Appendix A

WETLAND STATUS QUO REPORT

Alluvial Fan Status Quo Report

Baviaanskloof

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6/22/2015

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Introduction

Farmers of the western Baviaanskloof Valley have modified alluvial fan channels to reduce flood damage during times of heavy rainfall. It is believed that modifications made to fans have negatively affected the functioning of the Baviaanskloof fluvial system and as a result has contributed to a reduced water retention capacity in the landscape. Working for Wetlands, in partnership with the NGO LivingLands, has engaged in a fan restoration project to focus on water retention capacity issues in the valley. This rehabilitation project is a continuation of a medium term (±5 years) catchment, river and wetland rehabilitation program implemented by then SANBI (now the Department of Environmental Affairs) Working for Wetlands in partnership with the NGO LivingLands. The programme entails systematically rehabilitating various parts of the Baviaanskloof valley considered important for their water-related ecosystem services. These areas include part of the catchment, and areas within the Baviaans River such as wetlands and alluvial fans linked to the river drainage network. The rehabilitation project described in this report is focussed specifically on alluvial fans within the Baviaanskloof that have been degraded by various anthropogenic impacts. The purpose of this report is to provide an overview of the rehabilitation project, its objectives and expected outcomes. In addition, the report will describe the alluvial fans that are to be rehabilitated and explain how the rehabilitation interventions are intended to reverse degradation.

Alluvial fans

What are alluvial fans?

Alluvial fans are cone-shaped, depositional features that form along mountain fronts where steep, sediment-laden channels emerge from narrow, tributary valley and debauch onto the valley plain below (Charlton, 2010). Deposition is a result of loss of confinement, where a change in stream width (an increase) and a reduction in depth and volume, reduce the stream's ability to carry sediment, resulting in deposition (Ellery, et al., 2009) (Morisawa, 1968) (Leopold, et al., 1964). Fans tend to be found in arid locations where rainfall is highly variable and sediments are mobile due to limited vegetation cover. However, fans may also be located in humid areas (Leopold, et al., 1964). Fans can vary in size from hundreds and thousands of square meters to hundreds if not thousands of hectares. Alluvial Fans are not specifically classified within the classification system for wetland or rivers in South Africa (Ollis, et al., 2013). Some are well-supplied with water and have wetland habitats on their surface, while drier fans may have vegetation more characteristic of terrestrial habitats. On other fans, only the vegetation close to distributary channels and active depositional nodes on the fan surface may have characteristic wetland or riparian vegetation, but away from these areas, the fans are dry with terrestrial vegetation.

Why are fans important in the Baviaanskloof?

Fans in South Africa are almost always connected to the regional drainage network and are fed by a stream that may be ephemeral, seasonal or perennial. Alluvial fans are generally considered to be important alluvial aquifers (Woods, et al., 2006) (Herron & Wilson, 2001). Alluvial aquifers are unconfined aquifers found within alluvial deposits (Davie, 2008). On many fans, the stream that flows across the surface of the fan terminate and floods-out before it reaches the trunk valley. One of the primary reasons for the flood-out is that the streams lose water to the aquifer in the fan below. The water from the stream infiltrates down into the sediment deposited by the fan and then slowly seeps through the aquifer sediments towards the trunk stream. It is hypothesized by Jansen (2008) that the Baviaanskloof fans are important for local water supplies, as well as the health and functioning of the Baviaans River. Also, that the degradation of many of the fans has resulted in a loss of base flow support capacity and an increase in the (hydrological) flashiness of the system.

Context

Location

The Baviaanskloof is situated South-East of Willowmore and approximately 100 km north-west of Port Elizabeth. Its most southern point is 50 km from the Indian Ocean. Approximate coordinates are from 23°35'E to 24°25'E and 33°30'S to 33°45'S. The area is very rugged and deeply folded, with the exception of the valley bottom which consists of a fairly flat floodplain. The mountains are very steep, with only one third having a slope of less than 30% (Illgner and Haigh, 2003). The elevation of the valley floor ranges from approximately 700 to 300 m +MSL (= above mean sea level). To the north, the area is bounded by the Baviaanskloof Mountain range and to the South by the Kouga Mountains. The floodplain is divided into alluvial plains by higher-lying erosion-resistant ground. The rehabilitation project described in this report has interventions located on four different farms spread along the length of the Baviaanskloof. All of the interventions are located on alluvial fans (see below) that lead into the trunk valley (Baviaanskloof) from tributary streams flowing in from the sides of the valley. There are 58 fans along the length of the valley (Bobbins, 2011).

Hydrology

The Baviaanskloof River is the main river in the Baviaanskloof; it flows through the central portion of the valley. The river is not always visible. At certain sections the river proceeds as interflow through the permeable top section of the alluvial deposits or through joints in the underlying rocks. The alluvial aquifer over which the Baviaans Rivers flows, is considered to be important for dry season baseflows (Jansen, 2008).

Land use

The western side of the Baviaanskloof is characterised by commercial agriculture and game farming. Various crops including vegetable seed and tobacco are grown. Pastures are also cultivated as a fodder source. Ecotourism ventures are becoming more common with an apparent change in land use (Commonland 4 return from landscape restoration , 2015).

