shows, once again, the straight section leading up to the proposed weir position and the consistent and developed flow profile of the water as it approaches the site.

Figure 2.4 Downstream of Impendle Dam – Site 2 located at the control point on the right, as viewed from the right bank

Figure 2.5 View upstream from proposed Site 2 – downstream of Impendle Dam

A negative aspect about the site is that there is a stream joining the main river channel upstream of where the weir would be constructed as can be seen in **Figure 2.6** and **Figure 2.1**. In **Figure 2.1** the catchment area, of approximately 6.3 km^2, of this stream is visible. The problem with the stream is that it would impact on the ability of the weir to accurately determine the discharge leaving the future Impendle Dam as there would be additional flows entering the river system downstream of the dam. **Figure 2.4** indicates that there may be another, albeit small, stream entering the river at this site, but this should be downstream of where the weir would be constructed.

Figure 2.6 Downstream of Impendle Dam- Sites 1 and 2

2.3.3 Local site conditions

Figure 2.7 and **Figure 2.8** show the presence of rock material on both sides of the river. This is a good indication that there would be good founding material for the construction of a weir.

Figure 2.7 Downstream of Impendle Dam - Site 2 exposed rock in river channel

Figure 2.8 Downstream of Impendle Dam - Site 2 exposed rock in river channel and on river bank

2.4 SELECTION OF SITE 1

Site 1 has been selected as the preferred location for the construction of the gauging weir downstream of Impendle Dam at coordinates 29°39'8.92"S 29°46'29.65"E.

2.4.1 Discussion

Both sites have decent accessibility and a good presence of rock material in the river banks and channel, particularly in the case of the second site. The channel leading up to the site 2 is straighter for a longer distance which could possibly result in a better flow profile, however, as there is a stream running into the river before site 2; site 1 would be able to determine the discharges from Impendle Dam more accurately.

The construction costs of both sites would be similar as both are approximately 30 m wide and have quite steeply sloping banks on which to build. The environmental impact of the sites would be very similar as the same access road would be used for both sites and this road runs 100 m from the river. Additionally, both sites have a fair covering of natural bush along the water's edge.

The biggest difference between the sites is the presence of the stream which would distort the reading at site 2. Thus, site 1 is the preferred site for this location.

The centreline of the site selected for survey has been included below as **Figure 2.9**.

Figure 2.9 Downstream of Impendle Dam – Site 1 showing centreline to be surveyed

3 LOCATION 2 – DOWNSTREAM OF SMITHFIELD DAM

3.1 DETAILS

At Location 2, which is located downstream of Smithfield Dam a gauging weir was required in order to measure the total flows leaving the dam, inclusive of releases and spills up to 300 mm above the FSL of the dam – above which point the spillway is able to accurately measure the flow.

Two sites were examined within the first 2 km downstream of Smithfield Dam and these can be seen in **Figure 3.1**, below, as can the FSL (930 masl) of Smithfield Dam which is drawn in blue. The sites are at coordinates 29°46'53.09"S 29°55'52.70"E and 29°47'11.91"S 29°55'53.11"E, respectively. It was desirable to be as close to the dam as possible, this meant that the first straight section after the wall was also examined. This position, however, will become the plunge pool for the chute from the dam and thus, could not be considered further.

Figure 3.1 Possible locations of proposed gauging weir downstream of Smithfield Dam

3.2 SITE 1

3.2.1 Access

The accessibility of the site is an important aspect as it can significantly reduce the construction costs and time. Access to this site is good as there are roads which run close to the uMkhomazi River on the left hand side which can be seen at coordinates 29°46'36.87"S 29°56'04.00"E. These existing roads, however, will have to be upgraded and extended (± 600 m) to the weir for access to the river. With the Smithfield Dam being quite close (±1.3 km up river) to the proposed weir position, access is not viewed as being too much of an issue, as construction roads will already be in place for Smithfield Dam.

Access to the right side of the river would need to be achieved by constructing a temporary bridge from the left side of the river. This is necessary because the closest road on the right hand side is near the top of a high bank, approximately 900 m away, at coordinate 29°46'47.97"S 29°55'21.63"E. Construction would need to take place during the low-rainfall winter months to allow for access across the river and the construction of the weir in the river.

3.2.2 River Characteristics

Figure 3.2 shows the site from the left bank of the river. This image shows that the river has a straight section – which is approximately 250 m long – leading up to the proposed site, at which point the river is approximately 50 m wide. **Figure 3.2** also shows that there is a stream running into the river channel upstream of the proposed site 1, also visible in **Figure 3.4**. As the position of site 1 is the most upstream of the sites, situated ±1.3 km downstream of Smithfield Dam, this stream is unavoidable for all of the sites in this area. The stream does, however, appear to have a very small catchment – only inclusive of the bank on which it is positioned – thus, resulting flows should be minimal.

Figure 3.3 indicates that immediately downstream of the chosen site the bed slope of the river increases slightly, accelerating the water. This would help to reduce the chances of inundation.

