

**ANNEX A  
TO  
BSES KWAZULU NATAL 2005  
REPORT**

**BSES KwaZulu Natal spring expedition 2005 – Investigation of forest  
rehabilitation at Twin streams**

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## **1 Introduction**

The modern world requires an incessant search for new materials and resources. As supplies are drained in one area they become exploited in another and it is often to the detriment of the environment. Twinstreams, a coastal area in KwaZulu Natal, is important as an area of conservation and an environmental education centre, but it is also an excellent example of the conflict between conservation and economic development. Since 1945, numerous land-use changes and developments have affected the area and although efforts have been made to protect the environment, the local ecosystem of Twinstreams has radically altered in the last 60 years.

### **1.1 History of Twinstreams**

Twinstreams is an environmental education centre situated on the outskirts of the small coastal town of Mtunzini, just north of Durban in KwaZulu Natal, South Africa. It is adjacent to the Umlalazi Nature Reserve and is so named because the Siyaya and Amanzimyama rivers meet on the property. Between 1945 and 1989 Ian Garland farmed the area as a sugarcane plantation. However, by 1952 Ian Garland noted a significant change in the health of the natural environment, namely the quality of the rivers, and he set about a rehabilitation process of the small areas of indigenous forest that were still left. Garland set aside areas of former sugar cane around the indigenous forest and began planting indigenous trees, which he hoped would allow the present indigenous area to expand and strengthen. In total, 70 000 trees were planted including about 25 different species.

In 1989, Mondi (a large paper producing company) bought up Twinstreams and many neighbouring farms to create vast eucalyptus plantations. Garland included a condition of sale, that Mondi would have to continue his rehabilitation process and that the area would have to be used for environmental education. Mondi agreed to these conditions and paid for further indigenous trees that Ian Garland planted. In 1996 Ian Garland retired and left the environmental education centre that he had set up to Mondi, who in turn approached, The Wildlife and Environment Society of South Africa (WESSA) with the task of managing the centre. WESSA has continued to look after Twinstreams up to the present day, educating people in the need for caring for our environment. However,

the health of the whole area is becoming increasingly concerning as the two rivers have all but dried up and there have been significant changes in the local environment.

### **1.2 Environmental Change at Twinstreams**

Eyewitness reports reveal how dramatically the area of Twinstreams has changed in a period of less than 60 years. When Ian Garland first took charge of the sugarcane plantation, Twinstreams is recalled as being a swamp forest, where the area was renowned for producing peat-stained water (Ref). The Amanzimyama and Siyaya flowed readily and were connected to the Indian Ocean via a large lagoon. In the 1950s and 1960s local farming increased dramatically which created increased runoff and sedimentation and began to choke the rivers with sediment, with the resulting reduction in flow, the sediment began to accumulate. The introduction of the eucalyptus plantation has provided another enormous strain on the remaining pans of water in the catchment.

In 2001, the Amanzimyama River dried out completely and to date the Siyaya flows intermittently. The coastal lagoon is no longer present. The indigenous forests are still protected, but there are certain areas that are becoming stressed as the environmental conditions continue to change.

These land use changes, together with other important factors, such as the building of the nearby N2 motorway have had a significant effect on the health of the Twinstreams area. However, although such change is undeniable it is impossible to isolate such factors from a natural course of progression. The prograding sand dune system is very active with a strong long shore drift pattern and a healthy stabilising plant population. At present the shoreline is prograding at 2 metres per year (ref.) and such change must have played a key part with regard to the coastal lagoon that is no longer present.

### **1.3 Future of Twinstreams**

The changes seen at Twinstreams over the last 50 years have been very dramatic and can be attributed to excessive pressure on the surrounding land, changing land-use patterns, and natural changes within a very fragile system. The indigenous area and rehabilitated forest are still surviving but they are continually threatened with the degradation of the local environment. This factor is highlighted by a recent proposal for mining of titanium to begin in February 2006 on the doorstep of the indigenous area. Such a new land use proposal will undoubtedly have yet another significant effect on the ecosystem of Twinstreams and is the latest example of how it is proving increasingly difficult to maintain conservation programmes when they have to compete with economic development.

## 2 Project overview

The science projects conducted at Twinstreams by the KwaZulu Natal 2005 expedition took part in two phases. Phase one was conducted by Ingwe and Ndlovu fire whilst Nkombi and Ihubesi were out on the wilderness trails. During phase two Nkombi and Ihubesi continued the projects and started in phase one.

### 2.1 Study Area

The planted rehabilitation areas at Twinstreams can be found in two main plots: one north of the railway line and east of the Siyaya River; and the second, south of the railway line and south-east of the Siyaya River. Both plots have boundaries with indigenous areas but are predominantly surrounded by gum tree plantations. The study areas were mapped and a 'walk-through' investigation was carried out in order to provide a general impression of the type, variety and number of tree and plant species in each area. There was a noticeable difference between the two planted areas: the area north of the railway line was termed 'planted sad' (PL.SAD) and the area south of the railway line and nearer to Twinstreams was named 'planted happy' (PL. HAP).

PL.HAP was so called because of the abundance of mature tree species present and the large numbers of tree saplings. In contrast, PL.SAD was seen to have only a third of the number of tree species, compared to PL.HAP and with many fewer saplings. It was also noticed that in PL.SAD, the lower branches on a number of the trees had died and several trees neighbouring the gum tree plantation were dead signifying a greater level of stress.

PL.SAD was found to be bordered by indigenous forest along its southwesterly edge for roughly 250 metres and contained a significant amount of species diversity. The indigenous area in PL.HAP was much smaller, less diverse and restricted to a thin-stripped V-shape along the periphery of the gum tree plantation on the eastern boundary of the planted area.

### 2.2 Aim

The aims of the science projects conducted at Twinstreams by the BSES KwaZulu Natal 2005 expedition were:

- To provide the Young Explorers (YEs) with a valuable experience of conducting scientific research in the field;
- To test a hypothesis and provide WESSA with an indication of the health of the rehabilitated forest at Twinstreams;
- To document information regarding the tree species present in both the planted and indigenous forests at twin streams;

- To produce a sketch map of the areas investigated;
- To provide recommendations to WESSA regarding further investigations.

### 2.3 Scope

The projects were conducted in two phases over a two-week period. Phase one was completed by Ingwe and Ndlovu fires, and phase two by Nkombi and Ihubesi. The task completed during phase one were:

Identification of the three plots of forest for investigation. These were given the names Planted Happy, Planted Sad and Indigenous

1. 10mx10m quadrates were marked out in Planted Sad and Planted Happy;
2. The tree species in each quadrate was identified with the help of local botanists;
3. The number of mature tree species and saplings in each quadrate was counted;
4. The percentage of fern cover in each quadrate was estimated;
5. A sketch map of the tracks and forest areas investigated;
6. The boundary of Planted Sad was measured and mapped.

