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GEOHYDROLOGICAL ASSESSMENT OF THE AQUACULTURE DEVELOPMENT ZONE, AMATIKULU

NuLeaf PLANNING & ENVIRONMENTAL

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PREPARED BY: P.G. Hansmeyer *Pr.Sci.Nat.*

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Compiled for: NuLeaf PLANNING & ENVIRONMENTAL

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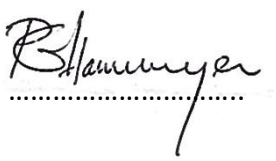

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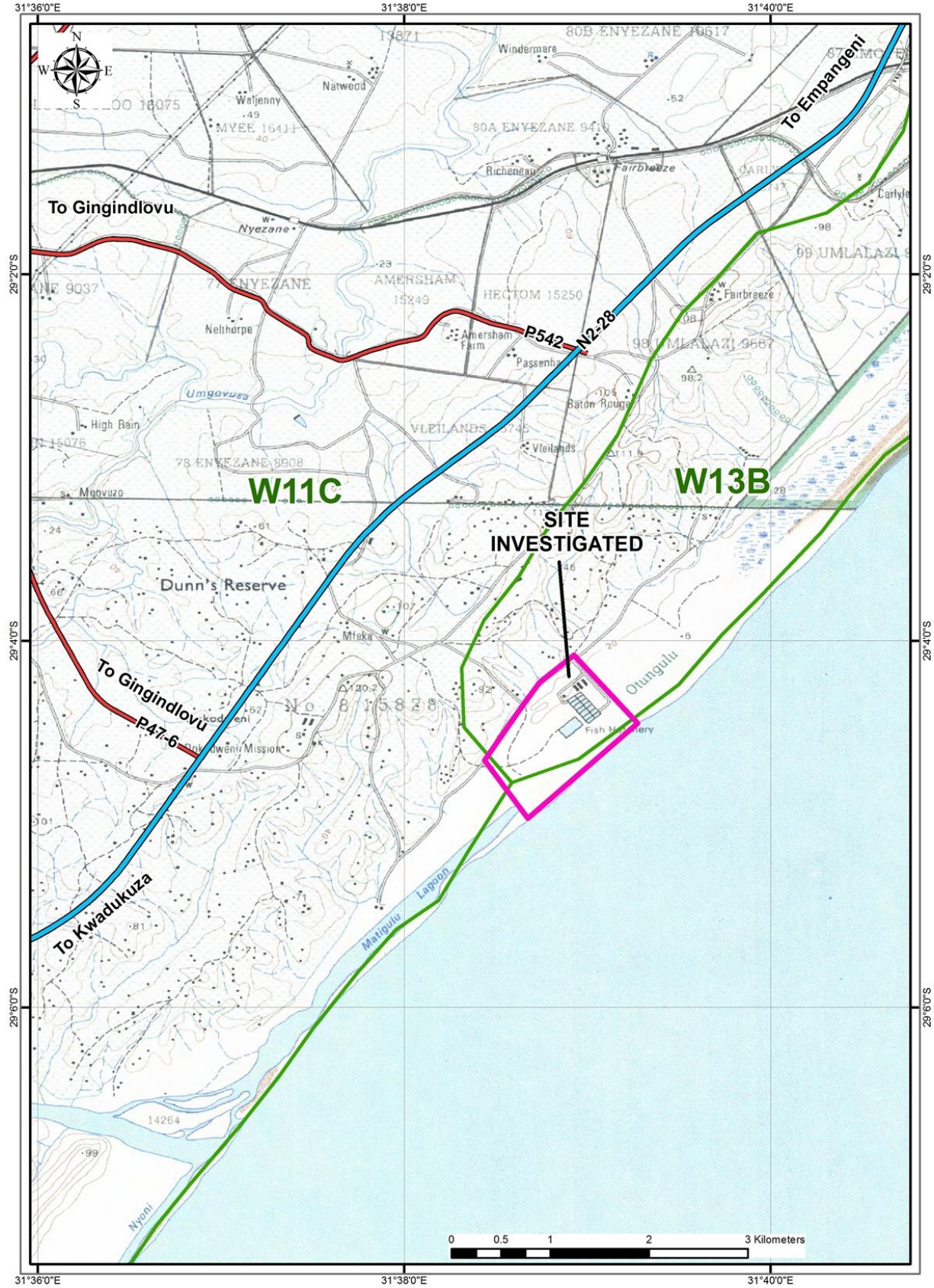