Figure 3.2 Downstream of Smithfield Dam – Site 1 viewed from the left bank

Figure 3.3 Downstream of Smithfield Dam – Site 1 viewed from river level on the left side showing some exposed rock and an increase in the bed slope

3.2.3 Local site conditions

Some surface rock boulders are present at the site, however, these are generally quite small (±150 mm in diameter). **Figure 3.4** shows the exposed rock on the right bank, as well as erosion which is taking place on that bank. The presence of erosion may indicate that there may be considerable excavation required in order to find suitable rock foundation material. However, further geotechnical studies would need to be conducted before this could be confirmed.

Figure 3.4 Downstream of Smithfield Dam – Site 1 view from left bank showing erosion on right bank and stream entering river above site

3.3 SITE 2

3.3.1 Access

The accessibility of the second site downstream of Smithfield Dam was similar to that of the first which can be seen at coordinates 29°46'36.87"S 29°56'04.00"E, the difference being that the road extension required would need to be approximately 1.1 km (not 600 m) and would have to take into account slightly

steeper banks than site 1. Additionally, the road would cover more virgin territory than for site 1.

3.3.2 River characteristics

As can be seen in **Figure 3.5** there is a straight approach channel, approximately 150 m long, leading up to the proposed site 2. There is a bend, however, just before this which is visible in **Figure 3.6**.

In addition to the stream flowing into to the river upstream of site 1, there is a stream with a slightly larger catchment which flows into the river channel between site 1 and site 2. This stream could lead to inaccuracies when attempting to measure the discharge from the dam.

Figure 3.5 Downstream of Smithfield Dam – Site 2 viewed from top of left bank

Figure 3.6 Downstream of Smithfield Dam – Site 2 viewed from top of left bank

3.3.3 Local site conditions

At site 2 the river is slightly wider (±60 m) than site 1, although the steeper banks would suggest that there may be less excavation required in order to find good founding rock on which to construct. The width of the site suggests that the straight length of pool leading up to it may be slightly too short to meet the guidelines as set out by *Van Heerden, et al. (1986)*. **Figure 3.7** shows exposed rock face seen on the right bank of the river approximately 60 m upstream of the proposed site 2 indicating again that excavation may be easier at site 2.

Figure 3.7 Downstream of Smithfield Dam – Site 2 showing exposed rock face on the right bank upstream of the proposed site

3.4 SELECTION OF SITE 1

Site 1 has been selected as the preferred location for the construction of the gauging weir downstream of Smithfield Dam at coordinates 29°46'53.09"S 29°55'52.70"E.

3.4.1 Discussion

Accessibility for the two sites is similar, with site 1 being marginally easier to access due to it having a closer proximity to the existing roads and the proposed Smithfield Dam.

There is not a large amount of exposed rock at either site, although on the banks there are larger rocks than what is seen in **Figure 3.3**. Upstream of site 2 there is some exposed rock face on the right bank, indicating that site 2 may require less excavation than site 1, although further analysis would be required.

The stream that enters the river in between the two sites and the length of the straight pool leading up to site 2 are the reasons site 1 has been selected. Additionally, there would be a larger impact on the local environment during the construction of site 2 as the road to the site would be longer and would have to run very close to the uMkhomazi River. Site 2 is also wider than site 1 implying that there may be additional construction costs at this site, however, these costs

could also be impacted by the foundation materials and amount of excavation required which could only be confirmed after a full geotechnical investigation.

The centreline of the site selected for survey has been included below as **Figure 3.8**.

Figure 3.8 Downstream of Smithfield Dam – Site 1 showing centreline to be surveyed

4 LOCATION 3 – HELLA HELLA

4.1 DETAILS

The third gauging weir was required to determine the runoff from the incremental catchment downstream of Smithfield Dam, to account for this in determining the magnitude of EWR releases from the dam. Three sites were examined at this location near Hella Hella, along the uMkhomazi River. The furthest downstream (site 3) being ±2.5 km downstream of the bridge next to site 1 as shown in **Figure 4.1** and **Figure 4.2**. The coordinates of the sites are 29°54'26.72"S 30° 5'39.28"E (site 1), 29°55'2.93"S 30° 5'28.76"E (site 2) and 29°55'12.31"S 30° 5'14.26"E (site 3). Also indicated on **Figure 4.1** are the access roads and the uMkhomazi River IFR/EWR site 2 that has been selected as part of the *Mkomazi IFR Study (IWR Environmental, 1998)*.