The tasks completed during phase two were:

1. Identification of the dominant tree species in the indigenous area;
2. Zulu names for the trees identified in each test forest
3. Infiltration rate sampling performed in the quadrates in Planted Sad and Planted Happy forests;
4. Soil profile pits were dug in planted Sad and Planted Happy forests;
5. The sketch maps started in phase one where completed, these indicated the boundary of the sad and happy forests and the locations of the quadrates.

An attempt was made to mark out quadrates in the indigenous forest adjacent to planted sad, however, the dense vegetation made it impractical to accurately measure the quadrates and identify all the species. Hence, quadrate sampling data was not collected in the indigenous areas. Instead, a list of the dominant mature and young tree species found throughout the entire patch were identified and listed.

Tasks completed:

- Mapping using GPS
- Happy, Sad (Indigenous) quadrates
- Water table level in frog pond

### 3 Method

#### 3.1 Overview

Five data collection campaigns were conducted to gain information on the current state of the four distinct plots of forest investigated on the twin streams estate. These campaigns were:

- Forest succession
- Soil profiling
- Water infiltration
- Lepidoptera diversity

This section describes the methods used.

#### 3.2 Forest Succession

1. The three selected sampling habitats will be measured and mapped, showing distances from fixed reference points and direction of magnetic North.
2. The number of mature trees (either planted or indigenous) together with the number of seedlings and the presence of flame lily or fern species (known not to have been planted) will be recorded within a series of 10m x 10 m quadrates. Trees and seedlings will be identified from reference books where possible (References 1, 3, 4 and 6) or will be sketched or photographed for future identification. Local expert advice will also be sought, particularly when identifying seedling trees. Thirty quadrates will be sampled from each of the planted forest habitats and ten from the indigenous forest. Quadrates in each series will be numbered 1-10 and separate series will be sampled at three distances from the indigenous forest boundary (A, B, C), giving a unique quadrate numbers e.g. PLSAD-B-9.
3. Sampling positions for each quadrate in each habitat will be marked out and uniquely identified using cut reed stems and labelled tags. Each quadrate will be 10 m square; the length of the hypotenuse being 14.1 m will be used to ensure square-ness. The distance between adjacent quadrates of the same series will be 10 m. The distances between the forest boundary and the first series

will be 15m. The distances between each of the three series in each habitat will be constant and will be recorded in the raw data.

4. Each quadrat will be divided into quarters (each 2.5 x 10m) to make recording more accurate but the numbers per quadrat will be recorded onto data sheets.
5. If a species cannot be identified in the field then a length of red and white tape will be attached to the trunk and it will be recorded on the data sheet that another site visit is required for identification.
6. Photograph these procedures and photograph specimens, which need identification.

### **3.3 Soil depth**

Soil depth in each of the three selected habitats will be measured by digging slit trenches. These will be approximately 1 m in length and the width of the spade blade. Trenches will be dug to a depth, which shows the change from humus to sand. The depth of this change below the surface will be measured and recorded.

At least three slit trenches will be dug per habitat, one in each third (A, B, C) as divided by the quadrat sampling.

### **3.4 Water Infiltration rates**

The time taken for a known volume of water to penetrate into soil will be recorded from within each of the forest succession quadrat areas. The diameter of the tubing used will be recorded once it has been located.

1. The tubing will be placed to a depth of 5 cm into the soil.
2. One litre of water will be poured into the tube and timing will start.
3. Timing will stop when all water has disappeared into the soil.
4. The time taken and the quadrat number will be recorded onto a data sheet.
5. The internal diameter of the pipe will be measured so as to calculate the surface area of soil into which the water dissipated.
6. The water volume infiltrated per unit area will be converted to  $L/m^2$
7. So as to allow comparison with previous studies.

Water infiltration rates will be measured in all three habitats on the same day to prevent differences being recorded due to weather events.

### 3.5 Water table depth

The depth of the water table will be established at one location within each of the three habitats.

1. Select one suitable site within each habitat for digging. It is proposed to dig the bottom of the frog pond in the PLSAD forest since this is already at some depth and the water table level can be compared with the brim of the pond, which represents the level in 1989.
2. Dig down using spades until the water table is found. Take care to make the sides of the hole at 45 degrees to avoid the chance of the sides collapsing. Create suitable dimensions for each of the holes and try and find the water table
3. Measure the depth from soil surface to surface of the water and record.
4. Using the GPS system record the height above sea level of the water table at each of the locations, also record the co-ordinates of the sampling location.

### 3.6 Data Storage and analysis

Data from all sampling procedures will be recorded onto pre-printed forms, which will be signed and dated on completion and stored in the study file. Each sampling procedure and all daily activity in this study will be recorded in a logbook with each entry being signed and dated.

## 4 Results

- Map
- List of planted trees
- List of indigenous trees
- Quadrating
  - No. saplings per area
  - No. tree species per area
  - % Fern cover per area
  - Description of vegetation etc
- Water table
  - Frog pond dig
- Any other observations ...

## **5 Results – Tree specie diversity**

A survey of the tree specie diversity in the PLSAD, PLHAP and indigenous forests was conducted with the help of local botany enthusiasts. A complete list of the species identified in each tests area is included in Appendix A.

Section 5.1 briefly describes the main species identified in the two indigenous forests.

### **5.1 Tree species diversity in the indigenous Forest**

#### **5.1.1 Canopy Cover Species**

Voacanga Thourasii/Wild Frangipani- this is the prominent species that the canopy of the forest is composed of. All the examples spotted so far have been mature.

Macaranga Capensis/Swamp poplar- A typical swamp forest tree usually grows up to 25 metres. A variety of ages found.

Syzigium Cordatum/ Waterberry-Grows up to 20m, only mature trees spotted. Several of these border the boundary between PLSAD and IND.

Bridelia Micrantha/Coastal Goldenleaf- Medium to tall deciduous tree (7-15 metres, up to 20 metres) All examples spotted were mature and coming to the end of their lives.

Ficus Sur/Cape Fig- Examples found include both saplings and mature trees. One of the mature trees found near to the PLSAD forest was stressed and had few leaves.

Ficus Trichopoda/Swamp Fig- ID from big leaves and roots coming down from branches. Examples found clustered together away from PLSAD.

#### **5.1.2 Sub-canopy/Mid-Layer trees**

Phoenix Reclinata/ Wild Date Palm- Same as date palm found in the middle east, only with smaller fruit. Grows between 3-10 metres high.

Kraussia Floribunda/Rhino Coffee- Most common sub-canopy species. Both mature trees and saplings found. Mature trees grow to about 6 metres high and when in season have lots of small flowers and fruit, making it popular with birds.