Figure 1. Locality Plan

EXECUTIVE SUMMARY

A geohydrological assessment of the Aquaculture Development Zone, Amatikulu was carried out. The current and historic developments concerning Amatikulu Fish Farm, Amatikulu Pet Food and the prawn hatchery were commented on. A walk- and drive-over survey was conducted on the site and the well points, tunnels, Amatikulu Pet Food factory, the effluent dam and boreholes outside the premises were recorded. The partially demolished pump house at the lagoon edge was also viewed and photographed.

The site is located within the W13B quaternary catchment and on Portion 2 of Lot 15828. The terrain is adjacent to Macambini which is located within the jurisdiction of the Ilembe District Municipality.

Fresh water provision is currently provided by well points and a single functional borehole. The water is pumped to elevated reservoirs with a combined capacity of 35Kl. Recommendations for additional fresh water supply include the investigation of a fresh water lake rather than the refurbishment of the existing boreholes on the outside as the community seems to resent the development, maintenance and use thereof by outsiders.

During high rain fall periods, the sheltered, 400m wide depression which hosted the defunct prawn hatchery becomes inundated. During normal rainfall periods the water table in this area is about 0.5m below surface and during times of drought it recedes to 1.5m below surface.

The site is located on Quaternary age deposits comprising a coastal dune, lagoonal and beach systems of two foredunes separated by a sheltered depression. The beach deposits comprise redistributed equigranular sand which is highly erodible by wind and water, highly permeable as well as compressible.

The terrain is underlain by a combined aquifer yielding fresh water to shallow well points and a single functional borehole. The hydraulic gradient is inferred to be seawards and seems to be fairly even over the coastal dune system with a sudden drop-off at the lagoon/marine interface. The borehole and well points which tap into the combined aquifer are low yielding and additional sources will have to be provided.

Due to high iron concentration in the groundwater, it is not suitable for human consumption unless treated; it also stains plumbing fixtures, incrusts well points as well as piping and a purification plant should be considered.

The pollution control measures at the Amatikulu Pet Food factory are seemingly dysfunctional and the effectiveness of the equipment doubtful, posing a potential pollution threat.

The landward salt water intrusion associated with the now defunct prawn hatchery took about three years to return to normal fresh water conditions after closure of the hatchery.

Future revival of the prawn hatchery and/or the establishment of a cob hatchery within the eight earth embankment dams used by the prawn hatchery should contain the import of salt water effectively, provided they are suitably lined, and prevent a recurrence of the previous salt water intrusion.

GEOHYDROLOGICAL ASSESSMENT OF THE AQUACULTURE DEVELOPMENT ZONE, AMATIKULU

1. INTRODUCTION

Engeolab (Pty) Ltd had been appointed by NULEAF Planning and Development Consultants to conduct a geohydrological assessment of the Aquaculture Development Zone, Amatikulu, located adjacent to Macambini Rural Authority, which falls within the jurisdiction of the Ilembe District Municipality.

The site investigated is indicated on the locality plan in the beginning of the report.

The terms of reference are to: -

i) determine the site soils and geology;
ii) conduct a borehole, spring and well point census;
iii) assess the functionality of the boreholes;
iv) comment on the potability of the groundwater;
v) do a superficial assessment of the saltwater intrusion;
vi) comment on the pollution potential of the current commercial enterprises on the site.

2. SOURCES OF INFORMATION

The following sources of information were consulted:

i) Geological map sheet 2930 Durban to a scale of 1:25000;
ii) National Groundwater Data Base (NGDB);
iii) Hydrogeological Map series of RSA, First Edition, 1998 to a scale of !:500,000;
iv) Google maps of Amatikulu;
v) Topocadastral map, Sheet 2931 BA to a scale of 1:50,000.

3. HISTORIC AND CURRENT DEVELOPMENTS

Amatikulu Fish Farm was established on Portion 2 of Lot 15828 in the 1980's and supplied ornamental aquarium fish through various outlets to the public. Aquarium plants were also produced and sold to the same market. Some 50 tunnels (a shade cloth covered fresh water pond) were constructed along the toe of the landward longshore foredune and used as breeding bays for the fresh water fish – refer to Plate 1 on the following page.