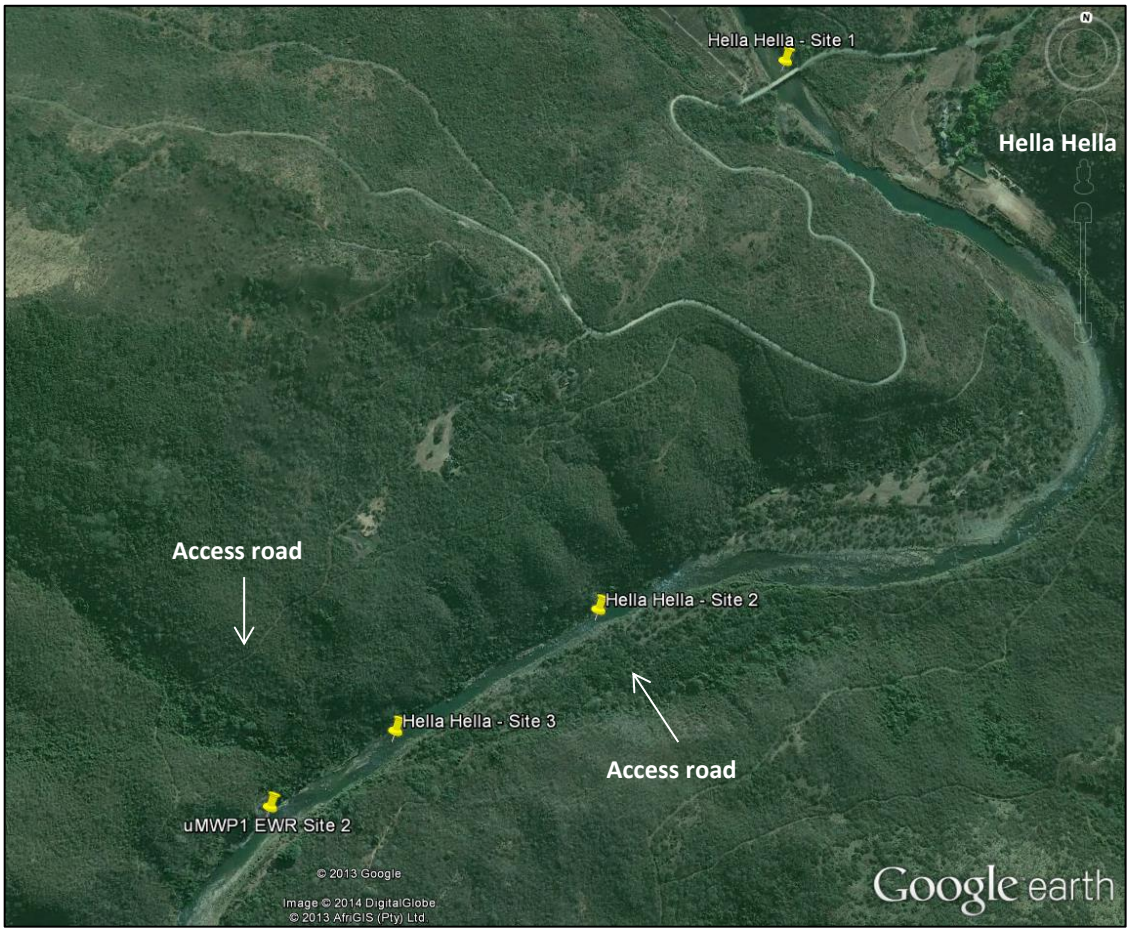

Figure 4.1 Possible locations of Hella Hella gauging weir

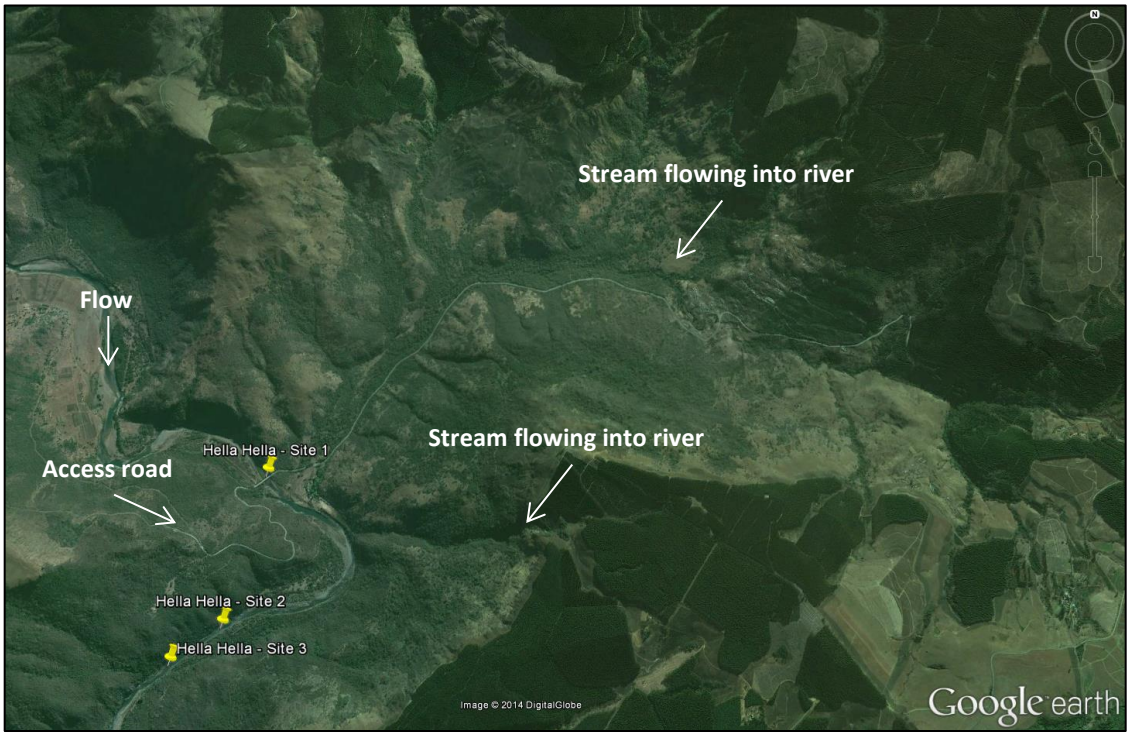

Figure 4.2 Possible locations for Hella Hella gauging weir and streams flowing into the river below site 1

4.2 SITE 1

4.2.1 Access

As mentioned previously, the accessibility of the site is an important part of the selection process. Site 1 is located immediately upstream of the main road crossing the river (at coordinates 29°54'26.72"S 30° 5'39.28"E), which is clearly visible in **Figure 4.1** – this should make accessing the site easy from either side of the river. However, short additional roads would be required to the exact point of construction.

4.2.2 River characteristics