Climate

Both temperature and rainfall of the Baviaanskloof is highly variable between the summer and winter months. Rainfall also has a high inter-annual variability. Average summer temperatures recorded in January-February vary between 16°C and 32°C respectively. Dry hot winds produced during the summer months along the flat plateaus increase summer temperatures up to 44°C (Illgner & Haigh, 2003). Average winter temperatures fall between 5°C and 20°C during June – July with the prevalence of snow on the mountain peaks (Jansen, 2008). Annual rainfall is low and can be both convective and orographic with frequent thunder storms during summer months (Jansen, 2008). The average rainfall per annum is 300 mm with a large temporal variation in rainfall; annual totals may vary from 100 m to >700 mm (Jansen, 2008).

Geology

The geology of the Baviaanskloof is dominated by sandstones and quartzites of the Table Mountain Group (TMG) interspersed with small amounts of shales of the Bokkeveld Group (Illgner and Haigh, 2003). The mountains in the Baviaanskloof are made up by the arenaceous rocks of the Table Mountain Group, whereas the valley floor (in the central portion of the Baviaanskloof) consists of shales of the Bokkeveld Group (Welman and Barnard, 2007). These shales daylight at a number of farms (Illgner and Haigh, 2003). Both formations have been subject to intensive folding. A major fault is running east-west through the valley, with steep mountain slopes to the north. The Enon Conglomerate, consisting of rounded to angular pebbles in a sandy matrix, and recent alluvial sands and gravels (mainly present in the valley) unconformably overlie the Bokkeveld shale and low-lying Table Mountain Formations (Welman and Barnard, 2007). Colluvial deposits are covering the lower mountain slopes. The conglomerates outcrop intermittently from Nieuwekloof in the west to Kruisrivier (near the confluence between the Kouga River and the Baviaanskloof River) in the east (Illgner and Haigh, 2003).

Vegetation

The vegetation within the fans is dominated by the Albany Alluvial vegetation type (Mucina & Rutherford, 2010). Typically the fans in an un-altered state are dominated by woody species such as *Acacia natalitia* , *A caffra* and *A karroo*. A grassy and forb component is also present; dominated by *Sporobolus nitens*, *Erogrositis obtuse*, *E curvula* and *Digiteria eriantha*. *Cynodon dyctylon* was common in wetter areas. In the drier parts of the fan surface various succulents (Aloe sp.) are common, as are various species of tall and low shrubs.

Assessment approach

There is no formal assessment methodology or approach for fan systems in South Africa. The WET Health and WET-EcoServices assessment methods do not allow for the assessment of fans and as such were not employed. The assessment of the fans used a simple approach where clear anthropogenic impacts on the fans were identified and, those that interfere with the fan's hydrological and geomorphic process, were prioritised for rehabilitation. The types of impacts that were considered important in terms of the fan hydrology and geomorphology, were those that modified the location, depth or course of the stream on the fan surface or those impacts that reduced the natural distribution and retention patterns of water on the fan surface. Typical impacts include the canalization of the fan stream through excavation and channel straightening, the constriction of the movement of the stream, and flood waters over the fan surface through dykes and berms.

Problem statement

The alluvial fans of the Baviaanskloof are considered to have important hydrological functions relating to baseflow support. Fifty-five percent of the fans (32 of 58) have been impacted by cultivation, 33% have been impacted by building construction and many have incised streams caused by either toe trimming (where the trunk stream has eroded the toe of the fan creating a new lower base level and thus erosion within the fan stream) or by canalization (Bobbins, 2011). The impacts described above, have all had an impact on the distribution and retention patterns of water within the fans. Typically, cultivation of the fans has led to the construction of berms around the fields to divert flood waters to ensure that crop losses are minimized. In order to regain the lost functionality of the fan, it is necessary to rehabilitate the areas of the fan impacted by humans.

Objectives of the project

The objective of the project is to restore the hydrology and geomorphology of the selected fans and in this manner, improve the delivery of hydrological-related ecosystem services derived from the fans. The specific objective for each fan is described in the section below.

What are the expected outcomes of the interventions?

It is expected that the various intervention on the selected fans will promote changes to the hydrological and geomorphic process on the fans; which will allow for more regular flooding of the fans and the retention of water within the fan aquifers; and thus the restoration of the lost hydrological related ecosystem services.