PLATE 1: TYPICAL TUNNEL

During the establishment of the Amatikulu Pet Food section, several sheds, an effluent dam, a boiler and workshops were added to the infrastructure. At about the same time, a prawn hatchery was established in the sheltered and flat, linear depression – a 'dune slack' - between the two longshore foredunes – refer to the Site Plan, Figure 2 on the following page. The prawn hatchery comprised 2 x 1 ha dams and 8 x 0.5 ha dams. Seawater was pumped from the Amatikulu Lagoon to the dams and the return water flowed back to the lagoon via a concrete canal – refer to Plate 2 below. Approximately 450m³ / day of saltwater was pumped through the system to sustain a single prawn harvest per year. Due to competitive markets in warmer climates where two harvests per year are possible and the fact that prawns could be imported cheaper than produced locally, the prawn enterprise was abandoned in 2003. However, cob fingerlings that were accidentally pumped into the prawn dams were discovered to have grown rapidly in the sheltered environment and although cob farming was considered to be a worthwhile venture, it was never pursued.

PLATE 2: PUMPHOUSE ON AMATIKULU LAGOON

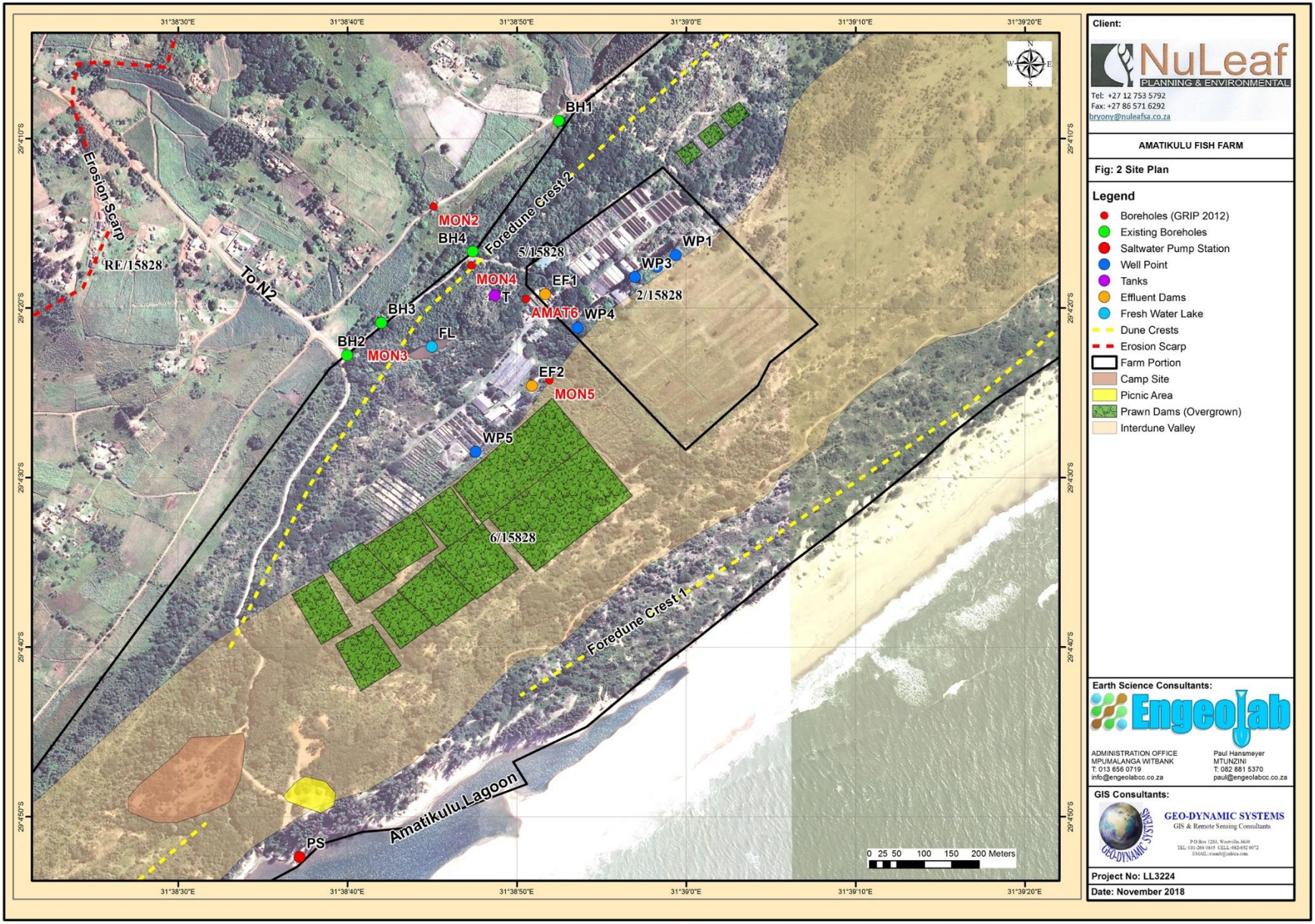


Figure 2. Site Plan

Fresh water supply to the 50 tunnels was managed through a number of well points installed in the 'dune slack' with its shallow water table located close to surface (<0.5m) along the toe of the landward longshore foredune, just below the office complex – refer to Plate 3 below. During the drought of 1997, the then JSB (Joint Services Board) funded the drilling of four boreholes (BH 1 – BH 4) along the access road to Amatikulu Fish Farm to supplement the fresh water supply – refer to the Site Plan, Figure 2 and the appended borehole profile (Appendix A). The boreholes were vandalized, and the pumps were stolen regularly, leading to several confrontations with the community.

PLATE 3: WELL POINT SYSTEM WITH POOL PUMP

Seven elevated 5,000 litre JoJo tanks were erected on tank stands near the security gate at the entrance to the farm and fresh groundwater from the boreholes could be used to supplement the dwindling water supplies extracted from the well points. Currently, a single (JSB) borehole and three of the four well points are functional.