At the proposed location of the weir the uMkhomazi River is about 50 m wide and there is a long straight section of about 230 m leading up to the site (as seen in **Figure 4.3**) and, thus, the flow profile should be steady and fully developed.

Figure 4.4 shows a control point downstream of the proposed site, this would assist in avoiding inundation of the weir.

Figure 4.3 Hella Hella – Site 1 viewed from the bridge looking upstream

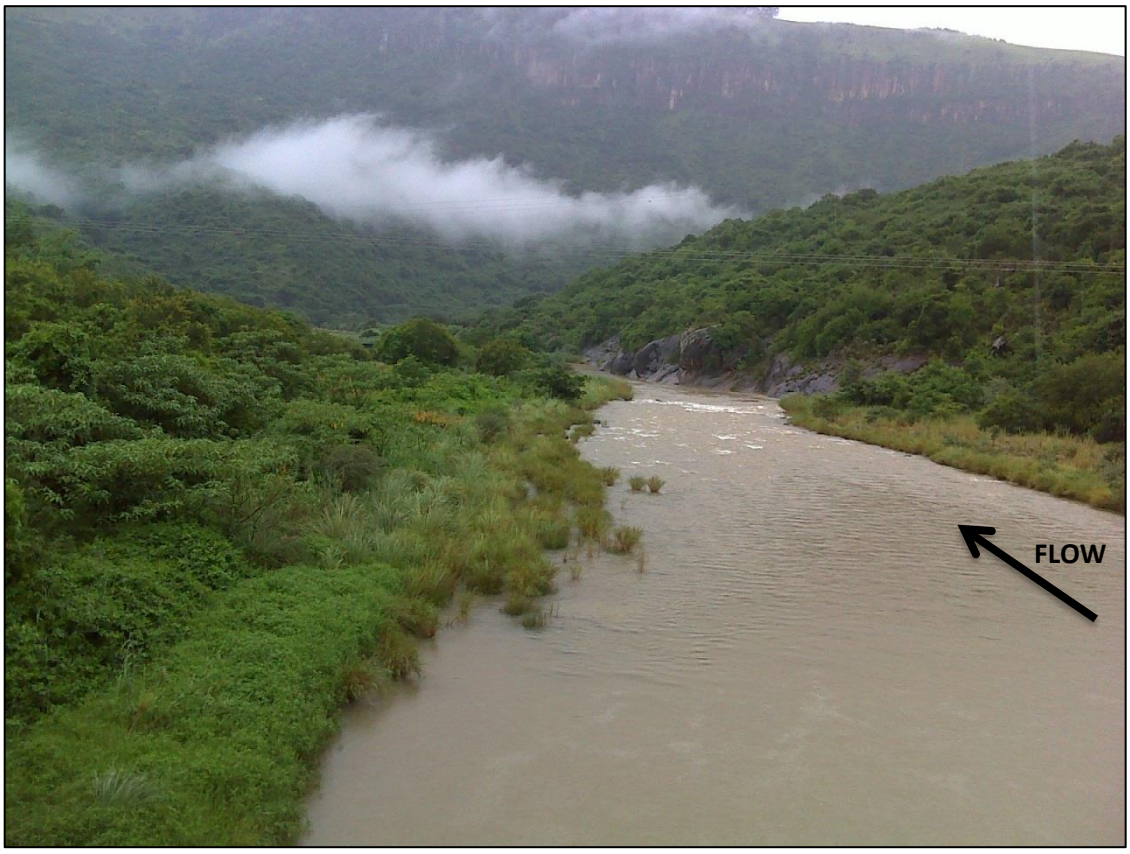

Figure 4.4 Hella Hella – Site 1 looking downstream from the bridge showing control point

4.2.3 Local site conditions

There was no visible rock at site 1; however, as there is already a bridge constructed at this point which suggests the presence of good foundations.