Fan 4 L81A-01

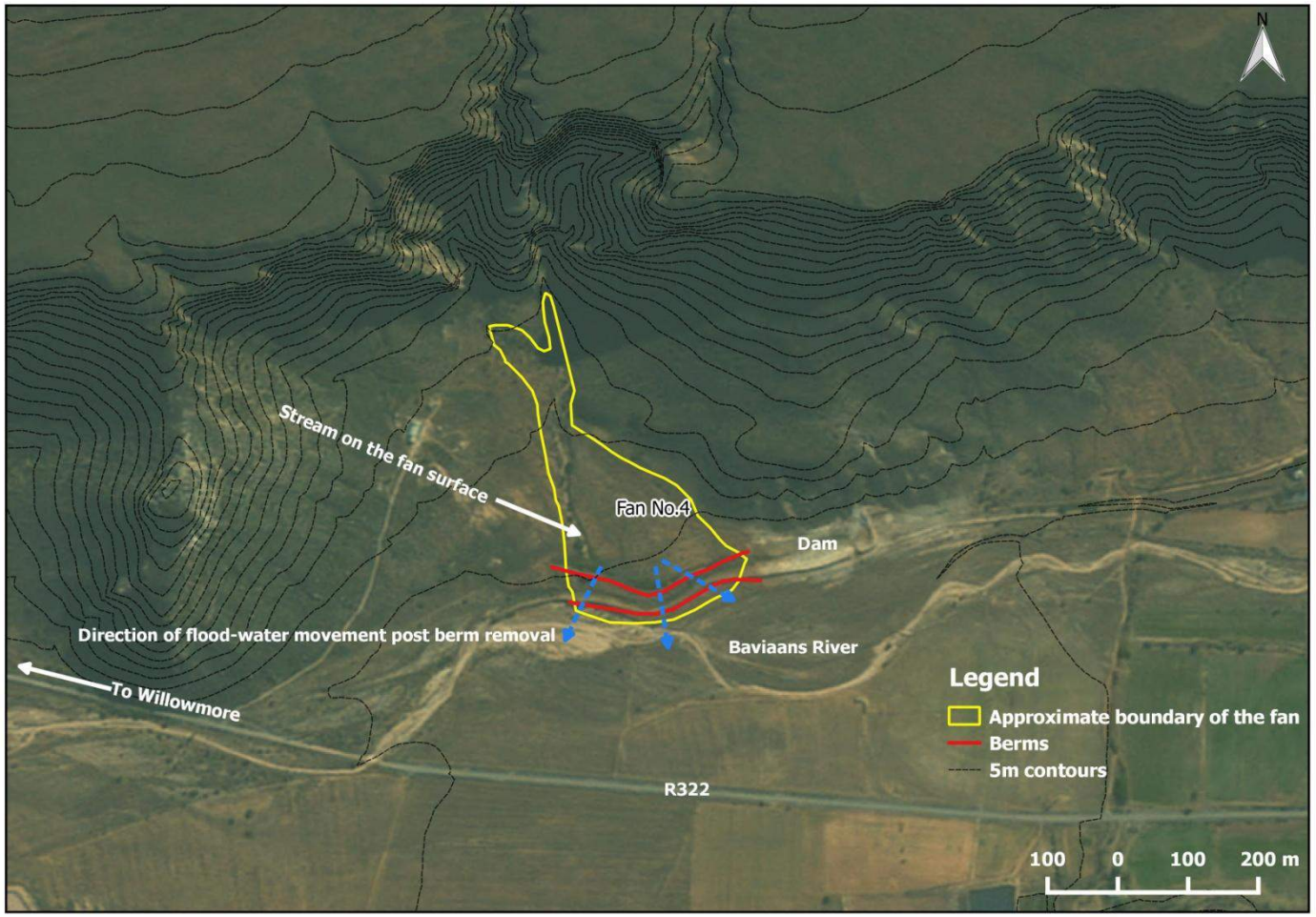
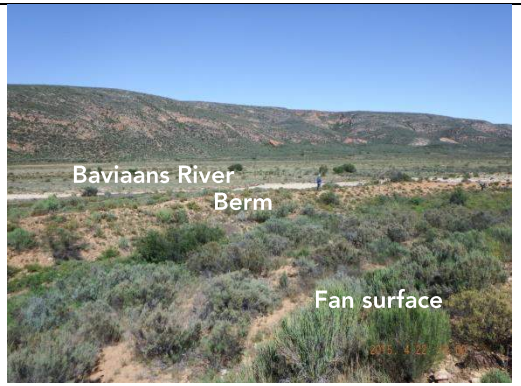


Figure 1 Fan No.4 (L81A-01) overview and impacts

Table 1 Fan 4 Description and summary data

Fan Name	Fan 4
Fan Number	L81A-01
GPS Location	33°31'6.41"S, 23°43'9.88"E
River System Name	Baviaans
General Description	Fan 4 is approximately 7.7 hectares in size. A shallow, ephemeral, distributary stream run along the right hand side of the fan. The stream has its origin in the Baviaans Mountains and flows south towards the Baviaans River. The stream terminates at the toe of the fan (at the junction with the Baviaans River) where it is diverted downstream by a berm towards an off channel. The fan has been hydrologically and sedimentologically disconnected from the Baviaans River into which it historically flowed. The fan was historically cultivated and is thus dominated by species typical of disturbed lands. The only land currently on the fan, is livestock grazing.
Land Use in Catchment	Natural grazing
Land Use in Wetland	Historic cultivation and grazing.
No. of Properties Intersecting Fan Area	1
Date of Assessment	22 April 2015
Assessor(s)	D Walters
Size	7.7 hectares
Overview map	See Figure 1
Photos of the fan	
	Looking upstream along the ditributary stream on the fan surface
Key impacts	The distal portion of the fan at its junction with the Baviaans River, has been altered. A cut-off berm has been constructed that run along the toe of the fan. Surface flows from the fan are captured by a cut-off berm at its base and the water is lead into an off channel dam (now defunct).