Tabernaemontana ventricosa/Forest toad- Grows between 4 and 15 metres high, only younger examples found so far.

Strelitzia nicolai/Wild Banana-wide Palm-like leaves, many examples found, varying between 3 and 12 metres tall.

### 5.1.3 Ferns

Microsorium punctatum

Stenochaena tenuifolia

Thelypteris dentate

### 5.1.4 Plants

Scadoxus sp

### 5.1.5 Vines/Creepers

Rhoicissus Rhomboidea/Glossy forest grape-Canopy climber grows up to 20 metres, the predominant vine species in the forest.

Adenia Gummifera- Thick vine, popular use as an herbal medicine

Canthium gueinzii/Climbing turkey-berry-Canopy climber, ID from clusters of black fruit (although it is currently nearing the end of its fruit-bearing season).

### 5.1.6 Alien Species

Lantana and Bugweed are both aliens to South Africa, several examples found in the forest.

One species of grass was also found (Setaria megaphylla/Broad-leaved bristle grass). This is alien to the forest and its presence is an indicator of the drying of the soil, as it would not exist in a damp environment.

### 5.1.7 Observations on Ind. Forest plot 'A'

The forest that we have labelled 'indigenous' has been known in the past as Storkwood Forest, due to the presence of a rare species of stork in the forest. KZN coast used to contain many pockets of this type of forest. These were removed throughout the 1950s and '60s and the soil was exploited for its good water and rich humus. By 1985 all the papyrus swamps had been drained and only a few patches of swamp forest remained (Storkwood being one of these).

Bruce the botanist gave us anecdotal evidence that the forest used to be much wetter (swamp-like). The forest certainly is dryer than would be expected of a swamp forest, **the presence of grasses and the stressed appearance of several trees also support the theory that the soil is dryer than it should be.**

It would also appear that the projected aim of the neighbouring planted forest (to provide shelter for the expansion of the indigenous forest) has not yet been realised. As **there does not appear to be any spreading of indigenous forest species into PLSAD** (the easiest explanation for this is

that the soil in PLSAD is much too dry for germination of any of the indigenous species to occur).

#### **5.1.8 Indigenous forest – plot ‘B’**

This small grouping of trees ran adjacent to one edge of the planted ‘Happy’ forest. It is approximately 30m wide with a V shaped cross section, seeming to indicate the presence of a drainage ditch there at some point in its history (perhaps when the surrounding land was used for sugarcane farming). The dominant mature tree species identified are indicative of swamp forest. There was a layer of mulch on the top of a dense root system. It should be noted however, that the mulch was dry and not as wet as is common to a swamp forest.

Two species of canopy tree dominated the forest: *Macaranga Capensis*/Swamp Poplar (details above) and *Baringtonia resamosa*/Powder-puff tree (Small to medium size, large leaves, hard egg-shaped fruit). The latter was the most common.

Other species identified along the edge of the forest adjacent to planted ‘happy’ were *Albizia*, *Manilkara discolor*/Milkwood, *Tabernaemontana ventricosa* /toad tree and a rafia palm. These species were planted by Dr Ian Garland.

There were no dominant sub canopy layer trees and few saplings. The majority of the saplings were Toad Trees.

Both the *Baringtonia* and *macaranga* prefer very moist soils in which to germinate, and since the planted B forest has a very dry soil, it is unlikely that these species would naturally move across under these current conditions. Indeed, no evidence was found in the planted B of this occurring.

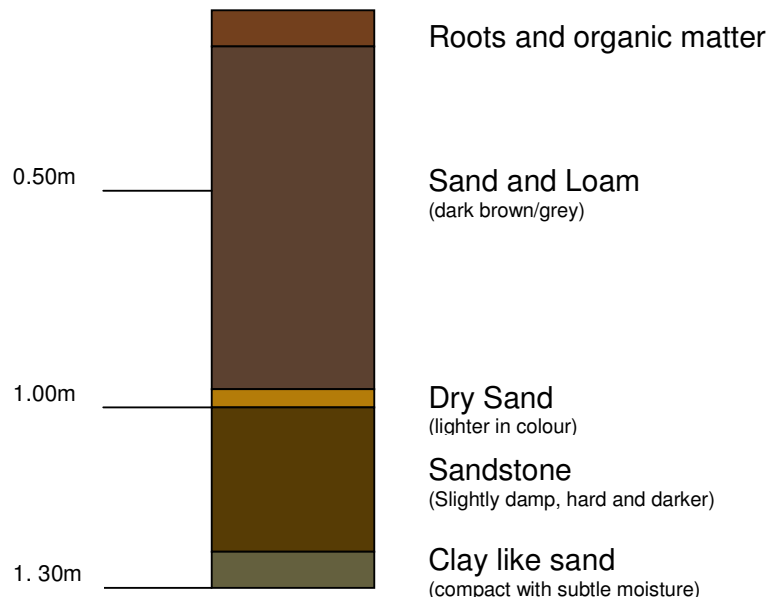
#### **5.2 Soil Profile and Water Table Investigation**

Suitable locations for digging test pits were identified within the quadrated areas in both Planted Happy and Planted Sad forests. Five pits were dug. Each test pit was dug to a depth of between 75cm and 150cm from surface level.

An accurate GPS reading of the height above sea level of each pit could be taken using the handheld GPS. This was because sufficient satellite coverage was not achievable at the time of the test. However a tape measure was used to measure the depth of the pit below surface level.

**5.2.1 Location 1: PLSAD Quadrate A3 – May 05 2005 0930**

Soil profile:

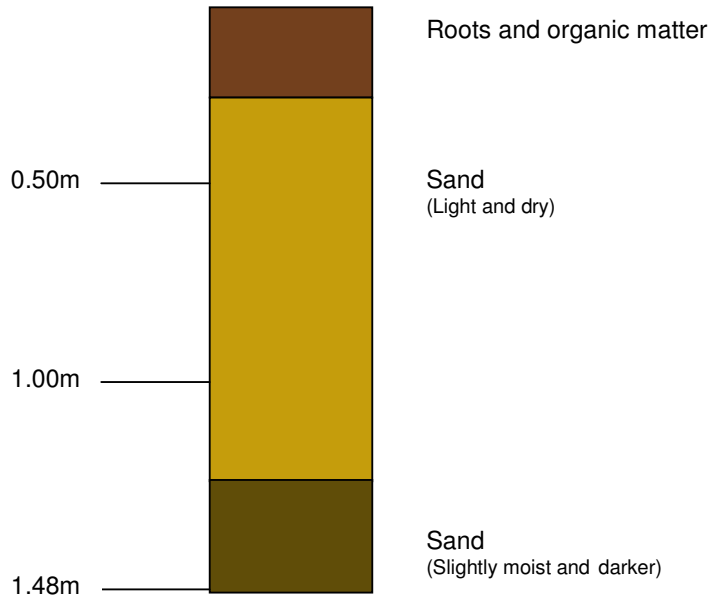


The water table had not been found by 1.30m below ground level and it had become impractical to dig any further due to time constraints and hard ground. Also, the moisture level of the soil was too low to indicate the water table was close.