4.3 SITE 2

4.3.1 Access

Access to the left bank of site 2 is more difficult than site 1. There is a road which passes through Hella Hella and runs through the natural bush about 50 m from the river at coordinates 29°54'04.60"S 30°05'31.03"E. This road would require some clearing of the bush as well as an extension to connect it to the river.

Access to the right bank could be possible from a road shown on Google Earth, **Figure 4.1**, which is situated approximately 300 m from the river. This should, however, be investigated further as the roads has not yet been explored and the river banks may be too steep for construction of an access road to the river. Alternatively, a temporary bridge crossing from the left bank could be constructed during the construction phase of the project.

4.3.2 River characteristics

The river at the position of this site is approximately 20 m wide and has a straight section leading up to the site of more than 200 m, however, there is a section of aerated water approximately 100 m upstream of site 2 as seen in **Figure 4.5**. At the site there is also a small section of aerated water (**Figure 4.6**) and the bed slope increases; this would assist with avoiding inundation of the weir.

Figure 4.5 Hella Hella – Site 2 looking upstream from site

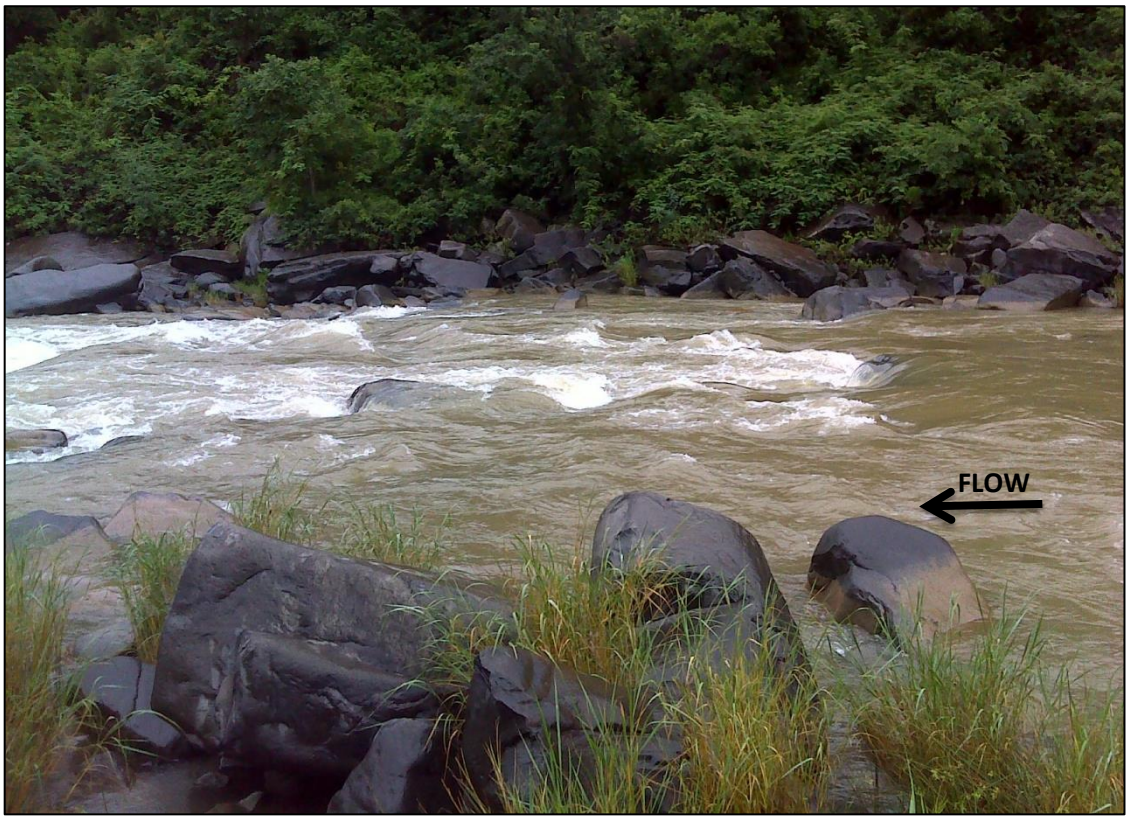

Figure 4.6 Hella Hella – Site 2 existing rapid and exposed rocks looking from left river bank

4.3.3 Local site conditions

As seen in **Figure 4.6**, there is a considerable amount of exposed rock at this location. This material could be useful during construction of the weir.

4.4 SITE 3

4.4.1 Access

Access to site 3 is similar to that of site 2, further upgrading of the existing road would be required, as the site is further downstream at coordinates 29°55'14.01"S 30°05'18.89"E. Additionally at the point of the site the connecting road, linking the existing road with the uMkhomazi River, would be 100 m long and would require clearing of the existing bush.

4.4.2 River characteristics

The site is on a long straight section of the river (±550 m) and is at a point where the river width is approximately 30 m wide. The water leading up to the site is calm and developed as seen in **Figure 4.7** and appears to increase in velocity as it travels through the site (**Figure 4.8**) indicating that there may be an increase in the river bed slope.