Photos of impacts		
	Looking downstream off the fan surface towards the cut-off berm (foreground) and Baviaans River (background) - L81A-01-201-00	Looking downstream along the cut-off berm towards the off-channel dam
Intervention points and rationale	L81A-01-201-00 Earth works – Removal of segments of the berms visible in Figure 1 to allow for floodwater and sediment to pass into the Baviaans River	
	The berms have disconnected the alluvial fan from the downstream river. The removal or deactivation of the berm will allow sediment and water to reach the river as what would have occurred naturally.	
Rehabilitation objectives	Reconnect the fan, hydrologically and geomorphically, with the Baviaans River.	
Expected outcomes	The removal of the berm will allow for the movement of water and sediment from the fan into the Baviaans River.	

Spitzkloof (L81B-01)

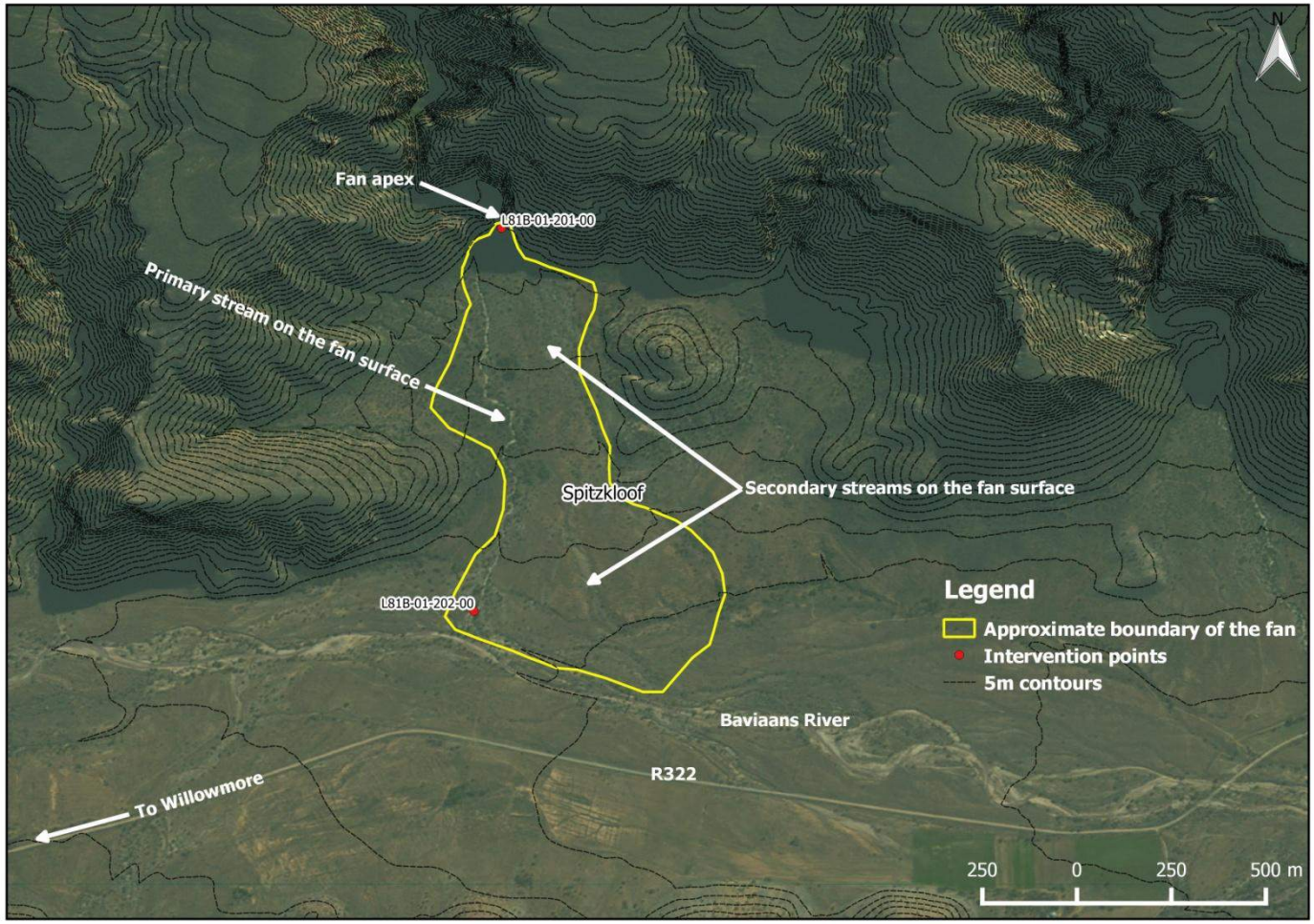
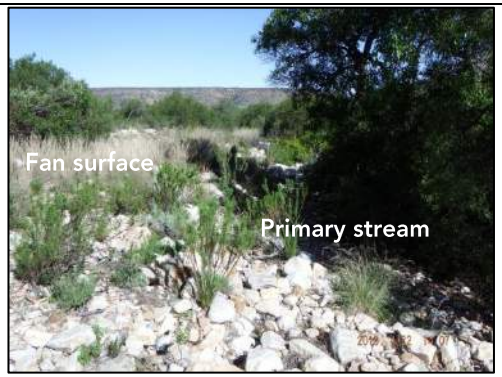