At the time of the field visit, the prawn dams were overgrown, the pump house on the lagoon was demolished by wave action in 2015 and the fish farm is currently running at about 30% of the capacity with most of the tunnels and fish dams in a state of disrepair – see Plate 4 below.

PLATE 4: FISH POND WITH SHADE CLOTH REMOVED

The Amatikulu Pet Food enterprise had established local and export markets and is still functioning, albeit at a much lower output than previously.

4. RAINFALL, FLOODING & WATER TABLE

The site is located within the southern portion of the W13B quaternary catchment with a mean annual precipitation of about 1,255mm. According to local sources, the 400m wide dune slack area tends to be inundated during high rainfall periods. Apparently, the water recedes slowly within this sheltered depression and a water table at or close to surface level is maintained for a prolonged period thereafter. During normal rainfall periods, the water table is usually 0.5m below surface and during very dry periods it drops down to 1.5m below surface.

5. METHODS OF INVESTIGATION

The site was viewed on Friday 16 November 2018 and a walk- and drive-over survey was conducted. Besides examining the site and the Amatikulu lagoon, the boreholes drilled in vicinity were also recorded – refer to Plate 5 below. A summary of sites that were recorded is attached as TABLE A and the various sites recorded are indicated on the Site Plan, Figure 2.

PLATE 5: BOREHOLE NEAR CATTLE DIP WITH ESKOM POWER SUPPLY

TABLE A: SUMMARY OF RECORDED SITES

Borehole No	Coordinates		Status
	South	East	
BH1	S29 04' 09"	E31 38' 52.5"	Eskom power supply near cattle dip; borehole status unknown
BH2	S29 04' 22.8"	E31 38' 40"	Demolished and covered by new road
BH3	S29 04' 20.9"	E31 38' 42"	Production borehole pump intact at 7m; Low yield ~1000l/hr; Pumping continuously to reservoirs.
BH4	S29 04' 16.7"	E31 38' 47.4"	Borehole with dysfunctional pump
T	S29 04' 19.3"	E31 38' 48.7"	7 x 5000l JoJo tanks
WP1	S29 04' 16.9"	E31 38' 59.4"	Well point with pool pump for fish farm
WP2	S29 04' 17.6"	E31 38' 58.3"	Well point with pool pump for fish farm
WP3	S29 04' 18.2"	E31 38' 57"	Well point with pool pump for fish farm
WP4	S29 04' 21.2"	E31 38' 53.6"	Well point with pool pump for fish farm
WP5	S29 04' 28.5"	E31 38' 47.6"	Well point with submersible pump
EF1	S29 04' 19.2"	E31 38' 51.7"	Secondary effluent Dam
EF2	S29 04' 24.6"	E31 38' 50.9"	Primary effluent dam
PS	S29 04' 52.4"	E31 38' 37.2"	Saltwater pump station
FL	S29 04' 22.3"	E31 38' 45"	Fresh water lake