The changes in soil appearance were noted and recorded as shown above.

**5.2.2 Location 2: PLHAP Quadrant C2 – 05/05/05 09:25**

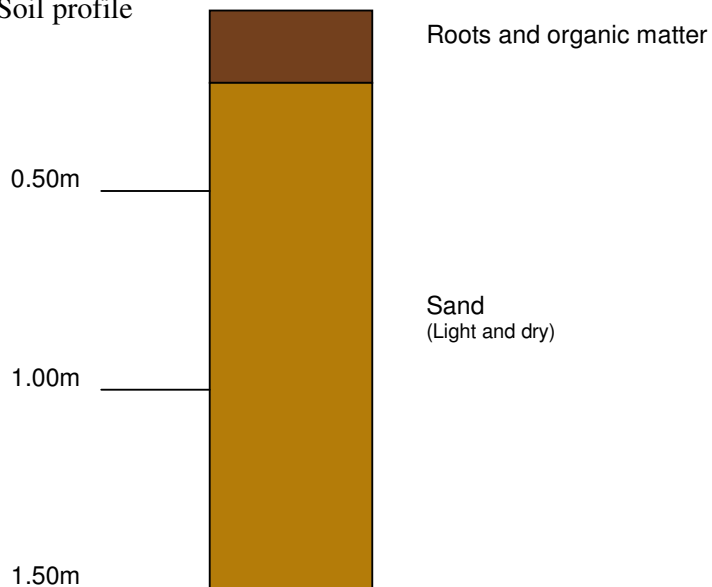
Soil profile



The water table had not been found by 1.48m below ground level and there was only evidence of very low moisture content in the sand. Due to time constraints it was not practical to keep digging, as the water table did not appear to be close. The changes in soil appearance were noted and recorded as shown above.

**5.2.3 Location 3: PLHAP Quadrant B6 – May 05 2005 1140**

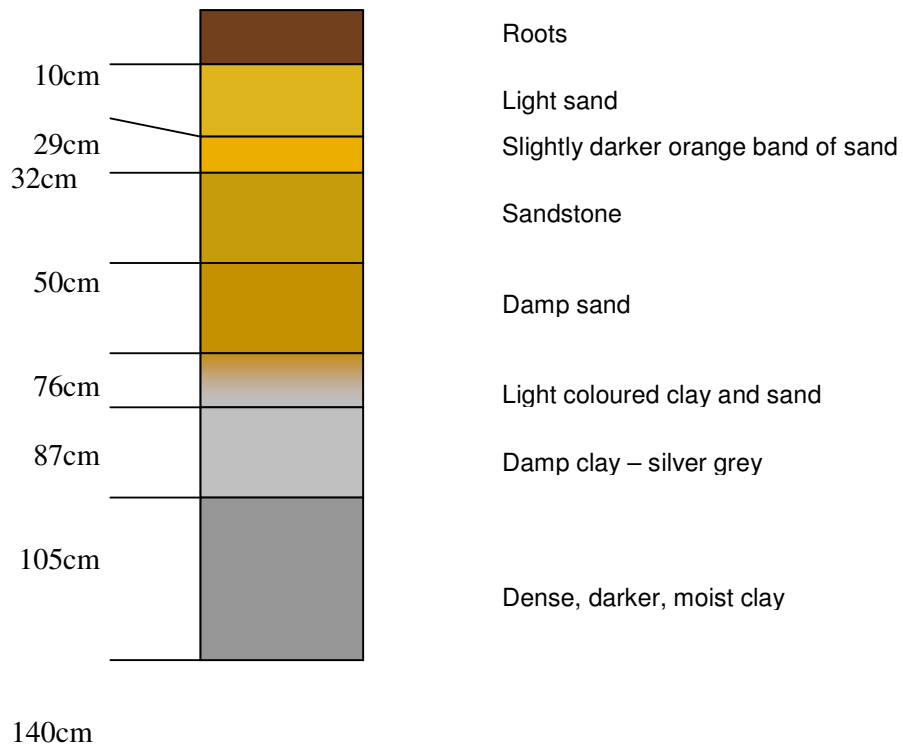
Soil profile



The water table had not been found by 1.50m below ground level and there was no evidence of any moisture content in the sand. Due to time constraints it was not practical to keep digging, as the water table did not appear to be close. The changes in soil appearance were noted and recorded as shown above.

**5.2.4 Location 4: PLSAD Quadrant A2 – Drainage channel - May 06 2005 0930**

Soil profile

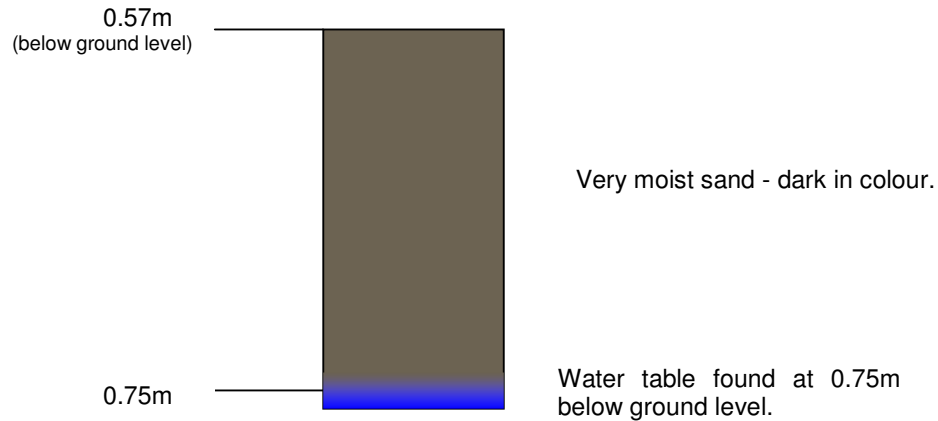


The water table had not been found by 140cm but there was increasing moisture content from 87cm down. Digging ceased at 140cm due to safety issues and the finding of impermeable clay. Therefore, it was no longer beneficial to keep digging. The changes in soil composition are as above.

**5.2.5 Location: PLSAD – Frog Pond – May 09 2005 0945**

As four previous holes had been dug and the water table had not been found, it was decided to reinvestigate the water table in the frog pond. A hole was dug from the bottom of the dry pond.

Soil profile



The water table had been found at a depth of 0.75m so digging was ceased. The moisture level from the start of the digging was high indicating that the water table would not be that far below ground level.