Figure 2 Spitzkloof (L81B-01) overview and impacts

Table 2 Spitzkloof Description and summary data

Fan Name	Spitzkloof	
Fan Number	L81B-01	
GPS Location	33°30'34.86"S, 23°52'33.09"E	
River System Name	Baviaans	
General Description	The Spitzkloof fan is approximately 7.1.25 hectares in size. An ephemeral, distributary stream run along the right hand side of the fan. The stream has its origin in the Baviaans Mountains and flows south towards the Baviaans River. The stream terminates at the toe of the fan (at the junction with the Baviaans River), where it has cut down through the fan surface, and joins the valley at the elevation set by the Baviaans River. The stream is relatively incised along most of its length and thus does not allow for flood waters to be spread over the surface of the fan; most of the water and sediment carried in the stream is transported rapidly along the stream channel and delivered into the Baviaans River. Several abounded distributary channels are located across the fan surface, none of which are likely to carry water except in most severe floods. The fan was historically cultivated and is thus dominated by species typical of disturbed lands. The only land currently on the fan is livestock grazing.	
Land Use in Catchment	Natural grazing	
Land Use in Wetland	Historic cultivation	
No. of Properties Intersecting Fan Area	1	
Date of Assessment	23 April 2015	
Assessor(s)	D Walters	
Size	71.25 hectares	
Overview map	See Figure 2	
Photos of the fan		
	The fan surface and primary stream at the apex of the fan	The primary stream atnd fan surface at the distal end of the fan
Key impacts	The key impacts of the fan: • Incision of the trunk stream (Baviaans River) has led to the lowering of the fan base and the incision of the fan along the primary stream.	

	• The incision of the stream has been aggravated by channel confinement caused by a berm constructed along the edge of the stream channel in the distal section of the fan. • Cultivation of the fan adjacent to the above-mentioned berms.
Photos of impacts	
	The incised primary channel near the apex of the fan at intervention point L81B-01-201-00.
	
	The berm that constrains the stream channel along the distal section of the fan. The berm protects now abandoned, cultivated lands on the adjacent fan surface (at intervention point 'L81B-02-201-00)
Intervention points and rationale	L81B-01-201-00 – Split the surface flows at the apex of the fan into two channels: the current primary stream channel and a historic channel. The reduction of flows into the primary channel will reduce the stream capacity to carry sediment and thus stop further degradation and encourage aggredation of the channel.
	L81B-02-201-00 – Remove the berm from the bank of the primary channel. The removal of the berm should allow for the more frequent flooding of the lower part of the fan
Rehabilitation objectives	Reduce the competency and capacity of the primary stream on the fan surface to encourage increased aggredation within the stream channel and flooding across the fan.
Expected outcomes	• Aggredation within the primary stream channel