- Unfortunately, the coordinates of the appended borehole are incorrect and although being drilled more than 20 years ago, the profile was recognised but it's position could not be confirmed correctly on site;
- The 'MON' boreholes indicated on the Site Plan, Figure 2 were obtained from the NGDB and were not verified.

6. SITE SOILS AND GEOLOGY

6.1 Regional Setting

According to the geological map, the area under investigation is blanketed by Quaternary age redistributed sand, forming the southern-most portion of the Zululand Coastal Section.

6.2 Site Geology

The Amatikulu Fish Farm is located on Quaternary beach deposits comprising a coastal dune system with a 15m high coastal foredune, a dune slack (a sheltered, wind eroded depression, some 6m above sea level which is at the same level of the lagoon) and a 25m high landward foredune (see Figure 2). The coastal dune system abuts against the 100m high, inland longshore dune of sand-clay-silt mixtures associated of the Quaternary age Berea Formation.

The beach deposits comprise equigranular, fine to medium grained light ivory to light grey sand, redistributed by wind and/or water. These non-plastic beach deposits are up to 25m thick and are sequentially underlain by 1m thick shell-rich sand followed by a layer of up to 1m thick of smooth sub-rounded sand and pebbles – refer to the appended borehole profile. Typical engineering characteristics of the beach sand include high permeability, high erodibility by wind and water. At near surface, these materials are highly compressible and may also exhibit a collapse fabric.

The Quaternary sand was deposited on shale bedrock of the Pietermaritzburg Formation (intruded by dolerite dykes and sills) – refer to the appended borehole profile. Based on the borehole profile information, bedrock is about 6m below the dune slack and the lagoon (which are on the same elevation) and about 4m below sea level.

7. GEOHYDROLOGICAL SETTING

The site is underlain by a combined aquifer comprising a primary aquifer associated with the top beach sands and the deeper secondary aquifer associated with the underlying shale bedrock.

Primary aquifers comprise porous or unconsolidated sediments where groundwater is contained in the voids between the silt/clay/sand. Due to the predominantly fine grained texture of these sands the permeability is low and screened boreholes or well points have low yields (<500l/hr). The well point systems located close to the landward boundary of the dune slack were installed to 5m below surface, producing about 500l/hr/unit with a combined yield of about 1500l/hr (for three functional units) and about 1.5Kl/day.

The underlying shale bedrock is associated with secondary aquifers where the dolerite/shale bedrock contact zones yield about 3000l/hr to the borehole. Secondary aquifers are associated with the groundwater moving through secondary openings and interstices which developed after the rocks were formed. The secondary openings formed as a result of weathering, fracturing and faulting.

8. HYDRAULIC GRADIENT AND GROUNDWATER FLOW DIRECTION

If it can be assumed that the groundwater flow emulates the surface topography – the hydraulic gradient of the primary aquifer is inferred to be generally seaward and evenly distributed in the coastal dune section with a sudden drop-off at the lagoon/marine interface from the lagoon towards the sea.

9. WATER QUALITY

Amatikulu Fish Farm's boreholes and well points that tap into the combined aquifer encounter water with high iron content which stains plumbing fixtures, incrusts well points as well as screens and pipes. The source of the iron is associated with the primary aquifer draining out of the landward Berea Formation as well as iron leaching out of the pyrite-rich carbonaceous shale associated with the secondary aquifer.

The most water problems that result from high iron content are associated with sudden change from ferrous (dissolved) to ferric (semi-solid iron). Iron-bearing water favours growth of iron bacteria with a marked clogging effect by the gel-like slime produced by the reaction. Where aeration occurs in the system, the gel-growths are a continuous hindrance and the well point systems on site have to be shut off and treated every six months, either by means of dissolving chemicals or by scrubbing.