The soil composition was the same all the way through, as shown above.

**5.3 Water Infiltration Rate Study**

In all corners of the quadrates a small space was cleared of any leaf litter and a tube with a diameter of 14cm was placed to a depth of 5cm. As a litre of water was poured into the tubing a stopwatch was started. When all water had infiltrated into the ground the time it had taken was recorded.

Measurements were also taken at the soil profile sites both at ground level and at the bottom of the hole.

**5.3.1 Location: PLHAP - May 06 2005 10:00**

Quadrat number	Time taken for water to disappear (s)	Comments
A1	236	Open cover
A2	237	
A3	190	

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Quadrat number	Time taken for water to disappear (s)	Comments
A4	235	
A5	206	
A6	205	
B1	105	Under trees
B2	204	
B3	311	Top of hole
	364	Bottom of hole
B4	212	
B5	289	Open cover
B6	253	Top of hole
	2449	Bottom of hole.
		Clay-like when ground was wet. Even circular print – 3/4cm outside of tubing.
C1	327	Forest cover
C2	166	Forest cover
C3	200	
C4	266	Under trees
C5	232	Open cover

5.3.2 Quadrat layout to show infiltration patterns from the above data

<b>A1</b> 236s	<b>A2</b> 227s	<b>A3</b> 190s	<b>A4</b> 235s	<b>A5</b> 206s	<b>A6</b> 205s
<b>B1</b> 105s	<b>B2</b> 204s	<b>B3</b> 311s	<b>B4</b> 212s	<b>B5</b> 289s	<b>B6</b> 253s
		364s			2449s
<b>C1</b> 327s	<b>C2</b> 116s	<b>C3</b> 200s	<b>C4</b> 266s	<b>C5</b> 232s	

KEY	
	100-150 s
	151-200 s
	201-250 s
	251-300 s

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	<b>301-350 s</b>
	<b>351-400 s</b>
	<b>&gt; 401 s</b>

From the data above it clearly shows that the infiltration rates at the bottom of the hole were greatly reduced from those at ground level. There could be two reasons to explain this:

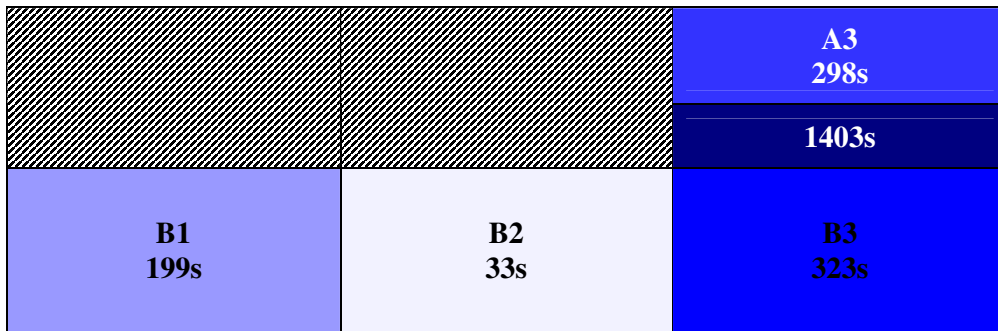
1. The bottom of the hole could have been close to the water table
2. The type of soil or the rock beneath the hole was more impermeable and the composition of the soil was becoming more compact.

From the results above, it would be unreliable to make any overall assumptions because the data spread is quite random. As only one set of results was taken from each quadrat repeats would be necessary for any conclusions to be made.

**5.3.3 Location: PLSAD – May 06 2005 10:00**

<b>Quadrat number</b>	<b>Time taken for water to disappear (s)</b>	<b>Comments</b>
A3	298	Top of hole: Clearing – tree cover
	1403	Bottom of hole: Hard compacted soil
B1	199	Dense tree cover, fern cover lots of humus
B2	33	Fern cover – thick humus layer
B3	323	Small saplings – grass cover

Quadrat layout to show infiltration patterns from the above data



<b>KEY</b>	
	<b>0-50 s</b>

	51-100 s
	101-150 s
	151-200 s
	201-250 s
	251-300 s
	301-350 s
	351-400 s
	> 401 s

5.3.4 Location: PLSAD – May 09 2005 09:30

Quadrat number	Time taken for water to disappear (s)	Comments
A1	157	Open cover – root network
A2	200	Tree cover – roots
A3	476	Open cover – top of hole
B1	163	Thick roots
B2	65	Shrub cover
B3	63	Tree shade, clear ground
C1	128	Shrub cover
C2	187	Tree shade, near irrigation ditch
C3	104	Tree shade, grassland

**Table 1**

Quadrat layout to show infiltration patterns from the above data

<b>A1</b> 157s	<b>A2</b> 200s	<b>A3</b> 476s
<b>B1</b> 163s	<b>B2</b> 65s	<b>B3</b> 63s
<b>C1</b> 128s	<b>C2</b> 187s	<b>C3</b> 104s