	• More frequent flooding across the fan surface

Dam se Drift L81C-06

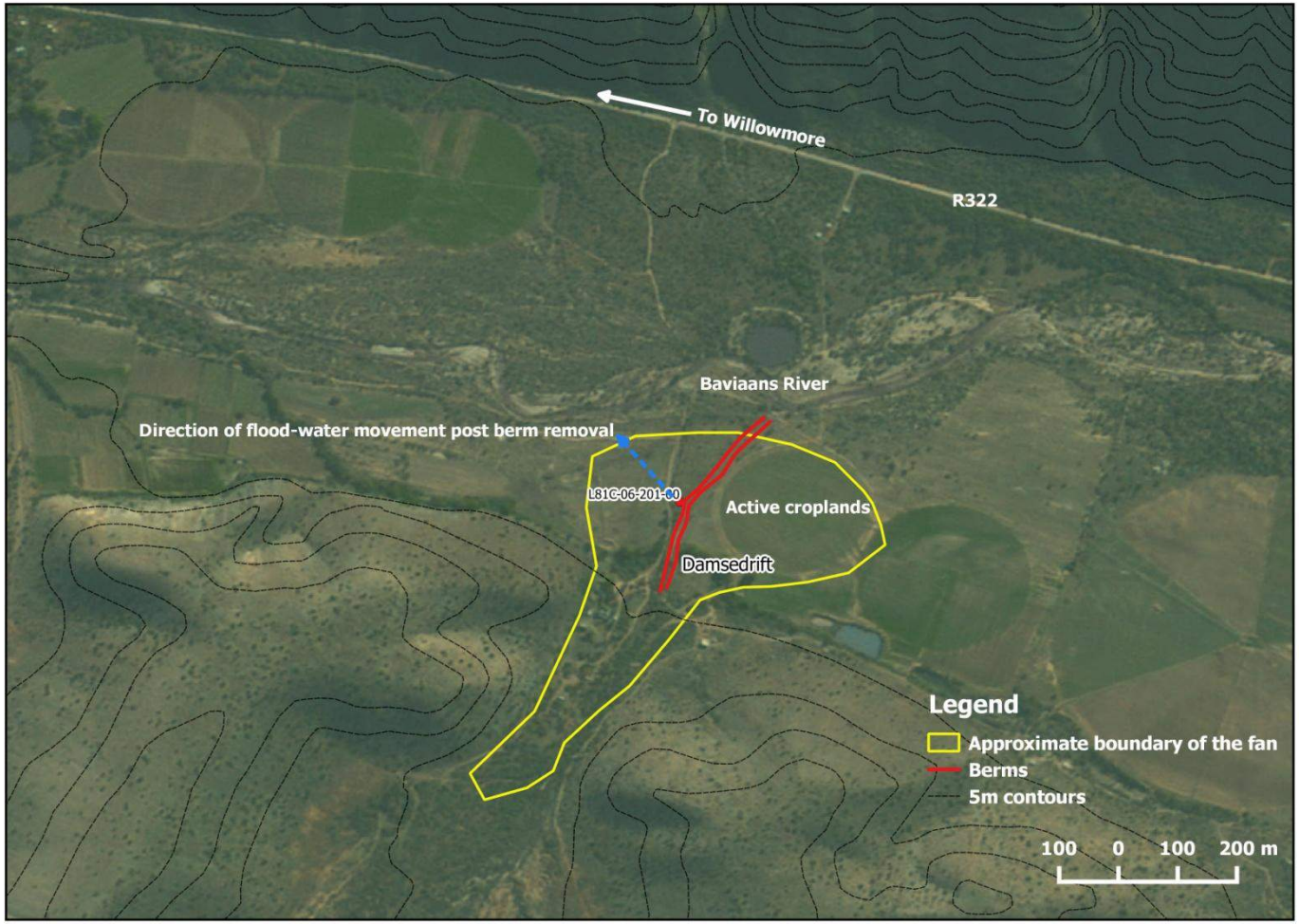


Figure 3 Dam Se Drift (L81C-06) overview and impacts

Table 3 Dam Se Drift Description and summary data

Fan Name	Dam Se Drift	
Fan Number	L81C-06	
GPS Location	33°33'35.70"S, 24° 2'55.85"E	
River System Name	Baviaans	
General Description	The Dam Se Drift fan is approximately 32.18 hectares in size. A shallow, ephemeral,. distributary stream run through the centre of the fan. The stream has its origin in the Kouga Mountains and flows north towards the Baviaans River. The stream terminates at the toe of the fan (at the junction with the Baviaans River). The stream has been "trained"; locked into place in the centre of the fan by a berm on either side of its banks. Approximately half of the fan is still being used for cropping (the right hand portion) while the rest is either abandoned or has never been disturbed.	
Land Use in Catchment	Natural grazing	
Land Use in Wetland	Historic and current cultivation	
No. of Properties Intersecting Fan Area	1	
Date of Assessment	21 April 2015	
Assessor(s)	D Walters	
Size	32.18 hectares	
Overview map	See Figure 3	
Photos of the fan		
	The primary stream on the fan surface near the fan apex.	The distal section of the fan impacted by berms
Key impacts	The key impacts on the fan:	

	• The stream that flows over the fan has been canalized by the construction of berm on both of its banks. • The berms stop flooding in adjacent cultivated lands. • The fan has and is being used for cultivation.
Photos of impacts	
	The berms that were constructed to constrain the primary stream on the fan surface to prevent flooding of adjacent cultivated lands at intervention point L81C-06-201-00
Intervention points and rationale	L81C-06-201-00 – Removal of a section of the left-hand bank berm (looking downstream). The removal of portion of the berm will encourage the flooding of the left-hand (north-western) portion of the fan where the cultivation has been abandoned.
Rehabilitation objectives	Reinstate the hydrological and geomorphic processes of the left-hand (north-western) portion of the fan where the cultivation has been abandoned
Expected outcomes	Regular flooding of the left-hand (north-western) portion of the fan where the cultivation has been abandoned

Tchandokloof (L81C05)