As a pollution control measure, the effluent from the Amatikulu Pet Food section is pumped into an effluent dam (EF2) near the factory where it is aerated and filtered and then pumped to a settling pond (EF1) from where it seeps into the ground – refer to Plate 6 below and EF1 and EF2 on the Site Plan, Figure 2. During the walk-over survey and an inspection of the dam and surroundings, the pollution control measures were seemingly dysfunctional as the effluent dam was filled to capacity and a pungent odor pervaded the surroundings.

PLATE 6: EFFLUENT DAM

The prawn hatchery required about 450m³ of sea water per day with the overflow return draining back to the Amatikulu lagoon, resulted in a landward salt water intrusion. The salt water plume encroached westwards to such an extent that the well points started yielding salt water. Following the closure of the prawn hatchery in 2003, the salt water plume receded slowly and according to local sources it took about three years before the well points yielded fresh water again.

10. CONCLUSIONS AND RECOMMENDATIONS

The boreholes drilled alongside the Amatikulu Fish Farm's southern boundary caused dissent among the local inhabitants leading to several acts of vandalizm. Currently, fresh water is supplied to the community by Amatikulu Fish Farm and there seems to be a margin of acceptance as the vandalizing of boreholes has not been repeated. In our opinion, the drilling of groundwater boreholes outside the premises is rather risky and alternative sources should rather be sought within.

The perennial fresh water lake (FL) indicated on the Site Plan, Figure 2 is located about 200m to the west of the tank stand and has never been exploited as a source of fresh water and should be investigated as a potential supply.

The pollution threat associated with the Amatikulu Pet Food enterprise has never been established and groundwater abstraction should not be considered within a 200m radius until a thorough investigation has been carried out.

Well point and borehole design should take cognizance of the high iron content of the groundwater and aeration at point of extraction should be minimized and a water purification facility should be considered.

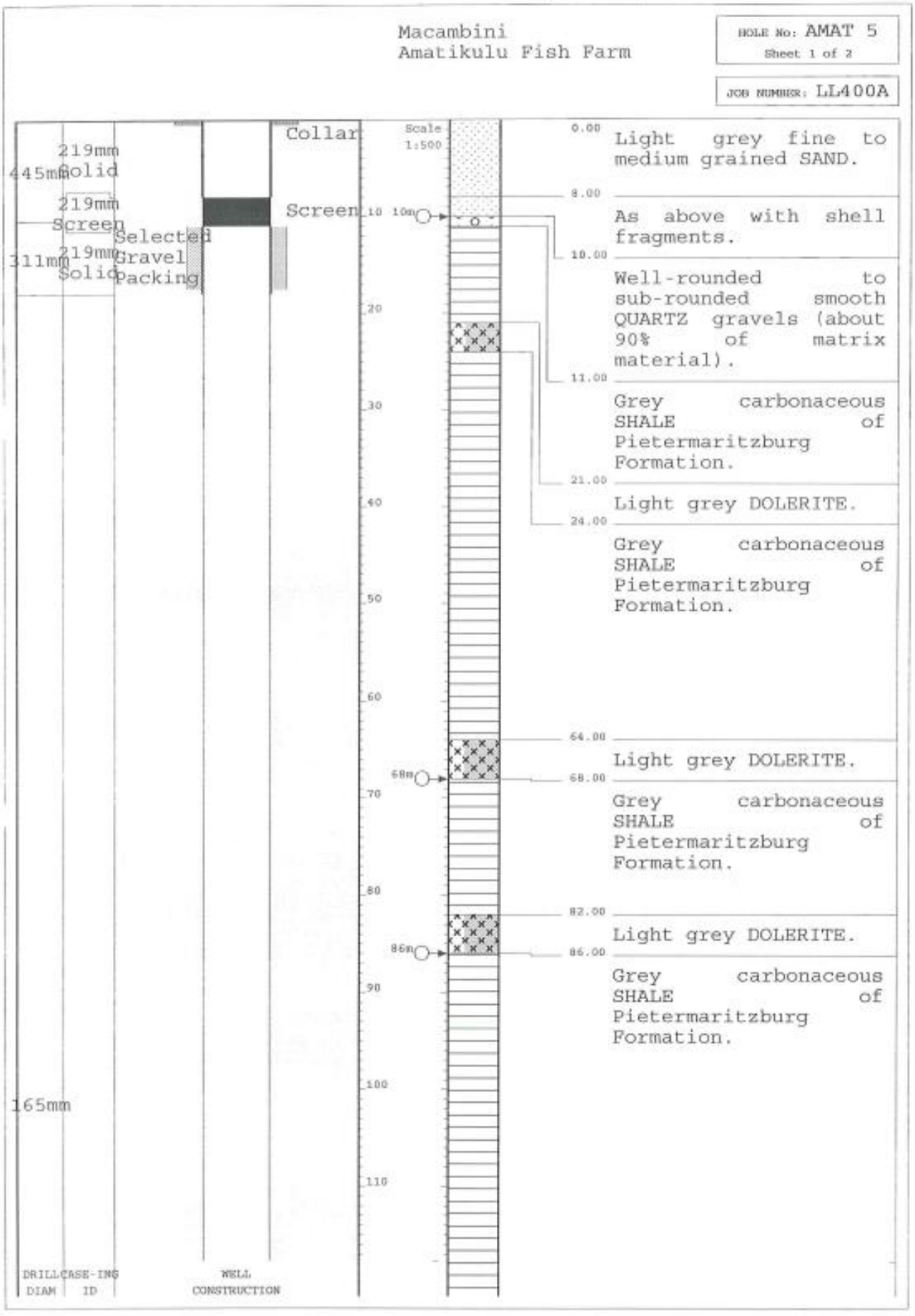
Revival of the prawn hatchery will require the dams to be grubbed and cleared, the pipeline re-established and the pumphouse rebuilt and electrical cabling refitted. Unless future and rehabilitated dams are lined with impermeable membranes, salt water intrusion will be repeated and fresh water regime affected.