Figure 4.7 Hella Hella – Site 3 looking upstream from the left bank

Figure 4.8 Downstream – Site 3 looking across river towards the right bank showing accelerating water and exposed rock

4.4.3 Local site conditions

Figure 4.8 shows that there is exposed rock across the river at the point of site 3. Additionally, the right side of the river has very steep banks and numerous areas where rock is exposed and this can also be seen in **Figure 4.8**. The left bank is less steep and some clearing would be required and some inundation of the natural bush would occur once the weir was constructed. The steep banks and existing rock are positive indicators when considering the cost of construction at this site.

4.5 SELECTION OF SITE 3

Site 3 has been selected as the preferred location for the construction of the gauging weir near Hella Hella at coordinates 29°55'12.31"S 30° 5'14.26"E.

4.5.1 Discussion

All three of the sites had good physical features which would ensure accurate readings from the weir and assist in bringing down construction costs. However, site 1 is considerably wider than the other sites. The disadvantage of sites 2 and 3 is that there would be some destruction of the natural bush surrounding the site and the access to these sites from the right hand side could be problematic.

The big advantage to site 3 – and the reason it was ultimately selected as the preferred site – is the sites close proximity to the ecological water requirement (EWR) / instream flow requirement (IFR) monitoring point – EWR/IFR Site 2. This point has been indicated on **Figure 4.1** and one can also see in this image that there are two streams joining the river downstream of site 1 and upstream of sites 2 and 3, which have been indicated in **Figure 4.2**. Since Smithfield Dam is going to have to release enough water to ensure sufficient flow at EWR/IFR Site 2 it is proposed that the gauging weir would be close to this point.

The centreline of the site selected for survey has been included below as **Figure 4.9**.

Figure 4.9 Hella Hella – Site 3 showing centreline to be surveyed

5 RECOMMENDATIONS

- It is recommended that the EIA process identify any fatal flaws with the proposed sites.

- It is recommended that gauging weirs be investigated for construction at the following positions:

1. Upstream of the Smithfield Dam (Downstream of the proposed Impendle Dam) with the following coordinates:

- Coordinates: **29°39'8.92"S 29°46'29.65"E**
- Objective/reason: **To determine the inflow to the proposed Smithfield Dam for operational purposes (i.e. timing & magnitude of EWR releases and accounting for incremental flows when making releases from Impendle Dam). Replacing the inundated existing gauging weir (U1H005).**

2. Downstream and close to Smithfield Dam at coordinates:

- Coordinates: **29°46'53.09"S 29°55'52.70"E**
- Objective/reason: **To determine the discharges (i.e. spills and releases) from Smithfield Dam for application in the dam balance.**

3. Near the IFR/EWR site with coordinates:

- Coordinates: **29°55'12.31"S 30°5'14.26"E**
- Objective/reason: **To determine the runoff from the incremental catchment downstream of Smithfield Dam to account for this in determining the magnitude of EWR releases from Smithfield Dam.**

6 REFERENCES

IWR Environmental, 1998. *Mkomazi IFR Study; Acc No: 502-2010; BRN: 503, Class: U1/U2, Box: 113,* Durban; South Africa: Umgeni Water.

Van Heerden, J. J., Van Der Spuy, D. & Le Roux, P. J., 1986. *Manual for the planning, design and operation of river gauging stations.* Pretoria: Department of Water Affairs.