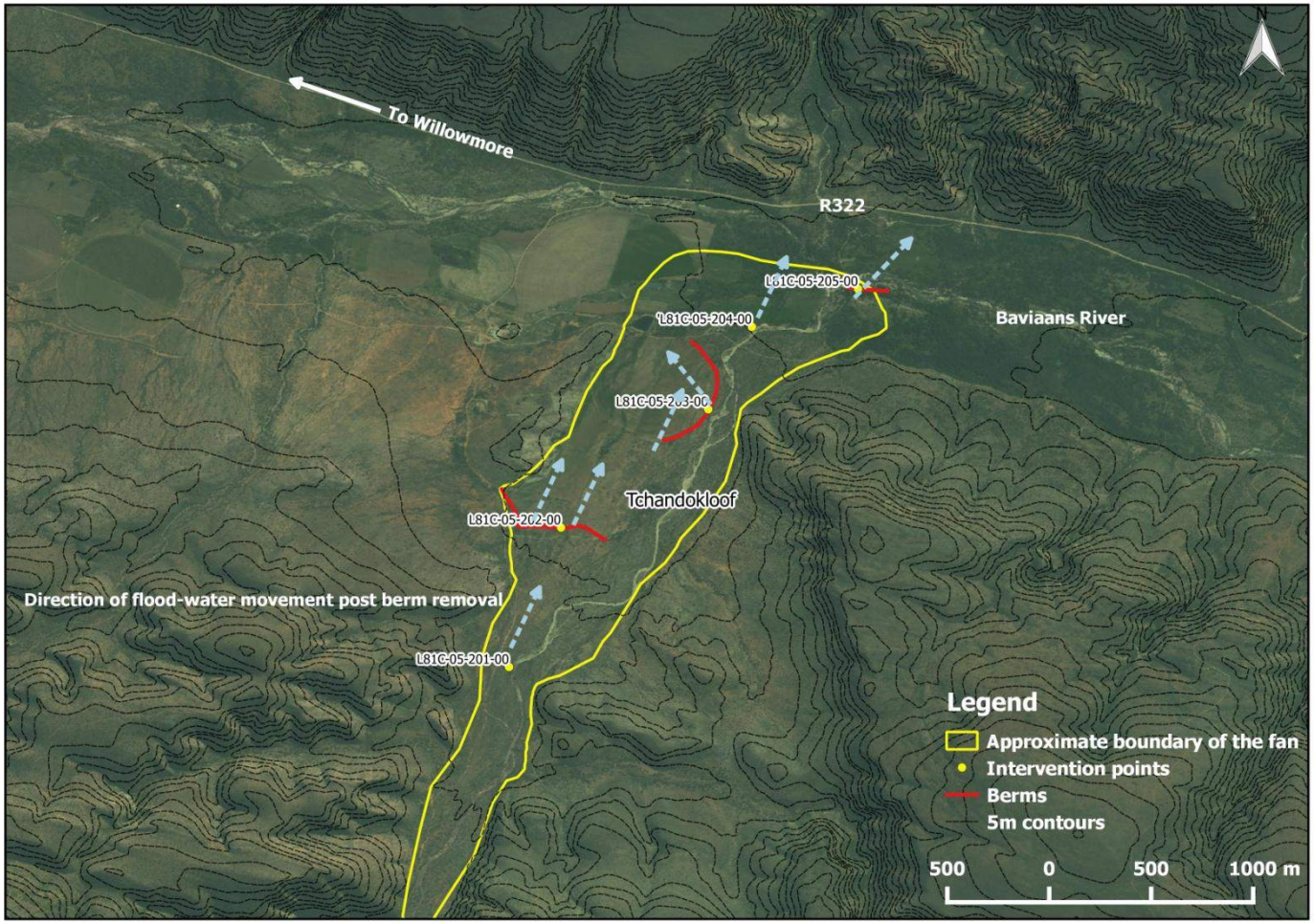
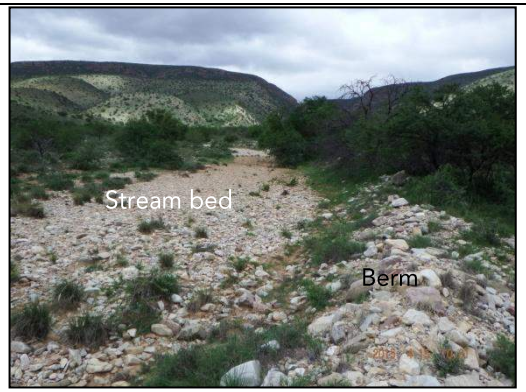
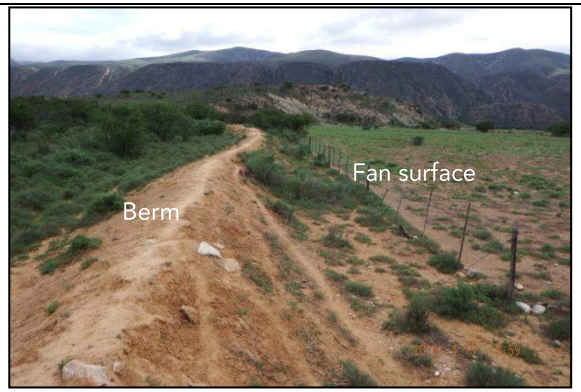


Figure 4 Tchandokloof (L81C-06) overview and impacts

Table 4 Tchandokloof Description and summary data

Fan Name	Tchandokloof	
Fan Number	L81B-01	
GPS Location	33°35'46.23"S, 24° 6'18.41"E	
River System Name	Baviaans	
General description	The Tchandokloof fan is approximately 307 hectares in size. The fan is supplied with water and sediment from a large catchment in the Kouga Mountains. There is a dominant, ephemeral, distributary stream that flows down the right-hand side of the fan. There is evidence across the fan surface of the abandoned distributary streams. A large portion of the fan has been used for cultivation. The extent of the distribution and retention of flood waters on the fan surface has been severely limited by a series of large berms built to protect crop field from floodwaters.	
Land Use in Catchment	Natural grazing	
Land Use in Wetland	Historic cultivation	
No. of Properties Intersecting Fan Area	1	
Date of Assessment	23 April 2015	
Assessor(s)	D Walters	
Size	307 hectares	
Overview map	See Figure 4	
Photos of the fan		
	The channel on the proximal reach of the fan near the apex.	The channel on the dital reach of the fan.
Key impacts	The key impacts of the fan: • Incision of the trunk stream (Baviaans River) has led to the lowering of the fan base and the incision of the fan along the primary stream. • The incision of the stream has been aggravated by channel confinement caused by berms constructed along the edge of the stream channel in the medial, distal sections of the fan. • Cultivation of the fan adjacent to the above mentioned berms.	