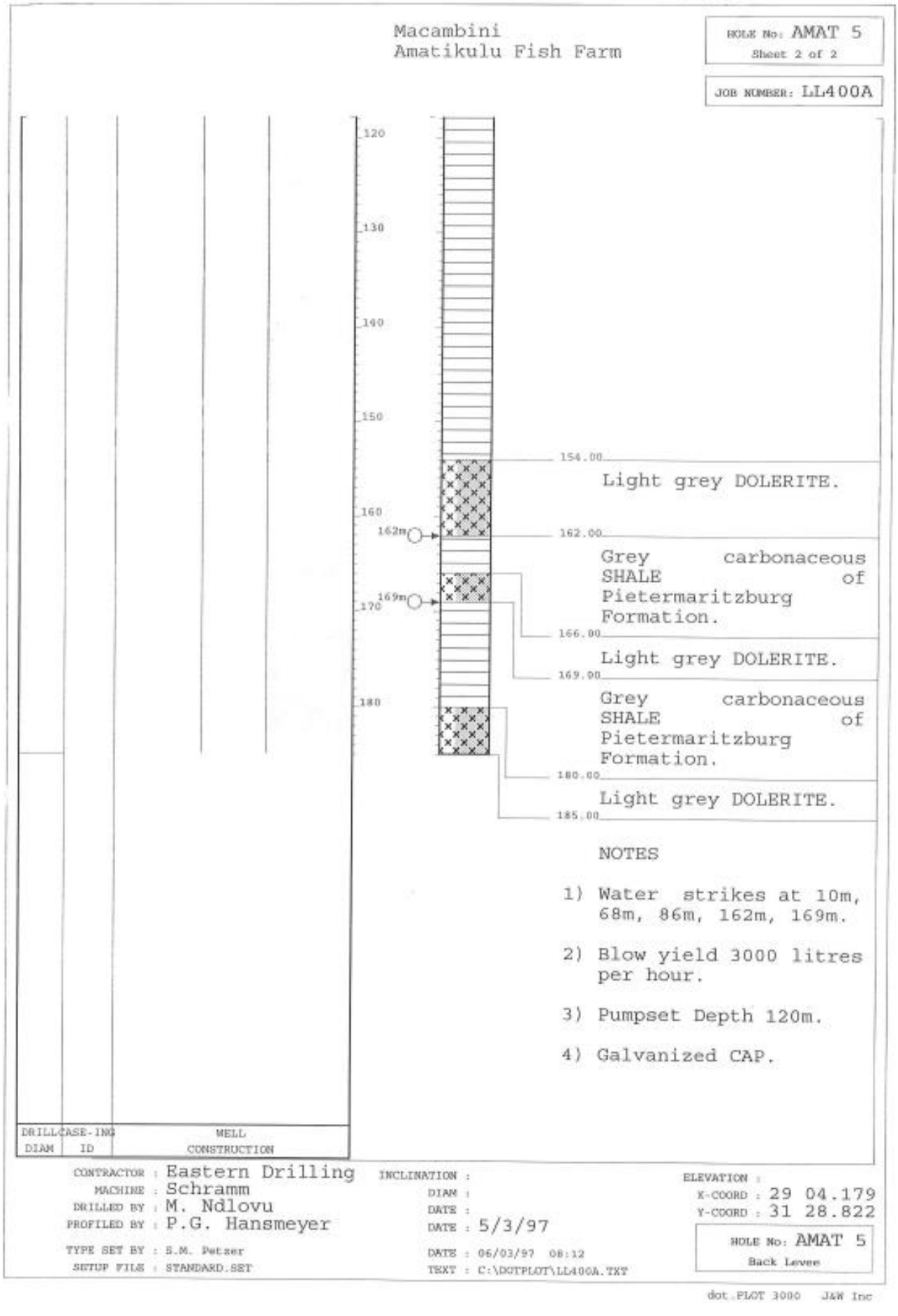
Cognizance must be taken of the inundation potential of the dune slack - that is the 400m wide sheltered depression between the two frontal longshore dunes and should be incorporated in the design of a future hatchery.