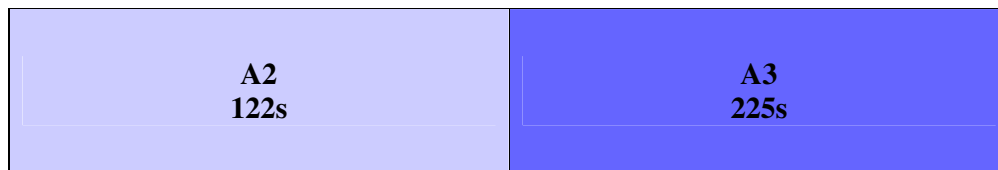
KEY	
	51-100 s
	101-150 s

	151-200 s
	201-250 s
	251-300 s
	301-350 s
	351-400 s
	> 401 s

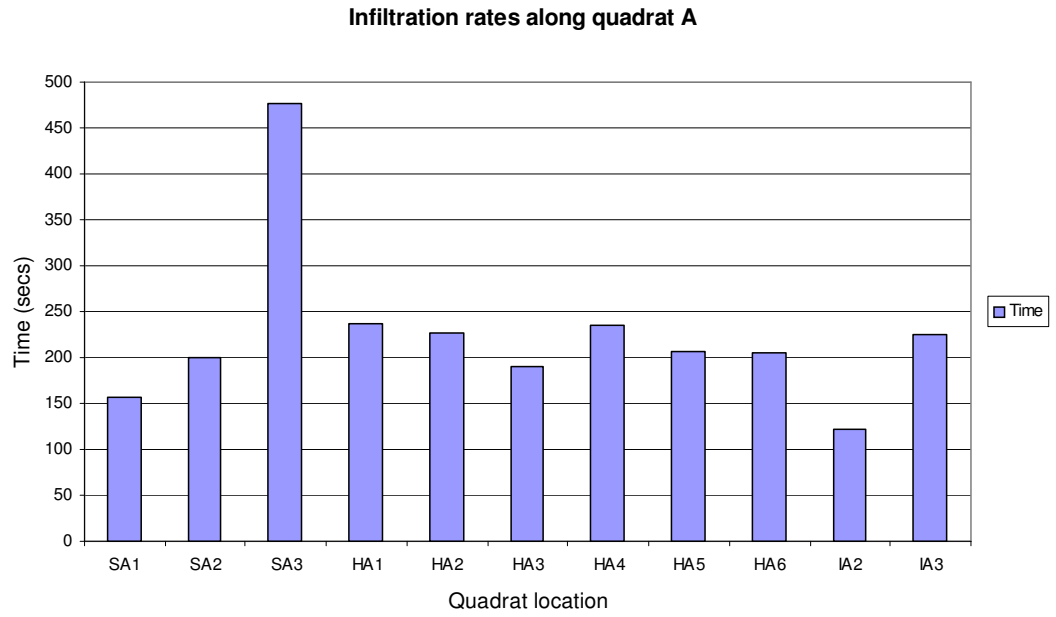
**5.3.5 Location: Indigenous – May 09 2005 09:30**

Quadrat number	Time taken for water to disappear (s)	Comments
A2	122	Dense shrub cover, root network
A3	225	Dense shrub cover, root network

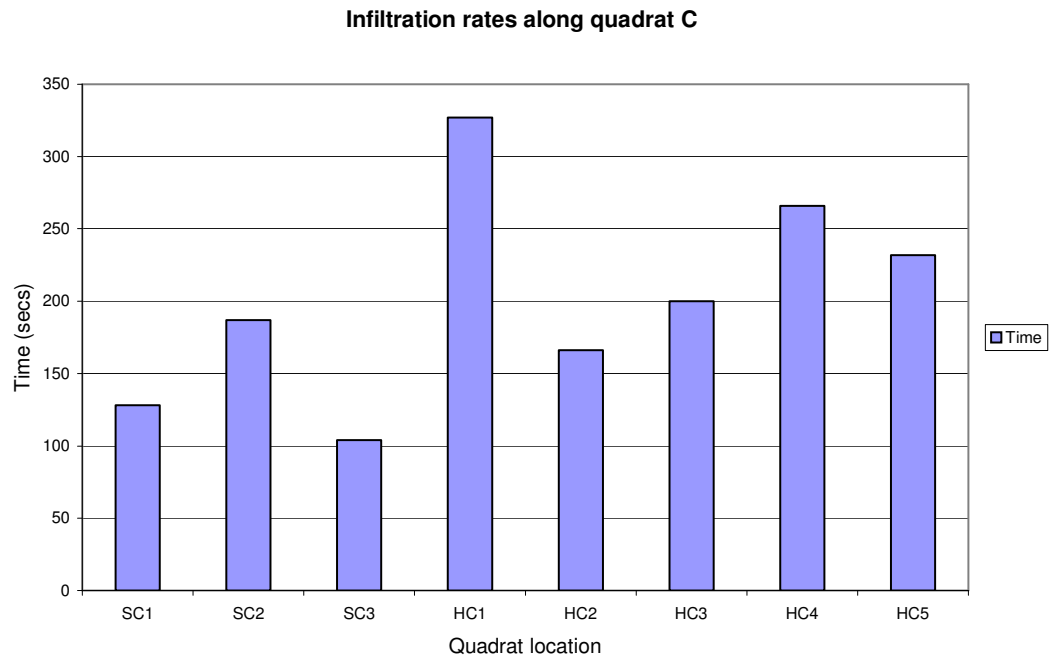
Quadrat layout to show infiltration patterns from the above data



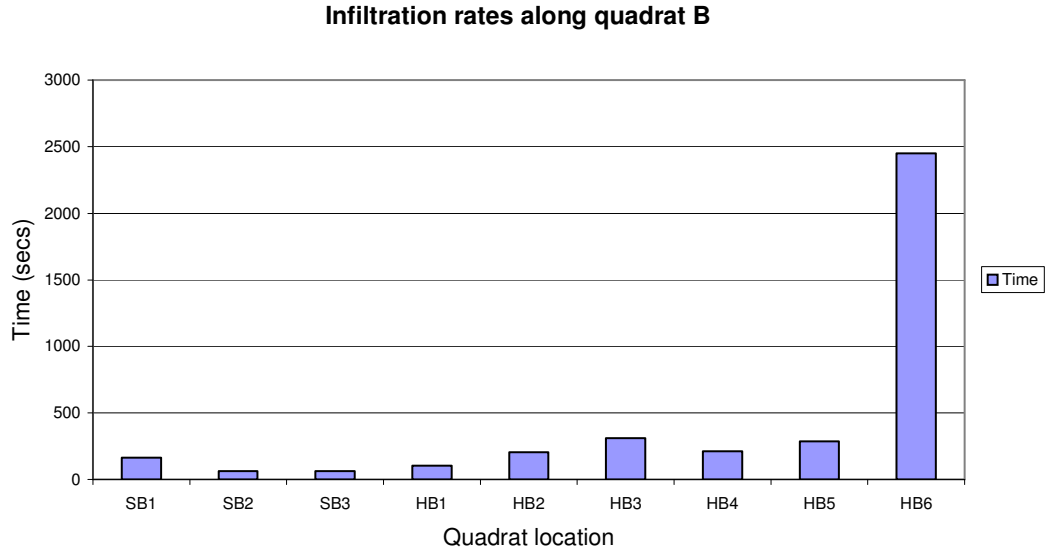
KEY	
	51-100 s
	101-150 s
	151-200 s
	201-250 s
	251-300 s
	301-350 s
	351-400 s
	> 401 s