<table>
<tr><td rowspan="6">Photos of impacts</td><td> 
</td><td> 
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<tr><td>A berm constraining the primary stream at intervention point L81C-05-201-00. See Figure 4.</td><td>Berm that excludes flooding across the fan at intervention point L81C-05-202-00. See Figure 4.</td></tr>
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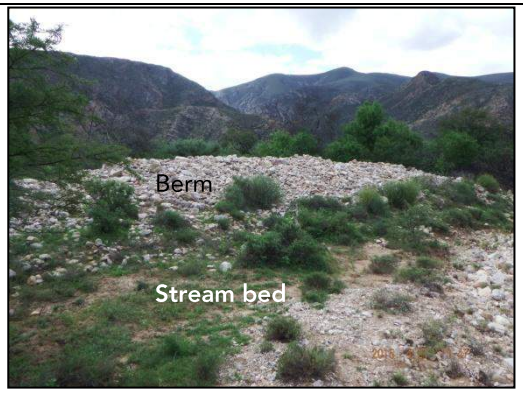
</td><td> 
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<tr><td>A berm constraining the primary stream at intervention point L81C-05-203-00. See Figure 4.</td><td>A berm constraining the primary stream at intervention point L81C-05-204-00. See Figure 4.</td></tr>
</table>

		
	Berm that excludes flooding across the fan at intervention point L81C-05-204-00. See Figure 4.	
Intervention points and rationale	**L81C-05-201-00** – Removal of a berm to allow for natural flooding patterns of the surface of the fan. By allowing for flood waters to escape the channel high up in the fan, it is expected that the ability of the stream to carry its sediment load will be reduced and the stream bed will aggrade along its length. The reduction in the depth of the stream will promote further flooding of the fan surface.	
	L81C-05-202-00 - Removal of a berm to allow for natural flooding patterns of the surface of the fan.	
	L81C-05-203-00 - Removal of a berm to allow for natural flooding patterns of the surface of the fan.	
	L81C-05-204-00 - Removal of a berm to allow for natural flooding patterns of the surface of the fan. This intervention point will also facilitate channel aggradation as described for intervention point L81C-05-201-00.	
	L81C-05-205-00 - Removal of a berm to allow for natural flooding patterns of the surface of the fan.	
Rehabilitation objectives	To restore the surface hydrology of the fan through the removal of berms.	
Expected outcomes	Regular flooding over the surface of the fan and channel aggradation downstream of the 1st intervention point.	

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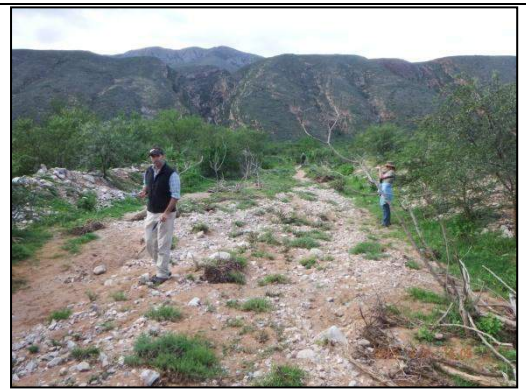
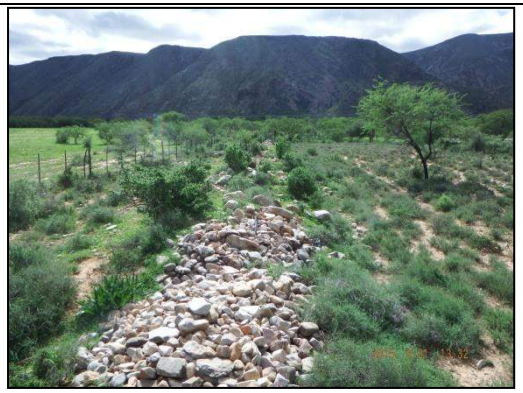
Fixed point photography

Fan	Location (D°M'S")	Description	Photo
Fan 4	33°31'06.410" S 23°43'09.880" E	A berm at the toe of Fan 4. The berm must be removed to allow the free flow of water to the Baviaans River.	

Spitzkloof	33°30'34.860" N 23°52'33.090" E	The channel at the apex of the Spitzkloof Fan must be partly filled in and a "spillway" created on the left-hand bank of the stream.	
	33°31'14.100" N 23°52'30.230" E	A berm on the surface of Spitzkloof Fan that must be removed to allow water to flow over the fan.	
Dam Se Drift	33°33'35.700" N 24°02'55.850" E	Artificial levy that constrains the stream on Dam Se Drift. Fan to be removed in part.	

Tchandokloof	33°35'46.230" N 24°06'18.410" E	A berm on the surface of Tchandokloof Fan that must be removed to allow water to flow over the fan.	
	33°35'21.650" N 24°06'36.360" E	A berm on the surface of Tchandokloof Fan that must be removed to allow water to flow over the fan.	
	33°35'02.310" S 24°06'50.730" E	A berm on the surface of Tchandokloof Fan that must be removed to allow water to flow over the fan.	

	33°34'41.570" N 24°07'04.640" E	A berm at the toe of Tchandokloof fan that must be removed.	
	33°34'34.070" N 24°07'22.840" E	A berm at the toe of Tchandokloof fan that must be removed.