Appendix A

Additional images

Figure A-1 Downstream of Smithfield Dam – Site 1 viewed from top of left bank

Figure A-2 Downstream of Smithfield Dam – Site 1 viewed from top of left bank

Figure A-3 Downstream of Smithfield Dam – Site 1 viewed from left bank

Figure A-4 Downstream of Smithfield Dam – Site 1 viewed from top of left bank

Figure A-5 Downstream of Impendle Dam – Site 1 viewed from right bank

Figure A-6 Downstream of Impendle Dam – Site 1 viewed from right bank

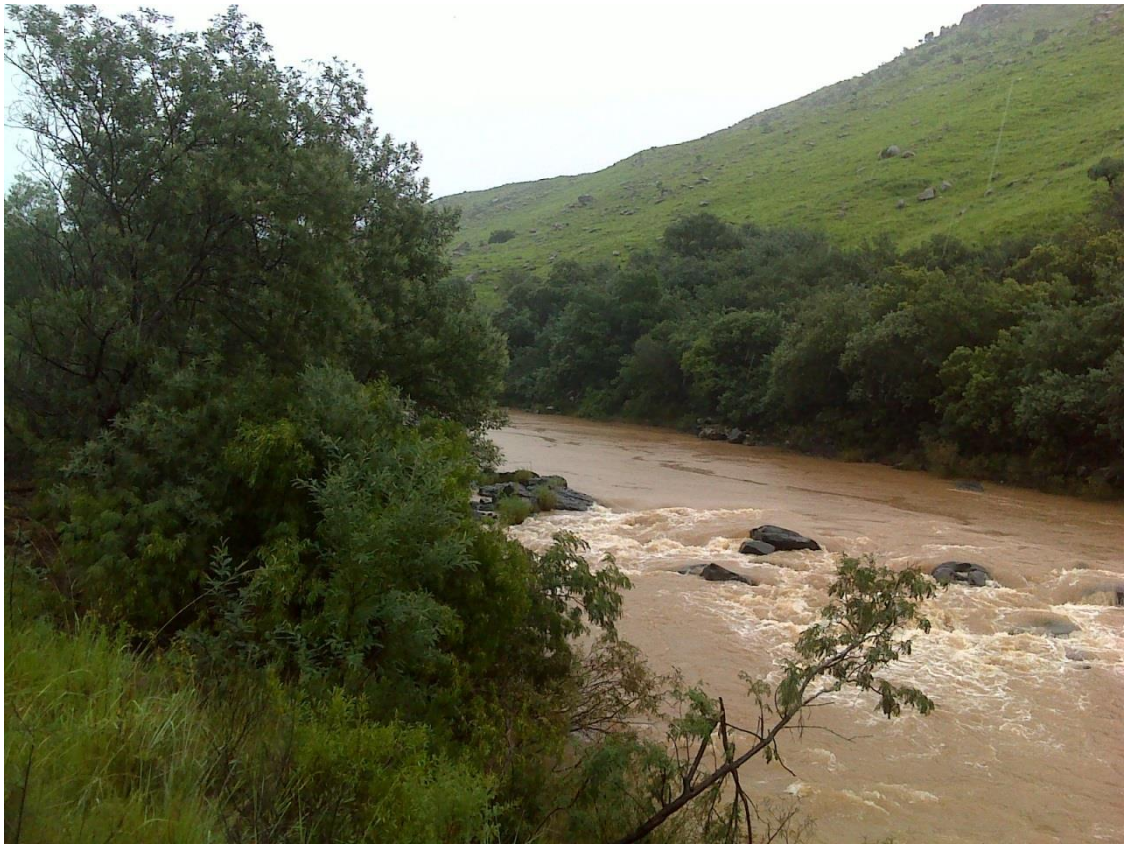

Figure A-7 Downstream of Impendle Dam – Site 1 viewed from right bank

Figure A-8 Hella Hella – Site 3 looking across the river from the left bank