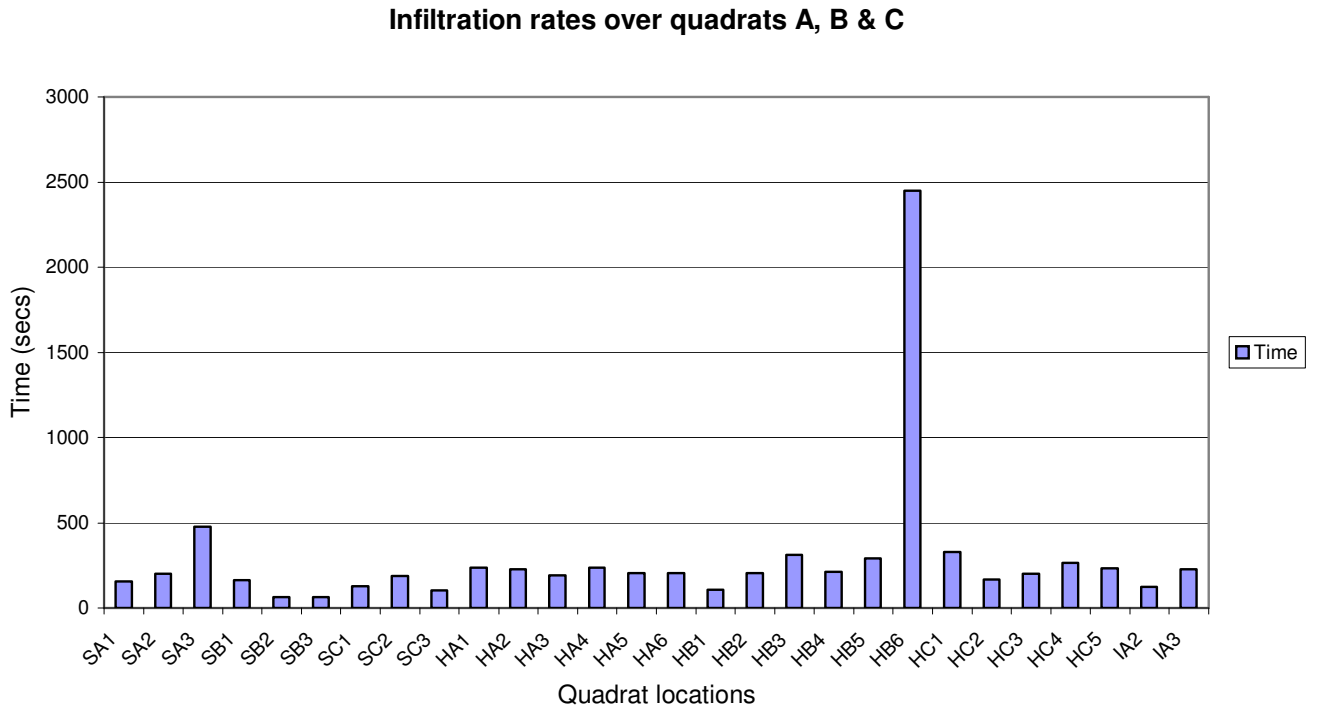
**Figure 1**



**Figure 2**



**Figure 3**



**Figure 4**

#### 5.4 Overview of mining proposal

This information was taken from a draft of a specialist study into soil land use and pre-mining land capabilities of Fairbreeze C Extension compiled by Ticor South Africa Ltd.

Ticor proposes to start mining near Twin Streams in February 2006. The area is 3km south of Mtunzini, east of the N2 and west of the railway line. There are two particular areas of concern: Fairbreeze C and Fairbreeze C extension because they are next to or even include the indigenous and planted sad forests. Ticor propose to use a water-based mining system with high-pressure water jets. These will turn ore into slurry that will flow to the processing plant on the other side of the N2. The plan is to mine approximately 9 million tonnes of mineral bearing sand per annum over 12 years.

#### 5.5 The impact of mining on Twin Streams (as stated by Ticor)

The fauna and flora at Twin Streams will be disturbed if not destroyed by the mining. This is particularly concerning because Strategic Environmental Focus Ltd identified the riverine forest in the Fairbreeze Extension C as of high conservation and ecological importance. For instance, 1 Red Data species was found, *Raphia australis*, as well as 4 protected families and 3 protected species. Also, more than 100 species of herpetofauna were found in the Mtunzini area of which 18 were 'conservation needy'. Of those 18, 8 were found on or near the Fairbreeze Extension C and therefore at a high risk of losing their natural habitat.

The species will also be exposed to other harmful effects. The moving of ground will be damaging, particularly to the smaller, fossorial species. Furthermore, the deterioration of the air quality will be detrimental to the wellbeing of the fauna and flora.

The mine will also impact aquatic ecology. Ticor plans to increase the base flows of the Amanzimnyama and Siyaya rivers and improve water quality. This could reinstate the fish biodiversity and abundance lost following the Eucalyptus and sugarcane cultivation that decreased the river base flow.

However, an increased base flow could have negative effects. An increase in sedimentation would decrease primary production and interfere with fish behaviour and physiology. The disruption of sediment could also be a problem. It could cause pH levels to drop, intoxicating the heavy metals in the system and potentially killing some fish and invertebrates.

Other problems include the temporary loss of agricultural potential, contamination of surface water, visual impact and a safety risk of residue deposit.

### **5.6 Further effects on Twin Streams**

The fact that the clay in the residue deposit is impermeable means flora will be unable to grow. Therefore, the minimal succession will decline and the local biosphere dramatically altered.

The residue deposit in the Amanzimnyama drainage basin could also cause problems because rainwater will be unable to infiltrate the clay. This could lead to an increase of surface run-off and perhaps a flowing river that could potentially cause flooding.

## **6 Recommendation**

It is recommended that:

- The further data be collected regarding the specie diversity on other sites at Twinstreams, and that this data be used to produce an Audit of the Twinstreams estate;
- That further mapping and surveying of the Twinstreams estate be produced. This will be useful for auditing the estate;
- That elevation profiles be mapped of the Twinstreams estate. This will aid in further hydrological investigations.

Future investigations several years down line before/after/during mining activity/

## **7 Acknowledgements**

The members of the BSES KwaZulu Natal 2005 expedition would like the following people and organisations for their support in conducting this research project:

- Lisa and Steve at Twinstreams WESSA for their time, support and use of the excellent facilities at Twinstreams. Without their help the science project would not have been possible;
- The botany enthusiasts who gave up their time to help in the tree specie diversity surveying. Robin Matthews for his informative talk on the ecology and history of research at Twinstreams;
- Cullum from KZN Wildlife for his talk on the coastal reserves of KwaZulu Natal.
- WESSA

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### 9 List of Abbreviations

BSES	British Schools Exploring Society
GPS	Global positioning System
WESSA	Wildlife and Environment Society of South Africa
YE	Young Explorer

### Appendix A – List of tree species

#### Tree species planted by Ian Garland

Albizia adanthifolia
Antidesma venosum
Bequiaertidendron natalensis
Bridelia micracantha
Cryptolaria Myrtifolia
Ficus sur (F. capensis)
Ficus sycamorus
Halleria lucida
Harpephyllum caffrum
Syzygium cordatum
Psychotria capensis
Raphia australis
Voacanga thouarsii
Podocarpus falcatus
Rauvolfia caffra
Protorus longifolia
Syzygium guineeze
Prachena usambarensis
Phoenix reclinata
Tabernaemontanum ventricosa
Peddiea Africana
Trema orientalis

**Tree species found in planted A – sad**

Acacia karroo
Brachylaena
Bridelia
Miteseri
Podocarpus
Quinine tree
Rafia
Red Beach
Swamp Popular
Zyzyguim
Tassel Berry
Wild poplar