11. BIBLIOGRAPHY

- Department of Water Affairs and Forestry: Characterization and Mapping of the Groundwater Resources KwaZulu-Natal Province, Mapping Unit 6, January 1995

12. APPENDIX A – BOREHOLE PROFILE


Macambini
Amatikulu Fish Farm
HOLE No: AMAT 5
Sheet 1 of 2
JOB NUMBER: LL400A
Collar
Screen
219mm Solid
445mm
219mm Screen
219mm Solid
311mm
Selected Gravel Packing
165mm
Scale 1:500
10m
68m
86m
0.00
Light grey fine to medium grained SAND.
8.00
As above with shell fragments.
10.00
Well-rounded to sub-rounded smooth QUARTZ gravels (about 90% of matrix material).
11.00
Grey carbonaceous SHALE of Pietermaritzburg Formation.
21.00
Light grey DOLERITE.
24.00
Grey carbonaceous SHALE of Pietermaritzburg Formation.
64.00
Light grey DOLERITE.
68.00
Grey carbonaceous SHALE of Pietermaritzburg Formation.
82.00
Light grey DOLERITE.
86.00
Grey carbonaceous SHALE of Pietermaritzburg Formation.
DRILL DIAM
CASE-ING ID
WELL CONSTRUCTION


Macambini
Amatikulu Fish Farm
HOLE No: AMAT 5
Sheet 2 of 2
JOB NUMBER: LL400A
120
130
140
150
160
162m
170
169m
180
154.00
Light grey DOLERITE.
162.00
Grey carbonaceous SHALE of Pietermaritzburg Formation.
166.00
Light grey DOLERITE.
169.00
Grey carbonaceous SHALE of Pietermaritzburg Formation.
180.00
Light grey DOLERITE.
185.00
NOTES
1) Water strikes at 10m, 68m, 86m, 162m, 169m.
2) Blow yield 3000 litres per hour.
3) Pumpset Depth 120m.
4) Galvanized CAP.
DRILL DIAM
CASE-ING ID
WELL CONSTRUCTION
CONTRACTOR : Eastern Drilling
MACHINE : Schramm
DRILLED BY : M. Ndlovu
PROFILED BY : P.G. Hansmeyer
TYPE SET BY : S.M. Petzer
SETUP FILE : STANDARD.SET
INCLINATION :
DIAM :
DATE :
DATE : 5/3/97
DATE : 06/03/97 08:12
TEXT : C:\DOTPLOT\LL400A.TXT
ELEVATION :
X-COORD : 29 04.179
Y-COORD : 31 28.822
HOLE No: AMAT 5
Back Levee
dot.PLOT 3000 J&W Inc