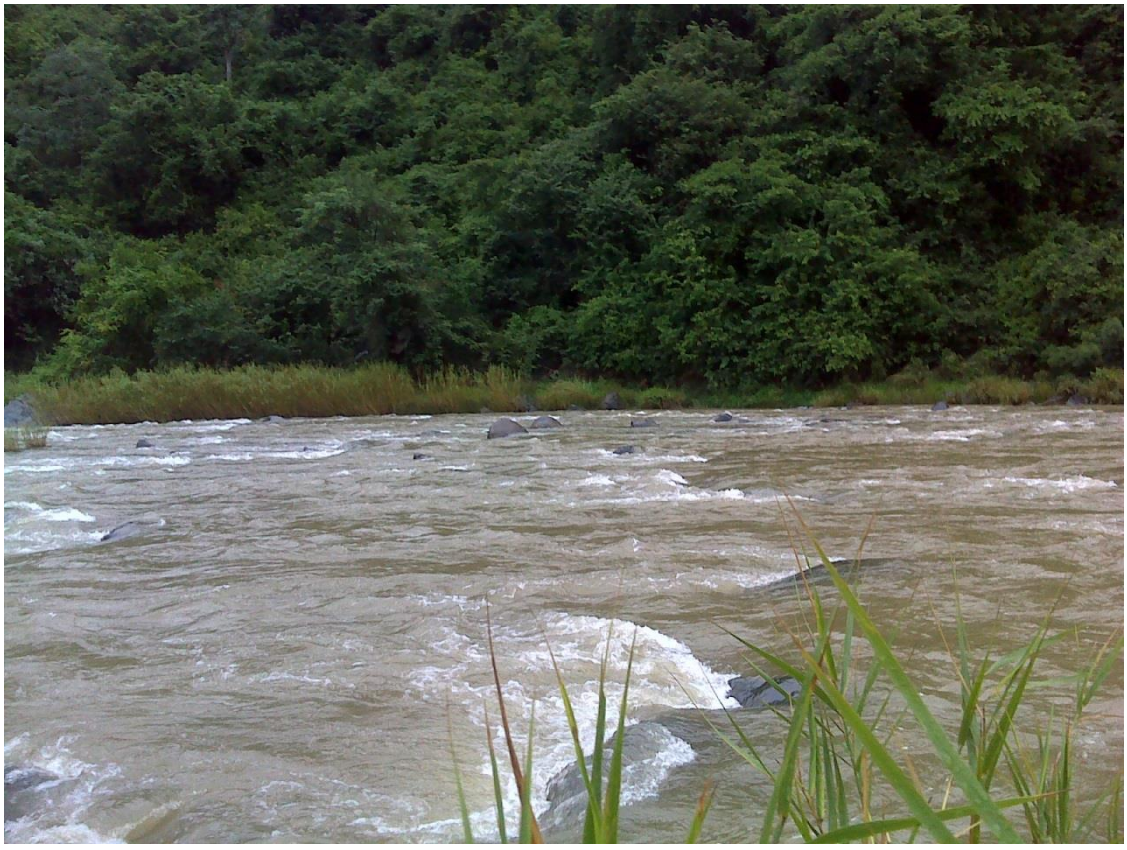

Figure A-9 Hella Hella – Site 3 looking across the river from the left bank

Figure A-10 Hella Hella – Site 3 looking across the river from the left bank

Figure A-11 Hella Hella – Site 3 looking upstream from the left bank

Figure A-12 Hella Hella – Site 3 looking upstream from the left bank

Figure A-13 Hella Hella – Site 3 looking downstream from the left bank at the pool leading to the site

Appendix B

GPS Tracks

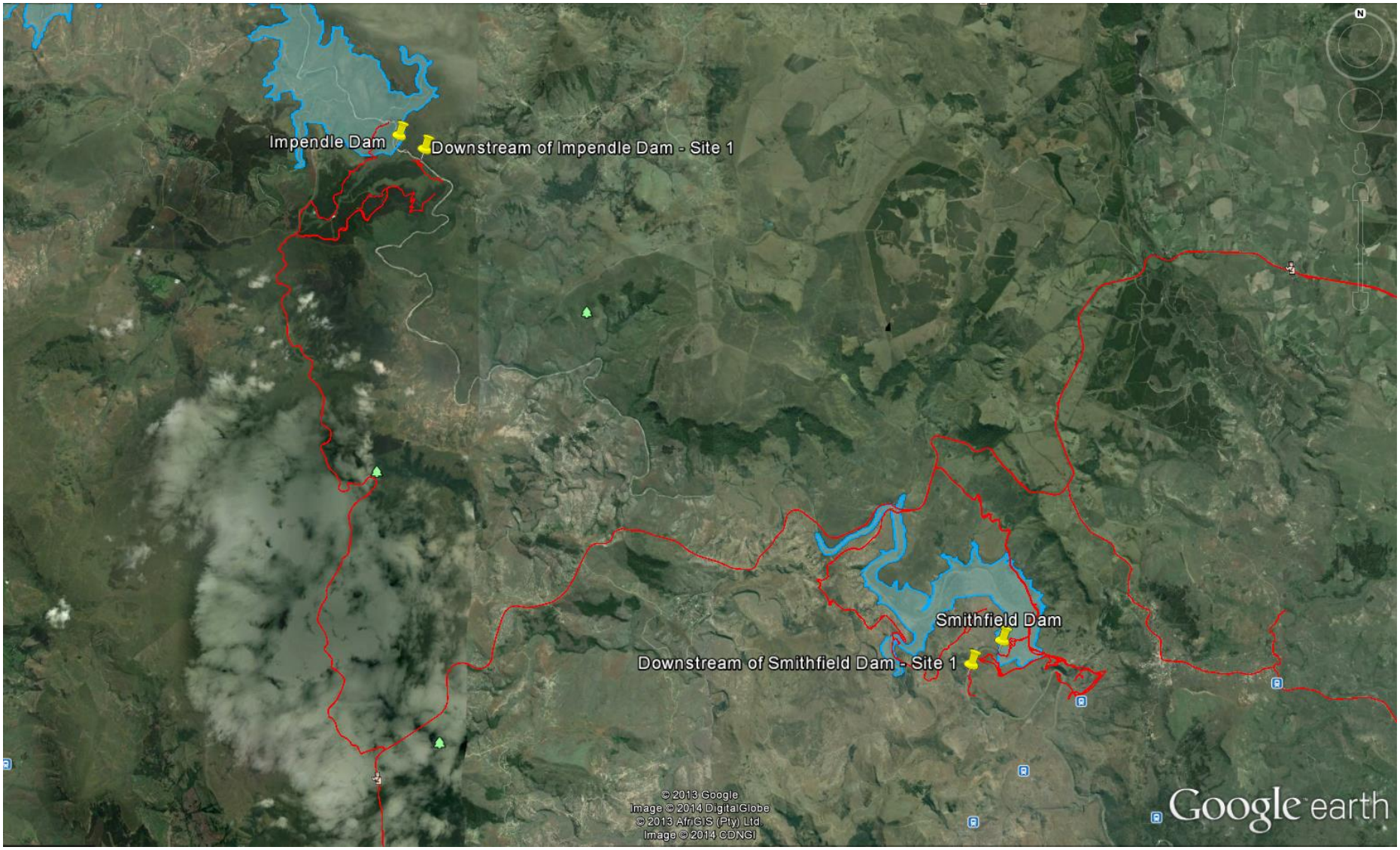

Figure B-1 GPS tracks for access to sites downstream of Smithfield Dam and downstream of Impendle Dam