**Tree species found in planted B – happy**

Latin name	Common name	Zulu name	Type	Comment
<i>Acacia albida</i>				
<i>Acacia karroo</i>	Sweet Thorn	umuNga		
<i>Acacia Nilotica</i>	Scented Thorn	umNqawe		
<i>Albiza forbesii</i>	Broad pod false thorn	umFomoshane		
<i>Allophylus natalensis</i>	Dune false current	isiHlohlela	<i>Shrub, small tree</i>	
<i>Apodytes dimidiata</i>	White pear	umDakane		
<i>Brachylaena</i>				
<i>Bridelia</i>		umHlalamagwababa		
<i>Canthium inerne</i>	Common turkey berry	umVuthwamini		
<i>Cassine Aethiopica</i>	Kooboo berry	umGunguluzampunzi		
<i>Cassine Transvaalensis</i>	Transvaal Saffron	iNgwavuma		
<i>Catunarugun</i>				
<i>Cleistanthus Schlecherii</i>	Folse Tamboti	uMzithi		
<i>Combretum erythryllum</i>	River Bushwillow	umBondwe		
<i>Combretum kraussi</i>				
<i>Combretum molle</i>	Velvet Bushwillow	umBodwe-omhlophe		

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Latin name	Common name	Zulu name	Type	Comment
<i>Combretum paniculata</i>				
<i>Croton grottissimus</i>	Lavender Fever berry	uHubeshane		
<i>Dialium shlechterii</i>	Zulu podberry	umthiba		
<i>Dovyalis caffra</i>	Keiappel	umqokolo		
<i>Eugenia carpensis</i>	Dune Myrtle	isiltangulula		
<i>Albizia adianthifolia</i>	Flat Crown	igowani		
<i>Lannea (Schweinfurthii)</i>	False Marula	umGanunkomo		
<i>Manilkara discolor</i>	Forest milkberry	unlwebe		
<i>Sclerocarya birrie</i>	Marula	umGanu		
<i>Bridelia micrantha</i>	Mitserie	umShonge		
<i>Mumdulea serrcea</i>	Cork Bush	umHlalandethe		
<i>Newtonia hildebrandtii</i>	Lebombo Wattle	umFomothi		
<i>Olea europaea</i>	Wild Olive	umNqumo		
<i>Ozoroa peniculosa</i>	Common Resin Tree	isiFice		
<i>Peddea africana</i>	Green Flower	inTozane		
<i>Peltophorum africana</i>	Weeping wattle	isiKhabamkhombe		
<i>Plectroniella amarta</i>	False Turkey-berry	umVuthwamini		
<i>Podocarpus</i>				
<i>Protorhus longifolia</i>	Red Beech	uNhlagothi		
<i>Ptaeroxylum obliquum</i>	Sneezewood	umThathi		
<i>Pteleopsis myrtifolia</i>	Stink Bushwillow	uMwandla		
<i>Rauvolfia caffra</i>	Quinine tree	umHlambamanzi		
<i>Rafia</i>				
<i>Mimusops obovata</i>	Red milk wood	umPhumbulu		
<i>Kigelia africana</i>	Sausage tree	umVunguta		
<i>Schotia brachypetala</i>	Tree Fushia	iHluze		
<i>Sterculia rogersii</i>	Common Star-chesnut	INkuphenkuphe		
<i>Strychnos spinosa</i>	Green Monkey Orange	umHlala		

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Latin name	Common name	Zulu name	Type	Comment
Swamp popular				
<i>Syzygium cordatum</i>	Water Berry	umDoni		
<i>Spirostachys africana</i>	Tamboti	umThombothi		
<i>Antidesma venosum</i>	Tassel berry	umHlabahlungulu		
<i>TBD 3</i>				
<i>Tedopoliopsis brematampi</i>				
<i>Terminalia sericea</i>	Silver cluster leaf	ikonono		
<i>Trema orientalis</i>				
<i>Macaranga capensis</i>	Wild Berry	iPhubane		
<i>Xylogheca</i>				
<i>Zanthoxylum carpense</i>	Small Knobwood	umLungumabele		

**Tree species found in Indigenous A – by sad**

Latin name	Common name	Type	Comment
<i>Adenia Gummifer</i>		Vine	
<i>Bridelia Micrantha</i>		Canopy	
<i>Ficus Sur</i>	Cape fig	Medial	
	Swamp fig or Hippo		
<i>Ficus trichopoda</i>	fig	Medial	
<i>Kraussia floribunda</i>		Medial	Most common
<i>Macaranga Capensis</i>		Canopy	canopy
<i>Phoenix Reclinata</i>		Medial	
<i>Rhoysisus rhombidia</i>	Glossy grape vine	Vine	
<i>Sedoxia</i>		Ground cover	
<i>Stylesia</i>		Ground cover	
<i>Syzygium Cordatum</i>	Water berry	Canopy	3rd common
<i>Tebernaemontana ventricosa</i>	Forest toad	Medial	
<i>Voacanga Thourasii</i>	Wild frangipani	Canopy	Comman

**Appendix B – research schedule at TwinStreams**

Date	AM	PM
22 <sup>nd</sup> April	Packing for trails	Science Preparation
23 <sup>rd</sup> April	Talk by Robin Matthews on previous research conducted at Twinstreams. Group 2 depart for wilderness	

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	trail. Group 1 begin science work.	
30 <sup>th</sup> April	Group 2 returned from wilderness trail	
1 <sup>st</sup> May		Group 1 presentation of science work
2 <sup>nd</sup> May	Visit to Eshowe Forest	Beach games
3 <sup>rd</sup> May	Visited by South Africa TV crew	Hand over and preparation of science project. Zulu feast, singing and dancing
4 <sup>th</sup> May	Group 1 depart for wilderness Group 2 begin science work	Science work continued
5 <sup>th</sup> May	Soil profiling in PLHAP and PLSAD	Swimming at Mtunzini Primary School
6 <sup>th</sup> May	Infiltration tests in PLHAP and PLSAD	Umlalazi Nature Reserve
7 <sup>th</sup> May	Species identification in indigenous forest with Bruce. Mapping of quadrates in PLSAD.	
8 <sup>th</sup> May	Ongoye Forest	Beach – extreme wipe-out
9 <sup>th</sup> May	Infiltration tests. Soil profile in frog pond. Mapping of PLHAP.	Continued science work.
10 <sup>th</sup> May	Species identification in indigenous forest with Jube. Mapping of PLHAP.	Swimming at Mtunzini Primary School. Overnight bivvi on beach
11 <sup>th</sup> May	Writing up report and presentation. Removed quadrate markers	Presentation to Lize and Steve from WESSA.